MUSSO

Workshop Manual

Foreword

This workshop manual contains notes, diagnoses, service data, precautions, etc. that are needed for the maintenance, adjustments, service, removal and installation of Ssangyong vehicle by service technicians of authorized Ssangyong dealers.

May 1996

Printed in Korea.

SsangYong Motor Company

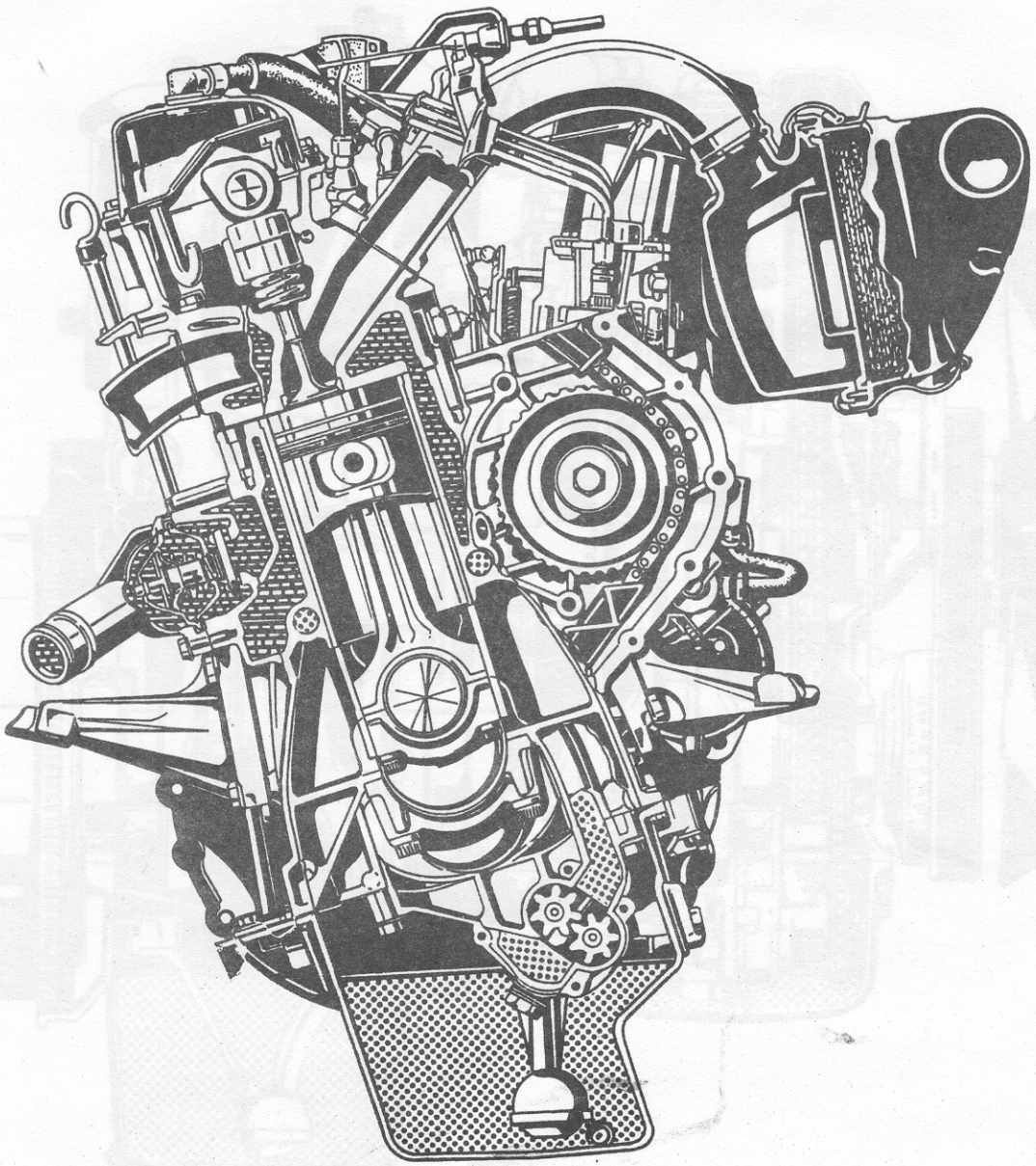
CONTENTS

Diesel Engine D

1. Sectional View

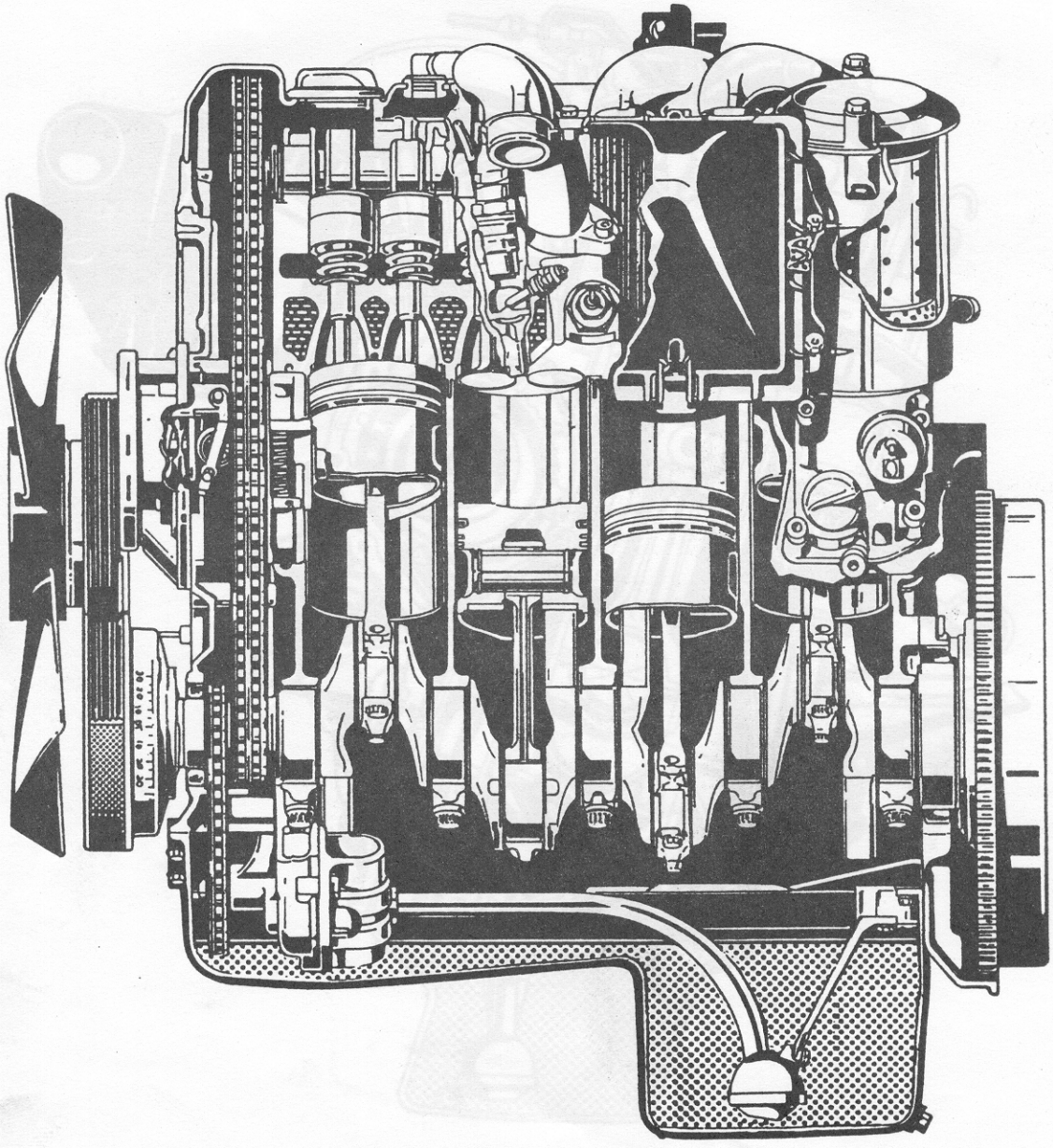
OM 661 Engine

Front view



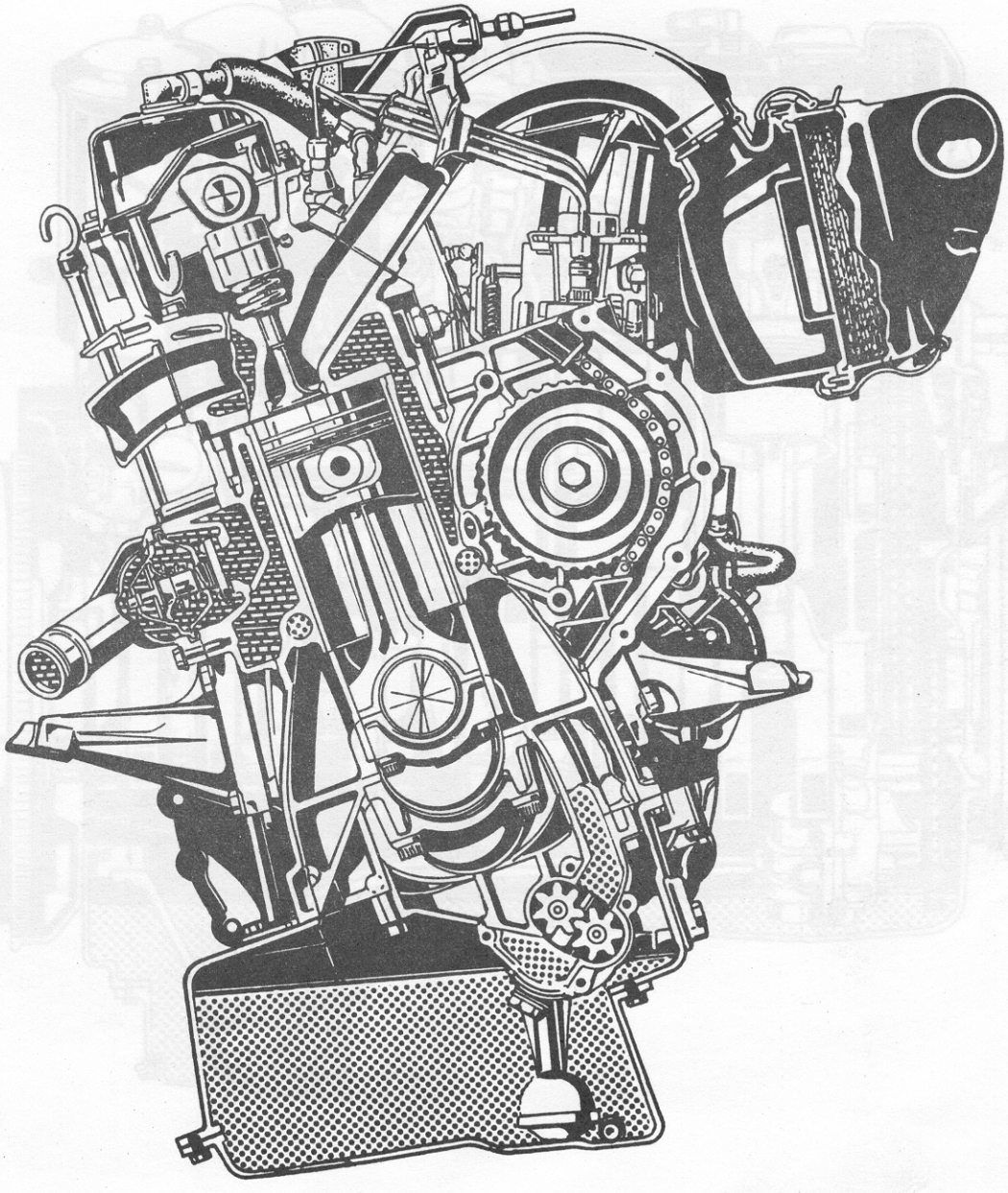
OM 661 Engine

Side view



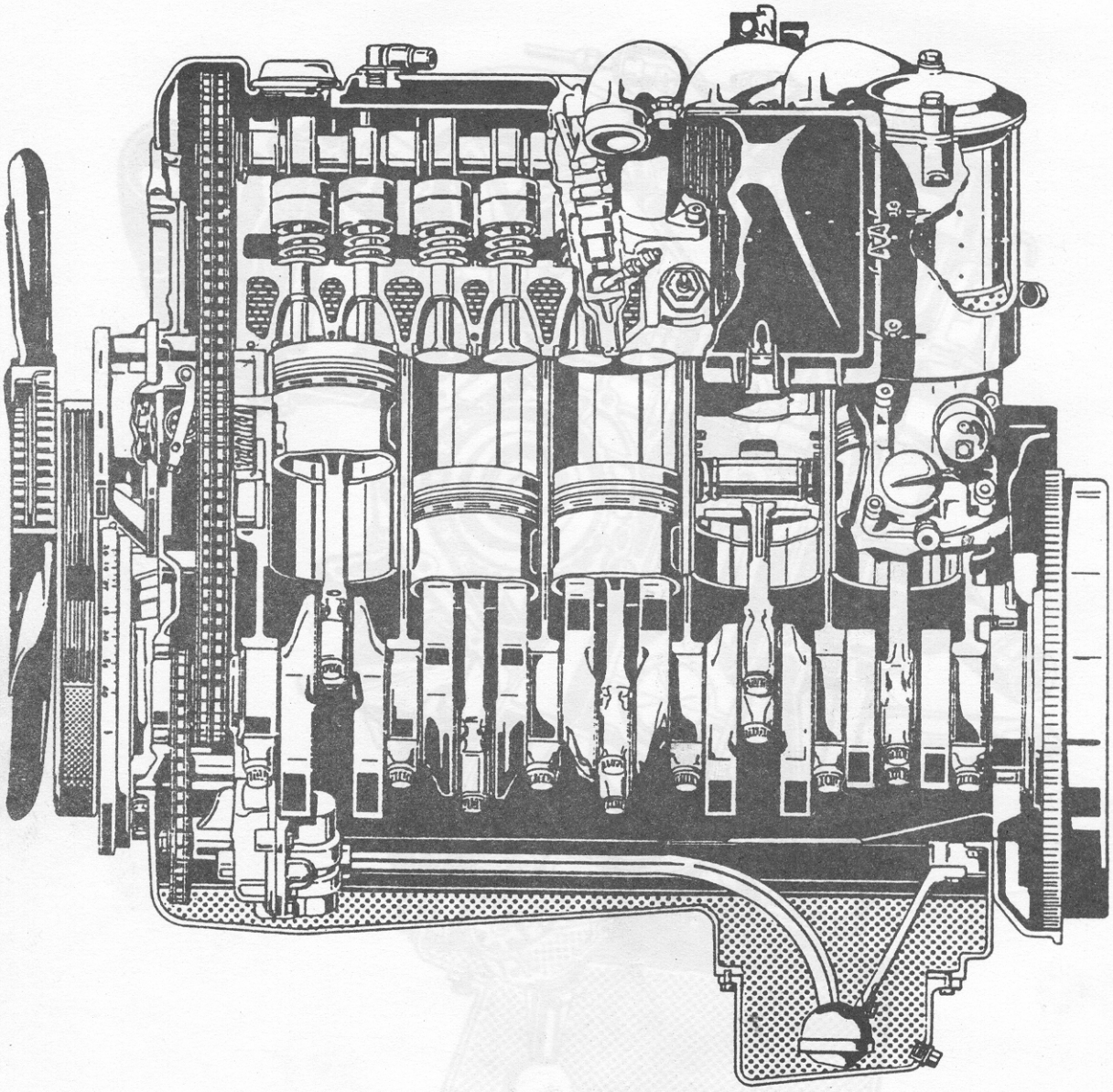
OM 662 Engine

Front view



OM 662 Engine

Side view

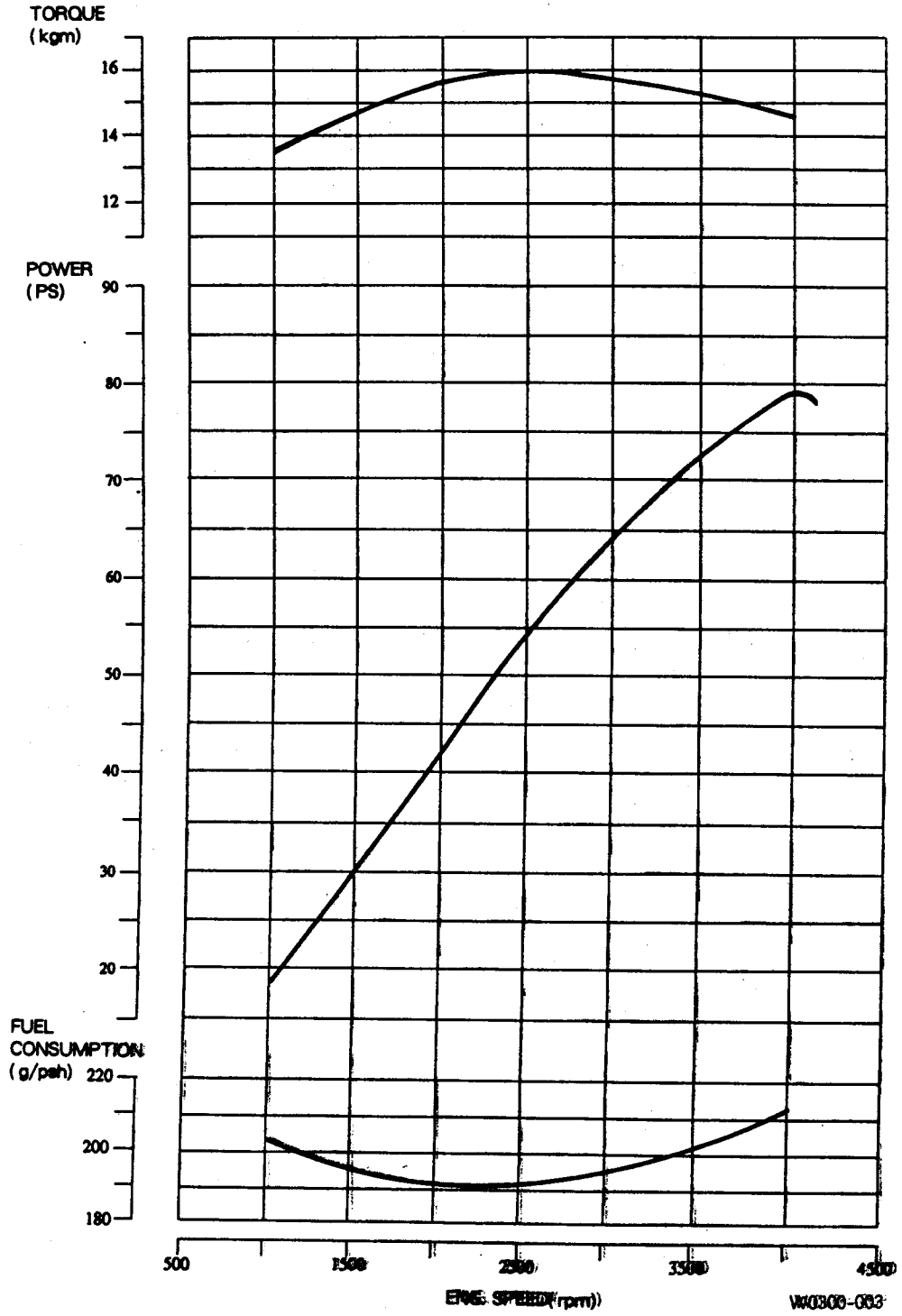


2. Specifications

Item	OM 661 Engine	OM 662 Engine
Type	4 - stroke Diesel, Prechamber	4 - stroke Diesel, Prechamber
Number of cylinders	4	5
Cylinder arrangement	Vertical in-line Angled 15 ° to the right	Vertical in-line Angled 15 ° to the right
Bore X Stroke (mm)	89 X 92.4	89 X 92.4
Displacement (cc)	2,299	2,874
Compression ratio	22 : 1	22 : 1
Firing order	1 - 3 - 4 - 2	1 - 2 - 4 - 5 - 3
Max. output	58kw (79ps) / 4,000rpm	70kw (95ps) / 4,000rpm
Max. torque	175Nm(16kgm)/2,400-2,800rpm	192Nm(19.6kgm)/2,400-2,600rpm
Weight (dry) (kg)	176	200
Valve arrangement	Overhead	Overhead
Camshaft arrangement	SOHC	SOHC
Oil capacity (ℓ)	Max. 8.0, min. 6.5	Max. 9.5, min. 8.0
Cooling system	Forced circulation by pump	Forced circulation by pump
Coolant capacity (ℓ)	9.0	10
Cooling fan	Fan with viscous coupling	Fan with viscous coupling
Thermostat opening	85℃	85℃
Lubrication system	Gear pump	Gear pump
Oil filter	Full-flow and partial-flow filter	Full-flow and partial-flow filter
Air cleaner	Dry, paper cartridge	Dry, paper cartridge

3. Engine Performance Curve

OM 661 Engine



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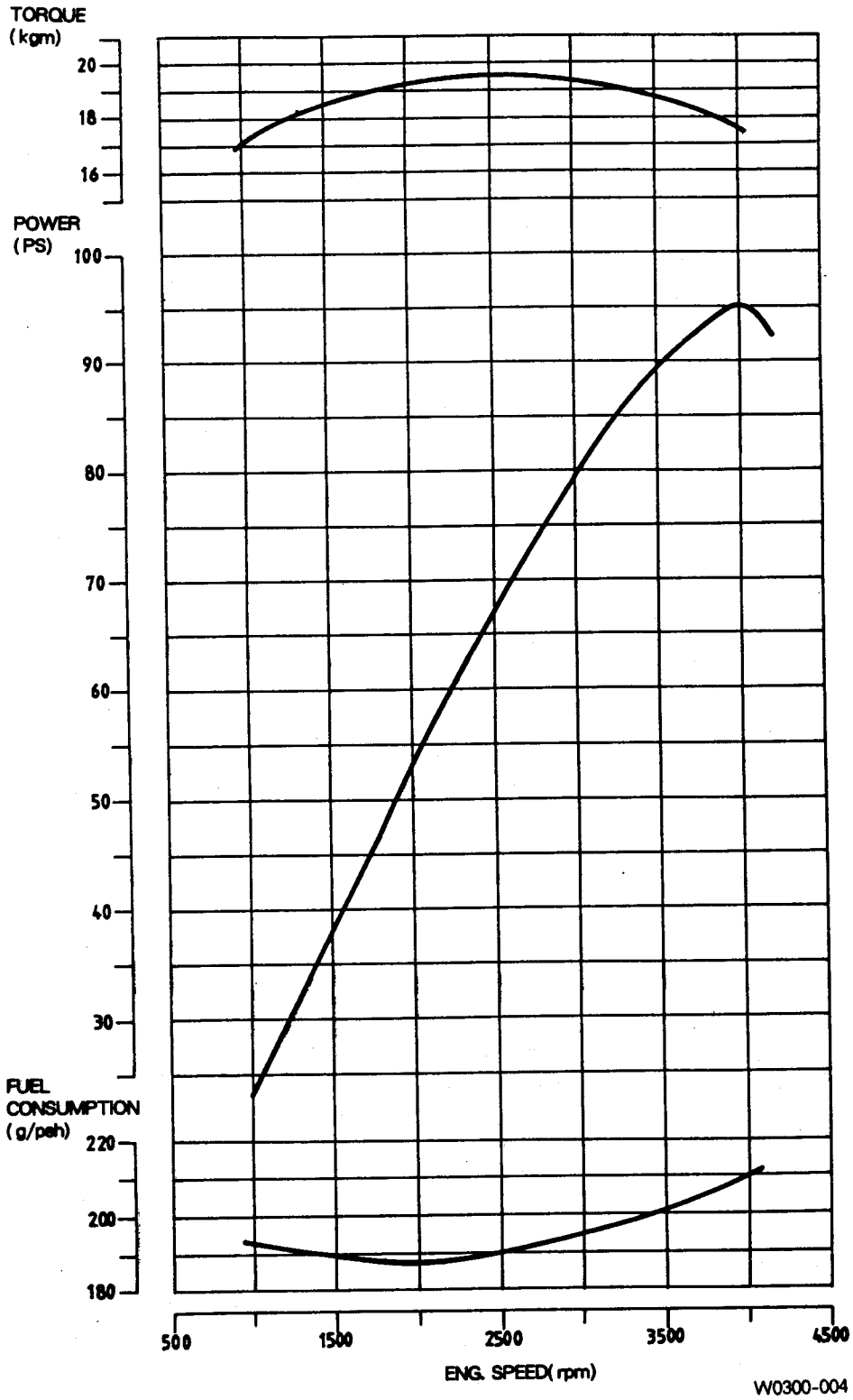
OM 662 Engine



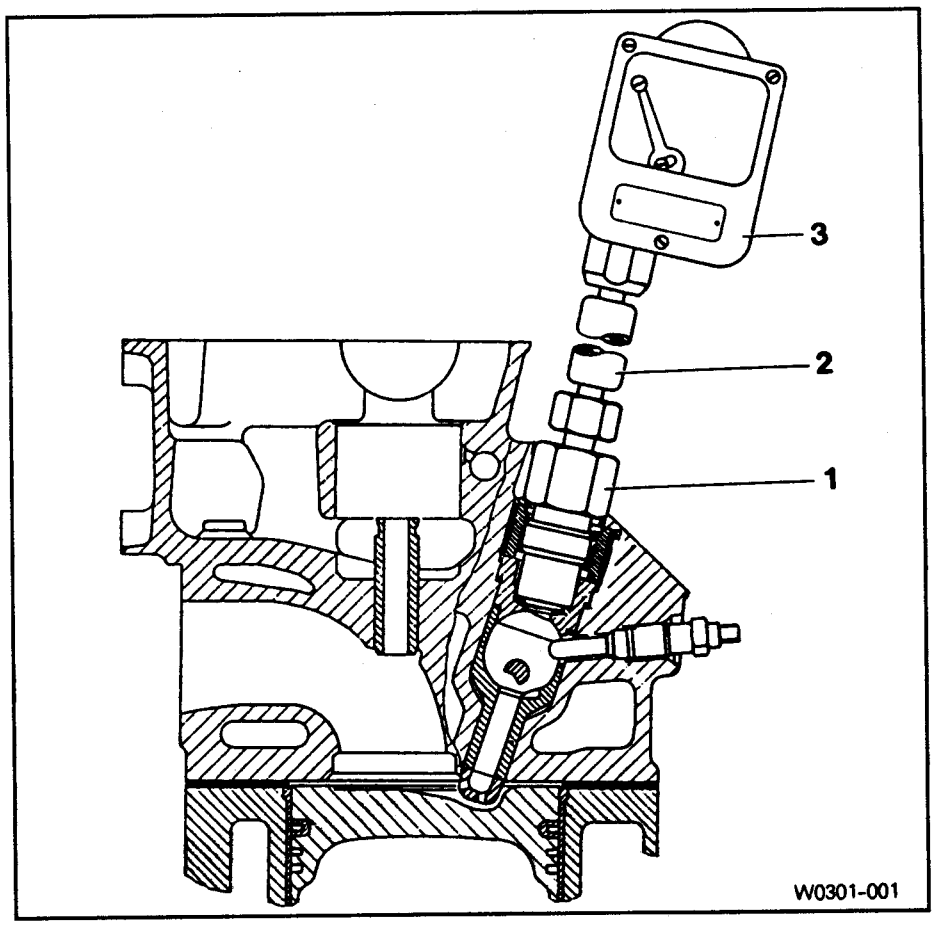
4. Special Tool List

Part Name	Part No.
Box Wrench Insert	000 589 77 03 00
T Type Socket Wrench	116 589 03 07 00
Flange	601 589 00 08 00
Socket Wrench Insert	001 589 65 09 00
Serration Wrench	603 589 00 09 00
Cylinder Head Bolt Wrench	601 589 00 10 00
Tensioning Strap	000 589 04 14 00
Sleeve	601 589 03 14 00
Assembly Cage	601 589 08 14 00
Drift	102 589 00 15 00
Drift	102 589 12 15 00
Drift	103 589 02 15 00
Drift	103 589 03 15 00
Drift	116 589 07 15 00
Drift	601 589 05 15 00
Drift	601 589 06 15 00
Drift	601 589 08 15 00
Dial Gauge	001 589 32 21 00
Dial Gauge	001 589 53 21 00
Hand Vacuum Pump	001 589 73 21 00
Compression Pressure Recorder	001 589 76 21 00
Vacuum Tester	201 589 13 21 00
Dial Gauge Holder	363 589 02 21 00
Extension	366 589 00 21 05
Blocking Screw	601 589 05 21 00
Depth Recorder	601 589 07 21 00
Tester	617 589 04 21 00
Position Sensor	617 589 08 21 00
RI. Adapter	617 589 09 21 00
RI. Sensor	617 589 10 21 00
TDC Pulse Generator	667 589 00 21 00

Part Name	Part No.
Timing Adjuster	667 589 01 21 00
GO/NO GO Gauge	102 589 00 23 00
GO/NO GO Gauge	117 589 03 23 00
GO/NO GO Gauge	601 589 02 23 00
Height Gauge	667 589 00 23 00
Pressure Measuring Plate	601 589 00 25 00
Fuel Injection Nozzle Tester	000 589 14 27 00
Press Lever	667 589 00 31 00
Internal Extractor	000 589 25 33 00
Counter Support	000 589 33 33 00
Puller	102 589 05 33 00
Puller	103 589 00 33 00
Sliding Hammer	116 589 20 33 00
Threaded Pin	116 589 02 34 00
Flier	104 589 00 37 00
Magnetic Bar	102 589 03 40 00
Engine Rotate Fixer	601 589 02 40 00
Engine Rotate Fixer	602 589 00 40 00
Counter Holder	603 589 00 40 00
Holding Wheel	603 589 01 40 00
Chain Assembler	000 589 58 43 00
Drift	601 589 02 43 00
Reamer	000 589 10 53 00
Reamer	000 589 21 53 05
Oil Seal Assembler	601 589 03 43 00
Broaching Tool	115 589 00 53 00
Broaching Tool	115 589 01 53 00
Assembling Plate	601 589 01 59 00
Supporting Bridge	601 589 02 59 00

Part Name	Part No.
Suspension Device	115 589 34 63 00
Magnetic Finger	116 589 06 63 00
Super Cooling Box	346 589 00 63 00
Supporting Bar	667 589 02 63 00
Sliding Hammer	667 589 03 63 00
Retaining Plate	667 589 04 63 00
Guide Sleeve	102 589 00 63 00
Guide Sleeve	102 589 08 63 00
Guide Sleeve	601 589 15 63 00
Counter Sink	601 589 00 66 00
Cleaning Set	000 589 00 68 00
Cylinder Brush	000 589 10 68 00

1. Compression Pressure Test



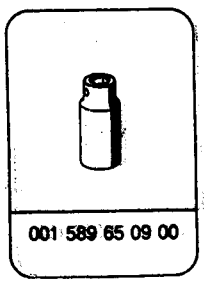
1. Test Adapter
2. Flexible Connector
3. Compression Pressure Recorder

Service data

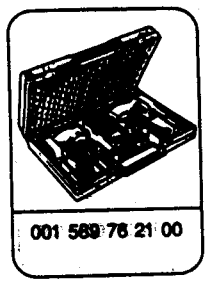
Normal compression pressure	28bar
Minimum compression pressure	Approx. 18bar
Permissible pressure difference between individual cylinders	Max. 3bar

• Engine at normal operating temperature of 80℃

Special tools


001 589 65 09 00


001 589 73 21 00


001 589 76 21 00

Compression pressure measurement

[Note] Ensure that no gear is engaged and that the vehicle is protected from rolling.

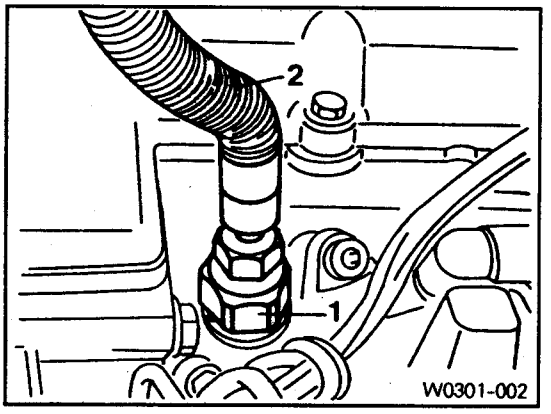
1) Run the engine to be the coolant temperature 80℃.

2) Remove the fuel injection nozzle.

Socket wrench insert 001 589 65 09 00

3) Install the test adapter (1) and connect the flexible connector (2) to the compression pressure recorder.

Compression pressure recorder 001 589 76 21 00

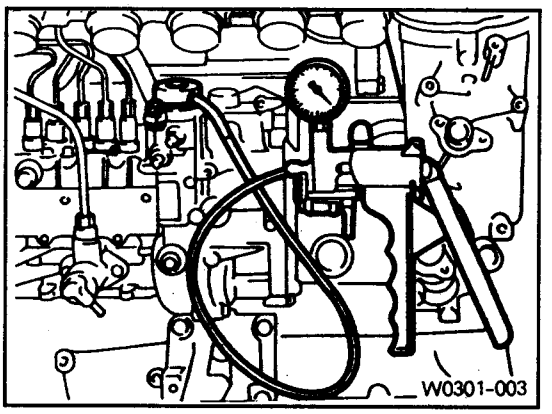


4) Disconnect the vacuum line from the stop unit and connect the hand vacuum pump to the stop unit.

5) Pump the hand vacuum pump and make the fuel injection pump in stop position.

Operating pressure	Approx. 500bar

Hand vacuum pump 001 589 73 21 00



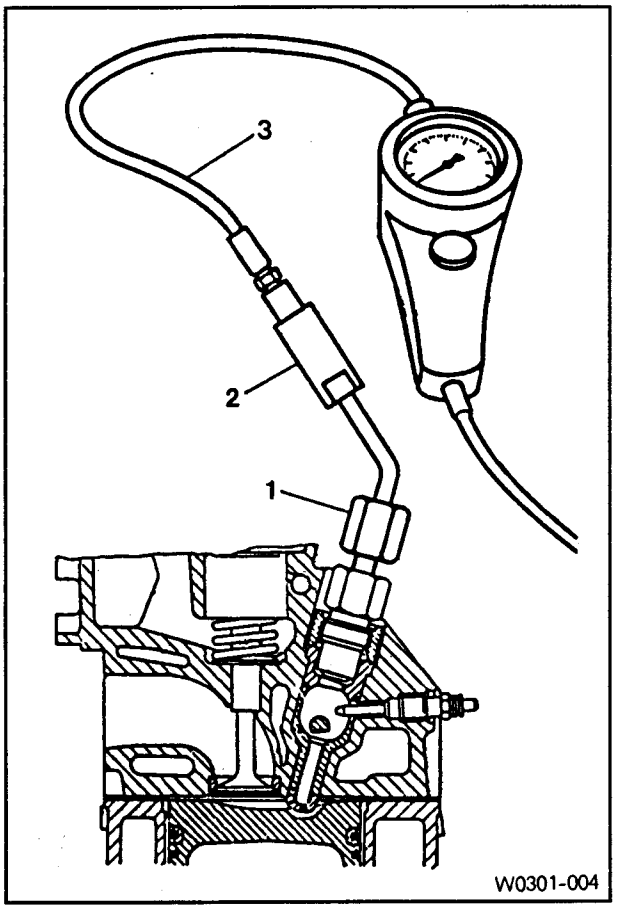
6) Using a starter motor, crank the engine 8 revolutions.

7) Measure the remaining cylinders' compression pressure in the same manner and compare it with service data.
[Note] If out of standard, do cylinder pressure leakage test.

8) Remove the compression pressure recorder.

9) Install the fuel injection nozzle.

2. Cylinder Pressure Leakage Test



1. Connector
2. Connection Piece
3. Connection Hose

Permissible pressure leakage (Engine at normal operating temperature of 80℃)

At whole engine	Max. 25%
At valve and cylinder head gasket	Max. 10%
At piston ring	Max. 20%

Commercial tools

Cylinder pressure leakage tester	BOSCH, EFAW 210 A or SUN CLT 228
Connection piece	BOSCH order no. 1 687 010 016

Leakage test

1) Run the engine to be the coolant temperature 80℃.

2) Remove the fuel injection nozzle.

3) Open the coolant subtank cap.

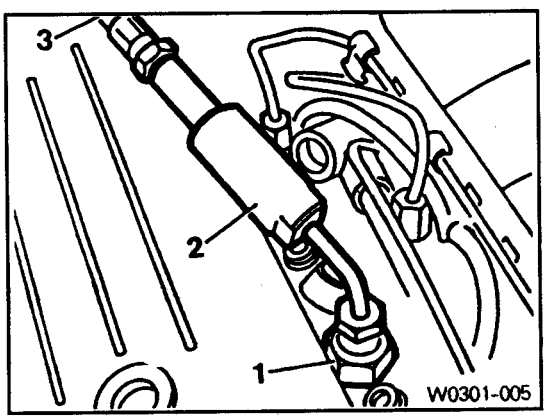
4) Check the coolant level and replenish if necessary.

5) Open the oil filler cap.

6) Remove the air cleaner cover and element.

7) Position the piston at TDC.

8) Install the connector (1) and connection piece (2).



9) Calibrate the tester and connect the connection hose (3) exactly.

10) Pressurize with compressed air and compare the pressure changes with permissible pressure leakage.

11) If permissible pressure leakage is out of standard, check followings :
- Intake and exhaust lines.
- Sounds in oil filler area.
- Air bubbles in radiator coolant.

12) Do pressure leakage test for the remaining cylinders according to the firing order.
- OM 661 Engine : 1 - 3 - 4 - 2
- OM 662 Engine : 1 - 2 - 4 - 5 - 3

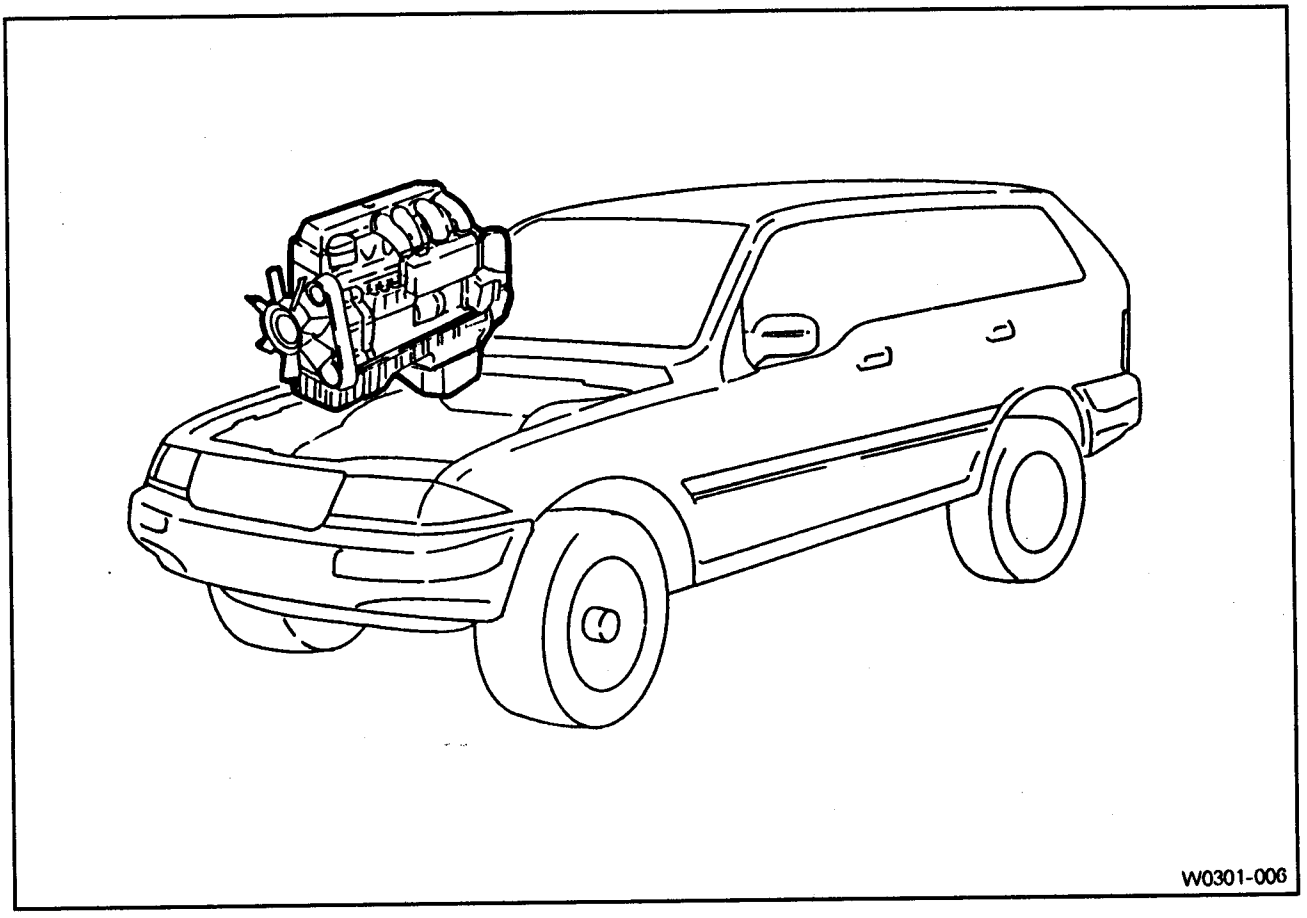
13) Remove the tester.

14) Close the coolant pressure cap and oil filler cap.

15) Install the air cleaner element and cover.

16) Install the fuel injection nozzle.

3. Removal and Installation of Engine

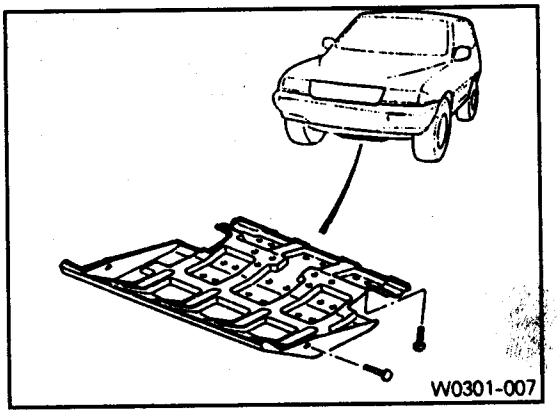


Removal

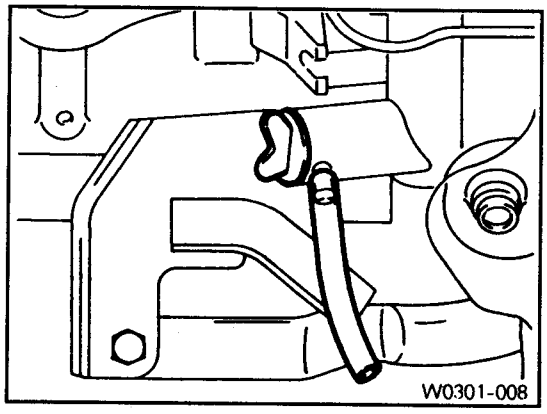
1) Disconnect the battery negative terminal.

2) Remove the hood.

3) Remove the under cover.



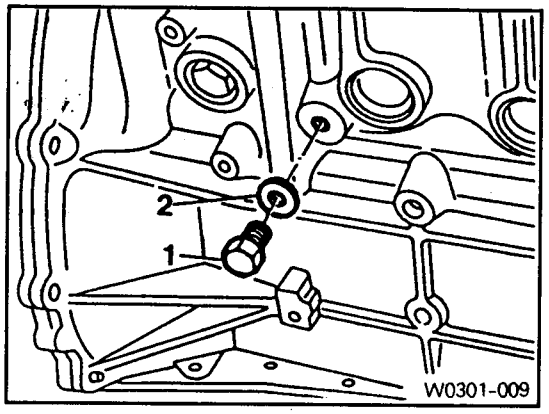
4) Remove the radiator drain cock and drain the coolant.
[Note] Open the coolant reservoir tank cap.



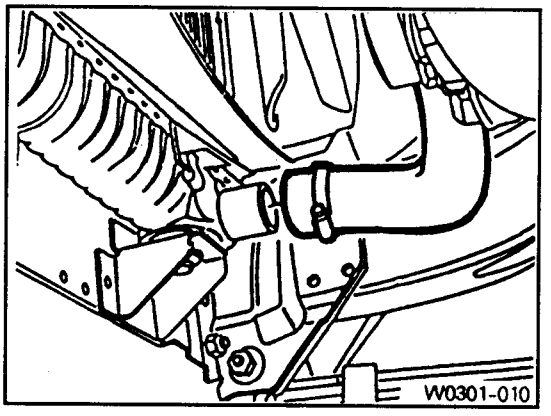
5) Remove the drain plug (1) and seal (2) from the cylinder block and drain the coolant completely.

6) After draining, replace the seal and reinstall the drain plug.

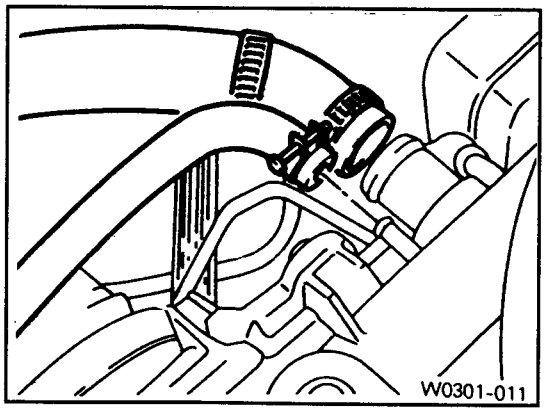
Tightening torque	30Nm



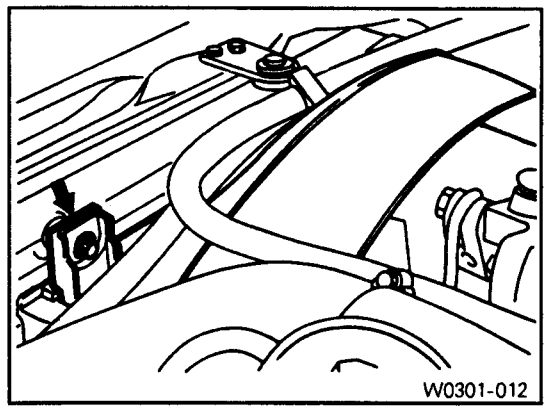
7) Disconnect the lower coolant hose from the radiator.



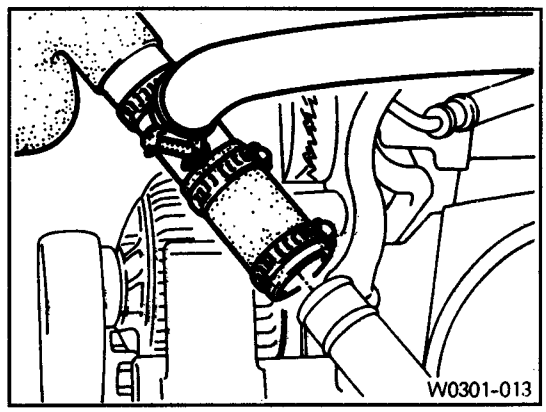
8) Disconnect the upper coolant hose from the radiator.



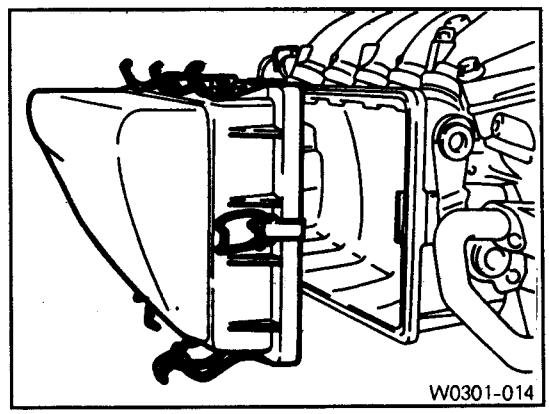
9) Remove the cooling fan shroud.



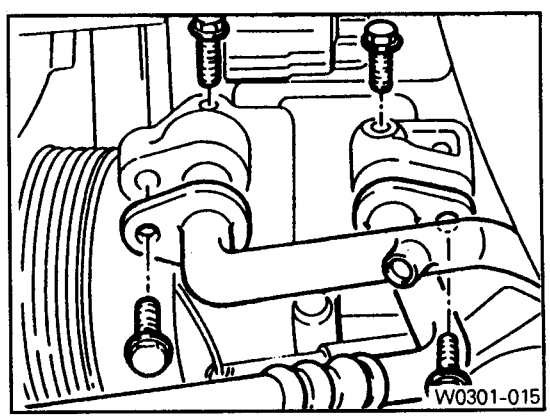
10) Disconnect the coolant hose from the thermostat.



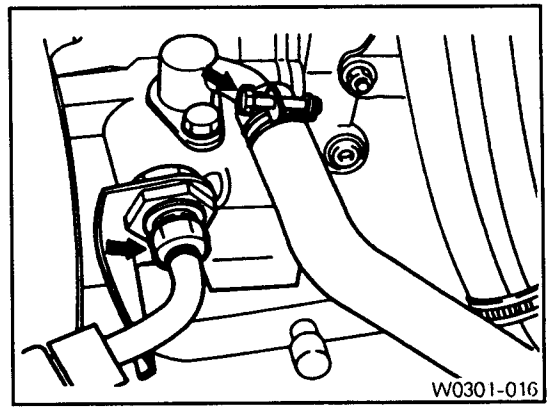
11) Remove the air cleaner cover and element.



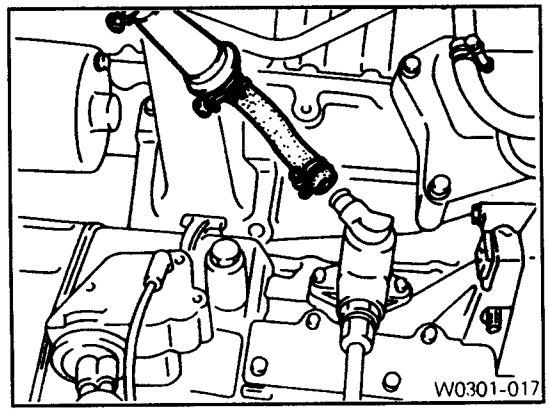
12) Remove the air-conditioner lines from the compressor.
[Note] Evacuate the refrigerant before removal.



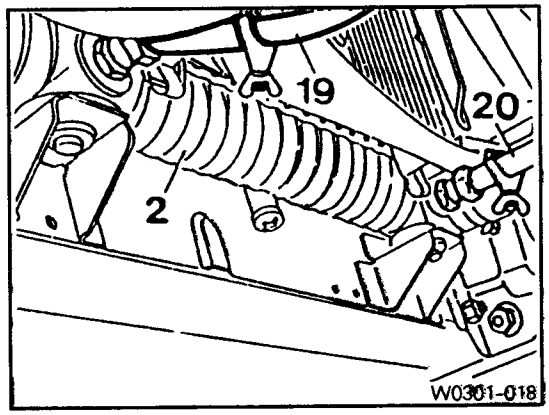
13) Remove the power steering pump lines.
[Note] Completely drain the fluid.



14) Disconnect the fuel feed line from the prefilter.

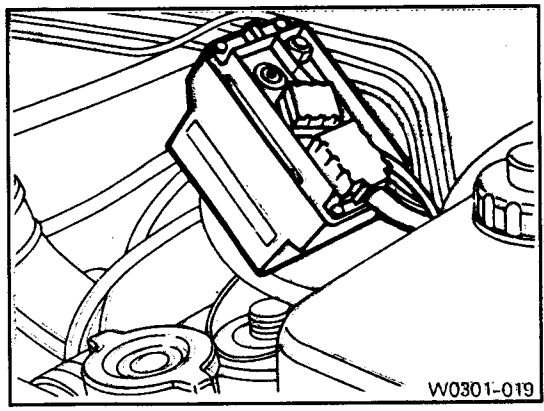


15) **Vehicle with automatic transmission.**
Remove the hydraulic lines (19, 20) from oil cooler (2).

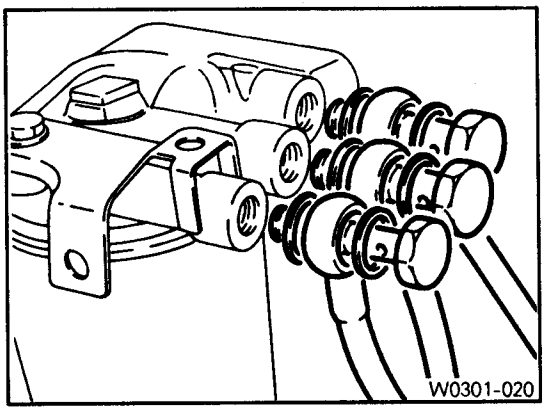


16) Disconnect the engine harness.

17) Disconnect the preheating time relay cable.

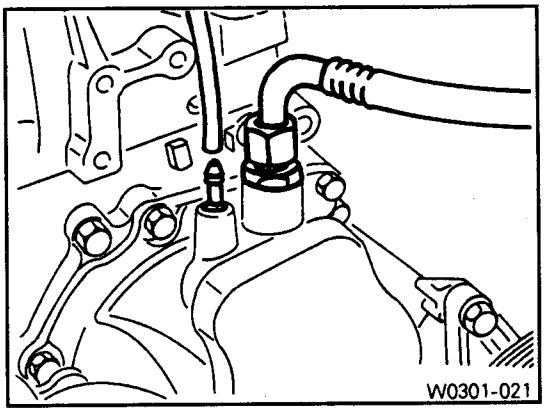


18) Remove the fuel lines from the fuel filter and cover the filter with plug.



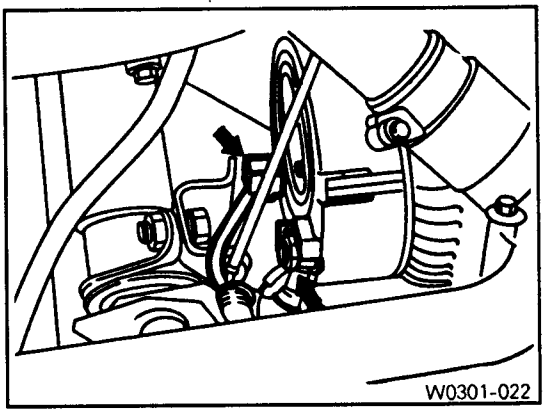
19) Disconnect the brake booster hose from vacuum pump.

20) Disconnect other vacuum lines.

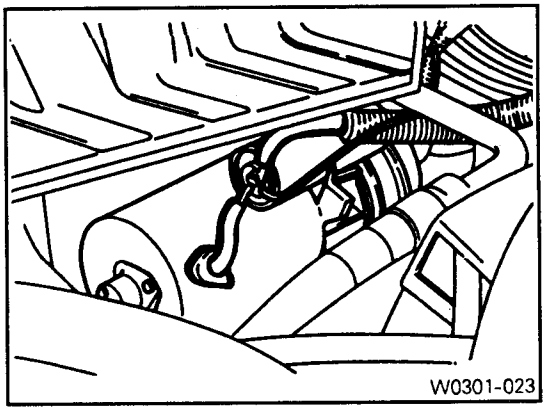


21) Disconnect the ground cable.

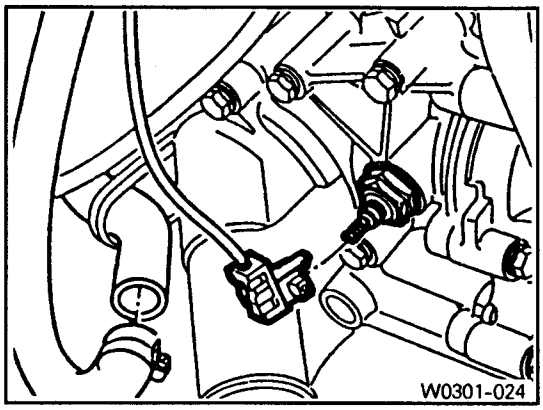
22) Disconnect the alternator wires.



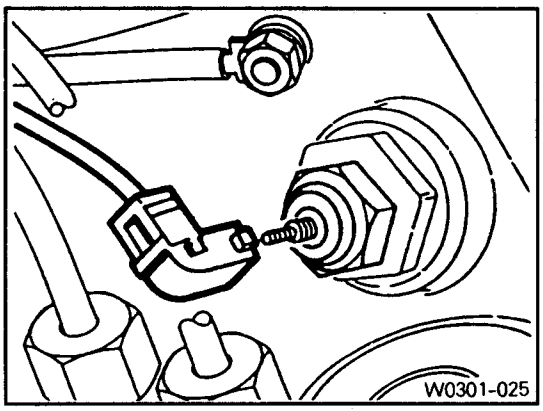
23) Disconnect the starter motor wires and remove the starter motor.



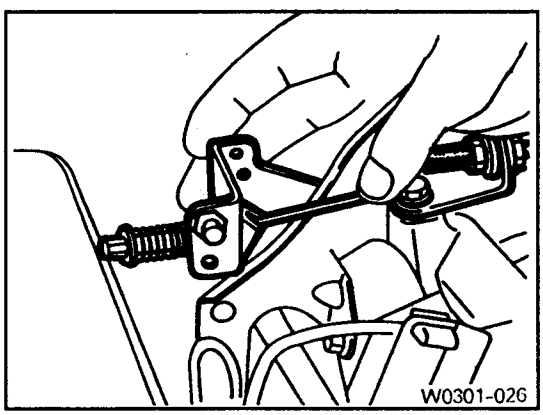
24) Disconnect the preheating time relay sensor plug.



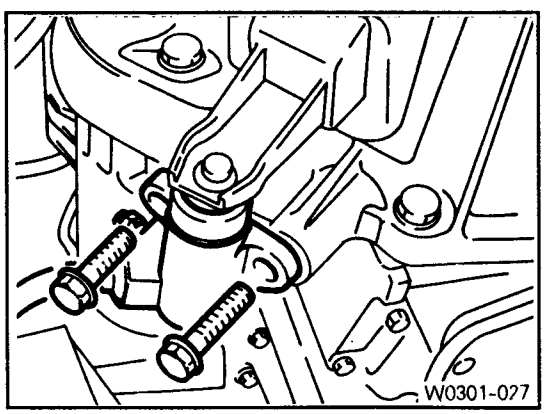
25) Disconnect the coolant temperature sensor plug.



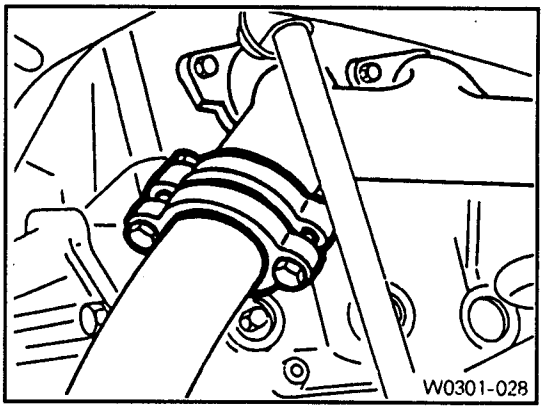
26) Separate the accelerator cable from the control linkage.



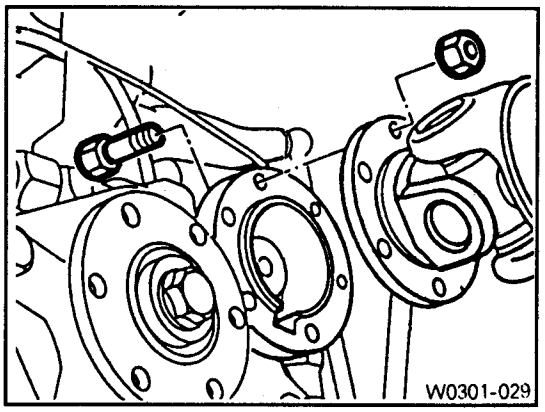
27) Remove the clutch release cylinder.



28) Separate the exhaust pipe flange from the exhaust manifold.

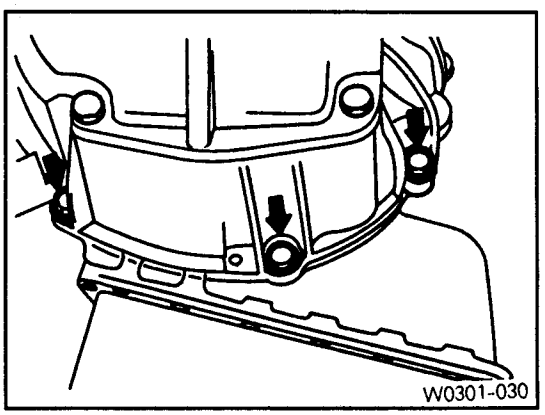


29) Remove the propeller shaft from the transmission.

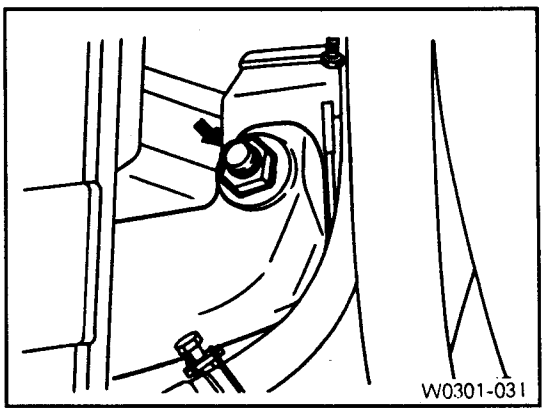


30) Remove the shift control cable.

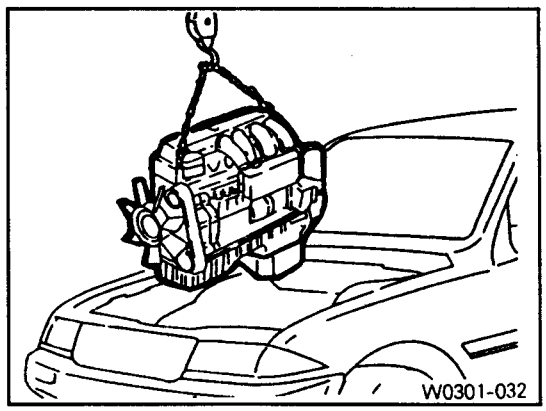
31) Remove the transmission.



32) Remove the engine mounting bracket bolts.



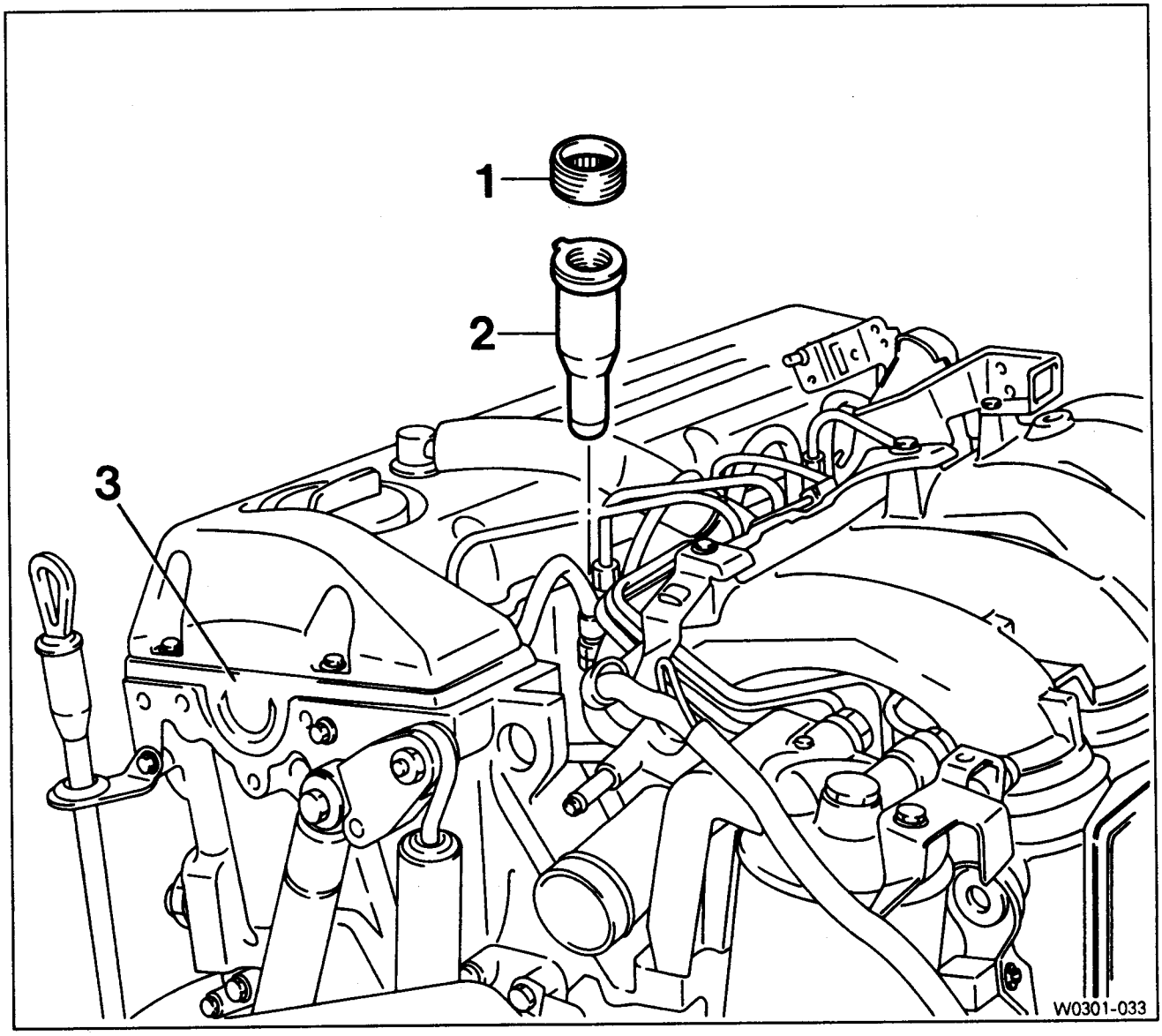
33) Remove the engine assembly from the vehicle by using a hoist or crane.



34) Installation is reverse order of the removal.

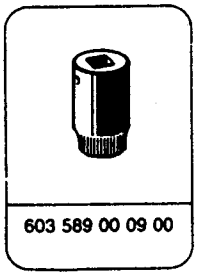
4. Removal and Installation of Prechamber

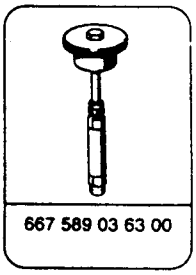
Preceding work : Removal of glow plug (15-08)
Removal of fuel injection nozzle (07-19)



1. Threaded Ring ---------- 120Nm
2. Prechamber
3. Cylinder Head ---------- 20Nm

Special tools

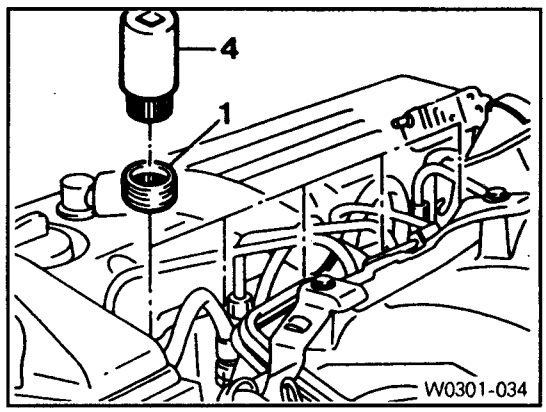

603 589 00 09 00


667 589 03 63 00

Removal · Installation

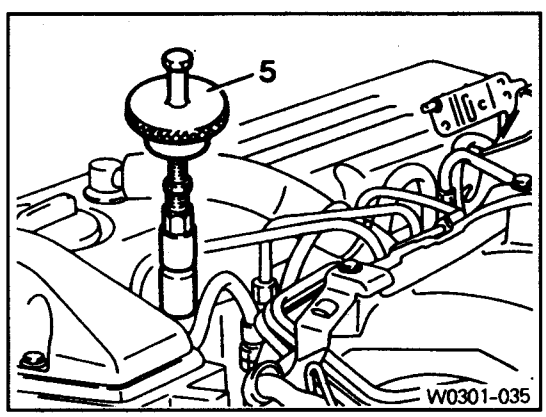
1) Using the serration wrench (4), remove the threaded ring (1).

Serration wrench 603 589 00 09 00

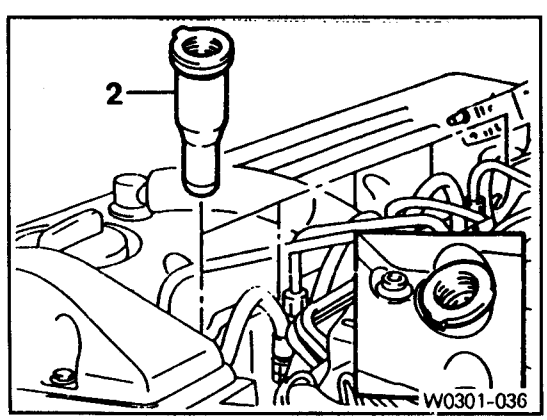


2) Install the sliding hammer into the prechamber.

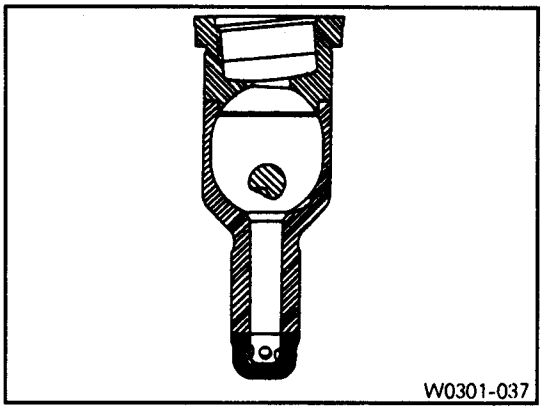
Sliding hammer 667 589 03 63 00



3) Remove the prechamber (2).
[Note] After removing the prechamber, cover over the bores with clean rag.



4) Inspect the prechamber.
[Note] If the prechamber seats in the cylinder head are leaking or if the prechambers are replaced, the sealing surfaces in the cylinder head must be remachined.



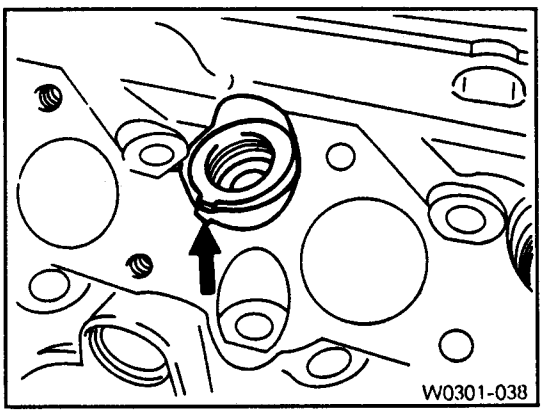
Assembly

[Note] In case the prechambers are reused, inspect the prechambers thoroughly, if the ball pin by heat and fire is broken, it can not be used.

1) Clean the sealing surface of the prechamber.

2) Insert the prechamber into the cylinder head, at the same time aligning the cam on the collar of the prechambers with the slots in the cylinder head.
[Note] If the spacer rings are fitted to the prechambers, the spacer rings should be replaced with rings of the same thickness.

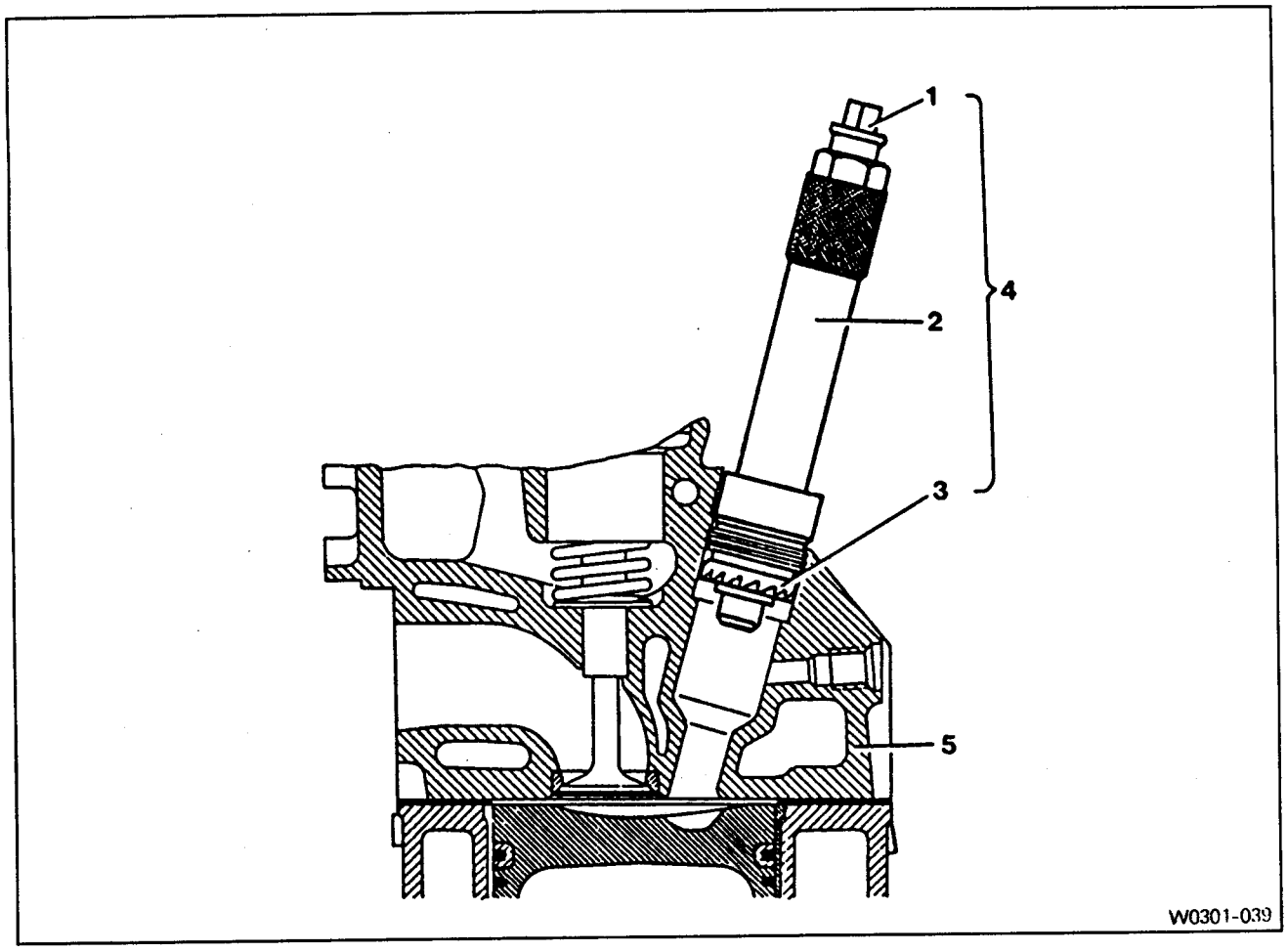
Thickness of spacer ring	0.3, 0.6, 1.0㎜



3) Coat the threaded ring with oil and assemble the ring by using the serration wrench.

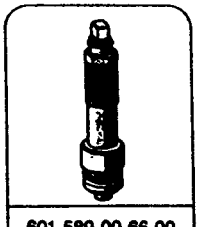
Tightening torque	130Nm

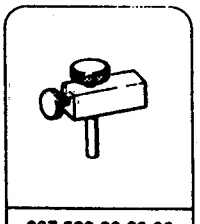
5. Milling of Prechamber Sealing Surface



1. Drift
2. Sleeve
3. Milling Cutter
4. Counter Sink (Special Tool - 601 589 00 66 00)
5. Cylinder Head

Special tools


601 589 00 66 00


667 589 00 23 00

Milling of the prechamber sealing surface

[Note] **The prechamber sealing surface may only be remachined once with the cylinder head fitted. It is essential to adhere to the specified projection 'C' of the prechamber of 7.6~8.1mm. This ensures that the required clearance exists between prechamber and piston crown with the piston in TDC. For this reason, spacer rings should be inserted on remachined sealing surfaces.**

Thickness of spacer ring (mm)	0.3, 0.6, 1.0mm

If a spacer ring is already fitted, or a marking is made on the cylinder head, the cylinder head must be removed and size 'C' measured if further remachining is necessary on a prechamber sealing surface.

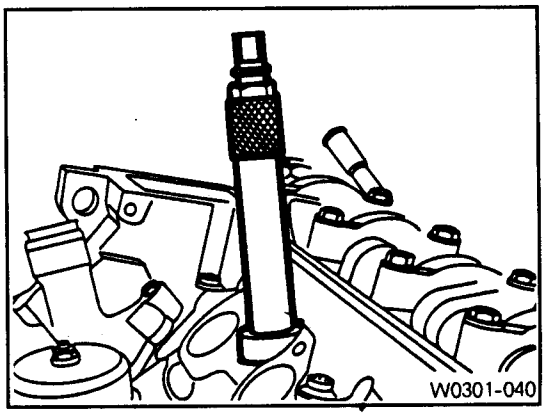
1) Remove the injection nozzle.

2) Remove the prechamber.

3) Cover the prechamber bore to avoid any chips dropping into the combustion chamber.

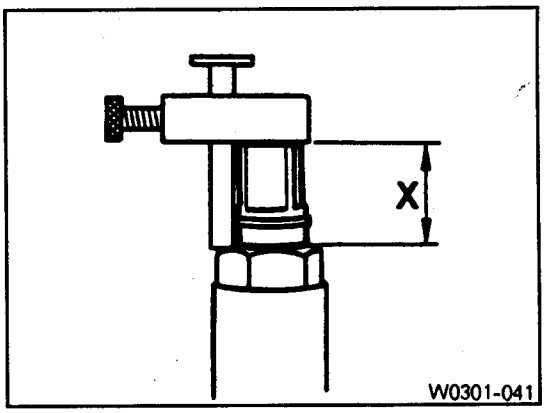
4) Remove the protective sleeve from the countersink and rotate the countersink into the prechamber bore to be machined as far as the stop.

Counter sink 601 589 00 66 00

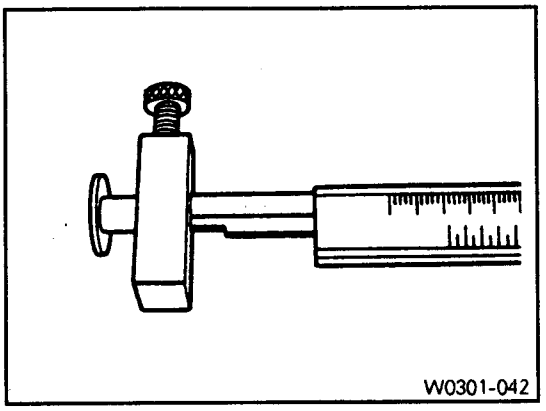


5) Maintain size 'X' from the top edge of mandrel to the top edge of the sleeve with the gauge.

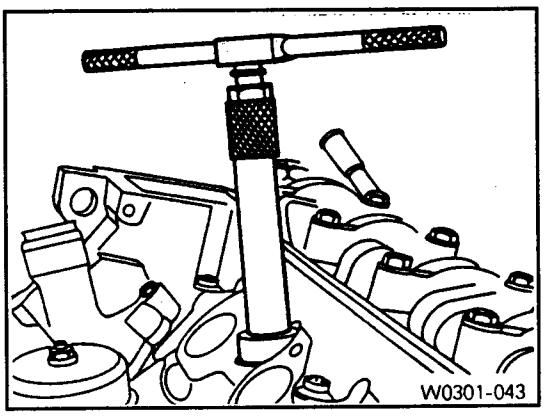
Height gauge 667 589 00 23 00



6) Measure the 'X' by using a vernier caliper.



7) Mount the turning tool onto the countersink tool and rotate to the right approx. 5 revolutions by applying slight pressure.



8) Remeasure size 'X' and compare it with the first measurement and determine the thickness of spacer ring.

ex)	Size before machining	25.7mm
	Size after machining	25.5mm

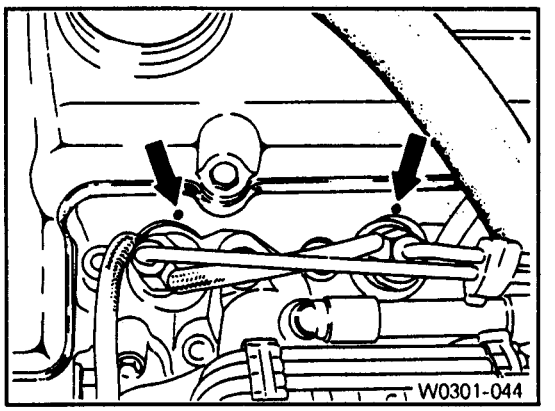
The spacer ring should be selected so that it is at least 0.1mm and not more than 0.3mm thicker than the measured on the sealing surface. In this example, the necessary thickness of spacer ring should be within 0.3~0.5mm and the thickness of spacer ring to be installed is 0.3mm.

9) Remove the countersink tool and clean the chips.
[Note] If the sealing surface is not completely flat, remachine the sealing surface.

10) Remove rag from the prechamber bore and crank the engine with starter motor to throw out any chips which may have got into the combustion chamber.

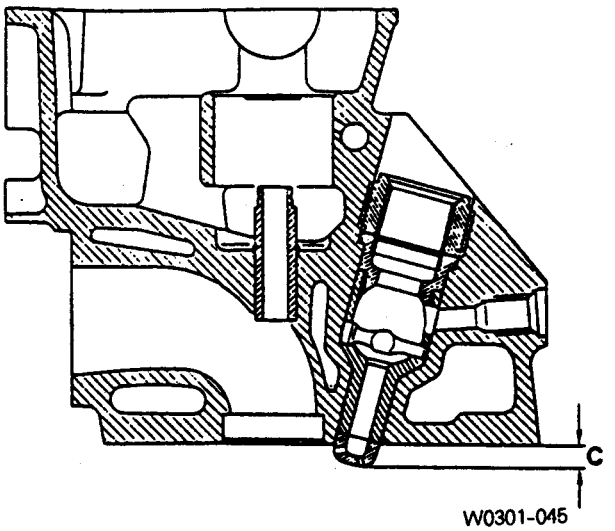
11) Insert the proper spacer ring into the prechamber sealing surface.

12) Punch a mark on the cylinder head above the prechamber sealing surface which has been machined.

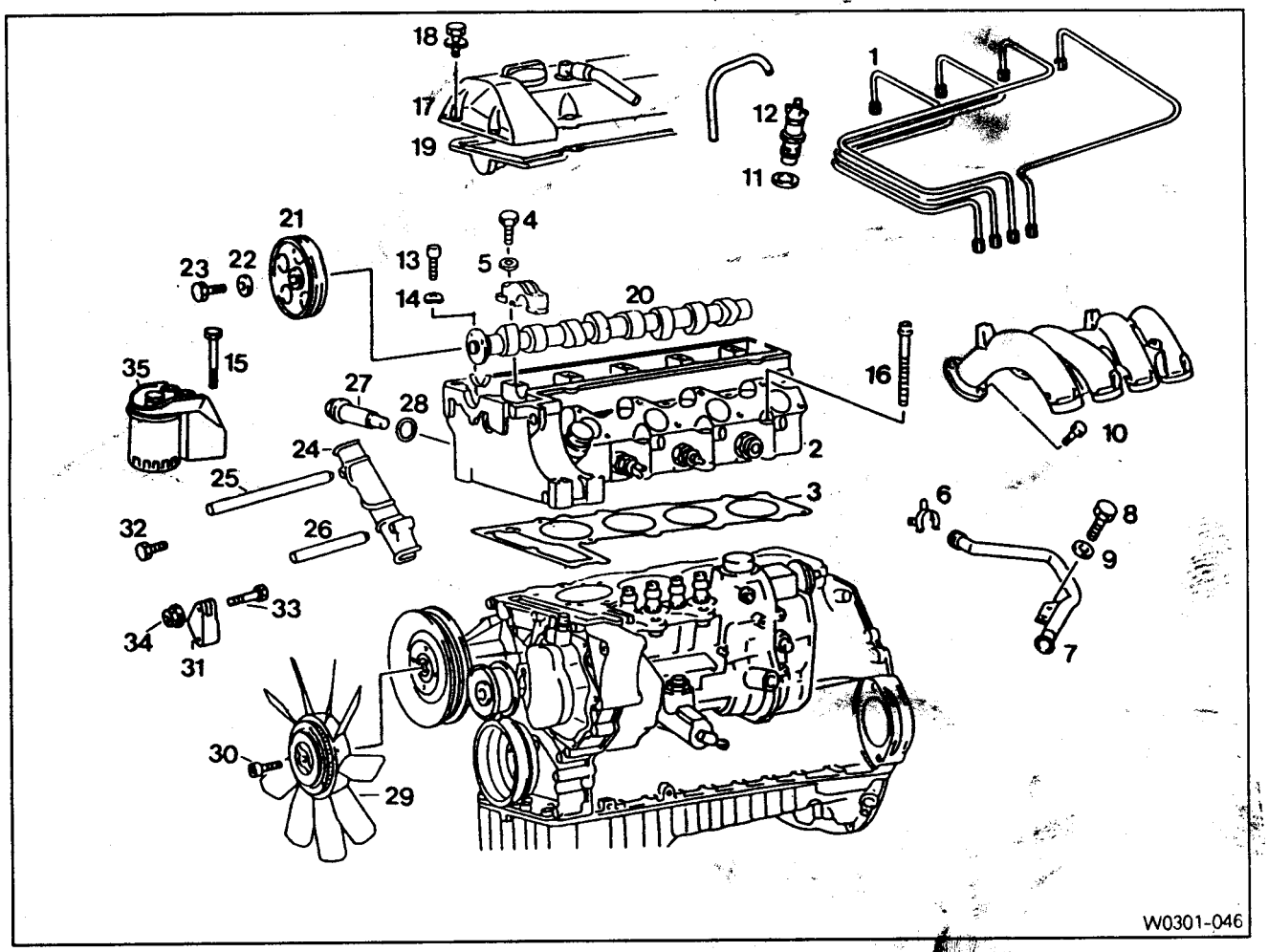


13) Install the prechambers.

[Note] If the cylinder head is removed, the projection 'C' is measured in place of size 'X' and the appropriate size of spacer ring selected.



6. Disassembly and Assembly of Cylinder Head



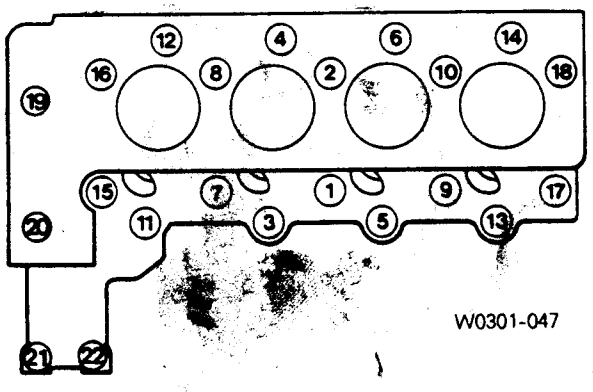
1. Fuel Injection Pipe ---------- 18Nm
2. Cylinder Head
3. Gasket ---------- Replace
4. Bolt ---------- 25Nm
5. Washer
6. Clamp
7. Heater Feed Pipe
8. Bolt
9. Washer
10. Bolt ---------- 25Nm
11. Nozzle Washer ---------- Replace
12. Fuel Injection Nozzle ---------- 35~40Nm
13. Hexagon Socket Bolt ---------- 25Nm
14. Washer
15. Bolt ---------- 25Nm
16. Cylinder Head Bolt ---------- See table
17. Cylinder Head Cover
18. Bolt ---------- 10Nm
19. Gasket
20. Camshaft
21. Camshaft Drive Sprocket ---------- Replace
22. Washer
23. Bolt (12-Sided) ---------- 25Nm + 90
24. Sliding Rail
25. Sliding Rail Pin
26. Sliding Rail Pin
27. Chain Tensioner ---------- 80Nm
28. Gasket ---------- Replace
29. Cooling Fan ---------- Check
30. Hexagon Socket Bolt ---------- 45Nm
31. Tensioning Lever
32. Bolt ---------- 25Nm
33. Bolt
34. Nut ---------- 23Nm
35. Fuel Filter

Tightening torque

Cylinder bolts (12-sided socket head)	Tightening torque	Stage 1	15Nm
(Engine cold)		Stage 2	35Nm
	Torque angle	Stage 3	90 °
	Wait for		10 minutes
	Torque angle	Stage 4	90 °
M8 cylinder head bolts			25Nm

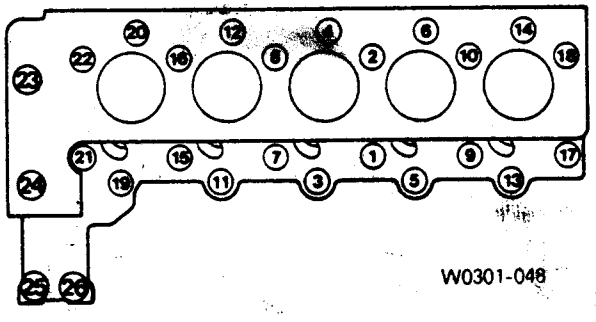
Tightening sequence for cylinder head bolts

OM 661 Engine



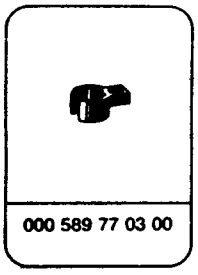
W0301-047

OM 662 Engine



W0301-048

Special tools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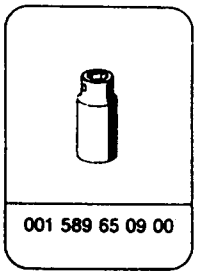
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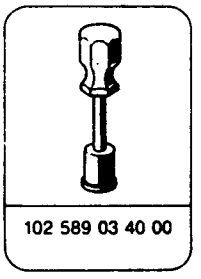
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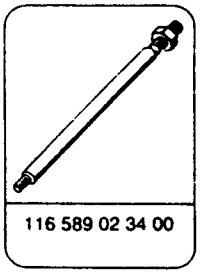
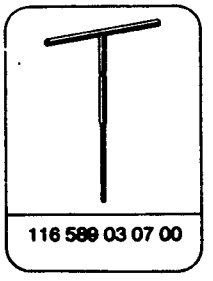

116 589 02 34 00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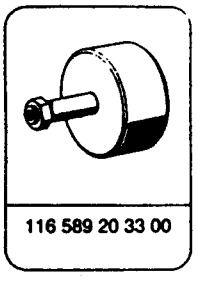
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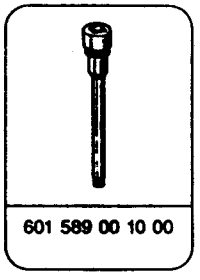
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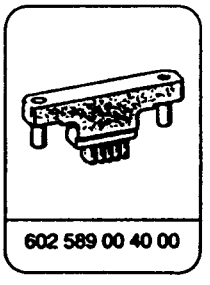
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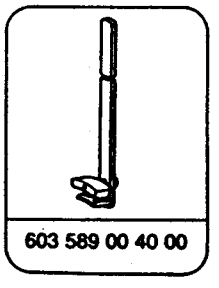
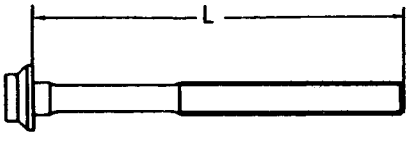

603 589 00 40 00

[Note] The cylinder head may only be removed when the engine has cooled down. The cylinder head is removed together with the exhaust manifold. As the cylinder head bolts undergo a permanent tightening, they require to be replaced if they exceed the maximum lengths indicated in the table.



W0301-049

Thread Dia.	Length (L) When New	Max. Length (L)
M10	80mm	82mm
M10	102mm	104mm
M10	115mm	117mm

The twelve-sided socket head bolts are tightened with each stages of torque and torque angle.

It is not necessary to retighten the cylinder head bolts at the 1000~1500km inspection or after 1000~1500km of repairs.

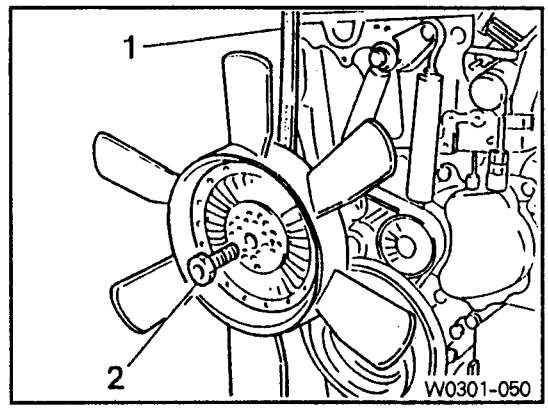
Disassembly

1) Completely drain the coolant from the radiator and cylinder block.

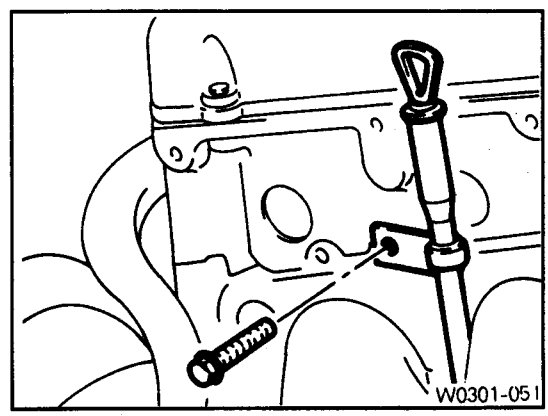
2) Remove the cooling fan shroud.

3) Hold the fan with counter holder and remove the bolt and then remove the cooling fan.
[Note] Keep the fan in vertical position.

Counter holder **603 589 00 40 00**

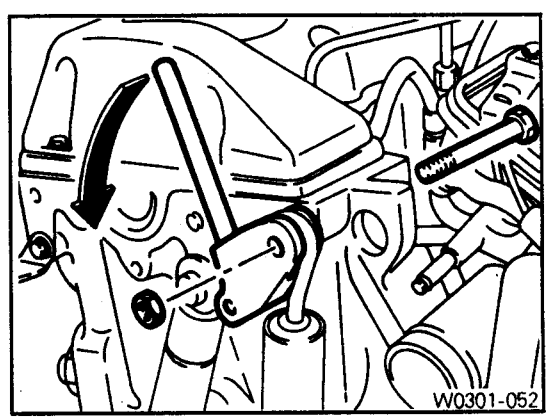


4) Remove the bracket of oil filler guide tube.

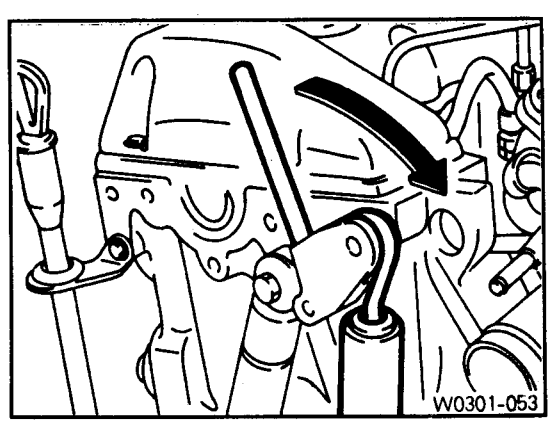


5) Remove the nut.

6) Remove the nut on the tensioning lever and insert the rod (ϕ12 × 180mm). By pushing the rod to the arrow direction, pull back the bolt.

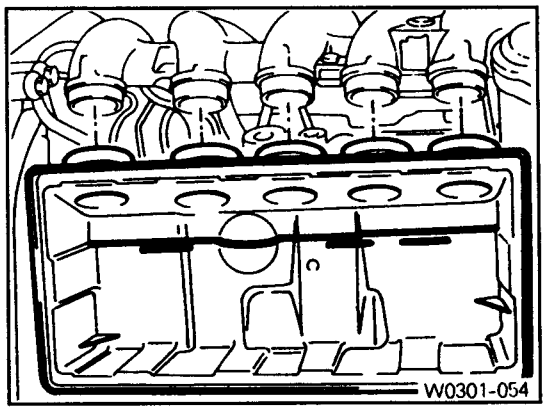


7) Push the tensioning lever to the opposite direction to release the spring tension and remove the poly V-belt.

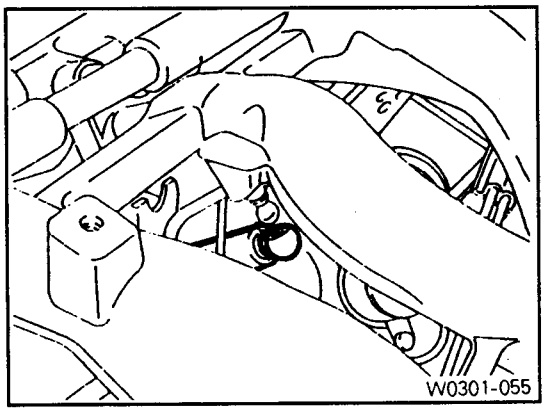


8) Remove the air cleaner cover and element and then remove the air cleaner housing.

9) Remove the oil return hose and plug.
[Note] Cover them to prevent chips are coming into.

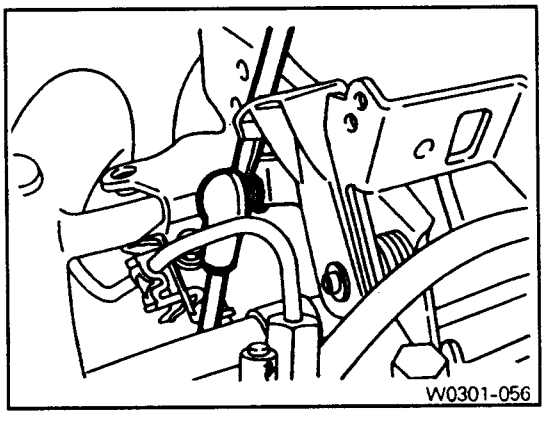


10) Remove the damper from the intake manifold.

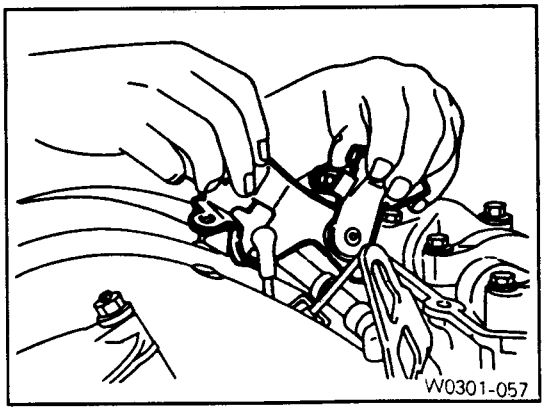


11) Remove the damper for accelerator control linkage.

12) Separate the connecting rod from the relay lever.

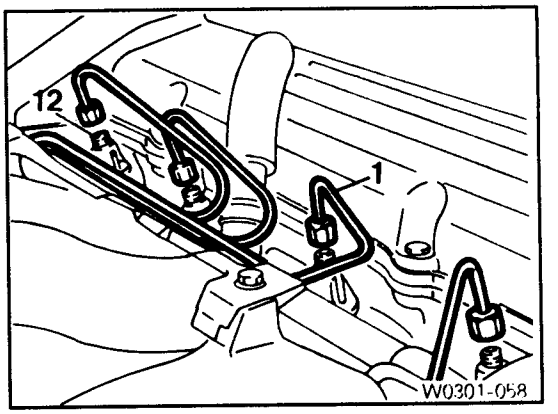


13) Pull out the accelerator control linkage.



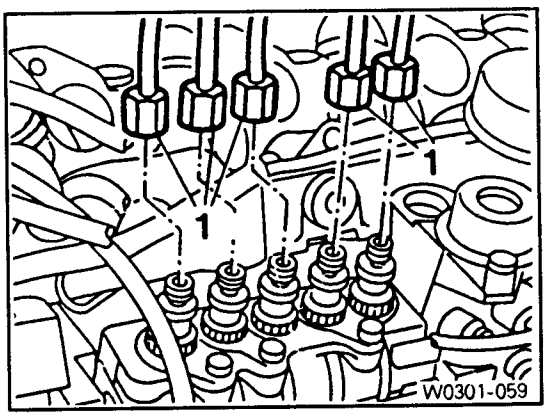
14) Remove the fuel injection line (1) from the fuel injection nozzle (12).

Box wrench insert 000 589 77 03 00

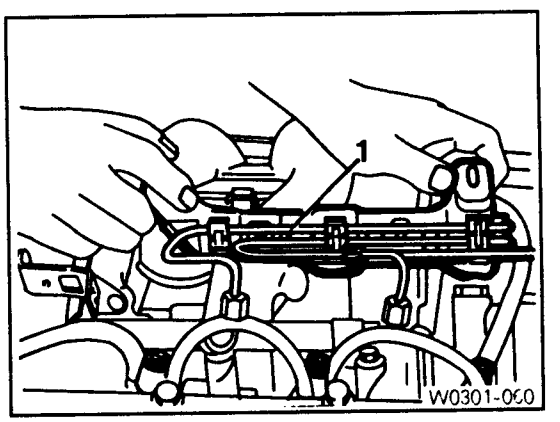


15) Remove the fuel injection line from the fuel injection pump.

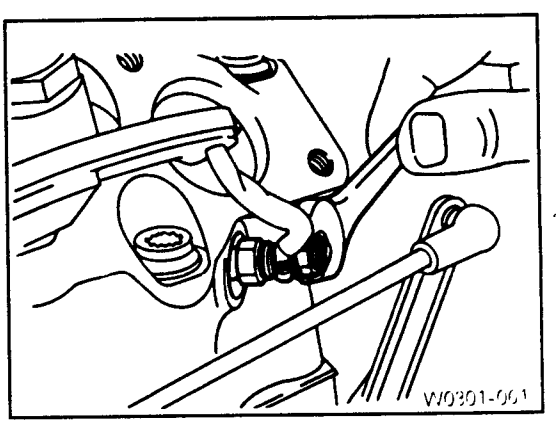
Box wrench insert 000 589 77 03 00



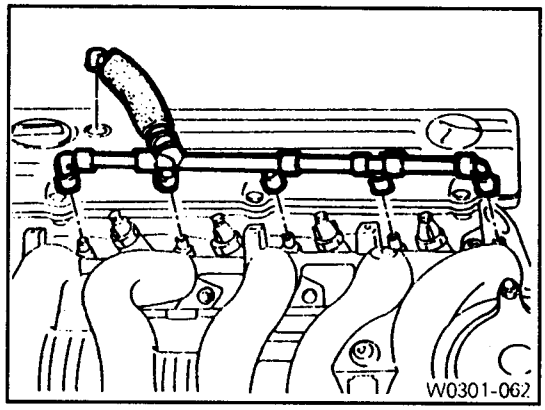
16) Remove the bracket mounting bolts and then remove the fuel injection line (1).



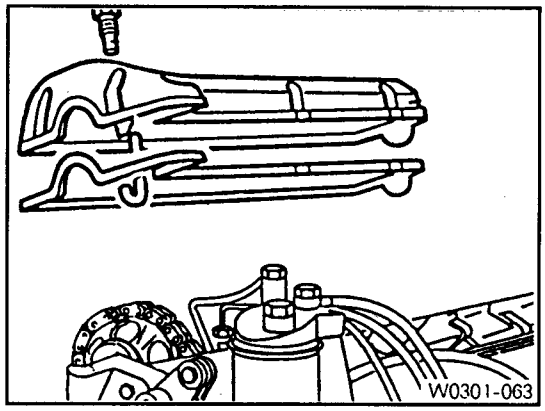
17) Disconnect the glow plug cables.



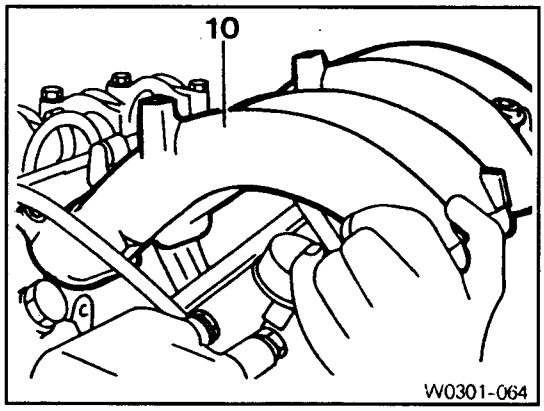
18) Disconnect the blowby gas hose from the cylinder head cover.



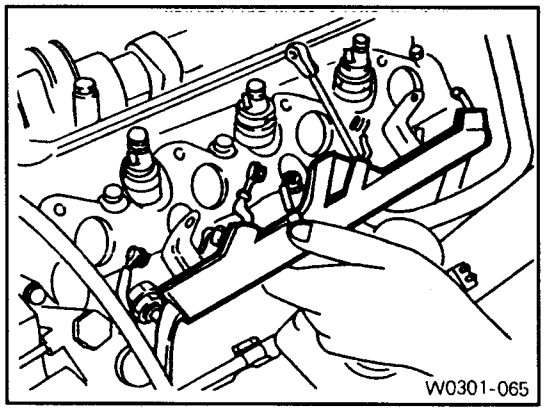
19) Remove the cylinder head cover and gasket.



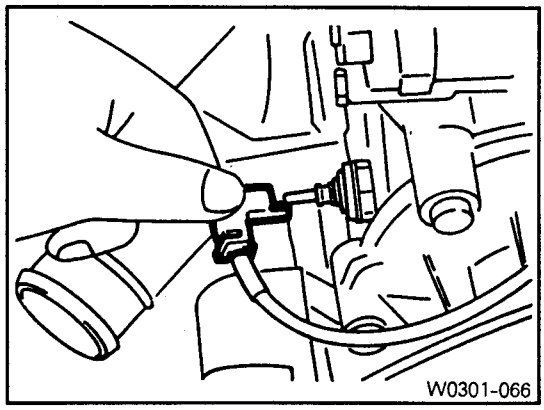
20) Remove the intake manifold (10) and gasket.



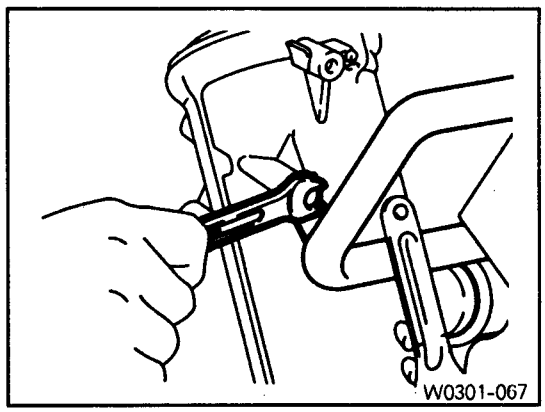
21) Remove the cable channel.



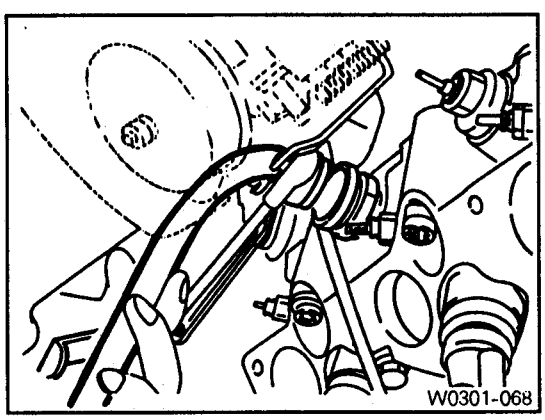
22) Disconnect the cables from the glow plug sensor and coolant temperature sensor.



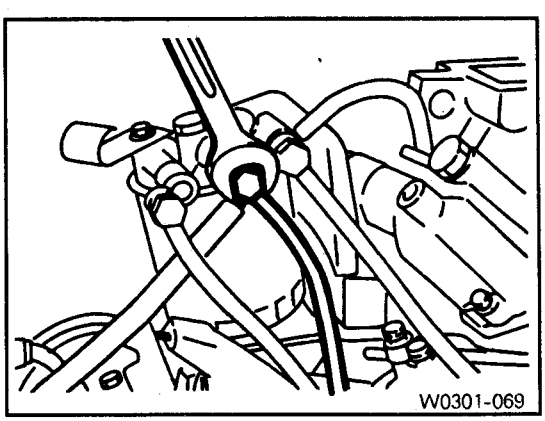
23) Remove the heater feed pipe bracket from the oil filter.



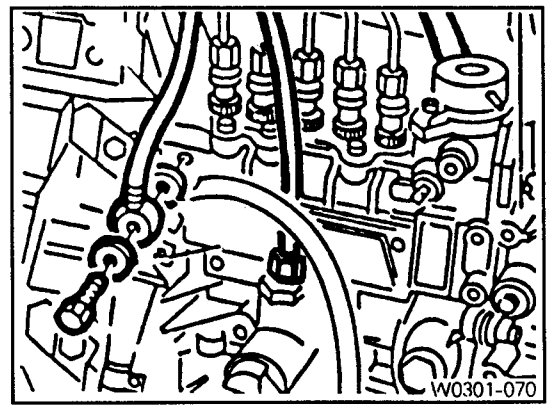
24) Pry off the clamp and push the heater feed pipe forward and then pull out the pipe.



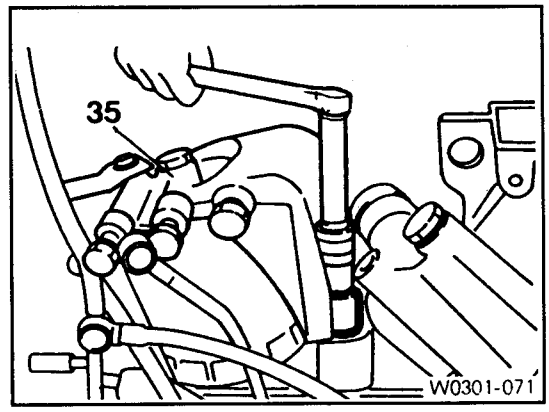
25) Disconnect the fuel lines from the fuel filter.



26) Disconnect the fuel lines from the injection pump.

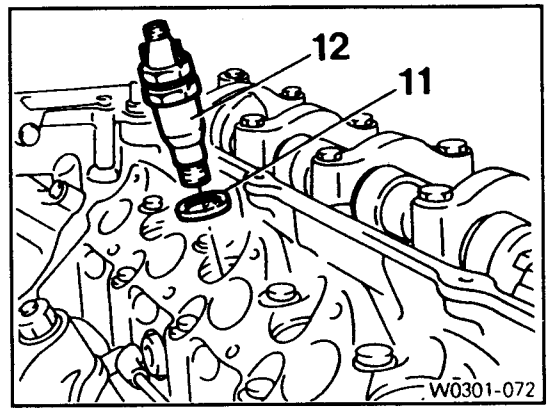


27) Remove the fuel filter (35).

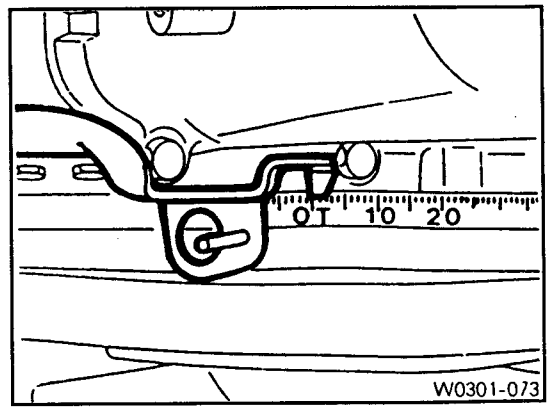


28) Remove the fuel injection nozzle (12) and nozzle washer (11).

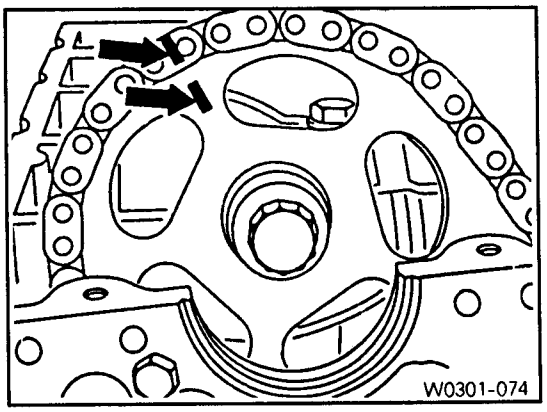
Socket wrench insert 001 589 65 09 00



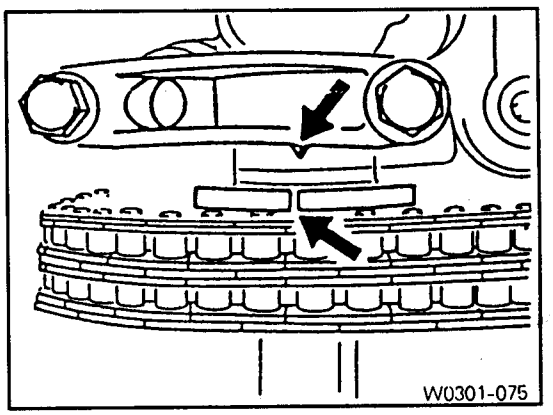
29) Rotate the crankshaft and set the no.1 cylinder at TDC.
[Note] Do not rotate the crankshaft to the opposite direction of engine revolution.



30) Place alignment marks on the camshaft gear and timing chain.

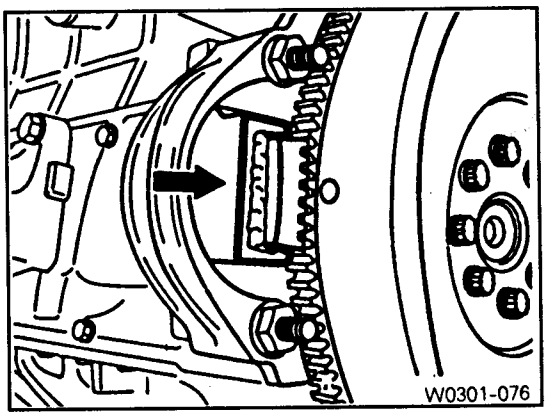


31) Ensure that the camshaft and the bearing cap marking are aligned.

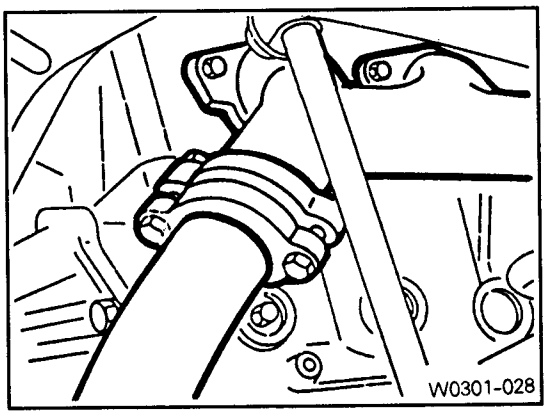


32) Remove the starter motor and install the engine lock onto the flywheel ring gear.

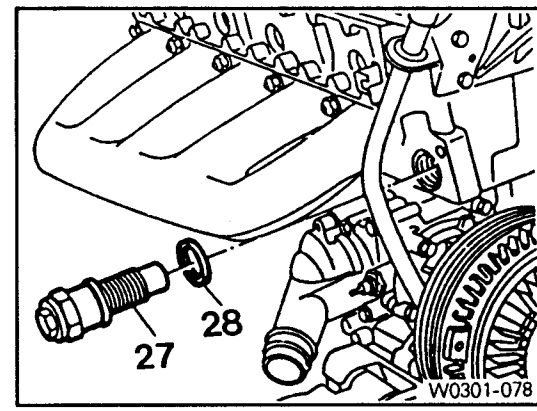
Engine lock 602 589 00 40 00



33) Remove the exhaust pipe and exhaust manifold.

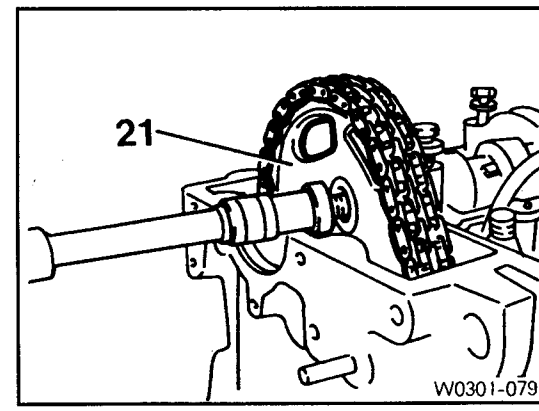


34) Remove the chain tensioner (27) and seal (28).



35) Remove the bolt and separate the drive sprocket (21).

[Note] During removal, be careful not to drop the sprocket and chain into the timing case. Carefully pull off the chain and then pull out the sprocket.



36) Remove the camshaft bearing cap bolts (4) according to the numerical sequence.

[Note] Remove the no.1 bolts first and then remove the no.2 bolts.
Do not remove the bolts at a time completely but Remove them step by step evenly or camshaft can be seriously damaged.

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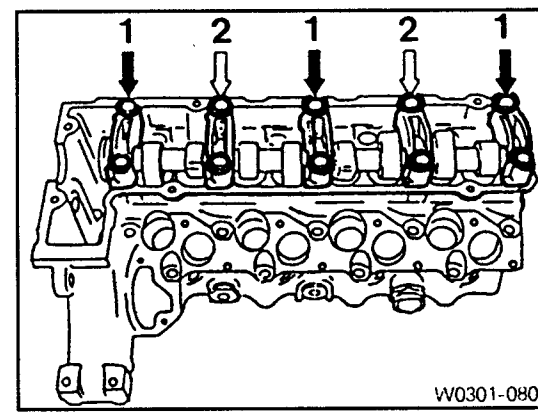
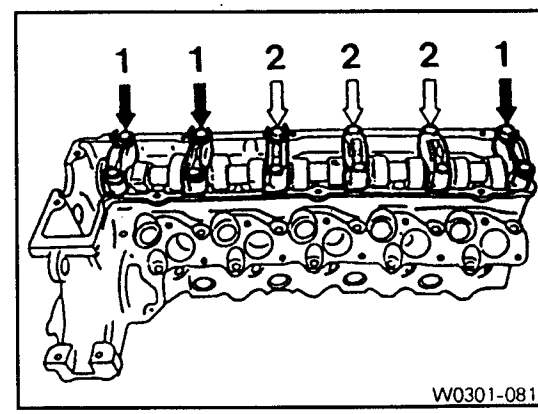
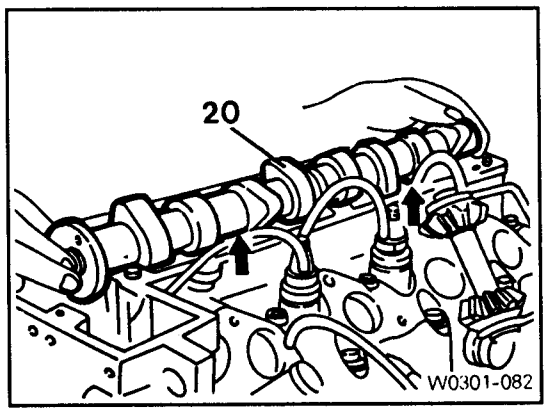


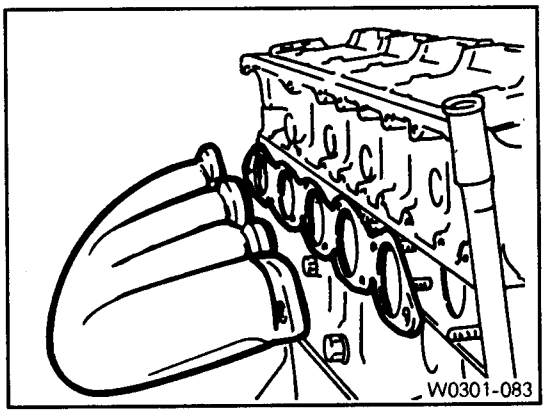
OM 662



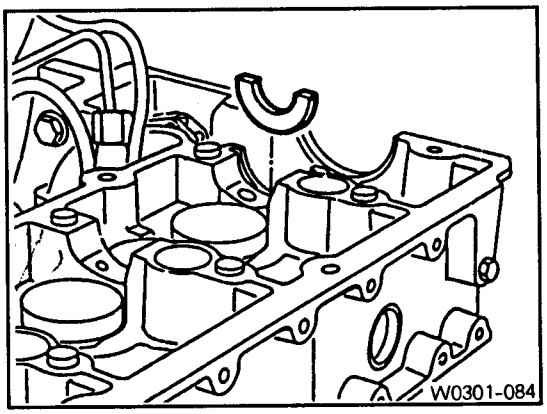
37) Remove the bearing caps and then pull out the camshaft (20) upward.
[Note] Be careful not to miss the locking washer.



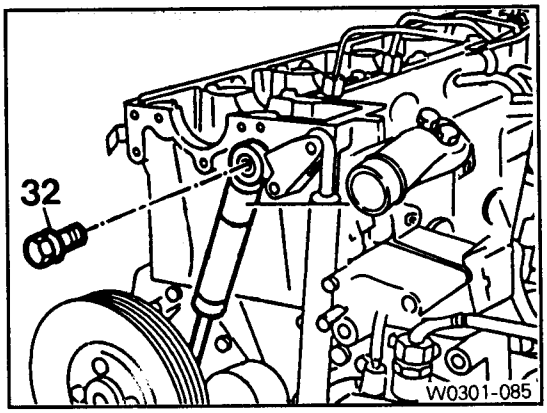
38) Remove the exhaust manifold and gasket.



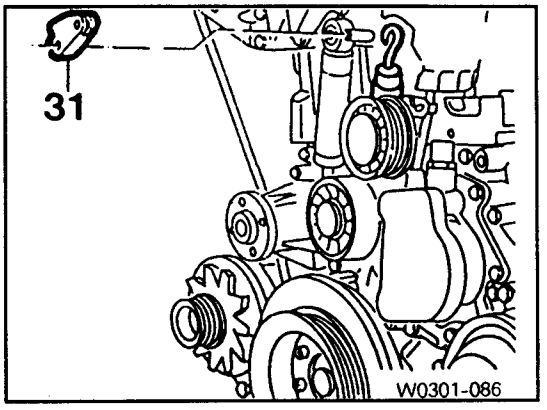
39) Remove the locking washer.
[Note] Check the locking washer and replace if necessary.



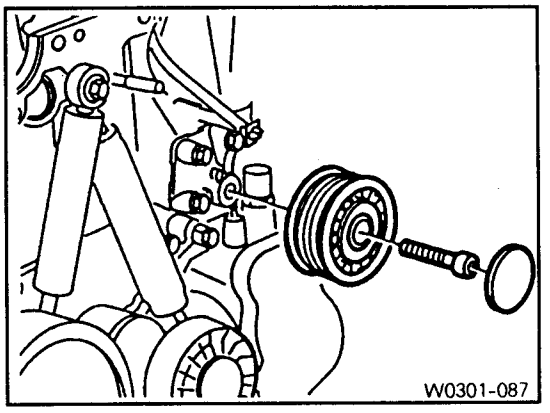
40) Remove the bolt (32).



41) Separate the spring and pull out the tensioning lever (31).

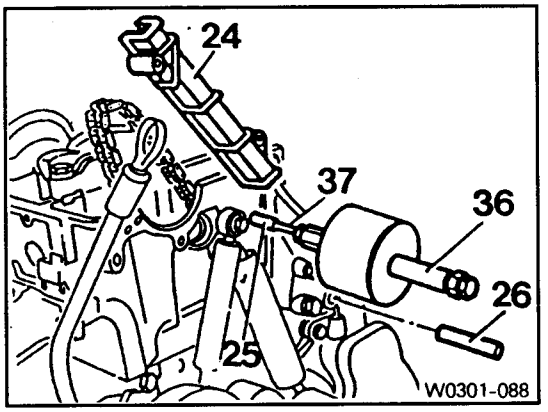


42) Pry off the closing cover. Remove the bolt and then remove the guide pulley.

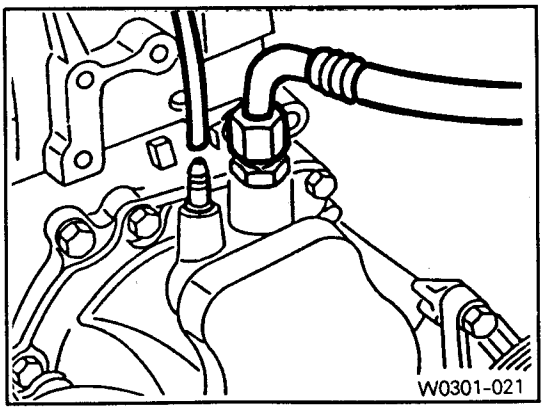


43) Using the sliding hammer (36) and the threaded pin (37), pull out the sliding rail pins (25, 26) and remove the sliding rail (24).

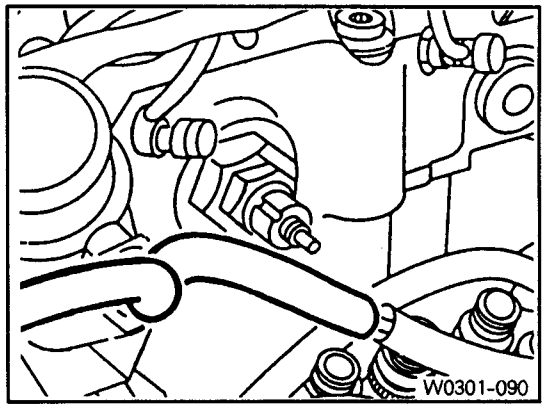
Sliding hammer 116 589 20 33 00
Threaded pin 116 589 02 34 00



44) Remove the vacuum line from the vacuum pump.

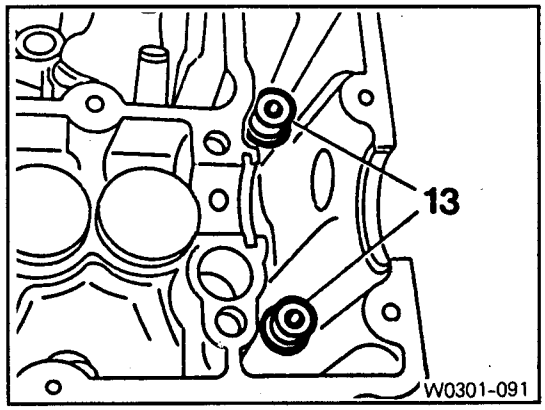


45) Disconnect the vacuum pipe from thermo valve.



46) Remove the socket bolts (13) of the chain box.

T type socket wrench 116 589 03 07 00
Magnetic bar 102 589 03 40 00



47) Remove the cylinder head bolts (16) in numerical sequence.

Cylinder head bolt wrench 601 589 00 10 00

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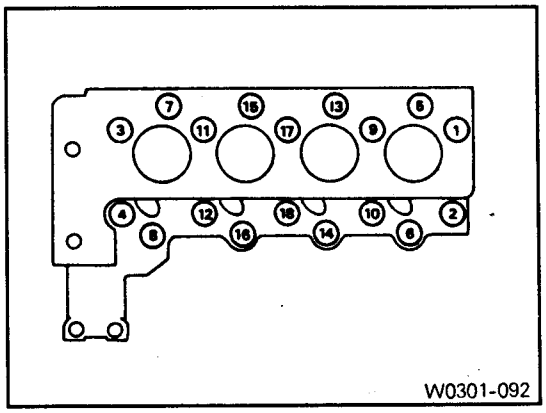

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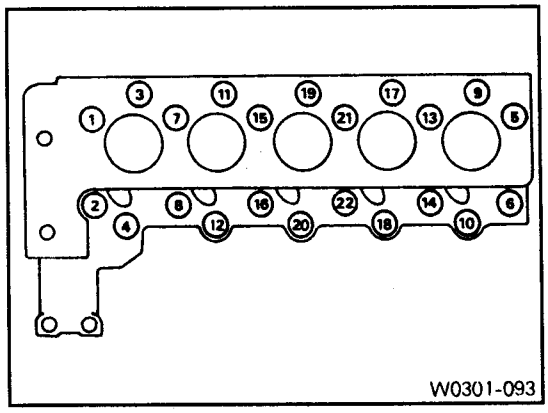
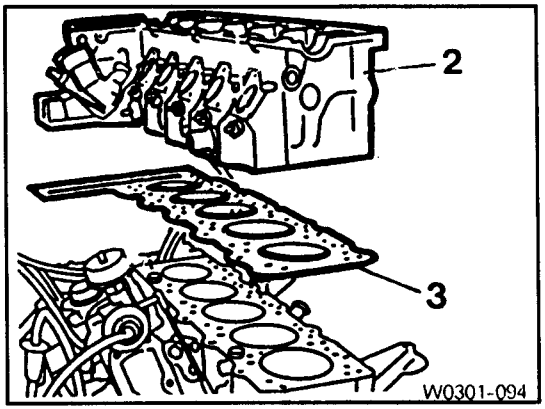


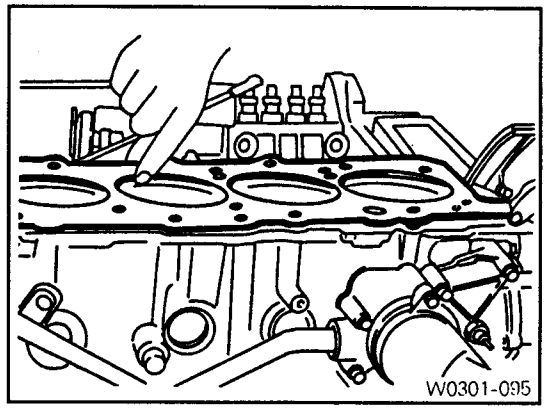
48) Remove the cylinder head (2) and gasket (3).

49) Clean all cylinder head and crankcase sealing surfaces.

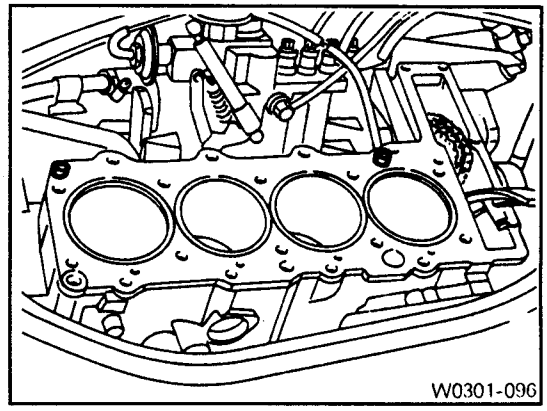


Assembly

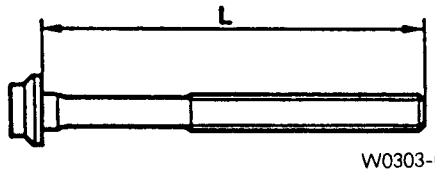
1) Replace the cylinder head gasket.



2) Install the cylinder head onto the crankcase.
[Note] Align the cylinder head holes with the guide pins.



3) Measure the length (L) of cylinder head bolts.
[Note] If the max. length is exceeded, replace the bolts.



Thread Dia.	Length (L) When New	Max. Limit (L)
M10	80mm	82mm
M10	102mm	104mm
M10	115mm	117mm

4) Coat the head contact surface of bolts and thread with oil and insert them as shown.

· Cylinder head bolts arrangement

Bore	Bolt
1	M10 × 80
2	M10 × 102
3	M10 × 115
4	M8 × 50
5	M8 × 80

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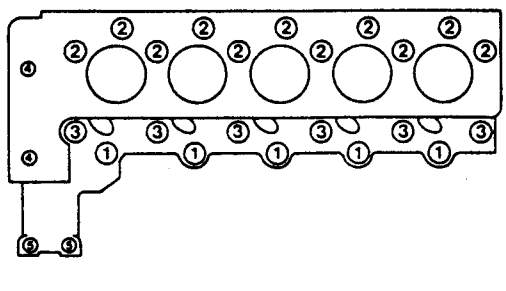
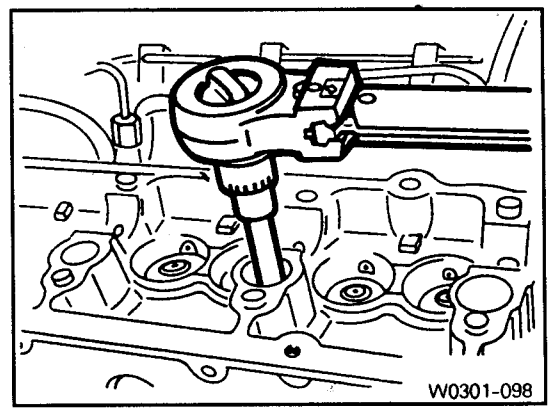


5) Tighten the cylinder head bolts to specified torque and torque angle.

Tightening torque	Stage 1	15Nm
	Stage 2	35Nm
	Torque angle	90 °
	Wait for	10 minutes
	Torque angle	90 °



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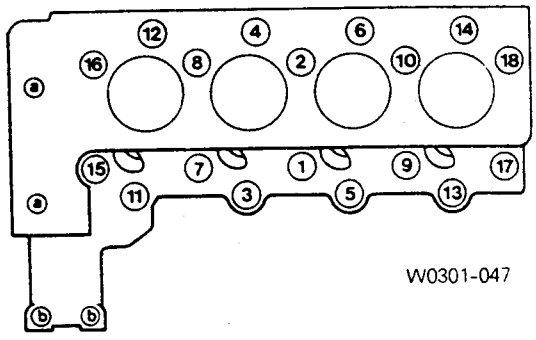

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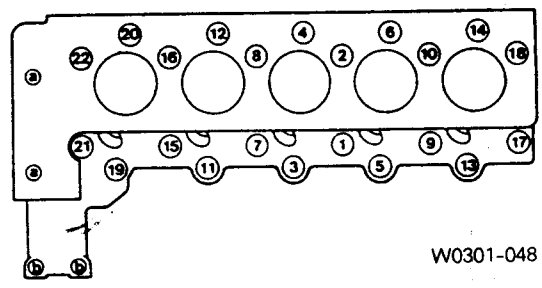
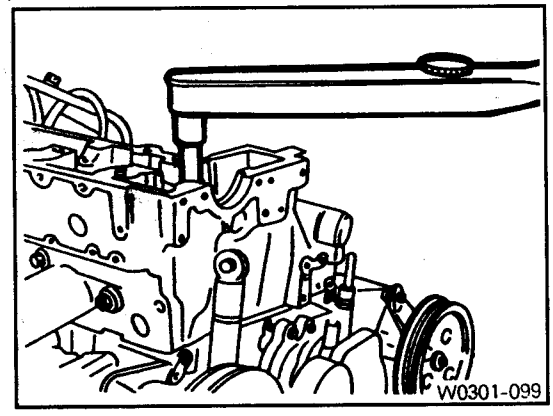
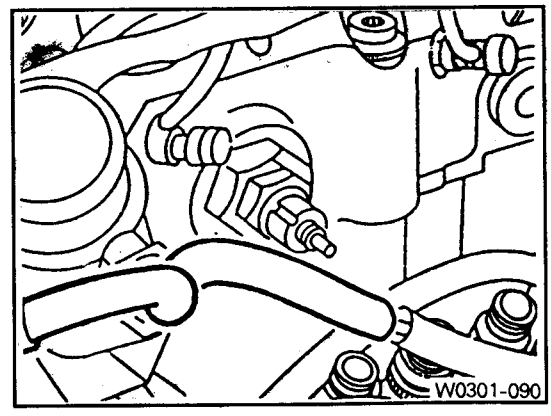


6) Install the socket bolts in the chain box.

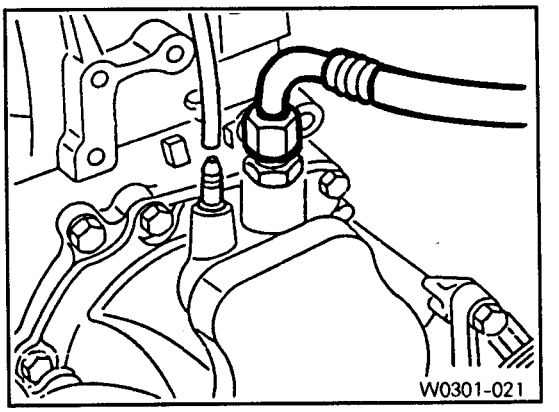
Tightening torque	25Nm



7) Connect the vacuum pipe to the thermo valve.



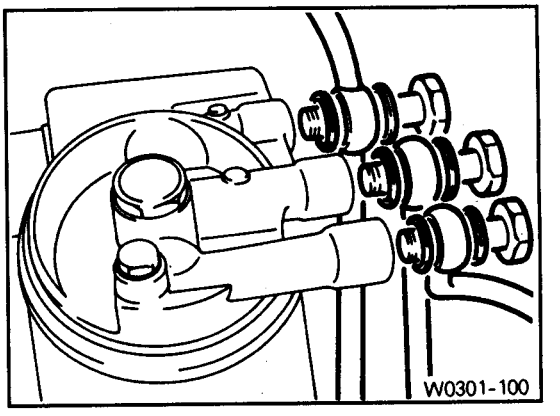
8) Connect the vacuum lines to the vacuum pump.



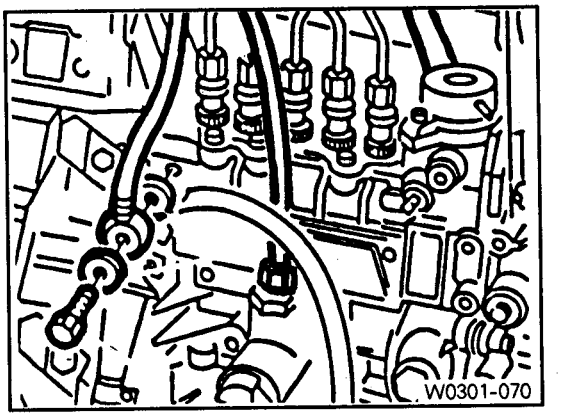
9) Install the fuel filter and connect the pipe.

Tightening torque	25Nm

[Note] Be careful not to be changed between the connections and hoses.



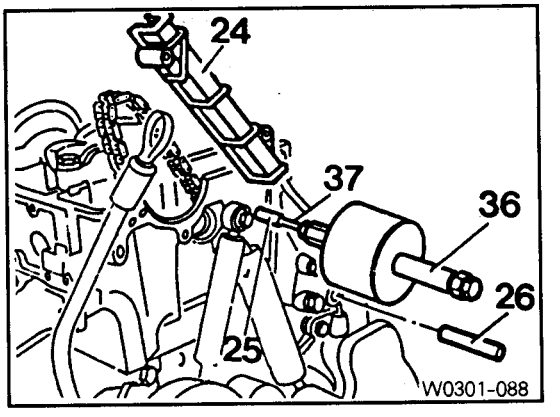
10) Connect the fuel pipe to the injection pump.



11) Install the sliding rail (24) and insert the sliding rail pins (25, 26).

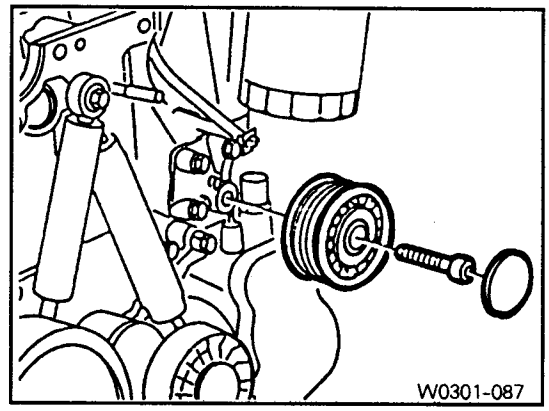
[Note] Apply sealing compound on the each collar of the sliding rail pins.

Sliding hammer 116 589 20 33 00
Threased pin 116 589 02 34 00

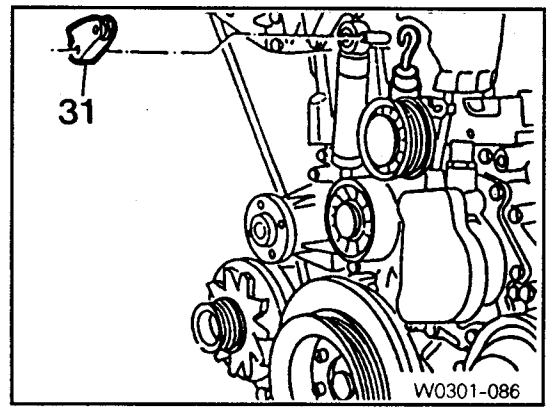


12) Install the guide pulley and fit the closing cover.

Tightening torque	23Nm



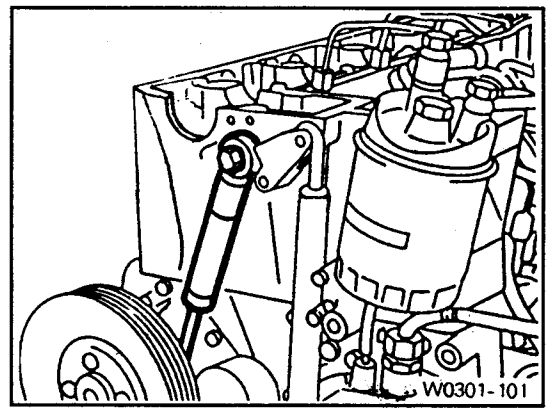
13) Insert the tensioning lever (31) and install the spring.



14) Install the damper.

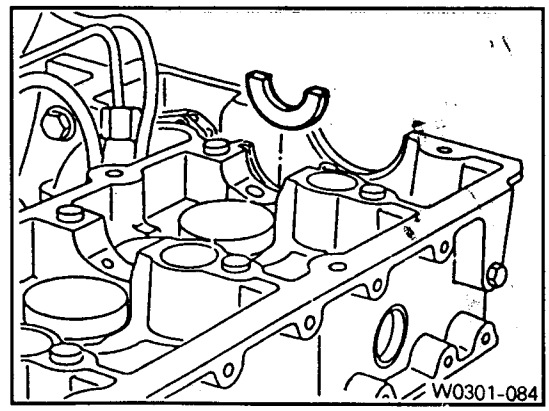
Tightening torque	23Nm

[Note] Insert the tensioning lever bolts onto the mounting hole.

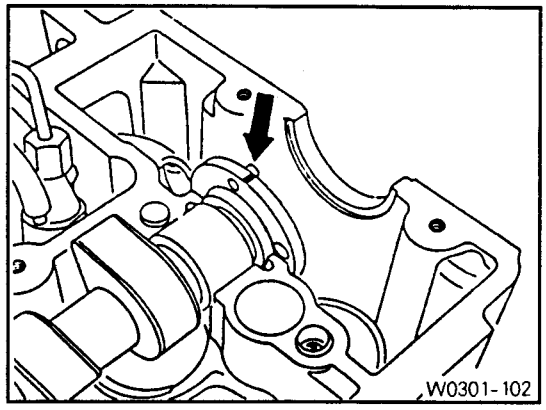


16) Insert the locking washer.

17) Inspect the valve tappet and check that the tappet moves smoothly.



18) Coat the camshaft with oil and install the camshaft on the cylinder head to be the TDC mark (arrow) upward.

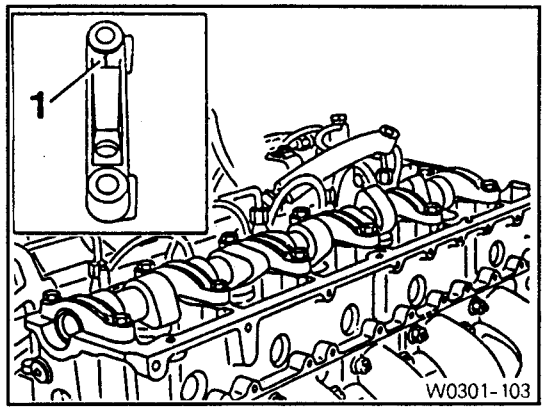


19) Measure the axial end play of the camshaft.

End play	0.06~0.21 mm

[Note] If out of standard, adjust it with the proper thickness of locking washer (42).

20) Install the bearing caps on the camshaft according to the number on the caps.

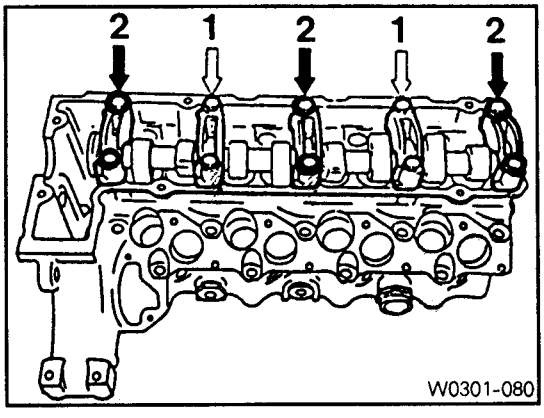


21) Tighten the bearing cap bolts according to the numerical sequence.

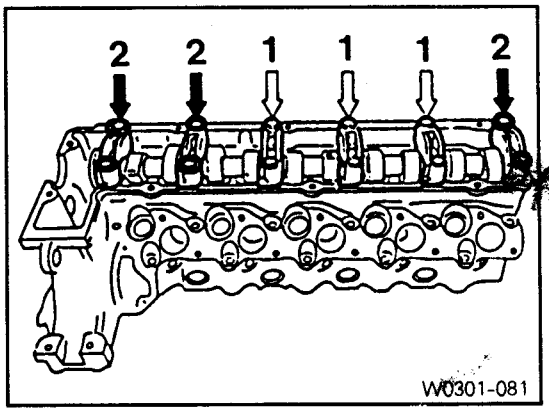
Tightening torque	25Nm

[Note] Tighten the no. 1 bolts (light arrow) first and then tighten the no. 2 bolts (dark arrow) stage by stage.

OM 661

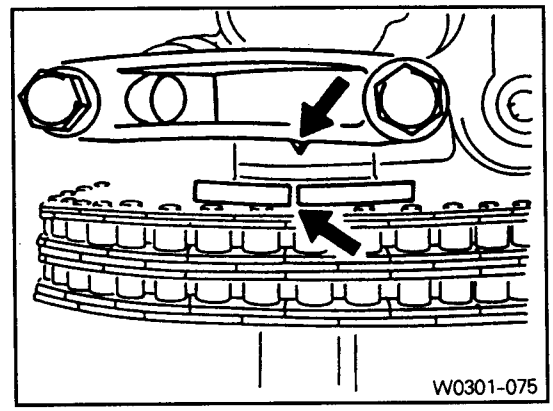


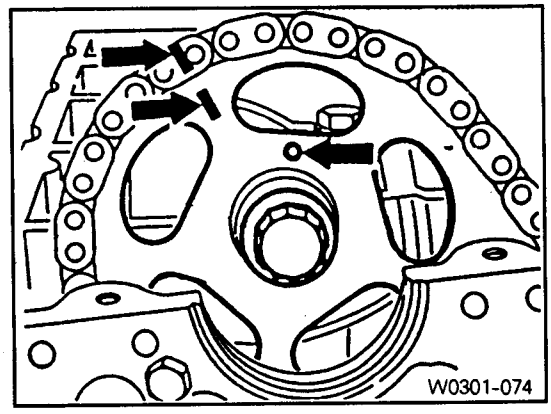
OM 662



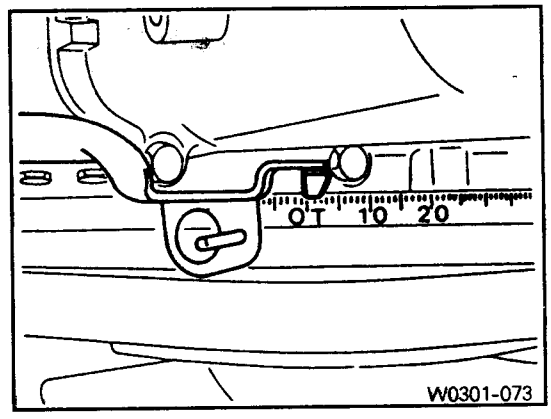
22) Position the camshaft on marking and install the camshaft sprocket.

[Note] Align the alignment marks on the chain and sprocket.



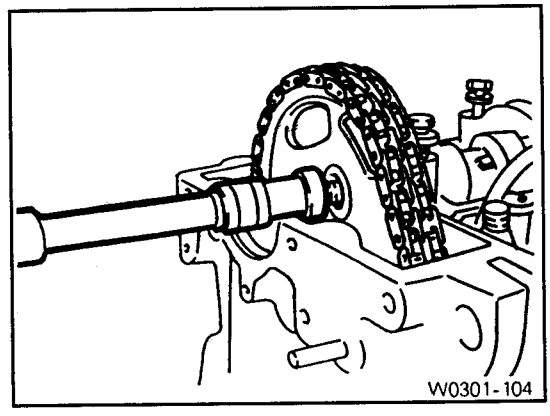


23) Check the TDC position of the crankshaft.

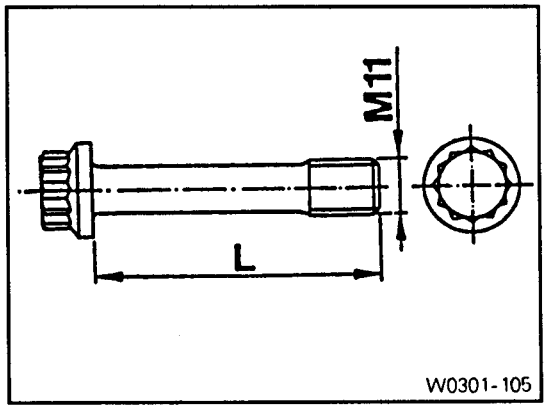


24) Install the camshaft sprocket bolt.

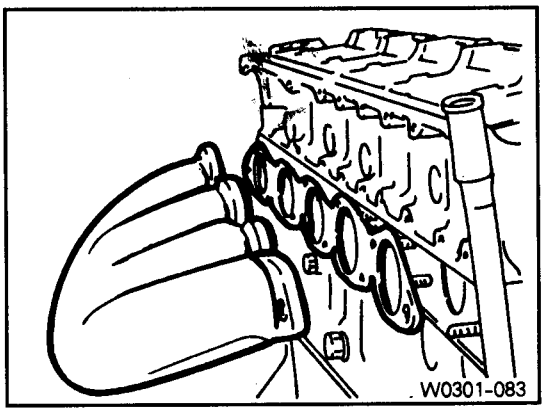
Tightening torque	25Nm + 90 °



[Note] Measure the max. length 'L' and replace the bolt if it exceeds 53.6mm.

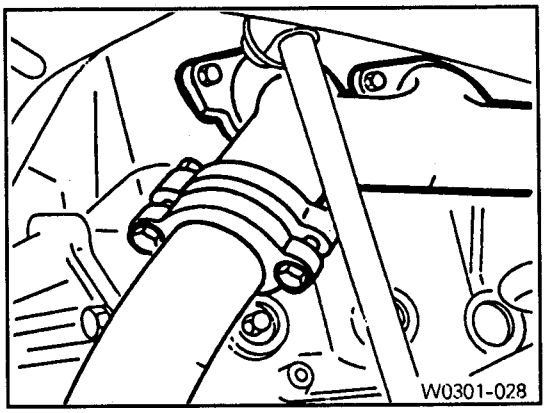


25) Install the exhaust manifold and gasket.



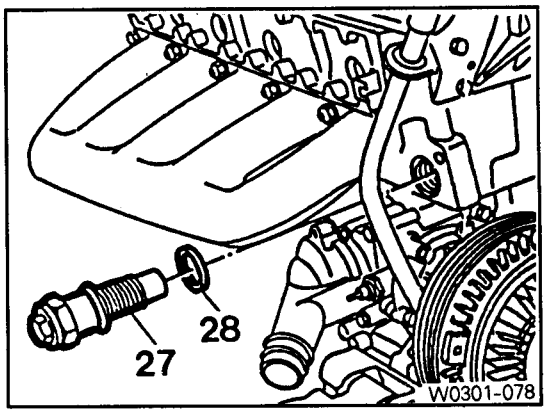
26) Install the exhaust pipe onto the exhaust manifold.

Tightening torque	25Nm

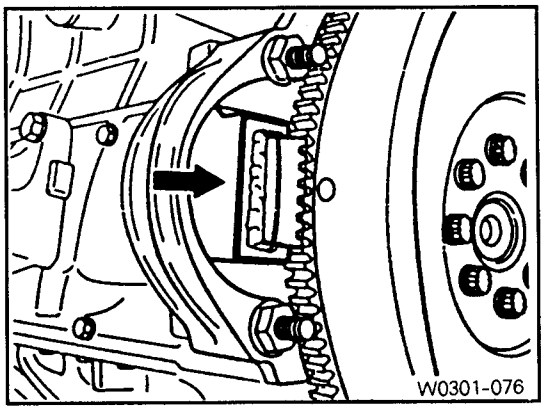


27) Replace the seat (28) and then install the chain tensioner (27).

Tightening torque	80Nm



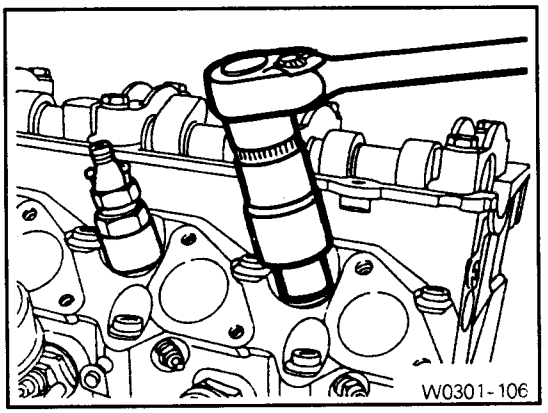
28) Remove the engine lock.



29) Insert the nozzle washer into the hole to face the round part downward.

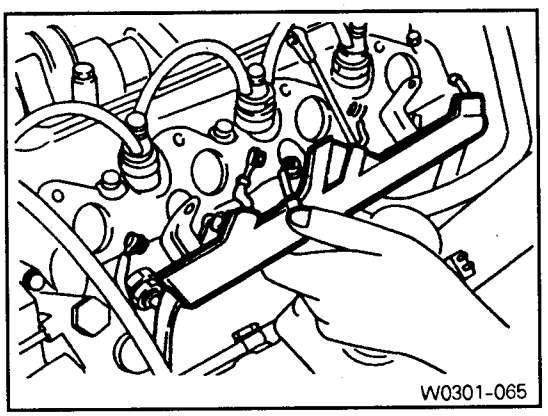
30) Install the fuel injection nozzle.

Tightening torque	40Nm



31) Connect the fuel hose.

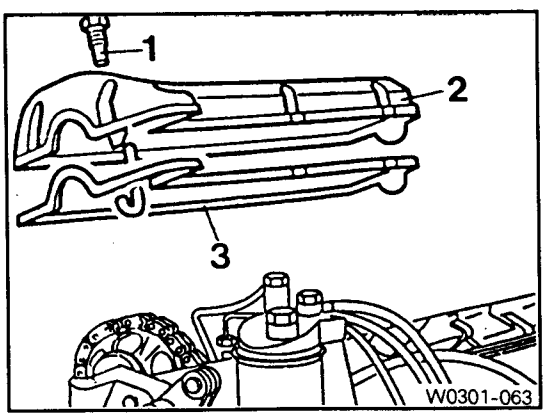
32) Install the cable channel and connect the cables to glow plugs.



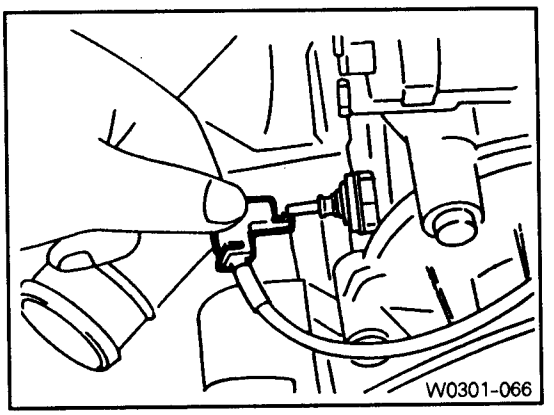
33) Replace the gasket (3) and install the cylinder head cover (2).

Tightening torque	10Nm

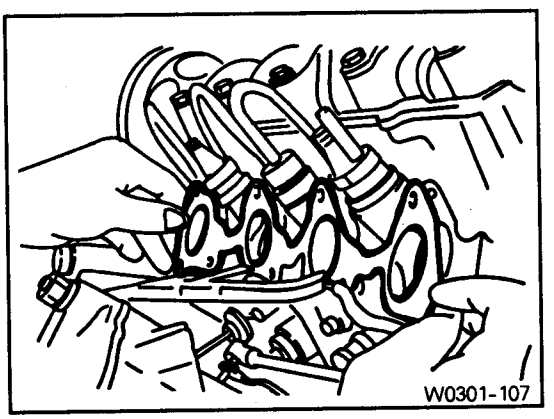
34) Install the blowby gas hose.



35) Connect the wires to the coolant temperature sensor and the glow plug sensor.

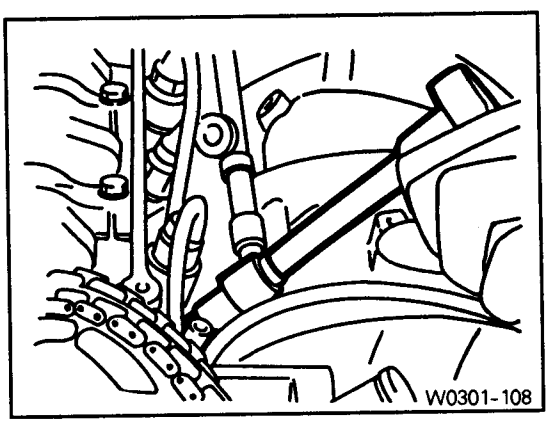


36) Replace the intake manifold gasket.

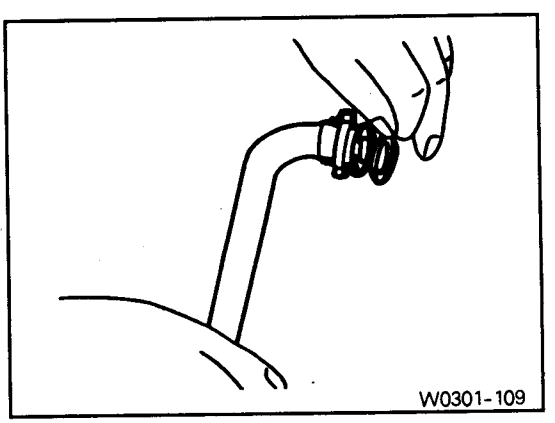


37) Install the intake manifold.

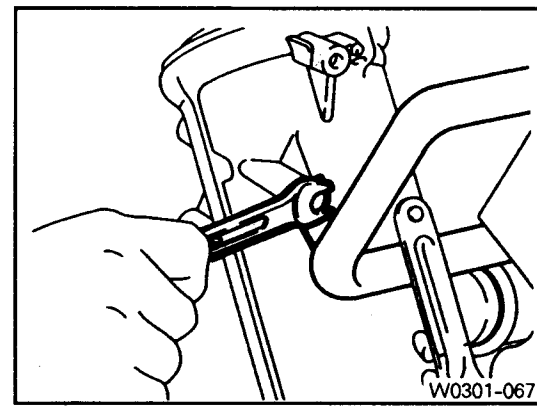
Tightening torque	25Nm



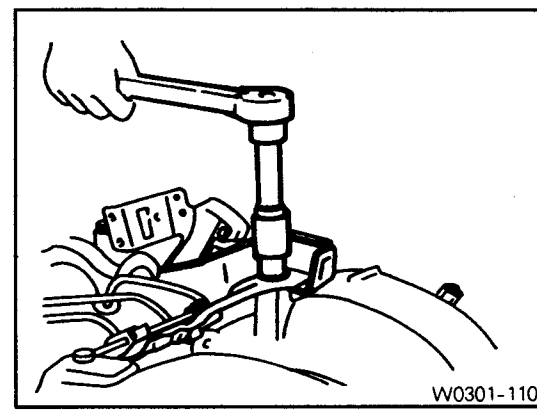
38) Replace the O-ring of heater feed pipe and install it to the cylinder head.
[Note] For installation, clean the hole.



39) Install the bracket of heater feed pipe to the oil filter.



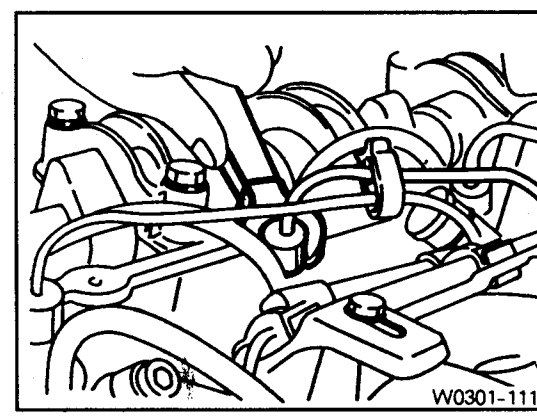
40) Install the fuel pipe and the accelerator control linkage.
Install the accelerator control linkage damper.



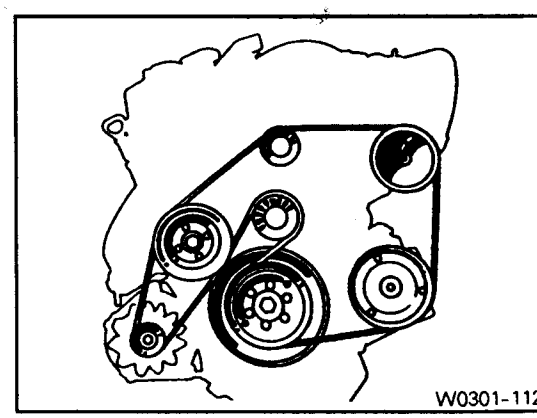
41) Connect the fuel lines to the injection nozzles and to the injection pump.

Tightening torque	18Nm

Box wrench insert 000 589 77 03 00

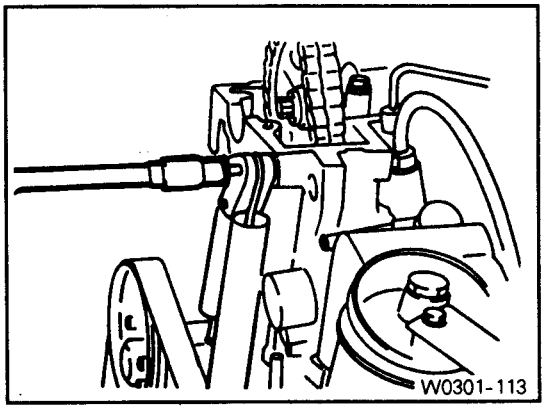


42) Install the poly V-belt.
[Note] Be careful not to contaminate the belt.



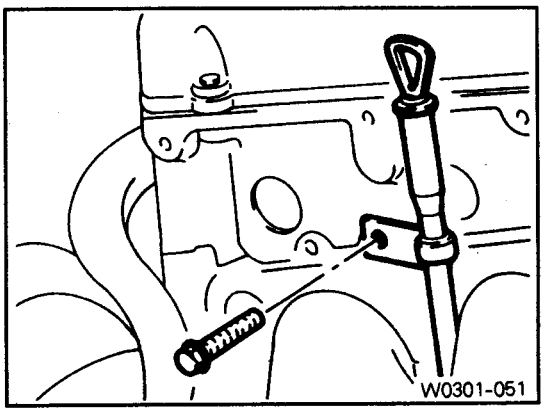
43) By inserting a rod into the tensioning lever upper hole and pulling the rod, install the bolt and then tighten the nut.

Tightening torque	23Nm

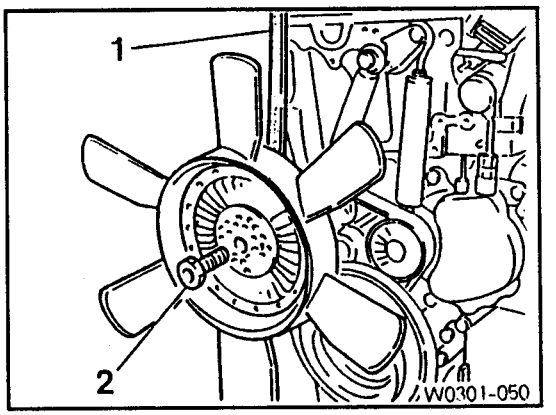


44) Install the oil filler guide tube bracket.

Tightening torque	10Nm

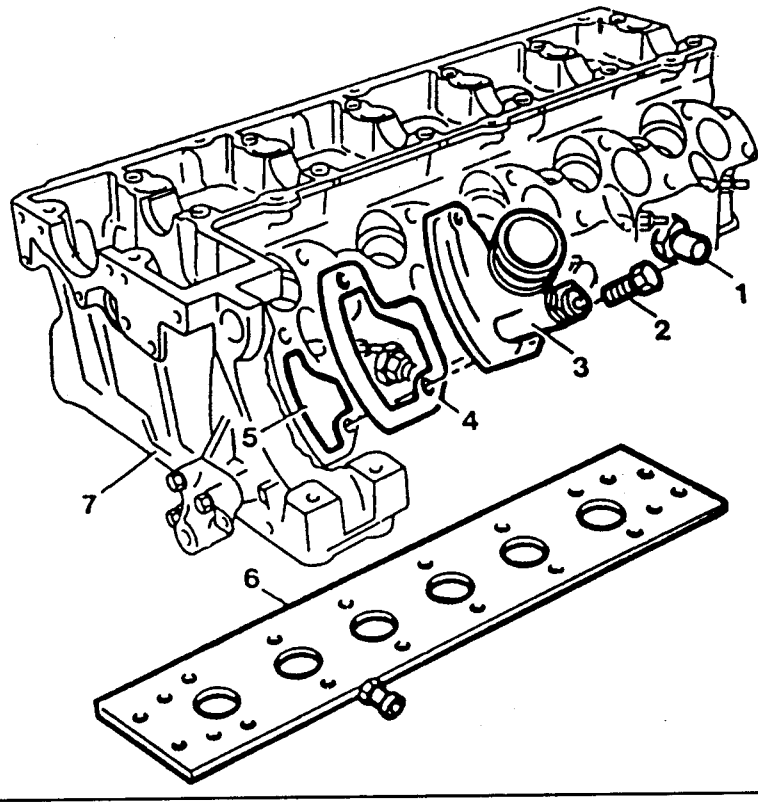


45) Hold the cooling fan with the counter holder and tighten the bolt.



7. Cylinder Head Pressure Leakage Test

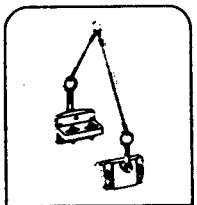
Preceding work : Removal of the cylinder head (01-20)
Removal of the exhaust manifold
Removal of the valve



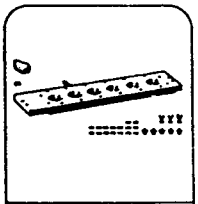
W0301-114

1. Feed Pipe
2. Bolt
3. Return Connection
4. Gasket ---------- Replace
5. Coolant Gallery---------- Sealing
6. Pressure Measuring Plate---------- Completely tight to the cylinder head
7. Cylinder Head---------- Immerse with pressure measuring plate into warm water of approx. 60℃ and pressurize with compressed air of 2 bar.
[Note] If air bubbles are seen, replace the cylinder head.

Special tools



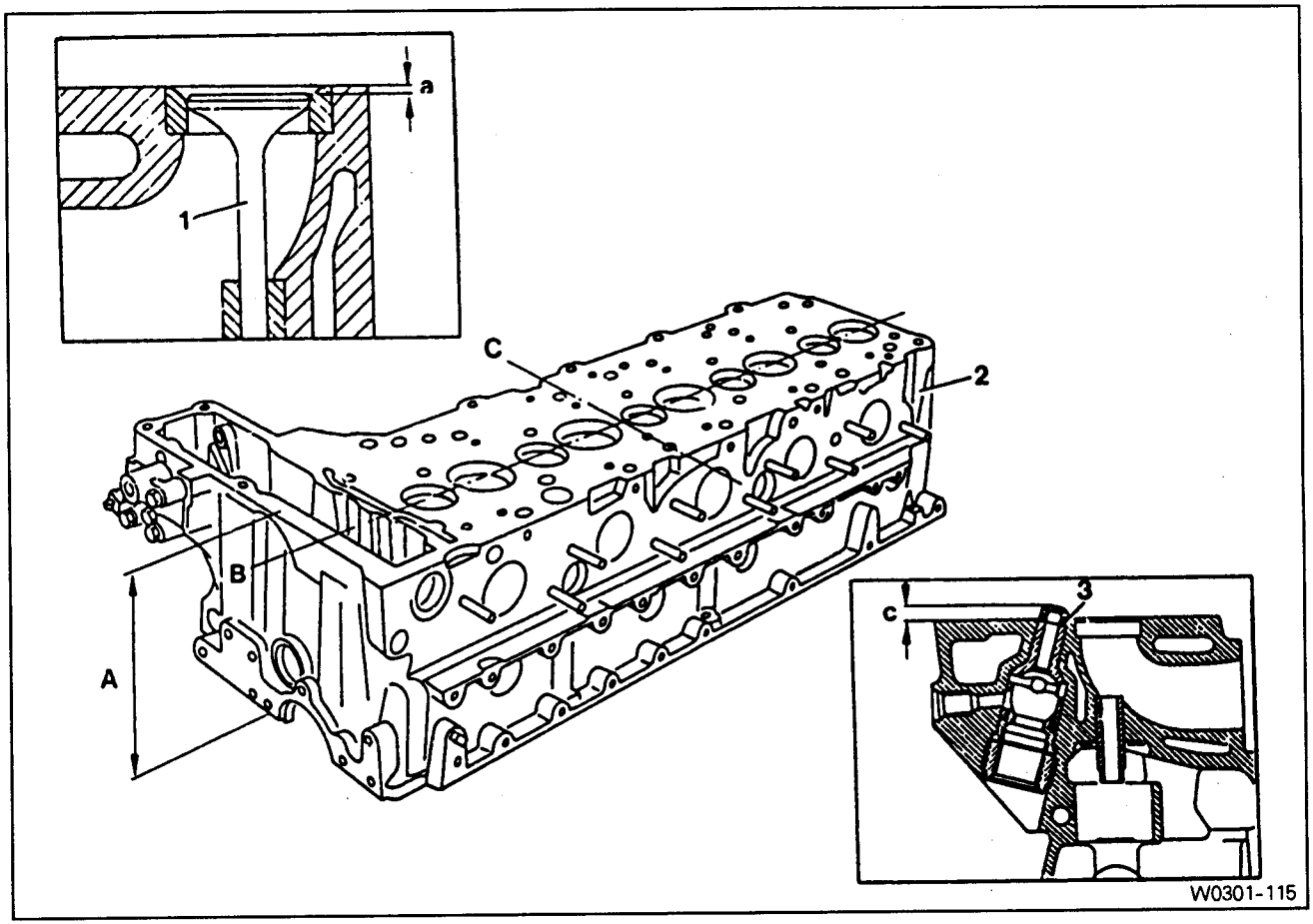
115 589 34 63 00



601 589 00 25 00

8. Facing Cylinder Head Mating Surface

Preceding work : Removal of prechamber (01-13)
Cylinder head pressure leakage test (01-03)



1. Valve
2. Cylinder Head
3. Prechamber

A. Height of Cylinder Head
B. Longitudinal Direction
C. Transverse Direction
a. Valve Arrears
b. Prechamber Protrusion

Service data

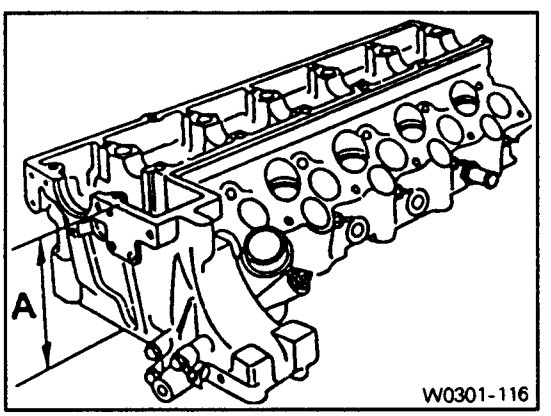
Height 'A' (cylinder head surface - cylinder head cover surface)		142.9~143.1mm
Minimum height after machining		142.5mm
Permissible unevenness of parting surface	In longitudinal direction	0.08mm
	In transverse direction	0.0mm
Permissible variation of parallelism (longitud. direction)		Max. 0.1mm
Peak-to-valley height		0.0017mm
Valve arrears 'a'	Intake valve	0.1~0.7mm
	Exhaust valve	0.1~0.7mm
Prechamber protrusion		7.6~8.1mm

Measurement

1) Measure height 'A'.

Limit	142.5mm

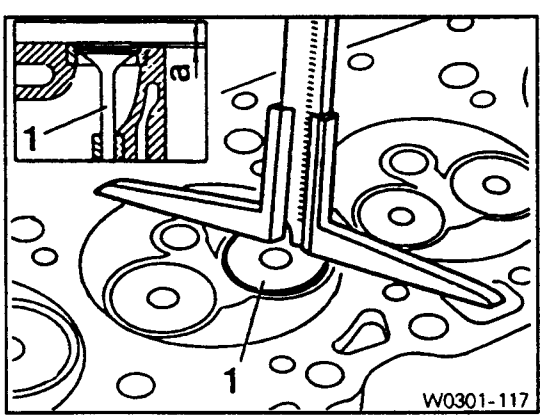
[Note] If the height is less than 142.5mm, replace the cylinder head.



2) Insert the valve (1) and measure valve arrears 'a'.

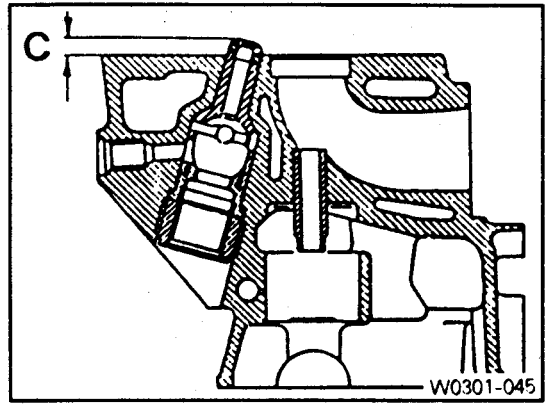
Valve arrears 'a'	0.1~0.7mm

[Note] If out of standard, machine the valve seat.



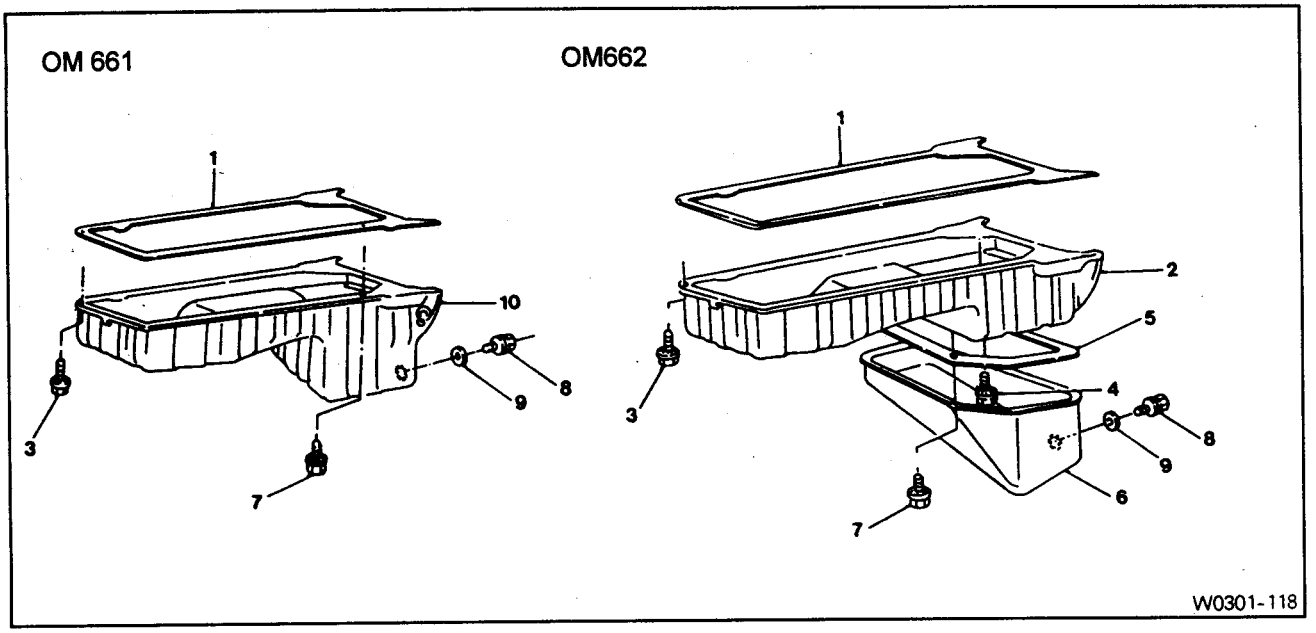
3) Install the prechamber and measure protrusion 'C'.

Protrusion 'C'	7.6~8.1mm



4) Assemble the engine and check the valve timing.

9. Removal and Installation of Oil Pan



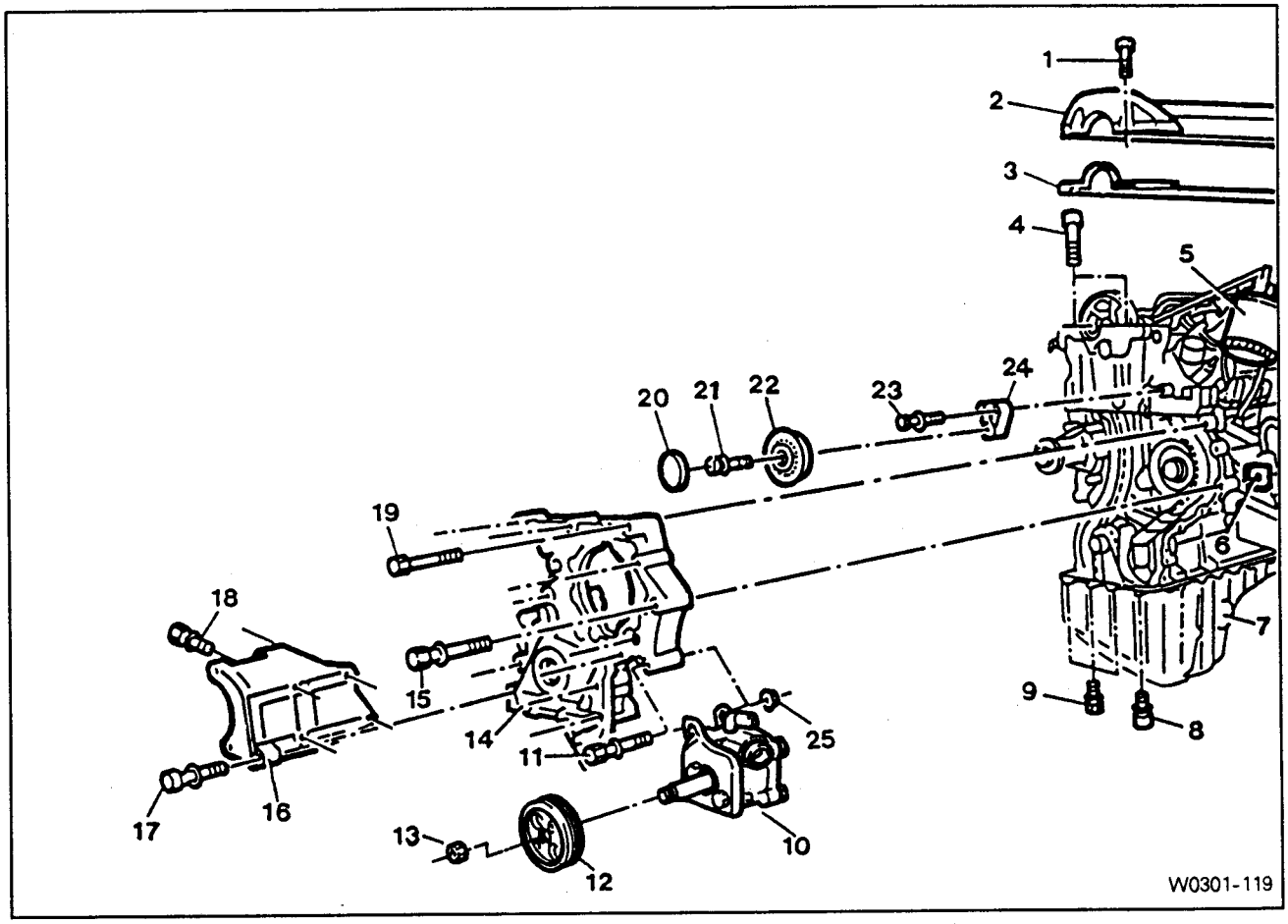
1. Gasket ---------- Replace
2. Upper Oil Pan
3. Combination Bolt ---------- 10Nm
4. Combination Bolt ---------- 10Nm
5. Gasket ---------- Replace
6. Lower Oil Pan
7. Combination Bolt ---------- 23Nm
8. Drain Plug ---------- 25Nm
9. Washer Seal ---------- Replace
10. Oil Pan

* Remove and install as numerical sequence.

[Note] Replace the washer seal with new one.

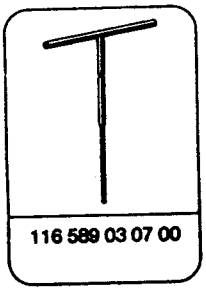
10. Removal and Installation of Timing Case Cover

Preceding work : Removal of the cooling fan
Removal of the V-belt tensioning device (03-06)
Removal of the vibration damper and hub (15-03)
Removal of the alternator (15-10)



1. Bolt ---------- 10Nm
2. Cylinder Head Cover
3. Gasket ---------- Replace
4. Socket Bolt---------- 23Nm
5. Fuel Filter
6. Square Nut
7. Oil Pan
8. Socket Bolt---------- 10Nm
9. Bolt ---------- M6 : 10Nm
   M8 : 23Nm
10. Power Steering Pump
11. Bolt
12. Belt Pulley
13. Bolt---------- 32Nm
14. Timing Case Cover
15. Bolt---------- 23Nm
16. Alternator Bracket
17. Bolt---------- 23Nm
18. Bolt---------- 23Nm
19. Bolt---------- 23Nm
20. Closing Cover
21. Socket Bolt---------- 23Nm
22. Guide Pulley
23. Bolt---------- 9Nm
24. Guide Pulley Bracket
25. Nut ---------- 23Nm

Special tool



Removal

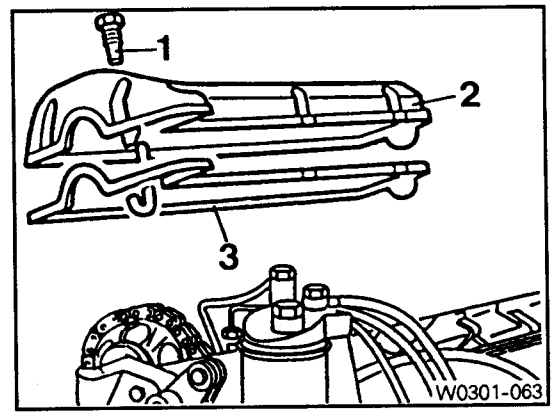
1) Remove the fan clutch and cooling fan belt pulley.

2) Drain the engine oil completely.

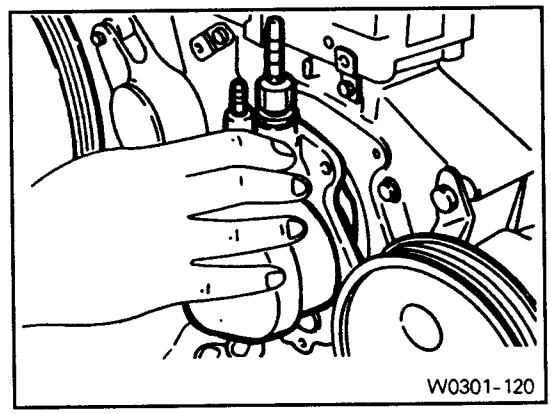
3) Remove the oil dipstick tube bracket bolts.

4) Remove the crankshaft pulley.

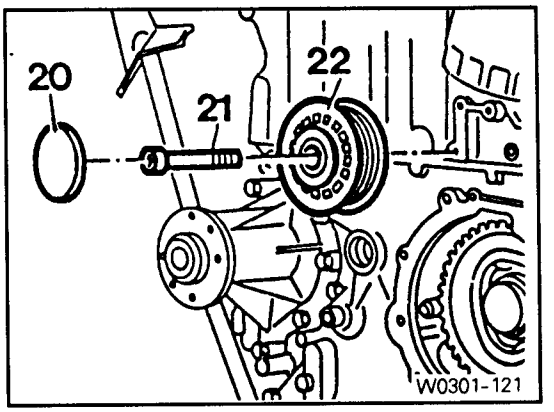
5) Remove the bolts (1) and then remove the cylinder head cover (2) and gasket.



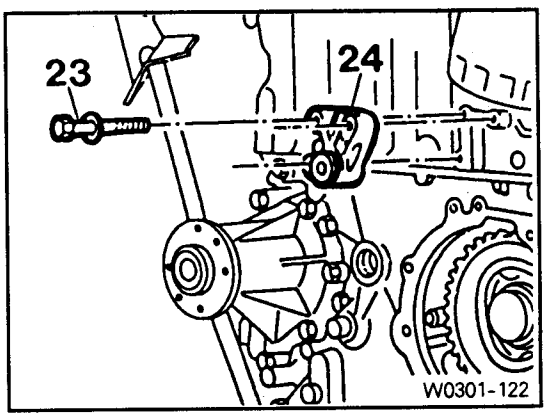
6) Remove the vacuum pump.



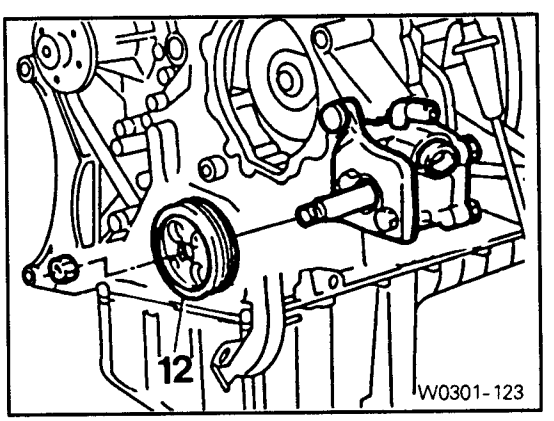
7) Detach the closing cover (20). Remove the bolts (21) and then remove the guide pulley (22).



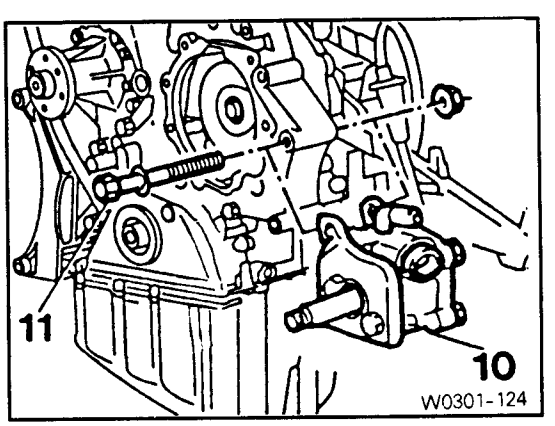
8) Remove the guide pulley bracket (24).



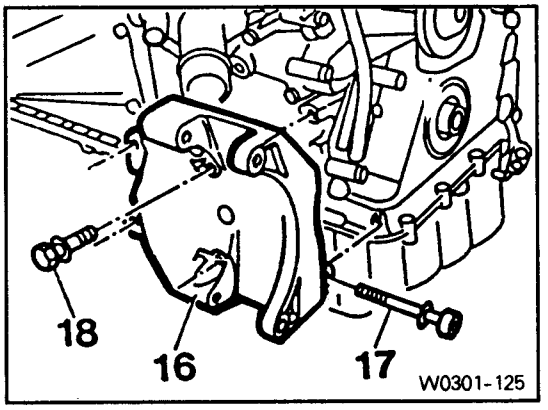
9) Disconnect the pipes of power steering pump and remove the belt pulley.
[Note] Be careful not to lose the key.



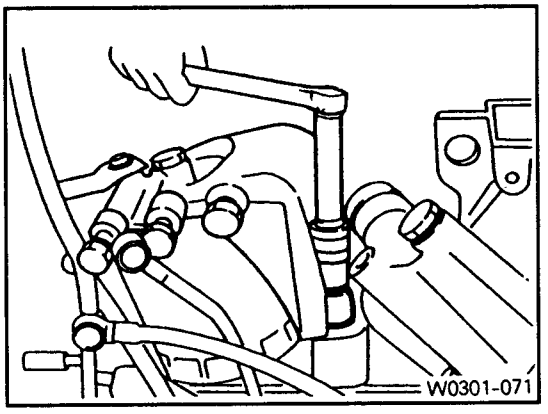
10) Remove the nut and pull out the bolt and then remove the power steering pump.



11) Remove the alternator bracket (16).



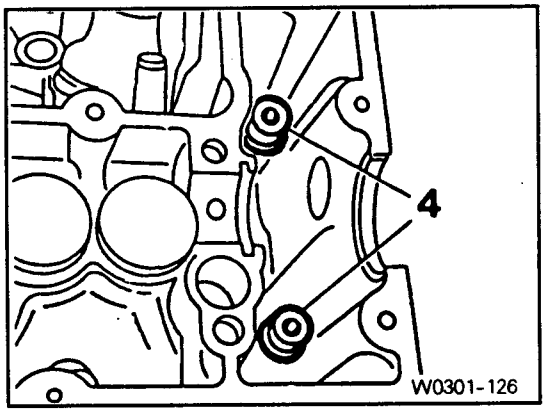
12) Remove the fuel filter.



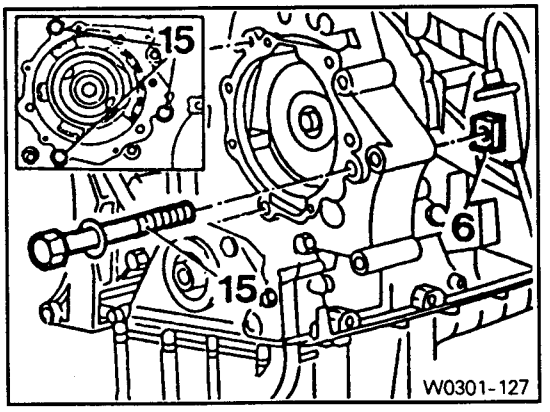
13) Remove the camshaft.

14) Remove the socket bolts (4) in the chain box.

Socket wrench 116 589 03 07 00

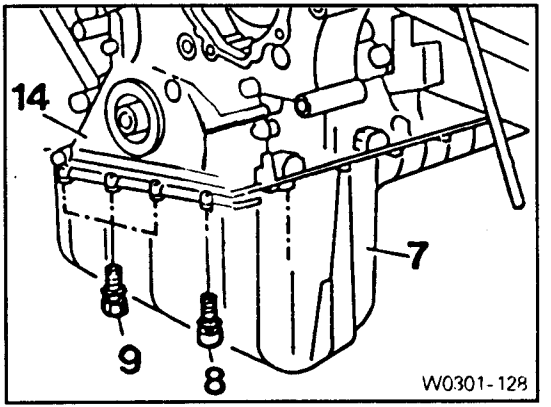


15) Remove the injection pump.
[Note] See the 'Removal of fuel injection pump'.

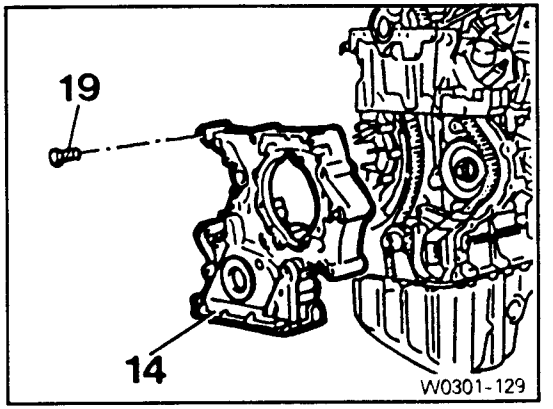


16) Remove the oil pan bolts (8, 9) in the area of the timing case cover (14).

17) Slightly loosen the remaining oil pan bolts.

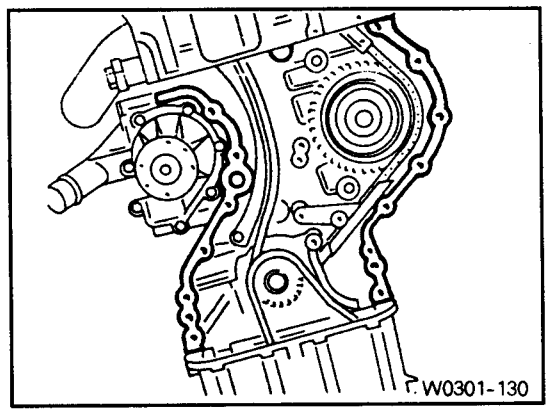


18) Remove the timing case cover (19) bolts and then remove the timing case cover (4).
[Note] Be careful not to damage the cylinder head gasket or oil pan gasket.



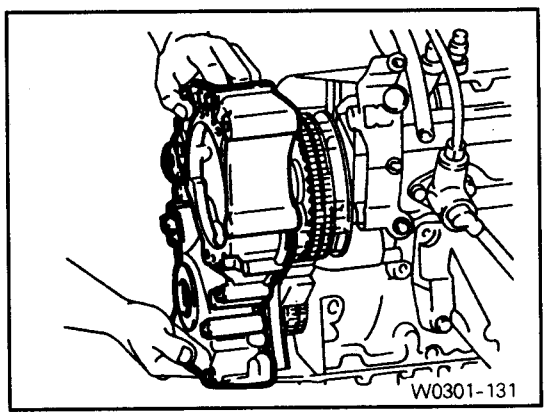
Installation

1) Thoroughly clean the sealing surface and apply sealant.



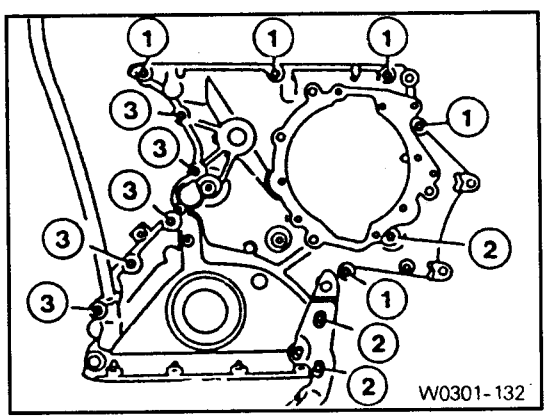
2) Install the timing case cover.

Tightening torque	10Nm



[Note] Bolts arrangement

① M6×60
② M6×70
③ M6×40

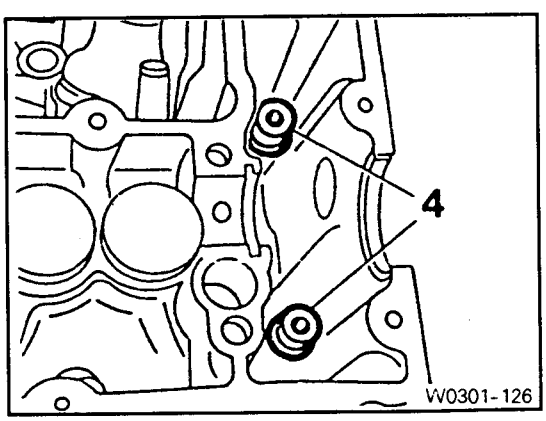


3) Tighten the socket bolts in the chain box.

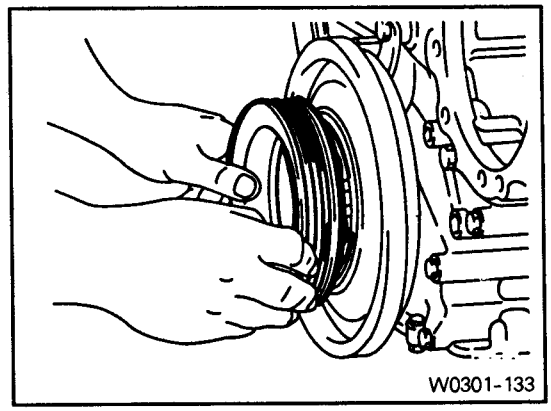
Tightening torque	23Nm

4) Tighten the oil pan bolts.

Tightening torque	Socket bolt	10Nm
	M6 bolt	10Nm
	M8 bolt	23Nm

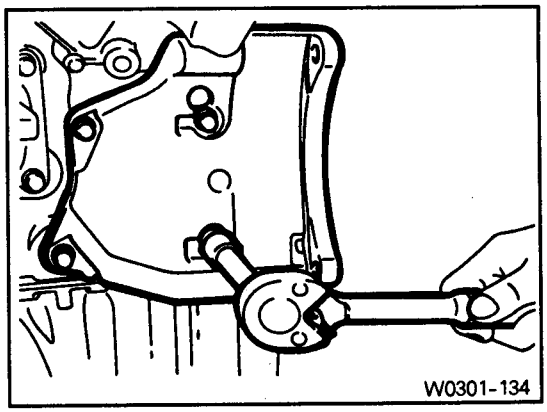


5) Install the flange, vibration damper and crankshaft belt pulley.
[Note] Replace front radial seal if necessary.



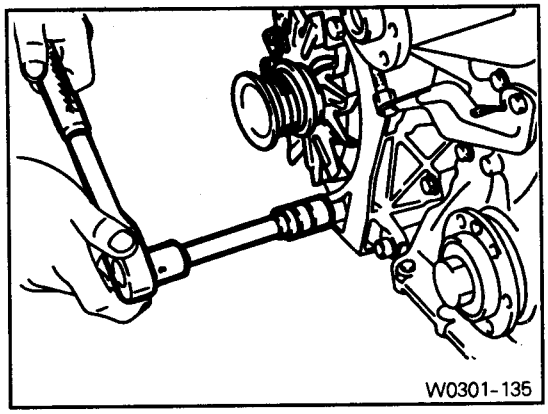
6) Install the alternator bracket.

Tightening torque	Front	25Nm
	Side	25Nm



7) Install the alternator.

Tightening torque	45Nm

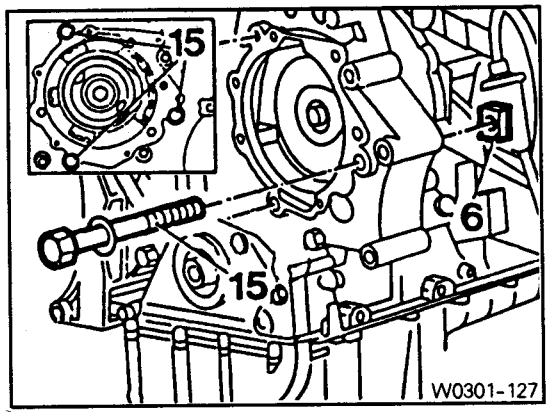


8) Install the cylinder head cover.

Tightening torque	10Nm

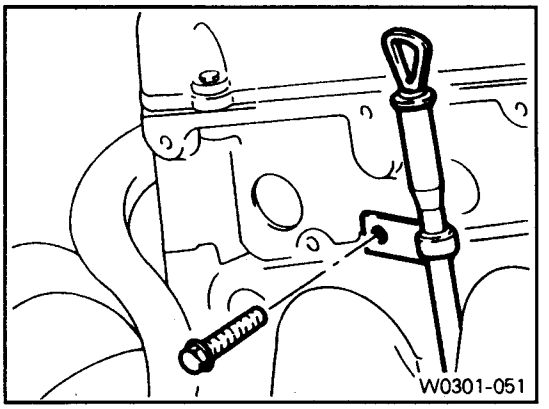
9) Tighten the injection pump mounting bolts.

Tightening torque	23Nm



10) Install the fuel filter.

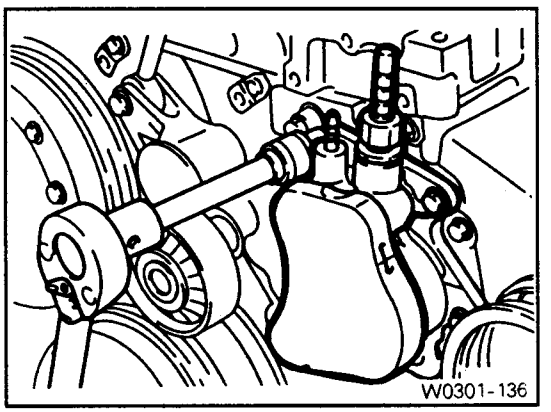
Tightening torque	23Nm



11) Install the oil filler guide tube bracket.

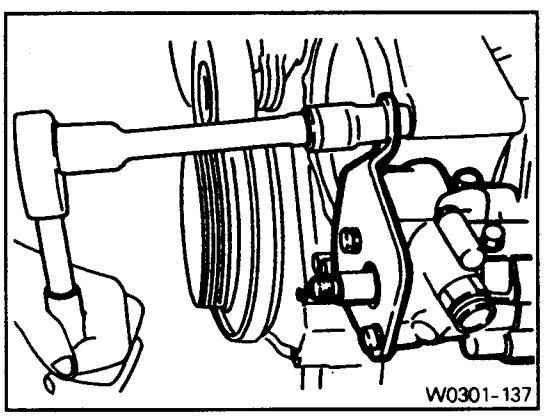
12) Install the vacuum pump.

Tightening torque	10Nm



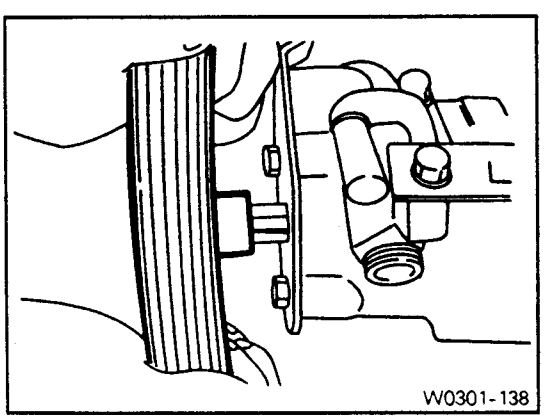
13) Install the power steering pump.

Tightening torque	23Nm



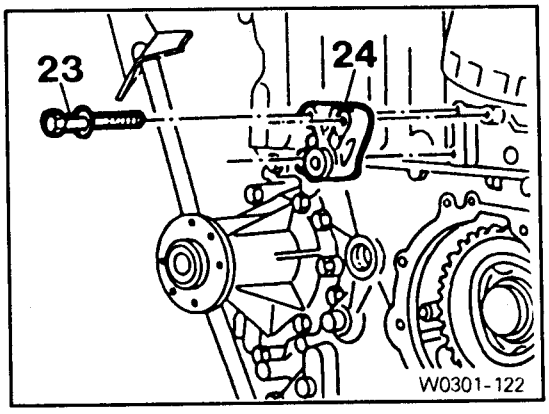
14) Install the power steering pump pulley.

Tightening torque	32Nm



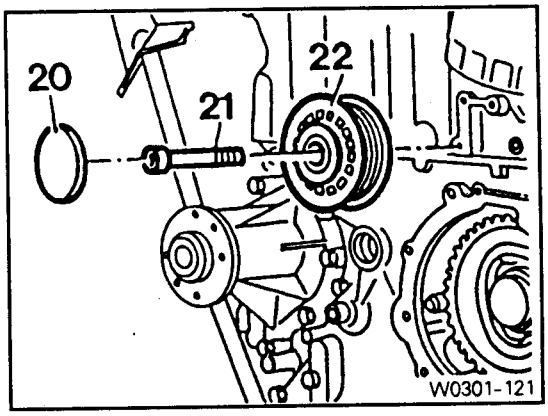
15) Install the guide pulley bracket.

Tightening torque	9Nm



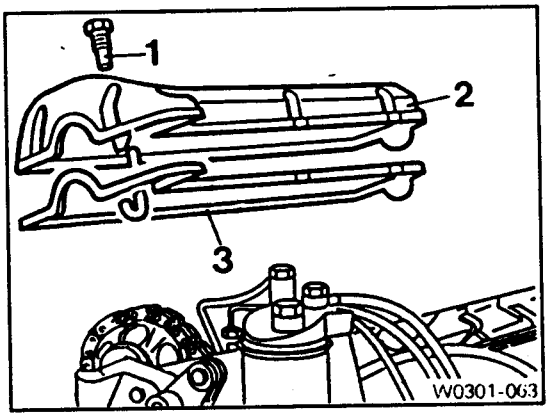
16) Install the guide pulley (22) and fit the closing cover (20).

Tightening torque	23Nm



17) Replace the gasket (3) and install the cylinder head cover (2).

Tightening torque	10Nm



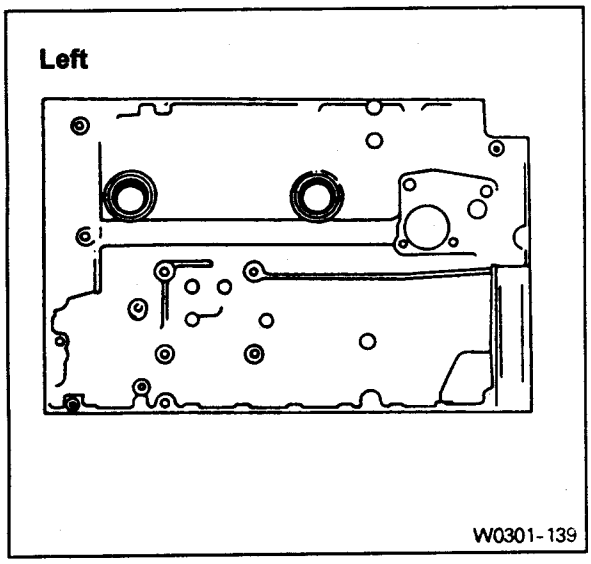
18) Install the cooling fan belt pulley and fan clutch.

19) Install the belt tensioning device and then install the belt.

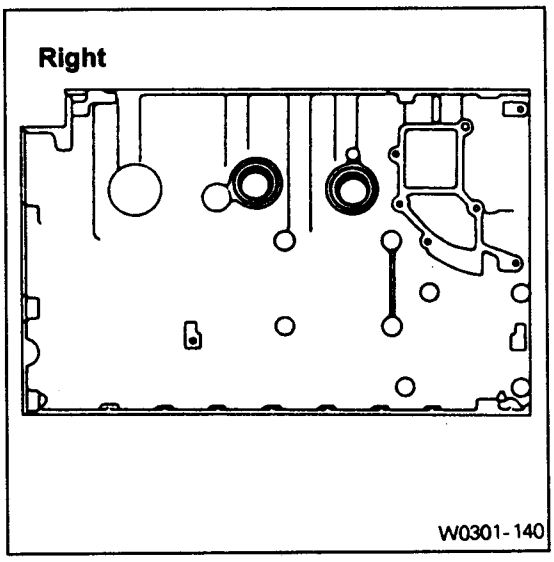
20) Install the cooling fan.

21) Fill the engine oil and check oil leaks by running the engine.

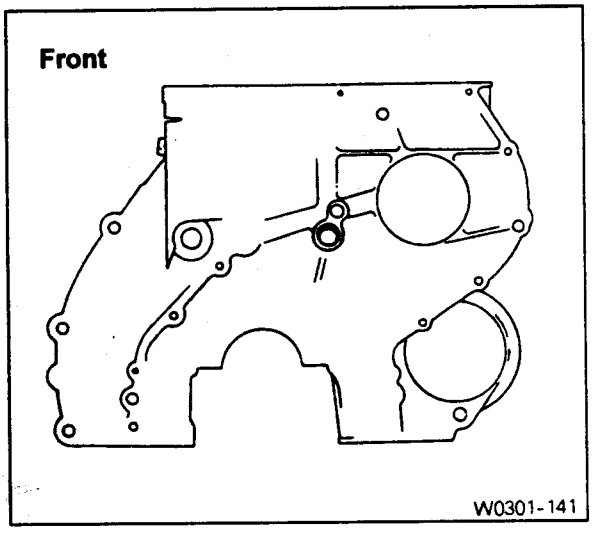
11. Replacement of Crankcase Core Plug



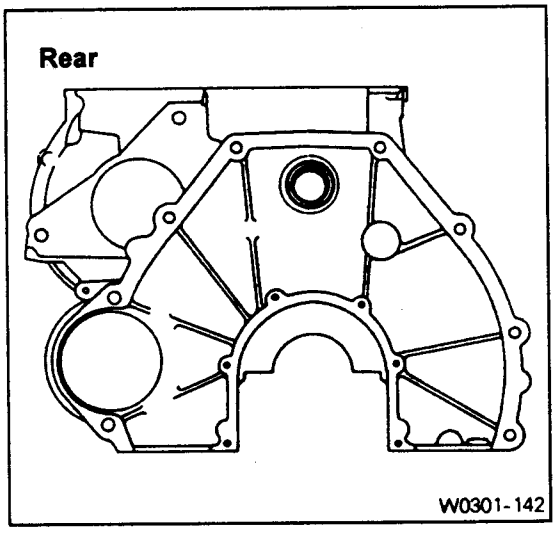
Core Plug---------- ϕ 34mm
OM661 - 2 EA
OM662 - 3 EA



Core Plug---------- ϕ 34mm
OM661 - 2 EA
OM662 - 3 EA

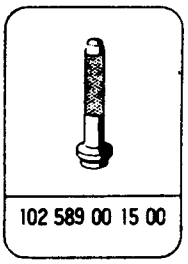


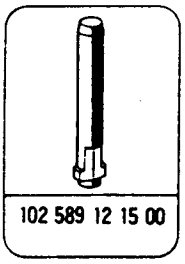
Core Plug---------- ϕ 17mm
OM661 - 1 EA
OM662 - 1 EA



Core Plug---------- ϕ 34mm
OM661 - 1 EA
OM662 - 1 EA

Special tools



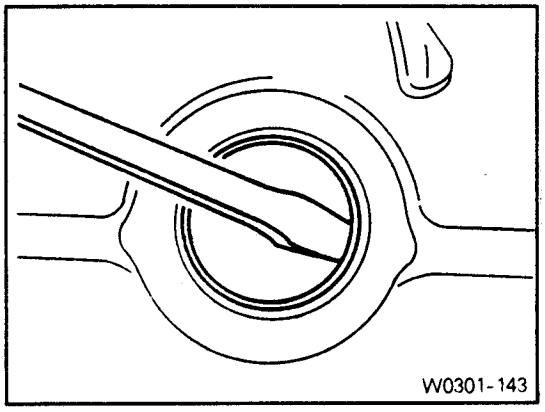


Replacement

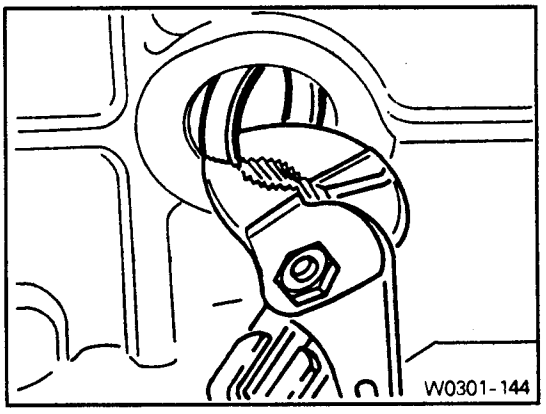
1) Completely drain the coolant.

2) Remove any parts which impede access.
(Example : transmission, injection pump)

3) Place the screwdriver to the deepdrawn edge of the core plug and pull forward and then rotate 90 ° .



4) Pull out the core plug with pliers.



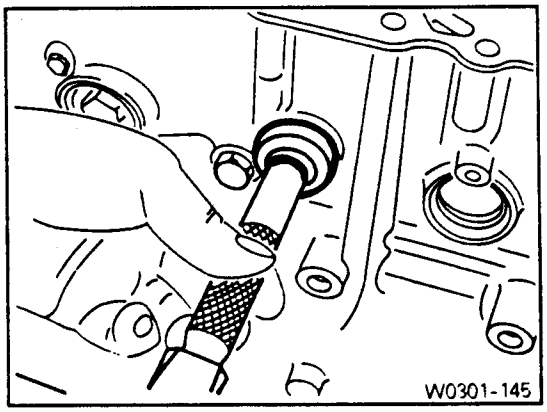
5) Thoroughly clean the sealing surface and apply Loctite 241.

6) Install the new core plug by using a drift.

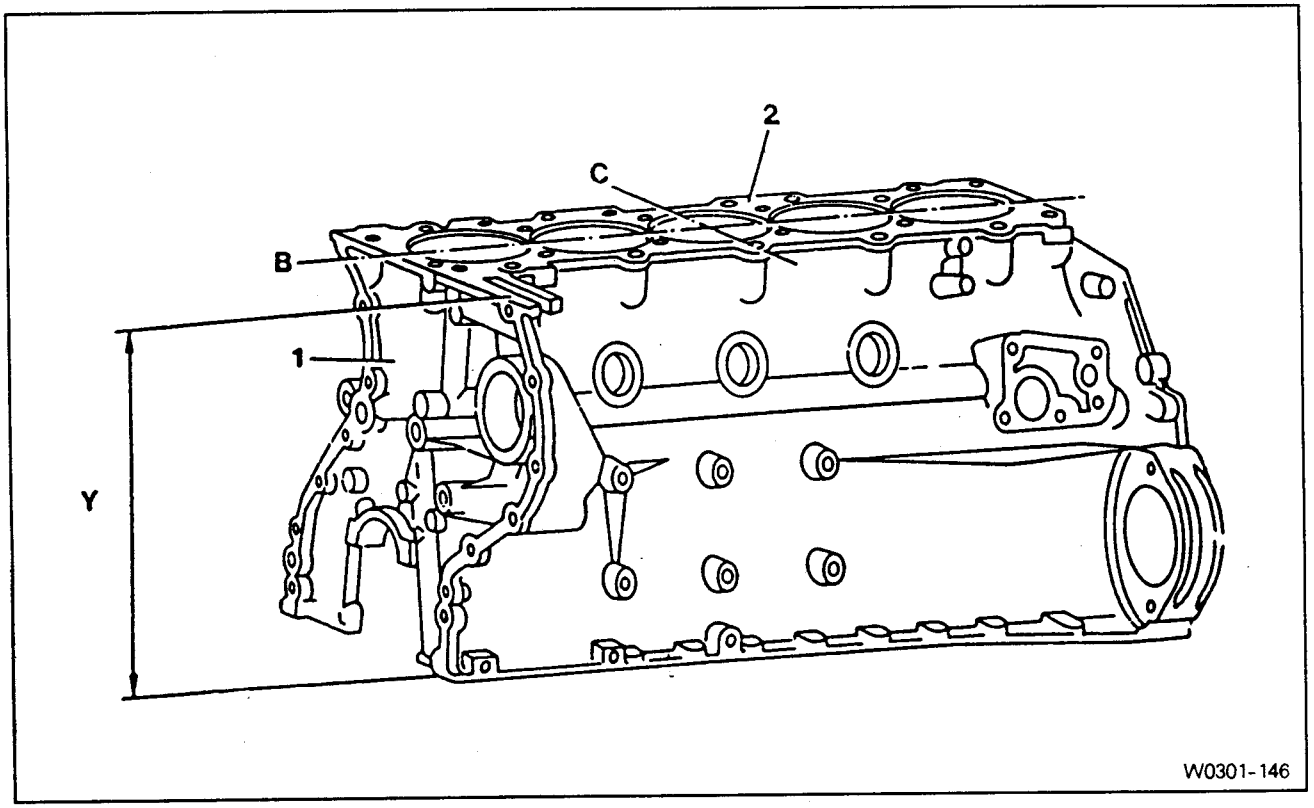
Drift 102 589 00 15 00 (ϕ34)
Drift 102 589 12 15 00 (ϕ17)

7) Install the removed parts and fill the coolant.
[Note] The adhesive must be allowed to harden for about 45 minutes before filling of coolant.

8) Warm up the engine and check the coolant for leaks.



12. Facing Crankcase Contacting Surface



1. Crankcase
2. Crankcase Contacting Surface

Y. Height (crankcase upper surface - crankcase lower surface)

B. Longitudinal Direction

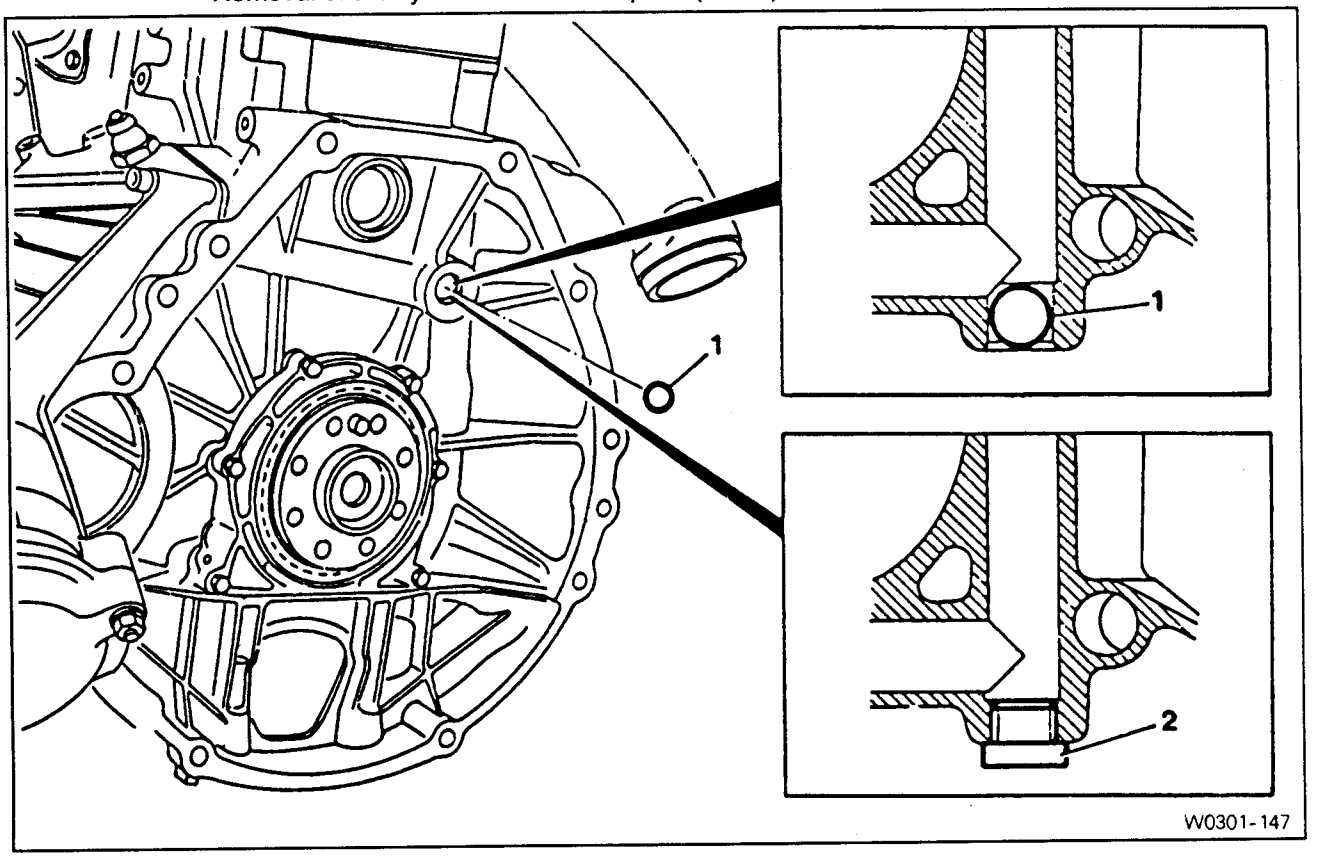
C. Transverse Direction

Service data

Height 'Y'		Min. 299.62mm
Permissible unevenness of contacting surface	In longitudinal direction (B)	0.06mm
	In transverse direction (C)	0.06mm
Permissible roughness upper contacting surface		0.0006~0.0016mm
Permissible variation of parallelism of crankcase upper surface to lower surface in longitudinal direction		0.05mm
Piston protrusion at TDC to crankcase upper surface	Max.	0.965mm
	Min.	0.735mm

13. Removal and Installation of Oil Gallery Steel Ball

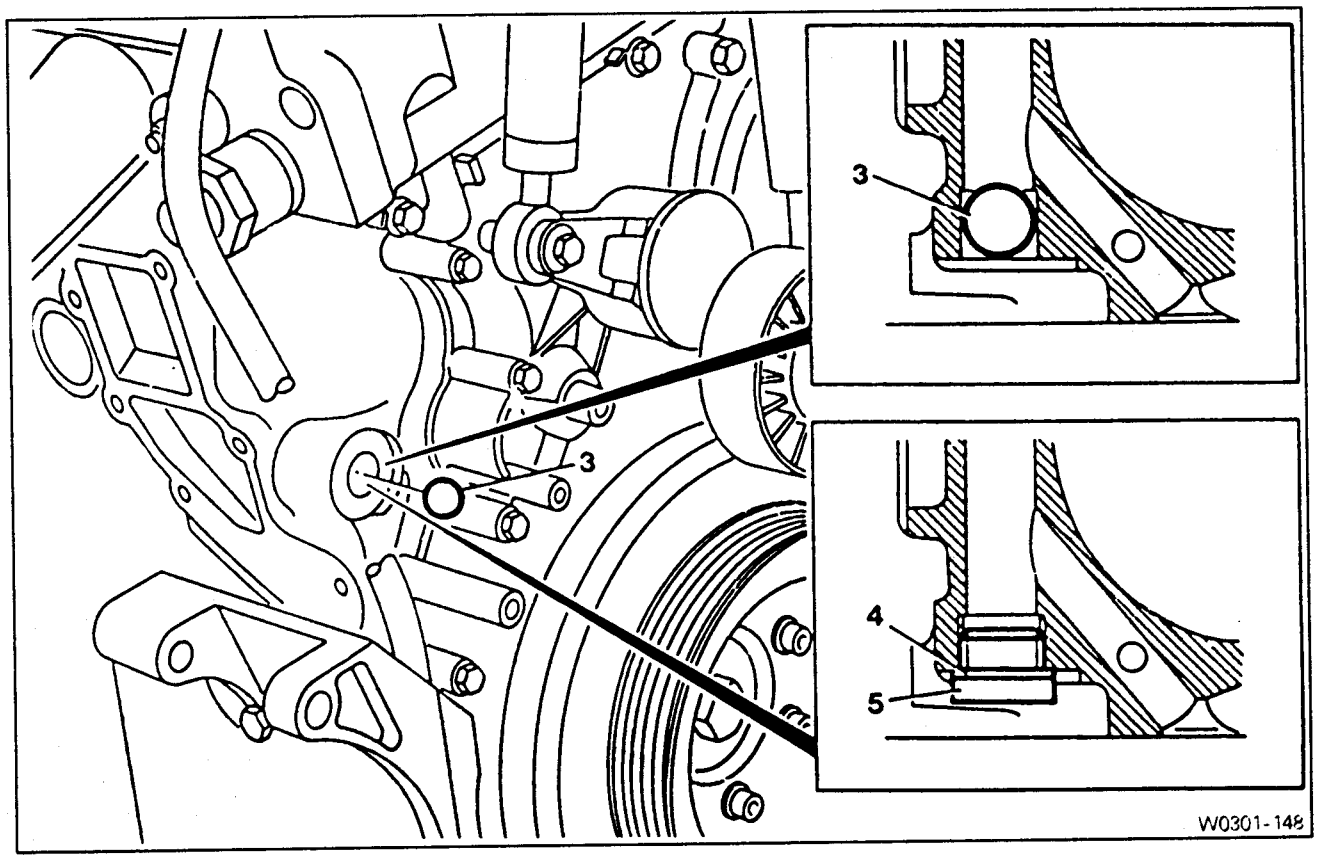
Preceding work : Removal of cooling fan
Removal of the coolant pump housing (20-05)
Removal of the flywheel and driven plate (03-38)



1. Steel Ball ---------- ϕ 15mm

2. Screw Plug M16 × 1.5 ---------- Loctite 241, 50Nm

[Note] The screw plug (2) has to be installed as a repair solution if the steel ball (1) is leaking.



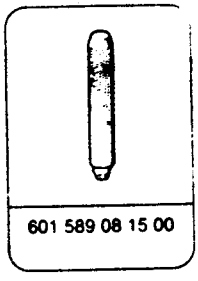
3. Steel Ball ---------- ϕ 17mm

4. Seal

5. Screw Plug M18 × 1.5 ---------- 50Nm

[Note] The seal (4) and screw plug (5) have to be installed as a repair solution if the steel ball (3) is leaking.

Special tool

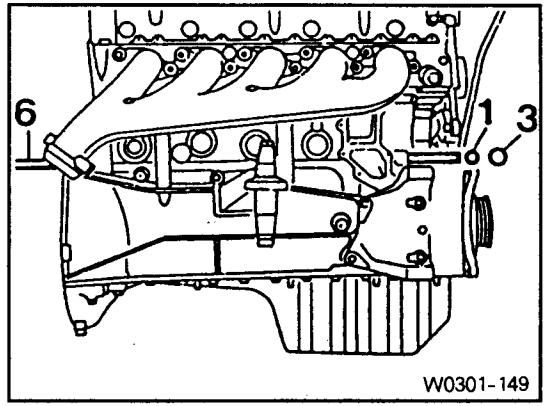


Removal · Installation

1) Remove the timing case cover.

2) By inserting a round bar (6) approx. 0.7m from the back to the front side through the oil gallery, knock out the steel balls (1, 3).
[Note] Be careful not to damage the bores of the steel balls.

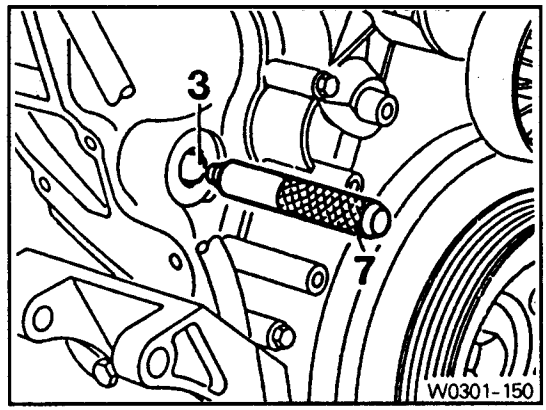
6 Shop-made tool



3) Thoroughly clean the bores of steel balls.

4) Place the steel ball (3) onto the drift (7) with a little grease and position to the bore and then tap until the drift stops.

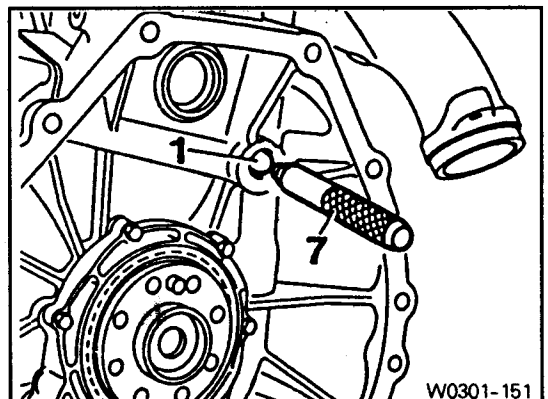
Drift 601 589 08 15 00



5) Place the steel ball (1) onto the drift (7) with a little grease and position to the bore and then tap until the drift stops.

Drift 601 589 08 15 00

6) Warm up the engine and check the oil for leaks.



Installation of screw plug

[Note] If steel ball leaks again, install the screw plug.

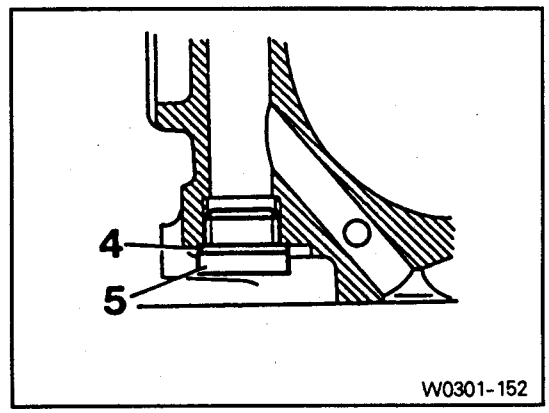
1) Remove the steel ball.

2) Tap thread into the bores of the oil gallery.
[Note] Front bore : M18 × 1.5, depth 10mm
Rear bore : M16 × 1.5, depth 14mm

3) Thoroughly clean the oil gallery.

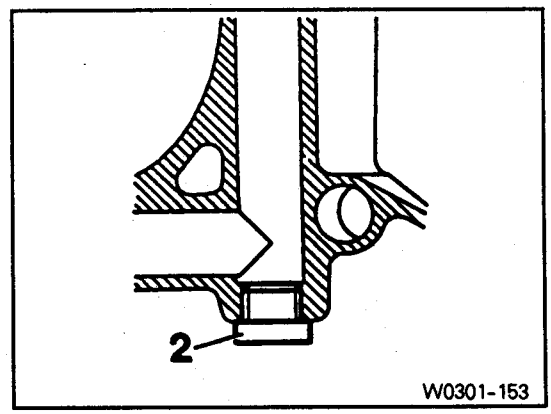
4) Tighten the front plug (5) with seal (4).

Tightening torque	50Nm

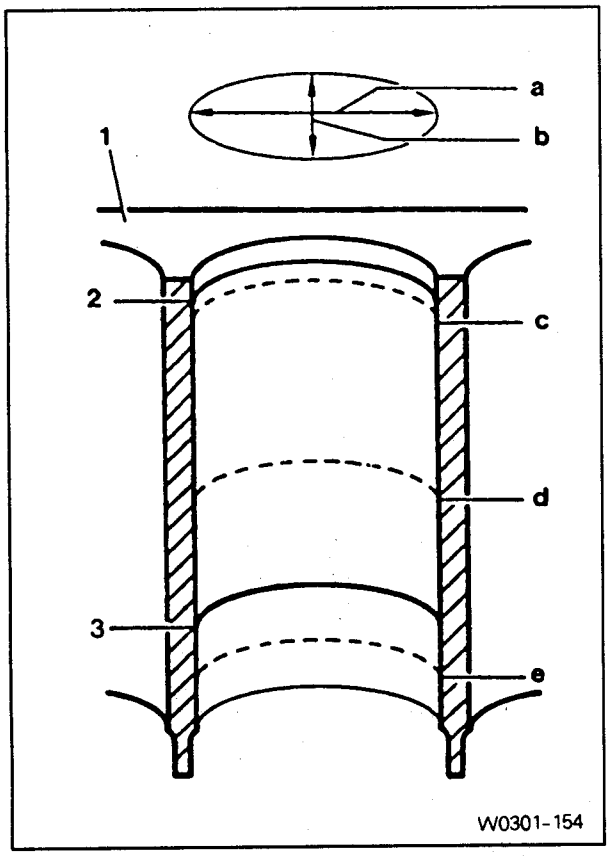


5) Apply Loctite 241 and then tighten the rear plug (2).

Tightening torque	50Nm



14. Cylinder Bore Measurement



a. Longitudinal Direction
b. Transverse Direction
c, d, e. Measuring Point

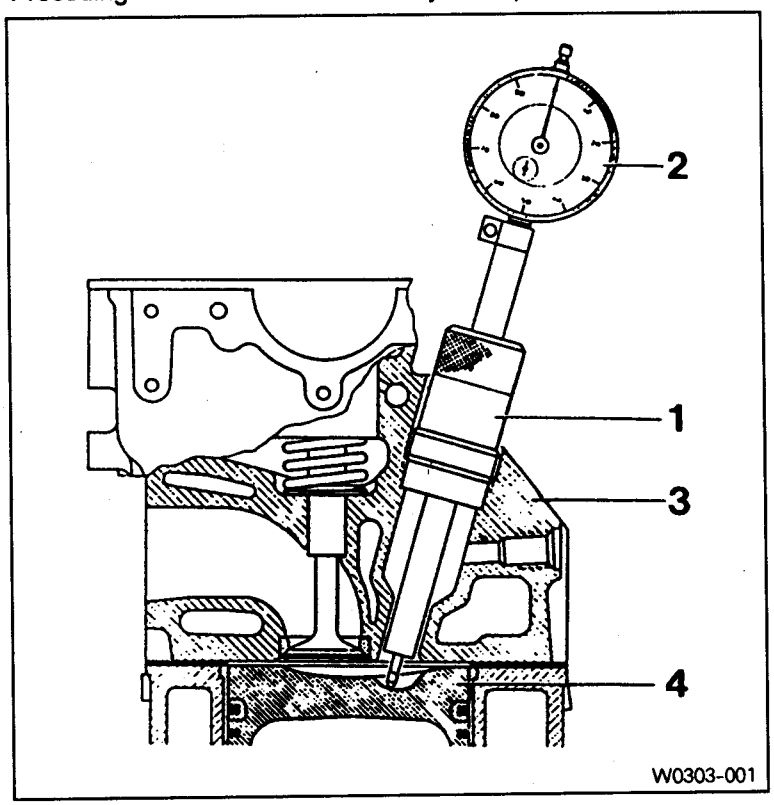
1. Crankcase contacting surface
2. TDC of 1st piston ring
4. BDC of oil ring

Service data

Standard size	Code letter 'A'	89.000~89.006mm
	Code letter 'X'	89.006~89.012mm
	Code letter 'B'	89.012~89.018mm
Wear limit in direction of travel and in transverse direction		Max. 0.20mm
Permissible deviation of cylinder shape	When new	0.01mm
	Wear limit	0.05mm
Honing angle		50° ± 10°

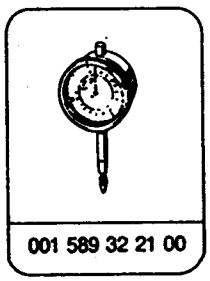
1. TDC (TDC Sensor Bracket) Setting

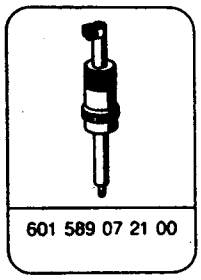
Preceding work : Removal of no.1 cylinder prechamber

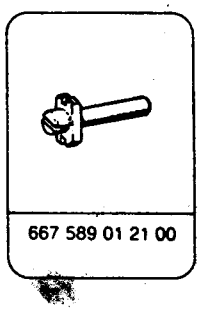


1. Measuring Device
2. Dial Gauge
3. Cylinder Head
4. Piston ----------Set at TDC

Special tools


001 589 32 21 00


601 589 07 21 00


667 589 01 21 00

[Note] The TDC sensor bracket must be adjusted in case of followings :

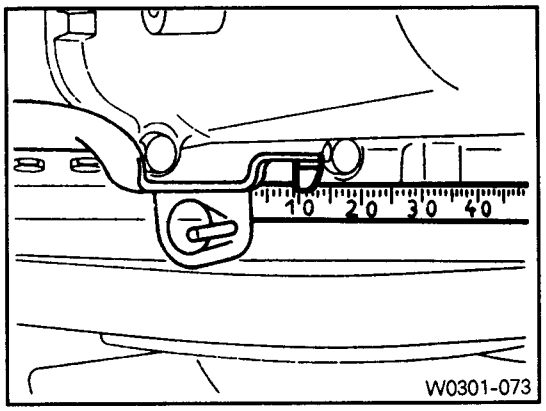
- **When replacing the TDC sensor bracket.**
- **When replacing the crankshaft, the hub or the vibration damper.**
- **When replacing or installing the timing case cover.**
- **After engine overhauling.**

*** If the cylinder head is removed, the measuring pin of the dial gauge can be positioned on the piston crown. This is done by placing the magnetic dial holder on the mating surface of the crankcase.**

Setting (with cylinder head installed)

1) Remove the prechamber of no.1 cylinder.

2) Position the piston of no.1 cylinder at BTDC 10.

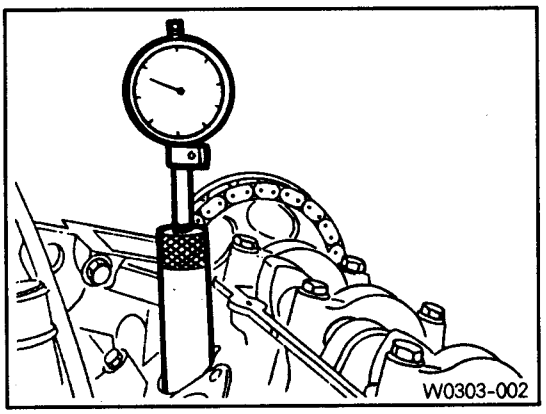


3) Install the measuring device into the prechamber bore and position the dial gauge with a preload of 5mm.

Dial gauge 001 589 53 21 00
Depth gauge 601 589 07 21 00

4) Slowly rotate the crankshaft in the direction of engine rotation until the large pointer on the dial gauge stops (TDC position).

[Note] The position of TDC is when the large pointer on the dial gauge is stopped before moving back.



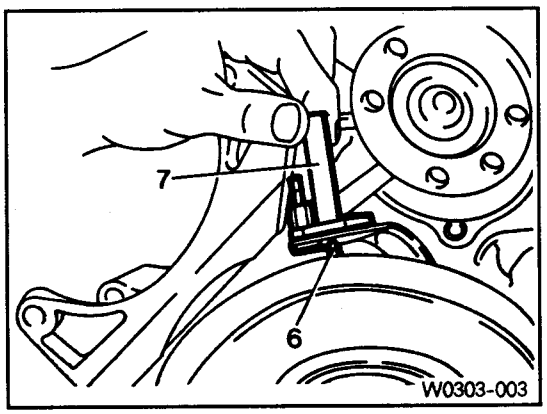
5) Remove and reinstall the measuring device and position the dial gauge scale at '0'.

6) Slowly rotate the crankshaft in the direction of engine rotation until the dial gauge has moved back (counterclockwise) by 3.65mm.

7) Insert a fixing device into the sensor bracket.

[Note] The pin on the vibration damper must engage into the slot of the fixing device.

Fixing device 667 589 01 21 00



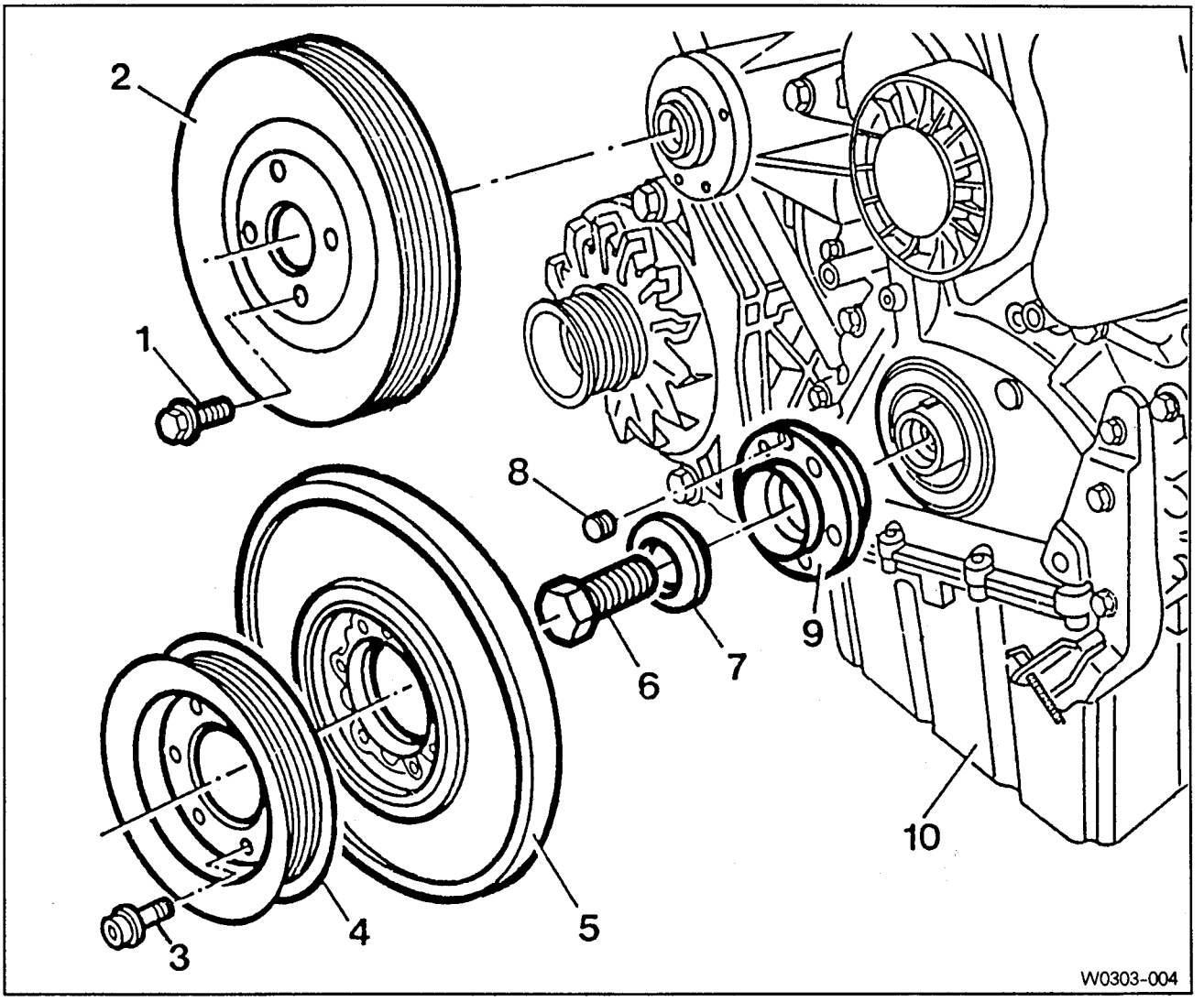
8) If the pin does not engage, adjust the setting of the sensor bracket by removing and tightening of the sensor bracket bolts.

Tightening torque	10Nm

[Note] The timing mark on the damper must be positioned at ATDC 20 °.

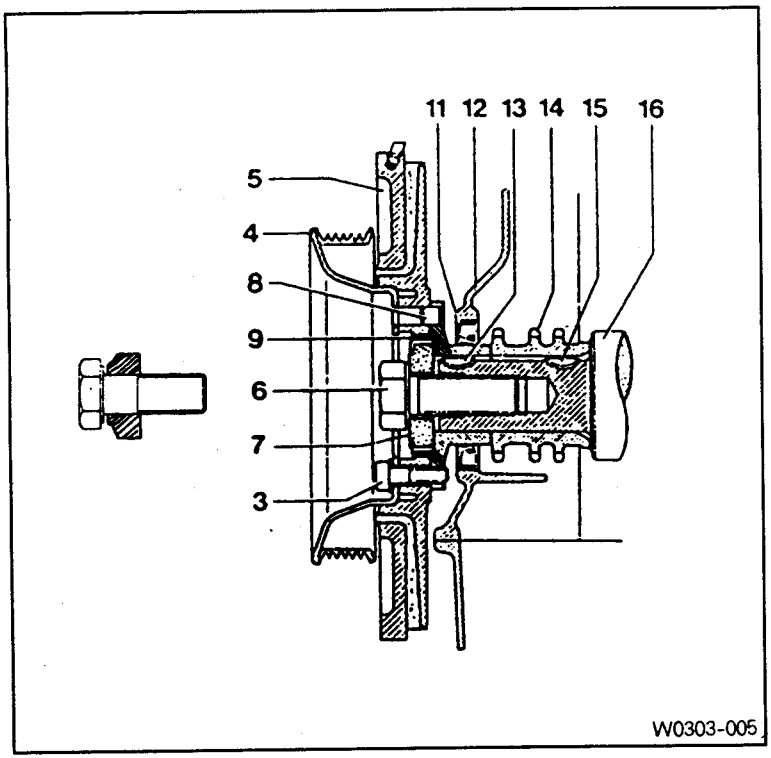
2. Removal and Installation of Vibration Damper and Hub

Preceding work : Removal of the cooling fan
Removal of poly V-belt



1. Bolt---------- 10Nm
2. Cooling Fan Belt Pulley
3. Socket Bolt---------- 23Nm
4. Crankshaft Belt Pulley
5. Vibration Damper
6. Bolt---------- 200Nm + 90°
7. Washer
8. Straight Pin
9. Hub
10. Oil Pan

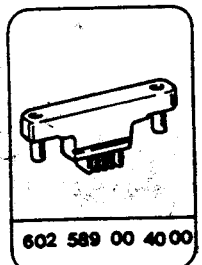
Sectional view

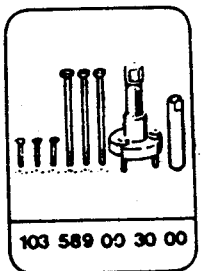


3. Socket Bolt
4. Crankshaft Belt Pulley
5. Vibration Damper
6. Bolt
7. Washer
8. Straight Pin
9. Hub
11. Radial Seal
12. Timing Case Cover
13. Woodruff Key
14. Crankshaft Sprocket
15. Woodruff Key
16. Crankshaft

[Note] The mounting position of vibration damper is fixed by straight pin (8).

Special tools

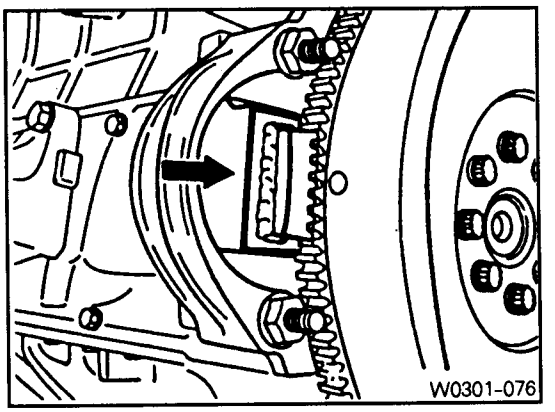




Removal

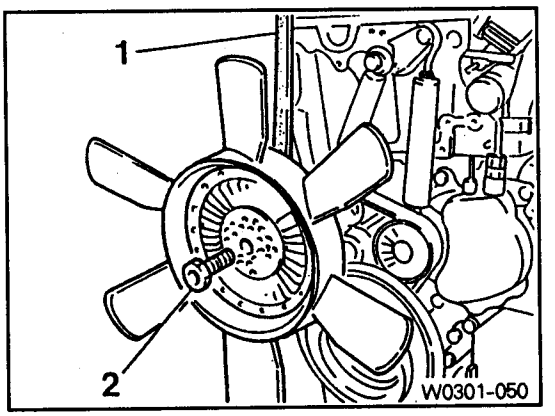
1) Remove the starter motor and install the engine lock into the wheel ring gear.

Engine lock 602 589 00 40 00



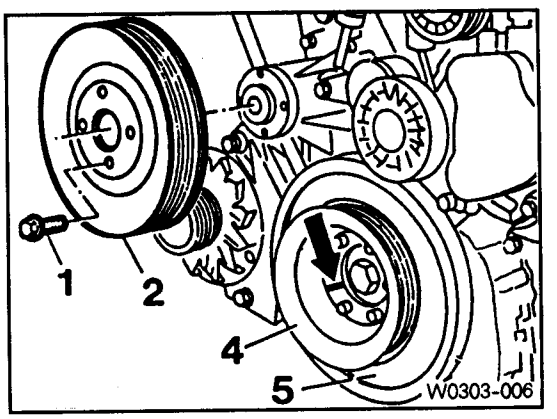
2) Remove the poly V-belt.

3) Remove the cooling fan.
[Note] Keep the fan in vertical position.

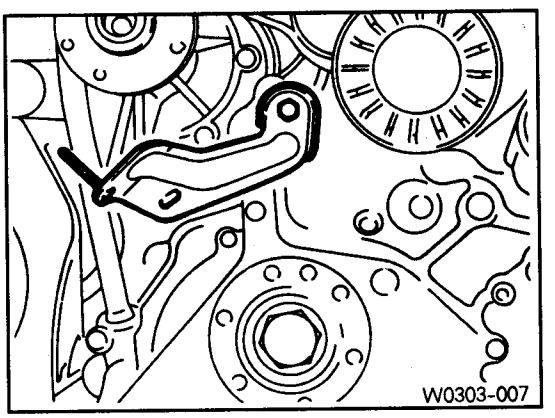


4) Remove the cooling fan belt pulley (2).

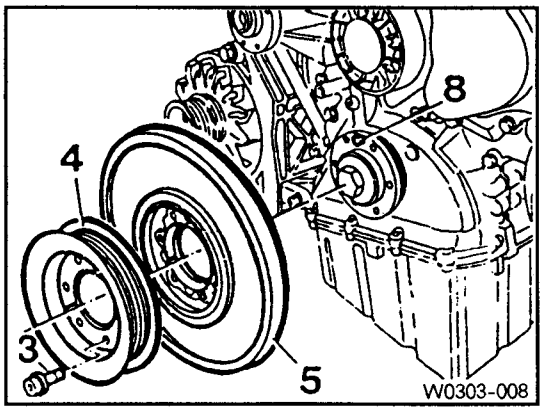
5) Place alignment marks (arrow) on the vibration damper (5) and crankshaft belt pulley (4).



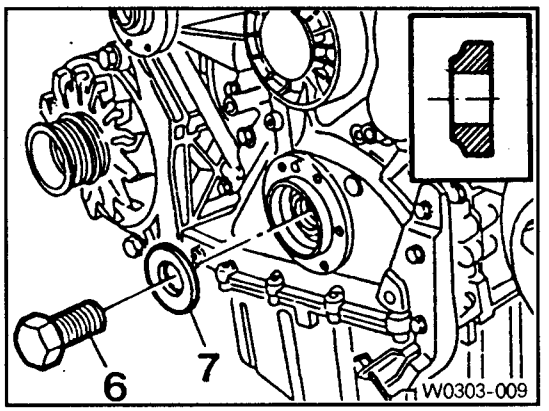
6) Remove the timing sensor bracket.
[Note] Remove if necessary.



7) Remove the socket bolts (3) and then remove the belt pulley (4) and vibration damper (5).

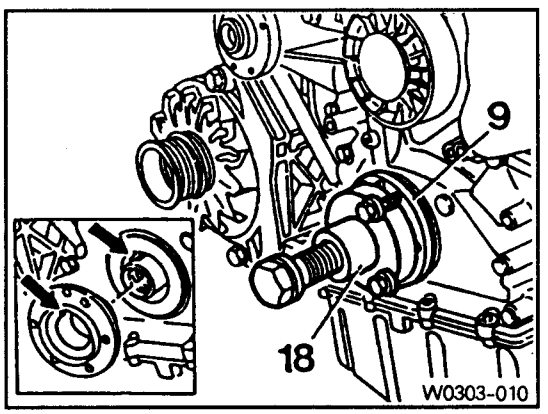


8) Remove the washer and bolt.



9) Remove the hub by using a puller.

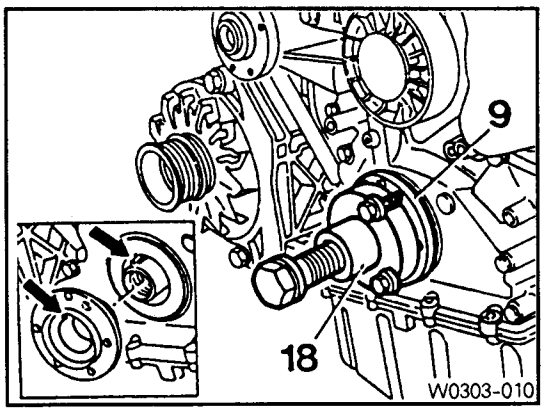
Puller 103 589 00 33 00



10) Replace the radial seal.

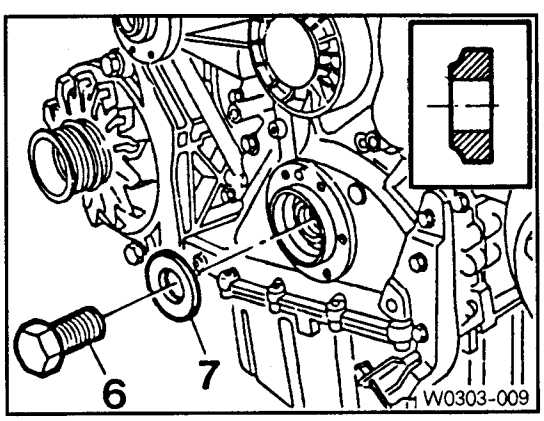
Installation

1) Install the hub.
[Note] Exactly align the woodruff key and the groove of hub (arrow).

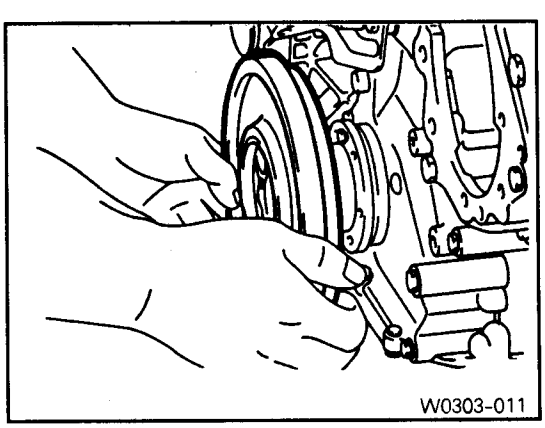


2) Install the washer (7) and tighten the blot (6).

Washer (old) : 3 EA	320Nm
Washer (new) : 1 EA	200Nm + 90 °



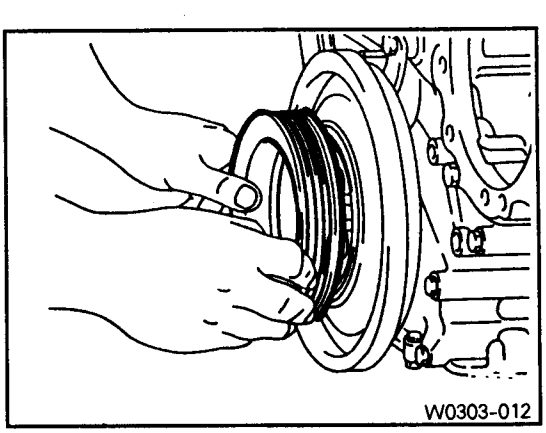
3) Install the vibration damper.
[Note] Exactly align and insert onto the straight pin.



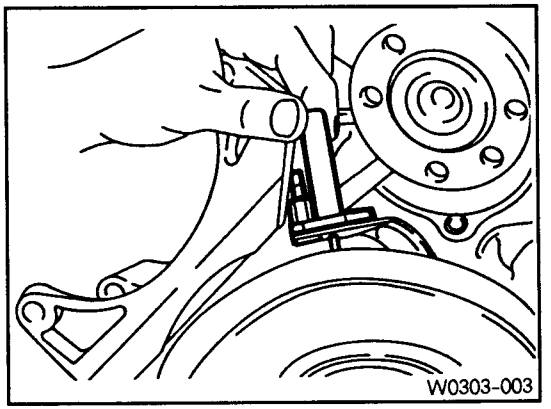
4) Install the belt pulley.

Tightening torque	25Nm

[Note] Align the alignment marks.

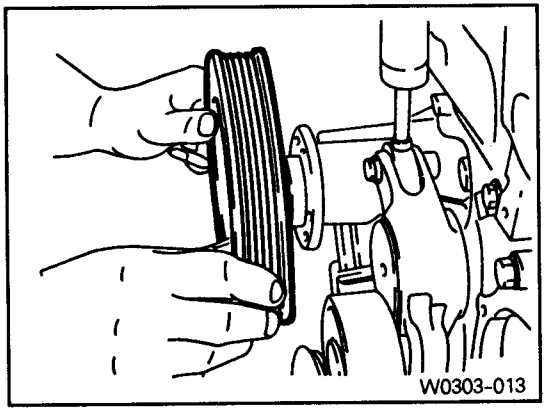


5) Install the timing sensor bracket.
[Note] See the 'TDC setting'.



6) Install the cooling fan pulley.

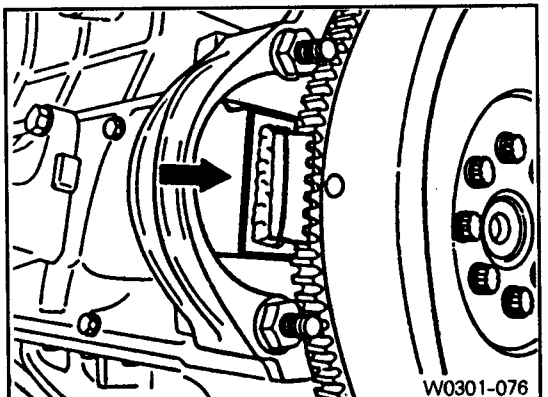
Tightening torque	10Nm



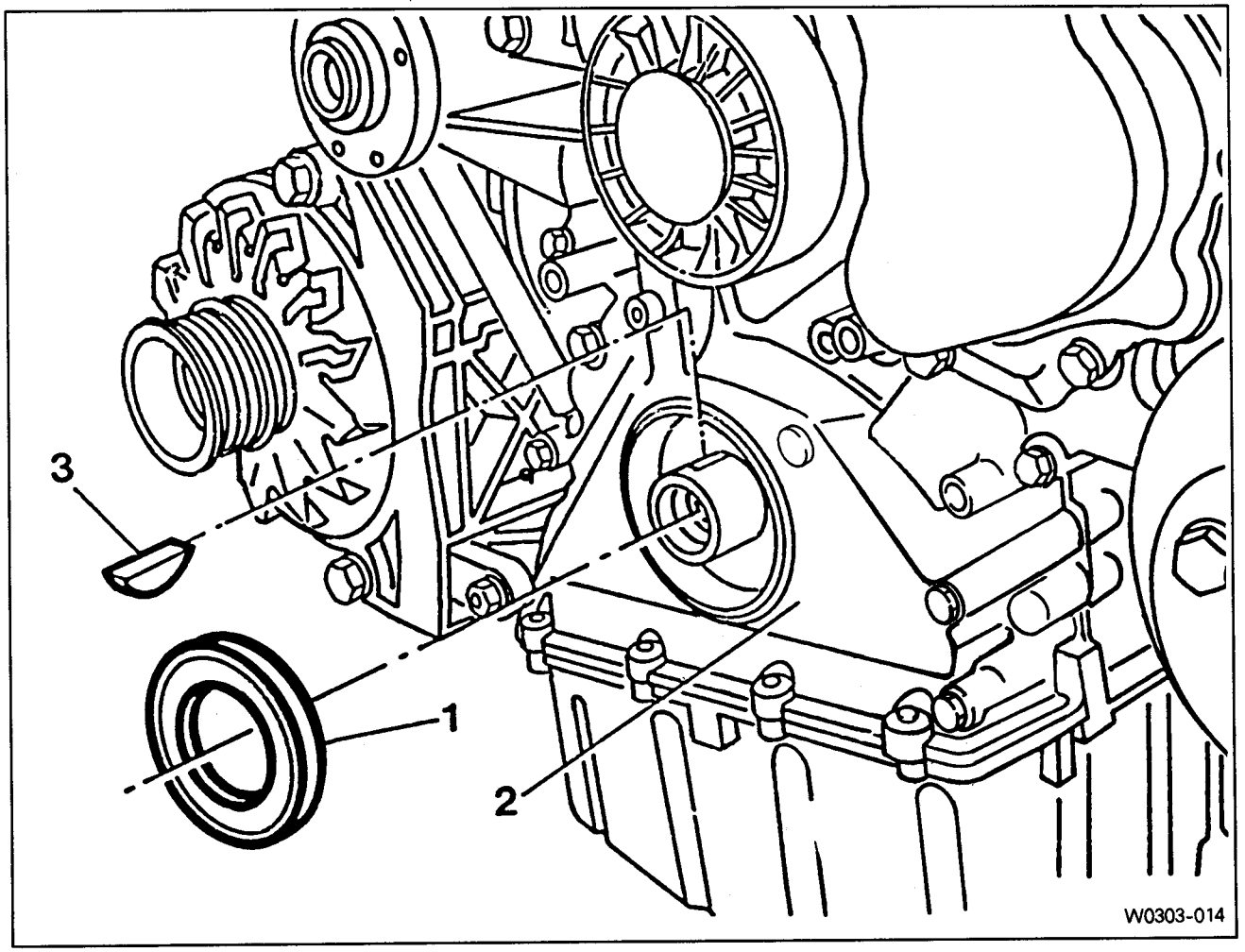
7) Install the cooling fan.

8) Install the fan belt.

9) Remove the engine lock.

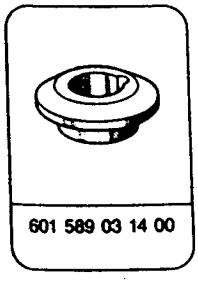


3. Replacement of Front Radial Seal



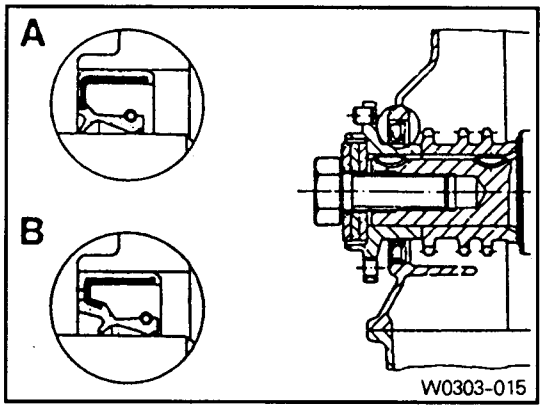
1. Radial Seal
2. Timing Case Cover
3. Woodruff Key

Special tool



[Note] The sealing lip of the repair radial seal is offset to the inside by 2mm to ensure that it does not run in any groove which the standard radial seal may have left on the crankshaft flange.

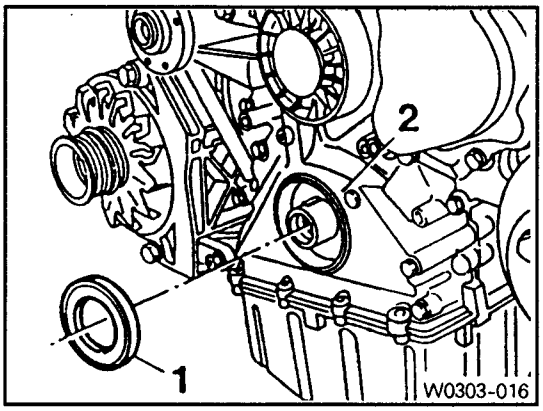
A. Standard radial seal
B. Repair radial seal



Replacement

1) Pull out the radial seal (1) and be careful not to damage the sealing surface of timing case cover.

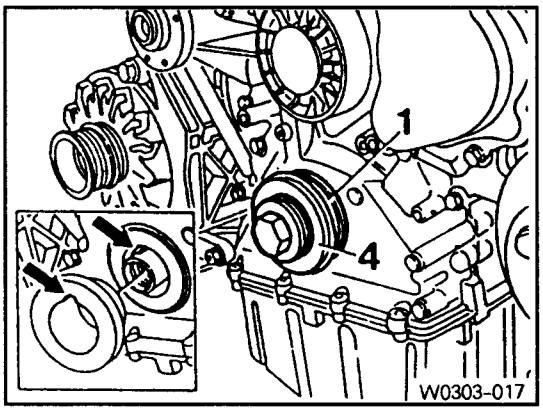
2) Thoroughly clean the mounting bore of the radial seal.



3) Coat a little oil on the sealing lip of new radial seal (1) and contact surface.
[Note] Don't use grease.

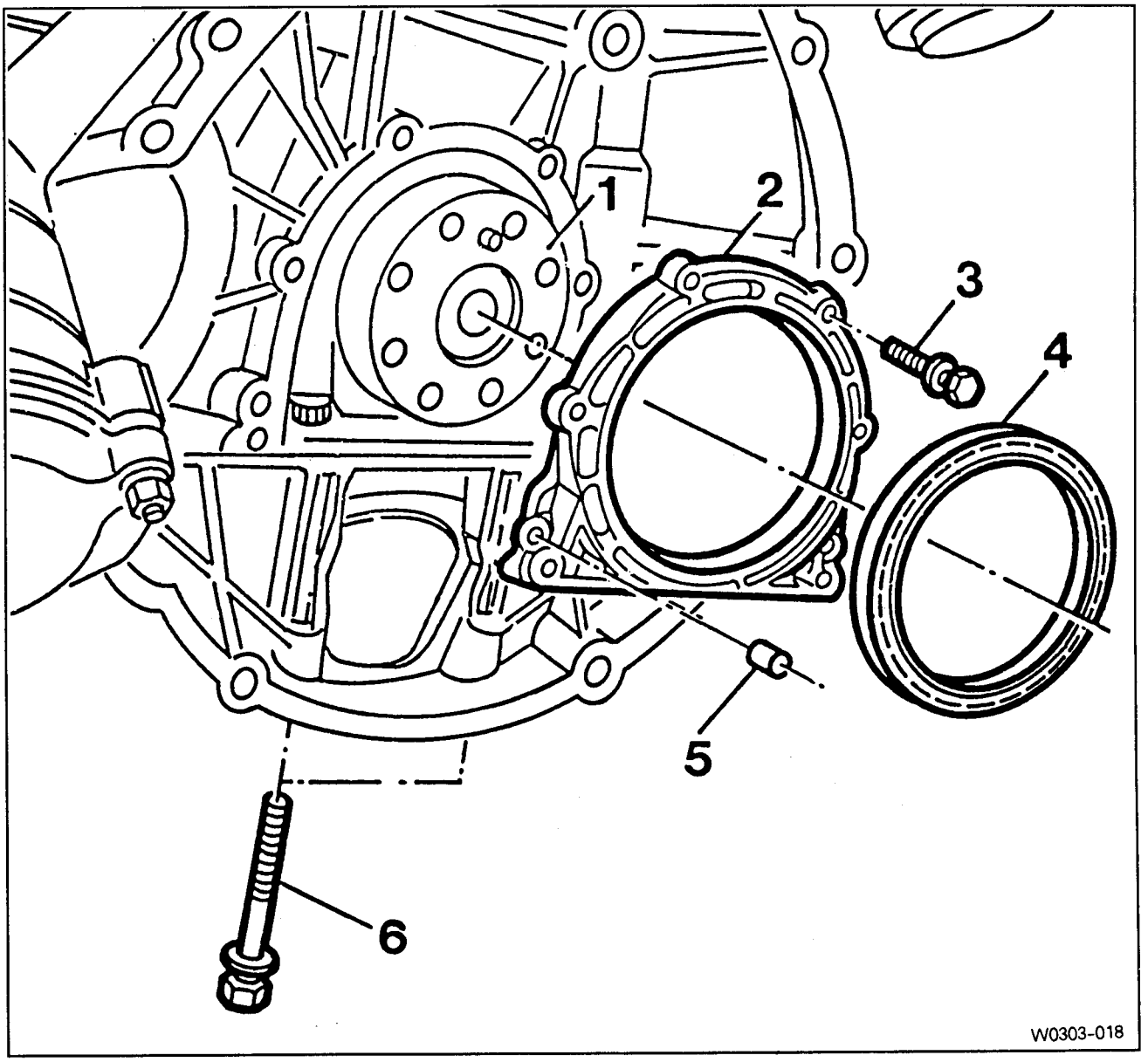
4) Install the radial seal (1) by using a sleeve (4).
[Note] Align the groove of sleeve and woodruff key (arrow).

Sleeve 601 589 03 14 00



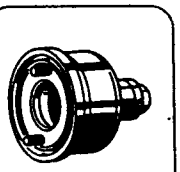
4. Removal and Installation of End Cover

Preceding work : Removal of flywheel and driven plate (03-38)



1. Crankshaft Flange
2. End Cover ----------Clean, Loctite 573
3. Bolt ----------10Nm, Loctite 573
4. Radial Seal ----------Replace
5. Dowel Sleeve
6. Bolt ----------10Nm, Loctite 573

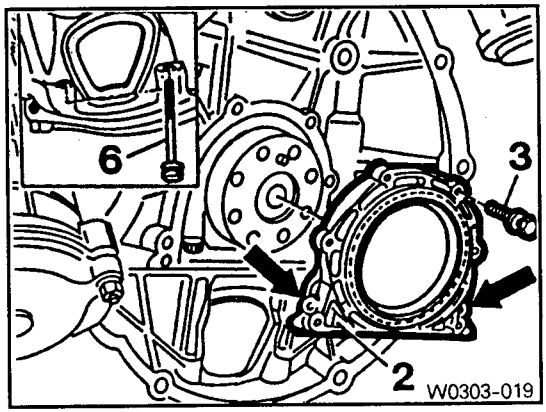
Special tool



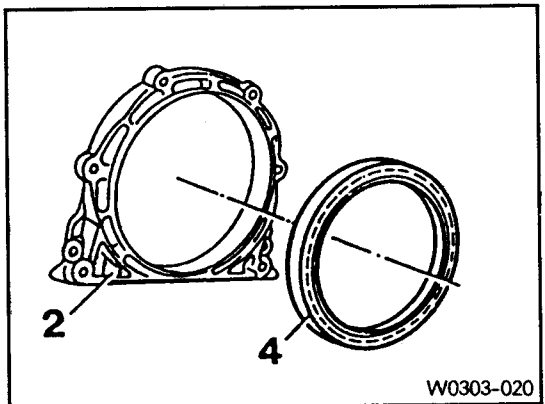
601 589 03 43 00

Removal

1) Remove the bolts (3, 6) from end cover. By pulling out the lugs (arrow), remove the cover.
[Note] Be careful not to damage the oil pan gasket.



2) Remove the radial seal (4) with care not to damage the sealing surface.



Installation

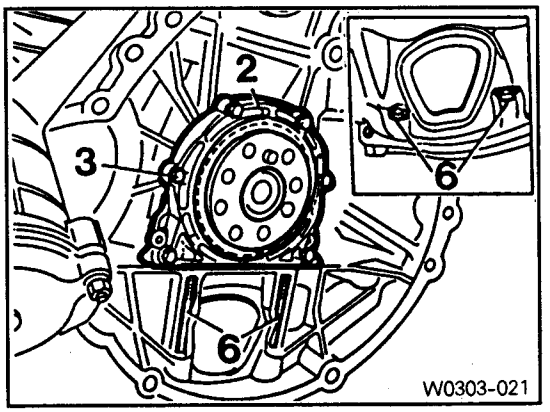
1) Thoroughly clean the sealing surface of end cover and apply Loctite 573.

2) Clean the groove of radial seal.

3) Apply Loctite 573 on the bolts and install the end cover.

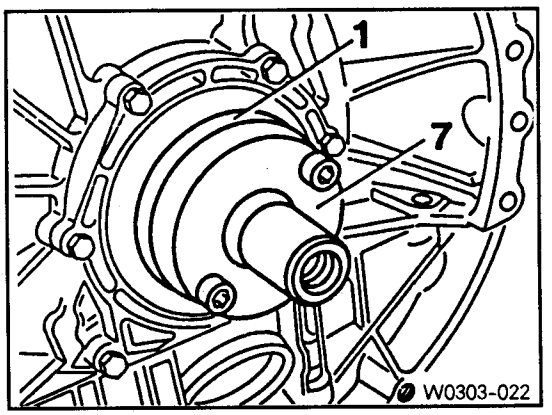
Tightening torque	10Nm

[Note] Be careful not to damage the oil pan gasket.



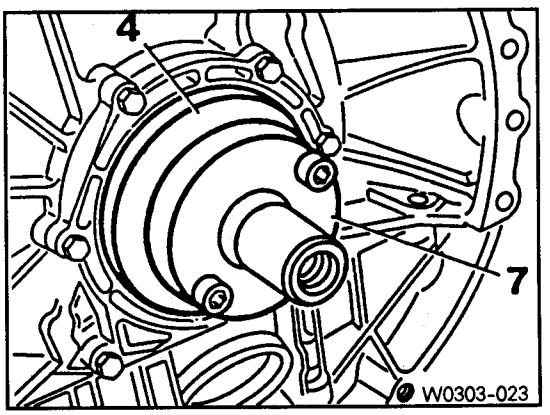
4) Install the inner oil seal assembler to the crankshaft flange.

Oil seal assembler 601 589 03 43 00



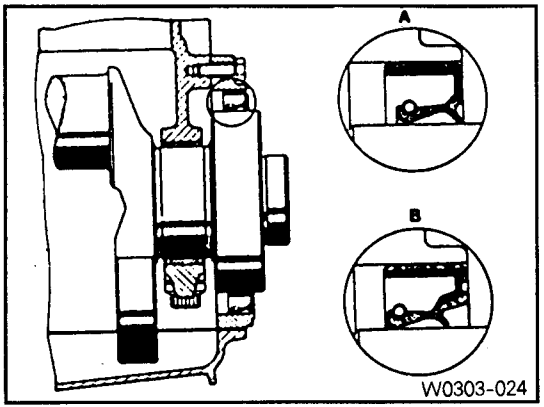
5) Coat a little oil on the sealing lip of new radial seal and contacting surface.
[Note] Don't use grease.

6) Insert the new radial seal (4) onto the oil seal assembler (7).



[Note] The sealing lip of the repair radial seal is offset to the inside by 3mm to ensure that it does not run in any groove which the standard radial seal may have left on the crankshaft flange.

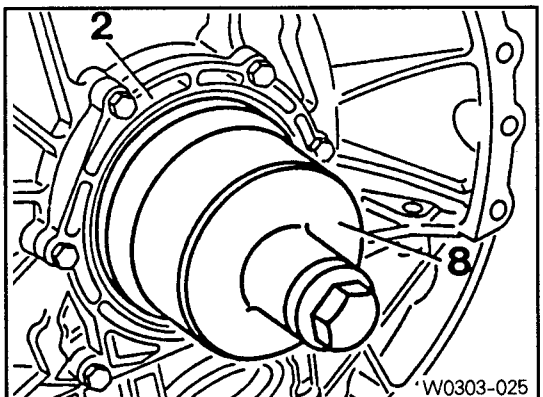
A. Standard radial seal
B. Repair radial seal



7) Install the outer oil seal assembler on the seal and by tightening the bolts, press the radial seal into the end cover as far as the stop.

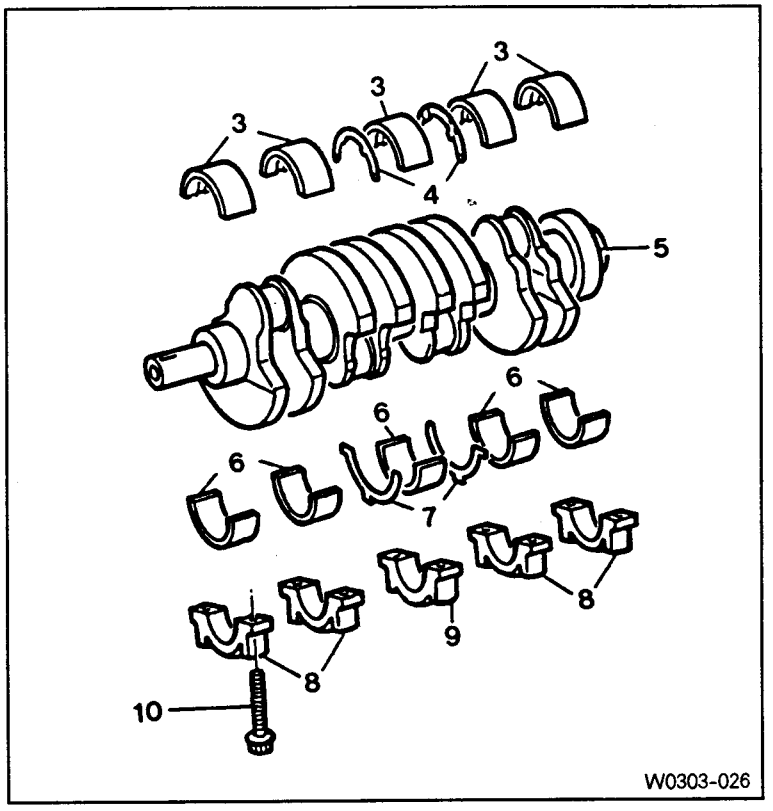
[Note] The seal must be positioned exactly at right angles in the end cover to ensure that it provides a proper seal.

Oil seal assembler 601 589 03 43 00



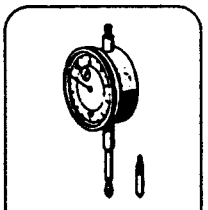
5. Replacement of Crankshaft

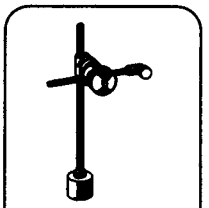
Preceding work : Removal of the end cover (03-11)
Removal of the piston (03-32)
Removal of the crankshaft sprocket (03-27)

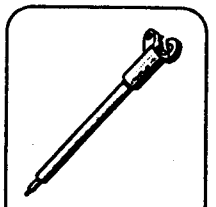


3. Crankshaft Main Bearing Shells (Upper)
4. Thrust Washers (Upper)
5. Crankshaft
6. Crankshaft Main Bearing Shells (Lower)
7. Thrust Washers (Lower)
8. Crankshaft Bearing Cap
9. Crankshaft Bearing Cap (Fit Bearing)
10. 12-sided Stretch Bolts ---------- 55Nm + 90 °

Special tools

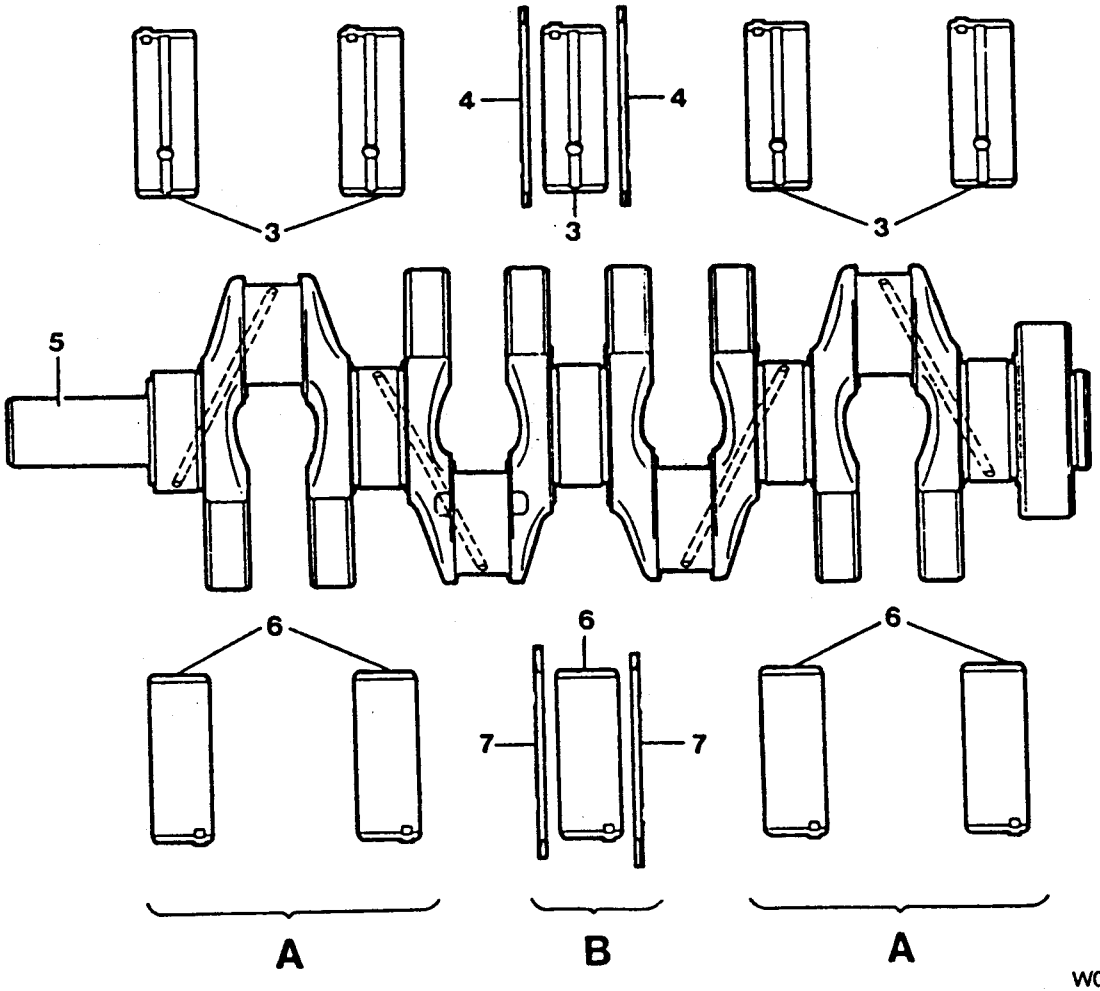

001 589 53 21 00


363 589 02 21 00


366 589 00 21 05

Thrust washer and bearing arrangement

OM 661 Engine



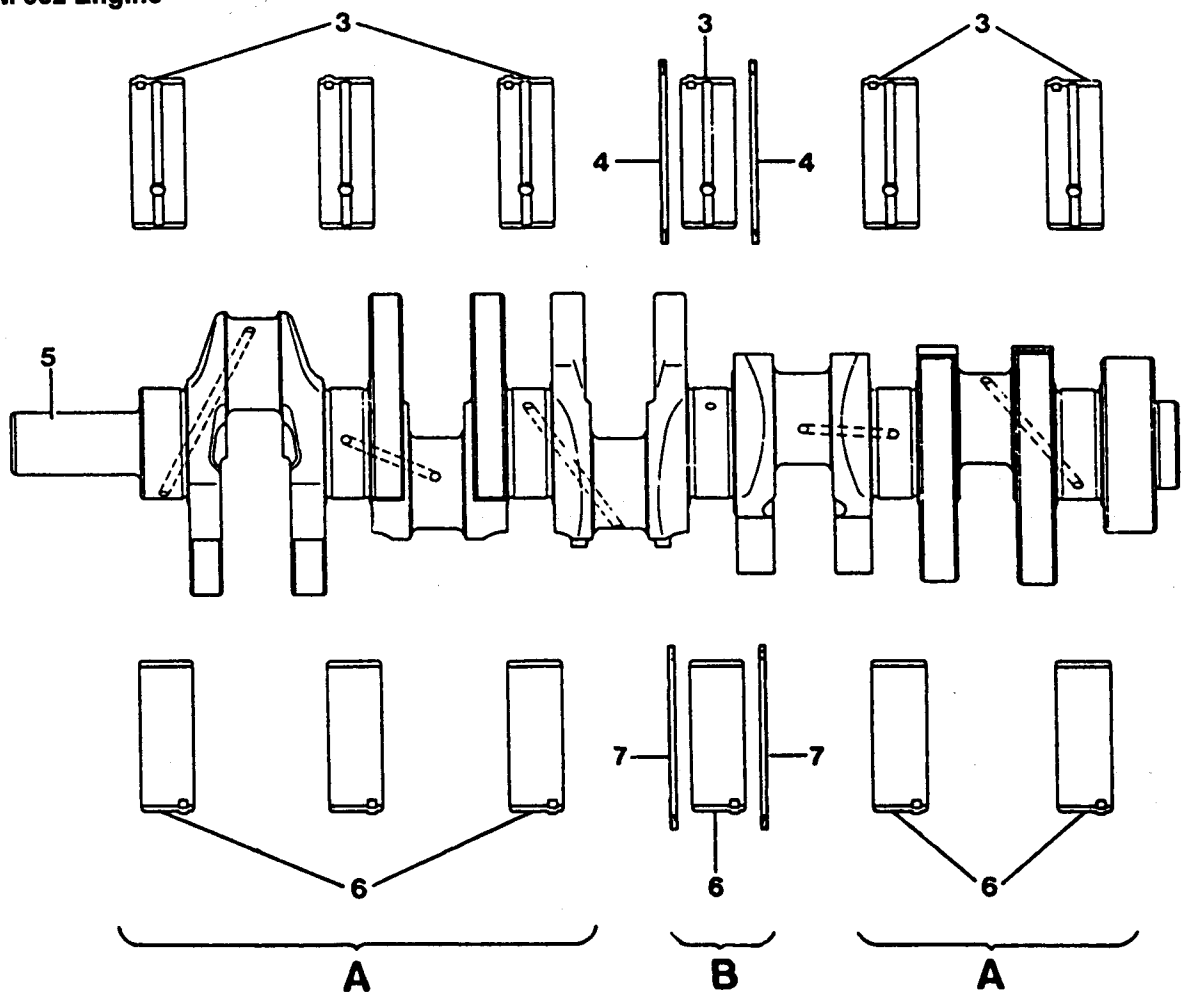
3. Crankshaft Main Bearing Shells (Upper)
4. Thrust Washers (Upper)
5. Crankshaft
6. Crankshaft Main Bearing Shells (Lower)
7. Thrust Washers (Lower)

A. Radial Bearings

B. Radial and Axial Bearings (Thrust Bearing)

[Note] The gaps between the bearing shell and bore and between the bearing shell and journal are different each other. Refer to service data.

OM 662 Engine



W0303-028

3. Crankshaft Main Bearing Shells (Upper)
4. Thrust Washers (Upper)
5. Crankshaft
6. Crankshaft Main Bearing Shells (Lower)
7. Thrust Washers (Lower)

A. Radial Bearings
B. Radial and Axial Bearings (Thrust Bearing)

[Note] The gaps between the bearing shell and bore and between the bearing shell and journal are different each other. Refer to service data.

Crankshaft standard and repair sizes mm

	Crankshaft bearing journal diameter	Thrust bearing journal width	Thrust bearing journal diameter
Standard size	57.950 ~ 57.965	24.500 ~ 24.533	47.950 ~ 47.965
		24.600 ~ 24.633	
Repair size 1	57.700 ~ 57.715	24.700 ~ 24.733	47.700 ~ 47.715
Repair size 2	57.450 ~ 57.465	24.900 ~ 24.933	47.450 ~ 47.650
Repair size 3	57.200 ~ 57.215	25.000 ~ 25.033	47.200 ~ 47.215
Repair size 4	56.950 ~ 56.965	-	46.950 ~ 46.965

Bearing clearances mm

		Crankshaft bearing	Thrust bearing
Radial clearances	New	0.027 ~ 0.051	0.026 ~ 0.068
	Limit	Max. 0.070	Max. 0.080
Axial clearances	New	0.100 ~ 0.254	-
	Limit	Max. 0.300	-

Matching fit bearing journal width to thrust washers mm

Fit bearing journal width	Thrust washer thickness
24.500 ~ 24.533	2.15
24.600 ~ 24.633	2.20
24.700 ~ 24.733	2.25
24.900 ~ 24.933	2.35
25.000 ~ 24.033	2.40

[Note] · **Measure crankshaft axial clearance and adjust with proper thrust washer.**
· **The same thickness of thrust washers must be installed on both sides of the fit bearing.**

Matching crankshaft bearing shells to basic bearing bore in crankshaft

Marking of basic bearing bore in lower parting surface	Color code of relevant crankshaft bearing shell
1 punch mark or blue	Blue or white-blue
2 punch marks or yellow	Yellow or white-yellow
3 punch marks or red	Red or white-red

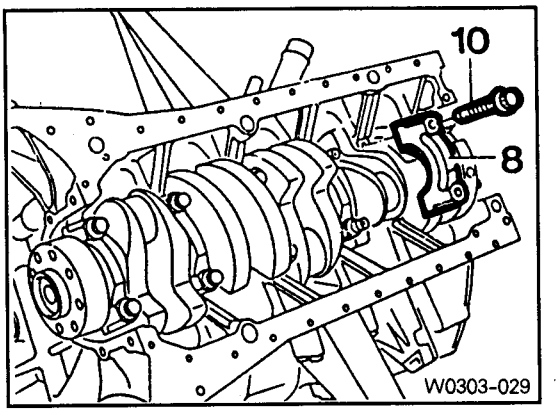
Matching crankshaft bearing shells to basic bearing journal of crankshaft

Marking of bearing journals on crank webs	Color code of relevant crankshaft bearing shell
Blue or white-blue	Blue or white-blue
Yellow or white-blue	Yellow or white-yellow
Red or white-blue	Red or white-red

Replacement

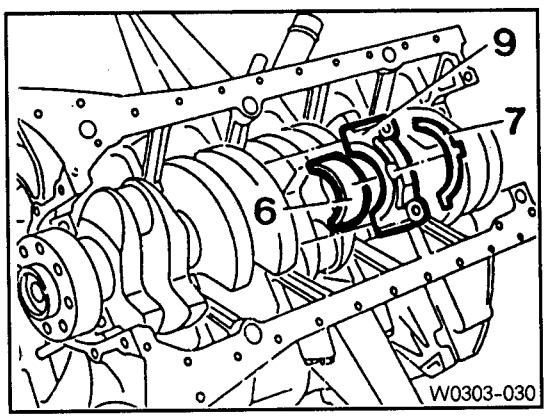
1) Remove the bearing cap bolts.

2) Remove the bearing caps (8).
[Note] The crankshaft bearing caps are marked with stamped numbers. Remove the bearing cap from the vibration damper side.

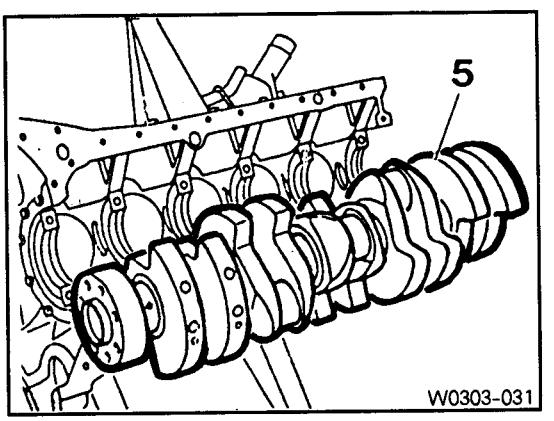


3) Remove the crankshaft bearing caps (9) and lower thrust washers (7).

4) Remove the lower thrust washers (6) from the bearing cap (9).

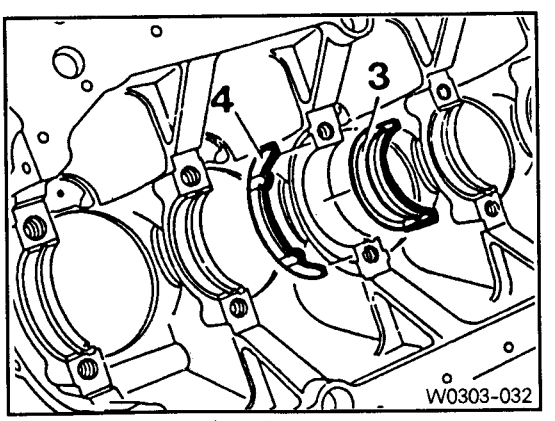


5) Remove the crankshaft (5).



6) Remove the upper thrust washer (4).

7) Remove the upper bearing shells (3) from crankcase.



8) Thoroughly clean the oil gallery.

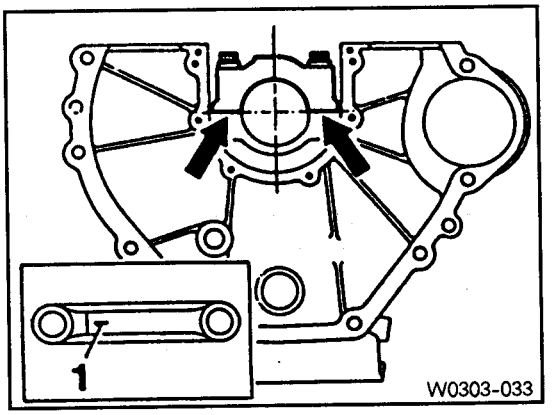
9) Select a proper new bearing shells with reference to table (03-18, 03-19).

10) Coat the new bearing shells with oil and insert into the crankcase and into the crankshaft bearing caps.
[Note] Do not mix up upper and lower crankshaft bearing shells.

11) Install the bearing caps according to marking and tighten the 12-sided stretch bolts.

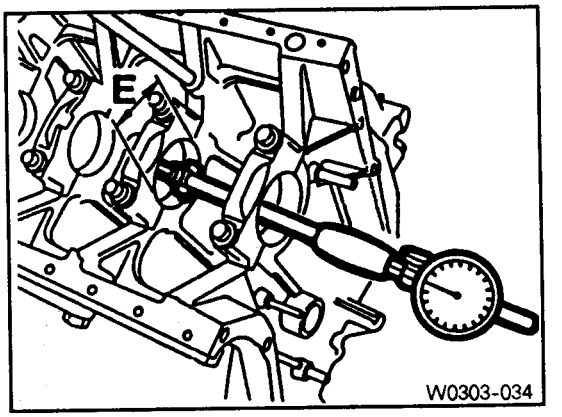
Tightening torque	50Nm + 90°

[Note] No. 1 is vibration damper side.

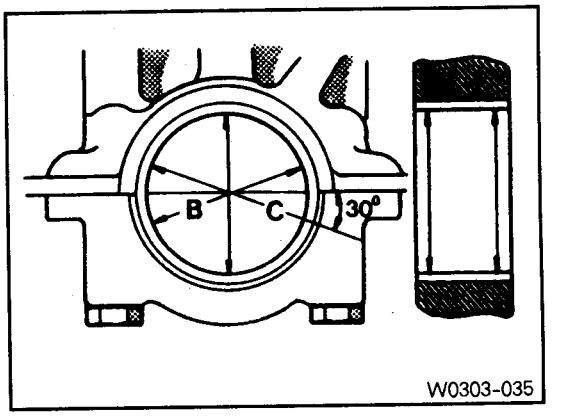


12) Measure crankshaft bearing diameters (E).
[Note] Measure at 3 points (A, B and C).

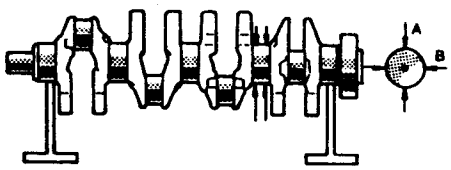
Extension 366 589 00 21 05



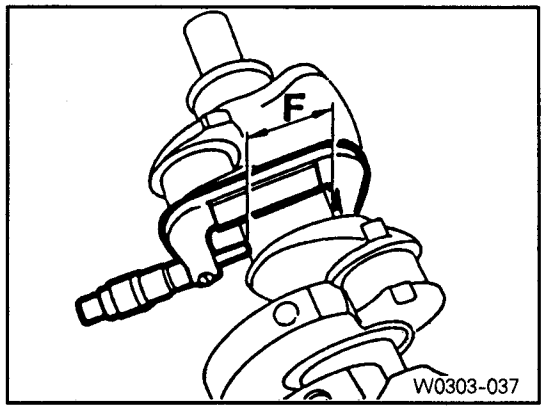
Measure at 3 points (A, B and C) and if the average value of B and C is less than A's value, the average value of B and C is the mean value and if more than A's value, A's value is the mean value.



13) Measure crankshaft bearing journal diameter (F).



W0303-036



W0303-037

[Note] When measured in A and B, the runout should not exceed 0.010mm.

14) Measure radial clearance of crankshaft bearing (G).

Clearance 'G'	0.027~0.051mm

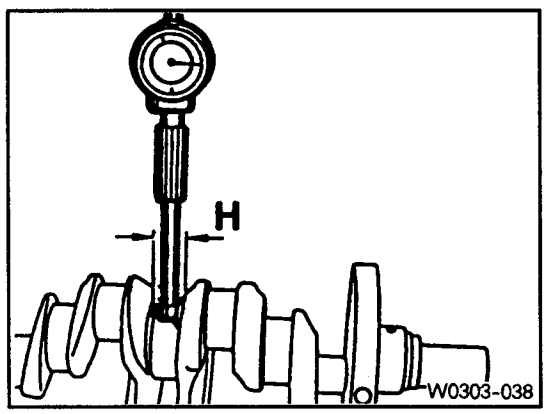
[Note] If 'G' is out of standard, replace the bearing shells and adjust the radial clearance of crankshaft bearing.

Example) Measured value 'E' = 57.700mm
Measured value 'F' = 57.659mm

Clearance 'G' = 0.041mm

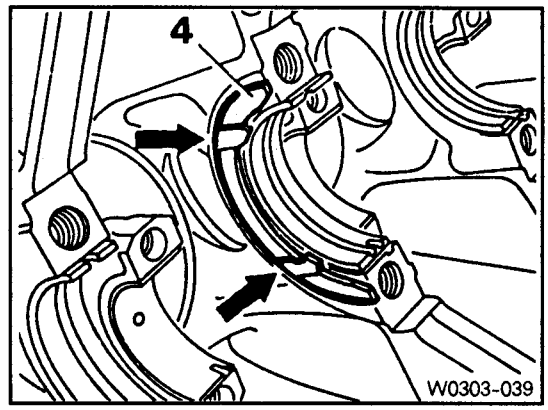
15) Remove the crankshaft bearing cap.

16) Measure width of thrust bearing journal (H) and adjust with proper thrust washers (see table).
[Note] The same thickness of thrust washers should be installed on both sides of the thrust bearing.

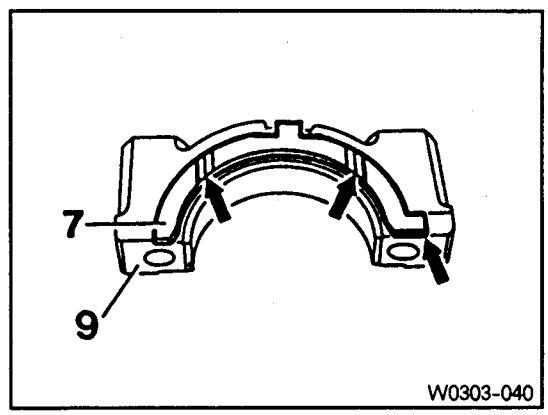


W0303-038

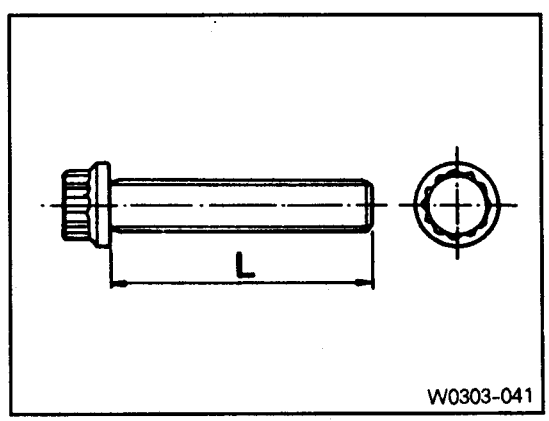
17) Coat the upper thrust washer (4) with oil and insert into the crankcase so that the oil grooves are facing the crank webs (arrow).



18) Coat the lower thrust washer (7) with oil and insert into the crankshaft bearing cap so that the oil grooves are facing the crank webs (arrow).
[Note] The retaining lugs should be positioned in the grooves (arrow).



[Note] If the max. length of bolts exceed 63.8mm, replace them.

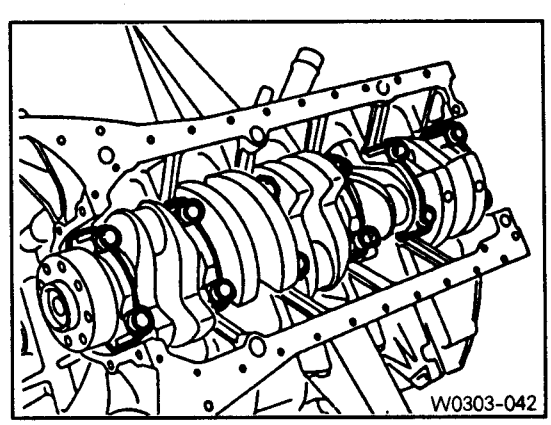


19) Coat the new crankshaft with engine oil and place it on the crankcase.

20) Install the crankshaft bearing caps according to marking and tighten the bolts.

Tightening torque	55Nm + 90°

[Note] Install from no. 1 cap.



21) Rotate the crankshaft with hand and check whether it rotates smoothly.

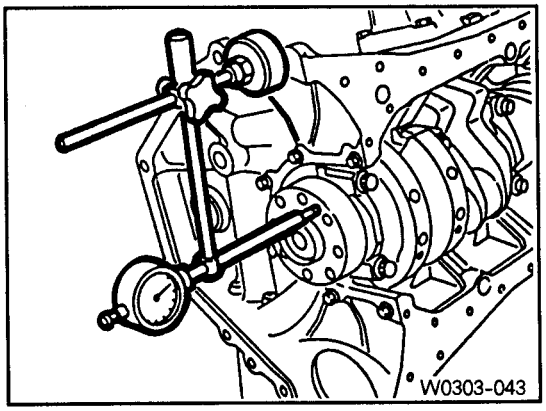
22) Measure crankshaft bearing axial clearance.

Clearance	0.100~0.245mm

[Note] If the clearance is out of standard, adjust the axial clearance of crankshaft bearing by replacing the thrust washers.

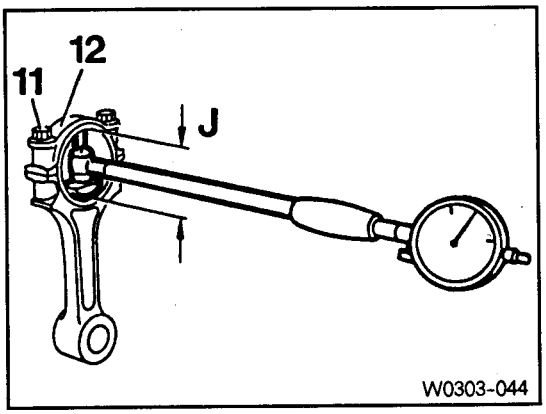
Dial gauge 001 589 53 21 00
Dial gauge holder 363 589 02 21 00

[Note] The same thickness of thrust washers should be installed on both sides of the thrust bearing.


W0303-043

23) Insert the new connecting rod bearing shells into the connecting rod and connecting rod bearing cap and tighten the 12-sided stretch bolts (11).

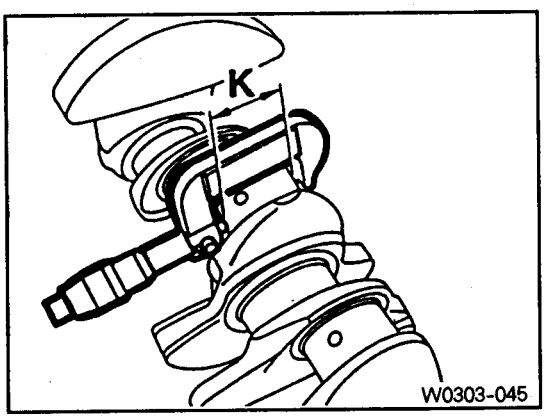
Tightening torque	30Nm + 90°



W0303-044

24) Measure inner diameter of connecting rod bearing.

25) Measure connecting rod bearing journal diameter (K).
[Note] Refer to measurement of the crankshaft bearing journal diameter.



W0303-045

26) Measure the radial clearance (L) of the connecting rod bearing.

Example) Measured value 'J' = 47.700mm
Measured value 'K' = 47.653mm

Clearance 'L' = 0.047mm

Radial clearance 'L'	0.026~0.068mm

[Note] If the clearance is out of standard, adjust the radial clearance of connecting rod bearing by replacing the connecting rod bearing shells.

27) Remove the connecting rod bearing cap.

28) Install the piston.

29) Rotate the crankshaft by hand and check whether it rotates smoothly.

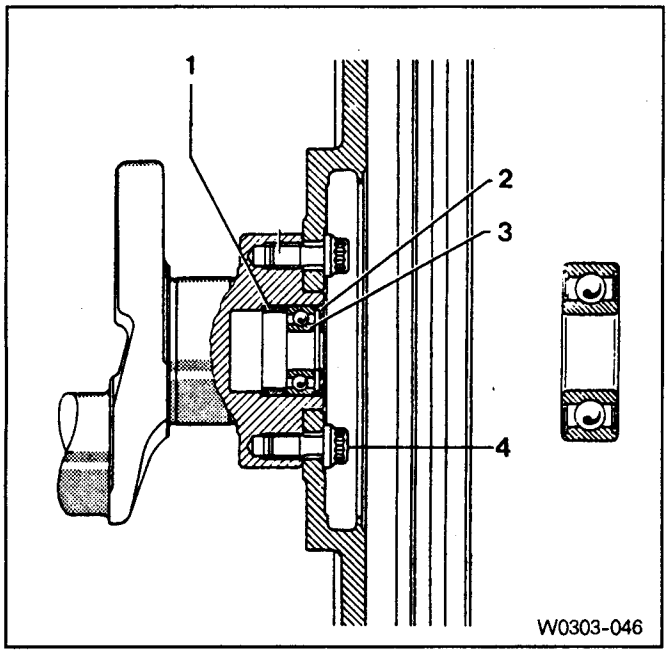
30) If the bearings are damaged,
- replace the oil presser relief valve.
- clean the oil pump and oil filter housing carefully and replace the hose if necessary.

[Note] After assembling the engine, check the camshaft timing, adjust the start of fuel injection and check the TDC sensor bracket setting.

31) Fill oil and run the engine and then check the oil pressure and oil level.

[Note] Install the original oil filter element and then change the engine oil and oil filter element after 1,000~1,500km.

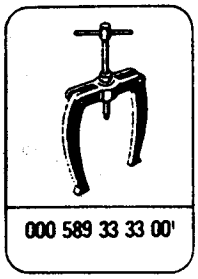
6. Disassembly and Assembly of Crankshaft Ball Bearing

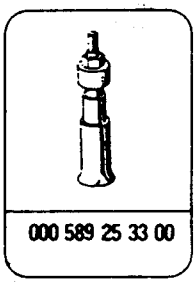


1. Spacer
2. Locking Ring ---------- Replace
3. Ball Bearing
4. Bolt ---------- 45Nm + 90°

[Note] Manual transmission only.

Special tools



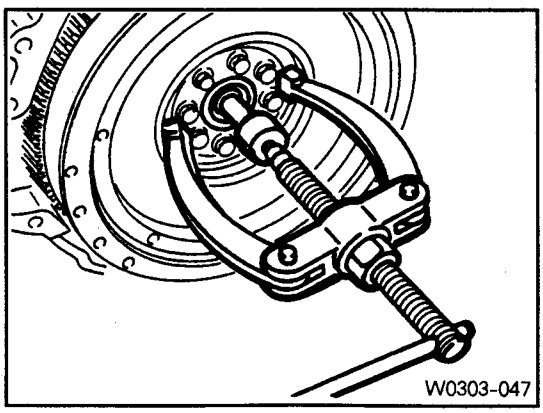


Removal · Installation

1) Remove the manual transmission.

2) Using a puller, pull out the locking ring and ball bearing together.

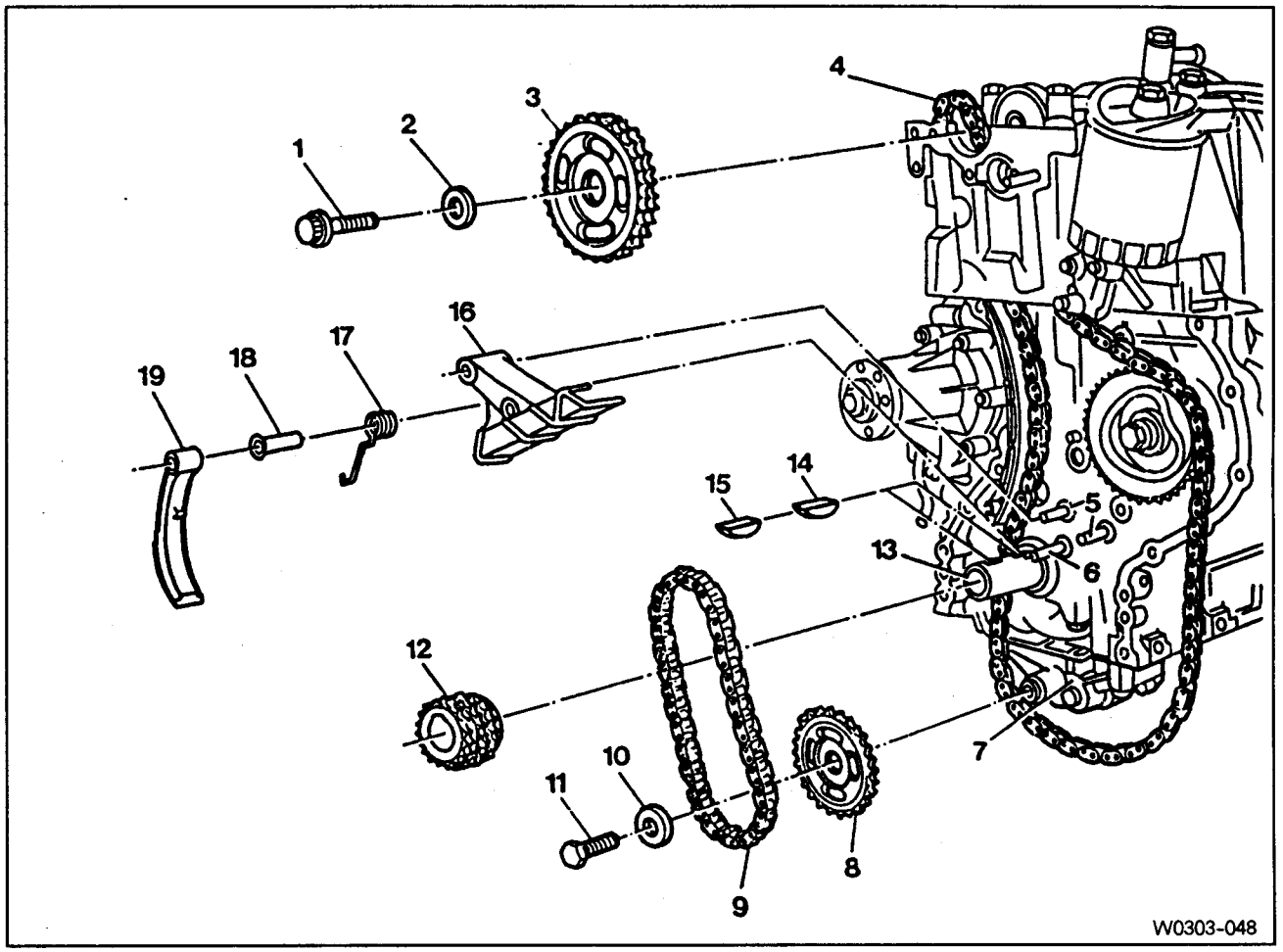
Counter support 000 589 33 33 00
Internal extractor 000 589 25 33 00



3) Apply Loctite 241 on the new ball bearing and then insert the ball bearing to be stopped at the spacer ring by using a proper mandrel.

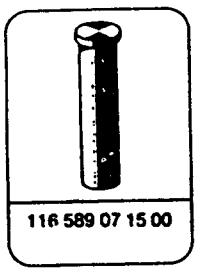
7. Removal and Installation of Crankshaft Sprocket

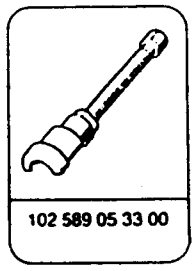
Preceding work : Removal of oil pan (01-50)
Removal of timing case cover (01-51)



1. 12-Sided Stretch Bolt (M11) ---------- Check, 25Nm + 90°
2. Washer
3. Camshaft Sprocket
4. Timing Chain
5. Bearing Pin
6. Bearing Pin
7. Oil Pump
8. Oil Pump Sprocket
9. Oil Pump Chain
10. Washer
11. Bolt ---------- 32Nm
12. Crankshaft Sprocket
13. Crankshaft
14. Woodruff Key
15. Woodruff Key
16. Guide Rail
17. Spring
18. Bushing
19. Tensioning Lever

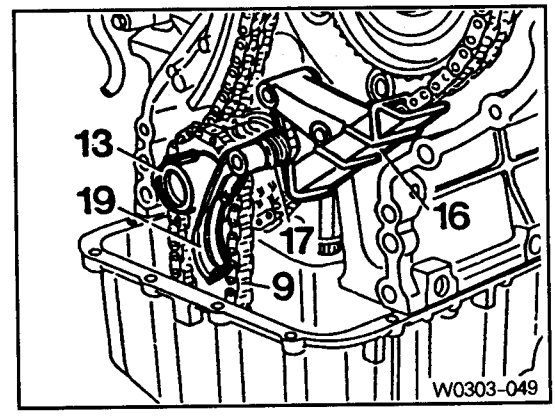
Special tools



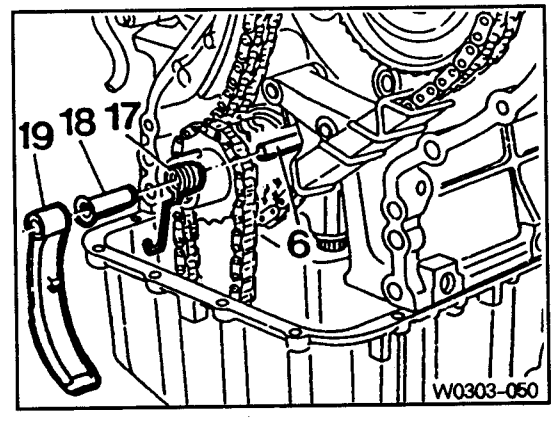


Removal

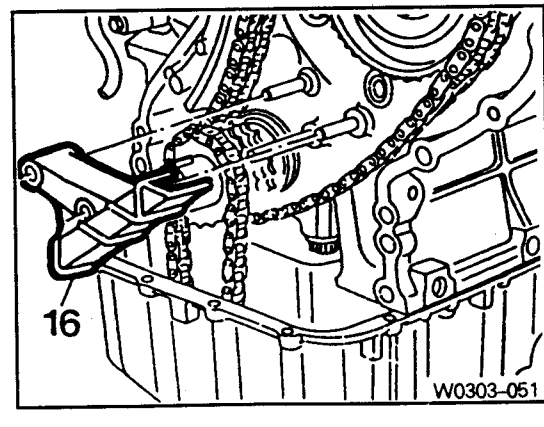
1) Pull out the tensioning lever (19) together with the spring (17) and guide rail (16) far enough until the tensioning lever has passed the oil pump chain (9) and is resting against the crankshaft (13).



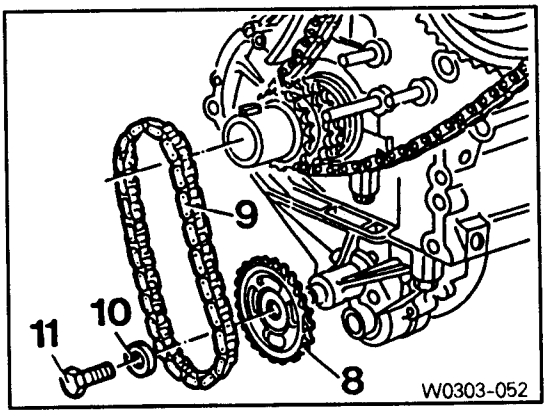
2) Pull out the tensioning lever (19), spring (17) and bushing (18) from the bearing pin (6).



3) Pull out the guide rail (16).

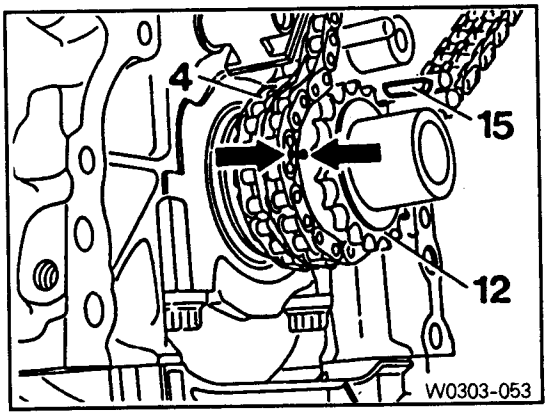


4) Remove the bolt (11) and then remove the washer (10), oil pump chin (9) and sprocket (8).

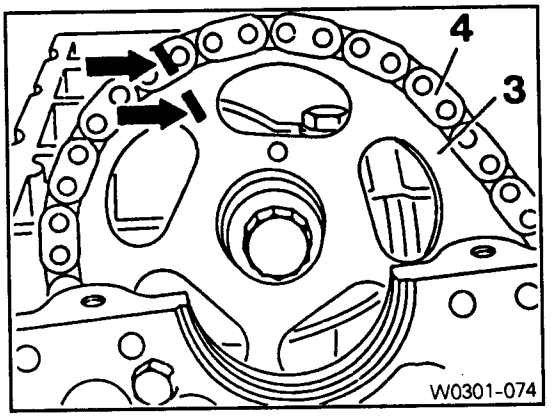


5) Place alignment marks (arrow) on the timing chain (4) and crankshaft sprocket (12).

6) Remove the woodruff key (15).

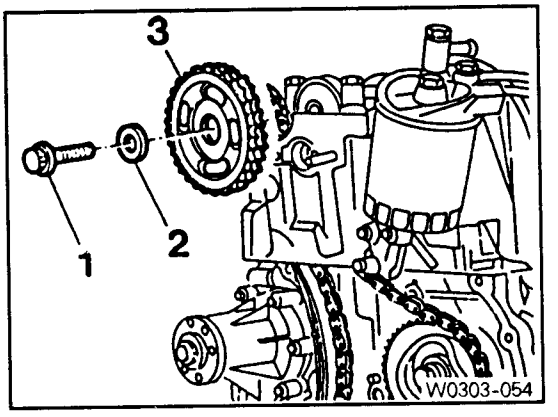


7) Place alignment marks (arrow) on the timing chain (4) and camshaft sprocket (3).



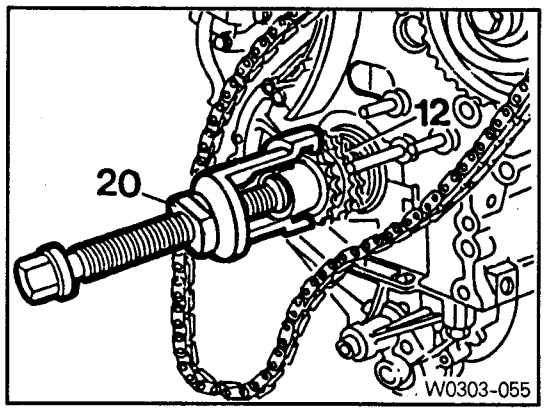
8) Remove the chin tensioner.

9) Remove the bolt (1) and then remove the washer (2) and camshaft sprocket (3).



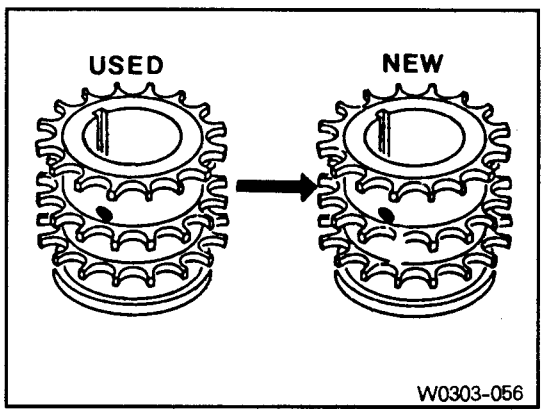
10) Remove the crankshaft sprocket (12) by using a puller (20).

Puller 102 589 05 33 00



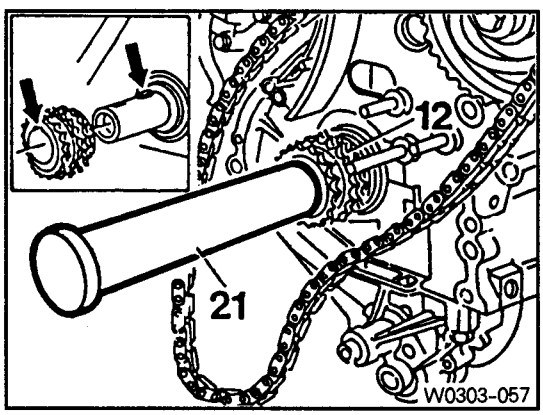
Installation

1) Put the same alignment mark on the new crankshaft sprocket as in the old sprocket.
   [Note] Check the timing chain, camshaft sprocket, injection pump timing sprocket, oil pump chain and oil pump sprocket for wear and replace if necessary.

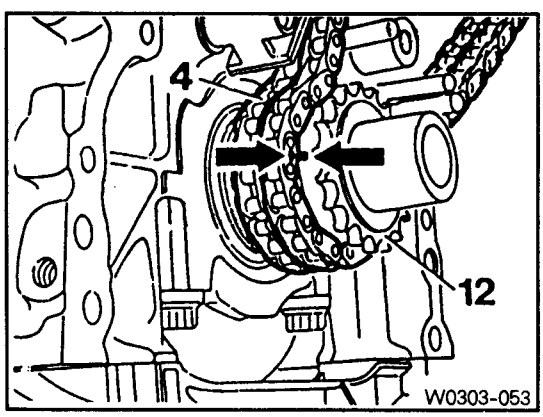


2) Install the new crankshaft sprocket (12) by using a drift (21).
   [Note] Align the groove of sprocket and woodruff key (arrow) exactly.

Drift 116 589 07 15 00



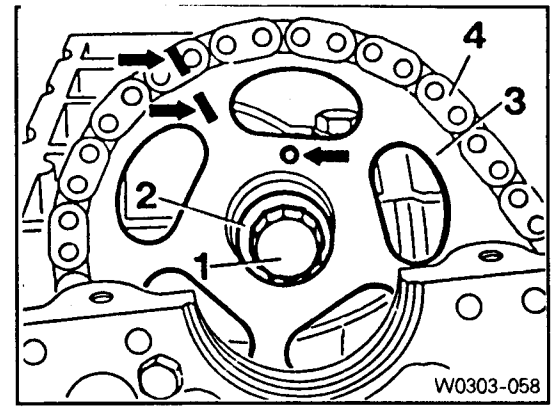
3) Fit the timing chine (4) on the crankshaft sprocket (12).
   [Note] Align the alignment marks (arrow) on the chain and sprocket.



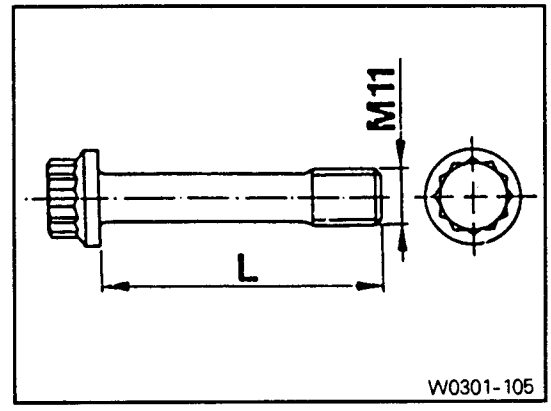
4) Install the camshaft sprocket (3).

Tightening torque	25Nm + 90°

[Note] Pay attention to the alignment marks and dowel pin (arrow).



[Note] If the max. length 'L' of the stretch bolt exceeds 53.6mm, replace it.

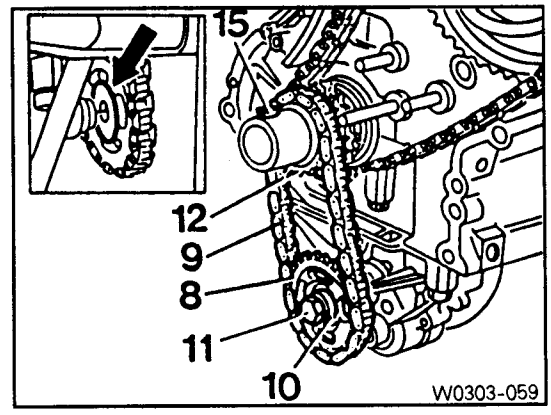


5) Fit the oil pump chain (9) on the crankshaft sprocket (12) and insert the oil pump sprocket (8) into the oil pump chain and then install it on the oil pump.

Tightening torque	32Nm

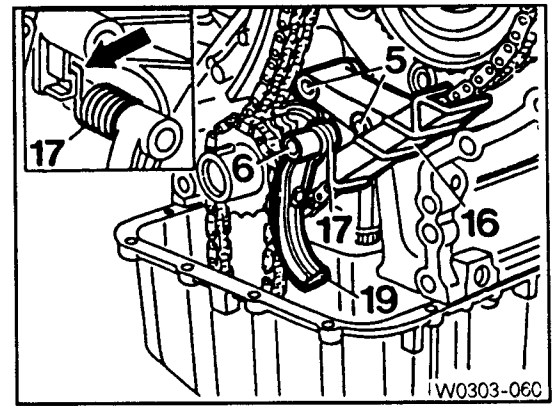
[Note] The curved side of the oil pump sprocket should face the oil pump.

6) Insert the woodruff key (15).



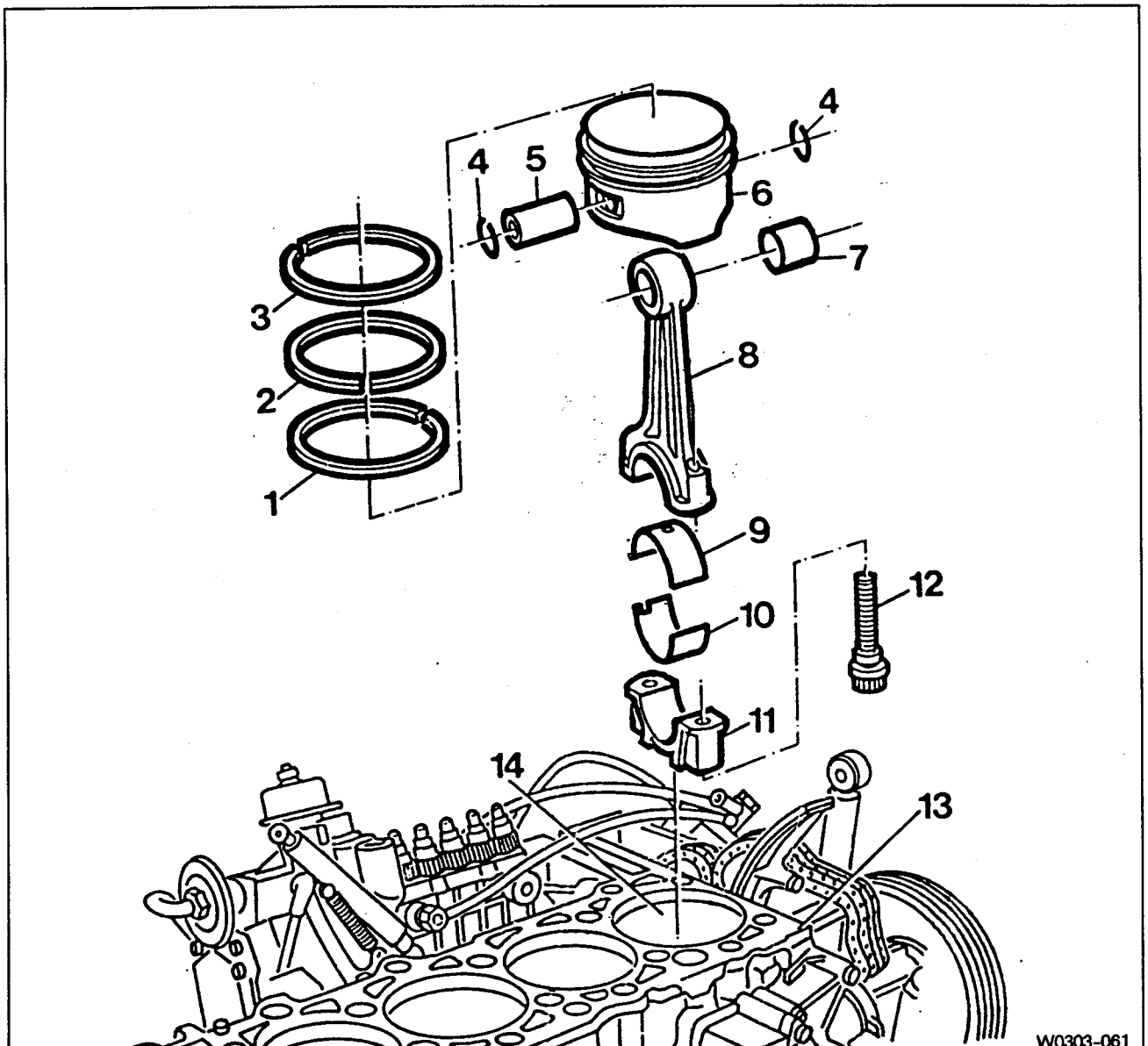
7) Install the guide rail (16). Attach the spring (17) to guide rail and to tensioning lever (19). Push guide rail, spring, bush and tensioning lever together onto the bearing pins (5, 6).

[Note] Ensure that the spring is correctly located in the guide rail (arrow).



8. Removal and Installation of Piston

Preceding work : Removal of the cylinder head (01-20)
Removal of the oil pump



1. Bevel Ring
2. Taper Fogy Ring
2. Rectangular Ring
4. Snap Ring---------- Replace
5. Piston Pin
6. Piston
7. Connecting Rod Bushing---------- Check
8. Connecting Rod
9. Connecting Rod Upper Bearing Shell
10. Connecting Rod Lower Bearing Shell
11. Connecting Rod Bearing Cap
- 12. Connecting Rod Bolt---------- 35Nm + 90 °
13. Crankcase
14. Cylinder Bore

[Note] There are two kinds of connecting rods (for machining) and they are different in weight approx. 15g. When replacing the connecting rod, measure its weight and ensure that a engine has the same weight of connecting rods. If not, there would be a unbalancing of engine.

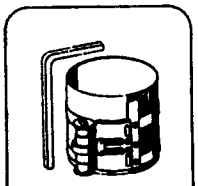
Service data

Piston clearance	Max. 0.12mm
Piston crown protrusion in TDC position	0.735~0.965mm
Connecting rod bushing diameter	26.012~26.018mm

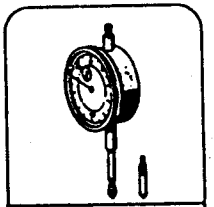
Connecting rod bolt dimensions

Thread	M9×1
Stretch shaft (C) diameter (new)	$7.4^{-0.1}$mm
Minimum stretch shaft diameter (C)	7.1mm
Length (L) (new)	$52^{-0.3}$mm

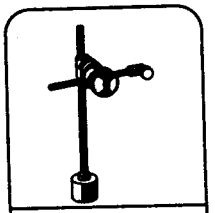
Special tools



000 589 04 14 00



001 589 53 21 00

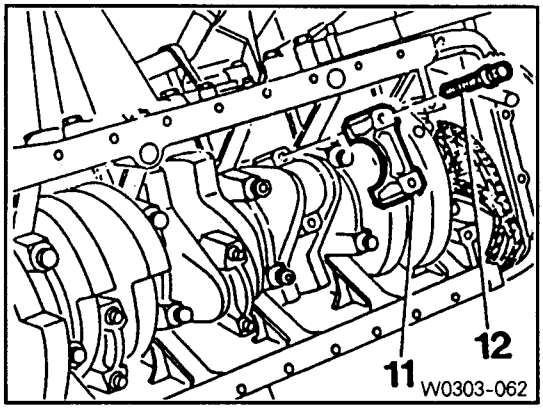


363 589 02 21 00

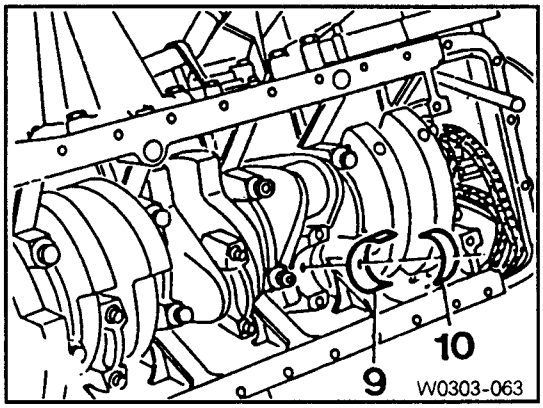
Removal

1) Remove combustion residues from the cylinder bores.

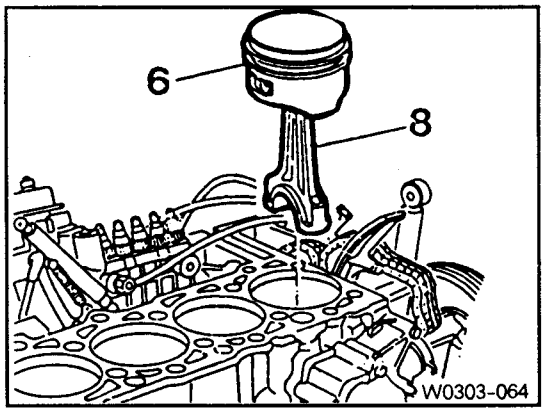
2) Remove the connecting rod bolts (12) and then remove the connecting rod bearing caps (11).



3) Remove the connecting rod bearing shells (9, 10).
[Note] Be careful not mix the bearing caps and shells each other.

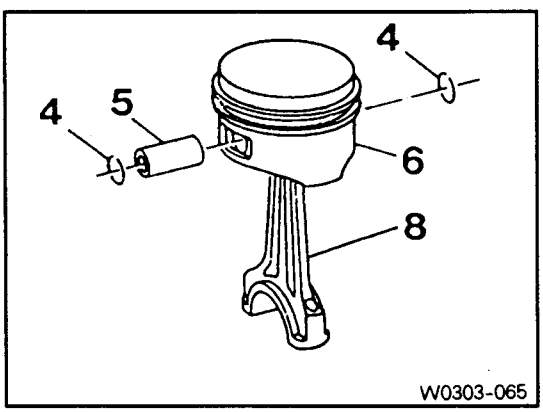


4) Remove the piston (6) and connecting rod (8).



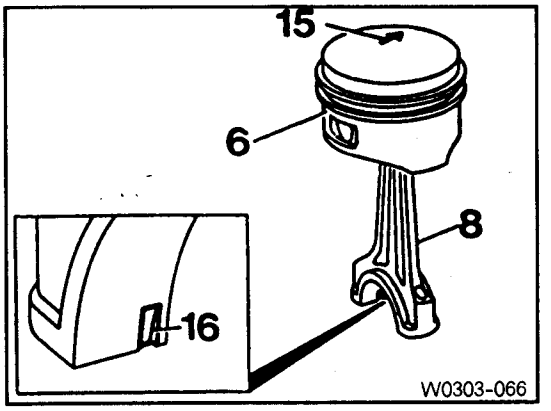
5) Remove the snap ring (4) and pull out the piston pin (5).

6) Separate the piston and connecting rod.

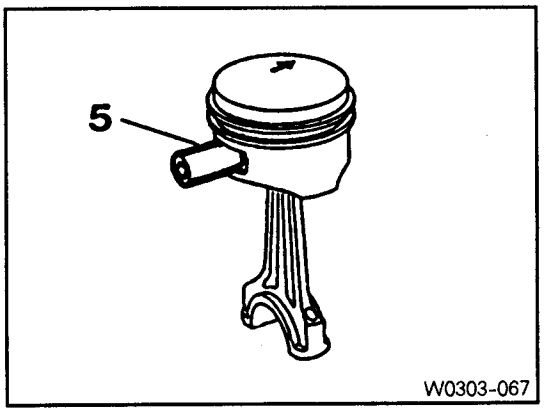


Installation

1) Fit the piston onto the connecting rod so that the arrow (15) and the locking slot (16) are facing in direction of the vehicle.

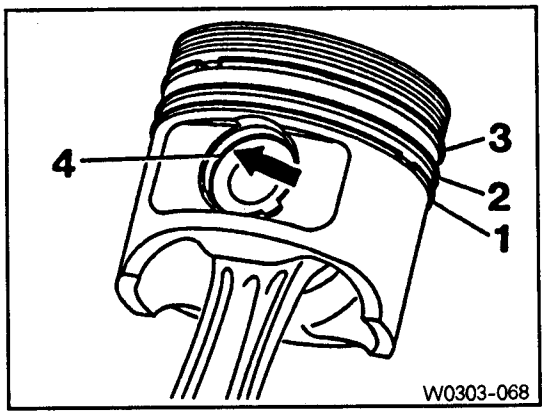


2) Coat the piston pin (15) with engine oil and insert it by hand.
[Note] Do not heat up the piston.

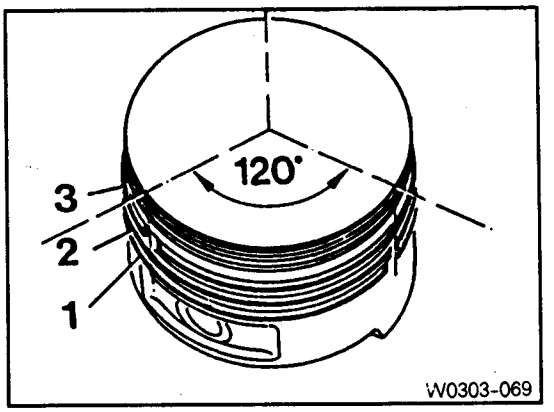


3) Install the new snap ring (4) into the grooves (arrow).

4) Check the piston rings (1, 2, 3) and replace them if necessary.



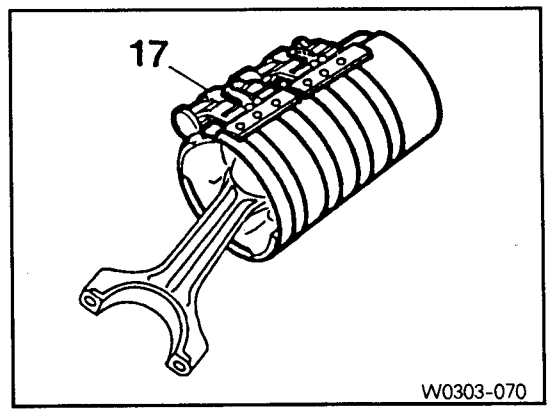
5) Install and arrange the piston rings to be evenly 120 ° from each ends gap.



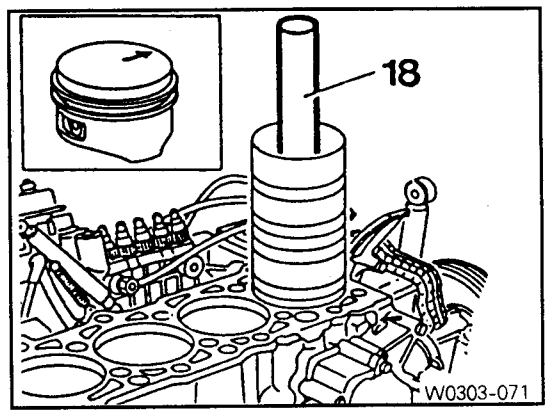
6) Coat the cylinder bore, connecting rod bearing journal, connecting rod bearing shell and piston with oil.

7) Compress the piston rings with a tensioning strap (17).

Tensioning strap 000 589 04 14 00

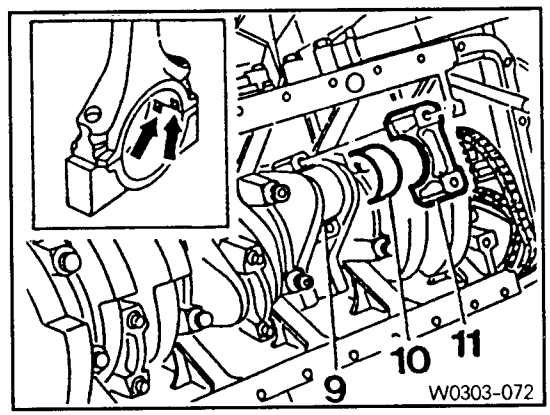


8) Insert the piston assembly into the cylinder with a wooden stick (18).
[Note] The arrow on the piston crown must point toward the front of vehicle.



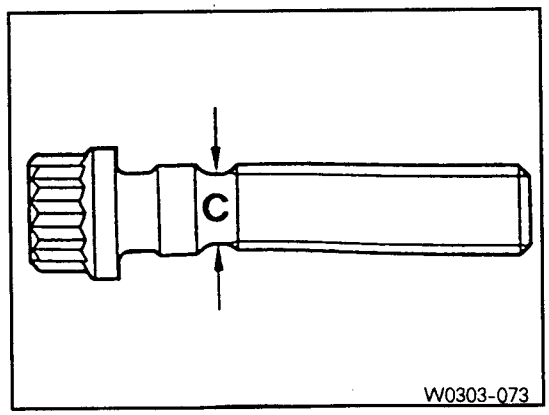
9) Insert the connecting rod bearing shells (9, 10).
[Note] Be careful of the difference in upper and lower bearing shells and not to be changed.

10) Position the connecting rod bearing caps.
[Note] Position so that the retaining lugs are on the same side of the connecting rod bearing (arrow).



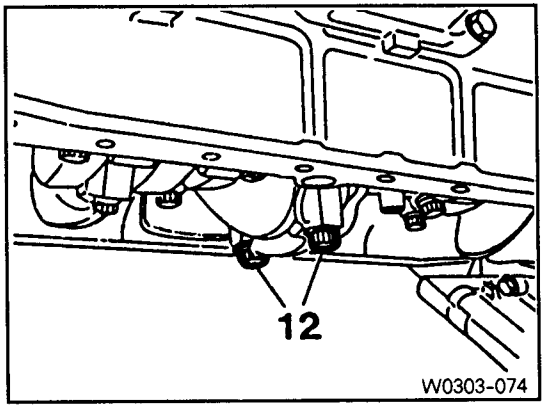
11) Measure stretch shaft diameter (C) of the connecting rod bolts.

Limit 'C'	7.1mm



12) Coat the bolts (12) with oil and then tighten the bolts.

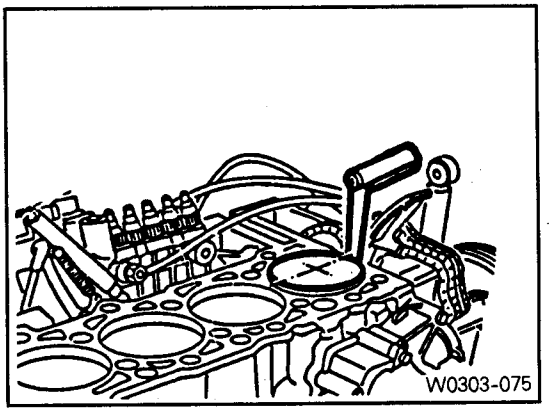
Tightening torque	40Nm + 90°



13) Rotate the crankshaft and check axial clearance between the connecting rod and crankshaft.

14) Measure clearance between the piston crown and cylinder.

Standard	Max. 0.12mm

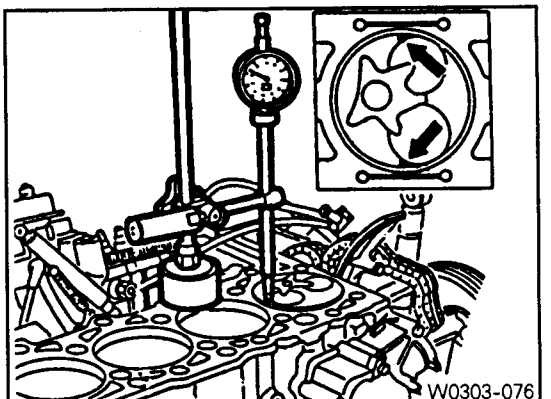


15) Position the piston at TDC and measure the distance between the piston crown and the crankcase surface.

Standard	Max. 0.965mm

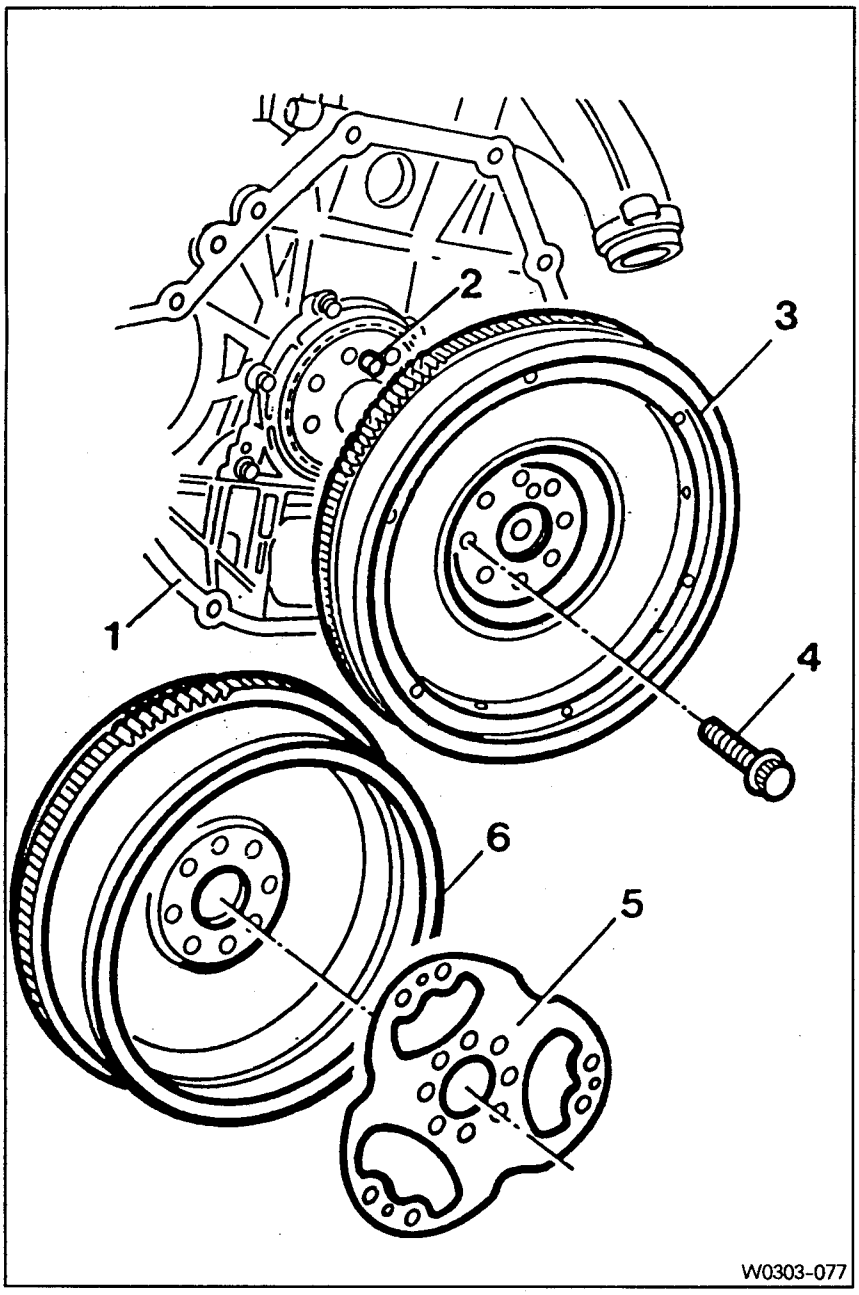
[Note] Measure at points marked.

Dial gauge 001 589 53 21 00
Dial gauge holder 363 589 02 21 00



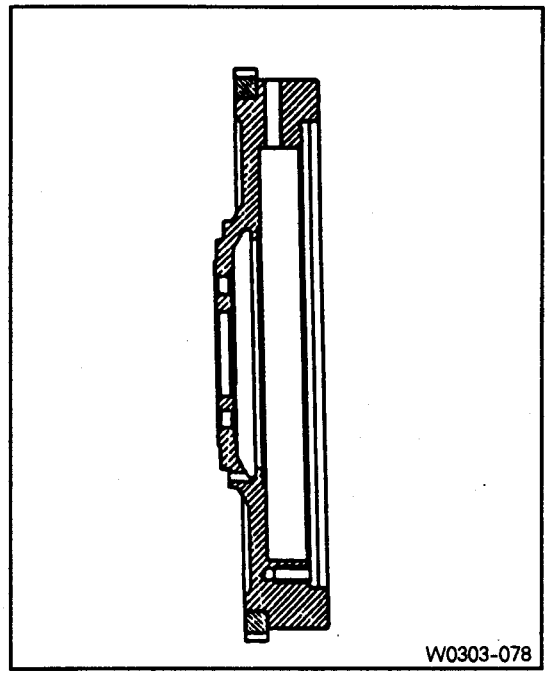
9. Removal and Installation of Flywheel

Preceding work : Removal of the transmission
Removal of the clutch

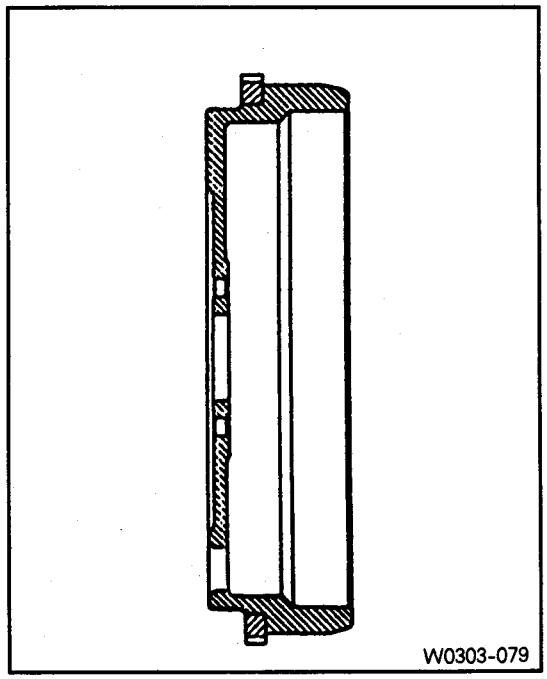


1. Oil Pan
2. Straight Pin
3. Flywheel
4. 12-Sided Stretch Bolt----------Check, 40Nm + 90°
5. Driven Plate (Automatic Transmission)
6. Flywheel (Automatic Transmission)

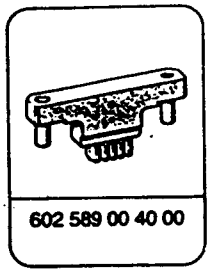
· Manual transmission flywheel



· Automatic transmission flywheel



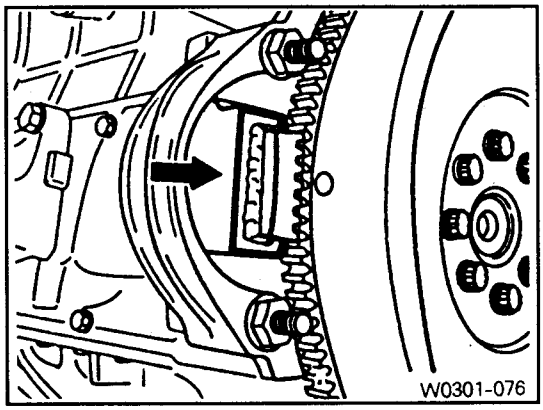
Special tool



Removal · Installation

1) Install the engine lock.

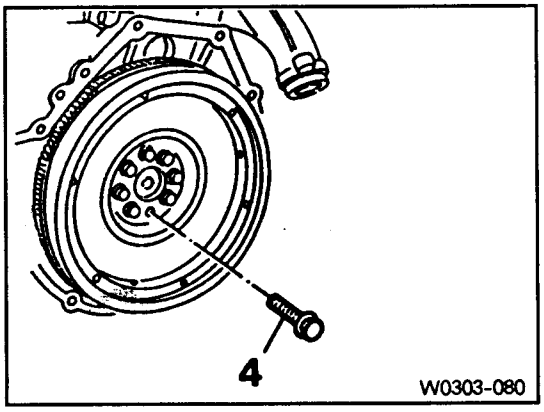
Engine lock 602 589 02 40 00



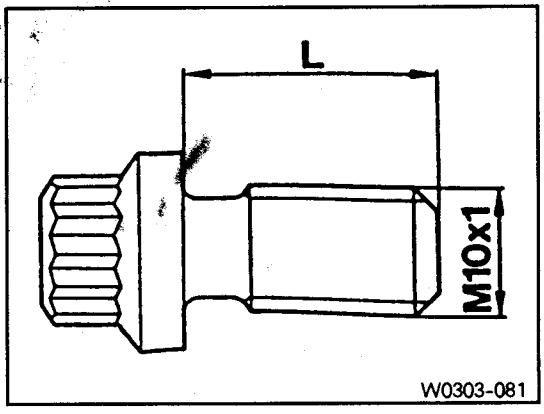
2) Remove the 12-sided stretch bolts (4).

Installation

Tightening torque	45Nm + 90°



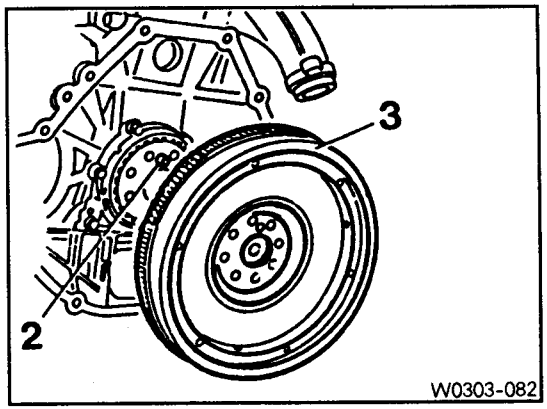
[Note] If the length 'L' of bolts exceeds 22.5mm, replace the bolts.



3) Remove the flywheel (3), if equipped with manual transmission.

