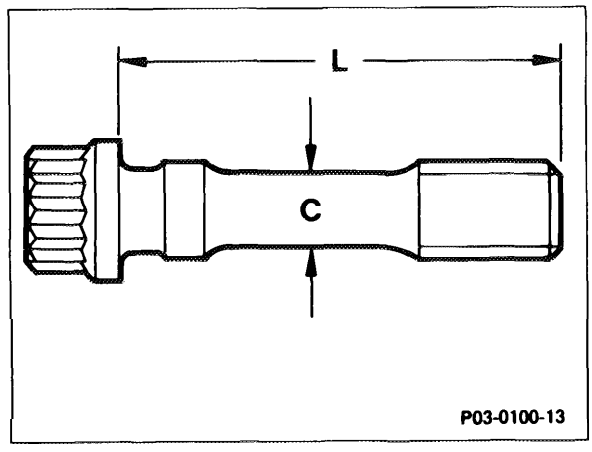
Crankshaft assembly 03

Job No.

03-310 Checking, replacing and tightening connecting rod bolts



Stretch bolt dia. (dimension c)	measure, minimum dia. = 7.1 mm. If shaft dia. is less than 7.1 mm replace connecting rod bolts.
Threads on connecting rod bolts	oil.
Connecting rod bolts	initially tighten to 30 Nm and then tighten to rotation angle of 90 - **100”.**

⚠Warning
Do not use torque wrench with flexible shaft for rotation angle tightening.

Note
Estimate angle of rotation. For this purpose insert adjustable torque wrench in break position (locked) into ratchet.
Position adjustable torque wrench with plug-in ratchet lengthwise in relation to engine and continue to turn until it is transverse in relation to engine.

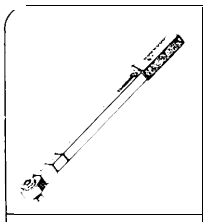
Dimensions

Part No.	102 038 00 71
Thread	M 9x1
Necked down shaft dia. (c) in new condition	7.4 – 0.1
Minimum necked down shaft dia. (c)	7.1
Length (L) in new condition	52 – 0.3

Tightening torques and rotation angles

Initial tightening torque	30 Nm
Rotation angle	90 – 100°

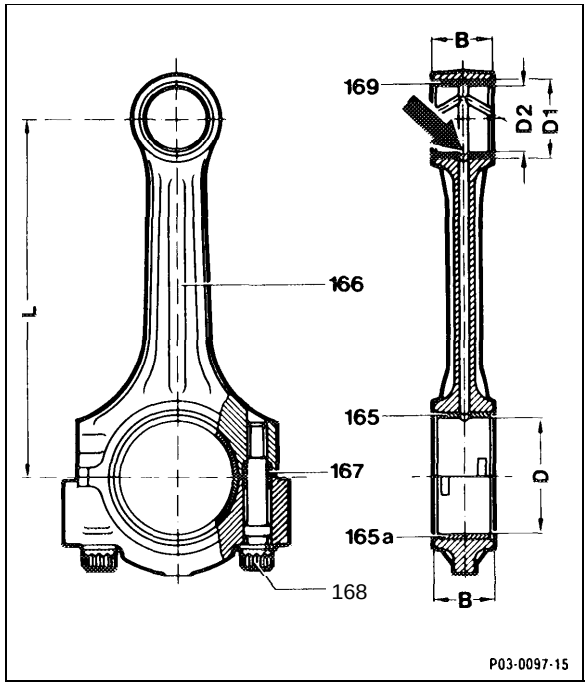
Special tool



001 589 72 21 00 00

03-313 Reconditioning and squaring connecting rods

Preliminary jobs:
Pistons removed (03-316).



Connecting rod bolts (168) and sleeves (167) ...	oil.
Connecting rod bearing cap	attach without connecting rod bearing shells (165, 165a), remove, 30 Nm (item 1).
Basic bore (D)	measure, max. 51.619 mm, if dimension is exceeded, machine bearing cap down max. 0.02 mm (item 2).
Connecting rod bushing (169)	press in, approx. 2450 N and machine or ream out (items 3, 4).
Connecting rod (166)	touch up lateral thrust surfaces (item 5).
Connecting rod (166)	square with connecting rod tester (items 6 - 8).

Caution!
The connecting rod bearing bore and connecting rod bushing bore must be parallel to one another.

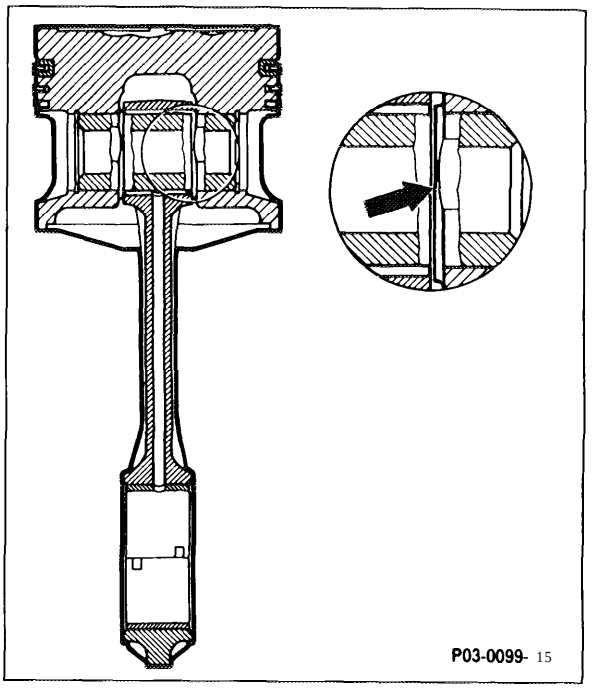
Data

Center of connecting rod bearing bore to center of connecting rod bushing bore (L)		Engine 602 603.96	148.97 149.03
		Engine 603.970	144.97 145.03
Width of connecting rod (B) at connecting rod bearing bore and connecting rod bushing bore		1 st version	23.974 24.026
		2nd version	22.000 21.948
Basic bore for connecting rod bearing shells			51.600 51.619
Basic bore for connecting rod bushing (D 1)		1 st version	29.500 29.521
		2nd version Engine 602.91	28.500 28.521
		Engine 603.96 602.96	30.500 30.525
Connecting rod bushing Ø		1 st version	29.560 29.600
		2nd version	28.575 28.600
		Engine 603.96	30.575 30.600
Connecting rod bushing Ø (D 2)	Engine 602.91	1 st version	27.018 27.024
		2nd version	26.000 26.000
	Engines 602.96, 603.96/97		28.000 28.000
Roughness of connecting rod bushing, inside			0.005
Permissible offset of connecting rod bearing bore in relation to connecting rod bushing bore with reference to 100 mm length			0.1
Permissible deviation of parallel axis alignment: Connecting rod bearing bore in relation to connecting rod bushing bore with reference to 100 mm length			0.045
Permissible difference in weight within engine			4 g

Note on connecting rod versions

The axial play of the connecting rods is limited by the piston pin eye (piston-guided connecting rods). For this purpose appropriate thrust surfaces (arrow) are cast on the piston pin eye.

Connecting rods for engines 602.96, 603.96/97 are not bored hollow.

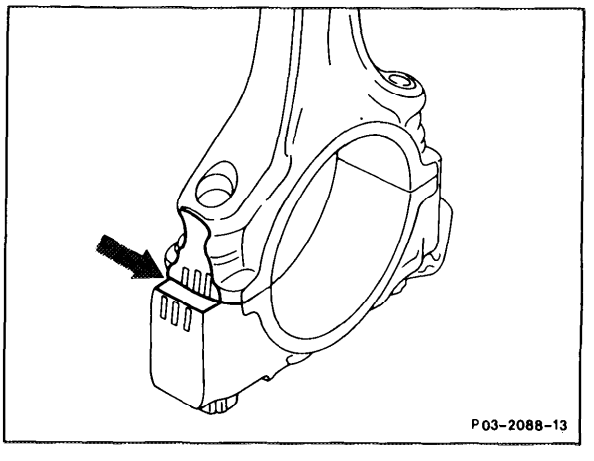


Overheated connecting rods

Connecting rods which have been overheated due to a damaged bearing (blue discoloration) cannot be reused.

Matching connecting rods and connecting rod bearing caps are marked (arrow). The connecting rod shafts should not have any transverse score marks or notches.

Replacement connecting rods are supplied with machined connecting rod bushings.



Connecting rod width

Connecting rod width (B) on engines 602 and 603 from start of production is 22 mm.

Engines 602.91, 603.91 starting 1 1/85

The connecting rods are heat treated before machining to reduce the tendency to warp.

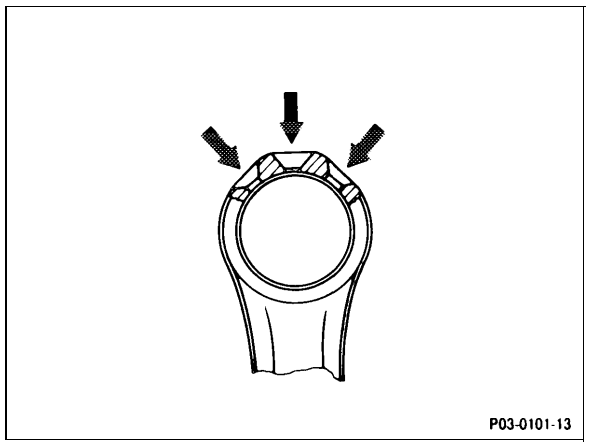
Production beakpoint: 1 1/85

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	009490	002235	268999	175981

* not registered

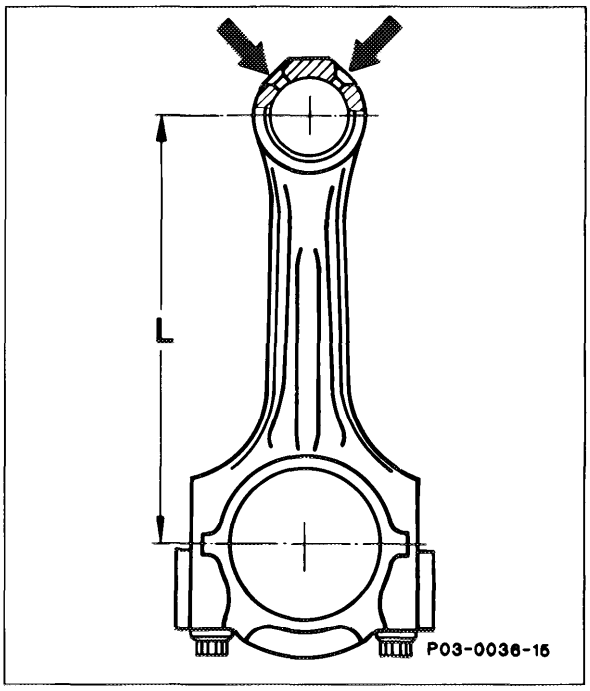
Engine 603.960 starting 01/88

On these engines there are 3 bores (arrows) with a dia. of 4.5 mm in the connecting rod eye for lubrication of the piston pin.



Engines 602.961, 602.962, 603.970 and 602.96, 603.96 starting 09/88

On these engines the connecting rod eye is now equipped with 2 bores (arrows) with a dia. of 4.5 mm.



Engines 602.91, 603.91

Shaft cross section of piston rods reduced (standardized with M 102) and material changed 49 Mn VS 3 (was CK 45 V 7 50).

Production breakpoint: 09-12/86

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	028194 – 034399	006787 – 008285	*	*

* not registered

Engine 602.91

Shaft cross section was changed back, material 49 Mn VS 3.

Production breakpoint: 12/86

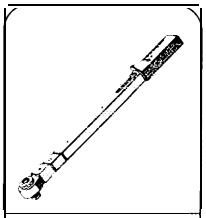
Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	034400	008286	*	*

* not registered

Tightening torque

Connecting rod bolts	Initial tightening torque	30 Nm
	Rotation angle	90 – 100"

Special tool



001 589 66 21 00

00

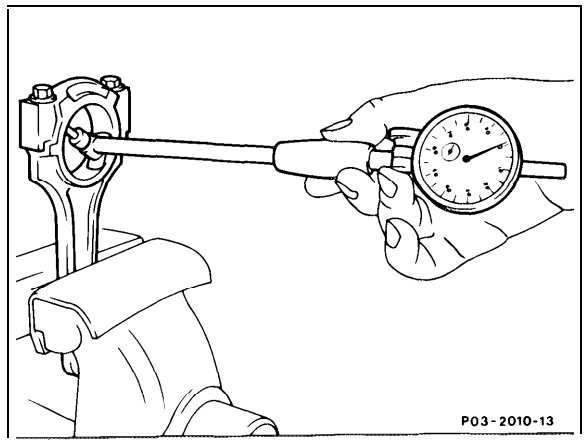
Commercially available tools

Connecting rod straightener	e.g .	Hahn & Kolb, D-7000 Stuttgart Model BC 503
Runout gauge	e.g .	Carl Mahr, D-7300 Esslingen Model 844 N

Reconditioning

1 Install connecting rod bearing cap without connecting rod bearing. For this purpose lubricate threads and bolt head contact surface and tighten to 30 Nm.

2 Measure connecting rod bearing basic bore. If the basic bore diameter exceeds the value of 51.619 mm or if it is conical, touch up bearing cap at contact surface on surface plate up to max. 0.02 mm.

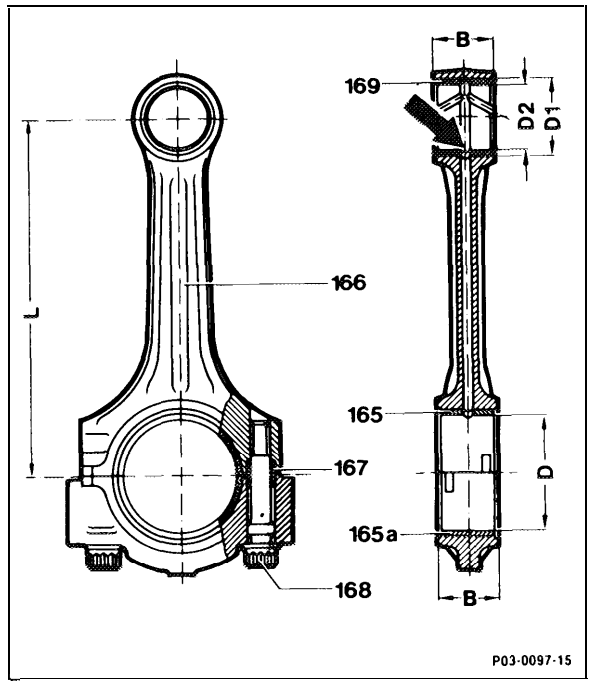


3 Press in new connecting rod bushing (169) such that oil bores are aligned (arrow). Pressing force 2450 N.

4 Machine or ream connecting rod bushing (169).

5 Touch up lateral thrust surfaces of connecting rod (166) on surface plate.

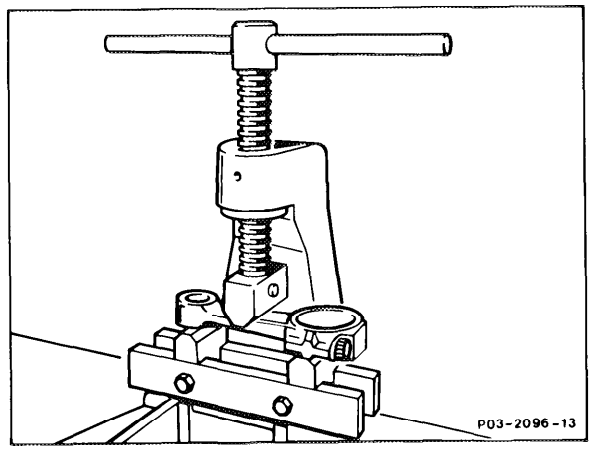
D1	Connectmg rod bushing basic bore
D2	Connectmg rod bushing Ø
165	Upper connecting rod bearing shell
165 a	Lower connecting rod bearing shell
166	Connecting rod
167	Sleeve
168	Connecting rod bolts
169	Connecting rod bushing
B	Connecting rod width
D	Basic bore
L	Center of connecting rod bearing bore to center of connecting rod bushing bore



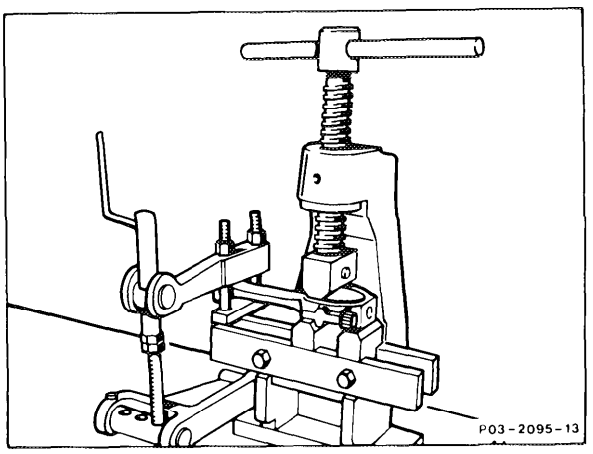
Squaring

6 Square connecting rod with connecting rod tester.

7 Align connecting rod bearing bore with connecting rod bushing bore (parallel alignment).

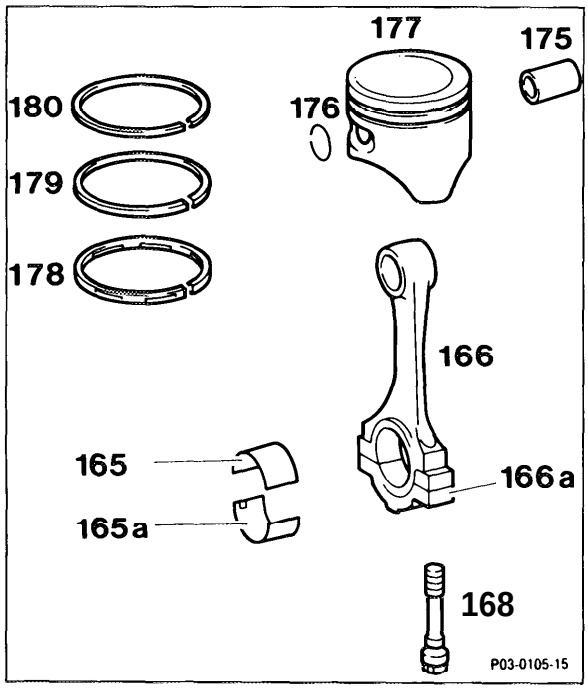


8 Check offset of connecting rod bearing bore in relation to connecting rod bushing bore and correct, if required.



03-316 Removal and installation of pistons

Preliminary jobs:
Engine removed (01-030).
Cylinder head removed (01-415).
Oil pan removed (01-310).



Cylinder	clean.
Connecting rod bolts (168)	remove, check (03-310), reinstall (items 2, 12).
	Caution! Do not mix up upper and lower connecting rod bearing shells (165, 165a).
Connecting rod bearing cap (166 a)	remove, oil connecting rod bearing, position connecting rod bearing cap (166 a) so that code numbers match on connecting rod (166) (item 11).
Piston (177)	remove together with connecting rod (166) toward top (item 2), check piston rings (178, 179, 180) for easy motion, check gap tolerance and axial play. Oil piston and cylinder.
	Caution! Do not heat piston.
	Attach clamping strap 000 589 04 14 00 and insert piston into cylinder bore (item 10). The arrow on the piston crown should point toward the front of the vehicle.

Piston pin retainer (176)	remove, install (items 3, 7).
Piston pin (175)	press out, oil, press in by hand (items 3, 6).
Piston (177)	remove from connecting rod (166) (item 3), position on connecting rod (166), the arrow should point toward the front of the vehicle and the retaining groove in the connecting rod toward the left side of the engine (item 5).

After installation:

Crankshaft	turn and check clearance between connecting rod and crankshaft (item 13).
Piston (177)	move to TDC and measure distance between piston crown and crankcase mating surface (item 14). Projecting length max.: 0.965 mm Projecting length min.: 0.735 mm

Cross reference, pistons – cylinders

Engine	Piston code number	Group code letter	Piston dia.	Cylinder dia.
602.91	01, 05, 07, 08[1]), 15[2]), 16[3]), 17[3]), , 12[6]), 14[7])	A	86.970-86.976	87.000-87.006
602.96, 603.96	09[1]), 01'), 00[4]), 13[4])	B	upon 86.982-86.988	upon 87.012-87.018

[1]) Engines 602 and 603.96 from beginning of production.
[2]) Engine 602.91 starting 02/88.
[3]) Engine 602.91 starting 09/88.
[6]) Engine 602.91 03/88 up to 06/88.
[7]) Engine 602.91 06/88 up to 11/88.

Cross reference, pistons – cylinders

Engine	Piston code number	Group code letter	Piston dia.	Cylinder dia.
603.970	16	A	88,858–88,864	89,000–89,006
		X	88,863–88,871	89,006–89,012
		B	88,870–88,876	89,012–89,018

Piston projecting length

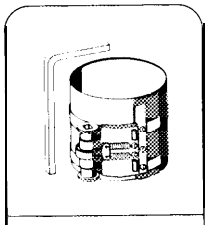
Distance between piston crown and crankcase parting surface	Projection max.0,965 Projection min.0,735

Test values			When new	Wear limit
Difference in weight between pistons in one engine				20 g
Piston pin diameter		Engines 602.91	1st version 2nd version	26.995-27.000 25.995–26.000
		Engines 602.961, 603.96		27.995-28.000
Distance, piston pin eye		1 st version 2nd version	22.05-22.35 24.1-24.3	
Piston pin clearance	in connecting rod bushing	1st version 2nd version	0.012–0.023 0.018–0.029	
	in piston		0.004–0.015	
Connecting rod in piston (end play)		1 st version 2nd version	0.126-0.274 0.050-0.402	
Piston ring gap clearance		Groove 1 Groove 2 Groove 3	0.25-0.45 0.20-0.40 0.20-0.40	1.0 1.0 1.0
Piston ring side clearance		Groove 1 Groove 2 Groove 3	0.090-O. 122 0.050-0.085 0.030-0.065	0.20 0.15 0.1

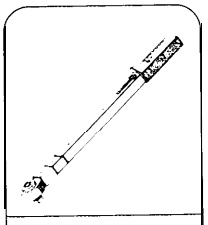
Tightening torque and rotation angle

Connecting rod bolts	Initial tightening torque	30 Nm
	Rotation angle	90 – 100”

Special tools



000 589 04 14 00
03 13



001 589 72 21 00
00

Standard tool

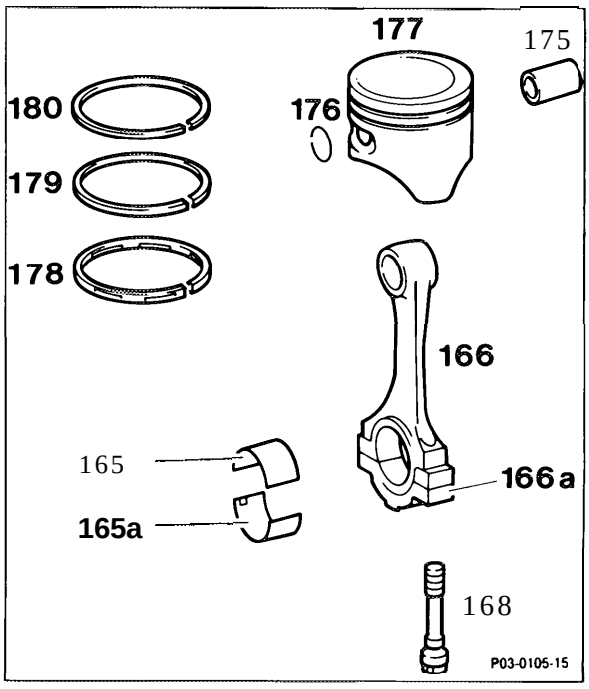
Dial gauge Al DIN 878	e.g.	Mahr, D-7300 Esslingen Order No. 810

Removal

1 Remove combustion residues in cylinder.

2 Remove connecting rod bolts (168), remove connecting rod bearing cap (166a) and remove connecting rod (166) together with piston (177) in upward direction.

