Service Manual Engines M 110



Mercedes-Benz of North America Inc.

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.

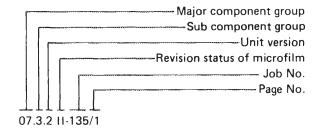
For example, engine 110 applies to all 2.8 liter 6 cylinder engines with dual overhead camshafts.

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:

07.3-135 Checking Injection valves Job Title appears on same line as Group No.



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.

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

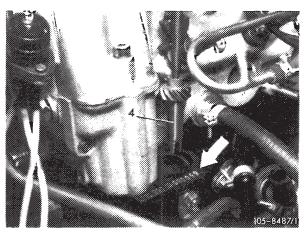
Identification of Vehicle

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.



- Certification Tag (left door pillar) Identification Tag (left window post)
- Chassis No.
- Engine No.
- Body No. and Paintwork No.
- Information Tag California Version Vacuum line routing for emission control system
- Emission Control Tag Emission Control Tag
- Catalyst Information



Engine No. stamped on left front of cylinder block

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280	280 C	280 <i>\$</i>	
114.060	114.073	116.020	
110.921/92	22		
1976	1975	1974	1973
Four stroke	, gasoline eng	ine with carbo	uretor
6			
upright in li	ine	_	
86/78 (3.39	9/3.10)		
2746 (167.6)			
9:1	8:1	9:1	8 : 1
1-5-3-6-2-4			
6500			
160/5500	145/5500	160/5500	130/5000
165/4000	154/4000	165/4000	150/3500
7			
overhead			
DOHC			
None			
Water circulation pump, thermostat with by-pass line finned tube radiator, fan with viscous coupling			
Forced oil circulation via gear-type oil pump			
Full-flow filter			
Air filter with paper cartridge			
	114.060 110.921/92 1976 Four stroke 6 upright in li 86/78 (3.39 2746 (167.0 9 : 1 1.5-3-6-2-4 6500 160/5500 165/4000 7 overhead DOHC None Water circu finned tube Forced oil of Full-flow fi	114.060 114.073 110.921/922 1976 1975 Four stroke, gasoline eng 6 upright in line 86/78 (3.39/3.10) 2746 (167.6) 9:1 8:1 1.5-3-6-2-4 6500 160/5500 145/5500 165/4000 154/4000 7 overhead DOHC None Water circulation pump, finned tube radiator, fan Forced oil circulation via Full-flow filter	114.060 114.073 116.020 110.921/922 1976 1975 1974 Four stroke, gasoline engine with carbone of the carbo

Filling Capacities

Model			280	280 C	280 S	
Chassis T	ype		114.060	114.073	116.020	
Engine Ty	ype		110.921/92	?2		
Year		1976	1975	1974	1973	
	Initial filling	Engine oil approx. Itr. (US qt)	7 (7.4)			
	Oil and filter change	Engine oil approx. Itr. (US qt)	6.5 (6.9)			
Engine	Oil pan up to max. marking on oil dipstick	Engine oil max. Itr. (US qt)	6 (6.3)			
	Oil filter	Engine oil approx. Itr. (US qt)	0.6 (0.62)			
Cooling s with heat	-	Coolant approx. Itr. (US qt)	11 (11.6)	10.5 (11)*		11 (11.6)
Water pu	mp		maintenance free			
Brake sys	tem	Brake fluid approx. Itr. (US qt)	0.5 (0.53)			
Autom. Trans- mission	Initial filling/ fluid change	Autom. transmission fluid (ATF) approx. Itr. (US qt)	6.6/5.3 (7.0/5.6)			
Autom transmission Power steering fluid (ATF) approx. Itr. (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		110.984/98	5		
Year		1980/1981	1979	1978	1977
Operation		, gasoline eng n with airflo	jine, mechanio w sensor	cal (CIS)	
Number of cylinders		6			
Arrangement of cylinders		upright in li	ne		
Bore/stroke	mm (ins.)	86/78 (3.39	/3.10)		
Total eff. piston displacement	cm³ (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 c	irculation via	gear-type oil	pump
Oil filter		Full-flow filter			
Air filter	ACCEPTANCE OF THE PROPERTY OF	Air filter wi	th paper cart	ridge	
¹) Federal		·			

¹) Federal ²) California

Filling Capacities

Model			280 E	280 CE	280 SE	
Chassis T	ype		123.033	123.053	116.024	
Engine Ty	ype		110.984/98	5		
Year		1980/1981	1979	1978	1977	
	Initial filling	Engine oil approx. Itr. (US qt)	6.5 (6.9)	7 (7.4)		
	Oil and filter change	Engine oil approx. Itr. (US qt)	6 (6.3)	6.5 (6.9)		
Engine	Oil pan up to max. marking on oil dipstick	Engine oil max. Itr. (US qt)	5.4 (5.7)	6 (6.3)		
	Oil filter	Engine oil approx. Itr. (US qt)	0.6 (0.62)			
Cooling so	•	Coolant approx. Itr. (US qt)	10 (10.6)*			
Water pur	mp		maintenance free			
Brake sys	tem	Brake fluid approx. Itr. (US qt)	0.5 (0.53)	0.5 (0.53)		
Autom. Trans- mission	Initial filling/ fluid change	Autom. transmission fluid (ATF) approx. Itr. (US qt)	6.6/5.3 (7.0/5.6)			
Autom transmission Power steering fluid (ATF) approx. Itr. (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
110.9211)	114.060	280	118/5500
110.9211)	114.073	280 C	118/5500
110.9221)	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
110.001 NV	117.072	200 GL	123/0000
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

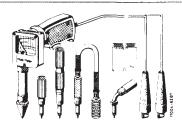
¹⁾ for USA
2) Sweden only
NV = low compression (SA 012.276)
SA = special equipment

Test values in bar for engine at operating temperature

Engine		Compression ratio $\epsilon:1$	Compression normal	Min. Compression	Max. difference between separate cylinders
Normal cor	mpression	9,0	10-12	approx. 8,5	
Low compi	ression				max. 1,5
S J AUS	starting 1976 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 $80^{\mbox{\scriptsize o}}$ C.

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

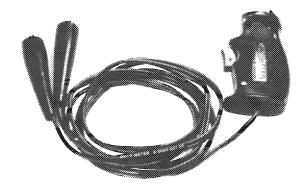
Unscrew all spark plugs for testing.

Checking

Models 107, 114 and 116

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

Disconnect cable on ignition coil terminal 1.

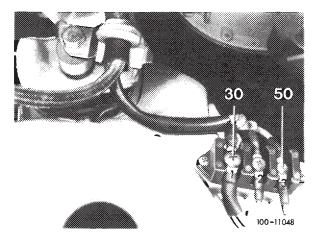


105-9061

Model 123

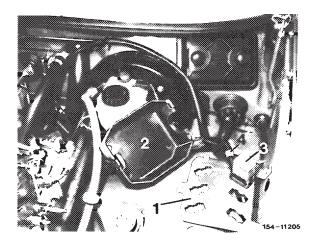
Connect contact handle to terminal 30 and to terminal 50 on cable connector.

Disconnect cable on ignition coil terminal 1.



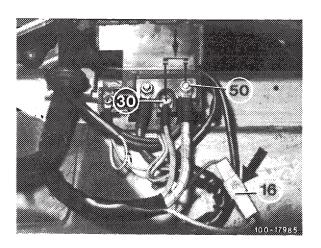
Attention!

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

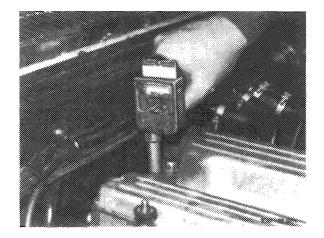


Model 126

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.



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

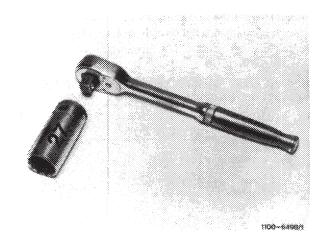
Checking

- 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.

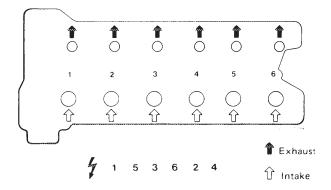
For this purpose, turn engine on crankshaft by means of tool combination.

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.



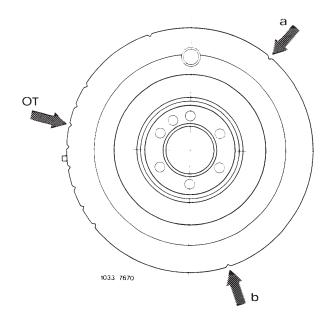
Note: The respective pistons are in TDC position when the markings on vibration damper as shown in adjacent drawing are below TDC indicator.

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.



Conventional tool

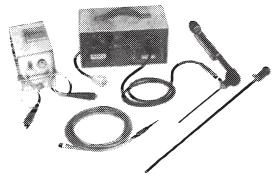
Cylinder illuminating lamp

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	11004-7663	115 589 15 21 00
Oil dipstick with millimeter scale for engines without oil suction	11004-8082	110 589 11 21 00
Telethermometer	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	116 589 27 21 00
Valve for interrupting oil return flow from oil cooler	La continue de la con	110 589 00 91 00

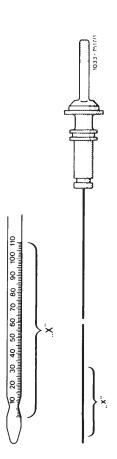
Note

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 e of data sheet.	xplained on front page

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



 $^{\rm 1}$) During constant outside temperatures above + $30^{\rm O}\text{C}$ (+ $86^{\rm O}$ 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	7
brown (USA 1975/76 only)	
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

Double connection for radiator cap test in combination with tester

Radiator cap with hose for leak test

O01 589 48 21 00

000 589 73 63 00

605 589 00 25 00

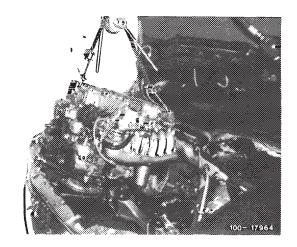
Conventional tool

Engine hoist e.g. made by Bäcker, D-5630 Remscheid (Motordirigent) size 1.5 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.

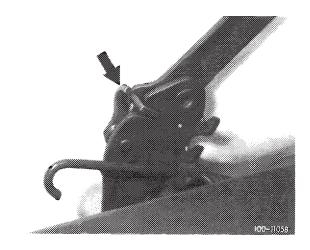


Removal

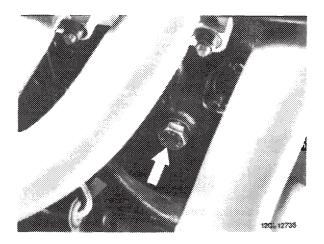
1 On model 123 and 126 move engine hood into 90° position and let left-hand locking lever (arrow) engage.

On other models, remove engine hood.

2 Disconnect battery cable.



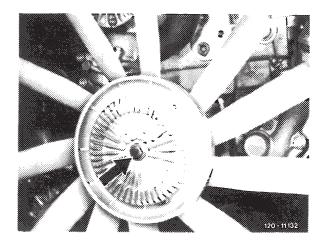
- 3 Drain coolant (arrow).
- 4 Disconnect and close lines for air oil cooler and transmission oil cooler on radiator and close, so that no oil will run out.



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

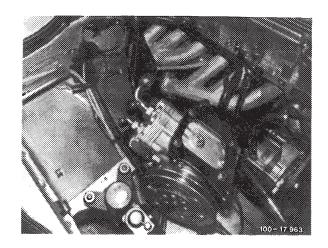
6 Remove fan.

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

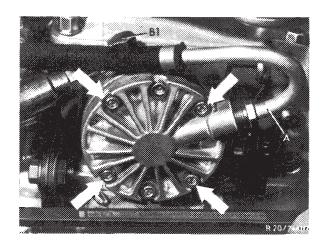


7 On vehicles with air conditioning, unscrew refrigerant compressor and put aside with lines connected.

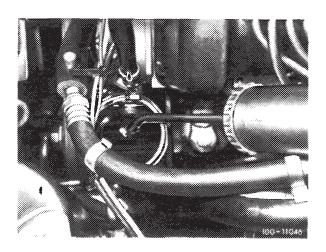
When removing refrigerant compressor, drain air conditioning system (83—516).



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

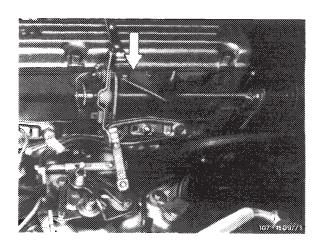


- 9 Draw oil out of power steering pump tank.
- 10 Disconnect hoses at power steering pump.

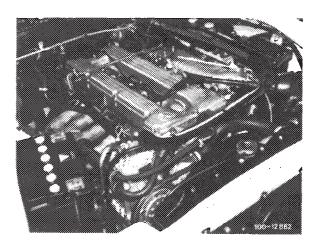


- 11 Disconnect electric harness for starter motor and alternator.
- 12 Disconnect all electric connections on engine.

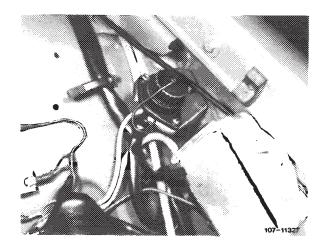
13 Remove longitudinal control shaft.



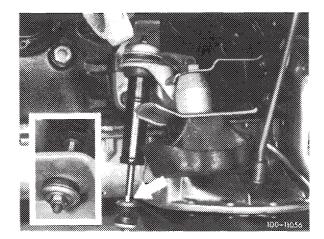
14 Disconnect all coolant, vacuum. oil and electric lines leading to the engine.



- 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).

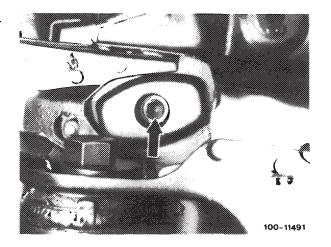


Model 123

18 Remove engine mounting bolts from engine mount.

Model 114 from above.

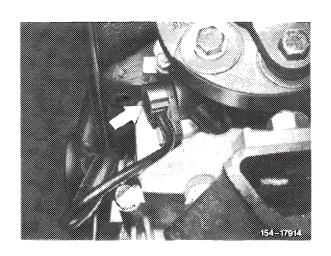
Models 107, 116, 123 and 126 from bottom of vehicle (arrow).



19 Remove rear engine carrier with engine mount.

20 Disconnect tachometer shaft on transmission.

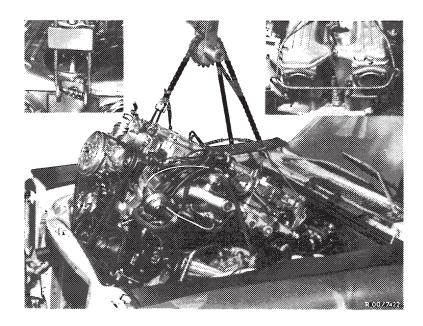
Models with inductance transmitter (arrow): Disconnect inductance transmitter for tachometer. For this purpose, unscrew screw M 6 and pull out inductance transmitter.



21 Disconnect propeller shaft on transmission and slide back.

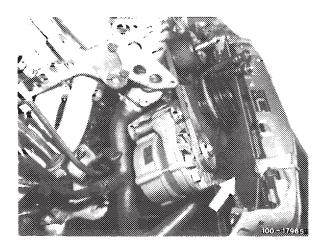
Support propeller shaft, so that shaft will not abut against transmission flange when installing engine.

- 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).

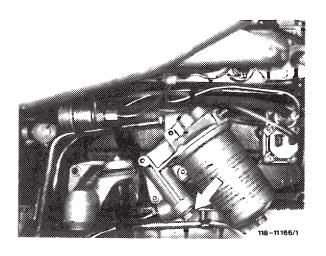


Installation

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.



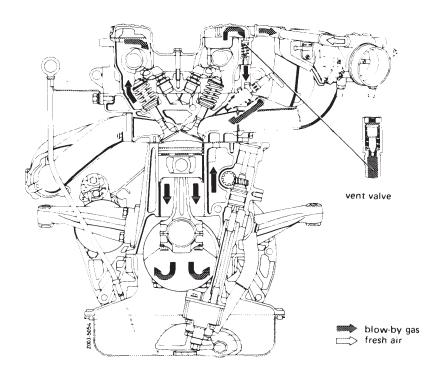
- 27 Install engine and connect.
- 28 Adjust rear engine mount free of tension (00-220).
- 29 Connect propeller shaft.
- 30 Check all drain plugs for tight seat.
- 31 Add oil and coolant (20-010).
- 32 Check cooling system for leaks with leak tester.

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

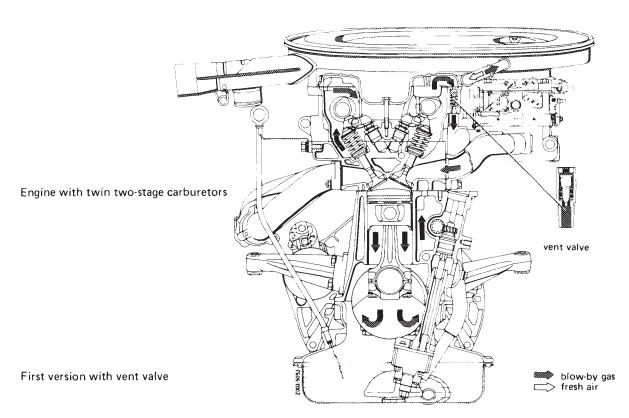
- 33 Check coolant for antifreeze.
- 34 Clean air filter and renew, if required.
- 35 Check dwell angle and firing point.
- 36 Adjust idle speed and emission value (07.2–100).
- 37 Check regulating shaft for function.

A. Engine with vent valve

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



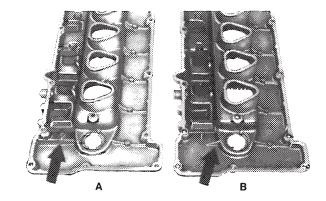
Engine with electronic fuel injection system.



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.



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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.

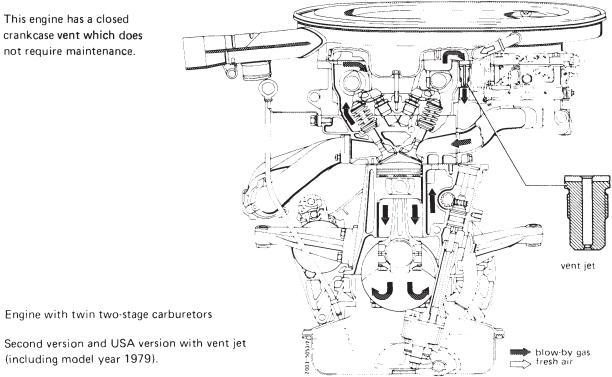
Since the through-flow capacity of the vent valve is larger than the amount of blow-by gas from the crankcase, fresh air is also drawn off from the air cleaner of a carburetor engine or from the throttle housing in front of the throttle valve via a pipe of an engine with fuel injection.

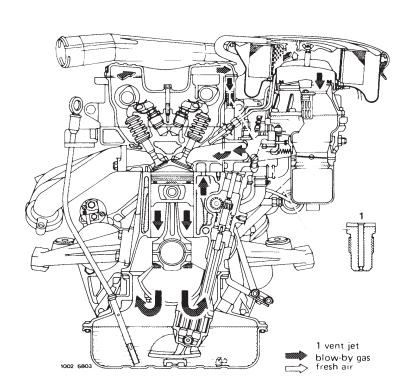
The additional fresh air is taken from an air cleaner of a carburetor engine via a hose.

When coasting the high intake manifold pressure will close the vent valve. The very slight amounts of blowby 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



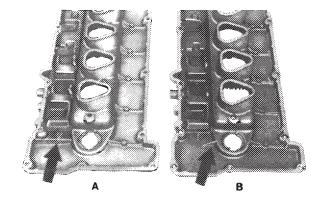


Engine with continuous fuel injection

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

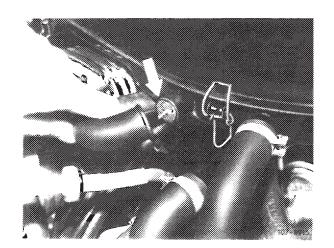
At idle speed and in low speed ranges the blow-by gas will enter into the combustion chambers via the vent jet and intake manifold or idle air passage.

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 blowby gas.

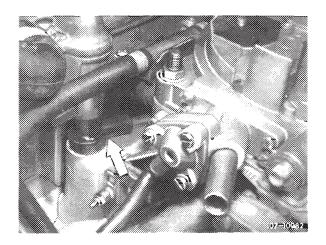
In the upper speed range blow-by gas will also flow from the fresh air side of the air cleaner depending on the blow-by quantity.

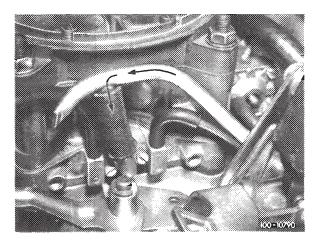
This is drawn off to the combustion chambers via the carburetor or air flow sensor and intake manifold.

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

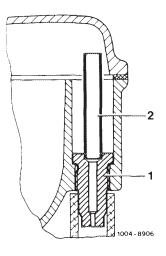


For 1975 and 1976 USA models, 1976 Sweden model and 1976 Japan models the blow-by gas is drawn off to the carburetor via an angle connector (arrow).





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.



Group number ¹)		0	1	2	
		05.070.05.000	05.000.05.000	05 000 00 000	
Standard dimension 86.0	piston dia. cylinder dia.	85.970–85.982 85.998–86.008	85.980—85.992 86.008—86.018	85.990-86.002 86.019-86.028	
Repair stage 1 + 0.5	piston dia. cylinder dia.	86.470-86.482 86.498-86.508	86.480—86.492 86.508—86.518	86.490-86.503 86.519-86.523	
	Cylinder dia.				
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	87.01987.028	
1) Decisive for association is the s	manest measured cynno	ier dia. and the largest in	easured piston dia.		
Max. wear limit in driving or t bores at upper reversing point		f cylinder	0,	10	
Piston clearance		When	new 0,0	0,025-0,035	
		Wear I	imit 0,0	0,08	
Machining tolerances					
Permissible deviation (radial distance) from cylinder shape		When	new 0,0	007	
		Wear I	imit 0,0	0,025	
Permissible deviation from squ reference to cylinder height	uare with		0,0	05	
Mean height of roughness			0,0	002-0,004	
Permissible height of waviness			50	% of roughness	
Chamfer of cylinder bores			sec	e fig. point 2	
Comment and to the					
Conventional tools					

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.

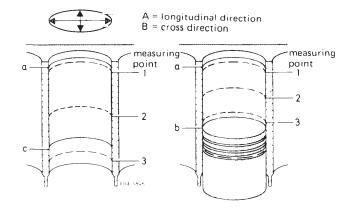
The difference in diameter of dimension shown on top land zone and the dimension at measuring point 1 generally indicates the respective max. wear.

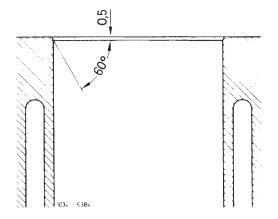
In the event of repairs, hone cylinder bores according to dimensions of available pistons plus piston clearance.

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.





-			
I)	2	٠	2

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	ines with normal compression		compression	USA version and low compression	
piston crown and crankcase mating Oversi	Standard size piston	Below	min. 0.20 max. 0.70	above 0 below 0	
	Oversizes + 0.5 and 1.0	Below	min. 1.0 max. 1.5	below	min. 0.55 max. 0.95

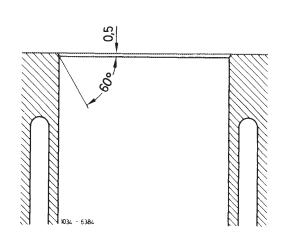
Conventional tools

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

Note

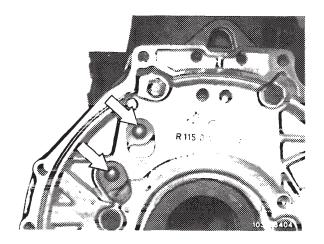
Chamfer cylinder bores after grinding.

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



Note

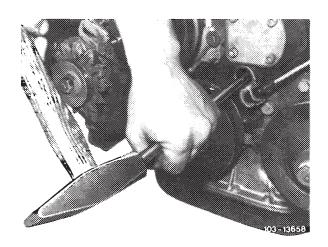
Since October 1976 the 2 main oil ducts (arrows) in cylinder crankcase at transmission end are closed by means of steel balls 15 mm dia. VO DIN 5401 part no. 005401 515001.



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

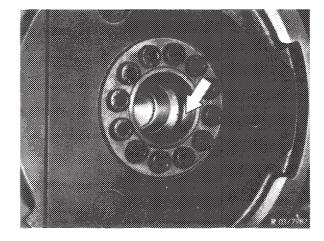
Undamaged steel balls can be used several times without refinishing ball seat in crankcase.

Damaged and rusty steel balls should be replaced.

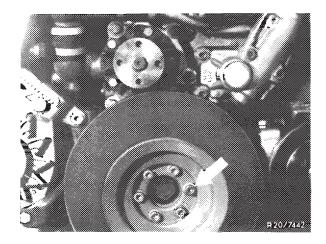


Knocking-out steel ball in upper main oil duct

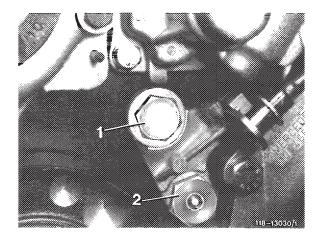
- 1 Remove transmission.
- 2 Remove flywheel (03-410).



- 3 Remove radiator (20-420).
- 4 Remove vibration damper (03-340).

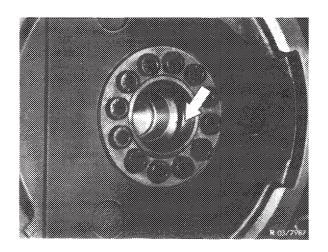


- 5 Unscrew closing plug (1) and screw oil pressure relief valve out of main oil duct.
- 6 Knock-out steel ball from direction of engine front end by means of a round steel bar 13 mm dia. and approx. 700 mm long.

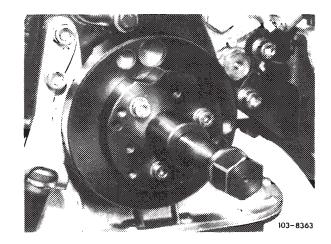


Knocking-out steel ball in lower main oil duct

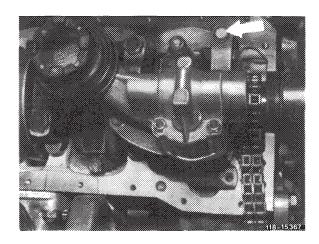
- 1 Remove transmission.
- 2 Remove flywheel (03-410).



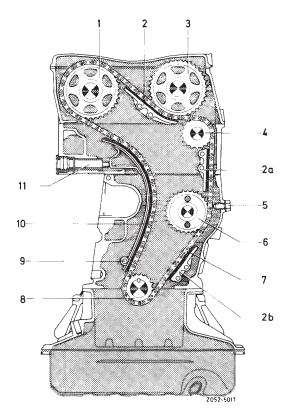
- 3 Remove radiator (20-420).
- $4\,$ Remove vibration damper and compensating weight (03–340).



- 5 Remove complete oil pan (01-310).
- 6 Remove oil pump (18-210).



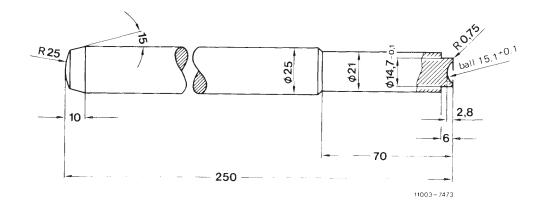
- 7 Remove slide rail (2b) in crankcase (05-340).
- 8 Knock-out steel ball from direction of engine front end by means of a round steel bar 13 mm dia. and approx. 700 mm long.



- 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 - 13 405



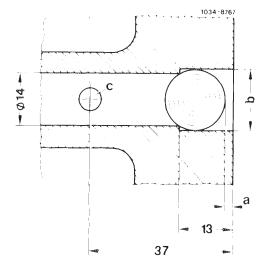
Material: C 45

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



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



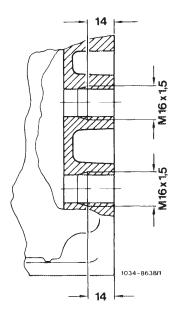
- 4 Mount all parts taken off or removed.
- 5 Run engine warm and check for leaks.

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.

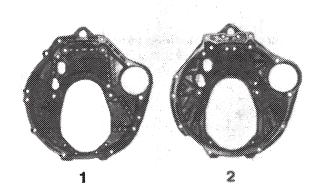
3 Screw closing plug M 16 x 1.5 mm DIN 908, part no. 000 908 016 001 with aluminum sealing ring A 16 x 22 mm DIN 7603 — AL, part no. 007 603 016 102, and tighten to 40 Nm.



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	90100 ⁰
Special tool	·1	
Dial gage holder (two required)	825 - 1000	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, order no. 810	7300 Esslingen

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 Modified intermediate flange 110 011 15 452 Former intermediate flange 115 011 11 45

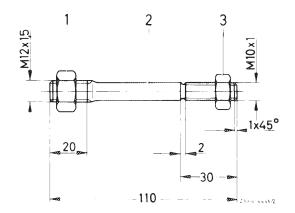
WH- W2W

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 -12-067 894 110.932 -10-010 365 -12-002 796	116.020—121 410
110.985 ⁻¹⁰ -014 287 -12-073 060	116.024/025—154 967
110.986 ⁻¹⁰ -003 392	107.042–007 301
-12-007 701	107.022–007 921

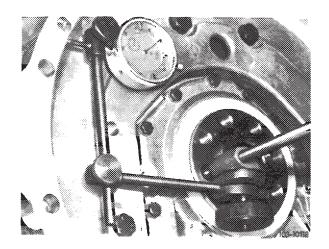
Installing and centering

- 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.



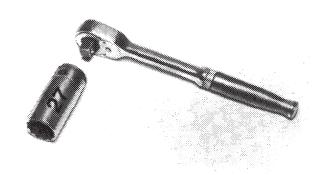
- 1 Hex nut M 12 x 1.5 2 Threaded bolt 10 mm dia 3 Hex nut M 10 x 1

- 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.



1100-8400

- 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.

Oil capacity in liters			
Oil dipstick color code	wine red, pink brown ¹)		yellow-green
Oil pan	6		5.5
Oil filter		0.5	
	Model 107, 114, 116	0.7	
Air oil cooler	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	11004-6721		117 589 02 07 00
Stud wrench 5 mm, 300 mm long	,		116 589 02 07 00
Stud wrench 6 mm, 440 mm long	*1004 1*87		116 589 03 07 00
Engine support	0029-19011		107 589 02 61 00
Knocking-in tool for oil dipstick guide tube	11004-8254		117 589 00 31 00
Knocking-out mandrel 9 mm dia	1004 5114		110 589 02 15 00
Conventional tool			
Engine hoist (Motordirigent) size 1.5	e.g. mad order no		ker, D-5630 Remsche

Self-made tools

Gauges for cutting-off radial sealing rings

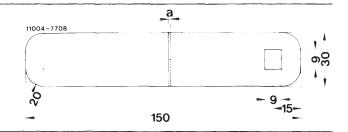
Radial sealing ring graphite-grey

Part no. 000 997 65 41

a = 1 mm

Radial sealing ring yellow-brown

 $a = 0.5 \, \text{mm}$



Note

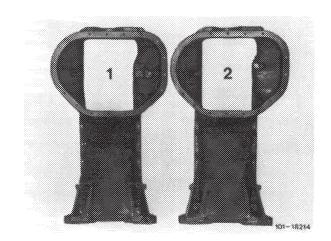
The modified oil pan (1) is installed on models 107, 116 and 123 since October 1979 and model 126 since begin of series.

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

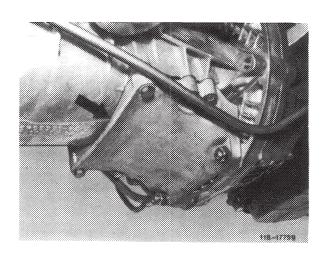
Begin of series: October 1979

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

This modified oil pan is screwed to cylinder crankcase at the rear with 6 screws M 8 \times 95 mm, formerly 4 screws M 6 \times 40 mm and 2 screws M 6 \times 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 8×110 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.

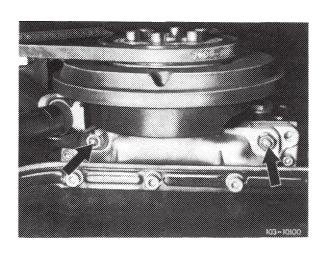
In the event of repairs, use radial sealing ring 000 997 90 41 (yellow-brown) with a projection of 0.5 mm on both sides, except when a new or newly ground crankshaft with new crankshaft bearings is installed. In such a case, use radial sealing ring 000 997 69 41 (graphite-grey) with a projection of 1 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.

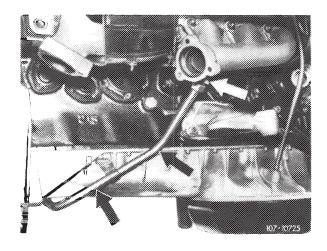
Note: Hold engine with engine support when working underneath engine.



Model 114

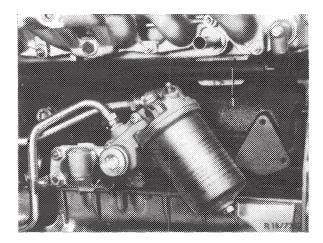
1 Remove front axle (33-100).

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



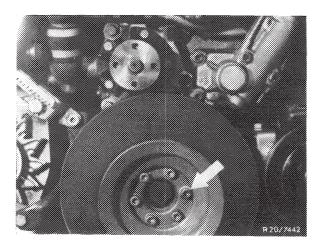
- 3 Remove oil lines for automatic transmission.
- 4 Detach oil dipstick guide tube at cylinder head.
- 5 Pull oil return line (1) off of oil pan (18-030).
- 6 Drain engine oil.
- 7 Remove oil pan.

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

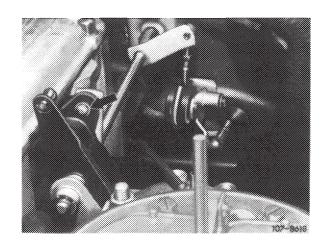


Model 116

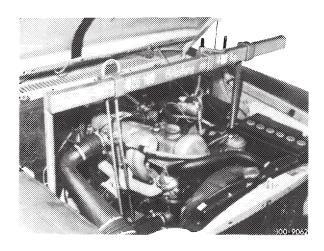
- 1 Remove radiator.
- 2 Remove vibration damper (03-340).



3 Detach control shaft (07.2-442).



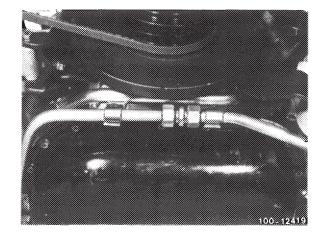
- 4 Detach both front engine mounts and engine dampers.
- 5 Pull oil return line off of oil pan (18-030).
- 6 Drain engine oil.



- 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.

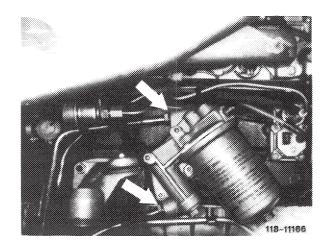




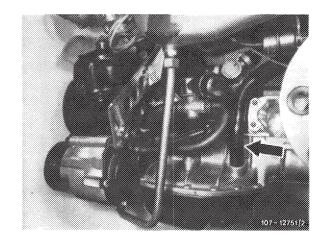
- 10 Detach rear engine mount, lift engine and place an approximately 40 mm thick piece of wood underneath.
- 11 Lift front of engine and place approximately 60 mm thick pieces of wood on both sides between the engine carrier and engine mounts.
- 12 Detach oil pan and remove forward.

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.

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.	

7 Unscrew oil pan upper half to the extent that

it is still held to crankcase by 2 screws.

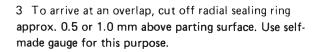
8 Remove oil pan lower half.

9 Remove oil pump (3 screws).

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.



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.

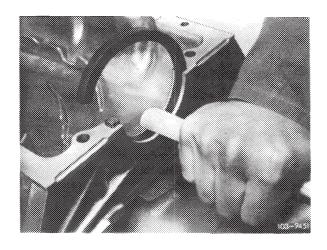
Attention!

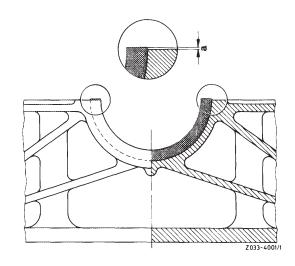
The oil pan should rest against or be screwed to intermediate flange prior to tightening fastening screws for crankcase.

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
Campital Code Hamber	Intake	25, 67, 74	25, 74	33, 91
Intake valve	opens after TDC	70		11 ⁰
That is a second	closes after BDC	21 ⁰		15 ⁰
Exhaust valve	opens before BDC	30°		22 ⁰
Exhibit valve	closes before TDC			
1) The camshaft code number is punche	d into rear end of camshaft.			
Valve clearance	on cold engine (appr	ox. 20 ^o C)	on warm engine (60	0°C ± 15°C)
Intake	0.101)		0.151)	
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 hea	d cover		5	
Necked-down screw for camshaft sp	prockets		80	
Cylinder head bolts M 12 x 1.5 on	cold angine	step 1	40	
Cymruer rieau borts W 12 x 1.3 on	cord engine	step 2	70	
		after 10 min. sett	ing time 110	
Bolts M 8 for cylinder head to cran	kcase		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 ar	m (4)	100 · 100	110 589	9 04 61 00

Rigid chain tensioner	11004-7006	110 589 03 31 00
Chain tensioner holder	11004 - 7005	110 589 02 31 00
Bearing pin impact extractor (basic unit)		116 589 20 33 00
M 6 x 50 bolt for impact extractor	الم أنسسية 100 م 100	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	31 (4 67%	116 589 03 34 00
Camshaft wrench	11004-7004	116 589 01 01 00
17 mm valve adjusting wrench	11004-7003	110 589 01 01 00
27 mm socket to turn engine, 1/2" square	100.00	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	

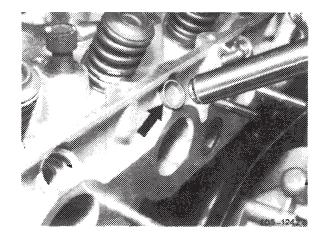
Note

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.

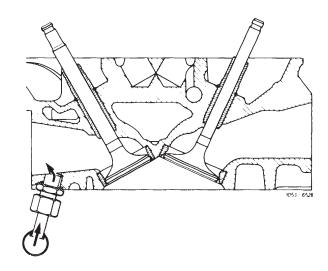
Starting April 1978 exhaust valve seat rings 42 mm OD and valve guides 9 mm ID are installed in cylinder head. Exception: engines national version.



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

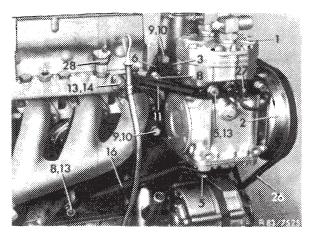
The diameter of the combustion chamber frame on cylinder head gaskets for the various repair stages varies:

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

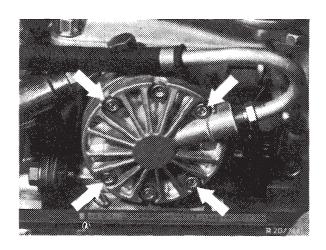


Removal

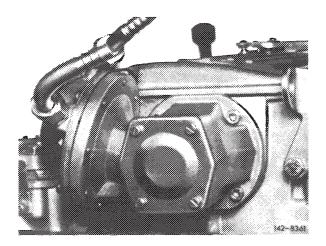
1 Remove compressor of models with an air conditioner.



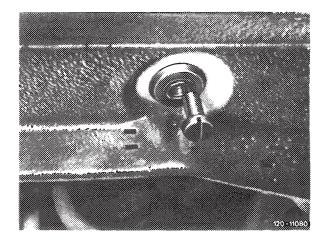
2 Remove oil pump of models with a level control system and place it to one side without undoing the lines. Only unscrew the bolts marked with an arrow for this purpose.



3 Remove vacuum pump of models for USA.

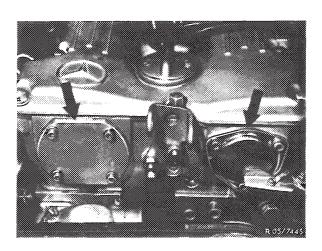


4 Drain coolant from radiator and engine.



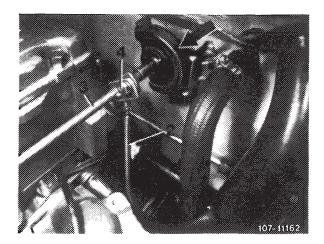
Model 123

5 Unscrew both covers at front of camshaft housing.

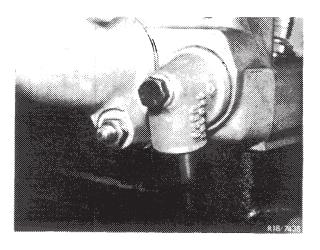


6 Disconnect all electric wires, heater water, fuel and vacuum lines which are connected to the cylinder head and intake manifold or carburetor.

7 Remove longitudinal regulating shaft (3).

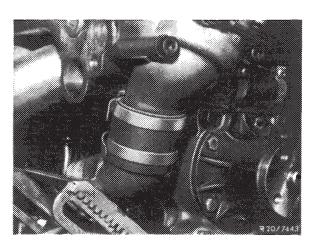


8 Disconnect oil return pipe at cylinder head.



9 Remove hose between thermostat housing and water pump.

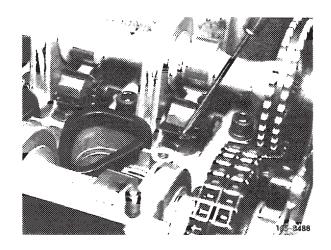
Disconnect bypass line at water pump.



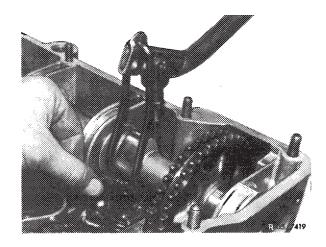
10 Disconnect oil dipstick guide tube from clamp on cylinder head and bend to one side.

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).



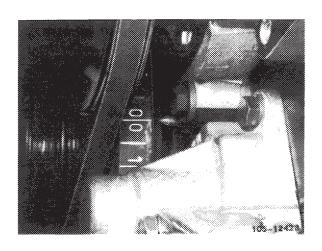
14 Turn crankshaft with combination tool.

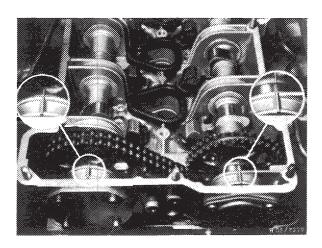
Attention!

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

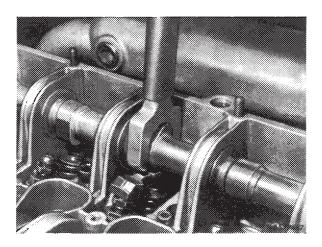


15 Position 1st cylinder of engine at ignition TDC. Marks on camshaft sprockets and camshaft housing must align.



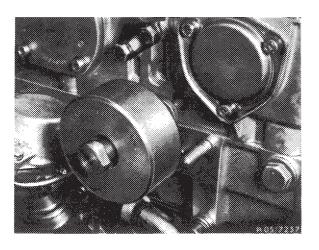


16 Remove both expansion bolts of camshaft sprockets. Counterhold camshaft with holder.

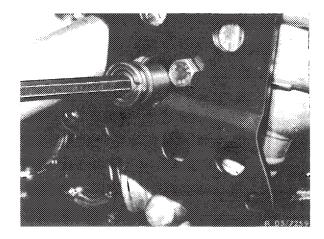


17 Remove upper slide rail in camshaft housing (05-340).

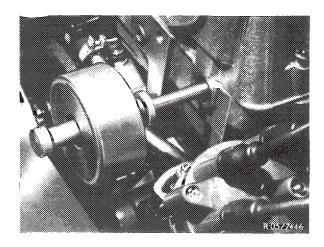
Knock out bearing pins with the impact extractor for this purpose.



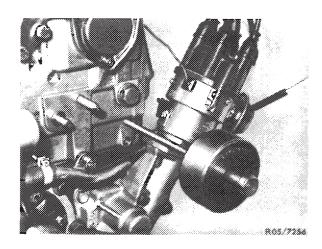
- 18 Remove chain tensioner (05-310).
- 19 Push both camshafts to the rear and remove camshaft sprockets.



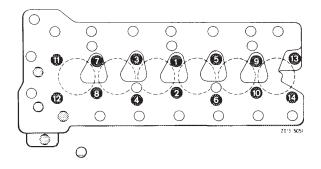
20 Remove guide wheel. Knock out bearing pins with impact extractor (M 10 bolts) for this purpose.



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.

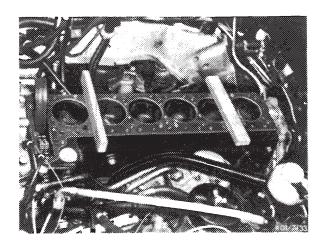
Installation

- 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 \times 35 \times 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.

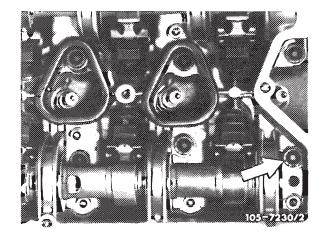
Note: If possible, connect cylinder head with camshaft housing to eyes for engine removal, carefully lower with a crane and set down.



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

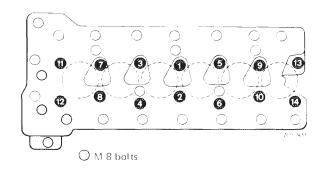
Attention!

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).

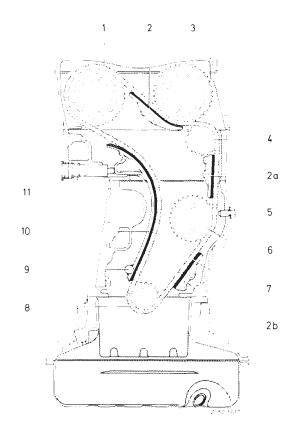


Attention!

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.