Installation

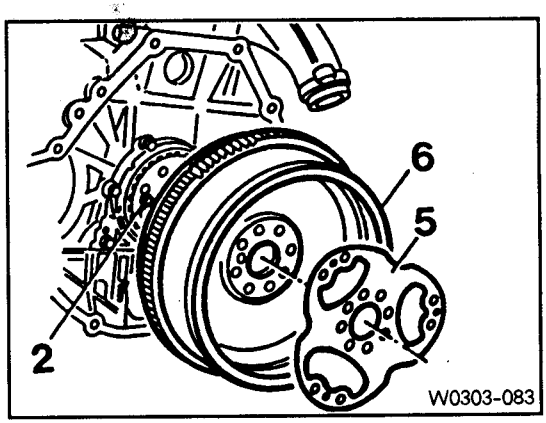
Correctly align the position of dowel pin (2).



4) Remove the flywheel (6) and driven plate (5), if equipped with automatic transmission.

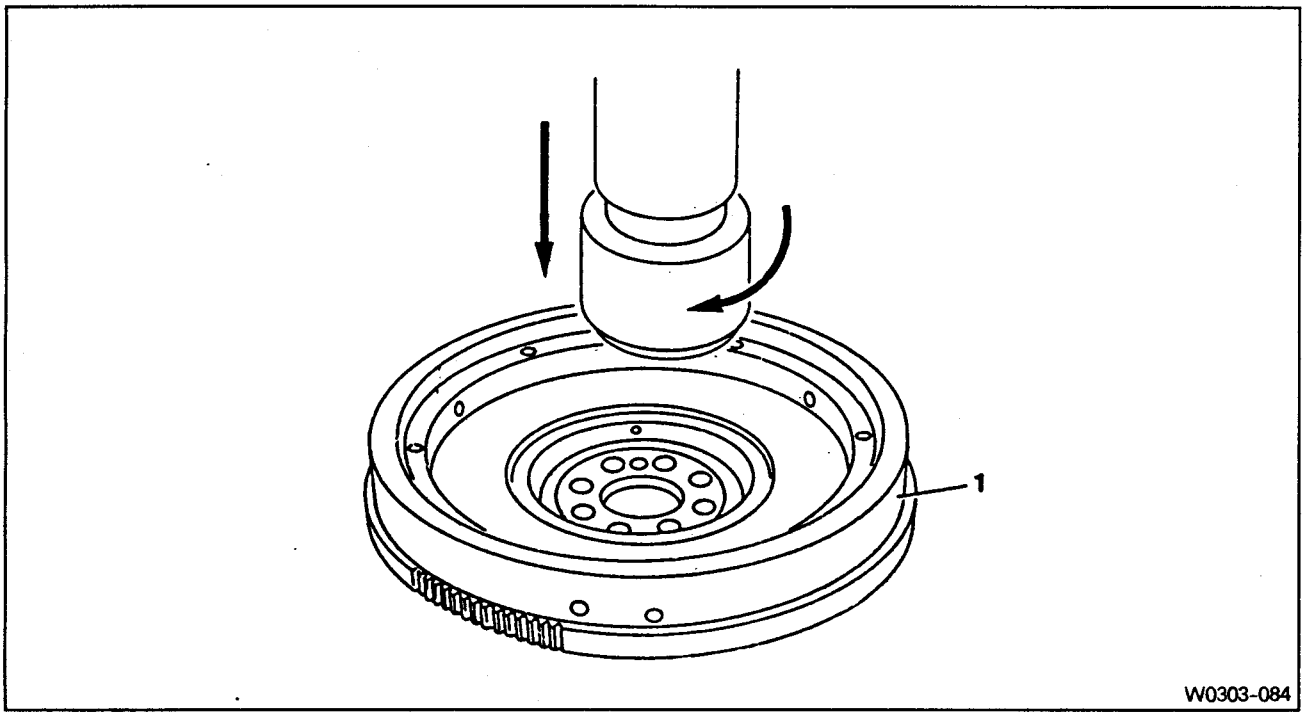
Installation

Correctly align the position of dowel pin (2).



5) Installation is reverse order of the removal.

10. Machining of Flywheel

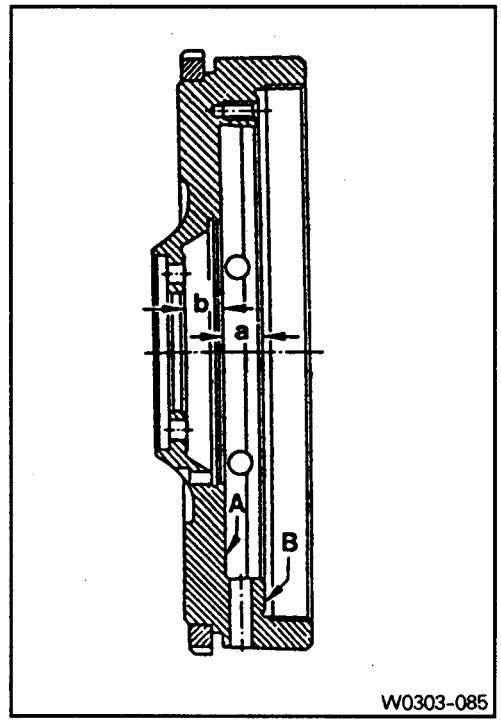


1. Flywheel

Machining of flywheel

[Note] Flywheels which have scorch marks, scoring or cracks in the clutch surface should be machined by grinding or precision-turning. If the scores or cracks are severe than permissible specifications, replace the flywheel.

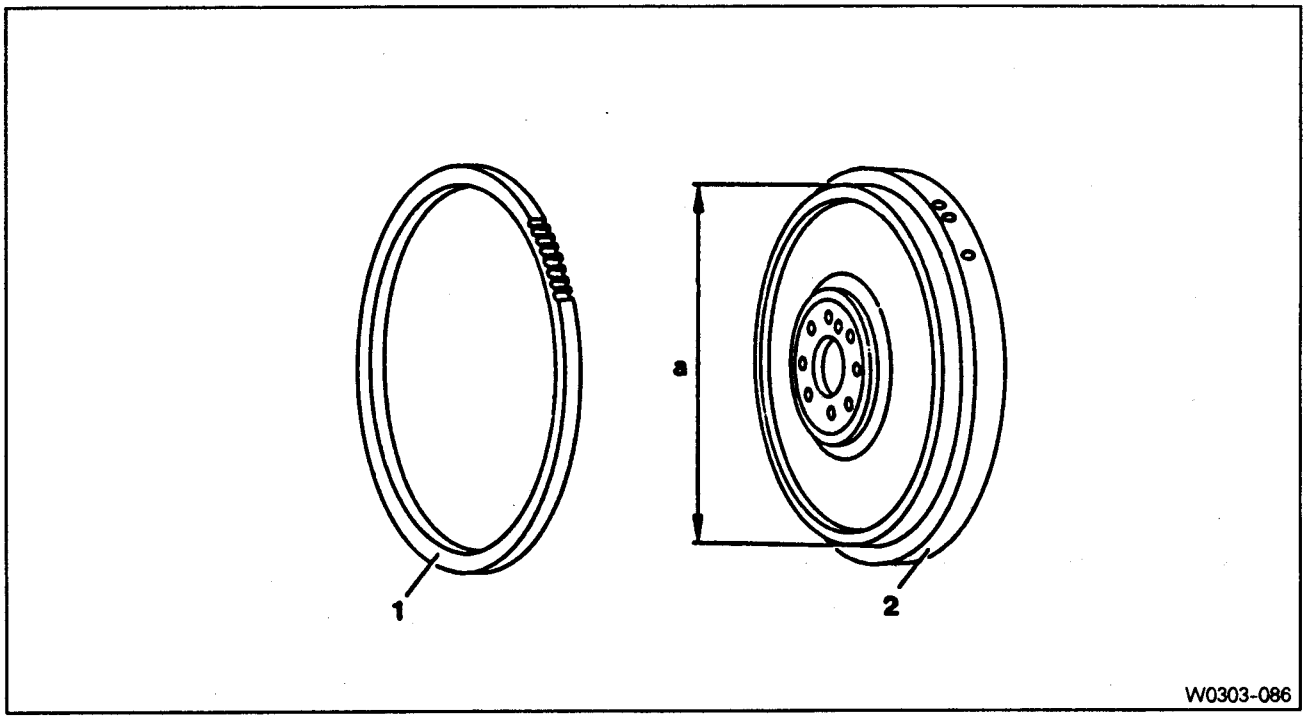
Distance 'a'		19.3~19.5mm
Distance 'b'	New	16.6mm
	Repair up to	15.6mm
Max. axial runout		0.05mm



- When machining the clutch surface 'A', the mounting surface (B) for the clutch pressure plate should also be machined in accordance with 'A' to keep the distance 'a'.
- Do not machine under 'b' value.
- When machining, fix the flywheel exactly not to exceed the standard runout.

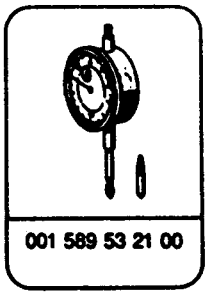
11. Replacement of Flywheel Ring Gear

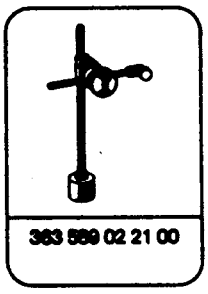
Preceding work : Removal of flywheel (03-38)



1. Ring Gear
2. Flywheel
3. Centering Collar Diameter

Special tools

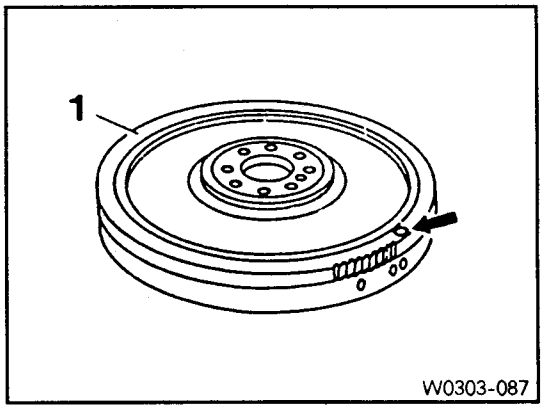




Replacement

1) Drill a hole into the ring gear (1) (arrow) and snap with a chisel.

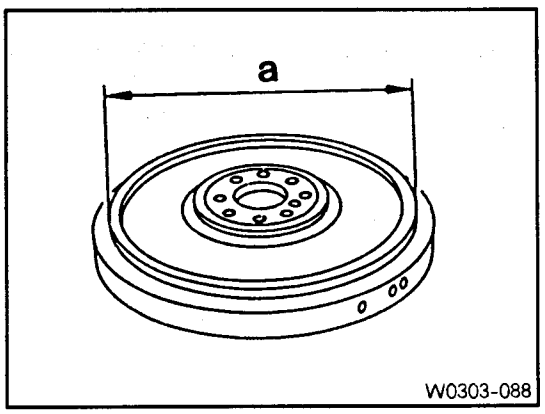
2) Thoroughly clean the collar surfaces of ring gear.



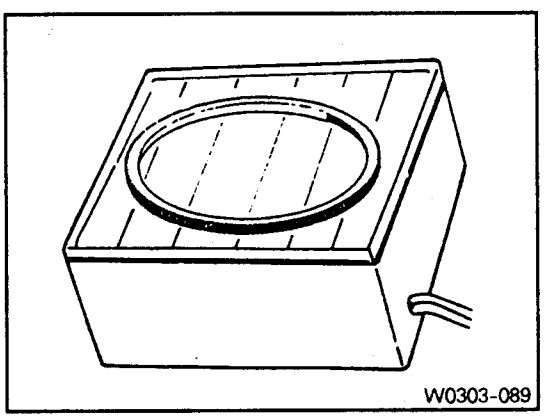
3) Measure diameter (a) of centering collar.

Diameter 'a'	275 + 0.5mm

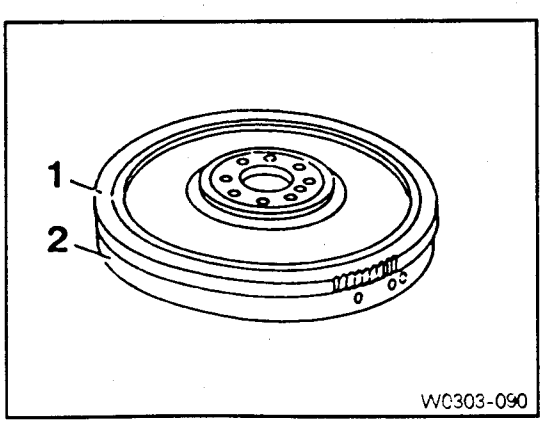
[Note] If out of standard, replace the flywheel.



4) Heat up the new ring gear up to 220℃ by using a heating device.
[Note] Use temperature measuring chalk.



5) Install the new ring gear (1) onto the flywheel by using a drift.

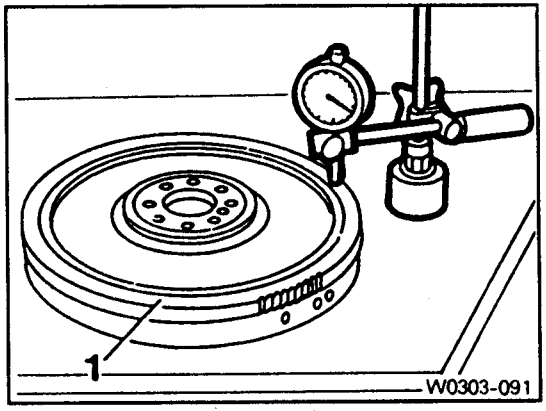


6) Measure axial runout of ring gear (1) on a surface plate.

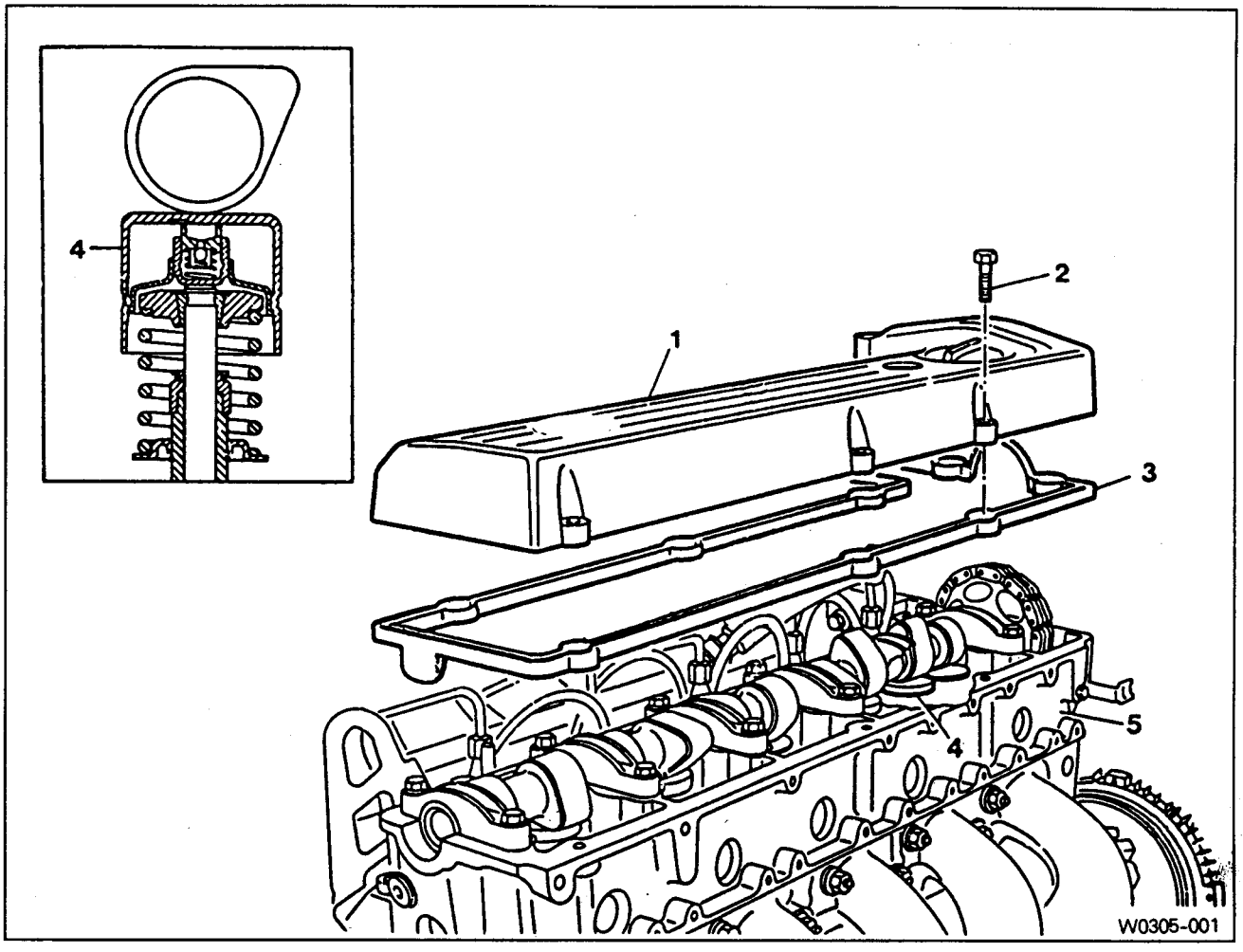
Limit	Max. 0.4mm

[Note] For correct measurement, put the flywheel on the flat measuring board.

Dial gauge 001 589 53 21 00
Dial gauge holder 363 589 02 21 00



1. Hydraulic Valve Clearance Compensation Element Check



1. Cylinder Head Cover
2. Bolt ----------10Nm
3. Gasket ----------Replace
4. Valve Tappet
5. Cylinder Head

Checking

[Note] The noise which continues short time during short travel (frequent starting of the engine) or engine starting after a long time storage is normal operating conditions. So, it does not need to be repaired. Determine the malfunctions in valve clearance compensation device with noise through following tests. If defective, replace as respectively.

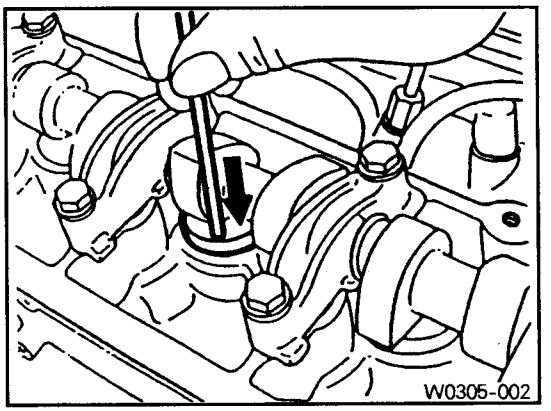
1) Run the engine at more than 3000rpm for approx. 4 minutes.

2) Stop the engine. After 5minutes, check the engine oil level and adjust if necessary.

3) Remove the cylinder head cover.

4) Check the valve tappets at TDC position of each cylinders.

5) Using a drift, lightly press the valve tappet and measure clearance between the cam and valve tappet.
[Note] If the clearance exceeds 0.4mm, replace the valve tappet.

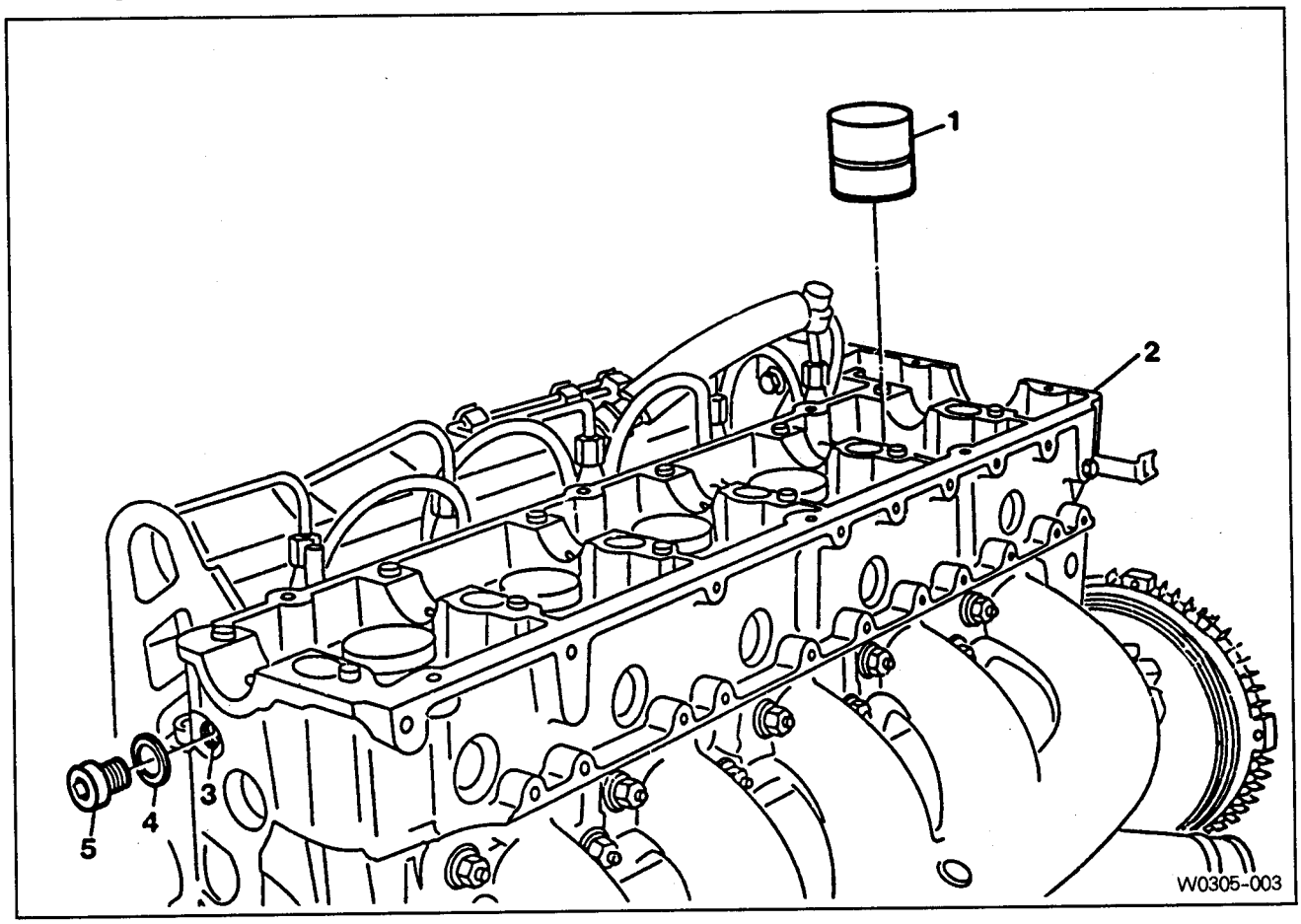


6) If a valve tappet moves down too far in comparison to the others, replace the valve tappet.

7) Rotate the engine and check the remaining valve tappets.
[Note]
- **Unnecessary rotation of the engine will damage the valve tappets.**
- **Do not rotate the engine by using the camshaft sprocket bolt or to the opposite direction of the engine rotation.**

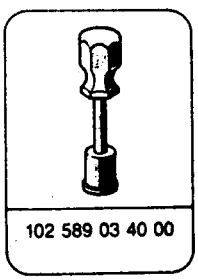
2. Replacement of Valve Tappets

Preceding work : Removal of camshaft



1. Valve Tappet
2. Cylinder Head
3. Oil Gallery
4. Seal----------Replace
5. Screw Plug

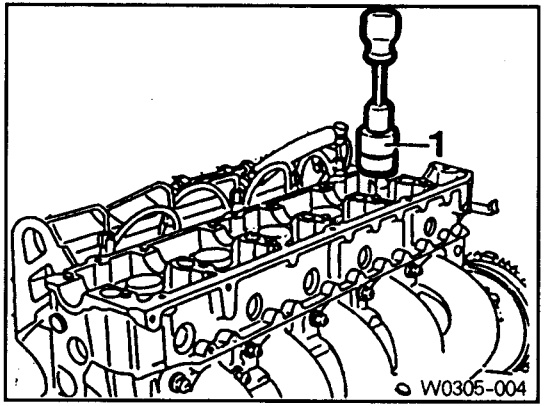
Special tool



Replacement

1) Pull out the valve tappet (1).

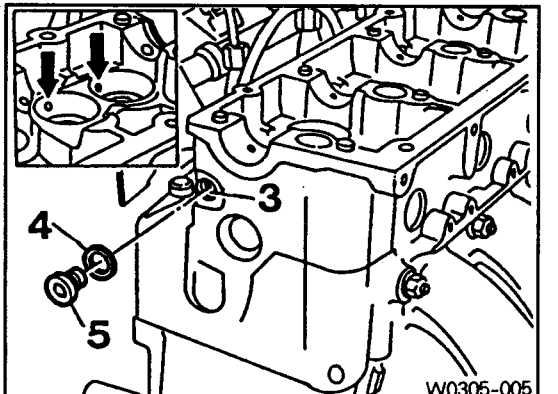
Magnetic bar 102 589 03 40 00



2) Remove the plug (5) and blow compressed air into the oil gallery (3). At this time, check that the outlet bores (arrow) at the seat of the valve tappet are clear.

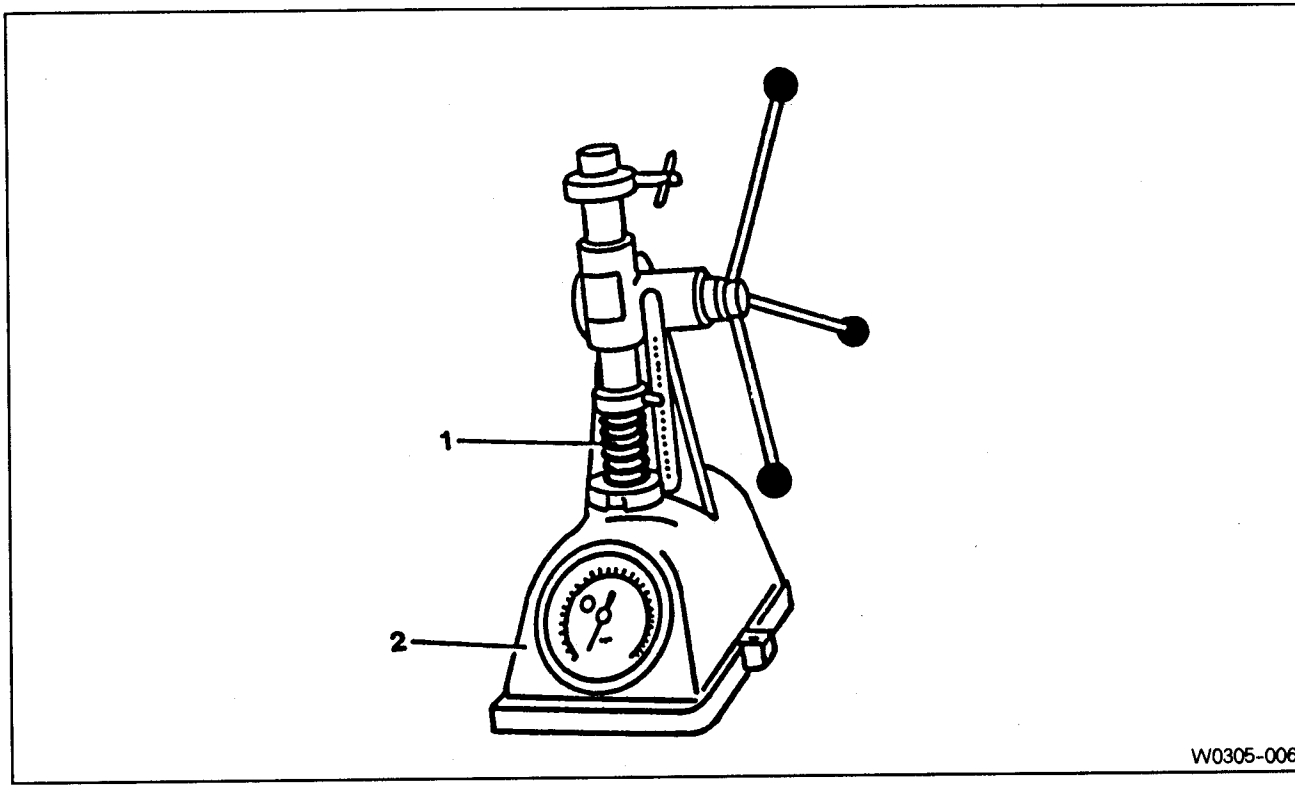
3) Replace the seal (4) and tighten the plug (5).

4) Insert the new valve tappet.
[Note] Coat the valve tappet with oil.



3. Valve Springs Check

Preceding work : Removal of valve spring



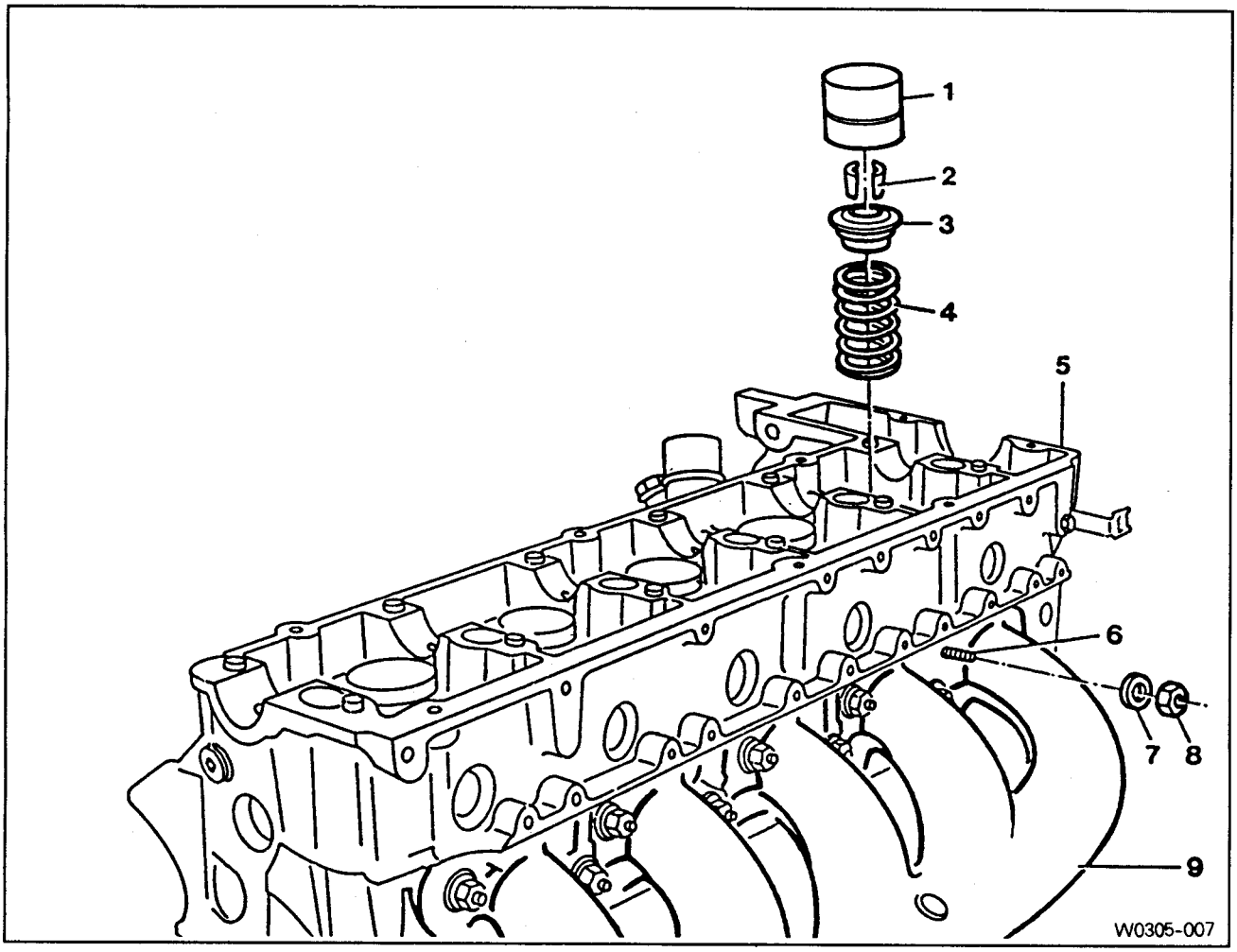
1. Valve Spring
2. Spring Scale

Service data

Outer diameter	Wire diameter	Free length	At preloaded		
			Length	Tension (new)	Limit
33.1mm	4.20mm	50.0mm	27mm	680~740N	612N

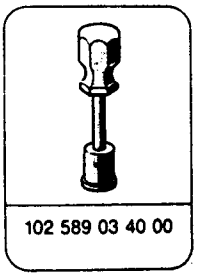
4. Removal and Installation of Valve Springs

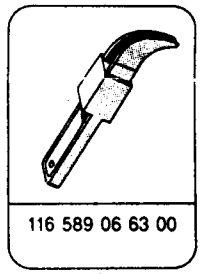
(1) Cylinder head removed

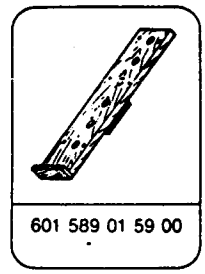


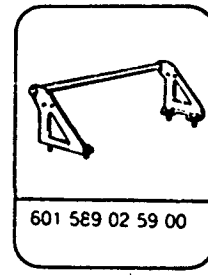
1. Valve Tappet
2. Valve Collets
3. Spring Seat
4. Valve Spring---------- Check, replace if necessary
5. Cylinder Head
6. Stud Bolt---------- 12Nm
7. Washer
8. Nut---------- Replace, 25Nm
9. Exhaust Manifold

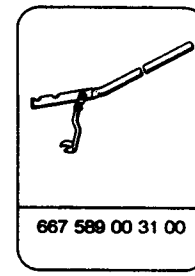
Special tools


102 589 03 40 00


116 589 06 63 00


601 589 01 59 00


601 589 02 59 00


667 589 00 31 00

Removal · Installation

1) Remove the nuts (8) uniformly and then remove the washer (7), exhaust manifold (9) and gasket.

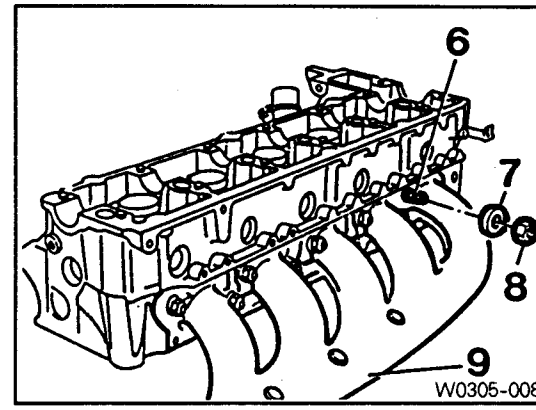
Installation

Check the stud blot (6) for damage and replace if necessary.

Tightening torque	12Nm

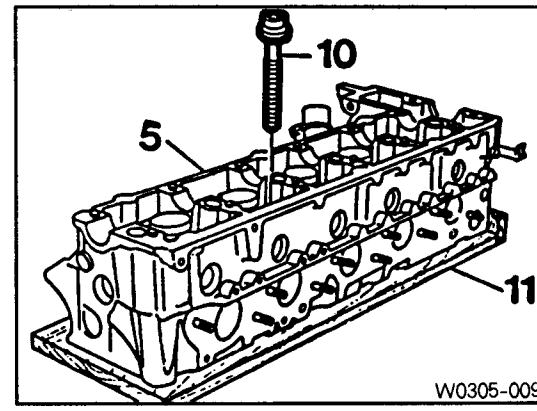
Replace the gasket and tighten the nuts (8).

Tightening torque	25Nm



2) Install the assembling board (11) to the cylinder head with 4 cylinder head blots (10).

Assembling board 601 589 01 59 00



3) Pull out the valve tappet (1) with magnetic bar (12).

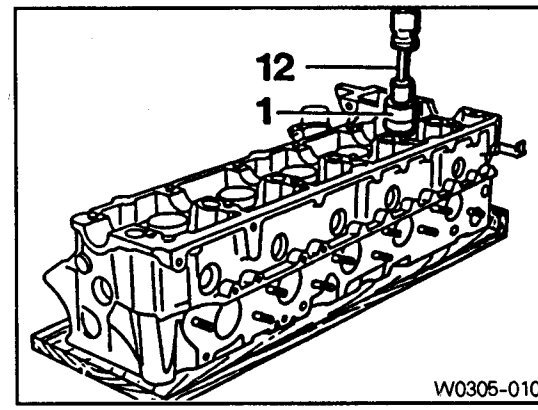
[Note] Place the valve tappets upside down (open end upward).

Magnetic bar 102 589 03 40 00

Installation

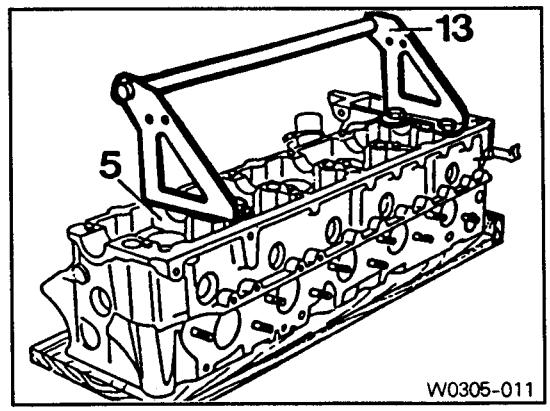
Installation is reverse order of the removal.

Coat the valve tappet with oil.



4) Install the supporting bridge (13) on the cylinder head (5).

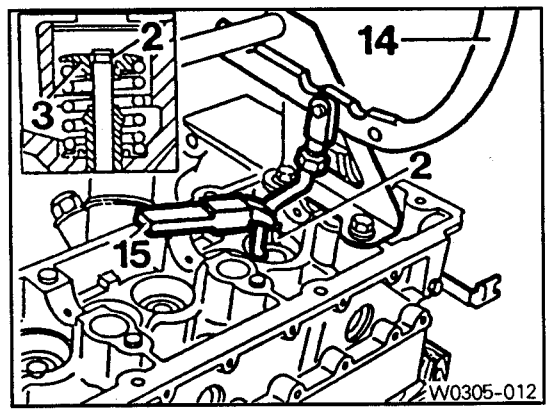
Supporting bridge 601 589 02 59 00



5) Using the press lever (14), press the spring seat downward and remove the valve collets (2) with magnetic finger (15).

[Note] Be careful not to damage guide bore of the valve tappet.

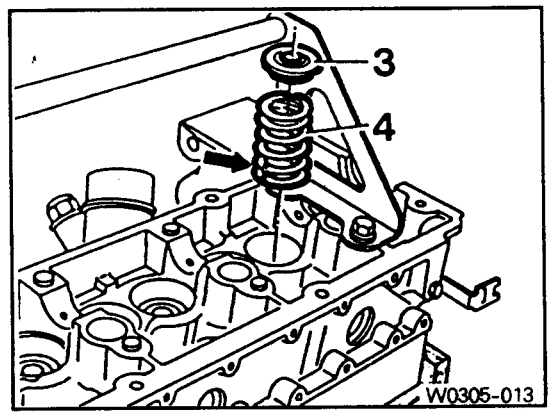
Press lever 667 589 00 31 00
Magnetic finger 116 589 06 63 00



6) Remove the spring seat (3) and spring (4).

Installation
Install the valve spring with the color coding (arrow) facing down.

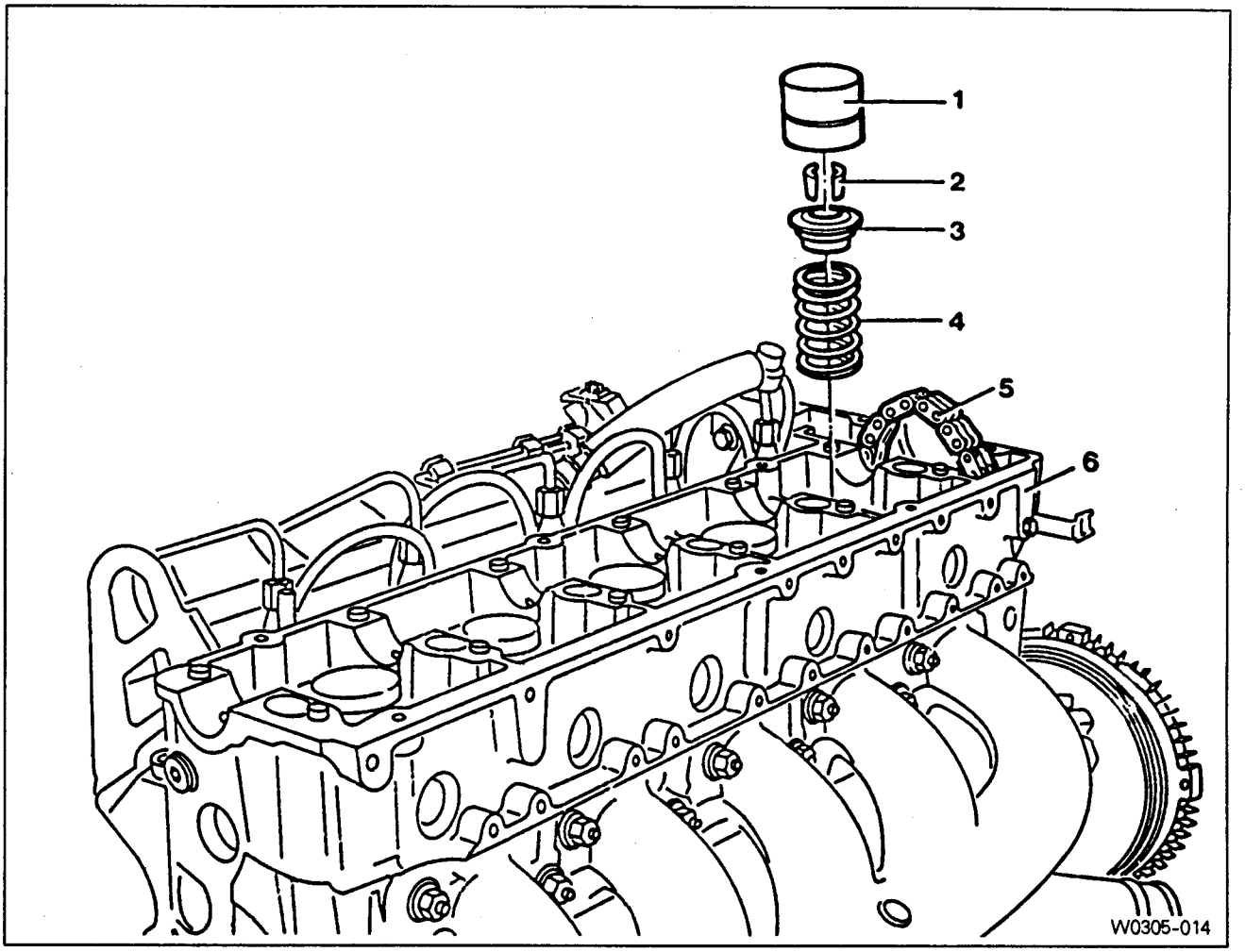
7) Check the valve spring and replace if necessary.



8) Installation is reverse order of the removal.

(2) Cylinder head installed

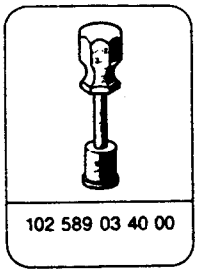
Preceding work : Removal of camshaft

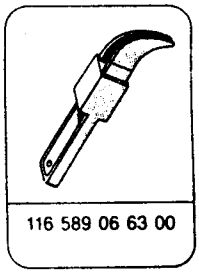


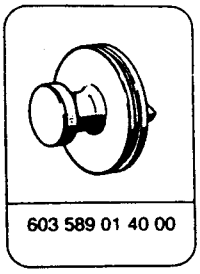
1. Valve Tappet
2. Valve Collets
3. Spring Seat
4. Valve Spring----------Check, replace if necessary
5. Timing Chain
6. Cylinder Head

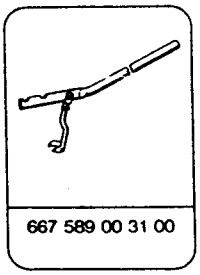
[Note] Remove the valve springs only when the piston is at TDC.

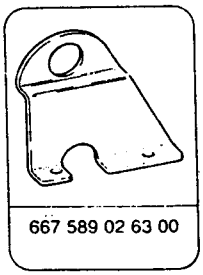
Special tools


102 589 03 40 00


116 589 06 63 00


603 589 01 40 00

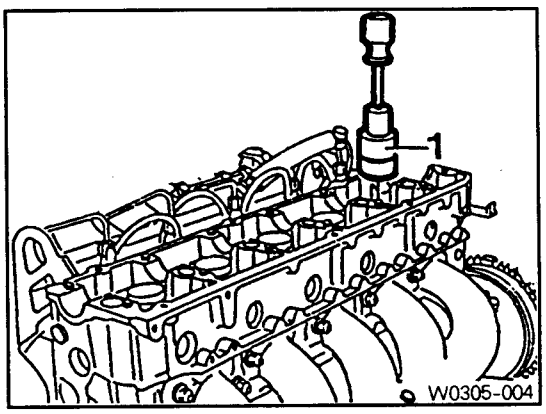

667 589 00 31 00


667 589 02 63 00

Removal · Installation

1) Remove the valve tappet (1) with magnetic lifter.
[Note] Place the valve tappets upside down (open end upward).

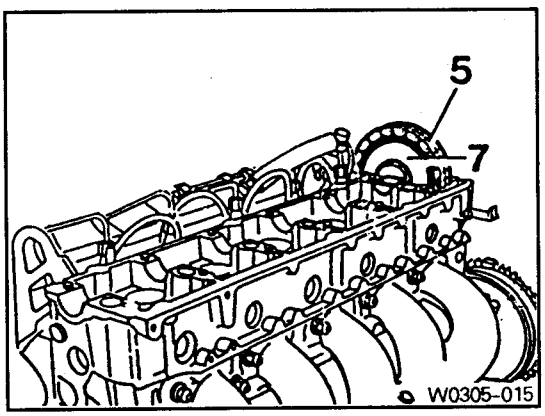
Magnetic lifter 102 589 03 40 00



2) Install the holding wheel (7) into the timing chain of camshaft sprocket position.

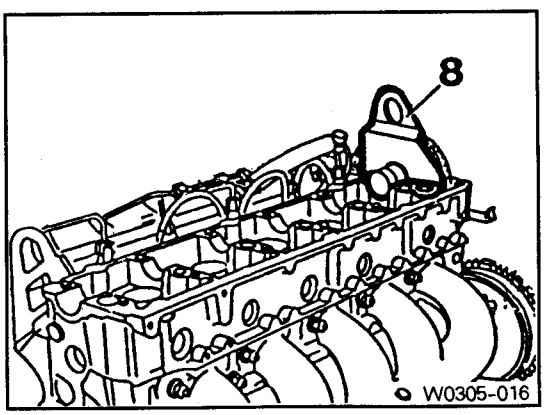
Holding wheel 603 589 01 40 00

3) Position the piston of relevant cylinder at TDC.



4) Install the supporting bar (8).

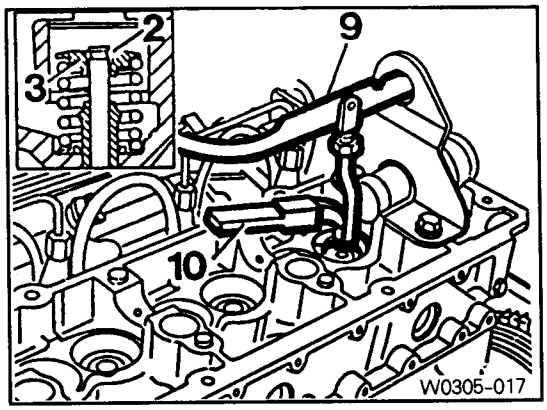
Supporting bar 660 589 02 63 00



5) Using the press lever (9), press the spring seat (3) downward and remove the valve collets (2) with magnetic finger (10).

[Note] Be careful not to damage guide bore of the valve tappet.

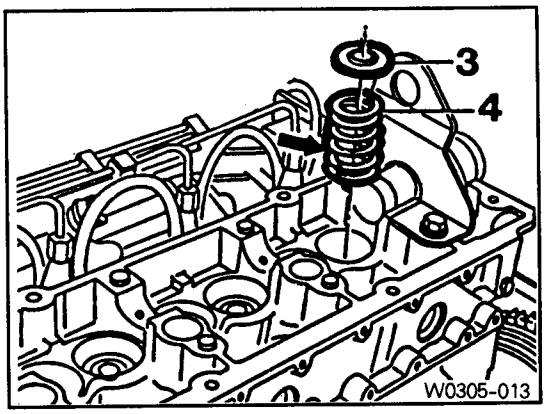
Press lever 667 589 00 31 00
Magnetic finger 116 589 06 63 00



6) Remove the spring seat (3) and spring (4).

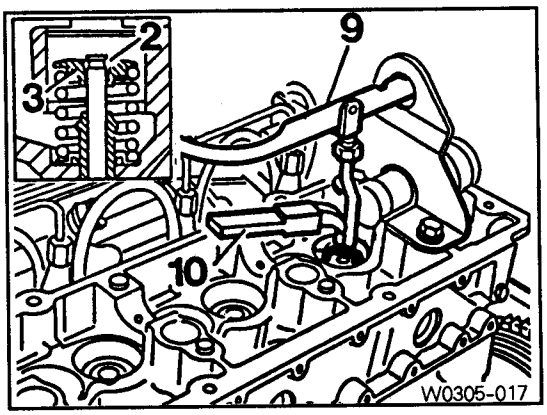
7) Check the valve spring and replace if necessary.

8) Insert valve spring (4) with the color coding (arrow) facing down and insert valve spring seat (3).



9) By press the spring seat (3) with press lever (90), install the valve collets with magnetic finger (10).

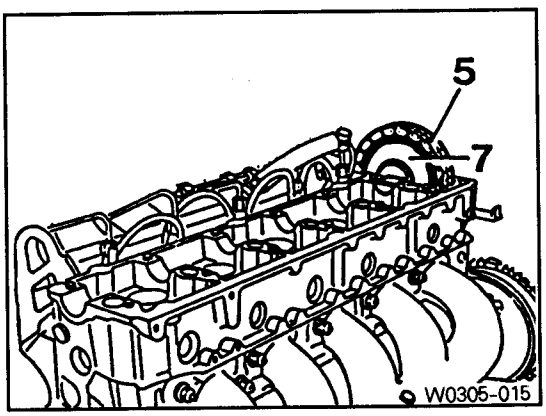
Press lever 667 589 00 31 00
Magnetic finger 116 589 06 63 00



10) Remove the supporting bar.

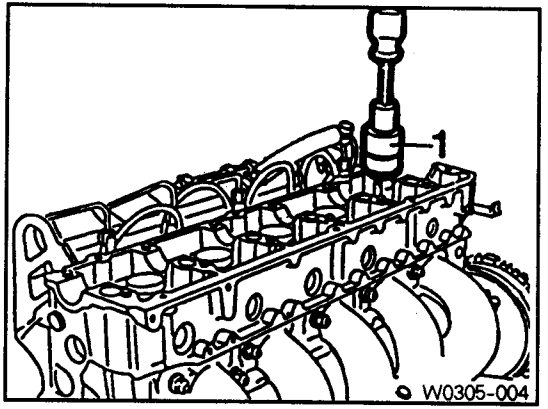
11) Remove the holding wheel (7) from the timing chain (5).

Holding wheel 603 589 01 40 00



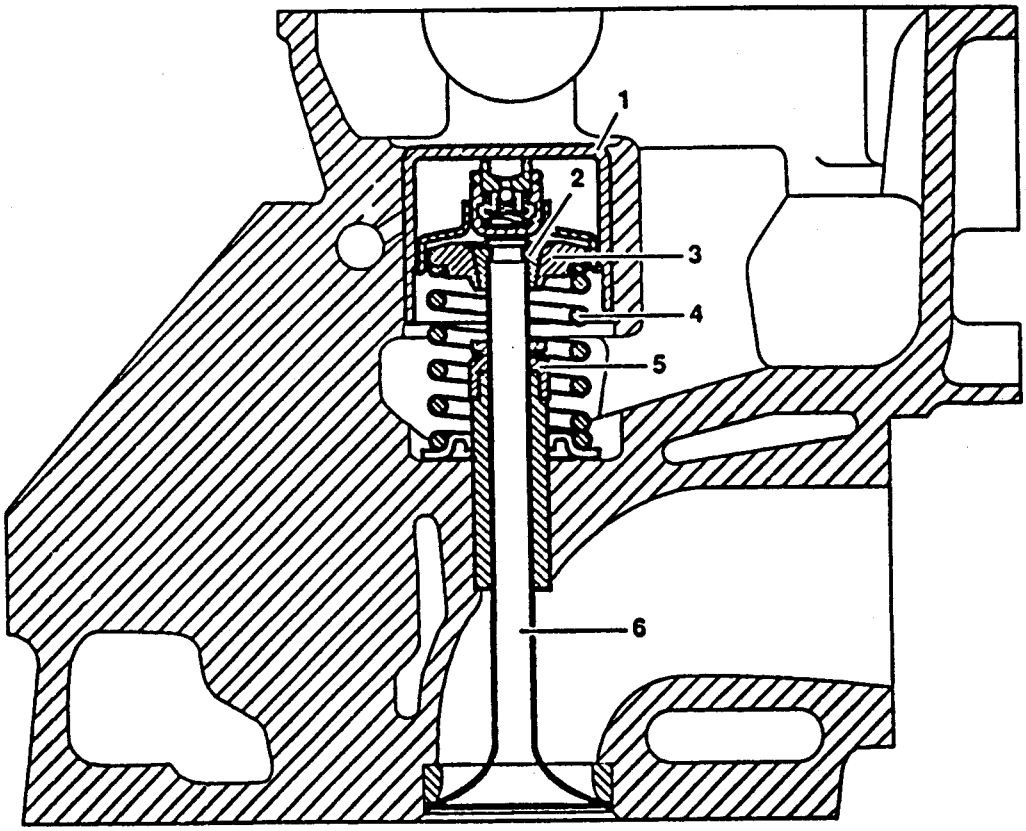
13) Coat the valve tappet with oil and install it.

Magnetic bar 102 589 03 40 00



5. Replacement of Valve Stem Seals

Preceding work : Removal of camshaft

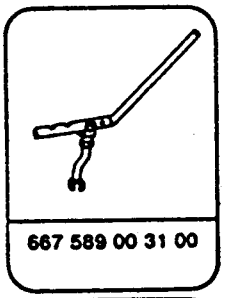


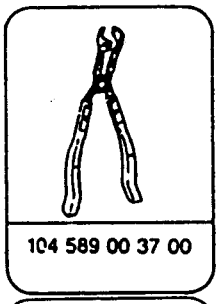
W0305-018

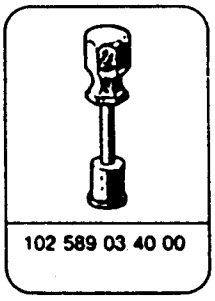
1. Valve Tappet
2. Valve Collets
3. Spring Seat
4. Valve Spring----------Check, replace if necessary
5. Valve Stem Seal
6. Valve

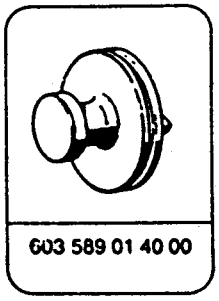
[Note] Remove the valve stem seals when the piston is positioned at TDC.

Special tools


667 589 00 31 00


104 589 00 37 00


102 589 03 40 00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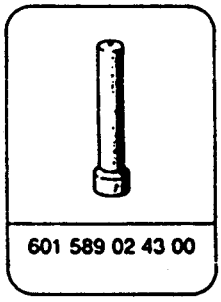
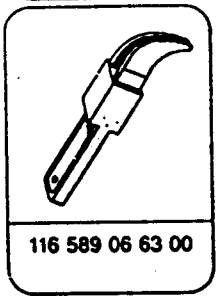
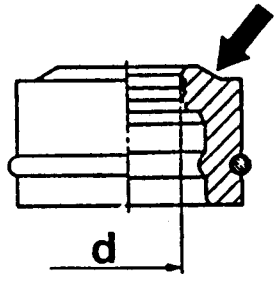

601 589 02 43 00


116 589 06 63 00

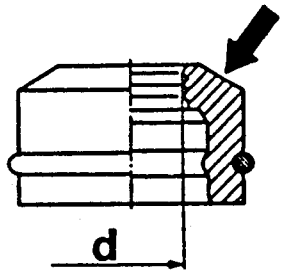

667 589 02 63 00

A. Intake valve stem seal



W0305-019

B. Exhaust valve stem seal



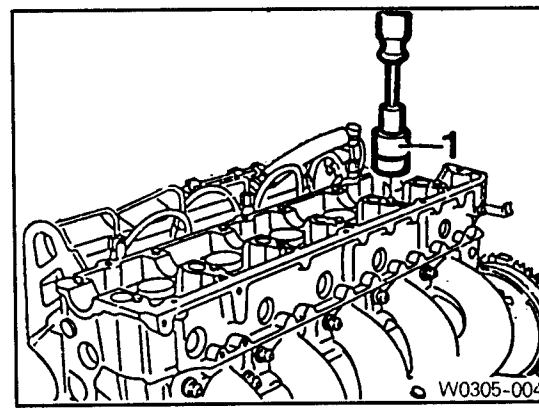
W0305-020

	Intake valve stem seal	Exhaust valve stem seal
Chamfer	Offset	All round
Inner diameter 'd'	7.3mm	8.2mm
Color	Brown	Brown
Wire ring	Black	Yellow

Replacement

1) Remove the valve tappet (1) with magnetic lifter.
[Note] Place the valve tappets upside down (open end upward).

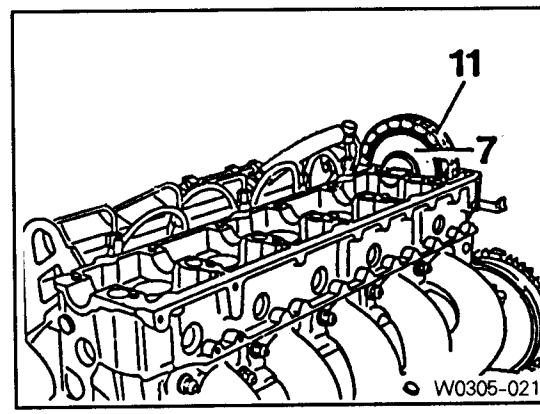
Magnetic lifter 102 589 03 40 00



2) Install the holding wheel (7) into the timing chain (11).

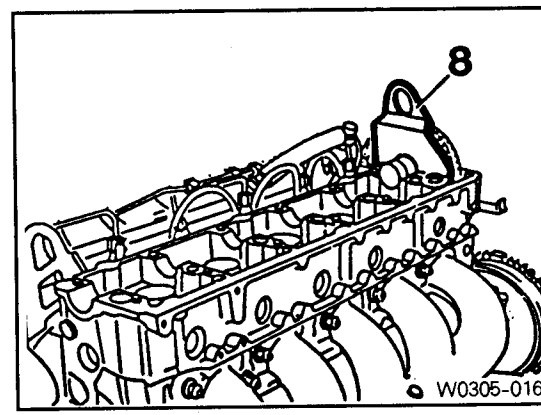
Holding wheel 603 589 01 40 00

3) Position the piston of relevant cylinder at TDC.



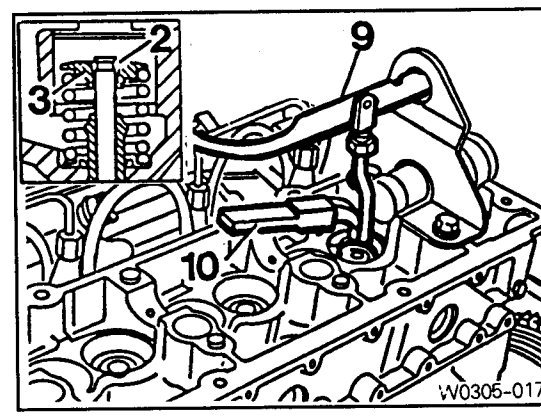
4) Install the supporting bar (8).

Supporting bar 667 589 02 63 00

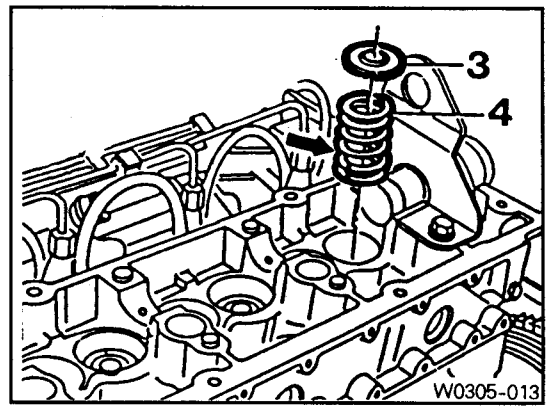


5) Using press lever (9), press the spring seat (3) downward and remove the valve collets with magnetic finger (10).

Press lever 667 589 00 31 00
Magnetic finger 116 589 06 63 00

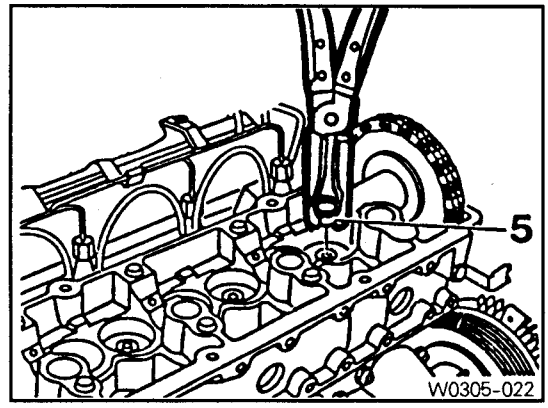


6) Remove the spring seat (3) and valve spring (4).



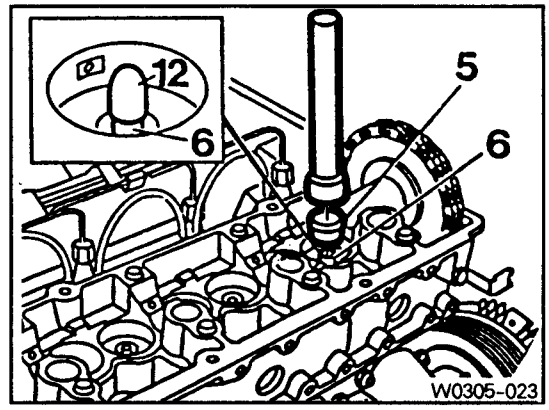
7) Remove the valve stem seal (5).

Pliers 104 589 00 37 00



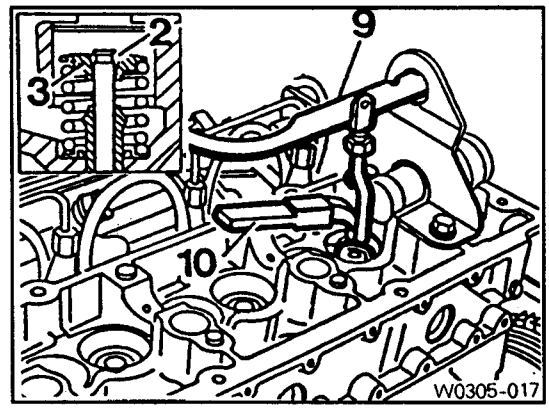
8) Insert the cap (12) onto the valve (6) and install the new valve stem seal (5) and then remover the cap.

Drift 601 589 02 43 00



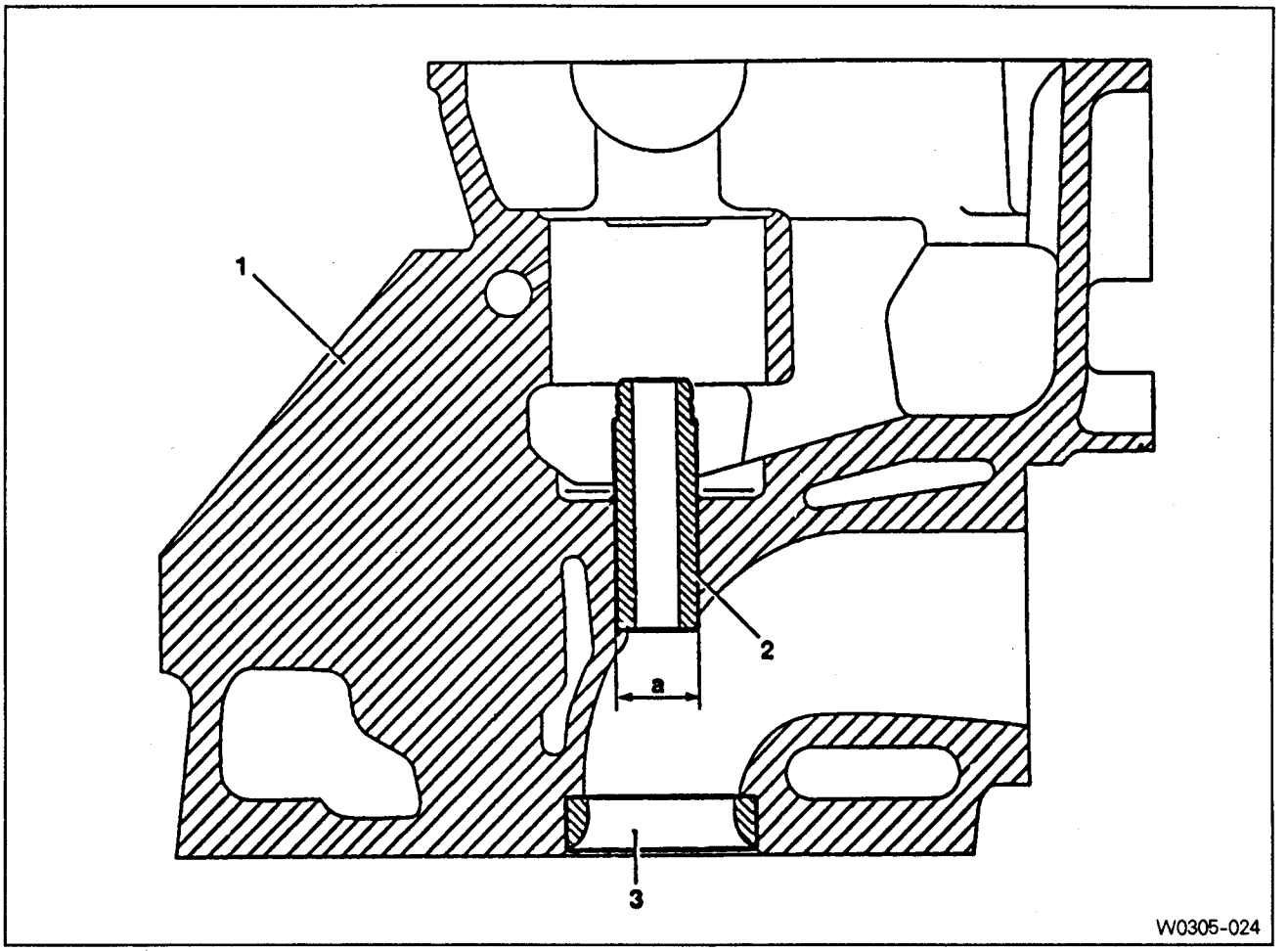
9) By pressing the spring seat with press lever (9), install the valve collets (2) with magnetic finger (10).
[Note] Be careful not to damage guide bore of the valve tappet.

Press lever 667 589 00 31 00
Magnetic finger 116 589 06 63 00



6. Check and Replacement of Valve Guides

Preceding work : Removal of cylinder head (01-20)
Removal of valve spring
Removal of valve



1. Cylinder Head
2. Valve Guide
3. Valve Seat Ring

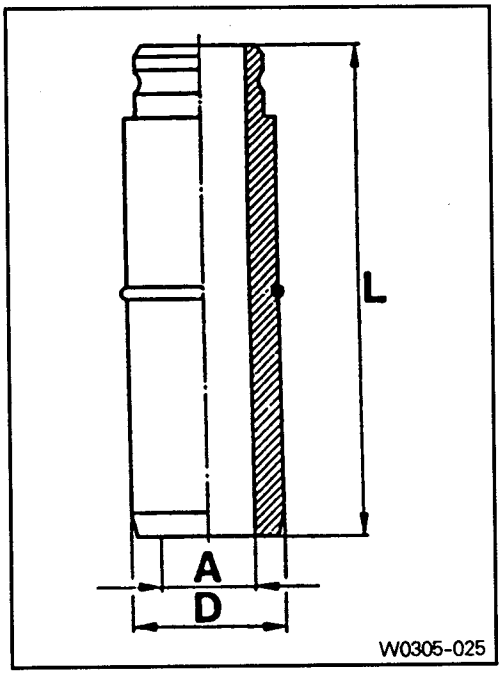
a. Basic Bore Diameter

Service data

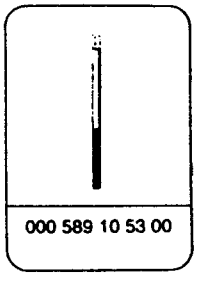
mm

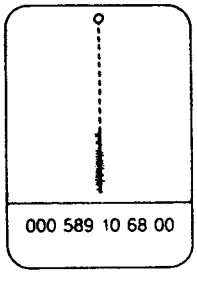
	Item	Outer Diameter 'D'	Color Code	Basic Bore Diameter 'a'	Overlap 'D' - 'a'	Valve Guide Inner Diameter 'A'	Length 'L'
Intake	Repair size 1	14.240~14.251	Red	14.200~14.211	0.029 ~ 0.051	8.000 ~ 8.030	39.5
	Repair size 2	14.440~14.451	White	14.400~14.411			
Exhaust	Repair size 1	14.240~14.251	Red	14.200~14.211	0.029 ~ 0.051	9.000 ~ 9.050	37.7
	Repair size 2	14.440~14.451	White	14.400~14.411			

[Note] Measure center (arrow) of the valve guide and if the inner diameter 'A' exceeds standard value, replace the guide.



Special tools


000 589 10 53 00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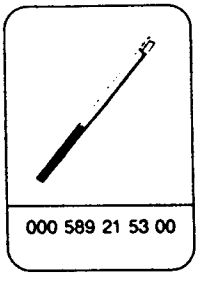
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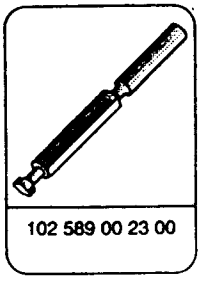
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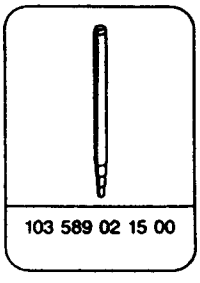
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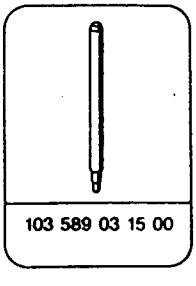
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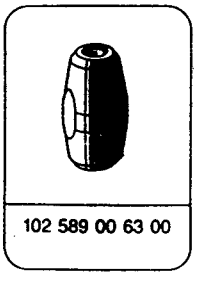
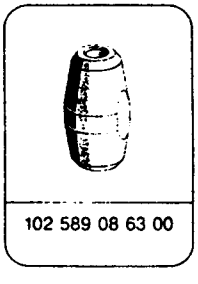

102 589 00 63 00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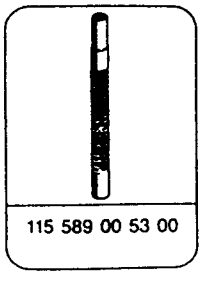
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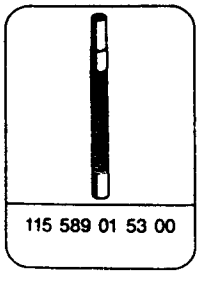
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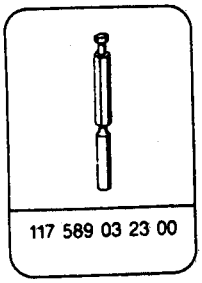
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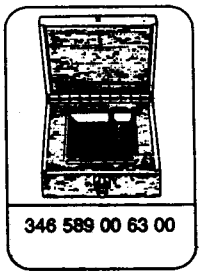
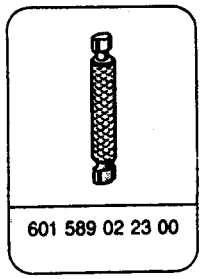
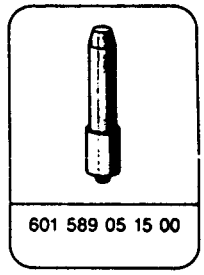
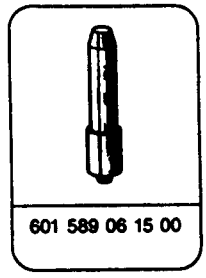
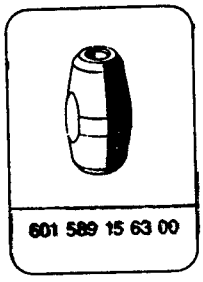

346 589 00 63 00


601 589 02 23 00


601 589 05 15 00


601 589 06 15 00


601 589 15 63 00

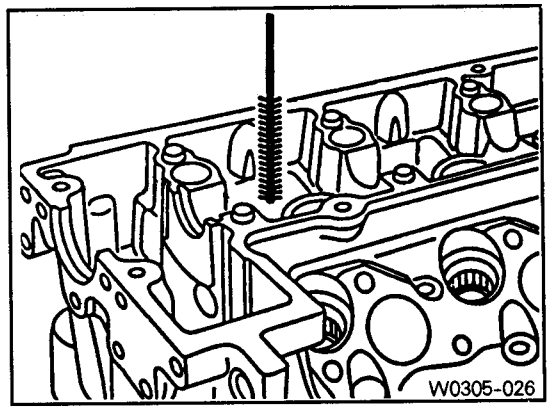
Matching valve seat - broaching tools - guide sleeves

Valve Seat	Broaching Tool No.	Guide Sleeve Tool No.	Guide Sleeve Side
Intake	115 589 00 53 00 (14.2mm)	102 589 00 63 00	B
Exhaust		102 589 08 63 00	B
Intake	115 589 01 53 00 (14.4mm)	601 589 15 63 00	A
Exhaust			B

Checking

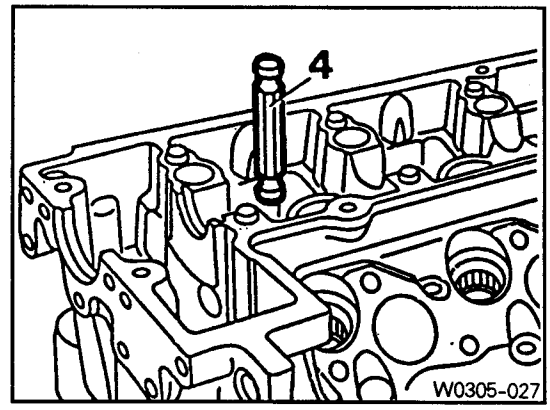
1) Thoroughly clean the valve guide bore using a cylinder brush.

Cylinder brush 000 589 10 68 00



2) Insert the GO/NO GO gauge into the valve guide bore. If the NO GO side is inserted fully, replace the valve guide (Intake 8mm, Exhaust 9mm).

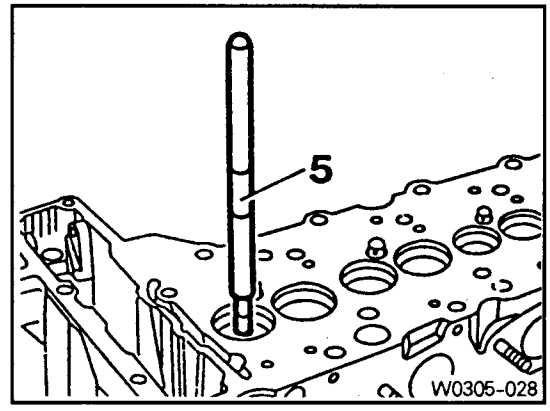
GO / NO GO gauge 601 589 02 23 00



Replacement

1) Drive out the valve guide (2) by using a drift (5).
[Note] The valve guide must be driven out upward of the cylinder head.

Drift(for intake) 105 589 03 15 00
Drift(for exhaust) 103 589 02 15 00



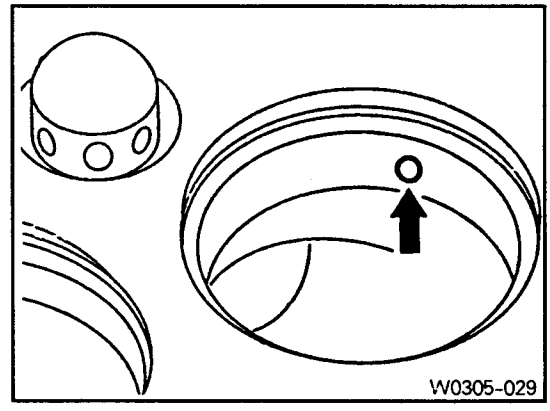
2) Thoroughly clean the basic bore by using a cylinder brush.

Cylinder brush 000 589 10 68 00

3) Check the basic bore in cylinder head for scoring marks and ream to next repair size if necessary.

4) Reaming basic bore in cylinder head (repair size).
– Thoroughly remove carbon deposits in cylinder head.
[Note] Particularly remove the insides of the valve seat rings.

– Remove the elevation (arrow) of intake valve seat rings.



- Select correct broaching tool and guide sleeve (refer to the table).

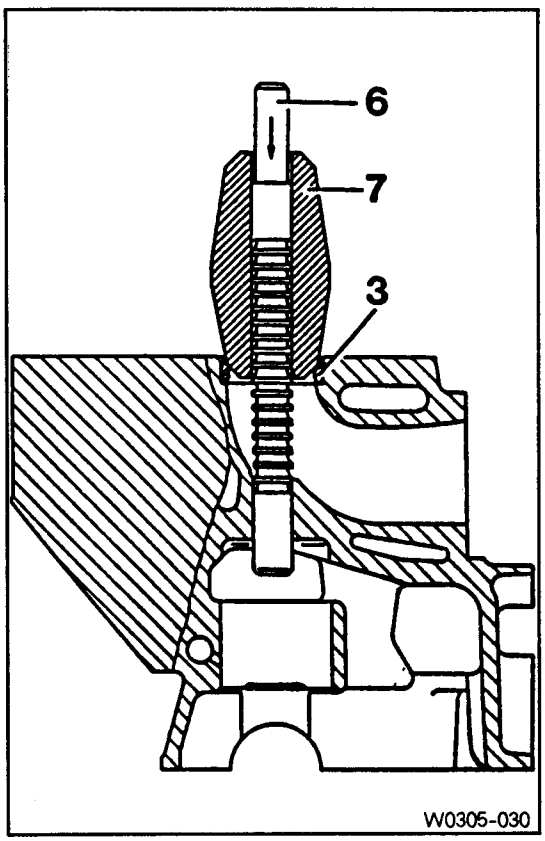
[Note] Before broaching work, the broaching tool must be cleared of swarf with a stiff plastic brush.

- Lubricate the basic bore, guide sleeve and broaching tool with petroleum.

- Push broaching tool (6) in broaching direction (arrow) into the guide sleeve (7) far enough so that the first cut of the broaching tool is positioned in the basic bore when guide sleeve is fitted onto the valve seat ring (3).

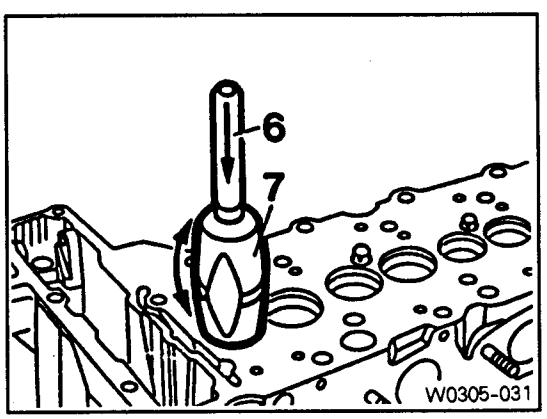
6. Broaching tool
7. Guide sleeve

See the 'standard data'

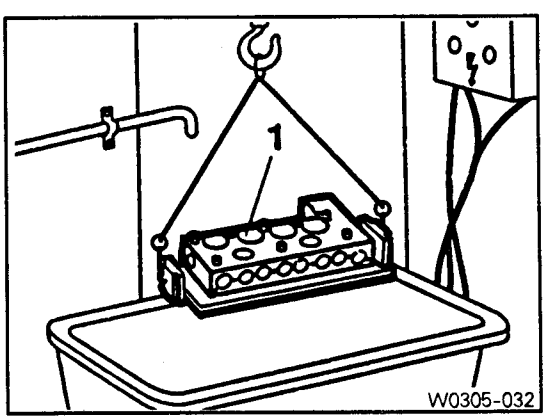


- Center the guide sleeve (7) in the valve seat ring (3) by turning.

- Knock through the broaching tool (6) with a plastic hammer (approx. 25g) and aluminum drift.

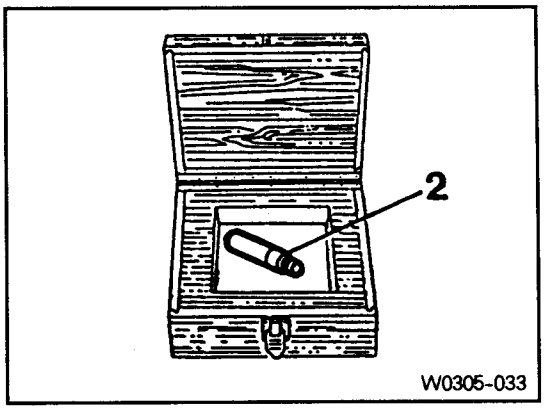


5) Heat the cylinder head (1) in a water tank to approx. 80℃.



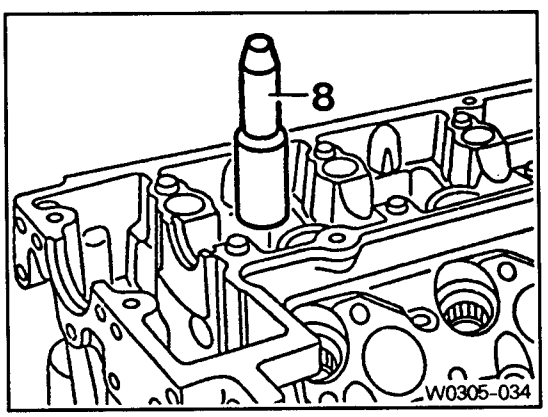
6) Cool down the new valve guide (2) with liquid nitrogen.
[Note] Do not touch the cooled valve guide by hand.

Super cooling box 346 589 00 63 00



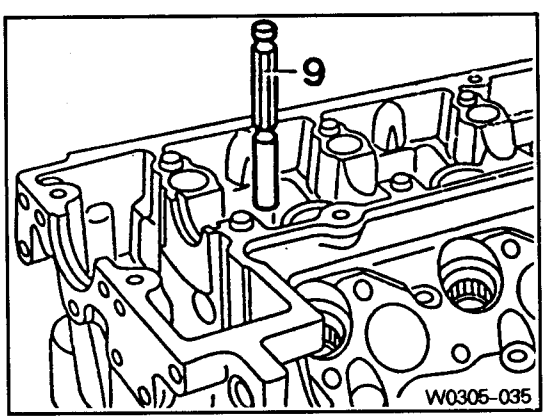
7) Drive in new valve guide with drift (8) until the wire ring makes contact.
[Note] The valve guide must be driven in from the cylinder head cover.

Drift(for intake) 601 589 05 15 00
Drift(for exhaust) 601 589 06 15 00



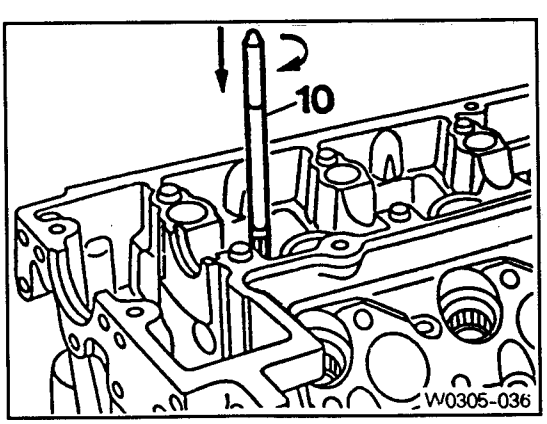
8) Check the valve guide bore with GO / NO GO gauge (9). The GO side (marked '0') should just still drop. If the GO side cannot be inserted, the bore of valve guide should be reamed.
[Note] Perform the check only on cooled down cylinder head.

GO / NO GO gauge (for intake) 102 589 00 23 00
GO / NO GO gauge (for exhaust) 117 589 03 23 00



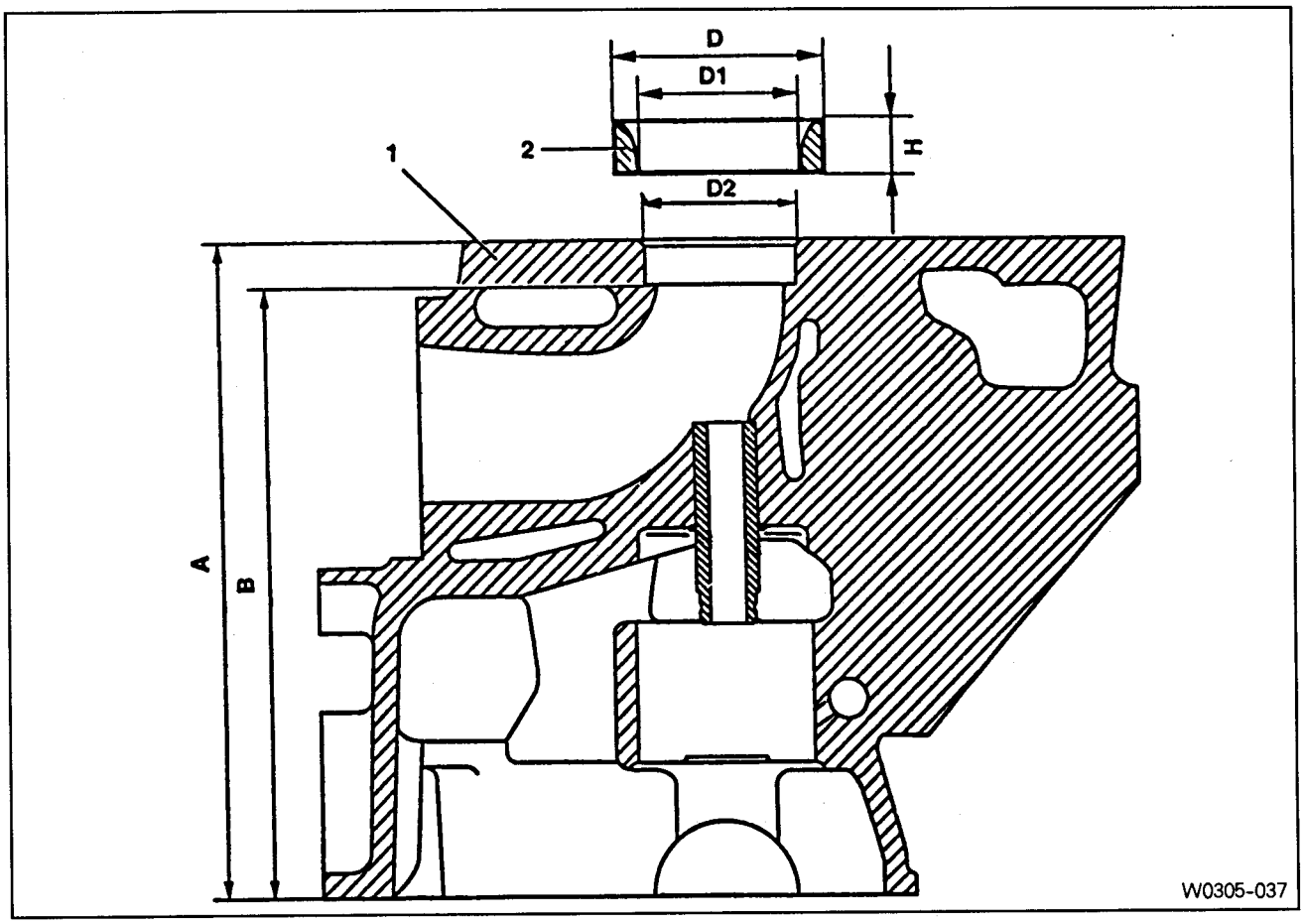
9) If necessary, ream the valve guide bore by evenly straight turning and advancing.
[Note] Never turn the reamer against the direction of rotation.

Reamer (for exhaust) 000 589 10 53 00
Reamer (for intake) 000 589 21 53 00



7. Replacement of Valve Seat Rings

Preceding work : Removal of valve
Checking of valve guide, replace if necessary
Removal of prechamber (01-13)



1. Cylinder Head
2. Valve Seat Ring
3. Valve Guide

A. Height (Cylinder head upper / lower surface)
B. Height (Cylinder head cover surface - seat of valve seat ring)
D. Valve Seat Ring Outer Diameter
D1. Valve Seat Ring Inner Diameter
D2. Basic Bore Diameter
H. Height of Valve Seat Ring

Service data

Item	Intake	Exhaust
D2	40.000~40.016mm	37.000~37.016mm
D	40.084~40.100mm	37.084~37.100mm
D1	33.400~33.600mm	30.400~30.600mm
H	6.955~7.045mm	6.955~7.045mm
Overlap U = D - D2	0.068~0.100mm	0.068~0.100mm
B	133.4mm	133.4mm
A	142.5mm	142.5mm

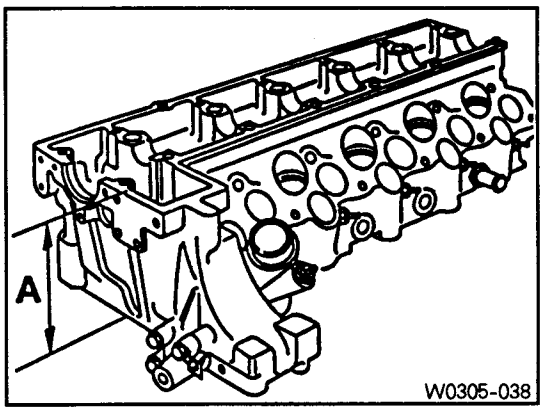
Commercial tools

Cylinder head clamping device	Hunger D-8000 München 70 Type Ventilknecht K2000 Order No. 221 00 100
Valve seat turning tool	Hunger D-8000 München 70 Type VDS 1A Order No. 236 03 308
Ring seat turning tool	Hunger D-8000 München 70 Type RDS 1 Order No. 219 00 100
Pneumatic removal / installation device (Drift : 8mm, 9mm, 14mm)	Hunger D-8000 München 70 Type PVM 1
Tensioning head	Hunger D-8000 München 70 Order No. 250 15 250
Cutting tool for recessing grooves	Hunger D-8000 München 70 Order No. 217 93 601
Test set for valves	Hunger D-8000 München 70 Order No. 216 69 210
Internal dial gauge (range : 25~60mm)	Mahr D-7300 Esslingen Order No. 844
External micrometer (range : 25~60mm)	Mahr D-7300 Esslingen Order No. 40 S
Electrically heated water tank	Otto Dürr D-7123 Sachsenherm - Ochsenbach

Removal

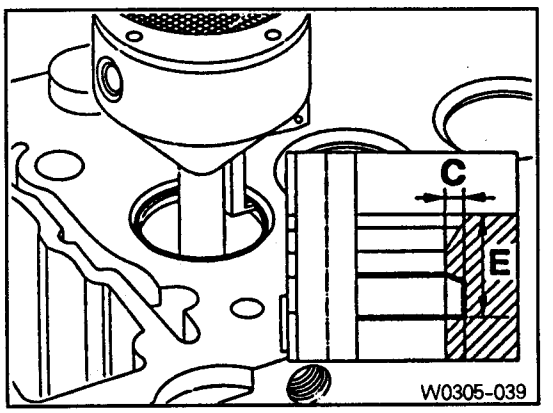
1) Measure dimension 'A'.

Limit	142.5mm



2) Clamp the cylinder head with clamping device.

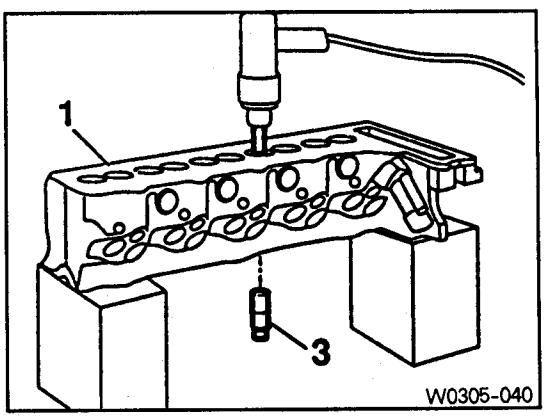
3) Cut groove into the valve seat ring so that dimension 'C' is approx. 2mm and dimension 'E' is approx. 6mm.



4) Remove the cylinder head from the clamping device and place it onto wooden blocks.

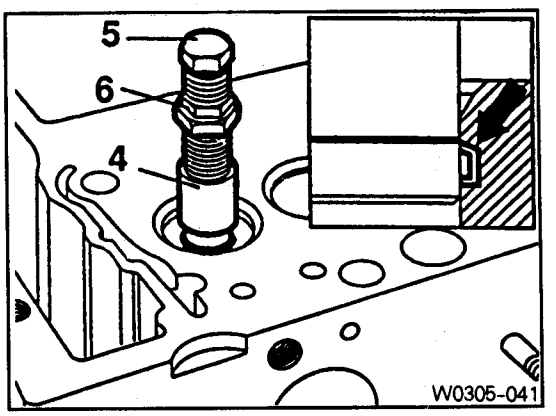
5) Remove the valve guide (3).

Drift (intake) 8mm
Drift (exhaust) 9mm



6) Insert the tensioning head (4) and extracted wedges (arrow) by turning the bolt (5).
[Note] Carefully tighten the bolt (5) otherwise the valve seat ring in the cylinder head will be excessively tensioned.

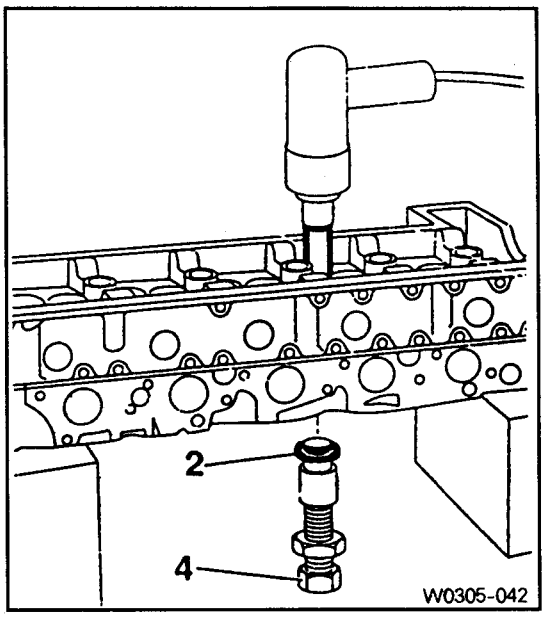
7) Lock the bolt (5) with nut (6).



8) Turn over the cylinder head.

9) Remove the tensioning head (4) and valve seat ring (2) with drift (14mm) and removal tool.

10) Clean the basic bore of valve seat ring.



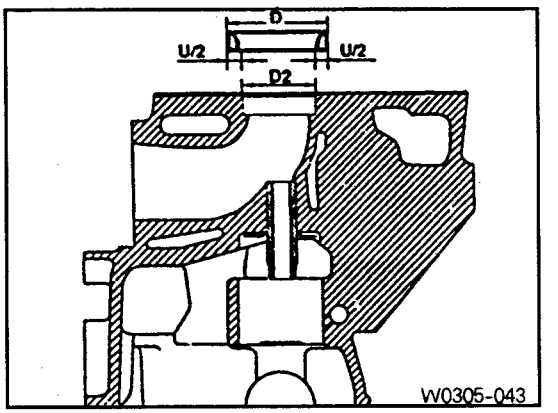
11) Measure the basic bore diameter (D2) and outer diameter (D) of the new valve seat ring (standard size).

12) Calculate the overlap value 'U' (D - D2).

Overlap value 'U'	0.068~0.100mm

Example) Measured value D = 37.100mm
Measured value D2 = 37.010mm

Overlap value 'U' = 0.090mm
If overlap value 'U' is out of standard, machine the basic bore for the valve seat ring.



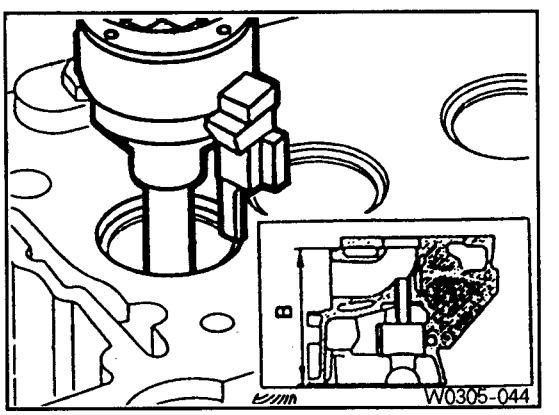
13) Clamp the cylinder head with clamping device.

14) Machining basic bore for valve seat ring (repair size).
[Note] Maintain minimum value of 'B'.

– Machine the basic bore.

Limit

Max. D2	Intake	40.516mm
	Exhaust	37.516mm
Min. B		133.4mm



– Measure machined basic bore and outer diameter 'D' of valve seat ring (repair size).

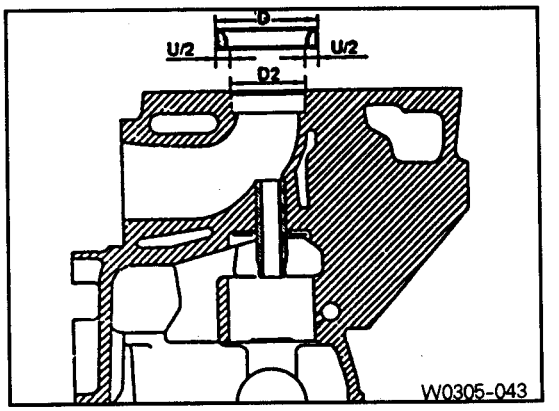
– Measure the overlap 'U'.

Overlap 'U' (D - D2)	0.068~0.100mm

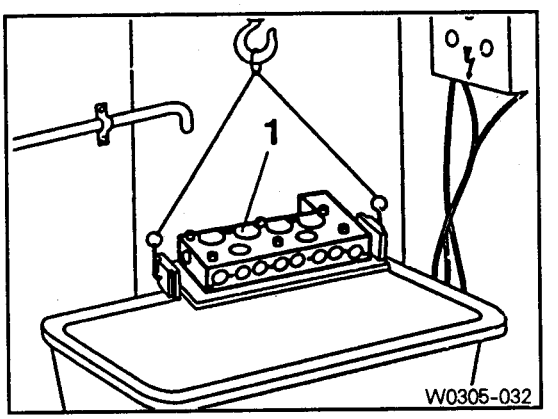
Example) Measured value D = 37.600mm
Measured value D2 = 37.480mm

Overlap U = 0.120mm

The basic diameter D2 must be machined by 0.020mm in order to get the required overlap value.

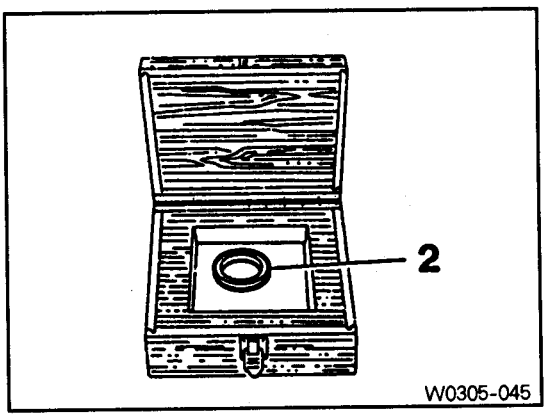


15) Hang the cylinder head (1) to the lifting device and heat in a water tank to approx. 80℃.

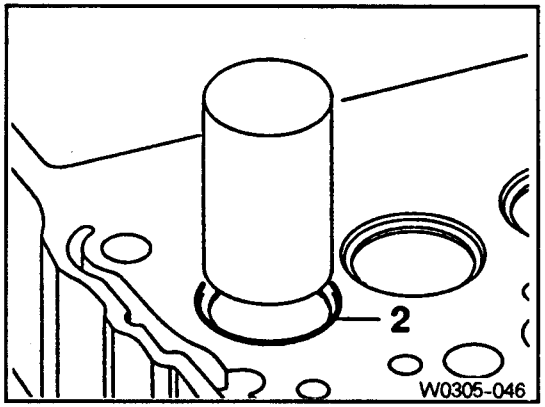


16) Cool down new valve seat ring (2) into the cooling box with liquid nitrogen.
[Note] Do not touch the cooled valve seat rings with hand.

Super cooling box 346 589 00 63 00



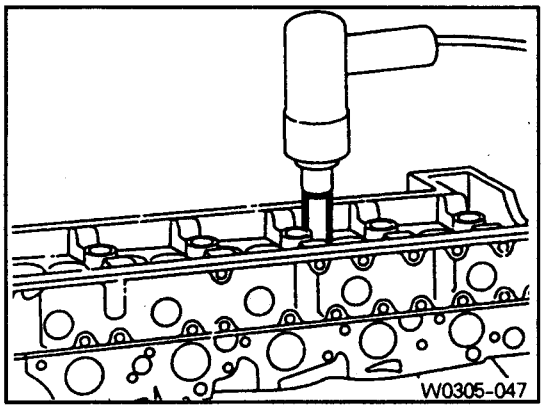
17) Drive in new valve seat ring (2) with a proper wooden drift.



18) Install the valve guide (3) with a proper drift and assembling tool.

[Note] The valve guide must be driven in from the cylinder head cover.

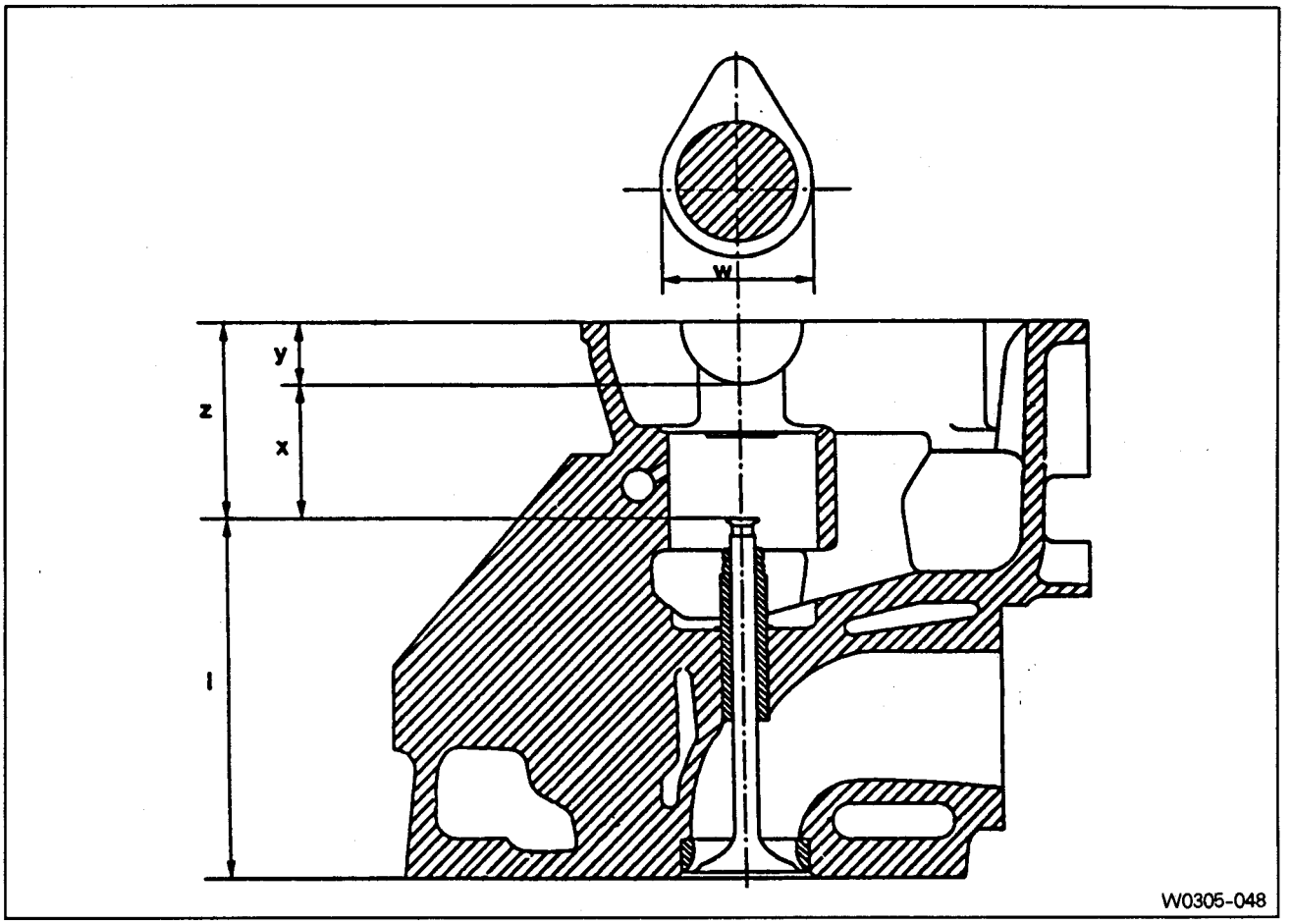
Drift (intake) 8mm
Drift (Exhaust) 9mm



19) Machine the valve seats.

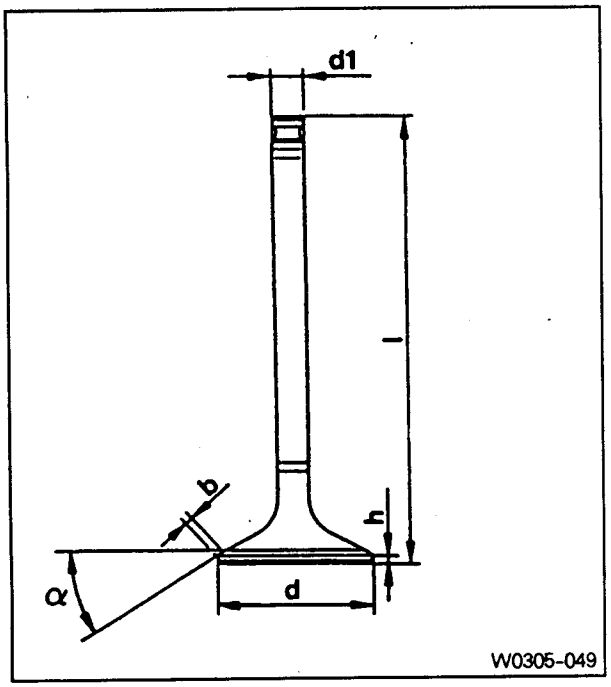
8. Check and Machining of Valves

Preceding works : Removal of cylinder head
Removal of the valve spring
Removal of the valve

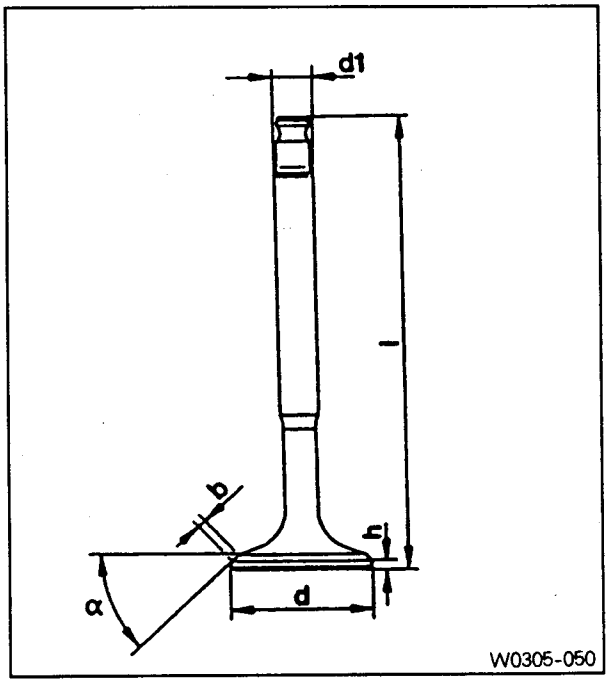


l. Valve Length
w. Camshaft Cam Basic Diameter
x. Distance (Camshaft basic bore - valve stem)
y. Half Camshaft Basic Bore Diameter
z. Distance (Cylinder head cover parting surface - valve stem)

Intake valve



Exhaust valve

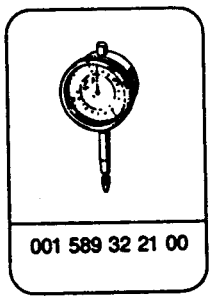


Item		Intake Valve	Exhaust Valve
Valve disc diameter 'd'		37.90~38.10mm	34.90~35.10mm
Valve disc height 'h'		1.7mm	1.7mm
Setting angle 'α' for machining the valve		45°	45°
Valve stem diameter 'd1'		7.955~7.970mm	9.945~8.960mm
Valve length 'l'	Standard	106.20~ 106.60mm	106.20~106.60mm
	Repair	105.30~105.70	105.30~105.70mm
Max. permissible runout at valve stem and valve seat		0.03mm	0.03mm

Matching valves

	Camshaft cam basic dia. w = 38.0 ± 0.2mm	**Camshaft cam basic dia. w = 36.6 ± 0.2mm**	**Valve to be used**
Size (x)	19.5~20.3mm	19.5~20.1mm	Use machined valve, if necessary new repair valve l = 105.5 ± 0.2mm
Size (x)	20.4~21.4mm	20.2~21.2mm	Reuse valve
Size (x)	21.4~21.97mm	21.2~21.97mm	Use standard size valve l = 106.4 ± 0.2mm

Special tool



Commercial tool

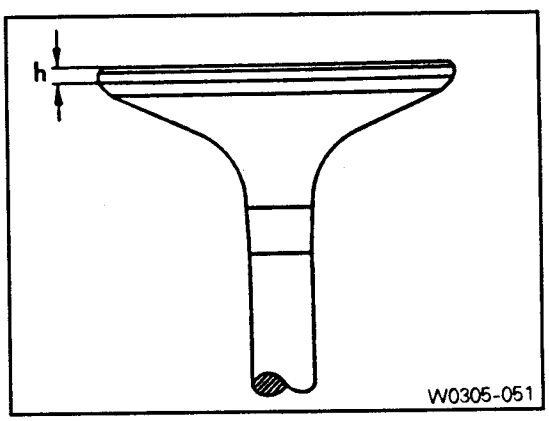
Valve corn grinding machine

Checking and machining

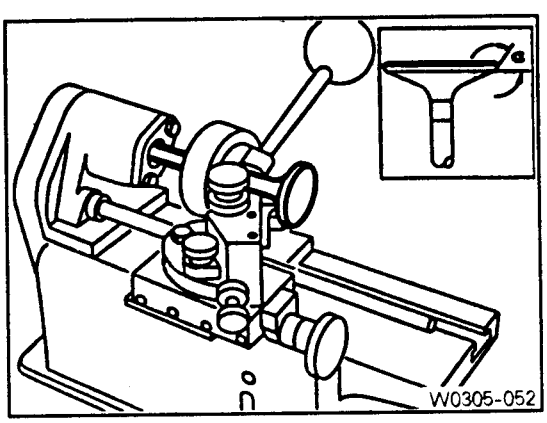
1) Clean the valves and do visual check.
   Valves with wobbled valve disc, with worn or scored valve stem should be replaced.

2) Measure valve disc height 'h'.

Service data	Intake	1.7 ± 0.15mm
	Exhaust	1.7 ± 0.15mm



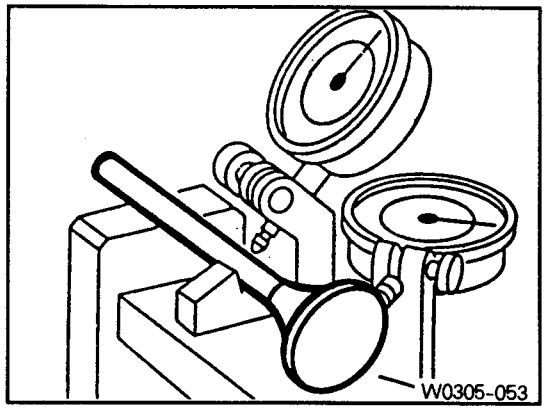
3) Machine the valve.
   [Note] Pay attention to setting angle 'α'.



4) Measure radial runout between valve stem and valve seat.

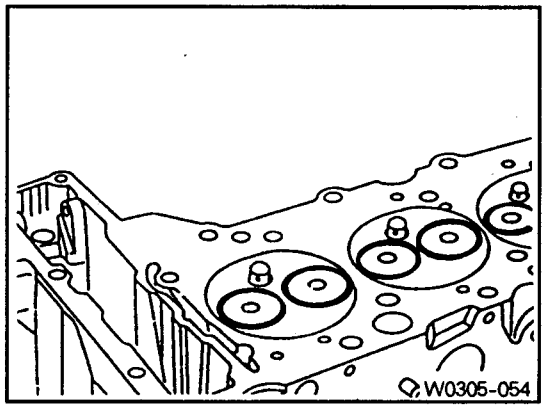
Limit	Max. 0.03mm

Dial gauge 001 589 32 21 00



5) Clean the valves, valve seats and valve guides.

6) Coat the valve stem with oil and insert it into valve guide.

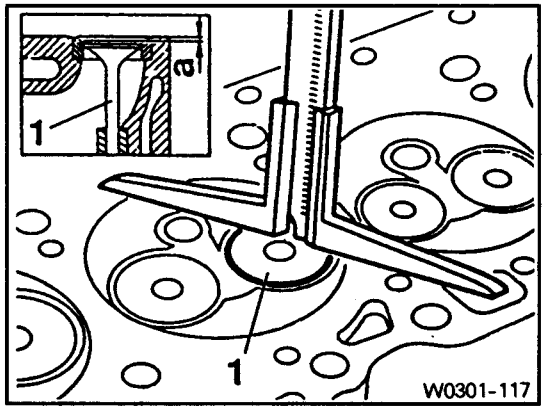


7) Insert the valves (1) into the valve guides according to marking.

8) Measure amount by which the valve arrears 'a'.

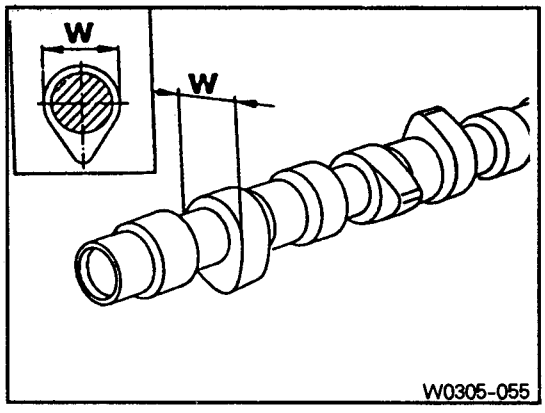
Arrears 'a'	0.1~0.7mm

[Note] If out of standard, replace the valve seat ring.

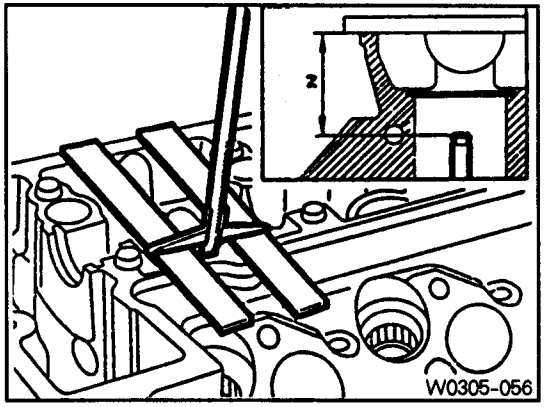


9) Measure camshaft cam basic diameter (w).

Diameter 'w'	38 ± 0.2mm or 37.6 ± 0.2mm



10) Measure distance 'z' (cylinder head cover parting surface - valve stem).



11) The distance 'x' (camshaft basic bore - valve stem).
'x' = 'z' - 'y'.

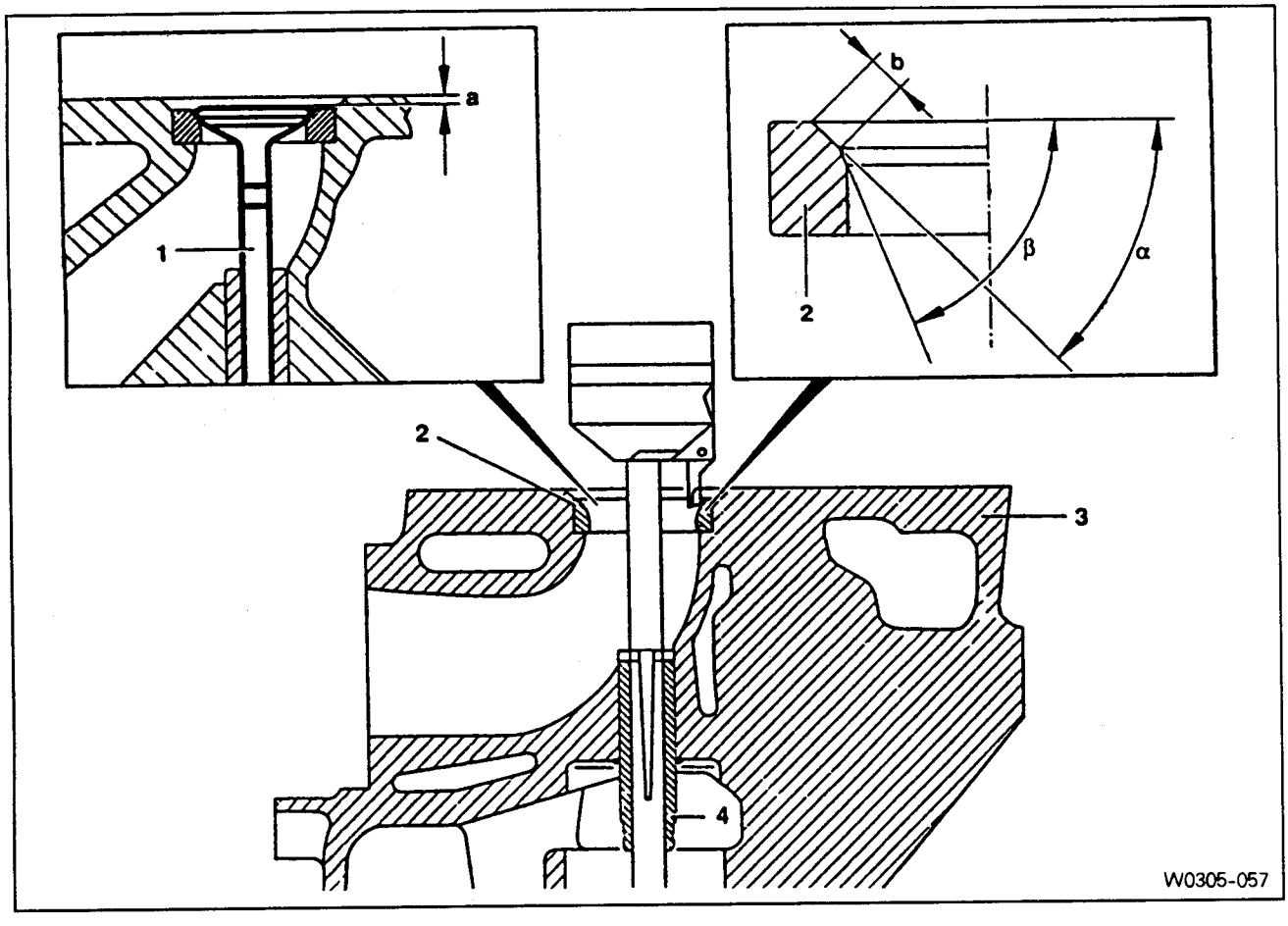
Determine the valve to use according to this measurement (See 'matching valves')

Example) Measured value 'w' = 38.2mm
Measured value 'z' = 36.5mm
Value 'y' = 15.5mm

'x' = 36.5 - 15.5 = 21.0mm
In this case according to 'Matching valves' table, the installed valve may be used.

9. Machining of Valve Seat

Preceding work : Removal of prechamber (01-13)
Removal and inspection of valve, replace if necessary
Inspection of valve guide, replace if necessary



1. Valve
2. Valve Seat Ring
3. Cylinder Head
4. Valve Guide

a. Valve Arrears
b. Valve Seat Width
α. Valve Seat Angle
β. Valve Seat Free Angle

Service data

Item		Intake	Exhaust
Valve arrears 'a'		0.1~0.7mm	0.1~0.7mm
Valve seat width 'b'		1.2~1.7mm	1.5~2.0mm
Valve seat angle 'α'		45°	45°
Valve seat free angle 'β'		65°	65°
Permissible radial runout		0.03mm	0.03mm
Valve length 'l'	Standard	106.20~106.60mm	106.20~106.60mm
	Repair	105.30~105.70mm	105.30~105.70mm

Matching valves

	Camshaft cam basic dia. w = 38.0 ± 0.2mm	Camshaft cam basic dia. w = 37.6 ± 0.2mm	Valve to be used
Size (x)	19.5~20.3mm	19.5~20.1mm	Use machined valve, if need use repair valve l = 105.5 ± 0.2mm
Size (x)	20.4~21.4mm	20.2~21.2mm	Reuse the valve
Size (x)	21.4~21.97mm	21.2~21.97mm	Use standard size valve l = 106.4 ± 0.2mm

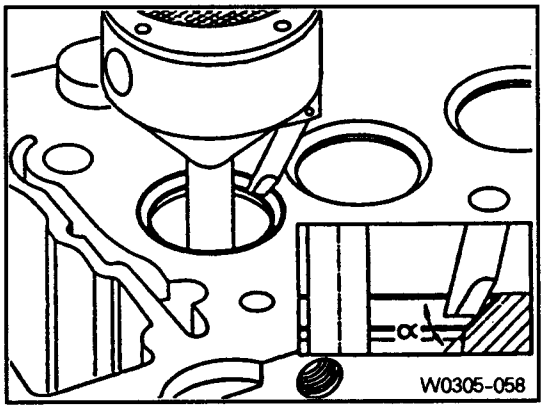
Commercial Tools

Cylinder head clamping device	Hunger D-8000 München 70 Type Ventilknecht K2000 Order No. 221 00 100
Valve seat turning tool	Hunger D-8000 München 70 Type VDS 1A Order No. 236 03 308
Test set for valves	Hunger D-8000 München 70 Order No. 217 93 601

Machining

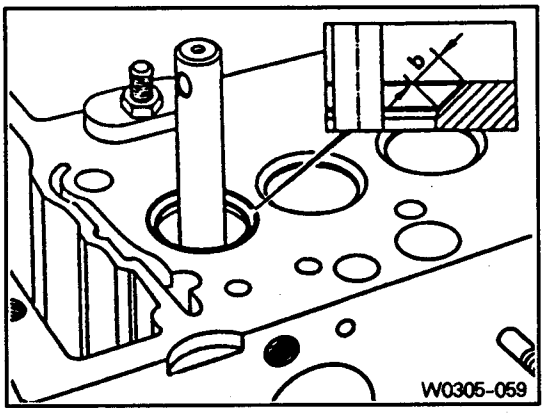
Valve machining is required :
- When the valve is leaking.
- When replacing the valve.
- When replacing the valve guide.
- When replacing the valve seat or valve seat ring.

1) Machine the valve seat (α=45°).

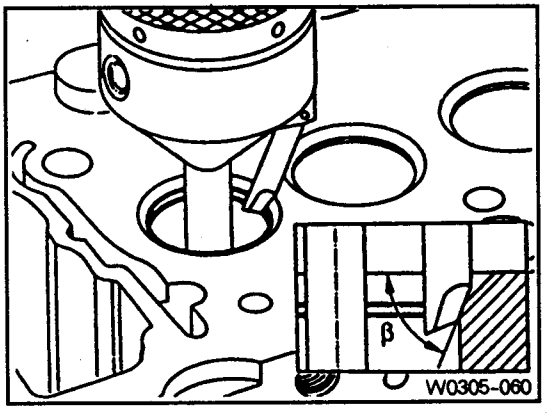


2) Measure valve seat width 'b'.

Valve seat width 'b'	Intake	1.2~1.7mm
	Exhaust	1.5~2.0mm

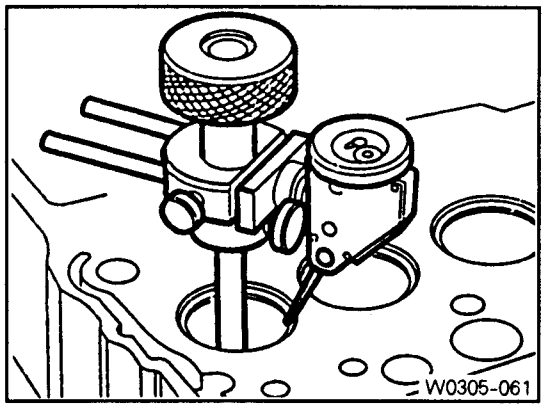


3) If the specification is exceeded, the valve seat width has to be corrected at the lower free angle of β = 65°.



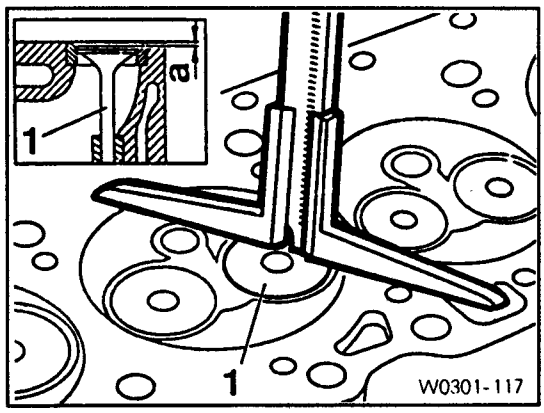
4) Measure radial runout.

Runout	Max. 0.03mm



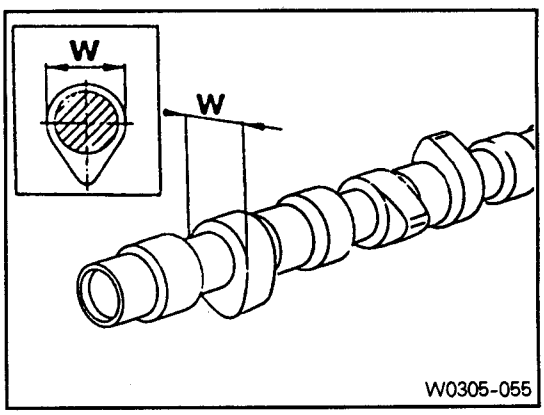
5) Insert the valve (1) into the valve guide according to marking and measure amount by which the valve arrears 'a'.

Arrears 'a'	0.1~0.7mm

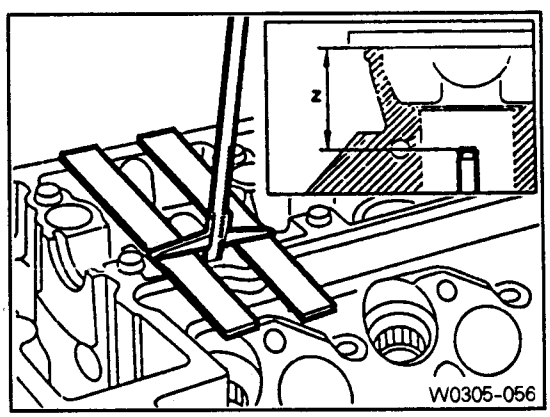


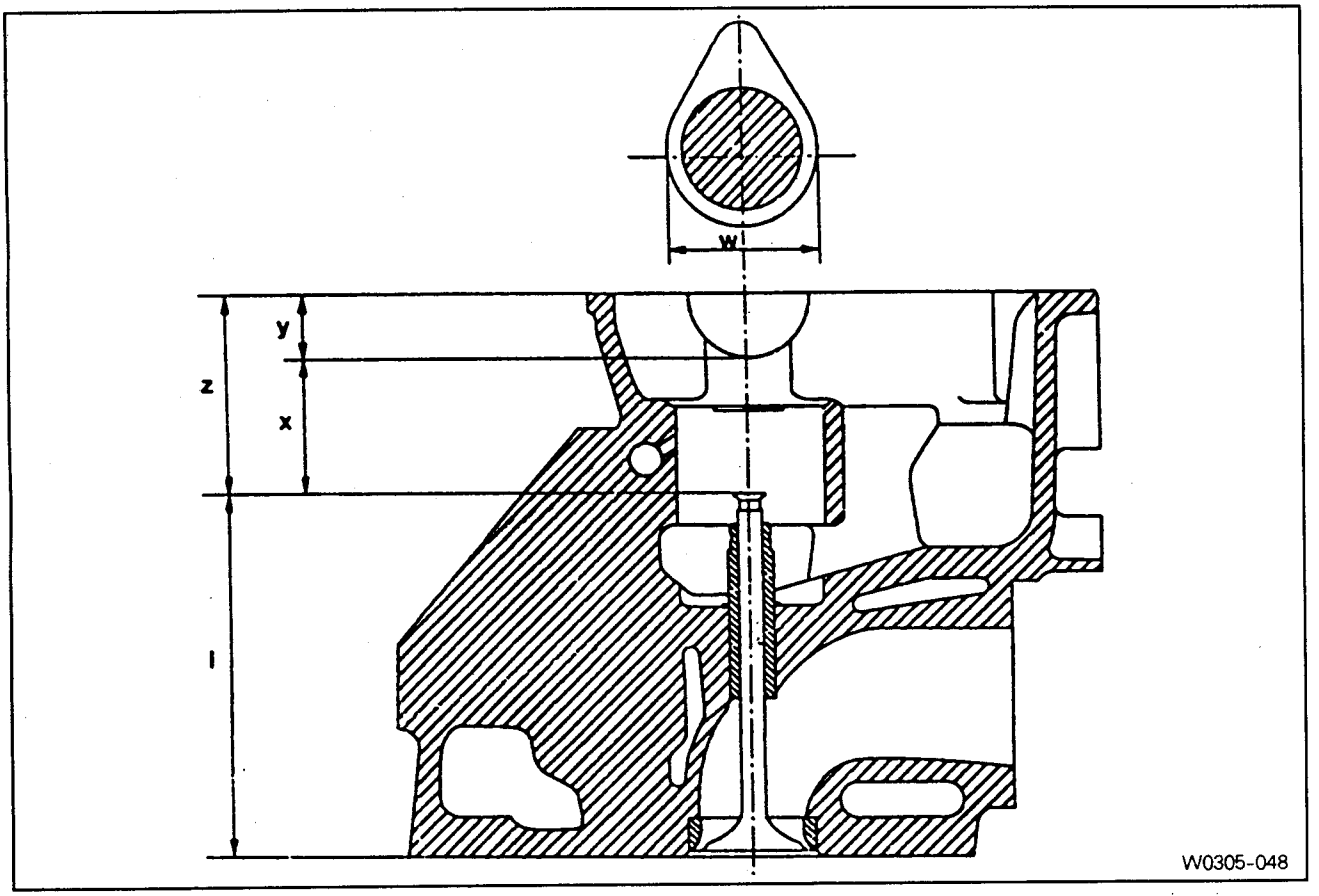
6) Measure camshaft cam basic circle diameter (w).

Diameter 'w'	38 ± 0.2mm or 37.6 ± 0.2mm



7) Measure distance 'z' (cylinder head cover parting surface - valve stem).





l. Length of Valve
w. Camshaft Cam Basic Circle Diameter
x. Distance (Camshaft basic bore - valve stem)
y. Half Camshaft Basic Bore Diameter
z. Distance (Cylinder head cover parting surface - valve stem)

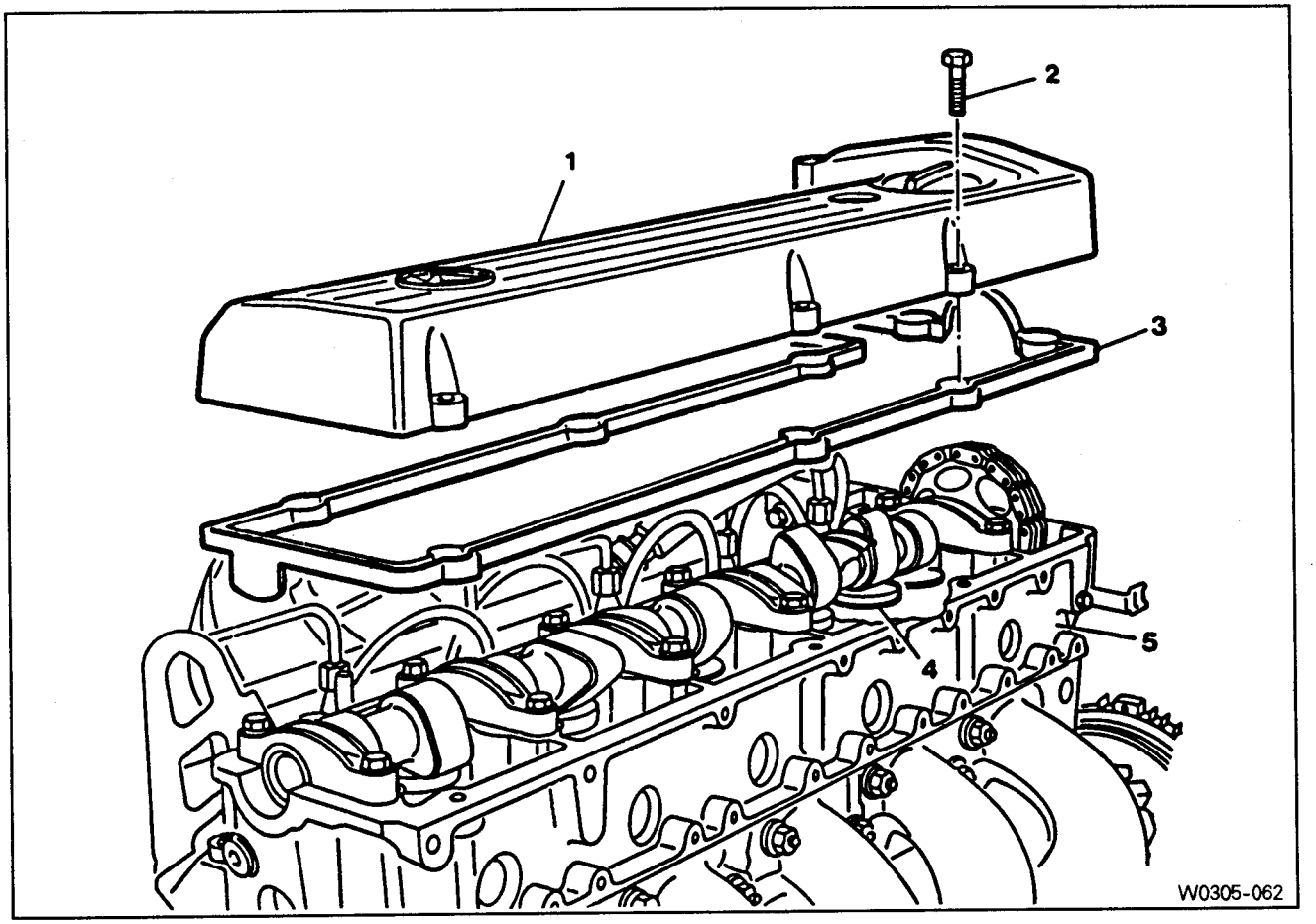
8) Measure 'x' (Camshaft basic bore - valve stem).
'x' = 'z' - 'y'

9) Determine the valve to be used.
(See 'Matching valves')

Example) Measured value 'w' = 38.2mm
Measured value 'z' = 36.5mm
Value 'y' = 15.5mm
'x' = 36.5 - 15.5 = 21.0mm
In the case of a camshaft cam basic circle diameter 'w' = 38.2mm and a distance 'x' = 21.0mm, the installed valve may be used.

10. Camshaft Timing Test

Preceding work : Removal of glow plug



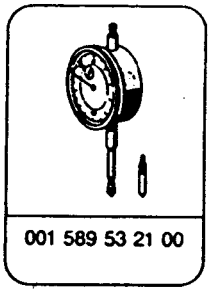
1. Cylinder Head Cover
2. Bolt ---------- 10Nm
3. Gasket ---------- Replace
4. Valve Tappet
5. Cylinder Head

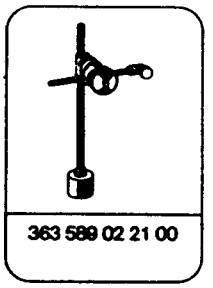
Timing

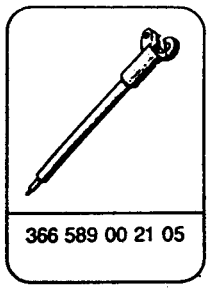
Condition of camshaft	Intake valve		Exhaust valve	
	Open	Close	Open	Close
New	ATDC 11°	ABDC 17°	BBDC 28°	BTDC 15°
After approx. 20,000km	ATDC 12°	ABDC 18°	BBDC 27°	BTDC 14°

* A valve double cycle 2mm

Special tools


001 589 53 21 00

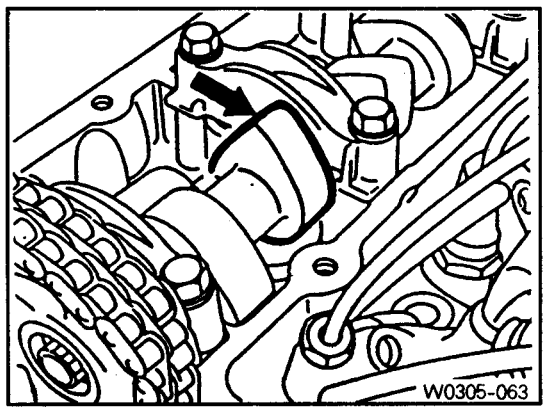

363 589 02 21 00


366 589 00 21 05

Measurement

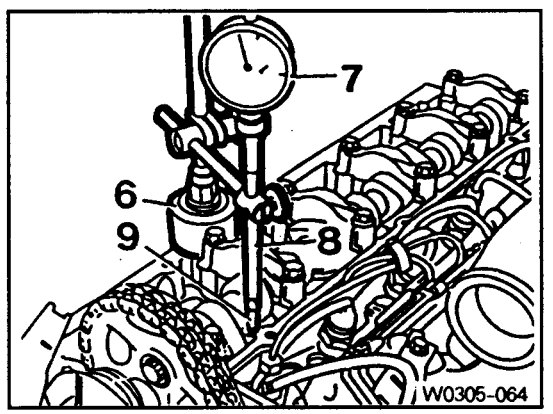
1) Remove the cylinder head cover.

2) Rotate the engine in the direction of engine rotation until the intake valve of no.1 cylinder is completely closed. The cam lobe faces up (arrow).
   [Note] Do not rotate the engine at the bolt of the crankshaft sprocket. Do not rotate the engine in the opposite direction of engine rotation. If do, this will cause serious measuring errors.


W0305-063

3) Install the dial gauge holder and dial gauge (7) with the extension (8) to the cylinder head and position the tracer pin (9) onto the valve tappet (intake valve of cylinder no.1) with a preload of min. 3mm.
   [Note] The tracer pin should be positioned exactly vertical.

Dial gauge holder 363 589 02 21 00
Dial gauge 001 589 53 21 00
Extension 366 589 00 21 05



W0305-064

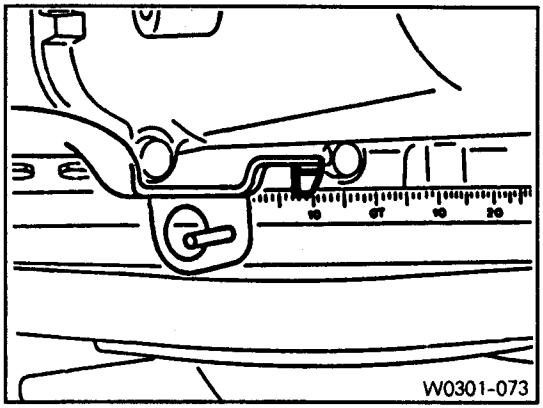
4) Set the dial gauge to '0'.

5) Rotate the engine further in direction of rotation until the dial gauge has moved back by 2mm (valve lift) to 1mm.

Check the timing.

New	ATDC 11°
After approx. 20,000km	ATDC 12°

[Note] If timing is out standard, the camshaft should be checked for wear and the timing chain for stretch. If a difference of more than 4 ° exists, the timing chain should be replaced.

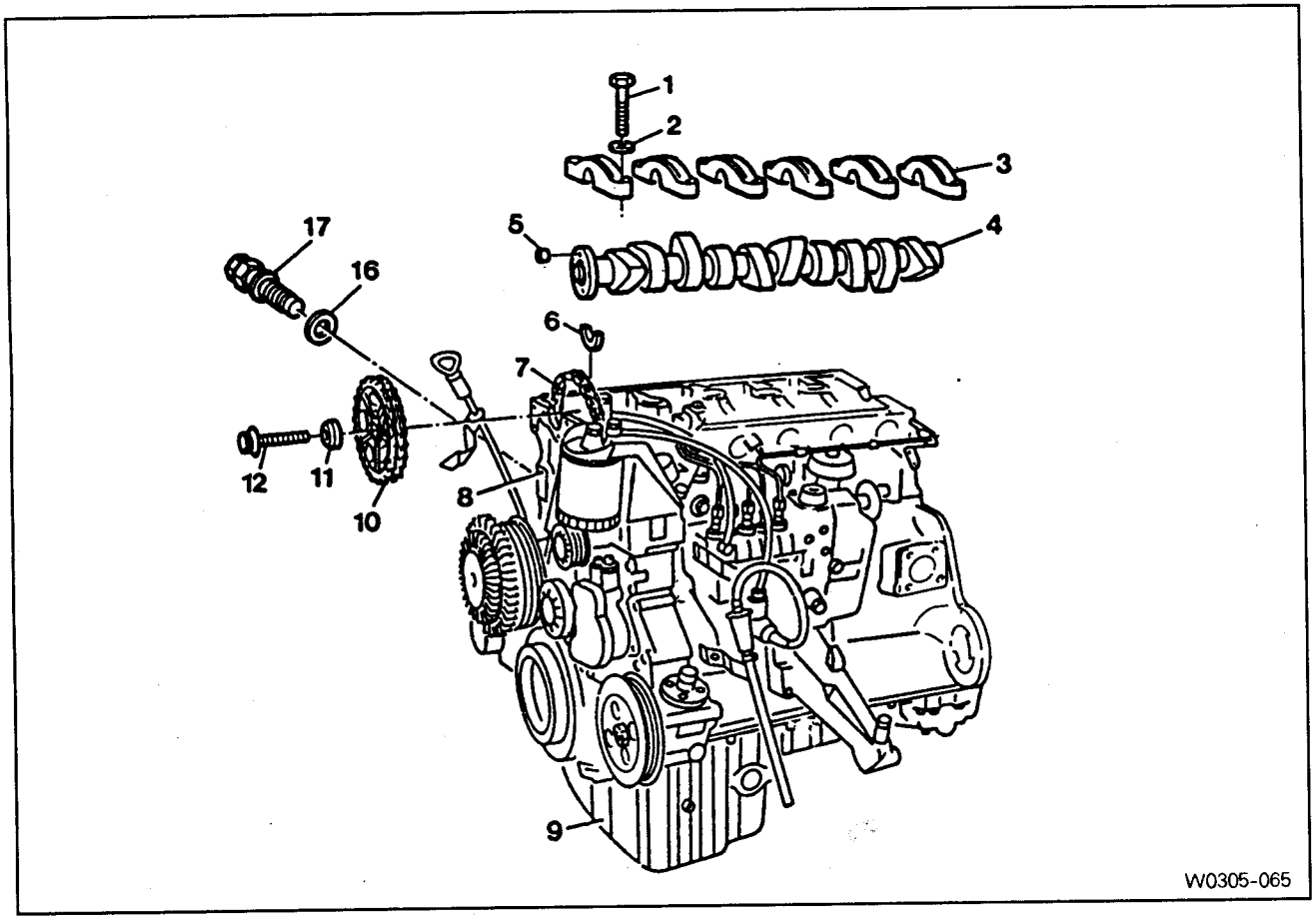


Replace the gasket and install the cylinder head cover.

Tightening torque	10Nm

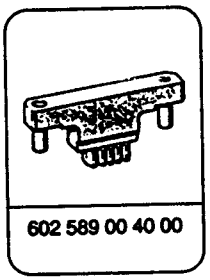
11. Removal and Installation of Camshaft

Preceding work : Removal of cylinder head cover



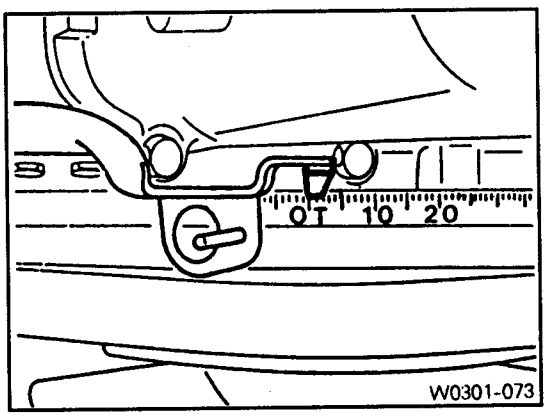
1. Bolt---------- 25Nm
2. Washer
3. Camshaft Bearing Cap
4. Camshaft
5. Dowel Pin
6. Locking Washer
7. Timing Chain
8. Cylinder Head
9. Oil Pan
10. Camshaft Sprocket
11. Washer
12. 12-Sided Bolt (M11)---------- Check, 25Nm + 90°
13. Gasket ---------- Replace
14. Chain Tensioner ---------- 80Nm

Special tool

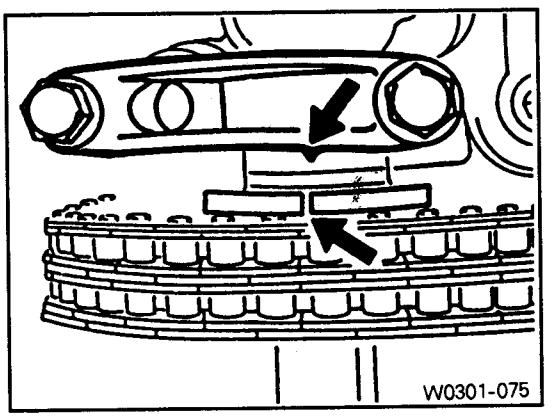


Removal

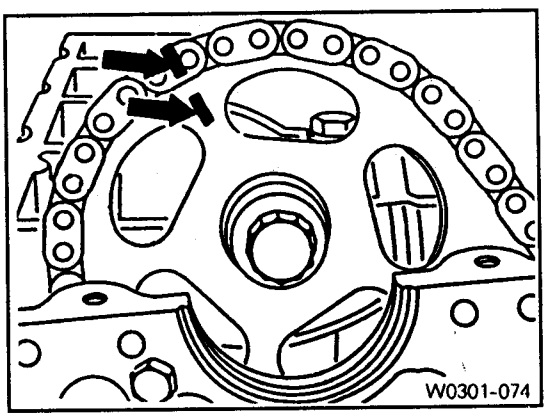
1) Rotate the crankshaft and position the piston of no.1 cylinder at TDC.
   [Note] Do not rotate the crankshaft in the opposite direction of engine rotation.



In this position, the markings of the camshaft/camshaft bearing cap (arrow) must be aligned.

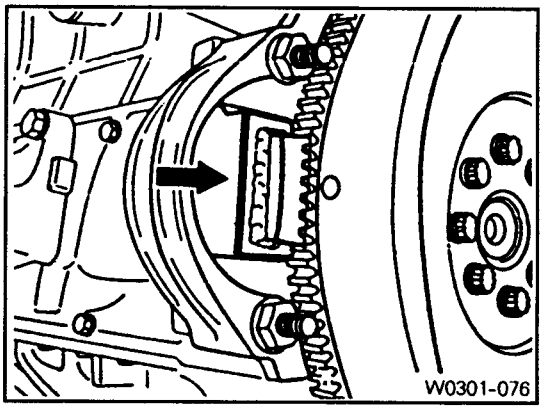


2) Place alignment marks on the camshaft sprocket and timing chain.

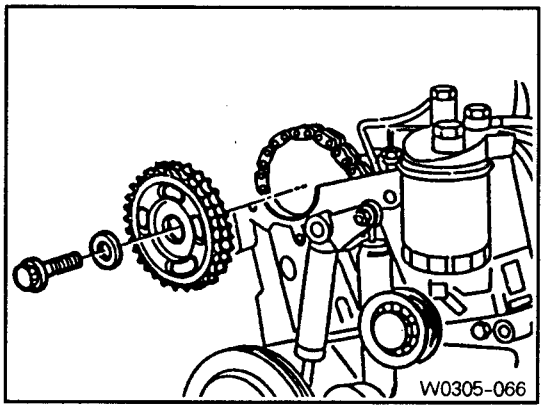


3) Remove the starter motor and install the engine lock.

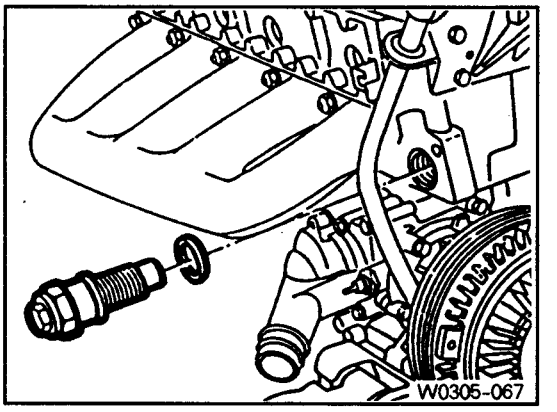
Engine lock 602 589 00 40 00



4) Remove the bolt and then remove the camshaft sprocket.
[Note] During removal, be careful not to drop the sprocket with chain. Remove the chain carefully and then pull out the sprocket.

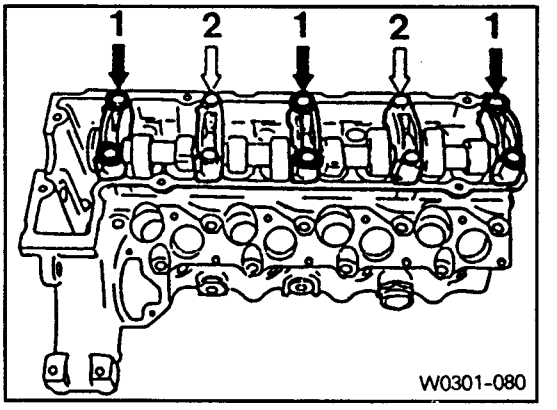


5) Remove the chain tensioner.

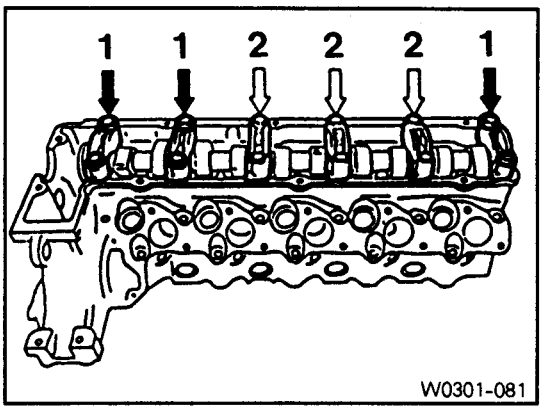


6) Remove the camshaft bearing cap bolts according to the removal order.
[Note] Remove the camshaft bearing cap bolts of 1 (dark arrow) first and then remove the bolts of 2 (light arrow) one revolution in stages until the counter-pressure is released. In order to avoid damaging the camshaft, it is essential to adhere to the removal order for the camshaft bearing caps.

OM 661

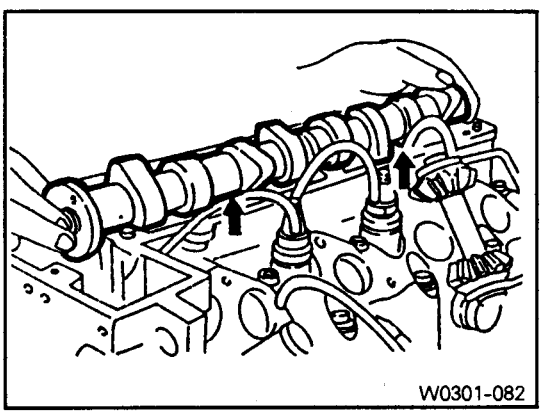


OM 662

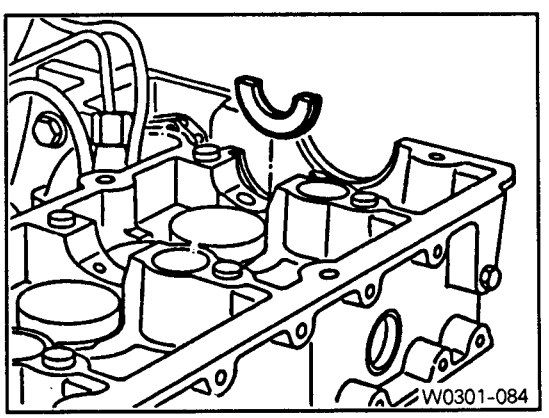


7) Remove the camshaft bearing cap.

8) Pull off the camshaft.
[Note] Be careful not to miss front locking washer.



9) Pull out the locking washer.
[Note] Check the condition of locking washer and replace if necessary.

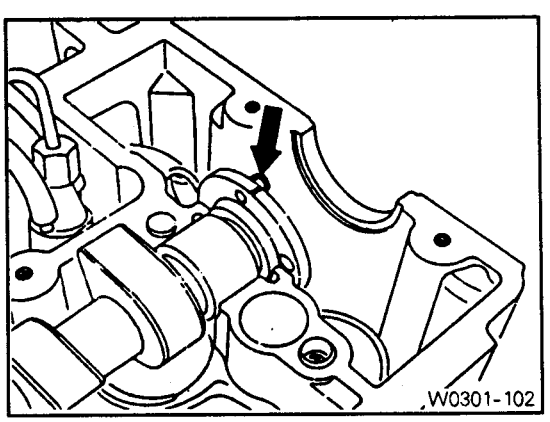


Installation

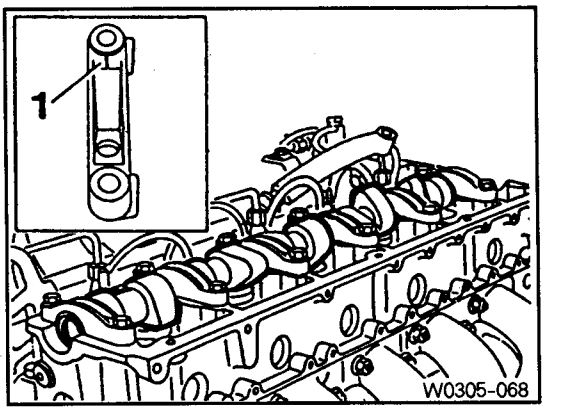
1) Insert the locking washer.

2) Check the valve tappet and ensure that tappet moves smoothly.

3) Coat the camshaft with oil and install the camshaft onto the cylinder head so that the TDC marking (arrow) is positioned upward vertically.



4) Install the camshaft bearing caps according to markings (1, 2, 3 etc.).

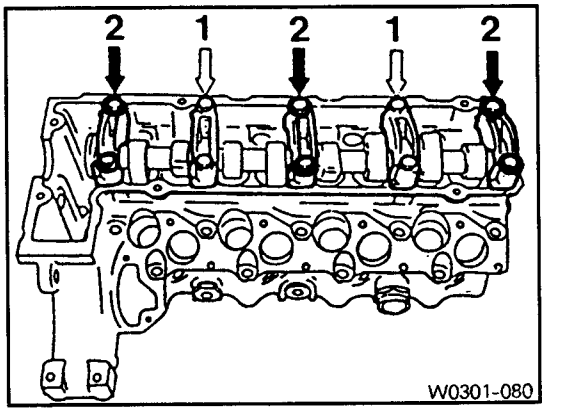


5) Tighten the camshaft bearing cap bolts according to installation order.

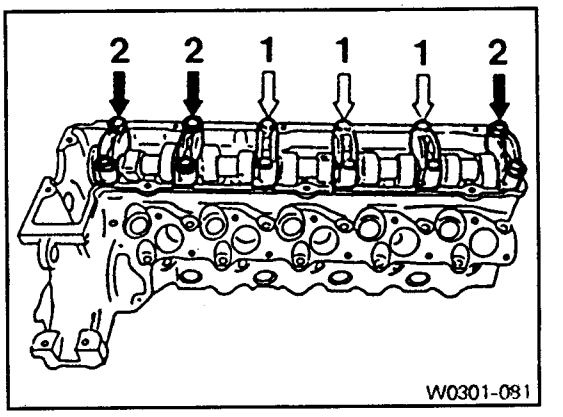
Tightening torque	25Nm

[Note] Tighten the no. 1 bolts (light arrow) by one revolution in stages first and then tighten the no. 2 bolts (dark arrow).

OM 601

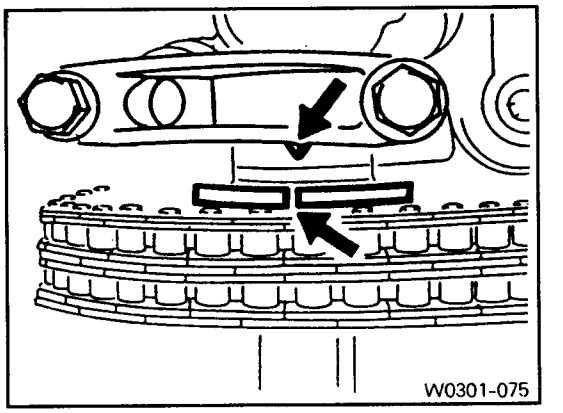


OM 602



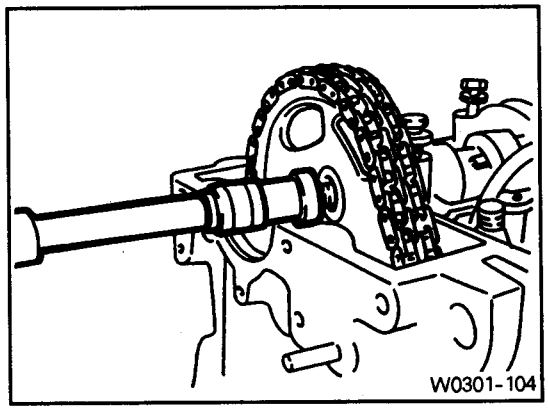
6) Install the camshaft sprocket to be aligned the markings of the camshaft / camshaft bearing cap (arrow).

[Note] Align the alignment marks on the timing chain and sprocket.

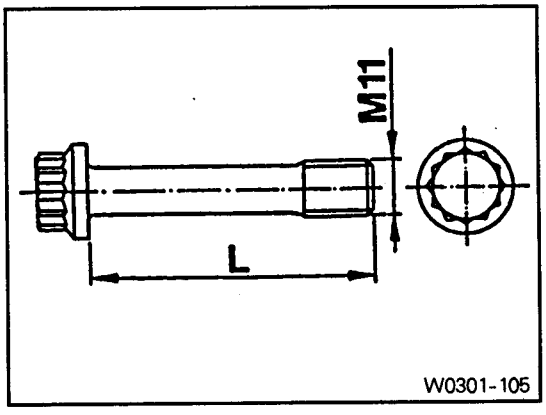


7) Tighten the camshaft sprocket bolt.

Tightening torque	25Nm + 90°



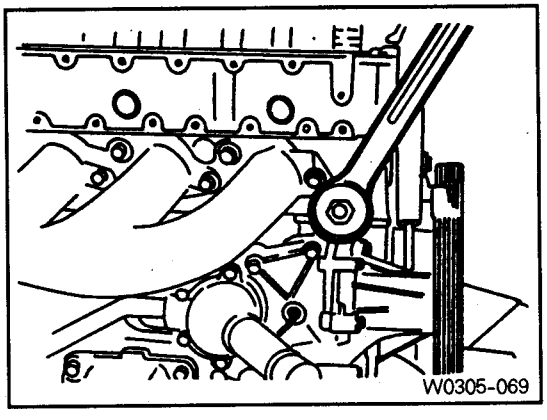
[Note] If max. length 'L' of the 12-sided bolt exceeds 53.6mm, replace it.



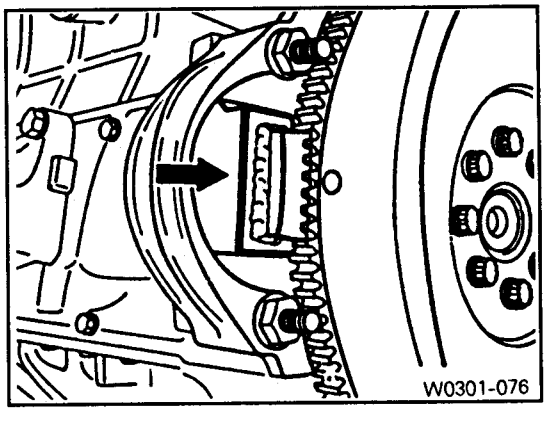
8) Install the chain tensioner.

Tightening torque	80Nm

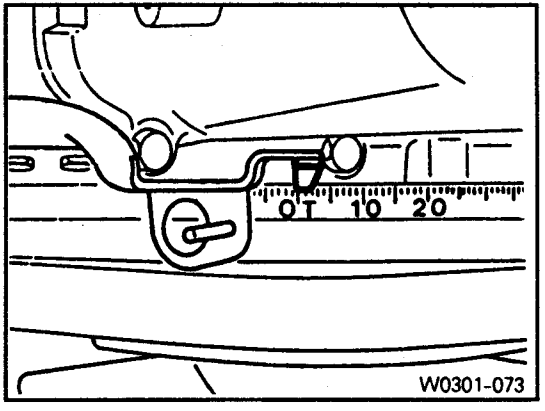
[Note] Replace the seal.
Before installation, by pumping in the oil approx. 10 times, fill the oil.



9) Remove the engine lock.

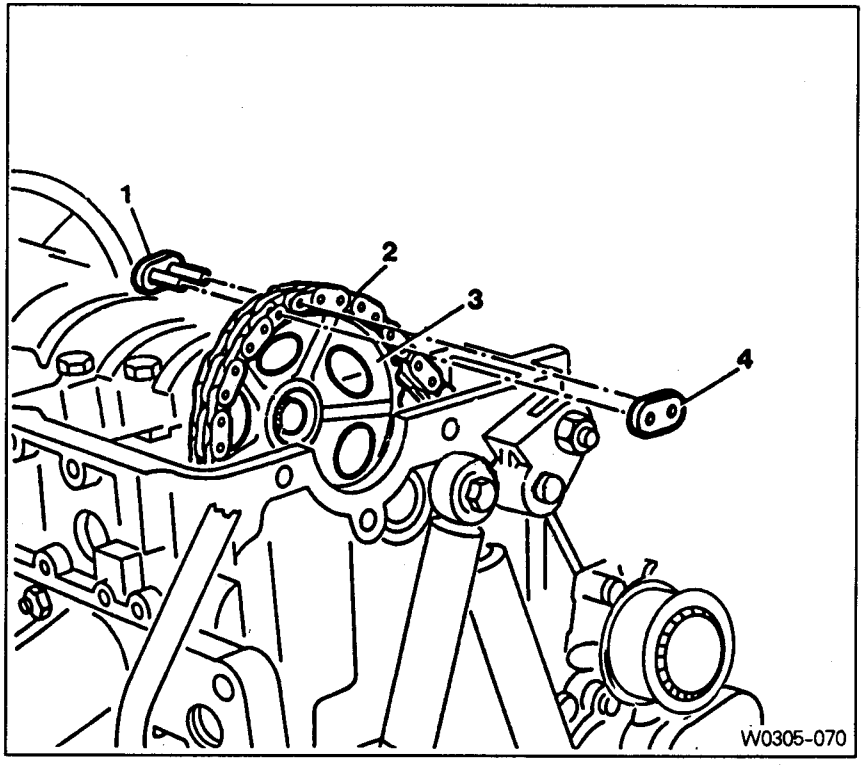


10) Check the TDC marking of OT on the crankshaft.



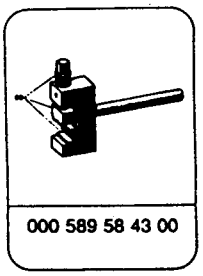
12. Replacement of Timing Chain

Preceding work : Removal of glow plug (15-08)
Removal of chain tensioner (05-54)
Removal of cooling fan
Removal of cylinder head cover



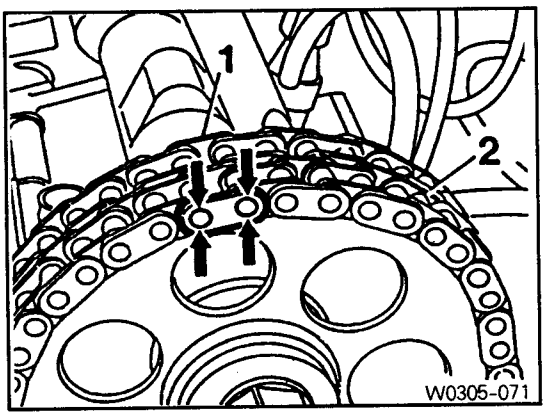
1. Chain Link
2. Timing Chain
3. Camshaft Sprocket
4. Outer Plate

Special tool

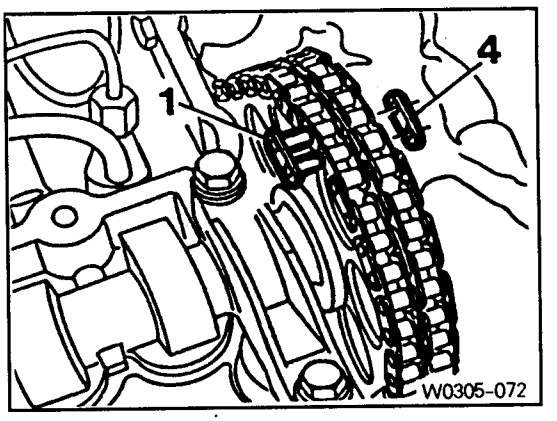


Replacement

1) Cover over the chain box with cleaning rag and grind off both chain pins (arrow) at a chain link (1) of the timing chain.

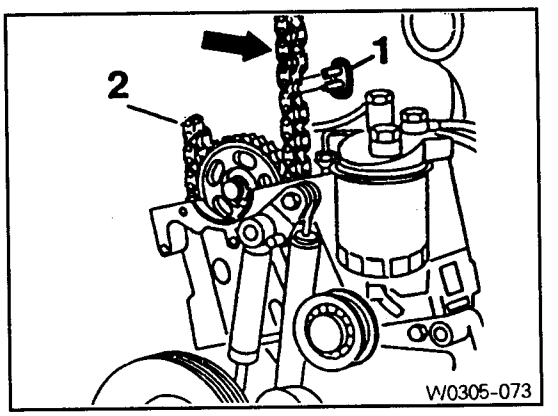


2) Remove the outer plate (4) and chain link (1).
[Note] Ensure that the ends of the timing chain do not drop into the chain box.



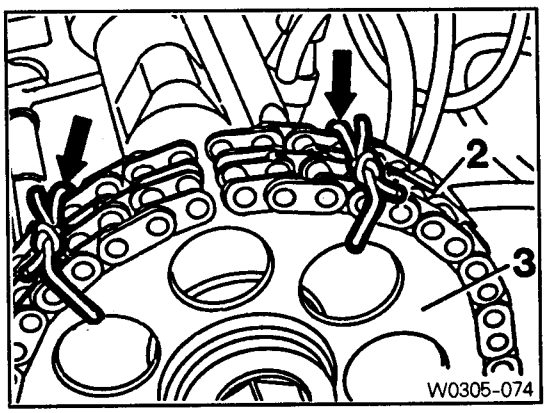
3) Loosen the chain tension with approx. 4 turns.

4) Connect the new timing chain (arrow) with chain link (1) to the old timing chain (2).

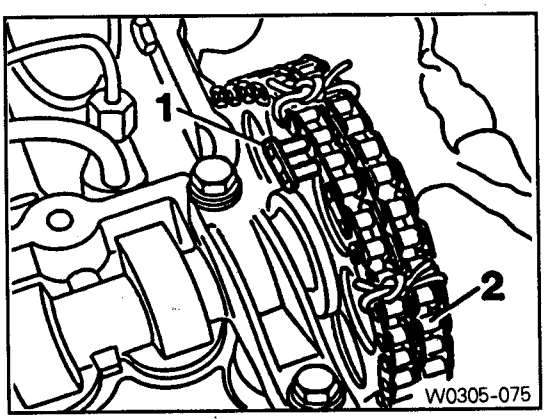


4) By rotating the crankshaft in the direction of engine rotation, pull out the old timing chain with installing the new timing chain.

5) Remove the old timing chain and hold the ends of the new timing chain to camshaft sprocket (3) with wire (arrow).

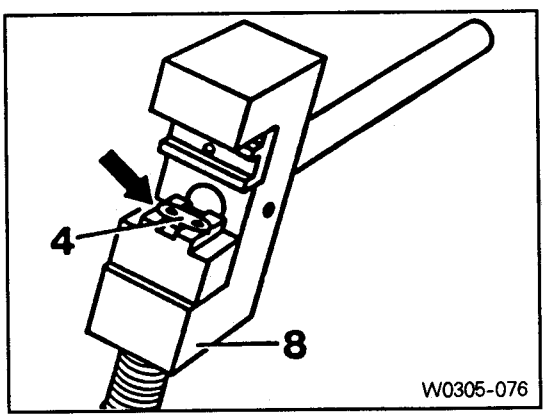


6) Insert the new chain link (1) to connect the chain.

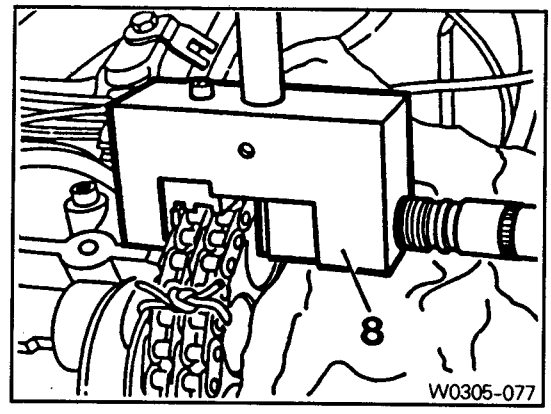


7) Insert the new outer plate (4) into the fitting tool (8) and then the outer plate will be held by a magnet.

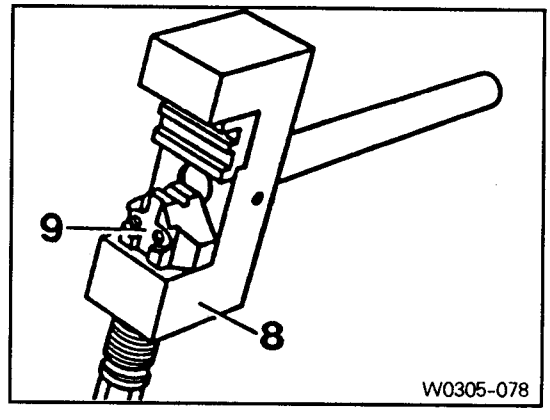
Chain assembling device 000 589 58 43 00



8) Place the fitting tool (8) onto the chain link and press the outer plate on as far as the stop.

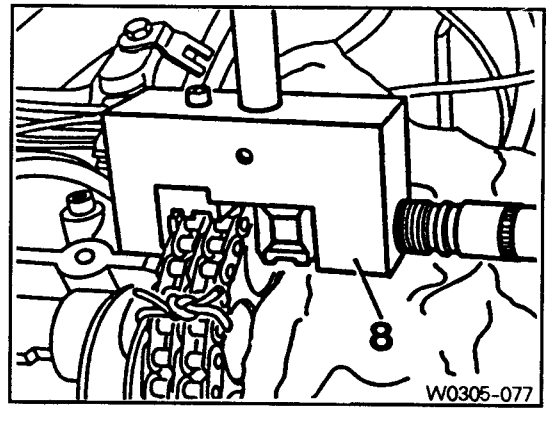


9) Switch over the die (9) of the fitting tool (8).



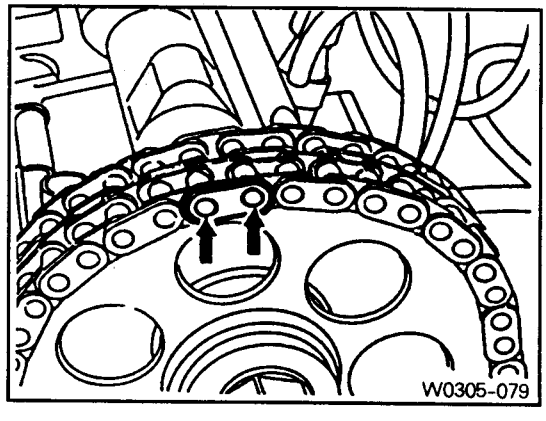
10) Place the fitting tool (8) onto the chain link and rivet the chain pins one by one.

Tightening torque	30~35Nm

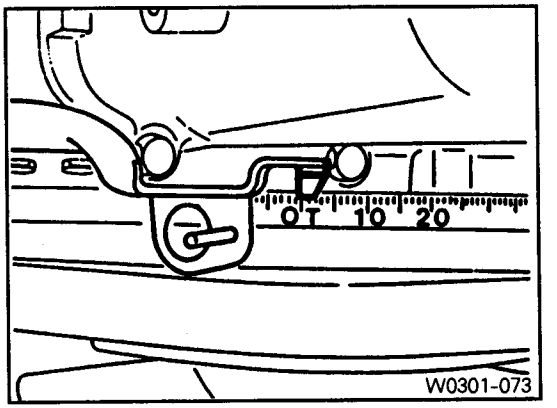


11) Check the riveting of chain pins and re-rivet if necessary.

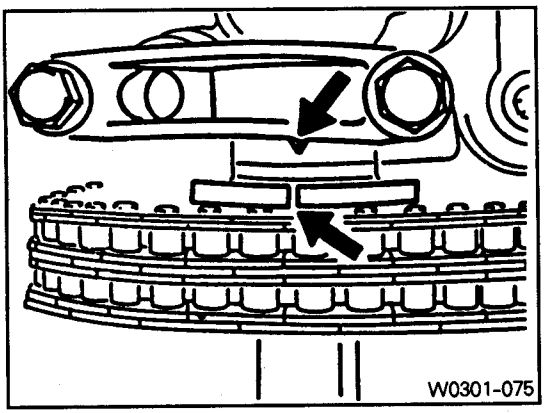
12) Remove the wire.



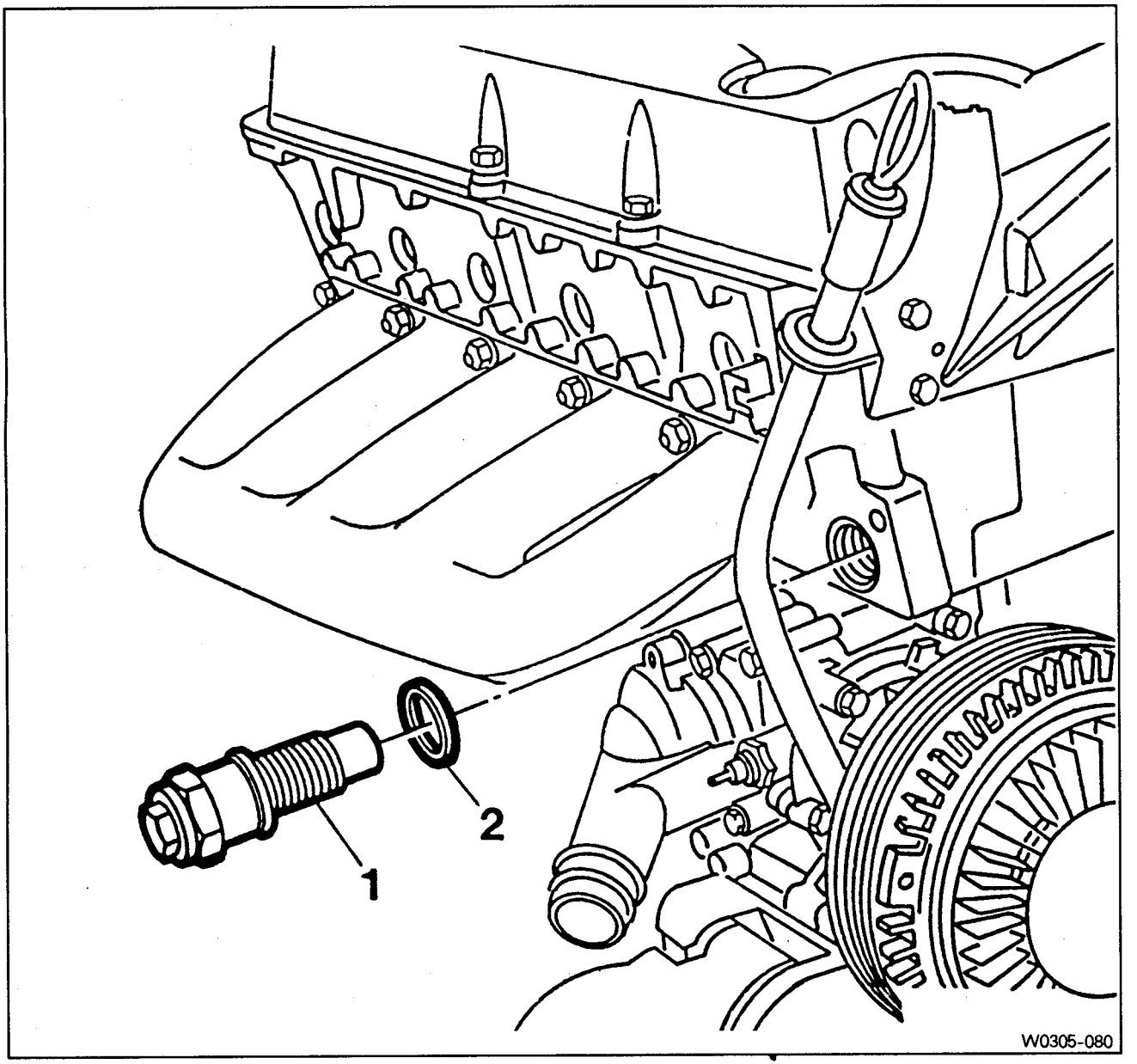
12) Position the no.1 cylinder at TDC.



In this position, the markings on camshaft / camshaft bearing cap (arrow) must also be aligned. If the markings are not aligned, the timing chain must be re-set and the injection pump timing has to be set.



13. Removal and Installation of Chain Tensioner

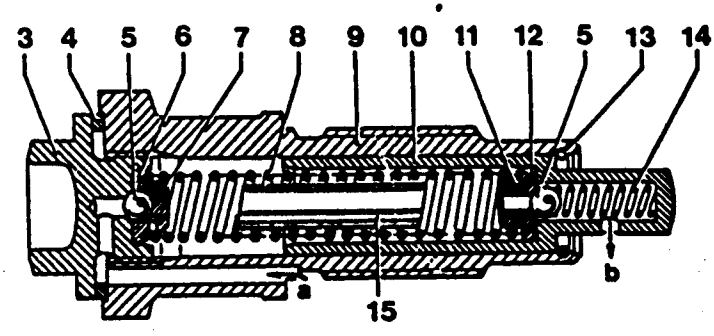


1. Chain Tensioner----------80Nm
2. Seal----------Replace

[Note] Always install the chain tensioner to be filled with oil.

Place the chain tensioner in engine oil up to over the collar on the hexagon head with the thrust pin facing up. Slowly push down the thrust pin as far as the stop 7~10 times with the aid of a press or a column drill.

Faulty chain tensioners should be replaced completely.



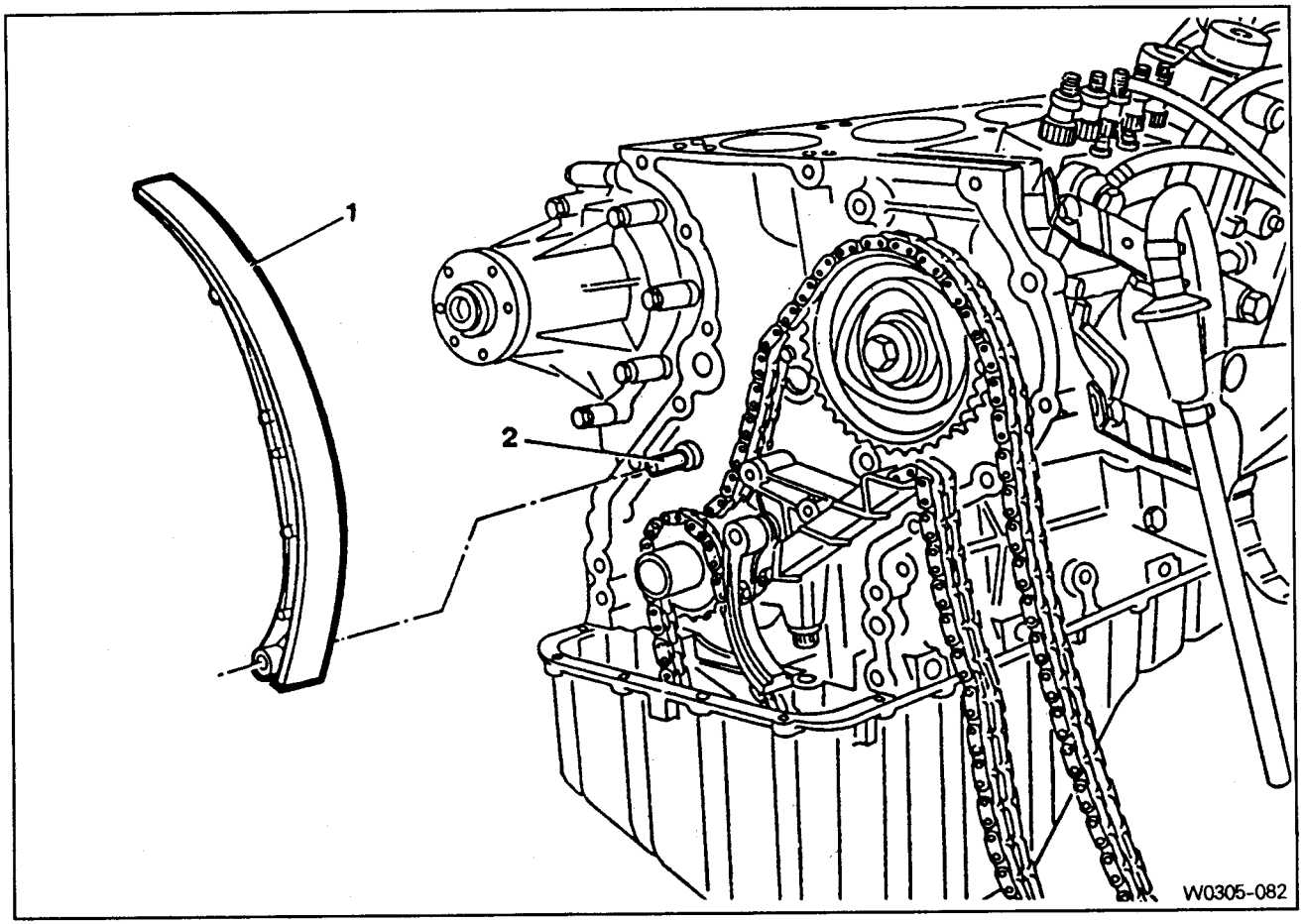
W0305-081

3. Screw Plug
4. Aluminum Gasket
5. Ball
6. Ball Guide
7. Compression Spring
8. Compression Spring
9. Housing
10. Thrust Pin
11. Valve Disc
12. O-Ring
13. Snap Ring
14. Compression Spring
15. Filler

A. Feed Bore from Cylinder Head
B. To Oil Pan

14. Removal and Installation of Tensioning Rail

Preceding work : Removal of cylinder head (01-20)
Removal of timing case cover (01-51)

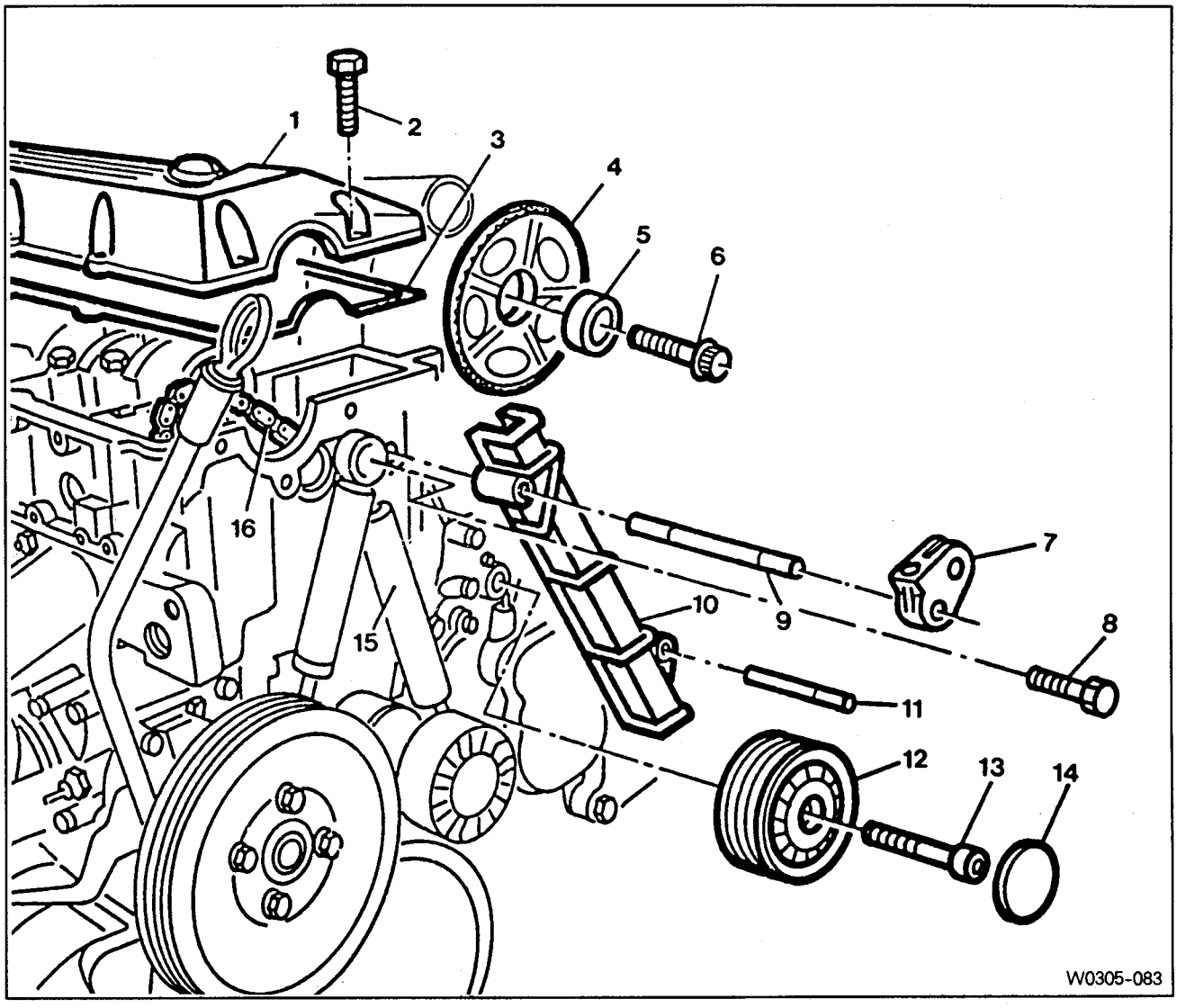


1. Tensioning Rail
2. Bearing Pin

[Note] The plastic coating of the tensioning rail can not be replaced.

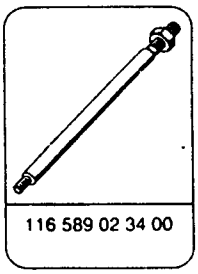
15. Removal and Installation of Cylinder Head Guide Rail

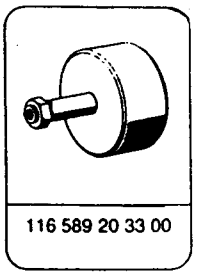
Preceding work : Removal of the cooling fan
Removal of poly V-belt (13-04)
Removal of chain tensioner (05-54)



1. Cylinder Head Cover
2. Bolt ---------- 10Nm
3. Gasket ---------- Replace
4. Camshaft Sprocket
5. Washer
6. 12-Sided Bolt (M11) ---------- Inspect, 25Nm + 90°
7. Tensioning Lever
8. Bolt ---------- 23Nm
9. Bearing Pin ----------Sealing Compound
10. Guide Rail
11. Bearing Pin----------Sealing Compound
12. Guide Pulley
13. Socket Bolt----------23Nm
14. Closing Cover
15. Spring
16. Timing Chain

Special tools

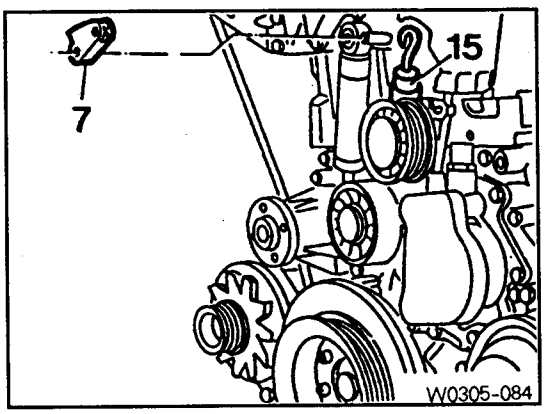




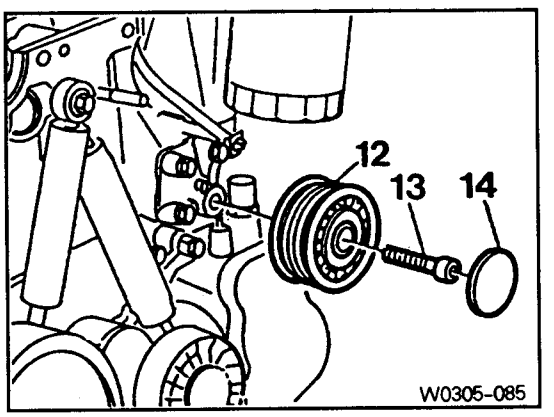
Removal

1) Remove the cylinder head cover.

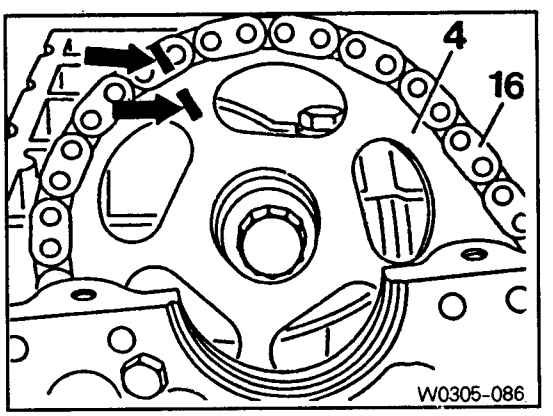
2) Pull off the tensioning lever (7) and remove from the spring (15).



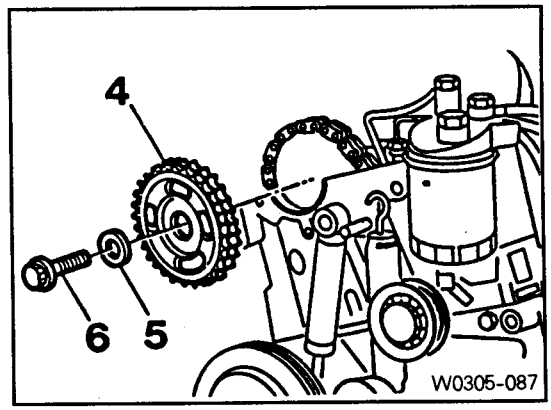
3) Pry off the closing cover (14) and remove the bolt (13) and then remove the guide pulley (12).



4) Place alignment marks (arrow) on the timing chain (16) and camshaft sprocket (4).

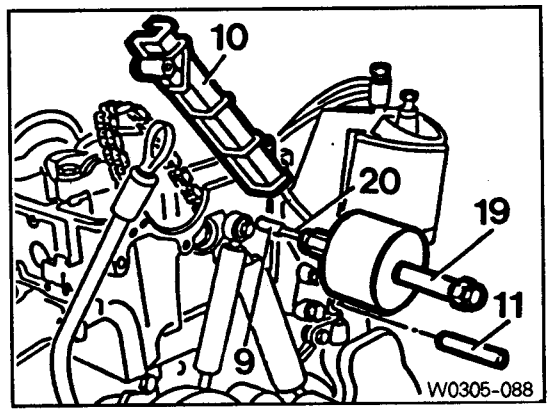


5) Remove the camshaft sprocket.



6) Pull out the bearing pins (9, 11) with sliding hammer and remove the guide rail 10.

Sliding hammer 116 589 20 33 00
Threaded pin 116 589 02 34 00



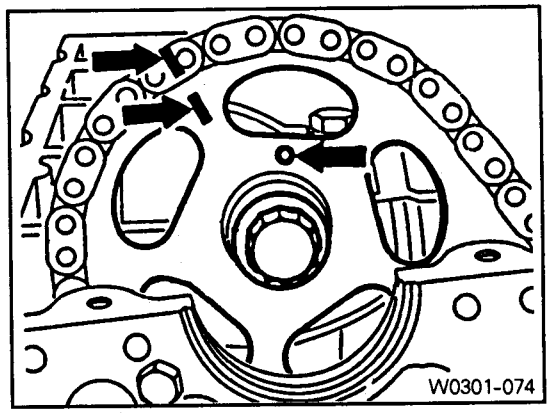
Installation

1) Apply collar of both bearing pins with sealing compound.

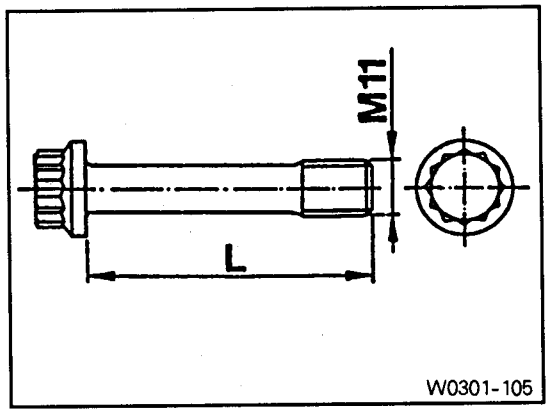
2) Position the guide rail and insert the bearing pins.

3) Install the camshaft sprocket.

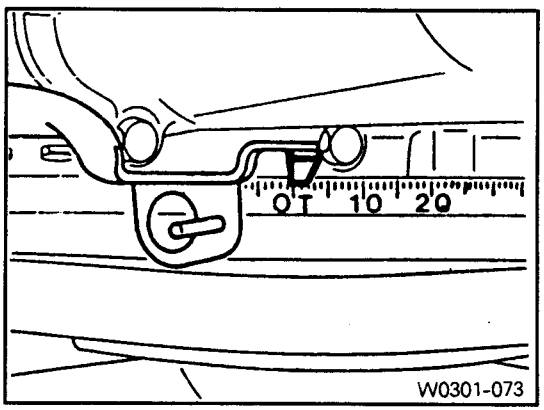
Tightening torque	25Nm + 90°



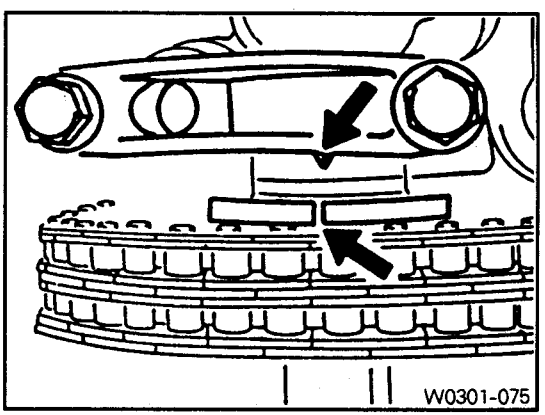
[Note] If the max. length 'L' of the 12-sided bolt exceeds 53.6mm, replace it.



4) Position the no.1 cylinder at the TDC of OT.



In this position, the marking on the camshaft / camshaft bearing cap (arrow) must also be aligned.



5) Install the guide pulley (12).

Tightening torque	23Nm

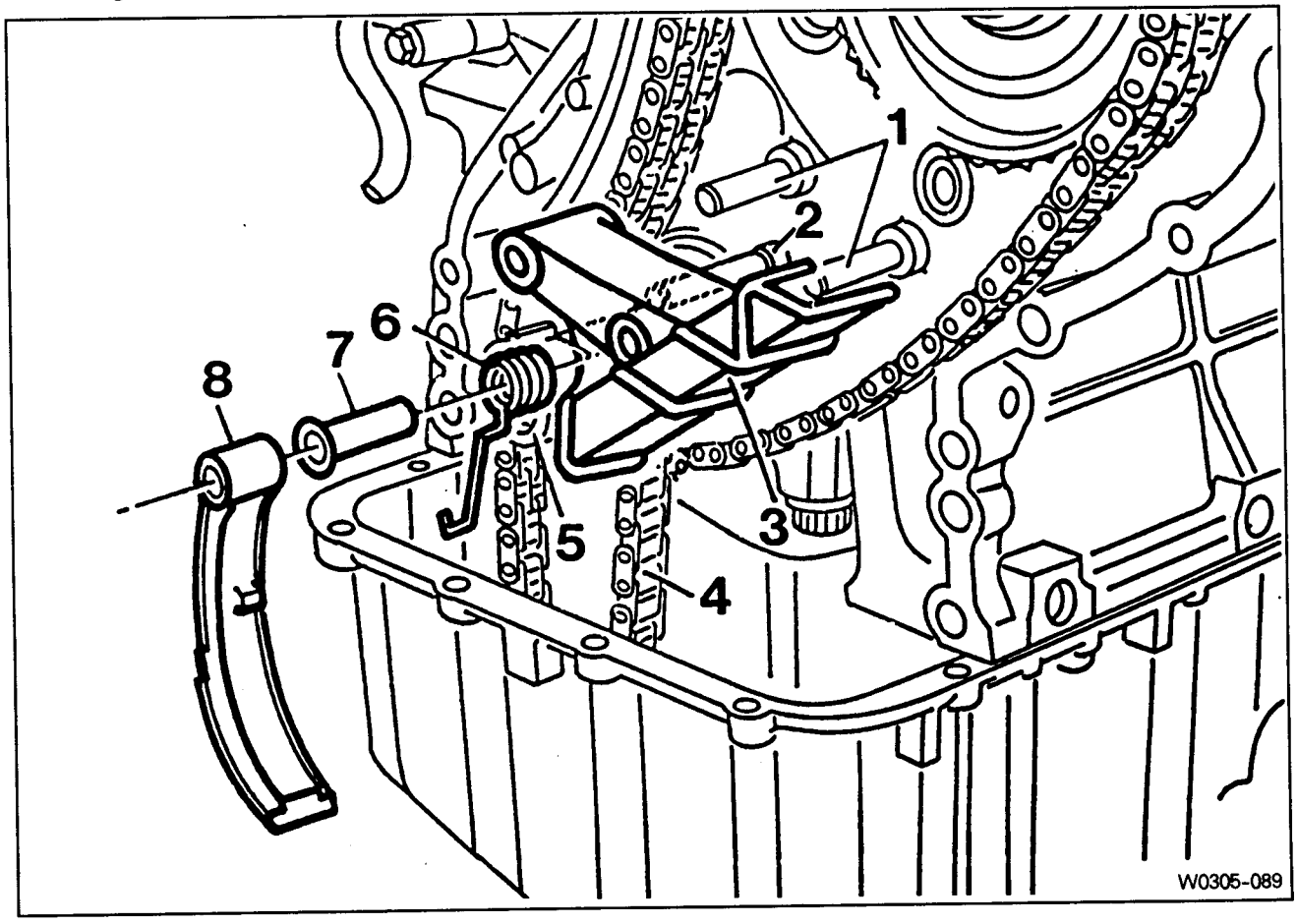
6) Attach the tensioning lever (7) to the spring (15) and install.

7) Replace the gasket and install the cylinder head cover.

Tightening torque	10Nm

16. Removal and Installation of Timing Case Cover Guide Rail

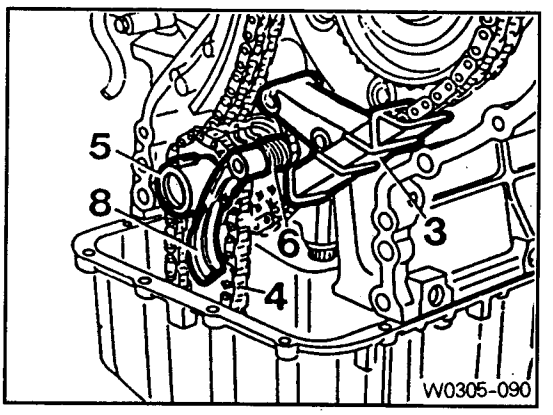
Preceding work : Removal of cylinder head cover



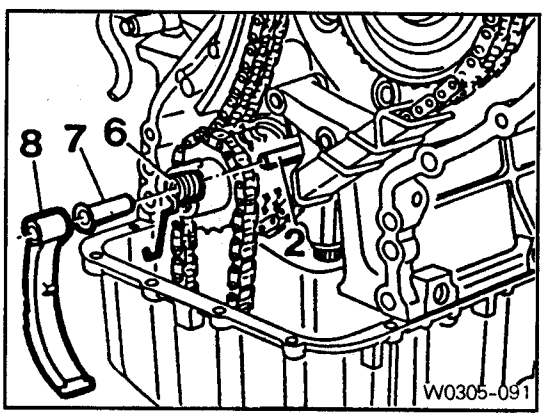
1. Bearing Pin
2. Bearing Pin
3. Guide Rail
4. Oil Pump Chain
5. Crankshaft
6. Spring
7. Bushing
8. Tensioning Lever

Removal

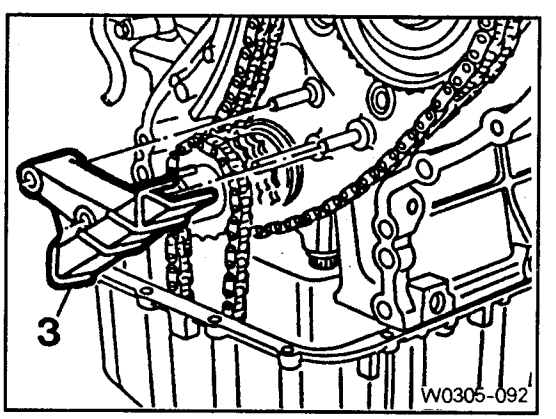
1) Pull out the tensioning lever (8) together with the spring (6) and guide rail (3) far enough until the tensioning lever has moved passed the oil pump chain (4) and is resting against the crankshaft (5)



2) Pull the tensioning lever (8) off the bearing pin (2) and carefully remove the spring (6). Remove the tensioning lever (8) together with the spring (6) and bushing (7).



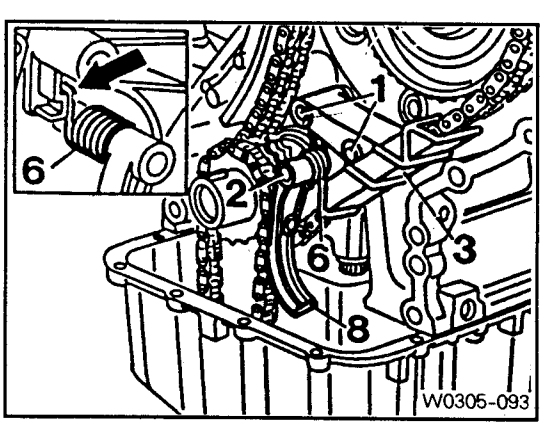
3) Remove the guide rail (3).



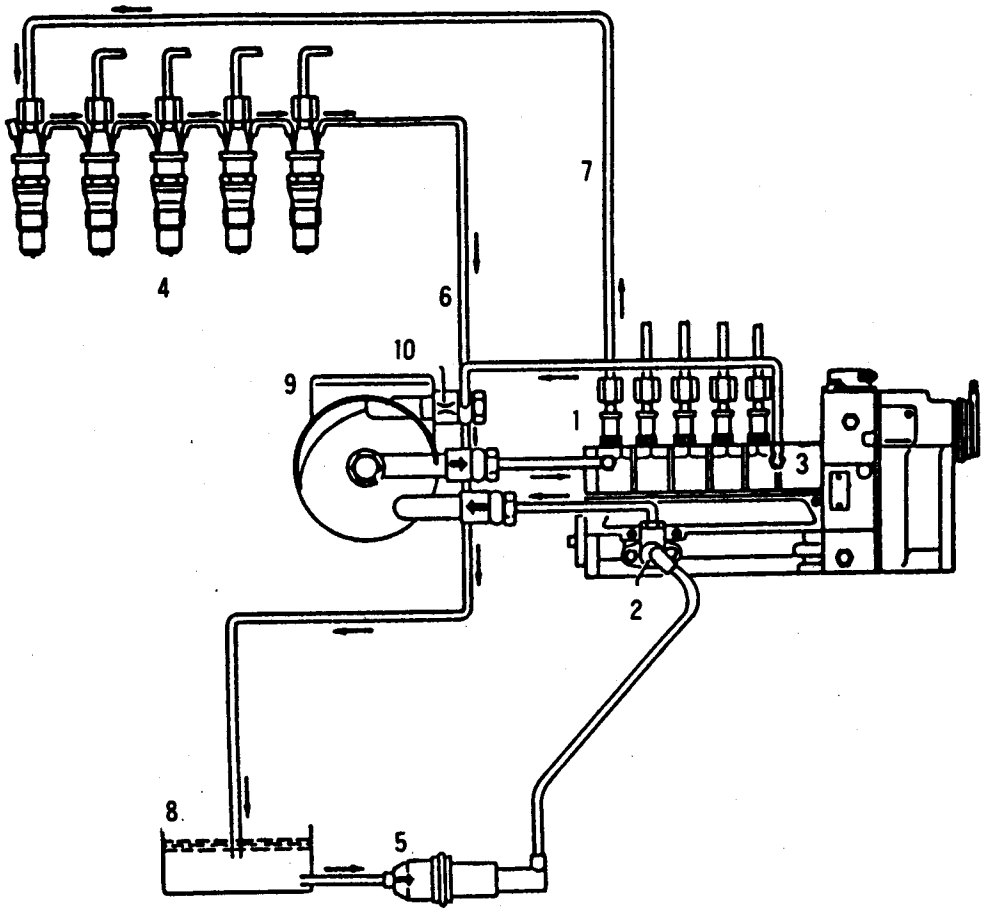
Installation

1) Install the guide rail (3). Attach the spring (6) to the guide rail and to the tensioning lever (8).
   [Note] Ensure that the spring is correctly located in the guide rail (arrow).

2) Push the guide rail, spring, bushing and tensioning lever together onto the bearing pin (1, 2).



1. Fuel System



1. Fuel Injection Pump
2. Fuel Feed Pump
3. Overflow Valve
4. Injection Nozzle
5. Pre-filter
6. Fuel Return Hose
7. Injection Line
8. Fuel Tank
9. Fuel Filter
10. Choke Orifice

2. Fuel Injection Pump Coding

Model code

OM661 Engine	PES 4M 55C 320 RS 167
OM662 Engine	PES 5M 55C 320 RS 168

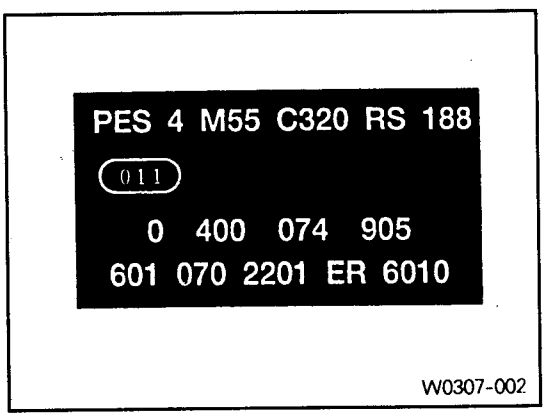
Fuel injection pump code

Example) PES 5M 55C 320 RS 168

P	Pump
E	Self-driven
S	End flange mounting
5	Number of cylinders (5 EA)
M	Pump size
55	Element diameter
C	Modification letter
320	Assembly number
R	Direction of rotation (clockwise)
S168	Special version

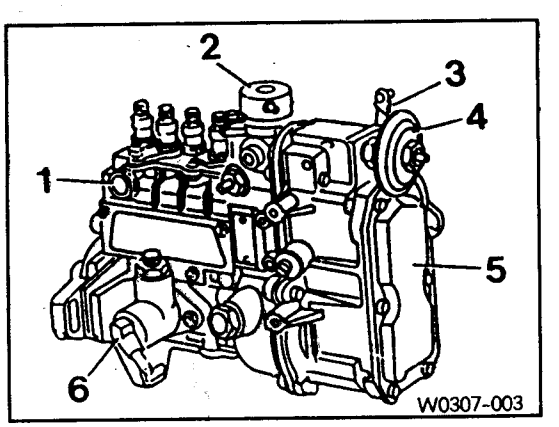
RSF Governor

R	Governor
S	Coil spring
F	Drive governor

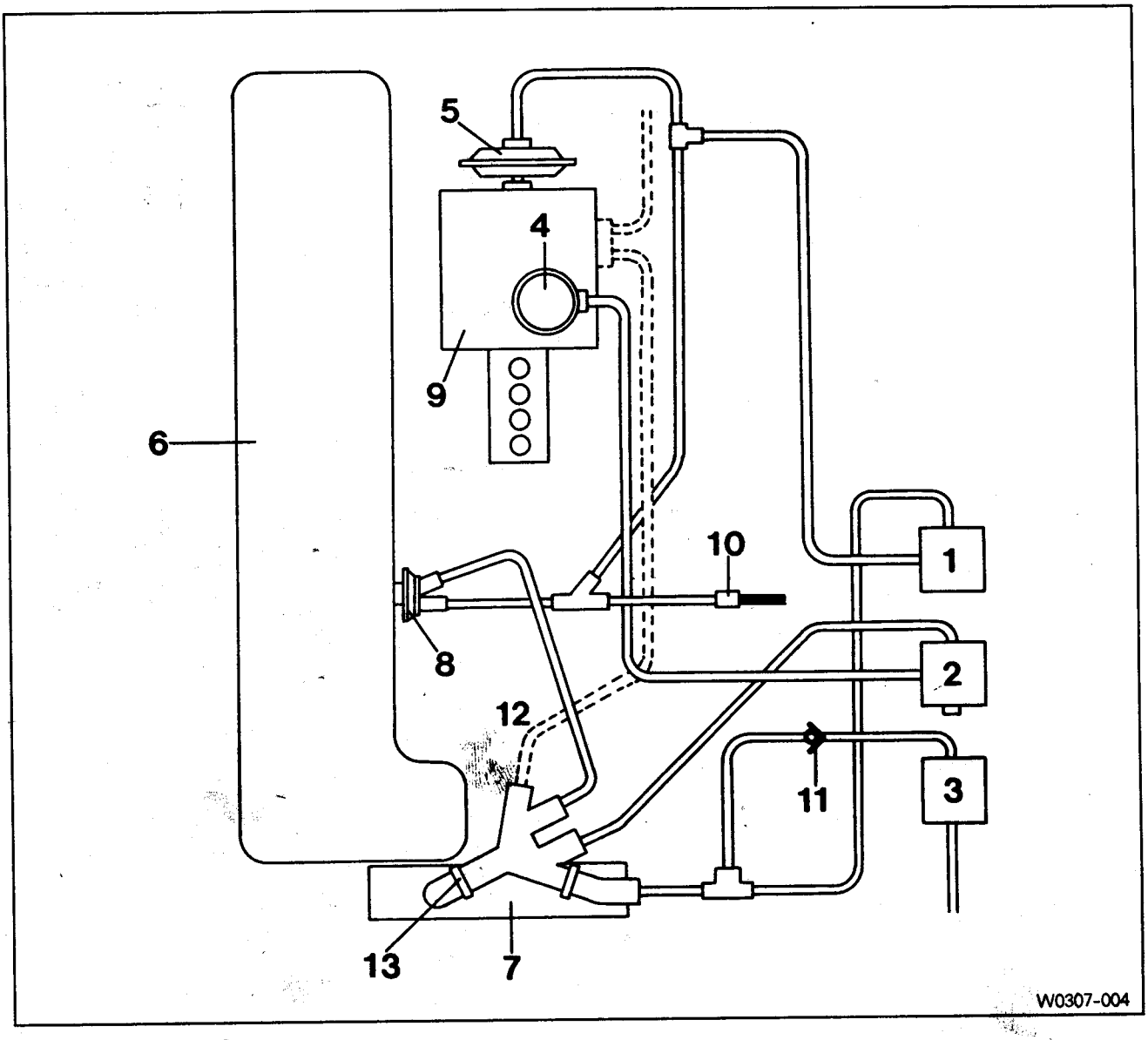


Component location

1. Fuel Injection Pump
2. Vacuum Unit (Stop Unit)
3. Control Lever
4. PLA Vacuum Unit (Idle Speed Adjustment)
5. Governor
6. Fuel Pump



3. Vacuum Control System Test

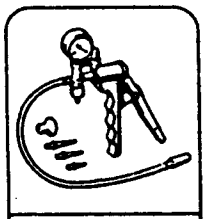


1. Air-conditioner Solenoid Valve (Idle Speed Increase)
2. Engine Cut-Off Valve (Ignition Key Switch)
3. Auto-locking Hub Solenoid Valve
4. Engine Stop Vacuum Unit
5. PLA Vacuum Unit (Idle Speed Adjustment)
6. Engine
7. Vacuum Pump
8. 30℃ Thermovalve
9. Fuel Injection Pump
10. Filter with Restriction
11. Check Valve
12. Modulating Pressure Line (Automatic T/M)
13. Air Admission Filter
14. Brake Booster
15. Check Valve

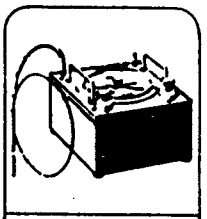
Test data

Idle speed increase	At least 100 rpm at approx. 500 mbar
Permissible pressure drop of system	400~500mbar approx. 1 min.

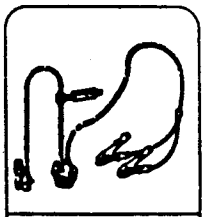
Special tools



001 589 73 21 00
00



201 589 13 21 00
00 42 80

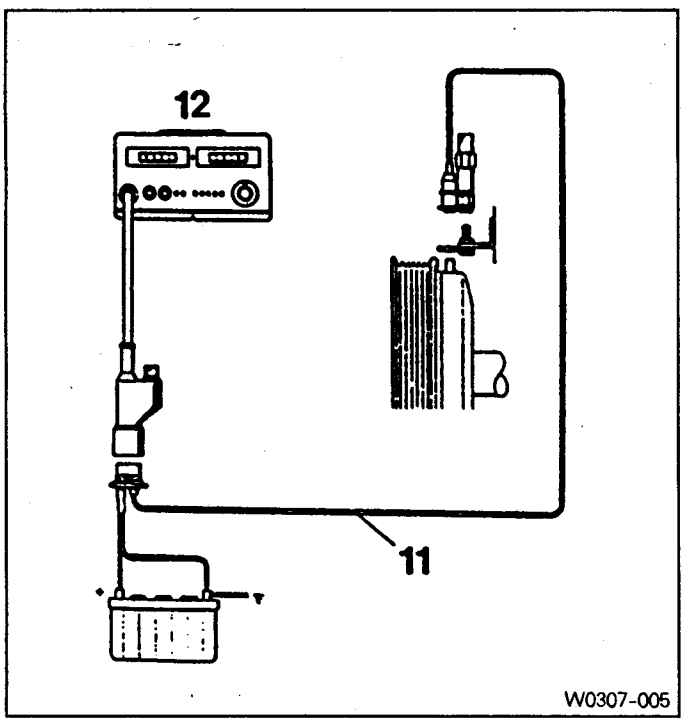


667 589 00 21 00
07

Commercial tools

Digital tester	e.g. Bosch MOT 001.03 Sun DIT 9000
Temperature measuring instrument with test probe WB24	e.g. Ahlborn, Therm 2263-2 Eichenfeldstra β e 1 - 3 D-8150 Holzkirchen

Tester connection



11. TDC Pulse Sender Unit
12. Digital Tester

Test step 1

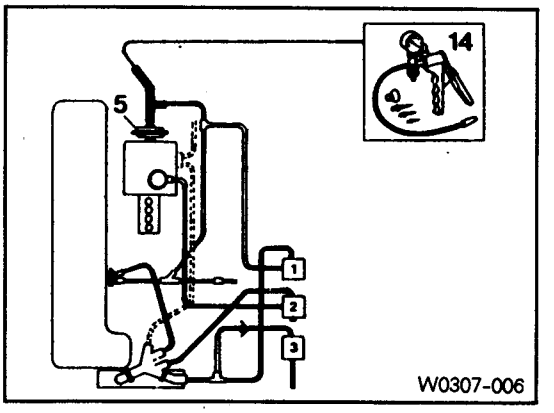
Connect vacuum pump (14) with Y adapter to PLA vacuum unit (5). Run engine at idle speed.

Vacuum ≥ 500 mbar

YES

NO

Lines and connections leaking.
Faulty PLA vacuum unit.



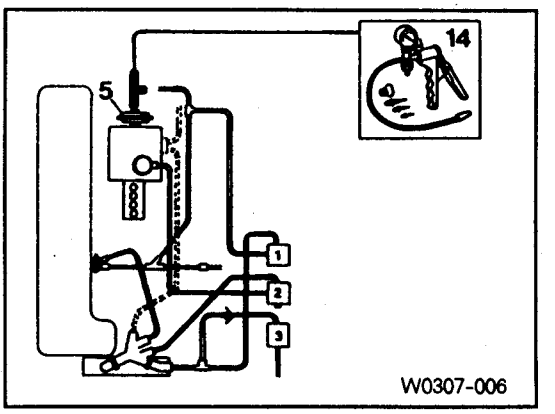
Connect vacuum pump (14) direct to PLA vacuum unit (5) and pressurize with vacuum.

Vacuum is built up and idle speed increases approx. 150~200 rpm.

YES

NO

Faulty PLA vacuum unit.



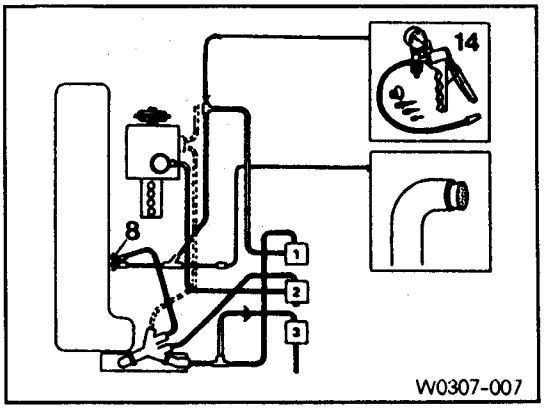
Stop the engine. Seal the air admission line with plug (arrow). Connect the vacuum pump to line to thermovalve and pressurize the line with vacuum.

Vacuum is built up.

YES

NO

Lines and connectors leaking.
Faulty thermovalve.



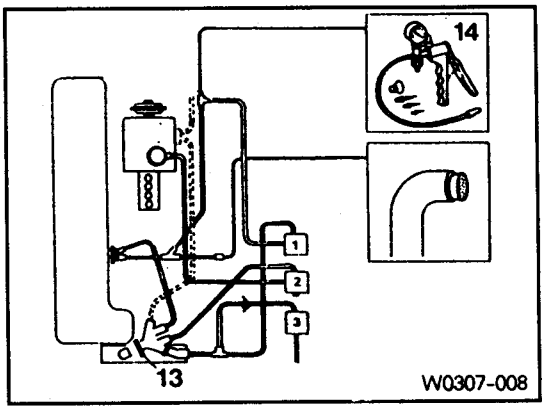
Detach line downstream of air admission filter (13).

Vacuum drops.

YES

NO

Faulty thermovalve



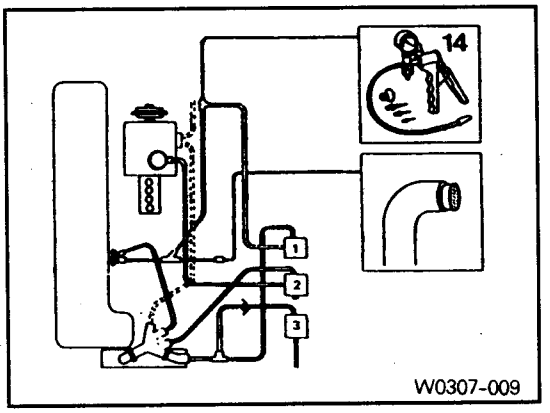
Fit the line onto air admission filter. Built up vacuum with vacuum pump. Detach the plug from air admission line.

Vacuum drops.

YES

NO

Faulty filter with restriction.



Continue with test step 2.

Test step 2

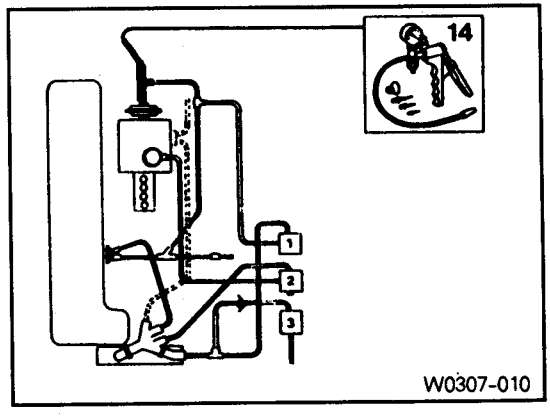
Connect vacuum pump (14) with Y adapter to PLA vacuum unit (5). Run the engine at idle speed.

Vacuum drops to '0' at approx. 30℃ of the thermovalve.

YES

NO

Faulty thermovalve.
Defective filter with restriction.



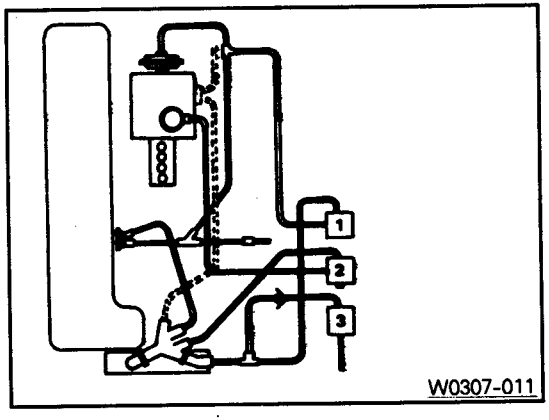
Stop the engine. Detach the filter with restriction.

Filter with restriction is clear.

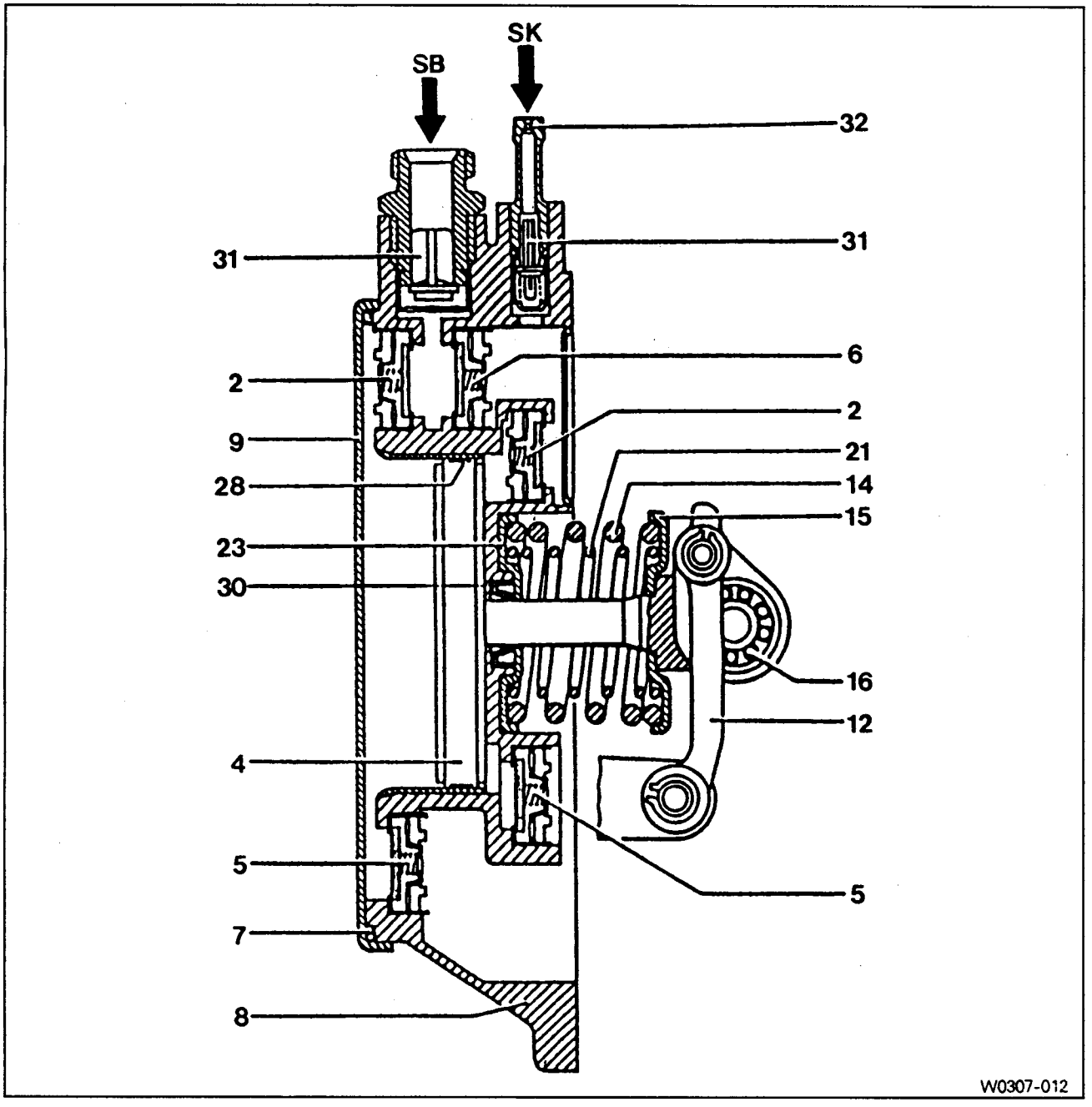
YES

NO

Defective filter with restriction.



4. Vacuum Pump (Sectional View)



2. Suction Valve
4. Piston
5. Pressure Valve
6. Safety Valve
7. O-Ring
8. Pump Housing
9. Pump Cover
12. Lever
14. Outer Return Spring
15. Inner Spring Retainer
16. Roller Cam
17. Piston Rod
21. Inner Return Spring
23. Upper Spring Retainer
28. Piston Ring
30. Seal Ring
31. Oil Return Valve
32. Restrictor
SB. To Brake Booster
SK. To Vacuum Lines

5. Idle Speed Adjustment

Service data

Engine	Idle speed
OM 661 Engine	750 ± 50rpm
OM 662 Engine	700 ± 50rpm

Special tool

Commercial tool

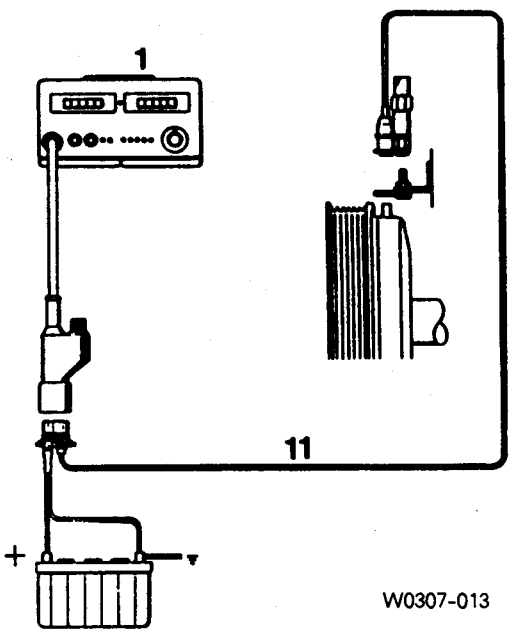
Digital tester	e.g. Bosch, MOT 001.03 Sun, DIT 9000

Adjustment

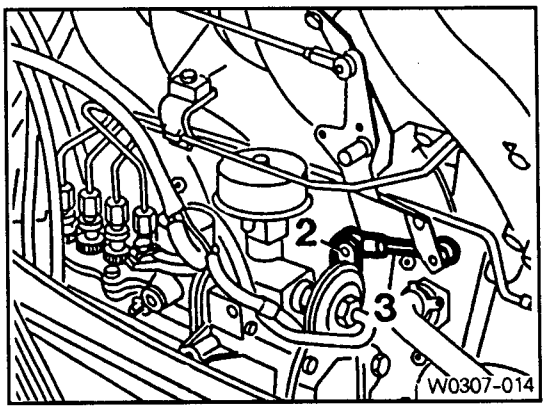
1) Connect the digital tester (1) and TDC pulse sender unit (11).

2) Run the engine and warm up the coolant to 60~80℃.

TDC pulse generator 667 589 02 21 00



3) Separate the connecting rod (3) from the control lever (2).

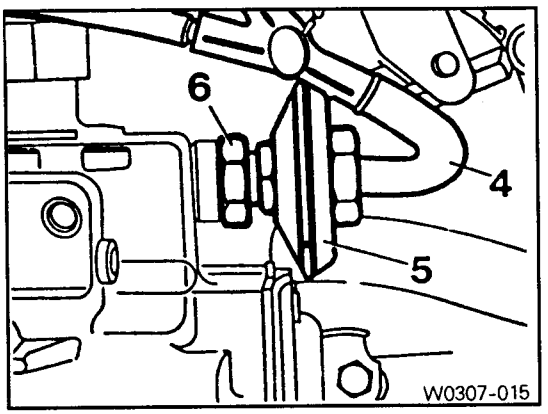


4) Disconnect the vacuum hose (4) from the PLA unit to check idle speed with tester.

5) Check idle speed with tester.

OM 661 Engine	700~750rpm
OM 662 Engine	650~700rpm

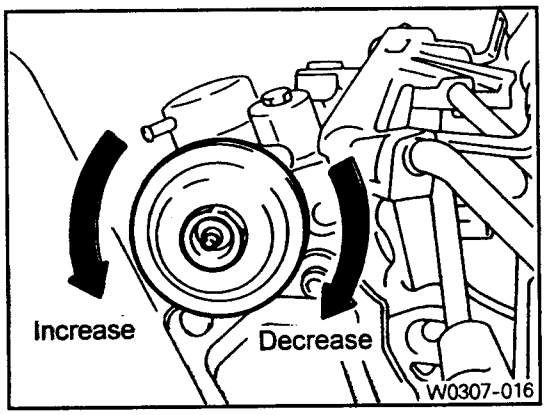
[Note] To adjust idle speed, loosen the locking nut (6) of PLA unit.



6) Ensure that not to damage the idle spring in the governor and adjust idle speed by turning the PLA unit (5) slowly.

Clockwise	RPM decrease
Counterclockwise	RPM increase

[Note] Do not rotate the PLA unit over 1/2 turn from the position marking. If do, idle spring in the governor will be severely damaged.

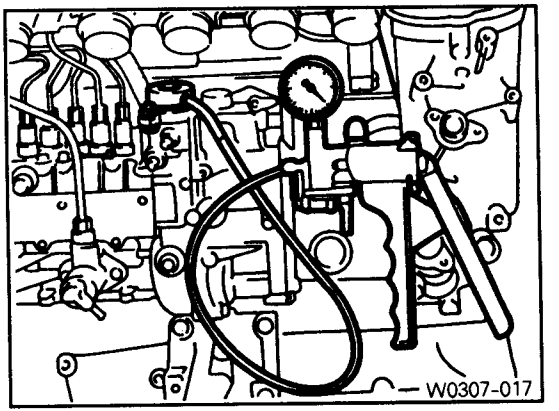


7) After adjustment, tighten the locking nut and place the position marking with different color of paint.

[Note] If there are no changes in idle speed with PLA unit adjustment, perform the service at a BOSCH Service Center.

8) Connect the vacuum pump to the PLA vacuum unit and build up vacuum approx. 500mbar. If engine rpm increases by approx. 100rpm, It is normal.

Vacuum pump 001 589 73 21 00



9) Connect the vacuum line (4).

10) Install the connecting rod without any tension.

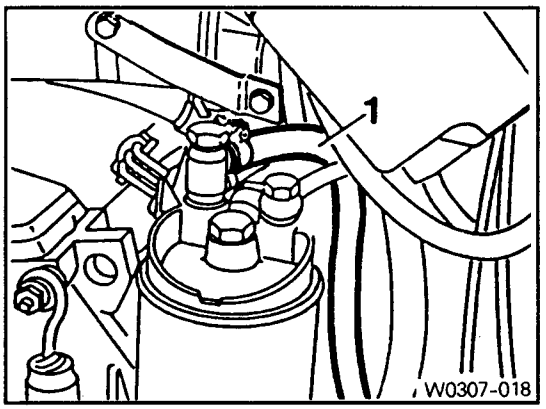
11) Switch on all ancillaries and check the idle speed.

6. Fuel Pump Test

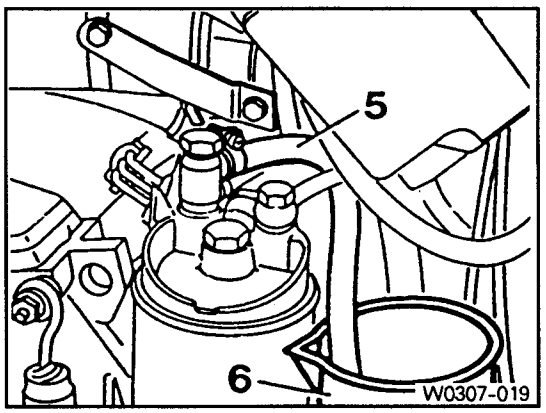
[Note] Before test, replace the fuel filter cartridge and fuel prefilter.

Fuel feed test

1) Disconnect the fuel return line (1) and seal up it with plug.



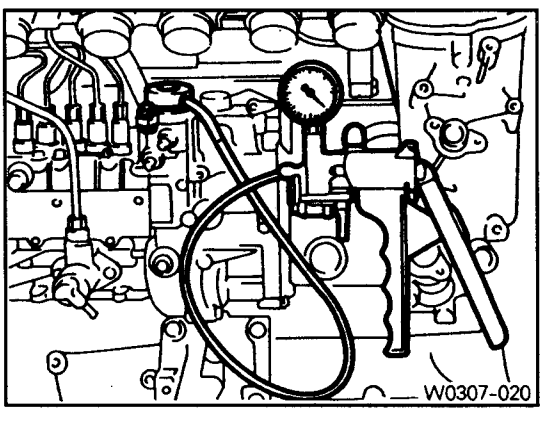
2) Insert the plastic hose (5) and put the end into the measuring beaker (6).



3) Disconnect the vacuum line (4) from vacuum unit (engine stop) (5) and connect the vacuum pump (7) to the vacuum unit.

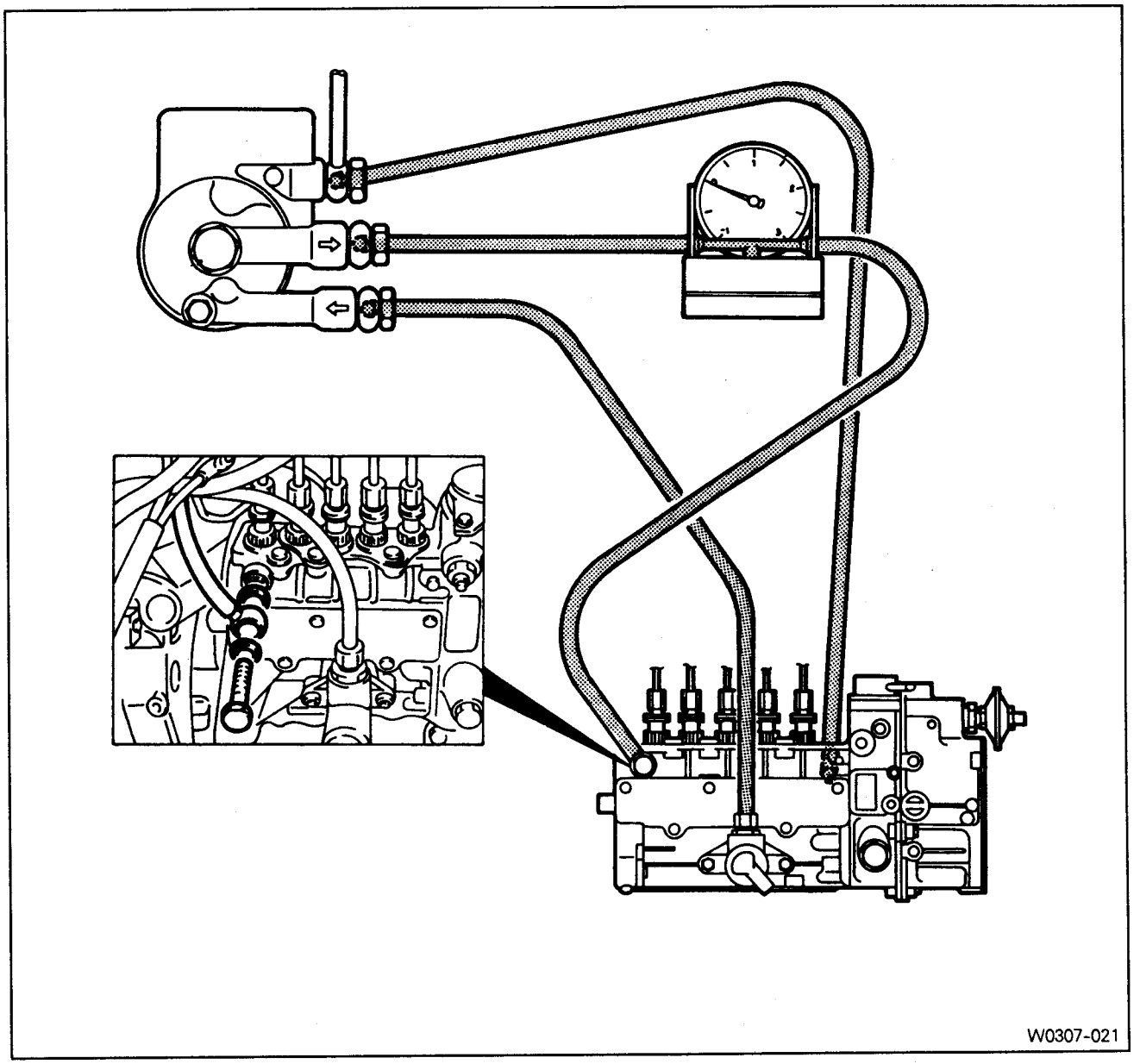
4) To avoid the engine starting, build up vacuum (approx. 500 mbar).

5) Operate the starter motor for exactly 30 seconds and measure fuel volume in the beaker.

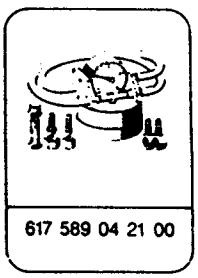


Min. volume	150㎤ for 30 seconds

Fuel pressure test

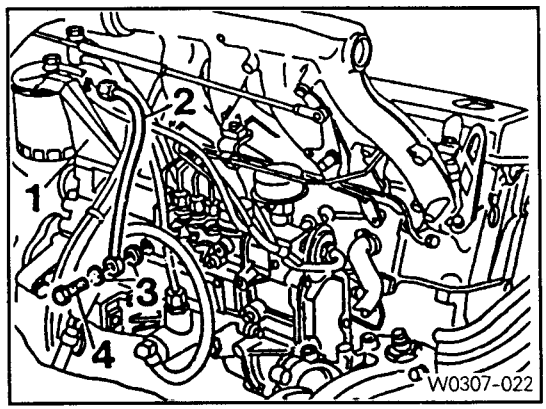


Special tool



1) Disconnect the fuel line (2) from the fuel filter.

2) Remove the banjo bolt (4) from the fuel injection pump and remove the seals (3) and fuel line (2).



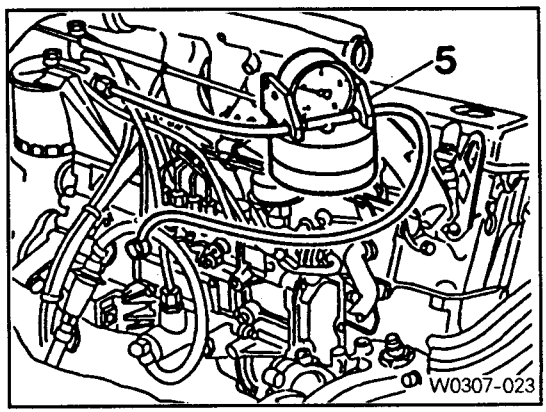
3) Connect the tester (5).

4) Start the engine and read off the fuel pressure on tester (5).

At idle speed	> 0.3bar
At full load	> 0.5bar

[Note] If out of standard, replace the fuel feed pump.

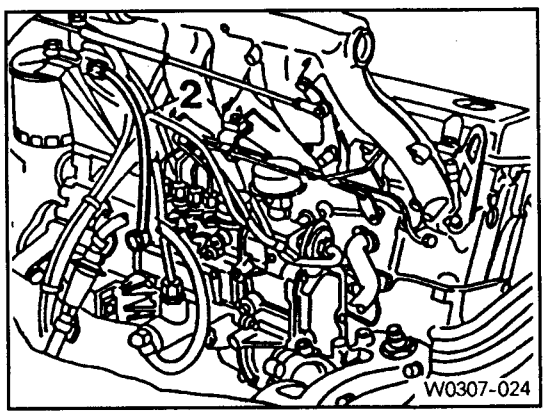
Tester 617 589 04 21 00



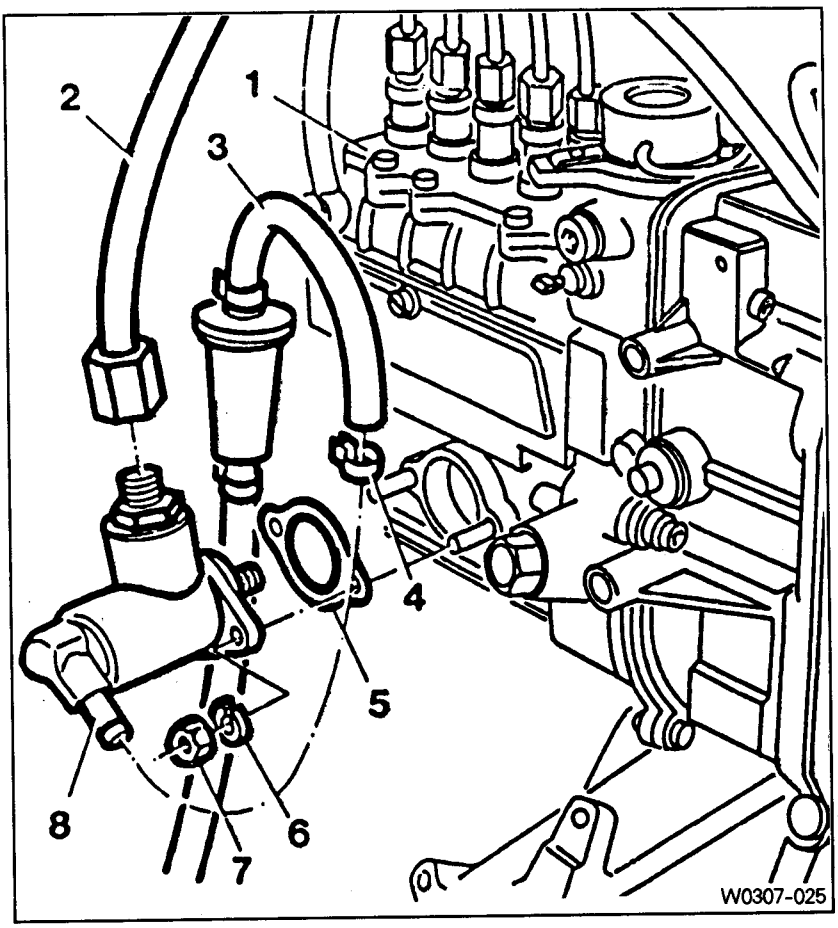
5) Stop the engine.

6) Remove the tester.

7) Replace the seal and connect the fuel line (2).



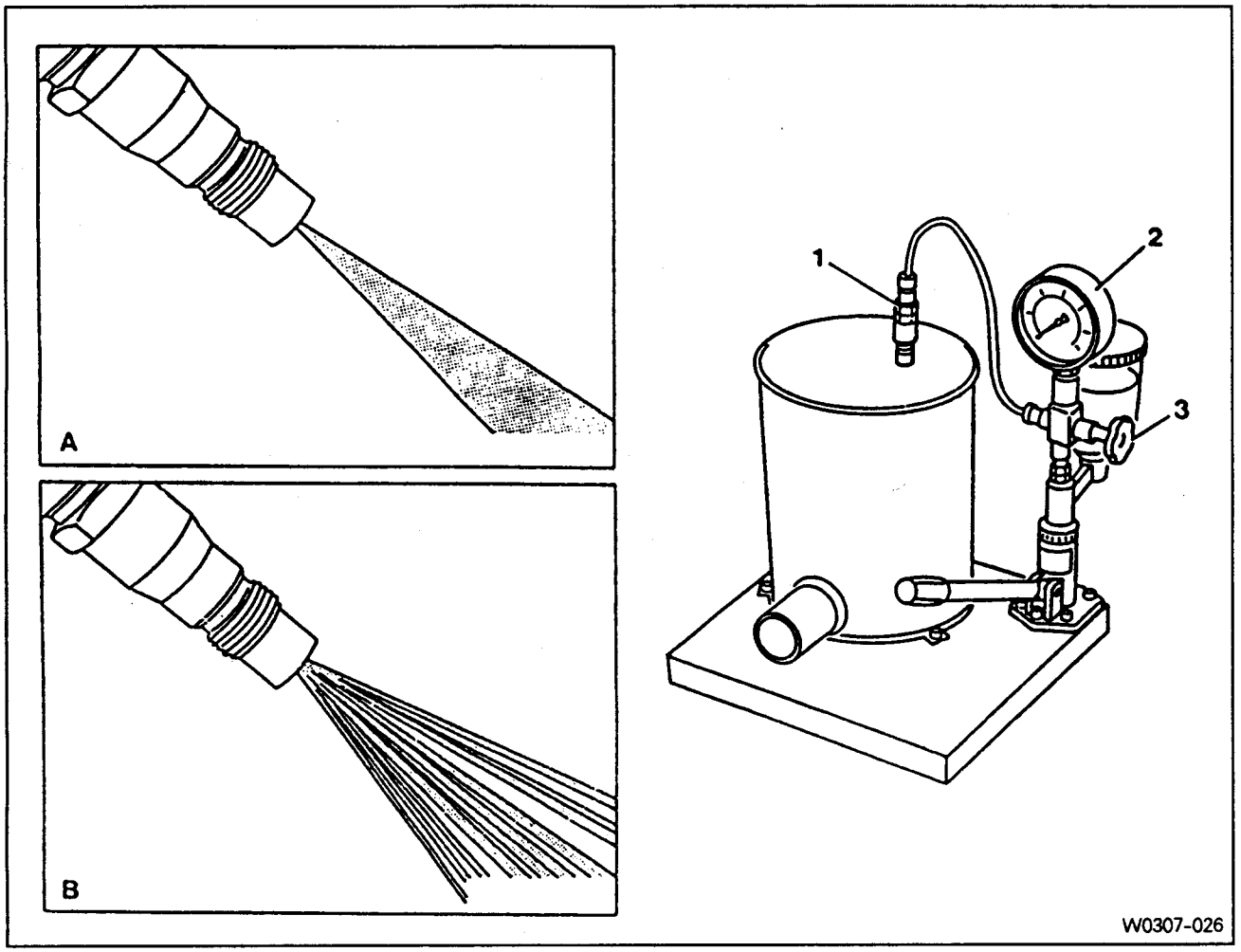
7. Removal and Installation of Fuel Pump



1. Fuel Injection Pump
2. Pressure Line ----------13Nm
3. Suction Line
4. Hose Clip----------Replace
5. Gasket----------Replace
6. Spring Lock Washer
7. Hexagon Nuts
8. Fuel Pump

8. Injection Nozzle Test

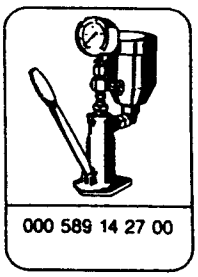
Preceding work : Removal of fuel injection nozzle



1. Fuel Injection Nozzle----------New : 115~125bar
   Used : min. 100bar
2. Tester
3. Valve

A. Closed Spray = good
B. Stringy Spray = poor

Special tool

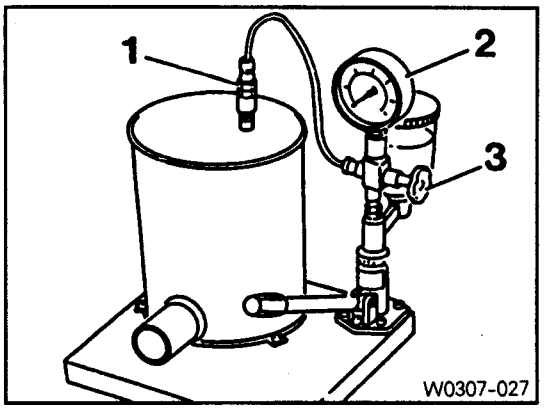


Test

[Note] When testing the injection nozzle, do not place your hand into the spray of a nozzle. The spray will penetrate deep into the skin and destroy the tissue.

1) Connect the fuel injection nozzle to the tester (2).

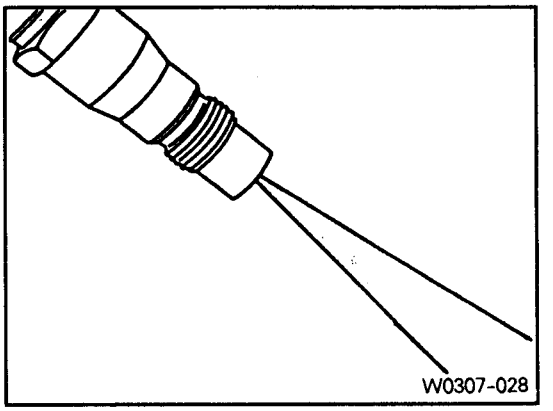
Tester 000 589 14 27 00



2) Close the valve (3) and pump 5 times strongly.

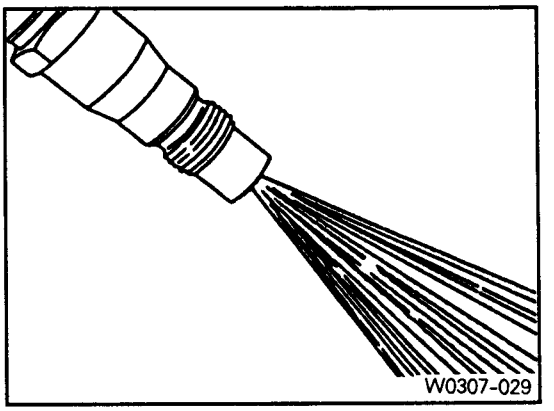
3) Chatter test :
Slowly operate the hand lever at tester (approx. 1 stroke per second). The nozzle must spray with a gentle chattering.

4) Spray pattern test :
Operate the hand lever at tester rapidly (approx. 2~3 strokes per second).



· Good
The spray pattern shows closed and well atomized.

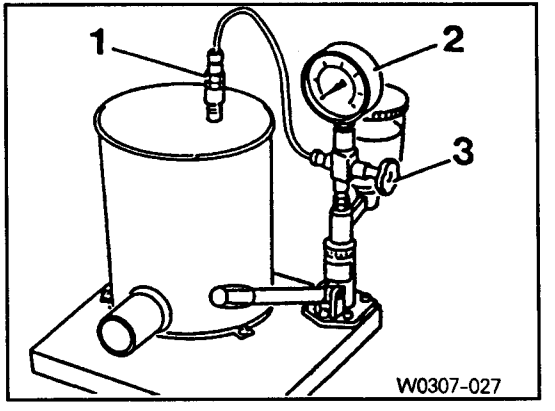
· Poor
The spray pattern shows split, too wide and stringy.
(Repair the fuel injection nozzle)



5) Opening pressure test :
Open the valve (3) and slowly operate the hand lever at tester (approx. 1 stroke / second) and measure opening pressure.

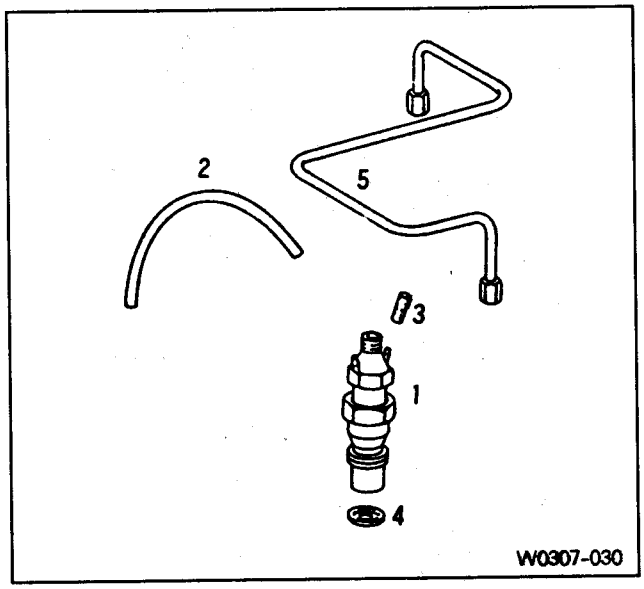
New nozzle	115~125bar
Used nozzle	Min. 100bar
Difference between nozzles	Max. 5bar

[Note] If out of standard, repair the injection nozzle.



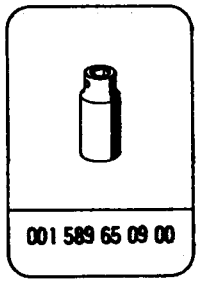
6) Leak test
Slowly operate the hand lever at the tester until get a pressure of approx. 90bar. Maintain this pressure for more than 20 seconds and within this period no drop of fuel should build up at the nozzle tip.

9. Removal and Installation of Injection Nozzles



1. Fuel Injection Nozzle------ 35~40Nm
2. Fuel Return Hose
3. Plug
4. Nozzle Washer---------- Replace
5. Fuel Injection Pipe-------- 18Nm

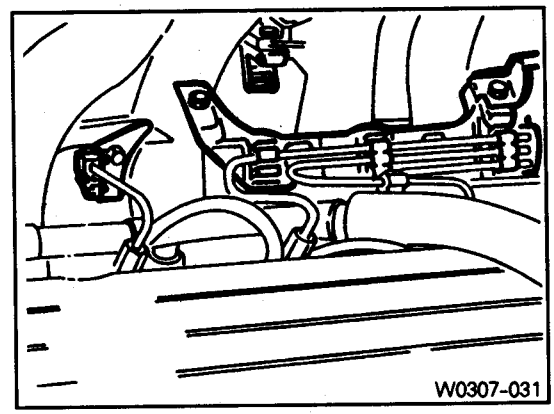
Special tool



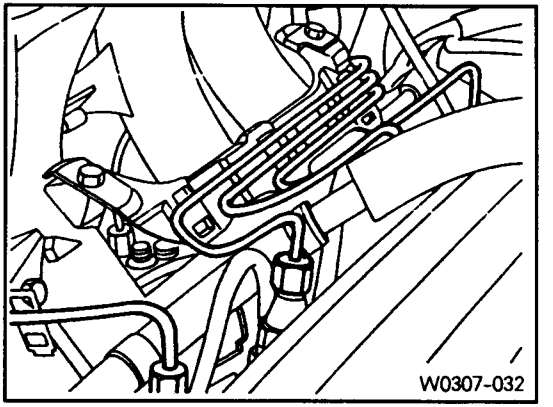
Removal · Installation

1) Remove the plastic clip from the injection pipe.

2) Remove the fuel return hose.



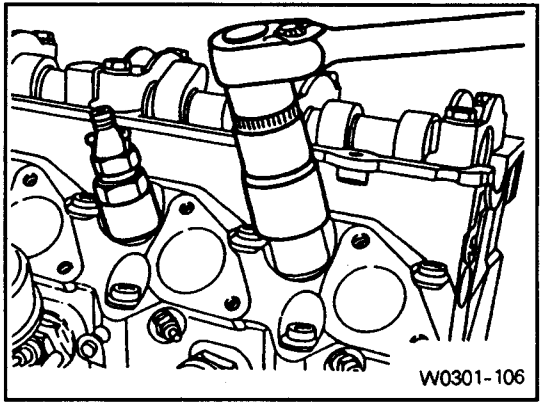
3) Disconnect the injection pipes from the injection nozzles and push them to the side.



4) Remove the fuel injection nozzle.

Serration wrench 001 589 65 09 00

[Note] Replace the washers.

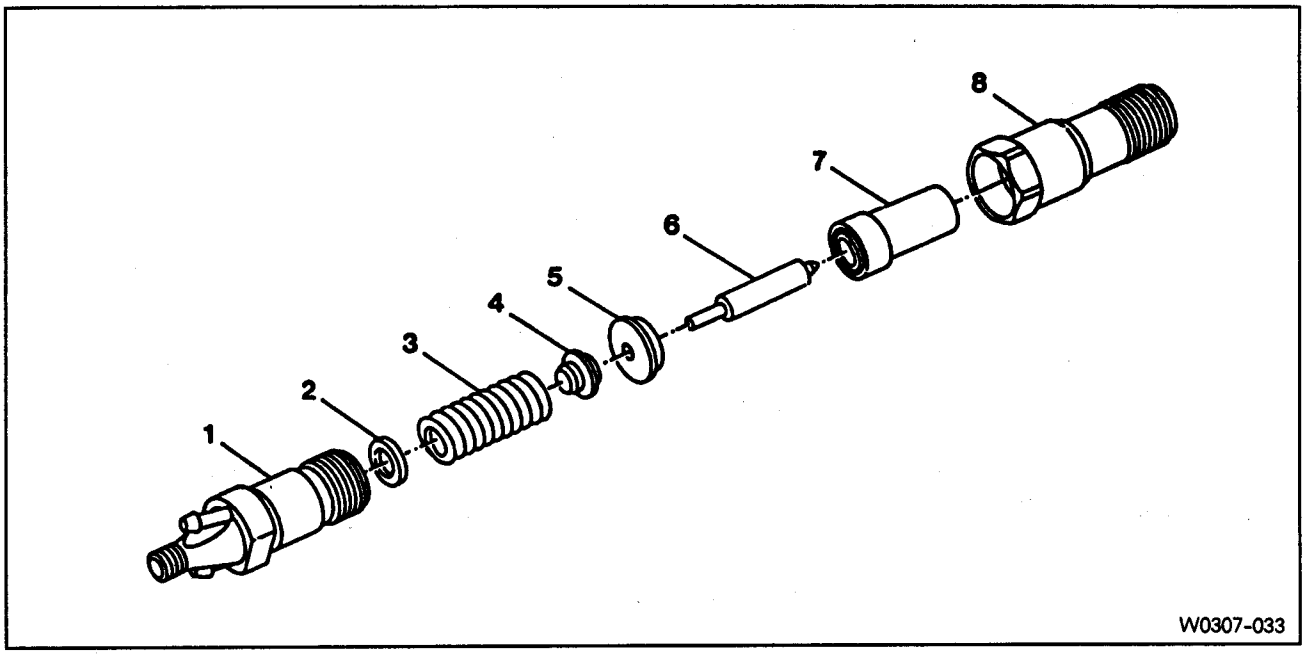


* Installation is reverse order of the removal.

[Note] Pay attention to the installation position of new nozzle washer and tightening torque.

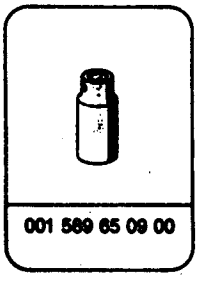
10. Injection Nozzle Repair

Preceding work : Removal of fuel injection nozzle



1. Nozzle Holder
2. Steel Washer
3. Compression Spring
4. Thrust Pin
5. Intermediate Disc
6. Nozzle Needle
7. Nozzle Body
8. Nozzle Tensioning Nut----------80Nm

Special tools

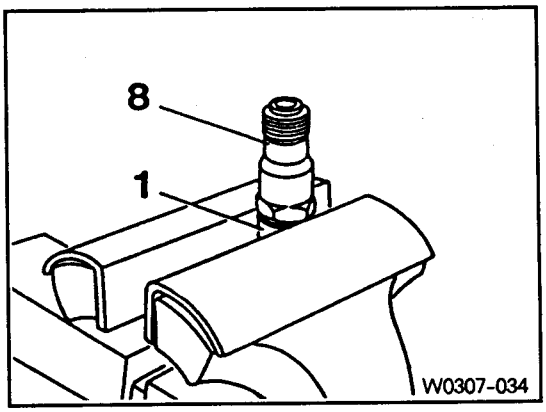


Repair

1) Clamp the nozzle holder (1) in a vice and remove the nozzle tensioning nut (8).
[Note] Use protective jaws for clamping.

2) Disassemble the fuel injection nozzle.

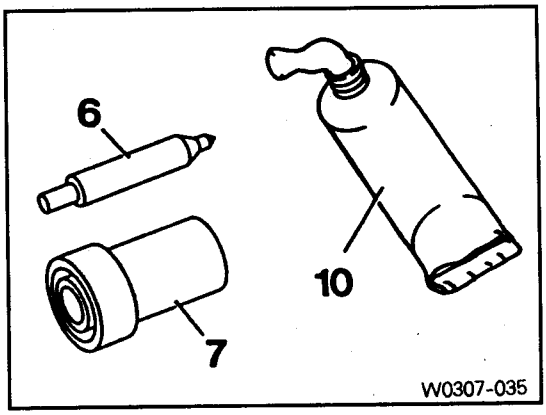
Socket wrench insert 001 589 65 09 00



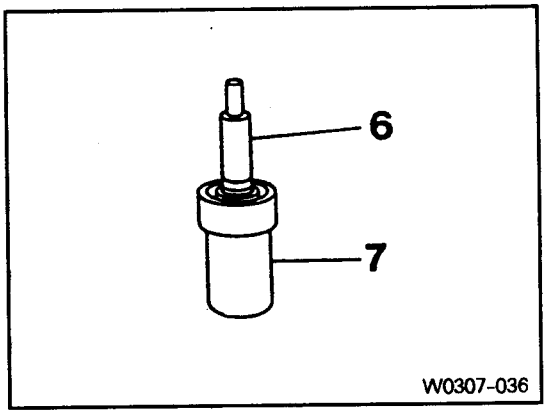
3) Clean the nozzle needle (6) and nozzle body (7) with an abradant.

4) Clean the nozzle seat with cleaning cutter.

Cleaning set 000 589 00 68 00



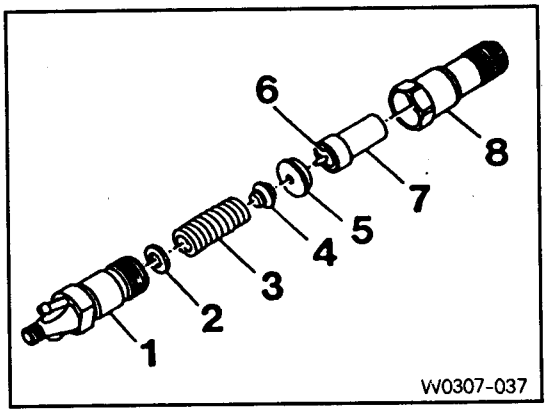
5) Immerse nozzle needle (6) and nozzle body (7) in filtered diesel fuel. When the nozzle body is held vertical, the weight of the nozzle needle must cause it to slide down toward the nozzle needle seat.



6) Assemble the injection nozzle so that the tip of the thrust (4) pin is facing toward the nozzle holder.

Tightening torque	80Nm

[Note] Nozzle needle (6) and nozzle body (7) should always be replaced as a pair.



7) Check the fuel injection nozzle and adjust opening pressure if necessary.

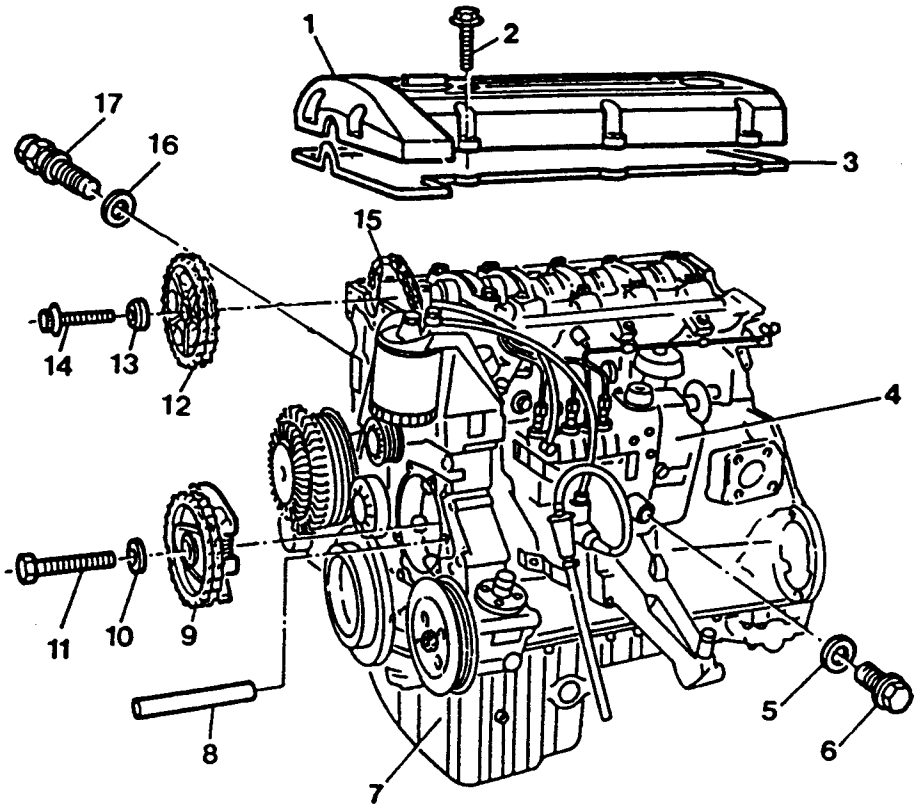
Opening pressure adjustment

Disassemble the fuel injection nozzle and replace the steel washer (2).

[Note] Each 0.05mm thickness of the washer results in a pressure difference of approx. 3bar.

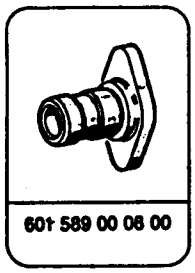
11. Removal and Installation of Injection Timing Device

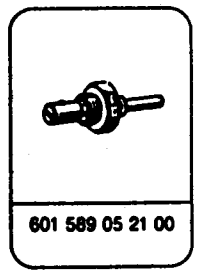
Preceding work : Removal of vacuum pump

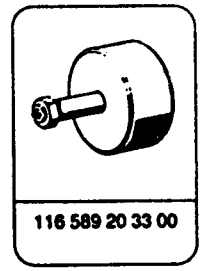


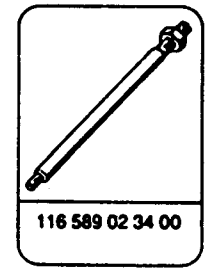
1. Cylinder Head Cover
2. Bolt ---------- 10Nm
3. Gasket ---------- Replace
4. Fuel Injection Pump
5. Seal ---------- Replace
6. Screw Plug ---------- 30Nm
7. Oil Pan
8. Locking Pin
9. Injection Timing Device
10. Washer
11. Bolt (Left-Hand Thread) ---46Nm
12. Camshaft Sprocket
13. Washer
14. 12-Sided Stretch Bolt -------Check, 25Nm + 90°
15. Timing Chain
16. Seal
17. Chain Tensioner ----------80Nm

Special tools


601 589 00 08 00


601 589 05 21 00

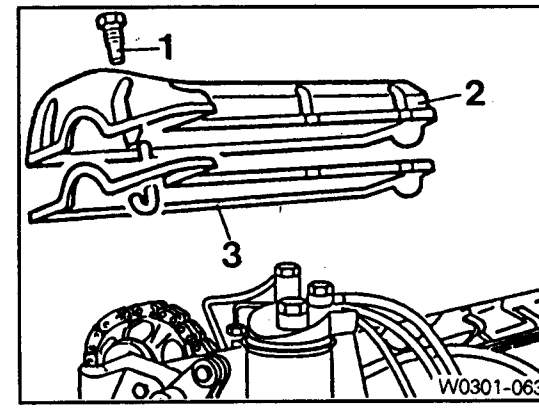

116 589 20 33 00


116 589 02 34 00


667 589 04 63 00

Removal · Installation

1) Remove the bolts (2) and then remove the cylinder head cover (1) and gasket (3).

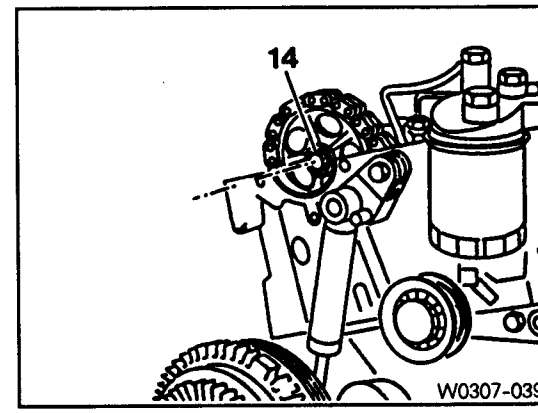


Installation

Tightening torque	10Nm

[Note] Replace the gasket.
Rotate the engine 1 revolution by hand and check TDC marking of the crankshaft and camshaft.

2) Loosen the camshaft sprocket bolt (14).
[Note] Do not remove the bolt.

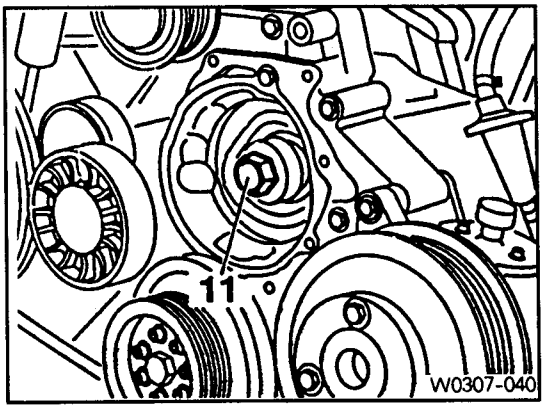


Installation

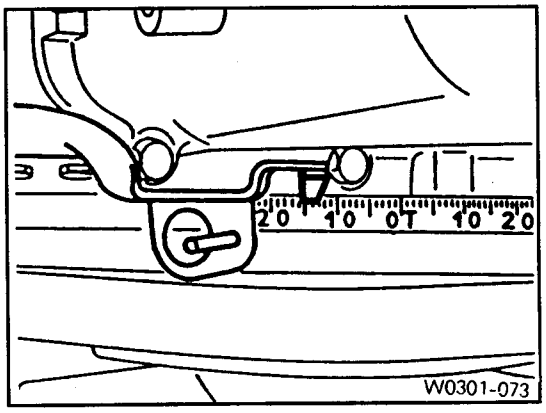
Tightening torque	25Nm + 90°

[Note] If max. length of bolt exceeds 53.6mm, replace it.

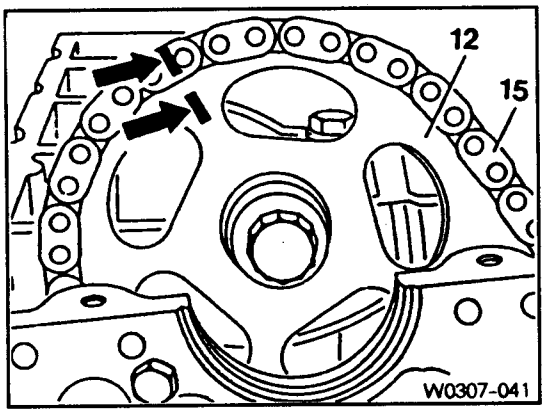
3) Loosen the bolt (11) (left-hand thread).
[Note] Do not remove the bolt.



4) Position the no.1 cylinder at ATDC 15 °.
[Note] Do not rotate the engine with camshaft sprocket bolt or opposite direction of the engine rotation.



5) Place alignment marks (arrow) on the timing chain (12) and camshaft sprocket (15).

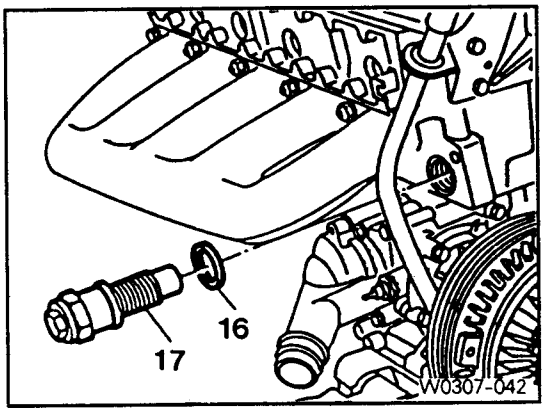


6) Remove the chain tensioner (17).

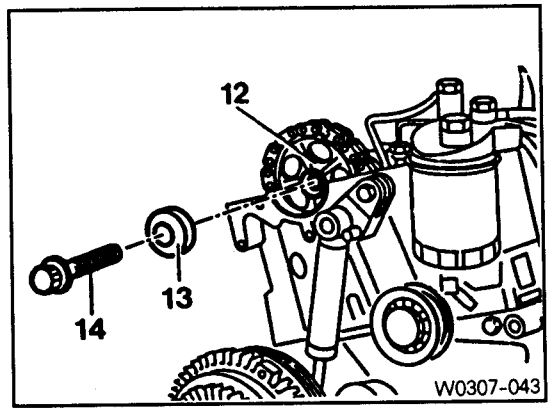
Installation

Tightening torque	80Nm

[Note] Replace the seal (16).



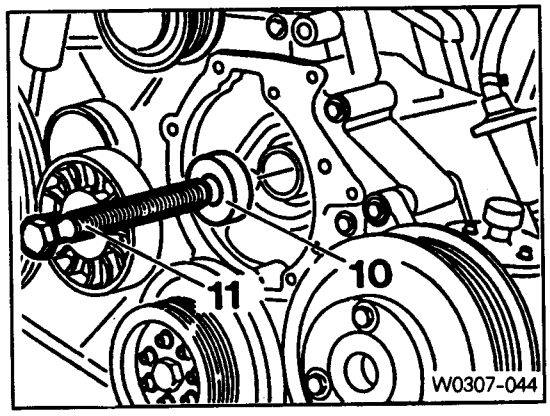
7) Pull out the 12-sided stretch bolt (14) and washer and remove the camshaft sprocket (12).



8) Pull out the bolt (11) and washer (10).
[Note] Be careful that the bolt is left-hand thread.

Installation

Tightening torque	46Nm

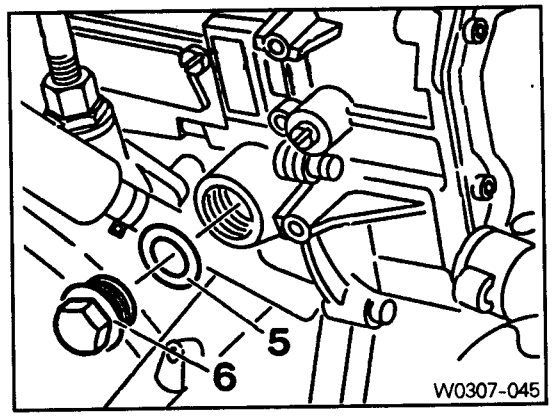


9) Remove the plug (6) and seal (5) from the injection pump and collect oil in a suitable vessel.

Installation

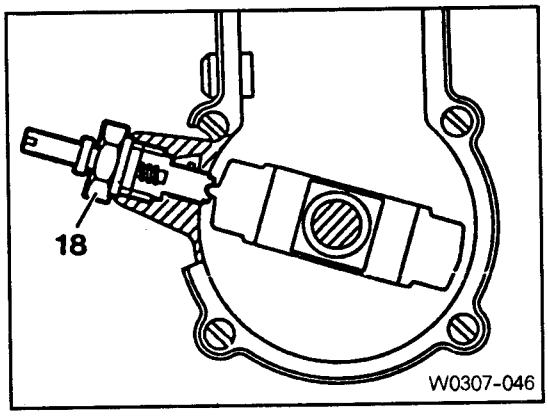
Tightening torque	30Nm

[Note] Replace the seal.



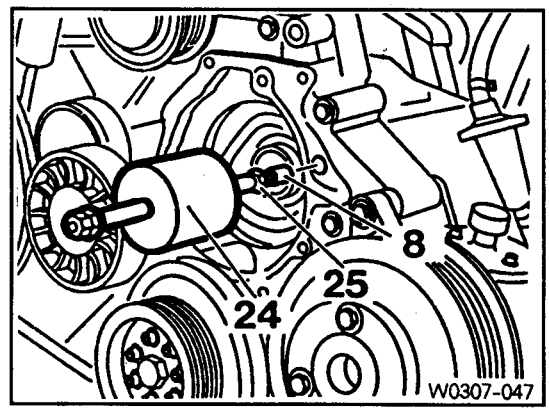
10) Install the locking screw (18) into the injection pump.
[Note] Before tightening the bolts for the injection timing device and the camshaft sprocket, always remove the locking screw from the injection pump and reinstall the plug.

Locking screw 601 589 05 21 00



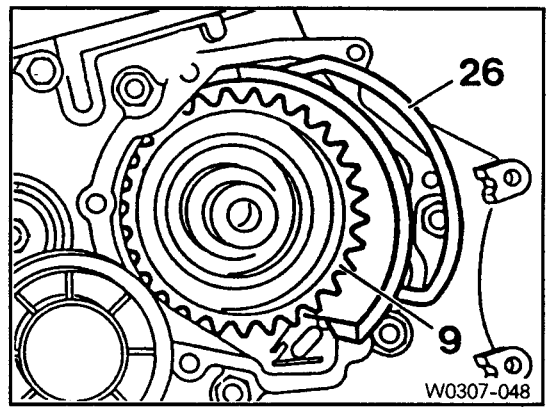
11) Using special tool (24, 25), remove the locking pin (8).

Sliding hammer 116 589 20 33 00
Threaded bolt 116 589 02 34 00



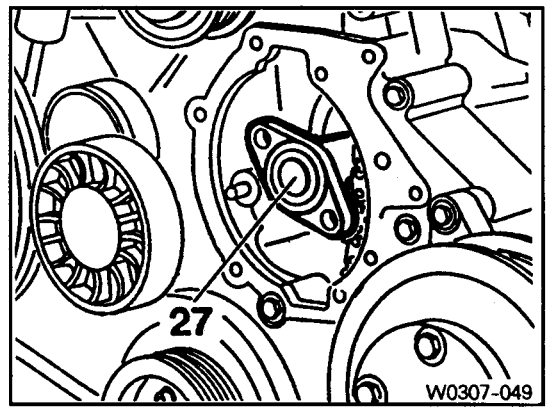
12) Push back the timing chain with retaining plate (26) and remove the injection timing device (9).

Retaining plate 667 589 04 63 00



Installation
Fit the flange (27) onto the injection pump shaft, move back and forward slightly to check whether the locking screw at the injection pump is engaged.

Flange 601 589 00 08 00

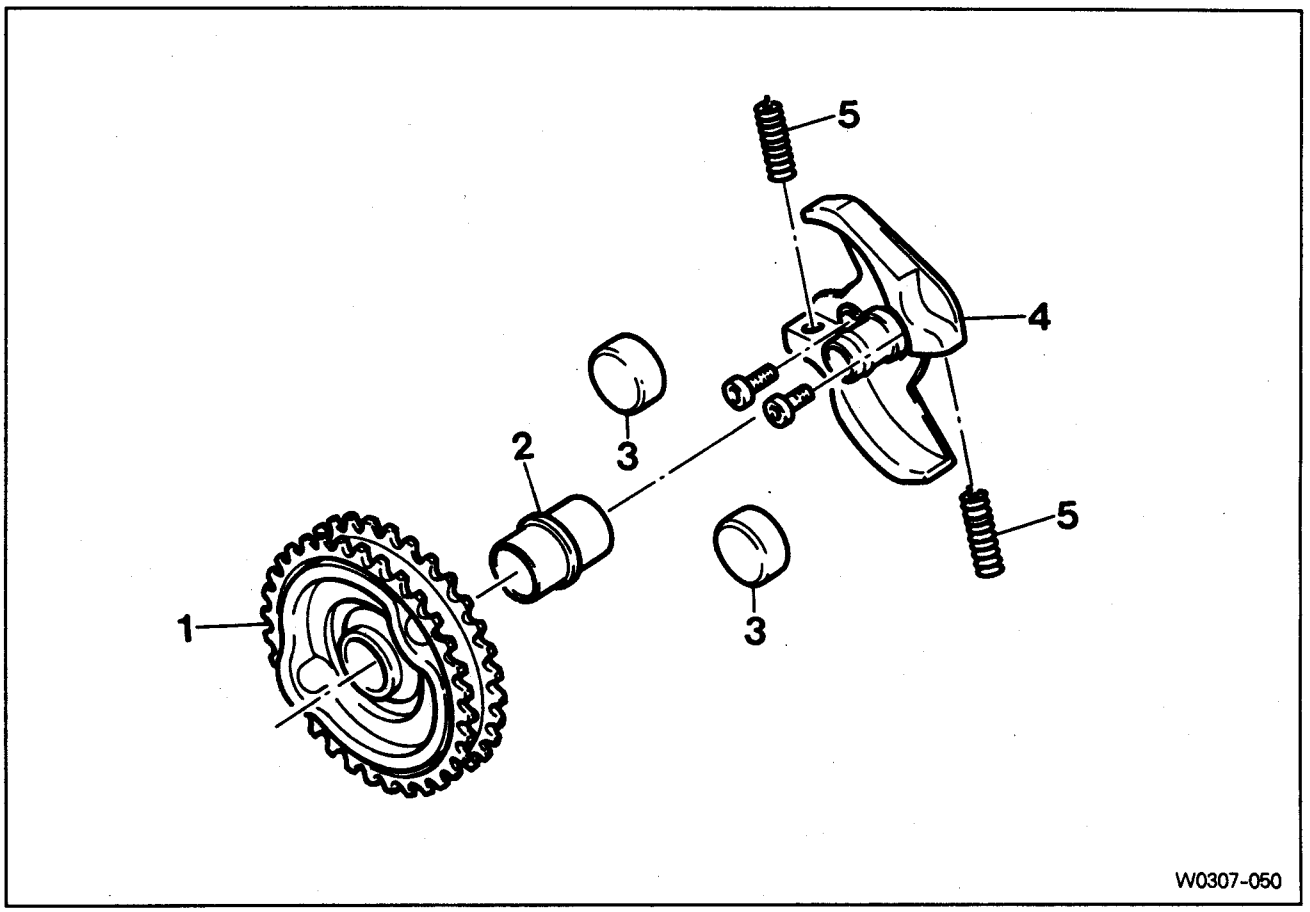


13) Installation is reverse order of the removal.

14) After assembling the engine, check start of delivery and adjust if necessary.

12. Disassembly and Assembly of Injection Timing Device

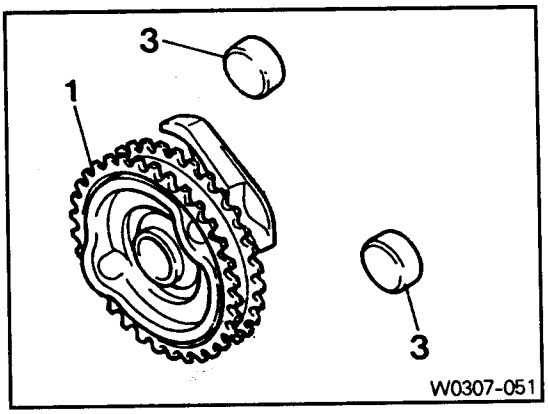
Preceding work : Removal of injection timing device (07-24)



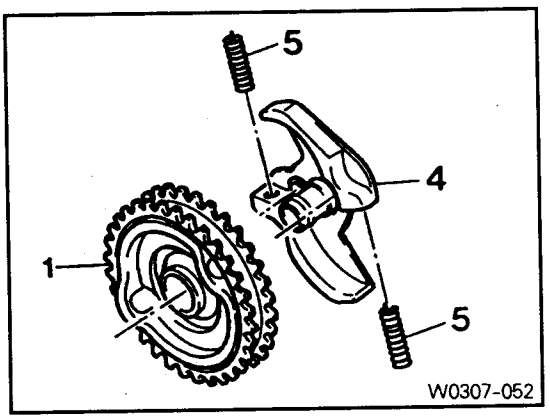
1. Cam Sprocket---------- Check
2. Bushing---------- Check
3. Governor Weights
4. Segment Flange and Drive Hub
5. Compression Springs

Disassembly · Assembly

1) Remove the governor weights (3).

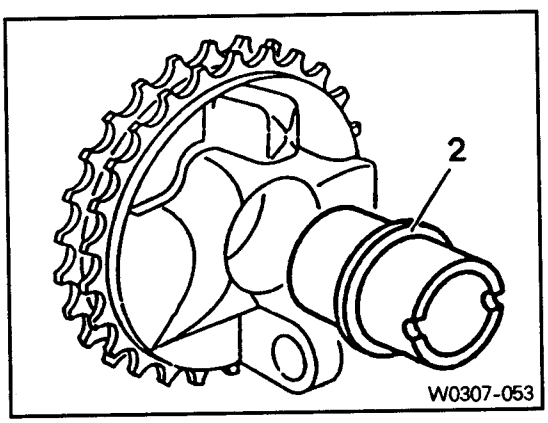


2) Pull out the compression springs (5) and cam sprocket (1) from the segment flange (4).

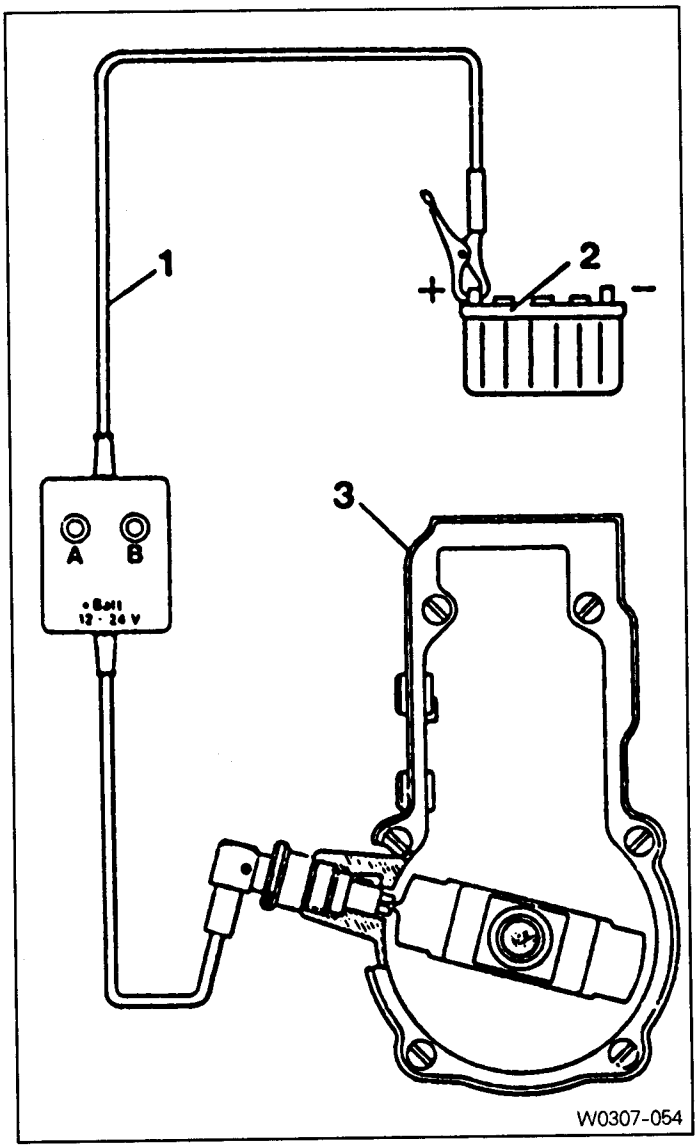


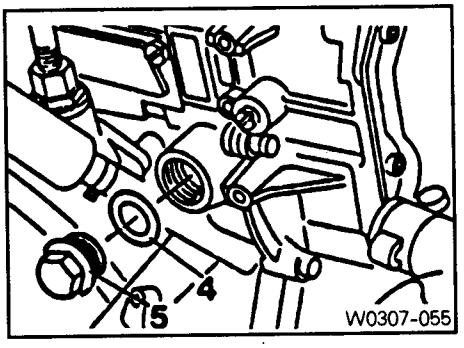
3) Knock out the bushing with a proper drift.

4) Installation is reverse order of the removal.



13. Start of Delivery Test (Position Sensor, RIV Method)



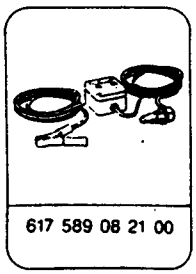


1. Position Sensor
2. Battery
3. Fuel Injection Pump
4. Seal---------- Replace
5. Screw Plug---------- 30Nm

Service data

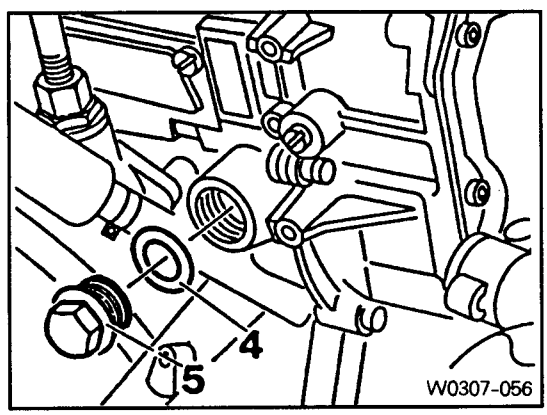
Start of delivery (RIV)	OM 661 Engine	ATDC 15° ± 1°
	OM 662 Engine	

Special tool



Test

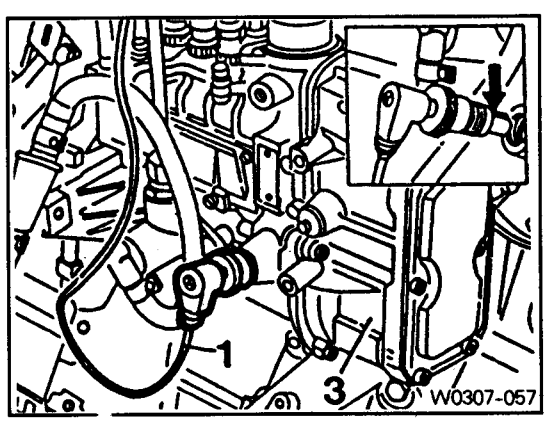
1) Remove the screw plug (5) and seal (4) and collect oil in a suitable vessel.



2) Install the position sensor (1) into the governor housing of the injection pump to be the guide pin of the position sensor facing up.

3) Connect the battery terminal of position sensor (1) to positive terminal (+) of battery.

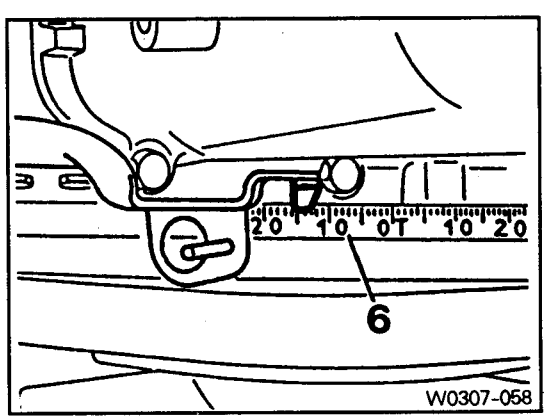
Position sensor 617 589 08 21 00



4) Rotate the crankshaft by hand (in direction of engine rotation) until the lamp 'B' lights up. Rotate the crankshaft carefully further until both lamps 'A and B' come on. In this position, check the RI value on the crankshaft vibration damper.

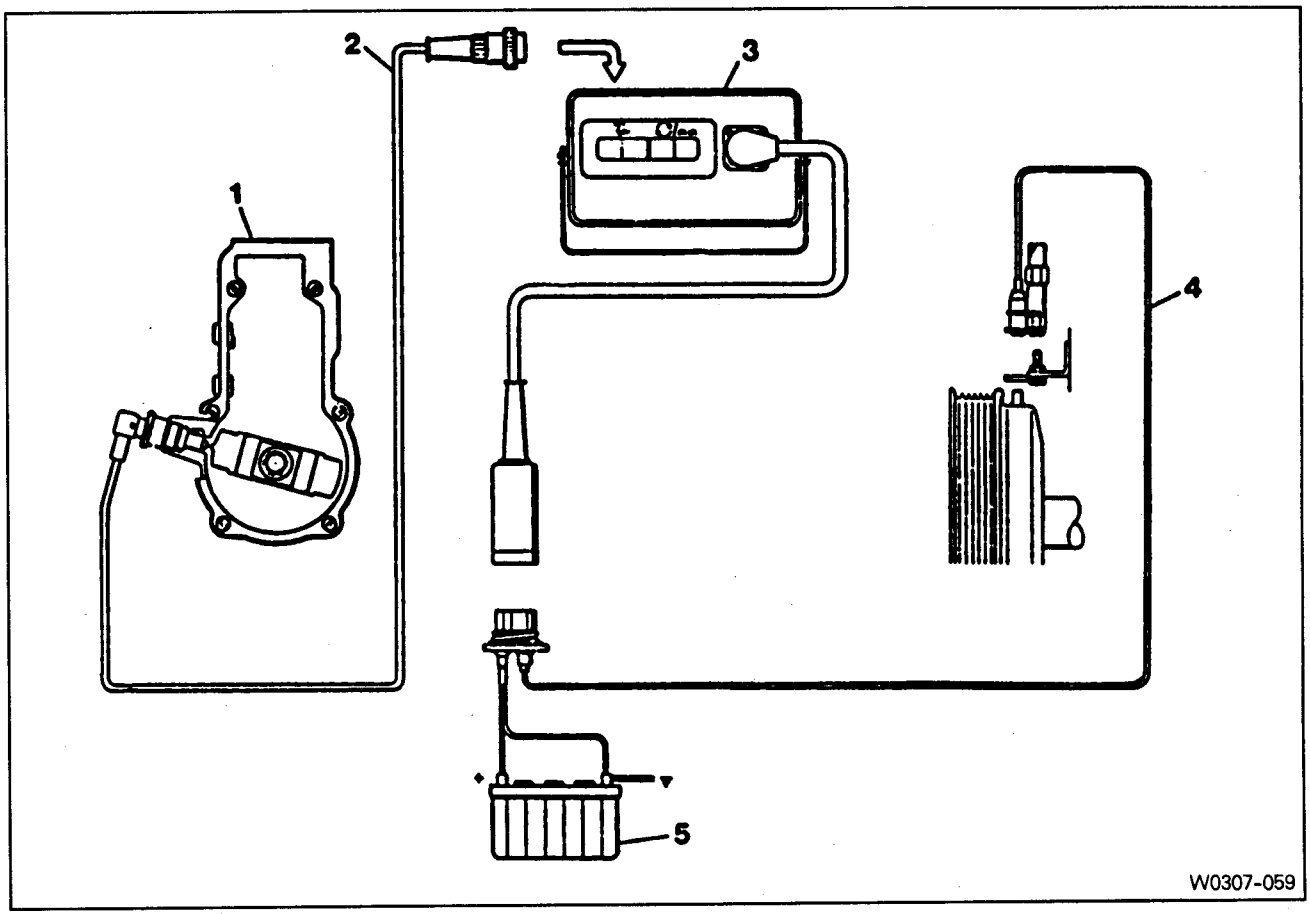
Specification	ATDC 15° ± 1°

[Note] If only lamp 'A' lights up, repeat the test and if out of specification, adjust start of delivery.



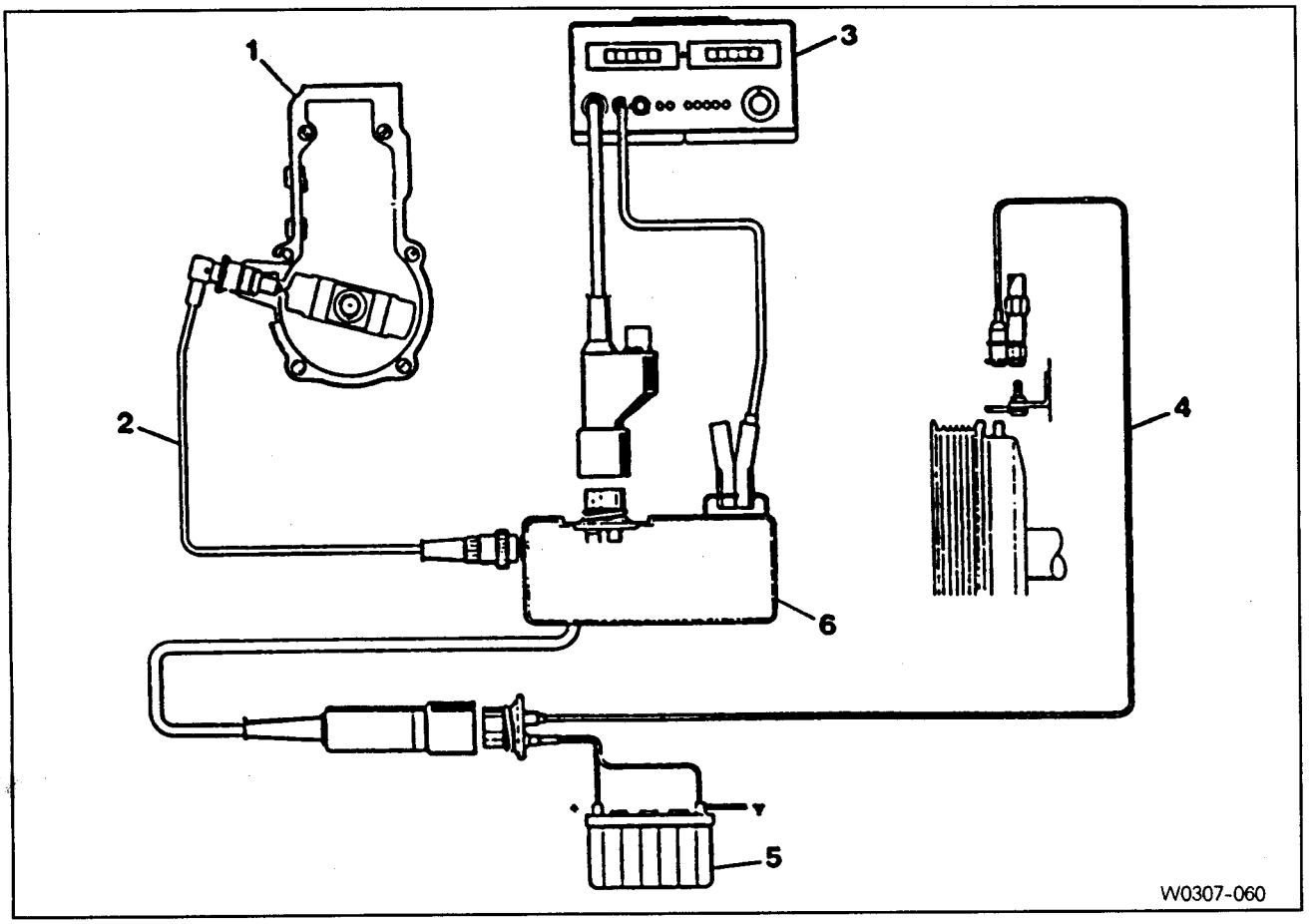
14. Start of Delivery Test (Digital Tester, RIV Method)

Connection diagram for testers without adapter



1. Fuel Injection Pump
2. RI Sensor
3. Digital Tester
4. TDC Pulse Sender Unit
5. Battery

Connection diagram for testers with adapter

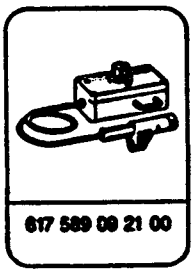


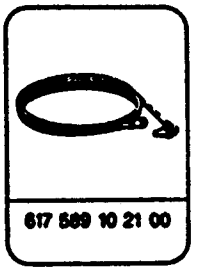
1. Fuel Injection Pump
2. RI Sensor
3. Digital Tester
4. TDC Pulse Sender Unit
5. Battery
6. RI Pulse Generator

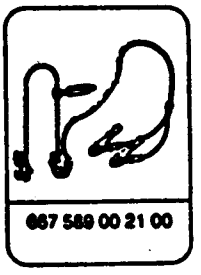
Service data

Start of delivery (RIV)	OM 661 Engine	ATDC 15° ± 1°
	OM 662 Engine	
Idle speed	OM 661 Engine	750 ± 50 rpm
	OM 662 Engine	700 ± 50 rpm

Special tools





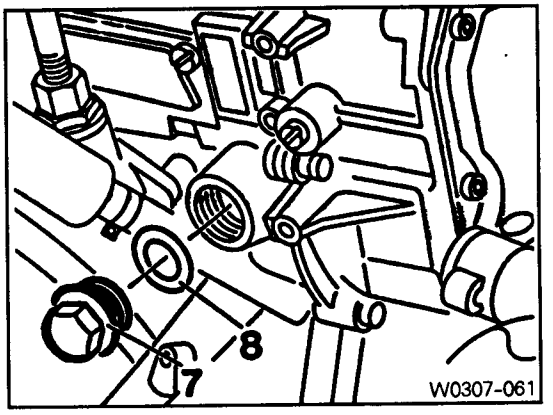


Commercial tools

Item		Tools
Digital tester	With pulse generator	Bosch, MOT 001.03
		Hartmann & Braun, EOMT3
	Without pulse generator	Bosch, ETD 019.00
		Sun, DIT 9000
		ALV, Diesel - Tester 875

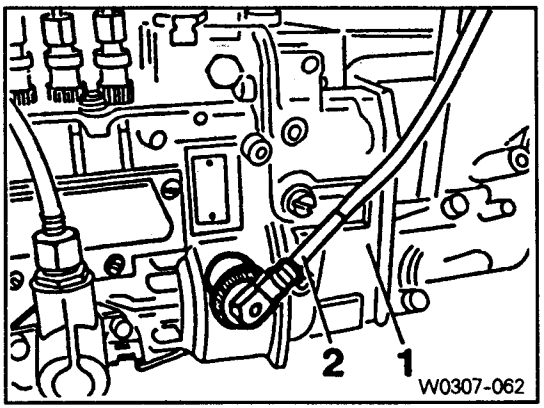
Test

1) Remove the screw plug (7) and seal (8) and collect oil in a suitable vessel.



2) Install the RI sensor into the governor housing of injection pump (1).

RI sensor 617 589 10 21 00



3) Connect the digital tester and TDC pulse sender unit according to connection diagram.

4) Run the engine at idle speed and check the RI value on the digital tester.

RI value	ATDC 15° ± 1°

[Note] If out of standard, adjust the start of delivery.

5) Stop the engine.

6) Remove the RI sensor, digital tester and TDC pulse sender unit.

7) Replace the seal and tighten the plug.

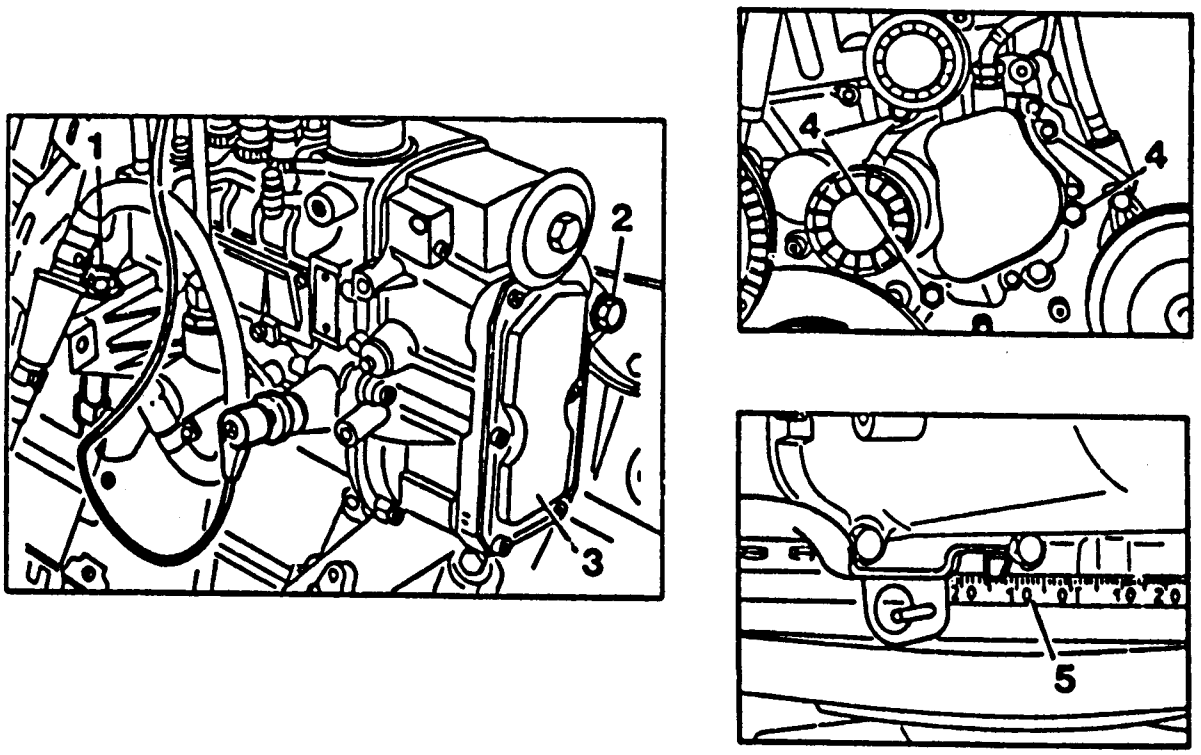
Tightening torque	30Nm

8) Check engine oil level and adjust if necessary.

15. Start of Delivery Adjustment (After Testing)

Preceding work : Start of delivery test

(1) Position sensor (RIV method)



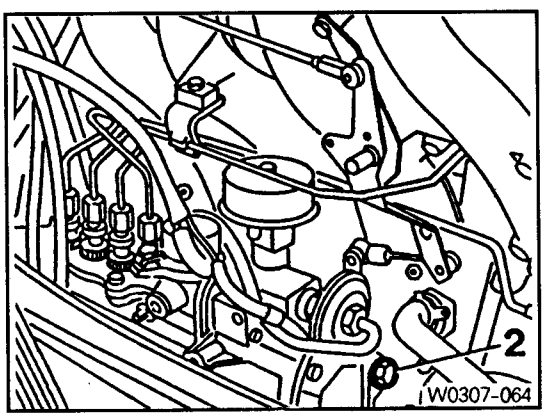
W0307-063

1. Adjusting Screw
2. Bolt ---------- 23Nm
3. Fuel Injection Pump
4. Bolt ---------- 23Nm
5. Scale ---------- RI start of delivery = 15° ± 1° ATDC

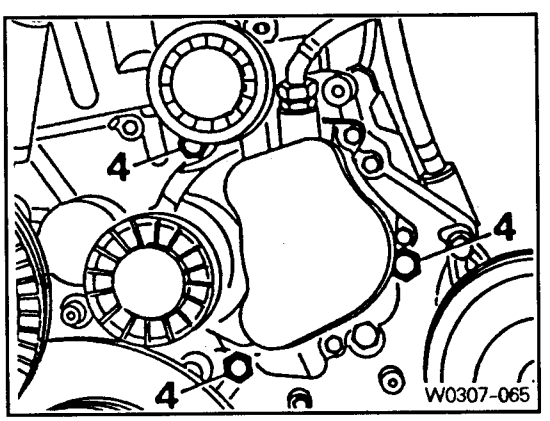
Special tool

Adjustment

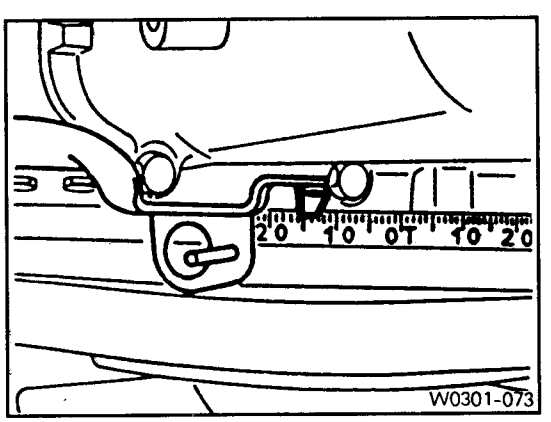
1) Remove the bolt (2) at the supporting bracket.



2) Remove the bolts (4) at the timing case housing.



3) Position the no.1 cylinder at 15° ATDC.
[Note] Do not rotate the engine in opposite direction of engine rotation.

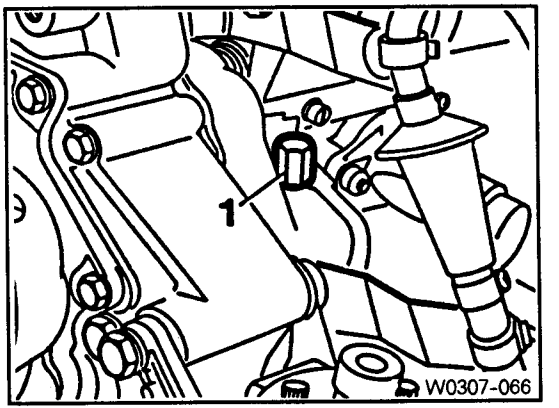


4) Turn the adjusting screw (1) until both lamps 'A' + 'B' on the position sensor light up.

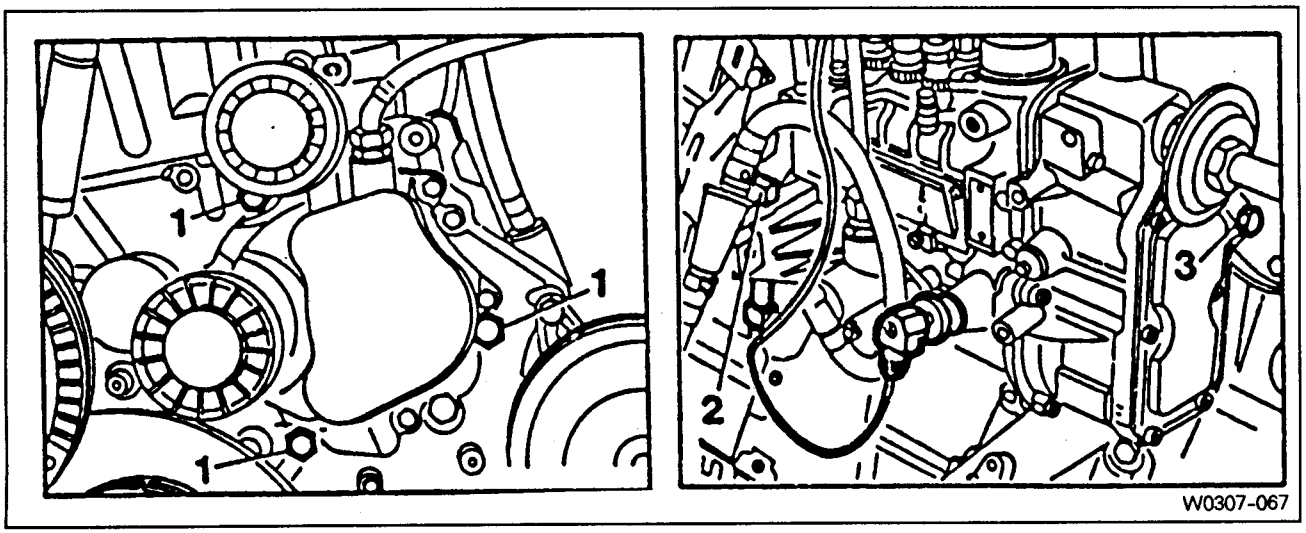
To the right	Start of delivery retarded
To the left	Start of delivery advanced

[Note] If the adjustment range is not adequate, remove the injection pump and reinstall.

Position sensor 617 589 08 21 00



(2) Digital tester (RIV Method)

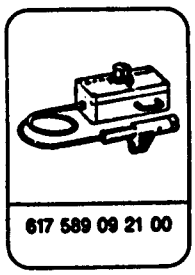


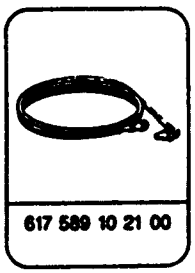
1. Bolt ---------- 23Nm
2. Adjusting Screw ---------- To the right : start of delivery retarded
   To the left : start of delivery advanced
3. Bolt ---------- 23Nm

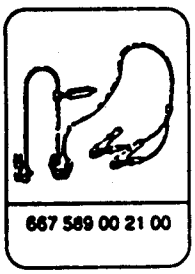
Service data

Start of delivery (RIV)	OM 661 Engine	ATDC 15° ± 1°
	OM 662 Engine	
Idling speed	OM 661 Engine	750 ± 50 rpm
	OM 662 Engine	700 ± 50 rpm

Special tools





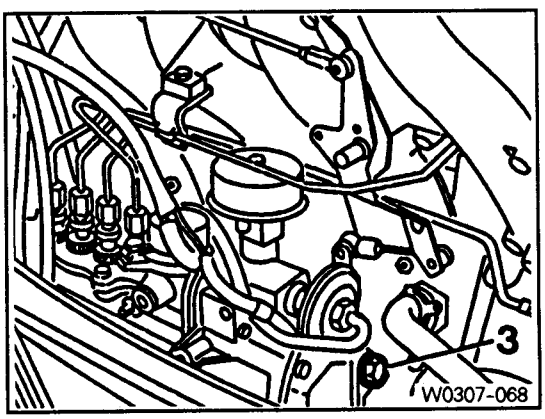


Commercial tools

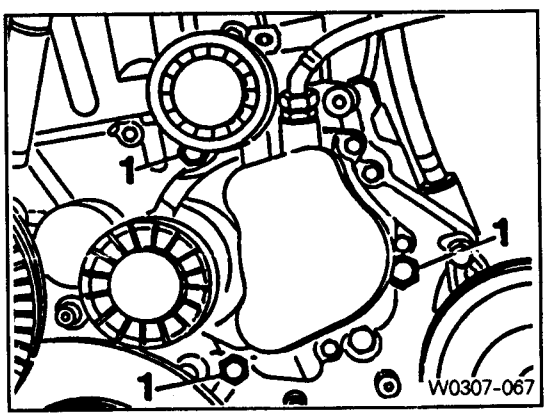
Item		Tools
Digital tester	With pulse generator	Bosch, MOT 001.03
		Hartmann & Braun, EOMT3
	Without pulse generator	Bosch, ETD 019.00
		Sun, DIT 9000
		ALV, Diesel - Tester 875

Adjustment

1) Remove the bolt (3) at the supporting bracket.



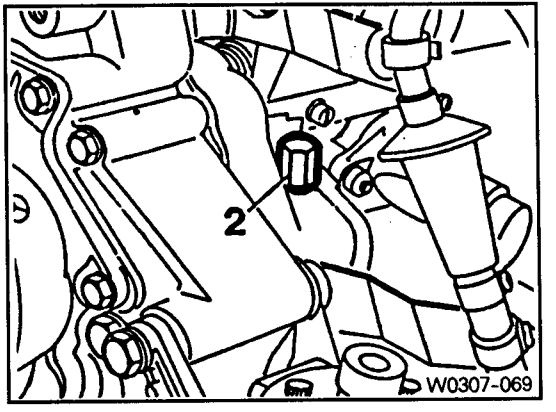
2) Remove the bolts (1) at the timing case cover.



3) Run the engine at idle speed.

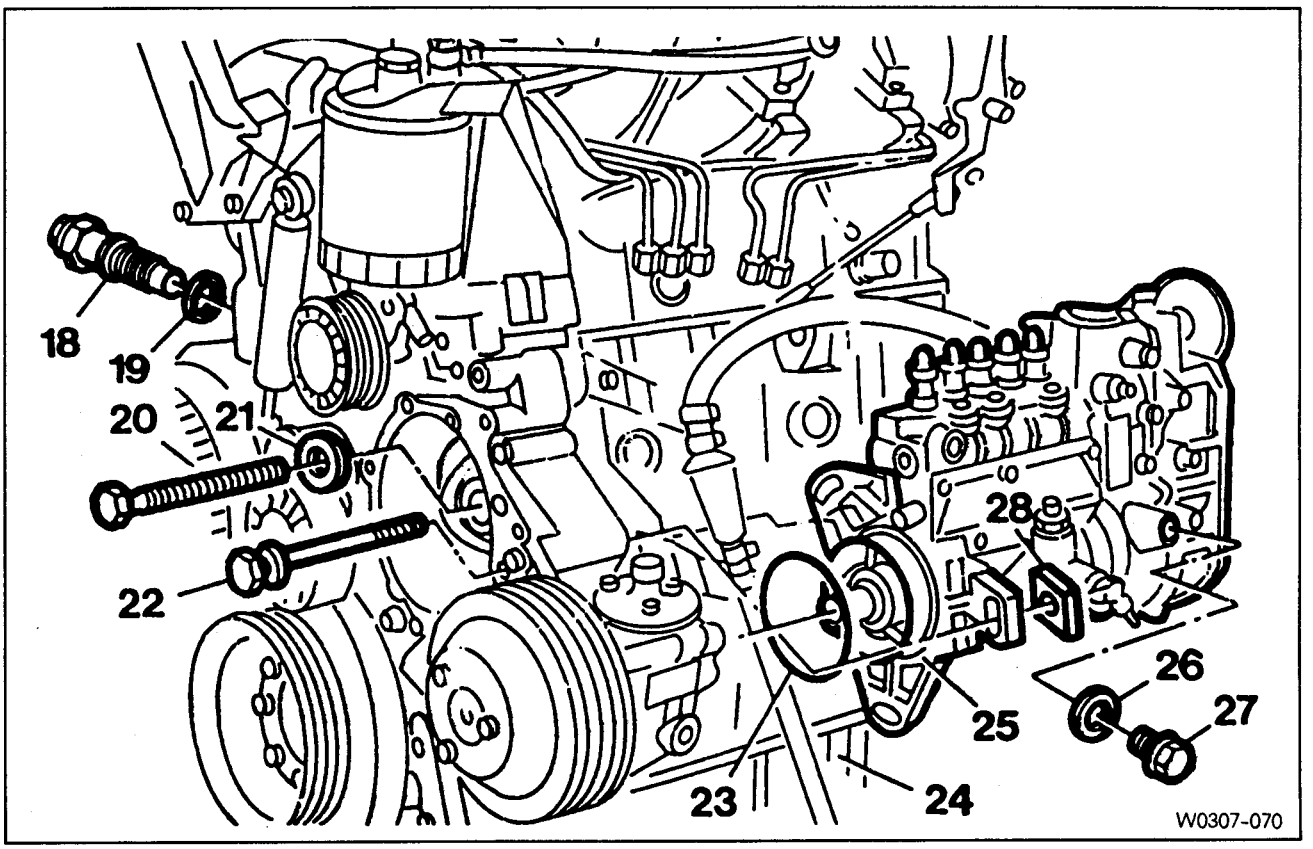
4) Turn the adjusting screw (2) until the specification (15° ± 1° ATDC) is indicated on the digital tester.

To the right	Start of delivery retarded
To the left	Start of delivery advanced



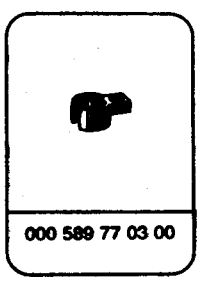
16. Removal and Installation of Fuel Injection Pump

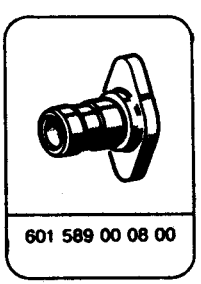
Preceding work : Removal of vacuum pump
Removal of air cleaner housing
Removal of intake manifold

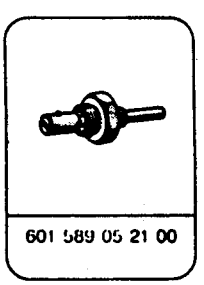


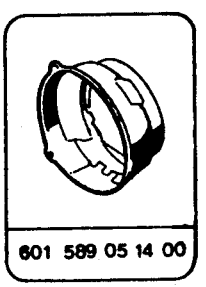
18. Chain Tensioner ---------- 80Nm
19. Seal ---------- Replace
20. Bolt (Left-Hand Thread) -------- 46Nm
21. Washer
22. Bolt ---------- 23Nm
23. Seal ---------- Replace
24. Oil Pan
25. Fuel Injection Pump
26. Seal ---------- Replace
27. Screw Plug ---------- 30Nm
28. Square Nut

Special tools


000 589 77 03 00

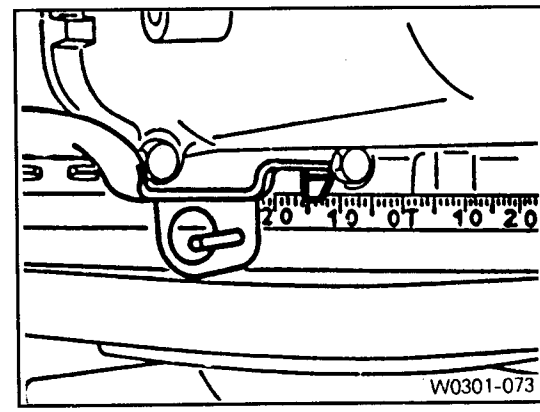

601 589 00 08 00


601 589 05 21 00


601 589 05 14 00

Removal

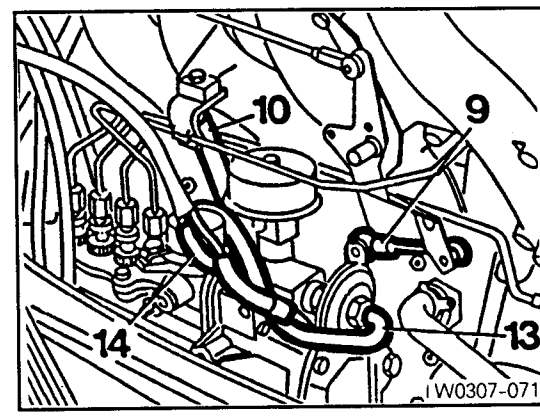
1) Position the no.1 cylinder at 15° ATDC .
   [Note] Do not rotate the engine in opposition direction of engine rotation.



2) Remove the connecting rod (9).

3) Disconnect the vacuum lines (13, 14).

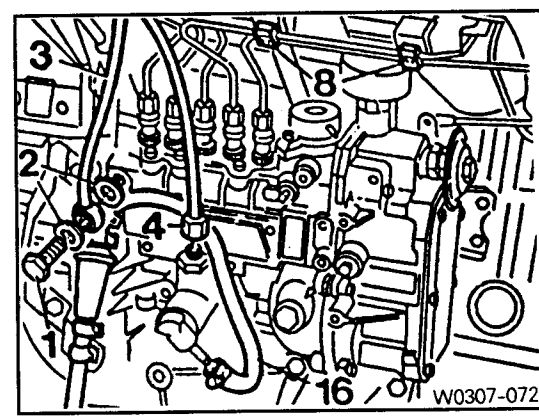
4) Remove the accelerator control damper (10).
   (Manual transmission vehicle)



5) Remove the suction line (16) and pressure line (4).

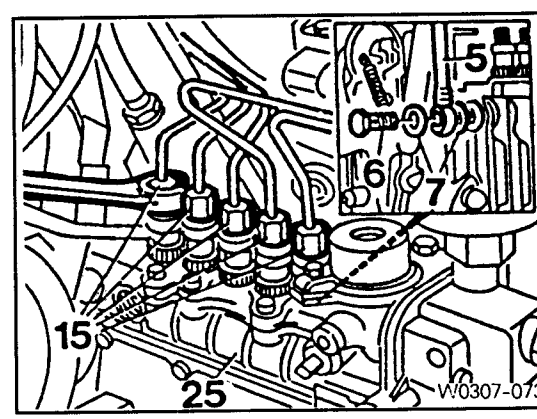
6) Remove the banjo bolt (1) and then remove the seal (2) and fuel line (3).

7) Remove the plastic clip (8) on the injection line.

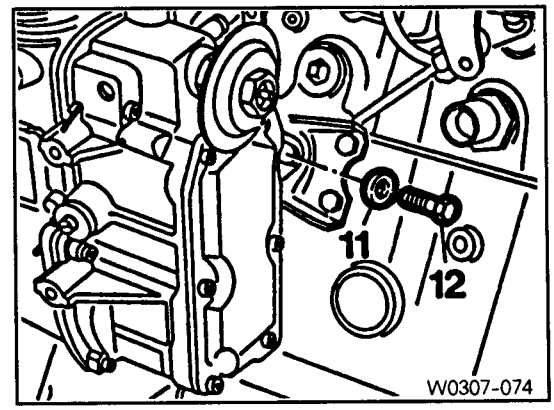


8) Disconnect the injection lines (15) from the injection pump (25).

9) Remove the banjo bolt (1) and then remove the seal (7) and return line (5).

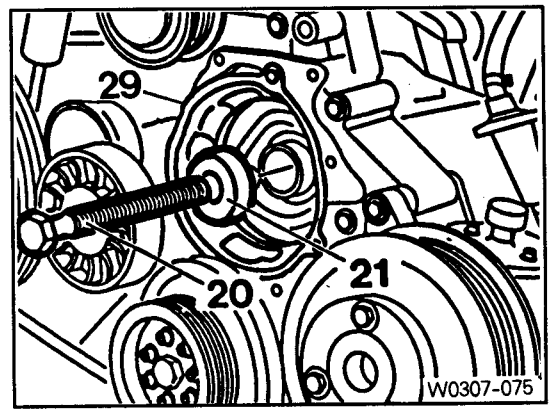


10) Remove the bolt (12) and pull off the washer (11).

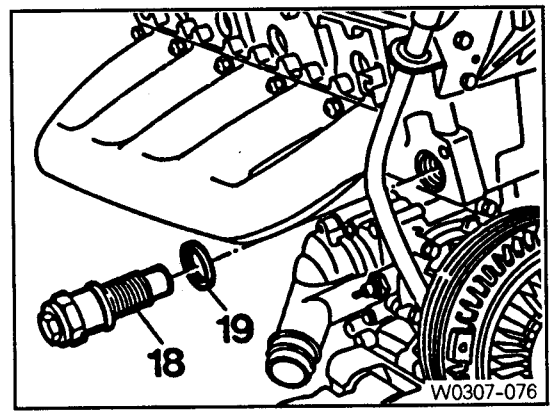


11) Install the assembly cage (29) and remove the bolt (20) and pull off the washer (21).
[Note] Be careful that the bolt (20) is left-hand thread.

Assembly cage 601 589 05 14 00

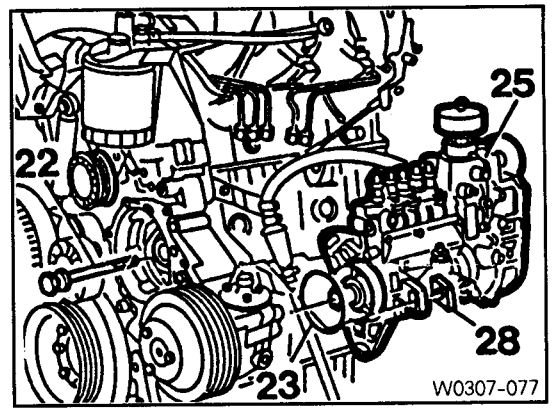


12) Remove the chain tensioner (18) and seal (19).



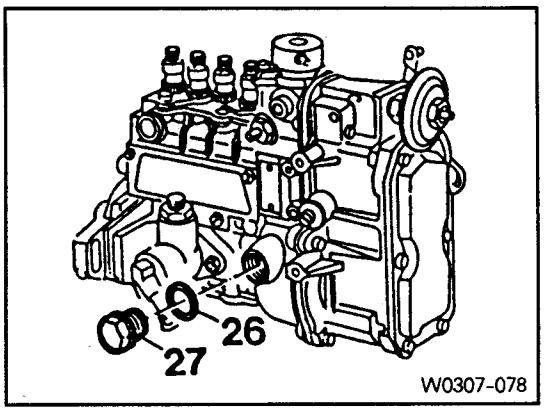
13) Remove the bolt (22) and pull off the square nut (28).

14) Pull out the fuel injection pump (25) and seal (23).



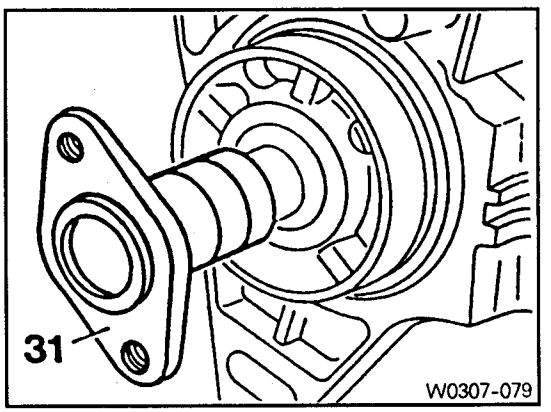
Installation

1) Remove the screw plug (27) and seal (26) and collect oil in a vessel.



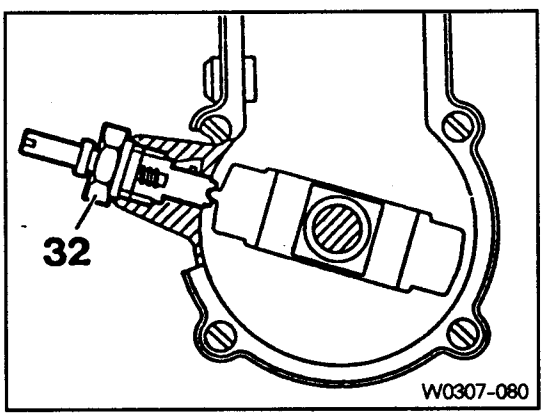
2) Insert flange (31) onto the injection pump camshaft and turn until the cam of the governor is visible in the hold.

Flange 601 589 00 08 00

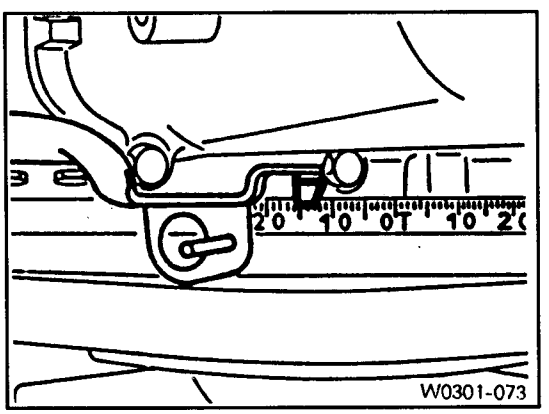


3) Tighten the locking screw.

Locking screw 601 589 05 21 00



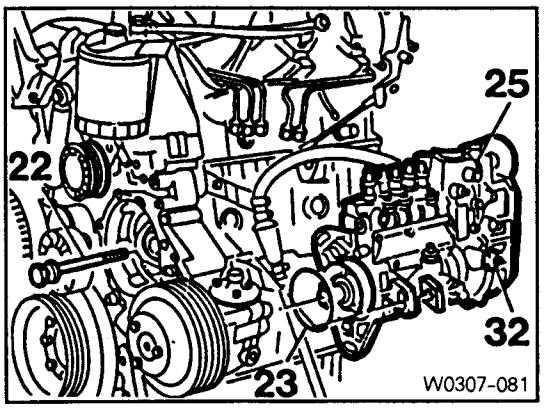
4) Ensure that the no.1 cylinder is positioned at 15° ATDC.



5) Coat the new seal (23) with engine oil and install it.

6) Insert the fuel injection pump (25) and tighten the bolts (22).

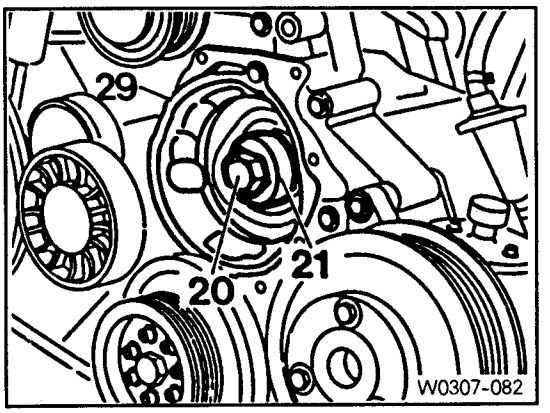
Tighten torque	23Nm



7) Remove the locking screw (32).

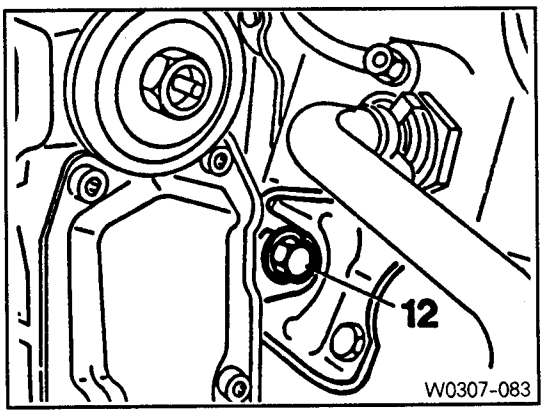
8) Insert the washer (21) and tighten the bolts (20) and then remove the assembly cage (29).

Tighten torque	46Nm



9) Tighten the bolt (12).

Tighten torque	23Nm

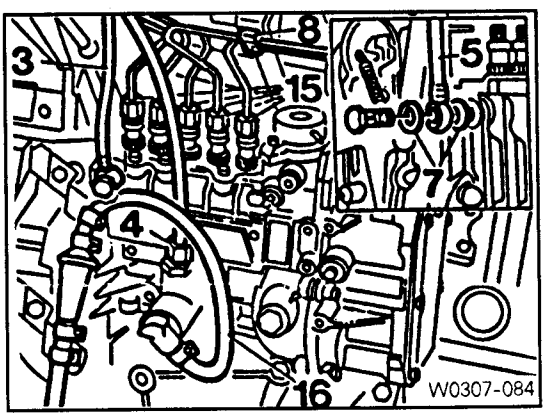


10) Connect the fuel pipes.

Return line (5)	13Nm
Fuel injection line (15)	18Nm
Fuel feed line (3)	13Nm
Suction (16) and pressure line (4)	13Nm

[Note] Replace the seal.

Box wrench insert 000 589 77 03 00

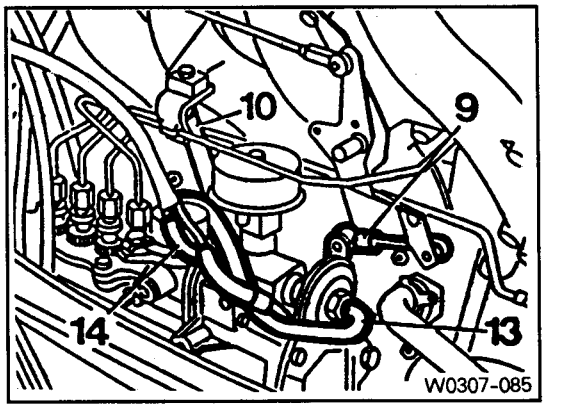


11) Assemble the plastic clip (8).

12) Connect the vacuum line (13, 14).

13) Connect the connecting rod (9).

14) Connect the accelerator control damper (10).
(Manual transmission vehicle)



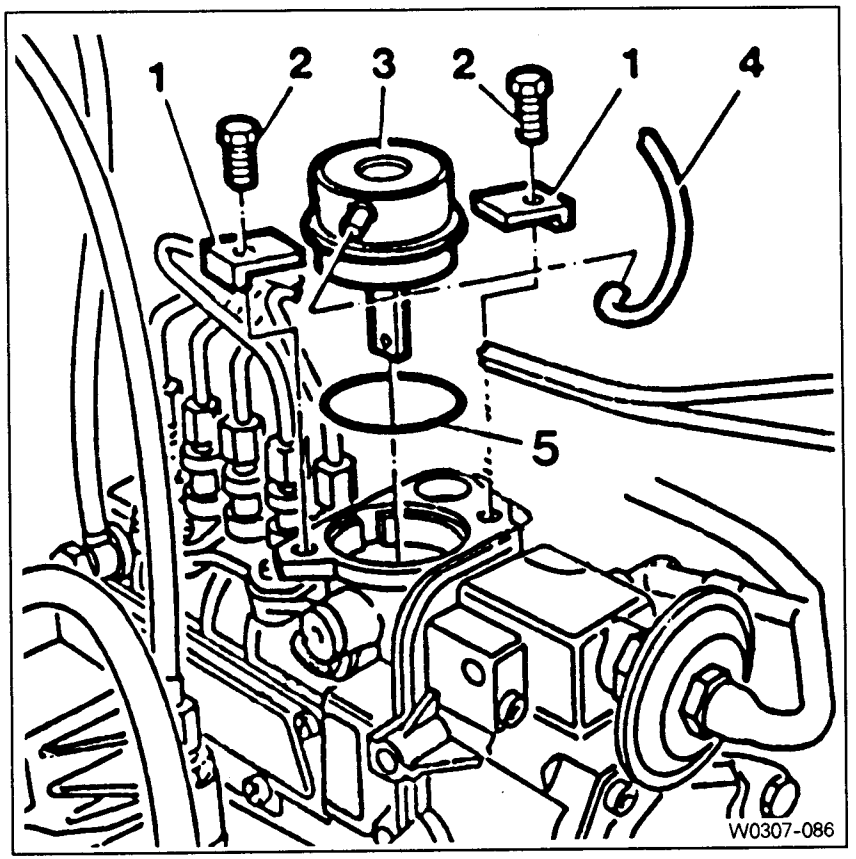
15) Install the chain tensioner.

16) Install the vacuum pump.

17) Check the start of delivery.

18) Adjust the idle speed.

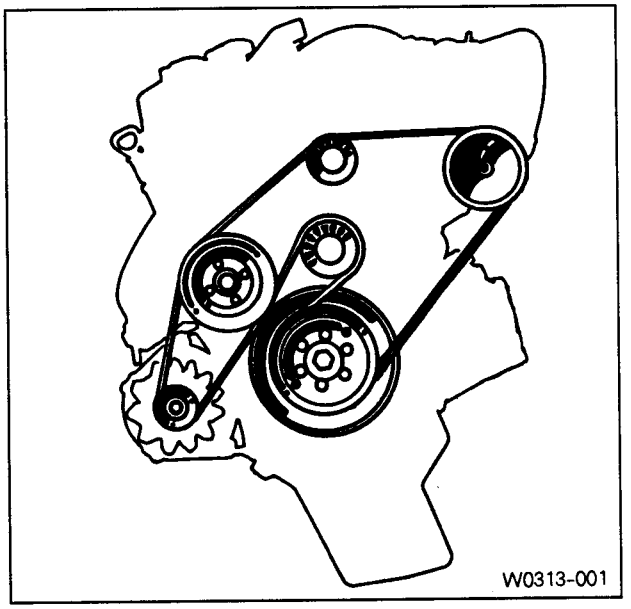
17. Vacuum Unit Replacement



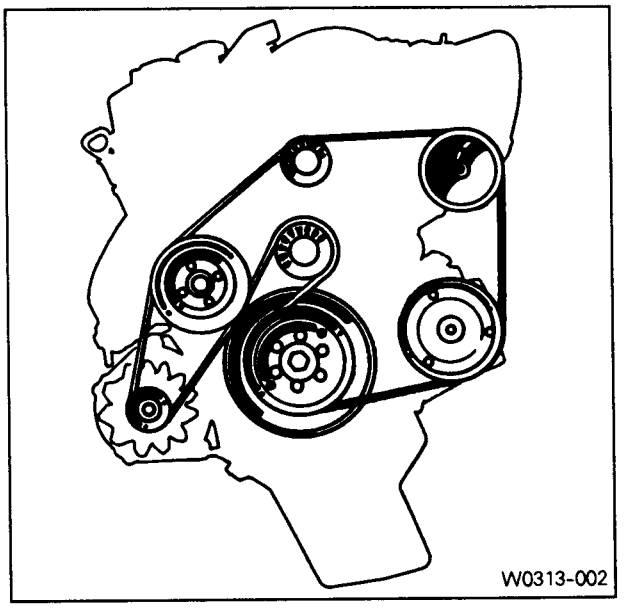
1. Bracket
2. Bolt
3. Vacuum Unit
4. Vacuum Line
5. Seal----------Replace

1. Belt Arrangement and Inspection

OM 661 Engine

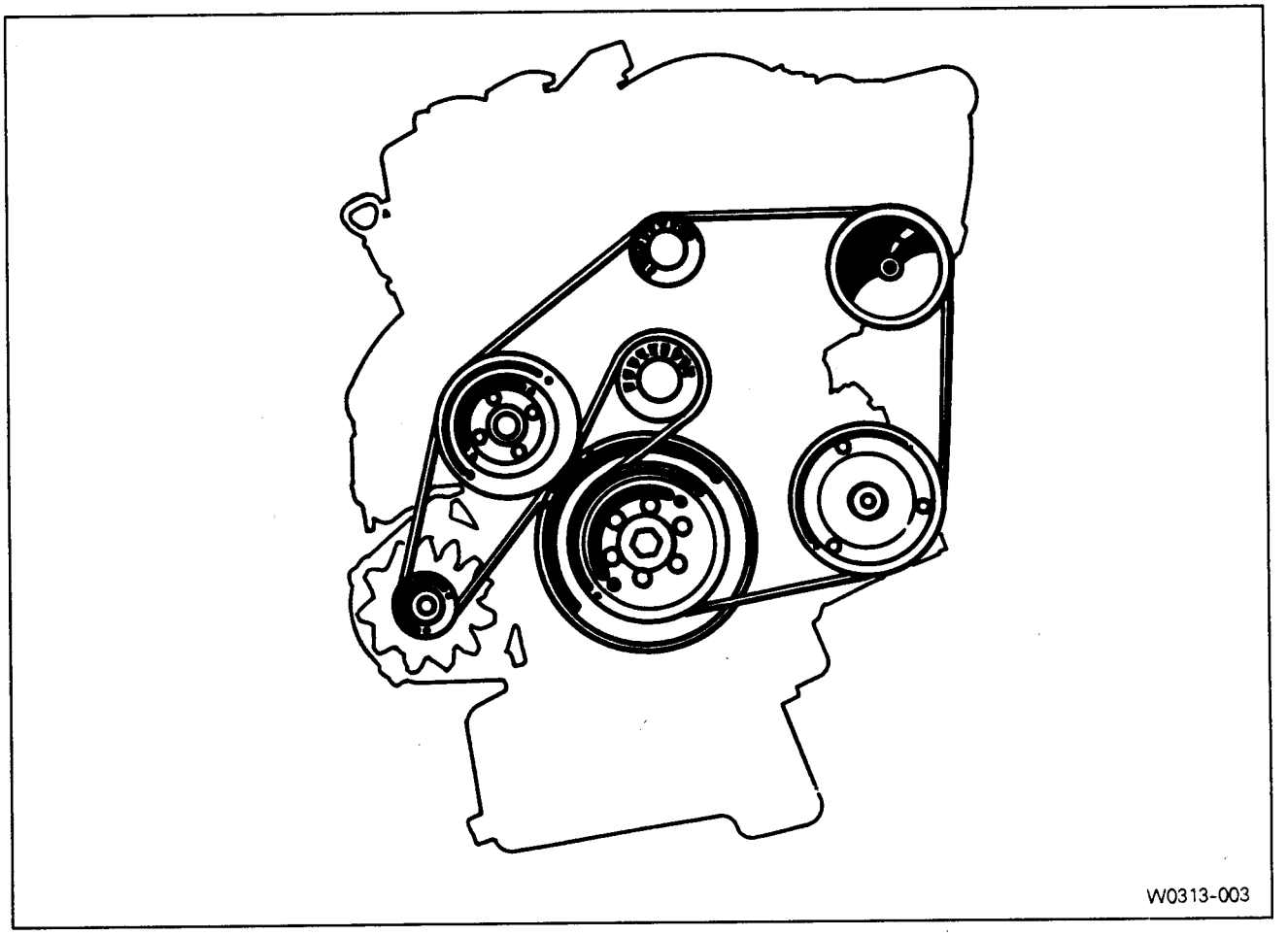


Without Air Conditioner



With Air Conditioner

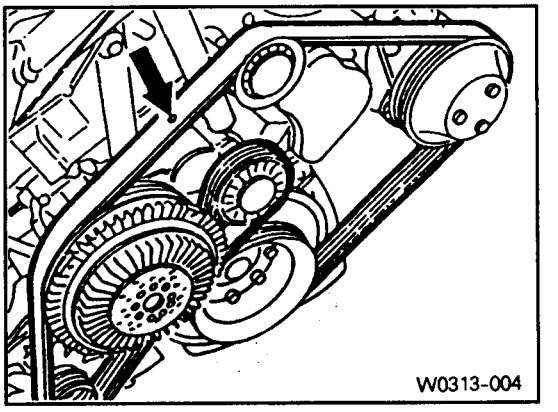
OM 662 Engine



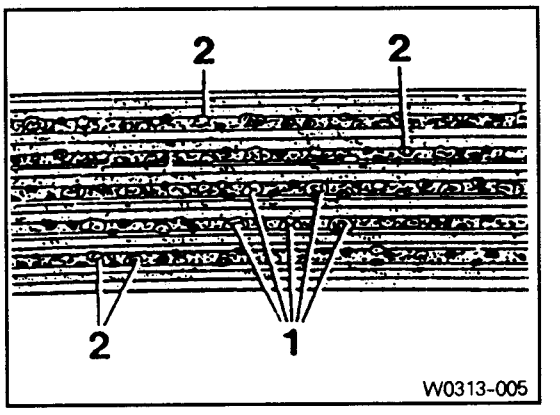
Inspection

1) Mark poly V-belt at a clearly visible point with chalk.

2) Rotate the engine and check the belt.
[Note] If one of the following types of damage is found, replace the belt.

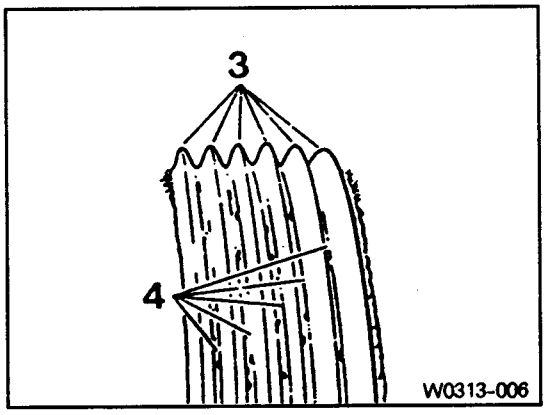

W0313-004

1. Rubber lumps in the base of rips.
2. Dirt or grit ingrained.



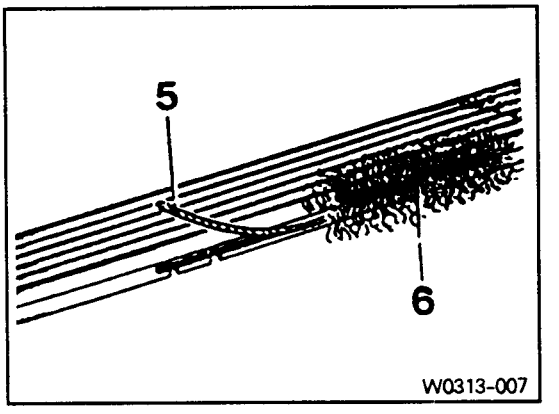
W0313-005

3. Pointed rips.
4. Belt cord visible in the base of rips.



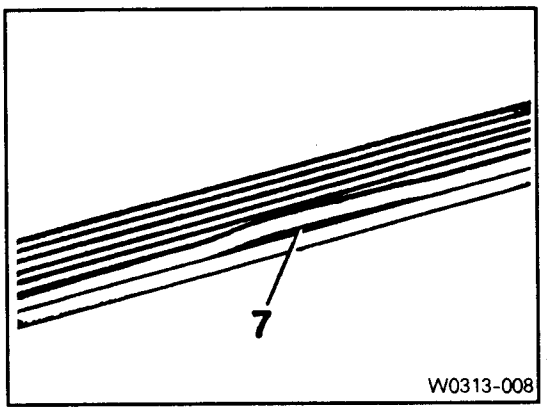
W0313-006

5. Cord torn out at the side.
6. Outer cords frayed.



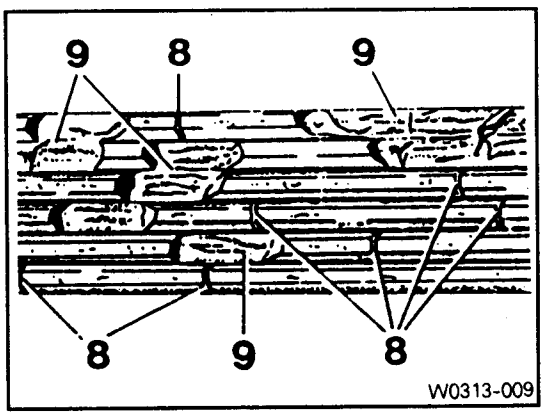
W0313-007

7. Belt detached from the base of rip.

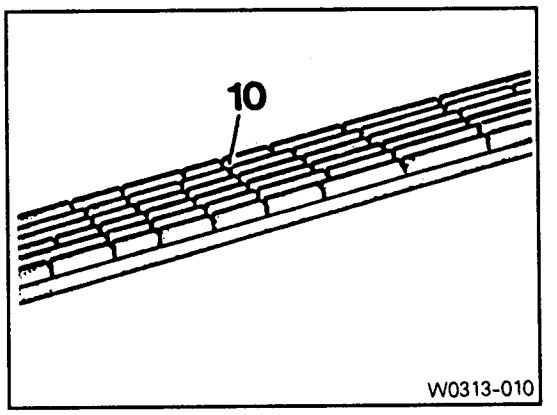


8. Splits across the rips.

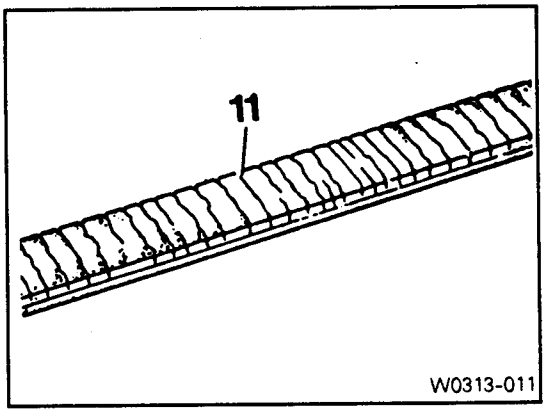
9. Sections of rip torn out.