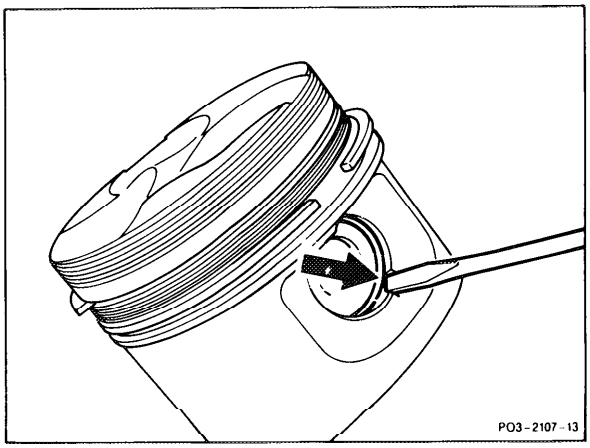
Caution !
Do not mix up upper and lower connecting rod bearing shells (165, 165a).



175 Piston pm
176 Piston pm retainer
178 Piston ring
179 Piston ring
180 Piston ring

3 Remove piston pin retainer (arrow) and press out piston pin, remove piston from connecting rod.

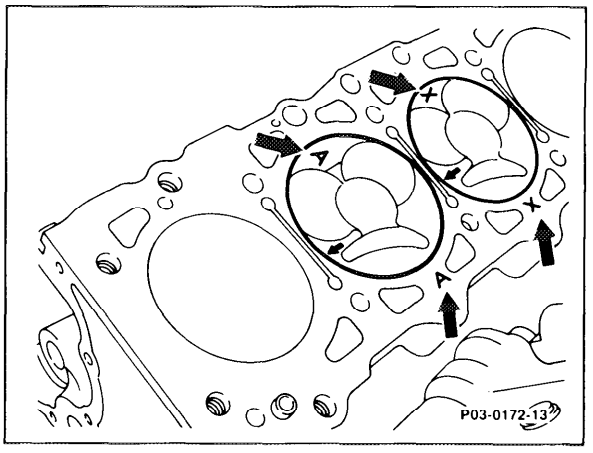
4 Recondition and square connecting rod (03-313).



Installation

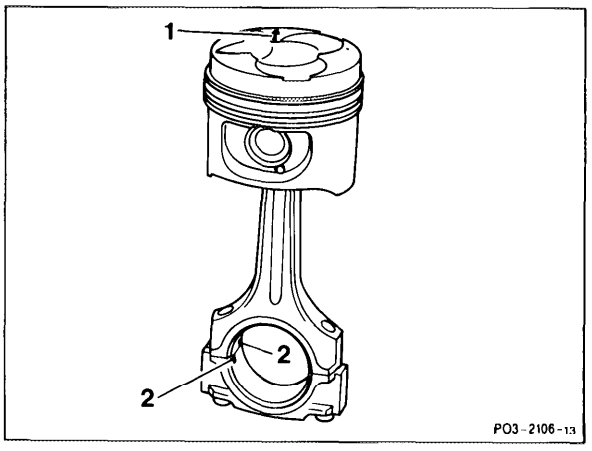
Note
The group code letters (arrows) are stamped on the crankcase mating surface. Only pistons with the group code letter "X" are available for repair. These pistons should also be installed in cylinder bores with group code letters “A” or "B".

When repairing hone cylinder bores according to dimensions of present pistons "X" plus piston clearance.

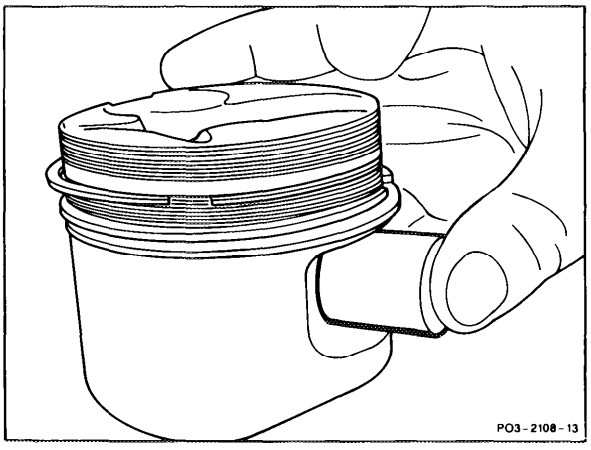


5 Position piston on connecting rod so that arrow (1) points toward front of vehicle and retaining grooves (2) in connecting rod point toward left side of engine.

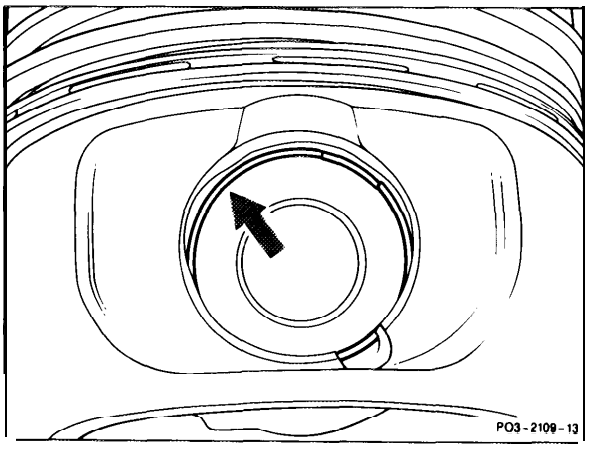
Caution !
Do not heat pistons.



6 Coat piston pins with oil and press in **by hand.**



7 Insert piston pin retainer into groove (arrow).

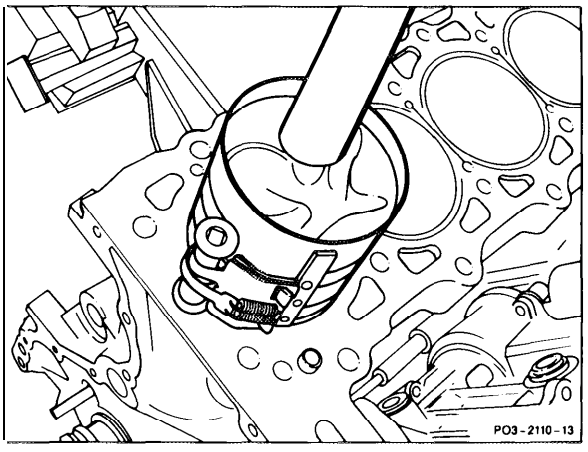


Check piston rings for easy motion.

When installing used pistons check gap and side clearance of piston rings.

8 Oil cleaned cylinder bores, connecting rod bearing journals, connecting rod bearing shells and pistons.

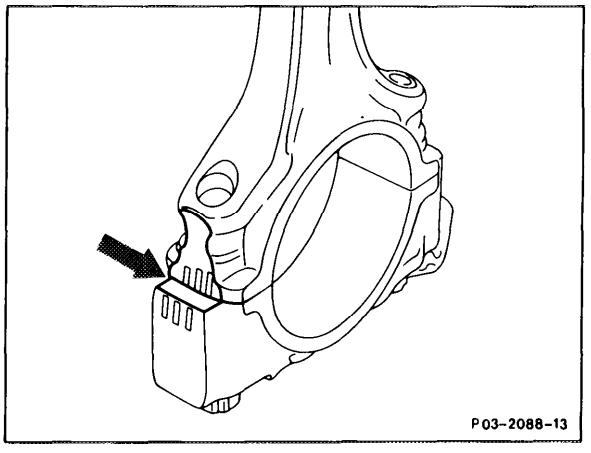
9 Turn piston rings so that gaps are distributed uniformly around circumference of piston.



10 Attach clamping strap 000 589 04 14 00 and install piston.

The arrow on the piston crown must point toward the front of the vehicle.

11 Position connecting rod bearing caps on connecting rods with codes (arrow) on same side.



12 Check connecting rod bolts, replace and tighten (03-310).

13 Turn crankshaft and check clearance between connecting rod and crankshaft.

14 Measure distance between piston crown and crankcase parting surface with pistons in TDC position (see table).

03-317 Modifications to pistons

Piston pin bearings, engine 602

Piston pin bore provided with angular oil pockets (previously flat oil pockets) for improved lubrication.

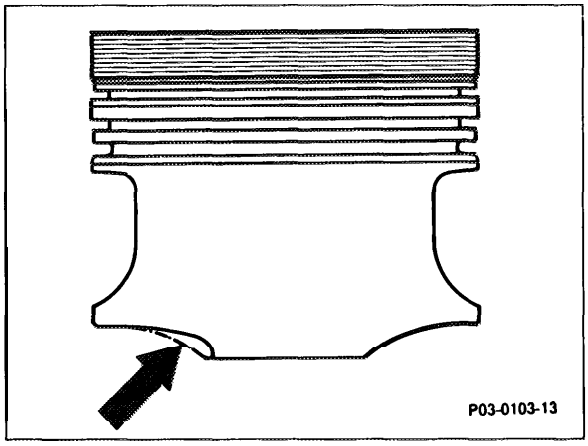
Production breakpoint: 08/85

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	003632	000648	*	141956

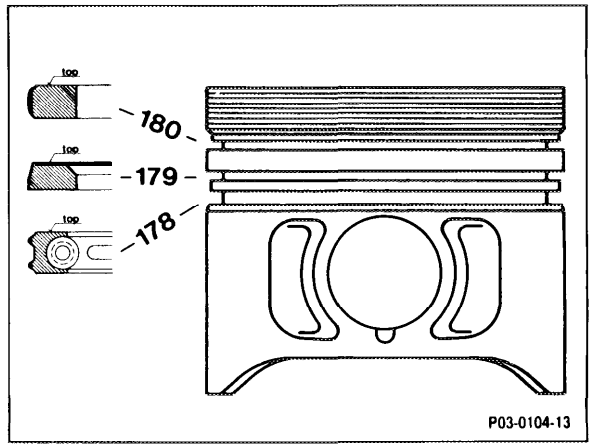
"not registered

Engine 602.91

The piston skirt has been provided with a larger recess (arrow) for better clearance on engines with oil injection nozzles or exhaust gas recirculation..



Each piston is equipped with two compression rings and one oil scraper ring. The first piston ring groove is provided with a Niresit ring carrier.

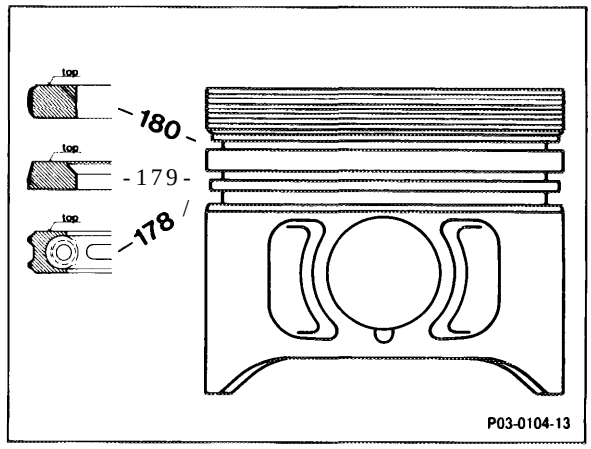


178 Bevelled ring with expander, 3 mm thick, running surface chrome-plated
179 Taper face ring with inside bevel, 2 mm thick, running surface chrome-plated
180 Rectangular ring, 2 mm thick, running surface chrome-plated

Engine 602.91 starting 09/89

The height of the ring groove for the rectangular ring (180) has been increased from 2.0 to 2.5 mm.

Piston code 16 (Mahle co.)
Piston code 17 (Alcan co.)



178 Bevelled rrng with expander, 3 mm thick, running surface chrome-plated
179 Taper face ring with inside bevel, 2 mm thick, running surface chrome-plated
180 Rectangular nng, 2.5 mm thick, running surface chrome-plated

These pistons can also be installed in engines with cylinder sleeves.

Engine 602.91

Temporary installation of pistons from Alcan co., piston code 12, KS co., piston code 14

Production breakpoint 03/88

(Piston code **12,** Alcan co.)

Model	Engine	Engine end No. manual transmission	Engine end No. automatic transmission	Vehicle ident end No. A	Vehicle ident end No. F
201.126	602.911	061160 to 061260	012853 to 012867	*	*

* not registered

Production breakpoint: 03/88

Piston code 12, Alcan co.)

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	061529 to 061588	–	*	*

* not registered

Production breakpoint: 04 - 06/88

(Piston code 12, Alcan co.)

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	062470 to 065290	013059 to 013475	*	*

* not regrstered

Production breakpoint: 06/88

(Piston code 14, KS co.)

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	065291 to 065513	013476 to 013501	*	*

* not registered

Production breakpoint: 06/88

(Piston code 14, KS co.)

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	065635 to 065871	013516 to 013549	*	*

* not registered

Production breakpoint: 1 1/88

(Piston code 14, KS co.)

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	**067047 to** 070443	**013749 to** 014296	*	*

* not registered

Production breakpoint: 06/88

(Piston code 14, KS co.)

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	065635 to 065871	013516 to 013549	*	*

* not registered

Production breakpoint: 1 1/88

(Piston code 14, KS co.)

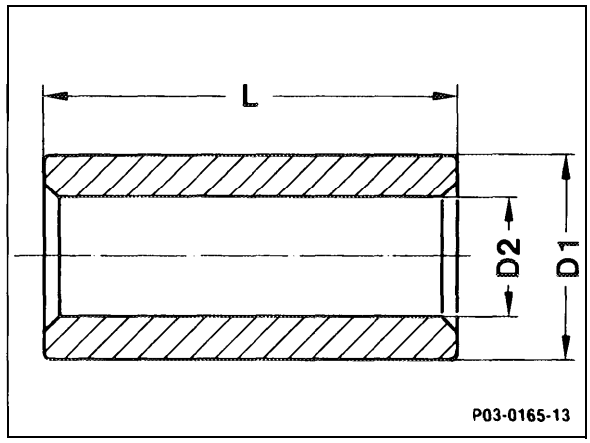
Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	067047 to 070443	013749 to 014296	*	*

* not registered

Engines 602.961, 603.96/97 starting 12/87 (turbo)

Piston pins

The size of the piston pin has been increased to reduce the surface pressure.



Engine 602.961, 603.96:

D1 = 28 mm
D2 = 13,5 mm
L = 70 mm

Engine 602.91:

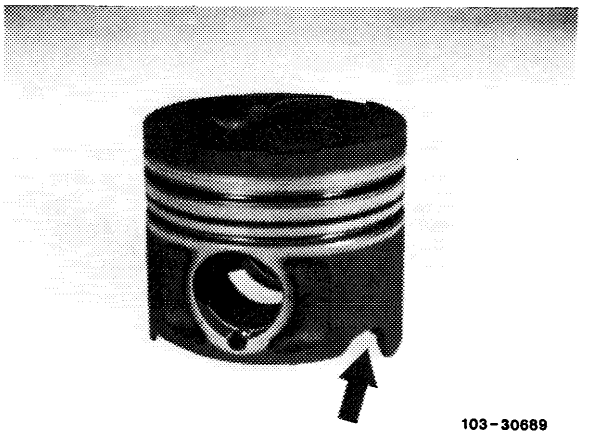
D1 = 26 mm
D2 = 14 mm
L = 55 mm

Pistons with angular channel

Due to the higher thermal load the pistons are cooled with oil via an annular channel in the piston crown. Moreover the piston pins are supplied with oil injected through the two bores (2.0 mm dia., arrows), ending in the annular channel.

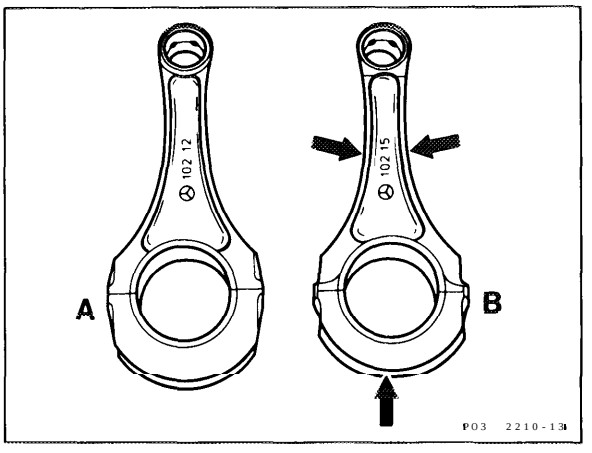
The required oil is supplied via injection nozzles located in the crankcase on the right side.

The annular channel is deleted on engine 603.970. Only the piston crown is supplied with oil.



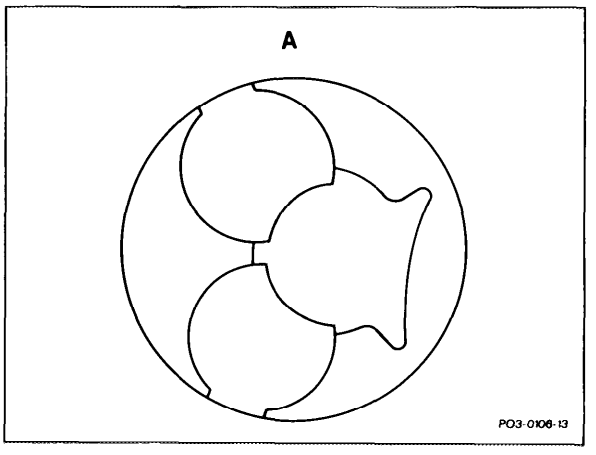
A **recess is** located on the piston skirt (arrow) for the oil injection nozzle.

The prechamber recess in the piston crown has a diameter of 18 mm (normally aspirated engine = 17 mm).

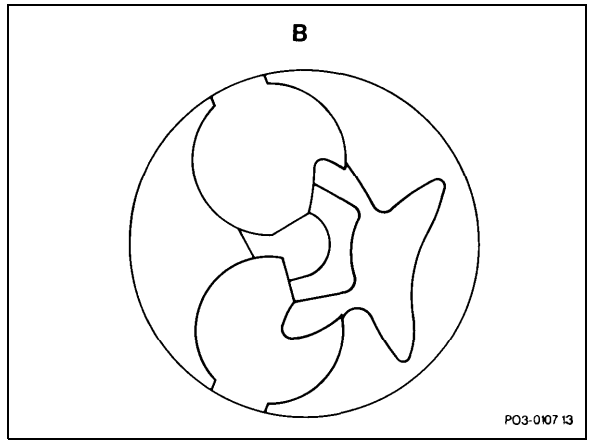


Piston crown

On **engines** 602.96 **and** 603.97 **from the start of production and on engine** 603.96 **starting** 08/88 'moose horn' recess pistons are installed (previously 'star' recessed pistons).
The piston **crown is coated with aluminum oxide on both piston versions.**



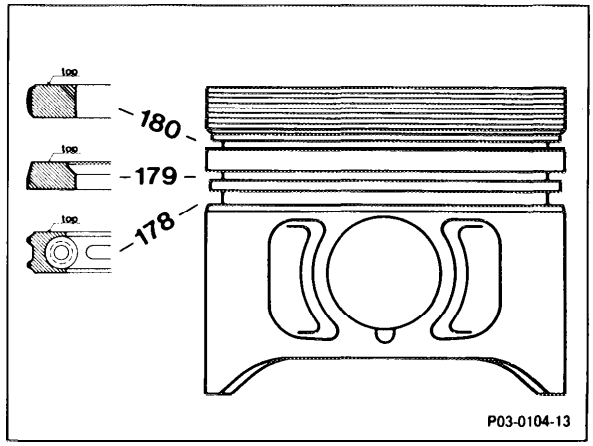
A. 'Moose horn' piston



B. 'Star' recessed piston

These pistons each have two compression rings and one oil scraper ring. The piston skirt is graphitized.

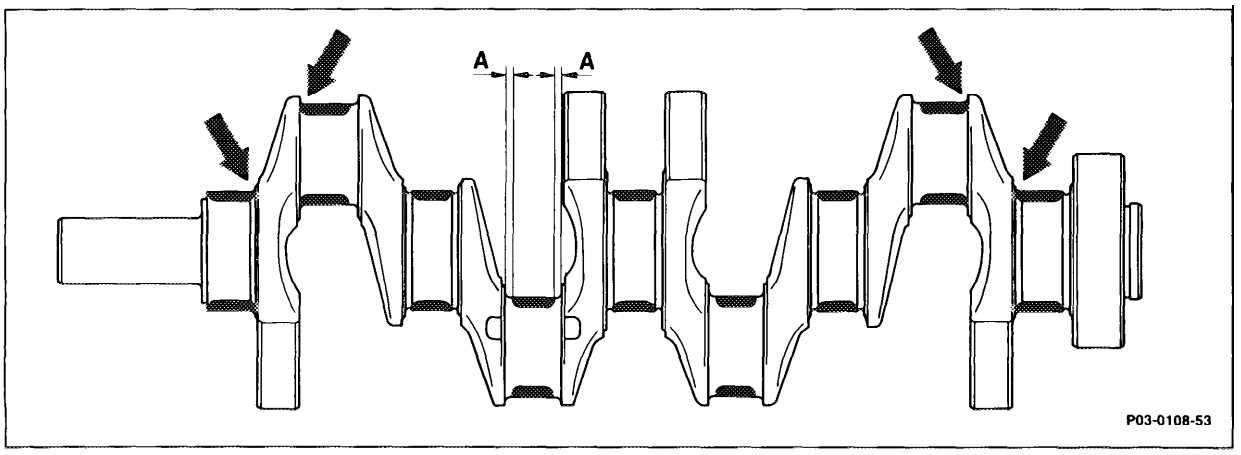
Piston codes: 00 Engine 602.96
13 Engine 603.96



178 Bevelled ring with expander, 3 mm thick, running surface chrome-plated
179 Taper face ring with inside bevel, 2 mm thick,
180 Rectangular ring with inside bevel, 2.5 mm thick, running surface molybdenum-coated

03-318 Checking and reconditioning crankshaft

Preliminary lobs:
Crankshaft removed.



Crankshaft	clean
Crack test	perform; apply fluorescent powder (magnaflux) or use penetration method.
Hardness test (scleroscope hardness)	perform with impact hardness tester 000 589 20 21 00.
Distance (A = 5 - 6 mm)	when hardening journals without hardened fillets, maintain distance A between hardened runout and fillet radius.
Journals	can be hardened inductively or with flame.

Caution!
Harden journals with hardened fillets (arrows) inductively only.