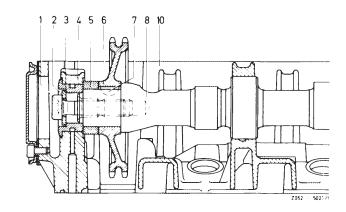
Chain drive

- Exhaust camshaft sprocket
- 2b Sliding rail
 Intake camshaft sprocket
- Guide wheel
- Lock bolt
- Intermediate wheel
- Timing chain
- Crankshaft sprocket
- Tensioning rail bearing pin
- Tensioning rail
- 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

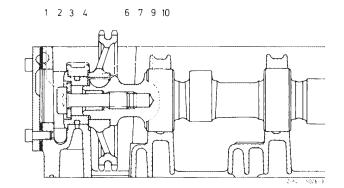
- Expansion bolt
- Washer
- 3 Spacer Bearing
- Spacer
- 6 Camshaft sprocket
 - Woodruff key
- Camshaft
- Camshaft housing



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

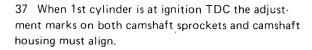
Exhaust camshaft

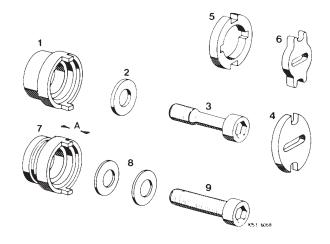
- Expansion bolt
- 2 3 Washer
- Spacer
- Bearing
- Camshaft sprocket
- Woodruff key Camshaft
- Camshaft housing

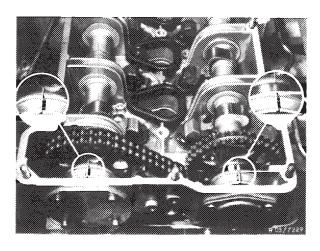


36 During repair jobs, mount necked-down screw (3) with washer (2) only, but do not yet tighten.

- Spacer 2nd version without lubricating groove (for pressure oil pump and vacuum pump 2nd version)
- Washer
- Expansion bolt
- Dog (for pressure oil pump and vacuum pump 2nd version)
- Dog (for vacuum pump 1st version)
- 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
- Spring washers (not valid)
- Mounting bolt (not valid)

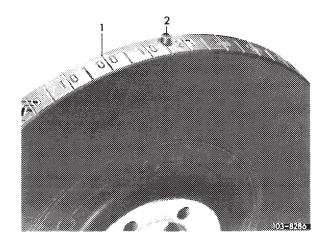






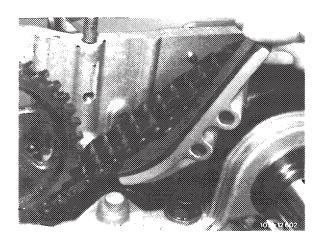
Attention!

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

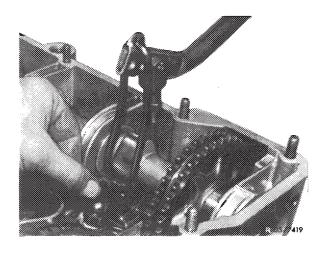
38 Install sliding rail in camshaft housing so that the timing chain cannot jump.



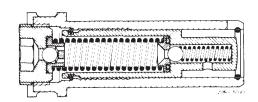
- 39 Install rigid chain tensioner and tighten by hand.
- 40 Turn crankshaft with combination tool and adjust to ignition TDC. Check adjustment marks (fig. of point 37).

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.
- T 0.7713
- 42 Install rocker arms and spring clamps (05-230).

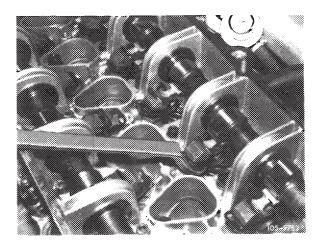


43 Position chain tensioner for insallation and install (05-310).



44 Adjust valve clearance (05-210).

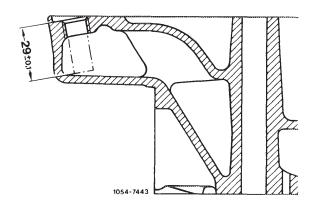
Further installation instructions in reverse sequence of removal.



Note

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

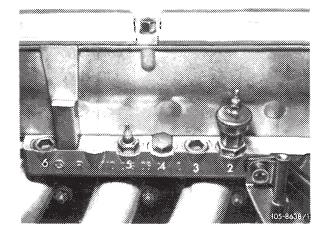
Note screwed depth and use seals of sufficient thick-



Measuring sensor box for carburator engine with air conditioner

- 100°C temperature switch and adaptor for extra fan/air conditioner

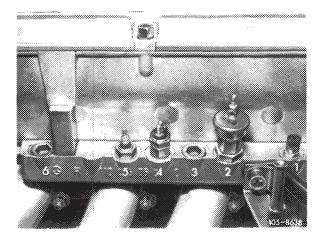
- Core plug M 22 x 1.5
 Plug M 14 x 1.5
 Coolant temperature gage sensor
 Core plug M 22 x 1.5



Measuring sensor box for fuel injection engine with air conditioner

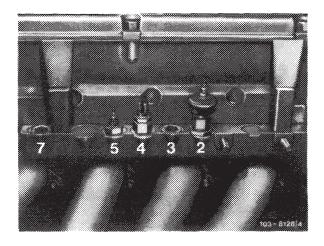
- Coolant temperature sensor for control unit 100^{0} C temperature switch and adaptor M 18 x 1.5 for extra fan/air conditioner
 Core plug M 22 x 1.5
 Temperature timing switch for cold starts
 Coolant temperature gage sensor

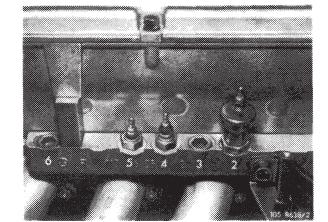
- Core plug M 22 x 1.5



Measuring sensor box for continuous fuel injection engine with air conditioner

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



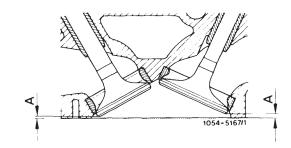


Measuring sensor box for carburetor engine USA with air conditioner

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

01-418 Facing cylinder head mating surface

Total cvl	inder head height			93.9-94.0
	tht after machining			93.1
	-		in longitudinal direction	0.08
Permissib	ole unevenness of mating surfac	ces	in cross direction	0.0
	ole deviation in parallel of uppe mating surface in longitudinal	•		0.1
Peak to v	alley height			0.010
Pressure	test with air under water in ba	gauge pressure		2
new valve	n distance A with new valves are seats, cylinder head parting ot machined	3.3	Minimum distance A with new valve seats, cylinder he surface 0.4 mm milled off	
Exhaust	Valve retainer dia. 37 mm	0.6		0.2
LXIIdust	Valve retainer dia. 39 mm	0.04		0.36 standout
machined	ance A with new valves and I valve seats, cylinder head urface not machined		Max. distance A with new machined valve seats, cylin surface 0.4 mm milled off	
Intake		4.2		3.8
Exhaust	Valve retainer dia. 37 mm	1.5		1.1
				0.54



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

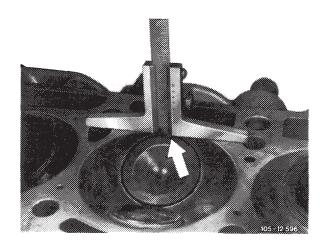
Facing

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).



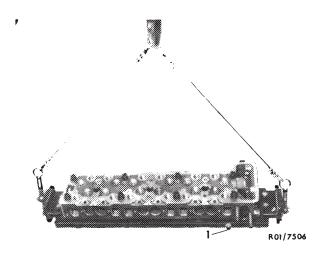
01-420 Pressure testing cylinder head

Data		
Pressure test with air under water in b	oar gauge pressure	2
Special tools		
Pressure testing plate	1000 670	110 589 00 25 00
Suspension fixture	1000-000	110 589 34 63 00
Conventional tool		
Electrically heated sink	e.g. made by Otto Dürr, D-7123 S	Sachsenheim-Ochsenba

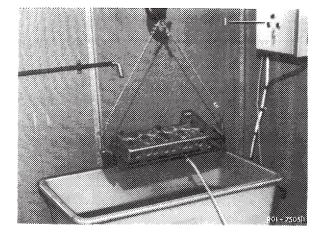
Pressure testing

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.



Data			
Valve clearance	Cold engine ((ca. 20 ^o C)	Warm engine (60°C ± 15°C)
Intake	0.101)		0.151)
Exhaust	0.25		0.30
1) 0.05 mm more for consistent outs	ide temperatures belo	w – 20 ^o C.	
Tightening torques			Nm
Cylinder head bolts M 12 x 1.5			110
Bolts M 8 for camshaft housing t and crankcase	o cylinder head		25
Expansion bolt for camshaft spro	ockets		80
Ball locating ring in chain tension	ner		25
Valve adjusting screw			20-40
Cylinder head cover bolts and ca	pped 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		11004-7006	110 589 03 31 00
Chain tensioner holder		11004 - 7005	110 589 02 31 00
Bearing pin impact extractor (ba	sic unit)	11004-1920	116 589 20 33 00
M 6 x 50 bolt for impact extract	or	11004-6368	116 589 01 34 00
Holding wrench for camshafts		1100	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

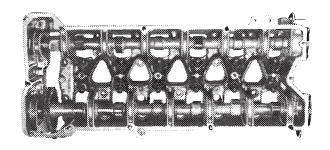
10 mm wrench socket 1/2" square, 140 mm long

000 589 05 07 00

Note

Camshaft housing may only be removed after engine is cold.

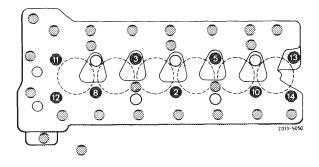
The camshaft housing must be removed to remove the camshafts and valve springs or to replace the valve seals.



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.

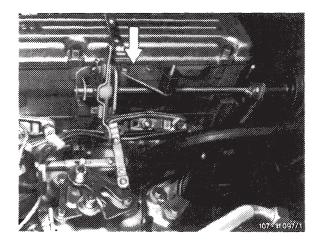


For engines with CIS, use camshaft housing with lug for attaching air cleaner (arrow).

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

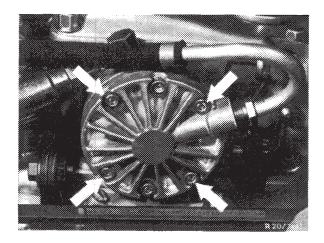
Exchange engines are in part supplied with camshaft bearing intermediate stages and repair stages (01–471).

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

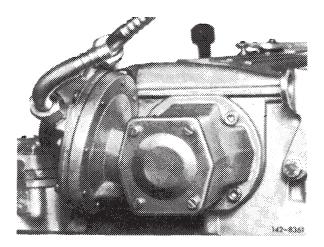


Removal

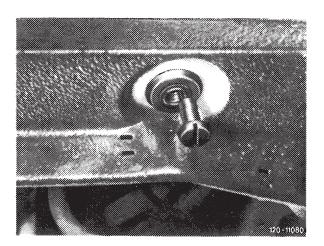
- 1 Remove pressure oil pump of models with level control and place to one side without disconnecting the lines. This requires loosening only those bolts marked with an arrow.
- 2 Remove compressor of models with an air conditioner.



3 Remove vacuum pump of models in USA version.

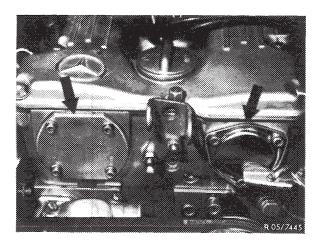


4 Drain coolant from radiator and remove upper water hose from engine to radiator. Remove cylinder head cover.

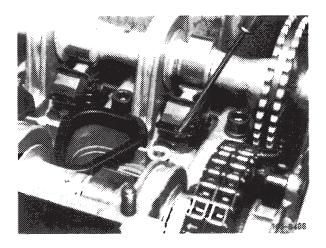


Radiator drain plug of type 123.

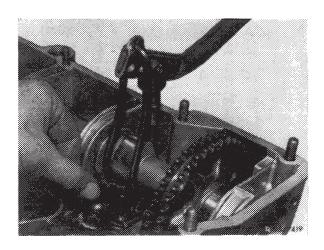
5 Unscrew right cover (arrow) on front of camshaft housing.



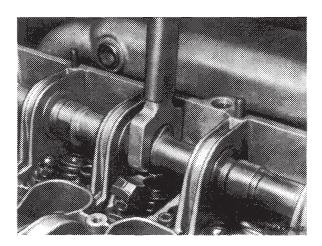
6 Remove all spring clamps with a wrench socket.



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.

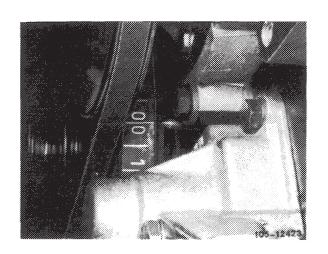


9 Position piston 1 at ignition TDC and both camshafts at marks.

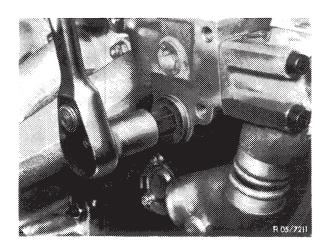
This requires turning the crankshaft with the combination tool.

Attention!

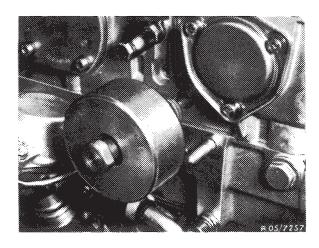
Do not turn engine at the mounting bolts of the camshaft sprockets. Don't turn engine in **reverse direction** of rotation.



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

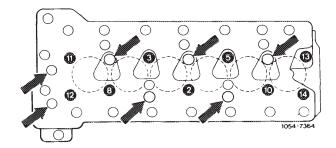


11 Remove sliding rail in camshaft housing. This requires knocking out bearing pins with an impact extractor.

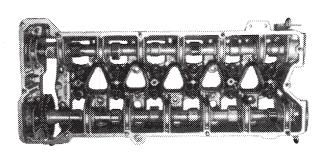


- 12 Push back righthand camshaft and remove camshaft sprocket.
- 13 Guide camshaft into bearings again. Unscrew M 8 bolts and cylinder head bolts in reverse sequence of tightening.

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



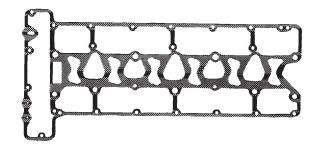
14 Remove camshaft housing with camshafts.



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.

16 Install camshaft housing.

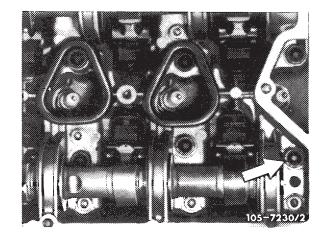


105 - 12 599

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

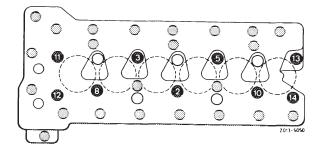
Attention!

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.

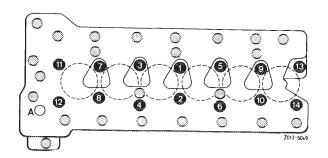


2nd step: all cylinder head bolts to 110 Nm starting with bolt No. 1. This requires first loosening the five cylinder head bolts 1, 4, 6, 7 and 9 located deeper separately somewhat.

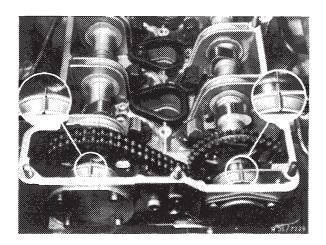
Tighten the M 8 bolts from inside to outside to 25 Nm.

Attention!

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

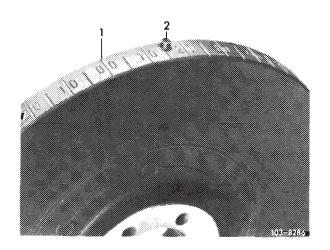


19 Install right camshaft sprocket making sure that the adjustment marks of both camshafts align when the crankshaft is at TDC.



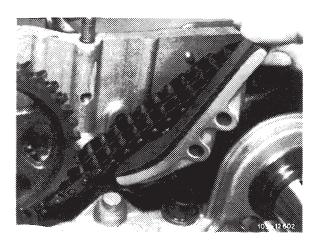
Attention!

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.

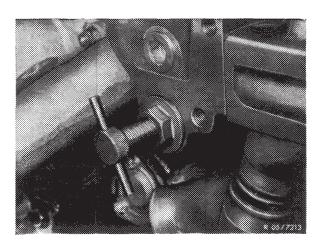


21 Install "rigid" chain tensioner and tighten by hand.

Attention!

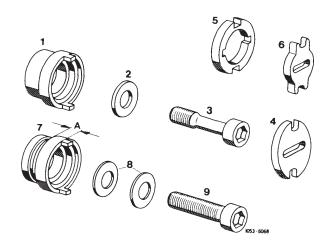
If camshaft housing has been ground, the timing must be adjusted.

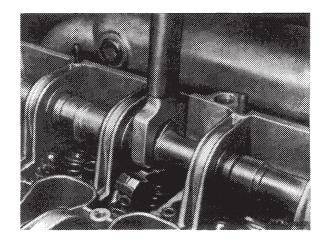
22 Lubricate spacers with engine oil and slide them into camshaft housing.



- 1 Spacer 2nd version without lubrication groove (for pressure oil pump and vacuum pump 2nd version) 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)
- 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
- 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.

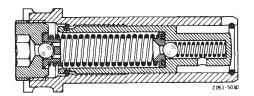
Note: Washer (2) with 30 mm OD is not fitting into spacing sleeve for vacuum pump on USA vehicles up to January 1973. In such a case, machine OD of washer (2) down by approx. 1 mm.



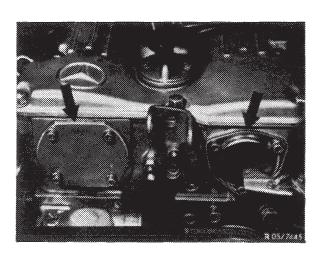


24 Position chain tensioner for installation and install. Also install pressure spring (05-310).

Chain tensioner in installation position



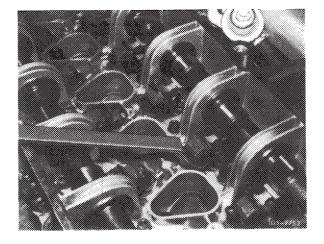
- 25 Install cover on front of camshaft housing and install level control pump or vacuum pump with gaskets.
- 26 Install rocker arms (05-230).



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.

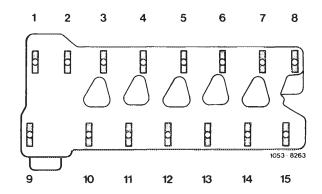
Camshaft housing with 15 bearing points

Bearing points		1, 9	2	3, 10, 11	4,5,12,13	6,7,14,15	8
00-31	bearing dia.	38.016	50.066	50.016	51.519	53.019	54.019
Standard dimension	bodi ing dia.	38.000	50.050	50.000	51.500	53.000	54.000
otalida dimension	journal dia.	23.993	49.950	49.950	51.440	52.940	53.940
	,	23.980	49.934	49.934	51.421	52.921	53.921
	bearing dia.		49.966	49.916	51.419	52.919	53.919
Intermediate stage -0.	-		49.950	49.900	51.400	52.900	53.900
(exchange engines)	journal dia.		49.850	49.850	51.340	52.840	53.840
	journar dia.		49.834	49.834	51.321	52.821	53.821
	bearing dia.		49.816	49.765	51.269	52.769	53.769
Repair stage 1	bearing dia.		49.800	49.750	51.250	52.750	53.750
-0.25 mm	journal dia.		49.700	49.700	51.190	52.690	53.690
	journal dia.		49.684	49.684	51.171	52.671	53.671
	bearing dia.		49.566	49.516	51.019	52.519	53.519
Danais stars 2	bearing dia.		49.550	49.500	51.000	52.500	53.500
Repair stage 2 -0.50 mm	:		49.450	49.450	50.940	52.440	53.440
	journal dia.		49.434	49.434	50.921	52.421	53.421
	radial	0.057	0.100	0.050	0.060	0.060	0.060
Camshaft bearing	radiai	0.124	0.132	0.082	0.098	0.098	0.098
play	* . 1	0.050					
	axial	0.120					
Sleeve for bearing a	OD	37.950	1D	24.013			
•		37.925		24.000			

Combinations in the event of repairs

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

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



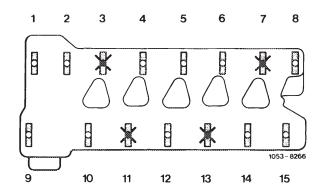
b) Camshaft housing with 15 bearing points, with bearing points 11 and 13 at intake end or 3 and 7 at exhaust end out of function.

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

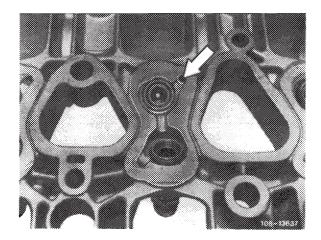
Exhaust camshaft code no. 78 and 95 with 6 bearing journals and intermediate stage or repair camshafts with reduced bearing dia.

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.



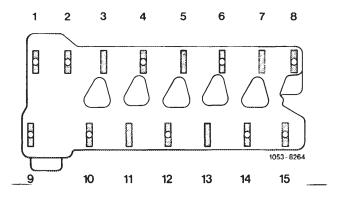
X close oil bores



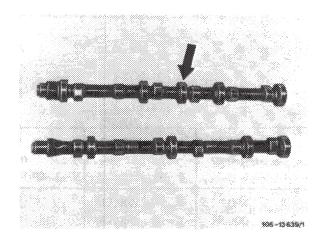
c) Camshaft housing with 15 bearing points, with bearing points 11 and 13 (intake end) or bearing points 3.5 and 7 (exhaust end) without oil supply.

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).

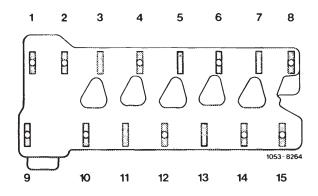


Camshaft housing with 15 bearing points of which 5 bearing points without oil bore

Bearing p	oints	1, 9	2	3, 11	4, 12	5, 13	6, 14, 15	7	8	10
Bearing	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
points	Journal dia.	23.993	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.

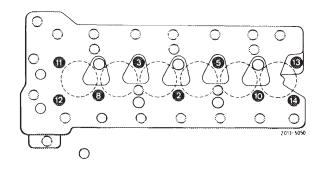
On this camshaft housing, the bearing points 3, 5, 7, 11 and 13 are without oil bore and their ID is 1 mm larger than the respective camshaft bearing journals. This camshaft housing can be used to install all camshafts with normal dimension.



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 p	oints	1, 9	2	4, 12	5	6, 14, 15	8	10
Dania	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
Bearing points	Journal dia.	23.993	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.	<u>49.966</u> <u>49.950</u>	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

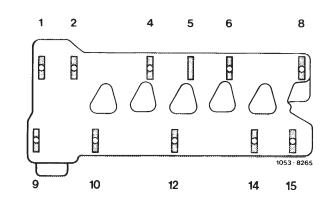
Repair stage $2-0.50~\mathrm{mm}$

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	50.940		52.440	53.440	49.450	
	49.434	50.921		52.421	53.421	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.

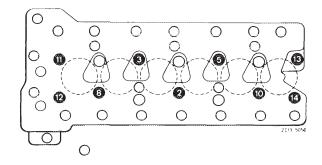
This camshaft housing can be used to install camshaft without changes on bearing journals.



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	e.g. made by Ruaro u. Fi., Schio/Italy
equipment for light alloy surfaces	Scledum, type RTY

Note

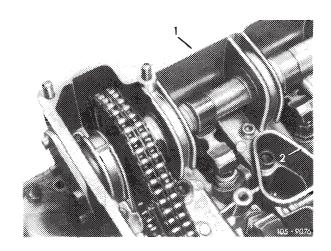
The camshaft housing may only be faced, if mechanical damage is visible on the mating surfaces.

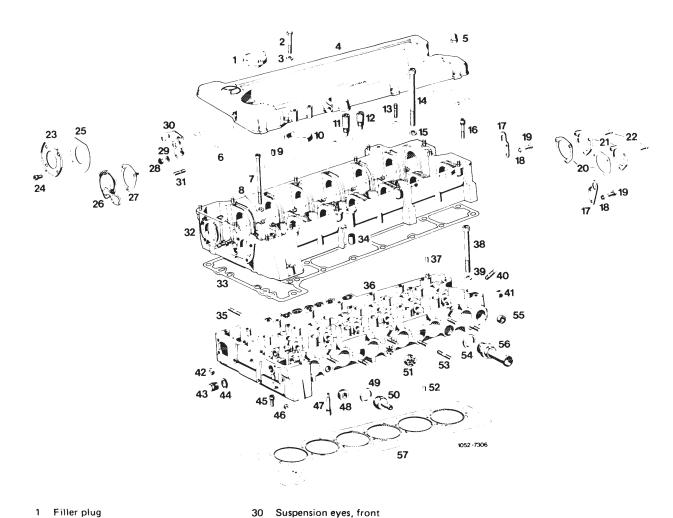
A distorted camshaft housing will align with the cylinder head when tightened.

Knife-edged straightedge approx. 750 mm long

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).





2 3 4 5 6 7 8 9 10 3 bolts M 8 x 55 3 seals C 8 x 13 Valve cover Capped nuts Cylinder head cover gasket 2 bolts M 8 x 135 Plain washers 38 x 15 3 threaded inserts M 8 x 16 5 cylinder head cover gaskets Vent valve 12 13 Vent jet 12 studs M 8 x 18 14 9 bolts 15 9 washers 21 combination bolts M 8 x 40 17 2 suspension eyes, rear 18 19 Circlip 4 bolts M 8 x 15 20 21 22 23 24 2 gaskets 2 covers

6 combination bolts

Cover with holder

7 combination bolts M 6 x 15

Cover

Gasket

Gasket 2 nuts M 8

2 circlips

30 31 32 33 34 35 36 37 38 39 40 41 42 Suspension eyes, front 2 studs M 8 x 18 Camshaft housing Sheet metal foil for repairs Engine vent connecting hose Stud M 8 x 30 Cylinder head 2 dowel pins 8 x 16 5 bolts 5 washers Studs M 8 x 20 2 plugs for oil bores Plug AM 22 x 1.5 Plug M 18 x 1.5 Seal A 22 x 27 43 45 2 combination bolts M 8 x 20 Plug M 10 x 1 for oil connecting bore Return flow oil jet Plug OM 30 x 1.5 49 50 51 52 53 54 55 Seal A 30 x 36 Connector for pre-heating Connectors for carburetor heating 2 dowel pins 8 x 16 Stud M 8 x 35 Seal A 30 x 36 Cover for injection bore 56 57 Heater connection Cylinder head gasket

Conrod bolt sizes

Version	Part Number	Distance a and b (fig., po a		Thread dia. d	Expansion stem dia. c when new (fig., point 1)	Min. Expansion stem dia.
1st version	110 038 01 71		3			
2nd version	110 038 03 71	5.5	4.5	M 10×1	8.4-0.1	8.0
3rd version	110 038 04 71	6.6	4.5			

Conrod bolt installation pressure

45000 N

Conrod nut torque

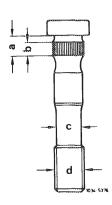
Initial torque	4050
Torque angle	90-100 ⁰

Self-made tool

Steel plate	see fig., point 3
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Checking

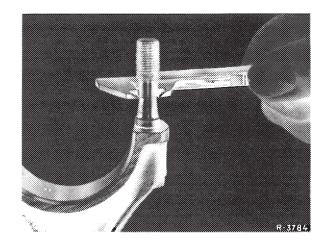
1 Measure smallest expansion stem diameter before reusing.



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.

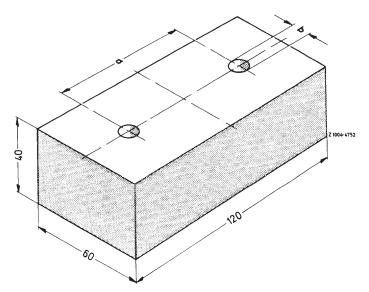
Use third version conrod bolts for repairs.



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.



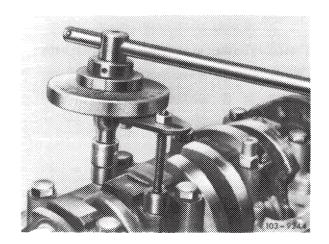
Distance between holes a = 64.6 mm Bore b = 11 mm

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 $90-100^{\circ}$ 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		131.950
center of conrod bushing bore		130.050
Width of conrod at conrod bearing bore		27.890
and conrod bushing bore		27.857
Basic bore for conrod bearing shells		51.619
_		51.600
		26.021
Basic bore for conrod bushing		26.000
Conrod bushing inside dia.		23.013
Somod Bushing Inside dia.		23.007
Peak to valley height on inside of conrod bushing		0.004
Permissible stagger of conrod bore to conrod bushing bore		0.1
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
J.		
Permissible deviation of conrod bearing bore from true		0.020
Permissible difference in weight of all		5 gr.
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 G e.g. Model CL 6	mbH, 5309 Meckenheim

Note

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

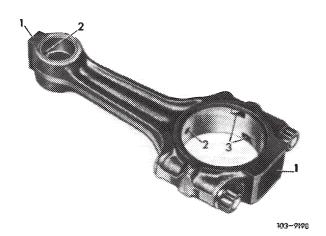
The connecting rod and its cap are marked to fit together. The connecting rod stem must not show cross scoring and notches.

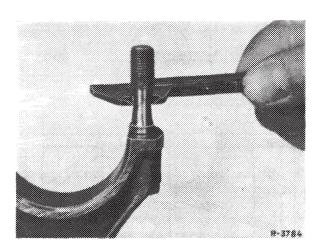
Connecting rods with a machined conrod bushing are delivered as replacement parts.

When renewing conrods pay attention to different weights of rods.

Repairing

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





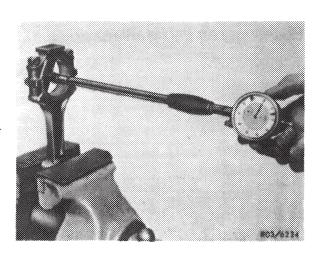
2 Check conrod bolt bores.

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



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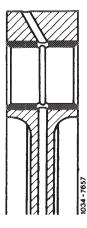
- 3 Mount connecting rod bearing cap and tighten to 40–50 Nm and 90–100° angle of rotation torque.
- 4 Measure conrod bearing basic bore. If a basic bore exceeds the value of 51.62 mm or shows conicity, hone bearing surface of bearing cap on a surface plate up to max. 0.02 mm.



5 Press in new conrod bushing that oil bores match.

Installation pressure 2500 Nm.

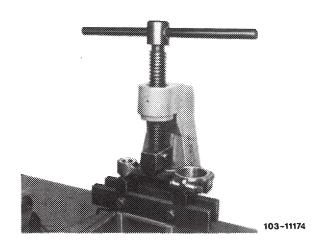
- 6 Mill or ream out conrod bushing.
- 7 Hone side bearing surfaces of connecting rod on a surface plate.



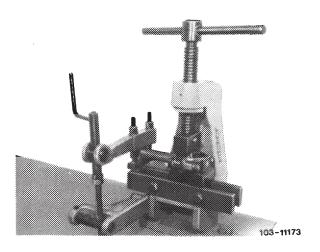
Squaring

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 — cylinder¹)

Group number		0	1	2
Standard dimension	Piston dia Cylinder dia		85.980–85.992 86.009–86.018	
1st repair stage + 0.5	Piston dia Cylinder dia		86.480-86.492 86.509-86.518	
2nd repair stage + 1.0	Piston dia Cylinder dia	00,0,0	86.980-86.992 87.009-87.018	00.000

 $^{^{1}}$) The smallest measured cylinder dia and the largest measured piston dia are decisive for association.

Piston code number and piston distance

Engine		Compression ratio $\epsilon:1$	1	Piston code number	Distance between piston crowr and cylinder crankcase parting surface
Normal co	ompression				
110.921	110.983		Std	37, 40, 50, 60, 64, 69	Standback 0.20 to 0.70
110.922	110.984			80 ¹), 83, 86 ¹), 89	
110.923	110.985	0.01.00		00 11 51 03 30	
110.924	110.986	9.0 ± 0.2	+ 0.5	38, 41, 51, 67, 70,	
110.981	110.987	8.7 ± 0.2		84, 90	Standback 1.0 to 1.50
110.982			+ 1.0	39, 42, 52, 68, 71,	otanabaok 1.0 to 1,00
				85, 91	
Low comp	pression				
110.921	110.984				0.25 standout up to
110.922	110.985		Std	28, 54, 72, 75	0.15 standback
110.923	110.991	8.0-0.4			
110.924			+ 0.5	29, 55, 73, 76	
110.931	110.992		+ 1.0	30, 56, 74, 77	Standback 0.55 to 0.95
110.932	110.993		5	,, ,	

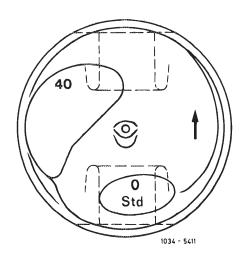
¹) Installed in engine 110.984, 110.985, 110.986 and 110.987 as standard equipment. Not available as repair stages. Use only together with piston of same piston code number.

Test values		New (Installation toleran	Wear limit nce)
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	
Title in the state of the state	in piston	0.002 to 0.011	
	groove 1	0.30 to 0.45	1.0
Piston ring gap	groove 2	0.30 to 0.45	0.8
	groove 3	0.25 to 0.40	0.8
	groove 1	0.05 to 0.08	0.15
Piston ring clearance	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	4050 Nm
		torque angle	90100 ⁰
Special tools			
Piston ring pliers	1024.4187		000 589 51 37 00
Piston ring compressor		v/o +001	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).

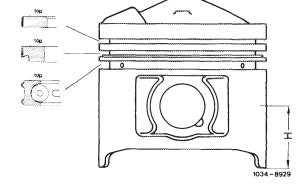
This will guarantee the specified piston clearance.

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.

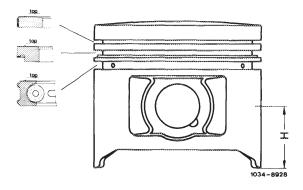
The measuring point for nominal diameter of pistons is offset by $90^{\rm O}$ in relation to piston pin axis at level H.

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

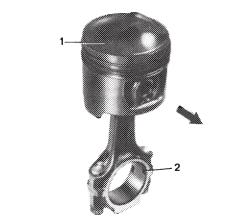
- 1 Take out connecting rod with piston from above.
- 2 Remove piston pin circlips and press out piston pin.
- 3 Repair and square connecting rod (03-313).

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).

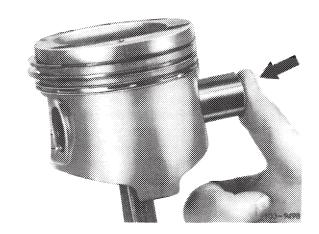
Attention!

Don't heat piston.



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

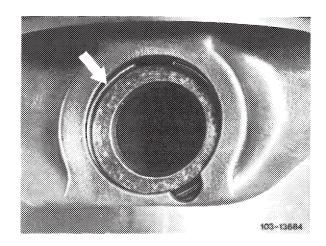


6 Insert piston pin circlips in grooves.

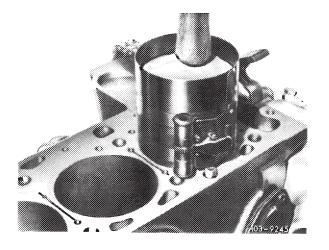
When installing used pistons, check piston ring gaps and clearances.

Check piston rings for easy movement.

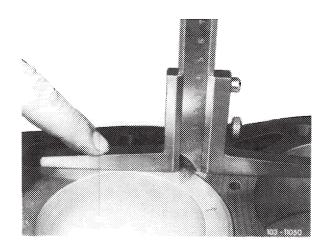
7 Lubricate cleaned cylinder bores, conrod bearing journals, conrod bearing shells and the pistons.



- 8 Distribute gaps of piston rings around piston circumference evenly.
- 9 Install piston ring compressor and guide in piston with arrow facing forward.



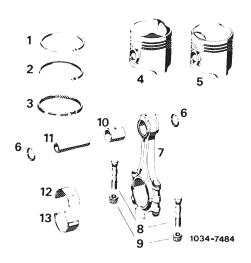
- 10 Place connecting rod bearing caps with code numbers facing each other on connecting rod and tighten connecting nuts to 40-50 Nm initial torque and to 90-1000 angle of rotation torque.
- 11 Turn crankshaft and check clearance between piston pin boss and connecting rod.
- 12 Measure distance between piston crown and crankcase mating surface when piston is positioned at TDC (see chart).



Pistons and connecting rods

- 1 Plain compression ring
- 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 jour at thrust bearing	nal	Conrod bearing jo dia.	ournal	Conrod bearing journal width
Standard size	59.96 59.95	29.00 29.02		47.96 47.95		28.00
1st Undersize	59.71 59.70			47.71 47.70		
2nd Undersize	59.46 59.45	20.60		47.46 47.45		to 28.30
3rd Undersize	59.21 59.20	to 29.60		47.21 47.20		
4th Undersize	58.96 58.95			46.96 46.95		
Crankshaft journal dia. for r	mounting				0.030	
Permissible deviation of crai	nkshaft journal prior	fr	om cyl. sh	ape	0.005	
to mounting compensating		fr	om true ¹⁾		0.030	
Permissible deviation of crar bearing journals from true	nk pins and crankshaft			***************************************	0.0025	
Permissible deviation of cral line from parallel	nk pin cyl.		2.00		0.010	
Permissible deviation of run bearing from parallel ¹⁾	ning surfaces of fitted				0.020	The second secon
Permissible deviation of run radial sealing ring from cond	The state of the s			0.015		
Permissible deviation of flyv from axial true ¹)				0.010		
Permissible deviation of cra	jc	ournal II, \	/1	0.070		
bearing journal from concer	jo	ournal III,	IV, V	0.100		
Fillets on crankshafts and crank pins				2.5 to 3		

Scieroscope hardness of crankshaft	when new	74-84	
bearing journals and crank pins	boundary value	60 ²)	
Permissible unbalance of crankshaft		15 cmg	

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

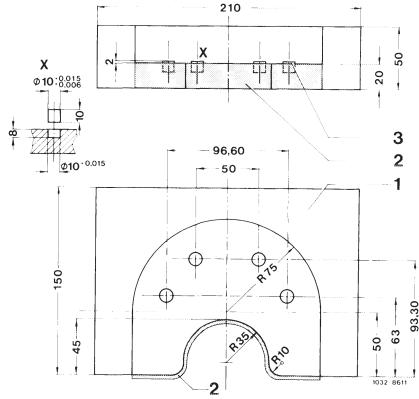
Special tool

11004 - 6210 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.

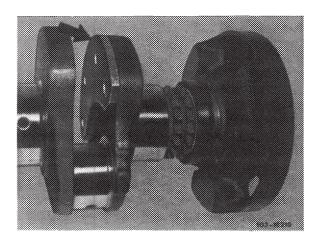
Remove additional weight when machining first crank pin.

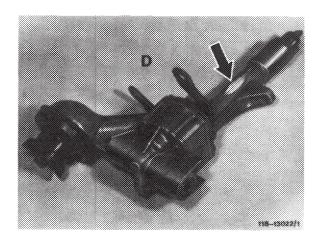
After machining crank pin, rivet additional weight on again. Then check crankshaft for runout, and balance together with flywheel and balancing disc, also when re-using the old additional weight.

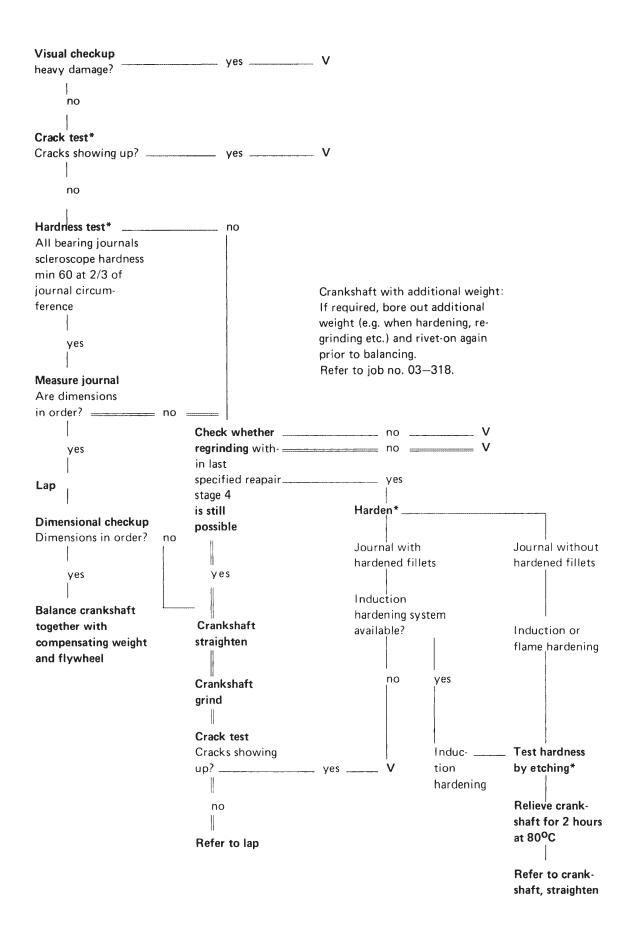
The crankshaft with riveted-on additional weight may be used only together with a modified oil pump which is provided with a recess (arrow) on housing shaft.

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.







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:

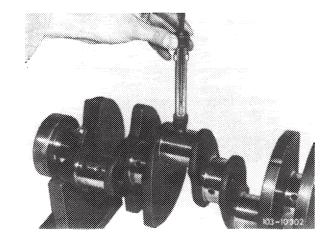
paint or fluorescent powder,

cleaning agent, developer.

Hardness test

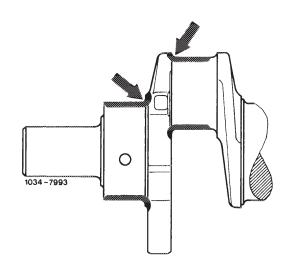
Test hardness with impact hardness tester (scleroscope hardness).

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

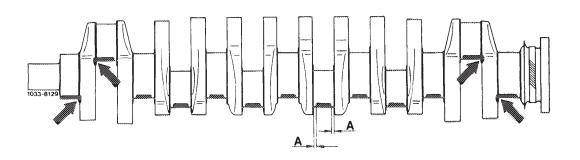


Hardening

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 crank-shafts.

Check hardening by etching surface of journal with a 2% alcoholic nitric acid (HNO₃).

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.

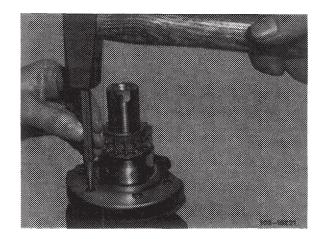
Then, carefully wash off nitric acid by means of alcohol.

Corrosion protection

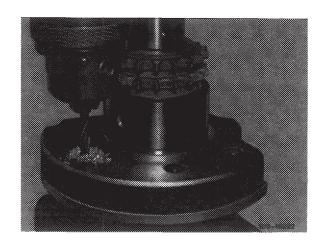
Crankshafts which are not immediately installed again should be lubricated with engine initial operation oil (SAE 30).

Riveting additional weight off and on

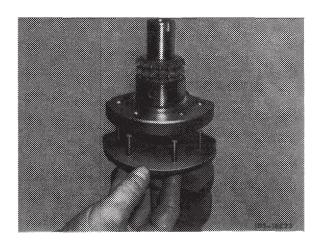
1 Punch mark countersunk rivet 6 x 28 mm accurately in center.



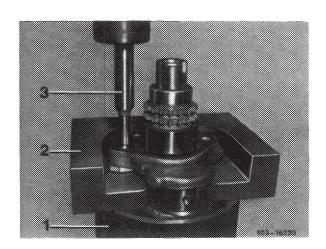
2 Drill into rivet heads with a 6.5 mm dia. drill and knock out.



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

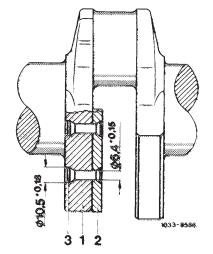


4 Introduce crankshaft into a suitable steel tube (approx. 165 mm dia. x 420 mm long) and place self-made rivet support (2) underneath.



- 1 Steel tube 165 mm dia. x 420 mm long2 Self-made rivet support3 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
110.98410014 634 12051 160	123.033 –050 600 123.053 – 013 292
110.984 -10-014 634 -12-051 160	123.093001 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

-		
п	₽-2	40

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		47.715 47.705	
2nd repair stage	59.465 59.455	up to 29. 60	47.465 47.455	up to 28.30
3rd repair stage	59.215 59.205	up to 25.55	47.215 47.205	σ ρ το 20.30
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	51.60	
		67.02	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 limi		0.08		
Axial bearing play	when new	0.10-0.24	0.11-0.23	
, who sources play	wear limit	0.30	0.50	
			······································	

 $^{^{\}scriptscriptstyle 1}$) Try for mean value of radial play (vertical runout).

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

Measured at apex of bearing shell.
 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.

Tightening torques		Nm
Crankshaft bearing bolts		80
Connecting rod nuts	initial torque	40–50
Committee in the commit	angle of rotation torque	90-100°
Balancing disc to crankshaft		400–450
Necked down screws for	initial torque	30–40
flywheel or driven plate	angle of rotation torque	90-100°
Special tools		
Puller for balancing disc		116 589 10 33 00
Puller for crankshaft gear	1107-0011	615 589 01 33 00
Detent	11004-8590	110 589 00 40 00
Countersupport for internal puller	11004-7724	000 589 33 33 00
Internal puller 14.5—18.5 mm for radial ball bearing	11004-7247	000 589 25 33 00
Dial gauge holder for measuring end play		116 589 12 21 00

Note

Engine removed and disassembled.

Main oil duct in crankcase open (if with steel balls, refer to 01-130). Oil ducts in crankcase and in crankshaft carefully cleaned.

Test crankshaft for cracks, accuracy and hardness (03–318).

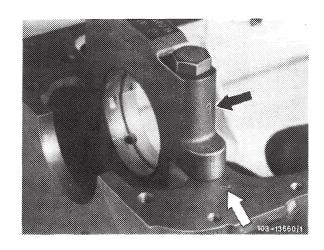
When grinding crankpins a difference of one repair stage only permitted per crankshaft.

Associating cranskhaft bearings, installing crankshaft

1 Install crankshaft bearing cap. Pay attention to identification, 1 is at front (arrows).

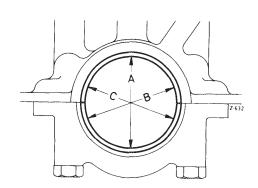
Do not mix up crankshaft bearing caps.

2 Tighten bolts to 80 Nm.



 $3\,$ Measure basic bore in direction A, B and C in two levels (conicity).

If a basic bore exceeds the specified value or is conical, touch up bearing cap at its contact surface on a surface plate up to max. 0.02 mm.