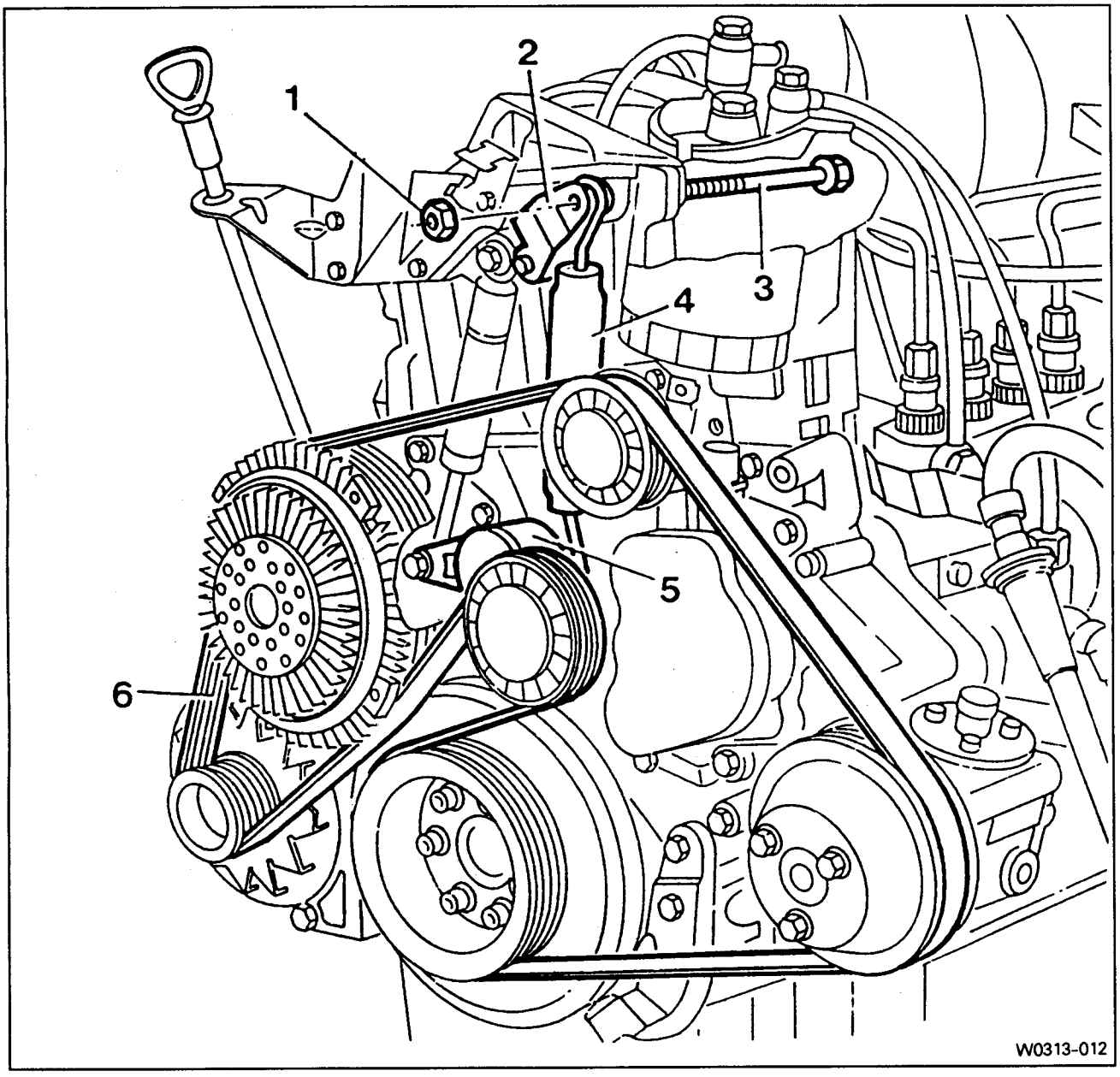
10. Splits across several rips.



11. Splits across the back.



2. Removal and Installation of Poly V-Belt

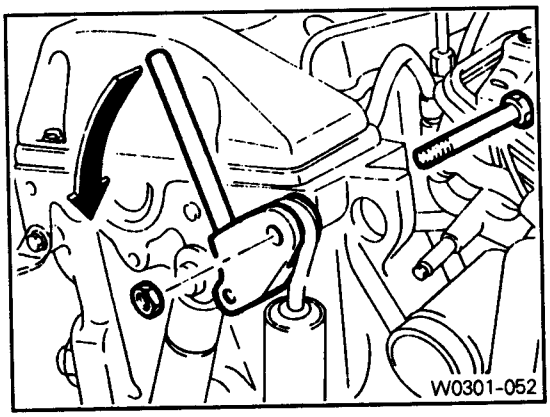


1. Nut----------23Nm
2. Tensioning Lever
3. Bolt
4. Spring
5. Tensioning Lever
6. Poly V-Belt

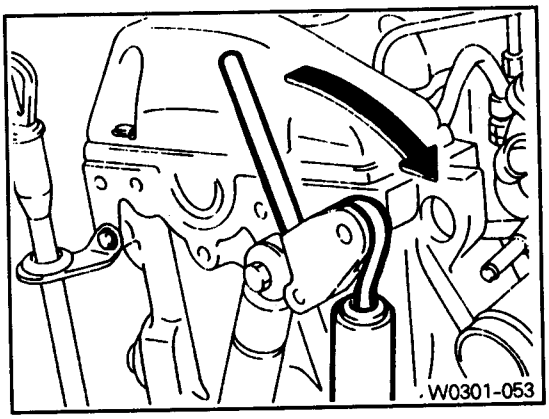
Removal · Installation

1) Remove the nut (1).

2) Push the tensioning lever (2) in direction of arrow with a rod (ϕ 12 × 180mm) and pull out the bolt (3) to the rear.

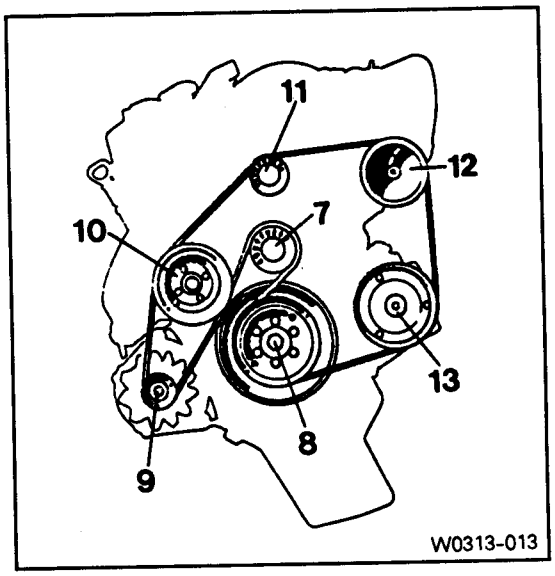


3) Push back the tensioning lever (arrow direction) to release the spring tension and remove the belt.



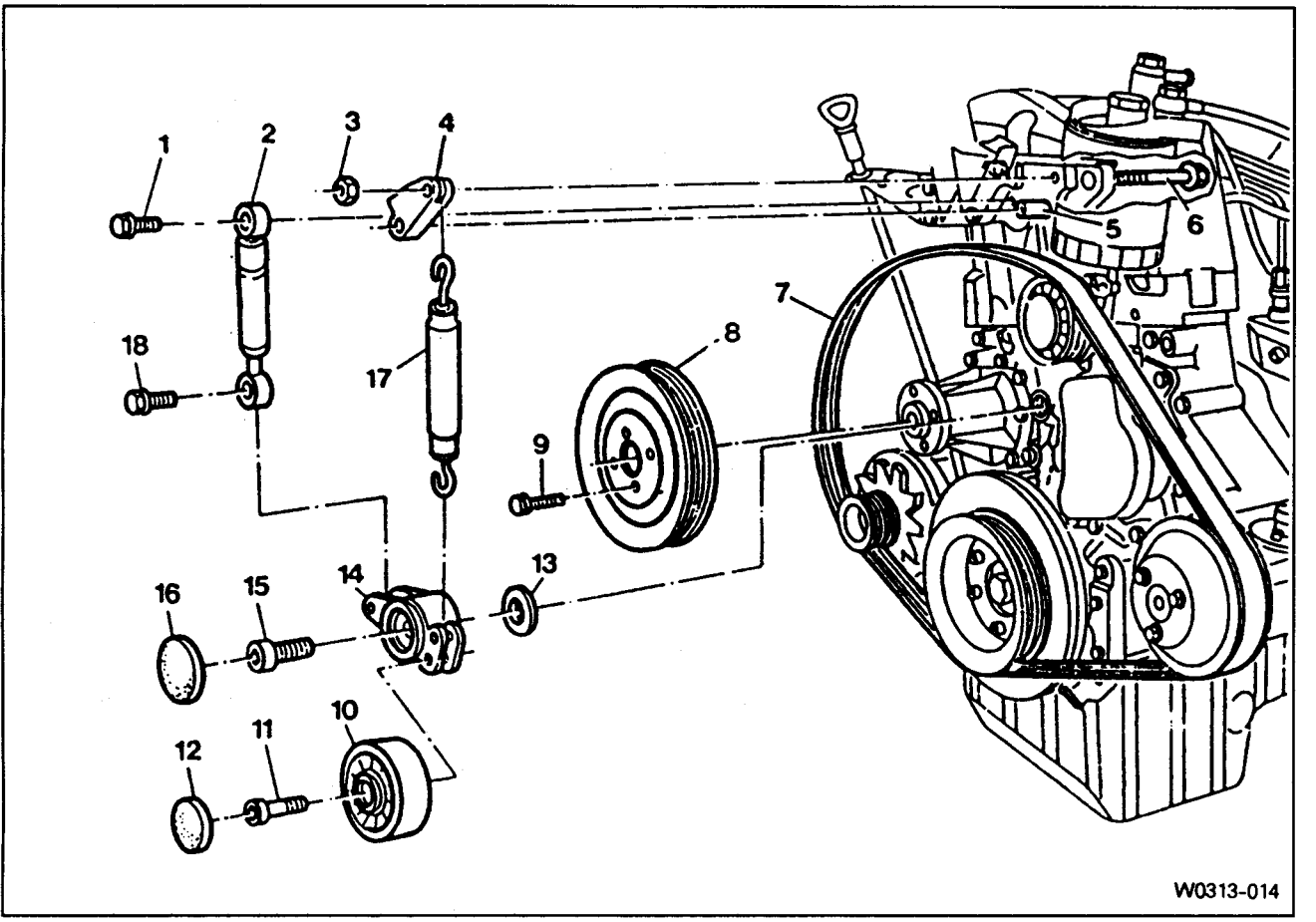
4) Install the poly V-belt beginning at the tensioning pulley (7).

7. Tensioning Pulley
8. Crankshaft
9. Alternator
10. Coolant Pump
11. Guide Pulley
12. Power Steering Pump
13. Aircon. Compressor



3. Removal and Installation of Poly V-Belt Tensioning Device

Preceding work : Removal of cooling fan



1. Bolt----------23Nm
2. Damper
3. Nut
4. Tensioning Lever
5. Guide Rail Pin
6. Bolt
7. Poly V-Belt
8. Belt Pulley
9. Bolt----------10Nm
10. Tensioning Pulley
11. Socket Bolt----------29Nm
12. Closing Cover
13. Washer
14. Tensioning Lever
15. Fit Bolt----------100Nm
16. Closing Cover
17. Spring
18. Bolt----------22Nm

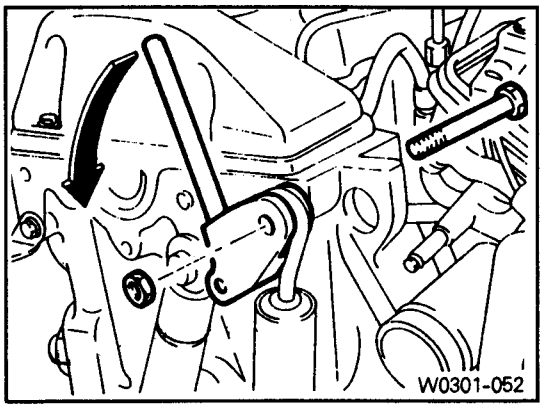
Removal · Installation

1. Remove the nut.

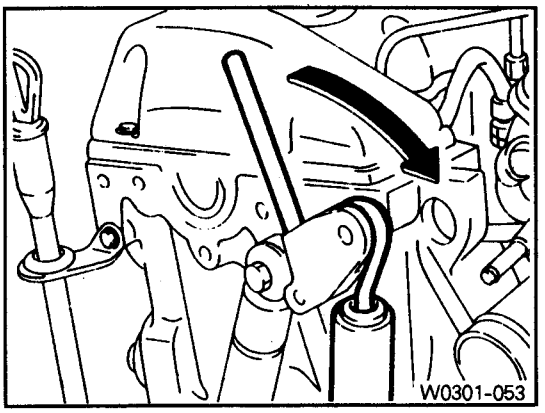
Installation

Tightening torque	23Nm

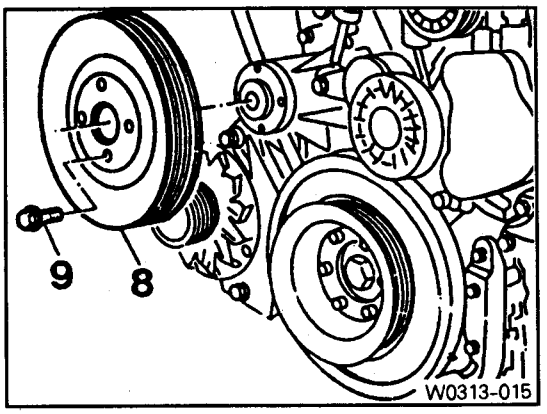
2) Push the tensioning lever in direction of arrow with a rod (φ12 × 180mm) and push out the bolt to the rear.



3) Push back the tensioning lever to release the spring tension and remove the belt.



4) Remove the bolt (9) and then remove the belt pulley (8).

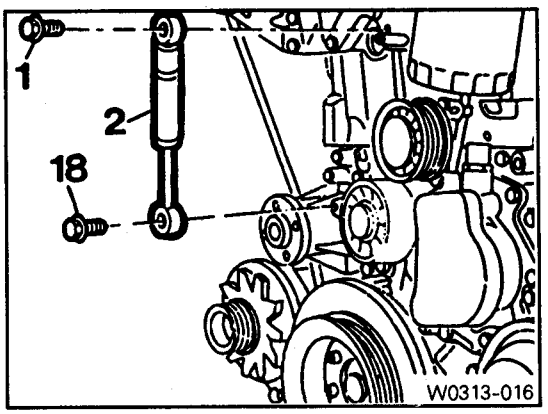


5) Remove the bolt (1, 18) and take off the damper (2).

Installation

Tightening torque (1)	23Nm
Tightening torque (18)	22Nm

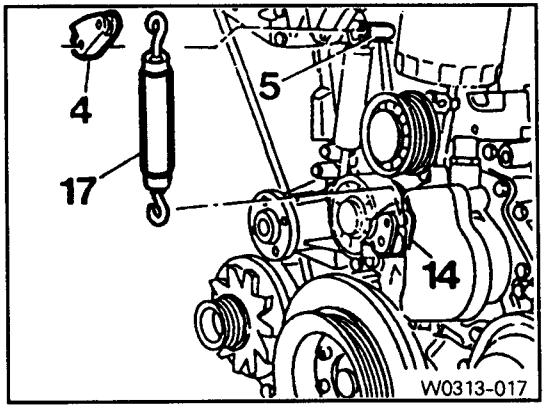
[Note] Pay attention to installation position of the damper.



6) Pull off the tensioning lever (4) from guide rail pin.

7) Remove the spring (17).

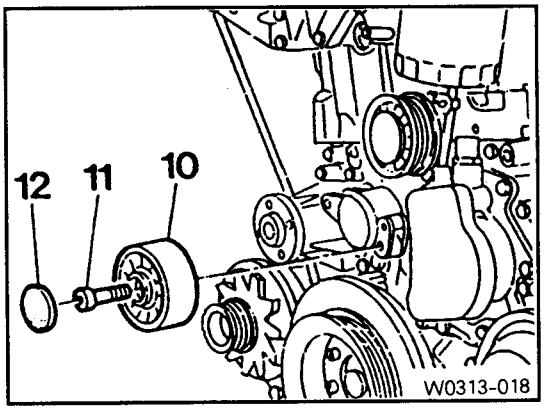
Installation
Insert spring (17) with color coding (blue/violet) facing up.



8) Pry off the closing cover (12) and remove the socket bolt (11) and then remove the tensioning pulley (10).

Installation

Tightening torque	29Nm



9) Pry off the closing cover (16) and remove the fit bolt (15).

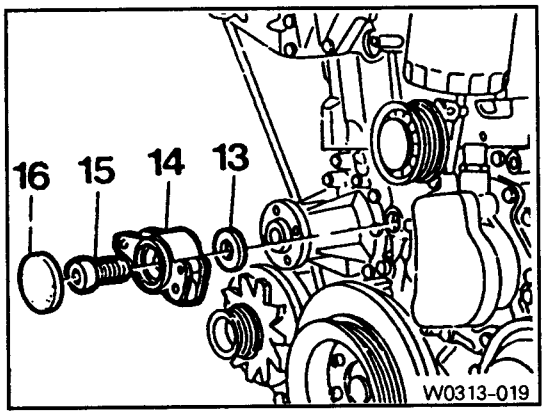
10) Remove the tension lever (14) and washer (13).

11) Clean thread in the timing case cover and fit bolt.

Installation

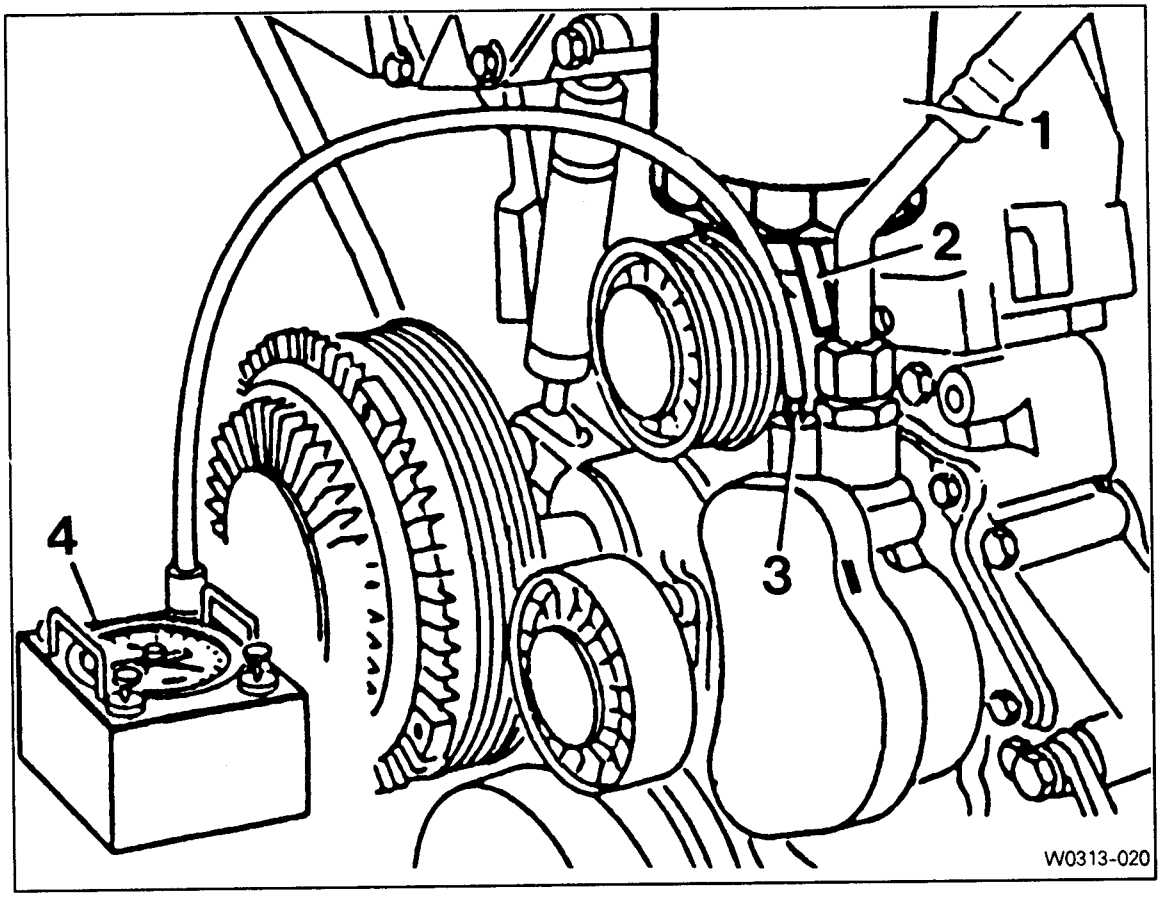
Apply Loctite on thread of fit bolt.

Tightening torque	100Nm



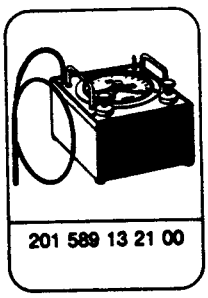
12) Installation is reverse order of the removal.

4. Vacuum Pump Test



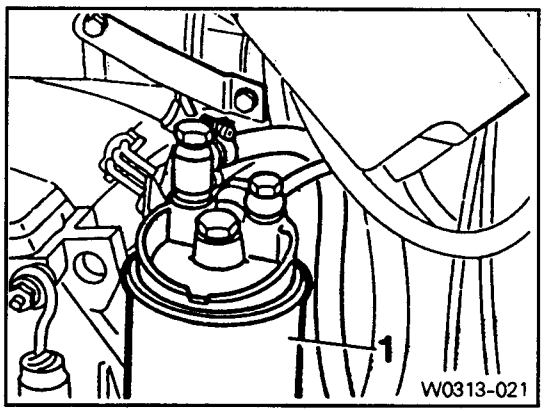
1. Fuel Filter
2. Vacuum Line
3. Ancillaries Connection
4. Vacuum Tester

Special tool



Test

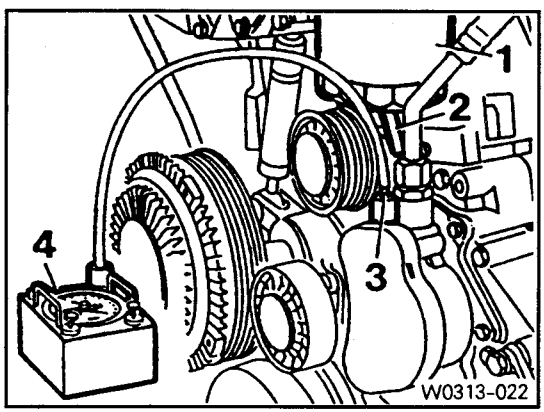
1) Remove the fuel filter (1) and keep the filter not to be damaged from running engine.



2) Remove the vacuum line (2) from ancillaries connection (3).

3) Connect the vacuum tester (4) to the ancillaries connection (3).

Vacuum tester 201 589 13 21 00



4) Run the engine at idle and check vacuum after 30 sec..

Standard	> 700mbar

[Note] If out of standard, replace the vacuum pump.

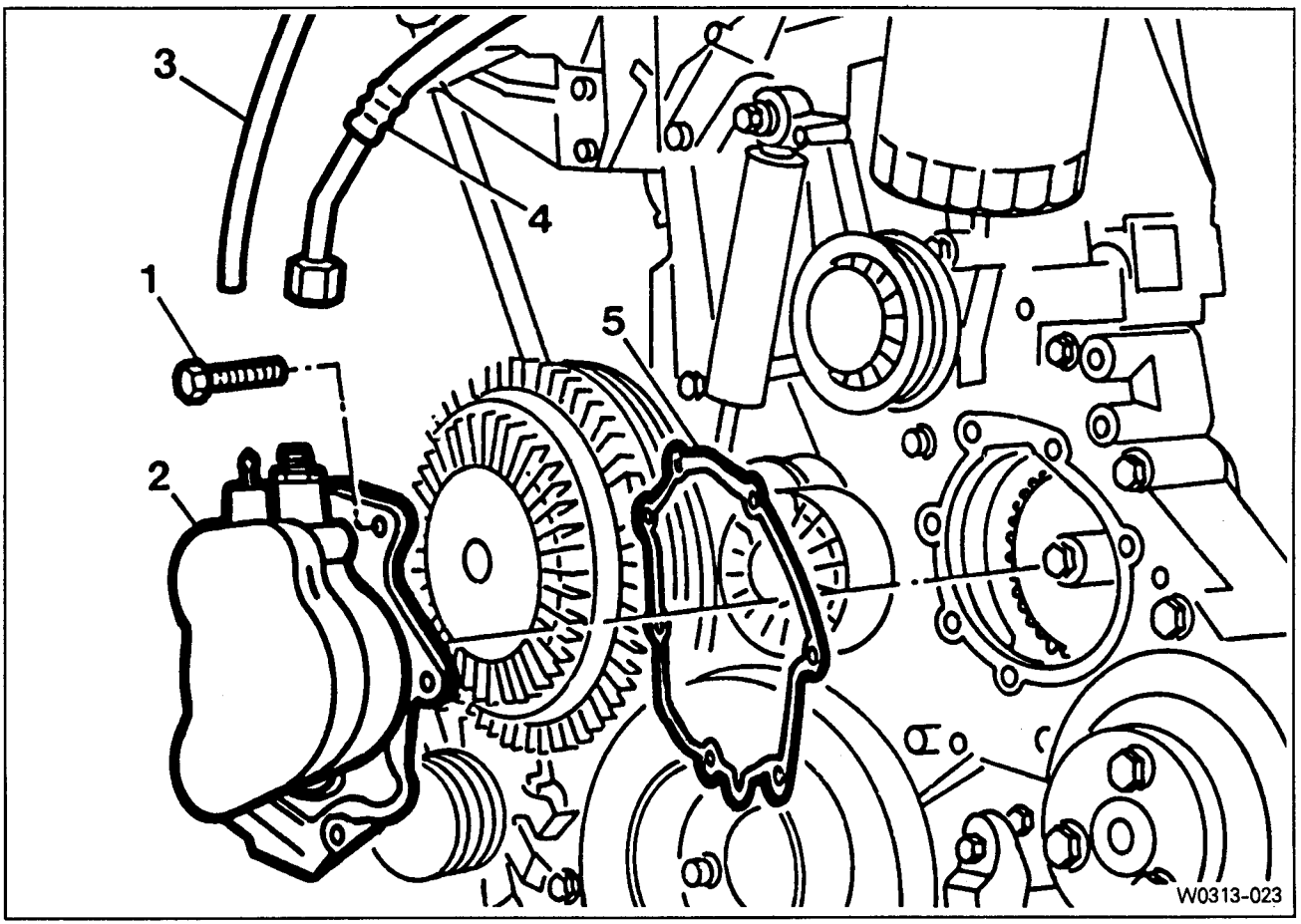
5) Remove the vacuum tester.

6) Connect the vacuum line to the ancillaries connection.

7) Install the fuel filter.

5. Removal and Installation of Vacuum Pump

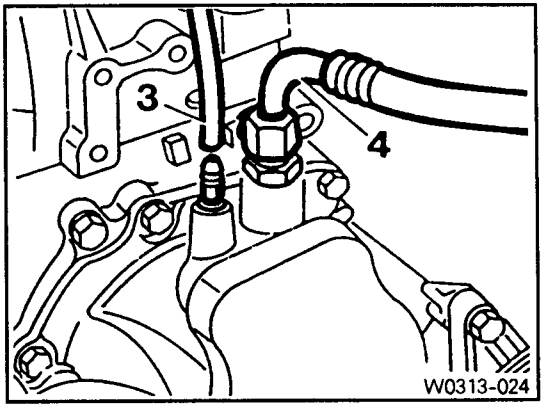
Preceding work : Remove the poly V-belt



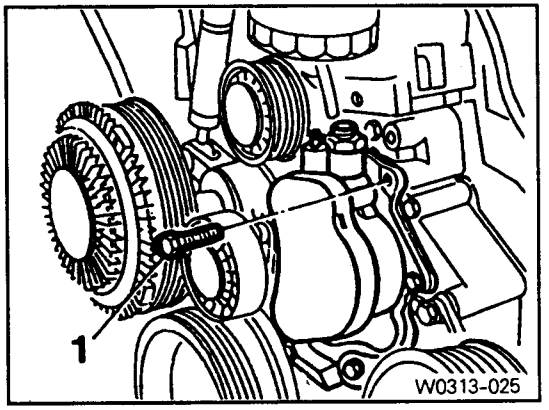
1. Bolt ----------10Nm
2. Vacuum Pump
3. Vacuum Line (Ancillaries)
4. Vacuum Line (Brake Booster)
5. Gasket- ----------Replace

Removal · Installation

1) Disconnect the vacuum line (3, 4).



2) Remove the bolts (1) evenly.
[Note] If necessary, rotate the engine until the pressure on the tappet of the vacuum pump is released.



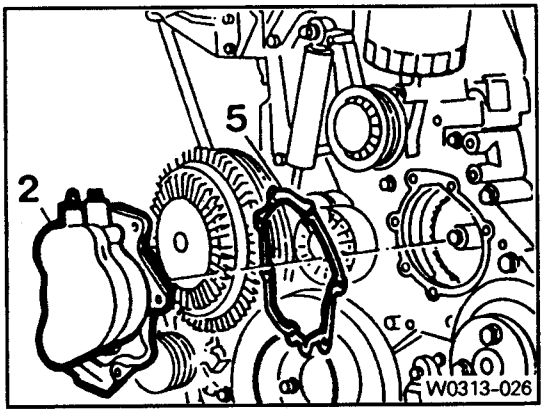
3) Remove the vacuum pump (2).

4) Install the vacuum pump (2).

Tightening torque	10Nm

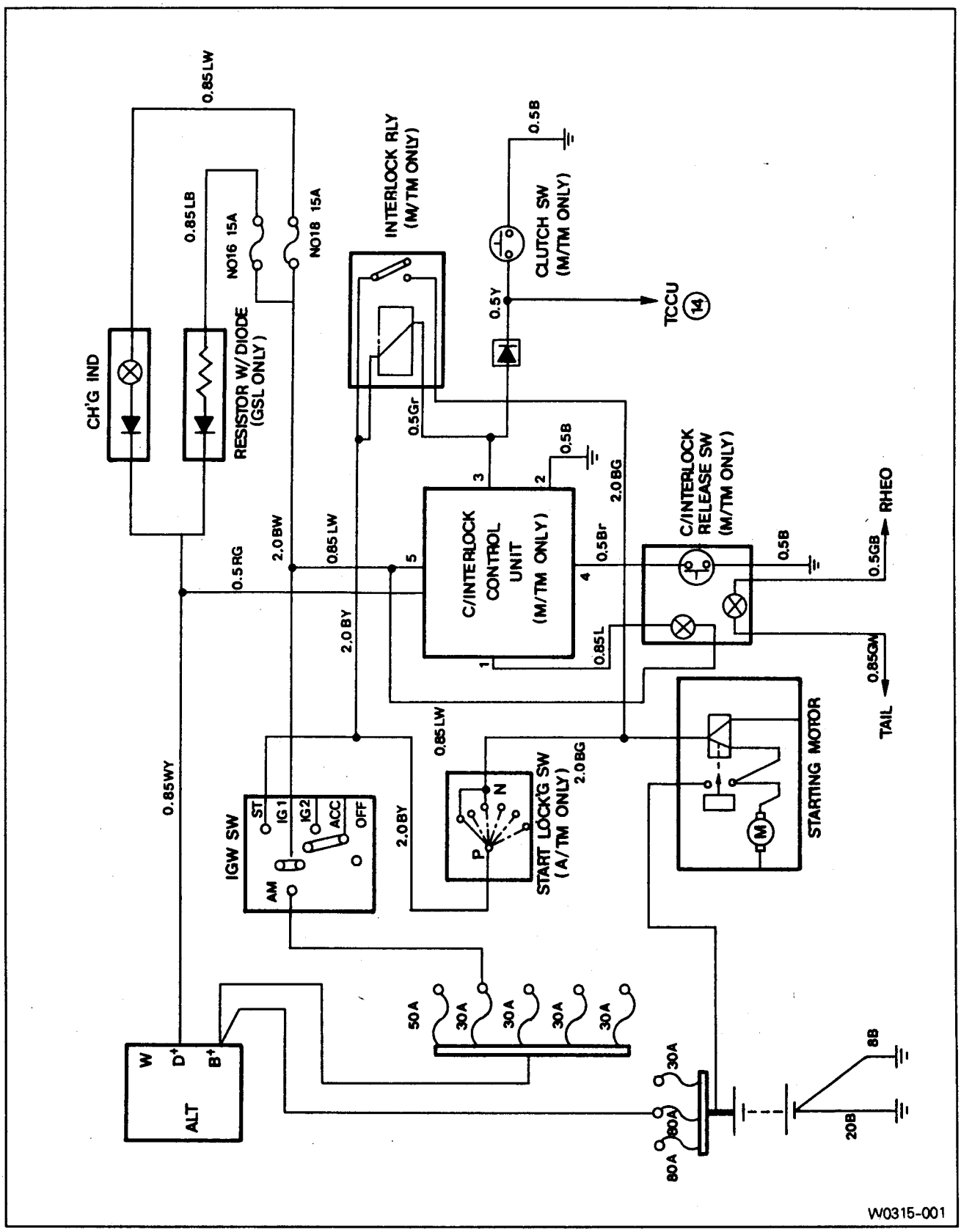
[Note] Clean the gasket residues of sealing surface of vacuum pump and replace the gasket.

5) Connect the vacuum line (3, 4).

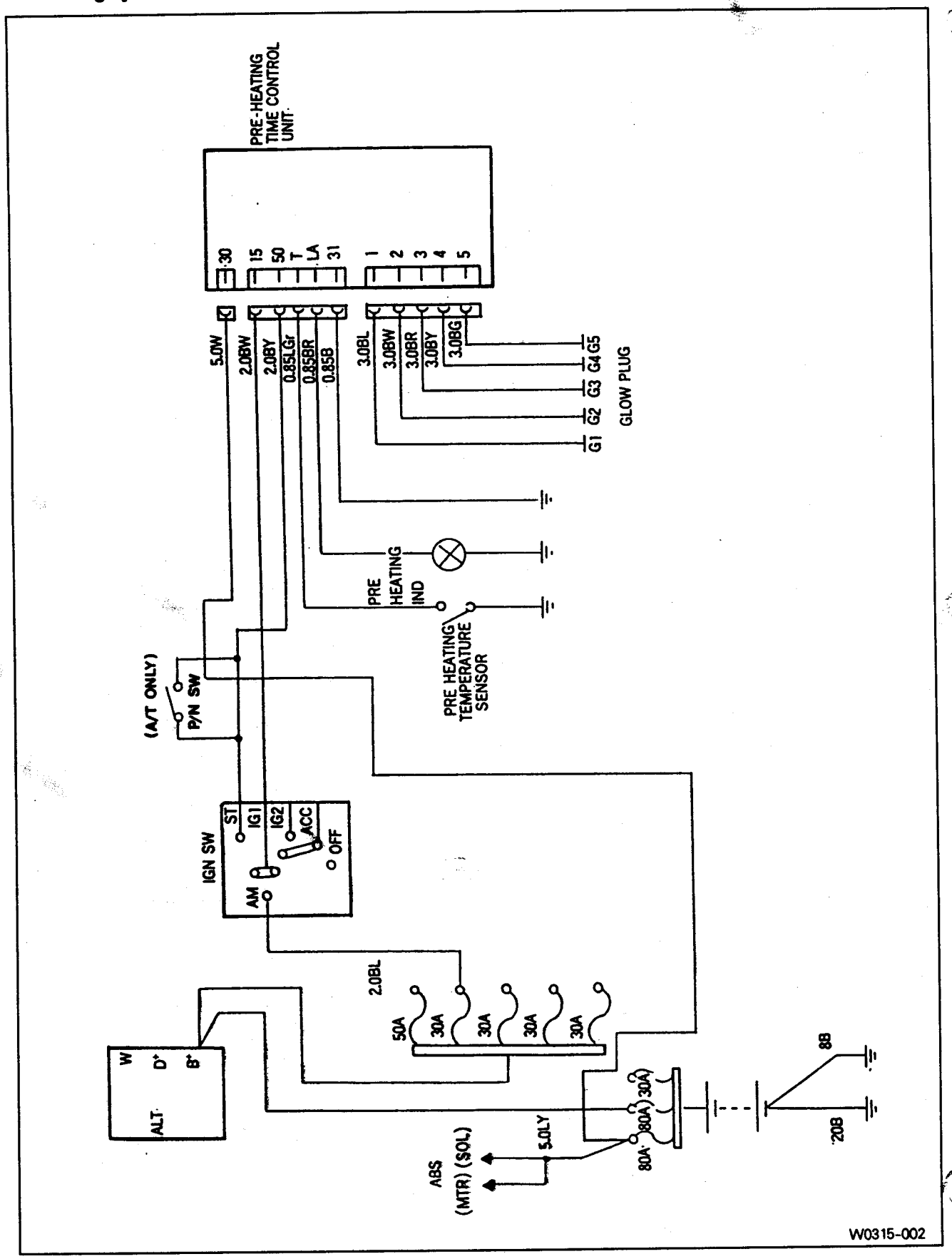


1. Circuit Diagram

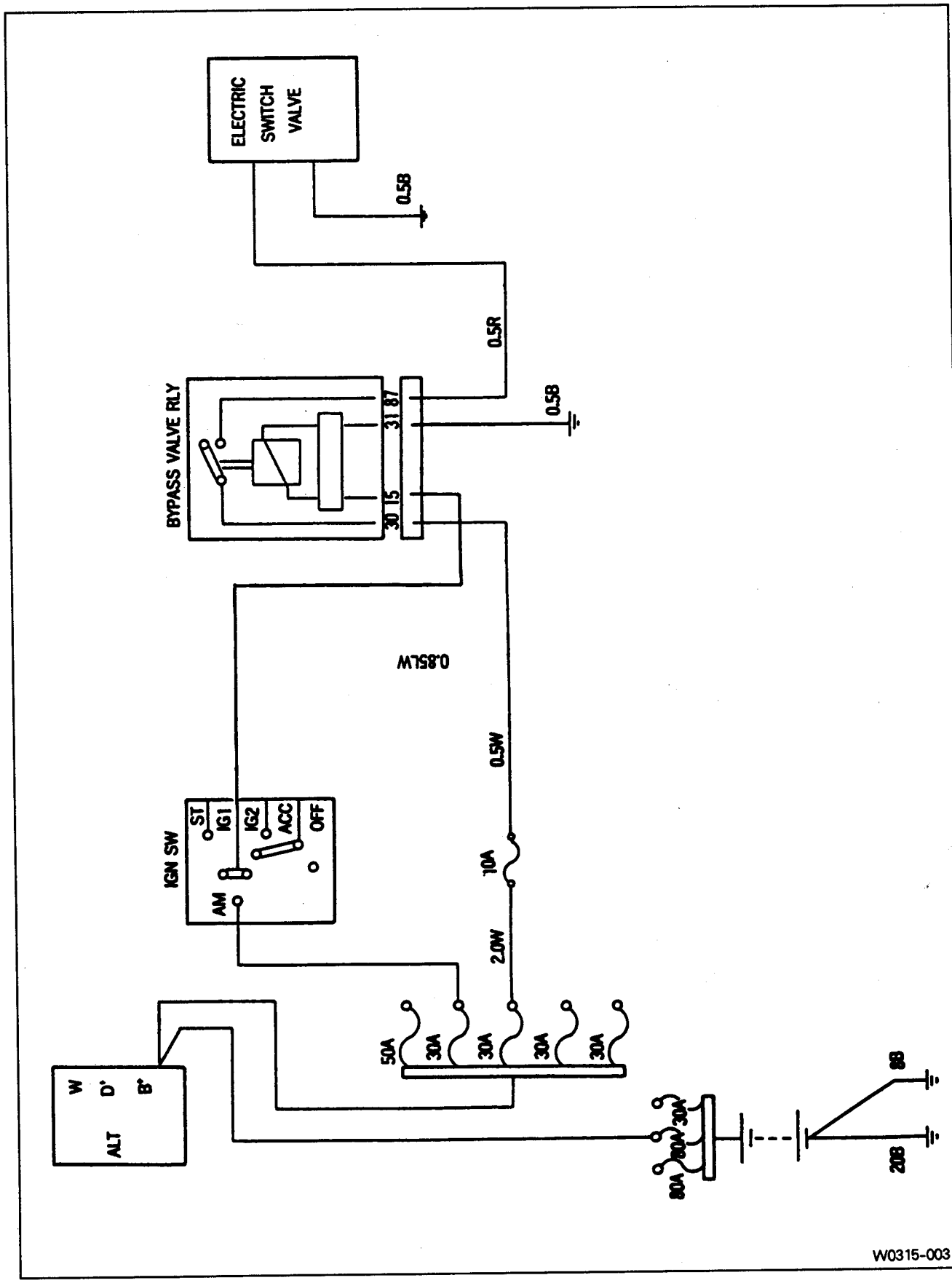
Starting and charging system



Preheating system



Fuel-cut system



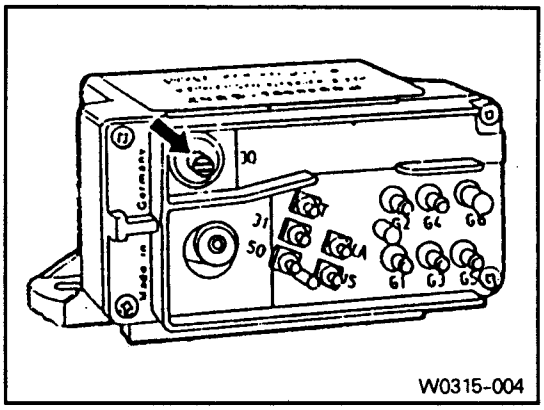
2. Preheating System

General information

The preheating system consists of control relay, coolant temperature sensor and glow plugs.

- Control relay - preheating time.
- Coolant temperature sensor.
- Glow plug.

1) Preheating time - control relay.
Control relay functions as followings :
- Switching of preheating current.
- Indication of preheating finish.
- Control of preheating sequence.
- Indication of fault.



W0315-004

2) Coolant temperature sensor.
Coolant temperature sensor senses coolant's temperature and signals it to the preheating relay continuously.

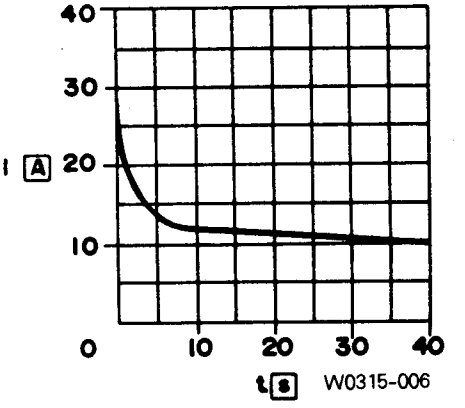
3) Glow plug
The glow plug parts are housing with M12 × 1.25 thread and heating pin in housing. It is connected in a parallel circuit with the specified voltage of 11.5V.
The heating element has a heating coil and a control coil and they are connected in series.

1. Control Coil
2. Heater Coil

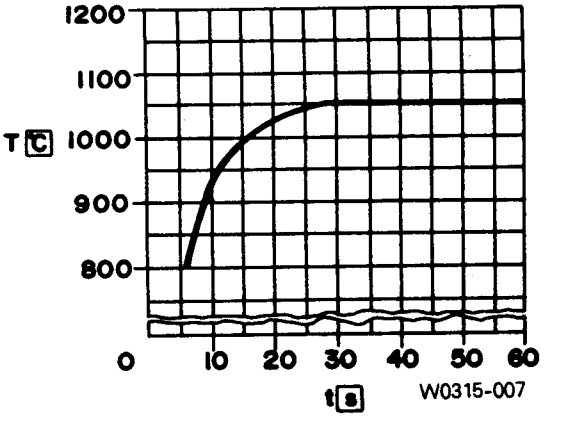
W0315-005

4) Current and temperature of glow plug

- **Current of glow plug**
  While the preheating system operates, current of about 30A flows in each glow plug and temperature of heating coil rises very fast.
  Due to the rise of temperature, the resistance of control coil increases therefore the current is controlled to about 8~15A and that protects the glow plug from over-heating.

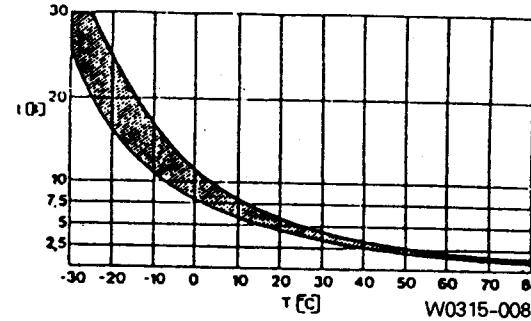


- **Temperature of glow plug**
  The temperature of the glow plug reaches up to 900℃ after about 9 seconds and up to 1,050℃ after 30 seconds.

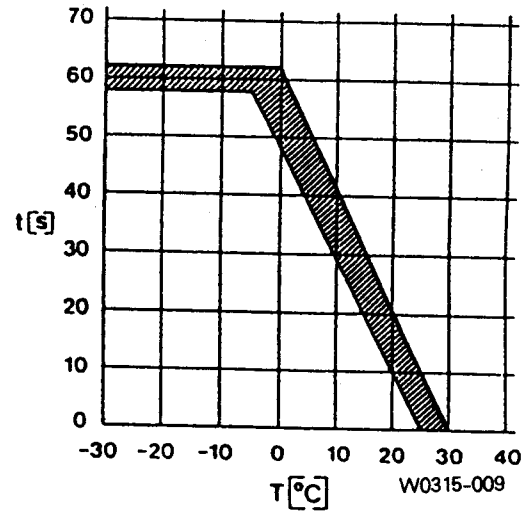


Preheating system operation

1) Preheating before start.
   Preheating time is different by coolant temperature and it is on until the glow indicator light goes off.



2) Preheating after start.
   Preheating continues for max. 60 seconds to rise in characteristic of warming-up on engine after starting too.

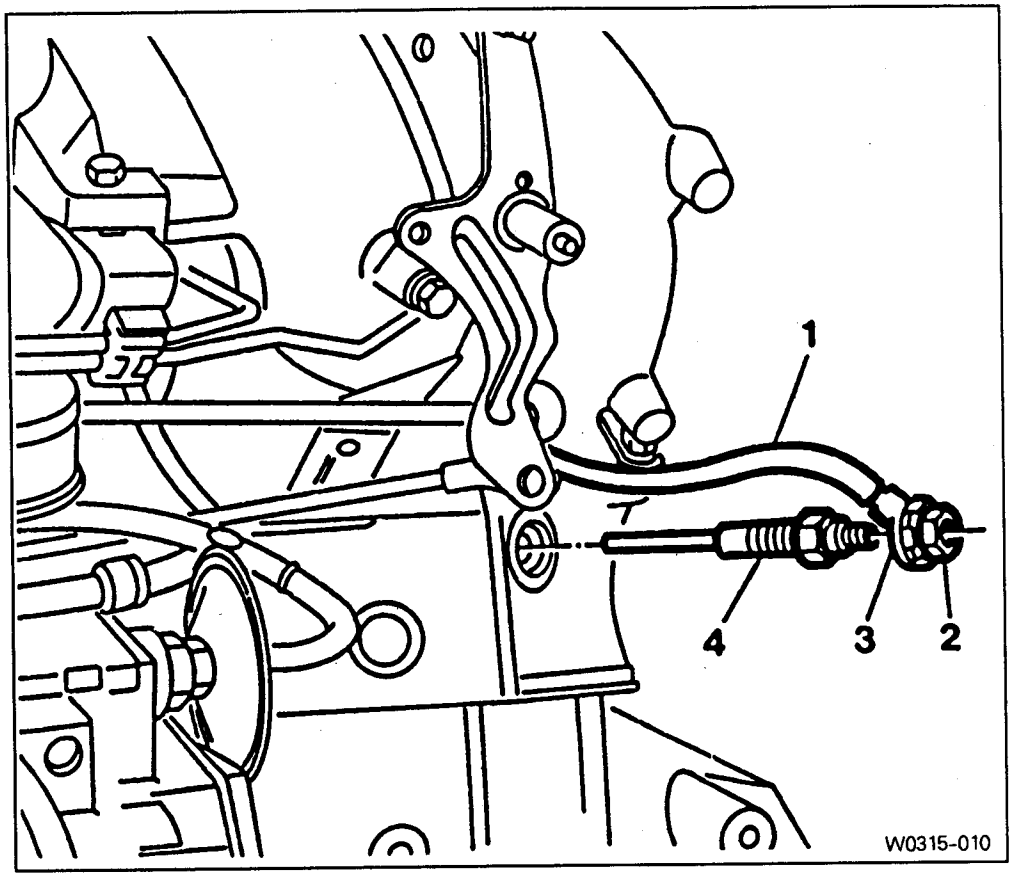


3) Monitoring on glow plug.
   Glow plugs are monitored by low current by the micro processor in control relay respectively while running the engine.
   If glow indicator comes on after starting for about one minute, it indicates one or several plugs are faulty.

Troubleshooting

	Problem	Possible cause
1	Glow indicator does not come on in preheating time and comes on after starting the engine.	- One or several glow plugs are faulty
2	Glow indicator does not come on while preheating and after starting engine.	- Faulty glow indicator - Faulty circuit of glow indicator - Faulty control relay
3	Glow indicator does not go off.	- Faulty control relay
4	Glow indicator does not come on and engine's starting is difficult or does not start at all.	- Circuits short in one or several glow plugs - Faulty preheating circuits - Faulty control relay
5	Glow indicator comes on after starting for about one minute.	- One or several glow plugs are faulty

3. Removal and Installation of Glow Plug

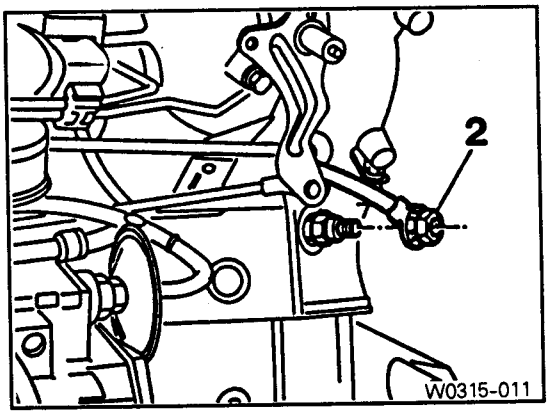


1. Wiring Harness
2. Nut ---------- 4Nm
3. Wire Terminal
4. Glow Plug ---------- 20Nm

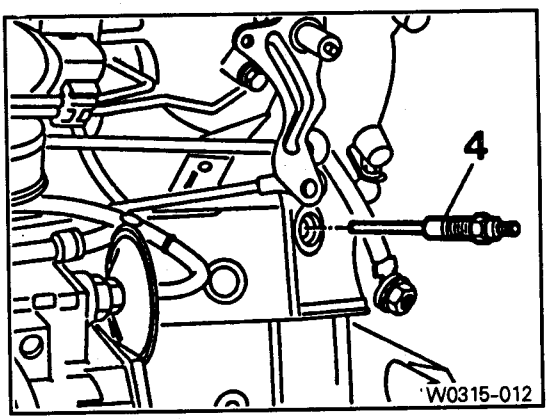
Removal · Installation

1) Disconnect the negative terminal of battery.

2) Remove the nut (2).



3) Remove the glow plug (4).



4) Install the glow plug (4).

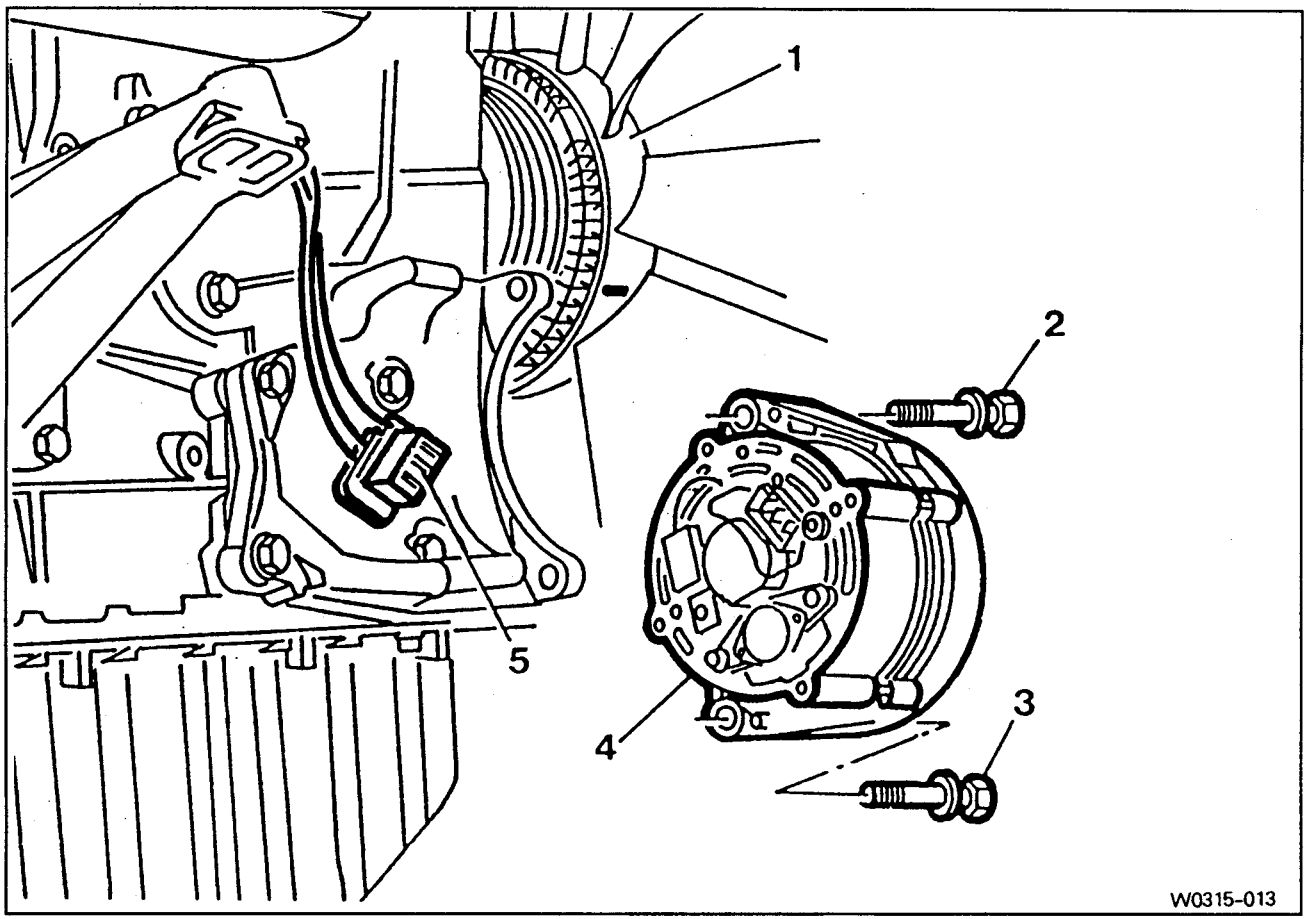
Tightening torque	20Nm

5) Tighten the nut (2).

Tightening torque	4Nm

4. Removal and Installation of Alternator

Preceding work : Removal of poly V-belt

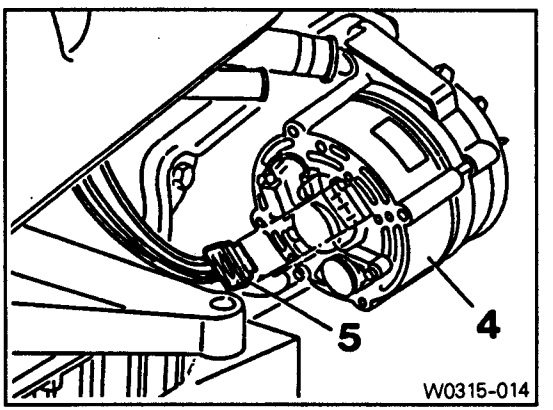


1. Cooling Fan
2. Bolt----------45Nm
3. Bolt----------45Nm
4. Alternator
5. Plug Connection

Removal · Installation

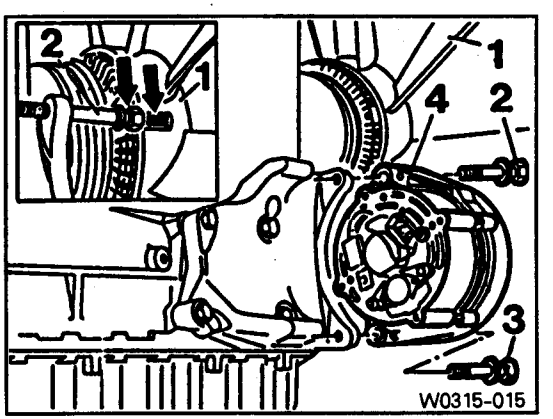
1) Disconnect the negative terminal of the battery.

2) Disconnect the plug connection (5).



3) OM 662 Engine
Align the groove of cooling fan with bolt (2) (arrow).

4) Remove the bolts (2, 3) and take out the alternator.

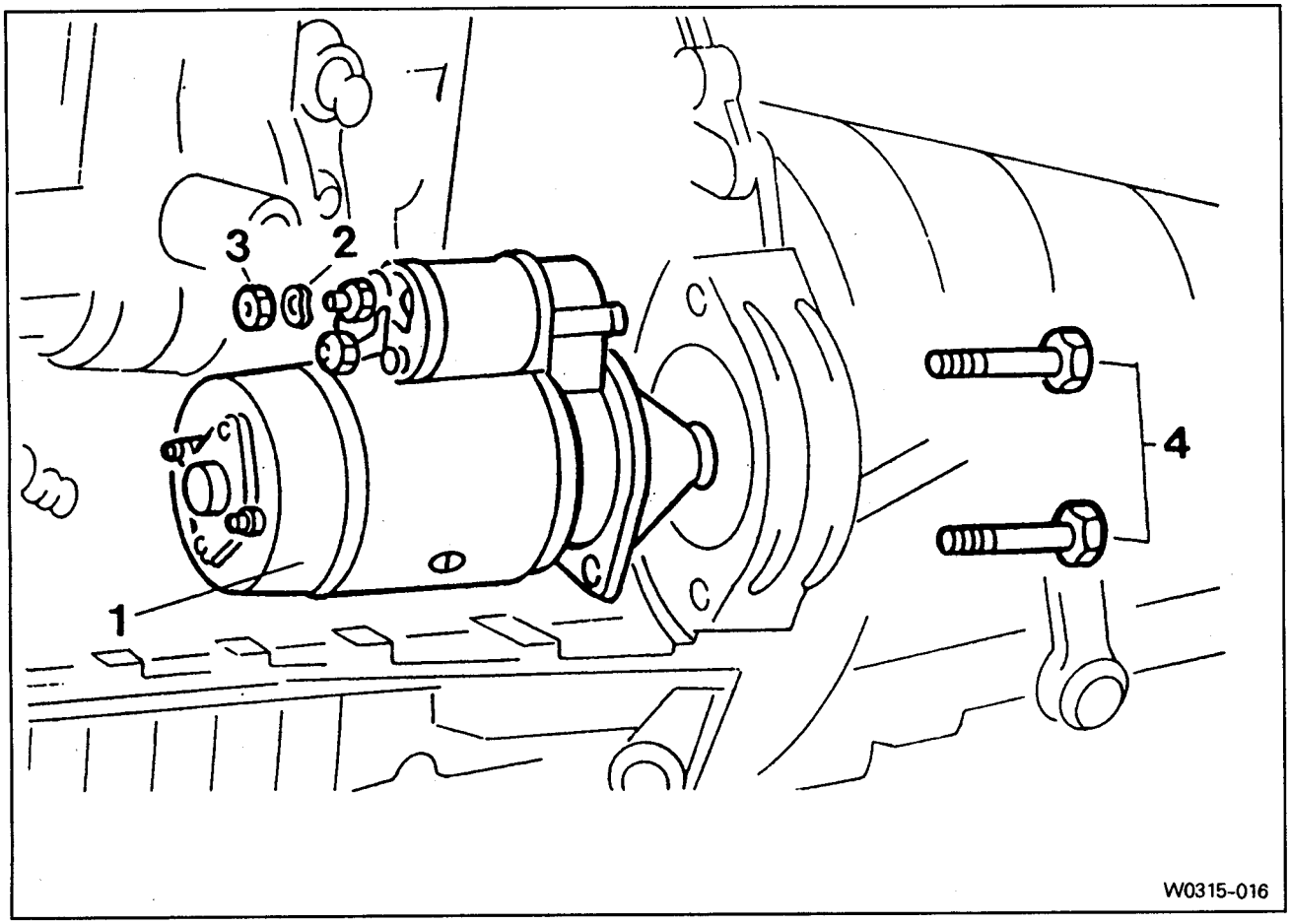


Installation

Tightening torque	45Nm

5) Installation is reverse order of the removal.

5. Removal and Installation of Starter Motor



1. Starter Motor
2. Washer
3. Nut ---------- 15Nm
4. Bolt ---------- 48Nm

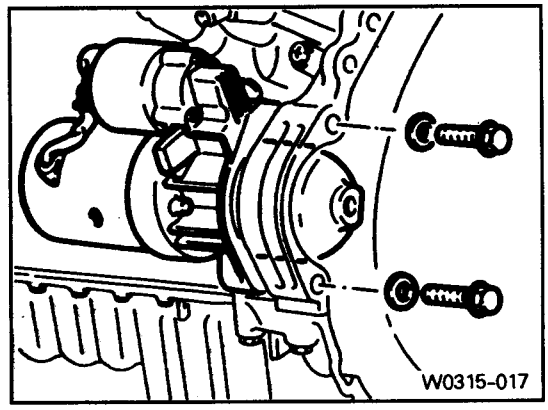
Removal · Installation

1) Disconnect the battery terminals.

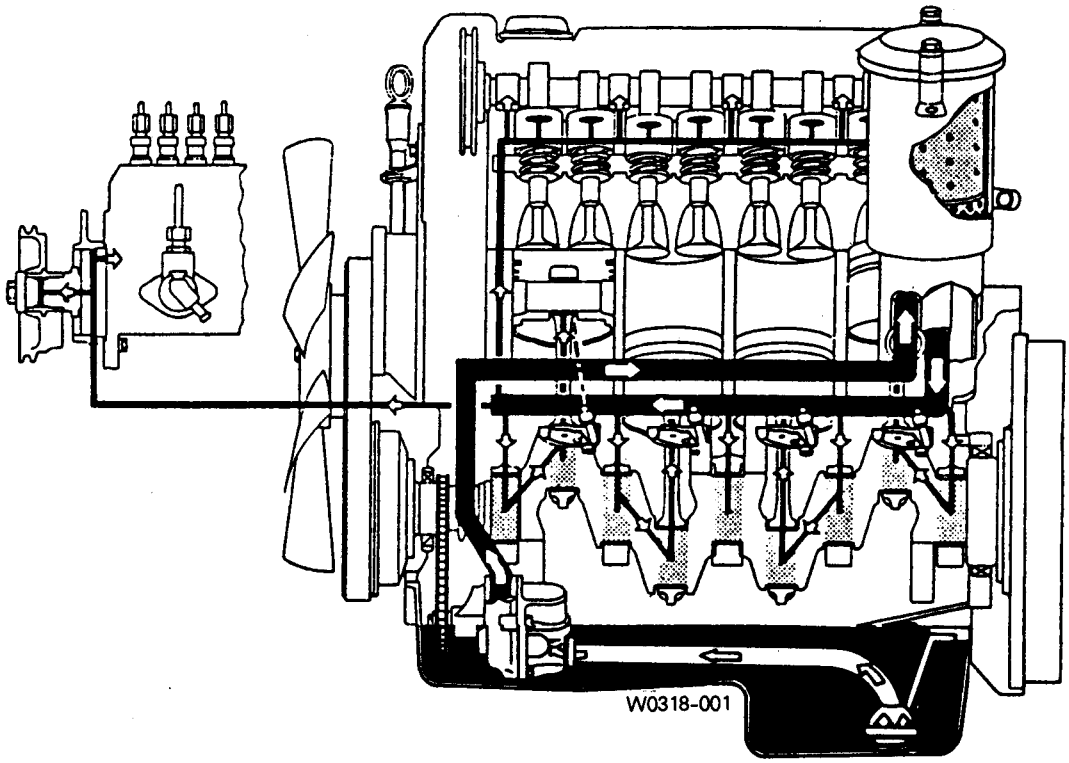
2) Disconnect the starter motor cable harnesses.

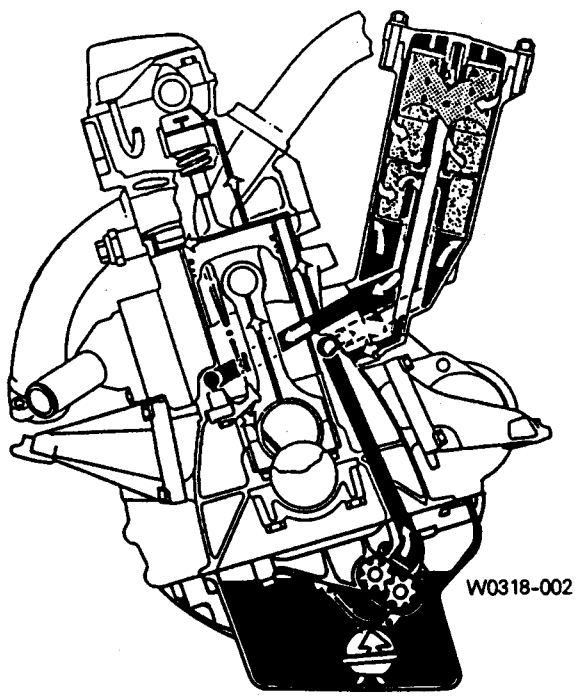
3) Remove the bolts and then remove the starter motor.

4) Installation is reverse order of the removal.

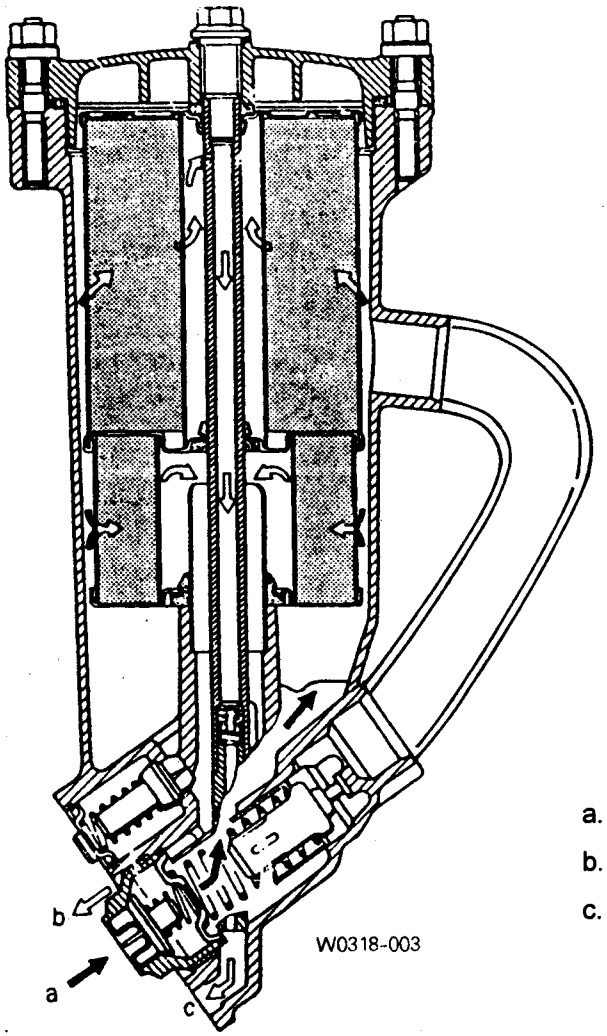


1. Lubrication System





Oil filter

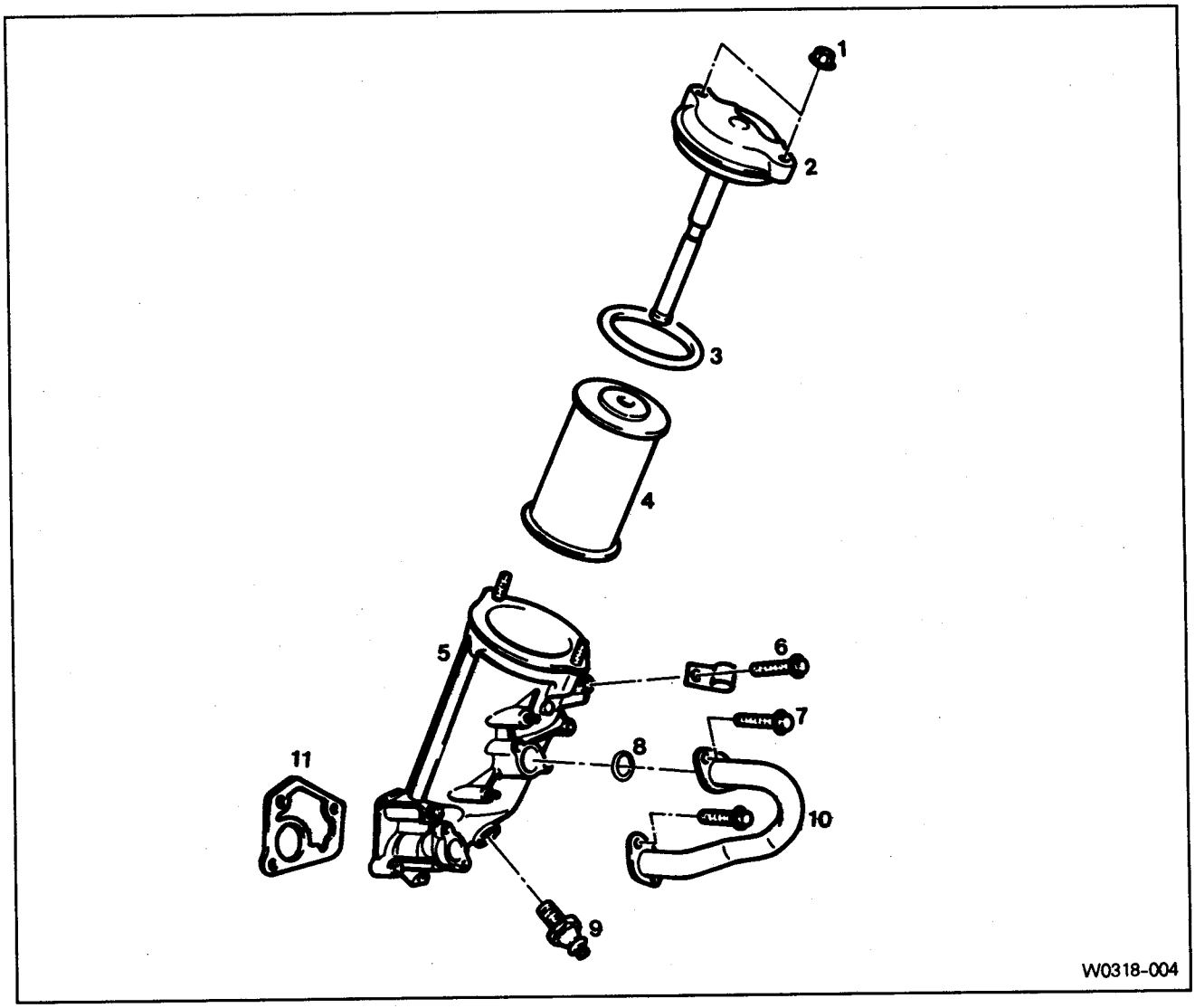


a. From Oil Pump

b. To Main Oil Gallery

c. To Oil Pan

2. Disassembly and Assembly of Oil Filter

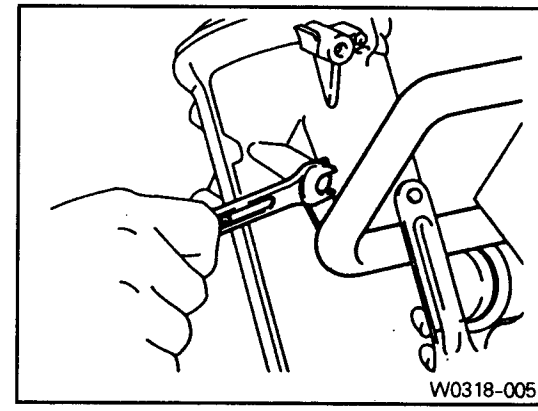


1. Nut ---------- 25Nm
2. Oil Filter Cover
3. O-Ring ---------- Replace
4. Oil Filter Element ---------- Replace if necessary
5. Oil Filter Housing
6. Bolt M8 × 100 ---------- 25Nm
7. Bolt
8. O-Ring ---------- Replace
9. Oil Pressure Switch
10. Oil Pipe
11. Gasket ---------- Replace

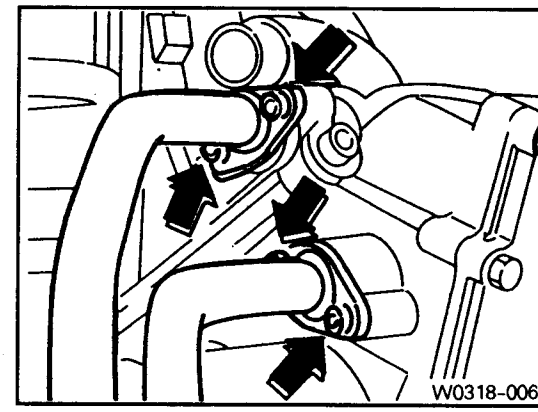
Removal · Installation

1) Drain the engine oil completely.

2) Remove the bracket for heater feed pipe from oil filter.

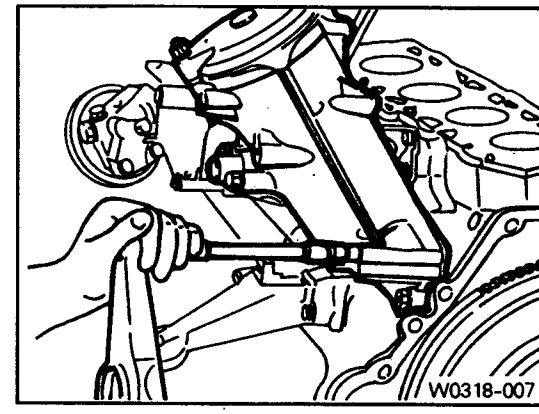


3) Disconnect the oil pressure switch wire.



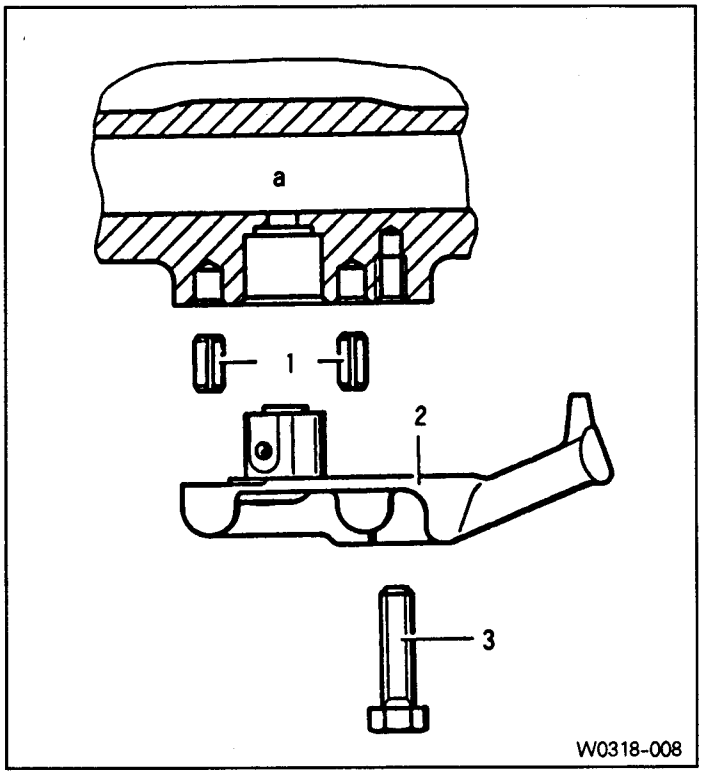
4) Remove the oil filter housing.

5) Clean the sealing surface.



6) Installation is reverse order of the removal.

3. Oil Spray Nozzle

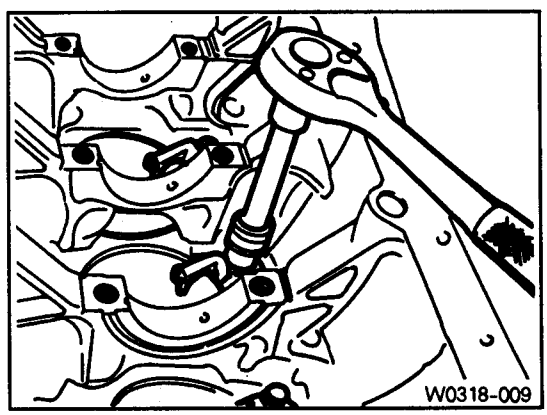


1. Fitting Sleeve
2. Oil Spray Nozzle
3. Combination Bolt----------10Nm
A. Oil Duct

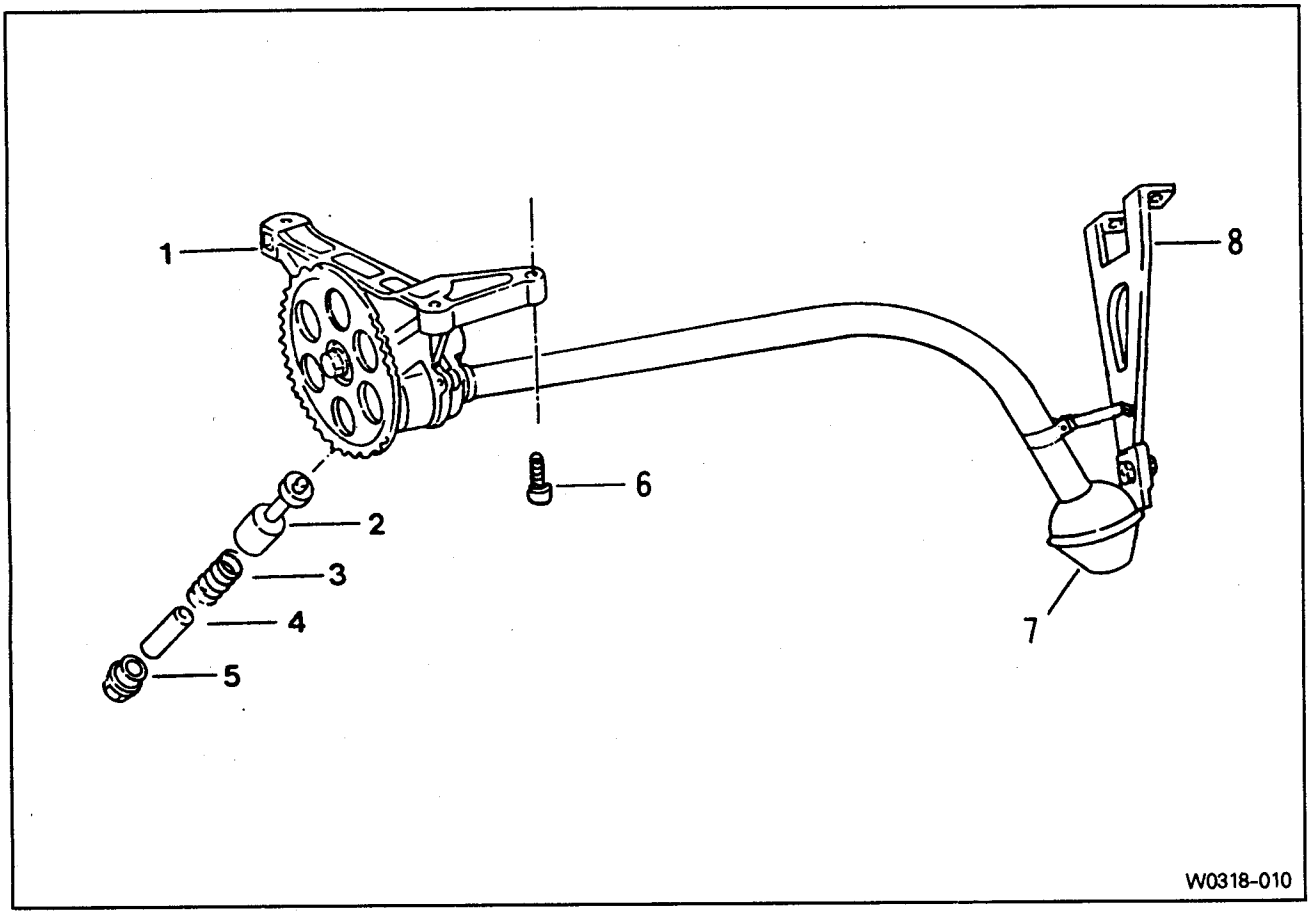
Removal

1) Remove the oil pan or crankshaft.

2) Remove the bolt and then remove the nozzle.



4. Removal and Installation of Oil Pump

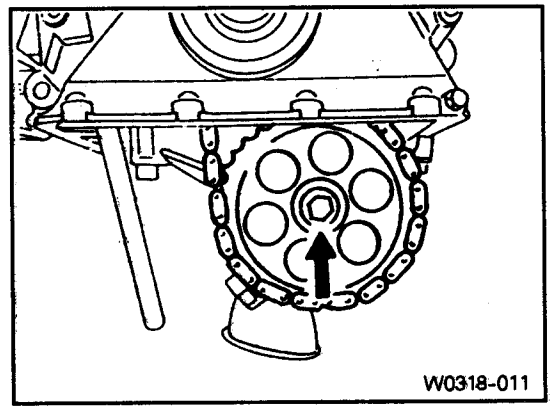


1. Oil Pump
2. Plunger
3. Compression Spring
4. Guide Pin
5. Screw Plug ——————————50Nm
6. Combination Plug ——————————25Nm
7. Oil Strainer
8. Bracket

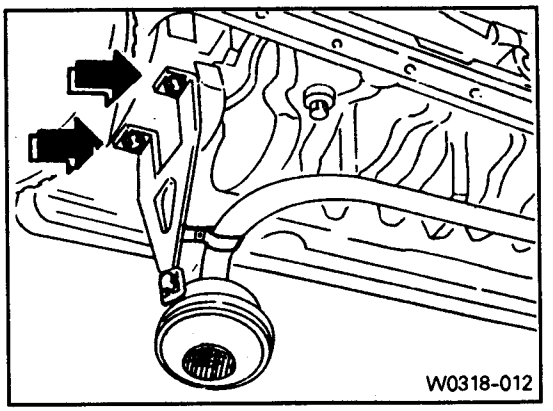
Removal

1) Remove the oil pan.

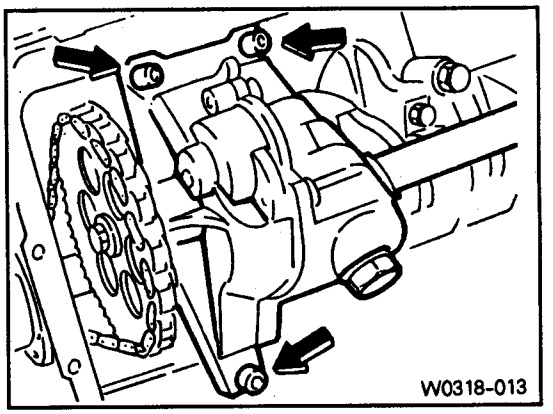
2) Remove the oil pump sprocket bolt.



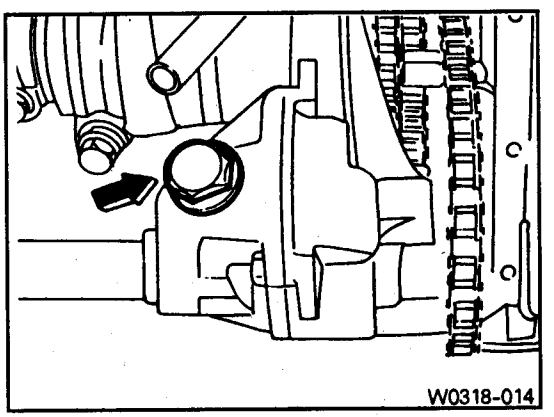
3) Remove the oil strainer bracket bolt.



4) Remove the oil pump.



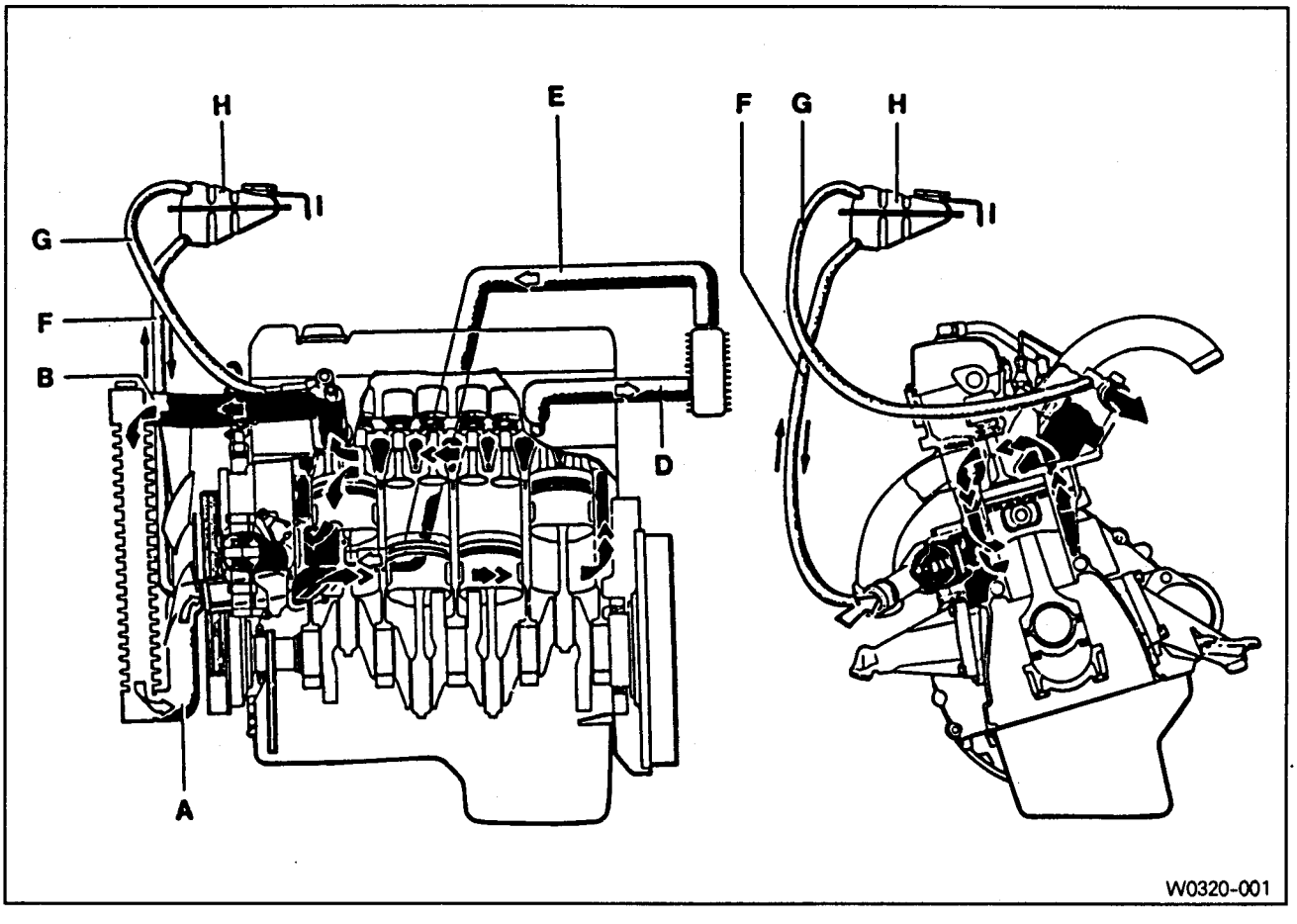
5) Remove the screw plug and then remove the relief valve.



6) Installation is reverse order of the removal.

7) Start the engine and check the leakage.

1. Cooling System



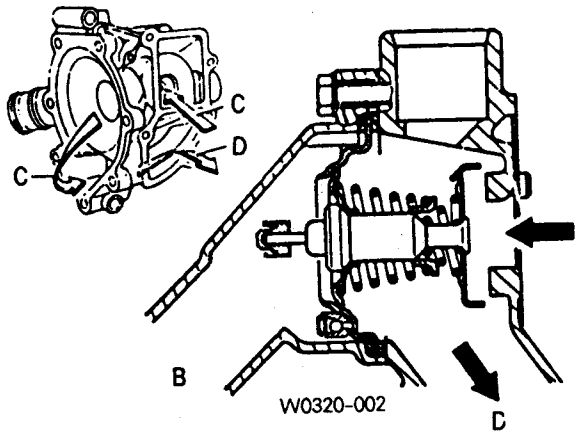
A. To Thermostat
B. To Radiator
D. To Heater
E. From Heater
F. Filling Hose
G. Vent Line
H. Reservoir Tank
I. Overflow Hose

2. Thermostat Operation

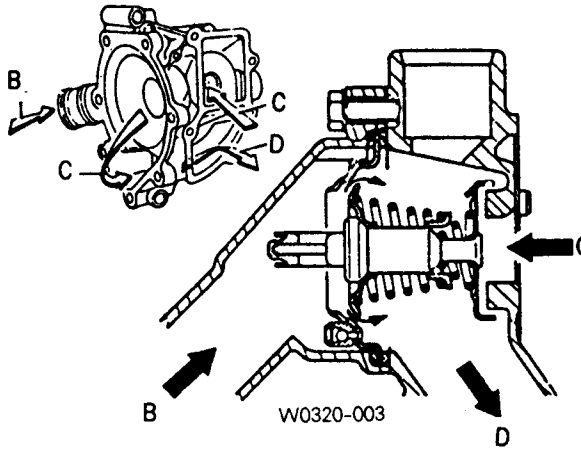
Operation

1) At warming up.
Valve closes until temperature of coolant reaches to 85℃.

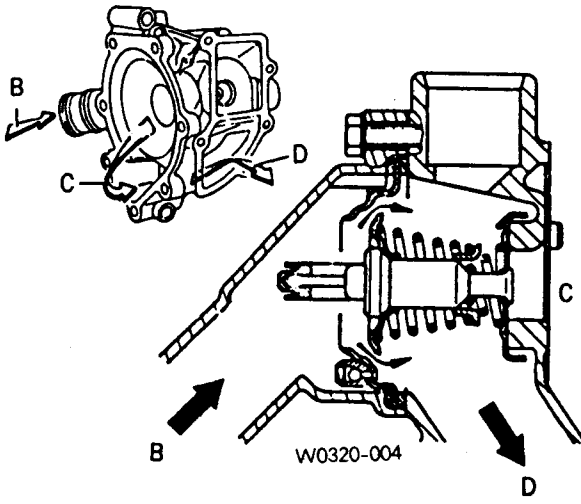
B. From radiator
C. From crankcase
D. To crankcase



2) At partial opening.
Valve opens partially as temperature of coolant is maintained between 85~100℃.

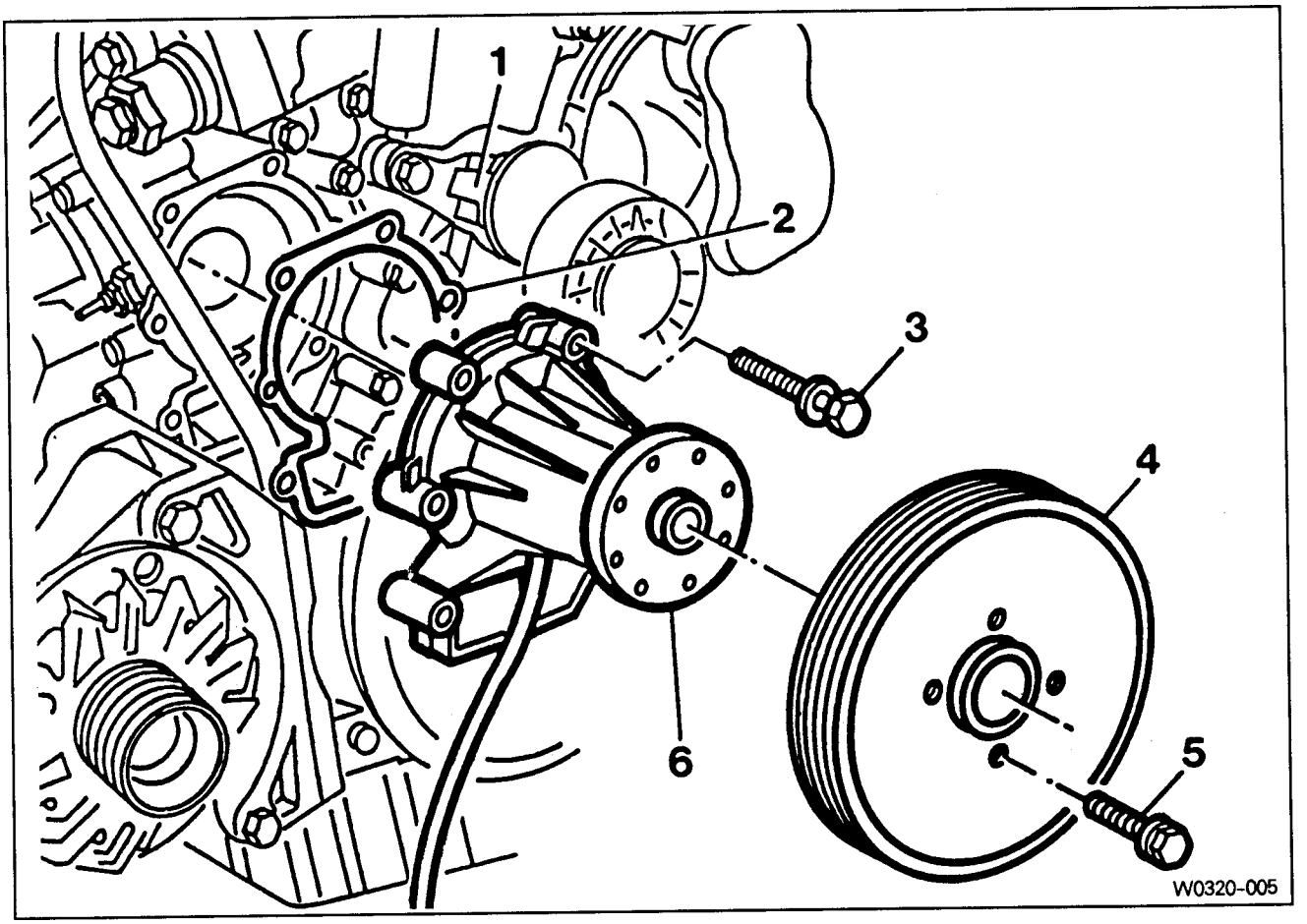


3) At full opening.
Valve opens full as temperature of coolant is more than 100℃.



3. Removal and Installation of Coolant Pump

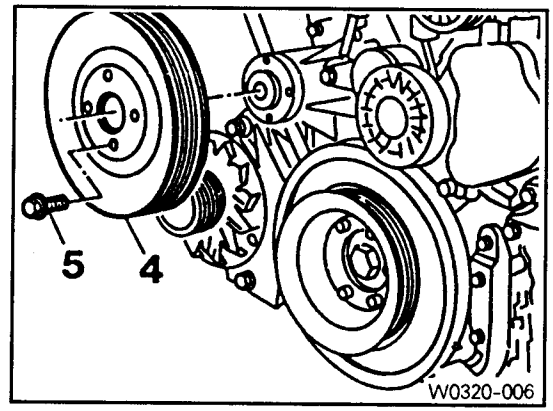
Preceding work : Removal of cooling fan
Removal of poly V-belt



1. Tensioning Lever
2. Gasket ---------- Replace
3. Bolt ---------- 10Nm
4. Belt Pulley
5. Bolt ---------- 10Nm
6. Coolant Pump

Removal · Installation

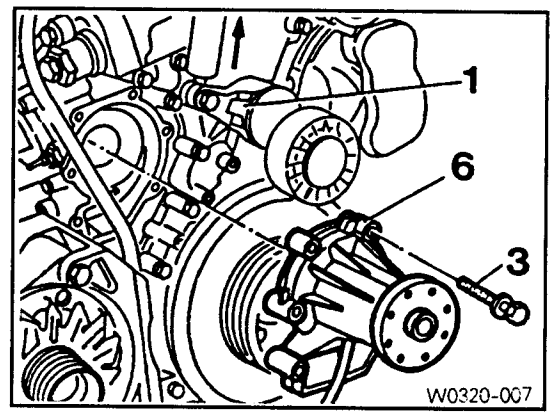
1) Remove the bolts (5) and pull out the belt pulley (4).



Installation

Tightening torque	10Nm

2) Remove the bolts (3) evenly.



Installation

Tightening torque	10Nm

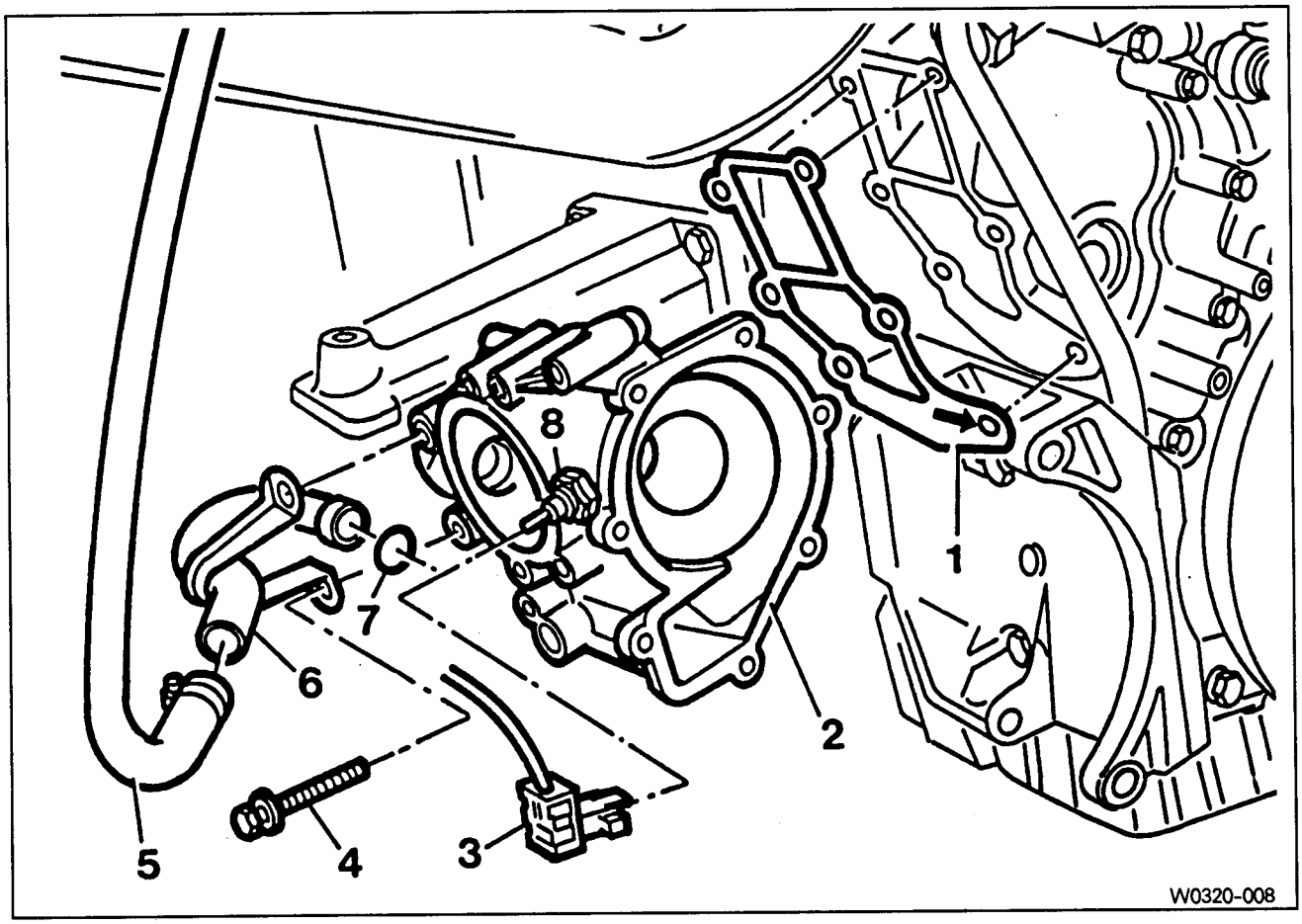
3) Push the tensioning lever (1) in arrow direction.

4) Remove the coolant pump (6).
[Note] Clean gasket residues on the sealing surface of coolant pump and replace the gasket.

5) Installation is reverse order of the removal.

4. Removal and Installation of Coolant Pump Housing

Preceding work : Removal of coolant pump
Removal of thermostat
Removal of alternator



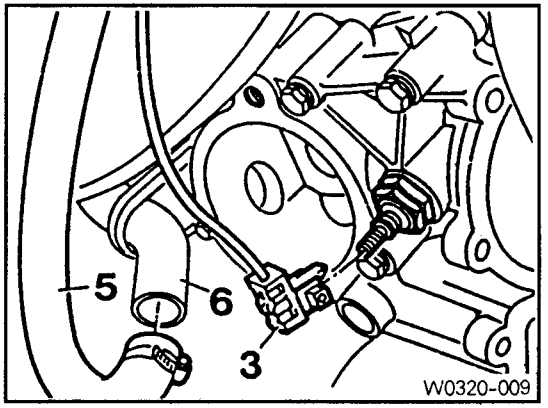
1. Gasket ---------- Replace
2. Coolant Pump Housing
3. Connector
4. Bolt ---------- 10Nm
5. Coolant Hose
6. Return Pipe
7. O-Ring
8. Temperature Sensor

[Note] The bolt on the arrow should be installed last.

Removal · Installation

1) Disconnect the connector (3).

2) Separate the coolant hose (5) and return pipe (6).

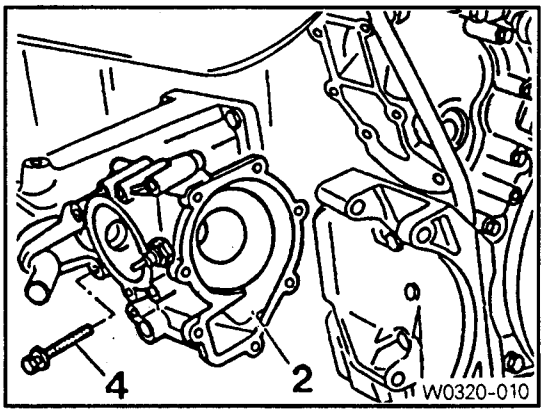


3) Remove the bolts (4) evenly.

Installation

Tightening torque	10Nm

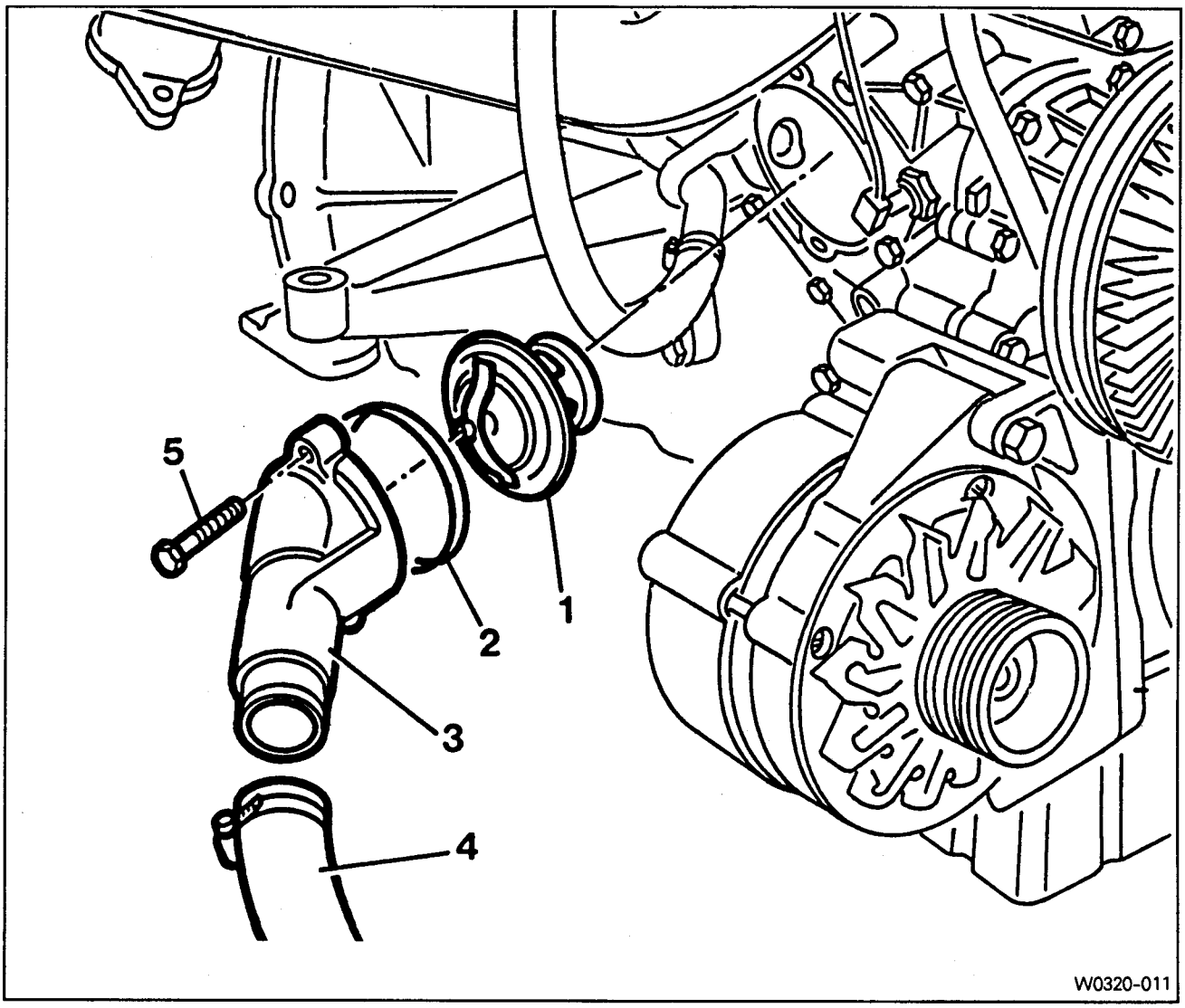
[Note] Clean gasket residues on the sealing surface of coolant pump and replace the gasket.



4) Remove the coolant pump housing (2).

5) Installation is reverse order of the removal.

5. Removal and Installation of Thermostat

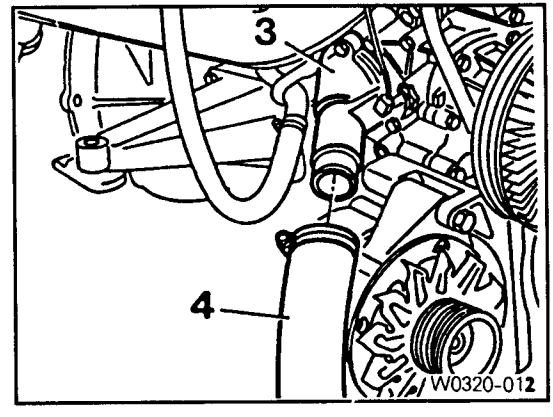


1. Thermostat
2. Seal---------- Replace
3. Thermostat Housing Cover
4. Coolant Hose
5. Bolt ---------- 10Nm

Removal · Installation

1) Drain the coolant completely.

2) Disconnect the coolant hose (4) from the thermostat housing cover (3).

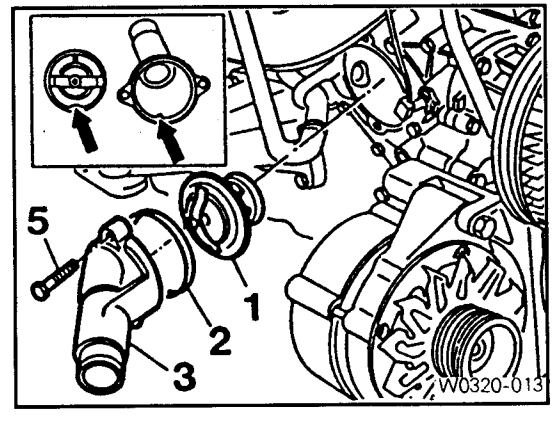


3) Remove the bolts (5) and then remove the thermostat (1) and housing cover (3).

Installation
Align the groove on the thermostat and the housing cover rib (arrow).

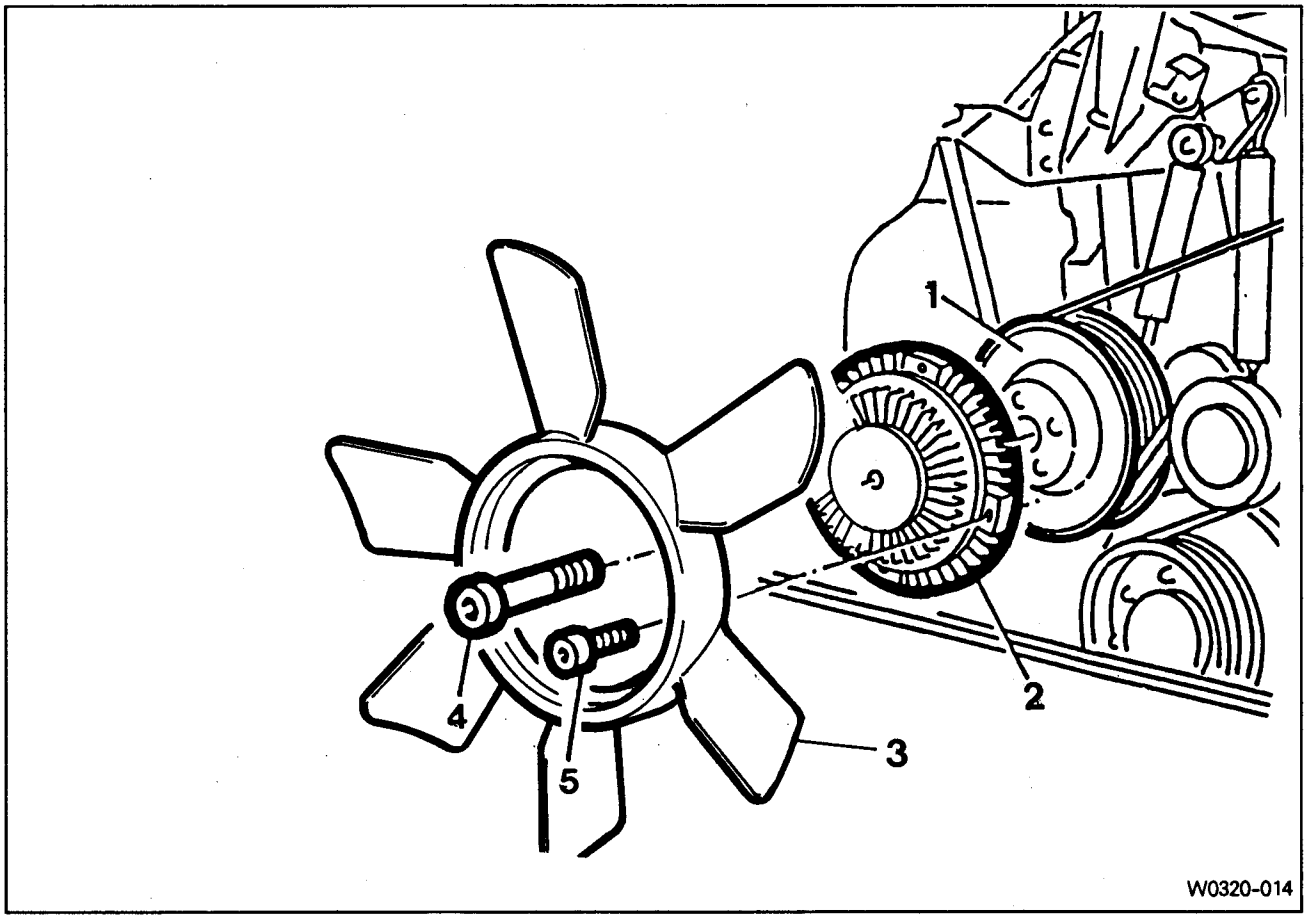
Tightening torque	10Nm

[Note] Replace the seal (2).



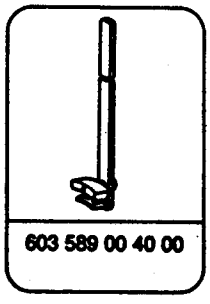
4) Installation is reverse order of the removal.

6. Removal and Installation of Cooling Fan Clutch



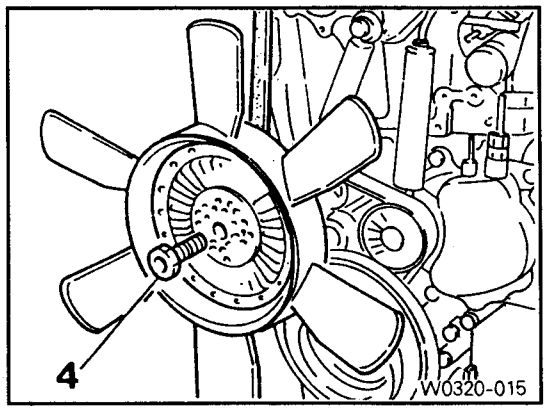
1. Belt Pulley
2. Cooling Fan Clutch
3. Cooling Fan
4. Socket Bolt----------45Nm
5. Socket Bolt----------10Nm

Special tool



1) Hold the belt pulley with counter holder and remove the bolt (4).

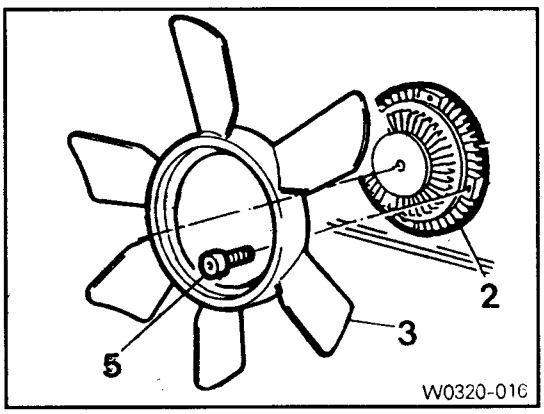
Counter holder 603 589 00 40 00



Installation

Tightening torque	45Nm

2) Remove the socket bolt (5) and then remove the cooling fan (3) and fan clutch (2).
[Note] Keep the fan clutch vertically.



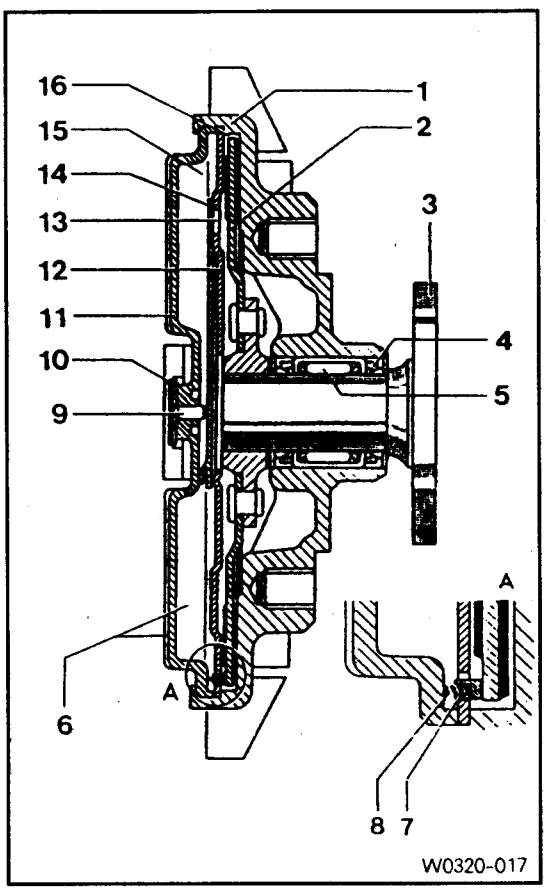
Installation

Tightening torque	10Nm

3) Installation is reverse order of the removal.

Function

If engine rpm is approx. 4,000~4,500rpm and the coolant temperature reaches approx. 90~95℃, then the fan rotation speed will be increased by approx. 1,000rpm together with wind noise.

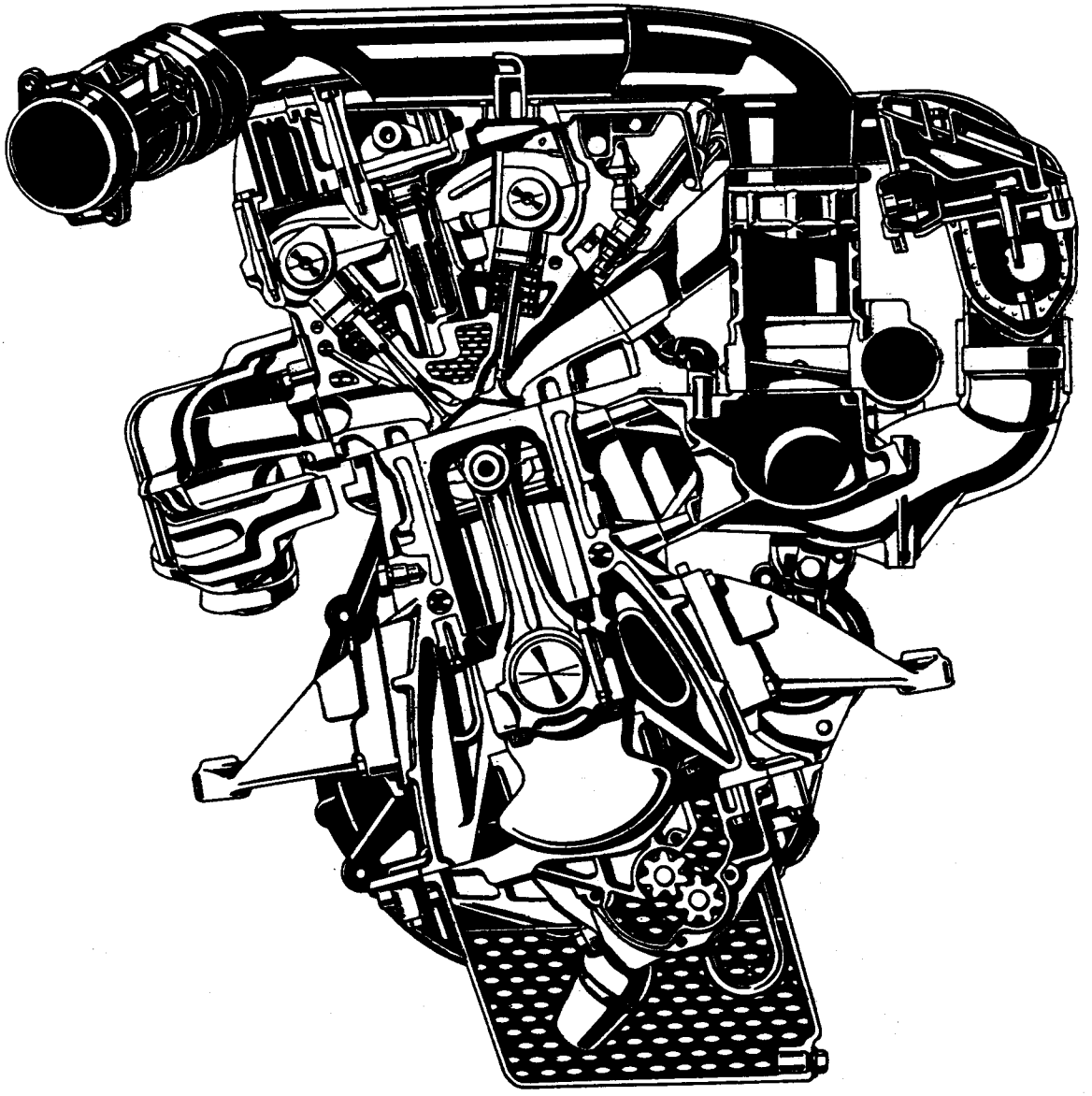


1. Clutch Housing
2. Drive Disc
3. Flange
4. Seal Ring
5. Needle Bearing
6. Cooling Fan
7. Oil Scraper
8. Spring
9. Pin
10. Bimetal
11. Bracket Cover
12. Separate Disc
13. Feed Port
14. Lever Valve
15. Oil Chamber
16. Working Chamber

Gasoline Engine G

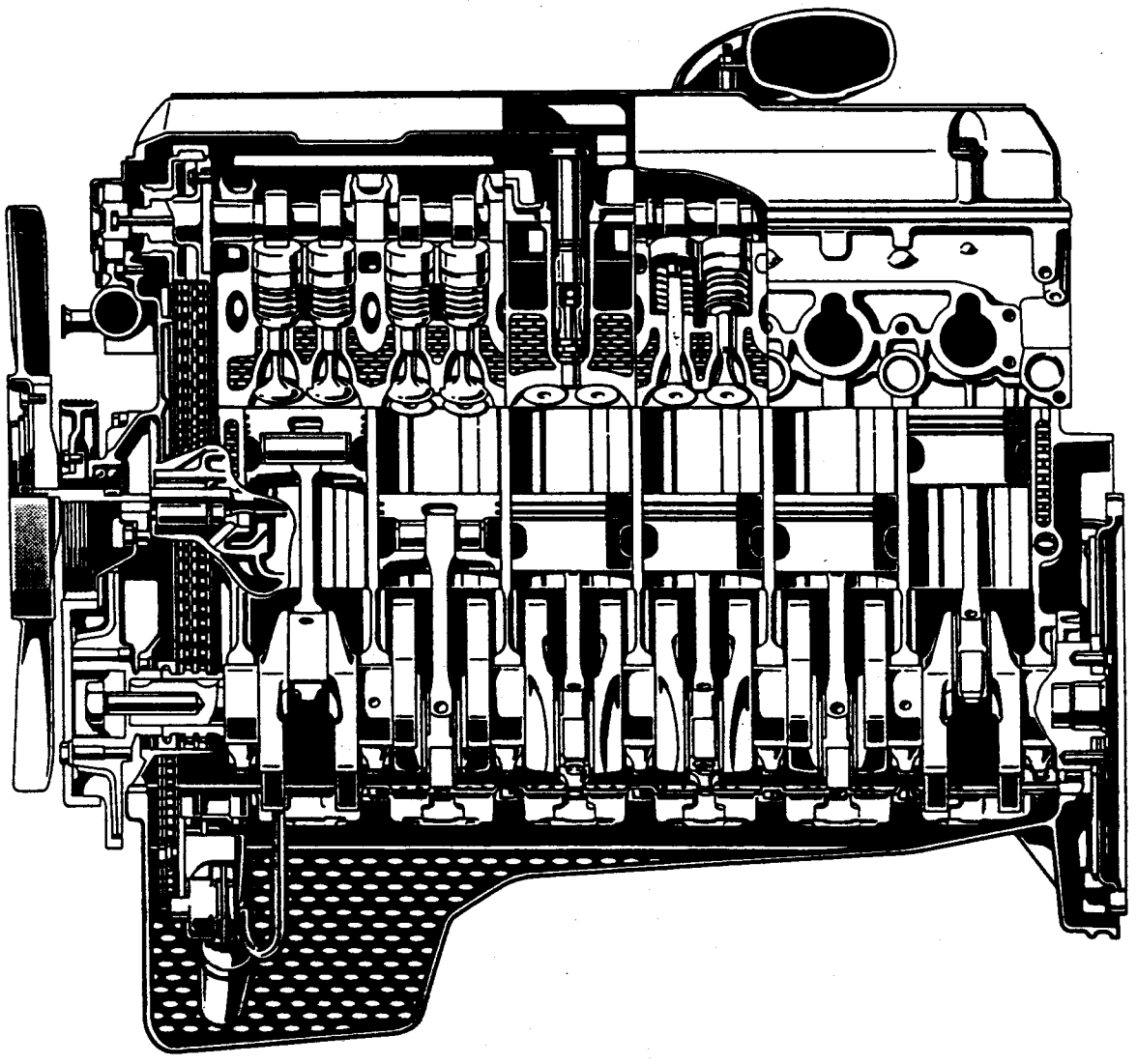
1. Sectional View

Front view



V1300-001

Side view

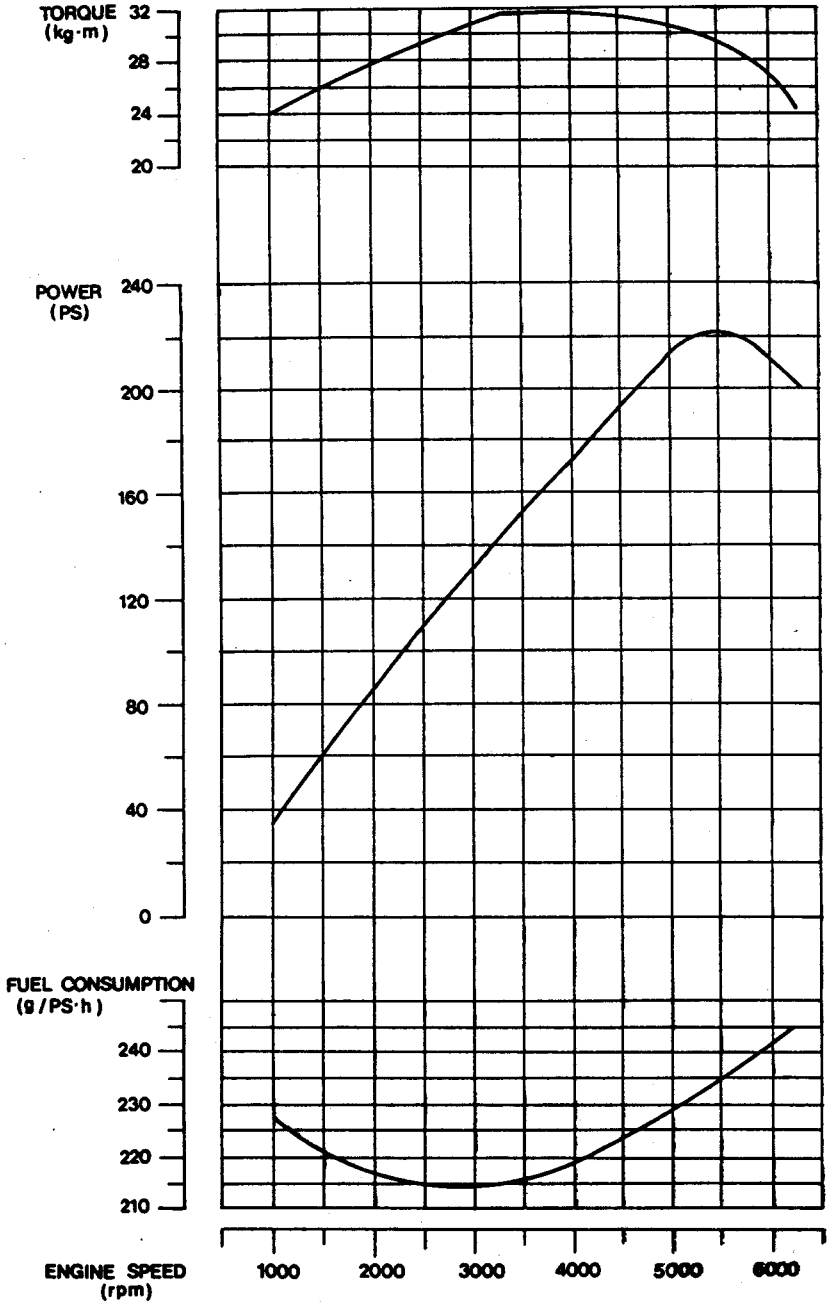


W1300-002

2. Specifications

Item			Specification
Engine model			M162E32
Displacement(cc)			3,199
Cylinder (bore × stroke) (mm)			89.9 × 84
Compression ratio			10 : 1
Camshaft valve arrangement			DOHC
Number of cylinders			6
Camshaft drive type			Chain drive
Max. output (ps/rpm)			220 / 5,500
Max. torque (kg · m/rpm)			31.6 / 3,750
Firing order			1 - 5 - 3 - 6 - 2 - 4
Ignition type			Distributorless double ignition simultaneously
Ignition time			BTDC 8°
Valve timing	Intake	Open / Close	ATDC 11° / ABDC 34°
	Exhaust	Open / Close	BBDC 31° / BTDC 14°
Valve clearance adjustment			Automatic control
Idle speed (rpm)			700 ± 50
Fuel injection pressure (kg/㎠)			3.2 ~ 4.2
Oil capacity (ℓ)			8.4
Lubrication			Forced circulation by gear pump
Oil filter type			Full flow type by paper filter
Fuel			Unleaded gasoline

3. Engine Performance Curve



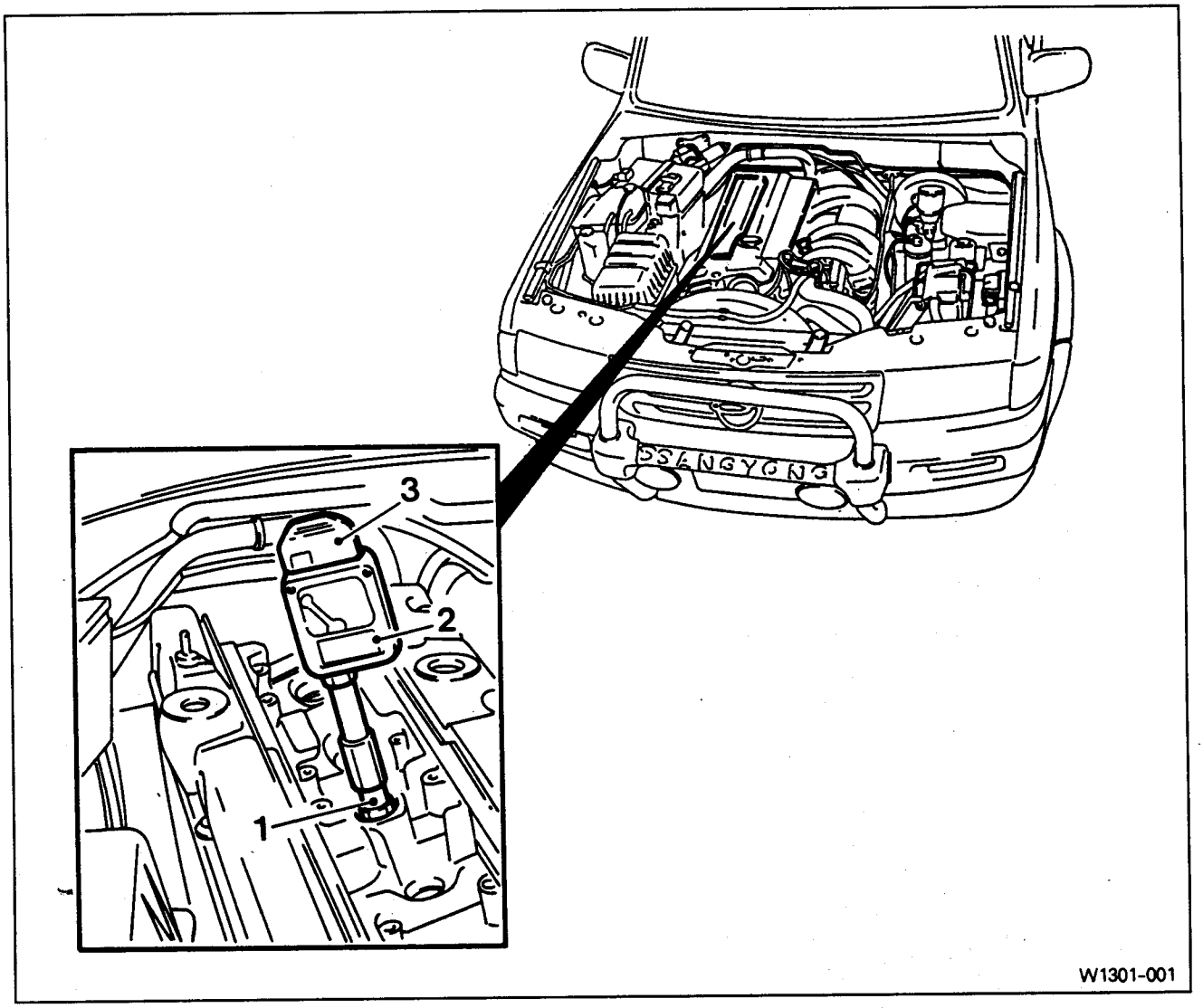
W1300-003

4. Special Tool List

Part Name	Part Number
Threaded Pin	116 589 02 34 00
Leakage Tester	124 589 15 21 00
Drift	102 589 12 15 00
Drift	102 589 00 15 00
Lever Pusher	111 589 18 61 00
Magnetic Finger	116 589 06 63 00
Mandrel	119 589 00 43 00
Box Wrench Insert	000 589 01 10 00
Socket Wrench Insert	001 589 65 09 00
Sliding Hammer	116 589 20 33 00
Sleeve	601 589 03 14 00
Sleeve	601 589 03 43 00
Supporting Bridge	111 589 01 59 00
Thrust Piece	111 589 25 63 00
Spark Plug Wrench	120 589 02 09 00
Compression Pressure Recorder	001 589 76 21 00
Engine Rotate Fixer	602 589 00 40 00
Open End Wrench	104 589 01 01 00
Oil Filter Socket Wrench	103 589 02 09 00
Oil Extractor	112 589 00 72 00
Oil Seal Assembler	601 589 03 43 00
Adapter Line	201 589 00 99 21
Fuel pressure hose	119 589 04 63 00
Fuel Pressure Tester	103 589 00 21 00
Connecting Box (126pin)	129 589 00 21 00
Chain Assembler	000 589 58 43 00
Puller	103 589 00 33 00
Puller	661 589 00 33 00
Flier	104 589 00 37 00

Part Name	Part Number
Puller	615 589 01 33 00
Counter Holder	603 589 00 40 00
Cocking Bolt	103 589 01 99 01
Torque Wrench	000 589 10 99 01
Hose Clamp	000 589 40 37 00
Test Cable	124 589 45 63 00

1. Compression Pressure Test



1. Test Adapter
2. Compression Pressure Recorder
3. Diagram Sheet

Service standard

Normal operating temperature of engine	At 80℃
Normal compression pressure	Min. 10bar, max. 14bar
Optimized fuel compression pressure	Min. 6bar, max. 10bar
Permissible pressure difference between individual cylinders	Max. 1.5bar

Special Tool

Measuring of compression pressure

[Note] Ensure that no gear is engaged and that the vehicle is protected from rolling.

1) Warm up the engine by normal operating temperature.

2) Remove the spark plug.

3) Place the diagram sheet to compression pressure recorder.

4) Connect the adapter to compression pressure recorder and install it into the spark plug hole.

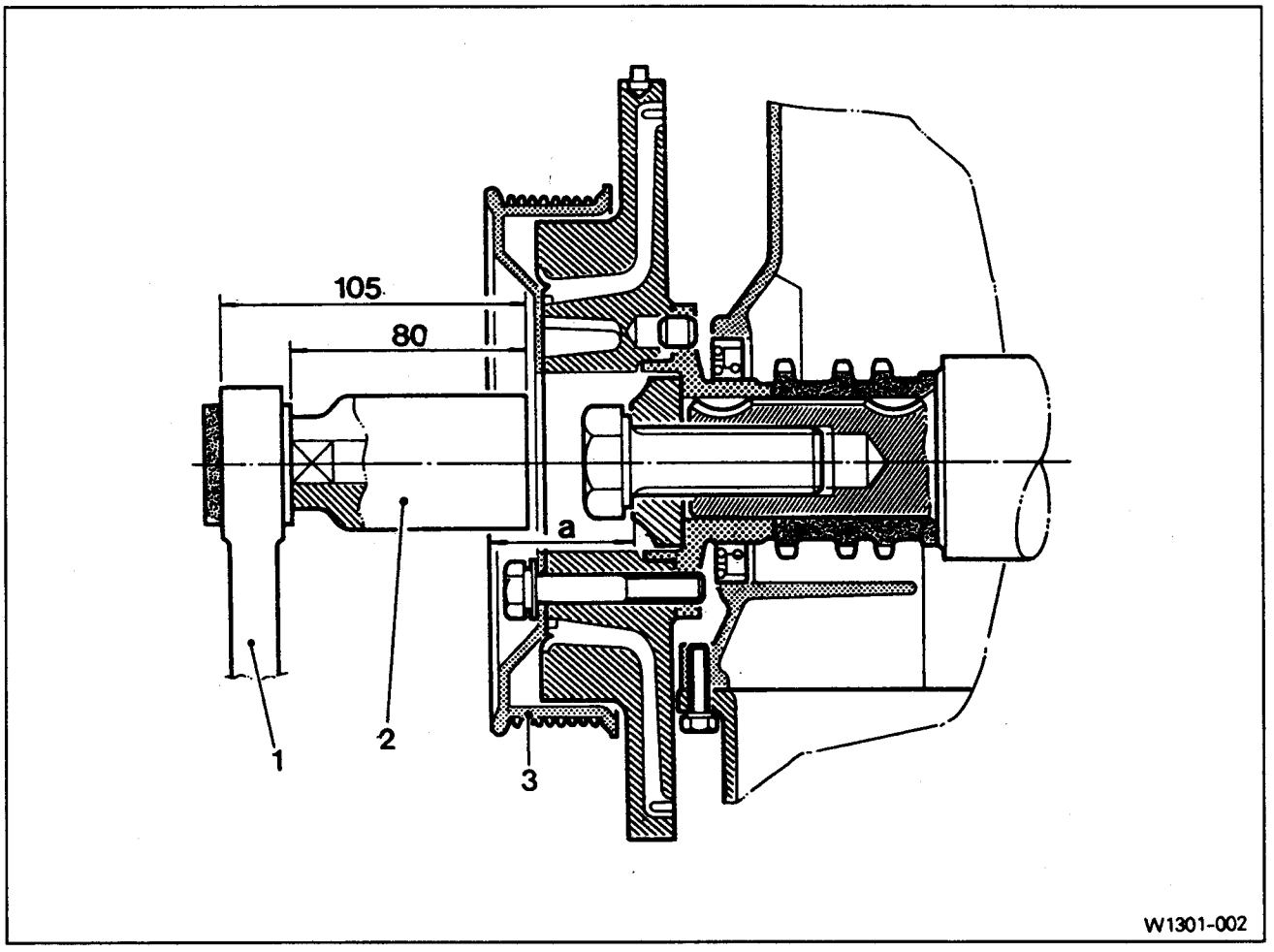
5) Crank the engine approx. 8 revolutions by using the starter motor.

6) If measured compression pressure is out of standard, do cylinder pressure leakage test (01-04).

7) Measure the compression pressure of the other cylinders in the same manner.

2. Engine Cranking at the Front of Crankshaft

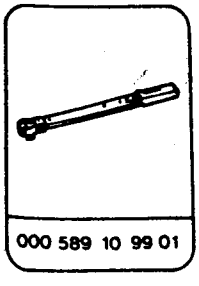
Preceding work : Removal of cooling fan (20-18)

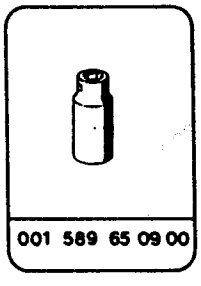


1. Torque Wrench
2. Socket
3. Crankshaft Pulley

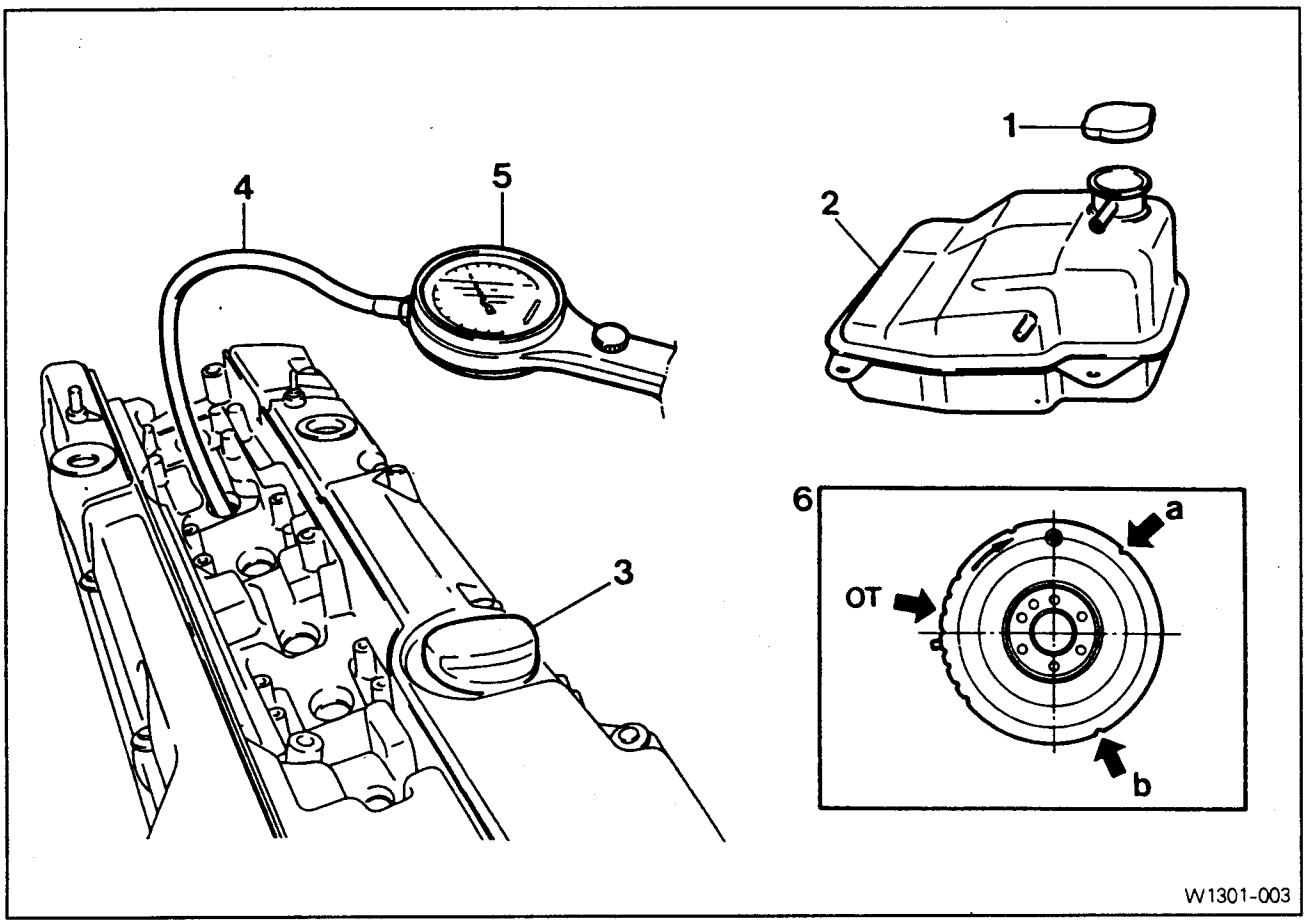
   Size 'a' = 38mm

Special Tools





3. Cylinder Pressure Leakage Test



1. Coolant Subtank Pressure Cap
2. Coolant Subtank
3. Engine Oil Filler Cap
4. Connection Hose
5. Cylinder Pressure Leakage Tester
6. Piston No. of TDC by Mark on Vibration Damper

Permissible pressure leakage

At whole engine	Max. 25%
At valve and cylinder head gasket	Max. 10%
At piston and piston ring	Max. 20%

Piston no. of TDC by mark on vibration damper

TDC mark	OT	a = 120°	b = 240°
Cylinder no.	1, 6	2, 5	3, 4

Commercial tool

Cylinder pressure leakage tester	BOSCH EFAW 210A or SUN CLT 228

Leakage test

1) Warm up the engine by normal operating temperature.

2) Disconnect the negative battery terminal.

3) Remove the spark plug.

4) Open the coolant subtank cap and check the coolant level or fill up.

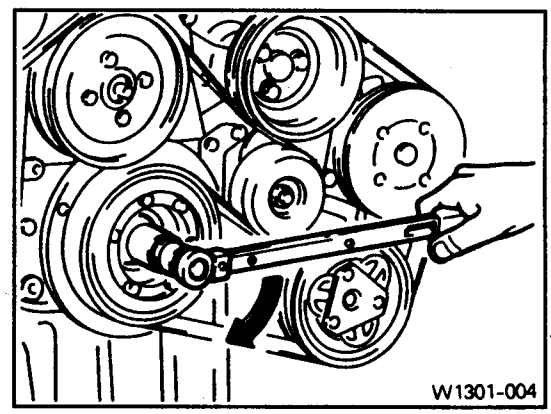
5) Open the engine oil filler cap.

6) Connect the tester (5) to air pressure line and adjust the scale of tester.

7) Install the connection hose (4) to spark plug hole.

8) Rotate the crankshaft and position the piston of no. 1 cylinder at TDC.

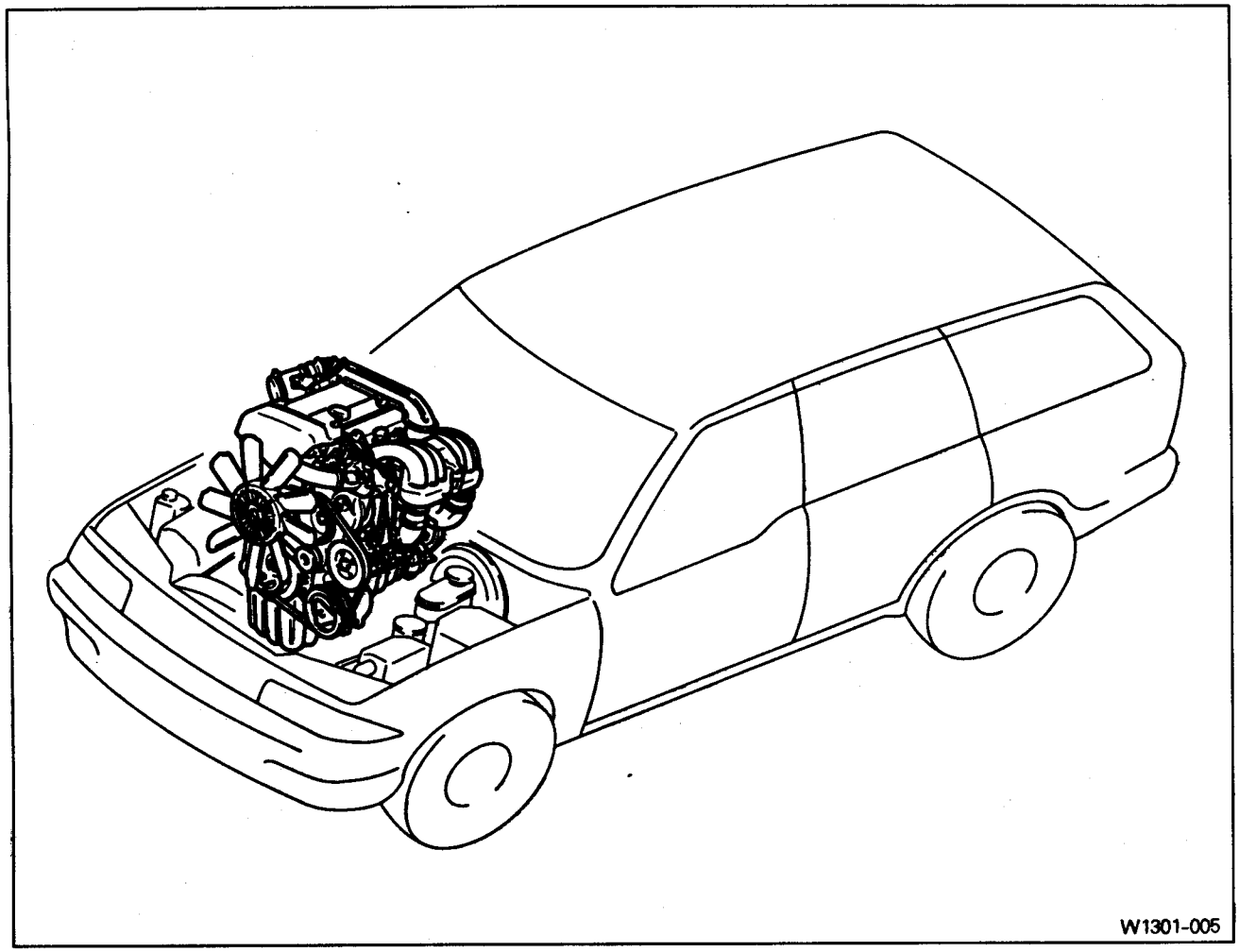
Socket wrench insert 001 589 65 09 00
Torque wrench 000 589 10 99 01



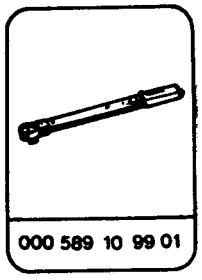
9) Connect the connection hose (4) to tester (5) and measure the leakage volume after blowing up 5bar of compressed air.
[Note] Measure the leakage volume in the completely opening condition of throttle valve by pulling the acceleration cable.

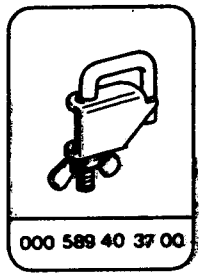
10) Do pressure leakage test according to firing order.
· Firing order : 1 - 5 - 3 - 6 - 2 - 4

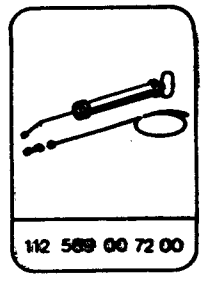
4. Removal and Installation of Engine



Special Tools







Removal · Installation

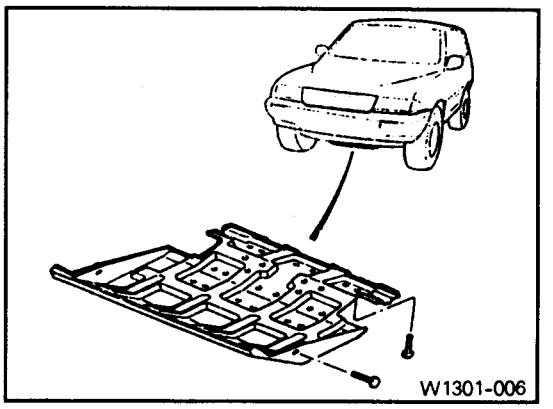
1) Disconnect the negative terminal of battery.

2) Remove the hood.

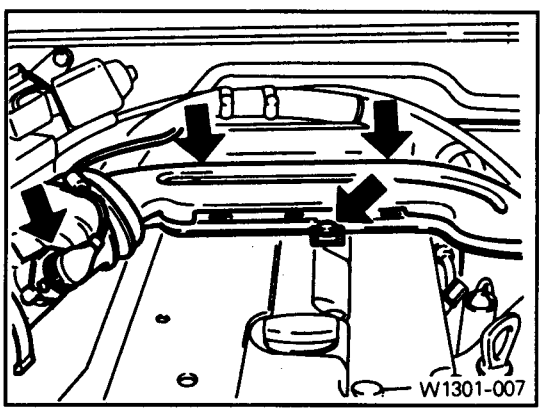
3) Remove the under cover.

Installation

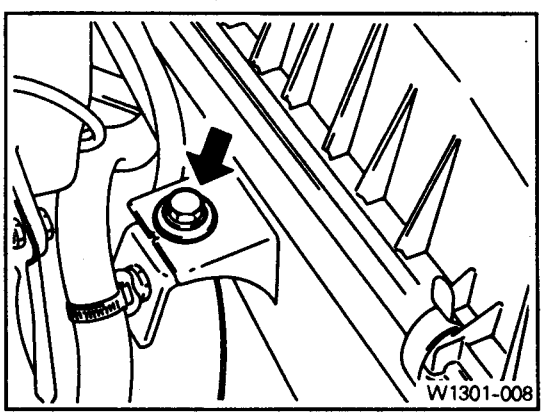
Tightening torque	28~47Nm



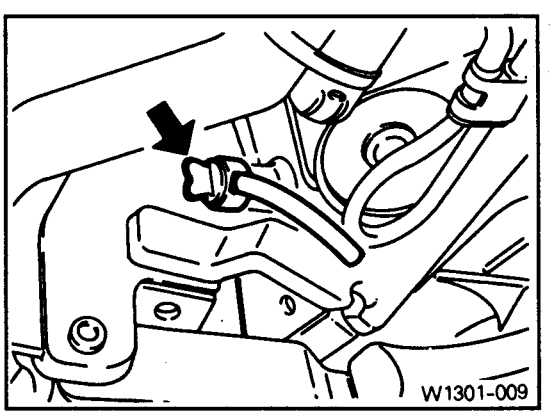
4) Disconnect the coupling of HFM sensor and remove the air cleaner cross pipe.



5) Remove the air cleaner cover. Remove the mounting bolts and air cleaner housing and element assembly.



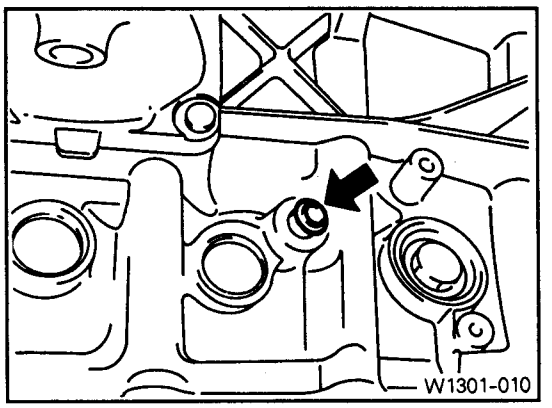
6) Loosen the radiator drain cock and drain the coolant.
[Note] Open the coolant reservoir cap.



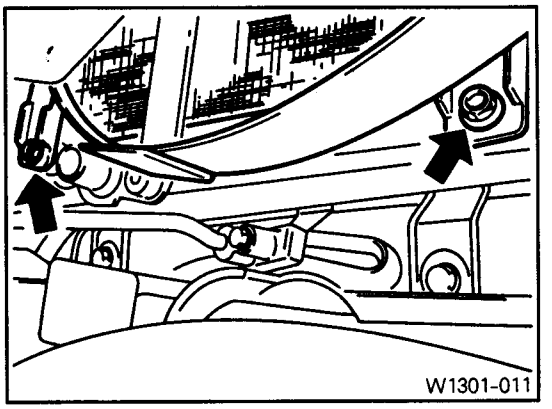
7) Loosen the cylinder block drain plug and then drain the coolant completely.
[Note] Replace the seal before installation of the drain plug.

Installation

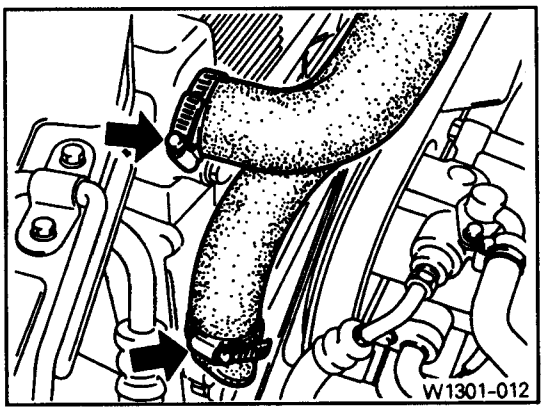
Tightening torque	30Nm



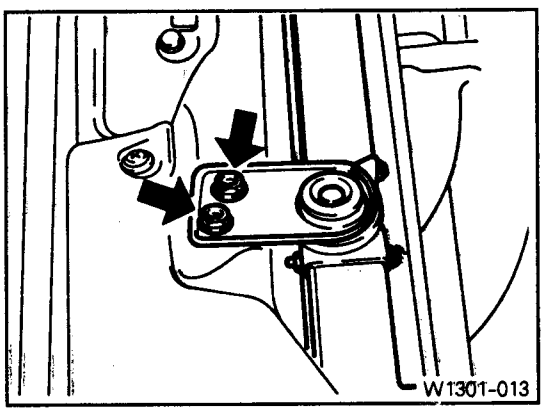
8) Remove the cooling fan shroud.



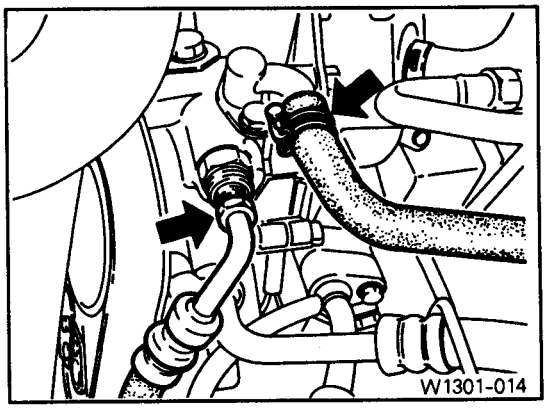
9) Disconnect the each hose from radiator.



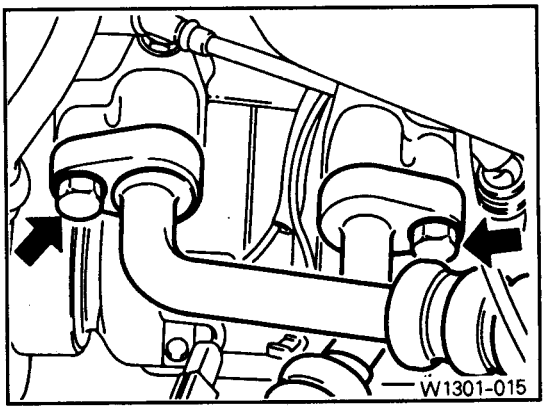
10) Remove the upper mounting bolts of radiator and then remove the radiator.



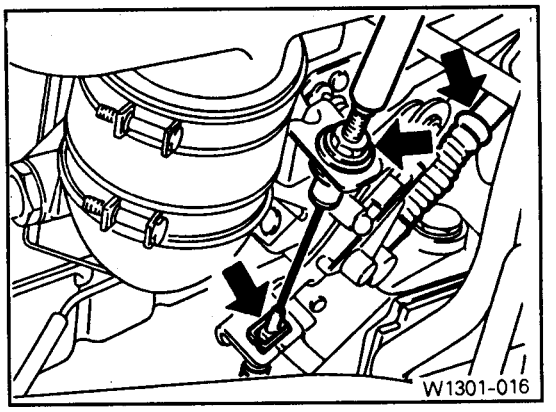
11) Remove the hydraulic pipe of power steering.
[Note] Completely drain the oil.



12) Remove the air-conditioner pipes from the compressor.
[Note] Evacuate the refrigerant before removing the pipes.



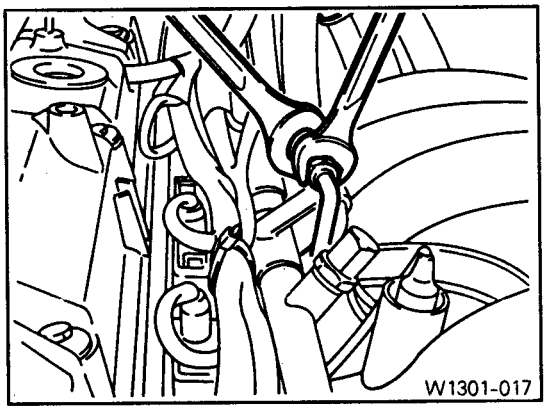
13) Remove the acceleration control cable and automatic transmission pressure cable.



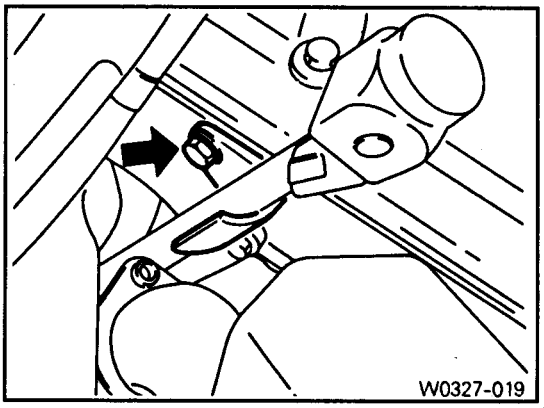
14) Remove the fuel feed and return line.
[Note] Before removing the fuel lines, release the pressure in the fuel system.

Installation

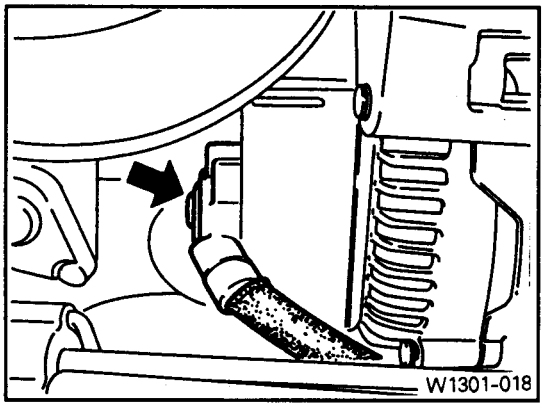
Tightening torque	21~25Nm



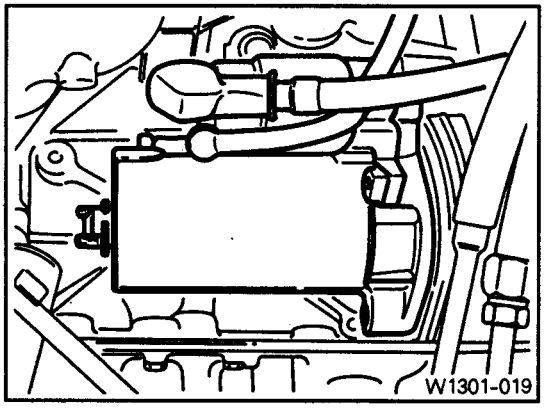
15) Remove the automatic transmission dipstick guide tube.



16) Disconnect the wire of alternator.

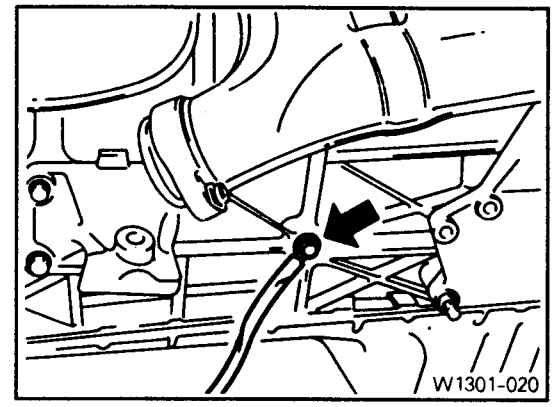


17) Disconnect the wire of starter motor and remove the starter motor.

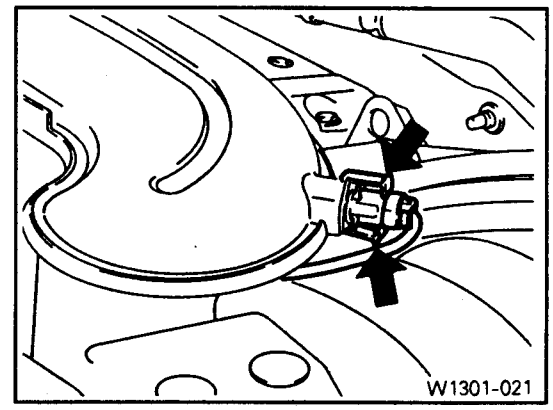


18) Disconnect the engine main harness ground.

19) Disconnect the engine ground wire.

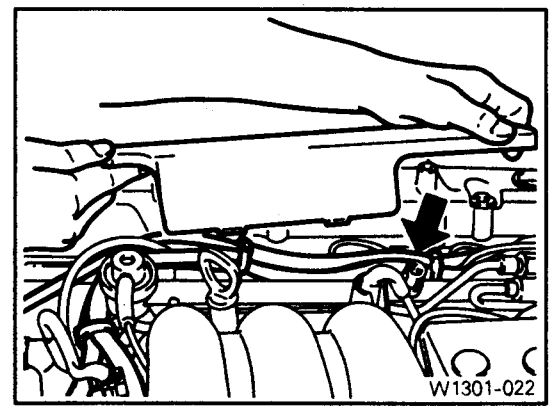


20) Disconnect following sensors connector :
- Intake temperature sensor.
- HFM sensor.
- Coolant temperature sensor.
- 2 knock sensors.
- Camshaft and crankshaft sensors.

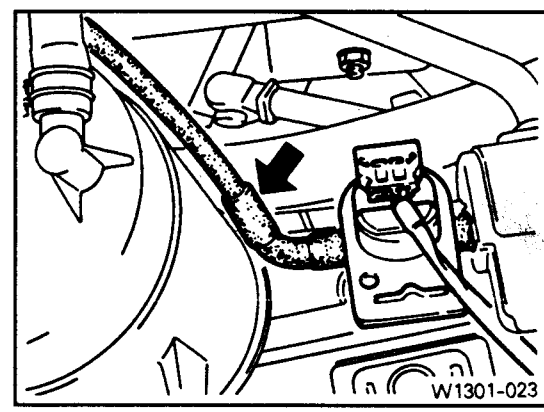


21) After removing the ignition coil cover, disconnect the ignition coil connector.

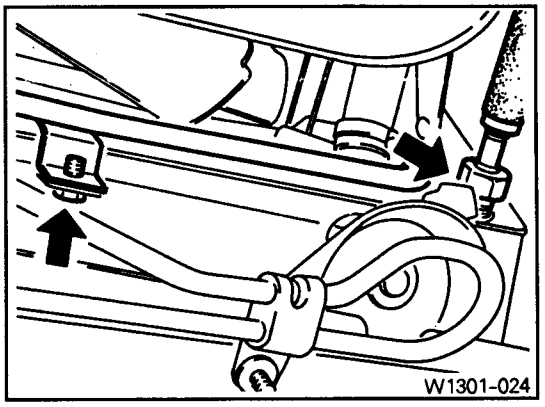
22) Remove the harness cover and disconnect the 6 injection valve connectors. Disconnect the main harness.



23) Separate the hose toward engine from canister purge solenoid valve.

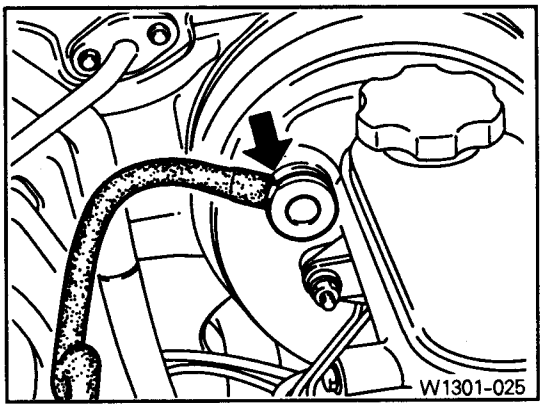


24) Remove the automatic transmission oil cooler line.



25) Separate the vacuum hose for brake booster.

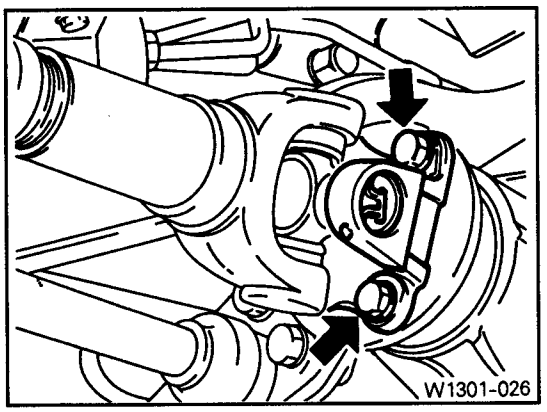
26) Separate the other vacuum hoses.



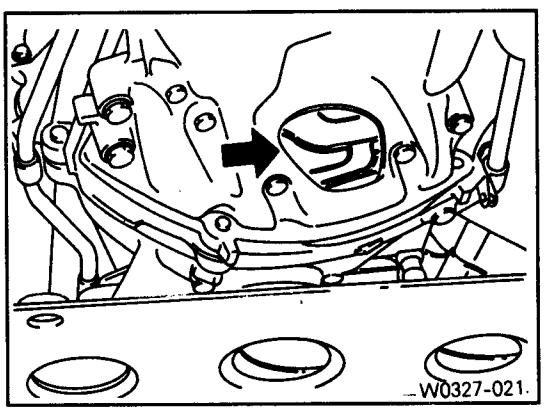
27) Remove the propeller shaft from the front axle.

Installation

Tightening torque	81~89Nm



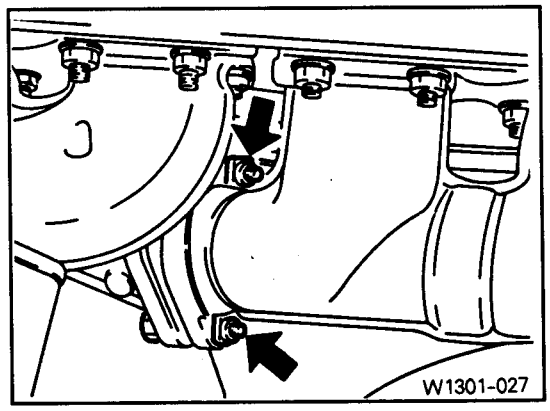
28) By rotating the crankshaft from the front of engine, remove the 6 torque converter mounting bolts from the engine ring gear plate.



29) Remove the exhaust manifold and exhaust pipe.

Installation

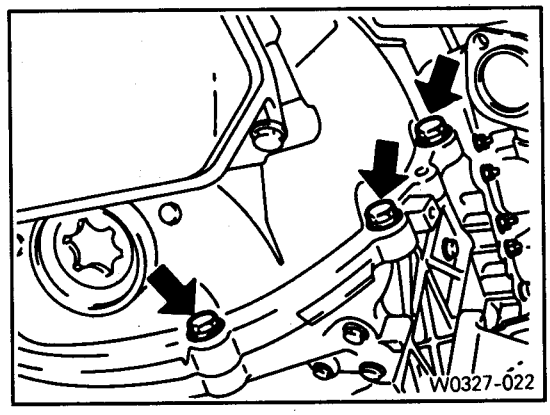
Tightening torque	30Nm



30) Remove the transmission mounting bolts and separate the transmission from the engine.

Installation

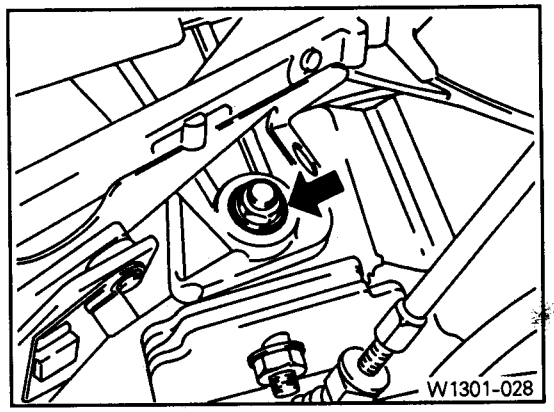
Tightening torque	65Nm



31) Remove the bolts for engine mounting bracket.

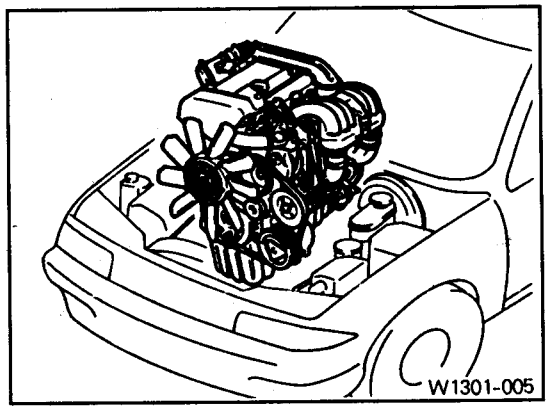
Installation

Tightening torque	50~75Nm

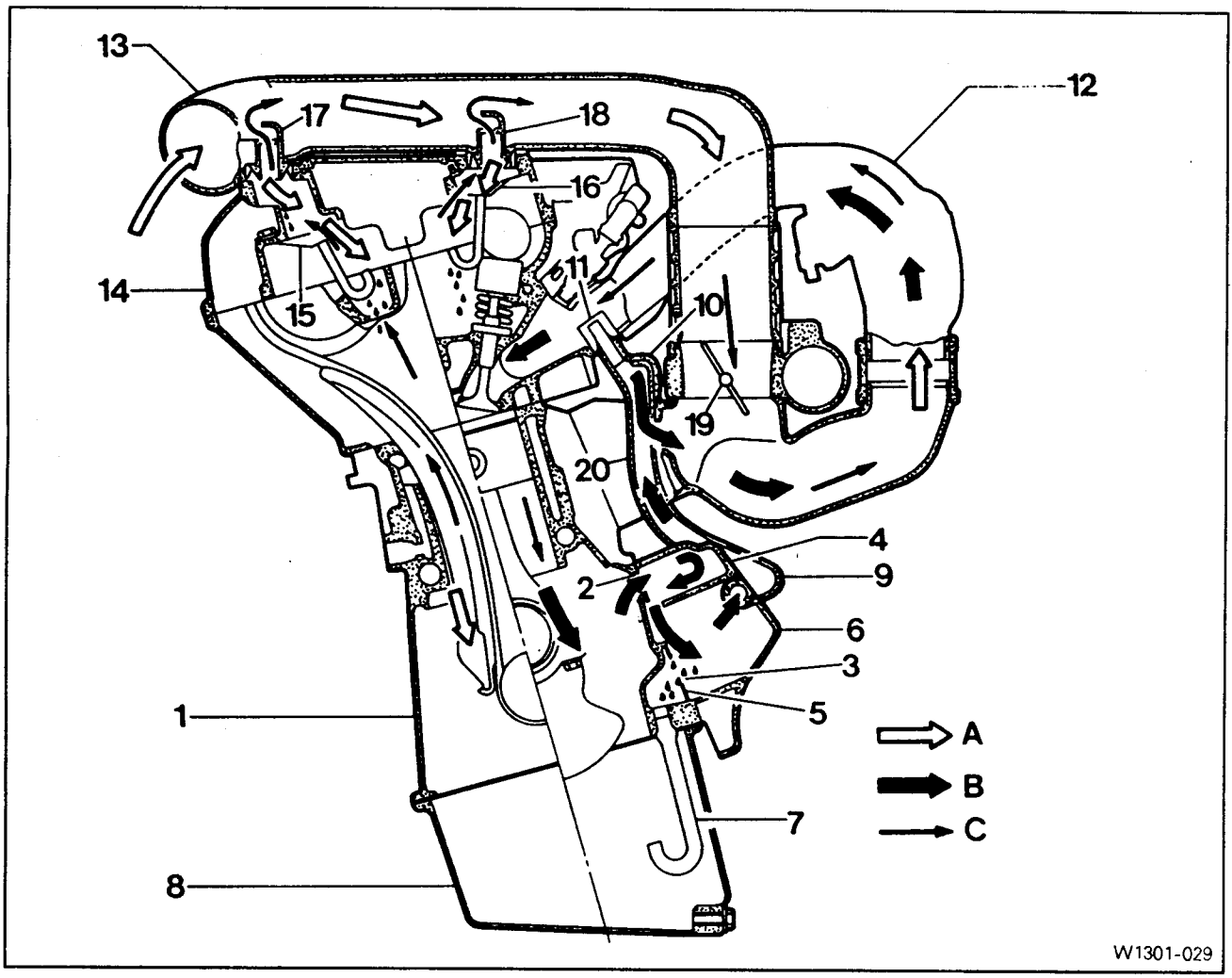


32) Hook the chain to the bracket of engine and by using a hoist or crane, carefully separate the engine assembly from the vehicle.

33) Installation is reverse order of the removal.



5. Crankcase Ventilation System



1. Crankcase
2. Air Admission Port in the Crankcase
3. Oil Drain Port
4. Filter
5. Gasket
6. Air Admission Housing
7. Oil Drain Pipe
8. Oil Sump
9. Air Admission Line
10. Vent Line
11. Restriction Hole (Diameter 2mm)
12. Intake Manifold
13. Intake Air Line (Cross Pipe)
14. Cylinder Head Cover
15. Oil Separator
16. Oil Separator
17. Air Admission and Vent Connection
18. Air Admission and Vent Connection
19. Throttle Valve
20. Vent Line

A. Fresh Air
B. Blowby Gas in Partial Load
C. Blowby Gas in Full Load

Operation in idle and medium load

- Throttle valve (19) is closed or opened a little and vacuum pressure in intake manifold is high.

In partial load, the blowby gas in the crankcase flows to intake manifold through the vent line (20) passing by the air admission housing (6) and filter (4). Air in the intake manifold is diluted by ventilating into the intake manifold through restriction hole (11) in the vent line (10).

Recirculation engine oil is separated at the air admission housing (6) and returns into oil sump through drain pipe (7).

Vacuum pressure created in the crankcase sucks in the fresh air from intake air line (13) through the air admission and vent connection (17, 18).

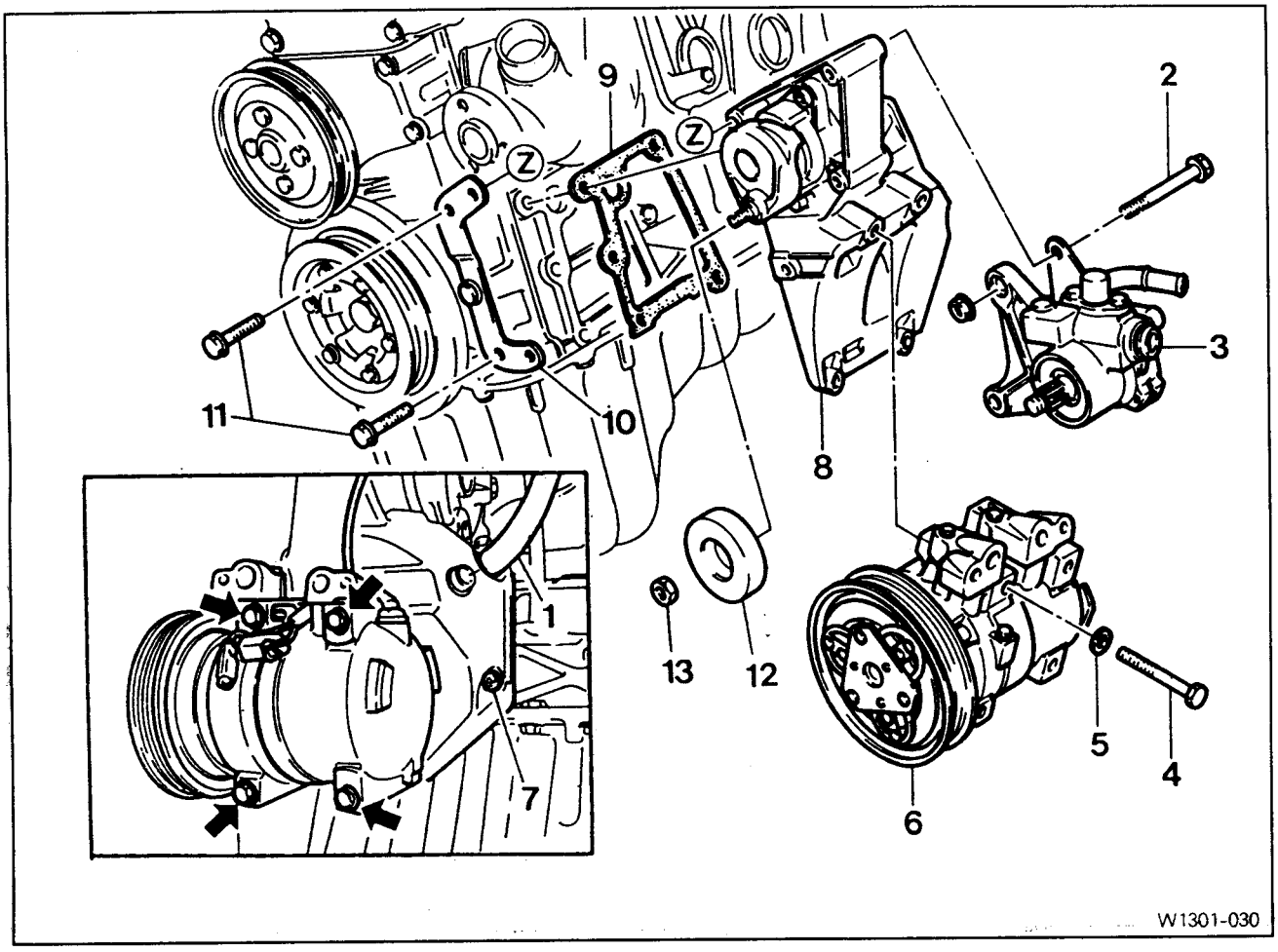
Fresh air prevents engine oil from being contaminated and the air admission and vent connector (17, 18) is designed to control the rapid pressure changes in intake air line (13).

Operation in full load

- Throttle valve (19) is fully opened.

In full load, all blowby gas flows into intake air line (13) through the oil separator (15, 16) in the cylinder head cover (14), and the diluted air flows into combustion chamber through the intake manifold (12).

6. Removal and Installation of Engine Air Admission Housing (Combination Support)



1. Vent Hose
2. Bolt
3. Power Steering Pump
4. Bolt
5. Washer
6. Compressor
7. Hexagon Socket Bolt + Washer -------23±2.3Nm
8. Air Admission Housing
9. Gasket ----------Replace
10. Bracket
11. Bolt----------23±2.3Nm
12. Tensioning Pulley
13. Nut (Left-hand Thread)----------45±4.5Nm

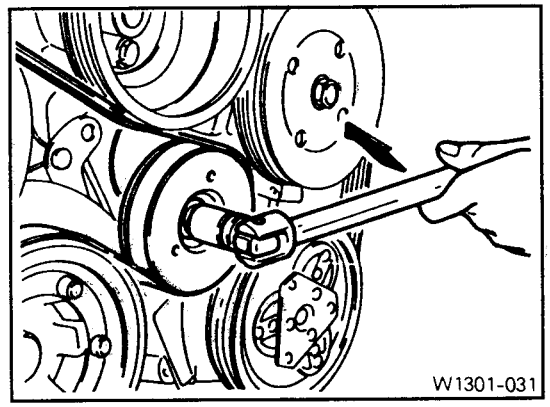
Removal · Installation

1) Turn the belt tensioning pulley nut counterclockwise and remove the pulley and belt.

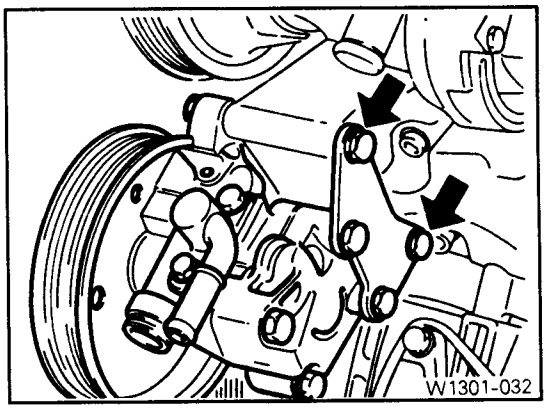
Installation

Tightening torque	45±4.5Nm

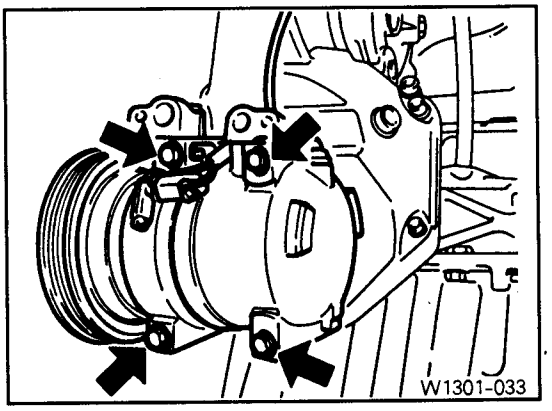
[Note] Be note that the nut is left-hand thread.



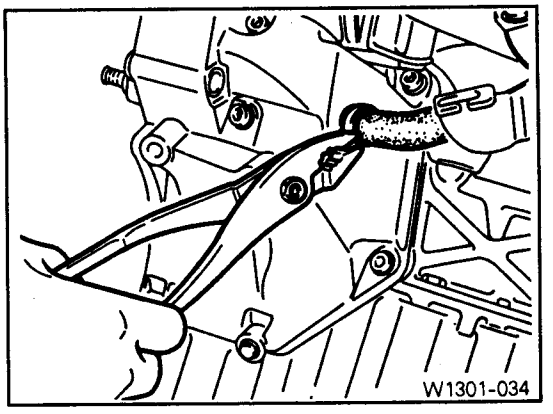
2) Disconnect the hydraulic pipe of power steering pump and remove the power steering pump.
[Note] Drain the oil before removal.



3) Disconnect the wiring connectors and pipes of air-conditioner compressor and remove the compressor.
[Note] Before removal, evacuate the refrigerant.



4) Disconnect the vent hose from air admission housing.



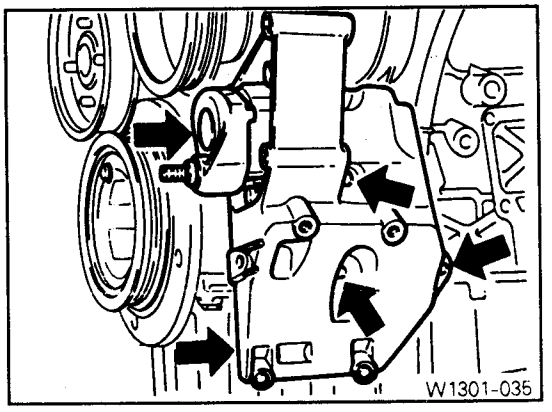
5) Remove the mounting bolts (arrow) and then remove the air admission housing and gasket.

Installation

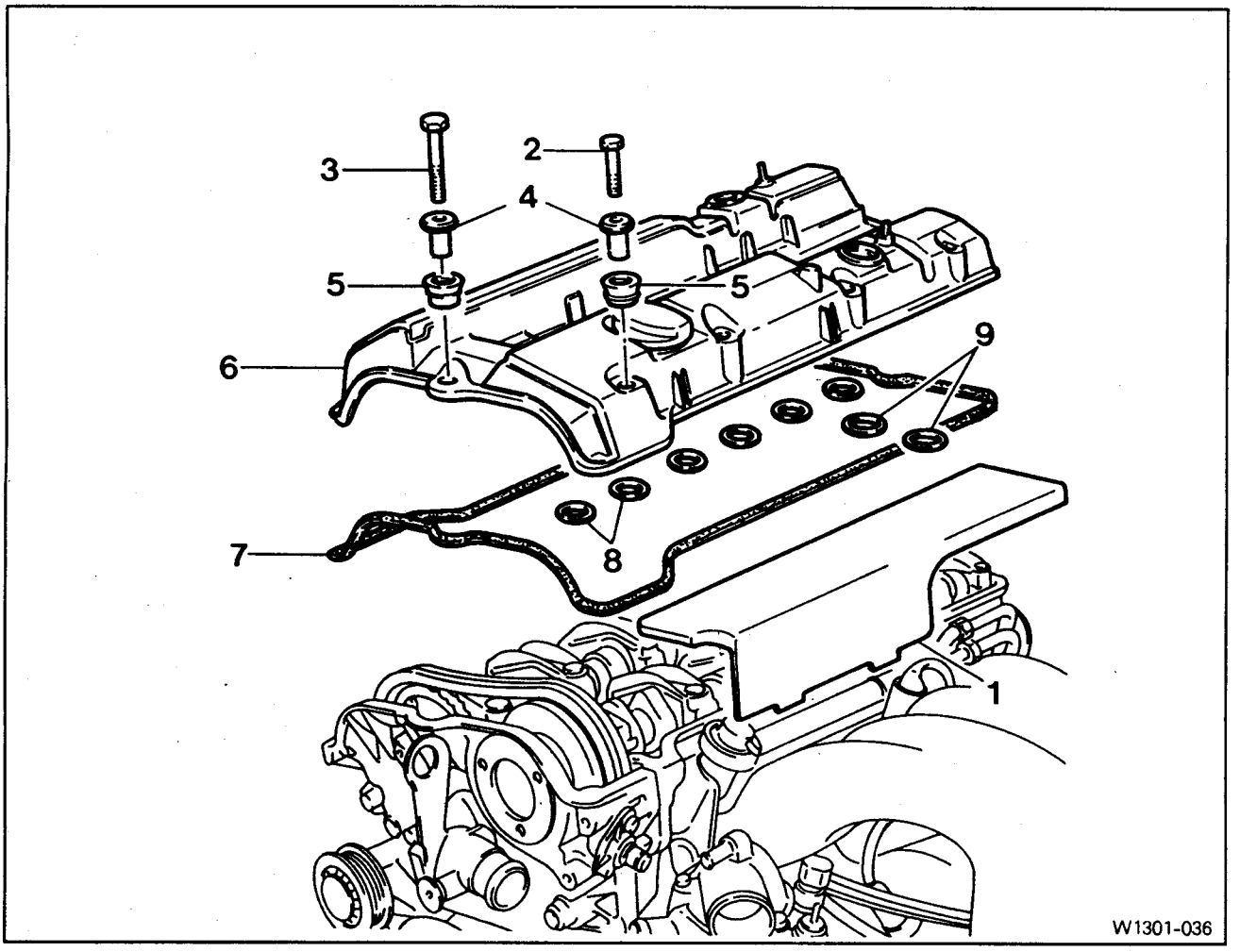
Tightening torque	23±2.3Nm

[Note] Replace the gasket.

6) Installation is reverse order of the removal.



7. Removal and Installation of Cylinder Head Cover



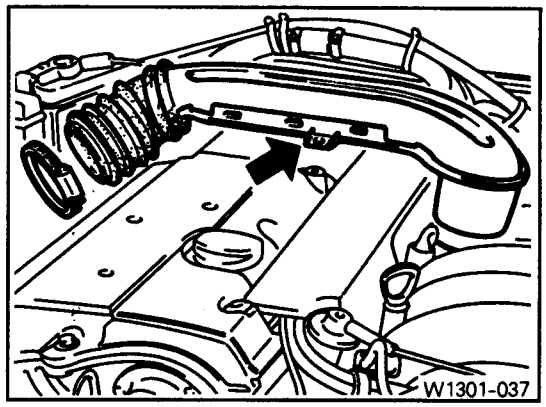
1. Cable Duct
2. Bolt ---------- 10Nm
3. Bolt ---------- 10Nm
4. Spacer Sleeve
5. Thrust Piece
6. Cylinder Head Cover
7. Gasket ---------- Replace
8. Ignition Coil Shaft Seal ---------- Replace
9. Camshaft Seal ---------- Replace

Removal · Installation

1) Remove the air cleaner cross pipe.

Installation

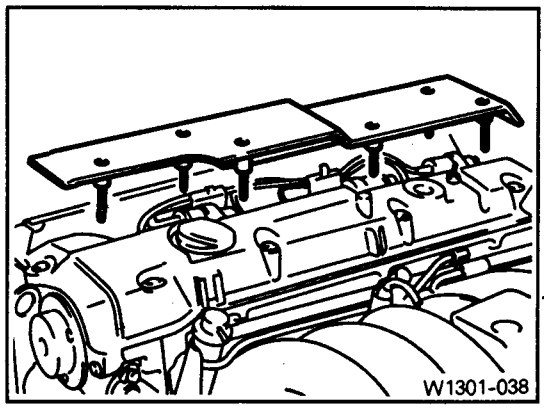
Tightening torque	9~11Nm



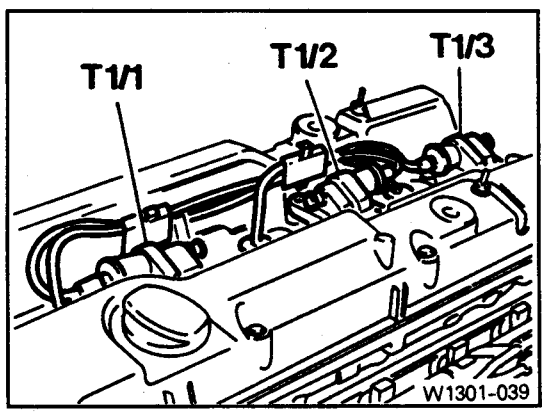
2) Remove the ignition coil cable duct cover.

Installation

Tightening torque	9~11Nm



3) Remove the ignition coils.



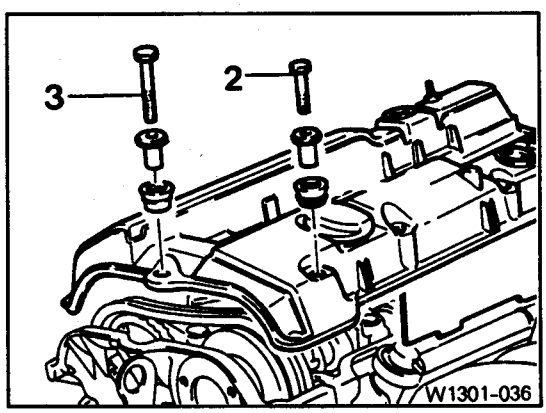
4) After removing the cable duct (1), remove the bolts (2, 3) and the cylinder head cover.

Installation

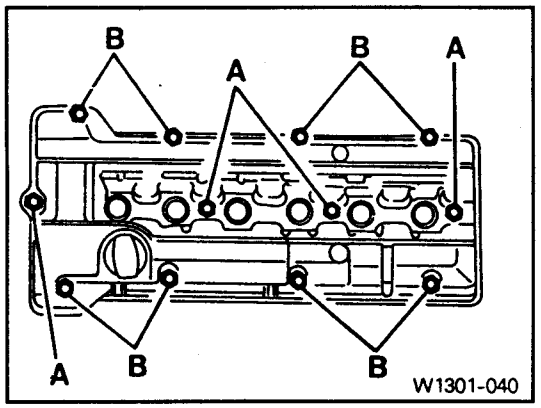
Tightening torque	9~11Nm

[Note] Replace the gasket (7), ignition coil shaft seal (8) and camshaft seal (9).

5) Installation is reverse order of the removal.



Bolts arrangement



A : M6 × 50, Washer

B : M6 × 65, Washer

8. Measuring, Boring and Honing of Cylinder Bore

Cylinder bore dimension table

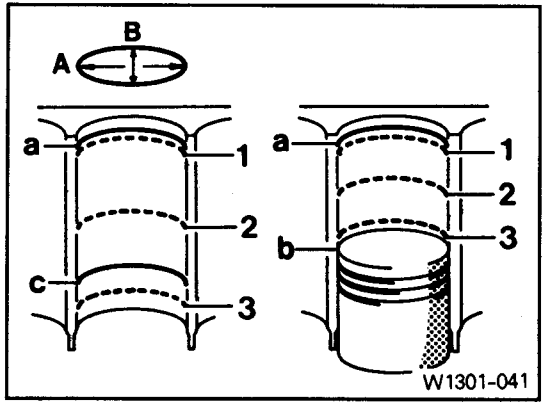
Section	Group code[1)]	Diameter of cylinder	Diameter of piston
Standard diameter : φ89.9mm	A	89.900 - 89.906	89.873 - 89.679
	X	89.906 - 89.912	89.878 - 89.886
	B	89.912 - 89.918	89.885 - 89.891
Repair size 1 + 0.25	A	90.150 - 90.156	90.123 - 90.129
	X	90.156 - 90.162	90.128 - 90.136
	B	90.162 - 90.168	90.135 - 90.141
Repair size 2 + 0.5	A	90.400 - 90.406	90.373 - 90.379
	X	90.406 - 90.412	90.378 - 90.386
	B	90.412 - 90.418	90.385 - 90.391

1) Group code letter is embedded on the piston crown and crankcase matching surface.

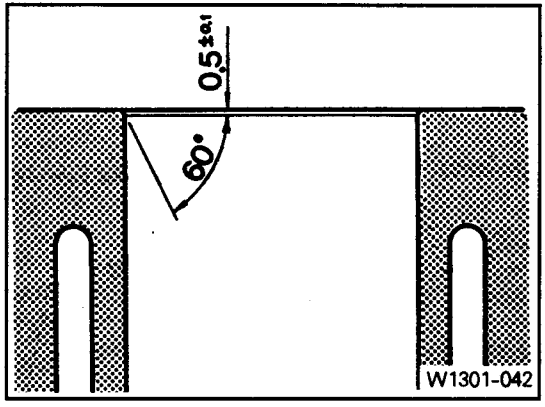
Service Data		mm
Wear limit in longitudinal and transverse direction		Max. 0.1
Permissible deviation of cylinder shape	New	0.007
	Wear limit	0.05
Permissible deviation of rectangularity related to cylinder height		0.05
Basic peak-to-valley height after final honing and brushing		0.003～0.006
Permissible waviness		50% of peak-to-valley height
Chamfer angle		60°
Honing angle		50 ± 10°

Measurement

Thoroughly clean the cylinder bore and measure at the 3 measuring points(1, 2 and 3) in the longitudinal and transverse directions by using a hole gauge.

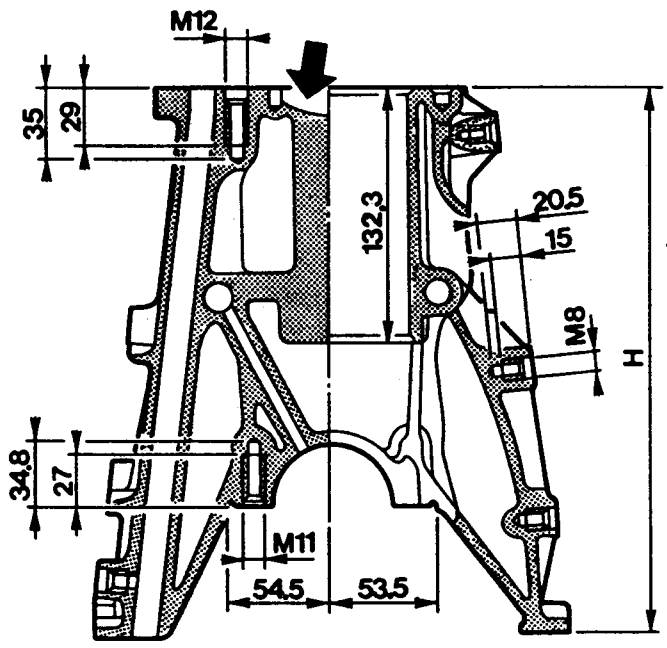


1-3 Measuring points
A. Longitudinal direction
B. Transverse direction
a. Upper reversal point of No. 1 piston ring
b. Piston BDC
c. Lower reversal point of oil ring



9. Milling of Crankcase Matching Surface

Preceding work : Removal of piston (03-07)

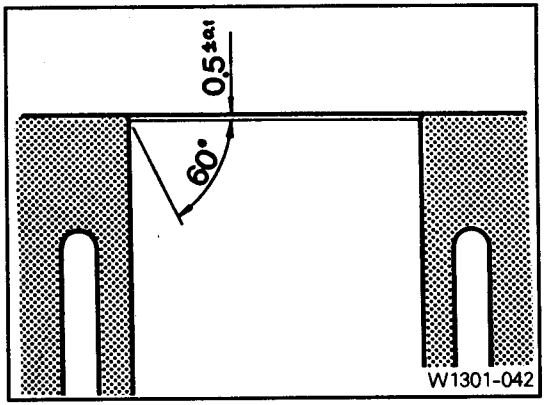


W1301-043

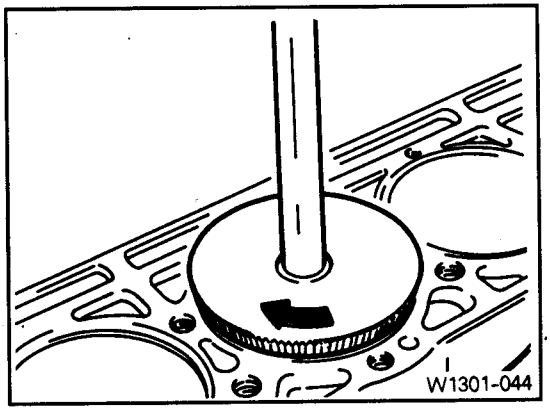
Service data		mm
Height 'H" of crankcase(New)		282.25~282.35
Minimum height after machining		281.95
Flatness	Upper crankcase contact surface	0.03
	Lower crankcase contact surface	0.04
Parallelism of upper to lower crankcase contact surface on the crankcase	Longitudinal direction	0.1
	Transverse direction	0.05
Peak-to-valley height waviness	Upper crankcase contact surface	0.005~0.020
	Lower crankcase contact surface	0.025

[Note] Machine the crankcase and timing case cover together.

- Chamfer angle : 60°

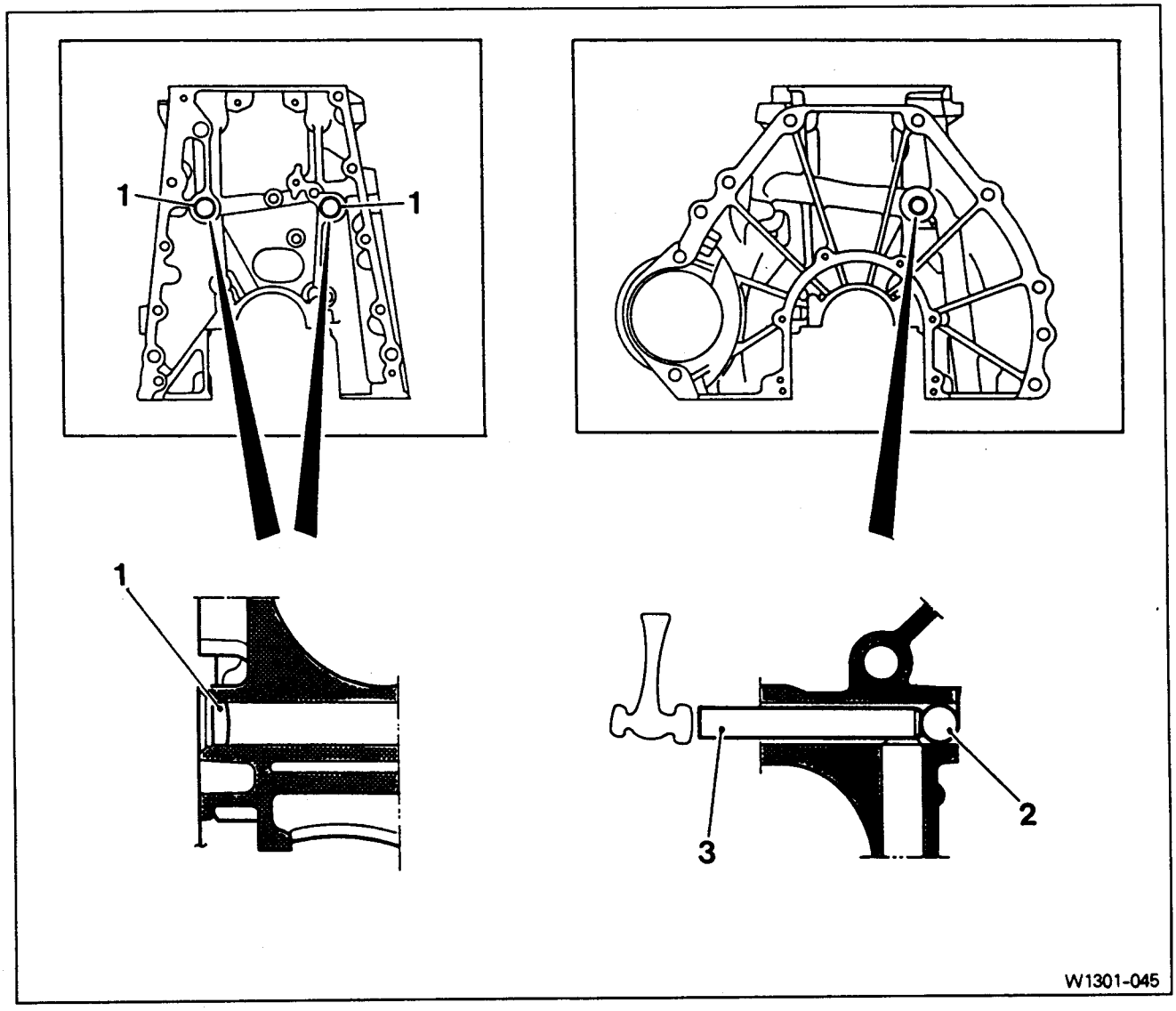


- After chamfering the cylinder bores with a hand milling cutter, equalize bottom edge of chamfer with polishing wheel.



10. Cleaning and Sealing of Oil Galleries

Preceding work : Removal of crankshaft
Removal of oil spray nozzle



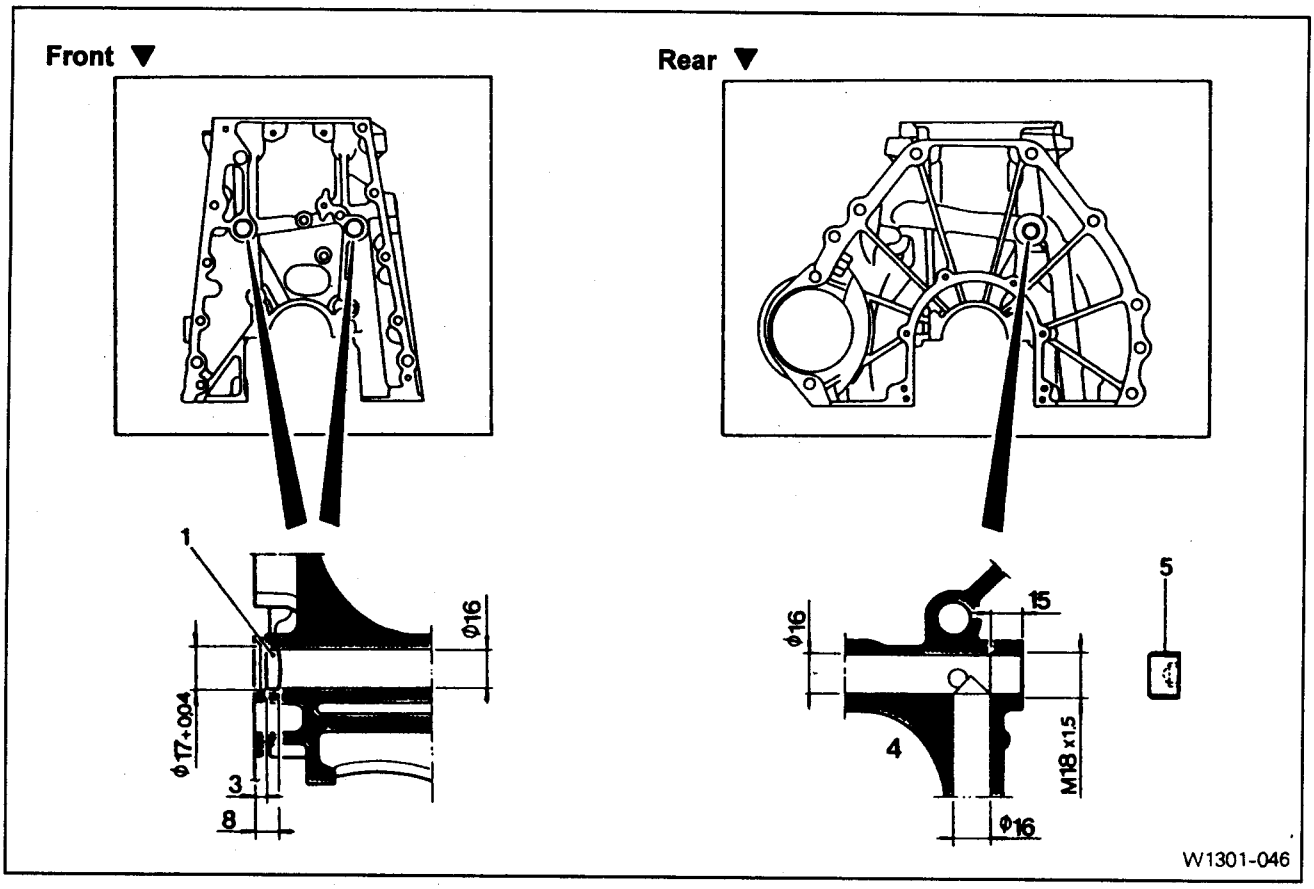
1. Plug
2. Steel Ball
3. Round Bar---------- ϕ 11 × 750mm

Cleaning

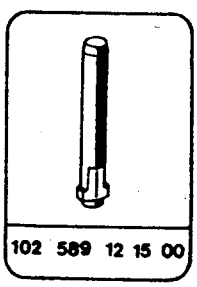
1) Remove the plug (1) with screwdriver.

2) Using a round bar (3) and hammer, remove the steel ball (2).

3) Using compressed air, blow into the oil galleries and clean it off.



Special Tool



Sealing

1) Enlarge the end of main oil gallery (4) to be diameter 16mm, depth 15mm.

2) Using a M16 × 1.5 thread (tap), make thread at the end of main oil gallery (4).

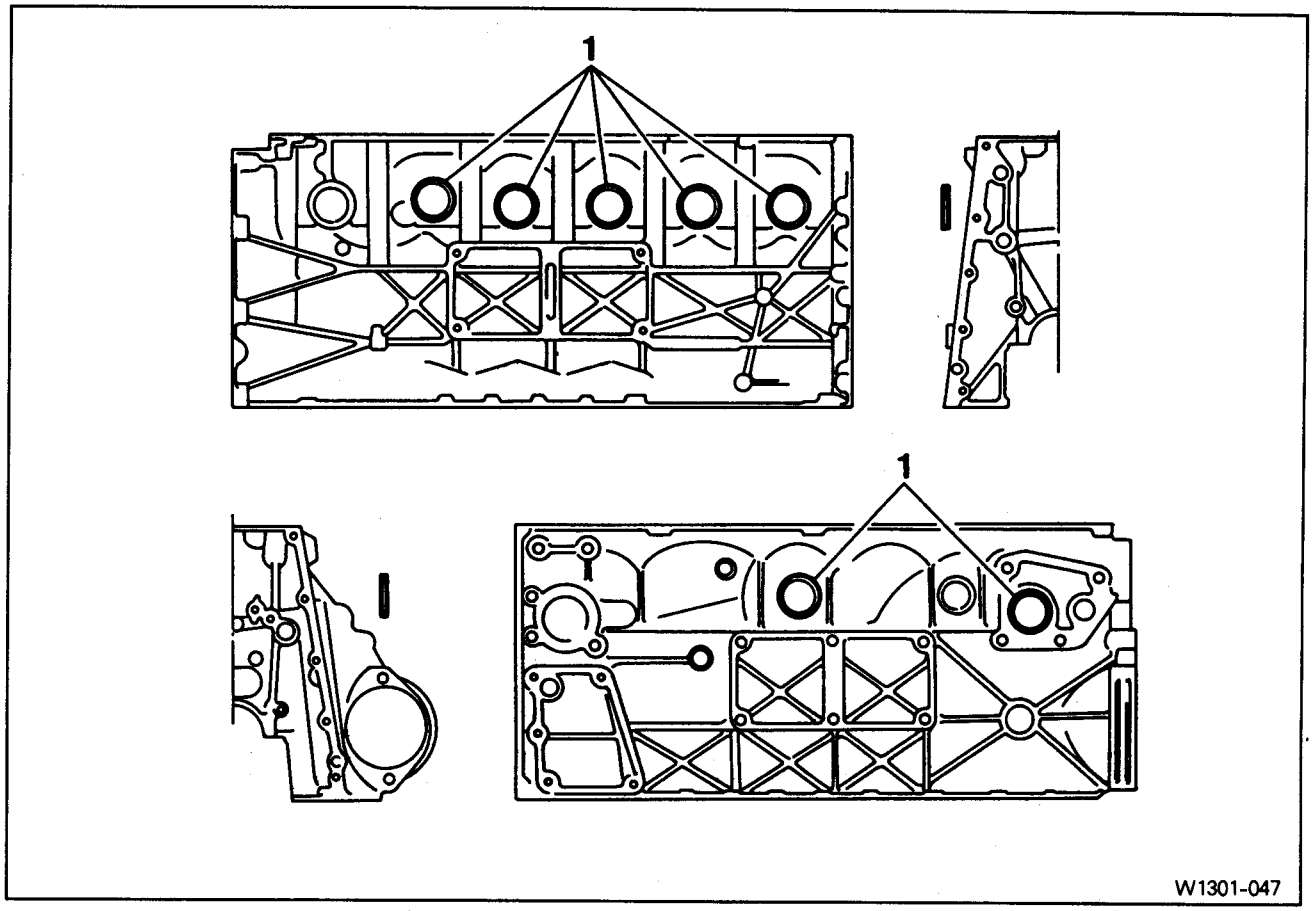
3) Thoroughly clean the oil gallery with compressed air.

4) Apply sealing bond on the M16 × 1.5 screw plug (5) and then tighten it.

5) Apply Loctite 270 on the new plug (2).

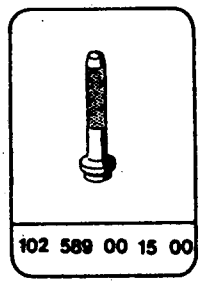
6) Insert the new plug (2, 4) into drift and tighten to the hole until the drift is stopped.

11. Replacement of Core Plugs in the Crankcase



1. Core Plug----------Replace

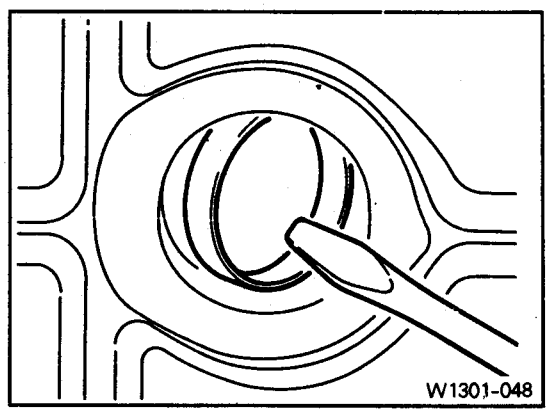
Special Tool



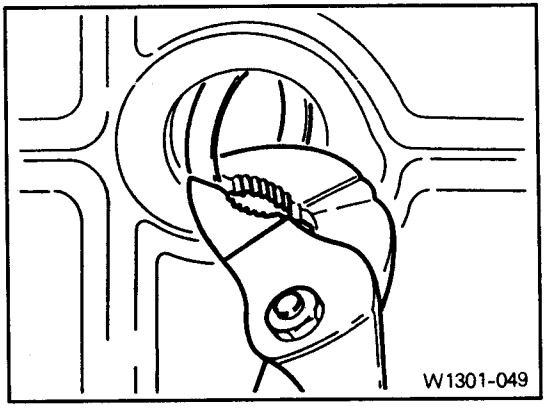
Replacement

1) Drain the coolant.

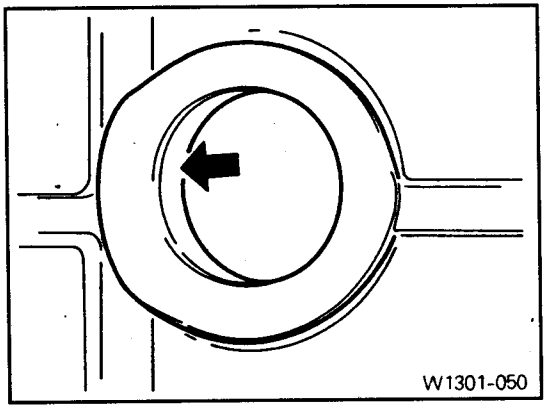
2) Using a screwdriver, pull back the core plug until one side is come out.



3) Carefully pull out the core plug with pliers.

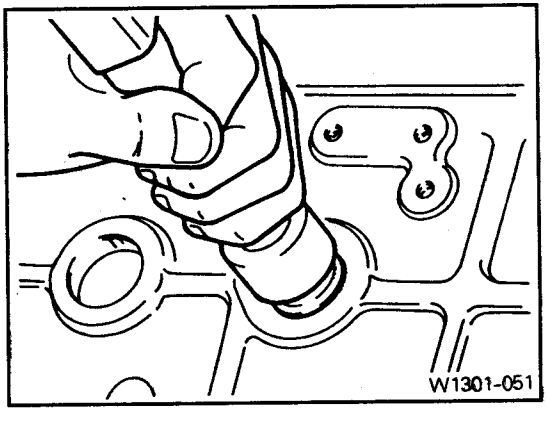


4) Thoroughly clean the sealing surface and apply Loctite 241.



5) Install the new plug with drift.

Drift 102 589 00 15 00

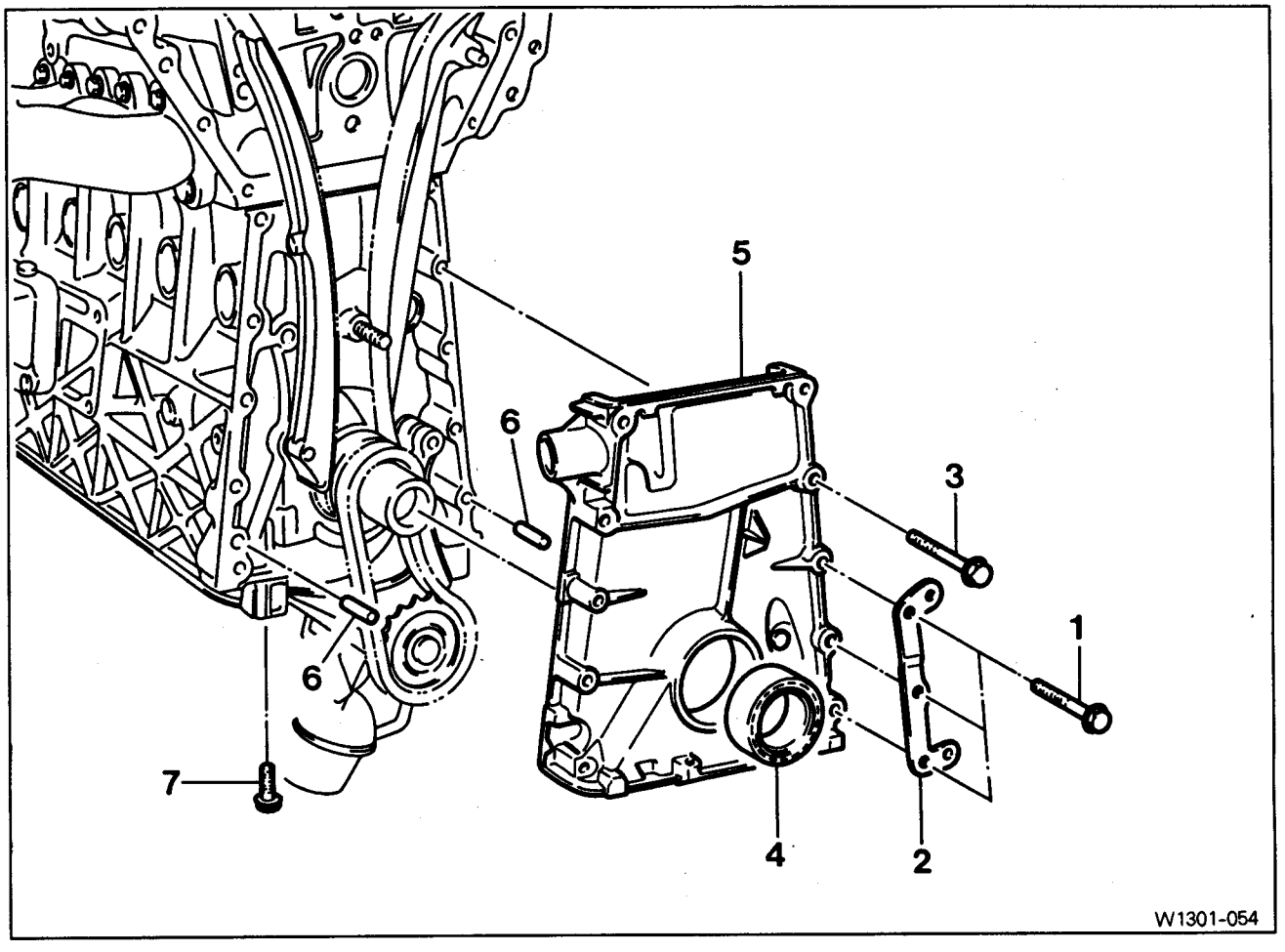


6) Fill up the coolant.
[Note] Wait for about 45minutes before filling the coolant for Loctite hardening.

7) Warm up the engine and check the coolant for leakage.

12. Removal and Installation of Timing Case Cover

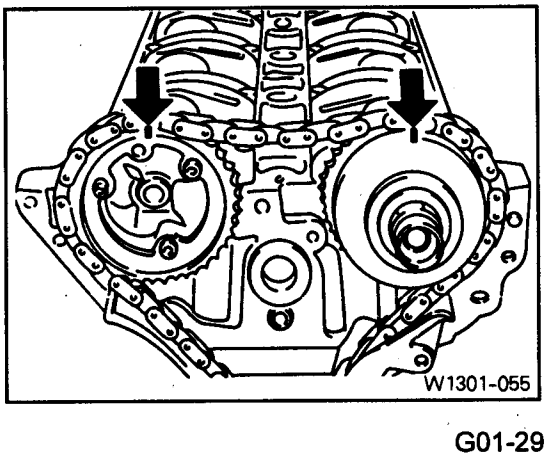
Preceding work : Removal of the cylinder head front cover (01-32)
Removal of alternator carrier (01-31)
Removal of tensioning device (13-05)



1. Bolt----------21Nm
2. Air Admission Housing Bracket
3. Bolt----------21Nm
4. Seal----------Check
5. Timing Case Cover
6. Roll Pin
7. Bolt----------10Nm

Removal · Installation

1) Place alignment marks (arrow) on the timing chain and camshaft sprocket.



2) Remove the air admission housing bracket bolts (1) and then remove the bracket.

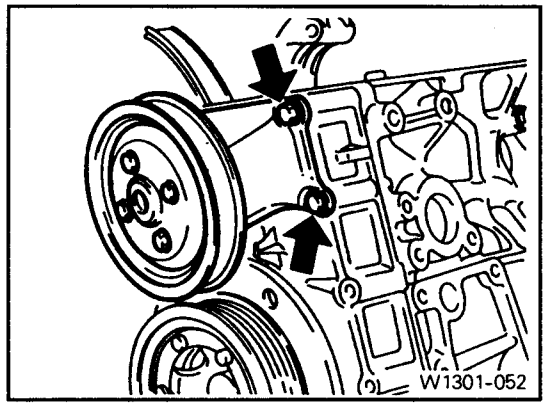
Installation

Air admission housing bolt	23Nm
Timing case cover bolt	21Nm

3) Remove the viscous fan clutch pulley and bracket.

Installation

Tightening torque	23Nm



4) Remove the belt pulley and vibration damper.

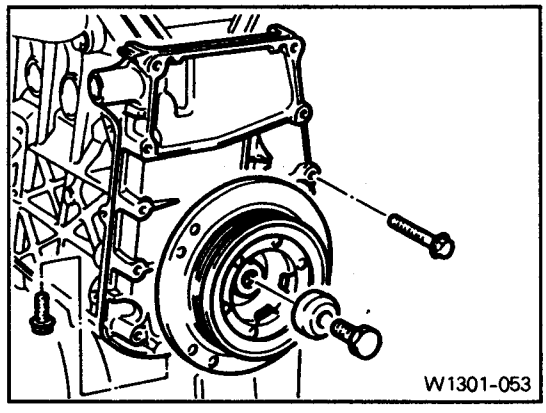
Installation

Tightening torque	400Nm

5) Remove the bolts of timing case cover (6 pieces) and lower oil fan (6 pieces) and then remove the timing case cover.

Installation

Timing case cover bolt (M8)	21Nm
Oil fan bolt (M6)	10Nm

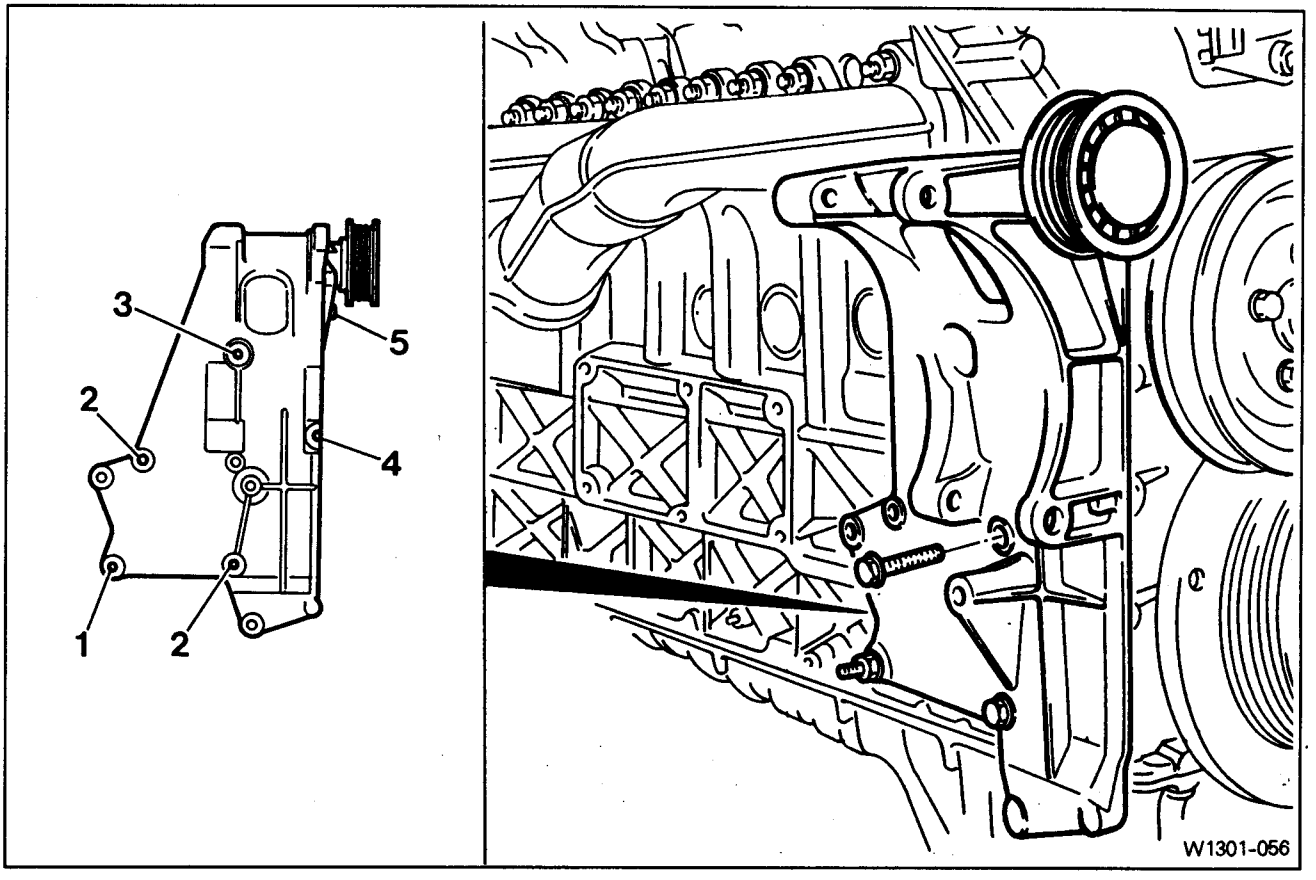


[Note]
- **Be careful not to damage the oil fan gasket during removal of the timing case cover.**
- **For installation, clean the timing case surface and then apply with sealant.**
- **Be careful not to stain the oil chamber of chain tensioner with sealant.**

6) Installation is reverse order of the removal.

7) Warm up the engine and check for leakage.

13. Removal and Installation of Alternator Carrier



1. M8 Nut
2. M8 × 30 Hexagon Socket Bolt + Washer
3. M8 × 40 Hexagon Socket Bolt + Washer
4. M8 × 70 Hexagon Socket Bolt + Washer
5. M8 × 80 Bolt + Washer

Removal · Installation

1) Remove the V-belt.

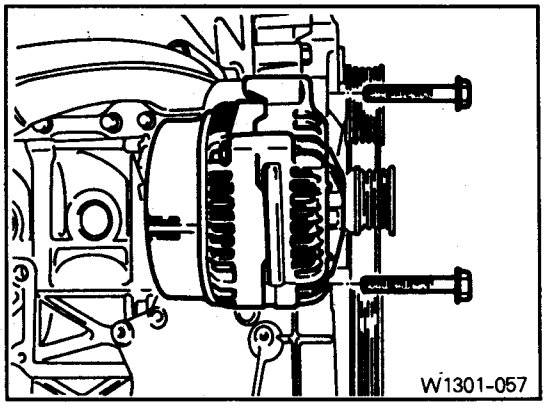
2) Remove the alternator.

3) Remove the alternator carrier bolts and then remove the carrier.

Installation

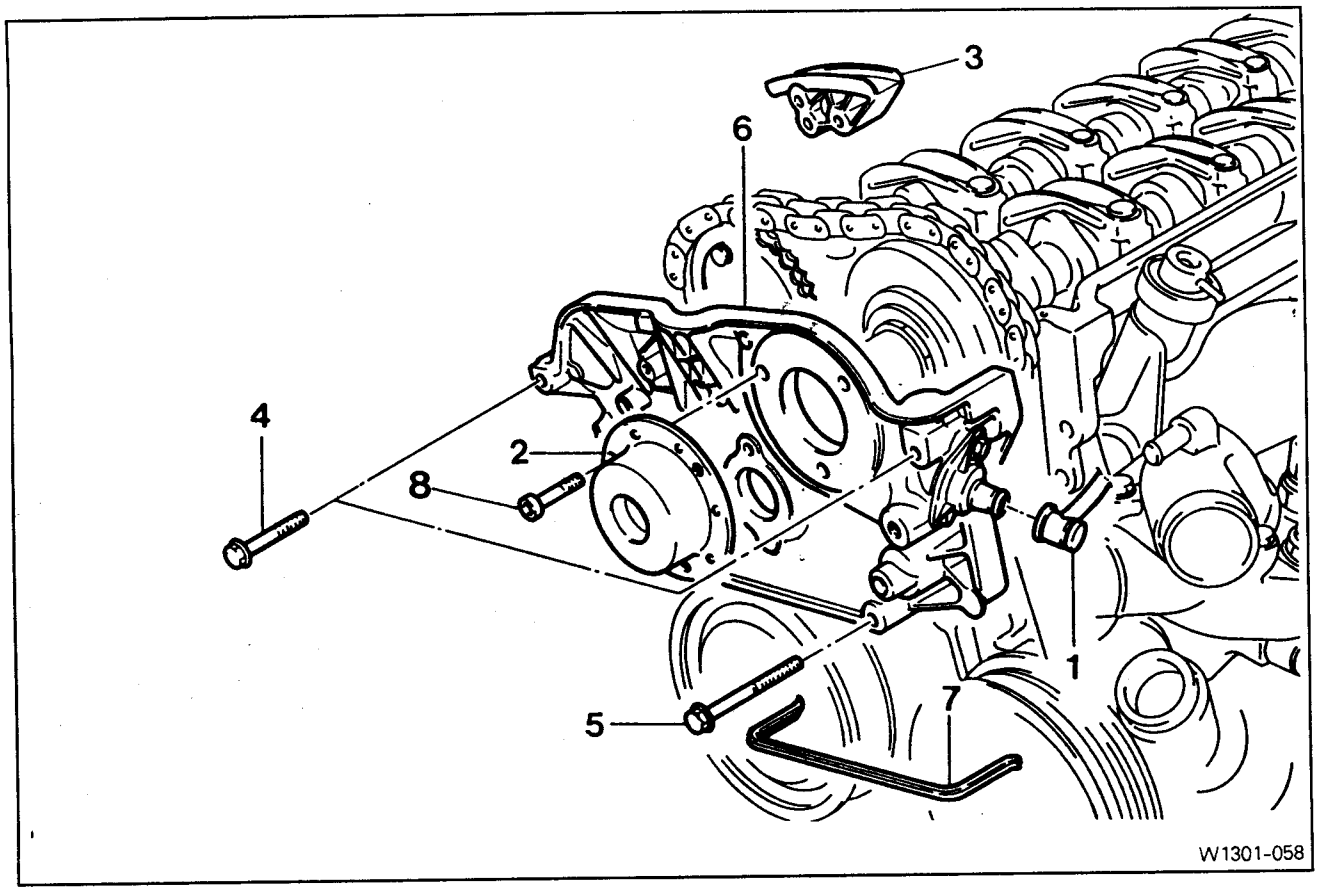
Tightening torque	21Nm

4) Installation is reverse order of the removal.



14. Removal and Installation of Cylinder Head Front Cover

Preceding work : Removal of the cylinder head cover (01-37)
Removal of the coolant connection fitting (20-04)



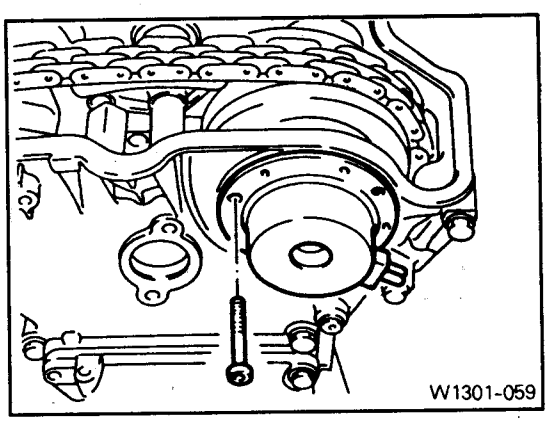
1. Camshaft Position Sensor
2. Camshaft Adjust Actuator
3. Upper Guide Rail
4. M8 × 60 bolt + Washer----------21Nm
5. M8 × 80 bolt + Washer----------21Nm
6. Front Cover
7. Rubber Gasket----------Replace
8. Bolt (M6 × 16) ----------10Nm

Removal · Installation

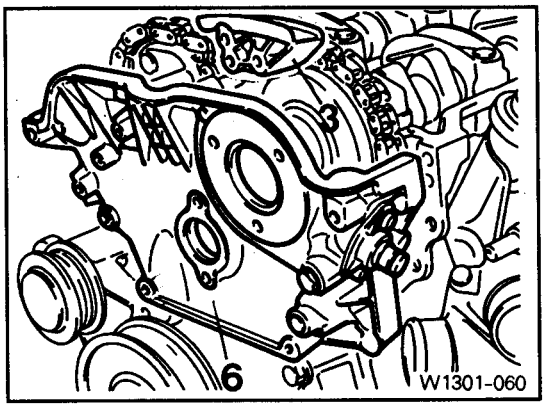
1) Remove the camshaft adjust actuator.

Installation

Tightening torque	10Nm



2) Remove the front cover (6) of the cylinder head.



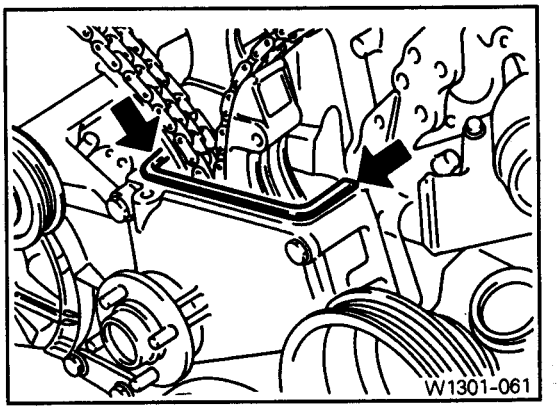
Installation

Tightening torque	21Nm

[Note] Apply sealant on the cylinder head and front cover matching surface.

3) Remove the upper guide rail (3).
[Note] For installation, do not install the chain tensioner to avoid tensioning force.

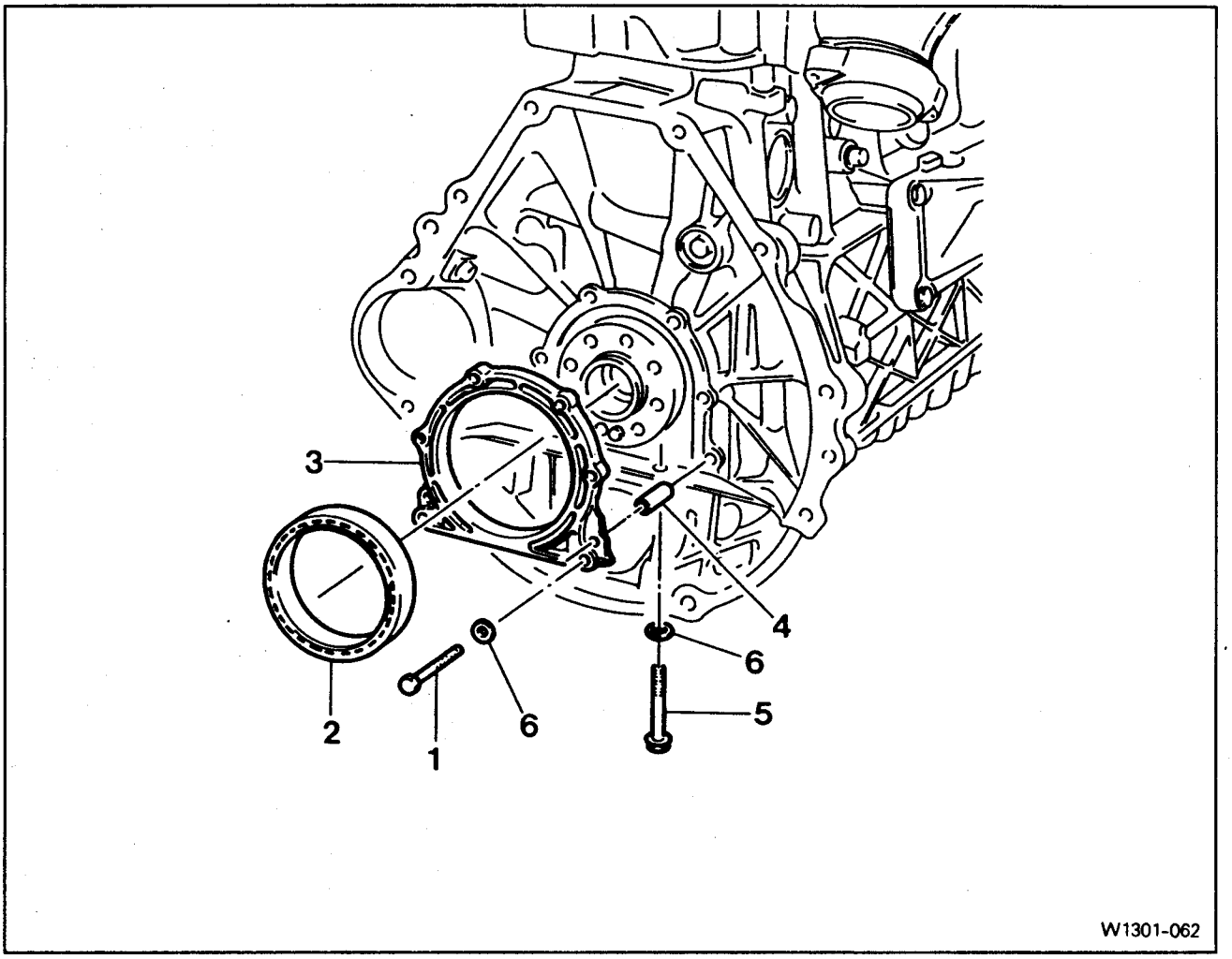
4) Remove the gasket.
[Note] For installation, replace the gasket and apply sealant.



5) Installation is reverse order of the removal..

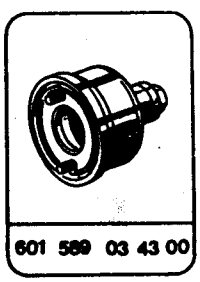
15. Removal and Installation of Closing Cover

Preceding work : Removal of the automatic transmission driven plate (03-17)



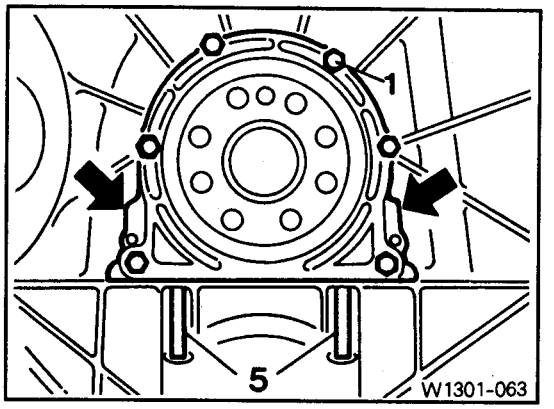
1. Bolt ---------- 9Nm
2. Radial Shaft Seal---------- Clean
3. Closing Cover
4. Pin
5. Bolt ---------- 10Nm
6. Washer

Special Tool



Removal · Installation

1) Remove the bolts (1, 5). By pulling out the lug (arrow) of closing cover, remove the closing cover.
[Note] Be careful not to damage the oil fan gasket.

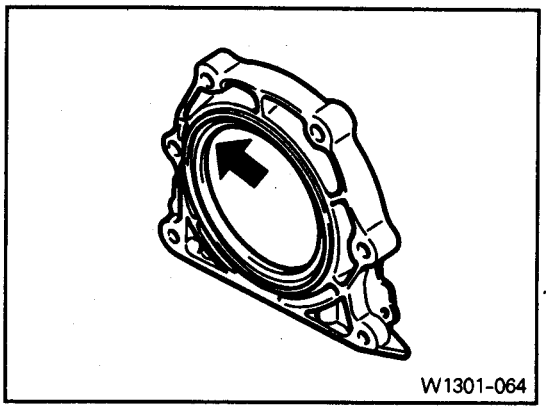


2) Clean the crankcase and closing cover sealing surface.

3) Check the radial seal and replace if necessary.

4) Apply the Loctite 573 to the closing cover sealing surface.

5) Coat the dust and rib of the radial shaft seal with engine oil.
[Note] Never use the grease.

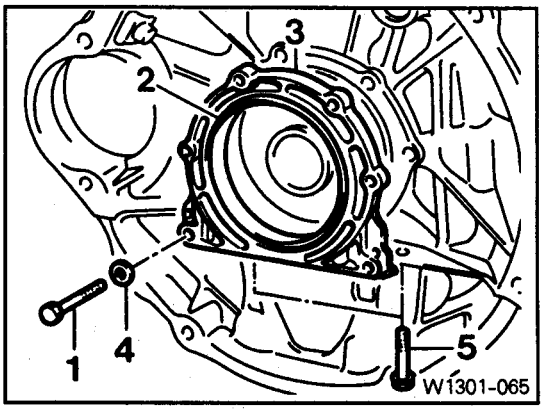


6) Using a special tool, press the radial seal and closing cover. Tighten the closing cover bolts (1) first and then tighten the oil pan bolts (5) as specified and remove the special tool.

Installation

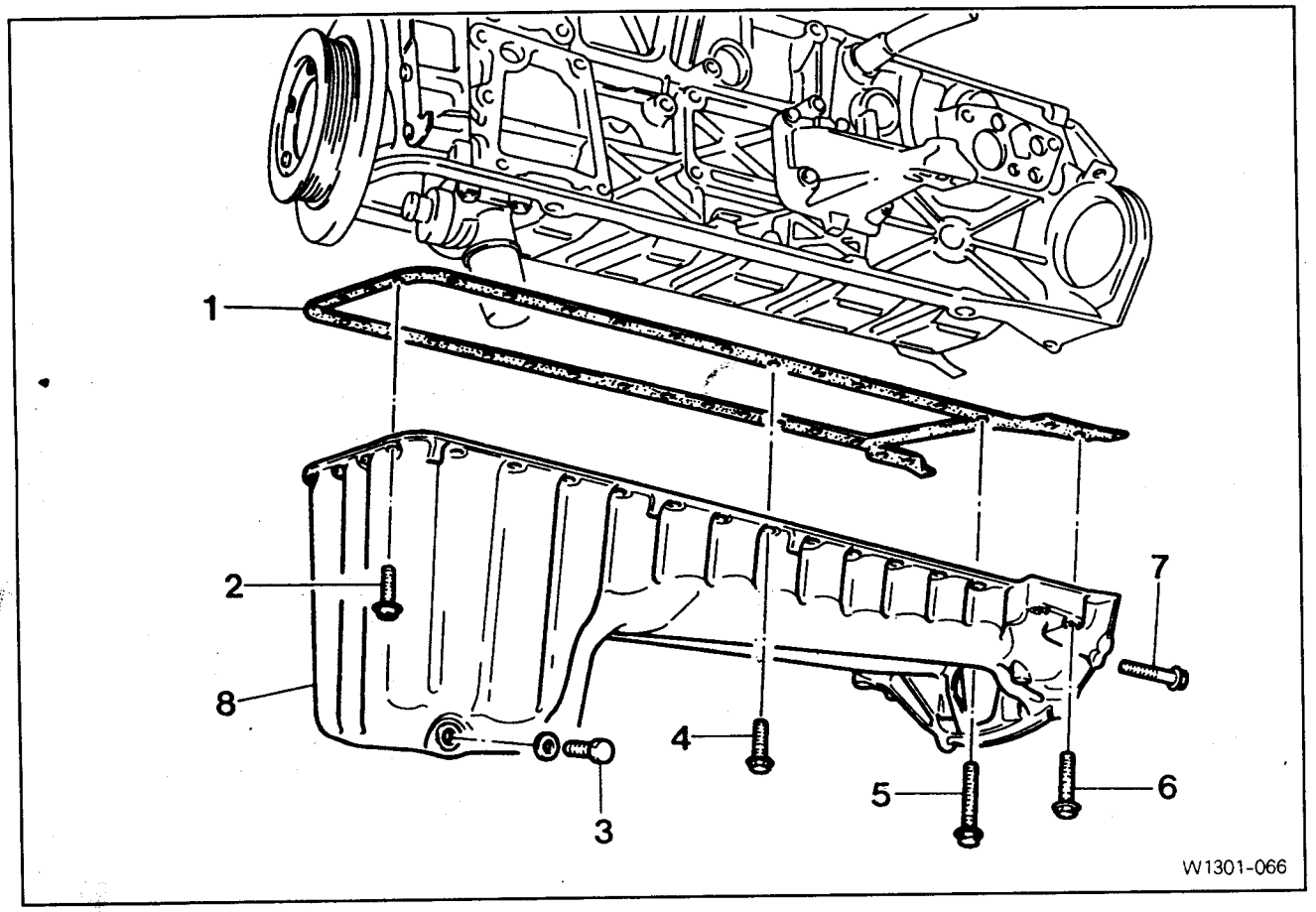
Tightening torque	Closing cover : 9Nm
	Oil fan : 10Nm

Seal assembler 601 589 03 43 00



7) Installation is reverse order of the removal.

16. Removal and Installation of Oil Pan



1. Gasket ---------- Replace
2. M6 × 22 Socket Bolt (6 Pieces) ---------- 10Nm
3. M6 × 20 Drain Plug ---------- 25Nm
4. M6 × 20 Hexagon Bolt (22 Pieces) ---------- 10Nm
5. M6 × 85 Hexagon Bolt ---------- 10Nm
6. M8 × 40 Hexagon Bolt ---------- 25Nm
7. M10 Hexagon Bolt ---------- 40Nm
8. Oil Pan

Removal · Installation

1) Remove the bolts and then remove the oil pan and gasket.
   [Note] Keep the bolts not to be changed each other.

2) Clean the oil pan sealing surface and apply sealant.

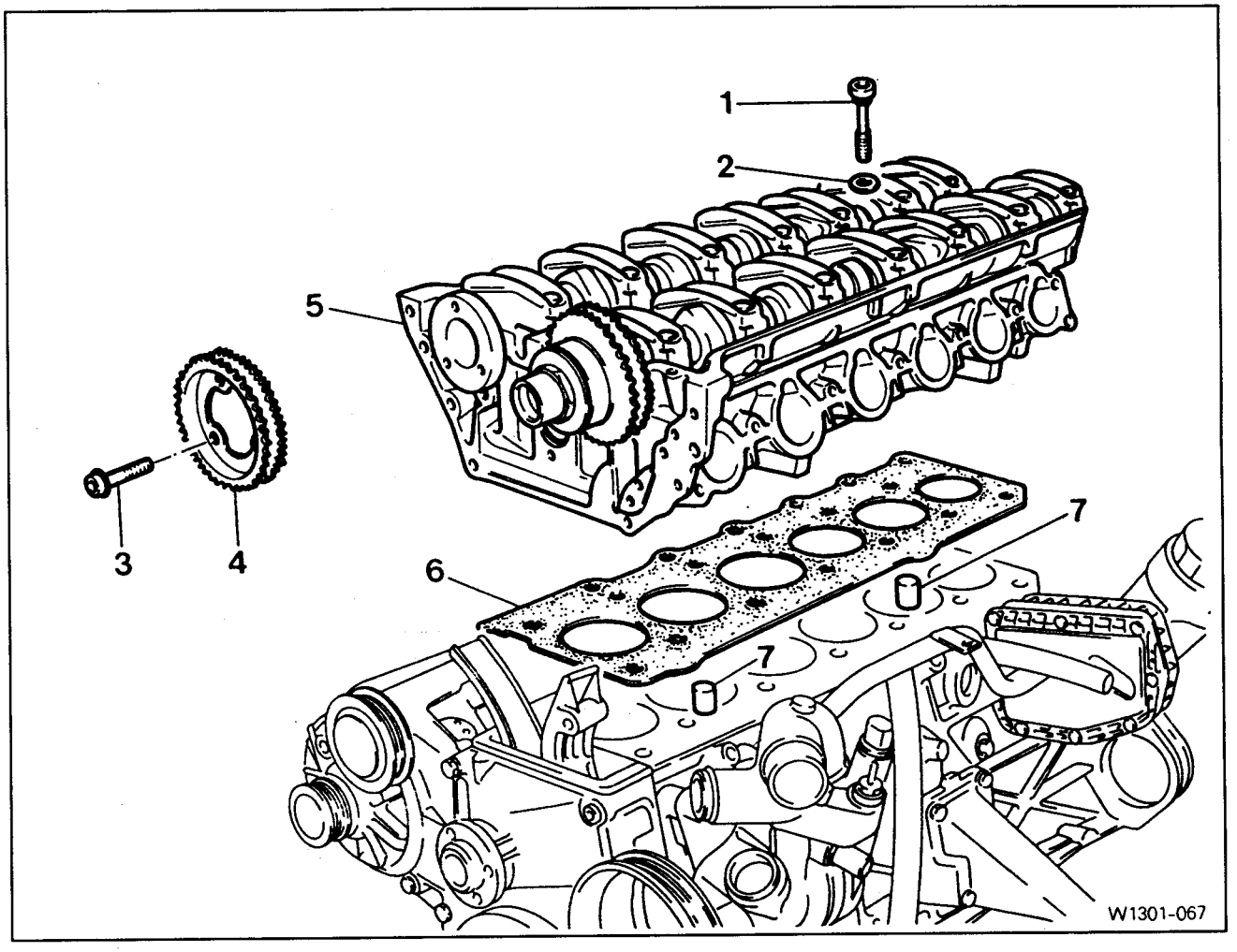
3) Thoroughly clean the oil pan inside.

4) Replace the gasket.

5) Carefully seat the gasket onto the oil pan and align it with the crankcase lower surface and then tighten the bolts as specified.

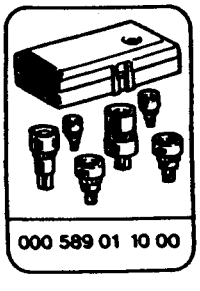
17. Removal and Installation of Cylinder Head

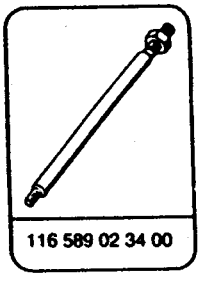
Preceding work : Removal of cylinder head cover (01-18)
Removal of the cylinder head front cover (01-32)
Removal of the upper intake manifold (14-01)

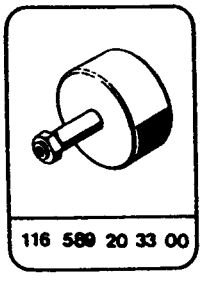


1. Bolt----------Stage 1 : 55Nm
   Stage 2 : torque angle 90°
   Stage 3 : torque angle 90°
2. Washer
3. Bolt----------21Nm
4. Exhaust Camshaft Sprocket
5. Cylinder Head
6. Gasket----------Replace
7. Dowel Sleeve----------Caution

Special Tools



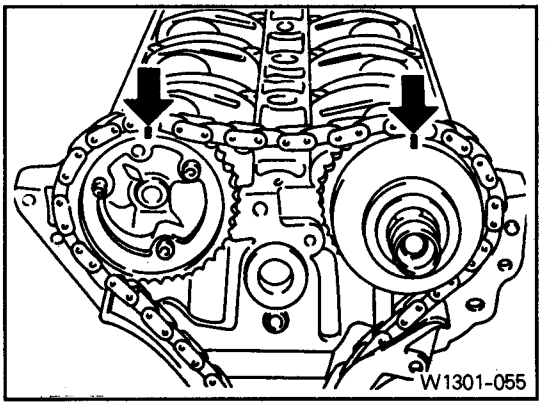




Removal · Installation

1) Rotate the crankshaft until the piston of no.1 cylinder is at TDC.

2) Place alignment marks (arrow) on the timing chain and camshaft sprocket.



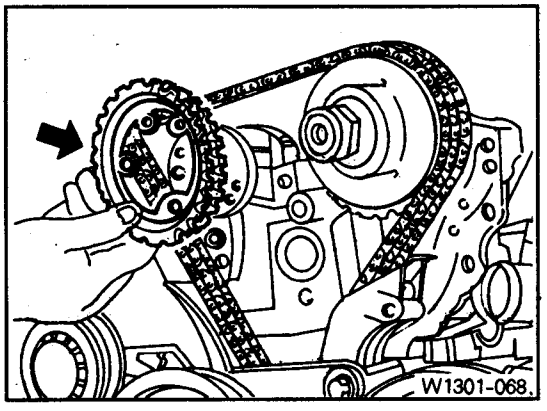
3) Drain the coolant from the crankcase.

4) Remove the bolt (3) from the exhaust camshaft sprocket.

Installation

Tightening torque	21Nm

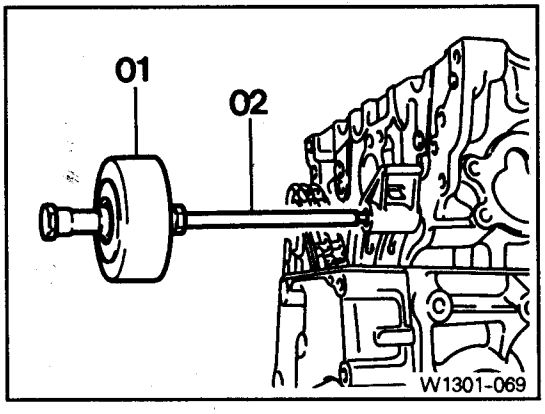
[Note] Do not reuse the bolt removed.



5) Separate the chain from the camshaft sprocket.
[Note] Be careful not to drop the chain into the timing case.

6) Remove the guide rail pin from the cylinder head by using a sliding hammer (01) and threaded pin (02).

Sliding hammer 116 589 20 33 00
Threaded pin 116 589 02 34 00

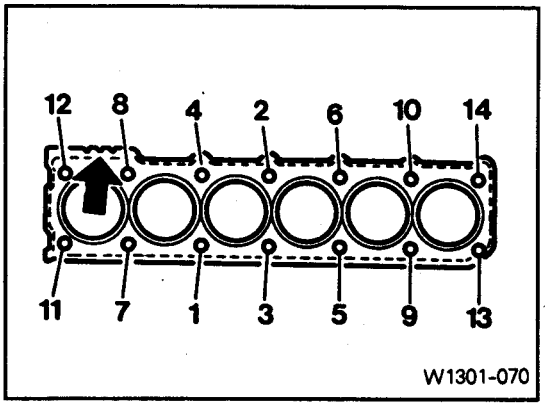


7) Remove the cylinder head bolts in numerical order.

Installation
Tighten the bolts in reverse order as specified.

Tightening torque (Engine cold)	Stage 1	55Nm
	Stage 2	Torque angle 90°
	Stage 3	Torque angle 90°

Box wrench insert 000 589 01 10 00

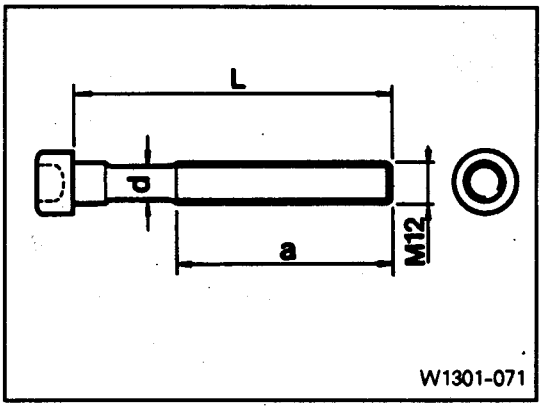


W1301-070

8) Measure the length of cylinder head bolts.

Length (L)	New	160±0.8mm
	Max. permissible length	162±70mm

[Note] • **Replace the bolts if it is over max. permissible length.**
• **Coat the bolt thread with oil.**



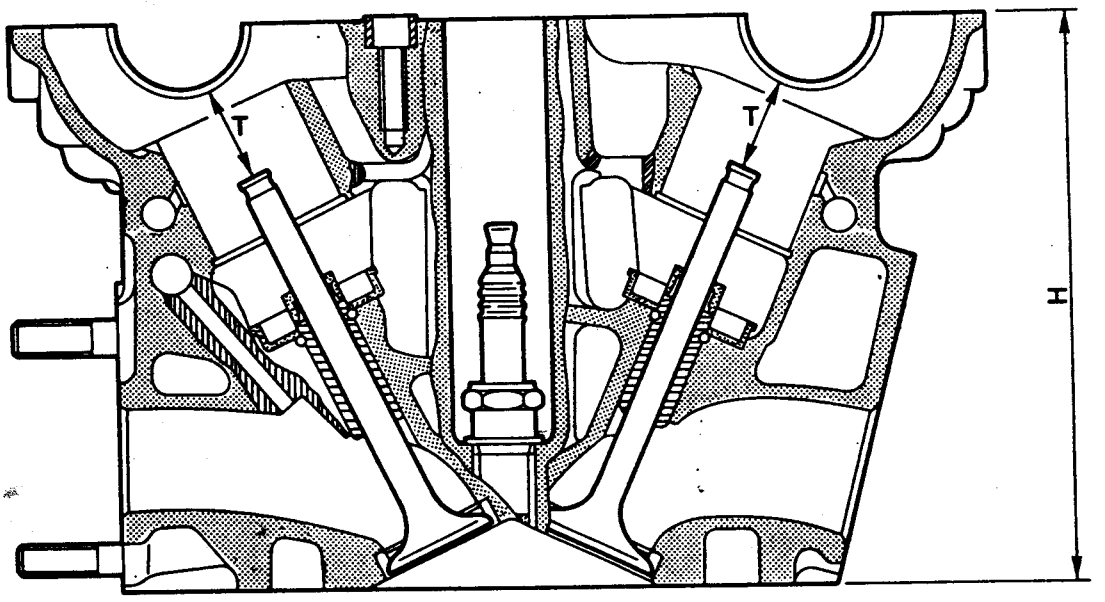
W1301-071

9) Carefully remove the cylinder head and check the matching surface of head.

10) Installation is reverse order of the removal.

18. Measuring of Cylinder Head Matching Surface

Preceding work : Removal of valve



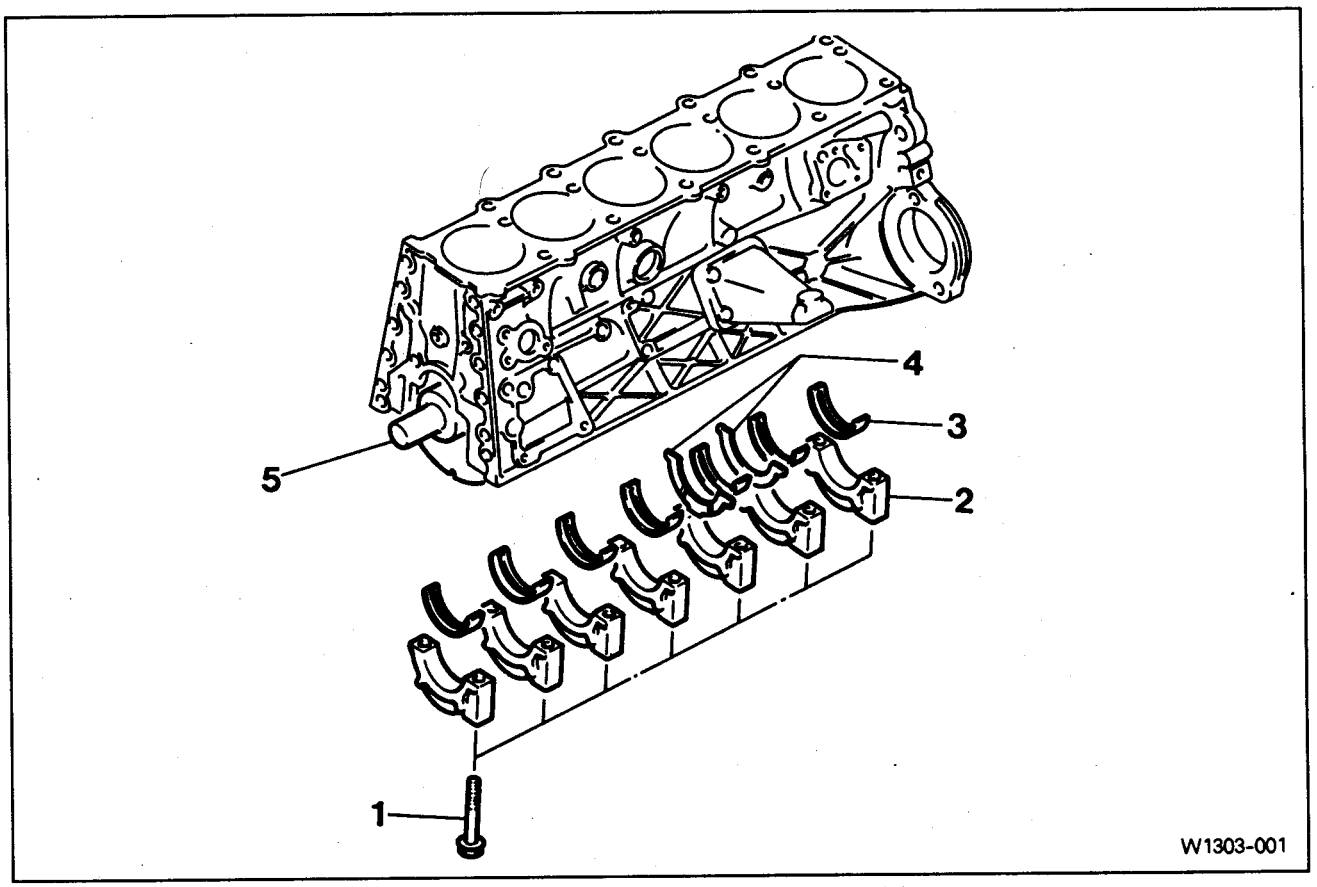
W1301-072

Service data			mm
Total height 'H' of cylinder head			135.9~136.0
Min. height after machining			135.5
Permissible deviation from evenness of contact surface		In longitudinal direction	0.08
		In transverse direction	0.0
Distance 'T' (Between camshaft bearing and valve stem)	Standard size	Intake	24.21~24.75
		Exhaust	22.21~22.75
	Repair size	Intake	23.96~24.51
		Exhaust	21.96~22.51

Commercial tools	
Surface grinding machine	Sceledum, Type RTY Roaro Schio/Italy

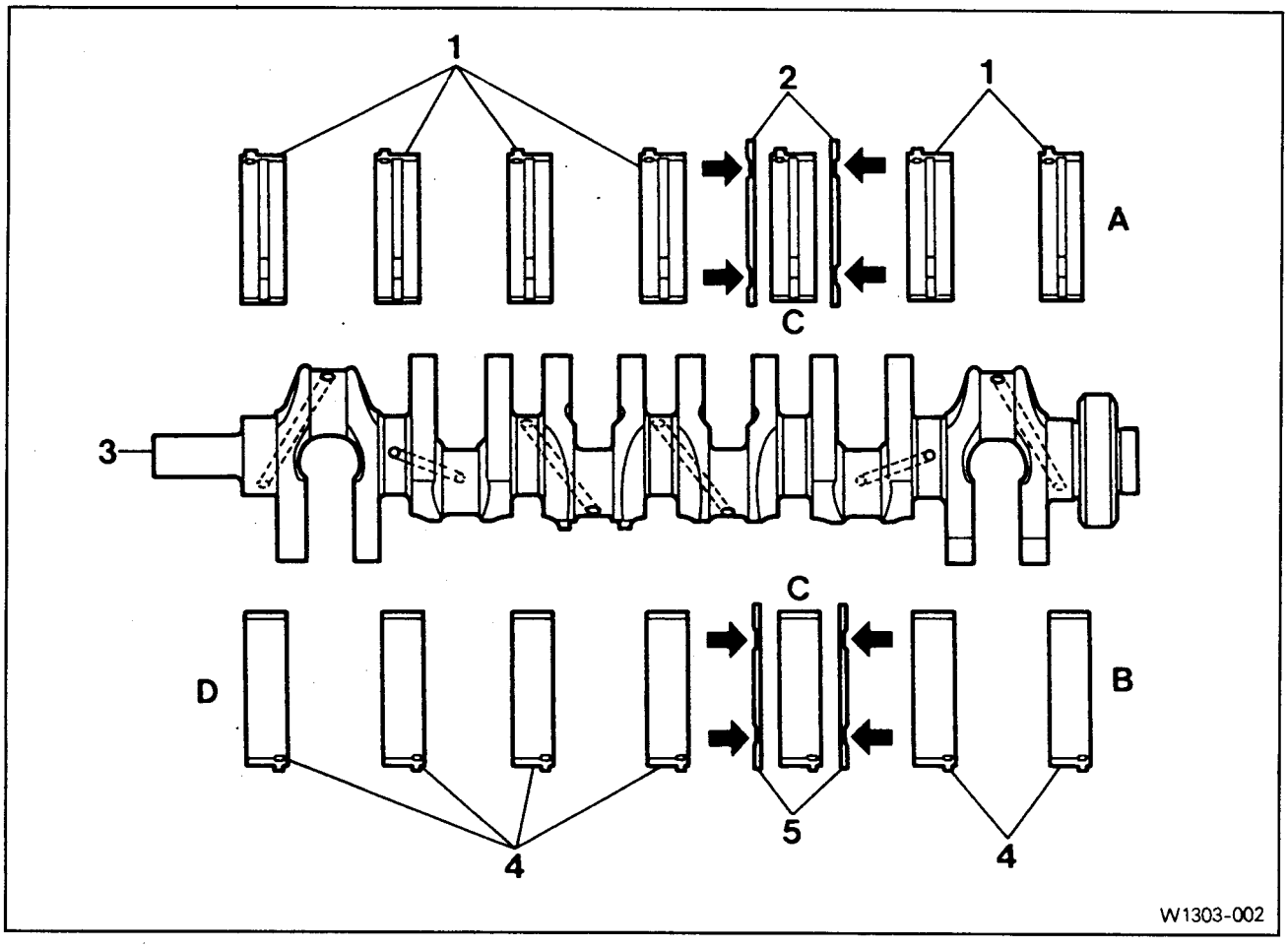
1. Removal and Installation of Crankshaft

Preceding work : Removal of engine assembly (01-06)
Removal of timing case cover (01-29)
Removal of cylinder head (01-37)
Removal of oil pump (18-06)
Removal of oil shield



1. 12-sided Stretch Bolt----------55Nm × 90°, lubricate
2. Crankshaft Bearing Cap
3. Crankshaft Lower Main Bearing
4. Lower Thrust Bearing
5. Crankshaft

Thrust bearings and main bearing shells arrangement



1. Crankshaft Upper Main Bearing Shell
2. Upper Thrust Bearing
3. Crankshaft
4. Crankshaft Lower Main Bearing
5. Lower Thrust Bearing

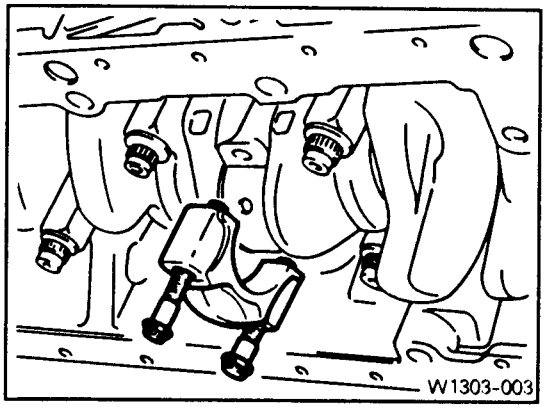
A. Toward Cylinder Block
B. Toward Bearing Cap
C. Fit Bearing at Bearing Point 5
D. Radial Bearing

Service data

Crankshaft standard and repair size	Crankshaft bearing journal diameter	Thrust washer thickness	Crankshaft journal width at fit bearing	Connecting rod bearing journal diameter	Connecting rod bearing journal width
Standard size	57.94~57.96	2.15 or 2.20	24.50~24.533	47.94~47.96	27.958~28.042
Repair size 1	57.75	2.25 or 2.35 or 2.40	—	47.75	—
Repair size 2	57.50			47.50	
Repair size 3	57.25			47.25	
Repair size 4	57.00			47.00	

Removal · Installation

1) Remove the connecting rod bearing cap bolts and then remove the bearing cap.

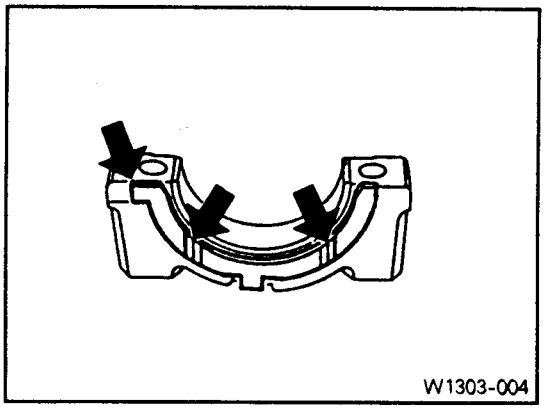


Installation

Tightening torque	40Nm + 90°

[Note]
- **Be careful of the upper and lower bearing shells not to be changed each other.**
- **For installation, coat the bearing shell with engine oil.**
- **Install the bearing cap according to the consecutive number.**

2) Remove the crankshaft bearing cap bolts and separate the upper and lower bearing shells and thrust washers.



Installation

Tightening torque	55Nm + 90°

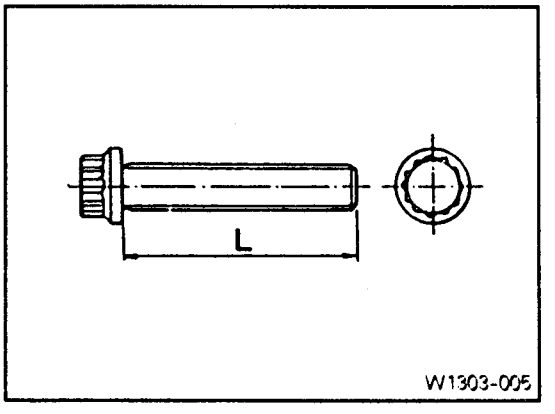
[Note]
- **Remove the bearing cap from front (pulley side) to rear.**
- **For installation, be careful of the upper and lower bearing shells not to be changed each other and coat with engine oil.**
- **The oil grooves (arrows) in the thrust washers must face upward and insert the thrust bearing into the bearing cap.**

3) Remove the crankshaft.

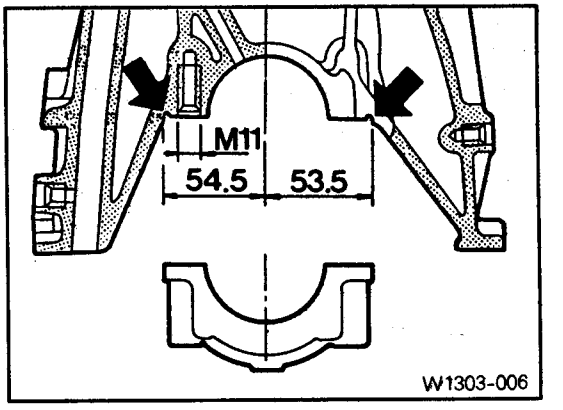
4) Installation is reverse order of the removal.

Inspection

1) If the length 'L' of the crankshaft bearing cap bolt exceeds 63.8mm, replace it.



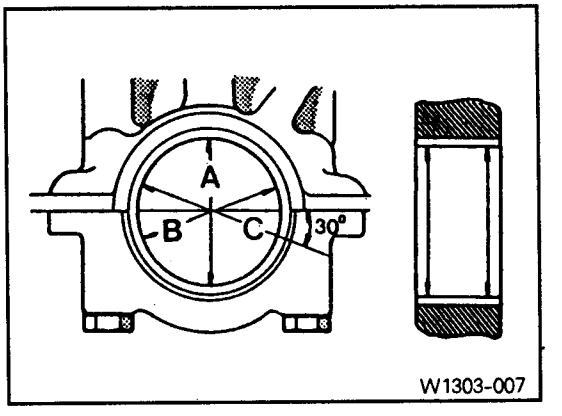
2) Correctly fit the crankshaft bearing cap at the side (arrow) of cylinder block.



3) Measure inner diameter of the crankshaft bearing.

[Note] · **Measure 'A', 'B' and 'C'.**

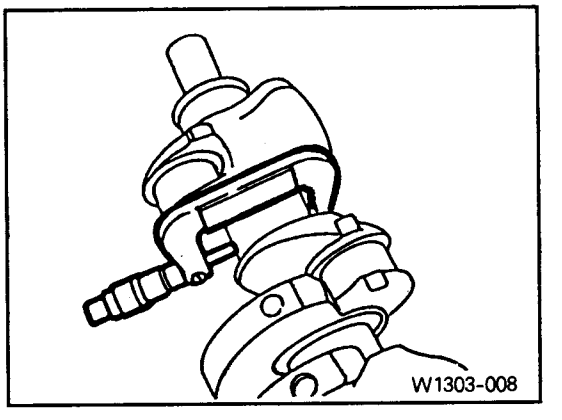
· **Measure 'A', 'B' and 'C' as shown. If averag value of 'B' and 'C' is less than 'A' value, then the average value of 'B' and 'C' is actual average valve. If average value of 'B' and 'C' is more than 'A' value, then the 'A' value is actual average valve.**



4) Measure diameter of crankshaft bearing journal.

[Note] · **Measure 'A', 'B' and 'C' points and get the average value.**

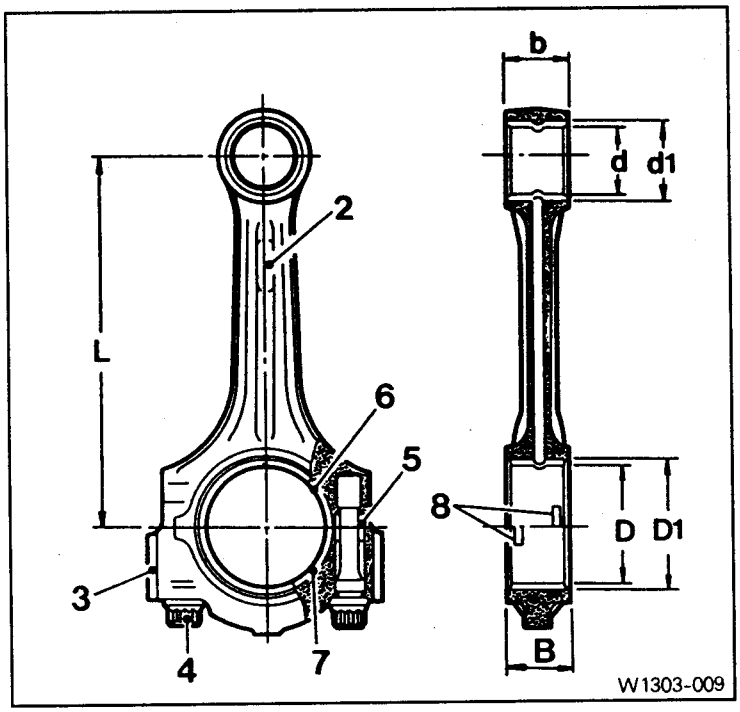
· **Measure the inner diameter of bearing and the diameter of journal and if it is out of the standard data, replace the bearing shell.**



Crankshaft bearing clearance	Radial	0.031 ~ 0.0510mm
	Axial	0.10 ~ 0.254mm
Connecting rod bearing clearance	Radial	0.02 ~ 0.065mm

2. Connecting Rod Inspection

Preceding work : Removal of piston (03-07)

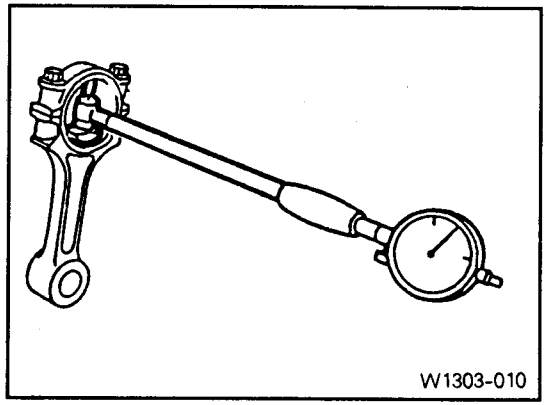


2. Marking
3. Balance Weight
4. Connecting Rod Bolt
5. Fit Sleeve
6. Upper Connecting Rod Bearing
7. Lower Connecting Rod Bearing
8. Bearing Shell lug

Service data	mm
Distance from center of connecting rod bearing bore to center of connecting rod bushing bore (L)	144.950~145.050
Width of connecting rod at connecting rod bearing bore (B)	21.948~22.000
Width of connecting rod at connecting rod bushing (b)	21.948~22.000
Connecting rod bearing shell basic bore (D1)	51.600~51.614
Connecting rod bushing basic bore (d1)	24.500~24.521
Connecting rod bushing inner diameter (d)	22.007~22.013
Piston pin clearance in connecting rod bushing	0.013~0.018
Peak-to-valley height of connecting rod bushing on inside	0.005
Permissible twist of connecting rod bearing bore to connecting rod bushing bore	0.15
Permissible deviation of axial parallelism of connecting rod bearing bore to connecting rod bushing bore	0.07
Permissible deviation of connecting rod bearing bore from concentricity	0.01
Permissible difference in weight of complete connecting rod within an engine	4g

Inspection

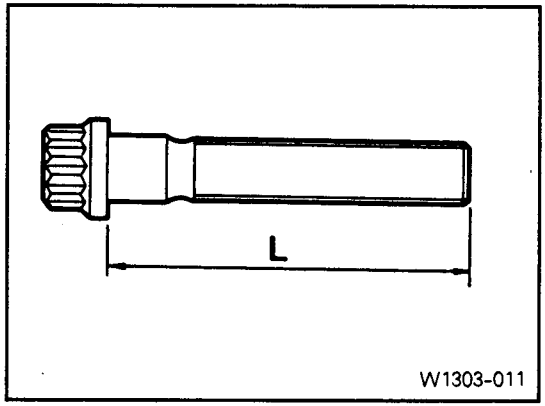
1) Measure the basic bore of connecting rod bearing.
[Note] If basic bore exceeds the value of 51.614mm, replace the bearing or check the connecting rod.



2) Check connecting rod bolts.

Length when new (L)	51~0.3mm
Max. length (L)	52.9mm
Tightening torque	40Nm + 90°

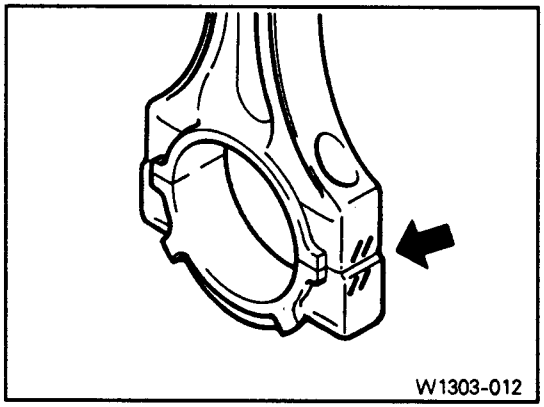
[Note] If the length exceeds max. length, replace it.



3) For installation, align the mark (arrow) on the connecting rod and connecting rod cap.

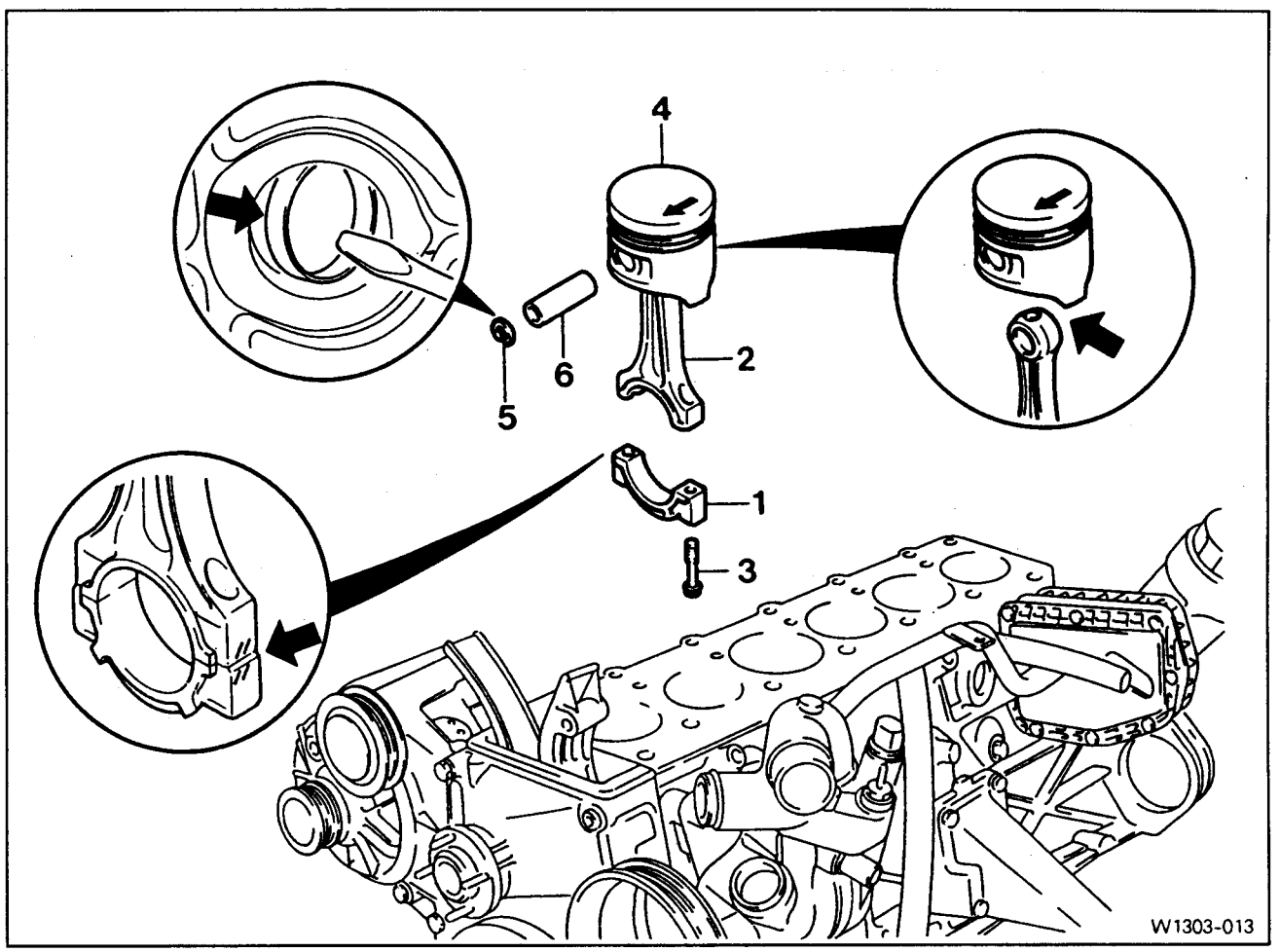
4) When replacing the connecting rod with new one, pay attention to difference in weight not to exceed more than 4g.

5) For bearing replacement, the connecting rod and the connecting rod cap should be located relative to each other with fit sleeves.



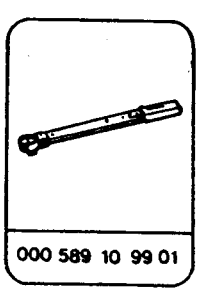
3. Removal and Installation of Piston

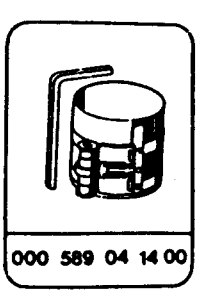
Preceding work : Removal of engine assembly (01-06)
Removal of cylinder head (01-37)
Removal of oil pump (18-06)
Removal of oil shield



1. Connecting Rod Bearing Cap
2. Connecting Rod
3. Bolt----------40Nm + 90°
4. Piston
5. Snap Ring
6. Piston Pin

Special Tools





Removal

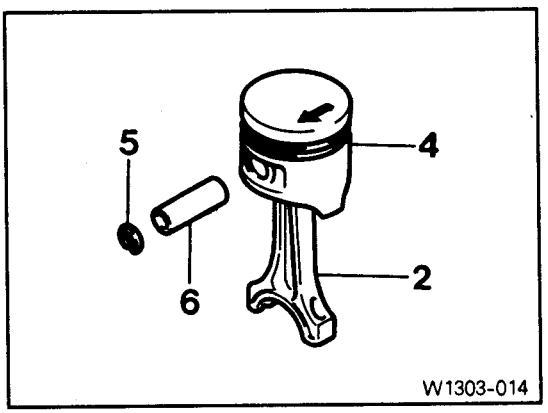
1) Remove the connecting rod bearing cap bolt (3).

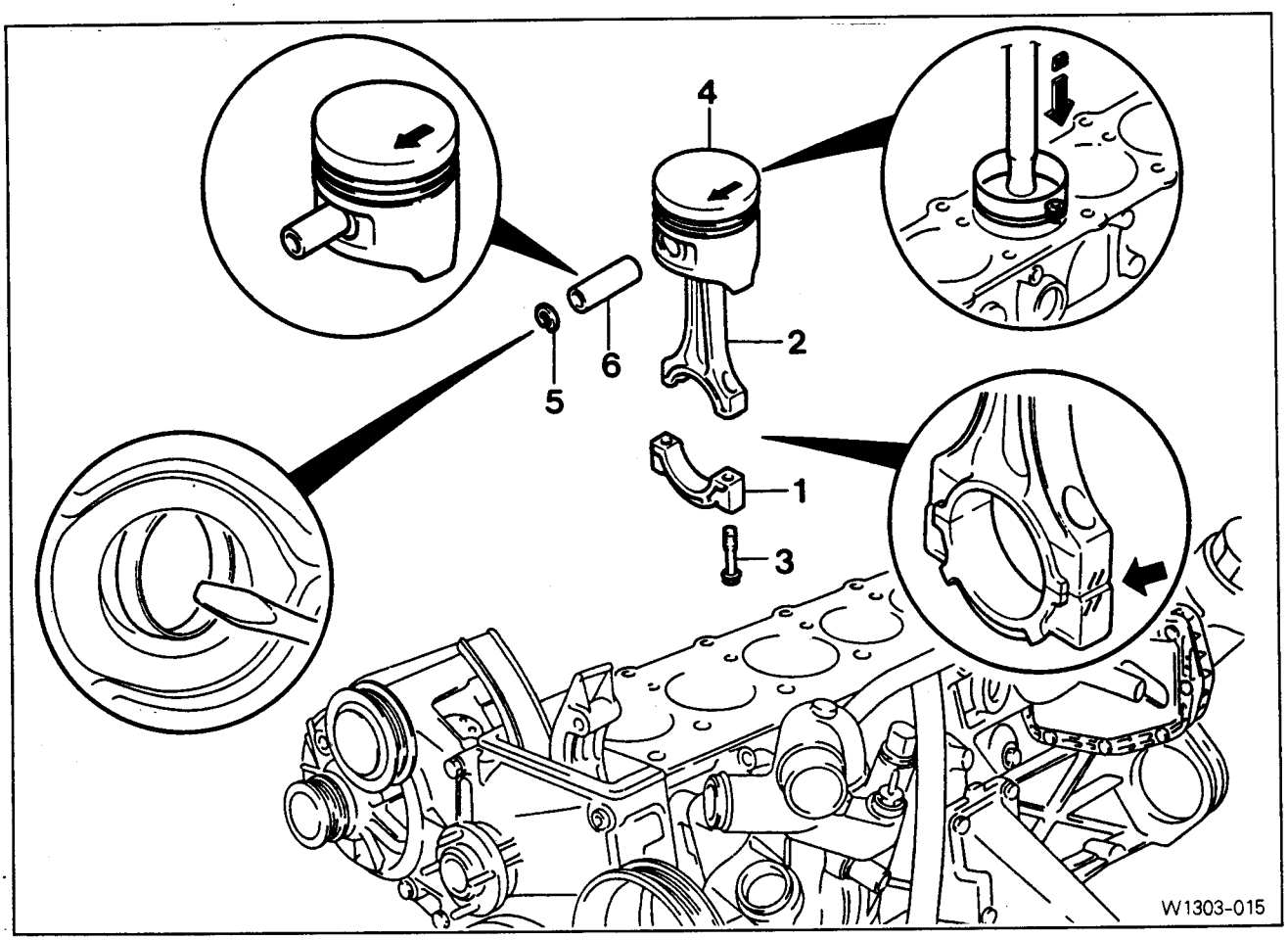
2) Remove the connecting rod (2) and piston (4) upward.
[Note] Be careful that the bearing cap and shell are not to be changed each other.

3) Remove the snap ring (5).

4) Pull out the piston pin (6).

5) Measure piston ring clearance.



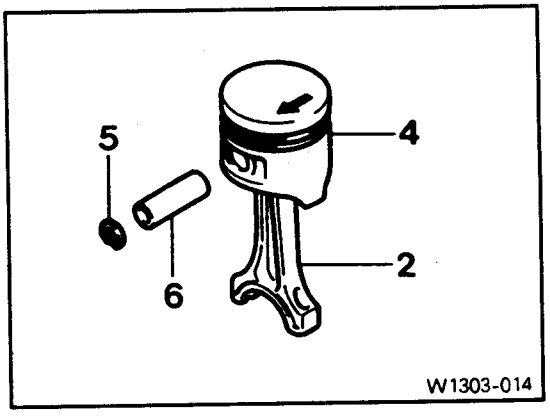


Installation

1) Clean the cylinder bore, connecting rod bearing journal, connecting rod bearing shell and piston and coat them with engine oil.

2) Press into the piston pin (6) by hand.

3) Install the snap ring (5) into the piston groove (arrow).



4) Insert the piston into the cylinder block by hand.
[Note] For installation, make sure that the arrow on the piston crown is facing the vehicle direction.

Tensioning strap 000 589 04 14 00

5) Clamp the piston ring to be the same position of the piston surface by using tensioning strap (7).

6) Install the piston with plastic hammer.

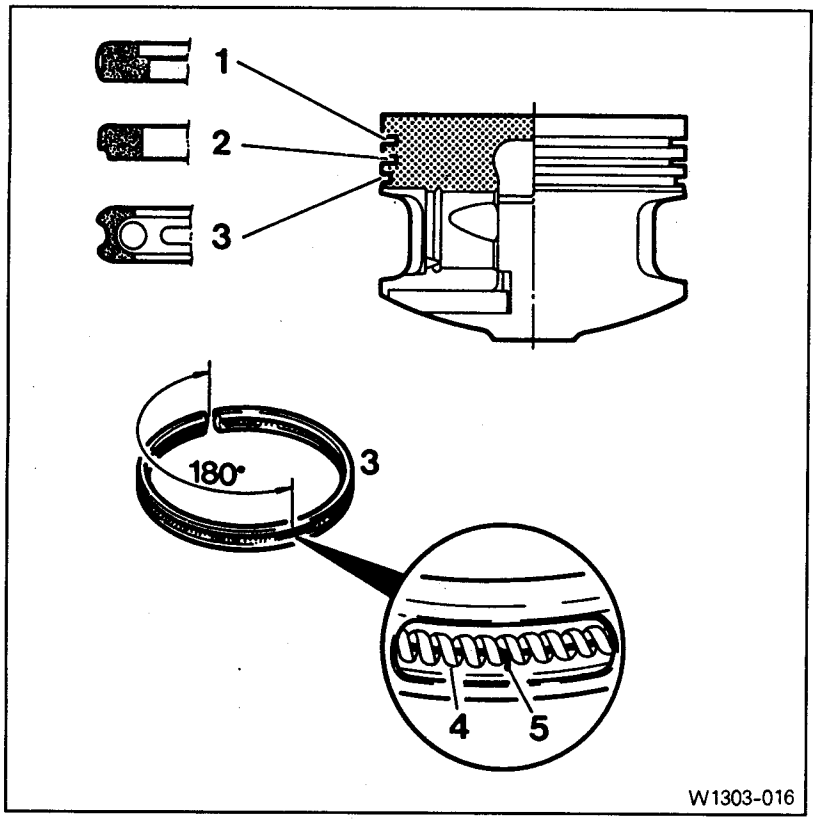
7) Tighten the connecting rod bolt.
[Note] Coat the bearing cap and upper and lower bearing shell with engine oil.

Tightening torque	40Nm + 90°

8) By rotating the crankshaft, measure end play.

4. Replacement of Piston Ring

Preceding work : Removal of piston (03-07).



1. Piston Compression Ring
2. Piston Compression Ring
3. Piston Oil Ring
4. Coil Spring and Control Ring
5. Hook Spring

Replacement

1) Measure piston ring gap.

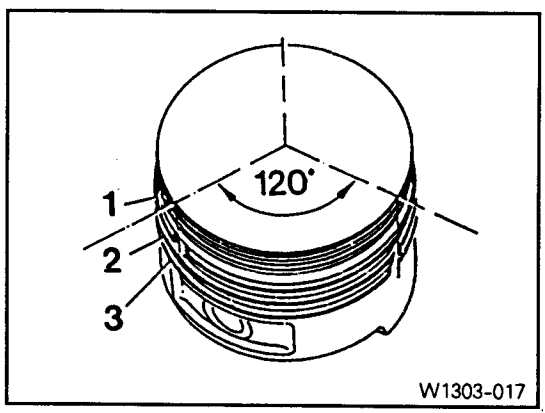
Gap clearance of piston rings	Groove 1	0.20~0.40
	Groove 2	0.20~0.40
	Groove 3	0.20~0.45
End clearance of piston rings	Compression ring 1	0.015~0.050
	Compression ring 2	0.020~0.040
	Oil ring	0.010~0.045

[Note] If out of specification, replace the piston ring.

2) Remove the piston rings with a pliers.

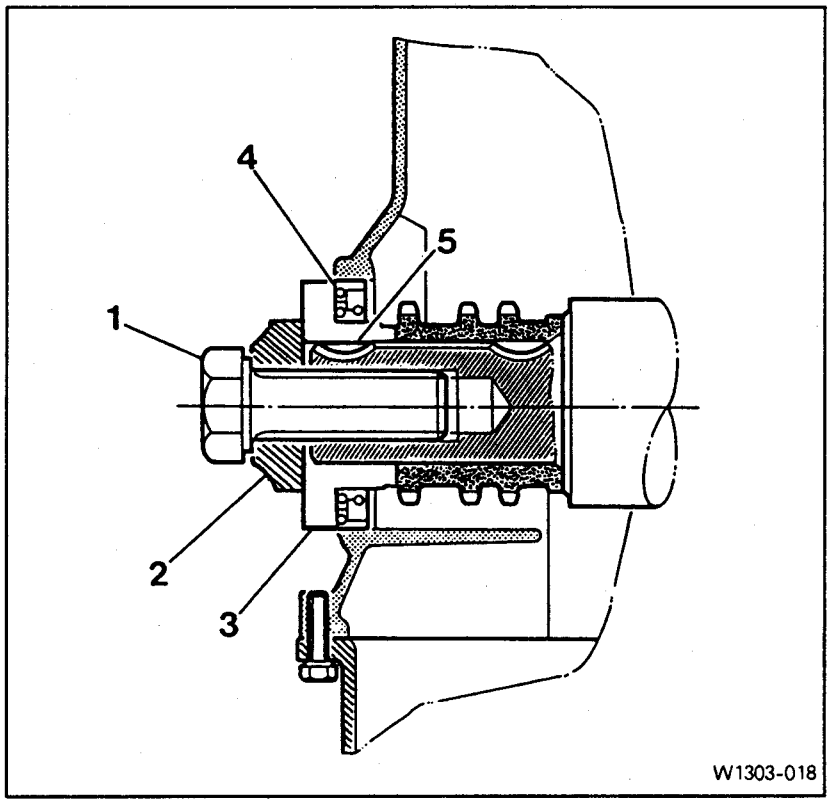
3) For installation, position the piston ring to be the 'TOP' mark on the piston ring upward and arrange the piston ring ends to be 120 ° apart.
[Note] Coat the piston and piston ring with engine oil.

4) Install the piston (03-07).



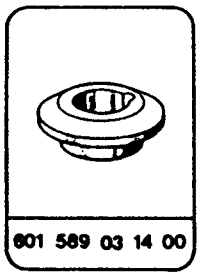
5. Replacement of Front Crankshaft Radial Seal

Preceding work : Removal of belt pulley and vibration damper (03-14)



1. Bolt
2. Disc
3. Sleeve (Special Tool)
4. Crankshaft Radial Seal
5. Woodruff Key

Special Tool



Replacement

1) Remove the radial seal with a screwdriver.

2) Coat the radial seal lip with engine oil and install the sleeve radial seal (601 589 03 14 00).

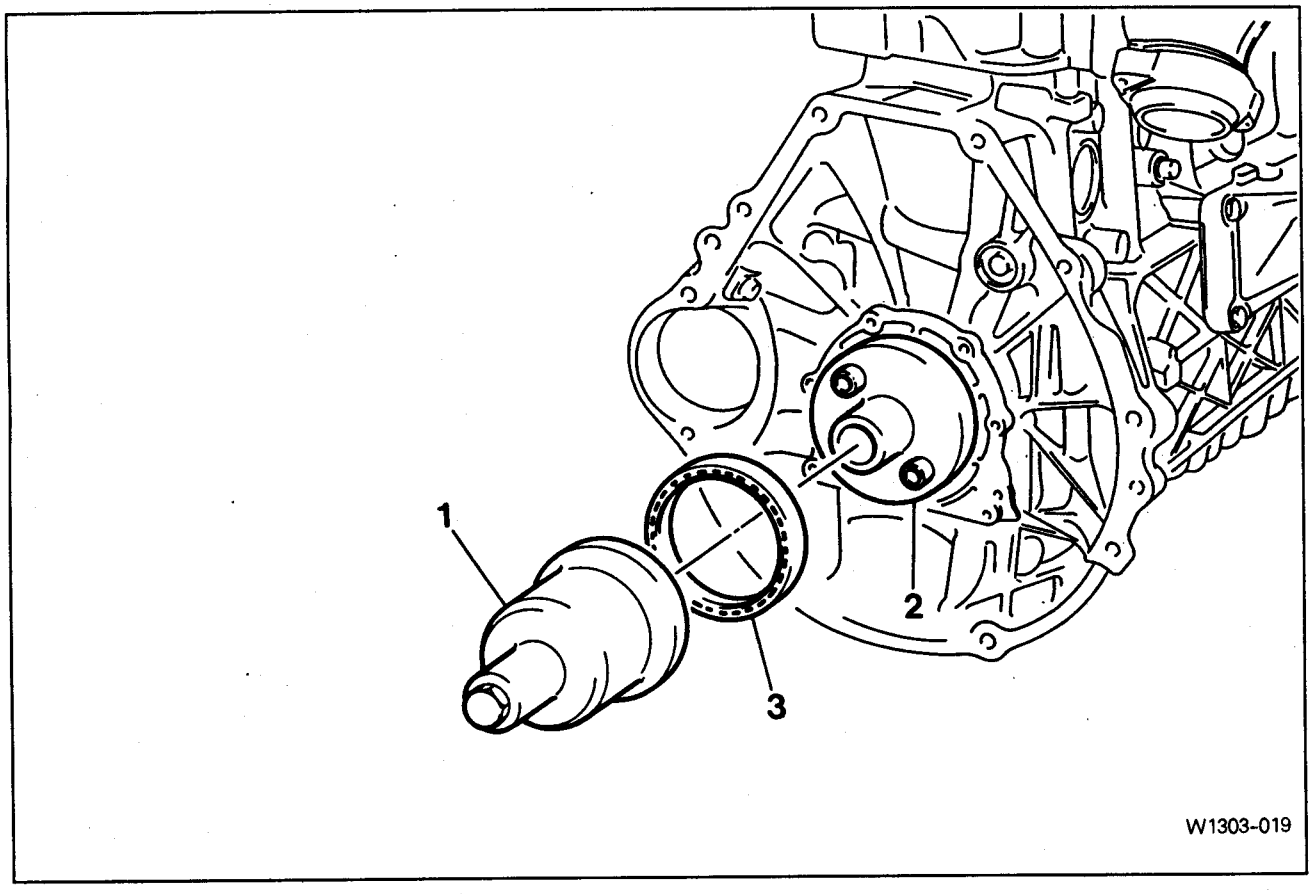
3) Align the sleeve groove and woodruff key and tighten the bolt until the sleeve and the disc to be stopped.

4) Remove the special tool and install the belt pulley and vibration damper (03-14).

5) Rotate the engine and check the engine for leaks.

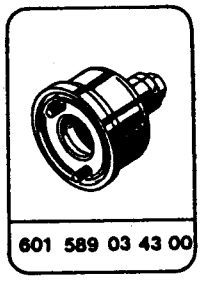
6. Replacement of Rear Crankshaft Radial Seal

Preceding work : Removal of the driven plate (03-17)



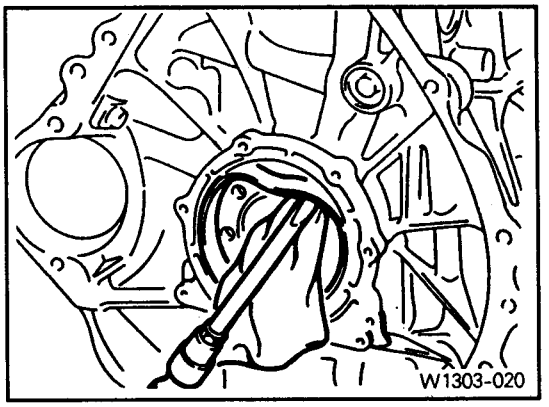
1. Inner Parts Assembler (Special Tool)
2. Outer Parts Assembler (Special Tool)
3. Radial Seal

Special Tool



Replacement

1) Remove the radial seal with screwdriver.
   [Note] Not to damage the crankshaft and radial seal mounting hole, use clean cloth.



2) Check the bearing surface on crankshaft.

3) Install the inner parts assembler to the crankshaft flange.

4) Coat the sealing lip of radial seal with engine oil.
   [Note] Do not use grease.

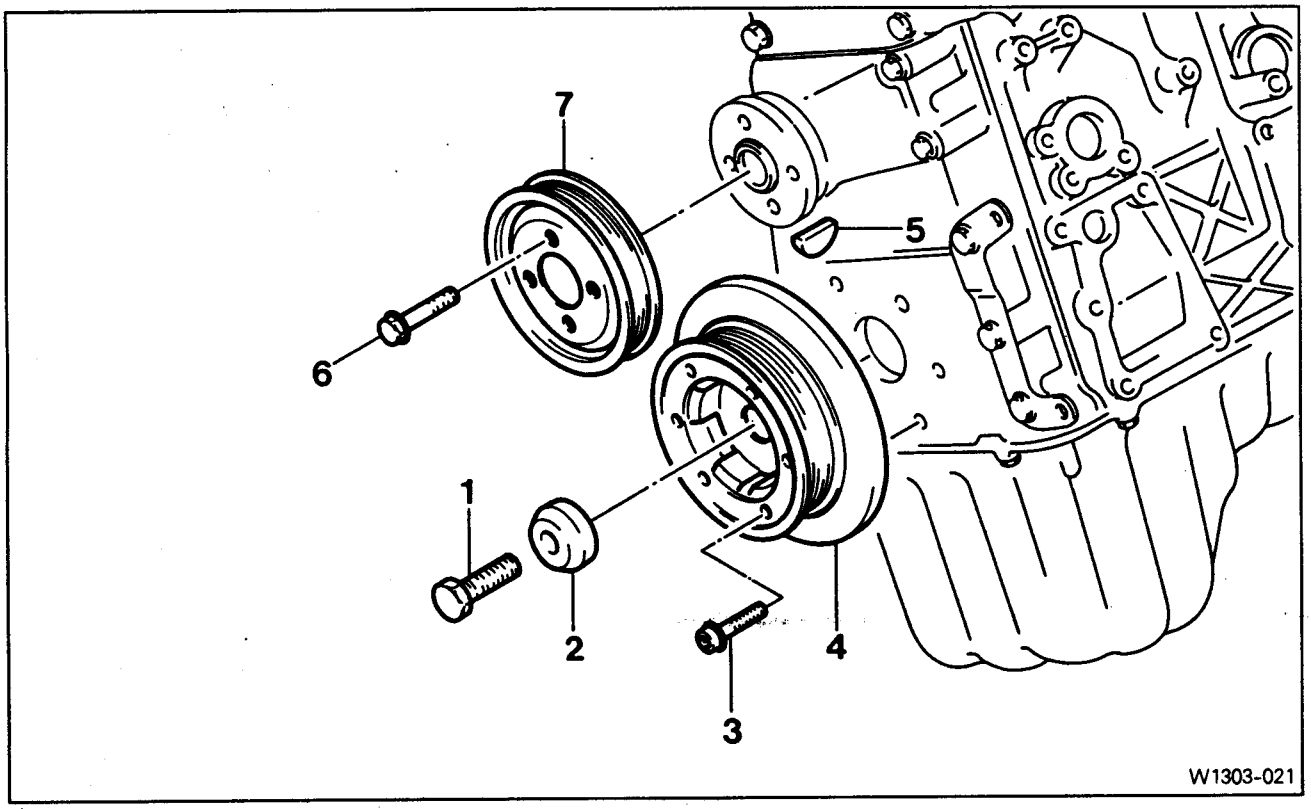
5) Install the radial seal onto the inner parts assembler.

6) Press the outer parts assembler till the radial seal is stopped.

7) Rotate the engine and check the engine for leaks.

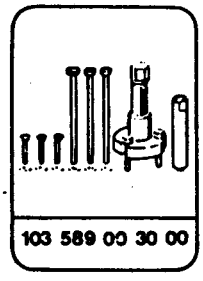
7. Removal and Installation of Belt Pulley and Vibration Damper

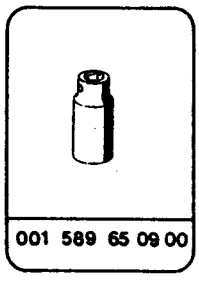
Preceding work : Removal of cooling fan and viscous clutch (20-08)
Removal of V-belt (13-01)

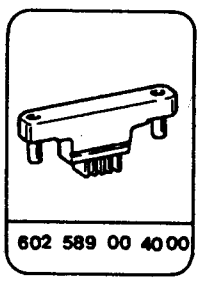


1. Bolt----------200Nm + 20Nm, torque angle 90° + 10°
2. Disc
3. Socket Bolt----------32Nm
4. Vibration Damper, Pulley and Hub Assembly
5. Woodruff Key
6. Bolt----------12Nm
7. Cooling Fan Pulley

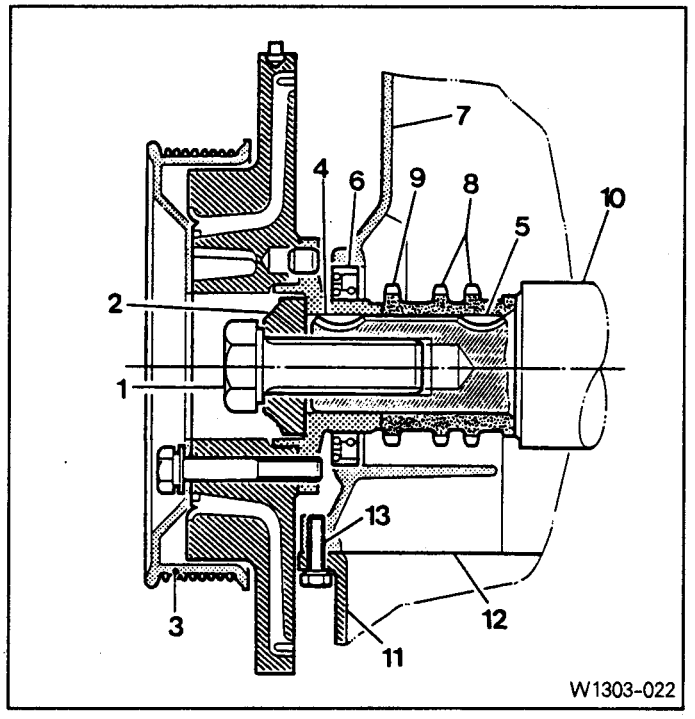
Special Tools







Sectional view

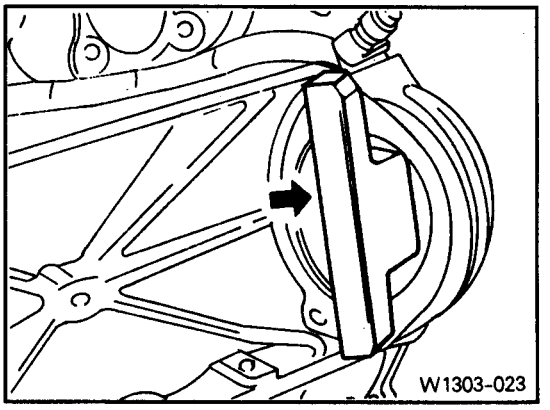


1. Bolt
2. Disc
3. Vibration Damper and Belt Pulley
4. Woodruff Key
5. Woodruff Key
6. Radial Shaft Seal
7. Crankcase
8. Crankshaft Sprocket (Valve Timing Drive)
9. Crankshaft Sprocket (Oil Pump Drive)
10. Crankshaft
11. Oil Pan
12. Oil Pan Gasket
13. Oil Pan Bolt

Removal · Installation

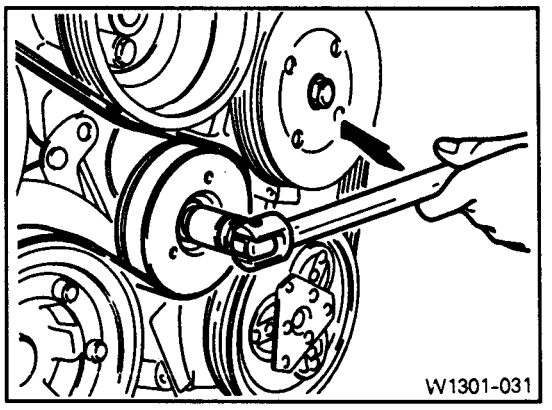
1) Remove the starter motor and install the engine lock on the flywheel ring gear.

Engine lock 602 589 00 40 00



2) Remove the V-belt.

3) Remove the cooling fan, viscous clutch and pulley.



4) Remove the crankshaft pulley bolt.

Installation

Tightening torque	200Nm + 20Nm

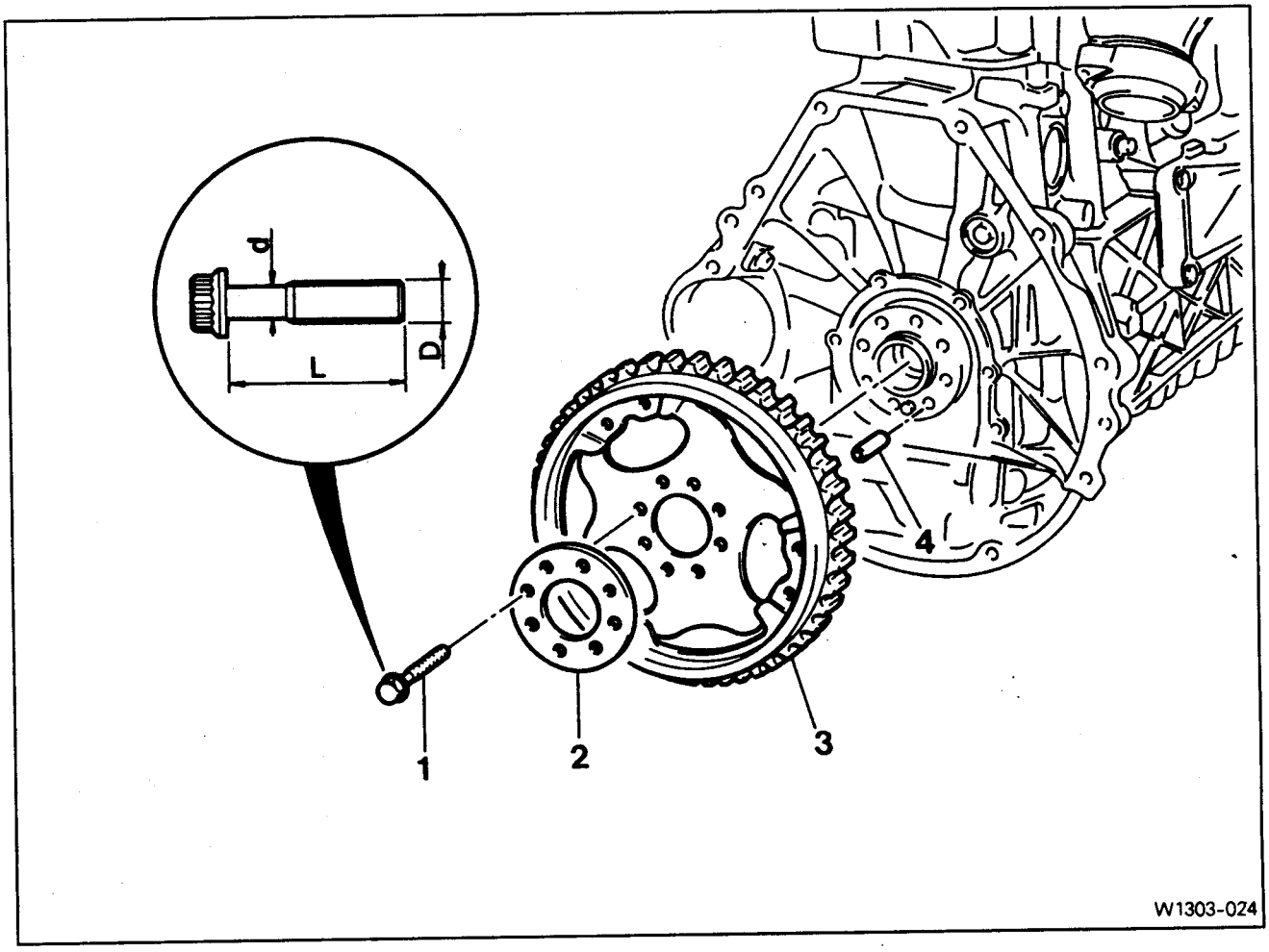
5) Remove the vibration damper, pulley and hub assembly by using a special tool.

[Note] For installation, align the crankshaft woodruff key with hub groove.

6) Installation is reverse order of the removal.

8. Removal and Installation of Ring Gear and Driven Plate

Preceding work : Removal of the automatic transmission (27-21)
Installation of engine lock



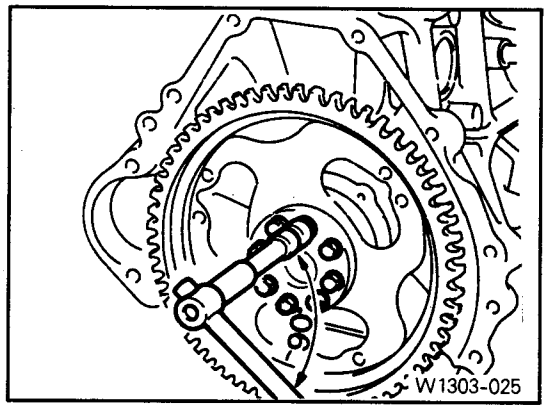
1. Stretch Bolt-----Check, 45Nm + 5Nm, torque angle 90° + 10°
2. Plate
3. Driven Plate and Ring Gear
4. Dowel Pin

Bolt size

Thread	D		M10 x 1.5
Stretch shaft	d	When new	8.5~0.2mm
		Min. diameter	8.0mm
Length	L	When new	22±0.2mm
Tightening torque			45Nm + 5Nm, torque angle 90° + 10°

Removal · Installation

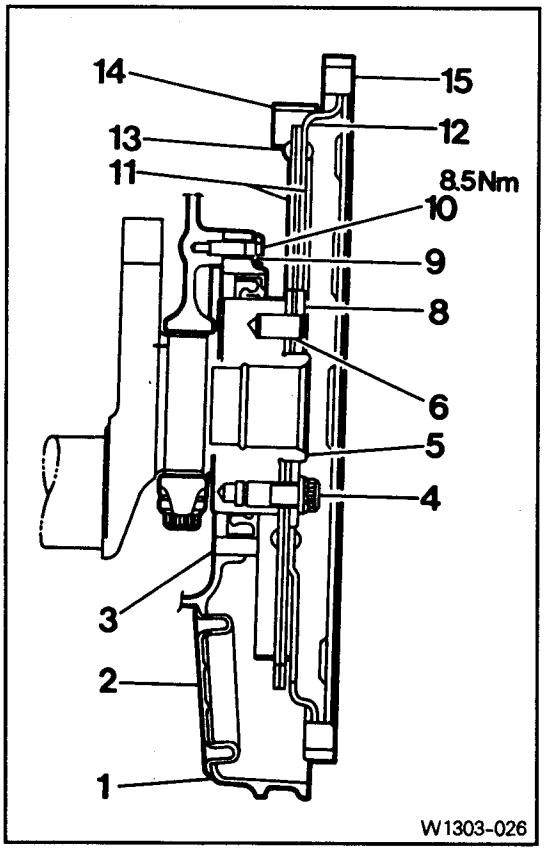
1) Remove the stretch bolt .
   [Note] · **Replace the bolt, If stretch shaft diameter (d) is out of specification, replace the bolt.**
   · **For the stretch bolt tightening, keep the socket wrench and bar to be 90° and tighten as specified.**



2) Carefully remove the ring gear and driven plate, plate and dowel pin.

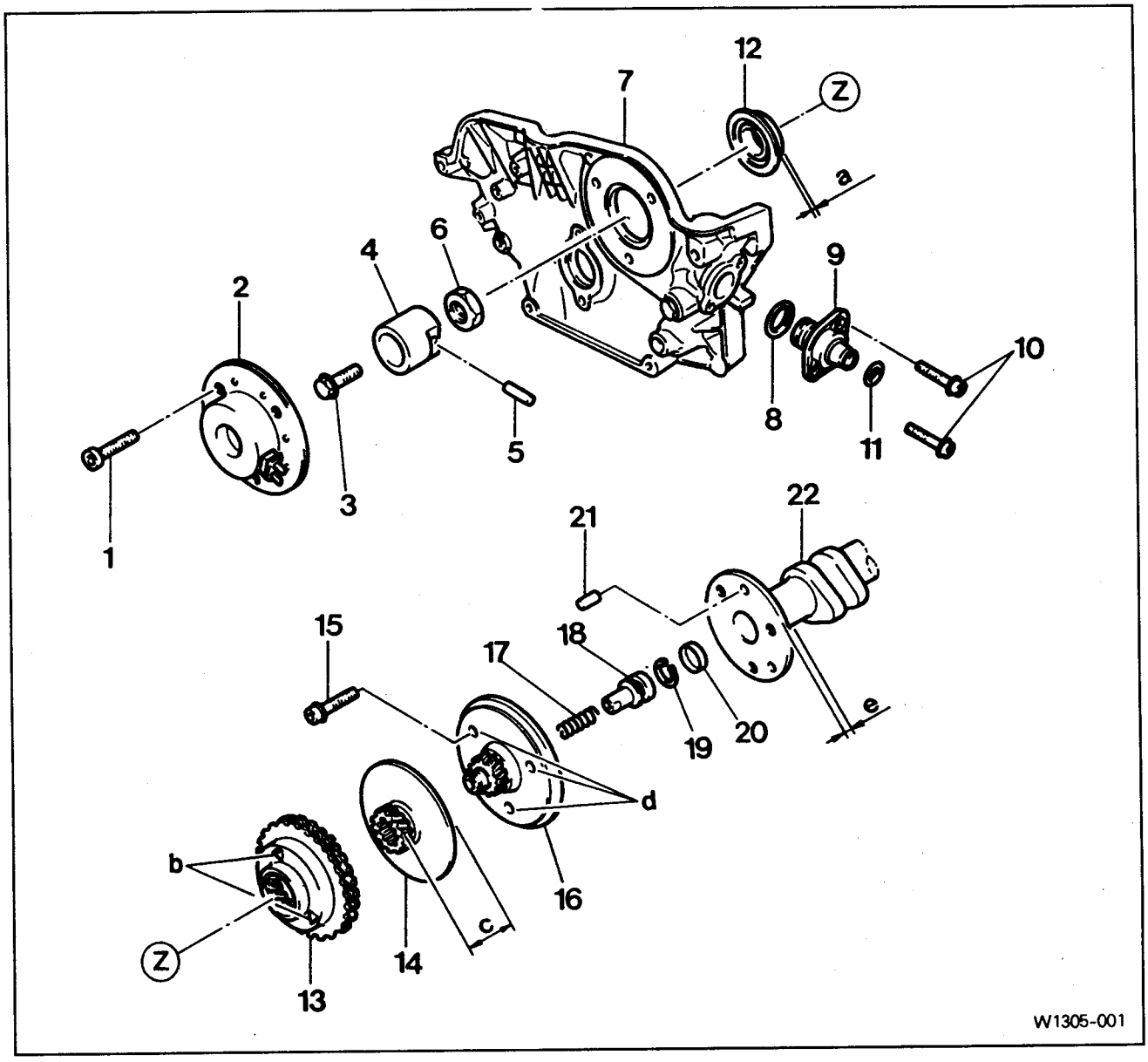
3) Installation is reverse order of the removal.

Sectional view



1. Oil Pan
2. Cover
3. Radial Seal
4. Bolt
5. Crankshaft
6 Dowel Pin
8 Washer (T : 3.5mm)
9. Washer
10. Bolt
11. Front Drive Plate
12. Rear Drive Plate
13. Rivet
14. Segment
15. Ring Gear

1. Function, Removal and Installation of Camshaft Adjuster



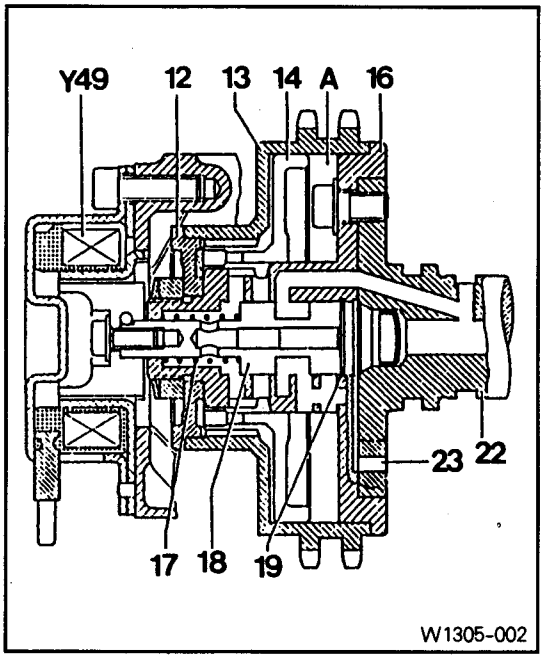
1. Bolt----------10Nm
2. Electromagnetic Actuator
3. Bolt----------3.5Nm
4. Amateur
5. Roll Pin
6. Nut----------65Nm
7. Front Cover
8. Seal
9. Camshaft Position Sensor
10. Bolt and Washer----------10Nm
11. Seal
12. Cover with Seal
13. Camshaft Sprocket and Position Indicator (b)
14. Positioning Piston
15. Bolt----------20Nm + 90°
16. Flange Shaft
17. Compression Spring
18. Control Piston
19. Circlip
20. Oil Drilling
21. Pin
22. Intake Camshaft

Function

When the engine is running, the camshaft adjuster rotates the intake camshaft hydraulically/mechanically relative to the camshaft sprocket by 32 ° crankangle to the 'advanced' position and back to the 'retarded' position. The camshaft adjuster is actuated electromechanically by the ECU. The positioning time of approx. 1 second is dependent on the engine oil pressure at the camshaft adjuster and on the oil viscosity and oil temperature, respectively. The position indicator (b) on the camshaft sprocket provides the camshaft rotational speed to the position sensor (9) as an input parameter for the engine ignition control unit.

1) Ignition switch OFF ('retarded')
   The compression spring (17) pushes the control piston (18) against the circlip (19). The engine oil pressure in the camshaft is eliminated.

2) From 0 to 1000 → 2000rpm ('retarded')
   The torque of the internally helically toothed camshaft sprocket (13) acting in the direction of rotation of the engine pushes the externally helically toothed positioning piston (14) against the cover (12) as a result of the screw action. Consequently, the likewise internally helically toothed positioning piston (14) holds the externally helically toothed flanged shaft (16) together with the bolted-on camshaft (22) in the 'retarded position'. The compressing spring (17) pushes the control piston (18) against the circlip (19). The engine oil flows through 2 oblique drillings in the camshaft flange and in the flanged shaft (16) into the working chamber (A) and holds the positioning piston (14) additionally in the 'retarded' position with the available engine oil pressure.
   Leak oil flows off over control and positioning piston surface, through the control piston drilling and 2 drillings (23) in the camshaft flange.

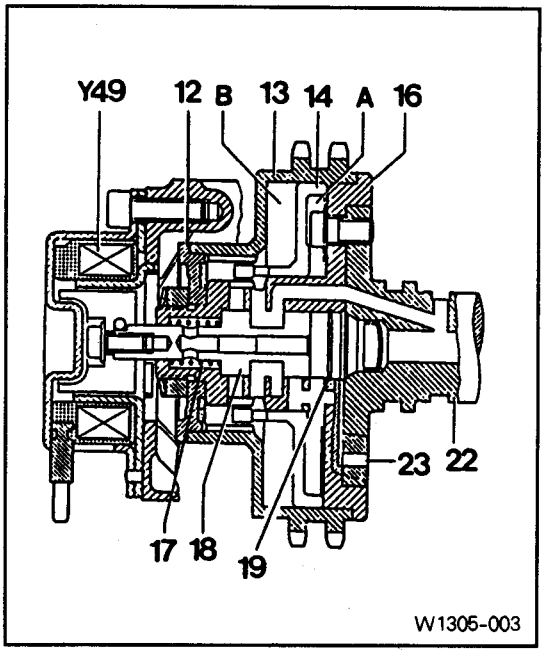


'Retarded' Position

Y49. Electromagnetic not active
18. Control piston against rear stop
14. Positioning piston against front stop
A. Oil pressure in working chamber

A. Working Chamber
12. Seal Cover
13. Camshaft Sprocket
14. Positioning Piston
16. Flange Shaft
17. Compression Spring
18. Control Piston
19. Circlip
22. Camshaft
23. Oil Outlet Drilling
Y49. Electromagnetic Actuator

3) From 1000 → 2000 to 4000rpm ('advanced')
The control piston (18) is pulled forward as far as the stop in the flanged shaft (16) by the actuator (Y49) against the force of the compression spring (17).
The control piston (18) closes the oil feed to the working chamber 'A' and at the same time allows oil to flow to the working chamber 'B' through 2 drillings each in the flanged shaft (16) and adjusting piston (14). The engine oil pressure moves the adjusting piston (14) as far as the stop on the flanged shaft (16). As a result of the axial movement of the adjusting piston (14), the camshaft (22) bolted to the flanged shaft (16) is turned into the 'advanced' position. The turning action is achieved as a result of the effect of the helical teeth on the camshaft sprocket (13), positioning piston (14) and flanged shaft (16). The engine oil in working chamber 'A' flows off, assisted by the pushing action of the adjusting piston (14), over the flanged shaft (16) and through 2 drillings (23) in the camshaft flange.



'Advanced' Position

4) From 4000rpm ('retarded')
The electromagnetic actuator (Y49) is not actuated and allows the control piston to move. The compression spring (17) pushes the control piston (18) against the circlip (19). The oil feed to the working chamber 'B' is closed off and oil is able to flow to working chamber 'A' along 2 drillings in the flanged shaft (16). As a result of the engine oil pressure, the control piston (18) is moved as far as the cover (12).
This axial movement of the adjusting piston (14) rotates the camshaft (22) bolted to the flanged shaft (16) into the 'retarded' position.

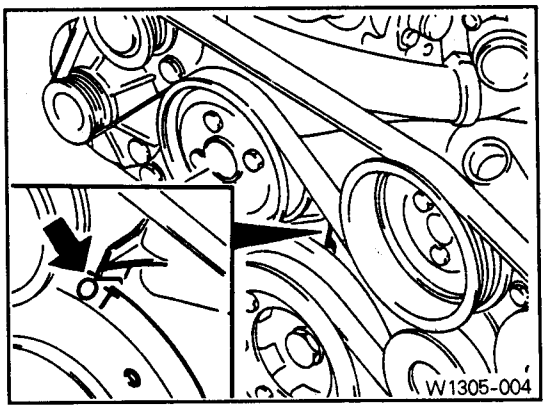
The rotational movement is a result of the screw effect of the helical teeth on the camshaft sprocket (13), positioning piston (14) and flanged shaft (16). The engine oil in the working chamber (B) flows off, assisted by the pushing action of the adjusting piston (14), through 2 drillings each in the adjusting piston (14), flanged shaft (16) and control piston (18) through the control piston (18) and 2 drillings in the camshaft flange(23).
Leak oil flows off over the control and adjusting piston surfaces through the control piston drilling and 2 drillings in the camshaft flange (23).

Y49. Electromagnetic actuated
18. Control piston against front stop
14. Positioning piston against rear stop
B. Oil pressure in working chamber

A. Working Chamber
B. Working Chamber
12. Cover
13. Camshaft Sprocket
14. Positioning Piston
16. Flange Shaft
17. Compression Spring
18. Control Piston
19. Circlip
22. Camshaft
23. Oil Outlet Drilling
Y49. Electromagnetic Actuator

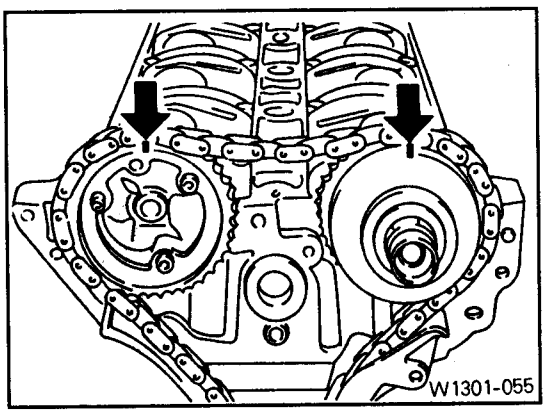
Removal · Installation

1) Turn the crankshaft to the direction of engine rotation and position the no.1 cylinder piston at TDC and the crankshaft at OT.



2) Remove the front cover of cylinder head (01-32).

3) Place the alignment marks on the intake and exhaust camshaft sprocket (arrow) and timing chain.



4) Remove the bolts (3) from the amateur (4) and then remove the amateur (4).

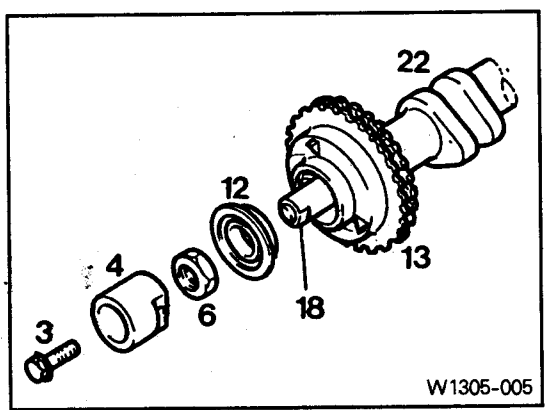
Installation

Tightening torque	3.5Nm

5) Remove the nut (6) and then remove the ring and seal cover (12).

Installation

Tightening torque	65Nm



6) Remove the bolt from the exhaust camshaft sprocket and then remove the sprocket.

Installation

Tightening torque	20Nm + 90°

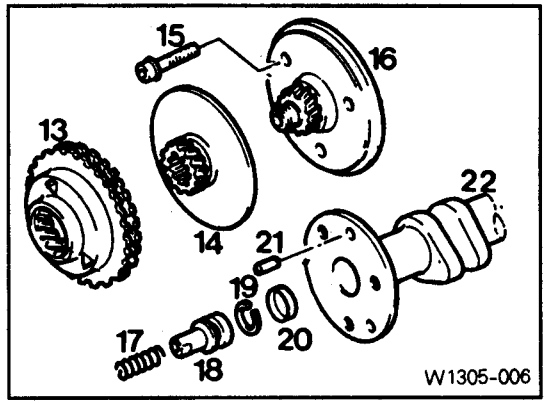
[Note] Replace the bolt.

7) Remove the camshaft sprocket (13) and positioning piston (14). Remove the bolts (15) and then remove the flange shaft (16) from the intake camshaft (22).

Installation

Tightening torque	20Nm + 90°

[Note] Replace the bolts.



8) Installation is reverse order of the removal.

9) Adjust the camshaft timing.

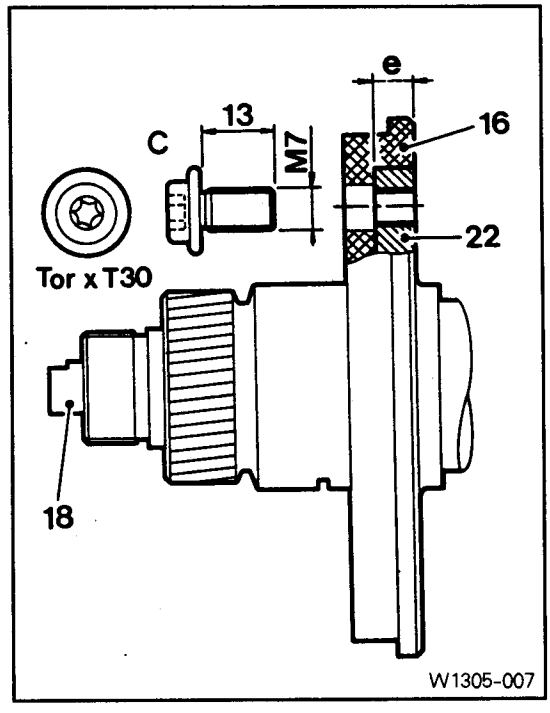
10) Install the front cover of cylinder head.

2. Camshaft and Combination Bolt

Flanged shaft bolt of intake

Tightening torque	20Nm + 90°
Part no.	A120 990 02 04

[Note] Do not reuse the bolt.

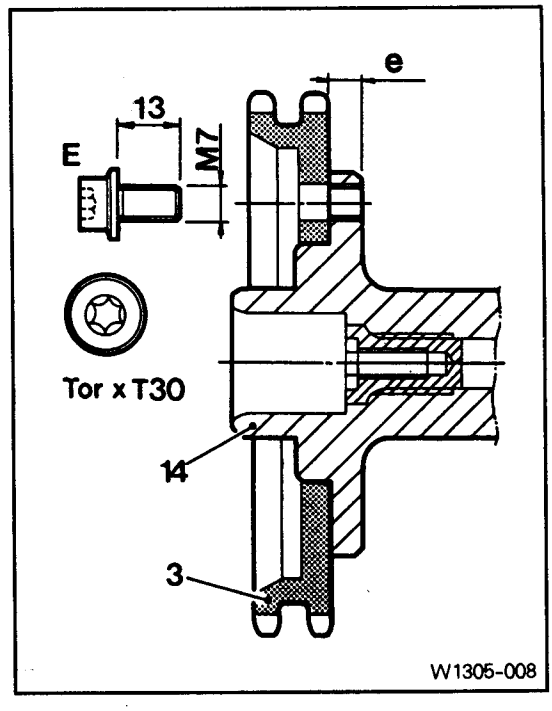


C. M7 X 13mm Collar Bolt Torx-T30
e. 6.8mm
16. Flange Shaft
18. Control Piston
22. Intake Camshaft

Camshaft sprocket bolt of exhaust

Tightening torque	20Nm + 90°
Parts no.	A120 990 02 04

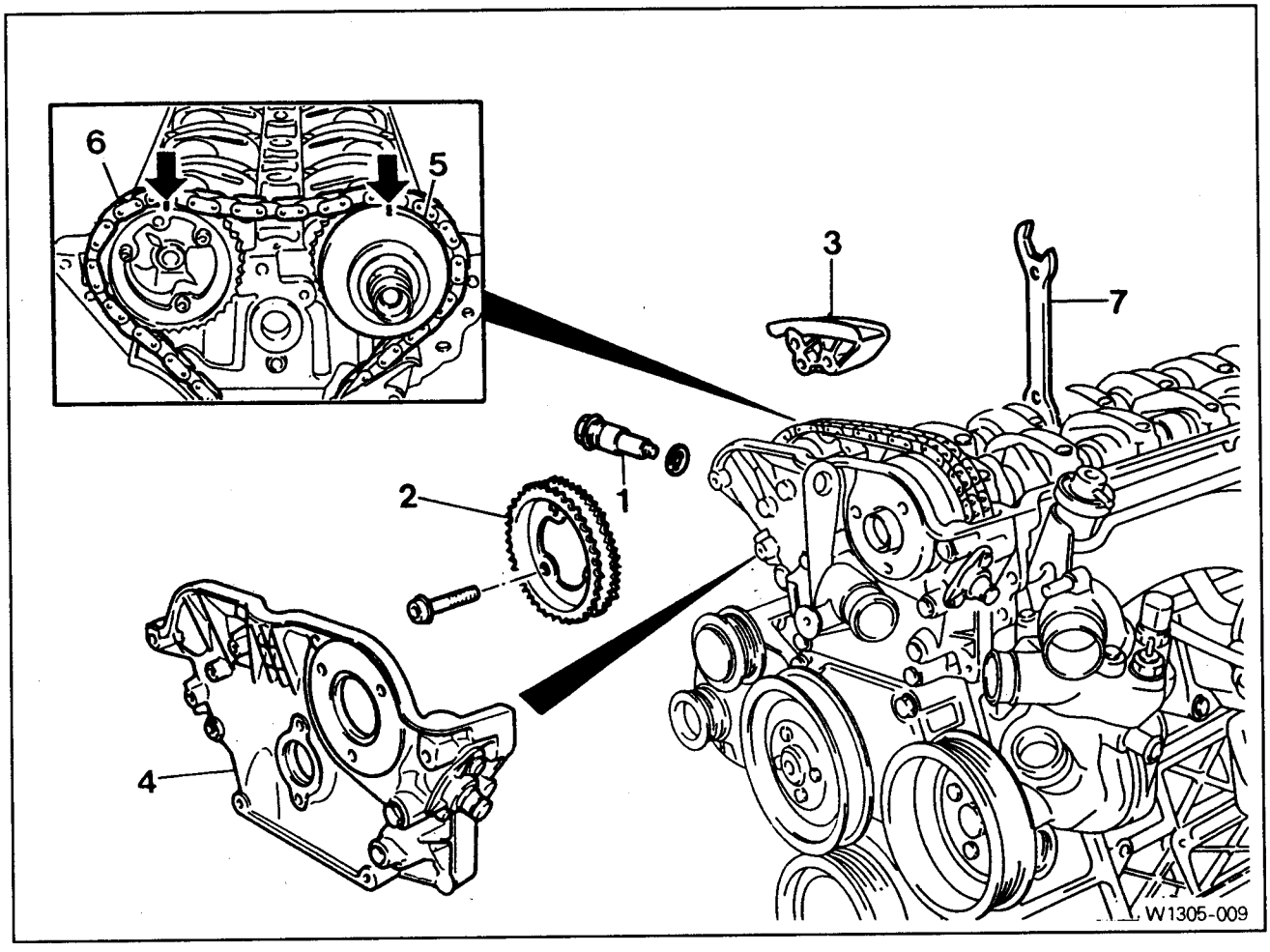
[Note] Do not reuse the bolt.



E. M7 X 13mm Collar Bolt Torx-T30
e. 6.8mm
3. Camshaft Sprocket
4. Exhaust Camshaft

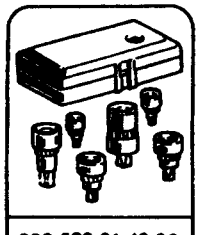
3. Removal and Installation of Camshaft

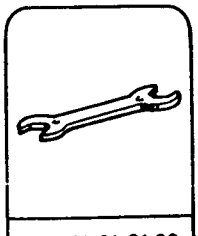
Preceding work : Removal of cylinder head cover (01-18)
Removal of coolant connection fitting (20-04)



1. Chain Tensioner
2. Exhaust Camshaft Sprocket
3. Chain Guide Rail
4. Front Cover of Cylinder Head
5. Intake Camshaft Sprocket
6. Chain
7. Wrench (Special Tool)

Special Tools



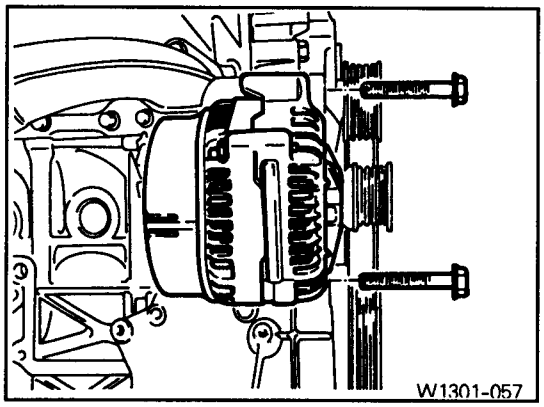


Removal

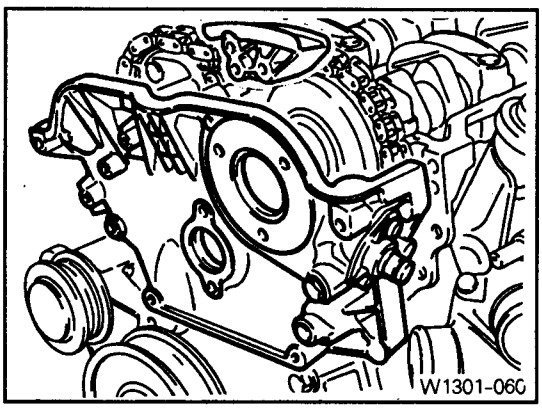
1) Turn the crankshaft and position the no. 1 cylinder piston at BTDC 30°.

2) Remove the alternator.

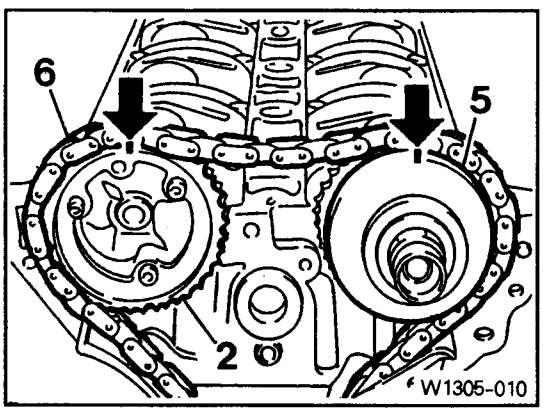
3) Remove the chain tensioner.



4) Remove the front cover and upper guide rail.

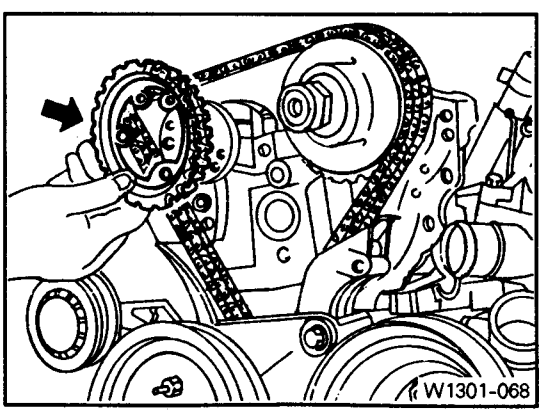


5) Place alignment marks (arrow) on the camshaft sprockets (2, 5) and timing chain (6).



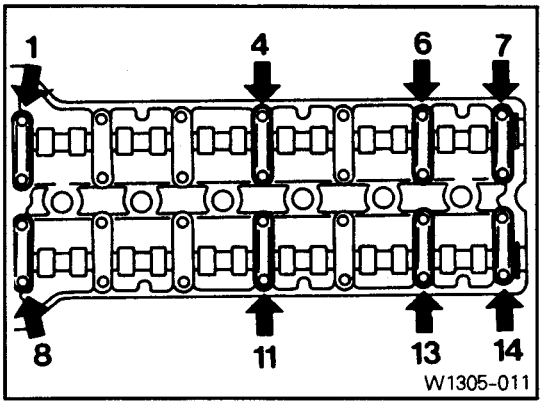
6) Remove the bolt from the exhaust camshaft sprocket and then remove the sprocket.

7) Separate the chain from the intake camshaft sprocket and put the chain not to be dropped into timing case.



8) Remove the bolts from the intake camshaft (8, 11, 13, 14) and the exhaust camshaft (1, 4, 6, 7) and then loosen the remaining camshafts bolts in steps of one revolution and remove the intake and exhaust camshaft bearing cap bolts.
   [Note] When removing the camshaft bearing cap bolts, arrange the bolts not to be mixed up each other as numerical sequence.

9) Remove the intake and exhaust camshafts.



Installation

1) Turn the crankshaft and position the no.1 cylinder piston at BTDC 30°.
   [Note] Turn the crankshaft in the direction of engine rotation.

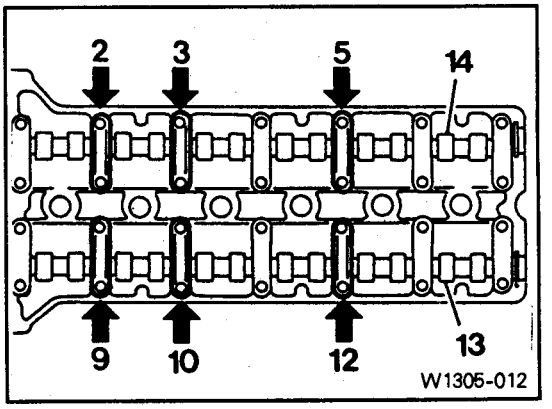
2) Coat the valve tappet and camshaft with engine oil.

3) Install the bearing caps (2, 3, 5) of exhaust camshaft (14) and bearing caps (9, 10, 12) of intake camshaft (13) and tighten the bolts as specified torque.

4) Install the remaining bearing caps and tighten the bolts.

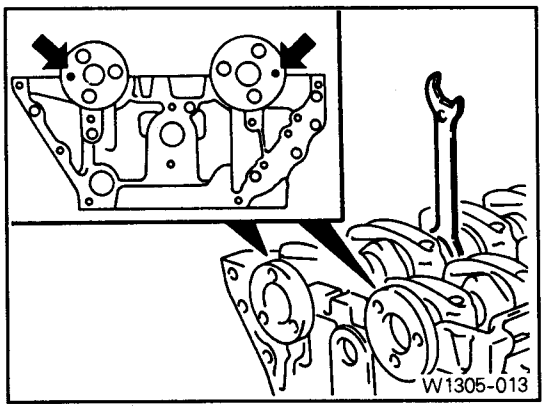
Tightening torque	25Nm

[Note] Install the bearing caps according to the numbers on the bearing caps.



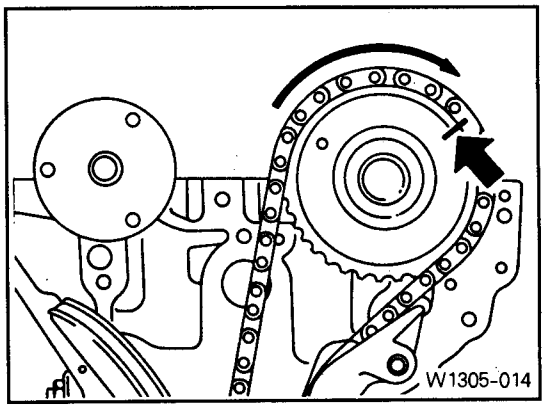
5) Using a special tool, align the intake camshaft adjust hole (to 3 o'clock position) and the exhaust camshaft adjust hole (to 9 o'clock position) with the upper surface of the cylinder head.

[Note] · **The adjust hole's diameter is 4mm.**
· **Turn the crankshaft and position the no. 1 cylinder piston at TDC and crankshaft at OT.**



6) Turn the intake camshaft adjuster to the direction of camshaft rotation by hand until it stops and then install the chain.

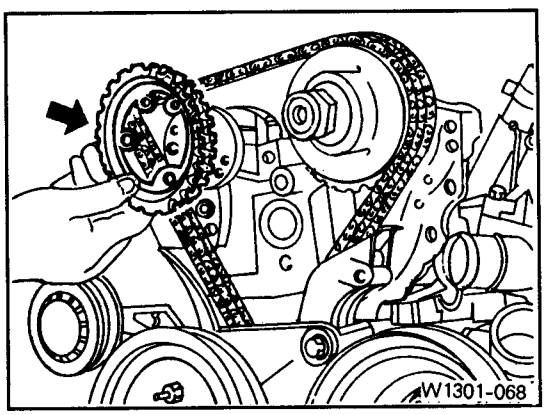
[Note] · **Make sure that the camshaft sprocket and timing chain are aligned with marks.**
· **Intake camshaft adjuster should be in 'retarded' position.**



7) Install the chain on the exhaust camshaft sprocket and tighten the sprocket bolt.

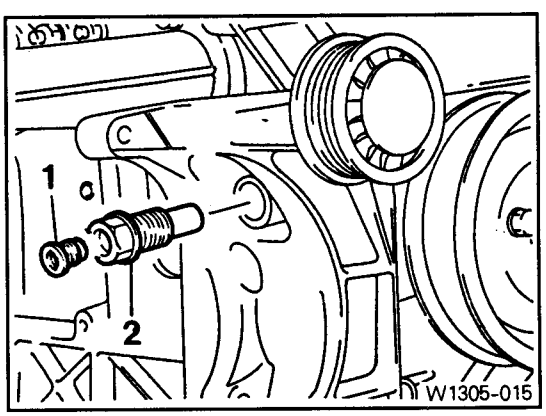
Tightening torque	20Nm + 90°

[Note] · **Use the new bolts.**
· **Make sure that the sprocket and timing chain are aligned with marks.**



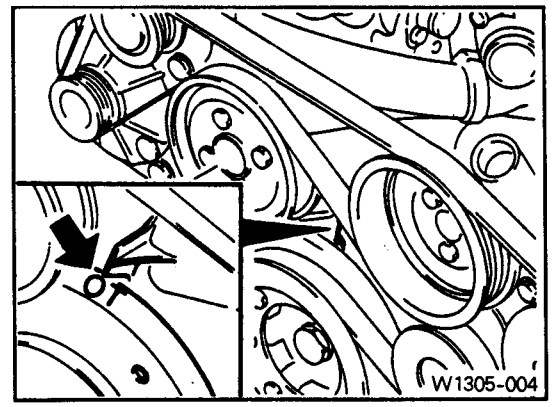
8) Install the chain tensioner and tighten it as specified.

Screw plug (1)	40Nm
Tensioner assembly (2)	80Nm



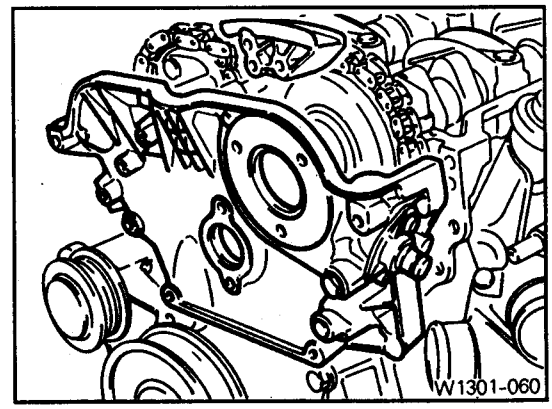
9) Rotate the crankshaft 2 revolutions and check followings :
- TDC of no.1 cylinder : OT
- Alignments between camshaft adjust hole and cylinder head surface.
- Alignments between timing chain and sprocket marks.