Data

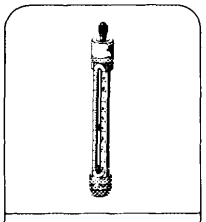
Crankshaft normal dimensions and repair stages	Crankshaft bearing journal dia.	Fitted bearing Associated thickness of thrust washers	Width of journal	Connecting rod bearing journal dia.	Connecting rod bearing journal width
Standard dimension	57.950 / 57.965	2.15	26.52" 24.53[2] / 26.50 24.50	47.950 / 47.965	27.96 / 28.04
		2.20	26.62" 24.63[2] / 26.60 24.60		
1st repair stage	57.700 / 57.715	2.25 or 2.35 or 2.40	26.72" 24.73[2] / 26.70 24.70 or 26.92" 24. 93[2] / 26.90 24.90 or 27.02" 25.03[2] / 27.00 25.00	47.700 / 47.715	– 28.30
2nd repair stage	57.450 / 57.465			47.450 / 47.650	
3rd repair stage	57.200 / 57.215			47.200 / 47.215	
4th repair stage	56.950 / 56.965			46.950 / 46.965	

[1]) Up to 06/84
[2]) Starting 07/84

Test values

Permissible deviation of crankshaft main and rod journals in mm		0.005
Permissible conicity of crankshaft main and rod journals in mm		0.01
Permissible roughness of crankshaft main and rod journals (Ra) in mm		0.005 – 0.015
Permissible deviation of flywheel flange from true in mm		0.02
Permissible axial runout of fitted bearing in mm		0.02
Fillet radii in mm	on crankshaft main journals	2.5 – 3.0
	on rod journals	3.0 – 3.5
Permissible deviation of crankshaft main journals when mounted in outer crankshaft bearing journals in mm	Journal II. IV	0.16
	Journal III	0.25
Scleroscope hardness of crankshaft main and rod journals		55 – 74
Permissible unbalance of crankshaft		10 cmg

Special tool

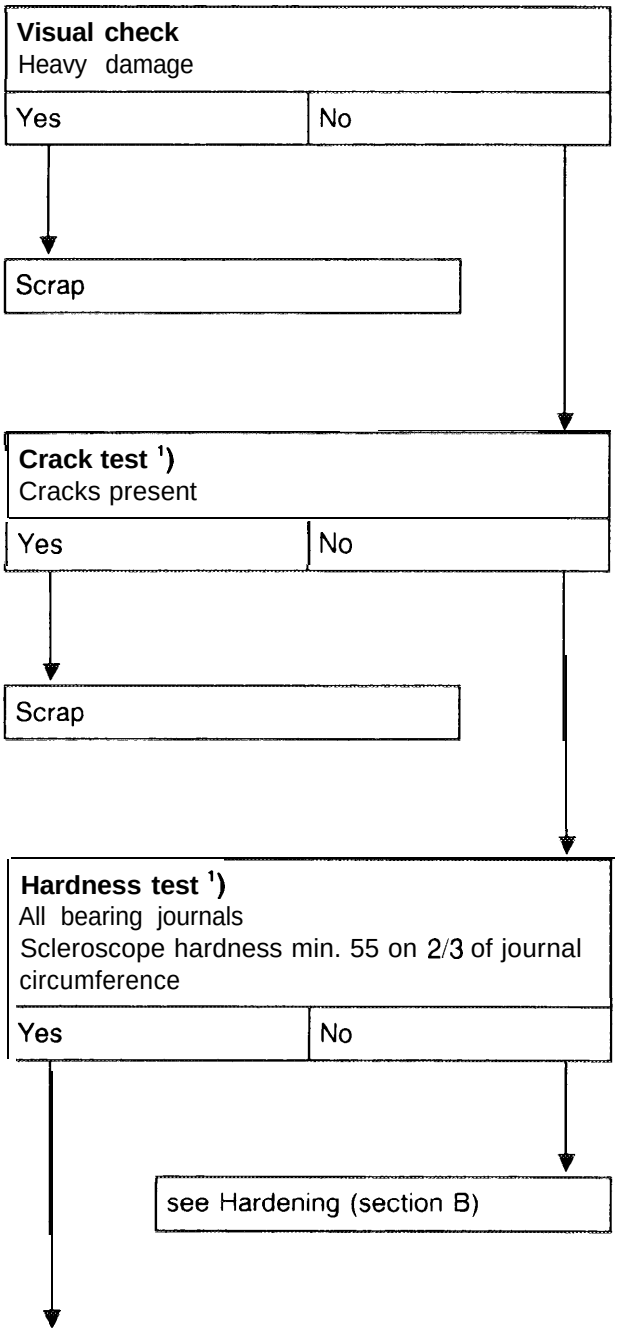


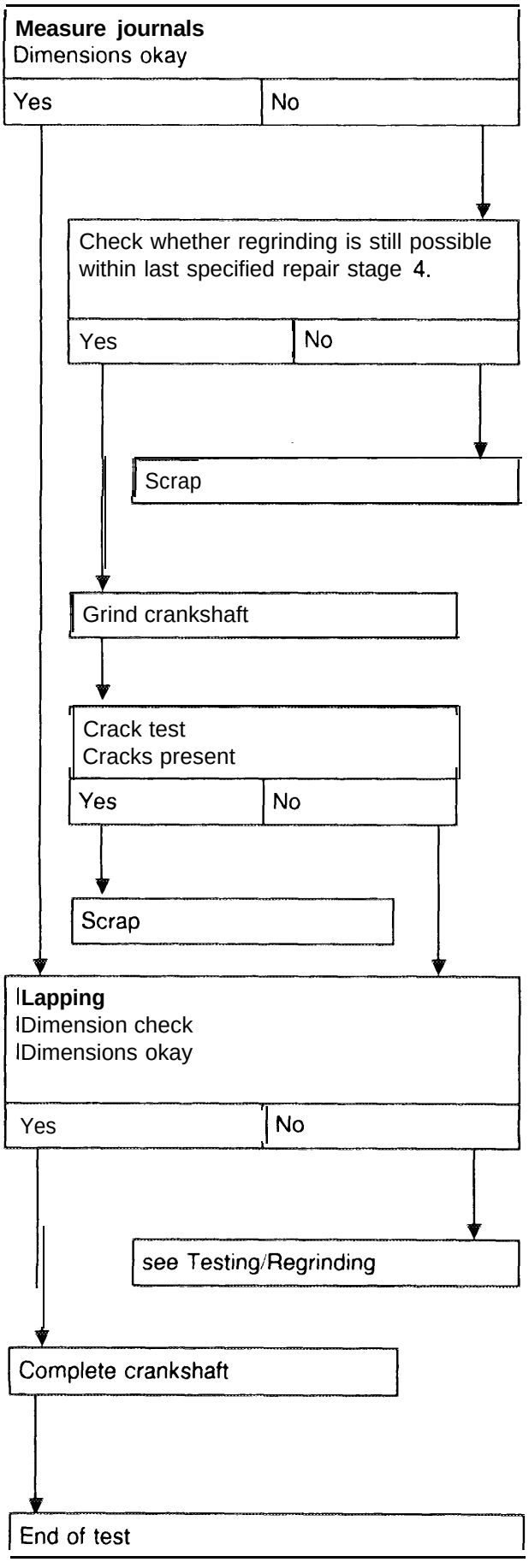
000 589 20 21 00
00 03

Note

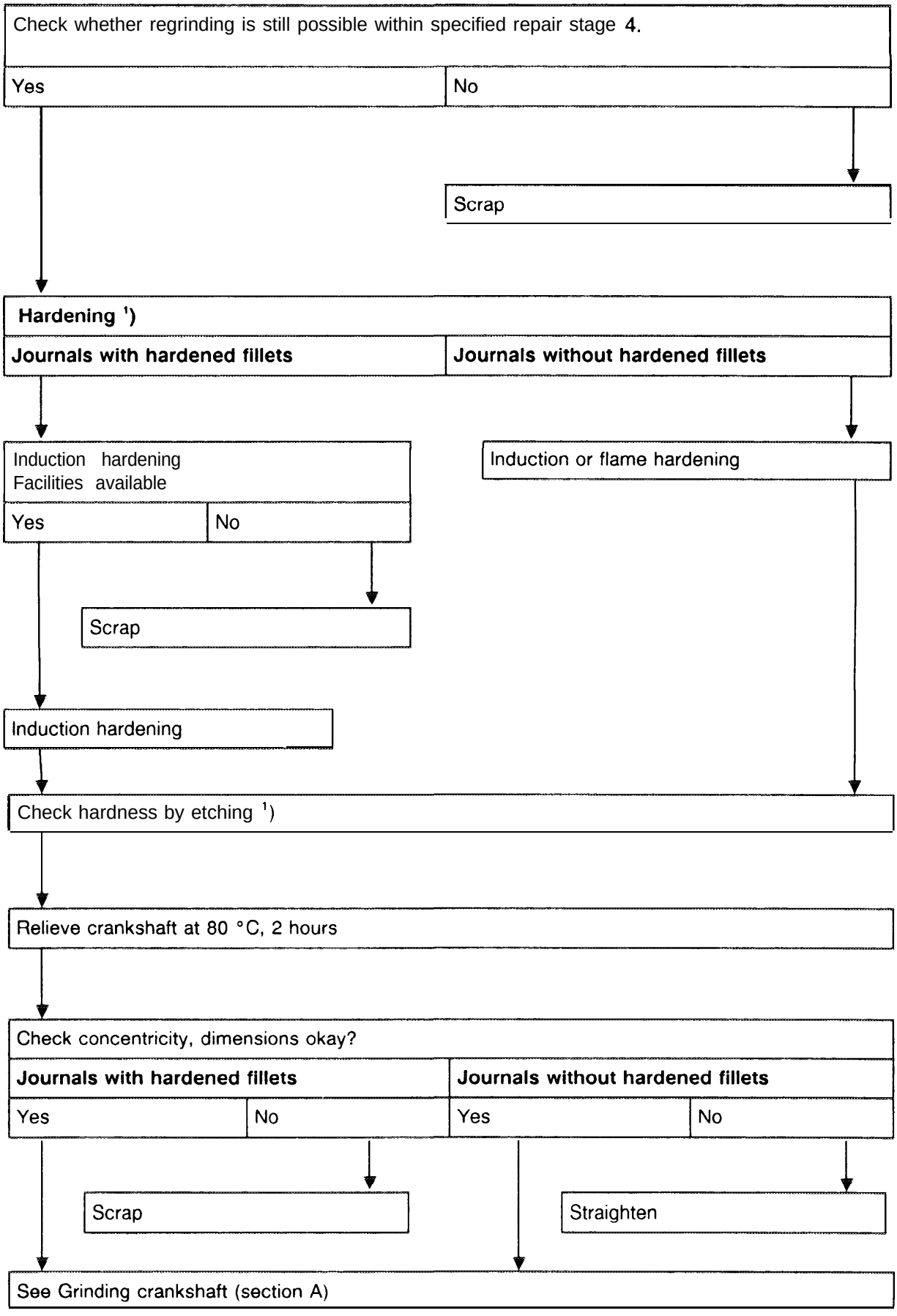
When testing and reconditioning crankshafts, proceed in sequence shown in diagram below.

A. Testing, grinding

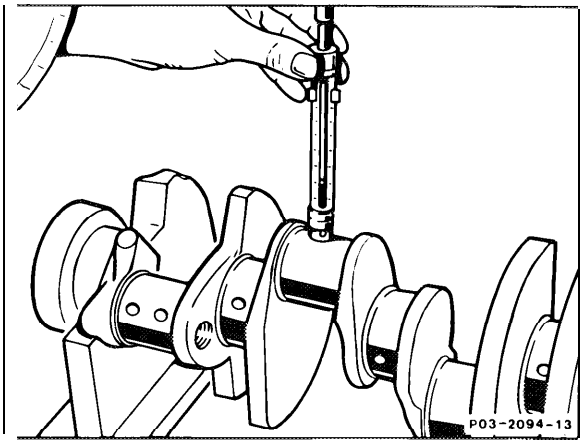



Measure journals
Dimensions okay
Yes
No
Check whether regrinding is still possible within last specified repair stage 4.
Yes
No
Scrap
Grind crankshaft
Crack test
Cracks present
Yes
No
Scrap
Lapping
Dimension check
Dimensions okay
Yes
No
see Testing/Regrinding
Complete crankshaft
End of test

B. Hardening


Check whether regrinding is still possible within specified repair stage 4.
Yes
No
Scrap
Hardening 1)
Journals with hardened fillets
Journals without hardened fillets
Induction hardening Facilities available
Yes
No
Scrap
Induction or flame hardening
Induction hardening
Check hardness by etching 1)
Relieve crankshaft at 80 °C, 2 hours
Check concentricity, dimensions okay?
Journals with hardened fillets
Journals without hardened fillets
Yes
No
Yes
No
Scrap
Straighten
See Grinding crankshaft (section A)

[1]) Explanations on diagram



Crack test

Clean crankshaft. Bearing journals should be free of oil and grease.
Magnetize crankshaft and apply fluorescent powder (magnaflux).
A fluorescent penetration method may also be used (immersion in bath or using spray can).

Agent:
Paint or fluorescent powder,
cleaning agent,
developer

Hardness test

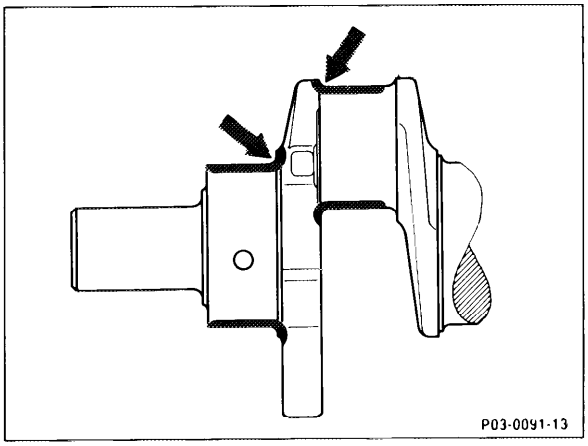
Test hardness with impact hardness tester 000 589 20 21 00 (scleroscope hardness).

The minimum hardness of 55 should be present on 2/3 of journal circumference.

Hardening

Journals without hardened fillets can be hardened inductively or flame-hardened.
Journals with hardened fillets (arrows) must always be hardened inductively.

If this is not possible, scrap crankshaft.



Checking hardening results

To achieve perfect hardening check adjustment of hardening equipment using microsections.

These can be obtained from scrapped crankshafts hardened for testing purposes.

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

Dark spots should not appear on the journal surface.

Unhardened fillets will become dark.

In the case of hardened fillets they should appear as bright as the surface of the journals.

We recommend comparing the etching test with a journal tested via metallographic microsection.

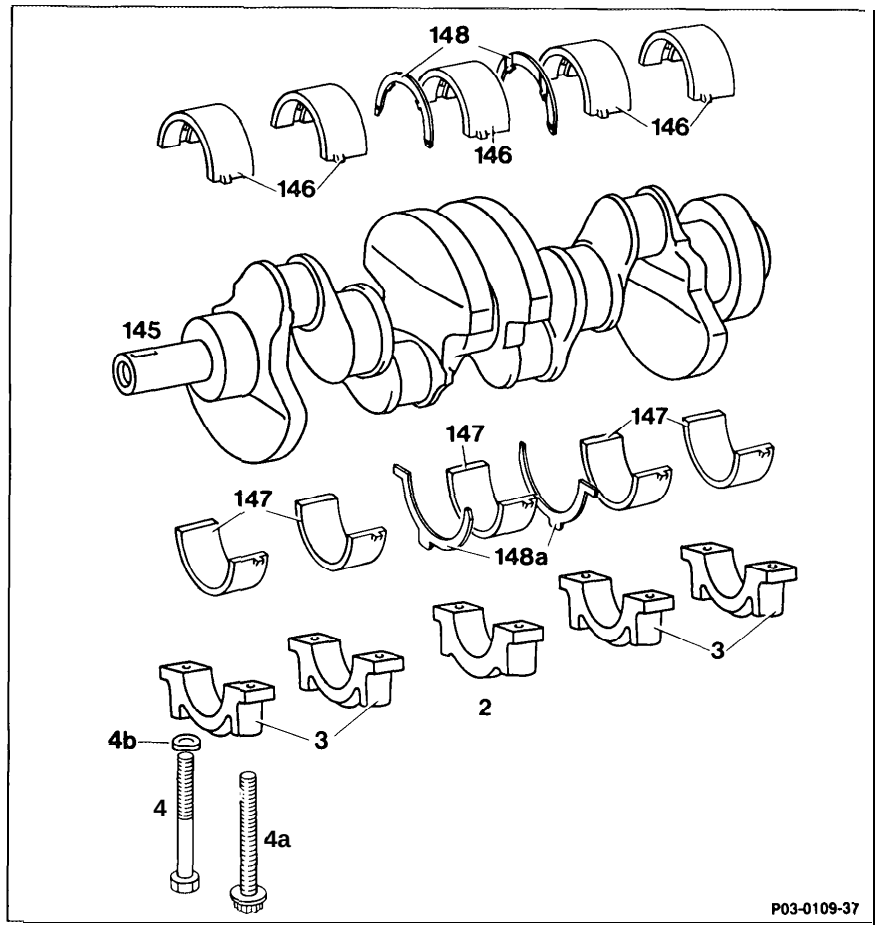
Then carefully wash off nitric acid with alcohol.

Corrosion protection

Crankshafts which are not installed again immediately should be lubricated with engine break-in oil (SAE 30).

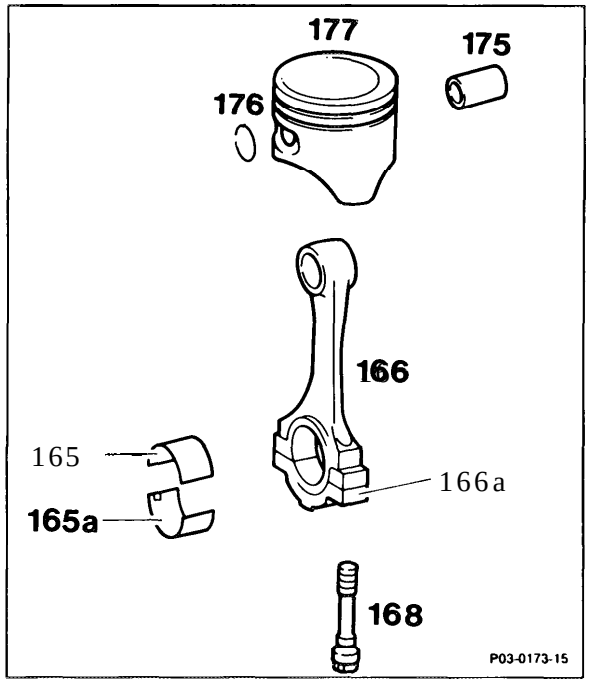
03-320 Installation of crankshaft and connecting rod bearings

Preliminary jobs:
Main oil passage in crankcase open (01-l 30).
Oil passages in crankcase and crankshaft cleaned.
Crankshaft tested (03-318).
Connecting rods reconditioned (03-313).



Crankshaft bearing caps (2, 3)	install without bearing shells, observe markings, tighten. Tightening torque or rotation angle: Crankshaft bearing bolt M 12 (4) 90 Nm Crankshaft bolt M 11 (4 a) 55 Nm, 90 - 100°.

Basic bores	measure conicity in directions A, B and C, min. 62.500 mm, max. 62.519 mm (item 3).
Crankshaft bearing caps (2, 3)	remove (item 4).
Crankshaft bearing shells (146, 147)	insert (item 4).
	Caution! Do not mix up upper and lower crankshaft bearing shells.
Crankshaft bearing caps (2, 3)	position in proper order, position washers (4 b) and tighten crankshaft bearing bolts (4 and 4a) (item 4). Tightening torque and tightening rotation angle crankshaft bearing bolts M 12 (4) 90 Nm crankshaft bearing bolts M 11 (4a) 55 Nm, 90 - 100° (item 4).
Crankshaft	measure bearing journals, determine bearing clearance (item 5).
Fitted bearing journal	measure width and match appropriate thrust washers (item 7).
Crankshaft bearing caps (2, 3)	remove crankshaft bearing bolts (4 and 4a), remove caps, remove lower bearing shells (147) and insert crankshaft (145) with thrust washers (148, 148a), position lower bearing shells (147) (items 8, 9). The oil grooves must point toward the crankshaft. Oil crankshaft, bearing shells and thrust washers.
Crankshaft bearing caps (2, 3)	position in correct order and tighten crankshaft bearing bolts (4 and 4 a) (items 10, 11). Tightening torque and tightening rotation angle crankshaft bearing bolts M 12 (4) 90 Nm, crankshaft bearing bolts M 11 (4a) 55 Nm, 90 - 100”.
Crankshaft (145)	measure end play, new value 0.100 - 0.254 mm; wear limit 0.30 mm.



Connecting rod bearing caps (166 a)	install without bearing shells and tighten, 30 Nm. Observe marking.
Basic bore for rod bearing	measure (03-313).
Rod bearing shells (165, 165 a)	insert, install rod bearing cap and tighten, rod bearing bolts (168) 30 Nm.
	Caution! Do not mix up upper and lower rod bearing shells.
Connecting rod bearing diameter	measure and note value (item 15).
Connecting rod bearing journals	measure, new value 47.950 mm, determine bearing clearance, wear limit 47.965 mm (item 16).
Connecting rod radial clearance	measure, new value 0.030 to 0.055 mm; wear limit 0.08 mm (item 16).
Pistons (177)	attach to connecting rod (166) together with piston pins (175) and piston pin retainers (176) and install (observe installation position) (03-316).

Pistons (177) and connecting rods (166)	install (arrow on piston crown toward front of vehicle) (03-316).
Connecting rod bearing end play	measure, new value 0.12 to 0.26 mm; wear limit 0.50 mm (item 20).
Oil pump and oil filter	disassemble and clean, renew oil pressure valve and install initial operation oil filter cartridge.

Data

Crankshaft standard dimensions and repair stages	Crankshaft bearing journal dia.	Fitted bearing Associated thickness of thrust washers	Width of journal		Connecting rod bearing journal dia.	Connecting rod bearing journal width
Standard dimension	57.950 / 57.965	2.15	26.52" / 26.50	24.53[2] / 24.50	47.950 / 47.965	27.96 / 28.04
		2.20	26.62" / 26.60	24.63[2] / 24.60		
1 st repair stage	57.700 / 57.715	2.25 or 2.35 or 2.40	26.72" / 26.70	24.73[2] / 24.70	47.700 / 47.715	– 28.30
2nd repair stage	57.450 / 57.465		or		47.450 / 47.650	
3rd repair stage	57.200 / 57.215		26.92" / 26.90	24.93[2] / 24.90	47.200 / 47.215	
4th repair stage	56.950 / 56.965		or 27.02" / 27.00	25.03[2] / 25.00	46.950 / 46.965	

1) Up to 06/84
2) Starting 07/84

Basic bore and bearing play in mm		Crankshaft bearing	Connecting rod bearing
Basic bore dia.		62.500 62.519	51.600 51.619
Basic bore width on fitted bearing	Engines 602 and 603	20.000 19.979	–
Connecting rod width	Engines 602 and 603	21.948 22.000	–
Permissible out-of-round of basic bore		0.01	
Permissible conicity of basic bore		0.01	
Bearing play, radial	New value	0.030 – 0.055[1])	
	Wear limit	0.08	
Bearing play, axial	New value	0.100 – 0.254	0.12 – 0.26
	Wear limit	0.30	0.50

[1]) For radial play, set to medium value.

Bearing shells

	Wall thickness Crankshaft bearing in mm	Width of bearing shells in mm	Thickness of fitted bearing thrust washers in mm	Wall thickness Connecting rod bearing in mm
Standard dimension	2.25	17.30 – 17.50	2.15 or 2.20	1.80
1st repair stage 2nd repair stage 3rd repair stage 4th repair stage	2.37 2.50 2.62 2.75		2.25 or 2.35 or 2.40	1.92 2.05 2.17 2.30

Engine 602.91

The tolerance range for the wall thicknesses of the connecting rod bearings was replaced starting 08/85 with three stages. The stages are indicated by a color code.

Only connecting rod bearing shells with the color code yellow are available as replacement parts.

Color code	Dimension
Red	1.804 to 1.808 mm
Yellow	1.808 tol.812
Blue	1.812 to1.816

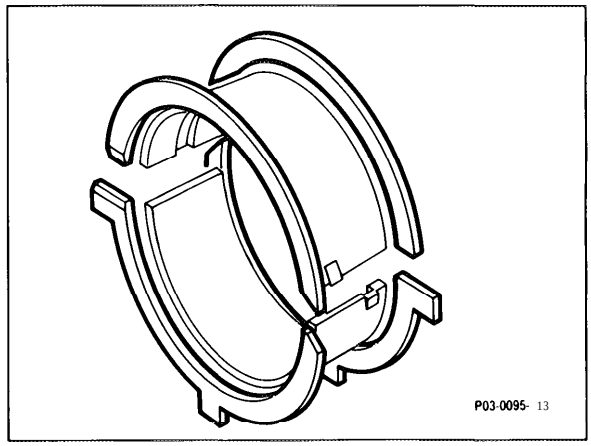
Engines 602.96, 603.96 and 603.96/97

Upper connecting rod bearing shells from Glyco with improved coating (cathode dust coating method).

