11 Engine

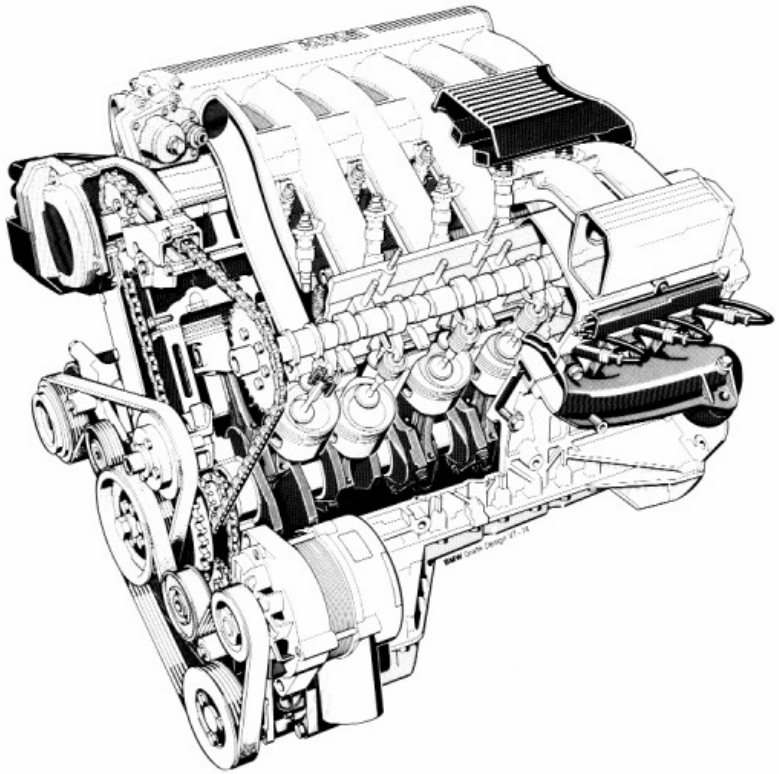
M 70

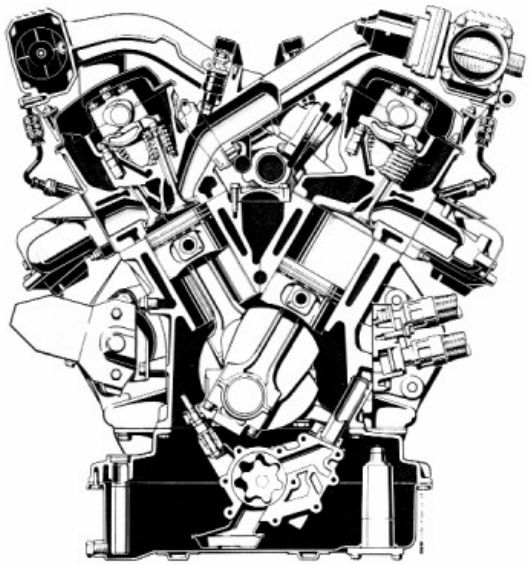
11 Engine

M 70

11-00/7.1

M 70 = V 12 cylinder
B = Gasoline
50 = Displacement (x 100)
M = Motronic





BMW 750 i – M 70 B 50 M

11-00/7.2

GENERAL INFORMATION

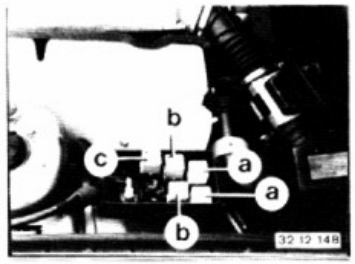
– Cylinder Arrangement:

  Cylinders 1 ... 6 are located on the right hand side of the engine as seen looking forward in the car (beginning with cylinder no. 1 at the front).

  Cylinders 7 ... 12 are located on the left hand side of the engine as seen looking forward in the car (beginning with cylinder no. 7 at the front).

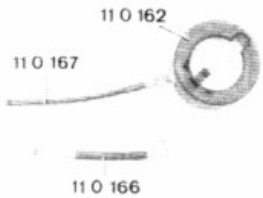
  Air collector, throttle valve necks and air cleaner with air flow sensor for the concerned banks of cylinders, however, are located on the opposite side in each case.

– Job procedures are applicable for both banks of cylinders. If special explanations are necessary, procedures will be described separately for each bank of cylinders.

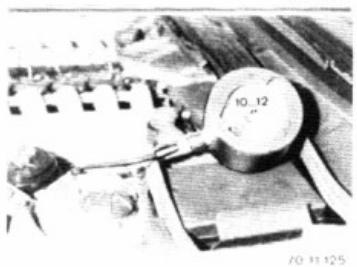


11 00 039 CHECKING COMPRESSION OF ALL CYLINDERS

Caution!
Interrupt power supply to ignition coil (disconnect terminal 1 on ignition coil).
High tension voltage – danger!
Pull off both fuel pump relays (b).



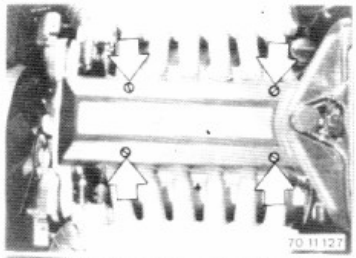
Unscrew all spark plugs (see 12 12 011).
Screw Special Tools 11 0 166 in spark plug threads by hand and connect the compression tester.



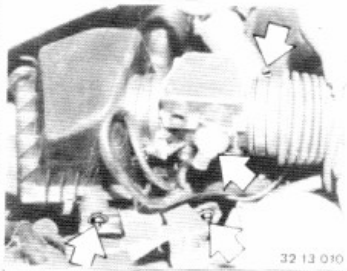
Floor the accelerator pedal and operate the starter motor so long, until compression pressure stops rising.
Value of all cylinders must not differ by more than 0.5 bar (7 psi) in comparison with each other.
Nominal value: 10 ... 12 bar (142 to 170 psi).

11 00 050 REMOVING AND INSTALLING ENGINE

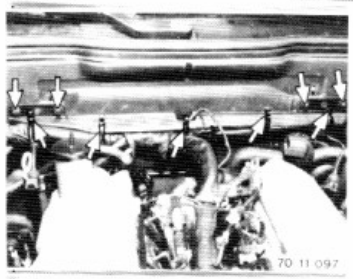
Remove transmission (see Group 24).
Remove radiator and coolant expansion tank (see Group 17).



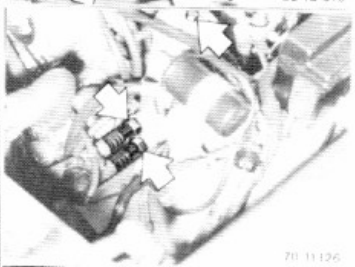
Unscrew cover.
Unscrew holder for cover on injection pipes.



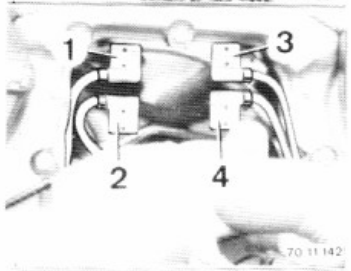
Remove both air cleaners.



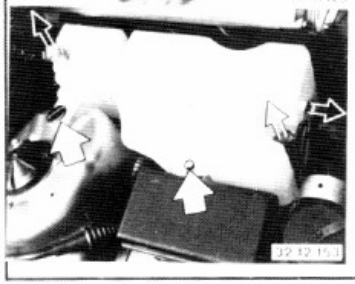
Cut through straps and take off wire harness plate.



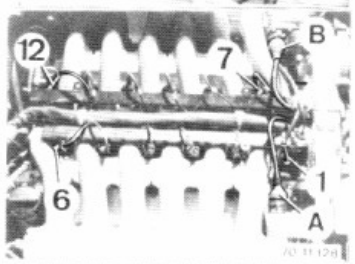
Drain oil in oil filter into oil pan by loosening the oil filter cover screw.
Disconnect pipes for oil cooler on oil filter.
Pull off plug on oil pressure switch.



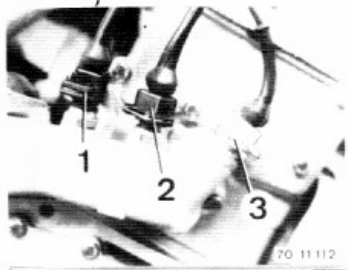
Pull off plugs (1 ... 4).
Note:
1 = pulse sender Cyl. 1 ... 6
2 = cylinder identification Cyl. 1 ... 6
3 = cylinder identification Cyl. 7 ... 12
4 = pulse sender Cyl. 7 ... 12
Plug receptacles: gray for plugs 1 and 2
black for plugs 3 and 4



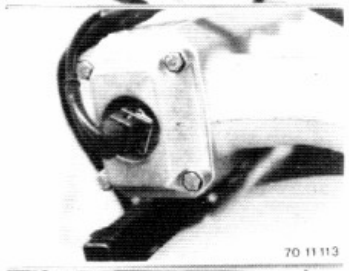
Drain washing fluid tank.
Pull off pumps and plug (level sender).
Remove tank.



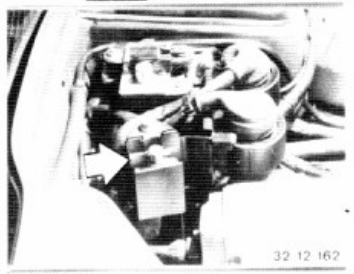
Pull off plugs (1 ... 12) on fuel injectors and plugs (A and B) on drive motors.
Unclip and lay wire harness aside.



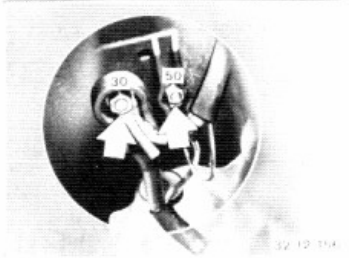
Pull off plugs (1 ... 3) on temperature sensors.



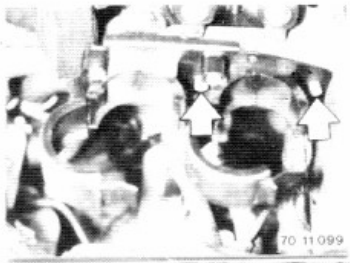
Pull off both plugs on intake air collectors.



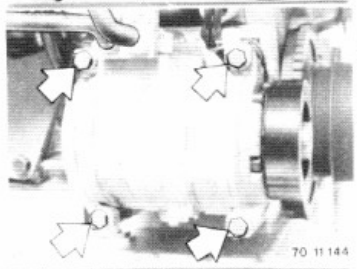
Disconnect alternator connecting lead on B + support.
Disconnect plug for alternator.



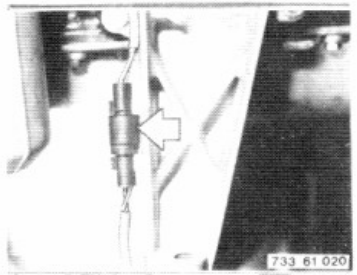
Disconnect leads for starter motor.
Pull off ignition leads on both ignition coils.



Unscrew holders for B + support and wire harness plug.

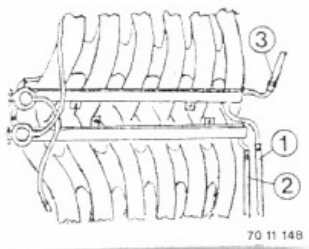


Remove drive belt for air conditioner compressor (see 11 28 030).
Unscrew air conditioner compressor.
Note:
Hoses remain connected.
Place compressor aside (if necessary, loosen hose clamps on side member).

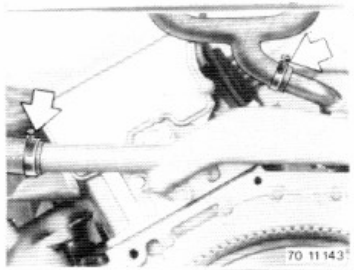


Disconnect plug for oil level sender.

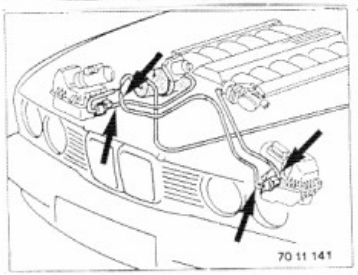
Unscrew oil filter on body.



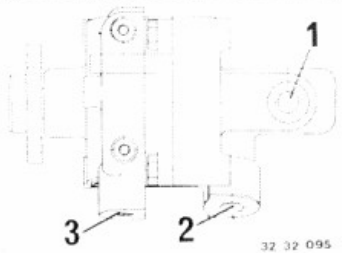
Remove fuel feed pipes (1 and 2) and return pipe (3).
Note:
Mark pipes (1 and 2) and install them in same position later.



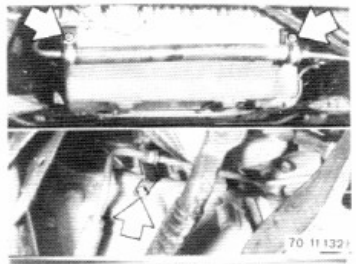
Disconnect heater hoses on coolant collector and coolant pipe.



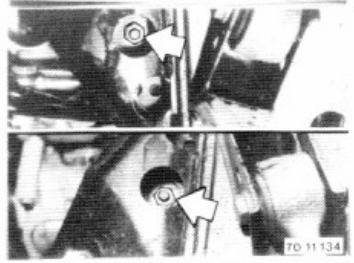
Pull off hoses on left and right charcoal filter pipes.



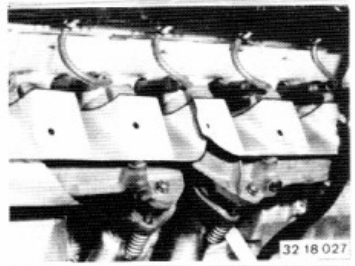
Unscrew pipes (1 ... 3) on tandem pump.
Connections: 1 = Steering
2 = Tank
3 = Ride control
Note:
See Group 32 for filling and bleeding the systems.



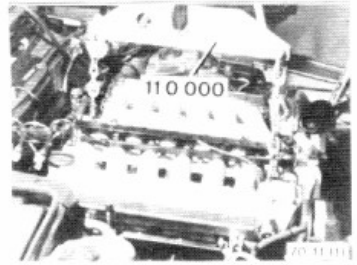
Unscrew pipe for ride control on oil pan.



Disconnect ground lead on engine carrier.
Loosen left and right engine mounts on front axle carrier.



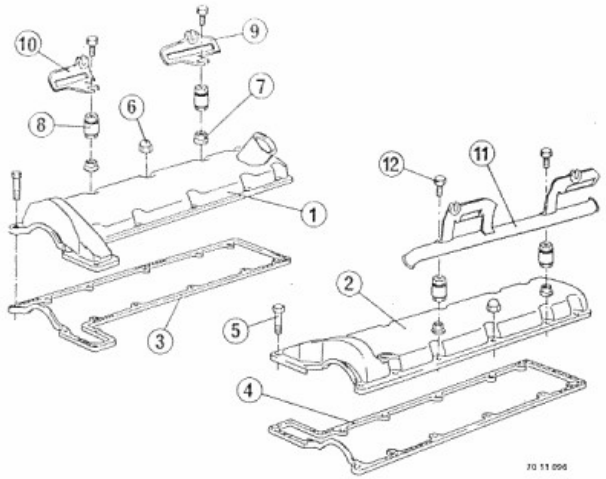
Unscrew both exhaust pipes on left and right sides (see 18 31 520).



Attach Special Tool 11 0 000 on holders and lift out the engine.