[Note] · **Turn the direction of engine rotation.**
· **Readjust if not aligned.**



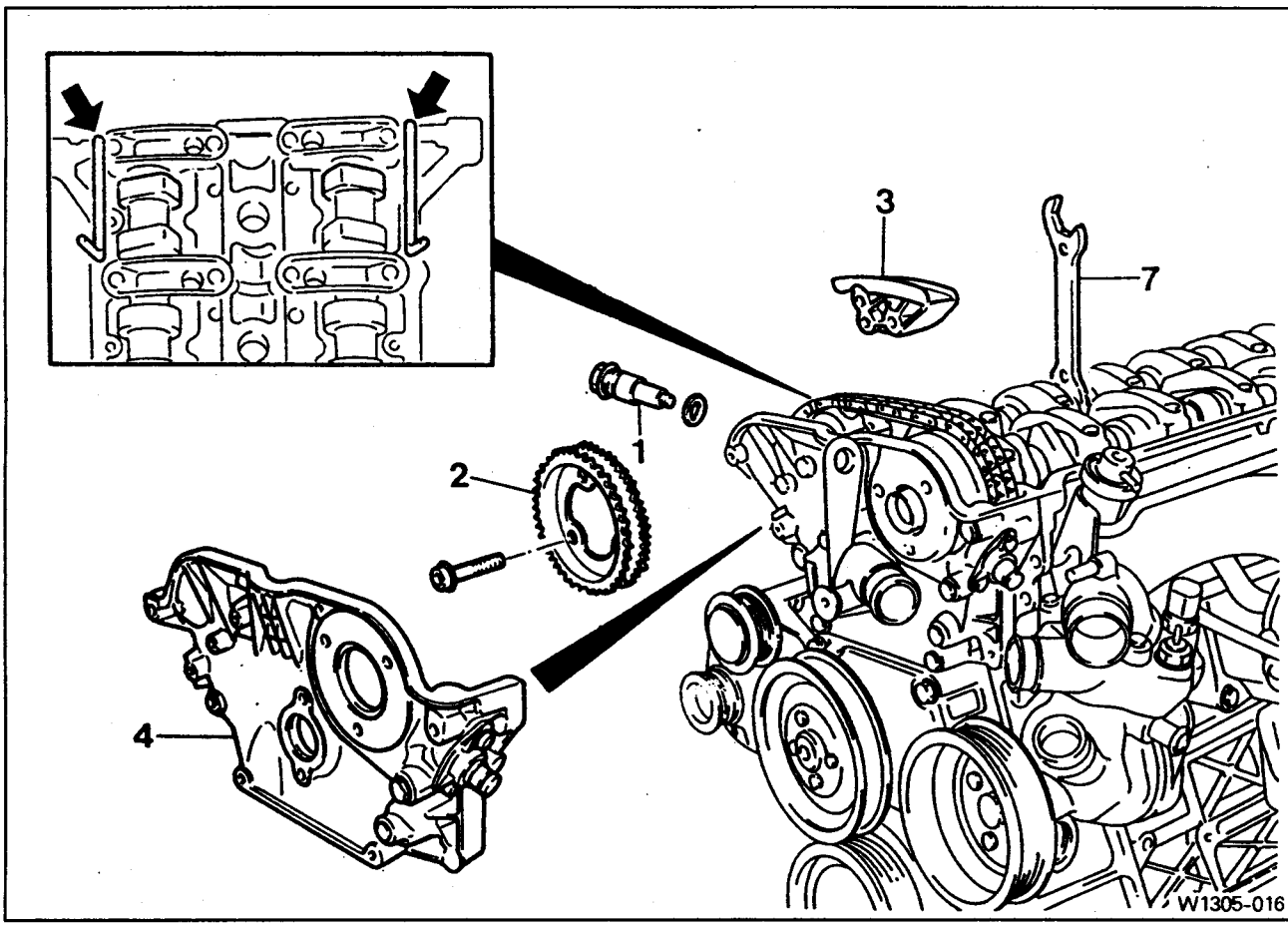
10) Install the front cover and upper guide rail.

11) Install the alternator.



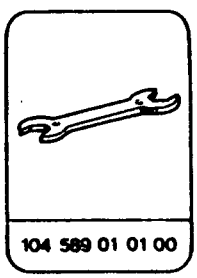
4. Camshaft Timing Position Check

Preceding work : Removal of cylinder head cover (01-18)



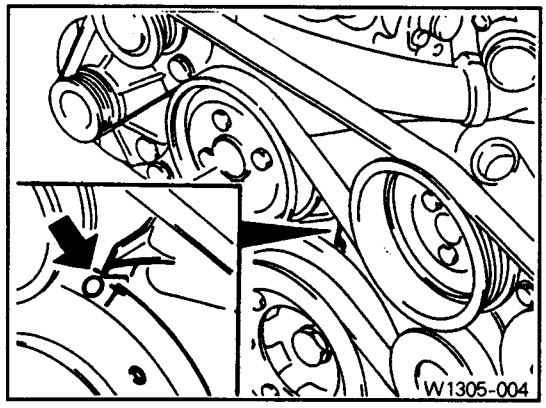
1. Exhaust Camshaft Sprocket
2. Chain Tensioner
3. Upper Guide Rail
4. Front Cover of Cylinder Head
5. Wrench (Special Tool)
6. Adjust Hole Fitting Pin

Special Tool

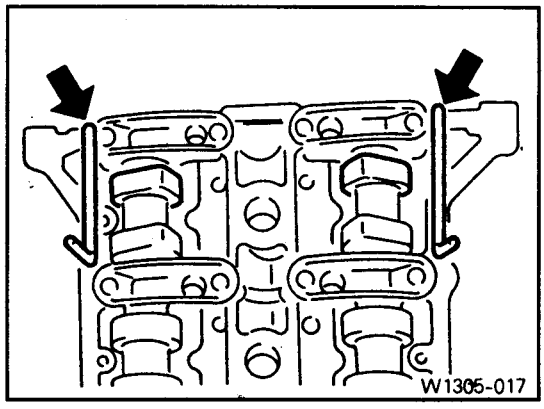


Checking

1) Turn the crankshaft 1 revolution to the direction of engine rotation and position the piston of no. 1 cylinder at TDC of OT.

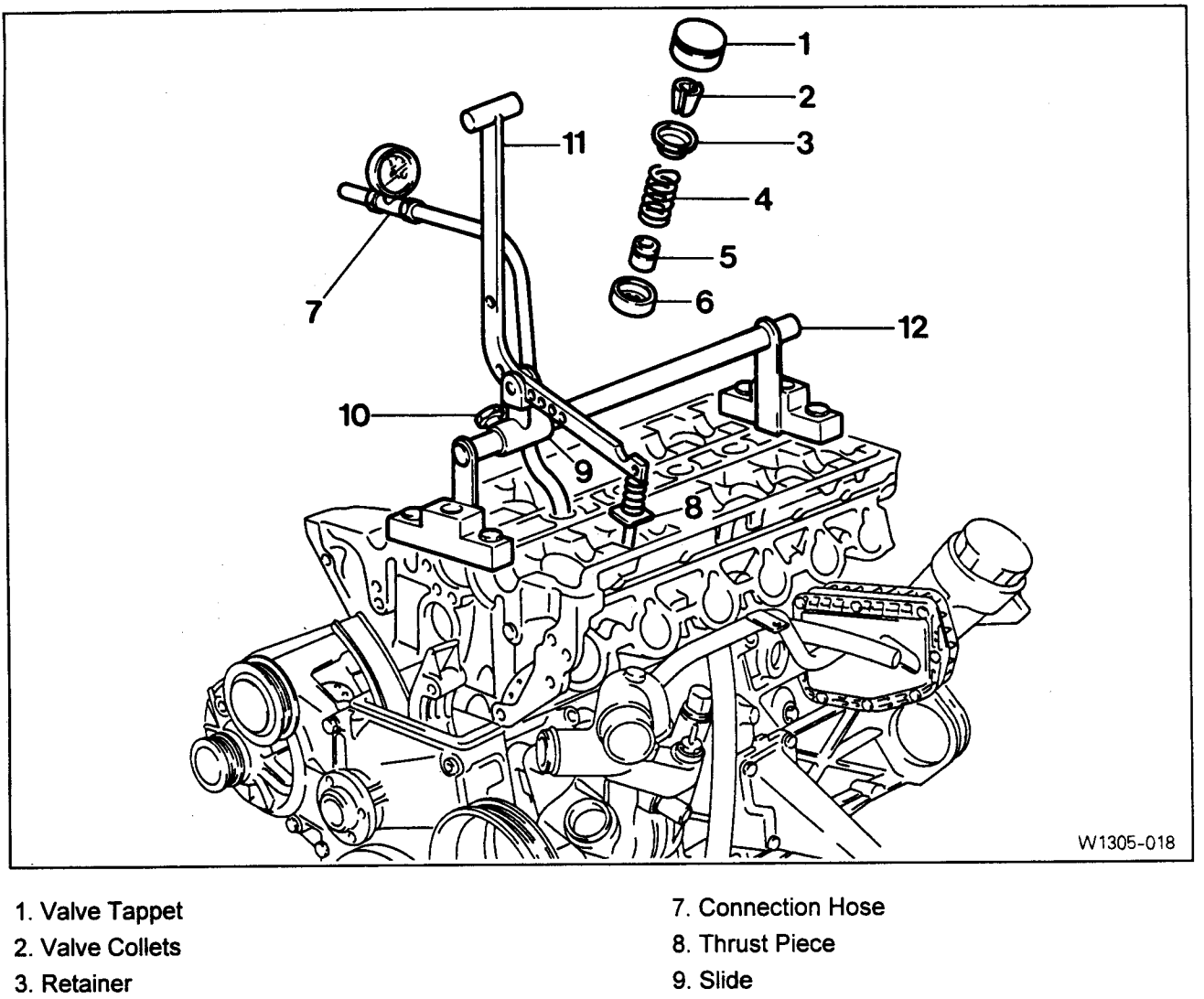


2) Using a special tool or by visual, check that the intake camshaft adjust hole (to 3 o'clock position) and the exhaust camshaft adjust hole (to 9 o'clock position) align with the cylinder head surface.
   [Note] If the camshaft adjust holes and upper cylinder head surface are not aligned, see the camshaft installation (05-07).



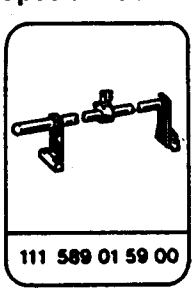
5. Removal and Installation of Valve Spring

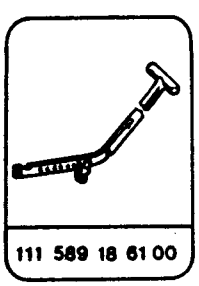
Preceding work : Removal of camshaft (05-07)
Removal of spark plug (15-01)
Removal of cooling fan shroud (20-09)

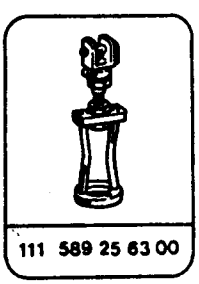


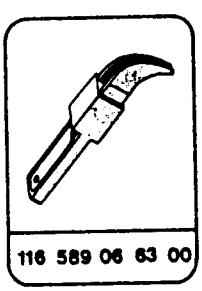
1. Valve Tappet
2. Valve Collets
3. Retainer
4. Valve Spring----------Check, replace if necessary
5. Valve Stem Seal
6. Lower Retainer
7. Connection Hose
8. Thrust Piece
9. Slide
10. Control Bolt
11. Lever Presser
12. Supporting Bar

Special Tools









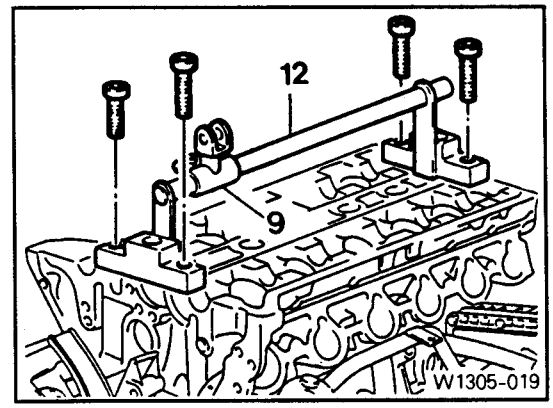
Removal · Installation

1) Place the supporting bar (12) and slide (9) and tighten them with camshaft bearing cap bolts.

Installation

Tightening torque	25Nm

Supporting bar 111 589 01 59 00

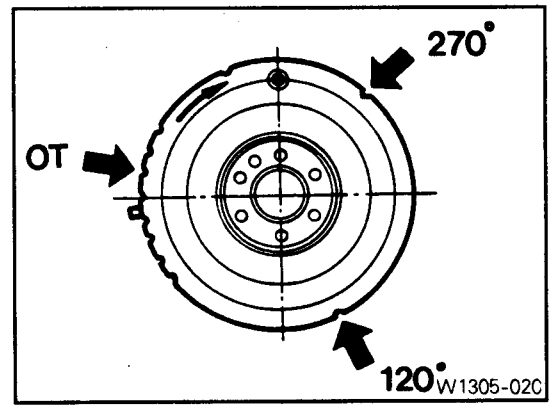


2) Turn the crankshaft to position the each cylinder pistons at TDC.

[Note] · **Remove the valve springs only in the TDC position.**

· **Turn the crankshaft by holding the timing chain to prevent the timing chain from being tangled.**

TDC Position	Piston
OT	1, 6
120 °	2, 5
240 °	3, 4

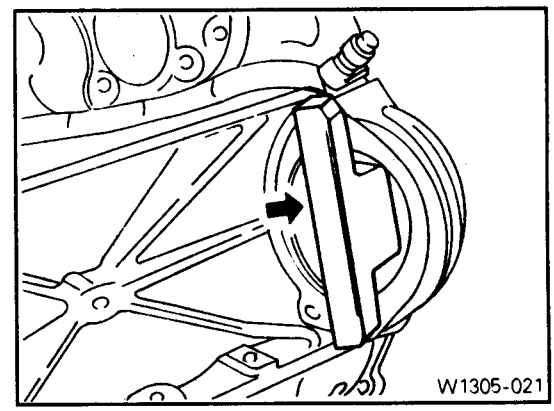


3) Remove the valve tappet (1) by using magnetic bar.

4) Install the connection hose (7) of the cylinder leakage tester into the spark plug hole.

5) Install the engine lock to the ring gear.

6) Blow up with compressed air.



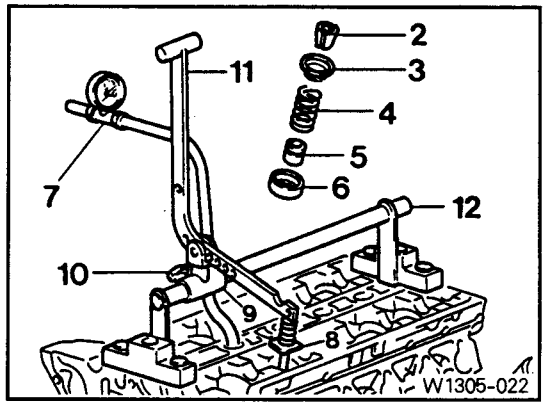
7) Install the lever presser (11) and thrust piece (8) to the slide (9).

Lever presser 111 589 18 61 00

8) Position the thrust piece (8) vertically to the valve spring retainer (3).

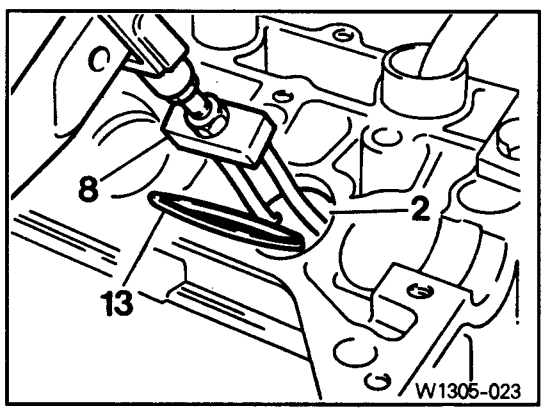
9) Fix the position of slide (9) with control bolt (10).

10) Press the spring retainer (3) by using the lever presser (11).



11) Remove the valve collets (2) using a holder (13) or magnetic finger.

Magnetic finger 116 589 06 63 00



12) Remove the valve spring (4) and spring retainer (3).

13) Remove the valve stem seal (5) (05-18).

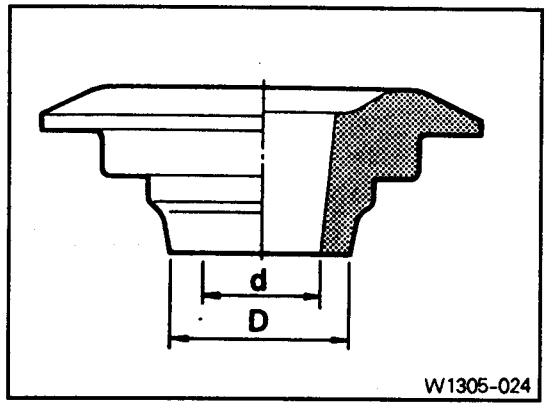
14) Remove the valve spring retainer (6).
[Note] Replace the valve spring retainer.

15) Installation is reverse order of the removal.

Inspection

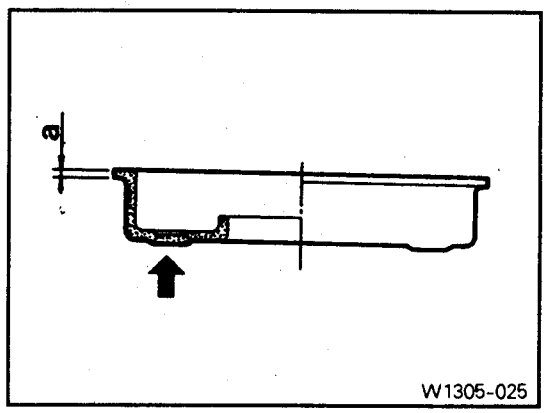
1) Upper valve spring retainer.

Size	(d) 8.5mm
	(D) 12.3mm



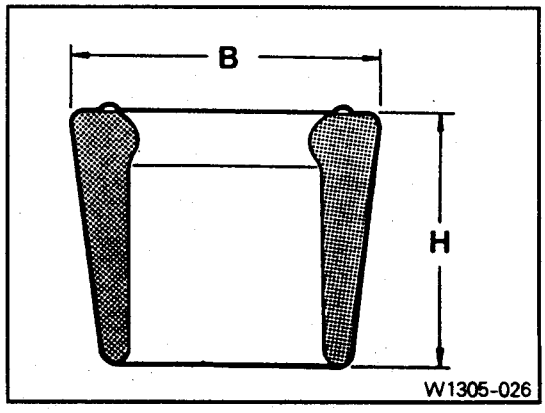
2) Lower valve spring retainer.

Thickness (a)	0.8~1.0mm



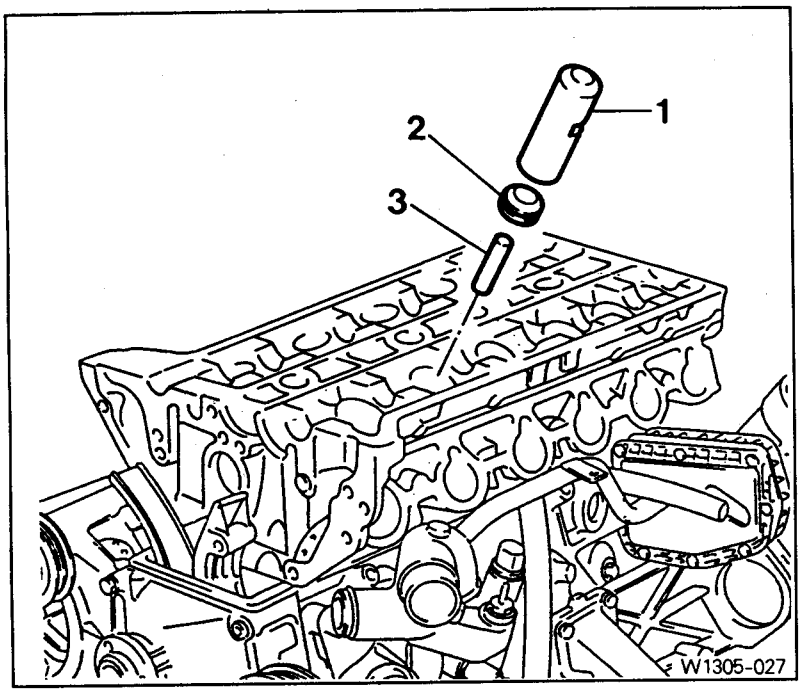
3) Valve collets.

Size	(B) 9mm
	(H) 9.2~9.8mm



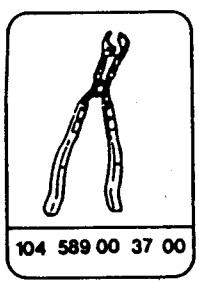
6. Replacement of Valve Stem Seal

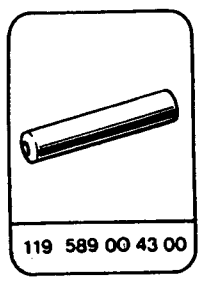
Preceding work : Removal of valve spring (05-14)



1. Drift (Special Tool)
2. Valve Stem Seal
3. Protective Sleeve

Special Tools





Replacement

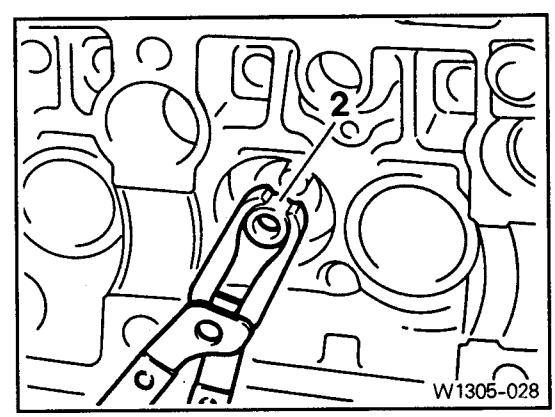
1) Using a pliers, remove the valve stem seal (2).
   [Note] Check the seal for damage and replace if necessary.

   Pliers 104 589 00 37 00

2) Coat the valve stem seal with oil and assemble the seal with protective sleeve.

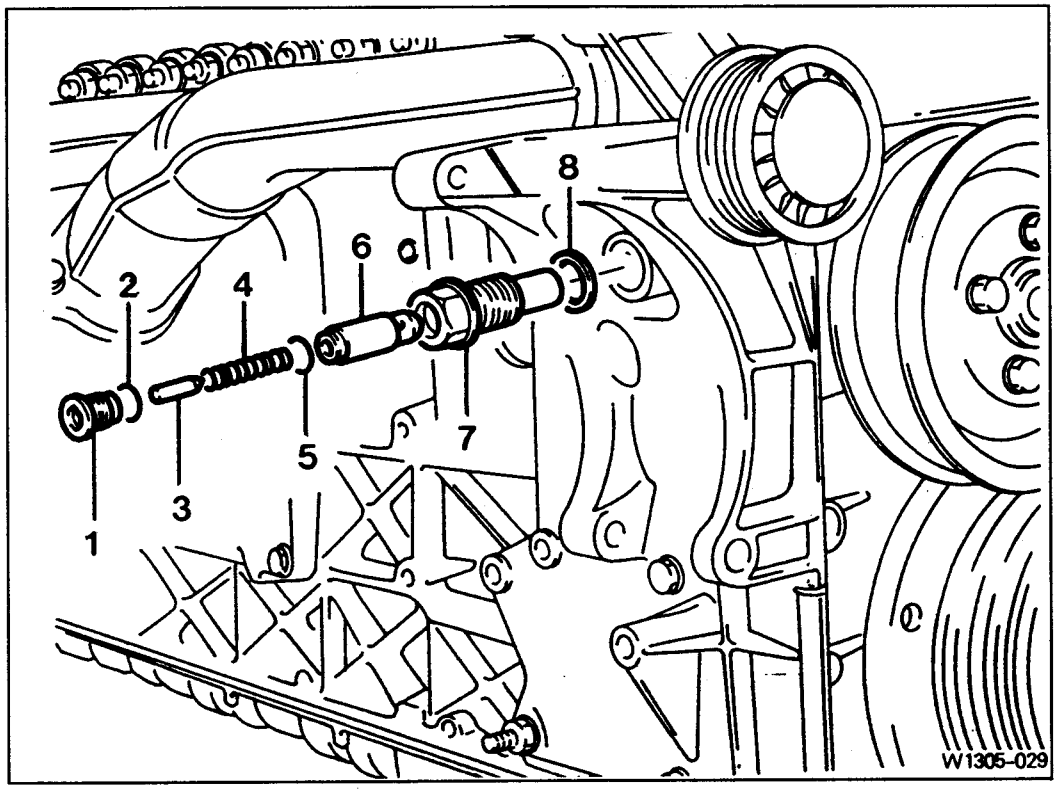
3) Using the drift, press the valve stem seal.

   Drift 119 589 00 43 00



7. Removal and Installation of Chain Tensioner

Preceding work : Removal of V-belt (13-1200)
Removal of alternator



1. Screw Plug----------40Nm
2. Seal
3. Filler Pin
4. Compression Spring
5. Detent Spring
6. Thrust Pin
7. Chain Tensioner Housing----------80Nm
8. Seal

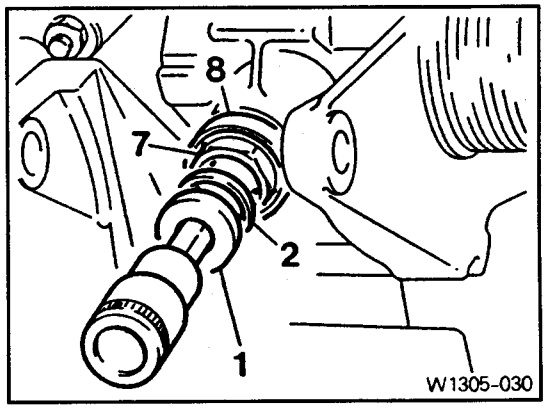
Removal · Installation

1) Remove the screw plug (1) and then remove the seal (2).

Installation

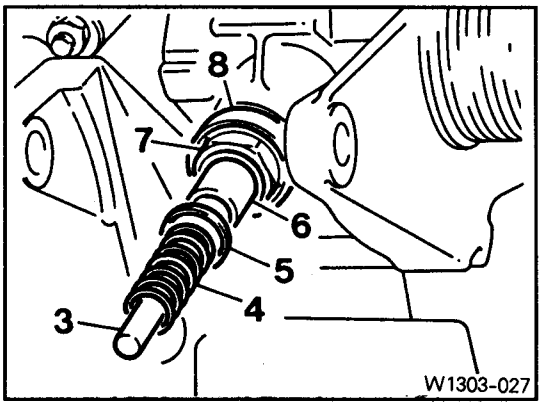
Tightening torque	40Nm

[Note] · For the screw plug removal, be careful that it can be jumped out due to the force of compression spring.
· Remove the screw plug only when the seal and compression spring are damaged.
· Apply grease to new seal and install it.



2) Carefully remove the filler pin (3), compression spring (4), detent spring (5) and thrust pin (6).

3) Remove the chain tensioning housing (7) and then remove the seal (8).



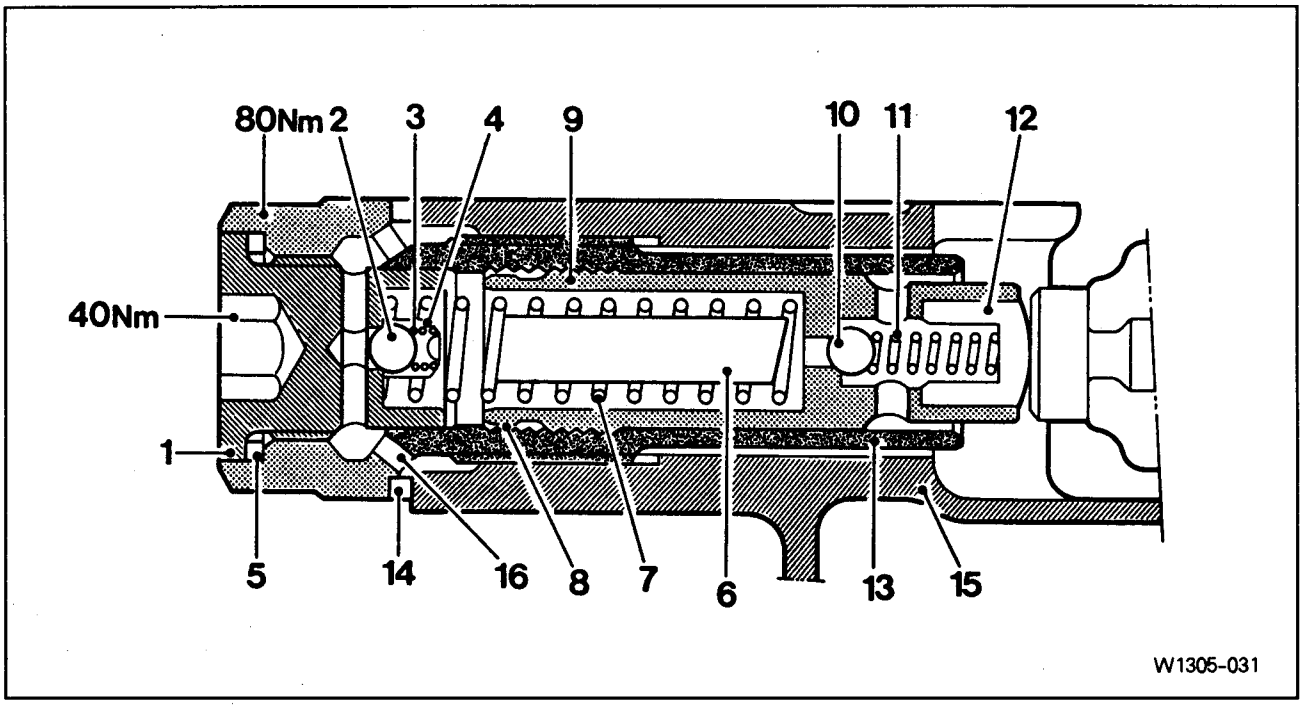
Installation

Tightening torque	80Nm

4) Installation is reverse order of the removal.

5) Turn the engine and check the engine for leaks.

Sectional view

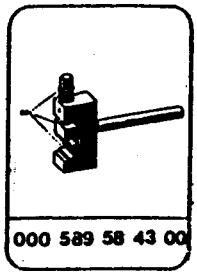


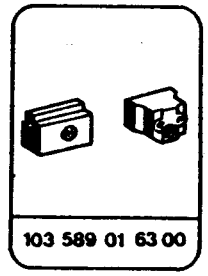
1. Screw Plug
2. Ball
3. Compression Spring
4. Ball Guide
5. Aluminum Seal
6. Filler Pin
7. Compression Spring
8. Detent Spring
9. Thrust Pin
10. Ball
11. Compression Spring
12. Thrust Piece
13. Chain Tensioner Housing
14. Aluminum Seal
15. Timing Case Cover

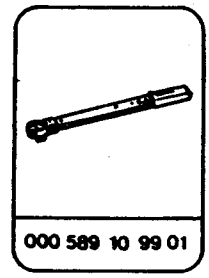
8. Riveting and Replacement of Timing Chain

Preceding work : Removal of chain tensioner (05-19)
Removal of front cover of cylinder head (01-32)

Special Tools

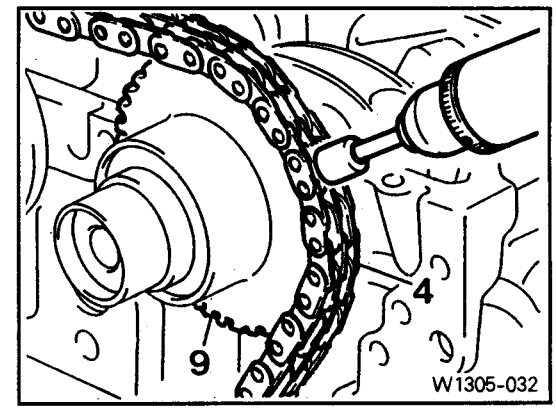




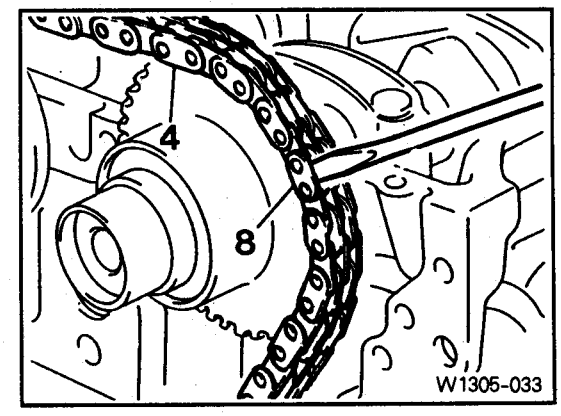


Replacement

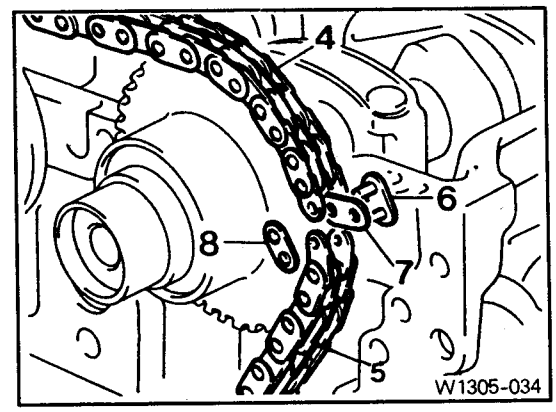
1) Protect the chain box with cloth and grind off the chain pin of timing chain (4) from the exhaust camshaft sprocket (9).



2) Remove the outer plate (8) with screwdriver and then remove the double link.
[Note] Be careful not to drop the timing chain (4) into the chain box.

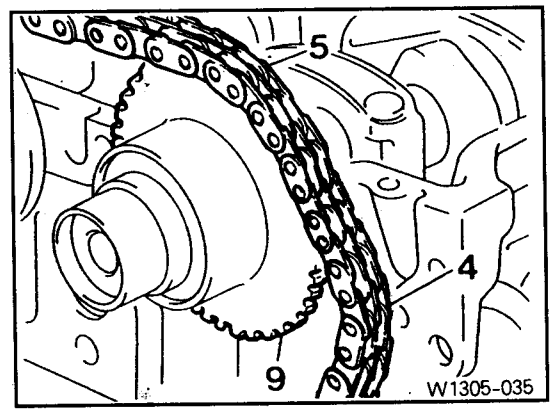


3) Connect the new timing chain (5) to the original timing chain (4) with double link (6), center plate (thickness : 1.6mm) (7) and outer plate (8).



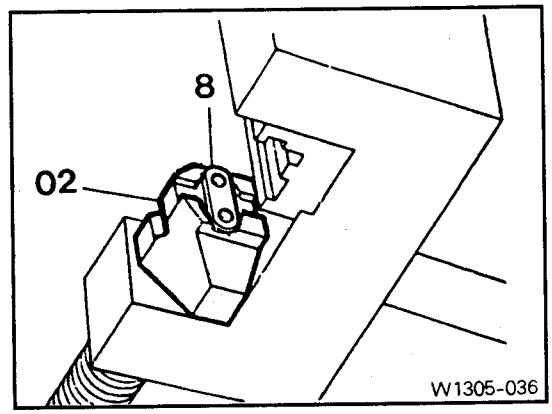
4) Place the new timing chain (5) on the exhaust camshaft sprocket (9) and remove the original timing chain (4) by turning the crankshaft to the direction of engine rotation.

5) Connect the new timing chain (5) with double link and center plate.



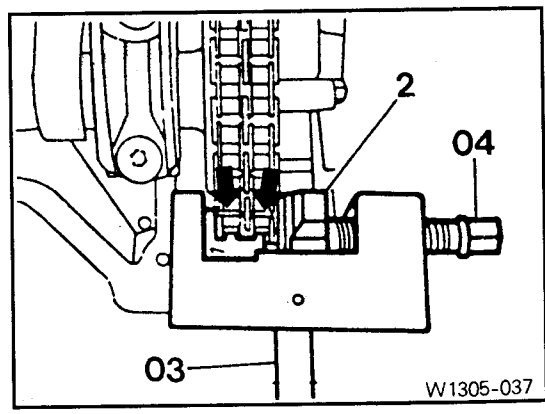
6) Insert the new outer plate (8) (thickness : 1.2mm) into the special tool (2).

Chain assembler 000 589 58 43 00

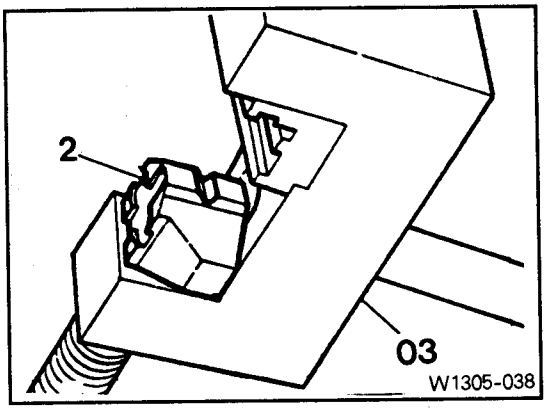


7) Position the special tool onto the chain link and rotate the spindle (04) until the outer plate stops.

8) Remove the special tool (03).

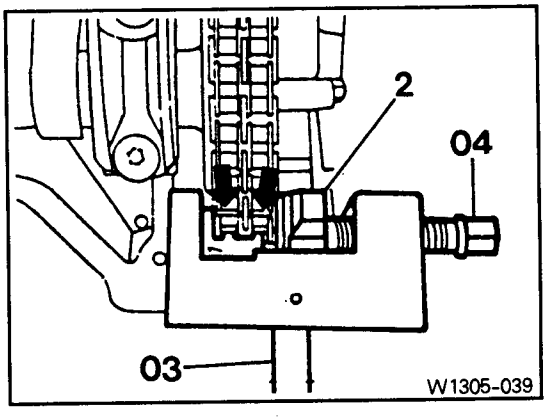


9) Switch the thrust piece (2) of special tool (03).

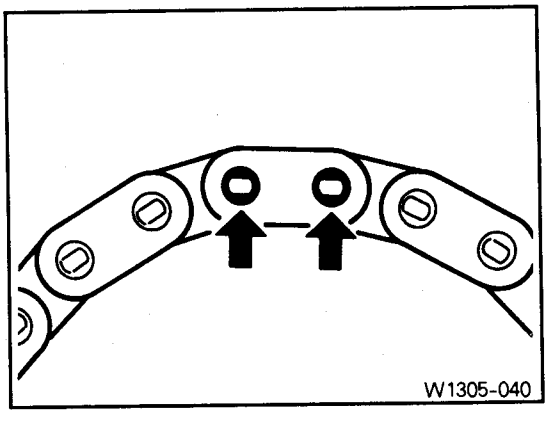


10) Position the special tool (03) onto the chain link and rivet the chain pin one by one.

Tightening torque of spindle	30Nm

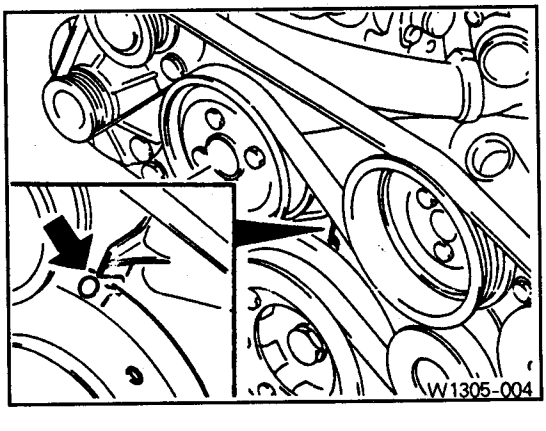


11) Check riveting condition and re-rivet if necessary.



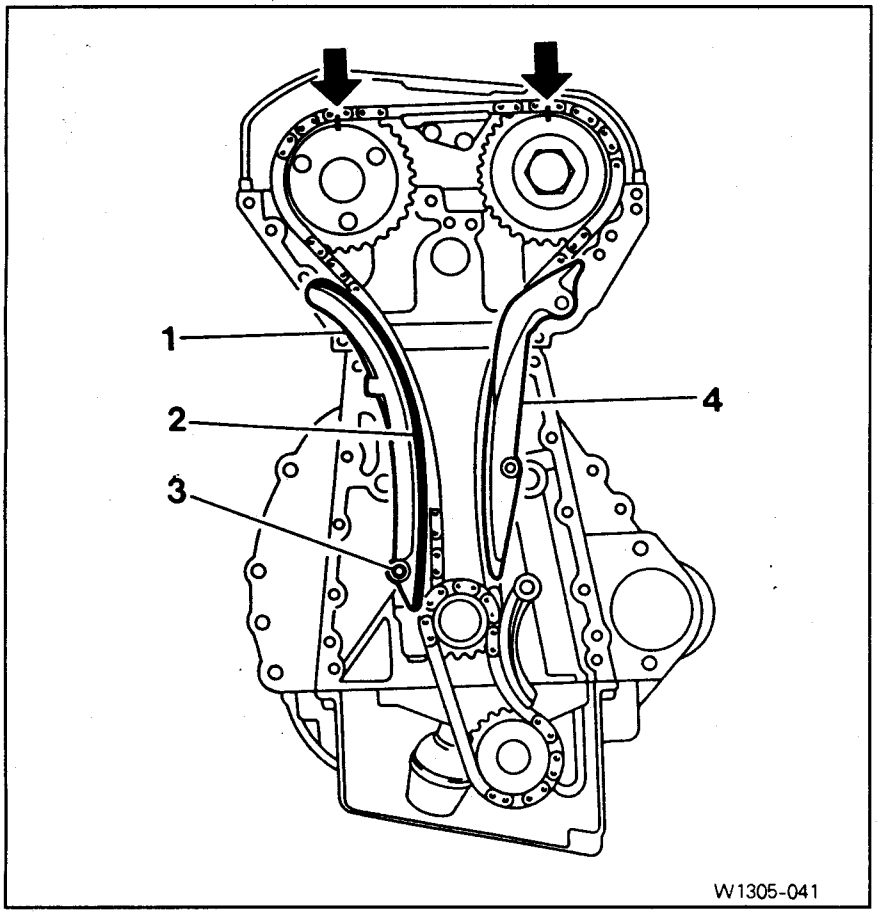
12) Position the no.1 cylinder at TDC.

13) Check that the camshaft adjust holes align with the cylinder head upper surface (05-12).



9. Removal and Installation of Tensioning Rail

Preceding work : Removal of timing case cover (01-29)



1. Tensioning Rail
2. Plastic Guide
3. Tensioning Rail Pin
4. Guide Rail

Removal · Installation

1) Place alignment marks (arrow) on the camshaft sprocket and timing chain.

2) Remove the exhaust camshaft sprocket.

3) Remove the tensioning rail (1) from the rail pin (3).

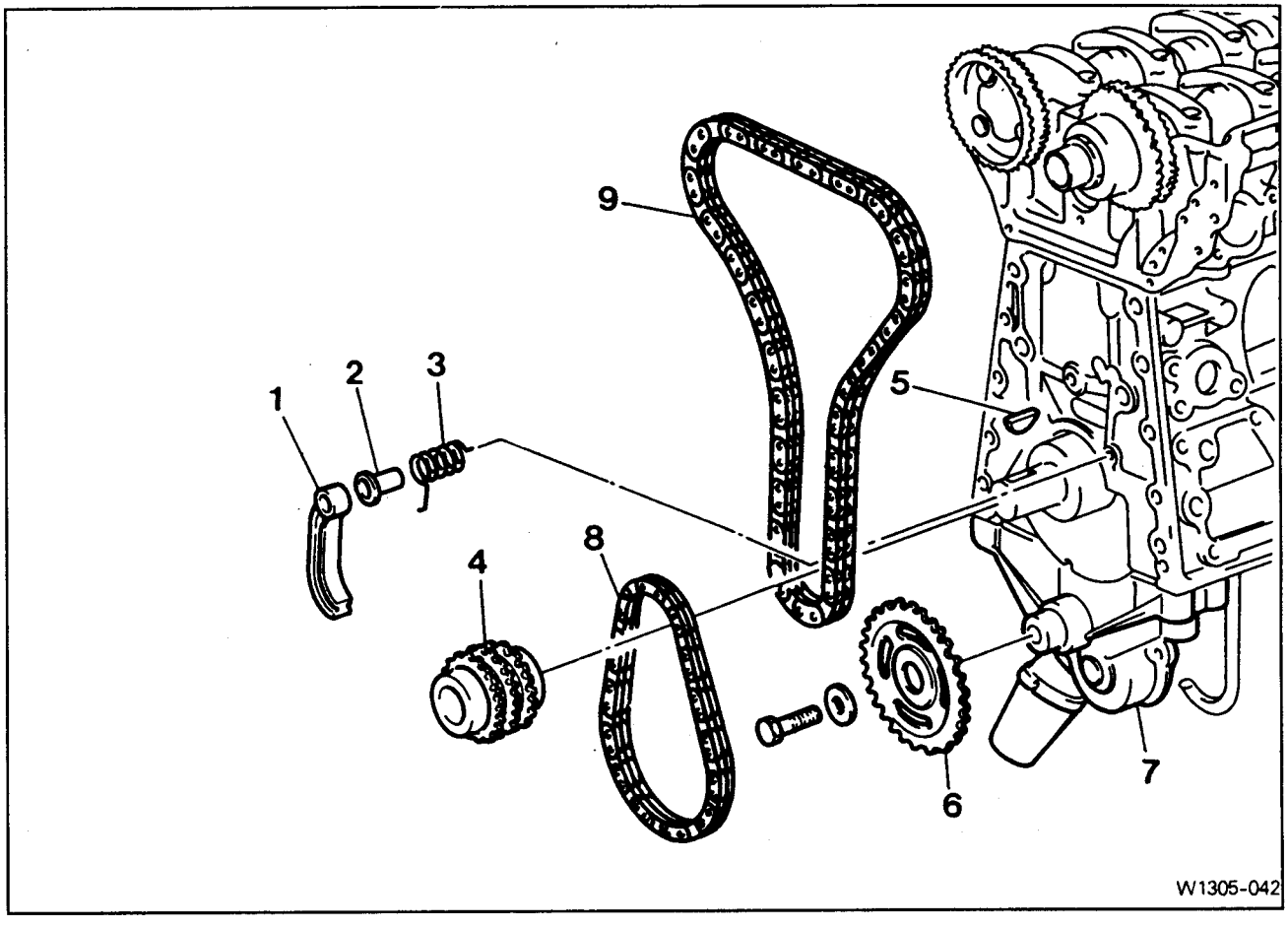
[Note] · **If plastic guide (2) is damaged, replace it.**
· **For installation, exactly align the plastic guide (2) with tensioning rail (1).**

4) Installation is reverse order of the removal.

5) Check the camshaft timing position (05-12).

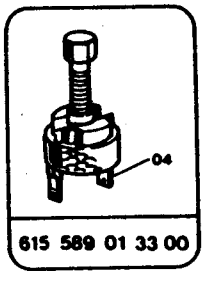
10. Removal and Installation of Crankshaft Sprocket

Preceding work : Removal of oil pan (01-36)
Removal of tensioning rail (05-24)
Removal of guide rail



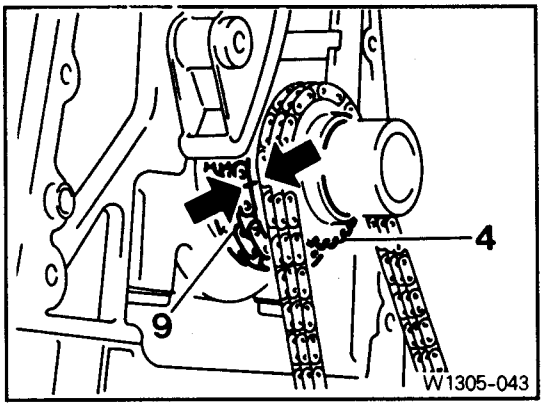
1. Tensioning Bar
2. Bushing
3. Spring
4. Crankshaft Sprocket
5. Key
6. Oil Pump Drive Gear
7. Oil Pump
8. Oil Pump
9. Timing Chain

Special Tool



Removal · Installation

1) Place alignment marks (arrow) on the crankshaft sprocket (4) and timing chain (9).
[Note] For installation, align the marks of crankshaft sprocket and timing chain and camshaft sprocket and timing chain.



2) Remove the oil pump drive gear from oil pump.

Installation

Tightening torque	32Nm

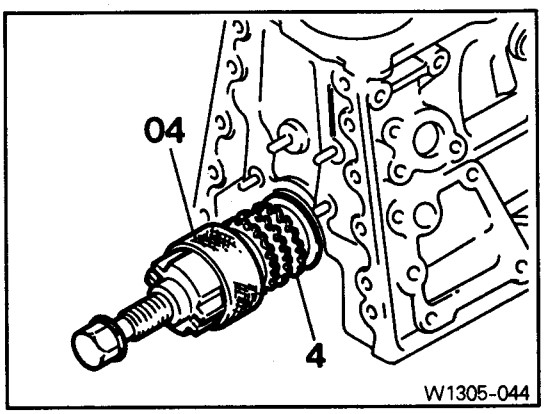
3) Remove the oil pump chain.

4) Remove the tensioning bar, bushing and spring.

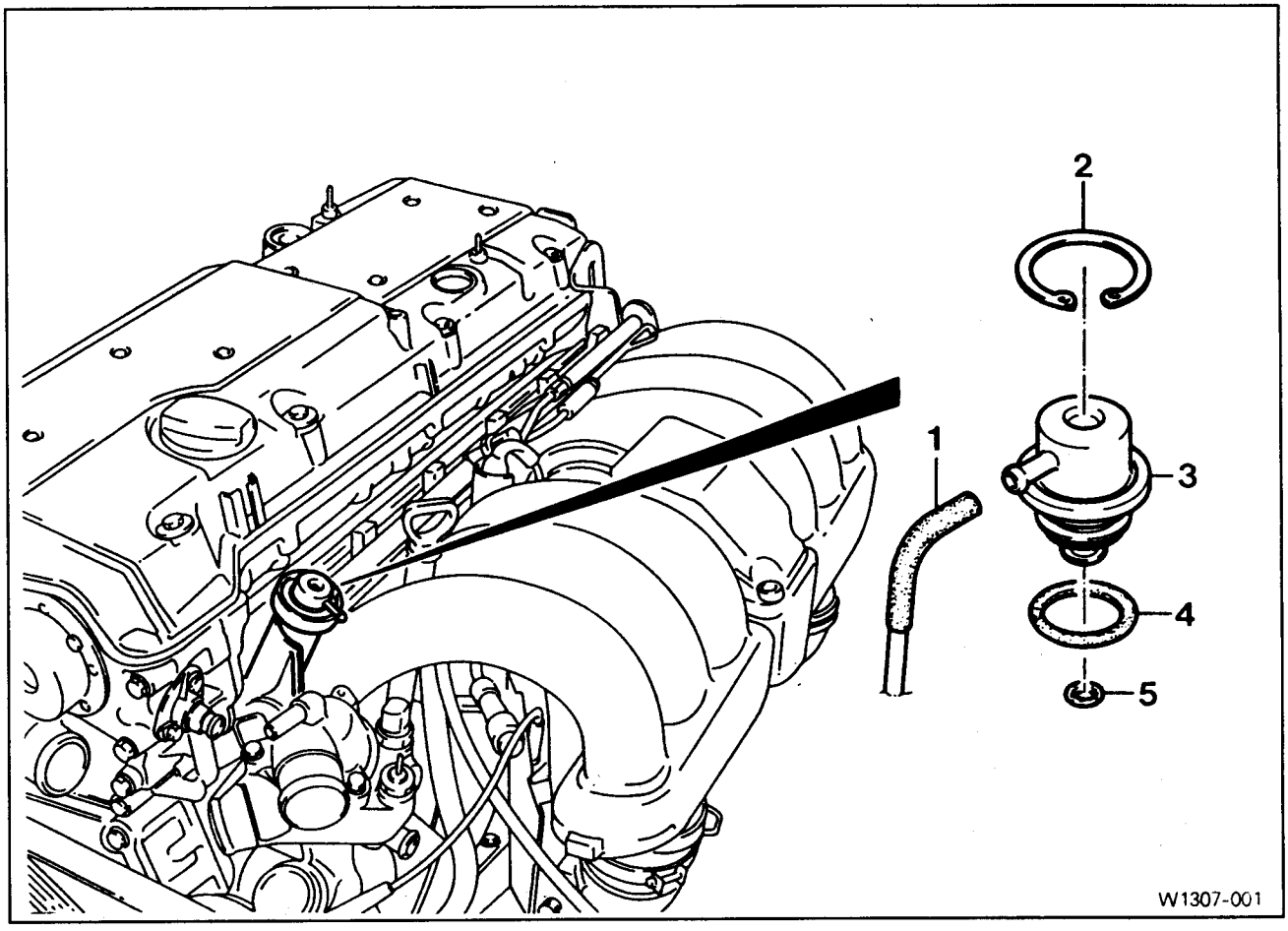
5) Remove the crankshaft sprocket (4) by using special tool (04).
[Note] · Be careful not to miss the key.
· For installation, heat up the crankshaft sprocket.

6) Installation is reverse order of the removal.

Puller 615 589 01 33 00



1. Diaphragm Pressure Regulator



1. Vacuum Hose
2. Circlip
3. Pressure Regulator
4. O-Ring----------Replace
5. O-Ring----------Replace

Removal · Installation

1) Remove the fuel pressure check plug and release the fuel pressure in the fuel system.

2) Disconnect the vacuum hose.

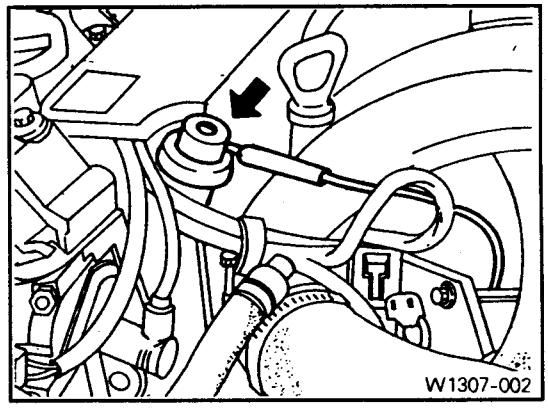
3) Remove the circlip.

4) Remove the fuel pressure regulator.

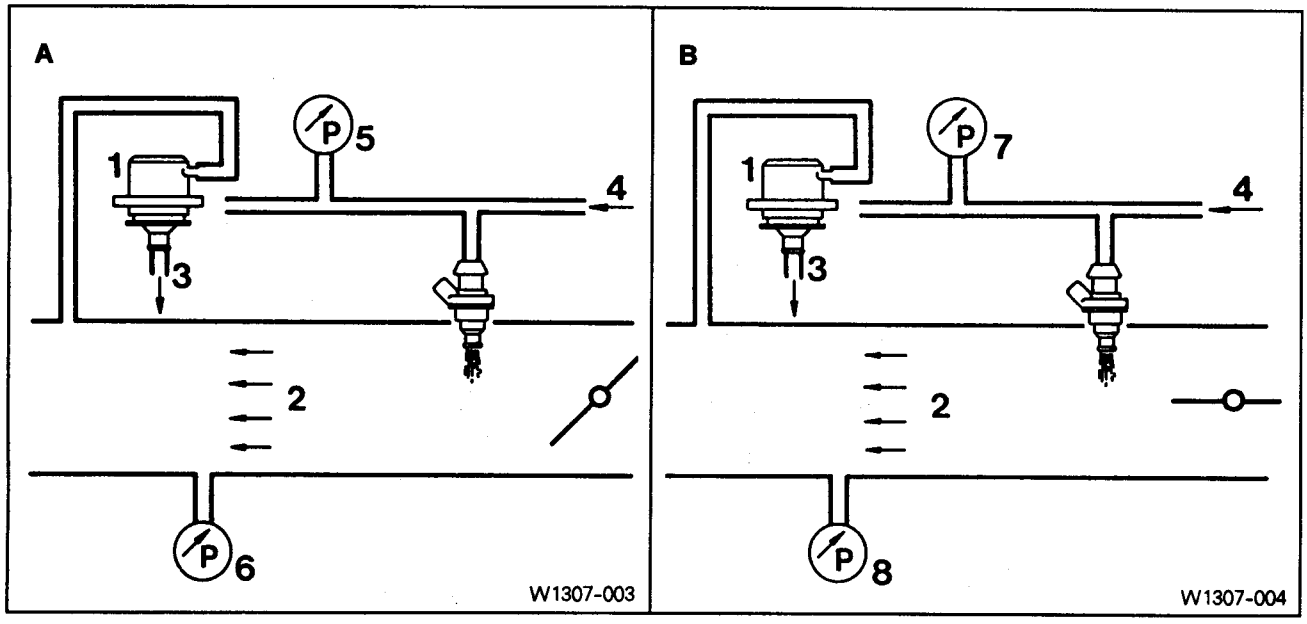
5) Replace the O-ring and coat it with oil for installation.

6) Installation is reverse order of the removal.

7) Start the engine and check the engine for fuel pressure and internal leaks (07-05).



Fuel pressure change

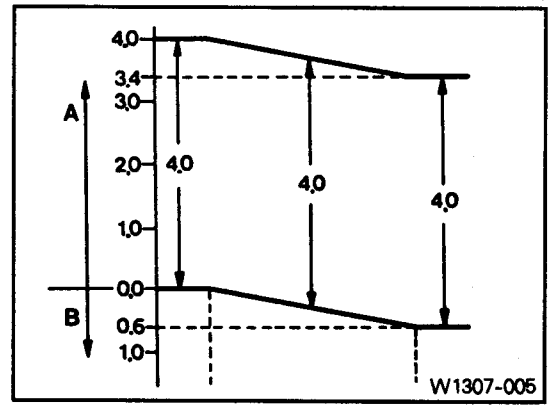


1. Fuel Pressure Regulator
2. Intake Manifold Pressure
3. Fuel Return (to Fuel Tank)
4. Fuel Feed (from Fuel Pump)
5. Fuel Pressure : 3.4bar
6. Intake Manifold Pressure : 0.6bar
7. Fuel Pressure : 4.0bar
8. Intake Manifold Pressure : 0bar

A ; Idle and Partial load
B : Full load

Function

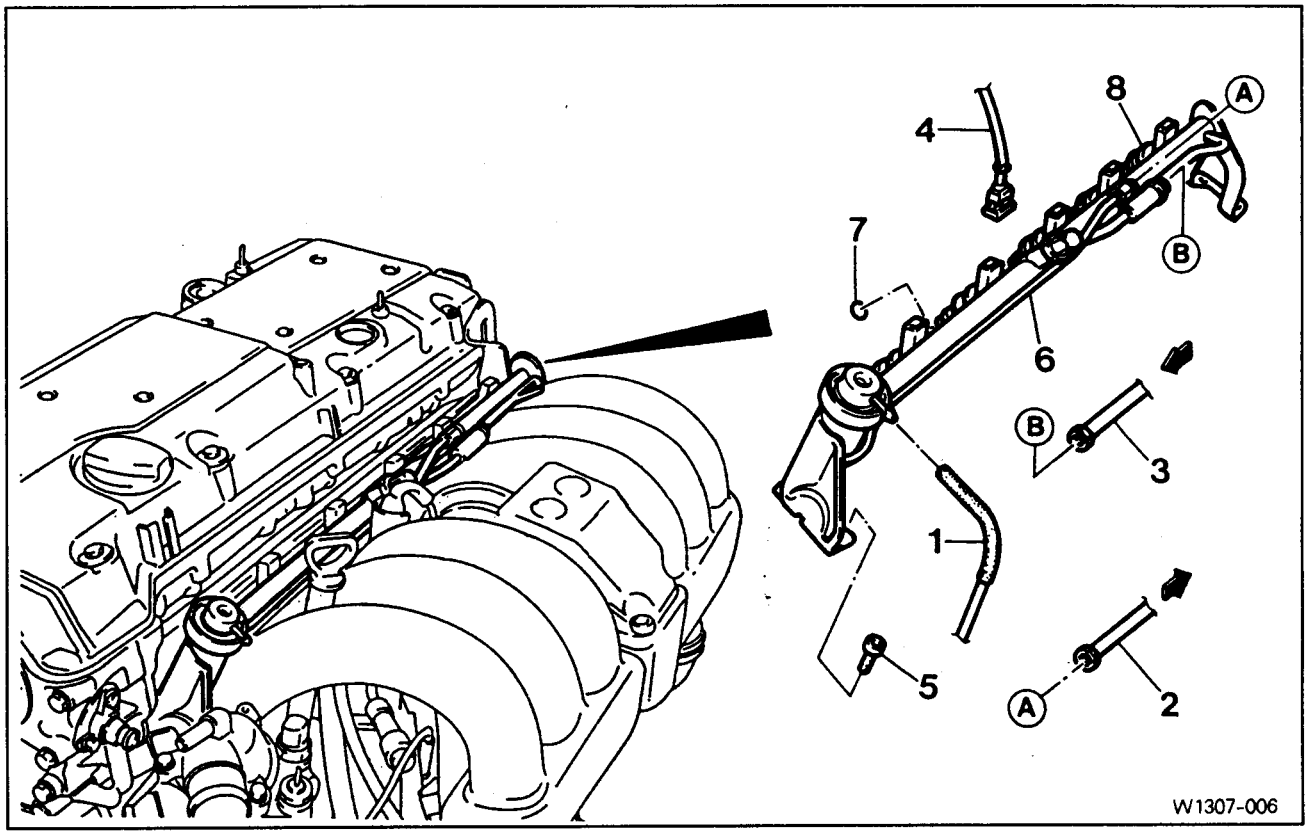
The fuel pressure regulator maintains the difference of pressure between fuel pressure in fuel line and intake manifold to be 4 bar. The fuel injection volume will be determined by injection time of injection valve and remaining fuel will return to the fuel tank.



A : Fuel pressure
B : Intake manifold pressure
LL : Idle condition
TL : Partial load
VL : Full load

2. Fuel Distributor and Injection Valve

Preceding work : Removal of air cleaner cross pipe (09-03)



1. Vacuum Hose
2. Fuel Return Line----------21~25Nm
3. Fuel Feed Line----------21~25Nm
4. Injection Valve Connector
5. Bolt----------25Nm
6. Fuel Distributor
7. O-Ring----------Replace
8. Injection Valve

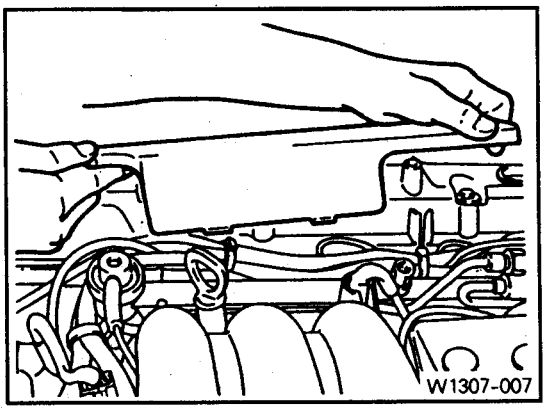
Removal · Installation

1) Release the fuel pressure from the fuel pressure check plug.

2) Disconnect the battery ground.

3) Disconnect the vacuum hose from the pressure regulator.

4) Remove the cable duct.

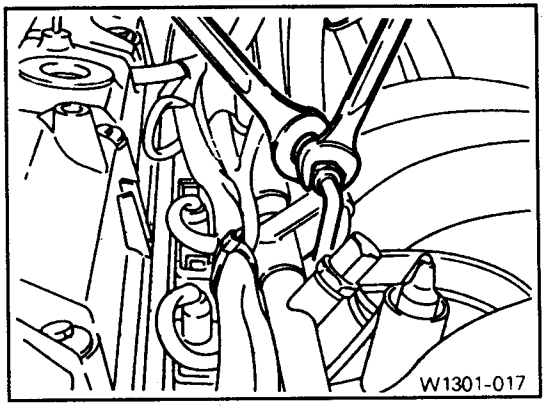


5) Remove the fuel return and feed line.

Installation

Tightening torque	21~25Nm

[Note] · **For removal, cover around parts not to be stained by fuel.**
· **In case of checking only injection valve, do not remove the fuel return and feed line.**

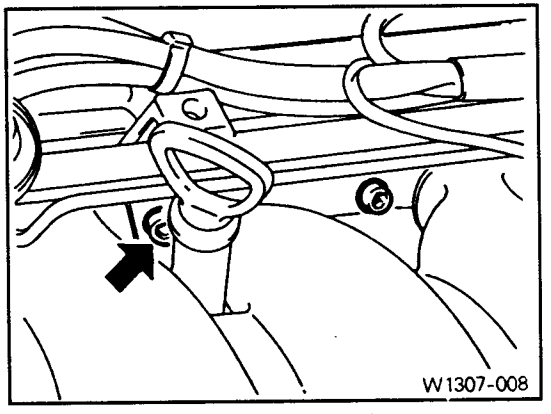


6) Remove the each injection valve connectors.

7) Remove the 3 bolts.

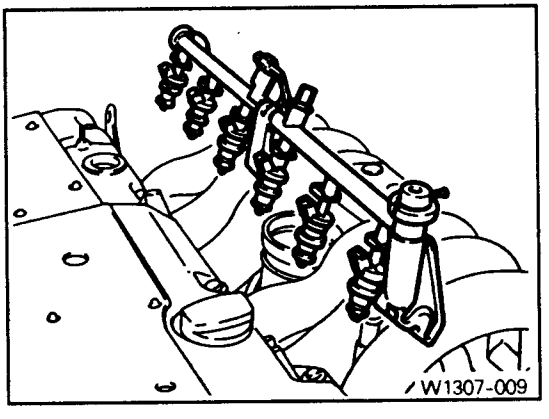
Installation

Tightening torque	25Nm



8) Carefully remove the injection valve and fuel distributor.

9) Installation is reverse order of the removal.

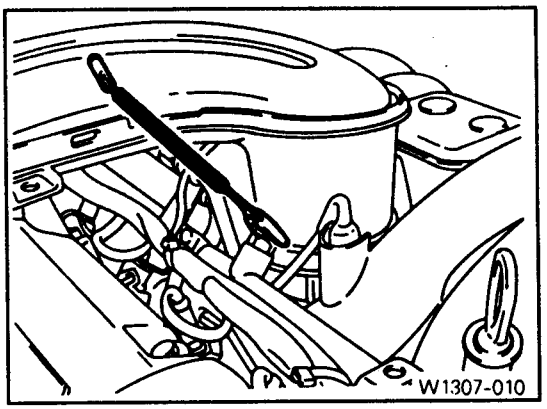


10) Start the engine and check the engine for fuel pressure and internal leaks (07~05).

Fuel pressure check

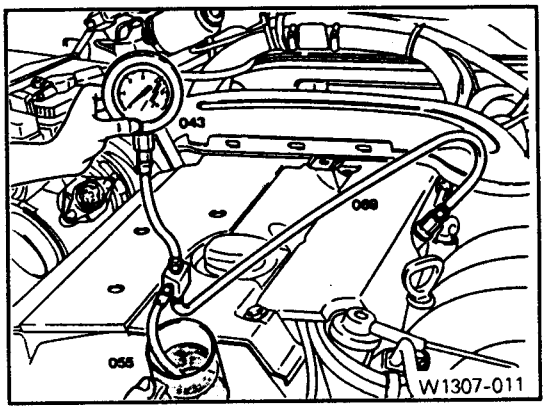
1) Position the ignition switch OFF.

2) Remove the fuel pressure check plug.



3) Connect the fuel pressure gauge to the fuel pressure check plug.

4) Start the engine and check the fuel pressure at idle.



Pressure regulator vacuum hose is connected	3.2~3.6bar
Pressure regulator vacuum hose is disconnected	3.7~4.2bar

5) If out of specification, replace the diaphragm pressure regulator.

Internal leakage test

1) Connect the fuel pressure gauge to the fuel pressure check plug.

2) Stop the engine approx. 30 minutes and then check the fuel pressure changes.

Pressure change	Possible Cause
Fuel pressure drops slowly.	• Fuel leaks in the injection valve. • Faulty pressure regulator and O-ring.
Fuel pressure drops rapidly.	• Faulty check valve in the fuel pump.

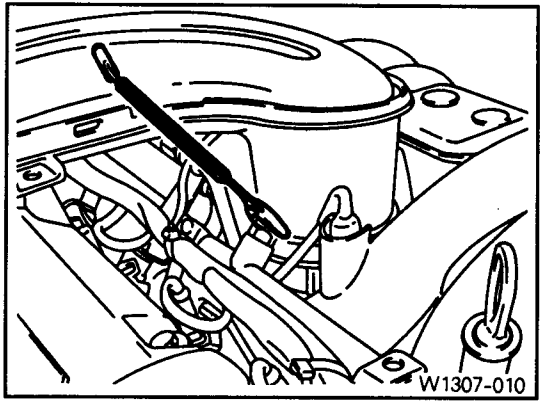
3) If there are no changes in fuel pressure, it is normal.

Fuel pressure releasing

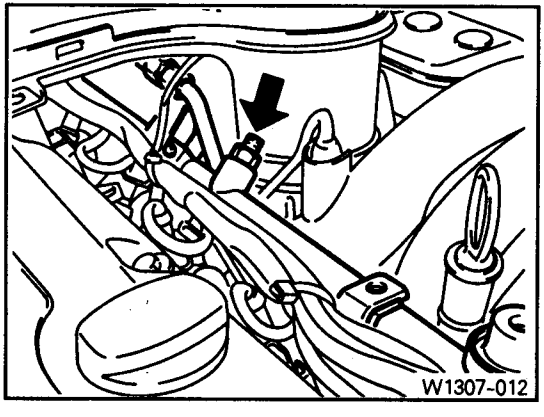
1) Remove the fuel pressure check plug.

Installation

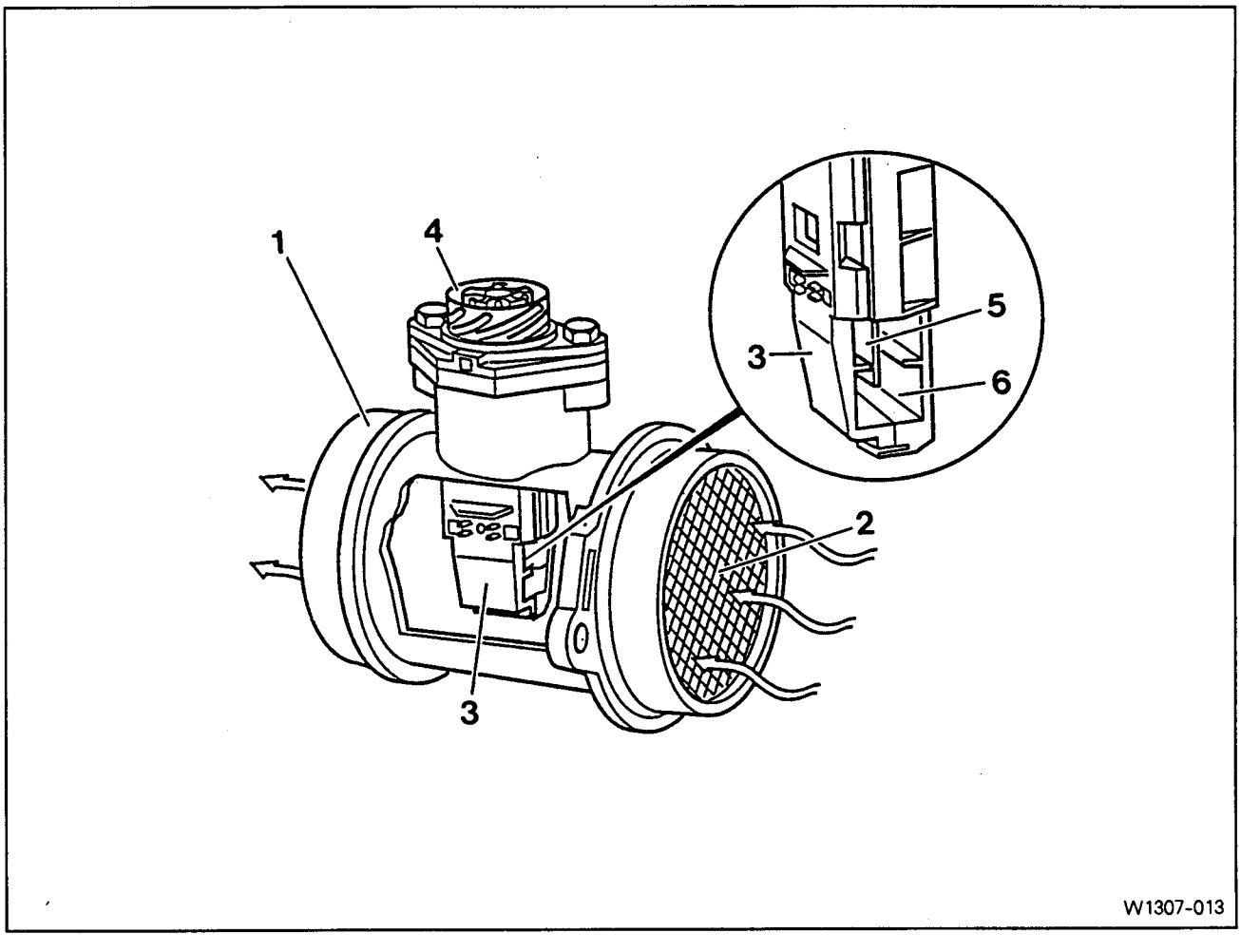
Tightening torque	21~25Nm



2) Using a proper tool, press the service valve and release the pressure in fuel system.
[Note] Protect from the fuel with rag.



3. Hot Film Air Mass (HFM) Sensor



1. Housing
2. Protective Screen
3. Electronic Housing
4. Connector
5. Hot Film Sensor
6. Measuring Channel

Removal · Installation

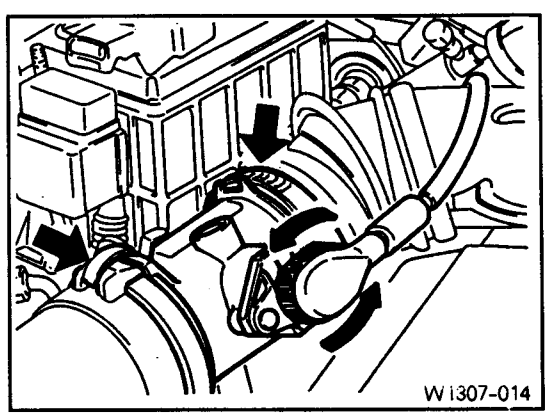
1) Turn the HFM sensor coupling in the direction of arrow and disconnect it.
   [Note] For installation, completely connect the HFM sensor coupling to the matching surface.

2) Pry up the clip with screwdriver.

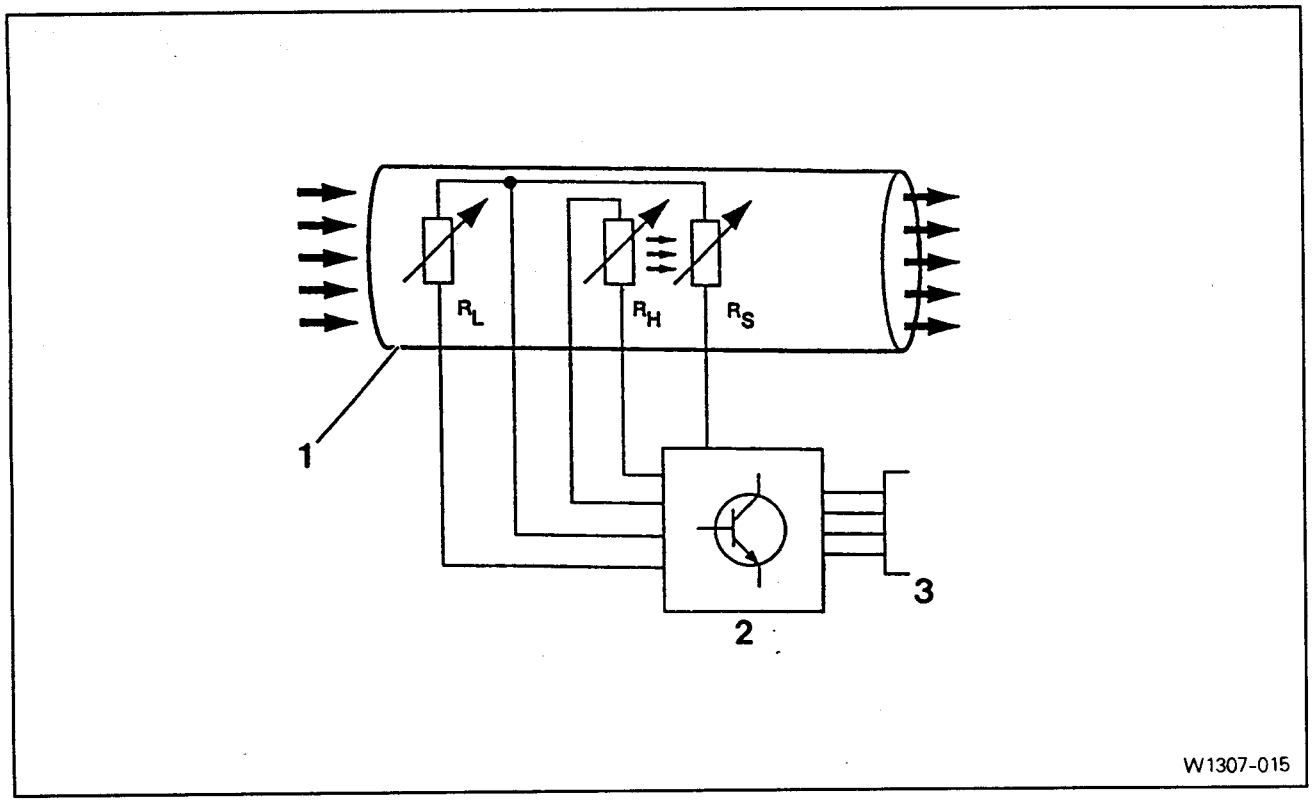
3) Loosen the 2 tensioning clamps.

4) Remove the HFM sensor.

5) Installation is reverse order of the removal.



Circuit diagram



1. Housing
2. Electronic
3. Connector

m : Intake Air Flow
RH : Heating Resistor
RL : Air Temperature Resistor
RS : Sensor Resistor

Inspection

1) Measure input voltage of HFM sensor by checking the ECU terminal 49 (+), and 71 (-) at engine idle.

Standard	0.8~1.1V

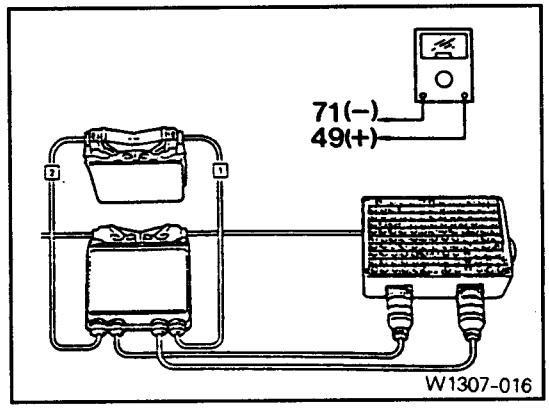
2) Position the ignition switch ON and measure input voltage of HFM sensor by checking the HFM sensor connector terminal 2 and 4.

Standard	11~14V

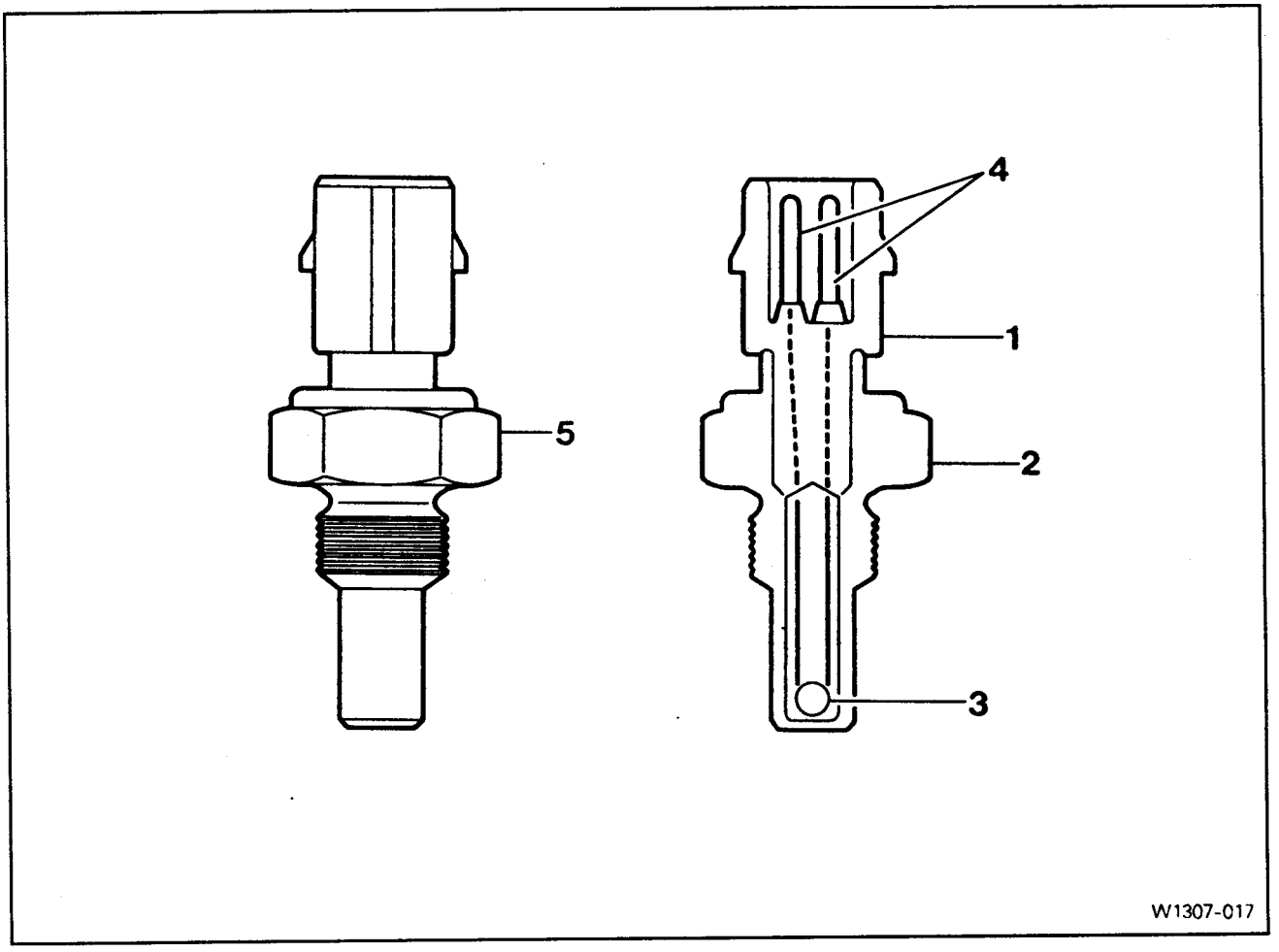
3) Disconnect the ECU coupling 2 and measure insulation resistance of HFM sensor by checking the ECU terminal 71 and 32.

Standard	< 20Ω

4) Check condition of air cleaner element.



4. Coolant Temperature Sensor

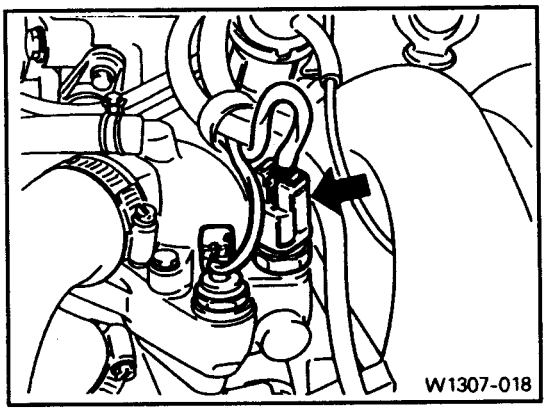


1. Resin Housing
2. Metal Housing
3. NTC Resistor
4. Connector
5. Coolant Temperature Sensor

Removal

1) Open the cap from the coolant subtank and release the pressure.

2) Disconnect the connector and remove the coolant temperature sensor.
[Note] For installation, replace the seal.



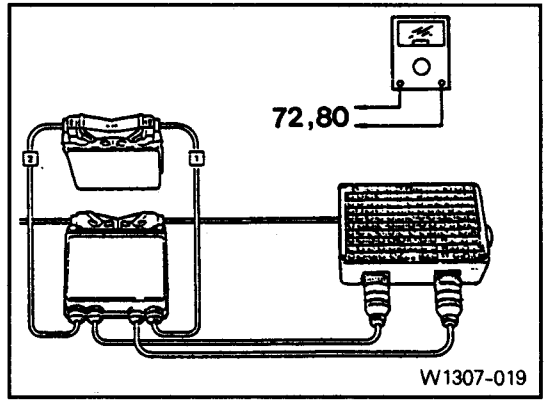
3) Start the engine and check each connections for leaks.

Inspection

1) Position the ignition switch ON and measure input voltage of the coolant by checking the ECU terminal 72 and 80.

Temperature (℃)	Voltage (V)	Temperature (℃)	Voltage (V)
20	3.5	60	1.9
30	3.1	70	1.5
40	2.7	80	1.2
50	2.3	90	1.0

* Tolerance : ±5%

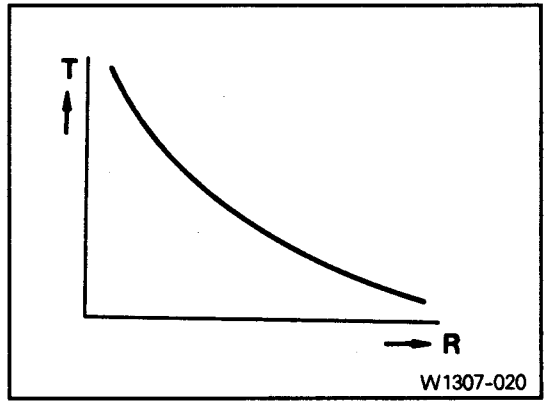


2) Position the ignition switch OFF and disconnect the ECU coupling 2. Measure resistance according to the temperature changes by checking the ECU terminal 72 and 80.

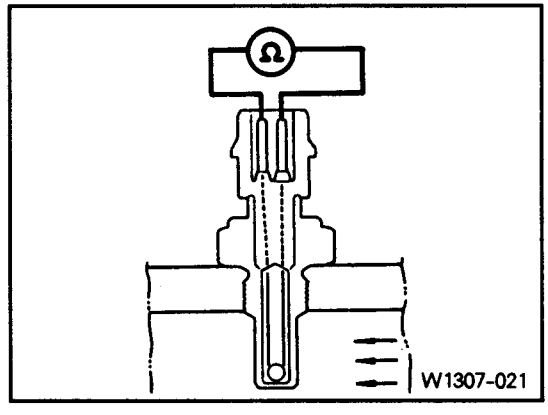
Temperature (℃)	Resistance (Ω)	Temperature (℃)	Resistance (Ω)
20	2500	60	600
30	1700	70	435
40	830	80	325
50	600	90	245

* Tolerance : ±5%

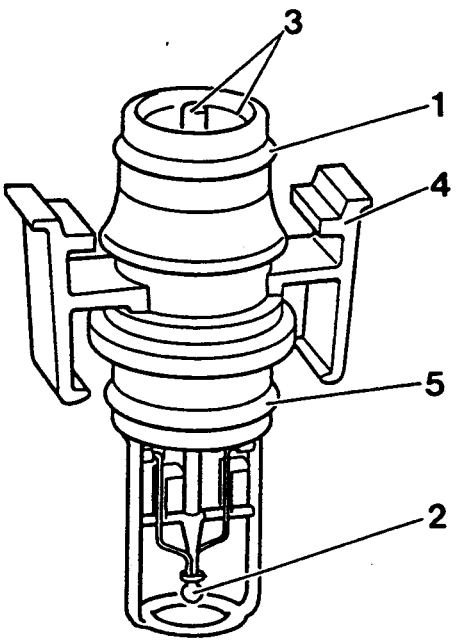
[Note] If out of standard, replace the wiring and coolant temperature sensor.



3) Disconnect the coolant temperature sensor connector and measure the resistance.
[Note] Refer to 2).



5. Intake Air Temperature Sensor



W1307-022

1. Case
2. NTC Resistor
3. Connector
4. Fixing Clamp
5. Seal Ring----------Replace

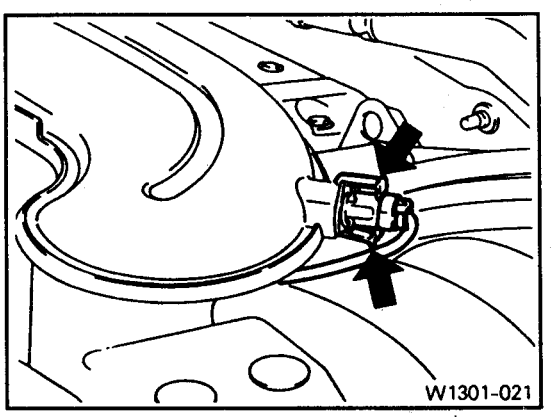
* NTC resistor : A resistor with negative temperature coefficient. It reduces its resistance at increasing temperature.

Removal · Installation

· Intake air temperature sensor is located on the air cleaner cross pipe. It is a kind of NTC resistor and measures the intake air temperature in the intake air flow. The ECU controls the volume of fuel injection according to the intake air temperature sensor signal.

1) Remove the intake air temperature sensor by pressing the coupling.
[Note] For installation, completely press the coupling until it makes a sound.

2) Check the seal ring and replace if necessary.



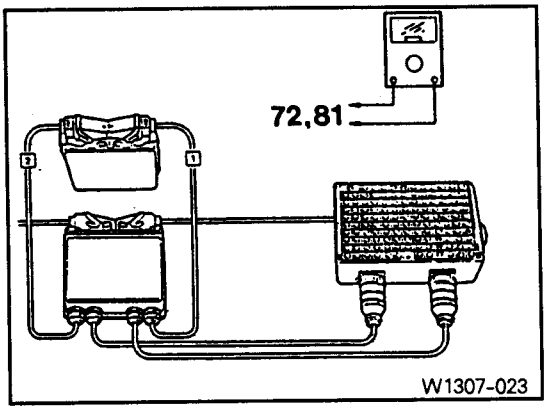
W1301-021

Inspection

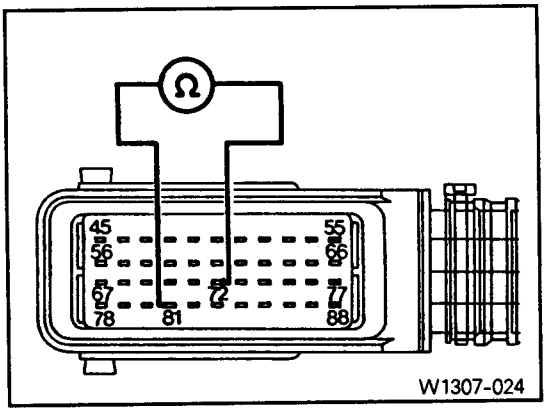
1) Position the ignition switch ON and measure input voltage of the intake air temperature sensor by checking the ECU terminal 72 and 81.

Temperature (℃)	Voltage (V)	Temperature (℃)	Voltage (V)
20	3.5	60	1.9
30	3.1	70	1.5
40	2.7	80	1.2
50	2.3	90	1.0

* Tolerance : ±5%



2) Position the ignition switch OFF and disconnect the ECU coupling 2. Measure resistance by checking the ECU terminal 72 and 81.
[Note] Refer to 3).

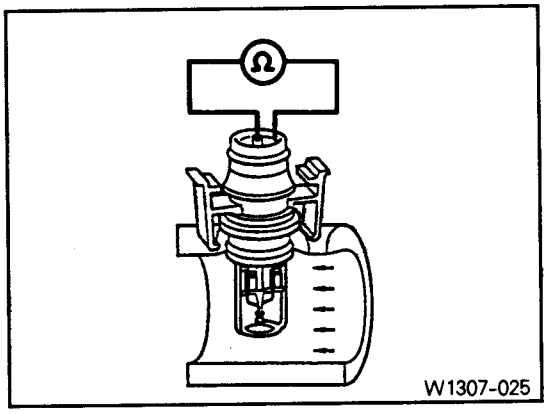


3) Disconnect the intake air temperature sensor connector and measure resistance.

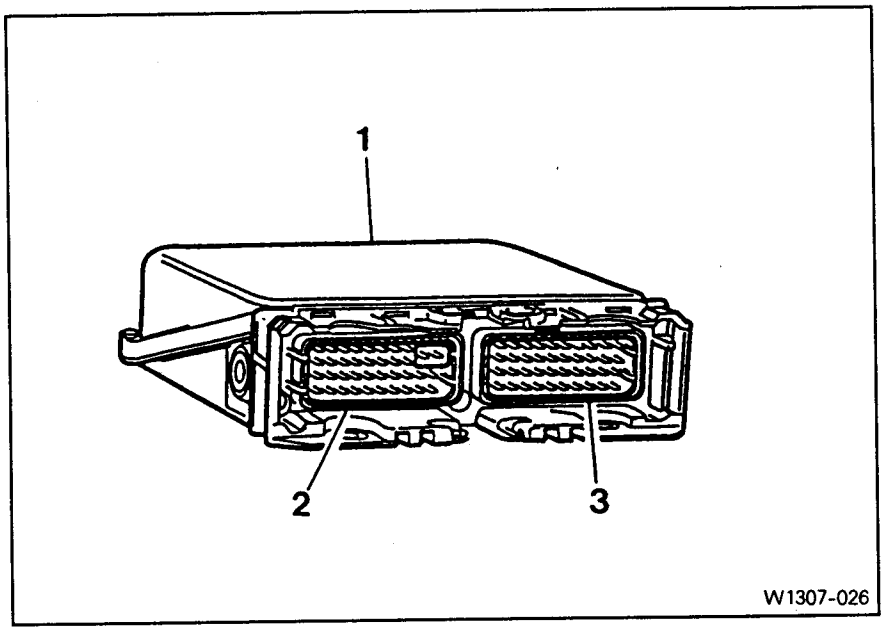
Temperature (℃)	Resistance (Ω)	Temperature (℃)	Resistance (Ω)
10	9670	50	1760
20	6060	60	1220
30	3900	70	860
40	2600	80	620

* Tolerance : ±5%

[Note] If out of standard, replace wiring and intake air temperature sensor.



6. ECU



1. ECU
2. Coupling 1
3. Coupling 2

Function

1) The ECU controls the following output signals according to the each input signals.
   - Fuel injection system.
   - Idle control.
   - Ignition system.

2) The ECU detects engine malfunctions under the following conditions and stores fault memory.
   - Faults happening continuously.
   - Faults continue more than 3 seconds.
   - Faults happening more than 5 times during a trip.

Removal · Installation

1) Position the ignition switch OFF.

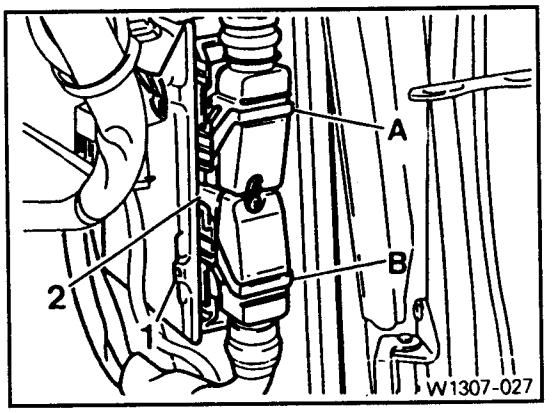
2) Disconnect the battery negative terminal (-).

3) Pry up the coupling A and B and remove the couplings.

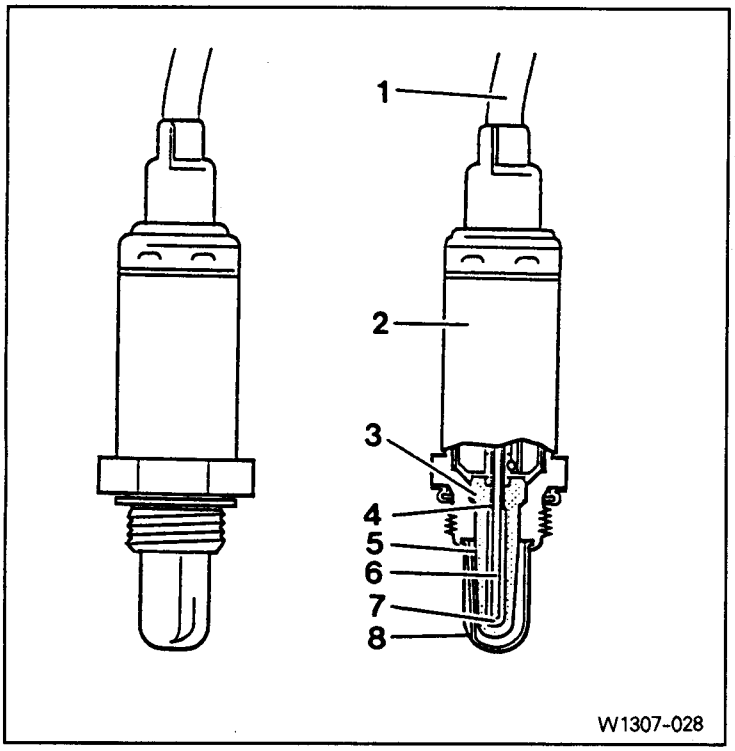
4) Remove the ECU bolt (1).

5) Pull out the ECU (2) from the case.

6) Installation is reverse order of the removal.



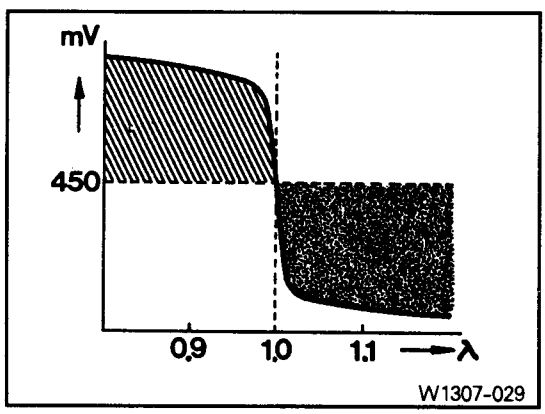
7. Oxygen Sensor



1. Wire
2. Oxygen Sensor Housing
3. Sensor Ceramic
4. Electrode (Inside)
5. Electrode (Outside)
6. Heating Coil
7. Open Space
8. Protective Tube

Removal · Installation

· The oxygen sensor measures the oxygen content still present in the exhaust gas. It generates a voltage depending on the percentage of oxygen and it signals to the ECU to control the air mixture ratio.
Rich mixture (<1) : approx. < 450mV
Lean mixture (>1) : approx. > 450mV

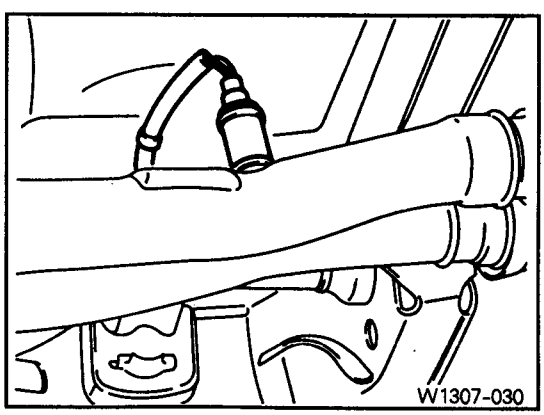


1) Disconnect the oxygen sensor wire.

2) Remove the oxygen sensor with special tool.

Tightening torque	50~60Nm

[Note] For installation, apply lubricant.
(Lubricant 000 909 76 51)



Inspection

1) With engine idling (normal operating temperature), measure oxygen sensor input voltage by checking the ECU terminal 34 and 35.

Standard	0~1V

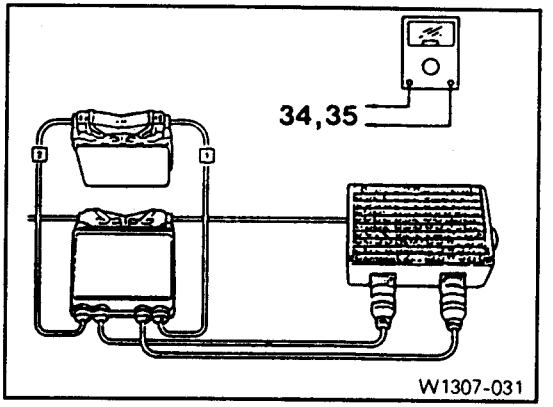
2) With engine idling, measure oxygen sensor heater input voltage by checking the ECU terminal 30 and 32.

Standard	11~14V

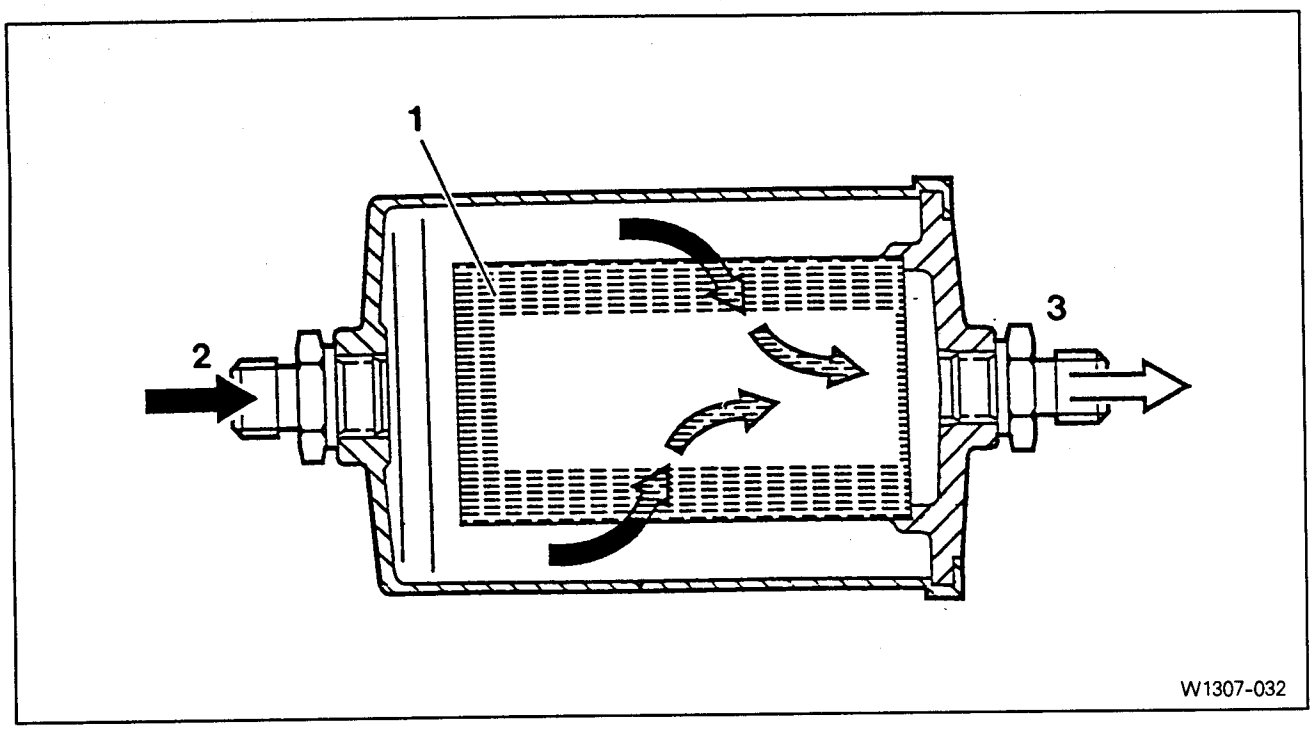
3) Position the ignition switch ON and measure current consumption by checking the ECU terminal 27 and 30.

Standard	1.1~3.4V

[Note] If out of standard, replace the oxygen sensor and check the electric wire.

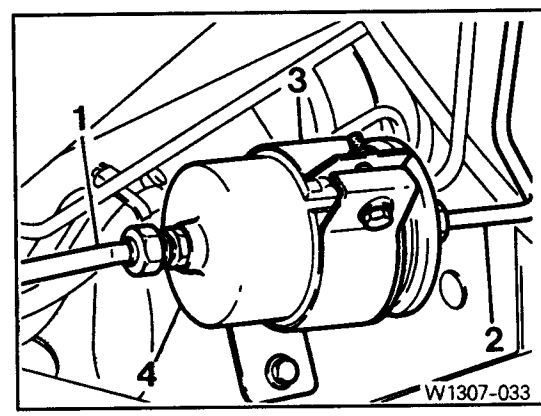


8. Fuel Filter



1. Fuel Filter
2. Inlet Line
3. Outlet Line

Removal · Installation



1) Open the fuel tank cap and release the fuel tank pressure.

2) Remove the inlet line (1).

3) Remove the outlet line (2).

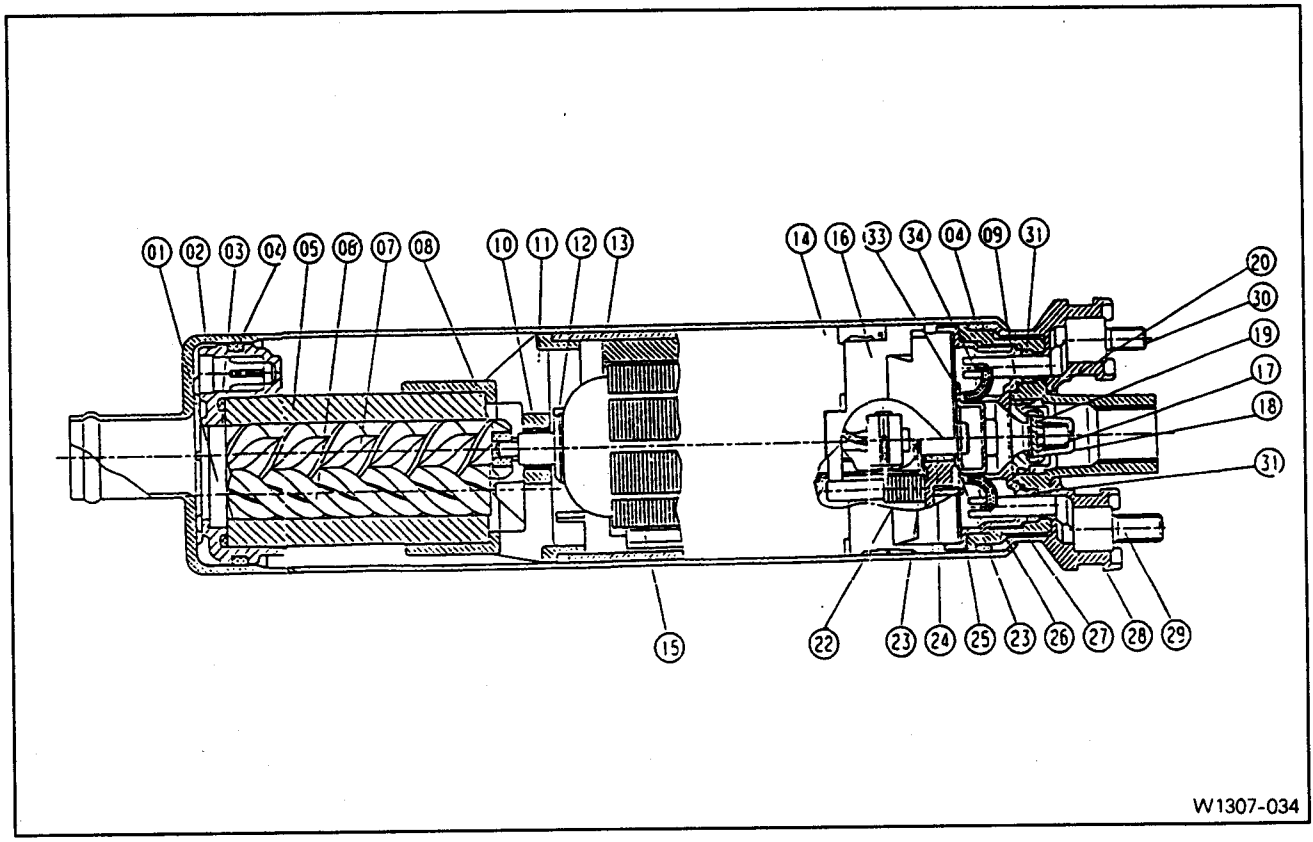
4) Remove the mounting bracket bolt (3) and then remove the fuel filter (4).
   [Note] For installation, place a plastic sleeve to prevent a rust between the fuel filter and bracket.

5) Installation is reverse order of the removal.

6) Start engine and check the each connections for leaks.

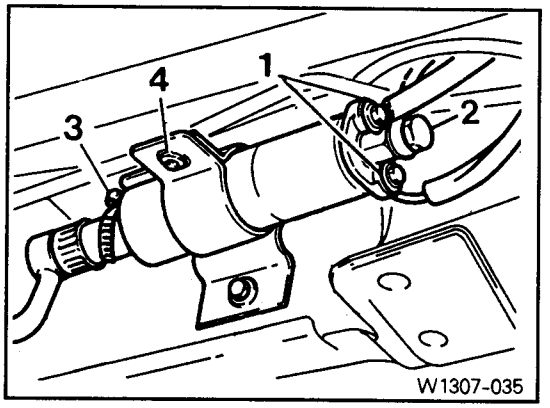
9. Fuel Pump

Sectional view



1. Fitting Spring
2. Valve Lead
3. O-Ring Seal
4. O-Ring Seal
5. Housing
6. Running Spindle
7. Drive Spindle
8. Coupling
9. O-Ring Seal
10. Bush
11. Bearing
12. End Plate
13. Bushing
14. Rear Metal Seat
15. Spring
16. Shield
17. Pressure Spring
18. Valve Body
19. Valve Lead
20. Valve Seat
22. Bush Spring
23. Separator Plate
24. Bush
25. Cover
26. Retaining Washer
27. Cover
28. Adapter
29. Contact
30. Contact
31. O-Ring Seal
32. Plug
33. Cap
34. Insulation Hose

Removal · Installation



1) Disconnect the battery negative terminal.

2) Disconnect the electric wire (1).

3) Remove the bolt (2) and separate the pressure line.

Installation

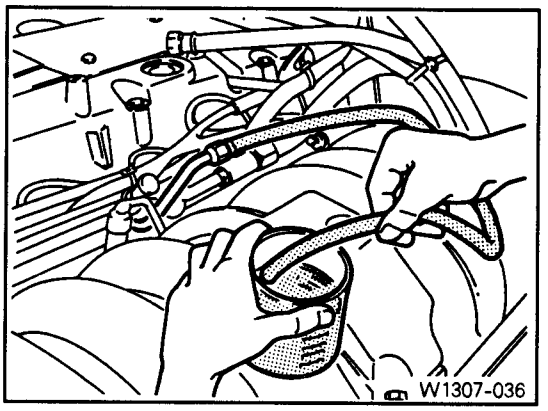
Tightening torque	26Nm

4) Loosen the clamp (3) and separate the inlet line.

5) Remove the fuel pump mounting bracket bolt (4) and then remove the fuel pump.

6) Installation is reverse order of the removal.

Inspection



- Fuel pump delivery measurement.

1) Disconnect the fuel return pipe and connect a return hose.

2) Prepare a measuring beaker.

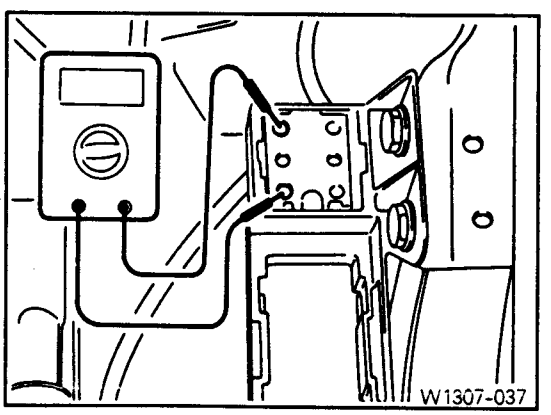
3) Position the ignition switch ON.

4) Bridge the ECU terminal no. 29 and no. 39.

5) Measure the fuel pump delivery.

Max. 30 seconds	Delivery : 1 ℓ

[Note] If out of standard, check the fuel filter and each fuel line.



- Fuel pump current consumption measurement.

1) Remove the fuel pump relay and position the ignition switch ON.

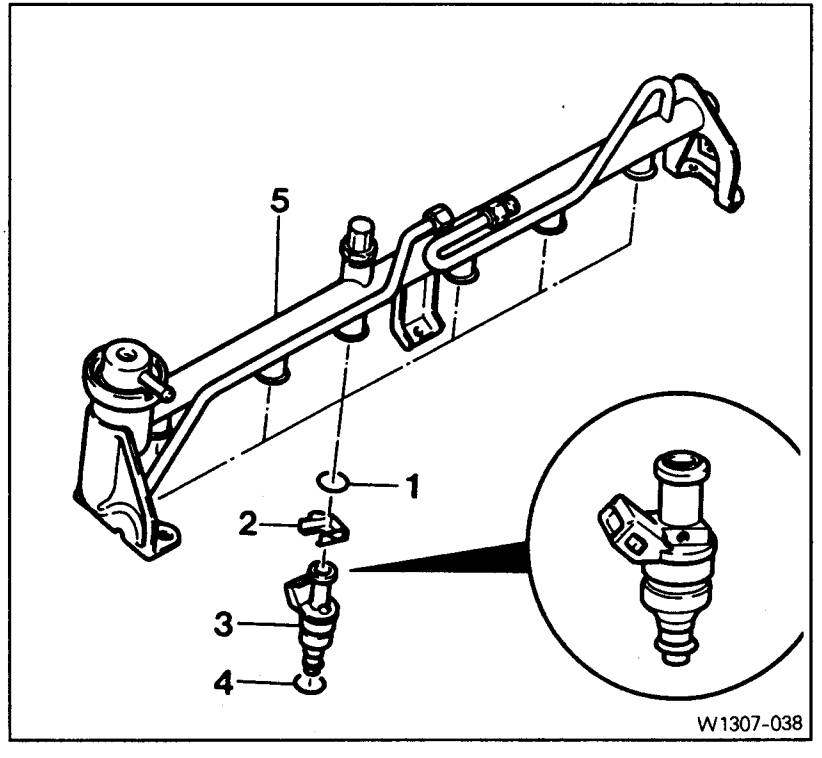
2) Using a multimeter, check fuel pump relay terminal 1 and 3.

Standard	4~7A

[Note] If over 7A, replace the fuel pump relay.

10. Injection Valve

Preceding work : Removal of fuel distributor and injection valve (07-03)



1. O-Ring----------Replace
2. Anti-twist Lock
3. Injection Valve
4. O-Ring----------Replace
5. Fuel Distributor

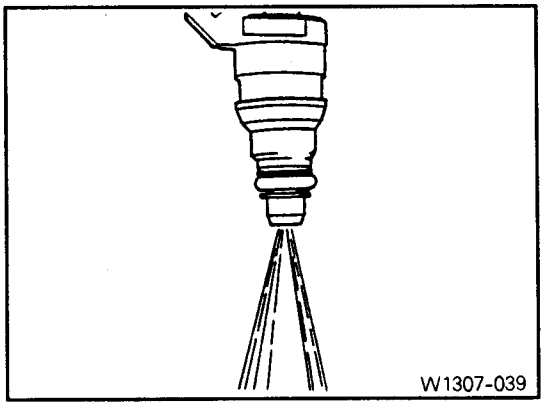
Removal · Installation

1) Remove the O-ring. Check for damage and replace if necessary.

2) Remove the anti-twist lock from injection valve.
[Note] For installation, exactly seat the anti-twist lock into the square groove in injection valve.

3) Separate the injection valve from fuel distributor.

Inspection



- Injection valve operation and spray pattern check.

1) Connect the contact box to the ECU.

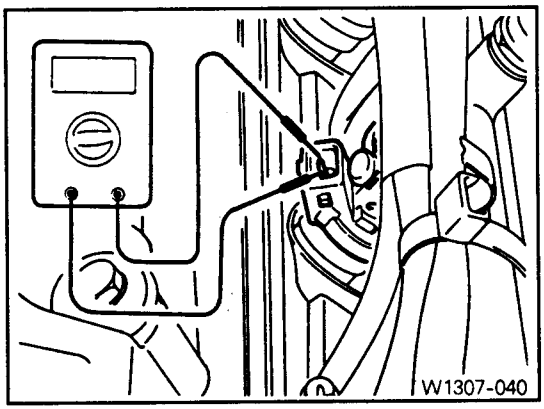
2) Prepare a measuring beaker.

3) Position the ignition switch ON.

4) Bridge the ECU terminal 29 and 39.

5) Connect a shop-made electric cable to the injection valve connectors and connect the shop-made electric cable to the contact box pin 32 and 39.

6) Check injection valve spray pattern.
[Note] If spray pattern is abnormal or fuel is not injected, replace the injection valve.



- Injection valve resistance measurement.

1) Disconnect the injection valve connector.

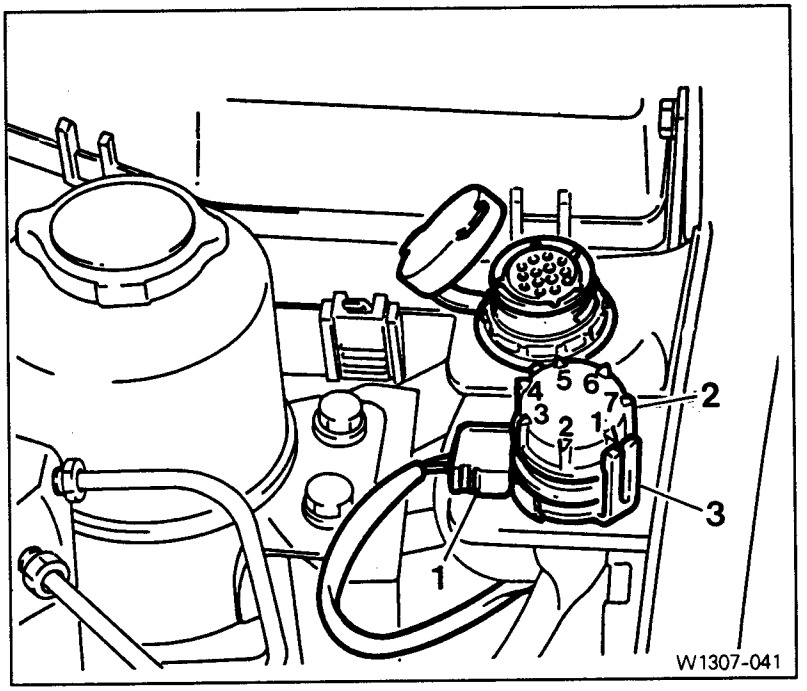
2) Measure injection valve coil resistance by using a tester.

Standard	15~17Ω

[Note] If out of standard, check connector connection and ECU and injection valve wiring connection.

11. HFM Resistance Trimming Plug

(Octane number selection)



1. Connector
2. HFM Resistance Trimming Plug
3. HFM Resistance Trimming Plug Lock

Caution

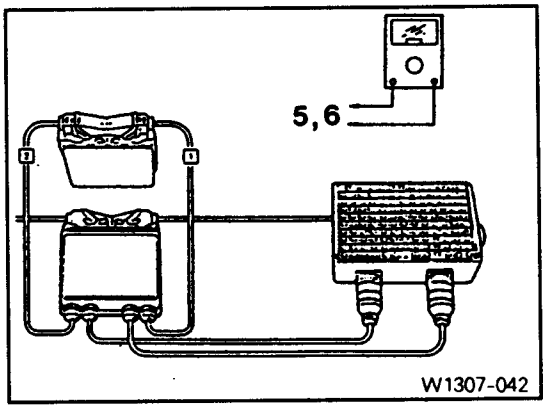
1) All vehicles are equipped with an HFM resistance trimming plug for adaptation of the various maps. A total of seven adjustment stages are possible. The HFM resistance trimming plug affects ignition and injection system.

2) Ensure that the '1' on the plug (1) should align with the plug lock ('M' mark on the upper edge).

Inspection

1) Position the ignition switch ON and measure input voltage of HFM plug by checking the ECU terminal 5 and 6.

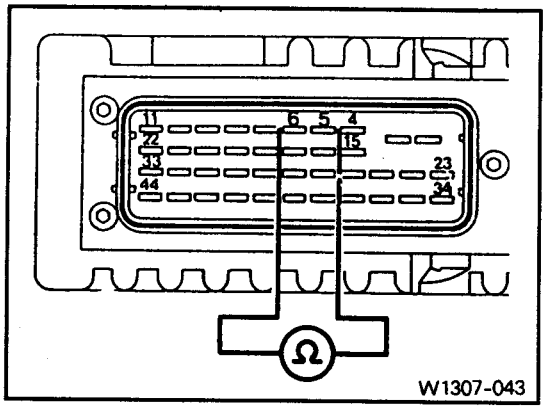
Plug position	Voltage (V)	Plug position	Voltage (V)
1	0.9~1.6	5	3.7~4.1
2	1.6~2.4	6	4.1~4.4
3	2.5~3.1	7	4.4~4.7
4	3.1~3.7		



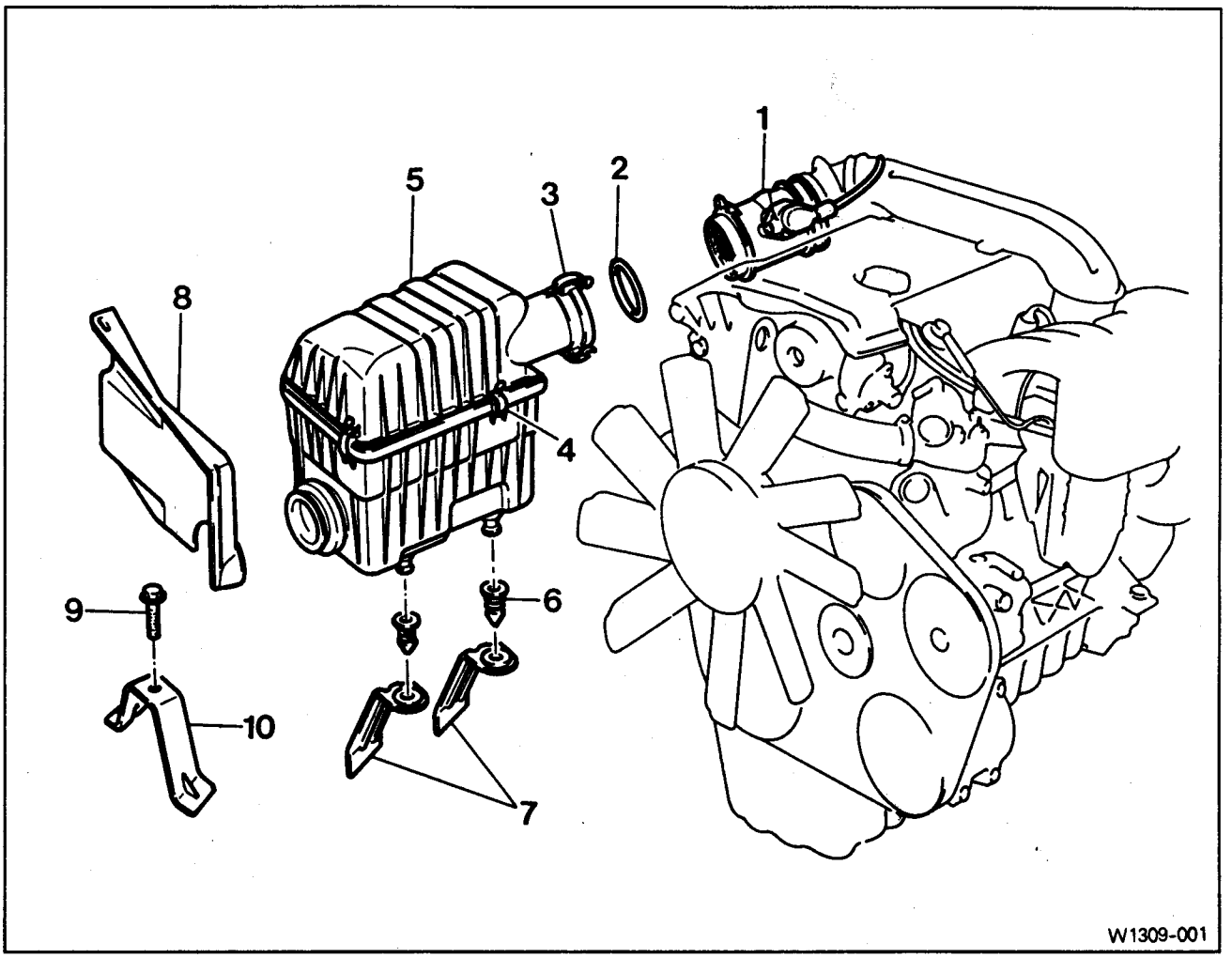
2) Position the ignition switch OFF and disconnect the ECU coupling 1. Measure resistance by checking the ECU terminal 5 and 6.

Plug position	Resistance (Ω)	Plug position	Resistance (Ω)
1	250	5	2610
2	490	6	4420
3	950	7	8660
4	1620		

* Tolerance : ±5%



1. Removal and Installation of Air Cleaner



1. HFM Sensor
2. O-Ring----------Replace
3. Clamp
4. Clamp
5. Air Cleaner
6. Insulator
7. Bracket
8. Air Intake Shield Upper Cover
9. Bolt
10. Bracket

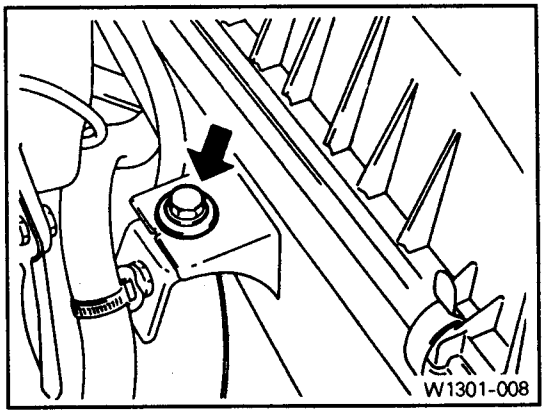
Removal · Installation

1) Pry up the clamps (3) and remove the HFM sensor (1) and air cleaner.

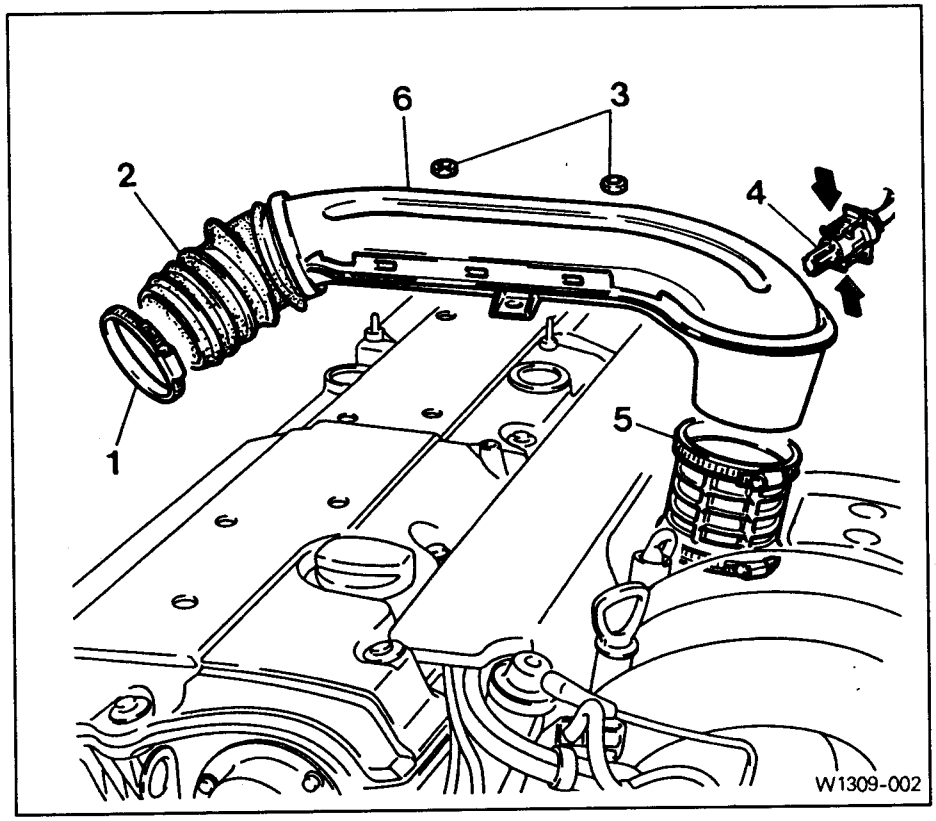
2) Remove the air cleaner mounting bolt (9).

3) Remove the air intake shield upper cover (8) and then remove the air cleaner (5) from insulator (6).
   [Note] For installation, exactly seat the air cleaner into the insulator.

4) Installation is reverse order of the removal.



2. Removal and Installation of Air Cleaner Cross Pipe

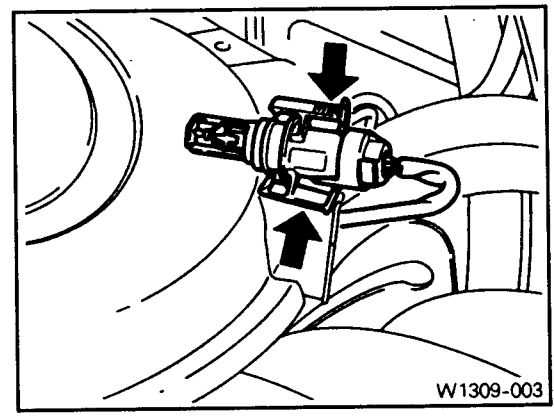


1. Clip
2. Hose
3. Nut
4. Intake Air Temperature Sensor
5. Clip
6. Air Cleaner Cross Pipe

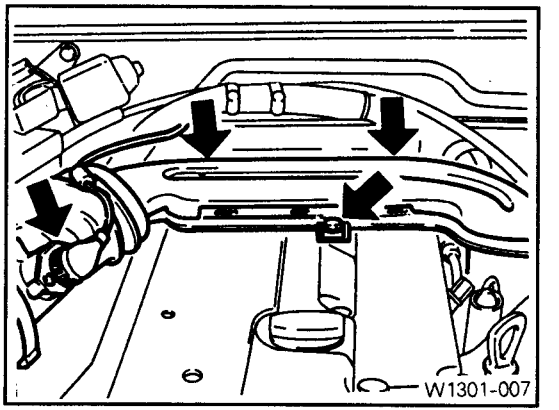
Removal · Installation

1) Loosen the clip (1) and remove it from the HFM sensor .

2) Press down the intake air temperature sensor (4) ends and remove it.
[Note] For installation, completely insert the intake air temperature sensor to make a sound 'click'.

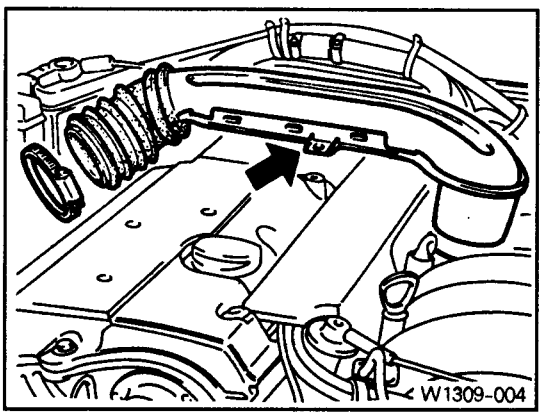


3) Remove the nuts (3).



4) Remove the clip (5) .

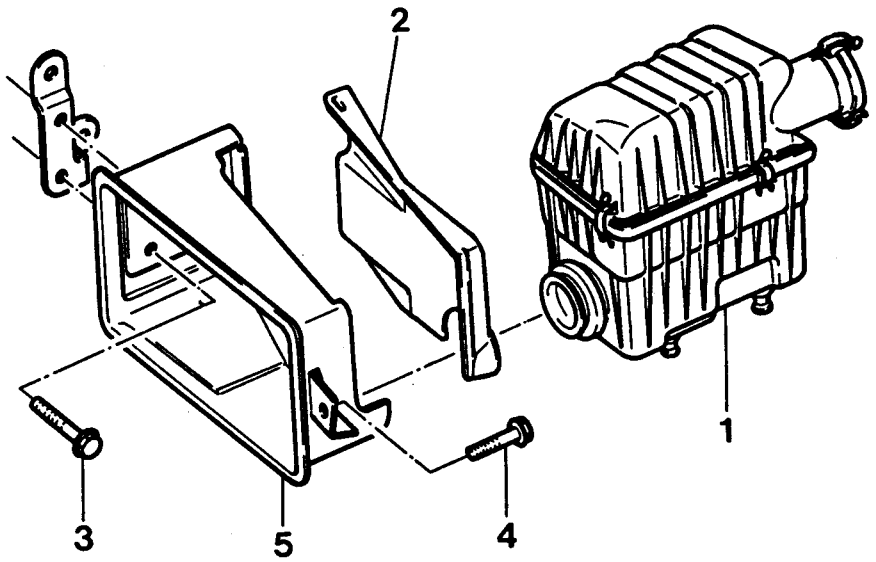
5) Carefully remove the air cleaner cross pipe (6).
[Note] For installation, exactly seat the pin of air cleaner cross pipe onto the crankcase ventilation rubber mount.



6) Installation is reverse order of the removal.

3. Removal and Installation of Air Intake Shield

Preceding work : Removal of air cleaner (09-01)



W1309-005

1. Air Cleaner
2. Air Intake Shield Upper Cover
3. Blot
4. Bolt
5. Air Intake Shield

Removal · Installation

1) Remove the upper cover (2) from the air intake shield (5) upper pins.

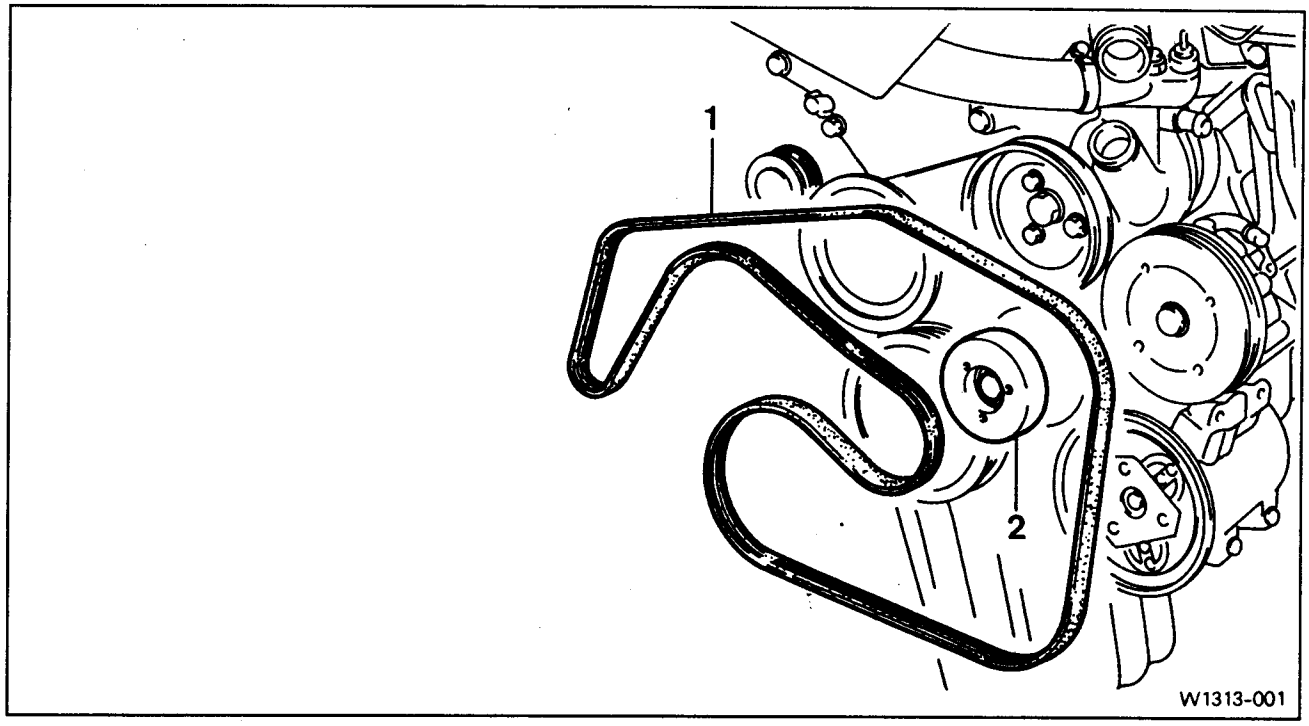
2) Remove the 2 bolts (3, 4).

3) Remove the air intake shield (5).

4) Installation is reverse order of the removal.

1. Removal and Installation of Poly V-Belt

Preceding work : Removal of cooling fan (20-08)



1. Poly V-Belt
2. Belt Tensioning Pulley

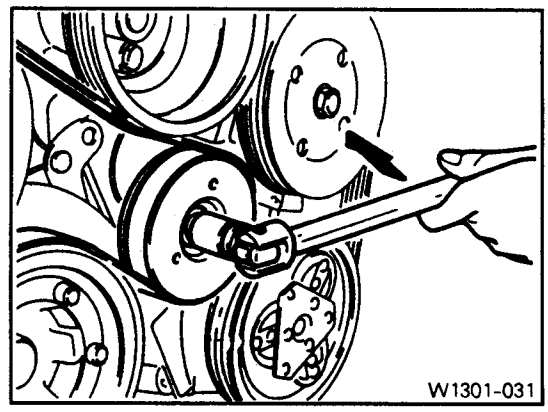
Removal · Installation

1) Turn the belt tensioning pulley nut counterclockwise and release the belt tension.

2) Remove the poly V-belt.

[Note] · **Check the belt for damage and tensioning pulley bearing point for wear and replace them if necessary.**

· **For installation, install the belt onto the tensioning pulley and then turn the nut clockwise as specified torque.**



Installation

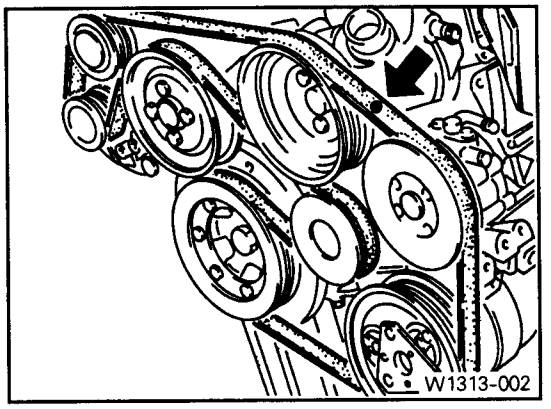
Tightening torque	41~49Nm

3) Installation is reverse order of the removal.

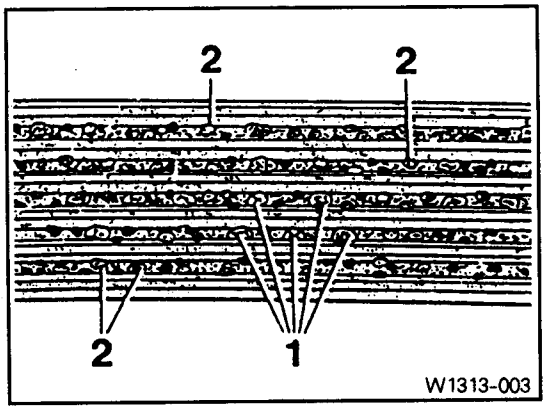
2. Poly V-Belt Inspection

1) For easy identification, make marks on the belt with chalk.

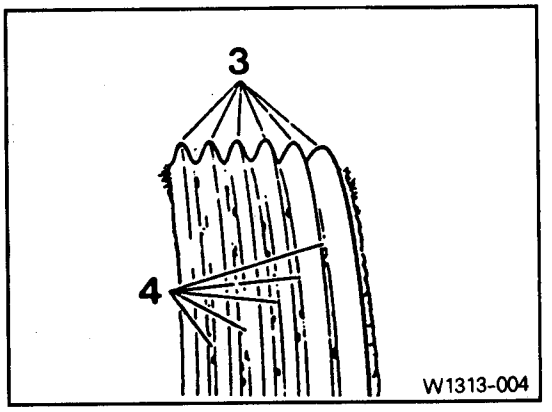
2) Rotate the engine and check the belt for damage.
[Note] If following damage patterns are identified, replace the belt.



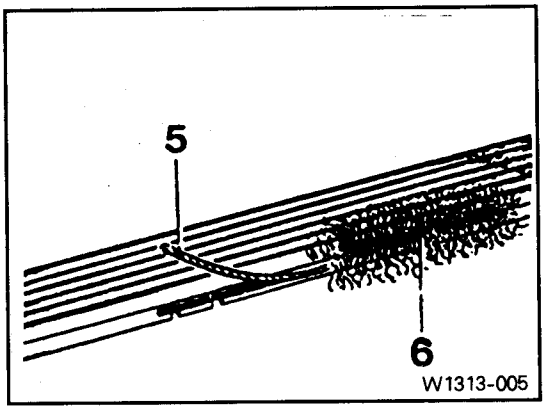
1. Rubber lumps in base of rib.
2. Dirt or grit embedded.



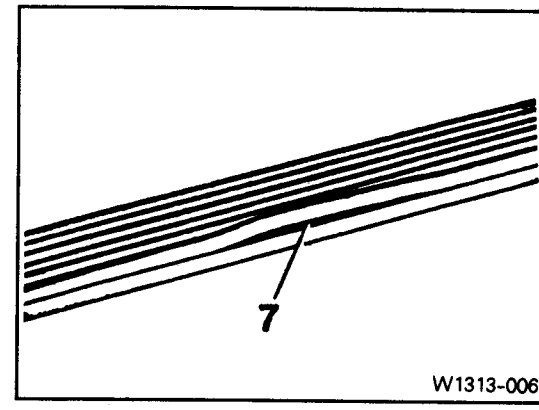
3. Wear to flanks, ribs are pointed.
4. Cord visible in base of rib.



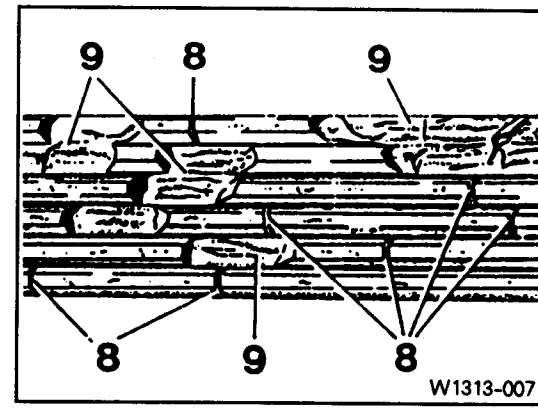
5. Cord torn out at the side.
6. Fraying of the outer cords.



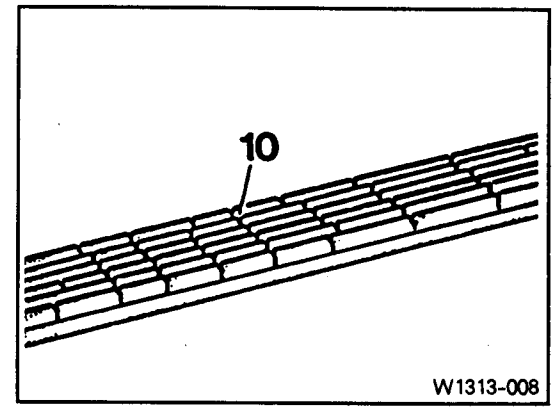
7. Rib separated from base of belt.



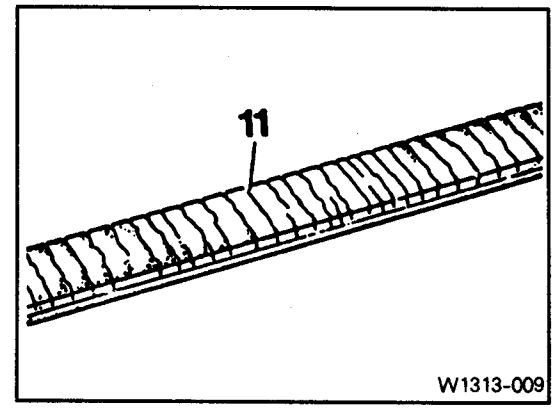
8. Splitting across the ribs.
9. Sections of rib torn off.



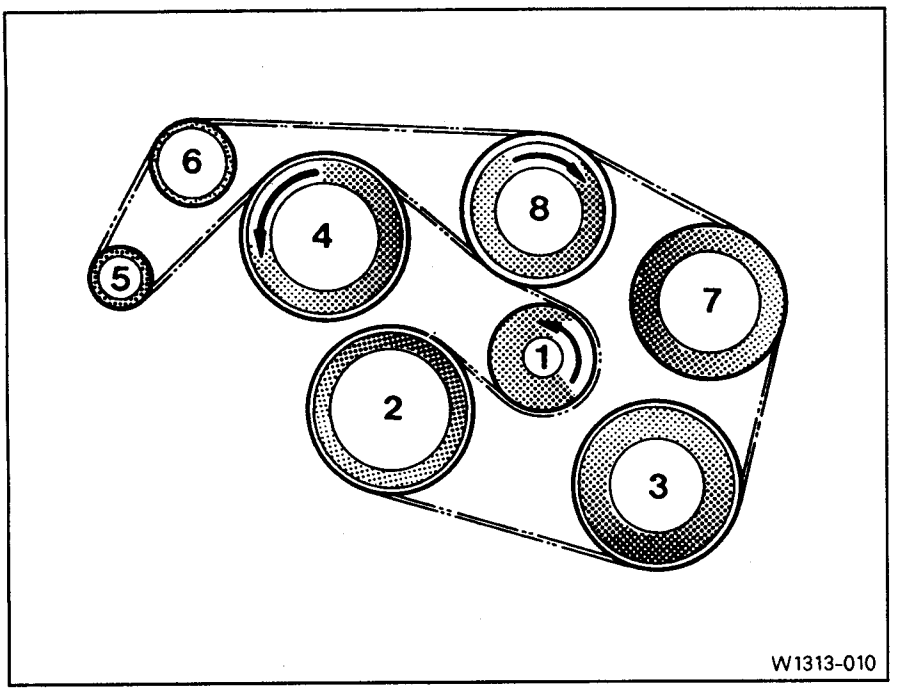
0. Splitting across the ribs.



1. Splitting across the back of the belt.



3. Poly V-Belt Arrangement

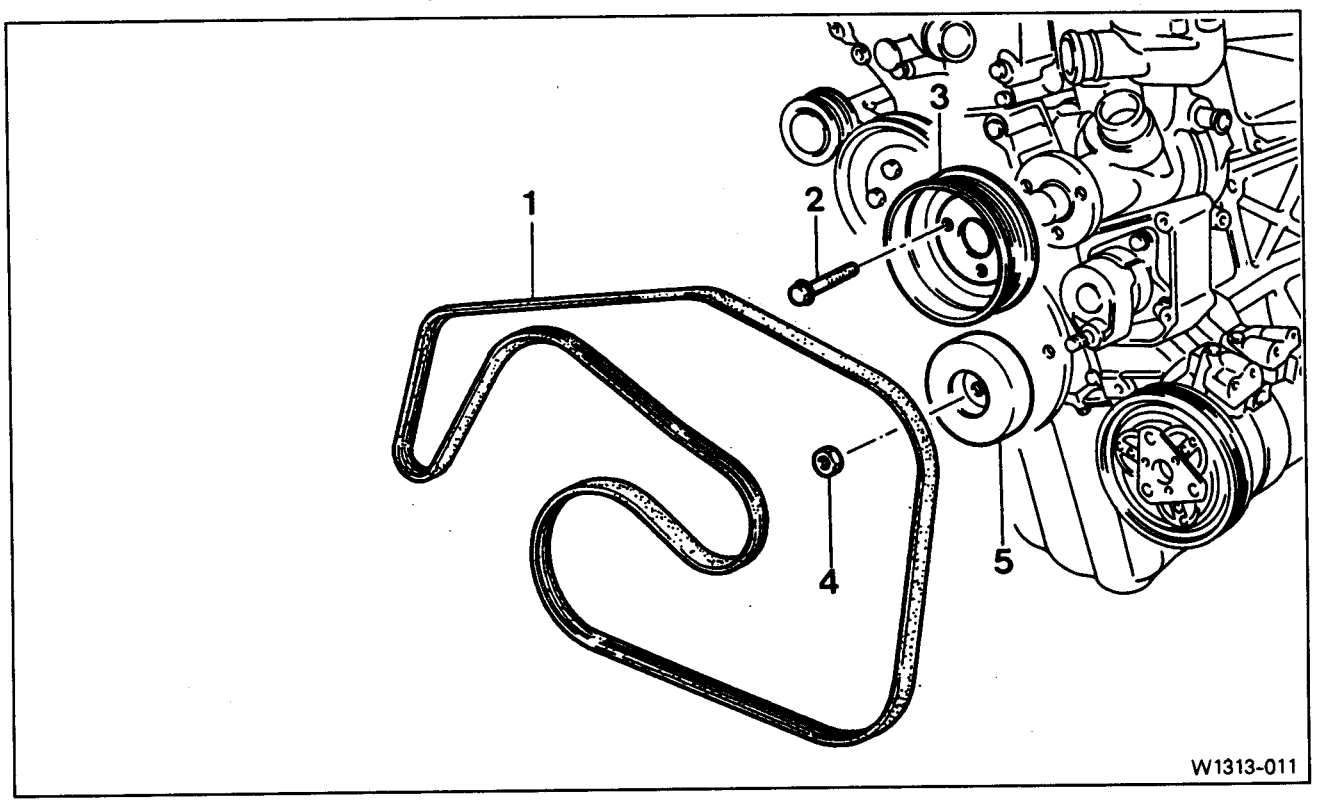


Length : 2,245mm

1. Belt Tensioning Pulley
2. Crankshaft
3. Air-Conditioner Compressor
4 Cooling Fan
5. Alternator
6. Idler
7. Power Steering Pump
8. Water Pump

4. Removal and Installation of Tensioning Device.

Preceding work : Removal of cooling fan shroud (20-09)
Removal of cooling fan (20-08)



1. Poly V-Belt
2. Bolt----------32Nm
3. Water Pump Pulley
4. Nut----------45Nm
5. Tensioning Pulley

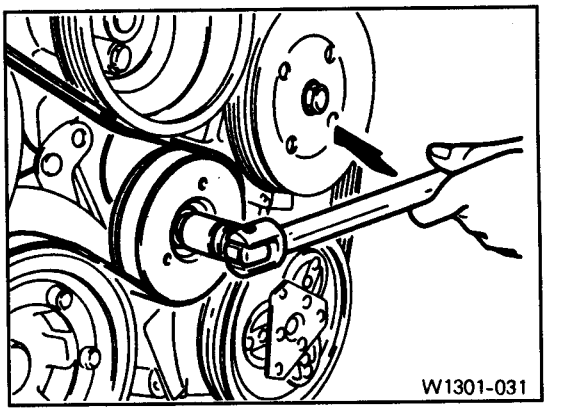
Removal · Installation

1) Remove the poly V-belt (13-01).

2) Remove the tensioning pulley.

Installation

Tightening torque	41~49Nm



3) Remove the water pump pulley.

Installation

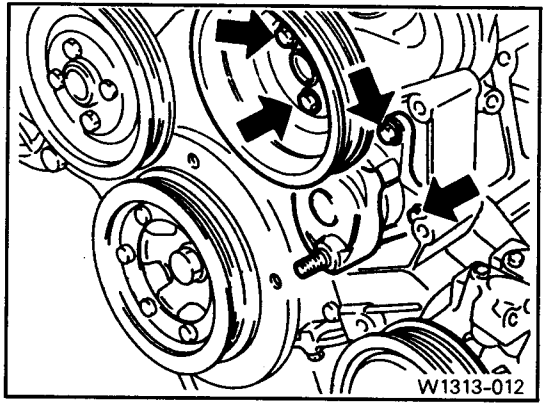
Tightening torque	32Nm

4) Remove the 3 tensioning device bolts and then remove the tensioning device.

Installation

Tightening torque	23Nm

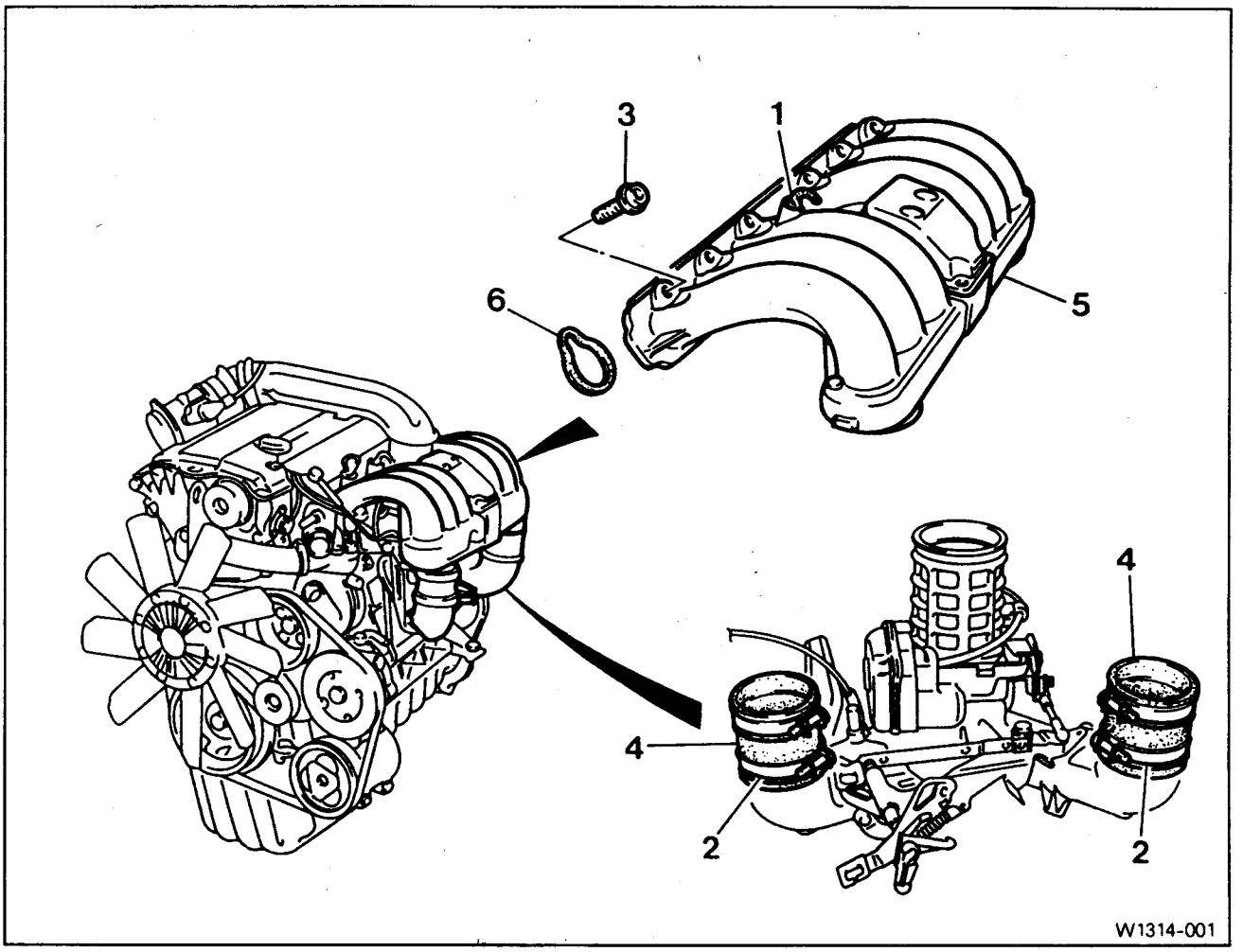
5) Installation is reverse order of the removal.



1. Removal and Installation of Intake Manifold

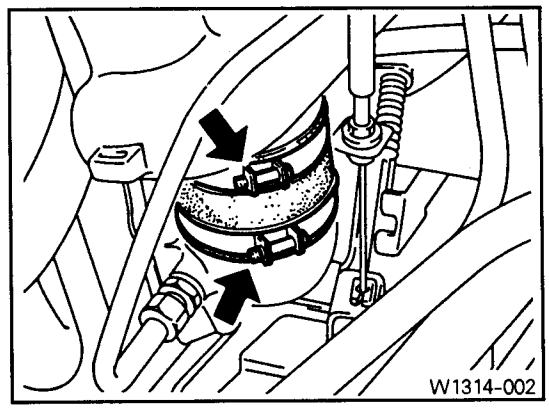
A. Upper intake manifold

Preceding work : Removal of fuel distributor and injection valve (07-02)



1. Vacuum Hose
2. Clip
3. Bolt----------25Nm
4. Rubber Seal
5. Upper Intake Manifold
6. Gasket----------Replace

Removal · Installation



1) Disconnect the vacuum hose (1).

2) Loosen the clip (2).

3) Remove the bolts (3) and then remove the upper intake manifold (5).
[Note] Check the gasket and replace if necessary.

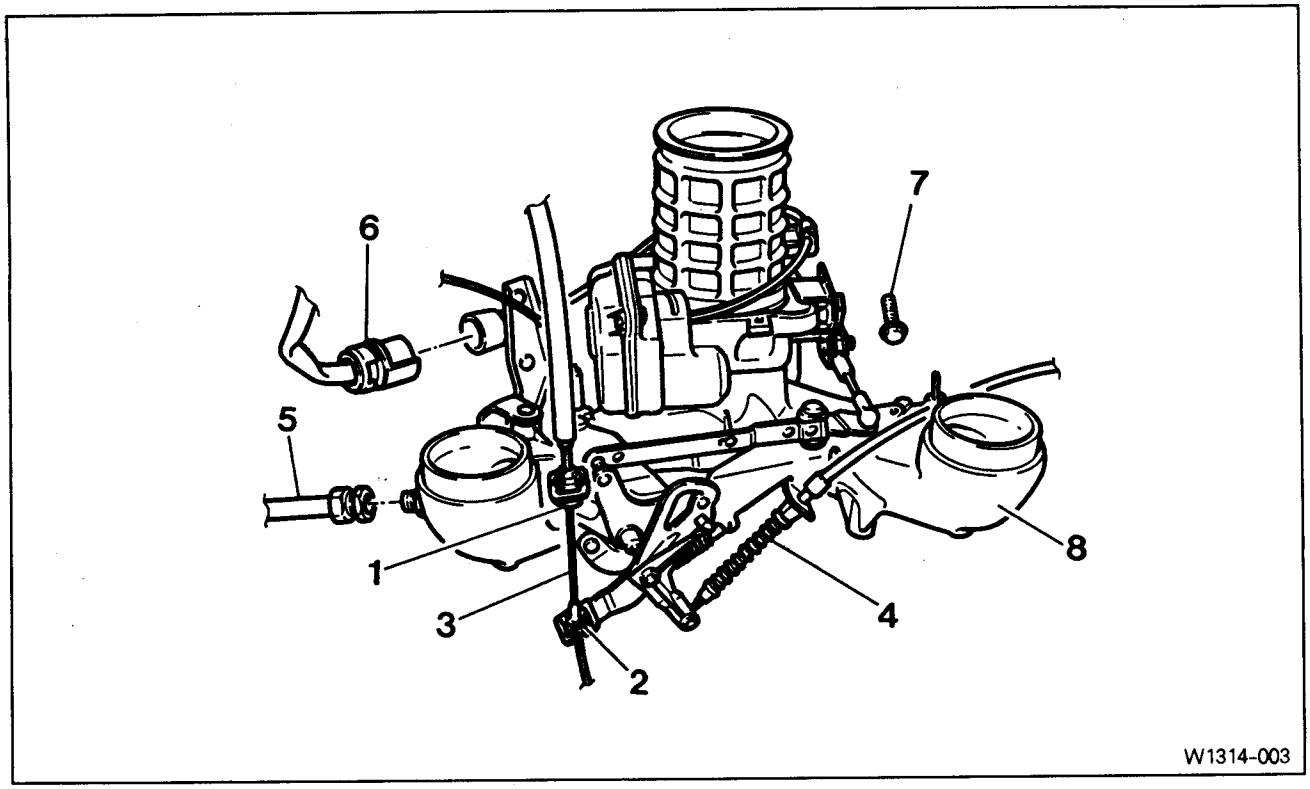
Installation

Tightening torque	25Nm

4) Installation is reverse order of the removal.

B. Lower intake manifold

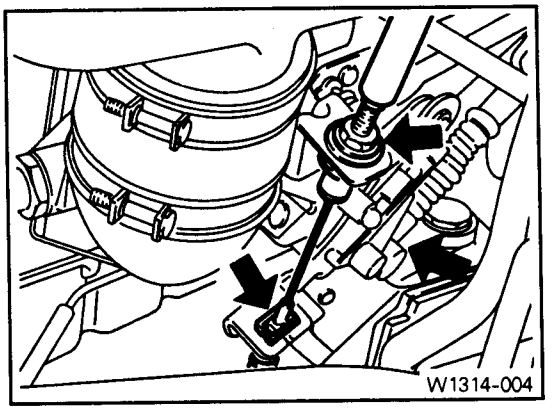
Preceding work : Removal of upper intake manifold



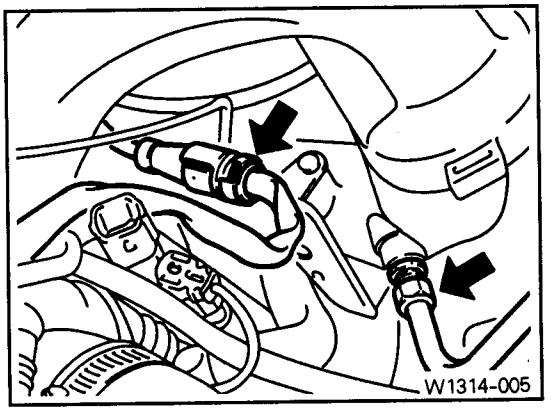
1. Plastic Clip
2. Guide Piece
3. Accelerator Control Cable
4. Automatic Transmission Control Pressure Cable
5. Brake Booster Vacuum Line
6. Idle Speed Control Connector
7. Bolt----------25Nm
8. Lower Intake Manifold

Removal · Installation

1) Remove the accelerator control cable (3) and automatic transmission control pressure cable (4) from the control lever bracket.
   [Note] After installation, exactly adjust each cables (30-01).



2) Remove the brake booster vacuum line (5), idle speed control connector (6) and each vacuum hoses.



3) Remove the bolts (7) and then remove the lower intake manifold (8).

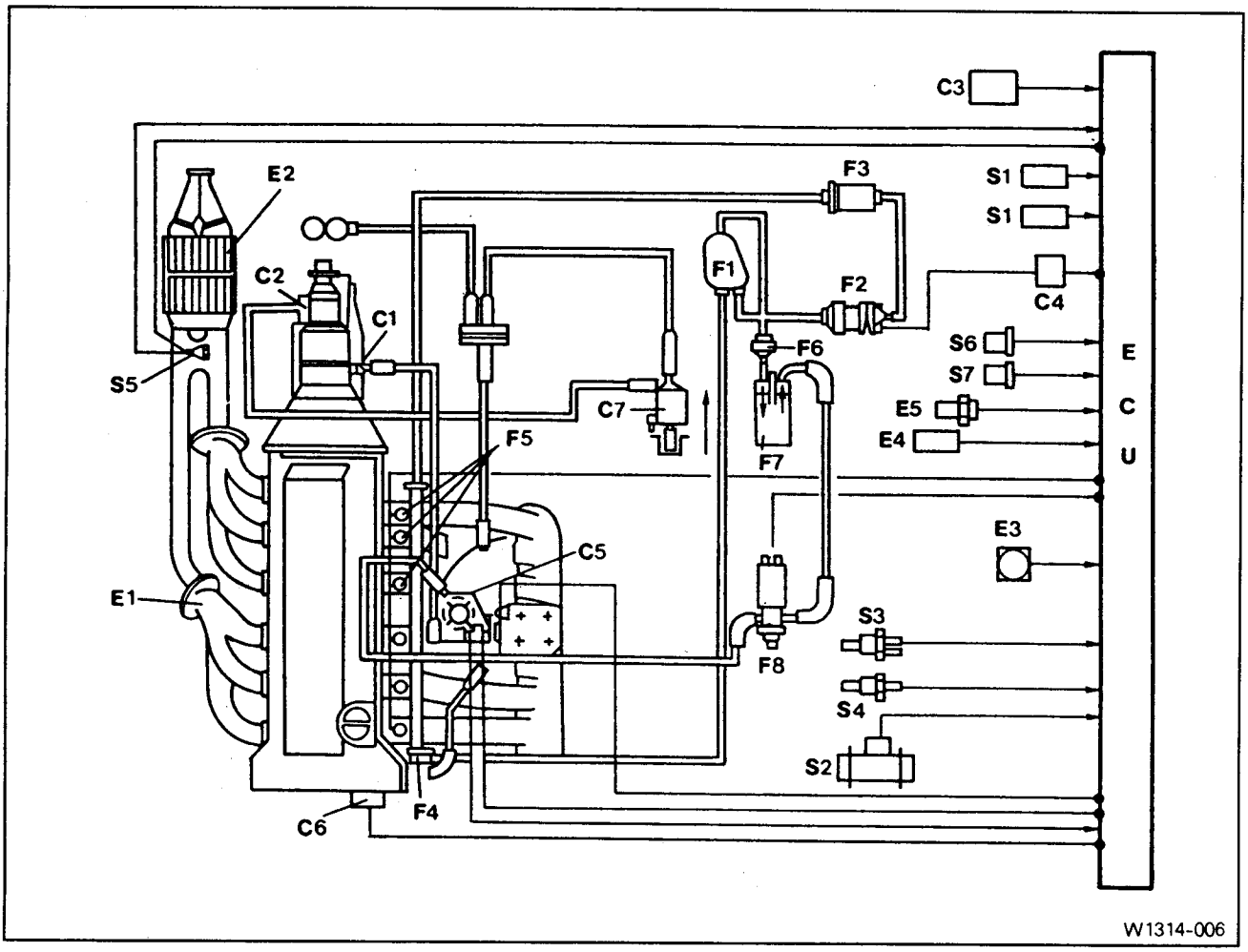
Installation

Tightening torque	25Nm

4) Installation is reverse order of the removal.

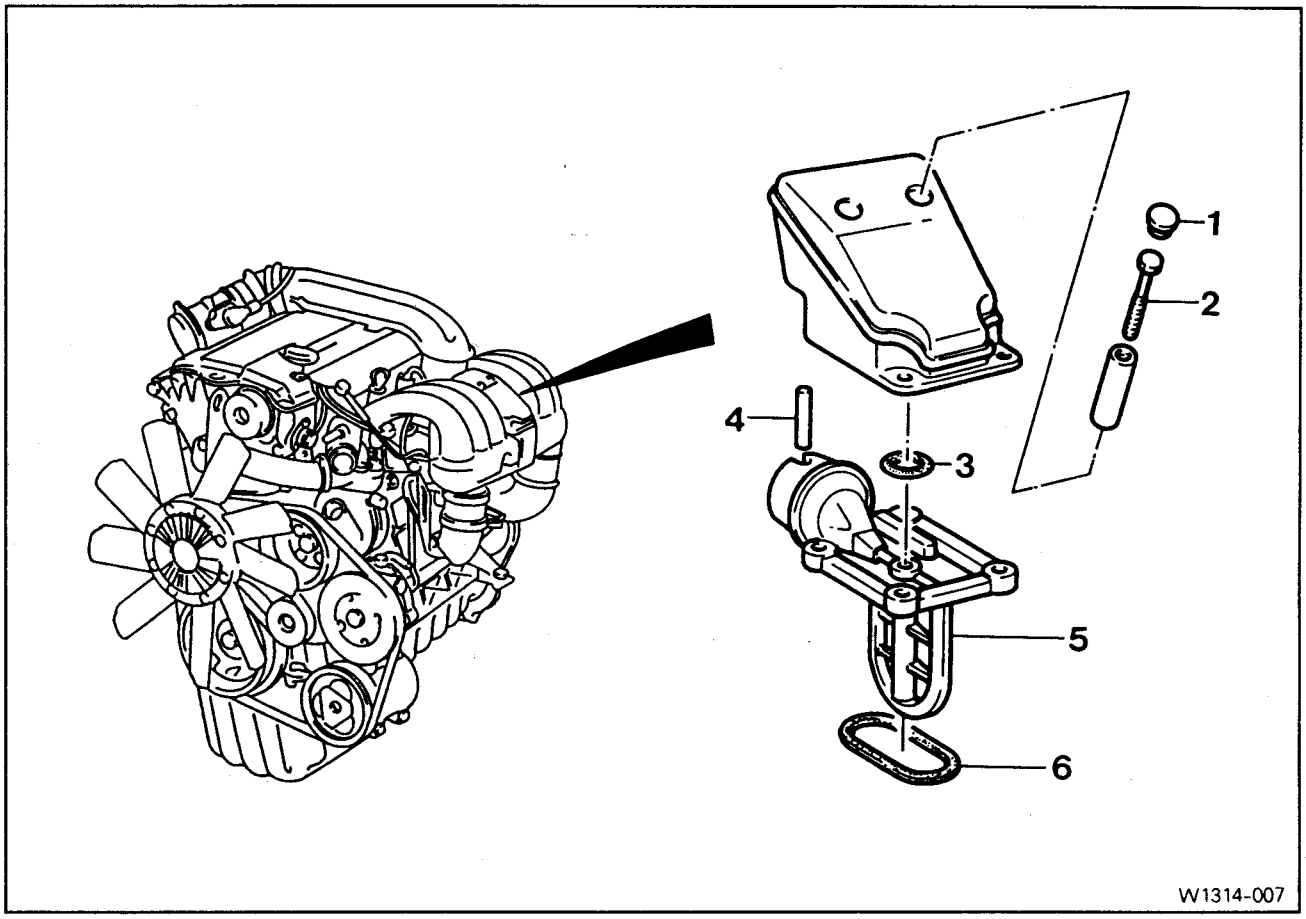
5) Start the engine and check each connections for leaks.

C. Function Diagram



C1. Vacuum Element for Modulating Pressure
C2. Vacuum Element for 'S' - 'E' Mode
C3. Air-Conditioner Compressor
C4. Fuel Pump Relay
C5. Idle Speed Control Actuator
C6. Camshaft Timing Actuator
C7. 'S' - 'E' Mode Solenoid
E1. Exhaust Manifold
E2. Catalytic Converter
E3. HFM Resistance Trimming Plug
E4. Starter Lock-out Switch
E5. A/T Overload Protection Switch
F1. Fuel Tank
F2. Fuel Pump
F3. Fuel Filter
F4. Diaphragm Pressure Regulator
F5. Fuel Injection Valve
F6. Vent Valve
F7. Charcoal Canister
F8. Purge Control Valve
S1. Knock Sensors
S2. HFM Sensor
S3. Coolant Temperature Sensor
S4. Intake Air Temperature Sensor
S5. Oxygen Sensor
S6. Crankshaft Position Sensor
S7. Camshaft Position Sensor

2. Removal and Installation of Resonance Flap



1. Plug
2. Bolt
3. O-Ring----------Replace
4. Vacuum Hose
5. Resonance Flap
6. Gasket----------Replace

Removal · Installation

1) Remove the plug (1).

2) Remove the bolt (2) and pull out the upper resonance flap coupling.
[Note] For installation, correctly connect the vacuum hose (4).

3) Check the O-ring (3) and replace if necessary.

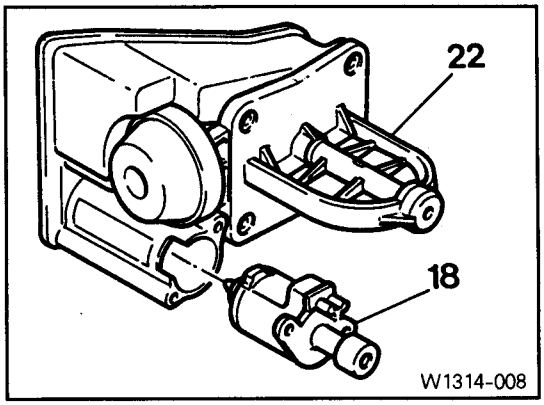
4) Remove the lower resonance flap (5).

5) Replace the gasket (6).

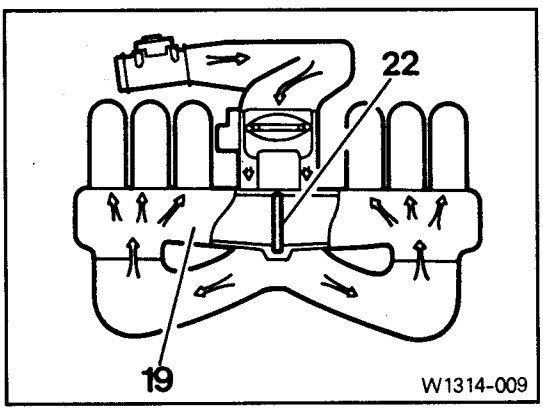
6) Installation is reverse order of the removal.

Function

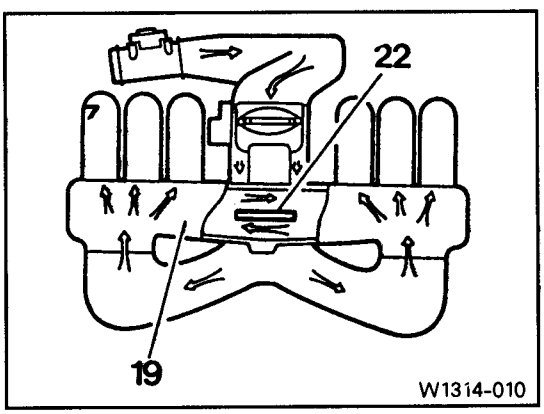
A pneumatically actuated resonance flap (22) is located on the intake manifold.
The resonance intake manifold switchover valve (18) is connected to the resonance flap and it is controlled at idling and full load by ECU.



1) Resonance flap closed (at idle : less than 3,800/rpm)
The intake air flows in the resonance intake manifold through the throttle valve and subsequent divided intake lines into the air collection housing (19) of the resonance tube. The collected air volume is divided in two by the resonance flap (22). This leads to a significant increase in the torque in the lower speed range.

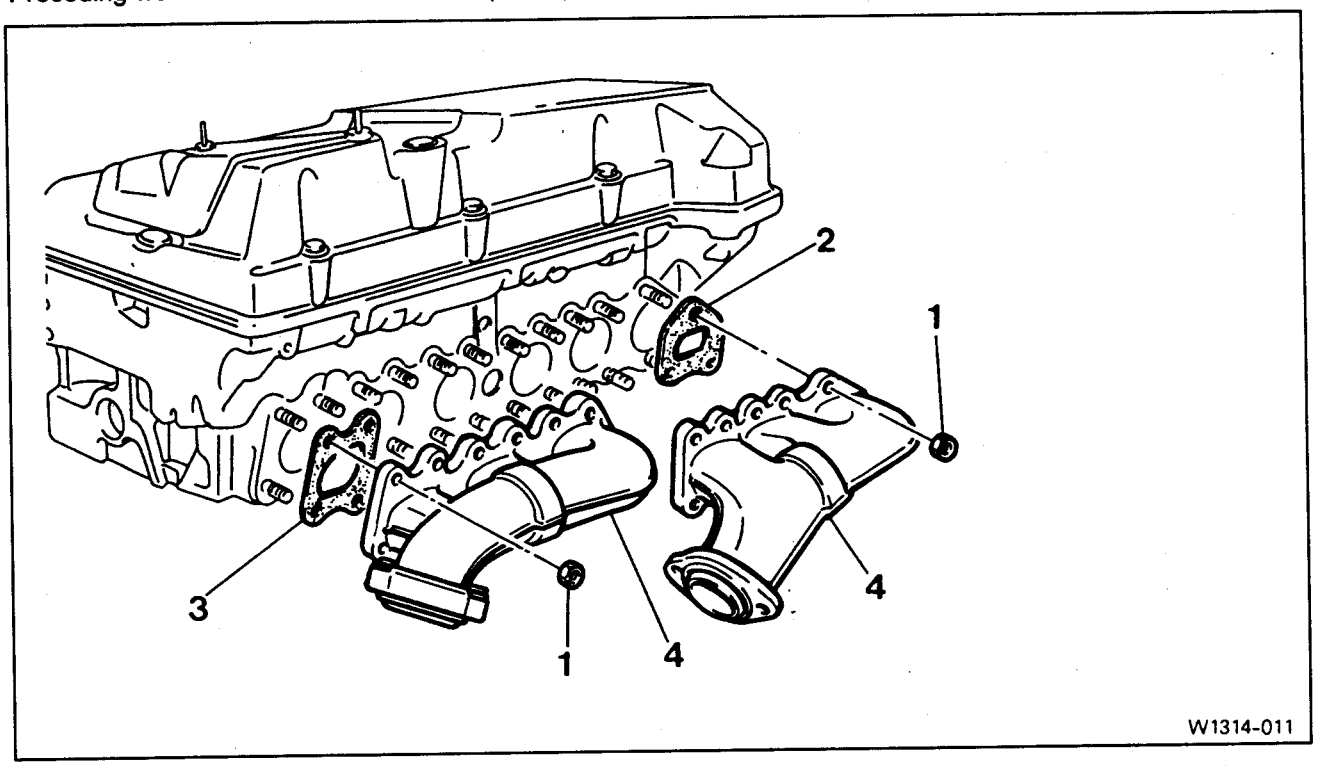


2) Resonance flap open(full load : more than 3,800/rpm)
When the resonance flap (22) is opened the collected air volume in the resonance tube (19) is not divided. The cylinder on the intake stroke uses the air in both intake lines of the resonance intake manifold.



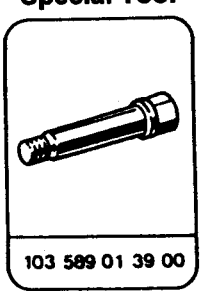
3. Removal and Installation of Exhaust Manifold

Preceding work : Removal of air cleaner (09-01)



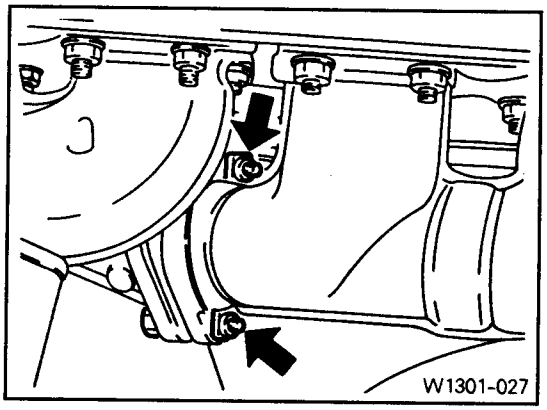
1. Nut ---------- 40Nm
2. Gasket (1 Piece) ---------- Replace
3. Gasket (5 Pieces) ---------- Replace
4. Exhaust Manifold

Special Tool



Removal · Installation

1) Remove the flange bolt from the exhaust manifold and then remove the front exhaust pipe.



Installation

Tightening torque	30Nm

[Note] Check the nut for damage and replace if necessary.

2) Remove the 23 nuts (1) from the stud bolts and then remove the exhaust manifold (4).

Installation

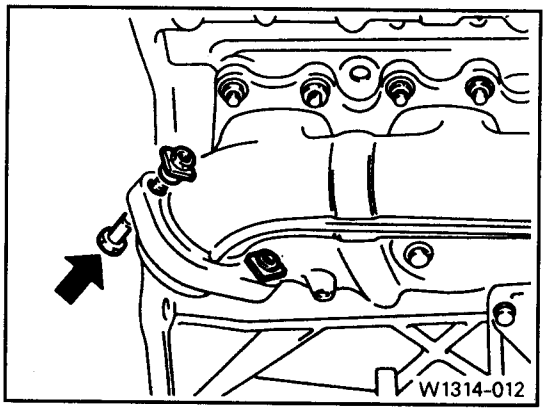
Tightening torque	40Nm

3) Replace the gaskets (2, 3).

4) Installation is reverse order of the removal.

Rivet nut replacement

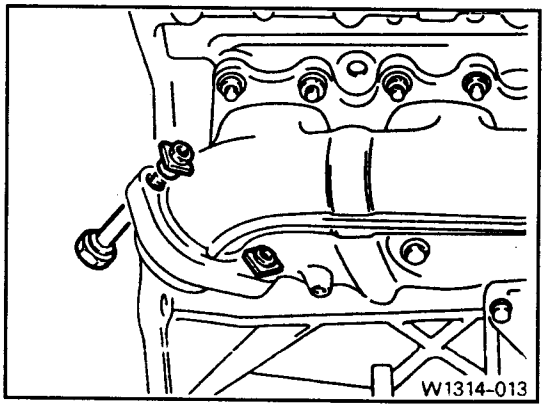
1) Remove the rivet nut from the exhaust manifold by using a proper bolt (arrow).



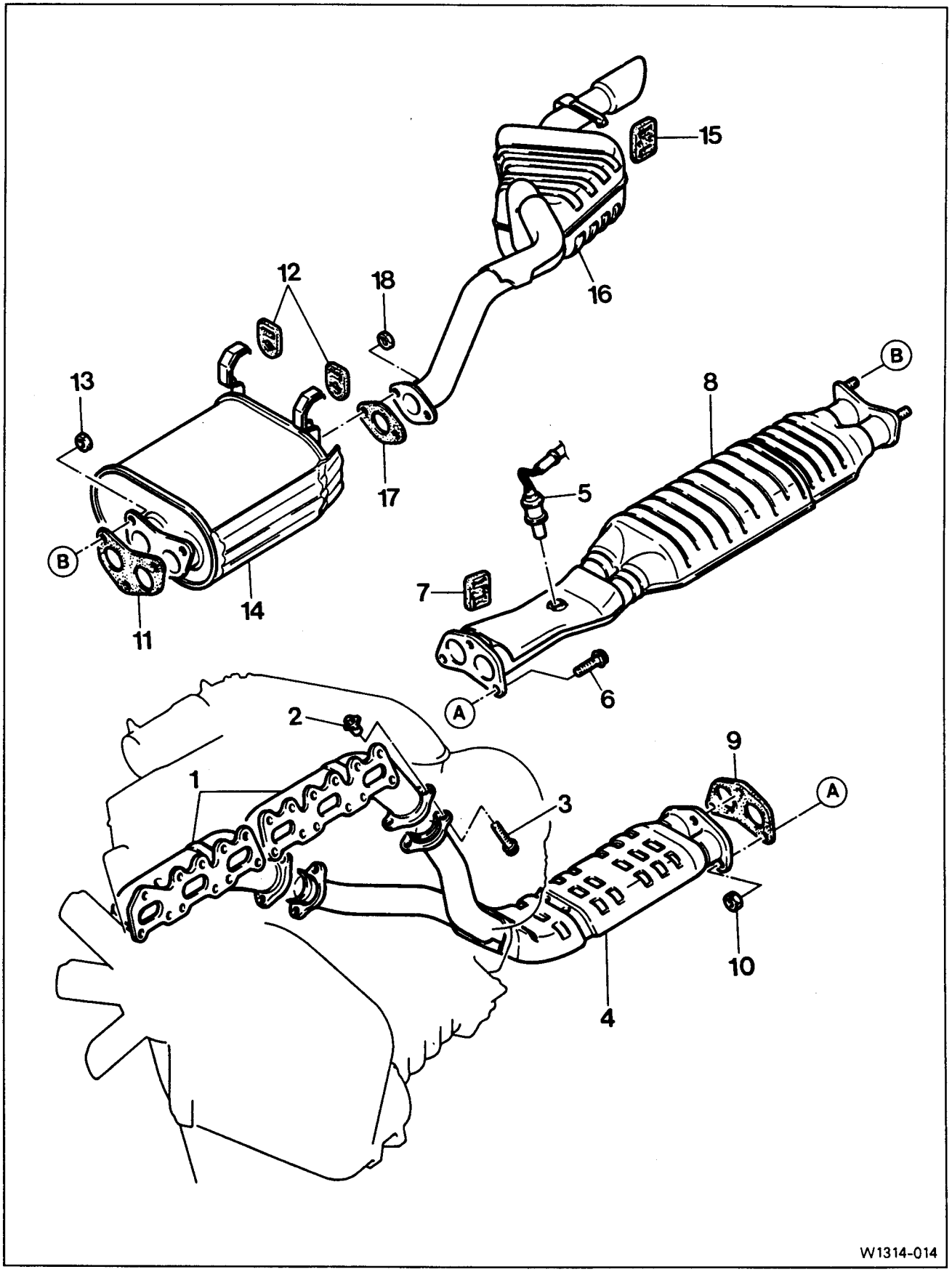
2) Insert a new rivet nut into the exhaust manifold and clamp it with special tool (cocking bolt).

Tightening torque	30Nm

Cocking bolt 103 589 01 39 00



4. Removal and Installation of Exhaust Line

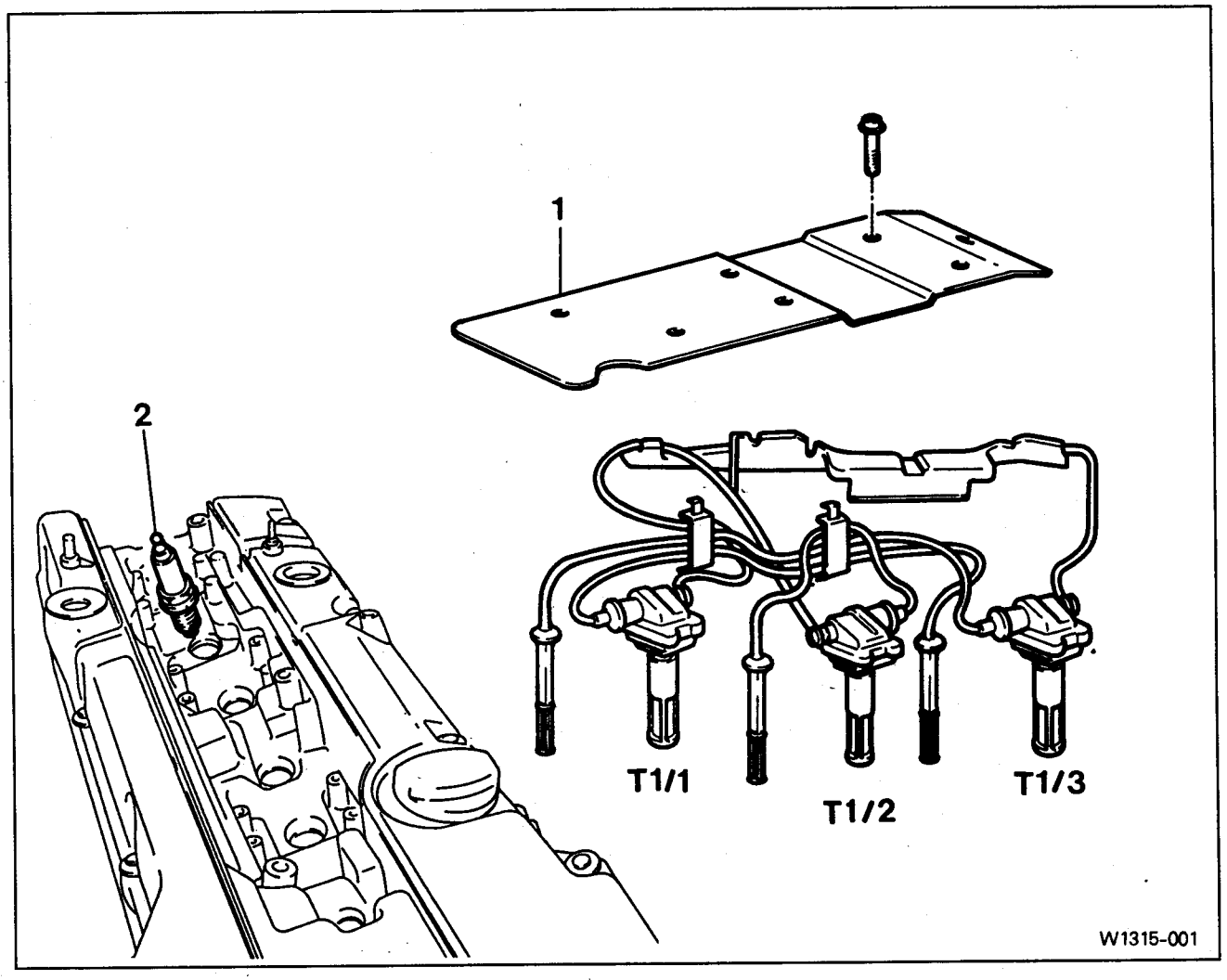


Intake and Exhaust Manifold

1. Exhaust Manifold
2. Rivet Nut
3. Bolt---------- 30Nm
4. Front Pipe
5. Oxygen Sensor
6. Bolt---------- 28~47Nm
7. Rubber Pad
8. Catalytic Converter
9. Gasket ---------- Replace
10. Nut
11. Gasket ---------- Replace
12. Rubber Pad
13. Nut ---------- 28~47Nm
14. Center Muffler
15. Rubber Pad
16. Tail Muffler
17. Gasket ---------- Replace
18. Nut ---------- 28~47Nm

1. Spark Plug Replacement

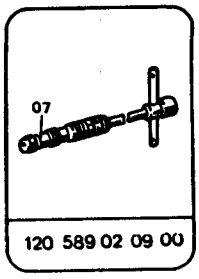
Preceding work : Removal of ignition cable (15-03)



1. Ignition Cable Duct Cover
2. Spark Plug

T1/1 Ignition Cable : Cylinder 2 + 5
T1/2 Ignition Cable : Cylinder 3 + 4
T1/3 Ignition Cable : Cylinder 1 + 6

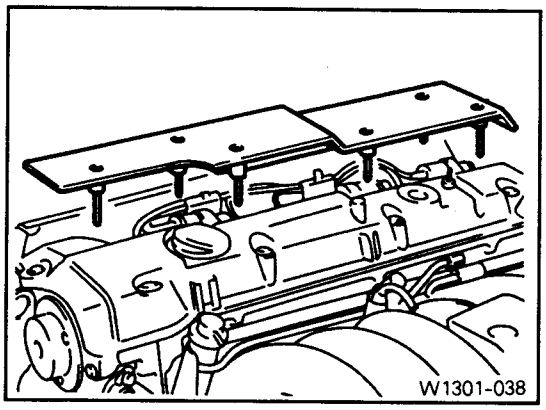
Special Tool



Replacement

1) Remove the ignition cable duct cover.

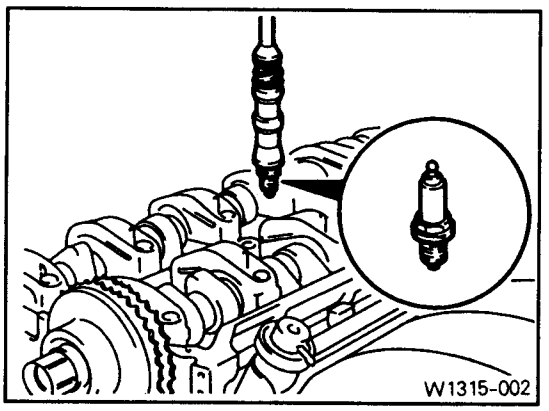
2) Disconnect the ignition cables.



3) Remove the spark plug by using a special tool.

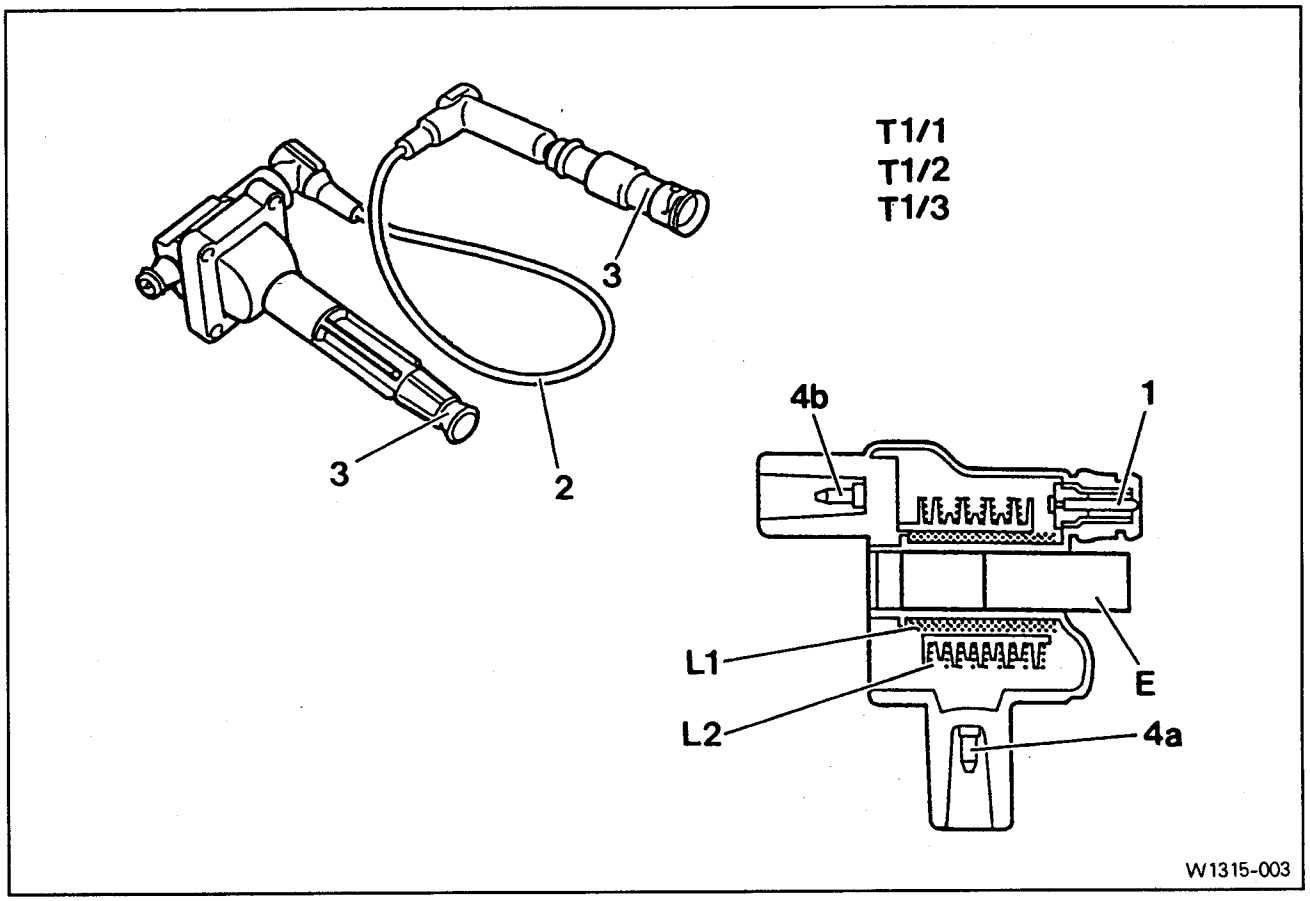
Electrode gap	0.8mm
Tightening torque	25~30Nm

Spark plug wrench 120 589 02 09 00



2. Removal and Installation of Ignition Cable

Preceding work : Removal of air cleaner cross pipe (09-03)



1. Control Cable Connection
2. Ignition Cable
3. Spark Plug Connector

4a. Primary Voltage Connection

4b. Secondary Voltage Connection

E. Iron Core

L1. Primary Ignition Cable

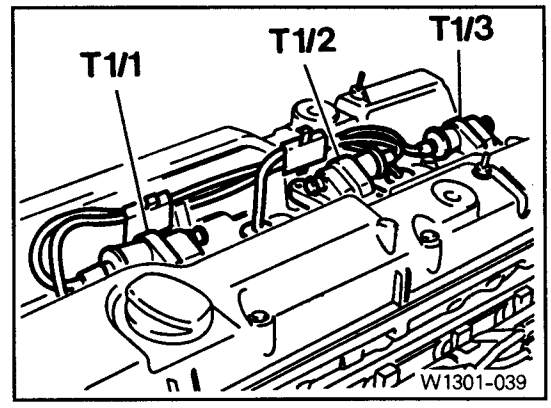
L2. Secondary Ignition Cable

T1/1 Ignition Cable (Cylinder 2 + 5)

T1/2 Ignition Cable (Cylinder 3 + 4)

T1/3 Ignition Cable (Cylinder 1 + 6)

Removal · Installation



1) Disconnect the battery negative terminal.

2) Disconnect the control cable connector from the ignition cable.

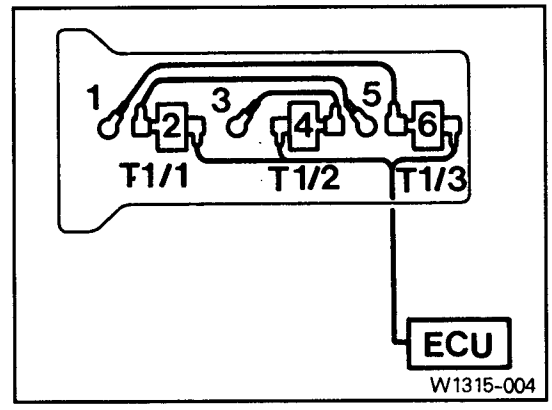
3) Disconnect the secondary spark plug connectors from the each spark plugs and remove the ignition cable.
   [Note] · **For installation, ensure the ignition cables are correctly routed.**
   · **Exactly install the ignition cable guide pin into the vehicle to be grounded.**

4) Measure the secondary coil resistance at the ignition cable (4a, 4b) with multimeter.

Standard	5.2~8.5kΩ

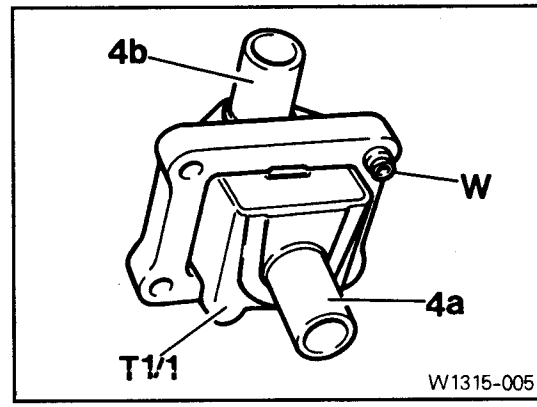
5) Installation is reverse order of the removal.

Function



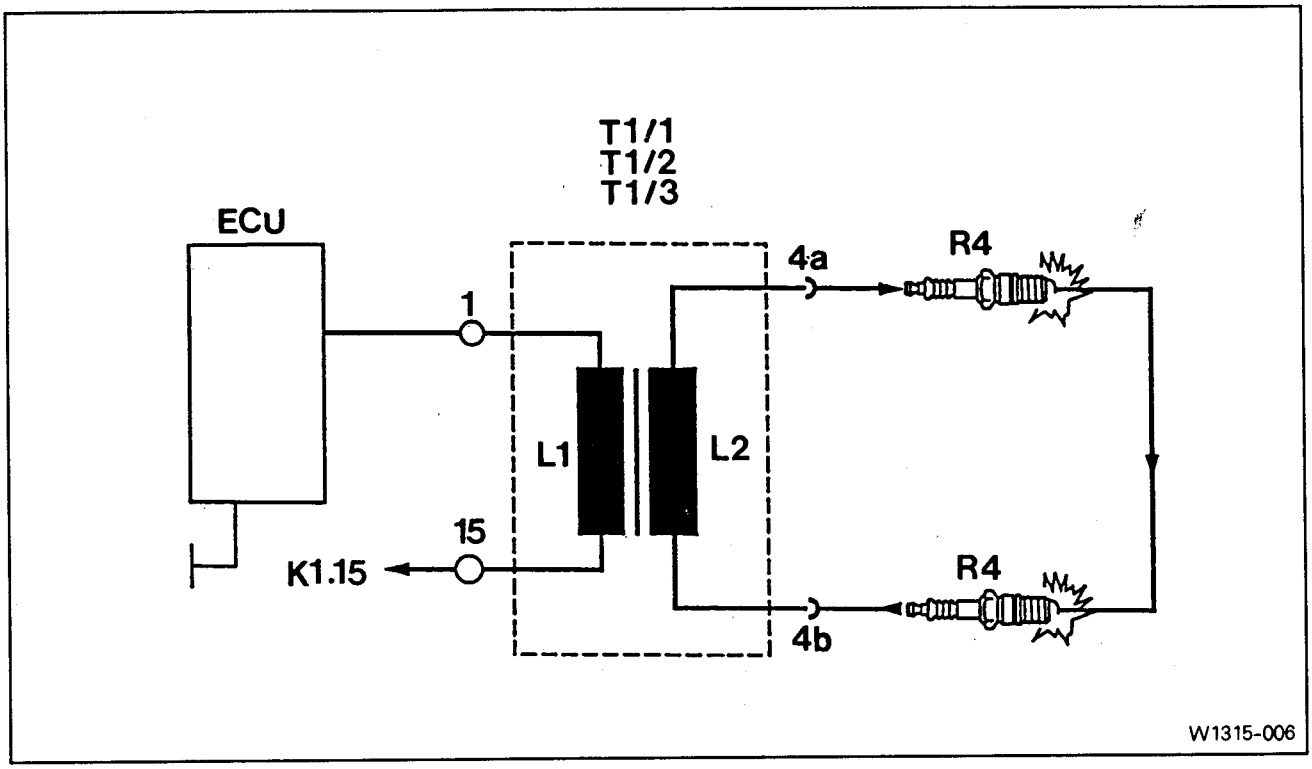
1) Firing order : 1 - 5 - 3 - 6 - 2 - 4

2) The ignition coils are located on the cylinder head cover. Each ignition coil provides the high voltage to two spark plugs simultaneously.
   - T1/1 : Cylinder 2 and 5
   - T1/2 : Cylinder 3 and 4
   - T1/3 : Cylinder 1 and 6



3) The secondary output (4a) of the ignition coils (T1/1, T1/2, T1/3) are connected directly to a spark plug by means of a spark plug connector. The secondary output (4b) leads to the other cylinder via an ignition cable. The guide sleeve (W) is simultaneously the ground connection for the ignition coil.

Circuit diagram

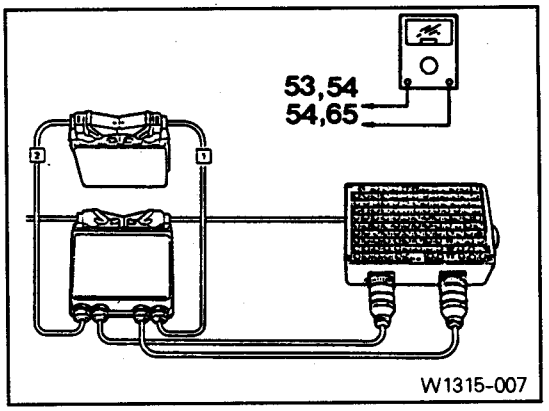


Inspection

1) Position the ignition switch OFF and measure primary coil connection resistance by checking the ECU terminal 53 and 54 or 54 and 65.

Standard	0.9~1.5Ω

[Note] If out of standard, replace the ignition coil.



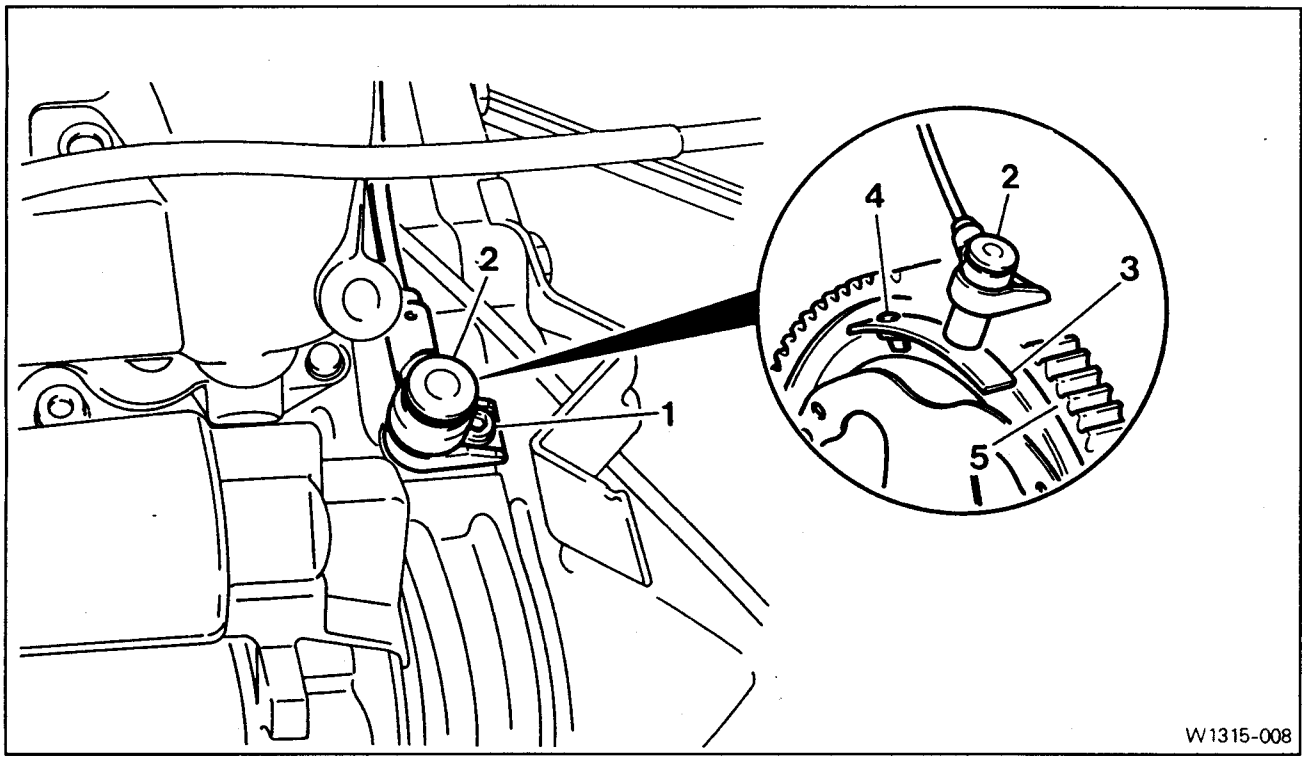
2) During engine cranking, measure primary voltage by checking the ECU terminal 27 and 53 (In case of T1/1).

Standard	200~350V

[Note] · **Measure remaining cables.**
- **T1/2 : No. 27 and 54.**
- **T1/3 : No. 27 and 65.**

· **If out of standard, check control cable and ECU.**

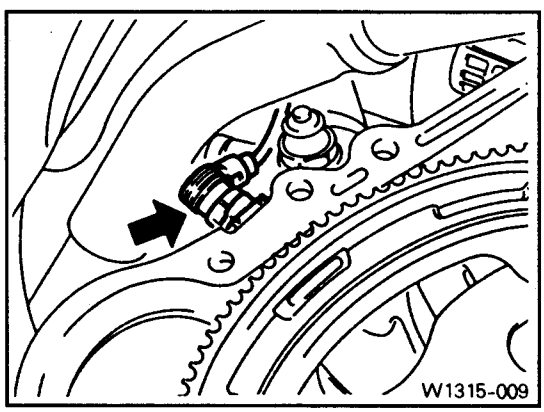
3. Crankshaft Position Sensor



1. Bolt----------10Nm
2. Crankshaft Position Sensor
3. Segment
4. Permanent Magnet
5. Flywheel

Removal · Installation

· Crankshaft position sensor detects the engine speed and crankshaft position of the no.1 cylinder and it signals to ECU to control the fuel injection and ignition timing.



1) Remove the starter motor.

2) Disconnect the crankshaft position sensor wiring connector.

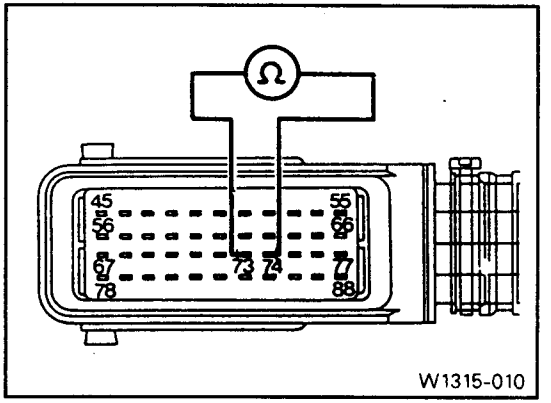
3) Remove the bolt and then remove the crankshaft position sensor.

Installation

Tightening torque	10Nm

4) Installation is reverse order of the removal.

Inspection



- Crankshaft position sensor resistance.

1) Position the ignition switch OFF.

2) Disconnect the ECU coupling 2.

3) Measure resistance on the terminal 73 and 74 by using multimeter.

Standard	680~1200Ω

[Note] If out of standard, measure resistance of crankshaft position sensor insulator.

- Crankshaft position sensor Insulator resistance.

1) Position the ignition switch OFF and connect the contact box to the ECU.

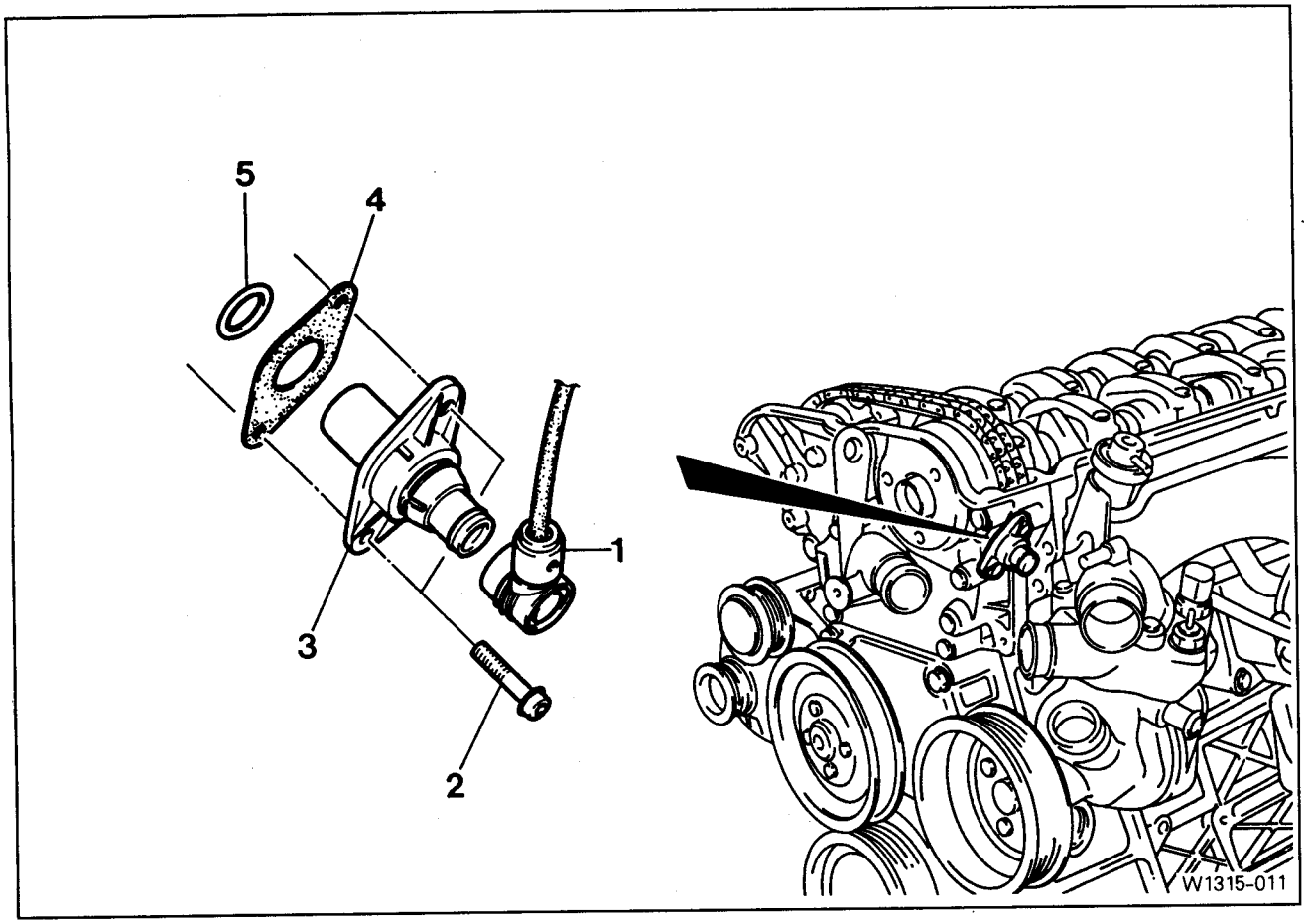
2) Disconnect the ECU coupling 2.

3) Measure between the ECU terminal 32 and coupling terminal 74.

Standard	〉200KΩ

[Note] If out of standard, replace the crankshaft position sensor.

4. Camshaft Position Sensor



1. Camshaft Position Sensor Coupling
2. Bolt----------10Nm
3. Camshaft Position Sensor
4. Spacer----------Check
5. O-Ring----------Replace

Removal · Installation

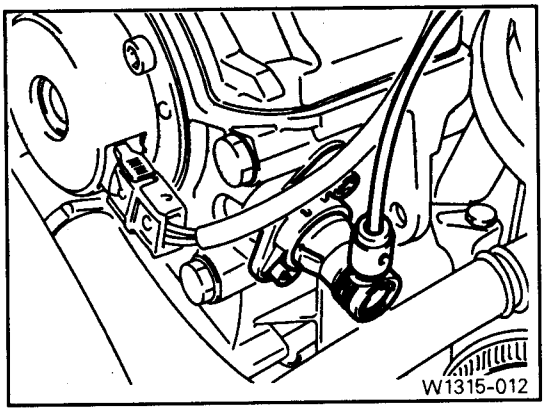
1) Disconnect the camshaft position sensor coupling.

2) Remove the bolt and then remove the camshaft position sensor.

Installation

Tightening torque	10Nm

[Note] Check the gap between the camshaft position sensor and camshaft sprocket segment.



3) After checking the gap, replace the spacer if necessary.

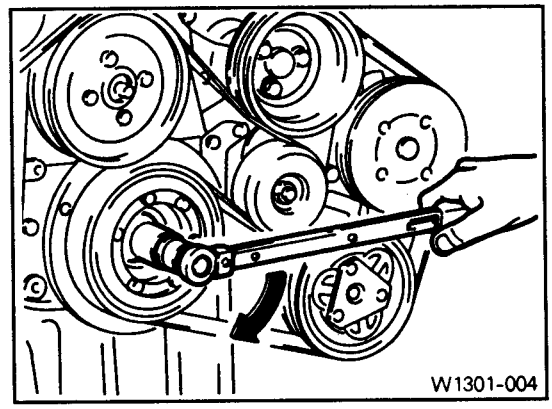
4) Check the O-ring for damage and, replace it if necessary.

5) Installation is reverse order of the removal.

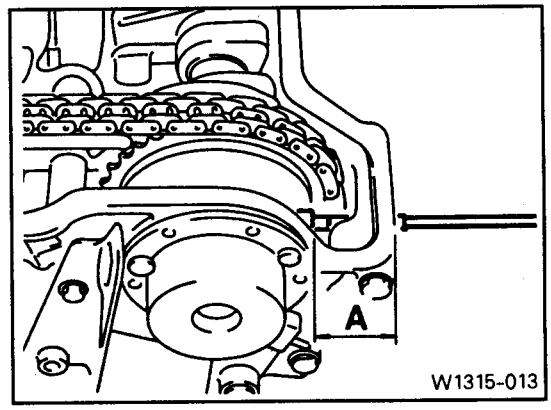
Measuring the gap between sensor and segment

1) Remove the camshaft position sensor.

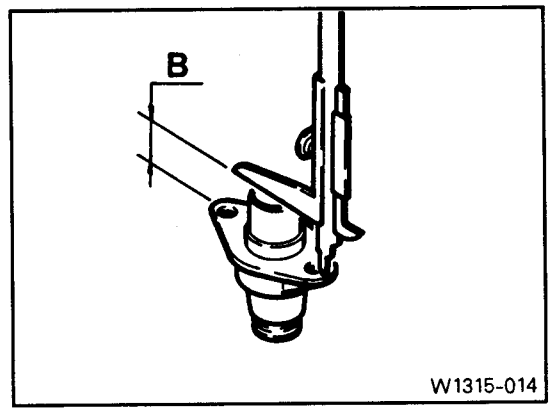
2) Position the crankshaft at the ATDC 20 ° .



3) Measure 'A' by using a vernier caliper (see 'A' in table).
   - 'A' : distance from plane face of camshaft position sensor on cylinder head to segment on camshaft sprocket.



4) Remove the spacer and measure 'B' by using a vernier caliper (see 'B' in table).
   - 'B' : distance from contact face to position sensor.



5) Difference between A and B is D (A - B = D).

6) Standard specification 'W' is 0.4~0.6mm.
   (Average : 0.5mm).

7) Determine the thickness 'S' of the spacer (W - D = S).

Table of calculation

Section	(Example 1) Size 'A' ≥ Size 'B'	(Example 2) Size 'A' < Size 'B'
Size 'A'	24.1mm	23.8mm
Size 'B'	-23.8mm	-24.1mm
Difference 'D'	0.3mm	-0.3mm
Standard 'W'	0.5mm	0.5mm
Difference 'D'	-0.3mm	+0.3mm
Thickness of spacer 'S'	= 0.2mm	= 0.8mm

* If 'D' value is negative, the specification of 0.5mm must be added to the amount of 'D' [S=W-(-D)=W+D].

Parts

Name	Thickness (mm)	Part no.
Spacer	0.1	119 153 11 52
	0.2	119 153 12 52
	0.3	119 153 13 52
	0.4	119 153 14 52
	0.5	119 153 15 52
	0.6	119 153 16 52
	0.7	119 153 17 52
	0.8	119 153 18 52
	0.9	119 153 19 52
	1.0	119 153 20 52

Commercial tool

Vernier caliper	Hahn & Kolb, 31215080

Inspection

- Camshaft position sensor voltage.

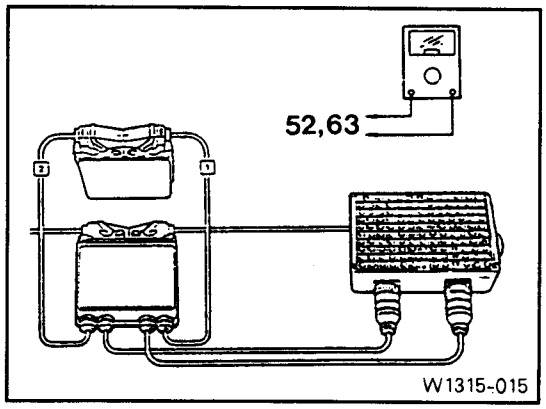
1) Connect the contact box to the ECU.

2) Run the engine at idle.

3) Using a multimeter, measure camshaft position sensor voltage by checking the ECU terminal 52 and 63.

Standard	>0.2V

[Note] If out of standard, readjust the gap between the camshaft position sensor and segment.



- Camshaft position sensor resistance.

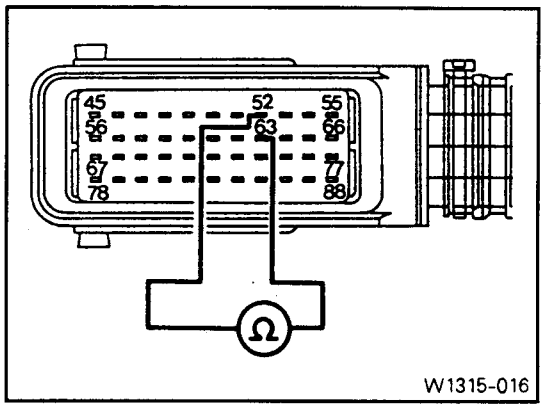
1) Position the ignition switch OFF.

2) Disconnect the ECU coupling 2.

3) Measure coupling terminal 52 and 63 with multimeter.

Standard	900~1200Ω

[Note] If out of standard, measure camshaft position sensor insulator resistance.



- Camshaft position sensor insulator resistance.

1) Position the ignition switch OFF and connect the contact box to the ECU.

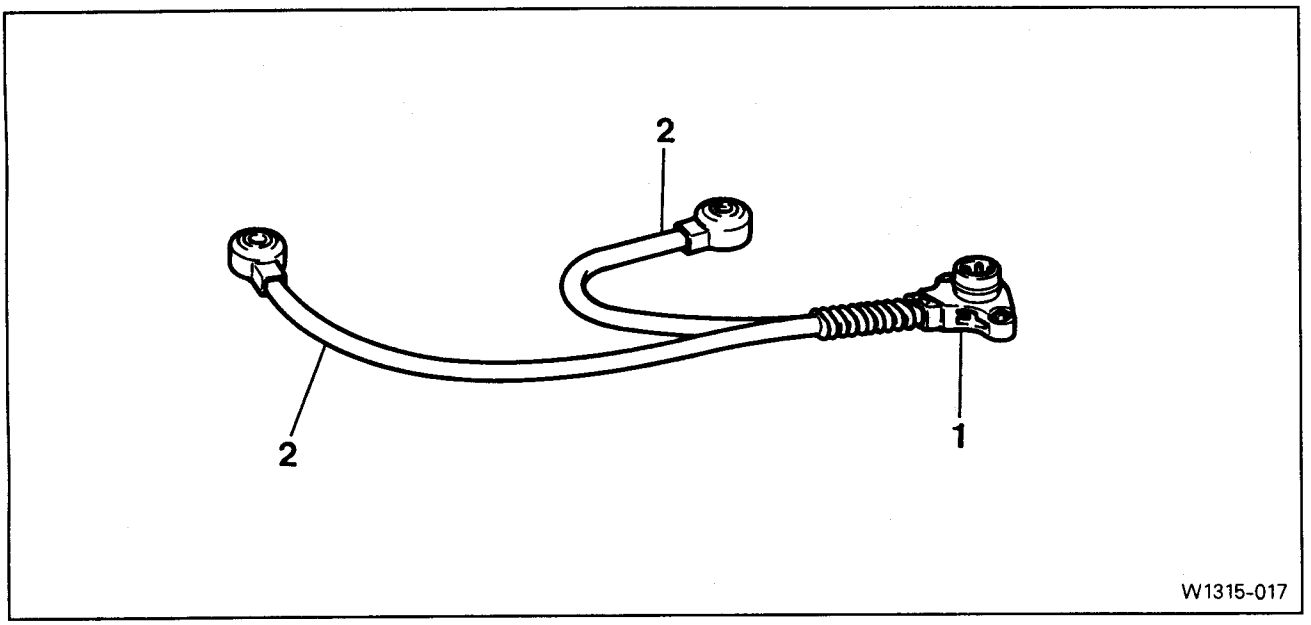
2) Disconnect the ECU coupling 2.

3) Measure between the ECU terminal 32 and coupling terminal 52.

Standard	>200KΩ

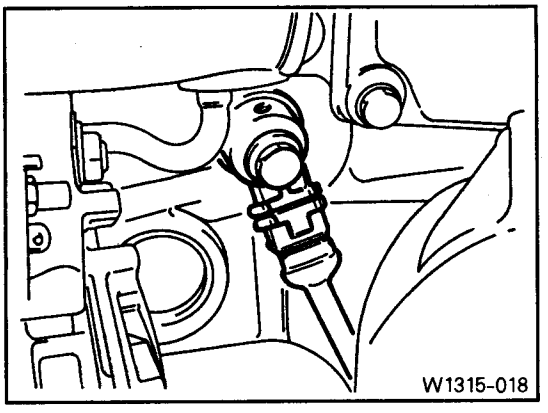
[Note] If out of standard, replace the camshaft position sensor.

5. Knock Sensor



1. Knock Sensor Connector
2. Knock Sensors

Removal · Installation



· Vibration of the engine block is transmitted to the sensor and transferred to the ECU in the form of an alternating voltage signal via a shielded cable. The knock sensor is fastened to the engine block to recognize knocking in all cylinders. The ECU compares signal and retards firing point.

1) Disconnect the knock sensor connector from the intake manifold bracket.

2) Remove the knock sensor bolts on the cylinder block and then remove the 2 knock sensors.

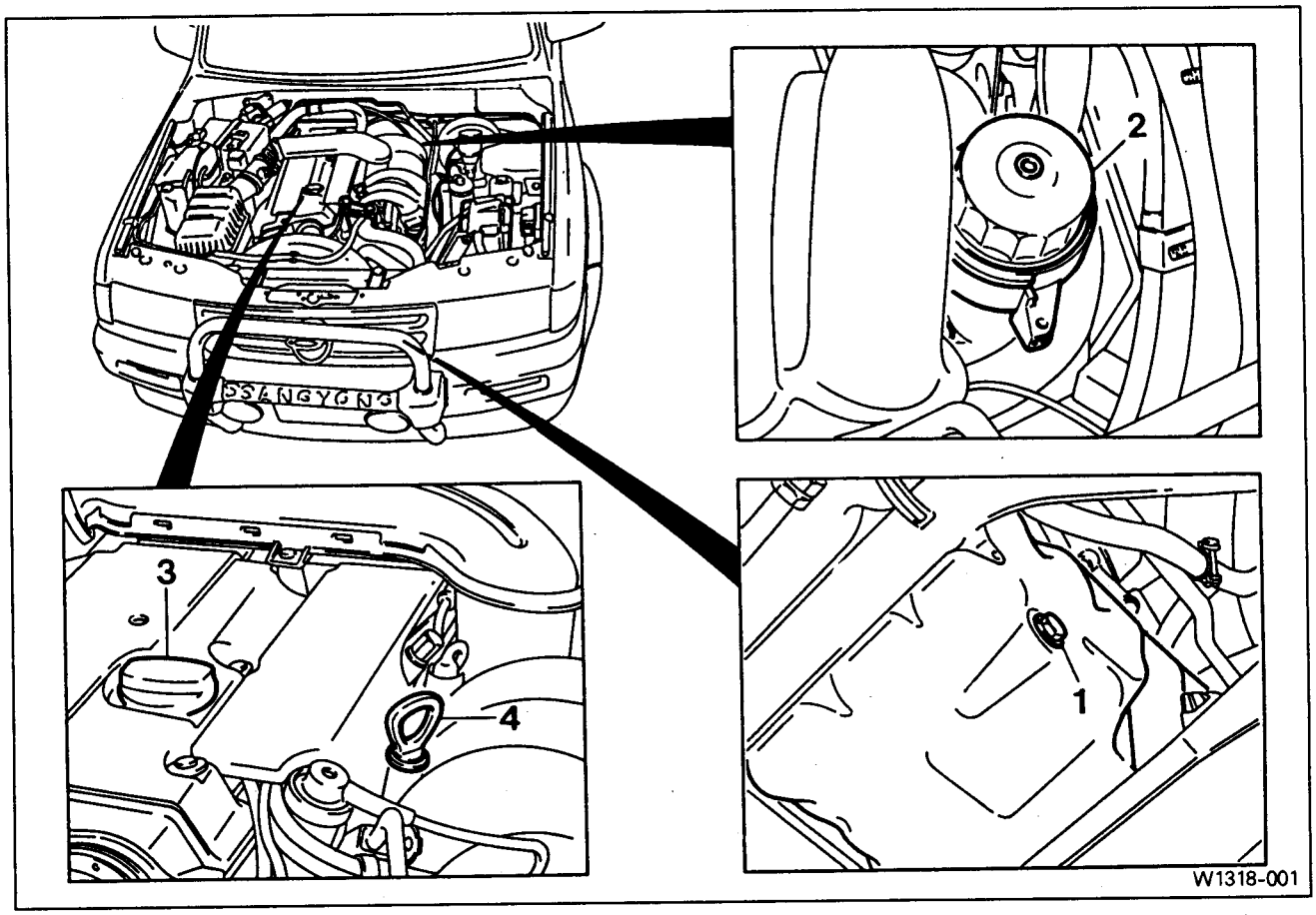
Installation

Tightening torque	20Nm

[Note] Replace the knock sensors as a set.

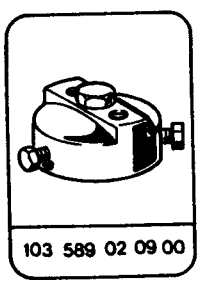
3) Installation is reverse order of the removal.

1. Replacement of Engine Oil and Oil Filter Element



1. Drain Plug----------25Nm
2. Oil Filter
3. Engine Oil Filler Cap
4. Dipstick Gauge

Special Tool



Engine oil	Capacity	Min. 6.7 ℓ Max. 8.2 ℓ
	Specification	· SAE 15W/40 or API SG · Approved oil by MB SHEET 226.5, 227.5, 228.1, 228.3
	Replacement	Initial at 1,000~1,500km, replace every 15,000km

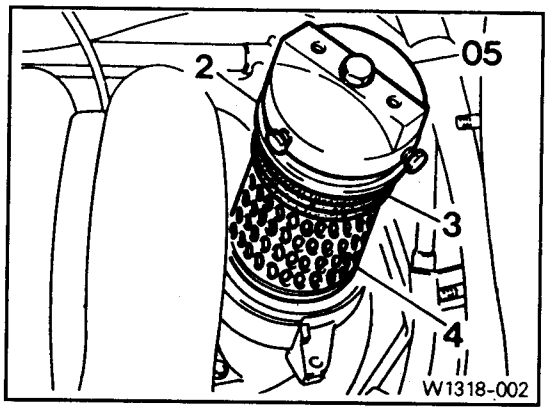
Replacement

1) Install the socket wrench (05) onto the screw cover (2).

2) Turn the socket wrench bolt (05) and remove the oil filter element (4).
[Note] For removal, position the rag not to drop oil.

Socket wrench 103 589 02 09 00

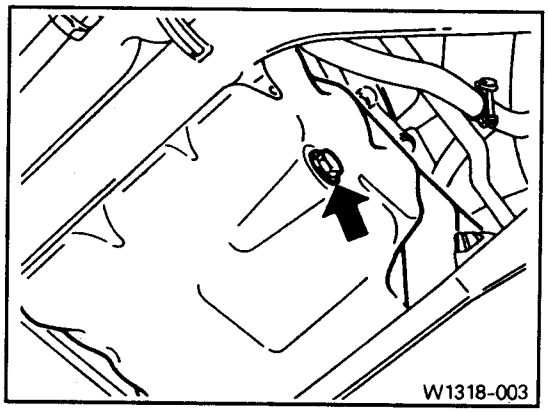
3) Check the seal (3) for damage and replace if necessary.



4) Remove the drain plug and drain the oil.

5) Reinstall the drain plug.
[Note] Replace the seal.

Tightening torque	25Nm



6) Install the new element (4) into the oil filter.

7) Install the socket wrench (05) onto the screw cover (2) and tighten it.

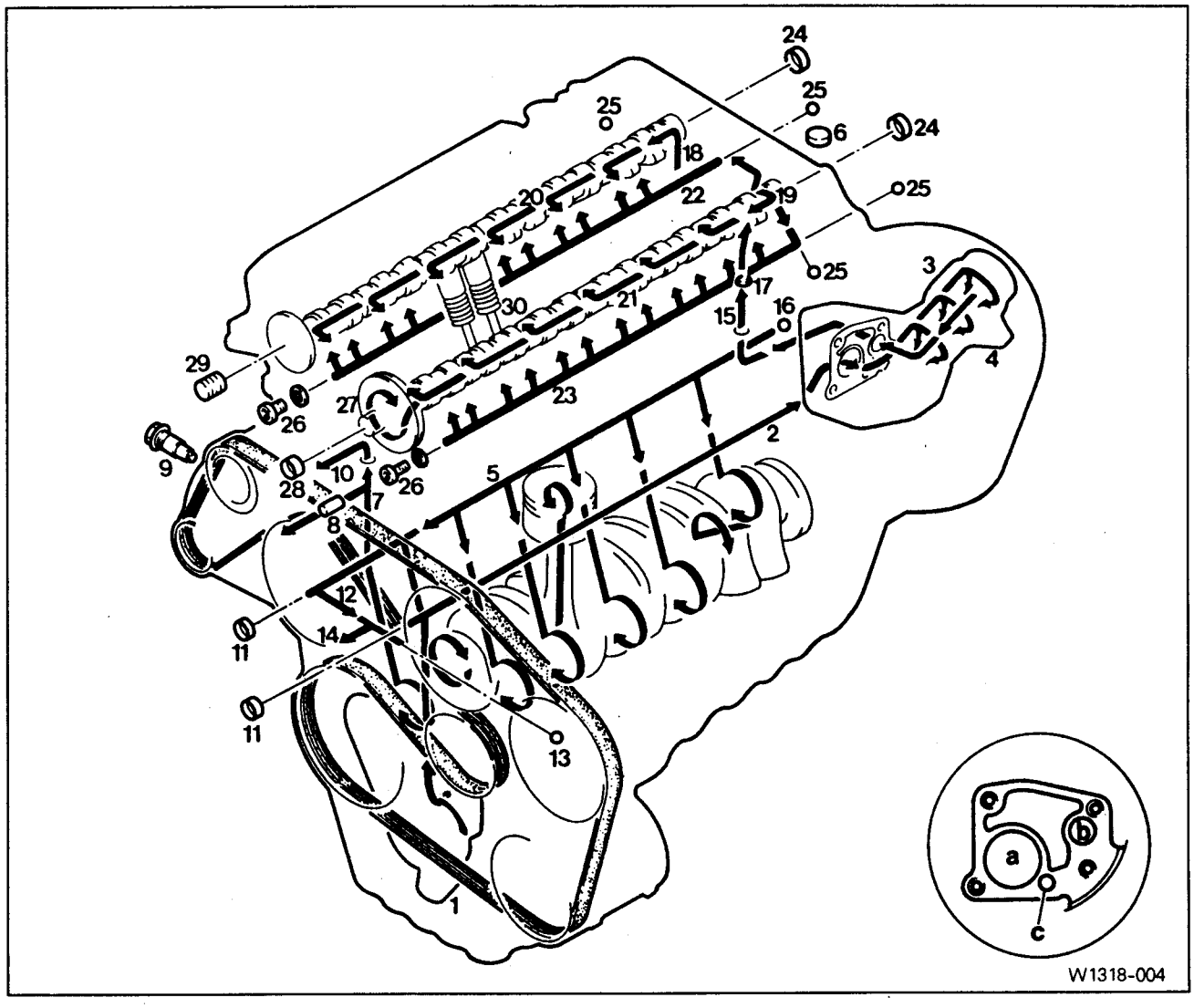
Tightening torque	25Nm

8) Open the filler cap and fill up oil.

9) Start the engine and check engine for leaks.

10) Warm up the engine and check the oil level.

2. Oil Circulation

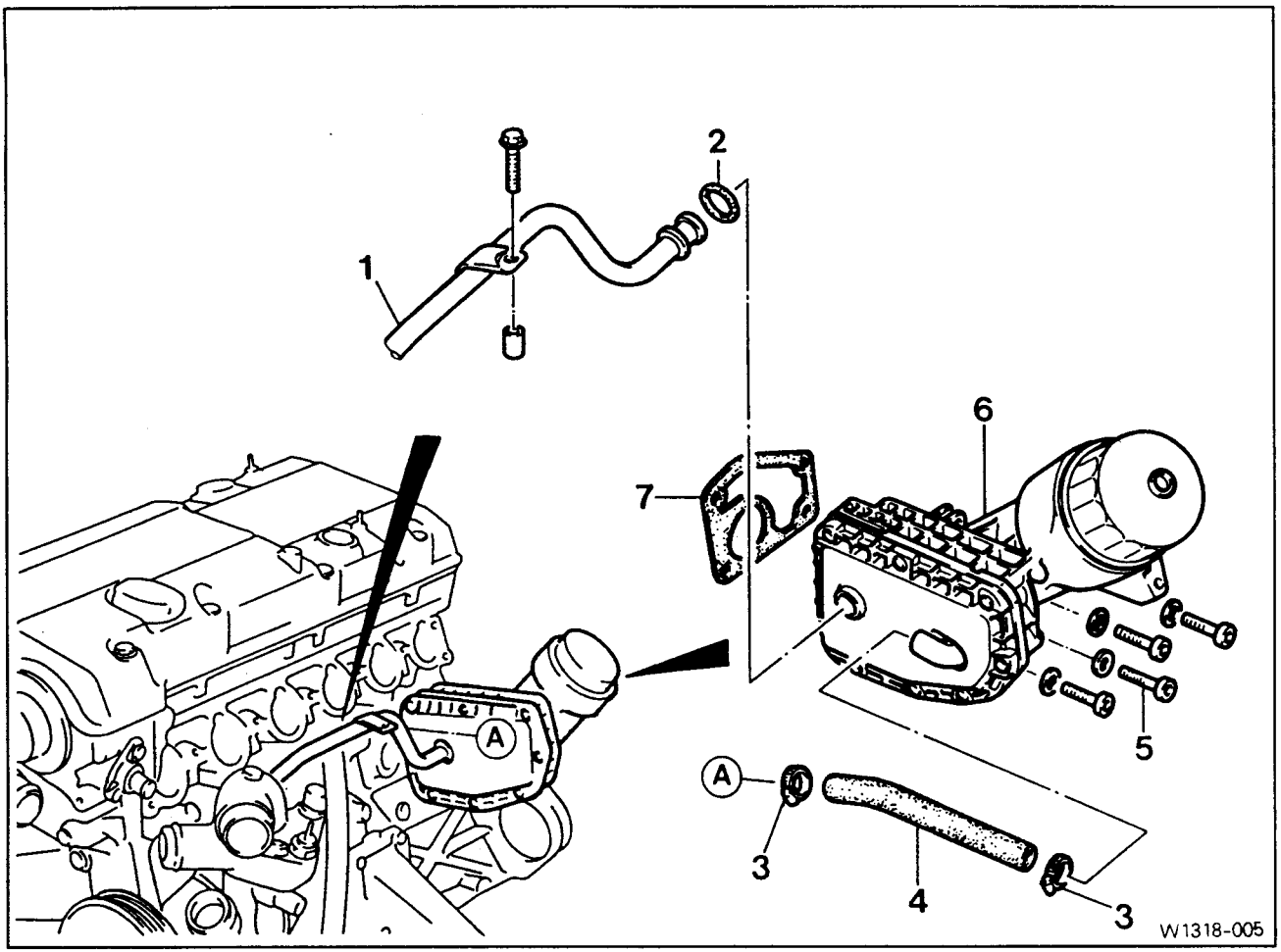


1. Oil Pump
2. Oil Longitudinal Gallery to Oil Filter
3. Oil Filter
4. Oil Pressure Sensor
5. Main Oil Gallery
6. Cylinder Head Closing Cover
7. Oil Riser Gallery to Chain Tensioner
8. Oil Non-Return Valve
9. Chain Tensioner
10. Chain Tensioner Vent
11. Front Closing Cover ϕ17mm
12. Oil Transverse Gallery
13. Ball ϕ6mm
14. Timing Chain Oil Spray Nozzle
15. Oil Riser Gallery to Cylinder Head
16. Ball ϕ15mm
17. Oil Restriction Inner ϕ4mm
18. Oil Feed in Exhaust Camshaft
19. Oil Feed in Intake Camshaft
20. Oil Supply Exhaust Camshaft Bearings
21. Oil Supply Intake Camshaft Bearings
22. Oil Gallery, Valve Tappet Oil Supply (Exhaust Side)
23. Oil Gallery, Valve Tappet Oil Supply (Intake Side)
24. Camshaft Closing Cover
25. Ball ϕ8mm
26. Screw Plug
27. Camshaft Adjuster
28. Front Closing Cover, Intake Camshaft
29. Front Treaded Bush, Exhaust Camshaft
30. Valve Tappet

A. Oil Longitudinal Gallery from Oil Pump to Oil Filter
B. To Main Oil Gallery
C. Dirty Oil Return Drilling to Oil Pan

3. Removal and Installation of Oil Filter

Preceding work : Removal of starter motor
Removal of upper intake manifold (14-01)

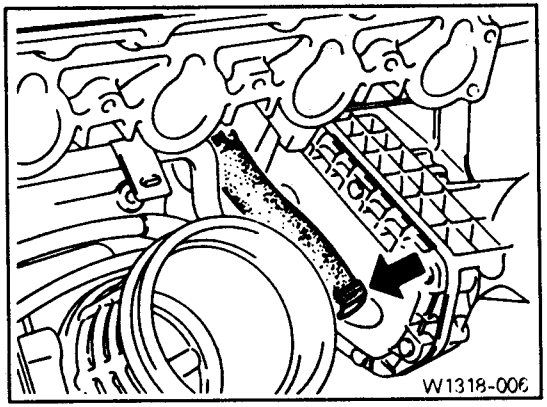


1. Coolant Line
2. O-Ring----------Replace
3. Clip
4. Hose
5. Bolt----------23Nm
6. Oil Filter
7. Gasket----------Replace

Removal · Installation

1) Drain the coolant from the crank case.

2) Remove the each coolant line and hose.



3) Remove the oil filter bolt and then remove the oil filter.

Installation

Tightening torque	23Nm

[Note] Replace the oil filter gasket.

4) Installation is reverse order of the removal.

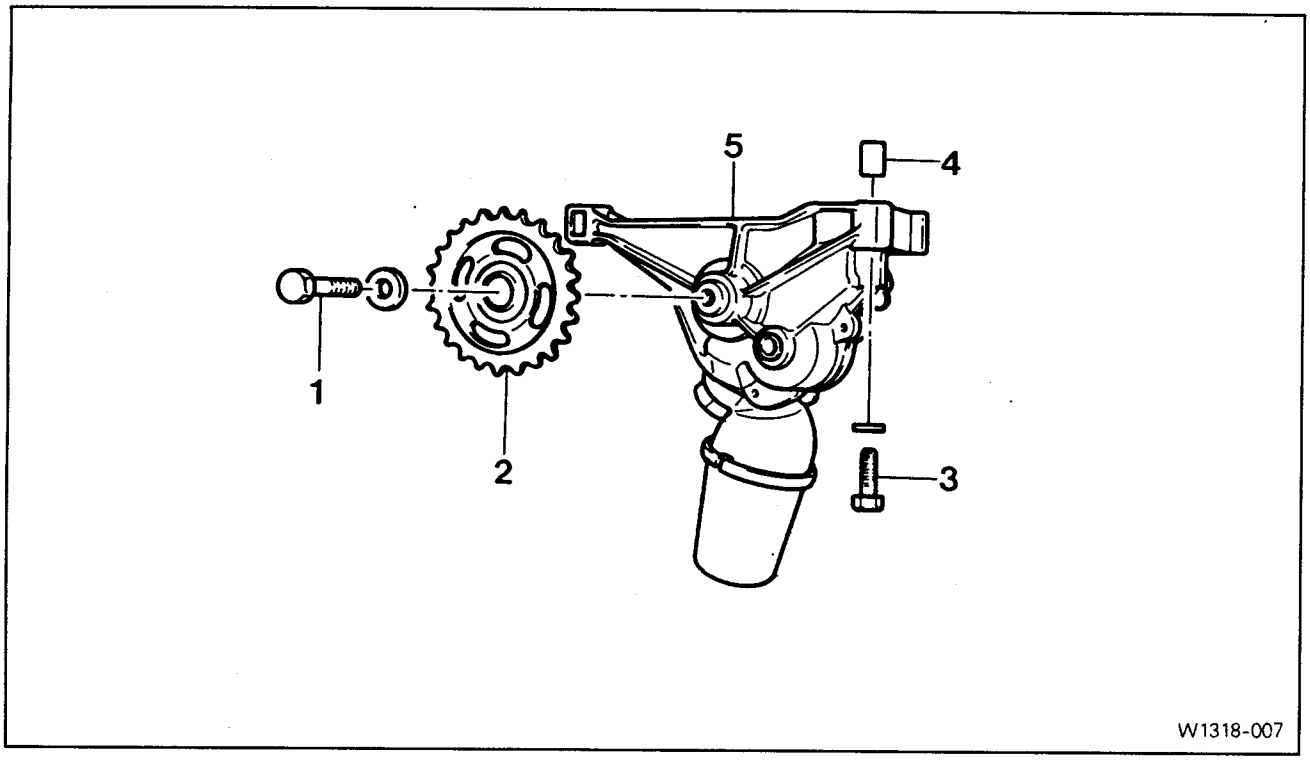
5) Fill up the coolant.

6) Check engine oil level.

7) Run the engine at idle and check the engine for leaks.

4. Removal and Installation of Oil Pump

Preceding work : Removal of oil pan (01-36)



1. Bolt----------32Nm
2. Oil Pump Driving Sprocket
3. Bolt----------23Nm
4. Spring Pin
5. Oil Pump

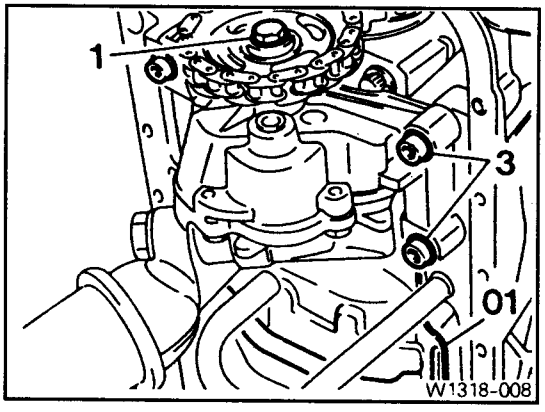
Removal · Installation

1) Remove the oil pump drive gear bolt and separate the oil pump chain from the gear.

Installation

Tightening torque	32Nm

2) Remove the oil pump mounting bolts (3) and then remove the oil shield (01) and oil pump.



Installation

Tightening torque	32Nm

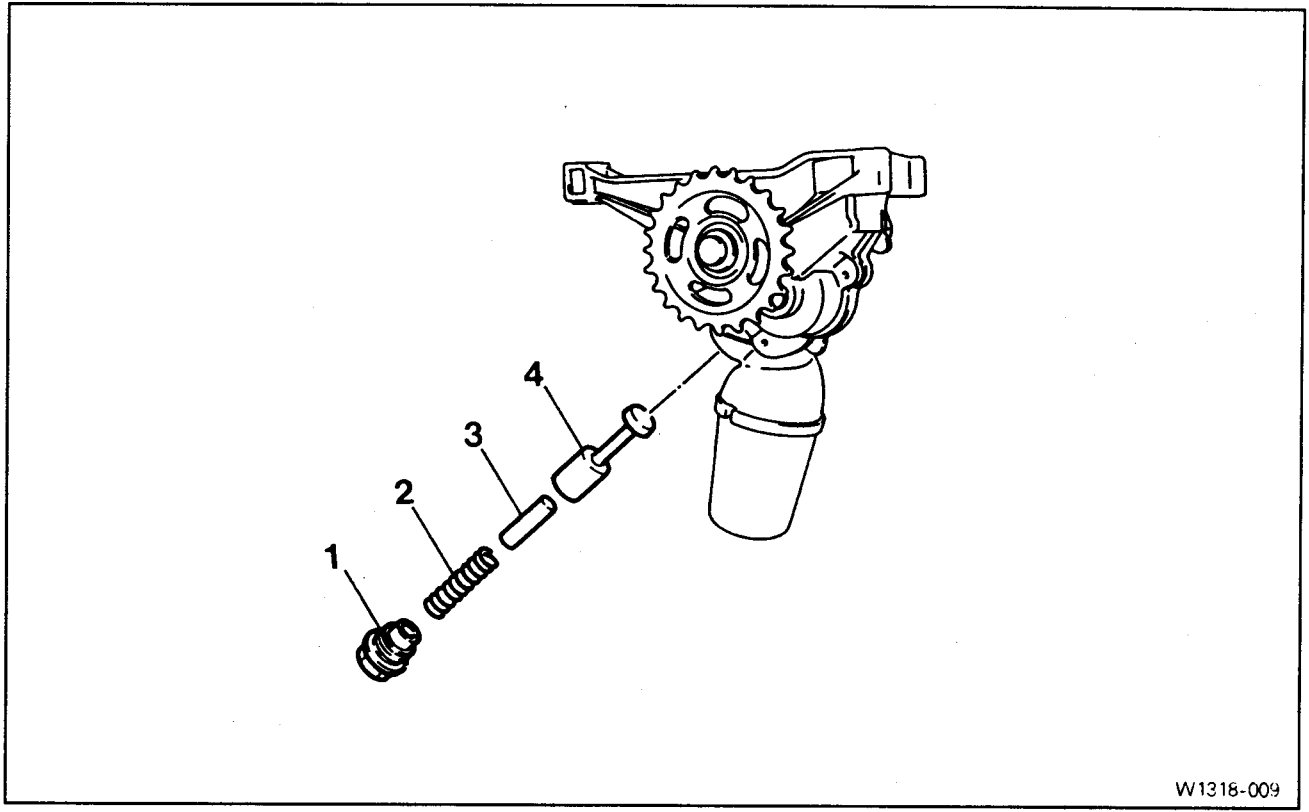
[Note] For installation, tighten the 2 bolts of oil shield first and tighten the 1 bolt.

3) Replace the strainer of oil pump.

4) Installation is reverse order of the removal.

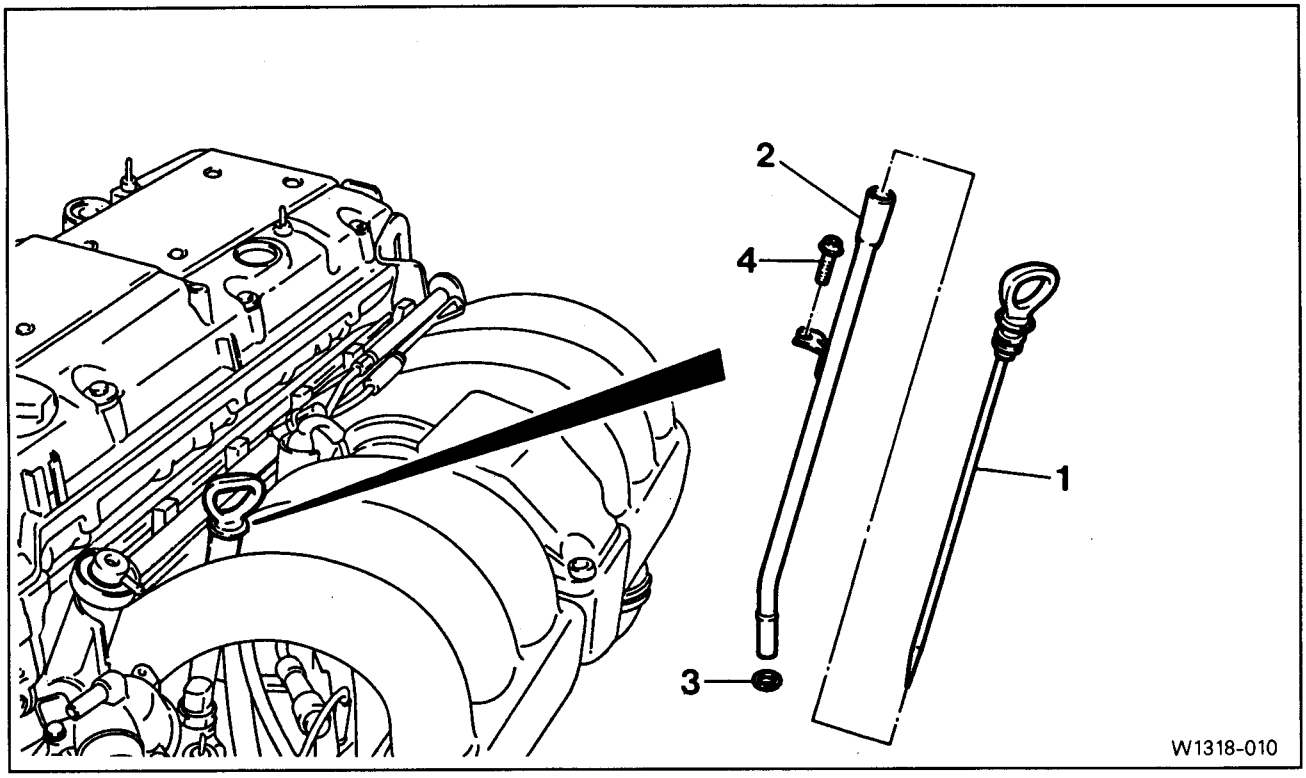
5. Disassembly and Assembly of Oil Pressure Relief Valve

Preceding work : Removal of oil pump (18-06)



1. Screw Plug----------50Nm
2. Compression Spring
3. Guide Pin
4. Piston

6. Removal and Installation of Oil Dipstick Guide Tube

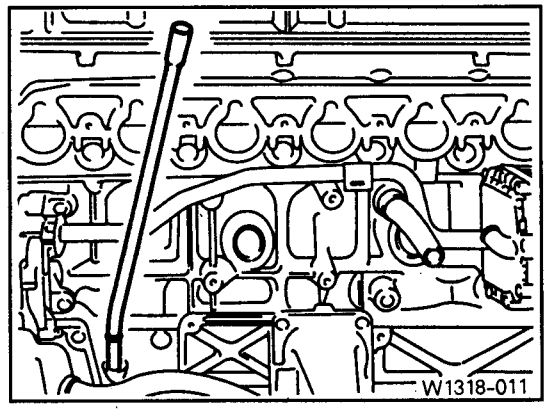


1. Oil Dipstick Level Gauge
2. Oil Dipstick Guide Tube
3. O-Ring----------Replace
4. Bolt----------9~11Nm

Removal · Installation

1) Remove the oil dipstick level gauge (1).

2) Remove the bolt (4) from the upper resonance intake manifold and remove the oil dipstick guide tube (2).



Installation

Tightening torque	9~11Nm

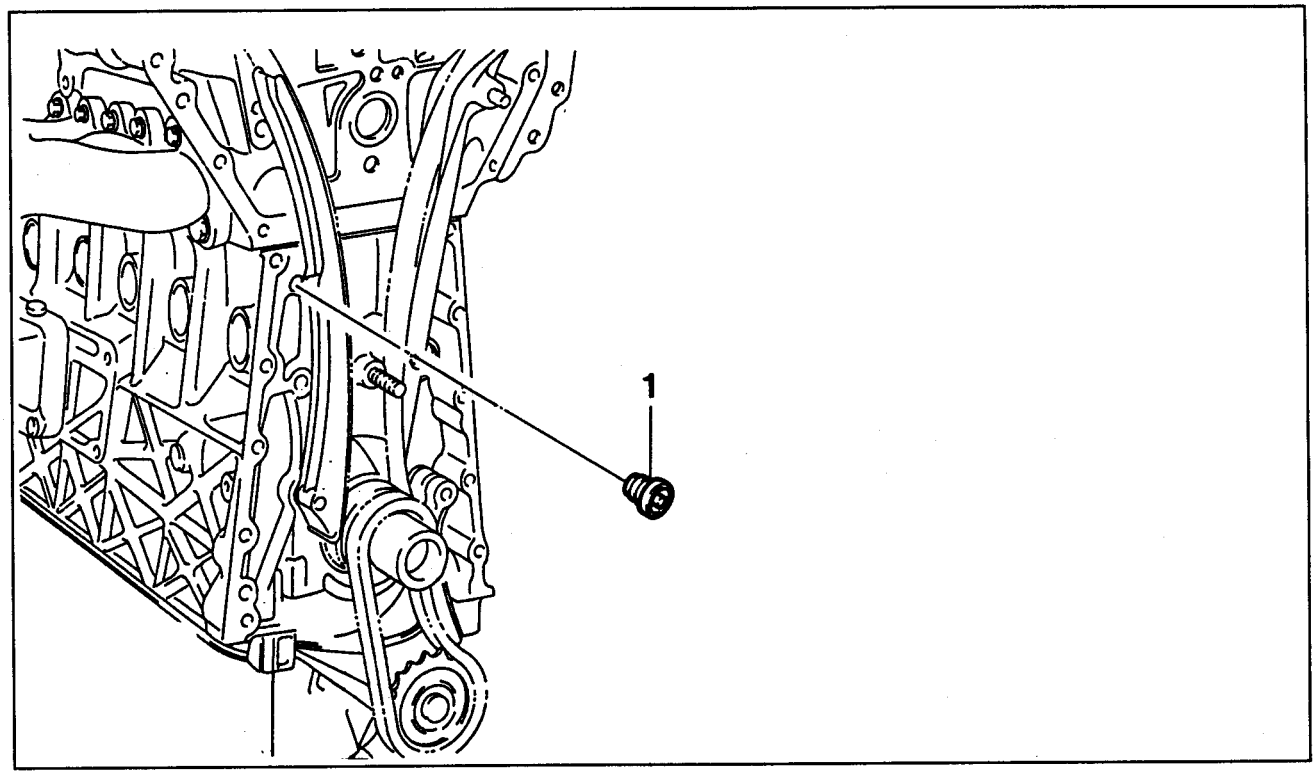
3) Replace the O-ring.

4) Installation is reverse order of the removal.

5) Turn engine and check the engine for leaks.

7. Replacement of Oil Non-Return Valve

Preceding work : Removal of timing case cover (01-29)

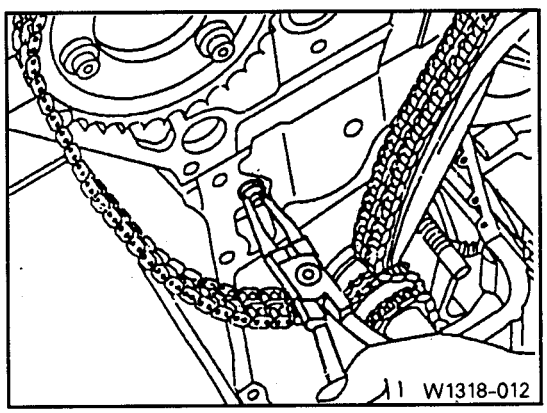


1. Oil Non-Return Valve

Replacement

1) Remove the non-return valve by using a proper pliers.
[Note] For installation, insert the new oil non-return valve by hand.

2) Function
- The non-return valve prevents the chain tensioner running dry when the engine is stopped.



1. Draining and Filling of Coolant

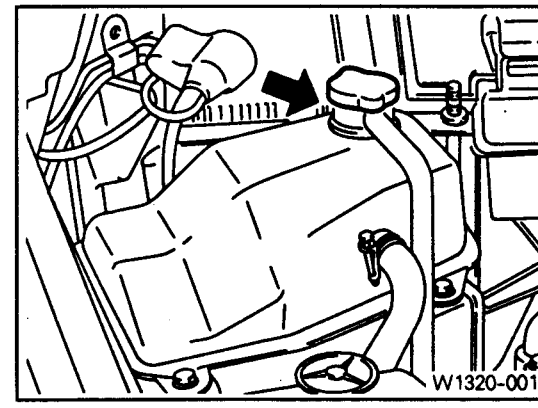
Preceding work : Removal of under cover

Specifications

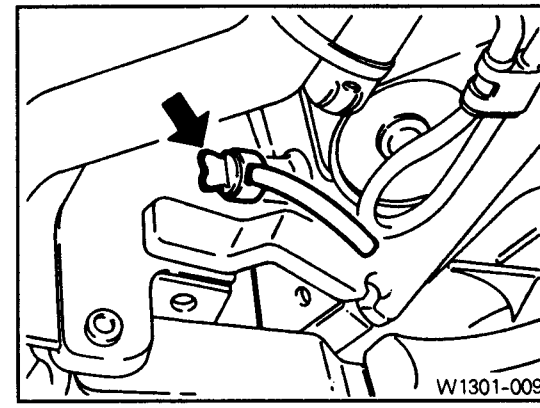
Specification	MB anti-freeze ALUTEC - P78
Mixing ratio (water : anti-freeze, by volume)	50 : 50
Coolant capacity	11.3 ℓ

Draining and filling

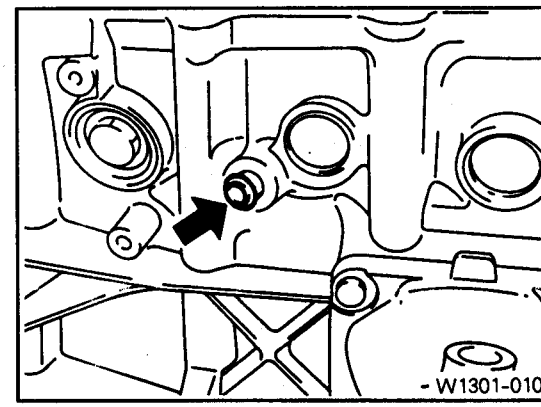
1) Turn the cap by 1 notch and release pressure and remove the cap.
   [Note] For the risk of scalding, cap must not be opened unless the coolant temperature is below 90℃.



2) Loosen the radiator lower drain cock and drain the coolant.
   [Note] Collect coolant by using a proper container.



3) Drain the coolant from the crankcase by inserting a hose (dia. 14mm) onto the crankcase drain bolt (exhaust manifold) and by loosening the plug.
   [Note] · Just loosen the drain plug to drain the coolant and do not remove the plug completely.
   · Collect coolant by using a proper container.



4) After coolant drain, remove the hose and reinstall the plug.

Tightening torque	30Nm

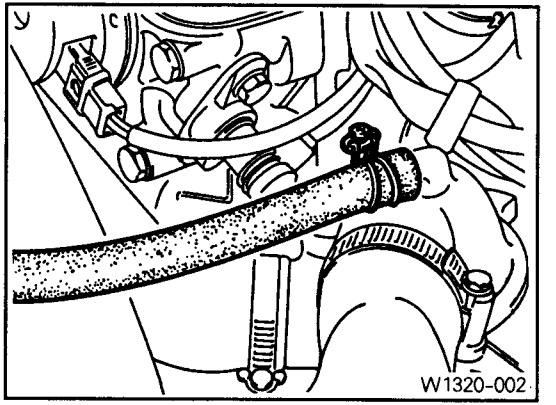
5) Tighten the radiator lower drain cock.

6) Remove the de-aeration hose clamp of the coolant pump and then remove the de-aeration hose.

7) Fill up coolant through subtank.

[Note] · **Mixing ratio (water : anti-freeze) by volume : 50 : 50.**

· **Fill up coolant until coolant is overflowed through de-aeration hose.**



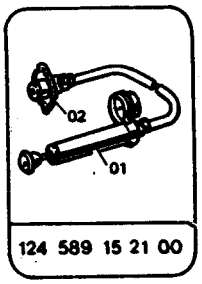
8) Install the de-aeration hose and tighten the clamp.

9) Check coolant level in the subtank.

10) Warm up (until thermostat is opened) the engine and recheck the coolant level in the sub tank and replenish if

2. Cooling System Leakage Test

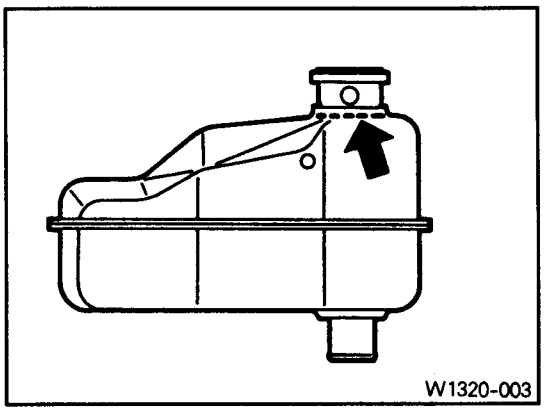
Special Tool



Inspection

1) Turn the cap by 1 notch and release pressure and remove the cap.
   [Note] For the risk of scalding, cap must not be opened unless the coolant temperature is below 90℃.

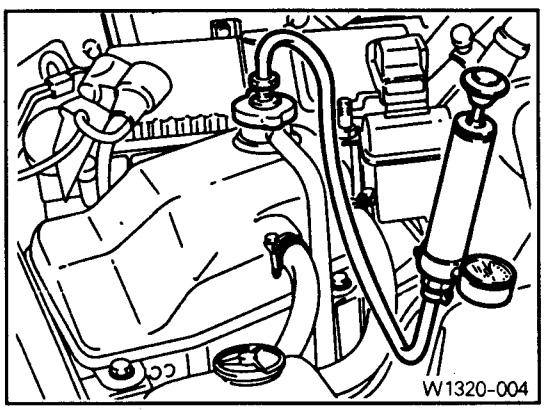
2) Fill coolant up to upper edge (arrow) of reservoir.



3) Connect the special tool to the reservoir filler cap and apply 1.4bar of pressure.

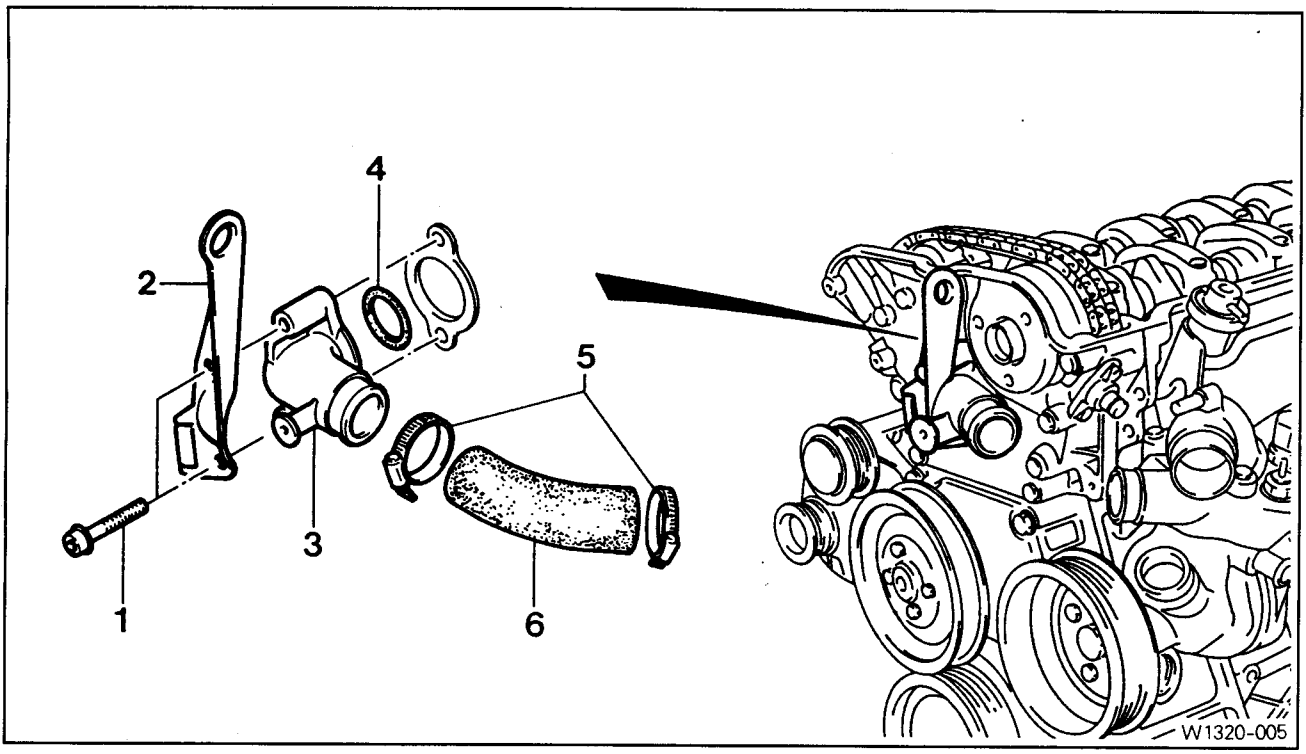
   Tester 124 589 15 21 00

4) If the pressure on the tester drops, check leakage at the all coolant hoses and pipes and each connections. Replace or retighten if necessary.



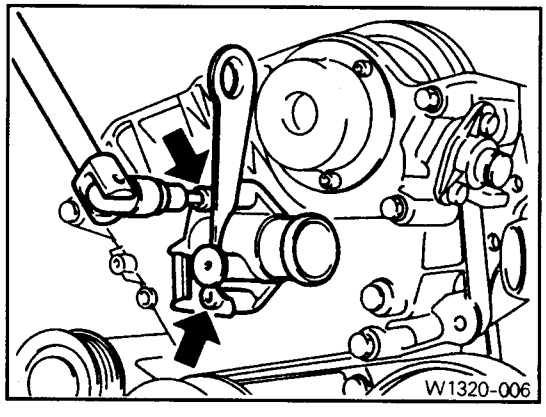
3. Removal and Installation of Coolant Connection Fitting

Preceding work : Removal of cooling fan shroud (20-09)



1. Bolt----------23Nm
2. Engine Hanger Bracket
3. Coolant Connection Fitting
4. O-Ring----------Replace
5. Clip
6. Hose

Removal · Installation



1) Drain coolant from the radiator (20-01).

2) Remove the hose clip (5) and disconnect the hose (6).

3) Remove the bolt (1) and then remove the engine hanger bracket (2) and coolant connection fitting (3).

Installation

Tightening torque	23Nm

[Note] Replace the O-ring (4).

4) Installation is reverse order of the removal.

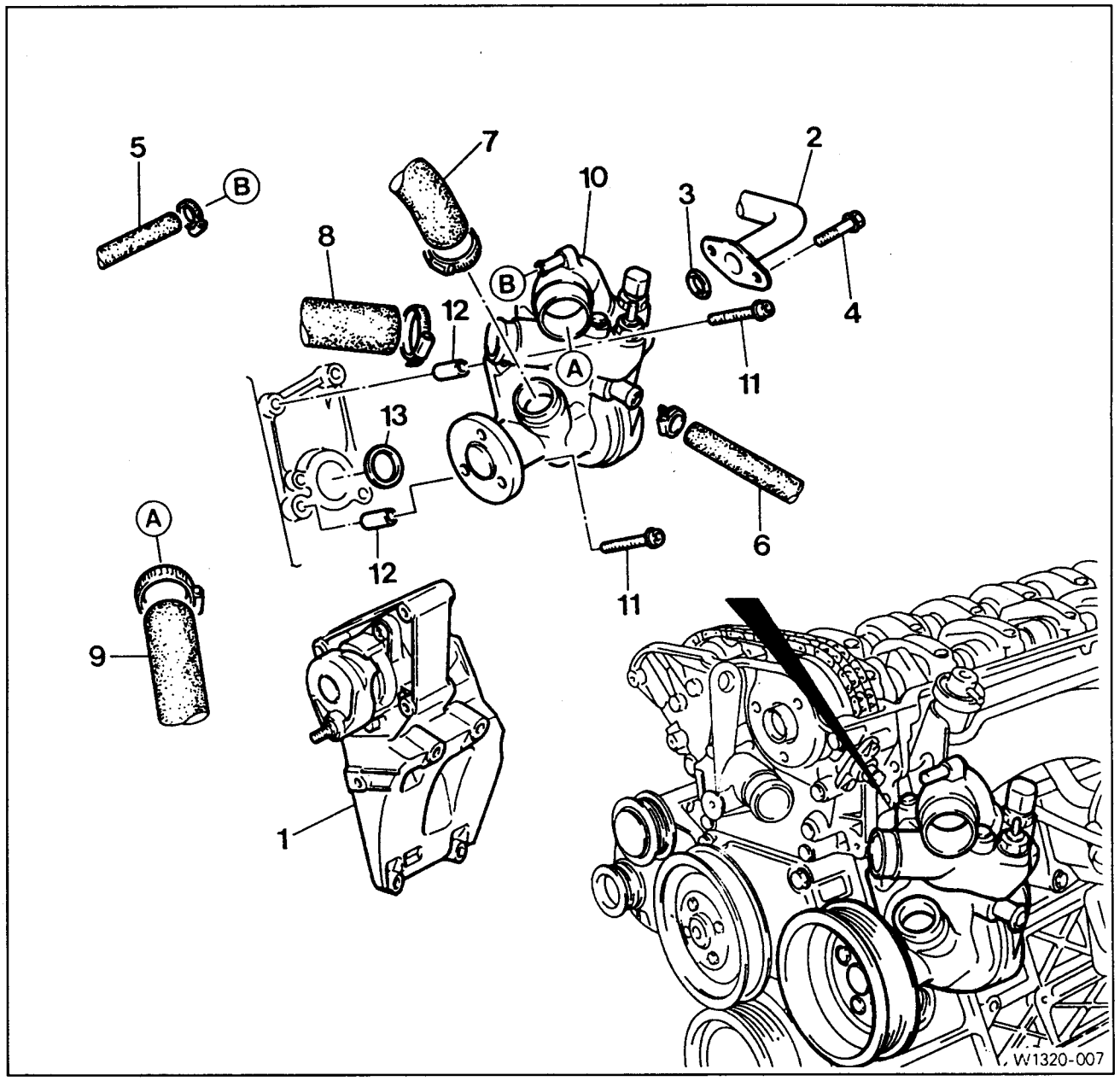
5) Replenish coolant (20-01).

6) Do cooling system leakage test (20-03).

4. Removal and Installation of Coolant Pump

Preceding work : Removal of V-belt (13-01)

Removal of air admission housing (01-16)



1. Air Admission Housing
2. Oil Cooler Pipe Line
3. Seal----------Replace
4. Bolt----------9~11Nm
5. Coolant Hose
6. Coolant Hose
7. Outlet Coolant Hose
8. Coolant Hose
9. Inlet Coolant Hose
10. Coolant Pump
11. Bolt----------21Nm
12. Dowel Sleeve
13. Seal----------Replace

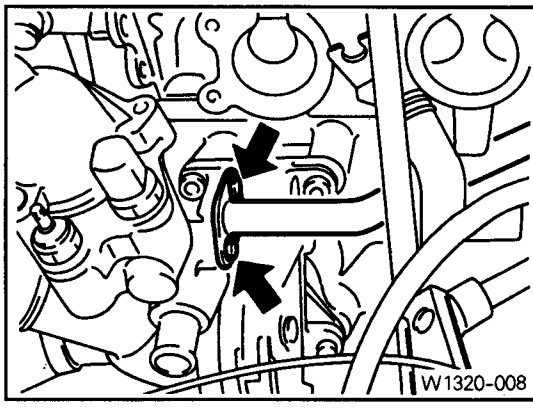
Removal · Installation

1) Drain the coolant (20-01).

2) Disconnect the coolant pump wire connector.

3) Loosen the hose clip and disconnect all hoses from the coolant pump.

4) Remove the coolant line bolts (4) and then remove the coolant line (2).

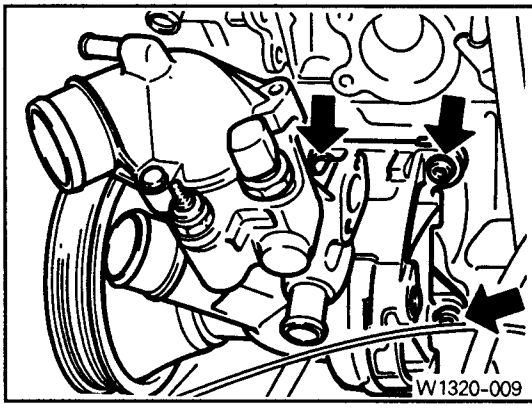


Installation

Tightening torque	9~11Nm

[Note] Replace the seal (3).

5) Remove the mounting bolts (11) and carefully pull out coolant pump (10).



Installation

Tightening torque	21Nm

[Note] Replace the seal (13).

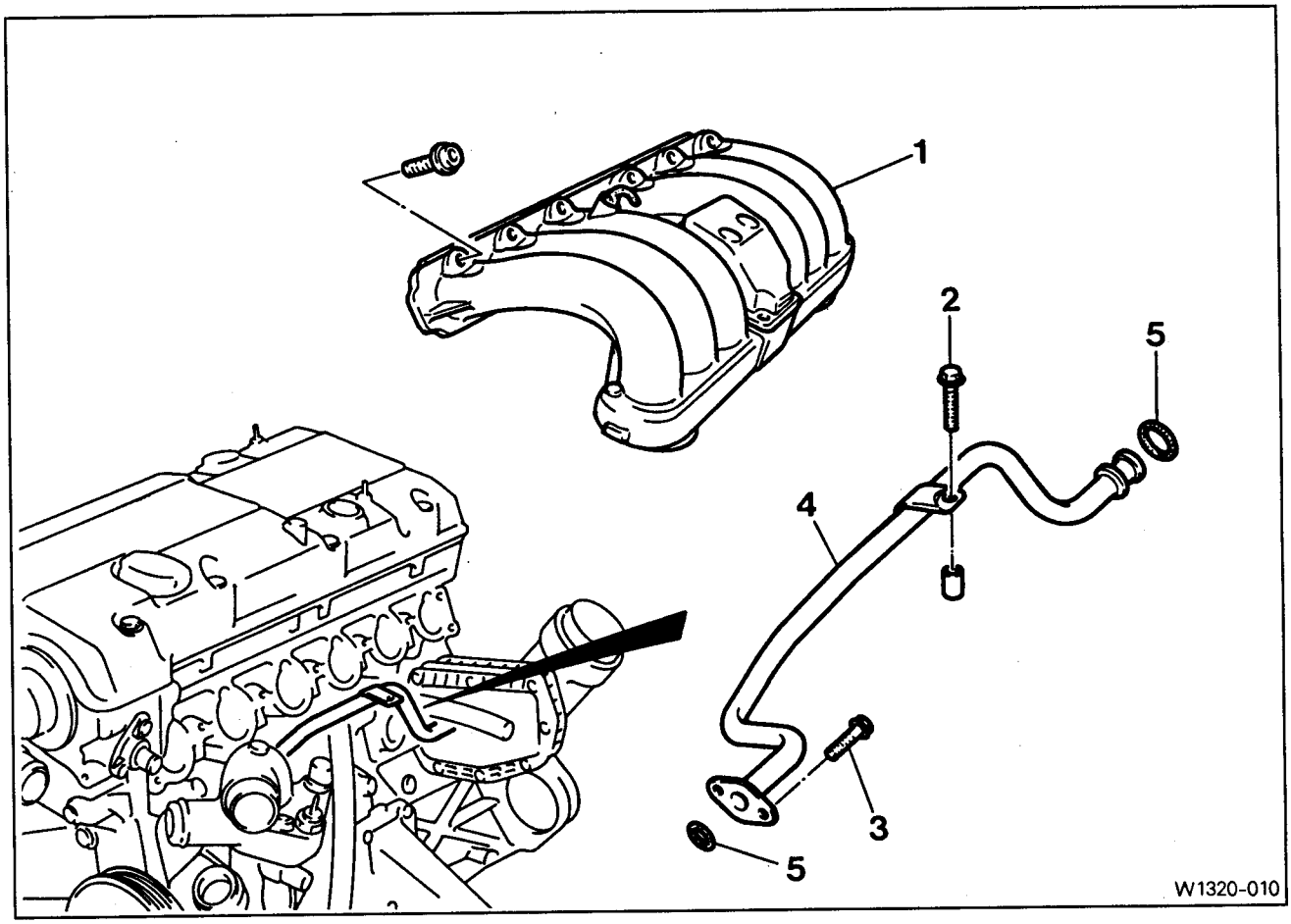
6) Installation is reverse order of the removal.

7) Fill up coolant (20-01).

8) Do cooling system leakage test (20-03).

5. Removal and Installation of Coolant Line

Preceding work : Removal of upper intake manifold (14-01)

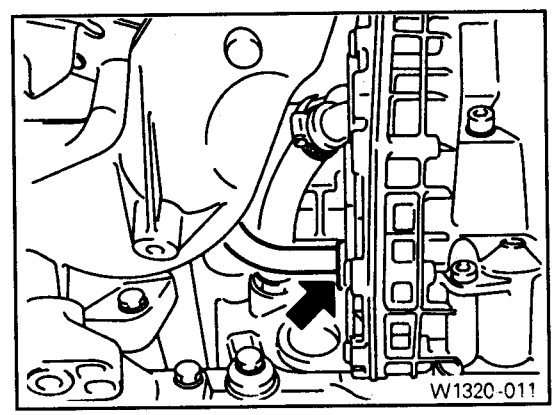


1. Upper Intake Manifold
2. Bolt----------10Nm
3. Bolt----------10Nm
4. Coolant Line
5. Seal ----------Replace

Removal · Installation

1) Drain the coolant.

2) Remove the bolts (2, 3) and then remove the coolant pipe (4).



Installation

Tightening torque	10Nm

[Note] Replace the coolant pump and heat exchanger seals.

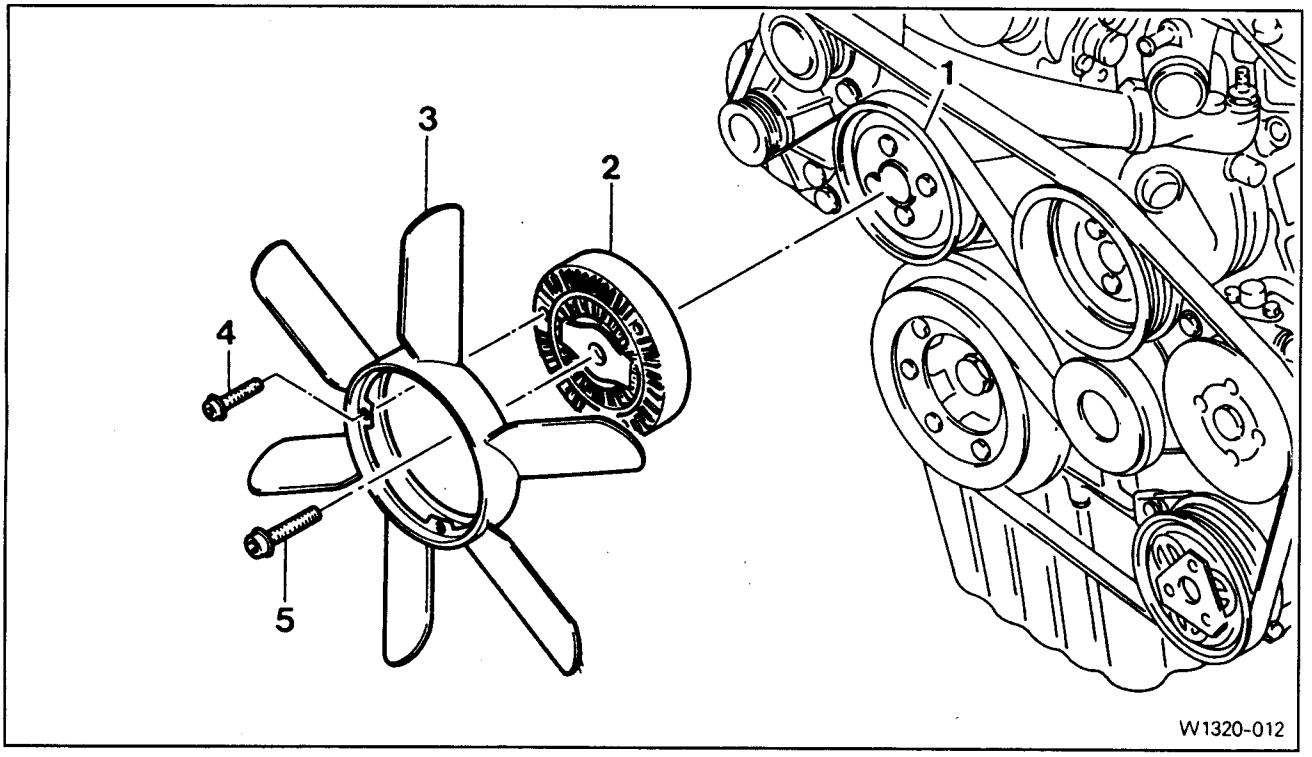
3) Installation is reverse order of the removal.

4) Fill up coolant.

5) Do cooling system leakage test (20-03).

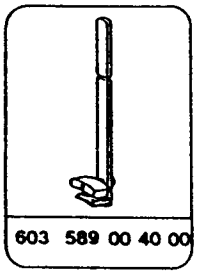
6. Removal and Installation of Cooling Fan and Viscous Clutch

Preceding work : Removal of cooling fan shroud (20-09)



1. Cooling Fan Pulley
2. Viscous Clutch
3. Cooling Fan
4. Bolt----------10Nm
5. Bolt----------45Nm

Special Tool



Removal · Installation

1) Using the counter holder (special tool), hold the belt pulley. Remove the 3 bolts (4) and then remove the cooling fan.

Installation

Tightening torque	10Nm

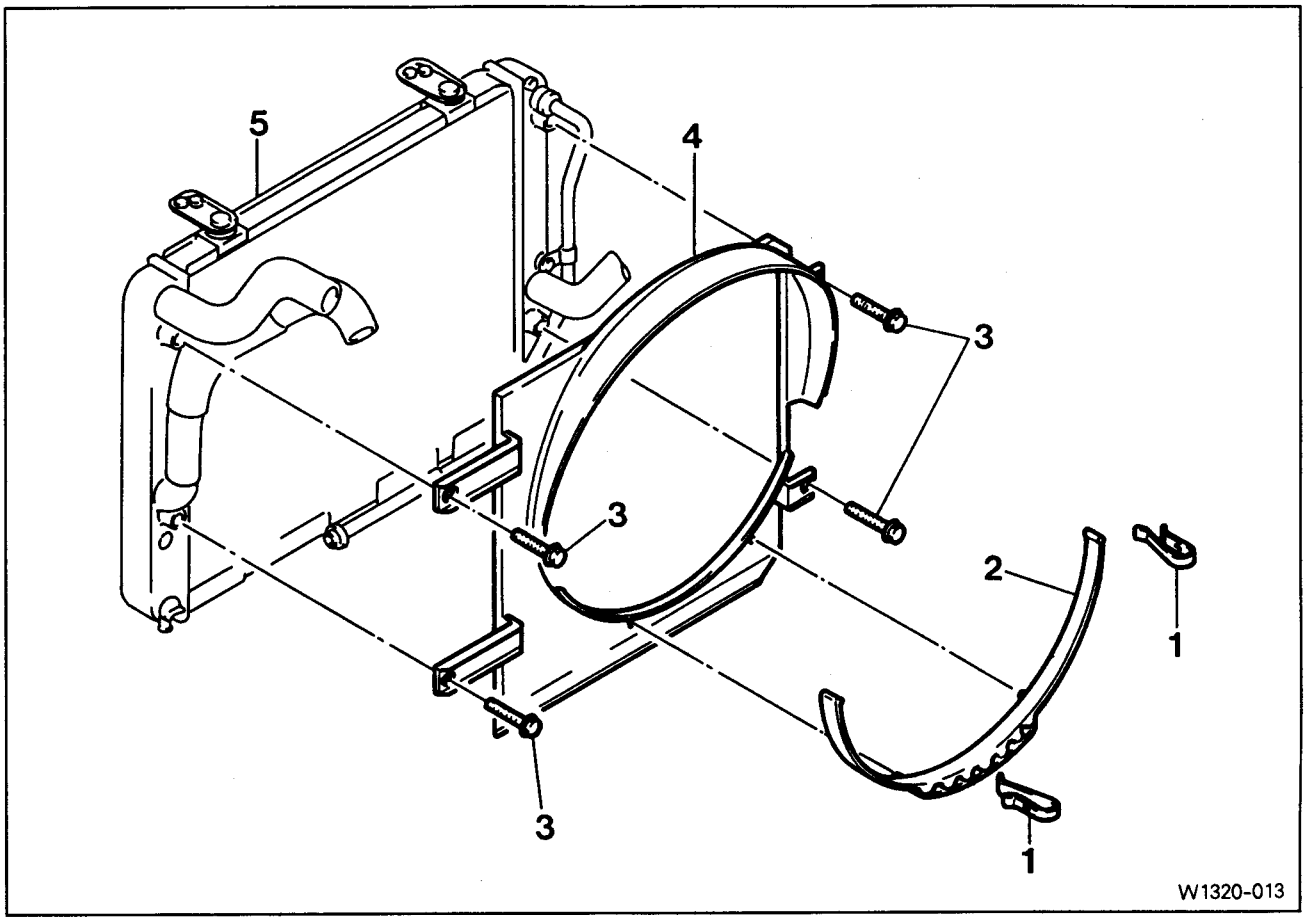
2) Remove the viscous clutch bolt (5) and then remove the clutch from the cooling fan pulley.

Installation

Tightening torque	45Nm

3) Installation is reverse order of the removal.

7. Removal and Installation of Cooling Fan Shroud



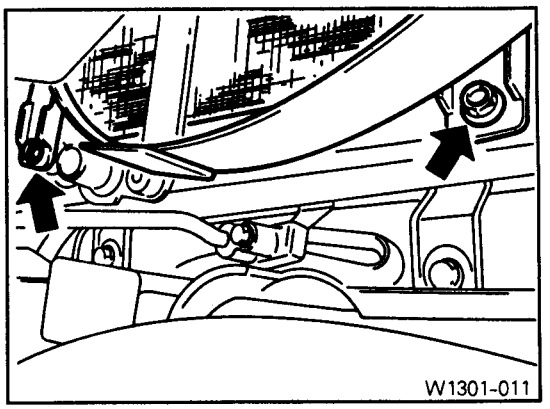
1. Clip
2. Lower Fan Shroud
3. Bolt
4. Fan Shroud Assembly
5. Radiator

Removal · Installation

1) Pull out the 2 clips (1) from the fan shroud assembly.

2) Remove the lower fan shroud (2).
[Note] For installation, exactly align the lower fan shroud pin into the hole of the fan shroud assembly (4) and insert the clips.

3) Remove the bolts (3) and then remove the cooling fan shroud assembly (4).



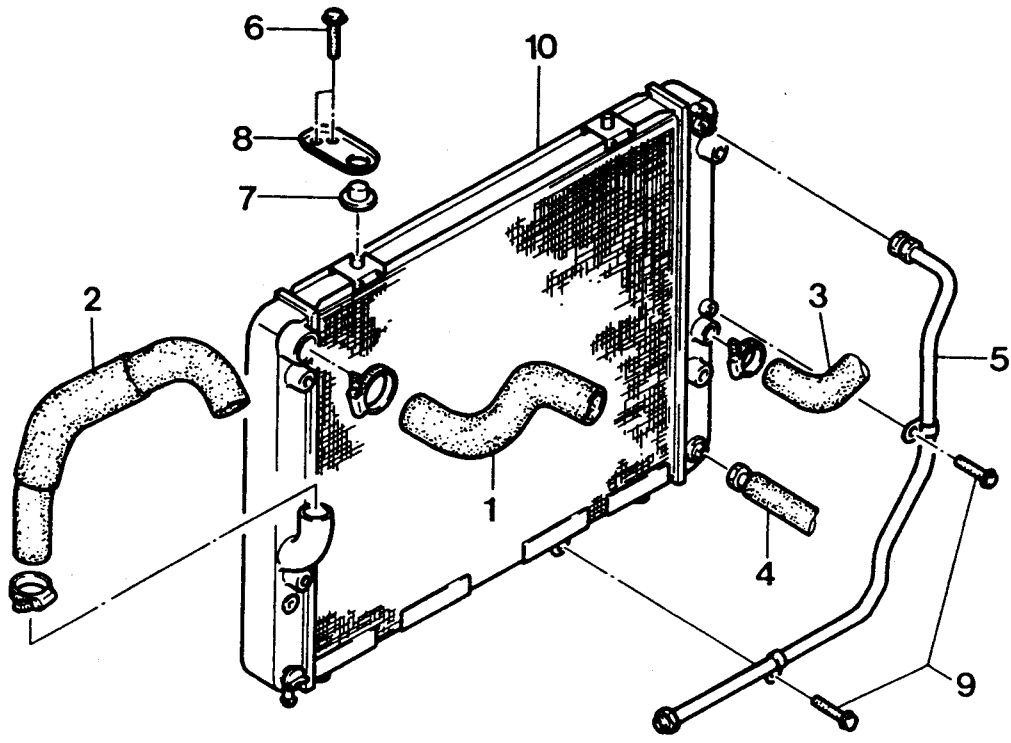
Installation

Tightening torque	7Nm

4) Installation is reverse of the removal.

8. Removal and Installation of Radiator

Preceding work : Removal of cooling fan shroud (20-09).



W

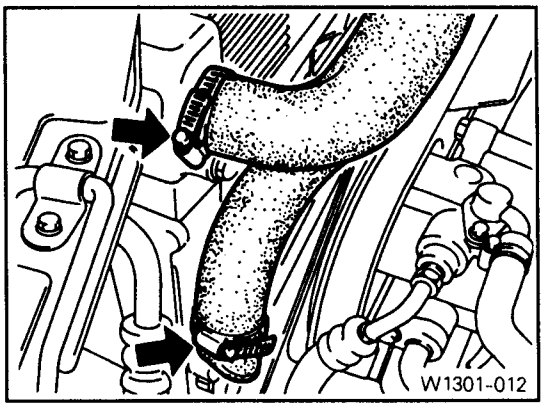
1. Inlet Coolant Hose
2. Outlet Coolant Hose
3. Make Up Coolant Hose
4. Automatic Transmission Oil Cooling Hose
5. Automatic Transmission Oil Cooling Line
6. Bolt
7. Insulator
8. Radiator Bracket
9. Bolt----------7Nm
10. Radiator

Removal · Installation

1) Drain coolant from the radiator (20-01).

2) Remove the coolant thermo connector from the radiator.

3) Remove the each coolant hoses.



4) Remove the automatic transmission oil cooling hose (4).

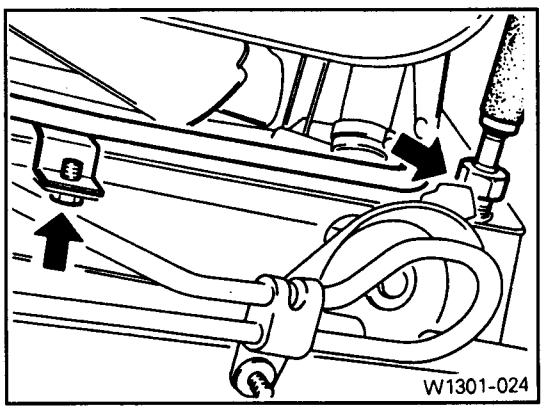
Installation

Tightening torque	20Nm

5) Remove the automatic transmission oil cooling line bolts and then remove the oil cooling line (5).

Installation

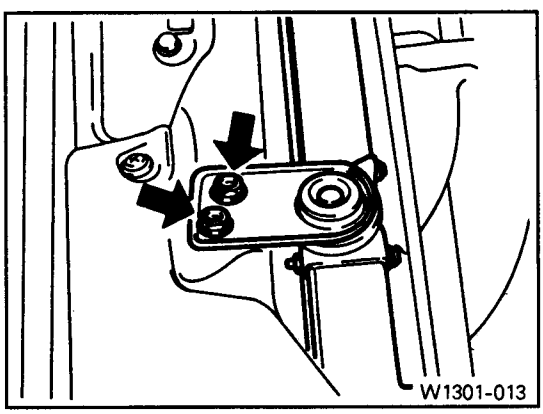
Tightening torque	7Nm



6) Remove the radiator upper mounting bolts (6) and then remove the bracket (8) and insulator (7).

7) Remove the radiator (10).

8) Check the radiator pin for crack, damage, leakage and bending and replace if necessary.



9) Installation is reverse order of the removal.

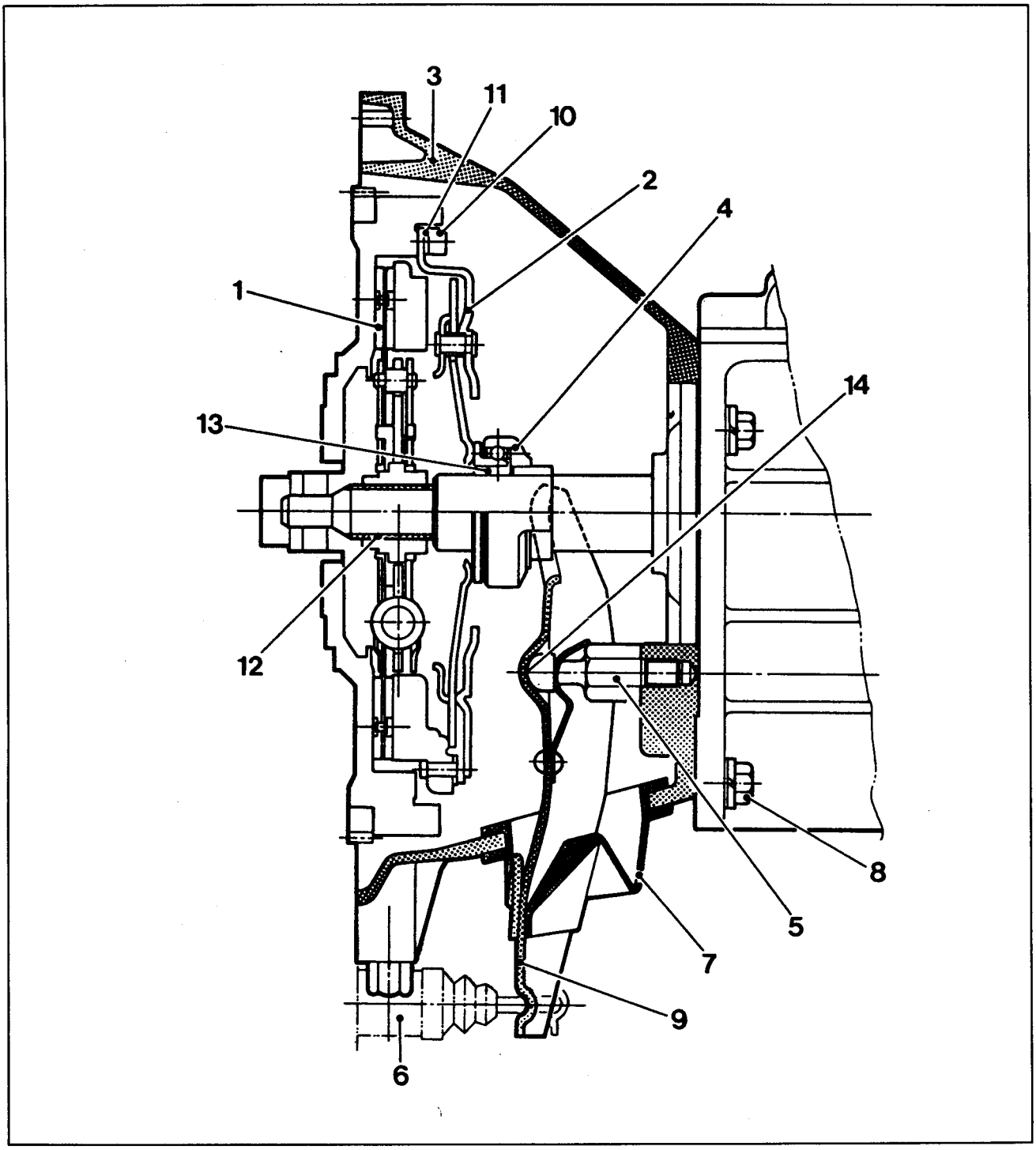
10) Do cooling system leakage test (20-03).

1. General

Specifications

Type			Hydraulic
Clutch pedal	Type		Suspended type
	Max. pedal stroke		158mm
	Pedal free play		5~10mm
Clutch disc	Type		Single dry diaphragm
	Facing size (O.D. × I.D. × T)		225 × 150 × 4.0 (mm)
	Facing area and quantity		221㎠ × 1 EA
	Thickness of disc	Free	9.85~10.2mm
		With load	9.2mm
Full load of the clutch cover assembly	OM 661 engine		430kg
	OM 662 engine		520kg
Clutch master cylinder	Stroke		19.8mm
	Inner diameter		ϕ 15.87mm
Clutch release cylinder	Stroke		14.0mm
	Inner diameter		ϕ 17.46mm
Clutch fluid			SAE J1703 / DOT3

Sectional view



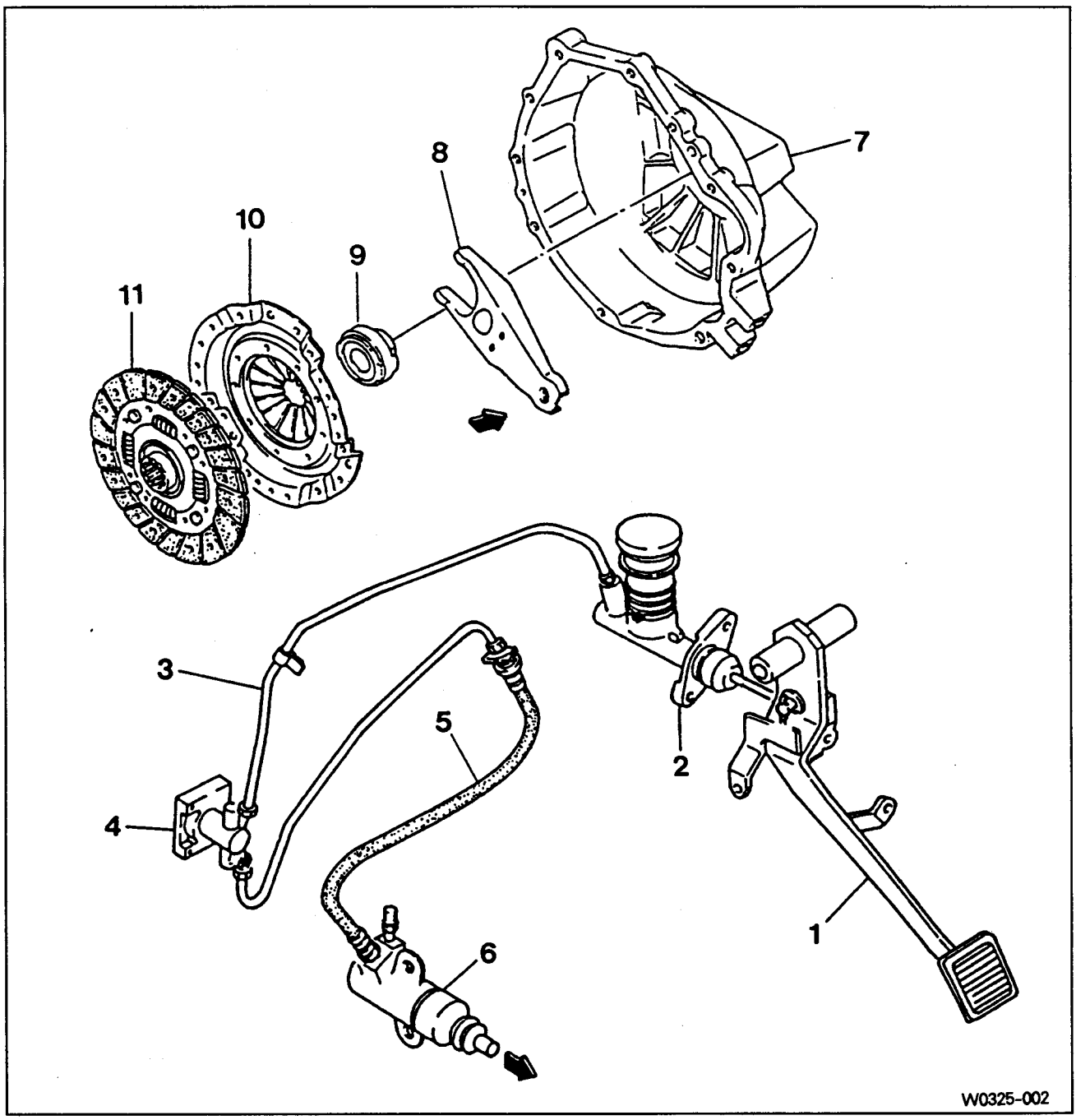
1. Clutch Disc
2. Clutch Cover
3. Clutch Housing
4. Release Bearing
5. Release Fork Pivot---------- 40Nm
6. Release Cylinder
7. Release Fork Boot
8. Bolt---------- 82Nm
9. Release Fork
10. Bolt---------- 24Nm
11. Spring Lock Washer
12. Transmission Input Spline---------- 1.5~2g
13. Release Bearing Contacting Surface------- 1~1.5g
14. Contacting Point of Release Fork and Pivot---------- 1~1.5g

[Note] Apply the long-term grease (DBL 6811.00) to No. 12, 13 and 14.

2. Troubleshooting

Problem		Possible Cause	Remedy
Clutch slips . Vehicle speed is dragging . Vehicle speed does not meet engine RPM during up - hill acceleration		Excessive wear of facing	Replace
		Hard or oily facing	Repair or replace
		Damaged pressure plate or flywheel	Replace
		Damaged or burnt diaphragm spring	Replace
		Clutch pedal freeplay insufficient	Adjust
		Faulty operation of clutch pedal	Repair or replace
		Worn or damaged clutch disc	Replace
Poor disengagement		Vibration or excessive run - out of disc	Replace
		Rust or wear of disc spline	Repair or replace
		Oily facing	Repair or replace
		Damaged diaphragm spring	Replace
		Excessive clutch pedal freeplay	Adjust
Hard to shift or will not shift		Excessive clutch pedal freeplay	Adjust pedal freeplay
		Faulty clutch release cylinder	Repair release cylinder
		Worn disc, excessive run - out, damaged lining	Repair or replace
		Dirty or burred splines on input shaft or clutch disc	Repair as necessary
		Damaged clutch pressure plate	Replace
Clutch chatters when starting		Oily facing	Repair or replace
		Hard or faulty facing	Replace
		Burnt torsion spring	Replace
		Faulty pressure plate	Replace
		Bent clutch diaphragm spring	Replace
		Hard or bent flywheel	Repair or replace
		Engine mounts loose or burnt lever	Tighten or replace
Clutch pedal difficulty		Poor lubrication on clutch cable	Lubricate or replace
		Poor lubrication on pedal shaft	Lubricate or replace
		Poor lubrication on clutch pedal	Repair
Clutch noisy	Not using the clutch	Insufficient clutch pedal freeplay	Adjust
		Excessive wear of facing	Replace
	After disengagement	Worn or damaged release bearing	Replace
	When disengaging	Poor lubrication on contact surface of bearing	Replace
		Faulty installation of clutch assembly or bearing	Repair
	Clutch pedal is partially depressed and vehicle speed is reduced	Damaged pilot bushing	Replace

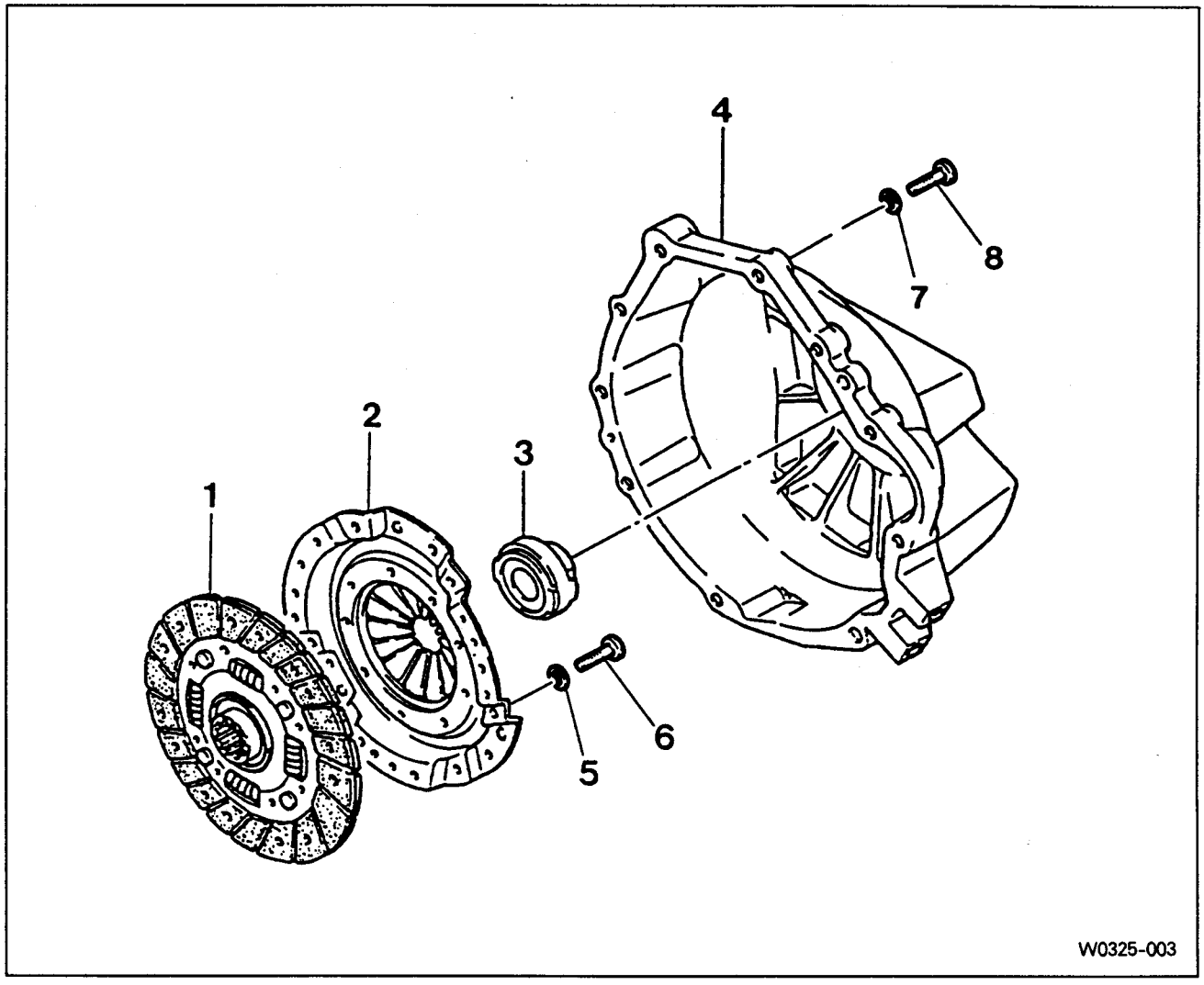
3. Clutch System Components



1. Clutch Pedal
2. Clutch Master Cylinder
3. Clutch Tube
4. Clutch Damper
5. Clutch Hose
6. Release Cylinder
7. Clutch Housing
8. Release Fork
9. Release Bearing
10. Clutch Cover
11. Clutch Disc

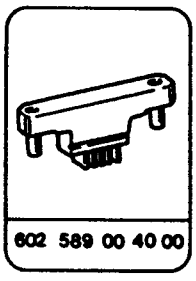
4. Removal and Installation of Clutch Disc

Preceding work : Removal of the transmission (26-03)



1. Clutch Disc
2. Clutch Cover
3. Release Bearing
4. Clutch Housing
5. Washer
6. Bolt----------35Nm
7. Washer
8. Bolt----------47Nm

Special Tools

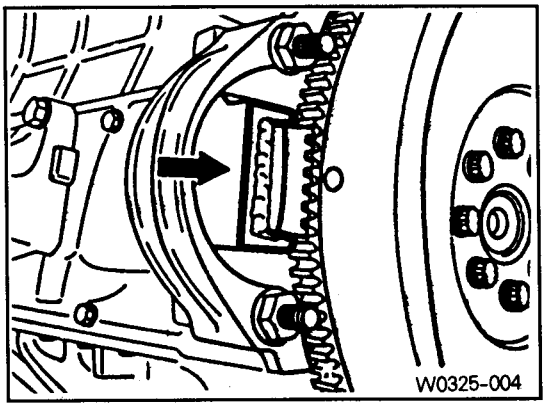

602 589 00 40 00


661 589 00 15 00

Removal · Installation

1) Remove the starter motor. Install the special tool to the flywheel through the starter motor mounting holes.

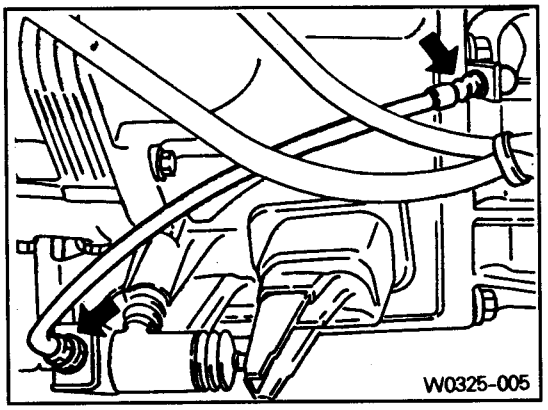
Engine lock 602 589 00 40 00



2) Remove the release cylinder mounting bolts.
Remove the release cylinder.

Installation

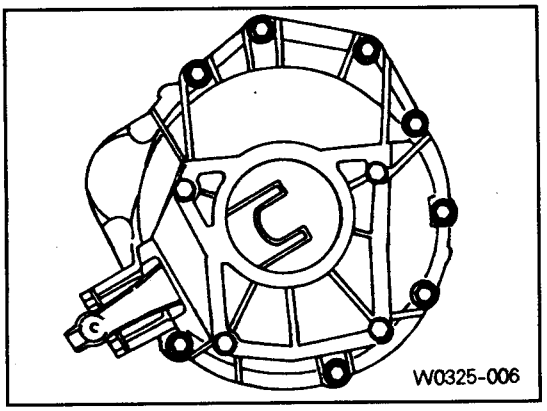
Tightening torque	30~40Nm



3) Remove the clutch housing bolts.
Remove the clutch housing, release fork and release bearing.

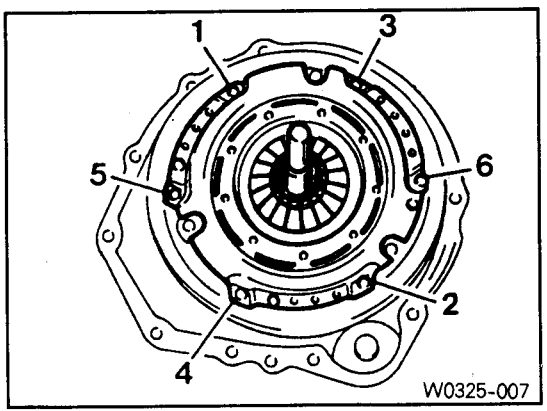
Installation

Tightening torque	47Nm



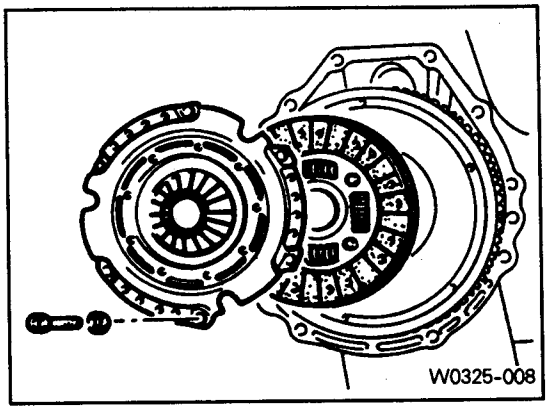
4) Insert the SST into the clutch spline.
Loosen the clutch cover bolts 1/2 turn in crisscross order until the spring tension is released.
[Note] Do not remove the bolts at a time, or clutch cover can be damaged or deformed.

Centering pin 661 589 00 15 00



5) Remove the bolts. Remove the clutch cover, pressure plate and clutch disc.

[Note] Be careful not to drop the pressure plate and clutch disc.



Installation

Tightening torque	35Nm

6) Installation is reverse order of the removal.

[Note] · **Before installation, clean oil and grease on the flywheel surface.**

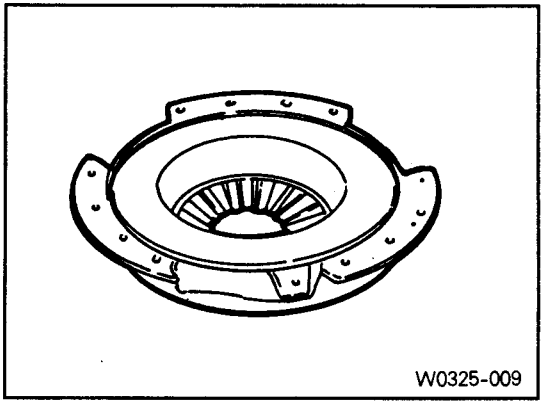
· **Do not clean the clutch disc and release bearing in solvent.**

Inspection

1) Clutch cover
- Check the diaphragm spring tip for wear and height unevenness.

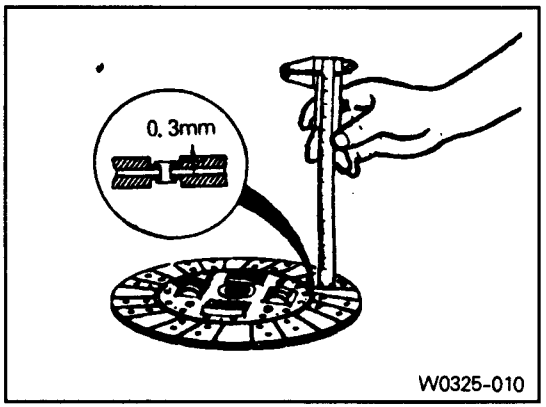
Unevenness limit	0.8mm

- Check the pressure plate surface for wear, crack and discoloration.
- Check the strap plate rivet for looseness and replace the clutch cover if loosened.


W0325-009

2) Clutch disc
- Check the facing for rivet looseness, excessive runout, sticks, oil and grease.
- Measure the rivet head depth.
  If out limit, replace the disc.

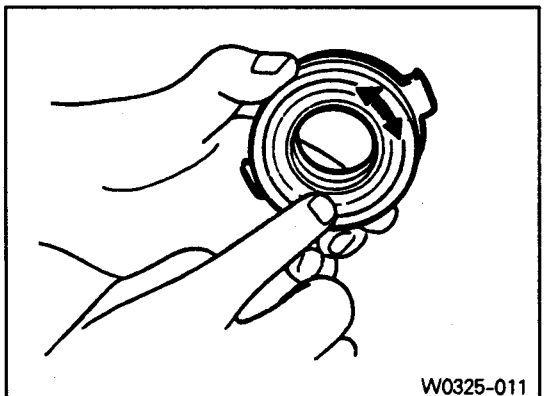
Wear limit	0.3mm



W0325-010

3) Clutch release bearing
- The release bearing is permanently lubricated and requires no cleaning.
- Check the bearing for sticks, damage, abnormal noise, turning drag and wear.

4) Release fork
- If there is abnormal wear in contact point with bearing, replace the release fork.


W0325-011

5. Bleeding of Clutch System

Bleeding procedure

[Note] Keep the fluid level over 'MAX' in reservoir during bleeding operation.
Do not let fluid contact a painted surface.

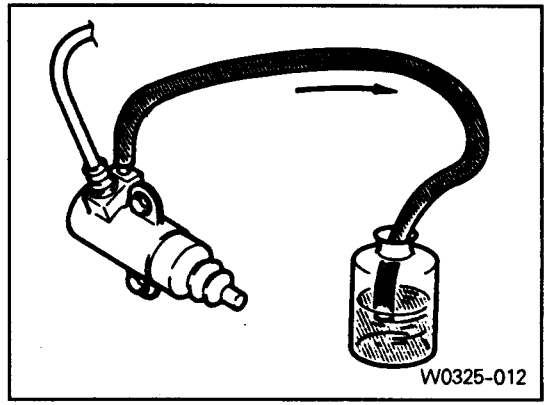
1) Remove the air bolt cap of the release cylinder.
   Connect a vinyl tube to the bolt.

2) Insert the other end of the tube in a vacant container.

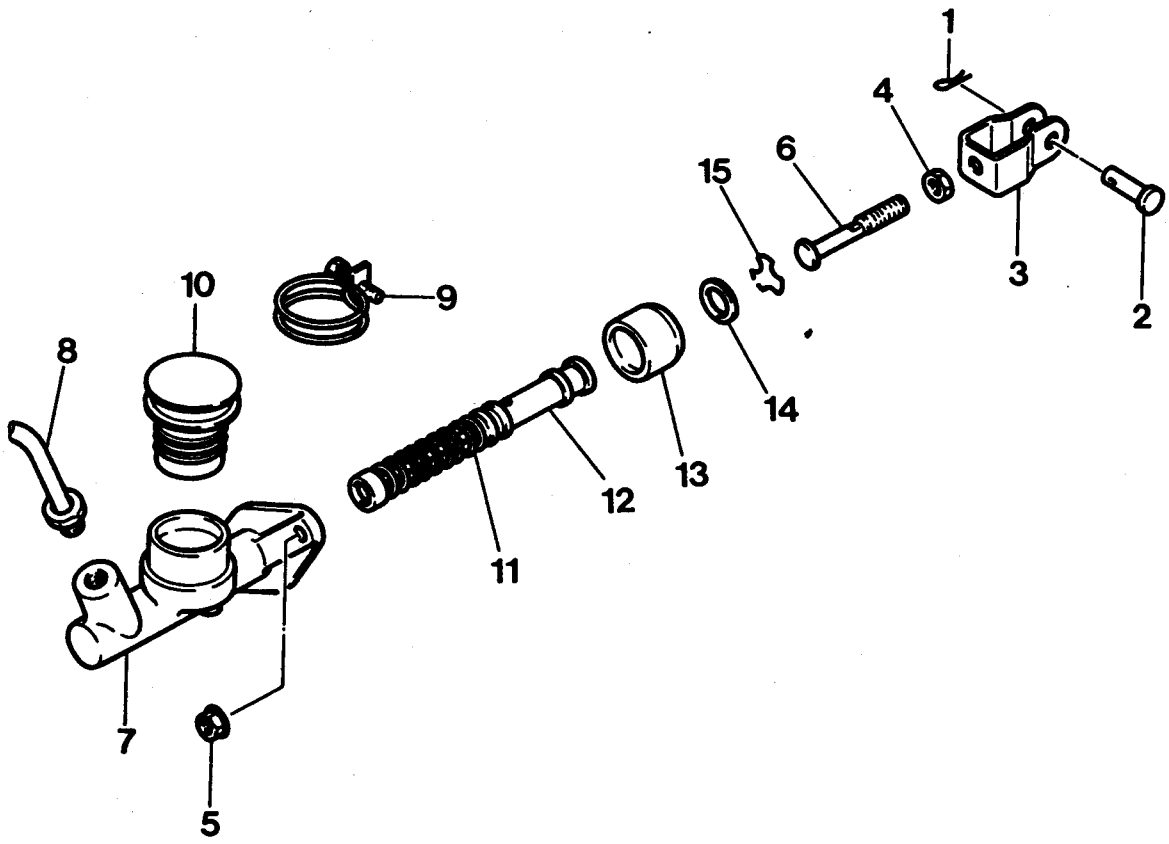
3) Slowly depress the clutch pedal several times.

4) With clutch pedal fully depressed, open the air bolt and release air and fluid in the fluid line.

5) Repeat this procedure until there are no more air bubbles in the fluid flows.



6. Removal and Installation of Master Cylinder

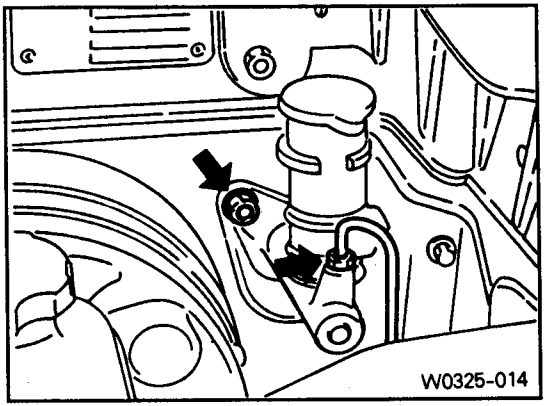


[Note] Do not disassemble the No. 12.

W0325-013

1. Snap Pin
2. Clevis Pin
3. Clevis
4. Lock Nut
5. Flange Nut---------- 30~40Nm
6. Push Rod
7. Cylinder Body
8. Clutch Tube---------- 15~18Nm
9. Clamp
10. Reservoir
11. Spring
12. Piston Assembly
13. Boot
14. Plate
15. Snap Ring

Removal · Installation



1) Draw out the fluid.

2) Pull out the snap pin and clevis pin from the clutch pedal connection.

3) Remove the clutch tube.

Installation

Tightening torque	15~18Nm

[Note] Be careful not the fluid contact a painted surface.

4) Remove the master cylinder mounting nuts and pull off the master cylinder.

Installation

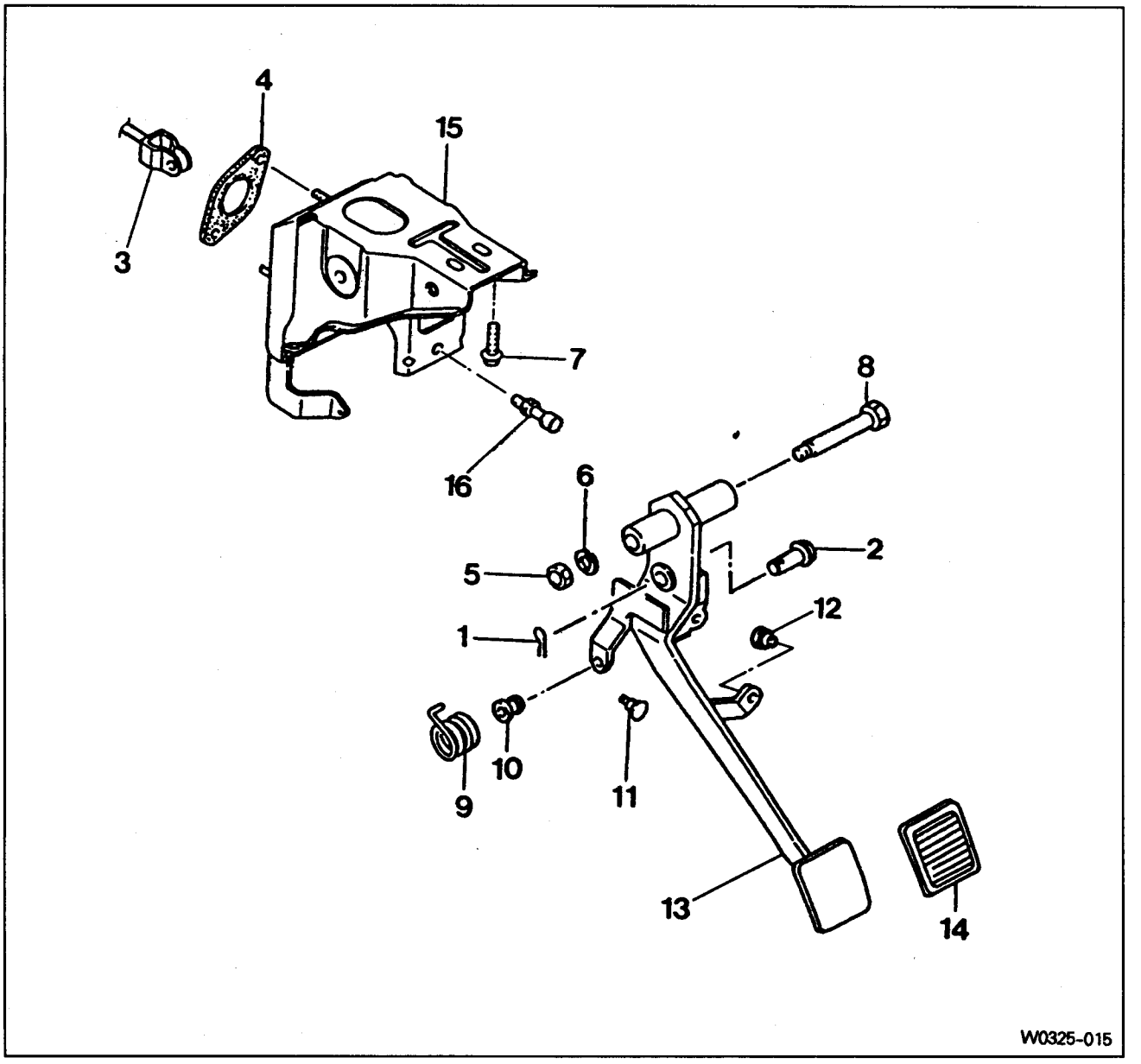
Tightening torque	30~40Nm

5) Installation is reverse order of the removal.

6) Check the clutch pedal operation.

7) Bleed the clutch system (25-09).

7. Removal and Installation of Clutch Pedal



<Disassembly>

1. Snap Pin---------- Replace
2. Clevis Pin---------- Apply Grease
3. Master Cylinder Push Rod
4. Gasket
5. Nut---------- 16~22Nm
6. Spring Washer
7. Bolt---------- 8~18Nm
8. Fulcrum Pin
9. Turn Over Spring---------- Apply Grease
10. Bushing---------- Replace
11. Full Stroke Stopper Contact Pad
12. Interlock Switch Stopper Pad
13. Clutch Pedal
14. Pedal Pad
15. Clutch Pedal Mounting Bracket
16. Stopper Bolt---------- 16~22Nm

[Note] Assembly is reverse order of the disassembly.

· Grease specification : Long - term grease (T/M DBL 6611.00)

Inspection

1) Pedal stroke (A)

Max. stroke	158mm

2) Pedal height (B)

Height (from the floor carpet)	192 ± 5mm

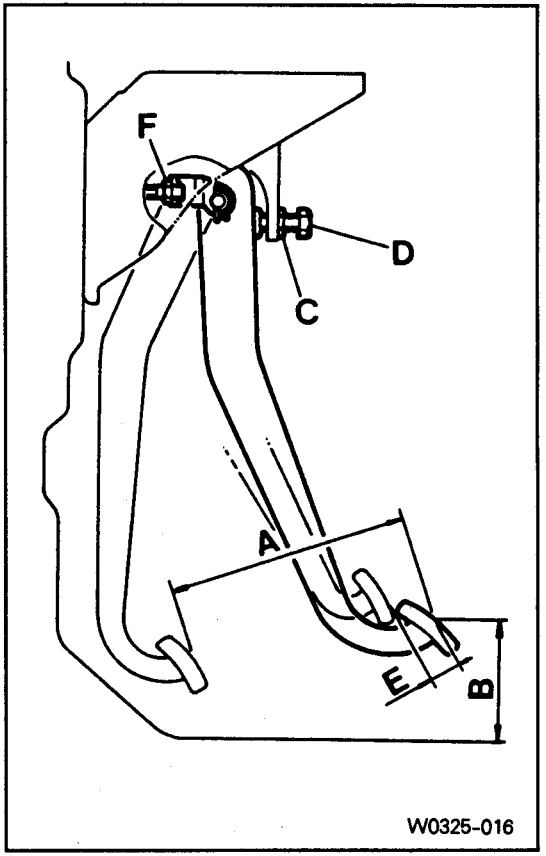
[Note] To adjust the pedal height, loosen the lock nut (C) of the stopper bolt (D) and turn the stopper bolt until the height is correct.
Tighten the lock nut.

3) Pedal free play (E)

Free play	5~10mm

[Note] To adjust the pedal free play, loosen the lock nut (F) of the master cylinder and turn the push rod until the free play is correct.
Tighten the lock nut.

4) Check the fulcrum pin and the bushing for wear, the pedal for bending and the spring for damage.



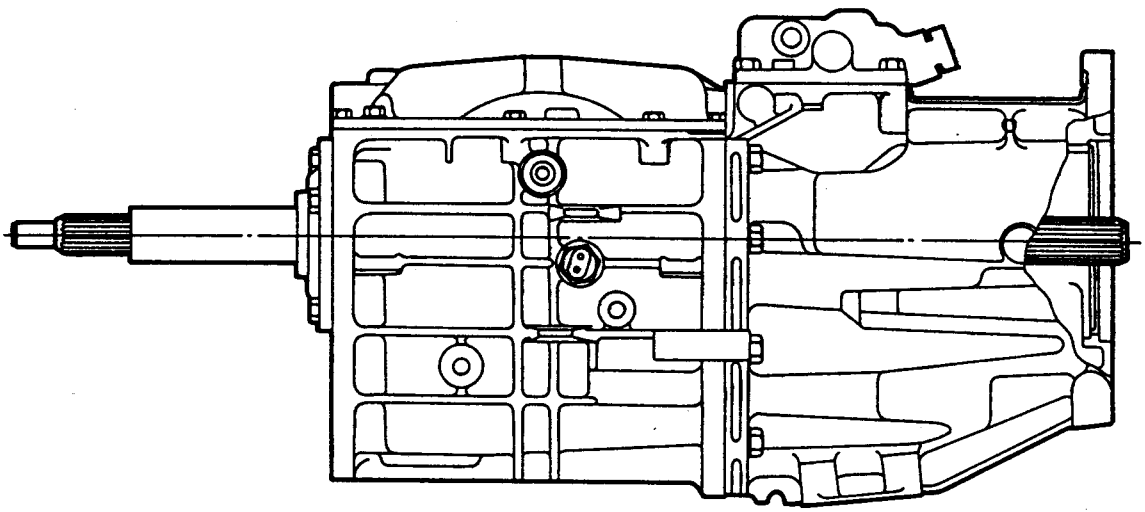
1. General

Specifications

Model		T5WC
Type		Floor - change
Gear ratio	1st	3.97 : 1
	2nd	2.34 : 1
	3rd	1.46 : 1
	4th	1 : 1
	5th	0.85 : 1
	Reverse	3.71 : 1
Oil	Specification	ATF DEXRON II
	Capacity (ℓ)	1.8~2.0
	Change	Check : every 15,000km, replace : every 50,000km
Weight (Dry)		33kg

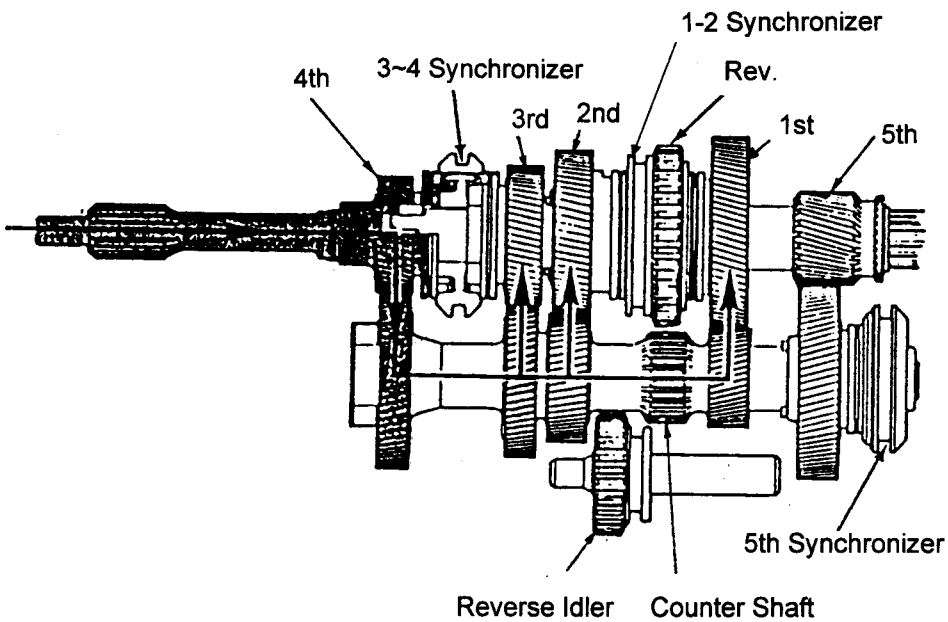
[Note] Add LUBRIZOL (280cc) in oil after overhauling.

External view



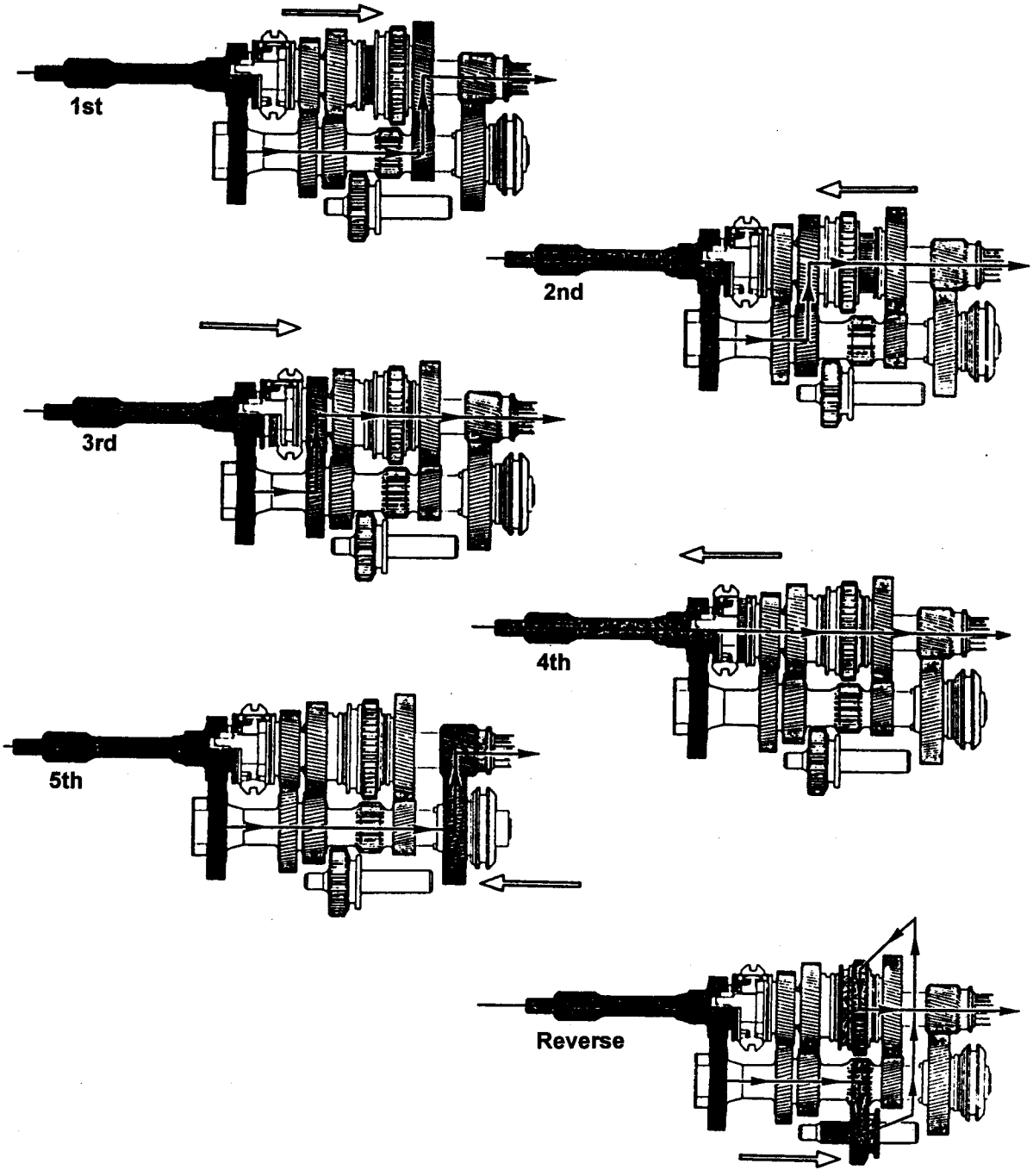
W0326-001

Component assemblies



W0326-002

Power flow



W0326-003

2. Troubleshooting

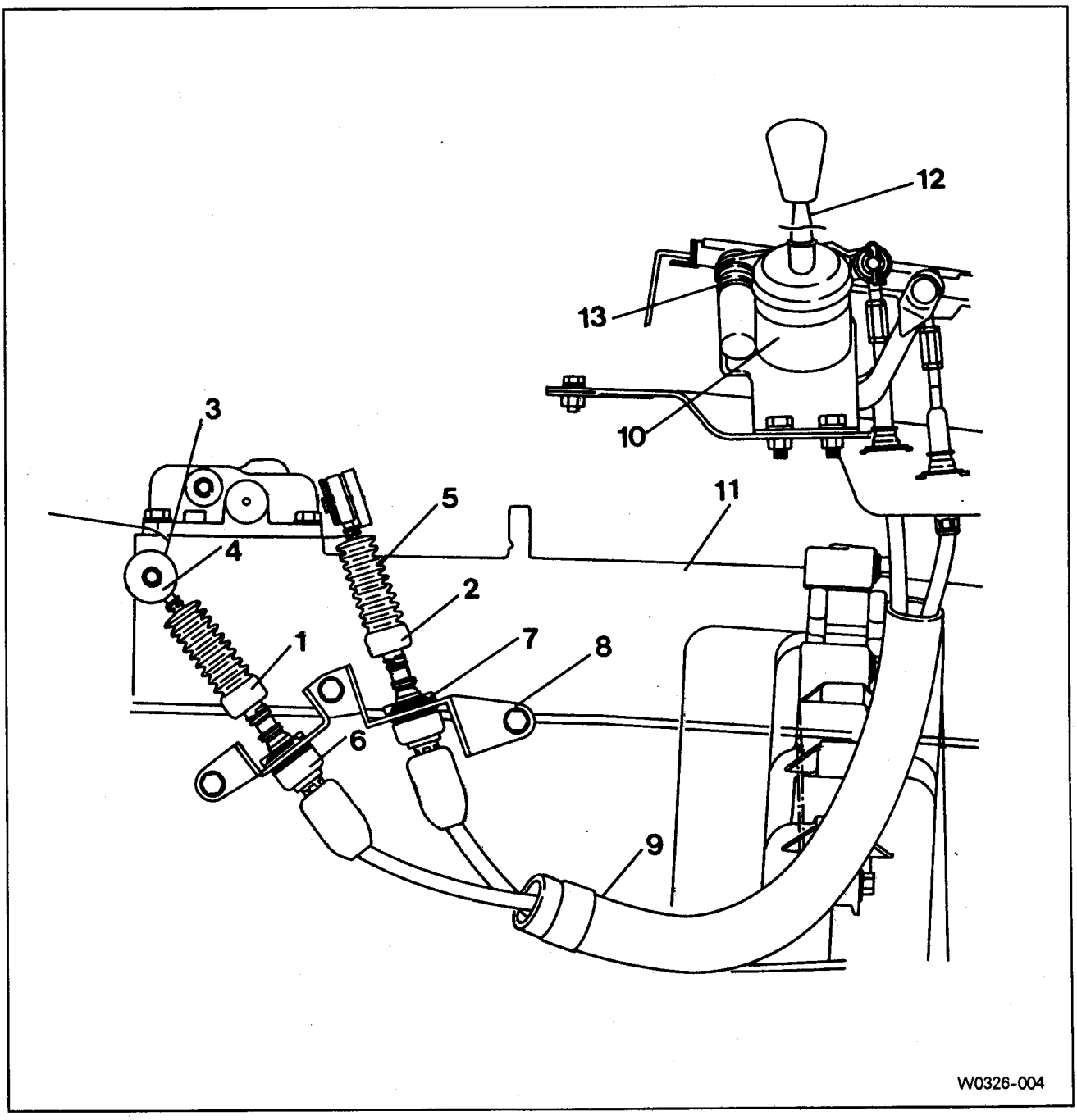
Problem	Possible Cause	Remedy
Will not shift (control lever moves)	Control lever ass'y broken or damaged.	Replace control lever and housing ass'y.
	Damaged offset lever, shift fork, selector plate or selector arm.	Remove extension, adapter or case cover. Check or replace damaged parts.
Hard shift or control lever will not move into gear	Clutch not releasing.	Adjust or replace clutch.
	Improper or low transmission oil.	Add or replace with specified oil.
	Shift shaft or shift rail binding.	Remove extension, adapter or case cover. Check or replace damaged parts.
	Binding of sliding synchronizers or gears.	Replace extension, adapter or case cover. Check synchronizers and gears and replace damaged parts.
	If reverse only, faulty backup switch.	Check or replace backup switch.
	Worn or damaged flywheel pilot bushing.	Replace pilot bushing.
Gears clash when shifting	Engine idle speed too high.	Adjust idle speed to specifications.
	Damaged or faulty clutch.	Adjust or replace clutch.
	Pilot bearing between input shaft and output shaft binding.	Replace or check roller bearings.
	Damaged synchronizer.	Check or replace synchronizer parts.
	Bell housing misaligned.	Align bell housing and bore.
	Damaged gear(s).	Check or replace gear(s).
	Worn or damaged flywheel pilot bushing.	Replace pilot bushing.
Transmission jumps out	Loosened transmission or flywheel housing bolts, improper alignment.	Tighten bolts to specifications. Realign if necessary.
	Synchronizer damaged or excessively worn.	Check or replace synchronizer parts.
	Blocking ring damaged, worn index slots or friction surfaces worn or damaged.	Check or replace blocking ring.
	Excessive countershaft end play.	Check worn or damaged parts. Reshim using roller bearings if necessary.
	Worn or damaged fork due to loosened shaft, rail or shifting fork.	Check for wear or damage. Replace worn or damaged parts.

Problem	Possible Cause	Remedy
Transmission locked in one gear	Fork or offset lever loose on shaft or rail.	Replace extension, adapter or case cover. Check or replace loose parts on shaft or rail. Replace roll pin(s).
	Worn or damaged forks, offset lever, shaft or rail.	Remove extension, adapter or case cover. Check for wear or damage. Replace damaged parts.
	Worn or damaged synchronizer.	Check worn or damaged synchronizer parts and replace if necessary.
	Worn or damaged gears.	Check worn or damaged gears and replace if necessary.
Transmission noise.	Improper or low transmission oil.	Add or drain and replace with proper oil.
	Loose bolts or other attaching parts.	Tighten as specified.
	Improper flywheel housing to engine crankshaft alignment.	Realign correctly.
	Noisy transmission bearings.	Check bearings, bearing rollers and parts for wear or damage. Replace if necessary.
	Noisy gears.	Check for worn or damaged gears (including speedometer gear). Replace if necessary.
Transmission leakage	Leakage from transmission.	Clean all exposed surfaces, then check for leaks.
	Vent or breather clogged.	Clean or replace vent or breather.
	Too much oil.	Check oil level.
	Loose bolts at sealing faces.	Tighten as specified.
	Improperly applied sealant.	Clean leaking surfaces. Reapply sealant.
	Worn or damaged oil seal.	Replace oil seal.

Diagnosis table

Condition														
1 Shift hop - out														
	2 Shift gear clash													
		3 Shift block - out												
			4 Hard shift											
				5 Noise in reverse only										
					6 Noise in 5th only									
						7 Noise in 4th only								
							8 Noise in 3rd only							
								9 Noise in 2nd only						
									10 Noise in 1st only					
										11 Noise in all speeds				
											12 Leak at rear			
												13 Leak at center		
													14 Leak at front	
														Possible Faulty Part
												●	●	Transmission case
											●	●		Extension housing
●			●									●	●	Shift cover / shift shaft
●			●								●			Shift control lever
			●										●	Input bearing retainer
										●				Input gear set
●							●			●				3rd speed gear / set
●								●		●				2nd speed gear / set
				●										Reverse speed gear / set
●									●	●				1st speed gear / set
●										●				5th speed gear / set
			●							●				Clutch housing and release system parts
			●							●				Crankshaft pilot bushing and release bearing
										●				Input bearing
										●				Main shaft pilot bearing
●										●				Main shaft thrust bearing
							●			●				3rd speed gear bearing
								●		●				2nd speed gear bearing
									●	●				1st speed gear bearing
				●										Reverse idler gear bushing
										●				Counter shaft front bearing
										●				Counter shaft rear bearing
●		●								●				Counter shaft thrust bearing
					●					●				5th speed drive gear bearing
											●			Slip yoke bushing
											●			Slip yoke seal
											●			Speedometer drive / driven gears
											●			Speedometer driven gear housing
													●	Input shaft seal
●	●	●						●	●	●				1 - 2 synchronizer assembly
●	●	●				●	●			●				3 - 4 synchronizer assembly
●	●	●				●				●				5th synchronizer assembly

3. Removal and Installation of Shift Control Cable

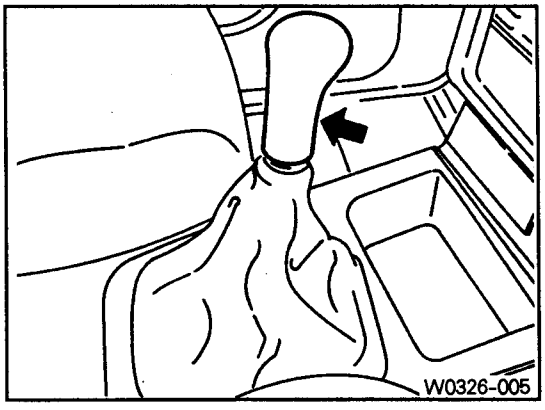


1. Shift Cable
2. Select Cable
3. End-Eye
4. Snap Pin
5. Boot
6. Socket
7. Clip
8. Cable Fixing Bracket
9. Protector
10. Boot
11. Transmission Housing
12. Shift Lever
13. Shift Shaft Lever

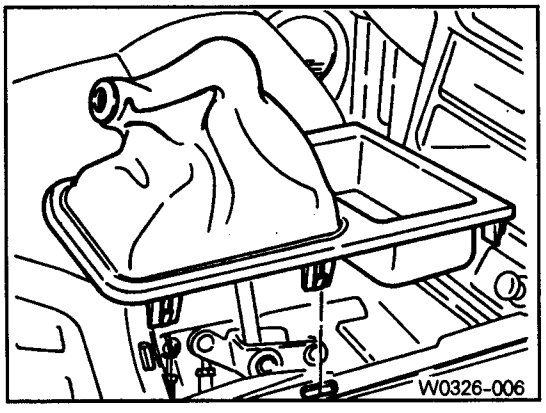
[Note] Apply grease to the end-eye before installation.

Removal · Installation

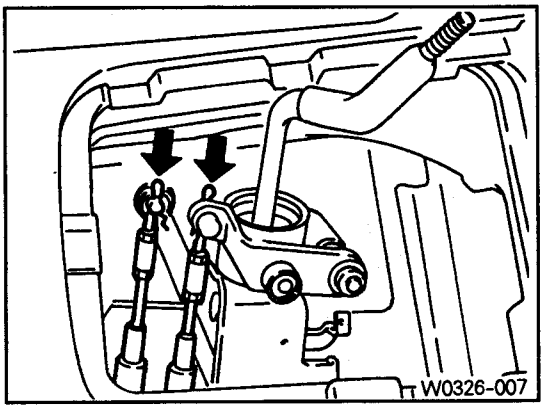
1) Position the shift lever in neutral and remove the knob.



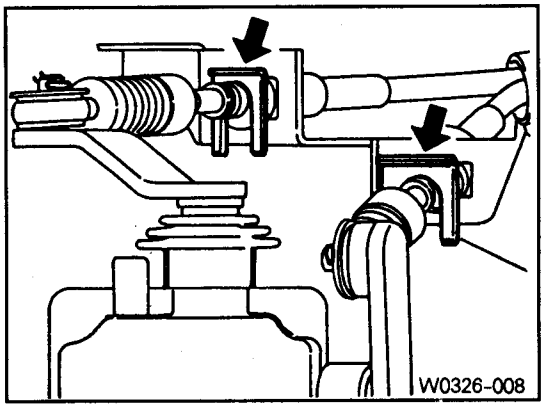
2) Remove the screws from the console box side and remove the shift lever cover.



3) Disconnect the cables by removing the snap pins from the control cable connections to the select lever and shift lever.



4) Disconnect the cables by removing the snap pins from the shift shaft and select shaft.
Pull out the clips from the cable mounting bracket and remove the cables.

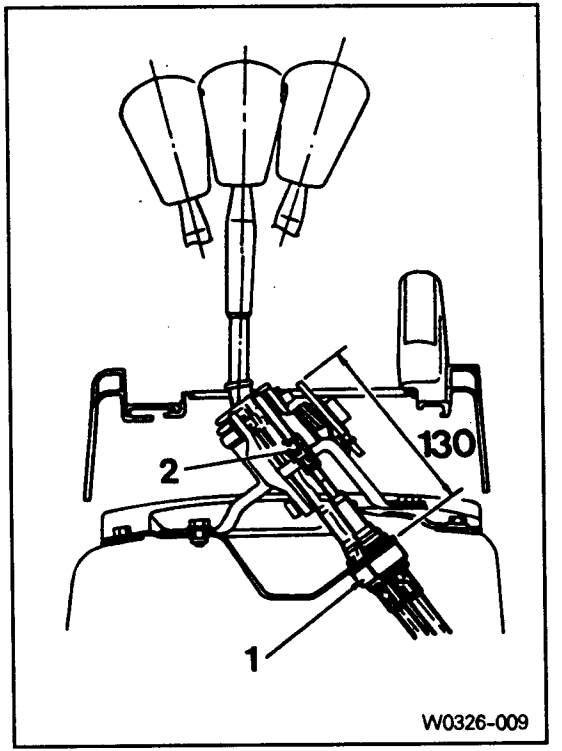


5) Installation is reverse order of the removal.