Engines 602.96, 603.96/97

The groove for fixing the connecting rod bearing was modified to assure correct installation position.

Dimension A: 3.2 mm for all engines
Dimension B: 2.5 mm 602.96, 603.96197
3.5 mm 602.91



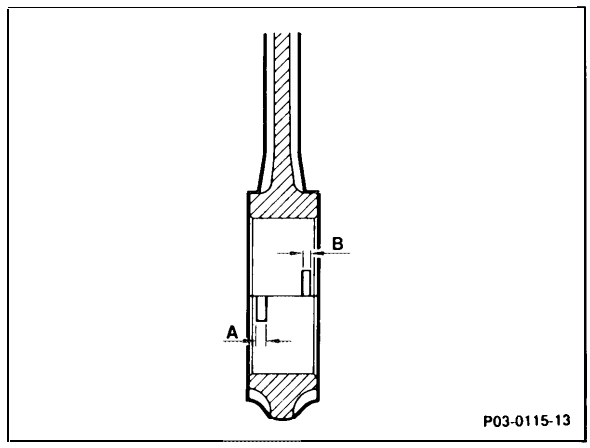
Production breakpoint: 05/86

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
124.133 124.193	603.960 603.960		001032	266393	013772
126.125	603.961		002508	260197	–

[1]) Engines 602.96 and 603.97 from star-t of production

Note

The axial forces of the crankshaft are taken up by the thrust washers.

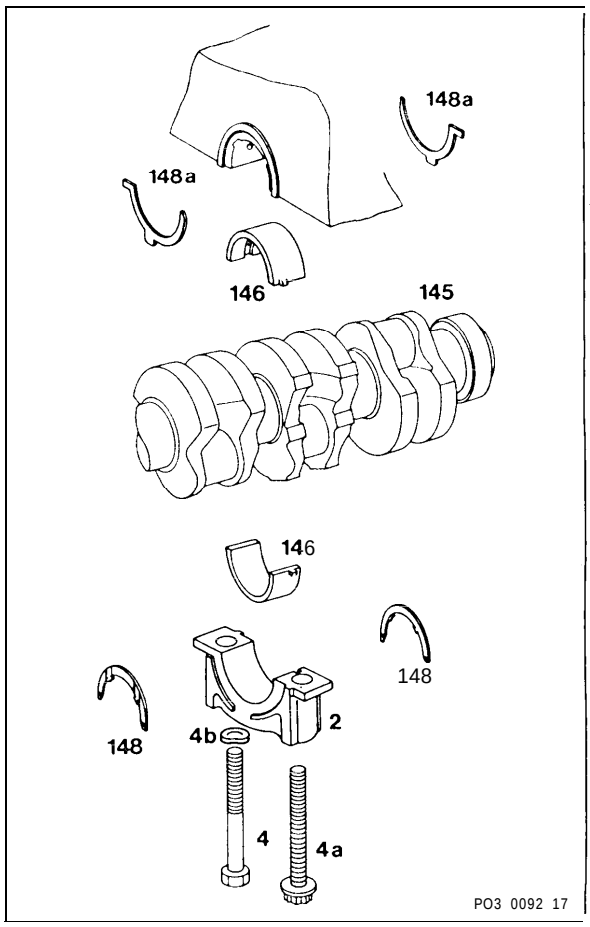


The thrust washers (148 and 148a) installed in the crankcase and in the bearing caps have a different shape.

The thrust washers in the crankshaft bearing caps each have two retaining lugs to prevent rotation and installation errors, whereby the lower retaining lugs are off-center.

When reconditioning crankshafts, regrind width of fitted bearing journals to one of the dimensions shown in the table (section “Data”).

Match thrust washers to respective journal width (table).



2	Bearing cap
4	Crankshaft bearing bolt M 12x60
4a	Crankshaft bearing bolt M 11 x 62
4b	Washer
145	Crankshaft
146	Bearing shell
148	Upper thrustwasher
148a	Lower thrust washer

Thrust washers of the same thickness must always be installed on both sides.

Do not regrind thrus? washers.

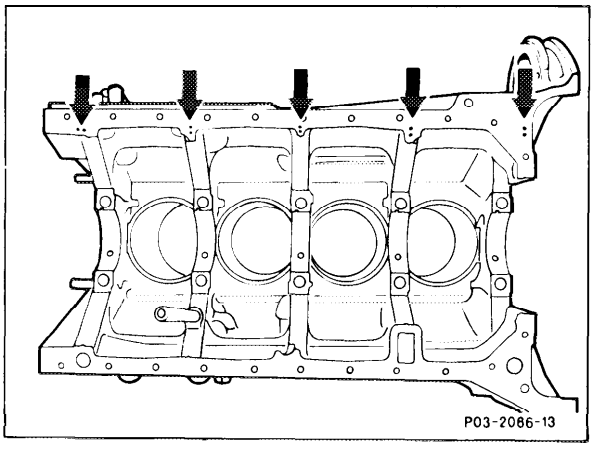
Thrust washers are available for replacement in sets only. One set consists of one upper and one lower thrust washer (148 and 148a).

Association of crankshaft bearing shells and crankcases

Crankshaft bearing shell [1]	Basic bores in crankcase		
	1 punch mark	2 punch marks	3 punch marks [2]
	Bearing shell association with color code		
Blue	Blue	Yellow	Yellow
Yellow	Blue	Yellow	Red
Red	Yellow	Yellow	Red

[1] Color dots on crankshaft cheeks or counterweights next to crankshaft Journals.
[2] Punch marks on parting surface of crankcase on oil pan side next to basic bore.

The standard dimension crankshaft bearing shells with color codes blue, yellow and red are available as parts.
They must be matched according to the table. This eliminates the necessity of measuring the bearing clearance.



Punch marks for matching crankshaft bearing shells

When ordering crankshaft bearing shells the code 52 for blue
54 for yellow
und 56 for red
must be indicated in addition to the part No.

Only the yellow version bearing shells are available for the connecting rod bearing shells.

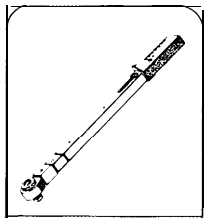
Thrust washer sets

Thickness in mm	Set Part No.
2.15	601 030 00 62
2.20	601 030 01 62
2.25	601 030 02 62
2.35	601 030 03 62
2.40	601 030 04 62

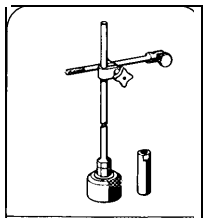
Tightening torques and rotation angle

Crankshaft bearing bolts	M 12		90 Nm
	M 11	Initial tightening torque	55 Nm
		Rotation angle	90 – 100”
Connecting rod bolts		Initial tightening torque	30 Nm
		Rotation angle	90 – 100”
M 18 x 1.5 x 50 bolts on crankshaft			320 Nm

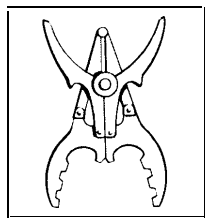
Special tools



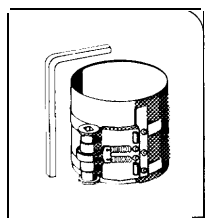
001 589 66 21 00
00



363 589 02 21 00
00



000 589 51 37 00
03



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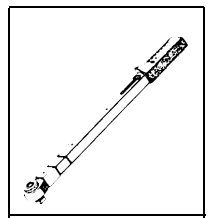
03 13



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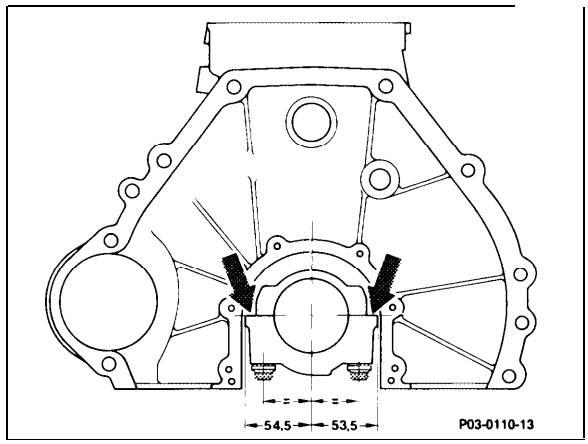
Commercially available tools

Connecting rod straightener	e.g.	Hahn & Kolb, D-7000 Stuttgart Model BC 503
Internal gauge	e.g.	Carl Mahr, D-7300 Esslingen Model 844 N
Micrometer screw	e.g.	Carl Mahr, D-7300 Esslingen
Dial gauge Al DIN 878	e.g.	Carl Mahr, D-7300 Esslingen Model 810

Installation of crankshaft and connecting rod bearings

1 Attach crankshaft bearing cap.



Note
All bearing caps are fitted laterally into crankcase (arrows) and are fastened with two M 12 x 60 or M 11 x 60 bolts each.

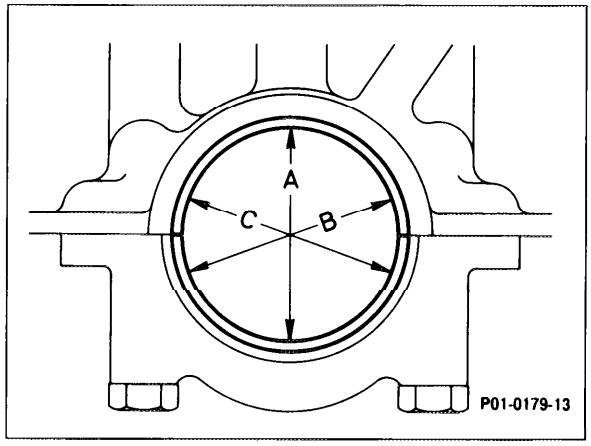
The pilot fit (arrows) is offset 0.5 mm from the center so that the bearing caps can be mounted in one position only.

The bearing caps are also identified from front to rear with the code numbers 1, 2, 3, 4 etc. and must not be mixed up.

2 Lubricate crankshaft bearing bolts for crankshaft bearing caps and tighten.

Tightening torque and rotation angle:

Crankshaft bearing bolts	M 12 90 Nm,
crankshaft bearing bolts	M 11 55 Nm,
	90 – 100”.



3 Measure basic bore in directions A, B and C at two levels (conicity).

If specified value for one basic bore is exceeded or conical, touch up bearing cap at parting surface on surface plate up to max. 0.02 mm.

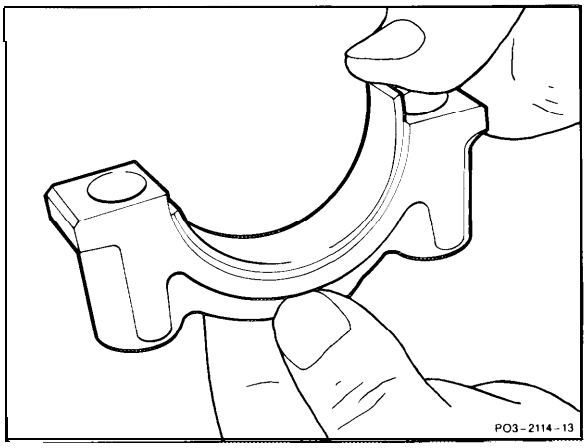
4 Remove crankshaft bearing bolts, insert crankshaft bearing shells, install crankshaft bearing caps and tighten.

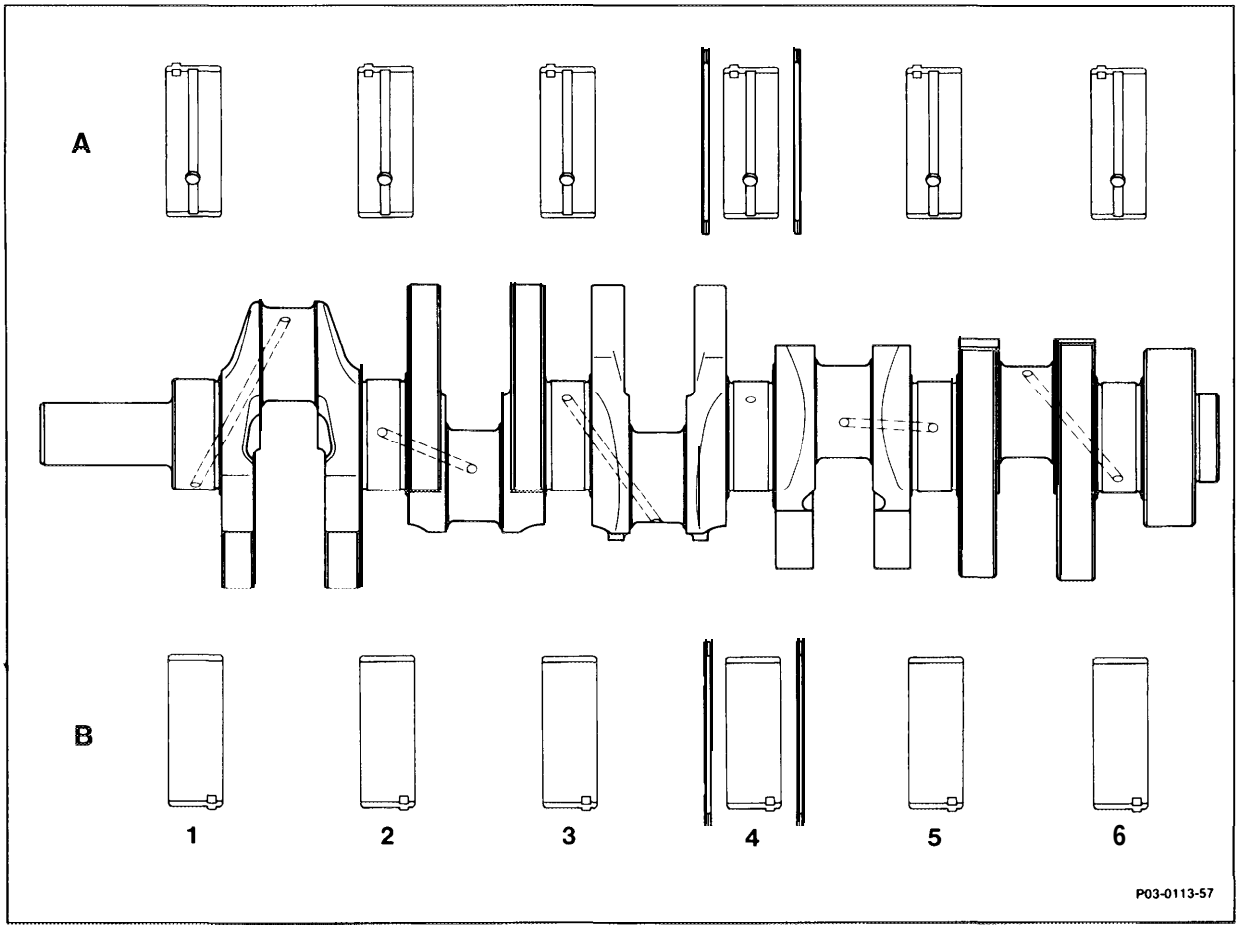
Tightening torque and rotation angle:

Crankshaft bearing bolts M 12 90 Nm
Crankshaft bearing bolts M 11 **55** Nm,
90 – 100".

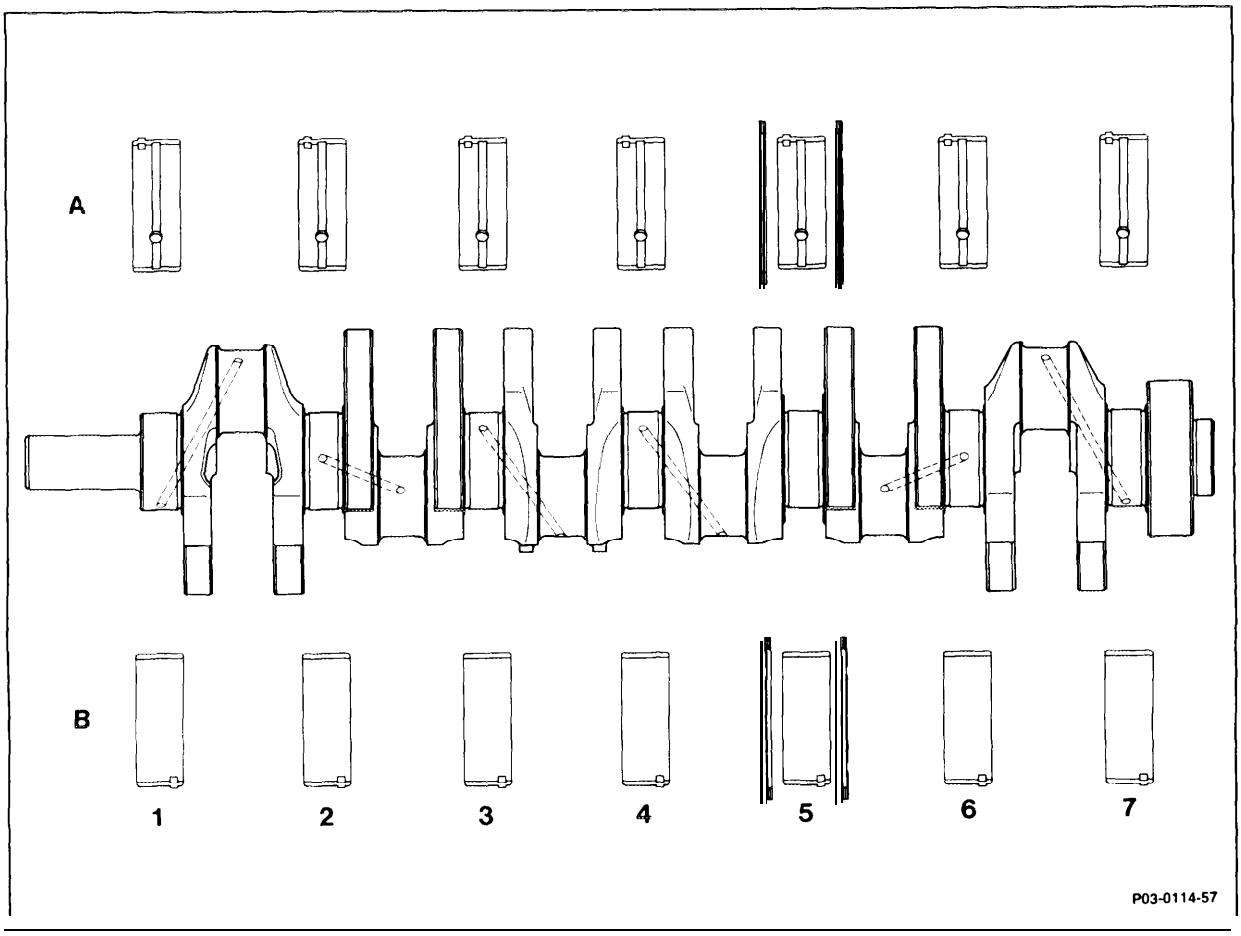
Caution!

Observe order of crankshaft bearing caps. Do not interchange upper and lower crankshaft bearing shells.



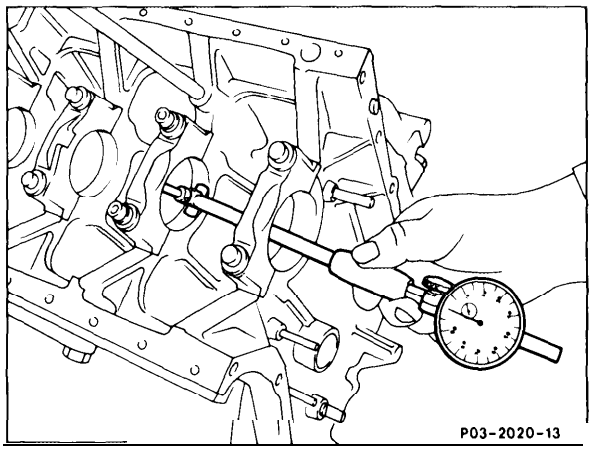


Engine 602
Fitted bearing: bearing 4



Engine 603
Fitted bearing: bearing 5
A Upper bearing shells, crankcase
B Lower bearing shells (cap shells)

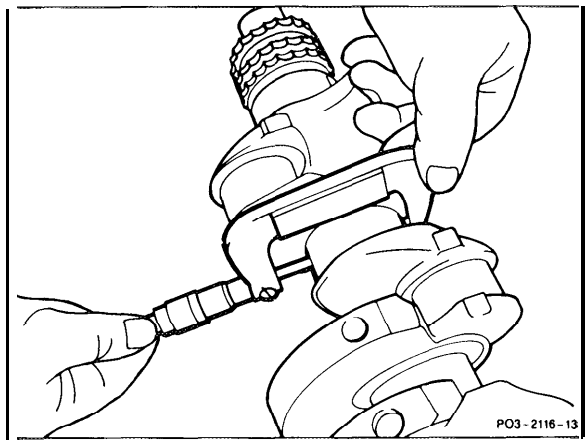
5 Measure crankshaft bearings and note values.



6 Measure crankshaft bearing journals, determine crankshaft bearing radial clearance.

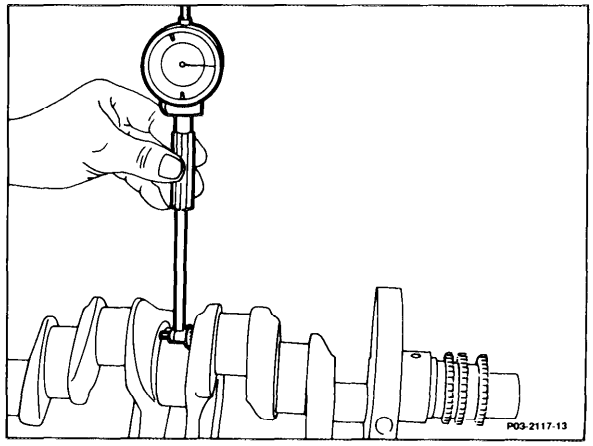
Note
The bearing clearance can be corrected by exchanging bearing shells. Attempt to achieve the mean value of the specified bearing clearance.

Caution!
Observe different wall thicknesses.



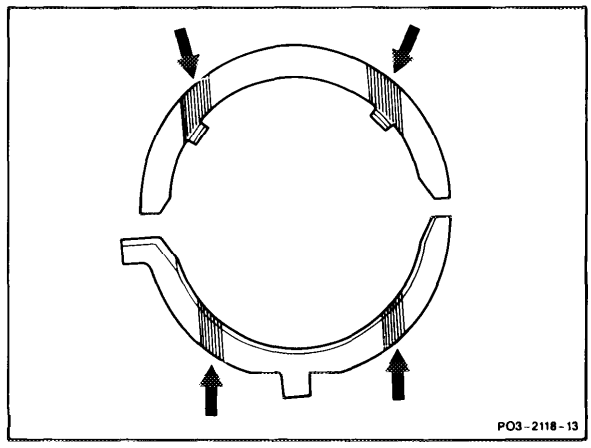
7 Measure width of fitted bearing journal and find proper thrust washers (see table, section Data).

8 Removecrankshaft bearing bolts, remove lower crankshaft bearing shell, oil crankshaft, position in crankcase and oil lower crankshaft bearing shell and reposition.



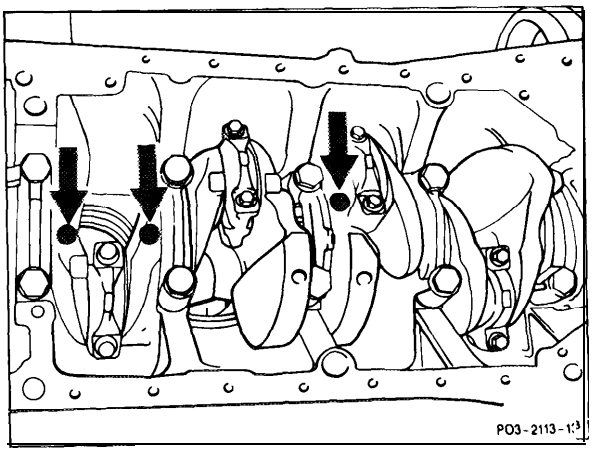
Caution!
The two oil grooves (arrows) in the thrust washers should point toward the crankshaft cheeks.