11-12/7.1

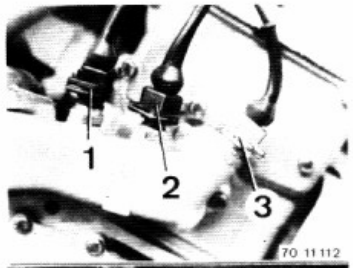
11 12 002 REMOVING AND INSTALLING CYLINDER HEAD COVER



1 Cylinder head cover, right
2 Cylinder head cover, left
3 Gasket, right
4 Gasket, left
5 Screw M 6 x 20-Z1 / 10 Nm (7 ft. lbs.)
6 Capped nut M 6 / 10 Nm (7 ft. lbs.)
7 Collar nut M 6 / 10 Nm (7 ft. lbs.)
8 Rubber mount
9 Holder rear right
10 Holder front right
11 Holder with electric lead tube
12 Screw M 6 x 10 / 10 Nm (7 ft. lbs.)

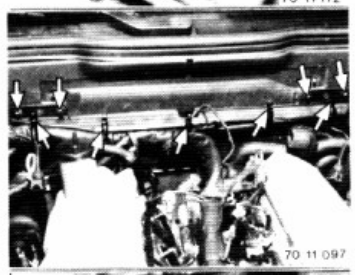
– Remove intake air collector – see 11 61 053.
– Unscrew screws (12) and remove holders (9 and 10 or 11).
– Remove rubber mounts (8).
– Unscrew screws (5) and nuts (6 and 7) and take off cylinder head cover (1 or 2).

Installation:
– Check gasket (3 or 4), replacing if necessary.
– Check tightening torque (see above).

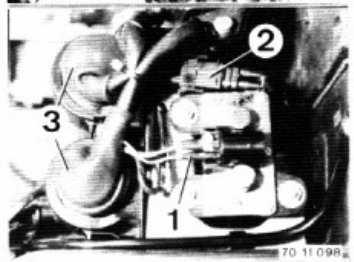


11 12 . . . REPLACING LEFT / RIGHT CYLINDER HEAD GASKET

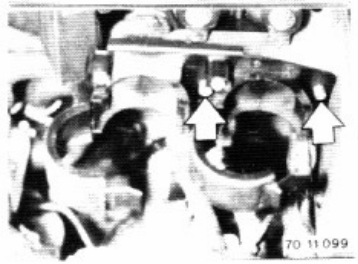
Remove upper timing case cover – see 11 14 100.
Remove coolant expansion tank – see Group 17.
Pull off plugs (1 ... 3) on coolant collector.



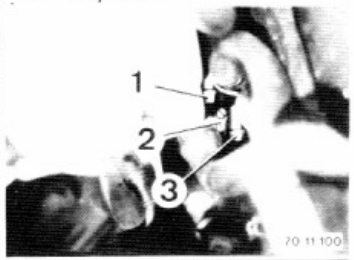
Cut through straps, unscrew nuts and take off wire harness plate.



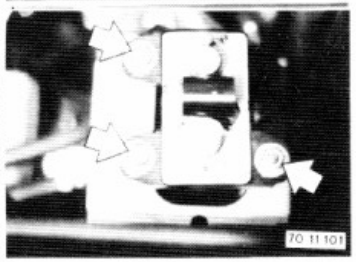
Pull off plug (1).
Disconnect plug (2).
Take plugs of engine wire harness (3) out of holders and lay engine wire harness aside.



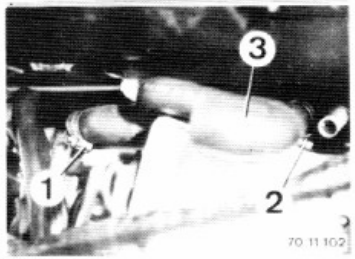
Unscrew bolts and take off holders.



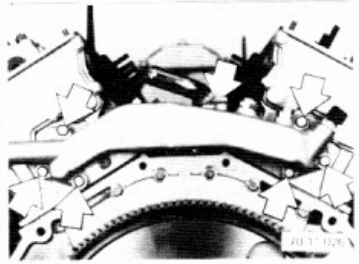
Loosen hose clamps (1 ... 3) and take off heater hoses.



Unscrew nuts and remove heater valve.

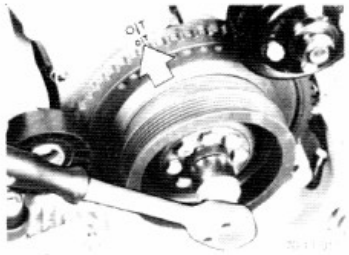


Loosen hose clamps (1 and 2) and remove hose (3).

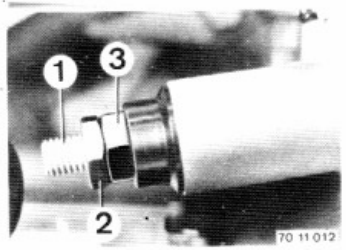


Unscrew coolant collector.
Installation:
Replace gaskets.
Check O-ring, replacing if necessary.
Coat O-ring with oil** to make installation easier.

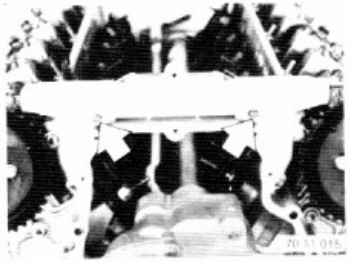
** Source: HWB



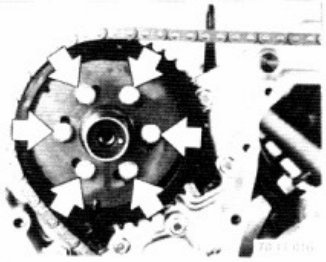
Set piston of cylinder no. 1 to TDC.



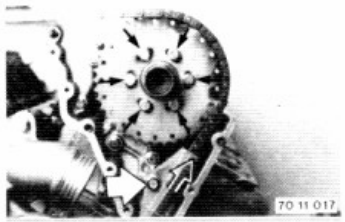
Loosen timing chain.
Loosen locknut (2).
Loosen adjusting screw (1) several turns.
Unscrew and remove plug (3).
Important!
Spring between plug and piston.



Unscrew guide rails.
Important!
Cover chain openings to prevent clips from falling into the crankcase.



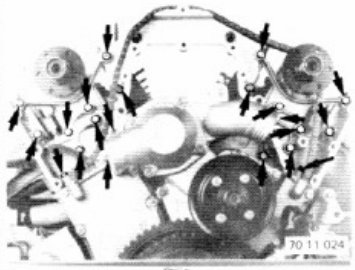
Cylinder Bank 1 ... 6:
Unscrew sprocket.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).



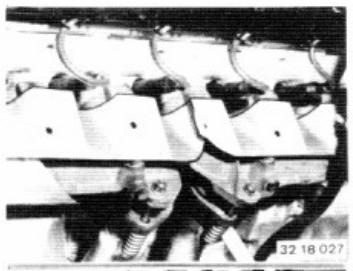
Cylinder Bank 7 ... 12:
Unscrew screw (1) on guide rail and pull up guide rail out of the lower holder.
Then unscrew the sprocket.

Installation:
Install and adjust timing chain.
Adjust chain tensioner.
Refer to 11 31 051 – Replacing Timing Chain.

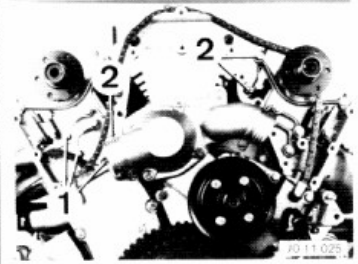
Note:
If only the left cylinder head gasket (cyl. 7 ... 12) has to be replaced, the camshaft must still be removed from the right cylinder head (cyl. 1 ... 6) since otherwise the upper timing case could not be lifted out to replace the gasket (as shown in the picture).
If both cylinder heads or only the right head are being removed, the camshaft does not have to be removed.
However, make sure of correct positioning while installing the timing cases (behind camshaft flange).



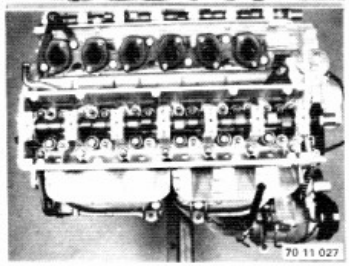
Unscrew screws on upper timing case and pull timing case off of dowel sleeves on cylinder head.
If necessary, loosen timing case with light knocks from a plastic hammer, being careful that dowel sleeves for the timing case cover do not fall into the chain opening.



Unscrew exhaust pipe (see 18 31 520).



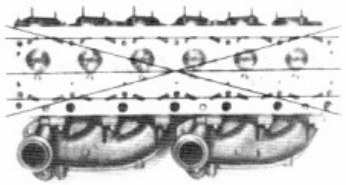
Installation:
Replace gaskets.
1 = Screw M 6 x 20
2 = Screw M 6 x 45
Tightening torque for all other M 6 x 30 screws = 10 Nm (7 ft. lbs.).
Cut off protruding gaskets.



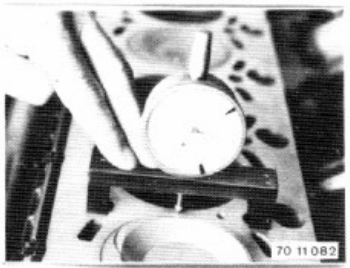
Unscrew cylinder head bolts from outside to inside and take off the cylinder head.
Note:
Remove gasket remainders on cylinder head and crankcase with a gasket remover** and hard wood scraper, keeping gasket remainders out of coolant and oil bores.

* See Specifications
** Source: HWB

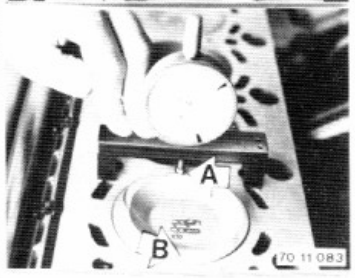
11-12/7.4



Check levelness* of cylinder head and crankcase with a standard steel ruler.



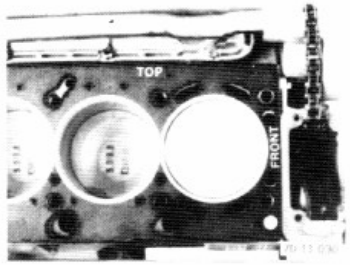
Select new cylinder head gasket according to highest piston protrusion of a cylinder bank.
Measuring Piston Protrusion:
Apply dial gage in Special Tool 00 2 530 on cleaned cylinder head surface and set gage to zero with preload.



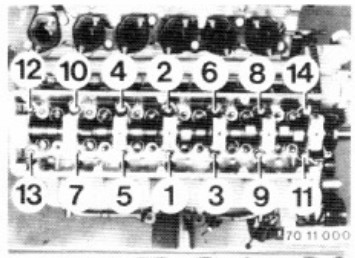
Apply dial gage at checkpoint "A" of cleaned piston and find highest point by turning the crankshaft.
Note displayed value = "piston protrusion A".
Apply dial gage at checkpoint "B" and note "piston protrusion "B".
Mean value of "A" and "B" is the "piston protrusion" of a piston.
Repeat these procedures on all 6 pistons.

The piston with the highest "piston protrusion" determines the thickness of the cylinder head gasket.
Cylinder Head Gaskets:

Highest Piston Protrusion of All 6 Pistons mm (in.)	Cylinder Head Gasket Code No. of Holes
0.388 to 0.610 (0.0153 to 0.0240")	1
0.610 to 0.832 (0.0240 to 0.0327")	2

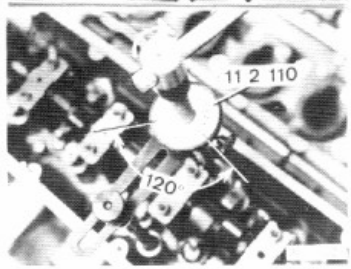


Installation:
Position cylinder head gasket with "FRONT" facing engine timing end and "TOP" facing up.
Important!
Different gaskets for cylinder banks 1 ... 6 and 7 ... 12.

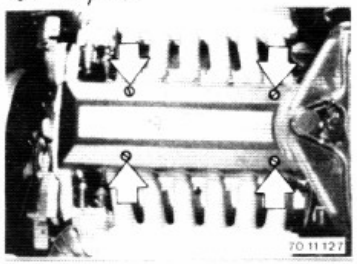


Mount cylinder head and tighten cylinder head bolts (washed and lubricated with oil) in order of 1 through 14 in two steps.
Check that cavities in the engine block do not contain oil while inserting the bolts (danger of cracking block).

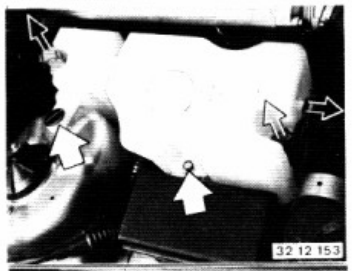
Step 1: Tighten to 30 Nm (22 ft. lbs.). Wait 15 minutes.
Step 2: Tighten to torque angle of 120° with Special Tool 11 2 110.



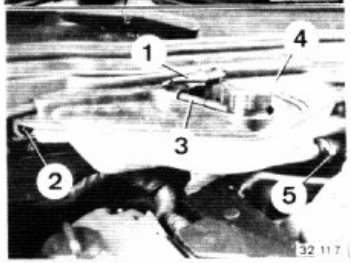
11 13 010 REMOVING AND INSTALLING OIL PAN UPPER SECTION



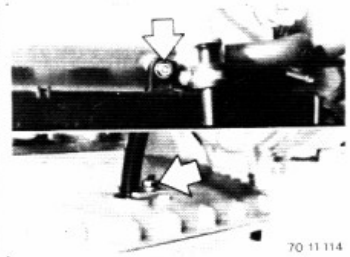
Remove transmission (see Group 24).
Remove oil pump – see 11 41 000.
Unscrew cover.



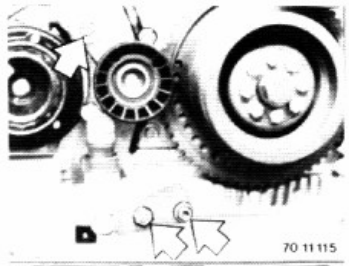
Drain washing fluid tank.
Pull off pumps and plug (level sender).
Remove tank.



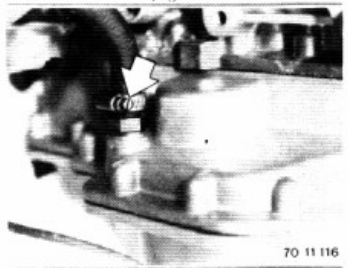
Remove coolant expansion tank.
Pull off plug (1) and overflow hose (3).
Unscrew left and right nuts (2).
Take off tank.
Note:
Hoses (4 and 5) remain connected.



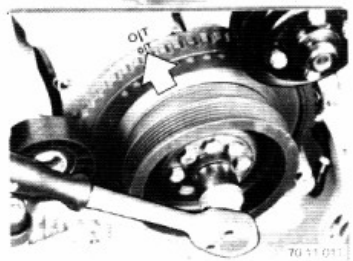
Remove guide tube for oil dipstick.



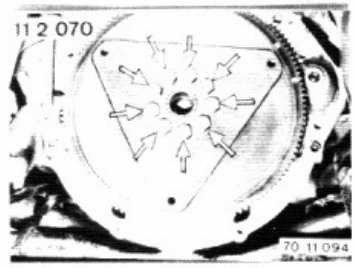
Unscrew belt tensioner.
Installation:
Tightening torque: 24 Nm (17 ft. lbs.).