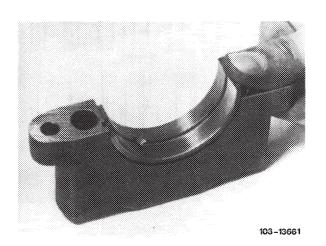


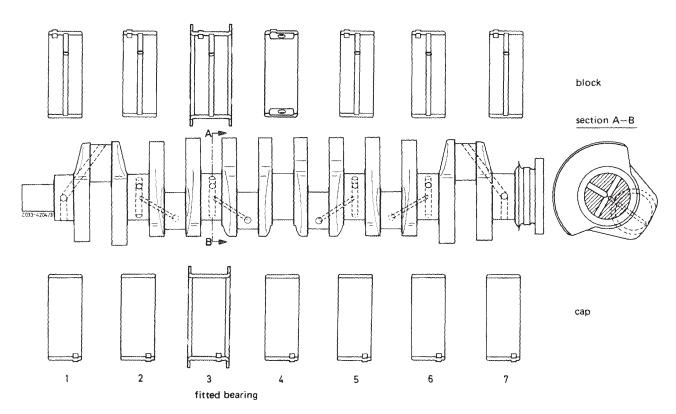
4 Insert crankshaft bearing shells and mount bearing cap. Tighten bolts to 80 Nm torque.

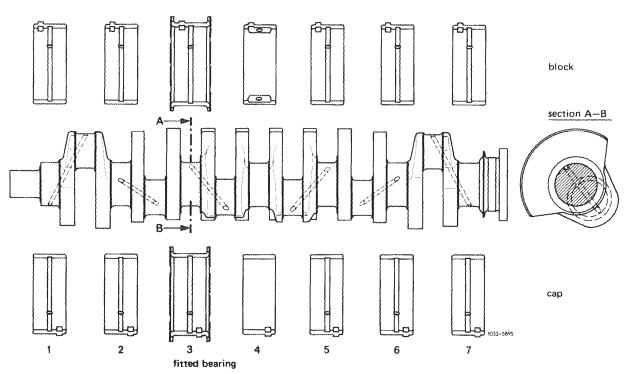
Attention!

When associating crankshaft bearing shells, observe the two different crankshafts.

On crankshafts with tapered bore (2nd version) install crankshaft bearing shells with 360° oil groove.



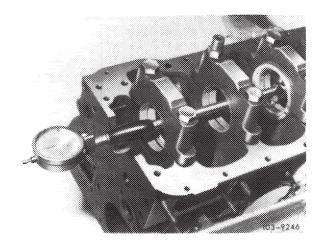




2nd version

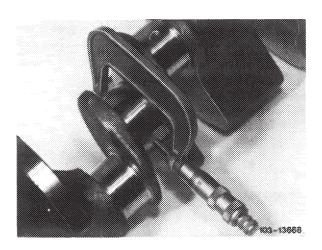
Crankshaft with inclined bore, bearing shells with 360° oil groove.

5 Measure bearing dia and write down.



6 Measure crankshaft bearing journal, find radial crankshaft bearing play (vertical runout).

Note: The bearing play can be corrected by exchanging bearing shells, while trying for lower value (0.031 mm) of specified bearing play. Crankshaft bearing shells without color code are thicker than those with a blue color code, but the fact must be taken into consideration that a wall thickness without and one with color code may overlap.

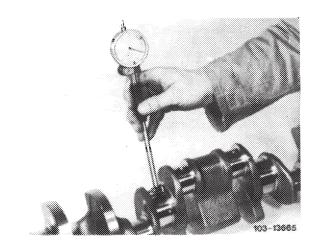


7 Measure width of fitted bearing journal and fitted bearing.

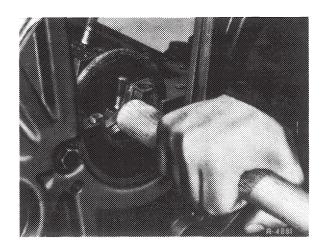
Measure crankshaft bearing end play.

Note: The fitted bearing shells of the repair stages are supplied at oversize.

Both fitted bearing shells must be machined on both sides down to width of fitted bearing journal minus end play. Try for lower value of 0.10 mm.



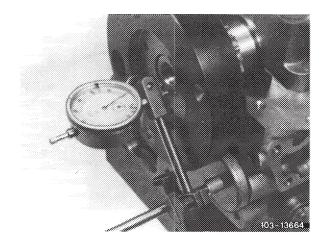
- 8 Replace rear crankshaft radial sealing ring (03–327).
- 9 Provide bearing shells, crankshaft and radial sealing ring with engine oil and install crankshaft.



10 Provide screws on threads and on screw head contact surface with oil and tighten to 80 Nm.

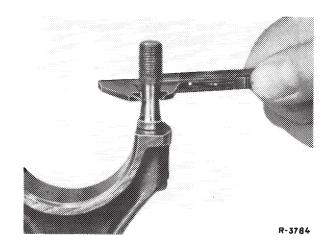
Note: Since January 1976 there are no more washers on crankshaft bearing bolts.

- 11 Measure end play of crankshaft bearings.
- 12 Rotate crankshaft manually and check whether shaft is freely running.

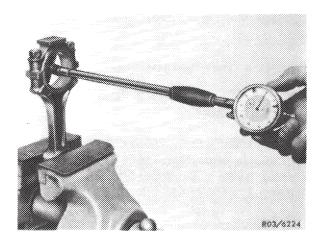


Associating connecting rod bearings and installing connecting rods

- 13 Check connecting rod bolts (03-310).
- 14 Recondition connecting rods and square (03–313).



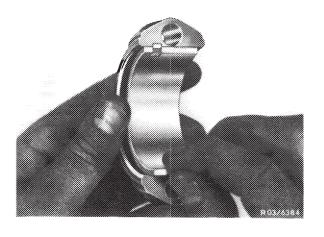
- 15 Mount connecting rod bearing caps while paying attention to identification. Tighten connecting rod nuts to 40–50 Nm.
- 16 Measure basic bore in two directions. If a basic bore exceeds the specified value or is tapered, touch up bearing cap at its contact surface on a surface plate up to max 0.02 mm.



17 Insert connecting rod bearing shells, mount connecting rod bearing caps with bearing shells and tighten connecting rod nuts to 40–50 Nm.

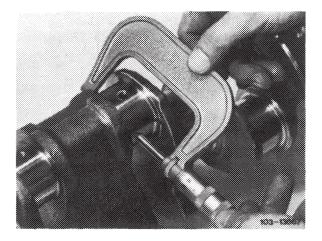
Attention!

Connecting rod bearing shell in connecting rod has an oil bore for lubricating piston pin.



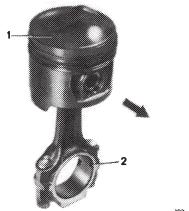
- 18 Measure bearing dia and write down.
- 19 Measure crankpins, determine radial play (vertical runout) of connecting rod bearings.

Note: The bearing play can be corrected by exchanging bearing shells, while trying for mean value (0.04 mm) of specified bearing play. Crankshaft bearing shells without color code are thicker than those with a blue color code, but the fact must be taken into consideration that a wall thickness without and one with color code may overlap.



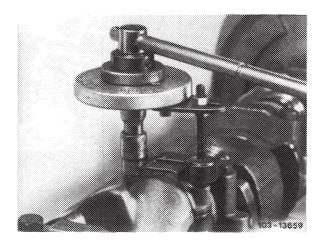
- 20 Mount piston on connecting rod (03-316).
- 21 Provide bearing shells, crankshaft, piston and cylinder with engine oil. Install connecting rod with piston (03–316).

Pay attention to identification.



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22 Tighten connecting rod nuts to 40–50 Nm initial torque and 90–100° angle of rotation.

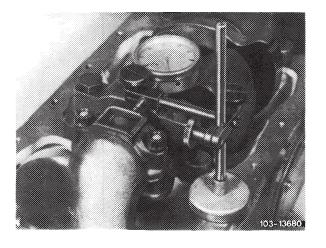


23 Measure end play of connecting rod bearing. Check connecting rod in piston for unobstructed operation.

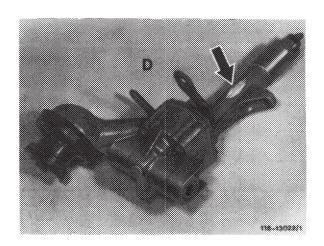
Attention!

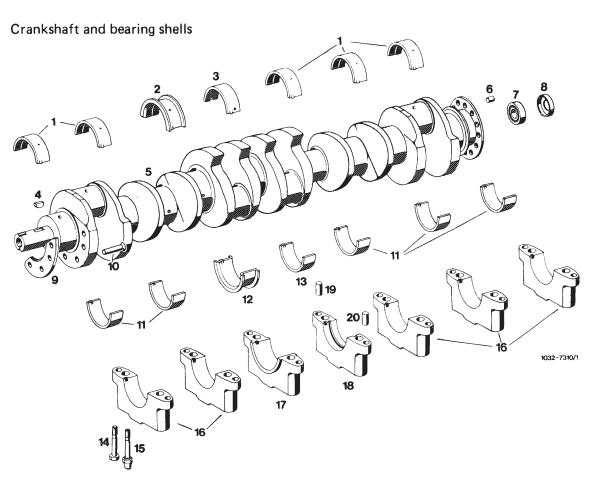
Disassemble and clean oil pump, renew if required. Renew oil pressure relief valve. Disassemble oil filter top and clean. Carefully clean air-oil cooler.

Install initial operation oil filter element. Change engine oil and oil filter element after 1000–1500 km.



Crankshafts with riveted-on additional weight may not be used together with oil pumps, which are provided with a recess (arrow) on housing shaft.





- Crankshaft bearing shells with oil groove and oil bore for bearing 1, 2, 5, 6 and 7
 Fitted bearing shell with oil groove and oil bore for
- bearing 3
- Crankshaft bearing shell with 2 oil pockets and 2 oil bores for bearing 4
- Woodruff key
- Crankshaft
- 6 Cyl. pin 10h 8 x 18
- Radial ball bearing
- Closing ring
- Additional weight
 4 Countersunk rivets 6 x 28 mm DIN 661 MUSt 34
- 1st version crankshaft bearing shells without oil groove and oil bore for bearing cap 1, 2, 5, 6 and 7 and crankshaft with T-bore

2nd version crankshaft bearing shells with oil groove and oil bore for bearing cap 1, 2, 5, 6 and 7 and crankshaft with $360^{\rm O}$ tapered bore

- 12 1st version fitted bearing shell without oil groove and oil bore for crankshaft with T-bore
 - 2nd version fitted bearing shell with oil groove and oil bore for crankshaft with $360^{\rm O}$ tapered bore
- Crankshaft bearing shell without oil groove and oil bore for bearing cap 4
- 12 screws for crankshaft bearing cap
- 2 screws for crankshaft bearing cap (for fastening oil pump)
- Crankshaft bearing cap 1, 2, 5, 6 and 7 Crankshaft bearing cap 4 (fitted bearing)
- Crankshaft bearing cap 4 (with oil groove)
- 7 cyl. pins 10 m 6 x 16 7 cyl. pins 8 m 6 x 16

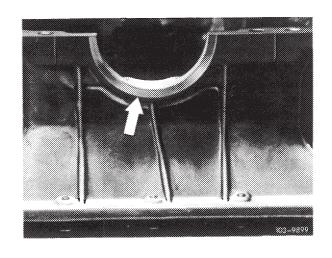
Tightening torques		Nm
Bolt M 18x1.5x45 on crankshaft		400
Bolt M 8 x 65		35
Special tools		
Torque wrench 150–500 Nm (15–50 kpm) 3/4" square	11004-6204	001 589 31 21 00
Puller for balance disc		116 589 10 33 00
Holder	The state of the s	116 589 01 40 00 or
Holder	J.1001.6188	110 589 00 40 00
27 mm socket 1/2" square	1004.6493	001 589 65 09 00
Puller for spacer	1100L-6218	616 589 00 33 00
Radial oil seal installer	11004-6222	110 589 07 61 00

Note

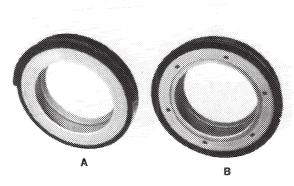
Install radial sealing rings, part no. 004 997 66 47 (two component ring) or 003 997 03 47 (solid viton ring), with all-around shoulder only in engines with oil pan milled flat (arrow).

Radial sealing rings, part no. 008 997 04 47 (two-component ring) or 008 997 05 47 (solid viton ring) with half-round shoulder are provided for oil pans not milled flat.

Prior to installation, provide all radial sealing rings with longterm grease between sealing lip and dust lip.



Install radial oil seals with a half shoulder in engines without a surface milled oil pan.

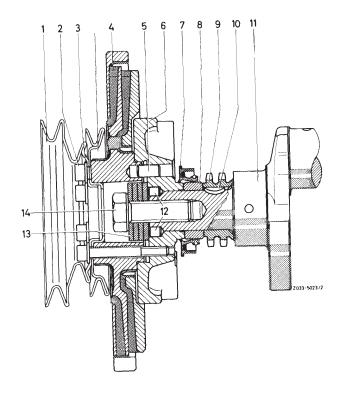


103-9897

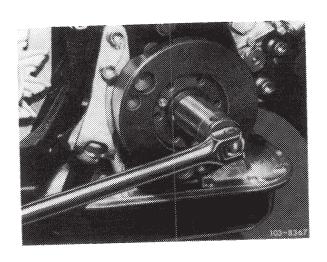
A Radial oil seal with half shoulder B Radial oil seal with full shoulder

Removal

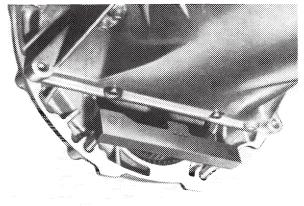
- 1 Remove radiator and fan.
- 2 Remove pulley (1) and vibration damper (4) (03–340).



3 Loosen bolt on crankshaft.

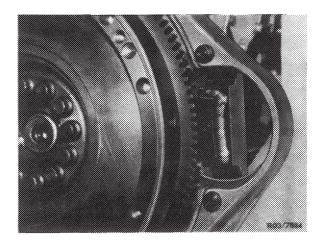


4 Counterhold crankshaft with holder.



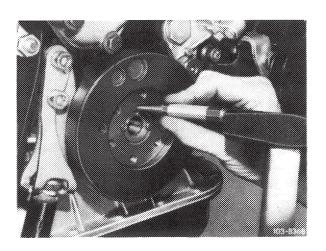
103 - 9243

Holder 100 589 00 40 00

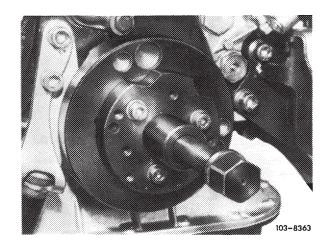


Holder 116 589 01 40 00 when starter is removed

5 Mark balance disc and crankshaft together with a punch mark.



6 Pull off balance disc with an extractor.

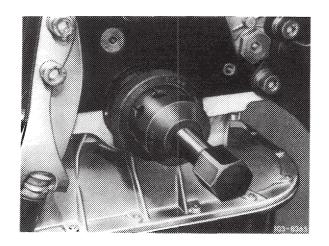


7 Press out radial oil seal with a screwdriver.

Attention!

Be careful not to damage crankshaft journals and radial oil seal bore.

8 If wear can be felt, pull off spacer with an extractor.



Installation

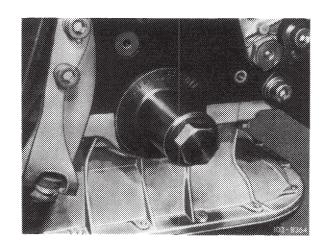
9 Deburr and clean radial oil seal bore.

Note: If the removed radial sealing ring has been leaking at outer shoulder, coat new radial sealing ring prior to insertion on outer shoulder in range of joints with sealing compound, part no. 001 989 29 20 or part no. 001 989 46 20. Permit sealing compound to harden for approx. 3 hours and do not remove inserting tool until then.

- 10 Fill new radial sealing ring behind sealing lip with longterm grease.
- 11 Insert radial sealing ring with inserting tool. For radial sealing rings inserted with sealing compound, remove inserting tool only after 10—15 minutes.

Attention!

The radial oil seal must be at an exact right angle to the crankshaft journal, since otherwise a perfect seal cannot be reached.



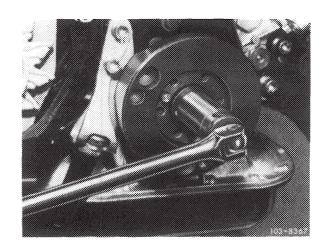
12 Install new spacing ring or turn spacing ring used up to now around and mount in such a manner that the worn groove comes to rest toward the rear.

13 Place balance disc on crankshaft, that the dowel pin bores align.

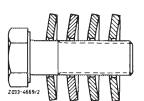
Note: The balance disc is located on the crankshaft by two offset dowel pins.

14 Pull balance disc on to crankshaft withM 18x1.5x45 bolt and one belleville spring washer.

Knock in both dowel pins.



- 15 Install four belleville spring washers with concave surface facing bolt head.
- 16 Tighten bolt on crankshaft to torque of 400 Nm (40 kpm), while counterholding the crankshaft with a holder.
- 17 Install vibration damper, pulley, fan and radiator (03-340).



Tightening torques		Nm
Necked down screw for camshaft gear		80
Connecting rod nuts	initial torque	40–50
Connecting rod nats	angle of rotation torque	90-100 ^o
Necked down screws for flywheel or driven plate	initial torque	30-40
	angle of rotation torque	90-100°
Crankshaft bearing bolts		80
Self-made tool		
Gage		see fig., point 4

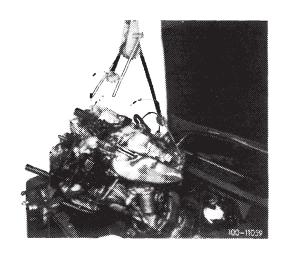
Note

When repairing engines 110, use radial sealing ring 000 997 90 41 (yellow-brown) and cut off with 0.5 mm projection.

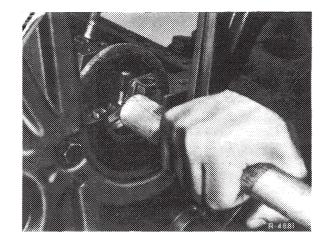
Exception: On engines which are provided with a new or a newly machined (refinished) crankshaft and new crankshaft bearings during repairs, install radial sealing ring 000 997 69 41 (graphite-grey) and cut off with 1 mm projection.

Replacing

- 1 Remove engine (01-030).
- 2 Remove crankshaft.



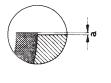
3 Place radial oil seal in crankcase and oil pan, and rub in with an oiled hammer handle.

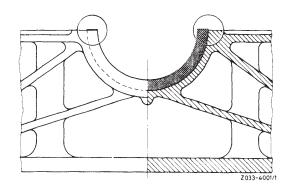


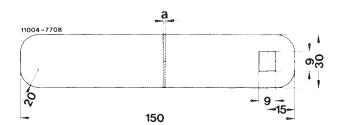
4 To provide an overlap, cut off radial oil seal in crankcase and oil pan about 0.5 mm or 1.0 mm above mating surface.

Note: For cutting off, a self-made gauge according to drawing can be used.

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







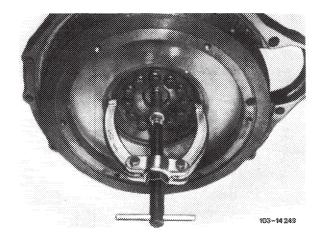
- 5 Coat radial oil seal with oil before installation of crankshaft.
- 6 Install crankshaft.
- 7 Install oil pan, turn crankshaft and check for easy movement.

03-330 Removal and installation of radial ball bearing and closing ring in crankshaft

Special tools Countersupport for internal puller 000 589 33 33 00 Internal puller 14.5–18.5 mm 000 589 25 33 00

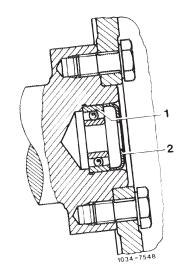
Removal

1 Pull ball bearing and closing ring out of crankshaft together with countersupport and internal puller.



Installation

- 2 Provide new ball bearing (1) with anti-friction bearing grease and knock into crankshaft with a suitable mandrel.
- 3 Knock-in closing ring (2).



03-340 Removal and installation of pulley, vibration damper and balancing disc

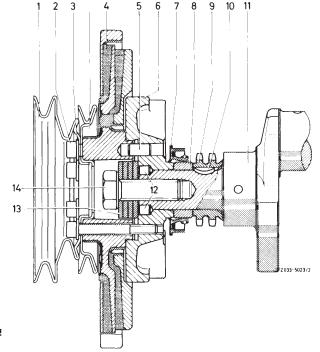
Tightening torques		Nm
Screw M 18 x 1.5 x 45 on crankshaft		400-450
Screw M 8 x 65		35
Special tools		
Socket 27 mm 1/2" square	11002.519)	001 589 65 09 00
Torque wrench 150—500 Nm (15—50 kpm), 3/4" square	11004- 6206	001 589 31 21 00
Detent	Coccessor C	110 589 00 40 00 or
Detent		116 589 01 40 00
Puller for balancing disc		116 589 10 33 00

Note

The vibration damper can be replaced without

If the balancing disc is renewed, static balancing is required (03-344).

Since May 1974 a balancing disc with 3 cutouts for removing tensioning rail bearing bolt is installed.



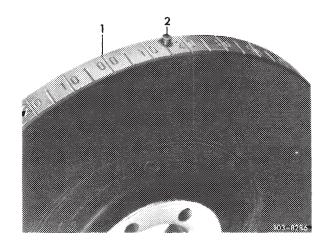
- Pulley
- Screw M 8 x 65
- Vibration damper 254 mm dia Cyl. pin 10h 8 x 18 Balancing disc

- Radial sealing ring
- 8 Spacing ring
- 9 Crankshaft gear
- 10 Woodruff key 11 Crankshaft 12 Set pin 8 x8

- 13 Cup spring 14 Screw M 18 x 1.5 x 4!

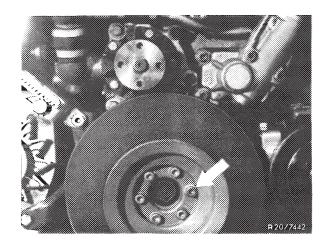
Attention!

For engines which have a "0/0" mark for BDC on the vibration damper besides TDC, the **TDC mark** in the vibration damper is **next to the pin**.

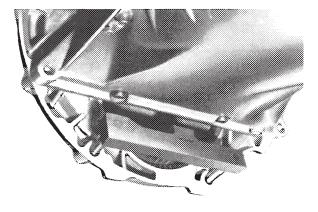


Removal

- 1 Remove radiator and fan.
- 2 Remove pulley and vibration damper.



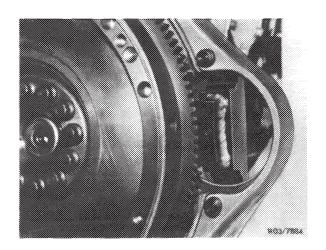
3 Counterhold crankshaft with holder.



103 - 9243

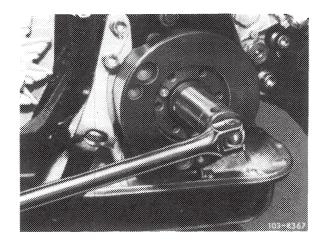
Holder 110 589 00 40 00

Also remove starter of engines with a manual transmission.

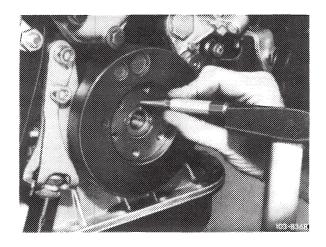


Holder 116 589 01 40 00

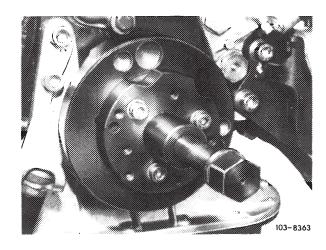
4 Remove bolt in crankshaft.



5 Mark balance disc and crankshaft together with a punch mark.



6 Pull off balance disc with an extractor.

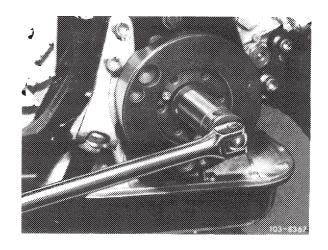


Installation

7 Install balance disc on crankshaft that bores for dowel pins align.

Note: The balance disc is located on the crankshaft by two **offset** dowel pins.

- 8 Pull balancing disc on crankshaft with screw M 18 \times 1.5 \times 45 and a cup spring.
- 9 Knock-in both set pins.

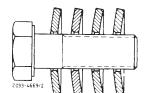


- 10 Mount four cup springs with convex face facing screw head.
- 11 Tighten screw on crankshaft to 400 Nm while applying counterhold to crankshaft by means of detent.

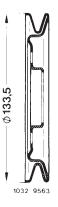
Note: Damaged threads M 18×1.5 in crankshaft journal at the front can be repaired by inserting a helicoil insert 0130 0184027.

12 Install vibration damper, pulley, viscofan and radiator.

Note: Take association of pulley on crankshaft for various engines 110 from the following list.



Pulley	Engine
110 155 00 15	110.921
	110.931
	110.981
	110 001



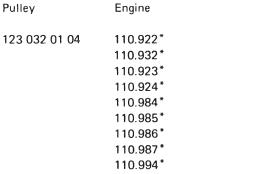
110 155 00 15

Pulley	Engine
110 466 01 15	110.921* 110.931* 110.922 version 1 110.032 version 1 110.981* 110.991* 110.982 110.992 110.983 110.993
	Control of the contro

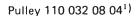
^{*} with special version power steering or air conditioning

Pulley	Engine
123 032 00 04	110.922 version 2 110.932 version 2 110.923 version 1 ³ 110.924 version 1 ³ 110.984 version 1 ³ 110.985
	110.986 110.987 version1* 110.994

^{*} with 55 Ah alternator



^{*} with special version air conditioning or emission control



Introduction into series JAugust 1978

starting engine end no. starting chassis end no.

Introduction into series (\$\sigma^2\$) and (USA) March 1980

starting engine end no. starting chassis end no.

123.007²)

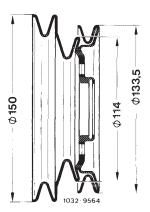
110.984 -10-023 276 123.033 019 600

-12-076 809 123.053

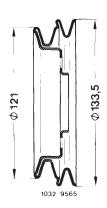
110.985 -12-075 271 116.024-157 385

1) Together with 65 Ah alternator

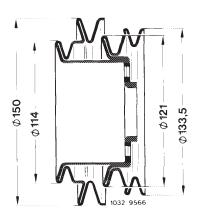
2) S only



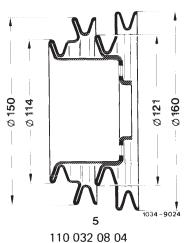
110 466 01 15



123 032 00 04



123 032 01 04

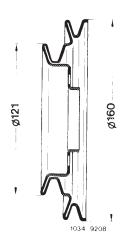


Pulley 110 032 09 04* (formerly 123 032 00 04)

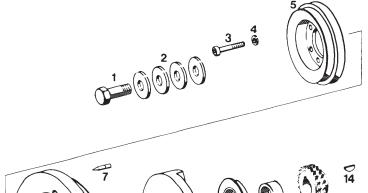
Introduction into series March 1980

starting chassis end no. starting engine end no.

110.923 -10-014 965	123.030-029 250
-12-018 195	123.050-003 705

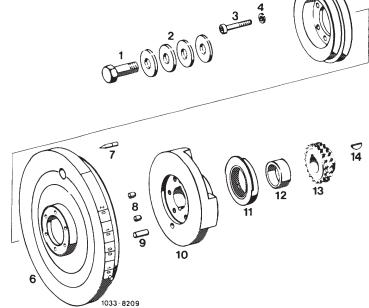


Pulleys, vibration damper and balancing disc



- 1 Screw M 18 x 1.5 x 45
- 2 Cup springs
- 3 6 screws M 8 x 65
- 4 6 washers 8.4
- 5 Pulley
 6 Vibration damper 254 mm dia
 7 Adjustment indicator
 8 2 set pins 8 x 8

- 9 Cyl. pin 10h 8 x 18
- 10 Balancing disc
- 11 Radial sealing ring12 Spacing ring13 Crankshaft gear
- 14 Woodruff key



^{*} together with 65 Ah alternator

Special tool

Balance disc holder



617 589 02 63 00

Conventional tool

Rolling device

Trebel, D-4030 Ratingen, type EO, order no. 03600/0904/E 0010

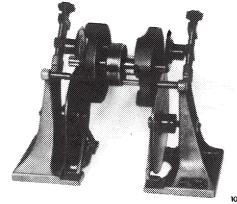
Note

The balance condition of the old balance disc must be transferred to the new balance disc.

All parts of a broken balance disc must be pasted together and be statically balanced with a new balance disc.

Static balancing

- 1 Place new balance disc on balancing holder with an offset of $180^{\rm O}$ over old one.
- 2 Let balancing holder with both balance discs oscillate on rolling device.

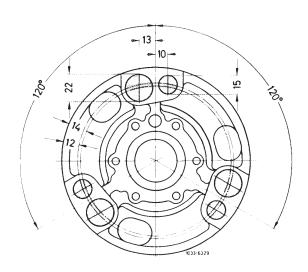


103-10649

3 Drill new balance disc in such a manner, that the balance discs remain still without oscillating in any position on the rolling device.

Pay attention to position of balancing bores (illustration).

Hole depth max 25 mm.



Balancing disc rear

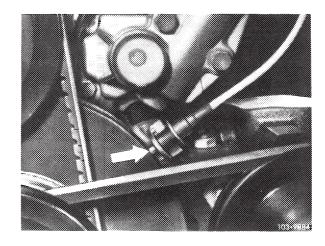
03-345 Checking and correcting adjustment of TDC transmitter

Tightening torque		Nm
Bolts and capped nuts for cylinder head cover	er	5
Special tools		
TDC tester	111004-7491	110 589 10 21 00
Locating device for adjusting slide (2nd version of adjusting slide)	100.54.7	116 589 19 21 00
27 mm socket to turn engine	1002L-0-\$1	001 589 65 09 00
Locating device for TDC transmitter (1st version of adjusting slide)	11004-7494	110 589 08 21 00
Guide for TDC transmitter (1st version of adjusting slide)	1004-7493	110 589 06 61 00

Note

With the crankshaft position at 20° the TDC transmitter must be exactly above the TDC pin in the vibration damper (arrow).

Distance between TDC transmitter and guide pin in vibration damper 0.2—2.0 mm.

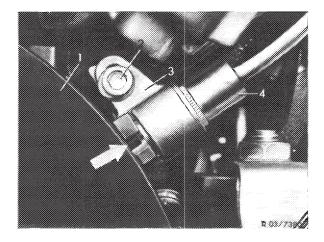


2nd version of adjusting slide

The adjustment of the TDC transmitter must be checked and corrected:

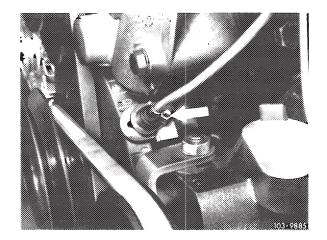
- a) when replacing TDC transmitter adjusting slide,
- b) when replacing crankshaft with balance disc and vibration damper, and
- c) when completing a partial engine.

1st version of adjusting slide



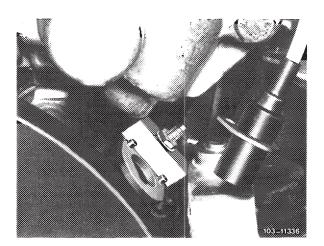
Checking

1 Unscrew TDC transmitter (arrow).

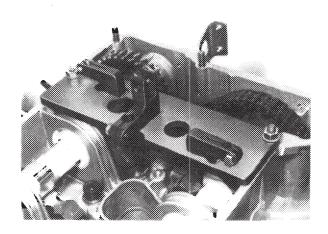


2 Pull out TDC transmitter.

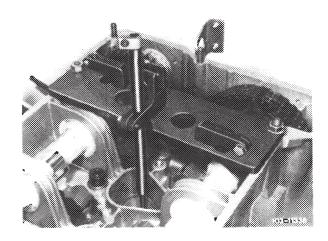
Note: TDC transmitters (1st version), which are fastened with a socket head cap screw, must be loosened and removed with guide 110 F89 06 61 00.



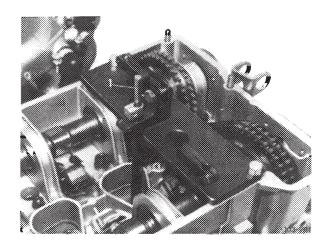
- 3 Take off cylinder head cover.
- 4 Unscrew spark plug of 1st cylinder.
- 5 Screw-on tester above 1st cylinder.



6 Guide in gage extension, do not clamp.

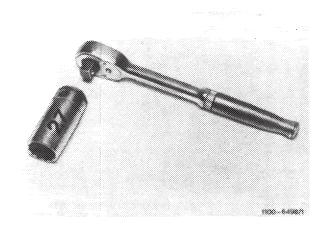


7 Insert adjusting pin (1) and press down.

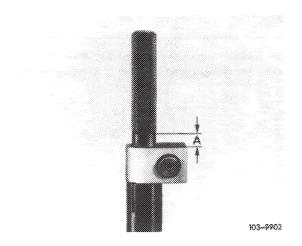


8 Turn crankshaft with tool combination until adjusting pin is at its highest point.

The piston is at TDC.



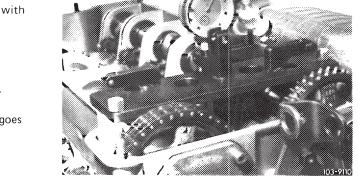
9 Clamp the gage extension in the tester that distance A will be about 5 mm when the adjusting pin is pressed down.



- $10\,\,$ Remove adjusting pin. Insert dial gage and clamp it with preload of about 5 mm.
- 11 Turn crankshaft and adjust TDC accurately with dial gage.

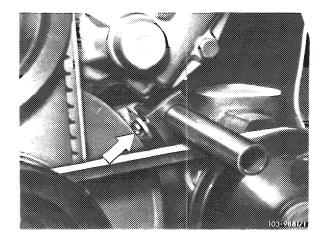
Always turn crankshaft in direction of rotation.

- 12 Turn dial gage scale until needle points to 0.
- 13 Continue turning crankshaft until dial gage goes back by **3.07 mm.**



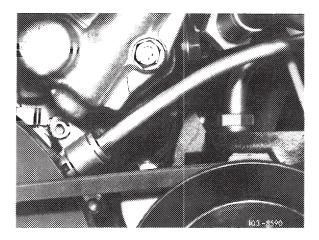
14 Insert locating device in adjusting slide.

Pin of vibration damper should engage in groove of locating device (arrow).



2nd version of adjusting slide, locating device 116 589 19 21 00

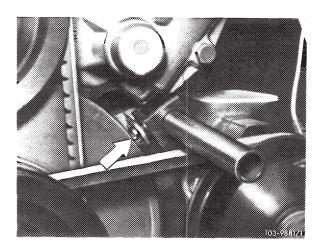
Note: Use locating device 110 589 08 21 00 for 1st version of adjusting slide.



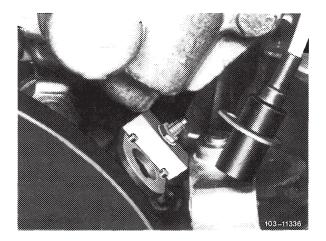
1st version of adjusting slide. locating device 110 589 08 21 00

Correcting

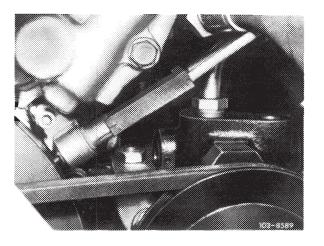
15 Loosen adjusting slide and displace until pin of vibration damper enters groove of locating device.



- 16 Tighten adjusting slide and remove locating device.
- 17 Install and fasten TDC transmitter.



Note: For 1st version of adjusting slide install the TDC transmitter with guide 110 589 06 61 00 and fasten with a socket head cap screw.



Tightening torques		Nm
Bolt M 18 x 1.5 x 45 on crankshaft		400450
Bolts and capped nuts for cylinder head cover		5
Special tools		
Torque wrench 150–500 Nm (15–50 kpm), 3/4'' square	1004-6206	001 589 31 21 00
Socket 27 mm, 1/2'' square	11004-6453	001 589 65 09 00
Detent	11004-6194	110 589 00 40 00
Detent	T TO SEE	116 589 01 40 00
Puller for balancing disc		116 589 10 33 00
Puller for spacing ring	11704 6218	102 589 00 33 00
Crankshaft sprocket extractor		615 589 01 33 00
Bearing pin impact extractor (basic unit)	1106-6220	116 589 20 33 00
Threaded pin M 6 x 50 for impact extractor	11004 - 635B	116 589 01 34 00
Threaded pin M 10 x 100 for impact extractor	11004-6216	116 589 03 34 00
Stud socket 10 mm, 1/2'' square, 140 mm long	11004-1112	000 589 05 07 00
Radial oil seal installer		110 589 07 61 00

Chain tensioner holder



110 589 02 31 00

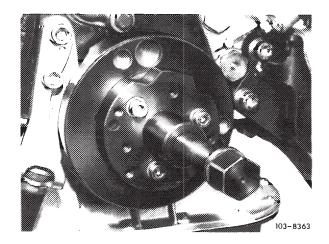
Knocking-out mandrel 9 mm dia

11004 5194

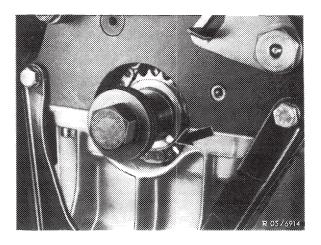
110 589 02 15 00

Removal

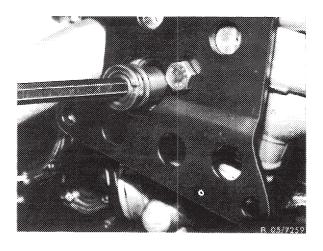
- 1 Remove radiator and fan.
- 2 Remove front crankshaft radial oil seal (03-324).



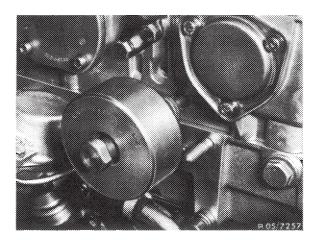
3 Use paint to mark both camshaft sprockets and camshaft sprocket to timing chain (arrow).



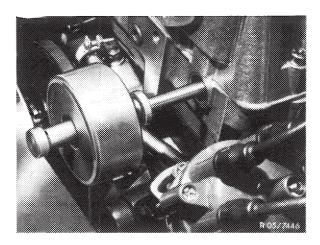
4 Remove chain tensioner (05-310).



5 Remove guide rail in camshaft housing.



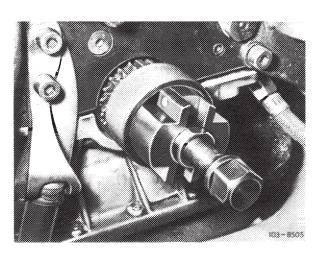
- 6 Remove reversing wheel. This requires unscrewing the plug and knocking out the bearing pin with an impact extractor (M 10 threaded pin).
- 7 Remove reversing wheel with a wire hook upward.
- 8 Remove oil pan to an extent that the timing chain can be taken off of the crankshaft sprocket.



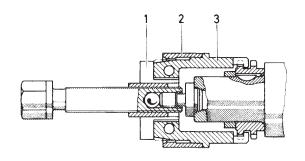
9 Pull-off spacing ring with puller.



10 Pull off crankshaft sprocket with an extractor.



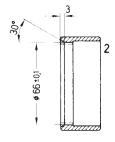
Note: Change puller 615 589 01 33 00 to dimensions shown in drawing.

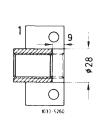




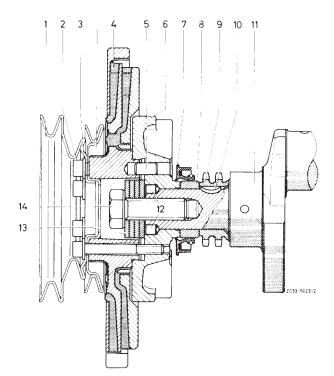
Installation

11 Transfer color marks from old to new crankshaft gear.





- 12 Heat crankshaft gear on a hot plate (approx. 80 $^{\rm O}$ C) and slip on crankshaft.
- 13 Slip spacing ring on crankshaft.



14 For further installation proceed vice versa, paying attention to pertinent color marks.

Necked down so	crews	for manual transmission	for automatic transmission		
		1034 - 5219/1	1034 - 5218/1	D	034-814
			1st version	2nd version	3rd version
Part no.		615 032 05 7	108 990 03 19	110 990 03 19	110 990 04 19
Thread dia D		M 10 x 1	M 10 x 1	M 10 x 1	M 10 × 1
Necked down	when new	8.5-0.2	7.7-0.2	7.7-0.2	7.7-0.2
dia d	minimum dia	8.1	7.3	7.3	7.3
Length L		20	31	31	31
Tightening torqu	ies				
			Initial to	rque 4	0 Nm
Necked down sc	rew for driven p	late and flywheel	Torque a	ngle 9	0—100°
Special tool					
Detent			100 min	1	16 589 01 40 00

Note

Do not mix up flywheel for automatic transmission of 110 engine with flywheel for automatic transmission of 4-cylinder engines 115 and 615.

Engine 110 dimension a = 4.5 mm

Engine 115 and 615 dimension a = 6.5 mm

On exchange engines, the mounting bore in flywheel of 35 mm dia can be bored to 50.00-50.016 mm dia (50 H6) for transmission with hydraulic clutch (722.200/202).

Layout of flywheel and driven plate for automatic transmission

Crankshaft Flywheel

4.5 mm

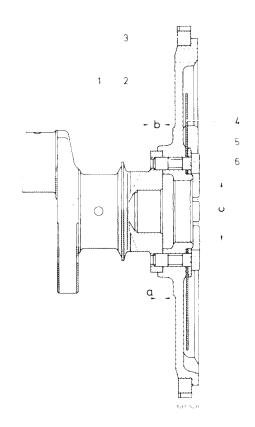
2 3 Ring gear b = 10 mm 50 mm dia (transmission

4 5 6 Driven plate Disc

with hydraulic clutch 722.200/202), transmission type K4C025 35 mm dia. (transmission with torque converter 722.1), transmission

Necked down screw

type W4B025



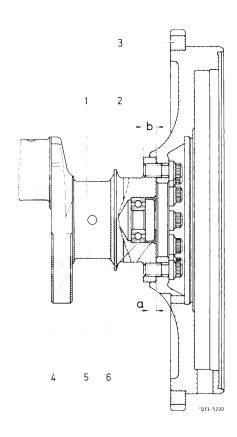
Layout flywheel for manual transmission

Crankshaft Flywheel

5 Closing ring6 Necked down screw 5 mm

Ring gear Ball bearing

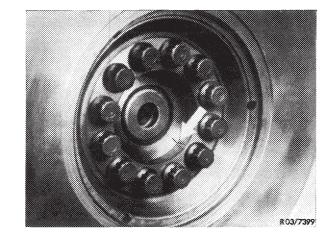
b = 10 mm



Removal

1 Loosen necked down screws, remove flywheel, driven plate and spacing washer.

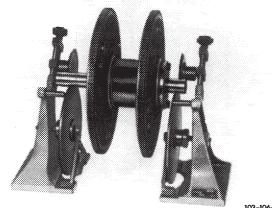
Note: The flywheels and the crankshaft are marked together (arrow).



Flywheel manual transmission

Installation

Note: If a new flywheel is installed, unbalance should be the same as for old flywheel (03—440).



103-10648

2 Measure necked down dia d of necked down screws.

When the minimum dia is attained, replace necked down screws.

Necked down screws 1st and 2nd version for automatic transmission can be replaced by 3rd version.

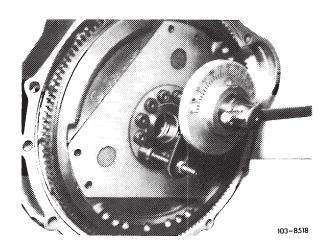
3 Position flywheel on crankshaft journal in such a manner that the markings (arrow) are in alignment.

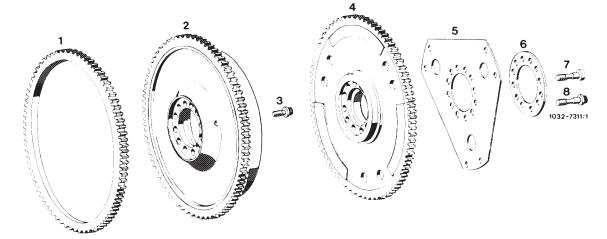


Flywheel automatic transmission

4 Screw-in necked down screws and pre-tighten to 30-40 Nm with torque wrench.

5 Complete angle of rotation torque 90-1000 by means of angle of rotation wrench.





- Starter ring gear Flywheel with starter ring gear for manual
- 12 necked down screws
 Flywheel with starter ring gear for automatic transmission

- 5 6 7 8
- Driven plate Spacing ring 12 necked down screws 1st version 12 necked down screws 2nd and 3rd version

Data

Distance a		19.4 + 0.1
Distance b	New	18.5
	Machining limit	17.5
Permissible axial runout		0.05

Note

Machine a flywheel for manual transmissions having grooves, cracks or burnt spots by grinding or milling.

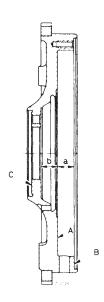
If grooves or cracks are deeper than the max permissible allowance, replace flywheel.

If clutch surface A is machined, mounting surface B must also be machined to maintain distance a.

Machining must never reduce distance b.

The flywheel must be held perfectly for machining, so that the permissible axial runout of 0.05 mm will not be exceeded.

After machining the clutch surface must not show blow-holds or chatter marks.



Data

Permissible axial runout measured on ring gear	max 0.4
Centering flange dia for ring gear	268.31-268.39
Shrink-on temperature	max 250°C
Annealing color	red brown

Conventional accessory

Temperature measuring chalk for 220°C

e.g. made by AW Faber-Castell D-8504 Stein bei Nürnberg Color no. 2815/220 (white) thermochrome

Note

The ring gear is hardened. To protect hardened structure a max temperature of 250 °C should never be exceeded at any point when heating ring gear. Heating can be reliably done by means of a hot plate or a heating furnace only.

A flame may be used as an exception only. Flame should cover inside of ring gear only.

Following replacement of ring gear, no balancing of flywheel is required.

Only ring gears with chamfered teeth are supplied as spare parts.

These ring gears can also be installed on vehicles with manual transmission in place of ring gears without chamfer.

Replacement

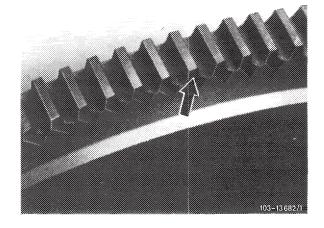
- 1 Drill into old ring gear and break up with a chisel, or heat quickly and then remove immediately.
- 2 Clean contact surface of ring gear on flywheel.
- 3 Uniformly heat new ring gear on a hot plate or in a heating furnace.

For this purpose, use temperature measuring chalk according to instructions.

4 Fit heated ring gear immediately on flywheel.

Attention!

The tooth chamfer (arrow) should face starting motor.