9 Oil thrust washers and slide into grooves at fitted bearing (crankcase).



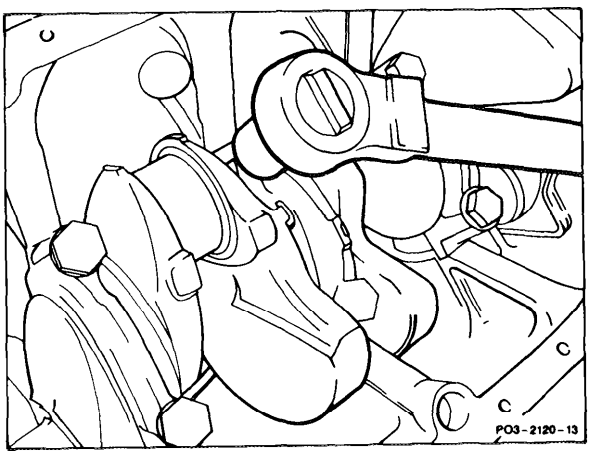
10 Position crankshaft bearing caps in proper order.

Note
The crankshaft bearing caps are marked with code numbers at the marking points (arrows).



11 Tighten crankshaft bearing caps.

Tightening torque and rotation angle:
Crankshaft bearing bolts M 12 90 Nm
Crankshaft bearing bolts M 11 55 Nm,
90 – 100".



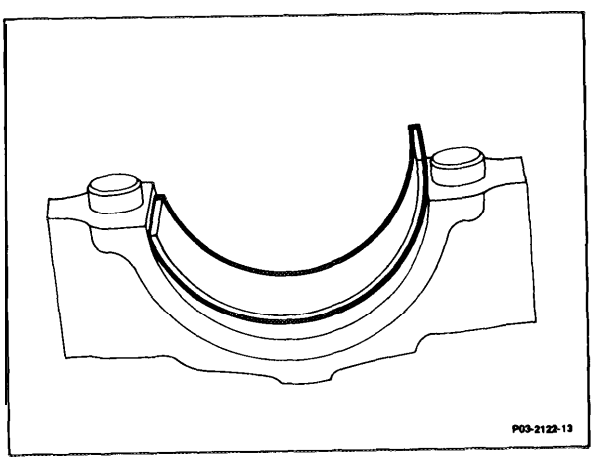
12 Measure crankshaft end play.

13 Turn crankshaft by hand and assure that it runs free.

Installation of connecting rod bearings and connecting rods

14 Insert connecting rod bearing shells, install connecting rod bearing caps with bearing shells and tighten connecting rod bolts to 30 Nm.

Connecting rod bearing shells are available only in the yellow version.



Note

The upper connecting rod bearing shells for engines 603.96 are made using a different material starting 05/86 due to the higher load.

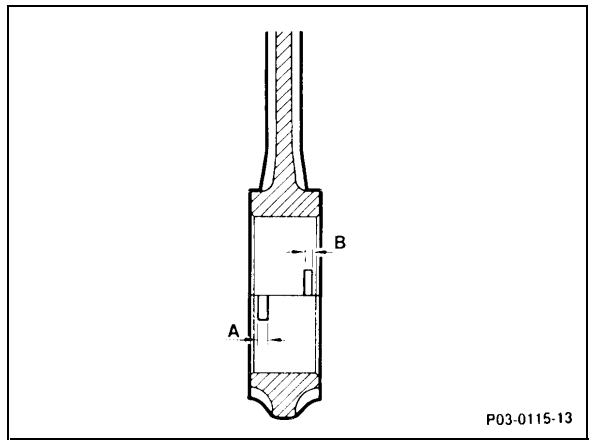
Caution!

Do not mix the upper and lower bearing shells. They can be recognized by the stamped-in part number.

Upper bearing shells	603 08 10
or	603 15 10
Lower bearing shells	601 04 11
or	601 08 11

The bore for lubrication of the piston pin has been eliminated.

Due to higher loads in engine 603.970, the upper connecting rod bearing shells are made of a different material than the lower shells.
To prevent misassembly, the upper locating groove is 0.7 mm narrower.



A 3.2 mm all engines
B 2.5 mm engines 603.96, 603.97
3.2 mm engine 602

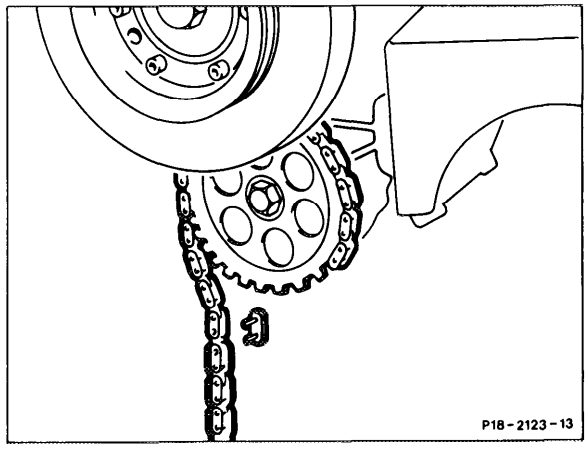
15 Measure connecting rod bearing diameters and note.

16 Measure connecting rod bearing journals. Determine connecting rod bearing radial clearance.

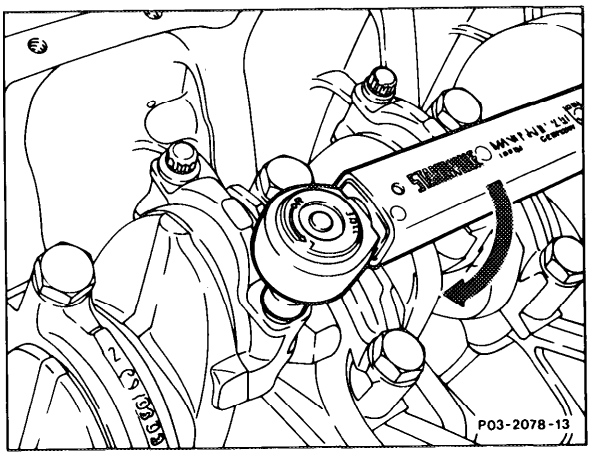
The bearing clearance can be corrected by changing the bearing shells, whereby it should be attempted to achieve the mean value of the specified bearing clearance. Observe different wall thicknesses.

17 Install pistons on connecting rods (03-316).

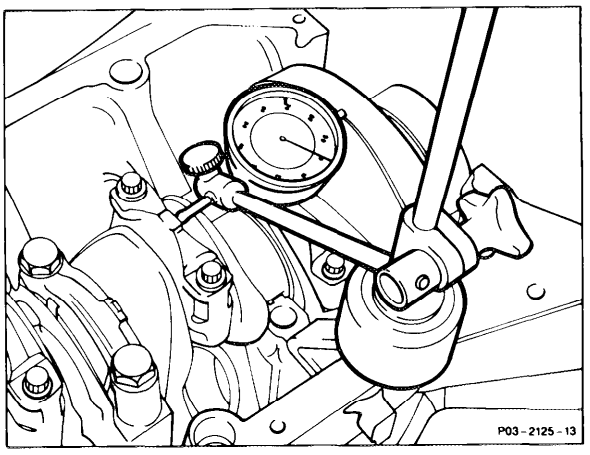
18 Coat bearing shells, crankshaft, pistons and cylinder walls with engine oil, install connecting rods with pistons (03-316).



19 Tighten connecting rod bolts to initial torque of 30 Nm and then turn 90 - 100".



20 Measure connecting rod bearing end play while moving connecting rod directly at piston pin. Assure that connecting rod moves freely in relation to crankshaft. Use dial gauge holder 363 589 02 21 00.



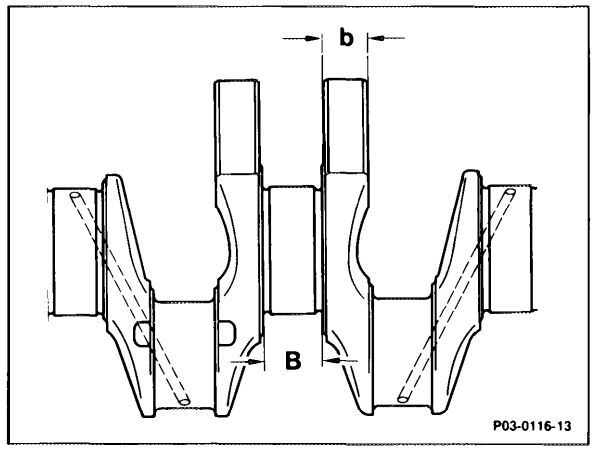
Caution!
Disassemble oil pump and clean, replace if required. Replace oil pressure valve. Disassemble oil filter and clean.

Install initial operation oil filter cartridge. Change oil filter cartridge and oil after 1000-l 500 km.

03-321 Modifications to crankshaft

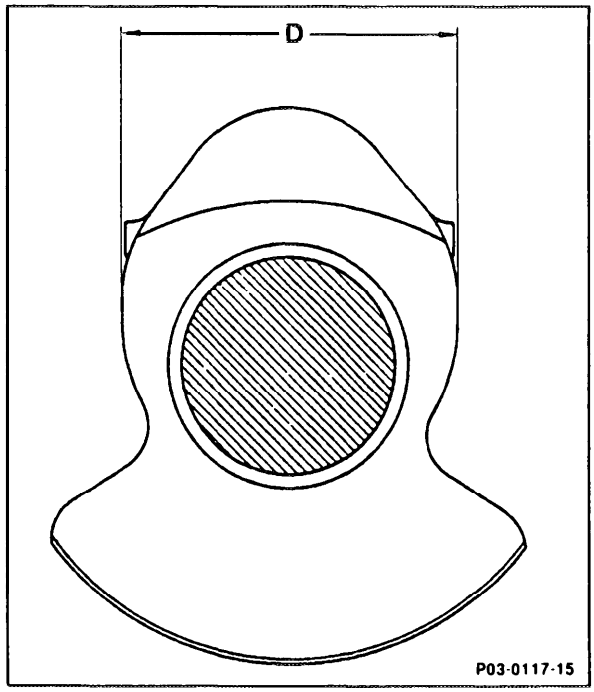
Increased displacement engine 603.970

The stroke was increased to 94.2 mm and the web width (b) reduced to 21.75 mm to increase the displacement (3.5 l) on the 603.970 engines.



Engine 602.96 crankshaft webs

On engine 602.96 starting 12/87 the web width (D) was increased by 8 mm for a total of 90 mm.



D 90 mm (engine 602.961)

Engine 602.91 flywheel locating pin

Cylindrical pin in crankshaft for locating the flywheel and driven plate.

Production breakooint: 01/86

Model	Engine	Engine end No.		Vehicle ident end No.	
		manual transmission	automatic transmission	A	F
201.126	602.911	010630	002533	276209	184189

• not registered

EXIT

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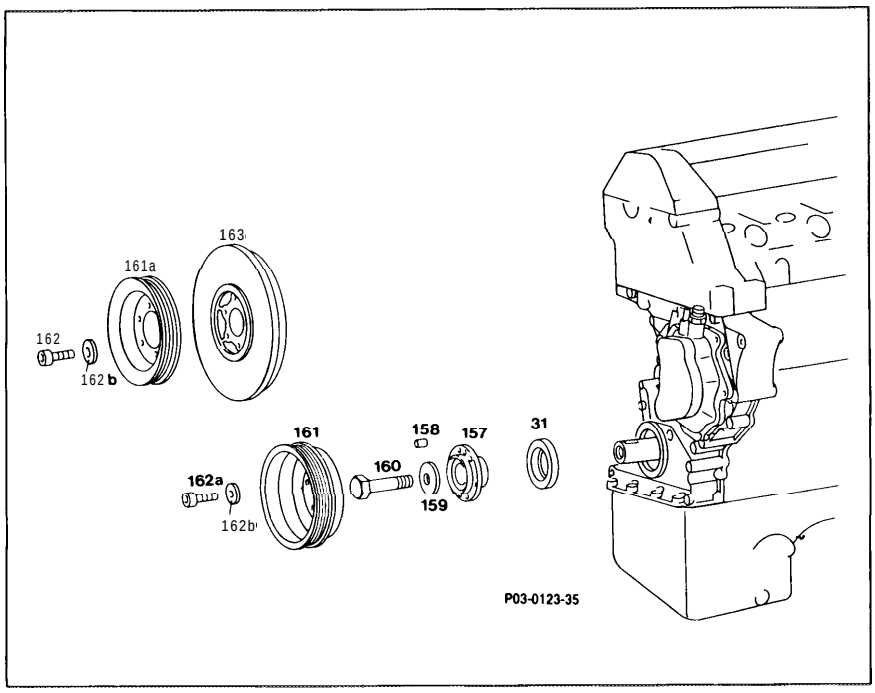
03-324 Replacing front crankshaft radial sealing ring

Preliminary jobs:
Radiator removed (20-420).
Poly-V-belt removed (13-342).



Engines 602, 603:

Crankshaft pulley (161 a) with vibration damper (163) and Allen screws (162) and washers (162 b) . . . . . remove, install (03-341) (item 2).

Note
The vibration damper for engine 602 is not interchangable with that from motor 603.
Do not interchange during repairs.

Hub (157) with hex. head bolts (160) and Belleville washers (159) . . . . . remove, install (item 3).

Note
The cylindrical pin (158) centers the crankshaft pulley and vibration damper.

Crankshaft radial seal (31) ..... replace. Deburr and clean mounting bore. Coat sealing lip with oil and press in with special tool 601 589 03 14 00 (item 4).

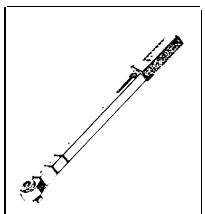
Note

The sealing ring for the repair crankshaft radial seal is offset 3 mm toward the inside so that it will not run in a groove left on the hub by the standard crankshaft radial seal.

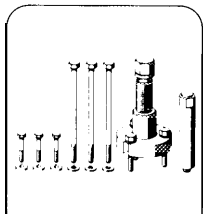
Part No. for repair crankshaft radial seal:
010 997 34 47 or 010 997 68 47.

Tightening torques	Nm
Allen bolts for crankshaft pulley	25
Mounting bolt for hub	320

Special tools

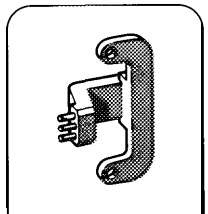


001 589 66 21 00
00

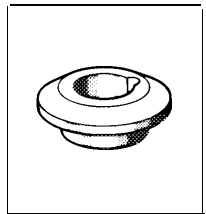


103 589 00 33 00
03

589 02
03



40 00



601 589 03 14 00
03

001 589 74 21 00
00

Commercially available too tool

Adapter 3/4" square socket to 1/2" square head	e.g.	Hazet, D-5630 Remscheid Order No. 1058 R-1

Replacement

Engine 601.921

1 Remove crankshaft pulley (03-341).

Engines 602, 603

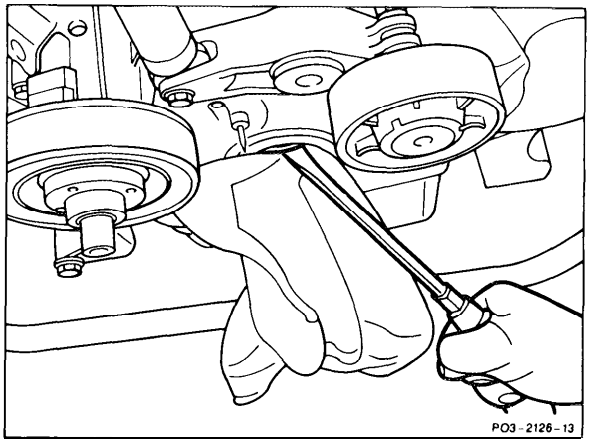
2 Remove crankshaft pulley with vibration damper (03-341).

Caution!
Do not interchange vibration dampers.

3 Remove crankshaft hub (03-341).

Note
The cylindrical pin centers the crankshaft pulley and vibration damper.

4 Press out crankshaft radial seal with screwdriver. Do not damage crankshaft journal or mounting bore.

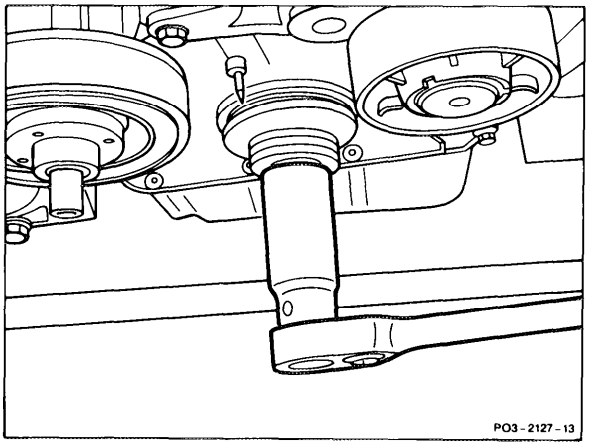


Installation note
Deburr and clean mounting bore for crankshaft radial seal.

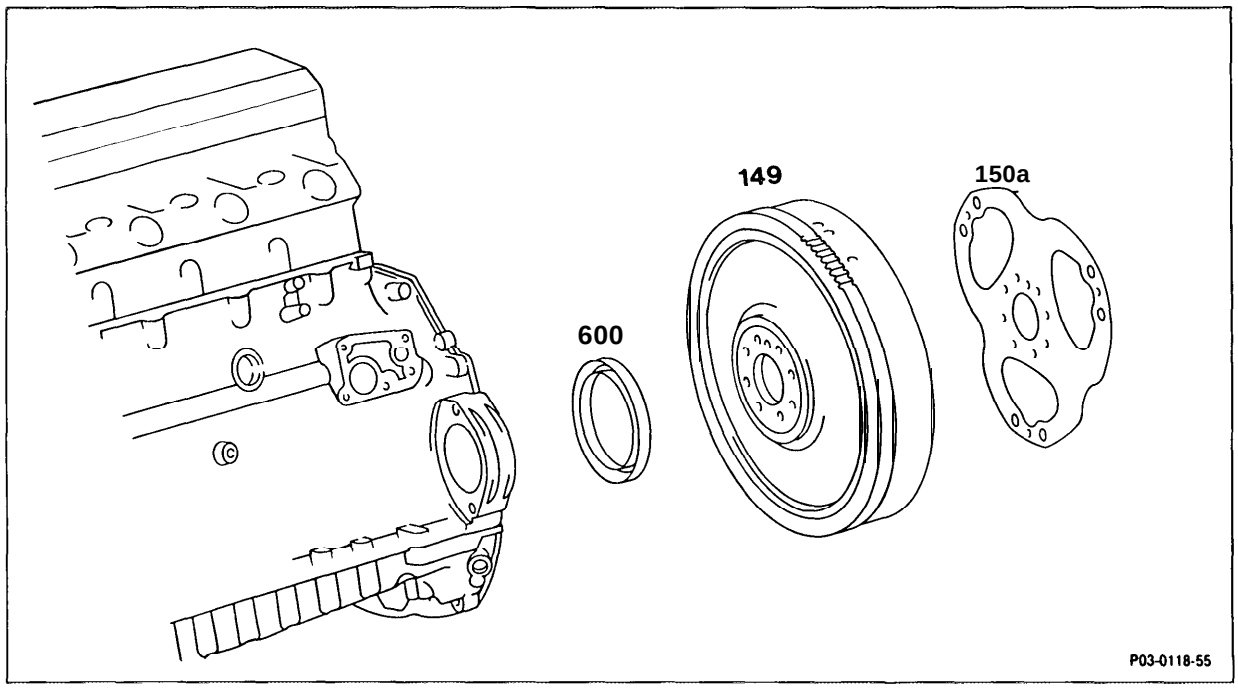
Coat sealing lip of new crankshaft radial seal with oil and press in with special tool 601 589 03 14 00.

Assure that the crankshaft radial seal is seated properly.

5 Reinstall in opposite order.



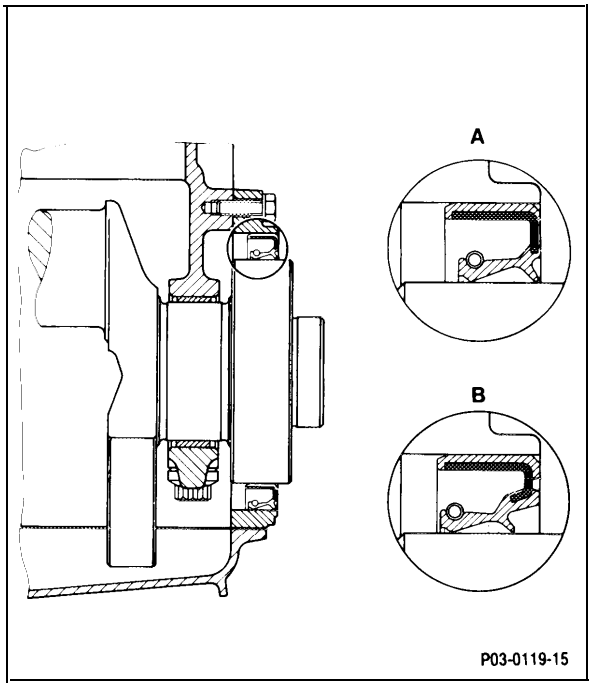
03-327 Replacing rear crankshaft radial sealing ring



Flywheel (149) and driven plate (150a)	remove, install, (03-410) (items 1, 9).
Crankshaft radial seal (600)	remove, replace. Check running surface on crankshaft flange, clean mounting bore, coat sealing lip of crankshaft radial seal with oil and press in with special tool 601 589 03 43 00 (items 2 • 8).
	Caution! Ensure that radial seal is seated properly.
Crankshaft radial seal (600)	check for leakage with engine running (item 10).

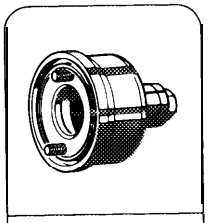
Note

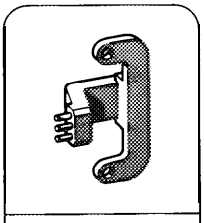
The sealing ring for the repair crankshaft radial seal is offset 3 mm toward the inside so that it will not run in a groove left on the hub by the standard crankshaft radial seal.

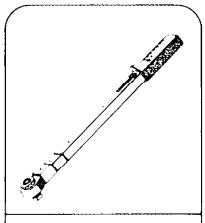


A Standard crankshaft radial seal
B Repair crankshaft radial seal

Special tools


601 589 03 43 00
03


601 589 02 40 00
03

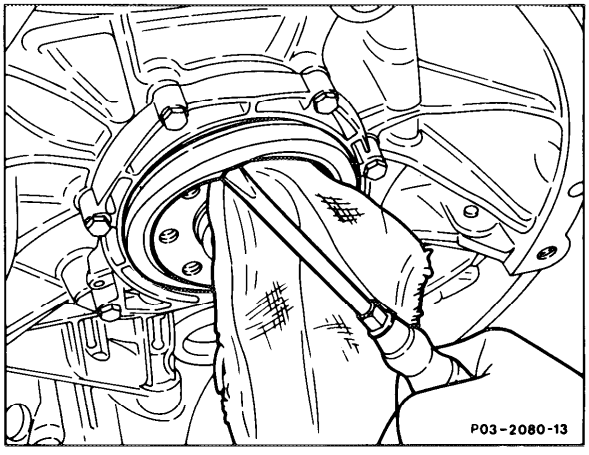

001 589 66 21 00
00

Renewal

1 Remove flywheel or flywheel and driven plate (03-410).

2 Press crankshaft radial seal out of end cover with screwdriver.

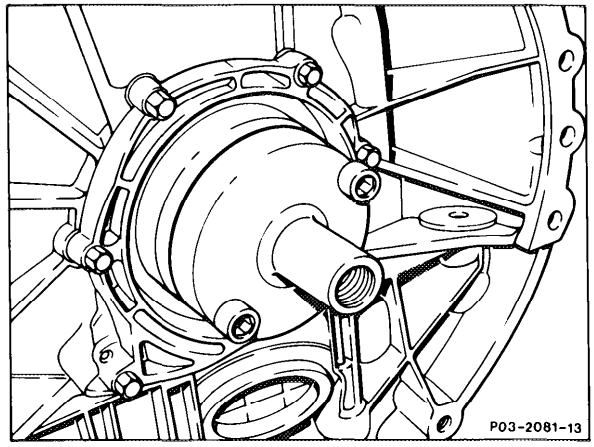
Do not damage crankshaft flange or end cover. Cover crankshaft flange with rag.