[Note] · **The shift lever should be positioned in neutral.**

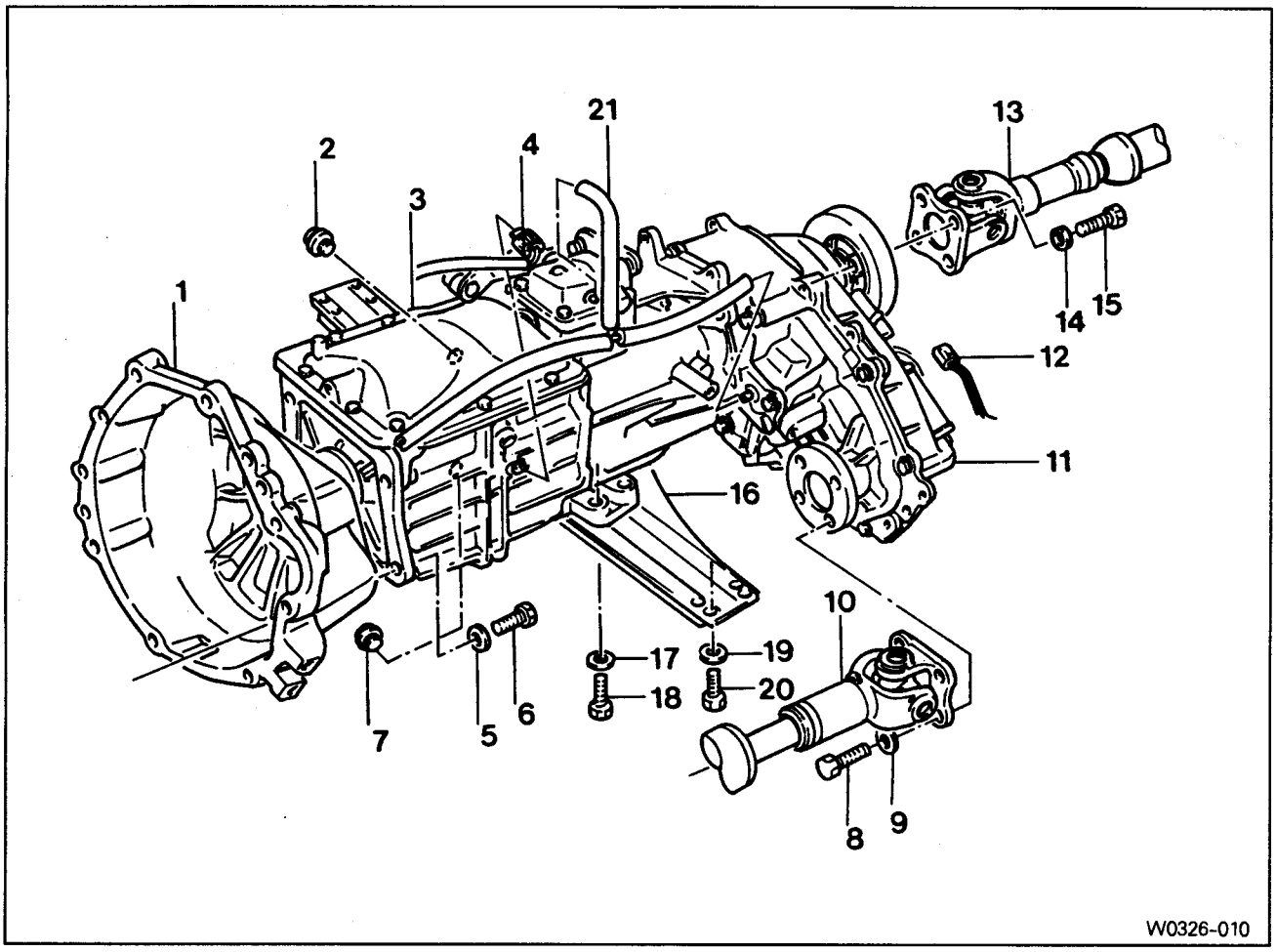
· **Apply liquid gasket on the cable contact surface (1).**

· **Keep 130mm between the center of the cable end-eye and floor. Loosening the nut (2), adjust if necessary.**



4. Removal and Installation of Transmission

Preceding work : Removal of the shift control cable (26-07)



1. Clutch Housing
2. Oil Fill Plug---------- 25Nm
3. Transmission
4. Back-Up Switch
5. Washer
6. Blot---------- 77~87Nm
7. Oil Drain Plug---------- 25Nm
8. Blot---------- 81~89Nm
9. Washer
10. Front Propeller Shaft
11. Transfer Case
12. Speedometer Cable
13. Rear Propeller Shaft
14. Washer
15. Bolt---------- 70~90Nm
16. Cross Member
17. Washer
18. Bolt---------- 21~35Nm
19. Washer
20. Bolt---------- 62~93Nm
21. Vent Hose

Removal · Installation

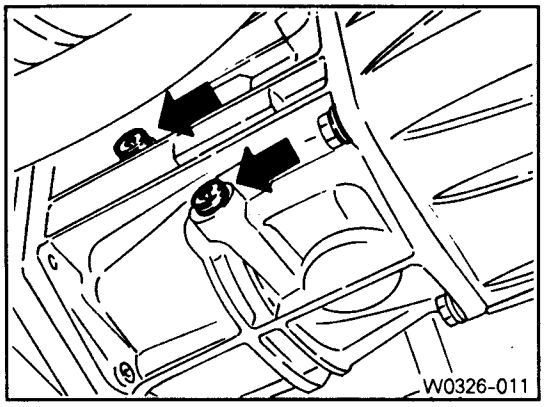
1) Disconnect the negative terminal from the battery.

2) Lift up the vehicle and fix it safely.

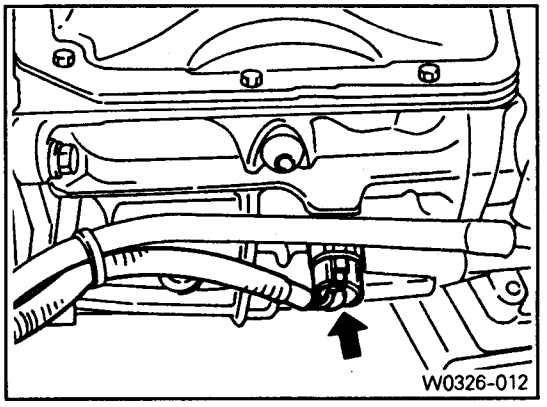
3) Remove the drain plug from the transmission housing and drain the oil. Reinstall the drain plug.

Tightening

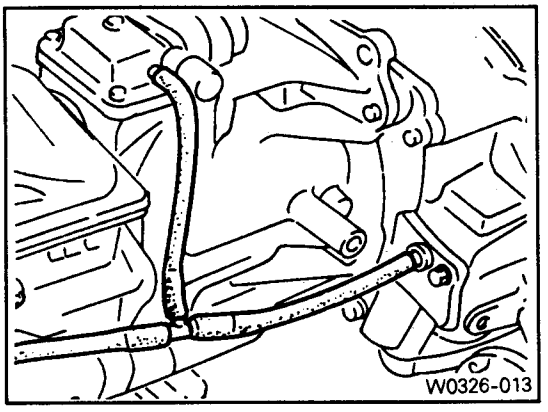
Tightening torque	25Nm



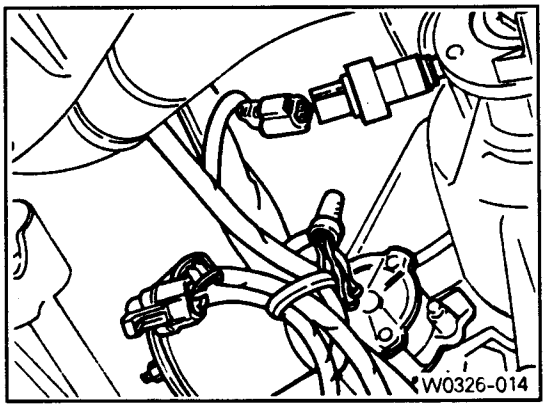
4) Disconnect the back-up switch connector.



5) Remove the vent hose.



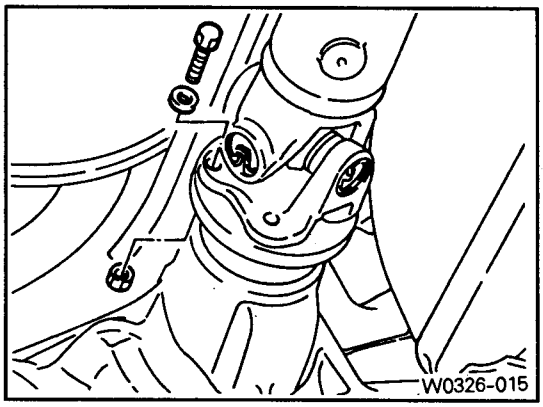
6) Remove the speedometer connector and other wiring harnesses and connectors.



7) Remove the front and rear propeller shafts from the transmission.

Installation

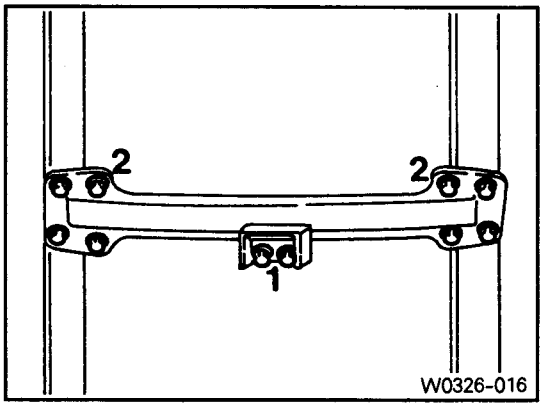
Tightening torque	Front	81~89Nm
	Rear	70~90Nm



8) Support the transmission on a suitable jack.
Remove the center mounting nuts and each sides mounting bolts and remove the cross member.

Installation

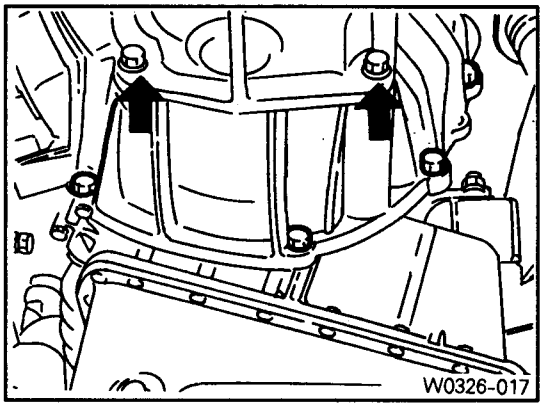
Tightening torque (1)	21~35Nm
Tightening torque (2)	62~93Nm



9) Remove the transmission mounting bolts.

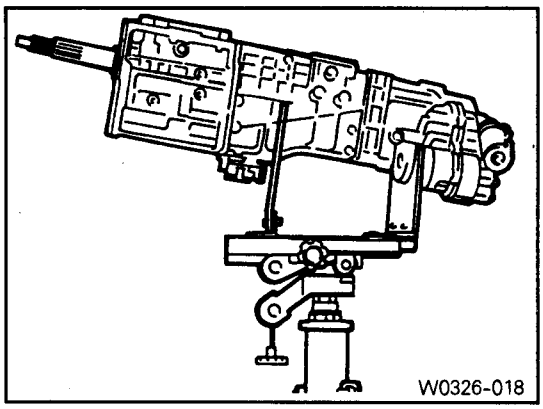
Installation

Tightening torque	77~87Nm



10) Move the transmission jack backward carefully and disengage the transmission input shaft from the engine.
Remove the transmission.

11) Installation is reverse order of the removal.



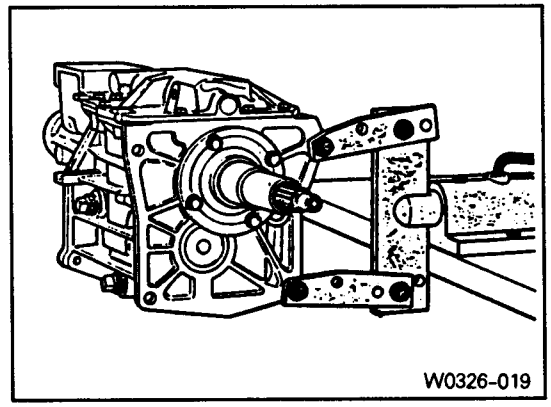
5. Disassembly and Assembly of Unit

Preceding work : Removal of the transmission (26-10)
Removal of the transfer case (28-09)

Disassembly

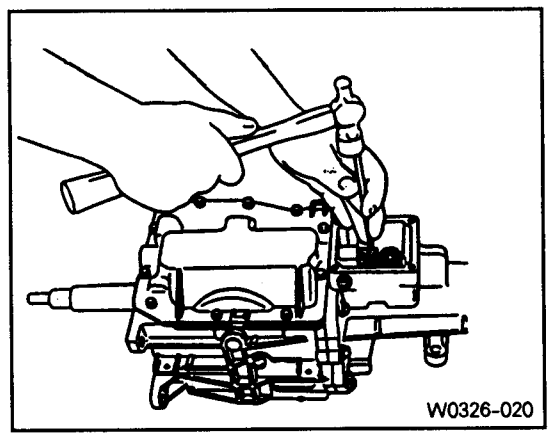
1) Install the removed transmission into a fixture.

2) Remove the drain plug and drain the oil. Using a 10mm wrench, remove the clamp blot and position the offset lever in the 3~4 position of neutral.
[Note] Removal of the offset lever in a position other than 3 - 4 of neutral will be difficult.

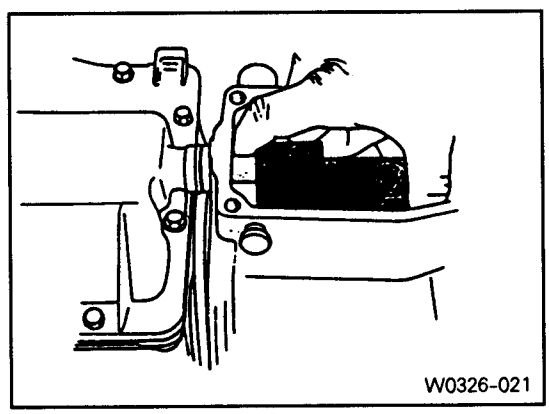

W0326-019

3) Using a pin punch and a hammer, remove the roll pin to remove the shift lever from the offset lever.

4) Using a 15mm wrench, remove the 8 bolts from the extension housing.

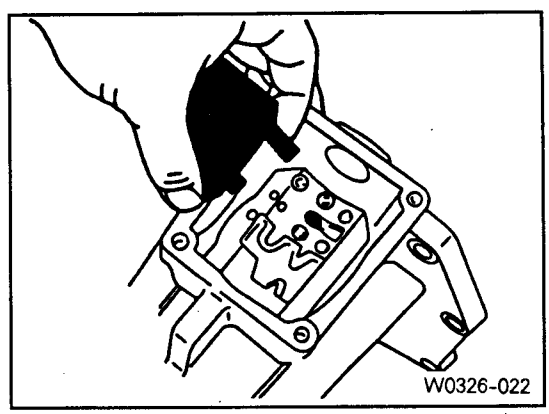

W0326-020

5) Separate the extension housing from the case and shift cover.
Separate the offset lever from the shift shaft.
[Note] Do not remove the offset lever while the extension housing is still assembled to the case.

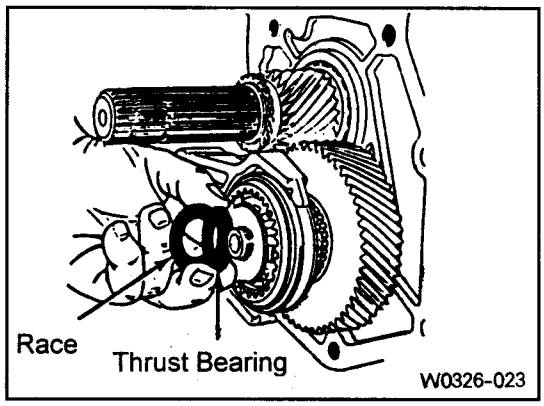

W0326-021

6) Remove the offset lever from the extension housing with the detent ball and spring

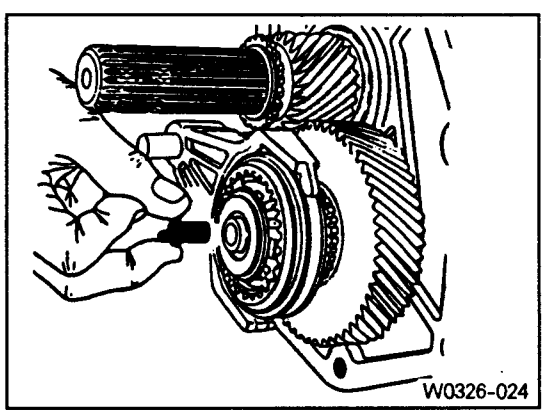
7) Remove the roll pin from either the offset lever or extension housing.


W0326-022

8) Remove the counter shaft thrust race and bearing.

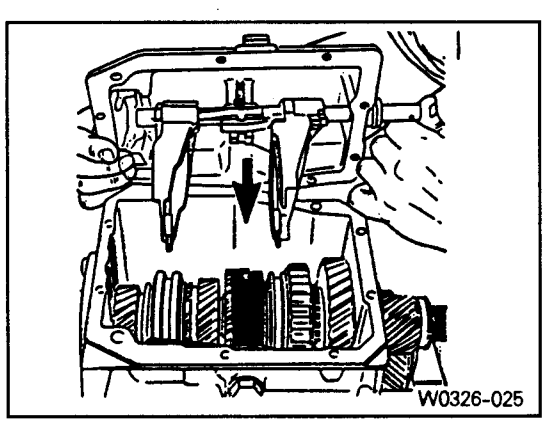


9) Carefully remove the oiling funnel from the end of the counter shaft.

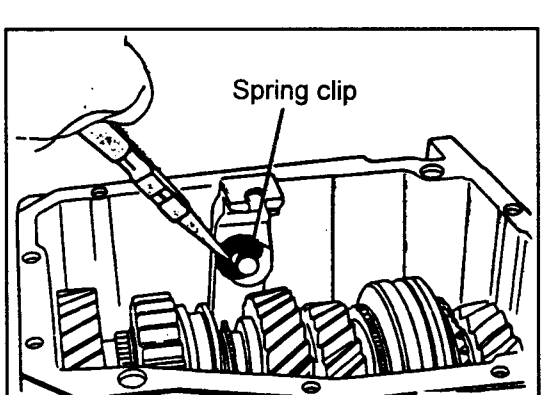


10) Using a 10mm wrench, remove the 10 bolts from the shift cover.
[Note] For assembly, note the location of the two bolts.

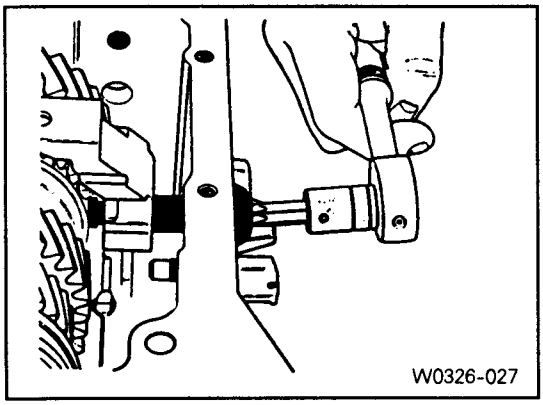
11) Lift up the shift cover after sliding it toward the drain plug about 3cm. At this time remove sealer bond.



12) Using a needle nose pliers, remove the 5 - R lever clip.

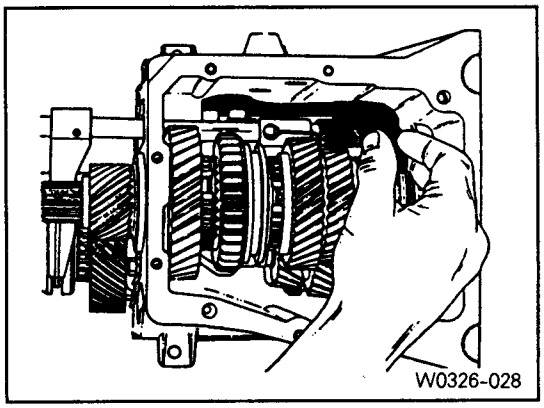


13) Using a 21mm wrench or a T - 50 bit, remove the 5 - R lever pivot bolt.
[Note] Apply sealer bond to this bolt during assembly.

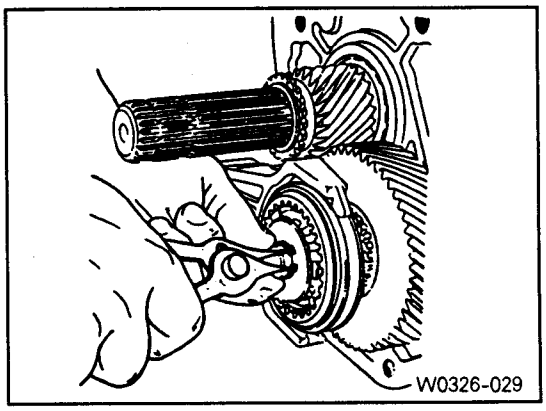


14) Using a 22mm wrench, remove the back-up lamp switch from the 5 - R lever side.
[Note] Apply sealer to the threads.

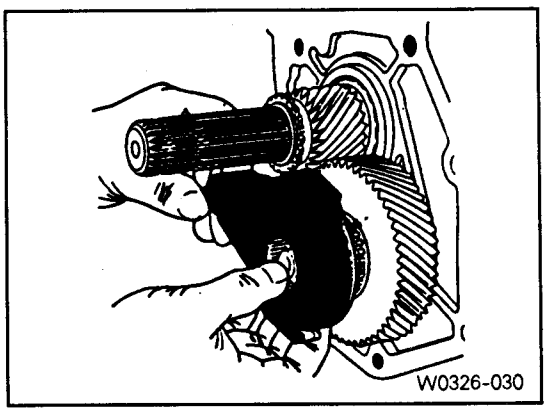
15) Pull out the 5 - R lever out of the transmission.



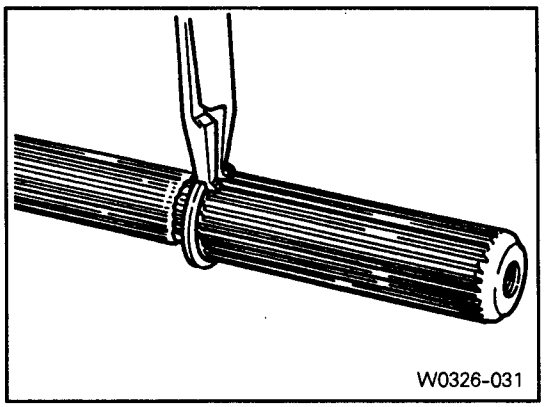
16) Using a snap ring pliers, remove the 5th synchronizer snap ring from the end of the counter shaft.



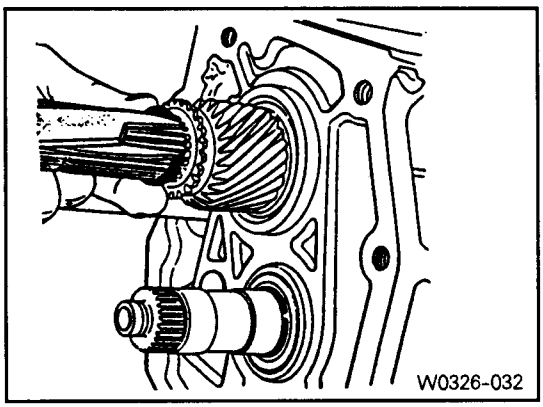
17) Remove the 5th synchronizer assembly with its fork and rail assembly from the counter shaft.



18) Remove the slip yoke snap ring from the main shaft.



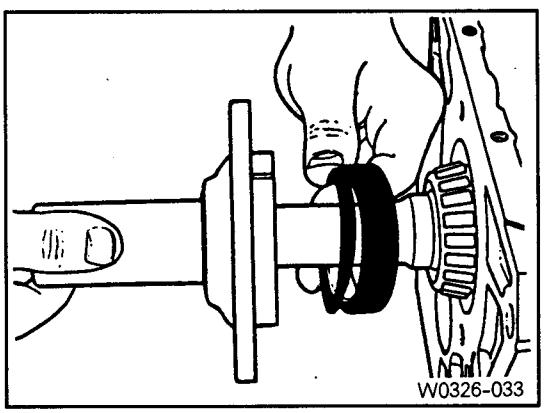
19) Remove the 5th speed driven gear snap ring from the main shaft.



20) Make alignment marks on the case and input bearing retainer and remove the 4 input shaft bearing retainer bolts, using a 13mm wrench.

[Note] Apply sealer on these bolts during assembly.

Remove the input bearing retainer with the bearing outer race and shim.

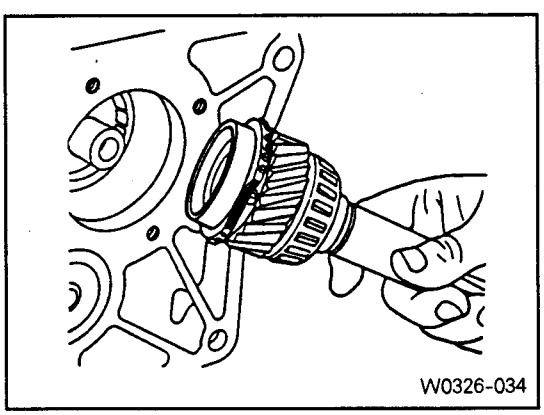


21) Remove the input shaft from the case by rotating it until the flat surface appears.

22) Remove the following parts from the input shaft.

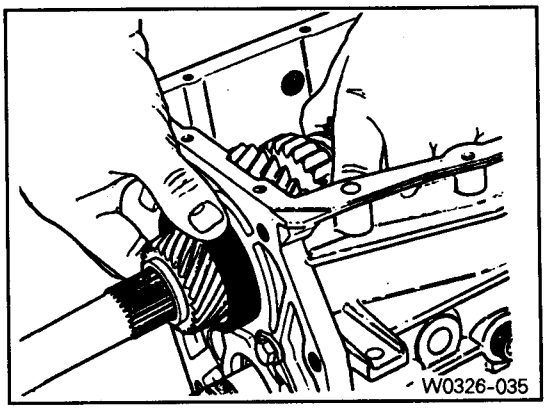
- 4th speed gear blocking ring.
- Main shaft thrust race and bearing.
- Main shaft pilot bearing rollers (15 rollers).

[Note] Be careful not to dissipate the pilot bearing rollers.

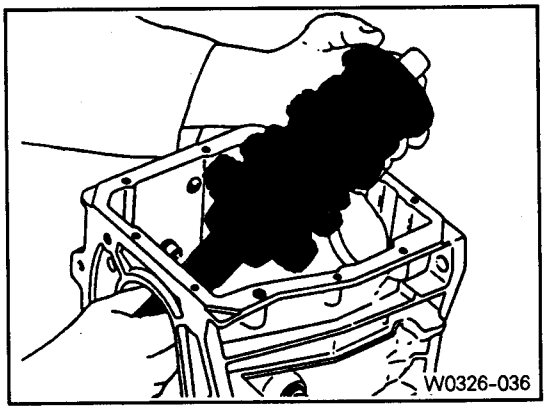


23) Remove the main shaft in 2 steps.

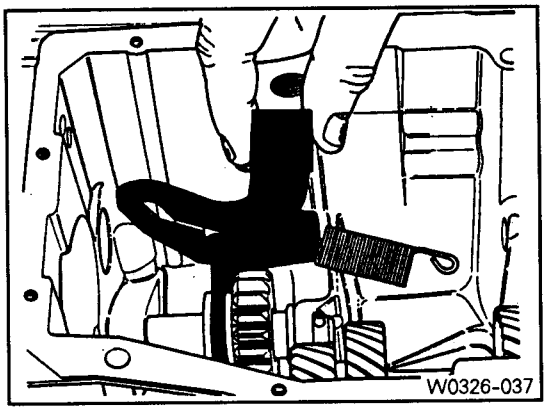
· To remove the rear bearing outer race, push the main shaft rearward.



· Tilt and lift the main shaft from the case.



24) Remove the reverse fork and spring from the case.



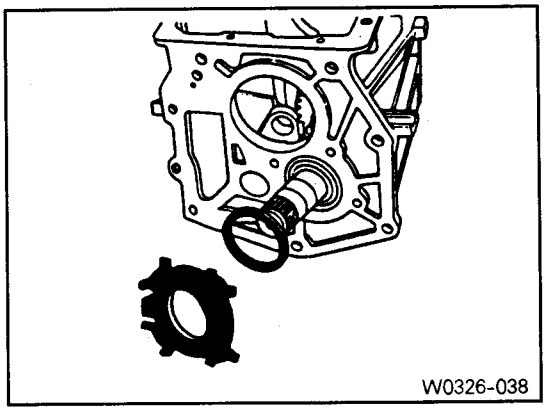
25) Remove the counter shaft as follows :

· Using a punch and hammer, pry up the lock tabs.

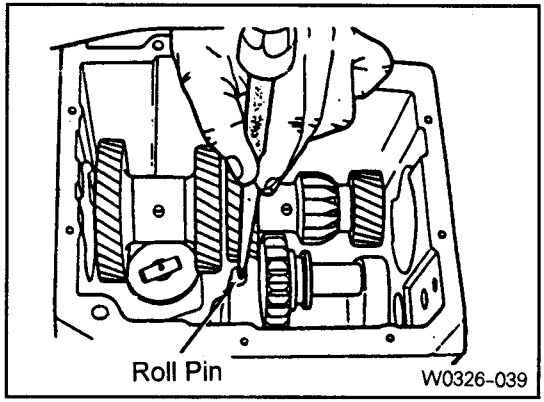
· Using a 13mm wrench or T - 40 bit, remove the 4 bolts.

· Remove the retainer and shim from the case.

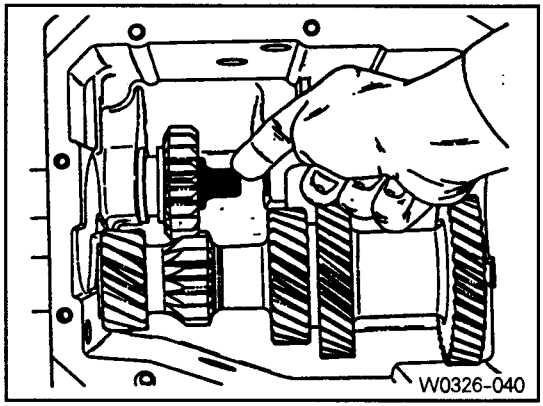
· Push the counter shaft rearward to remove the rear bearing outer race.



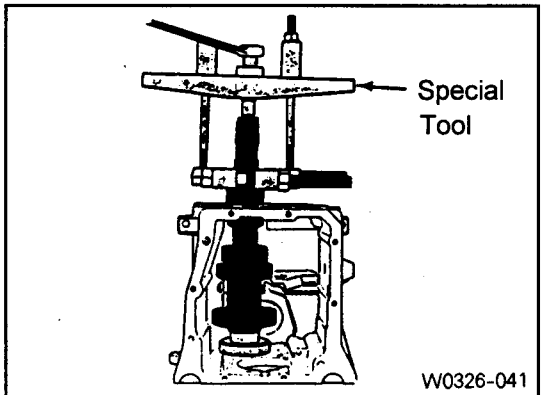
26) Using a pin punch and a hammer, remove the roll pin fixed on the reverse idler shaft.



27) By pushing the reverse idler shaft rearward and out of the case, remove the reverse idler gear and O-ring.

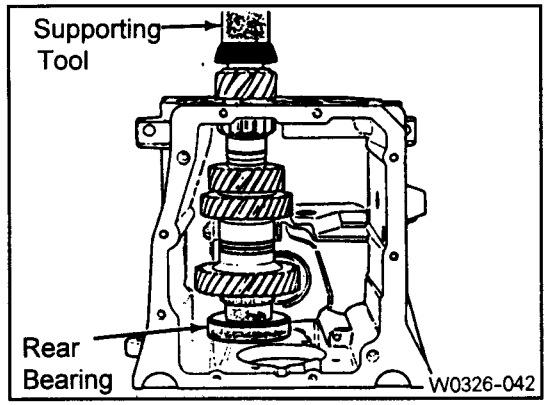


28) Using a puller, remove the rear bearing assembly from the counter shaft.



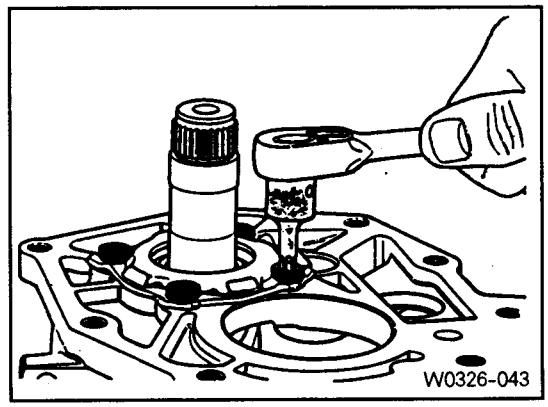
Assembly

1) Using a hydraulic press and a supporting tool, press the counter shaft rear bearing into the case. Be sure that the supporting tool inside of the case should support the counter shaft.

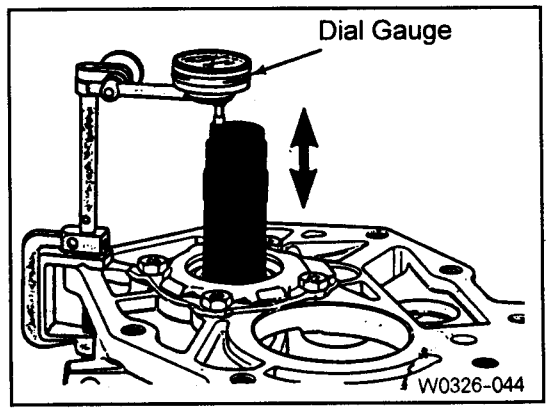


2) Without the shim, install the retainer and counter shaft rear bearing outer race. Tighten the 4 retainer bolts.

Tightening torque	20Nm



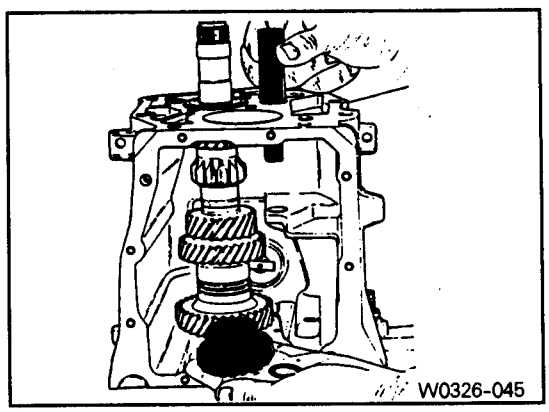
3) Place a dial indicator on the case and measure counter shaft end play by moving up and down.



4) Select a shim which is the same thickness as the indicator reading (up to 0.004 inch) and assemble it.

5) When the end play is correctly adjusted, remove the counter shaft rear bearing retainer and outer race.

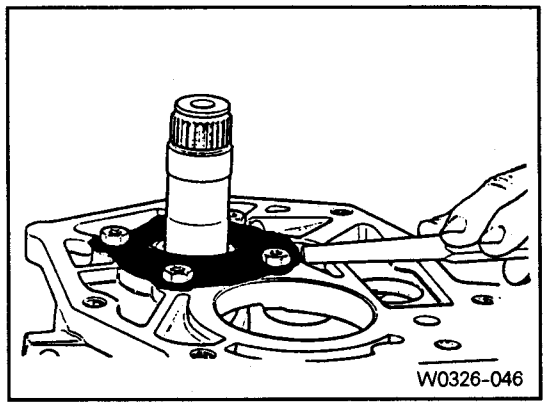
6) Using a pin punch and rubber hammer, install the reverse idler shaft, gear and O-ring.



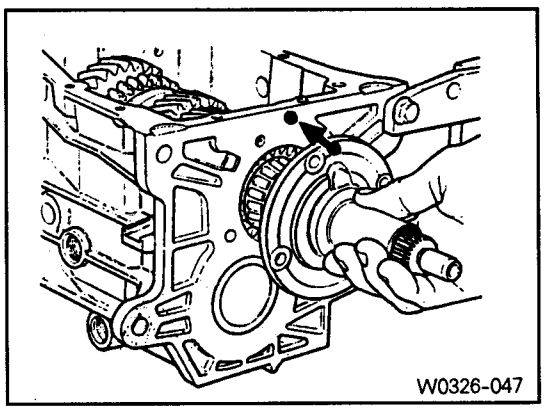
7) Install the counter shaft rear bearing outer race, shim and retainer.

Tightening torque	20Nm

· Using a punch and hammer, bend the lock tabs on the retainer.



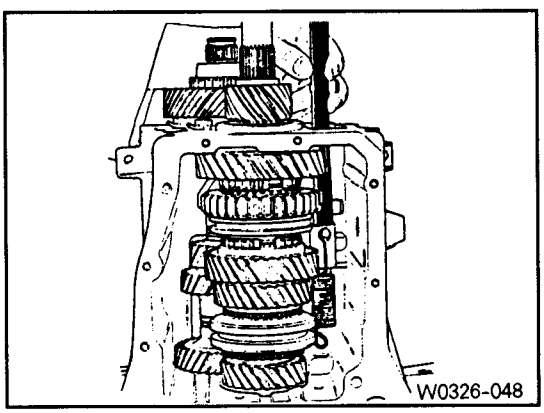
8) Install the following parts :
· Install the main shaft into the case.
· Install the main shaft rear bearing outer race into the rear of the case.
· Install the 4th speed blocking ring onto the front of the main shaft.
· Install the input shaft onto the front of the main shaft.
· Install the input bearing retainer without shim onto the front of the case.
· Using a torque wrench, tighten the 4 bolts.



9) Install the 5th speed drive gear and blocking ring on the counter shaft.

10) Install the 5th synchronizer and rail / fork.

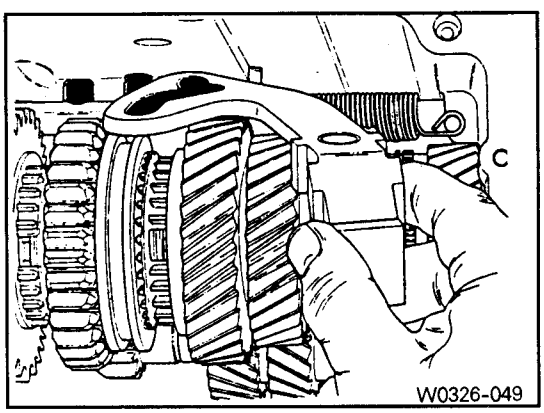
11) Install the 5th synchronizer snap ring and oiling funnel.



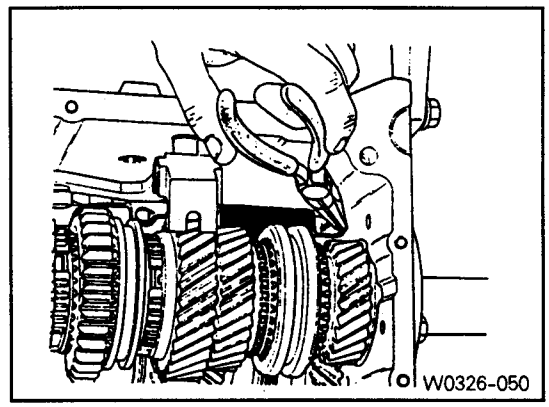
12) Align the slots of the lever with the rollers of the reverse fork and 5th shift rail. Apply sealer on the 5 - R lever pivot bolt and install it into the case.

Tightening torque	28Nm

13) Using a needle nose pliers, install the 5 - R lever clip.

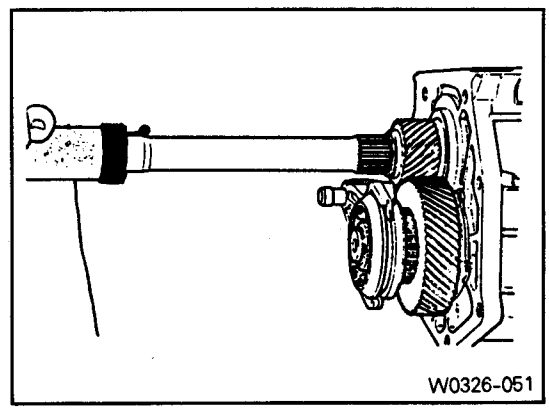


14) Using a needle nose pliers, install the reverse fork spring to its pin inside the case. Check the operation of the 5-R shift mechanism at this time.



15) Using a snap ring pliers, install the slip yoke snap ring onto the end of the main shaft.

16) Make sure that the 1-2 and 3-4 synchronizer sleeves and 5-R shift lever are in neutral position.

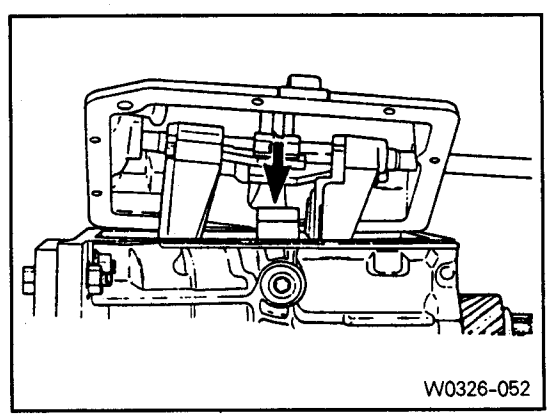


17) Align the holes of the case and cover with alignment-type bolts. Tighten the 10 bolts.

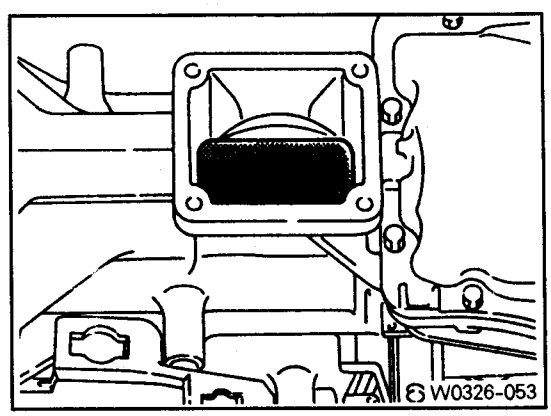
Tightening torque	15Nm

18) Apply 'RTV' sealant on the sealing surface of the extension housing.

19) Apply grease on the detent/guide plate in the extension housing. Install the detent ball in the 3-4 position.



20) Place the detent spring and offset lever in the extension housing and push the extension against the case and shift cover.



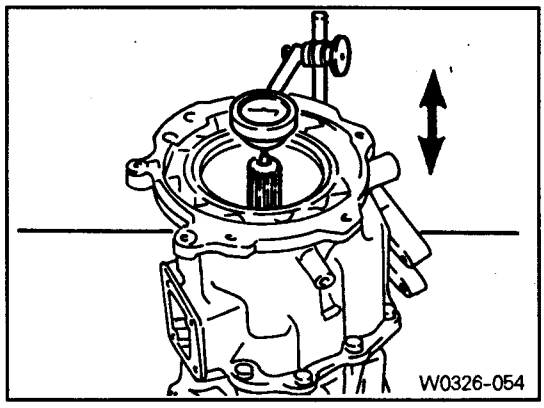
21) Completely compress the detent spring.

22) To install the extension housing to the case, apply sealer to the top two bolts and tighten them and tighten the 6 bolts.

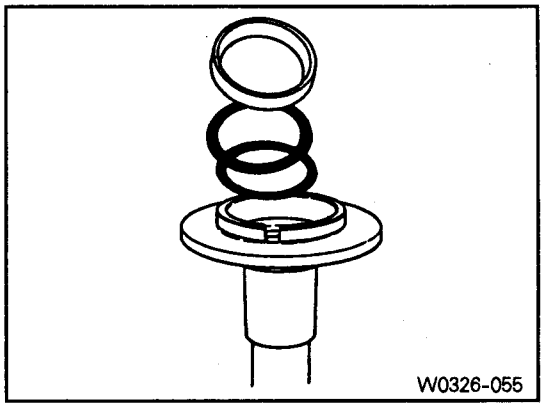
23) Apply sealer to the back-up lamp switch and drain plug and tighten them.

24) Using a hammer, install the offset lever-to-shift shaft roll pin.

25) Turn the transmission case reversely and place a dial indicator on the extension housing. Move the input and main shaft up and down and measure end play. Select a shim which is the same thickness as the measurement (± 0.001 inch). After shim installation, the end play should be '0'.



26) Remove the input bearing retainer and do the following :
- Install the adjusting shim behind the input bearing outer race in the retainer and if 2 shims are used, install the thinner one in first.
- Install the retainer to the case and tighten the bolts.
- If end play is not '0', change the shim again.
- Apply RTV sealant to the sealing surface of the retainer.
- Apply sealer to the 4 retainer bolts and tighten them.



27) Remove the fill plug.

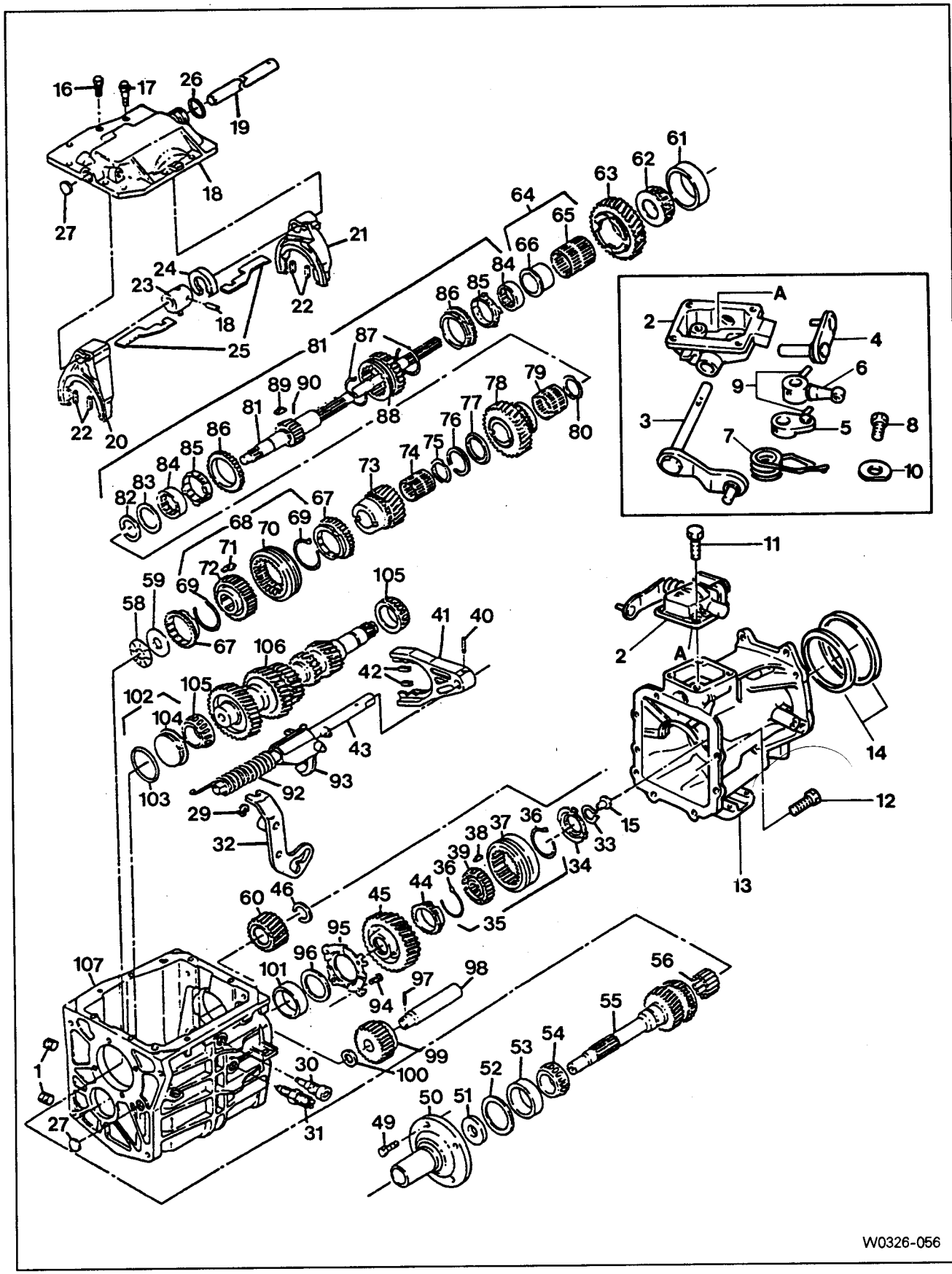
28) Remove the transmission from the holding fixture and install it to the vehicle.

29) Clean the sealing surface of the shift control lever.

30) Install the control cables to the shift lever.

6. Disassembly and Assembly of Components

Preceding work : Disassembly and assembly of unit (26-13)



Manual Transmission

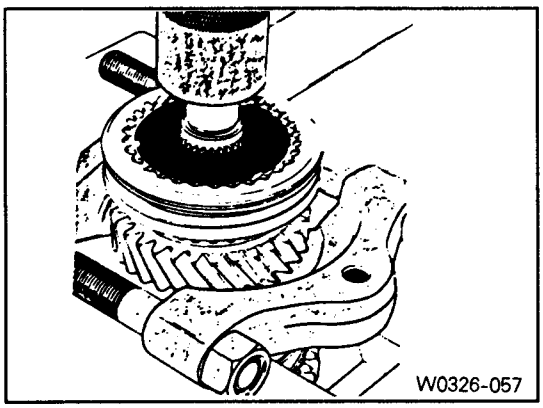
1. Fill/Drain Plug
2. Shift Mechanism Cover
3. Shift Shaft Lever
4. Select Outer Lever
5. Select Inner Lever
6. Offset Control Lever
7. Bias Spring
8. Bolt
9. Pin
10. Washer
11. Bolt
12. Bolt
13. Extension and Plate Assembly
14. Oil Seal
15. Oiling Funnel
16. Bolt
17. Alignment Bolt
18. Selector Arm
19. Shift Shaft
20. 3/4 Shift Fork
21. 1/2 Shift Fork
22. Shift Fork Pad
23. Selector Arm
24. Interlock Plate
25. Selector Plate
26. O-ring
27. Plug
28. Shift Cover
29. 5/R Lever Clip
30. Pivot Bolt
31. Back-up Switch
32. 5/R Shift Lever
33. Snap Ring
34. 5th Synchronizer Retainer
35. 5th Synchronizer Assembly
36. Synchronizer Spring
37. Synchronizer Sleeve
38. Synchronizer Key
39. Synchronizer Hub
40. Shift Fork Roll Pin
41. 5th Shift Fork
42. Shift Fork Pad
43. Shift Rail
44. Blocking Ring
45. Speed Drive Gear
46. Snap Ring
47.
48.
49. Bolt
50. Input Bearing Retainer
51. Input Shaft Seal
52. Shim
53. Bearing Cup
54. Bearing Cone
55. Input Shaft
56. A. Roller Bearing
56. B. Bearing Assembly
57.
58. Thrust Bearing
59. Thrust Bearing Race
60. 5th Speed Driven Gear
61. Bearing Cup
62. Bearing Cone
63. 1st Speed Gear
64. Bearing Sleeve Assembly
65. 1st Speed Gear Bearing
66. 1st Speed Gear Race
67. Blocking Ring
68. 3/4 Synchronizer Assembly
69. Synchronizer Spring
70. Synchronizer Sleeve
71. Synchronizer Key
72. Synchronizer Hub
73. 3rd Speed Gear
74. 3rd Speed Gear Bearing
75. Spacer
76. Snap Ring
77. Thrust Washer
78. 2nd Speed Gear
79. 2nd Speed Gear Bearing
80. Spacer
81. Output Shaft
82. Retaining Ring
83. Thrust Ring
84. 1/2 Synchronizer Inner Cone
85. 1/2 Synchronizer Outer Cone
86. 1/2 Synchronizer Blocking Ring
87. Spring
88. 1/2 Synchronizer Sleeve
89. 1/2 Synchronizer Key
90. Pin
91.
92. Reverse Fork Spring
93. Pin Fork and Reverse Roller Assembly
94. Bolt
95. Rear Bearing Retainer
96. Shim
97. Roll Pin
98. Reverse Idler Shaft
99. Reverse Idler Gear
100. O-ring
101. Bearing Cup
102. Bearing Cup Assembly
103. O-ring
104. Bearing Cup
105. Bearing Cone
106. Counter Shaft
107. Transmission Case

A. Disassembly · Assembly of Main Shaft

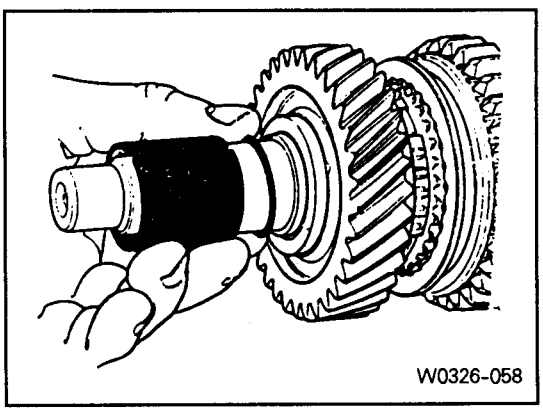
Disassembly of main shaft

1) For correct reassembly, place an alignment mark on the 3-4 synchronizer hub and sleeve.

2) Using a hydraulic press and puller plate, remove the 3-4 synchronizer assembly and the 3rd speed gear.

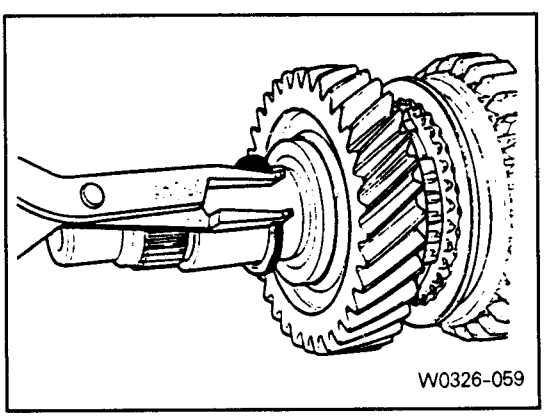


3) Remove the 3rd speed gear bearing and spacer .

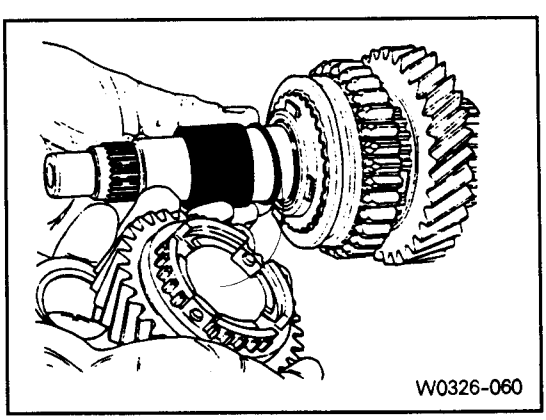


4) Using a snap ring pliers, remove the 2nd speed gear snap ring.

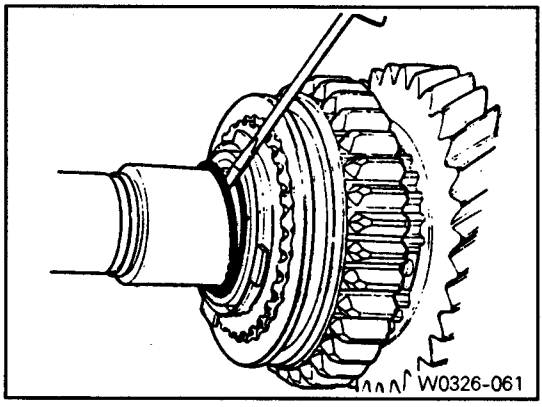
5) Remove the 2nd speed gear thrust washer.



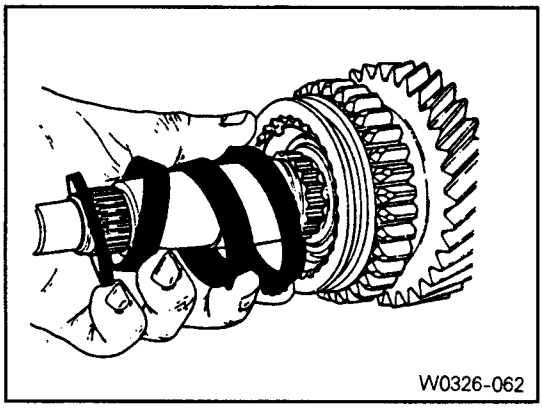
6) Remove the 2nd speed gear, bearing and spacer .



7) Using a screwdriver, remove the spiral retaining ring.

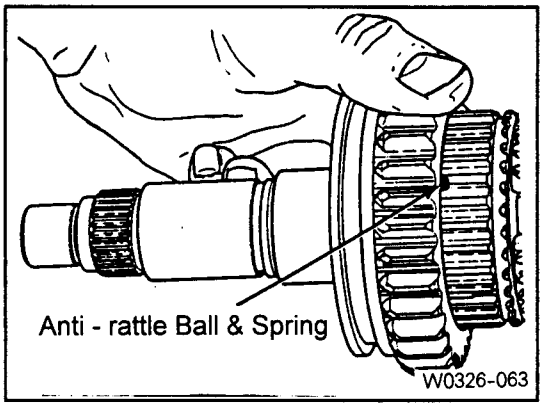


8) Remove the thrust washer and three-piece 2nd speed blocking ring assembly.

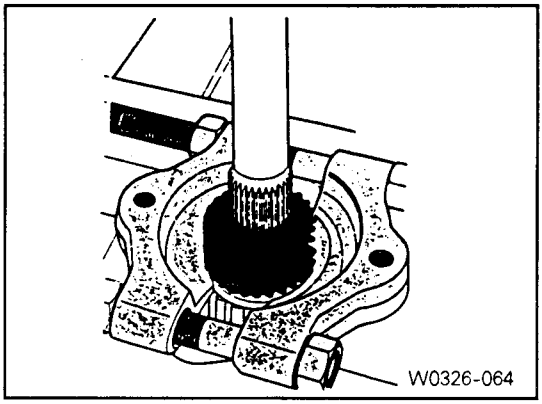


9) For correct reassembly, place an alignment mark on the 1-2 synchronizer hub and sleeve.

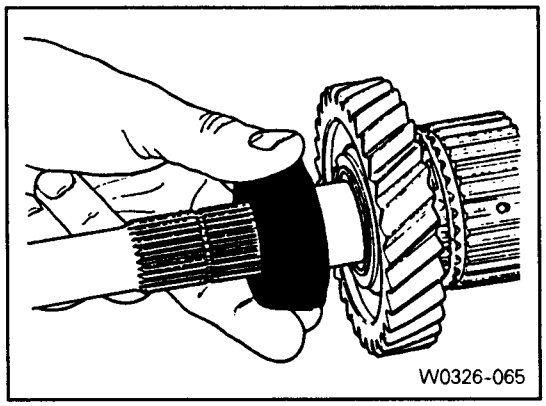
10) Remove the 1-2 synchronizer sleeve from the hub with following parts :
- The anti-rattle ball and spring.
- The three keys.
- One of the 3 springs.



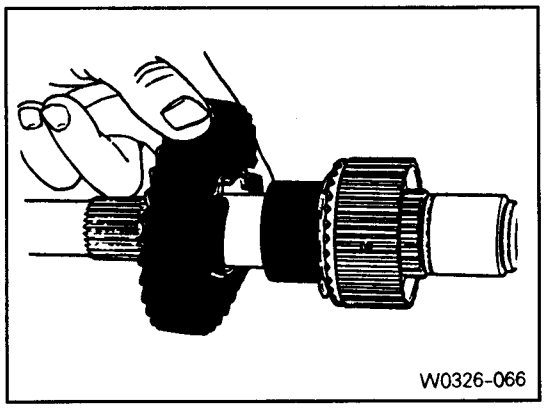
11) Using a hydraulic press and puller plate, remove the 5th speed driven gear from the main shaft.



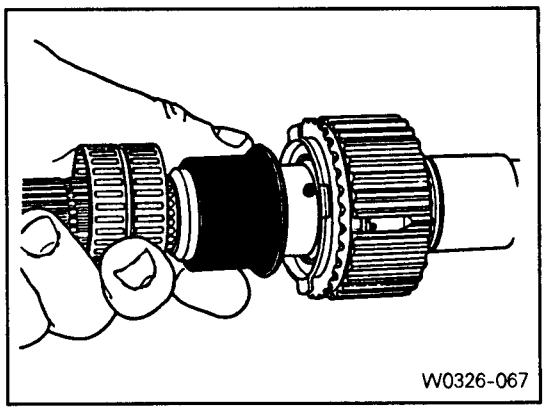
12) Remove the main shaft rear bearing assembly from the shaft.



13) Remove the 1st speed gear and bearing.

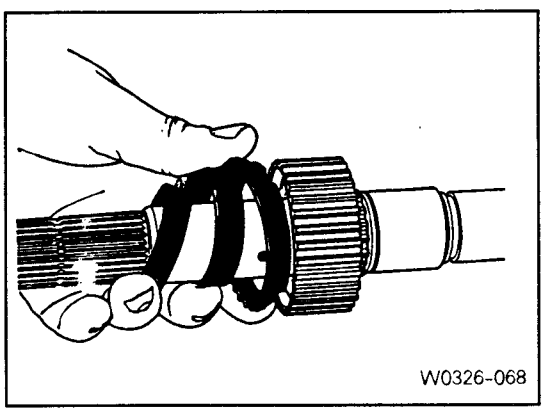


14) Remove the inner race.



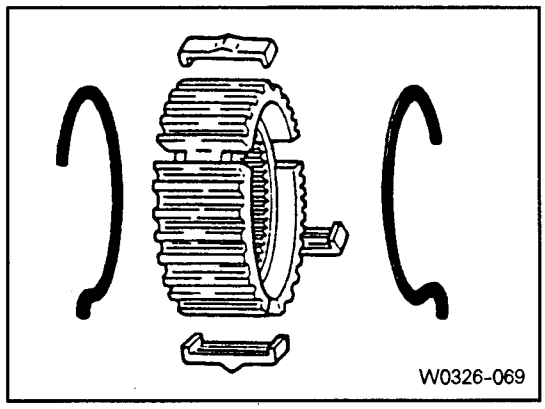
15) Remove the three-piece 1st speed blocking ring assembly and remaining synchronizer spring.

16) Check and clean all removed parts and replace if necessary.



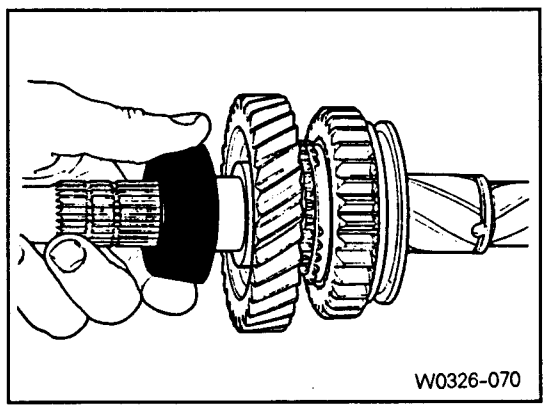
Assembly of main shaft

1) When assemble the synchronizers, make sure that the hubs and sleeves are matched and the 3 keys are installed properly. Also align blocking rings with keys during installation.
   [Note] Before assembly, coat all parts with lubricant. In case of the paper-lined blocking rings, soak them in Dexron II before installation.

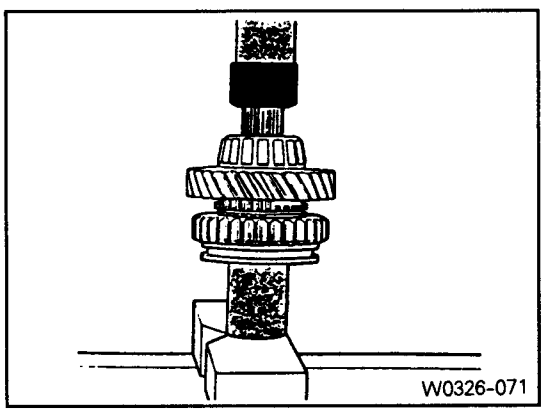


2) Assemble the following parts :
   - 1st speed blocking ring.
   - Alignment pin and 1st speed gear bearing race.
   - 1st speed gear and its bearing.

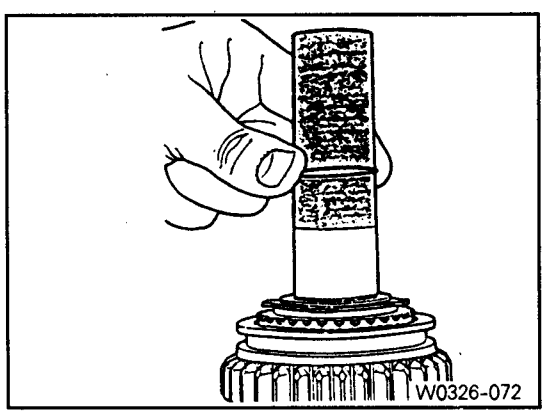
3) Install the rear bearing assembly to the main shaft.



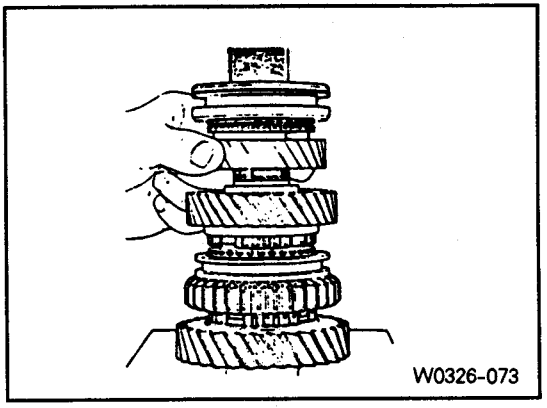
4) Using a hydraulic press and installer, press the 5th driven gear onto the main shaft. While the main shaft is still on the press bed, install the 5th driven gear snap ring. If the snap ring does not fit completely, continue pressing the 5th driven gear.



5) Install the following parts :
   - 2nd speed blocking ring assembly.
   - Thrust washer for the blocking ring inner cone.
   - Spiral retaining ring (Use special tools).
   - 2nd speed gear spacer, bearing and gear.
   - 2nd gear thrust washer and snap ring.
   - 3rd speed gear spacer, bearing and gear.
   - 3rd speed blocking ring.



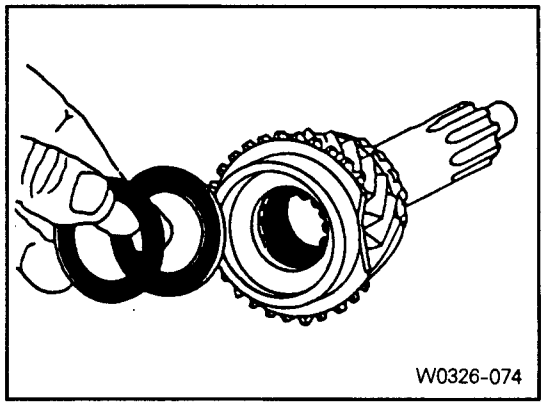
6) Using a hydraulic press and installer, install the 3-4 synchronizer hub onto the main shaft.
[Note] Align the blocking ring with the synchronizer keys while installing the hub.



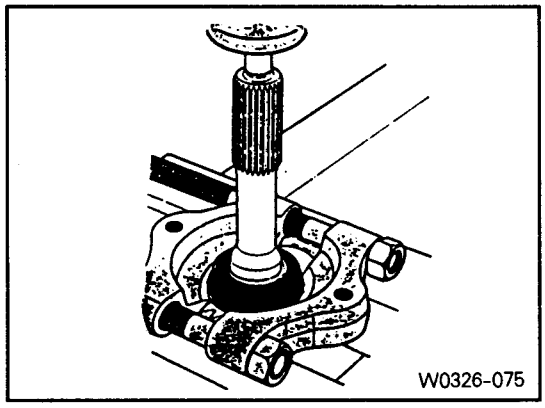
B. Disassembly · Assembly of Input Shaft

Disassembly of input shaft

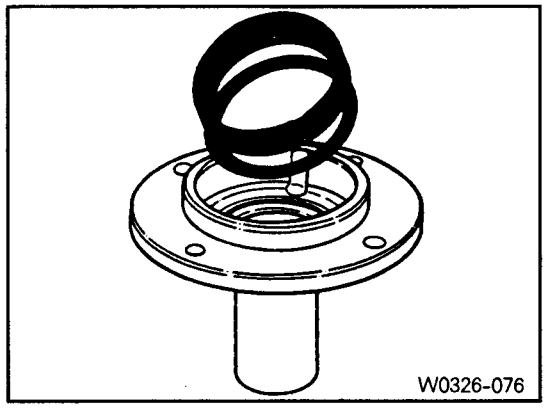
1) Remove the following parts from the input shaft :
   - Main shaft thrust race and bearing.
   - Main shaft pilot bearing rollers (15rollers).


W0326-074

2) Using a hydraulic press and puller plate, remove the input shaft bearing assembly from the shaft.

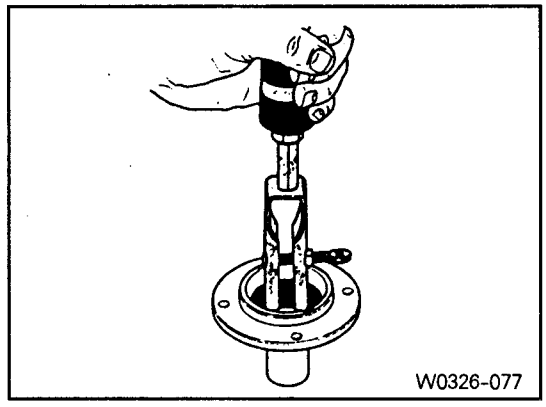

W0326-075

3) Remove the input bearing.


W0326-076

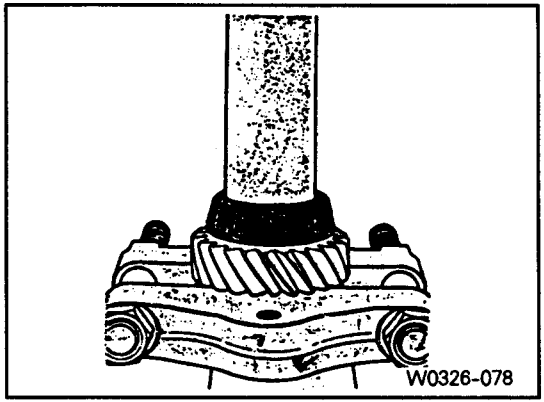
4) Remove the input shaft seal.

5) Check and clean all removed parts and replace if necessary.


W0326-077

Assembly of input shaft

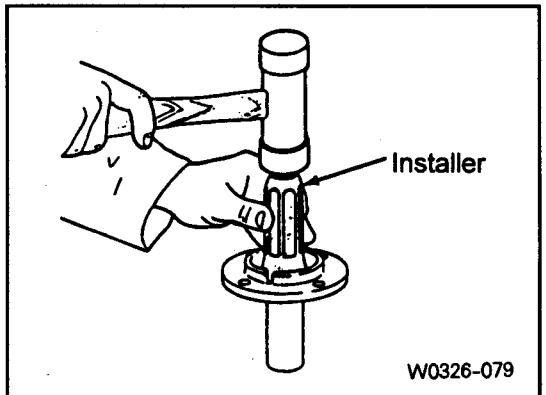
1) Using a hydraulic press and installer, press the input shaft bearing onto the input shaft.



2) Apply grease to the thrust bearing inner roller (15rollers) and install the main shaft thrust bearing and its race in the rear of the input shaft.

3) Using a rubber hammer and installer, install the input bearing retainer and input shaft seal after applying grease.

4) Install the bearing outer race to the retainer without end play adjusting shim.

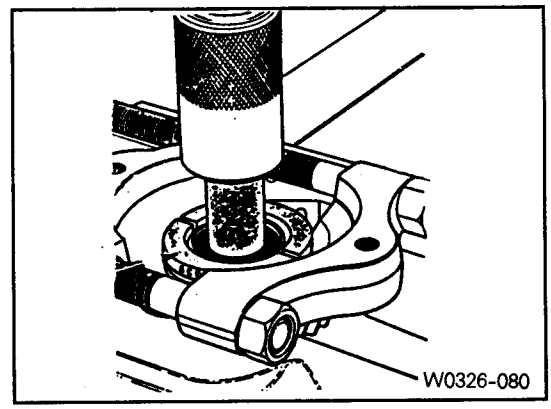


C. Disassembly · Assembly of Counter Shaft

Disassembly of counter shaft

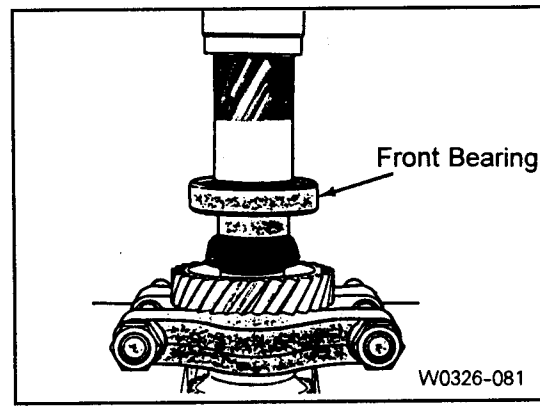
1) Using a hydraulic press and special tool, remove the front bearing assembly from the counter shaft.

2) Check and clean all removed parts and replace if necessary.

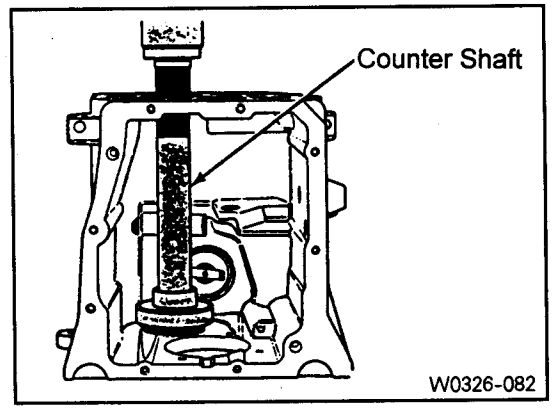


Assembly of counter shaft

1) Using a hydraulic press and installer, press the front bearing assembly onto the counter shaft.



2) Installation is as follows :
- Install a new O-ring on the counter shaft outer race and lubricate it.
- Using a installer, lightly tap the race into its bore until the O-ring is compressed.
- Install the race to be fully seated on the inside of the case.



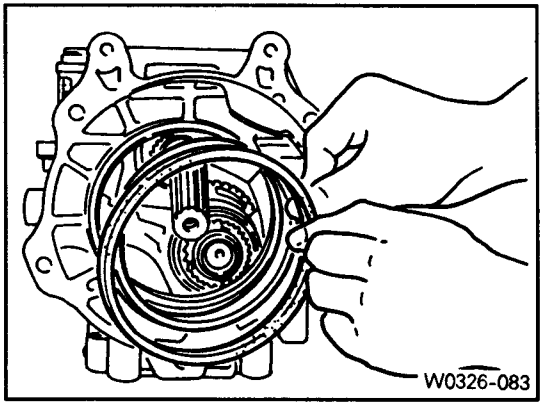
D. Disassembly · Assembly of Extension Housing

Disassembly of extension housing

1) Remove the vent from the extension housing.

2) Remove the O-ring and steel ring from the rear of the extension housing.

3) Check and clean all removed parts and replace if necessary.



Assembly of extension housing

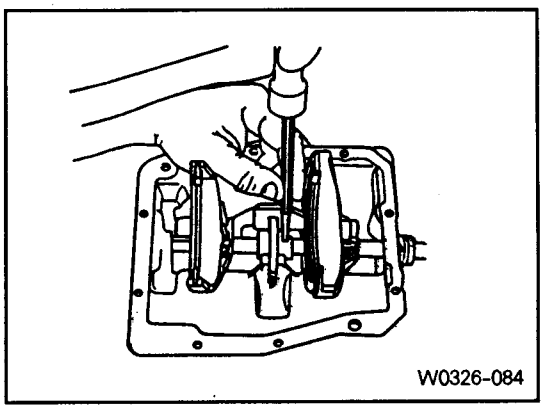
1) Install the O-ring and steel ring to the rear of the extension housing.

2) Install the vent to the extension housing.

E. Disassembly · Assembly of Shift Cover

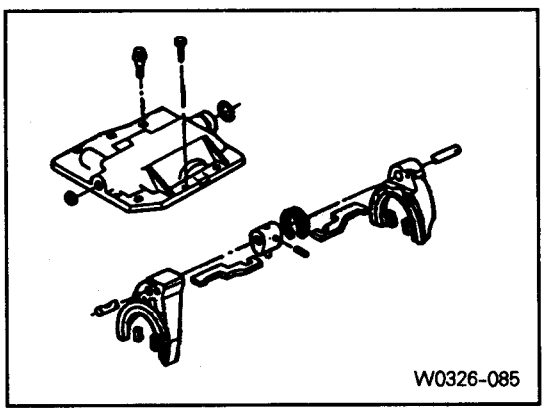
Disassembly of shift cover

1) Using a hammer and a pin punch (3/16"), remove the selector arm roll pin.



2) Before removal, note the correct position of the interlock plate and selector arm and remove the shift shaft.

3) Check and clean all removed parts and replace if necessary.

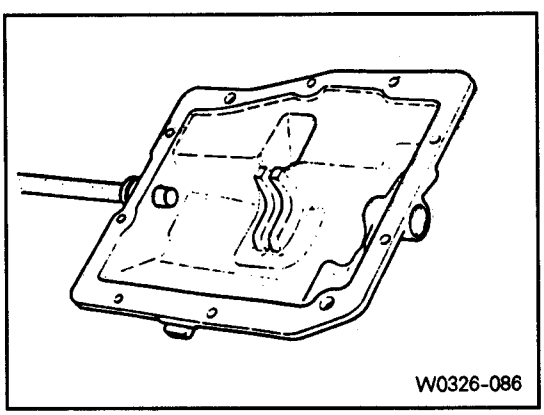


Assembly of shift cover

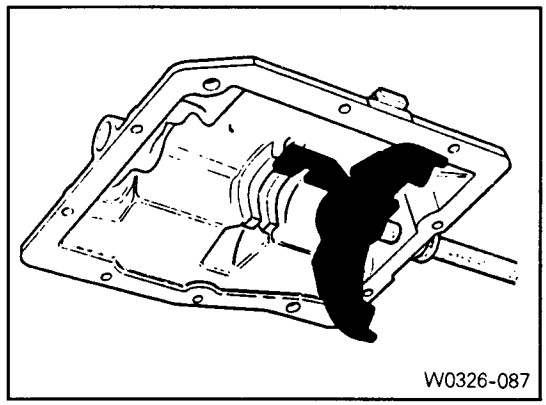
1) If the shift shaft cup plug was removed, apply plug outer surface with sealer and install it into the cover.

2) Install the fork pads and selector plates onto the 1-2 and 3-4 shift forks.

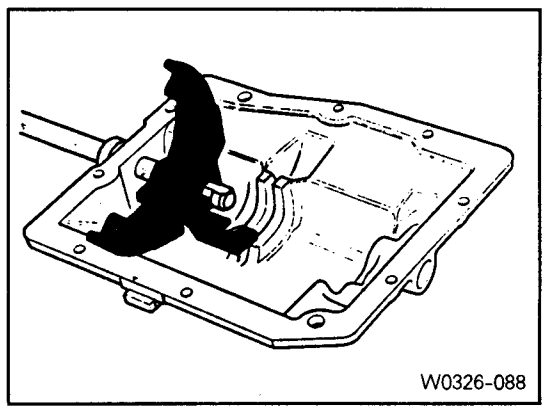
3) Assemble the shift cover parts as follows :
   · Push the shift shaft into the cover until the front of the shaft is at the inside of the cover.



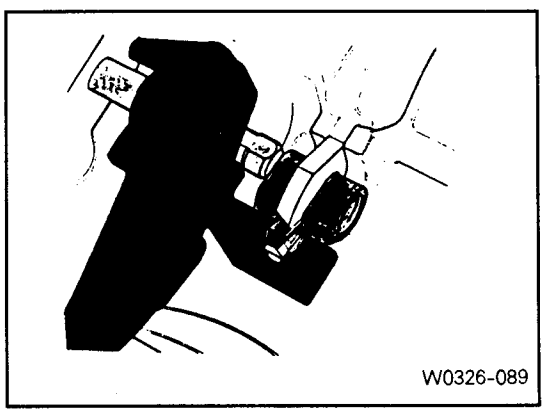
Install the 1-2 shift fork and its selector plate.



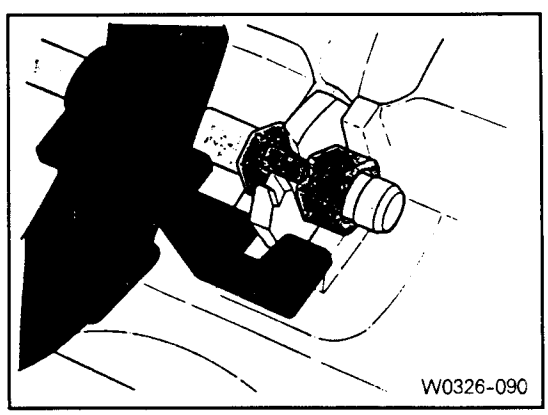
Push the shift shaft through the 1-2 shift fork.



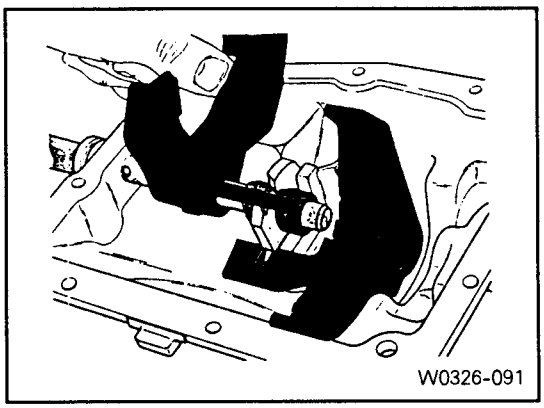
Place the selector arm and interlock plate in the cover. Note the position of the interlock plate and selector arm.



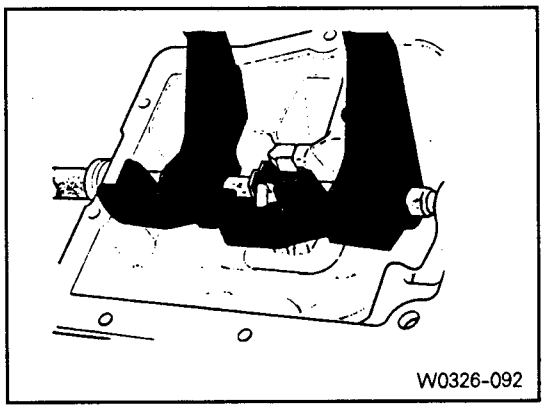
Push the shift shaft through the 3-4 shift fork.



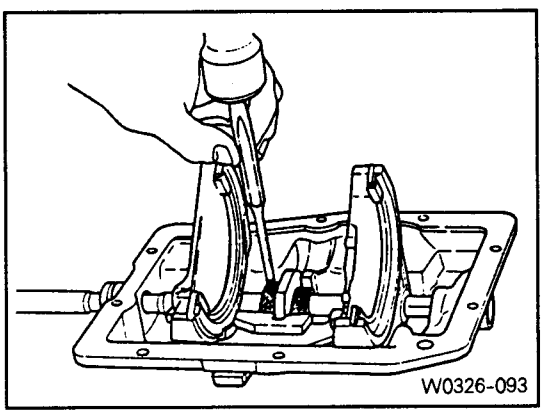
· Install the 3-4 shift fork and its selector plate.



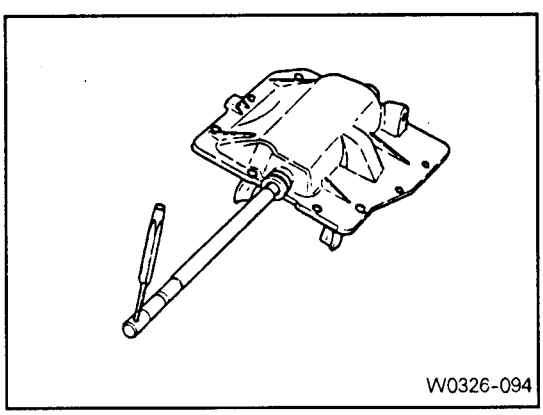
· Push the shift shaft through the 3-4 shift fork.



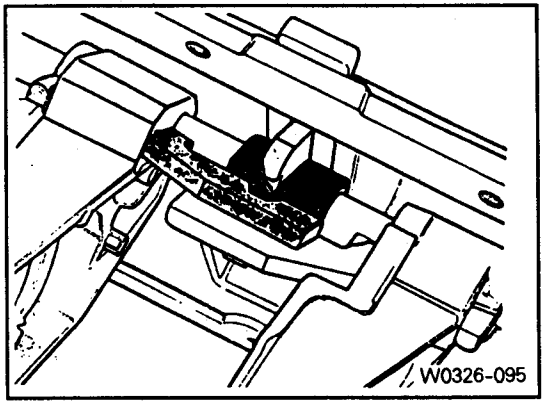
· Install the roll pin that fixes the selector arm to the shift shaft.



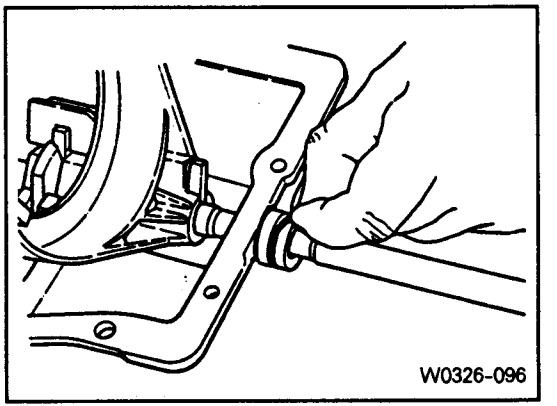
4) Check the shift cover parts for proper assembly as follows :
   · Insert a pin punch (3/16") into the offset lever hole of the shift shaft.
   · Place the shift cover to the flat ground and rotate the shift shaft so that the punch is vertical.



- Selector arm should be aligned with the 3/4 shift fork selector plate.



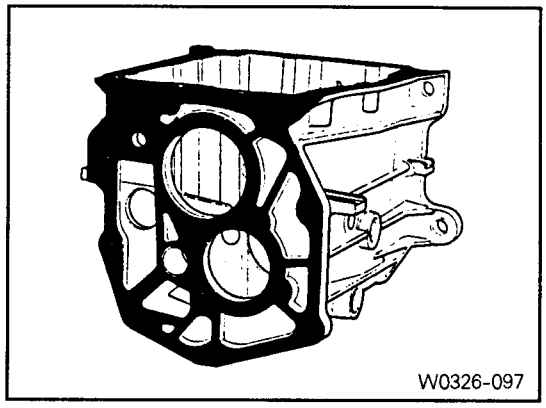
5) Lubricate and install the O-ring on the rear of the shift cover.



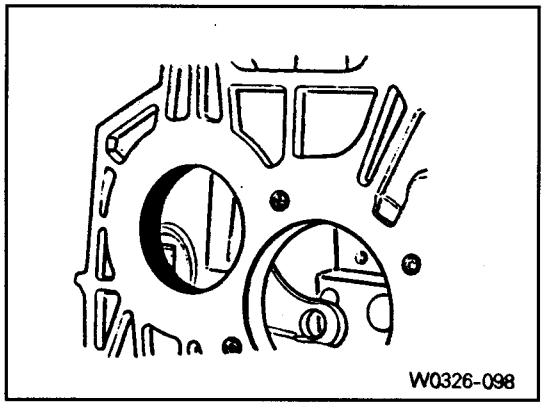
F. Inspection of Components

Inspection

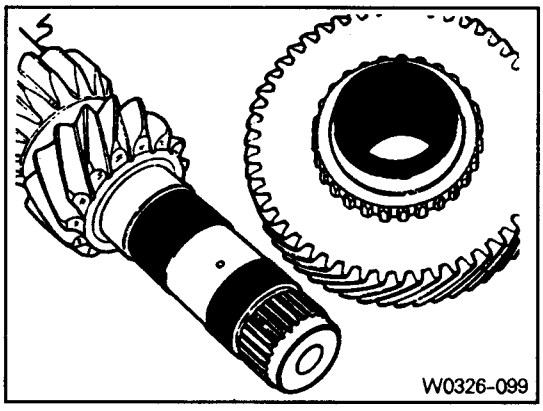
1) Clean all parts with solvent and dry them with compressed air. Check the following parts for cracks and damaged sealing surfaces.
   - Case.
   - Extension housing.
   - Shift cover.
   - Input bearing retainer.
   - Counter shaft rear bearing retainer.


W0326-097

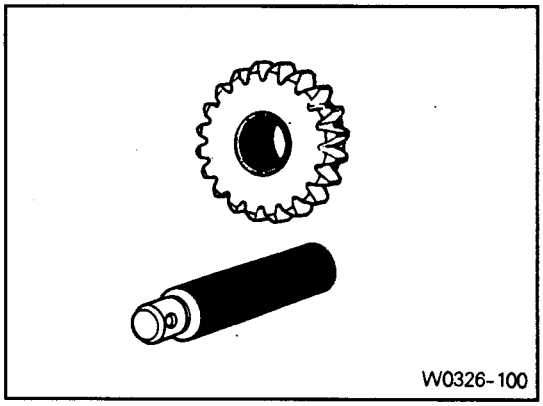
2) Check the parts which support bearings and shafts for excessive wear and replace them if necessary.


W0326-098

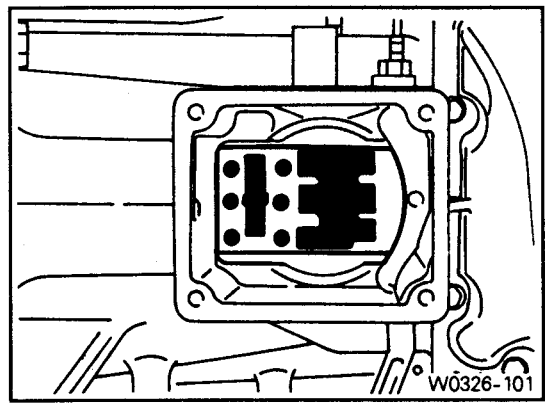
3) Check the bearing surfaces of the following parts :
   - Input shaft.
   - Main shaft and its gears.
   - Counter shaft and 5th drive gear.


W0326-099

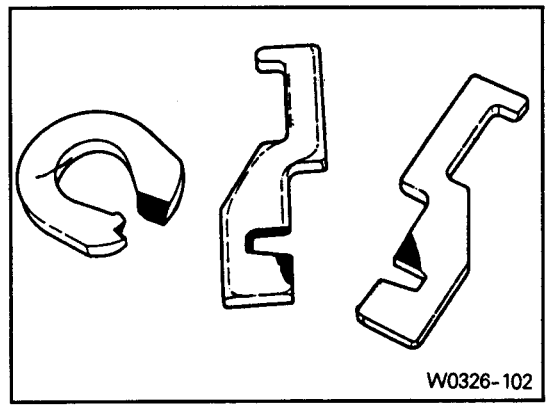
4) Check the reverse idler shaft and its gears.
   [Note] Replace excessive wear parts and do not file on the hardened surface and precision ground.


W0326-100

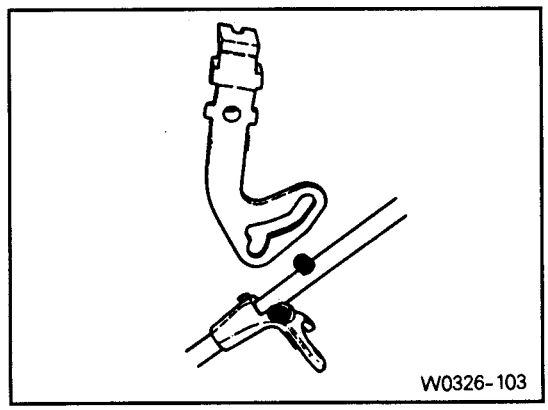
5) Check the shift mechanism parts as follows :
- Wear of the shift shaft.
- Wear of the detent/guide plate and offset lever.



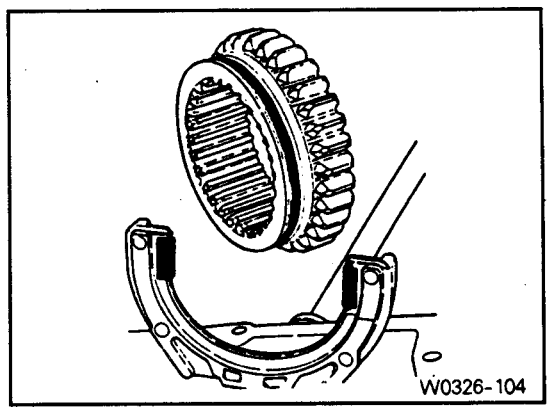
- Check worn edges on the following parts :
  - Selector arm.
  - Interlock plate.
  - Selector plates for the 1-2 and 3-4 shift forks.



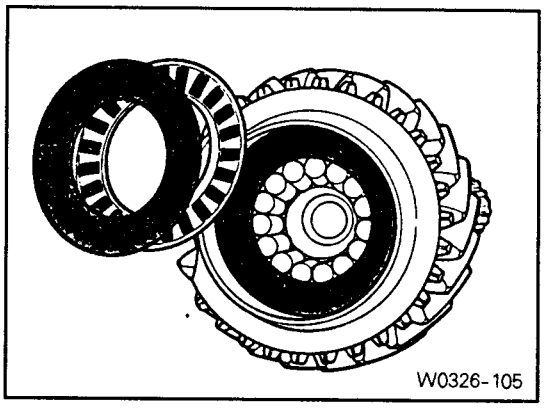
- 5-R shift lever and the rollers on the reverse fork and the 5th shift rail/fork.



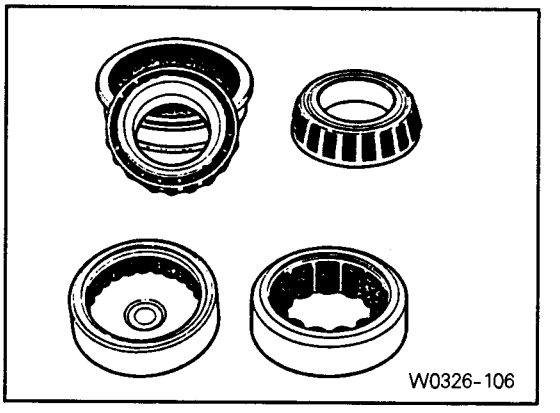
- Check worn mating surfaces on the following parts :
  - 1-2 shift fork, pads and synchronizer sleeve.
  - 3-4 shift fork, pads and synchronizer sleeve.
  - 5th shift rail/fork pads and synchronizer sleeve.
  - Reverse fork and reverse idler gear sleeve.



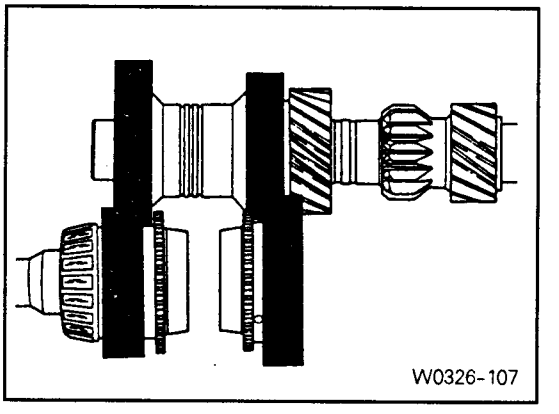
6) Check the following bearings for excessive wear :
- Crankshaft pilot bushing for the front of the input shaft.
- Clutch release bearing.
- Input shaft bearing.
- Main shaft pilot bearing rollers.
- Main shaft thrust bearing and its surfaces.


W0326-105

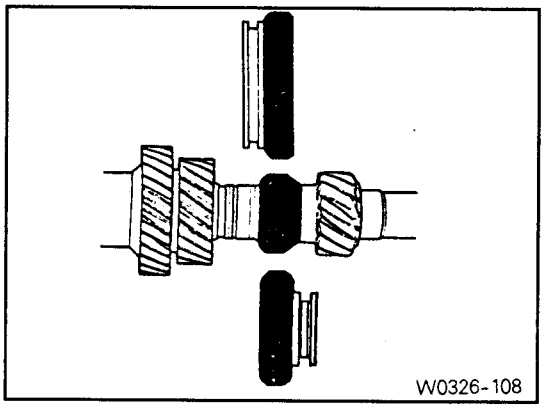
- Speed gear roller bearings on the main shaft.
- Main shaft rear bearing.
- Counter shaft front and rear bearings.


W0326-106

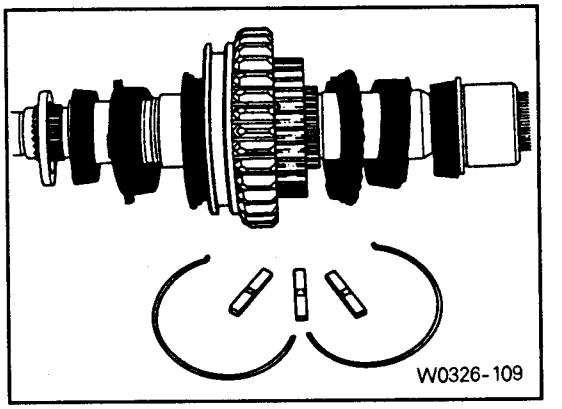
7) Check the gear tooth surfaces of all gear sets.


W0326-107

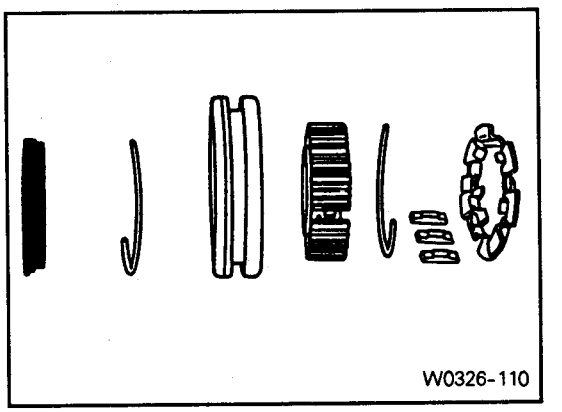
8) Check the reverse gear set tooth surfaces. Check the surfaces of gear teeth for excessive wear, pitting, scoring and spalling and replace if necessary.


W0326-108

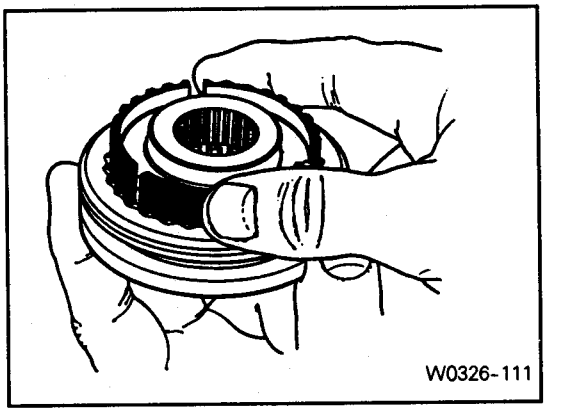
9) Take apart the three synchronizer assemblies and check :
- The 1-2 synchronizer.



- The 5th blocking ring.

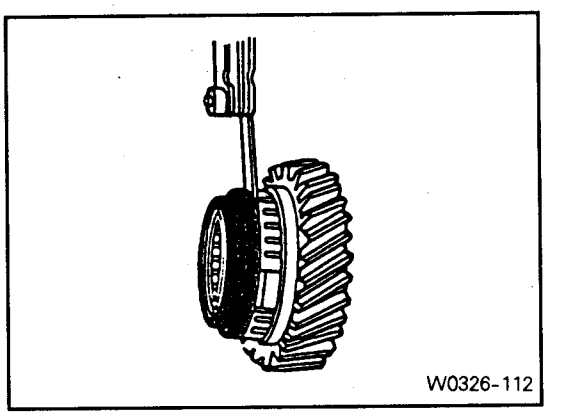


10) Check the fit between the hub and sleeve of each synchronizer.
- Excessively tight or loose hub-to-sleeve fit.
- Wear of the cone clutch surfaces of brass blocking rings and gears.

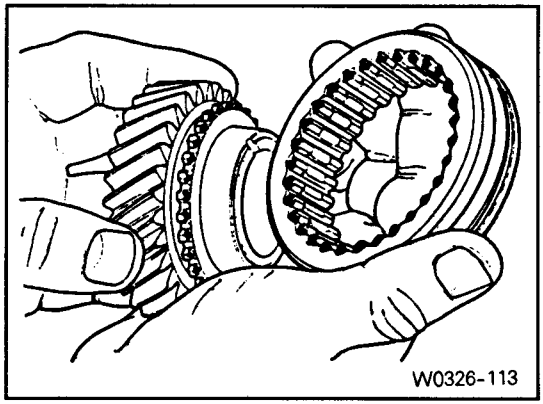


11) Measure the clearance between the blocking ring and the speed gear.
- New 1-2 blocking ring : 0.87 ~ 1.4mm
- New 3-4 blocking ring : 0.88 ~ 1.5mm

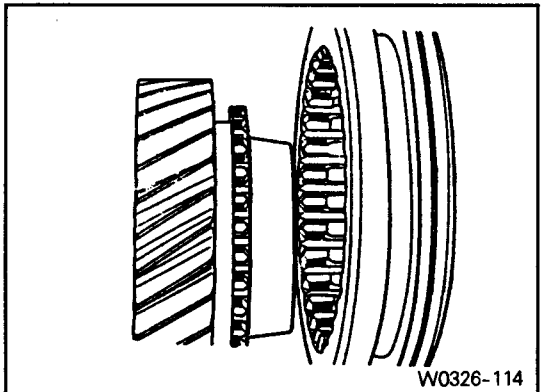
[Note] Excessive wear of the blocking ring or the speed gear cone surface will cause shift block-out or gear clash.



12) Check for gear clash on the synchronizer sleeve teeth or the clutch teeth on the speed gear.



13) Check the synchronizer sleeve and speed gear clutch tooth for hop-out.

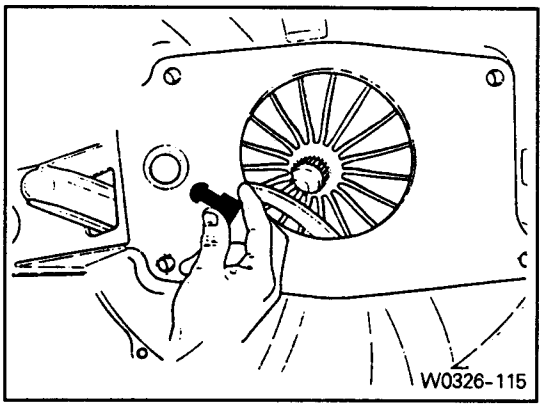


7. Pre-Installation Checks

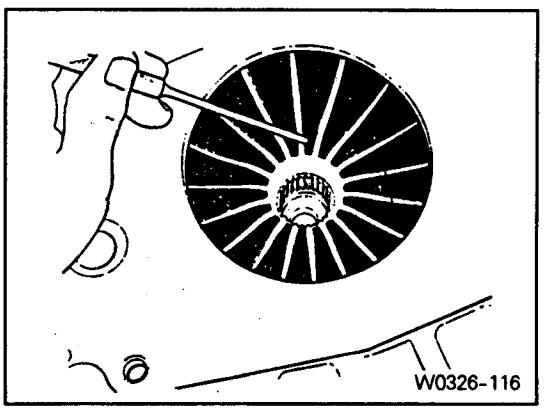
Inspection

1) Separate the clutch release fork from the pivot and remove the pivot from the clutch housing.

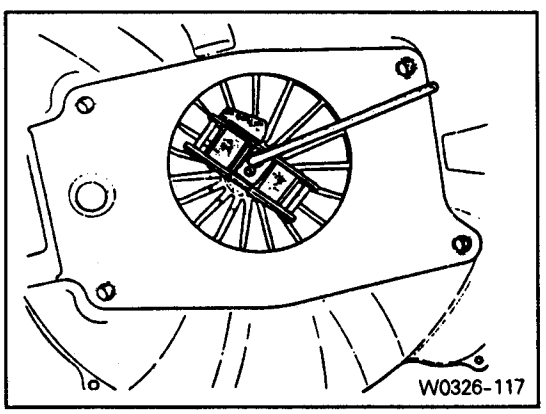
2) Check the pivot, fork and release bearing.



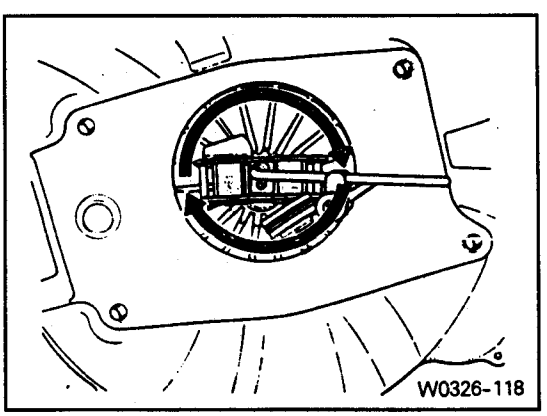
3) Check the pressure plate spring.
[Note] Inspect each parts and replace the excessively worn parts.



4) Check the clutch housing alignment as follows :
· Place the magnetic base on the pressure plate spring.

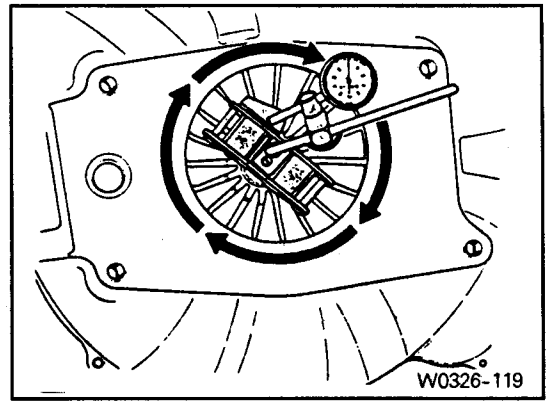


· Check the housing bore alignment.
- Place the dial indicator on the bore.
- By rotating the crankshaft one revolution, record the dial indicator reading.



· Check the housing face alignment.
  - Place the dial indicator on the housing face.
  - By rotating the crankshaft one revolution, record the dial indicator reading.

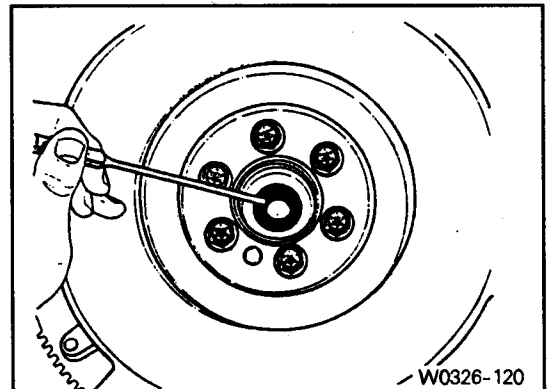
  [Note] If the reading is greater than 0.010 inch, insert the shim between the engine and clutch housing and adjust the alignment.



5) Check the following parts :
   · Pressure plate spring assembly.
   · Disc.
   · Flywheel.
   · Input shaft pilot bearing.

   [Note] Replace the excessively worn parts.

6) Lubricate the clutch release bearing bore, fork groove and fork pivot head during assembly.



1. General

[Note] : Gasoline means M162E32 engine only.

Specifications

Automatic transmission	Model		W4AO40
	Operation type		Planetary gear type
	Shift type		Floor shift type
	Gear ratio	1st	3.871
		2nd	2.247
		3rd	1.436
		4th	1.000
		Rev.	5.590
Automatic transmission fluid	Specification		Approved fluids on MB Sheets 236.6, 236.7, 236.1/9 (ATF Dexron II)
	Capacity		9.0 ~ 10.0 ℓ
	Check		Every 15,000 km
	Replacement		Every 50,000 km

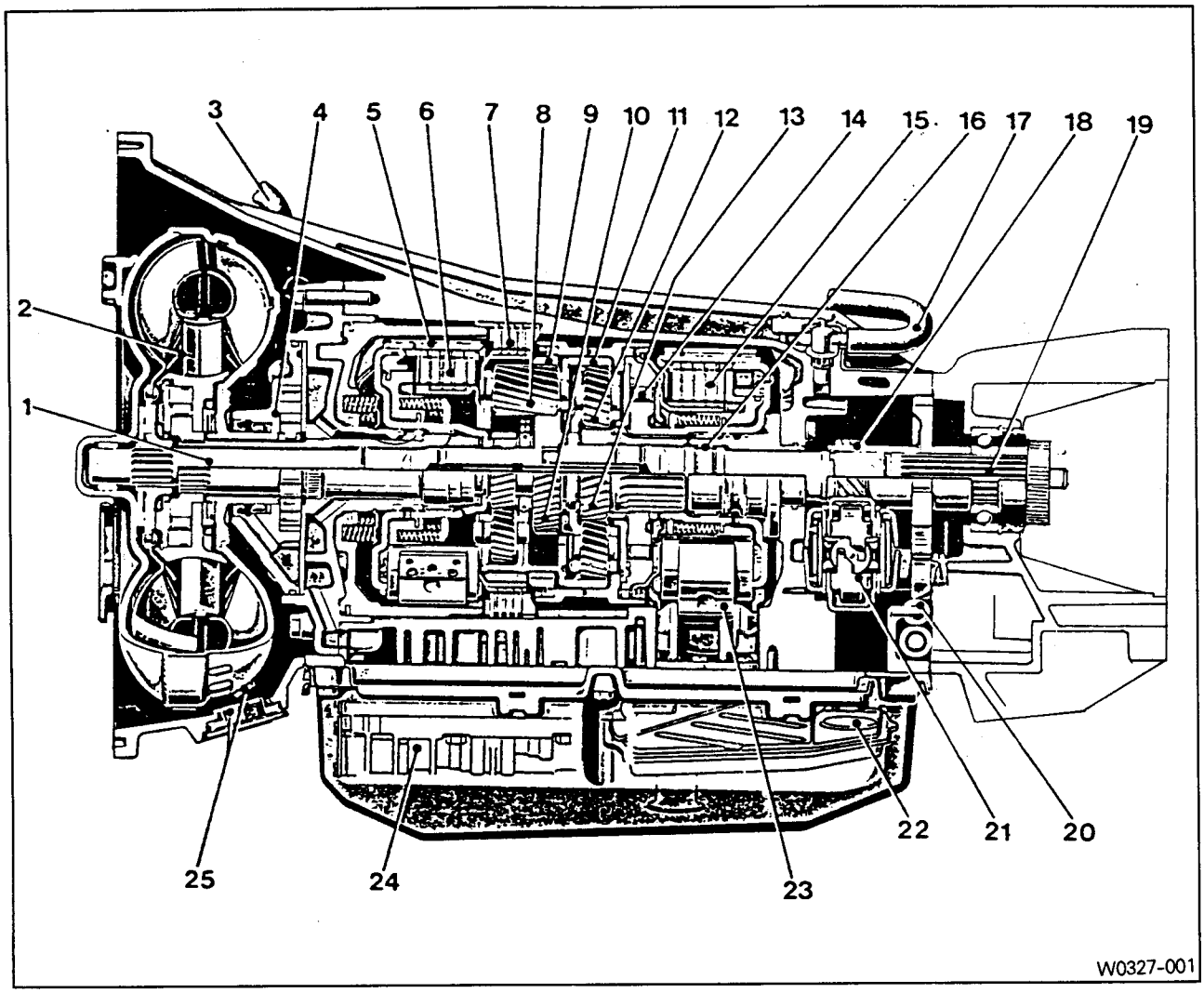
Shifting Elements

○: Actuated

Elements / Gear	K1	K2	B1	B2	B3	F	Gear ratio i
1st gear		○		○		○	3.871
2nd gear			○	○			2.247
3rd gear	○			○			1.436
4th gear	○	○					1.000
Reverse gear		○			○	○	5.590

[Note] K : Clutch B : Brake band F: Free - wheeling shift unit

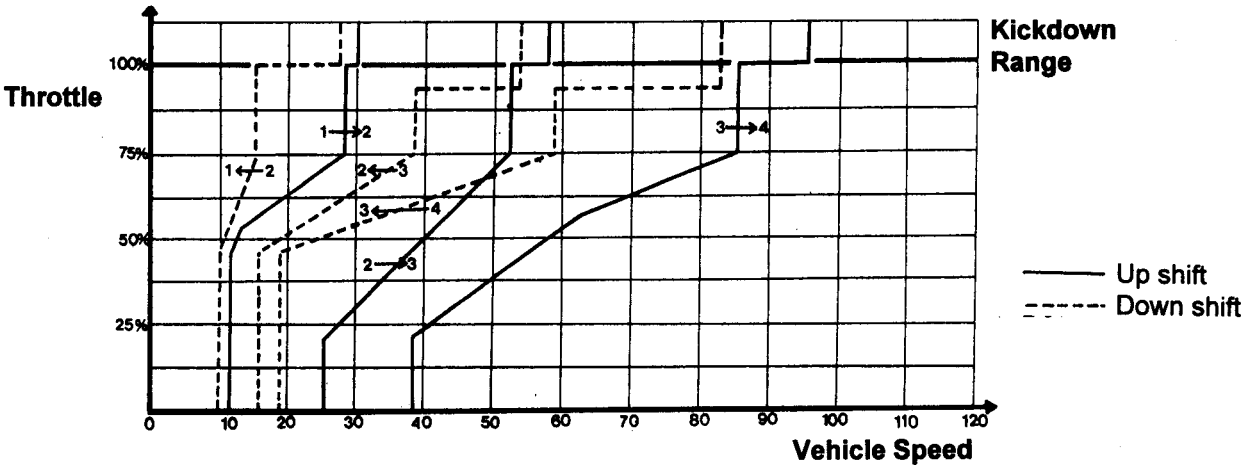
Sectional view



1. Input Shaft
2. Torque Converter
3. Torque Converter Housing Vent
4. Primary Pump
5. Brake Band B1
6. Clutch K1
7. Brake Band B3
8. Wide Planetary Gear
   (Ravigneaux Planetary Gear Set)
9. Hollow Gear
10. Sun Gear
11. Hollow Gear (Rear Planetary Gear)
12. Planetary Gear
13. Sun Gear
14. Free - Wheeling Shift Unit
15. Clutch K2
16. Output Shaft Bearing
17. Transmission Housing Vent
18. Governor Drive Gear
19. Output Shaft
20. Parking Lock Linkage
21. Flyweight Governor
22. Oil Filter
23. Brake Band B2
24. Control plate
25. Torque Converter Oil Drain

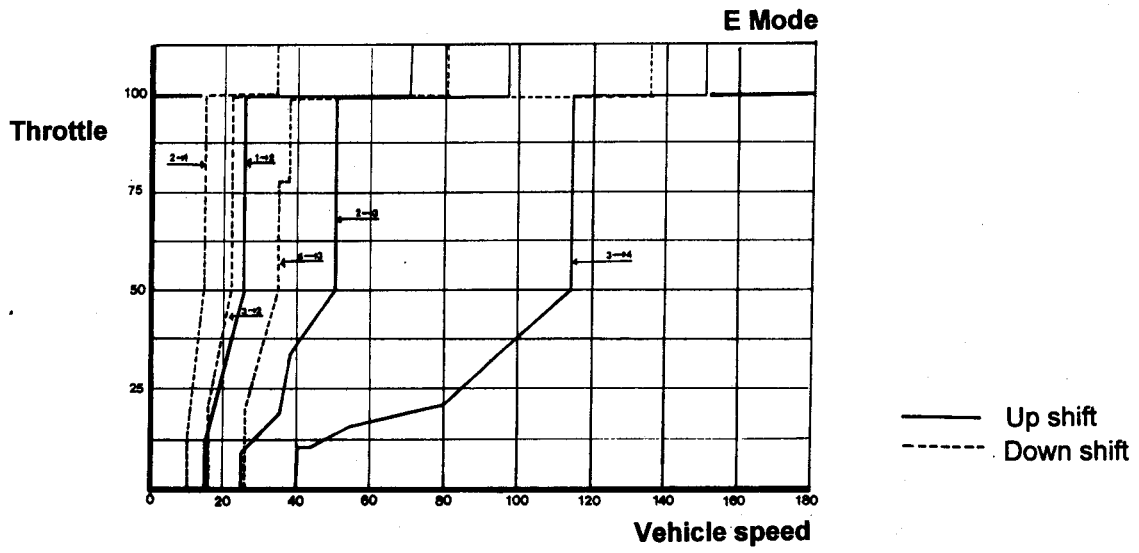
Shift pattern diagram

[Diesel]

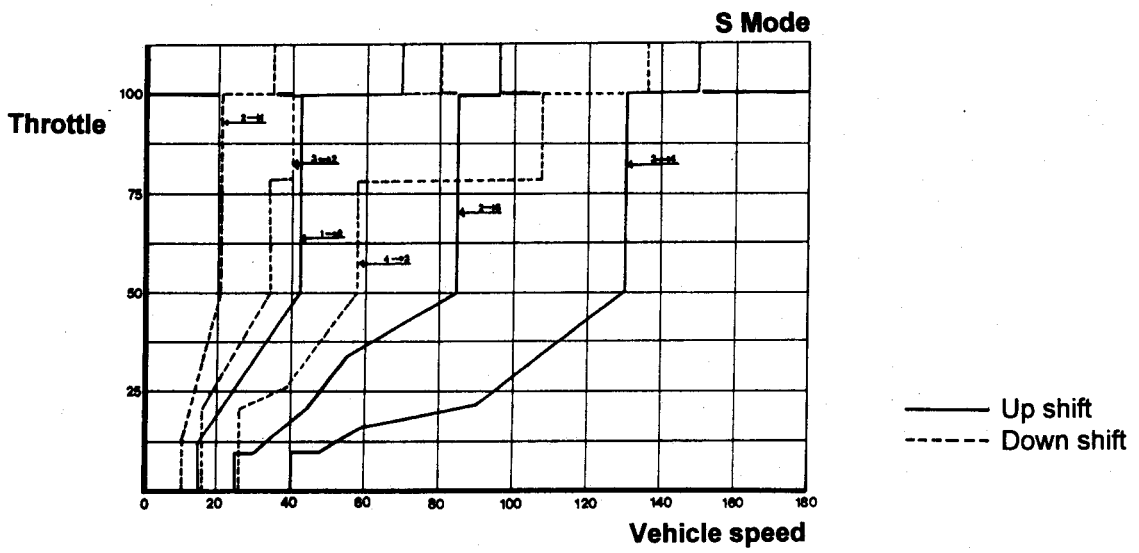


[Gasoline]

E Mode



S Mode



2. Troubleshooting

Power transfer problem

Problem	Possible Cause	Remedy
When the automatic power is not transferred or delayed in forward or reverse gear mode.	Bad gear shift linkage adjustment.	Gear shift linkage adjustment.
	Primary pump defective.	Measure the modulating pressure and working pressure and if necessary, replace the primary pump.
	Oil leakage in torque converter.	Replace the gasket.
	Sticky control valve and pick-up K2.	Clean and repair it.
When power is not transferred to the forward gear.	Gear shift linkage adjustment bad.	Gear shift lever linkage adjustment.
	Occurrence of slip in brake band B2.	Repair the brake band piston.
	Shift valve sticking.	Disassemble the valve body and clean the shift valve.
	Free-wheeling unit defective.	Disassemble the transmission and repair it.
When the power is not transferred in the reverse gear.	Gear shift linkage adjustment is bad.	Gear shift lever linkage adjustment.
	Seal and friction plate of the piston for multi-plate brake 3 is defective.	Inspect the multi-plate brake 3 for gear shift lever linkage, adjust and repair it.
	Shift valve sticking.	Disassemble the valve body and clean the shift valve.
	Free-wheeling unit is defective.	Disassemble the transmission and repair it.
After staring, when power is not transferred to all gear for a moment.	Leakage from lubrication pressure ring of the input shaft or pressure ring damage.	Inspect the lubrication pressure valve in the valve body and clean it.
		Inspect the lubrication pressure ring of the input shaft and if necessary, replace it.
In case power is not transferred after removing the transmission for reinstallation.	Torque converter assembly bad or the drive lug is not connected accurately to the primary pump drive wheel.	If necessary, replace the primary pump or torque converter.

Slip

Problem	Possible Cause	Remedy
When shifting from 1st to 2nd gear, the transmission slips.	Shift valve sticking.	Disassemble the valve body and clean the shift valve.
	Brake band B1 defective.	Disassemble the transmission and repair the B1.
When shifting from 2nd to 3rd gear, the transmission slips.	Shift valve sticking.	Disassemble the valve body and clean the shift valve.
	Leakage from teflon ring in the transmission front cover.	Remove the front cover and replace the teflon ring.
	Clutch K1 disc wear or leakage from the K1 seal part.	Remove the clutch K1 and repair it.
	Brake band piston B2 sticking or leakage.	Disassemble the transmission and repair the brake B2.
When shifting from 3rd to 4th gear, the transmission slips.	Shift valve sticking.	Disassemble the valve body and clean the shift valve.
	Leakage from the teflon ring in the support flange for K2.	Disassemble the transmission and replace the teflon ring.
	Plate for clutch K2 worn or leakage from piston seal part for K2.	Disassemble the clutch K2 and repair it.

Up shift / Down shift

Problem	Possible Cause	Remedy
Not shifted to higher gear.	Governor pressure too low.	Measure the governor pressure and if necessary, disassemble the governor.
	Defective kickdown control.	Check the kickdown control.
It can be shifted to higher gear only in low gear range.	Governor pressure too high.	Measure the governor pressure and if necessary, disassemble the centrifugal governor.
It can be shifted to higher gear only in high gear range.	Kickdown solenoid valve sticking.	Measure the voltage of kickdown solenoid valve.
	Governor pressure too low.	Measure the governor pressure and if necessary, disassemble the centrifugal governor.

Up shift / Down shift

Problem	Possible Cause	Remedy
Kickdown wiring shorted.	Kickdown wiring shorted.	Check and repair the kickdown control wiring.
	The kickdown solenoid valve cannot be switched.	Wiring supply check. Remove the solenoid valve and check the function. If necessary, replace it.
	Kickdown control valve sticking.	If necessary, replace the valve body.
Down shift or kickdown is delayed in full load causing too early up shift.	Kickdown control valve is defective.	Check and repair the valve body.
In case that it is unpredictably down-shifted automatically beyon partial throttle range downshift eve though the kickdown switch has no been operated.	Damaged sealing ring in the solenoid valve.	Disassemble the solenoid valve and replace the sealing ring.
	The kickdown switch is defective.	Check the switch and if necessary, replace it.
	Kickdown solenoid valve sticking in open position.	Check is solenoid valve and if necessary replace it
In case it is shifted from gear shift lever 'B' to 2nd gear.	The micro switch wiring harness or kickdown solenoid is defective.	Connect the test light to diode V2 in the fuse box and shift the gear shift lever to 'B' position. 1. When the test light does not illuminate : Check the micro switch and wiring harness. 2. When the test light illuminates : Check the kickdown solenoid valve and if necessary, replace it.
When down shift for the engine brake is not operative.	Lockout valve sticking in the mounting housing.	Repair or replace it.
When down shift for the engine brake is not operative in idling status.	Oil pressure control problem.	Check the control valve and lockout valve function and if necessary, clean the shift valve and mounting housing.

Transmission vibration (rattling)

Problem	Possible Cause	Remedy
When vibration (rattling) occurs with the gear being defective.	Defective control valve.	Check and clean the control valve.
Vibration occurs when shifting the gear.	The working pressure is too high or modulating pressure adjustment is bad.	Adjust the modulating pressure.
	Vacuum box defective.	Check the vacuum box and if necessary, replace it.

Gear selector lever

Problem	Possible Cause	Remedy
When it cannot be shifted to 'R' or 'P' in the status that the engine is stopped.	Lockout piston sticking in the lower cover.	Repair.
When it cannot be shifted to 'R' or 'P' in the status that the engine is running.	Centrifugal governor sticking.	Clean it and if necessary, replace it.
When the engine cannot be started in 'P' or 'N' position.	Shifting linkage and starter lockout switch adjustment are bad.	Adjust the shifting linkage and starter lockout switch.
	The starter lockout switch is defective.	Replace the starter lockout switch.
When shifting range is not indicated in the instrument panel.	Shifting linkage adjustment is bad.	Adjust the shifting linkage.

Others

Problem	Possible Cause	Remedy
Acceleration at stopping is not good.	The free-wheeling unit of torque converter slips.	Perform the stall test and if measured value is lower than specified value by 400-700 rpm, replace the torque converter.
Roaring noise is heard and it becomes louder as the engine is accelerated.	Defective primary pump.	Check the pump and if necessary, replace it.
Roaring noise is heard when shifting the gear in high engine R.P.M.	Primary pump impeller is hitting the middle plate.	Replace the primary pump.
Periodical noise is heard at the speed of 80-90km/h.	It is caused by the resonance between the engine, tire and torque converter.	It can be improved by rotating the torque converter by 120°.
Oil leakage from the backside of the starter lockout switch and backup light switch.	Damaged pressure element B2.	Replace the sealing ring on the pressure element B2.
Oil leakage from the vent when driving in the highway.	Excessive oil.	Check oil amount. **[Note]** **Check oil temperature carefully.**

3. Service Standard

Tightening torque		Nm
Kickdown solenoid valve		20
Rear cover bolt	M8	45~53
Drive flange collar nut	M12	120
Shift valve housing bolt	M6 × 55	8
Shift valve housing bolt	M6 × 56	8
Oil filter screw		4
Oil pan bolt	M8	8
Lower cover screw		8
Propeller shaft mounting bolt	M10	40
Torque converter drain plug		14
Transmission drain plug		14
Cross member mounting bolt		45
Torque converter mounting bolt		42
Transmission mounting bolt	M12	65
Transmission front cover bolt		15
Primary pump bolt		20
Pressure element B1 plug (reaction valve)		70
Selector lever detent spring bolt		8

Adjustment data

mm

End play 'B' of clutch K1	When the rear housing cover is installed	0.3~0.5
	When the rear housing cover is not installed	0.8~1.2
Disc clearance for brake band B3		1.5~2.0
Idling stroke in brake band B1		1.8~2.5
Idling stroke in brake band B2		5.5~5.7
Clearance 'C' between locking pistons on the linkage stop and spring mounted linkage		0.4~1.0
Disc clearance for clutch K1		0.7~1.3
Disc clearance for clutch K2		0.7~1.3
End play 'C' of output shaft (clutch K2)		0.4+0.1

Pressure value

		Diesel	Gasoline (E32)
Kickdown shut off engine R. P. M.		3,950 ± 50	6,100 ± 50
Modulating pressure		1.8 bar	3.8 bar
Working pressure [1]		9.8 bar	12.5 bar
Governor pressure [2]	When vehicle speed is 30 km/h	0.9 bar	0.9 bar
	When vehicle speed is 50 km/h	1.8 bar	1.5 bar
	When vehicle speed is 70 km/h	2.5 bar	2.0 bar

[1] At vehicle stationary, set the selector lever at ' D ' position and remove the vacuum line from the vacuum box.

[2] Rear axle gear ratio i = 3.73
Tire = P235 / 75R 15

4. Special Tool List

Part name	Part no.
Tester	201 589 13 21 00
Vacuum pump	001 589 73 21 00
Flyer	000 589 52 37 00
Measurement sleeve	126 589 06 14 00
Parallel gauge	126 589 04 31 00
Handle	126 589 01 62 00
Flushing mandrel	116 589 00 15 00
Torque wrench	001 589 66 21 00
Oil extractor	112 589 00 72 00
Wrench	126 589 00 01 00
Mounting plate	126 589 10 63 00
Mounting jig	116 589 06 59 00
Spring clamp	201 589 12 43 01
Counter piece	201 589 12 43 02
Assembly sleeve	126 589 02 14 00
Mounting jig	201 589 03 59 00
Assembly support	126 589 00 35 00
Torque gauge	001 589 49 21 00
Clamping tool	126 589 00 43 00
Assembly sleeve	126 589 02 14 00
Assembly sleeve	126 589 10 14 00
Oil insertion funnel	126 589 12 63 00
Oil removal hand pump	112 589 00 72 00
Pressure tester	123 589 04 21 00
Measurement sleeve	129 589 06 23 00

Automatic Transmission

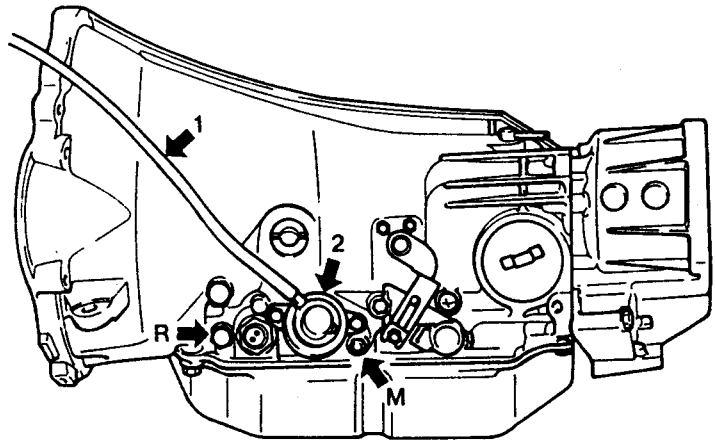
Commercial tools

Tachometer		
Multimeter	e.g.	SUN - DMM 5 SUN ELEKTRIK GmbH Auf dem Hüls 5 Mettmann
		Avemeter 2003 Hemann Elektronik Rathhausstr. 1 Cadolzburg Bachendorf
		Fluke 23 - DB Fluke GmbH Postfach 1153 Ismaning

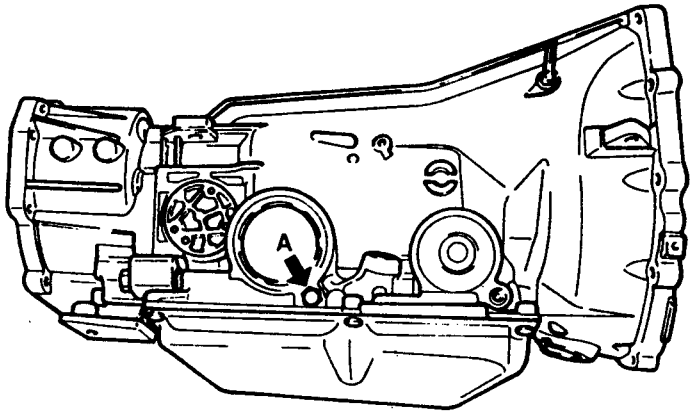
5. Measurement and Adjustment of Modulating Pressure and Working Pressure

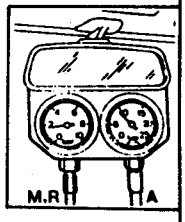
Preceding work : Inspection and adjustment of the vacuum control valve [Diesel]

[Common]

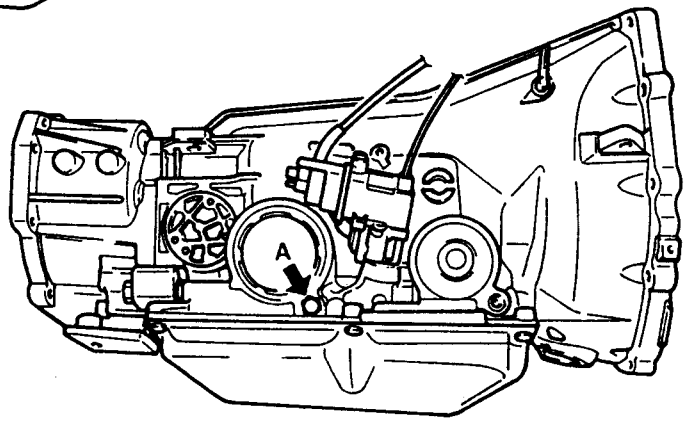


[Diesel]





[Gasoline]



1. [Diesel] Vacuum Line to the Vacuum Control Valve
   [Gasoline] Vacuum Line to the Intake Manifold
2. Vacuum Box

A. Test Connection for Working Pressure ---------- Use a gauge measuring up to 25 bar

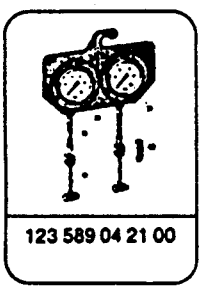
M. Test Connection for Modulating Pressure ---------- Use a gauge measuring up to 25 bar

R. Test Connection for Governor Pressure ---------- Use a gauge measuring up to 10 bar

Pressure value

	Diesel	Gasoline
Modulating Pressure	1.8 bar	3.8 bar
Working Pressure	9.8 bar	12.5 bar

Special tool

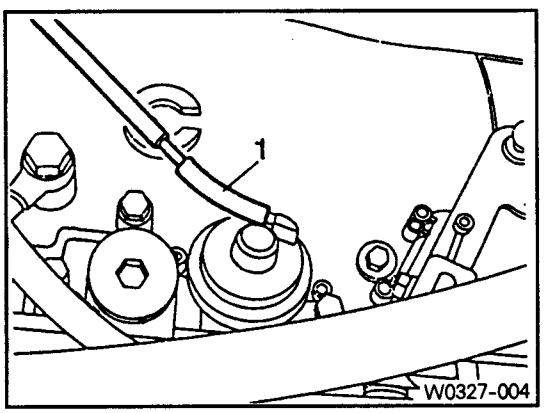


Measuring Modulating Pressure and Working Pressure

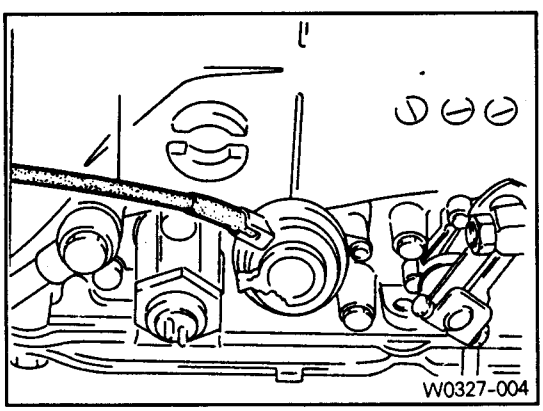
[Note]
- **Do test within normal operating temperature of the transmission and fluid.**
- **Apply parking brake and shift the selector lever to 'P' position.**

1) Disconnect the vacuum line (1) from the vacuum box.

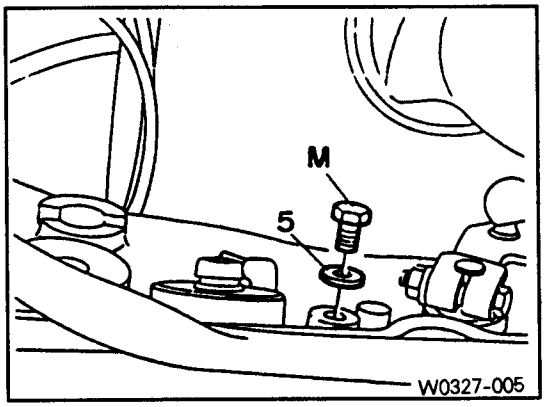
[Diesel]



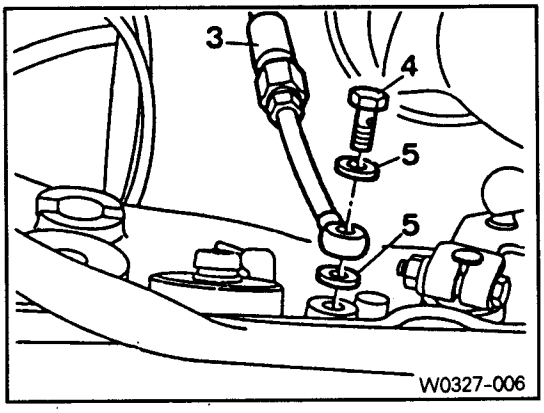
[Gasoline]



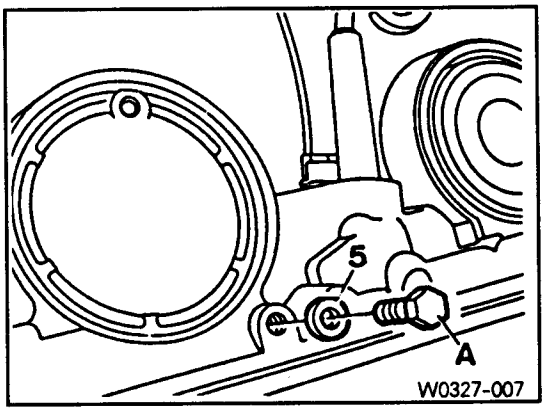
) Remove the sealing ring (5) and plug (M) from the test connection for modulating pressure.
[Note] Replace sealing ring.



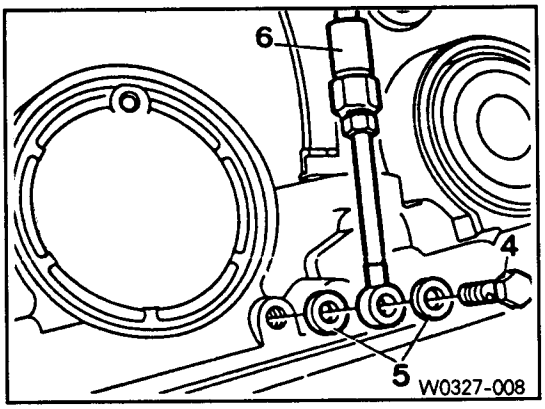
) Using the sealing ring (5) and union bolt (4), connect the tester (3) to the test connection for modulating pressure.



) Remove the sealing ring (5) and plug (A) from the test connection for working pressure.
[Note] Replace sealing ring.

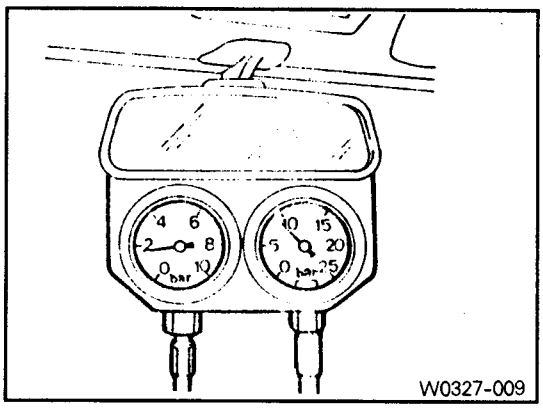


) Using the sealing ring (5) and union bolt (4), connect the tester (6) to the test connection for working pressure.
[Note]
- **Use a pressure gauge measuring up to 25 bar.**
- **Working pressure can be checked through reaction with modulating pressure and it cannot be adjusted.**
- **If working pressure is measured, ensure that modulating pressure is correctly adjusted.**
- **If working pressure is out of standard value, repair the shift valve housing.**



6) Clamp the tester on the inside mirror.
[Note] Be careful so that the tester hoses must not in contact with the exhaust manifold.

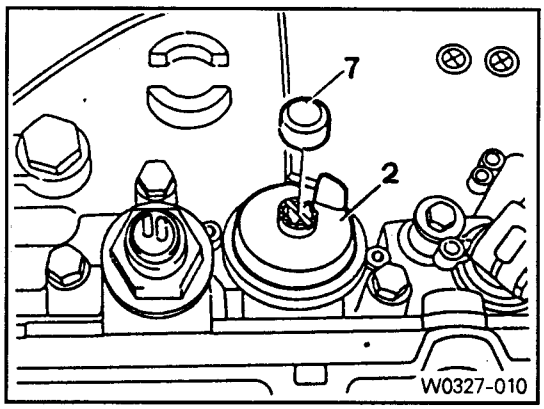
Tester 123 589 04 21 00



7) With the selector lever in 'D' position and engine idling, measure working pressure and modulating pressure.
[Note]
- **Because of the difference in height between the transmission and tester, add 0.1 bar to the measured value.**
- **Apply the service brake and parking brake.**

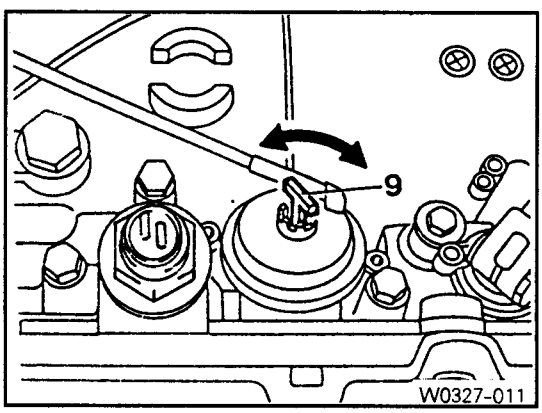
Adjustment of Modulating Pressure

1) Remove the rubber cap (7) from the vacuum box (2).

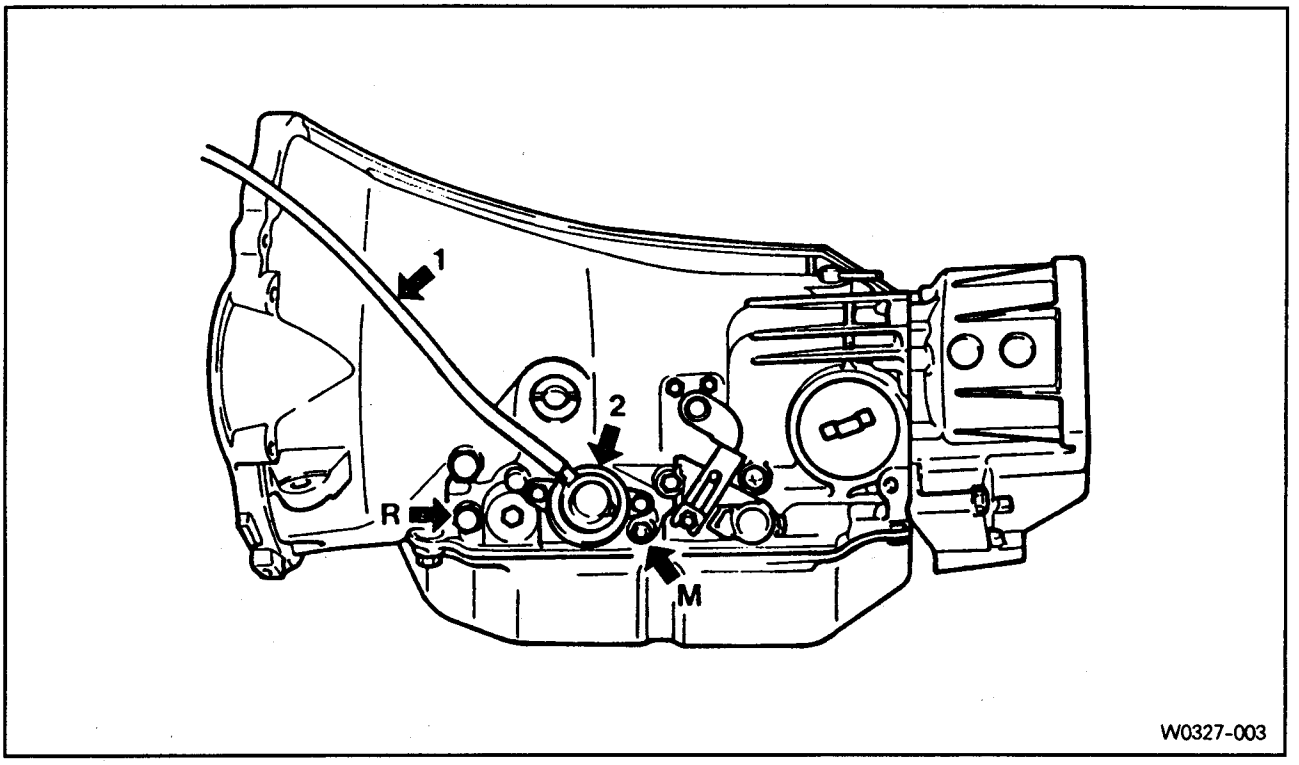


2) Pull out the adjust wrench (a) from the retaining cone and adjust pressure.

1 revolution to the right	0.4 bar increase
1 revolution to the left	0.4 bar decrease



6. Measurement of Governor Pressure



1. [Diesel] : Vacuum Line to the Vacuum Control Valve
   [Gasoline] : Vacuum Line to the Intake Manifold
2. Vacuum Box

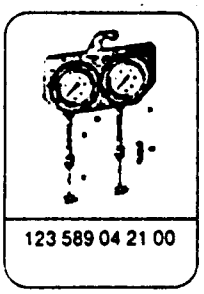
M. Test Connection for Modulating Pressure ---------- Use a gauge measuring up to 10 bar

R. Test Connection for Governor Pressure ---------- Use a gauge measuring up to 10 bar

Pressure value

	Diesel	Gasoline
When vehicle speed is 30km/h	0.9 bar	0.9 bar
When vehicle speed is 50km/h	1.8 bar	1.8 bar
When vehicle speed is 70km/h	2.5 bar	2.0 bar

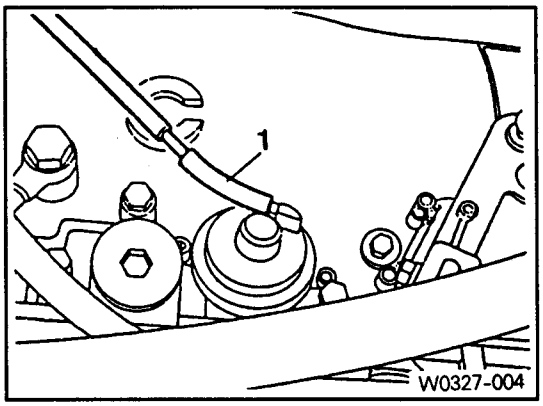
Special tool



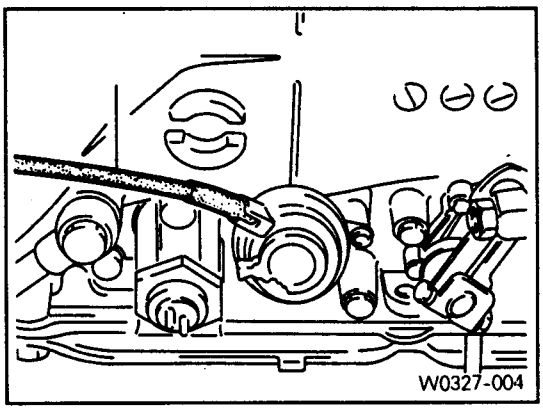
Measuring Governor Pressure

1) Disconnect the vacuum line (1) from the vacuum box.

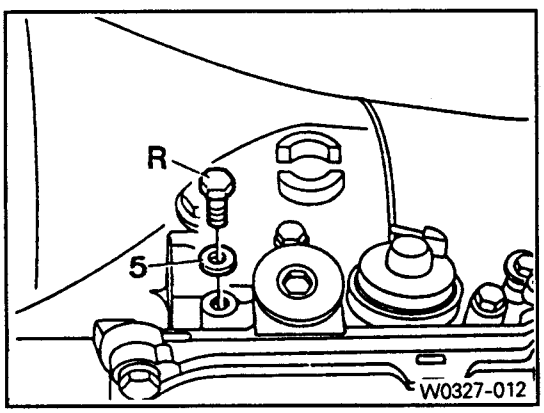
[Diesel]



[Gasoline]

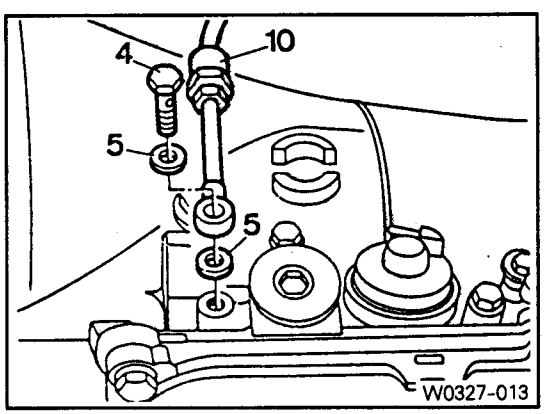


2) Remove the sealing ring (5) and plug (R) from the test connection for governor pressure.
[Note] Replace sealing ring.



3) Using the sealing ring (5) and union bolt (4), connect the tester (10) to the test connection for governor pressure.
[Note] Use a pressure gauge measuring up to 10 bar.

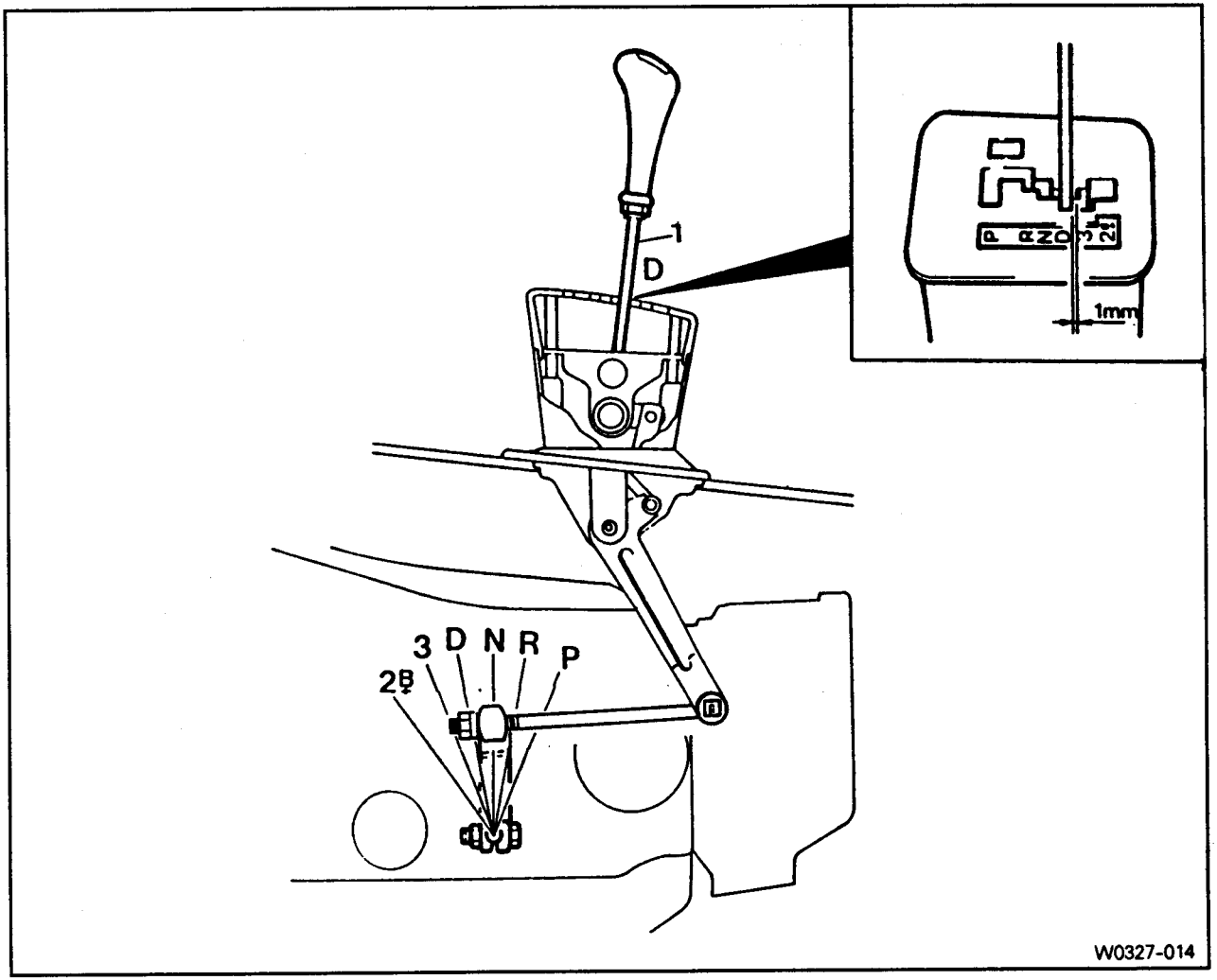
Tester 123 589 04 21 00



4) Drive the vehicle on the dynamo-meter or road and measure governor pressure level.

[Note]
- **If governor pressure is not generated, disassemble and clean the centrifugal governor.**
- **If measured value is different from the standards, clean or replace the centrifugal governor.**

7. Adjustment of Selector Lever Linkage



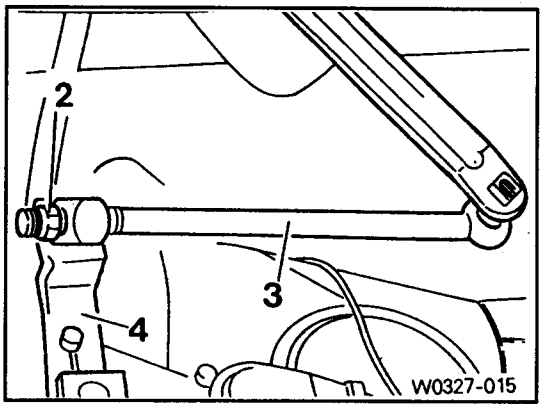
1. Selector Lever ----------Clearance between the shift gate 'D' stop and selector lever is 1mm.
2. Counter Nut
3. Shift Rod
4. Range Selector Lever

Adjustment

1) Disconnect the shift rod (3) from the range selector lever (4) and shift the range select or lever to 'D' position.

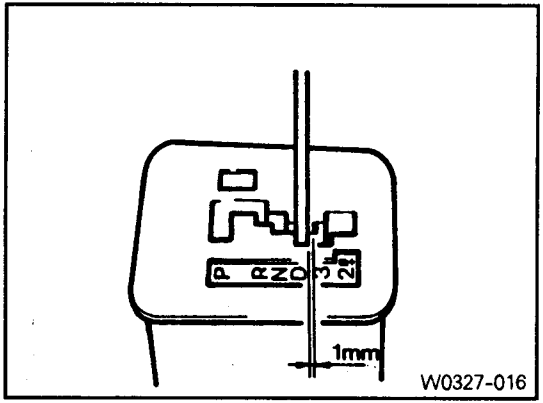
2) Shift the selector lever (1) to 'D' position.

3) Loosen the counter nut (2) and adjust the shift rod (3).



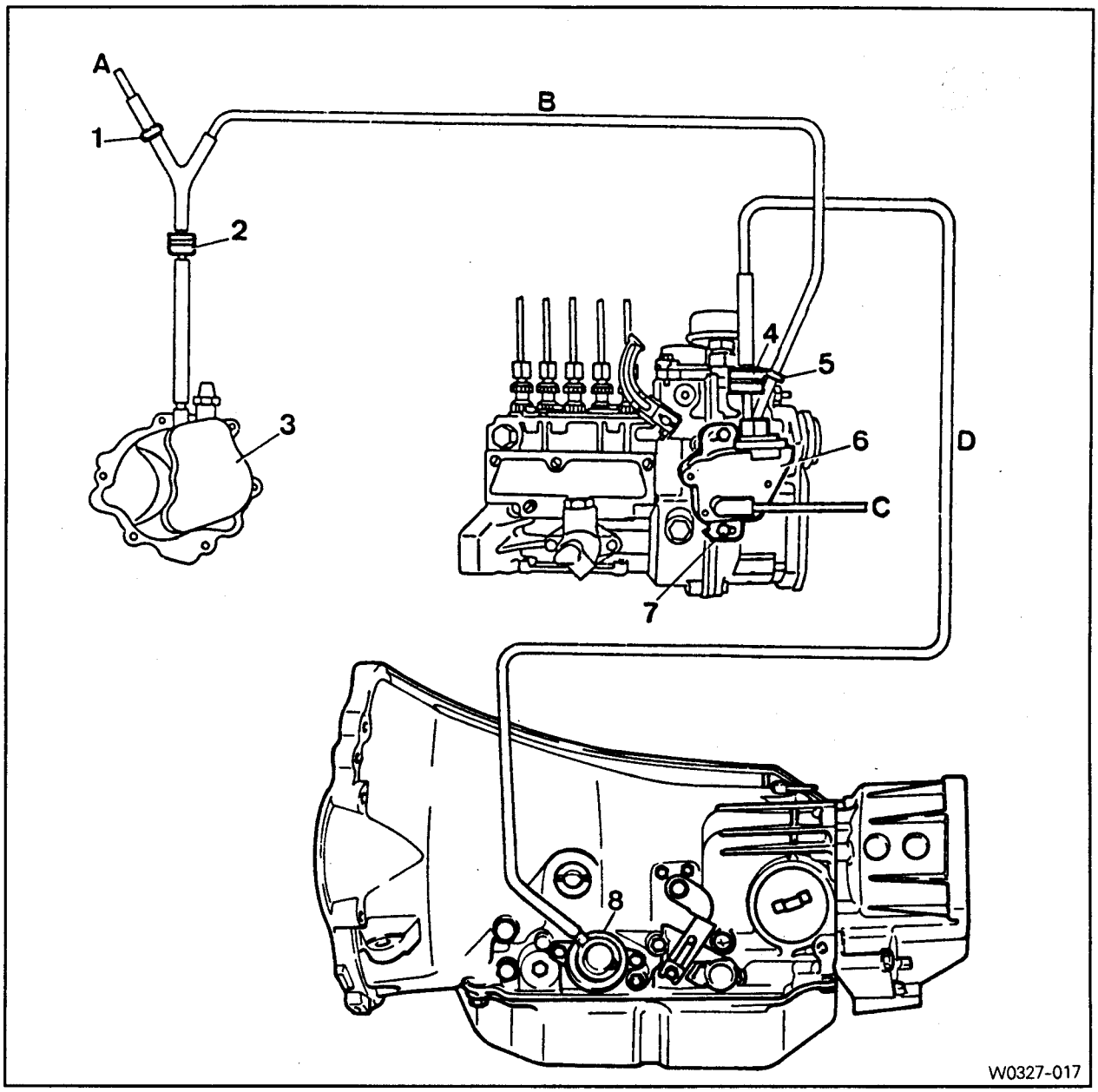
4) Check that the clearance between the shift gate 'D' stop and selector lever is 1mm.

5) After adjustment, tighten the counter nut.



[Note] See page '85' for the starter lockout switch adjustment in ' N ' position

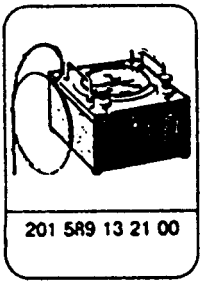
8. Check and Adjustment of Vacuum Control [Diesel Only]



1. Throttle ---------- Orange
2. Vent Filter ---------- Clogging check
3. Vacuum Pump-
4. Damper ---------- After inspection, replace it if necessary
5. Throttle ---------- Blue, after inspection, replace it if necessary
6. Vacuum Control Valve ---------- Inspection, adjustment
7. Bolt
8. Vacuum Box

A. Vacuum Line
B. Vacuum Line ---------- Lucid
C. Vent Line ---------- Black
D. Vacuum Line ---------- Black / White

Special tool



Vacuum control valve

The vacuum control valve is located on the side of the fuel injection pump and adjusts the vacuum pressure for modulating pressure control.
The vacuum control valve is controlled by the regulating lever of the fuel injection pump and it adjusts the vacuum pressure 0 mbar in full throttle and 400 mbar in idling condition.

Inspection

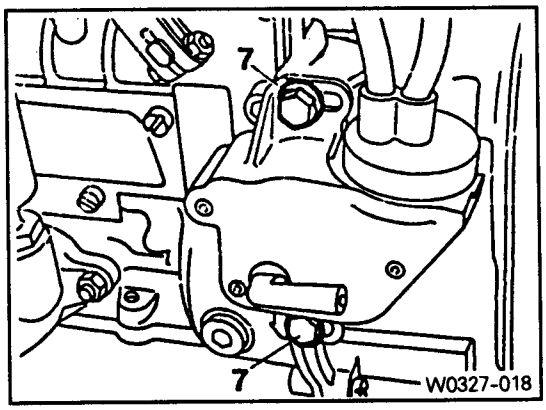
[Note] · **The engine idle speed should be adjusted properly and inspection should be performed under normal operation temperature of the engine.**
· **When up-shifting is difficult or delayed in part throttle range or the gear slips when shifting, inspect the vacuum control valve first.**

1) Check if there is any small hole or crack on the vacuum line and if necessary, replace it.

2) Inspect the vent filter (2) and if contaminated, replace it.

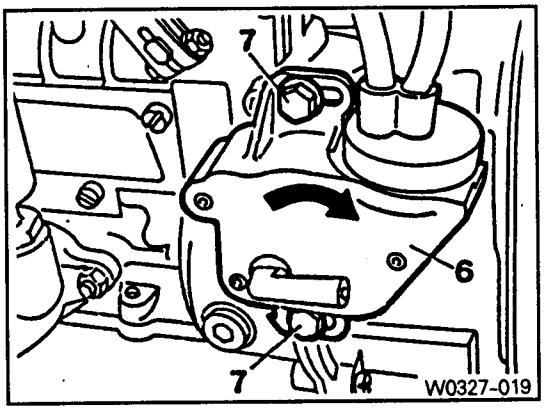
Adjustment of vacuum control valve (6)

1) Loosen the bolts (7) in the vacuum control valve.



2) At full throttle position, rotate the vacuum control valve (6) slowly to the arrow direction until resistance is felt. At this position tighten the vacuum control valve bolt (7).

[Note] After adjustment, inspect the vacuum control valve.



Inspection of vacuum control valve (6)

1) Remove the vacuum line (black/white) and connect the gauge to the damper (4).

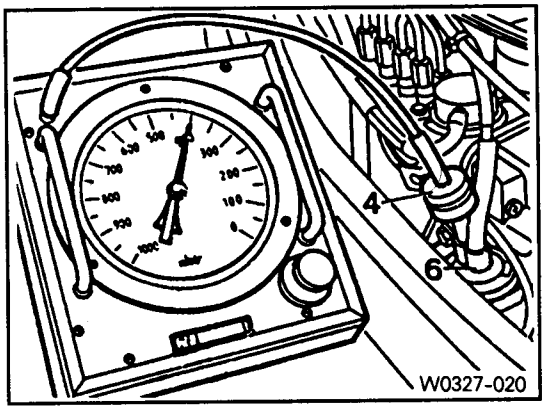
2) Start the engine.

[Note] After starting the engine, and within 10 seconds, the vacuum pressure should be 400mbar.

3) Stop the engine.

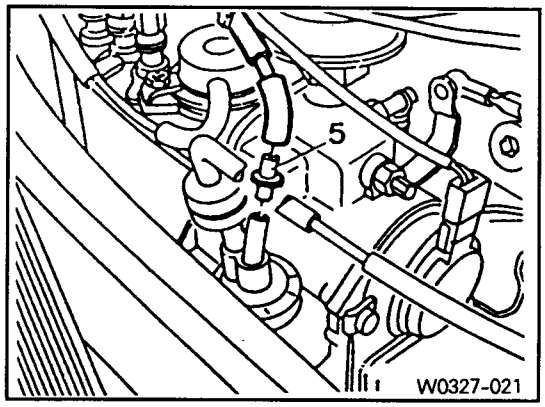
4) If the engine is stopped, depress the acceleration pedal to full throttle. At this time vacuum pressure should be 0 mbar.

[Note] If vacuum pressure does not drop to '0 mbar' in full throttle, replace the vacuum control valve.



Throttle (5) inspection

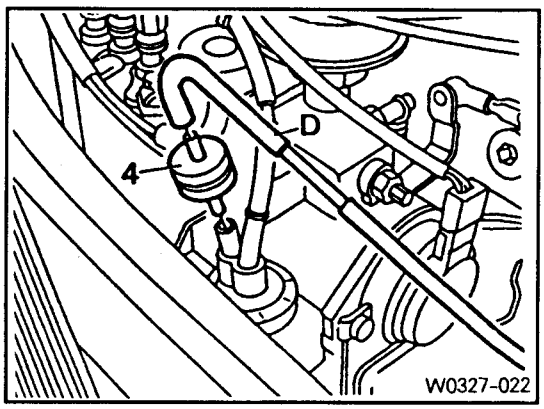
1) Disconnect the throttle (5-green) and check for clogging.
2) Clean or replace the throttle.
   [Note] Rough shifting may damage the throttle.



Damper (4) inspection

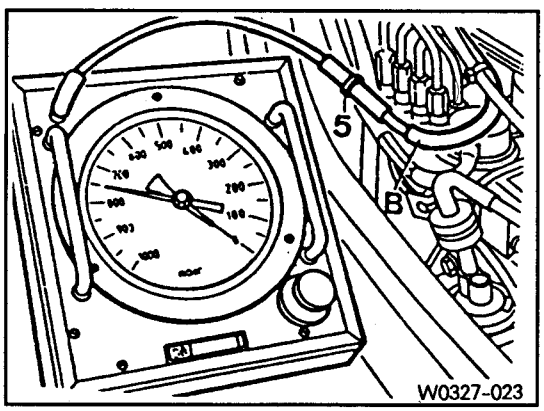
1) Disconnect the vacuum line (D-black/white).
2) Disconnect the damper (4-green) and check for clogging.

[Note]
- **If necessary, replace the damper.**
- **The damper can be used regardless of the direction.**



Vacuum pump inspection

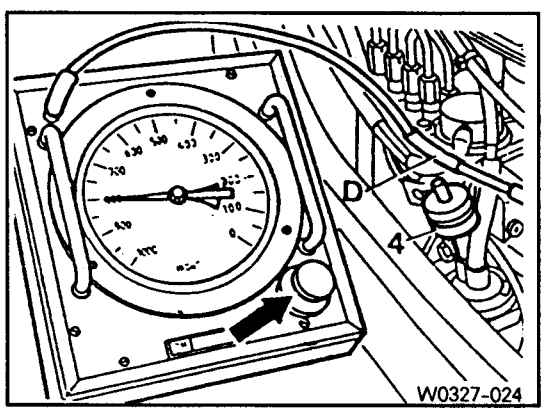
1) Connect the gauge to the throttle (5-green) of the vacuum pump line (B).
2) Start the engine.
3) Within 1 minute at idle, the vacuum pressure should be 700 ~ 800mbar.
4) Stop the engine.
5) The vacuum pressure should be maintained constant and it should not drop for more than 100mbar every 1 minute.
   [Note] If it is not within standard value, the vacuum line and vacuum pump should be checked.



Vacuum box inspection

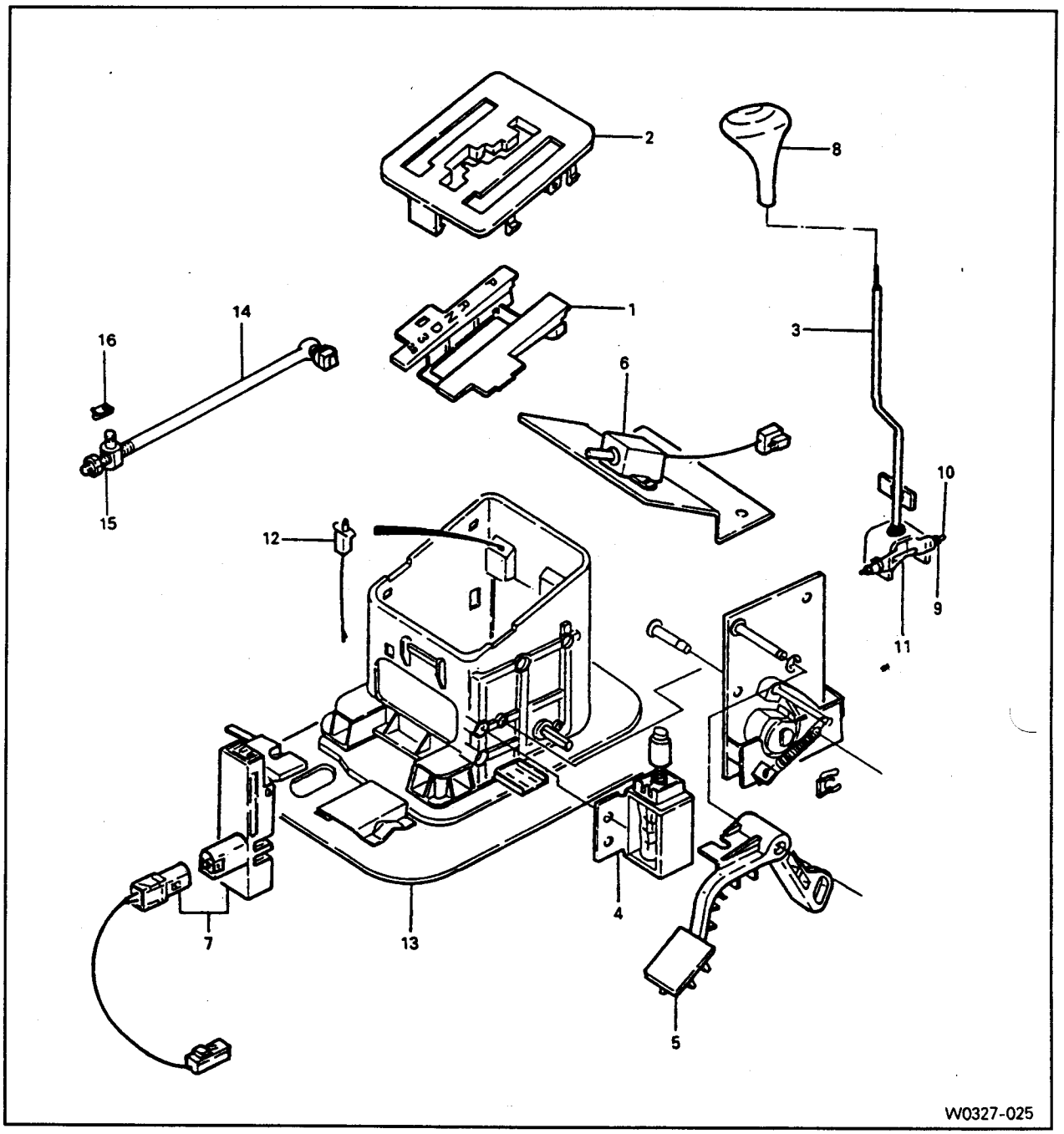
1) Disconnect the vacuum line of the damper (4).
2) Connect the gauge to the vacuum line.
3) Pump (arrow) up to 800mbar.

[Note] The vacuum pressure should be maintained 800mbar constantly and if not, leakage in the vacuum line and connection should be checked. If necessary, replace the vacuum box.



9. Removal and Installation of Selector Lever

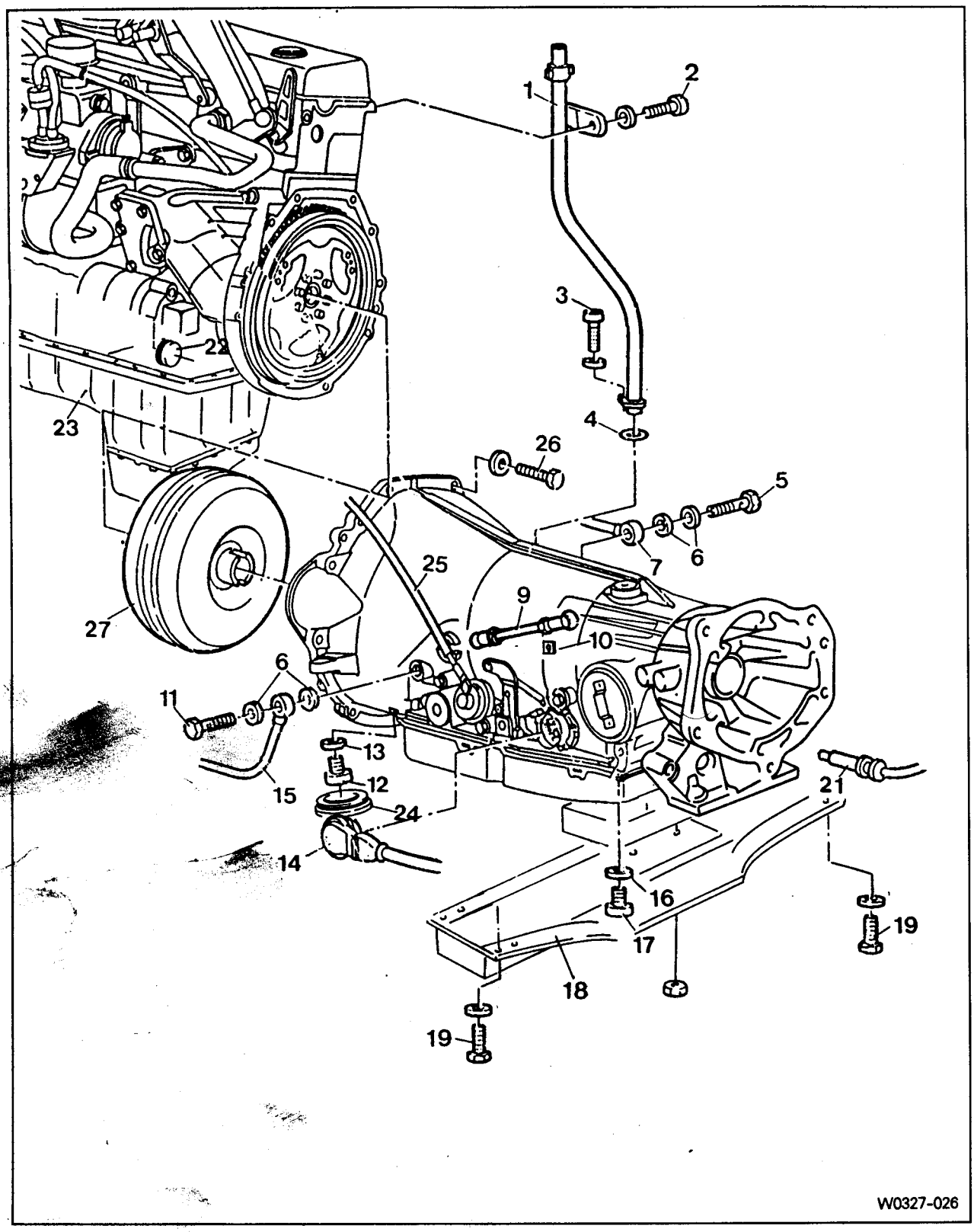
Components



1. Middle Housing Sub Assembly
2. Upper Housing
3. Shift Lever
4. Solenoid Assembly
5. Lock and Release Lever
6. ' P ' Position Switch
7. ' B ' Position Switch
8. Knob
9. Bushing
10. Pin
11. Torsion Spring
12. Extension Wiring Assembly
13. Lever Mounting Bracket Assembly
14. Rod
15. Rod Adjust Pin
16. Clip

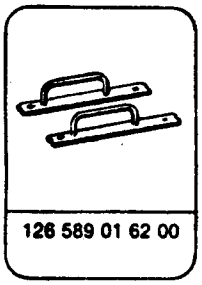
10. Removal and Installation of Transmission [Diesel]

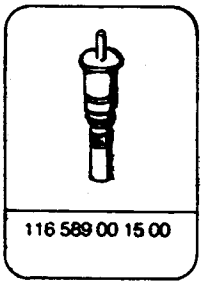
Preceding work : removal and installation of the transfer case

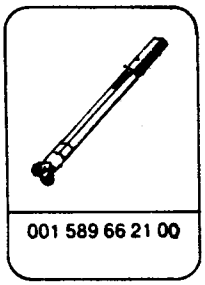


1. Oil Fill Tube
2. Bolt
3. Bolt
4. Sealing Ring ---------- Replace
5. Hollow Screw
6. Sealing Ring ---------- Replace
7. Oil Return Line(right)
9. Shifting Rod
10. Retaining Clip
11. Hollow Screw
12. Torque Converter Drain Plug ---------- 14Nm
13. Sealing Ring ---------- Replace
14. Starter Lockout Switch Plug
15. Oil Feed Line(Left)
16. Sealing Ring ---------- Replace
17. Transmission Drain Plug ---------- 14Nm
18. Cross Member
19. Bolt ---------- 45Nm
21. Kickdown Solenoid Switch Plug
22. Torque Converter Mounting Plug---------- 55Nm
23. Lower Oil Pan
24. Torque Converter Drain Plug Cover
25. Vacuum Line
26. Bolt ---------- 65Nm
27. Torque Converter

Special tools


126 589 01 62 00


116 589 00 15 00


001 589 66 21 00

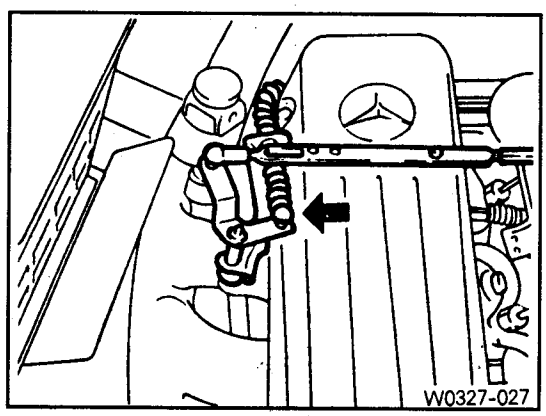
Removal

[Note] Removal and installation of the transfer case is the same as that for the manual transmission vehicle.

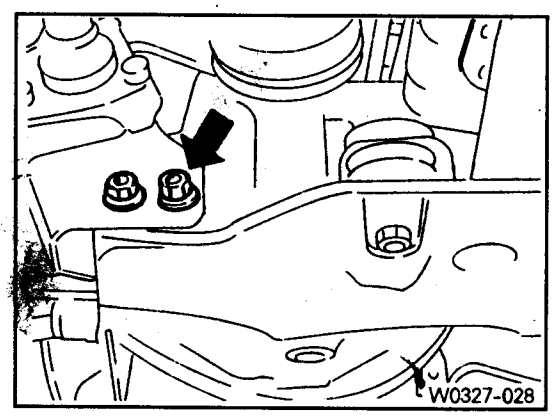
1) Disconnect the battery cables.
   [Note] Disconnect the negative terminal first.

2) Remove the oil dip stick gauge.

3) Disconnect the control pressure cable (arrow).

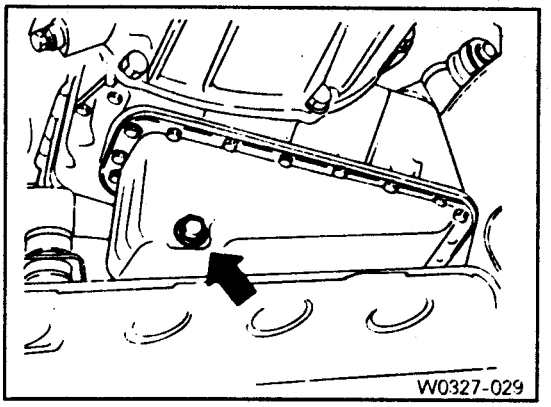


4) Remove the cross member of the front axle side.

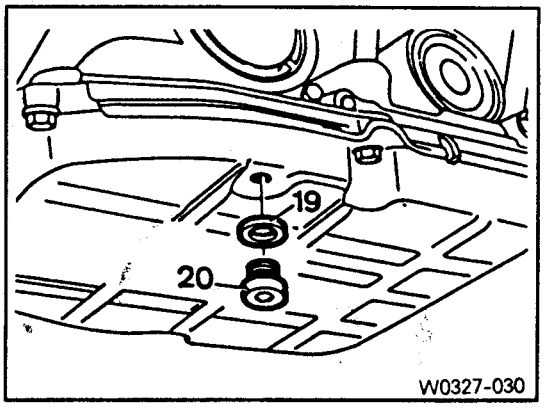


5) Drain the engine oil and remove the oil pan.

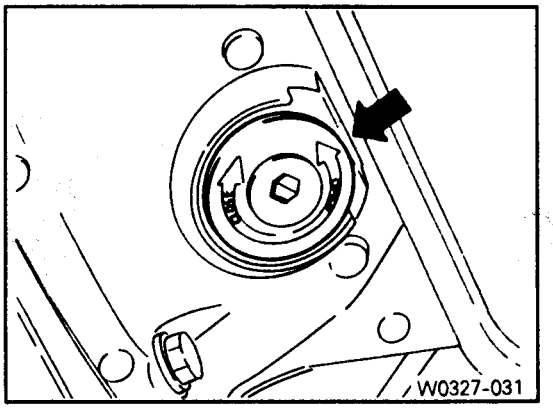
6) Remove the engine oil sump.
[Note] To remove the torque converter.



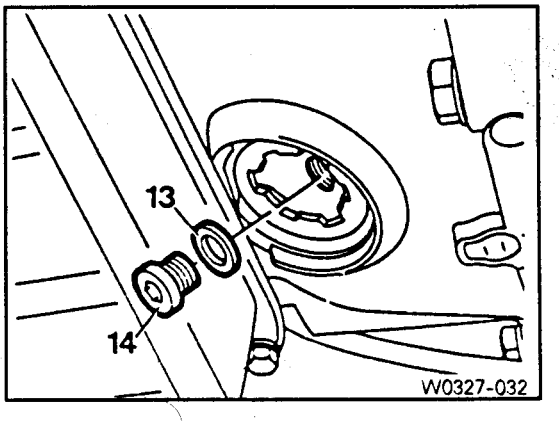
7) Drain the transmission oil.



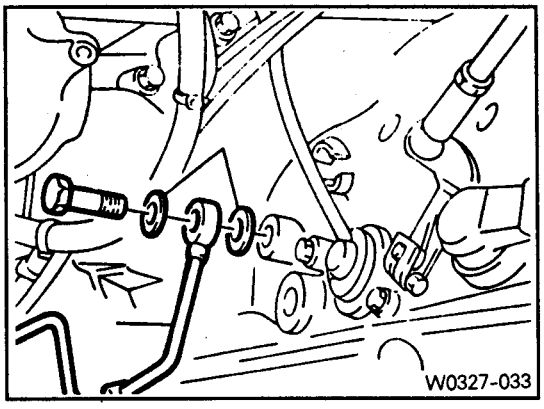
8) Remove the torque converter drain plug cover by pushing and turning to the 'open' direction in the lower side of the transmission.



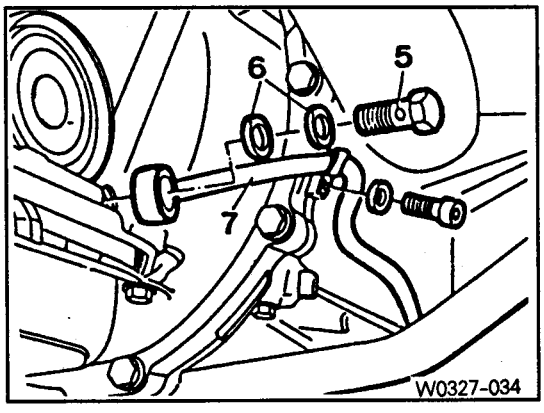
9) Align the drain plug of the torque converter by rotating the crankshaft and drain the torque converter oil.



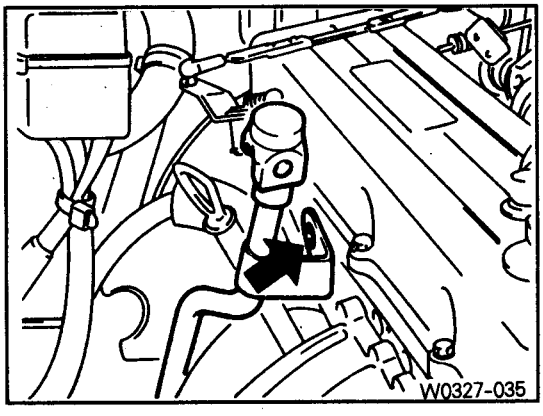
10) Remove the oil cooler feed pipe (left).



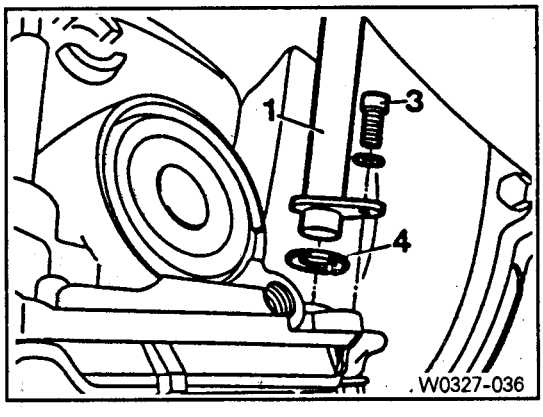
11) Remove the oil cooler return pipe (right).



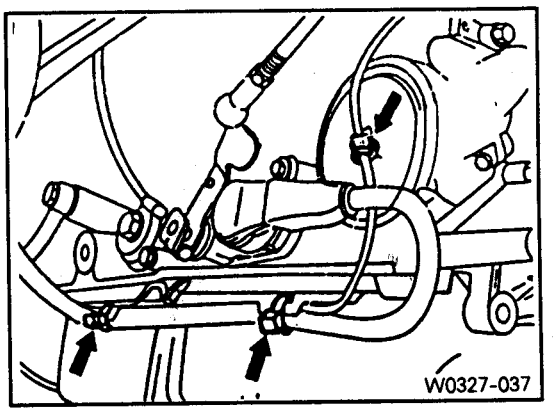
12) Remove the upper fixing bolt of the oil fill tube.



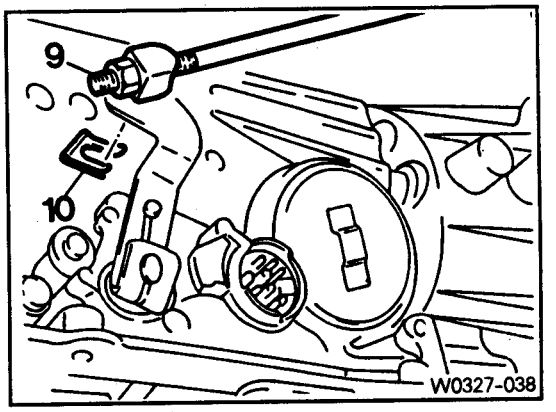
13) Remove the lower fixing bolt and remove the oil fill tube.



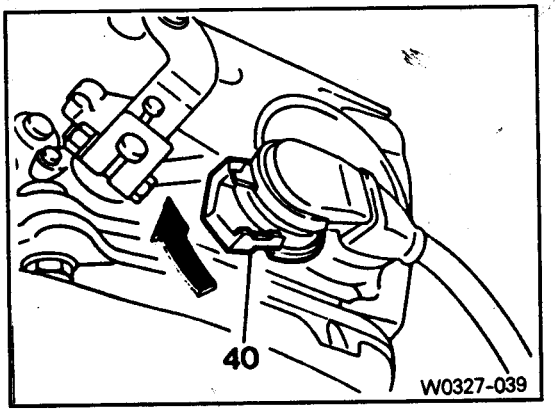
14) Remove each cable strap.



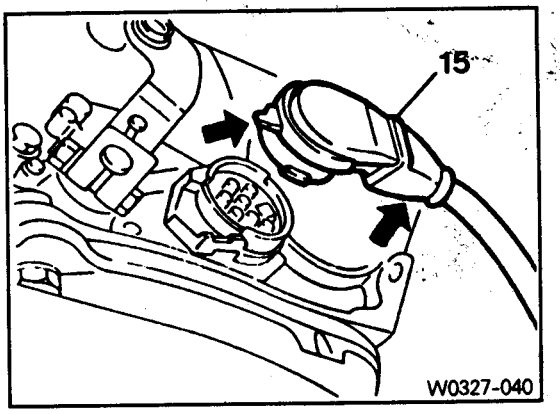
15) Remove the clip from the range selector lever and shifting rod connection and disconnect the lever and rod.



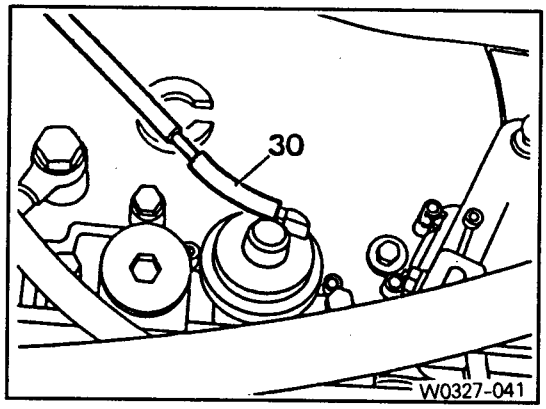
16) Turn the locking for the starter lockout switch upwards (arrow direction).



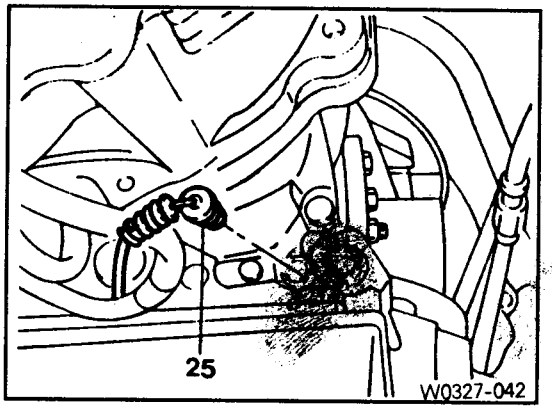
17) Lift the tap and cable (arrow) part carefully with the screw driver and remove the switch.



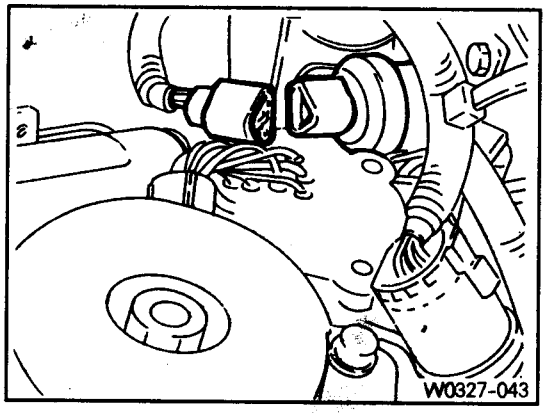
18) Remove the vacuum line.



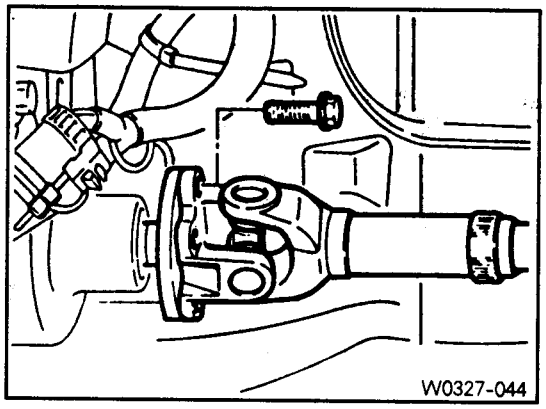
19) Disconnect the plug connection of the kickdown solenoid valve.



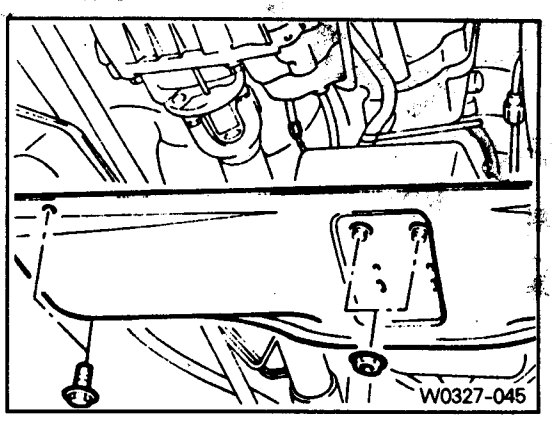
20) Disconnect the speedometer connection.



21) Remove the front and rear propeller shaft.



22) Support the transmission using a jack and remove the cross member.

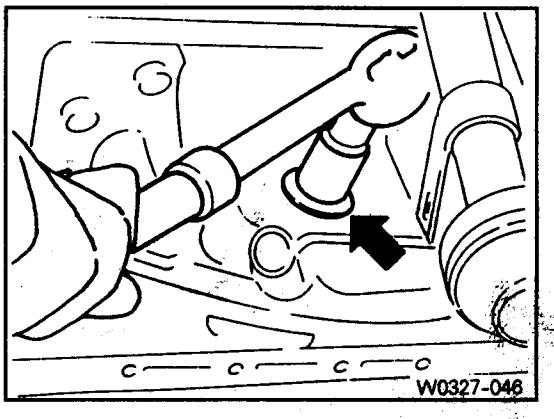


23) Remove the lower oil pan.

24) Remove the oil strainer bracket.

25) Using a hexagon wrench (Ø19), remove the plug.

26) By rotating the engine, align the drive plate with torque converter mounting bolts (6 pieces) and remove it.

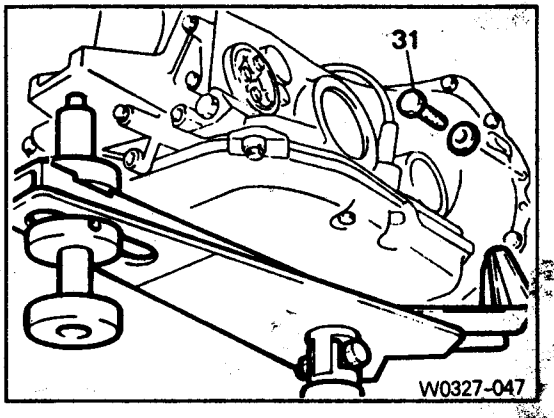


27) Place the attachment to the bottom of transmission and lift the transmission a little bit.

Attachment 116 589 06 62 00

28) Remove the transmission mounting bolts (31).

29) Move the transmission backward and lower it carefully.
[Note] Be careful not to damage the oil pan and cables and not to drop the torque converter.

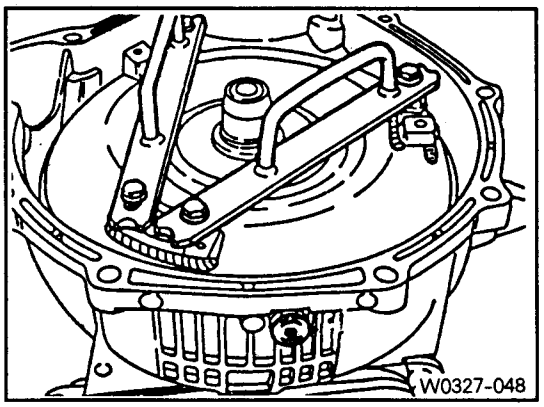


30) Remove the attachment.

31) Put the transmission up vertically.

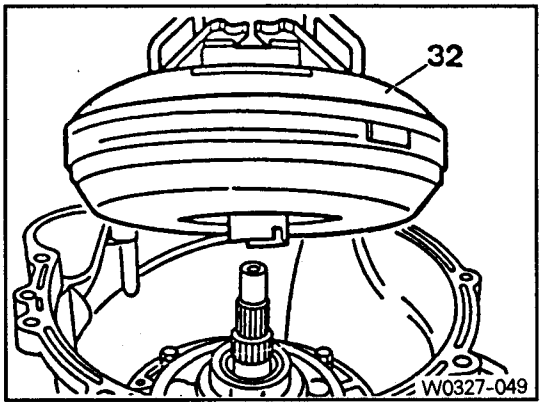
32) Install the torque converter handle.

Handle 126 589 01 62 00



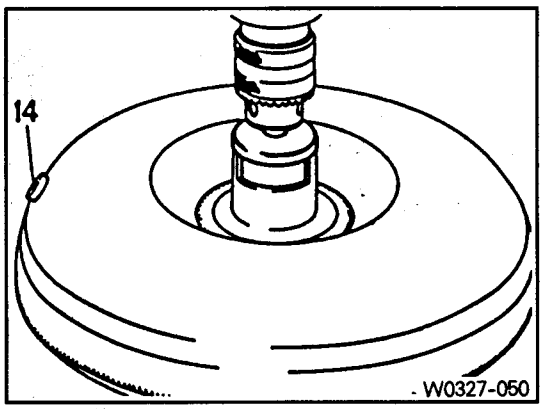
33) Remove the torque converter (32) and remove the handle.

[Note] If the transmission oil smells burnt or is saturated with particles of worn lining, the torque converter oil cooler lines and oil cooler must be flushed.



34) When flushing the torque converter, fill with 1 liter of cleaning liquid (kerosene) into the converter and insert the flushing mendrel. Using a electric drill, rotate it for 2~3 min. in low speed.
Then remove the drain plug (14) to drain cleaning liquid and repeat this flushing 2~4 times until the drained liquid is clear.

Flushing Mendrel 116 589 00 15 00



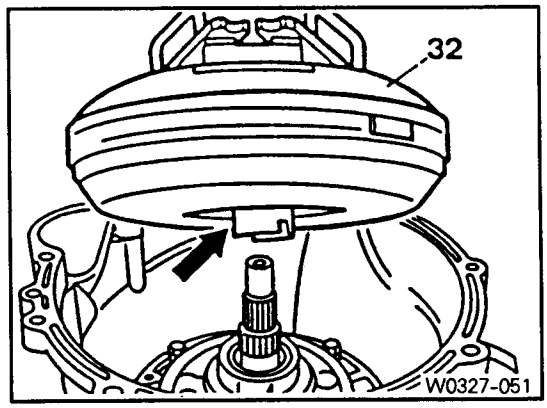
35) Fill with cleaning liquid into the oil cooler and pipes and blow out with compressed air.

Installation

1) Install the handle to the torque converter.

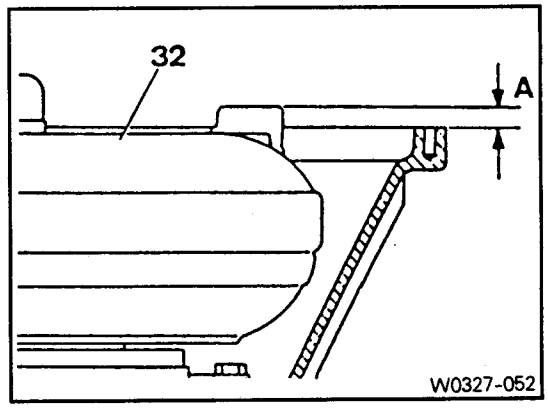
2) Apply long-term grease to the input flange (arrow) and remove the handle after installing the torque converter to the transmission.
[Note] Align the input shaft and the torque converter accurately.

Handle 126 589 01 62 00

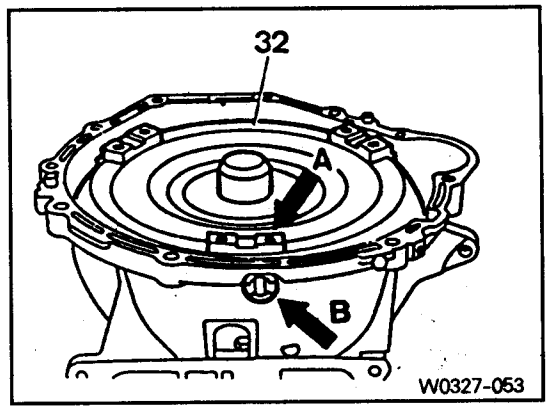


3) Measure 'A' from the torque converter mounting surface to the transmission housing.

Distance 'A'	Max. 10mm

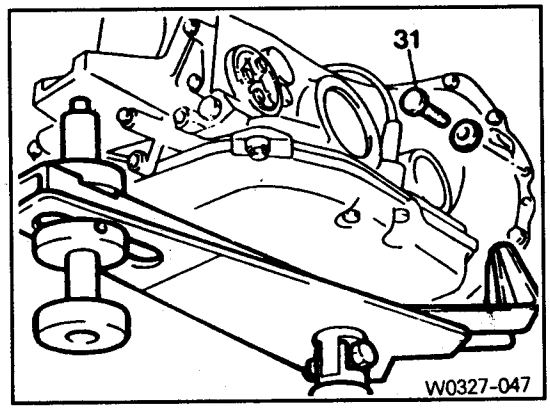


4) Align the one of the torque converter mounting holes to the position when it was removed (plug in the engine side).
[Note] Apply specified sealant on the surface of the housing.
(Dirko Silicon Compound Transparent Sealant - Ering)



5) Install the attachment to the transmission, lift the transmission up to engine height and move it forward until the engine and converter housing get in contact.

6) Install the transmission housing mounting bolts temporarily.



7) Tighten the drive plate and torque converter bolts (6 pieces).

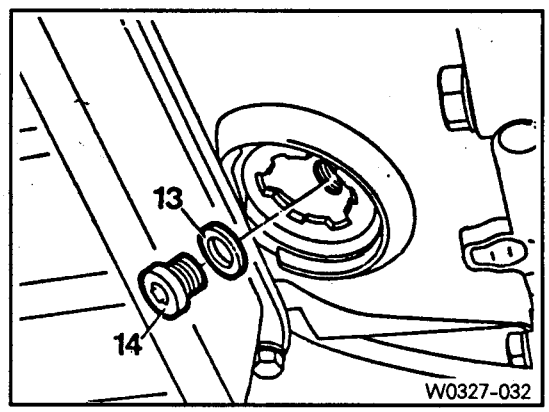
Tightening torque	42Nm

8) Tighten the transmission housing mounting bolts.

Tightening torque	65Nm

9) Replace the sealing ring (13) of the torque converter drain plug (14) and tighten the plug.

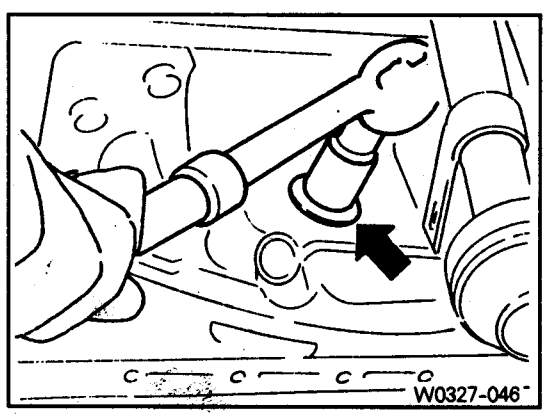
Tightening torque	14Nm



10) Install the drain plug cover.

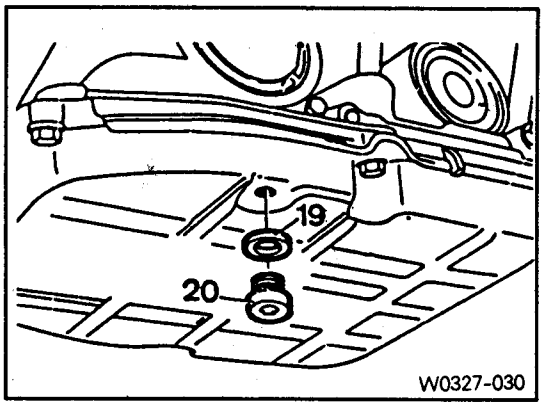
11) After applying 'Loctite (222)', install the plug for torque converter mounting.

Tightening torque	55Nm

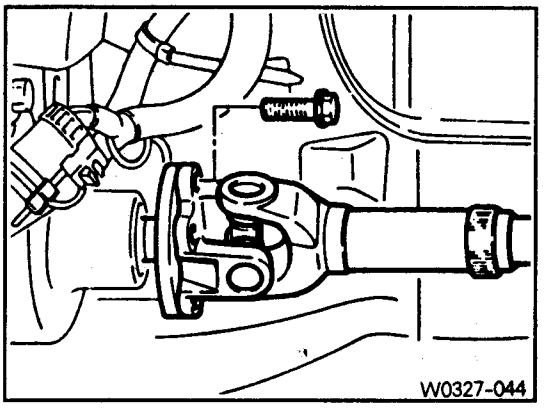


12) Replace the sealing ring (19) and tighten the transmission oil drain plug (20).

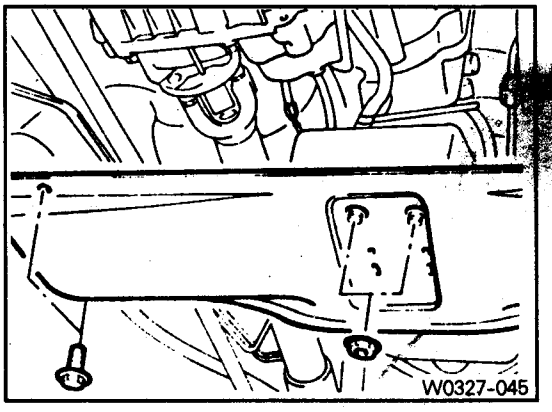
Tightening torque	14Nm



13) Install the propeller shaft.



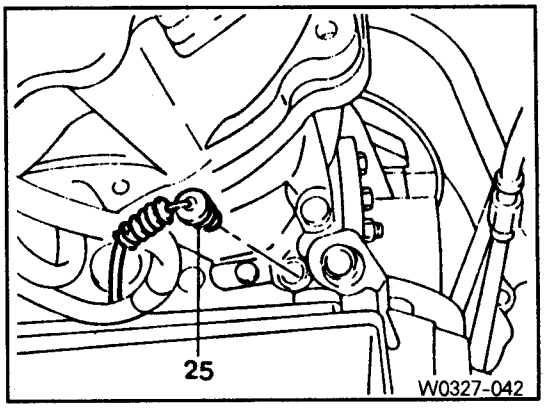
14) Install the cross member.



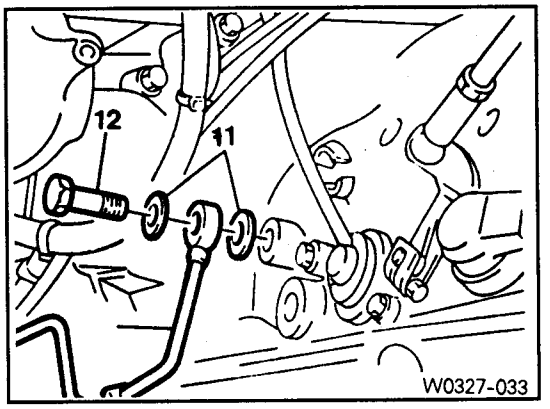
15) Install the oil strainer bracket and install the lower oil pan.

Tightening torque	25Nm

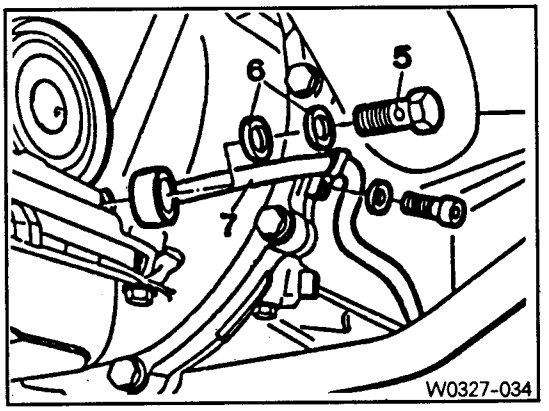
16) Connect the kickdown solenoid switch connector (25).



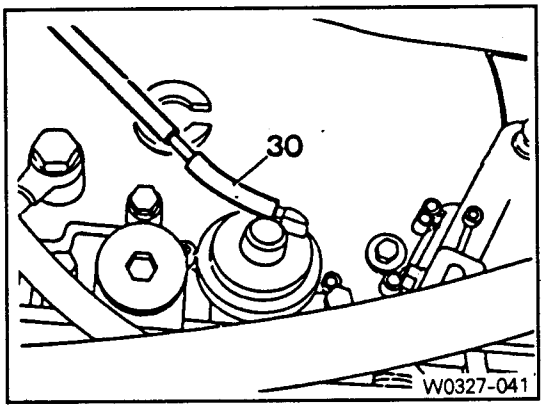
17) Install the oil cooler feed line (left).
[Note] Replace the sealing ring (11).



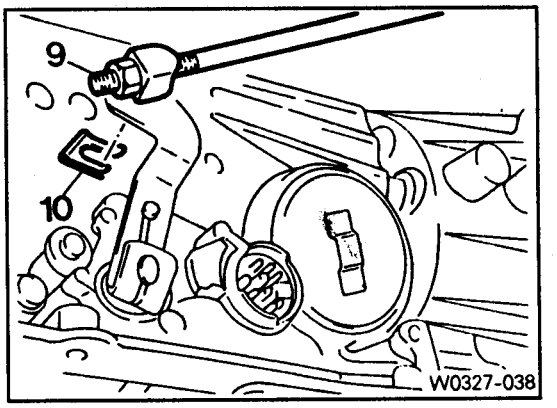
18) Install the oil cooler return line (right).
[Note] Replace the sealing ring (6).



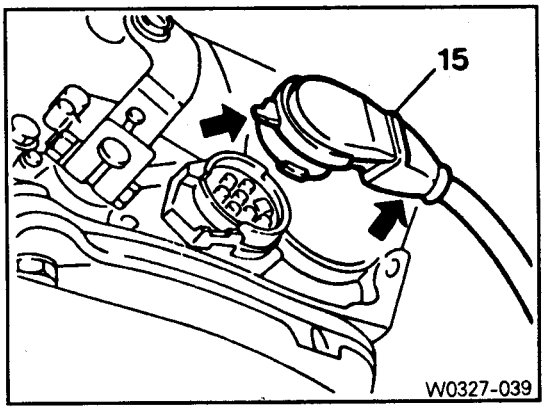
19) Insert the vacuum line (30) to the vacuum box.



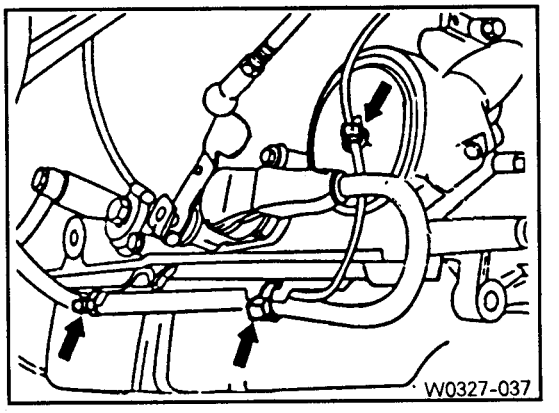
20) Assemble the range selector lever and shifting rod and fix it by inserting a clip.



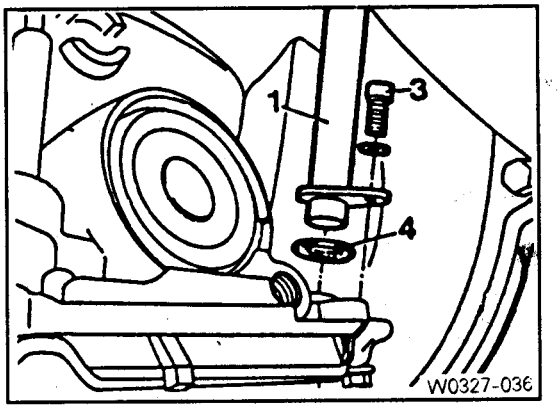
21) Install the starter lockout switch plug (15).



22) Fix each cables with a strap.

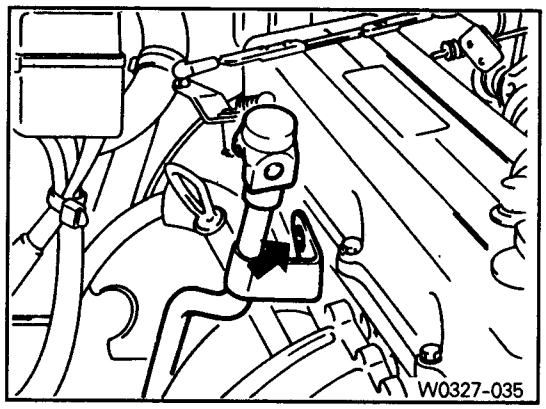


23) Replace the sealing ring (4) and install the lower oil fill tube (1).



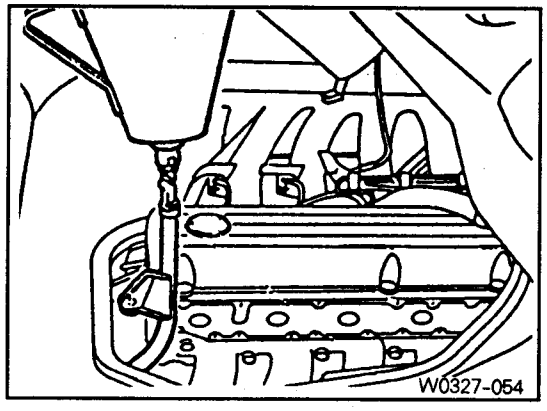
24) Install the upper oil fill tube.

25) Connect the battery cable.
[Note] Connect the positive terminal (+) first.

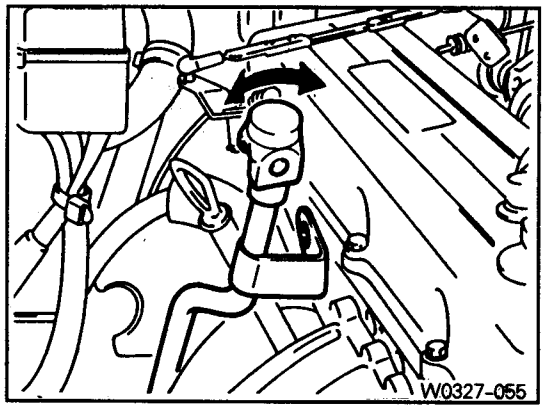


26) With engine stopped, fill with 6.5 liters of transmission oil through the funnel (2/3 of total capacity).

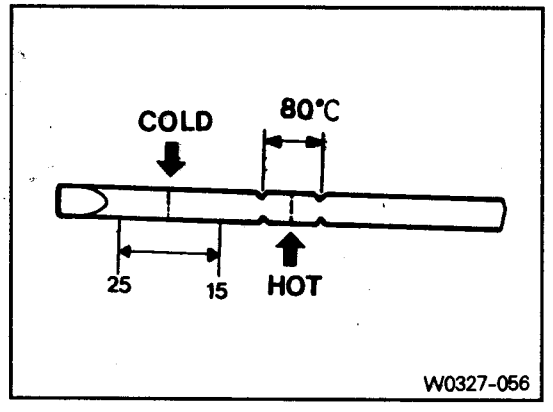
Funnel 126 589 12 63 00



27) Start the engine in 'P' position on the flat ground. With the brake pedal is applied, run the engine about 5 minutes at idle by shifting the selector lever 2~3 times to each positions.

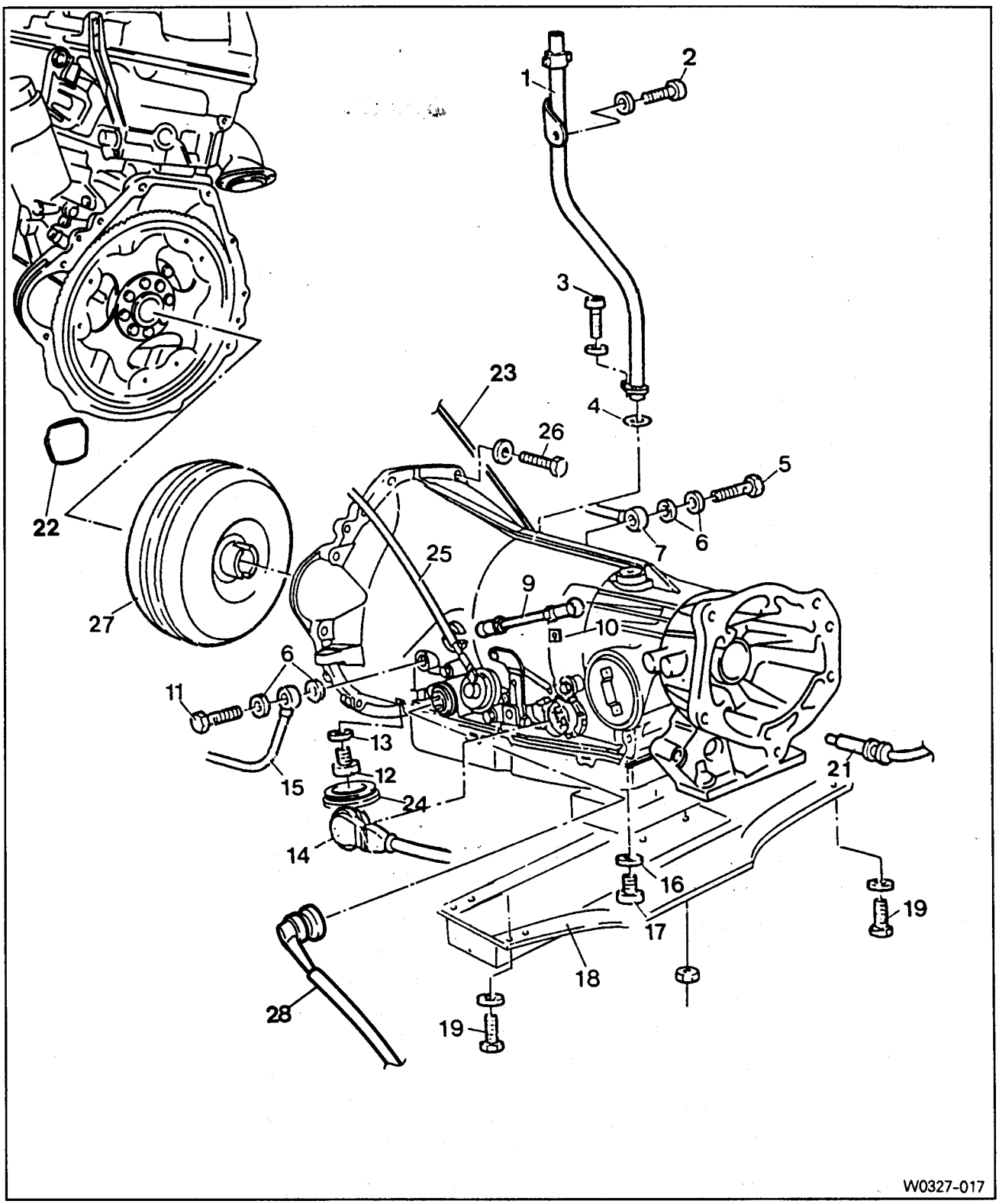


28) With engine running, check oil level and adjust if necessary.
[Note]
- **Oil level must be between 15~25mm below the 'MIN' when cold.**
- **Overfilling will severely damage the transmission.**



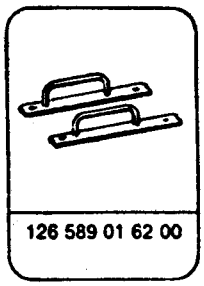
11. Removal and Installation of Transmission [Gasoline]

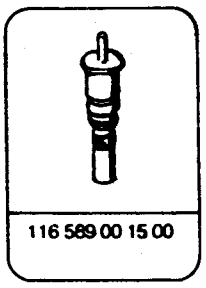
Preceding work : removal and installation of the transfer case

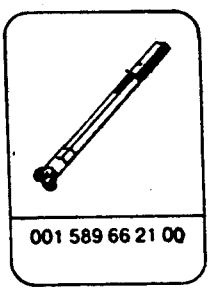


1. Oil Fill Tube
2. Bolt
3. Bolt
4. Sealing Ring---------- Replace
5. Hollow Screw
6. Sealing Ring---------- Replace
7. Oil Return Line(right)
9. Shifting Rod
10. Retaining Clip
11. Hollow Screw
12. Torque Converter drain Plug---------- 14Nm
13. Sealing Ring---------- Replace
14. Starter Lockout Switch Plug
15. Oil Feed Line(Left)
16. Sealing Ring---------- Replace
17. Transmission Drain Plug---------- 14Nm
18. Cross Member
19. Bolt---------- 45Nm
21. Kickdown Solenoid Switch Plug
22. Dust Cover for Torque Converter Removal and Mounting Bolt
23. Control Pressure Cable
24. Torque Converter Drain Plug Cover
25. Vacuum Line
26. Bolt---------- 65Nm
27. Torque Converter
28. Over Load Protection Switch

Special tools


126 589 01 62 00


116 589 00 15 00

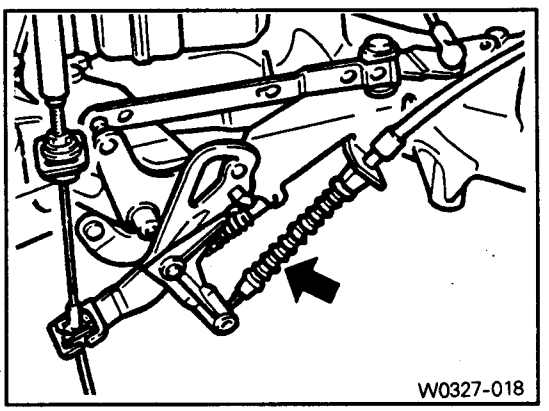

001 589 66 21 00

Removal

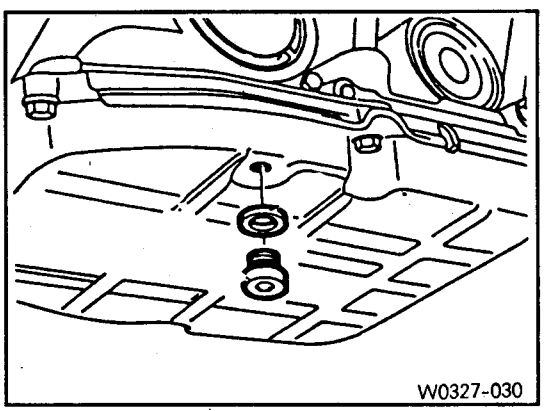
1) Disconnect the battery cables.
   [Note] Disconnect the negative terminal first.

2) Remove the oil dip stick gauge.

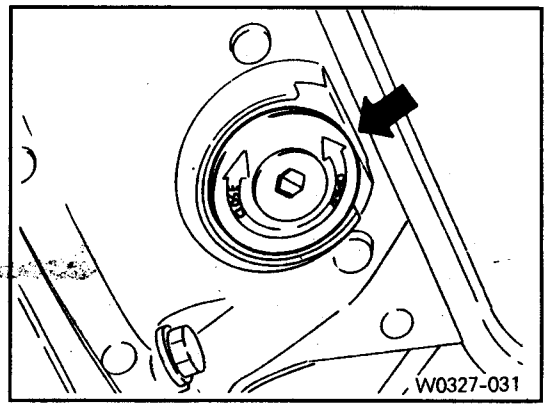
3) Disconnect the control pressure cable (arrow).


W0327-018

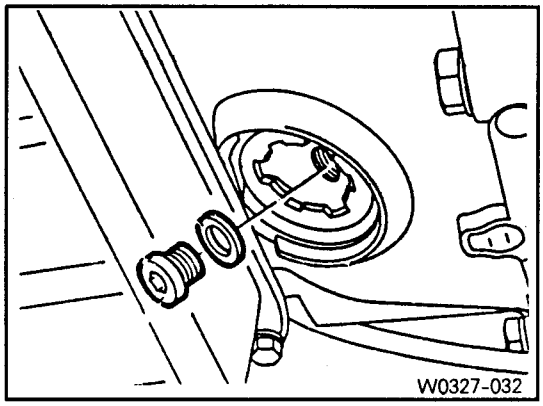
4) Drain the transmission oil.


W0327-030

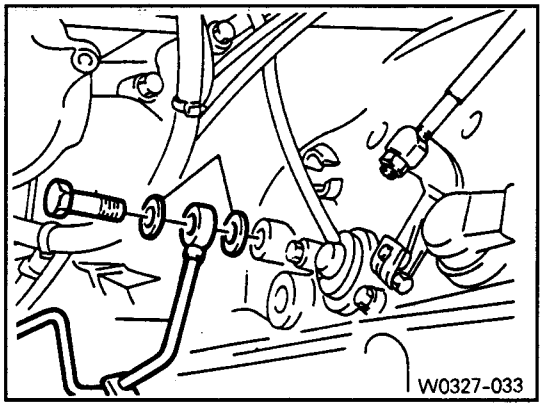
5) Remove the torque converter drain plug cover by pushing and turning to the 'open' direction in the lower side of the transmission.



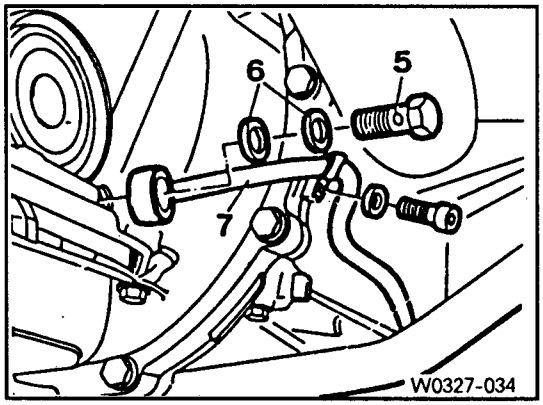
6) Align the drain plug of the torque converter by rotating the crankshaft and drain the torque converter oil.



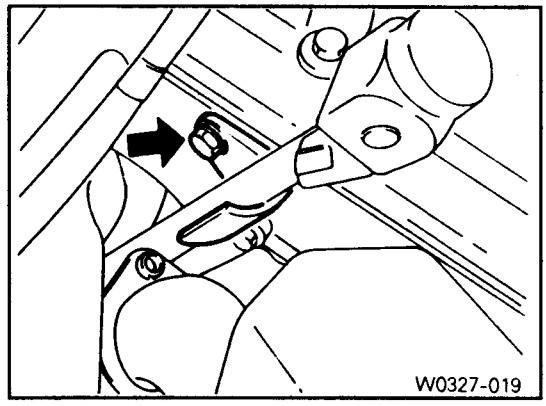
7) Remove the oil cooler feed pipe (left).



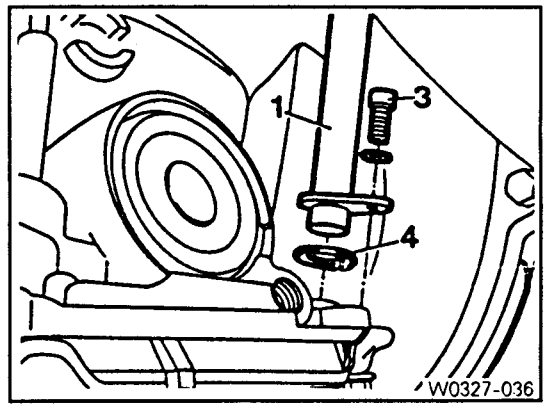
8) Remove the oil cooler return pipe (right).



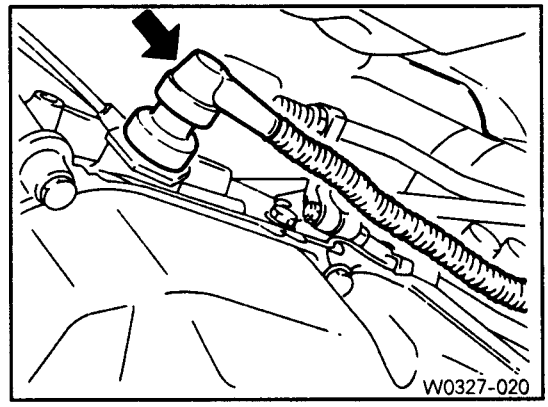
Remove the upper fixing bolt of the oil fill tube.



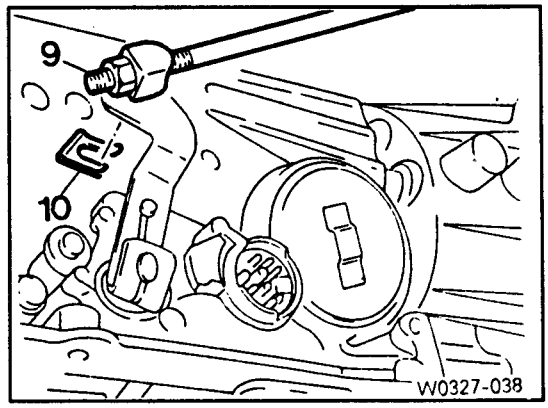
Remove the lower fixing bolt and remove the oil fill tube.



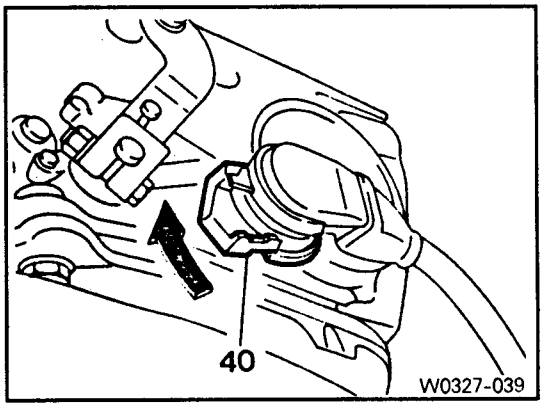
Disconnect the over - load protection switch connector .



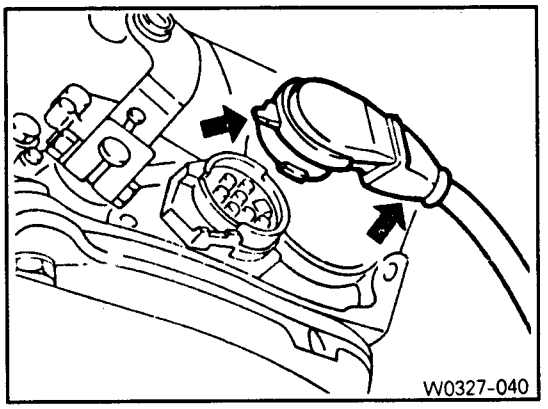
Remove the clip from the range selector lever and shifting rod connection and disconnect the lever and rod.



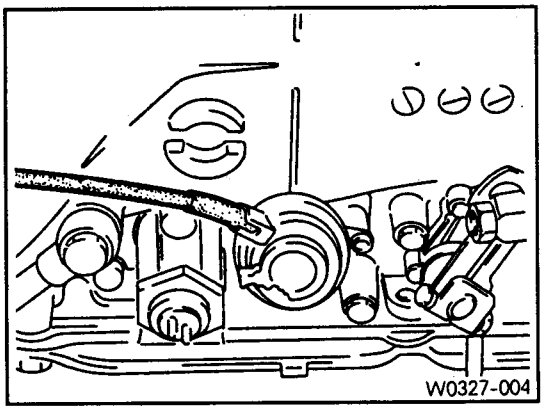
13) Turn the locking for the starter lockout switch upwards (arrow direction).



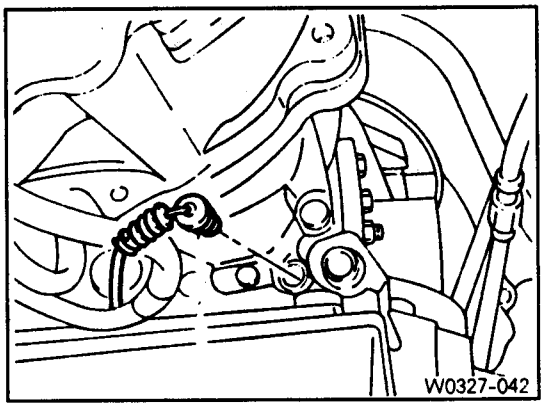
14) Lift the tap and cable (arrow) part carefully with the screw driver and remove the switch.



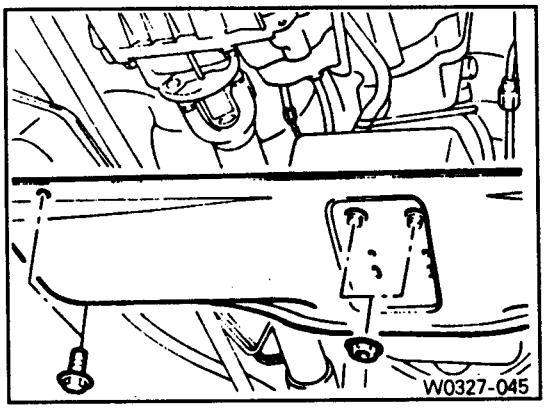
15) Remove the vacuum line.



16) Disconnect the plug connection of the kickdown solenoid valve.

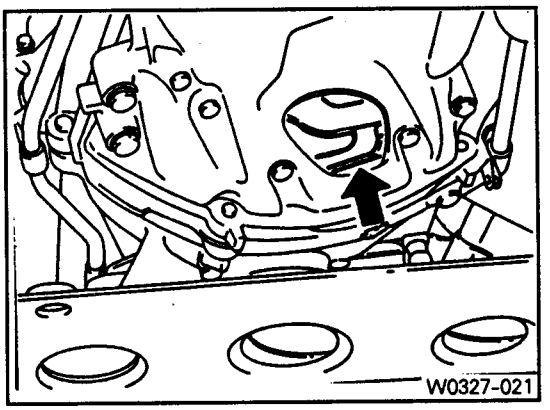


17) Support the transmission with the transmission jack and remove the cross member.



18) Remove the torque converter dust cover from the engine oil pan side.

19) By cranking the engine, align the drive plate with torque converter mounting bolt (6bolts) and remove it.

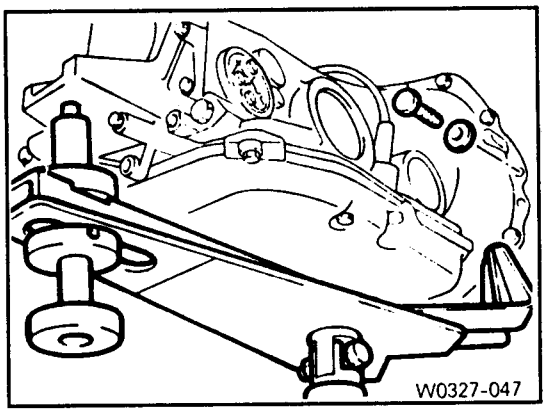


20) Install the attachment on the bottom side of transmission and then lift the transmission slightly.

Attachment 116 589 06 62 00

21) Remove the transmission housing mounting bolts.

22) Push the transmission backward and lower it carefully.
[Note] Be careful not to damage the oil pan and cables and not to drop the torque converter.

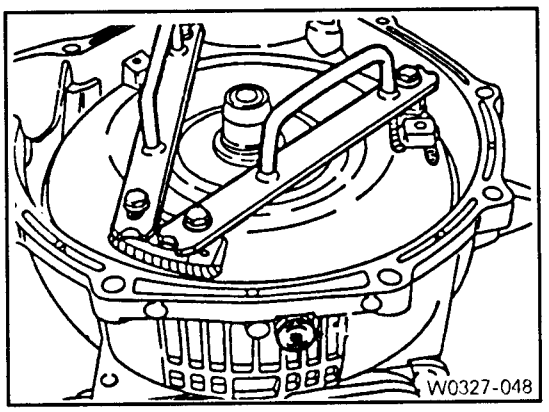


23) Remove the attachment.

24) Put the transmission up vertically.

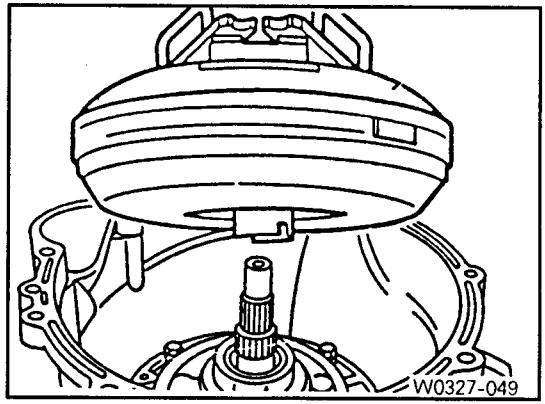
25) Install the torque converter handle.

Handle 126 589 01 62 00



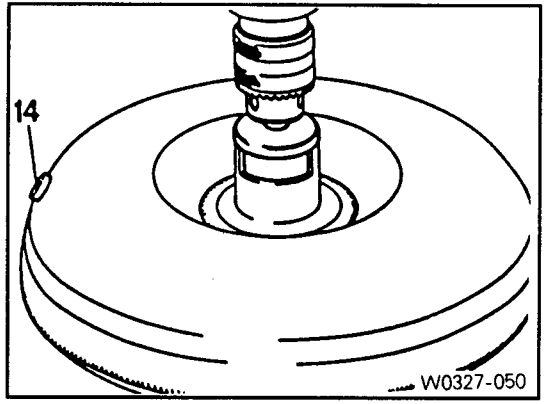
26) Remove the torque converter and remove the handle.

[Note] **If the transmission oil smells burnt or is saturated with particles of worn lining, the torque converter oil cooler lines and oil cooler must be flushed.**



27) When flushing the torque converter, fill with 1 liter of cleaning liquid (kerosene) into the converter and insert the flushing mendrel. Using a electric drill, rotate it for 2~3 min. in low speed.
Then remove the drain plug (14) to drain cleaning liquid and repeat this work 2~4 times until the drained liquid is clear.

Flushing Mendrel 116 589 00 15 00



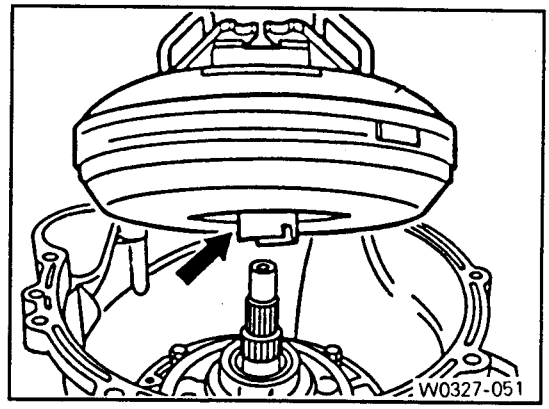
28) Fill with cleaning liquid into the oil cooler and pipes and blow out with compressed air.

Installation

1) Install the handle to the torque converter.

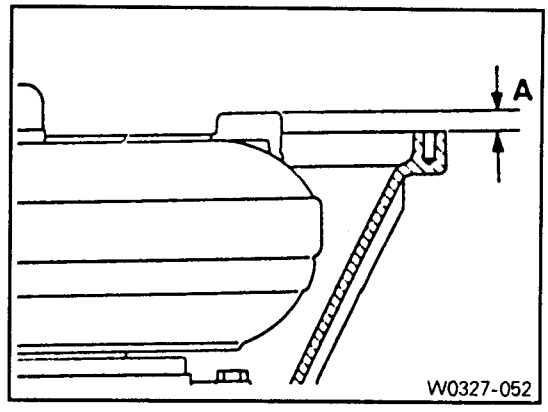
2) Apply long-term grease to the input flange (arrow) and remove the handle after installing the torque converter to the transmission.
[Note] Align the input shaft and the torque converter accurately.

Handle 126 589 01 62 00

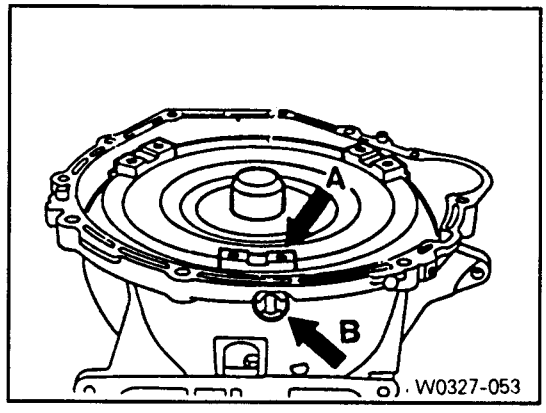


3) Measure 'A' from the torque converter mounting surface to the transmission housing.

Distance 'A'	below 10mm

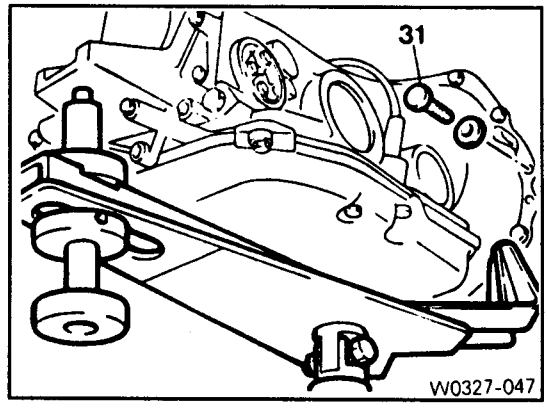


4) Align the one of the torque converter mounting holes to the position when it was removed (plug in the engine side).
[Note] Apply specified sealant on the surface of the housing.
(Dirko Silicon Compound Transparent Sealant - Ering)



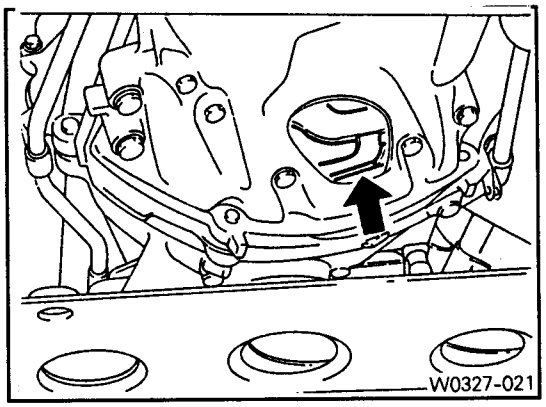
5) Install the attachment to the transmission, lift the transmission up to engine height and move it forward until the engine and converter housing get in contact.

6) Install the transmission housing mounting bolts temporarily.



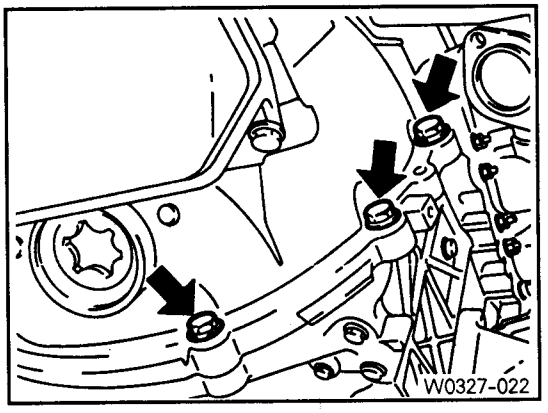
7) Tighten the drive plate and torque converter bolts (6bolts).

Tightening torque	42Nm



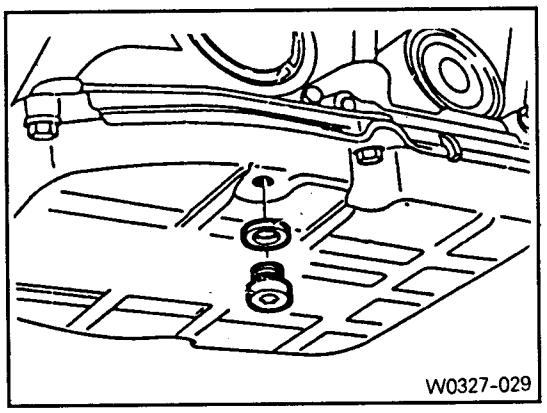
8) Tighten the transmission housing mounting bolts.

Tightening torque	65Nm

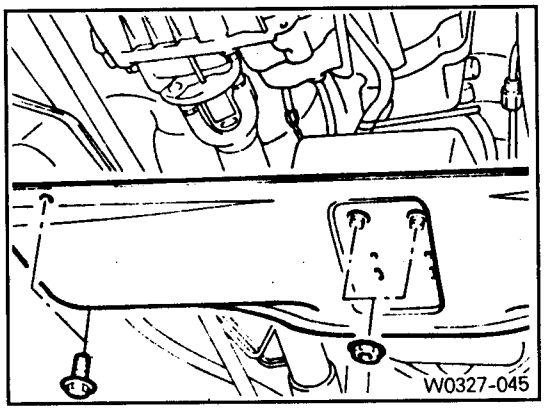


9) Replace the sealing ring (13) of the torque converter drain plug and tighten the plug.

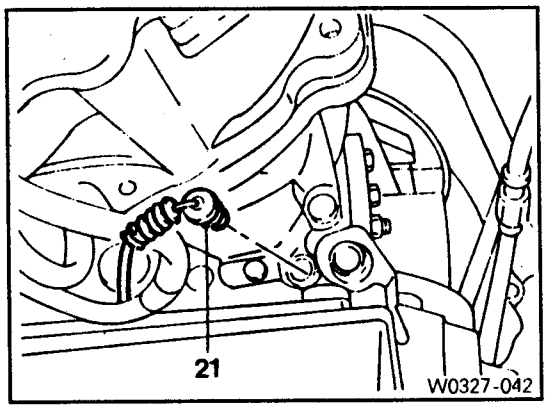
Tightening torque	14Nm



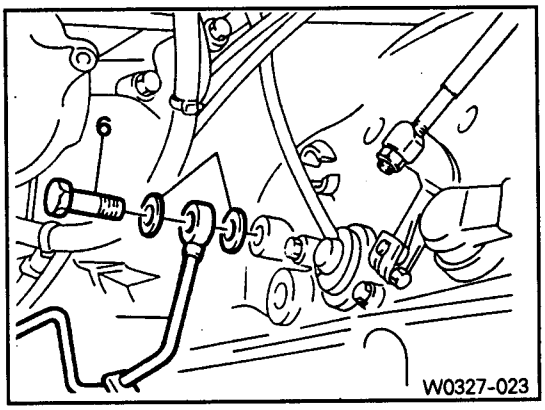
10) Install the cross member.



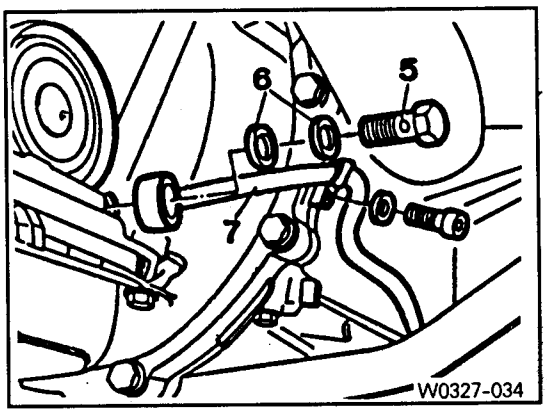
11) Connect the kickdown solenoid switch connector (21).



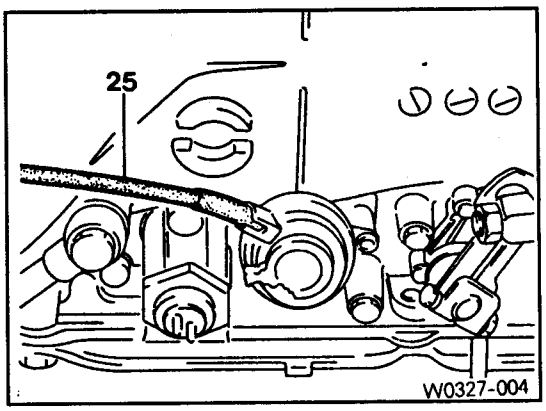
12) Install the oil cooler feed line (left).
[Note] Replace the sealing ring (6).



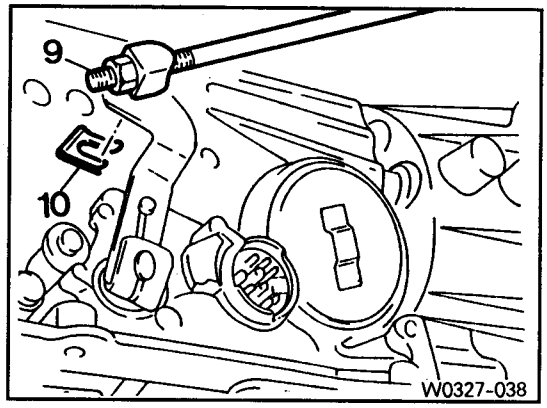
13) Install the oil cooler return line (right).
[Note] Replace the sealing ring (6).



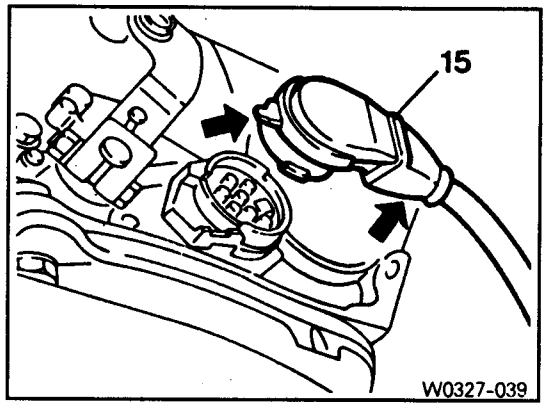
14) Insert the vacuum line (25) to the vacuum box.



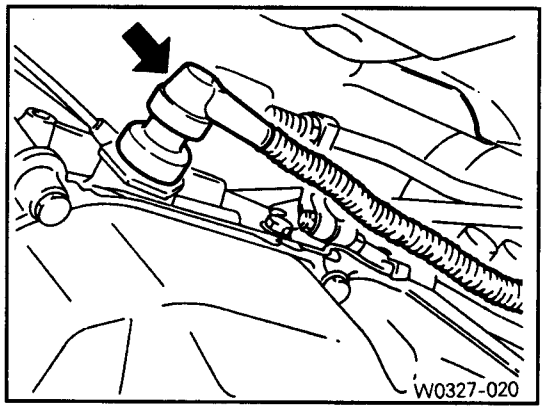
15) Assemble the range selector lever and shifting rod and fix it by inserting a clip.



16) Install the starter lockout switch plug (15).



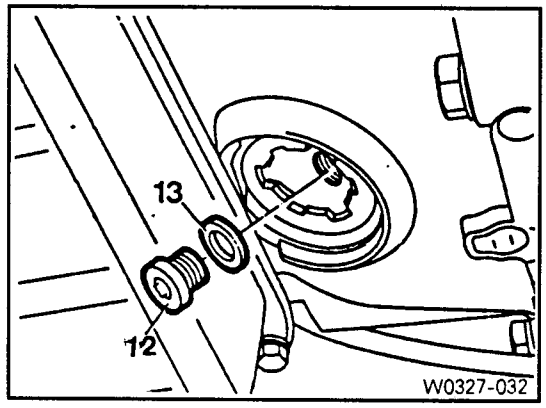
17) Install the over-load protection switch connector.



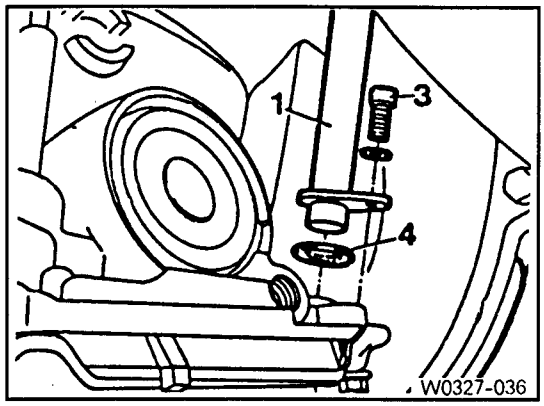
18) Replace the sealing ring (13) of the torque converter drain plug (12) and tighten the plug.

Tightening torque	14Nm

19) Install the drain plug cover.

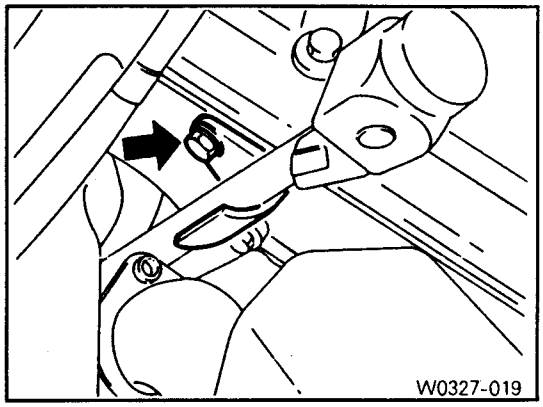


20) Replace the sealing ring (4) and install the oil filler tube (1).

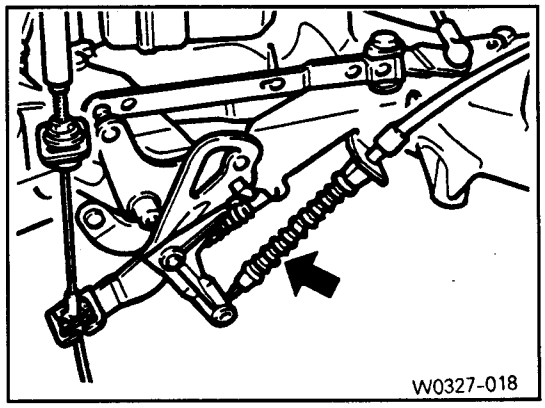


21) Tighten the oil filler tube bracket bolt with ground strap.

22) Connect the battery cable.
[Note] Connect the positive terminal (+) first.

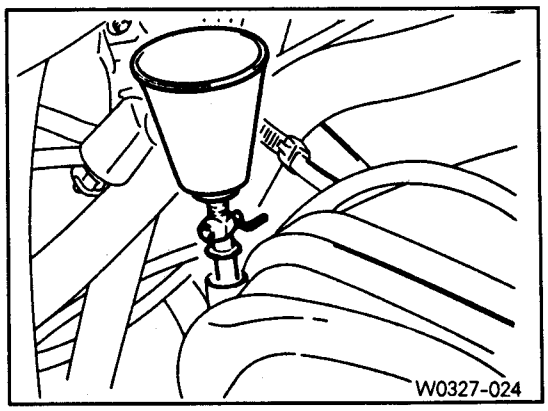


23) Connect the control pressure cable .
[Note] Refer to accelerator cable adjustment.

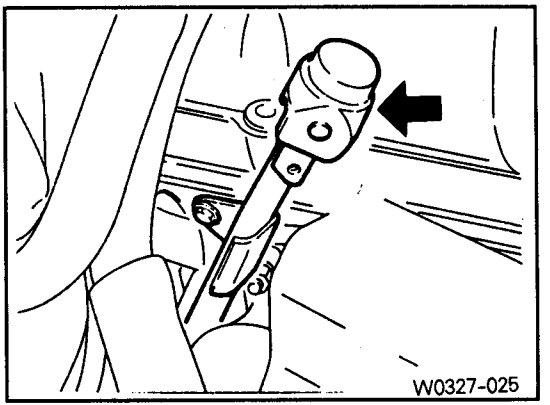


24) With engine stopped, fill with 6.5 liters of transmission oil through the funnel (2/3 of total capacity).

Funnel 126 589 12 63 00

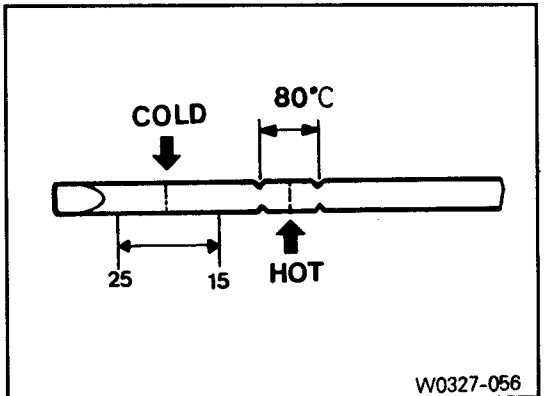


25) Start the engine in 'P' position on the flat ground. With the brake pedal is applied, run the engine about 5 minutes at idle by shifting the selector lever 2~3 times to each positions.

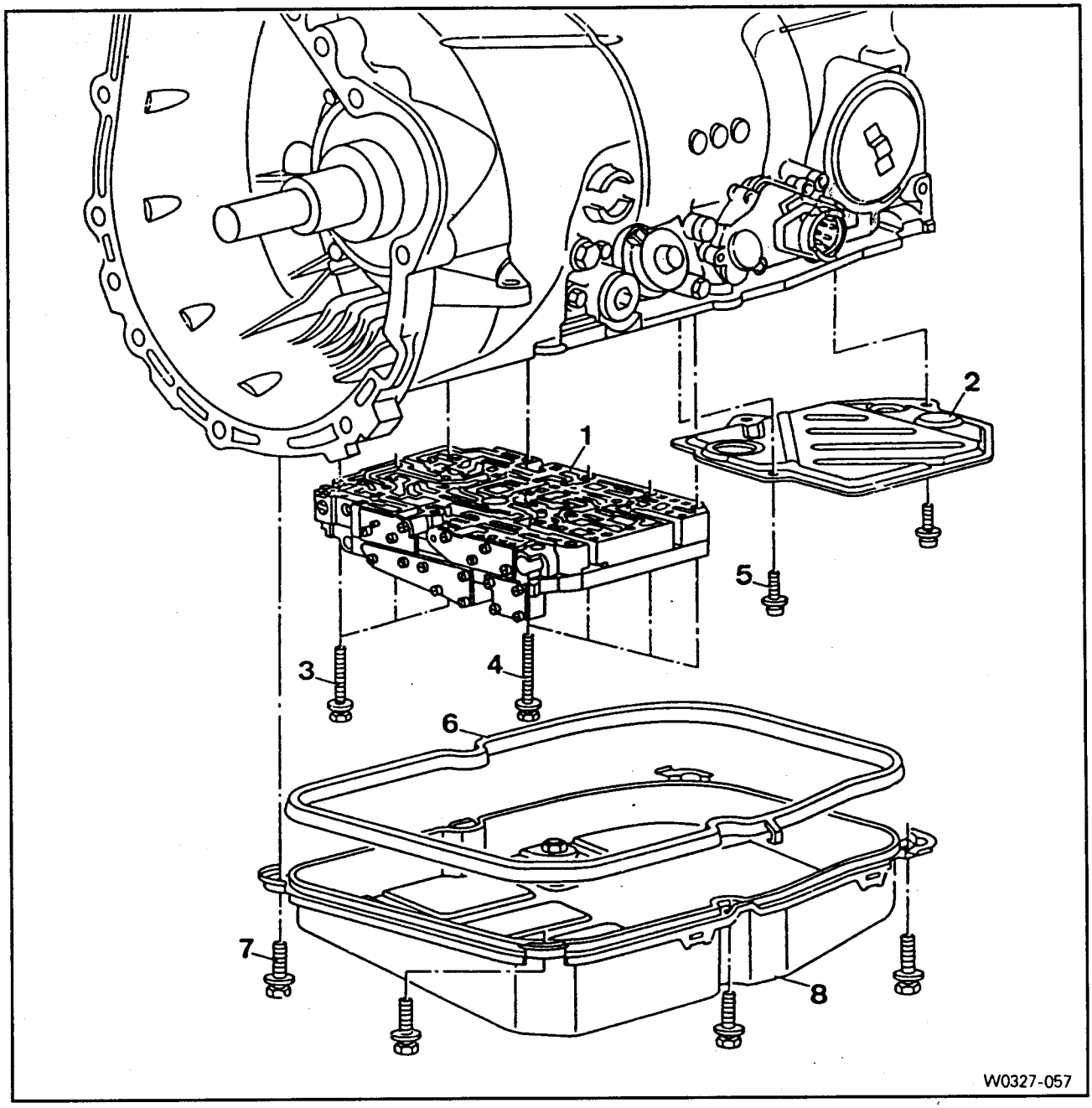


26) With engine running, check oil level and adjust if necessary.

[Note] · **Oil level must be between 15~25mm below the 'MIN' when cold.**
· **Over filling will severely damage the transmission.**



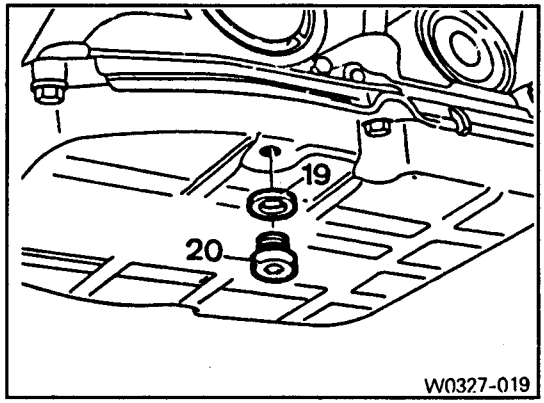
12. Removal and Installation of Shift Valve Housing



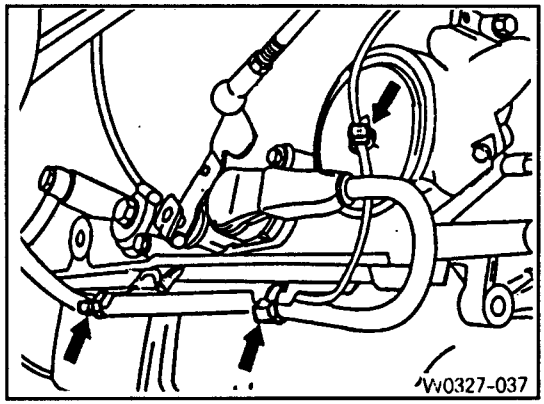
1. Shift Valve Housing
2. Oil Filter
3. Bolt M6 × 50 ---------- 8Nm
4. Bolt M6 × 55 ---------- 8Nm
5. Phillips Screw ---------- 4Nm
6. Gasket ---------- Replace
7. Bolt ---------- 8Nm
8. Oil Pan

Removal

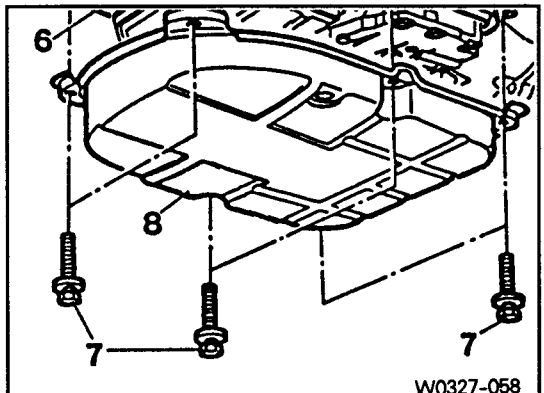
1) Shift the selector lever to 'P' position, remove the drain plug (20) and sealing ring (19) and then drain the transmission oil.



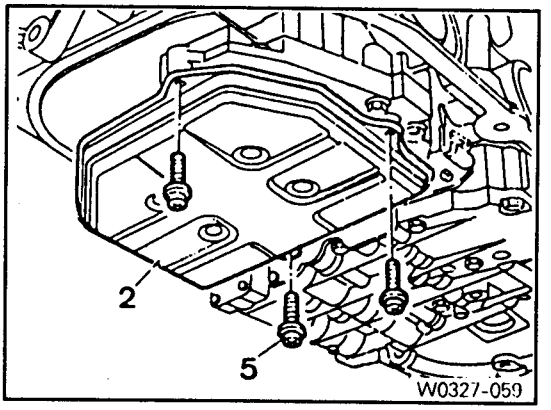
2) Pry off the cable strap (arrow).



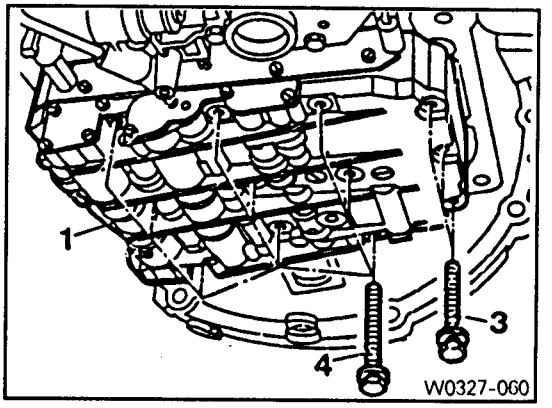
3) Remove the bolts (7) and separate the gasket (6) and oil pan (8).



4) Remove the Phillips screw (5) and remove the oil filter (2).



5) Remove the bolts (3, 4) and remove the shift valve housing (1).

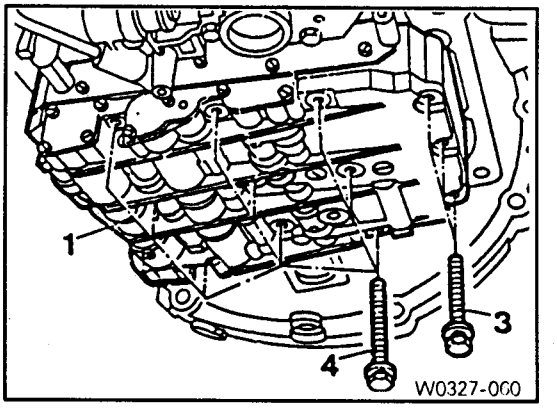


Installation

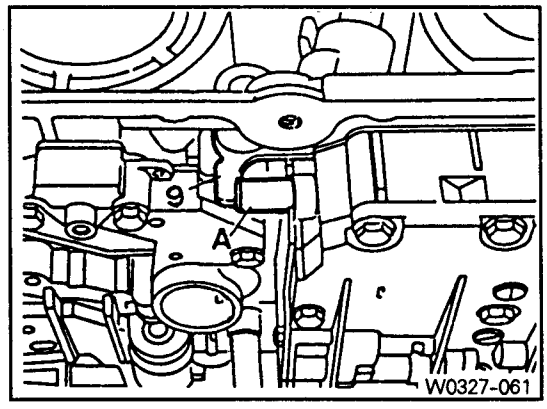
[Note] Clean all the components and sealing surfaces with cloth which is not cotton or wool.

1) Install the shift valve housing (1) and tighten the bolts (3, 4).

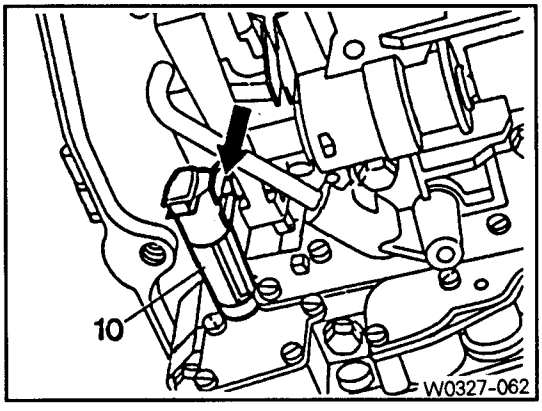
Tightening torque	8Nm



[Note] For control pressure adjustment, align the piston (A) with control pressure cable lever (9).

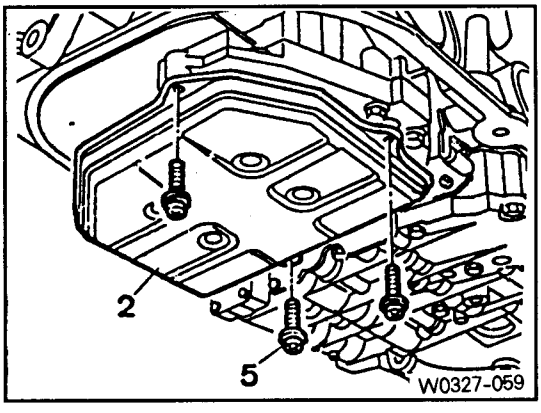


[Note] The range selector lever (10) should be engaged in the catch plate slot (arrow).

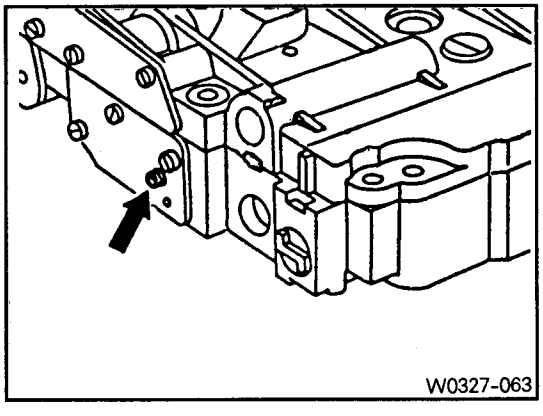


2) Install the oil filter (2) and tighten the Phillips screws (5).

Tightening torque	4Nm

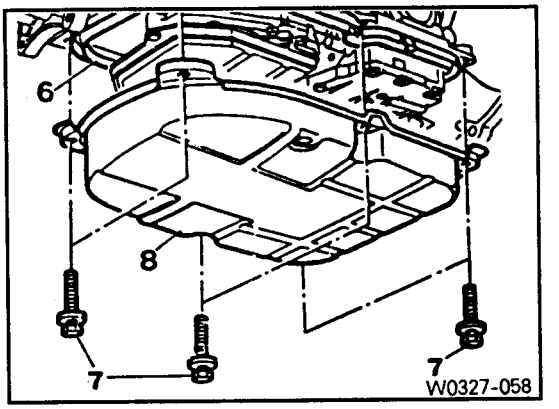


[Note] The adjustment screw (arrow) is used for fine adjustment of pressure in full throttle range in the dynamometer during production, so do not adjust it arbitrarily.

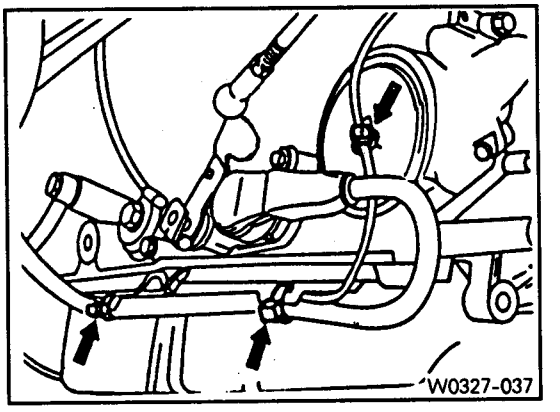


3) Replace the gasket (6) and install the oil pan (8).

Tightening torque	8Nm

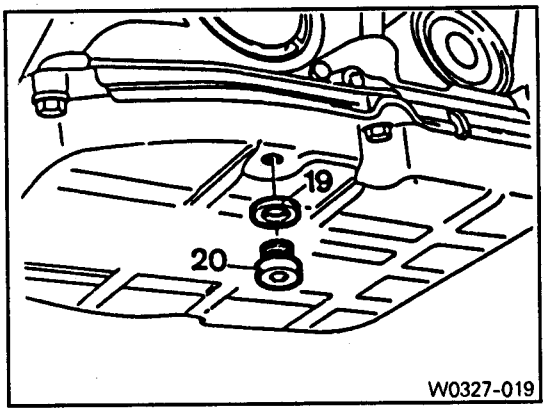


4) Fix the cable with new strap (arrow).



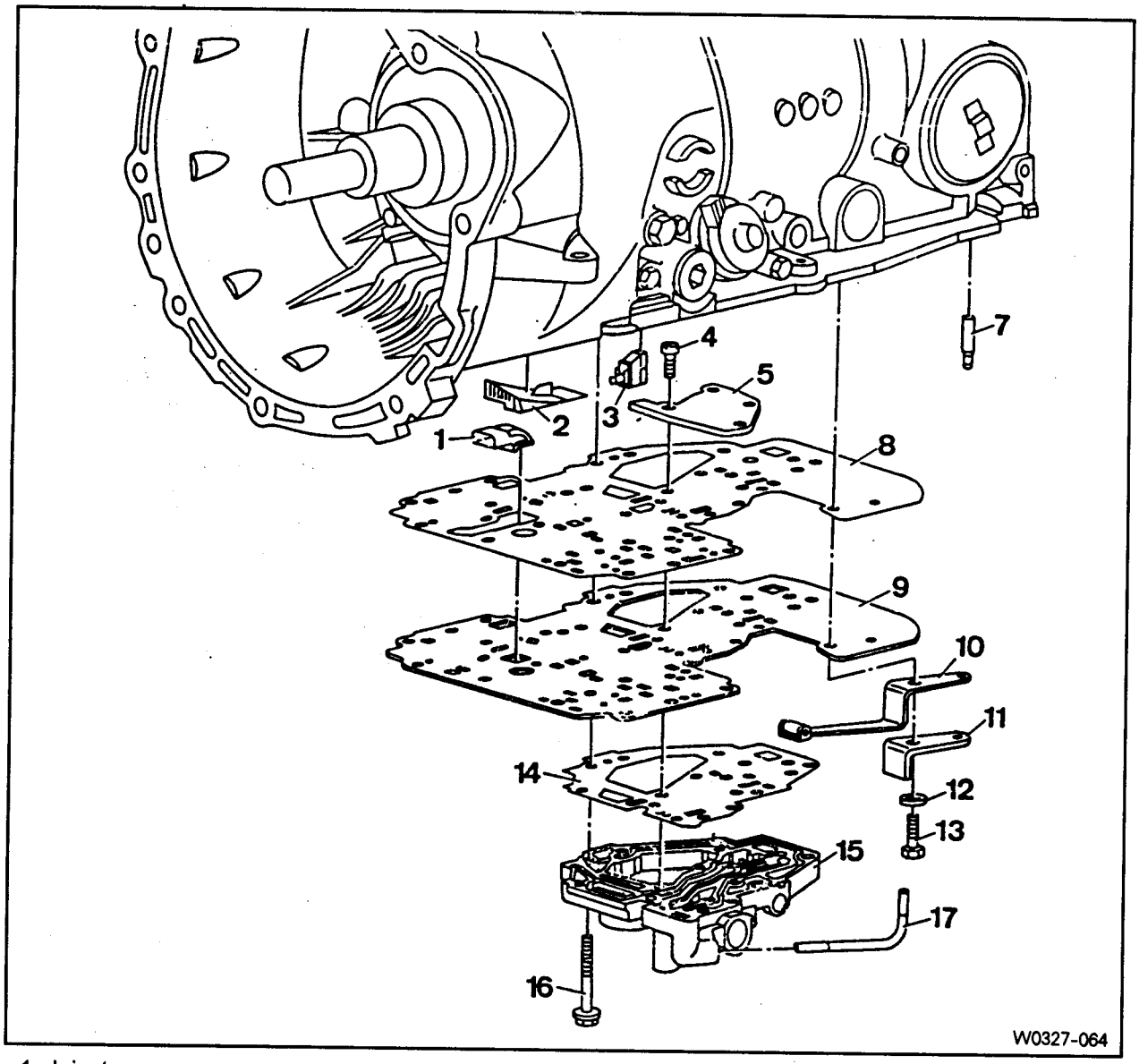
5) Replace the sealing ring (19) and tighten the drain plug (20).

Tightening torque	14Nm



6) Refill the automatic transmission fluid and check oil level.

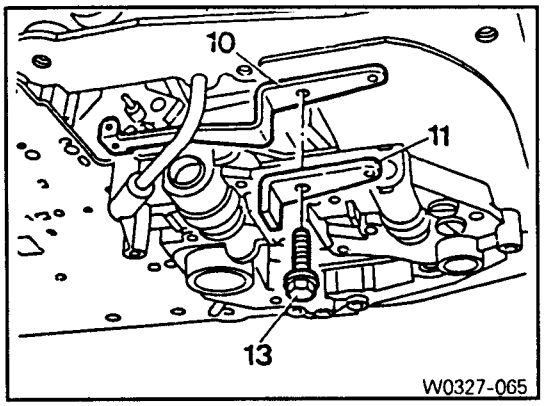
13. Removal and Installation of Lower Cover and Middle Plate



1. Injector
2. Oil Deflector
3. Temperature Throttle
4. Screw ---------- 8Nm
5. Cover Plate
7. Position Pin
8. Gasket ---------- Replace
9. Middle Plate
10. Detent Spring
11. Bracket
12. Washer
13. Bolt ---------- 8Nm
14. Gasket ---------- Replace
15. Lower Cover
16. Bolt
17. Oil Tube

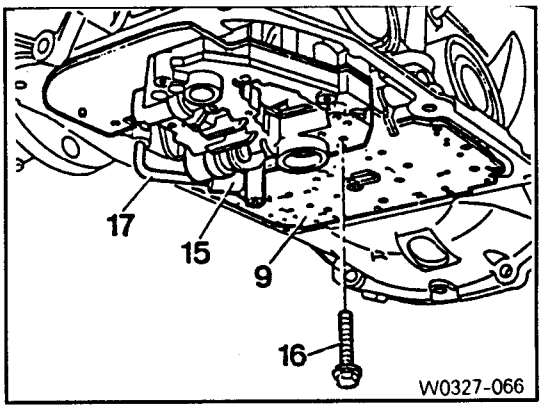
Removal

1) Remove the bolt (13) and remove the bracket (11) and (10) detent spring.

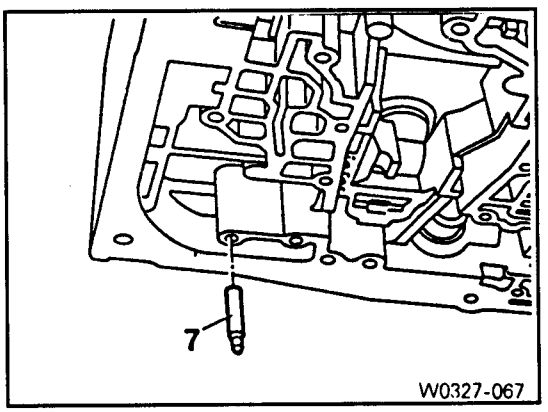


2) Remove the bolt (16).

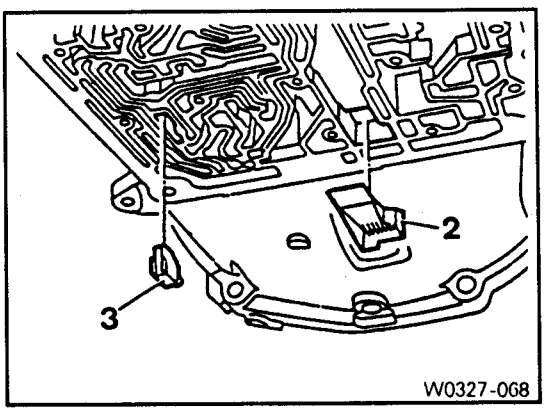
3) Lift the middle plate (9) and lower cover (15) and pull out the oil tube (17).



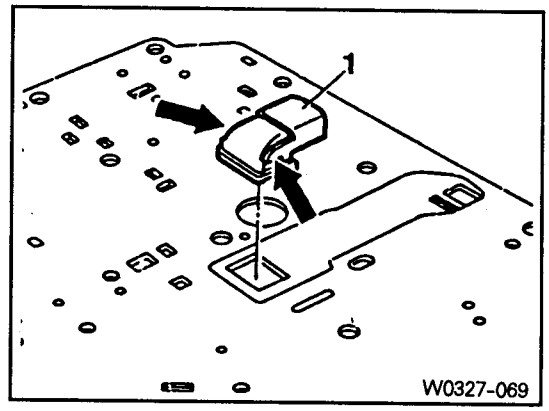
4) Remove the position pin (7).
[Note] Be careful not to drop pin.



5) Remove the oil deflector (2) and temperature throttle (3).

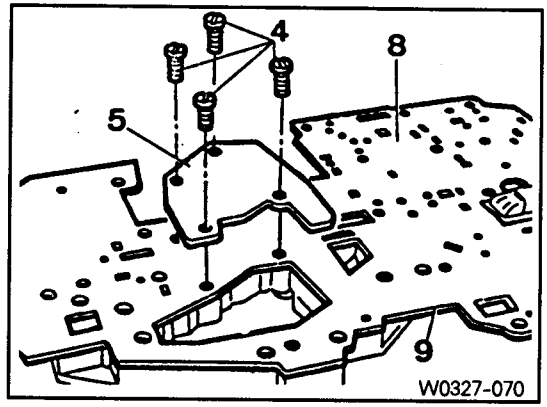


6) While pressing the tap (arrow), remove the injector (1).

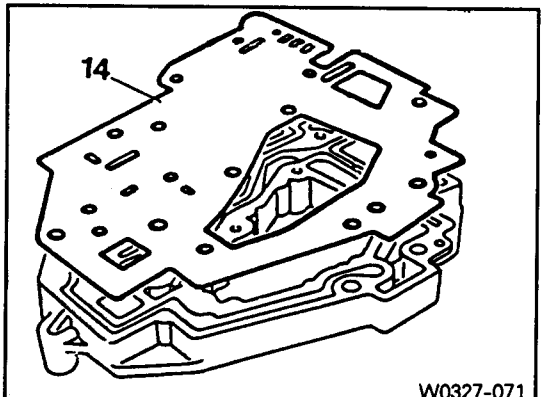


7) Remove the screws (4) and lift up the cover plate (5).

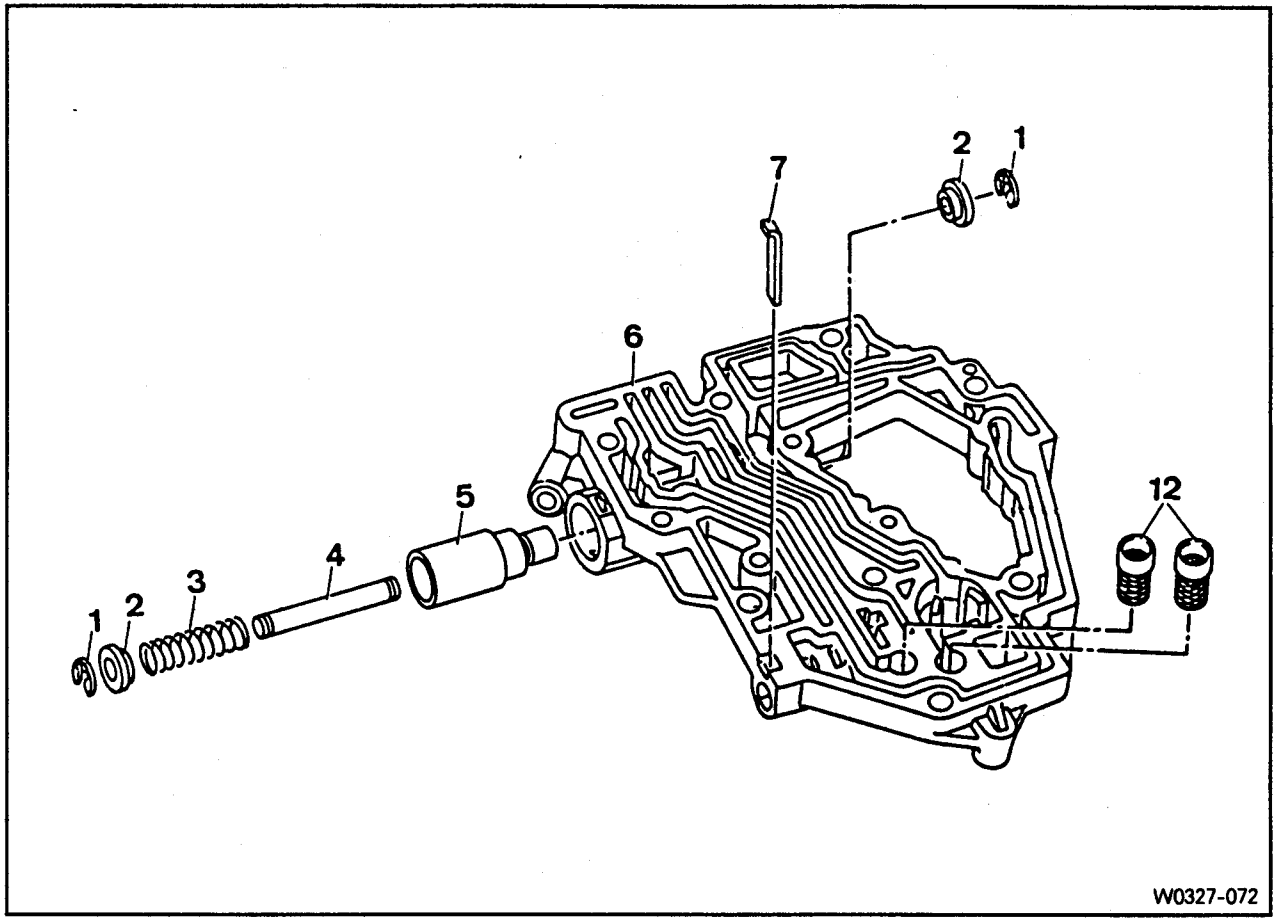
8) Remove the gasket (8) and middle plate (9).



9) Remove the gasket (14) from the lower cover.



Disassembly and assembly of lower cover

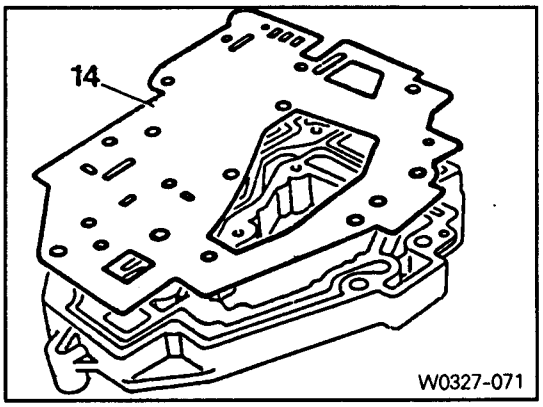


1. Retainer
2. Bushing
3. Spring
4. Pin
5. Lockout Valve
6. Lower Cover
7. Retaining Plate
12. Filter

[Note] Before assembling, apply automatic transmission fluid on each valve and check if each part is moving smoothly during assembly.

Installation

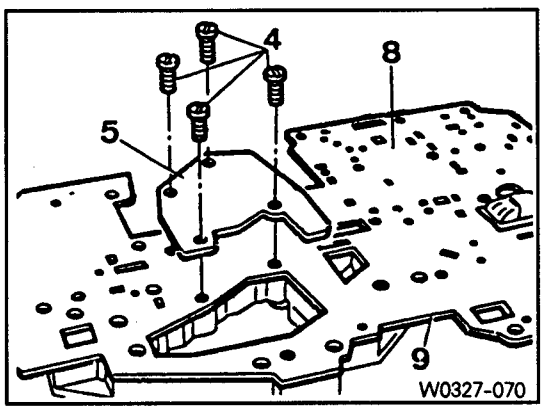
1) Replace the gasket (14) and put on the lower cover.



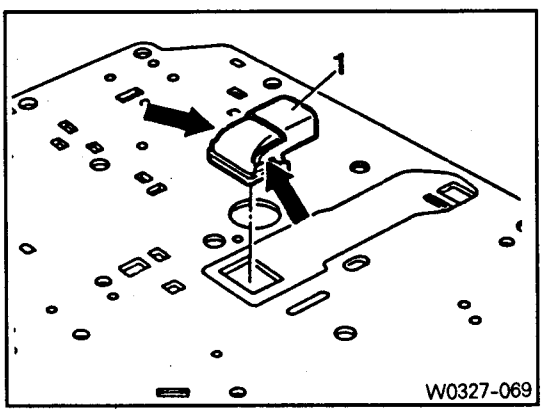
2) Align the middle plate (9) and gasket with the lower cover.

3) Install the cover plate (5).

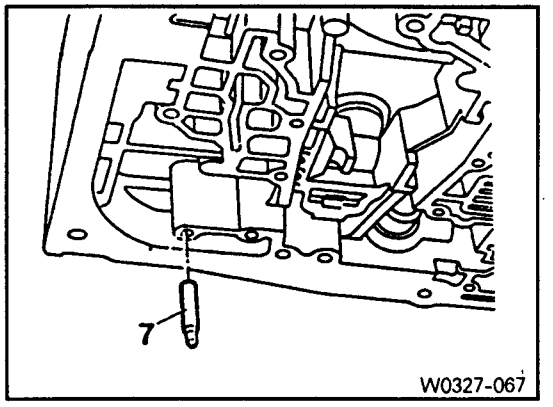
Tightening torque	8Nm



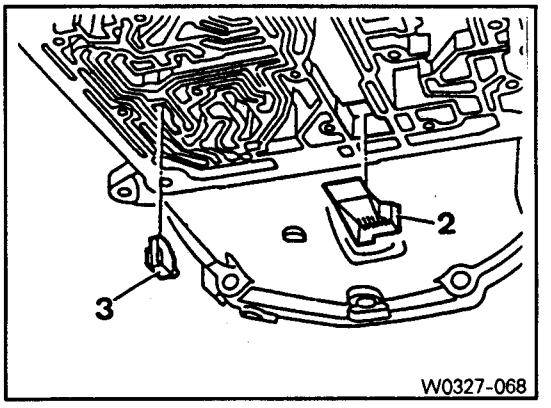
4) Press the tap (arrow) through the middle plat lower and insert the injector (1).



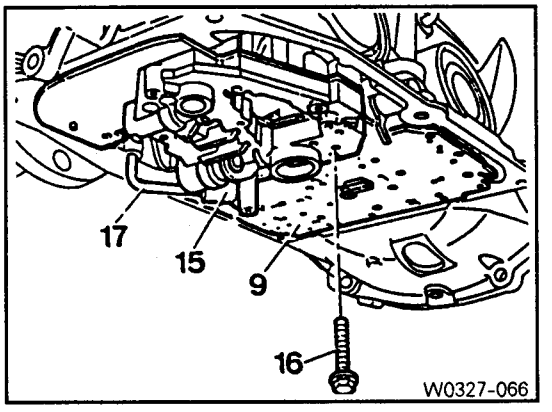
5) Insert the position pin (7).



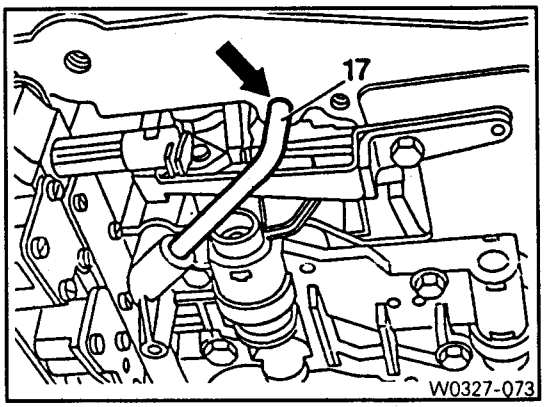
6) Install the oil deflector (2) and temperature throttle (3).



7) Install the middle plate (9), oil tube (17) and lower cover (15) and tighten the bolt (16).

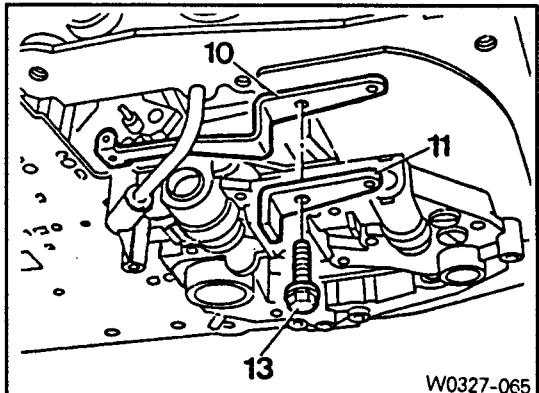


[Note] Before assembling the lower cover, check if the oil tube (17) is installed into the hole (arrow) without any resistance.

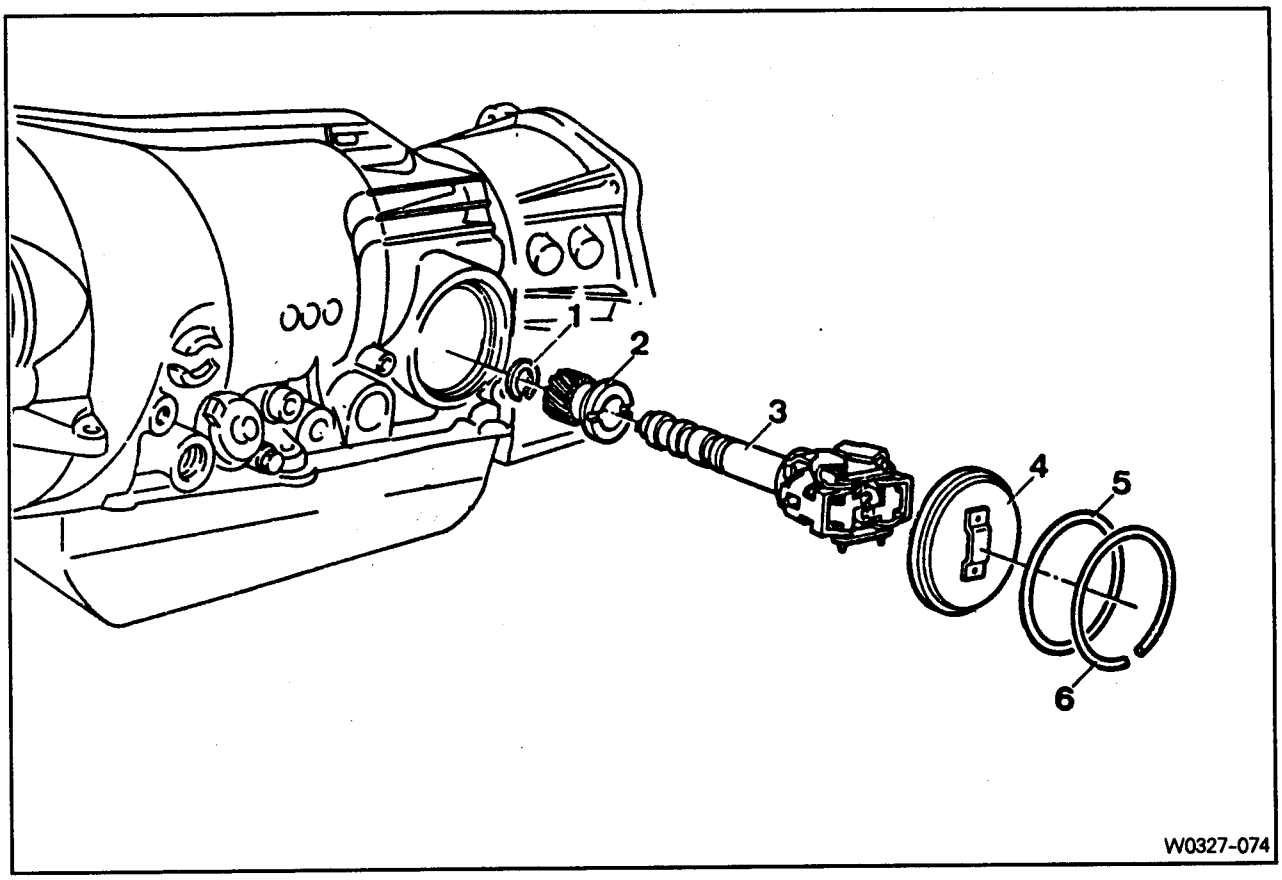


8) Align the detent spring (10) and bracket (11) and tighten the bolt (13).

Tightening torque	8Nm

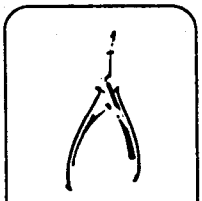


14. Removal and Installation of Centrifugal Governor



1. Snap Ring
2. Helical Gear
3. Centrifugal Governor ---------- Check operation
4. Cover
5. O-Ring ---------- Replace
6. Snap Ring

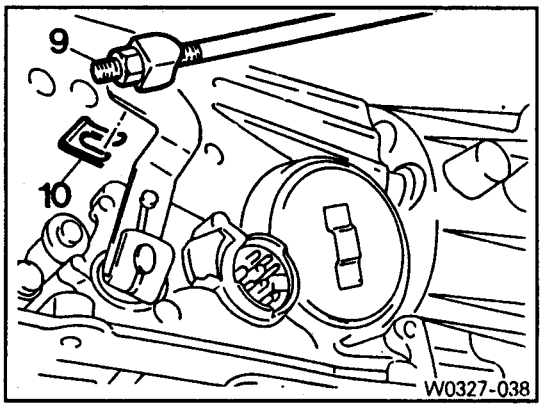
Special Tool



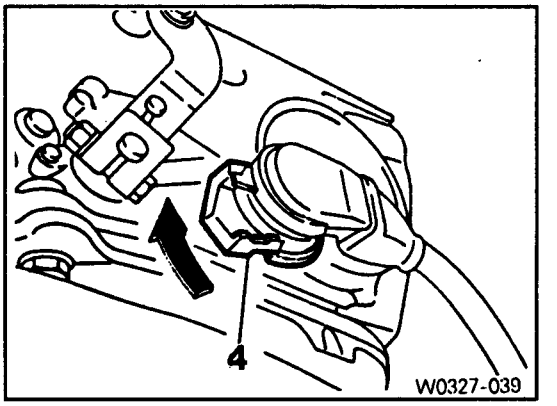
000 589 52 37 00

Removal

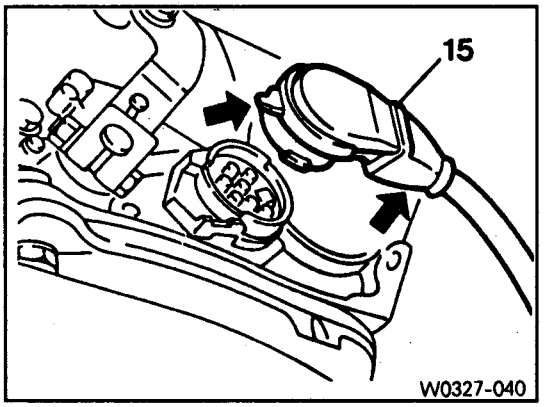
1) Pull off the retainer (10) and separate the shifting rod (9).



2) Turn the lock (40) upward direction (arrow direction).

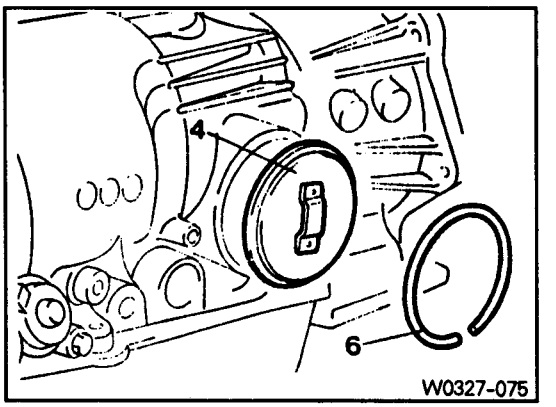


3) Separate the plug by lifting the arrow portion (tap, cable) with a screw driver.



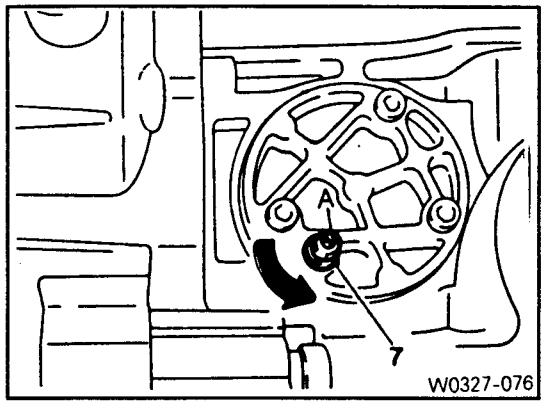
4) While pressing the cover (4) lightly, remove the snap ring (6).

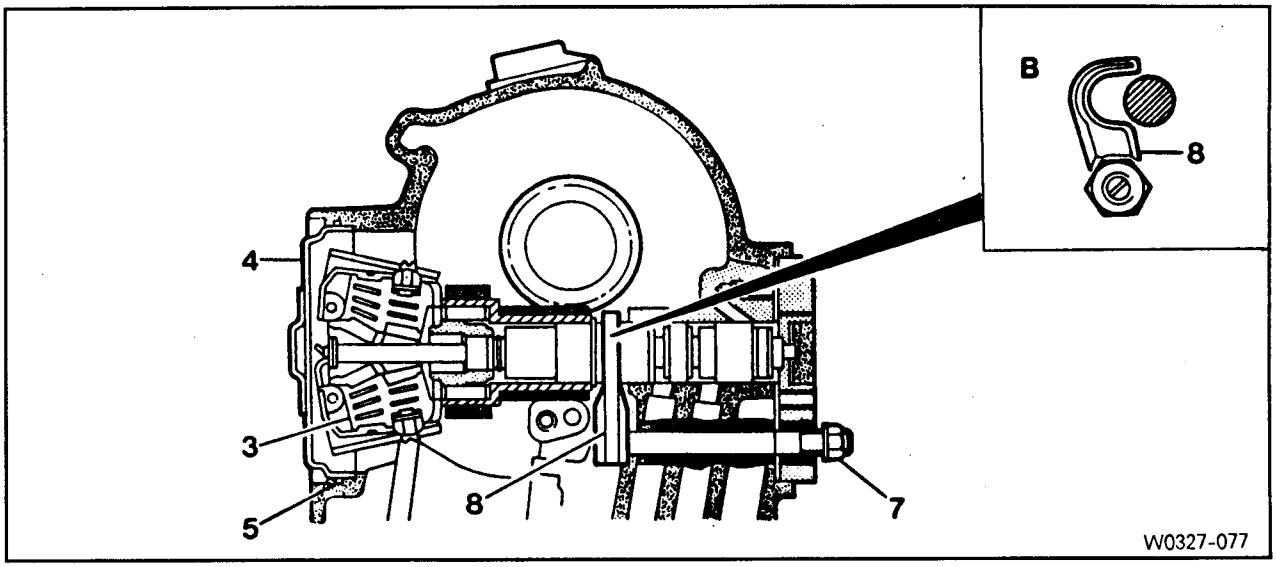
5) Remove the cover.



6) Loosen the axial holder nut (7).

7) Disengage the axial holder A by turning it to the arrow direction as shown in below ' B '.

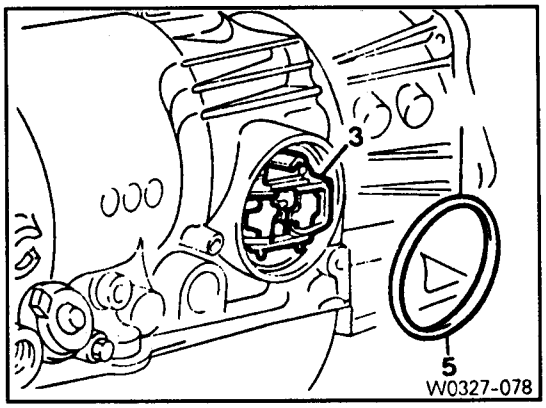




3. Centrifugal Governor
4. Cover
5. O-Ring
7. Axial Holder Nut
8. Axial Holder

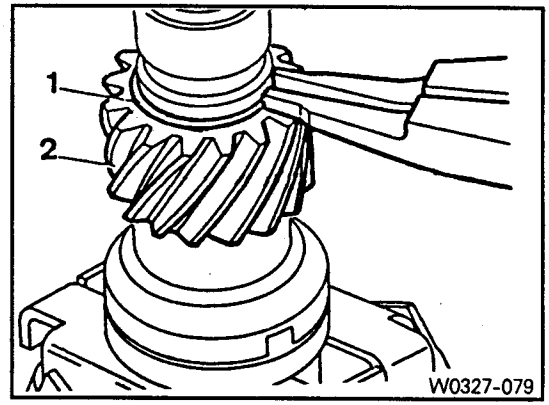
8) Remove the O-ring (5).

9) Pull out the centrifugal governor (3).



10) Remove the snap ring (1) and remove the helical gear (2).

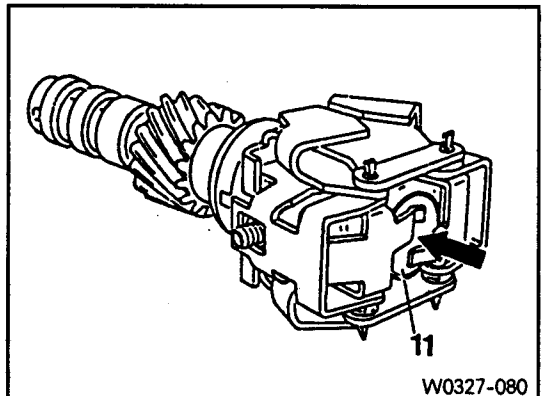
Snap ring pliers 000 589 52 37 00



Centrifugal governor inspection

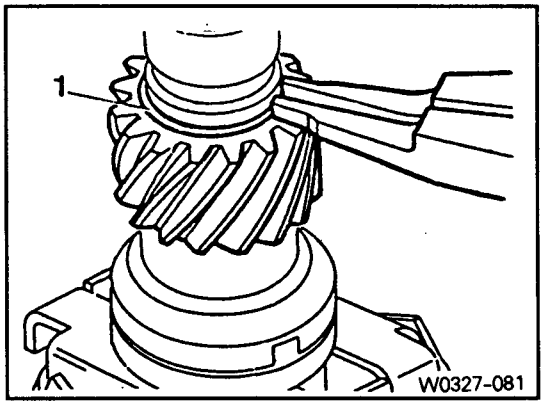
11) By tapping the control valve (11) from the arrow direction, check the governor flyweight and control valve operation.

[Note] The control valve should move smoothly and when replacing the centrifugal governor, reuse the removed helical gear of the governor.



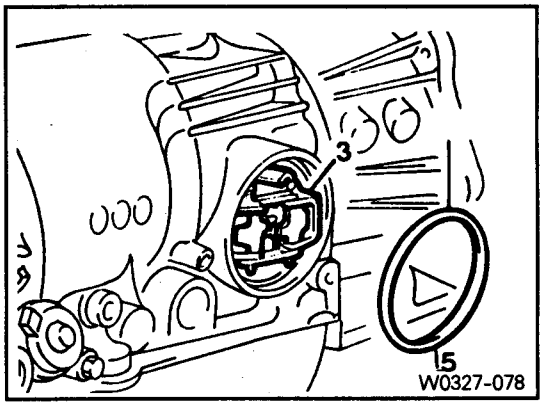
Installation

1) Install the snap ring (1).



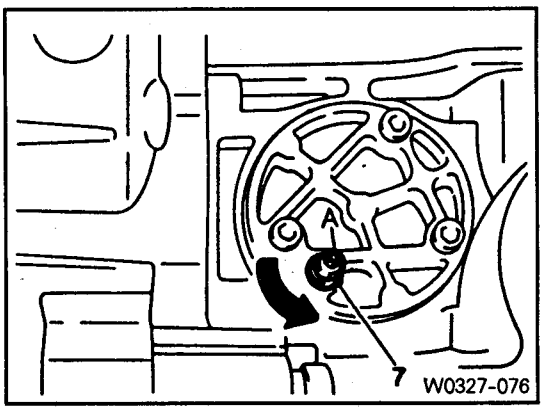
2) Install the centrifugal governor (3).

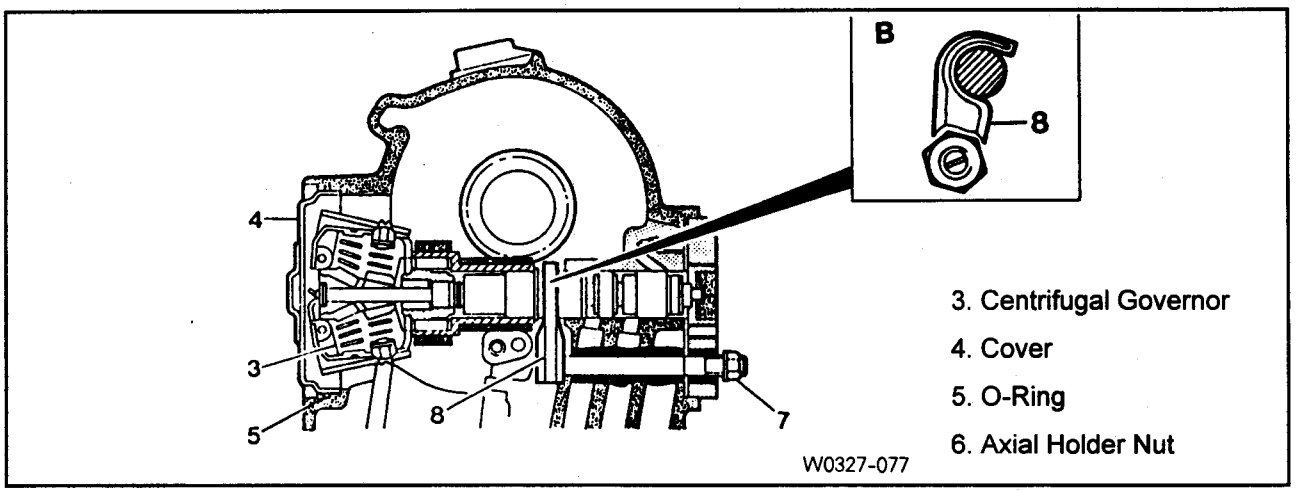
3) Install the O-ring (5).



4) Turn the axial holder (A) to the arrow direction until it stops, using a screw driver.
[Note] Install the axial holder completely as shown in below ' B '.

5) Tighten the axial holder nut (7).

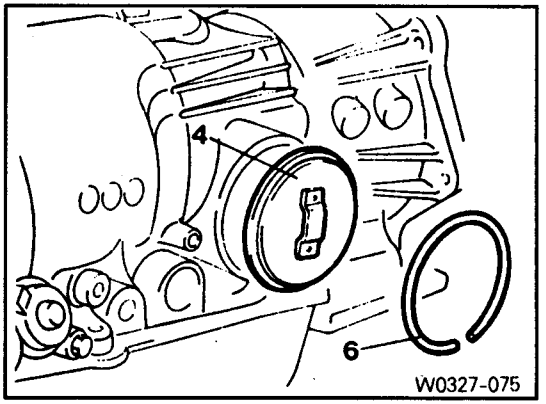




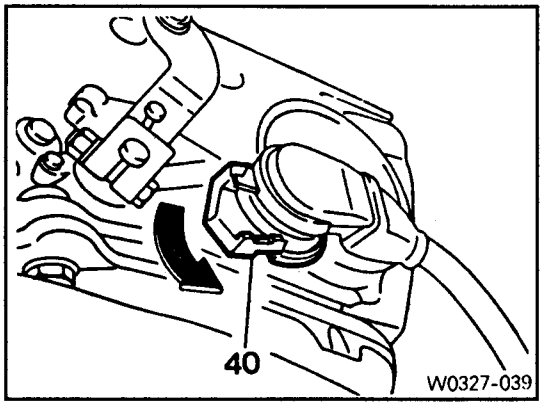
6) Position the cover (4) to the housing and install it by pressing.

7) Install the snap ring (6).

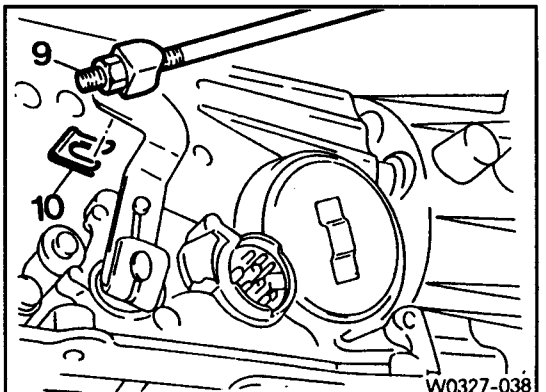
[Note] After installation of the snap ring, pull the cover backward to contact it with the snap ring.



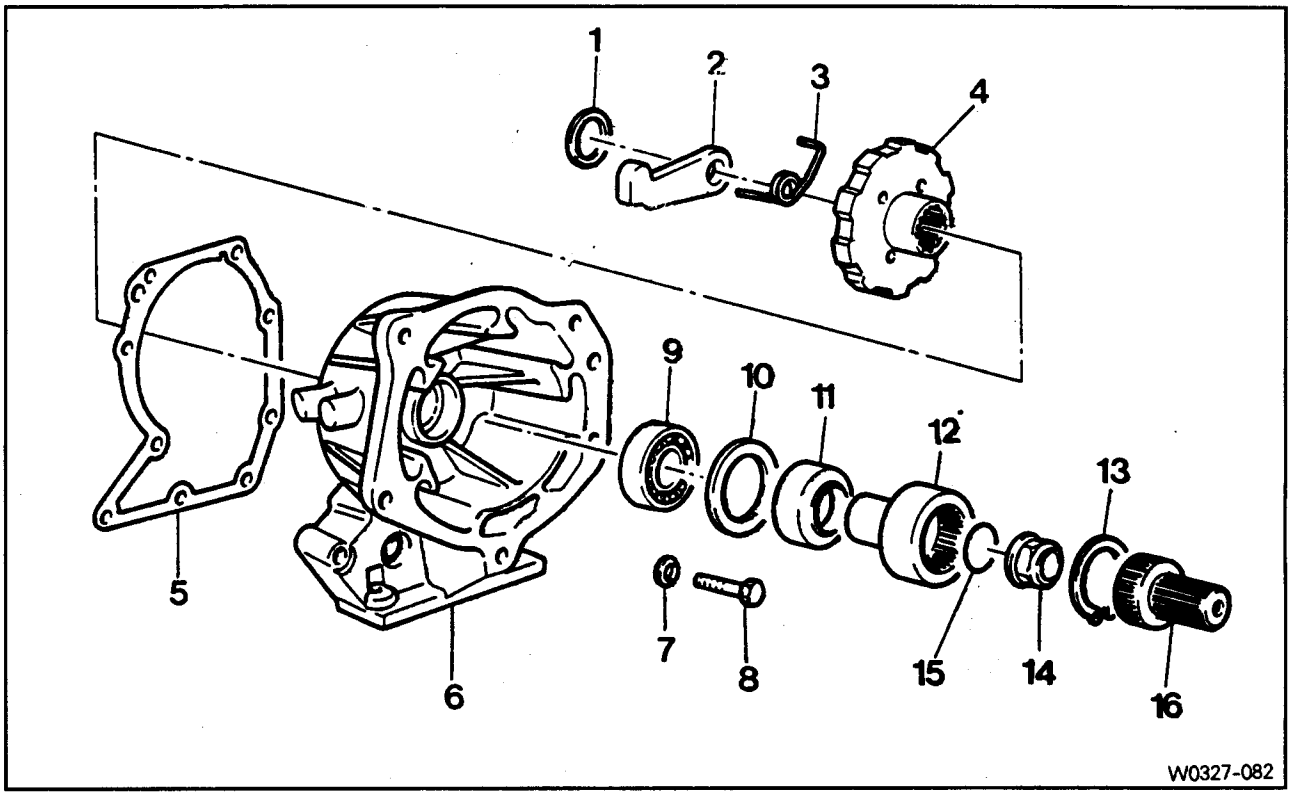
8) Install the plug and turn the lock (40) downward (arrow direction).



9) Connect the shifting rod (9) and insert the retainer (10).



15. Removal and Installation of Rear Cover



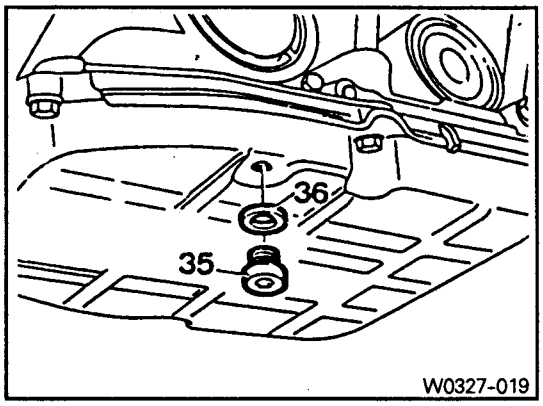
1. Spacer Washer ---------- Thickness : 0.1, 0.2, 0.5 ㎜
2. Pawl
3. Spring
4. Gear
5. Gasket---------- Replace
6. Rear Cover Case
7. Spring Washer
8. Bolt ---------- 45 ~ 53Nm
9. Ball Bearing---------- Inspection, replace
10. Washer
11. Seal---------- Replace
12. Drive Flange
13. O - Ring---------- Replace
14. Nut---------- 120Nm
15. Snap Ring
16. Intermediator

Removal

1) Disconnect the battery cables.
[Note] Remove the negative terminal first.

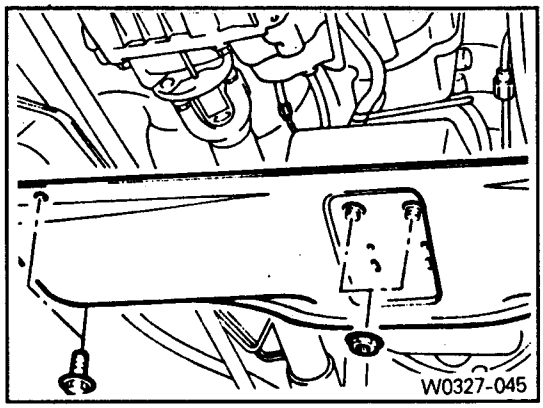
2) Remove the oil dip stick gauge.

3) Remove the sealing ring (36) and drain plug (35) and drain oil.



4) Remove the bolt and washer.

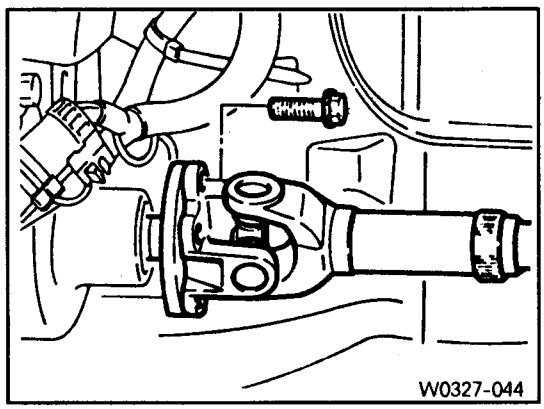
5) Remove the washer and nut.



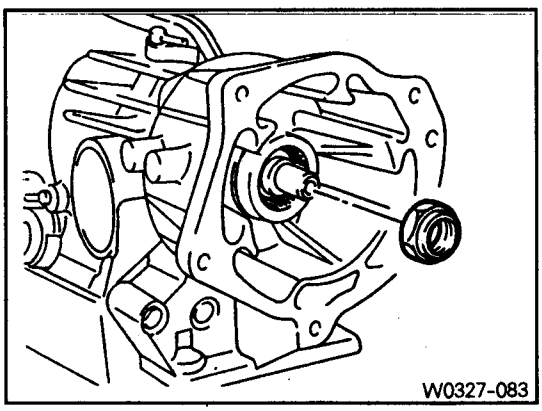
6) Remove the lock washer, nut and bolt.

7) Put the propeller shaft to the side.

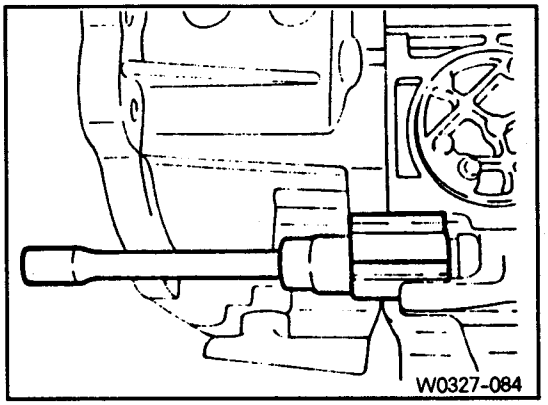
8) Remove the transfer case from the rear cover.



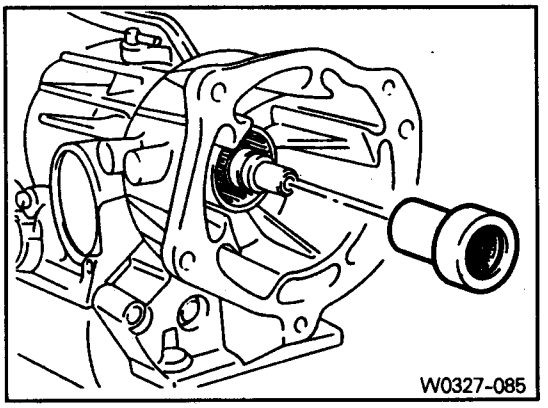
9) Remove the snap ring and intermediator and remove the 12-sided collar nut.



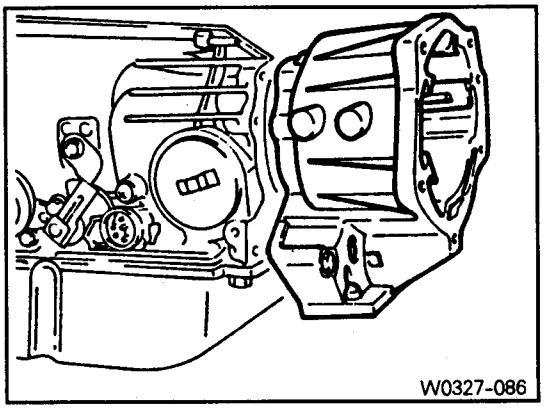
10) Remove the kickdown solenoid valve.



11) Remove the drive flange.



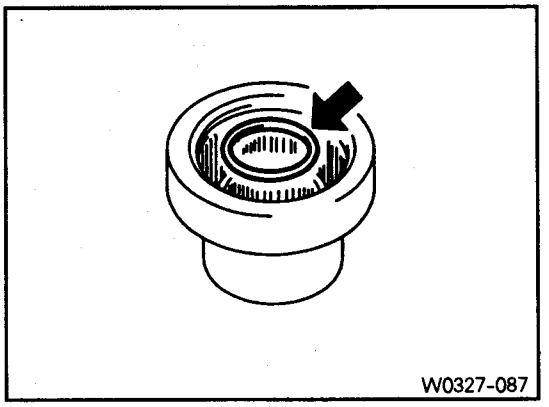
12) Remove the rear cover bolts and remove the rear cover housing.



Inspection

1) Check the O - ring in flange, and replace if necessary.

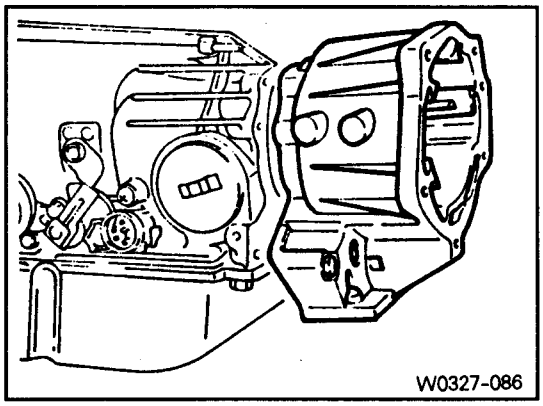
2) Check the ball bearing in the rear cover housing.



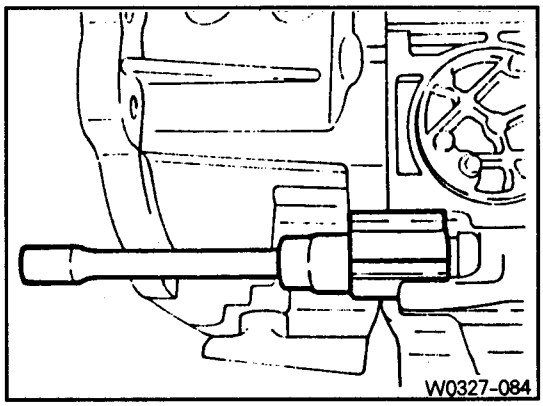
Installation

1) Replace the gasket and position the rear cover and tighten the bolts.

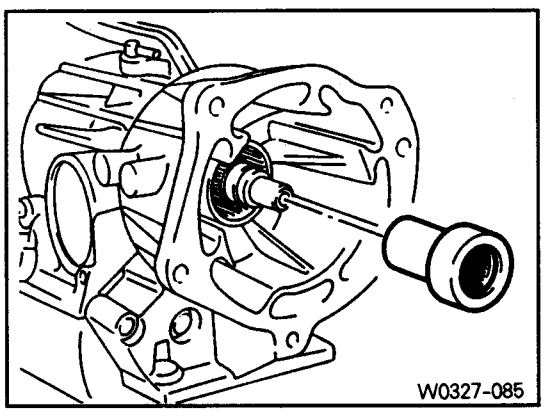
Tightening torque	45~53Nm



2) Install the kickdown solenoid valve.

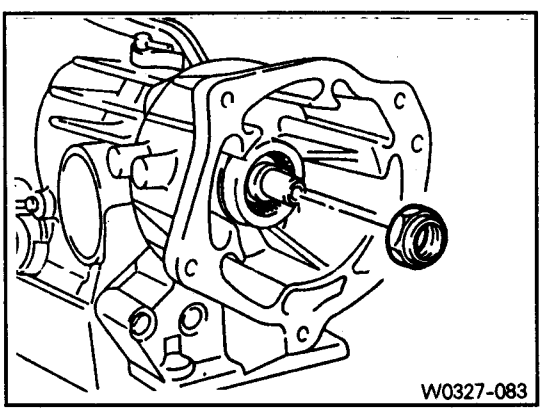


3) Insert the O - ring in flange and install the flange.

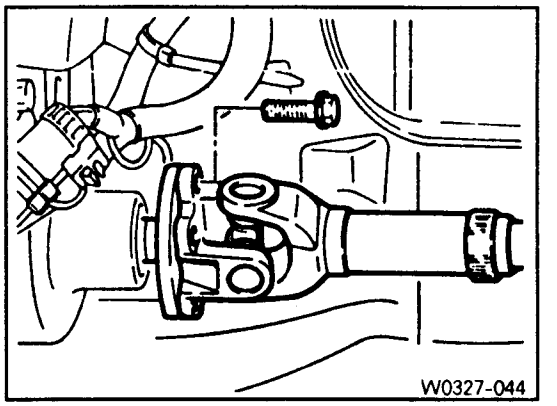


4) Tighten the 12-sided collar nut and install the snap ring and intermediator.

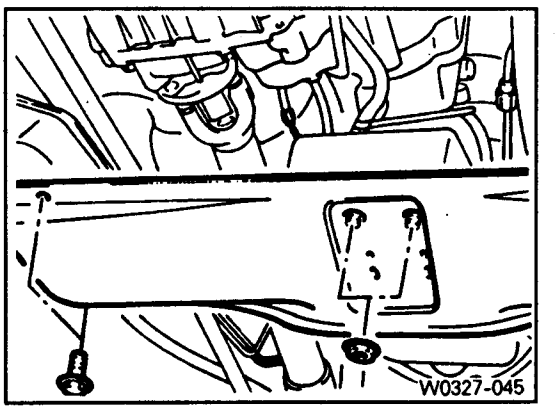
Tightening torque	120Nm



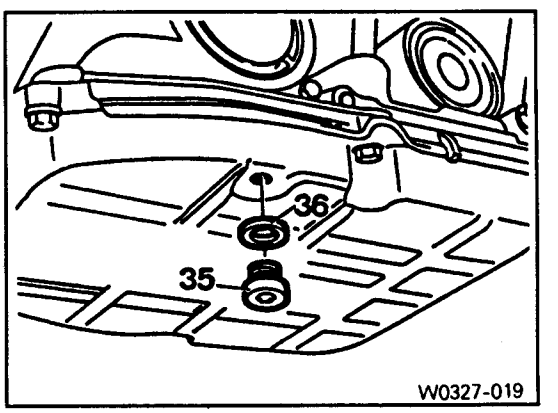
5) Install the transfer case to the rear cover. Tighten the propeller shaft bolt, nut and washer.



6) Install the cross member.



7) Replace the sealing ring (36) and install the drain plug (35).



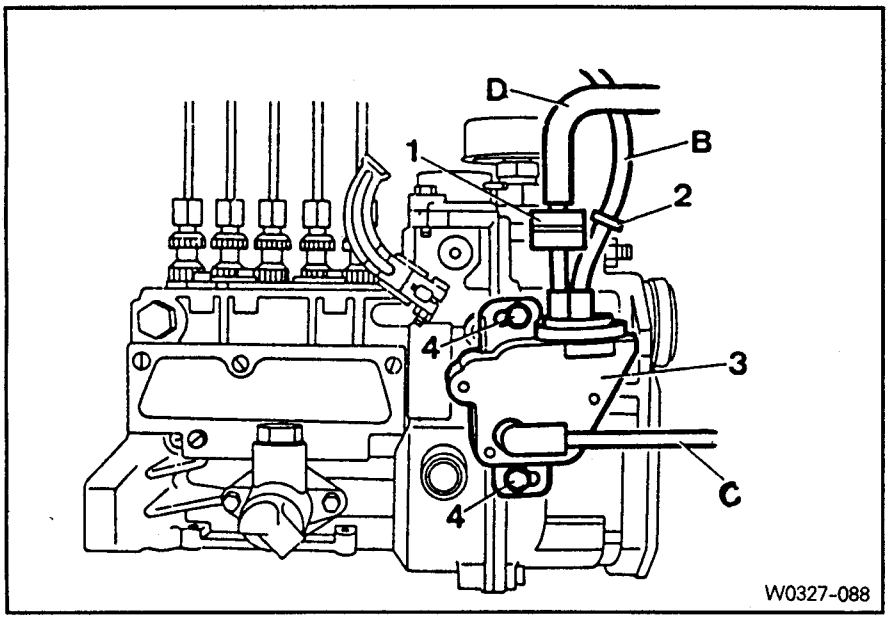
9) Fill the automatic transmission fluid and check oil level with engine running.
[Note] With engine stopped, fill 2/3 fluid of total capacity and fill 1/3 of fluid after engine started.
However, excessive oil may cause serious damage on the transmission. Special care should be taken.

10) Install the oil dip stick gauge.

11) Connect the battery cables.
[Note] Connect the positive terminal first.

16. Removal and Installation of Vacuum Control Valve

[Diesel only]

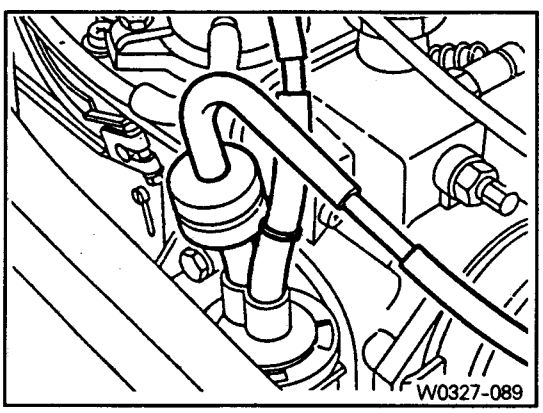


1. Damper ---------- Inspect, replace if necessary
2. Vacuum Pump Throttle ---------- Blue, Inspect and replace if necessary
3. Vacuum Control Valve ---------- Inspect, adjust
4. Bolt

B. Vacuum Line ---------- Lucid
C. Vent Line ---------- Lucid
D. Vacuum Line ---------- Black / white

Removal

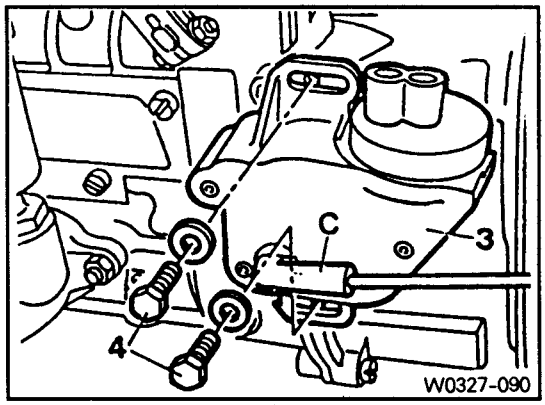
1) Pull out the vacuum line from the control valve.



2) Remove the bolts (4).

3) Remove the vacuum control valve (3).

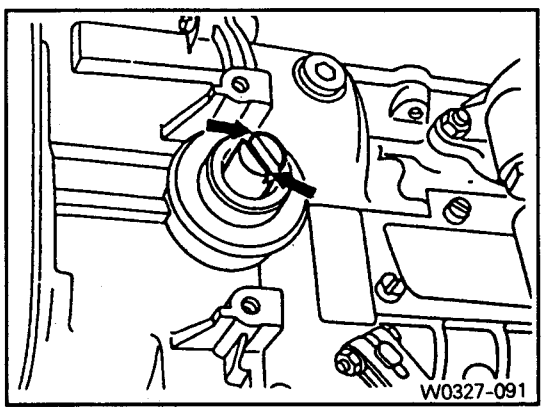
4) Pull out the vent line (C).



Installation

[Note] Before installation of the vacuum control valve, check for damage and leakage on each vacuum line.

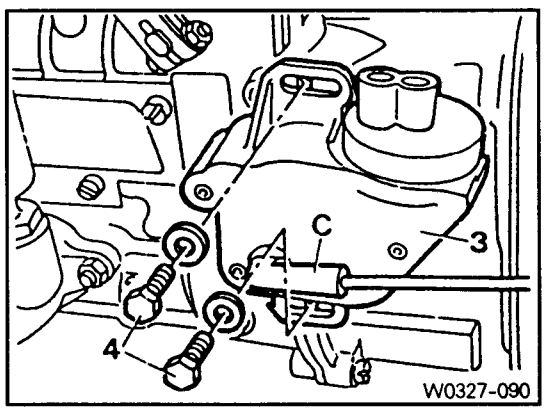
1) Check the fuel injection pump shaft and replace it if necessary.



2) Connect the vent line (C).

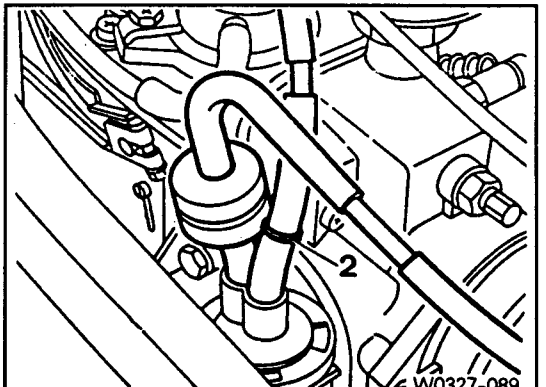
3) Install the vacuum control valve (3) with bolts (4).

[Note] After installation, check and adjust the vacuum control valve.

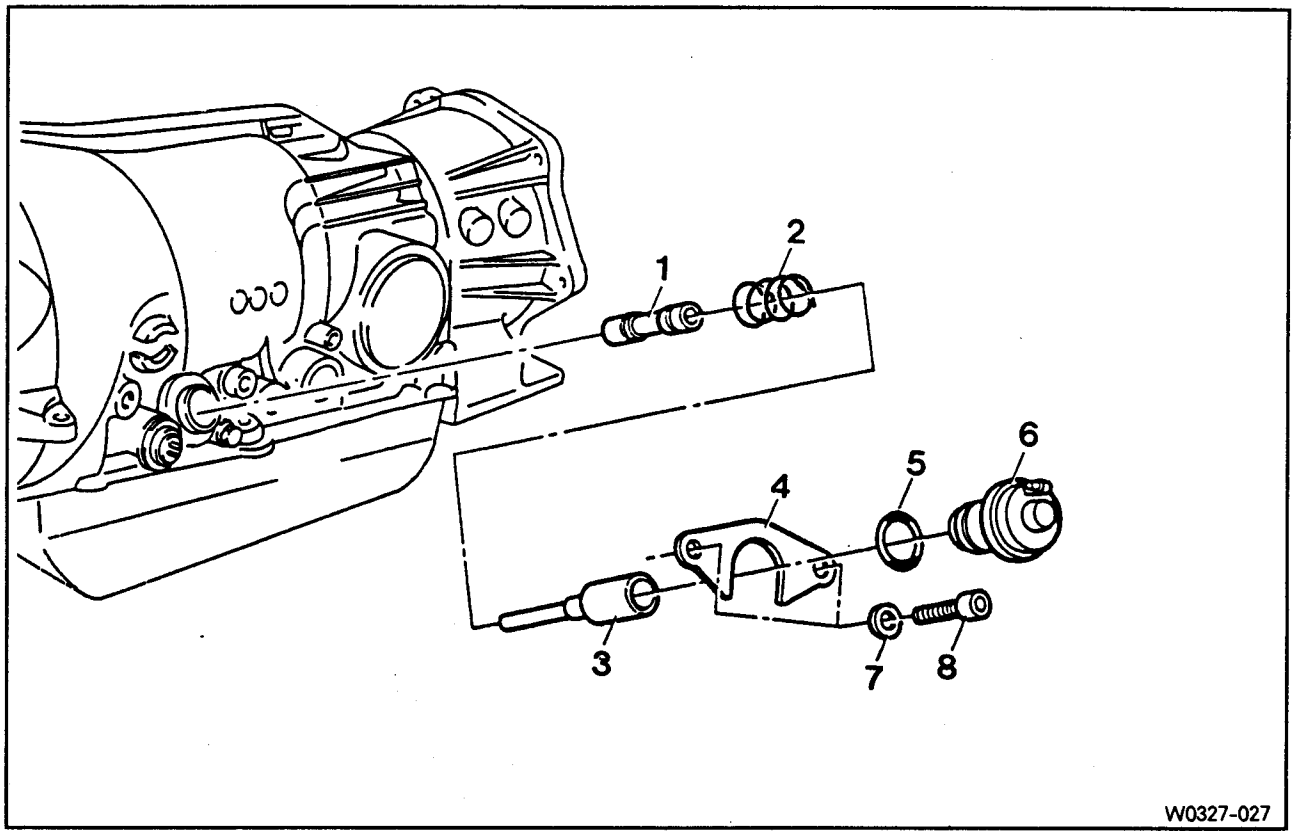


4) Connect the vacuum line to the vacuum control valve and install the vacuum line for the throttle (2) and vacuum pump to the center connection.

5) Adjust the vacuum control valve.



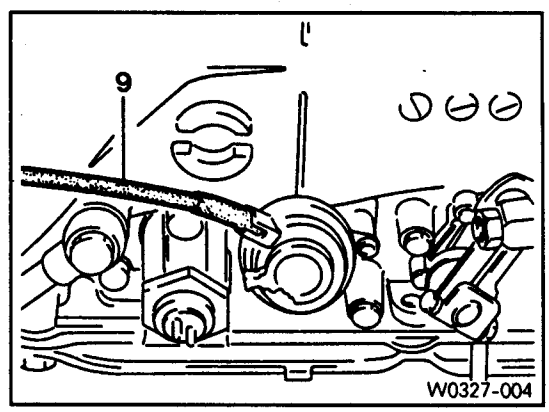
17. Removal and Installation of Vacuum Box



1. Modulating Pressure Control Valve
2. Spring
3. Heat-Expansion Compensation Pressure Pin --- Check operation, replace if necessary
4. Retaining Plate
5. Sealing Ring ---------- Replace
6. Vacuum Box
7. Washer
8. Allen Screw

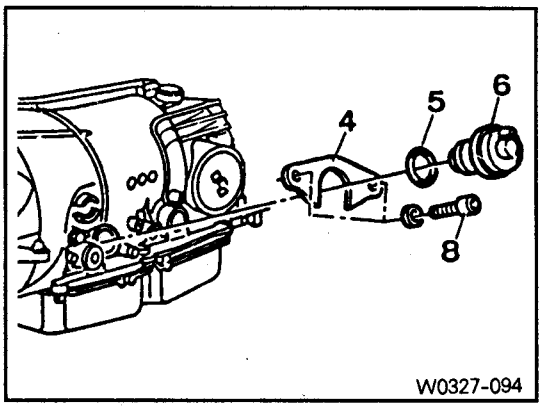
Removal

1) Remove the vacuum hose (9).

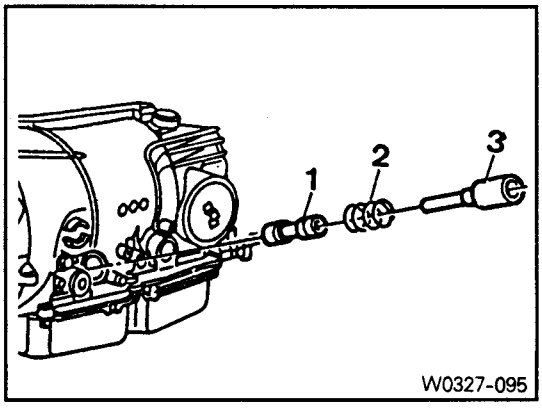


2) Remove the allen screw (8) and remove the retaining plate (4).

3) Remove the sealing ring (5) and vacuum box (6).

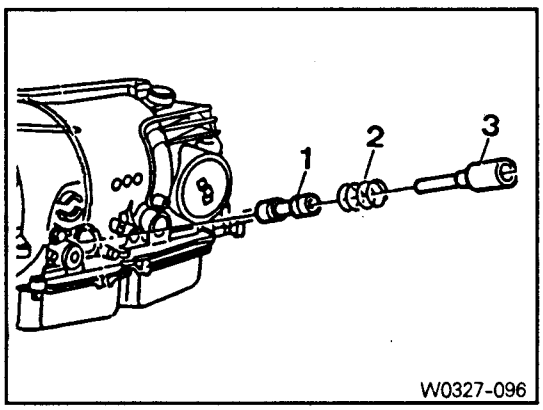


4) Remove the pressure pin (3), spring (2) and modulating pressure valve (1).



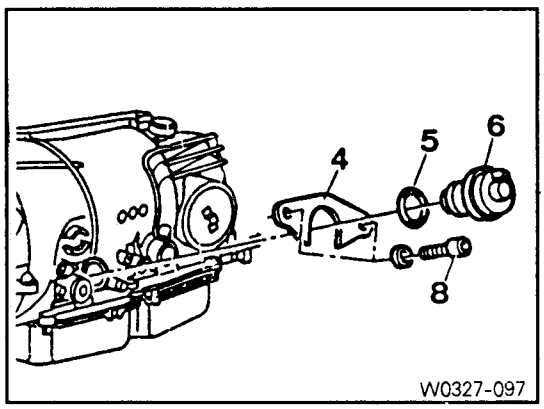
Installation

1) Install the pressure pin (3), spring (2) and modulating pressure valve (1).
[Note] Clean the pressure pin and check operation.

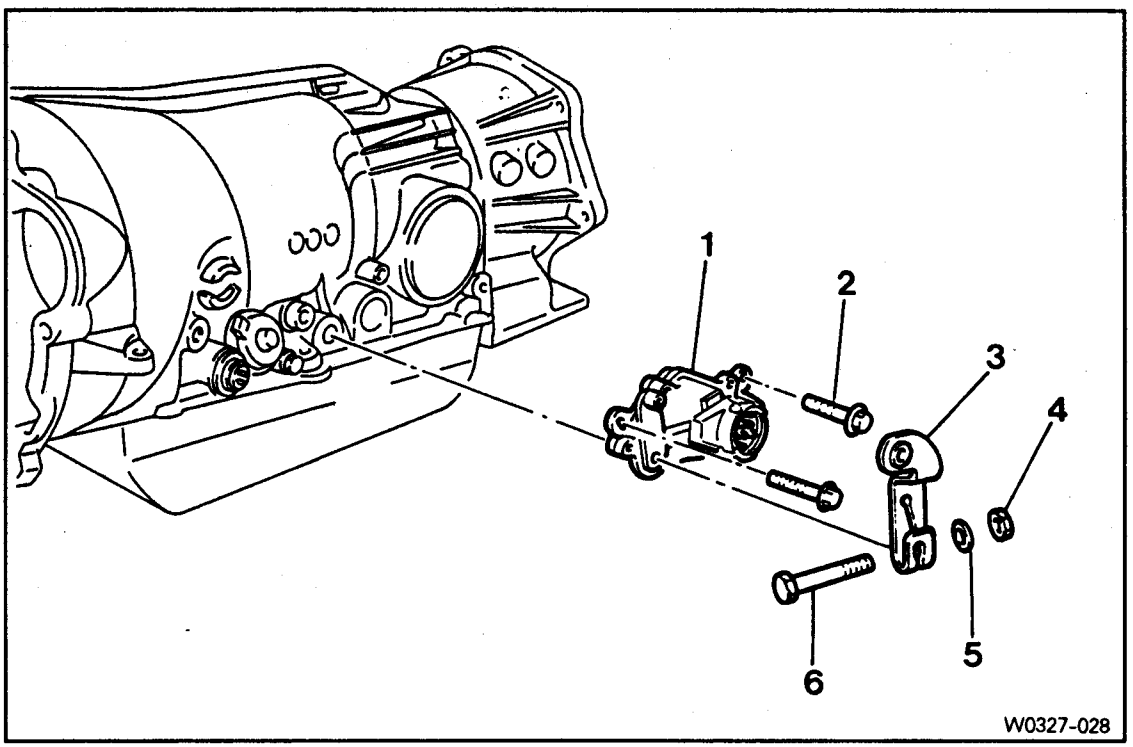


2) Replace the sealing ring (5) and install the vacuum box (6).

3) Install the retaining plate (4) with allen screws (8).



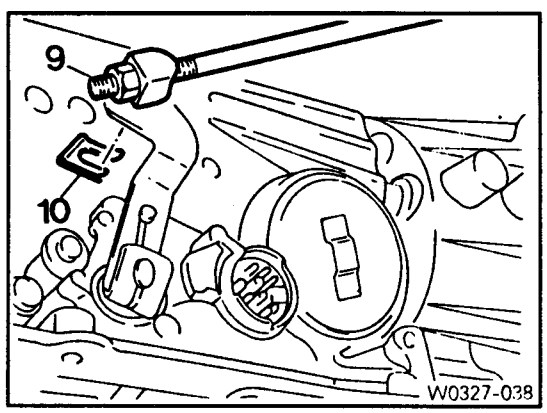
18. Removal and Installation of Starter Lockout Switch



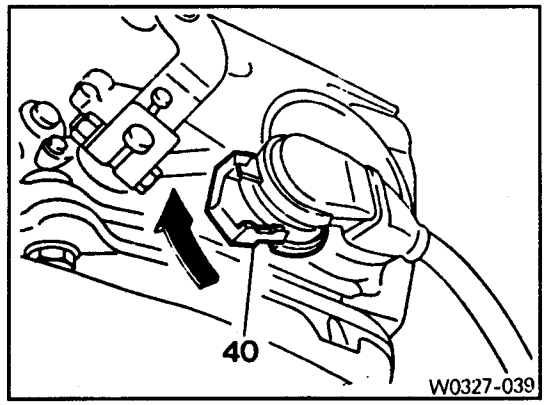
1. Starter Lockout Switch
2. Bolt
3. Range Selector Lever
4. Nut
5. Washer
6. Bolt

Removal

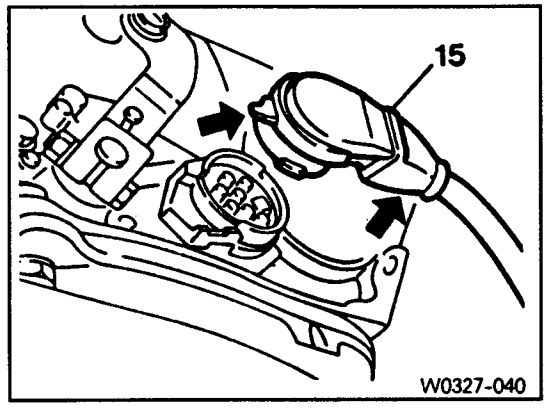
1) Pull out the retainer (10) and separate the shifting rod (9).



2) Rotate the lock (40) to the arrow direction.

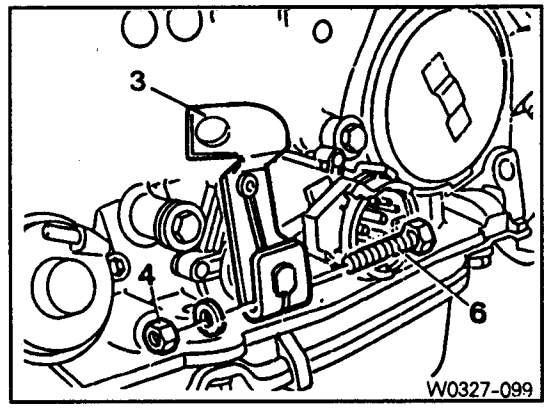


3) Using a screw driver, separate the plug by lifting the cable and tap (arrow) portion.

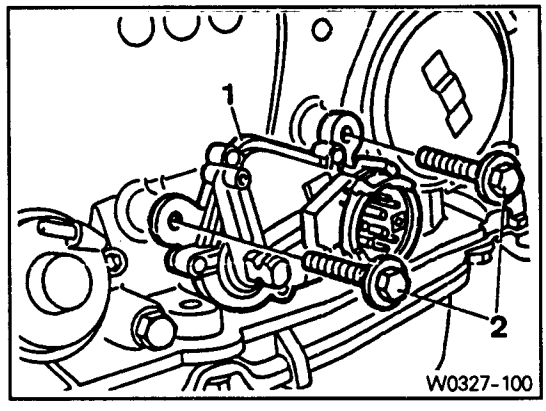


4) Remove the bolt (6), washer and nut (4).

5) Remove the range selector lever (3).

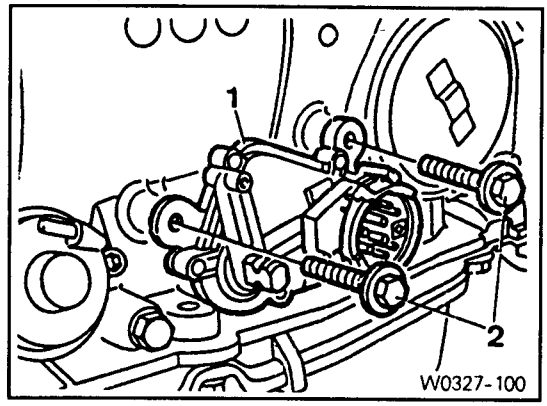


6) Remove the bolts (2) and pull out the starter lockout switch (1).



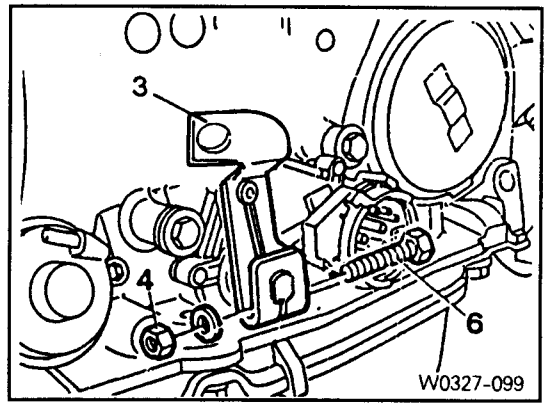
Installation

1) Position the starter lockout switch (1) and tighten the bolts (2).



2) Install the lever so that the driver is engaged to the range selector lever completely.

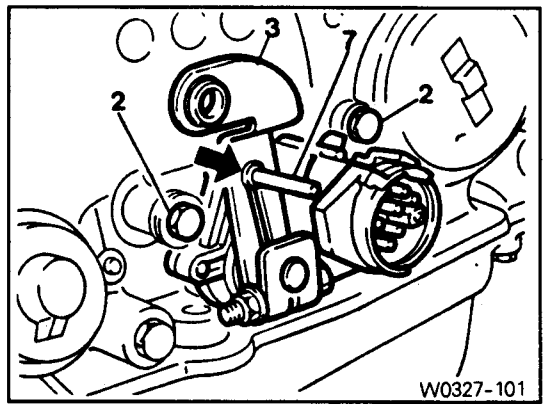
3) Tighten the range selector lever with bolt (6), washer and nut (4).



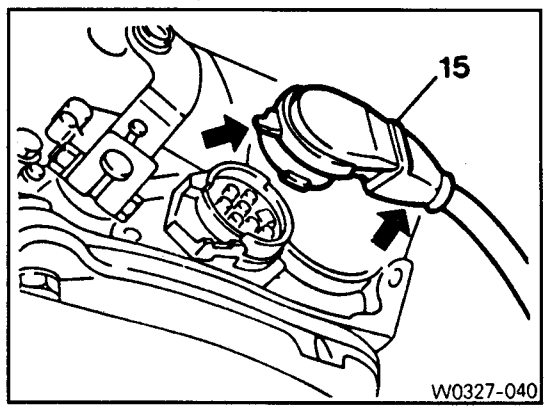
4) Shift the range selector lever to 'N' position .

5) Align the hole of the starter lockout switch housing with range selector lever hole (3).
Insert a 4 ㎜ cotter pin into the aligned holes.

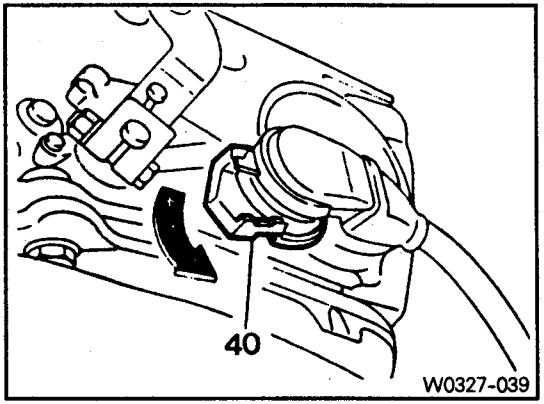
6) Tighten the bolts (2) and remove the cotter pin.



7) Install the plug (15).

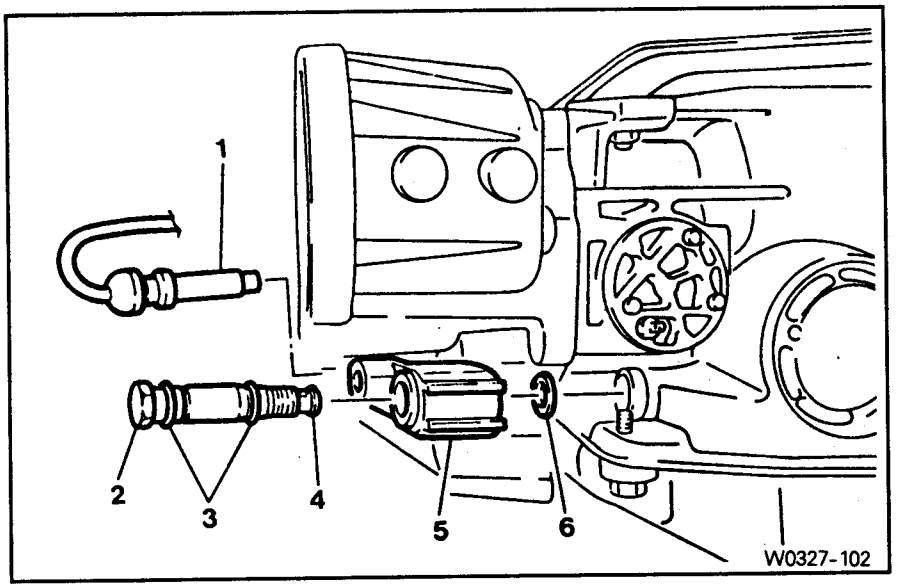


8) Rotate the lock (40) to the arrow direction.



9) Connect the shifting rod (9) and insert the retainer (10).

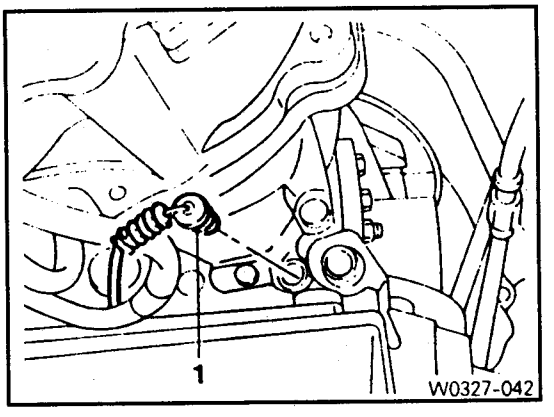
19. Removal and Installation of Kickdown Solenoid Valve



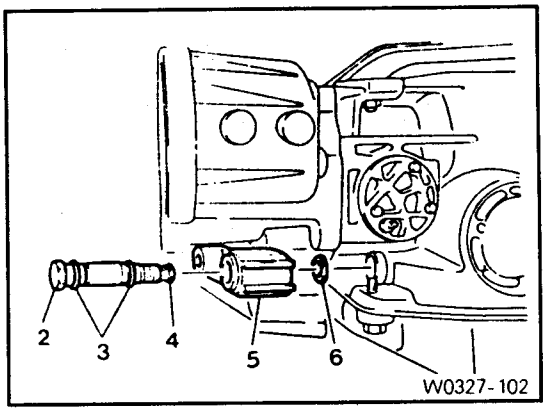
1. Plug Connector
2. Kickdown Solenoid Valve ---------- 30Nm
3. O-Ring ---------- Replace
4. O-Ring ---------- Replace
5. Magnetic Coil
6. Sealing Ring

Removal • Installation

1) Remove the plug (1).