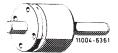


Data

Flywheel for	Balance bores max. drilling depth	Drill dia.	Hole locating dia.
manual transmission	20 + 1	11	251
tomatic transmission drilled through		11	251

Special tool

Balancing mandrel (flywheel for automatic and manual transmissions)



617 589 00 63 00

Conventional tool

Rolling device for static	Trebel, D-4030 Ratingen
balancing	type EO, order no. 03600/0904/E 0010

Note

Crankshaft, balance disc and flywheel are balanced together.

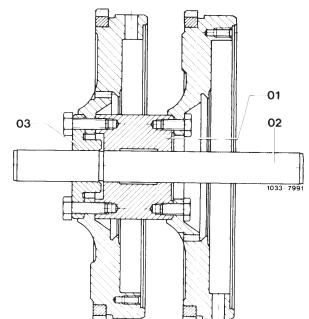
A new flywheel must be balanced to the same value of the one removed.

The balancing condition of a flywheel for manual transmission can be transferred to a flywheel for automatic transmission by static balancing (and vice versa).

Static balancing

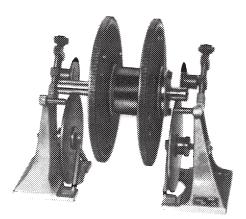
- 1 Place old and new flywheels on top of each other that all bores align and both clutch surfaces face in one direction.
- 2 Transfer mark from old to new flywheel.

3 Apply balancing mandrel and bolt new flywheel with an offset of exactly 1800 over old unit.



- 01 Mounting fixture
- 02 Shaft 03 Centering disc

4 Let balancing mandrel with both flywheels oscillate on rolling device.



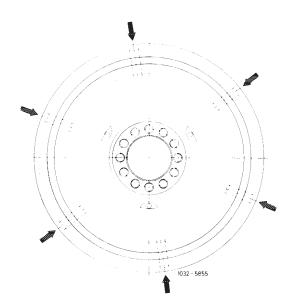
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5 If an unbalance is found, drill so many holes in mass of new flywheel until the flywheels remain still without oscillating in any position.

Attention!

The hole circle dia, the drill dia and the max drilling depth must be maintained (refer to table).

The dust bores (arrows) must not be drilled.



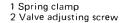
Valve clearance	cold engi	ne (approx. 20 °C)	warm engine (60 $^{\circ}$ C ± 15 $^{\circ}$ C)
Intake	0.10 ¹)		0.15¹)
Exhaust	0.25		0.30
1) 0.05 mm more for co	onsistent outside temperature be	low -20 °C.	
Tightening torques			Nm
Valve adjusting screv	v		20–40
Cylinder head cover	capped nuts and bolts		5
Special tools			
Valve adjusting wren	och 17 mm	11004-7003	110 589 00 01 00
Valve adjusting wren	och 17 mm, 1/2" square, of adjusting screw	11004-4001	110 589 00 01 00
Slip gauge		11004-6364	617 589 00 40 00
Slip gauge blades	0.10 mm thick 0.15 mm thick 0.20 mm thick 0.25 mm thick 0.30 mm thick	11004-6369	617 589 00 23 00 617 589 01 23 00 117 589 00 23 00 117 589 01 23 00 617 589 02 23 00
Socket wrench insert	t 27 mm, 1/2'' square	11004-6193	001 589 65 09 00
Contact grip to turn engine (part of compression recorder 001 589 46 21 00)			001 589 46 21 08

Check and adjust valve clearance of cold or warm engine.

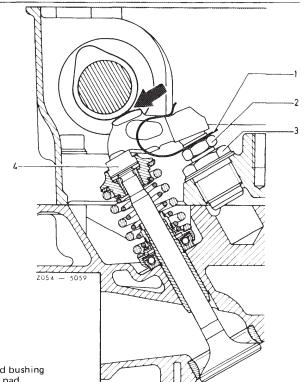
Install a thinner pressure pad (4) if the room for adjustment is no longer sufficient. Pressure pads are available in thicknesses of 2.5, 3.5 and 4.5 mm.

Attention!

The torque of easy going valve adjusting screws (2) must be checked. This requires removing all spring clamps (1) with a screwdriver and checking the torque with a valve adjusting wrench, part number 110 589 00 01 00, and a torque wrench (e. g. part number 000 589 27 21). If the torque of the valve adjusting screw is less than 20 Nm (2 kpm), replace valve adjusting screw (2) or threaded bushing (3) with valve adjusting screw (2).



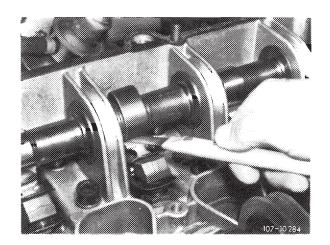
³ Threaded bushing 4 Pressure pad



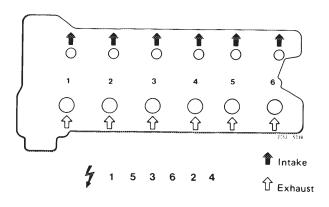
Adjusting valve clearance

- 1 Remove rubber seals.
- 2 Check valve clearance between rocker arm and camshaft, whereby the cam peak must be up.

The valve clearance is correctly adjusted, if the slip gauge fits tight when pulled through.

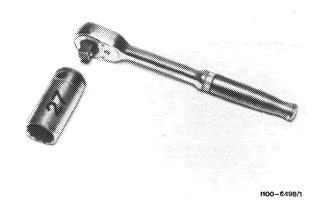


3 Note layout of intake and exhaust valves.



The engine can be turned as follows:

a) with the combination tool at front end of crankshaft.

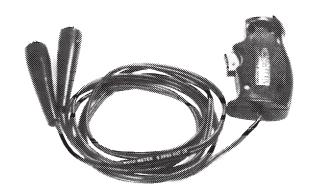


b) with the starter and contact grip.

Models 107, 114 and 116

Connect contact grip to battery plus and terminal 50 to starter.

Disconnect cable on ignition coil terminal 1.

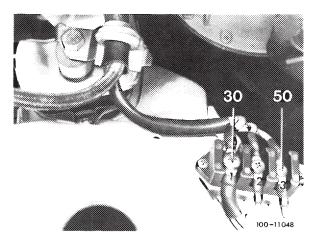


105-9061

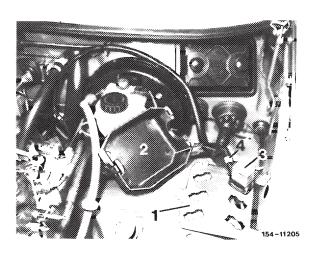
Model 123

Connect contact grip to terminal 30 and terminal 50 to wire connector.

Disconnect cable on ignition coil terminal 1.

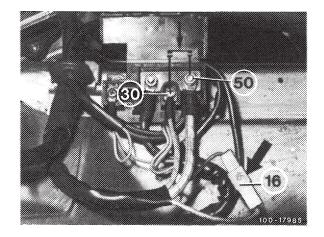


Disconnect fuel pump relay (3) of engines with continuous fuel injection.

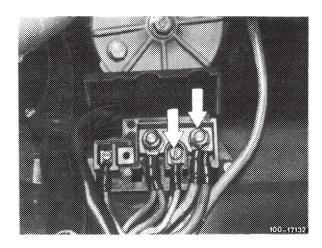


Model 126

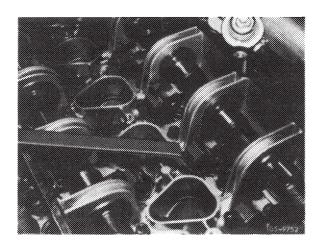
Separate cable plug (terminal 16, arrow) so that ignition coil and on engines with CIS the fuel pump cannot be activated.



Connect terminals designated with arrows.



- 4 Adjust valve clearance by turning the valve adjusting screw with a valve adjusting wrench.
- 5 Check spring clamps for perfect fit.
- 6 Check seals, replacing if necessary.



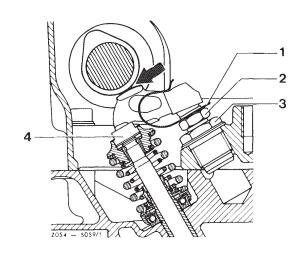
05-212 Replacing threaded bushing and valve adjusting screw

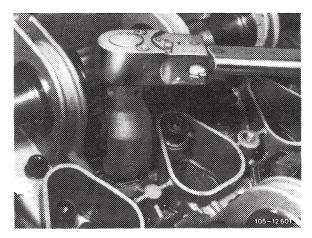
Valve clearance	Cold engine (approx. 20 $^{\circ}$ C)	Warm engine (60 $^{\circ}$ C \pm 15 $^{\circ}$ C)
Intake	0.10 ¹)	0.151)
Exhaust	0.25	0.30
1) 0.05 mm more for consistent outside term	nperatures below –20 °C.	
Tightening torques		Nm
Cylinder head cover bolts and capped	nuts	5
Cylinder head threaded bushing		80
Valve adjusting screw		2040
Special tools		
Depressor for valve spring		110 589 04 61 00
Valve adjusting wrench 17 mm, 1/2" s for checking torque of adjusting screw	K. Allendar N	110 589 00 01 00
Valve adjusting wrench 17 mm	11004-7003	110 589 01 01 00
Contact grip to turn engine (part of compression recorder 001 589 46 21 00)	1004	001 589 46 21 08

If torque of valve adjusting screw is less than 20 Nm (2 kpm), replace valve adjusting screw (2) or threaded bushing (3) with valve adjusting screw (2).

- Spring clamp Valve adjusting screw Threaded bushing

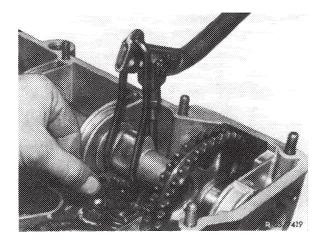
The torque can be checked with a valve adjusting wrench, part number 110 589 00 01 00 and a torque wrench (e. g. part number 000 589 27 21).



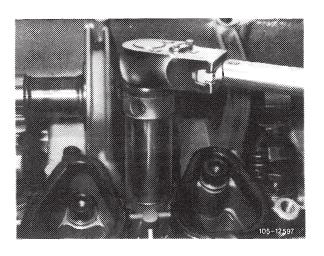


Replacing

1 Remove rocker arms (05-230).



2 Unscrew threaded bushing with valve adjusting screw.



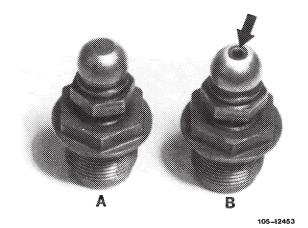
Attention!

Only use valve adjusting screws with an oil bore (arrow).

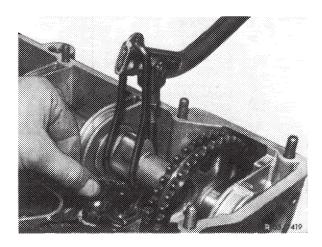
3 Coat threads of threaded bushing with valve adjusting screw with tallow, install and tighten threaded bushing to a torque of 80 Nm (8 kpm).

Attention!

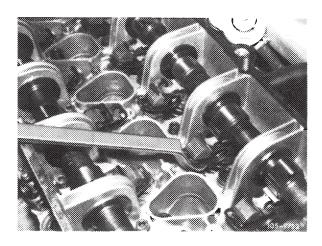
Threaded bushing must be free of burrs when installing, since these would find their way into the oil circuit.



4 Install rocker arms (05-230).



5 Adjust valve clearance (05-210).



Timing at 2 mm valve lift

			I		
Version		all	Exceptions USA California 1974	USA Federal 1973 and 1974	(J) (USA) 1981
Camshaft	Exhaust	24, 57, 71, 78	24	20, 95	78
code number ¹)	Intake	25, 67, 74	25, 74	33, 91	74
	Opens after TDC	7°	7°		7°
Intake valve	Closes after BDC	21°	21°		21°
Exhaust valve	Opens before BDC	30°	30°		34°
LANGUST VAIVE	Closes before TDC	12°	12°		16°

¹⁾ Camshaft code number is punched into rear end of camshaft.

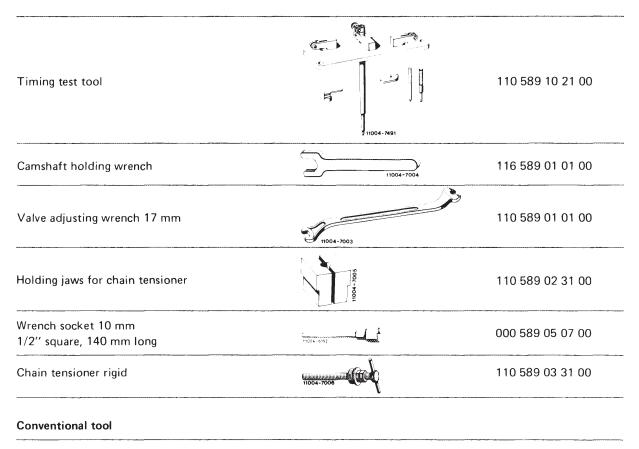
Valve clearance	On cold engine (approx. 20 °C)	On warm engine (60 °C ± 15 °C)		
Intake	0.10 ¹)	0.15 ¹)		
Exhaust	0.25	0.30		

 $^{^{\}rm 1})$ 0.05 mm larger during lasting outside temperatures below $-20~{\rm ^{O}C}.$

Tightening torques	Nm
Cylinder head cover bolts and capped nuts	5
Expansion bolts for camshaft sprockets	80
Ball locating ring in chain tensioner	25
Valve adjusting screw	20–40

Special tools

	110 589 04 61 00
11004-6193	001 589 65 09 00
11004-6220	116 589 20 33 00
11004-6368	116 589 01 34 00
	11001-6120



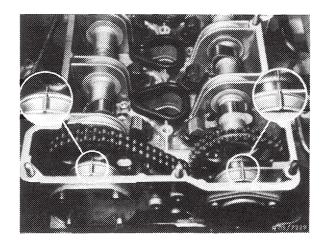
Dial gauge A 1 DIN 878

e.g. made by Mahr, 7300 Esslingen order no. 810

Note

Check when intake valve begins to open and exhaust valve of 1st cylinder stops to close.

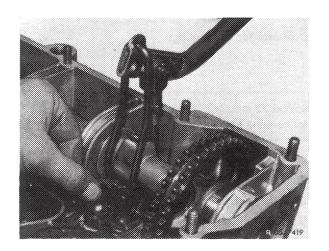
For assembly jobs it is sufficient when the marks on the camshafts are aligned for ignition TDC position of 1st cylinder.



Checking

1 Remove both rocker arms of 1st cylinder with the installation and removal tool.

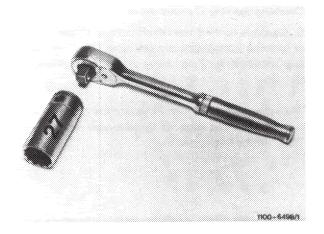
This requires turning the crankshaft until the cam peak is up.



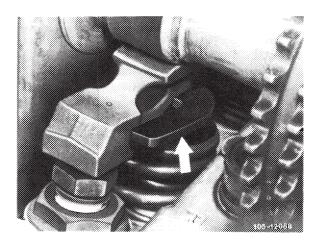
Turn crankshaft with combination tool.

Attention!

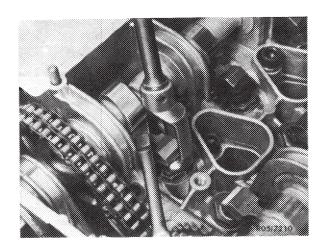
Never turn engine on camshafts.



2 Replace both pressure pads by test pads (arrow) and install rocker arms without spring clamps.

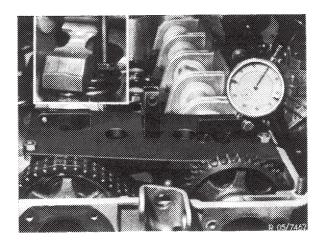


3 Turn valve adjusting screw until rocker arm rests free of play against cam base circle.



- 4 Set up and install tester.
- 5 When valve is closed, i. e. the cam faces up, insert the dial gage with an extension pin into the tester. Adjust for a preload of 3 mm (small indicator must point to 3) and clamp the dial gage.

Turn the adjustable dial, until the large indicator points to "0".



Checking opening of intake valve

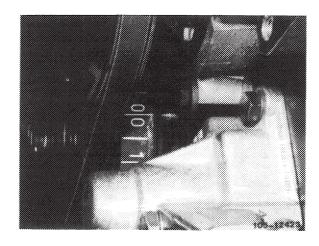
6 Continue turning crankshaft in engine's direction of rotation (cam begins to open valve), until the dial gage goes back by 2 mm (valve stroke) to a preload of 1 mm.

The value on the vibration damper must correspond with the specified value for "intake valve opens after TDC" in this engine position.

Checking closing of exhaust valve

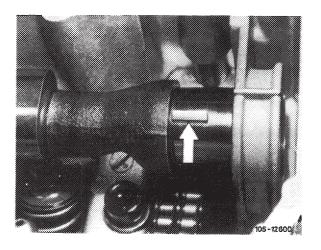
7 Continue turning crankshaft in engine's direction of rotation. The exhaust valve will be opened and the dial gage returns to "0". Now when closing the exhaust valve, the dial gage pin returns to position and the indicators begin to turn. The small indicator must stop at 1 and the large indicator at "0".

The value on the vibration damper must correspond with the specified value for "exhaust valve closes before TDC" in this engine position.



Adjusting

If the timing has to be corrected, an offset woodruff key or a new timing chain, if chain stretching is excessive, must be installed.

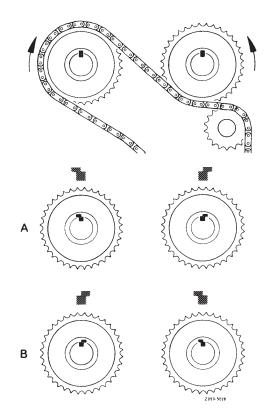


Woodruff keys are available in the following sizes.

Offset in mm	Part number	for correction of about
0.7	621 991 04 67	4° crankshaft
0.9	621 991 02 67	6 1/2° crankshaft
1.1	621 991 01 67	8° crankshaft
1.3	621 991 00 67	10° crankshaft

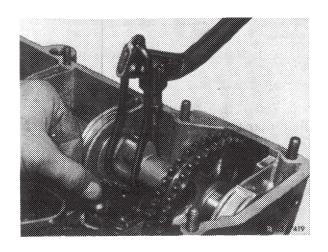
An offset of 1 tooth on the camshaft sprocket means about $18^{\rm O}$ on the crankshaft.

Since both camshafts rotate against each other, the installed position is important when installing an offset woodruff key.

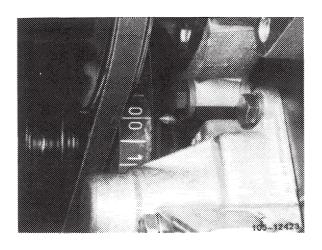


With installed position "A" opening begins earlier With installed position "B" opening begins later

8 Remove all rocker arms on camshaft to be adjusted (05-230).

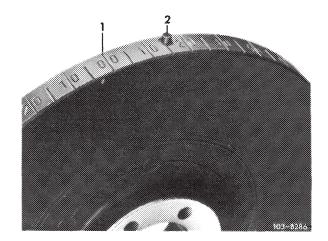


9 Set first cylinder of engine at ignition TDC. Marks on camshaft sprockets and camshaft housing must align.



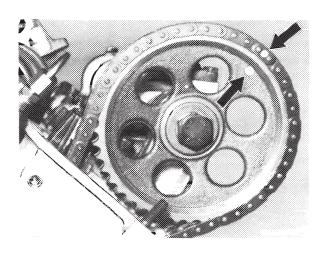
Attention!

If the vibration damper of an engine has a "0/0" mark for BDC in addition to one for TDC, the TDC mark is next to the pin in the vibration damper.

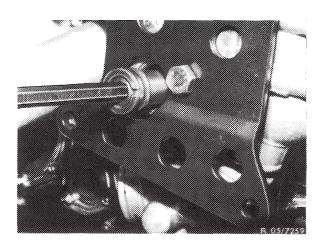


1 TDC mark

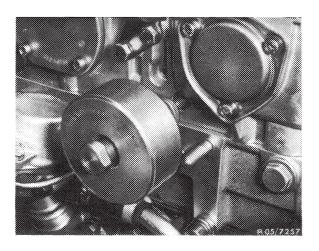
10 Mark relation between camshaft sprockets and chain with paint to facilitate assembly.



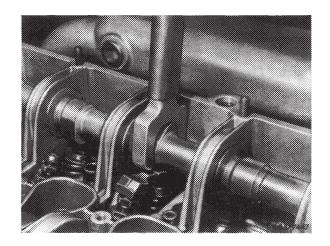
11 Remove chain tensioner (05-310).



12 Knock out only the bottom bearing pin of the sliding rail in the camshaft housing with an impact extractor.



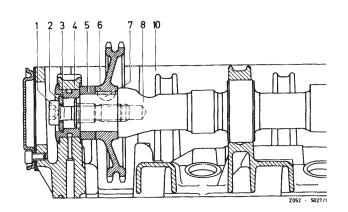
13 Remove expansion bolt for camshaft sprocket, counterholding camshaft with a holding wrench.



14 Press back camshaft and remove camshaft sprocket. Take spacer (5) off of intake camshaft.

Intake camshaft

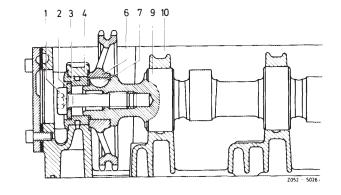
- Expansion bolt
- Washer
- Spacer Bearing
- Spacer
- Camshaft sprocket Woodruff key
- Camshaft
- 10 Camshaft housing



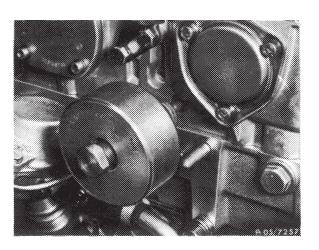
- 15 Place a clean cloth in timing chain housing underneath the camshaft and remove the woodruff key.
- 16 Install a woodruff key (7) selected according to the diagram.

Exhaust camshaft

- Expansion bolt
- 6 Camshaft sprocket 7 Woodruff key
- Washer Spacer
- Camshaft
- Bearing
- 10 Camshaft housing

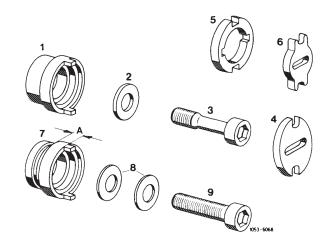


17 Install camshaft sprocket and bottom sliding rail bearing pin, so that the timing chain cannot jump.

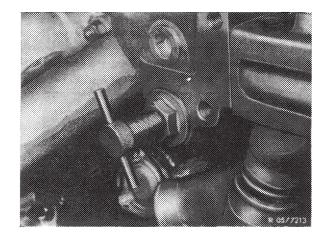


Note: Use only expansion bolt (3) with washer (2) for repairs.

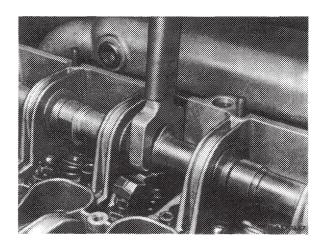
- Spacer 2nd version without lubricating groove (for pressure oil pump and vacuum pump 2nd version)
 Washer
- 2 Expansion bolt
- Dog for pressure oil pump and vacuum pump 2nd version
- Dog for vacuum pump 1st version
 Dog 1st version for pressure oil pump
 Spacer 1st version with lubricating groove
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



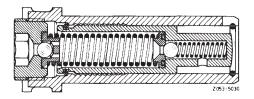
- 18 Install rigid chain tensioner and tension by hand.
- 19 Turn crankshaft with combination tool.
- 20 Check timing.



21 Torque expansion bolts for camshaft sprocket to 80 Nm (8 kpm), counterholding with a holding wrench.



- 22 Position chain tensioner for installation and install (05-310).
- 23 Install rocker arms (05-230).
- 24 Adjust valve clearance (05-210).



Chain tensioner positioned for installation.

Timing with 2 mm valve stroke

Version		all	Exceptions (ISA) California 1974	(USA) Federal 1973 and 1974	J (USA) 1981
Camshaft code ¹)	Exhaust	24, 57, 71, 78	24	30, 95	78
Carristiant code /	Intake	25, 67, 74	25, 74	33, 91	74
Intake valve	Opens after TDC	7°		11°	7°
iiitake vaive	Closes after BDC	21°		15°	21°
Exhaust valve	Opens before BDC	30°		22°	34°
Extraust valve	Closes before TDC	12°		14°	16°

¹⁾ Camshaft codes are stamped on rear end of camshaft.

Valve clearance	Cold engine (approx. 20 °C)	Warm engine (60 $^{\circ}$ C \pm 15 $^{\circ}$ 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.

Data

Permissible runout of center bearing journal and camshaft sprocket seat when camshaft turns on outer bearing journals	0.025
Scleroscope hardness of cams	68-82

Special tools

Depressor for valve spring

110 589 04 61 00

Rigid chain tensioner

110 589 03 31 00

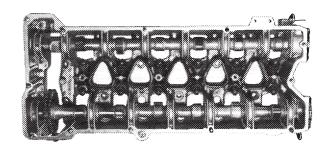
Chain tensioner holder

110 589 02 31 00

11004-7004	116 589 01 01 00
11004-7003	110 589 01 01 00
1002.8953	001 589 65 09 00
11004-5152	000 589 05 07 00
11004-6220	116 589 20 33 00
المراسية 1004-6368	116 589 01 34 00
	Nm
	100
crankcase	25
	80
	25
	20–40
	_
	5
	11004-7003 11004-8193 11004-8193 11004-6358

Camshafts can be removed from an installed engine only together with the camshaft housing.

If a new camshaft has to be installed, the rocker arms must also be replaced.



Camshafts with **wide** bearing journals (e.g. 21 mm) can be exchanged against camshafts with **narrow** bearing journals (arrow) (e.g. 16 mm).

Attention!

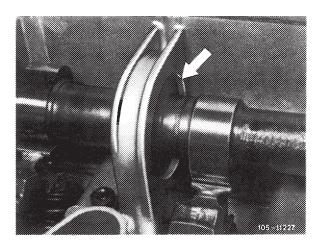
Exchange engines are partially delivered with camshaft bearing journals ground to intermediate or repair stage dimension (01–471).

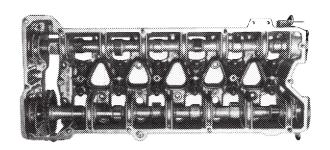
Install camshafts with reground bearing journals in a camshaft housing with a pertinent bearing diameter (05–225).

Also refer to coordination camshaft housing and camshafts (01–471).

Removal

- 1 Remove camshaft housing (01-470).
- 2 Unscrew both rear covers on camshafts housing.
- 3 Unscrew necked-down screw of lefthand camshaft while applying counterhold with holding wrench.





105-8003

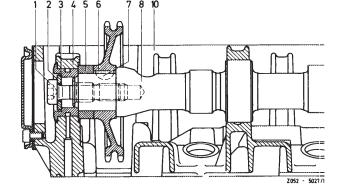
- 4 Press back camshafts and remove camshaft sprocket.
- 5 Remove both camshafts toward rear.

Installation

6 Coat camshaft bearings with engine oil and guide in left camshaft (intake). Slide on camshaft sprocket (6) and spacer (5). Coat spacer (3) with engine oil and install.

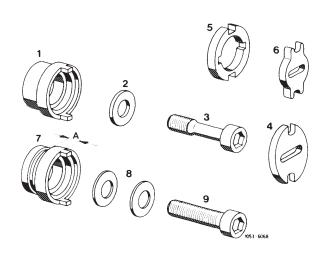
Intake camshaft

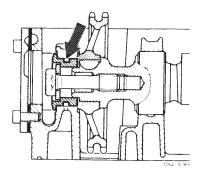
- 1 Expansion bolt
 - ι
- 2 Washer
- 3 Spacer 4 Bearing 5 Spacer
- 6 Camshaft sprocket
- 7 Woodruff key 8 Camshaft
- 10 Camshaft housing



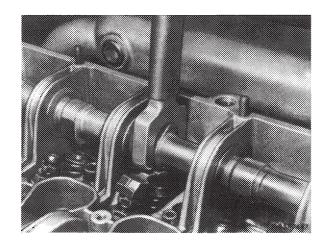
- 7 Expansion bolt (3) with washer (2) must be installed for repair jobs. Mounting bolt (9) and spring washers (8) must not be used.
 - 1 Spacer 2nd version without lubricating groove (for pressure oil pump and vacuum pump 2nd version)
 - Washer
 - 2 3 4 Expansion bolt
 - Dog (for pressure oil pump and vacuum pump 2nd version)
 - Dog (for vacuum pump 1st version)
 - Dog 1st version (for pressure oil pump)
 - Spacer 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
 - Spring washers (not valid)
 - Mounting bolt (not valid)

Note: Lubricating groove in spacing sleeve (arrow) no longer in place starting January 1974.





8 Tighten torque camshaft expansion bolt to 80 Nm (8 kpm), counterholding camshaft with a holding wrench.

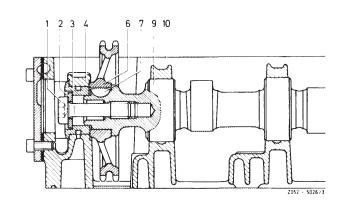


9 Guide right camshaft (exhaust) into lubricated bearings.

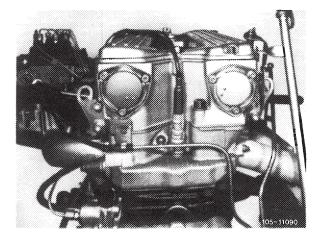
The right camshaft sprocket is installed after the camshaft housing has been mounted.

Exhaust camshaft

- Expansion bolt
- Washer
- Spacer
- 3 Bearing
- Camshaft sprocket
- Woodruff key
- Camshaft
- 10 Camshaft housing



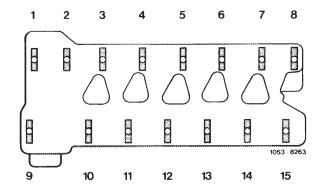
- 10 Install both rear covers with gaskets on camshaft housing.
- 11 Install camshaft housing (01-470).



Data							
Mean roughness of camshaft bearing journal 0.005							
Deviation of camshaft at camshaft sprocket					320-320	0.030	
Deviation of camshaft	t bearing journal	from true				0.010	
Bearing points (fig., re	efer to note)	1, 9	2	3, 10, 11	4,5,12,13	6,7,14,15	8
S	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
Standard dimension	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
ntermediate stage	bearing dia.		49.966 49.950	49.916 49.900	<u>51.419</u> 51.400	52.919 52.900	53.919 53.900
-0.1 mm (exchange engines)	journal dia.		49.850 49.834	49.850 49.834	<u>51.340</u> 51.321	<u>52.840</u> 52.821	53.840 53.821
1st repair stage —0.25 mm	bearing dia.		49.816 49.800	49.765 49.750	<u>51.269</u> 51.250	52.769 52.750	53.769 53.750
	journal dia.		49.700 49.684	49.700 49.684	<u>51.190</u> 51.171	<u>52.690</u> 52.671	53.690 53.671
2nd repair stage	bearing dia.		49.566 49.550	49.516 49.500	<u>51.019</u> 51.000	<u>52.519</u> 52.500	53.519 53.500
-0.5 mm	journal dia.		49.450 49.434	49.450 49.434	50.940 50.921	<u>52.440</u> 52.421	53.440 53.421
Camshaft bearing	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
play	axial	0.050 0.120					
Sleeve for bearing a	OD	37.950 37.925	ID	24.013 24.000			
Special tool							
Dial gauge holder for axial play	camshaft) 01 01		136 589 0	4 21 00

For camshafts with reground bearing journals, camshaft housings with repair stages -0.25 mm and -0.50 mm are available.

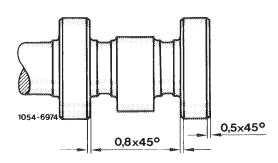
The bearing journals are not hardened.



Some exchange engines are delivered with camshaft bearings in intermediate and repair sizes. This means that a standard camshaft cannot be installed in this camshaft housing, since the bearing journals are larger in diameter than the bearings.

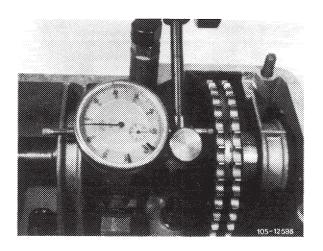
Also refer to coordination camshaft housing and camshafts (01–471).

Chamfer bearing journals after grinding (see sketch for dimensions).



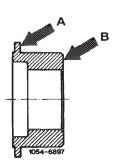
Checking axial play

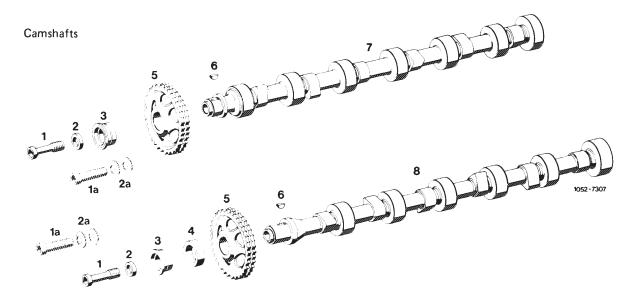
- 1 Bolt dial gauge holder to camshaft housing.
- 2 Clamp dial gauge with a preload of about 3 mm.
- 3 Press back camshaft and set needle at 0.
- 4 Press camshaft forward and read axial play.



Note: If the end play is too small, grind spacing sleeve or driver at face B as required.

If the axial play is too large, the spacer or dog must be ground at collar A.





- 2 expansion bolts 2nd version 2 bolts 1st version (not valid) 2 washers 2nd version 4 washers 1st version (not valid) 1 1a 2 2a 3

- 2 spacers

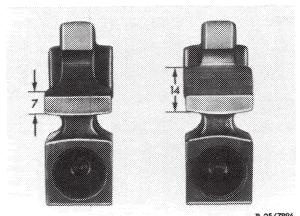
- 4 Spacer
 5 2 camshaft sprockets
 6 2 woodruff keys 4 x 6.5
 7 Exhaust camshaft
 8 Intake camshaft

Valve clearance	Cold engine (ca. 20 $^{\circ}$ C) Warm	engine (60°C	C ± 15 °C)
Intake	0.101)	0.151)		
Exhaust	0.25	0.30		
1) 0.05 mm more for consistent outs	de temperatures below -20 °C.			
Tightening torque			Nm	(kpm)
Cylinder head cover bolts and ca	pped nuts		5	(0.5)
Special tools				
Depressor for valve spring		\$887.75001	110 589	9 04 61 00
Valve adjusting wrench, 17 mm	J 11004-71	003	110 589	9 01 01 00
Contact grip to turn engine (Part pression recorder 001 589 46 21		11004-8487	001 589	9 46 21 08

1st version rocker arm, guiding surface 7 mm.

2nd version rocker arm, guiding surface 14 mm.

A 1st version rocker arm is replaced by a 2nd version rocker arm when repairing.



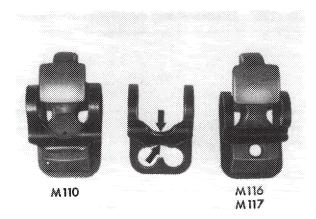
R 05/7896

Attention!

The rocker arms and spring clamps of engines 110 are not interchangeable with the rocker arms and spring clamps of engines 116 and 117.

The standard spring clamps (arrows) can be installed in engines 110, 116 and 117.

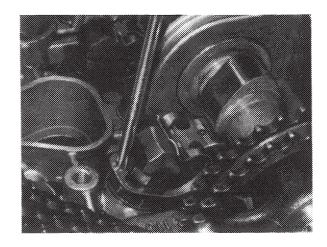
Always install rocker arms on cam from which they were removed.



105-10314/1

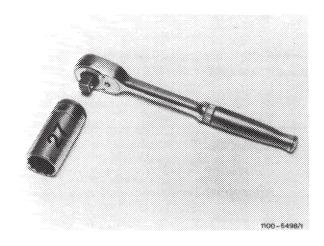
Removal

1 Press off spring clamps with a screwdriver.

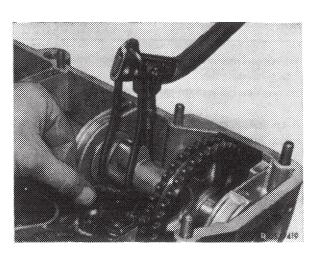


 $2\,$ Turn crankshaft with combination tool until cam peak is up.

Never turn engine on camshafts.

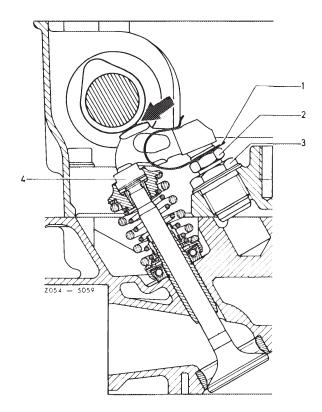


3 Remove rocker arms with installation and removal tool.



Installation

- 4 Check oil spray bore in rocker arm for plugging.
- 5 Coat bearing surfaces of rocker arm with oil and install rocker arm.
- 6 Press spring clamps into grooves of adjusting screws.
- 7 Adjust valve clearance (05-210).



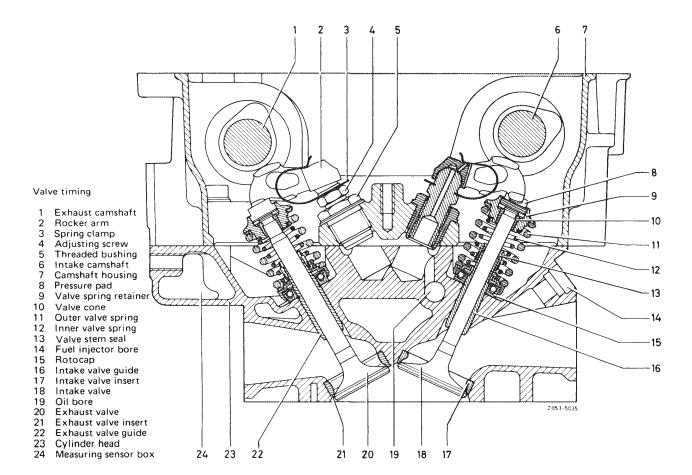
- Spring clamp
 Adjusting screw
 Threaded bushing
 Pressure pad

Exhaust 0.25 0.30 0.05 mm more for consistent outside temperatures below -20 °C. Fightening torques Nm Sylinder head bolts M 12 x 1.5 100 M 8 bolts for camshaft housing 25 Mounting bolts for camshaft sprockets 80 Sall locating ring in chain tensioner 25 Sylinder head cover bolts and capped nuts 5 Special tools Rail to hold down valve springs 110 589 06 62 00 Aganetic lifter for valve collets 116 589 06 63 00 Chain tensioner holder 110 589 02 31 00 Chain tensioner holder 110 589 00 30 00 M 6 x 50 bolt for impact extractor 116 589 00 134 00 Valve adjusting wrench 17 mm, 1/2" square 110 589 00 10 00 Verench socket 27 mm, 1/2" square 110 589 65 99 00 Verench socket 27 mm, 1/2" square 101 589 65 99 00 Verench socket 27 mm, 1/2" square 101 589 65 99 00 Verench socket 27 mm, 1/2" square 101 589 65 99 00 Verench socket 27 mm, 1/2" square 101 589 65 99 00 Verench socket 27 mm, 1/2" square 101 589 65 99 00	Valve clearance	Cold engine (ca. 20 °C)	Warm engine (60 $^{\circ}$ C \pm 15 $^{\circ}$ C)
Poly 1, 0,05 mm more for consistent outside temperatures below -20 °C. Fightening torques Nm Sylinder head bolts M 12 x 1.5 100 M 8 bolts for camshaft housing 25 Mounting bolts for camshaft sprockets 80 Sall locating ring in chain tensioner 25 Sylinder head cover bolts and capped nuts 5 Special tools Rail to hold down valve springs 110 589 06 63 00 Alagnetic lifter for valve collets 110 589 04 61 00 Chain tensioner holder 110 589 02 31 00 The sylinder head cover bolts and capped nuts 110 589 00 01 00 M 6 x 50 bolt for impact extractor Valve adjusting wrench 17 mm, 1/2" square Verench socket 27 mm, 1/2" square Verench socket 27 mm, 1/2" square Out 589 65 09 00 Verench socket 27 mm, 1/2" square	Intake	0.101)	0.151)
Tightening torques Nom Sylinder head bolts M 12 x 1.5 100 M 8 bolts for camshaft housing 25 Mounting bolts for camshaft sprockets 80 Sall locating ring in chain tensioner 25 Sylinder head cover bolts and capped nuts 5 Special tools Rail to hold down valve springs 110 589 06 62 00 Aganetic lifter for valve collets 116 589 06 63 00 Chain tensioner holder 110 589 02 31 00 The sylinder head cover bolts and capped nuts 110 589 09 03 00 The sylinder head cover bolts and capped nuts 110 589 01 34 00 A 6 x 50 bolt for impact extractor 110 589 00 10 00 Verench socket 27 mm, 1/2" square 110 589 65 99 00 Verench socket 27 mm, 1/2" square	Exhaust	0.25	0.30
Cylinder head bolts M 12 x 1.5 M8 bolts for camshaft housing 25 Mounting bolts for camshaft sprockets 80 Ball locating ring in chain tensioner 25 Cylinder head cover bolts and capped nuts 5 Special tools Rail to hold down valve springs 110 589 06 62 00 Aggnetic lifter for valve collets 116 589 06 63 00 Chain tensioner holder 110 589 02 31 00 The pressor for valve spring in (basic unit) M8 6 x 50 bolt for impact extractor Valve adjusting wrench 17 mm, 1/2" square Venech socket 27 mm, 1/2" square Venech socket 27 mm, 1/2" square Venech socket 27 mm, 1/2" square Out 589 65 09 00 Venech socket 27 mm, 1/2" square	1) 0.05 mm more for consistent outside tem	peratures below -20 °C.	
Mounting bolts for camshaft sprockets 80 Sall locating ring in chain tensioner 25 Special tools Rail to hold down valve springs 110 589 06 62 00 Aggnetic lifter for valve collets 116 589 06 63 00 Chain tensioner holder 110 589 02 31 00 The special tools The special tools 110 589 00 63 00 The special tools 110 589 00 63 00 The special tools The special too	Tightening torques		Nm
Mounting bolts for camshaft sprockets 30 3all locating ring in chain tensioner 25 Cylinder head cover bolts and capped nuts 5 Special tools Agail to hold down valve springs 110 589 06 62 00 Aganetic lifter for valve collets 116 589 06 63 00 Depressor for valve spring 110 589 04 61 00 Chain tensioner holder 110 589 02 31 00 Impact extractor for bearing pin (basic unit) 116 589 01 34 00 Valve adjusting wrench 17 mm, 1/2" square 110 589 00 01 00 Verench socket 27 mm, 1/2" square 110 589 65 09 00 Verench socket 27 mm, 1/2" square	Cylinder head bolts M 12 x 1.5		100
Again to hold down valve springs Again to hold down valve springs Depressor for valve spring Chain tensioner holder In 589 04 61 00 Chain tensioner holder In 589 02 31 00 M 6 x 50 bolt for impact extractor Valve adjusting wrench 17 mm, 1/2" square Out 589 05 09 00 Vench socket 27 mm, 1/2" square Out 589 05 09 00 Vench socket 27 mm, 1/2" square	M 8 bolts for camshaft housing		25
Explinder head cover bolts and capped nuts Special tools Rail to hold down valve springs 110 589 06 62 00 Magnetic lifter for valve collets 116 589 06 63 00 Depressor for valve spring 110 589 04 61 00 Chain tensioner holder 110 589 02 31 00 M 6 x 50 bolt for impact extractor 110 589 01 34 00 Venech socket 27 mm, 1/2" square 110 589 09 00 1589 65 09 00	Mounting bolts for camshaft sprockets		80
Agail to hold down valve springs 110 589 06 62 00 Magnetic lifter for valve collets 116 589 06 63 00 Depressor for valve spring 110 589 04 61 00 Chain tensioner holder 110 589 02 31 00 Impact extractor for bearing pin (basic unit) 116 589 01 34 00 Valve adjusting wrench 17 mm, 1/2" square Vench socket 27 mm, 1/2" square 001 589 65 09 00	Ball locating ring in chain tensioner		25
Agnetic lifter for valve collets 116 589 06 63 00 Depressor for valve spring 110 589 04 61 00 Chain tensioner holder 110 589 02 31 00 Impact extractor for bearing pin (basic unit) 116 589 01 34 00 Valve adjusting wrench 17 mm, 1/2" square 110 589 65 09 00 Vench socket 27 mm, 1/2" square	Cylinder head cover bolts and capped r	nuts	5
Magnetic lifter for valve collets 116 589 06 63 00 Depressor for valve spring 110 589 04 61 00 Chain tensioner holder 110 589 02 31 00 Impact extractor for bearing pin (basic unit) 116 589 20 33 00 M 6 x 50 bolt for impact extractor Valve adjusting wrench 17 mm, 1/2" square 110 589 00 01 00 Vench socket 27 mm, 1/2" square 001 589 65 09 00	Special tools		
Depressor for valve spring 110 589 04 61 00 Chain tensioner holder 110 589 02 31 00 Impact extractor for bearing pin (basic unit) 116 589 20 33 00 M 6 x 50 bolt for impact extractor 116 589 01 34 00 Valve adjusting wrench 17 mm, 1/2" square 110 589 65 09 00 Vench socket 27 mm, 1/2" square	Rail to hold down valve springs	1004-7002	110 589 06 62 00
Chain tensioner holder 110 589 02 31 00 mpact extractor for bearing pin (basic unit) 116 589 20 33 00 116 589 01 34 00 Valve adjusting wrench 17 mm, 1/2" square 110 589 00 01 00 Wrench socket 27 mm, 1/2" square	Magnetic lifter for valve collets	11004-6702	116 589 06 63 00
mpact extractor for bearing pin (basic unit) 116 589 20 33 00 16 x 50 bolt for impact extractor 116 589 01 34 00 110 589 00 01 00 110 589 00 01 00 110 589 65 09 00	Depressor for valve spring	1011-100	110 589 04 61 00
M 6 x 50 bolt for impact extractor 116 589 01 34 00 Valve adjusting wrench 17 mm, 1/2" square 110 589 00 01 00 Vrench socket 27 mm, 1/2" square 001 589 65 09 00	Chain tensioner holder	10001-10001	110 589 02 31 00
Valve adjusting wrench 17 mm, 1/2" square 110 589 00 01 00 Vrench socket 27 mm, 1/2" square 001 589 65 09 00	Impact extractor for bearing pin (basic	3	116 589 20 33 00
Vrench socket 27 mm, 1/2" square 001 589 65 09 00	M 6 x 50 bolt for impact extractor		116 589 01 34 00
\ \ \ \ ₩ UU 1 309 03 U9 UU	Valve adjusting wrench 17 mm, 1/2" so	quare	110 589 00 01 00
	Wrench socket 27 mm, 1/2'' square to turn engine	11004 - 0193	001 589 65 09 00

Conventional tool

Cylinder leak tester

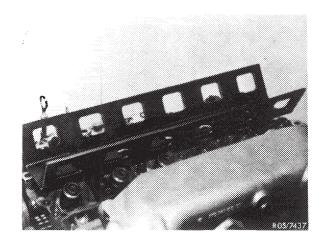
e.g. made by Bosch EFAW 210 A e.g. made by SUN CLT 228



Removal

- 1 Remove camshaft housing (01-470).
- 2 Remove pressure pads (8).
- 3 Unscrew spark plug of respective cylinder and set piston to ignition TDC to prevent valves from dropping in.