3 Check running surface for crankshaft radial seal on crankshaft flange for damage.

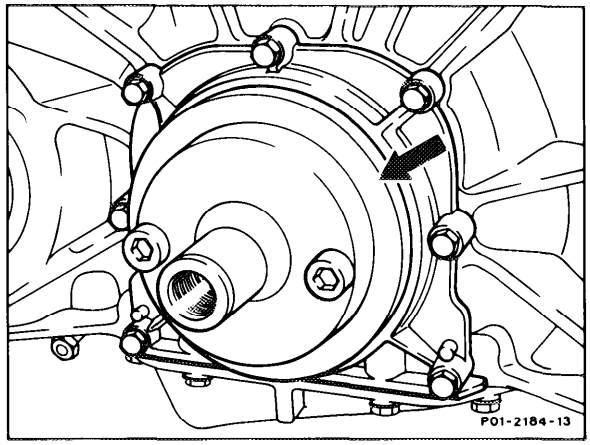
4 Clean mounting hole for crankshaft radial seal, deburr, if required.

5 Bolt inner part of installation tool 601 589 03 43 00 onto crankshaft flange.



6 Coat sealing lip of crankshaft radial seal and opposite running surface lightly with oil, do not use grease.

7 Slide crankshaft radial seal (arrow) over inner part of installation tool 601 589 03 43 00.

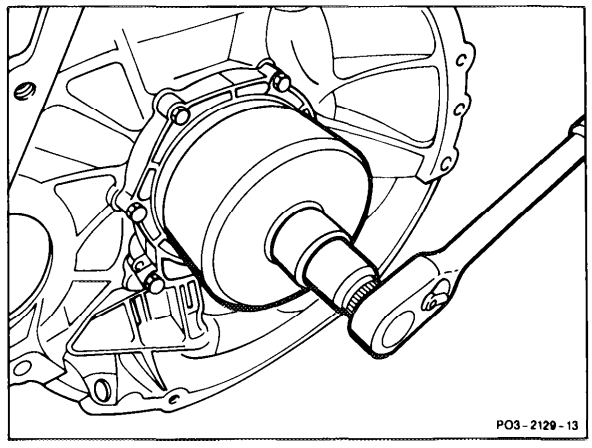


8 Press crankshaft radial seal against stop in end cover with outer part of installation tool 601 589 03 43 00.

Note
Assure that crankshaft radial seal is properly seated.

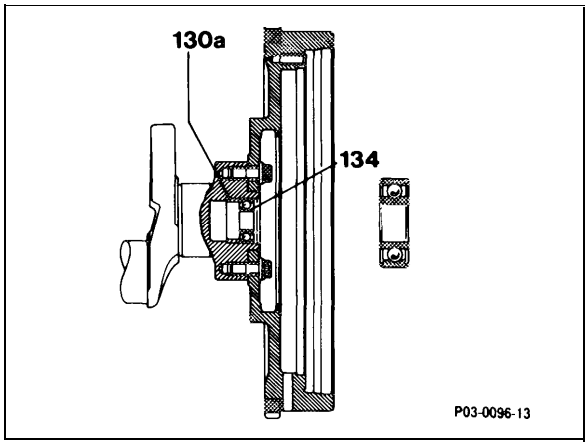
9 Install flywheel or flywheel and driven plate (03-410).

10 Check for leakage with engine running.



Note

For reasons of standardization the same radial ball bearing (134) as in engine 102 is installed. The ball bearing is sealed on both sides with Viton cover discs and cemented into the crankshaft.



130 a Spacer ring

Replacement parts

Designation	Part No.
Spacer ring	102 031 02 51
Locking ring	102 031 01 33
Ball bearing	115 980 01 15

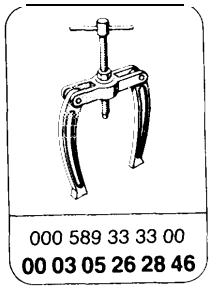
Engines 602, 603 from start of production.

For repair these parts can also be installed in engines produced earlier.

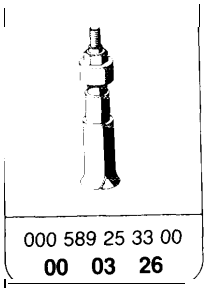
Cement

Loctite 241	002 989 94 71

Special tools



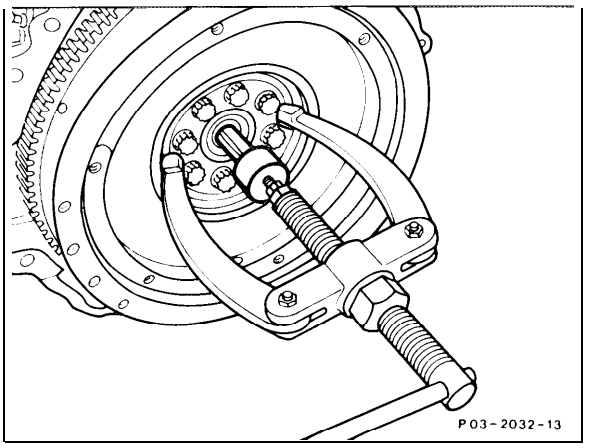
000 589 33 33 00
00 03 05 26 28 46



000 589 25 33 00
00 03 26

Removal, installation

1 Pull radial ball bearing out of crankshaft together with locking ring, use internal puller 000 589 25 33 00 and countersupport 000 589 33 33 00.

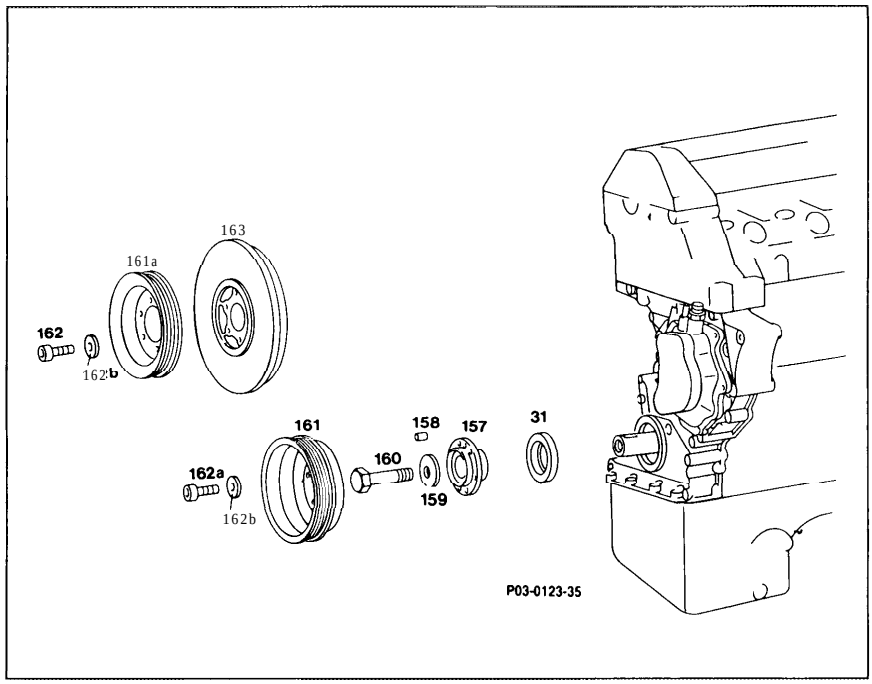


Installation note
Knock in spacer ring flush.

Coat new ball bearing with cement 002 989 94 71 and knock into crankshaft with suitable punch on outer race.

2 Install in opposite order.

03-341 Removal and installation of crankshaft pulley and hub



Engines 602, 603:

Crankshaft pulley (161 a) and vibration damper (163) .....

remove, install, use washers (162 b) and Allen screws (162), 25 Nm. Use lock 601 589 02 40 00 (items 1, 3).

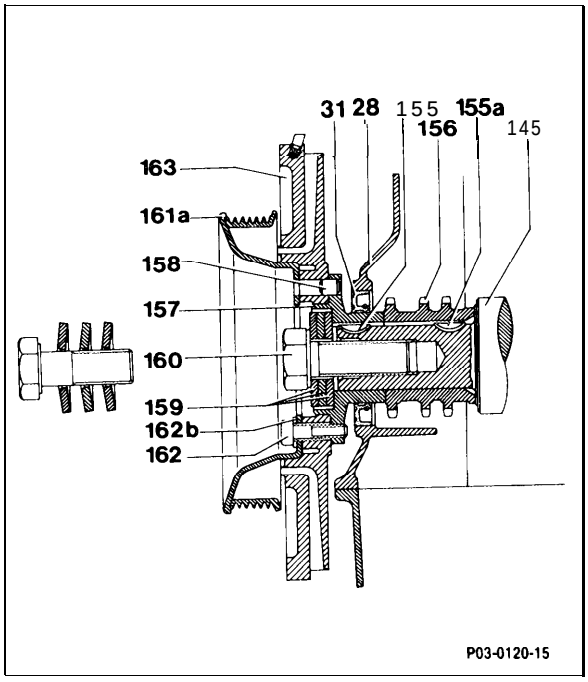
Note

The crankshaft pulley and vibration damper are centered by the cylindrical pin (158).
Do not mix up vibration dampers.

Hub(157)	remove, install, hex. head bolt (160) 320 Nm. Install Belleville washer (159) with arched side toward crankshaft pulley. Use puller 103 589 00 33 00 (items 2 - 4).
Crankshaft radial seal (31)	replace (03-324) (item 5).

Engines 602 and 603

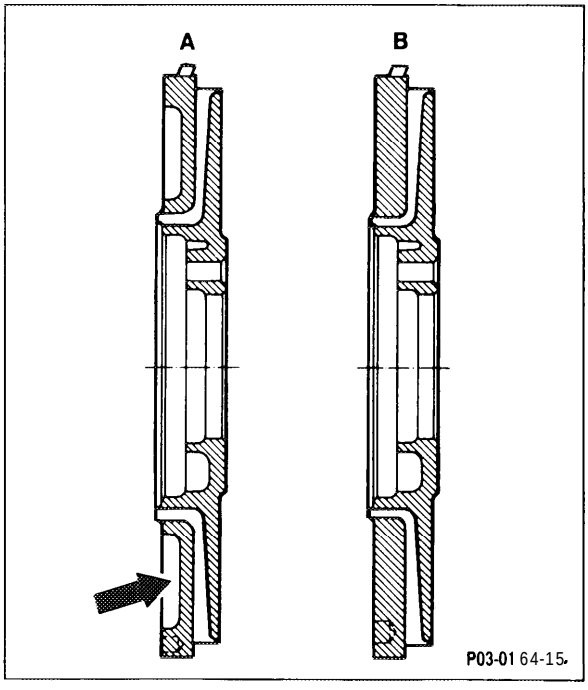
The scale and TDC pin are located in the vibration damper.



28	Timing case cover
31	Crankshaft radial seal
145	Crankshaft
155	Woodruff key
155a	Woodruff key
156	Crankshaft sprocket
157	Hub
158	Cylindrical pin 8 x 8 mm
159	Belleville washer
160	Bolt M 18 x 1.5 x 50
161a	Crankshaft pulley Dia. 152 mm engines 601, 602 Dia. 173 mm engine 603
162	Allen bolt M 8 x 28
162b	Washer B 8

Engine 602

The vibration damper on engine 602 has a 35 mm wide machined recess (arrow) on the front and are therefore lighter.



A Vibration damper, engine 602
B Vibration damper, engine 603

Engine 602.96

The vibration damper for engine 602.96 is a two-mass vibration damper. The diameter (D) was increased by 9 mm for a total of 228 mm (naturally aspirated engines, single-mass vibration damper 219 mm).

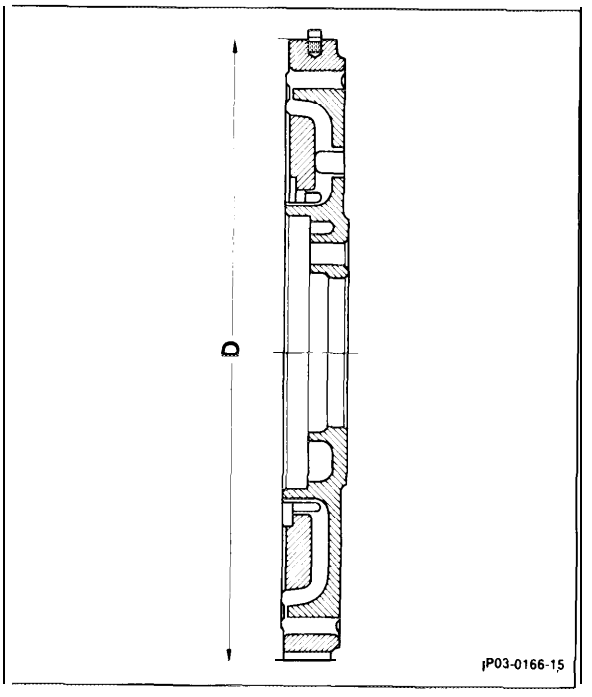
Caution!

These vibration dampers cannot be installed on engine 602.91.

Engine 603.96

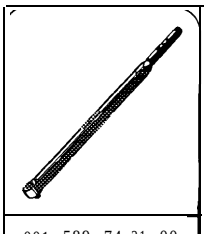
The vibration damper of engine 603.96 is a single-mass vibration damper and identical with that of the naturally aspirated engine except for the resonant frequency. Do not interchange.

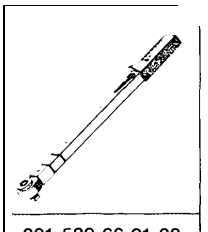
Engine 603.96 Color: grey



Tightening torques	Nm
Allen bolts on pulley	25
Crankshaft flange bolt	320

Special tools


001 589 74 21 00
00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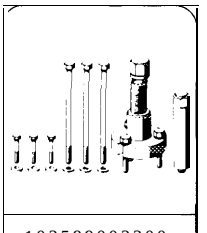
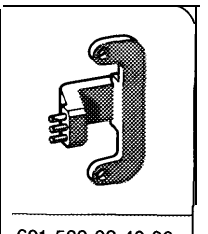
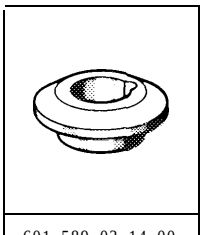

103589003300
03


601 589 02 40 00
03


601 589 03 14 00
03

Commercially available tool

Adapter 3/4" square socket to 1/2" square head	e.g.	I-lazet , D-5630 Remscheid Order No. 1058 R-1

Engines 602 and 603

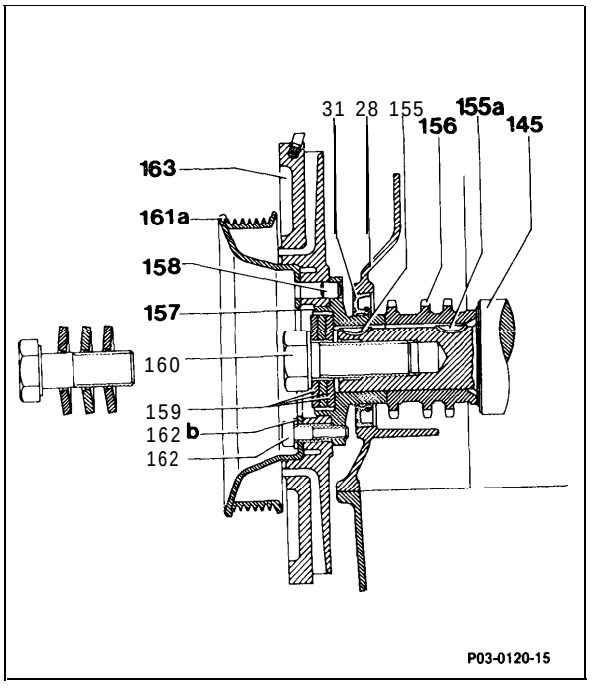
3 Unbolt crankshaft pulley (161a) and vibration damper (163) and remove.
Screw out hex. head bolt (160).

Installation note

Install Belleville washers (159) with arch toward crankshaft pulley (161 a). The crankshaft pulley (161 a) and vibration damper (163) are centered with the cylindrical pin (158).
Do interchange vibration damper (163).

Tightening torques

Hex. head bolt (160)	320 Nm,
Allen bolts (162)	25 Nm.

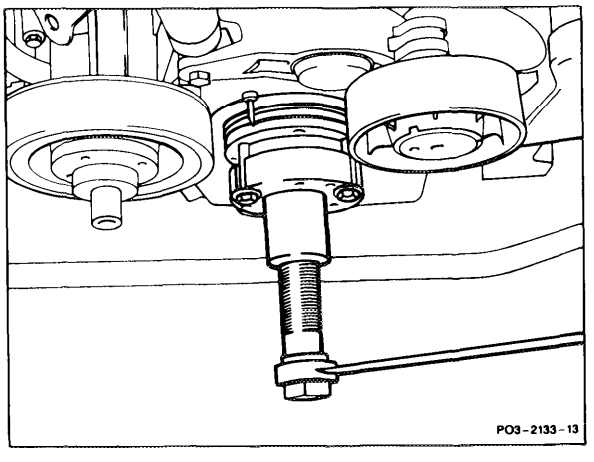


28 Timing case cover
31 Crankshaft radial seal
145 Crankshaft
155 Woodruff key
155a Woodruff key
156 Crankshaft sprocket
157 Hub
158 Cylindrical pin 8 x 8 mm
159 Belleville washers
160 Bolt M 18 x 1.5 x 50
161a Crankshaft pulley
Dia. 152 mm engines 601, 602
Dia. 173 mm engine 603
162 Allen screw M 8 x 28
162b Washer B 8

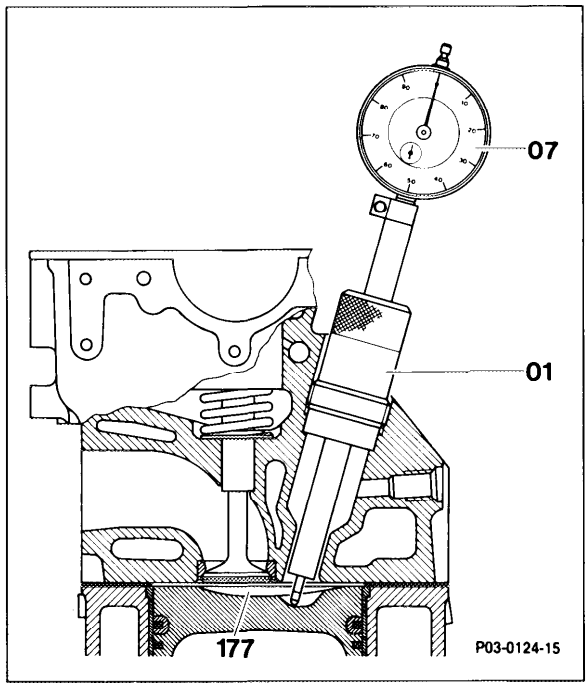
4 Pull hub off of crankshaft journal with puller 103 589 00 33 00.

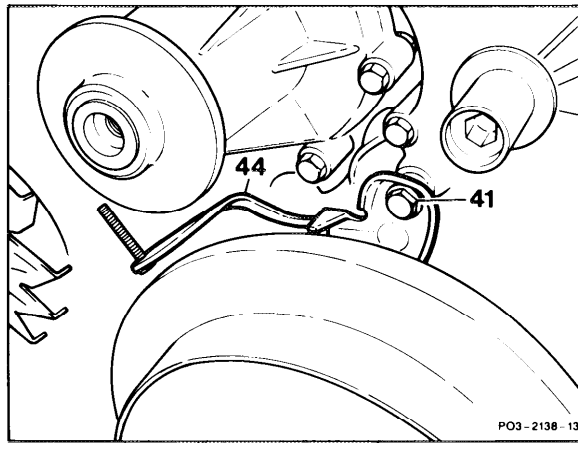
5 Replace crankshaft radial seal (03-324).

6 Install in opposite order.



03-345 Checking and correcting adjustment of TDC sensor



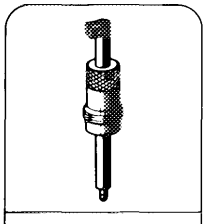


Holder for TDC sensor, engines 602 and 603 from start of production

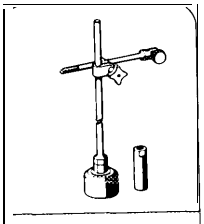
Cylinder 1 . . . . . turn to approx. 10° BTDC, ignition stroke (item 1).

Gauge (01)	boltinto preignition chamber bore and set dial gauge (07) on gauge to 5 mm pretension (item 2).
	Note If cylinder head is removed, position gauge pin of dial gauge directly on piston crown (177). Use dial gauge holder 363 589 02 21 00.
Engine	turn in running direction until dial gauge pointer stops moving (TDC position), set dial gauge scale to zero (item 3).
Engine	turn until dial gauge moves back 3.22 mm on engines 602 and 603 or until dial gauge moves back 3.65 mm on engines 601.921, 603.97 (item 4).
	Note Corresponds to crankshaft position of 20° ATDC.
Holder for TDC sensor (42) or (44)	install locating device 603 589 01 21 00 (item 5).
	Note The pin on the crankshaft pulley or on the vibration damper must catch in the groove on the locating device, if not, correct position of holder.
Holder for TDC sensor (42) or (44)	correct by loosening bolt (41), move holder for TDC sensor until pin on crankshaft pulley or vibration damper catches in locating device 603 589 01 21 00 and tighten bolt (41) (items 6 - 8).

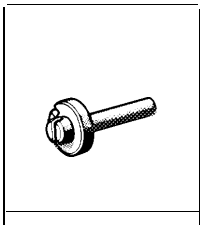
Special tools



601 589 07 21 00
03



363 589 02 21 00
00



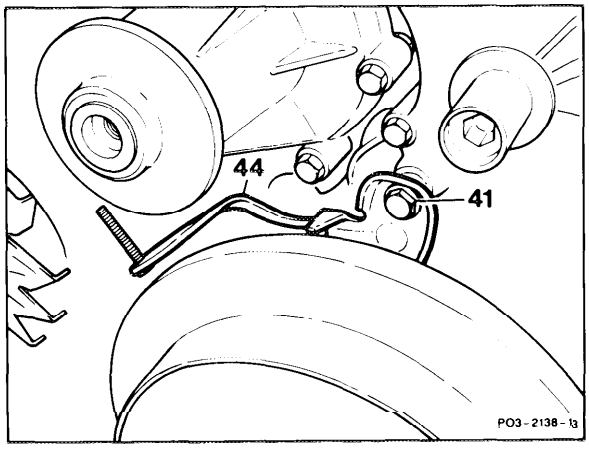
603 589 01 21 00
03

Commercially available tool

Dial gauge A 1 DIN 878	e.g.	Mahr, D-7300 Esslingen Order No. 810

Testing

Note
The holder for the TDC sensor is fastened to the timing case cover.