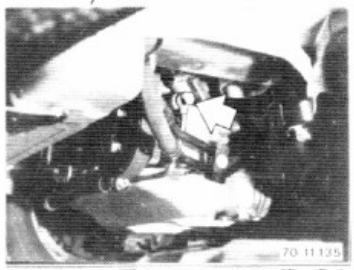
Loosen clamp and pull off oil drain hose.



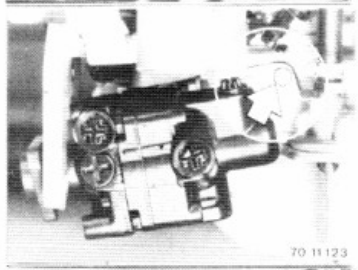
Crank engine to TDC.



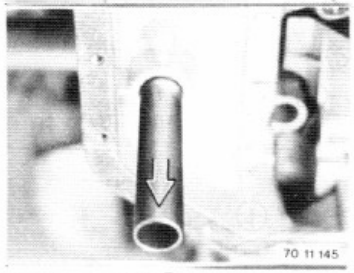
Hold flywheel with Special Tool 11 2 070 and unscrew flywheel.
Installation:
Tightening torque: 100 Nm (72 ft. lbs.).



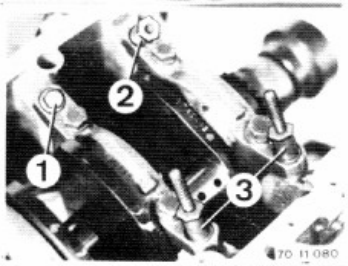
Unscrew oil pipe on tandem pump.
Installation:
Fill and bleed ride control system – see Group 37.



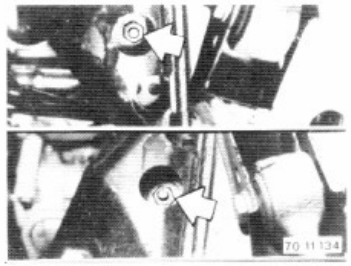
Unscrew holder for tandem pump on oil pan.



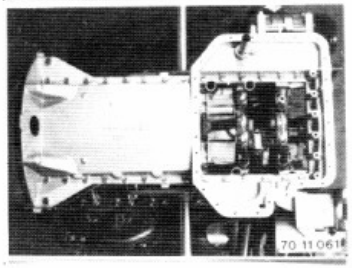
Pull off pipe adapter for oil extraction.
Note:
Heat the oil pan with a hot air blower to make removing and installing easier.



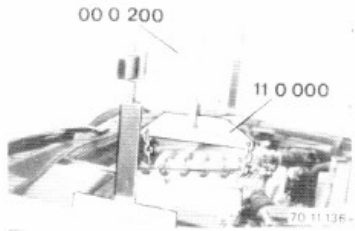
Remove oil pump consoles.
Installation:
Tightening torque: 34 Nm (25 ft. lbs.).



Unscrew left and right engine mounts at bottom.
Installation:
Tightening torque: 45 Nm (32.5 ft. lbs.).



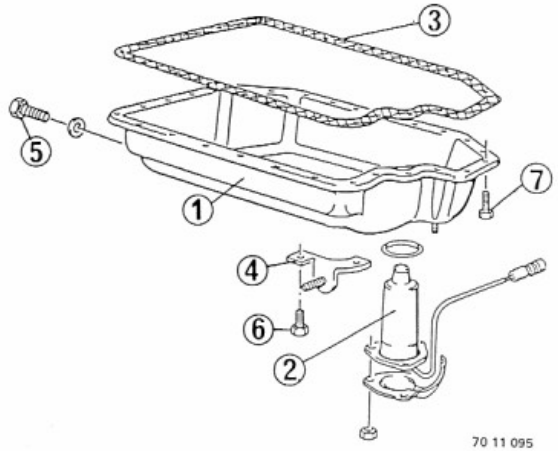
Unscrew oil pan bolts.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).



Mount Special Tools 00 0 200 and 11 0 000, and lift engine far enough that the oil pan can be removed from the rear.
Installation:
Clean sealing surfaces and install new gasket.

11-13/7.3

11 13 020 REMOVING AND INSTALLING OIL PAN LOWER SECTION



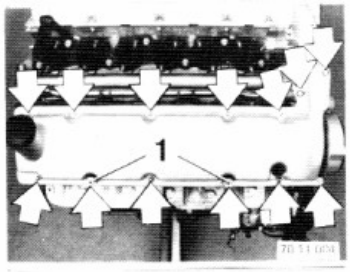
1 Oil pan lower section
2 Level switch
3 Oil pan gasket
4 Holder for hydraulic pipe, left (right inversed)
5 Drain plug M 12 x 1.5 / 33 Nm (24 ft. lbs.)
6 Screw M 6 x 18 / 10 Nm (7 ft. lbs.)
7 Screw M 6 x 16–Z3 / 10 Nm (7 ft. lbs.)

– Unscrew engine splash guard.
– Drain engine oil.
– Disconnect plug for level switch.
– Unscrew oil pan bolts and remove oil pan.
– When replacing oil pan, unscrew level switch and install it in new oil pan with a new O-ring.

Installation:
– Remove remainders of gasket on sealing surfaces.
– Replace oil pan gasket.
– Tighten bolts to torque specified above beginning at the middle and going to the outside.

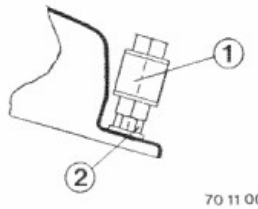
11 14 100 REMOVING AND INSTALLING UPPER TIMING CASE COVER

Remove both intake air collectors – see 11 61 053.
Remove both distributor housings – see 11 14 105.
Remove fan – see 11 52 000.

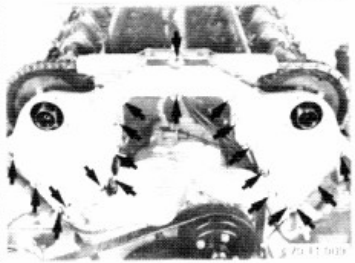


Remove both cylinder head covers (also refer to 11 12 002).
First unscrew round rubber mounts (1).
Then loosen bolts and nuts.
Take off cover.

Installation:
Check gasket, replacing if necessary.
Tighten cylinder head cover from inside to outside.
Tightening torque: 10 Nm (7 ft. lbs.).
Hold nuts (2) with an open-ended wrench while installing round rubber mounts (1).

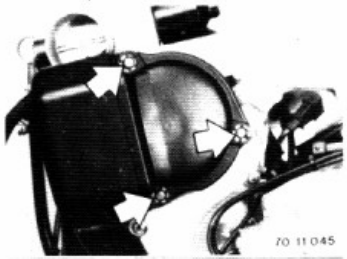


70 11 005

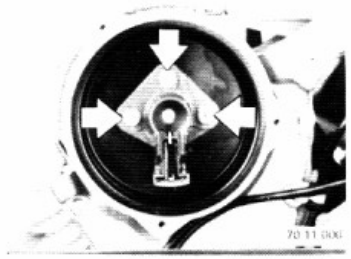


Unscrew bolts and take off timing case cover.
Installation:
Replace gaskets.
Tightening torque: 10 Nm (7 ft. lbs.).
Cut off protruding gaskets.

11 14 105 REPLACING RADIAL OIL SEAL IN DISTRIBUTOR HOUSING

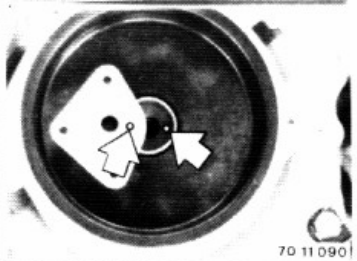


Unscrew distributor cover.

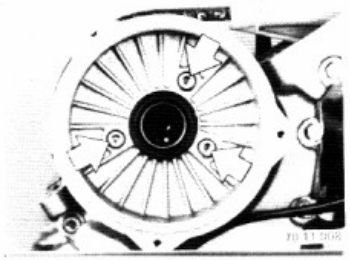


Unscrew distributor rotor.
Installation:
Tightening torque: 6 Nm (4 ft. lbs.).

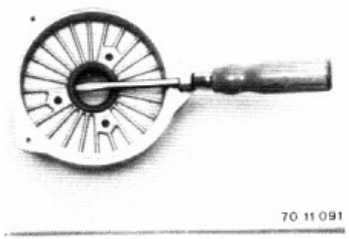
Unscrew adapter.



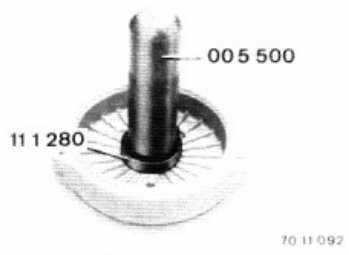
Installation:
Position adapter with dowel bore in dowel pin of camshaft.
Tightening torque: 24 Nm (17 ft. lbs.).



Unscrew bolts and take off distributor housing.
Installation:
Replace seals on back and underneath bolts.
Make sure radial oil seal is not damaged while mounting housing.



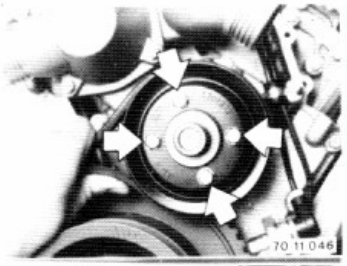
Lift out old seal with a blunt screwdriver.
Important!
Don't damage sealing surface on housing.



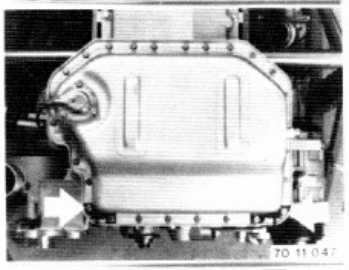
Lubricate new radial oil seal lip with oil and drive in seal against stop with Special Tools 11 1 280 and 00 5 500.

11 14 110 REMOVING AND INSTALLING LOWER TIMING CASE COVER

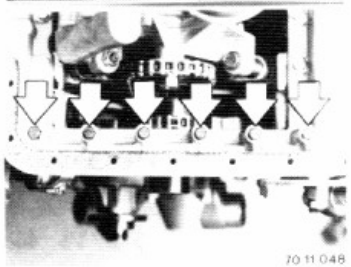
Remove upper timing case cover – see 11 14 100.
Remove hub for vibration damper – see 11 23 031.



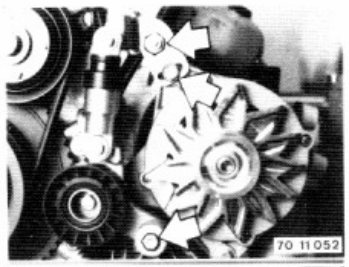
Counterhold and unscrew water pump pulley with belt.



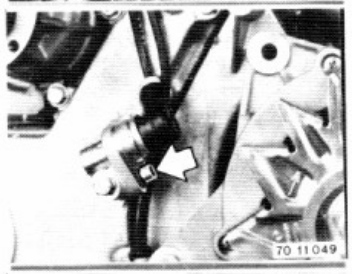
Drain engine oil.
Unscrew oil pan lower section.
Installation:
Replace gasket.
Mount together with both holders for ride control oil pipe.
Tightening torque: 10 Nm (7 ft. lbs.).



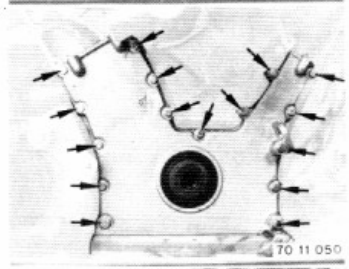
Unscrew lower mounting bolts of timing case cover and loosen the 4 adjacent oil pan bolts on each side.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).



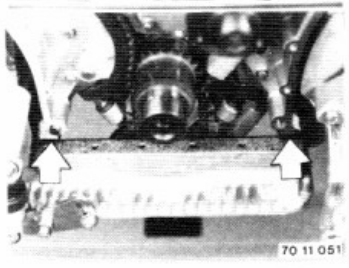
Unscrew tensioner for belt drive.



Unscrew reference mark sender.



Unscrew mounting bolts and take off timing case cover.

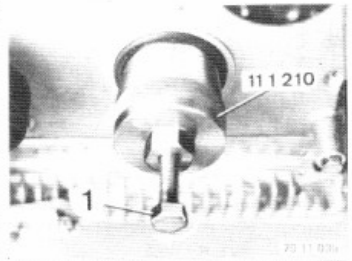


Installation:
Replace oil pan gasket, if it was damaged.
Apply a thin coat of brush-on universal sealing compound** on the corners of the oil pan/ timing case joint.
Replace gaskets for timing case cover.
Tightening torque: M 6 = 10 Nm (7 ft. lbs.)
M 8 = 24 Nm (17 ft. lbs.)

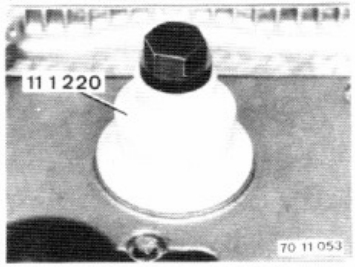
** Source: HWB

11 14 141 REPLACING RADIAL OIL SEAL IN LOWER TIMING CASE COVER

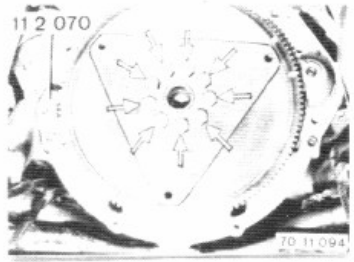
Remove hub for vibration damper – see 11 23 031.



Pull off shaft seal with Special Tool 11 1 210.
Screw tool into seal far enough, until it grabs hold of seal firmly.
Then pull off seal by screwing in screw (1).

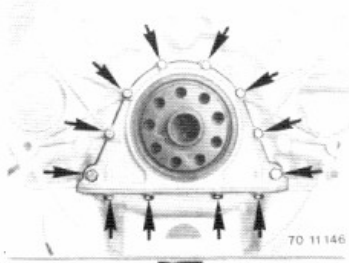


Lubricate sealing lip of shaft seal with oil.
Install shaft seal flush with timing case cover with help of Special Tool 11 1 220.

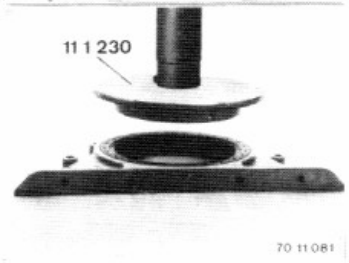


11 14 151 REPLACING CRANKSHAFT RADIAL OIL SEAL (IN END COVER)

Remove transmission (see Group 24).
Hold flywheel with Special Tool 11 2 070.
Unscrew bolts and take off flywheel.
Installation:
Tightening torque: 100 Nm (72 ft. lbs.).

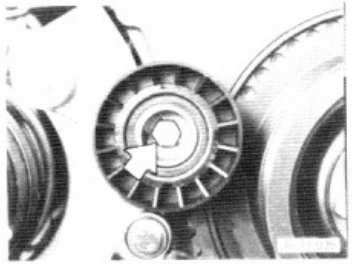


Unscrew bolts and take off end cover.
Installation:
Replace gasket (cut to length).
Coat engine block/oil pan joints with a brush-on universal sealing compound**.
Do not damage the radial oil seal during installation.
Tightening torque: M 6 = 10 Nm (7 ft. lbs.)
M 8 = 24 Nm (17 ft. lbs.)