- 4 Bolt hold-down rail to cylinder head.
- 5 Support valves with pneumatic air (cylinder leak tester).

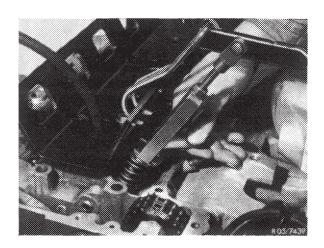


- 6 Loosen valve collets by applying light knocks from a hammer to valve spring retainers.
- 7 Press down valve spring retainer with removal and installation tool and remove valve collets with magnetic lifter.

Attention!

Valves must not rest on piston skirt, since this could bend the valves.

8 Remove valve spring retainer, outer and inner valve springs.



Installation

- 9 Check valve springs and replace if necessary (05-260).
- 10 Replace valve stem seals (05-270).
- 11 Further installation in reverse sequence of removal.

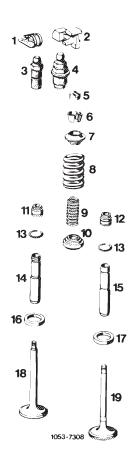
Attention!

Install valve springs that tighter coil ends rest on rotocap.

Valves and rocker arms

- 1 Spring clamp
- 2 Rocker arm 3 Adjusting screw
- Threaded bushing with adjusting screw
- 5 Pressure pad
- 6 Valve cone 7 Valve spring
- 7 Valve spring retainer 8 Outer valve spring
- 9 Inner valve spring

- 10 Rotocap
- Exhaust valve stem seal 12 Intake valve stem seal
- 13 Circlip
- 14 Exhaust valve guide
- 15 Intake valve guide
- 16 Exhaust valve insert17 Intake valve insert
- 18 Exhaust valve
- 19 Intake valve



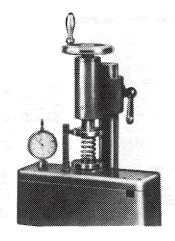
Valve springs

	Part No.	Color	Outside	Wire	Relaxed	Spring force at pretensioned length		
		code	dia. mm	gage dia. mm	length mm	mm	New N	Limit N
Inner	130 053 00 22	yellow/brown or violet/brown	22-22.4	2.5	45	21.5	235	224-246
	110 053 02 20	yellow	33.8-34.1	4.6	49.5	20.5		
Outer (optional)	110 053 01 20	violet/red yellow/red	34.2	4.75	49	30.5	863	843-902

Checking

- 1 Check valve springs with a valve spring tester or a spring testing scale.
- 2 Check spring force at specified length.
- 3 If value is less than limit, replace valve springs.

Note: Prior to installation, check wire surface of used valve springs for corrosion.



R 05/6383

Valve clearance	Cold engine (ca. 20 °	C) Warm engine (60 $^{\circ}$ C \pm 15 $^{\circ}$ C)
Intake	0.10 ¹)	0.151)
Exhaust	0.25	0.30
1) 0.05 mm more for consistent ou	utside temperatures below -20 °C	C.
Tightening torques		Nm
Cylinder head cover bolts and o	capped nuts	5
Cylinder head bots M 12 x 1.5		100
Bolts M 8 for camshaft housing	to cylinder head and crankc	ase 25
Necked-down screws for camsh	aft sprockets	80
Ball locating ring in chain tensi	oner	25
Special tools		
Depressor for valve spring		110 589 04 61 00
Socket 27 mm, 1/2" square for rotating engine		001 589 65 09 00
Impact extractor for bearing pi	n (basic unit)	116 589 20 33 00
M 6 x 50 bolt for impact extra	ctor 11004-5368	116 589 01 34 00
Camshaft holding wrench		116 589 01 01 00
Rigid chain tensioner	(<u>(((()))</u>	110 589 03 31 00
Wrench socket 10 mm, 1/2" square, 140 mm long	11 CO4 - 819 2	000 589 05 07 00
Rail to hold down valve springs		110 589 00 62 00

Chain tensioner holder	11004-7008	110 589 02 31 00
Assembly mandrel for valve stem seals intake and exhaust 9 mm dia.		116 589 00 43 00
Installation mandrel for exhaust valve stem seals 11 mm dia.	11004.6191	116 589 01 43 00
Magnetic lifter for valve collets	11004-6207	116 589 06 63 00
Valve adjusting wrench 17 mm	11004-7003	110 589 01 01 00

Remove camshaft housing with camshafts (01-470) and pertinent valve springs (05-250) to replace valve stem seals.

Valve stem seals are supplied in a repair kit with assembly sleeves.

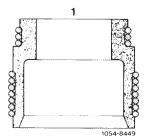
The exhaust valve stem seal with 9 mm ID for engines starting April 1978 (emission-controlled engines starting model year 1980) has a holding bead inside (arrow) Do not mix up with intake valve stem seal without holding bead.

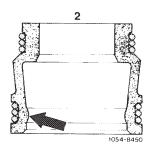
Valve guides, which are worn at the groove for the valve stem seal, must be replaced.

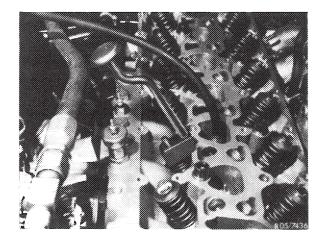
Valve stem seals

Repair set 123 586 03 05 (up to April 1978 or up to model year 1980 (USA)).

Repair set 110 586 03 05 (starting April 1978 or starting model year 1980 (USA)).





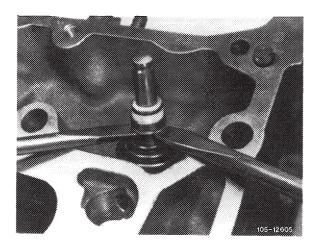


Replacing

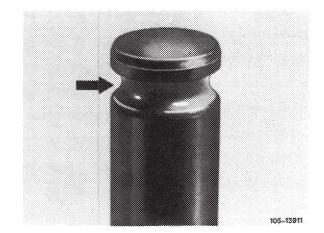
1 Press off valve stem seals.

Attention!

Don't damage valve stem and valve guide.

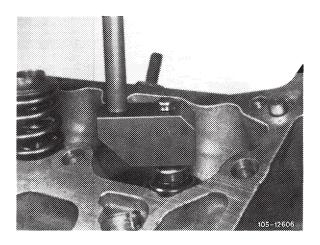


- 2 Deburr valve stem at groove (arrow).
- 3 Replace dented valve cones and spring retainers.
- 4 Check Rotocap and replace if necessary.

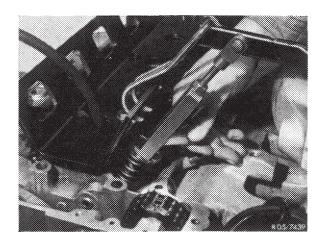


5 Lubricate valve stem seals and install with installation mandrel.

Use assembly sleeve on intake valve.



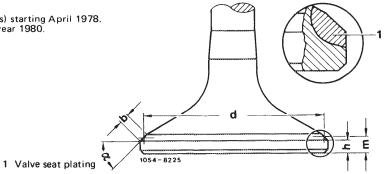
6 Install valve springs (05–250) and camshaft housing (01–470).



Data

		Intake valve	Exhaust valve Version 1	Exhaust valve ² , Version 2
Valve retainer dia.		45.1-45.3	37.0-37.2	38.9–39.01
Valve stem dia.		8.95-8.97	10.94-10.96	8.94-8.96
Valve length		115	118	118
Code number at end of stem		E 110 06 E 110 07 ¹)	A 110 00 A 110 00 C	A 117 00 A 117 00 C
Filled-in sodium		without	with	with
Valve seat plating		with	with	with
Height "h" of valve retainer	When new	1.5	2.5	2.5
The same recurrence	Limit value	1.0	2.0	2.0
Width ,,b" of valve seat		1.8-3.0	1.5–2.5	Ď
Dia. ,,d" on valve seat center		44.2	36.1	38.0
Height m" up to valve cost contex	When new	2.1–2.3	3.1-3.3	3.1–3.3
Height ,,m" up to valve seat center	Limit value	1.6-1.8	2.6-2.8	2.62.8
Adjusting angle for machining valve		45° + 15′		
Permissible runout on valve stem as	x.	0.03		
Permissible runout at face of valve when held at valve stem	stem		0.015	

 Valve with spherical section.
 Standard (except emission controlled engines) starting April 1978. Emission controlled engines starting model year 1980.



Conventional tools

Valve cone grining machine or	e.g. made by Krupp, D-5309 Meckenheim model VS
Valve cone machining tool	e.g. made by Hunger, D-8000 München 55 type VKDR 1, order no. 203.00.200

The exhaust valves are filled with sodium!

Observe safety regulations when scrapping. Because of the danger of explosion sodium filled valves must not be melted or converted into tools (punches, etc.), without first removing the sodium filling.

Be careful when removing sodium from valves, since sodium reacts violently and explosion-like when combined with water and watery solutions, to avoid any risk of fire caused by the resulting hydrogen gas.

Sodium from cut and broken valves can be neutralized in the open air in a vessel container in a mixture of 2 liters of spirits of alcohol and 1 liter of water.

Sodium filled valves can be collected and sent for neutralization to the Warranty Checking Department at Stuttgart-Untertürkheim.

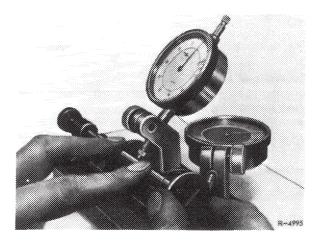
Checking and machining

1 Clean valves and inspect visually.

Valves with a burnt valve head, with insufficient height "h" of valve head and valves with a worn or scored valve stem, must be replaced.



2 Check valve stem runout. If runout measure exceeds 0.03 mm, replace valve.

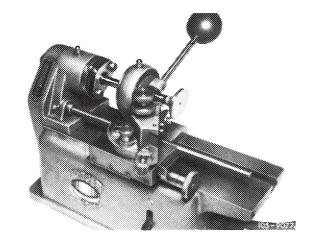


3 Machine valve seat.

Observe instructions supplied with machining equipment and adjusting angle of 45° .

4 Measure valve seat runout and valve head height ,,,h''.

Replace valve, if limits have been reached.



Valve guides

	settings part no.	OD	Color code	Basic bore in cylinder head	Code number in cylinder head 1)	Valve guide ID
	Standard dimension (110 050 25 24)	14.016—14.023 14.021—14.028 14.026—14.033	green without brown	14.000-14.006 14.007-14.012 14.013-14.018	1 2 3	
intake	Intermediate stage 110 050 26 24	14.034—14.040 14.039—14.046 14.045—14.051	gray-green gray gray-brown	- 1) - 1) - 1)		9.000-9.015
	1st repair stage 110 050 27 24	14.21614.233	red	14.200-14.218		
	2nd repair stage 110 050 28 24	14.416—14.433	white	14.400-14.418		
exhaust 11 mm ϕ	Standard dimension 110 050 33 24	15.016-15.023 15.021-15.028 15.026-15.033	green without brown	15.000-15.006 15.007-15.012 15.013-15.018	1 2 3	
	Intermediate stage 110 050 34 24	15.034—15.040 15.039—15.046 15.045—15.051	gray-green gray gray-brown	_1) _1) _1)		11.000-11.018
	1st repair stage 110 050 35 24	15.216—15.233	red	15.200—15.218		
	2nd repair stage 110 050 36 24	15.416—15.433	white	15.400—15.418		
	3rd repair stage 110 050 37 24	16.2 (roughing dim.) ²)	_	16.000-16.018		
	Standard dimension 110 050 40 24	15.016-15.023 15.021-15.028 15.026-15.033	green without brown	15.000—15.006 15.007—15.012 15.013—15.018	1 2 3	
exhaust 9 mm ϕ	Intermediate stage 110 050 41 24	15.034-15.040 15.039-15.046 15.045-15.051	gray-green gray gray-brown	-1) -1) -1)		3
	1st repair stage 110 050 42 24	15.216—15.233	red	15.200—15.218		9.0009.015 ³)
•	2nd repair stage 110 050 43 24	15.416—15.433	white	15.400—15.418		
	3rd repair stage 110 050 44 24	16.2 (roughing dim.) ²)	_	16.000—16.018		

For overlap of valve guide in cylinder head refer to table: Association basic bore valve guide

Special tools

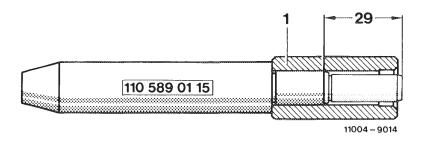
Master mandrel 9 mm dia. intake and exhaust		116 589 08 21 00
	11004-6211	
Master mandrel 11 mm dia. exhaust		116 589 09 21 00

After kocking-out valve guide, the basic bore is not essentially larger than the series basic bore. On exchange engines the basic bore is machined and does not correspond to series basic bore.

For machining OD 16.016—16.033.
Series (except emisssion-controlled engines) starting April 1978. Emission-controlled engines starting model year 1980.

Knock-out mandrel 9 mm dia. intake and exhaust		110 589 02 15 00
Knock-out mandrel 11 mm dia exhaust	1004-4194	110 589 03 15 00
Knock-in mandrel 9 mm dia. intake		116 589 20 15 00
Knock-in mandrel 11 mm dia. exhaust 1)	11004-5195	116 589 19 15 00
Reamer 8.99 mm dia. H 7 intake and exhaust		000 589 10 53 00
Reamer 10.99 mm dia. H 7 exhaust	11004-6*97	000 589 15 53 00

¹⁾ Change former knock-in mandrel 110 589 01 15 00 according to following drawing, so that exhaust valve guides with 9 mm ID can also be knocked-in. Press-off sleeve (1), machine guide pin (dimension 29 mm), press sleeve (1) on again.



Conventional tool

Internal precision measuring instrument 8–12 mm dia.

e.g. made by Hommel, D-5000 Köln 71 Subito, order no. 33 830 103

Note

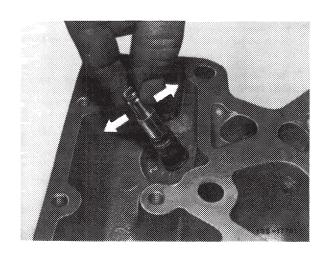
Valve guides which must be renewed due to wear, should permit installation in original basic bore in cylinder head without additional machining.

Valve guides which are loosely seated in cylinder head must be inserted in newly made basic bores.

Checking valve guide

Upon removal of valve spring and valve stem seal, the wear on valve guide can be determined in installed condition by moving valve stem predominantly crosswise in relation to engine.

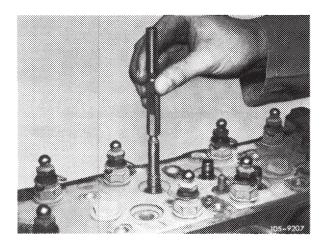
As a reference value, a max. wear of approx. 1.2 μm for 1000 km (0.12 mm for 100 000 km) should be assumed.



However, this value does not apply to upper and lower range of valve guide, since experience has shown that the wear at these points is higher.

Check valve guides with inspection mandrel and cylinder head disassembled.

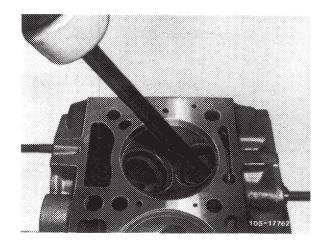
Valve guides, which are worn outside on seat of valve stem seal, should be replaced, since the valve stem seal is no longer tightly seated.



Assigning and inserting valve guides

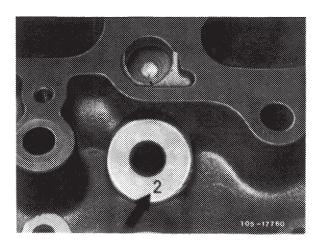
- 1 Knock-out valve guide with knock-out mandrel from direction of combustion chamber or press out.
- 2 Visually check basic bore in cylinder head for score marks and deposits.

Equalize deposits (if any) by means of a small file.



Attention!

A basic bore with punched-in code number, e.g. 2 (arrow) should be associated with the respective valve guide with regard to the applied color code or the measured OD.



On exchange engines the basic bore in cylinder head is larger than normal. This means, that the punched-in code numbers in cylinder head are no longer in accordance with basic bores according to table.

In such a case, measure basic bore or OD of knockedout valve guide prior to pertinent association.

Association of a valve guide with a not-refinished basic bore in cylinder head

Punched-in code number adjacent to basic bore in cylinder head ¹)	Color code of valve guide ²)	Overlap in cylinder head	Machining note
	without	0.015-0.028	Knock-in valve guide with knock-in mandrel.
0	brown	0.020-0.027	Undercool valve guide, knock-in with knock-in mandrel or heat cylinder head, knock-in with knock-in mandrel.
	gray-green ³)	0.028-0.040	Undercool valve guide, knock-in with knock-in mandrel, ream ID or heat cylinder head, knock-in, ream ID with reamer.
	brown	0.019-0.026	Knock-in valve guide with knock-in mandrel.
1	gray-green	0.022-0.033	Undercool valve guide, knock-in with knock-in mandrel or heat cylinder head, knock-in with knock-in mandrel.
	gray ³)	0.027-0.039	Undercool valve guide, knock-in with knock-in mandrel, ream ID or heat cylinder head, knock-in, ream ID with reamer.
	gray-green	0.016-0.027	Knock-in valve guide with knock-in mandrel.
2	gray	0.021-0.033	Undercool valve guide, knock-in with knock-in mandrel or heat cylinder head, knock-in with knock-in mandrel.
	gray-brown ³) ⁴)	0.027-0.038	Undercool valve guide, knock-in with knock-in mandrel, ream ID or heat cylinder head, knock-in, ream with reamer.

¹⁾ After knocking-out valve guide, the basic bore is not essentially larger than the series basic bore.

On exchange engines the basic bore is machined and does no longer correspond to series bore.

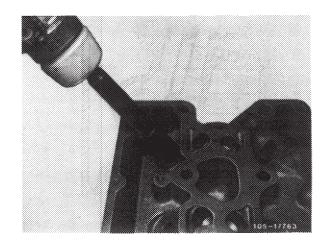
2) Valve guides with color code "green", overlap 0.010—0.023 mm, should not be used since they may become loose.

3) Use valve guides which require inside reaming after knocking-in, should be used only if no other valve guides are available.

4) Valve guide gray-brown with 0.027—0.038 mm overlap, may also be installed into cylinder head instead of a slightly loose valve guide without refinishing basic bore.

3 Insert valve guide for approx. 3—4 minutes into liquid oxygen, then insert **immediately** into knock-in mandrel and **immediately** into respective bore while following-up with a hammer.

Note: If the valve guide is not knocked-in immediately up to locking ring, it will absorb the temperature of the cylinder head and can then be completely knocked-in with considerable difficulty.



- 4 If no liquid oxygen is available, heat cylinder head in a water bath, e.g. a parts washing system or a heating oven to max. $80\,^{\circ}\text{C}$ (176 $^{\circ}\text{F}$).
- 5 Coat valve guide with tallow and knock-in with knock-in mandrel until circlip or knock-in mandrel rests against cylinder head.

Attention!

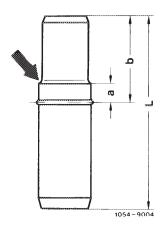
Use specified knock-in mandrel only.

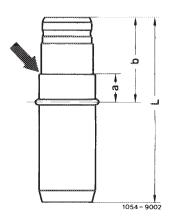
The stop in knock-in mandrel is adapted to valve guide and dimension a in such a manner that the valve guide can be knocked into end position without damage.

Intake valve guide

	Intake	Exhaust
a	5	7.5
b	23	20.5
L	51.5	54
ID	9	9 starting April 1978 starting ((sa) 1980
10	J	11 up to April 1978 up to (USA) 1980

Exhaust valve guide

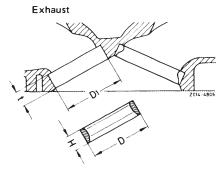




Data

Overlap of valve seat rings in cylinder head		0.08-0.10	
Intake	Normal dimension	Repair stage	
D	47.10 47.09	Rough dimension 48.30	Intake
D1	47.00 47.01	Max. up to 48.00	
t	8.60 8.70		2014-4605
Н	8.60 8.51		7
Exhaust	Normal dimension	Repair stage	
	Version 1 Version 2 1)	Version 1 Version 2 ¹)	

Exhaust	Exhaust Normal dimension		Repair stage	
	Version 1	Version 2 1)	Version 1	Version 2 ¹)
D	40.10 40.09	42.10 42.09	Rough dimer	nsion 43.3
D1	40.00	42.00	max. up to	max. up to
	40.01	42.01	41.00	43.00
t	10.50 10.60			
Н	10.5 10.3			



¹⁾ Series (except emission-controlled engines) starting April 1978. Emission-controlled engines starting model year 1980.

Conventional tools

Plug gauge 9 mm dia. for intake and exhaust valve guide	and the second s	116 589 08 21 00
	- P	
Plug gauge 11 mm dia. for exhaust valve guide	11004-6211	116 589 09 21 00

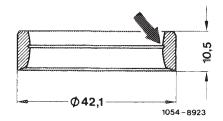
Conventional tools

Cylinder head clamping device	e.g. made by Christ, D-6801 Neckarhausen order no. DBK 60-2		
Ring seat machining tool	e.g. made by Hunger, D-8000 München size 2, order no. 220.03.110		
Valve seat machining tool	e.g. made by Hunger, D-8000 München order no. 236.03.308, type VDSNL 1/45/30		
Test set for valves	e.g. made by Hunger, D-8000 München order no. 216.93.300		

Internal micrometer (range 25–60 mm)	e.g. made by Mahr, D-7300 Esslingen order No. 844
External micrometer (range 25–50 mm)	e.g. made by Mahr, D-7300 Esslingen order No. 40 S

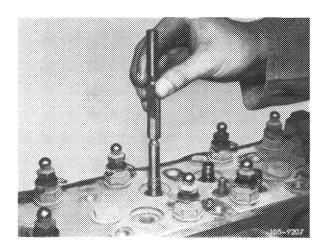
Note

Exhaust valve seat rings for unleaded fuel with red or blue color dot on inside may be installed only in USA engines starting model year 1975. Starting model year 1980 these valve seat rings are identified by a machined groove (arrow).



Replacing

- 1 Unscrew old valve seat ring by means of ring seat machining tool.
- 2 Check valve guides, replacing if necessary (05–285).

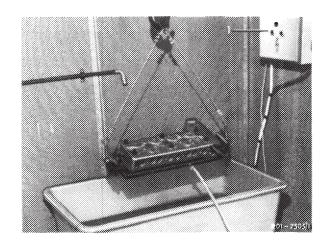


3 Measure basic bore D1.

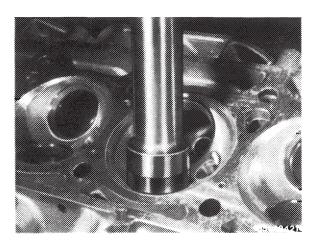
A new standard size valve seat insert can be used, if the specified overlap is given.

- 4 Machine basic bore repair stage D1 with ring seat machining tool in such a manner that bore is just cleaned.
- 5 Measure machined basic bore.
- 6 Provide specified overlap by machining the oversize valve seat inserts.

- 7 Heat cylinder head in water to approx. 80 $^{\circ}\text{C}$ (176 $^{\circ}\text{F}$).
- 8 Undercool valve seat insert with fluid air.

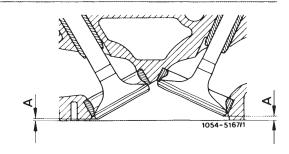


- 9 Knock in valve seat insert with a pertinent mandrel.
- 10 Machine valve seats (05-291).



Data	Intake	Exhaust	
Valve sea	t width a 1.8–2.5	1.5–2.0	3 × 34
Valve sea	t angle	45°	
Correctio	n angle, top	15°	Ses (
Correctio	n angle, bottom	60°	1054-7490
Permissib	le runout of valve seat	0.05	1
		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
Exnaust	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
Full acces	Valve retainer dia. 37 mm	1.5	1.1
Exhaust	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.



Special tools

Magnetic lifter for valve cone halves	11004-6202	116 589 06 63 00
Master mandrel 9 mm dia. for intake and exhaust valve guide	11004-6211	116 589 08 21 00
Master mandrel 11 mm dia. for exhaust valve guide		116 589 09 21 00

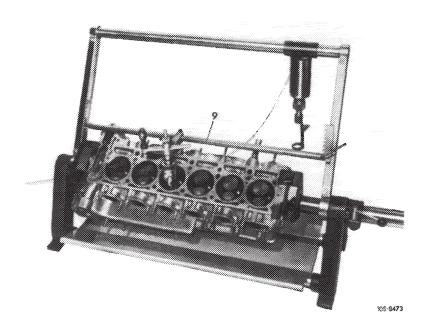
Conventional tools

Cylinder head clamping device	e.g. made by Rothenberger, D-6233 Kelkheim order no. 2.9900
Valve seat machining tool	e.g. made by Hunger, D-8000 München type VDSNL 1/45/30 order No. 236.00.308
Test set for valve seats	e.g. made by Hunger, D-8000 München order No. 216.93.300
60 ^o correcting bit No. 13 for bottom correction angle	e.g. made by Hunger, D-8000 München order No. 216.64.622

Note

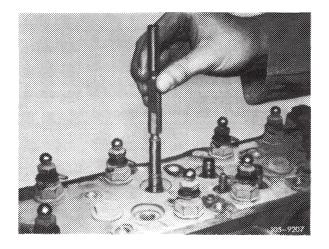
Clamp cylinder head in clamping device for disassembly and machining.

Machine valve seats with valve seat machining tool, valve seat grinding machine or with a valve seat cutter.



Machining valve seats

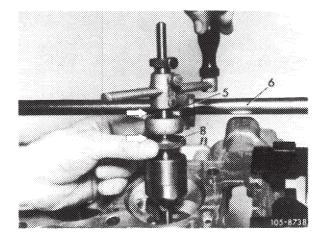
1 Check valve guides, replacing if necessary (05-295).



2 Machine valve seat (45°) according to instructions of tool manufacturer.

Attention!

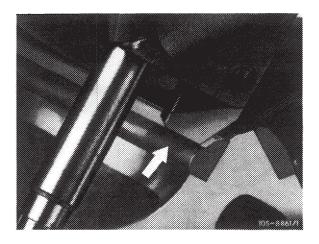
First loosen pilot after runout of valve seat has been checked (point 5).



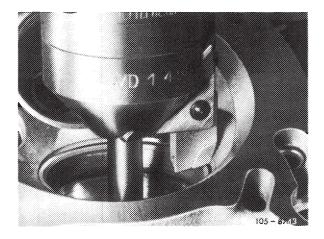
3 Correct bottom of valve seat to 60°.

Attention!

Do not machine bead (arrow) on lower part of valve seat.

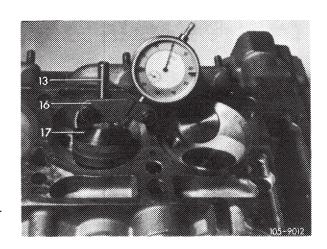


4 Measure valve seat width, and, if necessary, correct top to 150.



5 Check valve seat runout.

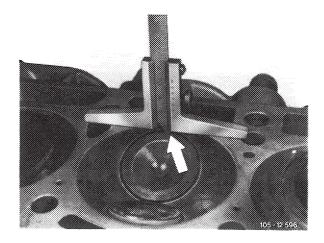
This requires sliding test sleeve (17) with dial gage holder (16) and dial gage on to pilot, and turning test sleeve. In so doing the permissible runout must not exceed 0.05 mm.



- 13 Pilot
- 16 Dial gage holder 17 Test sleeve

6 Guide in new valve and check max. distance A (arrow).

If necessary, replace valve seat insert (05-140).



Tightening torques		Nm
Ball locating ring (oil jet) in chain		25
Plug		50
Threaded ring		50
Special tool		
Wrench socket 10 mm, 1/2" square, 140 mm long	Track and the second	000 589 05 07 00
Holder for chain tensioner	\$00/-1001	110 589 02 31 00
Conventional tools		
Screwdriver socket 19 mm 1/2" square	e.g. made by 1 order No. 985	Hazet, D-5630 Remscheid i–19
Screwdriver socket 17 mm 1/2" square	e.g. made by F order No. 985	Hazet, D-5630 Remscheid 1–17

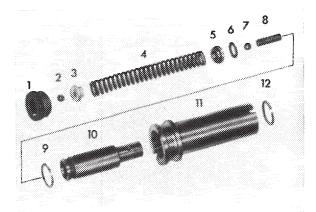
Note

Chain tensioners are available in two versions and interchangeable with each other.

1st version

- 1 Ball seat ring with 3.0 mm bore
- 2 Ball
 3 Ball cage
 4 Spring
 5 Valve disc
 6 O-ring

- 7 Ball 8 Spring 9 Snap ring 10 Pressure pin 11 Housing 12 Snap ring



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The 2nd version chain tensioner does not have valves and its oil jet (4) has a 1.1 mm bore.

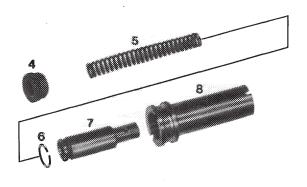
Difference when installed:

1st version: bore in ball locating ring closed by ball.

2nd version: bore in oil jet can be checked for plugging with a piece of 1 mm dia. wire.

2nd version

- 4 Oil nozzle with 1.1 mm bore
- 7 Pressure pin 8 Housing
- 5 Spring
- 6 Snap ring



R05-7322/2

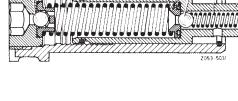
12 10

Attention!

Without counterpressure from the clamping rail the pressure pin (10) with snap ring (9) will be pressed forward up to the stop by spring (4).

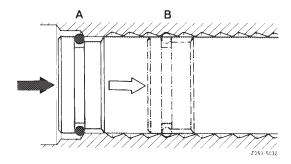
Chain tensioner in operating position

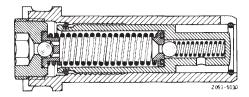
- 1 Ball locating ring
- 7 Ball
- 8 Spring 9 Snap ring 10 Pressure pin
- 11 Housing
- 2 Ball 3 Ball cage 4 Spring 5 Valve disc 6 O-ring
- 12 Snap ring



The pressure pin cannot be pressed back beyond the saw tooth type catch in assembly position ,,A".

Thus the chain tensioner must be disassembled before each installation to move the pressure pin to assembly position "A", since otherwise the timing chain would be too tight.

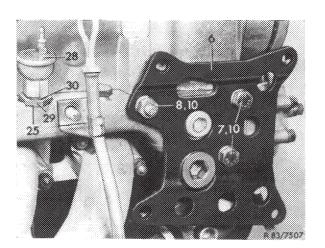




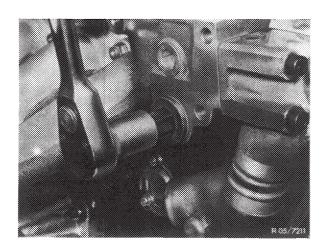
Chain tensioner in assembly position.

Removal

1 Remove battery and compressor of models with an air conditioner.

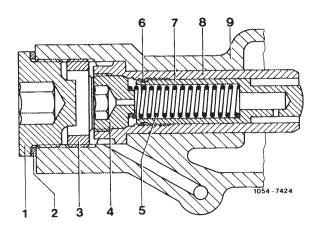


2 Remove plug with the 17 mm screwdriver socket.



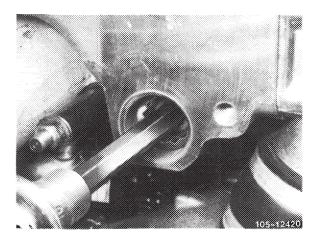
Attention!

If a 2nd version chain tensioner is installed, during assembly it will be sufficient to first remove spring (5) of an installed chain tensioner at the chain drive (e.g. remove camshaft sprocket or tensioning rail).

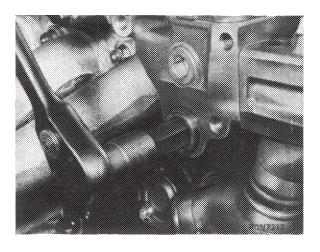


3 Loosen ball locating ring (oil jet) by about 2 turns with a socket wrench.

This requires that the threaded ring be tightened.



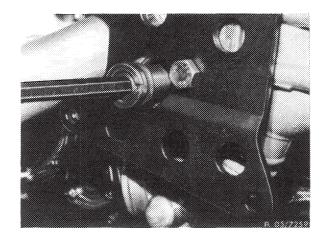
4 Remove threaded ring with a 19 mm screwdriver socket.



5 Pull out chain tensioner with a 10 mm socket wrench.

This requires that the socket wrench be canted slightly and the chain tensioner turned to the right.

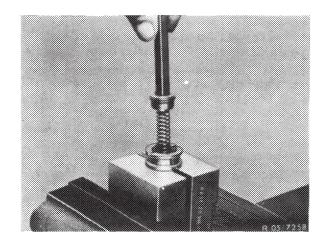
For pulling out stuck chain tensioner, screw a M 18 x 1.5 screw into chain tensioner housing instead of ball seat ring (oil nozzle).



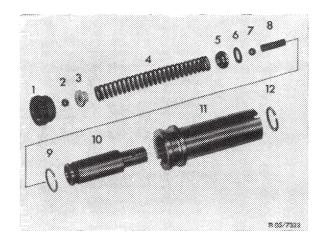
Disassembling

- 6 Clamp chain tensioner in holders.
- 7 Unscrew ball seat ring (oil nozzle) with hex. socket wrench.

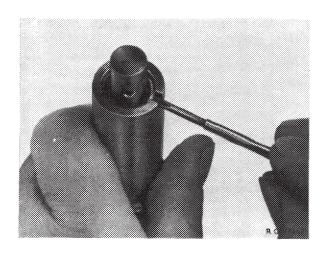
When disassembling be careful of the spring force and apply counterpressure with a socket wrench.



- 8 Remove spring (4) with ball cage (3), ball (2) and valve disc (5).
- 9 Relief chain tensioner, remove ball (7) and spring(8) from pressure limit valve.



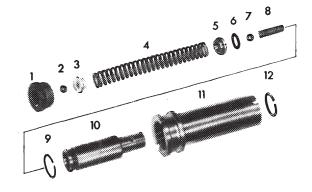
- 10 Take off snap ring (12) with a small screwdriver.
- 11 Pull out pressure pin toward front (pressure direction).
- 12 Clean out parts thoroughly.



Assembling and installation

1st version

- 13 Clamp housing (11) with installed snap ring (12) in holders.
- 14 Install pressure pin (10) with snap ring (9) from above. The snap ring rests on the assembly chamfer and prevents the pressure pin from falling through onto a catch.



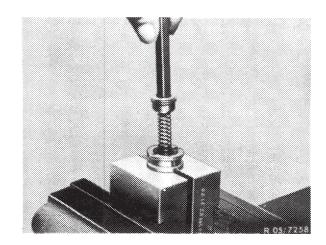
R 05/7322

- 15 Install spring (8) and ball (7) of pressure limit valve.
- 16 Install spring (4) with valve disc (5) and O-Ring (6).
- 17 Place ball cage (3) and ball (2) on spring (4).

18 Install ball locating ring (1) on ball cage with an internal socket wrench. Compress spring (4) and screw ball locating ring into housing by about 2 turns.

Attention!

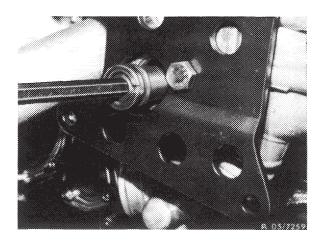
Don't tighten ball locating ring, since otherwise the pressure pin will jump forward and the chain tensioner will have to be disassembled again.



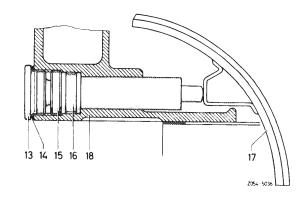
19 Guide chain tensioner into chain tensioner hole in cylinder head with an internal socket wrench.

Attention!

Don't apply knocks to socket wrench, since otherwise the pressure pin will jump forward.

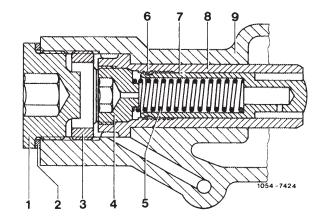


- 20 $\,$ Install threaded ring (15) and tighten to a torque of 50 Nm.
- 21 Tighten ball locating ring to 25 Nm whereby the pressure pin must **make a clicking noise** as it jumps forward.
- 22 $\,$ Install plug (13) with seal (14) and torque to 50 Nm.

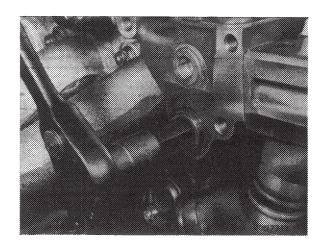


2nd version

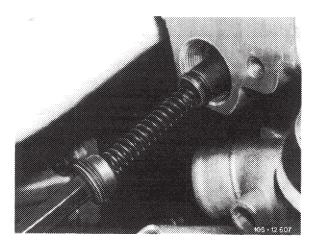
23 Guide housing (8) into cylinder head.



24 Install threaded ring (3) and torque to 50 Nm.



- 25 Install pressure pin (7) with installed snap ring (6) and spring (5) in housing and torque oil jet (4) to 25 Nm, whereby the pressure pin must make a clicking noise as it jumps forward.
- 26 Install plug (1) with seal (2) and torque to 50 Nm.



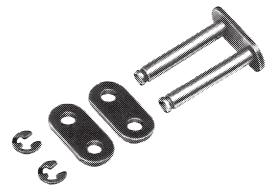
Valve clearance	Cold engine (approx. 20	°C) (68 °F) Warm engine	e (60 °C ± 15 °C) (140 °F ± 59 °F)
Intake	0.10 ¹)	0.15 ¹)	
Exhaust	0.25	0.30	
1) 0.05 mm more for consiste	ent outside temperatures belov	v -20 °C (-4.0 °F).	
Tightening torques			Nm
Cylinder head cover bolts	and capped nuts		5
Chain tensioner ball locat	ing ring		25
Valve adjusting screw			20-40
Special tools			
Depressor for valve spring	js	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	110 589 04 61 00
27 mm wrench socket, 1/to turn engine	2'' square,	11004. 6193	001 589 65 09 00
Rigid chain tensioner		fundamaning Time	110 589 03 31 00
Holder for chain tensions	er	11004-7008	110 589 02 31 00
Valve adjusting wrench 1	7 mm	J ₁₀₀₄₋₇₀₀₃	110 589 01 01 00
Wrench socket 10 mm, 1/2" square, 140 mm lon	g	1004-6192	000 589 05 07 00

Note

For repairs a repair chain with plug link, part no. 000 997 69 94 is available.

If only an endless timing chain with 130 links is available, chain can be split by grinding into **both pins of a link** and using a plug link for assembly. (Do not apply pressure, since this would result in lateral deflection). Use only one plug link, part no. 000 997 05 98 with two lock washers.

Check sprockets for scoring and pitting.



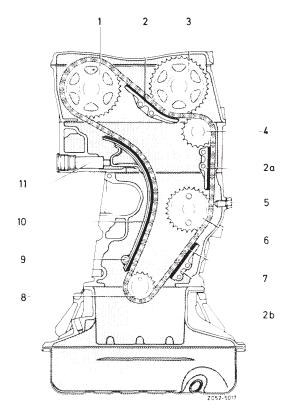
105-9259

Replacing

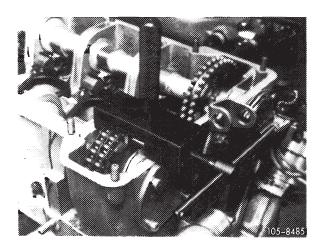
- 1 Remove spark plugs and take off cylinder head cover.
- 2 Remove rocker arm of righthand camshaft (exhaust) (05-230), so that camshaft will not rotate in jerks.
- 3 Remove chain tensioner (05–310). Install rigid chain tensioner and tighten by hand.

Chain drive

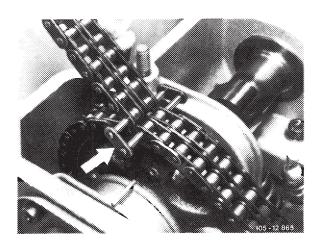
- 1 Exhaust camshaft sprocket
- 2-2b Sliding rail
- 3 Intake camshaft sprocket
- 4 Guide wheel 5 Lock screw
- 6 Intermediate gear
- 7 Timing chain
- 8 Camshaft sprocket
- 9 Bearing pin tensioning rail
- 10 Tensioning rail
- 11 Hydraulic chain tensioner



4 Cover chain housing with a clean cloth and break timing chain with chain separating device or grind off both chain pins of one link.



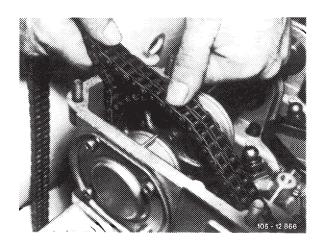
5 Connect new timing chain to old timing chain with one link, whereby the broken link is pressed out.



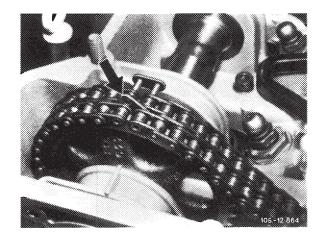
6 Turn crankshaft in engine's direction of rotation slowly with a 27 mm socket wrench and a ratchet, and at the same time lift the old chain until the link is at the uppermost point of the right camshaft sprocket.

Attention!

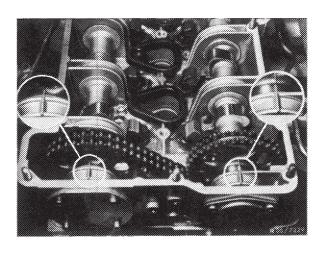
While turning the timing chain must be in constant engagement on both camshaft sprockets.



7 Detach old timing chain and connect ends of new timing chain with one link. Install center bar (arrow) and outer bar. Press on lock washers.



- 8 Turn crankshaft and check adjustment marks with engine in TDC position.
- 9 Disassemble chain tensioner, move to assembly position and install (05–310).
- 10 Install rocker arms (05-230).
- 11 Adjust valve clearance of exhaust camshaft (05–210).



Tightening torques		Nm
Expansion bolt for camshaft sprocket		80
Valve adjusting screw		20–40
Cylinder head cover capped nuts and bolts		5
Balance disc to cranskhaft		400 + 50
Pulley and vibration damper to balance disc		35
Ball locating ring in chain tensioner		25
Special tools		
Torque wrench 150–500 Nm (15–50 kpm) 3/4'' square	1104-5706	001 589 31 21 00
Holder	71004-598	110 589 00 40 00
Socket 27 mm, 1/2" square for rotating engine	11004-6193	001 589 65 09 00
Depressor for valve spring	I I I I I I I I I I I I I I I I I I I	110 589 04 61 00
Puller for bearing bolt (basic unit)	11004-6219	115 589 20 33 00
M 8 x 30 bolt for extractor	11004 - 6221	115 589 00 34 00
Wrench socket 10 mm 1/2'' square, 140 mm long	11004 - 8192	000 589 05 07 00
Valve adjusting wrench 17 mm	F ₁₀₀₄₋₇₀₀₃	110 589 01 01 00
Chain tensioner holder	2007 - POOIT	110 589 02 31 00

Impact extractor for bearing pin (basic unit)



116 589 20 33 00

M 6 x 50 bolt for impact extractor



116 589 01 34 00

Conventional tools

Connection 3/4" square socket to 1/2" square head

e.g. made by Hazet, D-5630 Remscheid 1 order no. 1058 R-1

Note

A 1st version tensioning rail (A) can be replaced by a 2nd version tensioning rail (B).



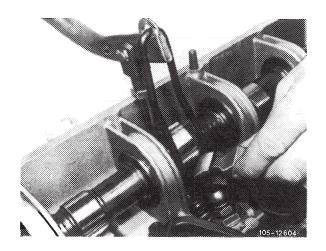


105-12452

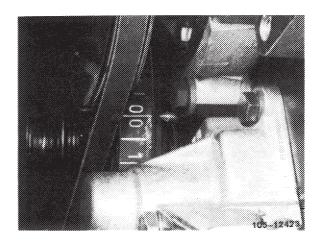
Removal

1 Remove radiator (20-240).

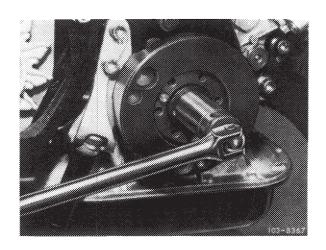
2 Remove rocker arms of right camshaft (exhaust) (05-230).



3 Position engine at ignition TDC.



4 Remove vibration damper (03-340). Remove balance disc without bore to extract the tensioning rail bearing pin (03-340).

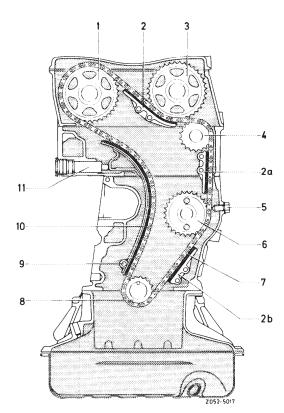


- 5 Remove chain tensioner (05-310).
- 6 Mark relation of left and right camshaft sprockets and timing chain with paint, and remove right camshaft sprocket (1).

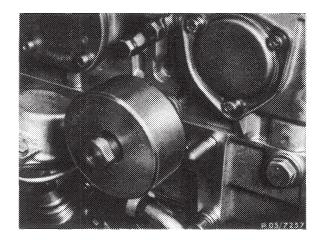
Chain drive

- Exhaust camshaft sprocket
- 2b Sliding rails
- Intake camshaft sprocket
- Guide wheel
- Lock screw Intermediate wheel

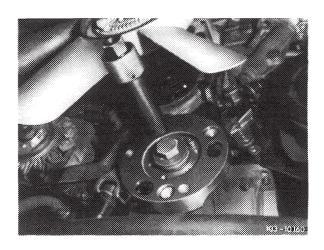
- Timing chain Crankshaft sprocket Bearing pin tensioning rail Tensioning rail Hydraulic chain tensioner



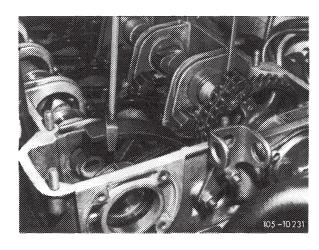
7 Remove sliding rail in camshaft housing.