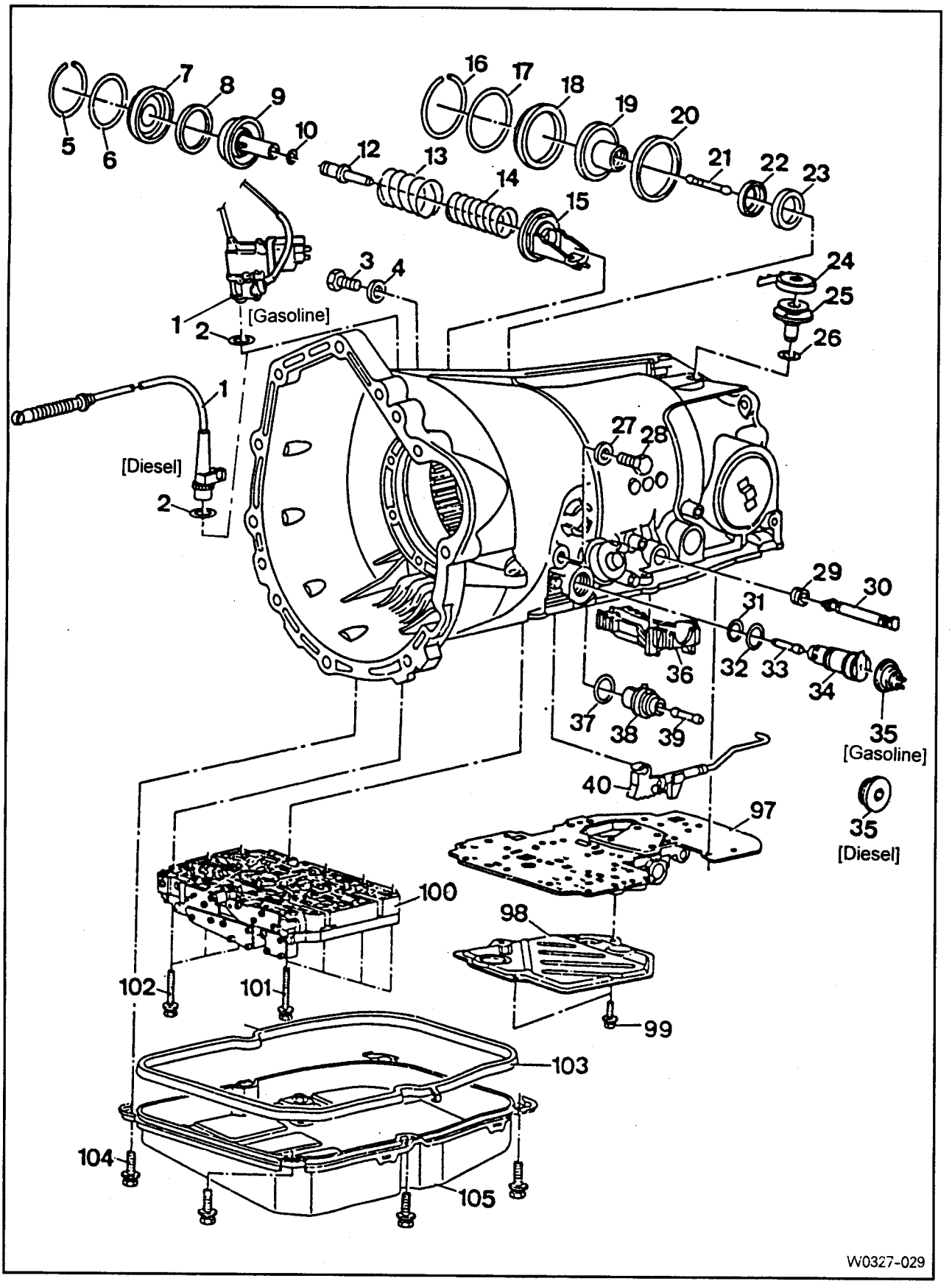


2) Remove the sealing ring (6), magnetic coil (5), O - ring (3, 4) and kickdown solenoid valve (2).

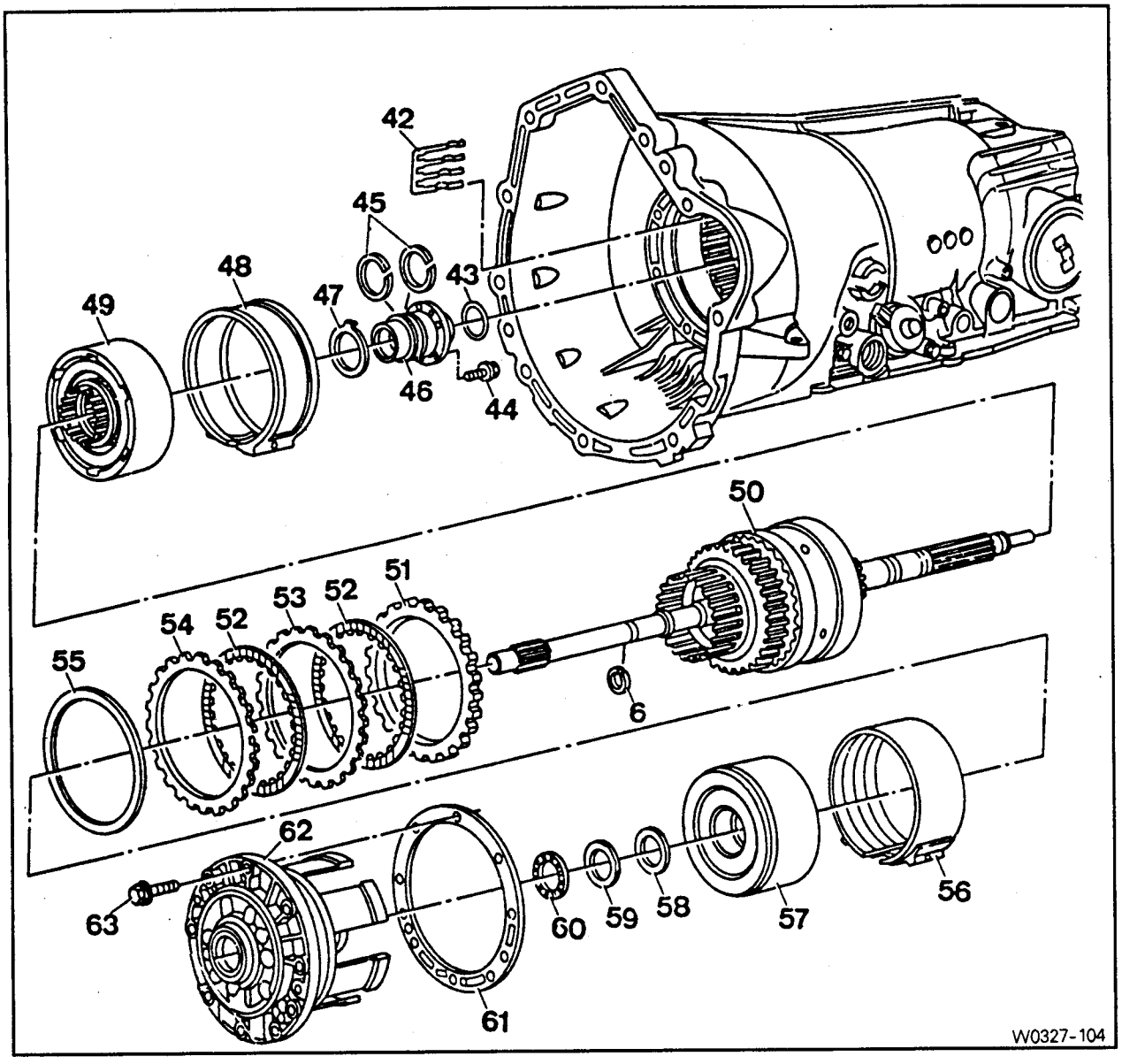


3) Installation is reverse order of the removal.

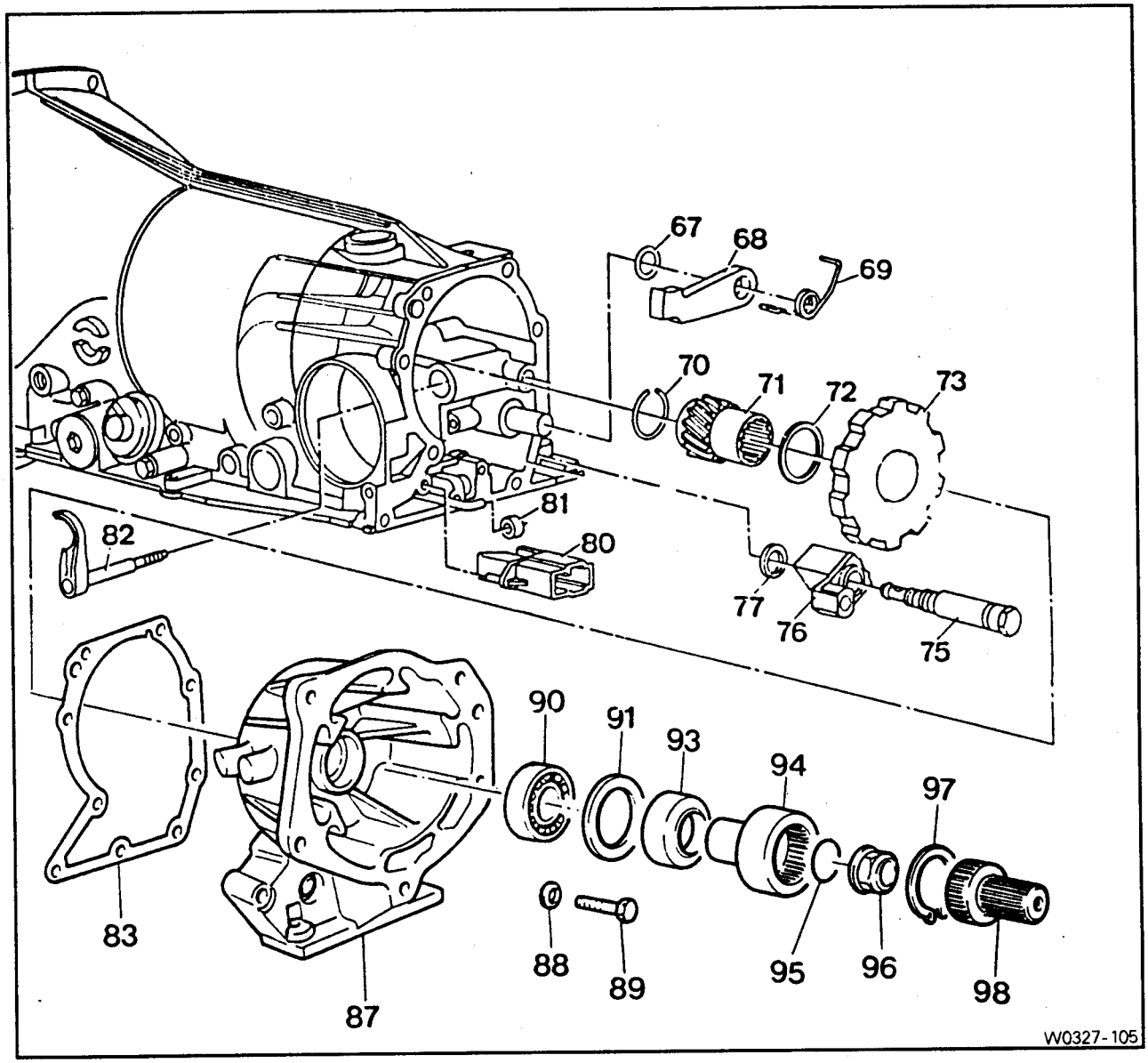
20. Disassembly and Assembly of Transmission



1. [Diesel] Control Pressure Cable
   [Gasoline] Vacuum Element
2. O-Ring ---------- Replace
3. Plug --- ---------- 13Nm
4. Sealing Ring ---------- Replace
5. Snap Ring
6. O-Ring
7. Brake Band Piston Cover B1
8. Sealing Rib ---------- Replace
9. Brake Band Piston B1
10. Sealing Ring ---------- Replace
12. Thrust Pin
13. Pressure Spring
14. Pressure Spring
15. Brake Band Holder B1
16. Snap Ring
17. O-Ring ---------- Replace
18. Brake Band Piston Cover B2
19. Brake Band Piston B2
20. Teflon Ring ---------- Inspect
21. Thrust Pin
22. Plastic Guide Ring
23. Sealing Rib ---------- Replace
25. Vent
26. O-Ring ---------- Replace
27. Sealing Ring ---------- Replace
28. Plug ---------- 13Nm
29. Radial Shaft Seal ---------- Replace
30. Range Selector Shaft
31. O-Ring ---------- Replace
32. O-Ring ---------- Replace
33. Thrust Pin
34. Thrust Element B1
35. [Diesel] Plug ---------- 70Nm
    [Gasoline] Over - Load Protection Switch ---------- 70Nm
36. Brake Band Holder B2
37. O-Ring ---------- Replace
38. Thrust Element B2
39. Thrust Pin
40. Linkage and Catch Plate
97. Middle Plate and Lower Cover
98. Oil Filter
99. Phillips Head Screw ---------- 4Nm
100. Mounting Housing and Shift Valve Housing
101. Bolt M6 × 55 ---------- 8Nm
102. Bolt M6 × 50 ---------- 8Nm
103. GasketReplace
104. Bolt --- ---------- 8Nm
105. Oil Pan



42. Damping Spring
43. O-Ring ---------- Replace
44. Bolt
45. Teflon Ring ---------- Check
46. Support Flange
47. Supporting Disc
48. Brake Band B2
49. Clutch K2
50. Gear Assembly
51. Steel Disc ---------- Check
52. Friction Plate ---------- 4 Pieces, check
53. Steel Disc ---------- 3 Pieces, check
54. Steel Disc ---------- Check
55. Leaf Spring
56. Brake Band B1
57. Clutch K1
58. Shim
59. Thrust Washer
60. Axial Bearing ---------- Check
61. Gasket ---------- Replace
62. Front Housing Cover
63. Bolt ---------- 15Nm
64. Lubrication Thrust Ring ------- Check

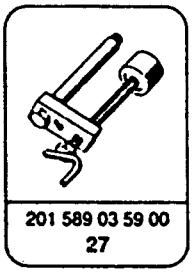


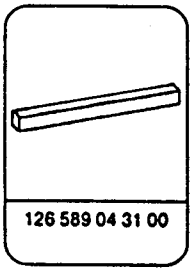
67. Thrust Washer
68. Parking Gear Detent
69. Spring
70. Snap Ring
71. Helical Gear
72. Shim
73. Parking Gear
75. Gasket and Solenoid Valve------- Replace gasket
76. Magnetic Coil
77. Sealing Ring---------- Replace
80. Plastic Guide
81. Roller
82. Axial Holder
83. Gasket---------- Replace
87. Rear Cover
88. Washer
89. Bolt ---------- 45 ~ 53Nm
90. Cylinder Roller Bearing --------- Check, replace
91. Washer
93. Seal
94. Drive Flange
95. O-Ring---------- Replace
96. Nut---------- 120Nm
97. Snap Ring
98. Intermediator

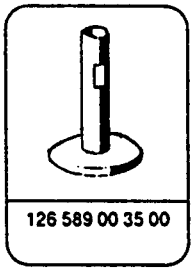
Adjustment data

		mm
End play 'B' (Clutch K1)	When rear housing cover is installed	0.3~0.5
	When rear housing cover is removed	0.8~1.2
Disc clearance (Brake B3)		1.5~2.0
Idling stroke in brake band B1		1.8~2.5
Disc clearance in brake band B2		5.5~5.7
Clearance 'C' between linkage stop and spring attached linkage		0.4~1.0
Output shaft clearance 'C' (Clutch K2)		0.4~0.5

Special tools


201 589 03 59 00
27

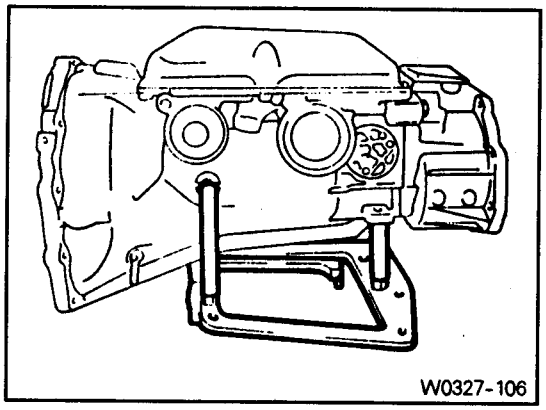

126 589 04 31 00


126 589 00 35 00

Disassembly

1) Insert the mounting plate to the assembly jig, and install the automatic transmission on the mounting plate and then fix it.

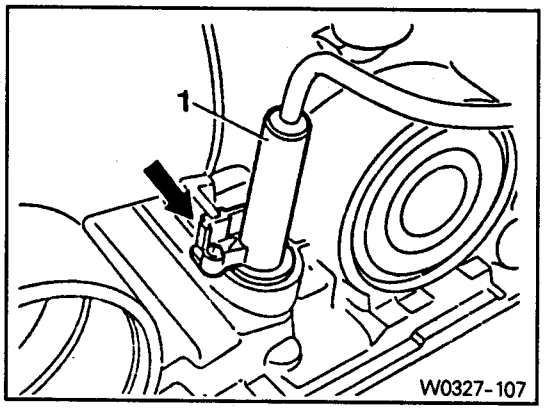
Mounting plat 126 589 10 63 00
Assembly jig 116 589 06 59 00


W0327-106

2) By pressing the control pressure cable (1) and holder (arrow) simultaneously, remove them.

3) Remove the control pressure cable.

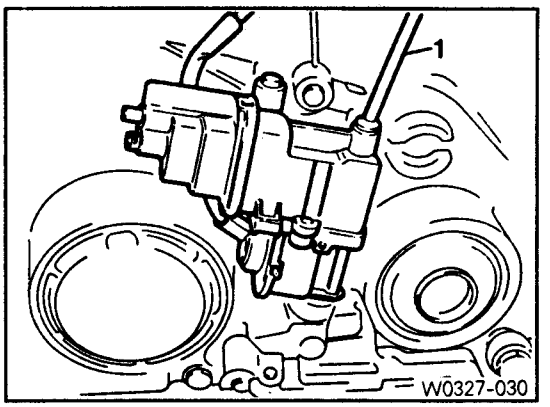
[Diesel]



W0327-107

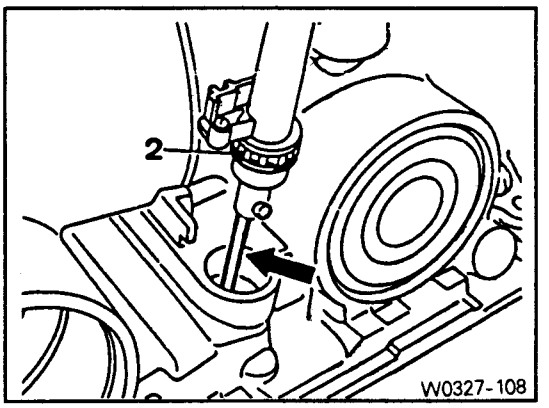
4) Remove the vacuum element.

[Gasoline]

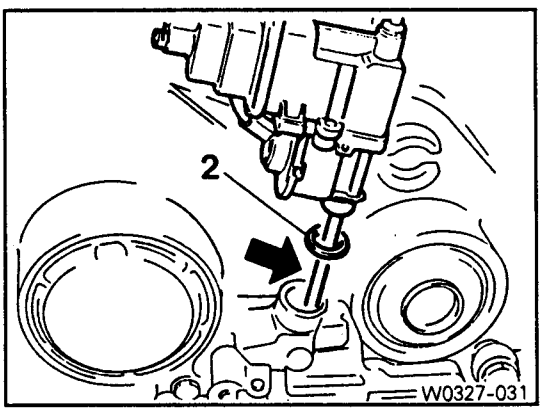


5) Remove the rod (arrow) and the O-ring (2).

[Diesel]

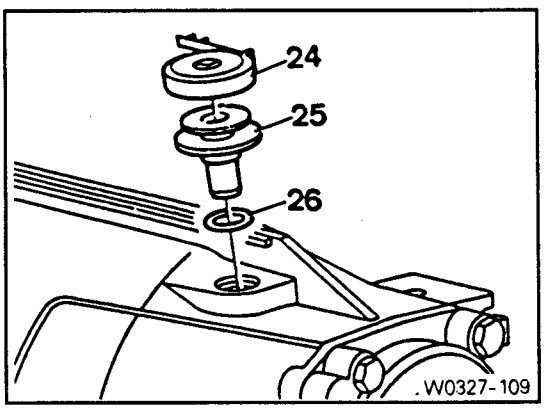


[Gasoline]

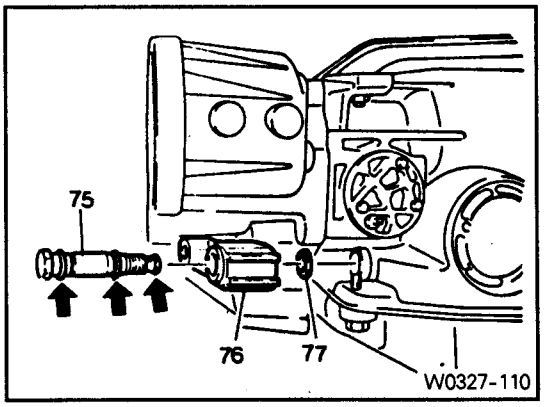


6) Remove the vent cover (24) and vent sitting (25).

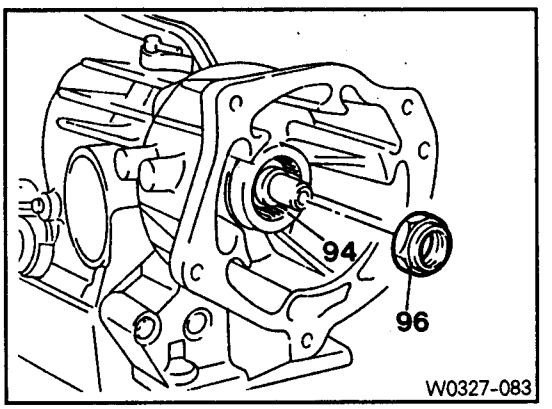
7) Remove the O-ring (26).



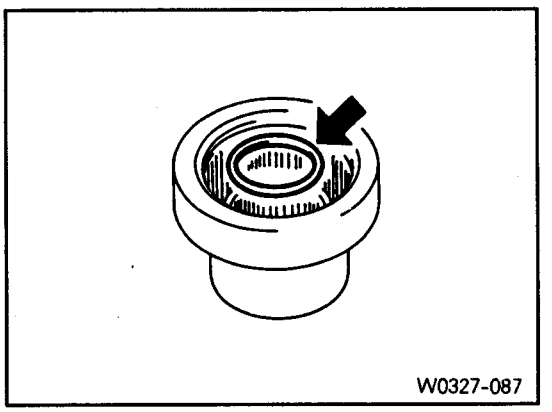
8) Remove the gasket (arrow) and kickdown solenoid (75) and pull out the sealing ring (77) and magnetic coil (76).



9) Remove the 12 - sided collar nut (96) and remove the flange (94).

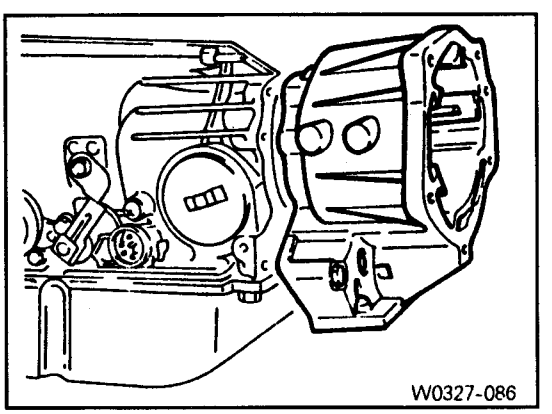


10) Remove the O-ring from the flange.

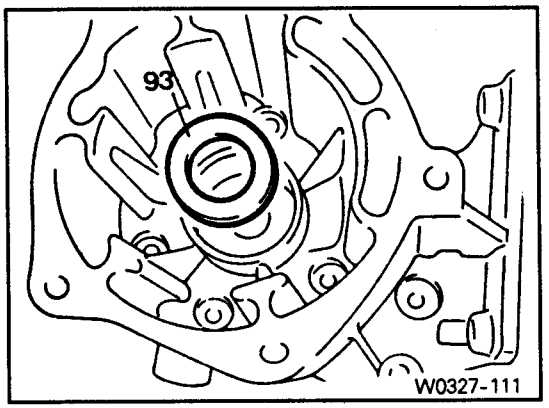


11) Remove the washer.

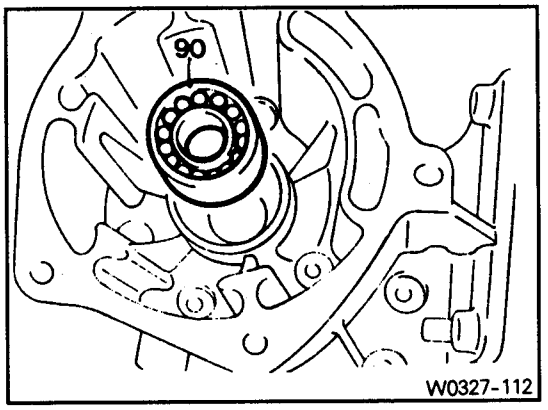
12) Remove the bolts and remove the rear cover.



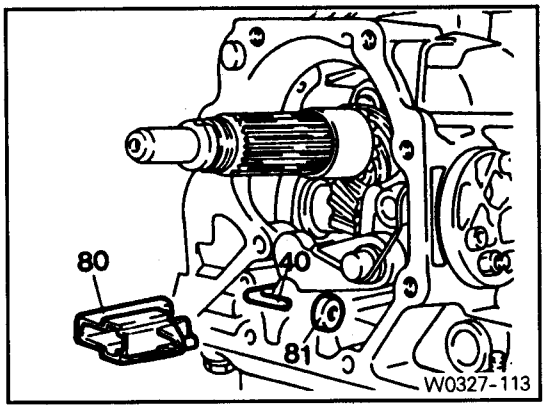
13) Remove the radial shaft seal (93).



14) Remove the bearing (90) from the rear cover.

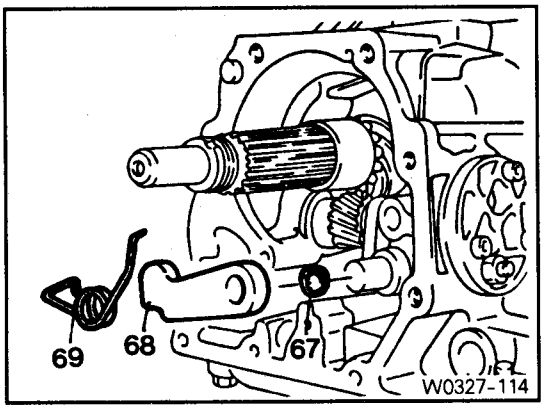


15) Remove the plastic guide (80) and remove the roller (81) of the linkage for catch plate (40).

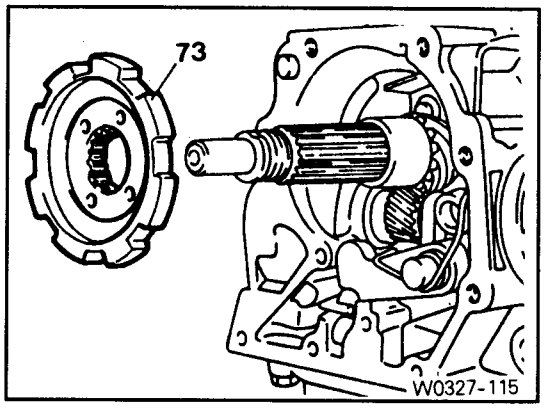


16) Remove the spring and parking gear detent.

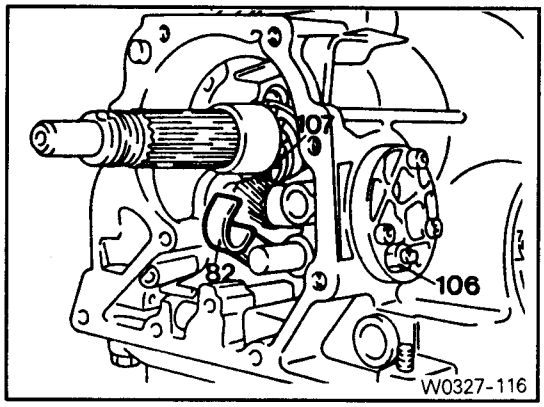
17) Remove the thrust washer (67) for the parking gear detent.



18) Remove the parking gear (73).



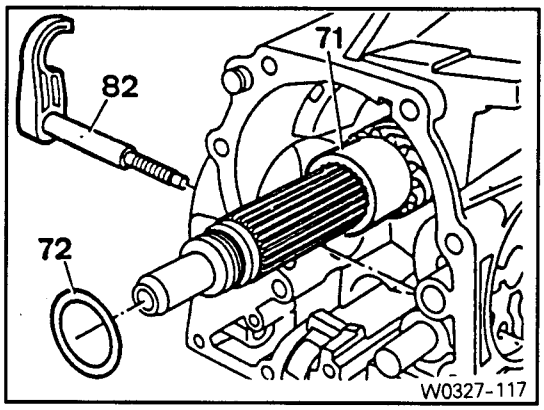
19) Remove the counter nut (106) and separate the axial holder (82) from the centrifugal governor (107).



20) Pull out the centrifugal governor.

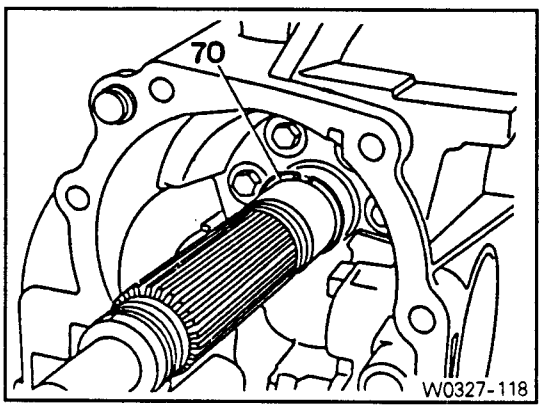
21) Remove the shim (72).

22) Remove the helical gear (71) and remove the axial holder (82).



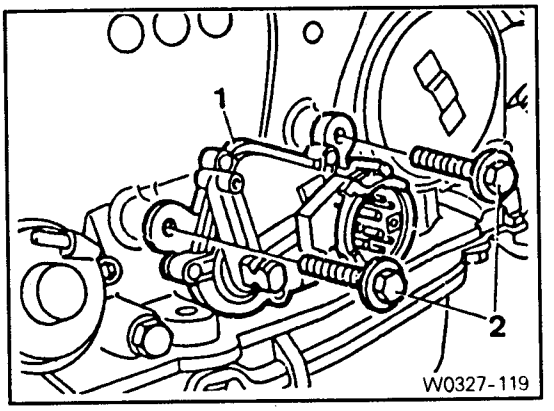
23) Remove the snap ring (70) using a pliers.

Pliers 000 589 52 37 00

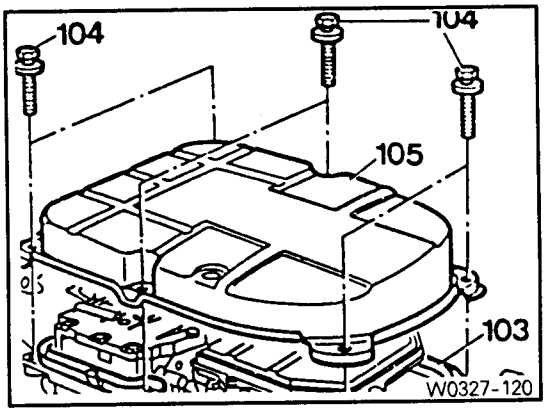


24) Remove the vacuum box.

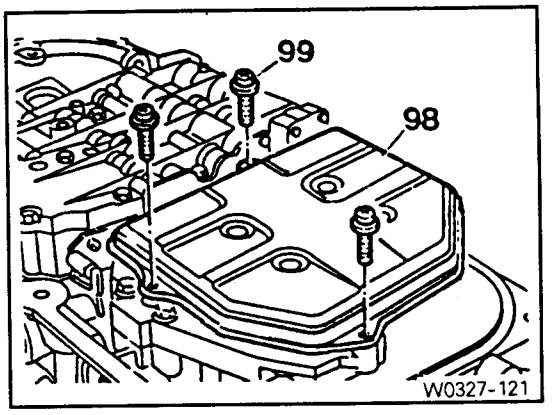
25) Remove the bolts (2) and remove the starter lockout switch (1).



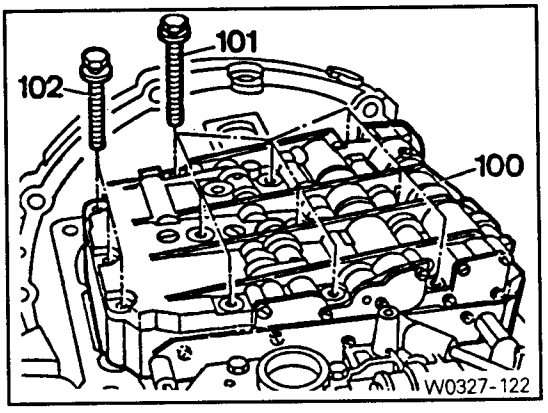
26) Remove the bolts (104) and remove the gasket (103) and oil pan (105).



27) Remove the Phillips screws (99) and remove the oil filter (98).

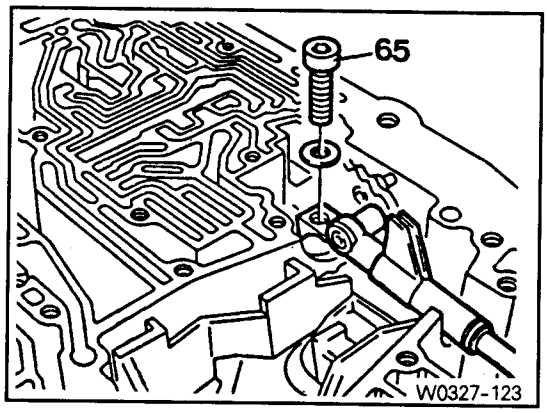


28) Remove the bolts (101, 102) and remove the shift valve housing (100).

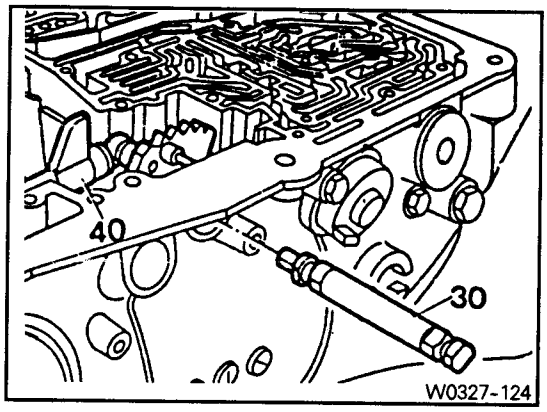


29) Remove the middle plate and lower cover.

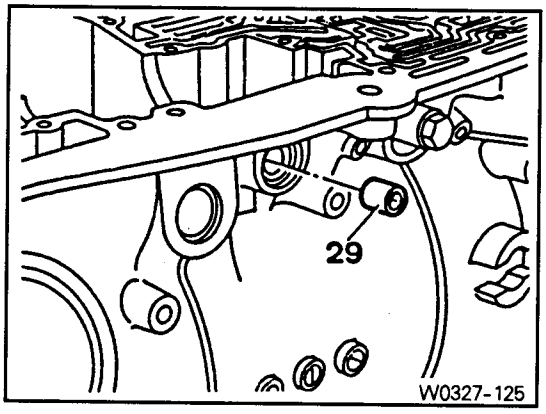
30) Remove the Allen screw (65).



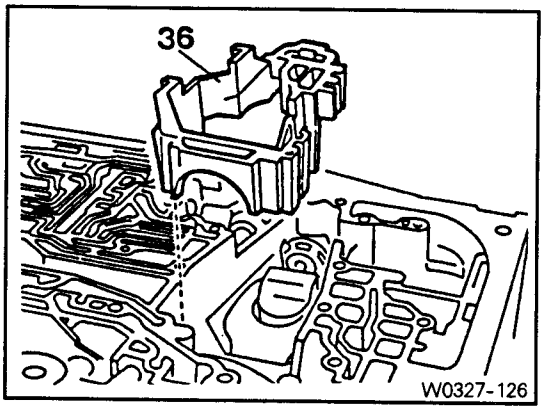
31) Pull out the range selector shaft (30) and remove the linkage (40) and catch plate.



32) Remove the radial shaft seal (29).

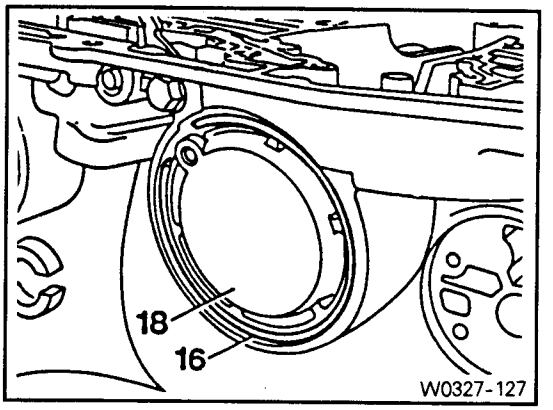


33) Remove the brake band holder B2 (36).



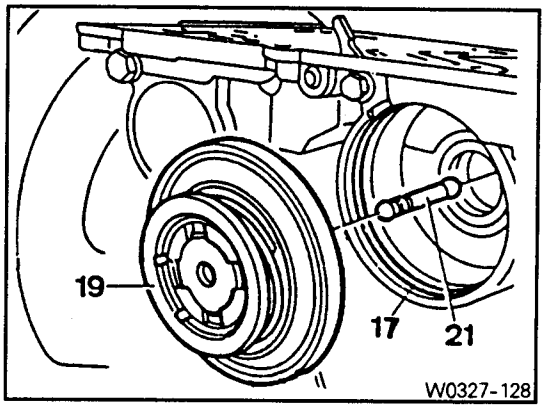
34) By pushing the brake band piston cover B2 (18), remove the snap ring (16).

35) Remove the brake band piston cover B2.

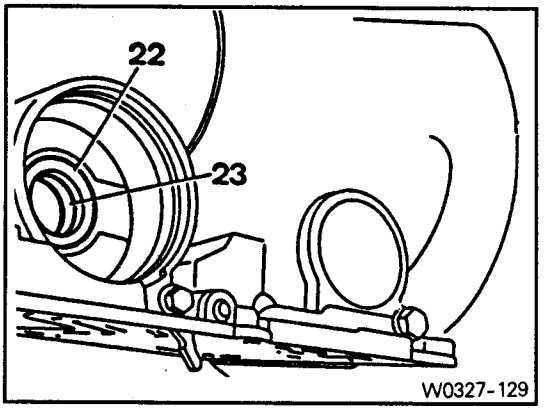


36) Remove the brake band piston B2 (19) and thrust pin (21).

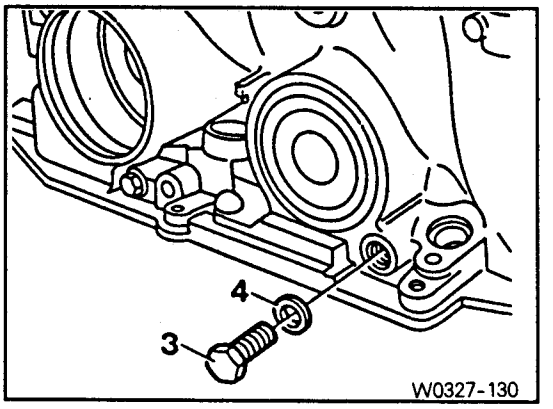
37) Remove the O-ring (17).



38) Remove the sealing rib (23) and plastic guide ring (22).



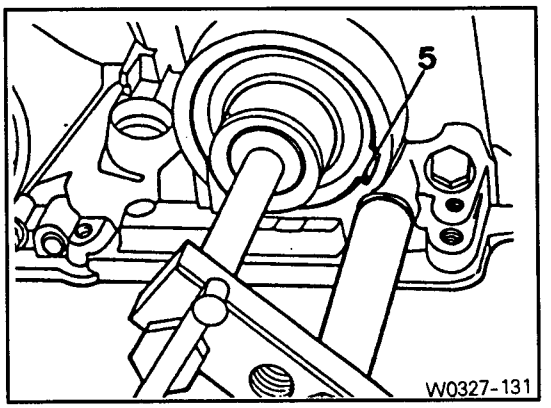
39) Remove the sealing ring (4) and bolt (3).



40) Install the assembly tool to the brake band piston cover B1.

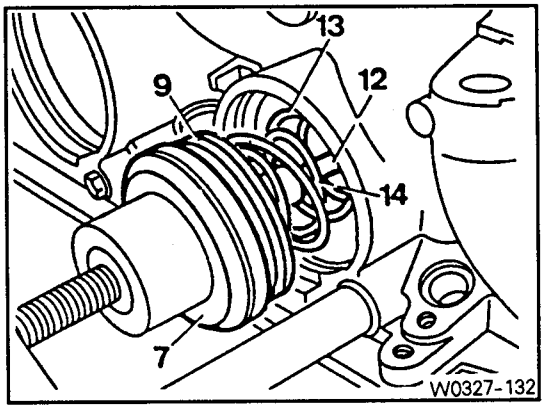
41) Slowly press the cover with assembly tool and remove the snap ring (5).

Assembly tool 201 589 03 59 00



42) Remove the assembly tool.

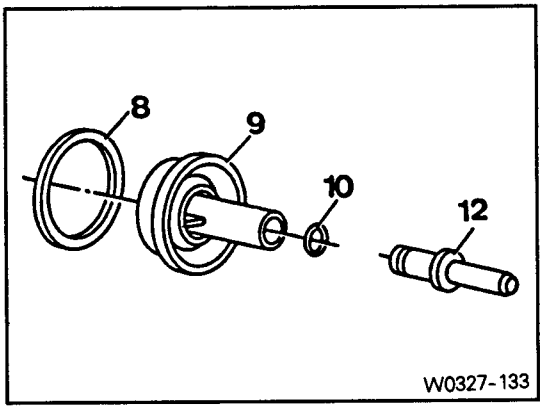
43) Remove the brake band piston cover (7), brake band piston B1(9), thrust pin (12) and pressure spring (13,14).



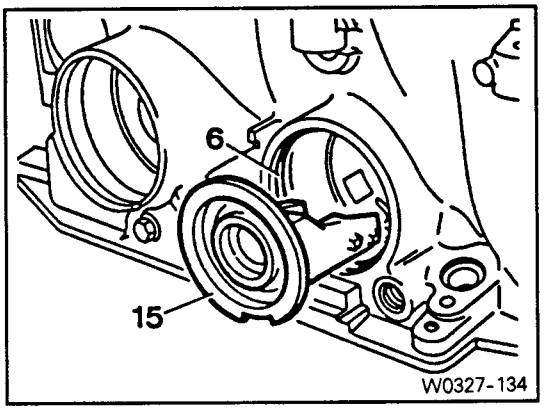
44) Remove the sealing rib (8) from the brake band piston (9).

45) Remove the thrust pin (12).

46) Remove the sealing ring (10).



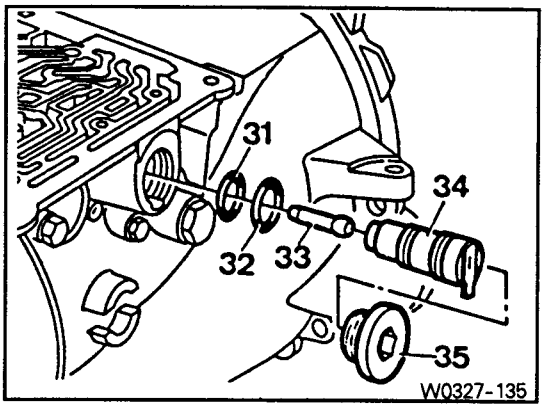
47) Remove the brake band holder B1 (15) and pull out the O-ring (16).



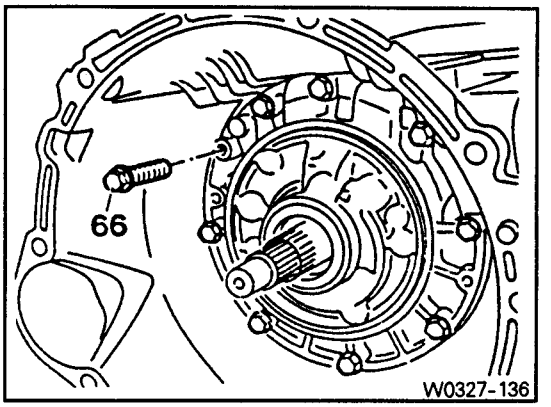
48) Remove the plug (35).

49) Remove the thrust pin (33) and thrust element B1 (34).

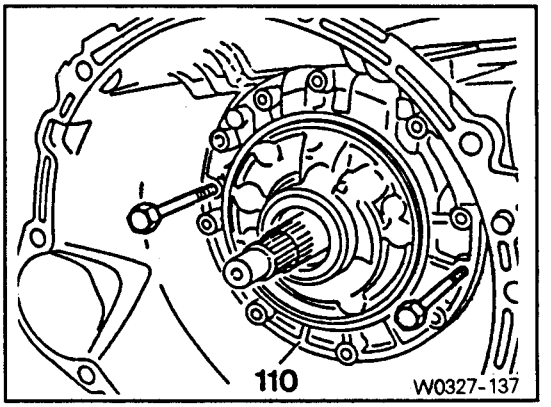
50) Remove the O-ring (31, 32).



51) Remove the bolts (66).

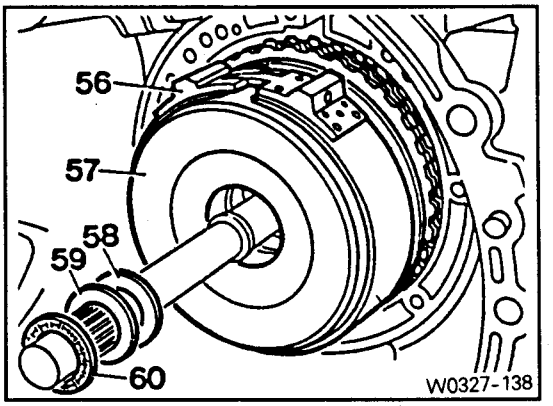


52) Install the bolts into service holes and remove the gasket and front cover (110).



53) Remove the primary pump.

54) Remove the axial bearing (60), thrust washer (59), shim (58), clutch K1 (57) and brake band B1 (56) from the gear assembly.

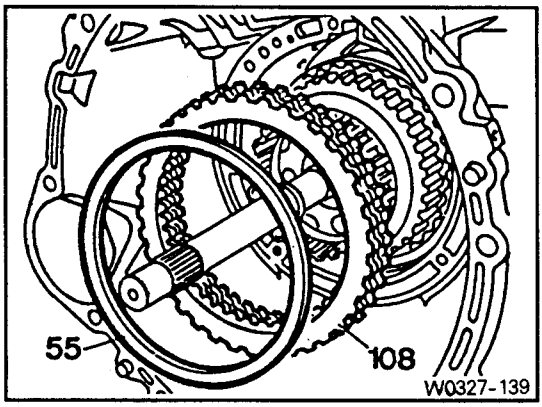


55) Remove the clutch K1.

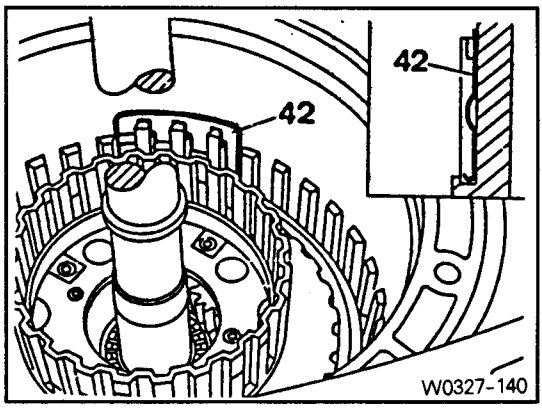
56) Remove the plate package B3 (108) and leaf spring (55).

57) Remove the gear assembly.

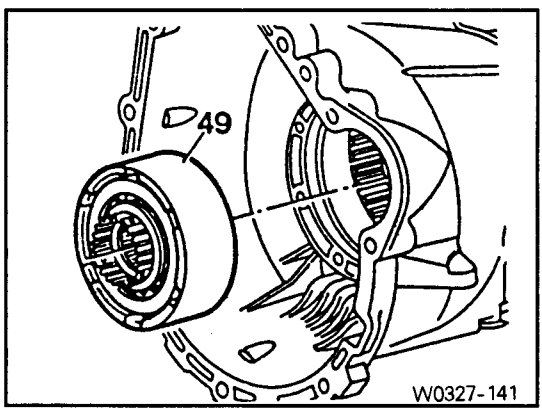
58) Disassemble the gear assembly.



59) Remove the damping spring (42).

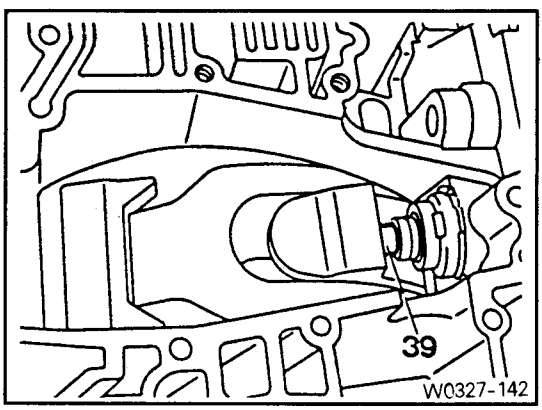


60) Remove the clutch K2 (49).

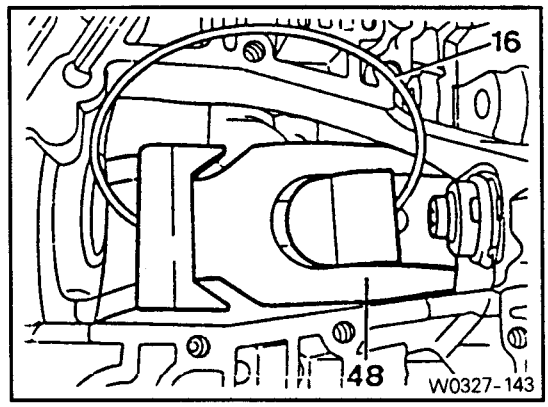


61) Remove the thrust pin (39).

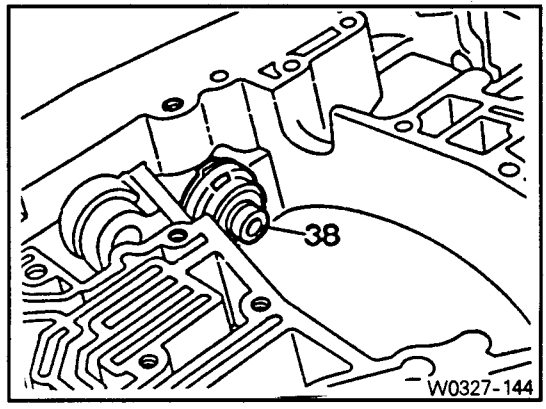
62) Remove the clutch K2.



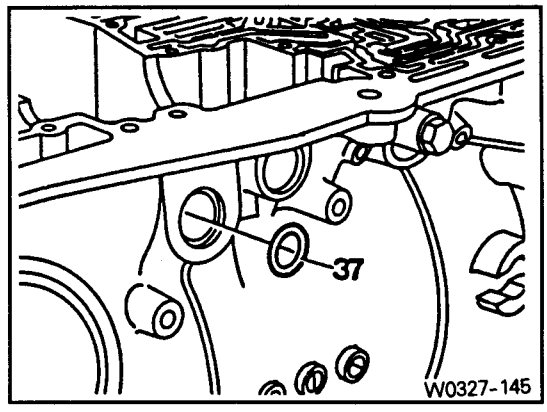
63) Using snap ring (16), fix the brake band B2 (48) and remove it by moving horizontal direction.



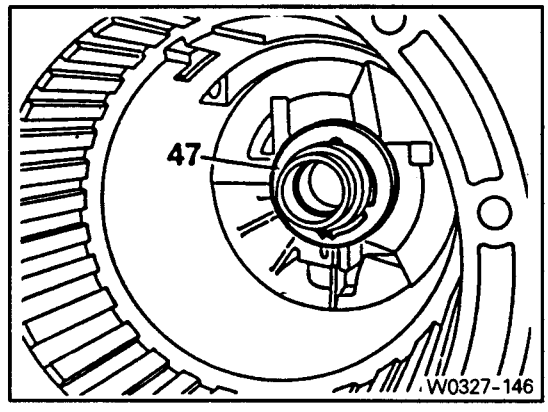
64) Remove the thrust element (38).



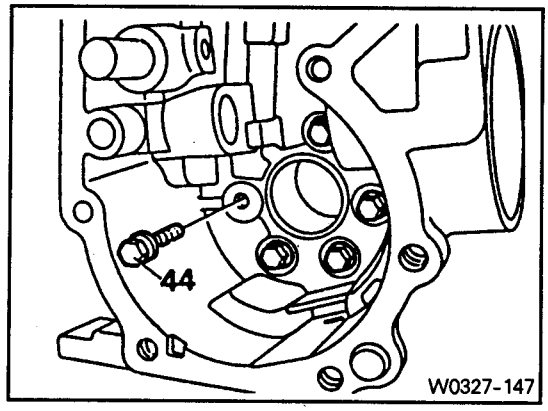
65) Remove the O-ring (37).



66) Remove the supporting disc (47).

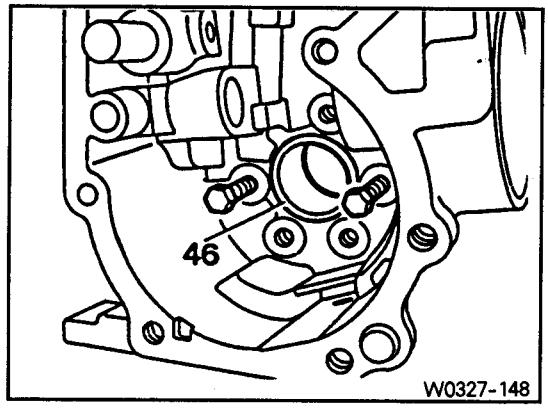


67) Remove the bolts (44).

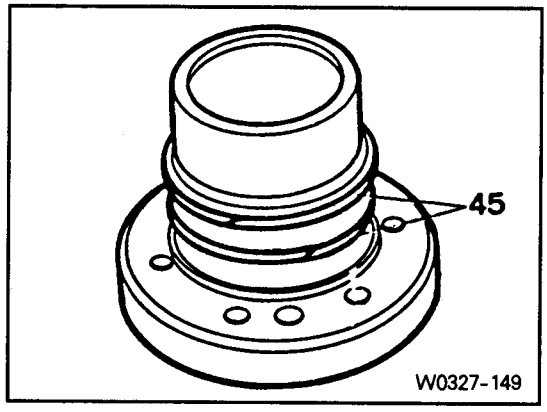


68) Install 80mm length bolts on both side diagonally.

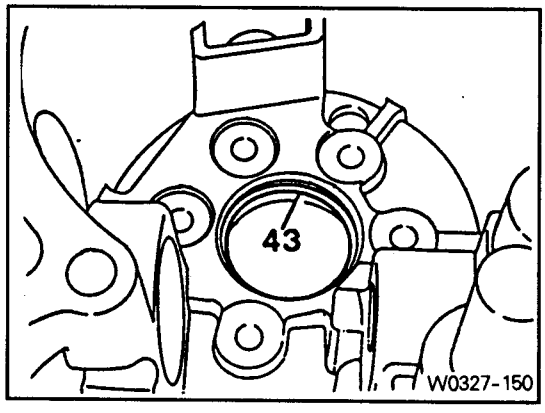
69) Using a hammer, tap the bolts uniformly and remove the support flange (46) to the inside.



70) Remove the teflon ring (45).



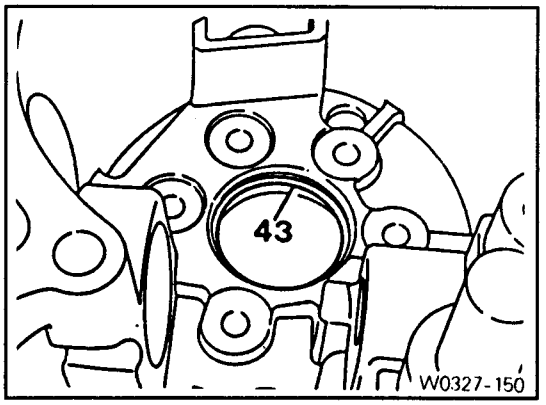
71) Remove the O-ring (43).



Assembly

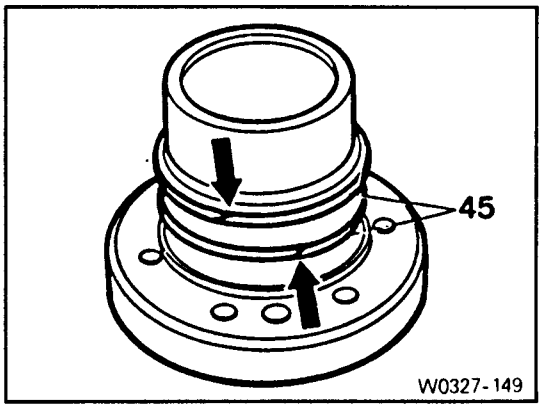
[Note] Saturate new friction disc and brake band in ATF for 1 hour.

1) Insert a new O-ring (43).

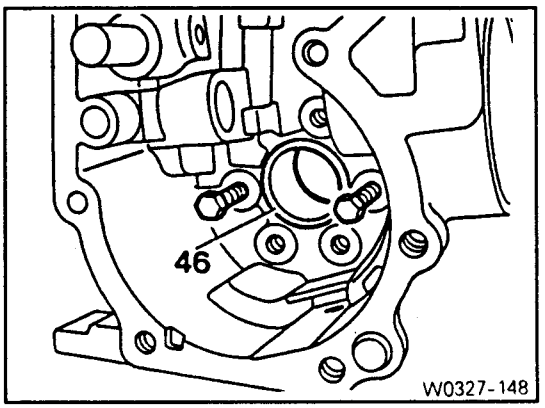


2) Apply grease on support flange (46) and install the teflon ring (45).

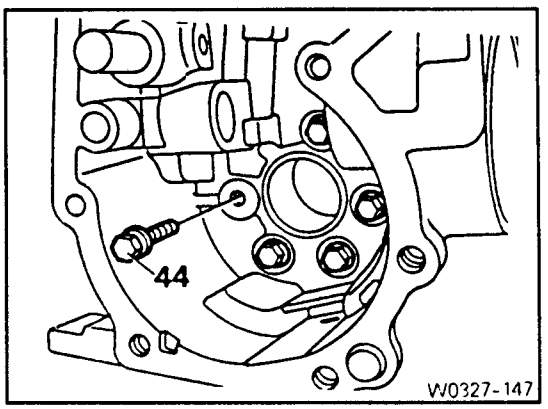
3) Press the teflon ring to make contact (arrow) the each end of the teflon ring.



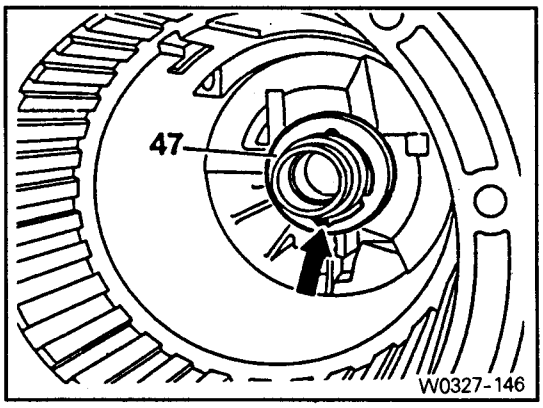
4) Install the 80mm length bolt in support flange (46). Align it to the mounting hole and install it.



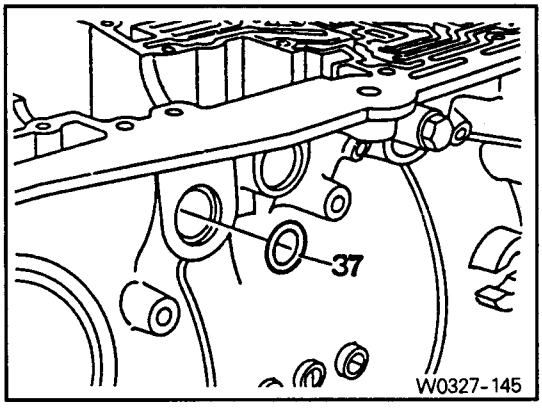
5) Tighten the bolts (44).



6) Install the supporting disc to be the tab correctly inserted into the groove.

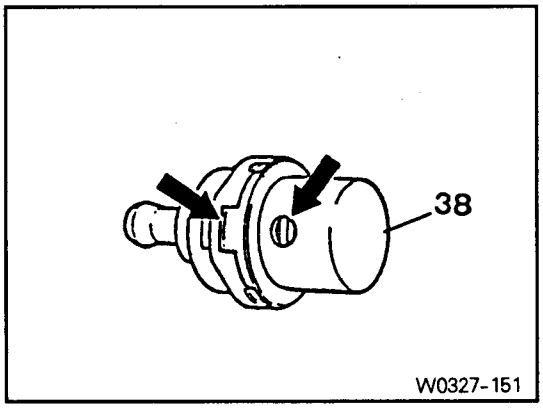


7) Insert a new O-ring (37).



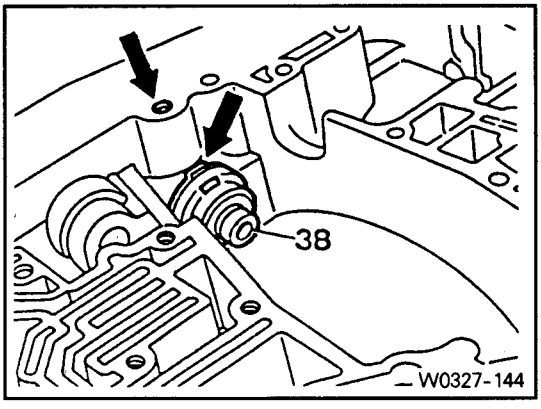
8) Make sure that the thrust element (38) does not get twisted.

[Note] When the thrust element is removed, the hole and the tap (arrow) should be aligned.



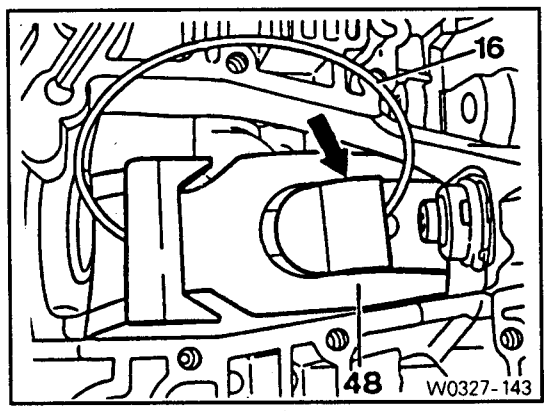
9) Install the thrust element (38) with the tap (arrow) facing up.

[Note] Install it so that the hole of the thrust element and the hole of the housing would align.



10) Pressing the brake band B2 (48), install into the housing from the support tap.

[Note] Brake band should be fixed by retaining ring (16) used for assembling.
The narrow side of the band (arrow) should face thrust element.



11) Install the gear assembly.

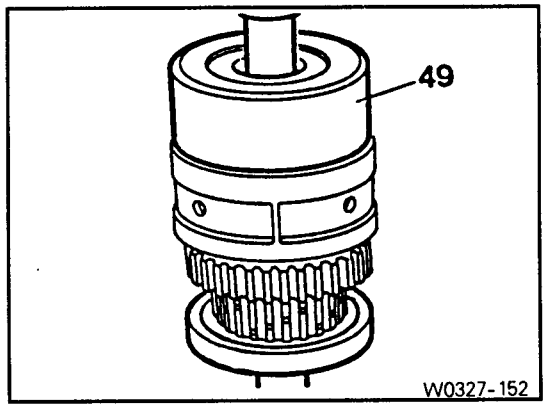
12) Install the clutch K2.

13) Clamp the assembly tool to the vice.

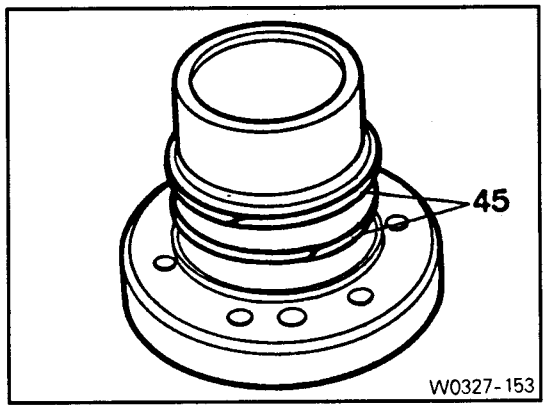
14) Install the gear assembly into the assembly tool.

15) Insert the clutch K2 (49) to the gear assembly.

Assembly tool 126 589 00 35 00



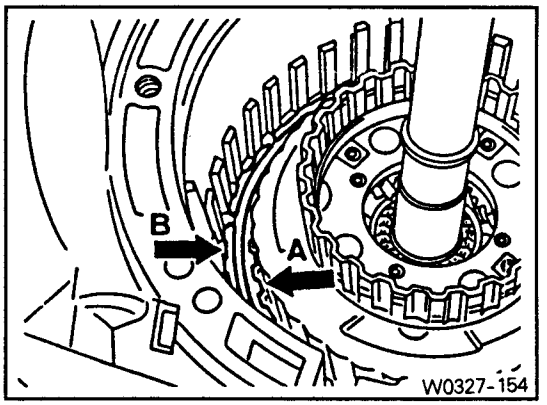
16) Install the gear assembly into the transmission housing and make sure the teflon ring (45) does not get damaged.



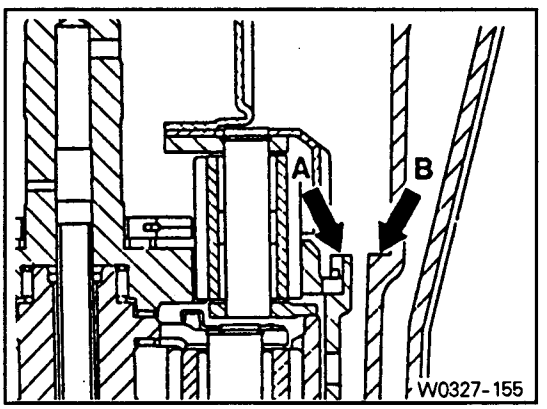
17) Position the transmission so that the drive shaft can be vertically upwards.

18) Check the installed position of the gear assembly.

[Note] Connection support (arrow A) should not be higher than the contact surface (arrow B) of the transmission housing.

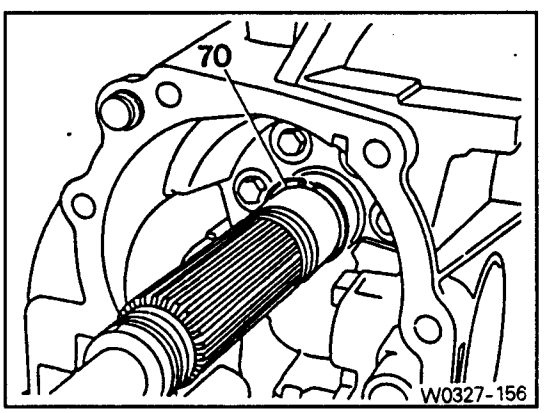


A : Connection support
B : Contact surface of the transmission housing.



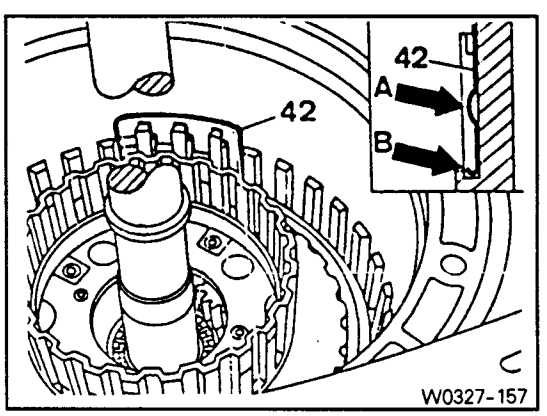
19) Install snap ring (70) using pliers.

Pliers 000 589 52 37 00



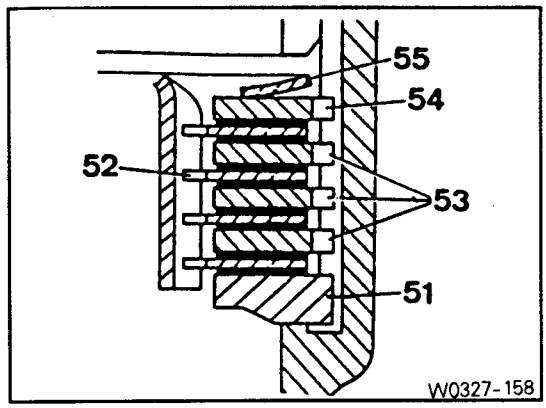
20) Insert the damping spring (42).

[Note] The arch part (arrow A) of the damping spring should face inwards and the damping spring should be attached to the pocket (arrow B) of the transmission housing.



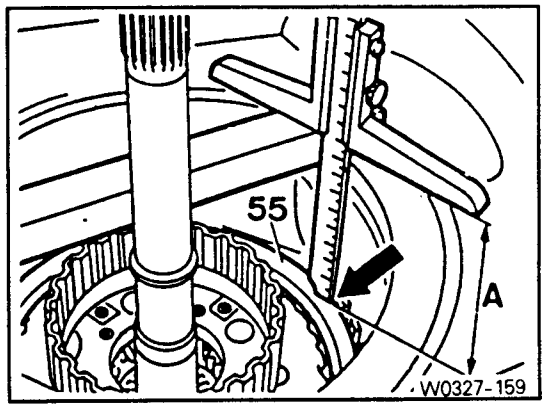
21) Insert the brake B3 plates in the following steps one by one.

51. Steel Disc, thickness 7.7mm
52. Friction Plate, 4EA
53. Steel Disc, 3EA thickness 2.8mm
54. Steel Disc, thickness 3.4mm
55. Plate Spring



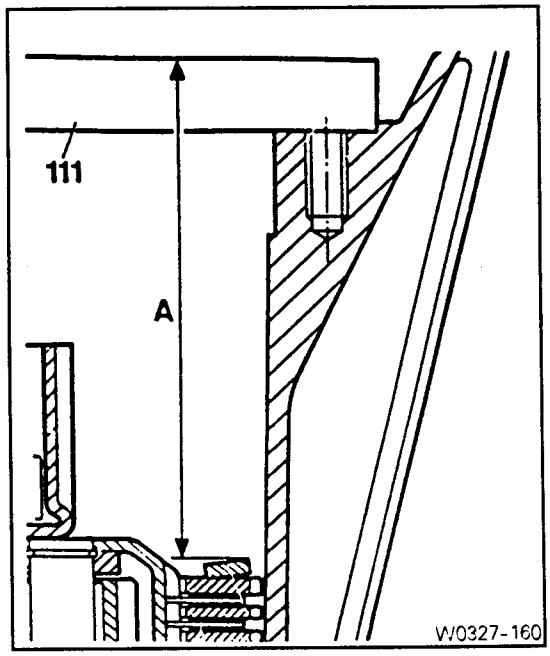
· **Disc clearance measurement and adjustment for brake B3.**

22) Measure distance 'A'.
- Install the parallel gauge onto the surface of the housing.
- Measure the distance 'A' from the parallel gauge to the end point of the upper plate spring using vernier caliper.



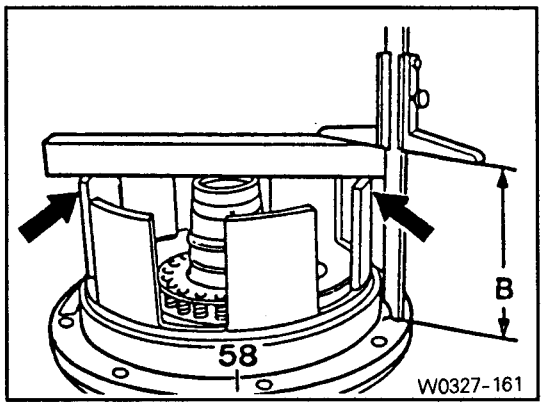
[Note] For an easy measurement, it is acceptable to change the positions of the steel disc (54) and plate spring (55). Make sure to put their positions back to the original position after measuring.

Parallel gauge 126 589 04 31 00



23) Measure distance 'B'.
- Install the parallel gauge on the piston (arrow) of the multi- plate brake.
- Measure the distance 'B' from the parallel gauge to the gasket using vernier caliper.

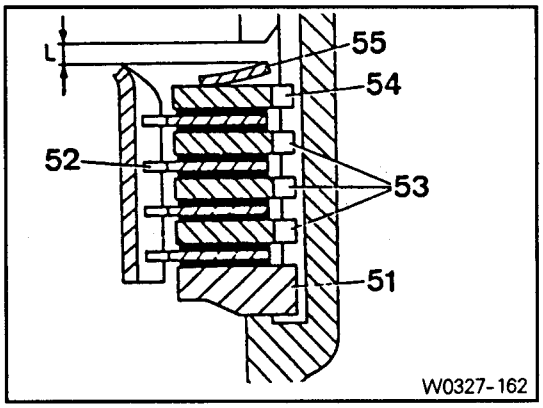
[Note] The difference between measurement 'A' and 'B' is the disc clearance and this clearance should be within 1.5 - 2.0mm.



24) This disc clearance can be adjusted by selecting different thickness of steel disc (53, 54).

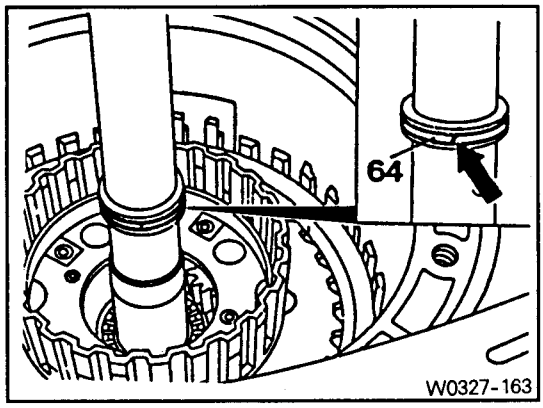
[Note] Remeasure after changing disc.

'L': Disc clearance

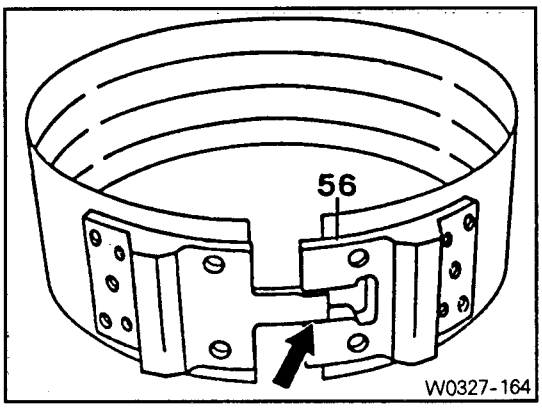


25) Apply grease to the input shaft groove.

26) Press the teflon ring (64) to contact the each end (arrow) of the teflon ring.



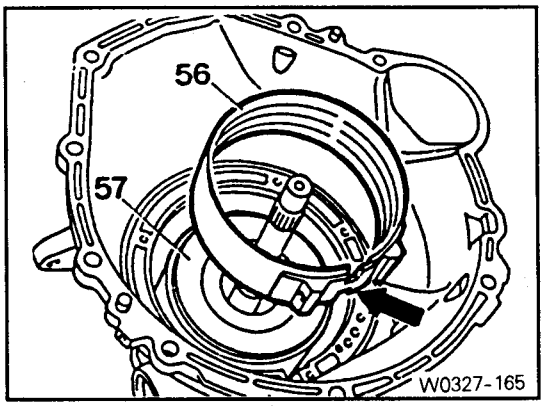
27) Engage the assembly lock (arrow) to the brake band B1 (56).



28) Insert the clutch K1 (57) and rotate it until it gets firmly contacts.

29) Insert brake band B1 (56).

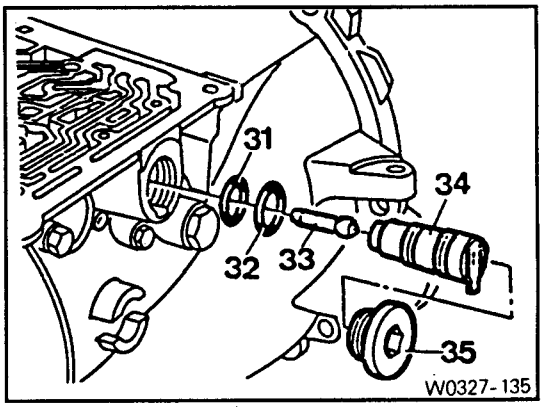
[Note] Make the assembling lock (arrow) of the brake band B1 face the thrust element B1.



30) Install the thrust element B1 (34) together with the thrust pin (33).

31) Tighten the plug (35).

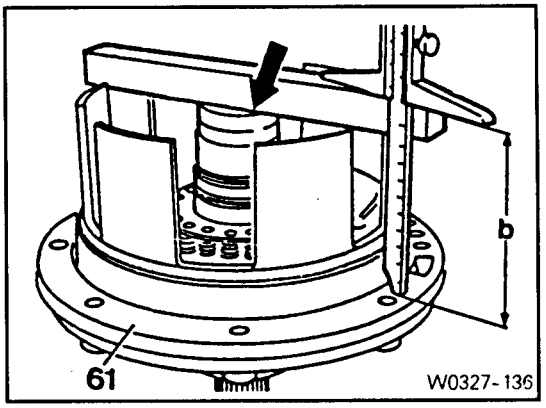
Tightening torque	70Nm



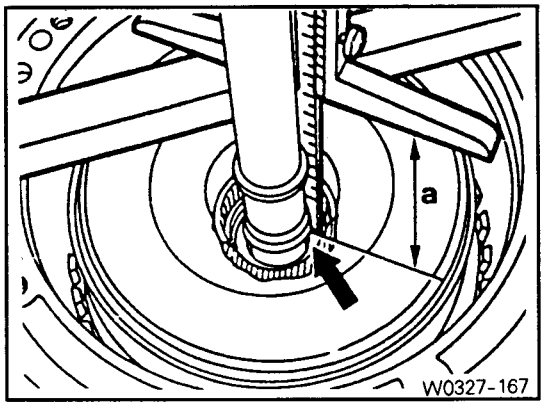
· **Measurement and correction of the clutch K1 axle direction clearance 'b'**

32) Measure distance 'b'.
- Place the parallel gauge on the flange (arrow).
- Measure the distance 'b' from the parallel gauge to the gasket (61) using vernier caliper.

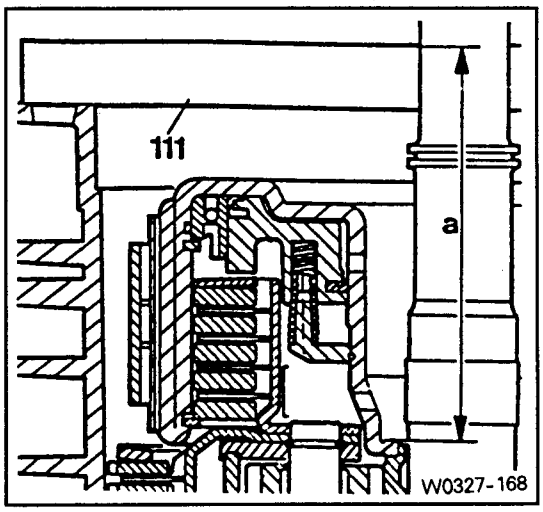
Parallel gauge 126 589 04 31 00



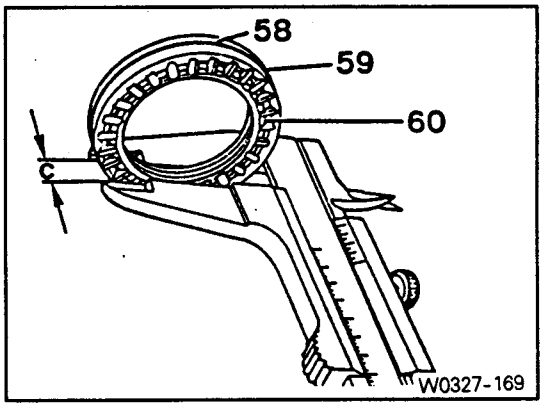
33) Measure distance 'a'.
- Install the parallel gauge on the housing surface.
- Using vernier caliper, measure the distance 'a' from the parallel gauge to the contact surface (arrow) of the clutch K1.



Distance 'a'



34) Measure width 'c'
- Holding the shim (58), thrust washer (59) and axial bearing (60), measure the width 'c'.



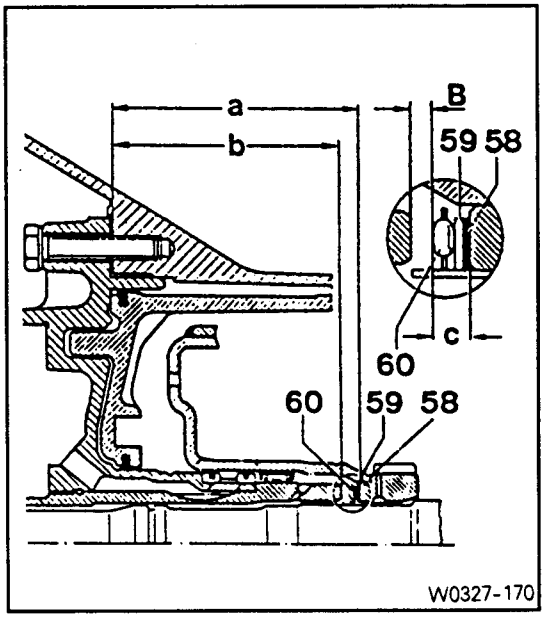
35) Measure the axle direction clearance 'B'.
' B ' = a - (b + c)

[Note] Make sure to calculate (b+c) first.

36) Clearance.

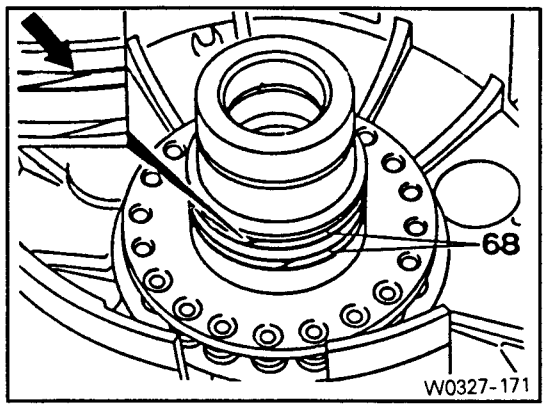
When rear housing cover is removed	0.8~1.2mm
When rear housing cover is installed	0.3~0.5mm

If necessary, select proper thickness shim (58) and adjust the clearance.
Shim thickness : 0.1, 0.2, 0.5mm



37) Install the teflon ring (68) after applying grease.

[Note] The end part (arrow) of the teflon ring should contact each other and if necessary, use one that has smaller diameter for increased tensional force.

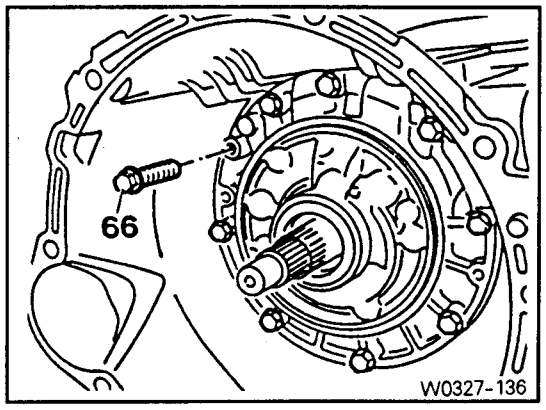


38) Install the primary pump.

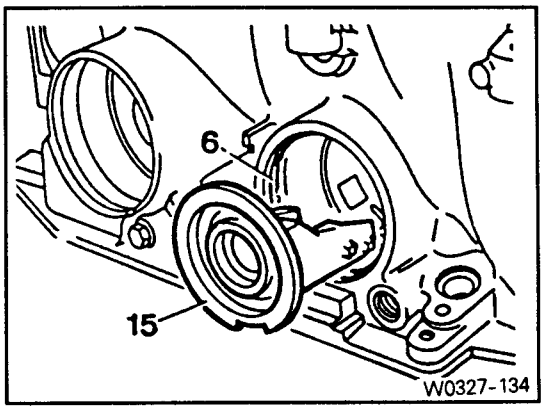
39) Replace the gasket and install the front cover.

40) Apply non-drying sealant to the bolt (66) and tighten the bolt.

Tightening torque	15Nm



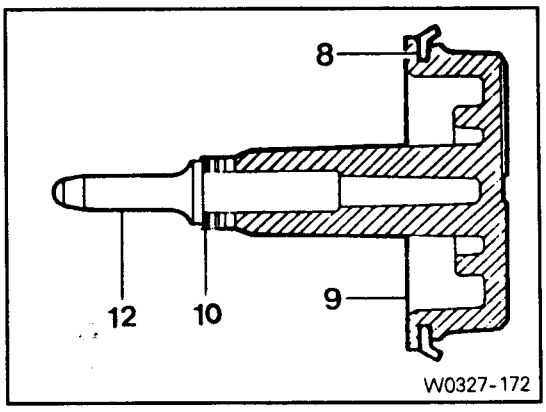
41) Replace the O-ring (6) and insert the brake band holder B1 (15).



42) Install new sealing ring (10) to the brake band piston B1 (9).

43) Insert the thrust pin (12).

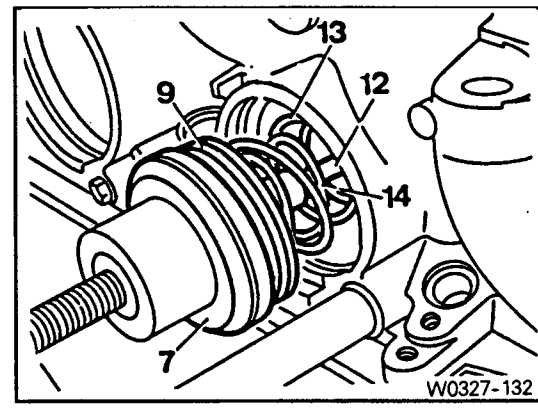
44) Insert a new sealing rib (8).



45) Install the assembly tool to the transmission housing.

Assembly tool 201 589 03 59 00

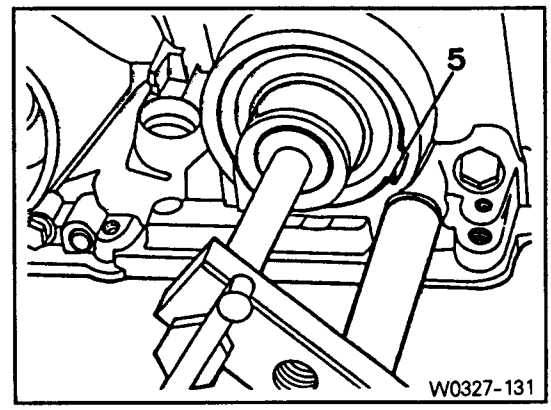
46) Install the pressure spring (13, 14), thrust pin (12), brake piston B1 (9) and brake band piston cover (7).



47) Rotate the spindle of the assembly tool until the thrust pin is securely contacted to the brake band B1.

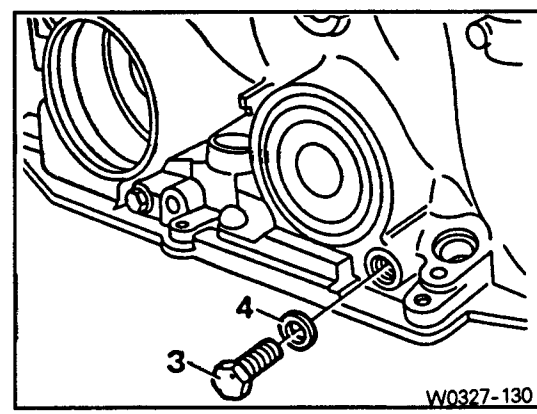
48) Install the snap ring (5).

49) Remove the assembly tool.



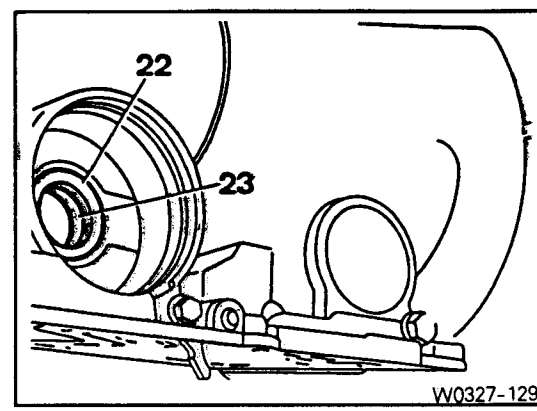
50) Replace the sealing ring (4) with a new part and tighten the bolt (3).

Tightening torque	13Nm

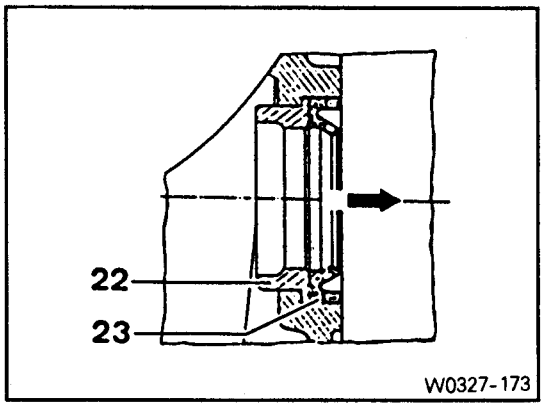


51) Insert the plastic guide ring (22) for brake band piston B2.

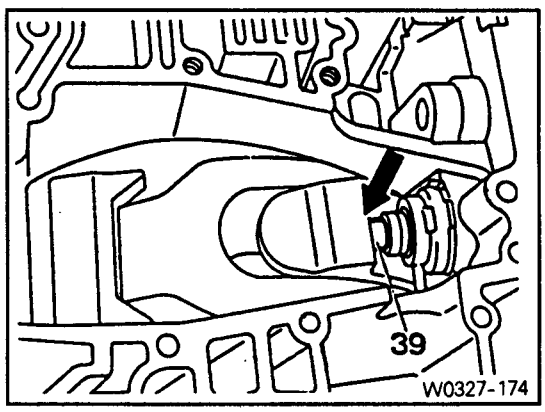
52) Install a new sealing rib (23) with a proper punch.



[Note] The sealing rib should face the brake band piston B2 (arrow).

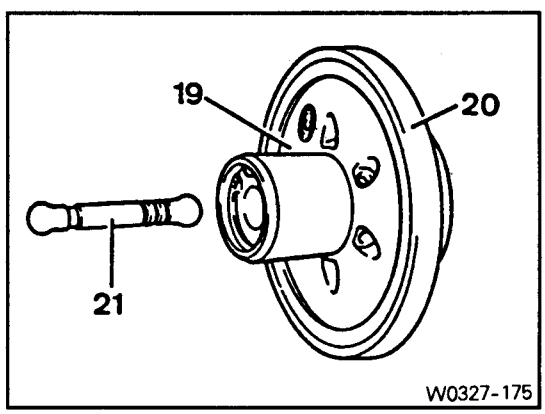


53) Install the thrust pin (39) towards brake band B2 (arrow).



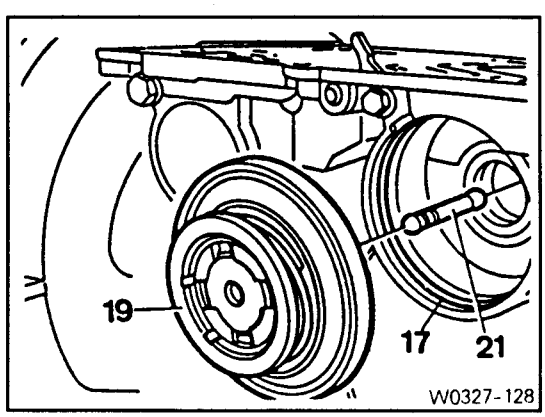
54) Apply grease on the teflon ring (20) and install it to the groove of the brake band piston B2 (19).

65) Install the thrust pin (21).

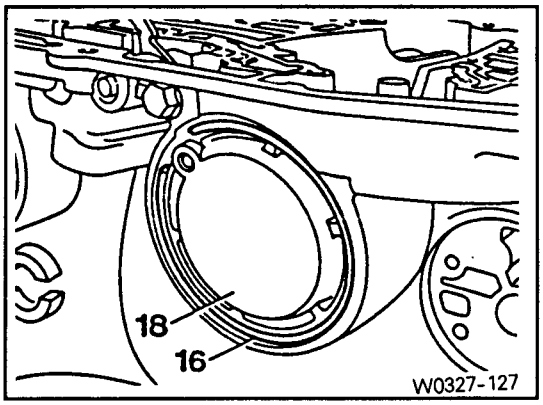


56) Install new O-ring (17).

57) Install the brake band piston B2 (19).



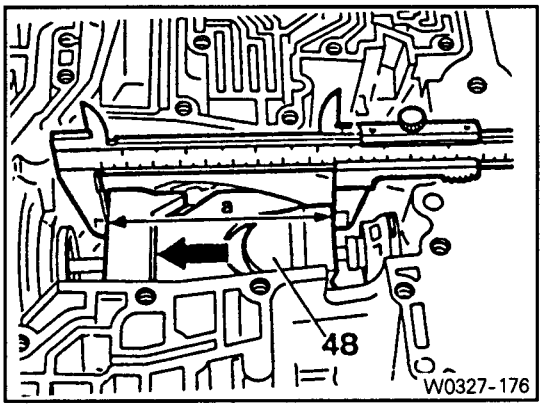
58) Install the snap ring (16) while pressing on the brake band piston cover B2 (18).



· **Idling stroke measurement and adjustment of on brake band B2.**

59) Push the brake band B2 (48) towards the brake band piston B2 (arrow direction) until brake band piston B2 gets in contact with brake band piston cover B2.

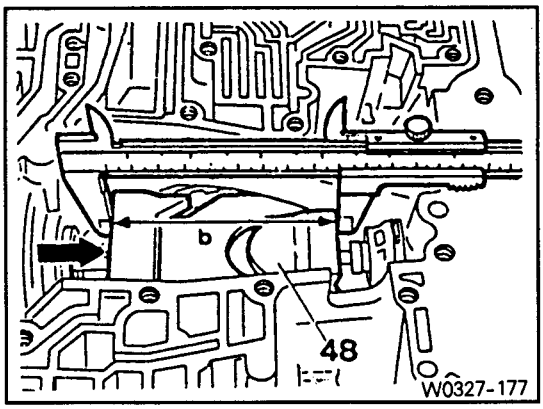
60) Measure distance 'a'.



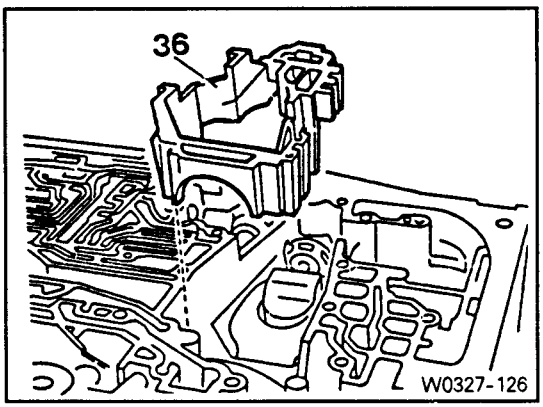
61) Push the brake band B2 (48) towards the thrust element (arrow direction).

62) Measure distance 'b'.

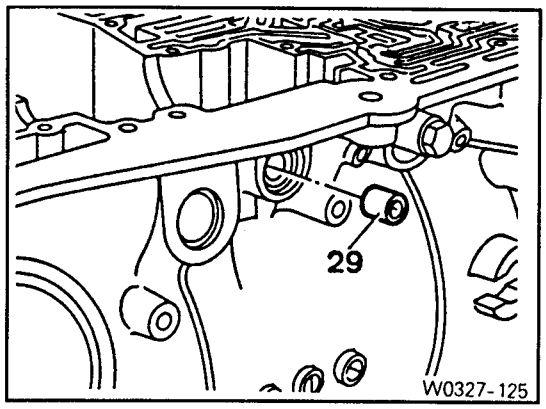
[Note] The difference between 'a' and 'b' is the idling stroke and it should be within the 5.5 - 5.7mm range. This difference can be adjusted by selecting a proper length of thrust pin.
Thrust pin length : 47.2, 48.0, 48.8, 49.6mm



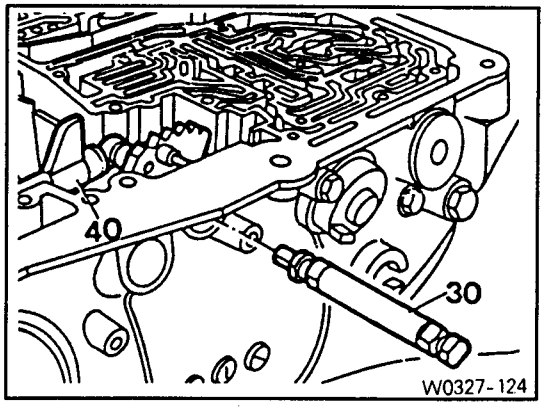
63) Install the brake band holder B2 (36).



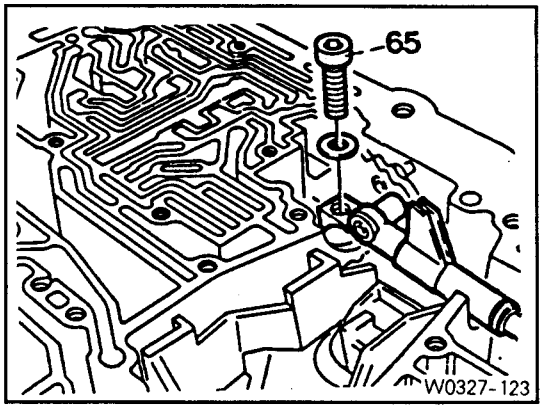
64) Install new radial shaft seal (29).



65) Install the linkage and catch plate (40) and insert the range selector shaft (30).



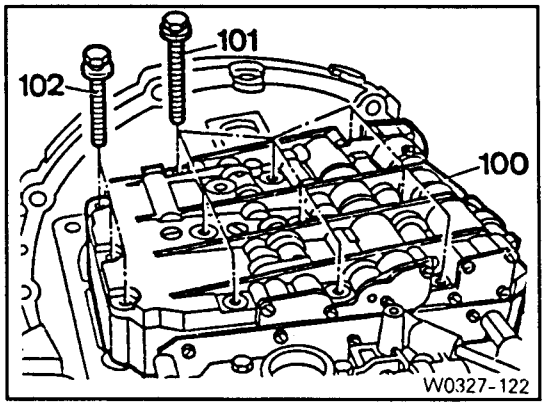
66) Install the catch plate with Allen bolt (65).



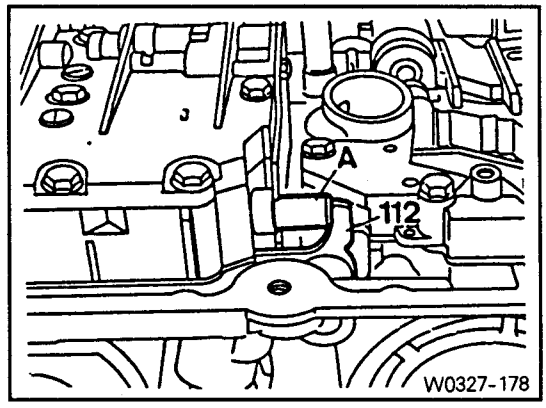
67) Install the middle plate and the lower cover.

68) Install the shift valve housing (100).

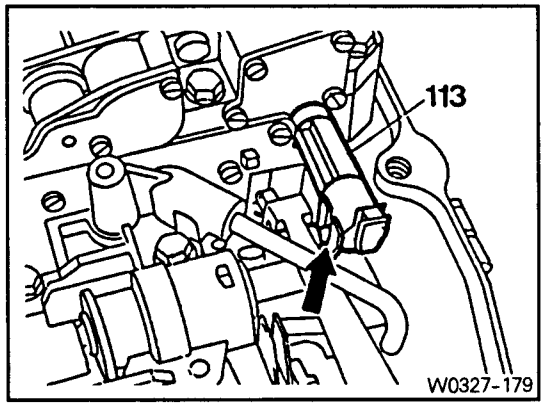
Tightening torque	8Nm



[Note] Piston (A) for control pressure adjust valve and transfer lever (112) should be in contact.



[Note] Range selector lever (113) should be engaged with groove (arrow) of the catch plate.

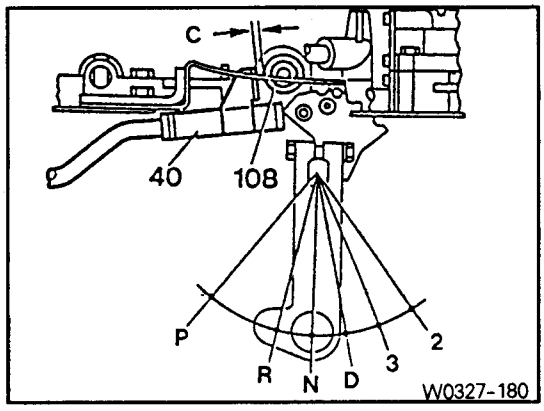


- **Measure the clearance 'C' between the locking piston (108) and the linkage stop for the catch plate (40).**

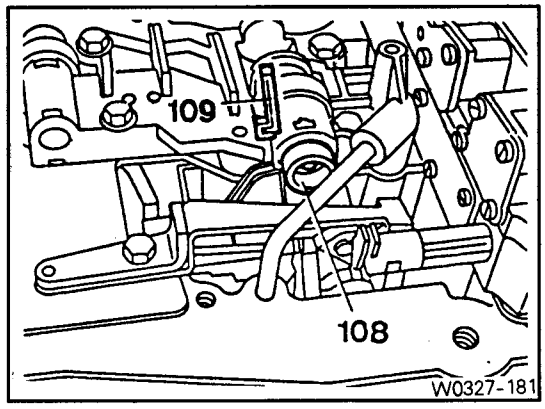
69) Shift the selector lever in 'N' position.

70) Measure clearance 'C' between the locking piston (108) and linkage stop for catch plate (40) with a feeler gauge.

[Note] The clearance 'C' should be within 0.4 - 1.0 mm range in ' N' position.

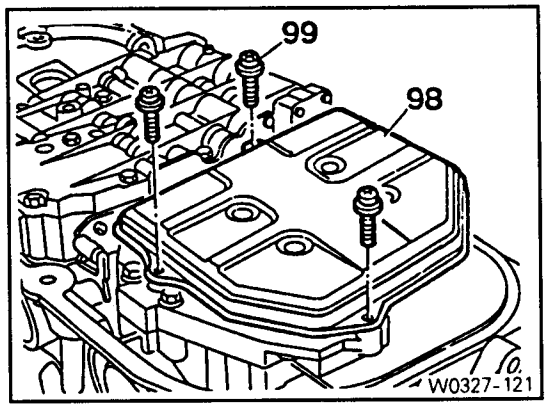


[Note] Clearance 'C' can be adjusted by selecting a proper thickness of plastic clip (109).
- **Clip thickness: 0.6, 1.2, 1.8mm**

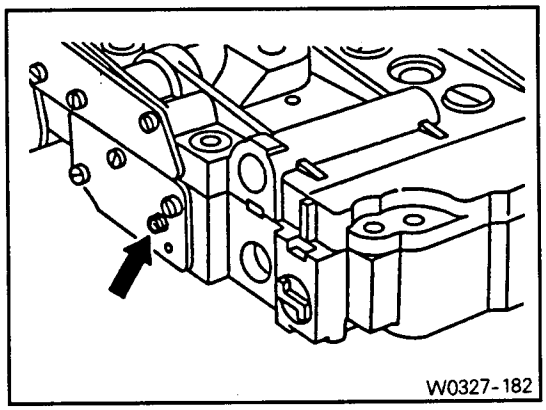


71) Install the oil filter (98) with Phillips screw (99).

Tightening torque	4Nm



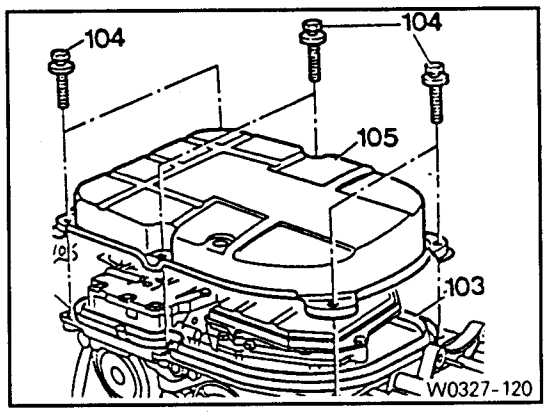
[Note] The adjustment screw (arrow) is used for fine adjustment of pressure in full throttle range in the dynamometer during production, so do not adjust it arbitrarily.



72) Replace the gasket (103) and install the oil pan (105).

Tightening torque	8Nm

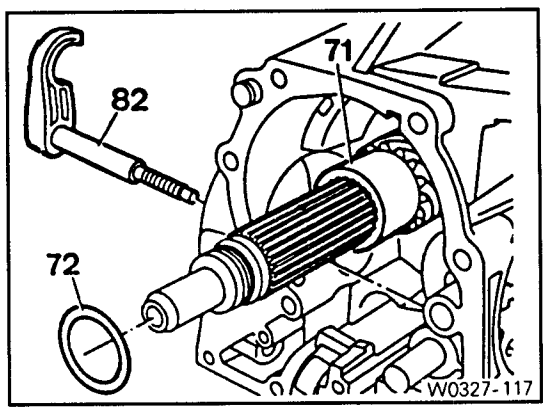
73) Install the starter lockout switch and adjust it.



74) Install the axial holder.

75) Install the helical gear (71) and shim (72).

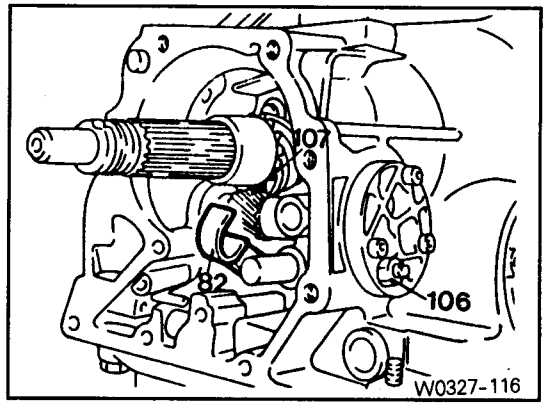
76) Install the centrifugal governor.



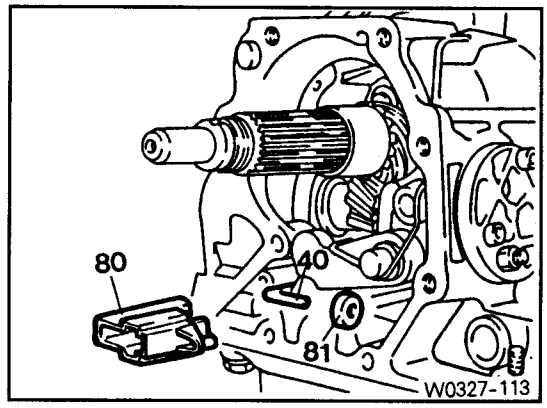
77) Engage the axial holder (82) to the centrifugal governor (107) groove.

[Note] The axial holder should be engaged with the centrifugal governor groove accurately.

78) Tighten the nut (106).

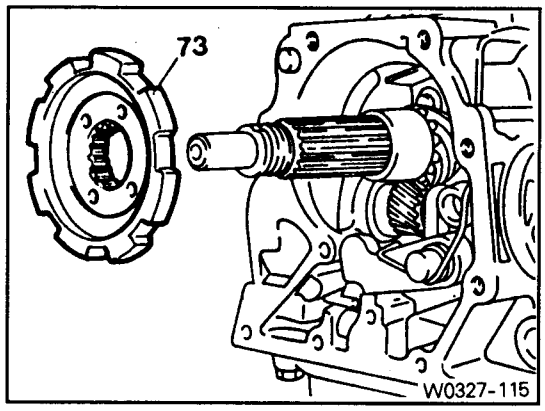


79) Install the roller (81) to the linkage (40) for catch plate and insert plastic guide (80) to the housing.

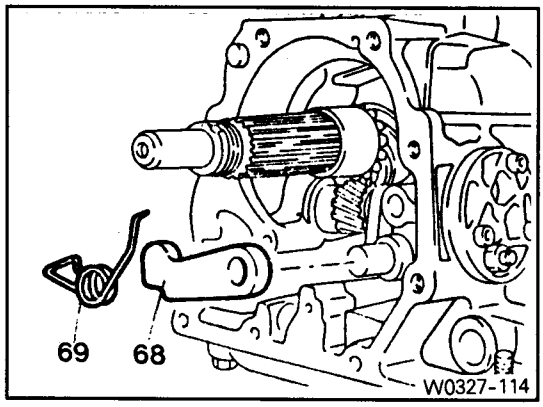


80) Install the thrust washer (67) for parking gear detent.

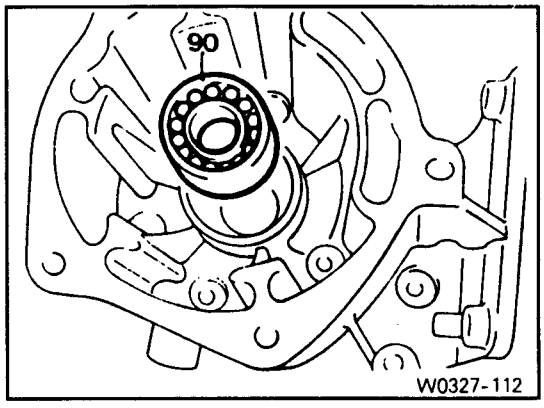
81) Install the parking gear (73).



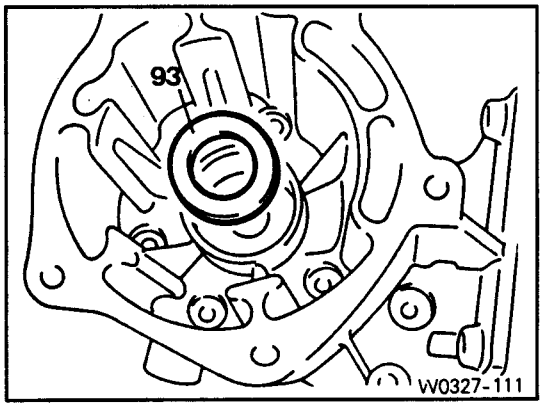
82) Install the spring (69) and parking gear detent (68).



83) Using a proper punch, install the ball bearing (90) in the rear cover.



84) Install the radial shaft seal (93).

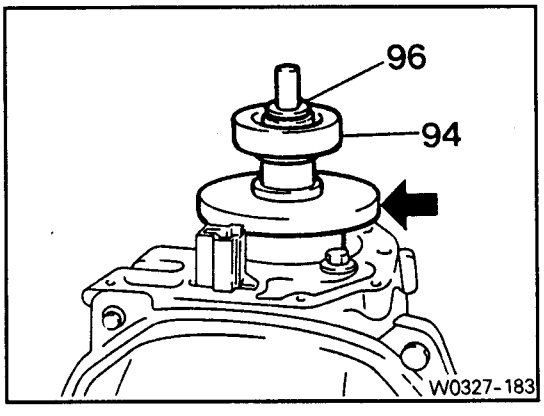


· **Measure and correction of the free play ' C ' on the output shaft (clutch K2).**

85) Install the measurement sleeve (arrow).

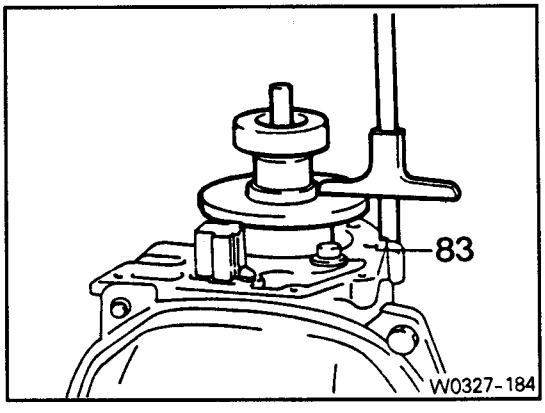
86) Install the flange (94) and tighten the collar nut (96).

Tightening torque	120Nm

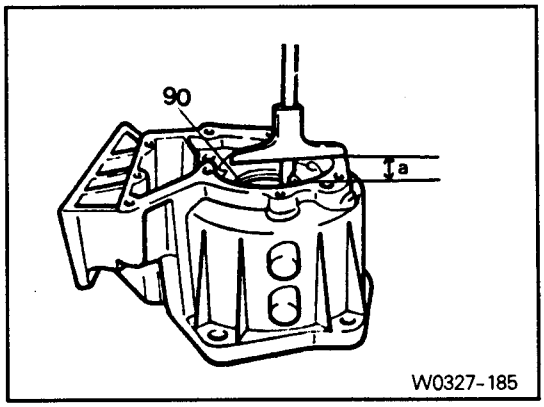


87) Measure distance from the measurement sleeve to the gasket (83).

88) 'Measured distance' - 5mm = value 'b'
[Note] 5mm is the height of the measurement sleeve.



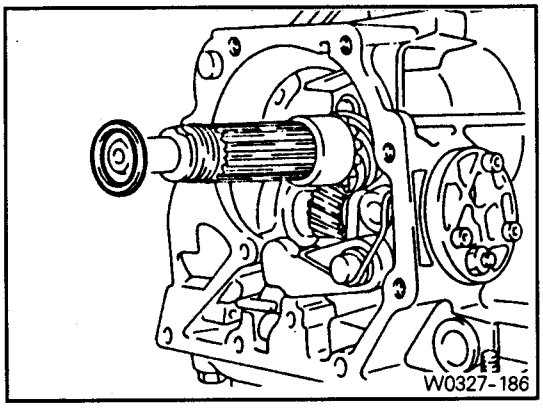
89) Measure distance 'a' from the rear cover ball bearing (90) face to the housing gasket.



90) 'a' - 'b' = end play 'c'.

End play 'c'	0.4~0.5mm

[Note] It can be adjusted by selecting a proper thickness of shim.
- **Shim thickness : 0.1, 0.2mm**

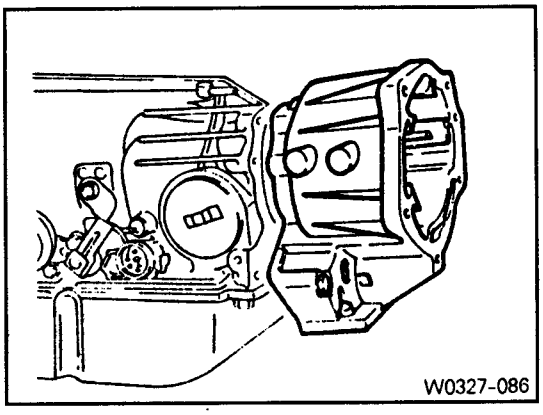


91) Remove the collar nut and remove the flange, measuring sleeve and parking gear.

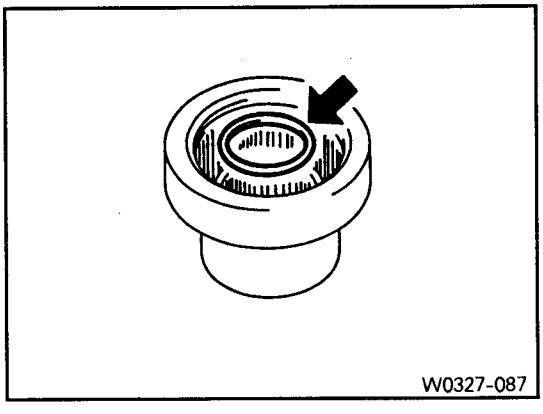
92) Install the selected shim (72) between helical gear and parking gear.

93) Replace the gasket and install the rear cover.

Tightening torque	45~53Nm



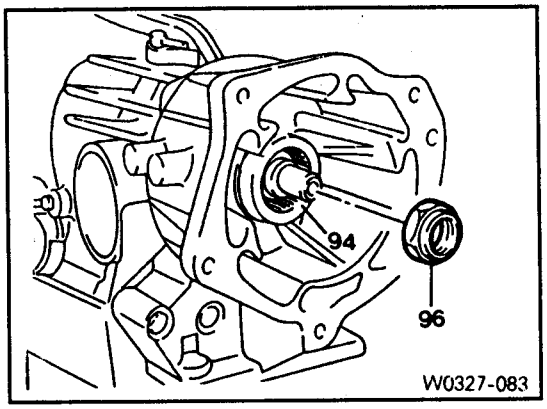
94) Install new O-ring (94) on the flange.



95) Install the flange (94).

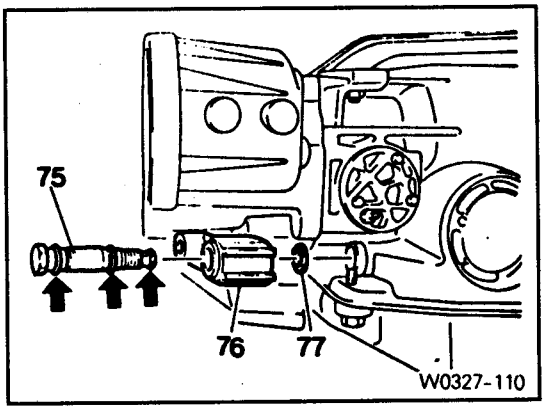
96) Tighten the collar nut (96).

Tightening torque	120Nm



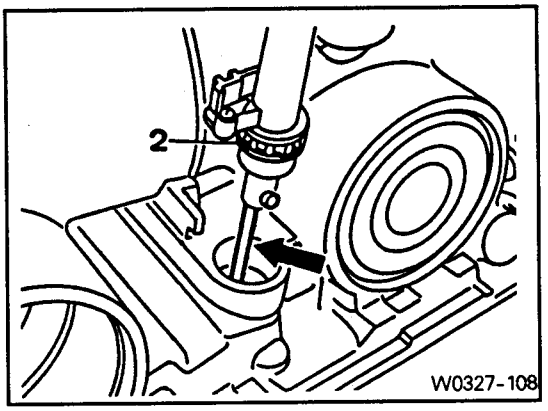
97) Replace the sealing ring (77) and install the magnetic coil (76) and kickdown solenoid (75).

[Note] Replace the sealing ring (arrow).

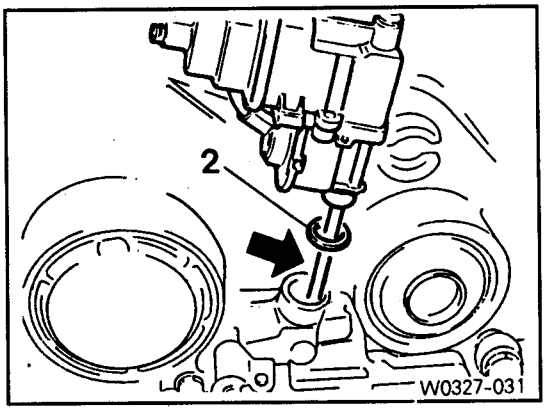


98) Replace the O-ring (2) and connect a pull rod (arrow).

[Diesel]

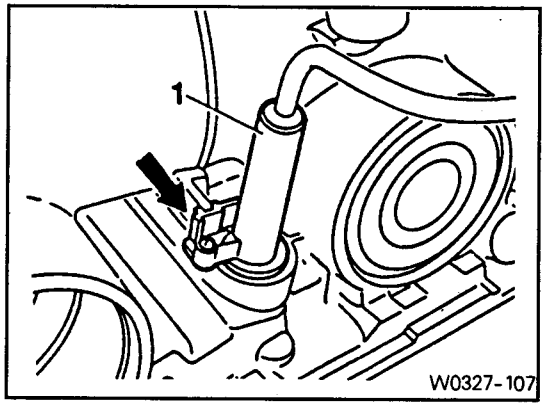


[Gasoline]



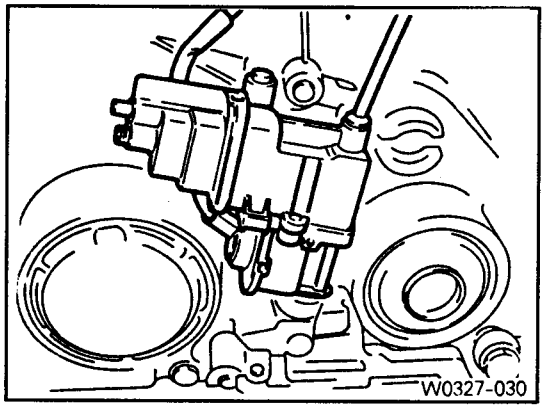
99) Install the control pressure cable (1).

[Note] Make sure to hold it with a plastic clip (arrow).



[Diesel]

100) Install the vacuum element.

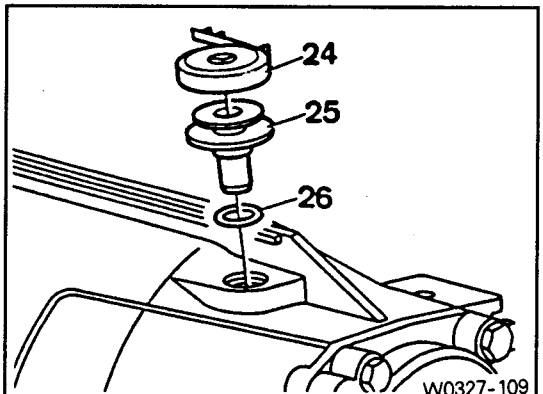


[Gasoline]

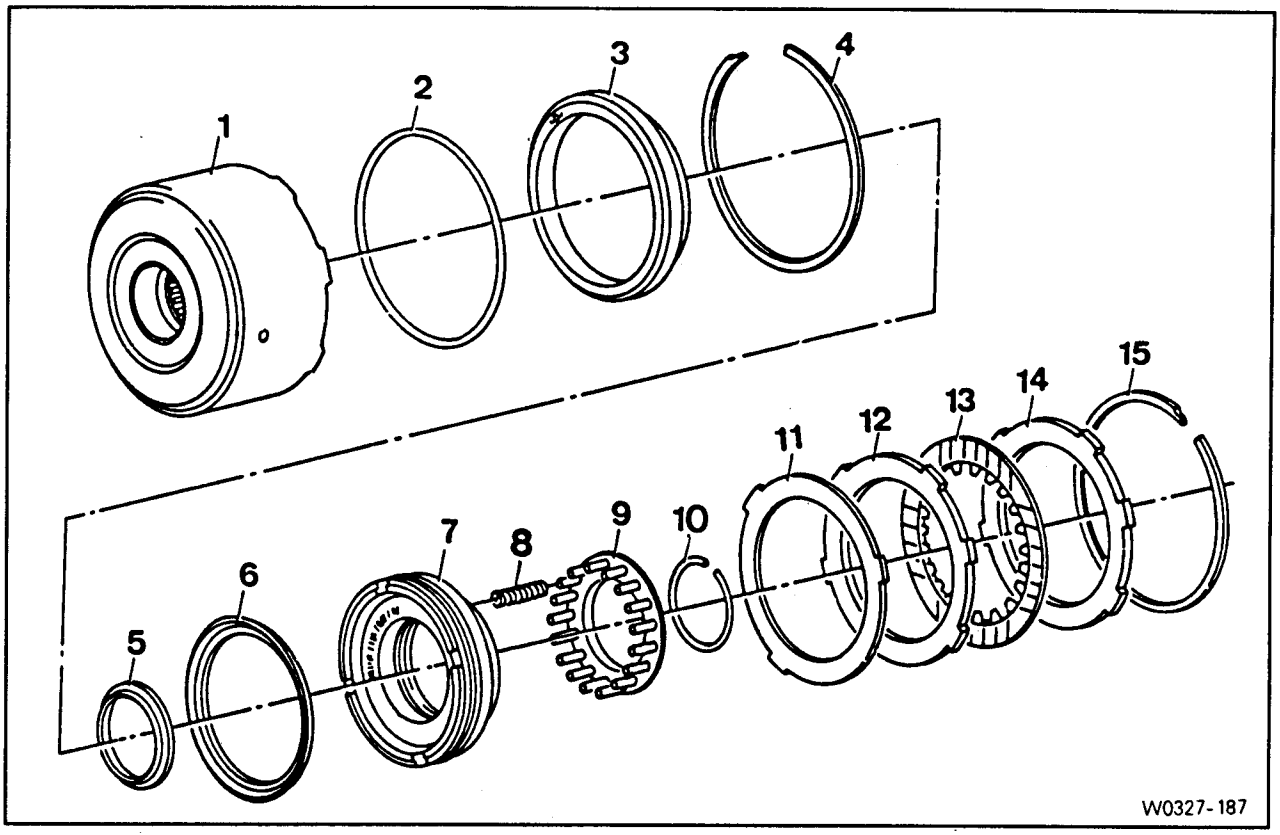
101) Install the modulating pressure box.

102) Replace the O-ring (26).

103) Install the vent (25) and cover (24).

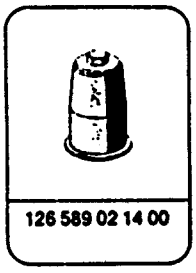


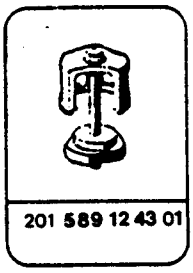
20. Disassembly and Assembly of Clutch K1

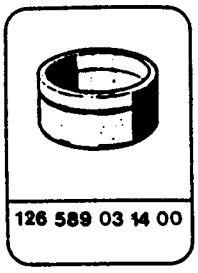


1. Outer Disc Carrier
2. O-Ring ---------- Replace
3. Piston Guide Ring
4. Snap Ring
5. Seal ---------- Replace
6. Seal ---------- Replace
7. Piston
8. Pressure Spring
9. Spring Plate
10. Snap Ring
11. Steel Disc---------- Inspect
12. Steel Disc ---------- 5 Pieces, inspect
13. Friction Disc ---------- 4 Pieces, inspect
14. Snap Ring

Special tools


126 589 02 14 00


201 589 12 43 01

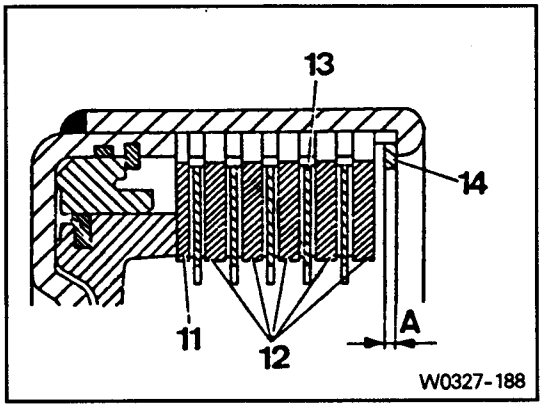

126 589 03 14 00

Service standard

Disc clearance 'A'	0.7 ~ 1.3mm

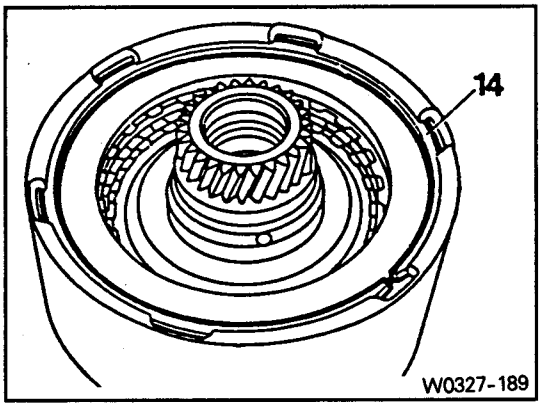
Disc assembly

11. Steel Disc
12. Steel Disc
13. Friction Disc
14. Snap Ring
A. Disc Clearance

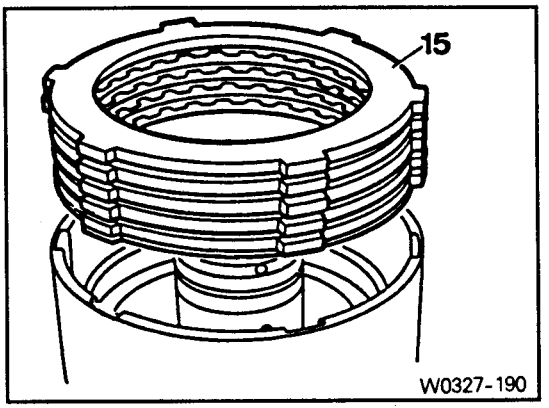


Disassembly

1) Remove the snap ring (14).



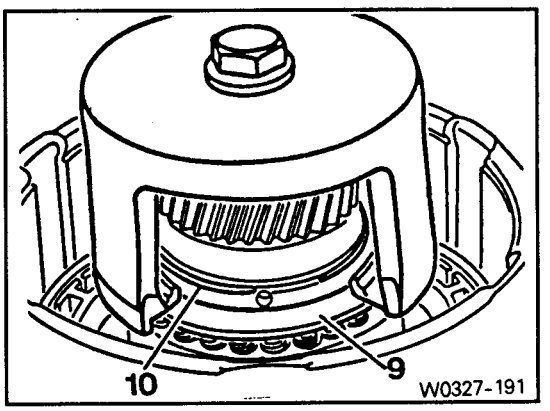
2) Remove the disc package (15) from the outer disc carrier.



3) Remove the snap ring (10) by pressing the spring plate (9) using the assembly tool.

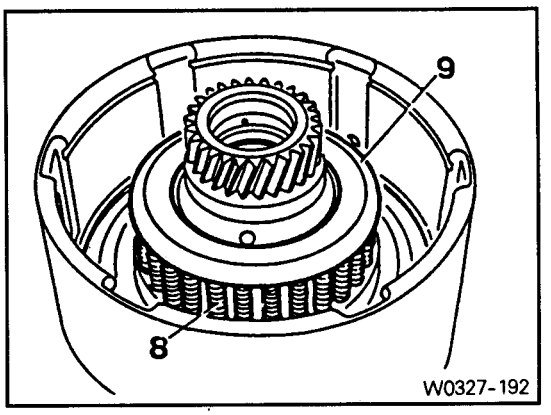
4) Remove the assembly tool.

Assembly tool 201 589 12 43 01

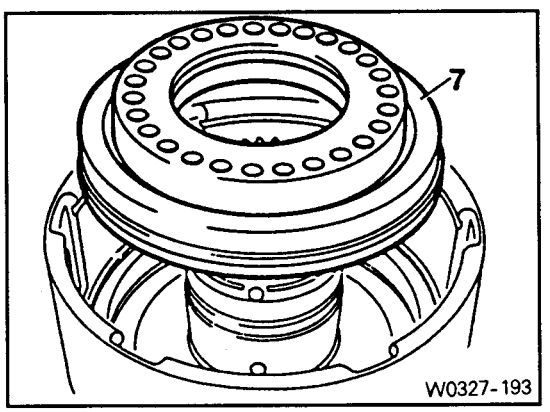


5) Remove the spring plate (9) and pressure spring (8).

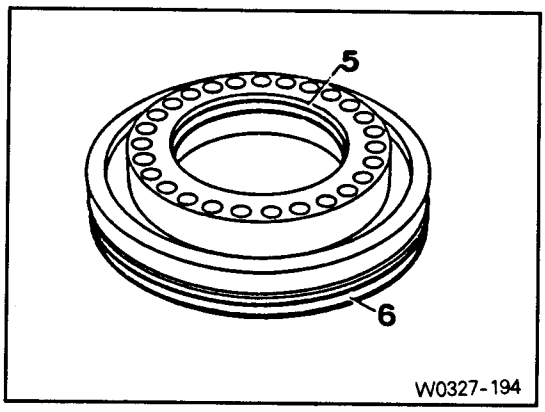
[Note] Record the number of pressure springs and be careful not to misplace the springs for K1 and K2.



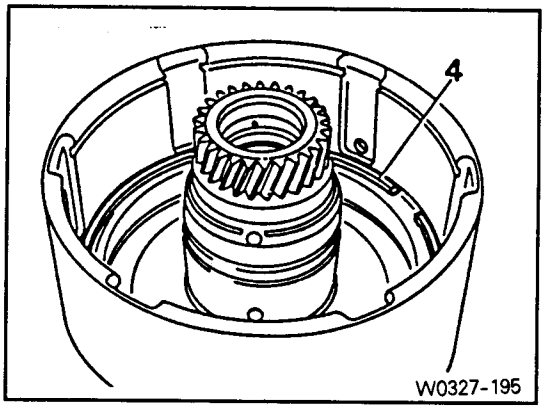
6) Pull out the piston (7) from the outer disc carrier.



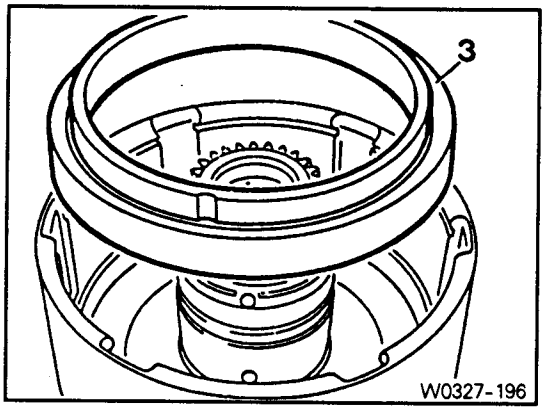
7) Pull out the seal (5, 6) from the piston.



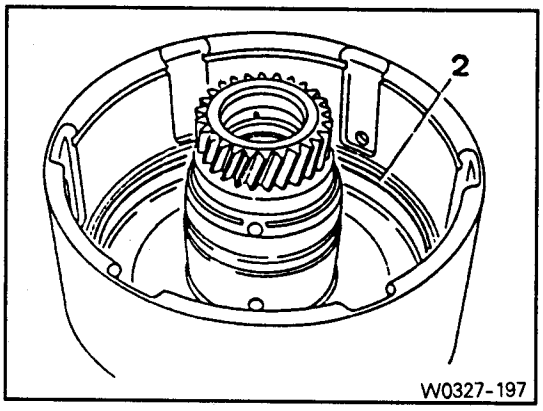
8) Remove the snap ring (4).



9) Remove the piston guide ring (3).



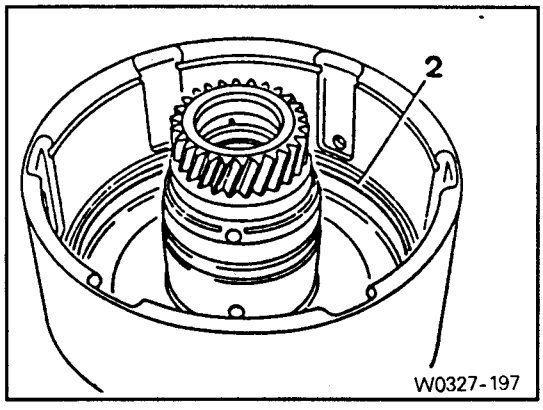
0) Remove the O-ring (2).



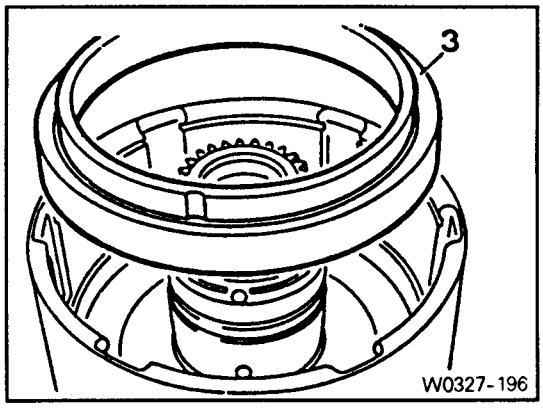
Assembly

[Note] Saturate new friction disc in the automatic transmission fluid for 1 - 2 hours before installing.

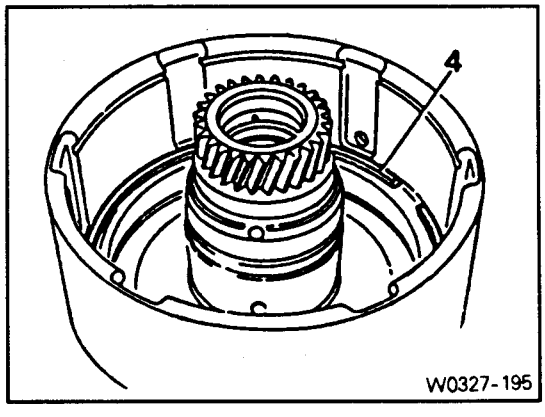
1) Install new O-ring (2).



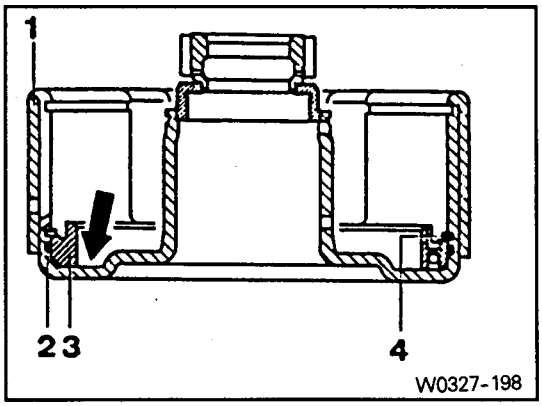
2) Install the piston guide ring (3).



3) Install the snap ring (4).

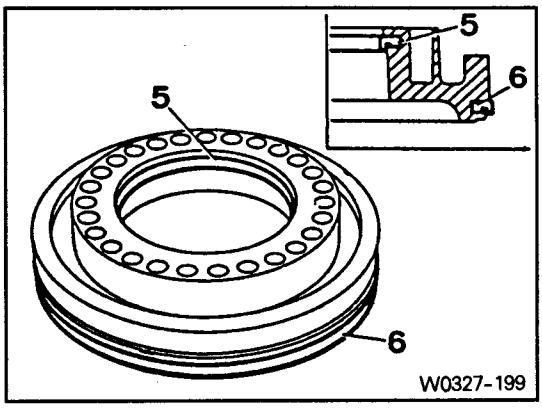


[Note] Fill the piston guide ring (3) with small amount of kerosene or nafta and make sure no liquid is coming out into (arrow) the outer disc carrier. In case of any leakage, inspect the piston guide ring and the outer disc carrier and replace it if necessary.



4) Apply automatic transmission fluid on the seal (5, 6) and install the sealing rib to face the lower part of the piston ring groove.

[Note] Make sure the seal does not get twisted by installing.

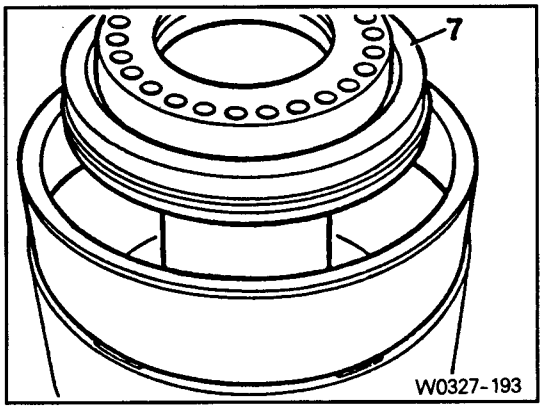


5) Install the guide sleeve to outer disc carrier.

6) Install the piston (7) to the outer disc carrier.

[Note] Be careful not to damage the seal when installing.

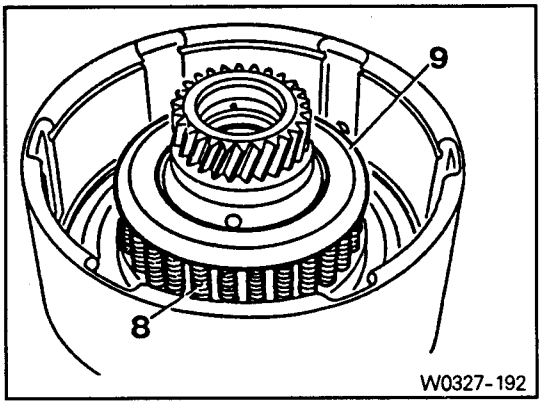
A : Install sleeve 126 589 02 14 00
B : Install sleeve 126 589 03 14 00



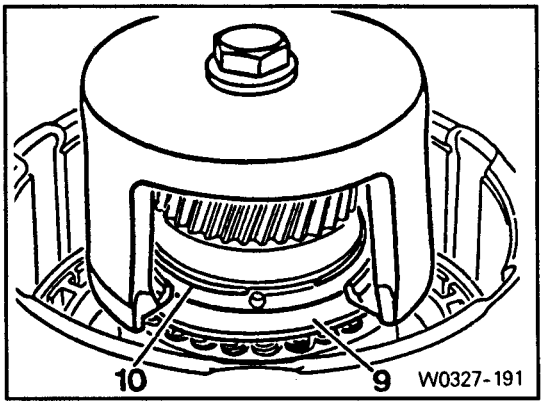
7) Install the pressure spring (8).

[Note] Compare it with the number of springs recorded during disassembly.

8) Install the spring plate (9).



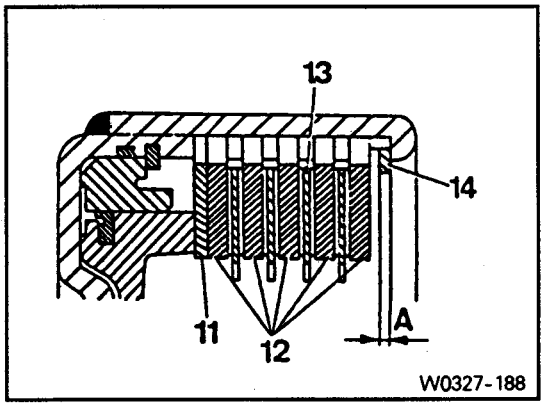
9) Install the snap ring (10) by pressing the spring plate (9) using the assembly tool.



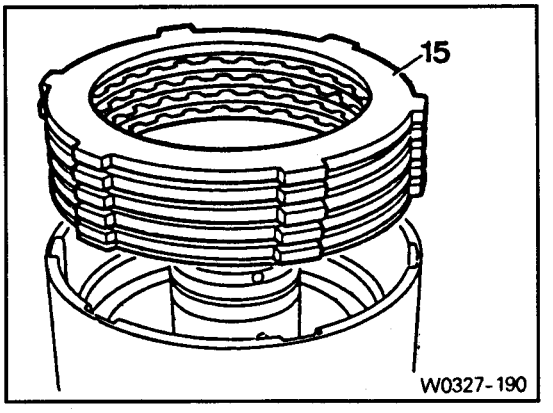
10) Remove assembly tool.

Assembly tool 201 589 12 43 01

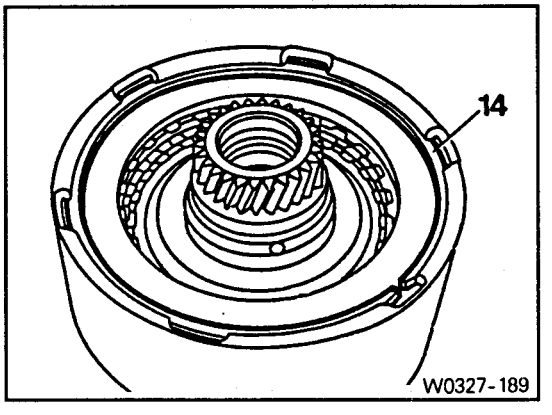
11) Install the disc package.
- Clutch disc assembly order.
  - Thin steel disc (11).
  - Install the steel disc (12) and friction disc (13) alternately.



12) Install the disc package (15) to the outer disc carrier.



13) Install the snap ring (14).

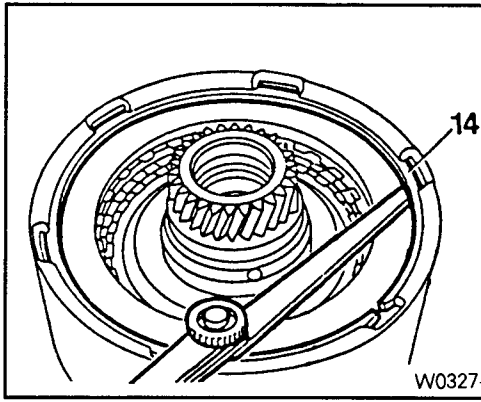


Measurement

[Note] In order to avoid errors in measurements, after installing snap ring lift up the whole circumference of the snap ring.

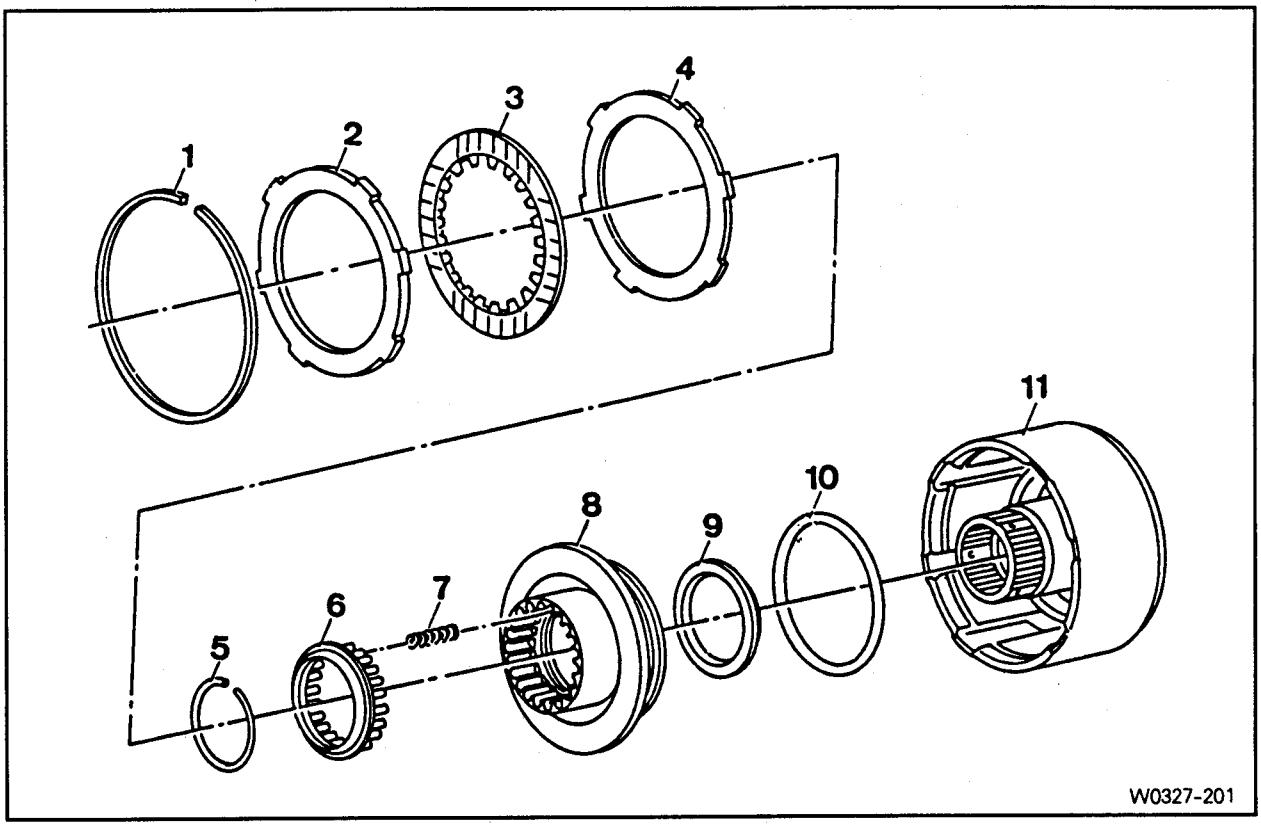
14) Measure disc clearance with a feeler gauge.

Disc clearance	0.7~1.3mm



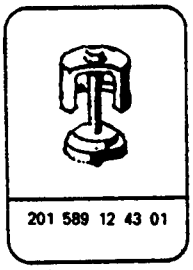
[Note]
- **The width of the groove for the snap ring is 3.2mm. Adjust the disc clearance by selecting a proper snap ring.**
- **Snap ring thickness : 2.0, 2.5, 3.0mm**
- **In case it is not easy to adjust the clearance just by the snap ring thickness change, replace steel disc with a proper thickness and adjust the clearance.**
- **Steel disc thickness : 4.5, 5.0mm**

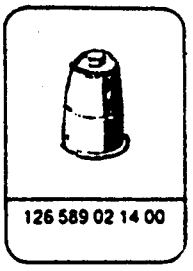
22. Disassembly and Assembly of Clutch K2



1. Snap Ring
2. Steel Disc ---------- 4 pieces, inspect
3. Friction Disc ---------- 4 pieces, inspect
4. Steel Disc ---------- Inspect
5. Snap Ring
6. Spring Plate
7. Pressure Spring
8. Piston
9. Seal ---------- Replace
10. Seal ---------- Replace
11. Outer Disc Carrier

Special tools





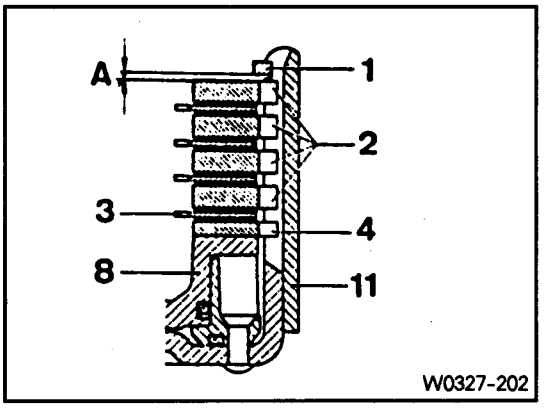
Service standard

Disc clearance	0.7 ~ 1.3 mm

Disc assembly

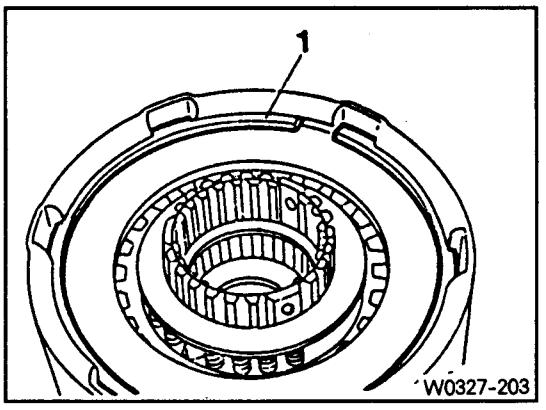
1. Snap Ring
2. Steel Disc
3. Friction Disc
4. Steel Disc

A. Disc Clearance

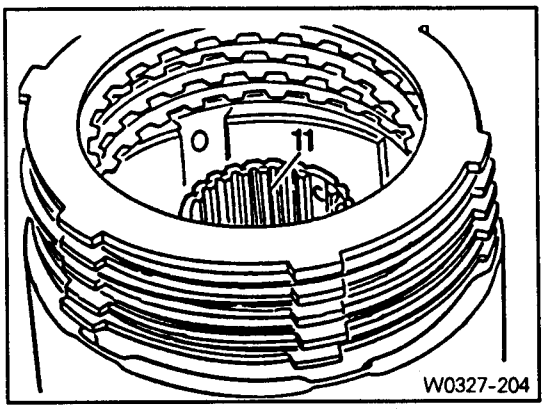


Disassembly

1) Remove the snap ring (1).



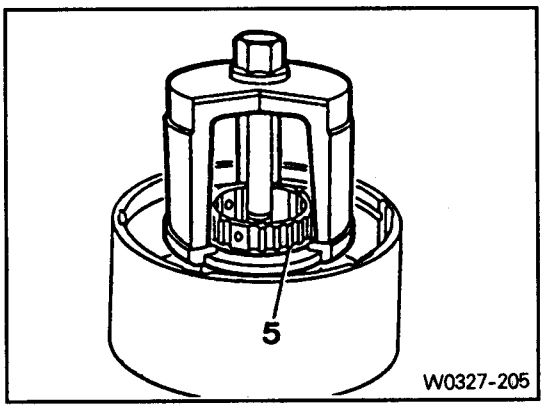
2) Remove the disc package (11) from the outer disc carrier.



3) Using assembly tool, while pressing on spring plate, remove the snap ring (5).

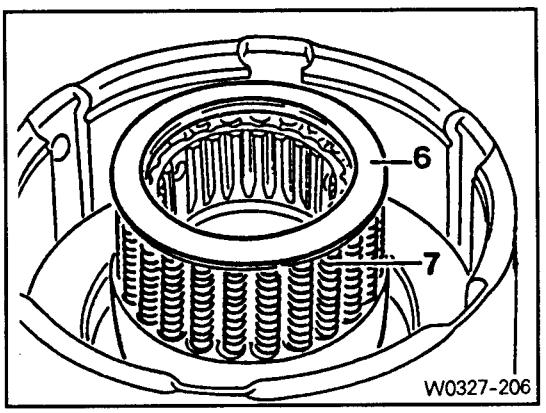
4) Remove the assembly tool.

Assembly tool 201 589 03 59 01

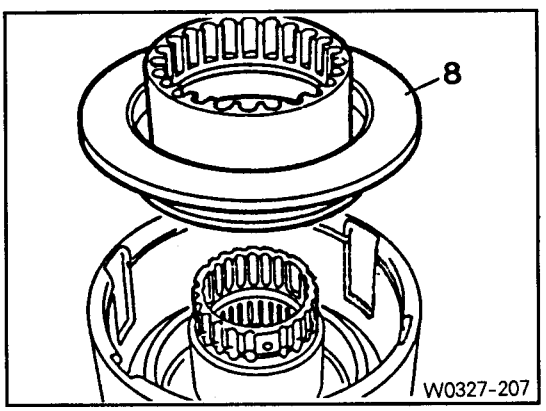


5) Remove the spring plate (6) and pressure spring (7).

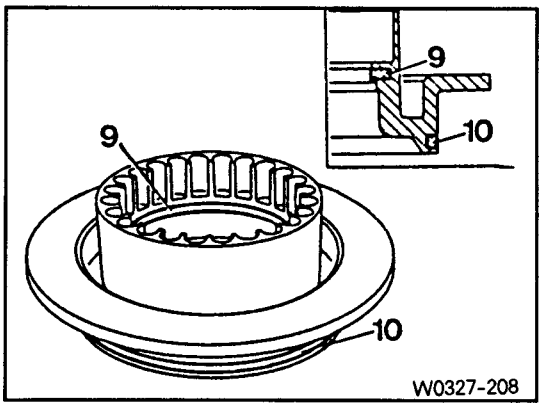
[Note] Record the number of pressure springs and be careful not to misplace the springs for K1 and K2.



6) Pull out the piston (8) from the outer disc carrier.



7) Remove the seal (9,10) from the piston.

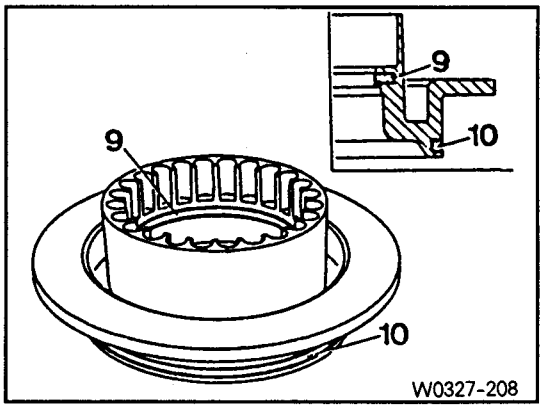


Assembly

[Note] Before assembly, saturate new friction disc in automatic transmission fluid for 1 - 2 hours.

1) Apply automatic transmission fluid on the seal (9, 10) and install the sealing rib to face the lower part of the piston ring groove.

[Note] The seal should not get twisted during installing.

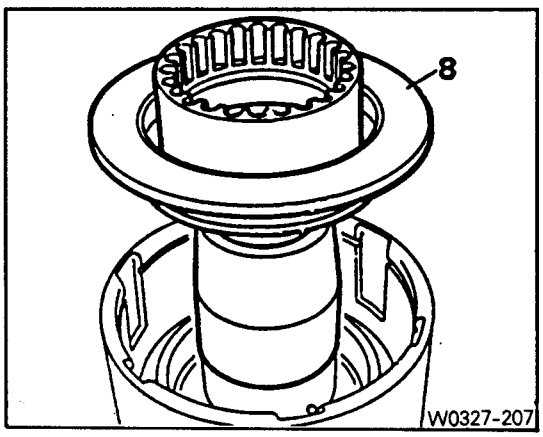


2) Install the guide sleeve to the outer disc carrier.

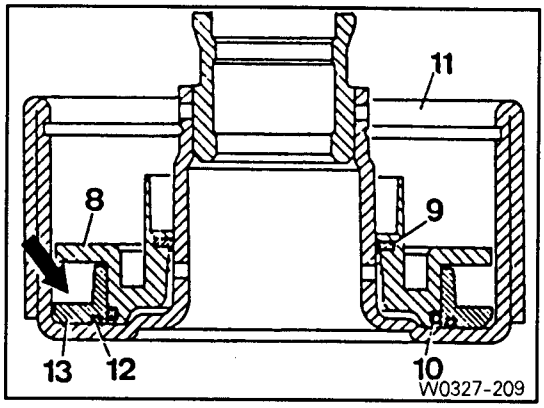
3) Install the piston (8) to the outer disc carrier.

[Note] Be careful not to damage the seal during installation.

Assembly tool 126 589 02 14 00



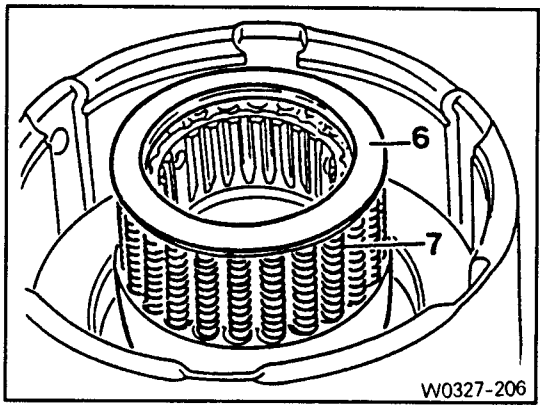
[Note] Fill the piston guide ring (13) with small amount of kerosine or nafta and make sure no liquid is coming out into (arrow) the outer disc carrier (11).
In case of any leakage, replace the outer disc carrier.



4) Install the pressure spring (7).

[Note] Compare it with the number of springs recorded during disassembly.

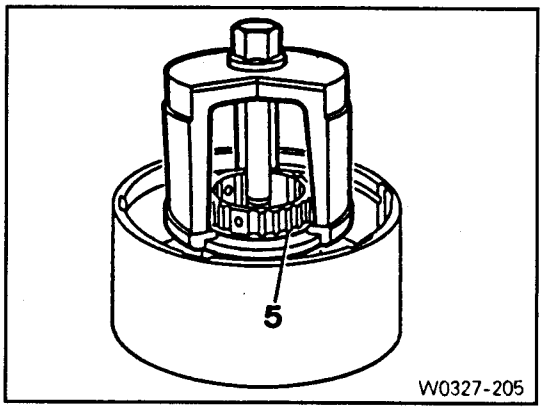
5) Install the spring plate (6).



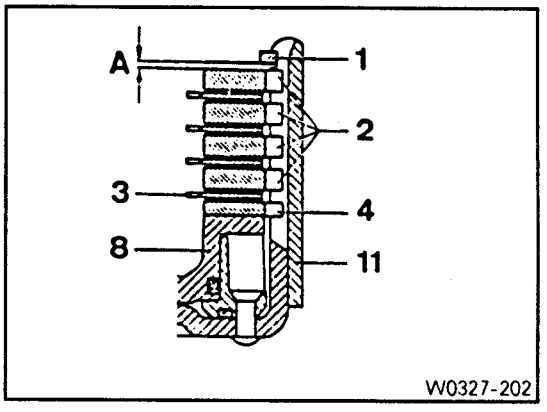
6) Using the assembly tool, while pressing on spring plate, install the snap ring (5).

7) Remove the assembly tool.

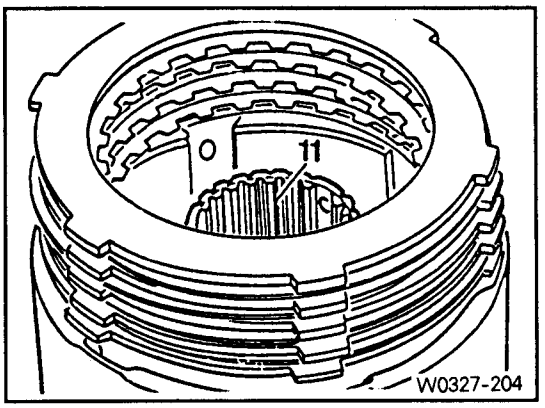
Assembly tool 201 589 12 43 01



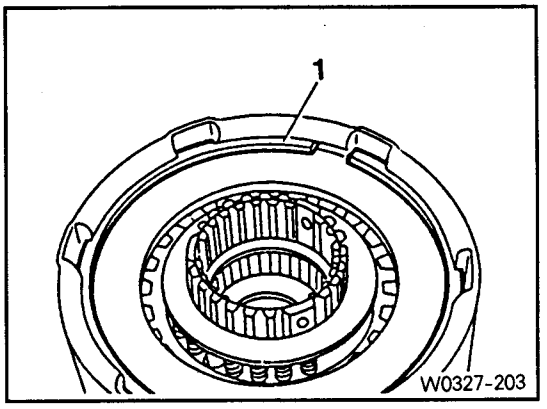
8) Install the disc package .
- Clutch disc assemble order.
  - Thin steel disc (4).
  - Install the steel disc (2) and friction disc (3) alternately.



9) Install the disc package (11) to the outer disc carrier.



10) Insert the snap ring (1).

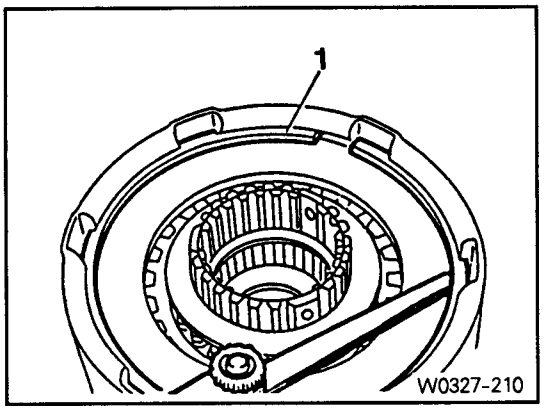


Measurement

[Note] In order to avoid errors in measurement, after installing snap ring, lift up the whole circumference of the snap ring.

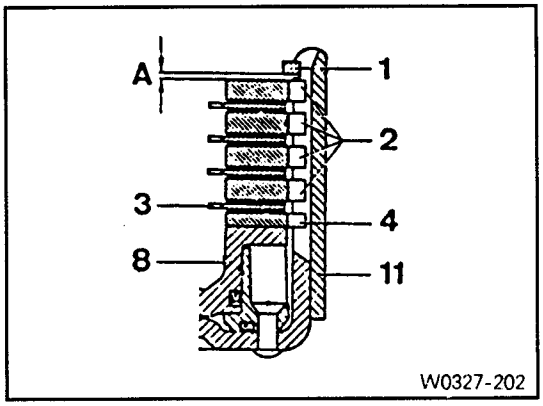
11) Measure clearance with a feeler gauge.

Disc clearance	0.7~1.3mm

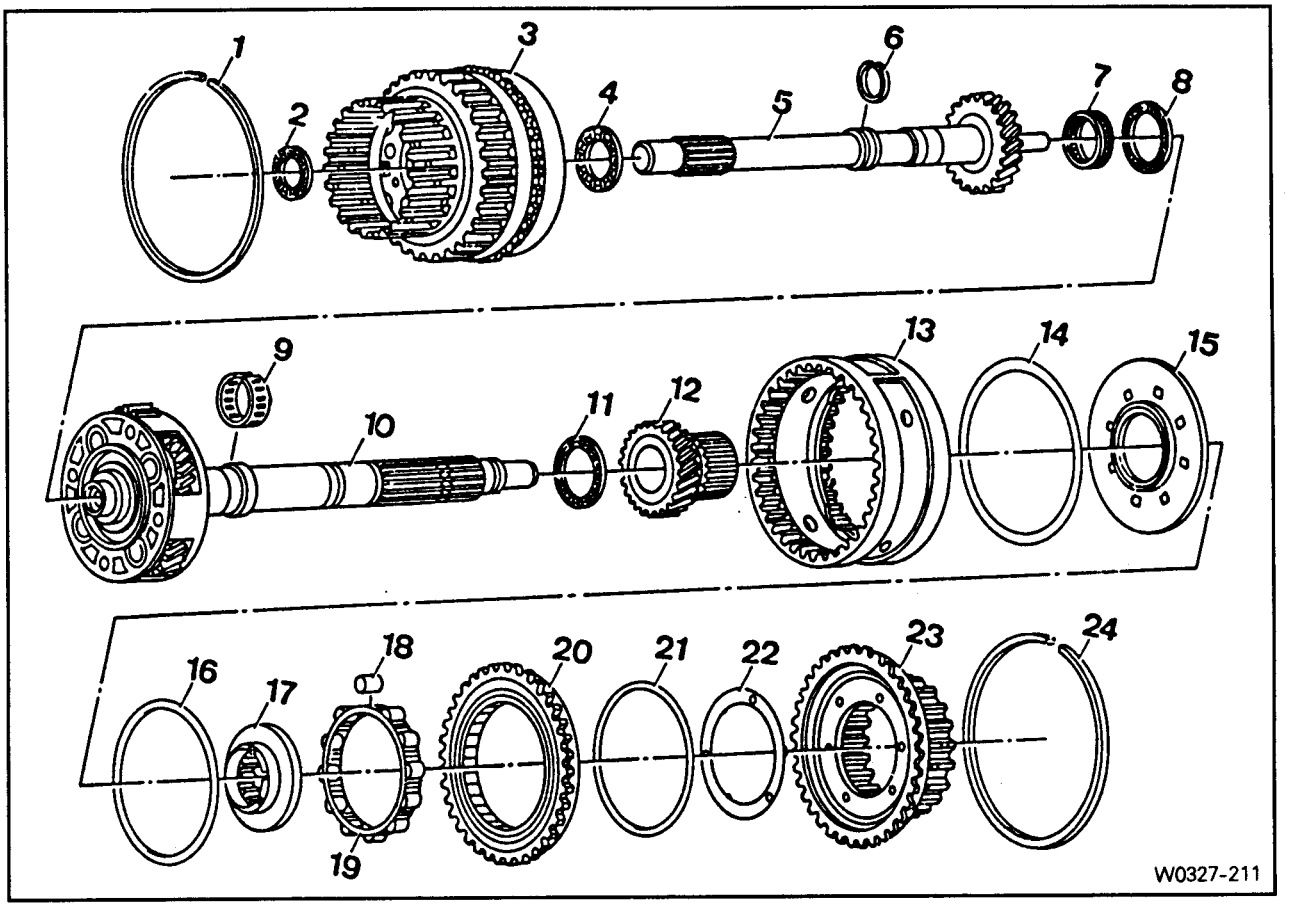


[Note]

- **The width of the groove for the snap ring is 3.2mm. Adjust the disc clearance by selecting a proper snap ring.**
  Snap ring thickness : 2.0, 2.5, 3.0mm
- **In case it is not easy ring thickness change, replace steel disc with a proper thickness and adjust the clearance.**
  Steel disc thickness : 4.5, 5.0mm

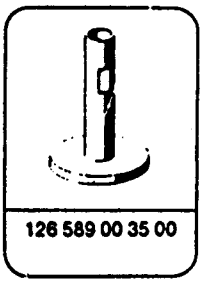


23. Disassembly and Assembly of Gear Assembly



1. Snap Ring
2. Axial Bearing ---------- Inspect, Replace
3. Front Planetary Gear Assembly
4. Axial Bearing ---------- Inspect, Replace
5. Input Shaft
6. Lubrication Pressure Ring ---- Replace
7. Radial Bearing ---------- Inspect, Replace
8. Axial Bearing ---------- Inspect, Replace
9. Radial Bearing
10. Output Shaft
11. Axial Bearing ---------- Inspect, Replace
12. Sun Gear
13. Connecting Carrier
14. Shim ----------Thickness: 0.1, 0.2, 0.5mm
15. Supporting Disc
16. O -Ring ----------Replace
17. One Way Clutch Inner Race
18. Cylindrical Roller
19. Roller Cage
20. One Way Roller Clutch Outer Race
21. O -Ring ----------Replace
22. Thrust Washer ---------Inspect, Replace
23. Inner Disc Carrier K2
    ----------End Play 0.05-0.2mm
24. Snap Ring

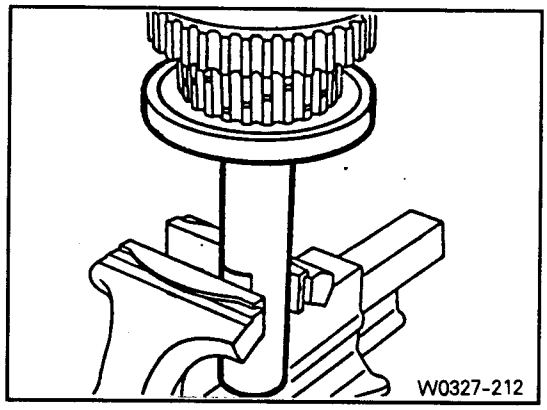
Special tool



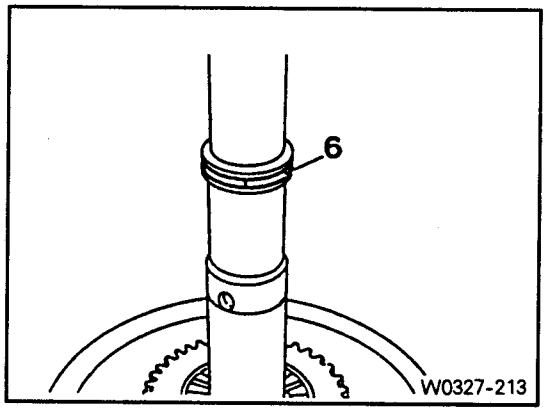
Disassembly

1) Install the special tool to the vise and install the gear assembly.

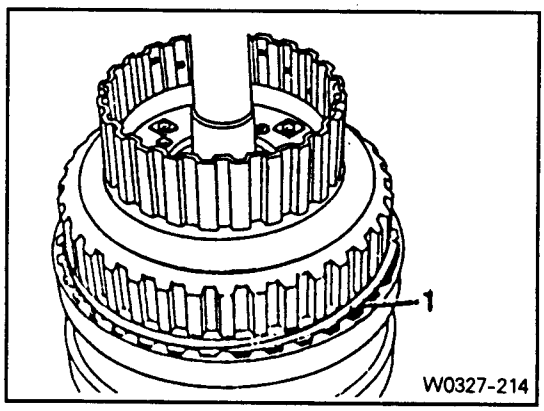
Special tool 126 589 00 35 00



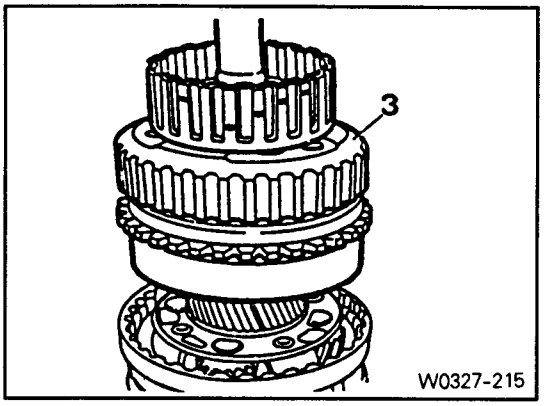
2) Remove the lubrication pressure ring (6) from the input shaft.



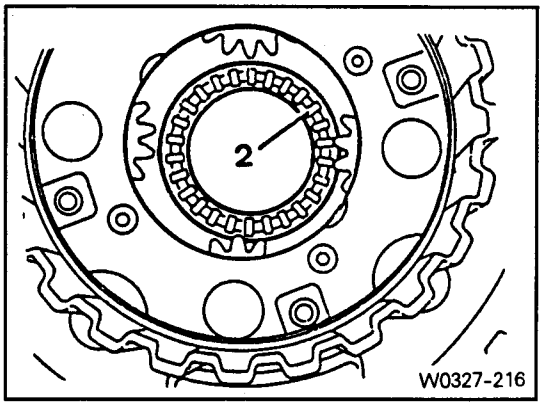
3) Using a screw driver, remove the snap ring (1).



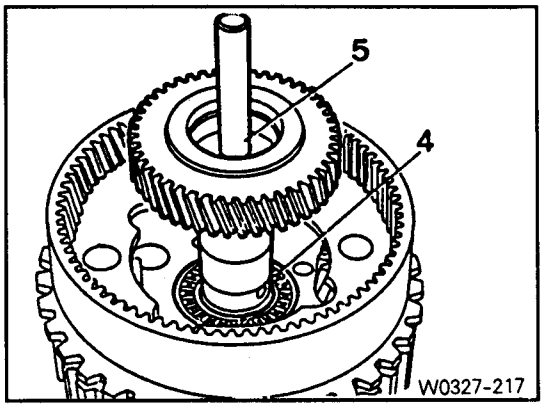
4) Lift the input shaft and front planetary gear assembly (3).



5) Remove the axial bearing (2) from planetary gear assembly.

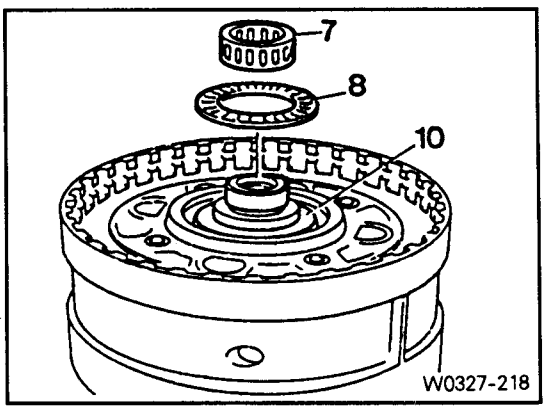


6) Remove the axial bearing (4) and input shaft (5).

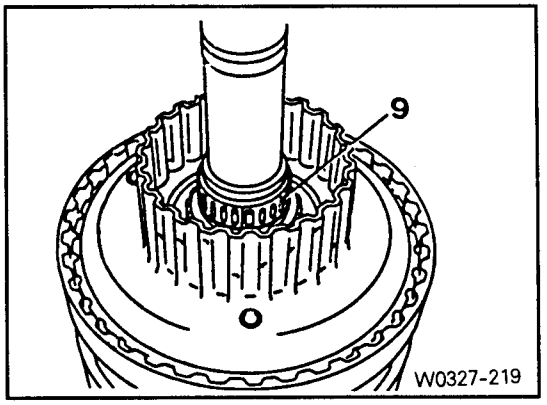


7) Remove the radial bearing (7) and axial bearing (8).

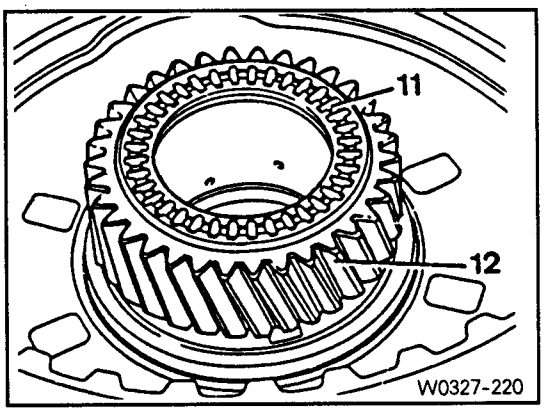
8) Remove the planetary gear and output shaft (10).



9) Remove the radial bearing (9) from the output shaft.

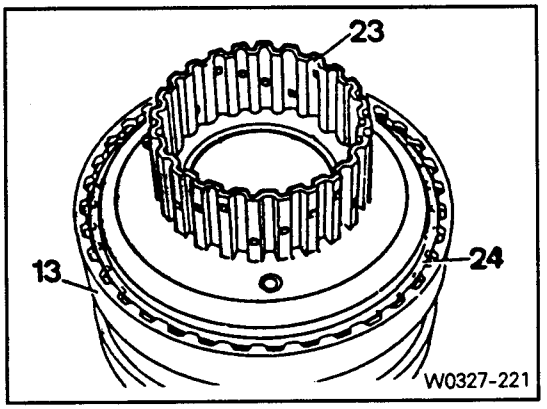


10) Remove the axial bearing (11) and remove the sun gear (12) from the connecting carrier.



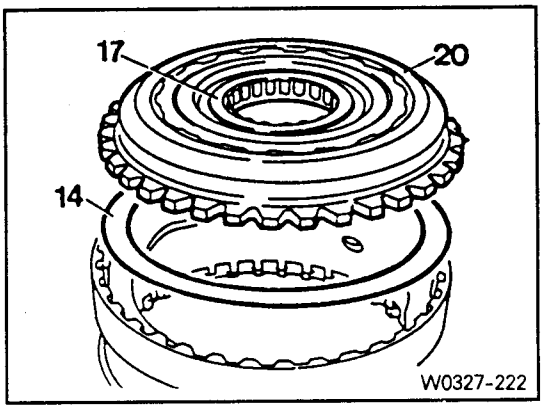
11) Remove the snap ring (24).

12) Remove the inner disc carrier K2 (23) from the connecting carrier (13).



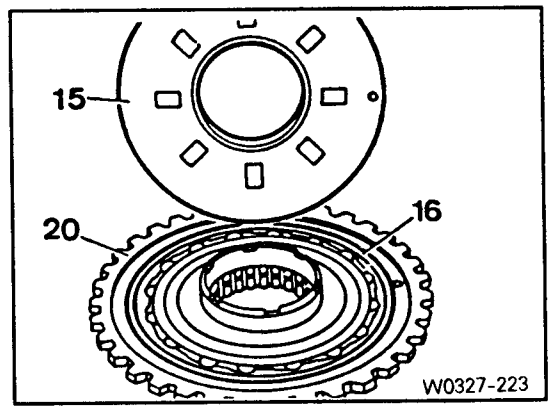
13) Remove the inner race (17) and outer race (20) from the one way clutch.

14) Pull out the shim (14).

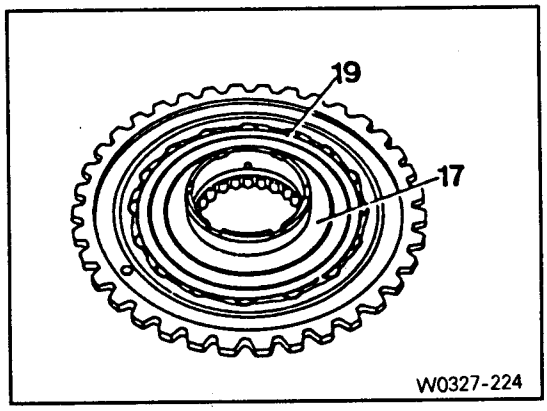


15) Remove the supporting disc (15).

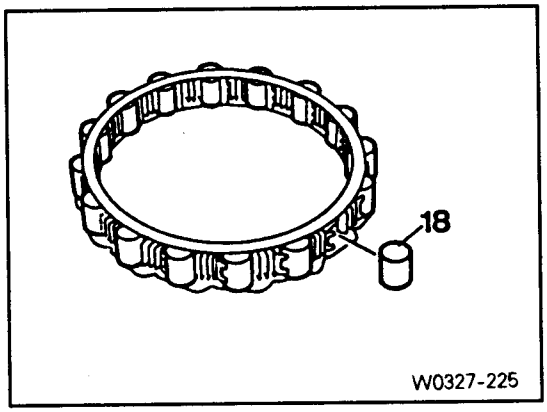
16) Remove the O-ring (16) from the outer race (20) of the one way clutch.



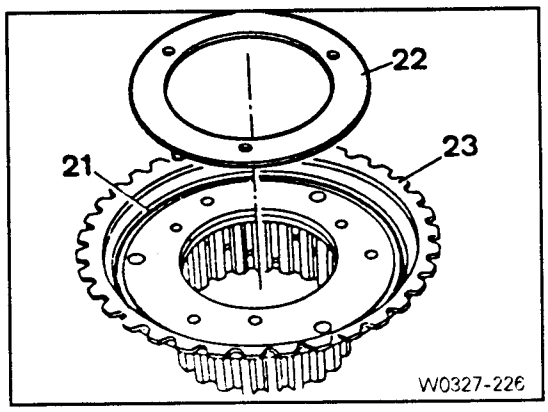
17) Remove the inner race (17)0 and roller cage (19) from the outer race of the one way clutch.



18) Remove the cylindrical roller (18) from the roller cage and inspect it..



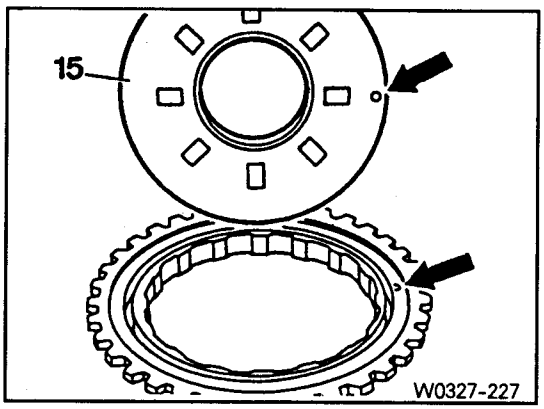
19) Remove the O-ring (21) and the thrust washer (22) from the inner disc carrier K2 (23).



Measurement

[Note] For end - play measurement, do not install the o - ring (16, 21).

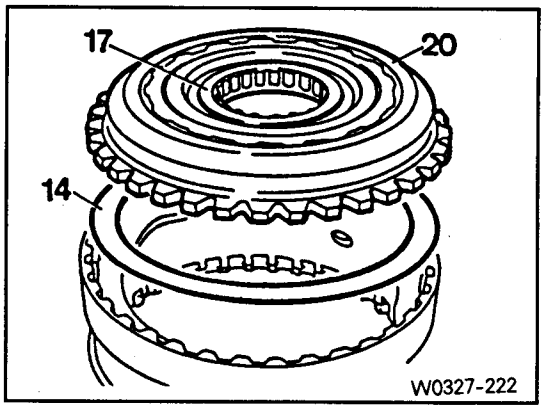
1) Engage the pin (arrow) of the supporting disc (15) and the outer race hole (arrow) of the one way clutch (20).



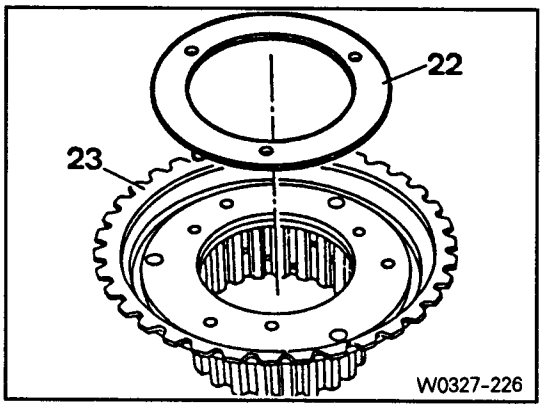
2) Insert the shim (14).

3) Install the inner race (17) and outer race (20) of the one way clutch to the connecting carrier.

[Note] When measuring the end play, do not install the roller cage.

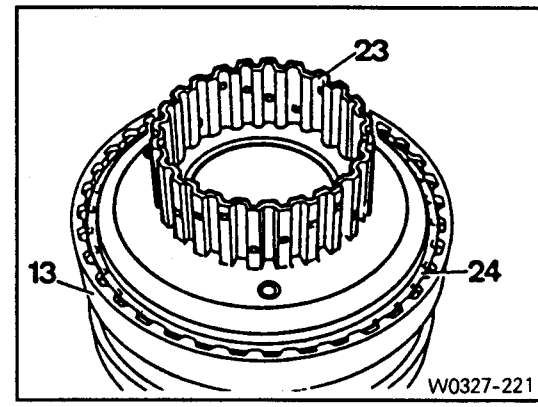


4) Install the thrust washer (22) to the inner disc carrier K2 (23).



5) Install the inner disc carrier K2 (23) to the connecting carrier (13).

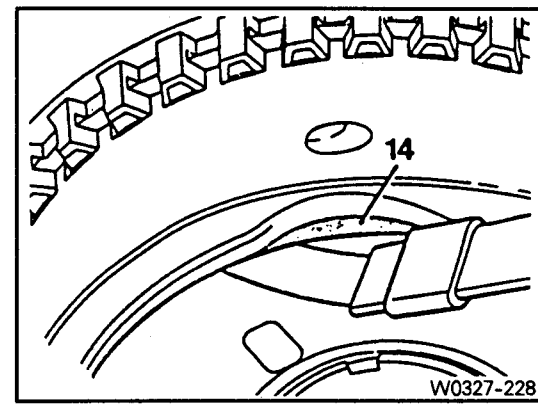
6) Fix it with the snap ring (24).



7) Using a feeler gauge, measure the end play between the connecting carrier and the shim (14).

End play	0.05~0.2mm

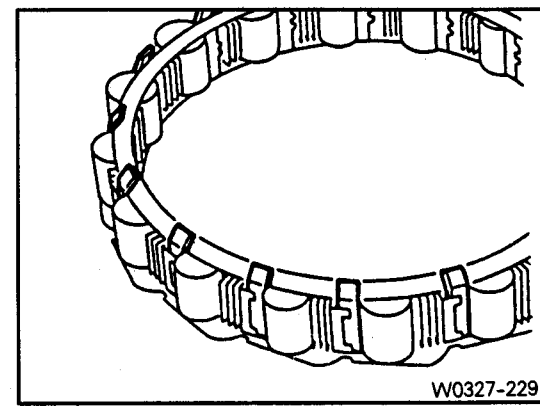
[Note] Adjust the end play by selecting a proper thickness shim.
- **Shim thickness : 0.1, 0.2, 0.3mm**



Assembly

[Note] Clean and inspect all the parts and replace them if necessary.

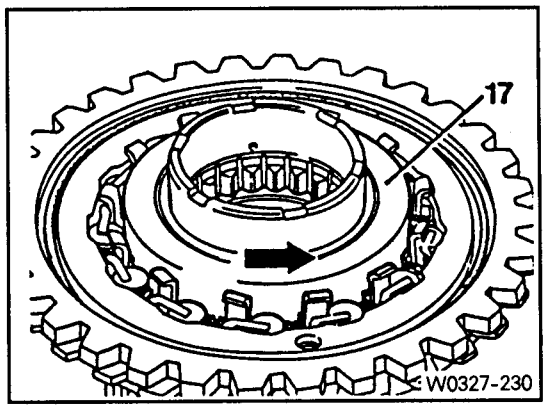
1) Insert the fix plate by pushing the cylindrical roller to the spring.



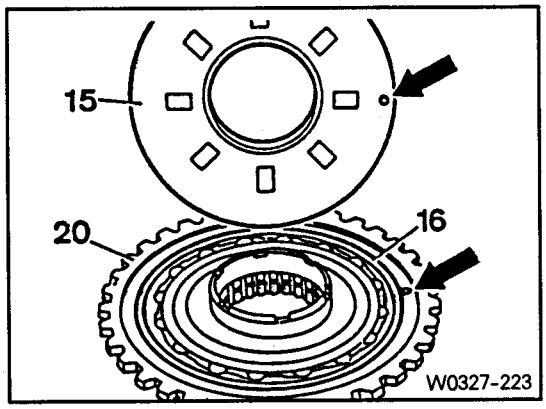
2) Install the fix plate and the roller cage to the outer race of one way clutch.

3) Install the inner race of the one way clutch (17). Rotate the inner race counterclockwise (arrow) when installing.

4) Remove the fix plate.

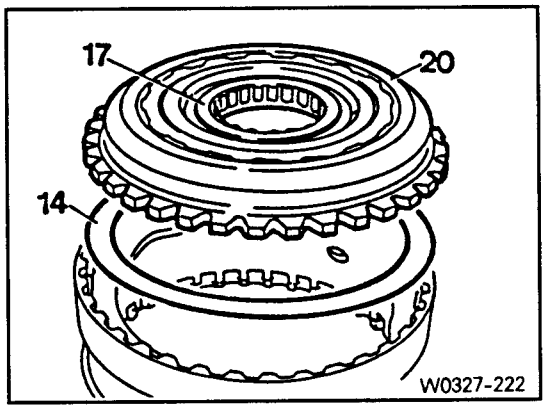


5) Install the O-ring (16) and engage the pin (arrow) of the supporting disc (15) and the hole (arrow) of the one way clutch outer race.

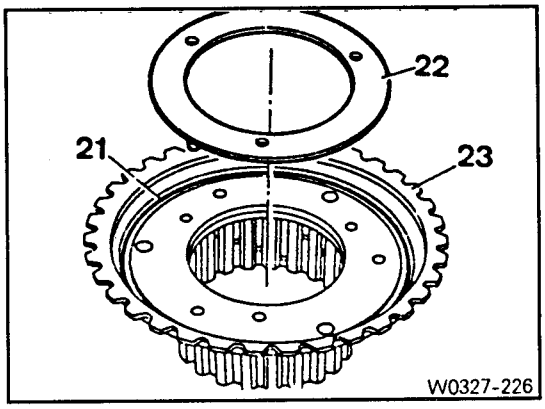


6) Install the selected shim (14) during end play measurement.

7) Install the inner race (17) and the outer race (20) of the one way clutch.

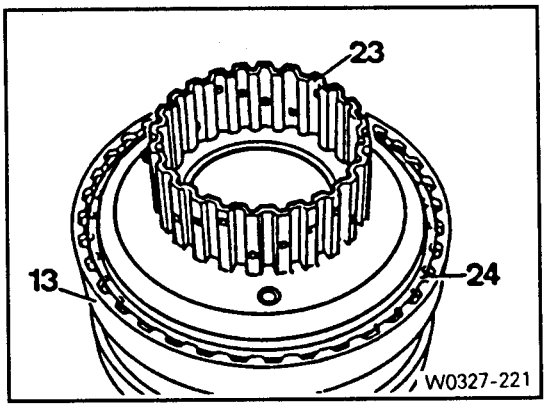


8) Install the new O-ring (21) and thrust washer (22) to inner disc carrier K2 (23).



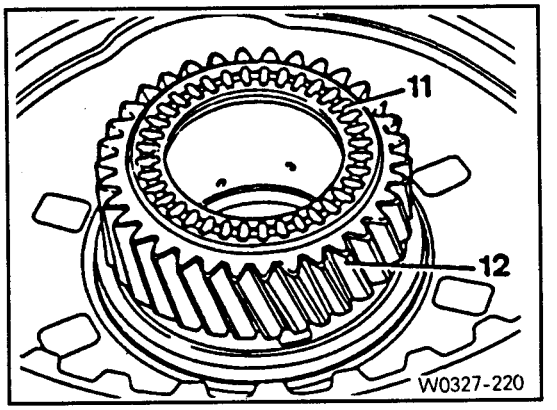
9) Install the inner disc carrier K2 (23) to connecting carrier (13).

10) Fix with the snap ring (24).

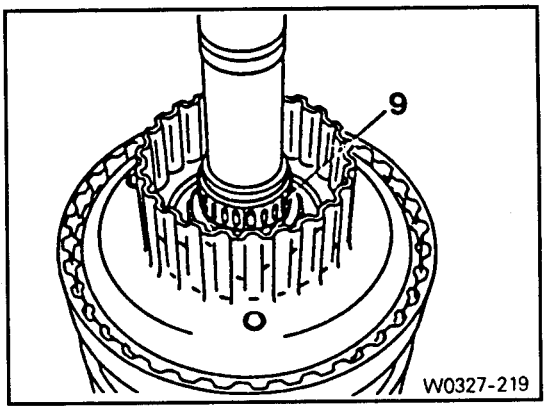


11) Insert the sun gear (12) to the connecting carrier and install the axial bearing (11).

[Note] Inspect the axial bearing wear. Replace it if necessary.



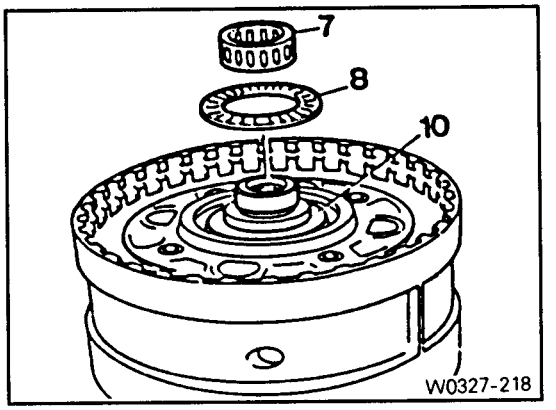
12) Install the radial bearing (9) to the input shaft.



13) Install the planetary gear and output shaft (10) to the connecting carrier.

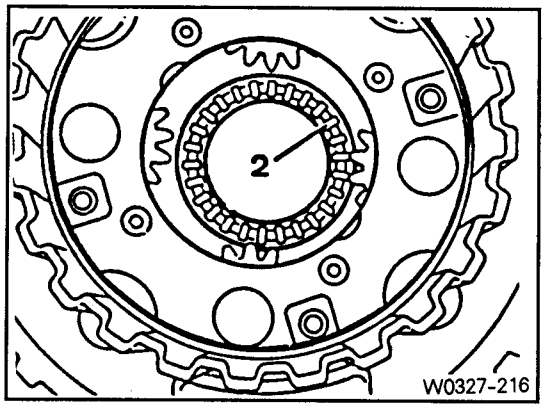
14) Install the radial bearing (7) and axial bearing (8).

[Note] Inspect the bearing wear. Replace it if necessary.



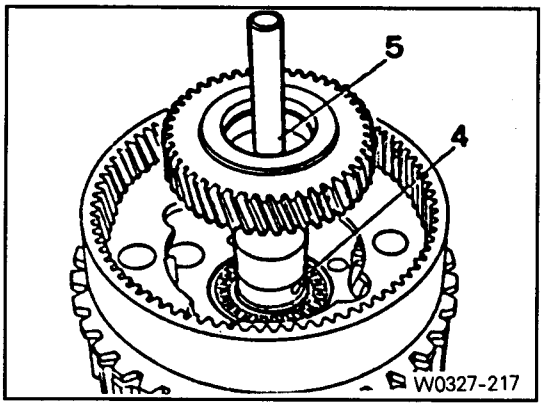
15) Install the axial bearing (2) to the planetary gear assembly.

[Note] Inspect the bearing wear. Replace it if necessary.

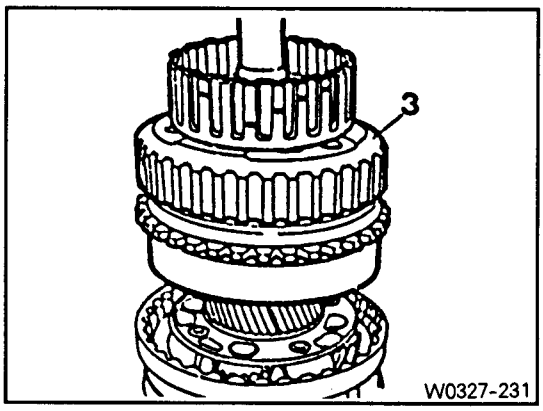


16) Install the axial bearing (4) and input shaft (5).

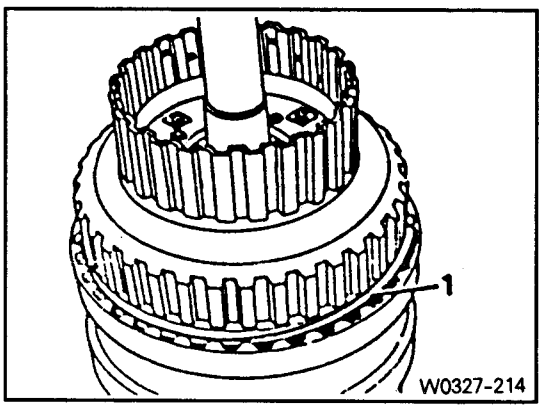
[Note] Inspect the bearing wear. Replace it if necessary.



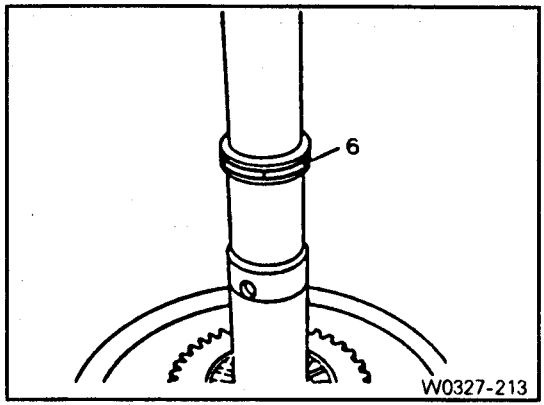
17) Install the input shaft and front planetary gear (3).



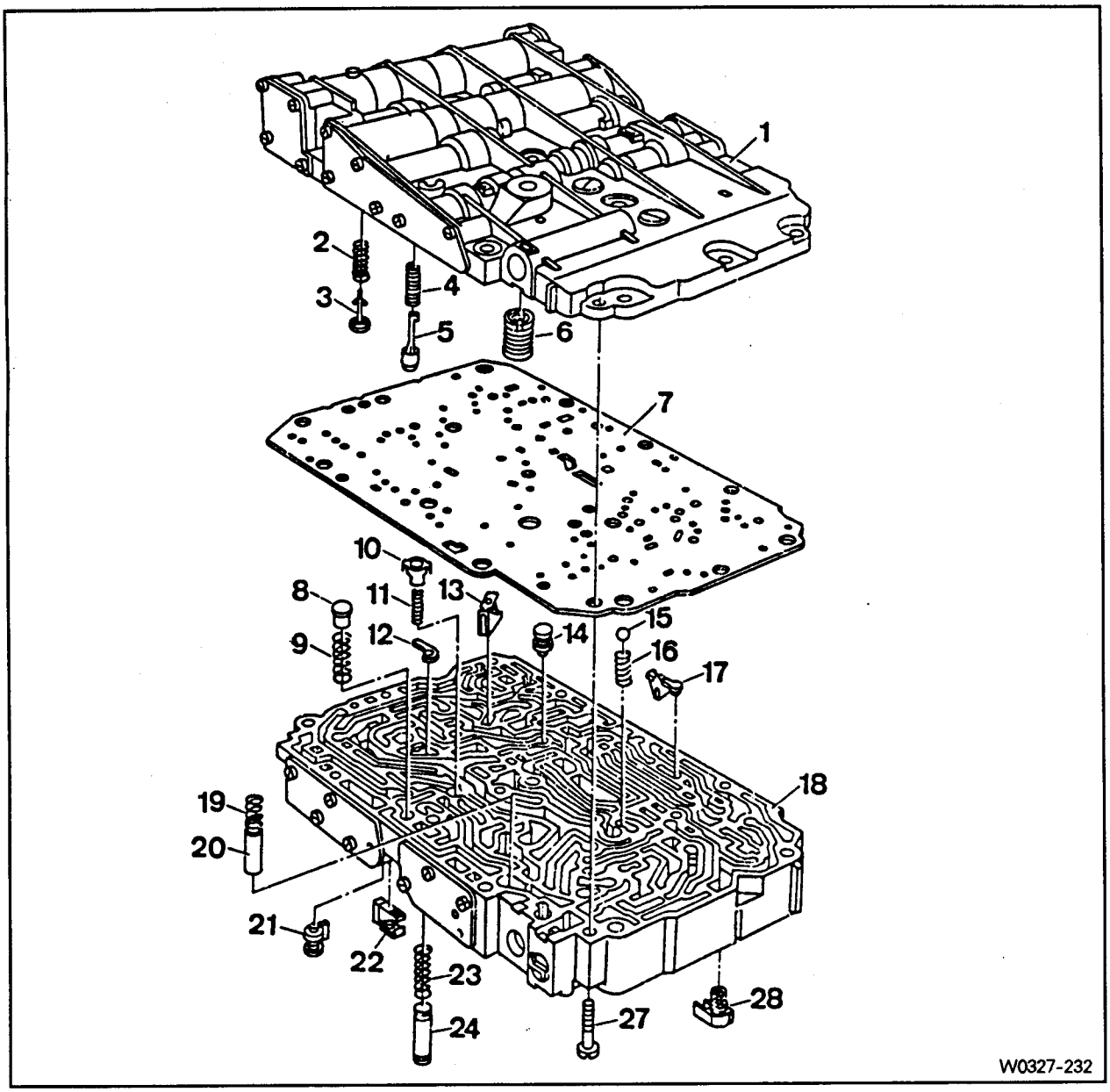
18) Install the snap ring (1).



19) Install the lubrication pressure ring (6) to the input shaft.

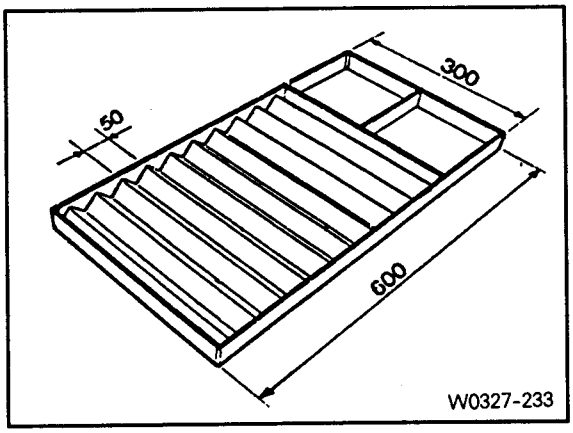


24. Disassembly and Assembly of Shift Valve Housing



1. Mounting Housing
2. Spring
3. Check Valve K1
4. Spring
5. Modulating Pressure Valve
6. Valve
7. Center Panel
8. Valve
9. Spring
10. Check Valve
11. Spring
12. Locking Valve Holder K1
13. Valve
14. Valve
15. Ball ----------18pieces
16. Spring
17. Check Valve
18. Selection Valve Housing
19. Spring
20. Control Valve - Lubrication Pressure
21. Safety Valve
22. Valve
23. Spring
24. Valve K1
27. Slot Screw
28. Filter

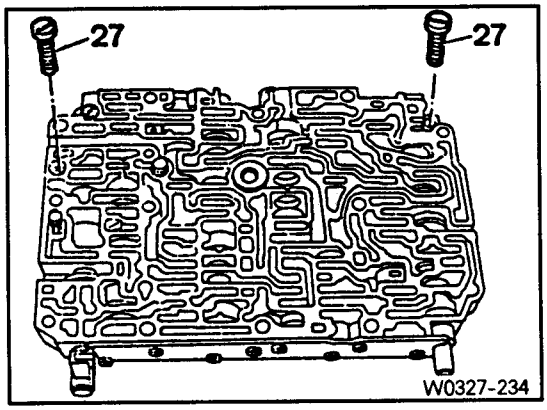
Shop made tool



2 for part storage

Disassembly of shift valve housing

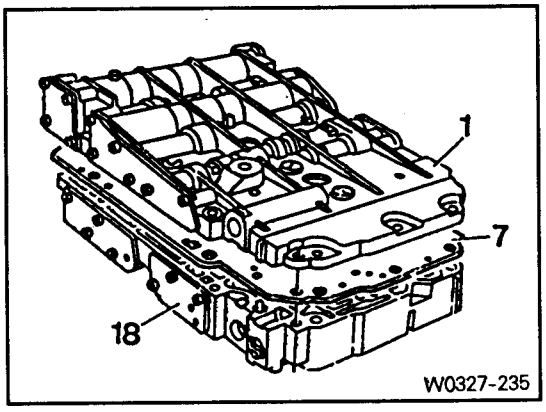
1) Remove the slot screws (27).



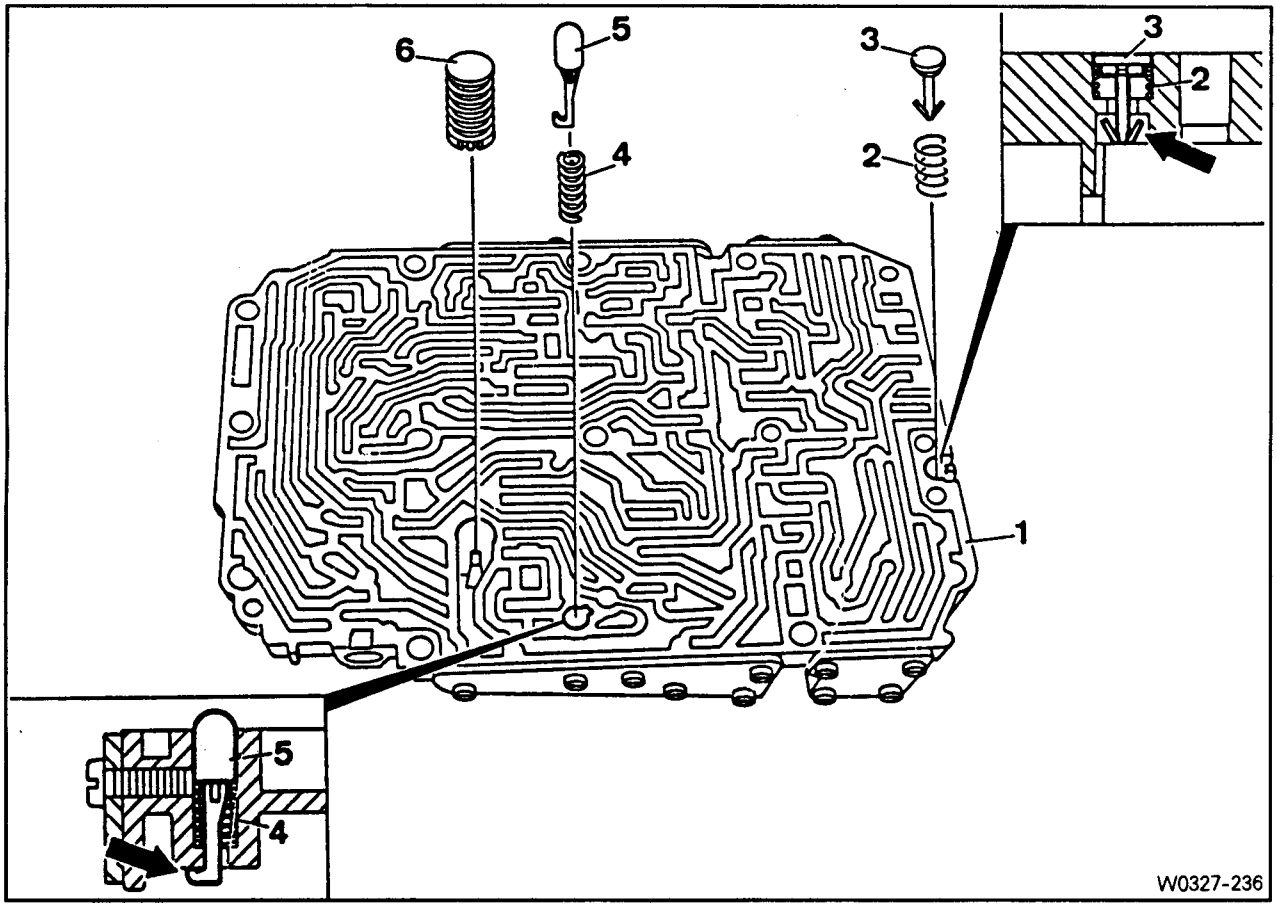
2) Holding the mounting housing (1) and selection valve housing (18), completely turn the shift valve housing over.

3) Carefully lift the mounting housing (1) from the selection valve housing (18) and carefully lift the center panel (7).

[Note] Be cautious not to drop any parts.



Mounting housing

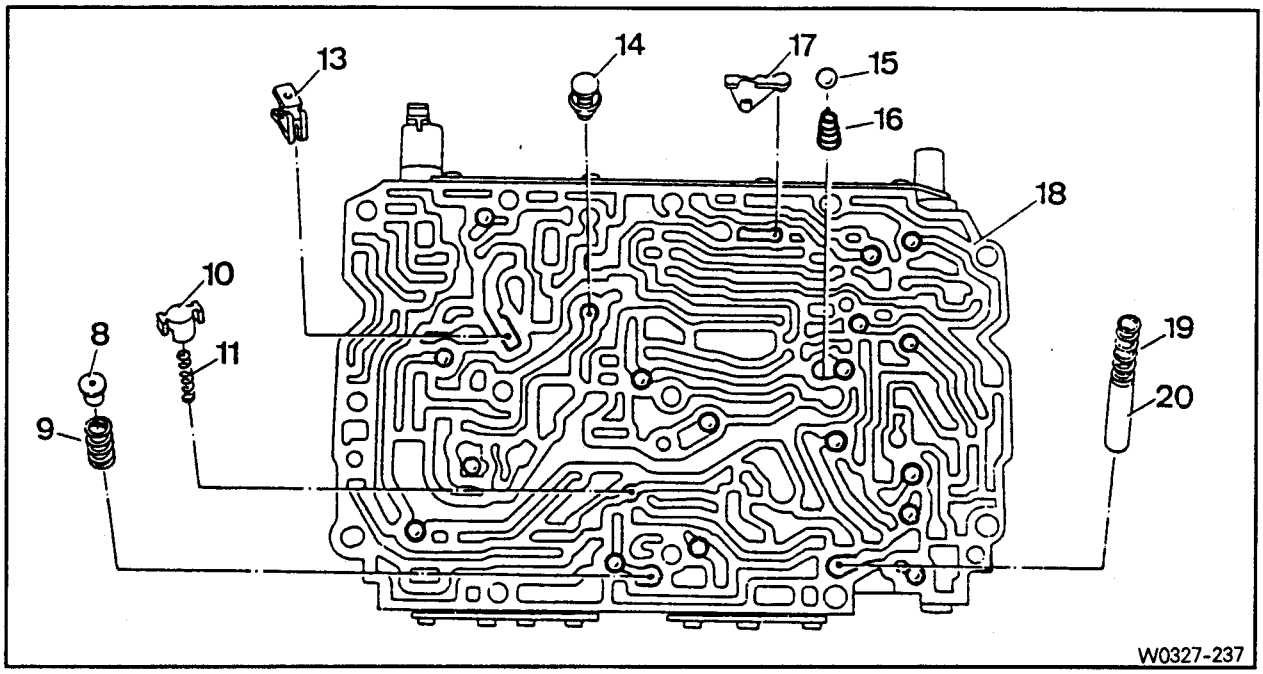


4) Holding down the tap of the check valve K1 (3), remove the spring (2) and check valve K1 from the mounting housing (1).

5) Hold down and rotate the modulating pressure valve (5) avoiding this being interfered by the bracket, remove the spring (4) and modulating pressure valve.

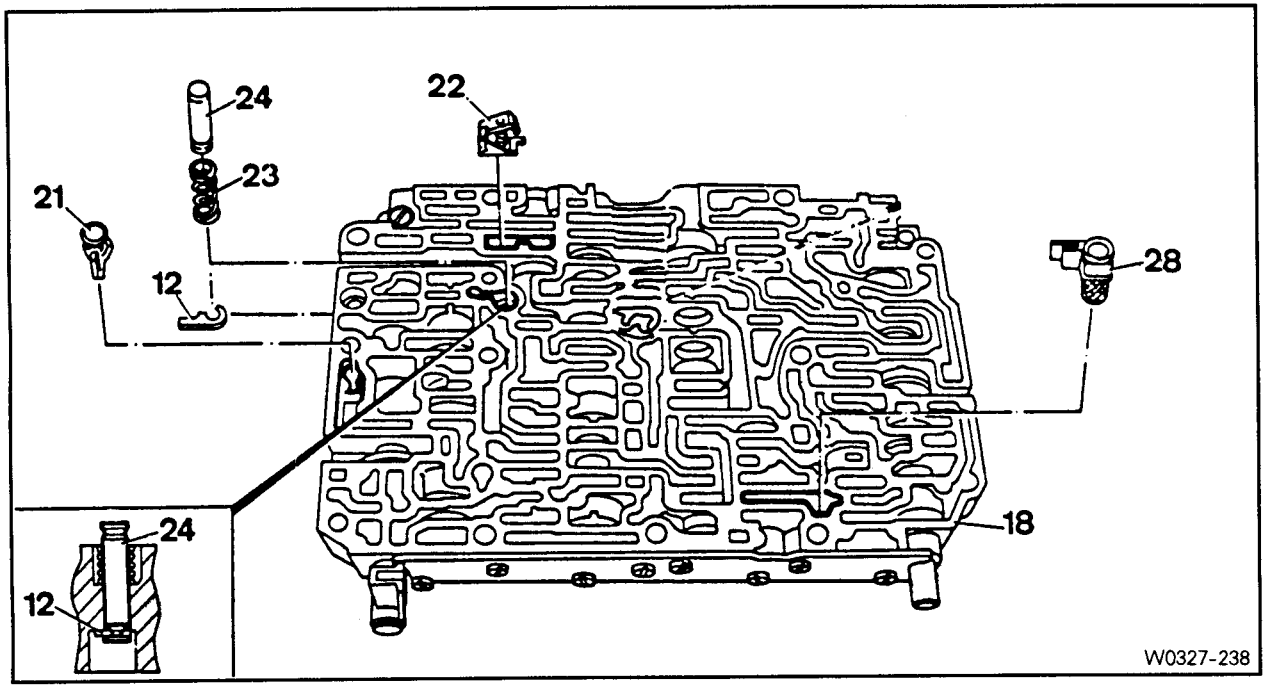
6) Remove the valve (6).

Selection valve housing



7) Remove the spring (16) and balls (15) from the shift valve housing - 18 pieces.

8) From the selection valve housing (18), remove the following parts.
   8. Valve
   9. Spring
   10. Check Valve
   11. Spring
   13. Valve
   14. Valve
   17. Check Valve
   19. Spring
   20. Control Valve - Lubrication Pressure

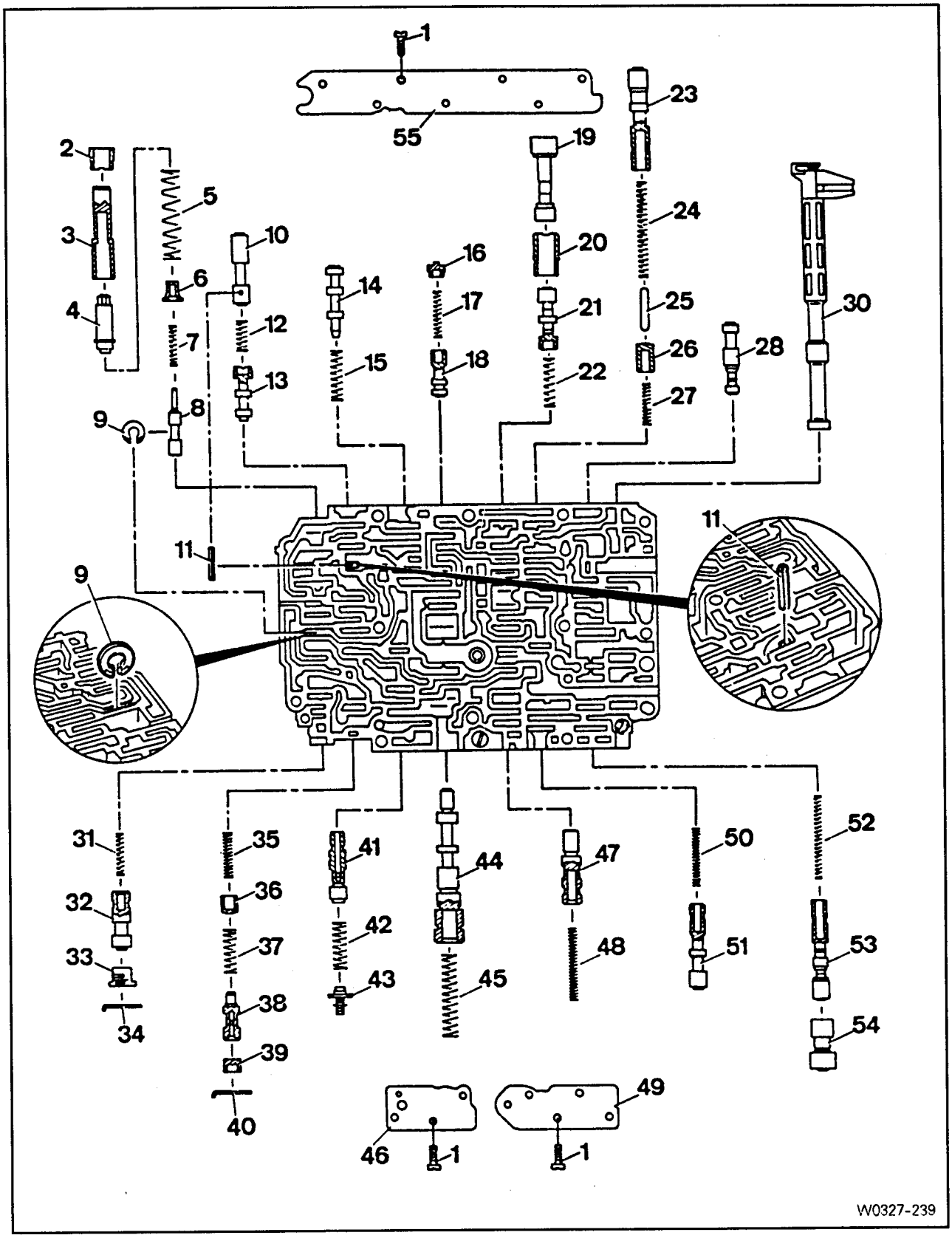


9) Turn the selection valve housing over.

10) From the opposite side, remove the locking valve holder K1 (12) and remove the spring (23) and valve K1 (24).

11) Remove the safety valve (21), valve (22) and filter (28).

Disassembly and assembly of selection valve housing

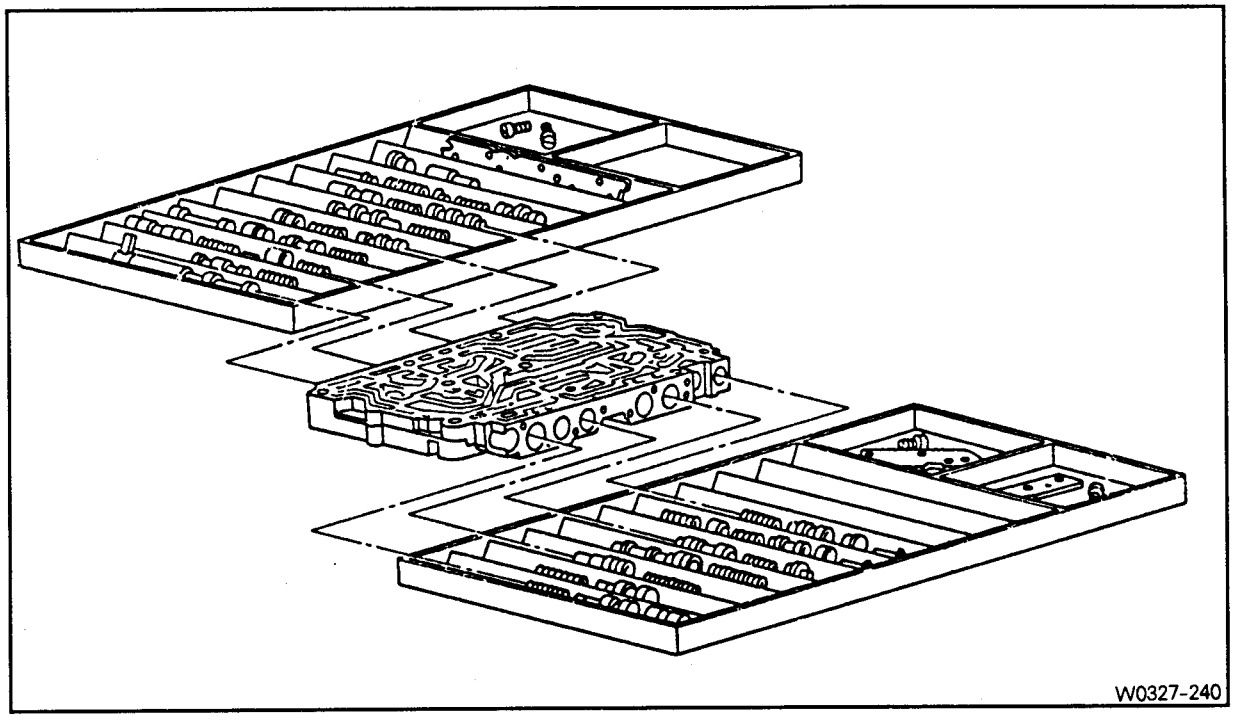


1. Slot Screw
2. Guide Bushing
3. Piston, Control Pressure
4. Bolt, Control Pressure
5. Spring, Control Pressure
6. Thrust Piece, Control Pressure
7. Spring, Control Pressure
8. Control Valve, Control Pressure
9. Retaining Ring
10. Control Valve, Down Shift 2-1
11. Clamping Pin
12. Spring, Down Shift 2-1
13. Control Valve, Kickdown
14. Control Valve, Overlap B2/K2
15. Spring, Overlap B2/K2
16. Center Ring Piston
17. Spring, Transition
18. Control Valve, Transition
19. Piston, Gear Shift 2-1
20. Bushing, Gear Shift 2-1
21. Control Valve, Gear Shift 2-1
22. Spring, Gear Shift 2-1
23. Control Valve, Gear Shift 4-3
24. Spring, Gear Shift 4-3
25. Thrust Pin, Gear Shift 4-3
26. Piston, Gear Shift 4-3
27. Spring, Gear Shift 4-3
28. Control Valve, Converter Adaptation
30. Range Selection Valve
31. Spring, Governor Boost
32. Control Valve, Governor Boost
33. Plug, Governor Boost
34. Retaining Plate
35. Spring, Contact Pressure B1
36. Piston, Contact Pressure B1
37. Spring, Contact Pressure B1
38. Piston, Contact Pressure B1
39. Plug
40. Retaining Plate
41. Control Valve, Full Throttle Control Pressure
42. Spring, Full Throttle Control Pressure
43. Adjust Screw, Full Throttle Control Pressure

----- Do not adjust

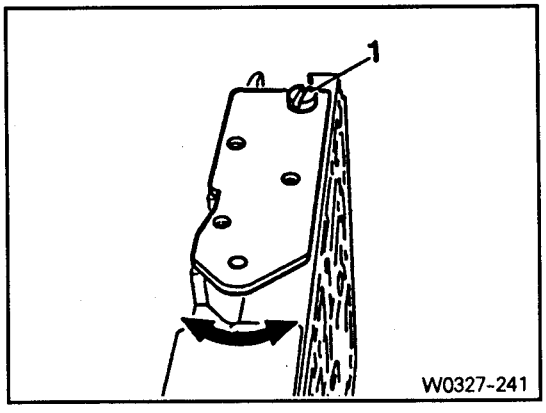
44. Control Valve, Working Pressure
45. Spring, Working Pressure
46. End Plate
47. Control Valve, Basic Pressure
49. End Plate
50. Spring, Overlab B1/K1
51. Control Valve, Overlab B1/K1
52. Spring, Gear Shift 2-3
53. Control Valve, Gear Shift 2-3
54. Piston, Gear Shift 2-3
55. End Plate

Use of shop made tool



For disassembly and assembly of parts, abide by following order :

- Vertically position the selection valve housing and the control valve.
- Unscrew the slot screw (1) from the end of the end plate (Do not remove the screw).
- Rotate the end plate to the direction of arrow.
- Remove the parts from the control valve in the right order, one by one, and put them into the parts storage case according to the original order.

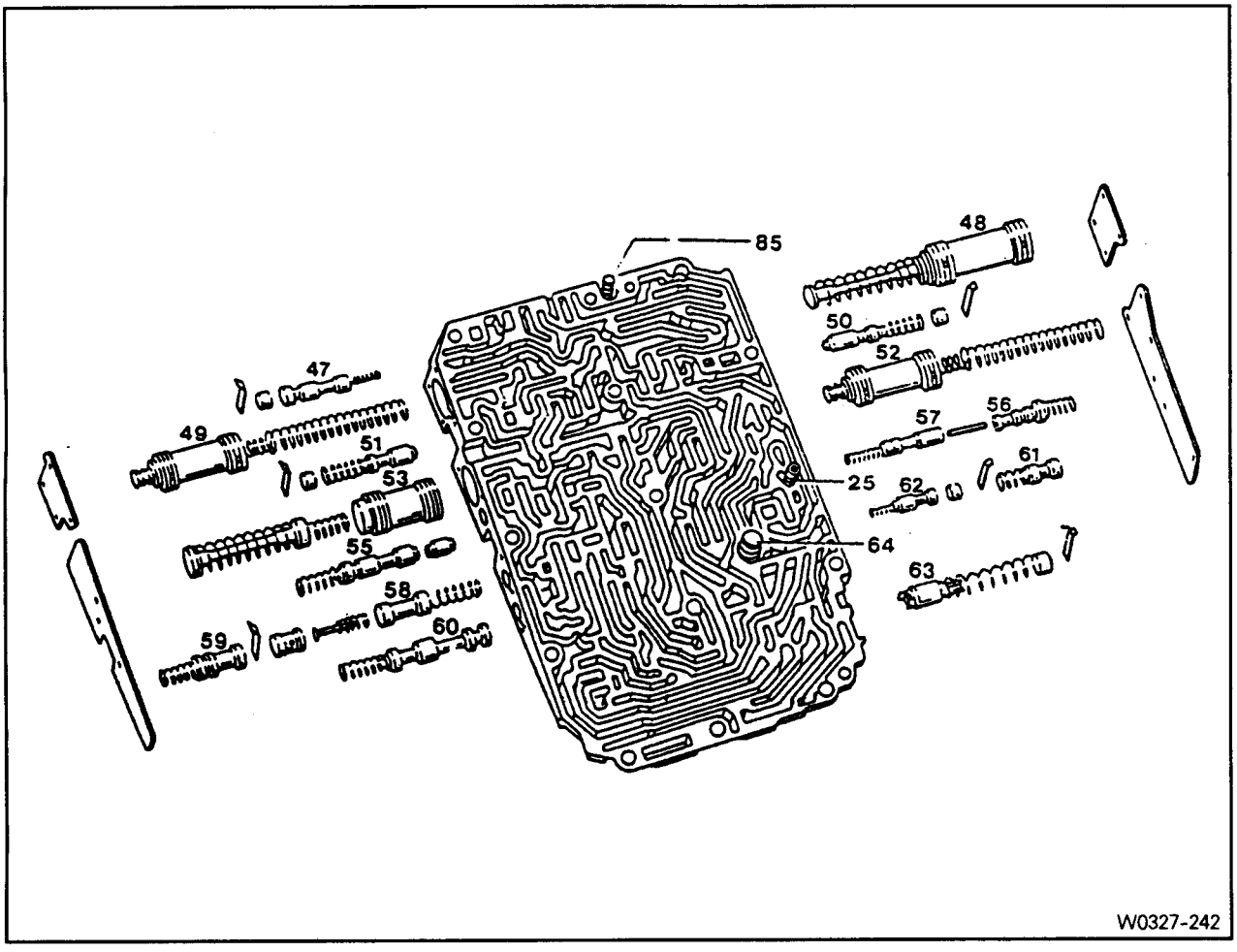


- Assembly is reverse order of the disassembly.

[Note]

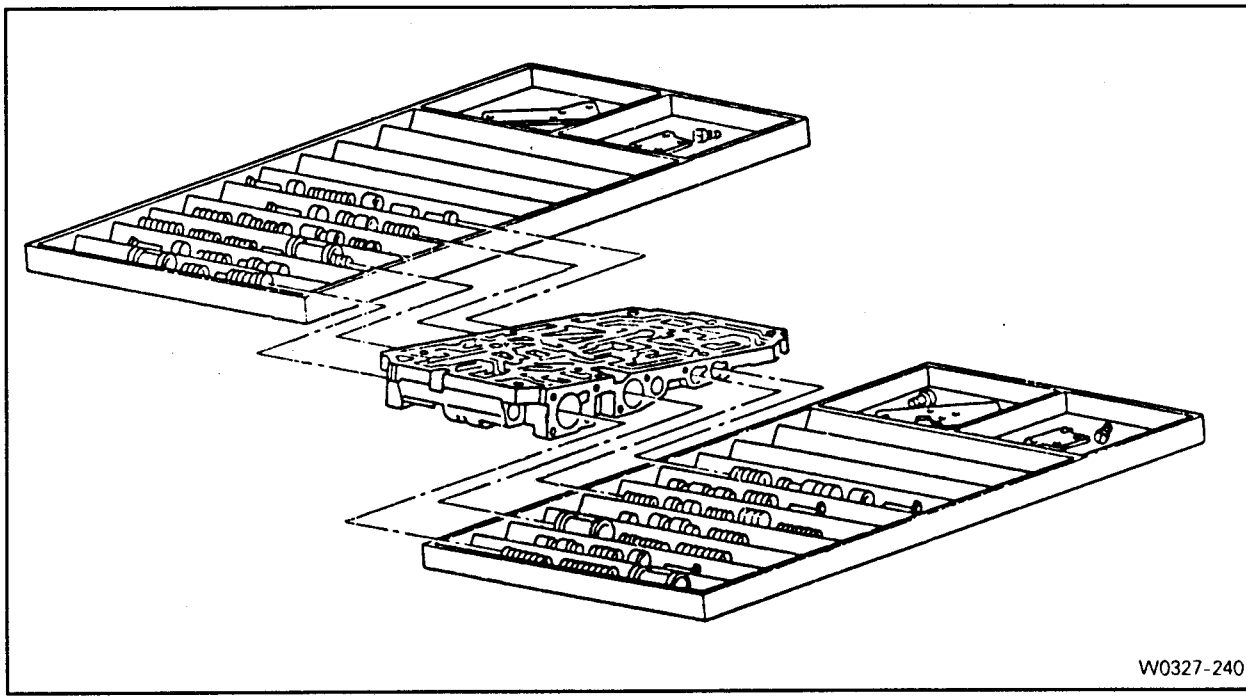
- **Before assembly, lubricate the valve with ATF and check if operation is smooth.**
- **Be cautious not to get injured during the end plate removal by spring force.**

Disassembly and assembly of mounting housing.



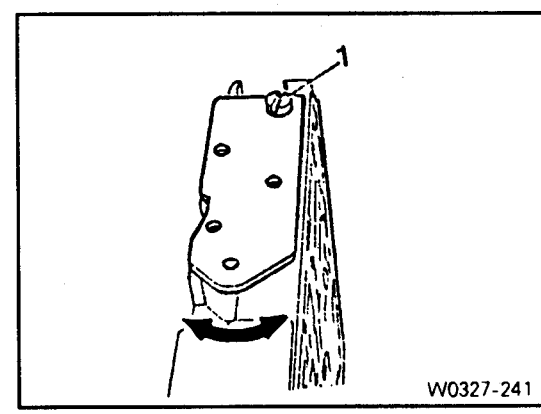
25. Valve, Positive Pressure (Modulating Pressure)
47. Control Valve
48. Damper K1
49. Damper K2
50. Control Valve, Damper K1
51. Control Valve, Damper K2
52. Damper B1
53. Damper Switching - ON
54. Shut - Off Valve RV2
56. Shift Valve, Deceleration Cut - Off
57. Control Valve, Damper B1
58. Control Valve, Damper Switching - ON
59. Shift Valve K2
60. Detent Valve B2
61. Shut - Off Valve, Braking Shift
62. Shut - Off Valve RV1
63. Damper, Kickdown
64. Lubricating Pressure Valve
85. Pressure Limiting Valve

Use of shop Made Tool



For disassembly and assembly of parts, abide by following order :

- Vertically position the selection valve housing and the control valve.
- Unscrew the slot screw (1) at the end of end plate. (Do not remove the screw.)
- Rotate the end plate to the direction of arrow.
- Remove the parts one by one from control valve and place them in the parts storage case according to the original order.

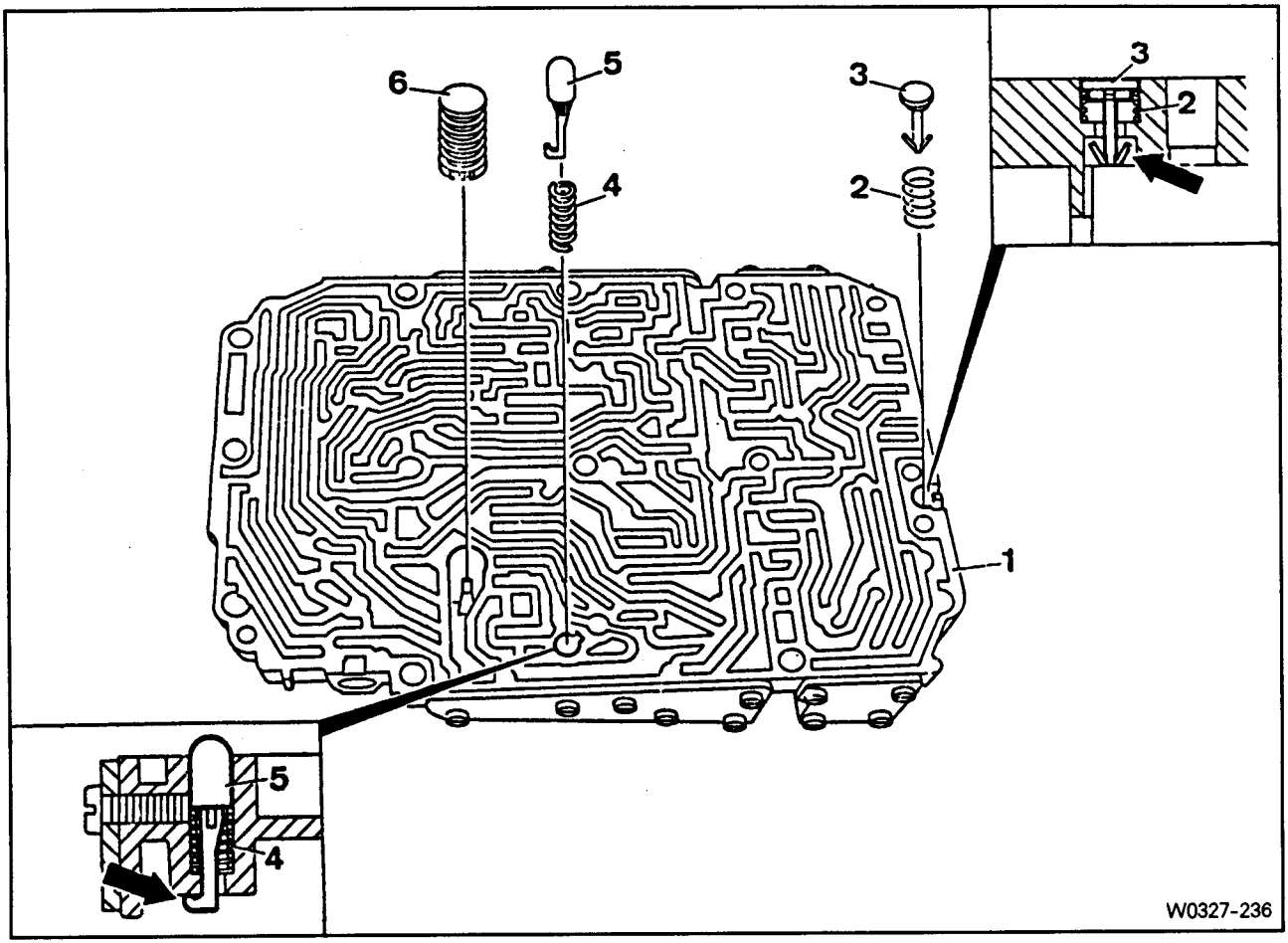


- Assembly is reverse order of the disassembly.

[Note]

- **Before assembly, lubricate the valve with ATF and check if operation is smooth.**
- **Be cautious not to get injured during the end plate removal by spring force.**

Assembly of shift valve housing

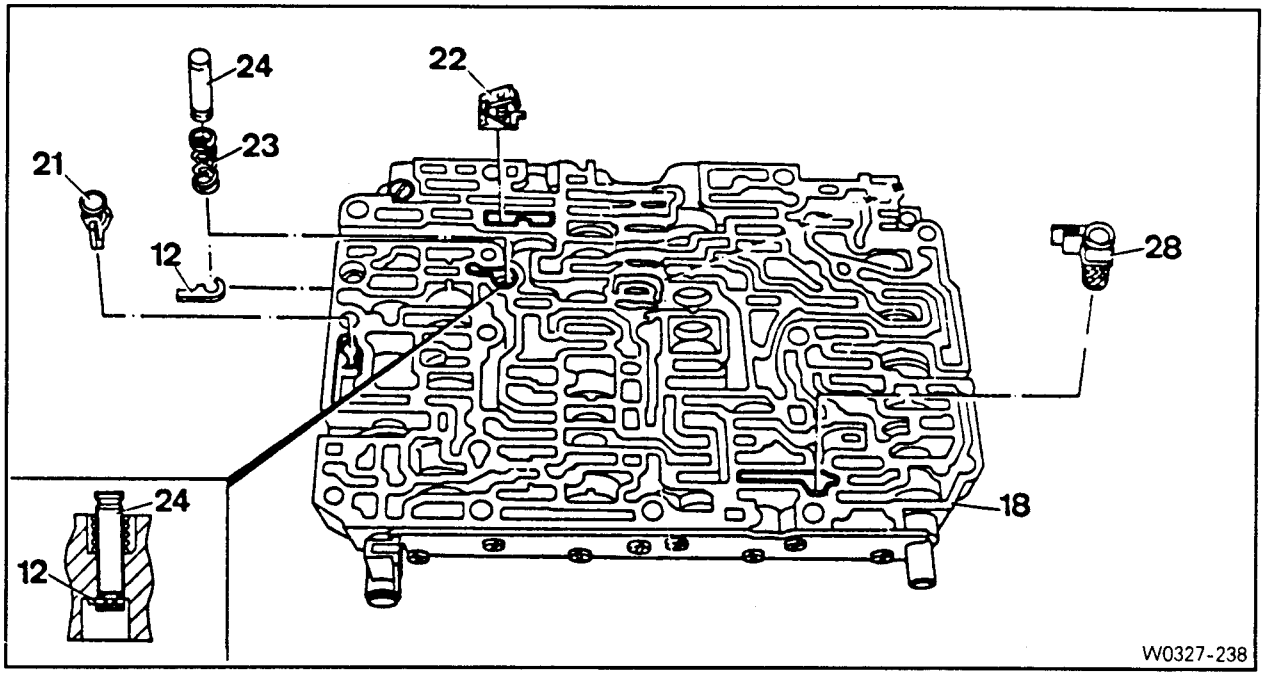


Installation of housing

1) Install the check valve K1 (3) and spring (2) on the mounting housing.

[Note] See if tap (arrow) of check valve K1 opens up inside of the mounting housing (1).

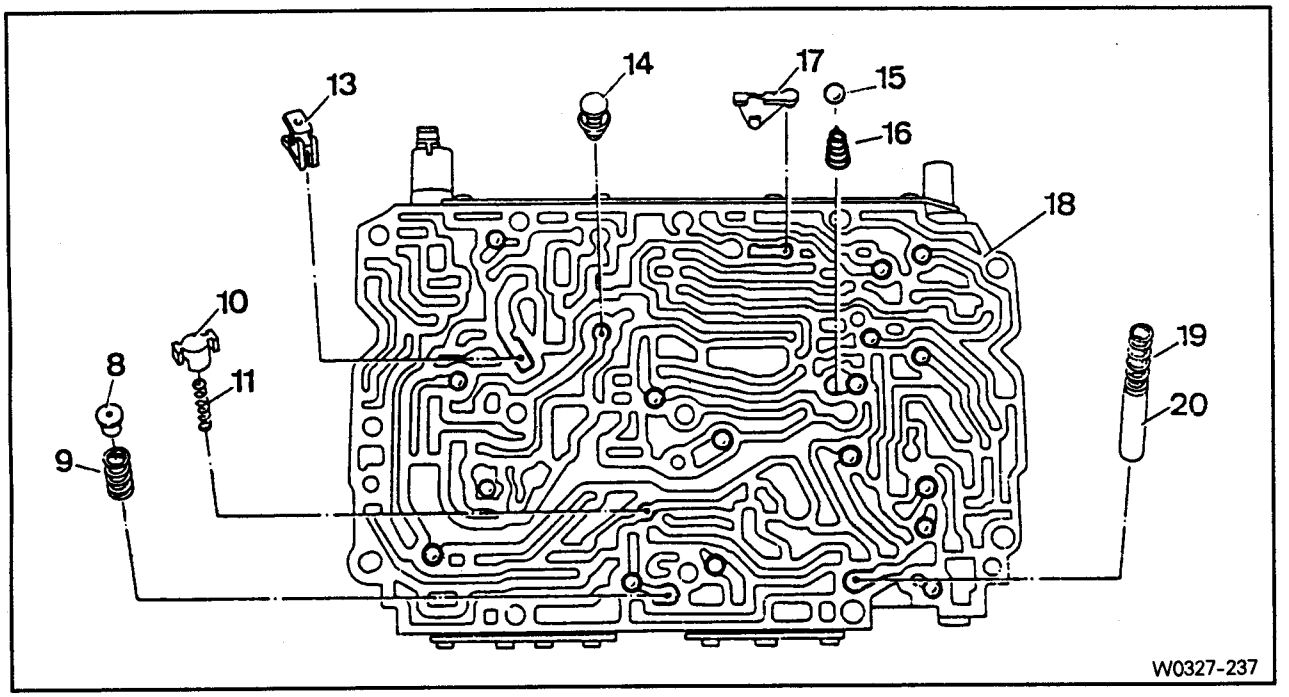
2) While pressing on the modulating pressure valve (5), rotate it until the bracket (arrow) gets hooked to the mounting housing.



Selection valve housing

3) Install the spring (23) and valve (24) into the selection valve housing (18) and install the locking valve holder K1 (12) to the opposite side.

4) Install the safety valve (21), valve (22) and filter (28) and turn the selection valve housing over.



5) Install following parts to the selection valve housing.
   8. Valve
   9. Spring
   10. Check Valve
   11. Spring
   13. Valve
   14. Valve
   17. Check Valve
   19. Spring
   20. Control Valve - Lubrication Pressure

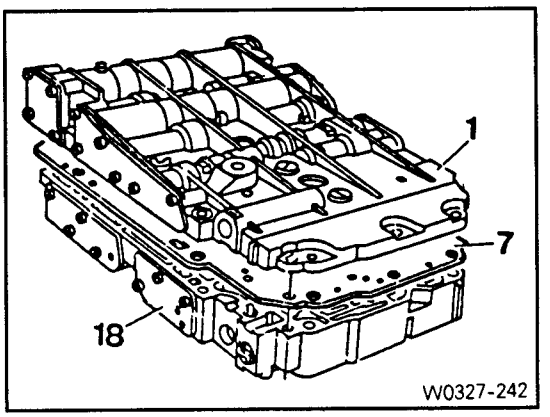
6) Install the spring (16) and ball (15).

7) Carefully place the center panel (7) on the shift valve housing (18).

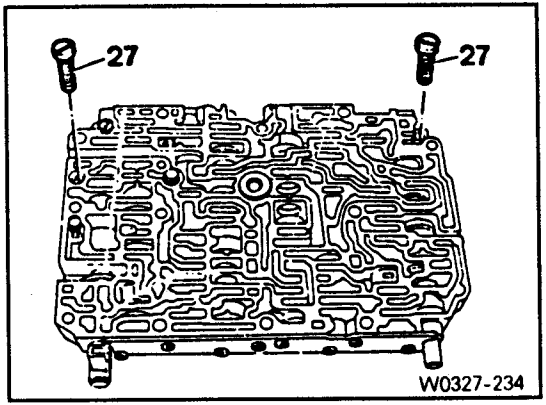
[Note] Align the holes accurately.

8) Install the mounting housing (1) on the center panel and align the screw holes.

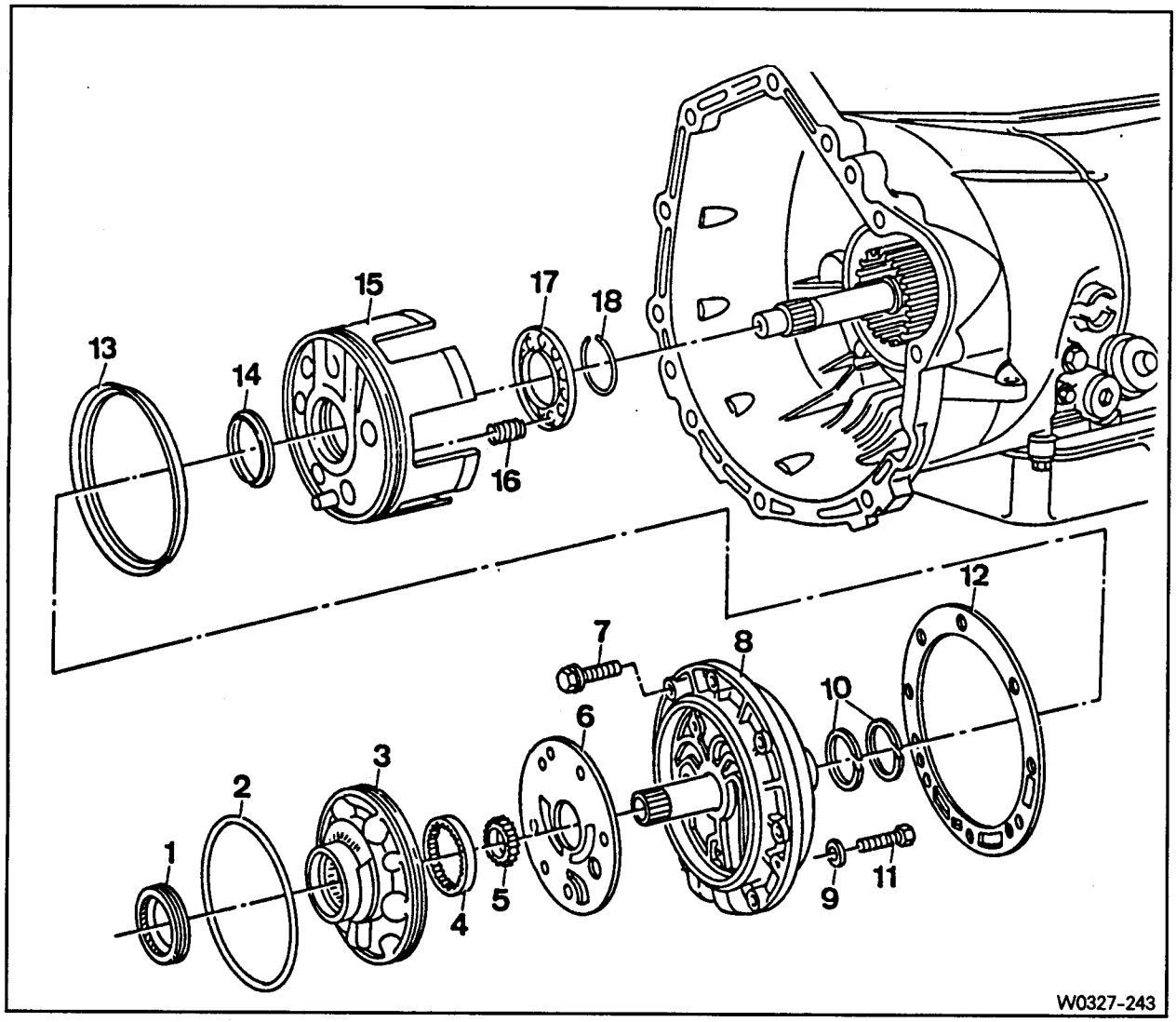
9) Holding the mounting housing and selection valve housing, turn the shift valve housing over.



10) Tighten the slot screw (27).

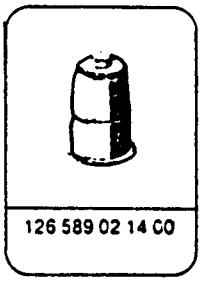


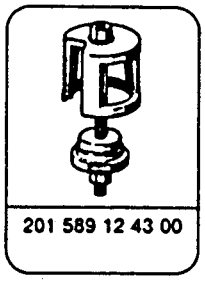
25. Removal and Installation of Primary Pump

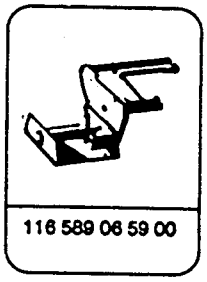


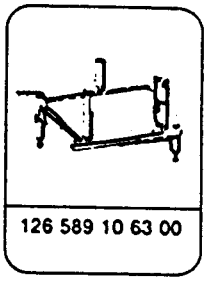
1. Radial Shaft Seal ---------- Replace
2. O-Ring ---------- Replace
3. Primary Pump Housing Cover ---------- Check primary pump housing roller bearing and replace if necessary.
4. Pump Gear
5. Pump Gear
6. Center Panel
7. Bolt ---------- 15Nm, apply nondrying sealant.
8. Front Cover
9. Washer
10. Teflon Ring ---------- 2 pieces
11. Bolt M8 X32 ---------- 20Nm
12. Gasket ---------- Replace
13. Seal ---------- Inspect, Replace
14. Seal ---------- Inspect, Replace
15. Piston LB3
16. Pressure Spring ---------- 20 pieces
17. Spring Plate
18. Snap Ring

Special tools


126 589 02 14 00


201 589 12 43 00


116 589 06 59 00

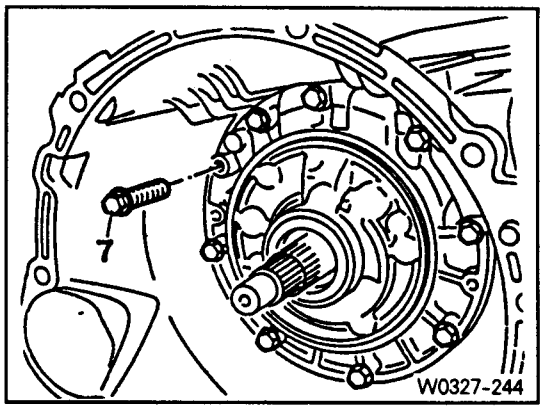

126 589 10 63 00

Pressure spring service standard

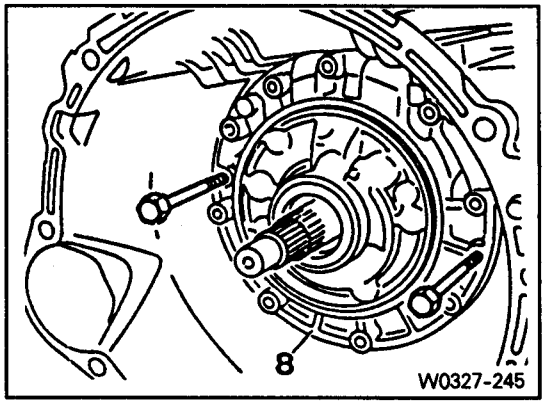
Quantity	20EA
Diameter	ϕ1.1
Free length	29

Removal

1) Remove the bolts (7).

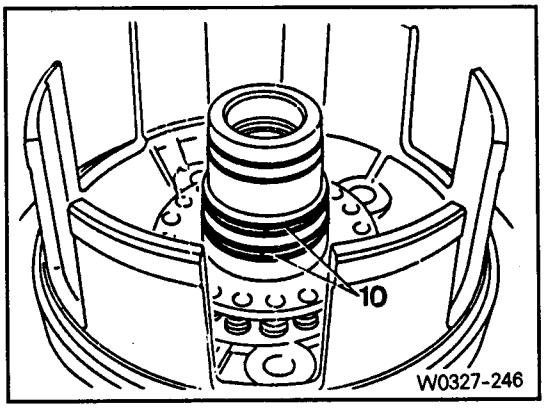


2) Install the service bolts to holes and remove front cover (8) together with the gasket.



Disassembly

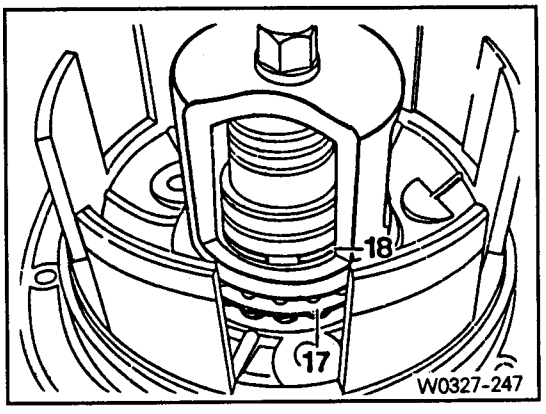
1) Remove the teflon ring (10).



2) Place the spring clamping tool on the spring plate (17), clamp with the counterpiece until the snap ring appears.

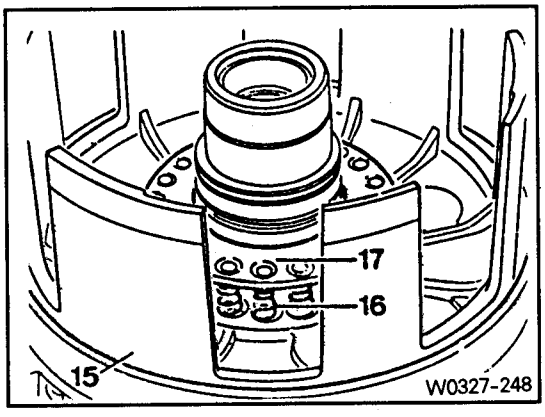
3) Remove the snap ring by pulling it up, and remove the tool.

Spring clamping tool	201 589 12 43 01
Counter piece	201 589 12 43 02



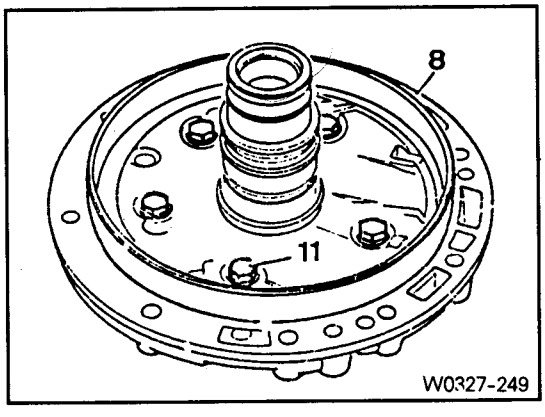
4) Remove the spring plate (17) and pressure springs (16).

5) Pull out the piston LB3 (15).

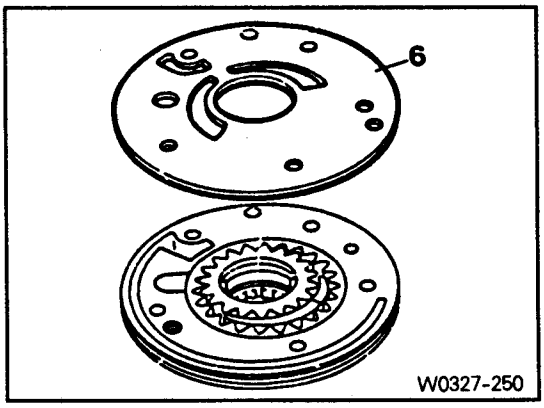


6) Remove the bolts (11).

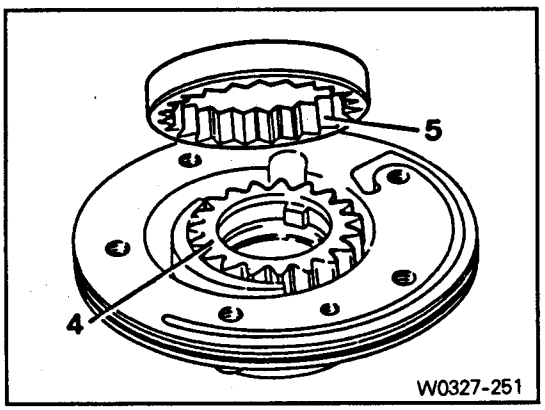
7) Remove the primary pump from the front cover (8).



8) Remove the center panel (6).

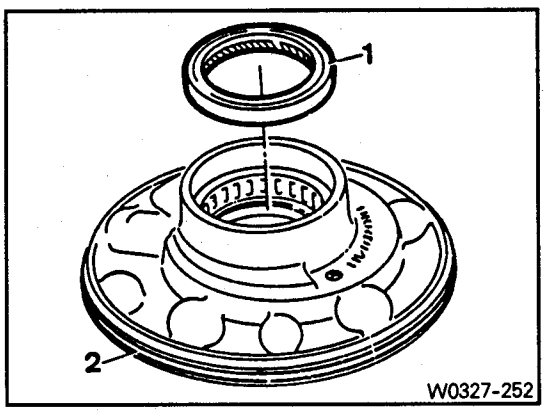


9) Remove the primary pump gear (4, 5) from the primary pump housing.



10) Remove the radial shaft seal (1).

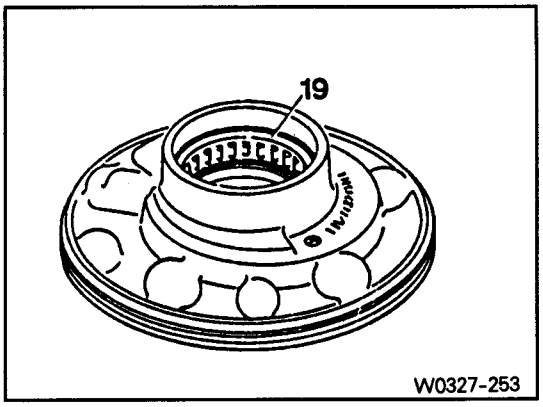
11) Remove the O-ring (2).



Assembly

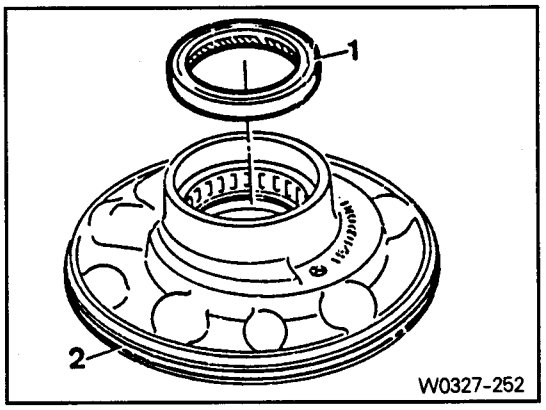
[Note] Clean all the parts and sealing surface, inspect its wear and replace if necessary.

1) Inspect the radial roller bearing (19).
[Note] If the radial roller bearing had been worn out or damaged, replace primary pump.

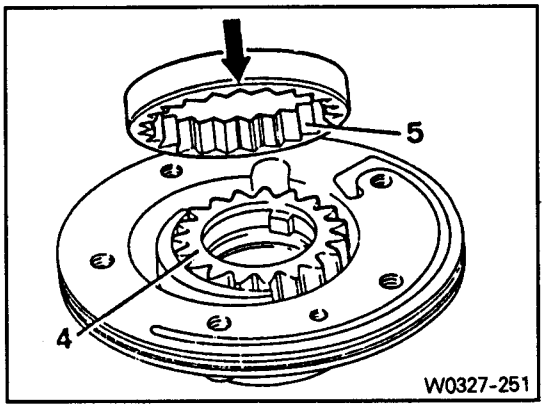


2) Replace the O-ring (2).

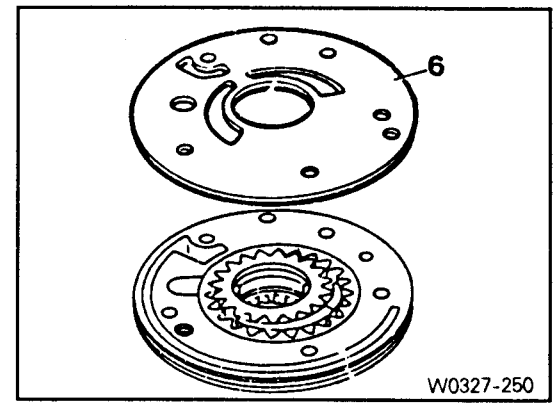
3) Install the radial shaft seal (1).



4) Fill oil to the primary pump gear (4,5) and install it to the primary pump housing.
[Note] Install the pump gear making the bezel (arrow) face the primary pump housing.

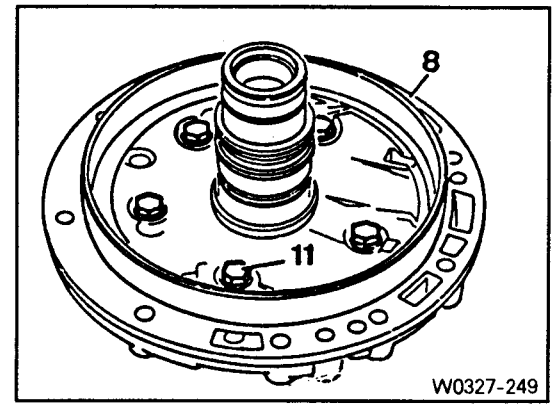


5) Position the center panel (6).

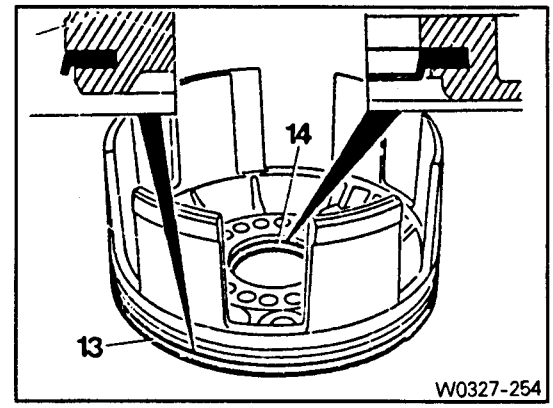


6) Install the primary pump to the front cover (8) and tighten the bolts (11).

Tightening torque	20Nm



7) Inspect the seal (13,14) and, if necessary, replace it .
[Note] Install the sealing rib so that it faces down.



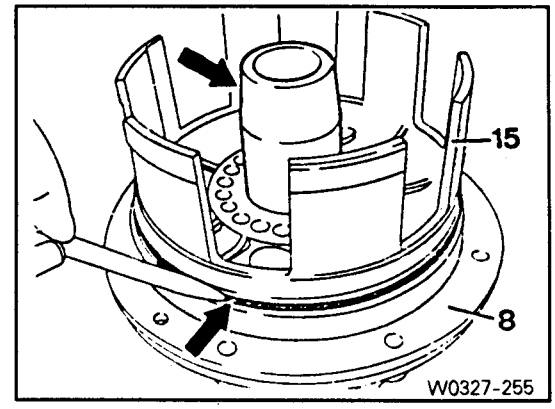
8) Apply oil on the sliding surface of the sleeve.
Install and insert it to the front cover (8).

9) Apply oil on the seal.

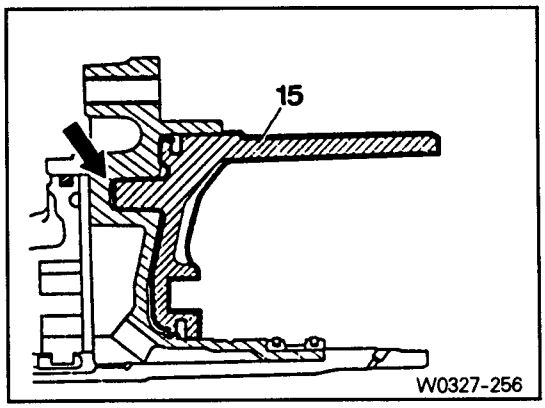
10) Carefully push down the piston LB3 (15) and push the outer seal (arrow) with a pin.

Assembly sleeve 126 589 04 14 00

11) Remove the assembly sleeve.



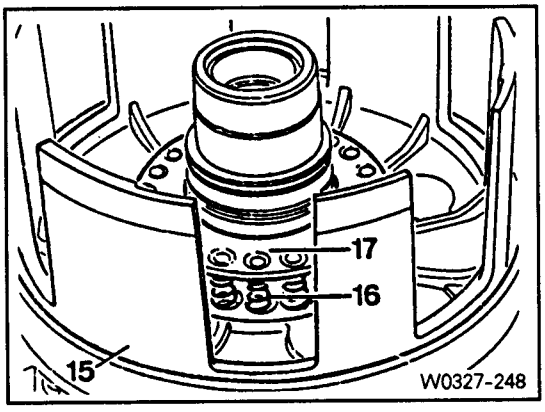
[Note] Insert the piston LB3 (15) so that the pin (arrow) would be accurately fit to the hole on the front cover.



12) Install the pressure spring (16).

13) Install the spring plate (17).

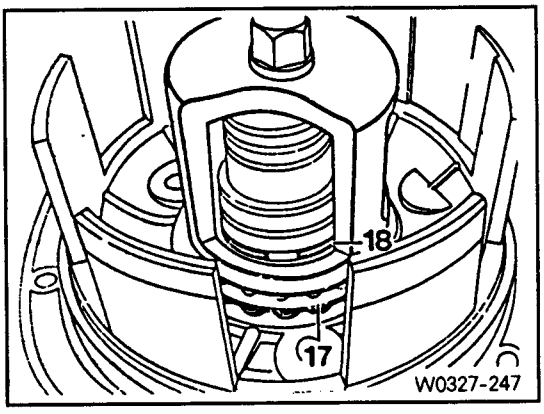
[Note] Align all the springs and the pins of spring plate to the center.



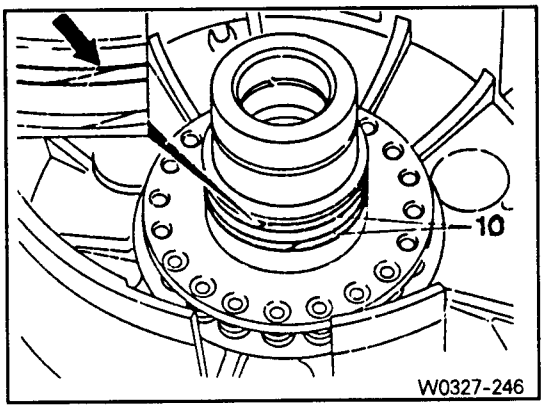
14) Install the spring clamping tool on the spring plate (17) and clamp until the snap ring groove (18) appears.

15) Install the snap ring and remove the tool.

Spring clamping tool	201 589 12 43 01
Counter piece	201 589 12 43 02



16) Install the tefron ring (10) after applying grease on it.



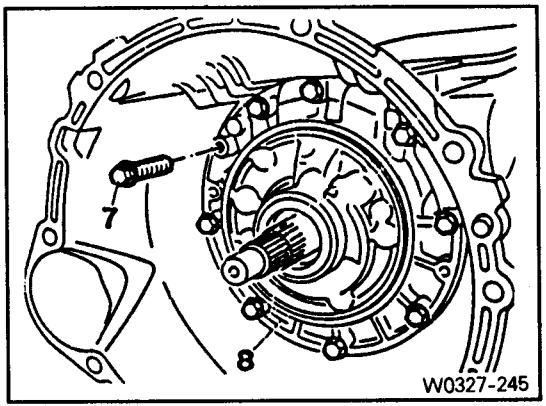
Installation

1) Wipe out the sealing surface of the front cover (7).

2) Install the new gasket to the front cover.
[Note] Do not apply sealant on the gasket.

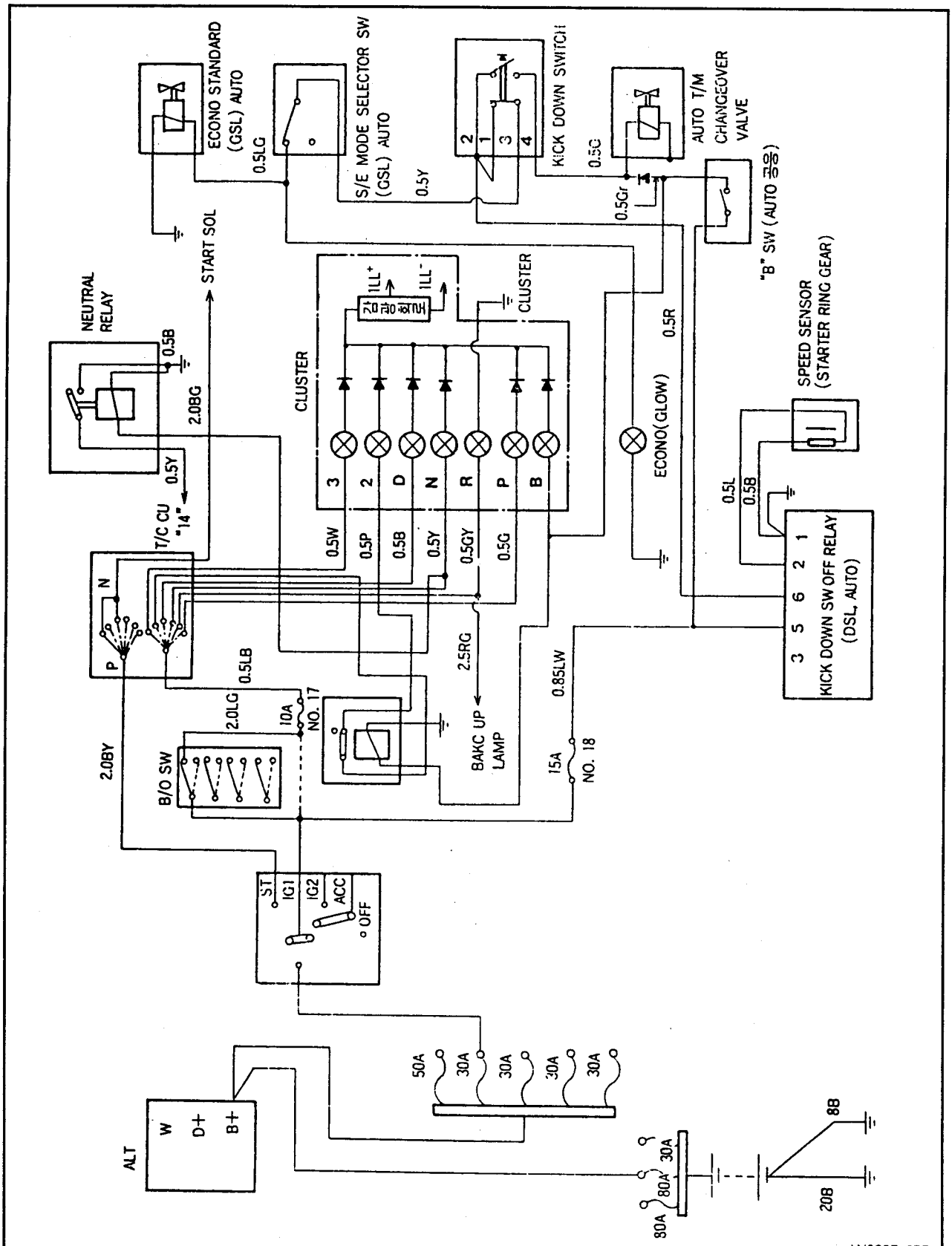
3) Tighten the bolt (7) after applying non-drying sealant.

Tightening torque	15Nm

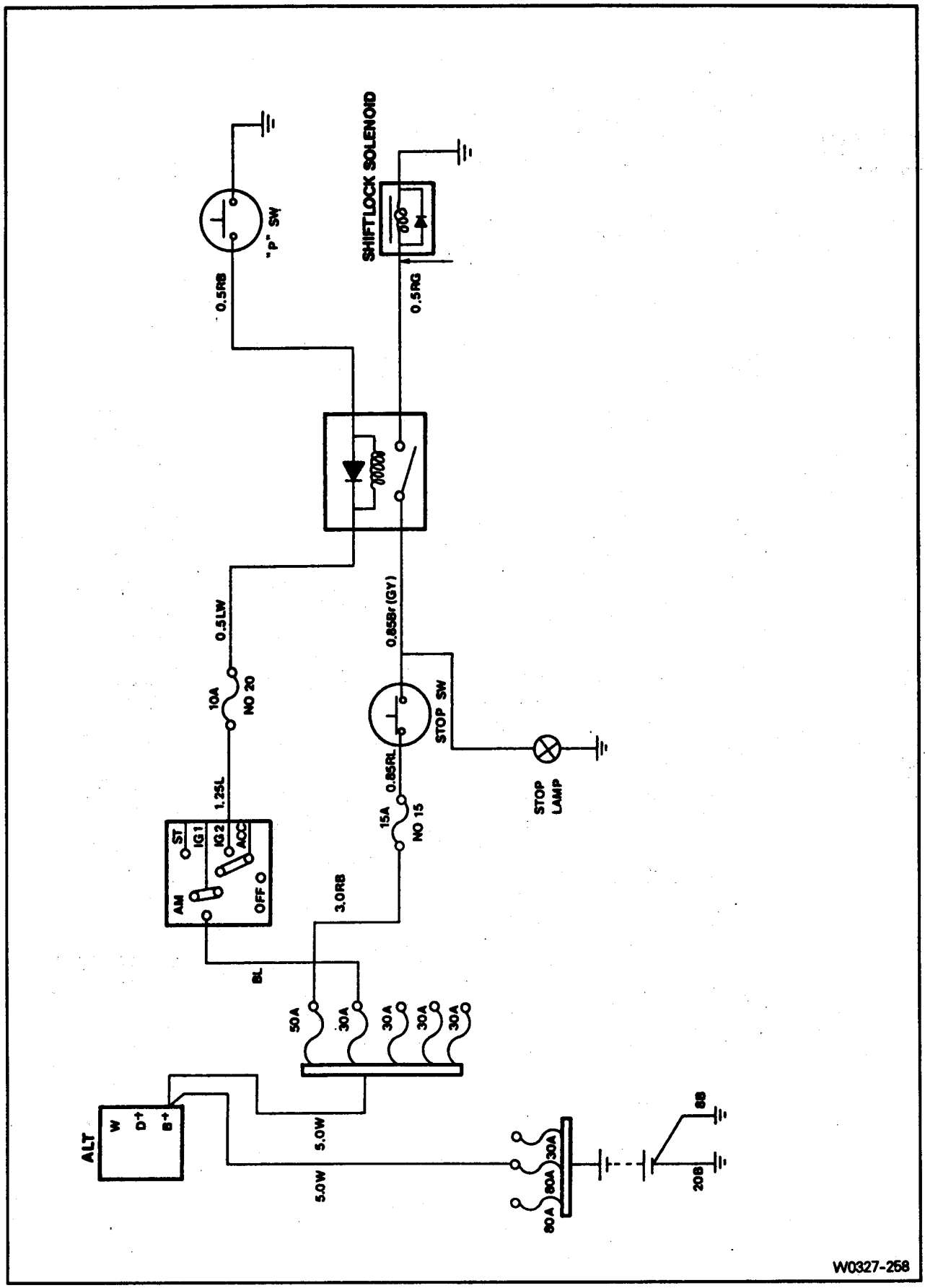


26. Circuit Diagram

Transmission

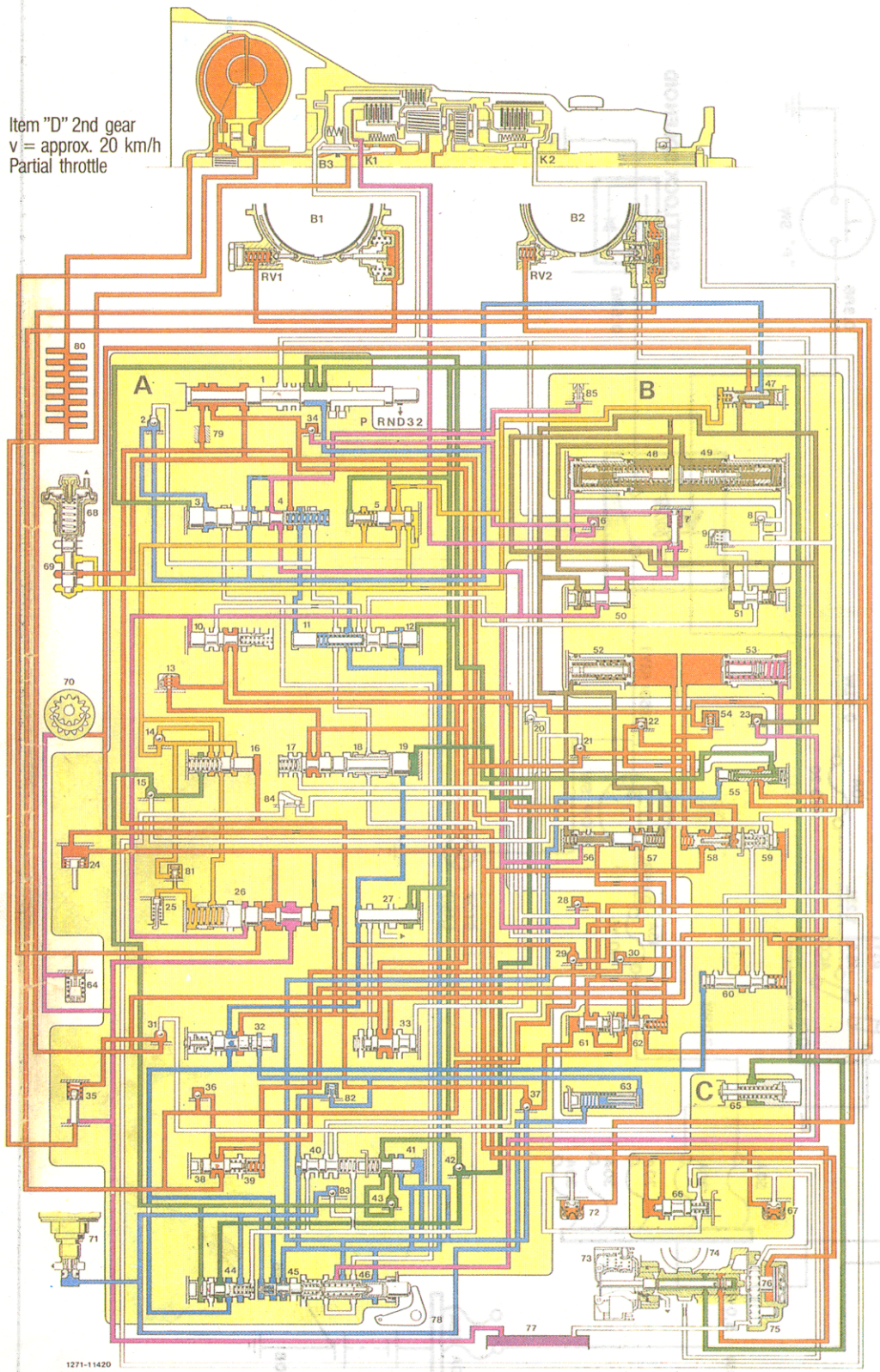


Selector lever lock



27. Hydraulic System

[Note] -Secondary pump is not applied



A
Shift valve housing

1 Selector valve
2 Two-way ball valve
3 Plunger command valve 2–3
4 Command valve 2–3
5 Control valve converter adaptation
6 Ball check valve
7 Shut-off valve K1
8 Ball check valve
9 Plate-type check valve
10 Shift valve B1
11 Plunger command valve 3–4
12 Command valve 3–4
13 Plate-type check valve with throttle
14 Two-way ball valve
15 Two-way ball valve
16 Control valve basic pressure
17 Command valve 1–2
18 Sleeve command valve 1–2
19 Plunger command valve 1–2
20 Two-way ball valve
21 Two-way ball valve
22 Ball check valve
23 Ball check valve
24 Check valve primary pump
25 Pressure relief valve modulating pressure (B) *)
26 Control valve working pressure
27 Plug shift valve bridging clutch
28 Ball check valve
29 Two-way ball valve
30 Ball check valve
31 Two-way ball valve
32 Control valve full throttle
33 Shift valve B2
34 Two-way ball valve
35 Shift pin lubricating pressure
36 Ball check valve
37 Two-way ball valve
38 Control valve B1
39 Plunger control valve B1
40 Shift valve kickdown
41 Shift valve governor pressure
42 Two-way ball valve
43 Two-way ball valve
44 Booster valve governor pressure
45 Control valve control pressure
46 Plunger control valve control pressure
81 Throttle check valve with strainer
82 Throttle check valve
83 Ball check valve
84 Throttle check valve

B
Accumulator housing

47 Shift control pressure valve
48 Accumulator K1
49 Accumulator K2
50 Control valve accumulator K1
51 Control valve accumulator K2
52 Accumulator B1
53 Accumulator switching on
54 Check valve (A) *)
55 Shut-off valve RV2
56 Shift valve deceleration shift
57 Control valve accumulator B1
58 Control valve accumulator switching on
59 Shift valve K2
60 Detent valve B2
61 Shut-off valve brake circuit
62 Shut-off valve RV1
63 Accumulator kickdown
64 Lubricating pressure valve
85 Pressure limiting valve

C
Lower cover

65 Shut-off plunger reverse gear
66 Shift valve secondary pump
67 Check valve

Hydraulic components transmission housing and front cover

68 Vacuum box
69 Control valve modulating pressure
70 Primary pump
71 Solenoid valve kickdown
72 Check valve
73 Centrifugal governor
74 Drive for governor and secondary pump
75 Secondary pump
76 Switch-off plunger secondary pump
77 Oil filter
78 Reverse-transfer lever for control pressure cable
79 Temperature throttle K1

Radiator

80 Oil cooler for automatic transmission

*) installed in housing section as shown in parenthesis

A Working pressure
SR Lubricating pressure
M1 Modulating pressure (vacuum-dependent)
R Governor pressure
S1 Control pressure (constant)
S3 Kickdown control pressure (S2 control pressure-dependent)
RA Oil quantity or circulated by oil
SD Shift control pressure
M2 Modulating pressure (speed-dependent)
VR Increased governor pressure
S2 Control pressure (load-dependent)

1. General

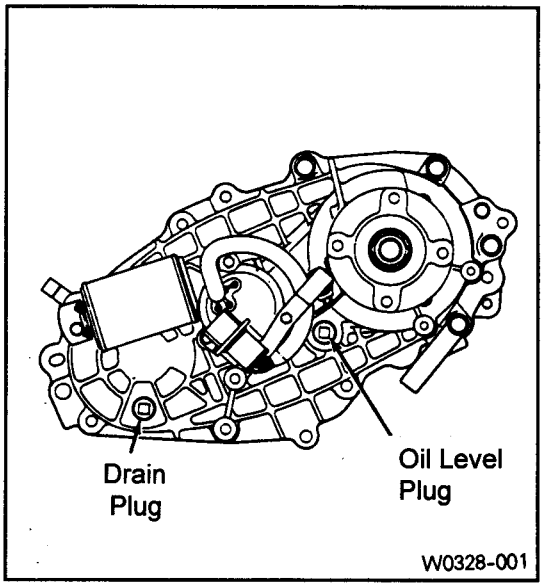
Specifications

Model		Part-time 4408 (E)
Type		E.S.O.F. type
Gear ratio	High	1 : 1
	Low	2.48 : 1
Oil	Specification	DEXRON II
	Capacity	1.4 ℓ
	Lubrication	Check : every 15,000km Replace : every 50,000km
Manufacturer		BorgWarner
Weight		30kg

Maintenance of transfer case lubricant

1) Oil level check
- Clean the oil level plug and surrounding area.
- Remove the oil level plug and check whether oil is drip out or not.
- Replenish if necessary.
- Tighten the oil level plug.

Tightening torque	20~30Nm



2) Oil change
- Clean the oil level plug, drain plug and surrounding area.
- Place a suitable container under the transfer case.
- Remove the drain plug first and remove the oil level plug.
- Drain the oil and tighten the drain plug.
- Fill the oil through the oil level plug until oil begins to drip out.
- Tighten the oil level plug.

3) Cautions for oil level check and plugs tightening.
- Check or drain the oil, after warming up the transfer case with driving.
- Do not use an impact wrench to remove or tighten the oil level plug or drain plug since this will damage the threads in the transfer case.

2. Troubleshooting

A. General

Problem	Possible Cause	Remedy
Electric shift problems	Faulty or damaged TCCU, speed sensor, motor, clutch or internal wirings	Overhaul and check Replace if necessary
	Damaged or worn shift cam, hub, fork and rail shift	Overhaul and check for wear and damage. Replace if necessary.
	Binding shift fork, hub collar or gear	Check sliding parts and replace if necessary
No front wheel drive when shifted 4H, 4L	Broken drive chain	Check internal parts and replace if necessary
Noise in 4WD operation	Improper or low oil	Drain and replace with specified oil
	Loosened bolts or mounted parts	Retighten as specified
	Noisy T/C bearing	Disassemble bearings and parts and check for wear or damage. Replace if necessary
	Noisy gears	Check for wear and damage including speedometer gear and replace if necessary
Noise in 4H or 4L	Worn or damaged sprockets or drive chain	Disassemble and check for wear and damage and replace if necessary
	Incorrect tire pressure	Adjust tire pressure
Transfer case oil leakage	Cracked transfer case	Replace the case
	Leakage from other parts	Clean case and parts and check for leakage
	Breather clogging	Remove breather hose and clean and replace if necessary
	Improper or too much oil	Use specified oil and adjust oil level
	Loosened sealing bolts	Retighten
	Improperly applied sealant	Use specified sealant and retighten
	Worn or damaged oil seal	Replace

B. Self-diagnosis

System description

1) TCCU detects transfer case system malfunctions and indicates malfunctioning part(s) through flashing 4H, 4L indicator lights.
   Using a service connector, connect it to the diagnosis box in the engine room and read the flashing of the '4WD CHECK' indicator light.
   The flashing indicator light will show you defective code(s).

2) Identify 7 defective codes after reading the flashing indicator light.
   - TCCU
   - Shift motor
   - Magnetic synchronizer clutch
   - Speed sensor
   - Hub solenoid
   - Selector switch
   - Motor position sensor

3) Transfer case system is malfunctioning when :
   - 4H, 4L indicator lights are remain on after 0.6 second when turn the ignition switch 'ON'.
   - 4H, 4L indicator lights are continuously come on during driving.

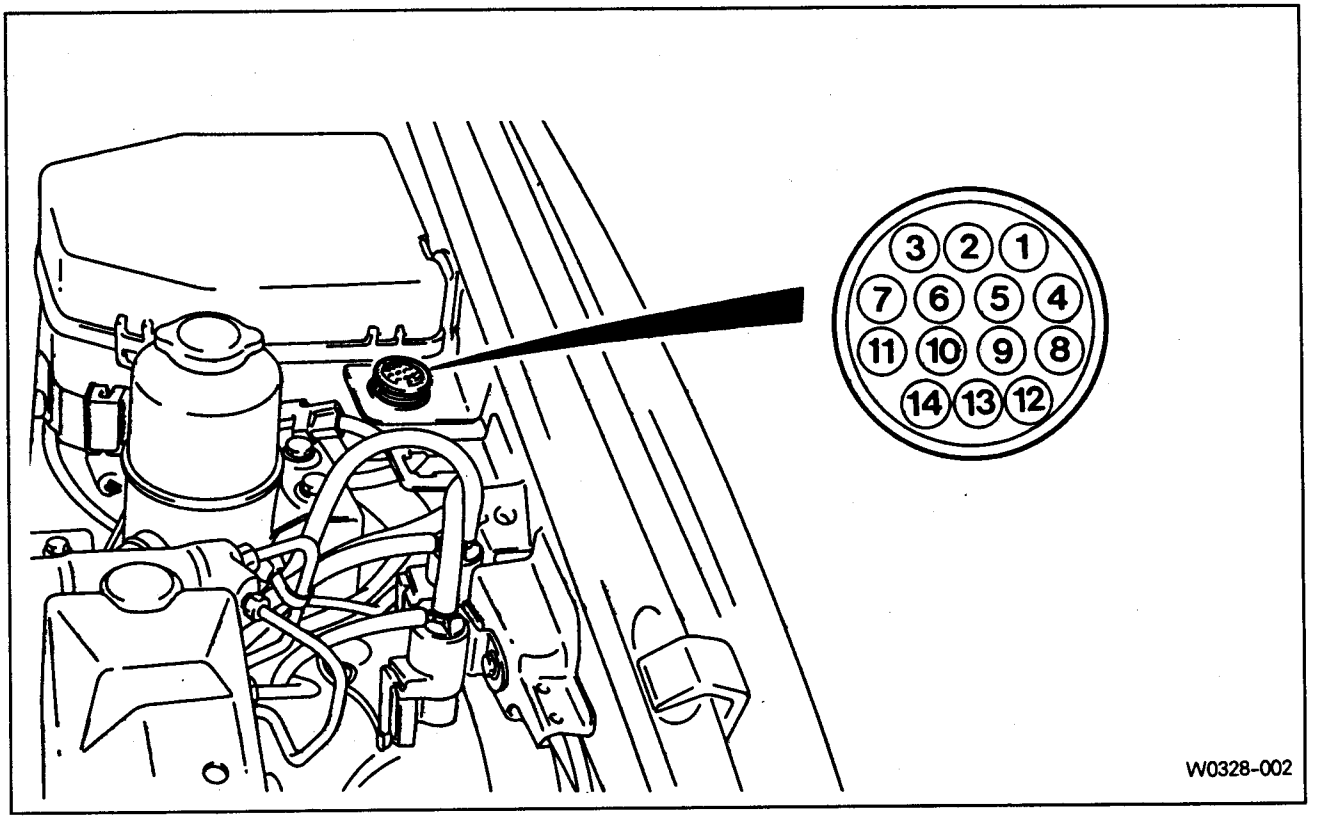
4) If only 1 part is malfunctioning, '4WD CHECK' indicator light will display defective code 3times continuously.

5) If more than 2 parts are malfunctioning, the first malfunctioning part will be displayed 3 times and following malfunctioning parts will be displayed.

6) To read defective code, connect the service connector and turn the ignition switch 'ON'.

7) After repair, erase the defective code stored in the TCCU.
   [Note] Before replacing the malfunctioning parts with defective code, check the wires and connectors for proper condition.

Diagnosis box in the engine room



Defective code reading

1) Position the ignition switch to 'OFF'

2) Using a service connector, connect the no.2 pin (Ignition) and no. 6 pin (TCCU) of the diagnosis box in the engine room.

3) Position the ignition switch to 'ON'.

4) Read the flashing '4WD CHECK' indicator light and identify the malfunctioning part.

How to erase defective code

1) Position the ignition switch to 'OFF'.

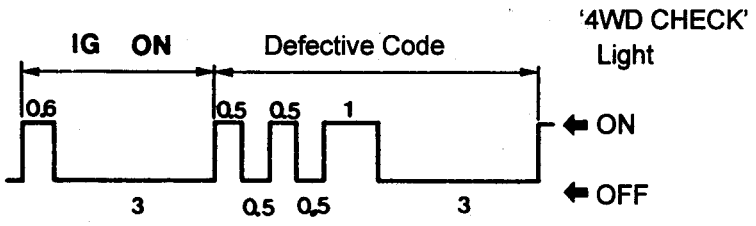
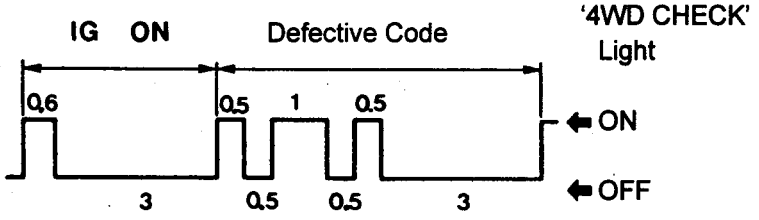
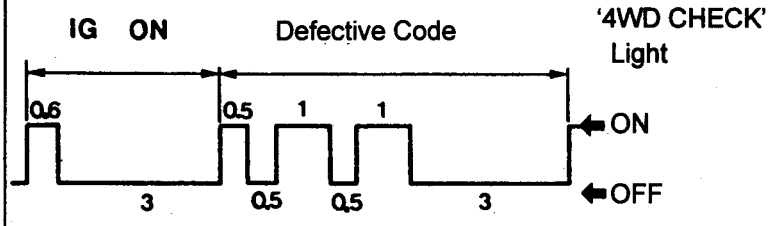
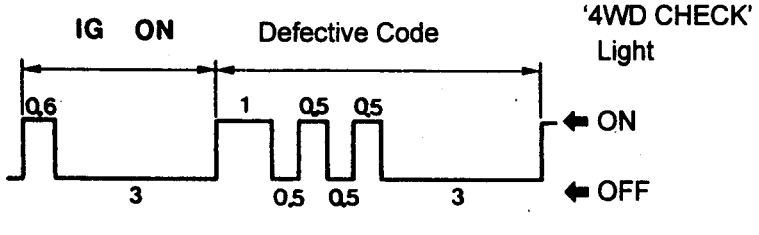
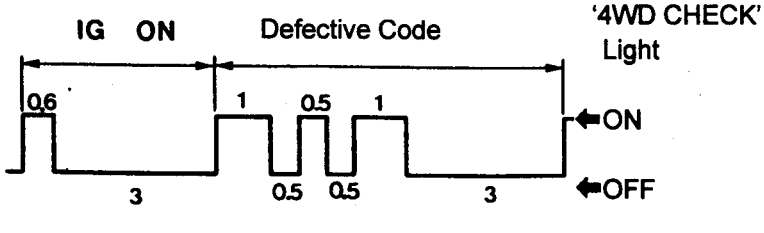
2) Using a service connector, connect the no. 1 pin (Ground) and no. 6 pin (TCCU).

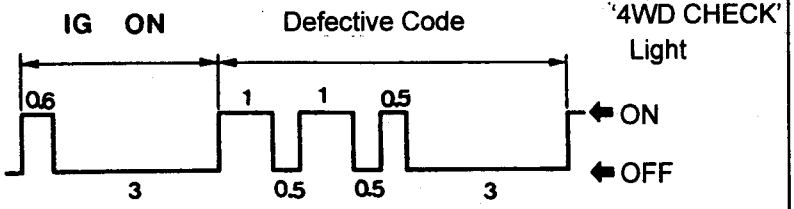
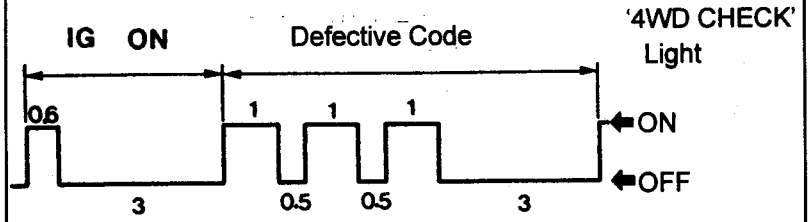
3) Position the ignition switch to 'ON' over 5 seconds.

4) Do defective code reading and make sure that all defective codes are erased.

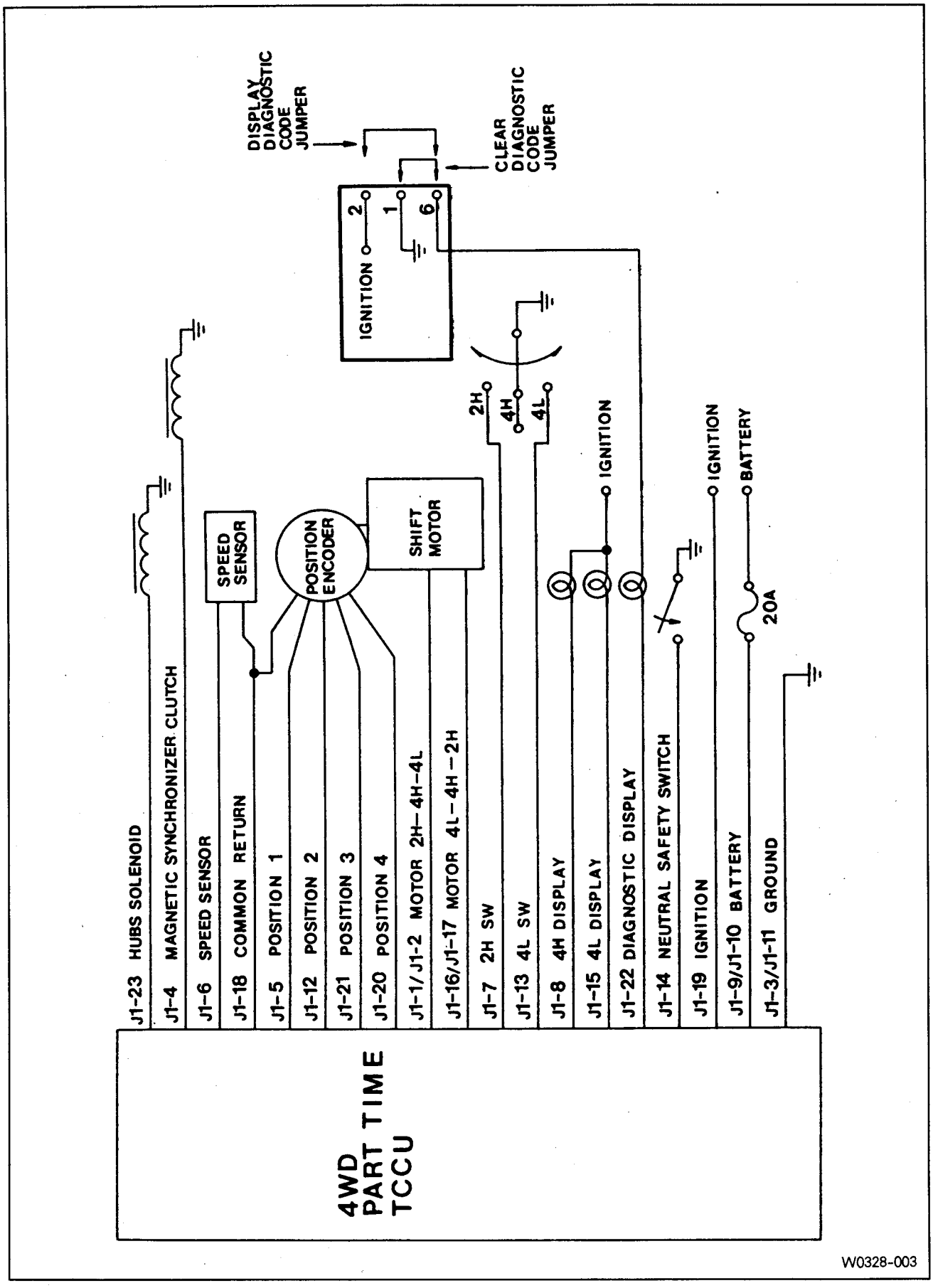
Diagnostic table

Connect a service connector. If turn the ignition switch 'ON', '4WD CHECK' indicator light will come on for 0.6 second and turn off for 3 seconds and then display a defective code 3times continuously.

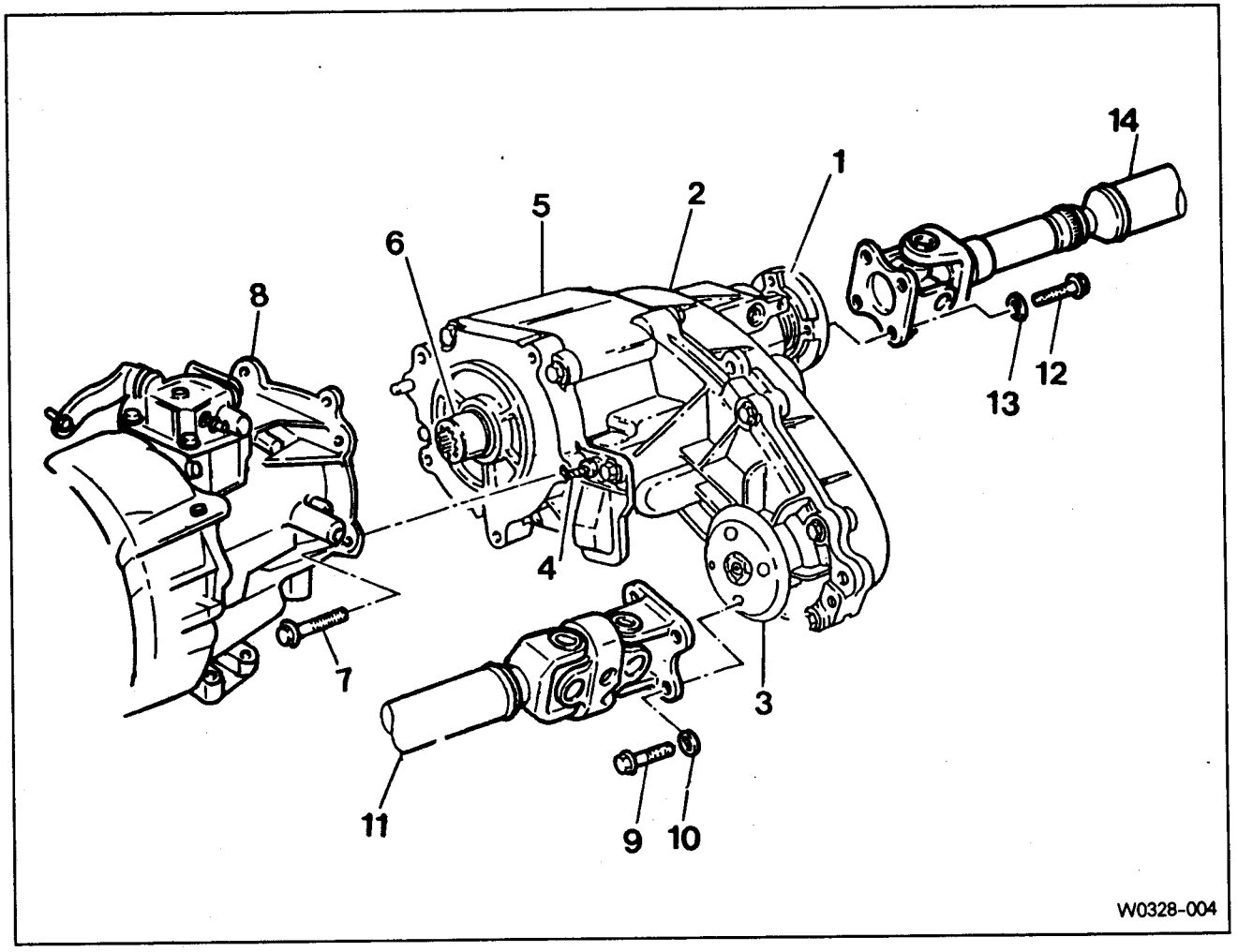
No.	Defective Code	Malfunctioning Part
1		TCCU
2		Shift Motor
3		Synchronizer Clutch
4		Speed Sensor
5		Hub Solenoid

No.	Defective Code	Malfunctioning Part
6		Selector Switch
7		Motor Position Sensor

Diagnostic diagram



3. Removal and Installation of Transfer Case



1. Companion Flange
2. Case Cover
3. Front Companion Flange
4. Breather Plug
5. Transfer Case Adapter
6. Input Shaft
7. Mounting Bolt----------35~60Nm
8. Transmission Adapter
9. Bolt----------81~89Nm
10. Washer
11. Front Propeller Shaft
12. Bolt----------70~90Nm
13. Washer
14. Rear Propeller Shaft

Removal · Installation

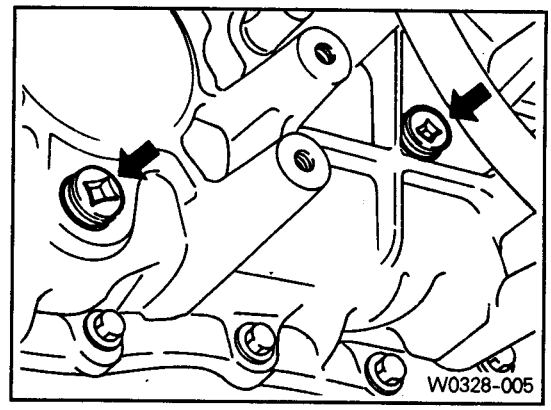
1) Disconnect the negative terminal from the battery.

2) Lift up the vehicle and fix it safely.

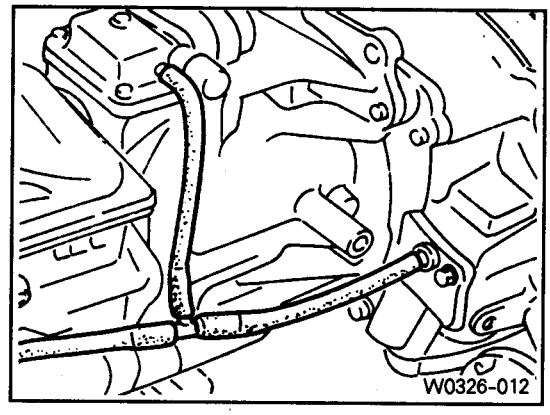
3) Remove the transfer case drain plug and drain the oil. Reinstall the drain plug.

Installation

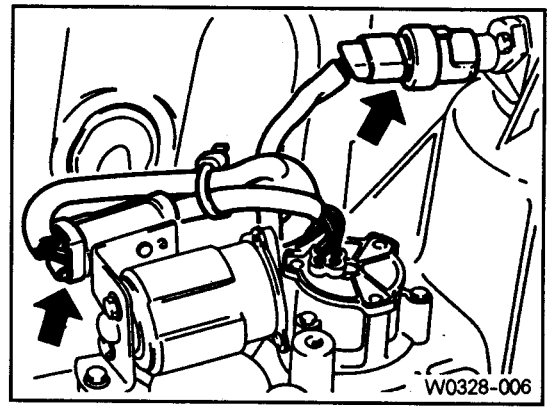
Tightening torque	19~30Nm



4) Remove the breather hose.



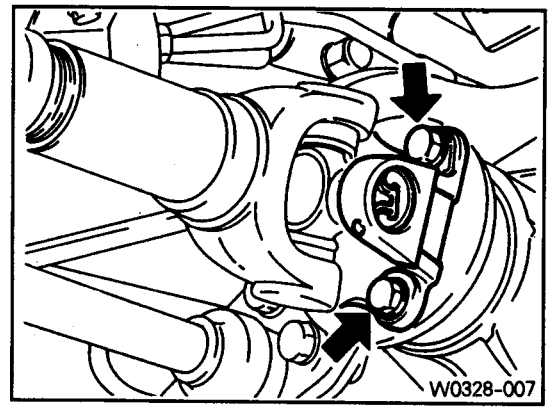
5) Disconnect the speedometer cable connector and other cable connectors and wiring harnesses.



6) Support the transfer case with jack and remove the front and rear propeller shafts from the transfer case.

Installation

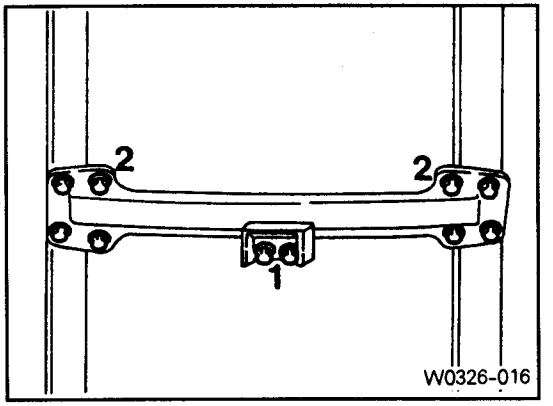
Tightening torque	Front	81~89Nm
	Rear	70~90Nm



7) Remove the center mounting nuts and end sides mounting bolts of the cross member and then remove the cross member.

Installation

Tightening torque (1)	21~35Nm
Tightening torque (2)	62~93Nm



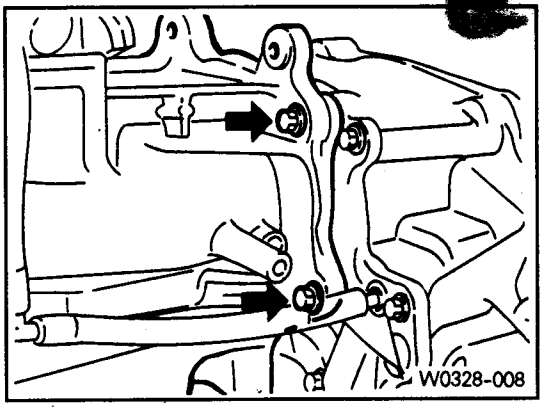
8) Remove the transfer case by removing the bolts attaching the transfer case to the transmission.

Installation

Tightening torque	35~60Nm

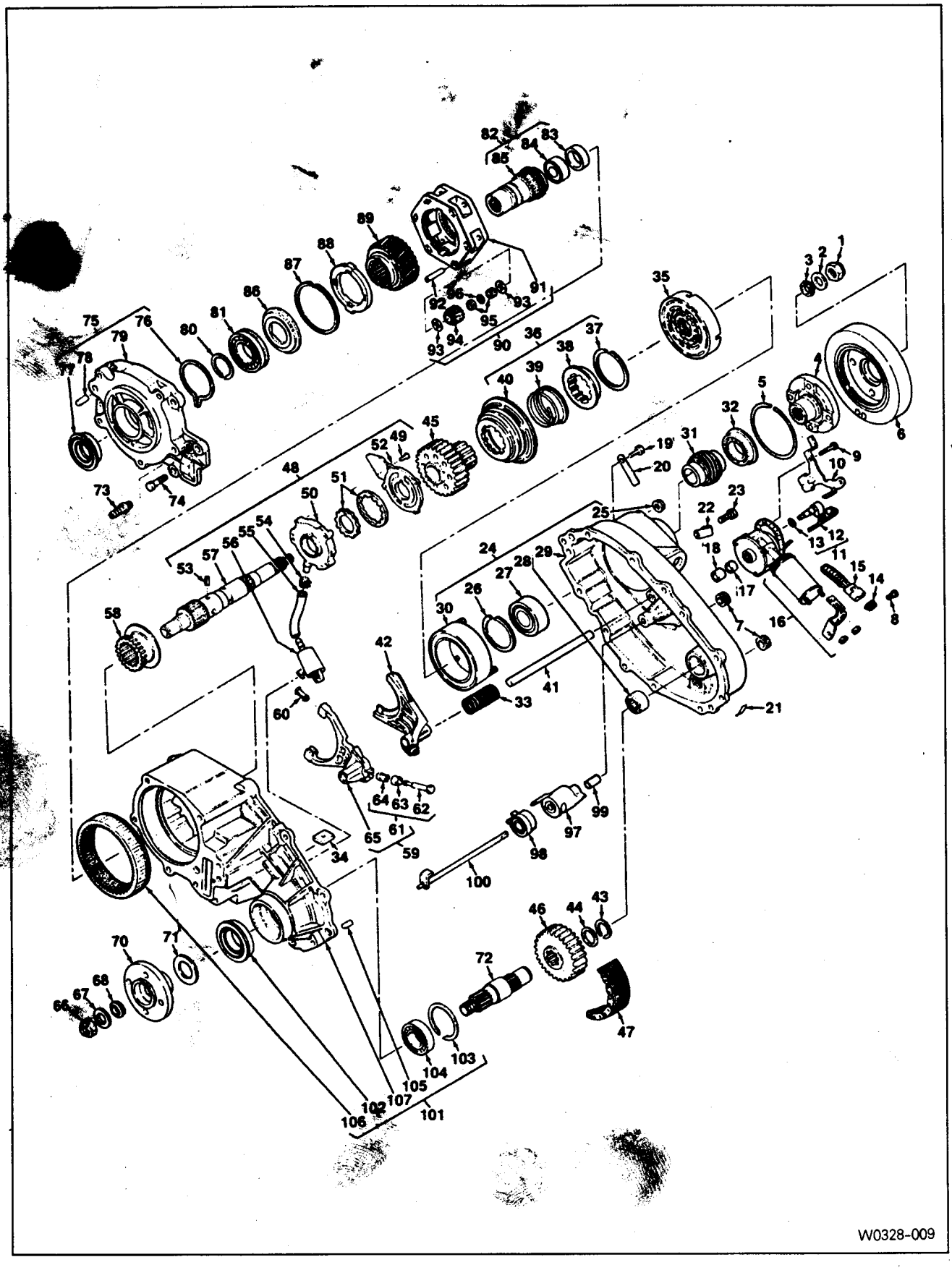
[Note] Apply long-term grease to the inner spline of the transfer case input shaft.

9) Installation is reverse order of the removal.



4. Disassembly and Assembly of Transfer Case

Preceding work : Removal of the transfer case (28-09)



1. Nut
2. Spring Washer
3. Oil Seal
4. Companion Flange
5. Snap Ring
6. Torsional Damper
7. Pipe Plug
8. Bolt
9. Bolt
10. Speed Sensor and Harness Bracket
11. Speed Sensor Assembly
12. Speed Sensor
13. O-Ring
14. Locking Clip
15. Connector
16. Motor Assembly
17. Oil Seal
18. Bearing
19. Bolt
20. Tag
21. Decalcomania
22. Wiring Harness Clip
23. Bolt
24. Cover Assembly
25. Nut
26. Snap Ring
27. Bearing
28. Needle Bearing
29. Transfer Case Cover
30. Clutch Coil Assembly
31. Speed Gear
32. Oil Seal
33. Return Spring
34. Magnet
35. Clutch Housing
36. Lock-up Assembly
37. Snap Ring
38. Lock-up Hub
39. Sleeve Return Spring
40. Lock-up Collar
41. Rail Shaft
42. Lock-up Fork
43. Snap Ring
44. Spacer
45. Drive Sprocket
46. Driven Sprocket
47. Drive Chain

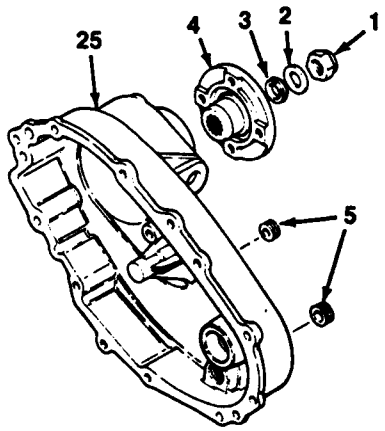
49. Screw
50. Pump Housing
51. Pump Gear Set
52. Pump Cover
53. Spring Pin
54. Hose Clamp
55. Hose Coupling
56. Oil Strainer
57. Output Shaft
58. Reduction Hub
59. Shift Fork Assembly
60. Shift Fork Facing
61. Pin, Roller and Retainer
62. Pin
63. Cam Roller
64. Retainer
65. Reduction Shift Fork
66. Nut
67. Flat Washer
68. Oil Seal
70. Companion Flange
71. Spacer
72. Front Output Assembly
73. Breather Hose
74. Bolt
75. Front Adapter Assembly
76. Snap Ring
77. Oil Seal
78. Spirol Pin
79. Front Adapter
80. Snap Ring
81. Bearing
82. Input Shaft Assembly
83. Sleeve Bearing
84. Needle Bearing
85. Input Shaft
86. Thrust Washer
87. Retaining Ring
88. Thrust Plate
89. Sun Gear
90. Gear Carrier Assembly
91. Planet Carrier
92. Pinion Shaft
93. Thrust Washer
94. Pinion Gear
95. Needle Roller Bearing
96. Pinion Needle Spacer
97. Electric Shift Cam
98. Torsion Spring
99. Spacer
100. Shift Shaft
101. Case Assembly
102. Oil Seal
103. Snap Ring
104. Bearing
105. Dowel Pin
106. Ring Gear
107. Transfer Case

Disassembly

<Companion flange>

1) Holding the companion flange, remove the nut and washer and then remove the companion flange and oil seal.

2) Remove the 2 plugs from the cover.



1. Nut
2. Washer
3. Oil Seal
4. Companion Flange
5. Plug
25. Cover

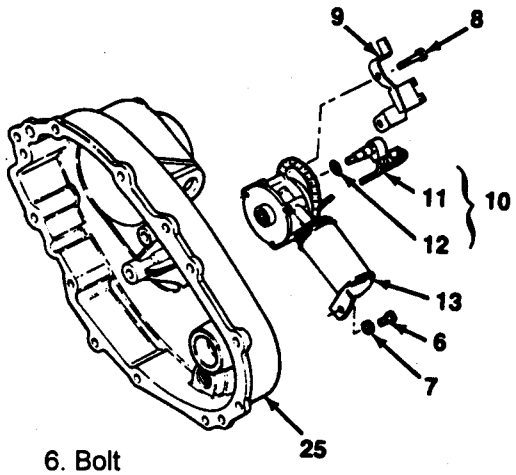
W0328-010

<External electric shift>

1) Remove the bolt, washer, 3 bolts and harness bracket.

2) Remove the sensor assembly and remove the O-ring from the speed sensor.

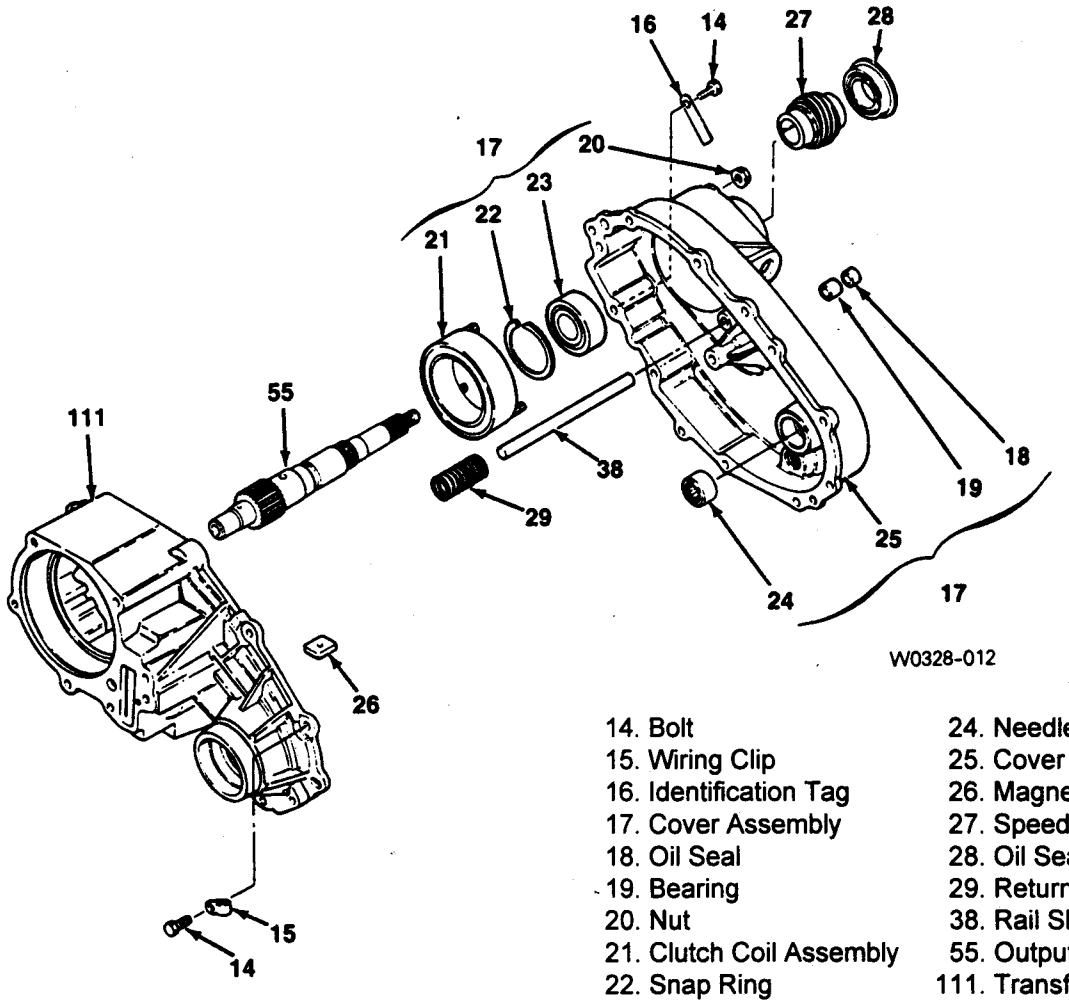
3) Remove the motor assembly.



6. Bolt
7. Washer
8. Bolt
9. Sensor and Harness Bracket
10. Sensor Assembly
11. Speed Sensor
12. O-Ring
13. Motor Assembly
25. Cover

W0328-011

<Cover assembly>



14. Bolt
15. Wiring Clip
16. Identification Tag
17. Cover Assembly
18. Oil Seal
19. Bearing
20. Nut
21. Clutch Coil Assembly
22. Snap Ring
23. Ball Bearing
24. Needle Bearing
25. Cover
26. Magnet
27. Speed Gear
28. Oil Seal
29. Return Spring
38. Rail Shaft
55. Output Shaft
111. Transfer Case

1) Remove the 9 bolts, wiring harness clip and identification tag.
   [Note] Identification tag has information required for ordering replacement parts, so be careful not to lose it.
2) Using a '-' driver, pry and disconnect the sealant bond of the cover and transfer case.
3) Remove the oil seal, bearing, 3 nuts and clutch coil assembly of the electric shift unit.
4) Remove the snap ring and pull out the ball bearing from the cover to remove the speed gear.
5) Pull out the needle bearing from the cover.
6) Pull out the oil seal from the cover.
7) Remove the magnet from the slot in case.
8) Remove the return spring from the rail shaft.
9) Be careful not to damage the metal surface when removing the sealant of the cover and case.

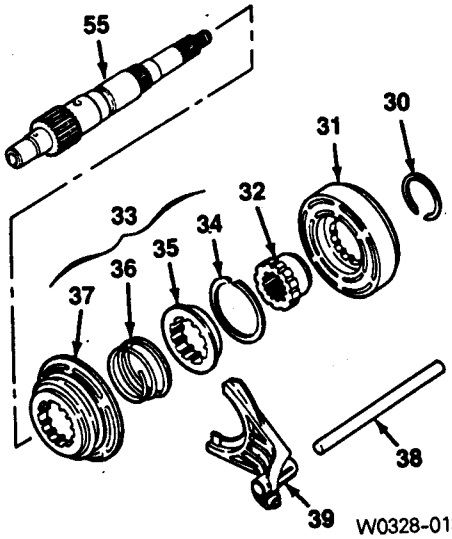
<Lock-up shift parts>

1) Remove the retaining ring and clutch housing from the shift collar hub.

2) Remove the shift collar hub from the output shaft.

3) Separate the 2WD - 4WD lock-up assembly and lock-up fork from the output shaft and remove the rail shaft.

4) To remove the 2WD - 4WD lock-up assembly, separate the return spring, lock-up hub and snap ring from the lock-up collar.



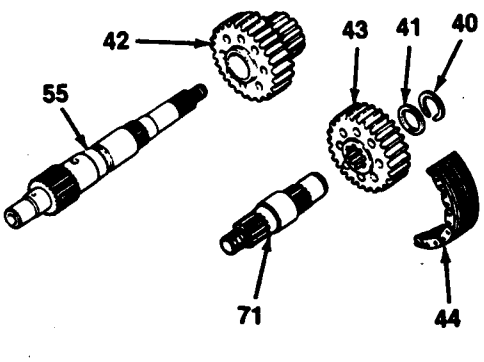
30. Retaining Ring
31. Clutch Housing
32. Shift Collar Hub
33. 2WD-4WD Lock-up Assembly
34. Snap Ring
35. Lock-up Hub
36. Return Spring
37. Lock-up Collar
38. Rail Shaft
39. Lock-up Fork
55. Output Shaft

<Drive chain>

1) Remove the snap ring and spacer from the output shaft.

2) Remove the drive chain, driven sprocket and drive sprocket from the output shaft.

3) Separate the chain and sprocket when removing the assembly.



40. Snap Ring
41. Spacer
42. Drive Sprocket
43. Driven Sprocket
44. Drive Chain
55. Output Shaft (Rear)
71. Output Shaft (Front)

<Pump parts>

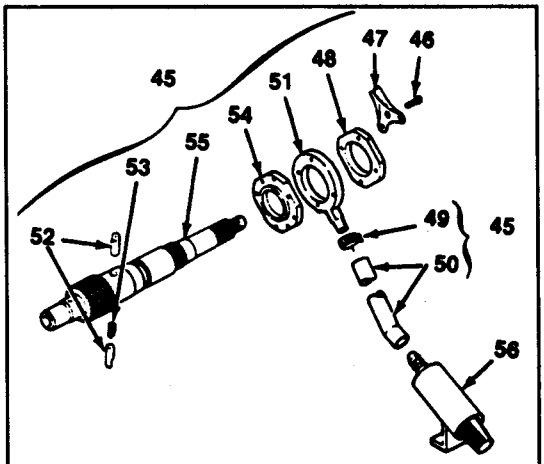
1) Remove the 4 bolts and retainer and separate the output shaft and rear pump cover.

2) Loosen the hose clamp and remove the hose coupling from the pump housing.

3) Remove the hose clamp, hose coupling and strainer.

4) Remove 2 pump pins and spring from the output shaft.

5) Separate the front pump and remove the output shaft.



W0328-015

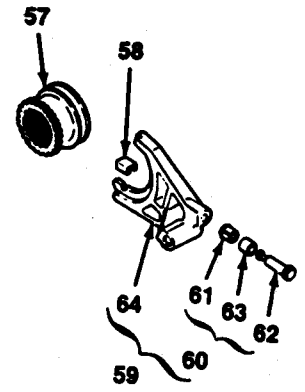
45. Shaft and Pump Assembly
46. Bolt
47. Pump Retainer
48. Rear Pump Cover
49. Hose Clamp
50. Hose Coupling
51. Pump Housing
52. Pump Pin
53. Spring
54. Front Pump Cover
55. Output Shaft
56. Strainer

<Reduction shift parts>

1) Remove the reduction hub and reduction shift fork assembly from the case.

2) Remove the 2 shift fork facings from the shift fork assembly.

3) To remove the roller cam and pin, cut off the plastic retainer when disassembling the fork assembly.



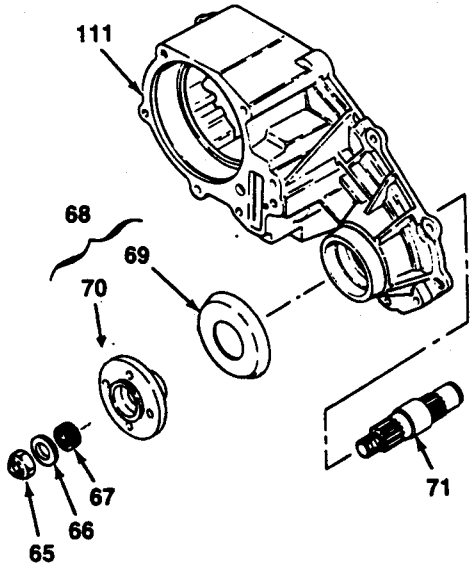
W0328-016

57. Reduction Hub
58. Shift Fork Facing
59. Reduction Shift Fork Assembly
60. Roller Pin and Retainer Assembly
61. Retainer
62. Pin
63. Roller Cam
64. Reduction Shift Fork

<Front output assembly>

1) Holding the companion flange, remove the nut and washer and then remove the companion flange and oil seal.

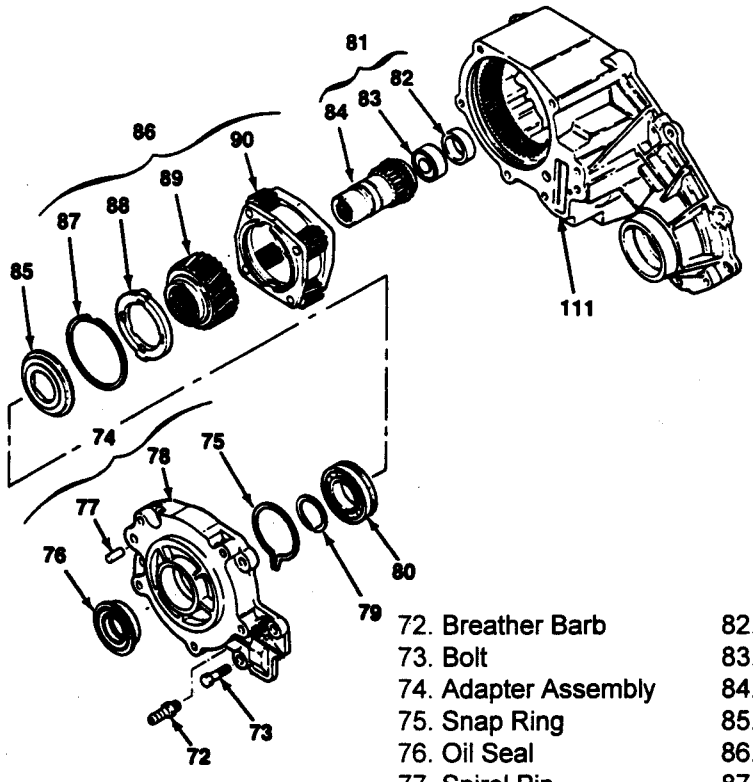
2) Separate the companion flange and deflector and remove the output shaft.



W0328-017

65. Nut
66. Washer
67. Oil Seal
68. Companion Flange Assembly
69. Deflector
70. Companion Flange
71. Output Shaft (Front)
111. Transfer Case

<Adapter, input shaft and carrier gear>



W0328-018

72. Breather Barb
73. Bolt
74. Adapter Assembly
75. Snap Ring
76. Oil Seal
77. Spirol Pin
78. Front Adapter
79. Retaining Ring
80. Bearing
81. Input Shaft Assembly
82. Sleeve Bearing
83. Needle Bearing
84. Input Shaft
85. Thrust Bearing
86. Carrier Gear Assembly
87. Retaining Ring
88. Thrust Plate
89. Sun Gear
90. Planet Carrier Assembly
111. Transfer Case

1) Remove the breather barb.

2) After removing 6 bolts, remove the front adapter by separating the adapter sealer bond from the case using a ' - ' driver.
[Note] Be careful not to damage the contacting surface of the case and adapter.

3) Remove the adapter assembly, input shaft assembly and carrier gear assembly.

4) Remove the snap ring and oil seal from the front adapter.

5) After removing snap ring, pull out the bearing and thrust washer from the input shaft assembly and separate the input shaft assembly from the carrier gear assembly.

6) Remove the needle bearing and sleeve bearing from the input shaft assembly.

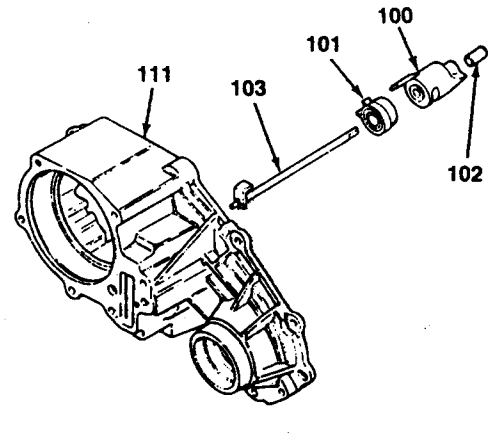
7) Remove the retaining ring, thrust plate and sun gear from the planet carrier assembly.
[Note] Do not disassemble the planet carrier assembly.

<Electric shift cam parts>

1) Remove the electric shift cam parts from the case assembly.

2) Separate the electric shift cam from the shift shaft.

3) Holding the shift shaft in a vise, remove the torsion spring and spacer from the shift shaft using a '-' driver.



W0328-019

100. Electric Shift Cam
101. Torsion Spring
102. Spacer
103. Shift Shaft
111. Transfer Case

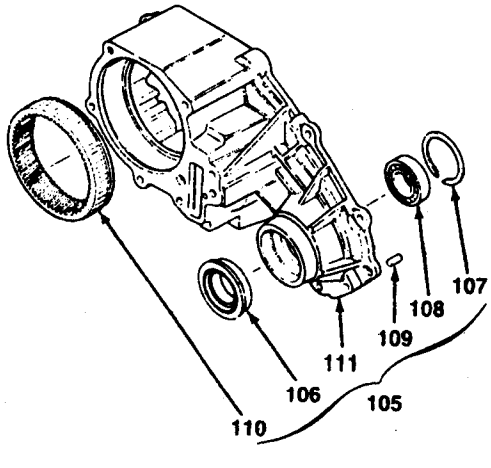
<Transfer Case Assembly>

1) Remove the oil seal.

2) Remove the retaining ring and bearing.

3) Remove the pin from the transfer case.
[Note] Be careful not to damage the pin.

4) Using a press, remove the ring gear from the case.
[Note] If removed, replace the ring gear.



W0328-020

105. Transfer Case Assembly
106. Oil Seal
107. Retaining Ring
108. Ball Bearing
109. Pin
110. Ring Gear
111. Transfer Case

Cleaning

[Note] Before cleaning, check the magnet for the presence of metal particles which indicate internal chipping of the transfer case.

1) Using cleaning solvent, clean the old oil and dirt deposits.
   [Note] During cleaning, be careful not to damage the metal surfaces.

2) After cleaning, dry the parts with low pressure (Max. 20 psi) compressed air.

3) Lubricate the ball bearings and needle bearings with transfer case oil after cleaning.
   [Note] Protect the lubricated bearings from dust.

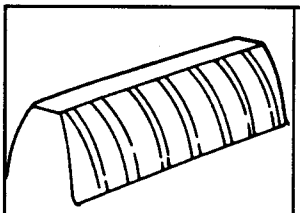
Inspection

1) Visually check the all removed parts.
   [Note] Always replace the hose coupling, O-ring and oil seal with new parts.

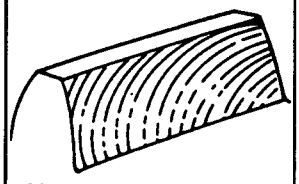
2) Inspection terms
   - Burr : Local rise of material forming protruding sharp edge.
   - Chip : An area from which a small fragment has been broken off or cut.
   - Crack : Surface break of line nature indicating partial or complete separation of material.
   - Excessive wear : Heavy or obvious wear beyond expectations considering conditions of operation.
   - Indentation : Displacement of material caused by localized heavy contact.
   - Galling : Breakdown of metal surface due to excessive friction between parts. Particles of the softer material are torn loose and welded to the harder material.
   - Nick : Local break or notch. Usually displacement of material rather than loss.
   - Scoring : Tear or break in metal surface from contact under pressure. May show discoloration from heat produced by friction.
   - Step wear : Heavy wear that produces a step that can be seen or felt between adjacent contact and noncontact surfaces.
   - Uneven wear : Condition of localized, unevenly distributed wear. Includes hollows, shiny spots, uneven polish and other visual indications.

3) Specific inspection

· Referring to normal gear tooth face, specifically inspect the uneven wear and chips of gear tooth. Replace or repair if necessary.



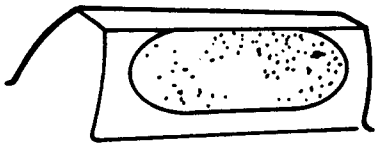
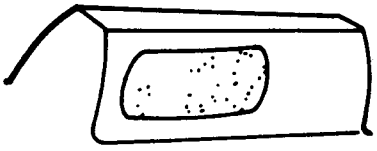
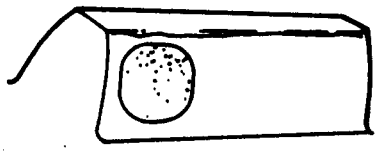
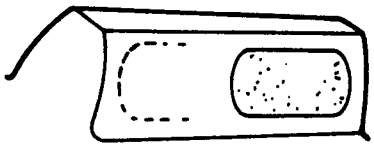
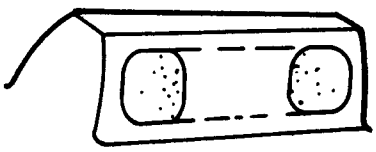
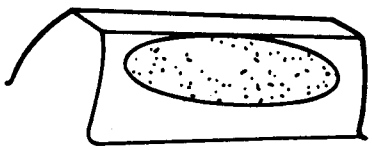
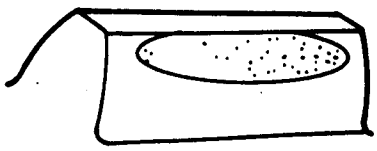
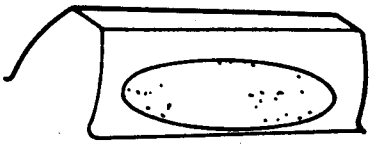
Normal gear shave marks



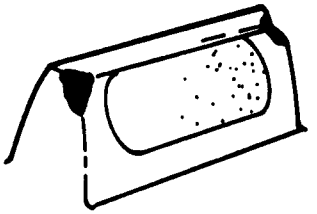
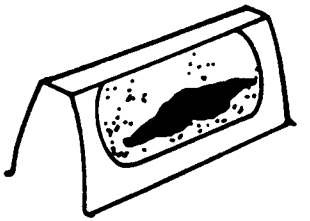
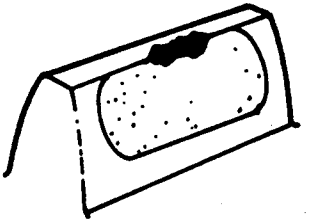
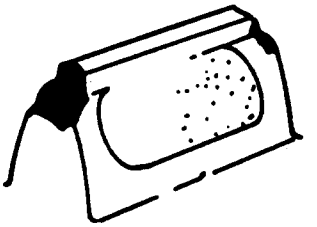
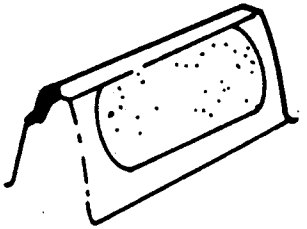
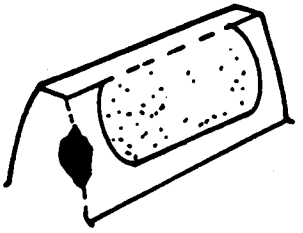
Normal gear grind marks

According to tooth marks decide whether reuse or not.

4) Inspection of contact patterns

Description	Normal	Abnormal
Normal wear		
End contact wear		
Traveling contact wear		
High contact wear		
Low contact wear		

5) Gear tooth chips

Description	Repair	Description	Replace
Corner chip at drive face		Chip within contact pattern	
Edge chip at drive face		Chip completely through tooth	
Corner chip at coast face			
Side edge chip at drive face			

Assembly

<General information>

1) Use special tools during assembly of oil seals and bearings.

2) Lubricate bearings, oil seals and bushings before assembly.

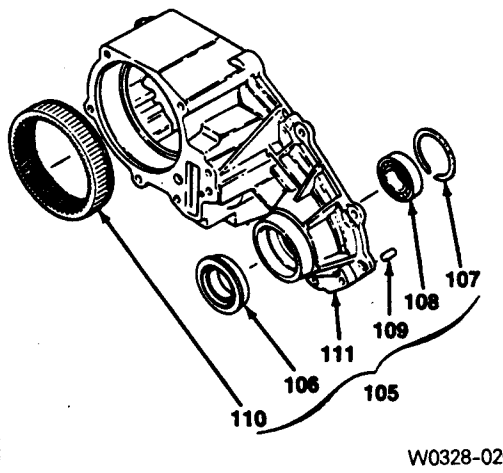
<Transfer case>

1) If the ring gear was removed, align the outer diameter of the new replaced ring gear with transfer case and assemble it.

2) Insert the pins.

3) Insert the ball bearing to the case and install the retaining ring.

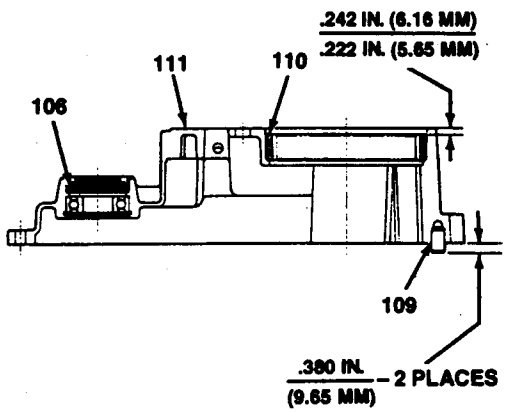
4) Install the new oil seal by pressing into the case.



W0328-020

105. Transfer Case Assembly
106. Oil Seal
107. Retaining Ring
108. Ball Bearing
109. Pin
110. Ring Gear
111. Transfer Case

5) Make sure that all parts are correctly and firmly installed into the case.



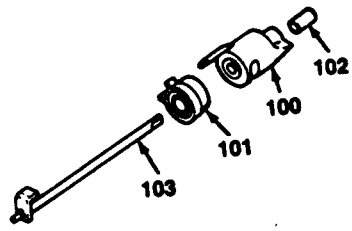
W0328-021

106. Oil Seal
109. Pin
110. Ring Gear
111. Transfer Case

<Electric shift cam parts>

1) Insert the spacer into the torsion spring.

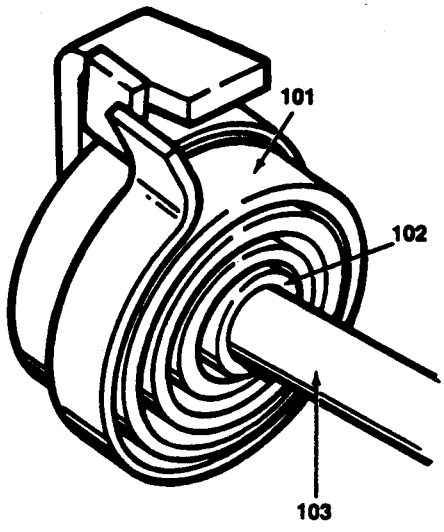
2) Insert the end of the shift shaft into the spacer smoothly.



W0328-022

100. Electric Shift Cam
101. Torsion Spring
102. Spacer
103. Shift Shaft

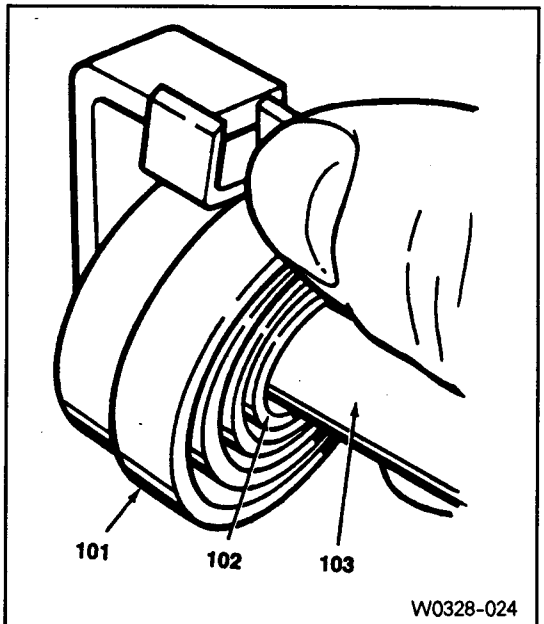
3) Slide the torsion spring and spacer to the left of the shift shaft and position the end of the first spring to fix on the drive tang.



W0328-023

101. Torsion Spring
102. Spacer
103. Shift Shaft

4) Push the end of the second spring to right and fix it on the drive tang.

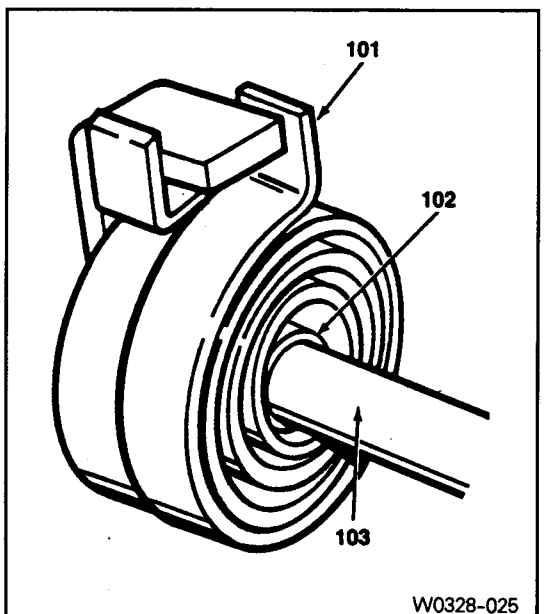


101. Torsion Spring
102. Spacer
103. Shift Shaft

5) Push the torsion spring and spacer together back and fix them completely.

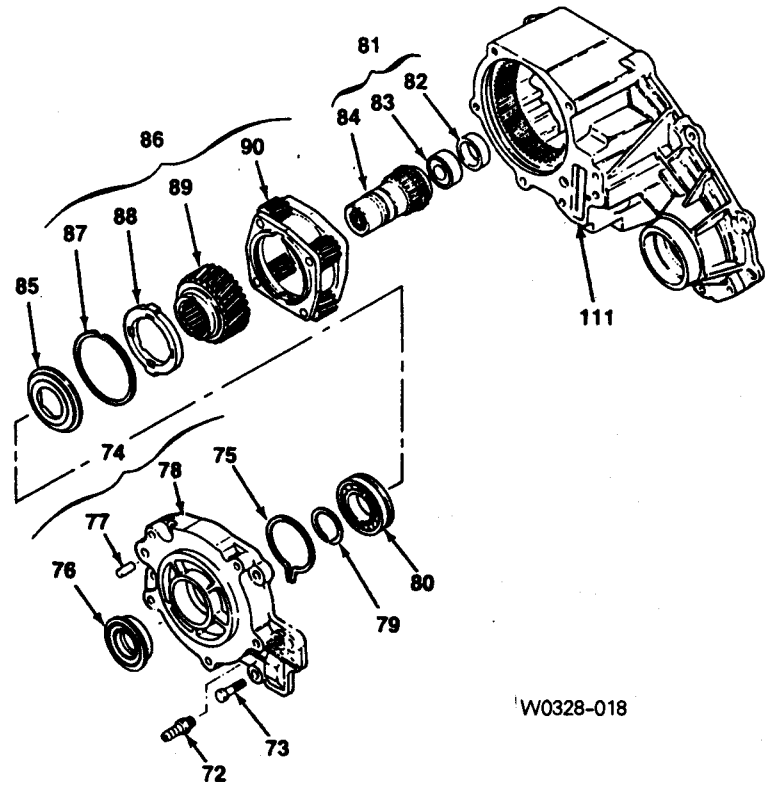
6) Slide the electric shift cam onto the shift shaft.

7) Install the electric shift cam assembly into the transfer case after installation of the shift fork.



101. Torsion Spring
102. Spacer
103. Shift Shaft

<Adapter, input shaft and carrier>



72. Breather Barb
73. Bolt
74. Adapter Assembly
75. Snap Ring
76. Oil Seal
77. Spirol Pin
78. Front Adapter
79. Retaining Ring
80. Bearing
81. Input Shaft Assembly
82. Sleeve Bearing
83. Needle Bearing
84. Input Shaft
85. Thrust Washer
86. Carrier Gear Assembly
87. Retaining Ring
88. Thrust Plate
89. Sun Gear
90. Planet Carrier Assembly
111. Transfer Case

1) Place the planet carrier assembly on a work bench to be the retaining ring mounting groove upward.

2) Install the sun gear with the hub end up into the planet carrier assembly and rotate the sun gear to make sure that gears are fully meshed.

3) Align the tabs and install the thrust plate into the planet carrier assembly.

4) Install the retaining ring to the planet carrier assembly.

5) Press the needle bearing into the input shaft and press the new sleeve bearing into the input shaft assembly.

6) Install the planet carrier assembly onto the input shaft and install the thrust washer. Press the bearing over input shaft.

7) After pressing the bearing, install the retaining ring.

8) Press the pin into the front adapter.

9) Slowly press the oil seal into the front adapter.

10) Install the front adapter assembly.

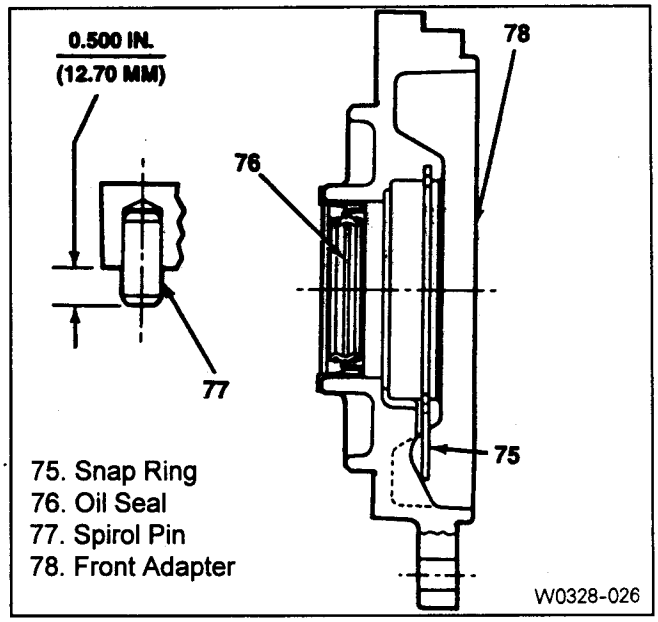
[Note] After installation, make sure that snap ring is correctly installed into the groove.

11) Position the input shaft assembly over front cover and engage into the bearing groove by expanding the ends of snap ring.

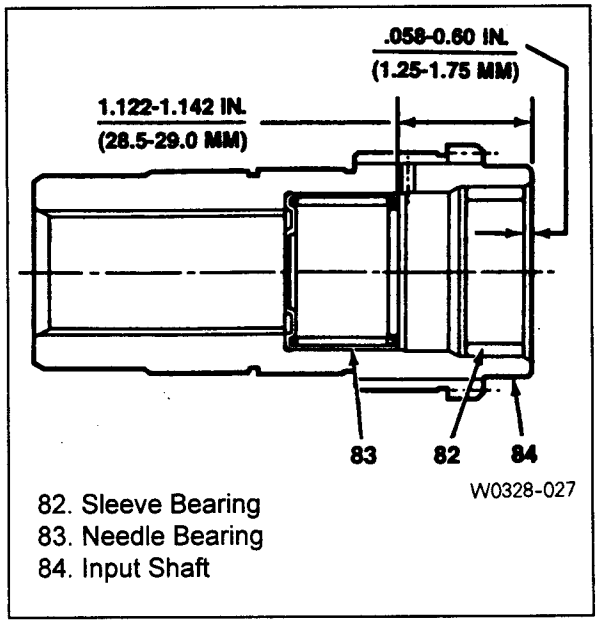
12) Apply 1.6mm bead of sealant on the mounting face for the transfer case and tighten the 6 bolts.

13) Install the breather barb.

Item	Tightening torque
6 bolts (of no. 12)	28~48Nm
Breather barb	8~20Nm



75. Snap Ring
76. Oil Seal
77. Spirol Pin
78. Front Adapter



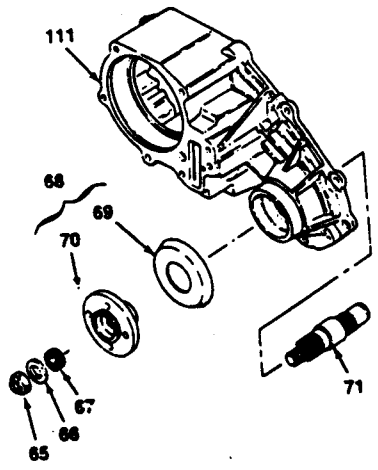
82. Sleeve Bearing
83. Needle Bearing
84. Input Shaft

<Front output shaft>

1) Press the deflector onto yoke.

2) Position the output shaft in transfer case and install the companion flange assembly, oil seal, washer and nut.

3) Holding the companion flange, tighten the nut.



W0328-028

65. Nut
66. Washer
67. Oil Seal
68. Companion Flange Assembly
69. Deflector
70. Companion Flange
71. Output Shaft (Front)
111. Transfer Case

<Reduction shift parts>

1) Install the new pin, roller and retainer into the reduction shift fork.

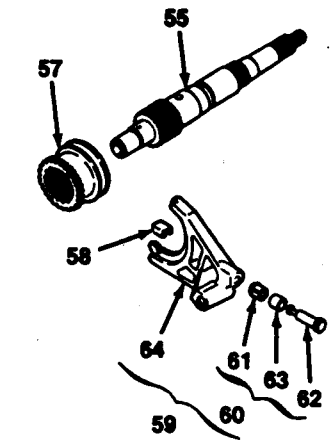
2) Press the pin, roller and retainer into the reduction shift fork bore completely.
[Note] Make sure that the cam roller turns freely.