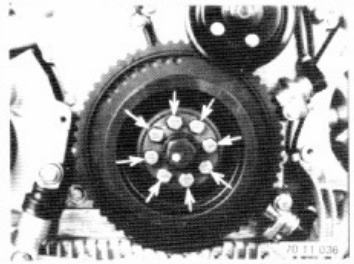
Lift out old radial oil seal and install new seal with help of Special Tool 11 1 230.

** Source: HWB

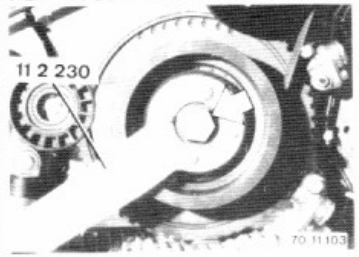


11 23 031 REMOVING AND INSTALLING VIBRATION DAMPER / HUB

Remove both drive belts – see 11 28 030.
Unscrew engine splash guard.
Unscrew bolt and take off tensioning roller.
Installation:
Tightening torque: 24 Nm (17 ft. lbs.).

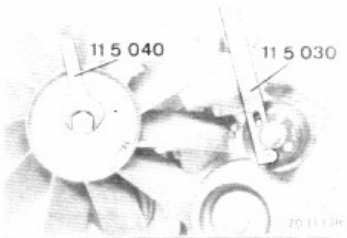


Unscrew bolts, but do not take off the vibration damper at this point.
Installation:
Tightening torque: 24 Nm (17 ft. lbs.).



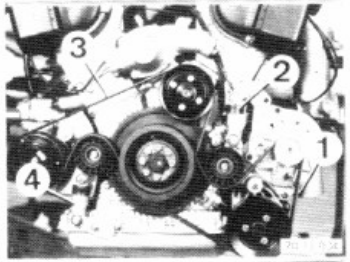
Mount Special Tool 11 2 230 and support on the car frame.
Unscrew central bolt.
Installation:
Tightening torque: 500 Nm (362 ft. lbs.).

Mount Special Tool 00 7 501 with two bolts and pull vibration damper hub off of the crankshaft.

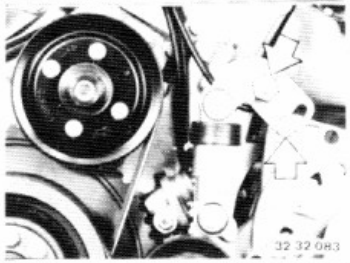


11 28 030 REMOVING AND INSTALLING DRIVE BELTS FOR AUXILIARY EQUIPMENT

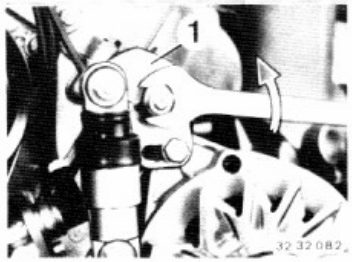
Remove fan (also refer to 11 52 000).
Important!
Left-hand threads.
Installation:
Tightening torque: 40 + 10 Nm (29 + 7 ft. lbs.).



Arrangement:
1 Drive belts for alternator and power steering pump
2 Tensioner for 1
3 Drive belts for water pump and air conditioner compressor
4 Tensioner for 3
Belts are tightened automatically by the tensioners.



Loosen bolt and nut on tensioner.
Take off drive belt.
Note:
Check drive belt for damage.

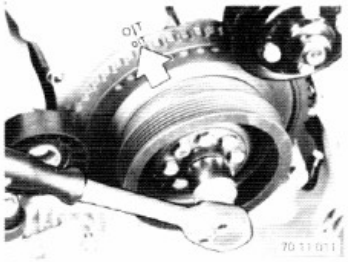


Installation:
Turn tensioner (1) against the stop slowly.
Now tighten bolt and nut.
Tightening torque: 24 Nm (17 ft. lbs.).

Remove and install the second belt in the same manner.

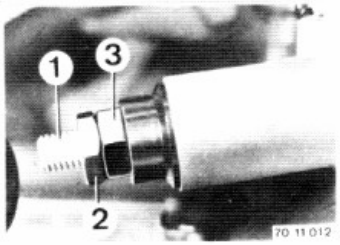
11 31 051 REPLACING TIMING CHAIN

Remove upper/lower timing case covers – see 11 14 100/120.

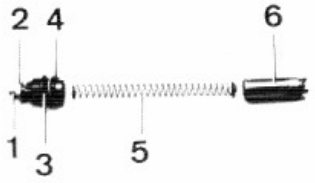


Set piston of cylinder no. 1 to TDC.

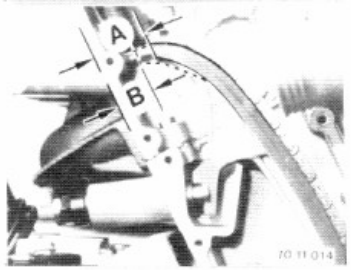
Adjust engine to TDC position with Special Tool 11 2 300.
Important!
Make sure that special tool is removed prior to operating the engine again.



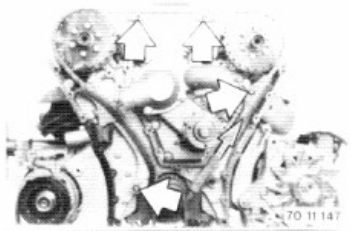
Loosen timing chain.
Loosen locknut (2).
Unscrew adjusting screw (1) several turns.
Then unscrew and remove plug (3).
Remove tensioning piston.
Important!
Spring between plug and piston.



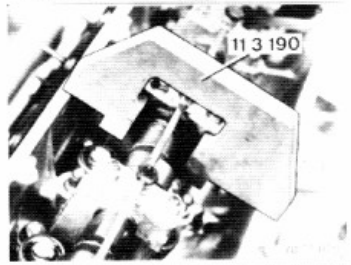
Installation:
1 Adjusting screw
2 Locknut
3 Plug
4 Gasket (replace)
5 Spring
6 Tensioning piston
Tightening torque for plug = 40 Nm (29 ft. lbs.).



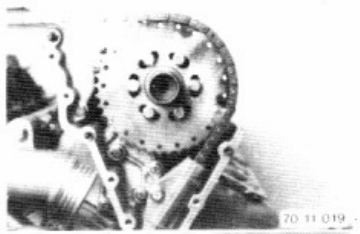
Adjusting Chain Tensioner:
Tighten plug.
Loosen adjusting screw until it no longer bears.
Crank engine once in turning direction.
Measure distance A.
Press tensioning rail against spring force to stop and measure distance B.
Adjust nominal value (A–B = 6 ± 0.5 mm / 0.236 ± 0.020") with the adjusting screw and tighten locknut.



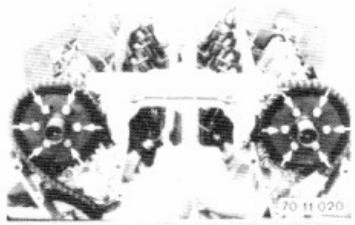
Unscrew guide rails and tensioning rail, and take off the timing chain.



Installation:
Stop both camshafts with Special Tool 11 3 190.

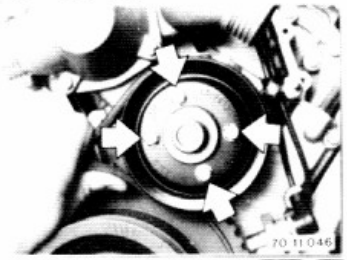


Loosen bolts on sprockets.
Install chain in direction opposite the engine turning direction, starting on the crankshaft.
Note:
Install chain on sprockets in such a manner, that it can be preloaded in the adjusting range of slots.



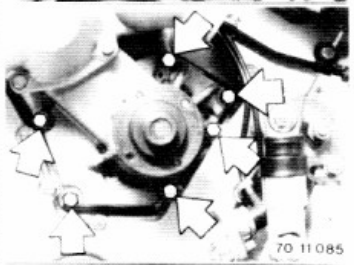
Mount guide and tensioning rails.
Install chain tensioner.
Tighten bolts of sprockets.
Tightening torque: 10 Nm (7 ft. lbs.).

Note:
Crank engine once and recheck timing for correct adjustment.
Adjust chain tensioner.

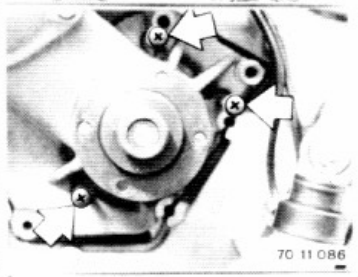


11 51 000 REMOVING AND INSTALLING WATER PUMP

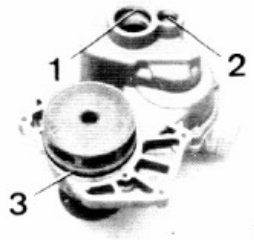
Drain coolant.
Remove vibration damper – see 11 23 031.
Counterhold and remove pulley with belt.
Note:
Fill and bleed cooling system – see Group 17.



Disconnect coolant hoses on water pump.
Unscrew bolts.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).

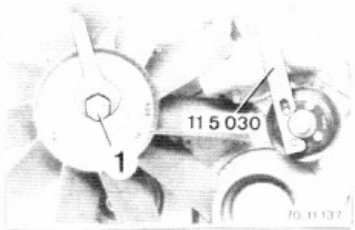


Screw M 5 screws in provided tapped bores and press water pump off of the engine uniformly.



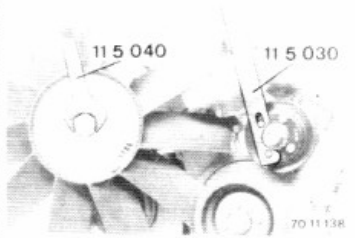
Installation:
Replace and lubricate O-rings with a special lubricant**.

** Source: HWB

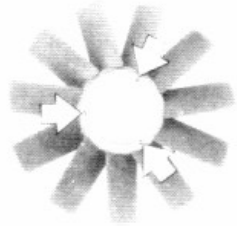


11 52 000 REMOVING AND INSTALLING FAN

Hold pulley with Special Tool 11 5 030 and unscrew coupling nut (1).
Important!
Left-hand threads – turn nut clockwise to unscrew.



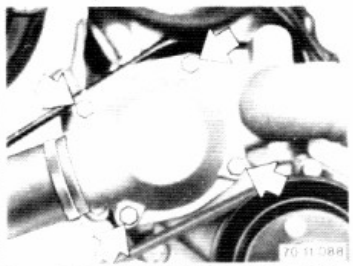
Installation:
Tighten fan with Special Tool 11 5 040.
Tightening torque: 40 Nm (29 ft. lbs.), which is equal to a setting of 30 Nm (22 ft. lbs.) on a torque wrench with Special Tool 11 5 040.



11 52 020 REPLACING FAN CLUTCH

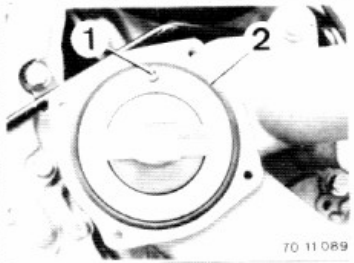
Remove fan – see 11 52 000.
Unscrew mounting bolts and take off fan clutch.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).

Replace fan clutch, if
a) it has axial or radial play,
b) it is losing oil or
c) has difficult movement (fan on a stopped engine must turn easily).

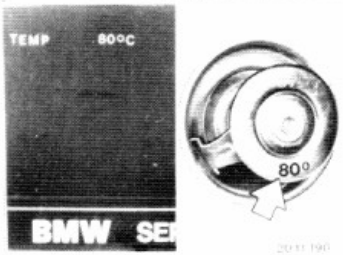


11 53 000 REMOVING AND INSTALLING COOLANT THERMOSTAT

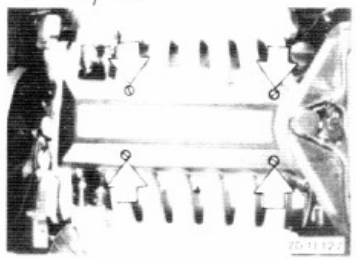
Drain coolant.
Unscrew bolts and take off thermostat housing.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).



Install thermostat with ball valve (1) facing up.
Replace O-ring (2).
Note:
Fill and bleed cooling system – see Group 17.

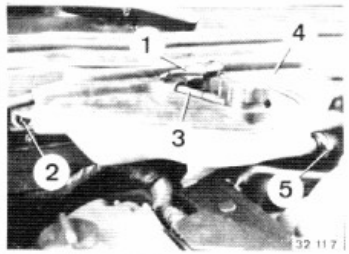


Checking Thermostat:
Check opening temperature in a hot water bath and compare with stamped opening temperature.

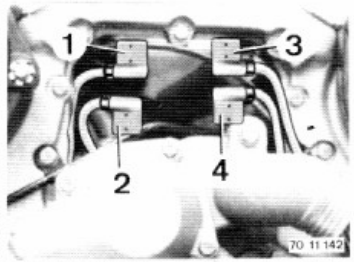


11 61 053 REMOVING AND INSTALLING INTAKE AIR COLLECTOR

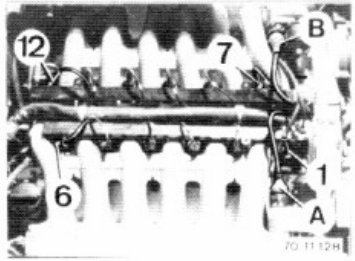
Disconnect battery at ground point.
Unscrew cover.
Unscrew holder for cover on injection pipes.



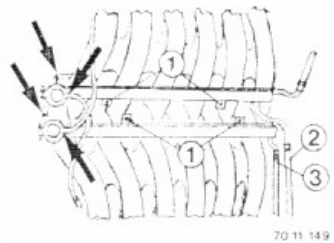
Remove coolant expansion tank.
Pull off plug (1) and spill hose (3).
Unscrew left and right nuts (2) and take off tank.
Note:
Hoses (4 and 5) remain connected.



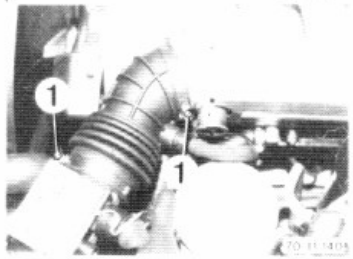
Pull off plugs (1 ... 4).
1 = pulse sender Cyl. 1 ... 6
2 = cylinder identification Cyl. 1 ... 6
3 = cylinder identification Cyl. 7 ... 12
4 = pulse sender Cyl. 7 ... 12
Plug receptacles: gray for plugs 1 and 2
black for plugs 3 and 4



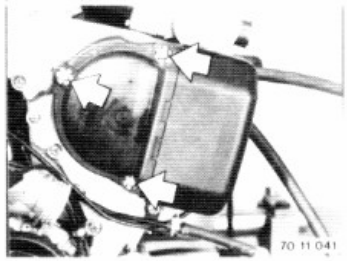
Pull off plugs (1 ... 12) on fuel injectors and plugs (A and B) on throttle valve drive motors.
Unclip and lay wire harness aside.
A = plug for drive motor of cyl. 7 ... 12
B = plug for drive motor of cyl. 1 ... 6



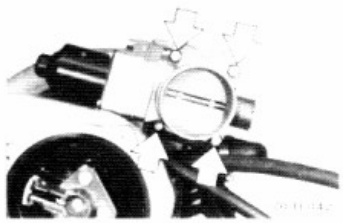
Unscrew fuel pipes on injection pipes.
Pull off hoses on pressure regulators.
Unscrew bolts (1) and lift out injection pipes.
Note:
Mark feed pipes (2 and 3) and re-install in same position.