44 Holder TDC sensor, engines 602 and 603 from start of production

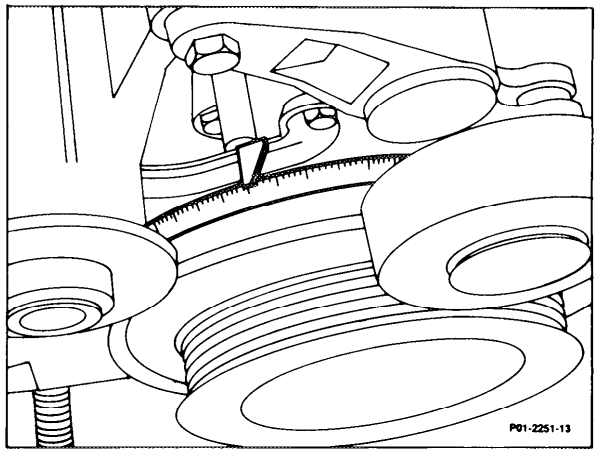
Check adjustment of holder and correct, if required:

a) When holder is replaced.

b) When crankshaft and hub, vibration damper and crankshaft pulley are replaced.

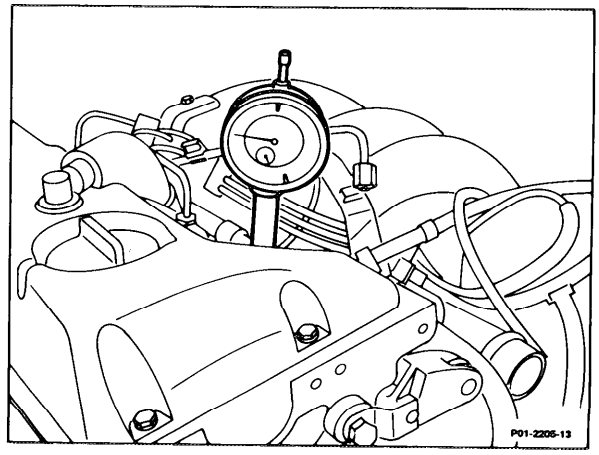
c) When timing case cover is removed, installed or replaced.

1 Position piston in cylinder 1 to approx. 10° BTDC, ignition stroke.

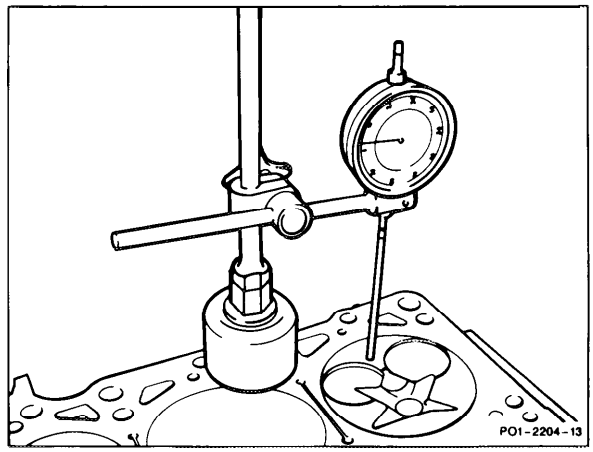


Holder for TDC sensor, engines 602 and 603 from start of production

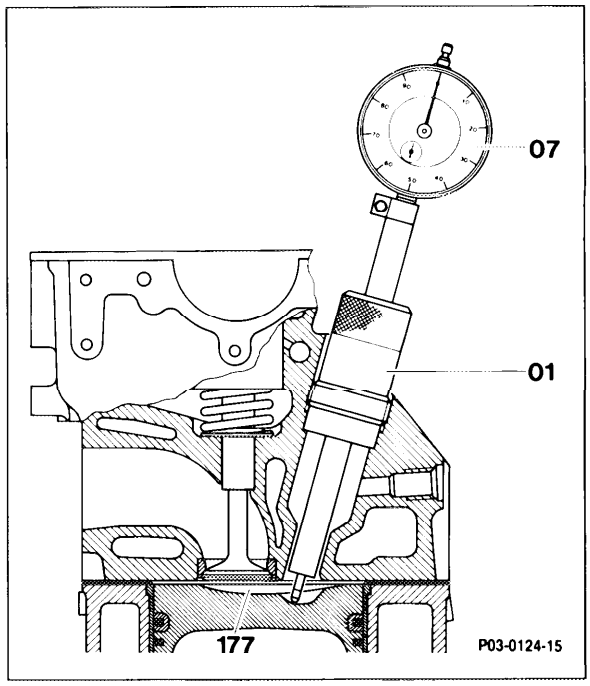
2 Bolt gauge 601 589 07 21 00 up to precombustion chamber bore and attach dial gauge to gauge with 5 mm pretension (small pointer on dial gauge).



If the cylinder head is removed, the measuring pin on the dial gauge can be positioned directly on the piston crown. Set dial gauge holder 363 589 02 21 00 on crankcase mating surface.



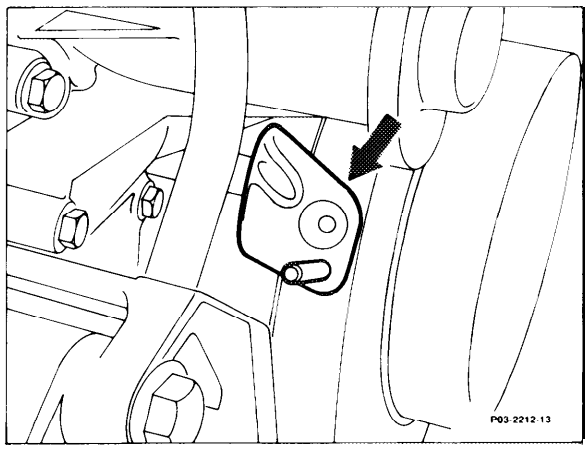
3 Turn crankshaft slowly in normal direction of rotation until large pointer on dial gauge (07) stops (TDC position). Turn dial gauge scale until large pointer points to zero.



01 Gauge
177 Piston crown

4 Turn crankshaft in normal direction of rotation slowly until the gauge moves back 3.22 mm on engines 602 and 603 or 3.65 mm on engine 603.97.

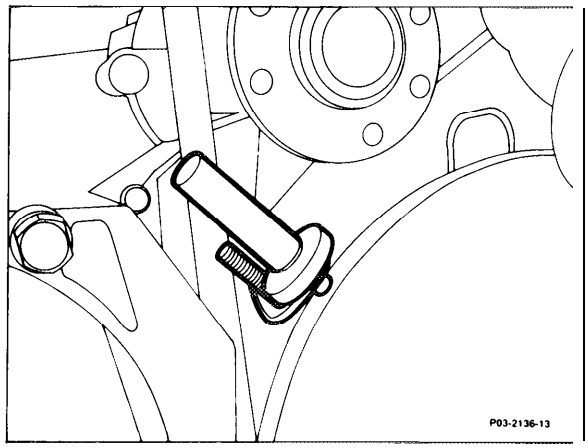
Note
After the dial gauge has moved back (crankshaft position 20° ATDC) the pin in the crankshaft pulley or in the vibration damper should be located exactly below the TDC sensor (arrow).



5 Position locating device 603 589 01 21 00 in holder for TDC sensor.

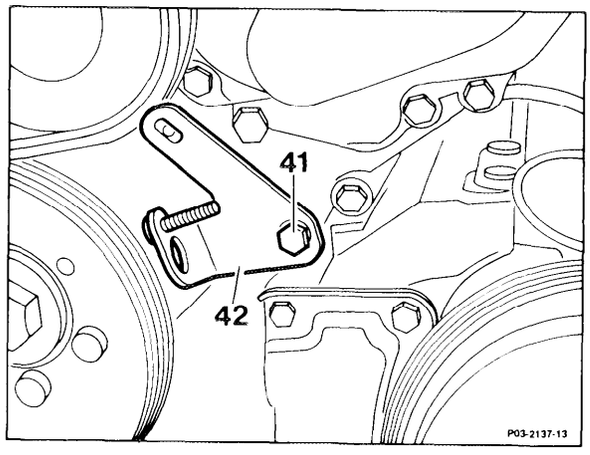
The pin on the crankshaft pulley or on the vibration damper must catch in the groove in the locating device.

If the pin on the crankshaft pulley or on the vibration damper does not catch, correct position of holder for TDC sensor.



Correcting

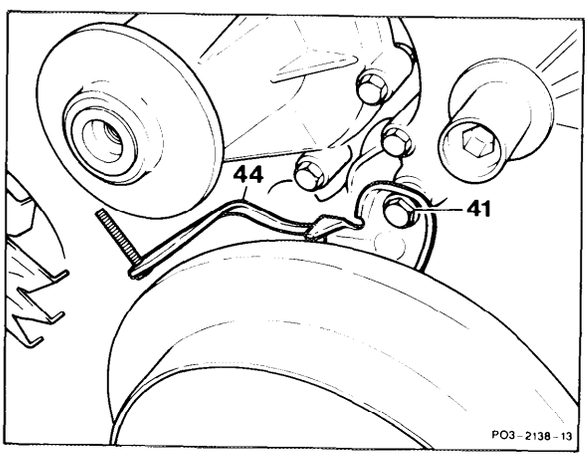
6 Loosen holder (42 or 44) with screw (41) and move until pin on crankshaft pulley or on vibration damper catches in the groove in the locating device 603 589 01 21 00.



42 Holder for TDC sensor, engine 601.921

7 Screw holder for TDC sensor down tight.

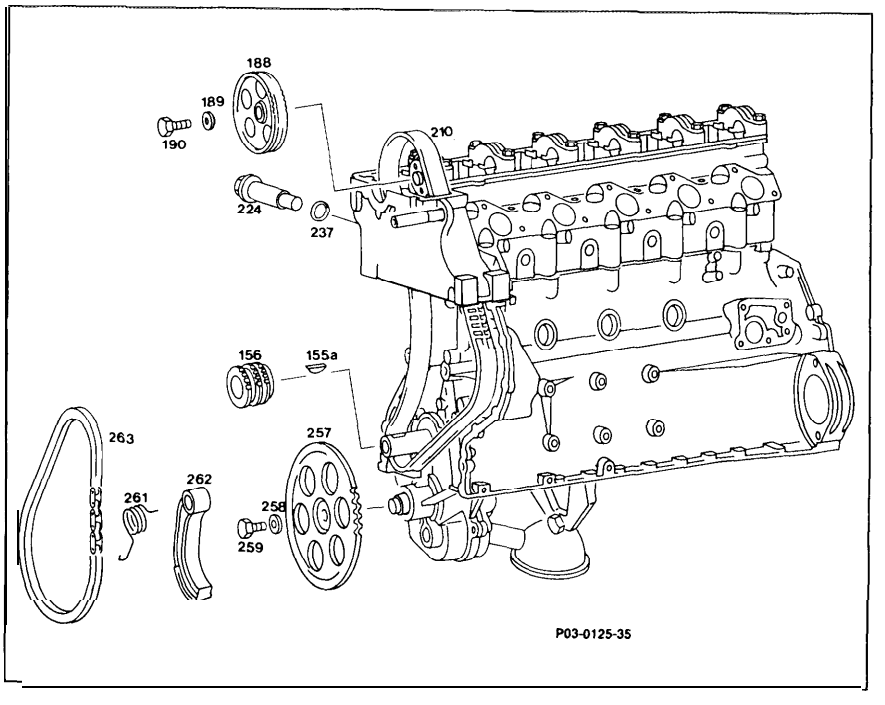
8 Remove dial gauge and gauge 601 589 07 21 00 and locating device 603 589 01 21 00.



44 Holder for TDC sensor engines 602, 603 from start of production

03-350 Removal and installation of crankshaft sprocket

Preliminary jobs:
Timing case cover removed (01-210).
Oil pan removed (01-310).
Vehicles with level control: Drive for oil pump removed (05-437).



Tensioning bracket (262)	remove together with torsion spring (261), install (items 1, 17).
Oil pump sprocket (257)	unbolt hex. head bolt (259) and remove together with washer (258) (item 2).
Chain for oil pump drive (263)	remove (item 3).
Chain tensioner (224)	remove, install. Replace sealing ring (237) (05-310) (items 4, 13).
Camshaft sprocket (188)	mark in relation to timing chain (210), remove retaining bolt (190) together with washer (189) and remove camshaft sprocket (items 6 - 8).
	Note Observe differences in bolts.
Crankshaft sprocket (156)	mark in relation to timing chain (210) (item 5).

Crankshaft sprocket (156)	pull off with puller 601 589 07 33 00 and check retaining wedge (155a), replace, if required (items 9 - 10).
Crankshaft sprocket (156)	replace, transfer color code and knock onto crankshaft with installation punch 116 589 07 15 00 while paying attention to retaining wedge (155a) (items 11 - 12).
Camshaft sprocket (188)	position on mark, install timing chain and tighten. Remove hex. head bolts (190) and washers (189). Hex. head bolt 65 Nm, 12-point bolt 25 Nm/90° rotation angle (item 13).
Crankshaft	continue to turn and check adjustment markings at TDC position (item 15).
Oil pump sprocket (257)	install with chain for oil pump drive (263) and tighten hex. head bolt (259), 25 Nm (item 16).

Note

Install chain sprocket so that arch points toward oil pump.

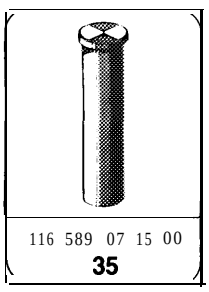
Engine	allow to run and check for leakage (item 18).

Bolt for camshaft sprocket

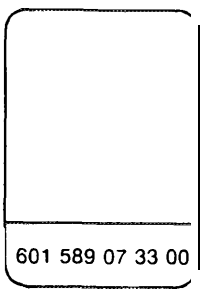
Starting 11/88 the bolt for mounting the camshaft sprocket was changed from an M 10 bolt to an M 11 stretch bolt on engines 602.91/96; 603.91196 and 603.970 (see 05-220).

Tightening torques and rotation angles	Nm	
Hex. head bolt for camshaft sprocket	65	
12-point bolt for camshaft sprocket	25	90”
Hex. head bolt for oil pump sprocket	25	

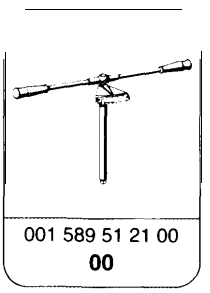
Special tools



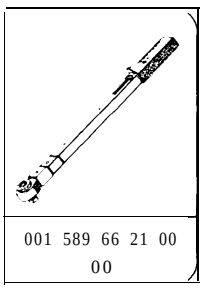
116 589 07 15 00
35



601 589 07 33 00



001 589 51 21 00
00



001 589 66 21 00
00

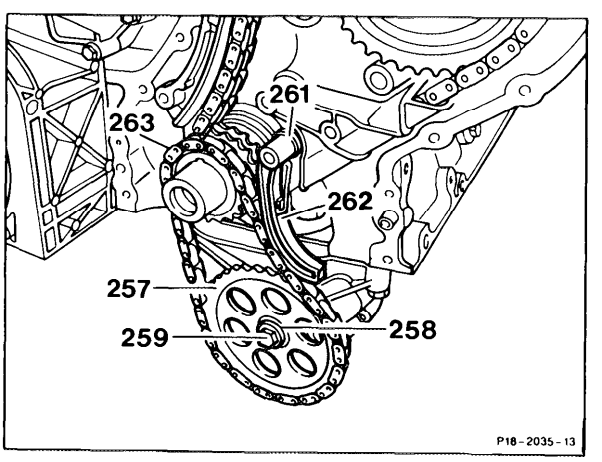
Removal

1 Remove clamping bracket (262) and torsion spring (261).

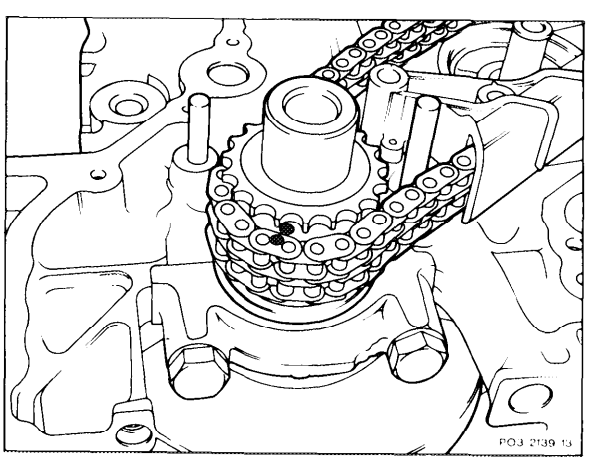
2 Remove hex. head bolt (259) with washer (258) and remove oil pump sprocket (257).

3 Remove chain for oil pump drive (263).

4 Remove chain tensioner (05-310).



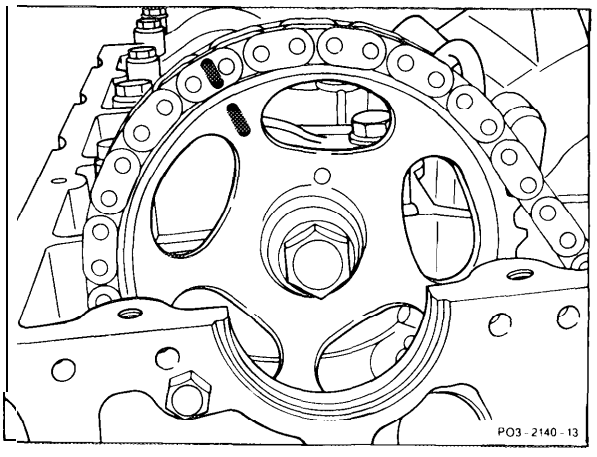
5 Mark position of timing chain and crankshaft sprocket in relation to one another.



6 Mark position of timing chain and camshaft sprocket in relation to one another.

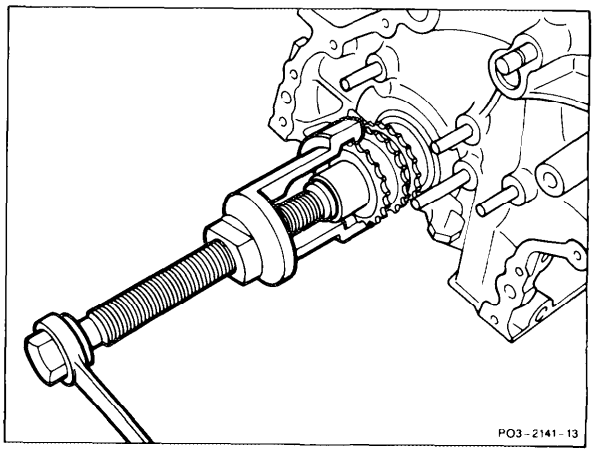
7 unbolt hex head bolt and remove with washer.

8 Remove camshaft sprocket and allow timing chain to sag.



9 Pull off crankshaft sprocket with puller 601 589 07 33 00.

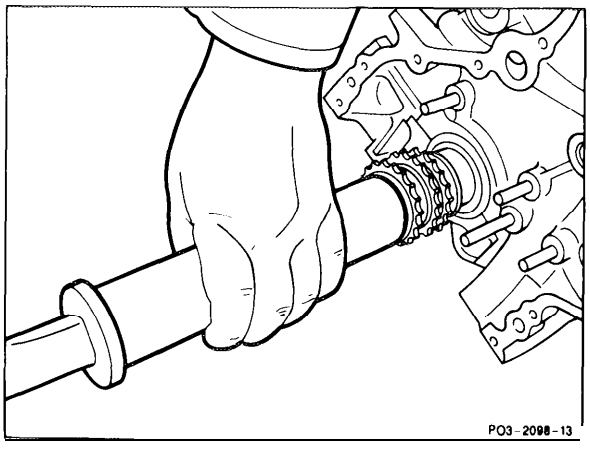
10 Check condition of retaining wedge in crankshaft, replace, if required.



Installation

11 Transfer color code from old crankshaft sprocket to new crankshaft sprocket.

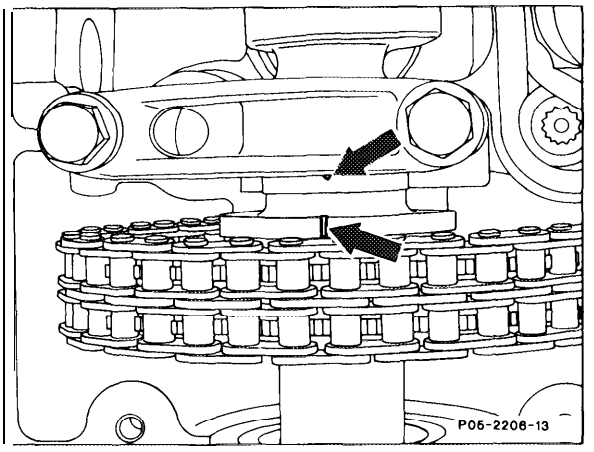
12 Knock crankshaft sprocket onto crankshaft with installation punch 116 589 07 15 00. Pay attention to retaining wedge.



13 Install camshaft sprocket and timing chain making note of marking and tighten.

Tightening torque and rotation angle

Wex. head bolt	65 Nm,
12-point bolt	25 Nm, 90°.



14 Install chain tensioner and replace sealing ring (05-3 10).

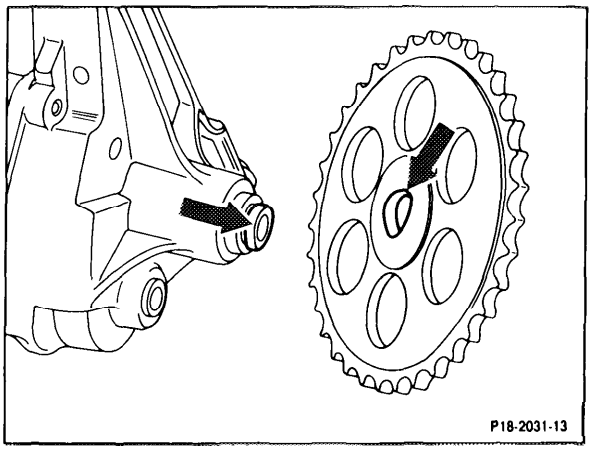
15 Continue to turn crankshaft and check adjustment marking at TDC (arrows).

16 Install chain for oil pump drive together with oil pump chain sprocket and tighten.

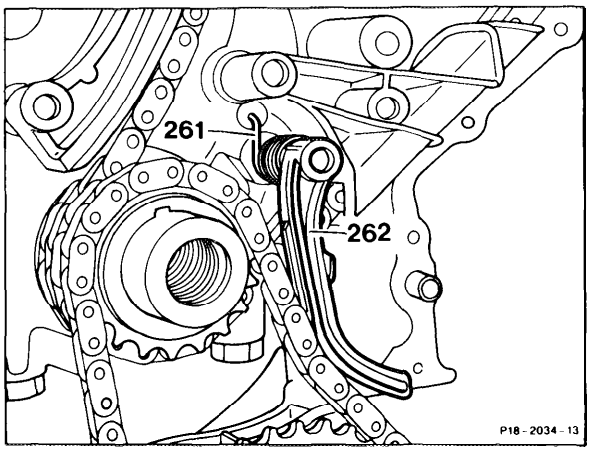
Note

Install oil pump sprocket so that arch points toward oil pump (arrows).