3) Install the 2 fork facing on the reduction shift fork assembly.

4) Install the reduction shift fork onto the previously installed reduction hub in the transfer case.

5) Install the output shaft spline into the reduction hub and engage the output shaft end with input shaft bearing.

[Note] For installation of the output shaft, assemble the oil pump temporarily.



W0328-029

55. Output Shaft
57. Reduction Hub
58. Shift Fork Facing
59. Reduction Shift Fork Assembly
60. Roller, Pin and Retainer Assembly
61. Retainer
62. Pin
63. Roller Cam
64. Reduction Shift Fork

<Oil Pump>

1) Install the pump front cover to be the 'TOP' mark down and turn the cover to be the 'TOP' mark up when installed in vehicle.

2) Install the 2 pump pins and spring to the output shaft.
[Note] Flat surface of the pins must point out and center the pins and spring.

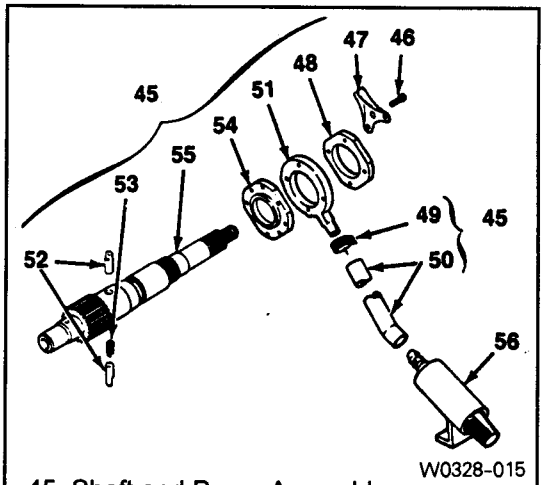
3) Connect the hose coupling to the strainer coupling barb and install the strainer foot into the transfer case slot.
[Note] The hose coupling must face the pump assembly.

4) Install the pump housing to be the 'REAR' mark up and seat the 2 pump pins inside of the pump housing by moving pump pins inward and compressing the spring.

5) Tighten the hose to pump housing by hose clamp.

6) Position the pump rear cover to be the 'TOP REAR' mark up and located at the top of transfer case when installed in vehicle. Position the pump retainer on the cover so that tab on the retainer is in notch in the transfer case. Apply Loctite to the bolts and tighten the bolts with turning the output shaft by hand to make the pump pins move freely.

Tightening torque	4~8.5Nm



W0328-015

45. Shaft and Pump Assembly
46. Bolt
47. Pump Retainer
48. Rear Pump Cover
49. Hose Clamp
50. Hose Coupling
51. Pump Housing
52. Pump Pin
53. Spring
54. Front Pump Cover
55. Output Shaft
56. Strainer

<Drive chain>

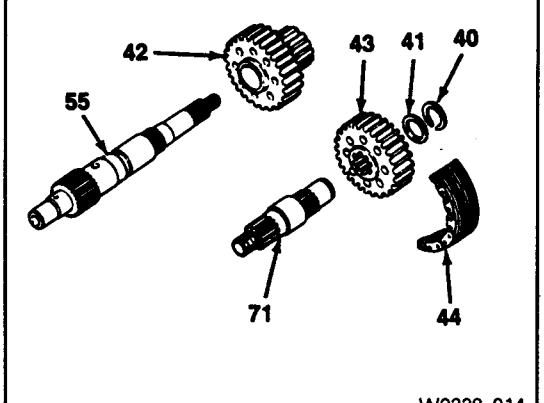
1) Position the drive sprocket to the rear output shaft end and driven sprocket to the front output shaft end.

2) Install the drive chain onto the sprocket.

3) Holding each sprocket to be the drive chain tight and parallel with transfer case, install the drive chain assembly to the output shafts.

4) Rotate the driven sprocket slightly to engage splines on the front output shaft.

5) Install the spacer to the front output shaft and insert the snap ring into the shaft groove over spacer.



W0328-014

40. Snap Ring
41. Spacer
42. Drive Sprocket
43. Driven Sprocket
44. Drive Chain
55. Output Shaft (Rear)
71. Output Shaft (Front)

<Lockup shift>

1) Install the lockup hub and return spring to the lockup collar and insert the snap ring.

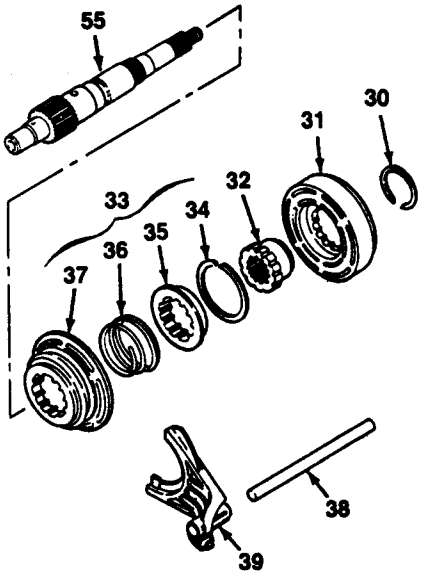
2) Install the rail shaft through reduction shift fork assembly previously installed and into the blind hole in case.

3) Engage the lockup fork into the 2WD-4WD groove and check operation.

4) Install the shift collar hub to the output shaft spline.

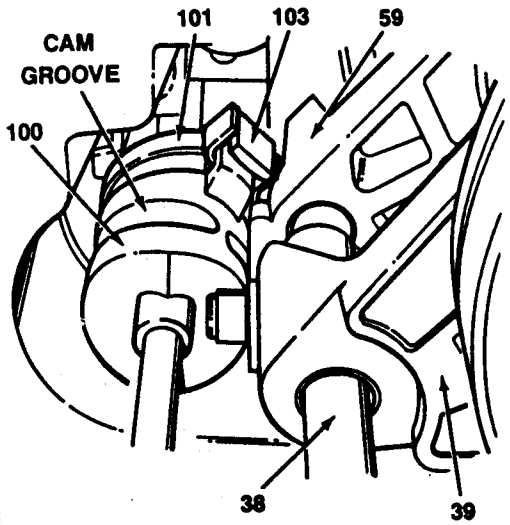
5) Install the previously assembled electric shift cam and assemble the clutch housing as follows:

- Rotate the shift cam assembly to right so that the end of the torsion spring contacts with reduction shift fork side.
- Holding the rail shaft, lift up the fork assembly slightly. Adjust electric shift cam assembly so that the roller on reduction shift fork assembly is in groove in shift cam and button on lockup fork is on cam end.
- Install the clutch housing over shift collar hub and insert the retaining ring into the clutch collar hub groove.



W0328-013

30. Retaining Ring
31. Clutch Housing
32. Shift Collar Hub
33. 2WD-4WD Lockup Assembly
34. Snap Ring
35. Lockup Hub
36. Return Spring
37. Lockup Collar
38. Rail Shaft
39. Lockup Fork
55. Output Shaft



W0328-030

38. Rail Shaft
39. Lockup Fork
59. Reduction Shift Fork Assembly
100. Electric Shift Cam
101. Torsion Spring
102. Shift Shaft

<Cover>

1) Position the cover to be the open end up on the work table.

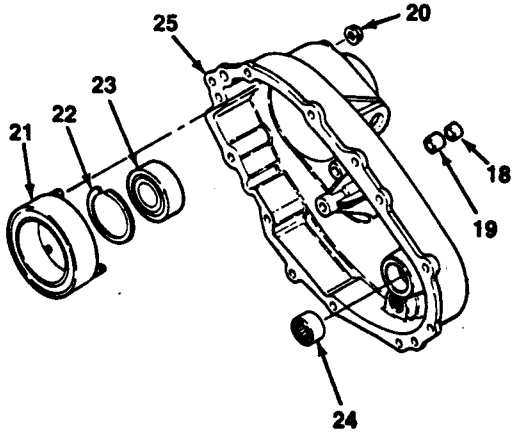
2) Position the end of needle bearing to be identification mark up and press into the cover until upper end of bearing is 40.47~40.97mm below cover face that contacts with transfer case.

3) Press the ball bearing into the cover and install the snap ring.

4) Install remaining parts as follows :
   - Install the 4 O-rings on the stud bolts of the clutch coil assembly.
   - Install the clutch coil assembly inside the cover and tighten 3 nuts.

Tightening torque	8~11Nm

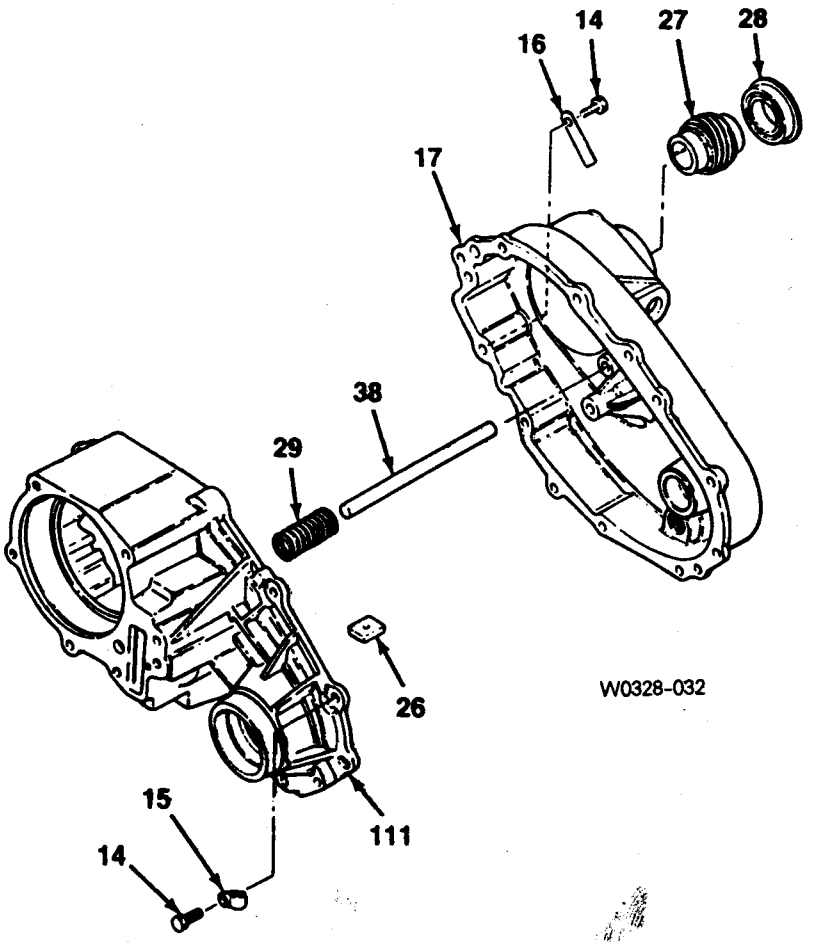
   - Install the bearing and motor bearing into the cover.



W0328-031

18. Oil Seal
19. Bearing
20. Nut
21. Clutch Coil Assembly
22. Snap Ring
23. Ball Bearing
24. Needle Bearing
25. Case Cover

<Cover assembly>



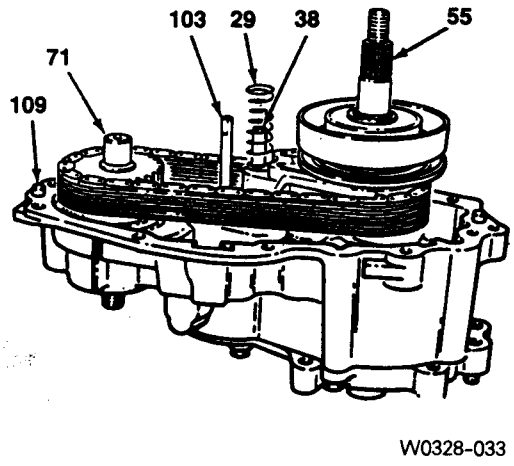
14. Bolt
15. Wiring Clip
16. Identification Tag
17. Cover Assembly
26. Magnet
27. Speed Gear
28. Oil Seal
29. Return Spring
38. Rail Shaft
111. Transfer Case

1) Install the return spring over rail shaft in the transfer case.

2) Insert the magnet into the transfer case slot.

3) Apply 1.6mm bead of Loctite RTV 598 to the transfer case mounting surface.
   [Note] For installation of cover, align the transfer case with cover not to use excessive force.

4) Install the cover onto the transfer case as follows :
- Align the cover holes with transfer case pins.
- Align the cover bearings with output shafts.
- Align the cover blind hole with rail shaft and make sure that return spring is not cocked.



W0328-033

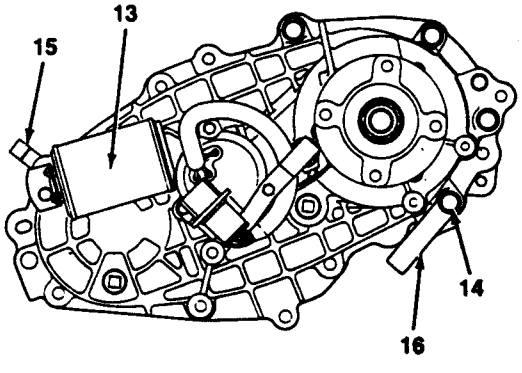
29. Return Spring
38. Rail Shaft
55. Output Shaft
71. Front Output Shaft
103. Shift Shaft
109. Dowel Pin

5) Tighten 9 bolts positioning identification tag and wiring clip.

Tightening torque	28~48Nm

6) Install the speedo gear over output shaft spline in the cover assembly.

7) Press the new oil seal into the cover assembly.



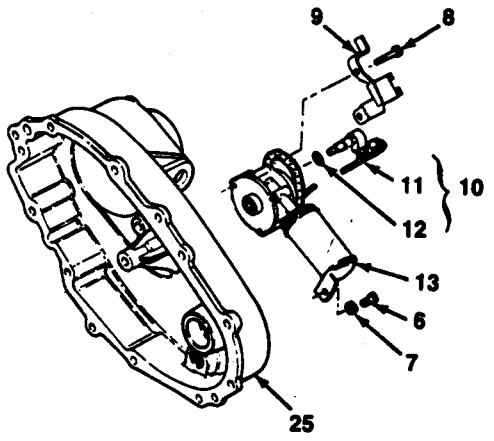
W0328-034

13. Motor Assembly
14. Bolt
15. Wiring Clip
16. Identification Tag

<External electric shift>

1) Align the motor with shift shaft and position the motor assembly onto the cover.

2) Install the motor to the shift shaft and contact cover and rotate the motor clockwise direction to check correct engagement.



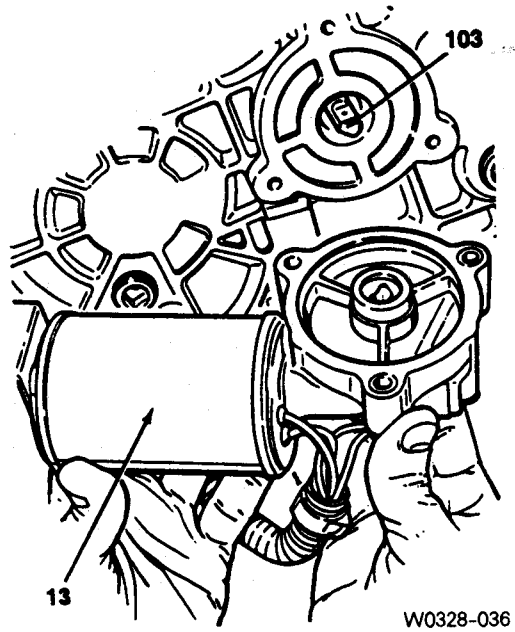
W0328-035

6. Bolt
7. Washer
8. Bolt
9. Sensor and Harness Bracket
10. Sensor Assembly
11. Speed Sensor
12. O-ring
13. Motor Assembly
25. Cover

3) Insert the O-ring on the speed sensor and install the speed sensor assembly to the cover.

4) Install the bracket to the motor assembly and tighten 3 bolts.

Tightening torque	8~11Nm



W0328-036

13. Motor Assembly
103. Shift Shaft

<Companion Flange>

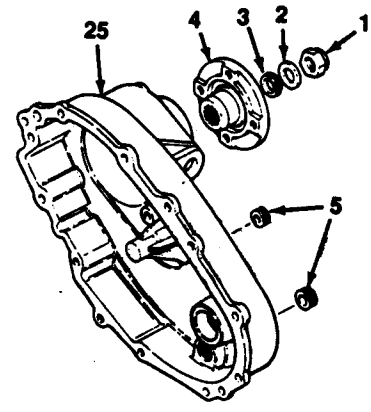
1) Install the 2 plugs to the cover.

2) Install the companion flange, oil seal and washer.

3) Holding the companion flange, tighten the nut.

Tightening torque	346~380Nm

[Note] Apply Loctite 262 to nut before installation.



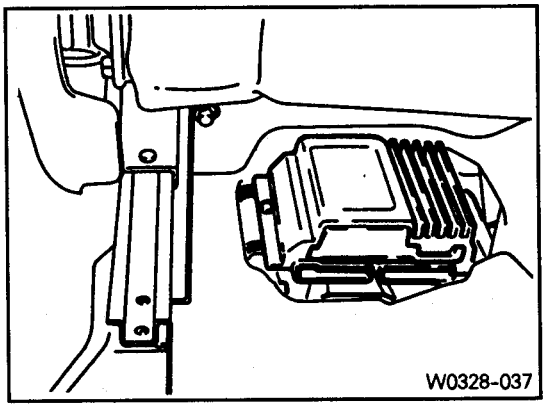
W0328-010

1. Nut
2. Washer
3. Oil Seal
4. Companion Flange
5. Plug
25. Cover

5. Transfer Case Control Unit (TCCU)

System description

TCCU is located under the driver's seat and permits the vehicle to shift from two-wheel drive to four-wheel drive (and back shift) according to driver's switch operation during driving (For the shifting between 4WD HIGH and 4WD LOW, stop the vehicle).



1) Shifting from 2WD to 4WD
- Position the transfer case switch from '2H' to '4H'.
- Shifting is possible during driving.
- '4WD HI' indicator light will turn on.

2) Shifting from 4WD to 2WD
- Position the transfer case switch from '4H' to '2H'.
- Shifting is possible during driving.
- '4WD HI' indicator light will turn off.

3) Shifting between 4H and 4L
- Shifting is possible when the vehicle is almost stopped (approx. 2km/h), so it would be better stop the vehicle.
- In case of manual transmission equipped vehicle, apply clutch pedal.
- Position the transfer case switch '4H' to '4L' or '4L' to '4H'.
- According to the shifted position, indicator light will turn on.

[Note] If there are malfunctions in shifting, '4H' or '4L' indicator light will flash.

Inspection and repair

1) 4H and 4L indicator light inspection
- When turn the ignition switch ON, 4H and 4L indicator light will turn on for 0.6 second and will turn off immediately.

[Note] If indicator light does not turn on, check bulb, wiring harness and TCCU.

2) TCCU inspection

Pin No.	Operation Condition	Voltage(V)
J1 - 7	4H or 4L	4.75 ~ 5.35
	2H	0 ~ 0.50
J1 - 8	4H indicator light ON	< 1.00
	4H indicator light OFF	> 11.00
J1 - 13	2H or 4H	4.75 ~ 5.35
	4L	0 ~ 0.50
J1 - 14	Clutch pedal applied	< 0.50
	Clutch pedal released	> 11.00
J1 - 15	4L indicator light ON	< 1.00
	4L indicator light OFF	> 11.00
J1 - 16	Motor OFF	< 1.00
	Motor ON	> 11.00
J1 - 17	Motor OFF	< 1.00
	Motor ON	> 11.00
J1 - 23	Auto locking hub ON	> 11.00
	Auto locking hub OFF	< 1.00

[Note]
- **DC 12V for the TCCU operation should be maintained.**
- **In case of J1-8 and J1-15, indicator light will turn on for 0.6 second when turn the ignition switch ON.**
- **If 4H and 4L indicator lights remain turned on when turn the ignition switch on or during driving, do TCCU diagnosis(28-04).**

1. General

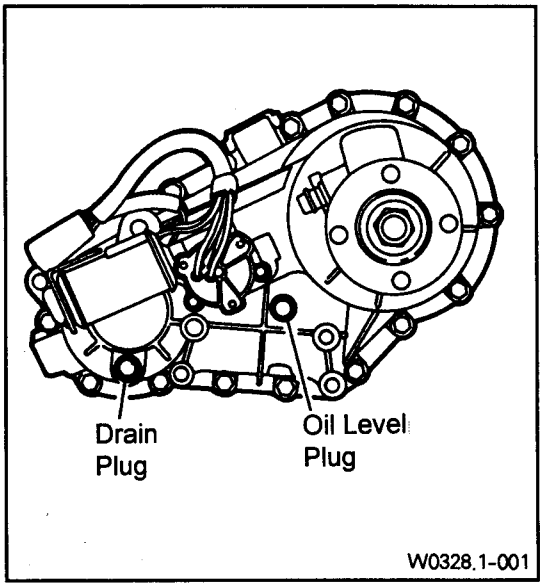
Specifications

Model		Full-time 4421(E)
Type		E.S.O.F. type
Manufacturer		BorgWarner
Gear Ratio	High	1 : 1
	Low	2.48 : 1
Oil	Specification	Dexron II
	Capacity	1.3 ℓ
	Replace	Check : every 15,000km, replace : every 50,000km

Maintenance of transfer case lubricant

1) Oil level check.
- Clean the oil level plug and surrounding area.
- Remove the oil level plug and check whether oil is drip out or not.
- Replenish if necessary.
- Tighten the oil level plug.

Tightening torque	19~30Nm



2) Oil change.
- Clean the oil level plug, drain plug and surrounding area.
- Place a suitable container under the transfer case.
- Remove the drain plug first and remove the oil level plug.
- Drain the oil and tighten the drain plug.
- Fill the oil through the oil level plug until oil begins to drip out.
- Tighten the oil level plug.

3) Cautions for oil level check and plugs tightening.
- Check or drain the oil, after warming up the transfer case with driving.
- Do not use an impact wrench to remove or tighten the oil level plug or drain plug since this will damage the threads in the transfer case.

2. Self-diagnosis

System description

1) TCCU detects transfer case system malfunctions and indicates malfunctioning part(s) through flashing '4L' and '4WD CHECK' indicator lights.
   Using a service connector, connect it to the diagnosis box in the engine room and read the flashing of the '4WD CHECK' indicator light.
   The flashing indicator light will show you defective code(s).

2) Identify 5 defective codes after reading the flashing indicator light.
   - TCCU
   - Shift motor
   - Speed sensor
   - Selector switch
   - Motor position sensor

3) Transfer case system is malfunctioning when :
   - 4L and 4WD CHECK indicator lights are remain on after 0.6 second when turn the ignition switch 'ON'.
   - 4L and 4WD CHECK indicator lights are continuously come on during driving.

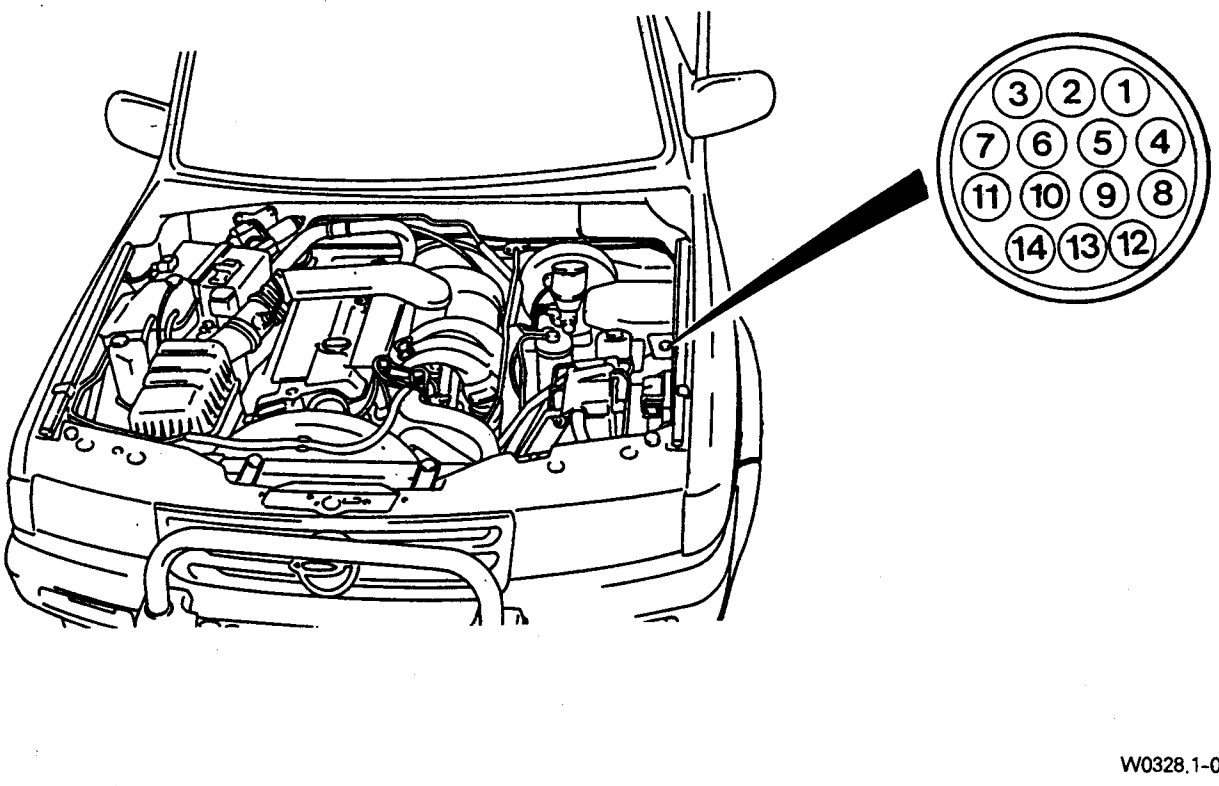
4) If only 1 part is malfunctioning, 4WD CHECK indicator light will display defective code 3times continuously.

5) If more than 2 parts are malfunctioning, the first malfunctioning part will be displayed 3 times and following malfunctioning parts will be displayed.

6) To read defective code, connect the service connector and turn the ignition switch 'ON'.

7) After repair, erase the defective code stored in the TCCU.
   [Note] Before replacing the malfunctioning parts with defective code, check the wires and connectors for proper condition.

Diagnosis box in the engine room



Defective code reading

1) Position the ignition switch to 'OFF'

2) Using a service connector, connect the no.1 pin (ground) and no. 9 pin (TCCU) of the diagnosis box in the engine room.

3) Position the ignition switch to 'ON'.

4) Read the flashing '4WD CHECK' indicator light and identify the malfunctioning part.

How to erase defective code

1) Position the ignition switch to 'OFF'.

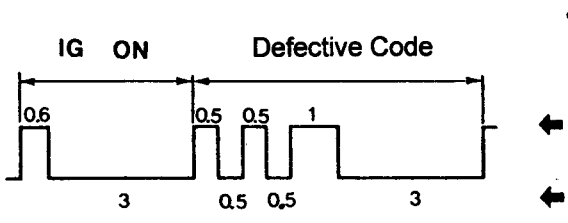
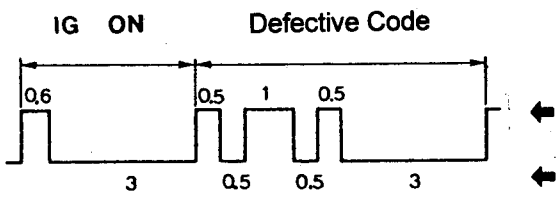
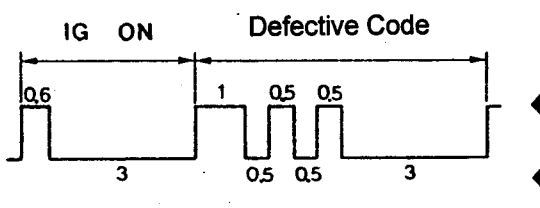
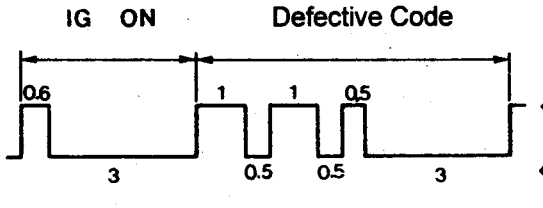
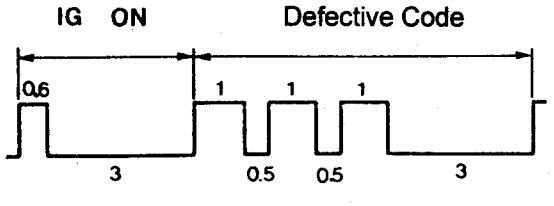
2) Using a service connector, connect the no.1 pin (Ground) and no.6 pin (TCCU).

3) Position the ignition switch to 'ON' over 5 seconds.

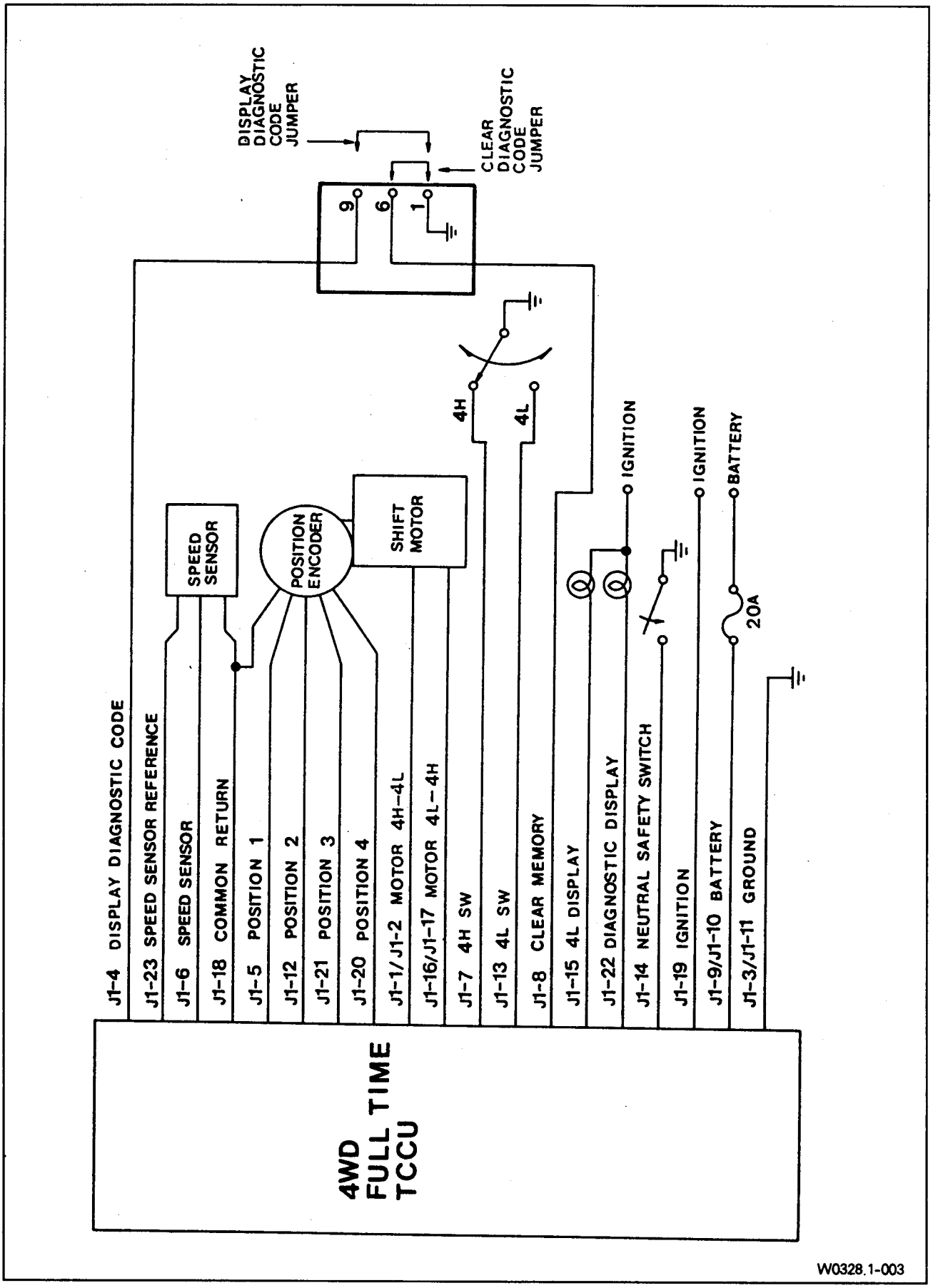
4) Do defective code reading and make sure that all defective coeds are erased.

Diagnostic table

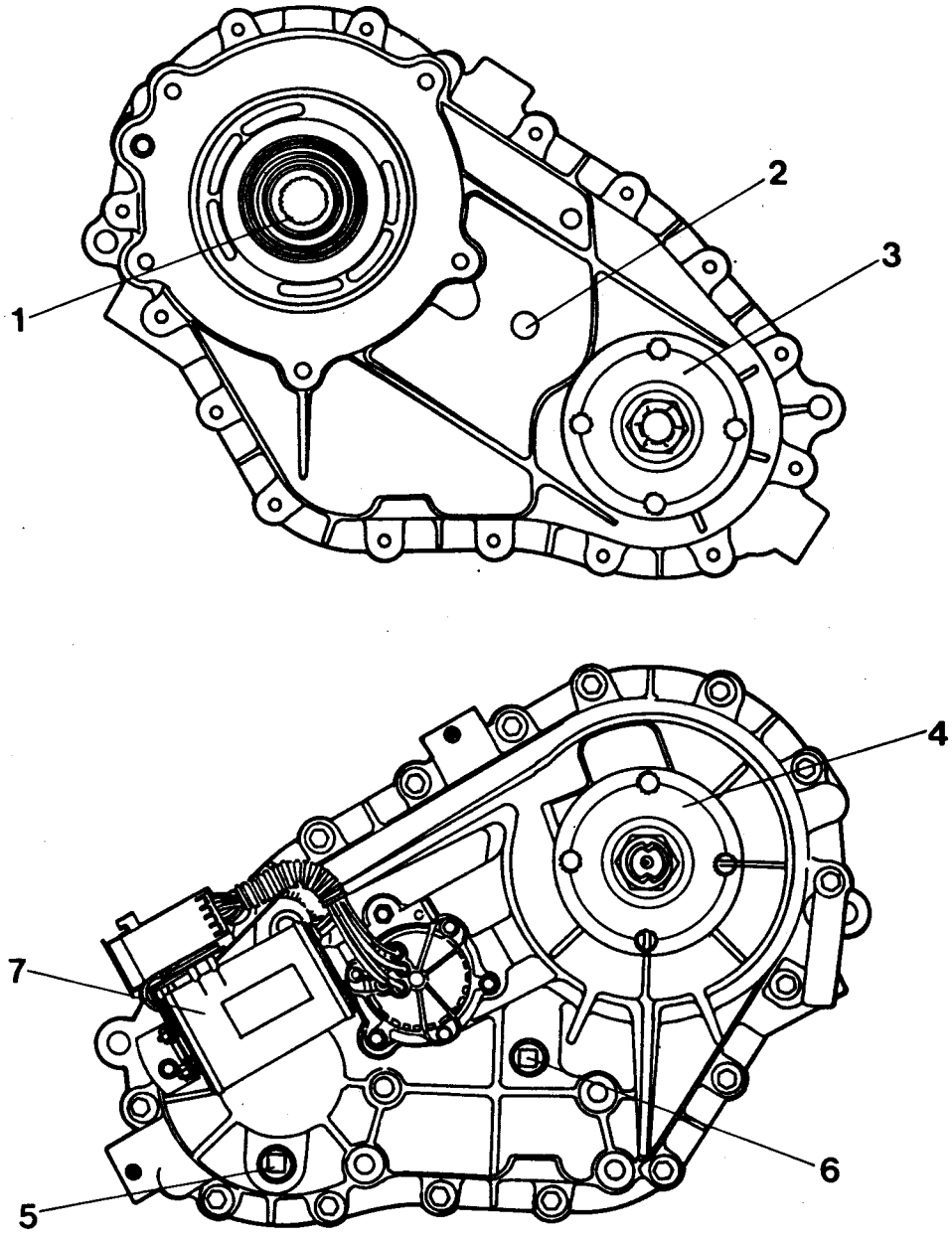
Connect a service connector. If turn the ignition switch 'ON', '4WD CHECK' indicator light will come on for 0.6 second and turn off for 3 seconds and then display a defective code 3times continuously.

No.	Defective Code	Malfunctioning Part
1		TCCU
2		Shift Motor
3		Speed Sensor
4		Selector Switch
5		Motor Position Sensor

Diagnostic diagram

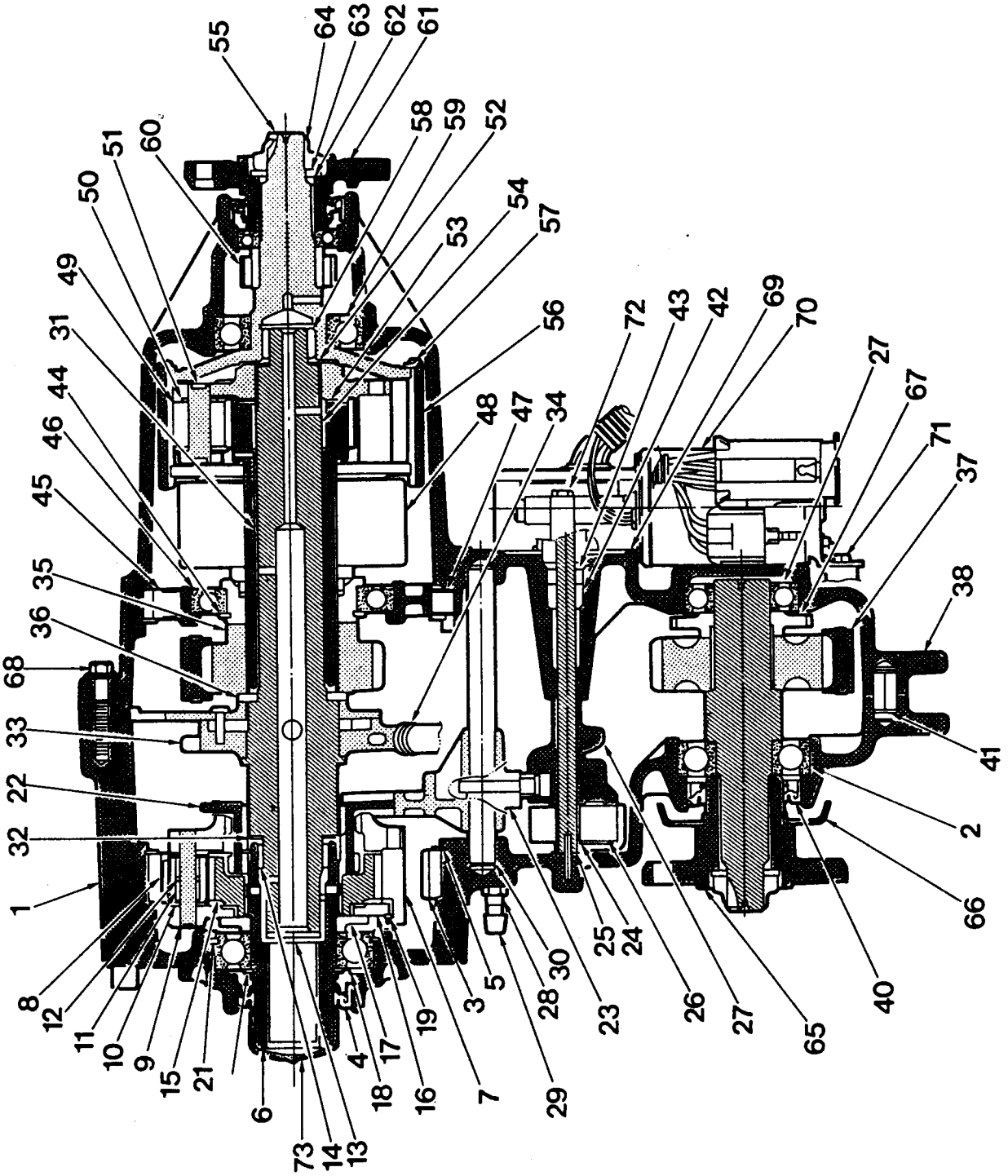


3. Components



W0328.1-004

1. Input Shaft
2. Breather Barb
3. Front Companion Flange
4. Rear Companion Flange
5. Drain Plug
6. Oil Level Plug
7. Shift Cam Drive Motor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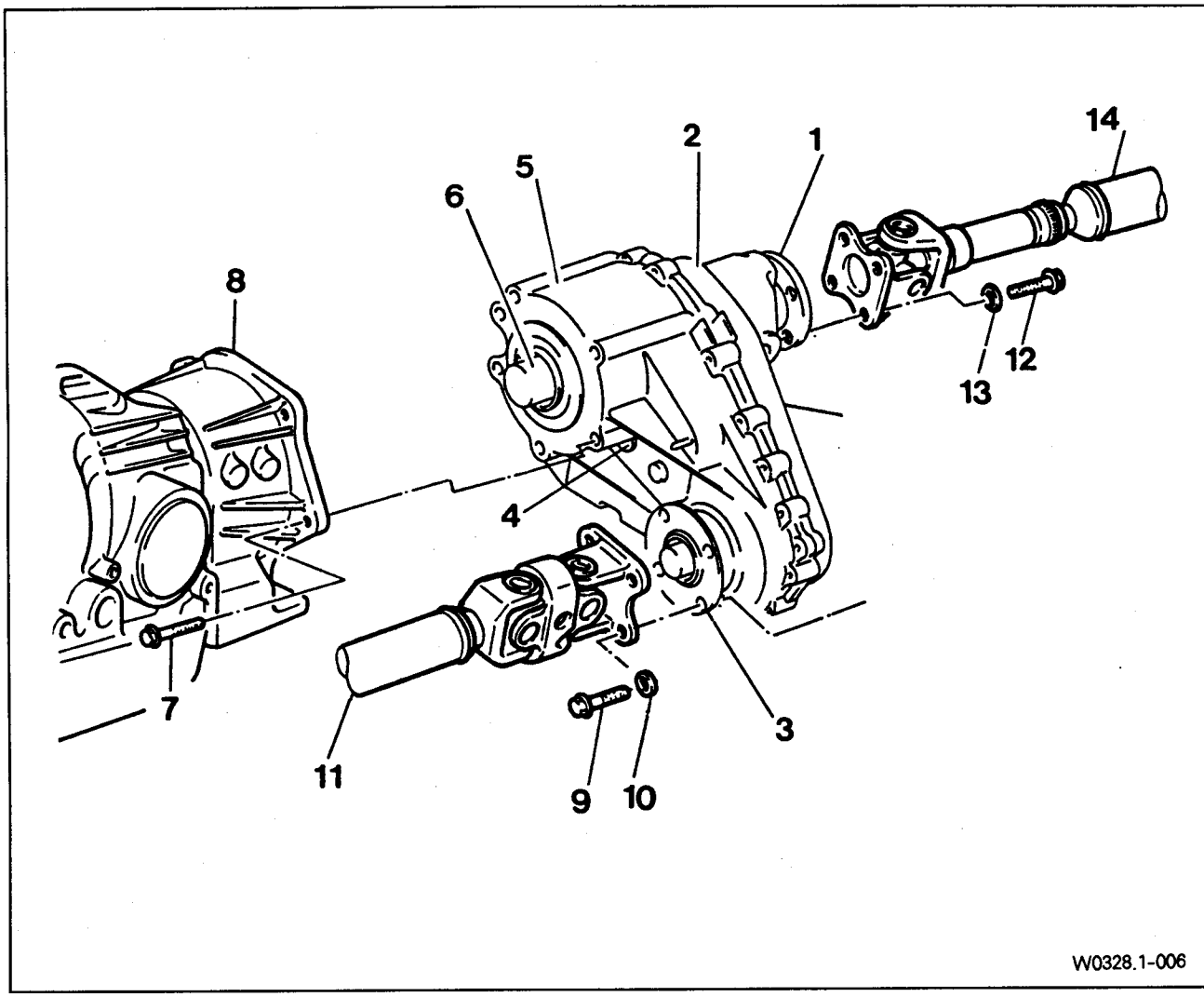
W0328.1-005

1. Case
2. Bearing
3. Ring Gear
4. Oil Seal
5. Retaining Ring
6. Input Shaft
7. Carrier
8. Pinion Gear
9. Pinion Shaft
10. Thrust Washer
11. Needle Roller
12. Spacer
13. Bearing
14. Bushing
15. Sun Gear
16. Thrust Plate
17. Circular Hub
18. Bearing
19. Snap Ring
20. Snap Ring
21. Snap Ring
22. Hub Reduction
23. Shift Fork
24. Spacer
25. Shift Shaft
26. Spring
27. Cam
28. Breather Hose
29. Breather Plug
30. Shift Rail
31. Shaft Intermediator
32. Thrust Washer
33. Thrust Washer
34. Clamp Hose
35. Upper Sprocket
36. Thrust Washer
37. Chain
38. Cover
39. Bearing
40. Oil Seal
41. Dowel Pin
42. Bearing Sleeve
43. Seal
44. Snap Ring
45. Center Bearing Support
46. Ball Bearing
47. Dowel Pin
48. Viscous Coupling
49. Pinion Gear
50. Thrust Washer
51. Pinion Shaft
52. Thrust Washer
53. Thrust Washer
54. Bushing
55. Output Shaft
56. Ring Gear
57. Retaining Ring
58. Needle Bearing
59. Ball Bearing
60. Speed Gear
61. Flange
62. Oil Seal
63. Washer
64. Nut
65. Flange
66. Dust Deflector
67. Tone Wheel
68. Bolt
69. Sealing Compound
70. Motor
71. Bolt
72. Cap Screw
73. Shipping Protector

4. Removal and Installation of Transfer Case



1. Companion Flange
2. Case Cover
3. Front Companion Flange
4. Breather Barb
5. Transfer Case Adapter
6. Input Shaft
7. Mounting Bolt---------- 35~60Nm
8. Automatic Transmission
9. Bolt---------- 81~89Nm
10. Washer
11. Front Propeller Shaft
12. Bolt---------- 70~90Nm
13. Washer
14. Rear Propeller Shaft

Removal · Installation

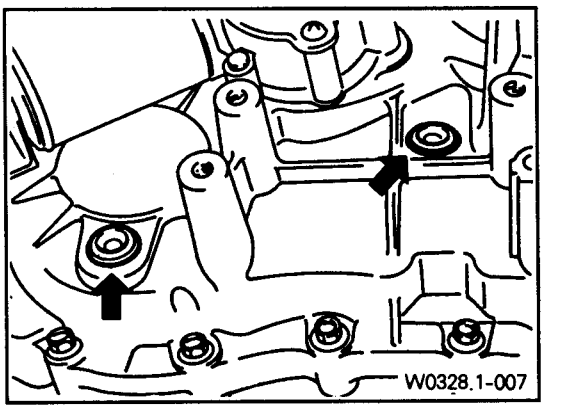
1) Disconnect the negative terminal from the battery.

2) Lift up the vehicle and fix it safely.

3) Remove the transfer case oil drain plug and drain the oil. Reinstall the drain plug.

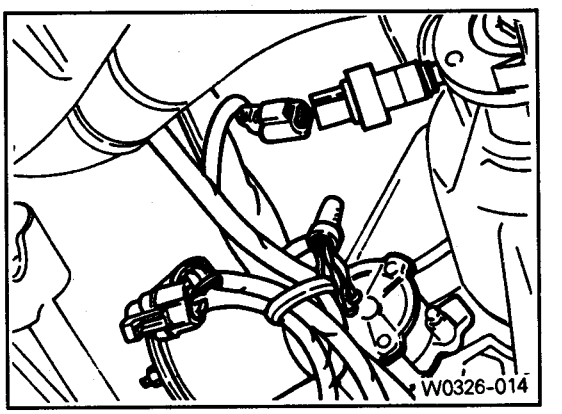
Tightening

Tightening torque	19~30Nm



4) Remove the breather hose.

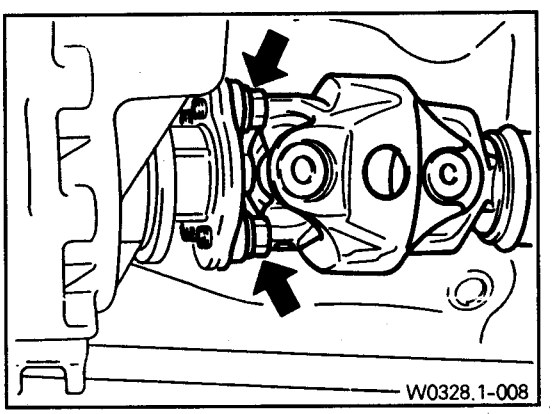
5) Disconnect the speedometer cable connector and other cable connectors and wiring harnesses.



6) Support the transfer case and remove the front and rear propeller shafts from the transfer case.

Installation

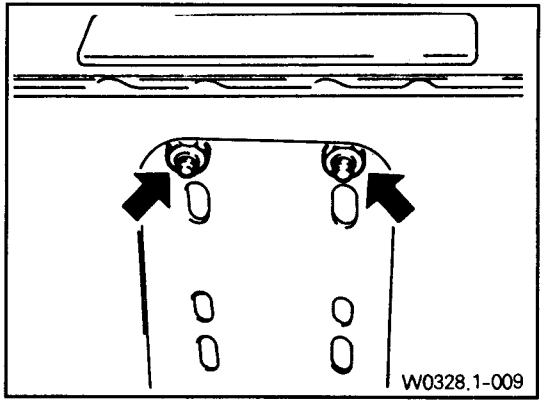
Tightening torque	Front	81~89Nm
	Rear	70~90Nm



7) Remove the center mounting nuts and each sides mounting bolts and remove the cross member.

Installation

Tightening torque (Nut)	21~35Nm
Tightening torque (Bolt)	62~93Nm

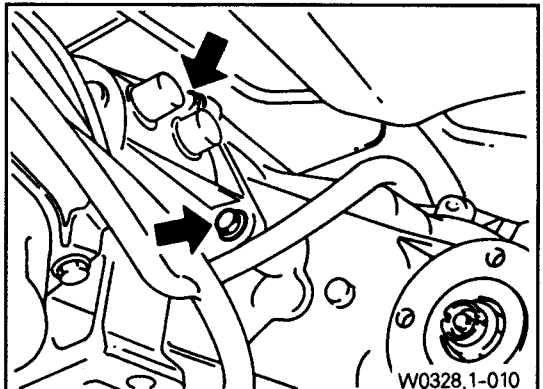


8) Remove the transfer case mounting bolts to the automatic transmission and remove the transfer case.

Installation

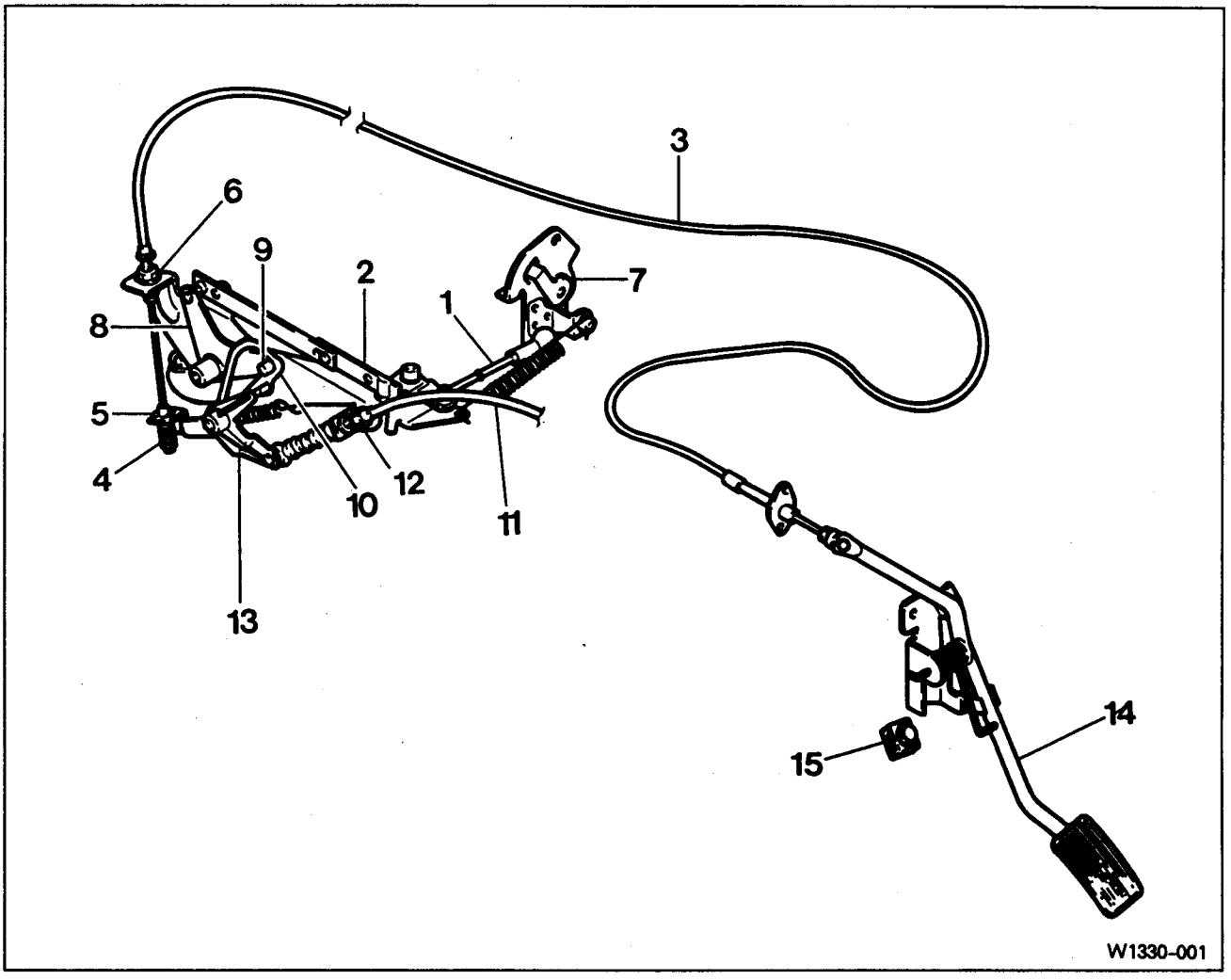
Tightening torque	35~60Nm

[Note] Apply long-term grease to the inner spline of transfer case input shaft.



9) Installation is reverse order of the removal.

1. Adjustment of Accelerator Control



1. Connecting Rod
2. Connecting Rod
3. Accelerator Cable
4. Driver Spring
5. Guide Piece
6. Adjusting Screw
7. Angle Lever
8. Accelerator Control Lever
9. Roller
10. Slotted Gate Lever
11. Automatic T/M Control Pressure Cable
12. Adjust Screw
13. Drag Lever
14. Accelerator Pedal
15. Kickdown Switch

Adjustment

1) Position the ignition switch 'OFF'.

2) Check the connecting rod (1, 2) and accelerator cable (3) for proper operation and replace if necessary.

3) Measure end play between the driver spring (4) and guide piece (5).

Standard	0.5~1.0mm

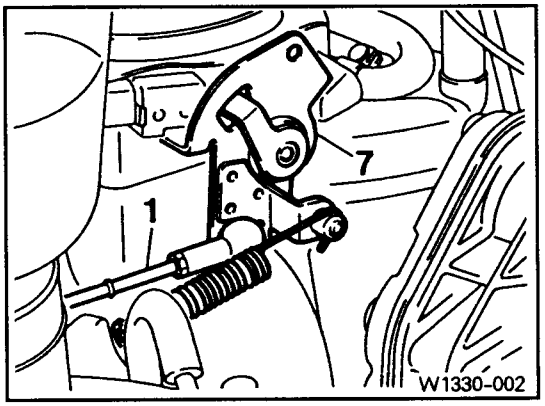
[Note] If out of specification, adjust it using the adjusting screw (6).

4) Disconnect the one end of the connecting rod (1).

5) Make sure that the angle lever(7) is positioning at the idle speed stop position of the idle speed control (LLR) actuator.

6) Connect the removed connecting rod (1) end.

[Note] · Connecting rod has fixed length and can not be adjusted.
· Connecting rod length means between the centers of the ball sockets.



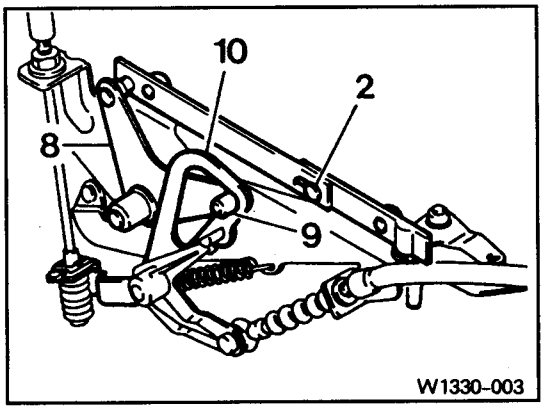
< Idle speed adjustment in engine >

1) The roller (9) of the accelerator control lever (8) must have free tension with fulcrum lever (10).

2) Loosen the adjusting screw (2) of the connecting rod and position the roller (9) at the end of slotted gate lever (10) to have free tension and tighten the screw (2), if necessary to adjust.

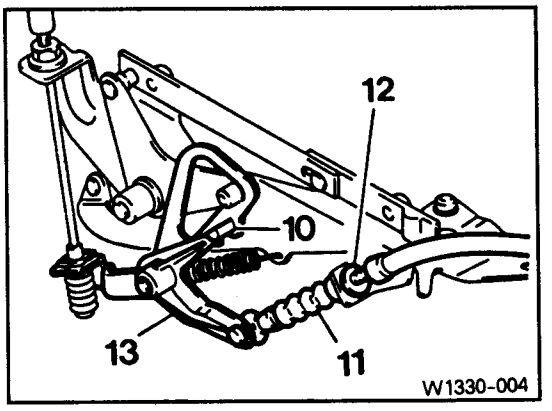
Size	144mm

[Note] · Adjustable
· Rod size means the distance between the centers of the ball sockets.



3) Do adjust with automatic T/M control pressure cable (11) is connected.

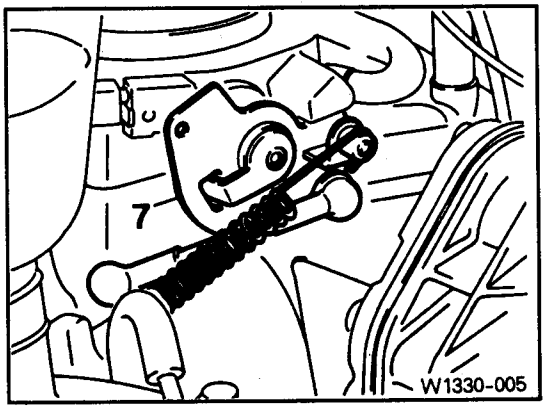
4) Using the adjusting screw (12), position the end of the slotted gate lever (10) and the end of the drag lever (13) to be the same level.



< Automatic transmission full throttle >

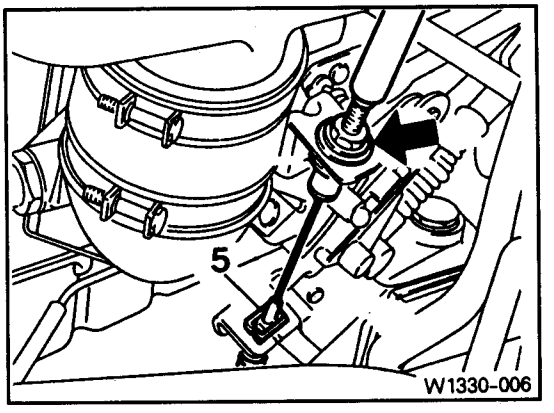
1) Stop the engine. Depress the accelerator pedal (3) fully until kickdown switch stops.

2) The angle lever will move to position, the idle speed control (LLR) actuator at the full throttle stop.



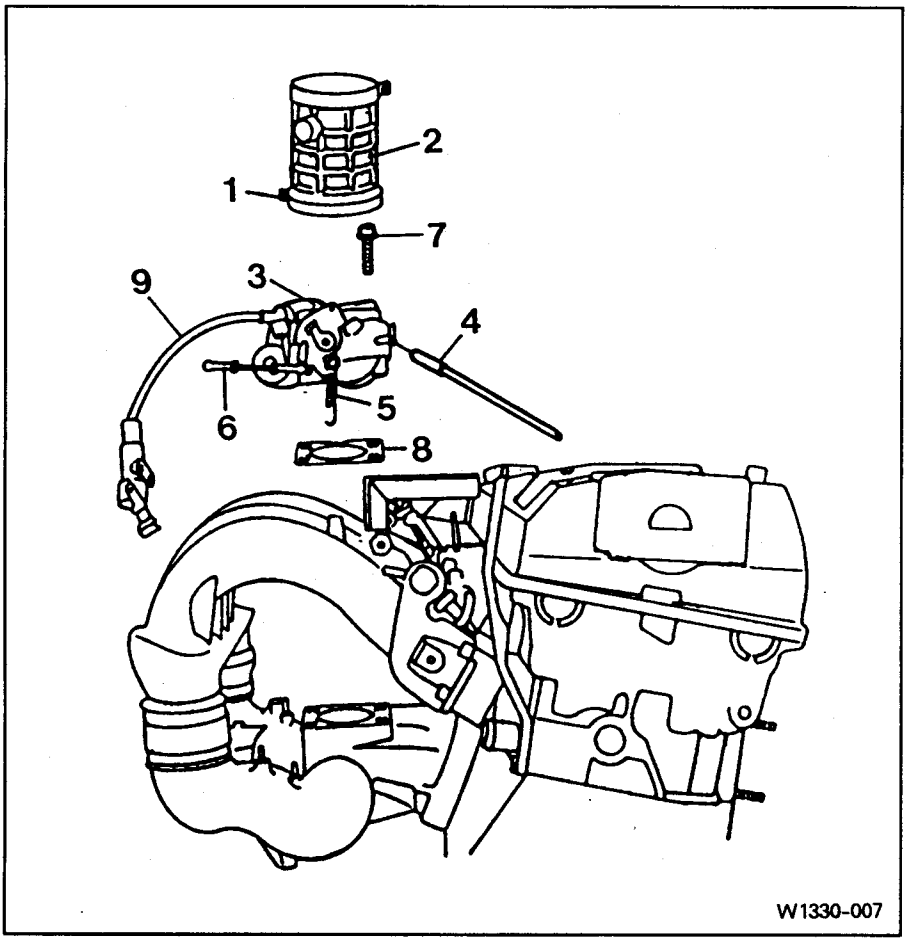
3) Adjust using a adjusting screw, if necessary.

4) Apply grease on the guide piece (5) of the accelerator cable (3) after adjustment.



2. Idle Speed Control (LLR) Actuator

Preceding work : Removal of the air cleaner cross pipe (09-03)
Removal of the upper intake manifold (14-01)

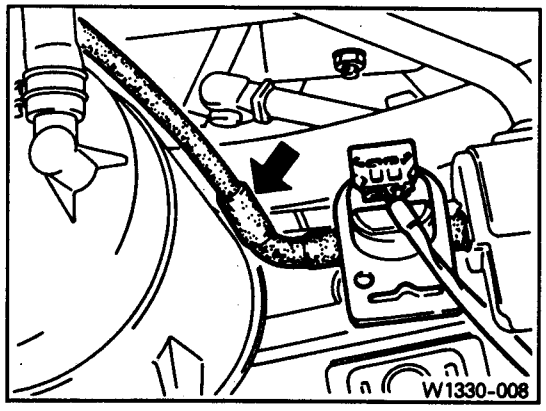


1. Clip
2. Connection Fitting
3. LLR Actuator
4. Hose
5. Accelerator Control Return Spring
6. Connecting Rod
7. Bolt---------- 10Nm
8. Gasket---------- Replace
9. LLR Actuator Connector

Removal · Installation

1) Disconnect the LLR actuator connector (9).

2) Disconnect the hose (arrow) from the purge canister solenoid valve.



3) Remove the clip (1).

4) Remove the connection fitting (2).

[Note] Carefully install it.

5) Remove the return spring (5) of the accelerator control.

6) Disconnect the one end of the connecting rod.

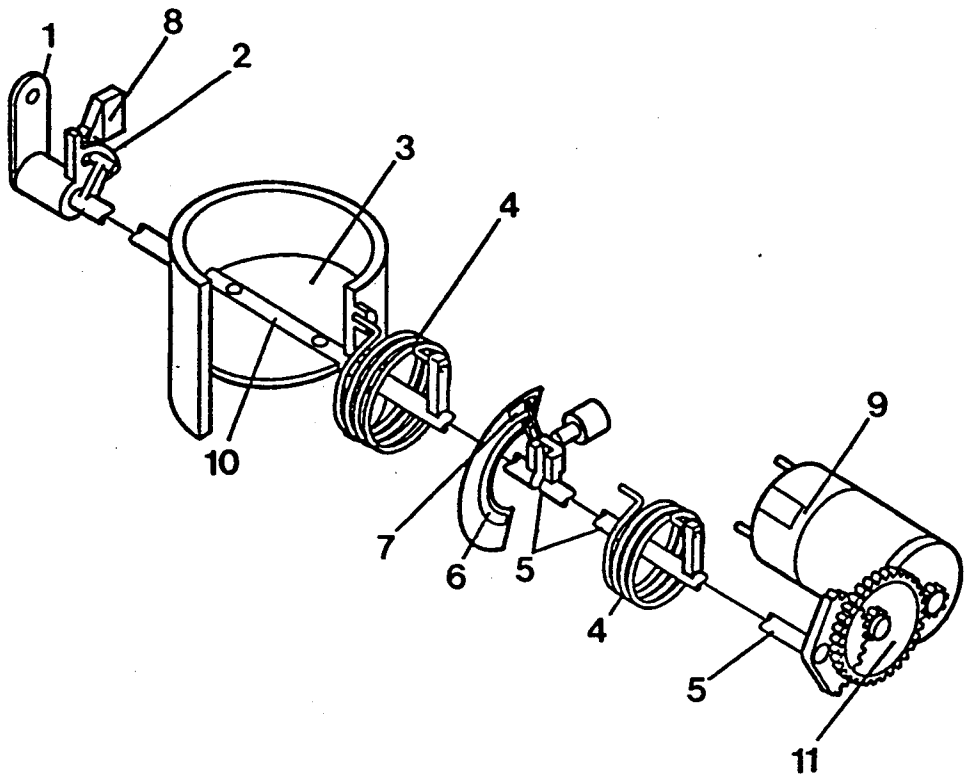
7) Remove the bolt (7) and remove the LLR actuator (3).

Installation

Tightening torque	10Nm

8) Installation is reverse order of the removal.

Disassembly



1. Adjusting Lever
2. Free Running
3. Throttle Valve
4. Spring
5. Drive Shaft
6. Throttle Shaft Real Valve (Potentiometer)
7. Drive Real Valve (Potentiometer)
8. Idle Running Contact Switch
9. Control Motor
10. Throttle Shaft
11. Motor Segment Gear

Function

- If engine RPM is lowered (cold coolant temperature) or electric load is applied, ECU receives throttle valve angle information through the idle running contact switch and 2 potentiometers.

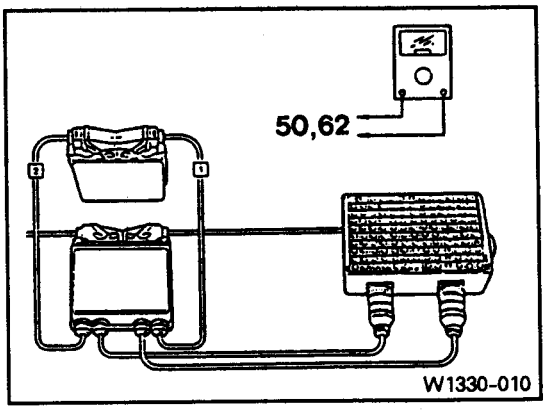
- ECU opens throttle valve (Max. 8 °) by driving the control motor to increase the engine RPM so that stabilizes RPM.

Inspection

1) Connect the contact box to the ECU.

2) Position the ignition switch ON. Check the ECU terminal no.50 and no.62 and measure voltage of the idle control.

Voltage	4.7~5.3V

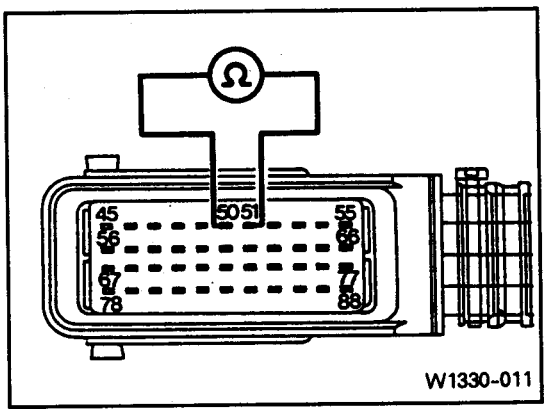


3) With engine idling, check ECU terminal no.50 and no.51 and measure signal voltage of the actual valve potentiometer drive.

Voltage	3.0~4.2V

4) Position the ignition switch OFF. Disconnect the ECU coupling 2 and check the coupling terminal no.50 and no.51. Measure resistance of the actual valve potentiometer drive.

Resistance	1.2~1.6KΩ

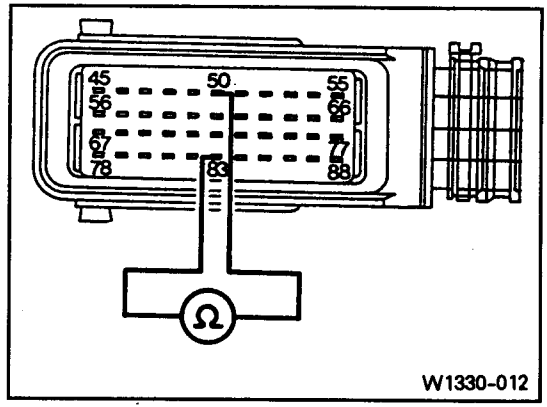


5) Position the ignition switch ON. Check the ECU terminal no.50 and no.83 and measure voltage of the actual valve potentiometer throttle valve.

Voltage	Idle > 4V
	Full throttle < 1V

6) Position the ignition switch OFF and disconnect the ECU coupling 2. Check the coupling terminal no.50 and no.83 and measure resistance of the actual valve potentiometer throttle valve.

Voltage	Idle : 2.3~3.0KΩ
	Full throttle : 1.5~2.2KΩ



7) Position the ignition switch ON. Check the ECU terminal no.66 and no.78 and measure the signal voltage of the idle speed contact switch.

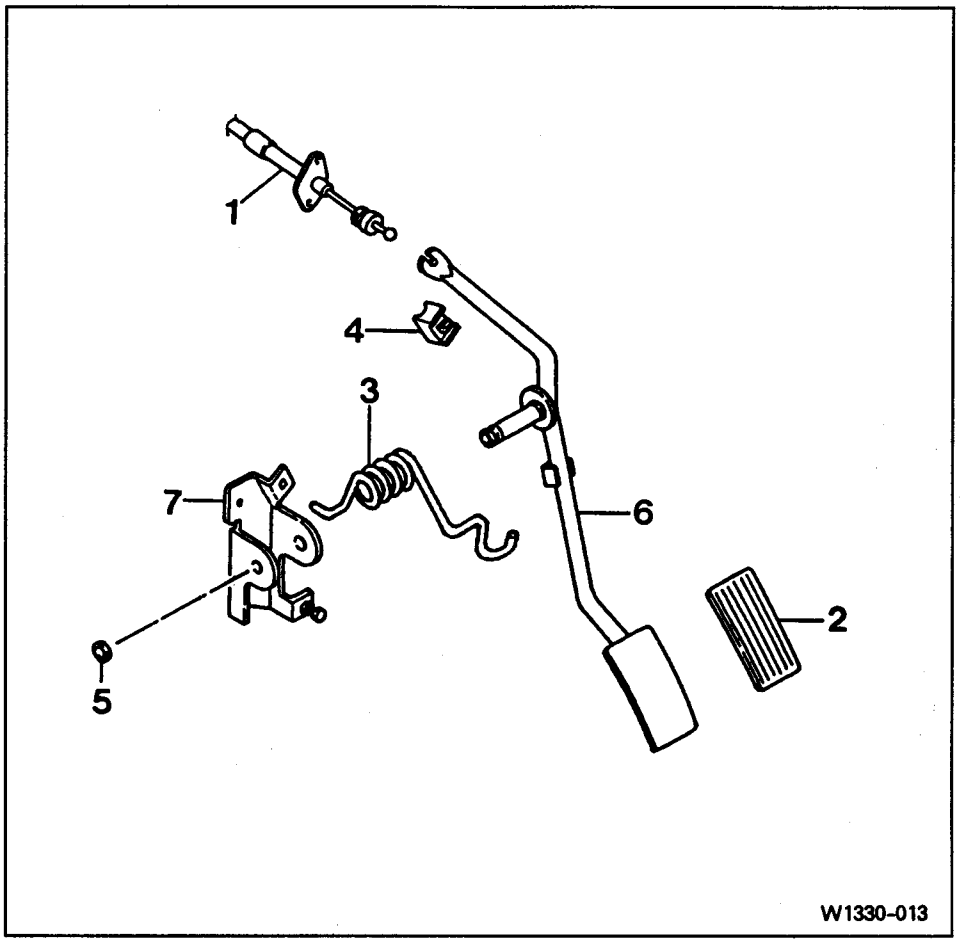
Voltage	Idle < 3V
	Accel. pedal applied > 10V

8) With engine idling, check the ECU terminal no.48 and no.70 and measure operating voltage of the servo motor.

Voltage	1.6~3.2V

[Note] If voltage is out of standard, check the wiring connector and ECU

3. Removal and Installation of Accelerator Pedal Lever



1. Accelerator Control Cable
2. Pedal Pad----------Replace
3. Return Spring
4. Return Stop Pad
5. Nut
6. Accelerator Pedal Lever
7. Accelerator Mounting Bracket

Removal · Installation

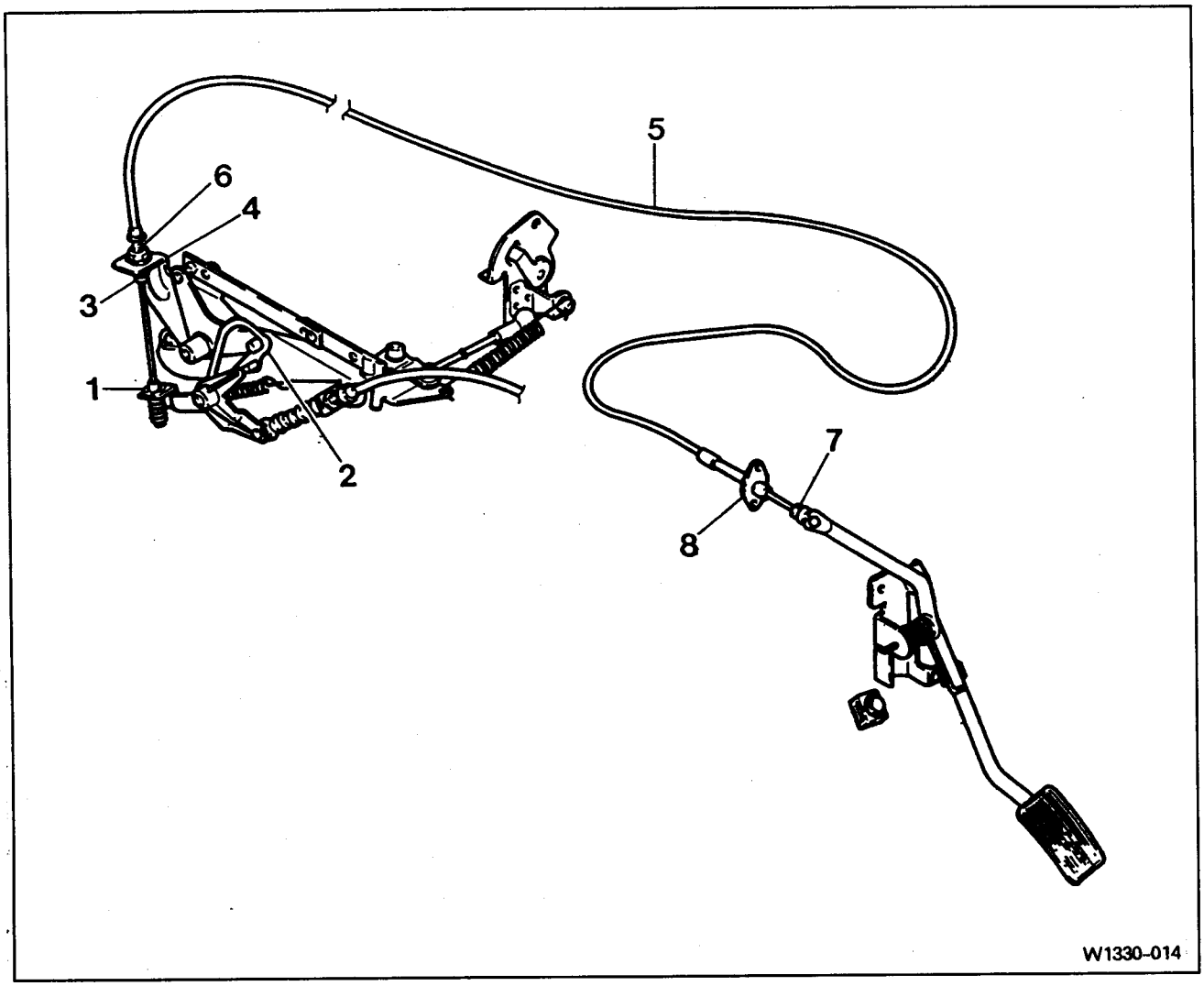
1) Remove the nut (5) from the accelerator mounting bracket (7).

2) Remove the return spring (3) from the pedal lever (6) and mounting bracket (7).

3) Remove the accelerator control cable (1) nut and remove the accelerator pedal lever (6).

4) Installation is reverse order of the removal.

4. Removal and Installation of Accelerator Cable

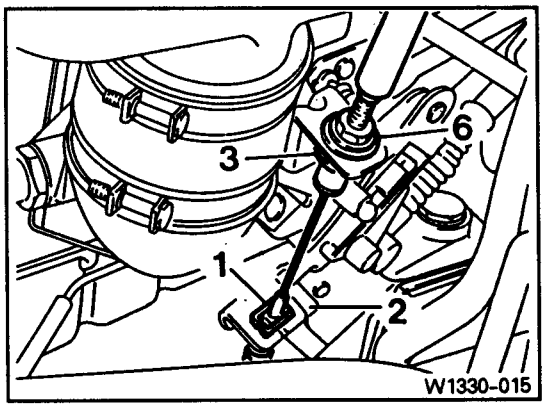


1. Guide Piece
2. Slotted Gate Lever
3. Nut
4. Accelerator Control Lever Bracket
5. Accelerator Cable
6. Adjust Nut
7. Nut
8. Accelerator Control Cable Mounting Bracket

Removal · Installation

1) Remove the adjusting nut (6) and nut (3) and loosen the cable.

2) Disconnect the plastic nipple from the guide piece (1) and pull out the accelerator cable from the inner groove of the slotted gate lever (2).

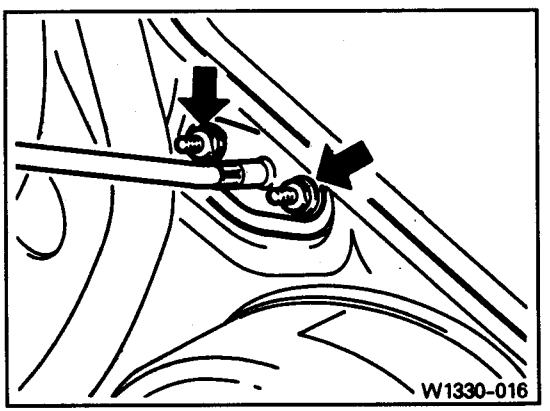


3) Remove the nut (7) from the vehicle inside and disconnect the cable from the pedal lever.

4) Remove the fixing nut from the accelerator control cable mounting bracket and remove the accelerator cable (5).

Installation

Tightening torque	6.2Nm



5) Installation is reverse order of the removal.

6) Adjust the accelerator control (30-01).

1. Specifications

Front suspension	Type		Ball joint wishbone
	Spring type		Torsion bar spring
	Torsion bar	Length	1,040mm
		Outer diameter (ϕ)	DSL : 24.5mm / GSL : 23.6mm
	Shock absorber		Double-acting type
	Stabilizer type		Torsion bar type
	Wheel alignment	Toe-in	0~4mm
		Camber	0 ° ± 30 ´
		Caster	2 ° 30 ´ ± 30 ´
		Kingpin	12 ° 30 ´
Rear suspension	Type		5 - link
	Spring type		Coil spring
	Coil spring	Item	DSL / GSL
		Wire diameter (mm)	13.3 / 13.3
		Coil diameter (mm)	127.3 / 127.3
		Free length (mm)	389.8 / 397.3
		Outer diameter (mm)	140.6 / 140.2
		Spring constant (kg · m)	2.58 / 2.33
	Shock absorber		Double-acting type
	Stabilizer type		Torsion bar type
Tire pressure	P215 / 75R15		30psi
	P235 / 75R15		30psi
	P255 / 70R15		28psi

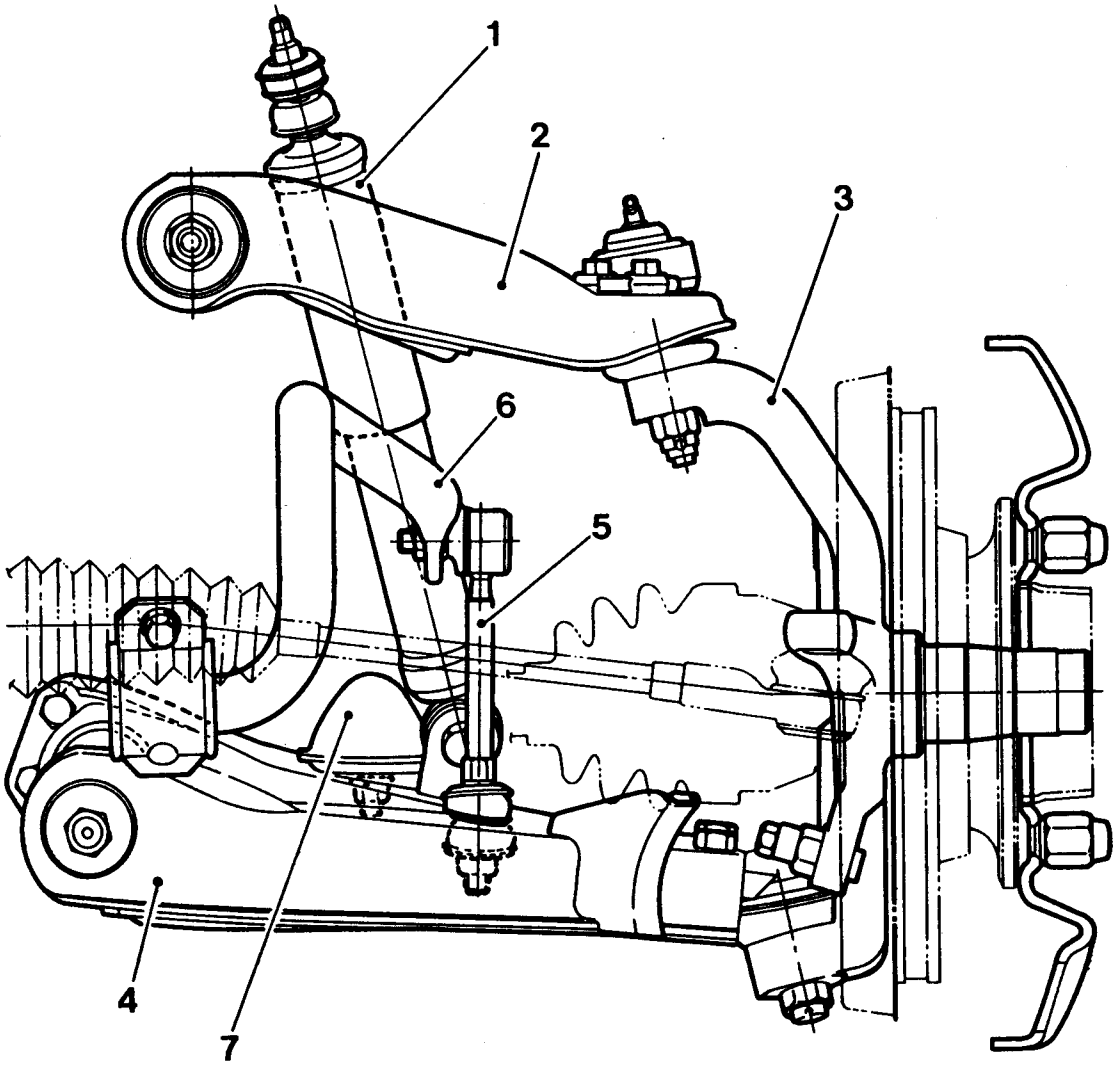
[Note] DSL : Diesel Engine
GSL : Gasoline Engine

2. Troubleshooting

Problem	Possible cause	Remedy
Vehicle rolling	Broken stabilizer bar	Replace
	Faulty shock absorber	Replace
Abnormal noises	Loosened mountings	Retightening
	Damaged or worn wheel bearing	Replace
	Damaged shock absorber	Replace
	Damaged tire	Replace
Poor riding	Over inflated tire	Pressure adjustment
	Faulty shock absorber	Replace
	Loosened wheel nut	Tighten as specified
	Bent or broken coil spring	Replace
	Damaged tire	Replace
	Worn bushing	Replace
Vehicle pulls to right or left	Deformed arm assembly	Replace
	Worn bushing	Replace
	Bent or broken coil spring	Replace
Hard steering	Incorrect wheel alignment	Repair
	Excessive resistance of lower arm ball joint	Replace
	Insufficient tire pressure	Adjust
	Faulty power steering	Repair or replace
Steering instability	Incorrect front wheel alignment	Repair
	Worn or loosened lower arm bushing	Retightening or replace
Vehicle bottoming	Worn or broken coil spring	Replace

3. Assembly Drawing

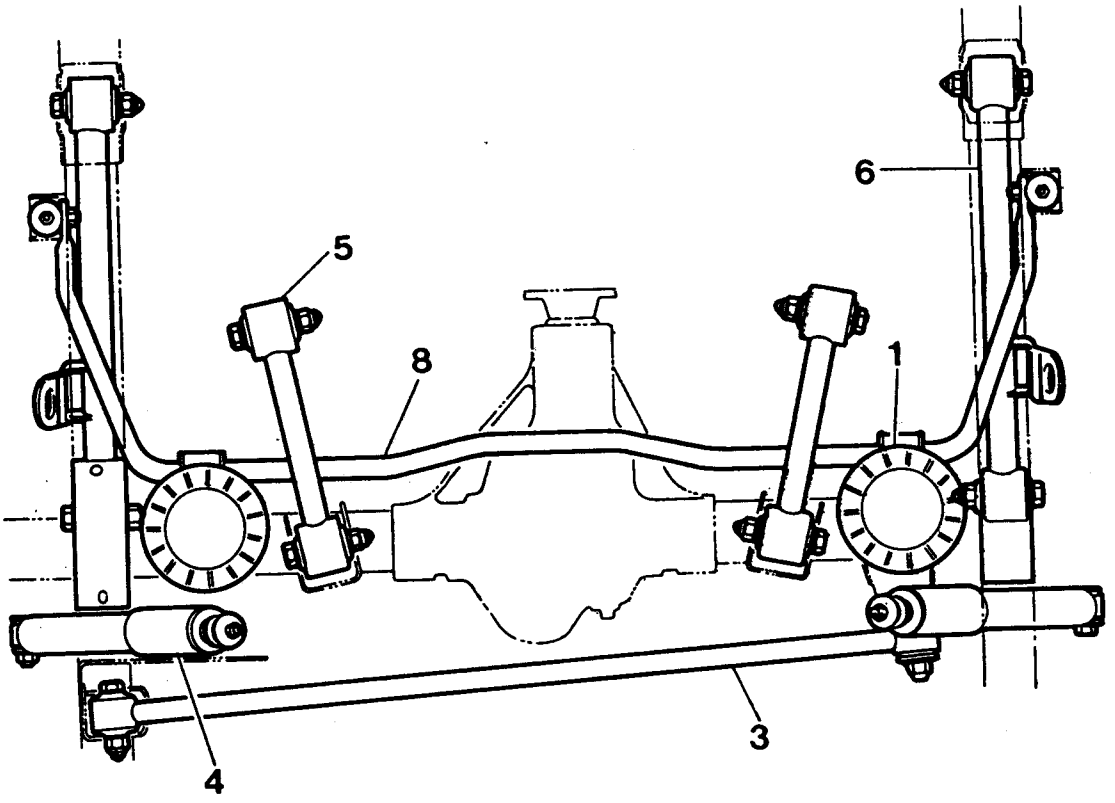
Front suspension

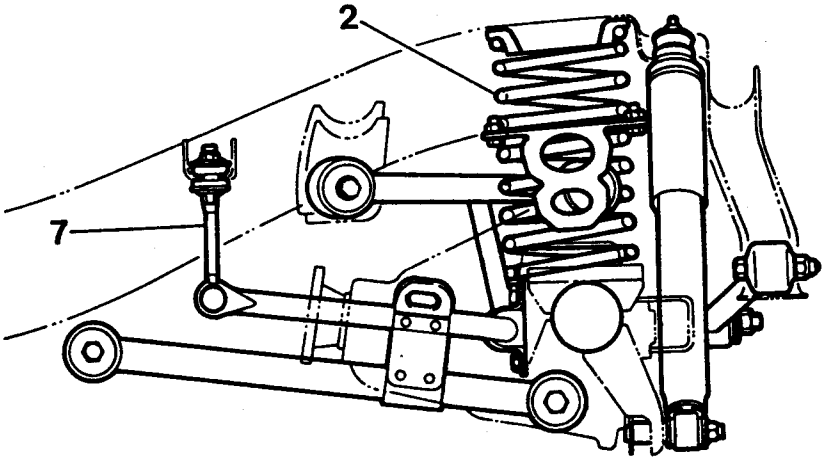


W0332-001

1. Shock Absorber
2. Upper Arm
3. Steering Knuckle
4. Lower Arm
5. Stabilizer Bar Link
6. Stabilizer Bar
7. Suspension Bumper

Rear suspension





W0332-002

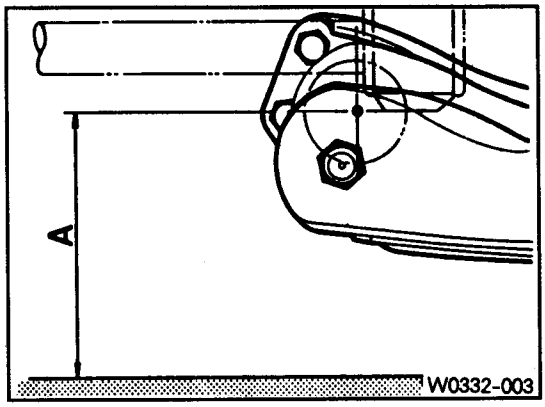
1. Spring Seat
2. Coil Spring
3. Lateral Rod
4. Shock Absorber
5. Upper Arm
6. Lower Arm
7. Connecting Link
8. Stabilizer Bar

4. Wheel Alignment

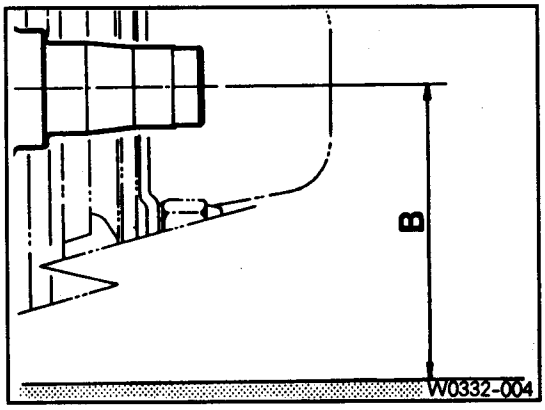
Vehicle height

1) Check the tire for proper inflation.

2) Measure 'A' from the center of the lower arm rear mounting bolt end to the ground.



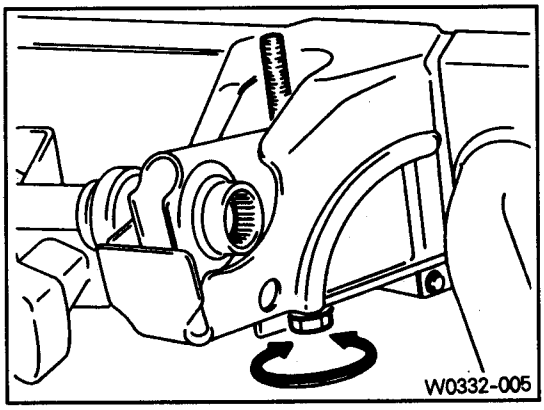
3) Measure 'B' from the center of the steering knuckle shaft to the ground.



4) If the difference between 'A' and 'B' is not within specification, adjust vehicle height using torsion bar height control bolt.

'B' - 'A'	31~36mm

[Note] Before wheel alignment, do vehicle height adjustment first.

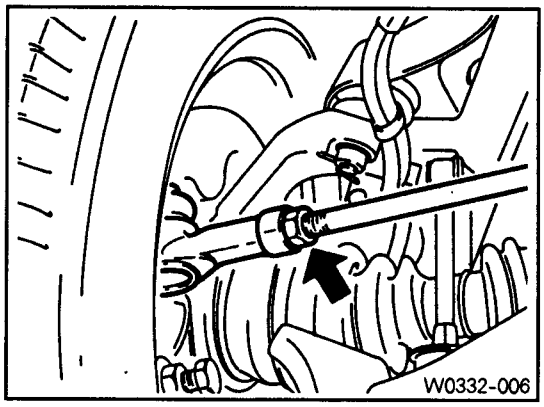


Toe-in

1) Measure toe-in.

Specification	0~4mm

2) If toe-in is not within specification, loosen the tie rod nuts and adjust it by turning the tie rod.

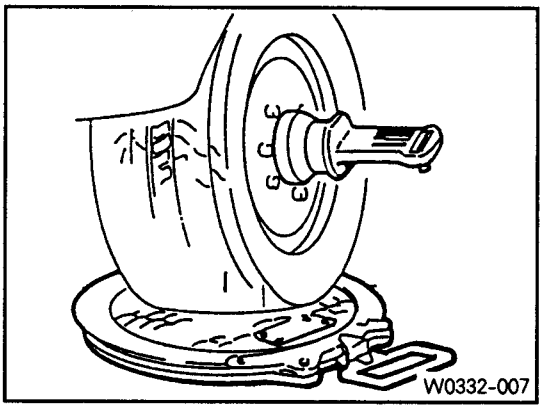


Camber

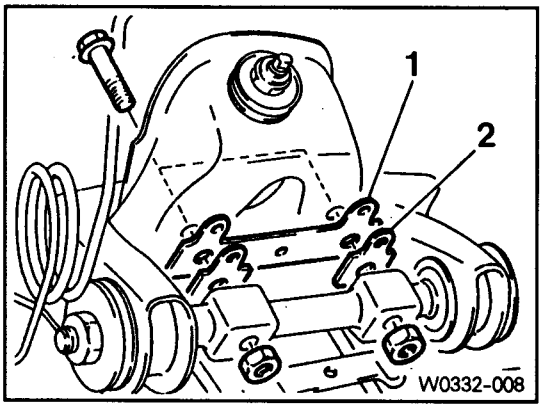
1) Remove the free wheel hub.

2) Measure camber with a wheel alignment equipment.

Specification	0 ° ± 30 ′



3) If camber measurements are not within specification, adjust it by increasing or decreasing the number of adjusting shims (1) inserted between the upper arm shaft and cross member.



Camber change

Adjusting shims	Increasing 1 EA	Decreasing 1EA
1.6 large	19 ′ ↑	19 ′ ↓
3.2 small	38 ′ ↑	38 ′ ↓

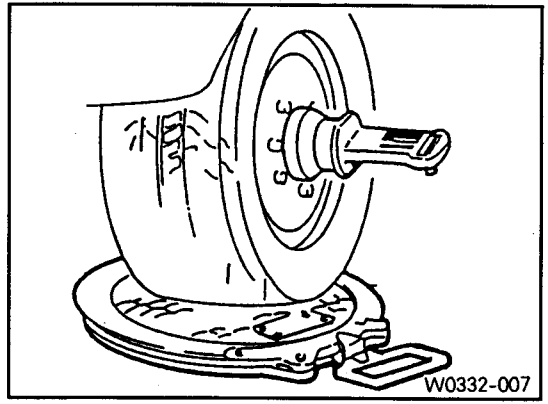
[Note] Difference between the left and right should be adjusted within 30 ′ .

Caster

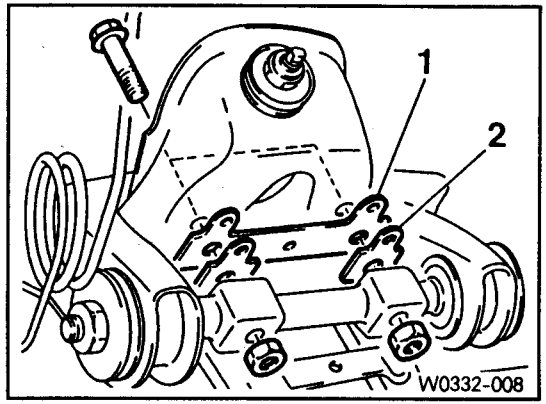
1) Remove the free wheel hub.

2) Measure caster with a wheel alignment equipment and a turning radius gauge.

Specification	2 ° 30 ′ ± 30 ′



3) If caster measurements are not within specification, adjust it by increasing or decreasing the number of adjusting shims (2).

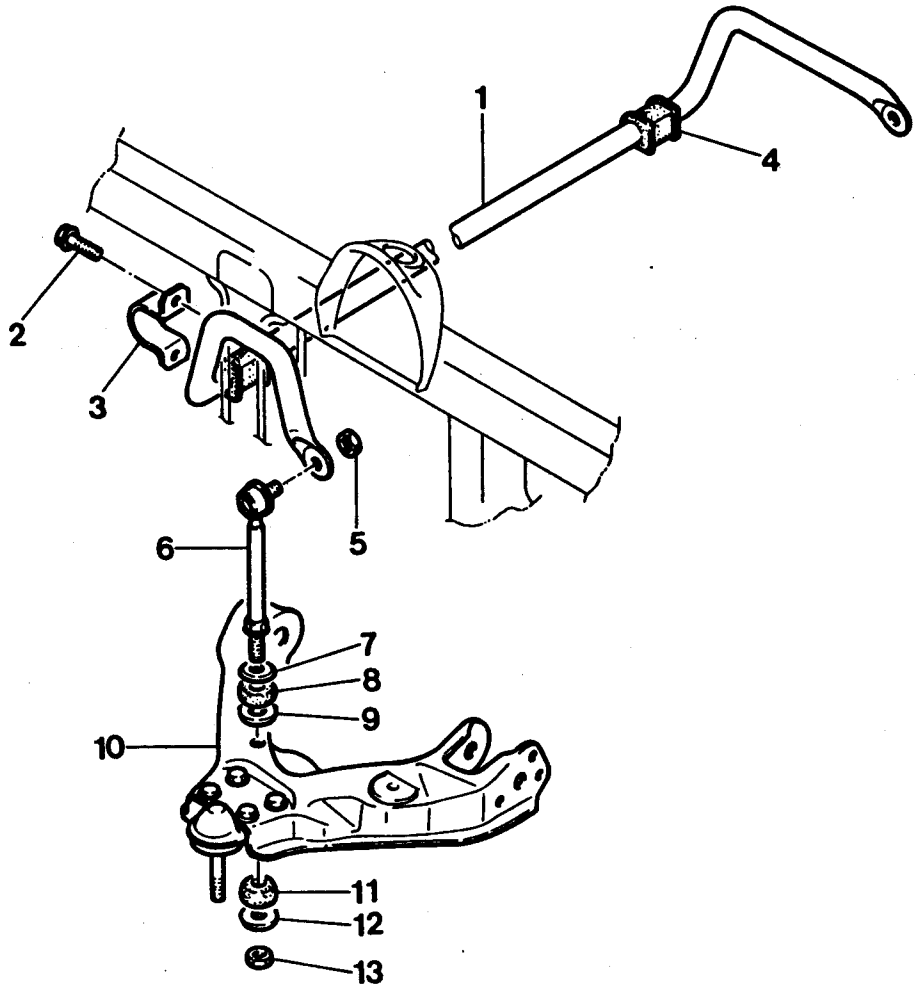


Caster change

Adjusting shims	Increasing 1 EA (rear)	Decreasing 1EA (front)
0.4 small	11 ′ ↑	11 ′ ↓
1.6 large	43 ′ ↑	43 ′ ↓

[Note] Difference between the left and right should be adjusted within 30 ′

5. Removal and Installation of front stabilizer bar



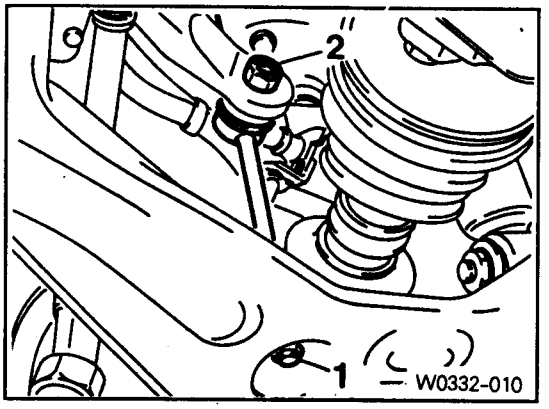
1. Front Stabilizer Bar
2. Bolt----------16~22Nm
3. Fixing Cap
4. Bushing
5. Nut----------40~60Nm
6. Stabilizer Bar Link Assembly
7. Outer Washer
8. Bushing
9. Center Washer
10. Lower Arm
11. Bushing
12. Outer Washer
13. Nut----------16~22Nm

Removal · Installation

1) Remove the connecting nuts (1) of the stabilizer bar link to the lower arm.

Installation

Tightening torque	16~22Nm

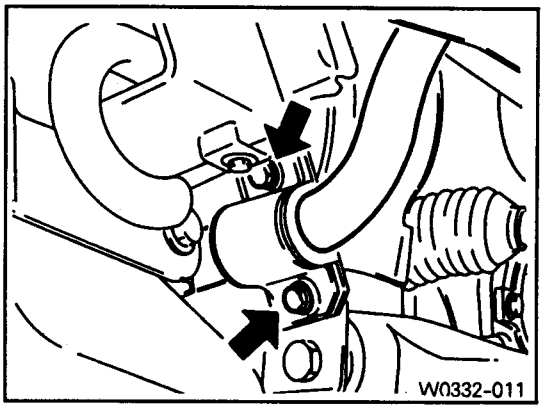


2) Remove the connecting nuts (2) of the stabilizer bar and link and then remove the link.

Installation

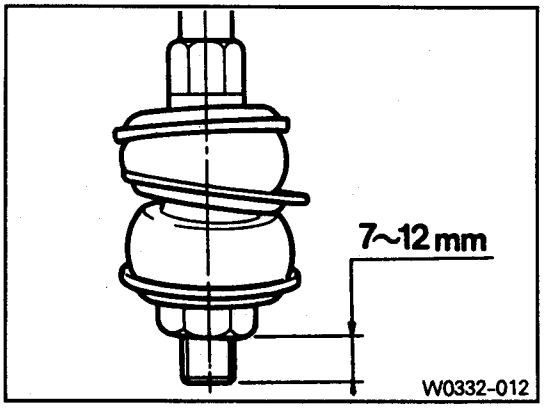
Tightening torque	40~60Nm

3) Remove the stabilizer bar fixing cap bolts (arrow) and remove the stabilizer bar.

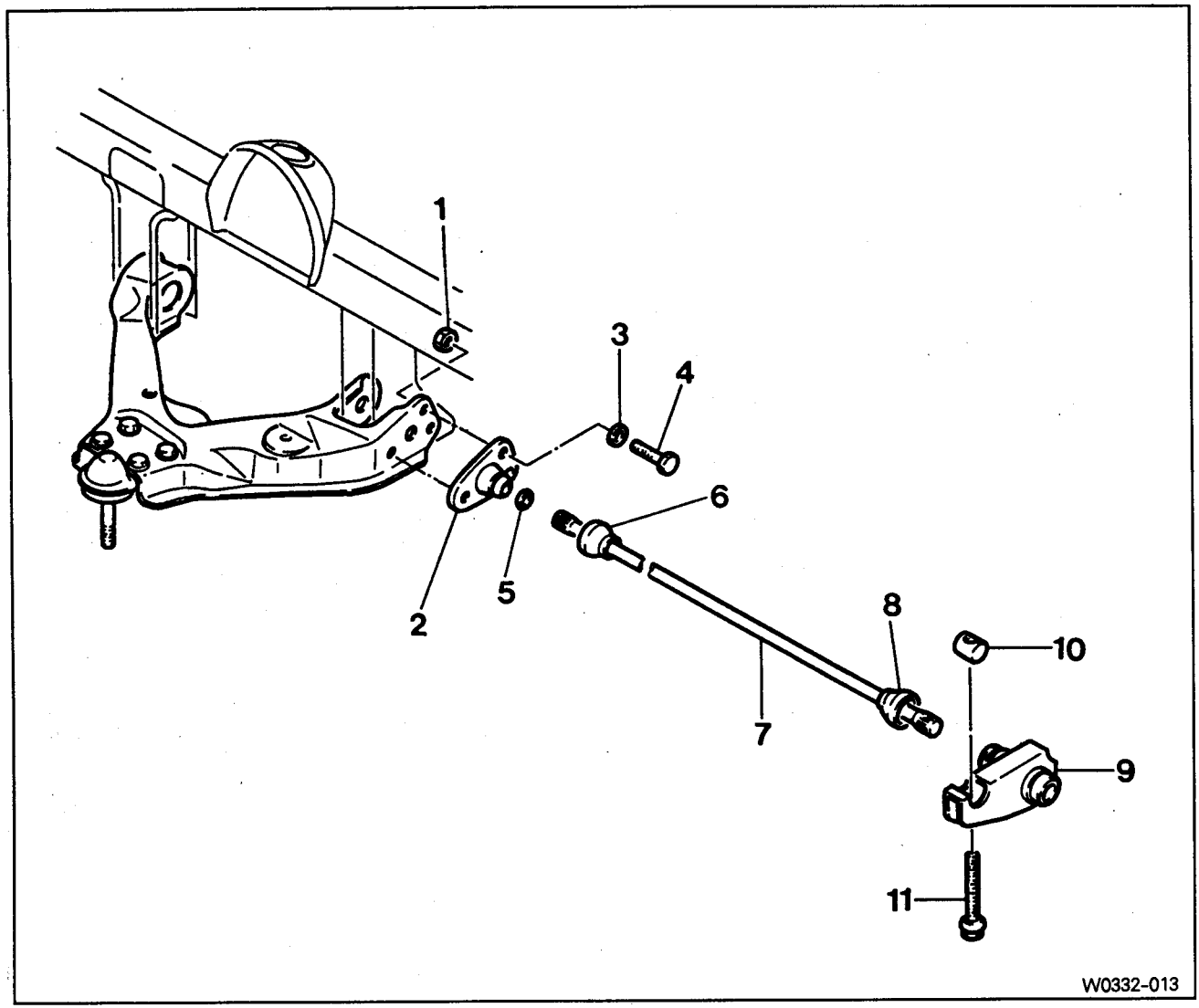


4) Installation is reverse order of the removal.

[Note] The distance between the end of the nut and the end of the link is 7~12mm at the connection of the stabilizer bar link and lower arm.



6. Removal and Installation of Torsion Bar



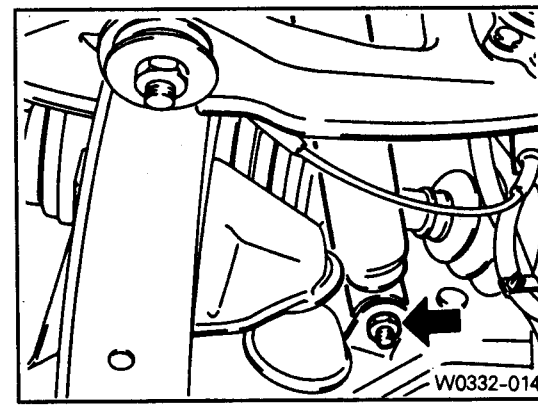
1. Nut---------- M10 : 40~60Nm
   M12 : 60~80Nm
2. Torque Arm
3. Washer
4. Bolt
5. Torsion Bar End Seat
6. Dust Cover
7. Torsion Bar
8. Dust Cover
9. Anchor Arm
10. Anchor Arm Bolt Pilot
11. Anchor Arm Bolt

Removal · Installation

1) Remove the fixing nuts and bolts of the shock absorber and lower arm connection.

Installation

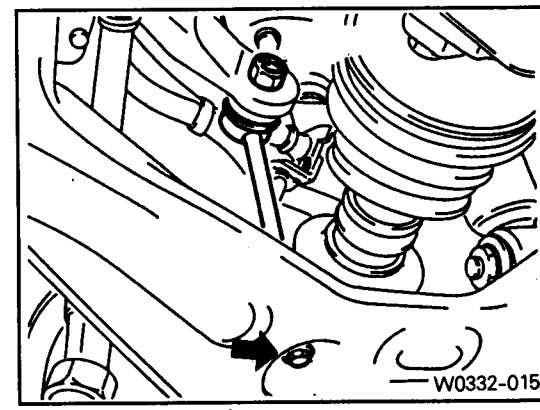
Tightening torque	60~80Nm



2) Remove the connecting nuts of the stabilizer bar link to the lower arm.

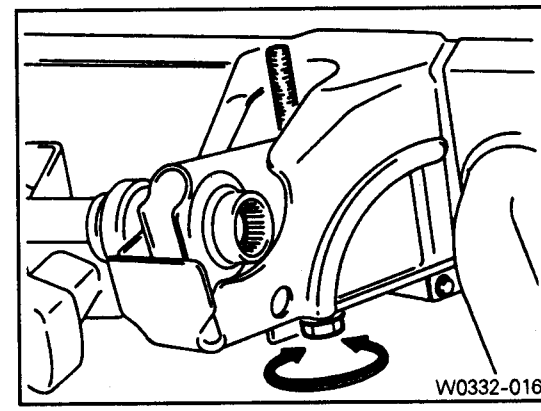
Installation

Tightening torque	16~22Nm



3) Turn the anchor arm bolt until the distance between the end of the anchor arm bolt pilot and the bolt end becomes 0 ~ 5mm.

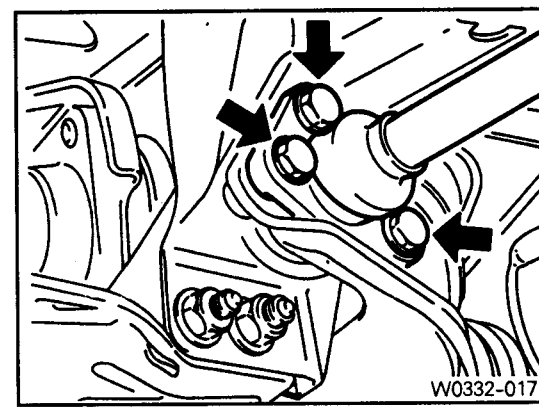
Installation
Install the torsion bar spring and adjust the distance between the end of the anchor arm bolt pilot and the bolt end to be 50~55mm. Do vehicle height adjustment.



4) Remove the torque arm fixing nuts and bolts and then withdraw the torsion bar spring.

Installation

Tightening torque	M10	40~60Nm
	M12	60~80Nm

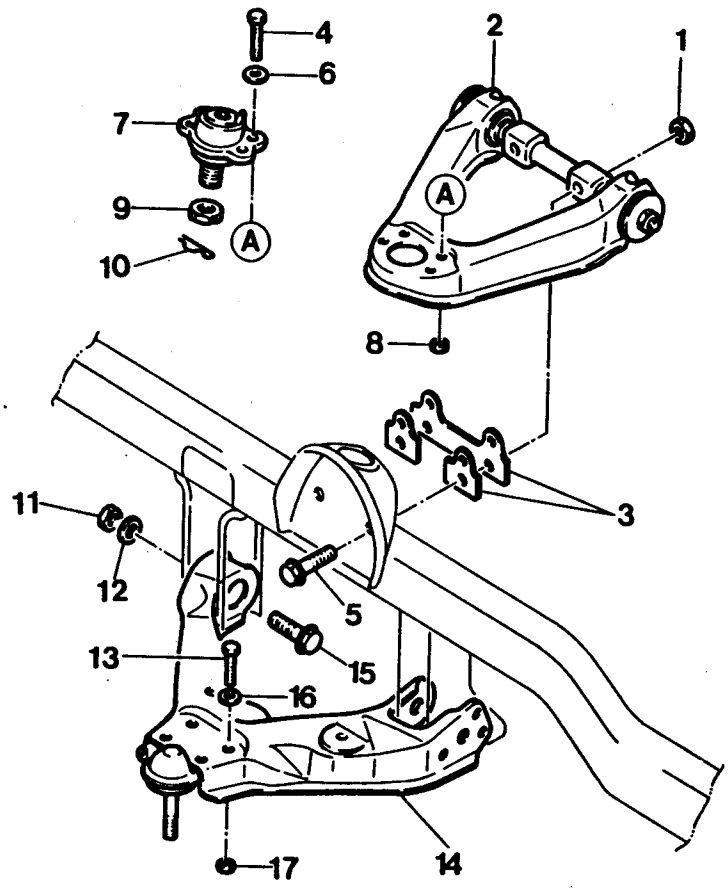


5) Installation is reverse order of the removal.

6) Do wheel alignment.

7. Removal and Installation of Front Lower and Upper Arm

Preceding work : Removal of the torsion bar spring (32-10)
Removal of the steering knuckle and drive shaft (33-04)



W0332-018

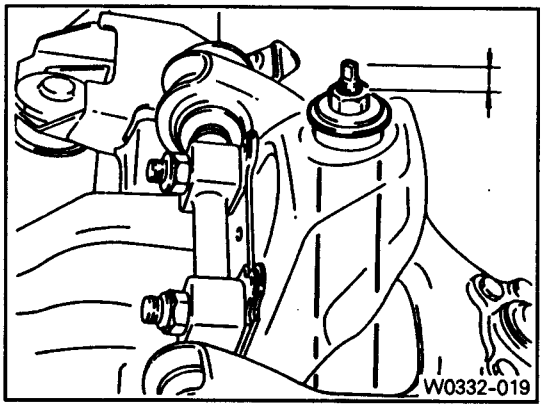
1. Nut----------120~140Nm
2. Fulcrum Pin and Upper Arm Assembly
3. Shim (Camber / Caster)
4. Bolt
5. Bolt
6. Washer
7. Upper Ball Joint
8. Nut----------16~22Nm
9. Nut----------80~150Nm
10. Cotter Pin ----------Replace
11. Nut----------110~130Nm
12. Washer
13. Bolt
14. Lower Arm Assembly and Lower Ball Joint
15. Bolt
16. Washer
17. Nut----------60~80Nm

Removal · Installation

1) Remove the shock absorber.

Installation

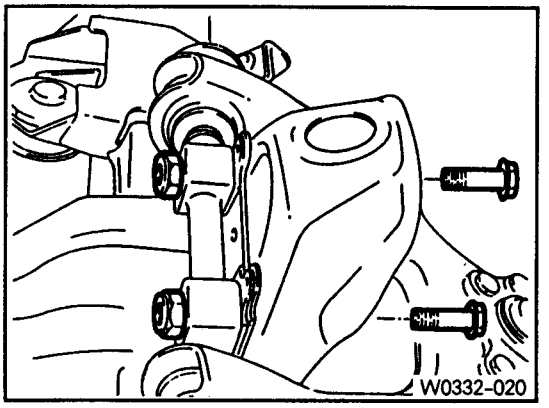
Upper	Distance between the nut end and the screw end	6~9mm
Lower	Tightening torque	60~80Nm



2) Remove the fulcrum pin mounting bolts and nuts and remove the upper arm assembly.
[Note] Be careful not to damage or lose the adjusting shims.

Installation

Tightening torque	120~140Nm

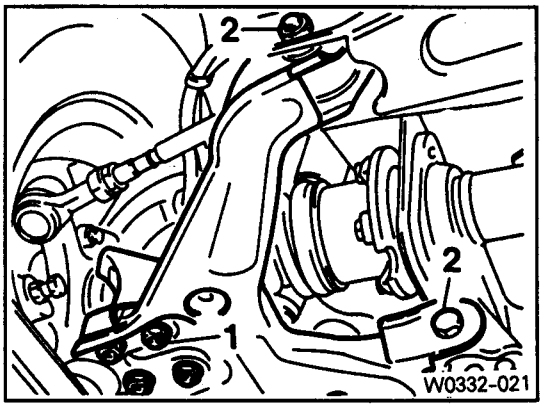


3) Remove the lower arm mounting bolts (2) and remove the lower arm.

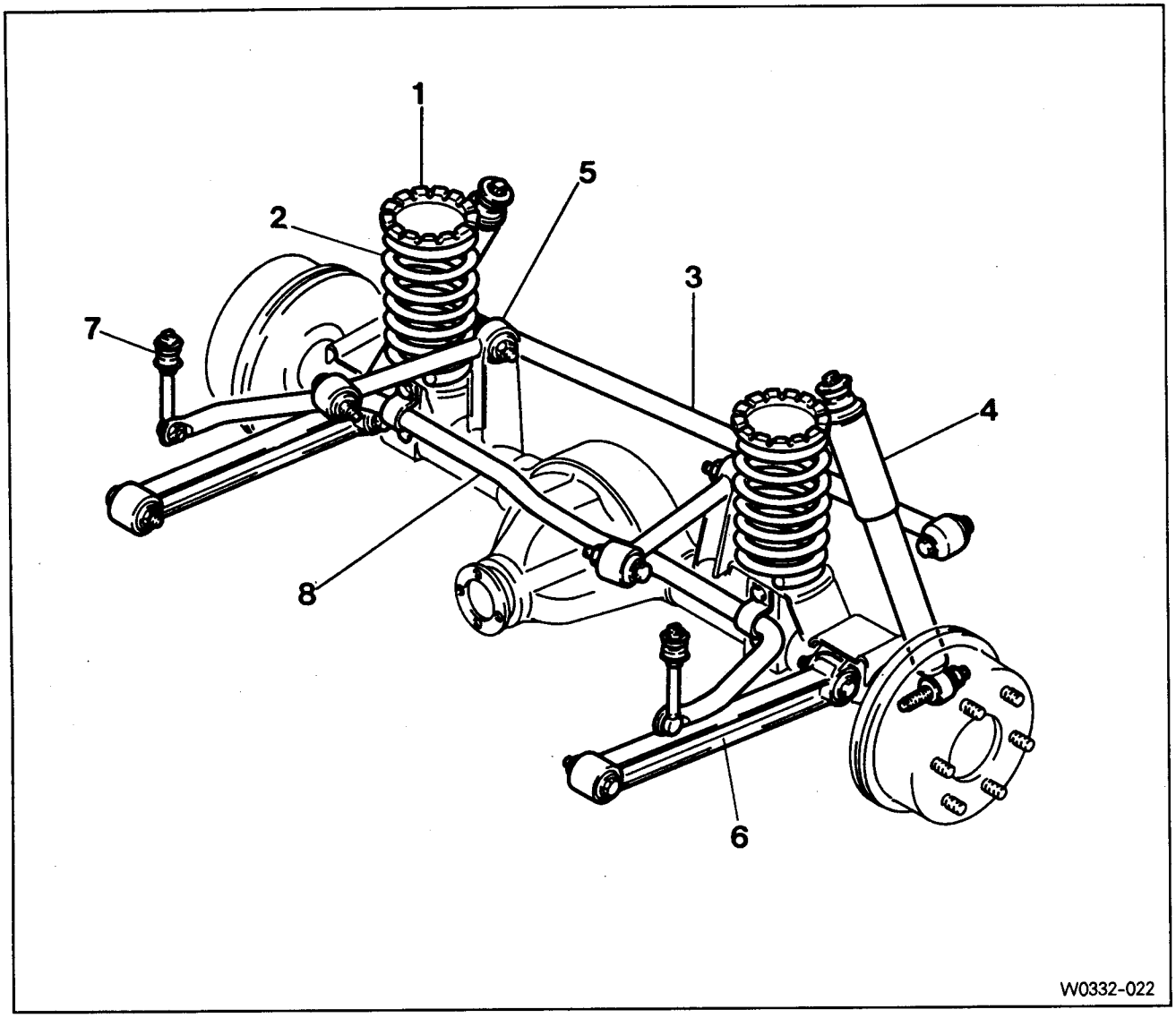
Installation

Tightening torque	110~130Nm

4) Installation is reverse order of the removal.



8. Removal and Installation of Rear Suspension (5 - Link)

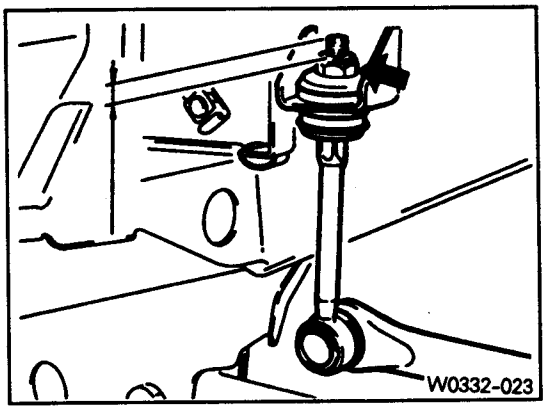


1. Spring Seat
2. Coil Spring
3. Lateral Rod
4. Shock Absorber
5. Upper Arm
6. Lower Arm
7. Connecting Link
8. Stabilizer Bar

Removal · Installation

1) Stabilizer bar.

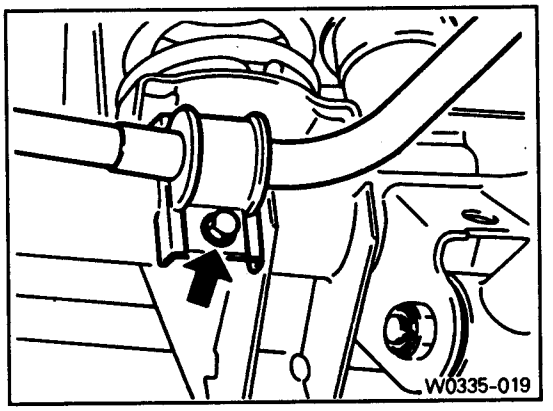
1.1) Remove the upper nut of the connecting link.



Installation

Distance between the nut end and the screw end	7~12mm
Tightening torque	30~45Nm

1.2) Remove the stabilizer bar cap fixing bolts (arrow) and remove the stabilizer bar.

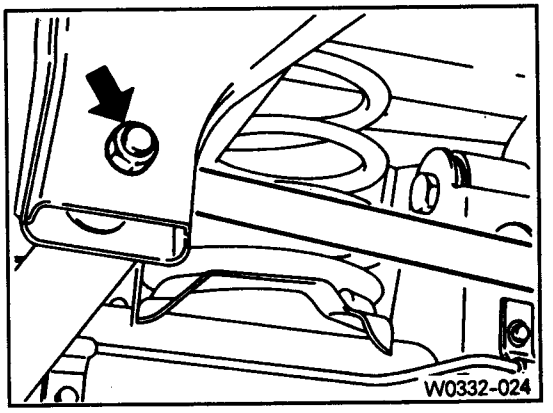


Installation

Tightening torque	30~45Nm

2) Lateral rod

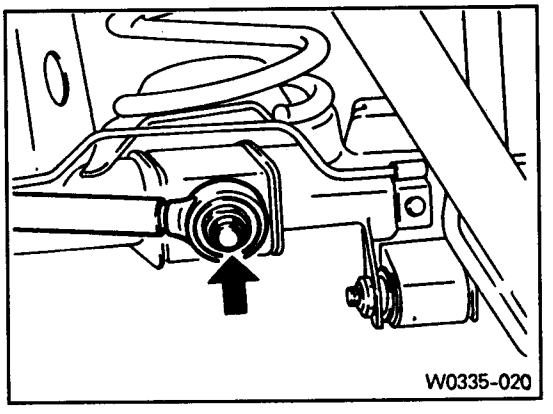
2.1) Remove the lateral rod fixing nut from the frame.
[Note] Completely press the coil springs.



Installation

Tightening torque	150~180Nm

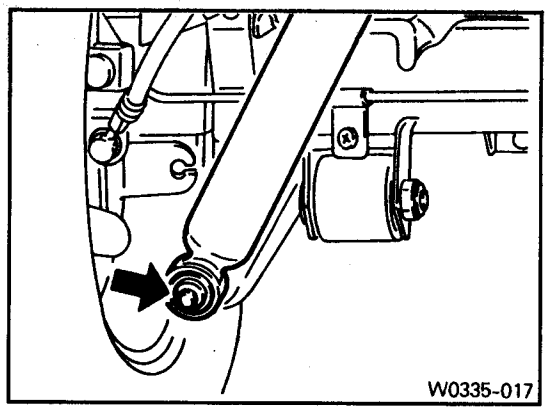
2.2) Remove the lateral rod fixing nut from the rear axle and remove the lateral rod.



Installation

Tightening torque	150~180Nm

3) Shock absorber.



3.1) Remove the lower mounting nut.

Installation

Tightening torque	50~65Nm

3.2) Remove the upper mounting nut and remove the shock absorber.

Installation

Distance between the nut end and the screw end	6~9mm
Tightening torque	30~45Nm

4) Upper Arm.

4.1) Remove the upper arm fixing nut from the frame.

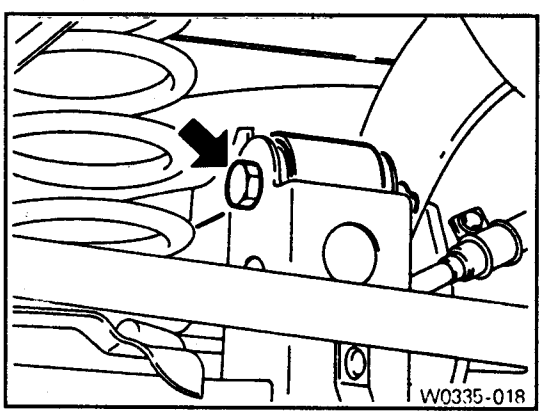
Installation

Tightening torque	150~180Nm

4.2) Remove the upper arm fixing nut from the rear axle and remove the upper arm.

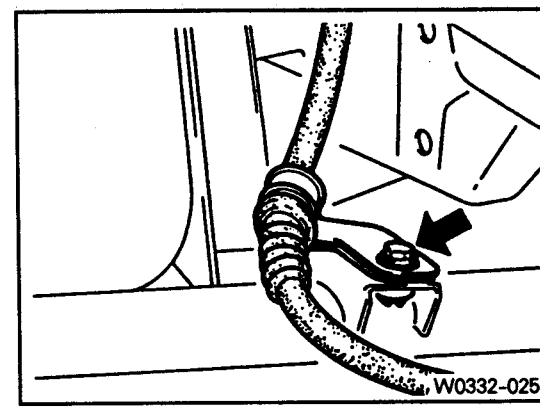
Installation

Tightening torque	150~180Nm



5) Lower arm.

5.1) Remove the parking brake cable bracket.



5.2) Remove the lower arm fixing nut from the frame.

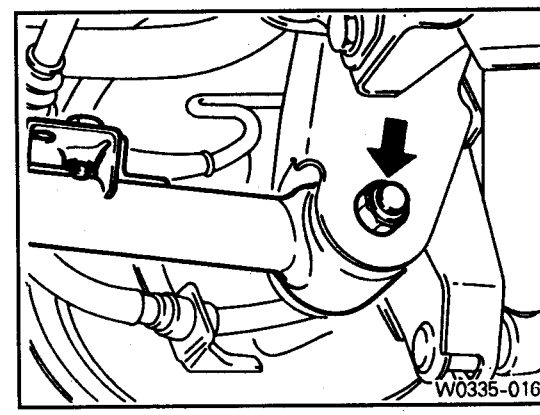
Installation

Tightening torque	150~180Nm

5.3) Remove the lower arm fixing nut from the rear axle and remove the lower arm.

Installation

Tightening torque	150~180Nm



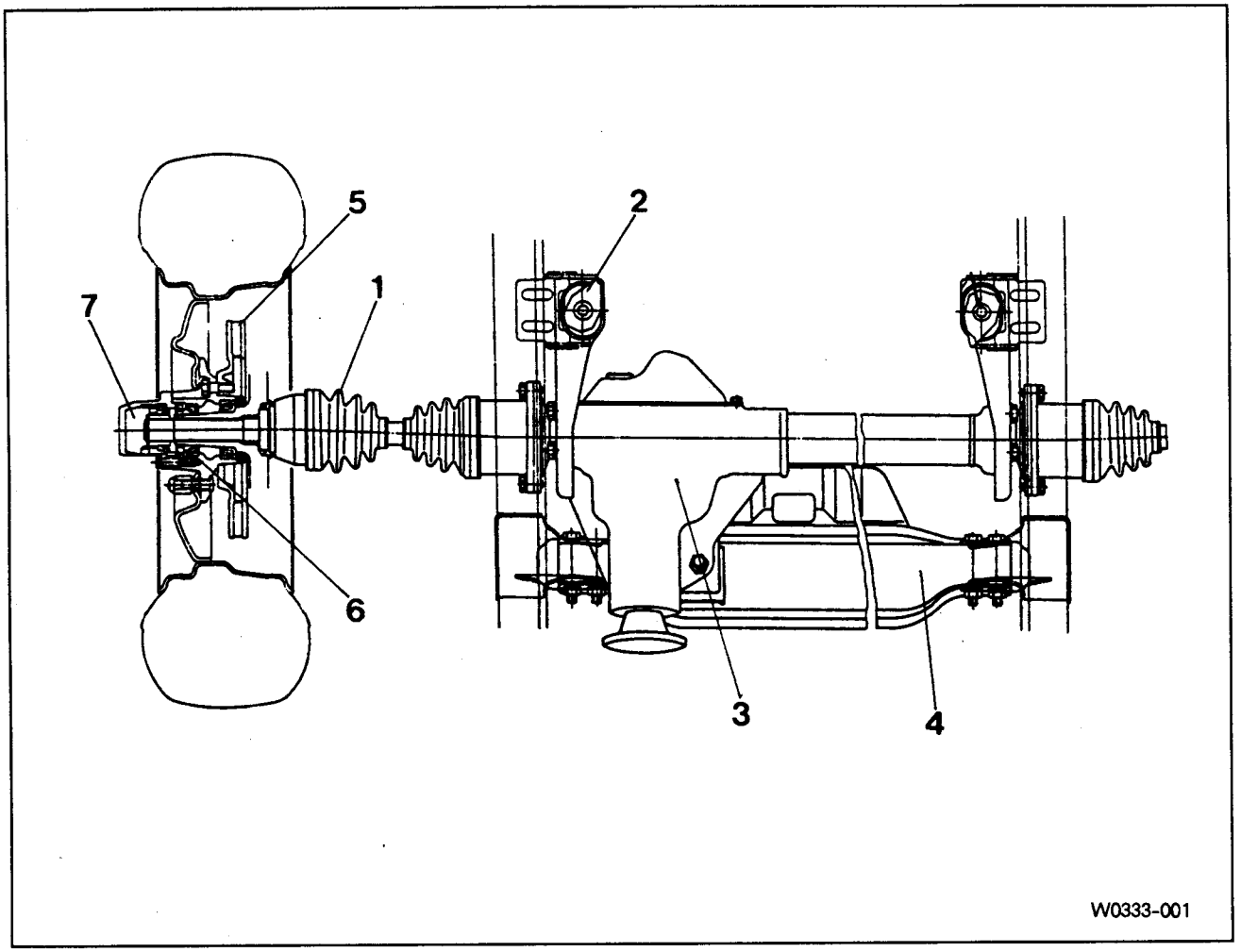
6) Installation is reverse order of the removal.

1. General

Specifications

Drive shaft type		CV joint
Axle housing type		Salisbury (build-up)
Differential	Type	Conventional
	Gear	Hypoid gear
Reduction ratio	Diesel engine + A/T, Gasoline engine	3.73
	Diesel engine + Manual transmission	4.56
Oil	Capacity	1.4 ℓ
	Specification	SAE 80W/90, API GL - 5

Assembly Drawing

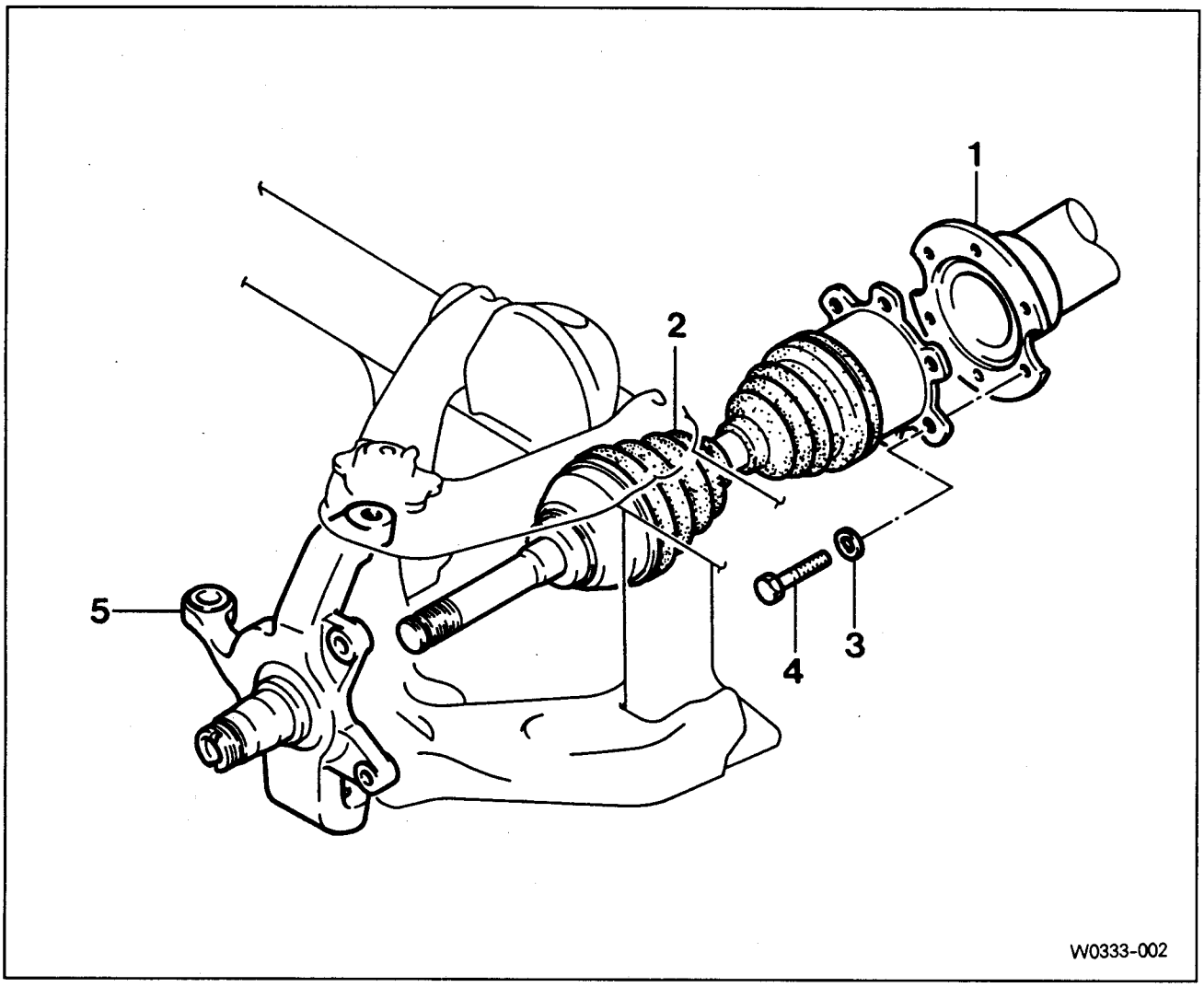


1. Drive Shaft
2. Axle Housing Mounting Bracket
3. Axle Housing
4. Cross Member
5. Brake Disc
6. Hub
7. Locking Hub

2. Troubleshooting

Problem	Possible Cause	Remedy
Noise (During straight driving)	Lack of oil	Replenish
	Low viscosity of oil	Replace
	Insufficient oil	Replace
	Excessive backlash of ring gear	Adjust
	Worn or damaged tooth of ring and pinion gear	Replace
	Worn or damaged drive pinion bearing	Replace
	Worn spline of side bearing and side gear	Replace
	Bent axle housing	Replace
	Bent differential case	Replace
	Worn pinion shaft	Replace
	Incorrect drive pinion preload	Adjust
	Incorrect contact of ring gear and pinion	Retightening
Oil leakage	Excessive oil	Adjust
	Faulty seal of carrier contact surface	Repair
	Axle housing crack	Replace
	Worn or damaged oil seal	Replace
Noise (During turning)	Worn or damaged tooth of pinion or side gear	Replace
	Worn pinion shaft	Replace
	Excessive backlash of pinion gear and side gear	Replace
	Excessive end-play of rear axle shaft	Adjust
	Incorrect contact of side gear and differential case	Replace
	Axle housing crack	Replace
	Bent or poor installation of drive pinion oil seal	Replace
	Damaged or torn drive pinion oil seal	Replace
	Loosened bearing collar	Replace
	Worn or damaged universal joint	Replace
	Worn or damaged axle shaft bearing	Replace
Heating	Lack of oil	Replenish
	Insufficient backlash of gears	Adjust
	Excessive preload of bearing	Adjust

3. Removal and Installation of Steering Knuckle and Drive Shaft



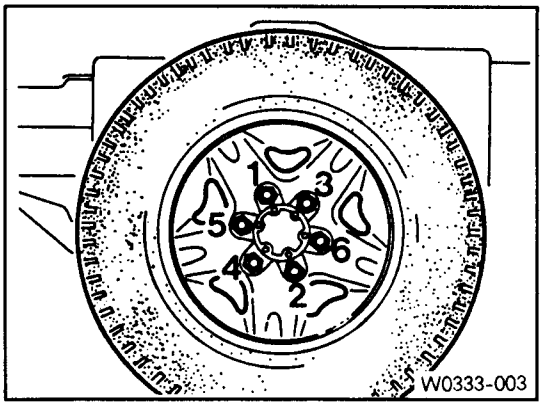
1. Front Axle Inner Shaft
2. Front Axle Drive Shaft
3. Washer
4. Bolt---------- 45~60Nm
5. Steering Knuckle

Removal · Installation

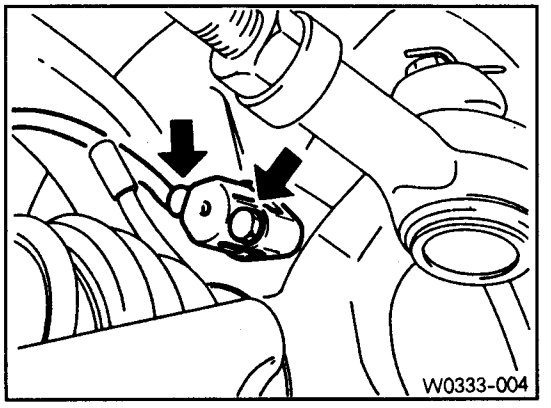
1) Remove the tire.

Installation

Tightening torque	Steel wheel	80~120Nm
	Aluminium wheel	110~130Nm



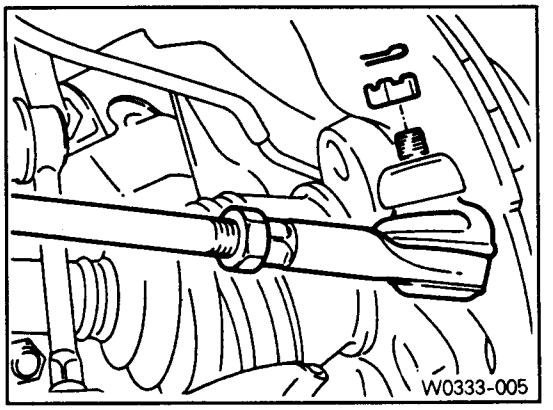
2) With ABS
Remove the wheel speed sensor from the steering knuckle.



3) Remove the cotter pin and nut. Disconnect the tie rod from the steering knuckle arm.

Installation

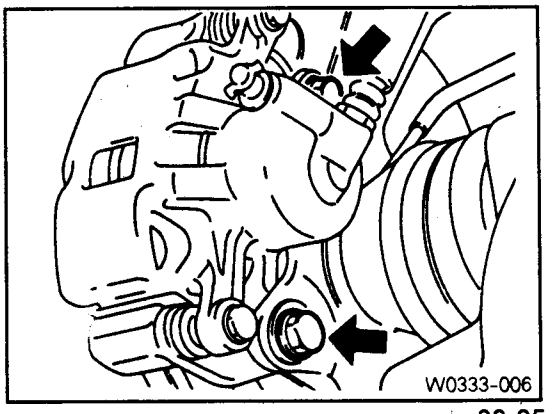
Tightening torque	35~45Nm



4) Remove the mounting bolts and pull off the caliper assembly.
[Note] Be careful not to damage the brake hose.

Installation

Tightening torque	20Nm

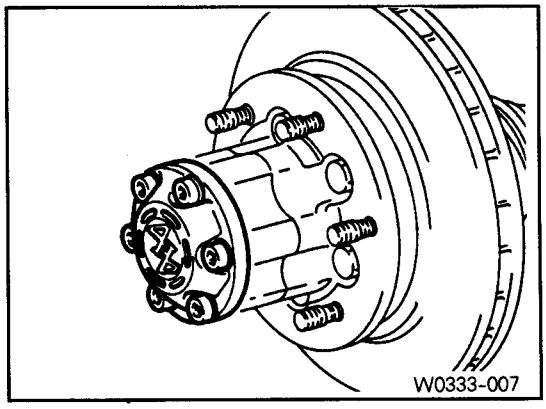


5) Part-time 4WD

5.1) Remove the cover mounting bolts and pull off the cover.

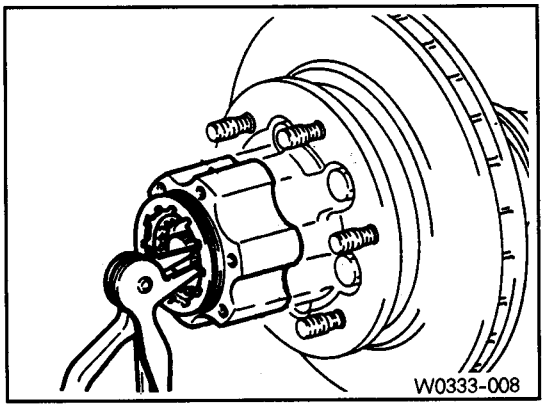
Installation

Tightening torque	70~90Nm



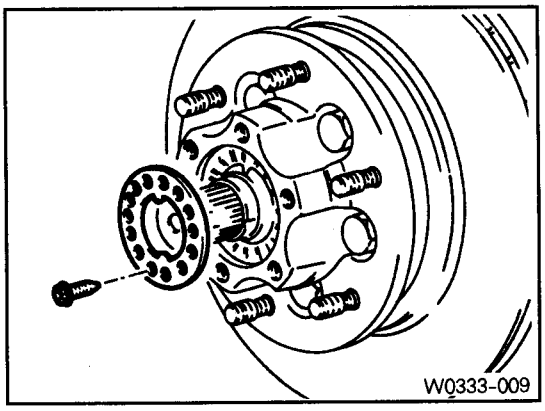
5.2) Remove the snap ring of the drive shaft and pull off the hub body.

[Note] For assembly, adjust the clearance between the snap ring and hub not to exceed 0.2 mm (Shim thickness : 0.2, 0.3, 0.5, 1.0mm).



5.3) Remove the screws and pull off the locking plate.

5.4) Remove the auto locking hub vacuum hose from the steering knuckle.

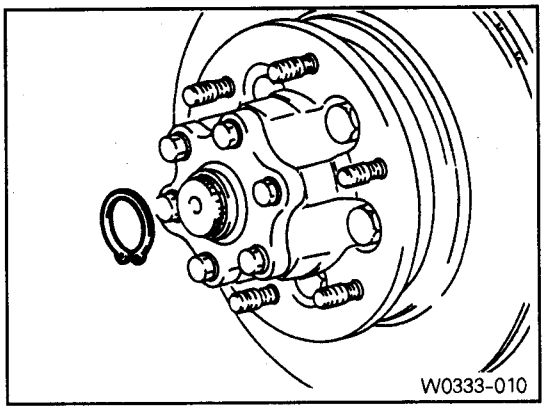


6) Full-time 4WD

6.1) Using a screwdriver, remove the hub cap. Remove the ring from the drive shaft.

[Note] · For assembly, adjust the clearance between the snap ring and hub not to exceed 0.2 mm (Shim thickness : 0.2, 0.3, 0.5, 1.0mm).

· Apply grease inside of the hub about 60g.

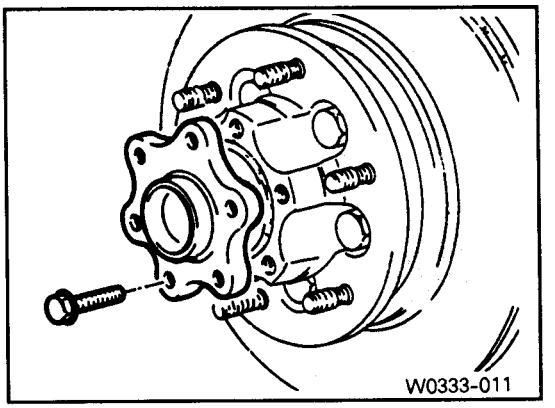


6.2) Remove the mounting bolts and pull off the hub flange.

Installation

Tightening torque	70~90Nm

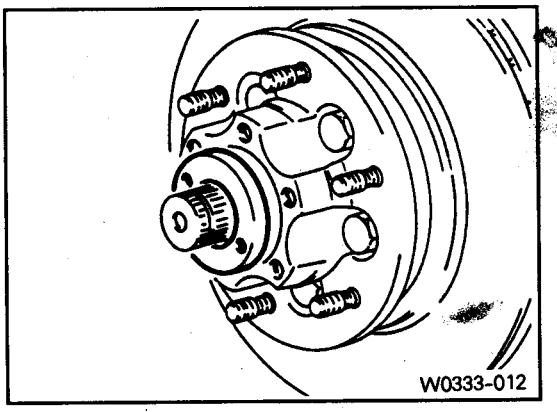
[Note] Apply Loctite between the hub and flange contact surface.



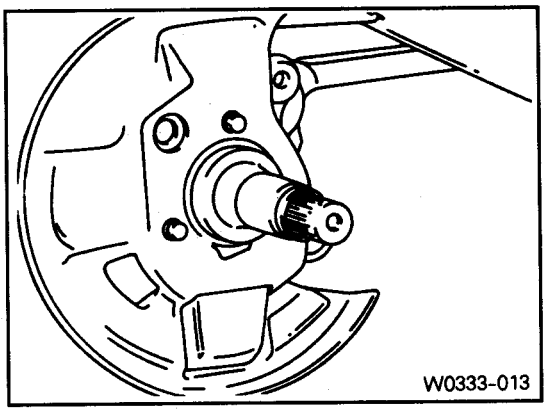
7) Using a special tool, remove the hub nut.

Installation

Tightening torque	15Nm



8) Remove the hub and brake assembly.

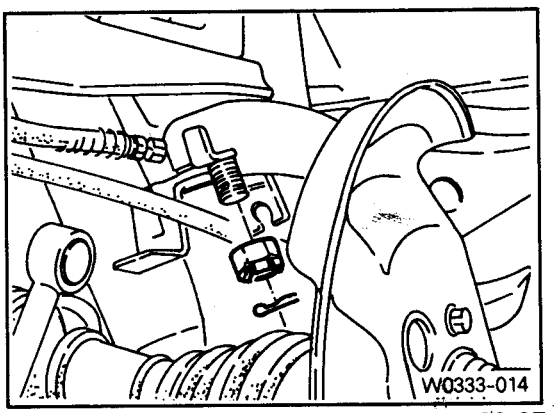


9) Remove the cotter pin and nut from the steering knuckle arm and upper arm ball joint connection.

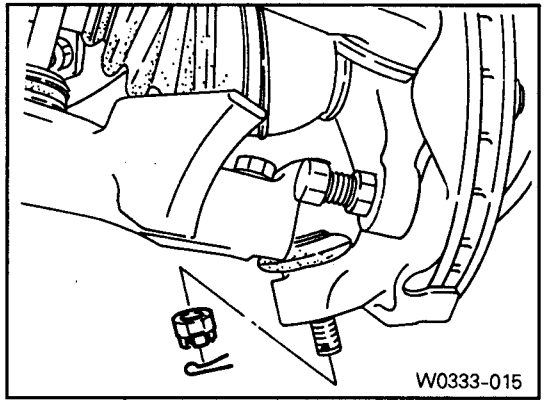
Installation

Tightening torque	80~150Nm

[Note] Replace the cotter pin.



10) Remove the cotter pin and unt from the steering knuckle arm and lower arm ball joint connection.



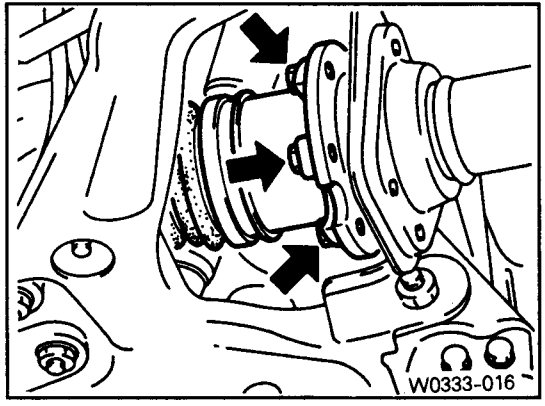
Installation

Tightening torque	120~180Nm

[Note] Replace the cotter pin.

11) Using a plastic or a brass hammer, tap the steering knuckle arm and remove it.

12) Remove the drive shaft mounting bolts and remove the drive shaft.



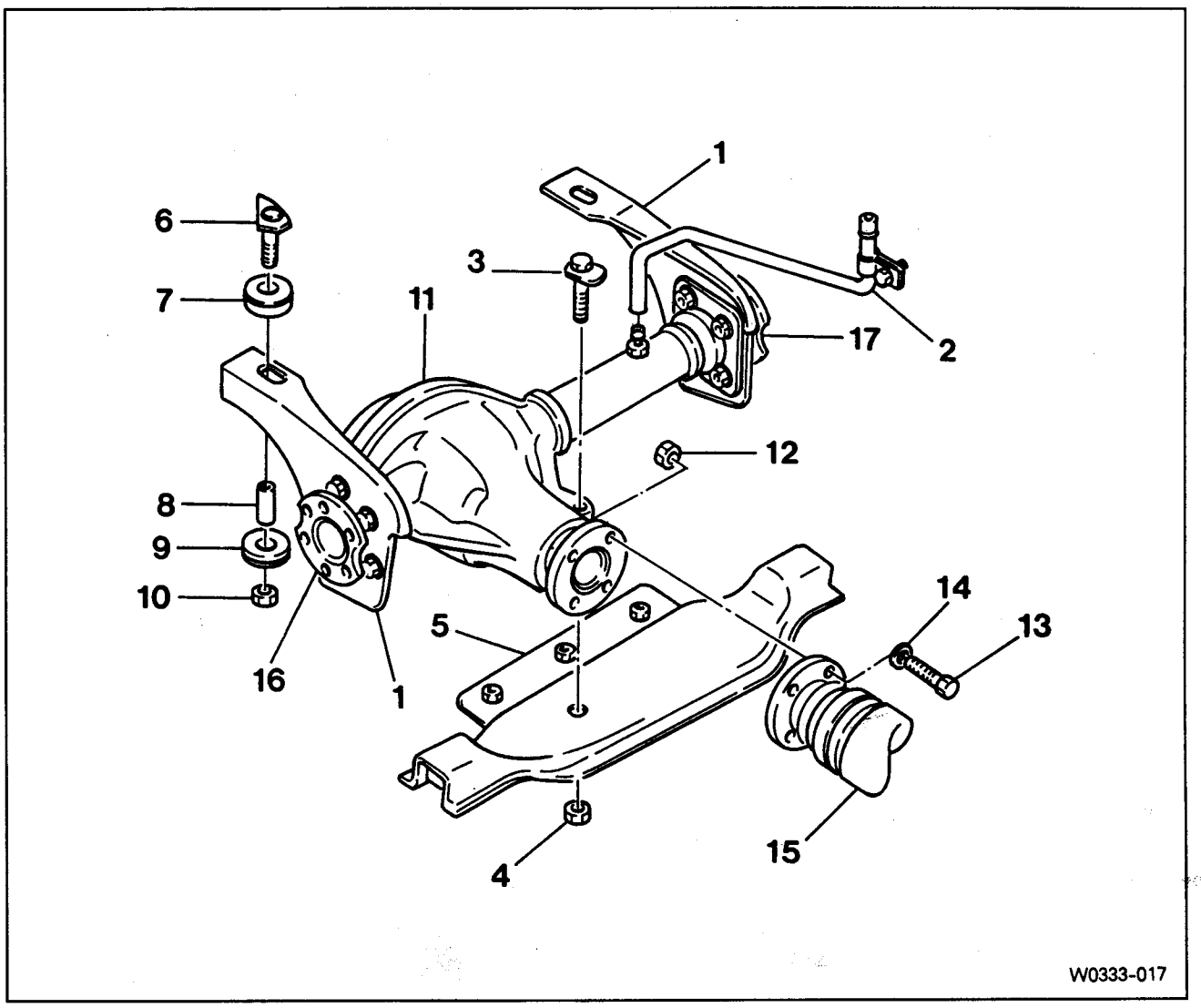
Installation

Tightening torque	45~60Nm

13) Installation is reverse order of the removal.

4. Removal and Installation of Axle Housing

Preceding work : Removal of the front axle drive shaft (33-04)
Removal of the steering gear box (46-11)



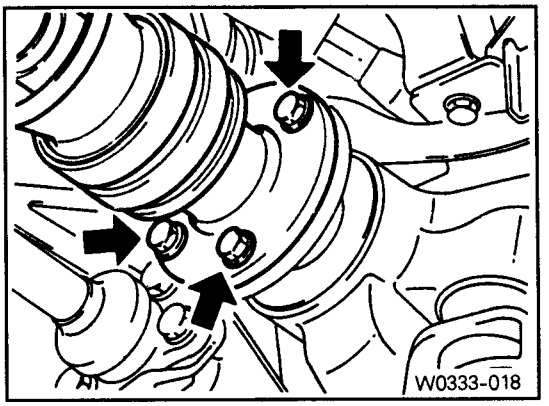
1. Axle Mounting Bracket
2. Vent Hose
3. Bolt
4. Nut---------- 95~142Nm
5. Cross Member
6. Bolt
7. Bushing
8. Spacer
9. Bushing
10. Nut---------- 95~142Nm
11. Front Axle Housing
12. Nut---------- 81~89Nm
13. Bolt
14. Washer
15. Propeller Shaft
16. Axle Shaft
17. Axle Shaft

Removal · Installation

1) Remove the propeller shaft from the front axle input shaft.
[Note] Before removal, place alignment marks.

Installation

Tightening torque	81~89Nm



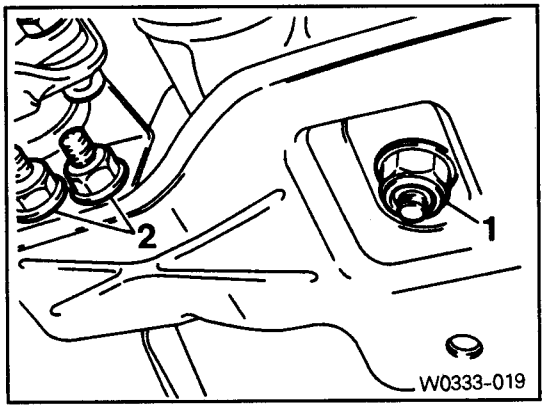
2) Remove the vent hose.

3) Remove the axle housing mounting nuts (1) from the cross member.
Installation

Tightening torque	95~142Nm

4) Remove the cross member mounting nuts (2) from the frame and remove the cross member.
Installation

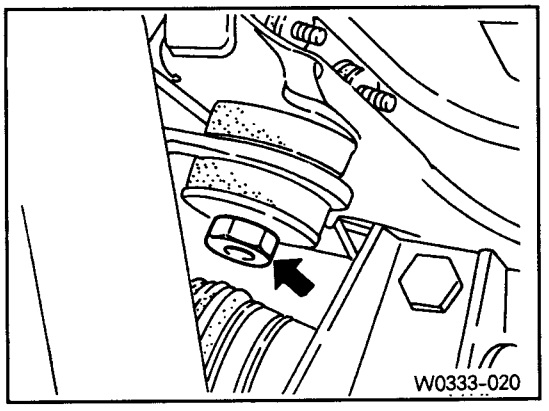
Tightening torque	62~93Nm



5) Support the axle housing on a suitable jack. Remove the axle housing mounting bracket nuts.

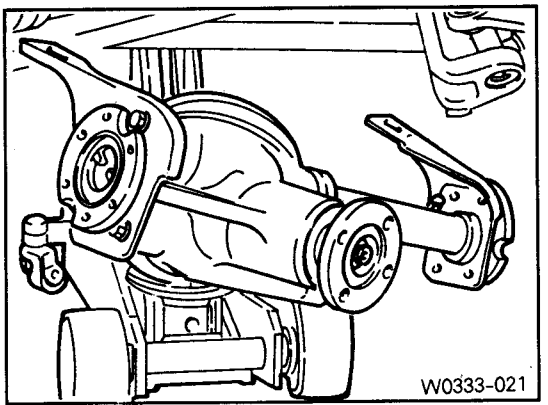
Installation

Tightening torque	95~142Nm



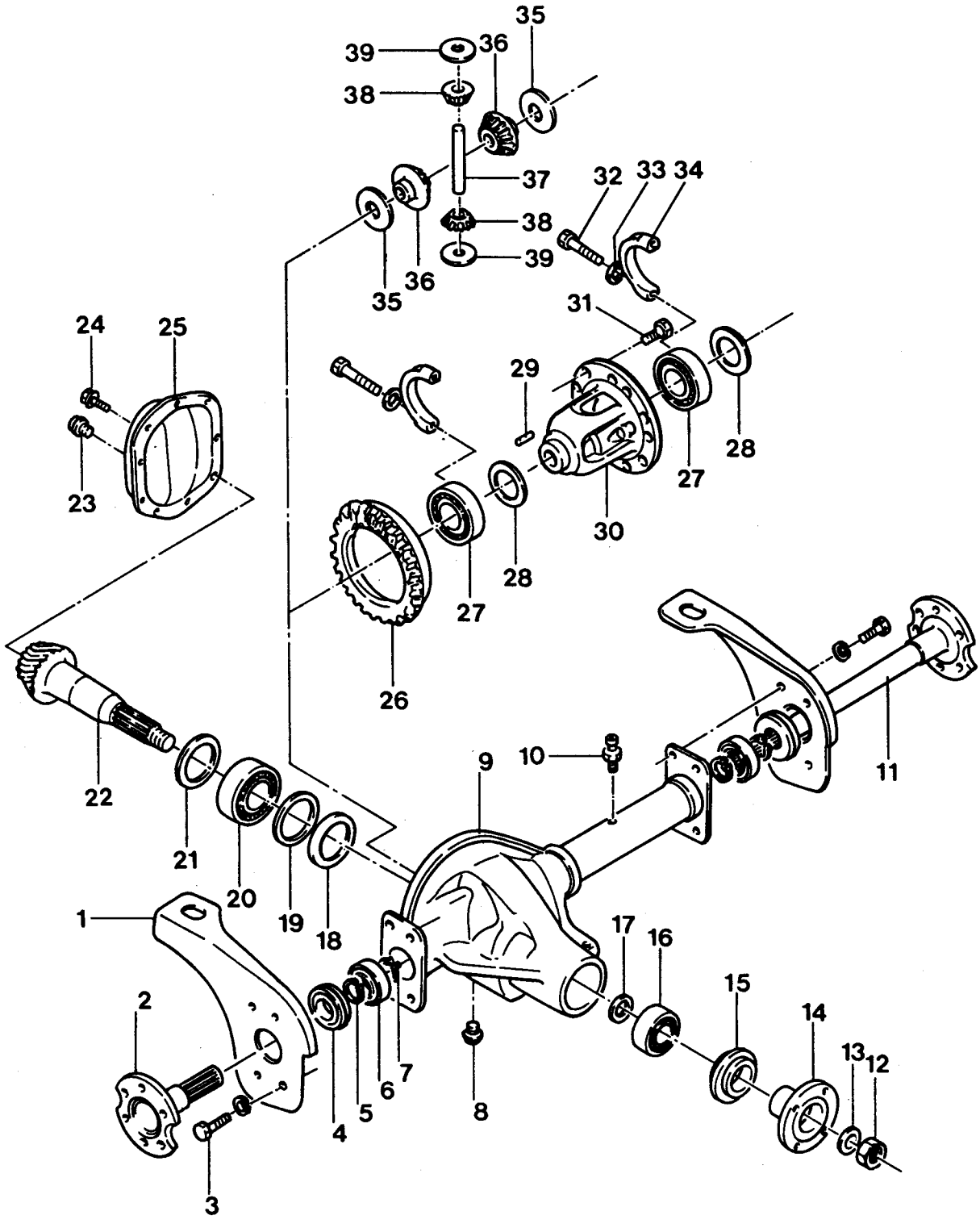
6) Lowering the jack carefully, remove the axle housing assembly.

7) Installation is reverse order of the removal.



5. Disassembly and Assembly of Axle Housing

Preceding work : Removal of the axle housing (33-09)

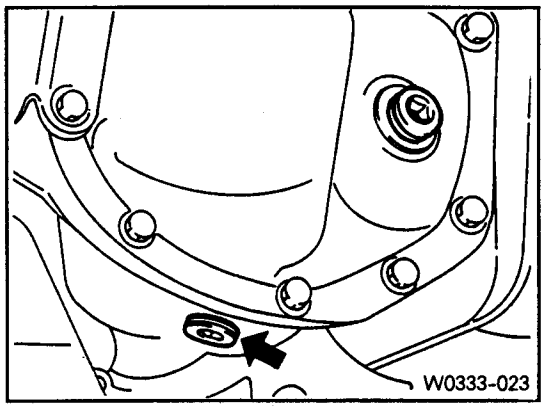


1. Front Axle Housing Mounting Bracket
2. Axle Shaft (Left)
3. Bolt---------- 80~100Nm
4. Oil Seal---------- Replace, Apply grease to the sealing rib
5. Snap Ring
6. Bearing
7. Snap Ring
8. Oil Drain Plug---------- 28~42Nm
9. Front Axle Housing
10. Breather Nipple
11. Axle Shaft (Right)
12. Pinion Lock Nut---------- 240~310Nm
13. Washer
14. Companion Flange
15. Oil Seal---------- Replace, Apply grease to the sealing rib
16. Bearing
17. Shim
18. Bearing Baffle
19. Shim
20. Bearing
21. Oil Slinger
22. Drive Pinion
23. Oil Fill Plug---------- 28~42Nm
24. Bolt---------- 39~46Nm
25. Axle Housing Cover---------- Apply liquid gasket to the contact surface
26. Ring Gear
27. Bearing
28. Shim
29. Shaft Lock Pin
30. Differential Case
31. Bolt---------- 75~90Nm
32. Bolt---------- 48~69Nm
33. Washer
34. Bearing Cap
35. Thrust Washer
36. Side Gear
37. Pinion Shaft
38. Pinion
39. Thrust Washer

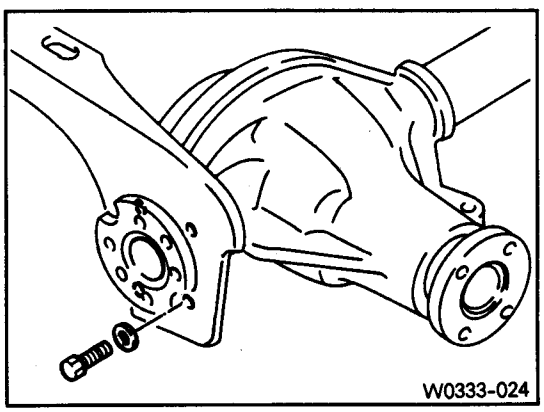
Disassembly

1) Remove the drain plug and drain the oil. Reinstall the drain plug.

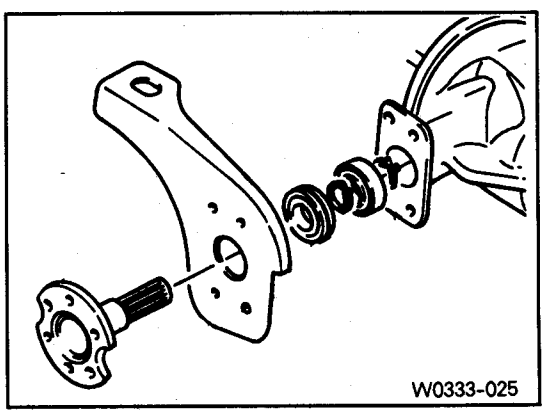
Tightening torque	28~42Nm



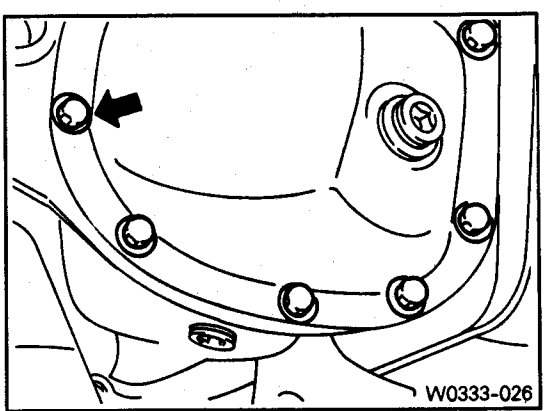
2) Remove the axle housing and housing mounting bracket bolts. Remove the bracket and axle shaft assembly.



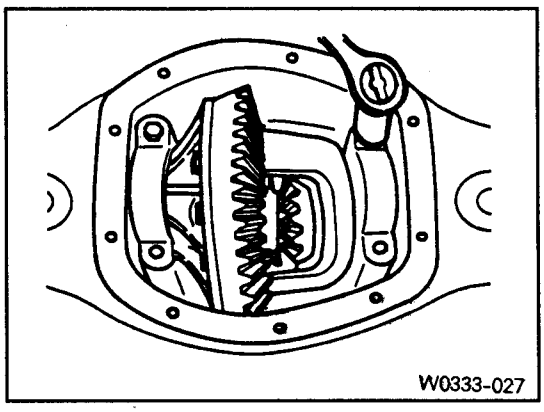
3) Remove the bearing fixing snap ring of the axle shaft and pull out the bearing. Separate the axle shaft and the mounting bracket.



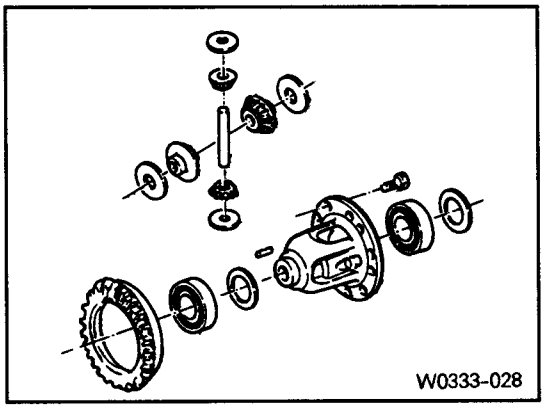
4) Remove the axle housing cover.
[Note] Clean the cover and housing contact surfaces.



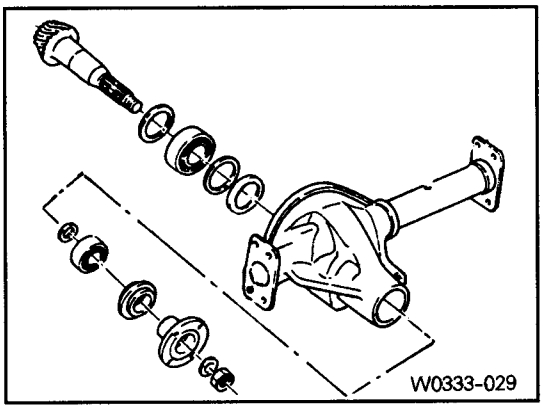
5) Remove the bearing cap bolts and remove the bearing caps. Pull out the differential carrier assembly.
[Note] Place alignment marks on the bearing cap not to change the caps before removal. When pulling out the differential carrier assembly, be careful not to damage the axle housing.


W0333-027

6) Disassemble the parts of the differential carrier assembly.

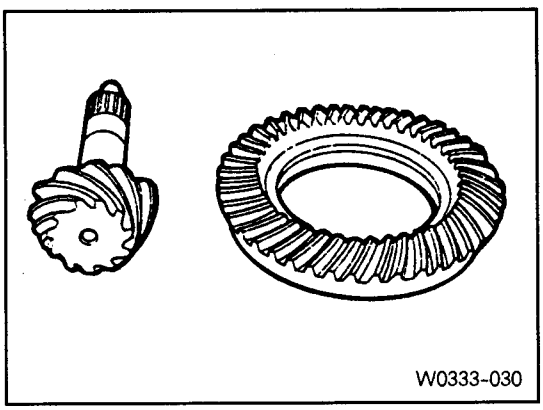

W0333-028

7) Remove the drive pinion lock nut. Disassemble the parts of the drive pinion.


W0333-029

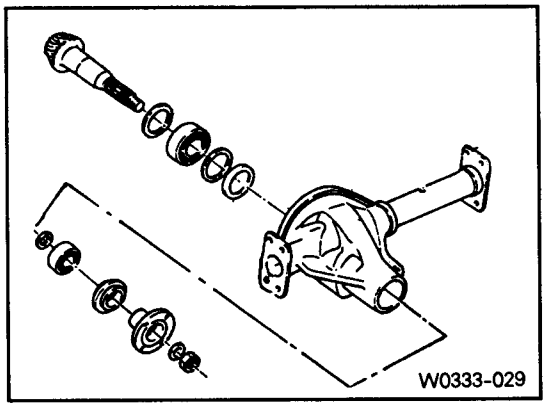
Assembly

1) Clean the all parts and check the followings :
- Check the ring gear and drive pinion for wear and damage.If damaged, replace it as a set.
- Check the bearing for sticks, wear, noise and turning resistance.
- Check the side gear, pinion, pinion shaft and thrust washer for wear and damage.
- Check the differential carrier for crack and wear (bearing contact surface). Check the gear case for crack.


W0333-030

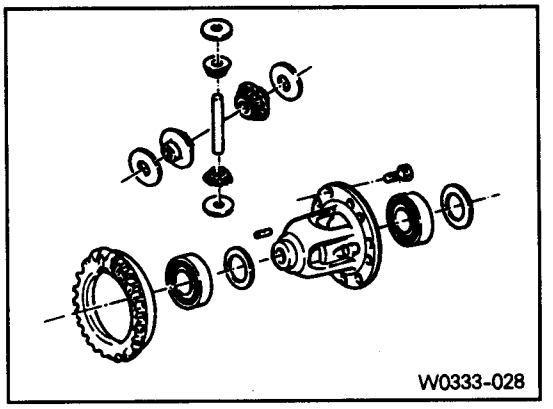
2) Assemble the parts of the drive pinion.

Tightening torque of the lock nut	240~310Nm



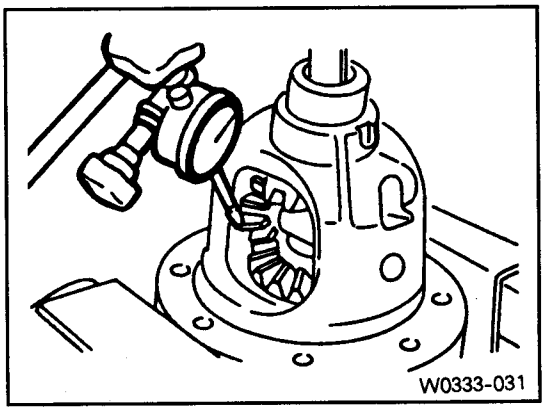
3) Assemble the parts of the differential carrier.

Tightening torque of the ring gear bolts	75~90Nm



4) Measure backlash of the side gear and pinion.

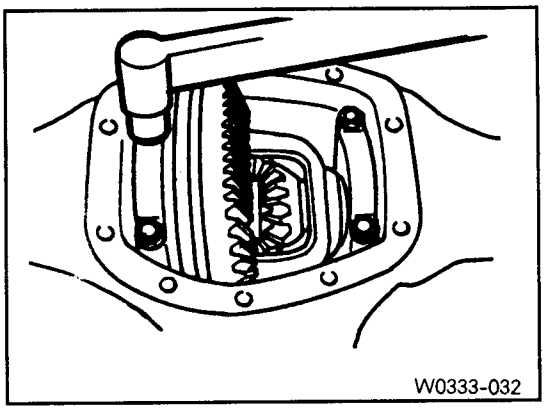
Standard	0~0.05mm



5) Install the differential carrier assembly into the axle housing.

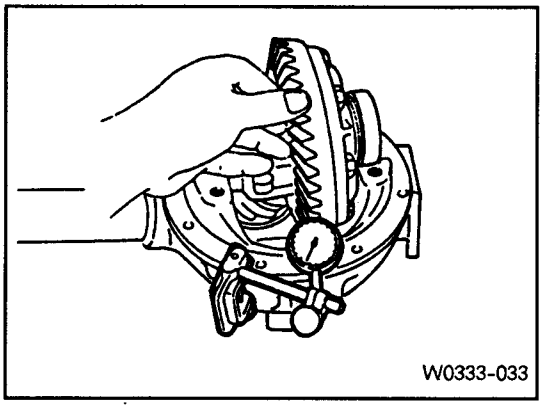
Tightening torque of the bearing cap bolts	48~69Nm

[Note] Be careful not to change the caps. Be sure to keep the original position of the caps.



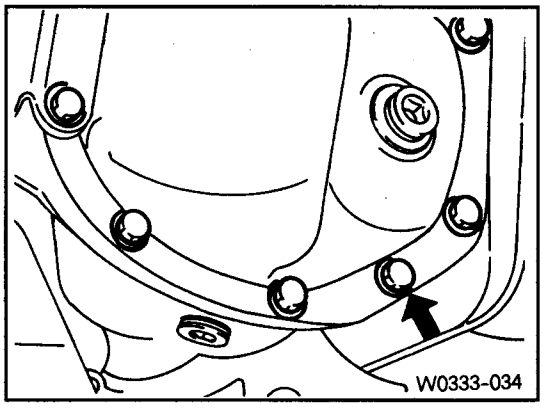
6) Measure backlash of the drive pinion and ring gear.

Standard	0.13~0.20mm

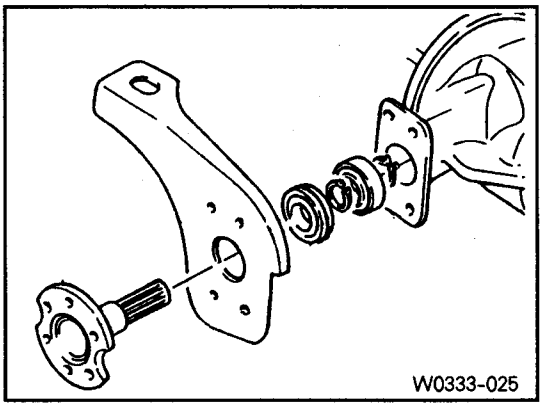


7) Install the axle housing cover.

Tightening torque	39~46Nm

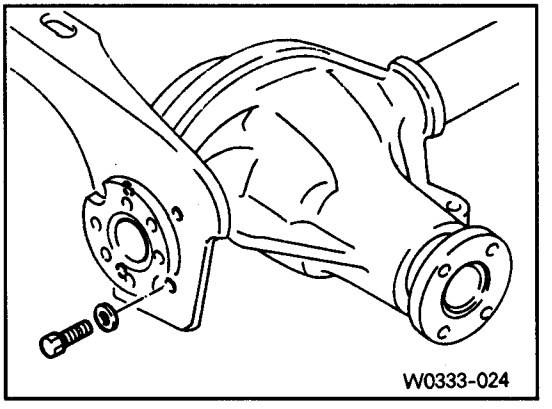


8) Assemble the parts of the front axle shaft and housing mounting bracket.
[Note] Apply grease to the oil seal rib.



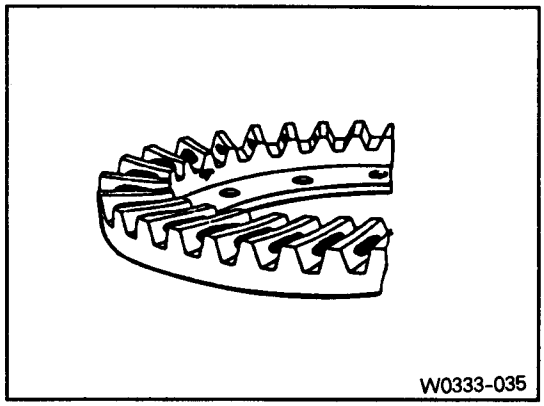
9) Align the axle shaft and differential carrier spline and insert the axle shaft. Assemble the axle housing mounting bracket to the axle housing.

Tightening torque	80~100Nm

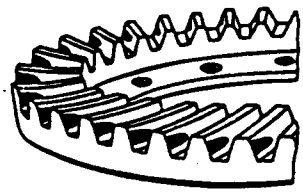
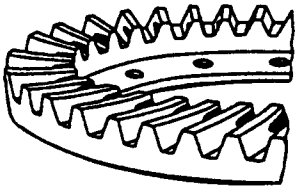
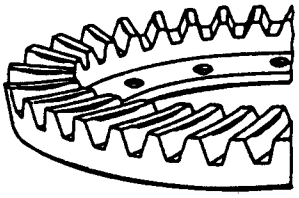
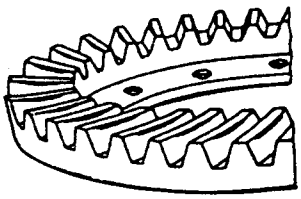


Inspection of ring gear tooth contact pattern

1) Normal contact
Apply gear-marking compound (Prussian blue / Red lead) on the ring gear teeth. Rotate the ring gear and check the tooth contact pattern.



2) Abnormal contact

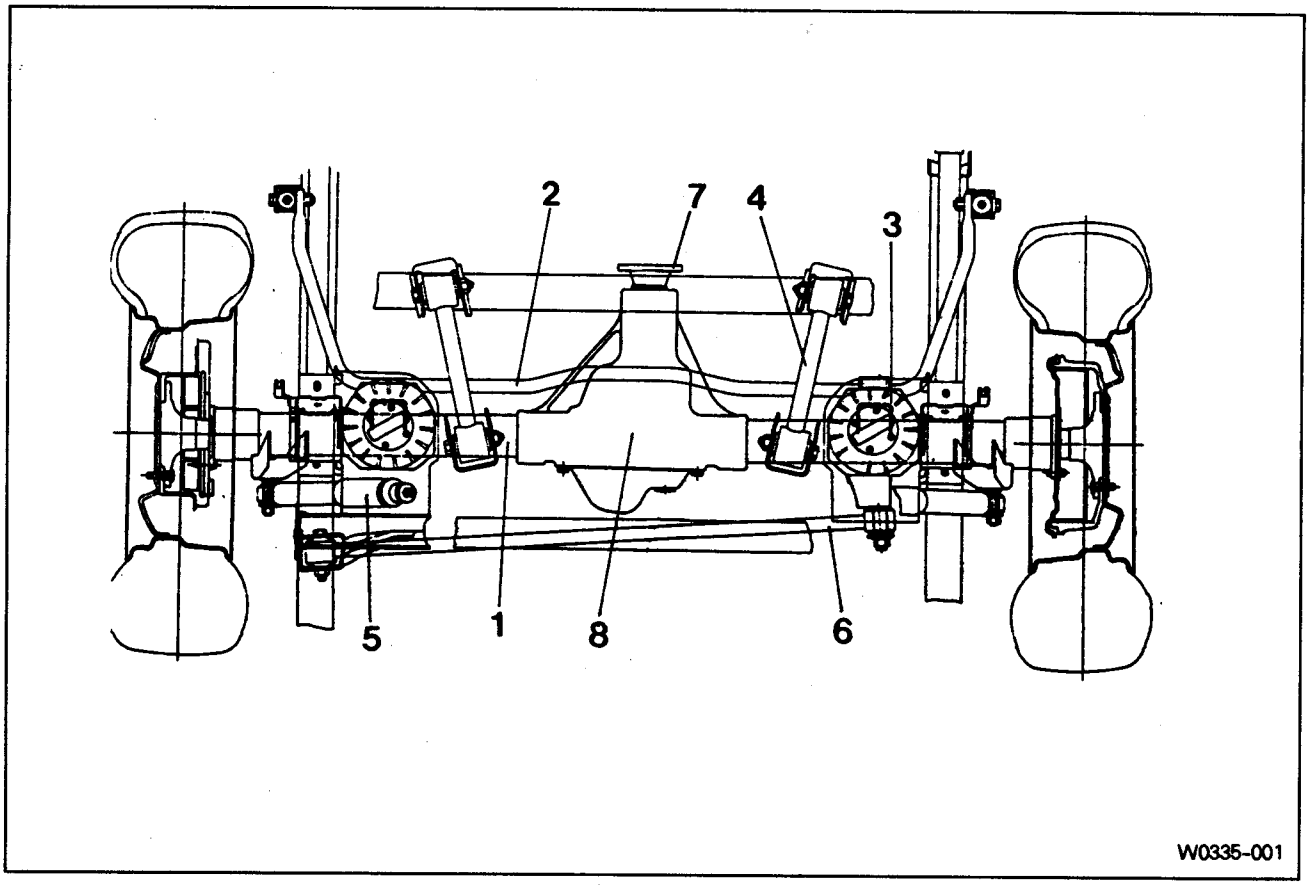
Tooth contact Pattern	Possible Cause	Remedy
1. Heel contact 	Excessive backlash (little) - Noise can be occured	Adjust backlash (Decrease backlash) - Select proper shim(s) to move the drive pinion toward the ring gear (toward toe) 
2. Toe contact 	Insufficient backlash (little) - Tooth can be damaged or broken under heavy load	Adjust backlash (Increase backlash) - Select proper shim(s) to move the drive pinion against the ring gear (toward heel) 
3. Face contact 	Excessive backlash (much) - Drive pinion shaft is apart from the ring gear - Noise can be occured	Adjust backlash (Increase pinion shim) - Move the drive pinion toward the ring gear (toward center of ring gear) 
4. Flank contact 	Insufficient backlash (much) - Gear contacts on the low flank - Gear can be damaged or worn - Noise can be occured	Adjust backlash (Decrease pinion shim) - Move the ring gear toward the drive pinion (toward ring gear center line) 

1. General

Specifications

Axle shaft type		Semifloating
Axle housing type		Salisbury (build-up)
Differential	Type	Conventional type
	Gear	Hypoid gear
Reduction Ratio	Diesel Eng. + A/T, Gasoline Eng.	3.73
	Diesel Eng. + Manual T/M	4.55
Oil	Capacity	1.9 ℓ
	Specification	SAE 80W/90, API GL - 5

Assembly drawing



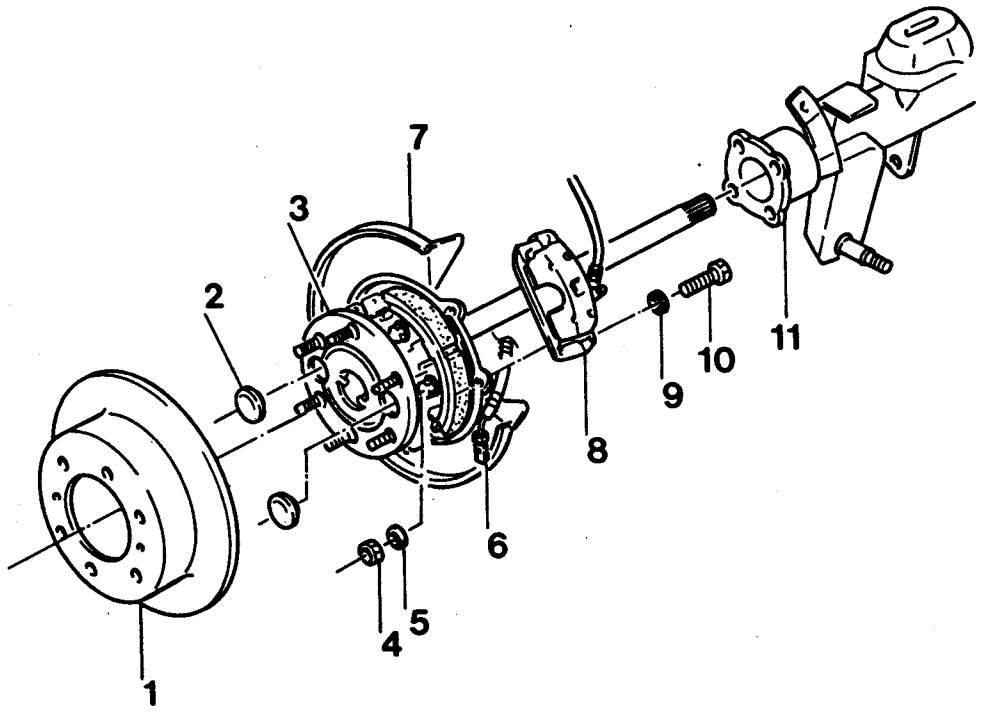
1. Axle Shaft
2. Stabilizer Bar
3. Spring Seat and Spring
4. Upper Arm
5. Shock Absorber
6. Lateral Rod
7. Input Shaft
8. Axle Housing

2. Troubleshooting

Problem	Possible Cause	Remedy
Noise (During straight driving)	Lack of oil	Replenish
	Low viscosity of oil	Replace
	Insufficient oil	Replace
	Excessive backlash of ring gear	Adjust
	Worn or damaged tooth of ring and pinion gear	Replace
	Worn or damaged drive pinion bearing	Replace
	Worn spline of side bearing and side gear	Replace
	Bent axle housing	Replace
	Bent differential case	Replace
	Worn pinion shaft	Replace
	Incorrect drive pinion preload	Adjust
	Incorrect contact of ring gear and pinion	Retightening
Oil leakage	Excessive oil	Adjust
	Faulty seal of carrier contact surface	Repair
	Axle housing crack	Replace
	Worn or damaged oil seal	Replace
Noise (During turning)	Worn or damaged tooth of pinion or side gear	Replace
	Worn pinion shaft	Replace
	Excessive backlash of pinion gear and side gear	Replace
	Excessive end-play of rear axle shaft	Adjust
	Incorrect contact of side gear and differential case	Replace
	Axle housing crack	Replace
	Bent or poor installation of drive pinion oil seal	Replace
	Damaged or torn drive pinion oil seal	Replace
	Loosened bearing collar	Replace
	Worn or damaged universal joint	Replace
	Worn or damaged axle shaft bearing	Replace
Heating	Lack of oil	Replenish
	Insufficient backlash of gears	Adjust
	Excessive preload of bearing	Adjust

3. Removal and Installation of Axle Shaft

A. Rear disc brake



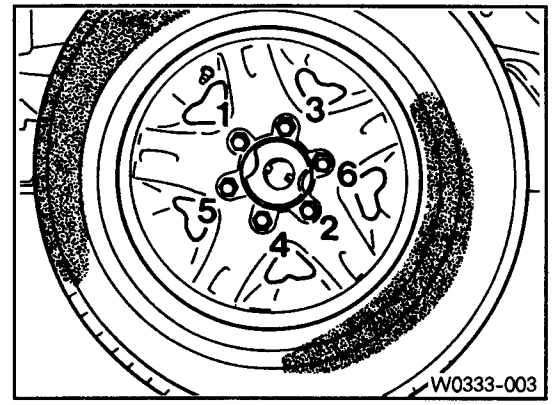
1. Disc
2. Plug
3. Rear Axle Shaft
4. Nut---------- 50~65Nm
5. Washer
6. Parking Brake Cable
7. Parking Brake Lining and Back Plate Assembly
8. Caliper Assembly
9. Gasket
10. Bolt---------- 20Nm
11. Rear Axle Housing

Removal · Installation

1) Remove the tire.

Installation

Tightening torque	Steel wheel	80~120Nm
	Aluminium wheel	110~130Nm

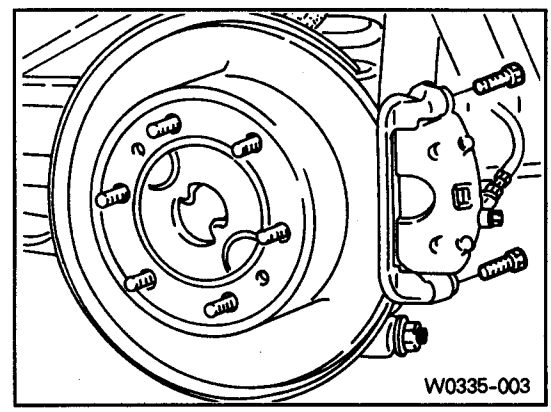


2) Release the parking brake.

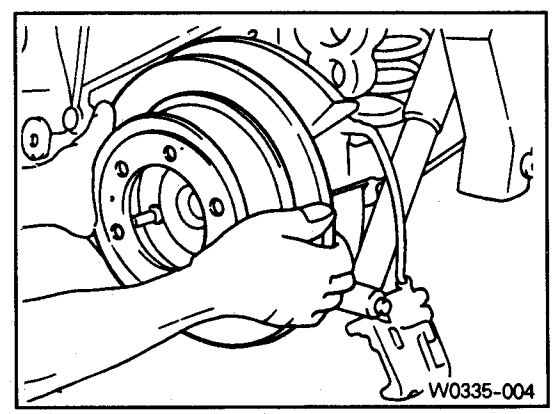
3) Remove the bolts and the brake caliper.
[Note] Be careful not to damage the brake hose.

Installation

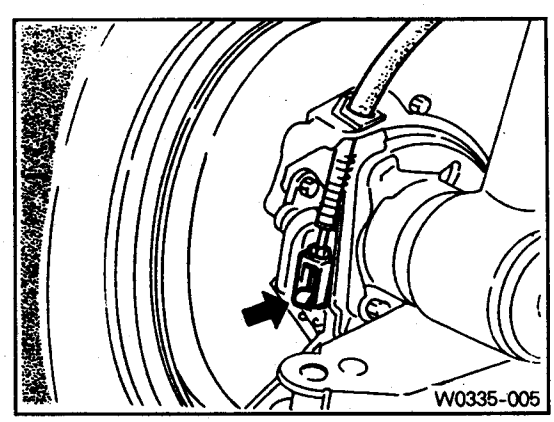
Tightening torque	20Nm



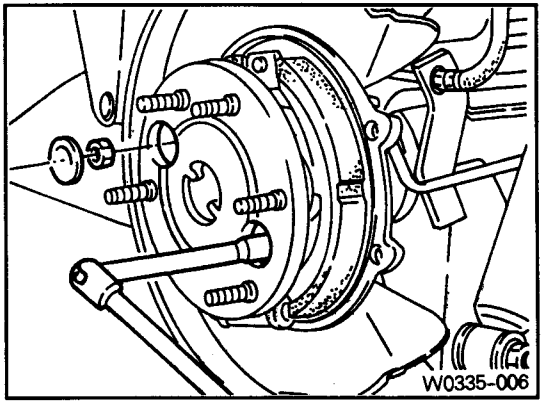
4) Remove the brake disc.
[Note] To remove the disc, install the bolts (M8 x 1.25) into the service hole and uniformly tighten the bolts.



5) Disconnect the parking brake cable.



6) Remove the plug from the axle shaft flange and remove the inner shaft mounting nuts.



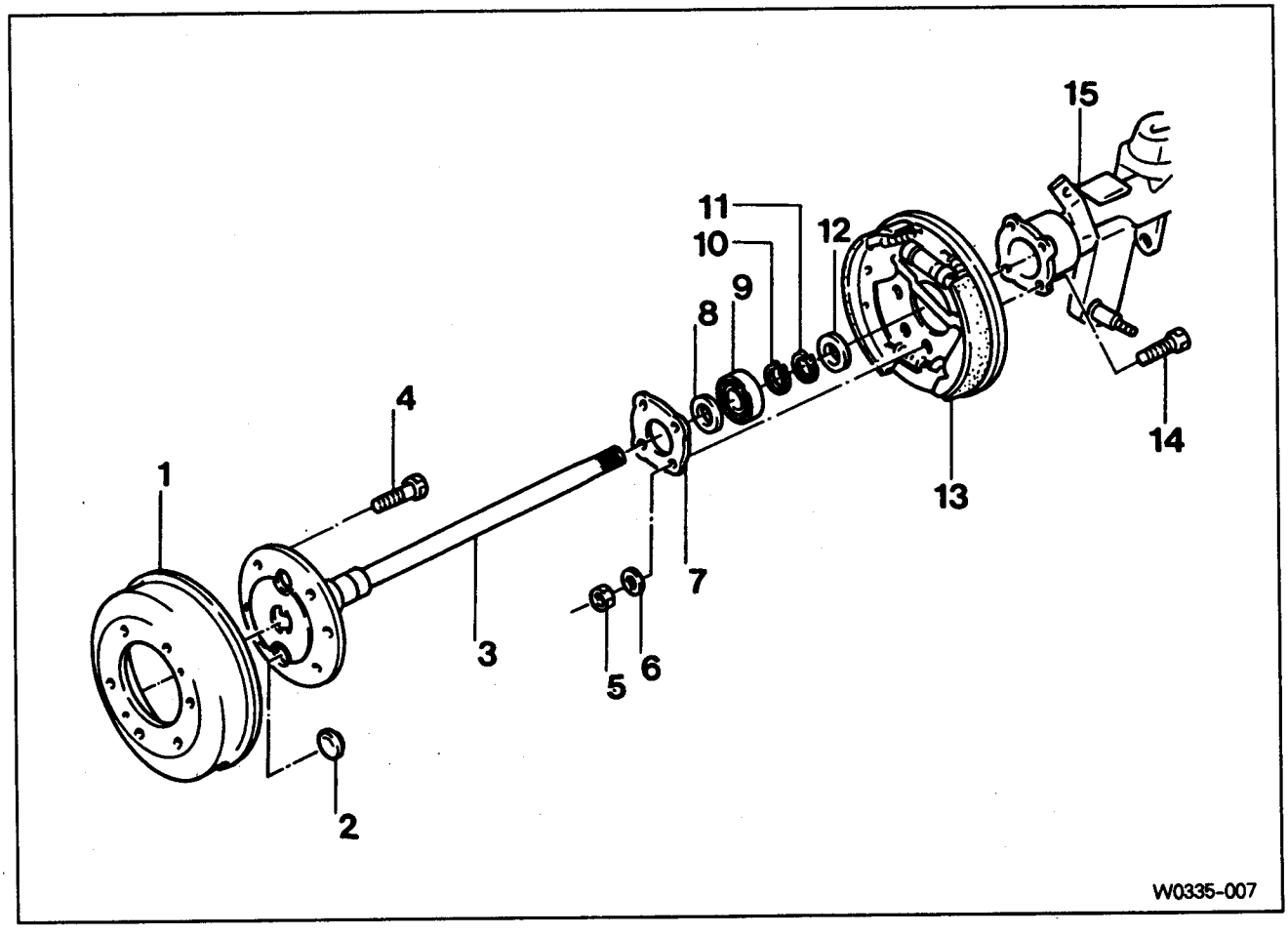
Installation

Tightening torque	50~65Nm

7) Remove the axle shaft, parking brake lining and back plate assembly.

8) Installation is reverse order of the removal.

B. Rear drum brake



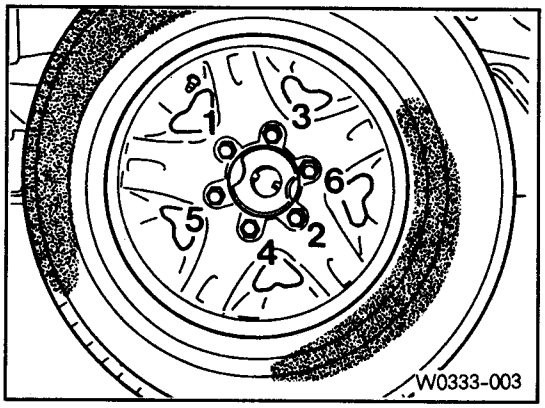
1. Brake Drum
2. Plug
3. Rear Axle Shaft
4. Wheel Bolt
5. Nut---------- 50~65Nm
6. Washer
7. Retainer Plate
8. Oil Seal
9. Bearing
10. Snap Ring
11. Snap Ring
12. Oil Seal
13. Shoe and Back Plate Assembly
14. Bolt
15. Rear Axle Housing

Removal · Installation

1) Remove the tire.

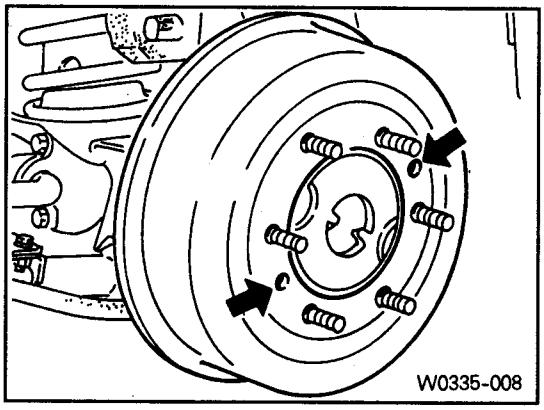
Installation

Tightening torque	Steel wheel	80~120Nm
	Aluminium wheel	110~130Nm



2) Release the parking brake.

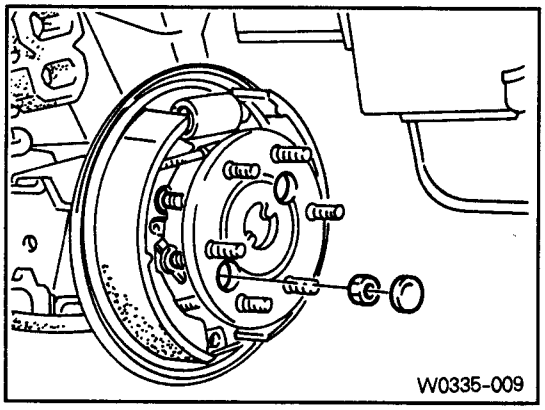
3) Remove the brake drum.
[Note] To remove the drum, install the bolts (M8 x 1.25) into the service hole and uniformly tighten the bolts.



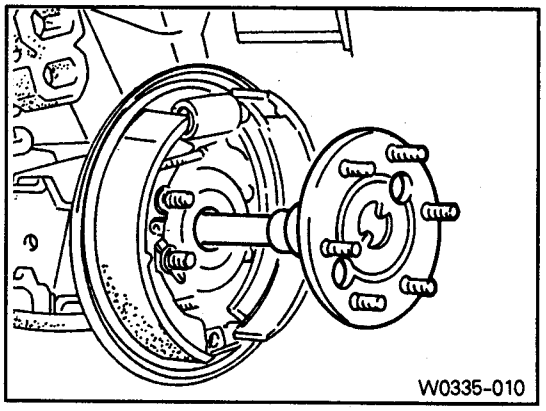
4) Remove the plug from the axle shaft flange and remove the inner bracket mounting nuts.

Installation

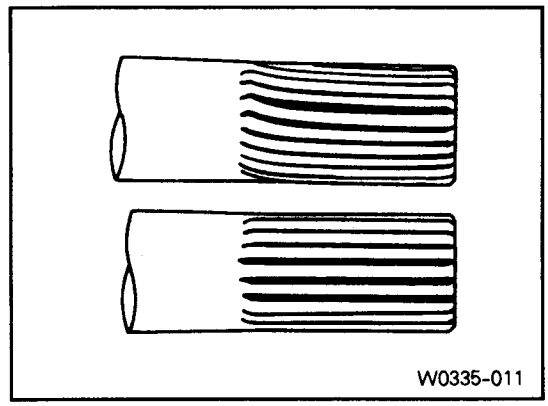
Tightening torque	50~65Nm



5) Remove the axle shaft.

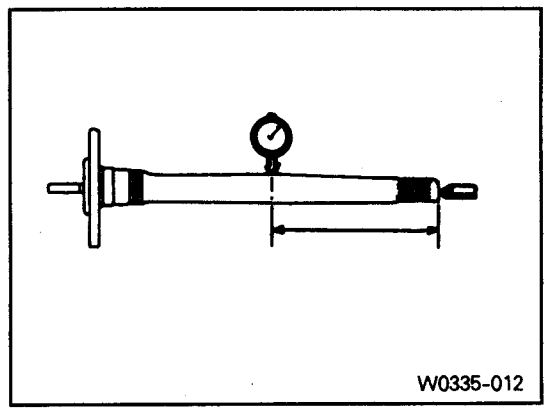


6) Check the shaft spline for wear or damage.



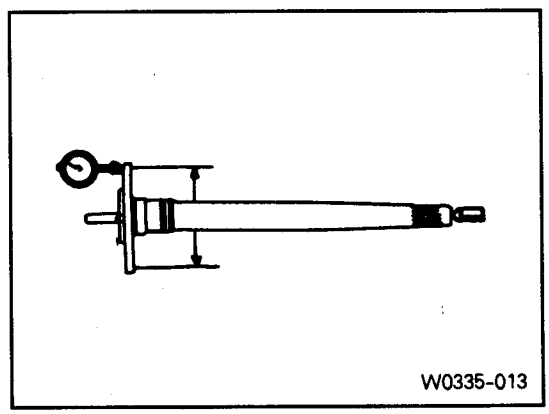
7) Check the runout of axle shaft.

Standard	Max. 1.0mm



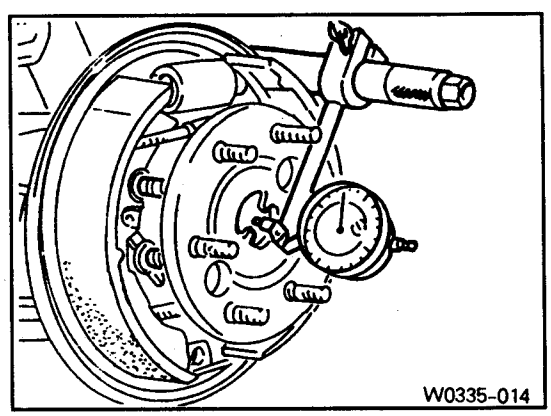
8) Check the runout of axle shaft flange.

Standard	Max. 0.13mm



9) Install the axle shaft and measure axial end play.

Standard	Max. 0.38mm



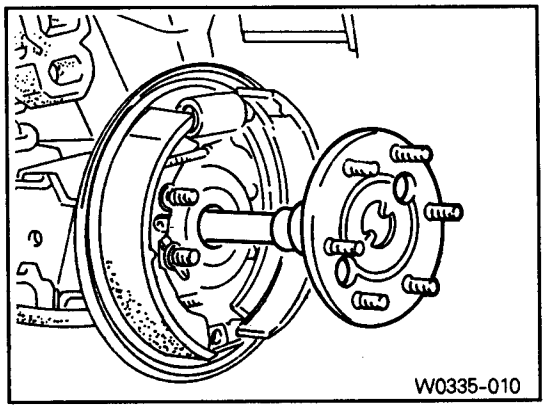
10) Installation is reverse order of the removal.

4. Removal and Installation of Axle Housing

Removal · Installation

1) Lift up the vehicle and support the frame safely.

2) Remove the axle shaft (35-04).

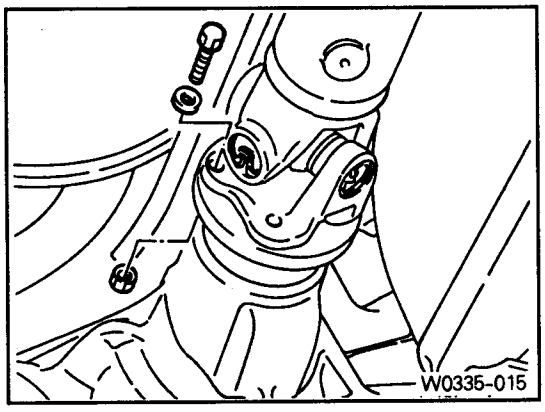


3) Remove the propeller shaft from the rear axle input shaft.

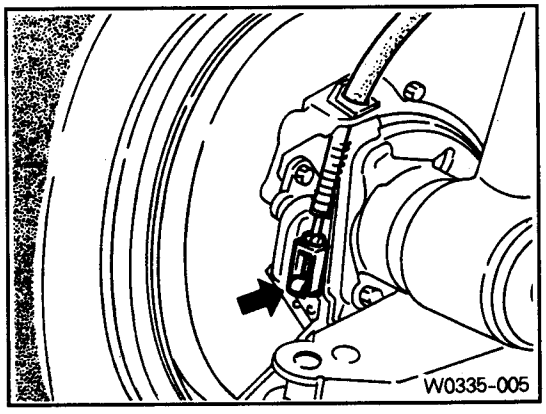
Installation

Tightening torque	81~89Nm

[Note] Place alignment marks before removal.



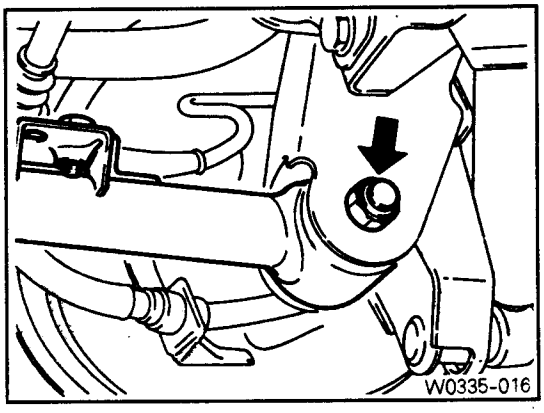
4) Disconnect the parking brake cable and brake hose.



5) Remove the lower arm mounting nuts and remove the lower arm from the axle housing.

Installation

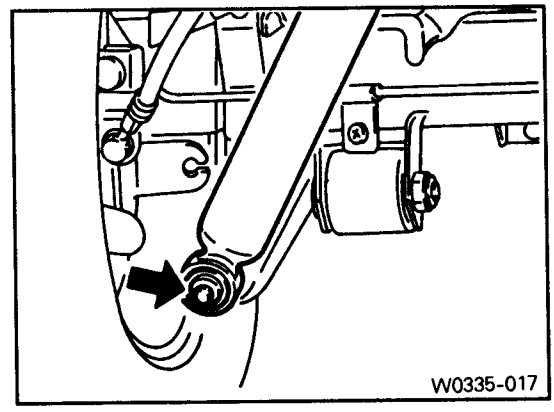
Tightening torque	150~180Nm



6) Separate the lower shock absorber from the axle housing.

Installation

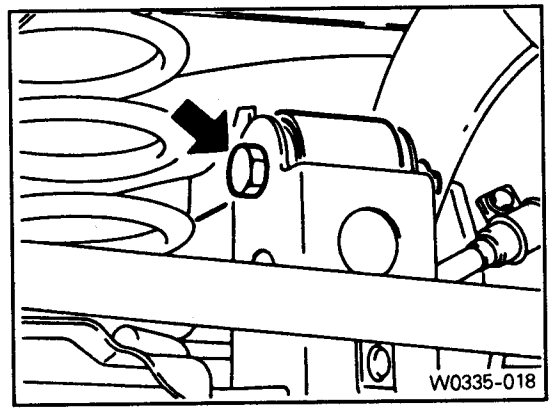
Tightening torque	50~65Nm



7) Remove the upper arm mounting nuts and remove the upper arm from the axle housing.

Installation

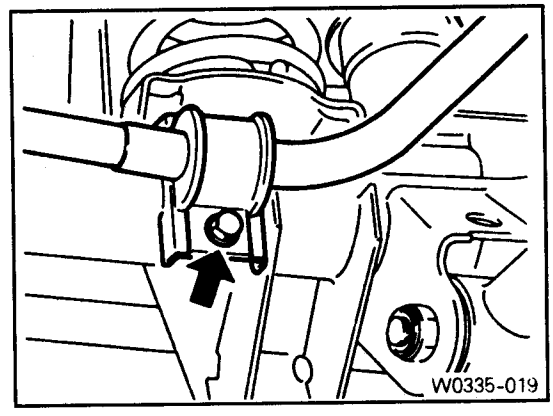
Tightening torque	150~180Nm



8) Remove the stabilizer bar.

Installation

Tightening torque	30~45Nm



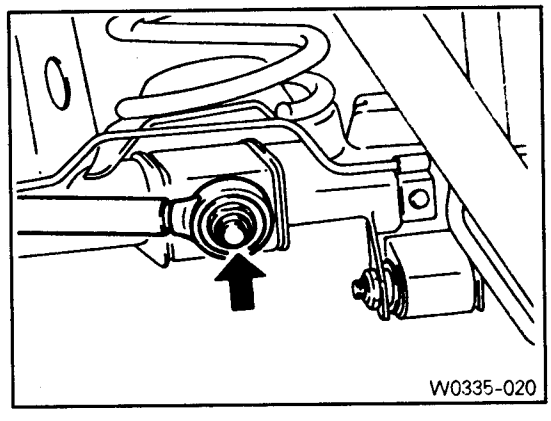
9) Remove the lateral rod mounting nuts and remove the lateral rod from the axle housing.

Installation

Tightening torque	150~180Nm

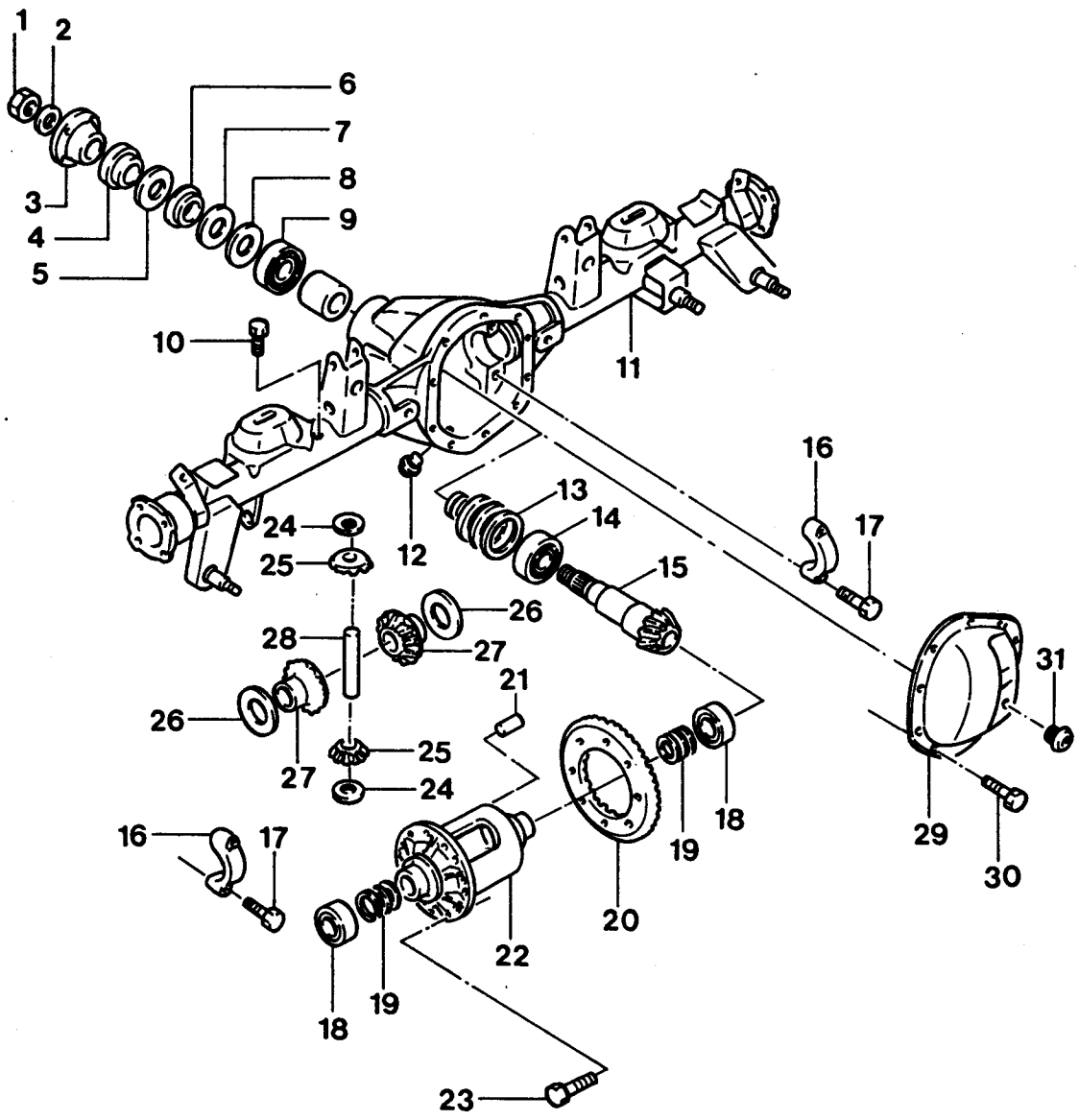
10) Lowering the axle housing slowly, remove the coil springs and spring seats.

11) Installation is reverse order of the removal.



5. Disassembly and Assembly of Axle Housing

Preceding work : Removal of the axle shaft (35-04)
Removal of the axle housing (35-10)

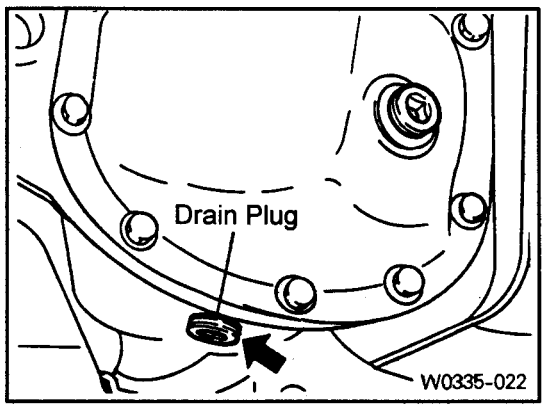


1. Drive Pinion Lock Nut---------- 240~310Nm
2. Washer
3. Companion Flange
4. Pinion Oil Seal
5. Bearing Slinger
6. Bearing
7. Shim
8. Shim
9. Bearing Cup
10. Breather Nipple
11. Rear Axle Housing
12. Oil Drain Plug---------- 28~42Nm
13. Shim
14. Bearing
15. Drive Pinion
16. Bearing Cap
17. Bolt---------- 87~124Nm
18. Bearing
19. Shim
20. Ring Gear
21. Shaft Lock Pin
22. Differential Case
23. Ring Gear Mounting Bolt---------- 75~90Nm
24. Thrust Washer
25. Differential Pinion
26. Thrust Washer
27. Side Gear
28. Pinion Shaft
29. Housing Cover
30. Bolt---------- 38~46Nm
31. Oil Fill Plug---------- 28~42Nm

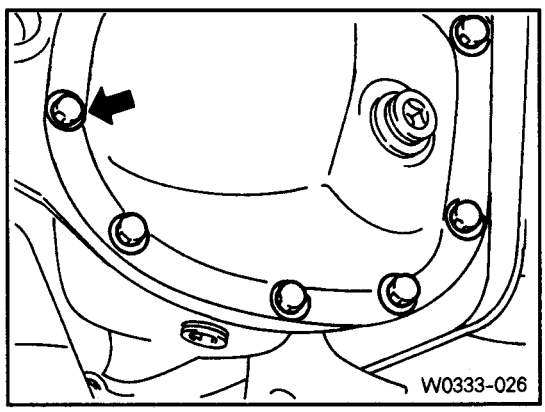
Disassembly

1) Remove the drain plug and drain the oil. Reinstall the drain plug.

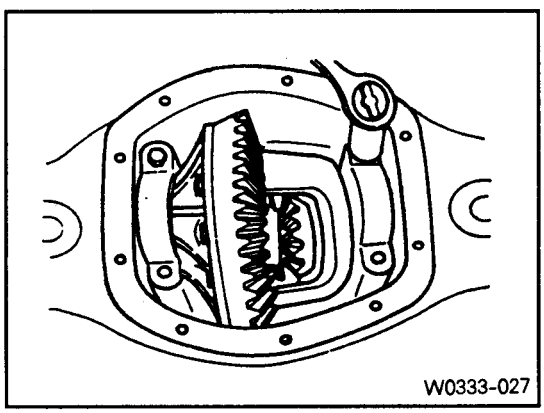
Tightening torque	28~42Nm



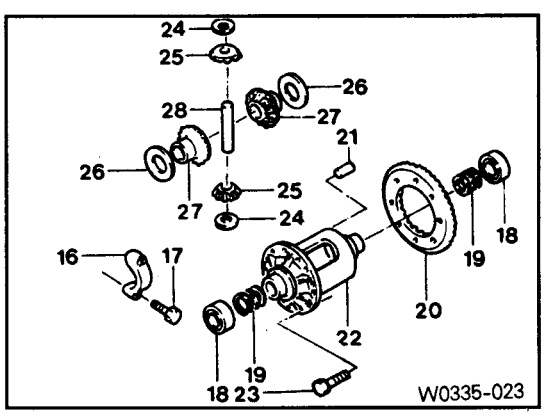
2) Remove the axle housing cover.
[Note] Clean the cover and housing contact surface.



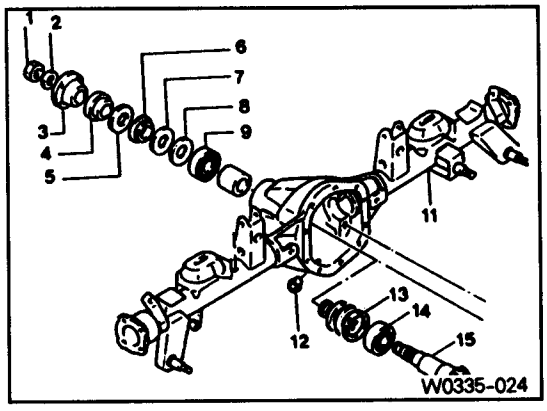
3) Remove the bearing cap bolts and remove the bearing caps. Pull out the differential carrier assembly.
[Note] Place alignment marks on the bearing cap not to change the caps before removal. When pulling out the differential carrier assembly, be careful not to damage the axle housing.



4) Disassemble the parts of the differential carrier assembly.

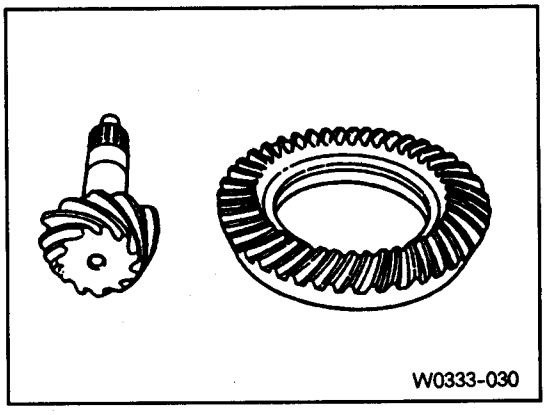


5) Remove the drive pinion lock nut. Disassemble the parts of the drive pinion.



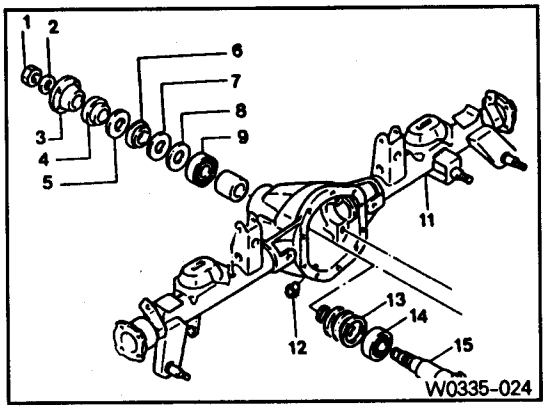
Assembly

1) Clean the all parts and check the followings.
- Check the ring gear and drive pinion for wear or damage. If damaged, replace it as a set.
- Check the bearing for sticks, wear, noise or turning resistance.
- Check the side gear, pinion, pinion shaft and thrust washer for wear or damage.
- Check the differential carrier for crack or wear (bearing contact surface). Check the gear case for crack.



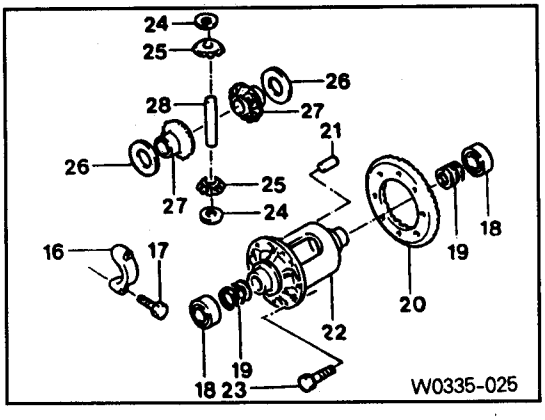
2) Assemble the parts of the drive pinion.

Tightening torque of the pinion lock nut	240~310Nm



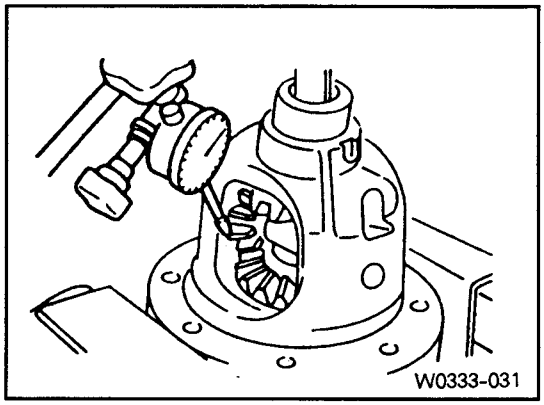
3) Assemble the parts of the differential carrier.

Tightening torque of the ring gear bolts	75~90Nm



4) Measure backlash of the side gear and pinion gear.

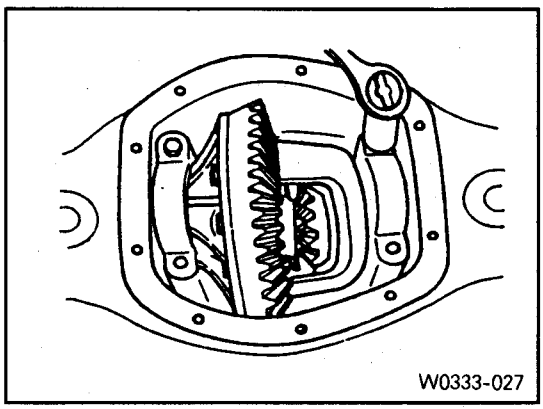
Standard	0~0.05mm



5) Install the differential carrier assembly into the axle housing.

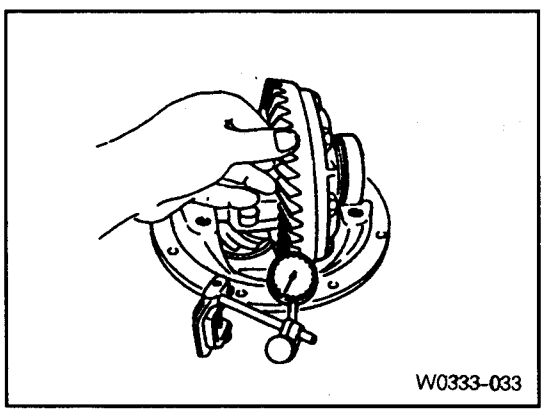
Tightening torque of the bearing cap bolts	48~69Nm

[Note] Be careful not to change the caps. Be sure to keep the original position of the caps.



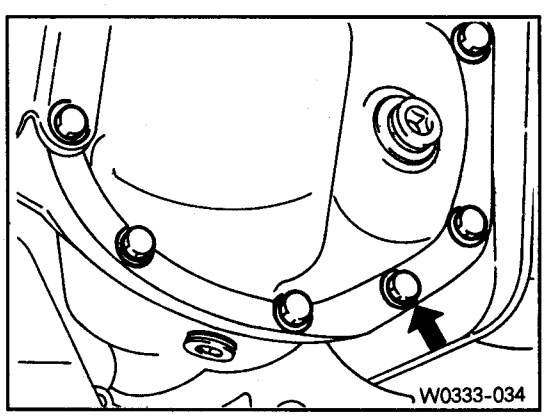
6) Measure backlash of the drive pinion and ring gear.

Standard	0.13~0.20mm



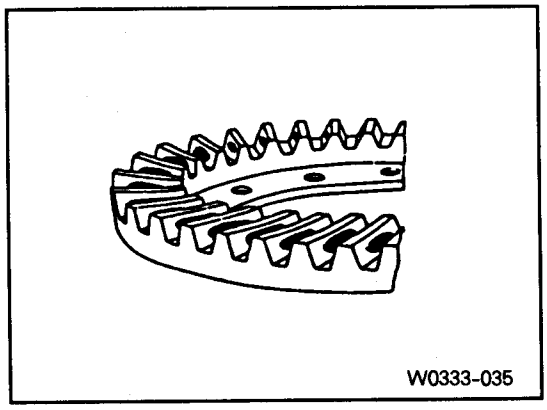
7) Install the axle housing cover.

Tightening torque	39~46Nm

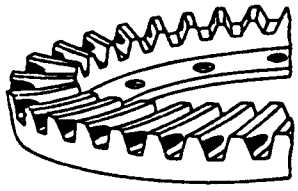
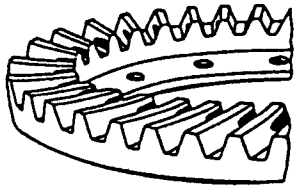
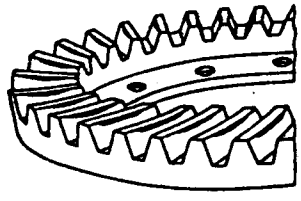
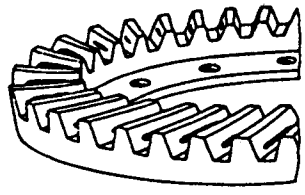


Inspection of ring gear tooth contact pattern

1) Normal contact
Apply gear-marking compound (Prussian blue / Red lead) on the ring gear teeth. Rotate the ring gear and check the tooth contact pattern.



2) Abnormal contact

Tooth contact Pattern	Possible Cause	Remedy
1. Heel contact 	Excessive backlash (little) - Noise can be occurred	Adjust backlash (Decrease backlash) - Select proper shim(s) to move the drive pinion toward the ring gear (toward toe) 
2. Toe contact 	Insufficient backlash (little) - Tooth can be damaged or broken under heavy load	Adjust backlash (Increase backlash) - Select proper shim(s) to move the drive pinion against the ring gear (toward heel) 
3. Face contact 	Excessive backlash (much) - Drive pinion shaft is apart from the ring gear - Noise can be occurred	Adjust backlash (Increase pinion shim) - Move the drive pinion toward the ring gear (toward center of ring gear) 
4. Flank contact 	Insufficient backlash (much) - Gear contacts on the low flank - Gear can be damaged or worn - Noise can be occurred	Adjust backlash (Decrease pinion shim) - Move the ring gear toward the drive pinion (toward ring gear center line) 

1. General

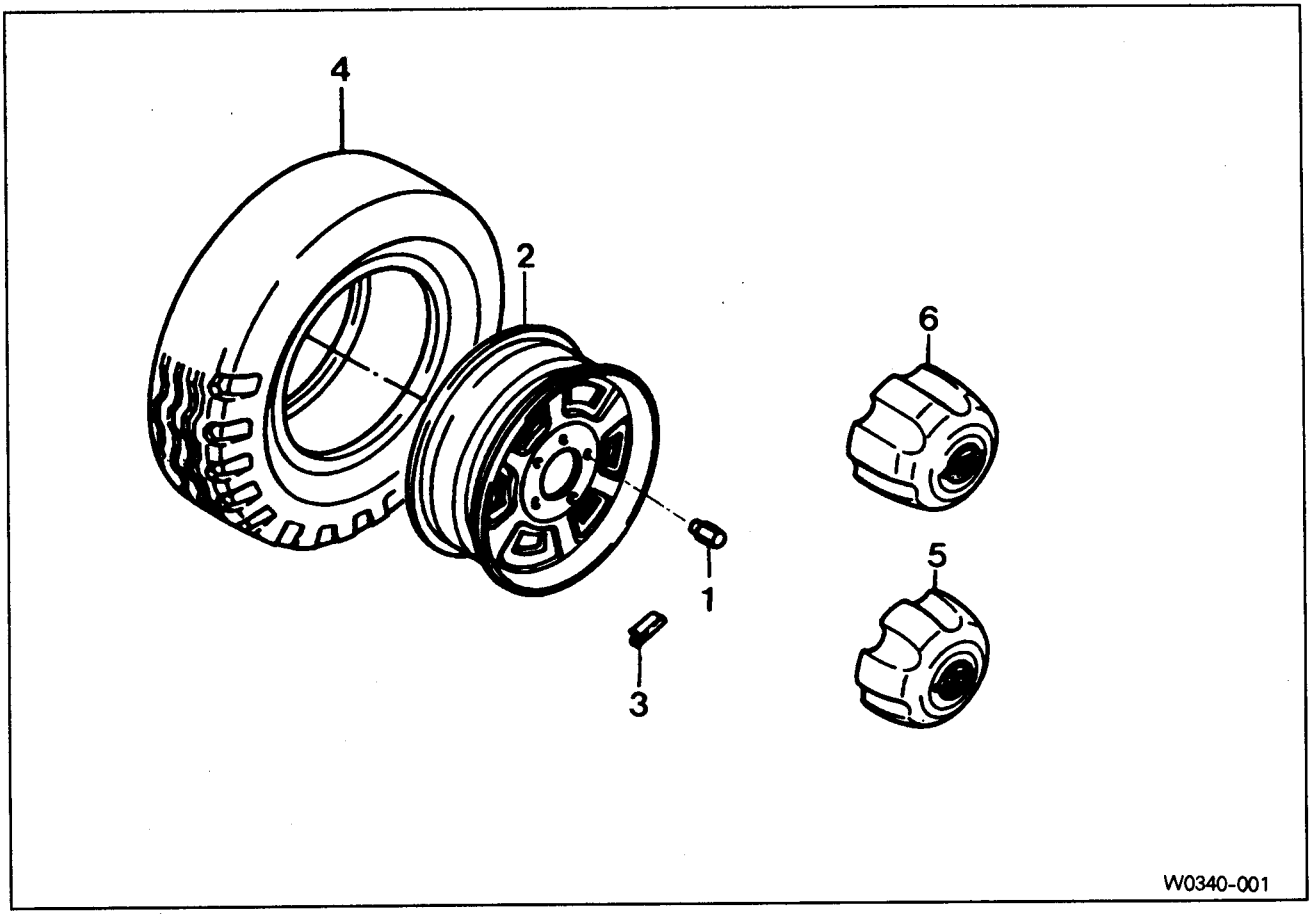
Specifications

Wheel	Type	Aluminum wheel
	Specification	7JJ × 15
	Wheel nuts tightening torque	110~130Nm
Tire	Type	Radial tire
	Size and tire pressure	P215 / 75R15 - 30psi
		P235 / 75R15 - 30psi
		P255 / 75R15 - 28psi

2. Troubleshooting

Problem	Possible Cause	Remedy
Uneven wear	Incorrect tire pressure	Adjust
	Wheel is out of balance	Adjust
	Tire rotation is not performed	Rotation
	Incorrect toe - in	Adjust
	Incorrect wheel bearing preload	Adjust
	Faulty brake	Adjust
Road noise, vehicle vibration	Incorrect tire pressure	Adjust
	Wheel and tire are out of balance	Adjust
	Excessive vibration of wheel and tire	Repair or replace
	Uneven wear of tire	Inspect and adjust
Premature wear of tire	Excessive tire pressure	Adjust
	High speed driving with low pressure	Adjust
	Over load	Load as specified

3. Components

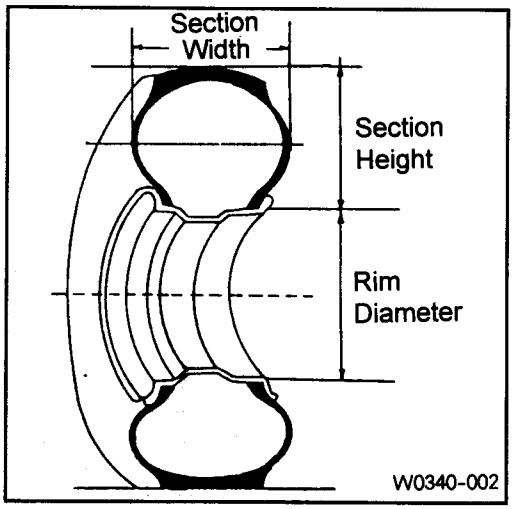


1. Wheel Nuts---------- 110~130Nm
2. Wheel (Aluminum)
3. Balance Weight
4. Tire
5. Front Hub Cap
6. Rear Hub Cap

Tire size

P 215 75 R - 15 100 S

- P: Tire type — P : Passenger
- 215: Section Width : 215mm
- 75: Aspect Ratio — (Section height / Section width) × 100
- R: Construction Type — R : Radial
- 15: Rim Diameter — 15 : 15 Inches
- 100: Load Range — 100 : 800kg
- S: Speed Rating — S : Max. 180km/h



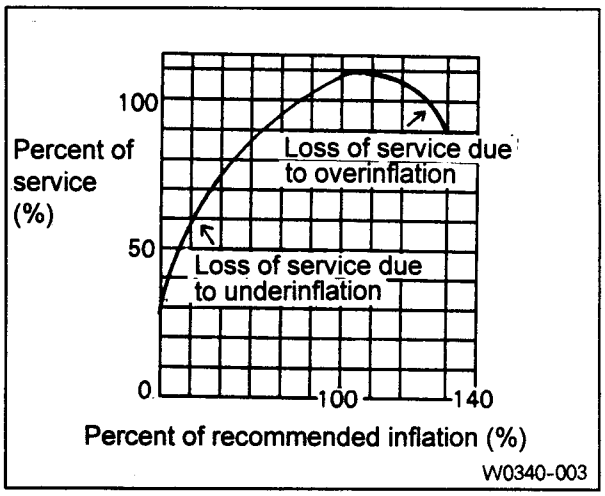
◎ Speed ratings

Sym.	Max. (km/h)
F	80
M	130
N	140
P	150
Q	160
R	170
S	180
T	190
U	200
H	210
V	240
Z	over 240

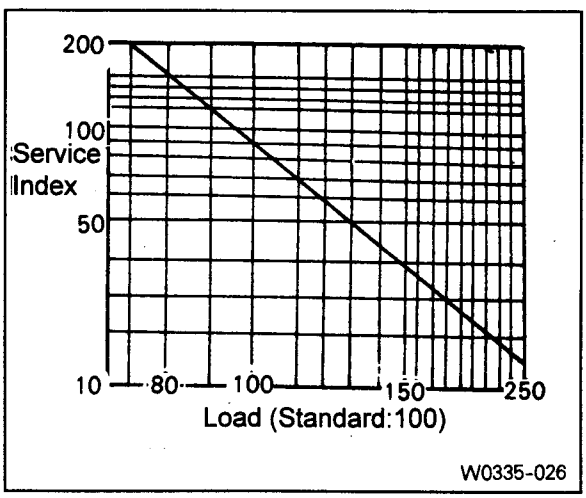
◎ Load ranges

Sym.	Max. (kg)
94	670
95	690
96	710
97	730
98	750
99	775
100	800
101	825
102	850
103	875
104	900
105	925

◎ Effect of inflation on tire service



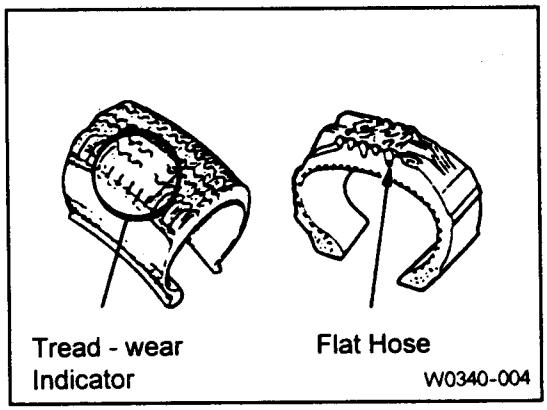
◎ Effect of load on tire service



4. Inspection of Wheels and Tires

Inspection

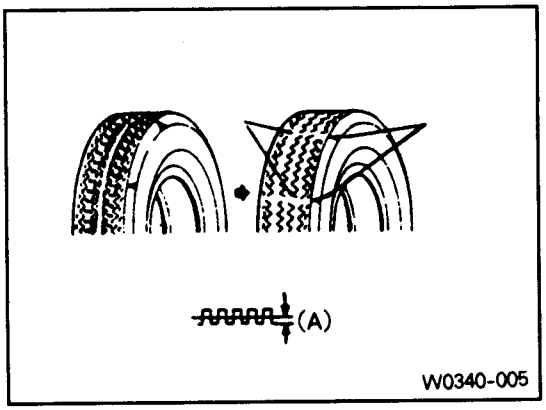
1) Inspection of tire.
Check tread area for tread surface, crack, damage by nail in or stones. Replace or repair if necessary.



2) Wear limit.

Limit	1.6mm

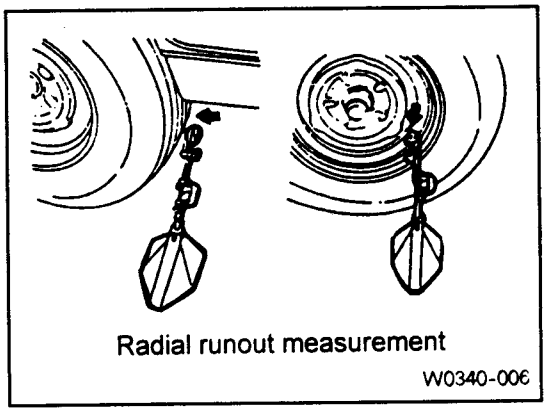
- Replace the tire if tread-wear indicator of the tread grooves appears where marked ' ▲' .
- The wear limit of snow tire is the same as normal tire (1.6mm) and indicator location is marked ' ↓ '.



3) Runout measurement.
- Excessive runout of tires and wheels can cause the abnormal wear of tire. Using a dial indicator, measure wheel and tire runout.

- Measure radial runout at the rim flange and center of the tire tread area.

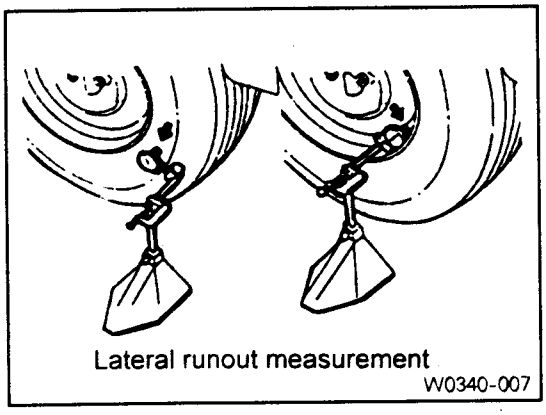
Standard	2.66mm



- Measure lateral runout at the tire bead area of the wheel and tire sidewall.

Standard	2.03mm

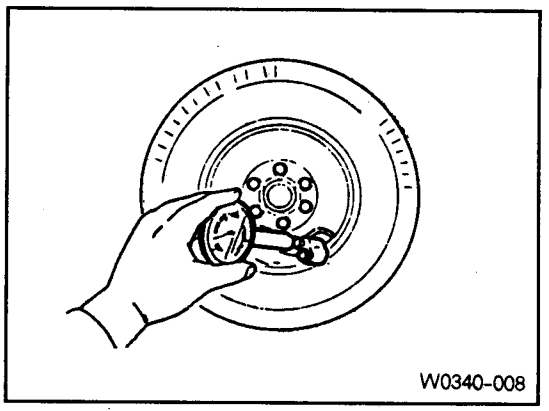
[Note] If runout is excessive, replace the tire or wheel.



4) Tire pressure inspection.

· Tire pressure.

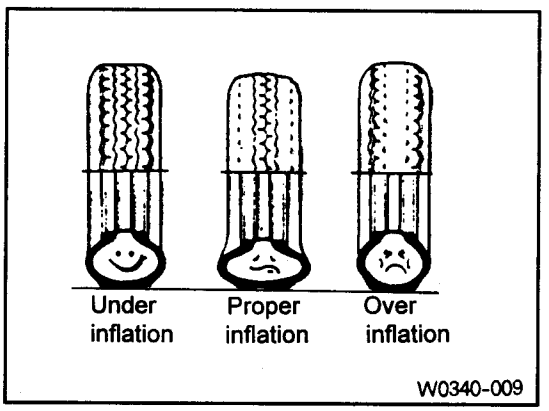
Front & Rear (P235 / 75R15)	2.1kg/㎠ (30PSI)



· Check tread contact with road.

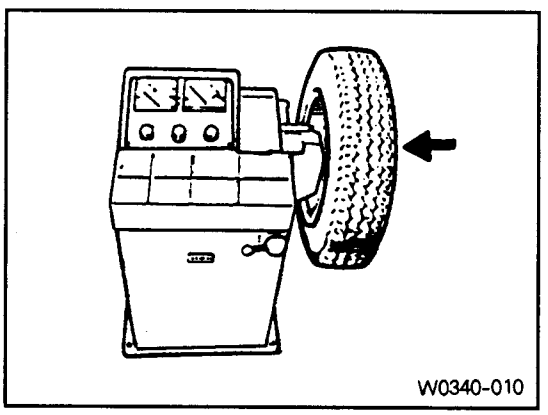
[Note] · **If underinflated, tire may come away from the wheel during rapid steering.**

· **An overinflated tire will cause a hard riding and uneven wear.**



5) Wheel balance.

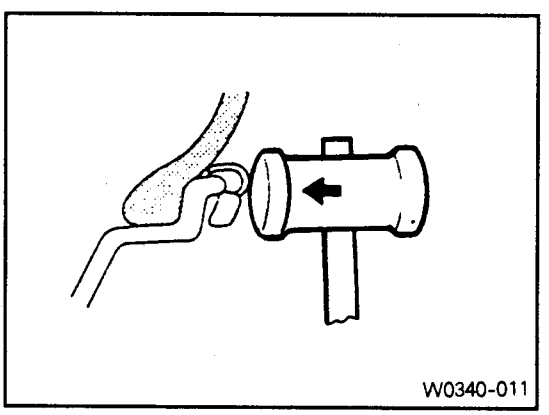
· Balance weights should be on each side. When the wheel is out of balance or a tire has been repaired, be sure to balance the wheel again.



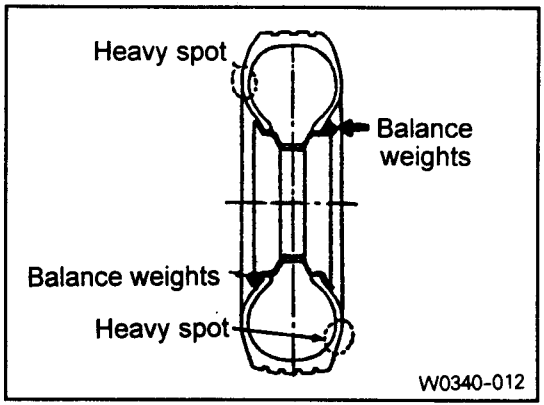
· If total weight is over 150g, readjust the balance by reinstalling the tire on the wheel.

· Balance weight should not protrude from the wheel rim over 3mm.

· For aluminum wheel, use aluminum wheel balance weight only.



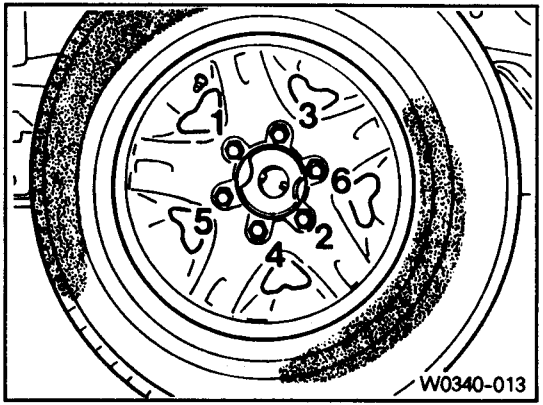
· To correct unbalance, install equal weights 180 ° opposite each other, one on the inside of the wheel and one on the outside, at the point of unbalance.



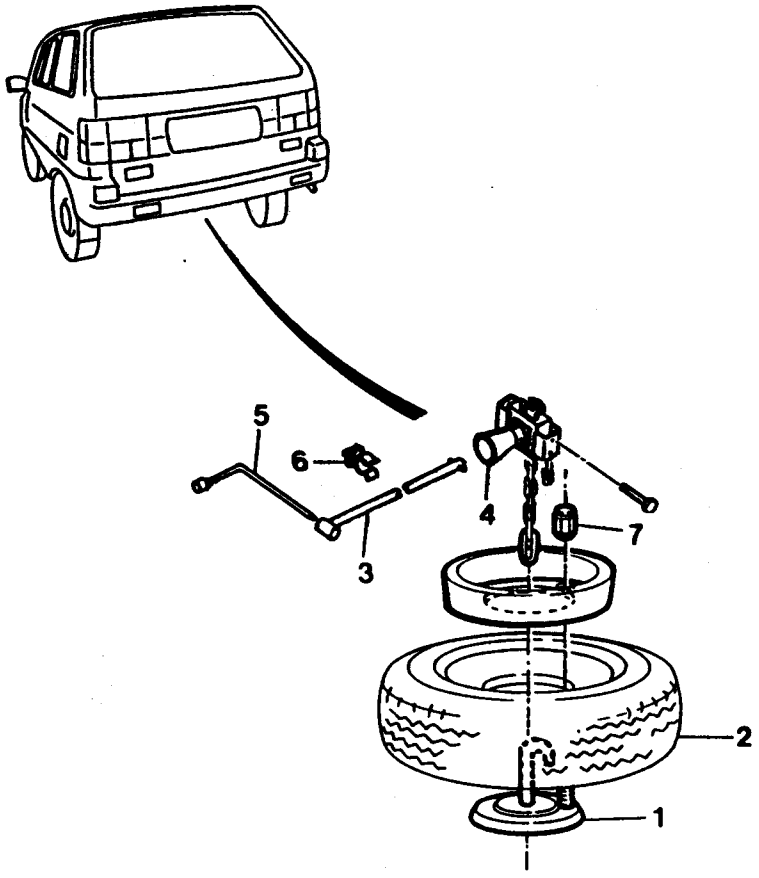
6) Cautions for installation and removal.

- · Clean the mounting surfaces of hub and wheel.
- · Do not apply grease or oil on the nuts and bolts (It will cause looseness and poor tightening).
- · Using a jack, lift up the tire about 3cm from the ground.
- · Tighten nuts in a criss-cross pattern 2~3 times.

Tightening torque	110~130Nm



5. Removal and Installation of Spare Tire

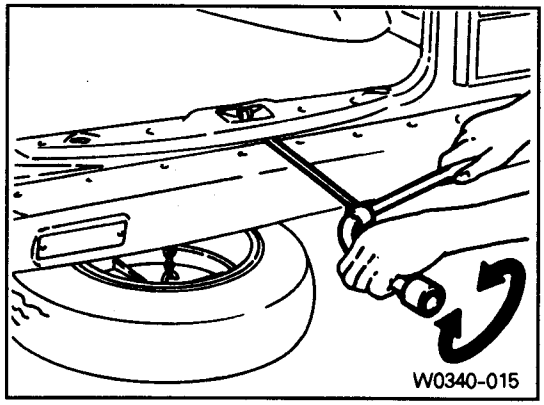


1. Spare Tire Mounting Anchor
2. Spare Tire
3. Spare Tire Mounting Handle
4. Actuator
5. Wheel Nut Wrench
6. Wheel Nut Wrench Holder
7. Fixing Nut

Removal

1) Connect the spare tire handle ③ into the actuator ④ through the hole on the rear bumper.

2) Insert the wheel nut wrench ⑤ into the spare tire handle ③ and rotate the handle counterclockwise until the actuator chain is loosened.



3) Remove the fixing nut ⑦ and disconnect the actuator chain from the spare tire mounting anchor ①. Remove the spare tire ②.
[Note] If over loaded on the wheel nut wrench during removal, rotate 1~2 times reversibly.

Installation

1) Install the spare tire ② onto the spare tire mounting anchor ① and tighten the fixing nut ⑦.

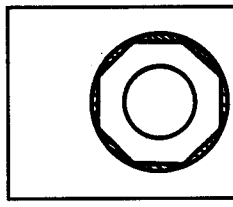
2) Connect the chain to the spare tire mounting anchor ①. Insert the handle ③ into the actuator ④ through the hole on the rear bumper.

3) Insert the wrench ⑤ into the handle ③ and rotate clockwise until the tire is completely fixed.

6. Tire Wear Patterns Diagnoses

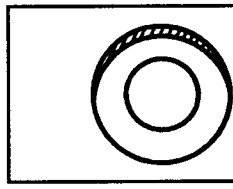
Abnormal tire tread wear and major causes :

[Note] Tire wear patterns can be caused by worn suspension parts, wheels and tires misalignment, and other suspension damages.



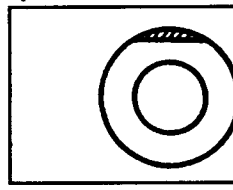
Spotty wear - wear localized on shoulder sections. In extreme cases, the tire becomes polygonal in shape.

- Tire or wheel out of round or distorted.
- Hub or knuckle out of round or distorted.
- Play in hub bearings or ball joints.
- Rotating parts out of balance.



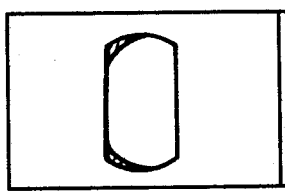
Tread wear one - sided.

- Rotating parts out of balance.
- Tire or wheel out of round.
- Hub or knuckle out of round / distorted.



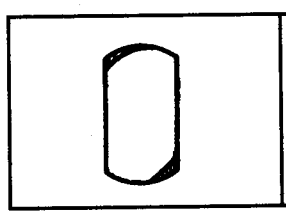
Localized tread wear.

- Once spotty wear develops in tread due to hard braking or abrupt starting, localized wear tends to be accelerated.



Shoulder wear (generally wear develops on outer shoulder).

- Camber or toe - in incorrect.
- Shoulder wear caused by repeated hard - cornering.

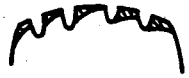


Wear on shoulders at points opposed to each other.

- Tire or wheel out of round or distorted.
- Play in bearings or ball joint.

Premature wear on shoulders.

- Flexing of tire excessive due to under - inflation.



One - sided feather edging.

- Wear caused by repeated hard cornering.
- Camber or toe - in incorrect.

1. General

Specifications

Joint type		Diesel	Front		Single or single & double cardan
			Rear		Single cardan
		Gasoline	Front		Constant velocity (CV) & double cardan
			Rear		Single cardan
Number of spiders		Diesel	Front	Full - time T/C	3
				Part - time T/C	2
			Rear		2
		Gasoline	Front		CV joint : 1, Double spiders : 1
			Rear		2
Shaft dimensions (L × O.D × I.D.)	Diesel	Front	M/T · A/T + Part - time T/C		598 × 63.5 × 59.5
			A/T + Full - time T/C		590 × 50.8 × 44.7
		Rear	M/T · A/T + Part - time T/C		1,008 × 63.5 × 59.5
			A/T + Full - time T/C		898 × 63.5 × 59.5
	Gasoline	Front			599 × 50.8 × 44.7
		Rear			867 × 63.5 × 59.5
Outer diameter of spider (mm)					φ16.668
Propeller shaft runout (Installed)					Max. 0.4mm
Unbalance volume at 3,000RPM					Max. 36g · cm

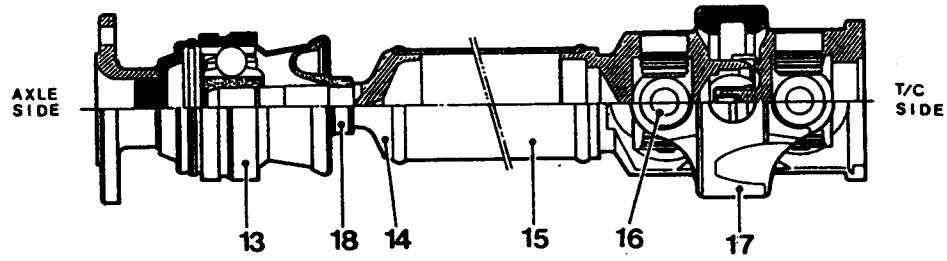
[Note] · **L : Length**
· **O.D. : Outer Diameter**
· **I.D. : Inner Diameter**
· **A/T : Automatic Transmission**
· **M/T : Manual Transmission**

2. Troubleshooting

Problem	Possible Cause	Remedy
Vibration	Faulty connection of sliding joint	Adjust
	Bent propeller shaft	Replace
	Symmetry of universal joint snap ring	Adjust
	Loosened yoke bolts	Tighten
Noise	Worn or damaged universal joint bearing	Replace
	Fallen off universal joint snap ring	Adjust or replace
	Loosened yoke connection	Tighten
	Worn sliding joint spline	Replace
	Insufficient grease	Apply as necessary

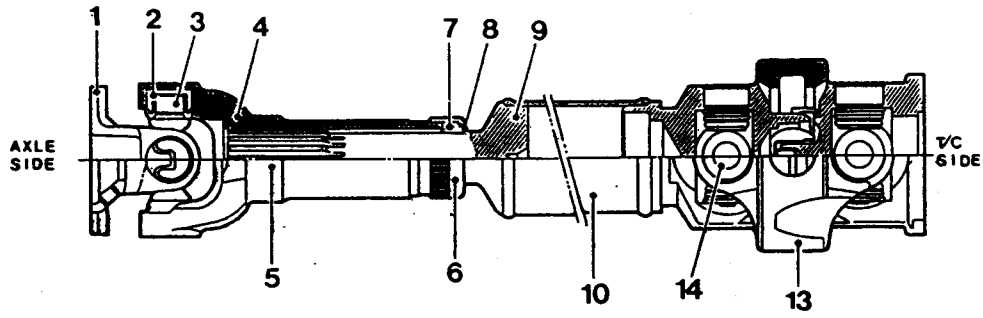
3. Components

1)



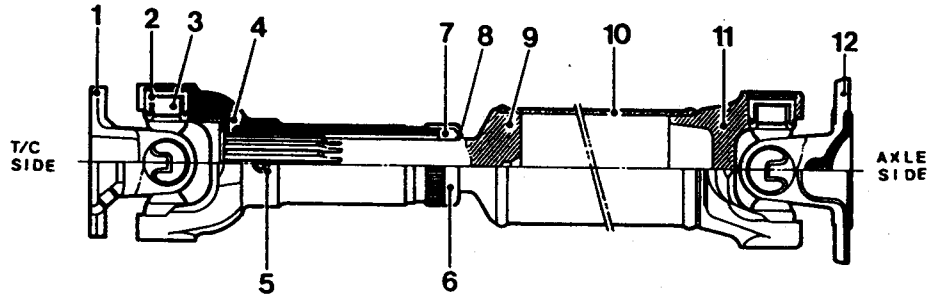
[Gasoline] Front Propeller Shaft

2)



[Diesel] Front Propeller Shaft : A/T + Full - time T/C

3)



[Gasoline] Rear Propeller Shaft

[Diesel] · Rear Proper Shaft : A/T + Full - time T/C

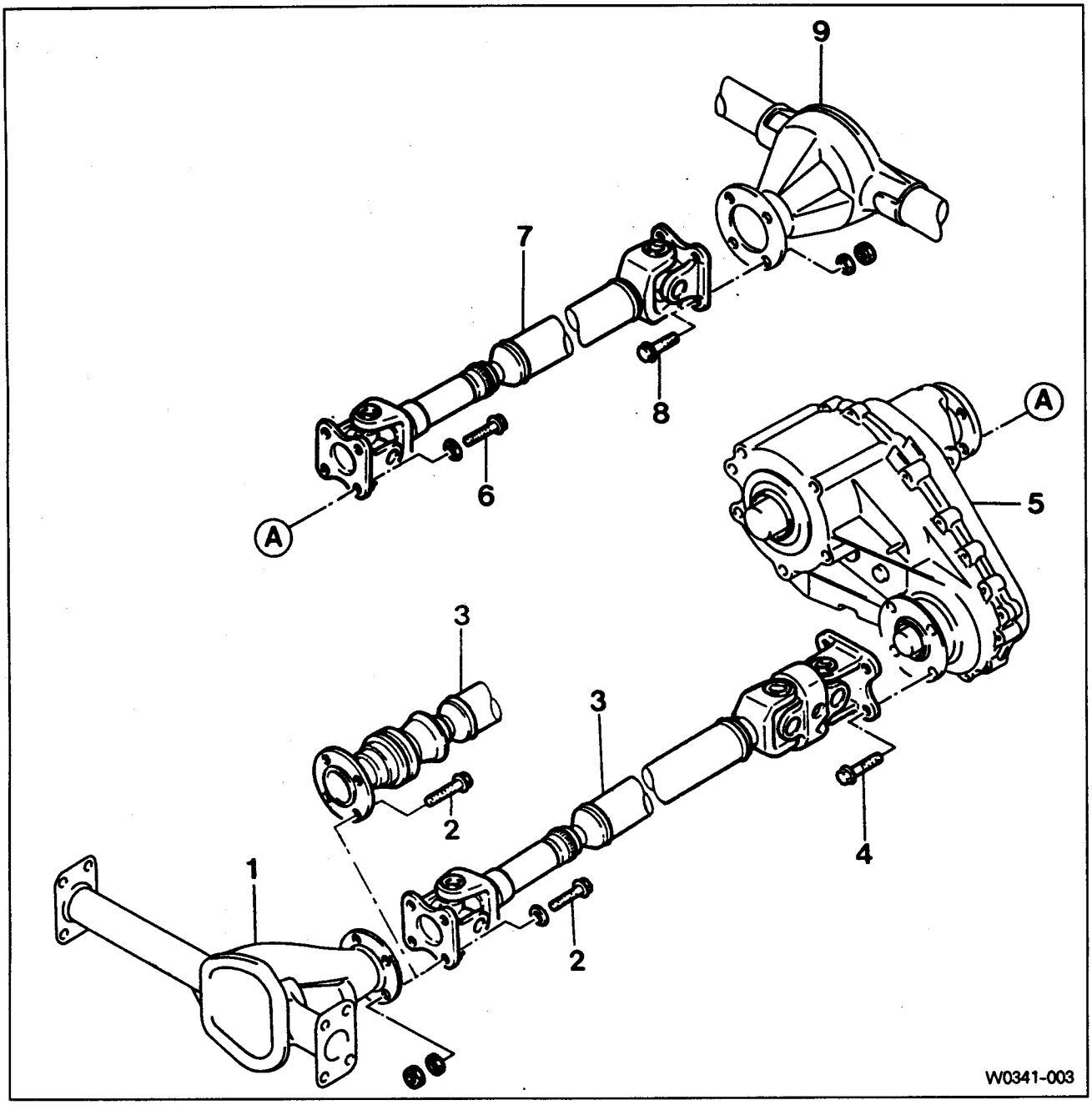
· Front and Rear Propeller Shaft : M/T · A/T + Part - time T/C

[Note] Only the length is different between the front and the rear propeller shafts.

W0341-001

1. Flange Yoke
2. 3. Cross and Bearing Assembly (with Snap Ring)
4. Slip Yoke
5. Grease Nipple
6. Dust Cap
7. Oil Seal
8. Split Washer
9. Slip Tube Shaft
10. Tube
11. Tube Yoke
12. Flange Yoke
13. [Diesel] Cross and Bearing Assembly (with Snap Ring)
    [Gasoline] CV Joint (DOJ)
14. [Diesel] Double Cardan
    [Gasoline] Shaft
15. Tube
16. Cross and Bearing Assembly (with Snap Ring)
17. Center Coupling Yoke
18. Boots Band

4. Removal and Installation of Propeller Shaft

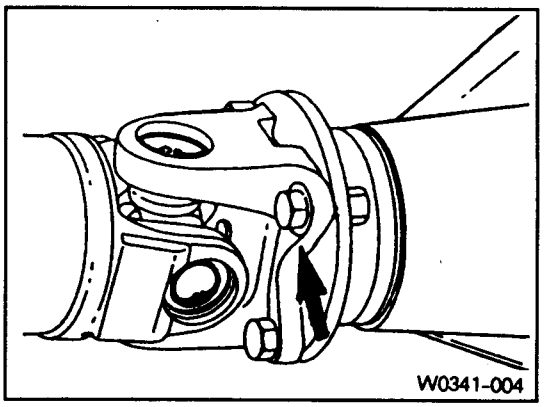


1. Front Axle
2. Bolt----------70~80Nm
3. Front Propeller Shaft
4. Bolt----------81~89Nm
5. Transfer Case
6. Bolt----------70~90Nm
7. Rear Propeller Shaft
8. Bolt----------81~89Nm
9. Rear Axle

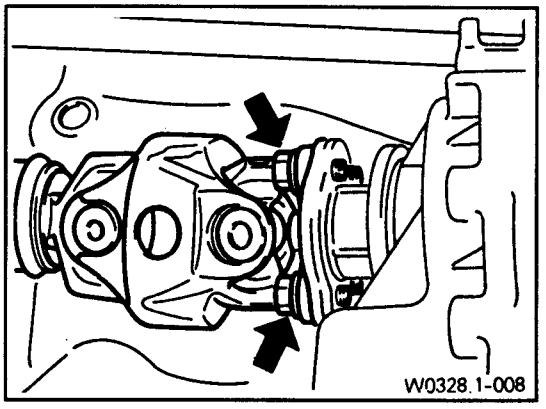
Removal

1) Place alignment marks and remove the propeller shaft.

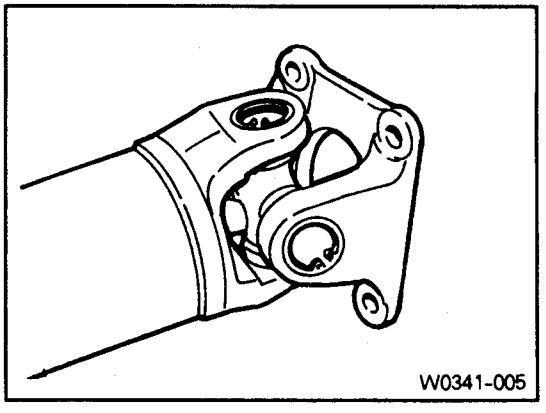
[Diesel]



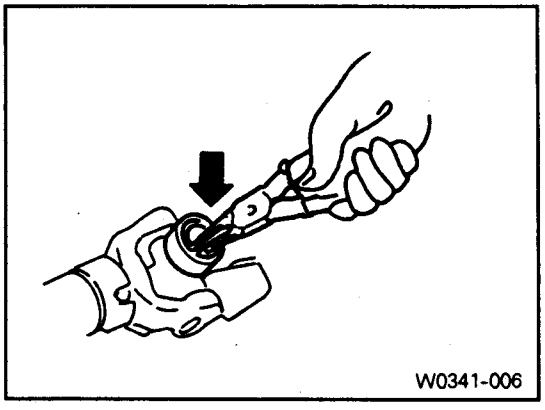
[Gasoline]



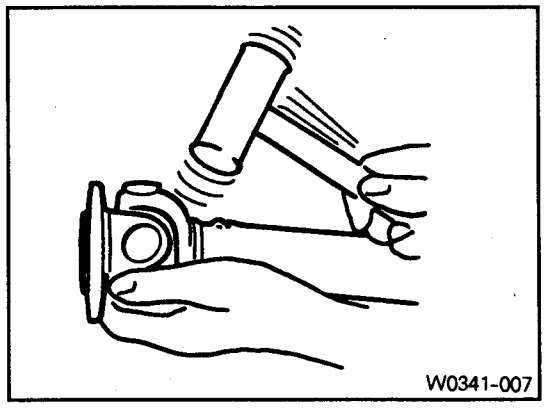
2) Place alignment marks before removing the spider.



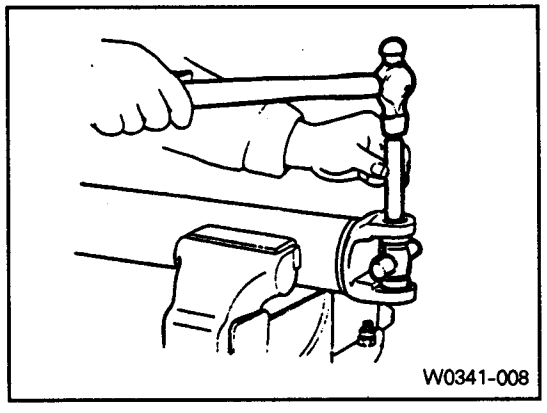
3) Using a snap ring pliers, remove the snap ring.



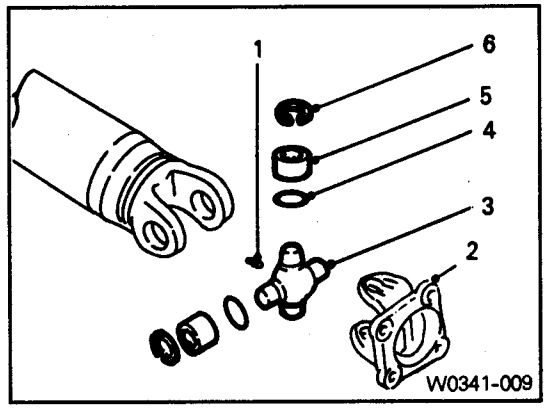
4) Slightly tapping the yoke shoulder using a brass hammer, remove the bearing. Remove the remaining bearings in the same way.



5) If difficult to remove, clamp the yoke side in a vise and tap off the needle bearing, using a proper tool.



6) Disassemble the universal joint parts.
   · As axles move up and down, universal joints allow drive angles to change without binding propeller shaft.



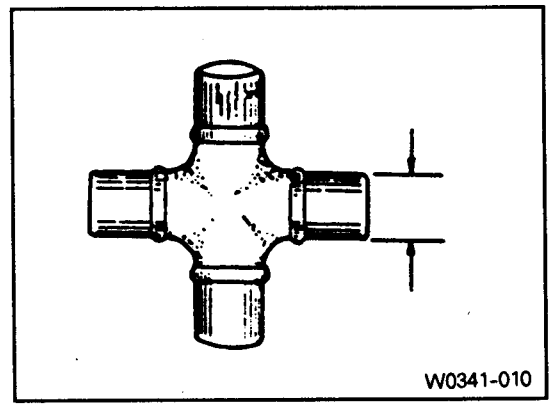
1. Grease Nipple
2. Flange Yoke
3. Spider
4. Seal
5. Needle Roller Bearing
6. Snap Ring

Inspection

1) Visual check.
   Check the disassembled parts for wear or crack.
   Replace them if necessary.

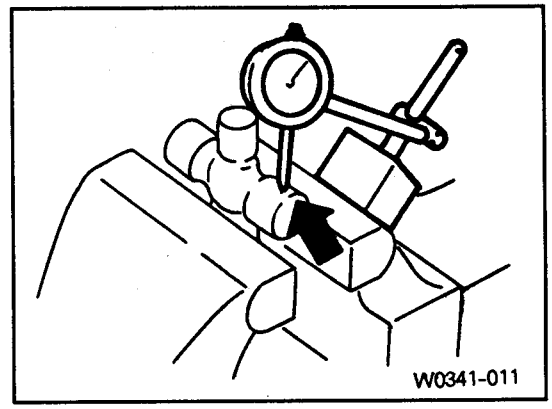
2) Spider outer diameter (mm).

Standard	Limit
16.668	16.647



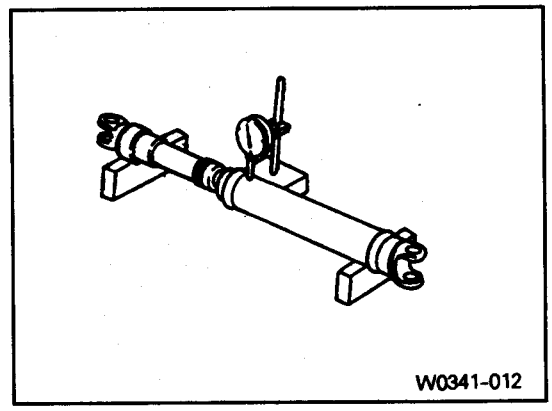
3) Clearance between the spider and bearing.

Standard	Limit
0.03~0.098mm	0.25mm



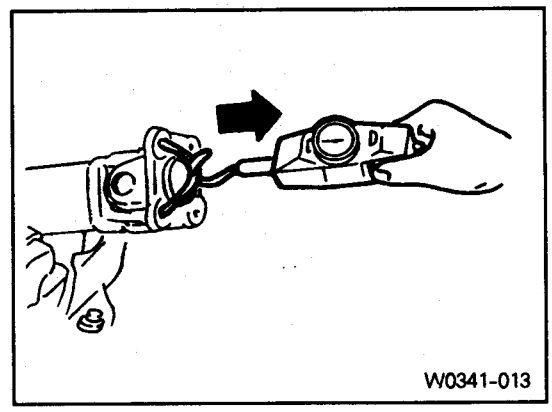
4) Propeller shaft runout
- Using a dial indicator, measure propeller shaft runout by turning the shaft. If runout exceeds limit, replace the propeller shaft or correct it using a press.

Limit	0.4mm



5) Universal joint starting torque.

Starting torque	3~8kg · cm

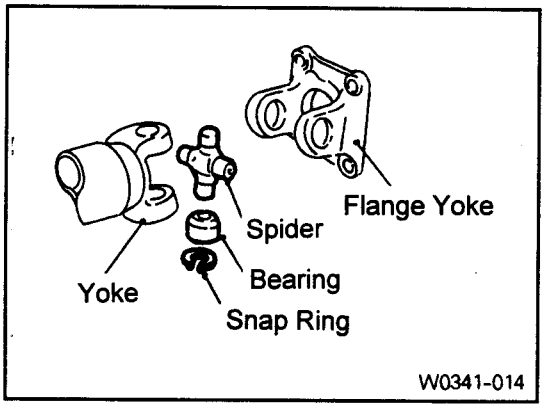


6) Possible cause of vibration.
- Drift away of balance weights.
- Excessive runout of the propeller shaft.
- Using normal bolts.
- Excessive wear of the universal joint.
- Sticks in sleeve joint.
- Drive angle changes in universal joints or cross causes vibration and can be detected around 60~100 km/h.

Installation

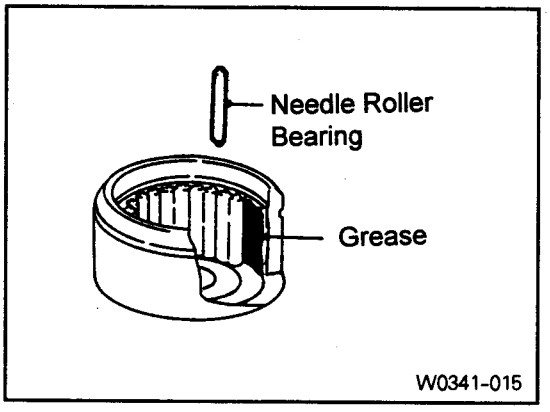
Clean the disassembled parts and replace them if damaged.

1) Align the alignment marks of the yoke and assemble the spider, bearing and snap ring.

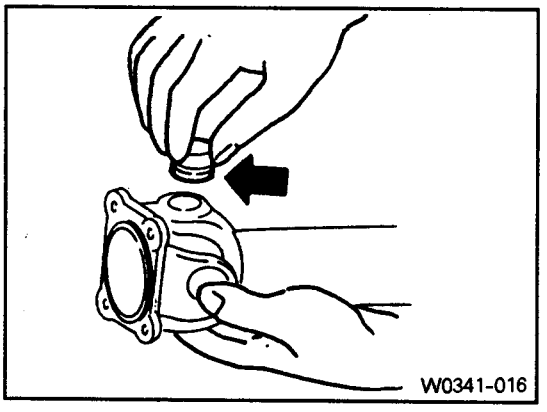


2) Apply grease to the inner of the bearing cap of the needle roller bearing and assemble the needle roller.

Grease	EP #2

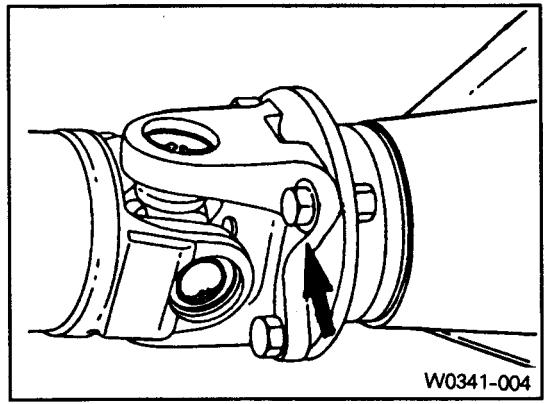


3) Install the bearing cap to the yoke and insert the spider. Install the opposite side cap by tapping with a plastic hammer. Adjust clearance of the spider pin to be within 0.1mm and install the snap ring.

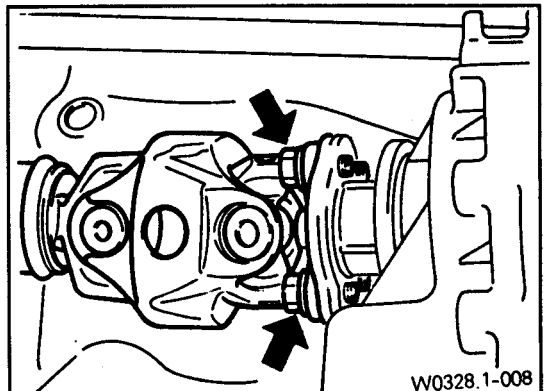


4) Align the alignment marks and install the front and rear propeller shaft. Tighten the nuts to the specified torque.

[Diesel]



[Gasoline]



1. General

Specifications

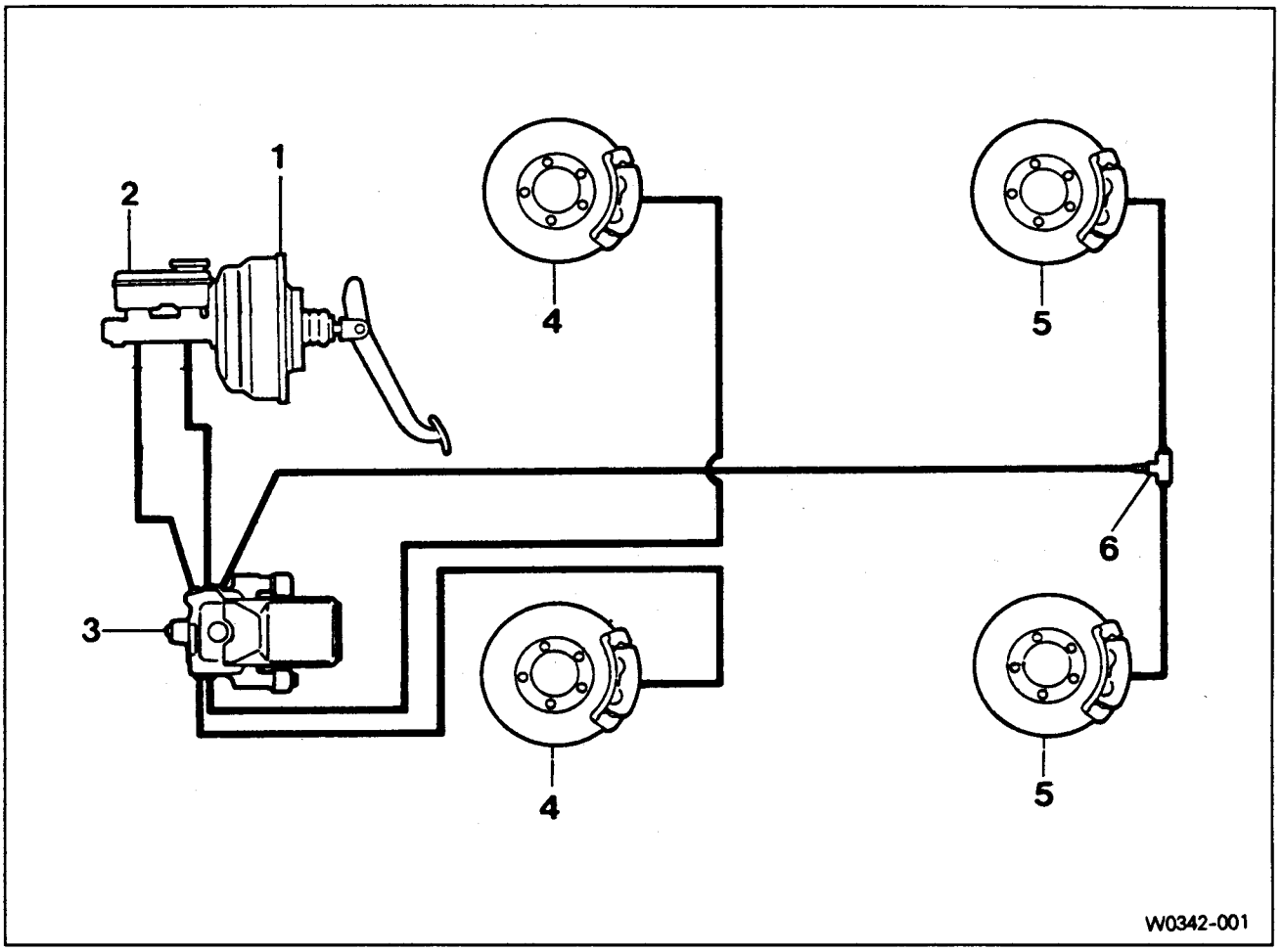
		MANDO Brake	PBR Brake
Brake pedal	Type	Suspended	
	Pedal ratio	4.3 : 1	3.8 : 1
	Pedal stroke	138mm	
	Pedal freeplay	1~4mm	
Master cylinder	Type	Tandem type with level sensor	
	Inner diameter	Ø25.4mm	Ø23.81mm
Brake booster	Type	Vacuum booster type	
	Ratio	5.6 : 1	5.0 : 1
Front brake	Type	Ventilated disc brake	
	I.D. of caliper cylinder	Ø60mm	Ø60.4mm
	Thickness of brake pad	10mm	
	Thickness of disc plate	24mm	
Rear brake	Type	Drum	Solid disc
	I.D. of drum	Ø254mm	—
	Shoe type	Leading and trailing	—
	W×L×T of lining	57×243.8×5mm	—
	I.D. of wheel cylinder	Ø22.23mm	—
	I.D. of caliper cylinder	—	Ø40.5mm
	Thickness of brake pad	—	9.5mm
	Thickness of disc plate	—	10.4mm
Parking brake	Type	Rear wheel internal expansion type	
	Operation	Mechanical	
Brake fluid	Specification	SAE J1703, DOT3	

2. Troubleshooting

Problem	Possible Cause	Remedy
Noise or vehicle vibration when applied brake	Incorrectly mounted back plate or caliper	Repair
	Loosened bolt of back plate or caliper	Retighten
	Crack or uneven wear of brake drum or disc	Replace
	Wedged brake drum	Cleaning
	Pad or lining sticking to contact surface	Replace
	Excessive clearance between caliper and pad	Repair
	Uneven contact of pad	Repair
	Lack of lubrication	Lubricate
	Loosened suspension	Retighten
Pulls to one side when braking	Incorrect tire pressure between left and right	Adjust
	Poor contact of pad or lining	Repair
	Oil or grease is applied to pad or lining	Replace
	Bent or uneven wear of drum	Replace
	Incorrectly mounted wheel cylinder	Repair
	Faulty auto adjuster	Repair
Poor braking	Dirty or lack of fluid	Replenish or replace
	Air in brake system	Bleeding
	Faulty brake booster	Repair
	Poor contact of pad or lining	Repair
	Oil or grease on pad	Replace
	Faulty auto adjuster	Repair
	Over heated rotor due to dragging pad or lining	Repair
	Clogging brake line	Repair
	Faulty proportioning valve	Repair
Increasing pedal stroke (pedal goes to floor) Brake dragging	Air in brake system	Bleeding
	Fluid leaking	Repair
	Excessive clearance between push rod and M/cylinder	Adjust
	Parking brake is not fully released	Repair
	Incorrect adjustment of parking brake	Adjust
	Weak return spring of brake pedal	Replace
	Incorrect pedal freeplay	Repair
	Broken rear drum brake shoe return spring	Replace
	Lack of lubrication	Lubricate
	Damaged master cylinder check valve or piston return spring	Replace
	Insufficient clearance between push rod and master cylinder	Adjust
Poor braking of parking brake	Worn brake lining	Replace
	Oil or grease on lining	Replace
	Binding parking brake cable	Replace
	Faulty auto adjuster	Repair
	Excessive lever stroke	Adjust or check cable

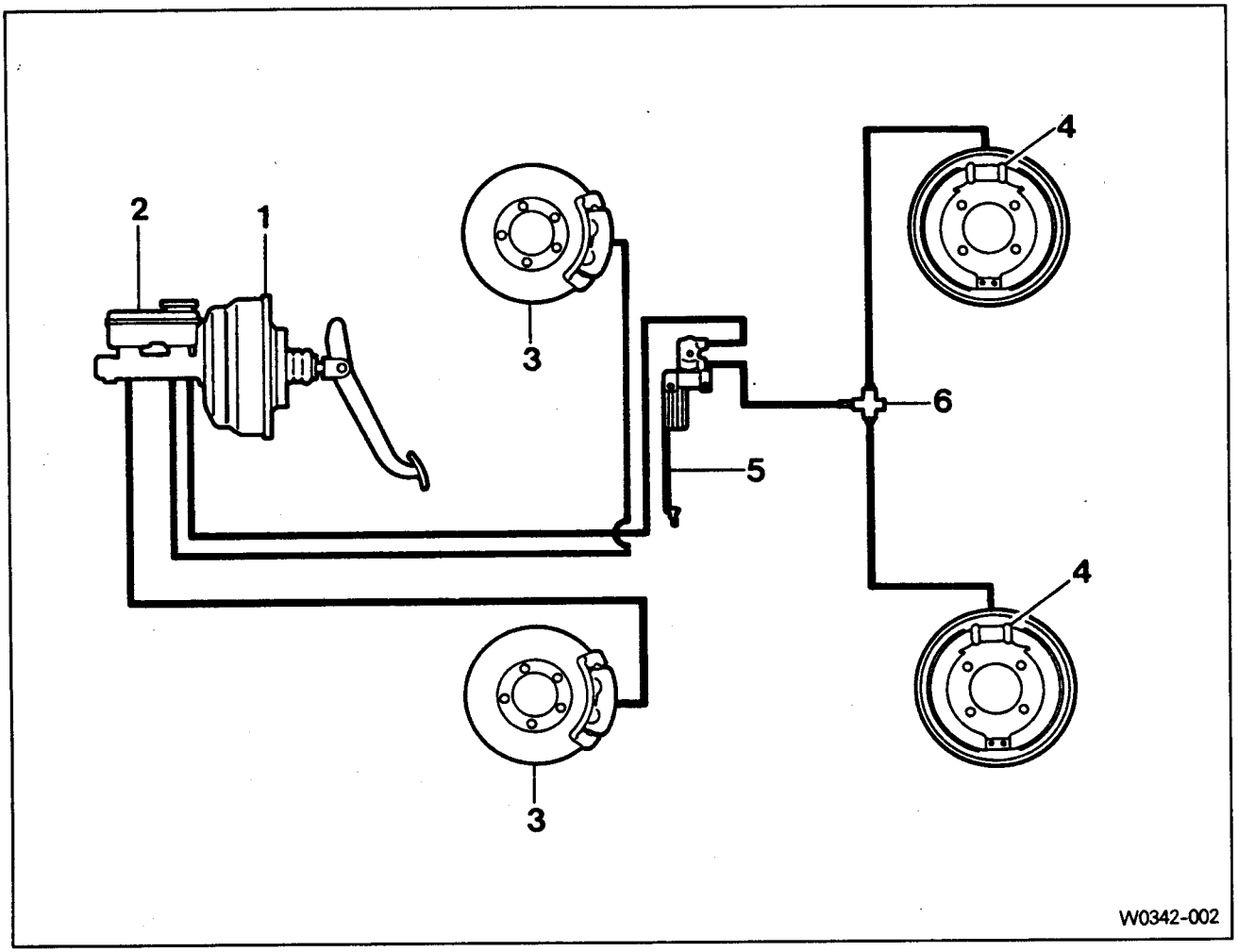
3. Brake System

Rear disc brake



1. Brake Booster
2. Reservoir and Master Cylinder
3. ABS Hydraulic Modulator
4. Front Disc Brake
5. Rear Disc Brake
6. 3-Way Connector

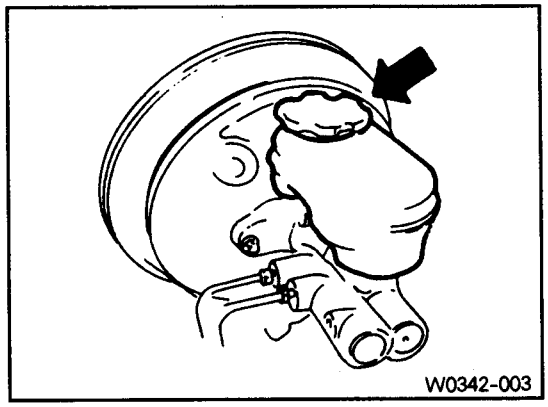
Rear drum brake



1. Brake Booster
2. Reservoir and Master Cylinder
3. Front Disc Brake
4. Rear Drum Brake
5. LCRV
6. 3-Way Connector

4. Bleeding of Brake System

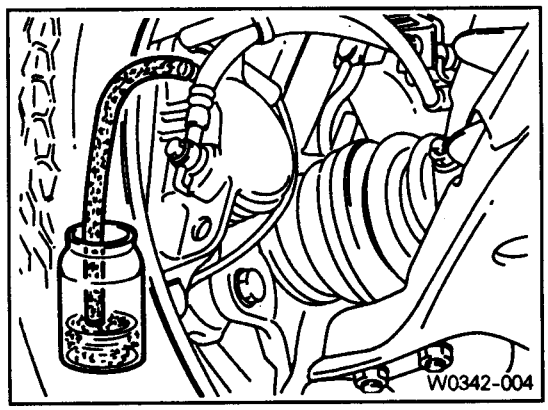
1) Remove the reservoir cap and add brake fluid.
[Note] Do not let the brake fluid remain on a painted surface. Wash it off immediately.



2) Connect a vinyl tube to the caliper or wheel cylinder bleeder screw. Insert the other end of the tube in a brake fluid container.

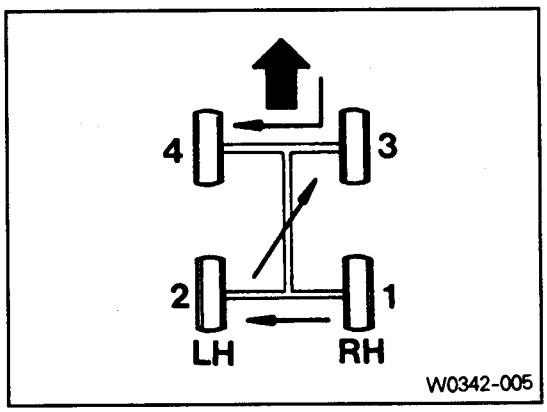
3) Slowly press the brake pedal several times.

4) With the brake pedal fully depressed, loosen the bleeder screw until fluid starts to run out. Then close the bleeder screw.



5) Repeat this procedure for each wheel until there are no more air bubbles in the fluid.

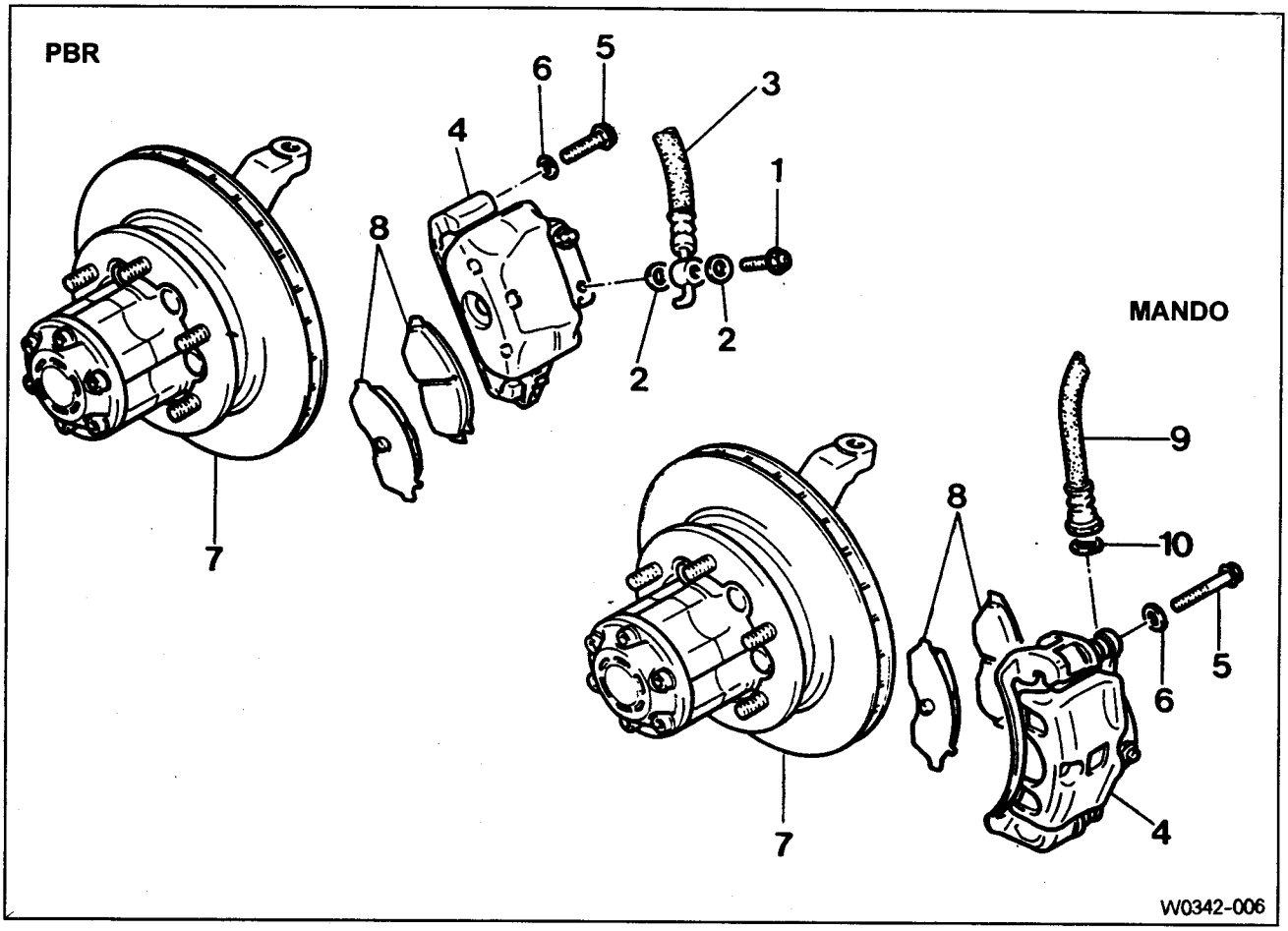
Item	Tightening torque
Front bleeder screw	7~13Nm
Rear bleeder screw	8~20Nm



[Note]
- **Do not let brake fluid remain on a painted surface.**
- **After bleeding, fill brake reservoir with brake fluid.**
- **Clean brake fluid completely.**
- **Check the bleeder screw for fluid leakage.**
- **While bleeding, slowly pump the brake pedal.**
- **Do not reuse the bled brake fluid.**

5. Removal and Installation of Front Brake

Preceding work : Removal of wheels and tires



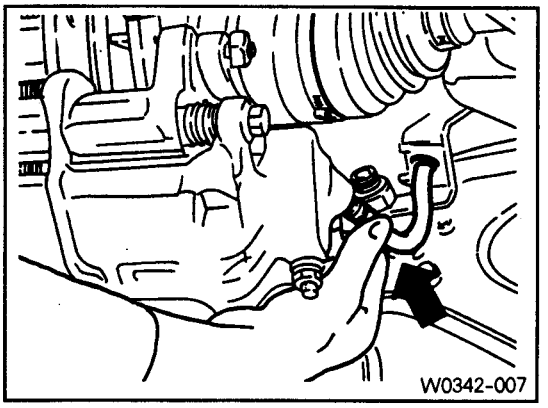
1. Eye-Hose Bolt---------- 25~35Nm
2. Gasket---------- Replace
3. Brake Hose
4. Caliper
5. Bolt---------- 20Nm
6. Washer
7. Front Disc Assembly
8. Brake Pad
9. Brake Hose and Nut---------- 25~35Nm
10. Gasket---------- Replace

Removal · Installation

1) MANDO Brake
Remove the hose mounting nut and disconnect the hose.

Installation

Tightening torque	25~35Nm

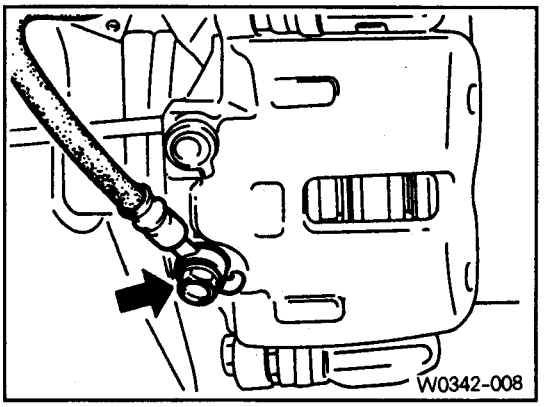


2) PBR Brake

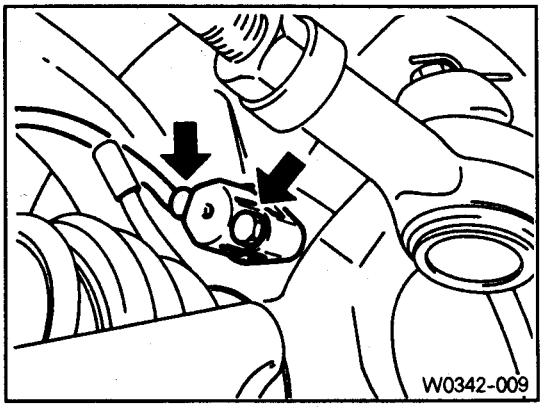
2.1) Remove the eye-hose bolt and disconnect the hose.

Installation

Tightening torque	25~35Nm



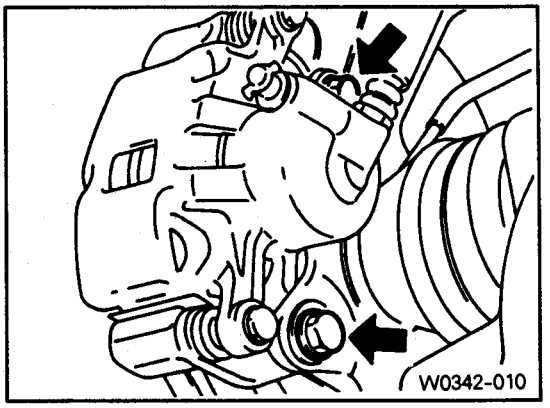
2.2) Remove the wheel speed sensor.



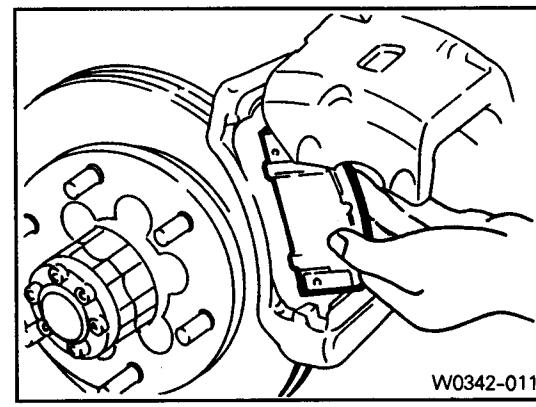
3) Remove the mounting bolts and then caliper assembly.

Installation

Tightening torque	20Nm



4) Pull out the brake pads. Replace pads if necessary.
[Note] Always change the all pads on one wheel at a time.



5) Installation is reverse order of the removal.

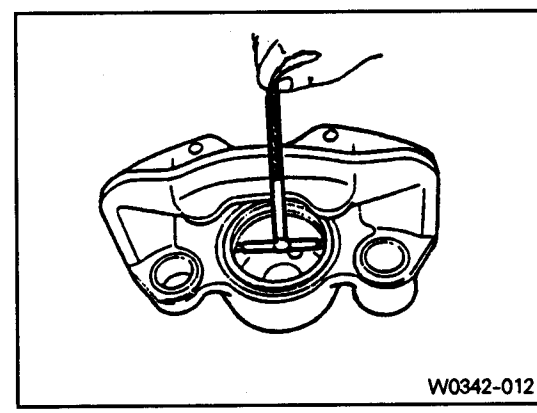
6) Do bleeding procedure (42-05).

Inspection

1) Clean all components and visually check the followings.
- Check the cylinder and piston for wear, rust or damage.
- Check the caliper body and guide pin for wear, damage or crack.
- Check the pads for uneven wear or oiliness.
- Check the boots for damage or tear.

2) Measure caliper housing inner diameter.

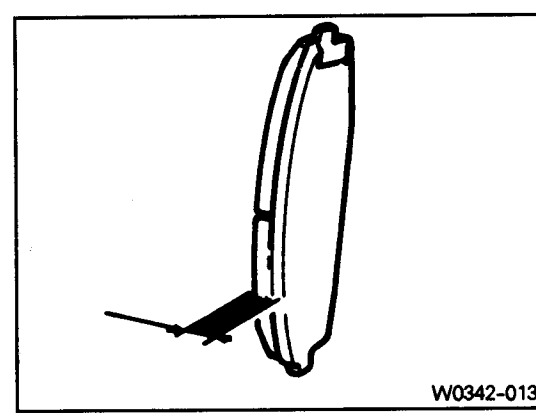
Item	Standard	Wear limit
With ABS	⌀60.4mm	⌀61.4mm
Without ABS	⌀60.0mm	⌀61.0mm



3) Measure pad thickness.

Standard	Wear limit
10mm	2.0mm

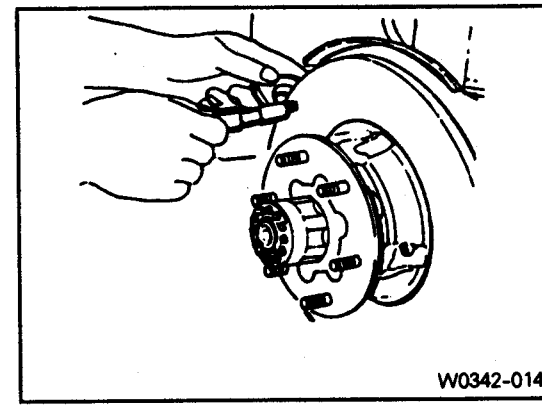
[Note] Always change the all pads on one wheel at a time.



4) Measure rotor disc thickness.

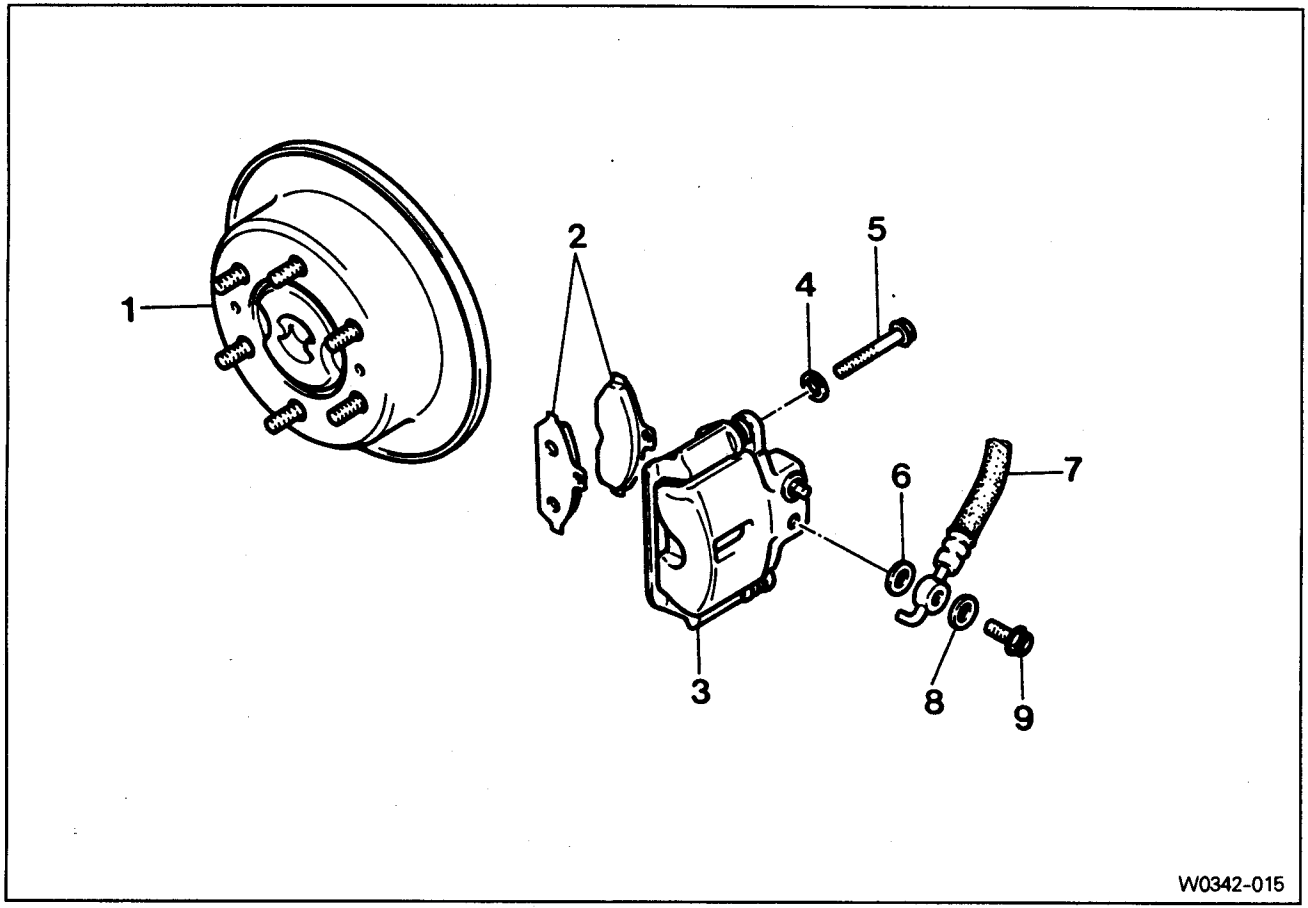
Standard	Wear limit
24mm	22mm

5) Check the rotor disc for score or runout.



6. Removal and Installation of Rear Disc Brake

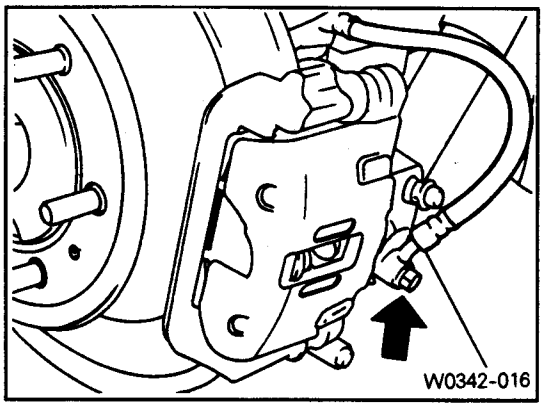
Preceding work : Removal of the wheels and tires



1. Rear Disc Assembly
2. Brake Pad
3. Caliper
4. Gasket---------- Replace
5. Bolt---------- 20Nm
6. Gasket---------- Replace
7. Brake Hose
8. Gasket---------- Replace
9. Eye-Hose Bolt---------- 8~18Nm

Removal · Installation

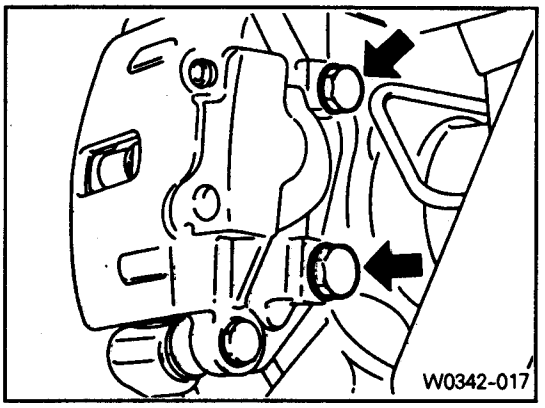
1) Remove the eye-hose bolt and disconnect the hose.



Installation

Tightening torque	8~18Nm

2) Remove the mounting bolts and then caliper assembly.



Installation

Tightening torque	20Nm

3) Pull out the brake pads. Replace pads if necessary.
[Note] Always change the all pads on one wheel at a time.

4) Installation is reverse order of the removal.

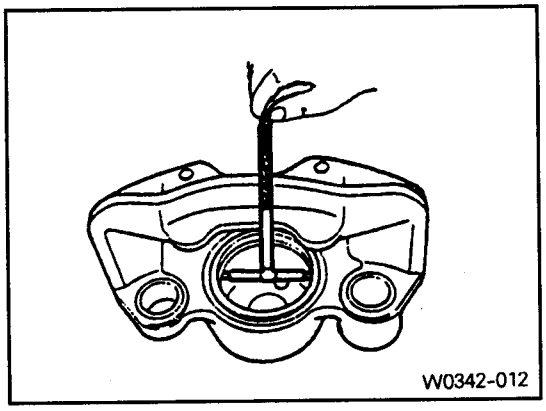
6) Do bleeding procedure (42-05).

Inspection

1) Clean all components and visually check the followings.
   - Check the cylinder and piston for wear, rust or damage.
   - Check the caliper body and guide pin for wear, damage or crack.
   - Check the pads for uneven wear or oiliness.
   - Check the boots for damage or tear.

2) Measure caliper housing inner diameter.

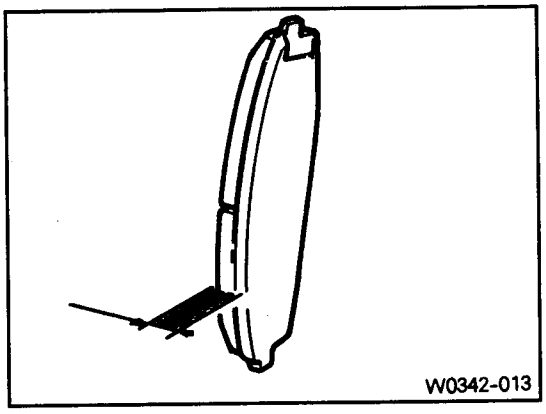
Standard	Wear limit
⌀40.5mm	⌀41.5mm



3) Measure pad thickness.

Standard	Wear limit
9.5mm	1.5mm

[Note] Always change the all pads on one wheel at a time.



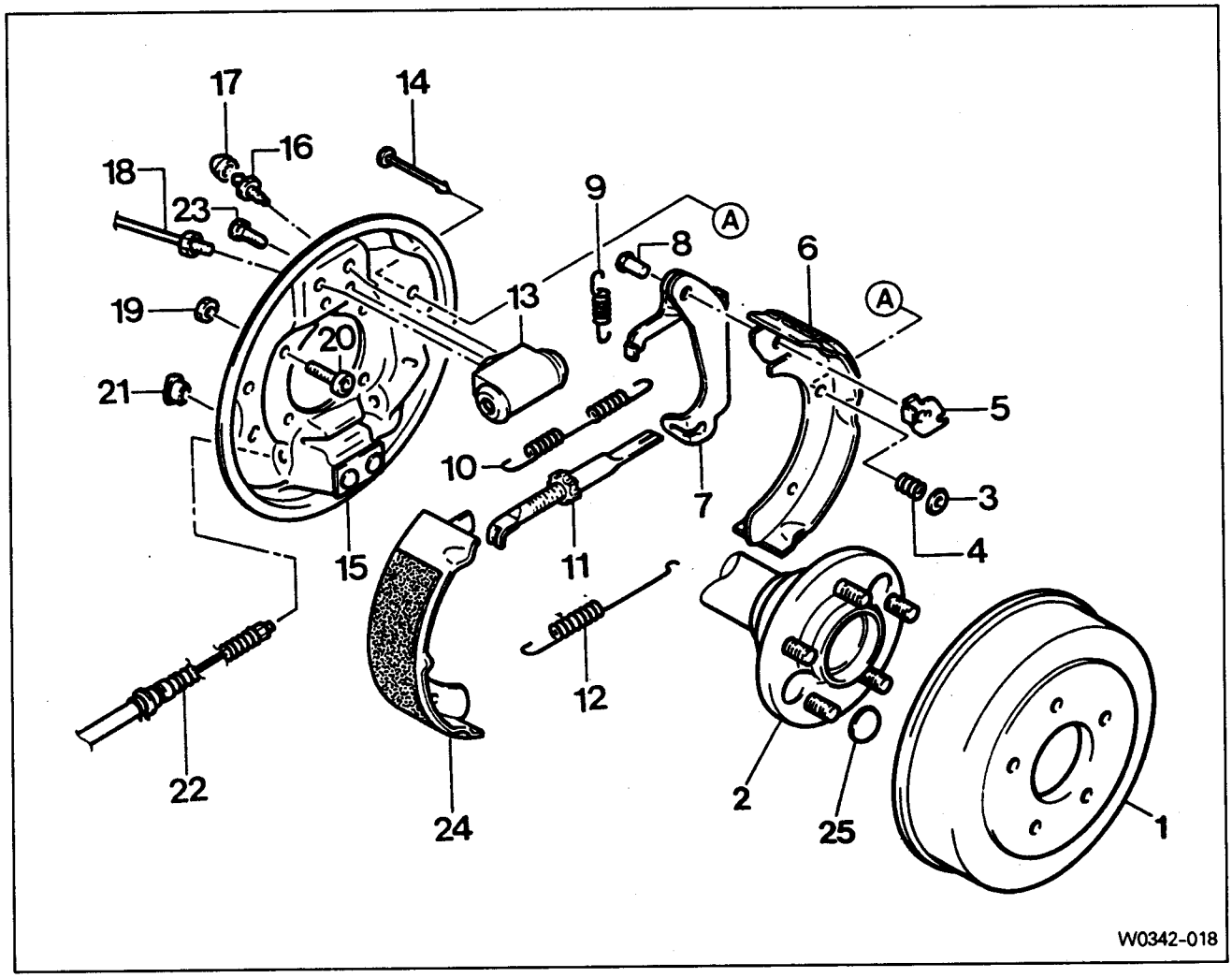
4) Measure rotor disc thickness.

Standard	Wear limit
10.4mm	9.3mm

5) Check the rotor disc for score or runout.

7. Removal and Installation of Rear Drum Brake

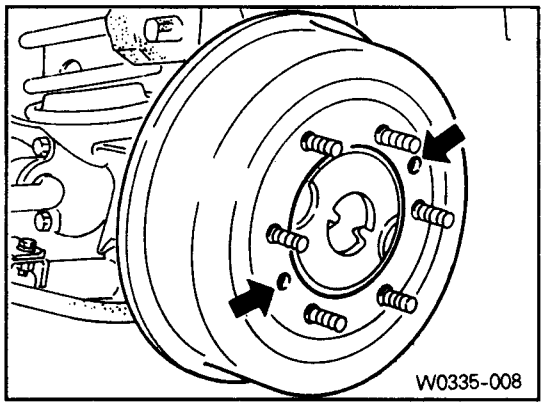
Preceding work : Removal of the wheels and tires



1. Brake Drum
2. Rear Axle Shaft
3. Shoe Hold-down Washer
4. Spring
5. Retaining Plate
6. Brake Shoe (Trailing)
7. Parking Brake and Adjusting Lever
8. Lever Pin
9. Lever Spring
10. Tension Spring
11. Adjuster
12. Anchor Spring
13. Wheel Cylinder
14. Pin
15. Back Plate
16. Bleeder Screw---------- 9~14Nm
17. Cap
18. Brake Tube---------- 25~35Nm
19. Nut---------- 50~65Nm
20. Bolt
21. Inspection Plug
22. Parking Brake Cable
23. Wheel Cylinder Bolt---------- 5.5~11Nm
24. Brake Shoe (Leading)
25. Plug

Disassembly · Assembly

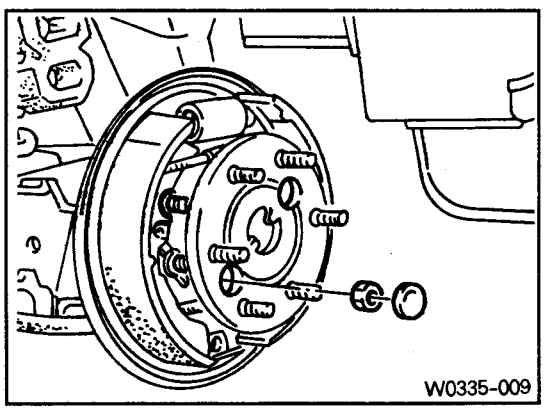
1) Remove the brake drum by install bolts (M8 x 1.25) into the service hole of the brake drum.
[Note] Uniformly tighten the bolts.



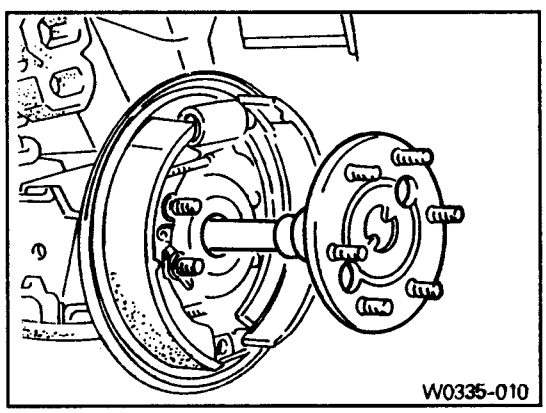
2) Remove the plug from axle shaft flange and remove the mounting nuts.

Installation

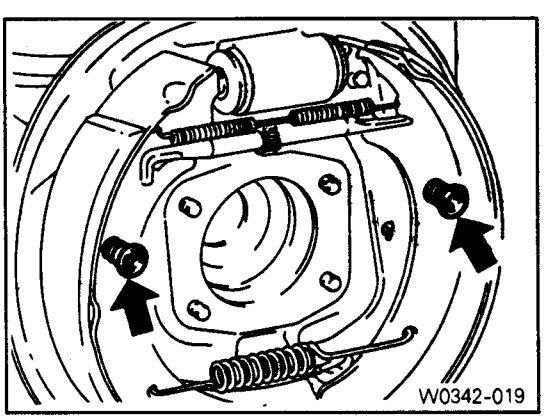
Tightening torque	50~65Nm



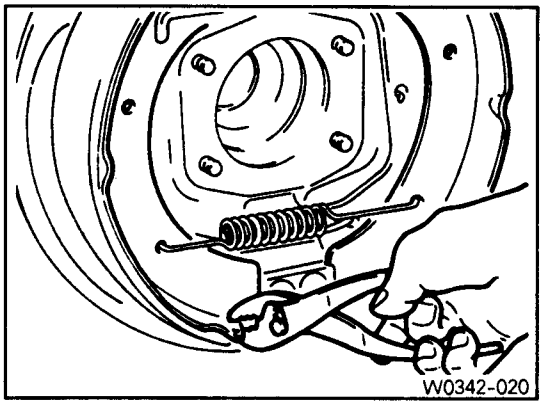
3) Remove the axle shaft.



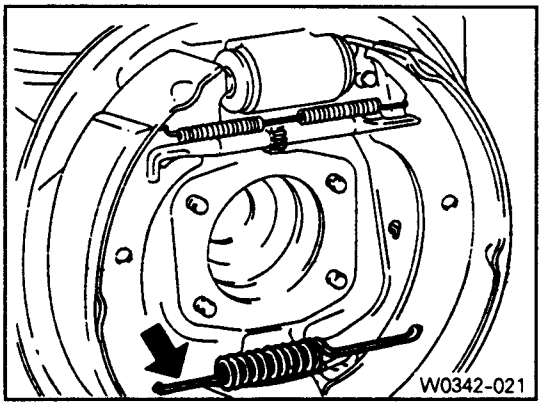
4) Using a pliers, align the shoe hold-down pin with washer hole and remove it.



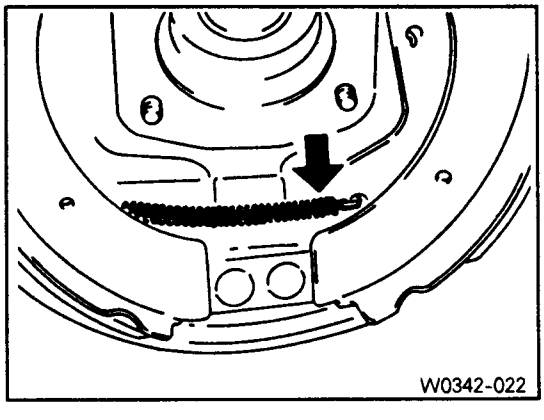
5) Pull out the lower part of the brake shoes from the anchor plate.



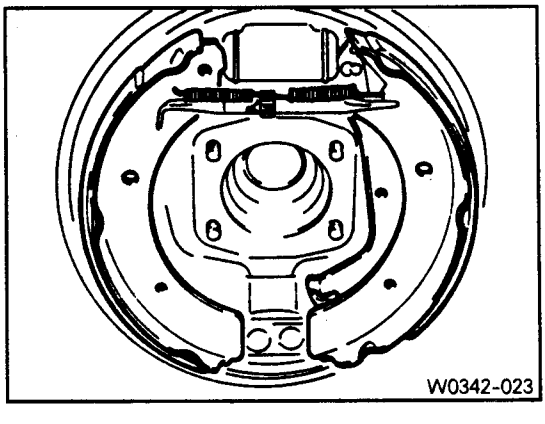
6) Remove the anchor spring.



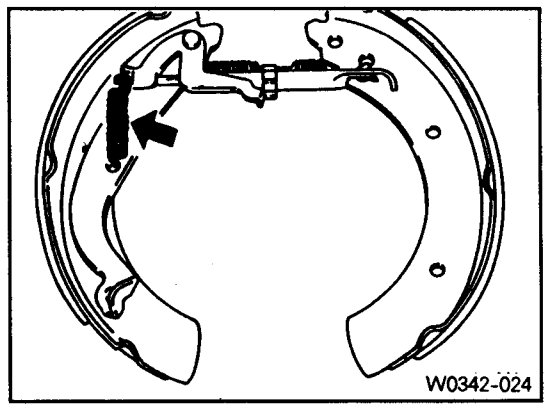
7) Disconnect the parking brake cable from parking brake lever.



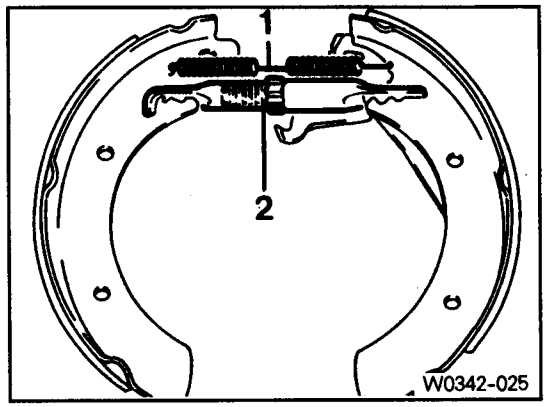
8) Remove the brake shoes and adjuster assembly.



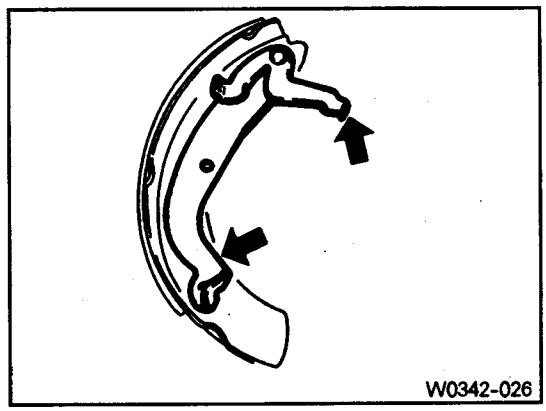
9) Remove the adjusting lever spring.



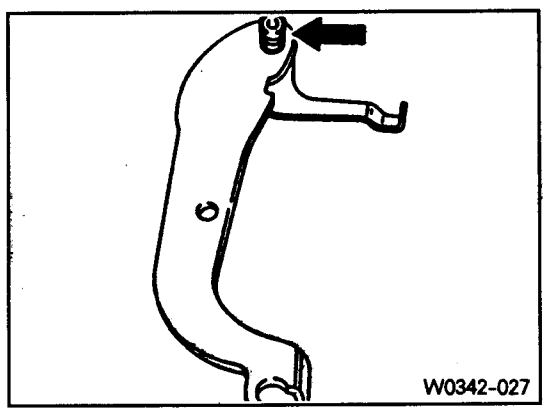
10) Pull out the adjuster (2) and remove the tension spring.



11) Remove the parking brake lever and adjusting lever from the brake shoe.



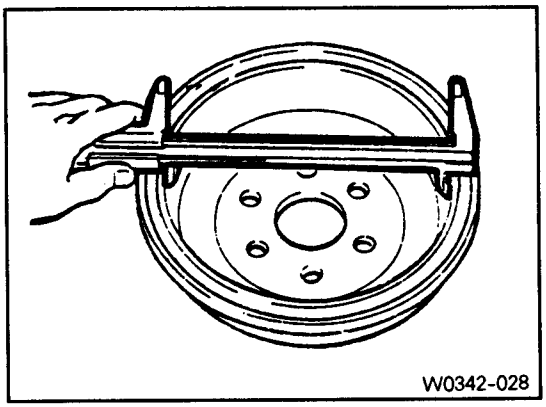
12) Remove the lever pin (arrow) and separate the parking brake lever and adjusting lever.



13) Measure brake drum inner diameter and replace it if necessary.

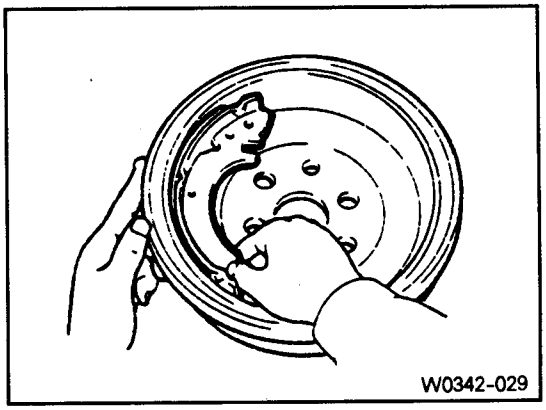
Standard	Wear limit
⌀254mm	⌀255.5mm

[Note] Measure at least 2 points.


W0342-028

14) Inspect brake lining and drum for proper contact.
Apply chalk inside of the drum and by moving the shoe, check lining and drum contact. If the contact between the brake lining and drum is improper, replace the brake shoe assembly or brake drum.

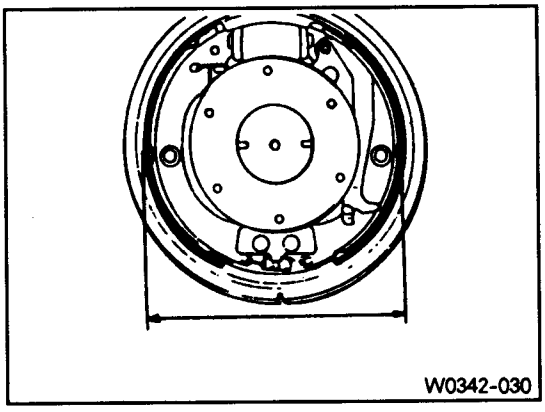
15) Installation is reverse order of the removal.


W0342-029

16) By turning the adjuster screw, set the shoe outer diameter to ϕ253.08 ~ ϕ253.50mm.

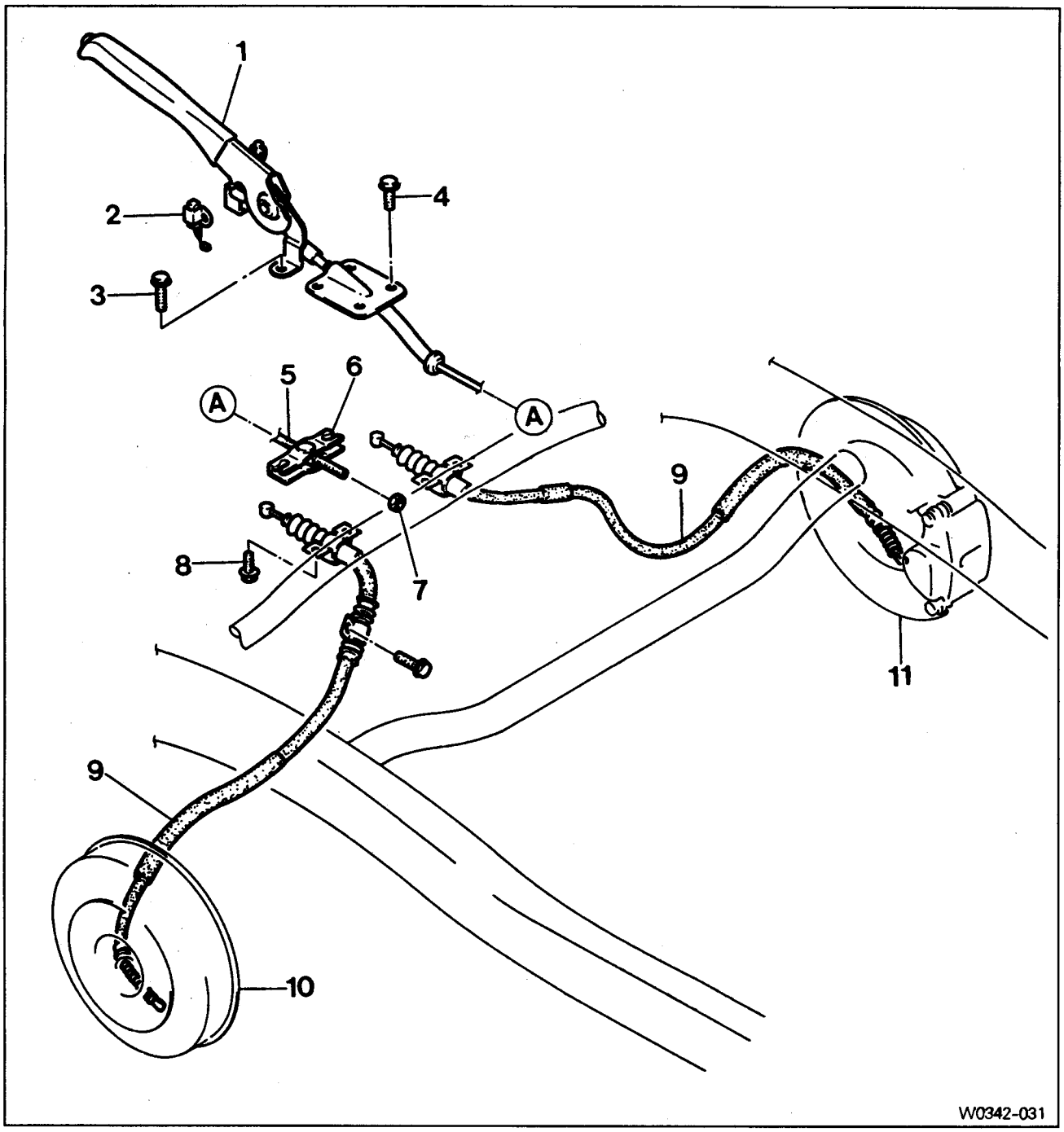
17) Install the brake drum and check for smooth rotation by hand.

[Note] If necessary, adjust the clearance using the adjuster.


W0342-030

18) Adjust the parking brake lever stroke.

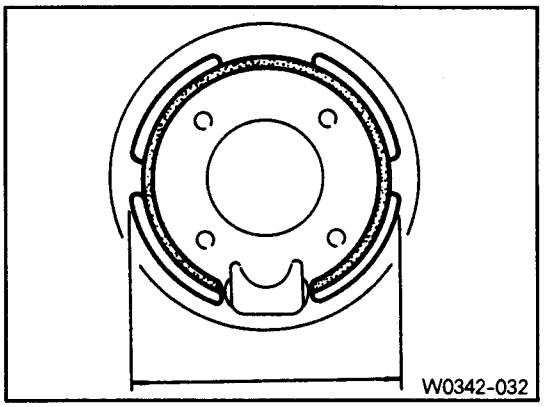
8. Parking Brake



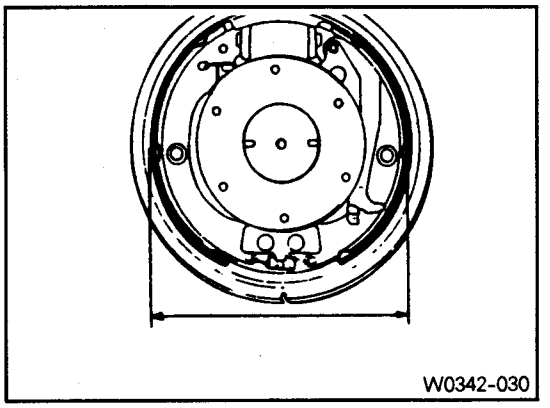
1. Parking Brake Lever
2. Parking Brake Lamp Switch
3. Bolt
4. Bolt
5. Front Parking Brake Cable
6. Equalizer
7. Nut
8. Bolt
9. Rear Parking Brake Cable
10. Brake Drum (If Equipped with Rear Drum Brake)
11. Brake Disc (If Equipped with Rear Disc Brake)

Adjustment

1) Disc brake.
   Set the parking brake shoe outer diameter to Ø189.6 ~ Ø189.8mm.

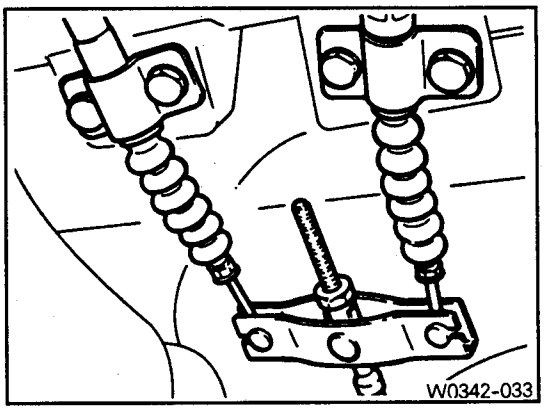


2) Drum brake.
   Set the shoe outer diameter to Ø253.08 ~ Ø253.50mm.

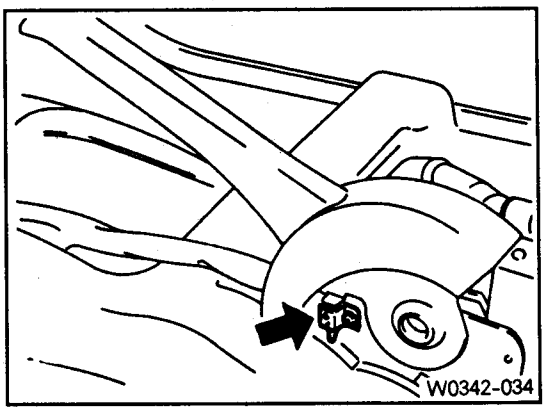


3) Install the brake disc and drum.
   Adjust that lever travel is within 5 ~ 7 notches when pulled the parking brake lever with a force of about 17.5 ~ 20.5kg.

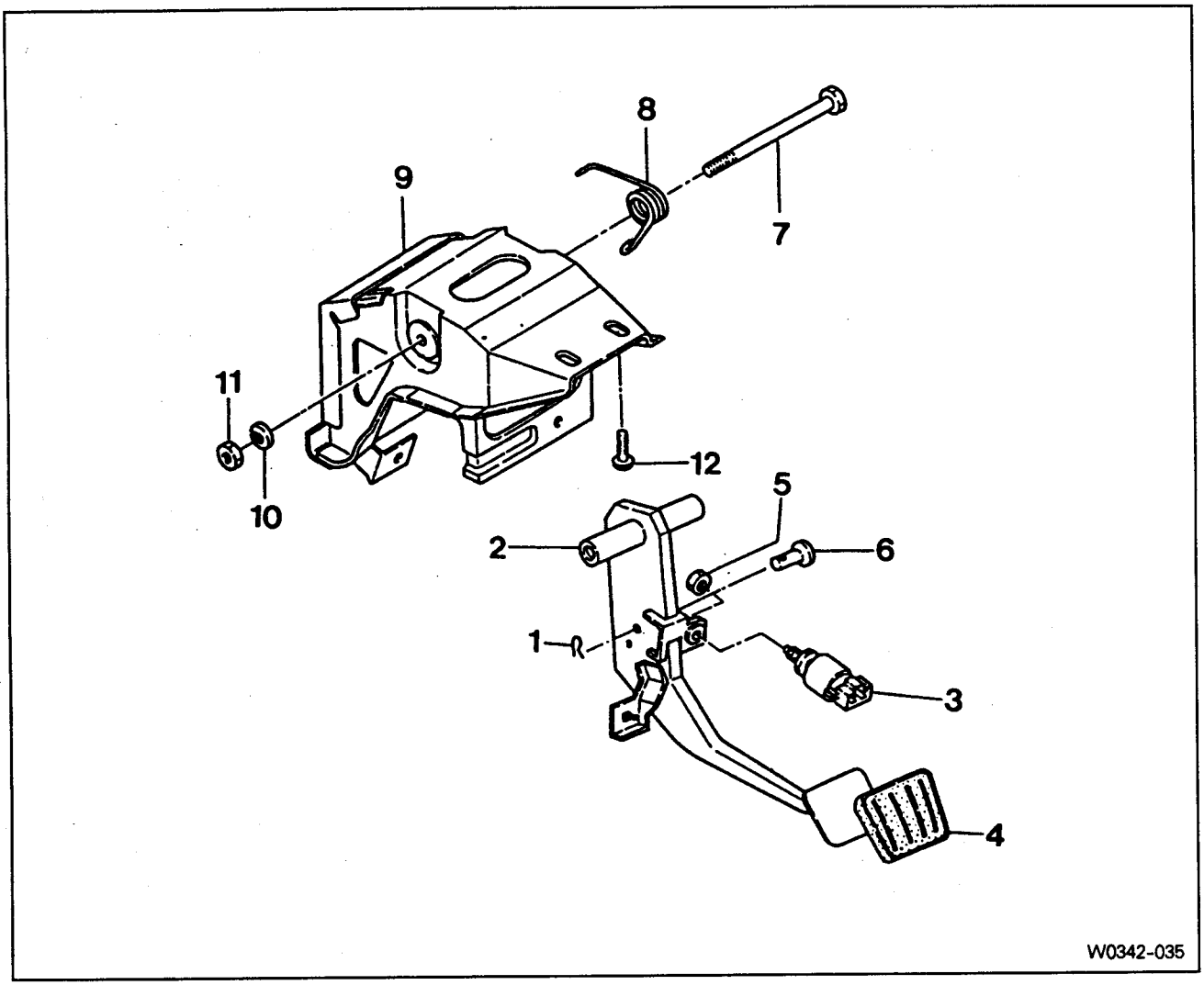
4) Release the parking brake.
   [Note] Be sure that wheels are rotating smoothly.



5) The brake warning lamp should come on when parking brake lever is pulled one notch.



9. Brake Pedal



1. Clevis Pin
2. Brake Pedal
3. Stop Lamp Switch
4. Pad
5. Nut---------- 21~35Nm
6. Yoke Pin
7. Fulcrum Pin
8. Return Spring
9. Pedal Mounting Bracket
10. Washer
11. Nut---------- 16~32Nm
12. Bolt----------12~23Nm

Removal · Installation

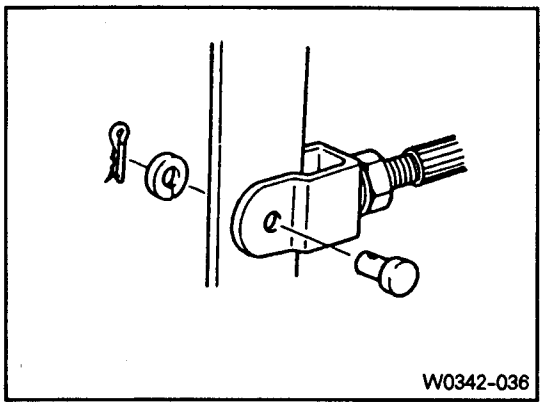
1) Remove the stop lamp switch.

2) Remove the fulcrum pin and return spring.

3) Remove the clevis pin and disconnect the brake booster push rod from the brake pedal.

4) Remove the brake pedal.

5) Installation is reverse order of the removal.



Inspection

1) Pedal height.

Height (A)	150mm (from the carpet)

[Note] If pedal height is incorrect, loosen the stop lamp nut (B) and adjust the pedal height.

2) Pedal stroke.

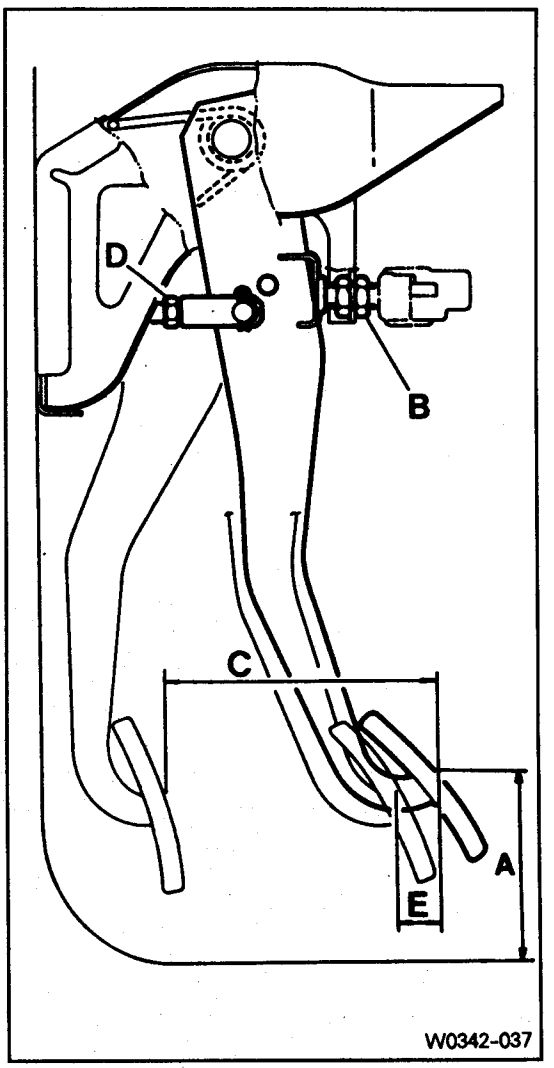
Max. (C)	138mm

3) Pedal freeplay.

Freeplay (E)	1~4mm

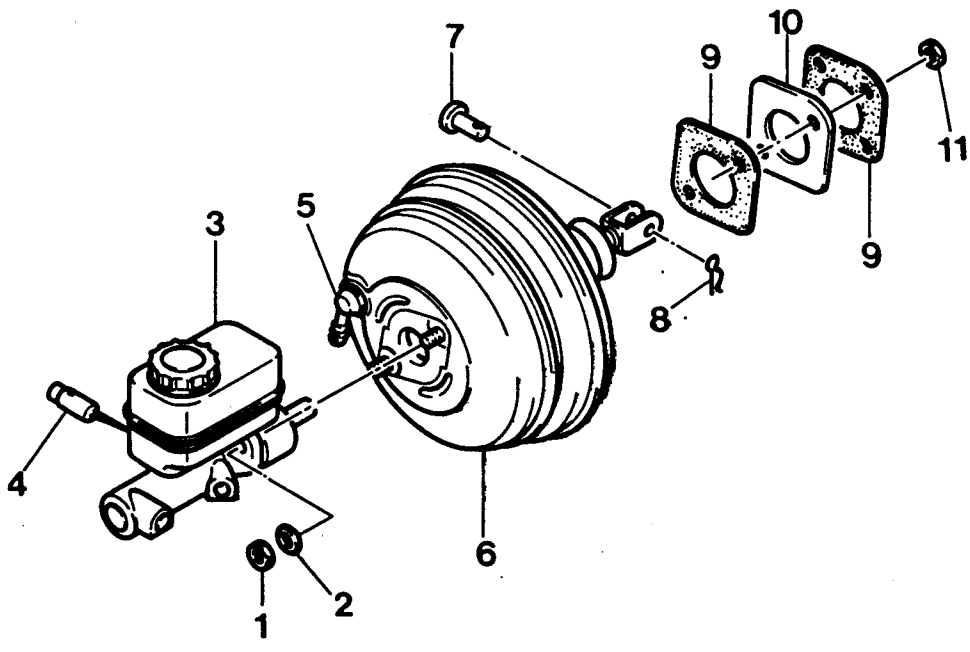
[Note] · **To adjust, depress the brake pedal several times until there is no more vacuum left in the vacuum line.**

· **To adjust, loosen the push rod nut (D) and turn the rod.**



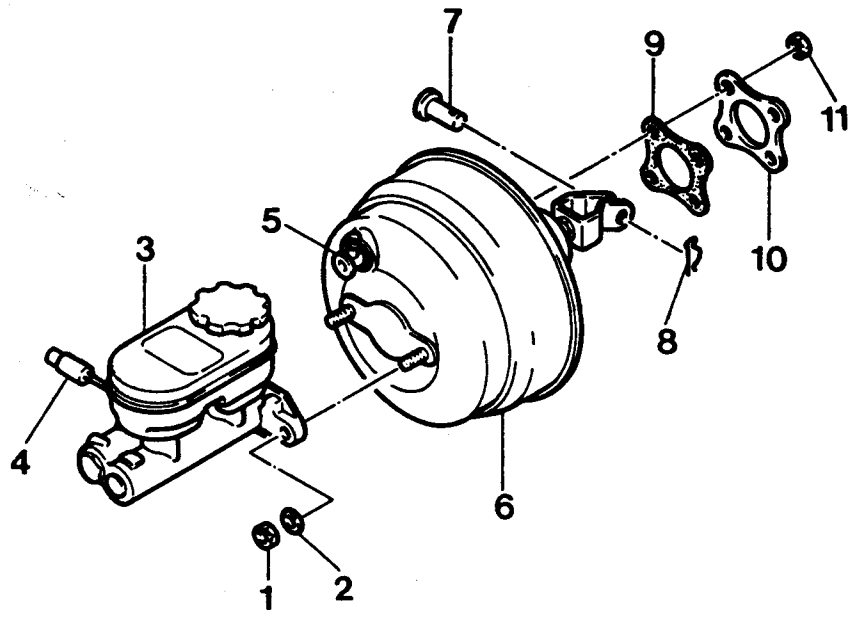
10. Removal and Installation of the Brake Master Cylinder and Booster

MANDO Brake



W0342-038

PBR Brake

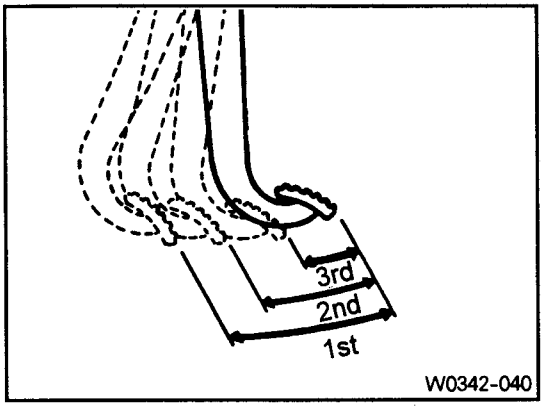


W0342-039

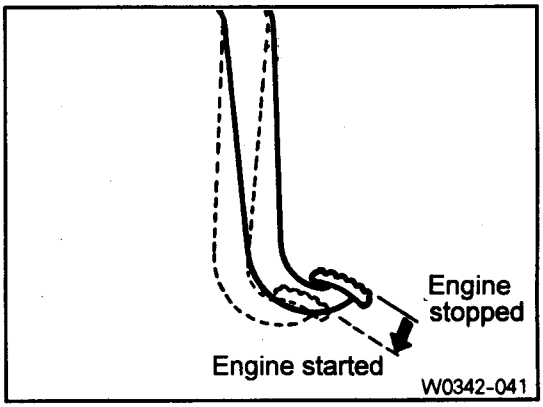
1. Nut---------- 21~29Nm
2. Washer
3. Master Cylinder
4. Oil Level Sensor
5. Check Valve
6. Brake Booster
7. Yoke Pin
8. Clevis Pin---------- Replace
9. Seal
10. Spacer
11. Nut---------- 21~28Nm

Inspection of the brake booster

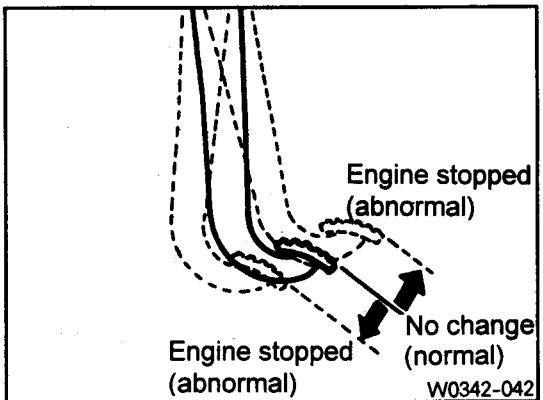
1) Start the engine and stop it after one or two minutes.
Depress the brake pedal several times.
If the pedal goes down furthest the first time, but gradually rises after the second or third time, brake booster is normal. If there is no change in pedal stroke, the brake booster is abnormal.



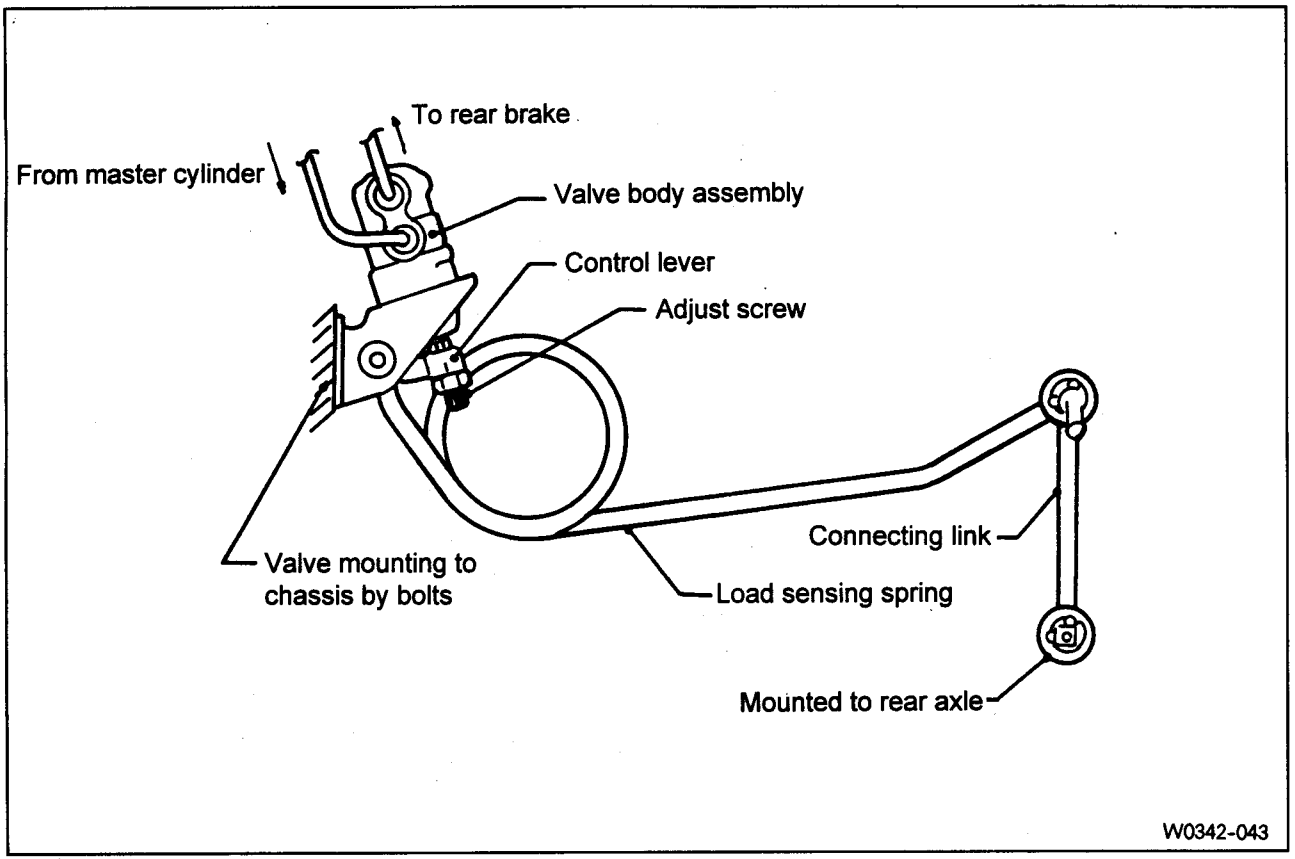
2) Depress the brake pedal several times with engine stopped, and depress the brake pedal and start the engine. If the pedal goes down slightly, the booster is normal.



3) Depress the brake pedal with engine running, and stop it with the pedal depressed. If there is no change in pedal height during 30 sec., the booster is normal.



11. Load Conscious Reducing Valve(LCRV)

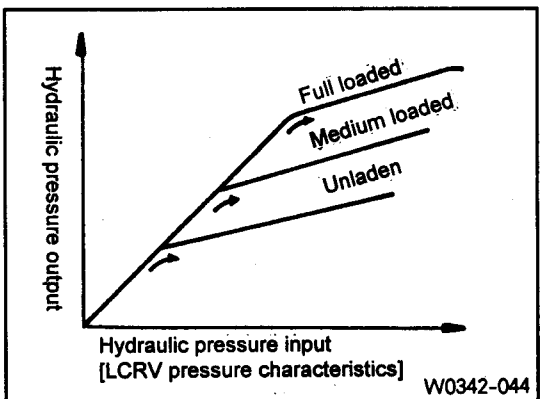


Construction

LCRV consists of sensing part and hydraulic control part.

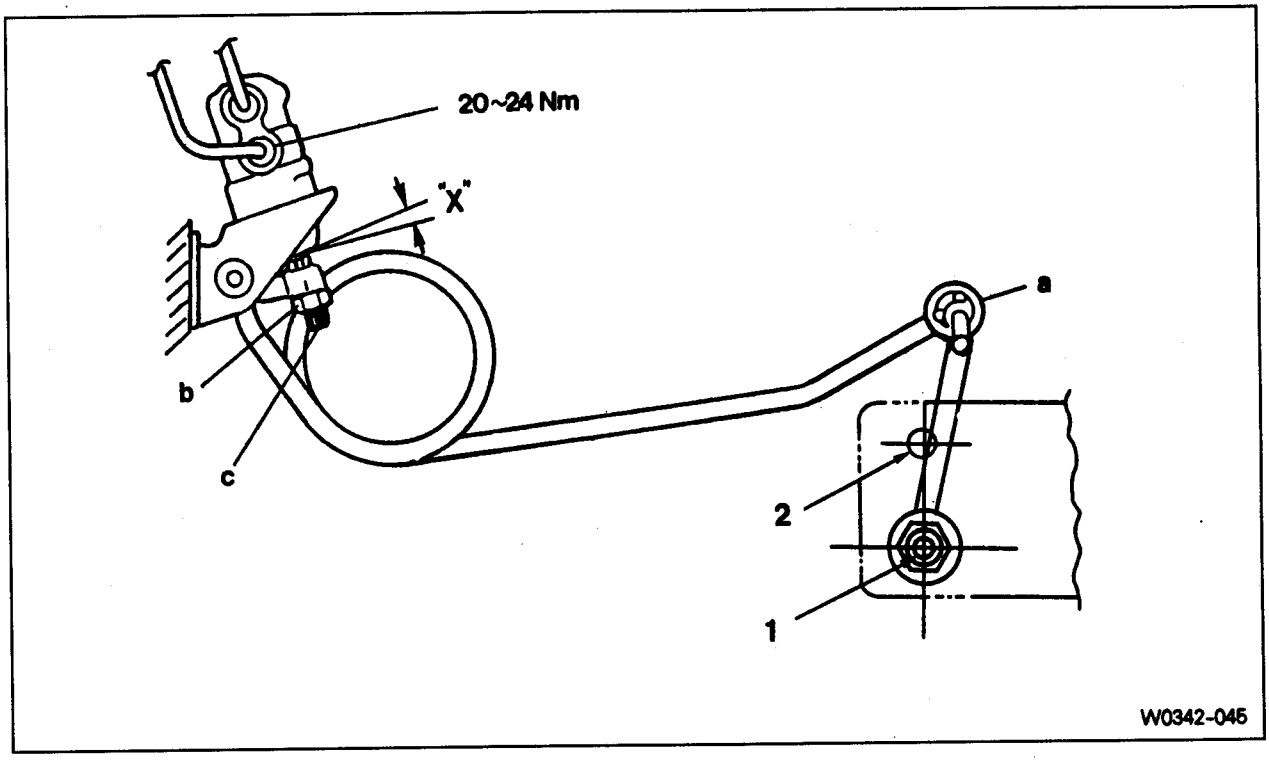
1) Sensing part.
It detects the changes of vehicle height caused by vehicle load. It consists of load sensing spring and control lever which change according to vehicle load.