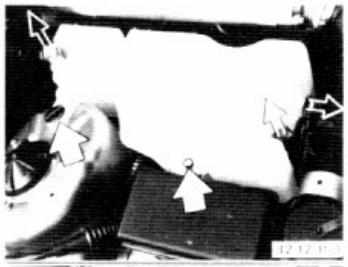
Loosen clamps (1) and take off intake air hose.



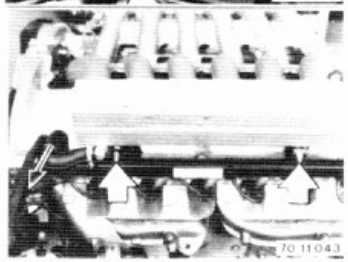
Take off distributor cap.



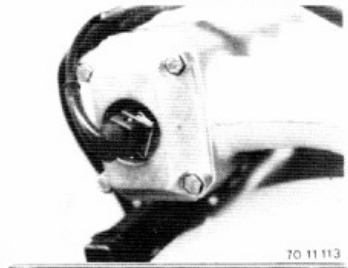
Unscrew throttle valve necks on intake manifold.
Installation:
Check gasket, replacing if necessary.
Tightening torque: 10 Nm (7 ft. lbs.).



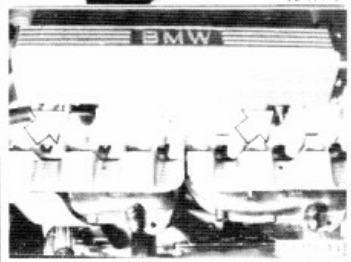
Collector for Cyl. 7 ... 12:
Drain washing fluid tank.
Pull off pumps and plug (level sender).
Remove tank.



Unscrew ignition lead tube.
Pull off crankcase breathing hose.
Installation:
Also mount the oil dipstick guide tube with the ignition lead tube for cyl. 1 ... 6.

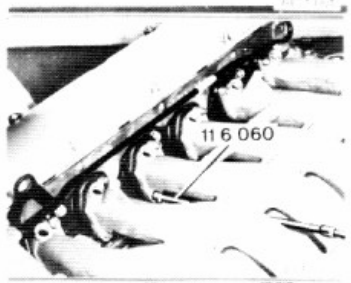


Pull off plug.

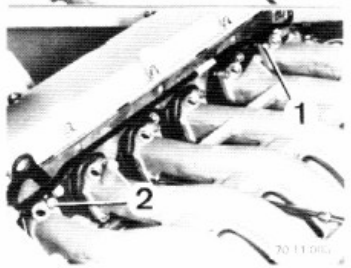


Loosen nuts of collector support several turns.

Unscrew noise suppressor (1).
Installation:
Place noise suppressor between cylinder head cover and collector prior to installing collector.



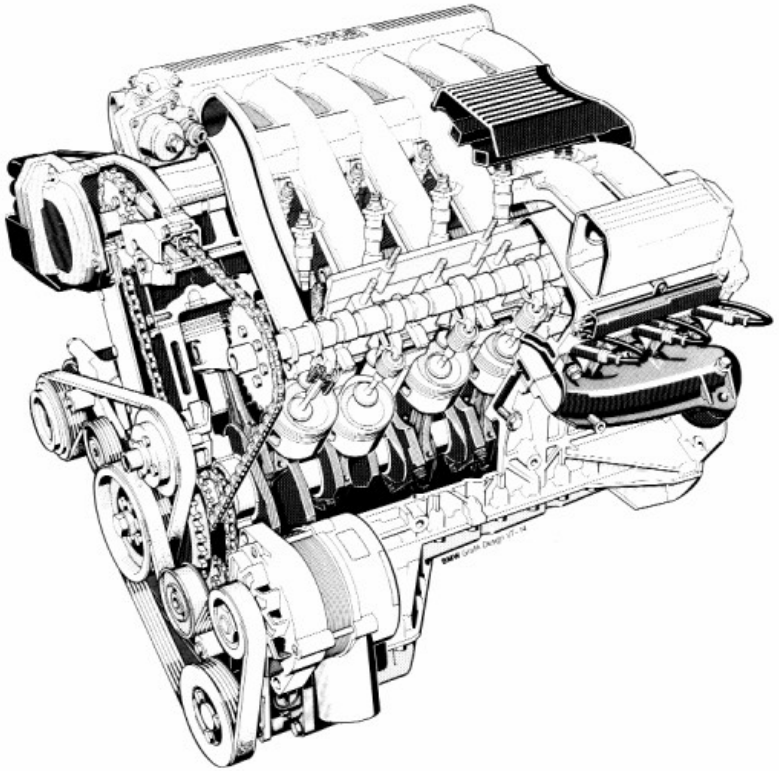
Unscrew collector with Special Tool 11 6 060.
Note:
The collector for the opposite bank of cylinders has been removed for better presentation.

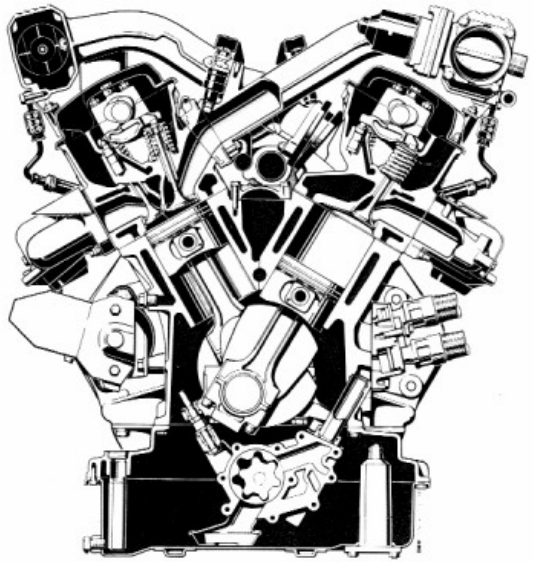


Installation:
Mount the fuel pipe with nuts (1 and 2) of the collector for bank of cylinders 1 ... 6.
Tightening torque: 10 Nm (7 ft. lbs.).

11-70/1

M 70 = Vee 12 cylinder
B = Gasoline
50 = Displacement x 100
M = Motronic

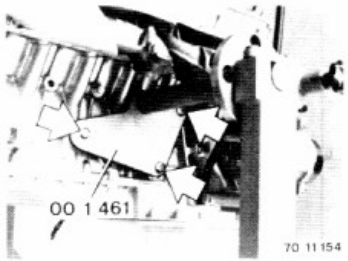




M 70 B 50 M – BMW 750 i

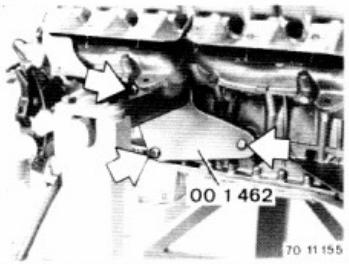
DISASSEMBLING AND REPAIRING ENGINE

A. REMOVING/DISASSEMBLING/REPAIRING CYLINDER HEADS

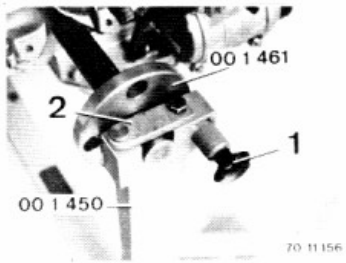


- MOUNTING ENGINE ON ASSEMBLY STAND:

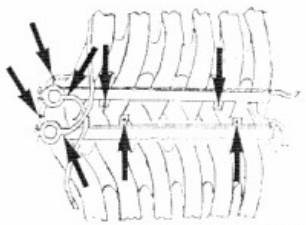
Mount Special Tool 00 1 461 on right side of engine.



Mount Special Tool 00 1 462 on left side of engine.



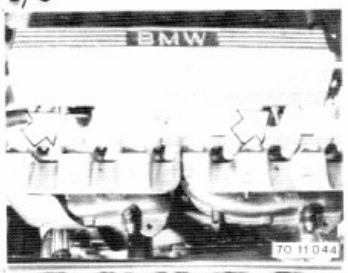
Install engine with mounted flanges in Special Tool 00 1 450 (assembly stand) in such a manner, that Special Tool 00 1 461 bears on lock (1). Apply locks (2) on left and right sides.



70 11 150

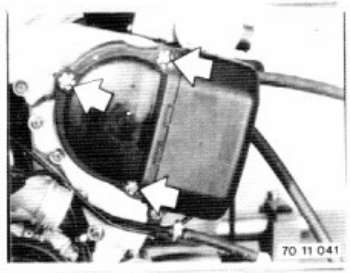
● REMOVING INTAKE MANIFOLD:

Loosen clamps for fuel lines.
Pull off vacuum hoses on pressure regulators.
Unscrew mounting bolts for injection pipes.
Lift out injection pipes with fuel injectors.



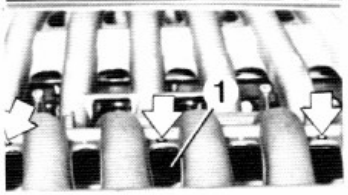
70 11 044

Loosen nuts of manifold support several turns.

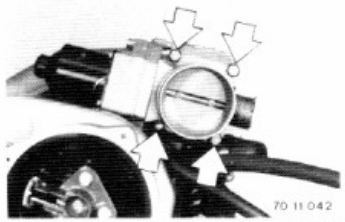


70 11 041

Remove distributor caps.

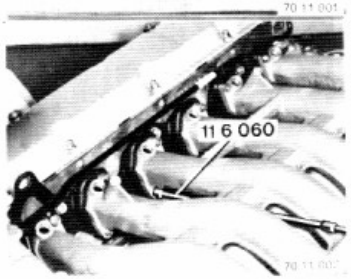


Remove noise guard (1).
Installation:
Place noise guard between the cylinder head cover and manifold prior to installation of the manifold, because installation later would be very difficult.



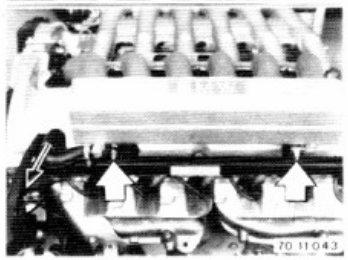
70 11 042

Remove throttle valve necks on manifolds.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).



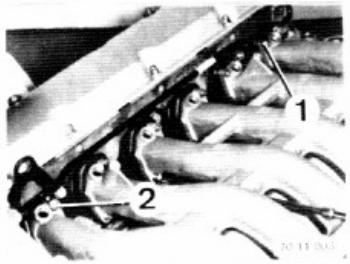
70 11 001

Remove manifold with Special Tool 11 6 060.
Information:
The manifold of the opposite bank of cylinders is removed for better presentation.

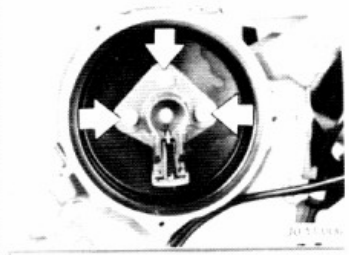


70 11 043

Pull off spark plug connectors and remove ignition lead pipes.
Pull off hose for crankcase breather.
Installation:
Also mount the oil dipstick guide tube in case of ignition lead pipe for cylinders 1 ... 6.



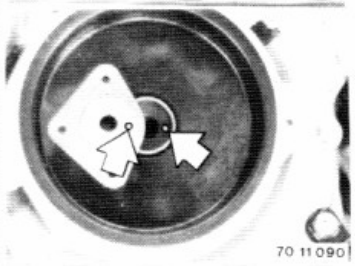
Installation:
Mount fuel pipe with nuts (1 and 2) in case of manifold for cylinder bank 1 ... 6.
Tightening torque: 10 Nm (7 ft. lbs.).



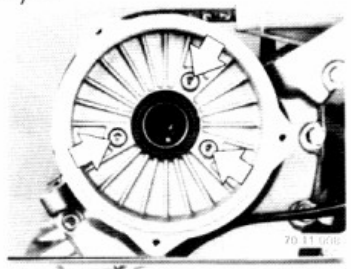
● REMOVING TAKE-UP COVER FOR DISTRIBUTOR:

Remove distributor rotor.
Installation:
Tightening torque: 6 Nm (4 ft. lbs.).

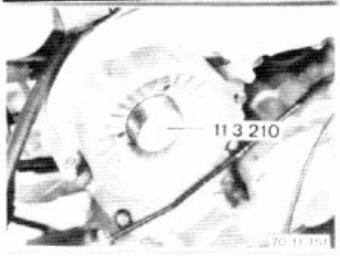
Remove adapter.



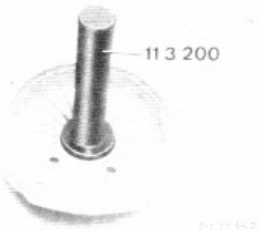
Installation:
Install adapter with dowel pin bore aligned with dowel pin of camshaft.
Tightening torque: 24 Nm (17 ft. lbs.).



Unscrew bolts and take off take-up cover.

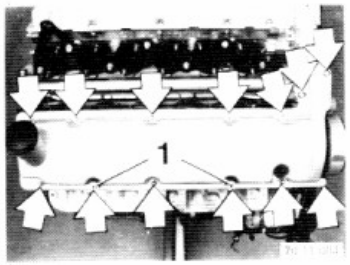


Installation:
Apply Special Tool 11 2 214 on camshaft.
Lubricate sealing lip of radial oil seal with oil.
Replace gaskets on back and underneath the bolts.
Mount take-up cover.



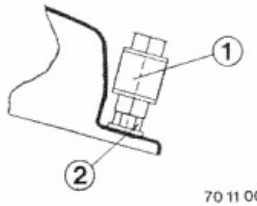
● REPLACING RADIAL OIL SEAL IN TAKE-UP COVER:

Lift out old seal and drive in new seal against the stop with Special Tool 11 3 200.
Lubricate sealing lip with oil prior to mounting the cover.



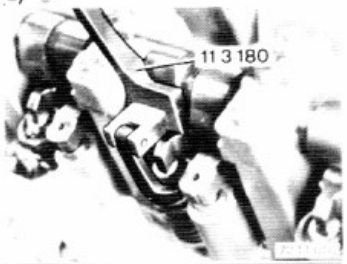
● REMOVING CYLINDER HEAD COVER:

First unscrew round rubber mount (1).
Unscrew bolts and nuts and take off cover.



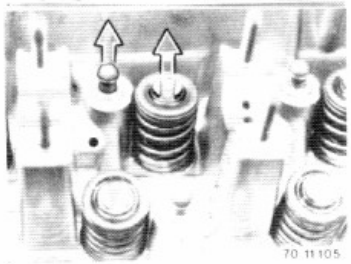
70 11 005

Installation:
Check gasket, replacing if necessary.
Tighten nuts and bolts from inside to outside.
Tightening torque: 10 Nm (7 ft. lbs.).
Counterhold nut (2) with an open-end wrench while installing round rubber mount (1).



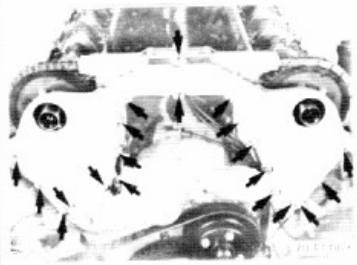
● REMOVING ROCKER ARMS:

Press down valve with Special Tool 11 3 180 and remove rocker arms.
Note:
Always position cams upright facing up to the cylinder head – special tool must not bear on cams.
Place rocker arms aside in correct order and reinstall them in the same position.