8 Pull out tensioning rail bearing pin with extractor.

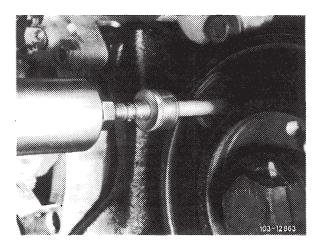


9 Remove tensioning rail upward.



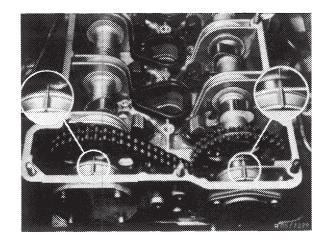
Installation

10 Guide in tensioning rail. Coat bearing pin with a sealing compound and knock in.

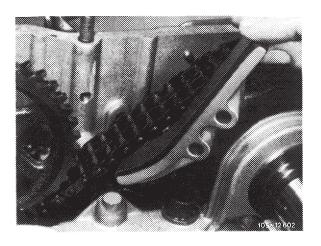


11 Install righthand camshaft sprocket, while paying attention to color symbol on camshaft sprocket and timing chain.

Marks on camshaft sprockets and camshaft housing must align when engine is set at TDC position.



- 12 Insall sliding rail in camshaft housing (05-340).
- 13 Set chain tensioner at assembly position and install (05-310).
- 14 Install balance disc and vibration damper (03–314).
- 15 Install rocker arms (05-230).
- 16 Install radiator.

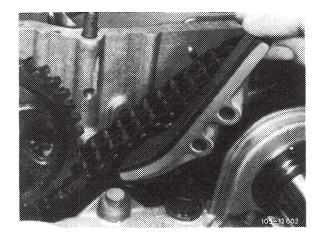


Tightening torques		Nm
Cylinder head cover capped nuts and bolts		5
Radiator drain plug		10
Ball locating ring in chain tensioner		25
Necked-down screw camshaft sprocket		80
Balance disc to crankshaft		400+50
Oil cooler drain plug		35
Special tools		
Impact extractor for bearing pin (basic unit)	11004-6220	116 589 20 33 00
Bolt 6 x 50 for impact extractor	11004-6368	116 589 01 34 00
Bolt 6 x 150 for impact extractor		116 589 02 34 00
Bolt 10 x 100 for impact extractor		116 589 03 34 00
Balance disc extractor		116 589 10 33 00
Rigid chain tensioner	11004-7006	110 589 03 31 00
Chain tensioner holder	11004-7005	110 589 02 31 00
Holder	Language Services	116 589 01 40 00

Sliding rail (2) in camshaft housing

- 1 Remove valve cover and knock out sliding rail pin with an impact extractor. Remove sliding rail.
- 2 Watch position of sliding rail when installing.

Coat collar of sliding rail pin with a sealing compound.

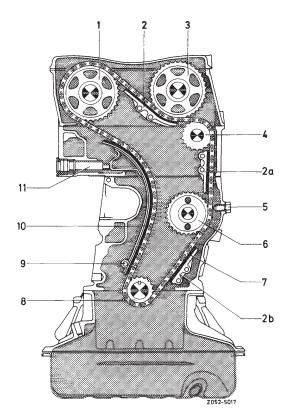


Sliding rail (2a) in cylinder head

- 1 Remove radiator.
- 2 Remove chain tensioner or spring in chain tensioner (05-310).
- 3 Mark relation of camshaft sprockets and timing chain with paint.
- 4 Remove sliding rail (2) in camshaft housing.

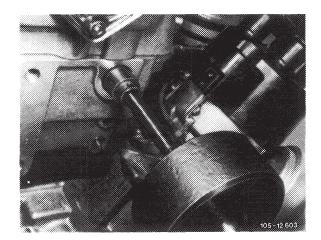
Chain drive

- 1 Exhaust camshaft sprocket
- 2-2b Sliding rail3 Intake camshaft sprocket
- Guide wheel
- Lock screw
- Intermediate wheel
- Timing chain Crankshaft sprocket
- Tensioning rail bearing pin
- Tensioning rail
- Hydraulic chain tensioner

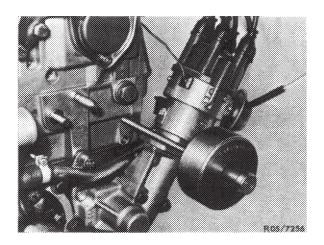


5 Connect a wire hook (5 mm thick) to guide wheel (4) and knock out the bearing pin with an impact extractor (10 mm bolt).

Remove guide wheel.

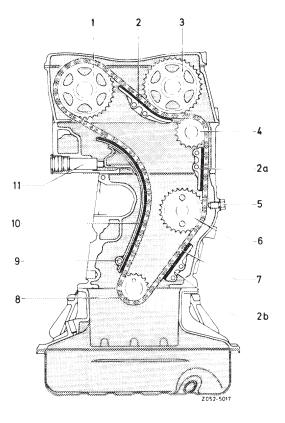


- 6 Knock out sliding rail pin with an impact extractor and pull out sliding rail with a wire hook.
- 7 Installation in reverse sequence of removal.



Sliding rail (2b) in crankcase

- 1 Remove radiator.
- 2 Remove entire oil pan (01-310).
- 3 Remove vibration damper and balance disc (03-340).
- 4 Mark relation of camshaft sprockets and timing chain with paint.
- 5 Remove sliding rail (2) and guide wheel (4).
- 6 Remove chain tensioner or compression spring (05-310).
- 7 Knock out sliding rail pin with an impact extractor and remove sliding rail.
- 8 Installation in reverse sequence of removal.



Special tools

Impact puller for bearing bolt (basic unit)



116 589 20 33 00

Threaded bolt M 6 x 150 for impact puller



116 589 02 34 00

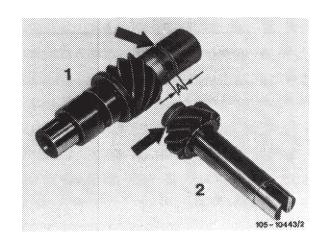
Note

The oil pump drive comprises the intermediate gear shaft (1) and the helical gear shaft (2), and may be replaced in sets only (05–412).

In the event of repairs, install oil pump drive part no. 110 050 02 06:

Intermediate gear (1): 9 teeth, groove (arrow), dimension A = 5 mm

Helical gear (2): 12 teeth, groove (arrow).



Standard installation oil pump drive 110 050 02 06

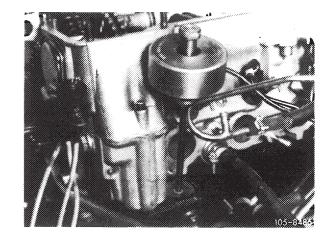
Engine	Engine end no. from to
110.921 — 10 —	009381 009738
— 12 —	039115 040762
110.922 — 10 — and starting — 12 — and starting	018226 019645 033340 (1.1978) 027657 030434 055136 (1. 1978)
110.923 — 10 —	010452 (1. 1978)
— 12 —	012890 (1. 1978)
110.931 — 10 —	001071 001080
— 12 —	000137 000138
110.932 — 10 —	002861 003151
and starting	007879 (1. 1978)
— 12 —	000432 000491
and starting	001954 (1. 1978)
110.981 — 10 —	010491 010636
— 12 —	022258 022809
110.982 — 10 —	000547 000704
— 12 —	001196 001528
110.983 — 10 —	013511 014341
— 12 —	035853 038811
110.984 — 10 —	005137 (1. 1977)
— 12 —	013900 (1. 1977)

110.985 10	002060 (1. 1977)
- 12	009179 (1. 1977)
110.986 - 10 -	000461 (1. 1977)
- 12 -	000991 (1. 1977)

All exchange engines starting unit no. 464 130 are provided with oil pump drive part no. 110 050 02 06.

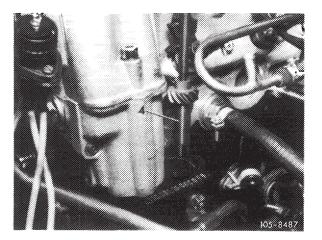
Removal

- 1 Remove intake pipe (09-400).
- 2 Knock out closing cover by means of impact puller (6 mm threaded bolt).



3 Pull out helical gear shaft (4) in upward direction by means of an M-6 screw.

Note: The bearing body together with bearing bushing for helical gear shaft can be knocked out in upward direction with intermediate gear shaft removed.

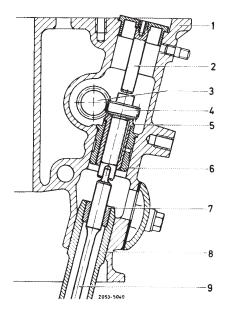


Installation

- 4 Guide in helical gear shaft (4). Oil pump drive shaft (9) must engage in dog claws of helical gear shaft (4).
- 5 Knock in new cover (2) with a pertinent sleeve (approx. 35 mm dia.).
- 6 Install intake manifold with a new gasket (09-400).

Oil pump drive

- Crankcase
 Cover with stop pin
 Intermediate gear shaft of oil pump drive
 Helical gear shaft of oil pump drive
 Bearing bushing
 Bearing
 Bearing bushing of oil pump housing
 Oil pump housing
 Oil pump drive shaft



Tightening torques		Nm
Bolt on intermediate gear shaft		25
Expansion bolt for camshaft sprocket		80
Valve adjusting screw		20-40
Cylinder head cover capped nuts and bolts		5
Ball locating ring in chain tensioner		25
Oil pressure relief valve in main oil bore		40
Plug for oil pressure relief valve		40
Special tools		
Rigid chain tensioner	11004-7006	110 589 03 31 00
Chain tensioner holder	11004-7005	110 589 02 31 00
Impact extractor for bearing pin (basic unit)	11004-6270	116 589 20 33 00
M 6 x 50 bolt for impact extractor	المارسيسة 11004 - 5366	116 589 01 34 00
M 6 x 150 bolt for impact extractor	11-04-9216	116 589 02 34 00
M 8 x 150 bolt for impact extractor	11004 - 6217	616 589 00 34 00
Camshaft holding wrench	11004-7004	116 589 01 01 00
Valve adjusting wrench 17 mm	11004-7003	110 589 01 01 00
Wrench socket 10 mm 1/2" square, 140 mm long	11004-6192	000 589 05 07 00
Wrench socket 27 mm, 1/2'' square to turn engine	1002.5193	001 589 65 09 00

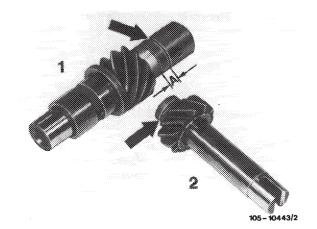
Note

The oil pump drive consists of intermediate gear shaft (1) and helical gear shaft (2), and must always be replaced in pairs (05–410).

For repairs, install oil pump drive part no. 110 050 02 06.

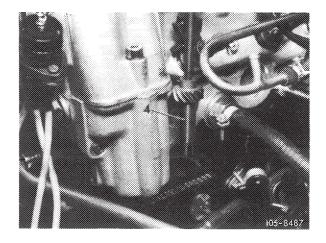
Intermediate gear (1): 9 teeth, groove (arrow). Dimension $A=5\,$ mm.

Helical gear (2): 12 teeth, groove (arrow), standard installation refer to 05–410.

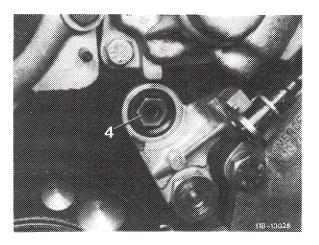


Removal

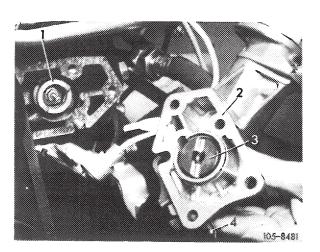
- 1 Partially drain coolant. Remove fan and radiator.
- 2 Remove helical gear shaft (05-410).
- 3 Remove vibration damper and pulley (03-340).



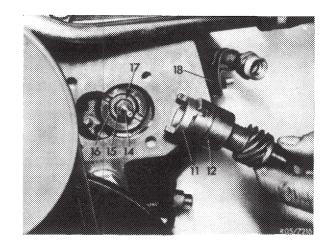
4 Unscrew plug in crankcase and remove oil pressure relief valve (4).



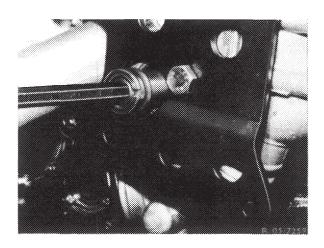
5 Remove distributor housing (2) and take off dog (1). Do not take distributor drive shaft (3) out of distributor housing (2).



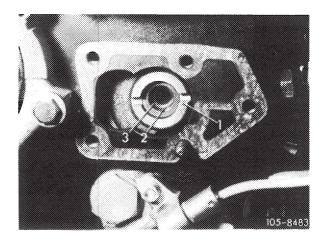
6 Remove screw (15) and washer (16).



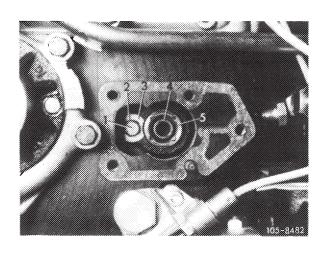
7 Remove chain tensioner (05-310).



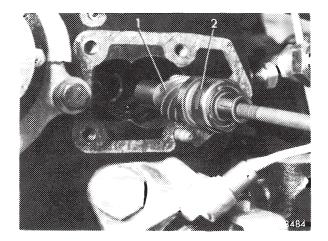
- 8 Relief tension on timing chain at intermediate wheel by turning crankshaft backwards briefly. Remove chain lock screw.
- 9 Knock in intermediate wheel shaft (3) and at the same time pull off intermediate wheel (1) forward.



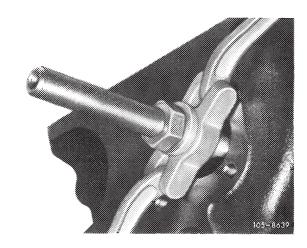
- 10 Place intermediate wheel down until bolt (1) is accessible.
- 11 Cover bottom of chain case with a cloth.
- 12 Unscrew bolt (1). Remove circlip (2) and lock washer (3).



13 Pull out intermediate wheel shaft (1) and bearing sleeve (2) with a M 8 bolt.

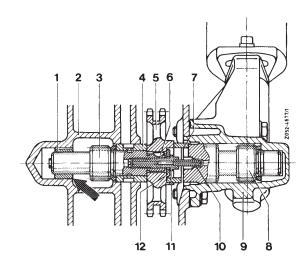


14 Pull out rear bearing bushing with an internal claw extractor.

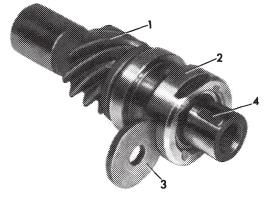


Installation

15 Knock in rear bearing bushing (1) with groove facing up using a 17 mm dia. stepped mandrel until it is flush with crankcase (arrow).



16 Install new intermediate wheel shaft (1) with woodruff key (4), bearing bushing (2) and lock washer (3).



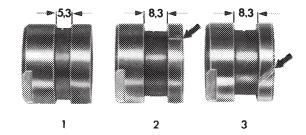
105-10442

Attention!

Use bearing bushing (2) part no. 110 052 00 06 with straight splash groove only.

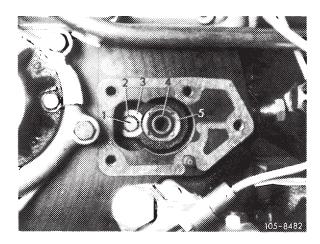
Front bearing bushing

Version 2 : valid Version 1 and 3 : not valid

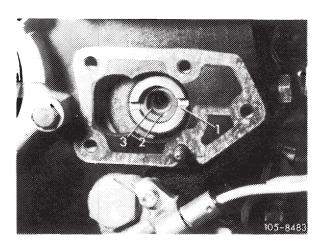


105-8287

17 Install bolt (1) with circlip (2) and washer (3), and tighten.

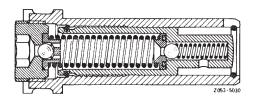


18 Position intermediate wheel on intermediate wheel shaft and pull on with a M 8 bolt. In so doing the woodruff key must be aligned with groove in intermediate wheel. Teeth of intermediate wheel must grasp timing chain.

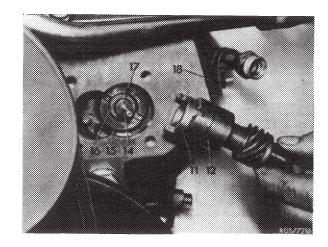


19 Move chain tensioner to assembly position and install (05–310).

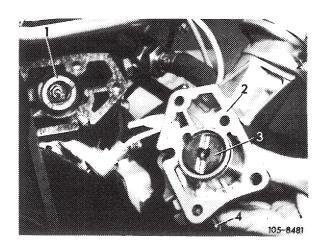
Chain tensioner in assembly position



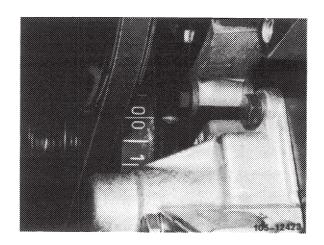
20 Install bolt (15) with oil tube (14) and washer (16), and torque to 25 Nm.



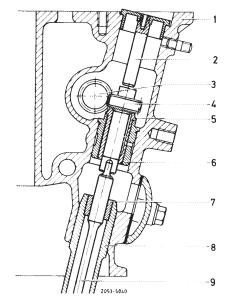
21 Place dog (1) on intermediate wheel and install distributor housing (2) with drive gear (3). Also fasten TDC pointer (4).



- 22 Set piston 1 at ignition TDC and install distributor.
- 23 Install new helical gear (4). Turn engine until oil pump drive shaft (9) engages in helical gear.



- 24 Knock in new cover (2) with an approx. 35 mm dia. sleeve.
- 25 Install intake manifold.



Attention!

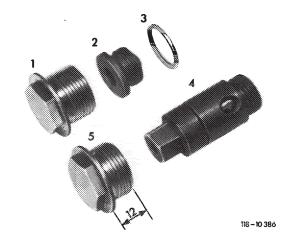
Additionally install an oil pressure relief valve 114 180 02 15 with 5 bar gauge pressure into main oil duct in cylinder crankcase together with oil pump drive 110 050 02 06.

Standard installation refer to 18-020.

- 26 Install 5 bar oil pressure relief valve (4) without seal in main oil bore of crankcase and torque to 40 Nm.
- 27 Coat plug (5) with a sealing compound, install without seal and torque to 40 Nm.



- Oil bore plug Aluminium seal Oil pressure relief valve (5 bar)
- Plug for oil pressure relief valve



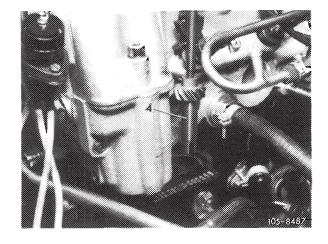
- 28 Install vibration damper and pulley (03-340).
- 29 Install radiator and fan (20-420).
- 30 Check and adjust ignition timing (07.5-510).

Tightening torques		Nm
Intermediate wheel shaft bolt		25
Camshaft sprocket expansion bolt		80
Valve adjusting screw		20-40
Cylinder head cover capped nuts and bolts		5
Balance disc to crankshaft		400+50
Ball locating ring in chain tensioner		25
Special tools		
Torque wrench single-arm, 3/4'' square, 150—500 Nm	\$ 100-100s	001 589 31 21 00
Balance disc extractor		116 589 10 33 00
Holder	L'accesses	110 589 00 40 00
Depressor for valve spring		110 589 04 61 00
Impact extractor for bearing pin (basic unit)	11004-6220	116 580 20 33 00
Threaded bolt M 8 x 150 long (for impact puller)	11004 - 8417	616 589 00 34 00
Puller for bearing bolt (basic unit)	1100 6.219	115 589 20 33 00
M 8 x 30 bolt for extractor	11004-5221	115 589 00 34 00
Camshaft holding wrench	11004-7004	116 589 01 01 00

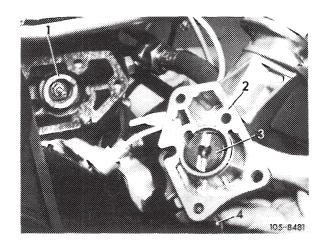
Valve adjusting wrench 17 mm	11004-7003	110 589 01 01 00
Wrench socket 27 mm, 1/2" square	1004.6493	001 589 65 09 00
Wrench socket 10 mm, 1/2" square, 140 mm long	11024 - 6192	000 589 05 07 00

Removal

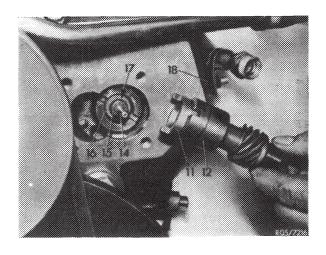
- 1 Remove radiator and fan.
- 2 Remove oil pump drive helical gear shaft (4) (05-410).



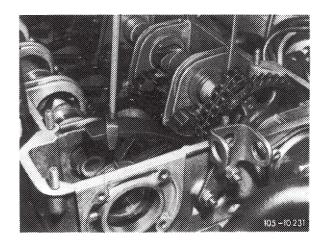
3 Remove distributor housing (2) with drive gear (3) for distributor drive (05-450).



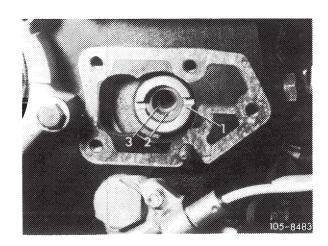
- 4 Remove bolt (15) with oil tube (14), lock washer (17) and washer (16).
- 5 Unscrew chain lock screw (18).



6 Remove tensioning rail (05-330).

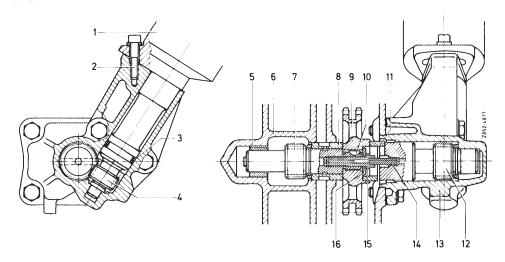


- 7 Turn intermediate wheel shaft (3) until woodruff key (2) is up.
- 8 Press back intermediate wheel shaft (3) until intermediate wheel (1) can be removed upward. Watch woodruff key.

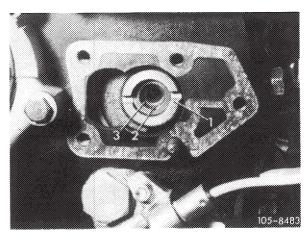


Installation

9 Guide intermediate wheel into chain case and install on intermediate wheel shaft.

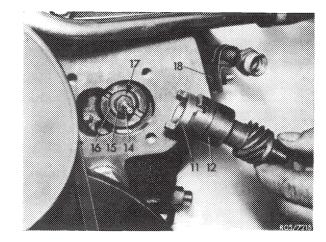


10 Pull intermediate wheel shaft (3) forward carefully with a M 8 bolt and at the same time turn intermediate wheel (1) until woodruff key (2) slides into groove of intermediate wheel.

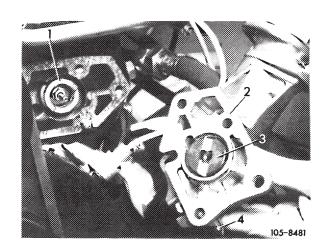


11 Install bolt (15) with oil tube (14), lock washer (17) and washer (16), and torque to 25 Nm.

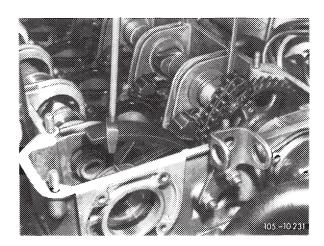
Install chain lock screw (18).



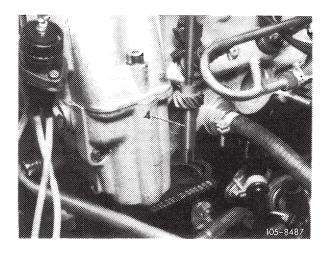
12 Install distributor housing with drive gear for distributor drive (05–450).



13 Install tensioning rail (05–330).



- 14 Install helical gear shaft for oil pump drive (05-410).
- 15 Install radiator and fan.

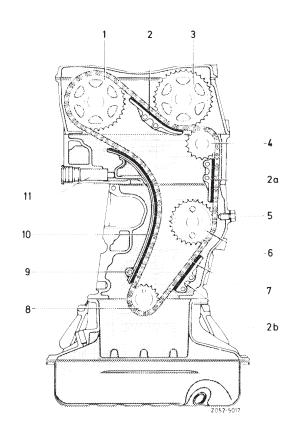


05-440 Removal and installation of guide wheel

Tightening torques		Nm
Cylinder head cover bolts and capped nuts		5
Ball locating ring in chain tensioner		25
Special tools		
Impact extractor for bearing pin (basic unit)	11004 - 62720	116 589 20 33 00
Chain tensioner holder	1004-7001	110 589 02 31 00
Wrench socket 10 mm 1/2" square, 140 mm long	11004-6192	000 589 05 07 00
M 6 x 50 mm bolt for impact extractor	الم المستند 11004 - 6368	116 589 01 34 00
M 10 x 100 mm bolt for impact extractor	10024 6218	116 589 03 34 00

Removal

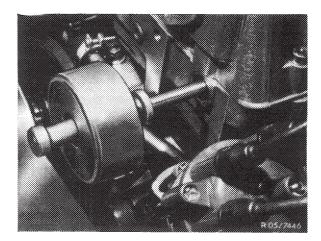
- 1 Mark relation to timing chain and left camshaft sprocket with paint.
- 2 Remove chain tensioner or spring (05-310).
- 3 Remove sliding rail (2) in camshaft housing. This requires knocking out bearing pin with impact extractor (05-340).



- Exhaust camshaft sprocket
- 2b Sliding rail
- Intake camshaft sprocket
- Guide wheel Locking screw Intermediate wheel

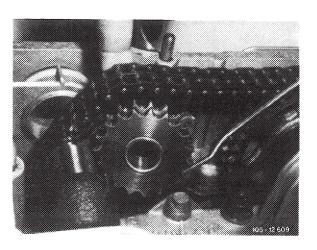
- Timing chain
 Camshaft sprocket
 Tensioning rail bearing pin
- 10 11
- Tensioning rail
 Hydraulic chain tensioner

4 Hold guide wheel with a 5 mm dia. wire hook and knock out bearing pin with an impact extractor (10 mm bolt).



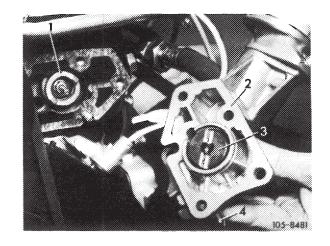
Installation

- 5 Guide in guide wheel with a 5 mm dia. wire hook, position correctly and knock in bearing pin with an impact extractor.
- 6 Install sliding rail in camshaft housing, noting marks on timing chain and left camshaft sprocket.
- 7 Set chain tensioner at assembly position and install, or install spring (05–310).

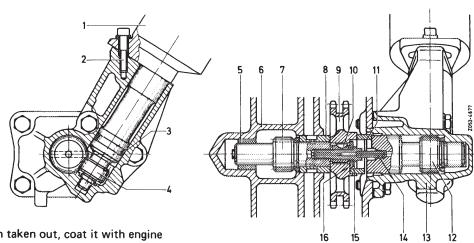


Removal

- 1 Remove radiator and fan.
- 2 Remove distributor housing (2) with distributor and take off dog (1).
- 3 Mark location of drive gear (3) to distributor housing.

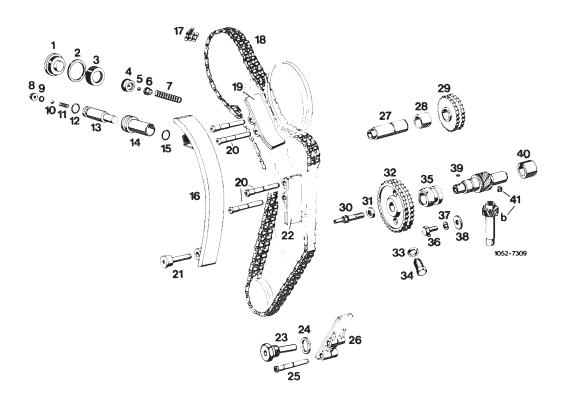


Installation



- 4 If drive gear has been taken out, coat it with engine oil and slide it into distributor housing, watching marks.
- 5 Place dog (11) on intermediate wheel (9) and install distributor housing (13) with a new gasket, also bolting the TDC pointer.
- 6 Check and adjust distributor adjustment (07.5-510).
- 7 Install fan and radiator.

- Distributor
- Screw M 6 x 30
- Seal
- 2 3 4 5 6 Distributor drive gear
- Rear bearing bushing
- Crankcase
- Intermediate wheel shaft Front bearing bushing
- Intermediate wheel
- 10 Woodruff key 3 x 3.7 Dog
- Distributor drive gear
- Distributor housing Oil tube
- Bolt with oil tube (14) Washer



- Plug Seal A 30 x 36
- Threaded ring
- Ball locating ring (oil jet)
- Ball 5 mm dia. (version 1 only) Ball cage (version 1 only)

- Spring
 Valve disc (version 1 only)
- O-ring (version 1 only)
 Ball 5 mm dia. (version 1 only)
 Spring (version 1 only)
 Snap ring
 Pressure pin 10 11

- 13 14 15
- Chain tensioner housing Circlip
- Tensioning rail
- Connecting link Timing chain
- 18
- Sliding rail in camshaft housing 4 bearing pins for sliding rails

- Tensioning rail bearing pin Sliding rail in cylinder head Bearing pin with plug Seal A 20 x 24

- 23 24 25 26 27
- Bearing pin Sliding rail in crankcase Guide wheel bearing journal
- Bushing
- Guide wheel with bushing
- Bolt with oil tube
- 28 29 30 31 32 33 34 35 36 37 38 Intermediate wheel washer Intermediate wheel
- Seal A 12 x 17
- Chain drive lock screw
- Front bearing bushing Screw M 6 x 12
- Circlip B 6 Washer
- Woodruff key 3 x 3.7
- Rear bearing bushing
- a Intermediate wheel shaft
 - b Helical gear wheel

A. General

This Solex carburetor 4 A 1 is a two-stage downdraft carburetor with an intake manifold ID of 32 mm in stage I and 54 mm manifold ID in stage II.

It is important that all measurements or adjustments of exhaust emissions are made without influence of emission control system. For this reason, the air injection or EGR (exhaust gas recirculation) must be made inoperative.

Identification code:

- 4 = number of mixing chambers
- A = identification of design principle
- 1 = identification of version

238

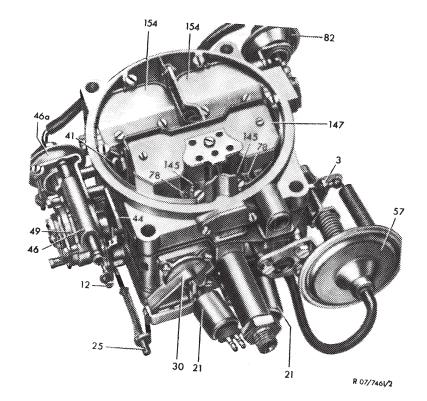
Solex carburetor 4 A 1 J 1976

- 214 Float chamber vent valve (vacuum-controlled)
- 237 Vacuum connection for vacuum booster of EGR238 Idle air combination jet



Solex carburetor 4 A 1 S 1976

- 236 TN auxiliary choke
- Vacuum connection for vacuum booster of EGR
- 238 Idle air combination jet



Solex carburetor 4 A 1 USA 1973/74

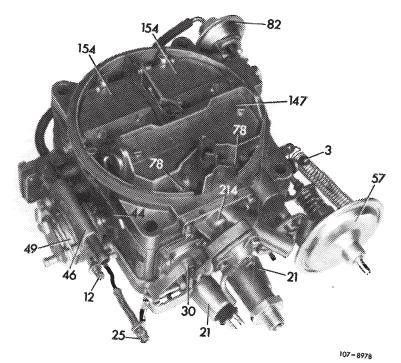
- Throttle valve lever
- 3 12 Cold starting speed adjusting screw Idle mixture cutoff valves
- Adjusting nut accelerating pump
- Accelerating pump cover Choke rod 30 41

- 44 Fast idle cam
 46 Choke housing
 46 Vacuum control unit for
 automatic choke
 49 Choke cover
 57 Vacuum governor
 82 Vacuum gets
 82 Vacuum
- 57
- Vacuum control unit air valve
- damper stage 11
- 145 Air correction jets stage I
- 147 Choke valve
- 154 Air valves stage II

Solex carburetor 4 A 1 USA California 1974

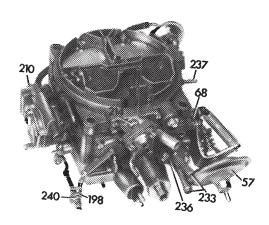
- Throttle valve lever
- Choke cover 12 21
- 25 30 44 49 57 78

- Choke cover Vacuum governor
- Idle air jets 82
- Vacuum control unit air valve damper stage II Choke valve
- 147
- Air valves stage II
- Float chamber vent valve



Solex carburetor 4 A 1 USA 1975/76

- Vacuum governor
- Actuating lever accelerating pump Pulldown cover 210
- 214 233
- Float chamber vent valve Coolant connection for TN starter 236
- TN starter (thermostatically controlled bypass choke) Vacuum connection for vacuum booster of EGR (Venturi connection)
- 240 Plastic guide piece



The Solex carburetor 4 A 1 comprises 4 main components which are screwed to each other.

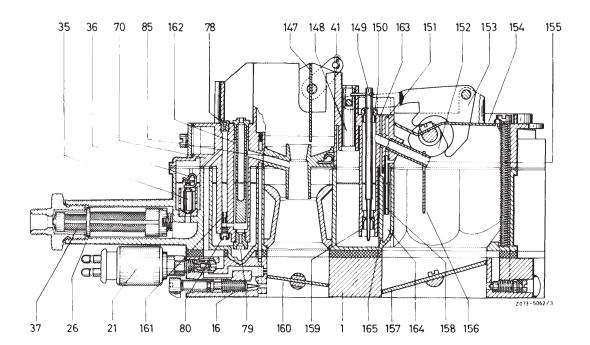
- carburetor cover
- carburetor housing
- throttle valve section
- starting device (choke)

Stage I is designed on the principle of Zenith carburetor:

- variable vacuum in mixing chamber
- main jet without change of cross section

Stage II operates on principle of Stromberg carburetor (constant pressure principle):

- constant vacuum in mixing chamber by means of an air valve constantly adapted to respective air flow
- main jets with variable cross section via needle control



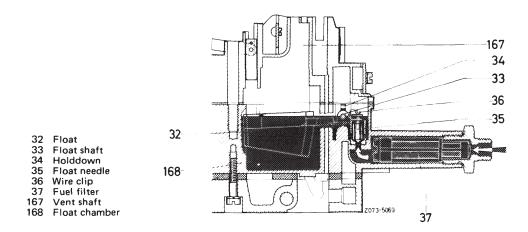
- Throttle valve section
- Idle mixture adjusting screw
- Idle mixture cutoff valve
- Float housing
- Float needle valve
- 35 36 37
- Wire clip Fuel filter
- Choke rod
- Carburetor cover
- Idle speed air jet
- Main jet stage I

- 80 Closing plug idle speed duct 85 Pre-atomizer with fuel outlet arm
- Choke valve
- 148 Guide pin jet needles stage II
- 149 Jet needle stage II
- 150 Air correction jet stage II
- 151 Bypass bore stage II
- Fast idle cam 152
- Transmitting lever stage II 153
- Air valve stage II
- 155 Fuel outlet arm stage II

- 156 Baffle plate
- 157 Throttle valve stage II
- Riser bypass system stage II 159 Needle-controlled main jet stage II
- 160
- Throttle valve stage I 161 Idle speed fuel jet
- 162
- Mixing tube stage I Vent bore reserve chamber 163
- Reserve chamber stage II
- 165 Feed bore - reserve chamber

B. Float

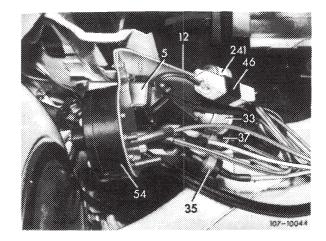
The float is centrally located between the four mixing chambers. The float needle seat is pressed into carburetor housing. The needle is positively controlled. The fuel intake connection is provided with a filter.



Float chamber vent system

The float chamber must be vented to provide the pressure difference between fuel level and mixture outlet. The fuel flows out under the influence of the pressure difference between float chamber and mixture outlet. The carburetor is vented internally and externally. The external venting is operative when the engine is stopped, the internal venting when the engine is running.

With the ignition switched on, the switchover valve for float chamber external venting is energized and switches.

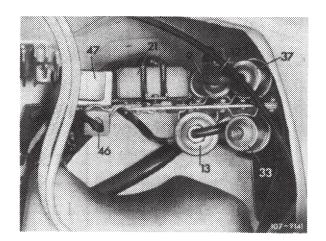


Model

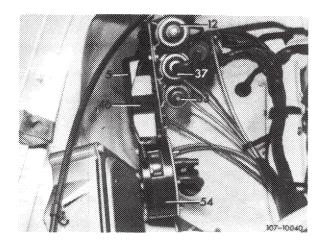
J 1976

(USA) 1975/76

37 Switchover valve



Model 114 (USA) California 1974 37 Switchover valve

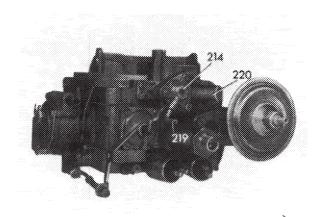


Model 114 USA 1975/76 37 Switchover valve

For the national version J 1976 and WSA 1975/76 the float chamber vent valve is provided with a vacuum upon starting and will switch to "internal venting".

For the national version (USA) California 1974 the float chamber vent valve is already provided with a vacuum from a vacuum reservoir with the engine stopped and the ignition switched on. The system switches to "internal venting".

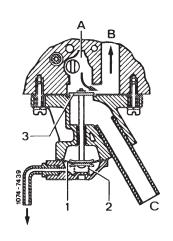
- 214 Float chamber vent valve219 Vacuum connection220 Negative vent connection



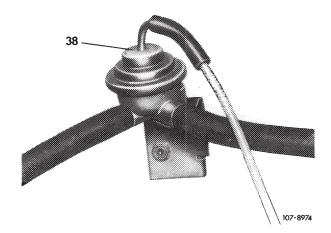
107-8977

Float chamber, internally vented

- Duct from air filter clean air end
- Diaphragm
- Compression spring Valve plate

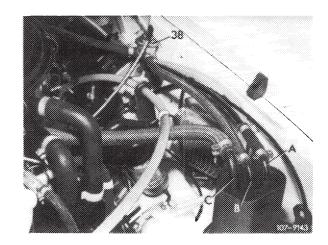


In dependence of the throttle valve position of stage I of the carburetor, the diaphragm of the intake valve is activated by a vacuum and the draw-off valve (purge valve) will switch.



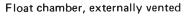
38 Draw-off valve (purge valve)

The intake pipe vacuum will now draw the stored vapors from charcoal canister by way of the draw-off valve and a connection on carburetor into intake pipe for combustion.



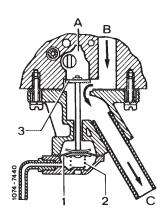
- 38 Draw-off valve (purge valve)
- Negative tank vent connection
- Draw-off valve connection
- A B C Float chamber positive vent valve connection

When the ignition is switched off, the switchover valve is de-energized and will switch. The vacuum in the diaphragm chamber is exhausted and the float chamber vent valve will switch to "external venting".



- Duct from float chamber
- Duct to atmosphere

To prevent the float chamber vent valve to switch to external venting at low intake pipe vacuum (e.g. during acceleration or when driving at full throttle), a check valve is installed in vacuum line.

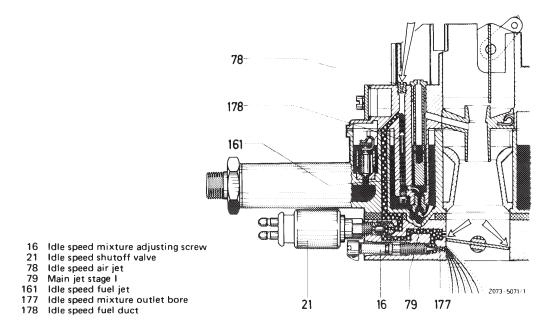


C. Idle speed

The idle speed system is associated with stage I. The fuel required for idle speed is taken from main jet system behind main jets (dependent idle speed system). The fuel flows via main jet through idle speed fuel jet.

The required air is fed via the idle speed air nozzle and mixes with the intake fuel. This idle speed emulsion (initial mixture) flows out below throttle valve. Its quantity can be changed by the idle speed mixture adjusting screw

The idle speed mixture is formed by the initial mixture and the air entering through annular gap of throttle valves.



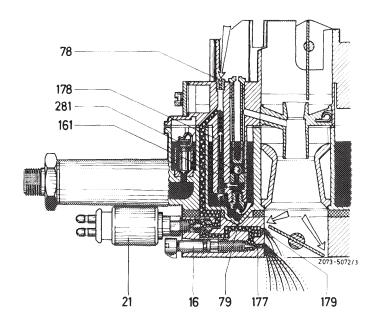
Idle speed shutoff valve

The idle speed mixture ducts are provided with screwed-in shutoff valves in front of idle speed mixture adjusting screws.

With the ignition switched on, the shutoff valves are energized and are open. When the ignition is switched off, the shutoff valves will be de-energized and will close the idle speed mixture flow holes by means of their spring-loaded sealing cones, so that any afterrunning of engine is prevented.

D. Bypass carburetor stage I

To guarantee perfect transition from idle speed to main jet system of stage I, bypass bores are provided above idle speed mixture outlet bores, covered by the throttle valves. When the throttle valves are opened, these calibrated bores are exposed. The resulting vacuum will draw off additional fuel emulsion through those bores.



- Idle speed mixture adjusting screw
- 21 78 Idle speed shutoff valve
- Idle speed air jet 79
- Main jet stage I Idle speed fuel jet 161
- Idle speed mixture outlet bore 177
- Idle speed fuel duct
- Bypass bores stage I

E. Acceleration

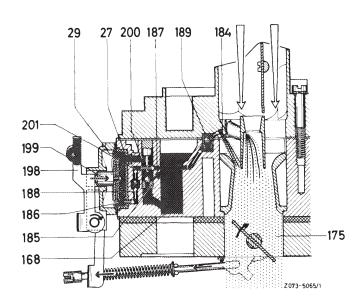
To guarantee adaptation of mixture quantity to heavily increasing air flow during sudden acceleration, an accelerating pump will be required.

The accelerating pump is a mechanically actuated diaphragm pump. The fuel is injected through calibrated bores or jets in carburetor cover.

During the suction stroke of the diaphragm, the fuel is sucked from float chamber through suction valve into pump chamber. The pump chamber is lined by a plastic shell for thermal insulation. Any vapor bubbles will escape through a vent bore in float chamber.

During pressure stroke of diaphragm, the fuel is injected into mixing chambers of stages I via the pressure valves and the calibrated injection bores. The two pressure valves prevent the penetration of air into pump system during suction stroke.

Note: To enrich the mixture, additional fuel is drawn from pump system (neutral pump) in dependence of the vacuum in the mixing chamber.



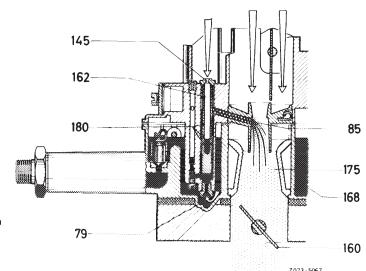
- Plastic shell
- 29 Diaphragm
- Calibrated injection bore 184
- 185 Suction valve
- Pump chamber
- 187 Vent bore
- 188 Pressure valve
- 189 Pressure valve

F. Main jet system carburetor stage I

Main jet system

The fuel flows from float chamber through main jets into the mixing tubes. When the air flow rate (vacuum) is adequately high, the fuel is drawn off into the mixing chambers.

At increasing speed, the fuel level in mixing tubes will drop and will expose the compensating air bores one after the other. The compensating air flowing in through air correction jets mixes with the fuel into an emulsion and prevents excessive enrichment.

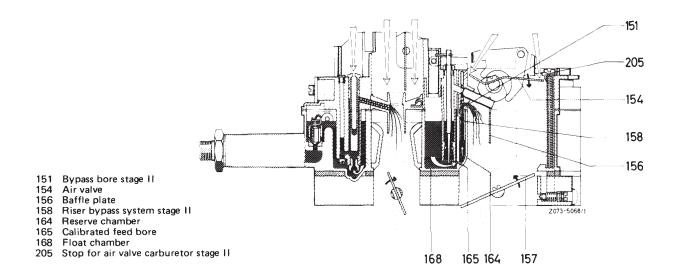


- 79 Main jet stage I
- 85 Pre-atomizer with mixture outlet arm
- 145 Air correction jet stage I
- 162 Mixing tube stage I
- 168 Float chamber
- 180 Compensating bores

G. Bypass carburetor stage II

To guarantee a lag-free transition (bypass) from stage I up to start of main jet system of stage II, bypass bores are located below air valves.

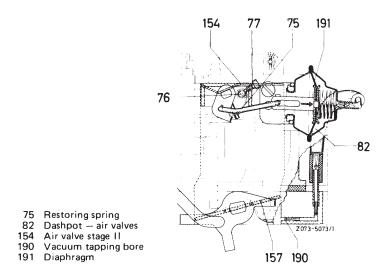
When the air valves are opening, fuel is drawn from reserve chambers through the riser pipes. The fuel flows to the reserve chambers through calibrated bores which are dimensioned in such a manner that only the follow-up fuel can be drawn from empty reserve chambers. This will limit a quantity available for enrichment. The mixture is guided by the baffle plates into the gap of the opening throttle valves.



Dashpot for air valve carburetor stage II

The vacuum-controlled dashpot serves the purpose of preventing the sudden opening of the air valves. The dashpot is provided with a vacuum by way of a vacuum line which opposes the vacuum at the air valve.

The location of the vacuum tapping bore for the dashpot, as well as the dimensions of the diaphragm in the dashpot are designed in such a manner that the vacuum effective at the air valve is always able to open the valves.



Note: During acceleration, the air flaps must be opened under delay so that enough fuel is available for a good bypass (fuel column will accelerate slower than air column) to eliminate faults when passing from carburetor stage I to carburetor stage II.

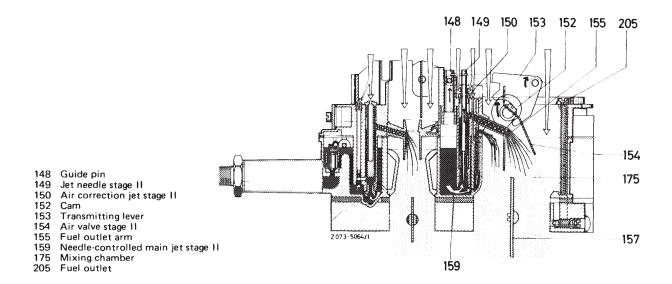
The dashpot serves the same purpose as that in Stromberg carburetor (accelerating pump effect). The dashpot acts in direction of restoring spring on air valves of stage II and only during acceleration, but not when the throttle valve position remains the same.