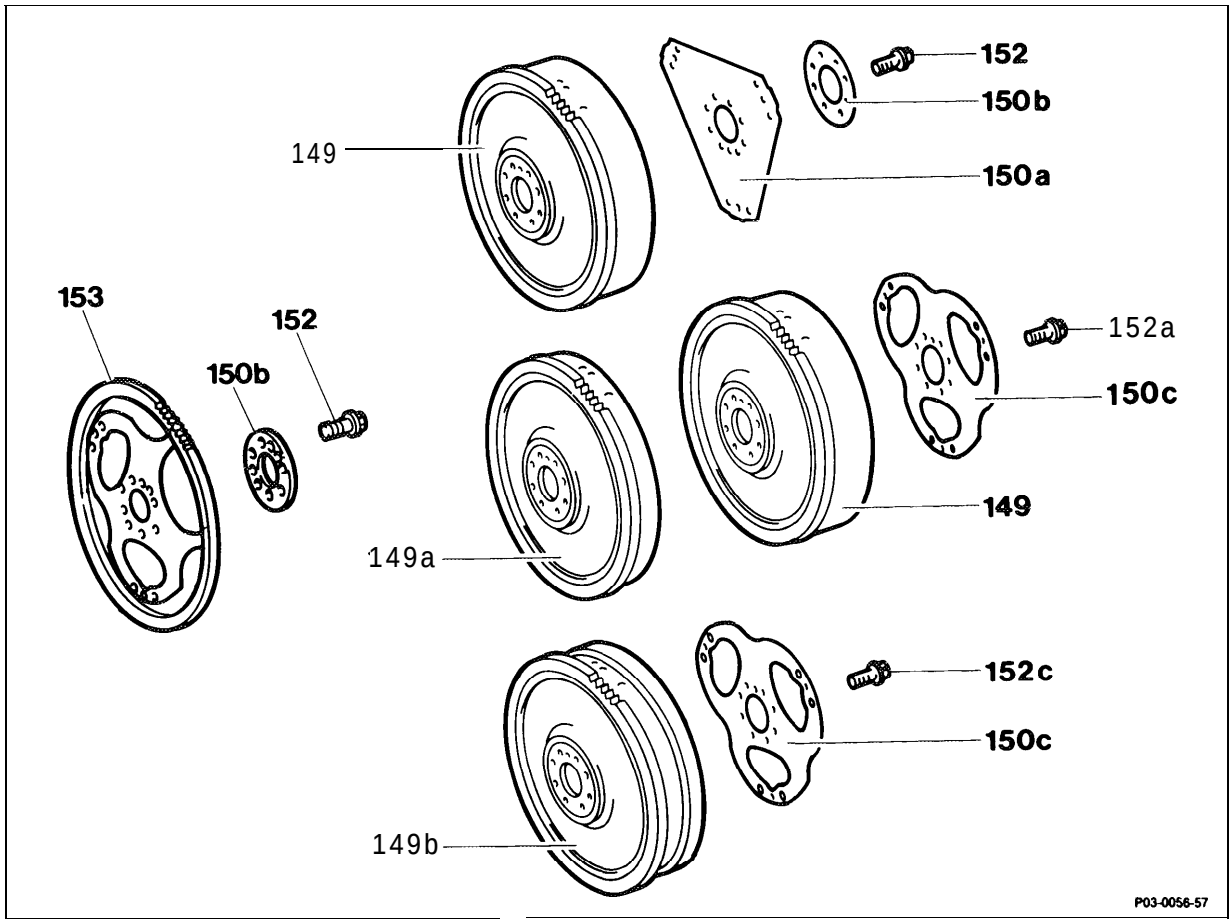
Tightening torque 25 Nm.



17 Attach clamping bracket (262) and torsion spring (261).



03-410 Removal and installation of flywheel and driven plate



Flywheel (149, 149a, 149b)	unbolt, reinstall. Position lock 601 589 02 40 00 in flywheel ring gear and remove flywheel together with driven plate (150a, 150c) and spacer disc (150b) (items 1, 2).
Driven plate (153) engine 603.970	unbolt, reinstall. Position lock 601 589 02 40 00 in teeth on driven plate and remove driven plate and spacer disc (150b) (items 1, 2).

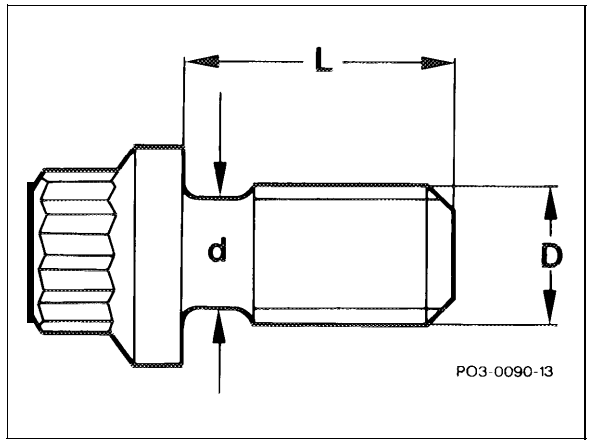
Stretch bolts (152, 152a) .....

check, max. length, 1 st version (152a) 26.5 mm, 2nd version (152) 22.5 mm, necked down shank diameter min. 8 mm, replace stretch bolts if required (item 2).
Initial torque 35 Nm,
rotation angle 90 – 100".

Stretch bolts (152c) on two-mass flywheel (149b) engine 602.91, ...

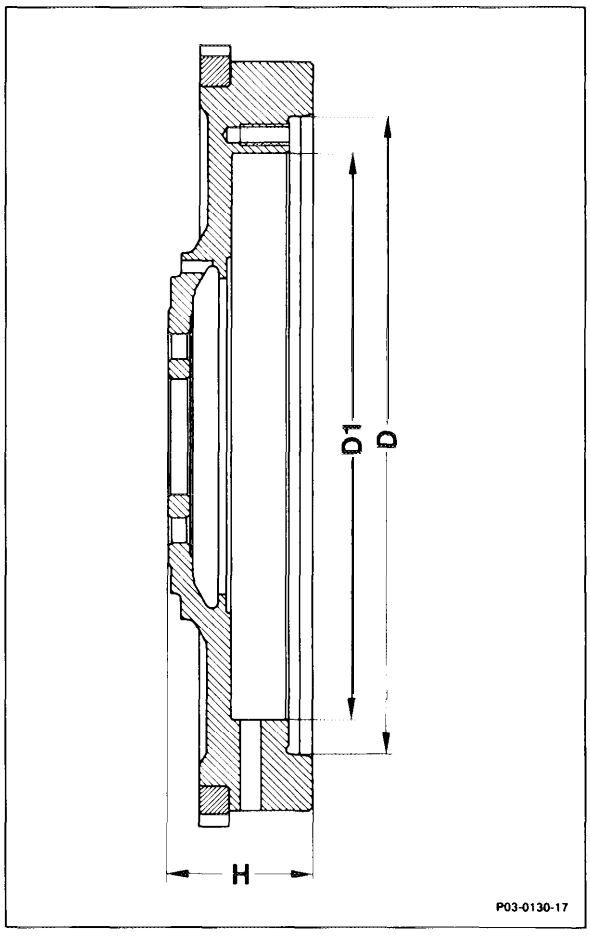
check, max. length 57.2 mm, necked down shank diameter min. 8.1 mm, replace stretch bolts if required (item 2).
Initial torque 40 Nm,
rotation angle 90 – 100".

Stretch bolts		152	152a	152c
		manual and automatic transmission Driven plate 2nd version	automatic transmission Driven plate 1 st version	manual transmission, two-mass flywheel
Part number		102 032 00 71	601 032 01 71	103 032 00 71
Thread D		M 10 × 1	M 10 × 1	M 10 × 1
Necked down shank dia. d	New state	8,5 – 0,2	8,5 – 0,2	8,5 – 0,2
	Min. dia.	8,0	8,0	8,1
Length L	New state	22 ± 0,2	26 ± 0,2	57 ± 0,2
	Max. length	22,5	26,5	–



Flywheels for manual transmissions

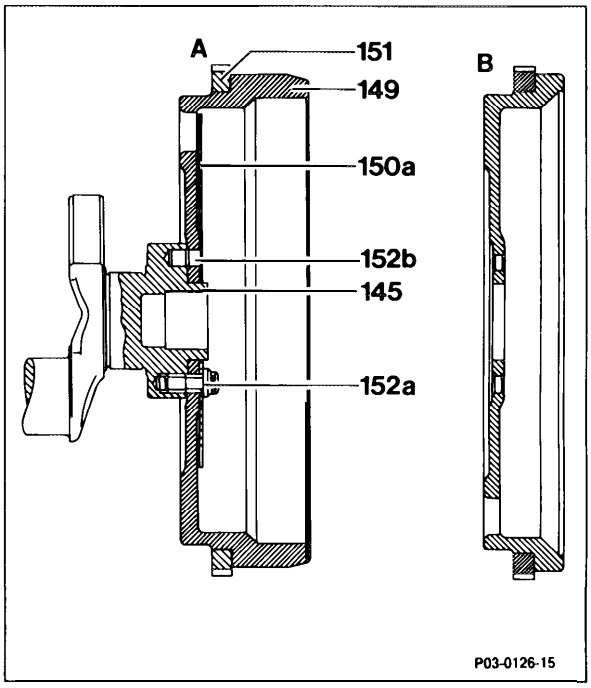
Engine 602



D	252.94–252,98	mm
DI	223.00-223.07	mm
H	57	mm

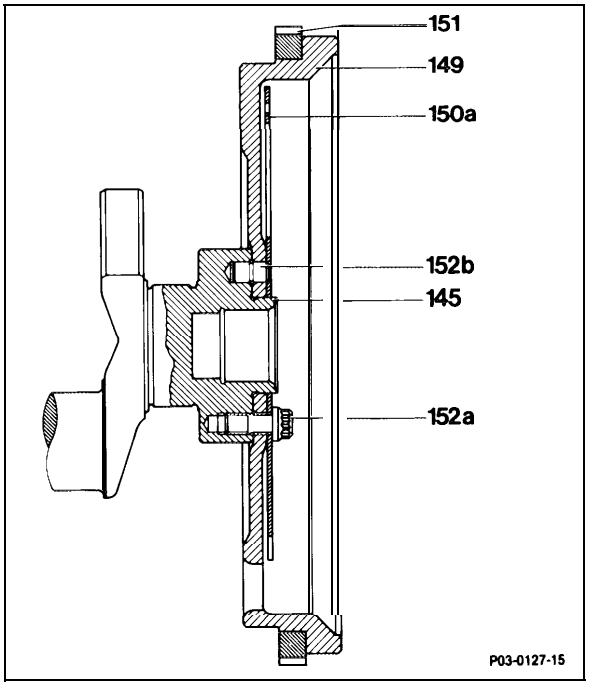
Engine 602.96

Engine 602.96 has **a** lighter flywheel than engine 602.91 with automatic transmission.



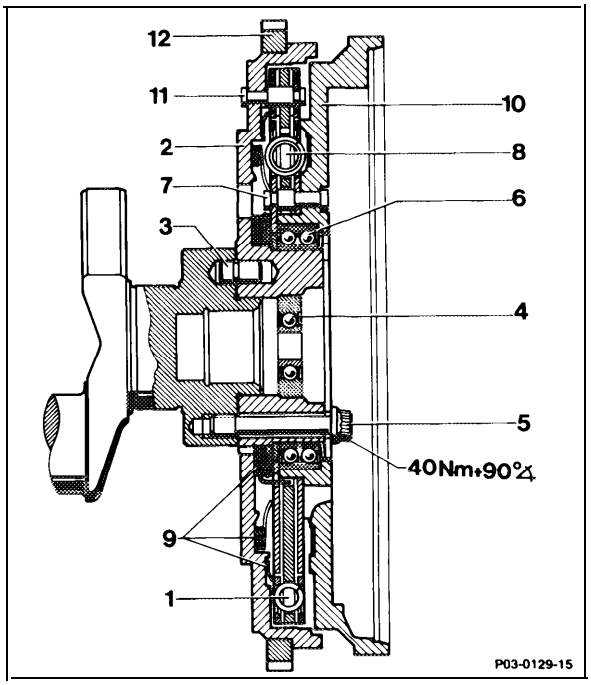
A	Flywheel, engine 602.91
B	Flywheel, engine 602.96
145	Crankshaft
149	Flywheel
150a	Driven plate
151	Ring gear
152a	Stretch bolt
152b	Cylindrical pm

Engine 603.96



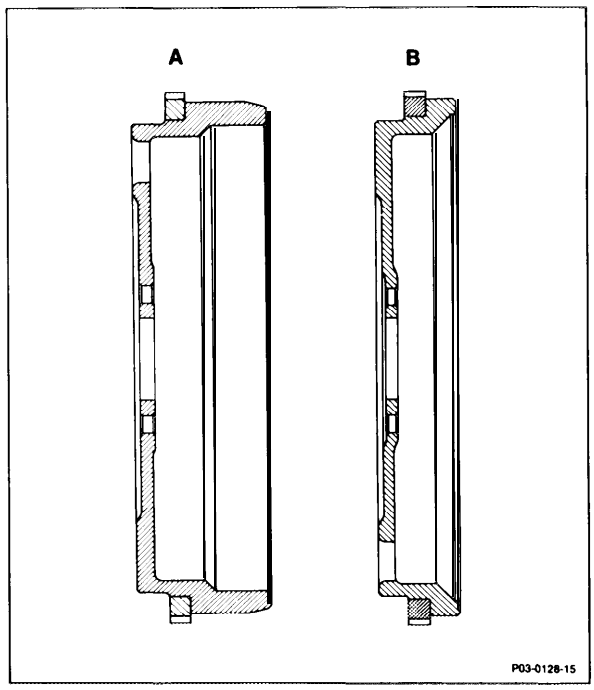
145	Crankshaft
149	Flywheel
150a	Driven plate
151	Ring gear
152a	Stretch bolt
152b	Cylindrical pm

Two-mass flywheels with manual transmissions, engine 602.91 starting 09/88.



1 Stop damper
2 Primary flywheel weight
3 Fitted pin
4 Radial ball bearing
5 Stretch bolt M 10 x 1 x 57
6 Self-aligning bearing
7 Spacer bolt
8 Torsion damper
9 Friction device
10 Secondary flywheel weight
11 Spacer bolt
12 Ring gear

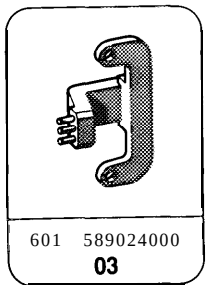
Flywheels with automatic transmissions

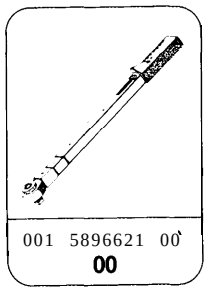


A Flywheel, engine 602
B Flywheel, engine 603

Tightening torques and rotation angles	Nm	
Stretch bolts for flywheel	35	90 – 100”
Stretch bolts for two-mass flywheel	40	90 – 100”

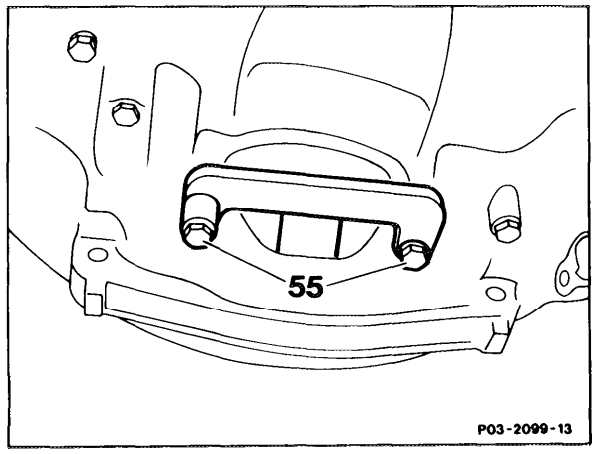
Special tools





Removal, installation

1 Remove hex. head bolts (55) and insert lock 601 589 02 40 00 into ring gear on flywheel and tighten with hex. head bolts (55).

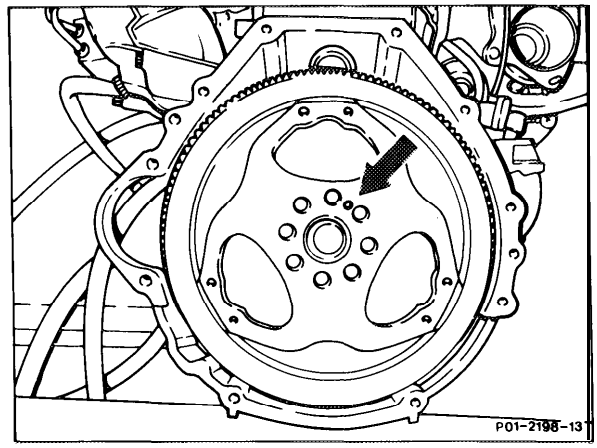


Installation note
Flywheels do not require balancing.

Flywheels are not interchangeable.

Engines 602, 603

Screw out stretch bolts and remove flywheel and driven plate.



Installation note

The cylindrical pin (arrow) centers the flywheel, driven plate and spacer disc.

Check stretch bolts, max. length 22.5 mm, necked down shank dia. min. **8** mm, renew stretch bolts if required.

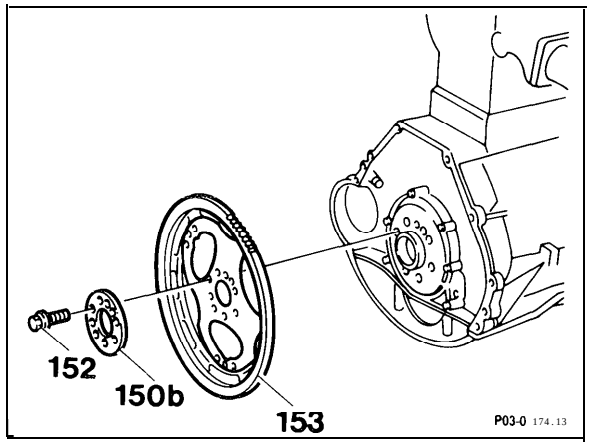
Tightening torque and rotation angle

Initial torque 35 Nm,

rotation angle 90 – 100".

Driven plate (engine 603.97)

Screw out stretch bolts (152), remove spacer disc (150b) and driven plate (153).



Installation note

Check stretch bolts, max. length 22.5 mm, necked down shank dia. min. 8 mm, replace stretch bolts if required.

Tightening torque and rotation angle

Initial torque 35 Nm,

rotation angle 90 – 100".

Two-mass flywheel with manual transmission, engine 602.91

Remove stretch bolts and remove two-mass flywheel.

Installation note

Check stretch bolts, max. length 57.2 mm, necked down shank dia. min. 8.1 mm, replace stretch bolts if required.

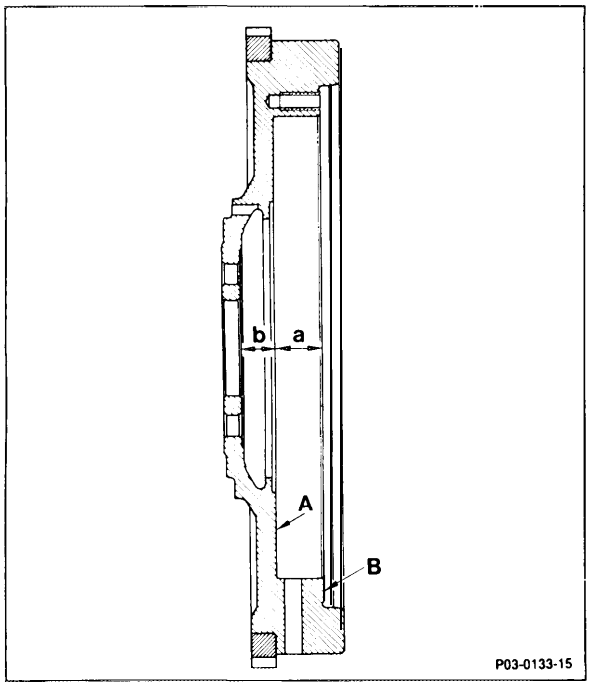
Tightening torque and rotation angle

Initial torque	40 Nm,
rotation angle	90-100°.

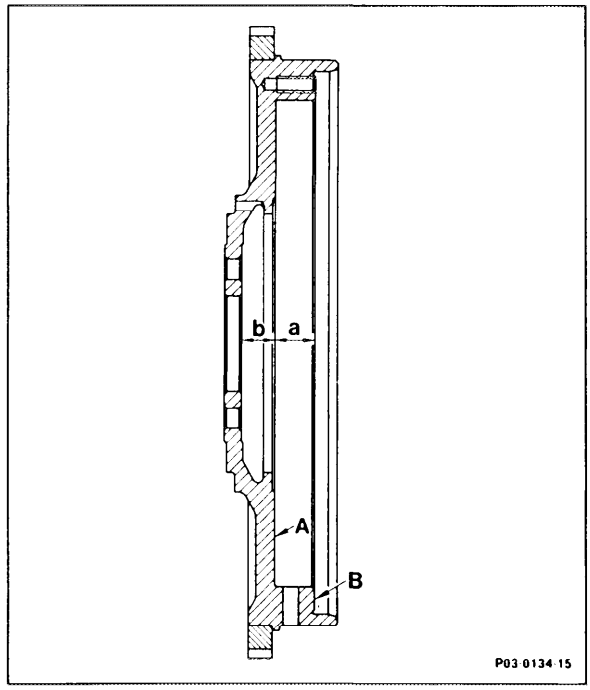
3 Install in opposite order.

03420 Refinishing flywheel

Preliminary lobs:
Flywheel and driven plate removed (03-410).



Engine 602



Engine 603 (except for 603.97)

Dimension (b) . . . . . measure, max. 17 mm, min. 15.6 mm.
If material removal causes dimension (a) to exceed max. causing dimension (b) to be less than 15.6 mm, replace flywheel.

Dimension (a) . . . . . measure, engine 602: 22.5 mm, engine 603: 19.4 mm. Maximum material removal 1 mm, if material removal is greater than 1 mm, replace flywheel.

Caution!
If the clutch surface (A) is refinished, the mounting surface (B) must be refinished by the same amount so that distance (a) is maintained.

Flywheel . . . . . refinish

Caution!
The two-mass flywheel cannot be refinished.
Clamp flywheel in lathe so that permissible deviation from flat = 0.05 mm is not exceeded.

Data

Engine		602	603
Distance a		22.5 ± 0.1	19.4 ± 0.1
Distance b	in new state	16.6 ± 0.4	
	for repair	up to 15.6 ± 0.4	
Permissible deviation from flat on clutch surface or clutch attachment surface		0.05 mm	

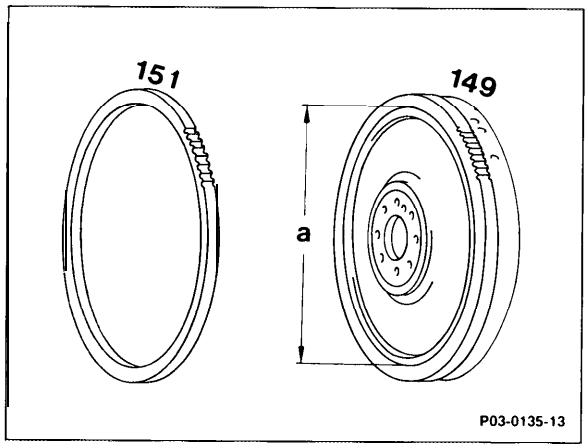
Note
Flywheels for manual transmissions with burned spots, scoring or cracks on the clutch surface should be refinished by precision turning.

If the scoremarks or cracks are greater than the maximum permissible material removal dimension, replace flywheel.

After machining the clutch surface should not have any porous spots or chatter marks.

03-430 Replacing ring gear

Preliminary jobs:
Flywheel and driven plate removed (03-410).



Flywheel (149)	check, centering flange dia. (a) for ring gear 275.00 + 0.05 mm. Clean mounting surface for ring gear on flywheel before installing ring gear.
Ring gear (151)	drill hole into old ring gear and break up with a chisel or heat quickly and then remove immediately. Heat new ring gear and install on flywheel. Temperature for shrink fit 220 °C. Lateral runout on ring gear max. 0.4 mm.

Standard accessories

Temperature measuring chalk Color No. 2815/220 (white) thermochrome	e.g.	AW Faber-Castell, D-8504 Stein bei Nurnberg

Caution!
The ring gear is hardened. For this reason do not exceed 220 °C at any point while heating with hot plate or heating furnace.

Use temperature measuring chalk in accordance with directions.

Use open flame only in exceptional cases. Apply flame to inside of ring gear only.

After replacing ring gear, it is not necessary to balance the flywheel.