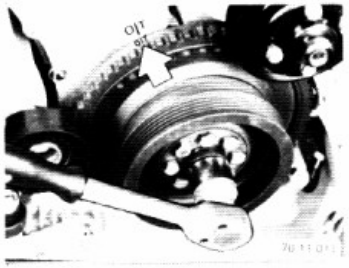
70 11 105

Remove hydraulic valve clearance compensators and guides for rocker arms.
Note:
Store hydraulic valve clearance compensators upright to prevent oil from running out.
Important!
Cover oil return bores to prevent guides from falling into the crankcase.



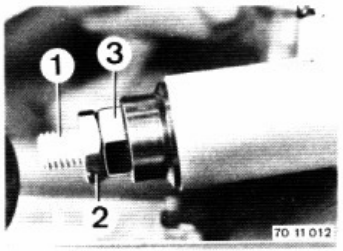
● REMOVING UPPER TIMING CASE COVER:

Unscrew bolts and take off timing case cover.
Installation:
Replace gasket.
Tightening torque: 10 Nm (7 ft. lbs.).
Cut off protruding gasket.

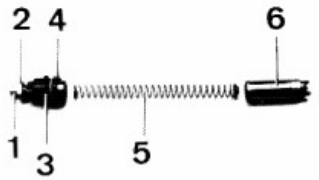


● REMOVING CAMSHAFTS:

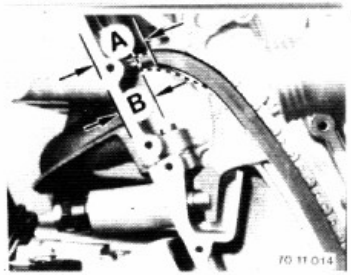
Position piston of cylinder no. 1 to TDC.



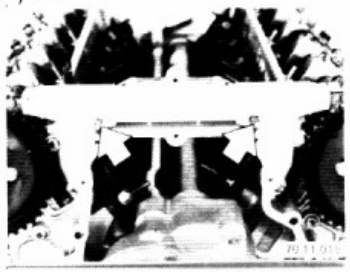
Loosen timing chain.
Loosen locknut (2).
Loosen adjusting screw (1) several turns.
Now unscrew plug (3).
Remove tensioning piston.
Important!
Spring between plug and piston.



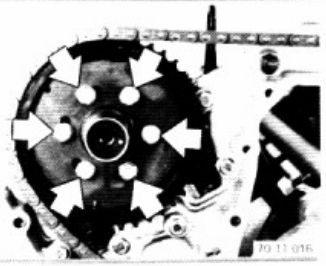
Installation:
1 = Adjusting screw
2 = Locknut
3 = Plug
4 = Gasket (replace)
5 = Spring
6 = Tensioning piston
Tightening torque for plug = 40 Nm (29 ft. lbs.).



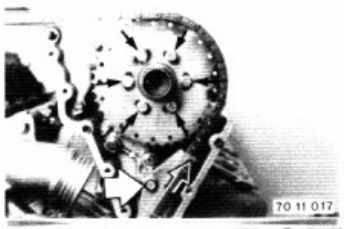
Adjusting Chain Tensioner:
– Loosen adjusting screw only enough, that it no longer bears.
– Crank engine once in direction of rotation.
– Measure distance A.
– Press tensioning rail against spring force up to the stop and measure distance B.
Adjust to nominal value (A – B = 6 ±0.5 mm or 0.236 ±0.020") with the adjusting screw and tighten the locknut.



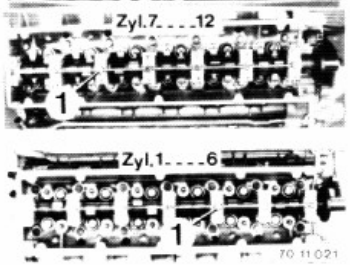
Remove guide rail.
Important!
Cover chain recesses to prevent clips from falling into the crankcase.



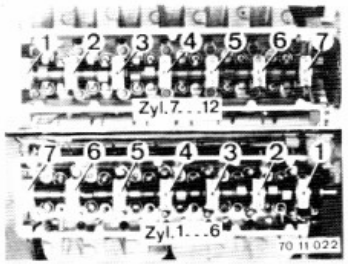
Cylinder Bank 1 ... 6:
Unscrew bolts and take off sprocket.



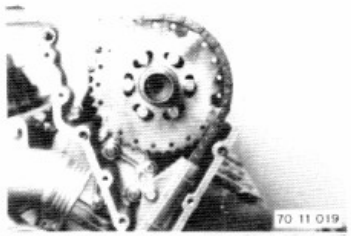
Cylinder Bank 7 ... 12:
Unscrew bolt (1) on guide rail and pull guide rail up out of the holder.
Unscrew bolts on sprocket and take off sprocket.



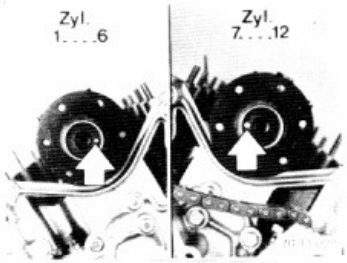
Remove oil pipes.
Installation:
Mount pipes with oil outlet bores facing the camshaft.
Install hollow union bolt (1) in bearing cap 3.
Replace gaskets.
Tightening torque: 12 Nm (9 ft. lbs.).



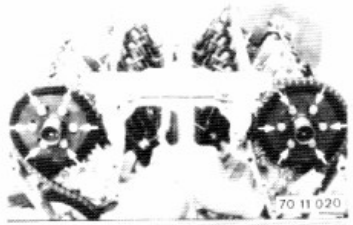
Remove bearing caps (1 ... 7) and take out camshaft.
Note:
Bearing caps are matched with one cylinder head and must not be mixed up.



Screw in bolts only finger tight.
Install chain in opposite direction of engine rotation beginning on the crankshaft.
Note:
Install chain on sprockets in such a manner, that it can be tightened in the adjusting range of the slots.



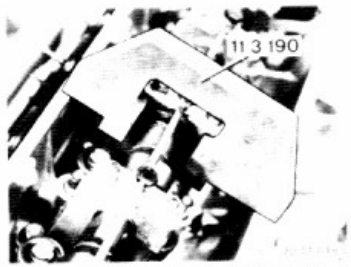
Installation:
Instakk camshaft with dowel pin facing in (cylinder 1 set to TDC).
Tighten bearing caps from inside to outside.
Tightening torque: 15 Nm (11 ft. lbs.).



Mount guide and tensioning rails.
Install chain tensioner.
Tighten sprockets.
Tightening torque: 10 Nm (7 ft. lbs.).

Adjust engine in TDC position with Special Tool 11 2 300.
Caution!
Always make sure that the special tool is removed again prior to operation of the engine.

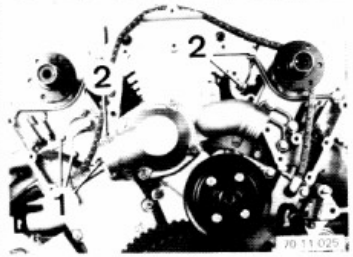
Note:
Crank engine once and recheck timing for correct adjustment.
Adjust chain tensioner.



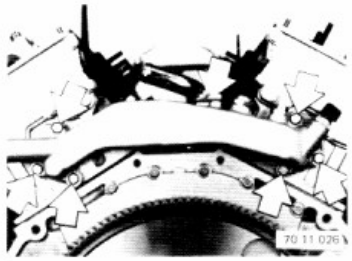
Hold both camshafts with Special Tool 11 3 190.

● REMOVING UPPER TIMING CASE:

Unscrew bolts on upper timing case and pull timing case out of dowel sleeves on cylinder head.
If applicable, loosen timing case with light knocks from a plastic hammer – being careful that dowel sleeves for the timing case cover do not fall into the chain recess.



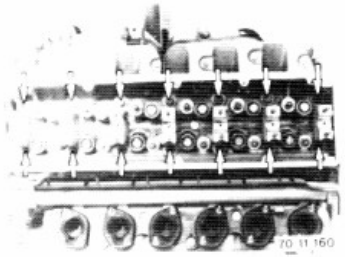
Installation:
Replace gaskets.
1 = Bolt M 6 x 20
2 = Bolt M 6 x 45
All other bolts are M 6 x 30.
Tightening torque: 10 Nm (7 ft. lbs.).
Cut off protruding gaskets.



● REMOVING COOLANT COLLECTOR:

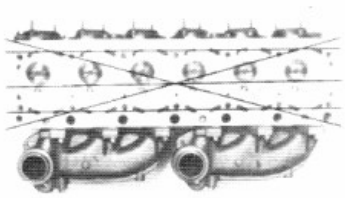
Unscrew bolts and take off collector.
Installation:
Replace gaskets.
Check O-ring, replacing if necessary.
Coat O-ring with a lubricant** to make installation easier.

** Source: HWB

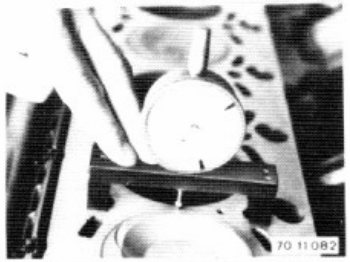


● REMOVING CYLINDER HEADS

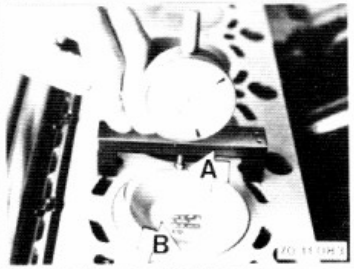
Unscrew cylinder head bolts from outside to inside and take off cylinder head.
Note:
Remove sealant remainders on cylinder head and crankcase with a sealant remover** and hard wood scraper, being careful that sealant remainders do not fall into coolant or oil bores.



Check levelness of cylinder head with a standard steel ruler.
Max. deviation in levelness: 0.05 mm (0.002").

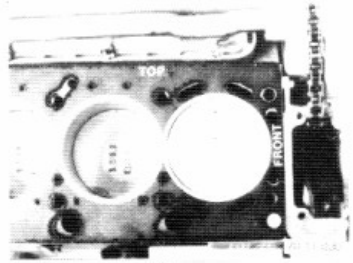


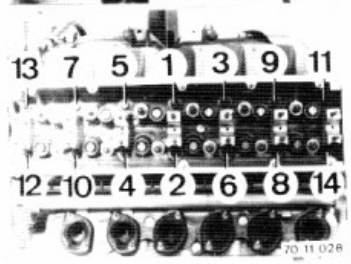
Select a new cylinder head gasket to match the maximum piston protrusion of a bank of cylinders.
Measuring Piston Protrusion:
Set up dial gage in Special Tool 00 2 530 on a cleaned cylinder head sealing surface and set to zero with preload.

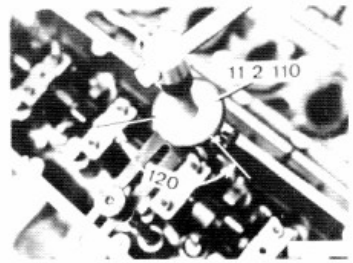


Place dial gage on measuring point "A" of the cleaned piston and find the highest point by turning the crankshaft.
Note the displayed value = "piston protrusion A".
Place dial gage on measuring point "B" and note "piston protrusion B".
The mean value of distances "A" + "B" is the "piston protrusion" of a piston.
Repeat these measurements on all 6 pistons.

** Source: HWB





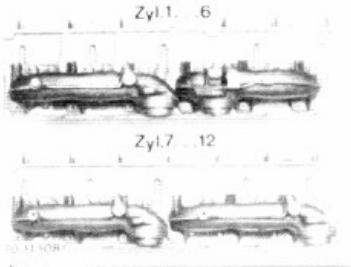


The piston with the greatest amount of "piston protrusion" determines the thickness of the cylinder head gasket.
Cylinder Head Gaskets:

Greatest Piston Protrusion of All 6 Pistons in mm (in.)	Identification of Cylinder Head Gasket No. of Holes
0.288 ... 0.610 (0.011 ... 0.024)	1
0.610 ... 0.832 (0.024 ... 0.033)	2

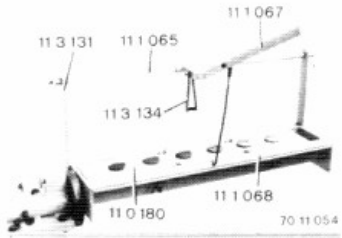
Installation
Mount the cylinder head gasket with the words "FRONT" facing the engine timing end and "TOP" facing up.
Important!
Gaskets differ for cylinder banks 1 ... 6 and 7 ... 12.

Mount cylinder head and tighten cylinder head bolts (washed and lubricated with oil) in order of 1 through 14 in two steps.
Make sure that there is no oil in cavities of the engine block prior to installation of the bolts (danger of cracking block!).
Step 1: 30 Nm (22 ft. lbs.) tightening torque.
Wait 15 minutes.
Step 2: 120° torque angle.
Use Special Tool 11 2 110.



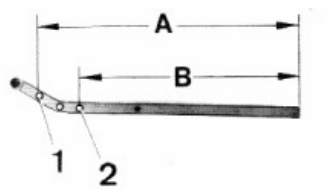
● REMOVING EXHAUST MANIFOLD:

Unscrew bolts and take off exhaust manifold.
Installation:
Replace gasket.
Replace self-locking nuts.
Tightening torque: 24 Nm (17 ft. lbs.).

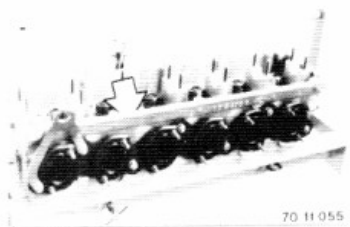


● REMOVING VALVES:

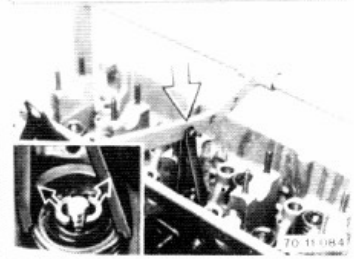
Install assembly fixture in assembly stand 00 1 490.
11 0 180 = Tray (insert with opening for spark plug facing guide rod)
11 1 065 = Assembly fixture
11 1 067 = Guide rod
11 1 068 = Pressure lever
11 3 131 = Guide bar
11 3 134 = Pressure cage



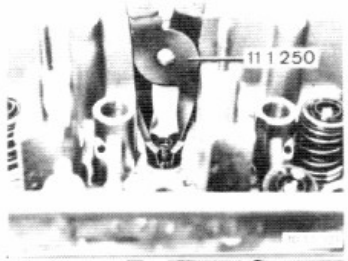
Note:
If not already taken care of, drill 5.1 mm (0.201") dia. holes (1 and 2) in Special Tool 11 1 068 at distance A = 496 mm (19.527") and B = 418 mm (16.457").
Hole 1 for removal of intake valve.
Hole 2 for removal of exhaust valve.



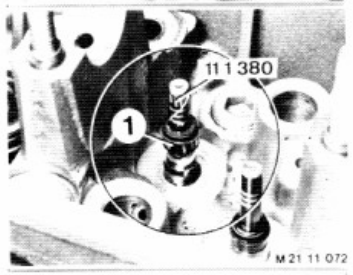
Place cylinder head on assembly fixture with its exhaust end facing the guide rod, align and mount with one cylinder head bolt (front left).



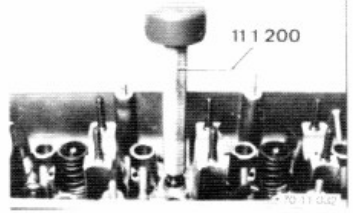
Press down on valve springs and remove valve collets.
Take off valve springs and spring retainers.
Take tray out of the assembly fixture from underneath and remove valve.