H. Main jet system carburetor stage II

When the throttle valves are opening, the vacuum in mixing chambers will increase. The eccentrically supported air valves are opened by this vacuum against the force of the restoring spring. The opening of the air valves makes the intake cross section larger and reduces the vacuum until an equilibrium is established between the vacuum on the one hand and the spring-loaded air valves on the other. As a result, the air valves will take a position which is in a given ratio to the throttle valve opening and to the air flow rate. Consequently, the vacuum at fuel outlet will remain approximately constant.

When the air valves are opening, the cam will simultaneously actuate the transmitting lever, the guide pin and the jet needles, with the latter releasing a pertinent annular gap in main jet with their conical section.

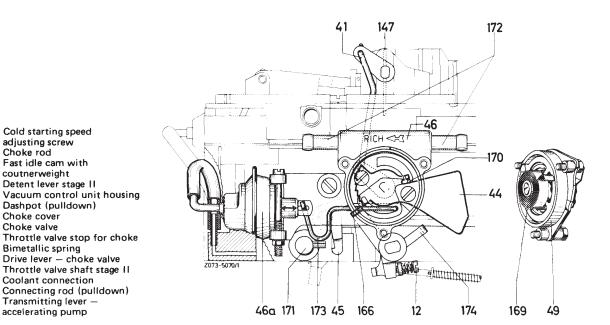
The correction air flows in via the annular gap between jet needle and air correction jet and mixes with the fuel into an emulstion which is drawn off into the mixing chambers via the outlet arms.



I. Starting device (choke)

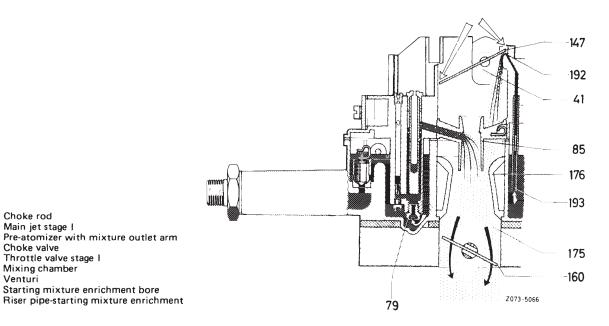
The starting device (choke) is controlled by means of the electrically and coolant-heated bimetallic spring in choke cover. The coolant heating is required to prevent re-engagement of choke when the engine is shut off for a short period.

The choke engages automatically on cold engine when the accelerator pedal is actuated once. The choke valve is closed by the bimetallic spring by way of a driver and the choke rod. The fast idle cam with the counterweight is simultaneously turned to cold starting position. This will place the throttle valve lever on the topmost step of the fast idle cam and the throttle valves of stage I are opened by a given angle.



The closed choke valve will increase the vacuum in the mixing chambers when the engine is started to the extent that fuel is drawn from main jet system. This vacuum will also act against closed choke valve and will open that valve against the force of the bimetallic spring to the extent that the air required for the starting mixture can flow

Additional fuel is drawn in via the riser pipes of the start enrichment system until the choke valve is slightly opened (choke valve gap). The result is an initially rich starting mixture which permits the engine to fire reliably even at low temperatures.



Following firing of the engine the choke valve is opened to a given gap dimension (choke valve gap) by the vacuum diaphragm of the choke via the connecting rod and the drive lever. The increasing heat of the bimetallic spring will open the choke valve still further so that at 70-75 °C coolant temperature the choke is completely switched off.

The throttle valve of stage II is locked by the detent lever. Unlocking will occur only when the choke is completely switched off, i.e. when the choke valve is fully opened by the drive pin of the fast idle cam.

12

45

46

49

147

166

170

172

173

in.

147

160

175

176

Cold starting speed adjusting screw Choke rod Fast idle cam with coutnerweight

Detent lever stage II

46a Dashpot (pulldown)

Bimetallic spring

Coolant connection

accelerating pump

Drive lever - choke valve Throttle valve shaft stage II

Connecting rod (pulldown) Transmitting lever

Choke cover

Choke valve

Thermostatically controlled auxiliary bypass choke (TN choke)

The thermostatically controlled auxiliary bypass choke is installed together with the following carburetors:

J 1976

(s) 1976

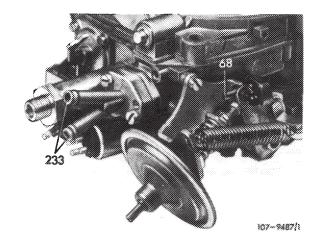
(USA) 1975/76

Significance of designation "TN":

T = temperature-controlled

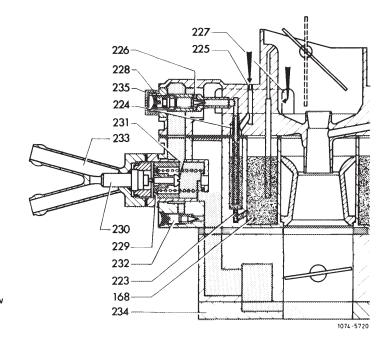
N = bypass

To improve the warming-up characteristics, the warming-up mixture is guided into the intake pipe in dependence of the coolant temperature, while bypassing the throttle valve.



233 Thermostatically controlled auxiliary bypass choke (TN choke)

The vacuum in intake pipe serves to draw fuel from float chamber by way of the starting fuel jet. The fuel will move upwards in mixing tube and will be mixed with air from the starting air jet into a fuel-air mixture. This fuelair mixture is mixed with additional air from air duct at outlet bores. The mixing ratio is set by the manufacturer by means of the temperature-controlled mixture adjusting screw (TN mixture adjusting screw).



168 Float chamber

223 224 Starter fuel jet

Mixing tube 225

Starting air jet 226 Outlet bore

227 Air duct (TN main air)

TN mixture adjusting screw

229 Control piston

230 Expanding element

231 Control window Leak volume adjusting screw

Coolant connection

Insulating flange

235 Plastic cap The mixture flowing to the intake pipe is metered by a control piston which is actuated in dependence of the coolant temperature by means of an expanding element. With increasing coolant temperature, the control piston will close the control window until it is completely closed at 70–75 °C. The choke is thereby switched off except for a very low amount of leak mixture, which flows to the intake pipe by way of the leak volume adjusting screw. The leak volume is set by the manufacturer.

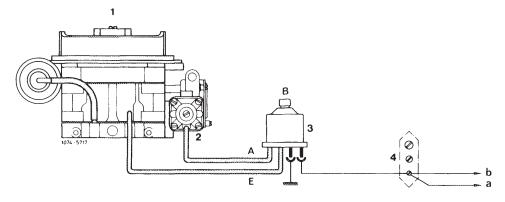
The setting of the throttle valve required for a cold start is no longer made by means of the fast idle cam, but via the vacuum governor. For this reason, the adjusting screw for cold starting speed is no longer installed. The fast idle cam now controls only the unlocking of stage II which results in the complete opening of the choke valve.

Switchover valve for pulldown delay (lag)

The switchover valve prevents the pulldown from pulling the starting valve immediately to a gap position during the starting procedure, since this might stop the engine immediately upon starting.

During the starting procedure (as long as the ignition key is in starting position) the choke provides the switchover valve in vacuum line to choke housing with control current via terminal 50. This will connect the vacuum chamber to the outside air (atmosphere).

When the ignition key moves back from its starting position, the switchover valve will switch over. This will provide the vacuum chamber in choke housing with a vacuum and the choke valve will be pulled to the specified gap.

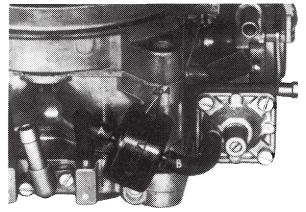


- 1 Solex carburetor 4 A 1
- 2 Choke housing
- 3 Switchover valve
- 4 Cable connector
- A Outlet (to choke housing red line)
- B Connection to atmosphere
- E Inlet (from carburetor white line)
- a To ignition starter switch
- b To starter terminal 50

The carburetor is provided with an orifice (throttle) in vacuum connecting pipe. As a result, the choke valve will not be opened suddenly, but is pulled to choke valve gap under delay.

Thermo delay valve for choke (S) 1976 only)

The thermo delay valve opens the choke valve upon firing of engine under delay in dependence of the temperature. The valve is located in vacuum line to pulldown.



254 Thermo delay valve

107-10706

The thermo delay valve serves the purpose of pulling the choke valve at temperatures above approx. -- 12 °C upon firing of engine not immediately to the required choke valve gap, but under delay.

At temperatures below approx. - 12 °C there is no delay under influence of thermo delay valve. At low outside temperatures, the vacuum generated by the engine is relatively low. If this vacuum would be additionally throttled, the choke valve would be opened too slowly and the warming-up mixture would become too rich, i.e. the spark plugs would soot up and misfiring would result.

Ambient temperature above approx. - 12 °C

The vacuum generated by the engine is established via connection (A), filter, sintered metal disc up to diaphragm of choke. The throttle effect of the sintered metal disc will pull (open) the choke valve under delay.

Filter

256 Sintered metal disc

Check valve Bimetallic valve plate 257

258 259 Rubber sealing ring

260 Spring

Connection to carburetor

Connection to pulldown

1073-6506

259 258

260

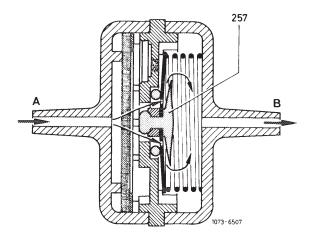
255

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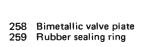
A rubber check valve is installed to make sure that the choke valve returns immediately and without delay into closing position prior to a possible attempt for a

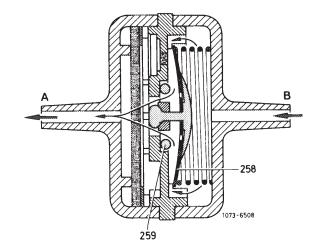
If the engine stops after starting, the vacuum in choke housing will open the check valve. The diaphragm chamber in choke housing will be energized, the choke valve will close immediately.



Ambient temperature below approx. - 12 °C

Below approx. - 12 °C the bimetallic valve plate will snap over and will lift off from rubber sealing ring, so that the vacuum can act unthrottled on diaphragm of automatic choke. The sintered metal disc will be bypassed.





Attention!

When installing the thermo delay valve, pay attention to direction of installation.

1. Thermo delay valve with arrow:

Arrow in direction of throttle valve section

2. Thermo delay valve in two colors:

Black side in direction of throttle valve section

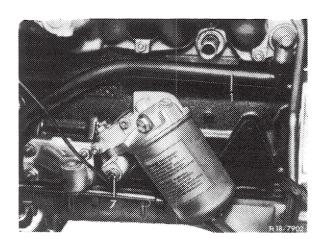
Choke cover-stepped heater

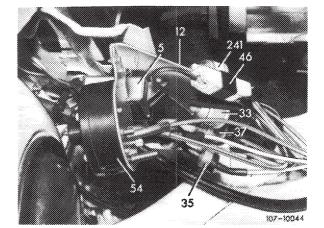
To improve warming-up characteristics, the choke cover of the automatic choke is heated in two steps. Below 17 °C oil temperature at reduced output, above 17 °C oil temperature the choke cover is heated at normal capacity.

Below 17 °C oil temperature the oil temperature switch (7) in oil filter housing is closed, the relay will switch, so that the current flows across pre-resistor.

7 Oil temperature switch 17 °C

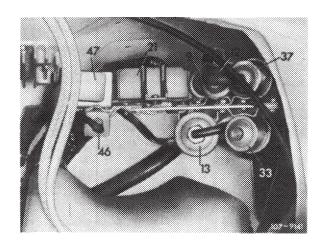
The oil temperature switch (7) will open above 17 °C oil temperature and thereby interrupt the ground connection to relay. The relay switches over, so that the current will flow directly to choke cover while bypassing the pre-resistor.





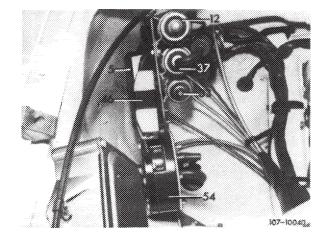
Model 116 (J) 1976, USA 1975/76

5 Relay 46 Resistor for choke cover-stepped heater



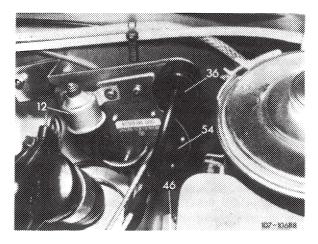
Model 114 (USA) California 1974

- 21 Relay46 Resistor for choke cover-stepped heater

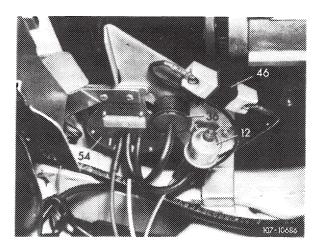


Model 114 (USA) 1975/76

- 5 Relay
 46 Resistor for choke cover-stepped heater



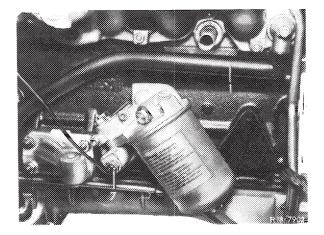
Model 114 S 1976 46 Resistor for choke cover-stepped heater



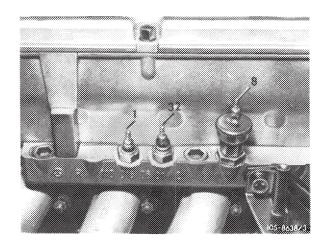
Model 116 (\$) 1976

46 Resistor for choke cover-stepped heater

As a result of the electric coupling of temperature switch 17 °C (7) and temperature switch 100 °C (8) the reduced heater output will also become effective at coolant temperatures above 100 °C, but the automatic choke will then no longer be affected.



7 Oil temperature switch 17 °C



8 Coolant temperature switch 100 °C

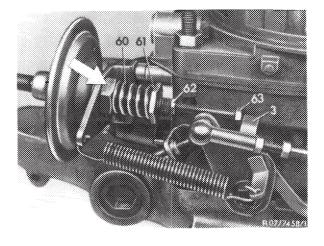
J. Vacuum governor

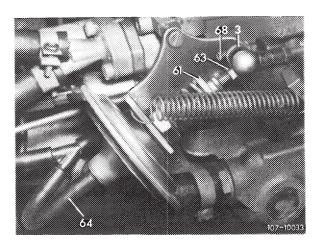
The vacuum governor is installed on all Solex carburetors 4 A 1 as standard equipment and serves the purpose of stabilizing the idle speed when the engine is loaded by the additional engagement of auxiliary units or by shifting into a driving position.

At idle speed of the engine, the intake pipe vacuum will pull back the diaphragm by means of the adjusting screw. If the idling speed drops as a result of the engine load, the effective vacuum will also drop and the compression spring can now adjust the throttle valve still further by means of the adjusting screw.

On Solex carburetors 4 A 1 with thermostatically controlled bypass choke (TN choke) the arrangement of the vacuum governor has been changed. Operation is as described above with the following difference. The throttle valve is no longer moved into starting position as before by means of the fast idle cam, but via the vacuum governor. During the warming-up period, the throttle valve lever rests against idle speed stop. When a driving position is engaged or when the power steering is operating, the vacuum governor can lift the throttle valve slightly when the engine speed drops.

Carburetor with thermostatically controlled bypass choke (TN choke)

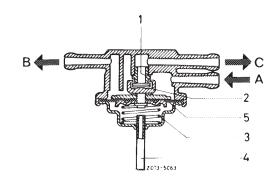




K. Fuel return valve

The fuel return valve is located in fuel feed line in front of carburetor and is connected to fuel tank by means of a return line.

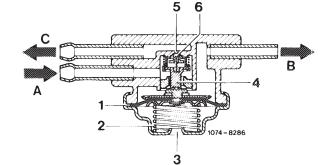
At idle and in partial load range the diaphragm is pulled down against the spring by the high vacuum and the valve will open. The excess fuel flows back into fuel tank. This fuel circulation will continuously feed relatively cool fuel to the carburetor and vapor lock will be checked.



- Valve seat
- Valve 2 3 4
- Spring
- Vacuum connection
- Diaphragm
- Fuel feed from delivery pump
- Fuel feed to carburetor
- Fuel return to fuel tank

Fuel return valve with pressure control (S) 1976 only)

The fuel return valve is simultaneously designed as a fuel pressure regulator. Regulation of fuel return quantity and fuel pressure to approx. 0.2 bar (gauge pressure) is effected by means of a spring-loaded valve. Fuel level fluctuations will be widely avoided. The former vacuum connection to fuel return valve is no longer in place.



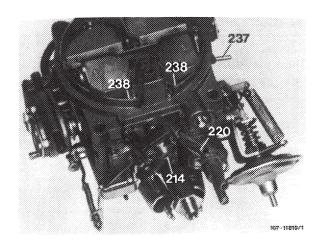
- Diaphragm
- Spring
- Vent bore
- Control cone
- Throttle bore
- Return valve
- Fuel feed from delivery pump
- Fuel feed to carburetor
- Fuel return to fuel tank

Notes

Below is a description of the different carburetor systems in relation to standard version or model years in relation to each other. Further below are the modifications introduced during the model year.

A. o model year 1976 Differences as compared with standard version

- Float chamber vent valve
- Full load enrichment in stage I no longer applicable
- Idle speed combination jet
- Vacuum connection for vacuum booster of EGR
- Carburetor cover with raised centering flange for air filter
- Draw-off connection for fuel evaporation control system and crankcase breather
- Pre-atomizer with slot
- New nozzle line-up (refer to adjusting data)
- New insulating flange
- Choke cover-stepped heater



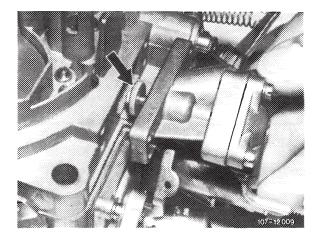
²¹⁴ Float chamber vent valve (vacuum-actuated)

238 Idle speed combination jet

²³⁷ Vacuum connection for vacuum booster of EGR

Float chamber vent valve

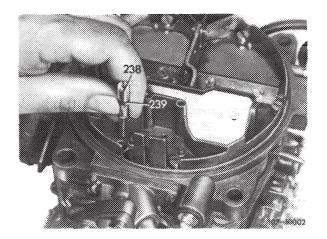
This valve (arrow) is vacuum-controlled. With the engine stopped and the ignition switched off the vent valve is set to external venting, as a result of which the fuel evaporation vapors will flow from float chamber into charcoal canister. This will improve hot starting.



Idle speed combination jet

The idle speed fuel jet and the idle speed air jet are united into a combination jet (238).

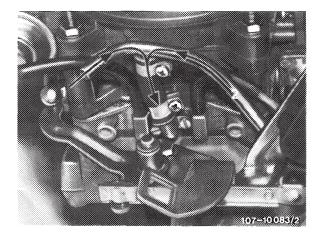
Access to idle speed fuel jet is thereby improved. Sealing is by means of a sealing ring (239).



Draw-off connection for fuel evaporation control system and crankcase breather

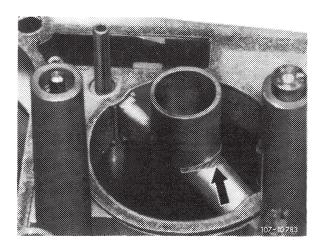
The fuel evaporation vapors from float chamber and fuel tank stored in charcoal canister, as well as the vapors of the crankcase venting system are drawn off in direction of arrow by way of a draw-off connection at the rear on carburetor while the engine is running.

- 1 From charcoal canister
- 2 From crankcase venting system



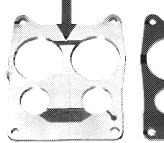
Pre-atomizer with slot

The pre-atomizer is provided with a slot (arrow) to improve atomization of the fuel.



New insulating flange

The new insulating flange is provided with a groove (arrow) by means of which the fuel evaporation vapors and the crankcase evaporation vapors are drawn off into stage II.

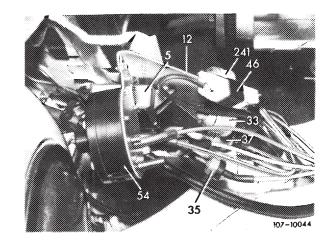




107 - 9 854/1

Choke cover-stepped heater

To improve the warming-up characteristics the starter cover of the automatic choke is heated in two steps. Below 17 °C oil temperature at reduced output via pre-resistor (46), above 17 °C oil temperature the choke cover is heated at normal output.

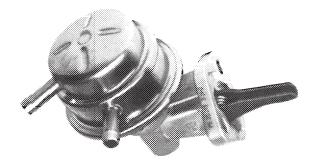


46 Pre-resistor for choke cover-stepped heater

Fuel pump

Following the installation of the air pump for air injection, the available space made the installation of a fuel pump with angle drive necessary.

The closing cap is brazed to housing and can no longer be removed. Cleaning of the filter strainer is no longer necessary.

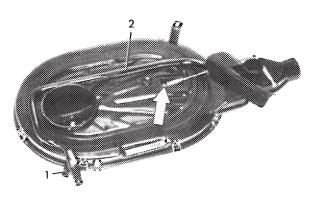


107 - 10 953/1

Air filter

The expanding element (arrow) for controlling the intake air preheater has been moved inside air filter.

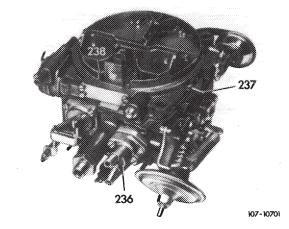
For air injection the air filter is provided with an additional hose connection (1). For reasons of available space, the air injection line (2) is attached below to air filter.



109-10802/2

B. s model year 1976 Differences as compared with standard version

- Idle speed combination nozzle
- Needle-controlled enrichment in stage I no longer applicable
- Vacuum connection (237) on carburetor cover for vacuum booster of EGR
- Carburetor cover with raised centering flange for air filter
- New fuel return valve with fuel pressure control
- New expanding element for thermostatically controlled bypass choke (TN choke)
- Thermo delay valve for choke
- Choke cover-stepped heater
- Pre-atomizer with slot
- Draw-off connection for crankcase ventilation
- Orifice (throttle) in hose to vacuum governor
- Jet line-up (refer to adjusting data)

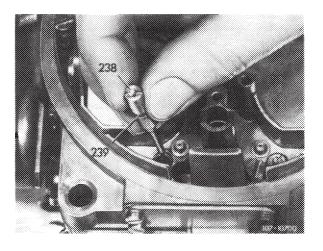


- 236 Thermostatically controlled bypass choke (TN choke)
- 237 Vacuum connection for vacuum booster of EGR
- 238 Idle speed combination jet

Idle speed combination jet

The idle speed fuel and idle speed air jets are united into a combination jet (238) which can be removed in upward direction.

Access to idle speed fuel jet is thereby improved. Sealing by means of rubber sealing ring (239).



New fuel return valve with fuel pressure regulation

The new fuel return valve is simultaneously designed as a fuel pressure regulator. Regulation of the fuel return flow rate and the fuel pressure to approx. 0.2 bar gauge pressure is performed by means of a springloaded valve. Fuel level fluctuations will then be widely avoided.

The former vacuum connection on fuel return valve is no longer applicable.

The new fuel return valve can also be installed on carburetors used up to now. Vacuum hose for fuel return valve and distributor are no longer installed. Vacuum hose from vacuum governor is directly plugged on connection "C" on throttle valve member.

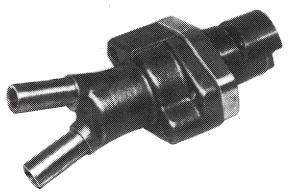


107 - 10705

New expanding element for thermostatically controlled bypass choke (TN choke)

The dimensions of the new expanding element are larger and the housing had to be enlarged accordingly.

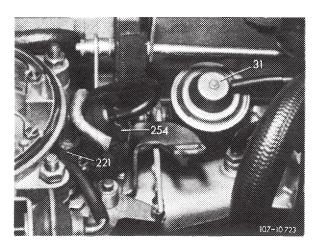
The new TN choke can also be installed on the type of carburetors used up to now.



107-10704

Thermo delay valve for choke

The thermo delay valve makes sure that at temperatures above approx. -12 °C the choke valve is not immediately pulled after the engine is started, but at a delay. There is no delay by the thermo delay valve at temperatures below approx. -12 °C.



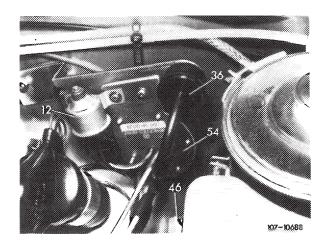
254 Thermo delay valve

Choke cover-stepped heater

The choke cover of the automatic carburetor choke is heated in two steps. Below 17 °C oil temperature at reduced output by way of a pre-resistor (46), above 17 °C oil temperature the choke cover is heated directly.

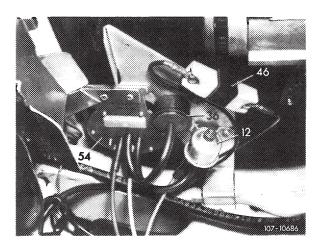
Model 114

46 Pre-resistor for choke cover-stepped heater



Model 116

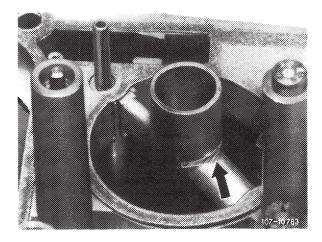
46 Pre-resistor for choke cover-stepped heater



46 Pre-r

Pre-atomizer with slot

The pre-atomizer has a slot (arrow), by means of which the atomization of the fuel is still further improved.

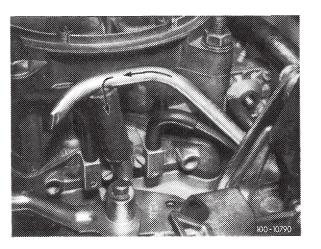


Draw-off connection for crankcase ventilation

The crankcase evaporation vapors are guided from cylinder head to draw-off connection at the rear on carburetor and are drawn off by the engine below throttle valves of stage II in direction of arrow.

Throttle in hose to vacuum governor

A throttle is installed in line to vacuum governor. As a result, the throttle valve will be dampened when returning to idle upon deceleration.

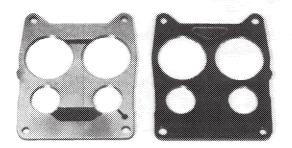


Insulating flange

To guide the starting and warming-up mixture from thermostatically controlled bypass choke into intake pipe, the insulating flange has been given a wide groove between stages I, and a narrow groove between stages II for drawing off crankcase evaporation vapors.

Attention!

Do not install this insulating flange in carburetors used up to now.

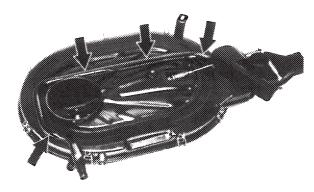


107-9854

Air cleaner

The air cleaner is provided with an additional hose connection for air relief (air discharge).

For reasons of available space, the air relief (air discharge) is attached below on cleaner.



109-10802

Fuel pump

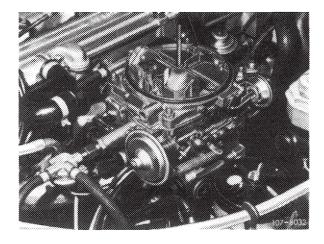
For lack of space following installation of air pump for air relief (air discharge) the fuel pump had to be provided with an angle drive.



107-9099

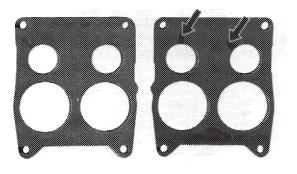
Differences as compared with standard version

- Needle-controlled enrichment in stage I no longer applicable
- Float chamber vent shaft with protective flange
- Modified jet line-up, new jet needle for stage II
- Location of vacuum bores changed
- New insulating flange



Insulating flange

The insulating flange is provided with two grooves (arrows) along which a portion of the emissions is returned to intake pipe.

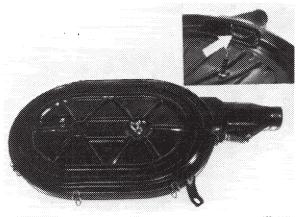


Left = top Right = bottom

XX7-8916/1

Air filter

An additional flap (arrow) is mounted in air filter intake pipe above connection for intake air preheater. The flap prevents the escape of fuel evaporation vapors of warm engine as a result of preheating the intake air.



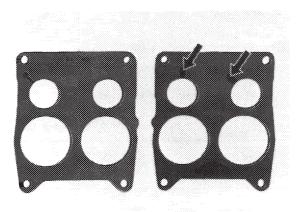
107-8001

Modifications in model year 1973

Insulating flange

The grooves (arrows) for controlling the exhaust gas return volume were milled flatter to reduce the respective exhaust emission volume.

This in turn improved driving characteristics at partial load (complaints about bucking). Former insulating flanges can be exchanged for modified version.



Left = top Right = bottom

307-8916/1

Identification

Depth of grooves (arrows) 2.3 mm (formerly 3.0 mm).

Start of production: October 1972

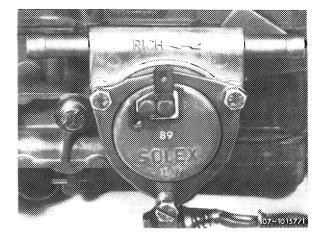
Model	Starting chassis end no.
114.060	006 650
114.073	001 326

Choke cover

The choke cover heater has been changed to 12 ohms (16 ohms before).

The bimetallic spring is now heated faster, the automatic choke is shut off earlier. Former choke cover exchangeable for modified version.





Identification

Choke cover code number 89

Start of production: December 1972

Model	Starting chassis end no.	
114.060	009 560	
114.073	002 080	

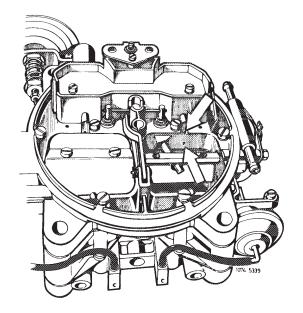
Bypass bores for stage II

The bypass bores of stage II were set 8 mm deeper and increased to 2 mm dia. (1.3 mm dia. before) (lower arrow).

As a result, improved bypass characteristics from stage I to II. Former carburetor cover exchangeable for modified version.

Layout bypass bore stage II

Upper arrow = former layout
Lower arrow = new layout



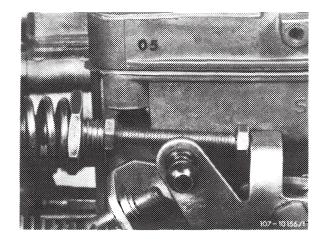
Identification

Starting carburetor cover code number **05** modified bypass bores for stage **11**.

Start of production: January 1973

Model	Starting chassis end no.		
114.060	010 439		
114.073	002 288		

Carburetor cover code number



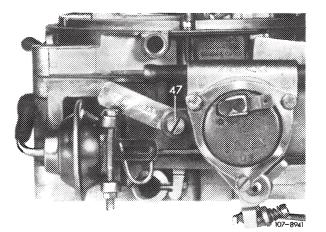
Choke housing

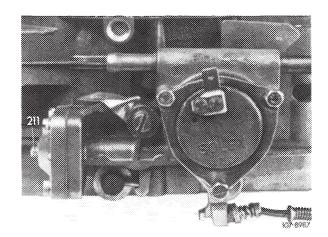
The choke housing installed up to now with separate sheet metal pulldown has been replaced by a cast iron housing with integrated pulldown and choke valve gap adjusting screw (211).

The choke valve gap adjusting procedure is now easier. Former choke housing exchangeable for modified version.

The carburetor part number has been changed to 000 070 **99 04** (000 070 87 04 before).

Choke housing with sheet metal pulldown





Cast iron choke housing with integrated pulldown

Identification

Externally recognized by choke valve gap adjusting screw (211).

Start of production: May 1973

Model	Starting chassis end no.		
114.060	014 400		
114.073	003 448		

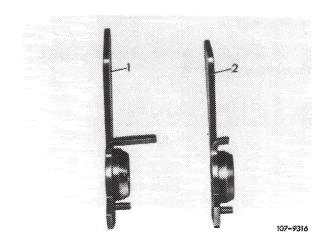
Repair instruction

The modified choke housing can be installed **only** in combination with a fast idle cam 2nd version (2) with shorter lever.

A longer bolt is used for fastening choke housing. (Subsequent conversion 07.2—140).

Fast idle cam versions

- 1 For choke housing with sheet metal pulldown
- 2 For cast iron housing with integrated pulldown



Accelerating pump

The adjusting nut with pinch lock has been replaced for a self-locking polystop adjusting nut. Simultaneously the connecting rod has been extended by 2 mm.

As a result, easier adjustment of injection volume.

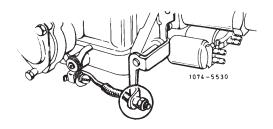
Subsequent installation is possible, connecting rod and adjusting nut are replaced together.

Identification

Externally recognized by self-locking polystop adjusting nut.



Model	Starting chassis end no.		
114.060	017 007		
114.073	004 200		







Former version

Present version

D. ws model year 1974 Federal Differences as compared with model year 1973 Federal

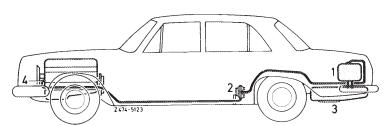
The carburetor (USA) 1974 Federal is similar to (USA) 1973 Federal.

The following components of the emission control system are new:

- fuel evaporation control system
- flame arrester coil

Fuel evaporation control system

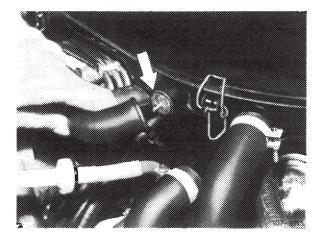
In the USA, starting model 1974, the fuel evaporation vapors from the fuel tank may no longer be discharged into the atmosphere. For this reason, they are guided through lines and a valve system into the crankcase, from where they will be flowing into the intake pipe via the engine venting system.



- Expansion tank
- Valve system
- Fuel tank
- Connection on crankcase

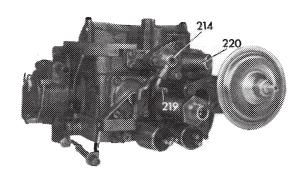
Flame arrester coil

To prevent flames from reaching the cylinder head cover in the event of a backfiring engine, a flame arrester coil (arrow) is installed in air filter.



E. (1934) model year 1974 California Differences as compared with model year 1973 Federal

- Float chamber vent valve
- Draw-off connection for fuel evaporation control system
- New insulating flange
- Choke cover-stepped heater
- Jet line-up

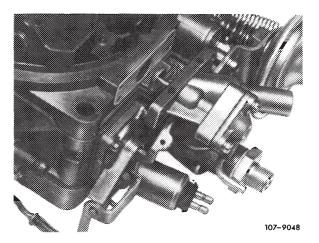


- 214 Float chamber vent valve
- 219 Vacuum connection
- 220 Vent connection

107-8977

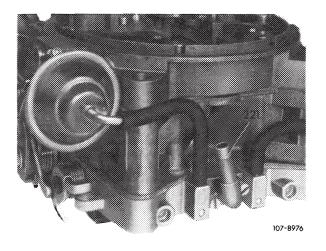
Float chamber vent valve

The float chamber vent valve opens with the engine switched off, so that the gases can escape toward charcoal canister.



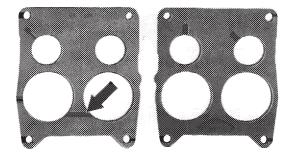
Draw-off connection for fuel evaporation control system

The fuel evaporation vapors from fuel tank and from float chamber are stored in charcoal canister and are drawn-off from canister via draw-off connection (221) by means of the engine vacuum.



Insulating flange

As a result of the fuel evaporation vapors drawn off into stage II, the insulating flange is provided with a groove (arrow) between carburetor and intake pipe.

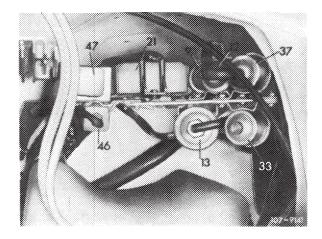


Left = top Right = bottom

107-8916

Choke cover-stepped heater

To improve warming-up characteristics, the choke cover is heated in two steps. Below 17 °C oil temperature at reduced capacity by way of a resistor. Above 17 °C oil temperature the choke cover is heated directly (functional description 07.2—090).

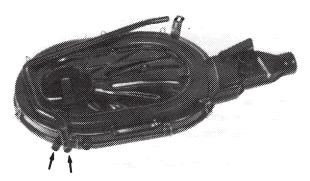


46 Pre-resistor for choke cover-stepped heater

Air filter

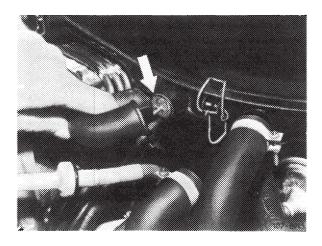
The air filter is provided with an additional hose connection for air relief (air discharge).

For reasons of available space, the air injection line is attached below on filter.



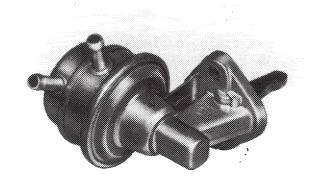
109-8972

The air filter is provided with a flame arrester coil (arrow). The coil prevents flames from reaching the cylinder head cover in the event of a backfiring engine.



Fuel pump

Lack of space caused by the installation of the air pump for air injection, required the use of an angle drive for fuel pump.



107-9099

Modifications in model year 1974 (Federal and California)

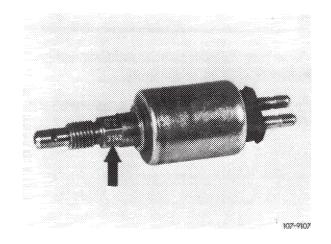
Idle air shutoff valve

The idle air shutoff valves were modified in electrical section and by increasing the shutoff voltage to approx. 3 volts.

The installation of this idle speed shutoff valves prevents afterrunning of the engine. Idle speed shutoff valves installed up to now can be exchanged for modified version, including model year 1973.

Production code number

3 = Production year 1973 142 = Production day (consecutive calendar day)



Identification

New version starting production code number 3142.

Start of production: August 1973

Model	Starting chassis end no.		
114.060	101 343		
114.073	100 355		

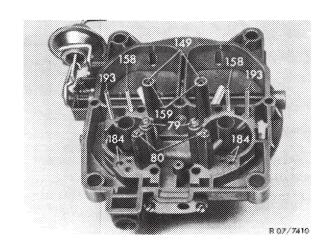
Riser pipes for bypass system stage II

The ID of the riser pipes (158) has been reduced to 1.0 mm (formerly 1.8 mm).

As a result, improved bypass characteristics during sudden full throttle acceleration of the stopped vehicle or from low engine speed.

Start of production: January 1974

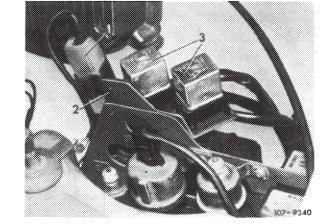
Subsequent conversion of riser pipes for stage II, also for model year 1973 (for conversion refer to programmed repairs at "Bypass faults during acceleration from carburetor stage I to II").



Choke cover-stepped heater

(For Federal emission control only, for California emission control installed from start of series).

- 1 Pre-resistor
- 2 Auxiliary mounting bracket
- 3 Relay



The choke cover is heated in two steps:

Up to + 17 °C engine oil temperature reduced by adding a pre-resistor (1), above + 17 °C engine oil temperature normally heated.

As a result, improved riding characteristics during warming-up stage in temperature range from -5 °C to +5 °C.

Identification

Externally visible by pre-resistor (1).

Start of production: January 1974

Model	Starting chassis end no.		
114.060	106 145		
114.073	101 989		

Repair instruction

Subsequent installation of choke cover-stepped heater also for model year 1973 (refer to 07.2—147). Simultaneously install a choke cover with code number 104 (formerly 89).

New float

Weight and shape of float has been changed. New float weight $6.8 \ g$ (formerly $8.7 \ g$).

As a result, higher buoyancy, as a result of which the closing force of float needle is increased. Former float can be exchanged for new version, also model year 1973.

Arrow = measuring point for float level

- 1 New version
- 2 Former version

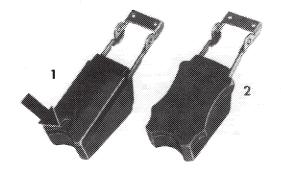
Simultaneously, the former fuel level checkup has been replaced by the float level checkup or adjustment (07.2.2–180).

Identification

Externally recognized by hip roof shape with measuring point for float level (arrow).

Start of production: January 1974

Model	Starting chassis end no.
114.060	104 986
114.073	101 671

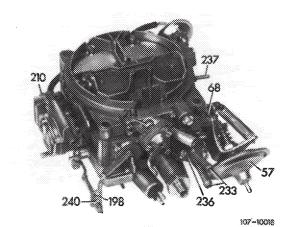


107 - 9844

F. (1934) model year 1975 Differences as compared with model year 1974 Federal

- Carburetor cover with raised centering flange for air filter
- Idle speed combination jet
- Vacuum connection (237) for vacuum booster of EGR (Venturi connection)
- Actuating lever for accelerating pump
- Seal for choke valve adjusting screw
- Thermostatically controlled bypass choke (TN choke)
- Float chamber vent valve
- Draw-off connection for fuel evaporation control system
- Modified insulating flange

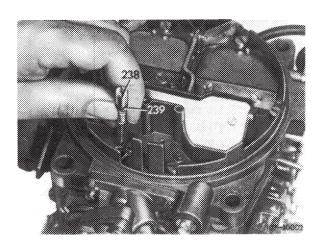
236 Thermostatically controlled bypass 57 Vacuum governor 198 Actuating lever for accelerating pump choke Pulldown cover Vacuum connection Float chamber vent valve for vacuum booster 233 Coolant connection for of EGR (venturi thermostatically controlled connection) bypass choke 240 Plastic guide piece



Idle speed combination jet

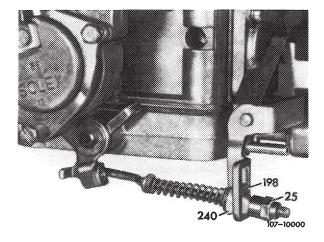
The idle speed fuel jet and the idle speed air jet are combined into a combination jet (238).

To improve access this jet is screwed into carburetor cover from above. Sealing is by means of a rubber sealing ring (239).



Actuating lever for accelerating pump

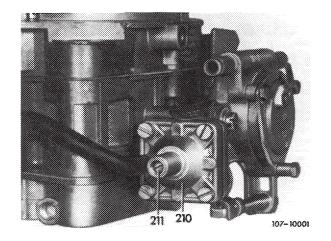
To improve guiding of actuating rod for accelerating pump, the actuating rod is provided with a plastic guide piece (240). The shape of the actuating lever (198) has been changed to hold the plastic guide piece.



Sealing of choke valve gap adjusting screw

The sealing of the adjusting screw (211) has been improved and is now effected by means of an exchangeable rubber sealing ring.

The shape of the pulldown cover (210) has been changed to mount the modified adjusting screw.

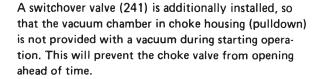


Thermostatically controlled bypass choke (TN choke)

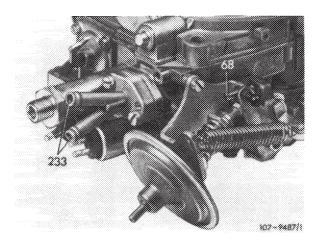
The carburetor has an additional choke with its own jet and control system carrying the designation of TN choke (TN = thermostatically controlled bypass choke).

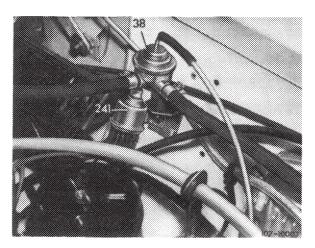
By means of this choke the warming-up mixture is guided into intake pipe in dependence of the coolant temperature while bypassing (shunt connection) the throttle valve (functional description 07.2–090).

233 Coolant connection for TN choke



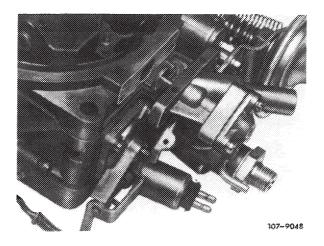
On model 116.020 the switchover valve for the automatic choke (241) is screwed to holder at front left in engine compartment.





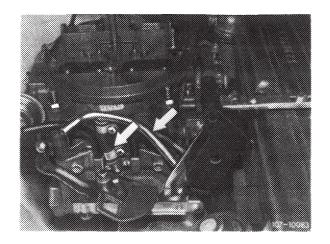
Float chamber vent valve

The float chamber vent valve opens with the engine stopped, so that the vapors can escape toward charcoal canister.



Draw-off connection for fuel evaporation control system

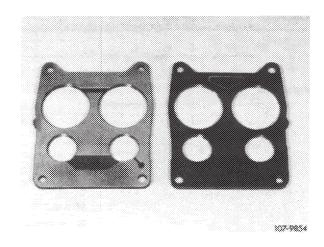
A connection (arrow) is mounted at the rear on carburetor for drawing off fuel evaporation vapors.



Insulating flange

To guide the cold start warming-up mixture from TN choke into intake pipe, the insulating flange has been provided with a groove between stages I.

The fuel vapors are drawn off in stage II by way of a groove.

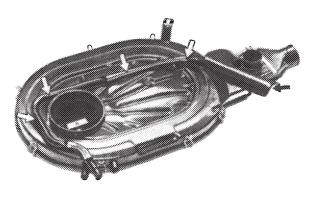


Left = top Right = bottom

Air filter

The installation of the catalyst required a rerouting of the air injection line. As a result, the line layout on air filter has also been changed.

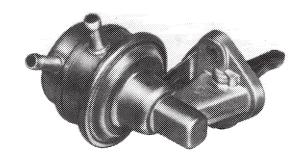
The air filters of model years 1974 and 1975/76 are not exchangeable.



107-10005

Fuel pump

Lack of space caused by the installation of the air pump for air injection required the use of an angle drive for fuel pump.



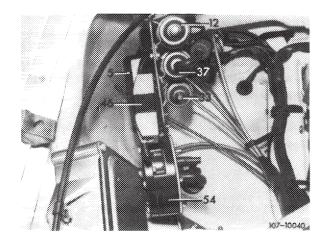
107-9099

Modifications in model year 1975

Choke cover-stepped heater

There is one diode less in relay box (5).

As a result, elimination of reduced heating of choke cover above + 65 °C coolant temperature.



Model 114 5 Relay box

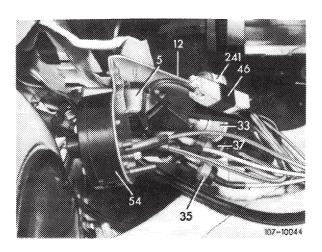
Identification

Externally recognized by spare part number on sticker on relay box (5). From now on, install this relay box only.

New part no. 001 542 30 19 (formerly 001 542 26 19).