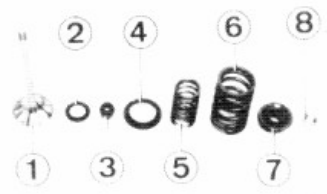
Pull off valve stem seal with Special Tool 11 1 250.



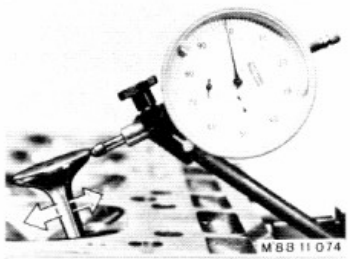
Installation:
Lubricate valve stem with oil and insert valve.
Use a new valve stem seal.
Use Special Tool 11 1 380 to avoid damaging the seal.
Lubricate valve stem seal (1) with oil and install.



Press on valve stem seal by hand against the stop with help of the Special Tool 11 1 200.

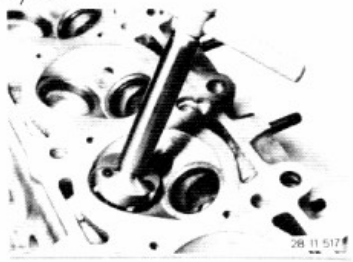


Installed Order:
1 = Valve
2 = Spring retainer - inner spring
3 = Valve stem seal
4 = Spring retainer - outer spring
5 = Inner spring
6 = Outer spring
7 = Upper spring retainer
8 = Valve collets



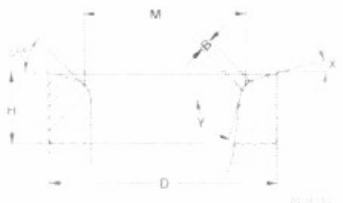
● CHECKING VALVE GUIDE:

Install a new valve for measuring in such a manner, that the valve stem end is flush with the valve guide.
Apply dial gage and measure tilt clearance.
Max. permissible tilt clearance = 0.5 mm (0.020").



● MACHINING VALVE SEAT:

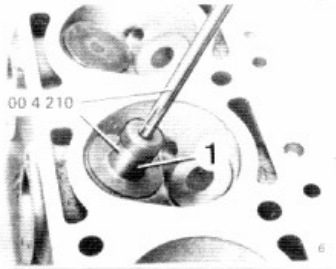
Machine valve seat with Special Tool 00 3 520 or 00 3 580 to instructions supplied with the tool (dimensions: see below).



After machining the valve seat angle (45°), produce the valve seat diameter M and valve seat width B by machining correction angles (X/Y). Grind in valves with a grinding paste and check for leaks.

M	Intake valve	40.6 mm (1.598")
M	Exhaust valve	33.6 mm (1.323")
B	Intake valve	1.65 ±0.25 mm (0.065 ±0.010")
B	Exhaust valve	2.00 ±0.25 mm (0.079 ±0.010")

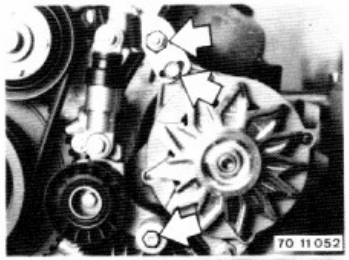
X/Y Intake valve --/60°
X/Y Exhaust valve 35°/60°



● REAMING OUT VALVE GUIDE:

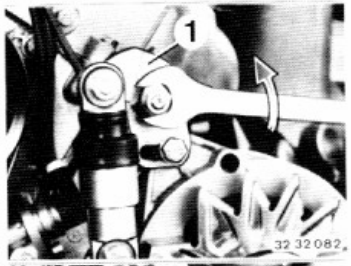
The valve guide must be reamed out and a repair valve with larger stem diameter "S" (+ 0.1/0.2 mm or 0.004/0.008") installed, if there is excessive play between the valve guide and valve stem.
The valve seat must then also be machined.
Press guide pad (1) on valve seat and ream out the valve guide beginning at the combustion chamber end – turn down the reamer once.

B. DISASSEMBLING AND REPAIRING ENGINE BLOCK / CRANKSHAFT

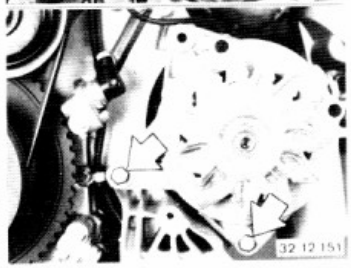


● REMOVING ALTERNATOR:

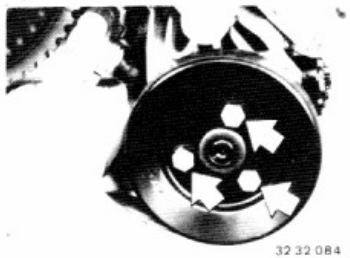
Unscrew bolts and nut.
Take off ribbed drive belt and tensioning element.



Installation:
Turn tensioning lever (1) against the stop slowly and then tighten the bolt and nut.
Tightening torque: 24 Nm (17 ft. lbs.).

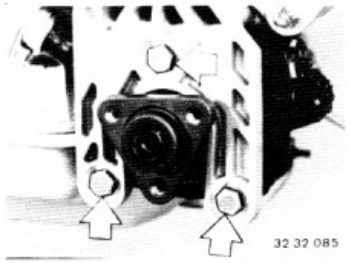


Unscrew bolts and take off alternator.

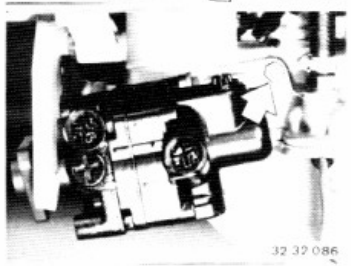


● REMOVING TANDEM PUMP:

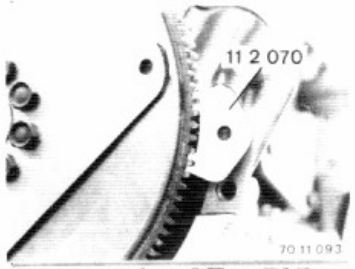
Hold the pulley tight with help of the ribbed drive belt.
Unscrew bolts and take off pulley.



Unscrew bolts.

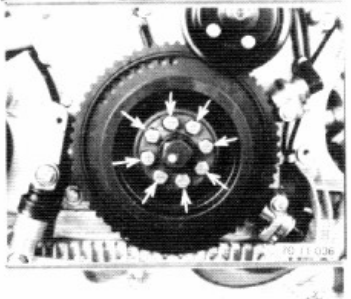


Unscrew bolts.
Take off tandem pump.



● REMOVING VIBRATION DAMPER:

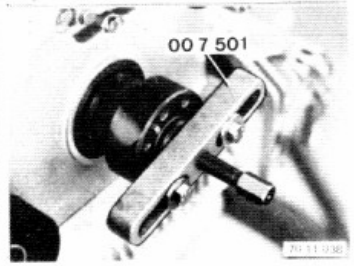
Hold crankshaft with Special Tool 11 2 070.



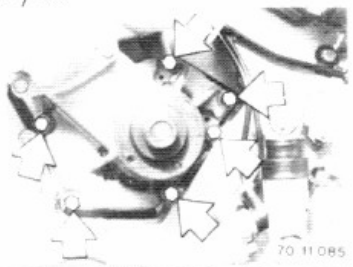
Unscrew bolts and take off vibration damper.
Installation:
Tightening torque: 24 Nm (17 ft. lbs.).

● REMOVING HUB FOR VIBRATION DAMPER

Unscrew bolt.
Installation:
Tightening torque for washed and oiled bolt: 500 Nm (362 ft. lbs.).

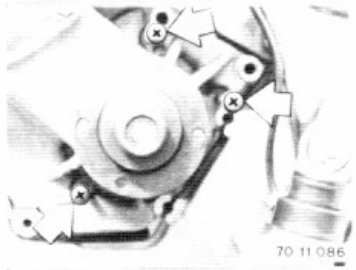


Mount Special Tool 00 7 501 with two bolts and pull off the hub.

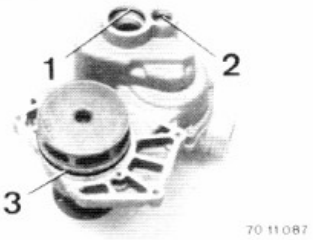


● REMOVING WATER PUMP:

Unscrew bolts.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).

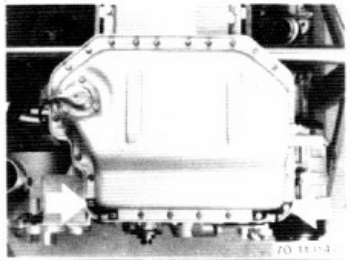


Screw the three M 5 screws in the provided tapped bores and press the water pump off of the engine uniformly.



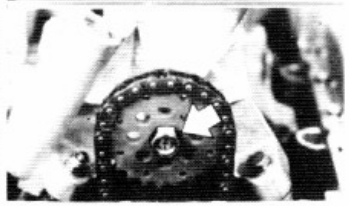
Installation:
Replace and coat O-rings with a lubricant**.

** Source: HWB



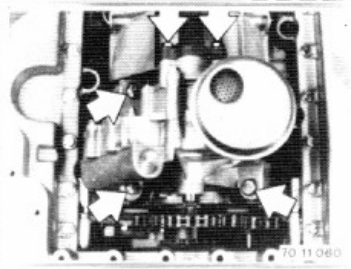
● REMOVING OIL PAN:

Unscrew bolts and take off oil pan.
Installation:
Also mount holder for pipe.
Tightening torque: 10 Nm (7 ft. lbs.)



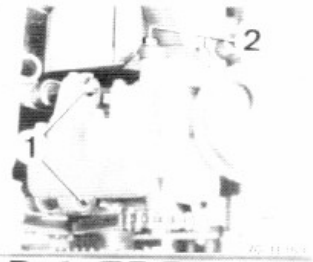
● REMOVING OIL PUMP:

Unscrew nut and take off sprocket with chain.
Installation:
Tightening torque: 28 Nm (20 ft. lbs.).

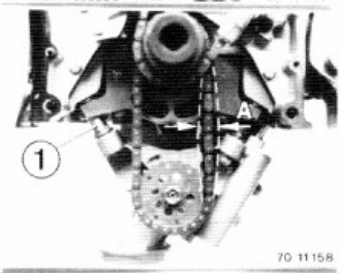


Unscrew bolts and nuts and take off oil pan.

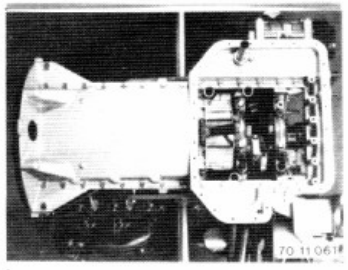
Installation:
Screw in threaded bushing (1) against the stop.
Replace O-rings (2 and 3).



Mount oil pump.
Replace self-locking nuts (1).
Tighten nuts (1) and bolts (2).
Install and tighten sprocket with chain.
Tightening torque:
M 6 – 10 Nm (7 ft. lbs.)
M 8 – 24 Nm (17 ft. lbs.)
M 10 – 28 Nm (20 ft. lbs.)

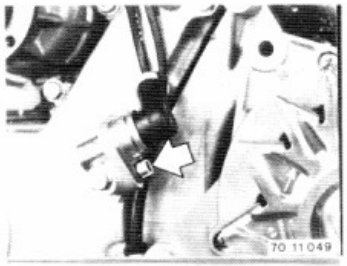


Adjust chain hang to distance A = 7 + 1 mm (0.276 + 0.039") by turning threaded bushing (1).
Install and tighten bolt.
Tightening torque: 24 Nm (17 ft. lbs.).



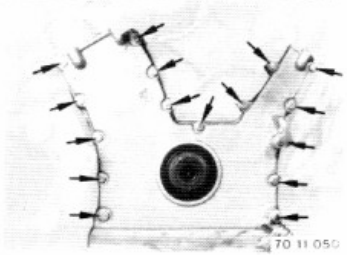
● REMOVING OIL PAN UPPER SECTION:

Unscrew bolts and take off oil pan.
Installation:
Replace gasket.
Tightening torque: 10 Nm (7 ft. lbs.).

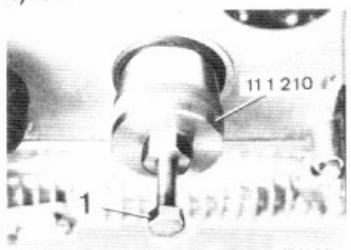


● REMOVING LOWER TIMING CASE COVER:

Remove reference mark sender.
Installation:
Tightening torque: 10 Nm (7 ft. lbs.).

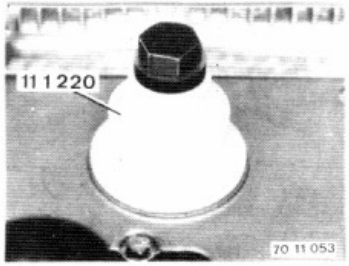


Unscrew mounting bolts and take off timing case cover.
Installation:
Tightening torque:
M 6 = 10 Nm (7 ft. lbs.)
M 8 = 24 Nm (17 ft. lbs.)

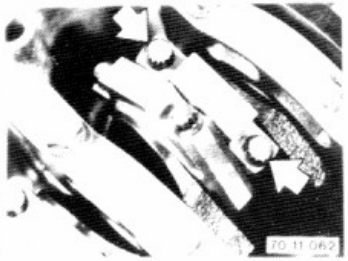


● REPLACING RADIAL OIL SEAL IN TIMING CASE COVER:

Pull off seal with Special Tool 11 1 210.
Screw special tool into seal so deep that it grabs hold of the seal firmly.
Then pull off seal by screwing in bolt (1).



Lubricate sealing lip of seal with oil.
Mount seal flush with timing case cover with Special Tool 11 1 220.

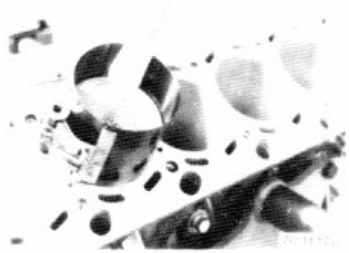


● REMOVING PISTONS:

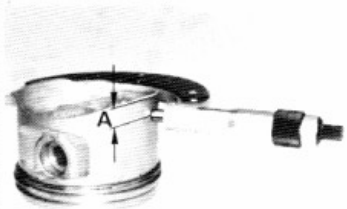
Take off conrod bearing cap and remove piston.
Important!
If conrod bearing shells are not being replaced, mark the installed position of the connecting rod to the crankshaft.
Connecting rods and caps are marked with the same pair number (1 ... 99) and must not be mixed up.

Lubricate piston and piston rings with oil lightly.
Offset end gaps of piston rings by about 120°, however, not higher than the piston pin bore.
Compress piston rings with Special Tool 11 2 260.

If the pistons are not being replaced, mark and reinstall pistons in same locations.

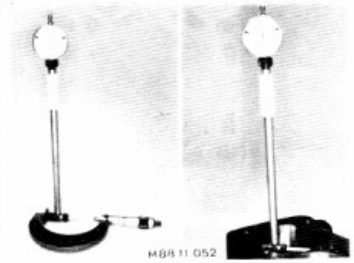


Install piston that arrow faces camshaft drive.
The compressing tool must bear firmly on the crankcase all around.
Then press in piston with light knocks with, for example, the handle of a hammer.
In this case the crankshaft must be aligned, that it cannot be damaged by the connecting rod.
Important!
Don't mix up pistons for cylinder banks 1 ... 6 and 7 ... 12.