Start of production: July 1975

Model 116 5 Relay box

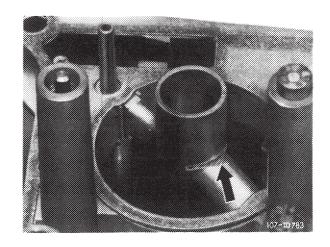


G. (SA) model year 1976 Differences as compared with model year 1975

- Pre-atomizer, main jet
- Expanding element for TN choke
- Fuel pump

Pre-atomizer, main jet

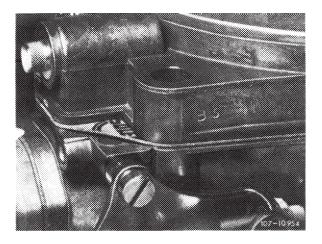
The pre-atomizer is provided with a milled slot (arrow). As a result, the main jet had to be increased to X 105 (formerly X 100).



Identification

Externally recognized by carburetor cover code number **B 5** (formerly B 1).

The pre-atomizer with slot can be installed only in combination with the large main jet $(X\ 105)$ in the event of repairs.



Carburetor code number

Expanding element for TN choke

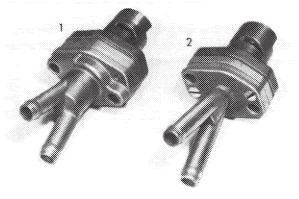
Expanding element and housing are larger.

Identification

Externally recognized by larger dimension.

In the event of repairs, the new expanding element can be installed as a complete TN unit only as a replacement for the former version.

- 1 New version
- 2 Former version

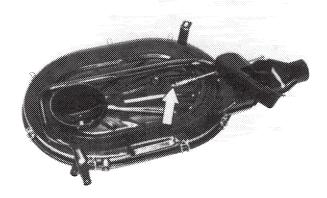


107-10971

Air filter

The expanding element (arrow) for control of intake air preheater has been moved to inside of air filter.

In the event of repairs, this air filter can be installed as a replacement for the former filter of model year 1975.



109-10802/1

Fuel pump

Due to the new safety rule (roll-over test) the fuel pump has been provided with a diaphragm-controlled fuel shutoff valve, which is closed when the engine is stopped.

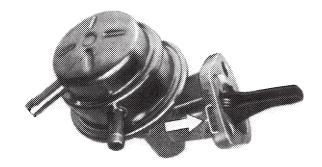
This will prevent fuel from fuel tank flowing outside via fuel pump and carburetor following an accident.

Identification

The closing cap of this fuel pump is brazed to housing and can no longer be disassembled. In addition, the index PE 20 215 is punched into pump flange (arrow).

Repair instruction

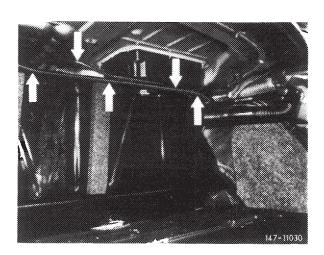
In the event of repairs, the new fuel pump can be installed to replace the former version.



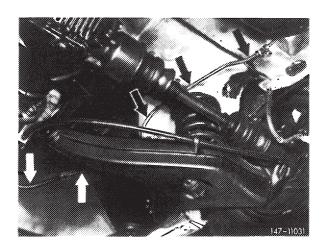
107-10953

Fuel system

As a result of the new safety regulation (rollover test) the line layout for the fuel evaporation control system has been modified (arrows).



Line layout



Line layout

Identification: Information plate in national language on cross member in front of radiator or on cylinder head cover. Adjust engines according to data of respective emission control information plate.

Testing and adjusting values

National version		Idle speed 1/min	Idle speed emission value % CO	
<u></u>	up to 1976		max. 1.5	
	1976	800-900	max. 1.0 without air injection	
S	1976			
USA	1973	750-900		
USA	1974 Federal	- 750-900	up to 1.5	
USA	1974 California	700-900	6-8 without air injection	
(USA) 1975/76		800900	max. 1.0 without air injection	

Vacuum governor¹)

National version		Engine speed Vacuum hose pul	lled off	Engine speed Driving position engaged 1/min
		without TN choke	with TN choke	
<u></u>	1976	-		
<u>s</u>	1976		1700—1900	600-700
USA	1973/74	1200-1400	1700-1900	
USA	1975/76			

 $^{^{1}\)}$ When engaging all auxiliary units, the engine should still run smoothly.

Special tools

Oil telethermometer



116 589 27 21 00

Digital tester



001 589 54 21 00

Connecting cable 6 m long



000 589 04 90 00

Intermediate plug (adaptor)



000 589 72 63 00

Trigger



000 589 71 63 00

Conventional tools

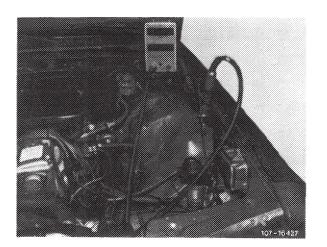
Rpm and CO measuring instrument

Note

Do not set idle speed on dynamometer when the engine is too hot, e.g. immediately after a fast drive or after measuring output. The air filter must be mounted.

Adjusting

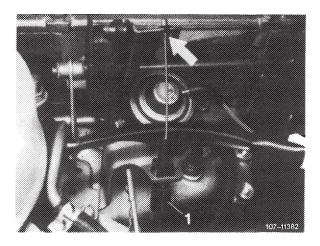
- 1 Connect test instruments:
- digital tester or revolution counter
- CO measuring instrument
- oil telethermometer
- 2 Switch off air conditioning system or automatic climate control. Move selector lever into position "P".

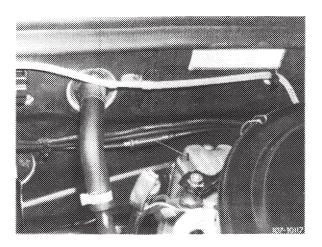


- 3 Check whether on vehicles with cruise control (Tempomat) the Bowden wire rests free of tension against regulating lever. Adjust Bowden wire with adjusting nut (1), if required. For this purpose, run engine.
- 4 Set engine oil temperature to 60-80 °C.
- 5 Check intake system for leaks. For this purpose, spray all sealed points with Iso-Oktan DIN 51 756 or benzine. A changing engine speed or CO value indicates the presence of leaks.

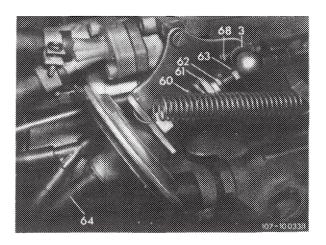
Attention!

Do not use conventional fuel for spraying (unhealthy vapors). Pay attention to inflammability and do not spray on the red-hot parts or components of the ignition system.





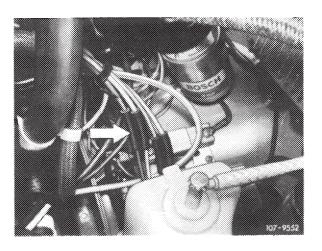
- 6 With the engine running, check whether throttle valve lever (3) rests against adjusting screw (68).
- 7 Check idle speed and adjust with adjusting screw (68), if required.



8 Check idle speed emission value without air injection. For this purpose, make air injection inoperative as follows (for \$\omega\$ 1973/74 nothing need be made inoperative):

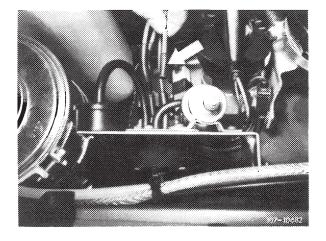


Pull off **blue/purple** vacuum line at connecting point (arrow).



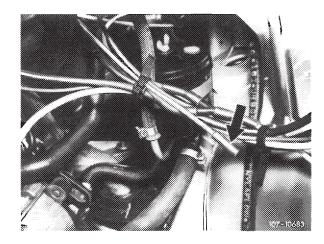
s 1976, model 114

Pull rubber cap (arrow) from blue/purple vacuum line.



§ 1976, model 116

Pull rubber cap (arrow) from blue/purple vacuum line.

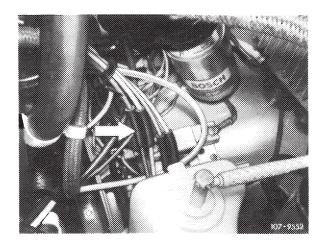


USA California 1974

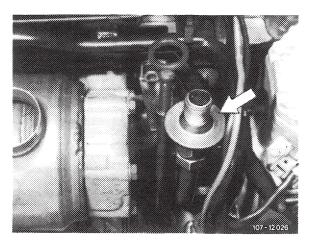
Pull off red vacuum line at connecting point (arrow).

USA 1975/76

Pull off **blue/purple** vacuum line at connecting point (arrow).



The exhaust gas for idle speed CO measurement on vehicles with catalyst, J 1976 and S 1975/76, is drawn off in front of catalyst at check valve (arrow) of air injection.



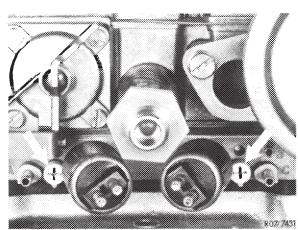
For measuring idle speed emissions, open valve plate of check valve by means of a self-made wire hook. Connect exhaust gas hose of CO measuring instrument to check valve.



9 Adjust idle speed emission value without air injection. For this purpose, adjust both adjusting screws (arrows) uniformly.

Screwing out = richer Screwing in = leaner

Accelerate for a short moment, check idle speed and idle speed emission value once again and readjust, if required.

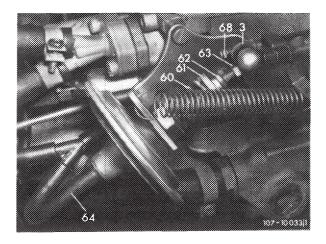


- 10 Reattach vacuum hose for air injection (air injection operating). The idle speed emission value should now be **below** the previously set value.
- 11 Adjust vacuum governor. Run engine, pull off vacuum hose (64), set to specified speed by means of an adjusting screw (63), attach vacuum hose.

Attention!

When loosening counternut, apply counterhold to diaphragm rod.

Engage driving position on automatic transmission, set to specified speed by means of adjusting nut (61). Turn power steering to full lock and engage air conditioning system, engine should still run smoothly. Readjust speed, if required.



Identification: Information plate in national language on cross member in front of radiator or on cylinder head cover. Adjust engines according to data of respective emission control information plate.

Testing and adjusting values

National version		Idle speed 1/min	Idle speed emission value % CO
<u></u>	up to 1976		max. 1.5
	1976	800-900	max, 1.0 without air injection
<u>s</u>	1976		max. 1.0 without all injection
USA	1973	750,000	40 1 E
USA	1974 Federal	750–900	up to 1.5
(USA)	1974 California	700–900	6–8 without air injection
(USA)	1975/76	800-900	max. 1.0 without air injection

Special tools

Oil telethermometer



116 589 27 21 00

Digital tester



001 589 54 21 00

Connecting cable



000 589 04 90 00

Intermediate plug (adaptor)



000 589 72 63 00

Trigger

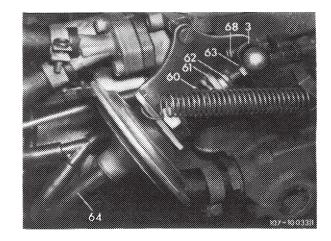


000 589 71 63 00

Rpm and CO measuring instrument

Synchronizing

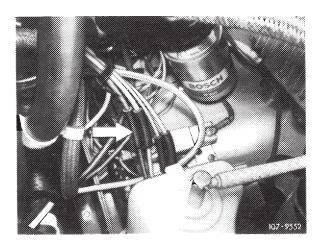
- 1 Connect test instruments. Run engine oil temperature to $60-80~^{\circ}\text{C}$.
- 2 Remove air filter.
- 3 Check idle speed and adjust with adjusting screw (68), if required.



4 Check idle speed emission value without air injection. For this purpose, make air injection inoperative as follows (for (USA) 1973/74 nothing need be made inoperative):

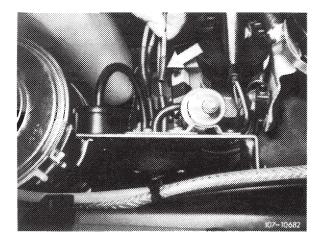
J 1976

Pull off **blue/purple** vacuum line at connecting point (arrow).



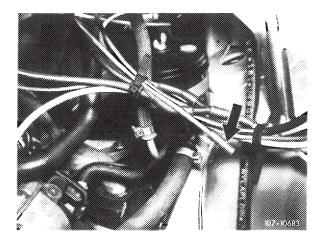
§ 1976, model 114

Pull rubber cap (arrow) from blue/purple vacuum line.



S 1976, model 116

Pull rubber cap (arrow) from blue/purple vacuum line.

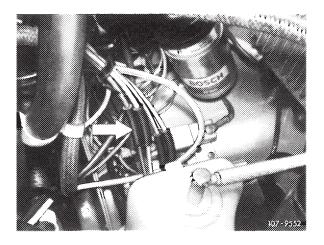


(USA) California 1974

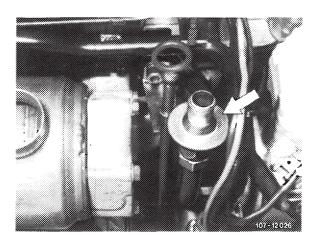
Pull off red vacuum line at connecting point (arrow).

USA 1975/76

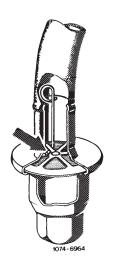
Pull off **blue/purple** vacuum line at connecting point (arrow).



The exhaust gas for idle speed CO measurement on vehicles with catalyst, 1976 and 1975/76, is drawn off in front of catalyst at check valve (arrow) of air injection.



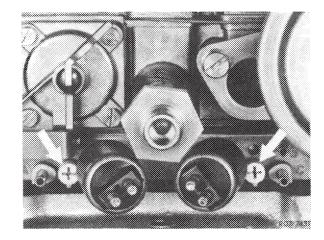
For measuring idle speed emissions, open valve plate of check valve by means of a self-made wire hook. Connect exhaust gas hose of CO measuring instrument to check valve.



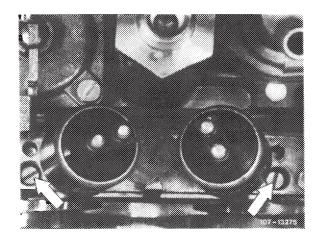
5 Adjust idle speed emission value without air injection. For this purpose, adjust both adjusting screws (arrows) uniformly.

Screwing out = richer Screwing in = leaner

Accelerate for a short moment, check idle speed and idle speed emission value once again and readjust, if required.

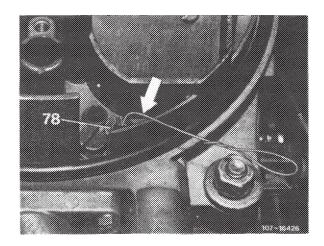


6 Check for uniform adjustment (synchronization) of mixture adjusting screws (arrows).



For this purpose, insert test wire of 0.5 mm dia. (arrow) into both air correction nozzles (78) one after the other and measure CO increase. CO increase should be uniformly high on both sides. Readjust with mixture adjusting screws, if required.

Note: To prevent measuring faults, do not insert test wire deeper than 10 mm into idle speed jet. Without test wire the max. idle speed emission value must not be exceeded.



Then check whether the max. permissible idle speed emission value is not exceeded without test wire and uniformly adjust both mixture adjusting screws, if required.

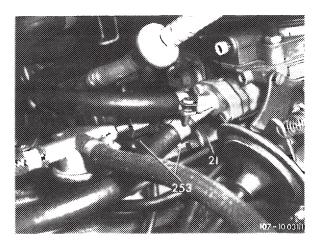
7 Reattach vacuum hose for air injection (air injection operating). The idle speed emission value should now be **below** the previously set value.

Function test

- 1 Switch ignition on and then off again, each time the operating noise of the idle speed shutoff valves should be clearly heard or should be felt with hand.
- 2 Run engine at idle speed. Pull plug (253) from one valve, engine speed should clearly drop or engine should start hunting. Check likewise at opposite valve.

Leak test

3 Run engine at idle speed. Simultaneously pull both plugs (253) from valves, engine should stop immediately without afterrunning. Replace shutoff valve, if required.



Tightening torques		Nm	(kpm)
Carburetor fastening nuts	with new insulating flange	10	(1.0)
	with insulating flange used up to now	8	(8.0)

Special tool

Torque wrench 4-16 Nm (40-60 kpcm)



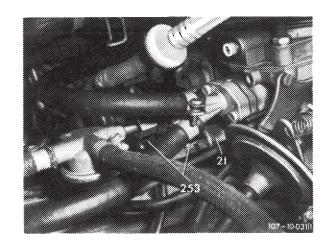
000 589 67 21 00

Removal

- 1 Remove carburetor (07.2-194).
- 2 Unscrew idle speed shutoff valves.

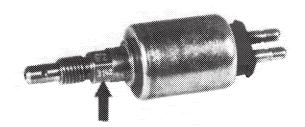
Installation

4 For installation proceed vice versa.



Starting August 1973 the shutoff voltage of the installed idle speed shutoff valves has been increased to 3.0 volts (formerly 0.5 volt). This will prevent afterrunning of engine. Subsequent installation is generally possible.

Identification: production code number 3 142 (arrow).



3 = Production year 1973 142 = Production day (consecutive calendar day)

Identification: Information plate in national language on cross member in front of radiator or on cylinder head cover. Adjust engines according to data of respective emission control information plate.

Testing and adjusting values

National version		Idle speed 1/min	Idle speed emission value % CO
•	up to 1976	800–900	max. 1.5
	1976		max. 1.0 without air injection
<u>s</u>	1976		
USA	1973	750-900	up to 1.5
USA	1974 Federal	730-300	
USA	1974 California	700–900	6-8 without air injection
USA	1975/76	800–900	max. 1.0 without air injection

Vacuum governor¹)

National version		Engine speed Vacuum hose pi 1/min	ulled off	Engine speed Driving position engaged 1/min
		without TN choke		
<u></u>	1976	6000		600–700
S	1976		1700 1000	
USA	1973/74	1200—1400	1700—1900	
USA	1975/76			

 $^{^{1}\}mbox{)}$ When engagigg all auxiliary units, the engine should still run smoothly.

Accelerating pump Begin of injection

immediately

Special tools

Oil telethermometer



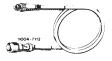
116 589 27 21 00

Digital tester



001 589 54 21 00

Connecting cable 3 m long



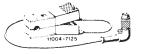
000 589 04 90 00

Intermediate plug (adaptor)



000 589 72 63 00

Trigger



000 589 71 63 00

Clamp



000 589 40 37 00

Conventional tools

Closing angle (dwell angle) and revolution counter, stroboscope, oscilloscope, CO measuring instrument

Note

Do not adjust idle speed when engine is too hot, e.g. after a fast drive or after measuring performance on a dynamometer. The air filter should be mounted.

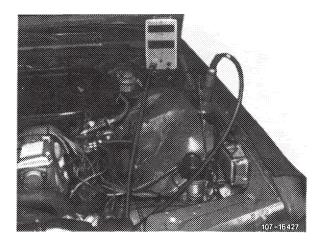
Regulation

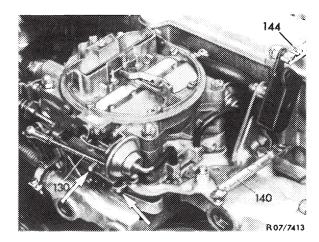
- 1 Connect test instruments:
- Closing angle and revolution counter
- Stroboscope
- Oscilloscope
- CO measuring instrument
- Digital tester
- 2 Check contact resistance, closing angle and closing angle change, adjust closing angle **only** when renewing contact breaker points (07.5–510).
- 3 Evaluate oscilloscope display.
- 4 Check firing point and adjust, if required. Check centrifugal and vacuum ignition adjustment (07.5–510).
- 5 Run engine oil temperature up to 60-80 °C.
- 6 Check intake system for leaks. For this purpose, spray all seal points with Iso-Oktan DIN 51756 or benzine. Change of engine speed indicates leaks.

Attention!

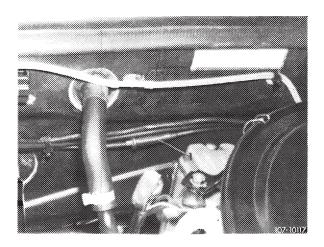
For spraying, do not use conventional fuel (unhealthy vapors). Pay attention to inflammability and do not spray on red-hot components or components of ignition system.

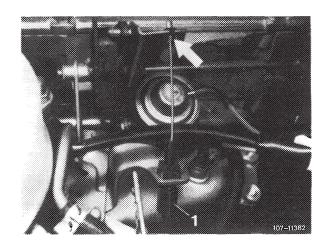
7 Check engine regulating linkage for easy operation and wear. Lubricate all bearing points and ball sockets.



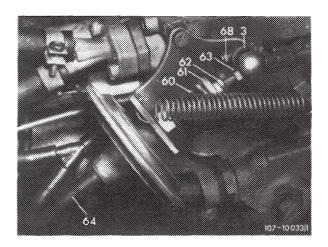


- 8 Switch off air conditioning system or automatic climate control. Move selector lever into position "P"
- 9 Check whether on vehicles with cruise control (Tempomat) the Bowden wire rests **free of tension** against regulating lever with the engine running. Adjust Bowden wire with adjusting nut (1), if required. For this purpose, run engine.





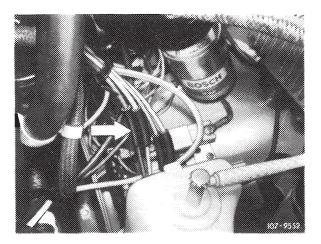
- 10 With the engine running, check whether throttle valve lever (3) rests against adjusting screw (68).
- 11 Check idle speed and adjust with adjusting screw (68), if required.



12 Check idle speed emission value without air injection. For this purpose, make air injection inoperative as follows (for USA) 1973/74 nothing need be made inoperative):

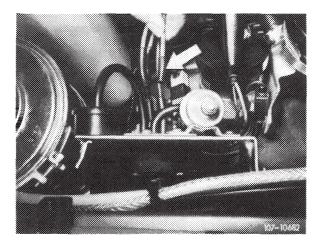
J 1976

Pull off **blue/purple** vacuum line at connecting point (arrow).



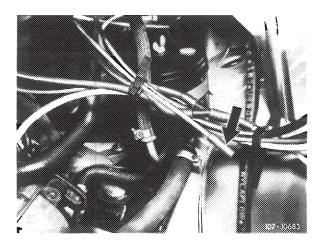
S 1976, model 114

Pull rubber cap (arrow) from blue/purple vacuum line.



s 1976, model 116

Pull rubber cap (arrow) from blue/purple vacuum line.

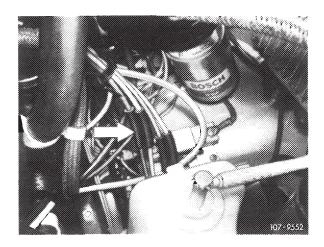


(USA) California 1974

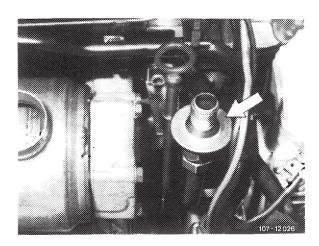
Pull off **red** vacuum line at the connecting point (arrow).

USA 1975/76

Pull off **blue/purple** vacuum line at connecting point (arrow).



The exhaust gas for idle speed CO measurement on vehicles with catalyst, J 1976 and S 1975/76, is drawn off in front of catalyst at check valve (arrow) of air injection.

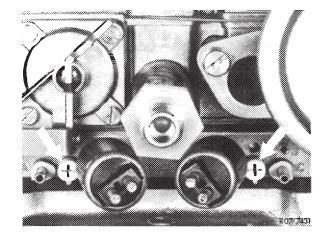


For measuring idle speed emissions, open valve plate of check valve by means of a self-made wire hook. Connect exhaust gas hose of CO measuring instrument to check valve.



13 Adjust idle speed emission value without air injection. For this purpose, adjust both adjusting screws (arrows) uniformly.

Screwing out = richer Screwing in = leaner



Then check idle speed synchronization while inserting test wire 0.5 mm dia (arrow) into both air correction nozzles (78) one after the other and measuring CO increase. The CO increase should be uniformly high on both sides. Readjust with idle speed mixture adjusting screws, if required.

Note: To prevent measuring faults, do not insert test wire deeper than 10 mm into idle speed air jet. Without test wire, the max. idle speed emission value may not be exceeded. Readjust uniformly, if required.

Accelerate for a short moment, check idle speed and idle speed emission value once again and regulate again, if required.

- 14 Reattach vacuum hose for air injection (air injection operating). The idle speed emission value should now be **below** the previously set value.
- 15 Adjust vacuum governor. For this purpose, run engine, pull off vacuum hose (64), adjust specified speed with adjusting screw (63), attach vacuum hose.

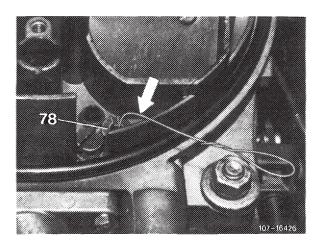
Attention!

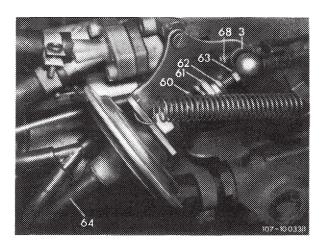
When loosening counternut, apply counterhold to diaphragm rod.

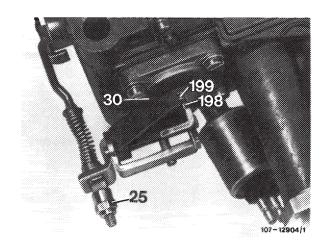
Engage driving position on automatic transmission, set to specified speed with adjusting nut (61). Turn power steering to full lock and engage air conditioning system, engine should still run smoothly. Regulate speed again, if required.

16 Adjust accelerating pump. For this purpose, run engine, pinch vacuum hose (64). Check whether throttle valve lever (3) rests against adjusting screw (68) (Fig. item 15).

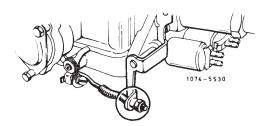
Set adjusting nut (25) in such a manner that the actuating lever (198) pushes the diaphragm thrust bolt (199) 1.0 mm inwards.







Starting June 1973 the adjusting nut with pinch lock is replaced by a self-locking polystop nut. Simultaneously, the connecting rod has been extended by 2 mm (to facilitate adjustments).







Former version

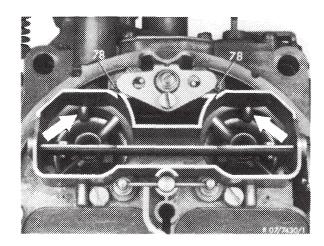
Present version

Checking operation and direction of injection.

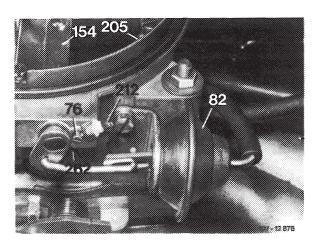
For this purpose, slowly actuate throttle valve lever, a uniform fuel jet should now come out of both injection bores (arrows) immediately and on both sides.

Attention!

The fuel jet should not touch edge of Venturi and pre-atomizer, since this may result in starting and bypass faults. If required, remove carburetor cover and clean injection bores.

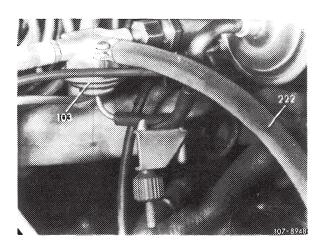


17 Check dashpot (82) for leaks. Then run engine, pinch vacuum hose of damper (82). Open air valve (154) and release, air valve should then snap back against stop (205). If not, replace dashpot. With the engine stopped, check whether air valve (154) operates easily and returns automatically to stop (205) if slightly opened.



82 Dashpot for air valve stage II

18 Check fuel return valve for leaks. For this purpose, run engine at idle speed. Pinch vacuum hose on fuel return valve, idle speed emission value or engine speed should not change. Replace return valve, if required.



Testing and adjusting values

Carburetor without thermostatically controlled bypass choke (TN choke)

National version and model year		€ 1973/74	(USA) 1974 California
Choke cover	Code number	80/104 ¹)	103
	Preload	on mark	
Choke valve gap		1.5 mm	2.5 mm
Cold starting speed (at operating temperature)			24002600/min
Vacuum governor	Engine speed Vacuum hose pulled off	1200—1400	
adjusting data	Driving position engaged	600-700	

¹⁾ Only in combination with choke cover-stepped heater.

Carburetor with thermostatically controlled bypass choke (TN choke)

National version and model year		J 1976	s 1976	USA 1975/76	
0	Code number		89		
Choke cover	Preload		on mark		
Delay time	Total	_	5—12 s		
	Choke (orifice)	*****	max. 3 s		
TN mixture			0.5-0.6 % CO		
Warming-up total mixture		7-8 % CO¹)			
TN control piston overlap at + 85 °C coolant temperature		0.8-1.0 mm			
Vacuum governor adjusting data	Engine speed Vacuum hose pulled off		1700—1900		
	Driving position engaged	600-700			

 $^{^{1}\!\!}$) On vehicles with draw-off for accelerating pump, adjust to lower tolerance value.

Special tools

Oil telethermometer	7.63 - 100M	116 589 27 21 00		
Digital tester	mr 50011	001 589 54 21 00		
Connecting cable 3 m long	1004-7112	000 589 04 90 00		
Intermediate plug (adaptor)	11004-7118	000 589 72 63 00		
Trigger	11004-7125	000 589 71 63 00		
Clamp	11004- 4130	000 589 40 37 00		
Conventional tools				
Rpm and CO measuring instrument				
Pliers, offset for inner locks	e.g. made by Hazet, order no. 1846 b-2			
Pliers, offset for outer locks	e.g. made by	e.g. made by Hazet, order no. 1846 d-2		
Self-made tool				
TN test choke	for instructi	for instructions, refer to section B, item 16		

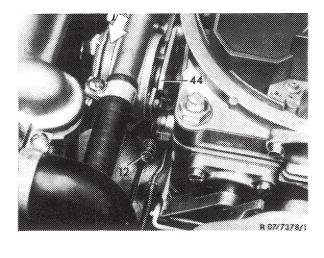
A. Carburetor without thermostatically controlled bypass choke (TN choke)

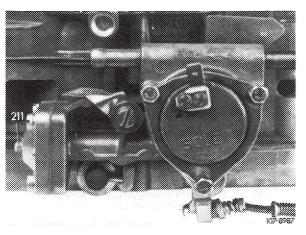
(SA) 1973/74, (SA) 1974 California

Testing, adjusting

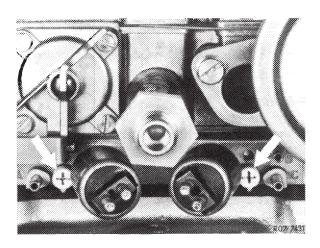
- 1 Remove air filter. Check whether marking notch on choke cover is exactly opposite mark on carburetor housing (arrow) and adjust choke cover, if required.
- 2 Check choke housing for tight seat, insert loose fastening screws with Omnifit or Loctite, if required.
- 3 Check choke valve for easy operation and make operable, if required.

Complete test with cold engine whenever possible. The choke valve and the transmitting linkage should move easily in any position. To check, disconnect choke rod, if required. If choke valve binds or is hard to move, refinish carburetor shaft laterally as required.





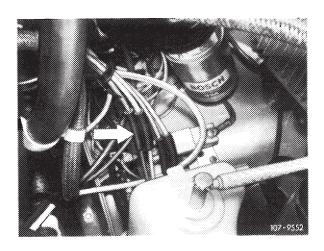
4 Check for uniform adjustment of idle speed mixture adjusting screws (arrows). For this purpose, run engine oil temperature to approx. 80 °C. Then run engine for approx. 5 min. at idle speed for stabilization.



For subsequent CO measurement, make air injection inoperative as follows (for \$\overline{USA}\$) 1973/74 nothing need be made inoperative):

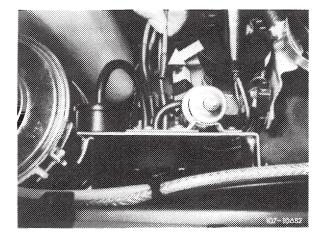
J 1976

Pull off **blue/purple** vacuum line at connecting point (arrow).



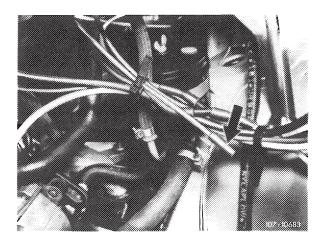
§ 1976, model 114

Pull rubber cap (arrow) from blue/purple vacuum line.



s 1976, model 116

Pull rubber cap (arrow) from blue/purple vacuum line.

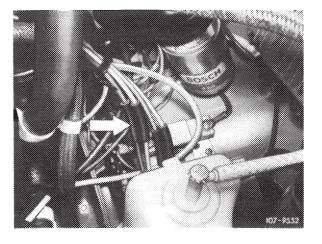


USA California 1974

Pull off red vacuum line at connecting point (arrow).

USA 1975/76

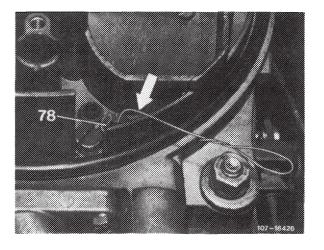
Pull off **blue/purple** vacuum line at connecting point (arrow).



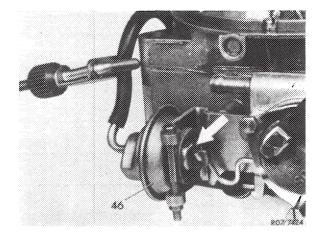
Insert test wire 0.5 mm dia. (arrow) into both air correction jets (78) one after the other and measure CO increase. The CO increase should be the same on both sides (corrections 07.2—101).

Note: To prevent measuring faults, do not insert test wire deeper than 10 mm into idle speed jet. Without test wire, the max. idle speed emission value should not be exceeded.

5 Reattach vacuum hose for air injection (air injection operating).

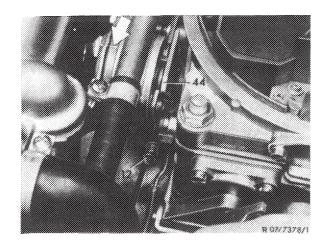


6 Adjust choke valve gap. For this purpose, run engine at idle speed until the vacuum has pulled the diaphragm in dashpot (46) completely back against stop (arrow). Then pinch vacuum hose.



Choke housing version 1 (sheet metal pulldown)

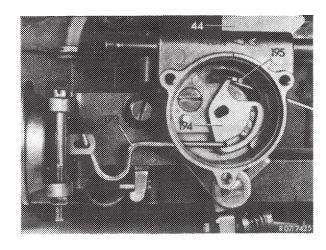
Slightly actuate throttle valve lever and push fast idle cam (44) upwards against stop. Release throttle valve lever.



Insert wire hook (195) through slot in choke housing to push drive lever (194) of bimetallic spring **up to noticeable stop.**

Attention!

Do not push drive lever too heavily against stop, since otherwise the **diaphragm will be pulled back** and measuring faults will result.

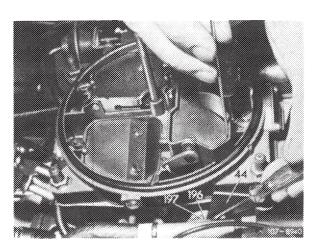


Starter housing version 1 (sheet metal pulldown)

Push drive lever (196) **up to noticeable stop** by means of a screwdriver.

Measure choke valve gap between downward-opening wing of choke valve and measure carburetor wall.

Note: To eliminate any play in linkage, make sure that the measuring plug enters tightly.

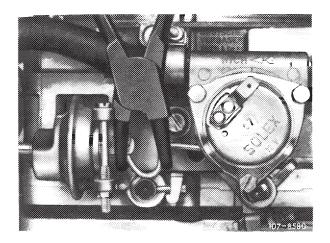


Choke housing version 2 (cast iron starter housing)

Adjust choke valve gap by bending connecting rod between automatic choke and dashpot as required.

Pushing apart = decreasing gap Pushing together = increasing gap

Decreasing choke valve gap



Increasing choke valve gap

Adjust choke valve gap by turning choke valve gap adjusting screw in choke housing cover.

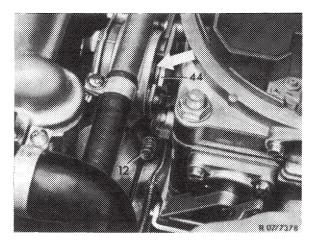
Screwing in = decreasing gap Screwing out = increasing gap

Attention!

If choke valve gap changes during adjustment, check pulldown for leaks, since the O-ring in pulldown cover might be leaking.

Adjusting choke valve gap (cast iron choke housing)

7 Adjust cold starting speed. For this purpose, run engine at operating temperature (60—80 °C engine oil temperature). Slightly lift throttle valve lever and push fast idle cam (44) upwards against stop. Release throttle valve lever. Measure engine speed and adjust with adjusting screw (12), if required.



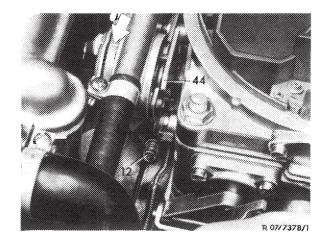
B. Carburetor with thermostatically controlled bypass choke (TN choke)

Note

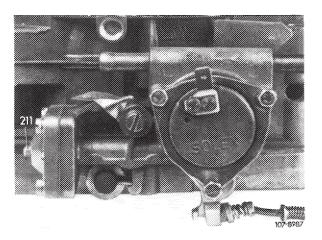
To obtain perfect starting and warming-up characteristics, the tests and adjustments described here should be performed with great care. It is particularly important that all CO measurements are made without air injection and EGR, as well as without draw-off for accelerating pump, if installed. The CO tester should be in perfect condition, CO value should be balanced well.

Testing, adjusting

1 Remove air filter. Check whether marking notch on choke cover is located accurately opposite mark on carburetor housing (arrow) and adjust choke cover, if required.

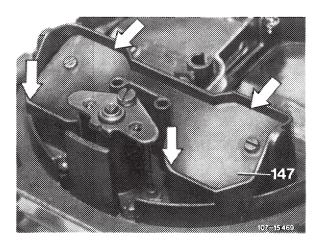


2 Check choke housing for tight seat and insert any loose fastening screws with Omnifit or Loctite.



3 Check choke valve (147) for easy operation and make operable, if required.

Complete test on cold engine whenever possible. The choke valve and the transmitting linkage should be easily moving in any position. To check, disconnect choke rod, if required. If choke valve binds or is hard to move, refinish carburetor shaft accordingly.



- 4 Run engine oil temperature to approx. 80 °C.
- 5 Check pulldown delay.

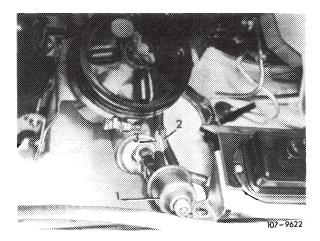
Note: If the delay is too long, the mixture is made leaner too slowly after starting and the spark plugs may soot up and fail. If the delay is too short, the mixture is made leaner too fast and the engine develops a trend towards stalling.

a) Testing switchover valve for pulldown delay

For this purpose, pull high-voltage cable 4 out of distributor cover and connect to ground.

Actuate starter several times for short periods. Switching procedure of switchover valve (1) should be heard or felt.

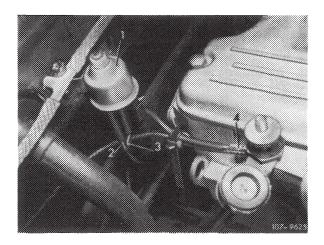
Pull red vacuum line (2) from switchover valve and connect vacuum tester to valve. Actuate starter, tester should indicate no vacuum (switchover valve switches vacuum to atmosphere).



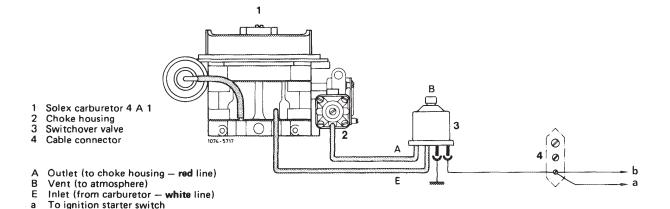
Model 114

Plug high-voltage cable 4 in again. Run engine, tester should now indicate a vacuum (switchover valve connects vacuum to pulldown).

Note: The vacuum on tester is indicated under delay, under influence of throttle jet in connecting pipe for vacuum.



Model 116



07.2.2 la-125/8

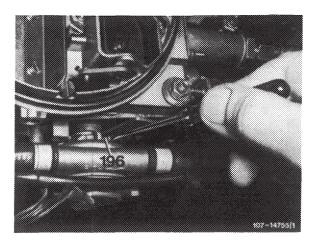
To starter terminal 50

b) Checking thermo delay valve

With the engine running, pull off vacuum hose for pulldown on throttle valve section. Plug vacuum hose in again while simultaneously measuring the time up to the moment when choke valve is not opening any further. The delay should amount to 5–12 seconds.

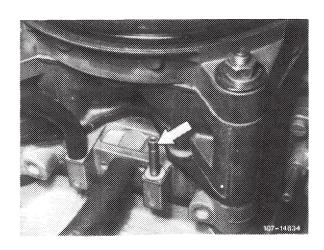
After attaching vacuum hose, wait for approx. 4–5 seconds, then push lever (196) lightly against stop. (If the idle speed drops, stop checkup and start again to avoid faulty measurements).

Yielding to counterpressure of pulldown now becoming effective on lever (196), watch until the choke valve stops opening any further. If the delay period is not the result of the tolerance, check pulldown throttle for passage and pulldown itself for leaks.



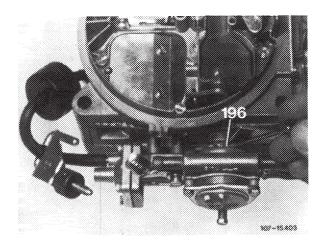
c) Checking pulldown throttle

For this purpose, remove thermo delay valve together with vacuum hoses. Plug the longer of the removed vacuum hoses to pulldown. Run engine and plug vacuum hose to throttle valve member. After max. 3 seconds, push lever (196) up to noticeable stop, the choke valve should now be at gap width. If not, clean throttle and replace, if required. Repeat checkup.

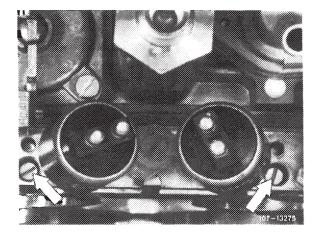


6 Check pulldown for leaks. For this purpose, pinch vacuum hose with a clamp while the engine is running, then stop engine and push choke valve to gap width; width of choke valve gap should not decrease, if it does, the pulldown is leaking. Replace pulldown cover r diaphragm, if required.

If the pulldown is sealed well and the throttle passage is in order, replace thermo delay valve.



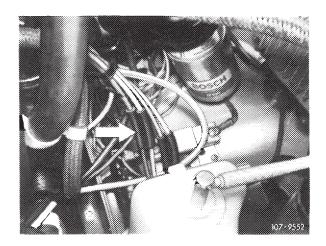
7 Check for uniform adjustment of idle speed mixture adjusting screws (arrows). For this purpose, run engine oil temperature up to approx. 80 °C. Permit approx. one minute for CO indication to come to rest.



Perform the following CO measurements without air injection and without EGR. Make air injection inoperative as follows:

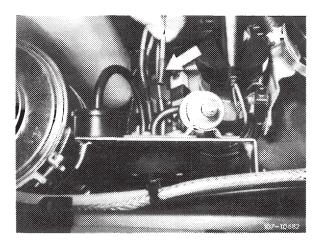
J 1976

Pull off **blue/purple** vacuum line at connecting point (arrow).



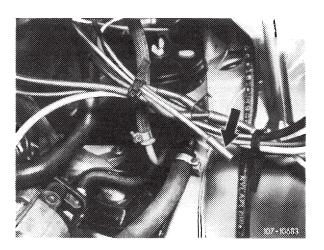
S 1976, model 114

Pull rubber cap (arrow) from blue/purple vacuum line.



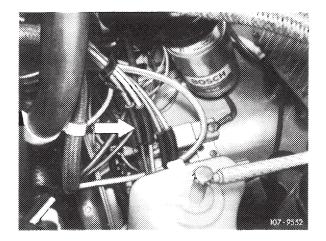
S 1976, model 116

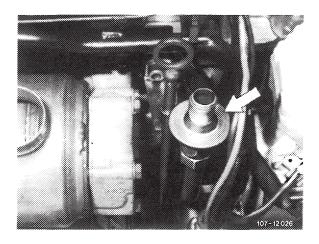
Pull rubber cap (arrow) from blue/purple vacuum line.



USA 1975/76

Pull off **blue/purple** vacuum line at connecting point (arrow).



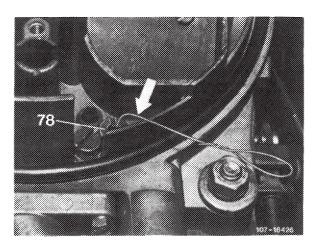


For measuring idle speed emissions, open valve plate of check valve by means of a self-made wire hook. Connect exhaust gas hose of CO measuring instrument to check valve.



Insert test wire 0.5 mm dia. (arrow) into both air correction jets (78) one after the other and measure CO increase. The CO increase should be the same on both sides (corrections 07.2–101).

Note: To prevent measuring faults, do not insert test wire for more than 10 mm into idle speed air jet. Without test wire, the max. idle speed emission value should not be exceeded.



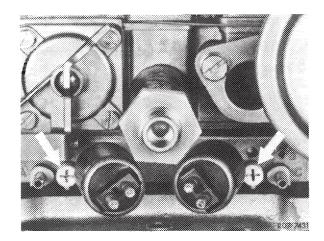
8 Check TN mixture and adjust. For this purpose, run engine oil temperature to approx. 80 °C. Then run engine for approx. five minutes to stabilize at idle.

Set idle speed emission value accurately to 1.0 % CO by uniform adjustment of adjusting screws (arrows).

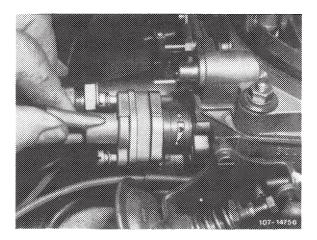
Screwing in = leaner Screwing out = richer

Attention!

Wait for approx. one minute to let CO values come to rest to avoid measuring faults. CO measurements should be taken and adjustments made at approximately the same engine oil temperature and, if installed, without drawing off at accelerating pump.



Remove thermostatically controlled bypass choke (TN choke) with water hoses connected and put aside. Then install TN test choke (self-made, refer to end of chapter) with gasket in such a manner that the bores are facing **upwards**.



Pull off hose for drawing off at accelerating pump, if installed, and close draw-off connection on TN choke duct. With the engine running and the choke valve completely open, check CO value, which should amount to 0.5–0.6 %. If required, adjust by means of TN mixture adjusting screw.

Screwing in = leaner Screwing out = richer

(Below 0.5 % CO, the TN mixture is too lean, above 0.6 % it is too rich).