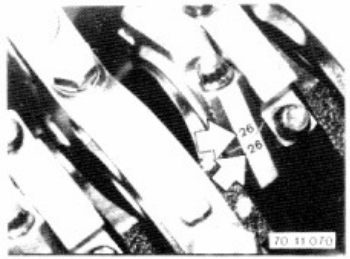


M88 11 051

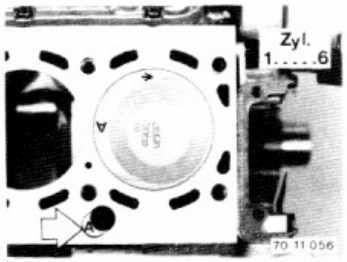
Installation
Measure the piston running clearance prior to installation.
Measure piston diameter with a micrometer at distance A = 14 mm (0.551") from the lower edge of the piston.

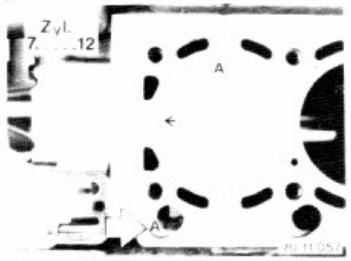


Set internal caliper to zero on the micrometer with the measured piston diameter.
Measure cylinder bore at bottom, middle and top crosswise.
New piston running clearance:
0.01 to 0.04 mm (0.0004 to 0.0016").
Max. permissible total wear:
0.15 mm (0.006").



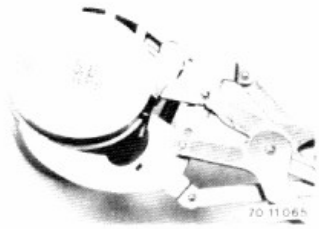
Lubricate conrod bearing shells with oil.
Mount bearing caps that pair numbers are above each other.
Use new conrod bolts.
Tighten conrod bolts in two steps.
Step 1: 20 Nm (14 ft. lbs.) torque
Step 2: 70° torque angle

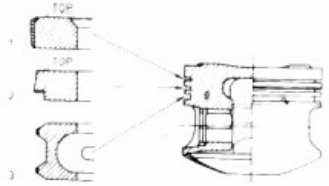


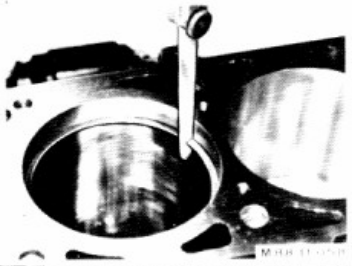


Piston Identification:
Die-stamped in piston crown:
Arrow for direction of installation (←)
Piston classification (A or B)
Rubber stamp information:
Engine type (M 70)
Compression ratio (8.8)
Oversize of repair pistons (0.25 or 0.5)

The cylinder bore identification corresponding with the piston classification is located in the adjacent oil return bore.







● REPLACING PISTON RINGS:

Remove piston rings with a piston ring pliers.

Installation:
Install piston rings with "TOP" facing the piston crown.
1 – Plain compression ring
2 – Tapered face compression ring
3 – Bevelled oil scraper ring with rubber lined spring
Offset piston ring end gaps to each other by 120°, however, not higher than the piston pin bore.

Measuring Side Clearance:

Nominal values:
Groove 1 = 0.040 to 0.065 (0.0016 to 0.0025")
Groove 2 = 0.030 to 0.072 (0.0012 to 0.0028")
Groove 3 = 0.020 to 0.055 (0.0008 to 0.0022")

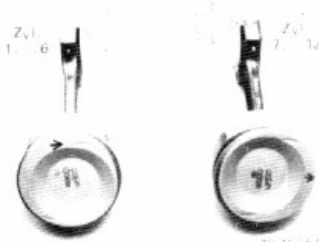
Measuring End Clearance:

Nominal Values:
Ring 1 = 0.20 to 0.40 mm (0.008 to 0.016")
Ring 2 = 0.20 to 0.40 mm (0.008 to 0.016")
Ring 3 = 0.25 to 0.50 mm (0.010 to 0.020")

70 11 063

● REMOVING CONNECTING RODS:

Lift out circlip and press out piston pin.
Important!
Pistons and piston pins are matched and must not be mixed up.
Installation:
Install the circlip that the opening is opposite the recess.



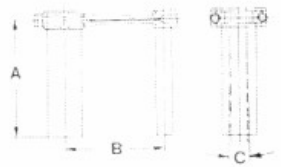
70 11 064

Cylinder Bank 1 ... 6:
Install connecting rod that boss on conrod big end faces timing chain end (in piston arrow direction).

Cylinder Bank 7 ... 12:
Install connecting rod that boss on conrod big end faces the flywheel end (opposite piston arrow direction).

● CHECKING CONNECTING RODS:

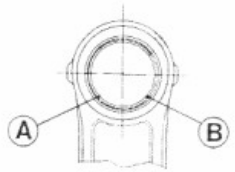
Check connecting rod for deviation in parallel and distortion.
A – Testing distance = 150 mm (5.905").
B – Max. permissible deviation in parallel at distance A ≤ 0.04 mm (0.0016").
C – Max. permissible distortion to each side 0° 30'.



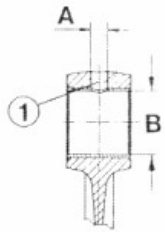
70 11 133

Checking Bushing in Connecting Rod:
The fit between the bushing and piston pin is okay, if the piston pin can be pressed through the bushing by hand with slight force and there is no noticable play.

70 11 068



70 11 131

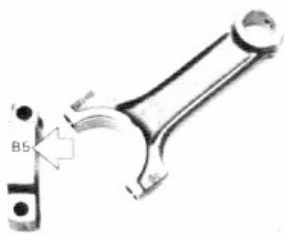


70 11 130

● REPLACING BUSHING IN CONNECTING ROD:

Press out old bushing with a suitable mandrel.
Press in new bushing.
Select point A or B for location of the bushing gap.

Drill oil bore (1) with A = 6 mm (0.236") dia. and deburr bore on bearing surface of bushing.
Ream out bushing with a reamer to diameter B $= 22^{+0.010}_{+0.005}$ mm ($0.8661^{+0.0004}_{+0.0002}$").



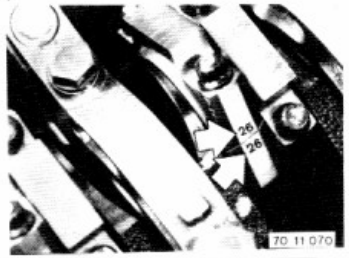
● REPLACING CONNECTING RODS:

Only connecting rods of the same weight group (die-stamped in bearing cap) may be installed in one engine.
In deviation from this a replacement connecting rod (only available in one weight group) or a second connecting rod on the same journal may be replaced.

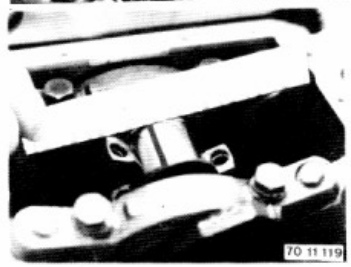
70 11 106

- **REPLACING CONNECTING ROD BEARING SHELLS:**

One each red and blue marked bearing shell half must be used on the connecting rod bearing journal for each connecting rod, regardless of the color code of the connecting rod.



70 11 070



70 11 119

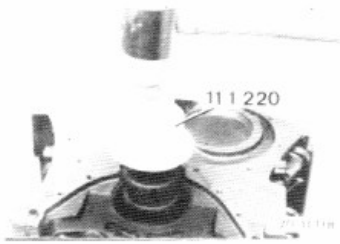
- **CHECKING CONNECTING ROD BEARING PLAY:**

Place Type PG - 1 Plastigage on a crankshaft wiped clean of oil in BDC position.
Mount bearing caps that pair numbers are aligned.
Bolt down bearing caps with old conrod bolts to specified tightening torque.

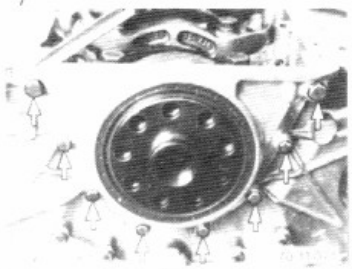
Important!
Don't turn the connecting rods or crankshaft.
Remove bearing caps.
Read bearing play = 0.016 to 0.058 mm (0.0006 to 0.0022") by measuring the width of flattened Plastigage with help of the supplied scale.
Correct bearing play by installing new bearing shells, bearing shells with a different machined size or bearing shells with a different color code.
Lubricate both bearing shells with oil and bolt down bearing cap with new conrod bolts to specified tightening torque for final installation.

● REMOVING CRANKSHAFT SPROCKET:

Pull off sprocket with Special Tools 00 8 500 and 33 1 309.
Note:
Heat sprocket to max. 200° C (392° F) to make removal and installation easier.

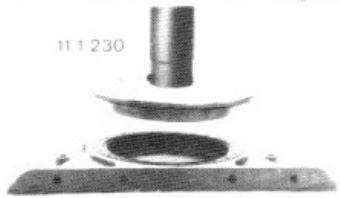


Important!
Sprocket could change its position in cold state.
If applicable, drive on sprocket to be flush with the crankshaft before it is completely cold with help of Special Tool 11 1 220 and a plastic hammer.

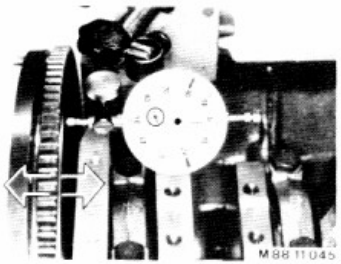


● REMOVING END COVER:

Unscrew bolts and take off cover.
Installation:
Be careful not to damage the shaft seal while mounting the cover.
Replace gasket.
Cut off protruding gasket.
Tightening torque: M 6 – 10 Nm (7 ft. lbs.)
M 8 – 24 Nm (17 ft. lbs.)

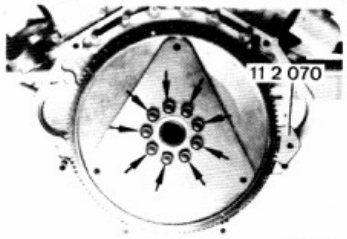


Replacing Radial Oil Seal in End Cover:
Lift out seal and install a new seal with Special Tool 11 1 230.



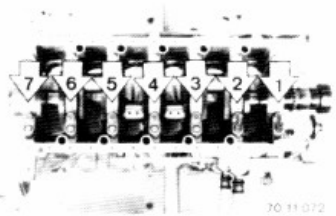
● REMOVING CRANKSHAFT:

Measure the axial play = 0.085 to 0.174 mm (0.0033 to 0.0068") prior to removal of the crankshaft.
Maximum Permissible Play Exceeded:
Check / replace thrust bearing.



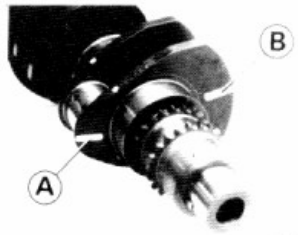
70 11 159

Unscrew bolts.
Take off flywheel and drive plate.
Installation:
Tightening torque: 100 Nm (72 ft. lbs.).



70 11 072

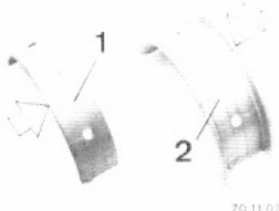
Remove crankshaft bearing caps and lift out crankshaft.
Note:
Bearing cap identification
Bearing caps 1 ... 5 with stamped numbers (bearing no. 1 on timing chain end)
Bearing cap 6 without identification
Bearing cap 7 (thrust bearing) without identification.
Refer to "Replacing Main Bearing Shells" for installation of bearing caps.



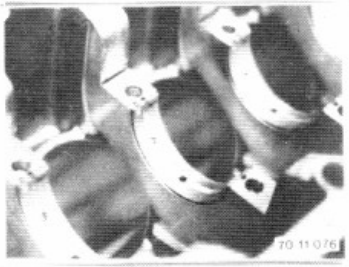
70 11 074

Note:
Crankshafts are surface treated and may only be reground in the factory.
Reground crankshafts are marked with stripes of paint.
Conrod Bearing Journals (A) and
Main Bearing Journals (B):
1 paint stripe – size 1 (0.25 mm / 0.010")
2 paint stripes – size 2 (0.50 mm / 0.020")

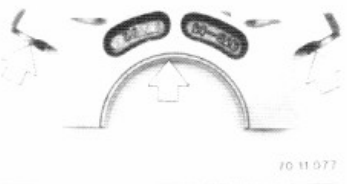
● REPLACING MAIN BEARING SHELLS:



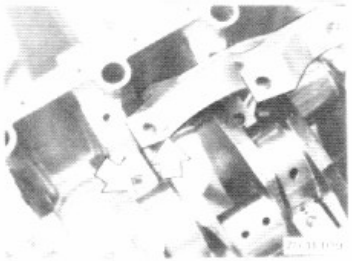
Always replace bearing shells with shells having a yellow color code, regardless of the color code on the crankshaft or crankcase.
1 = Bearing shells 1 ... 6
2 = Bearing shells 7 (thrust bearing)
Important!
Check ground size of crankshaft.



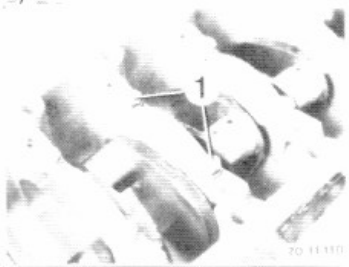
Place upper bearing shell (with oil groove) in the crankcase.
Install crankshaft.



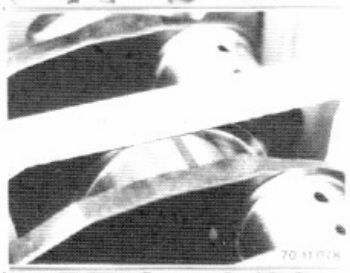
Turn back threaded bushings in bearing caps completely.
Install the lower bearing shell.



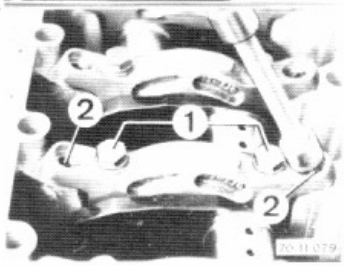
Place Type PG - 1 Plastigage on crankshaft wiped clean of oil.
Mount bearing caps that guide grooves in caps and crankcase are on one side.
Important!
Don't turn the crankshaft.



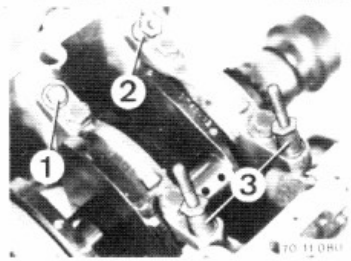
Align bearing caps and screw in bolts (1) by hand until caps bear.
Now tighten bolts (1) in two steps.
Step 1: 20 Nm (14 ft. lbs.) tightening torque
Step 2: 70^{0} torque angle



Remove bearing caps again.
Read bearing play (nominal: 0.026 to 0.078 mm or 0.0010 to 0.0031") by measuring width of flattened Plastigage with help of the supplied scale.
Starting with yellow bearing shells, white bearing shells could also be installed to correct excessive bearing play.
Reduction in play of 0.014 to 0.042 mm (0.0005 to 0.0016").



Lubricate both bearing shells with oil for final installation.
Tighten bolts (1) to specified torque.
Tighten threaded bushings (2) with 10 Nm (7 ft. lbs.) to have them bear.



Install bolts (1) and oil pump consoles (2 and 3) and torque with 34 Nm (25 ft. lbs.).