2) Hydraulic control part.
It consists of valve stem devices which controls hydraulic pressure according to load detected by sensing part.



Operation description

LCRV body is bolted on the vehicle frame and the end of load sensing spring is mounted on the rear axle. Depending on the load of vehicle, the distance between the body and rear axle changes and load sensing spring detects it. The amount of load sensing spring's change will be delivered to the valve stem devices and it will control hydraulic pressure output to rear wheel brakes.



Valve setting method

1) Install the connecting link (a) to the no.1 hole (real axle).

2) Adjust clearance 'X' to be 0mm using the lock nut.

Tightening torque	14~18Nm

3) Remove the connecting link (a) from the no.1 hole and reinstall it to the no.2 hole.

Tightening torque	14~18Nm

4) Place alignment marks between the lock nut (b) and adjusting screw (c) after the valve setting.

5) LCRV setting should be performed with unladen vehicle condition.

LCRV inspection and troubleshooting

Inspect the LCRV as follows when :

- Replacement of load sensing spring or valve body assembly due to damaged LCRV.
- Replacement of rear axle assembly or removal/installation of rear axle assembly.
- Replacement of rear coil springs.

Trouble shooting

Problem	Possible Cause	Remedy
Insufficient braking (long stopping distance)	Insufficient air bleeding.	Bleed
	Incorrectly adjusted load sensing spring.	Readjust
	Broken load sensing spring.	Replace
	Fluid leaks in brake line or LCRV.	Retighten brake line or replace LCRV
Premature lock of rear wheel	Incorrectly adjusted load sensing spring.	Readjust
	Internal leakage of LCRV.	Replace

[Note]

- **LCRV fluid leakage will be caused by valve ON/OFF defect due to contaminated brake fluid or seal ring wear.**
- **Be sure that the load sensing spring should be replaced with genuine part or braking efficiency will be severely damaged.**

12. ABS 2S System

Specifications

Item			Specification
ECU	Number of pins		35
	Operating temperature range		-40°~+85℃
	Max. current consumption		50mA
Hydraulic Modulator	Pressure maintaining current		1.97~2.23A
	Pressure reduction current		4.6~5.7A
	Solenoid coil resistance		1.14Ω
Wheel speed sensor	Internal resistance		1,000±2,000Ω
Impulse ring	Front wheel air-gap		0.25~1.75mm
	Rear wheel air-gap		0.15~1.2mm
	No. of teeth	Front	52
		Rear	52

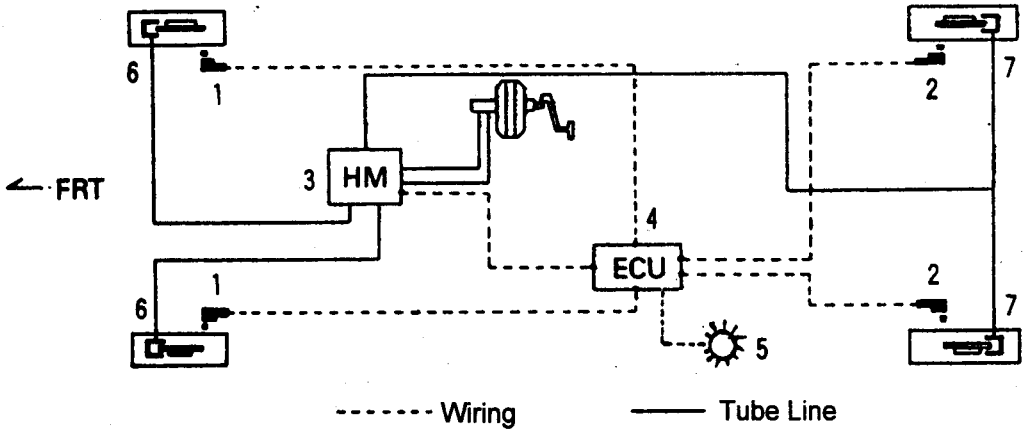
Troubleshooting

Item	Possible Cause	Remedy
ECU	· Damaged ECU circuit due to water penetration. · Damaged overvoltage protection diode or wiring due to over voltage. · Damaged ECU housing.	· Inspect mounting and mounting area to spot the cause. · Inspect charging system and repair. · Disconnect ECU connector during body welding. · Inspect mounting and handle with care.
Speed sensor	· Incorrect resistance. · No signal from the sensor.	· Replace speed sensor. · Check cable conditions or wheel speed sensor damage (speed sensor surface or wheel bearing). · Wheel speed sensor installation (when replacing the sensor, immediately install it from the box). · For installation of speed sensor, completely insert the sensor until hear the 'click' sound.
ABS warning indicator light	· Warning indicator light does not turn on when the ignition switch is ON. · Warning indicator light continues ON/OFF during driving	· Using a ABS tester, check the system. · Check wiring connection.

Purpose of ABS

The antilock-braking system(ABS) prevents wheel lockup during hard or rapid braking and prevents wheelspin during acceleration to provide the driver with full control of the vehicle. This system consists of ECU, hydraulic modulator, wheel-speed sensors and impulse rings.

Components



1. Wheel-speed sensor(Front)
2. Wheel-speed sensor(Rear)
3. Hydraulic Modulator
4. ECU
5. ABS Warning Indicator Light
6. Impulse Ring (Front)
7. Impulse Ring (Rear)

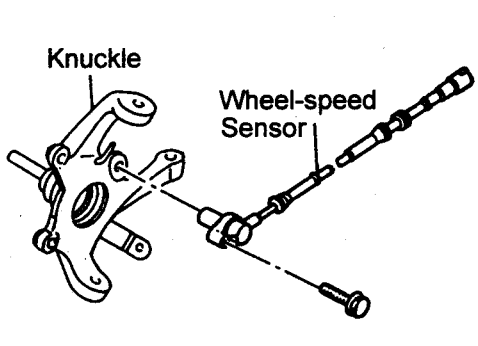
W0342-046

Operation of the ABS

A vehicle equipped with ABS has wheel-speed sensors at each steering knuckles and rear axle. The wheel-speed sensors send wheel-speed information to the ABS ECU. When the ECU senses a rapid change in wheel speed, it signals hydraulic modulator to control the brake pressure and prevents wheel lockup.

The ABS will operate on the following situations :

- When braking on a slippery road.
- During hard or rapid braking.

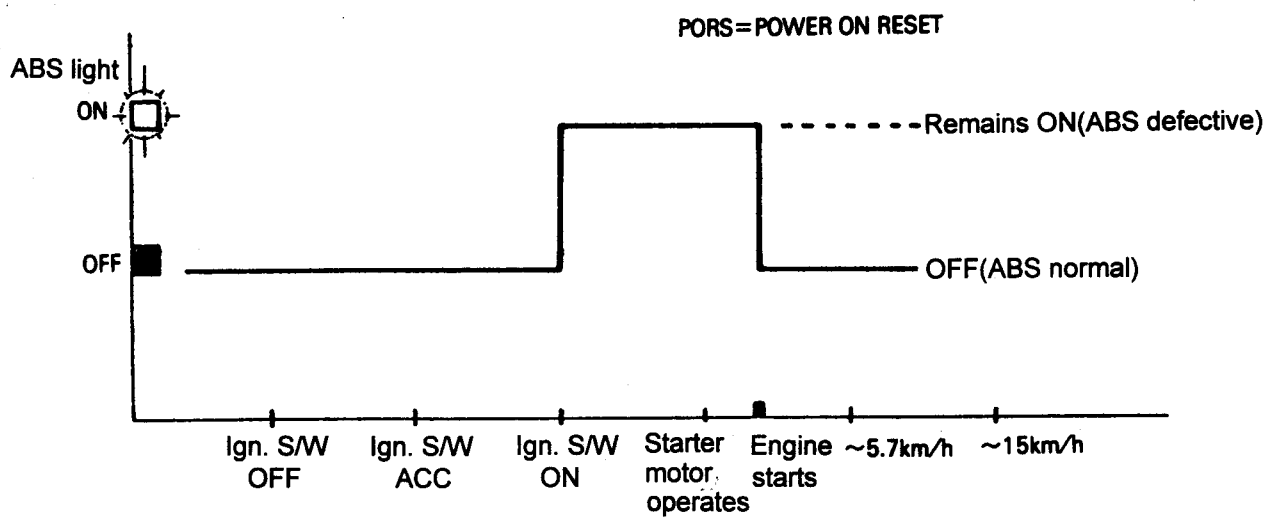


W0342-047

Operation check

1) Pedal vibration.
When ABS operates, it will make little noise and light vibration on the brake pedal. This is normal and is caused by the changes in hydraulic pressure within the solenoid valves, and this indicates the normal operation of the system.

2) ABS warning indicator light.
When the engine is started, the ABS warning indicator light will turn off and this indicates normal operation of the ABS. If warning light remains ON, the ABS is defective however conventional brake system operates normally.



[Note] The ABS will test pump motor at over 5.7km/h and detects vehicle speed at over 15km/h. If ABS is defective, the ABS warning indicator light will remain ON.

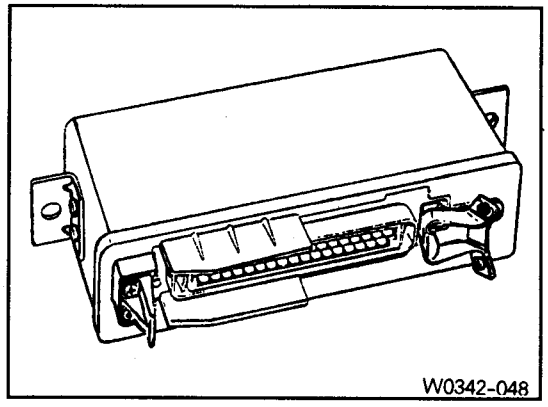
Service information

1) For welding, disconnect the ABS ECU.
Whenever a welding job is required on a body of the vehicle, disconnect the ECU connector to protect the ECU.

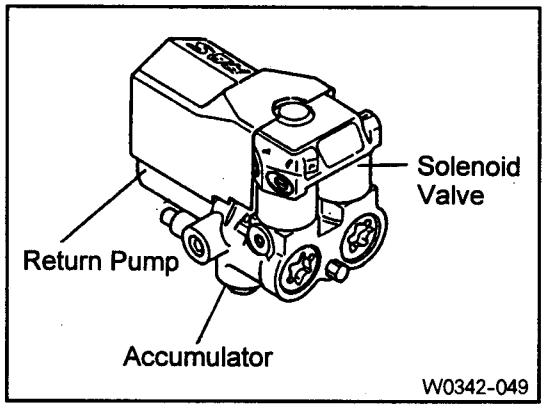
2) Battery connection.
Do not start the engine if the battery terminals are disconnected. If start, a reverse bias will flow through to the ECU and will damage the ECU.

Unit function

1) Electronic control unit (ECU).
- It receives the signal from the wheel-speed sensors to correctly identify the wheel speed. According to the wheel speed changes, it signals hydraulic modulator to control the solenoid valves which provide appropriate hydraulic pressure to the wheel cylinders.

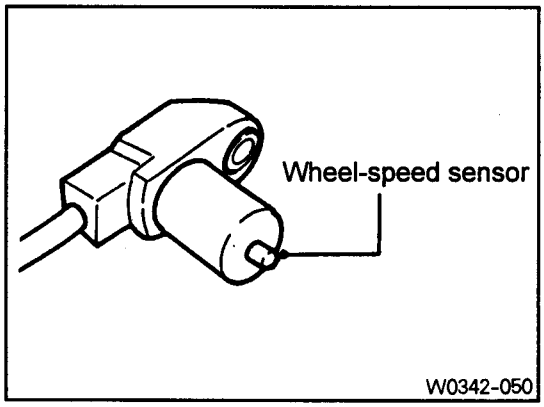

W0342-048

2) Hydraulic modulator.
- It consists of 3 solenoid valves, solenoid valve relay, return pump, return pump relay and accumulator.
- The return pump will return the fluid coming out of the wheel cylinder, when the pressure reduces, through the accumulator to the master cylinder.
- The accumulator temporarily accumulates the excessive fluid when the pressure increases.
- Each solenoid valve has three ports linking the master cylinder, wheel cylinder and the return pump.



W0342-049

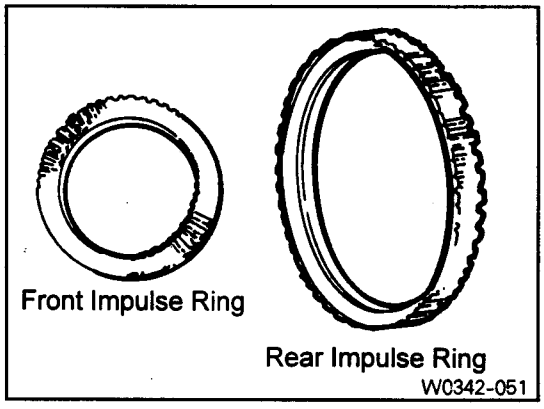
3) Wheel-speed sensor.
Through the impulse ring, it detects the wheel speed and sends it to the ECU.



W0342-050

4) Impulse ring.
There are 4 impulse rings. The wheel speed is detected by the pulses produced in the air gap between the speed sensor and the impulse ring. These signals are sent to the ECU.

Impulse ring	Front	Rear
Air gap(mm)	0.25~1.75	0.15~1.2
No. of teeth	52	52



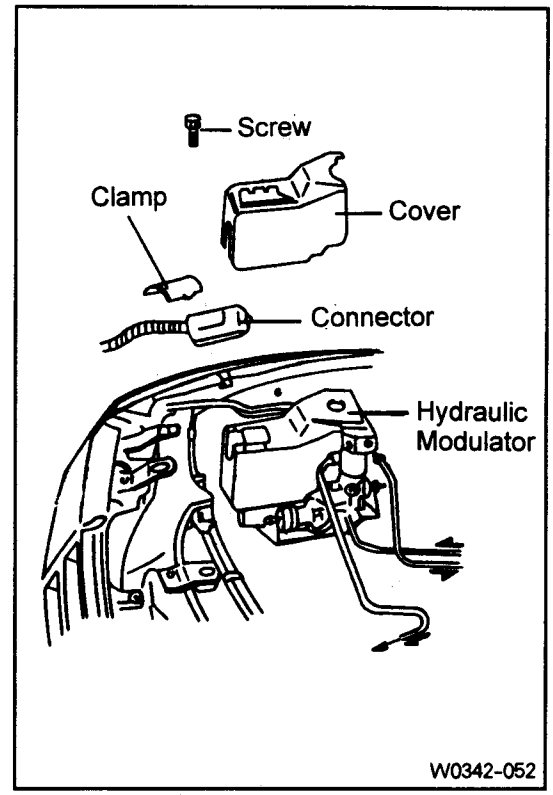
W0342-051

Removal and installation of hydraulic modulator

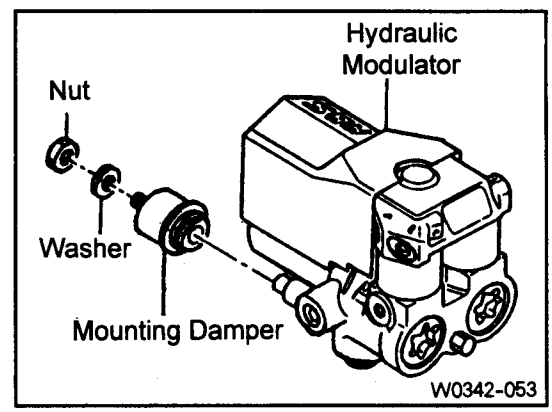
1) Disconnect the harness connector of hydraulic modulator.

2) Using a screwdriver, remove the hydraulic modulator cover.

3) Using a wrench, disconnect the each brake pipes.



4) Remove the 3 mounting damper nuts and then remove the hydraulic modulator assembly.

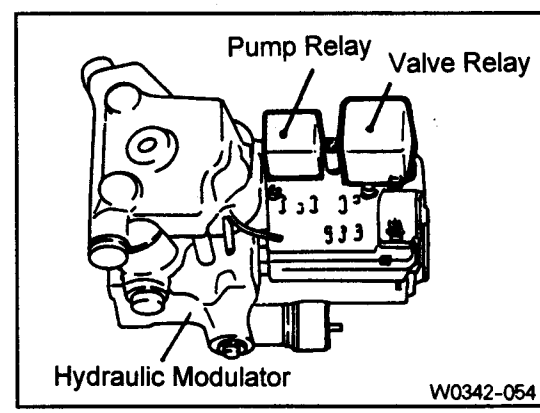


5) Remove the pump relay from the hydraulic modulator.

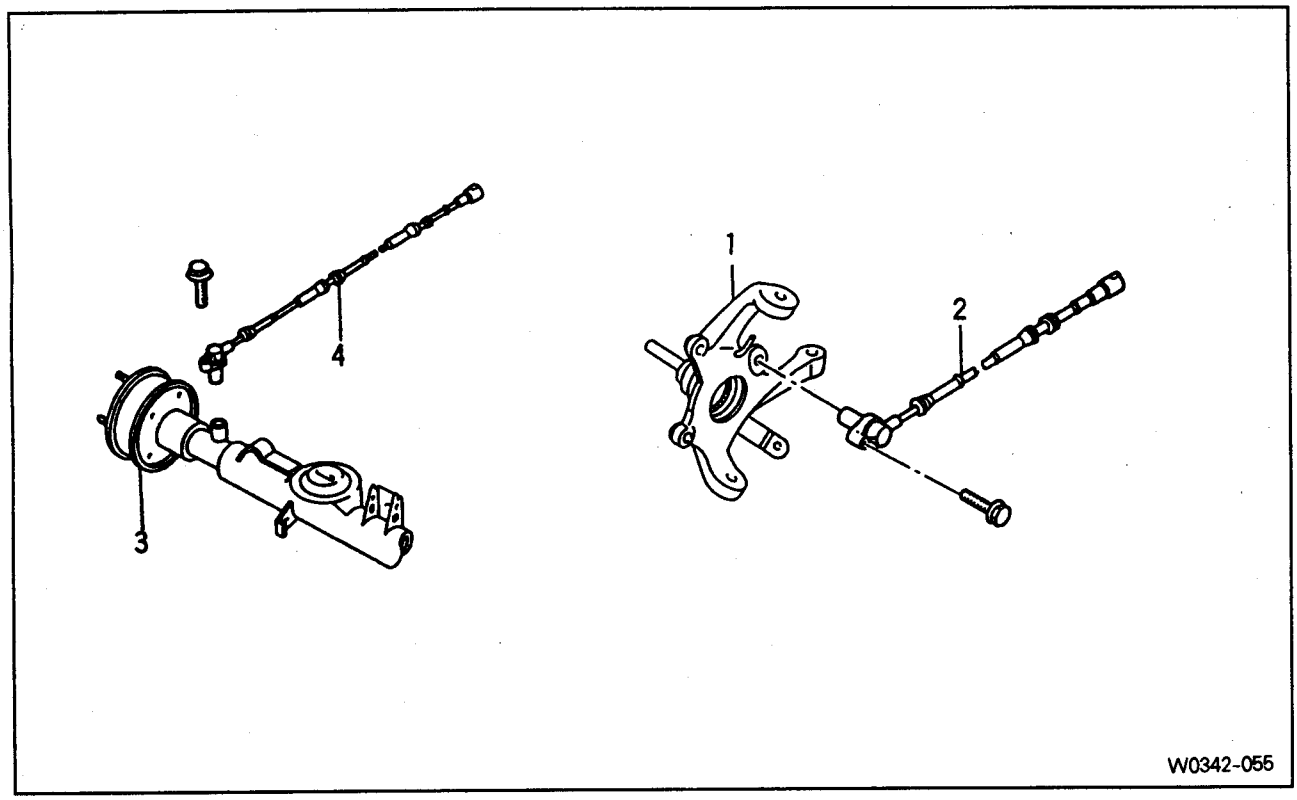
6) Remove the valve relay from the hydraulic modulator.

7) Installation is reverse order of the removal.

8) Do bleeding.



Wheel speed sensor

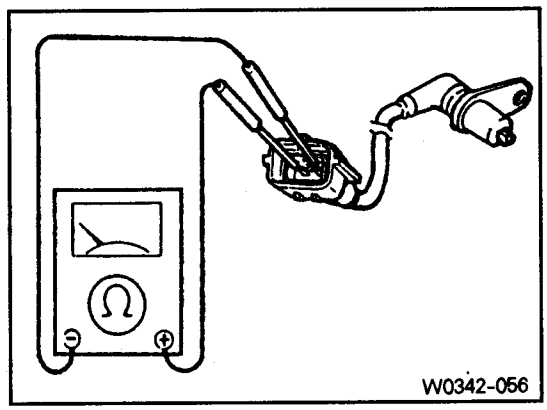


1. Front Knuckle
2. Front Wheel Speed Sensor
3. Rear Axle
4. Rear Wheel Speed Sensor

Inspection

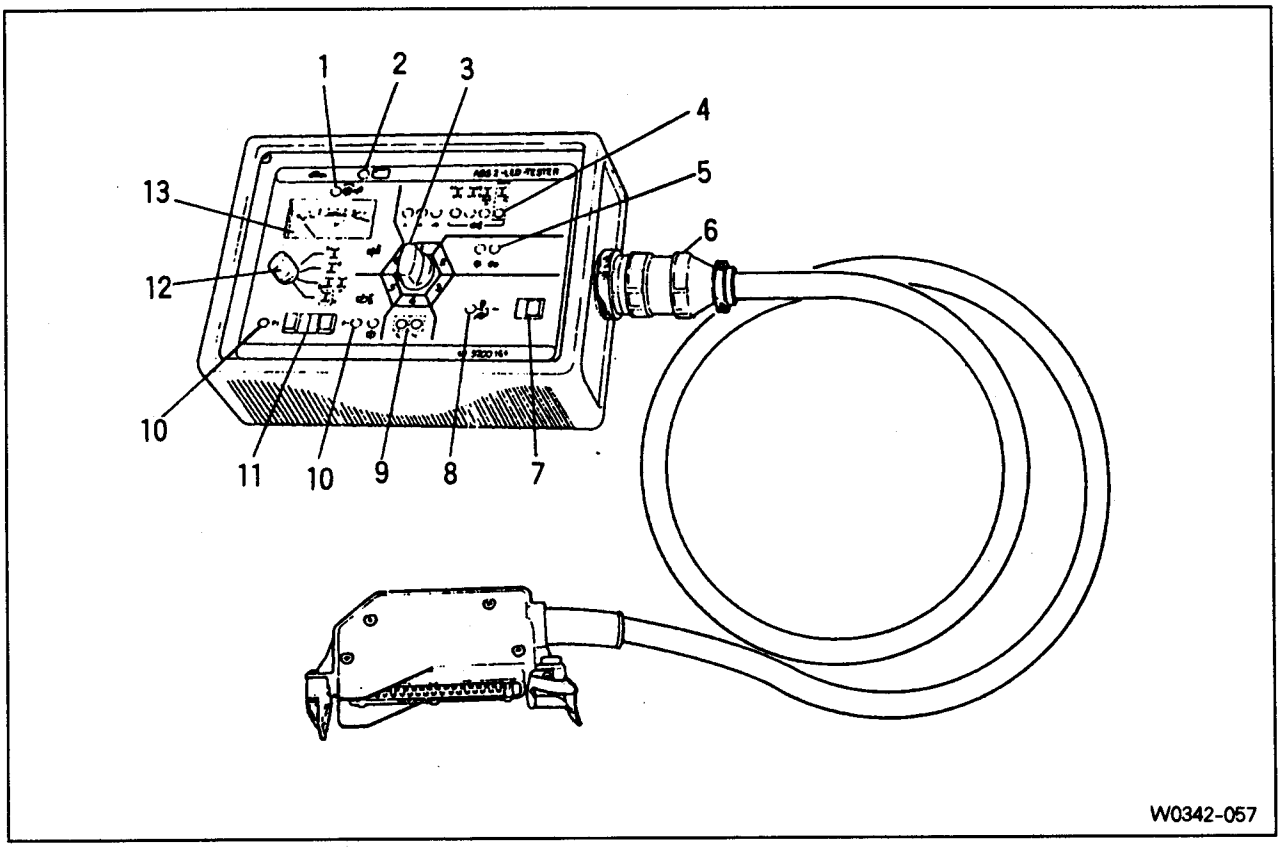
- Measure internal resistance of the wheel speed sensor.

Resistance	1,000 ± 2,000Ω



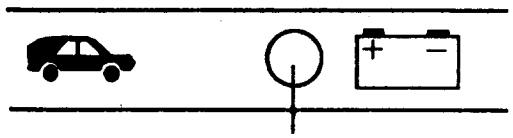
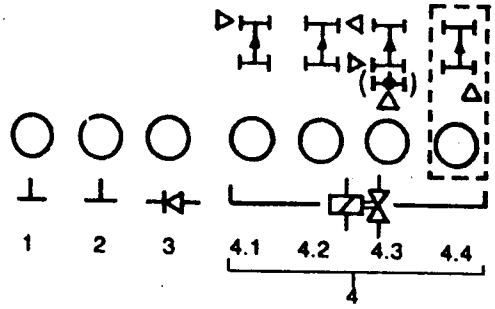
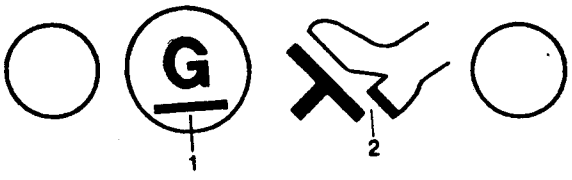
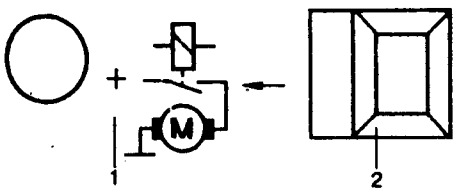
ABS 2 - LED tester

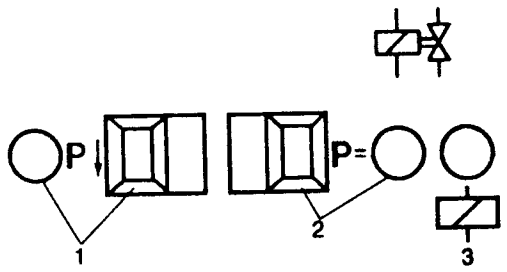
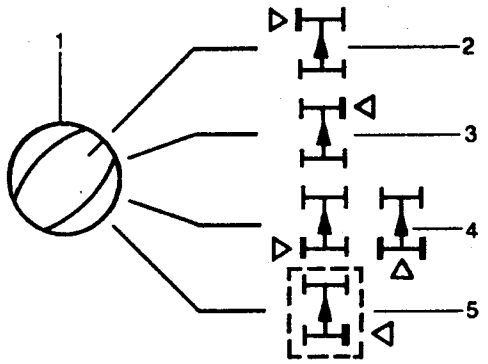
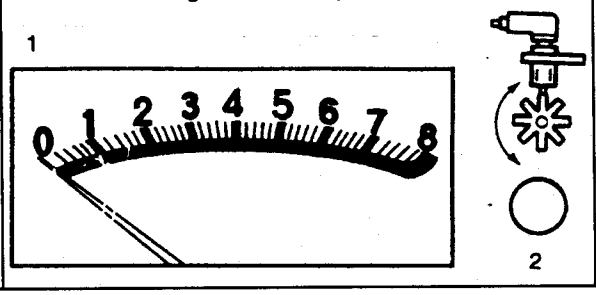
The ABS 2 - LED tester checks the ABS components in vehicle when the ABS system is defective. To test, remove the ECU connector and then connect the ABS tester to the ECU.
If defective components are not found in tests, check ECU and connectors for proper connection and then replace the ECU if defective.



1. LED indicator for the wheel speed when the program switch is set to 6.
2. 1 LED indicator for the battery voltage.
3. Program switch.
4. 7 LED indicators for program switch setting 1.
5. 2 LED indicators for program switch setting 2.
6. Adapter lead for connection to the ABS wiring harness in the vehicle.
7. Pushbutton for motor relay control when the program switch is set to 3.
8. 1 LED indicator for program switch setting 3.
9. 2 LED indicators for program switch setting 4.
10. 3 LED indicators for program switch setting 5.
11. 2 pushbuttons for triggering off the "Maintain pressure" and "Reduce pressure" solenoid valve functions when the program switch is set to 5.
12. Rotary switch for the selection of single wheels. This is operable when the program switch is set to 5 and 6.
13. Pointer instrument for program switch setting 6.

Description of symbols

No.	Symbol	Function
1		The tester obtains supply voltage from the car's battery. This supply voltage is monitored during the entire testing sequence and in all program switch settings. One LED (1) is constantly lit to indicate that the voltage is sufficient.
2	Program switch position 1 	1 - LED indicator for ground connection 1. 2 - LED indicator for ground connection 2. 3 - LED indicator for the diode for warning lamp control. 4 - LED indicator for the internal resistances of the solenoid valves in the hydraulic modulator and the offposition of the valve relay. 4.1 - LED indicator for the front left-hand wheel. 4.2 - LED indicator for the front right-hand wheel. 4.3 - LED indicator for the rear left-hand wheel in vehicles with a 4-channel hydraulic modulator or for the rear axle of vehicles with a 3-channel hydraulic modulator (bracketed symbol applies). 4.4 - LED indicator for the rear right-hand wheel in vehicles with a 4-channel hydraulic modulator. The dashed line means that the LED must only light up if a 4-channel hydraulic modulator is installed.
3	Program switch position 2 	1 - LED indicator for connection to alternator. 2 - LED indicator for connection to the stop-lamp switch.
4	Program switch position 3 	1=LED indicator for the motor relay and feedback pump in the hydraulic modulator. 2=Pushbutton for control of the motor relay. The LED indicator does not light up until the pushbutton is operated.

No.	Symbol	Function
5	Program switch position 5 	Functional tests of the solenoid valves and valve relay in the hydraulic modulator. Checking that the solenoid valves channel assignments are correct. 1 - Pushbutton and LED indicator for the "Reduce pressure" function. The LED must light up after operating of the pushbutton. 2 - Pushbutton and LED indicator for the "Maintain pressure" function. The LED must light up after operation of the pushbutton. 3 - LED indicator for functioning of the valve relay. This LED must light up continuously when the program switch is set to 5. 4 - Symbol for solenoid valves.
6	Program switch position 6 	1 - Rotary switch for wheel selection. 2 - Front left-hand wheel. 3 - Front right-hand wheel. 4 - Left-hand symbol: Rear left-hand wheel in vehicles with a 4-channel hydraulic modulator (program switch setting 5) or 4 wheel-speed sensors (program switch setting 6). Right-hand symbol : Rear axle in vehicles with 3-channel hydraulic modulator or 3 wheel-speed sensors. 5 - Rear right-hand wheel in vehicles with vehicles with 4-channel hydraulic modulator or 4 wheel-speed sensors. The dashed line means that this switch setting is not needed for ABS systems with a 3-channel hydraulic modulator or 3 wheel-speed sensors.
7	Program switch position 6 	Checking of the wheel-speed sensor signal and dynamic air gap change. Check of the wheel-speed sensors for incorrect connection. 1 - Pointer instrument 2 - LED indicator for rotary motion of the wheels. This LED lights up continuously when the test speed is adequate.

Diagnostic list

[Note]

- **Turn the ignition switch OFF before disconnection of ABS ECU.**
- **Do not drive the vehicle with the tester connected.**
- **Connect the tester adapter to ECU.**
- **Test as follows.**

Program switch	Test	Condition	Test Value	Possible Cause
All settings (start)	Power supply (Terminal 20 & 1)	Ign. switch: ON	LED lights up continuously. 	• Battery undercharged. • Excessive voltage drops. • Fuse blown. • Over-voltage protection rely defective. • Check lead to ignition terminal 15.
Position the program switch to 1.				
①	· Ground connection (Terminal 34 & 10). · Warning lamp diode (Terminal 29 & 32). · Solenoid valve internal resistance (Terminal 2, 35,18 & 19). · Off-position and ground connection of valve relay, ABS warning lamp.	Ign. switch: ON	· All 7-LED lights up (6-LED, in case of the 3-channel hydraulic modulator) · ABS warning lamp lights up	• LED does not light up. Check ground terminal connection. • LED does not light up. - ABS warning lamp defective. - Diode defective. - Check valve relay ground connection • LED does not light up. Check solenoid valve and leads connectors. • All LEDs and LED do not light up. - Check valve relay ground connection. - Valve relay defective. • Weaker illumination of the LED Contact resistance in the corresponding current path.
Position the program switch to 2.				

Program switch	Test	Condition	Test Value	Possible Cause
②	· Alternator voltage from terminal 61 (Terminal 15). · Voltage from oil pressure switch.	Ign. switch: ON	· LED Ⓖ lights up.	• LED does not turn off until after acceleration. Alternator and lead to the alternator terminal 61 are defective.
		Start engine.	· LED Ⓖ turns off when engine running.	
	· Stop lamp switch (Terminal 25).	Ign. switch: ON	· LED ≋ light up.	• Battery undercharged. • Excessive voltage drops. • Fuse blown. • Over-voltage protection rely defective. • Check lead to ignition terminal 15.
		Apply brake pedal	· LED ≋ turns off.	
Position the program switch to 3.				
③	Hydraulic modulator motor relay, pump motor (Terminal 14 & 28).	Turn the ignition switch ON and keep push-button depressed.	LED lights up and pump motor is operating. After releasing pushbutton, LED continues ON due to after-running of the motor.	• Motor relay defective. • Check hydraulic modulator ground connection. • Pump motor defective.
Position the program switch to 6.				
[Note] Program switch ④ and ⑤ is not applicable on Musso.				
⑥	Wheel-speed sensor for proper functioning and correct connection. [Note] Carry out testing consecutively for each wheel. (Front left-hand wheel : terminal 4,5,6 & 22) (Front right-hand wheel:terminal 21, 11 & 23) (Rear axle : terminal 8, 9 & 2) * Terminals assignments are vehiclespecific)	Jack up the vehicle. Ign. switch : ON The testing wheel must rotate freely by hand. The wheels not being tested must be held. Set the wheel selection switch to the wheel to be tested.		• Wheel-speed sensor lead incorrectly connected. • Wheel speed sensor lead open-circuit. • Excessive air gap between wheel-speed sensor and ring gear. • Ring gear defective or loose. • Ring gear has the wrong number of teeth (vehicle specific). • Excessive wheel bearing play.

Program switch	Test	Condition	Test Value	Possible Cause
⑥		Turn the wheel by hand until the LED above the instrument lights up without flickering (speed approx. 1 revolution per second. If the wheel speed is excessive, the light goes out). Then read off the instrument indication.	1. Minimum indication: >1.0 2. Permissible fluctuation (Max. indication-Min. indication) ≤ Max. indication × 0.25.	
	With the engine running (after engine starting), the control lamp (ABS warning indicator light) must go out.			If the ABS warning indicator light lights up after tests with all normal functions, check or replace the ECU. **[Note] Before replacement, check connection between ECU and connector. Repeat the each tests and replace the ECU if defective.**
	For Musso, drive at min. 30km/h and for more than 20 seconds and check that the warning light must not light up again.			

1. General

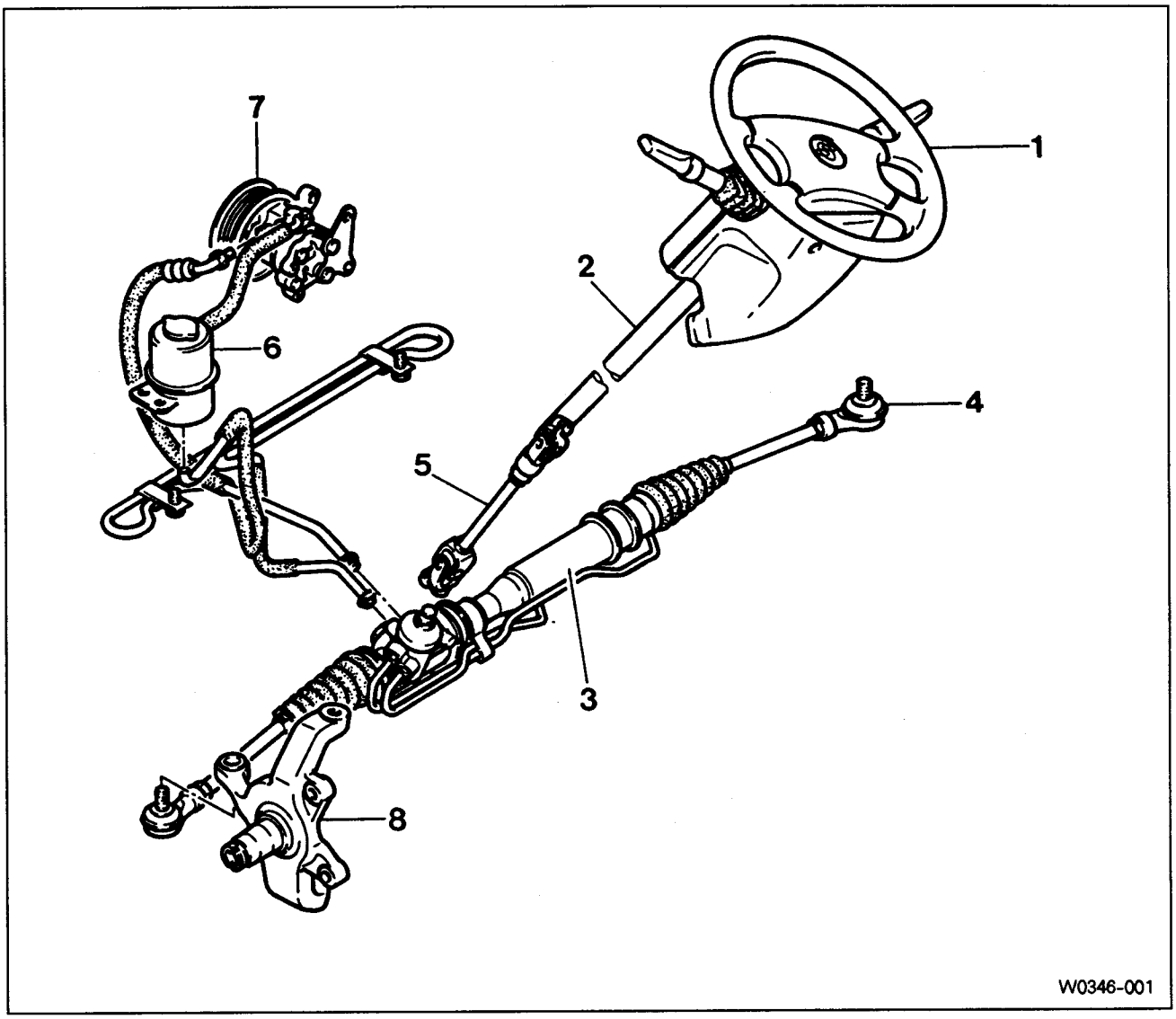
Specifications

Steering wheel	Number of spoke		4
	Outer diameter		393mm
Steering gear box	Type		Rack and pinion
	Gear ratio		∞
	Steering angle	Inner	33° 37′
		Outer	31° 50′
Oil pump	Type		Vane
	Max. pressure		$80\ ^{+2}_{-5}$ kg/㎠
Column tilting angle	Upper		3.6°
	Lower		6°
Min. turning radius			5.7m
Fluid	Specification		ATF DEXRON II
	Capacity		1.1 ℓ
	Replace		Every 24,000km

2. Troubleshooting

Problem	Possible Cause	Remedy
Hard steering	Lack of lubrication	Lubricate
	Abnormal wear or binding of steering ball joint	Replace
	Damaged or faulty steering gear	Replace gear assembly
	Improper preload of steering pinion	Adjust
	Faulty steering shaft joint	Replace
	Steering fluid leaks	Repair or replace
	Lack of fluid or air - in system	Replenish or bleed
	Faulty steering oil pump	Replace
	Damaged or loosened pump drive belt	Adjust or replace
	Clogging oil line	Repair or replace
	Damaged wheel or tire	Repair or replace
	Faulty suspension system	Repair or replace
Steering pulls to one side	Damaged steering linkage	Replace
	Damaged wheel and tire	Repair or replace
	Faulty brake system	Repair or replace
	Faulty suspension system	Repair or replace
Excessive wheel play	Worn steering gear	Replace gear assembly
	Worn or damaged steering ball joint	Replace
	Loosened steering gear box bolts	Retighten
Poor return of steering wheel	Damaged or binding steering ball joint	Replace
	Improper preload of steering pinion	Replace gear assembly
	Damaged wheel or tire	Repair or replace
	Faulty suspension system	Repair or replace
Steering wheel shimmy	Damaged steering linkage	Replace
	Loosened steering gearbox mounting bolt	Retighten
	Damaged or binding steering ball joint	Replace
	Worn or damaged front wheel bearing	Replace
	Damaged wheel or tire	Repair or replace
	Faulty suspension system	Repair or replace
Abnormal noise from steering system	Loosened steering gearbox mounting bolt	Retighten
	Faulty steering gear	Replace gear assembly
	Steering column interference	Replace
	Loosened steering linkage	Retighten
	Damaged or loosened oil pump drive belt	Adjust or replace
	Loosened oil pump bracket	Retighten
	Loosened oil pump mounting bolt	Retighten
	Air - in system	Bleed
	Faulty oil pump	Replace

3. Steering System



1. Steering Wheel
2. Steering Column Shaft
3. Steering Gear Box
4. Tie Rod
5. Lower Shaft
6. Oil Reservoir
7. Oil Pump
8. Steering Knuckle

4. Inspection

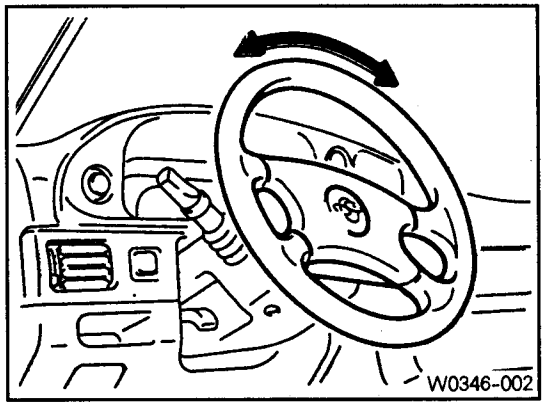
Steering wheel freeplay inspection

1) Start the engine and set the wheels in a straight ahead position.

2) Slightly move the steering wheel to the left and right and measure steering wheel play when the wheel is start to move.

Standard	Max. 30mm

[Note] If exceeds specification, check the steering column shaft connections and steering linkage clearance. Replace or repair if necessary.



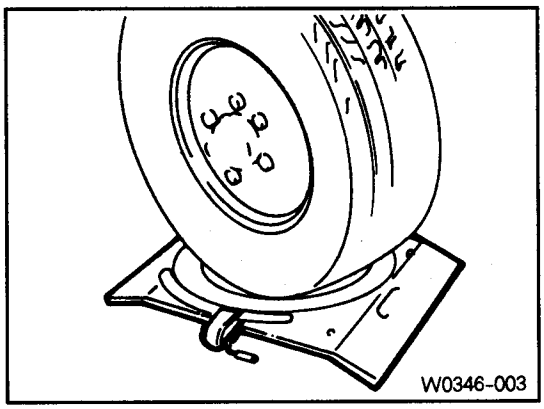
Steering angle inspection

1) Place the front wheel on a measuring tool.

2) Rotate steering wheel all the way right and left and measure steering angle.

Standard	Inner	33° 37 ′
	Outer	31° 50 ′

[Note] If out of standard, check or adjust toe-in.



Steering effort inspection

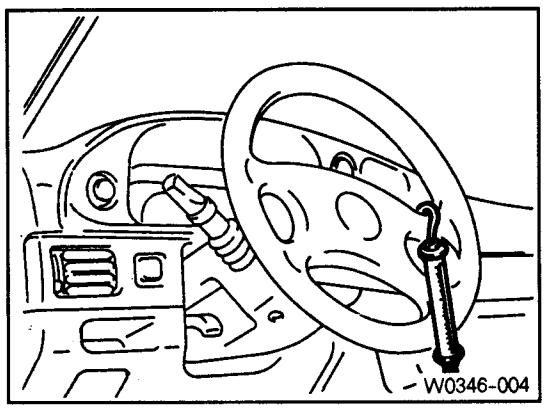
1) Place a vehicle on the paved flat ground with front wheels in a straight ahead position.

2) Start the engine and run it at 1,000rpm.

3) Using a scale, measure the steering effort in both directions.

Standard	Max. 3.0kg

[Note] The difference in steering effort of left and right should be within 0.6kg.



5. Oil Pump Pressure Check

Oil pump pressure check

1) Disconnect the pressure hose from the oil pump. Connect a pressure gauge between the oil pump and pressure hose.

2) Bleed the system. Start the engine and turn the steering wheel from lock to lock several times until oil temperature is up to 50℃

3) Run the engine at 1,000 rpm.

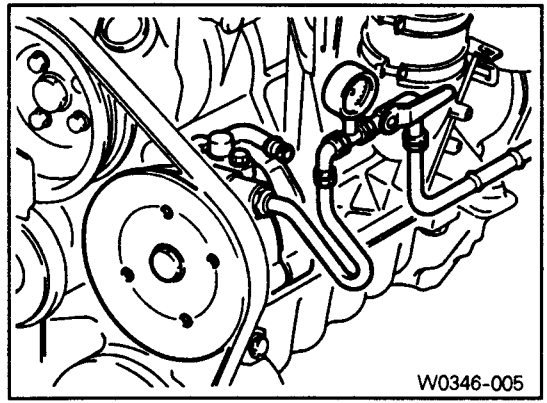
4) Close the pressure gauge valve and check oil pressure.

Relief pressure	80 $^{+2}_{-5}$ kg/㎠

[Note] Do not keep the valve closed for more than 10 seconds.

5) Remove the pressure gauge and connect the pressure hose.

6) Do bleeding procedure.



6. Bleeding of Power Steering System

Bleeding of power steering system

1) Disconnect the fuel feed line. Using a starter motor, crank the engine and turn the steering wheel from lock to lock 5 or 6 times.
   [Note] Do bleeding with engine cranking. If bleed with idling, there can be a air contact with oil.

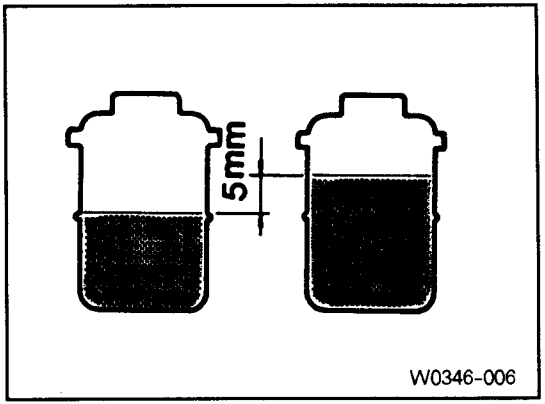
2) Connect the fuel feed line and start the engine at idle speed.

3) Turn the steering wheel from lock to lock until there is no more air in oil reservoir.

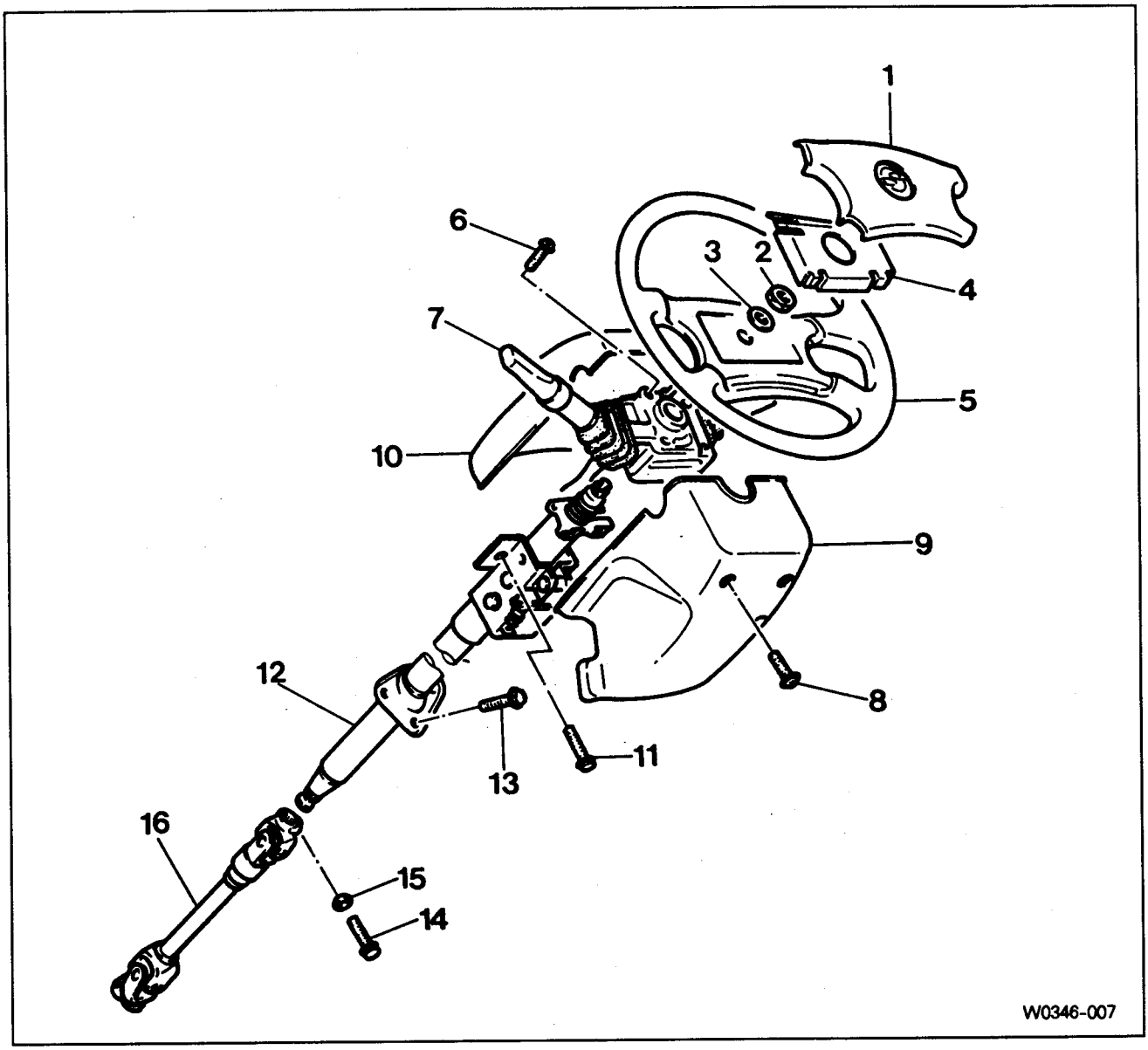
4

4) Check that oil is not cloudy and oil level is within specification.

5) By turning the steering wheel left to right, check the oil level change.
   [Note] · If oil level changes more than 5mm, do bleeding again.
   · If oil level rises suddenly when stopped engine, do bleeding again.



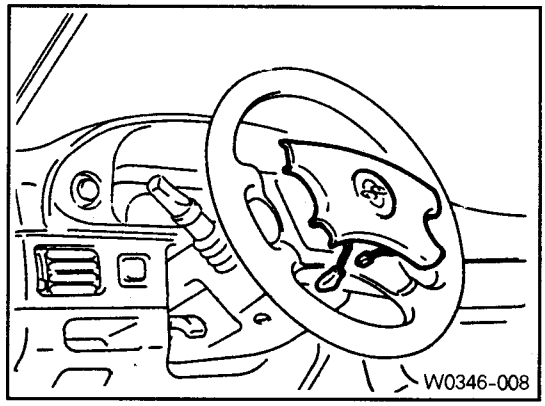
7. Removal and Installation of Steering Column



1. Horn Pad
2. Nut----------50~80Nm
3. Washer
4. Steering Wheel Damper
5. Steering Wheel
6. Screw
7. Combination Switch Assembly
8. Screw
9. Steering Column Lower Cover
10. Steering Column Upper Cover
11. Bolt----------15~20Nm
12. Steering Column
13. Bolt----------9~14Nm
14. Bolt----------13~40Nm
15. Washer
16. Lower Shaft

Removal · · Installation

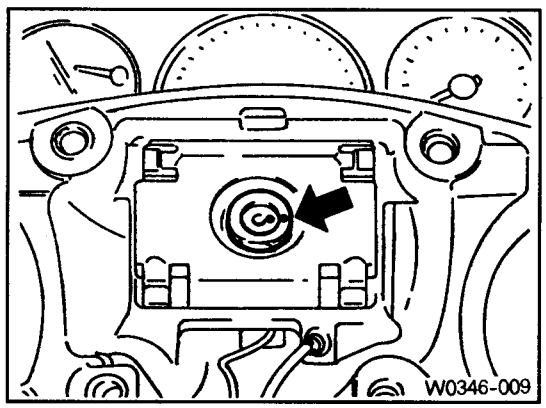
1) Remove the horn pad from the steering wheel and disconnect the connectors.



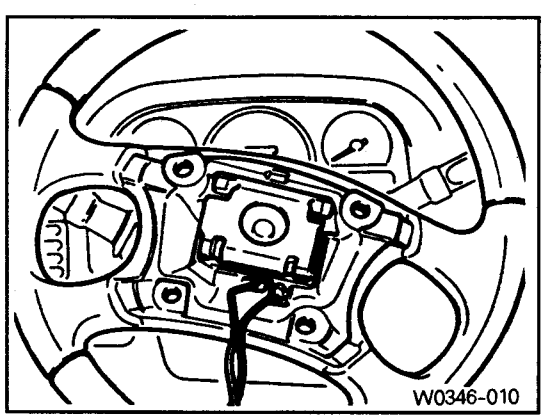
2) Place a alignment marks on the column shaft end and fixing nut and then remove the fixing nut.

Installation

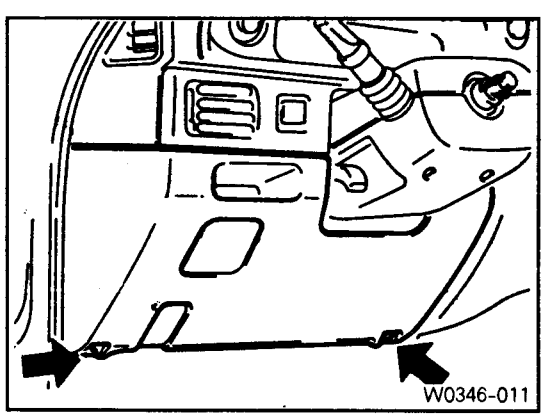
Tightening torque	50~80Nm



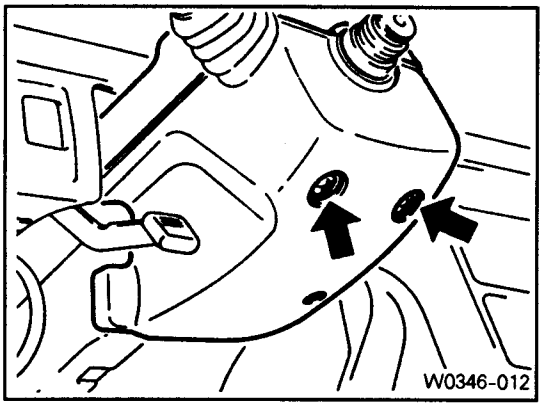
3) Remove the steering wheel damper and steering wheel.



4) Remove the crash pad panel.
[Note] Disconnect the hood release cable (and black-out switch connectors, if equipped).

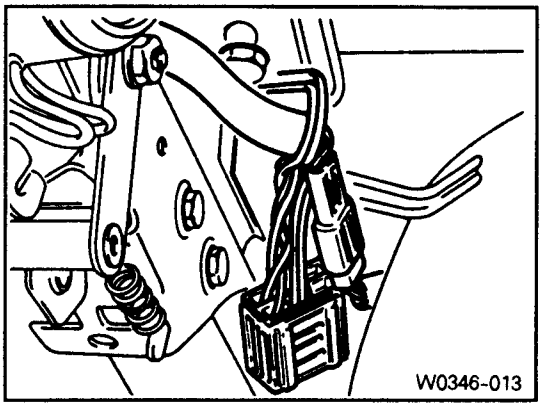


5) Remove the steering column cover.

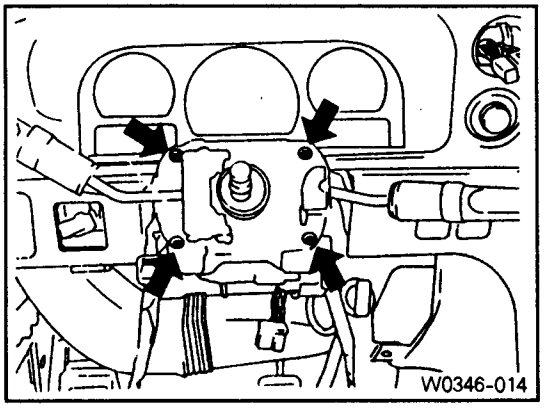


6) Disconnect each connectors.

7) Remove the vacuum hose from the ignition switch.



8) Remove the combination switch assembly.

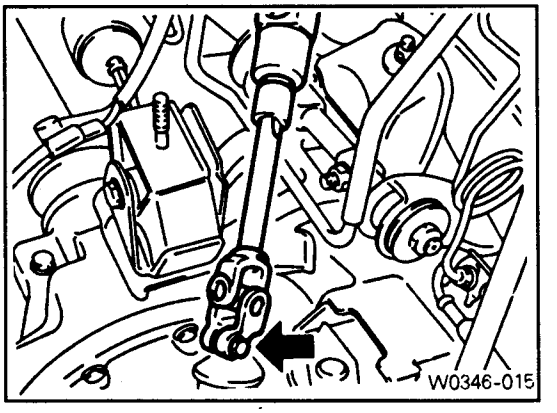


9) Remove the lower shaft by removing the coupling bolt of the steering gear box and column shaft.

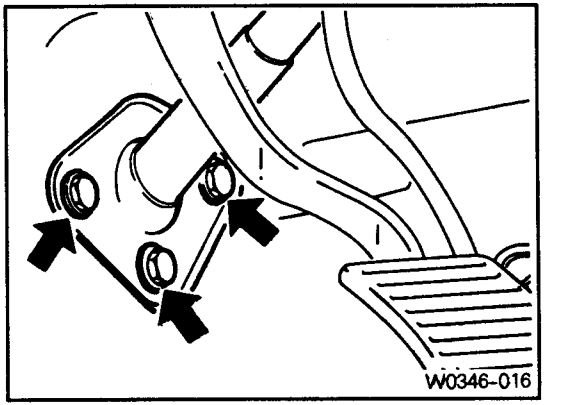
Installation

Tightening torque	30~40Nm

[Note] Insert the bolt through the cutout portion.



10) Remove the steering column floor mounting bolts.



Installation

Tightening torque	9~14Nm

11) Remove the steering column mounting bolts and pull out the steering column assembly.

Installation

Tightening torque	15~20Nm

12) Installation is reverse order of the removal.

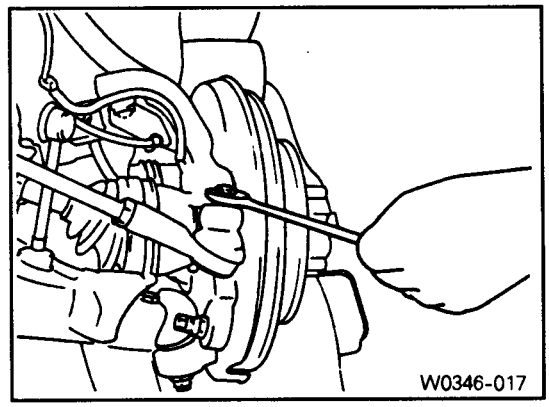
8. Removal and Installation of Steering Gear Box

Removal · Installation

1) Remove the cotter pin and nut and separate the steering gear box tie rod from the steering knuckle arm.

Installation

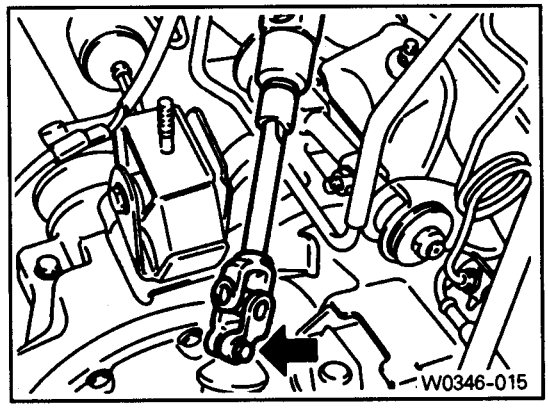
Tightening torque	35~45Nm



2) Remove the coupling bolt and separate the lower shaft from the steering gear box.

Installation

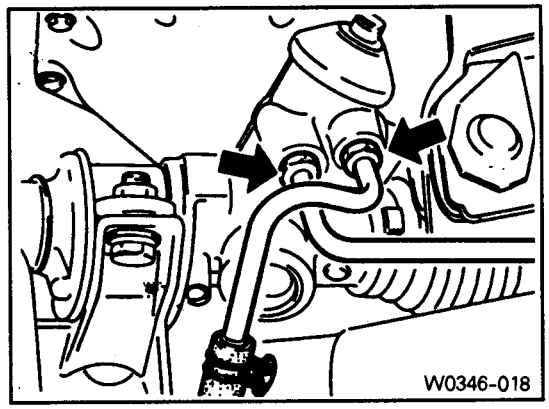
Tightening torque	30~40Nm



3) Remove the oil pipe from the steering gear box and drain the oil.

Installation

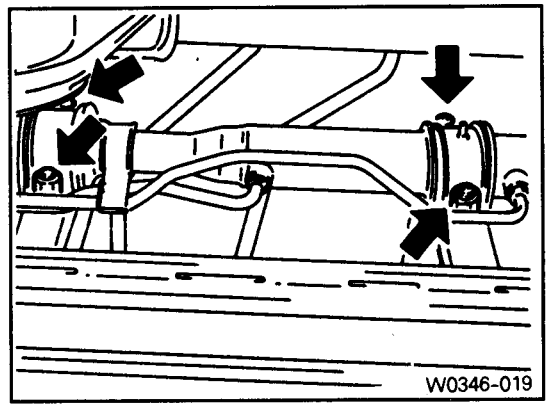
Tightening torque	12~18Nm



4) Remove the clamp bolts and remove the steering gear box assembly.
[Note] Be careful not to damage the boots.

Installation

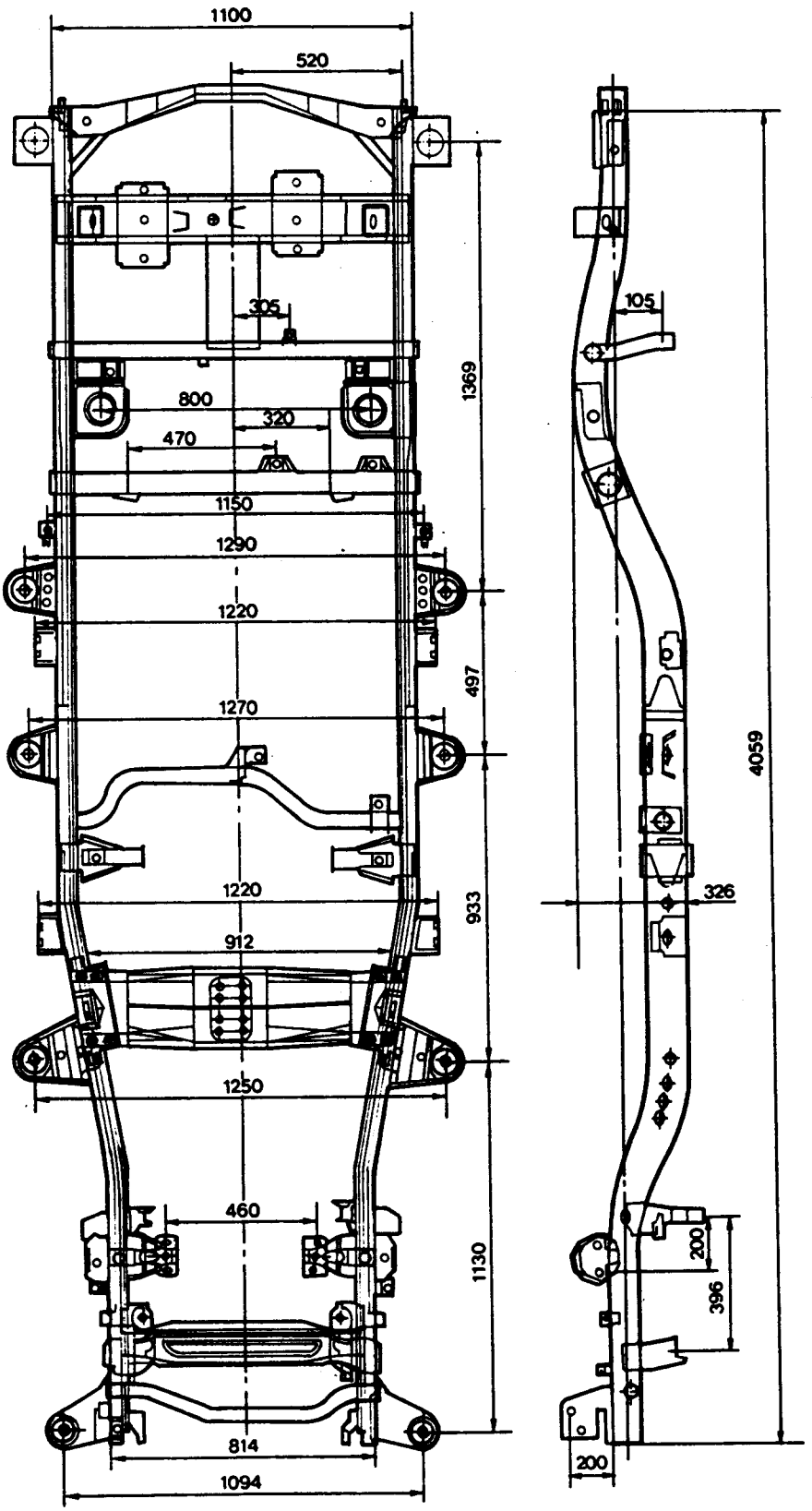
Tightening torque	70~90Nm



5) Installation is reverse order of the removal.

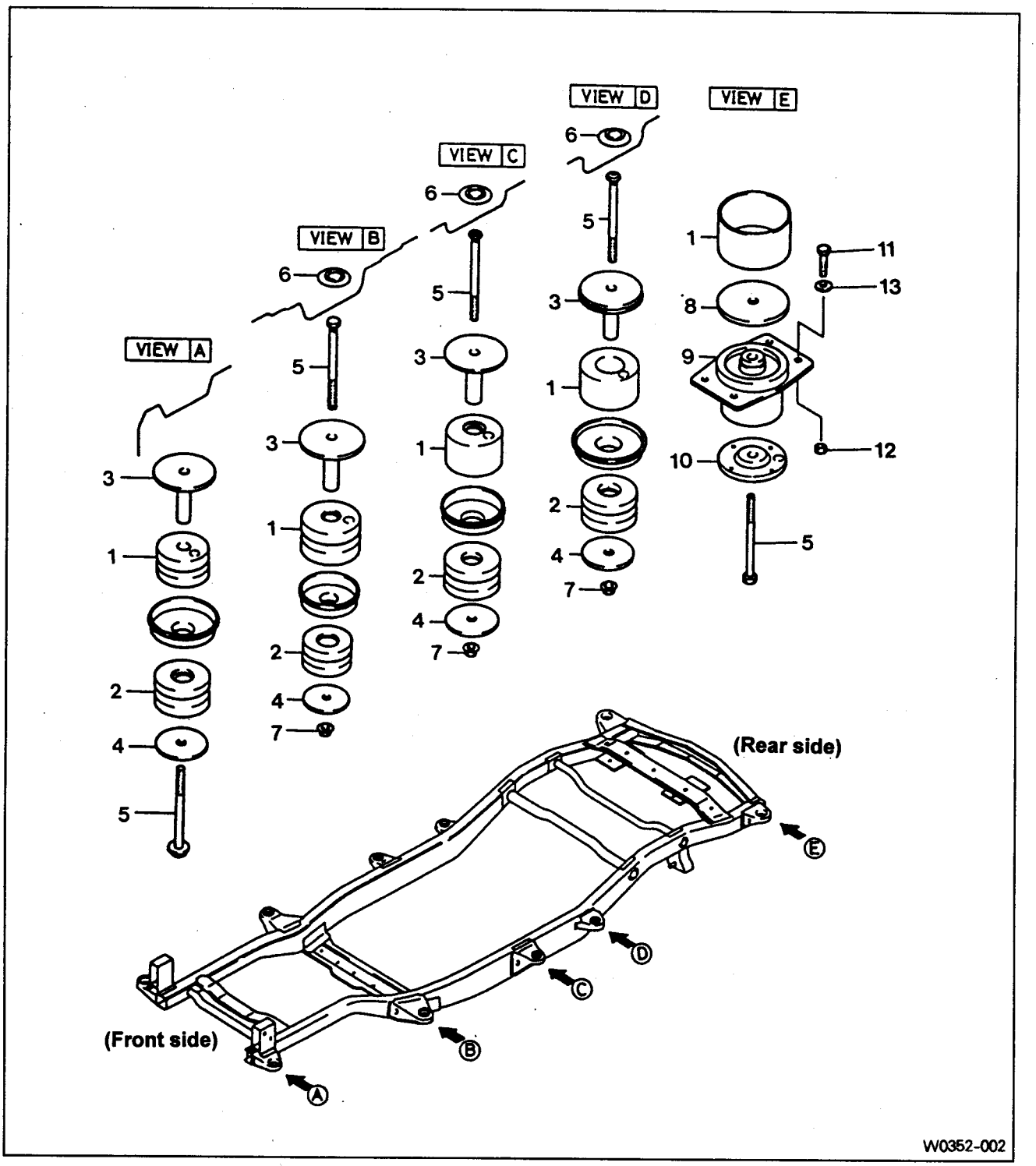
1. Frame

Frame dimensions



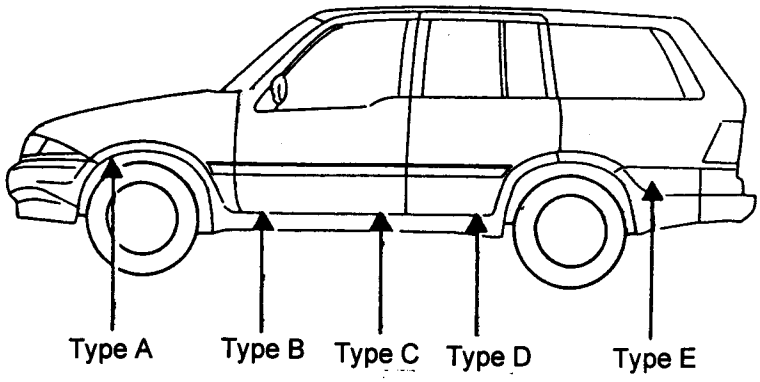
W0352-001

Body mounting - Components

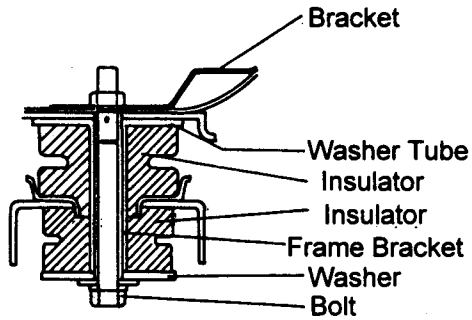


1. Upper Insulator
2. Lower Insulator
3. Washer Tube
4. Plain Washer
5. Bolt
6. Grommet
7. Nut
8. Plate
9. Upper Insulator
10. Lower Insulator
11. Bolt
12. Nut
13. Washer

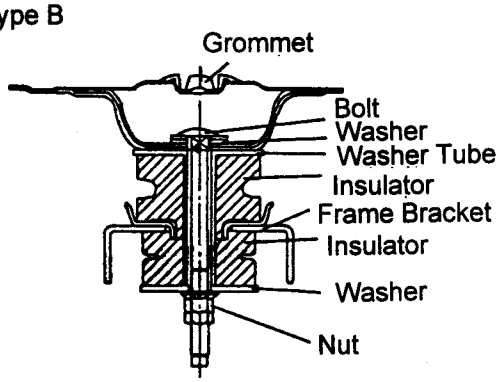
Body mounting - Sectional view



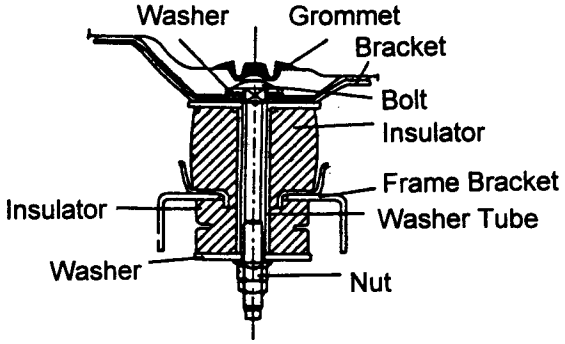
Type A



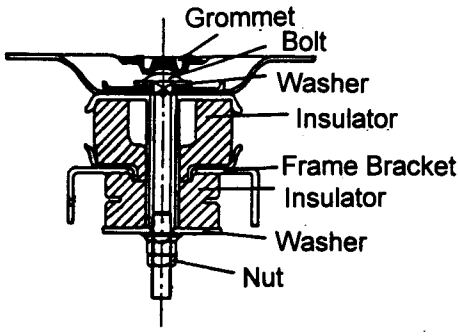
Type B



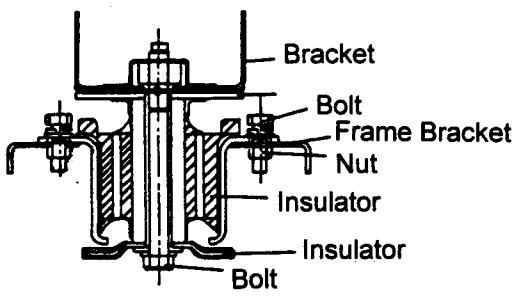
Type C



Type D

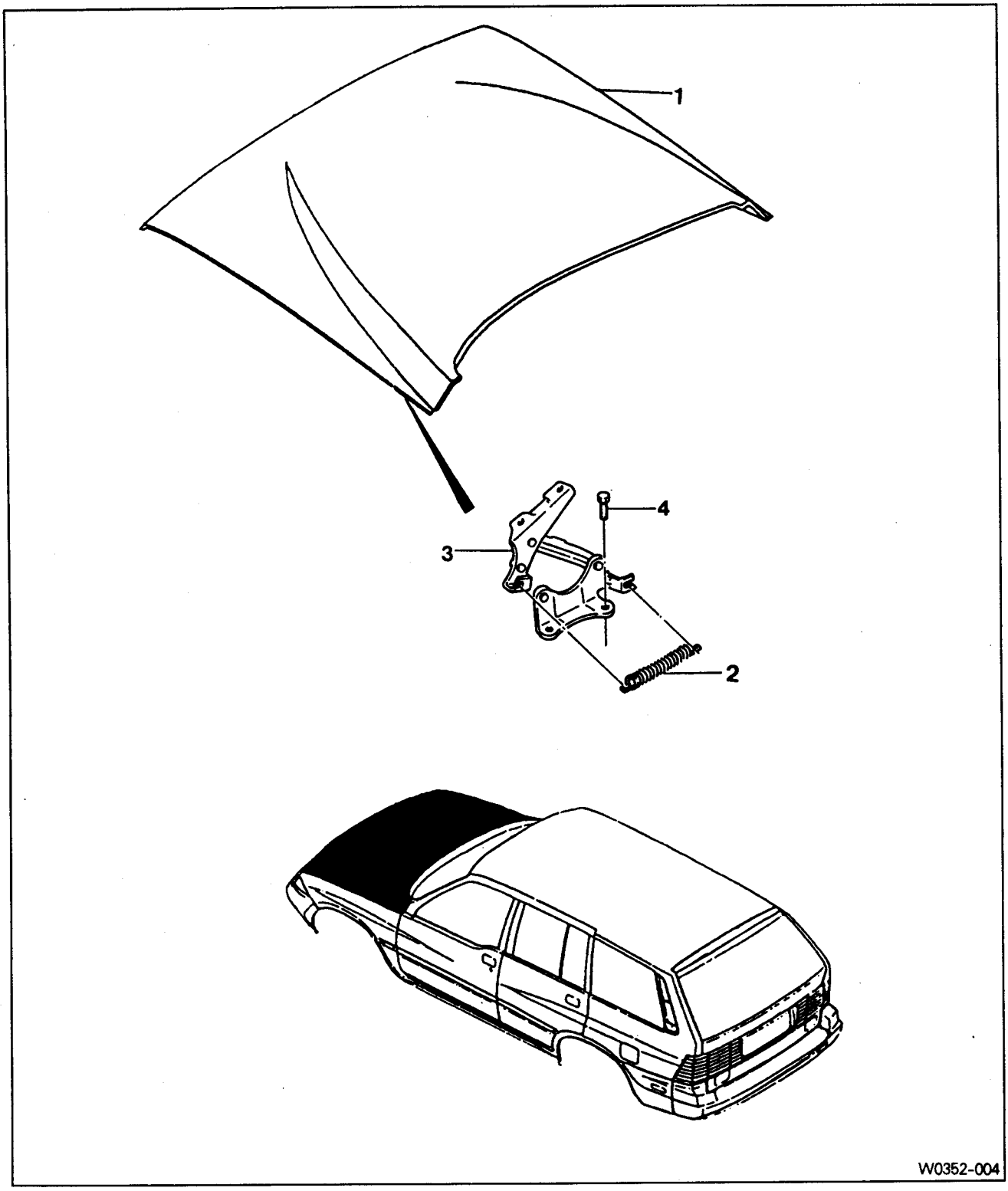


Type E



W0352-003

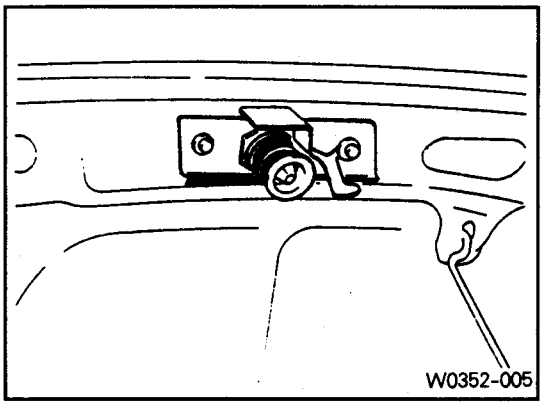
2. Hood



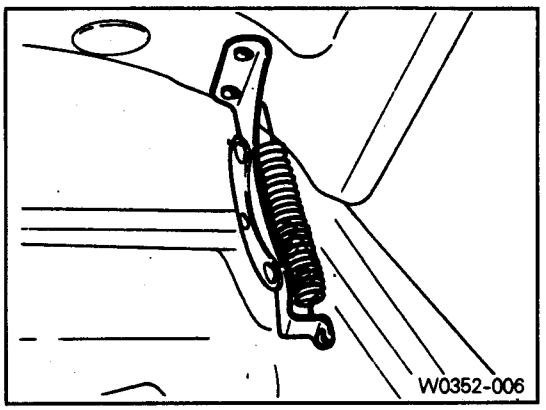
1. Hood
2. Spring
3. Hood Hinge Assembly
4. Bolt

Removal

1) Remove the hood striker assembly.



2) Remove the hood mounting bolts and hood.
   [Note] Place a protection not to damage the front body.



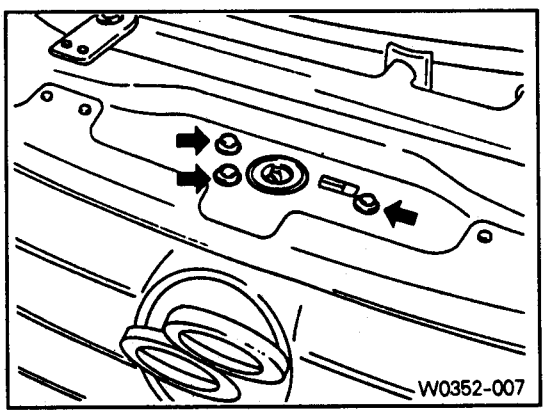
3) Remove the hood lock.

4) Remove the hood release cable from the clip.

5) Remove the cable holder screw.

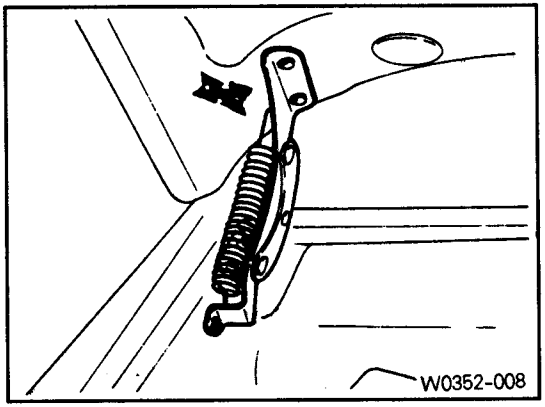
6) Pull the cable nut toward driver side.

7) Installation is reverse order of the removal.

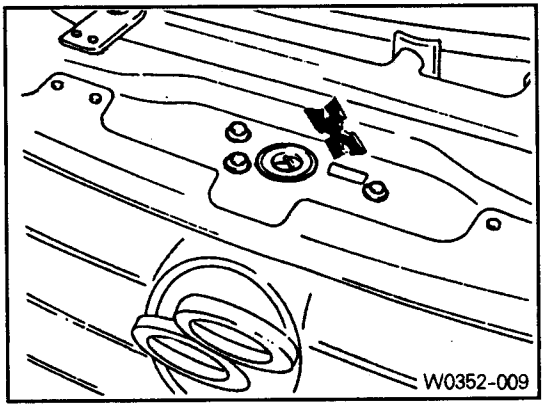


Adjustment

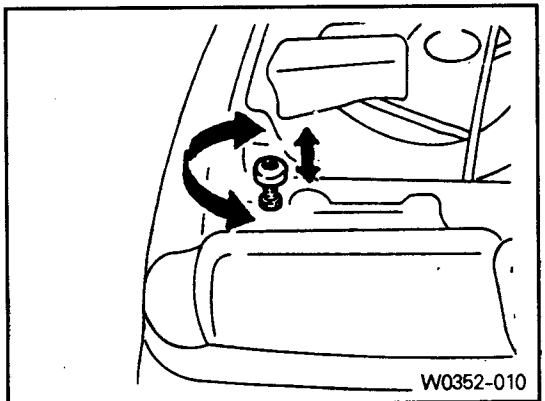
1) Hood hinge
- Loosen the hood hinge mounting bolts.
- Adjust hood in forward/rearward and left/right directions.
- Adjust front edge of hood in vertical direction by turning the hood stop adjust bolt.



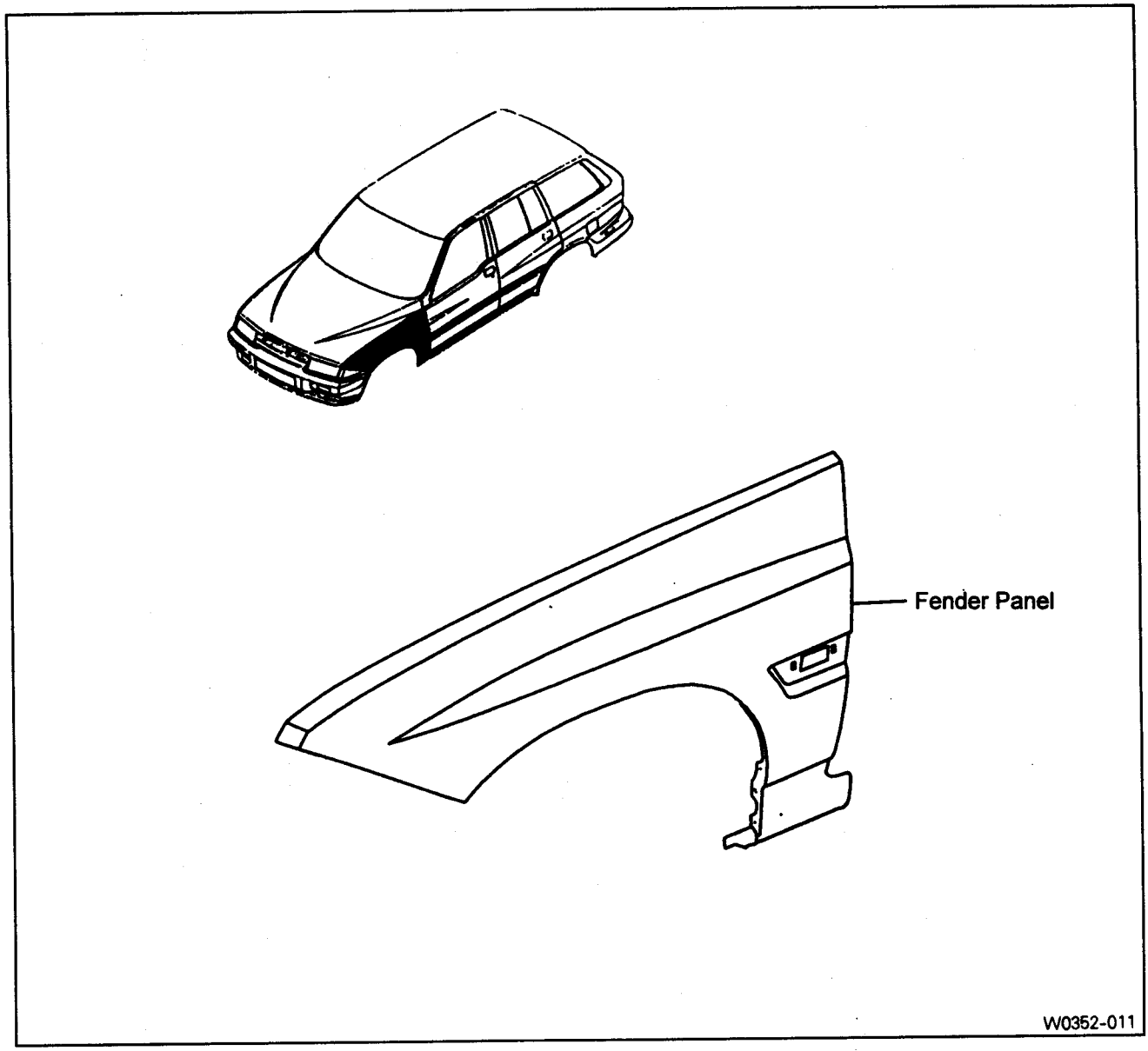
2) Hood lock
- Loosen the hood lock bolts.
- Adjust the lock in forward/rearward and left/right directions, align with the hood striker and adjust the hood height.



3) Safety hook
- Adjust by turning the hook adjusting bolts located left and right of the body.

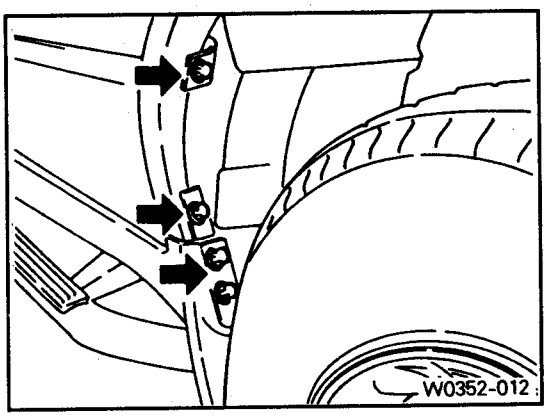


3. Fender



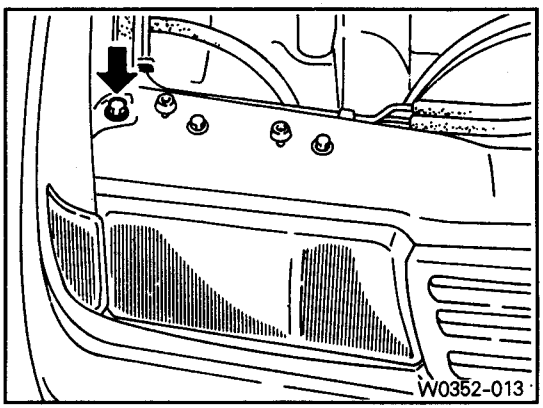
Removal

1) Remove the screws. Remove the mudguard and wheel guard.

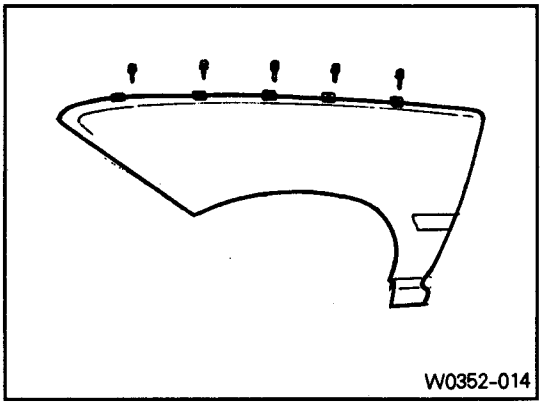


2) Disconnect the front lamps connectors.

3) Remove the front lamps.



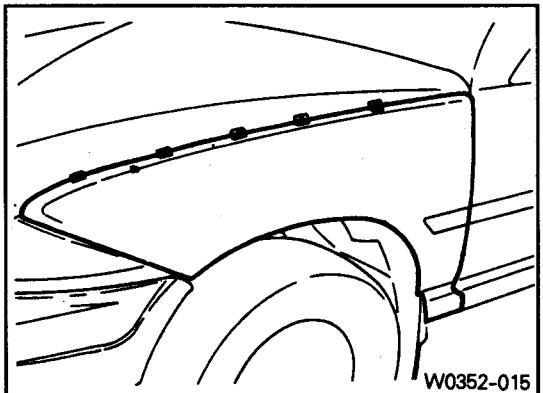
4) Remove the fender mounting bolts.
[Note] Be careful not to damage the paintwork.



Installation

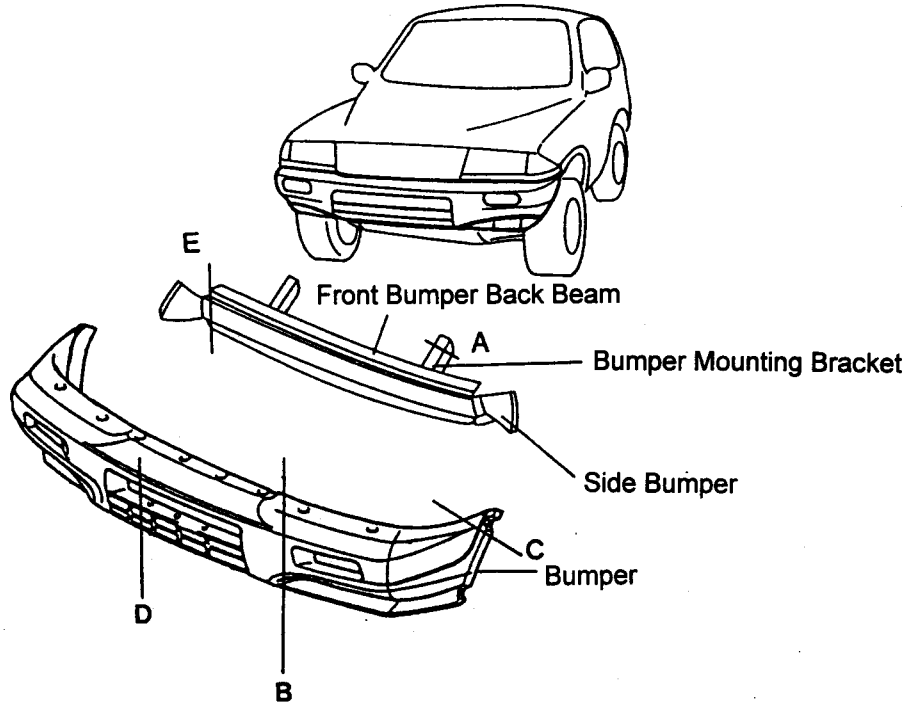
1) Installation is reverse order of the removal.
[Note] Apply a tape sealer to the fender and body panel to prevent rust in fender mounting bolts area.

Tightening torque	7~9Nm

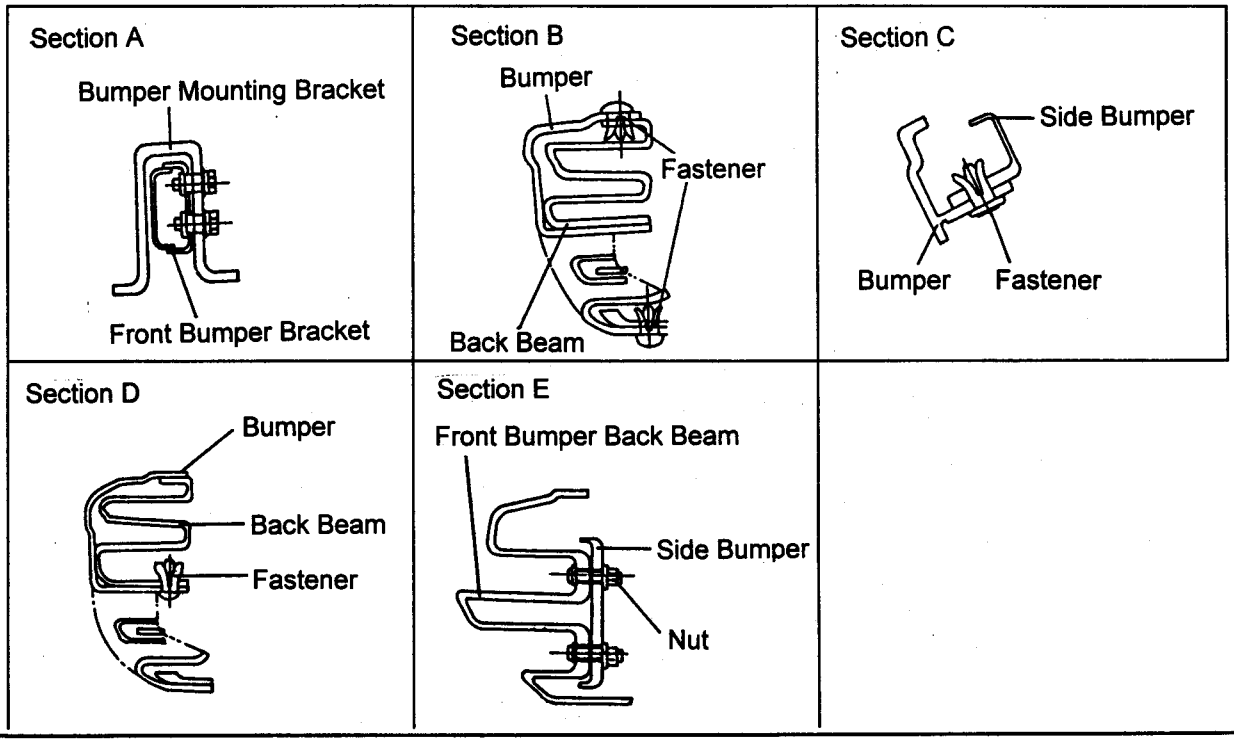


4. Bumper

Front Bumper



W0352-016

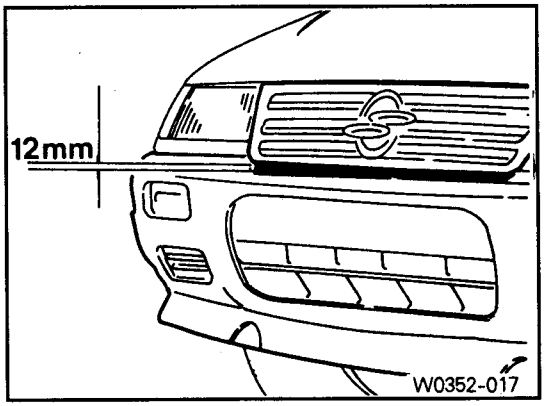


[Note] Removal and installation is as shown in upper drawings.

Mounting inspection

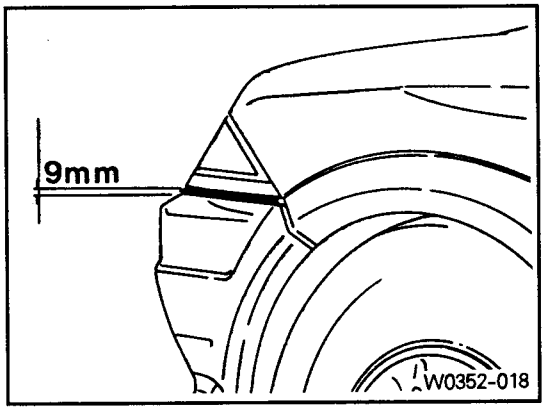
1) Clearance between the upper bumper and radiator grille.

Clearance	12 ± 1.0mm



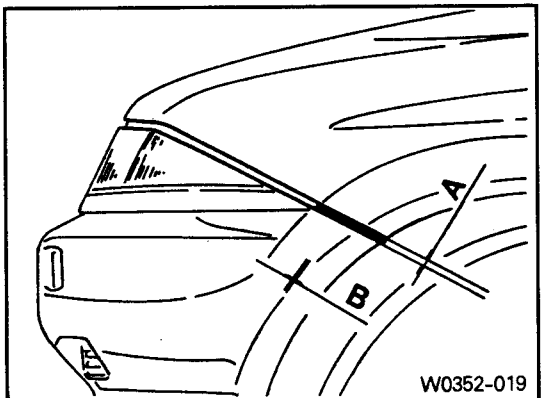
2) Clearance between the upper bumper and headlamp molding.

Clearance	9mm

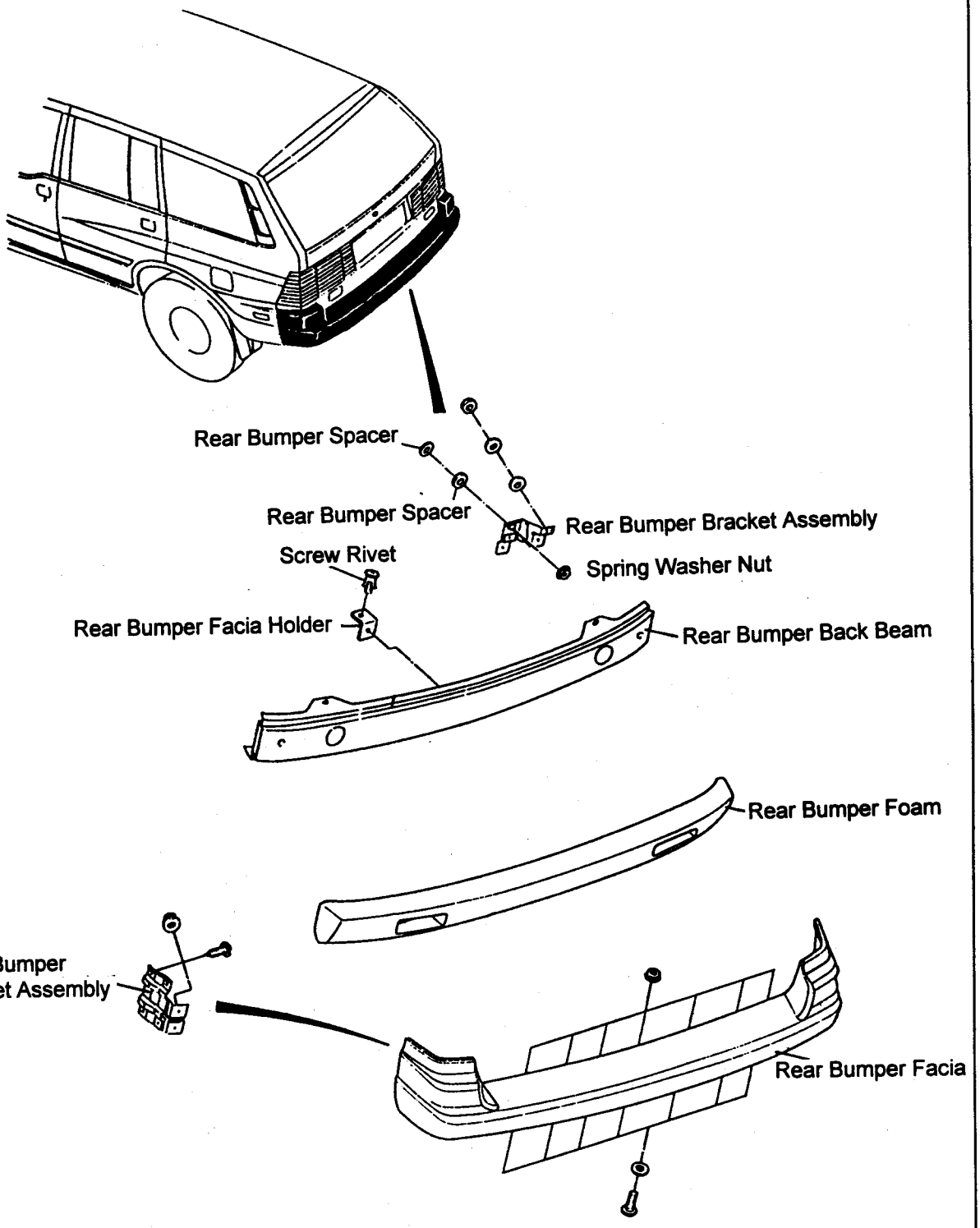


3) Clearance between the bumper and wheel arch.

Clearance	10mm



Rear Bumper

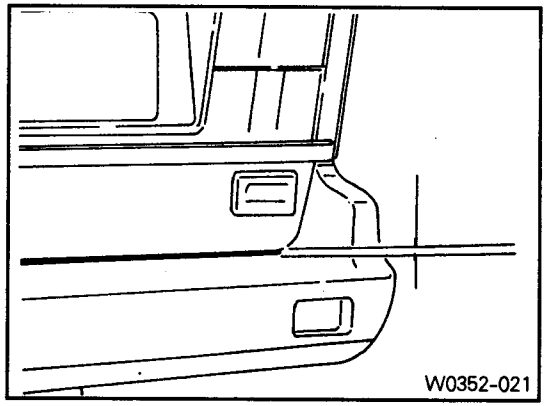


[Note] Removal and installation is as shown in upper drawings.

Mounting inspection

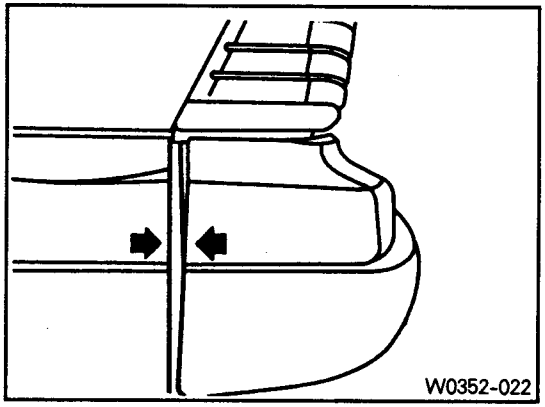
1) Clearance between the upper bumper facia and tailgate.

Clearance	12 ± 1.0mm



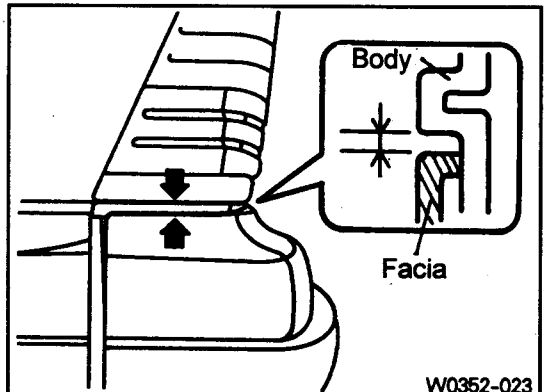
2) Clearance between the rear bumper facia and rear bumper molding.

Clearance	11.0mm



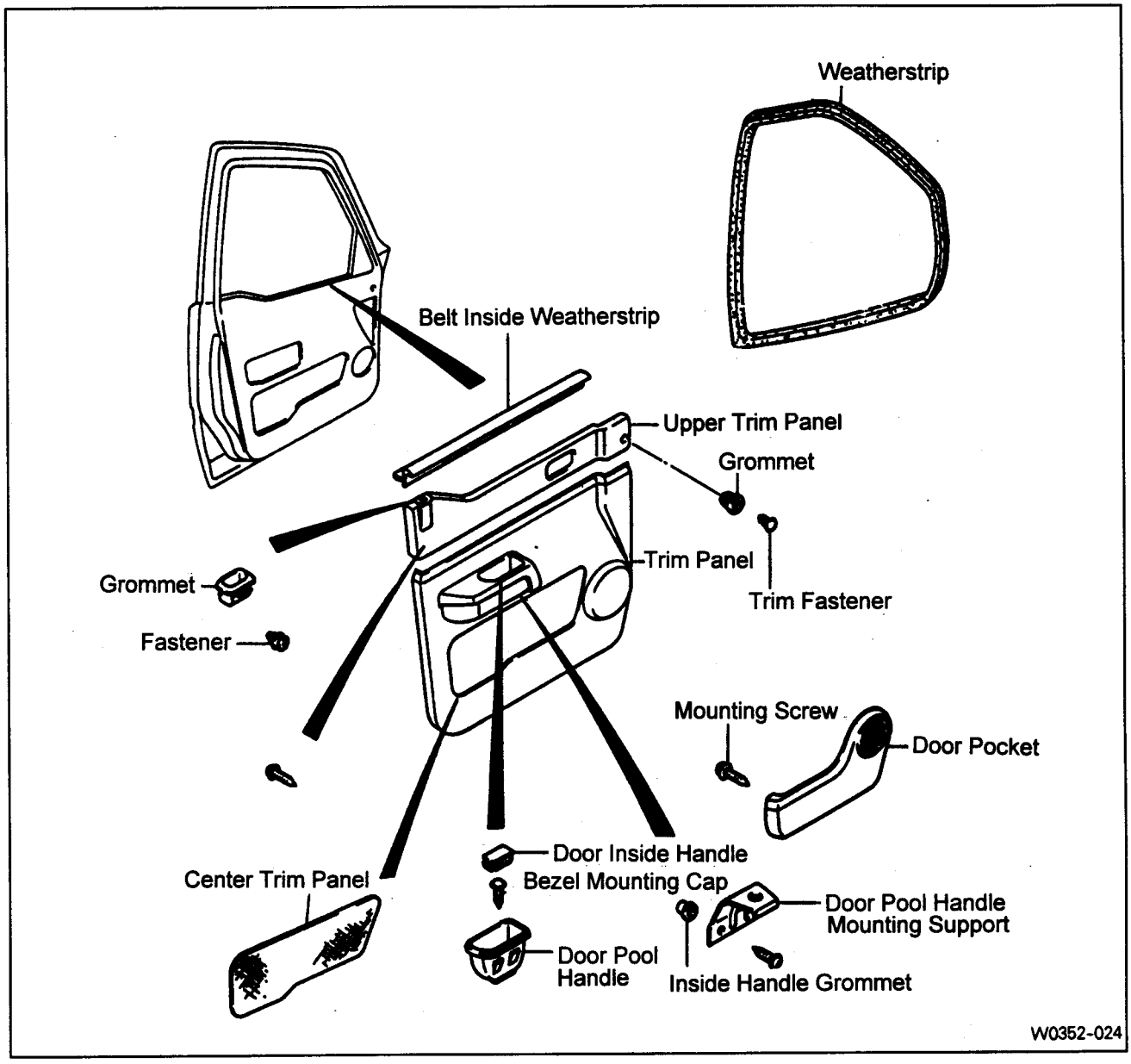
3) Clearance between the quarter outer panel and rear bumper facia

Clearance	10.0mm



5. Doors

Front Doors



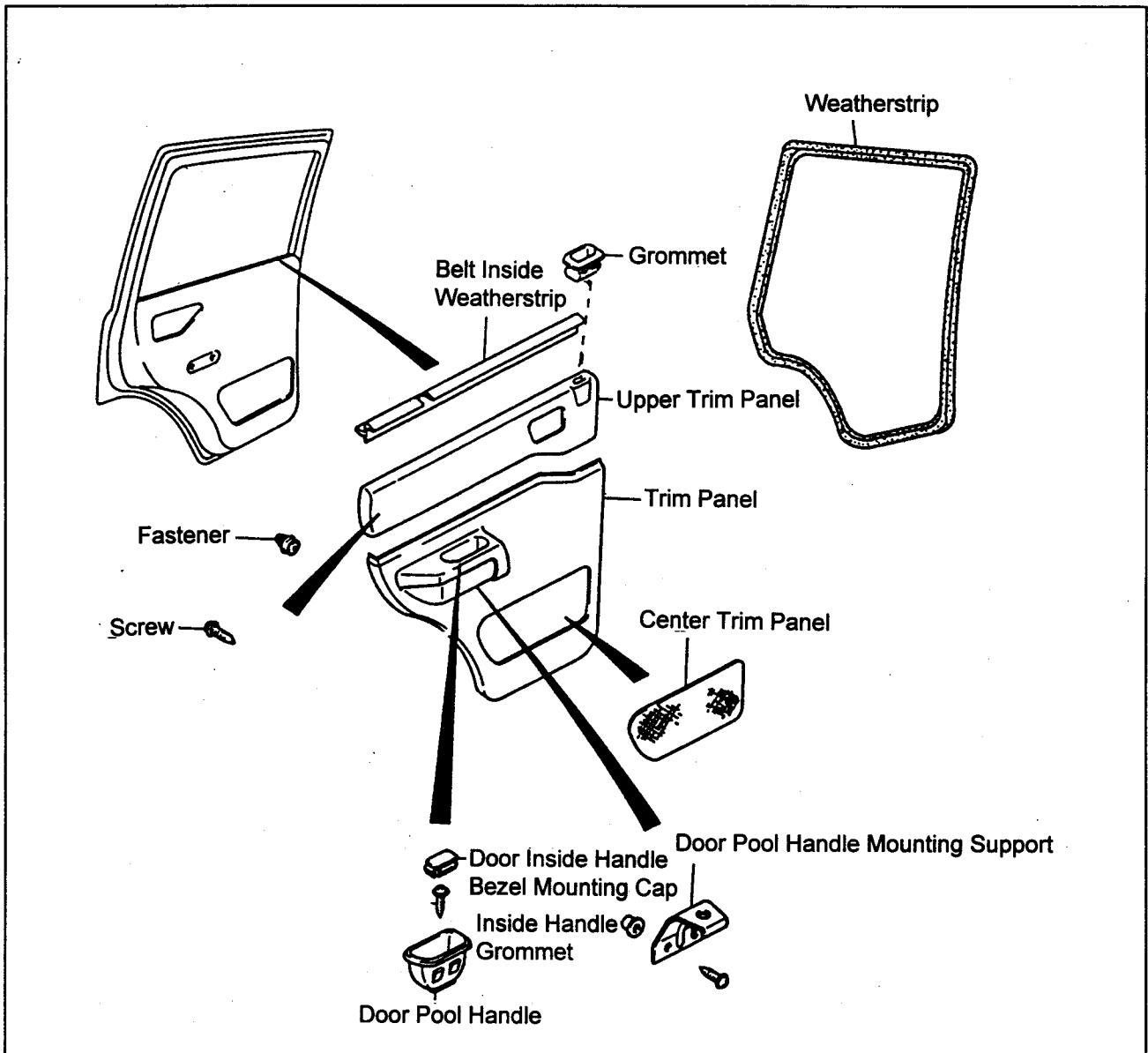
Removal · Installation

1) Remove the pin from the center hinge of the door.

2) Remove the upper / lower hinge bolts from the body and remove the door assembly.

3) Installation is reverse order of the removal.

Rear Doors

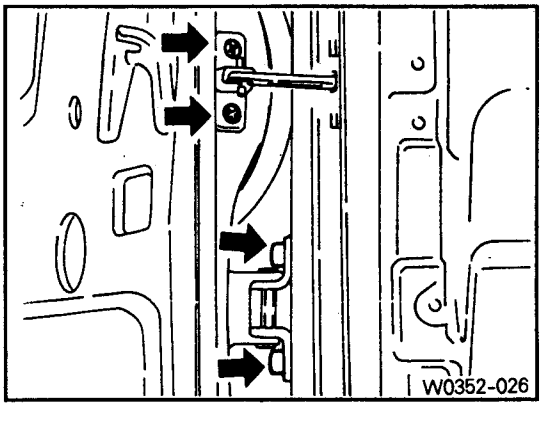


Removal · Installation

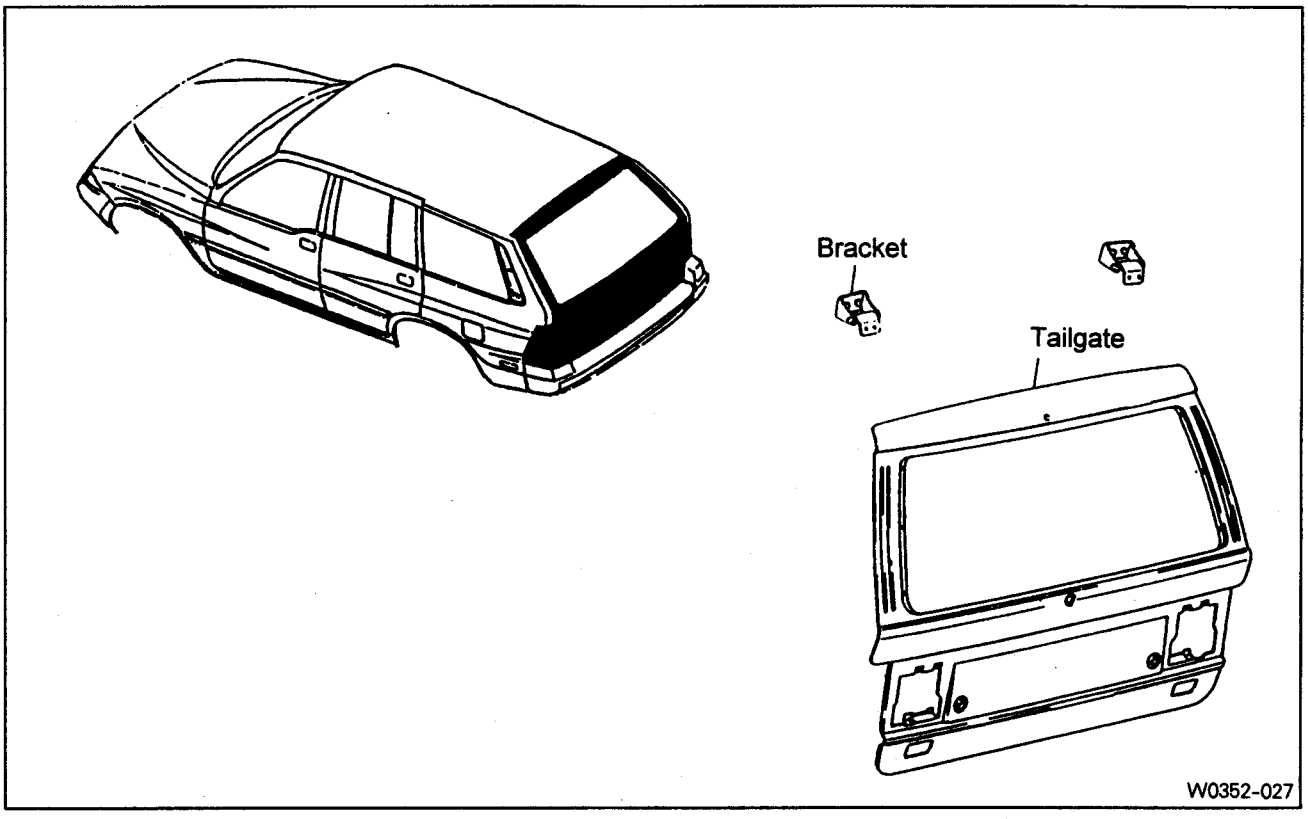
1) Remove the pin from the center hinge of the door.

2) Remove the upper/lower hinge bolts from the body and remove the door assembly.

3) Installation is reverse order of the removal.



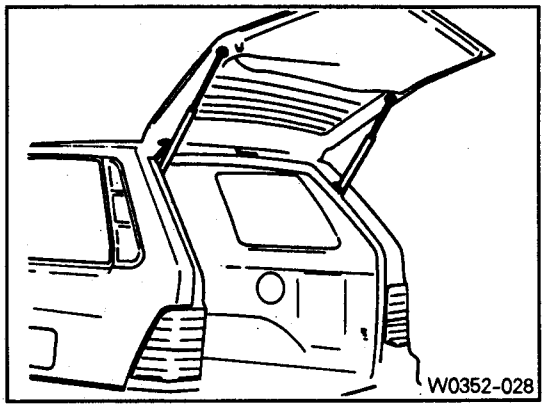
Tailgate



Removal · Installation

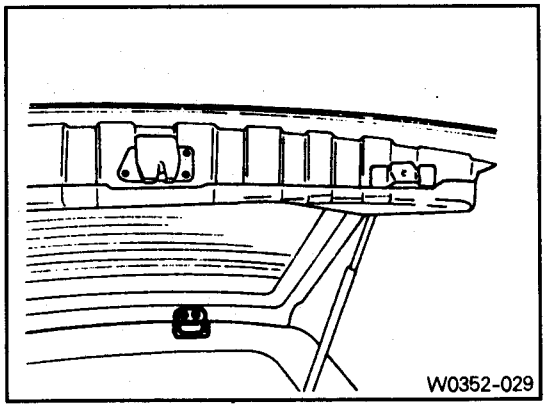
1) Remove the shock absorber mounting bolts.

2) Disconnect the tailgate wiring harness.



3) Remove the tailgate by removing the tailgate bracket bolts.

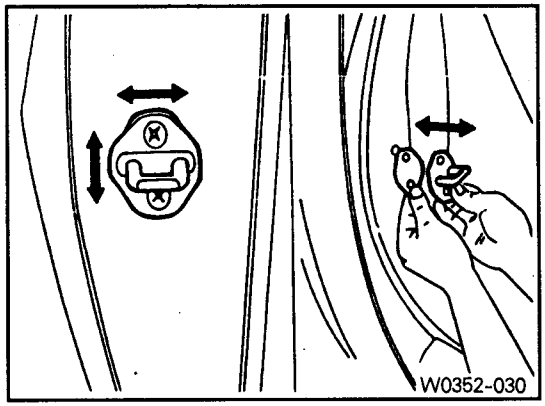
4) Installation is reverse order of the removal.



Adjustment

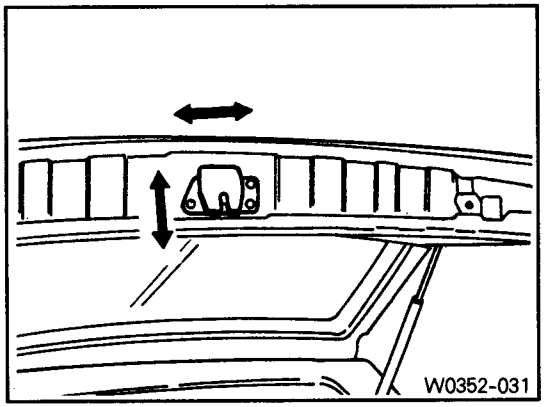
<Door striker>

1) Adjust the striker in forward / rearward and left / right directions. Adjust striker height by increasing / decreasing the shims.

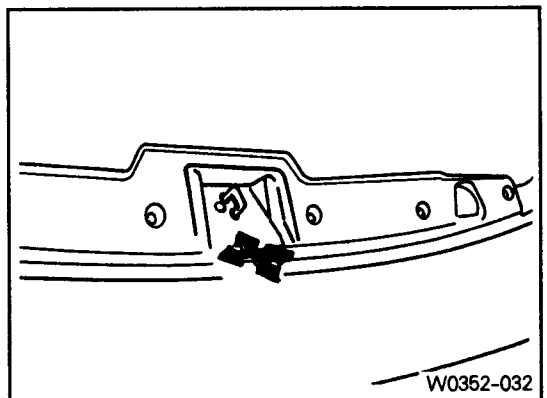


<Tailgate striker>

2) Adjust the position of the striker as described above.

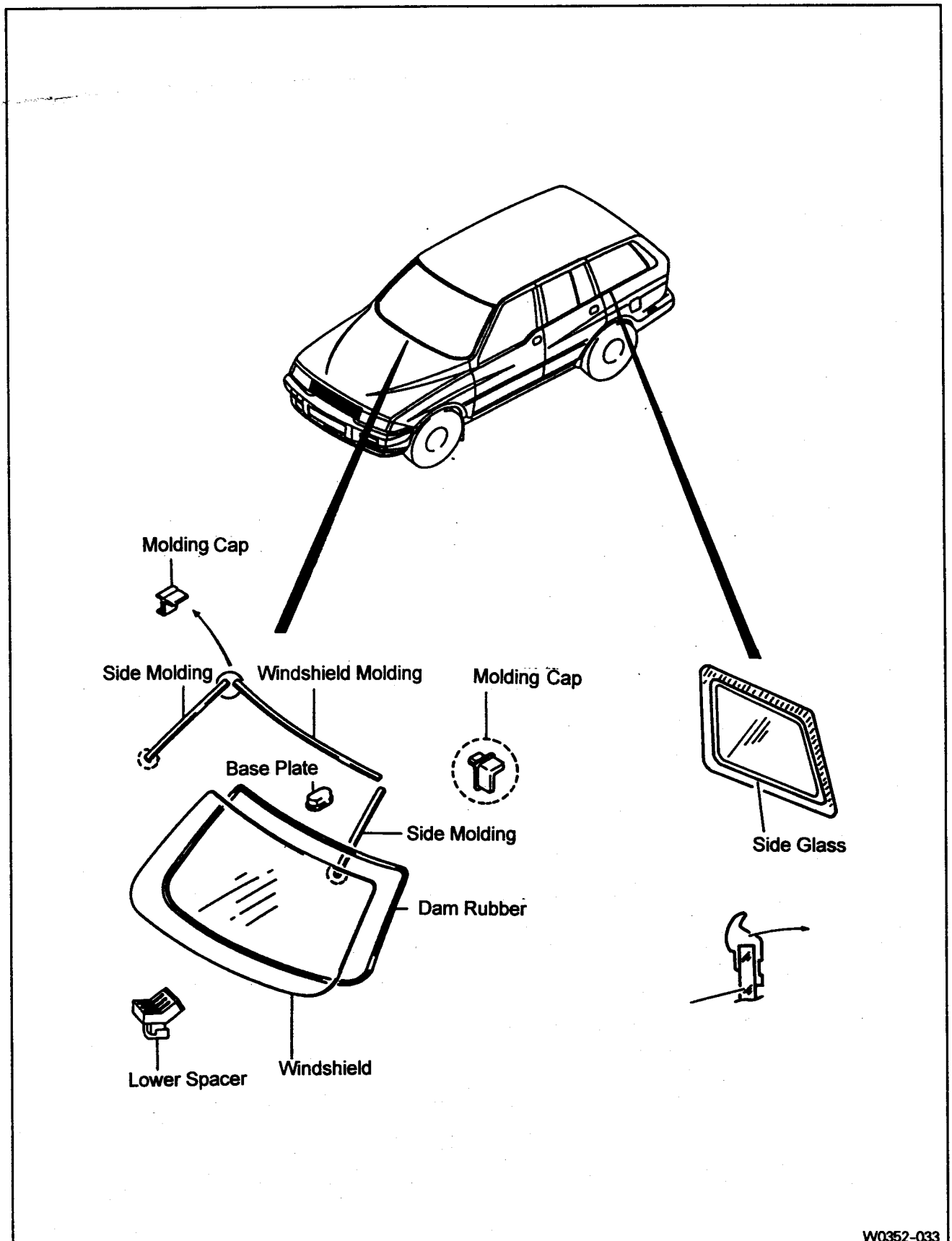


3) Adjust the position of the safety hook as described above.



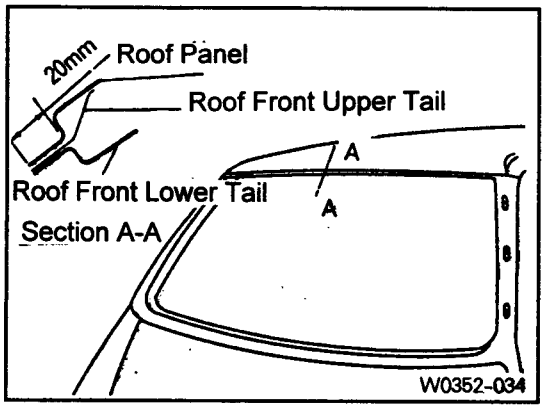
6. Windshield and Windows

Windshield and side glass

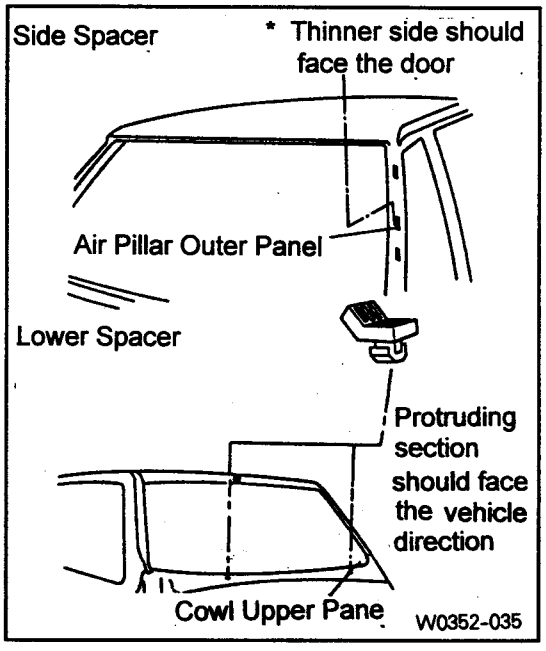


Installation of windshield

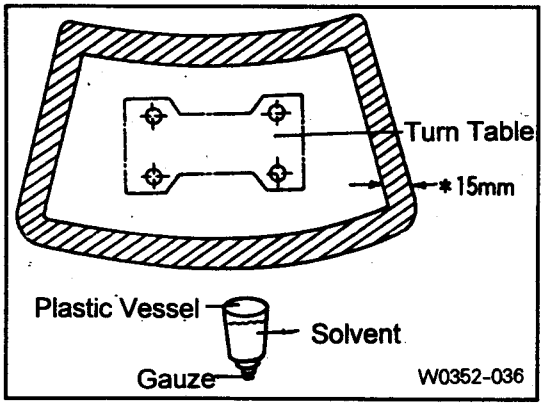
1) Cleaning of windshield mounting flange.
- Do not reuse a gauze over 20 times.
- Saturate the gauze in solvent (Isoprophyl alcohol).
- Keep the cleaned surface to be cleaned.
- Apply body primer to the cleaned and dry body flange.
- If body flange is oiled or contaminated, primer can not be applied.
- Duration : 3 minutes - 8 hours (reapply after 8 hours).
- If primer is applied to the body, clean off immediately with solvent (ethyl alcohol and ethyl acetate, 50 : 50 in volume).
- Do not apply primers which is over its duration.
- Be careful not to contaminate other parts.



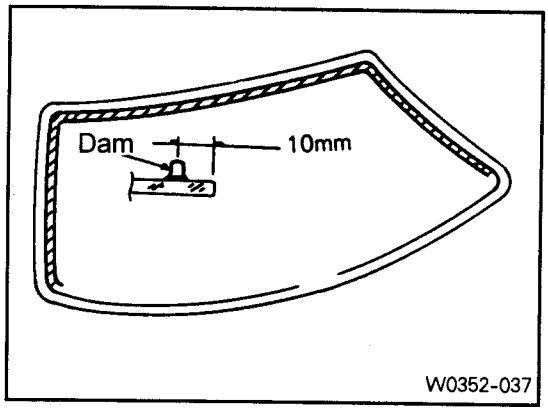
2) Installation of windshield spacer.
- Insert the spacer completely.
- After inserting, there should be no clearance on the body.
  - To the direction of the side spacer.
  - To the direction of the lower spacer.



3) Cleaning of windshield glass.
- Clean the windshield glass keeping 15mm from the edge of glass.
- Do not reuse a gauze over 20 times.
- Saturate the gauze in solvent (Isoprophyl alcohol).
- Do not touch the cleaned glass surface.
- Apply glass primer to the cleaned and dry glass.
- If glass is oiled or contaminated, primer can not be applied.

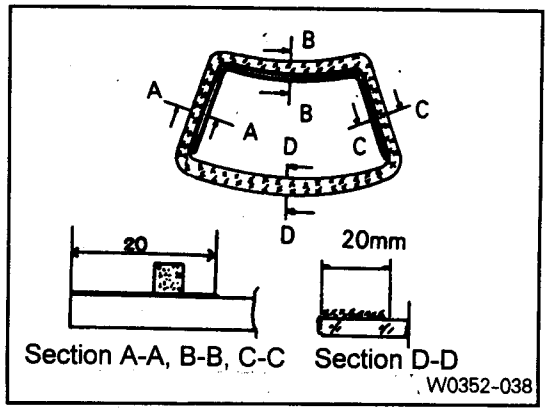


4) Installation of glass dam rubber.
- Using a double - faced adhesive tape, install the dam rubber keeping 10mm from the edge of glass. If intervals are irregular, primers and sealants can be applied unevenly.
- If need to remove the improper dam rubber, do not remain the double - faced adhesive tape on the glass. Improperly installed tape causes the inferior appearance and weakening of adhesive strength of sealant.

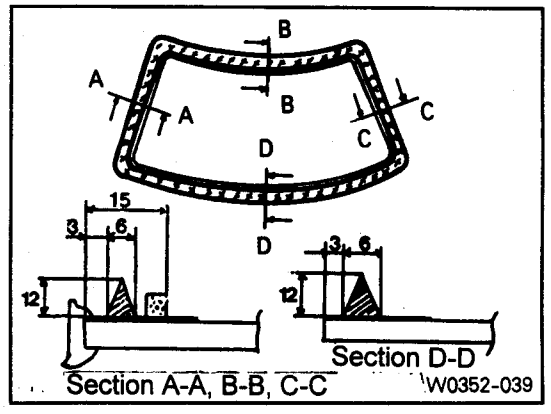


5) Apply glass primer to the outer area of the dam rubber.

[Note]
- **Do not apply body primer to the glass.**
- **Do not touch the primer applied surface. If you touch, this may cause water leakage after installation of the windshield.**
- **Keep water or dust away from the primer applied surface.**



6) Apply sealant to windshield glass.
- Uneven application of sealant may cause water leakage after installation of the glass.
- Do not touch the glass moldings and dam rubber while applying sealant.
- Turn over the glass and apply sealant.

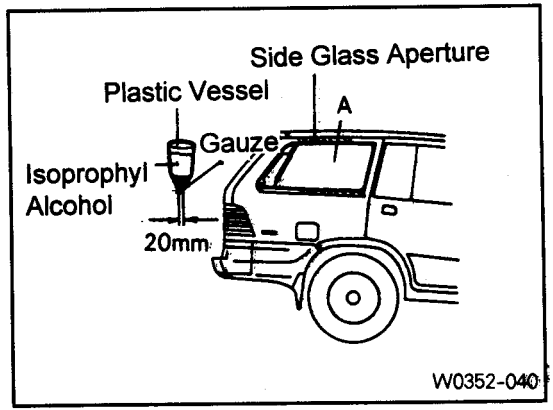


7) Installation.
Using suction holders, install the windshield within 5minutes after application of sealant.

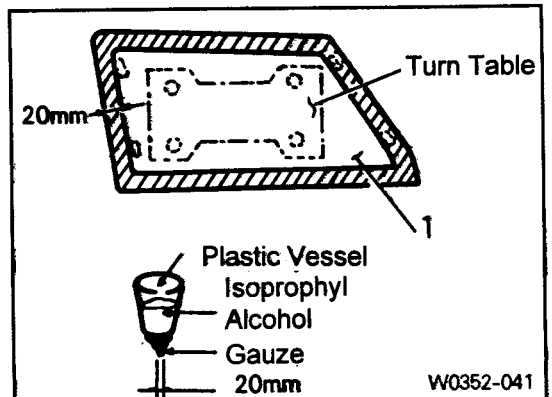
Installation of side glass

※ For installation, refer to 'Installation of Windshield'.

※ 1) Clean as the same procedure of windshield mounting flange (Apply primer).

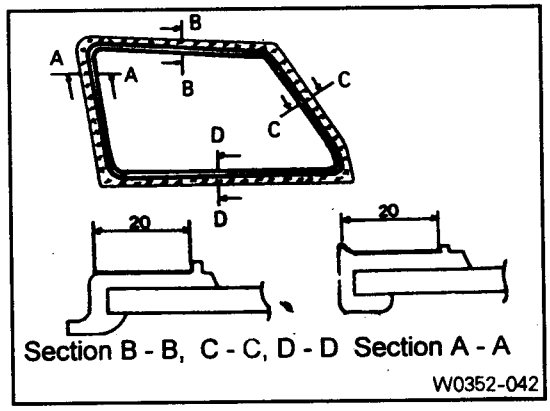


· Clean as the same procedure of windshield cleaning, however keep 20mm from the edge of glass.



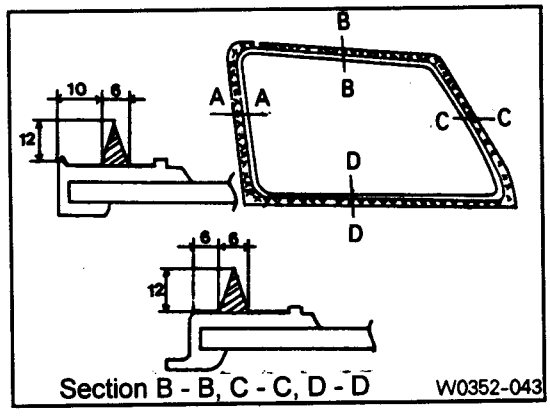
※ 2) Apply primer to the side glass.

- Use sufficiently mixed primer in a mixer over 10 minutes.
- Be careful not to contaminate other parts due to over application.
- Duration : 1 minute ~ 24 hours (reapply after 24 hours).
- Never use the primer containing deposits or floating materials.
- Do not apply primers which is over its duration.
- Do not reuse a gauze over 20 times.
- Apply evenly to glass.



3) Apply sealant to the side glass.

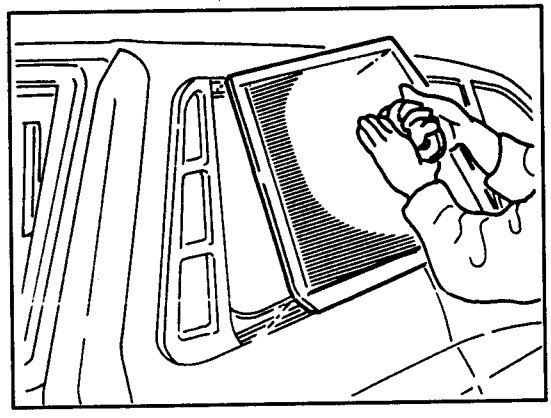
- Turn over the glass and apply sealant.
- Uneven application of sealant may cause water leakage after installation of the glass.



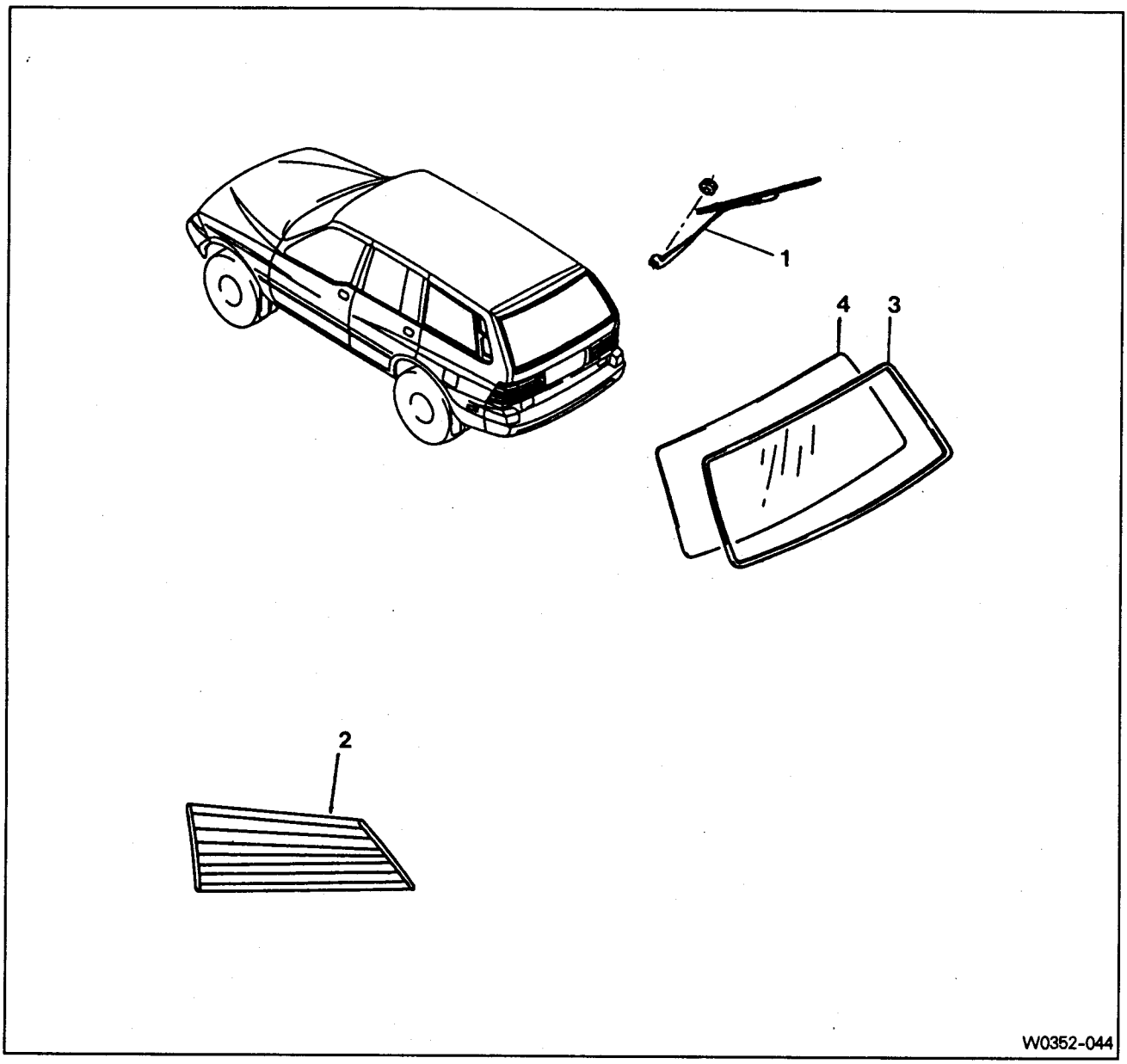
4) Before installation, ensure that the stay bolt washer is inserted.

Tightening torque	7.7Nm

5) Using suction holders, install the side glass within 5minutes after application of sealant.



Tailgate glass

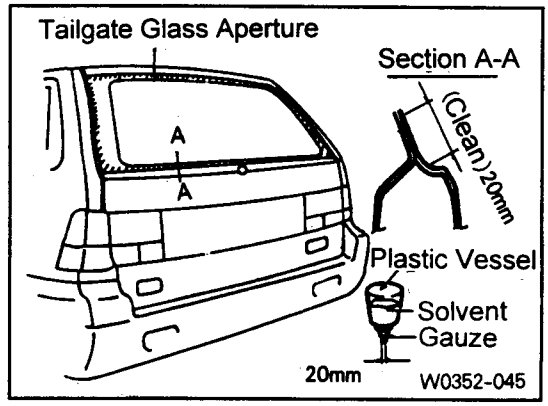


1. Wiper Arm and Blade Assembly
2. Heating Lines
3. Tailgate Trim
4. Tailgate Glass

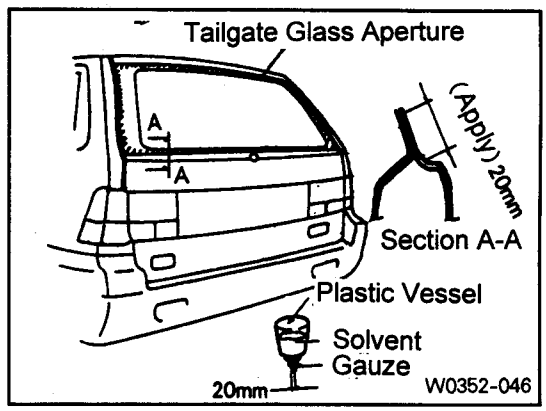
[Note] Removal and installation is as shown in upper drawings.

Installation of tailgate glass

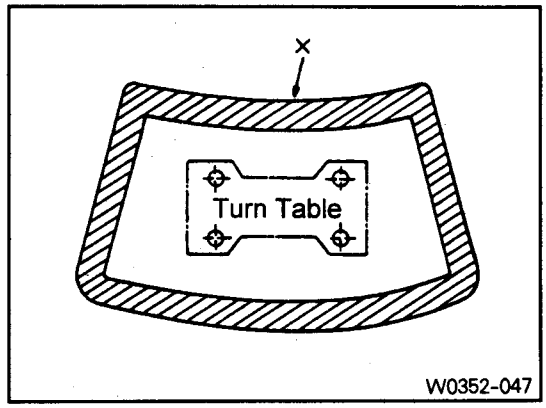
1) Clean the tailgate flange.
   - Do not reuse a gauze over 20 times.
   - Saturate the gauze in solvent (Isoprophyl alcohol).
   - Keep the cleaned surface to be cleaned.
   - Apply body primer to the cleaned and dry flange.
     - If flange is oiled or contaminated, primer can not be applied.



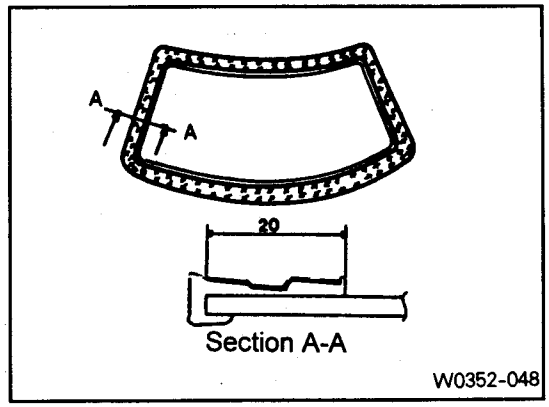
2) Apply primer after cleaning of tailgate flange.
   - Keep primers in a refrigerator (-2℃ ~ +5℃).
   - Use sufficiently mixed primer in a mixer over 10 minutes.
   - Apply primer within 2 hours after opening.
   - Do not apply primers which is over its duration.
   - Apply evenly to the flange.
   - Duration : 3 minutes - 8 hours (reapply after 8 hours).
   - If primer is applied to the body, clean off immediately with solvent.
   - Be careful not to contaminate other parts.



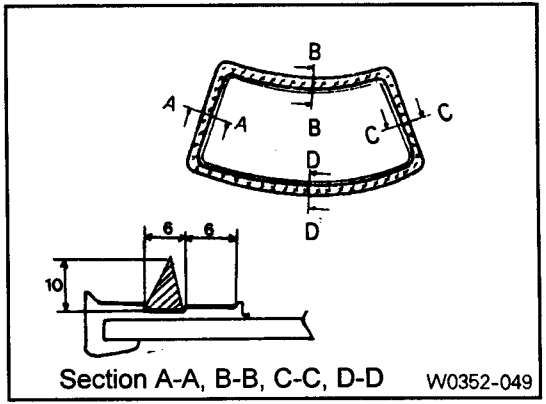
3) Clean the tailgate glass.
   - Clean the glass keeping 15mm from the edge of glass.
   - Do not reuse a gauze over 20 times.
   - Saturate the gauze in solvent (Isoprophyl alcohol).
   - Do not touch the cleaned glass surface.
   - Apply glass primer to the cleaned and dry glass surface. If glass is oiled or contaminated, primer can not be applied.



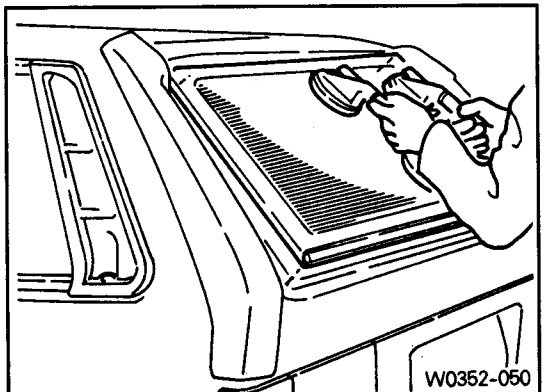
4) Apply primer to the tailgate glass.
   - Use sufficiently mixed primer in a mixer over 10 minutes.
   - Be careful not to contaminate other parts due to over application.
   - Duration : 1 minute - 24 hours (reapply after 24 hours).
   - Never use the primer containing deposits or floating materials.
   - Do not use primers which is over its duration.
   - Do not reuse a gauze over 20 times.
   - Apply evenly to glass.



5) Apply sealant to the glass.
- Turn over the glass and apply sealant.
- Uneven application of sealant may cause water leakage after installation of the glass.
- Do not touch the glass moldings and dam rubber while applying sealant.

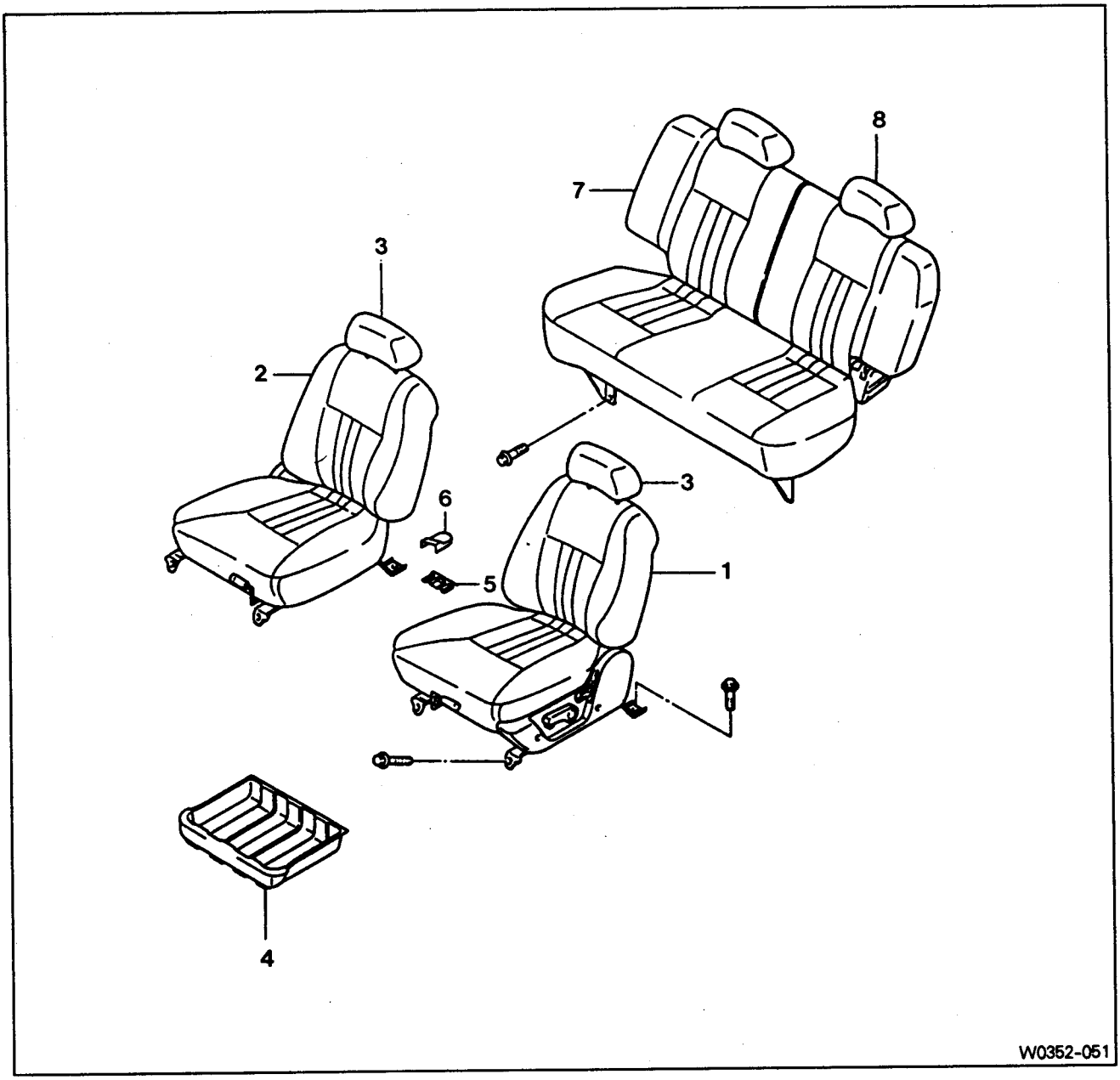


6) Using suction holders, install the tailgate glass within 5minutes after application of sealant.
- Fix the glass with adhesive tape.
- Apply sealant additionally between the quarter outer panel and tailgate glass moldings.



7. Seat and Seatbelt

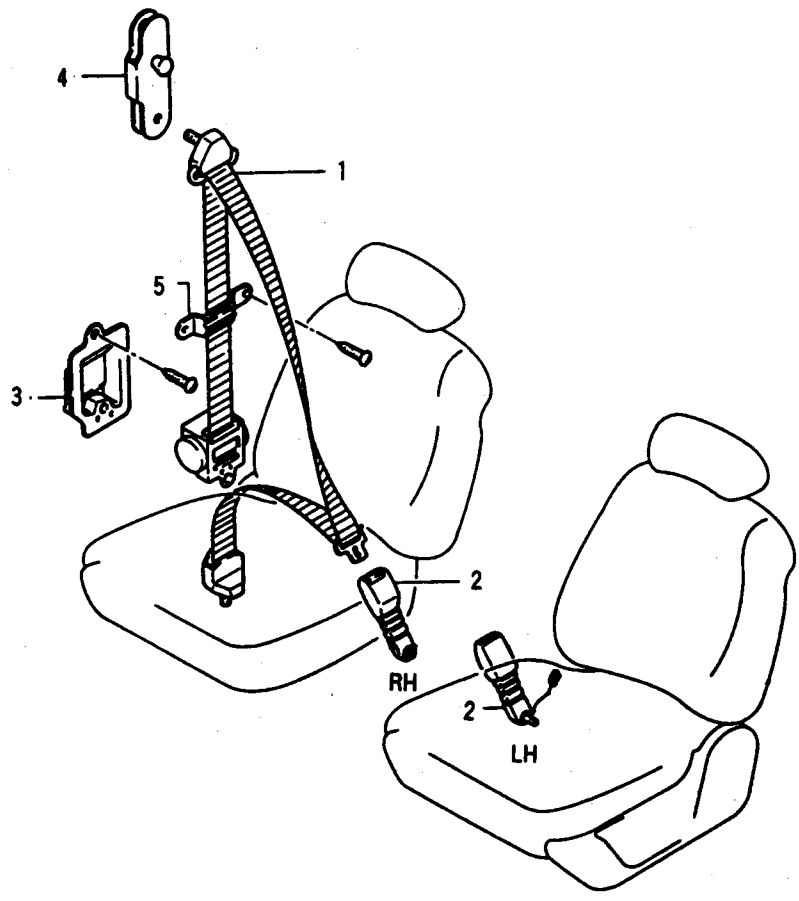
Front and rear seat



1. Front Seat (Driver)
2. Front Seat (Passenger)
3. Headrest
4. Under Tray Assembly
5. Front Seat Mounting Rear Outer Cover
6. Front Seat Mounting Rear Inner Cover
7. Rear Seat Assembly
8. Headrest

[Note] Removal and installation is as shown in upper drawings.

Front seat belt

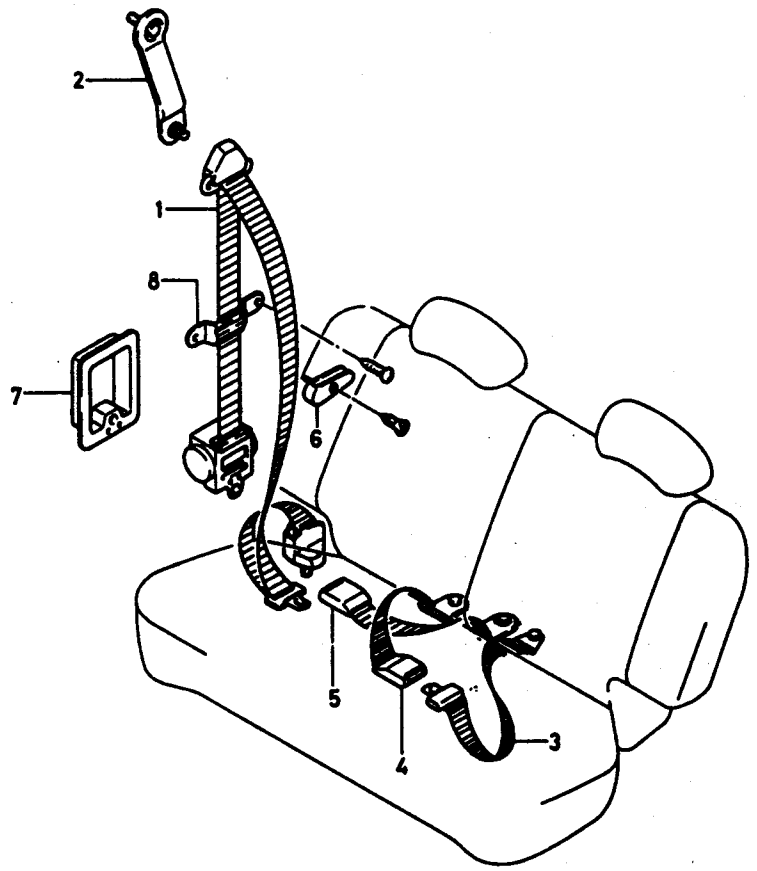


W0352-052

1. Front Seat Belt (3-Point)
2. Front Buckle Assembly
3. Front Seat Belt Dust Cover
4. Front Seat Belt Height Adjuster Assembly
5. Seat Belt Webbing Guide

[Note] Removal and installation is as shown in upper drawings.

Rear seat belt

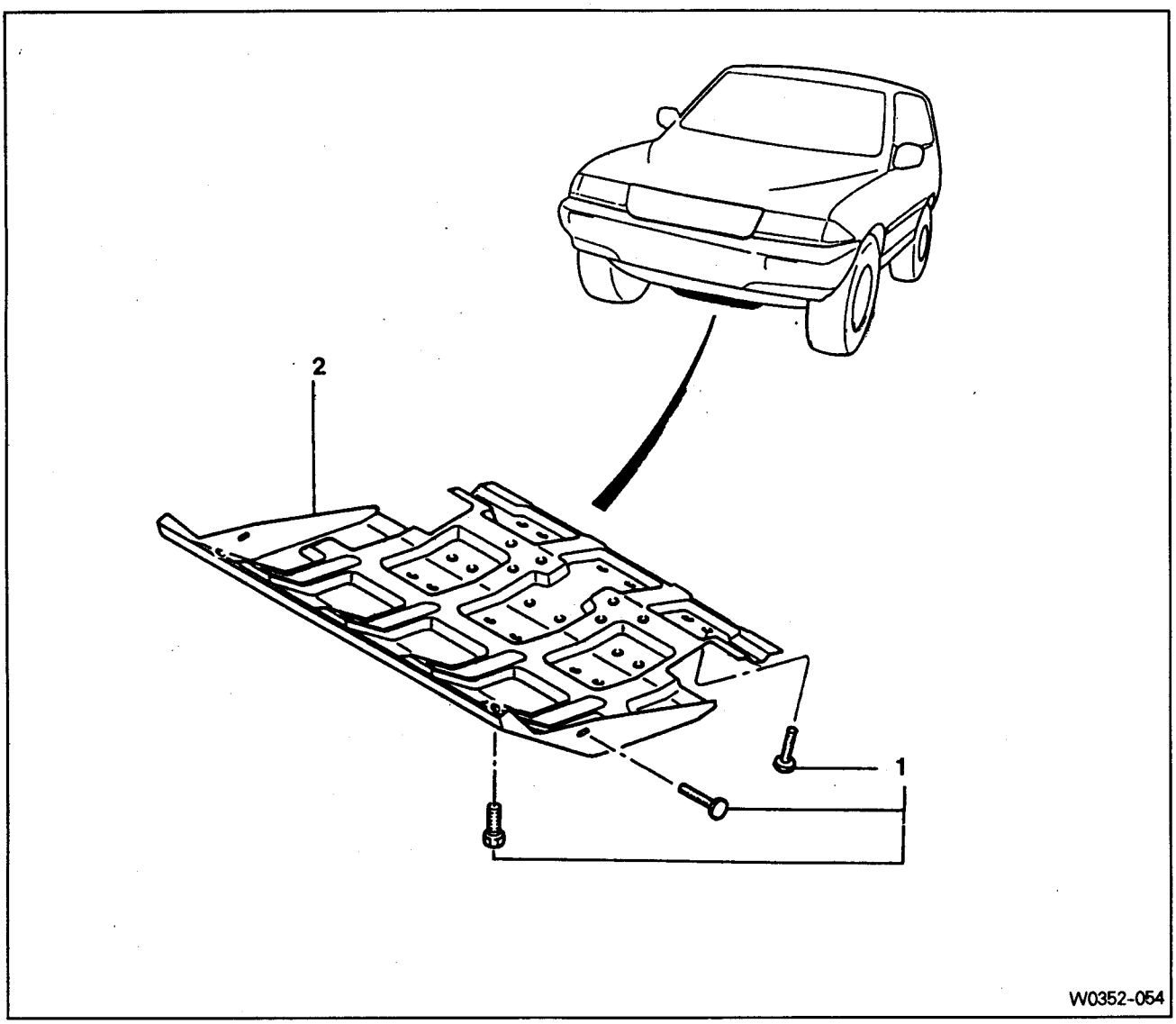


W0352-053

1. Rear Seat Belt (3-Point)
2. Rear Seat Belt Plate
3. Rear Seat Belt (2-Point, Center)
4. Rear Seat Belt Webbing Buckle Assembly (Center)
5. Rear Seat Belt Webbing Buckle Assembly (Side)
6. Rear Seat Belt Webbing Hanger
7. Rear Seat Belt Dust Cover
8. Seat Belt Webbing Guide

[Note] Removal and installation is as shown in upper drawings.

8. Under Cover



1. Mounting Bolts----------18~47Nm
2. Under Cover

Removal

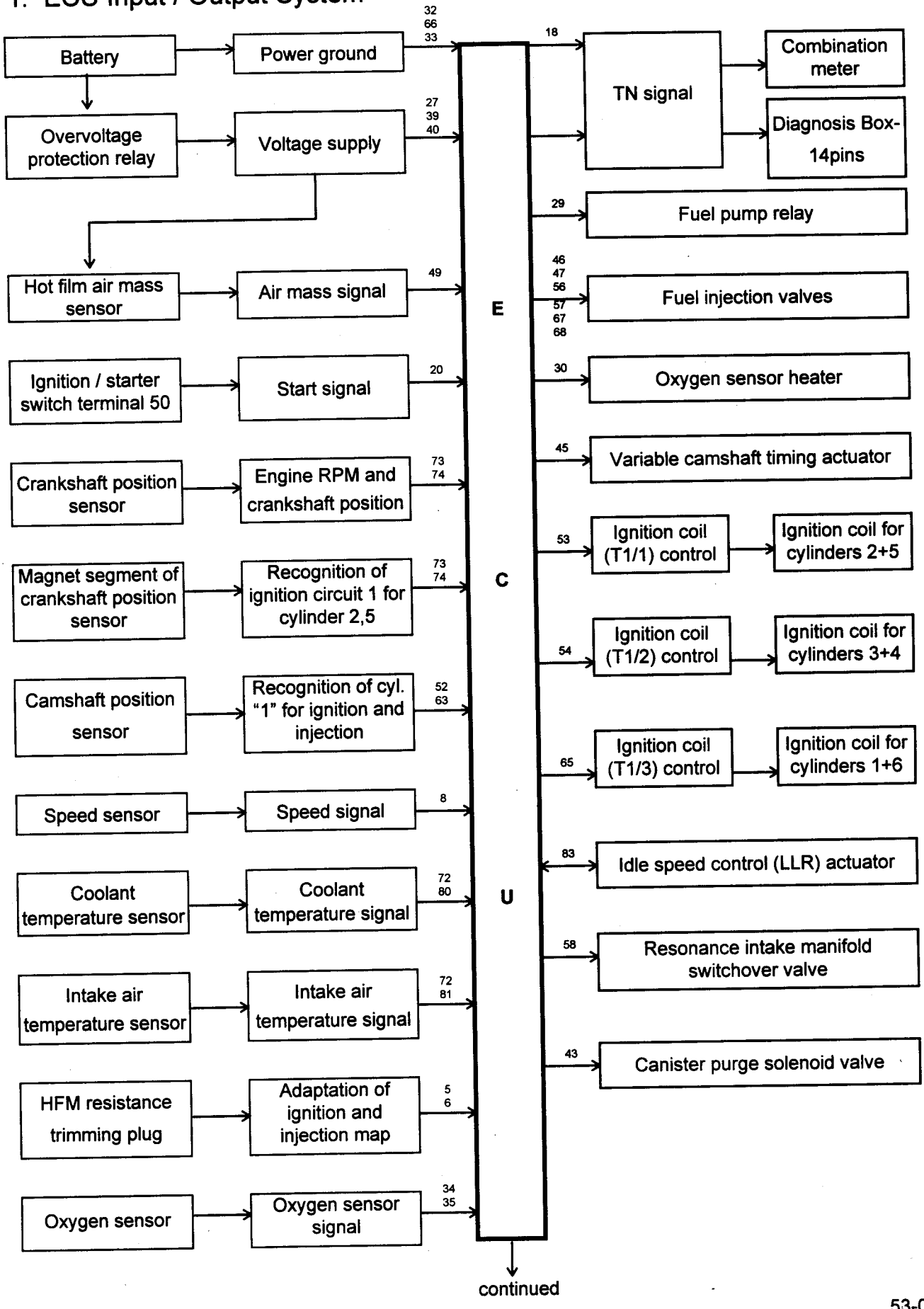
1) Remove 6 mounting bolts and carefully remove the under cover.

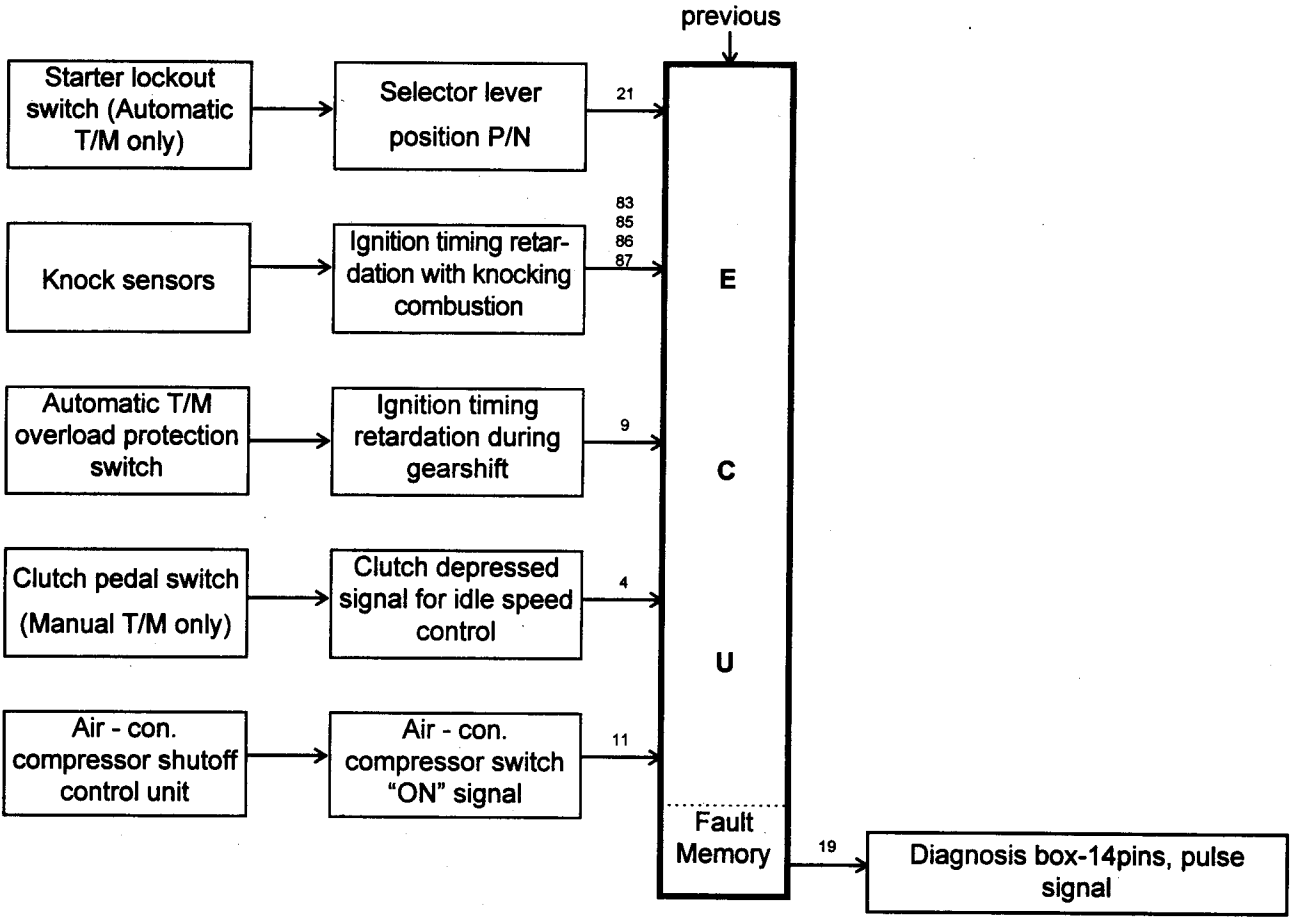
Installation

Tightening torque	28~47Nm

2) Installation is reverse order of the removal.

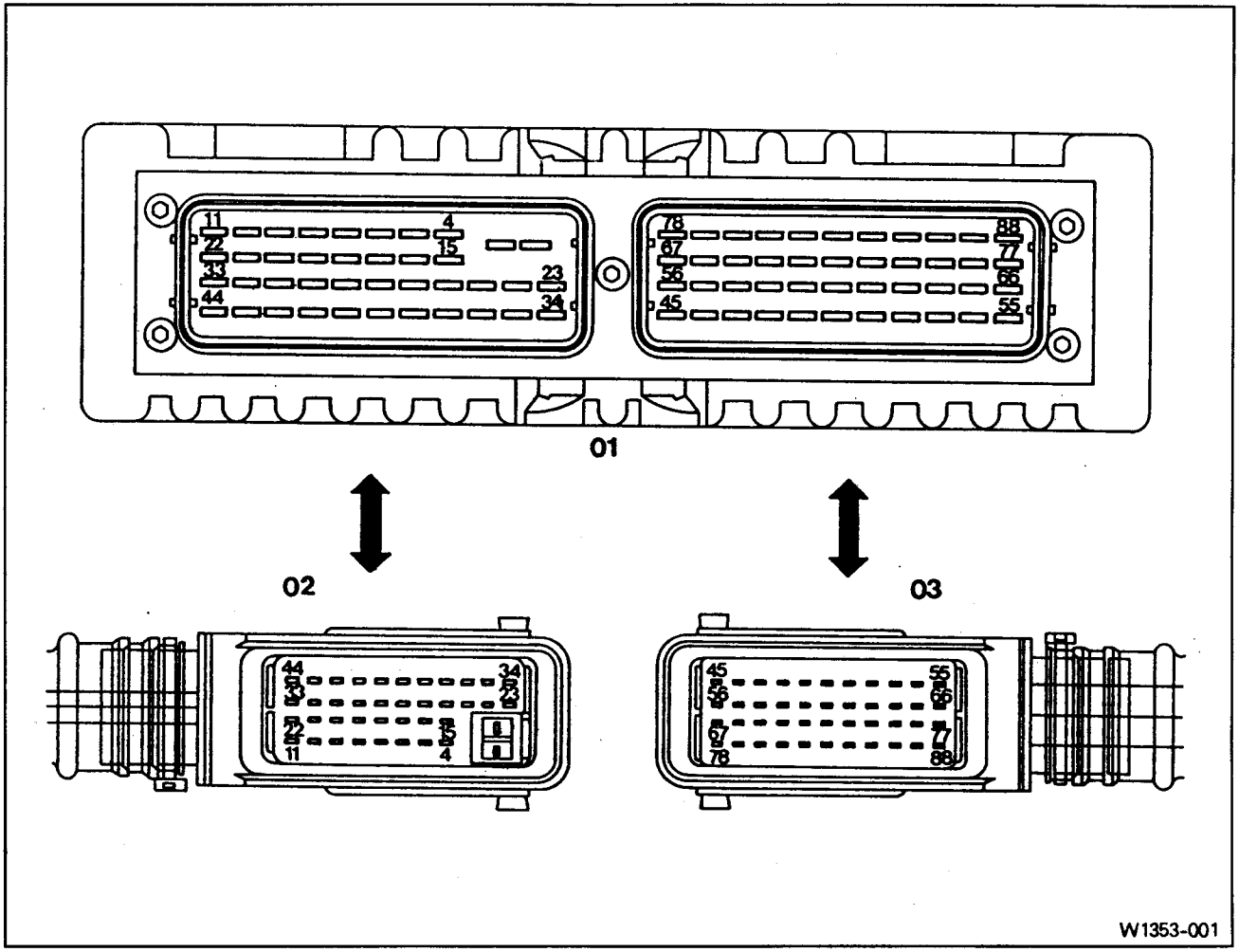
1. ECU Input / Output System





[Note] Each number means the number of ECU pins.

2. ECU Pin Number Arrangement

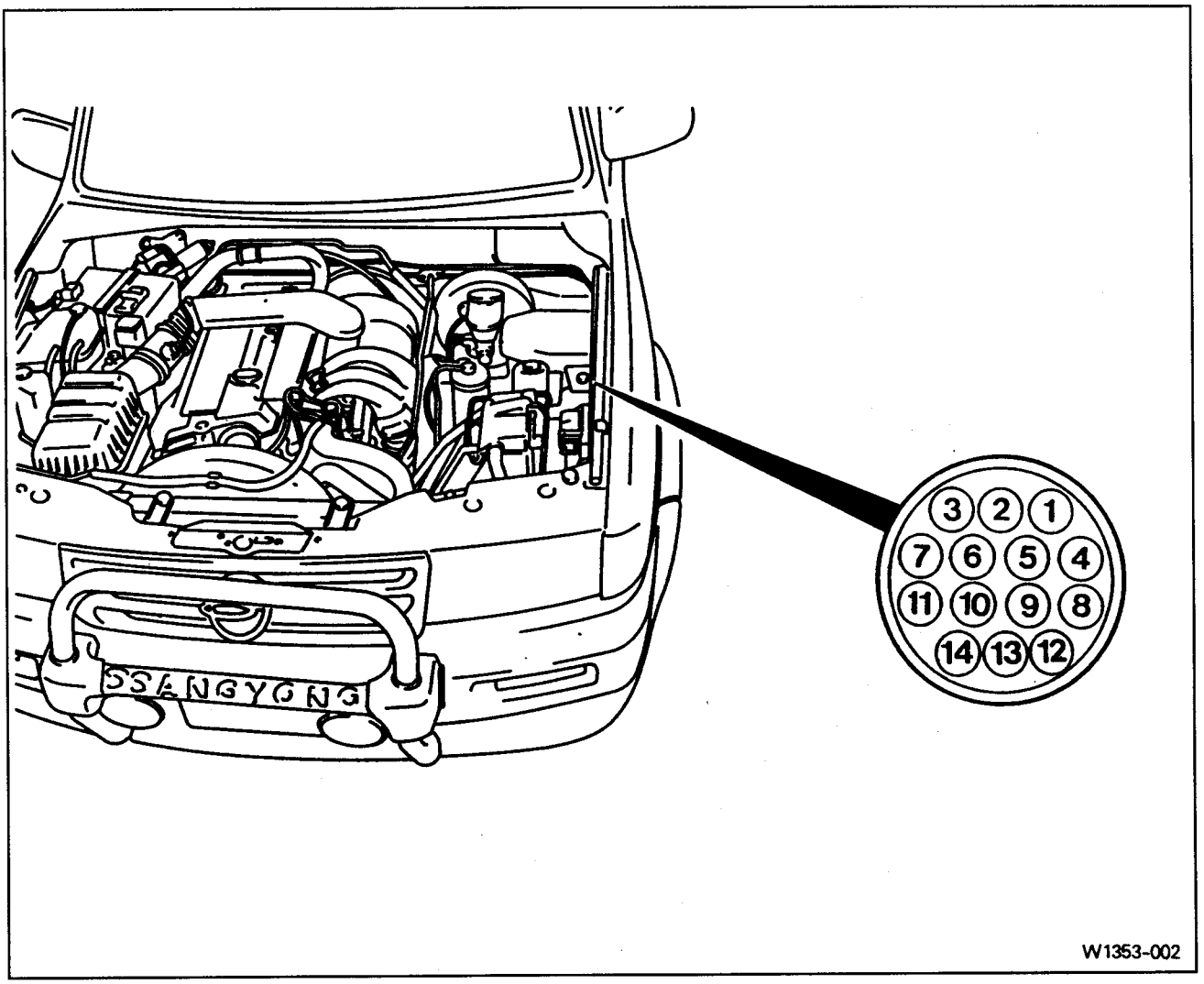


01. ECU
02. ECU Coupling No. 1
03. ECU Coupling No. 2

Pin No.	Connection	Pin No.	Connection
5	Resistance trimming plug (Ground)	51	Motor position sensor (Input), LLR
6	Resistance trimming plug (Input)	52	Camshaft position sensor signal (Input)
8	Speed sensor (Input)	53	Ignition coil 2, 5 (Output)
9	A/T overload protection switch (Input)	54	Ignition coil 3, 4 (Output)
11	A/C compressor switch-on signal (Input)	56	Fuel injection valve 5 (Output)
18	TN speed signal (Combi. meter, output)	57	Fuel injection valve 2 (Output)
19	Diagnostic cable	58	Variable intake valve signal (Output)
20	Starter signal (Input)	62	Throttle valve (Voltage supply), LLR
21	A/T position P/N recognition (Input)	63	Camshaft position sensor (Ground)
22	Auto cruise control (Input)	65	Ignition coil 1, 6 (Output)
27	Computer KL87 (Voltage supply)	66	Panel (Ground)
29	Fuel pump relay (Output)	67	Fuel injection valve 1 (Output)
30	Oxygen sensor heater (Output)	68	Fuel injection valve 6 (Output)
32	Computer (Ground)	70	Idle servo motor (Ground), LLR
33	Battery (Ground)	71	HFM sensor (Ground)
34	Oxygen sensor signal (Ground)	72	Coolant/air temperature sensor (Ground)
35	Oxygen sensor signal (Input)	73	Crankshaft position sensor (Ground)
39	Computer KL 15Z (Voltage supply)	74	Crankshaft position sensor signal (Input)
40	Computer KL 30Z (Voltage supply)	78	Idle speed control (LLR)
43	Canister purge solenoid valve (Output)	80	Coolant temperature sensor (Input)
45	Camshaft control actuator (Output)	81	Intake air temperature sensor (Input)
46	Fuel injection valve 3 (Output)	83	Throttle position sensor (Input), LLR
47	Fuel injection valve 4 (Output)	84	Knock sensor 1 (Ground)
48	Idle servo motor (Voltage supply)	85	Knock sensor 1 signal (Input)
49	HFM sensor signal (Input)	86	Knock sensor 2 (Ground)
50	Throttle sensor (Ground), LLR	87	Knock sensor 2 signal (Input)

[Note] A/T : Automatic transmission
A/C : Air conditioner

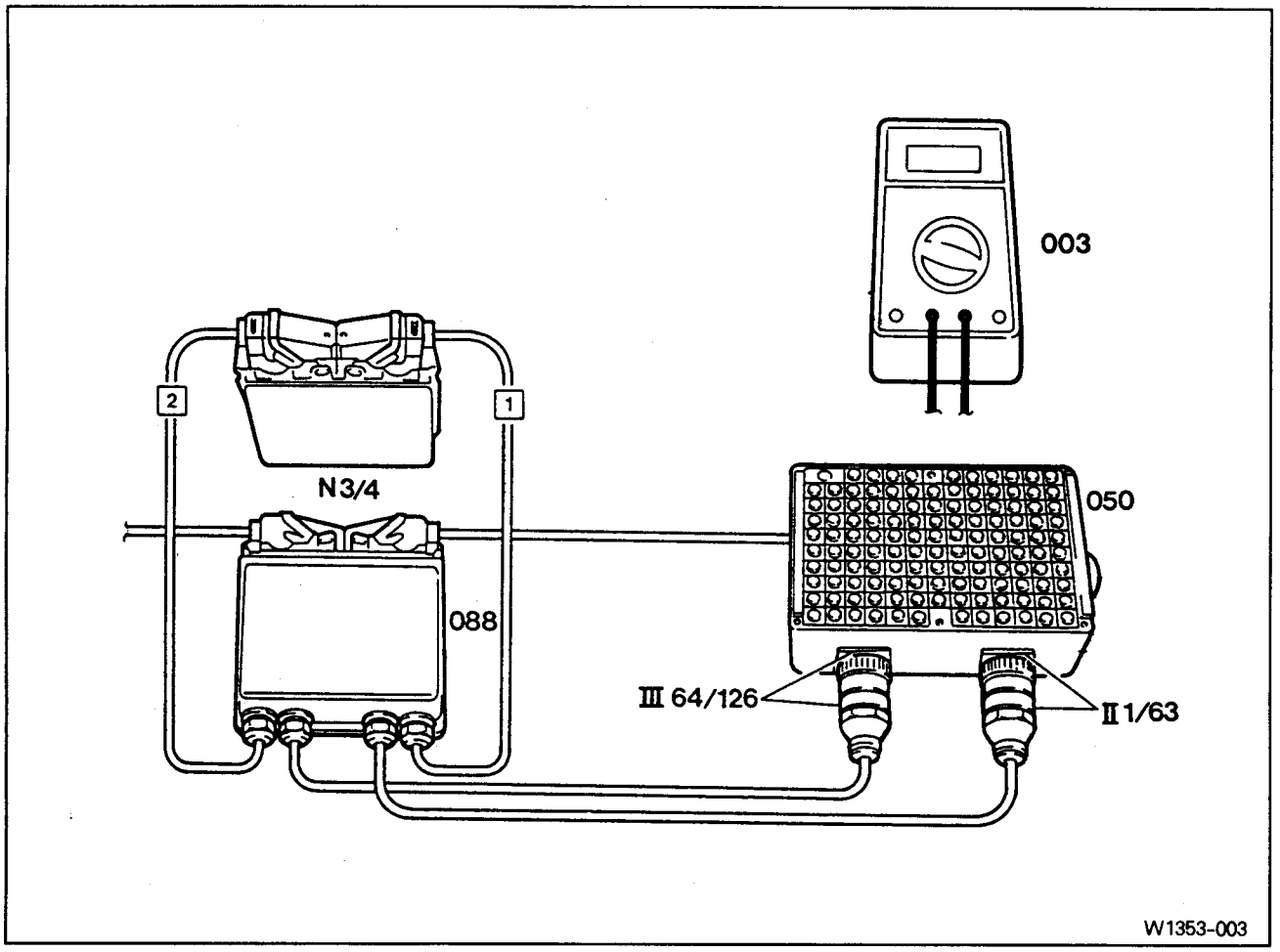
3. Diagnosis Box Pin Number Arrangement



1. Ground
2. Ignition 'ON'
3. Battery (Voltage supply)
4. REKES
5. Engine Speed Signal
6. Transfer Case Control Unit (TCCU, Full/Part -Time)
7. STICS
8. Synthesized Voice
9. TCCU (Full-Time)
10. Reserved
11. Cruise Control
12. Reserved
13. ABS/ASR
14. Engine Control (Diagnosis pulse signal)

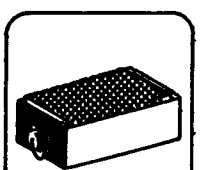
4. Test of Fuel Injection and Ignition System

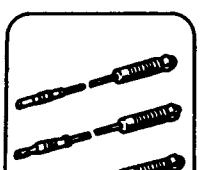
(1) Test connection

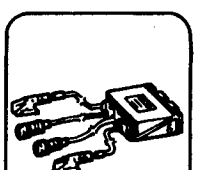


003 Multimeter
050 Contact Box, 126-Pin
088 Test Cable
N3/4 ECU
II 1/63 Test Coupling
III 64/126 Test Coupling

Special Tools


129 589 00 21 00

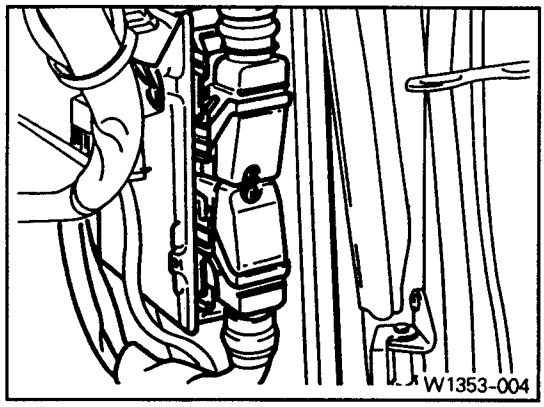

201 589 00 99 21


124 589 45 63 00

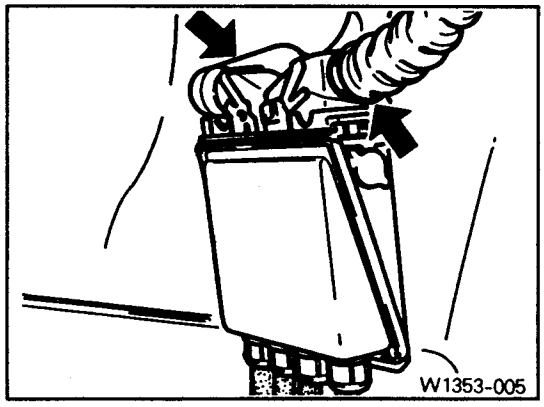
Preparation of test

1) Position the ignition switch 'OFF'.

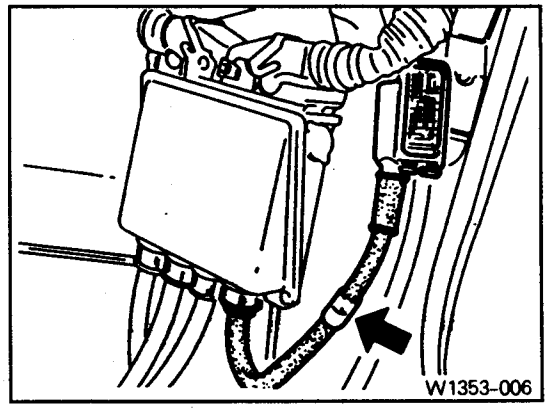
2) Pry up the ECU coupling clamp and disconnect the coupling no.1 and no.2.



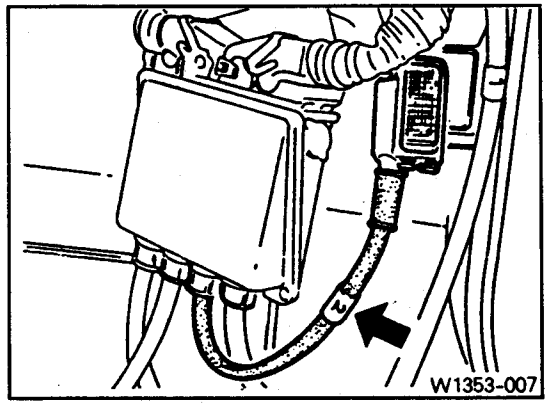
3) Connect the removed coupling no.1 and no.2 to the test cable socket.



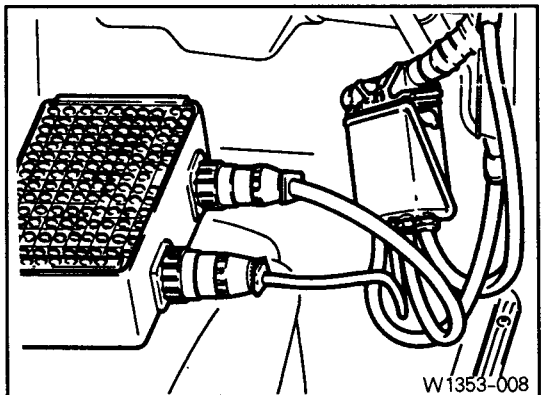
4) Connect the no.1 coupling of the test cable to the ECU no.1 socket.



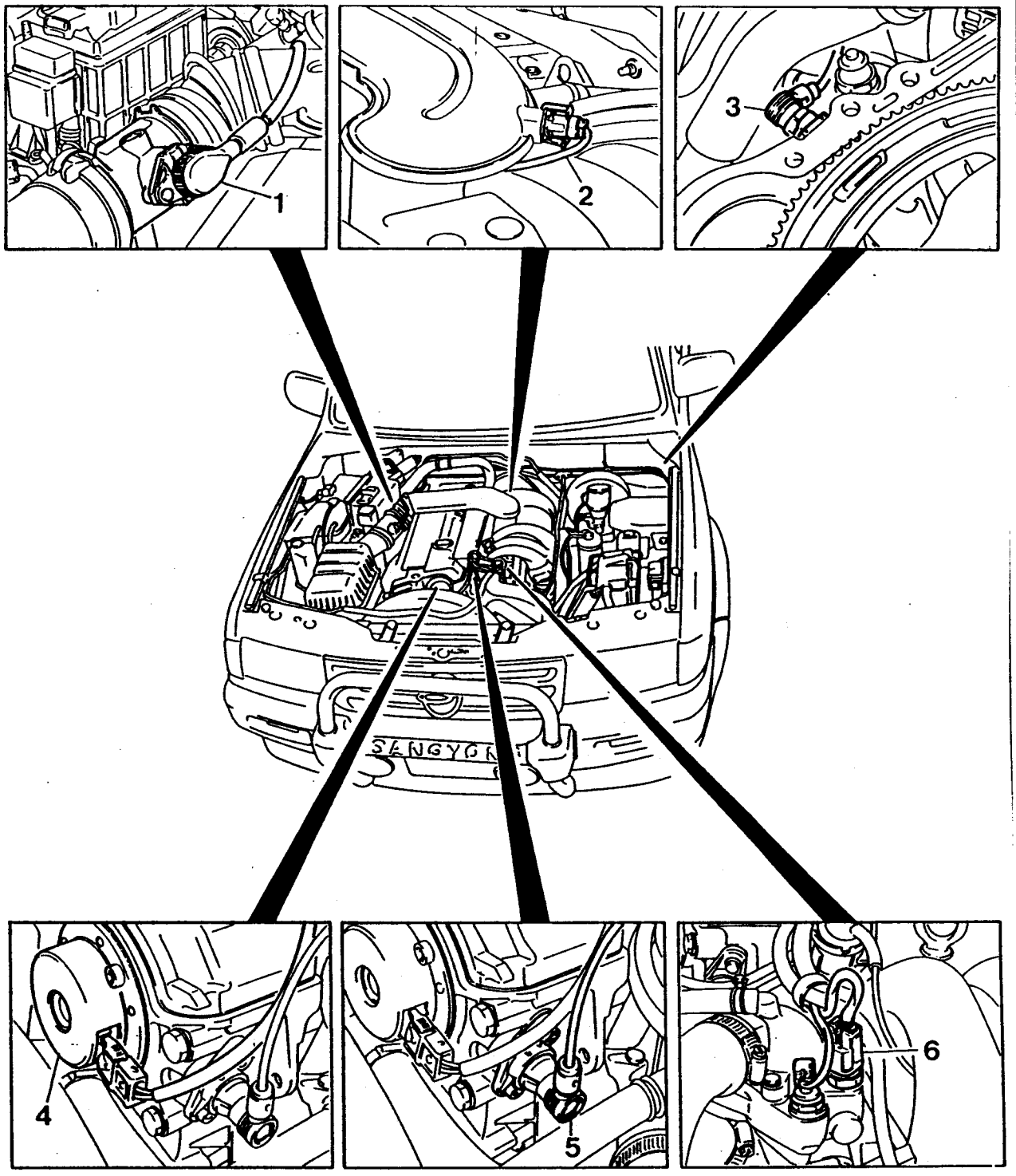
5) Connect the no.2 coupling of the test cable to the ECU no. 2 socket.



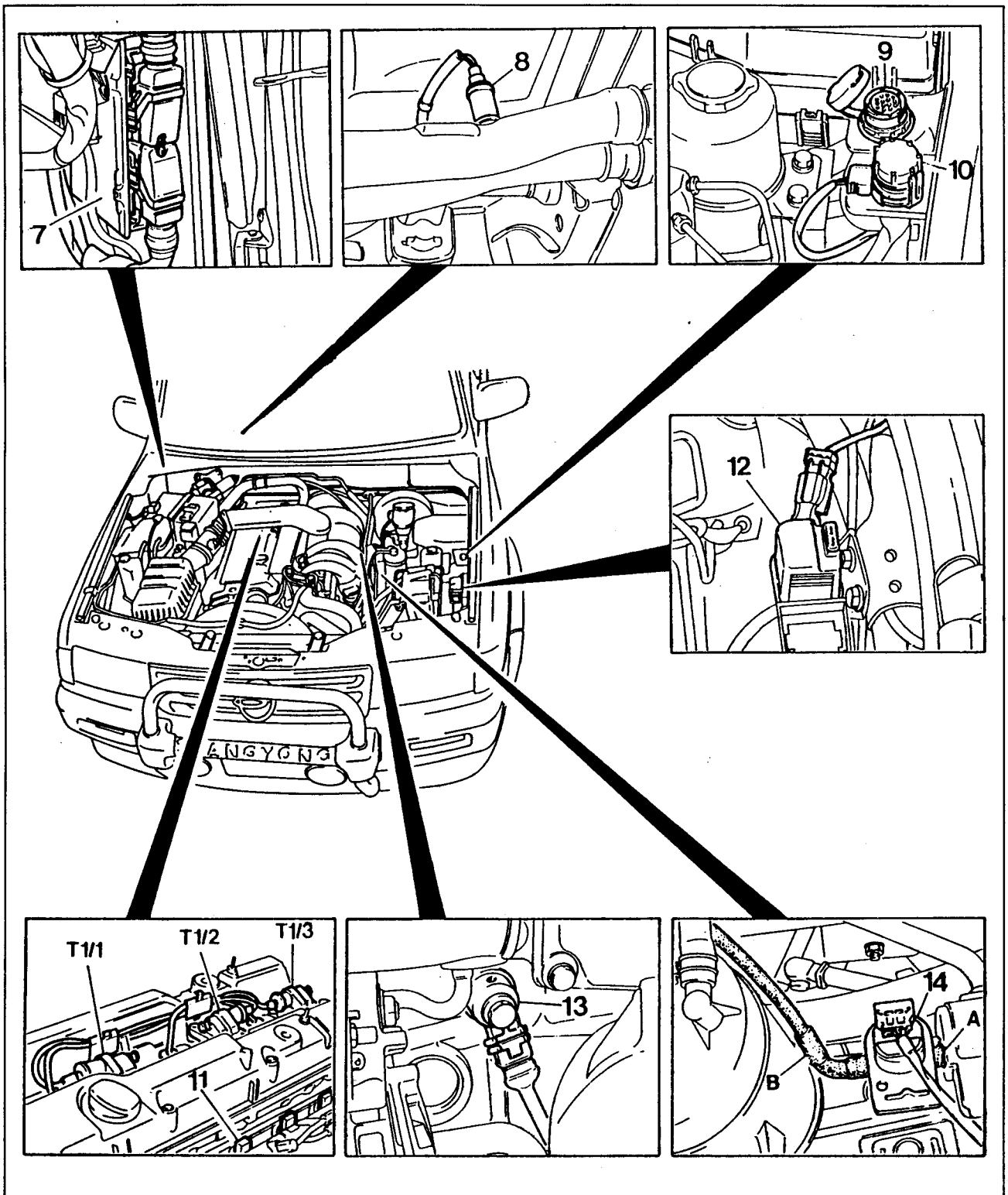
6) Connect the test cable couplings (Ⅱ 1/63, Ⅲ64/126) to the contact box.



(2) Location of components



1. HFM Sensor
2. Intake Air Temperature Sensor
3. Crankshaft Position Sensor
4. Camshaft Control Actuator
5. Camshaft Position Sensor
6. Coolant Temperature Sensor

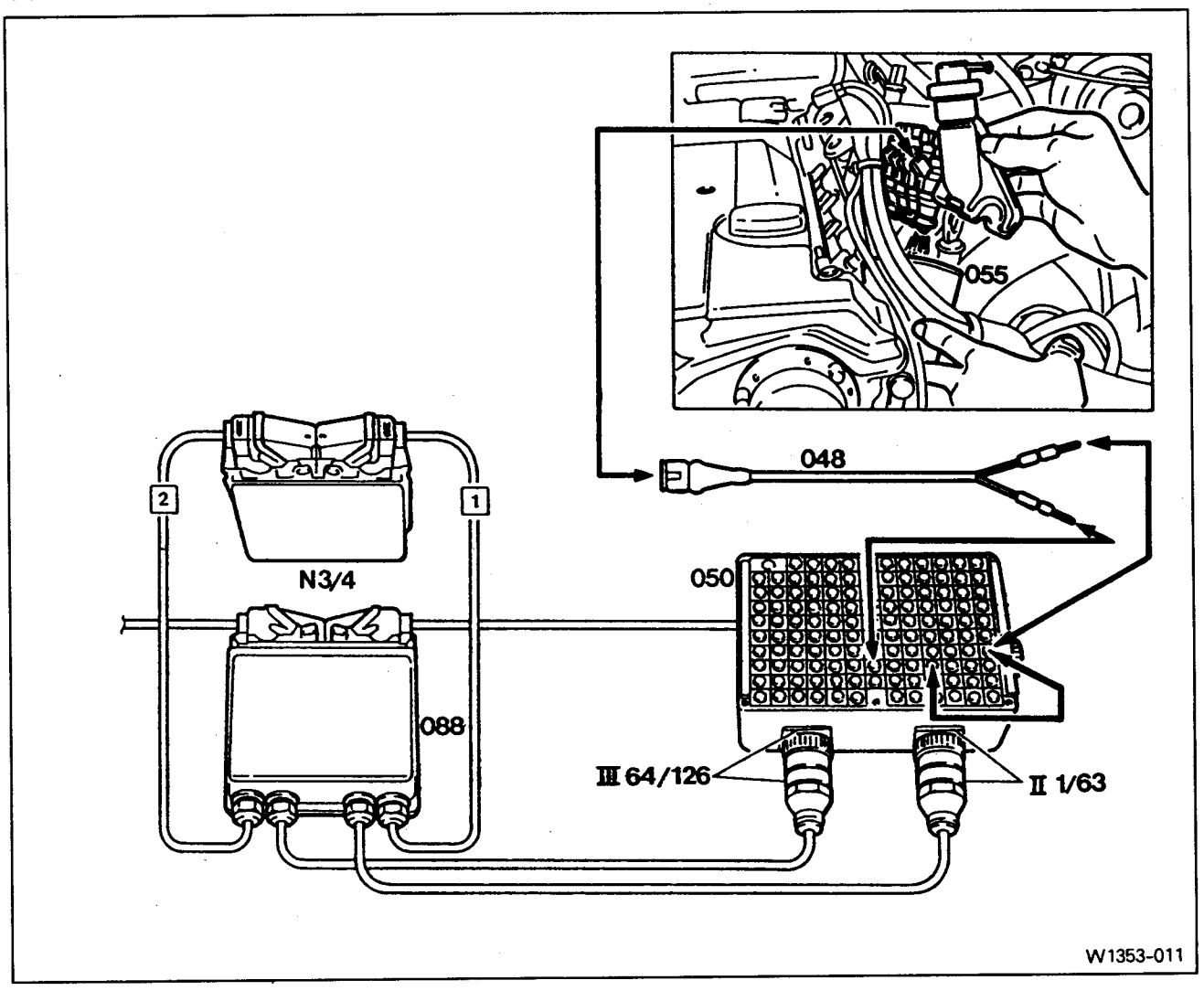


7. ECU
8. Oxygen Sensor
9. Diagnosis Box
10. HFM Resistance Trimming Plug
11. Fuel Injection Valve
12. Fuel Pump Relay

T1/1 Ignition Coil (Cyl. 2 + 5)
T1/2 Ignition Coil (Cyl. 3 + 4)
T1/3 Ignition Coil (Cyl. 1 + 6)
13. Knock Sensor
14. Canister Purge Solenoid Valve

A : From the Purge Canister
B : To the Engine

(3) Fuel injection valve test



048 Shop-made Electric Cable
050 Contact Box
055 Measuring Beaker
088 Test Cable
N3/4 ECU

Preparation of Test

1) Position the ignition switch 'OFF'.

2) Connect the test cable.

3) Remove the fuel distributor pipe and fuel injection valve.
[Note] Do not disconnect the fuel feed and return lines.

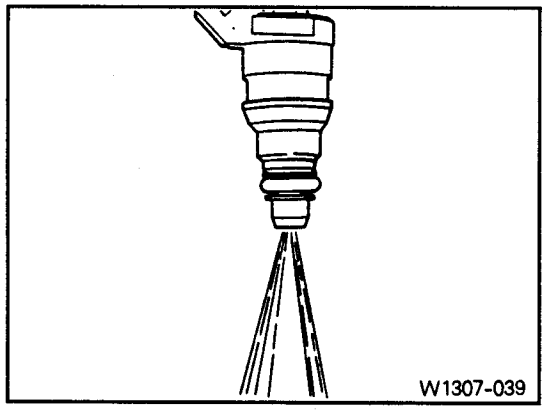
4) Connect the shop-made electric cable (048) to the fuel injection valve.

5) Position the fuel injection valve in a measuring beaker (055).

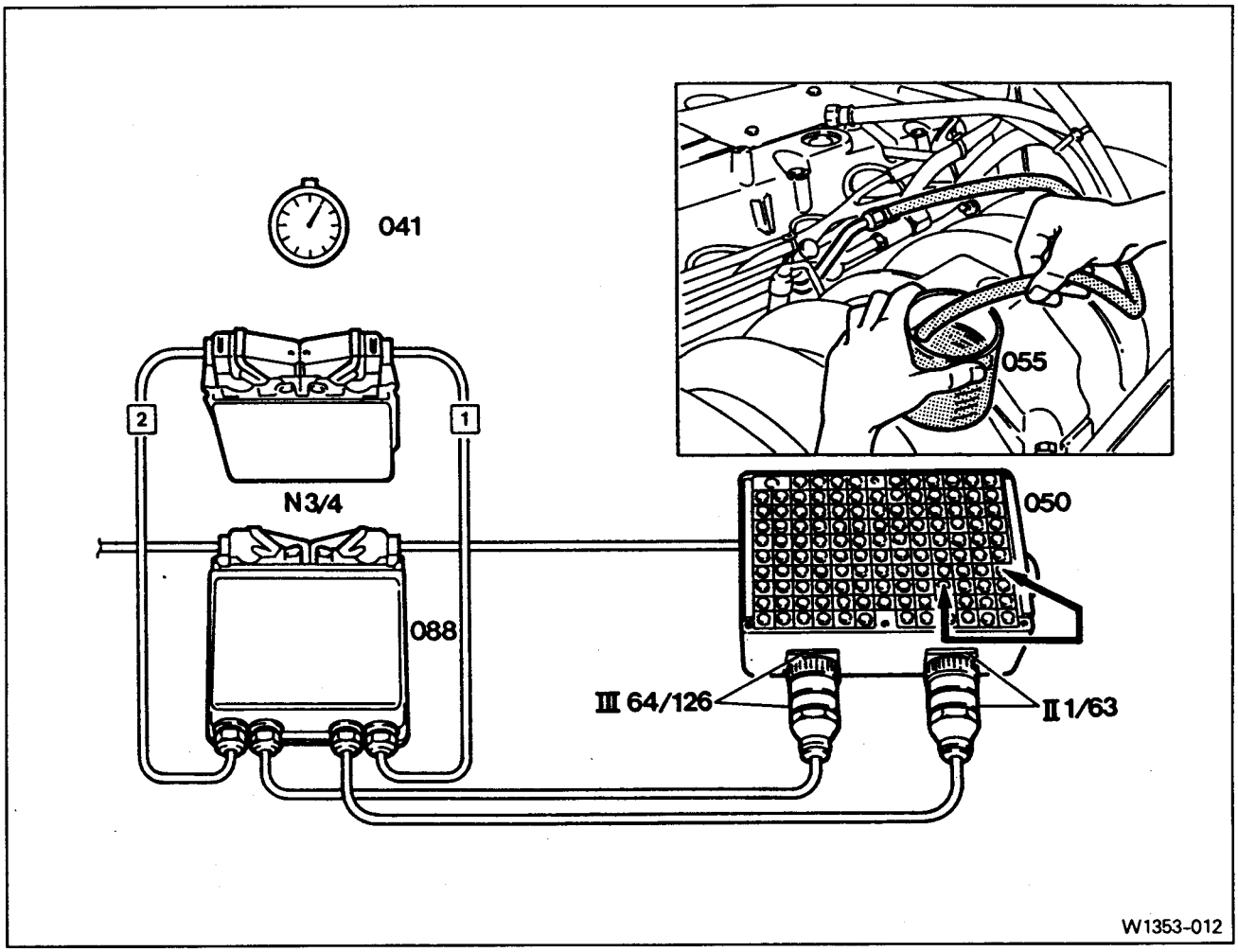
Testing fuel injection valves

Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒1.0	Fuel injection valves test leaktightness	- Bridge no.29 and no.39 terminal of ECU. - Remove the fuel distributor pipe and fuel injection valves. - Ignition switch : ON	Fuel injection valves must not drip.	- Fuel injection valves. - ⇒1.1
⇒1.1	Operation and spray pattern of the fuel injection valves.	- Bridge no.29 and no.39 terminal of ECU. - Ignition switch : ON - Connect the shop - made cable to the injection valve and hold the injection valve in a beaker. - Connect the shop - made cable to the contact box pin no.32 (-) and no.39 (+).	Normal spray pattern.	Fuel injection valves.

· Normal spray pattern of the fuel injection valves.



(4) Fuel pumps test



041 Stop watch
050 Contact Box (126-pin)
055 Measuring Beaker
088 Test Cable
N3/4 ECU

Preparation of test

1) Position the ignition switch 'OFF'.

2) Connect the ECU couplings to the test cable (088).
Connect the test cable couplings (no.1 and no.2) to the ECU (N3/4).

3) Connect the test cable (088) couplings to the contact box (050).

4) Disconnect the fuel return pipe and insert the return hose.

5) Prepare a measuring beaker (055).

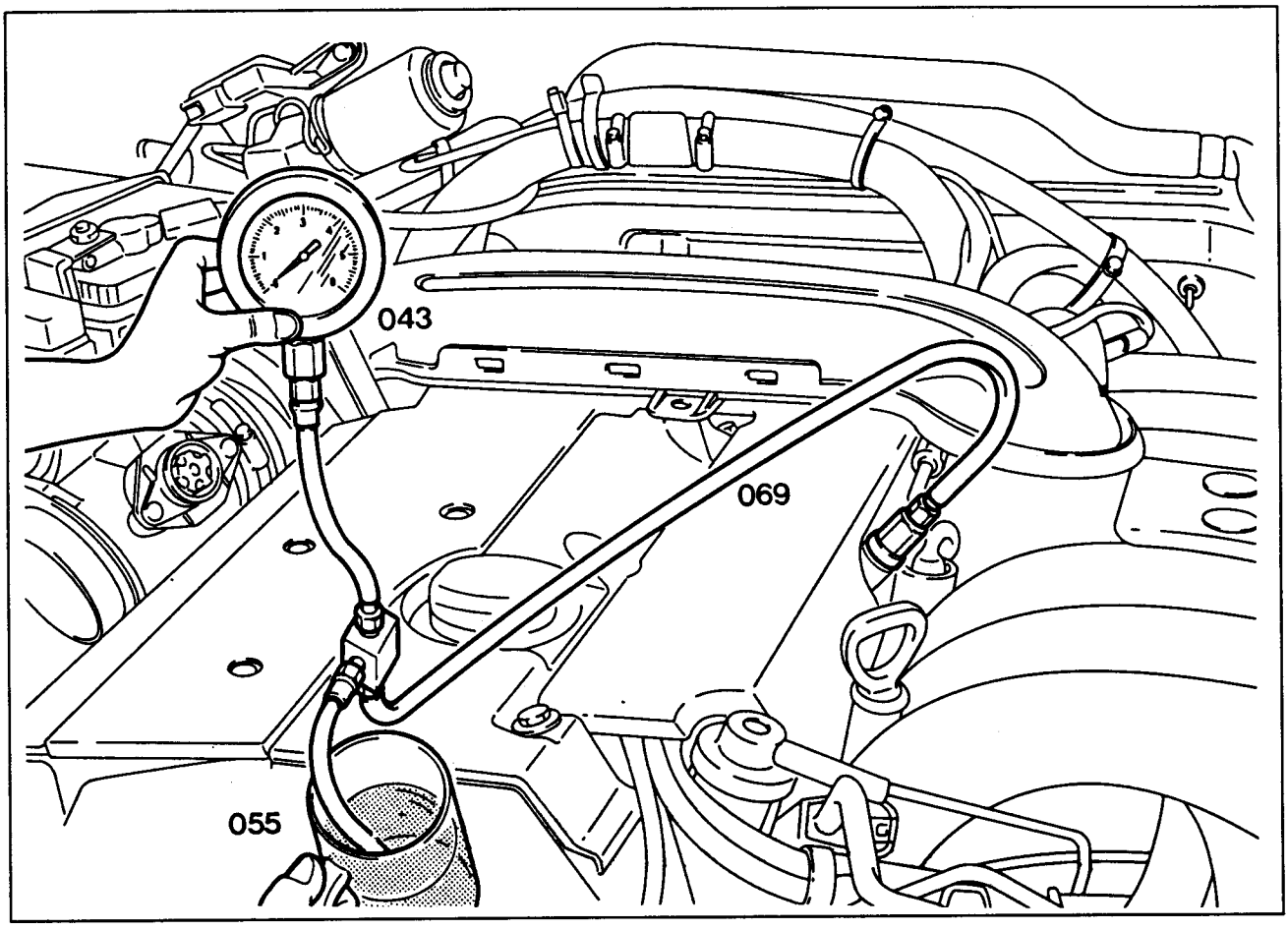
Commercial tools

Multimeter	Fluke, 23 - DB
Measuring glass or measuring beaker (Min. 1 liter), Stop watch	

Testing fuel pumps

Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒1.0	Fuel pumps delivery.	- Bridge no.29 and no. 39 terminal of ECU max. 30 seconds. - Prepare the measuring beaker. - Ignition switch : ON	Approx. 1 ℓ	- Fuel filter and connecting points of fuel line. - ⇒2.1
⇒2.0	Current consumption of fuel pump.	- Remove the fuel pump relay. Using a multimeter, connect no.1 and no.3 terminal. - Ignition switch : ON	4 ~ 7 A	- Fuel pump. **[Note] If current consumption is >7A, replace fuel pump relay.**

(5) Fuel pressure and internal leakage test



043 Pressure Measuring Device
055 Measuring Beaker
069 Pressure Hose

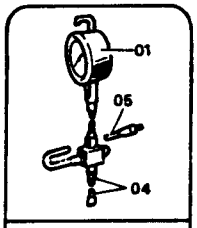
Preparation of Test

1) Position the ignition switch 'OFF'.

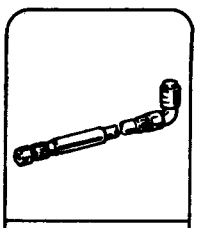
2) Connect the pressure measuring device and pressure hose to the fuel pressure check plug.

3) Prepare a measuring beaker.

Special tools



103 589 00 21 00



119 589 04 63 00

Fuel pressure and internal leakage test

Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒1.0	Fuel pressure at idling (with vacuum).	Engine : - Idling. - Tighten the valve of pressure measuring device.	3.2 ~ 3.6 bar	- Diaphragm pressure regulator. - Refer to test of fuel pumps.
⇒2.0	Fuel pressure at idling (without vacuum).	Engine : - Idling. - Disconnect the vacuum hose at diaphragm pressure regulator.	3.7 ~ 4.2 bar	- Diaphragm pressure regulator.
⇒3.0	Internal leakage of fuel system.	- Ignition switch : - OFF - After 30 minutes	 >3.0 bar >2.5 bar	- Rapid pressure drop : check valve of fuel pumps. - Slow pressure drop : · Refer to fuel injection valves test. · Diaphragm pressure regulator or O-rings.

(6) Fuel injection system test

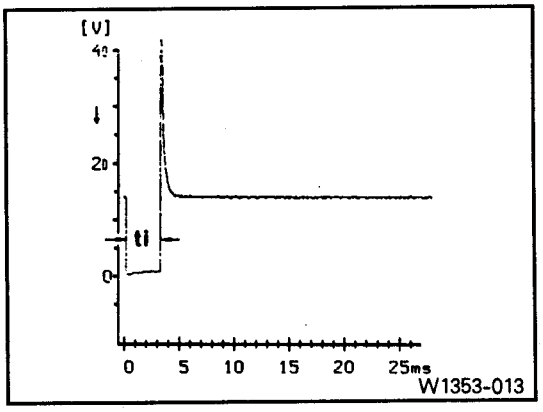
Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒1.0	Voltage supply.	- Check ECU terminal 32/33 (-), 40 (+). - Ignition switch : ON	11 ~ 14V	- ⇒1.1
⇒1.1	Battery ground (W10).	- Check ECU terminal 32/33 (-), 27/39/40 (+) - Ignition switch : ON	11 ~ 14V	- Ground cable (W10) (Fig. no. 4). - ⇒1.2
⇒1.2	Voltage supply terminal 30.	- Check diagnosis box no. 1 (-), ECU terminal 40 (+). - Ignition switch : ON	11 ~ 14V	—
⇒2.0	Voltage supply terminal 87U	- Check ECU terminal 32 (-), 39 (+). - Ignition switch : ON	11 ~ 14V	- ⇒2.1
⇒2.1	Electronics ground (W10/1)	- Check voltage ECU terminal 32 (-), 27/39/40 (+) - Ignition switch : ON	11 ~ 14V	- Ground cable (W10/1). - ⇒2.2
⇒2.2	Voltage supply terminal 87U.	- Check voltage ECU terminal 32/33 (-), 39 (+).	- Ignition ON : 11 ~ 14V - Ignition OFF : < 1V	- Wiring. - Overvoltage protection relay. - Ignition switch.
⇒3.0	Voltage supply terminal 87M.	- Check voltage ECU terminal 66 (-), 27 (+). - Ignition switch : ON	11 ~ 14V	- Cable, fuse. - Overvoltage protection relay. - ⇒3.1
⇒3.1	Electronics ground (W10/1)	- Check voltage ECU terminal 66 (-), 27/39/40 (+) - Ignition switch : ON	11 ~ 14V	- Ground cable (W10/1). - Diagnosis box plug connection.
⇒4.0	Voltage of HFM sensor.	- Check voltage ECU terminal 66 (-), 49 (+). - Engine : idling. - Coolant temperature : >70℃	0.8 ~ 1.1V	- Wiring. - ⇒4.1 - ⇒5.0 - HFM sensor.
⇒4.1	Voltage supply.	- Check voltage ECU terminal 71 (-), 39 (+). - Ignition switch : ON	11 ~ 14V	- ECU
⇒5.0	Ground cable resistance of HFM sensor.	- Check resistance ECU terminal 71 (-), 32 (+). - Ignition switch : OFF - Disconnect ECU no.2 coupling.	< 20Ω	- Ground cable.

Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒6.0	Fuel pumps relay voltage.	- Check voltage ECU terminal 32 (-), 29 (+). - Engine : starting.	11 ~ 14V (When starting)	- ⇒6.1 - ECU
⇒6.1	Current consumption.	- Check current ECU terminal 32 (-), 29 (+). - Ignition switch : ON	4 ~ 7A	- Wiring. - Fuel pump relay.
⇒7.0	Starter signal terminal 50.	- Check voltage ECU terminal 32 (-), 21(+). - Engine : starting.	11 ~ 14V (When starting)	- Cable.
⇒8.0	Coolant temperature sensor voltage.	- Check voltage ECU terminal 72 (-), 80 (+). - Ignition switch : ON	℃ V 20 3.5 30 3.1 40 2.7 50 2.7 60 1.9 70 1.5 80 1.2 90 1.0 100 0.8 ±5%	- ⇒8.1 - ECU
⇒8.1	Resistance.	- Check resistance ECU terminal 72 (-), 80 (+). - Ignition switch : OFF - Disconnect ECU coupling no. 2.	℃ Ω 20 2500 30 1700 40 1170 50 830 60 600 70 435 80 325 90 245 100 185 ±5%	- Wiring. - ⇒8.2
⇒8.2	Coolant temperature sensor resistance	- Check resistance of sensor terminal 1 and 2. - Disconnection of coolant temperature sensor connector.	Refer to ⇒8.1	- Coolant temperature sensor.
⇒9.0	Intake air temperature sensor voltage.	- Check voltage ECU terminal 72 (-), 81 (+). - Ignition switch : ON	℃ V 10 3.2 20 2.6 30 2.1 40 1.6 50 1.2 60 0.9 70 0.7 80 0.5 ±5%	- ECU - ⇒9.1

Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒9.1	Resistance.	- Check ECU terminal no.72 (-), 81 (+). - Ignition switch : OFF - Disconnection of ECU coupling no.2.	℃ Ω 10 9670 20 6060 30 3900 40 2600 50 1760 60 1220 70 860 80 620 ±5%	- Cable. - ⇒9.2
⇒9.2	Resistance of intake air temperature sensor.	- Disconnect sensor connector and check resistance.	Refer to 9.1	- Intake air temperature sensor.
⇒10.0	Input voltage of oxygen sensor.	- Check input voltage of ECU terminal no.34 (-), 35 (+). - Engine : idling.	0~1V	- Oxygen sensor. - ⇒11.0
⇒11.0	Voltage of oxygen sensor heater.	- Check ECU terminal no.32 (-), 30 (+). - Engine : idling. - Coolant temperature : > 60℃	11~14V	- ECU - ⇒11.1
⇒11.1	Current consumption.	- Check ECU terminal no.30 (-), 39 (+). - Ignition switch : ON	1.1~3.4A	- Wiring. - Oxygen sensor.
⇒12.0	- Operation of fuel injection valve. - Injection timing output pulse signal (Using a oscillo - scope).	- No.1 injection valve ECU terminal 27, 67. - No.2 injection valve ECU terminal 27, 57. - No.3 injection valve ECU terminal 27, 46. - No.4 injection valve ECU terminal 27, 47. - No.5 injection valve ECU terminal 27, 56. - No.6 injection valve ECU terminal 27,68.	- When starting : approx. 8ms - Idling : approx. 3~5ms · Refer to Fig.1 - Full throttle : approx.17ms · Refer to Fig.2	- ⇒12.1 - Coolant temperature sensor. - Intake air temperature sensor. - Oxygen sensor. - ECU - ⇒3.1
⇒12.1	Fuel injection valve resistance.	- Check resistance at ends of injection valve.	- 15 - 17Ω when injection valve coupling is connected.	- Cable. - Injection valve.

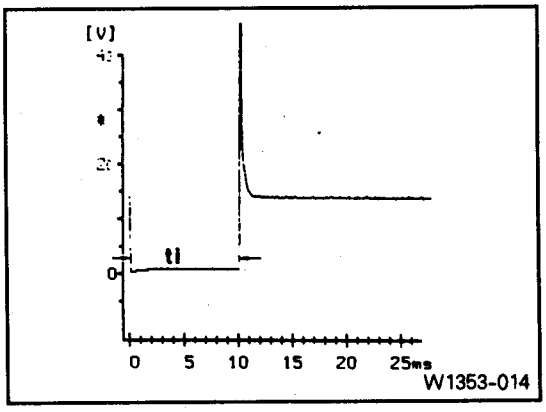
Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒13.0	HFM resistance trimming plug voltage.	- Check voltage ECU terminal 5 (-), 6 (+). - Ignition switch : ON	Position V 1 1.25 2 1.97 3 2.80 4 3.42 5 3.88 6 4.27 7 4.60	- ⇒13.1 - ECU
⇒13.1	Resistance.	- Check resistance ECU terminal 5 (-), 6 (+). - Ignition switch : OFF - Disconnect ECU coupling no.1.	Position Ω 1 249 2 487 3 953 4 1620 5 2610 6 4420 7 8660 ±5%	- Cable. - HFM resistance trimming plug.
⇒14.0	Vehicle speed input voltage.	- Check input voltage ECU terminal 32 (-), 8 (+). - Ignition switch : ON - Turn the wheel by hand.	> 3V	- Wheel speed sensor.
⇒15.0	Operation of canister purge solenoid valve and pulse signal (Using a oscilloscope).	- Check ECU terminal 27, 43. - Engine : idling. - Coolant temperature : 80℃	Refer to Fig. 3	- ⇒15.1 - ECU
⇒15.1	Current consumption.	- Check current ECU terminal 32 (-), 43 (+). - Ignition switch : OFF	0.2 ~ 0.3A	- Cable. - Canister purge solenoid valve.
⇒16.0	Camshaft timing actuator current consumption.	- Check current of terminal 1, 2 after disconnecting actuator connector. - Engine : approx. 3,000RPM	Approx. 1~1.5A	- ⇒16.1 - ⇒17.0 - ECU
⇒16.1	Resistance.	- Check resistance ECU terminal 45 (-), 53 (+).	4 ~ 8Ω	- Wiring. - Camshaft timing actuator.
⇒17.0	Camshaft timing actuator operation.	- Bridge ECU terminal 45, 66 about 10 sec. - Engine : idling.	Engine does not run smoothly or stops.	- Camshaft timing actuator.

Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒18.0	Variable intake switchover valve operation voltage.	- Check voltage ECU terminal 58 (-), 27 (+). - Engine : start.	- Engine RPM < 3,500 : 0 V - Engine RPM > 3,500 : 11 ~ 14 V	- ⇒18.1 - ECU
⇒18.1	Current consumption.	- Check current ECU terminal 32 (-), 58 (+). - Ignition switch : ON	0.4 ~ 0.6A	- Cable. - Variable intake switchover valve.
⇒19.0	Selector lever position operation voltage.	- Check voltage ECU terminal 20 (-), 39 (+). - Ignition switch : ON	P : 11 ~ 14 V R : < 1 V N : 11 ~ 14 V D/3/2 : < 1 V	- Cable. - Starter lockout switch. - Reverse switch.



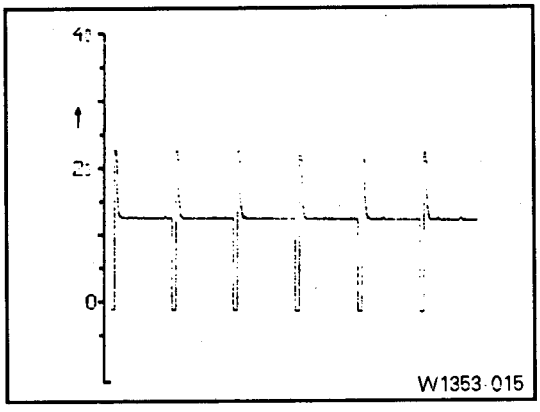
(Fig. 1)

Injection time signal of fuel injection valve at idle



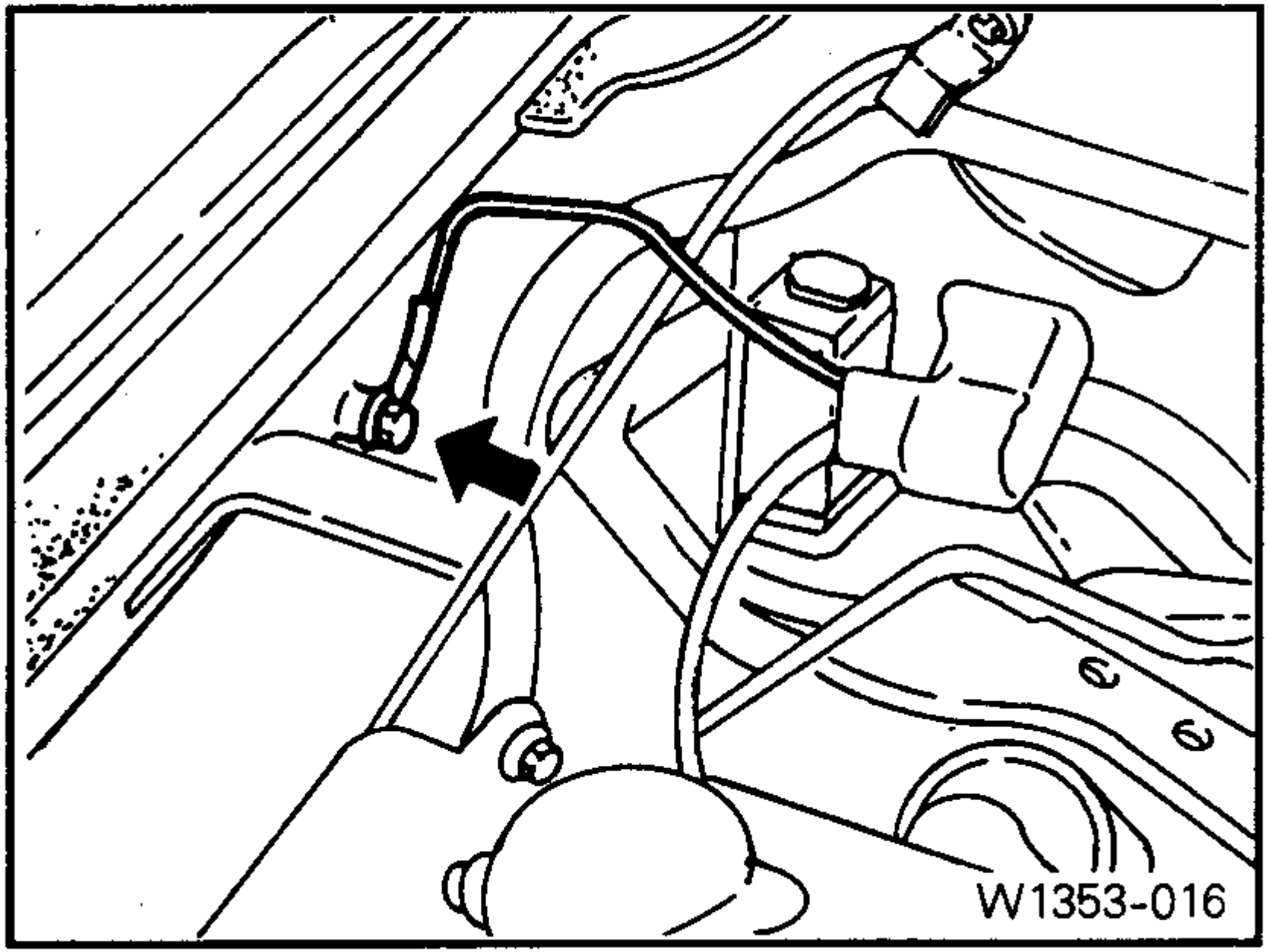
(Fig. 2)

Injection time signal of fuel injection valve at full throttle



(Fig. 3)

Canister purge solenoid valve operation signal

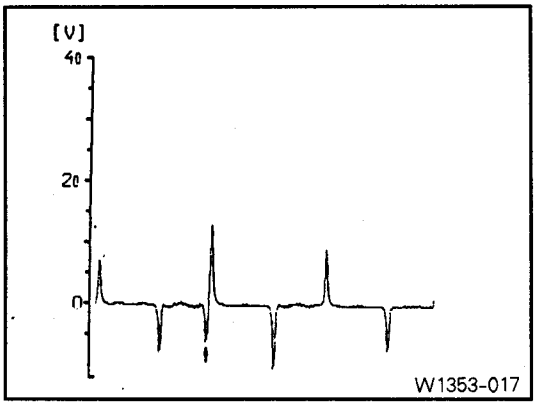


W10 Battery Ground (Fig. 4)

(7) Ignition system test

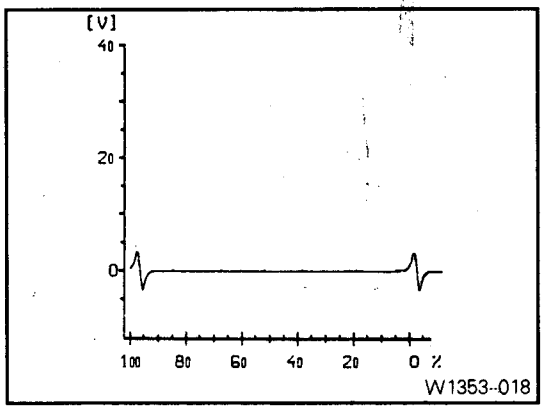
Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒1.0	Ignition coil voltage supply.	- Ignition coil 2, 5 : ECU terminal 27, 53. - Ignition coil 3, 4 : ECU terminal 27, 54. - Ignition coil 1, 6 : ECU terminal 27, 65.	- Ignition switch ON : 11 ~ 14 V - Starter motor operating : 210 V	- Ignition coil cable.
⇒2.0	Crankshaft position sensor input voltage and segment solenoid pulse signal.	- Check voltage ECU terminal 73 (-), 74 (+). - Check signal of ECU terminal 73, 74 (Using a oscilloscope).	- Idling : refer to Fig.1 - Starter motor operating : > 0.4 V ~	- ⇒2.1 - Segment. - Solenoid of starter ring gear.
⇒2.1	Crankshaft position sensor resistance.	- Check resistance ECU terminal 73 (-), 74 (+). - Ignition switch : OFF - Disconnect ECU coupling no.2.	680 ~ 1200Ω	- ⇒2.2
⇒2.2	Crankshaft position sensor insulation resistance.	- Check resistance ECU terminal 32 (-), 74 (+). - Ignition switch : OFF - Disconnect ECU coupling no.2.	> 200KΩ	- Crankshaft position sensor.
⇒3.0	Camshaft position sensor pulse signal and voltage.	- Voltage : check ECU terminal 63 (-), 52 (+). - Pulse signal : check ECU terminal 63, 52 (Using a oscilloscope).	- Engine idle > 0.2 V ~ - Idle : refer to Fig.2	- ⇒3.1 - Check clearance between camshaft position sensor and contacts.
⇒3.1	Camshaft position sensor resistance.	- Ignition switch : OFF - Disconnect ECU coupling no.2. - Check resistance ECU terminal 63(-), 52(+).	900 ~ 1,600Ω	- ⇒3.2
⇒3.2	Camshaft position sensor insulation resistance.	- Ignition switch : OFF - Disconnect ECU coupling no.2. - Check resistance ECU terminal 32 (-), 52 (+).	> 200 KΩ	- Camshaft position sensor.
⇒4.0	A/T overload protection switch voltage.	- Check voltage ECU terminal 33 (-), 9 (+). - Engine : idling.	D : < 1 V P/N : > 4 V	- Cable. - A/T overload protection switch.

Test Step	Test Item	Test Requirements	Standard	Possible Cause
⇒5.0	Ignition coil closing time (Using a oscillo-scope).	- Ignition coil 2, 5 : ECU terminal 53, 39. - Ignition coil 3, 4 : ECU terminal 54, 39. - Ignition coil 1, 6 : ECU terminal 65, 39. - Engine : idling.	4 ~ 6 ms	- ⇒5.1 - ECU
⇒5.1	Ignition coil closed circuit current cutoff.	- Ignition coil 2, 5 : ECU terminal 53, 39. - Ignition coil 3, 4 : ECU terminal 54, 39. - Ignition coil 1, 6 : ECU terminal 65, 39.	- Ignition switch ON : 0 V - Starter motor operating : 0.3 ~ 0.5 V	- Ignition coil.
⇒6.0	Primary voltage of ignition coil (Using a oscilloscope).	- Ignition coil 2, 5 : ECU terminal 53, 27. - Ignition coil 3, 4 : ECU terminal 54, 27. - Ignition coil 1, 6 : ECU terminal 65, 27. - Starter motor : operating.	200 ~ 350 V	- ⇒6.1 - ECU
⇒6.1	Primary winding of ignition coil resistance.	- Ignition coil 2/5, 3/4 : ECU terminal 53, 54. - Ignition coil 3/4, 1/6 : ECU terminal 54, 65. - Ignition switch : OFF	0.9 ~ 1.5Ω	- Ignition coil : 2/5, 3/4, 1/6. - ECU
⇒7.0	Secondary winding of ignition coil resistance.	- Disconnect ignition coil (2/5, 3/4, 1/6) and check resistance.	5.2 ~ 8.5 KΩ	- Ignition coil : 2/5, 3/4, 1/6.



(Fig. 1)

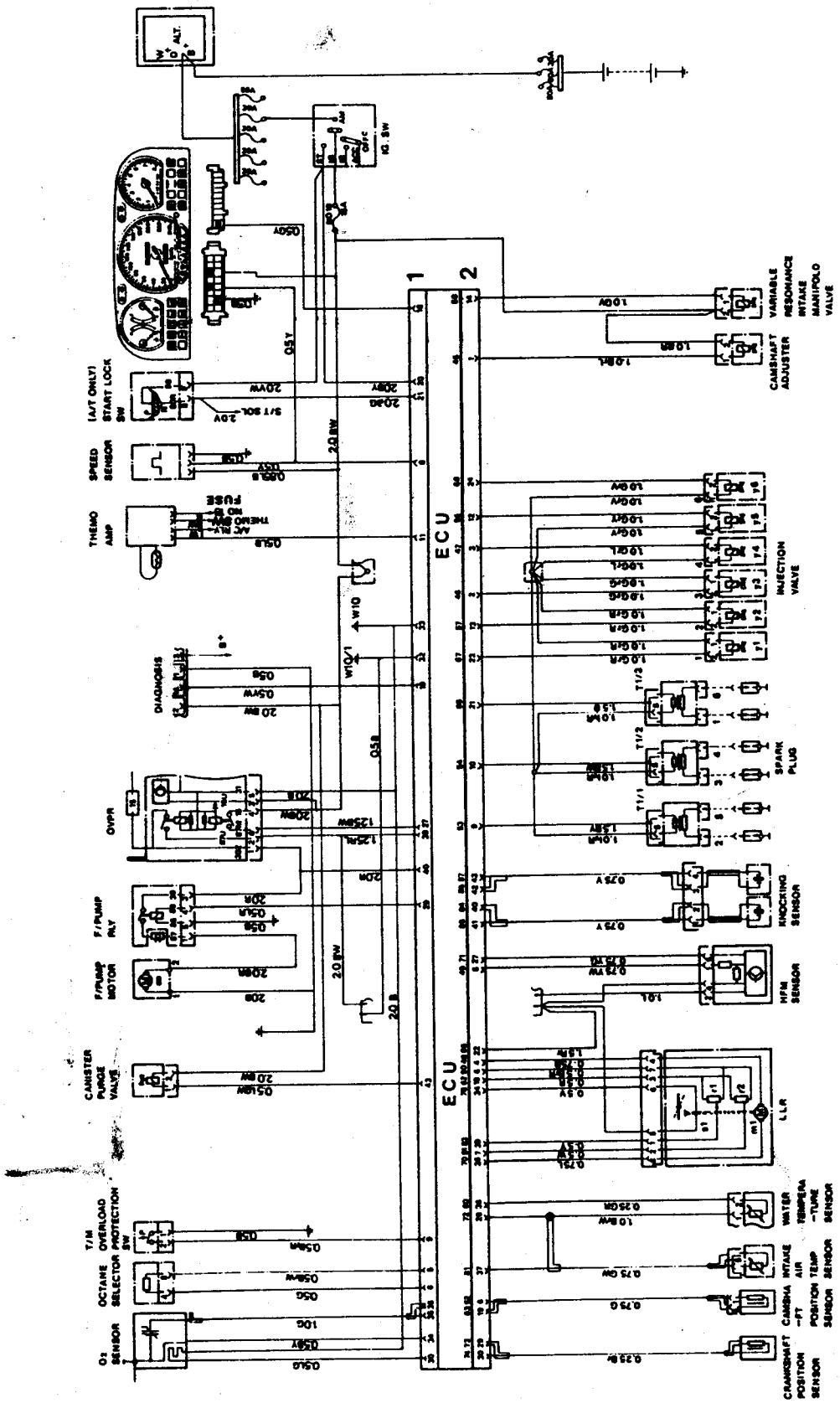
Crankshaft position sensor signal



(Fig. 2)

Camshaft position sensor signal

5. Engine Circuit Diagram



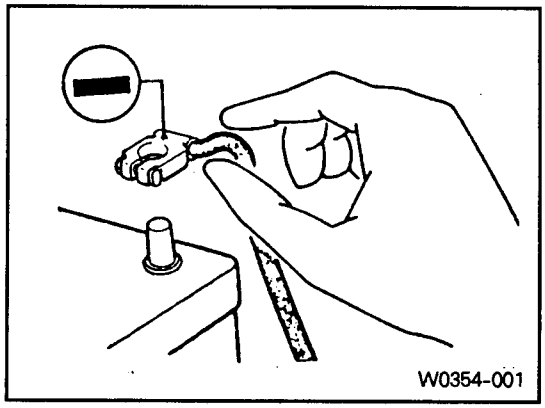
1. General

Specifications

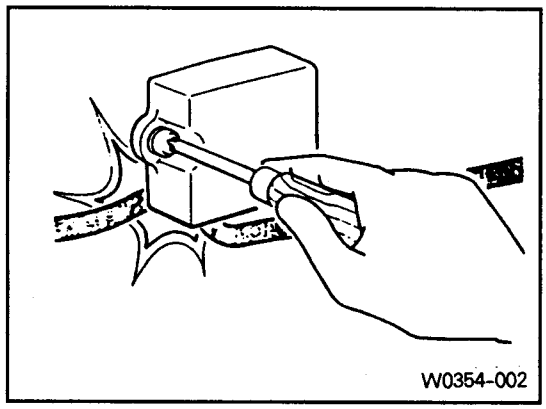
Battery	Type		MF Battery
	Capacity		85Ah
	Voltage		12V
Starter motor	Rated voltage		12V
	Rated out-put		2.2kw
Alternator	Rated out-put		75A
Head lamp	Wattage × No.	Low beam	60W×2
		High beam	55W×4
Turn signal lamp	Wattage × No.	Front	21W×2
		Rear	21W×2
Parking lamp	Wattage × No.		5W×2
Stop lamp	Wattage × No.		21W×4
Back-up lamp	Wattage × No.		21W×2
Position Lamp	Wattage × No.		5W×4
Fog lamp	Wattage × No.	Round	55W×2
		Rectangular	55W×2
Room lamp	Wattage × No.	Front	10W×1, 8W×2
		Rear	8W×2
		Luggage room	8W×1
Door courtesy lamp	Wattage × No.		5W×2
License plate lamp	Wattage × No.		5W×2
Combination switch	Lamp switch	Capacity	0.2 ± 0.05A
		Operating torque	14.5 ± 0.5kg.m
	Turn signal switch	Capacity	7.5A
		Operating torque	N→R, L : 0.8 ± 0.2kg.m
			R, L→N : 0.6 ± 0.2kg.m
	Dimmer & passing switch capacity	High beam	20A
		Low beam	10A
		Passing	20A
	Washer switch capacity		4A
	Horn switch capacity		7A

Precautions for inspection

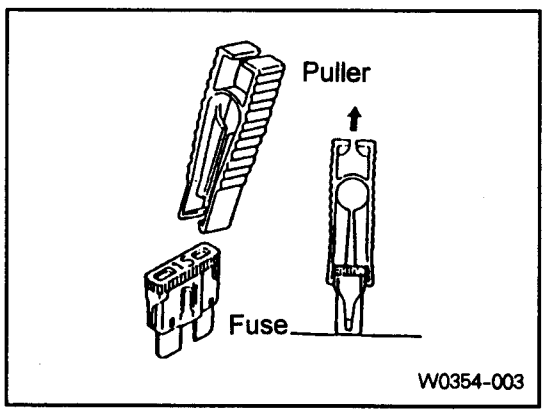
1) Always disconnect negative battery terminal before inspection.
   [Note] Turn off all electrical components and the ignition switch before disconnection.



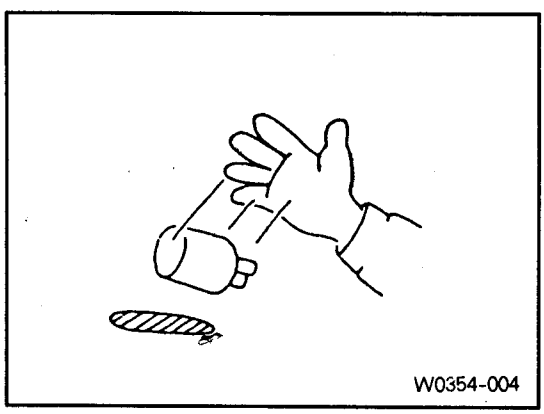
2) Be careful not to damage or chafe wires and connectors during service.



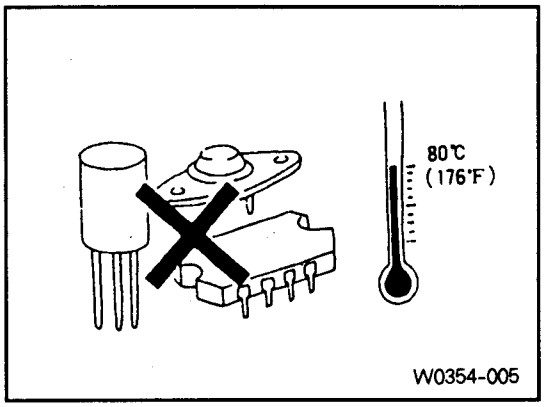
3) Install a new fuse or relay with specified capacity.
   [Note] Do not replace with overspecified or wires. This may damage the parts or cause fire on vehicle itself.



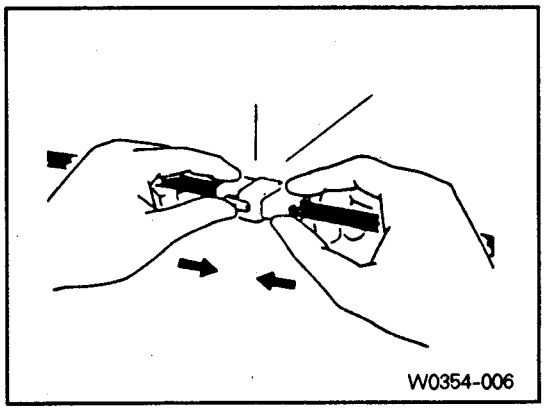
4) Be careful not to drop or shock the sensors or relays.



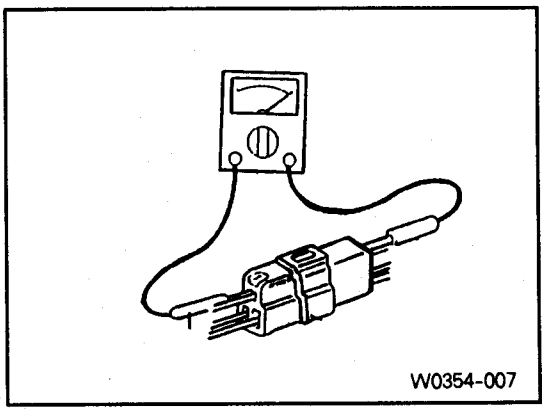
5) Keep the sensors or relays, very sensitive to heat, where ambient temperature is below 80℃ (176 F).



6) When connecting connectors, insert them until a 'click' sound is heard.
[Note] Do not pull the harness when disconnecting the connector but push the lock key and pull out.

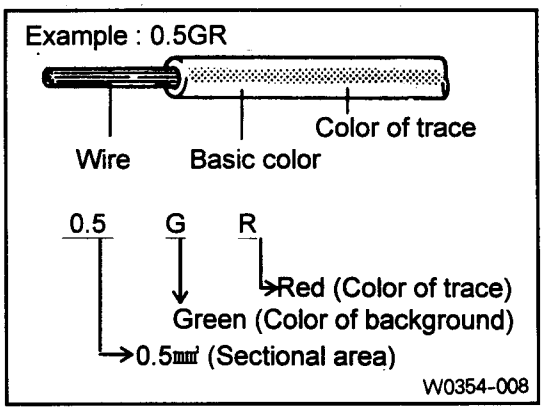


7) The tester probe is inserted only from the wire harness side.
[Note] Be careful not to damage the insulator.



Wires

1) Wiring color code.
The codes used in the wiring diagram represent the thickness of wires and color of insulator.
[Example] 0.5 : Thickness of wire (0.5㎟)
G : Background color of vinyl insulator
R : Color of trace



2) Color code

Code	Color	Code	Color
B	Black	Y	Yellow
L	Blue	Lg	Light Green
W	White	Gr	Gray
Br	Brown	O	Orange
G	Green	P	Pink
R	Red	V	Violet

3) Wire size

Size of wire (㎟)	SAE No.	Maximun allowable Current (A) (Ambient temperature : below 40℃)
0.5	AWG 20	9A
0.85	AWG 18	12A
1.25	AWG 16	15A
2.0	AWG 14	20A
3.0	AWG 12	28A
5.0	AWG 10	37A

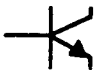
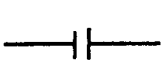
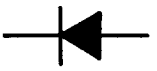
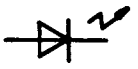
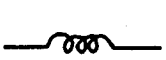
- The maximum allowable current for a wire varies depending on its size (Cross-sectional area). So the wire should be correctly selected according to electric load. The size of the wire varies depending on its length, ambient temperature, and length of time current is applied.

Abbreviations

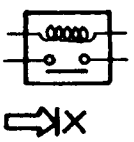
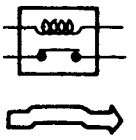
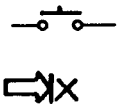
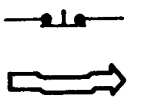
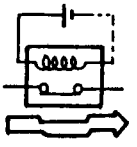
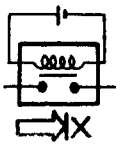
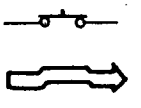
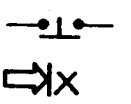
Abbreviation	Item	Abbreviation	Item
ABS	Antilock Braking System	MTR	Motor
A/C	Air Conditioner	M/TM	Manual Transmission
ACTR	Actuator	NC	Normal Closed
ACCEL	Accelerator	NO	Normal Open
BATT	Battery	O/S	Outside
B/O	Black - out	P/Ant	Power Antenna
CDS/Fan	Condenser Fan	PLA	Pneumatic Idle Speed Increase
DEF	Defogger	POS	Position
D/LOCK	Door Lock	PRES'	Pressure
DOM	Domestic	P/WDW	Power Window
Driv'g	Driving	RHEO	Rheostat
D/P	Dual Pressure Switch	RH	Right
ENG	Engine	RLY	Relay
EXP	Export	RR	Rear
FRT	Front	S/BELT	Seat Belt
F/Link	Fusible Link	SIG	Signal
G/Box	Glove Box	S/LP	Stop Lamp
Hi	High	SOL	Solenoid
H/LP	Head Lamp	S/ROOF	Sun Roof
HTD	Heated	T/Gate	Tailgate
IND	Indicator	T/LP	Tail Lamp
LH	Left	TS	Tail Switch
LP	Lamp	TWCS	Time and Warning Control System
STICS	Super Time and Integrated Control System	TACIS	Time Alarm Control Integrated System

Electrical symbols

1) Symbols

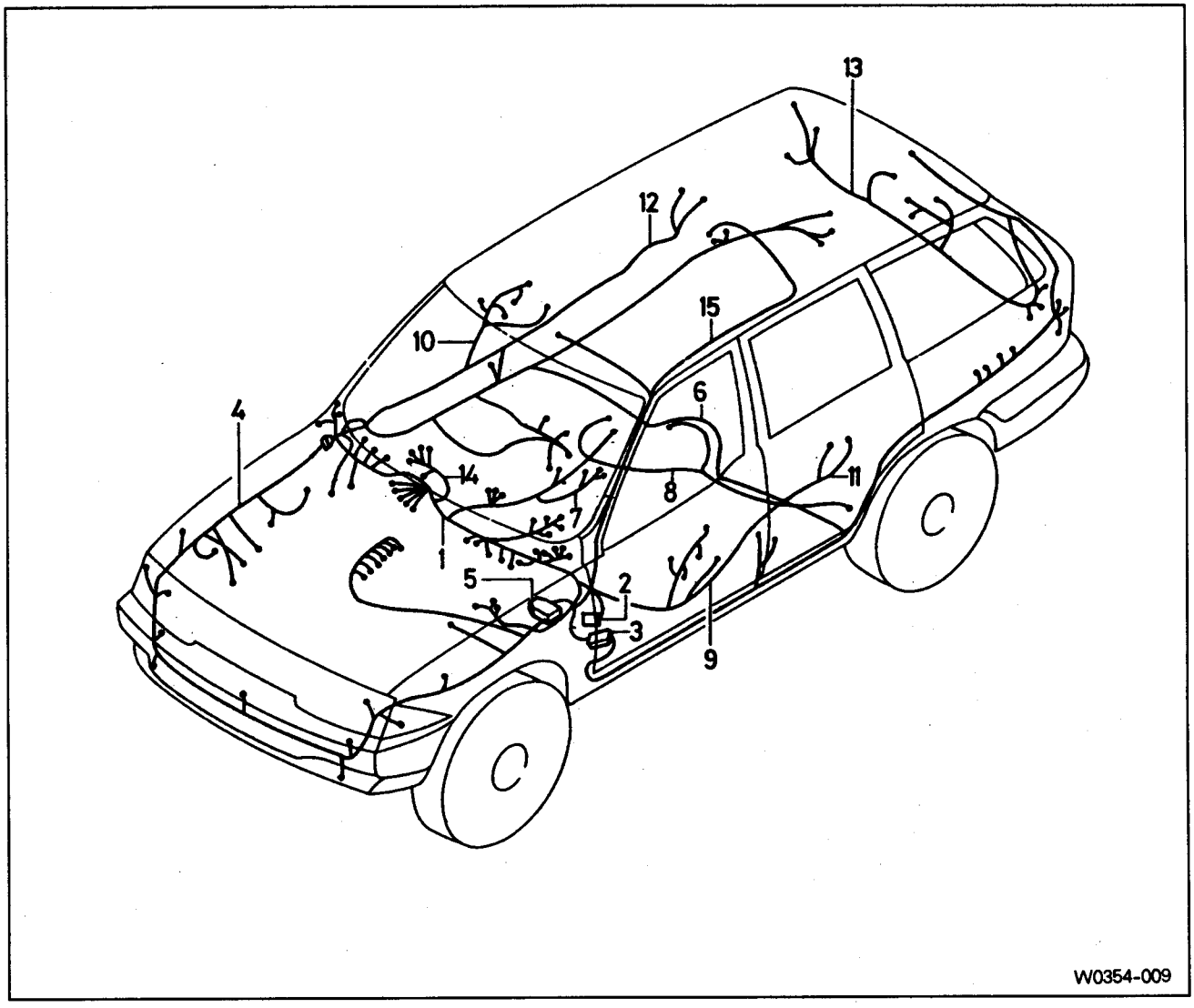
Symbol	Item	Symbol	Item	Symbol	Item
	Fuse		Battery		NPN Transistor
	Fusible Link		Disconnect Wiring		PNP Transistor
	Motor		Connect Wiring		Indicator
	Switch		Lamp		Thermistor
	Ground		Double Bulb		Amperemeter
	Condenser		Diode		Voltmeter
	Resistor		Zener Diode		Single Bulb
	Variable Resistor		LED		
	Coil		PTC (LED)		

2) Relays and switches

Type	Relay		Switch	
	NO Type Relay	NC Type Relay	NO Switch	NC Switch
OFF	 Does not flow	 Flows	 Does not flow	 Flows
ON	 Flows	 Does not flow	 Flows	 Does not flow

[Note] NO : Normal Open, NC : Normal Closed

2. Wiring Harness



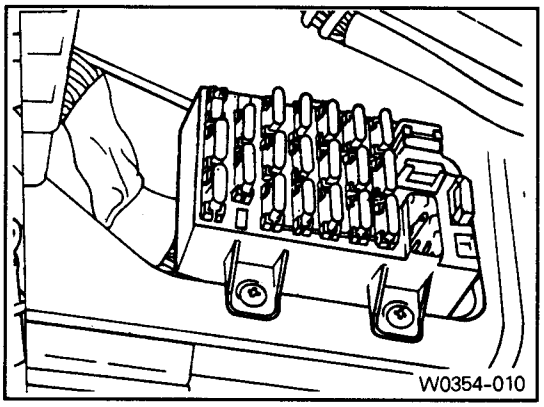
1. Main Wiring Assembly
2. Fuse Box
3. Relay Box
4. Engine Wiring
5. Relay and Fuse Box
6. Floor Wiring
7. Transfer Case Wiring
8. ABS Control Wiring
9. Front Door Wiring (Left)
10. Front Door Wiring (Right)
11. Rear Door Wiring (Left)
12. Rear Door Wiring (Right)
13. Tailgate Wiring
14. Air Conditioner Wiring
15. Roof Wiring

3. Fuse Box

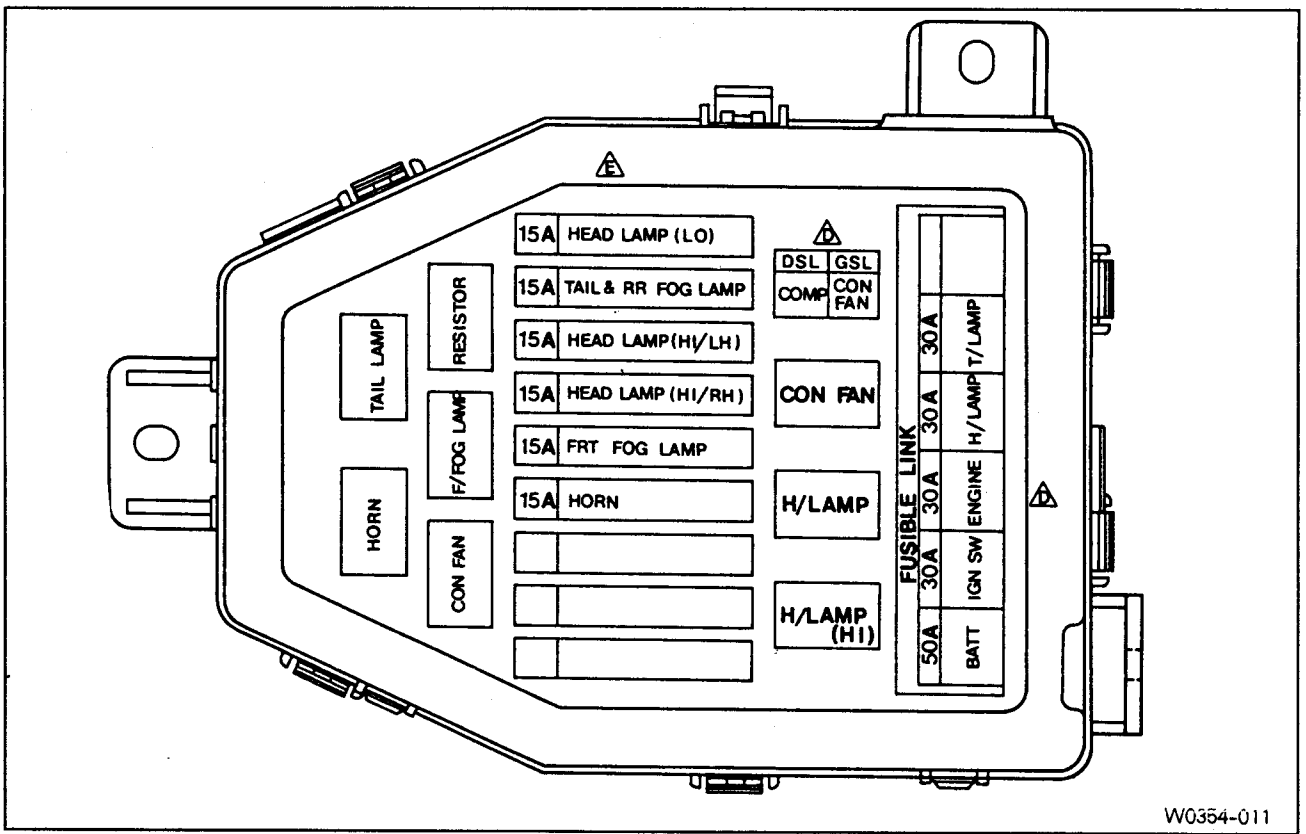
1) Fuse box - In vehicle

1 15 A	ABS	2 20 A	Sun Roof	3	—	4 15 A	Audio, O/S Mirror, Clock	5 20 A	C/Lighter

6 30 A	Heater	11 10 A	P/Antenna	16 15 A	T/sig LP, H/LP RLY	7 15 A	Door Lock	12 20 A	T/C	17 10 A	B/up LP
8 20 A	Heated Glass	13 10 A	Room LP	18 15 A	STICS, Cluster, A/Con	9 10 A	Audio, Buzz Chime, STICS	14 15 A	Hazard warning	19 15 A	Front Wiper Washer
10 30 A	P/Window	15 15 A	Stop LP	20 10 A	Rear Wiper Washer						



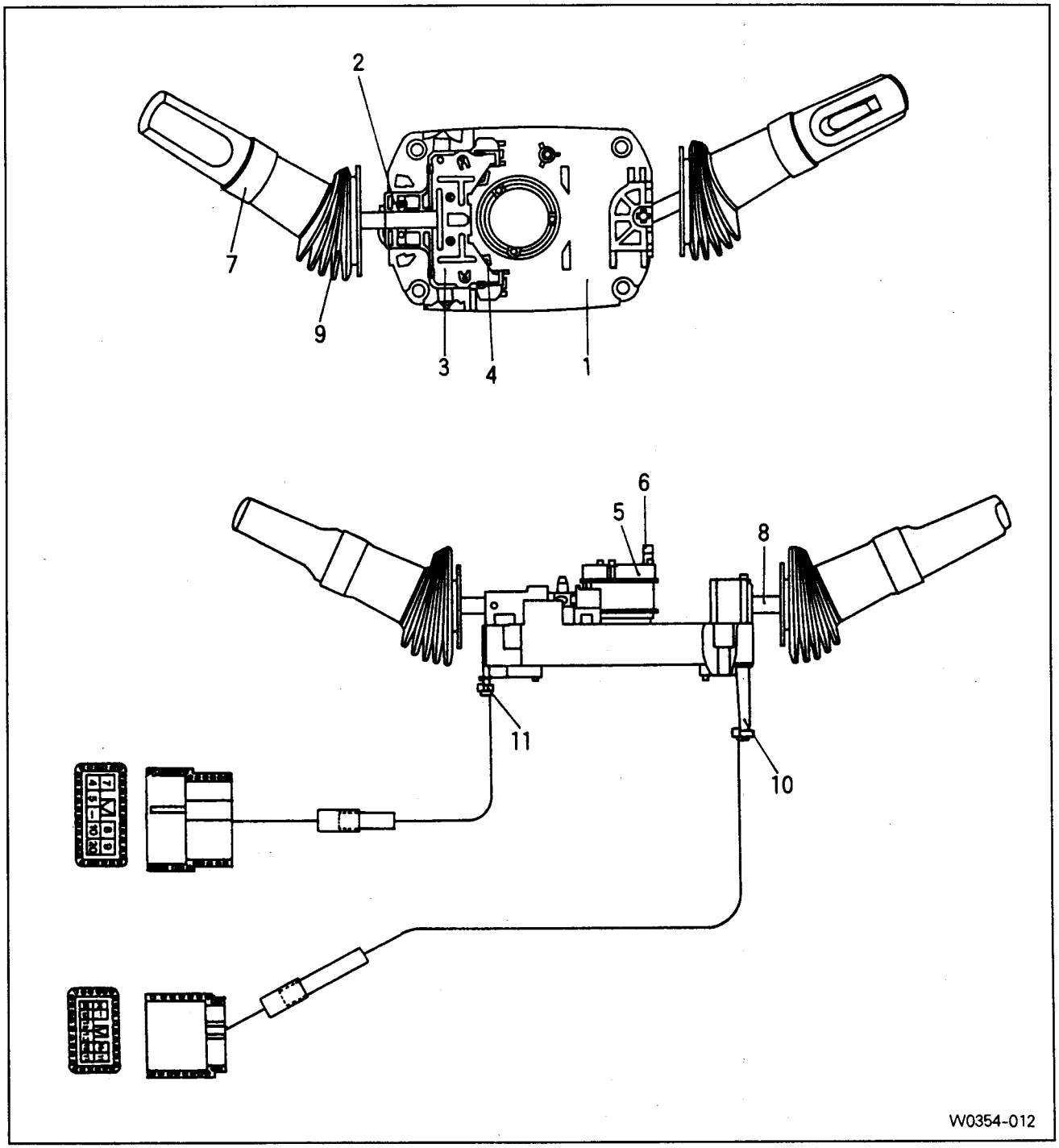
2) Fuse box - Engine room



[Note] Use fuse or relay as specified.

4. Combination Switch

Components



1. Body
2. T/S T-Mold
3. Guide Plate
4. Cancel Cam
5. Cancel Claw
6. Horn Contact
7. Knob
8. Lever
9. Protector
10. Protector
11. Cable Tip

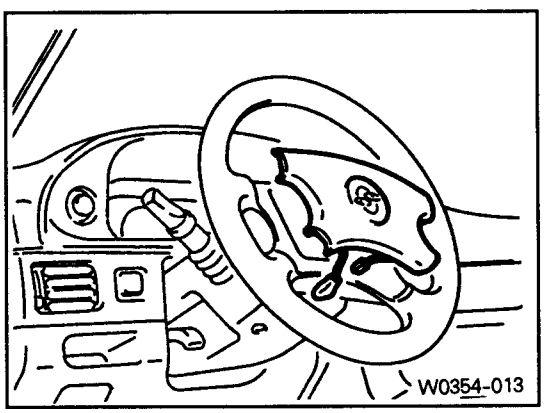
Connector.

Terminal	Position	Wire	Connection	Terminal	Position	Wire	Connection
1	EB	1.25B	Ground-H/LP Beam	11	HO	0.5BN	Horn
2	HU	1.25RL	H/LP Upper Beam	12	W	0.5LY	Washer
3	HL	1.25RBr	H/LP Lower Beam	13	P	0.85GB	Wiper parking
4	TS	0.3R	Tail Lamp S/W	14	HI	0.85RB	Wiper (Hi)
5	HS (1)	0.3LW	H/LP Switch	15	INT	0.5G	Wiper (INT)
6	HS (2)	1.25LW	H/LP - Passing	16	LO	0.85GR	Wiper (Low)
7	TB	0.85GR	Flasher Unit	17	E	0.85B	Ground - Wiper
8	TL	0.5W	T/Signal-Left	18	Re	0.3LgW	Resume (Speed)
9	TR	0.5Y	T/Signal-Right	19	SET	0.3LW	Set (Speed)
10	ES	0.3B	Ground-H/LP S/W	20	F	0.3LgW	Fog Lamp-Rear

Removal · Installation

1) Remove the horn cover.

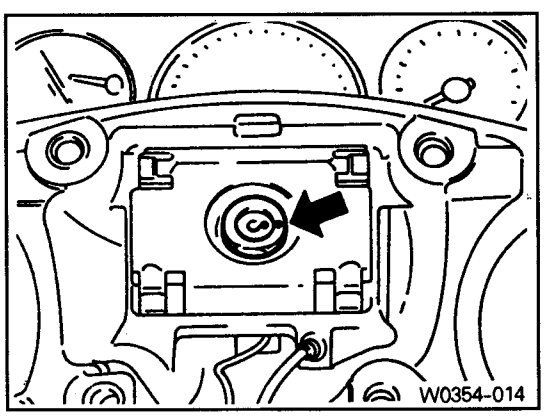
2) Remove the horn pad from the steering wheel and disconnect the connectors.



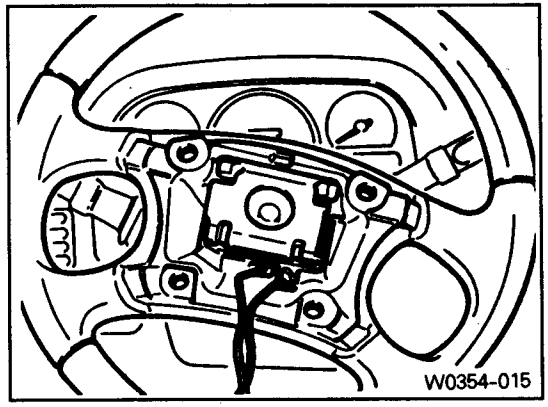
3) Place alignment marks on the column shaft and fixing nut and remove the fixing nut.

Installation

Tightening torque	50~80Nm

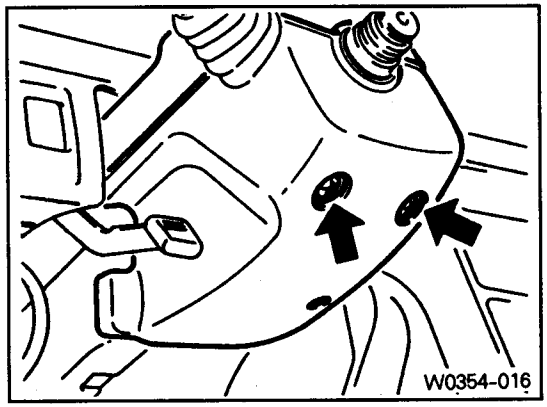


4) Remove the steering wheel damper and steering wheel.



5) Remove the steering column cover.

6) Disconnect each connectors.

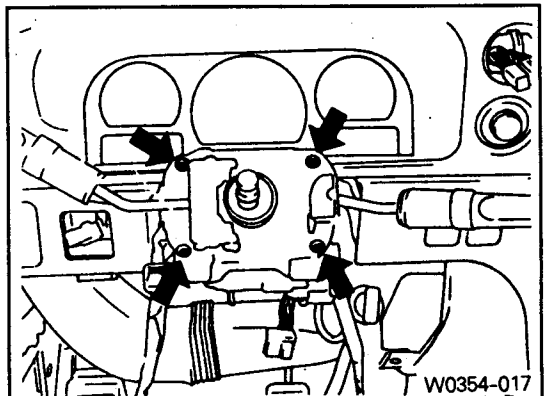


7) Remove the 4 bolts and combination switch assembly.

Installation

Tightening torque	2~4Nm

8) Installation is reverse order of the removal.



Inspection

1) Light Switch.

Position \ Terminal	TS	HS (1)	ES	F
OFF				
I	○		○	
II	○	○	○	○

2) Dimmer and passing switch.

Position \ Terminal	EB	HL	HU	HS (2)
High Beam	○		○	
Low Beam	○	○		
Passing	○		○	○

3) Turn signal switch.

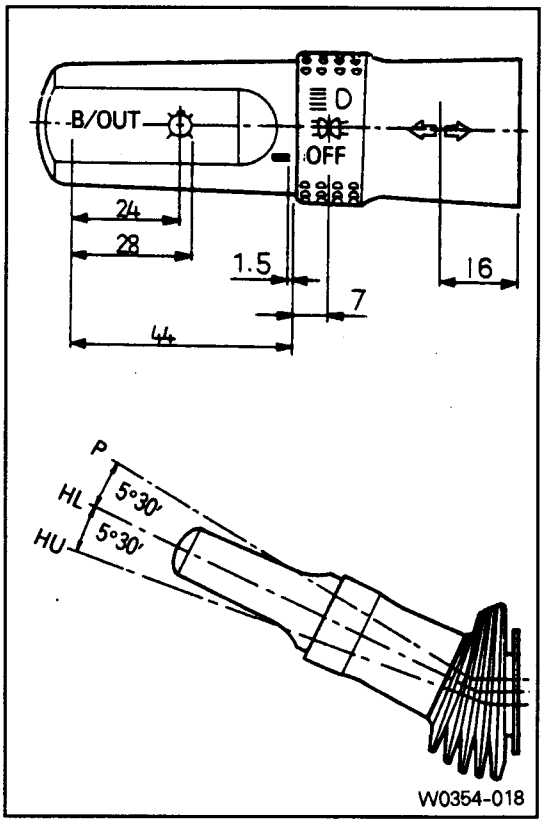
Position \ Terminal	TB	TL	TR
L	○	○	
N			
R	○		○

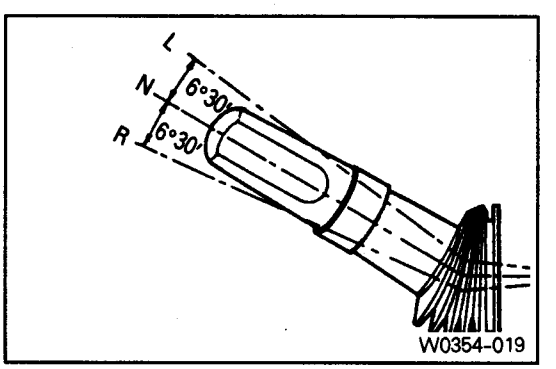
4) Wiper switch.

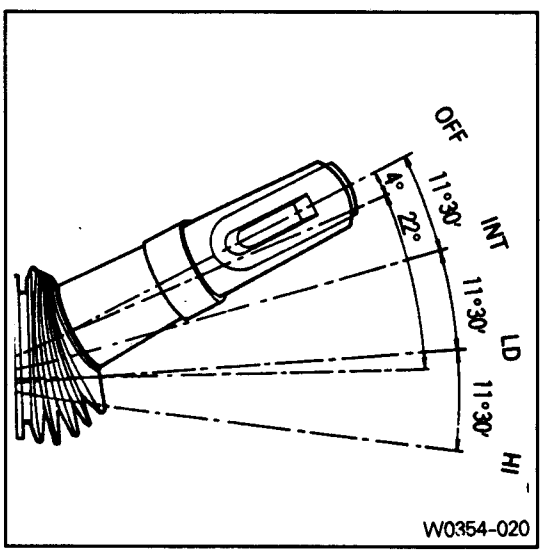
Position \ Terminal	LO	HI	P	INT	E
OFF	○		○		
INT	○		○	○	○
LOW	○				○
HI		○			○

5) Washer switch

Position \ Terminal	W	E
OFF		
ON	○	○

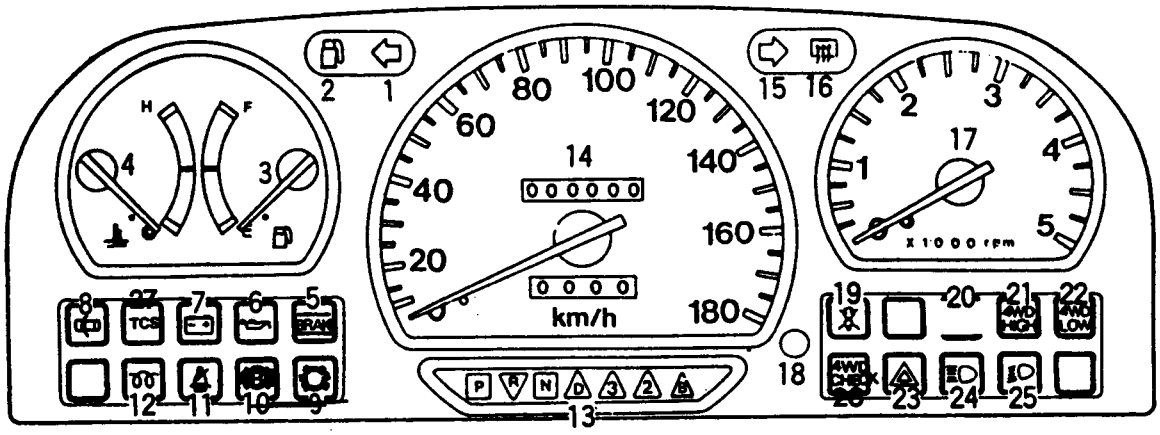






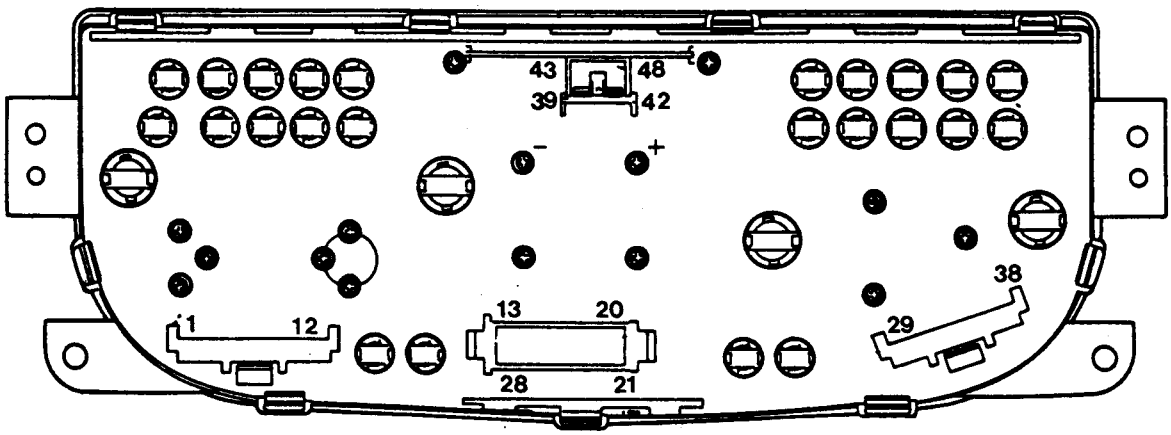
5. Combination Meter

[Diesel] - Components



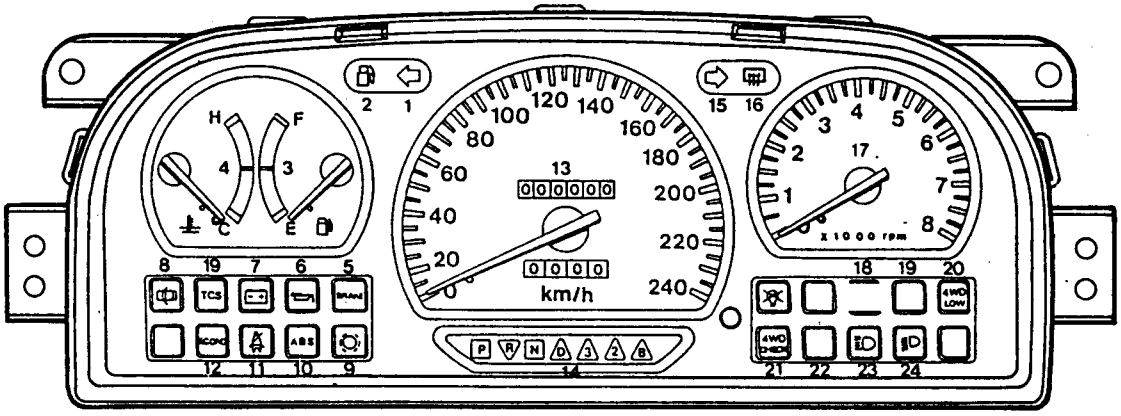
1. Turn Signal Indicator Light - Left
2. Low Fuel Level Warning Light
3. Fuel Gauge
4. Water Temperature Gauge
5. Brake & Parking Brake Indicator
6. Low Oil Pressure Warning Light
7. Discharge Warning Light
8. Door Ajar Warning Light
9. Pad Wear Warning Light - Front
10. ABS Warning Light
11. Seat Belt Reminder Light
12. Glow Indicator Light
13. Selector Lever Position Light
14. Speedometer
5. Turn Signal Indicator Light - Right
6. Rear Window Defogger Indicator Light
17. Tachometer
8. Odometer Reset Button
19. Stop Lamp Failure Warning Light
20. 2WD Indicator Light
21. 4WD High Indicator Light
22. 4WD Low Indicator Light
23. Hazard Warning Light
24. High Beam Indicator Light
25. Low Beam Indicator Light
26. 4WD CHECK Warning Light
27. TCS (ABS) Warning Light

Symmetrical view



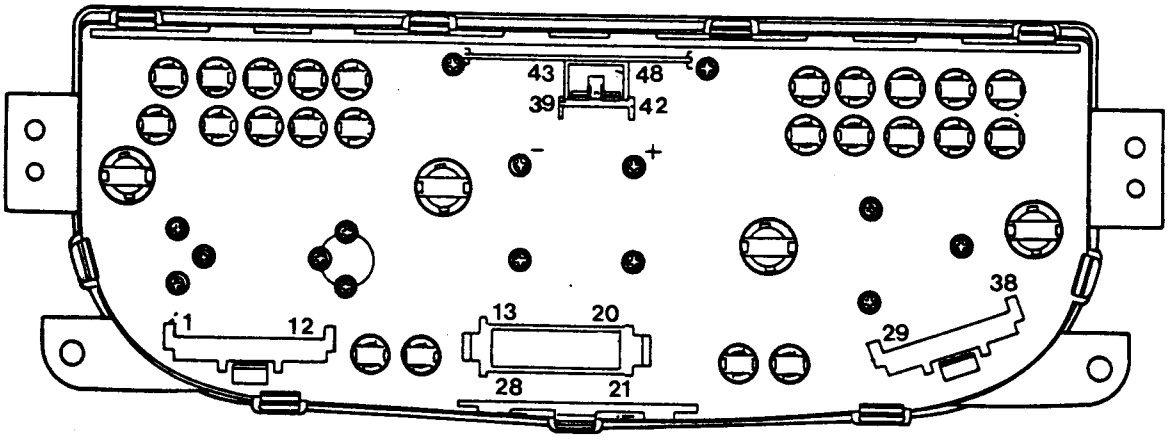
W0354-021

[Gasoline] - Components



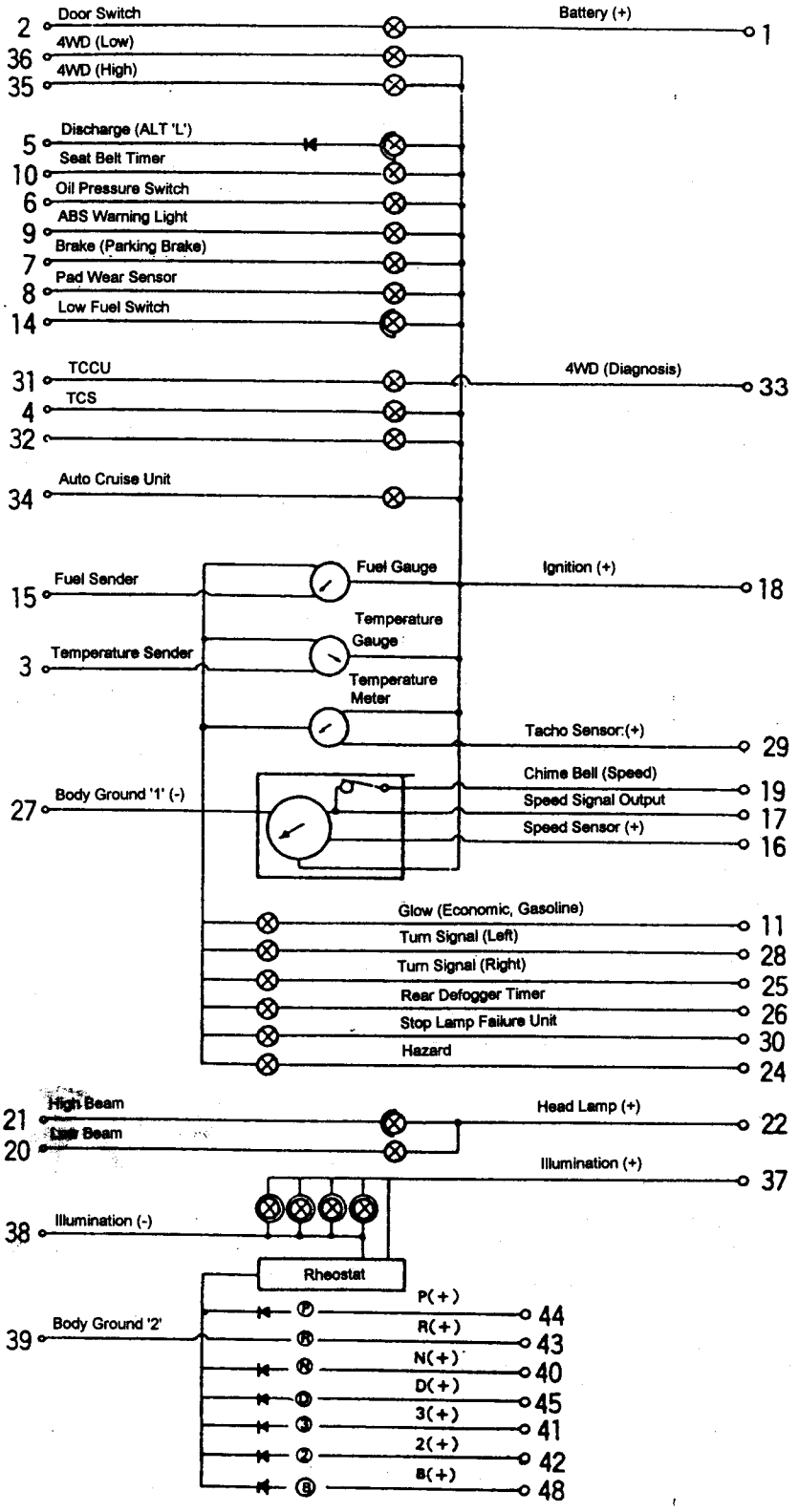
1. Turn Signal Indicator Light - Left
2. Low Fuel Level Warning Light
3. Fuel Gauge
4. Water Temperature Gauge
5. Brake & Parking Brake Indicator
6. Low Oil Pressure Warning Light
7. Discharge Warning Light
8. Door Ajar Warning Light
9. Pad Wear Warning Light
10. ABS Warning Light
11. Seat Belt Reminder Light
12. 'E' Mode Indicator Light
13. Speedometer
14. Selector Lever Position Light
15. Turn Signal Indicator Light - Right
16. Rear Window Defogger Indicator Light
17. Tachometer
18. Auto-cruise Indicator
19. TCS Indicator Light
20. 4WD Low Indicator Light
21. 4WD CHECK Warning Light
22. Stop Lamp Failure Warning Light
23. High Beam Indicator Light
24. Low Beam Indicator Light
25. Odometer Reset Button

Symmetrical view



W0354-022

Circuit diagram



W0354-023

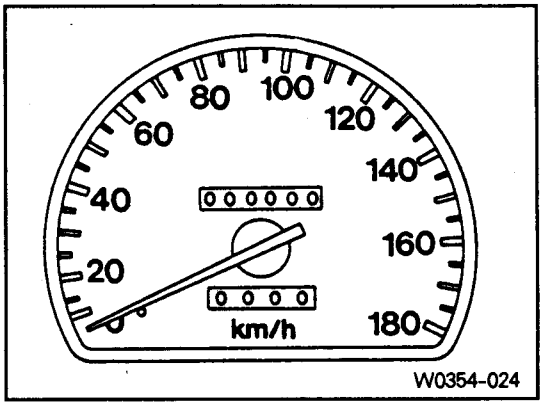
Inspection

[Diesel]

1) Speedometer

km/h

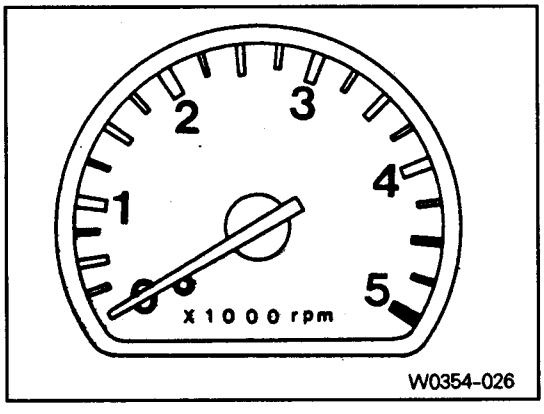
Speed	40	60	80	100	120	140	160	180
Tolerance	+3 +0	+4 +0	+5 +0	+5 +0	+5.5 +0.5	+5.5 +0.5	+5.5 +0.5	-



W0354-024

2) Tachometer

Revolution	1000	2000	3000	4000	5000
Tolerance	+ 137 - 63	+ 199 - 51	+ 261 - 39	+ 298 - 2	-



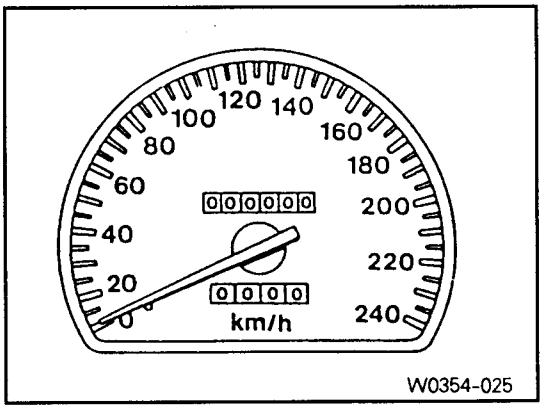
W0354-026

[Gasoline]

1) Speedometer

km/h

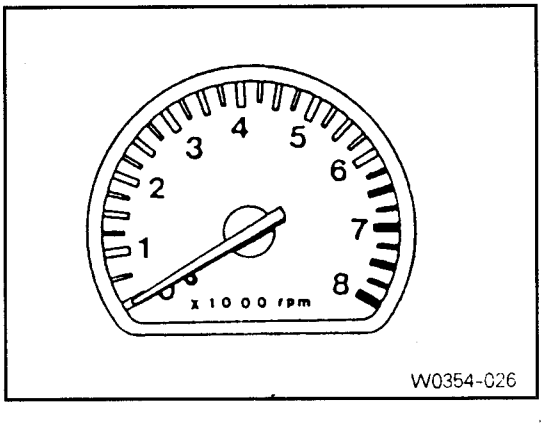
Speed	20	40	60	80	100	120	140	160
Tolerance	+4 +0	+3 +0	+4 +0	+5 +0	+5 +0	+5.5 +0	+5.5 +0.5	+5.5 +0.5
Speed	180	200	240					
Tolerance	+6 +1	+6 +1	–	–				



W0354-025

2) Tachometer

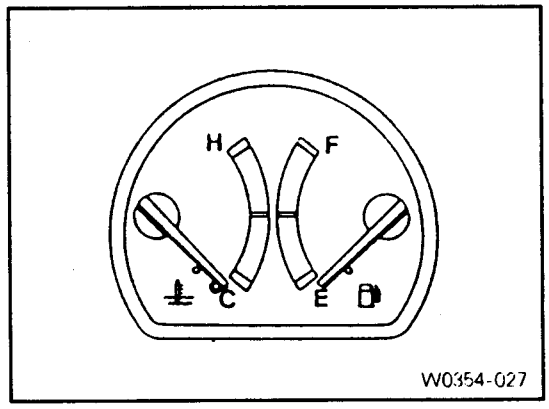
Revolution	1000	2000	3000	4000	5000	6000	7000	8000
Tolerance	±100	±125	±150	±150	±150	±180	±210	–



W0354-026

3) Fuel gauge

	E	1/2	F
Resistance	27	32.5	6
Tolerance	2.5	± 5	± 2.5



W0354-027

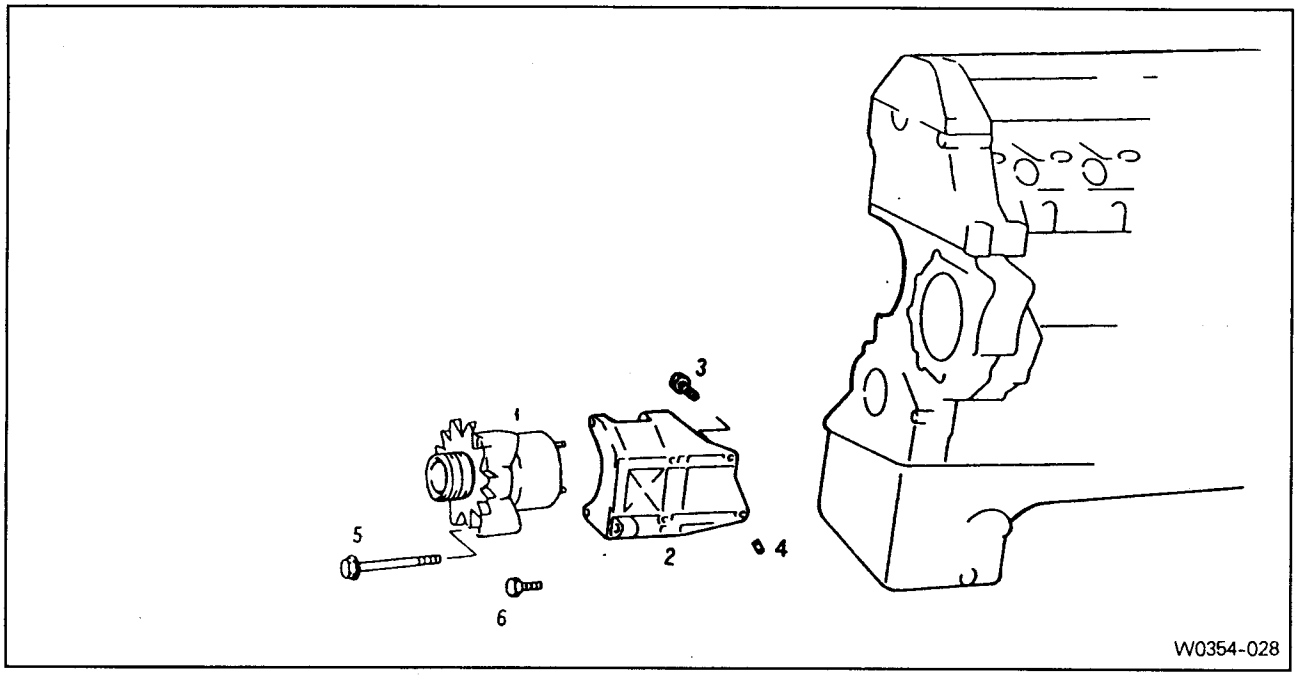
4) Water temperature gauge

Temperature	Resistance
50℃	156.9Ω
86℃	44.5Ω
105.5℃	27.3Ω
120℃	19.4Ω

6. Charging System

[Diesel]

Preceding work : Removal of the V- belt



1. Alternator
2. Alternator Bracket
3. Bolt
4. Spring Pin
5. Combination Bolt
6. Bolt

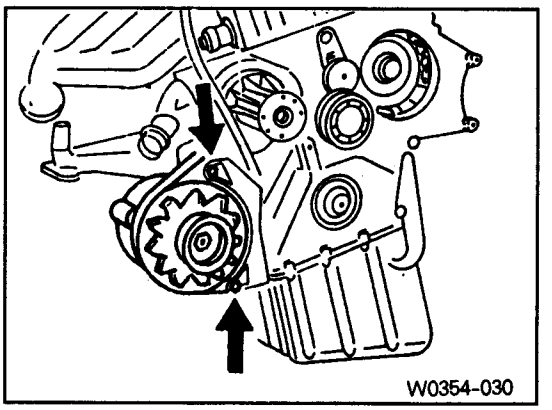
Removal · Installation

1) Remove the poly V-belt.

2) Disconnect the battery terminals.

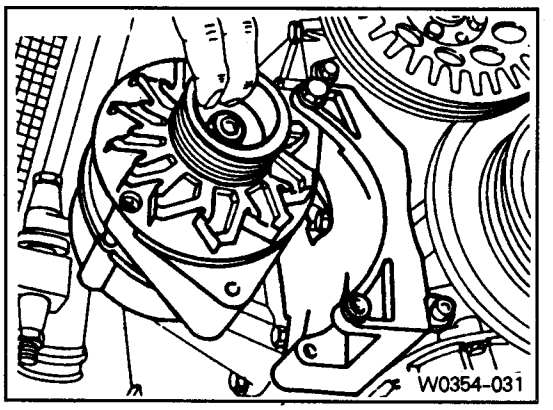
3) Disconnect the alternator cable harnesses.

4) Remove the bolts and then remove the alternator.



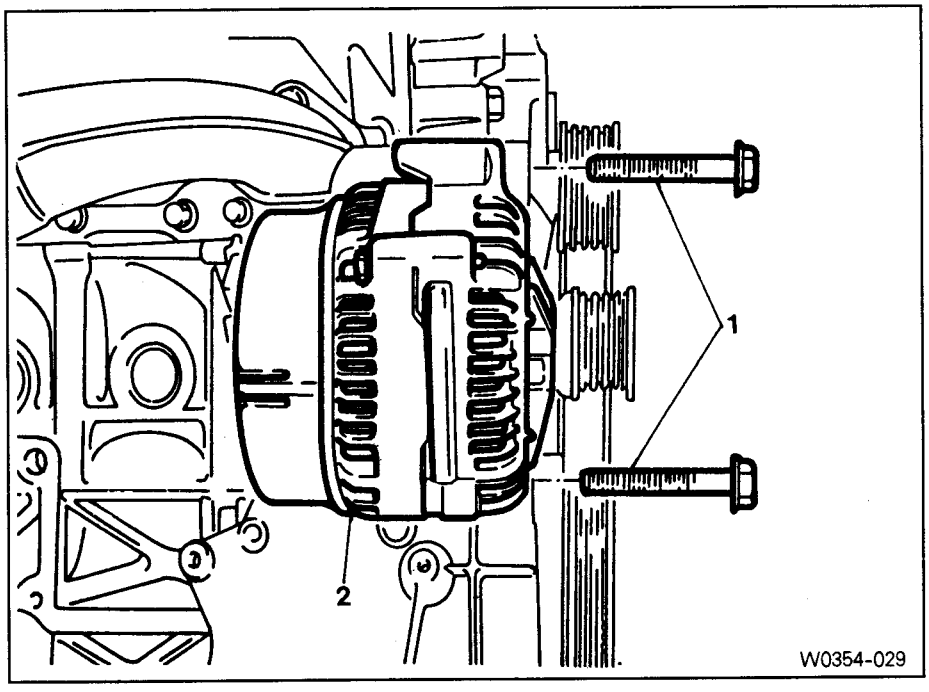
5) Installation is reverse order of the removal.

[Note] In case of OM 662 engine, there are interference between alternator upper mounting bolt and fan wheel. Remove the lower bolt first and then lift up the alternator and remove the alternator bracket.



[Gasoline]

Preceding work : Removal of the poly V- belt



1. Combination bolt
2. Alternator

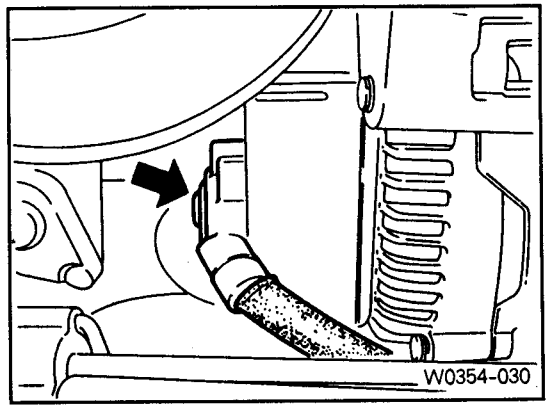
Removal · Installation

1) Disconnect the negative battery terminal.

2) Disconnect the alternator cable harnesses.

3) Remove the mounting bolts and alternator.

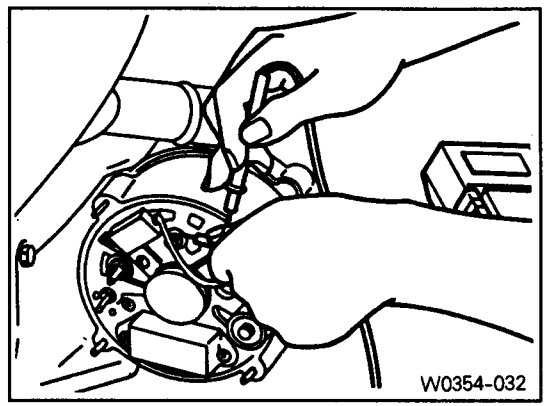
4) Installation is reverse order of the removal.



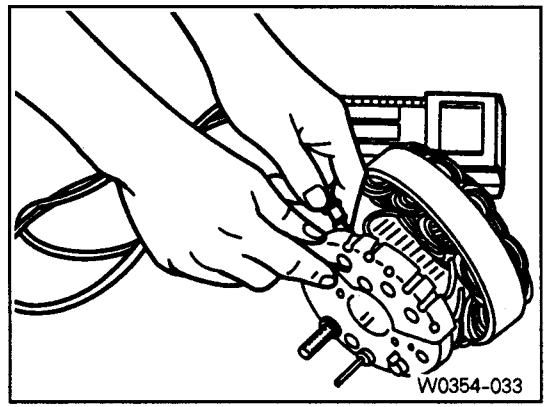
Inspection

1) Check voltage and amperage.

Voltage	12~14V

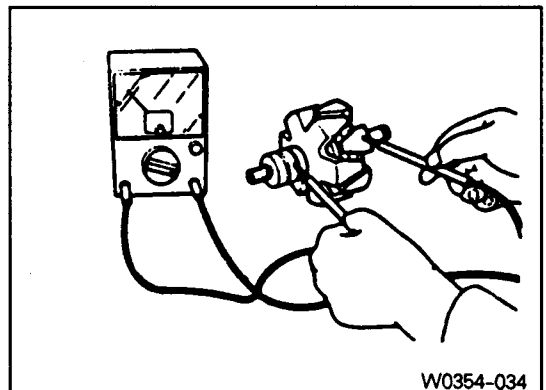


2) Check condition of diodes.



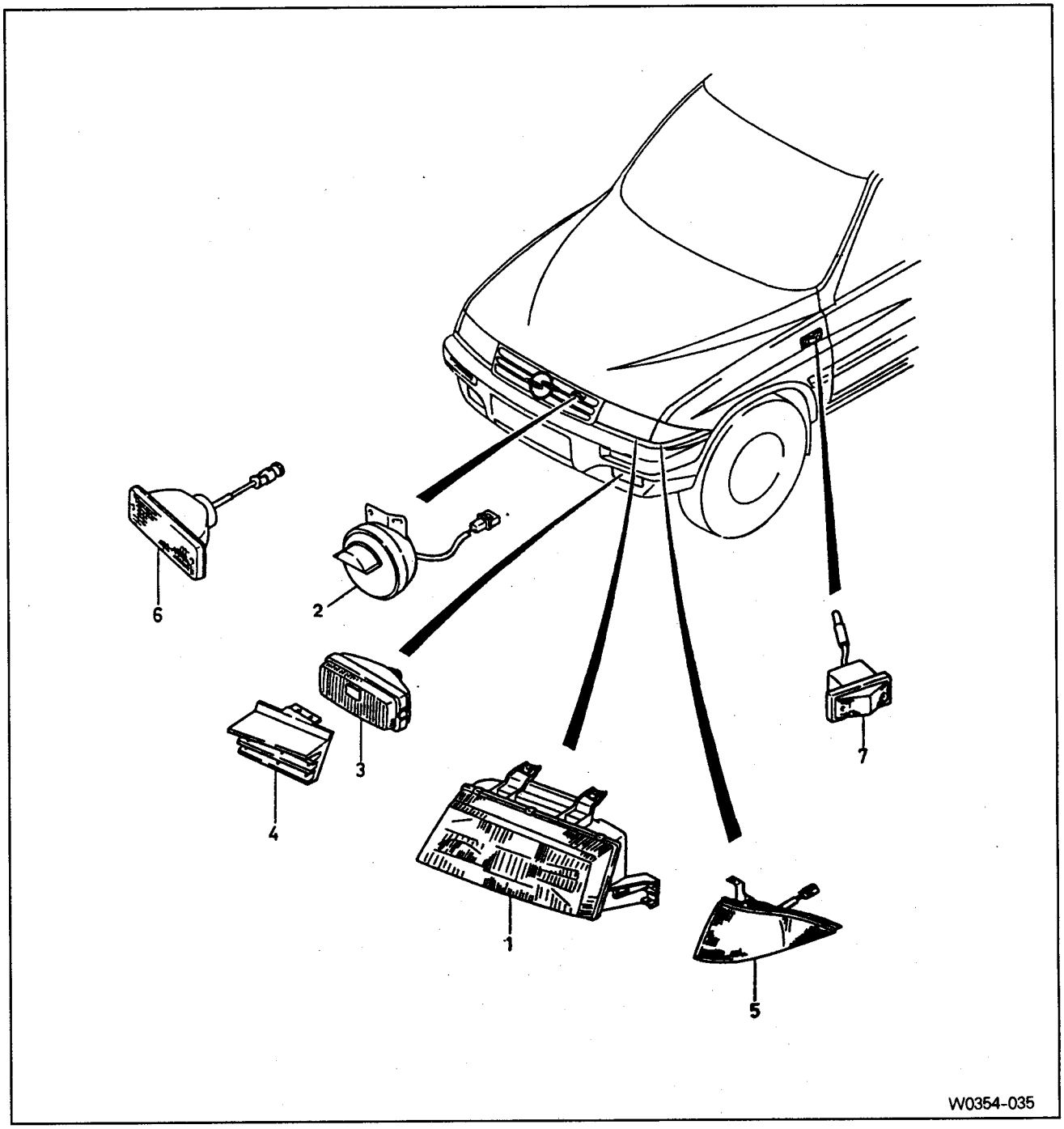
3) Check the rotor coil resistance across the slip rings.
Using a circuit tester, check insulation between the rotor core and slip rings. If continuity exists, replace the rotor assembly.

Standard	∞ Ω



7. Lamps

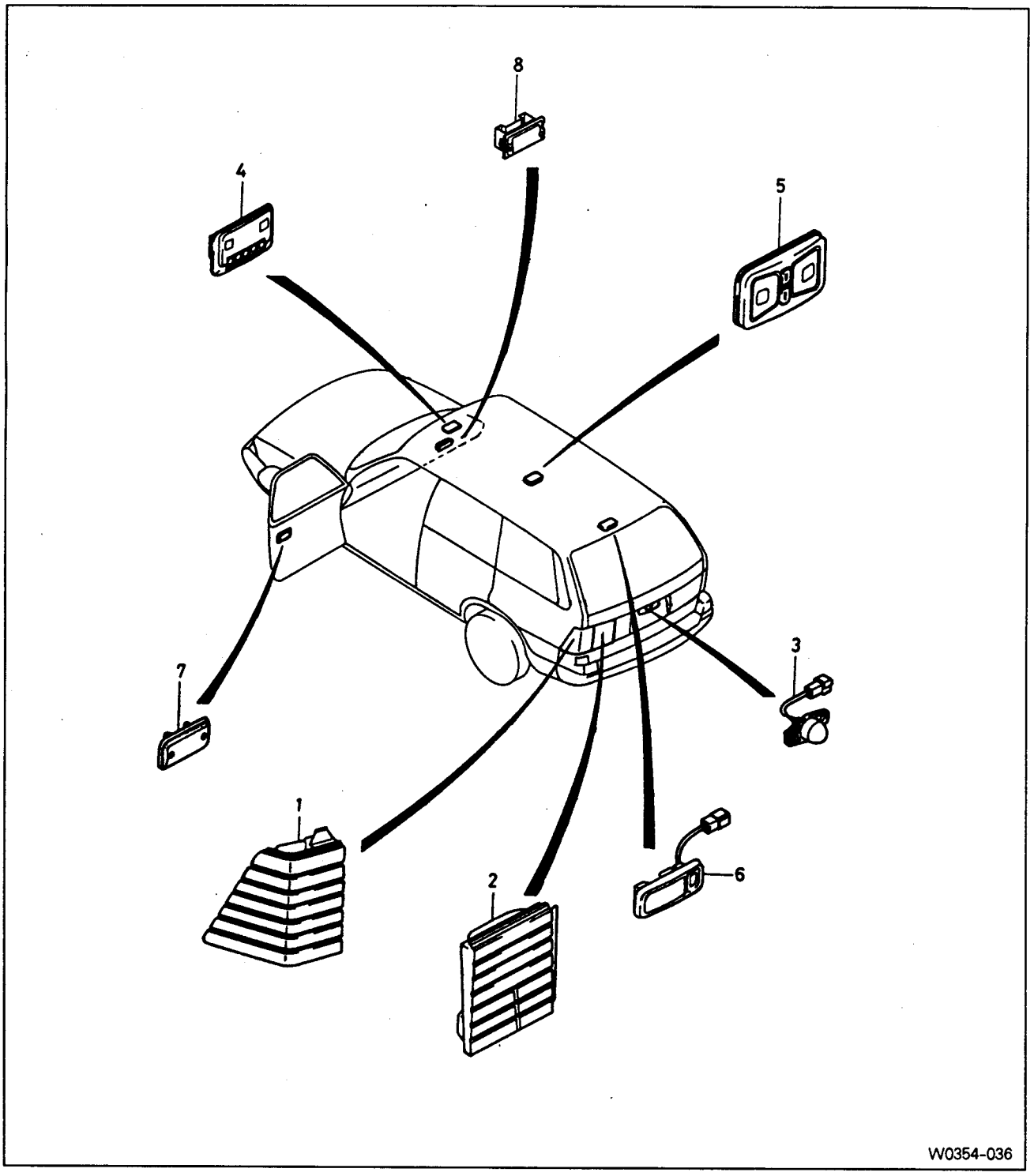
Front lamps



1. Head Lamp (Left)
2. Blackout Driving Lamp (Domestic)
3. Front Fog Lamp (Left)
4. Fog Lamp Grille
5. Turn Signal and Position Lamp
6. Turn Signal Lamp
7. Side Repeater Lamp

[Note] Removal and installation is as shown in upper drawings.

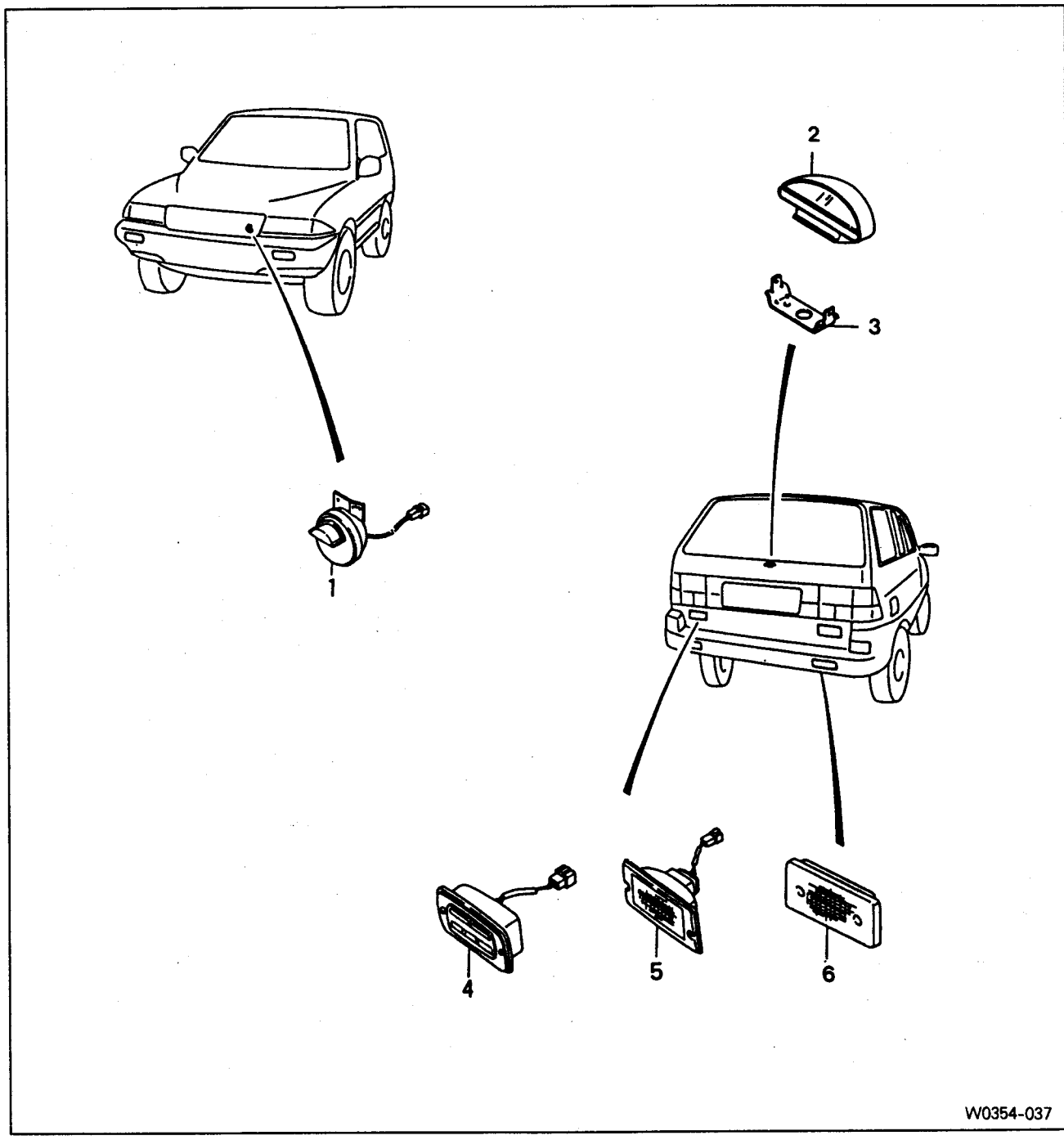
Room and rear lamps



1. Combi-quarter Lamp
2. Combination Tailgate Lamp
3. License Plate Lamp
4. Room Lamp
5. Map Lamp
6. Luggage Room Lamp
7. Door Courtesy Lamp
8. Glove Box Lamp

[Note] Removal and installation is as shown in upper drawings.

Special purpose lamps



1. Blackout Driving Lamp (Domestic)
2. High Mounted Stop Lamp
3. Bracket
4. Blackout Position Lamp (Domestic)
5. Rear Fog Lamp
6. Reflector

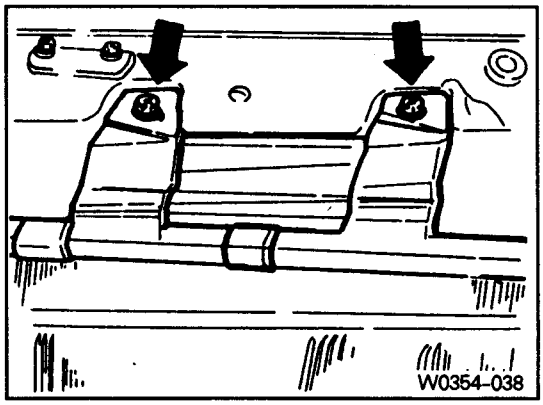
[Note] Removal and installation is as shown in upper drawings.

Removal · · Installation

<Head lamp>

1) Disconnect the connectors.

2) Remove the head lamp mounting bolts.

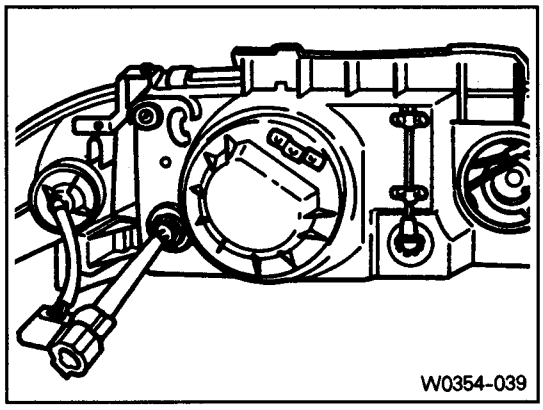


3) Remove the head lamp assembly.

4) Remove the rain cap.

5) Remove the bulb and check for damage.

6) Installation is reverse order of the removal.

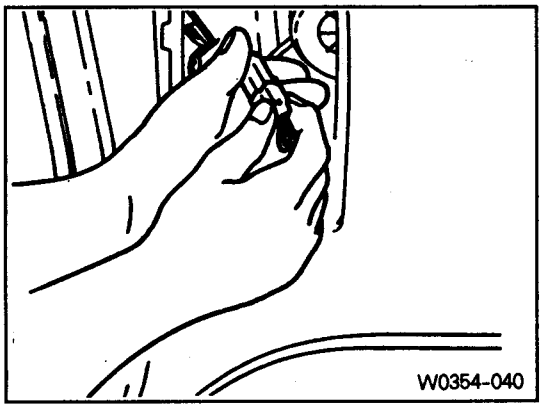


<Turn signal lamp>

1) Disconnect the connectors (front).

2) Remove the garnish and disconnect the connectors (rear).

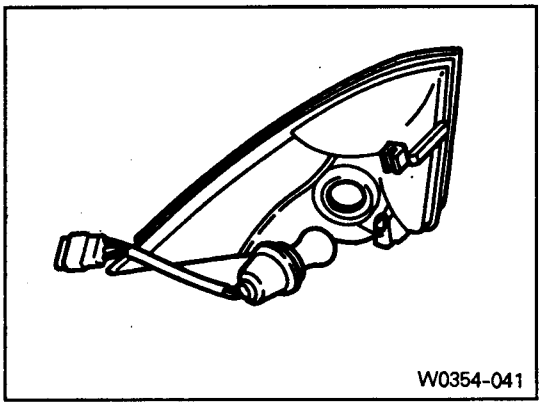
3) Remove the fixing screws.



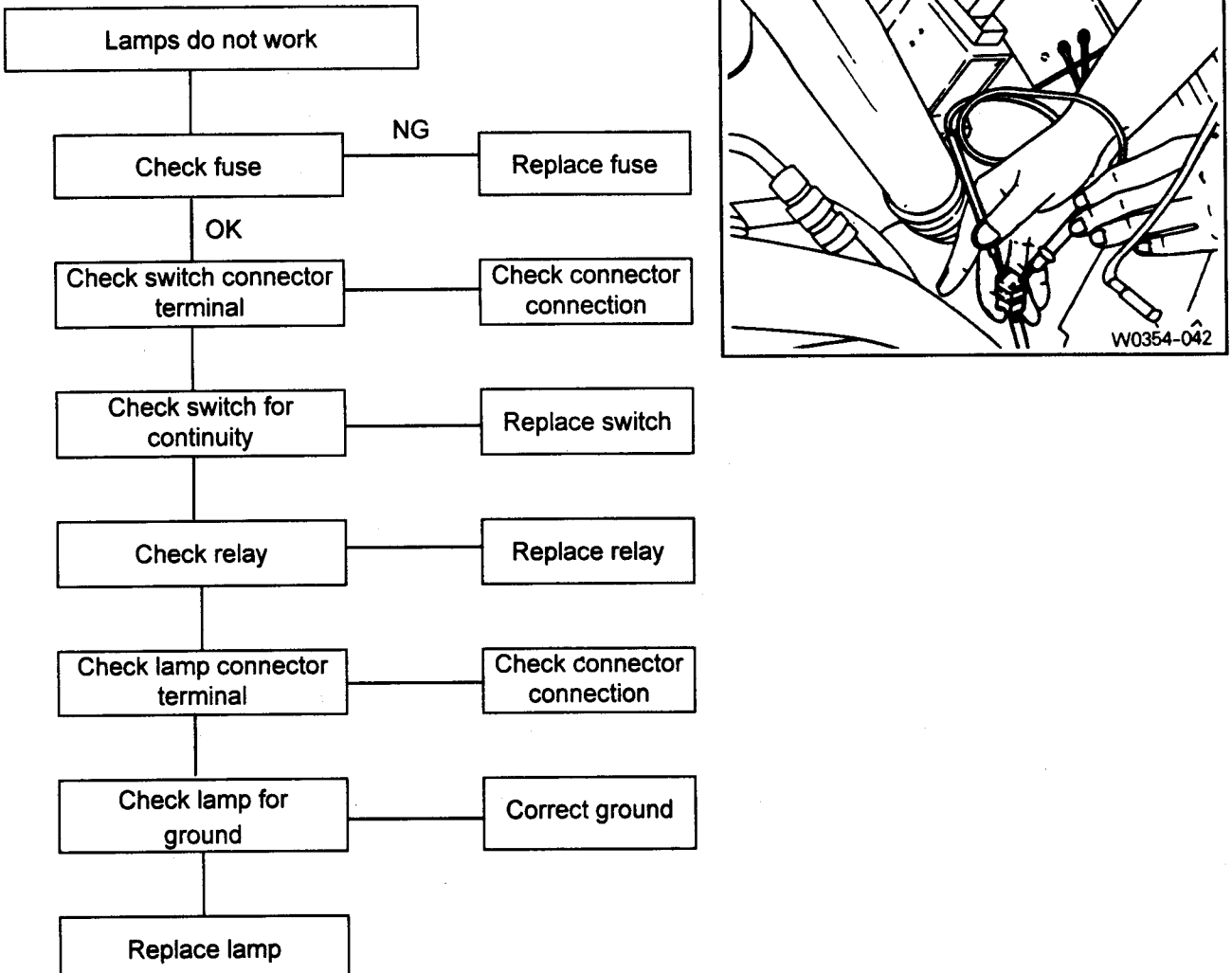
4) Remove the turn signal lamps.

5) Remove the bulbs and check for damage and connector connections.

6) Installation is reverse order of the removal.



Diagnosis


Lamps do not work
Check fuse
NG
Replace fuse
OK
Check switch connector terminal
Check connector connection
Check switch for continuity
Replace switch
Check relay
Replace relay
Check lamp connector terminal
Check connector connection
Check lamp for ground
Correct ground
Replace lamp

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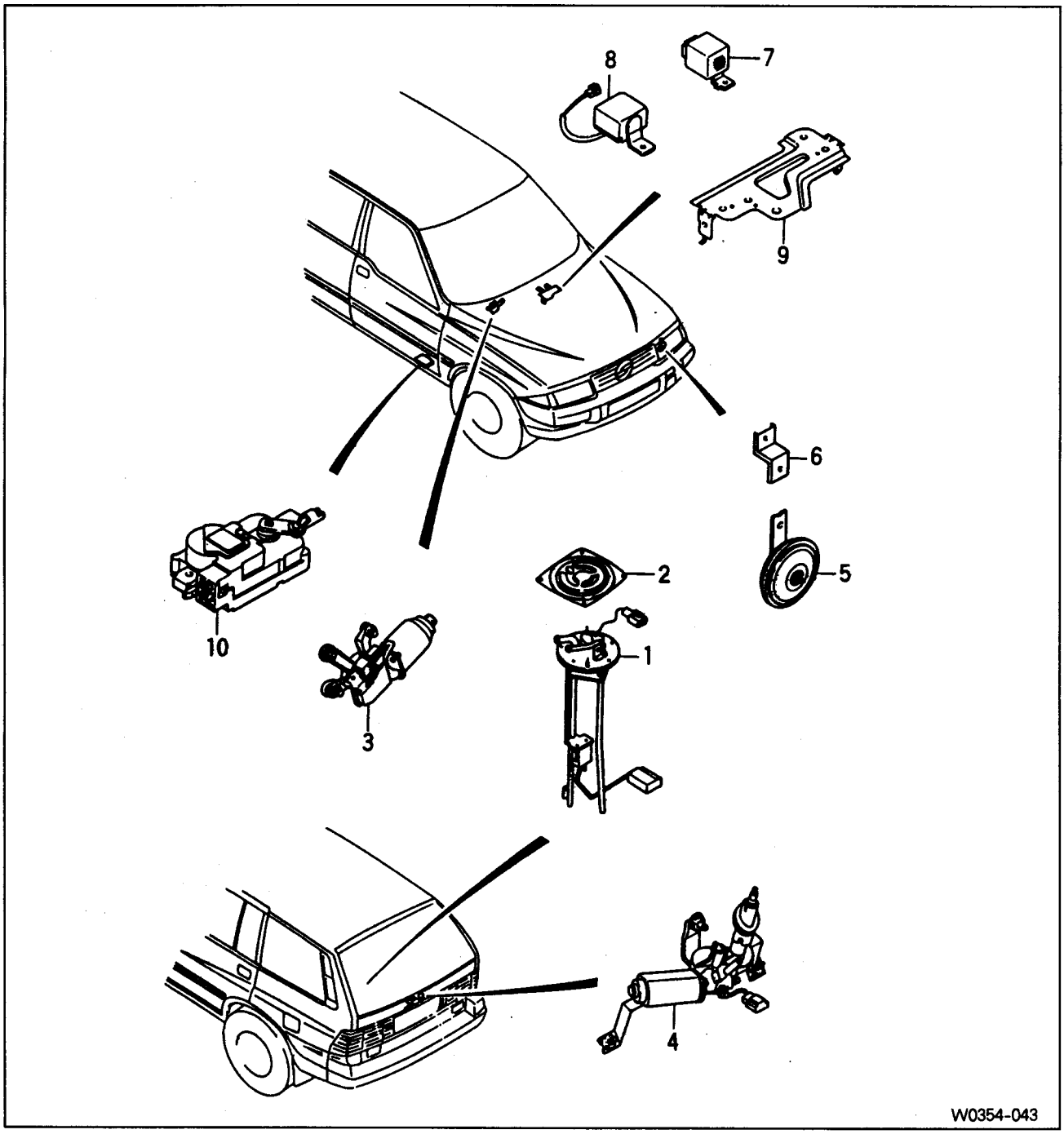
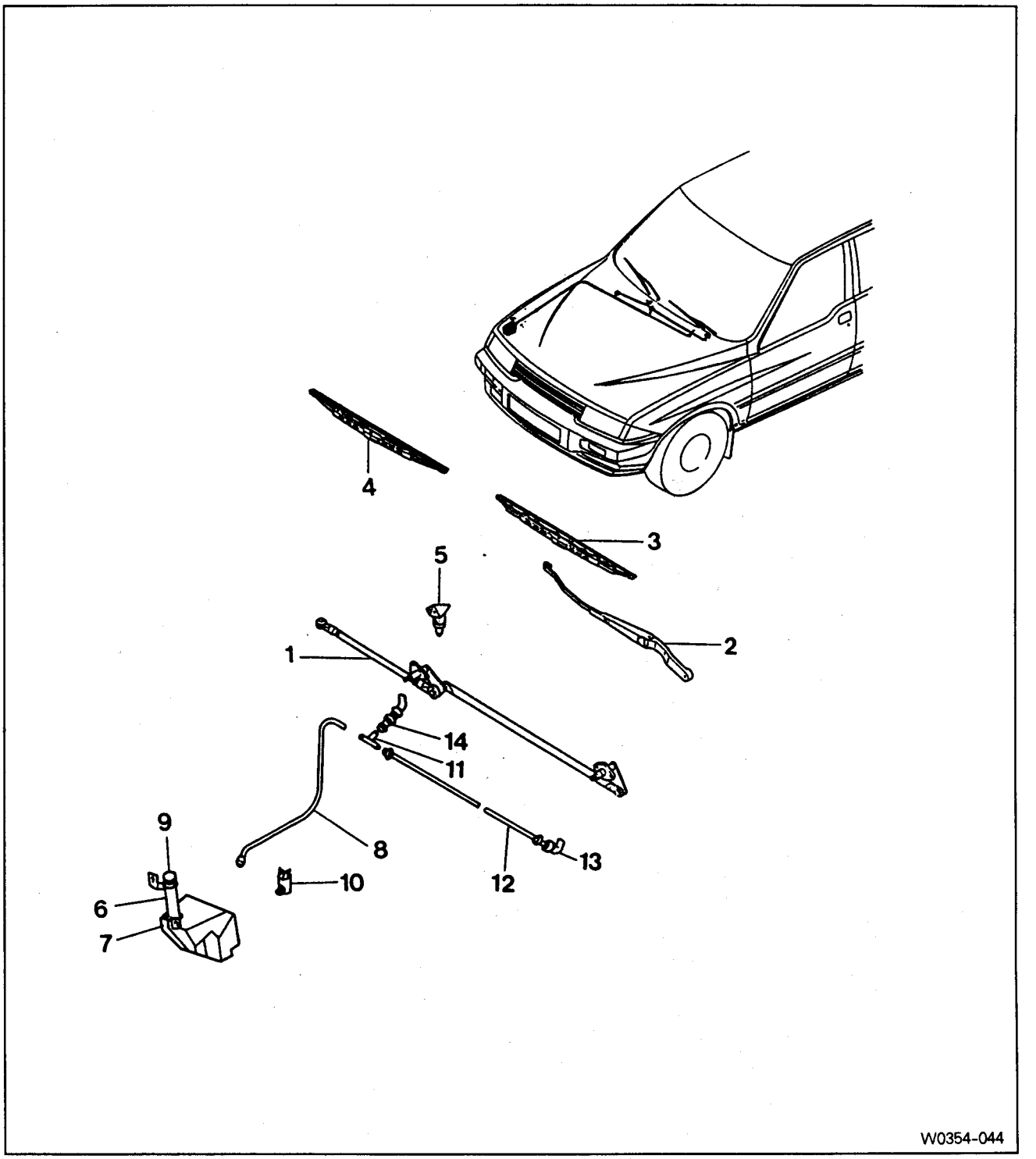
8. Electrical Equipments

Motors and actuators



1. Fuel Tank Sender Assembly
2. Sender Unit Cover
3. Front Wiper Motor
4. Rear Wiper Motor
5. Horn
6. Horn Bracket
7. Chime Bell
8. Buzzer Assembly
9. Chime Bell Mounting Bracket
10. Door Lock Actuator

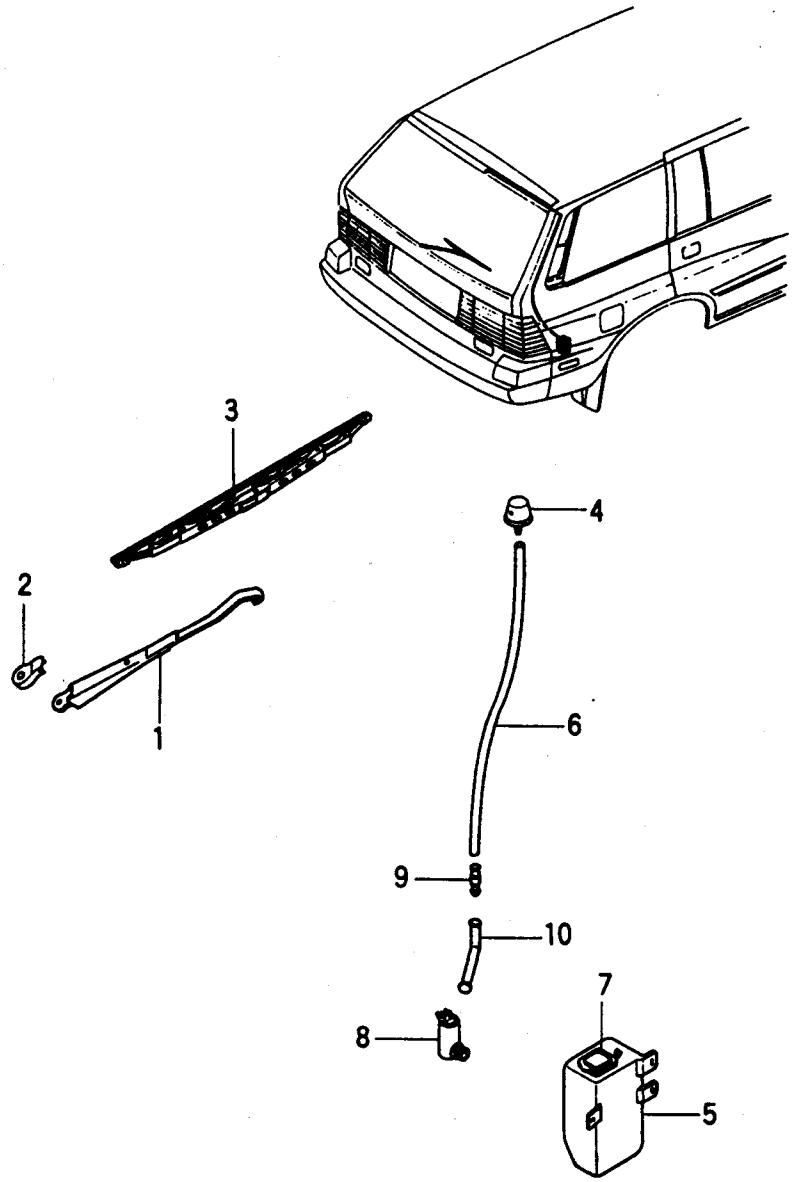
Front wiper and washer



1. Wiper Linkage
2. Wiper Arm
3. Wiper Blade (Left)
4. Wiper Blade (Right)
5. Washer Nozzle
6. Reservoir Tank Guide
7. Reservoir Tank
8. Washer Hose
9. Cap
10. Washer Motor
11. Hose Connector (Y-type)
12. Washer Hose (Left)
13. Nozzle Pipe
14. Washer Hose

[Note] Removal and installation is as shown in upper drawings.

Rear wiper and washer



1. Wiper Arm
2. Wiper Cap
3. Wiper Blade
4. Washer Nozzle
5. Reservoir Tank
6. Washer Hose
7. Cap
8. Washer Motor
9. Washer Hose Socket
10. Outer Joint

[Note] Removal and installation is as shown in upper drawings.

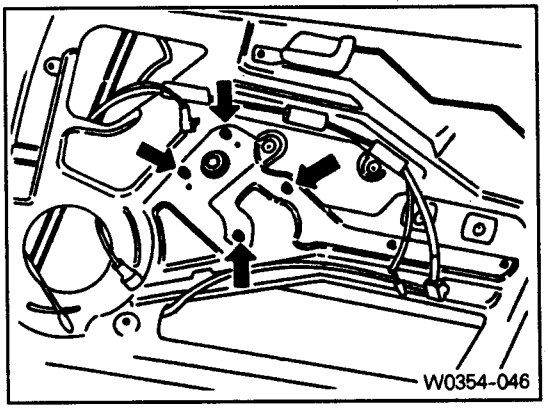
Removal · Installation

<Power window motor>

1) Remove the arm rest and wiring connectors.

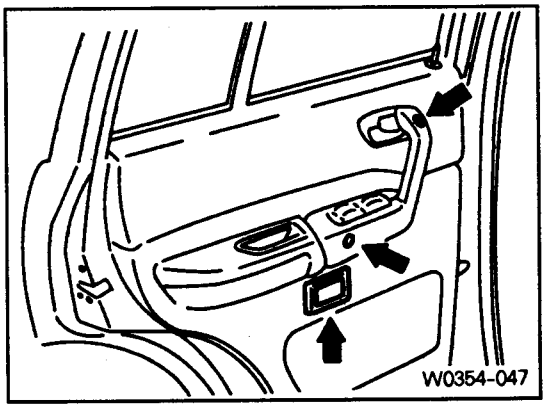
2) Remove the 4 bolts and power window motor.

3) Installation is reverse order of the removal.



<Central door lock>

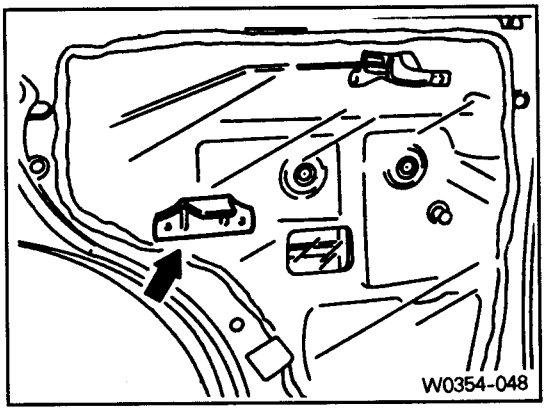
1) Remove the door panel.
[Note] Be careful not to damage the door panel.



2) Remove the vinyl cover.

3) Remove the door lock actuator.

4) Installation is reverse order of the removal.

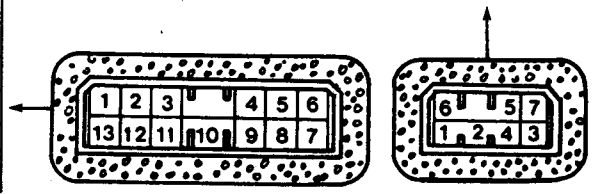


Inspection

<Power window>

No.	Terminal	Wire	Remark
1	E	AVS2.0B	
2	DS2	AVS1.25LB	
3	USI (US0)	AVS1.25BW	( ) : RHD
4	DSI (DS0)	AVS1.25LR	( ) : RHD
5	L	AVS0.85GW	
6	B	AVS2.0YR	
7	US2	AVS1.25Br	
8	DS3	AVS1.25LY	
9	US3	AVS1.25BY	
10	LS	AVS1.25LgB	
11	US0 (US1)	AVS1.25BR	( ) : RHD
12	DS0 (DS1)	AVS1.25L	( ) : RHD
13			

No.	Terminal	Wire
1	Down (Motor)	AVS1.25L
2	Up (Motor)	AVS1.25BR
3	Tail (+)	AVS0.85GW
4	Ground	AVS0.5B
5	US	AVS1.25BW
6	DS	AVS1.25LR
7	LS	AVS1.25LgB

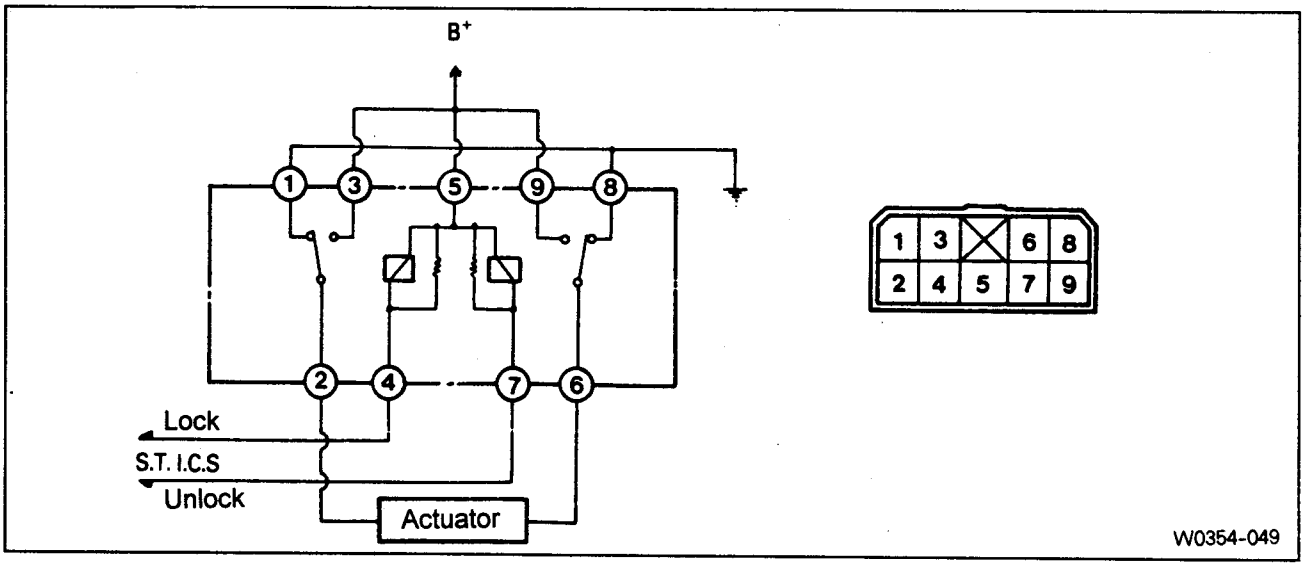


Terminal / Position	Driver				Passenger				Rear (Left)				Rear (Right)			
	B	US0	US0	E	B	US1	DS1	E	B	US2	DS2	E	B	US3	DS3	E
UP	○—○		○—○		○—○		○—○		○—○		○—○		○—○		○—○	
OFF		○—○	○—○			○—○	○—○			○—○	○—○			○—○	○—○	
DOWN	○	○—○		○	○	○—○		○	○	○—○		○	○	○—○		○

P \ T	B	LS
LOCK		
NORMAL	○—○	

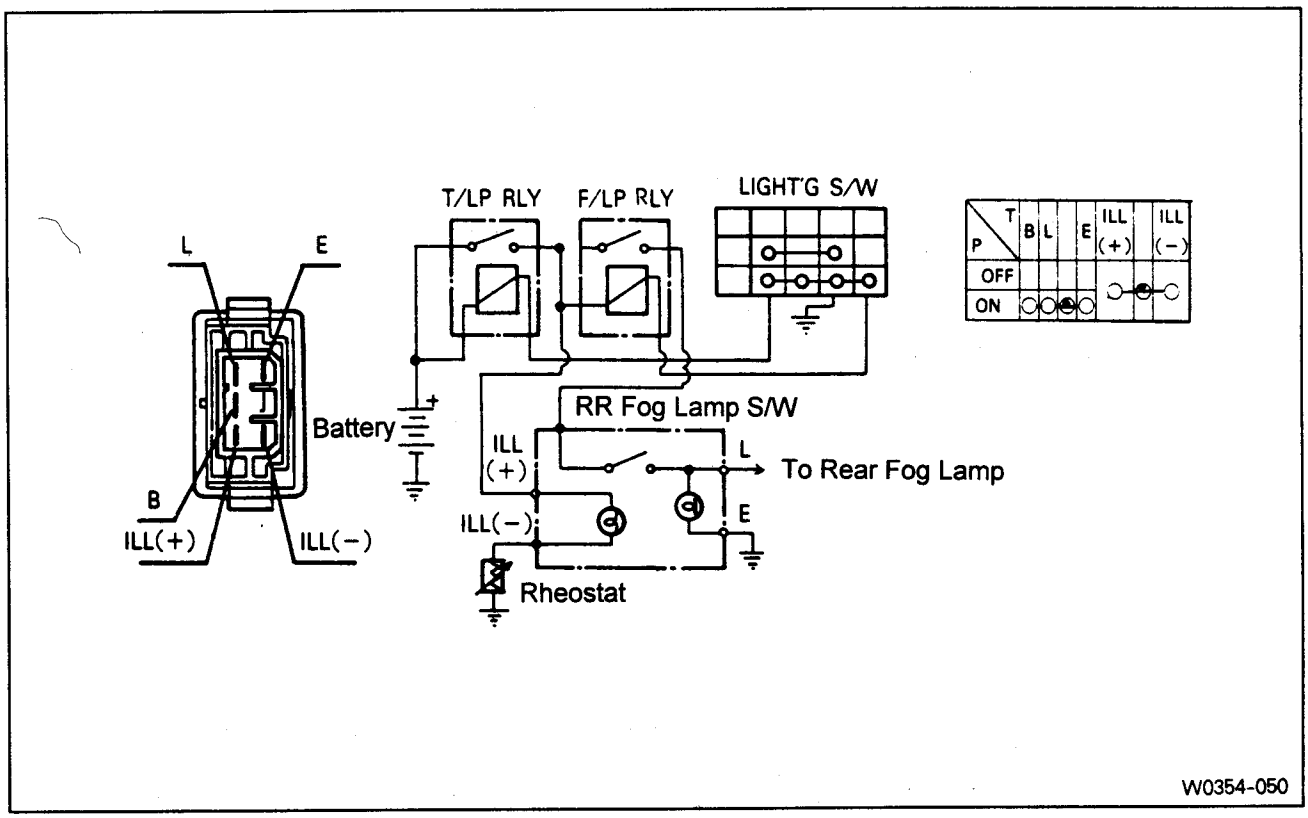
To the power window excluding main switch

<Central Door Lock>

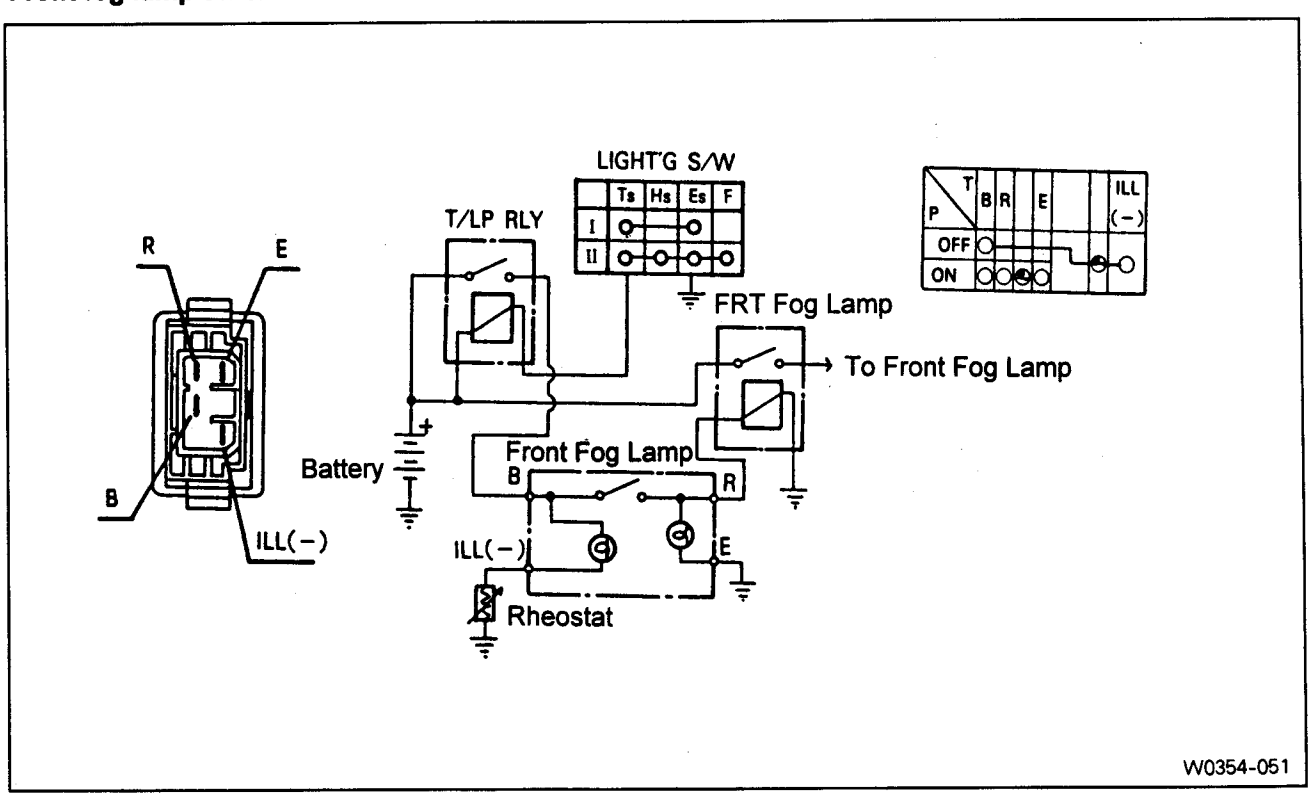


9. Switches and Relays

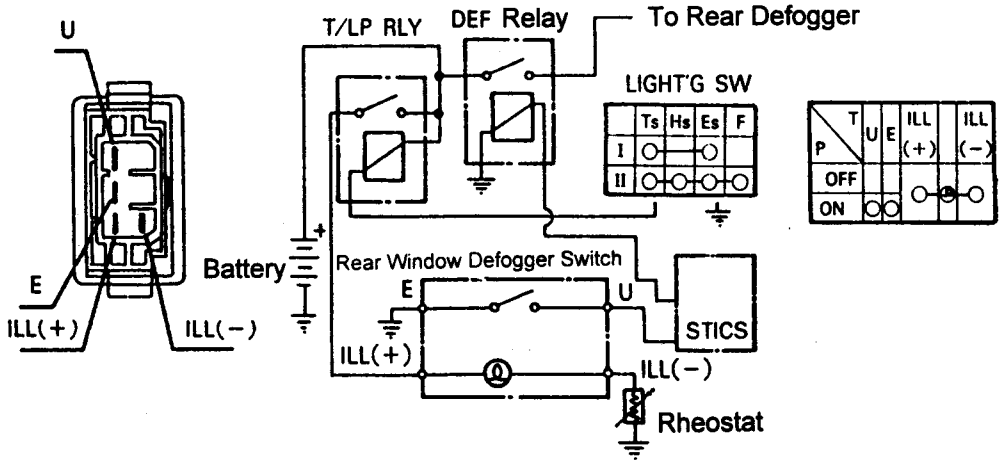
Rear fog lamp switch



Front fog lamp switch



Rear defogger switch



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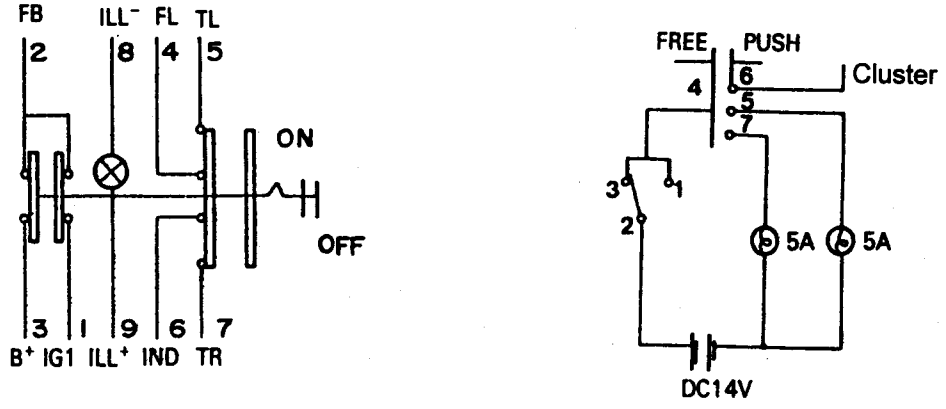
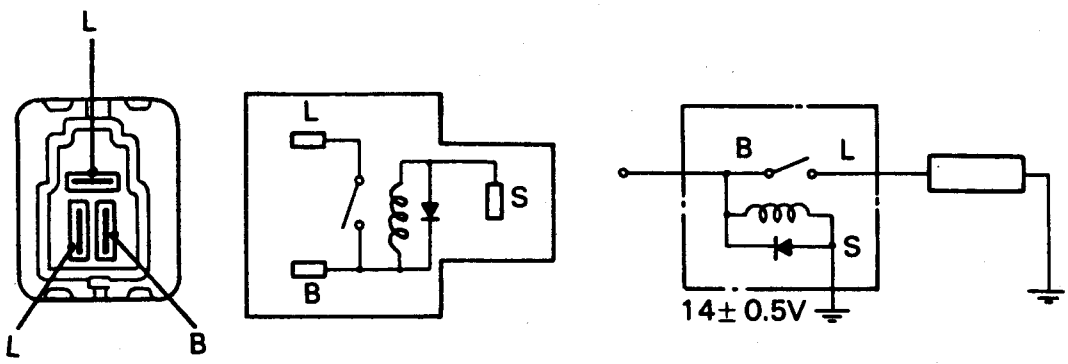
Hazard switch



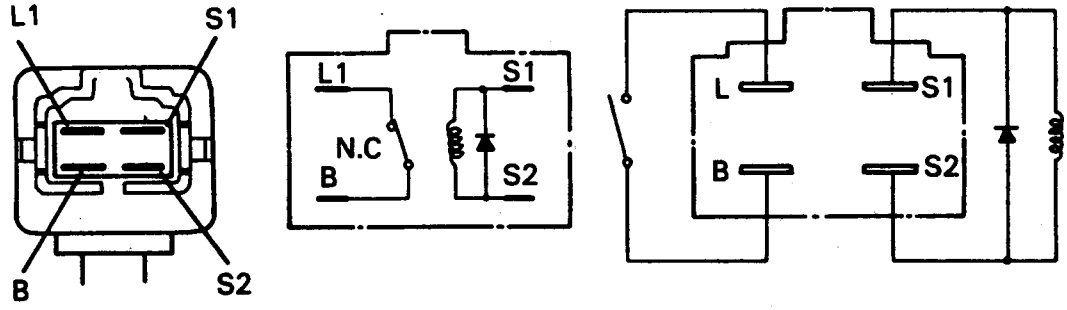
W0354-053

Relays

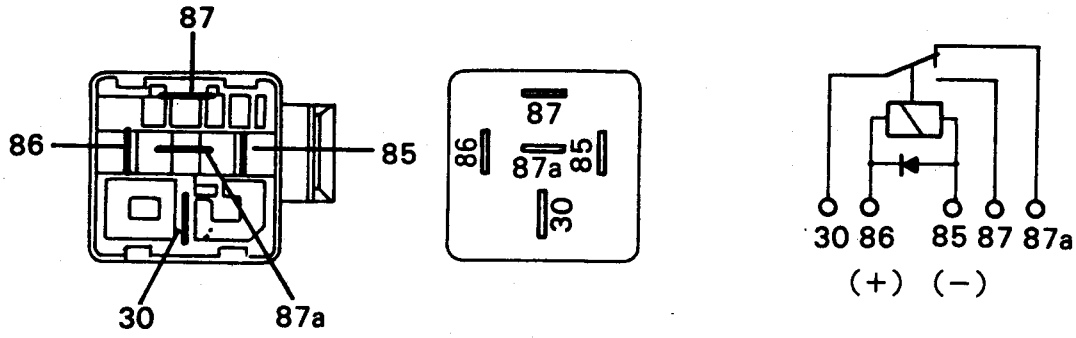
1) 3P Type



2) 4P Type

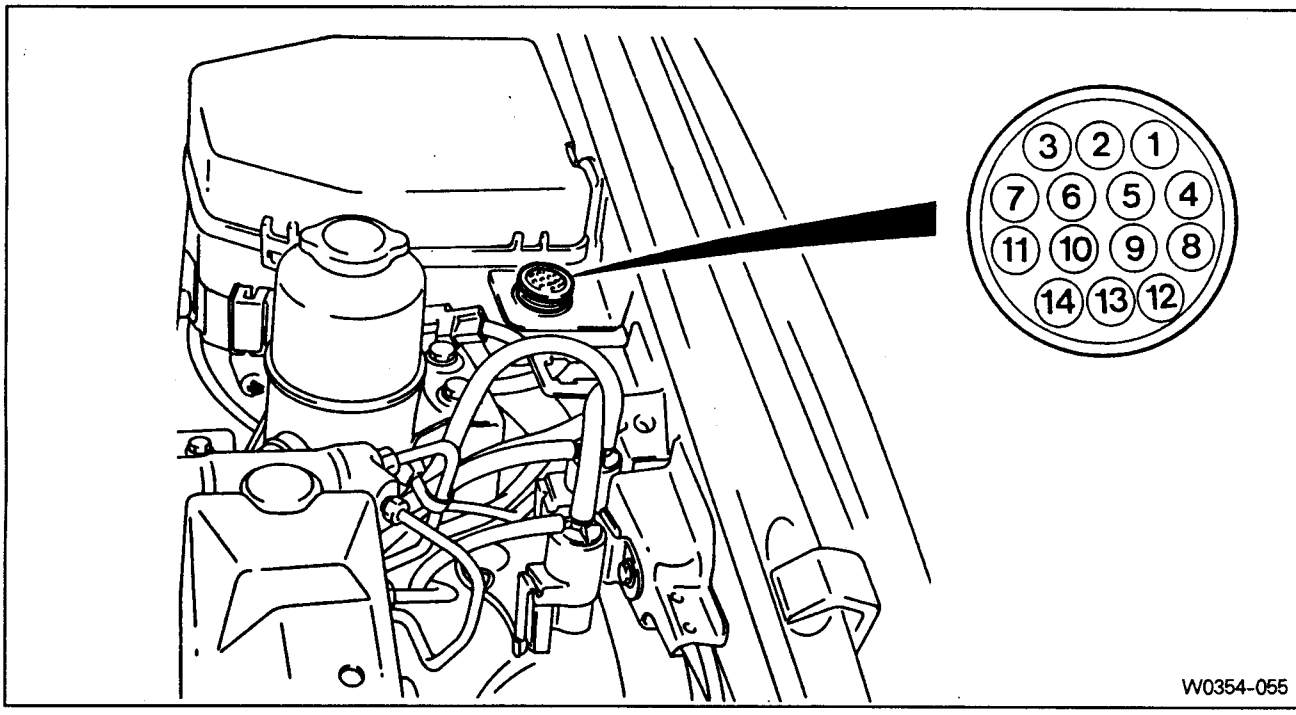


3) 5P Type



W0354-054

10. STICS Diagnosis



No. 1 : Ground No. 7 : STICS

STICS diagnosis

The self-diagnosis is useful to diagnose 8 malfunctioning items in the STICS system.

[Note] Self-diagnosis detects malfunctions in switches or sensors. If motors, relays, lamps, or actuators are defective, malfunction codes will not be displayed.

Diagnostic procedure

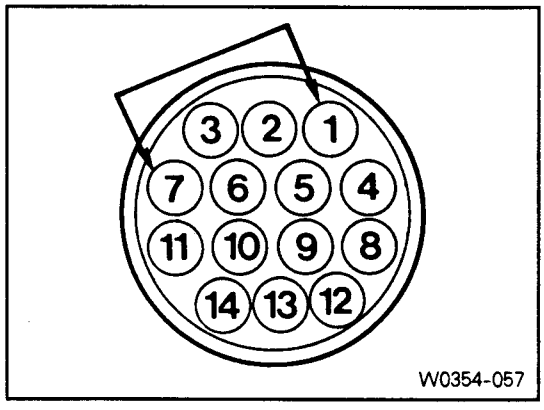
1) Check fuses which are related to defective parts.

2) Check wiring or connectors for proper connections.

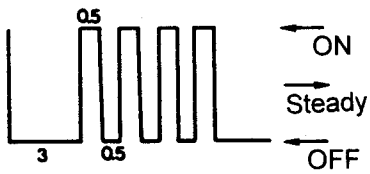
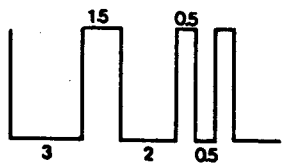
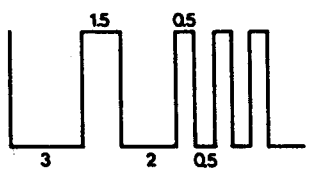
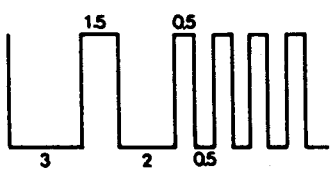
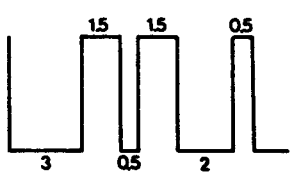
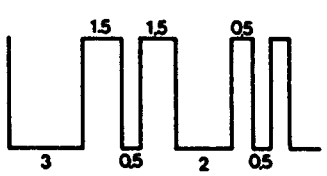
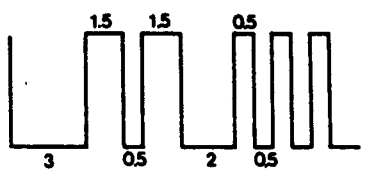
3) Using a service connector, connect the no.1 and no.7 terminals.

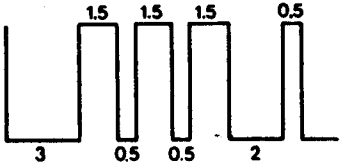
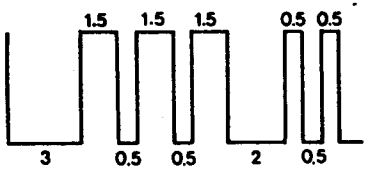
4) Close all the doors and position the ignition switch to 'LOCK' position.

5) Count the number of 'door ajar warning light' flashes and read malfunction code number.



Diagnostic table

Code No.	Display	Related Device	Related System	Related Parts
Normal		—	—	—
12		Door lock switch	- Central door lock system - Mark lamp left on warning - Key reminder warning - Auto door lock - REKES coupling	- Door lock relay - Door lock actuator - Chime bell warning - Buzzer
13		Seat belt switch	- Seat belt indicator	- Seat belt indicator - Chime bell
14		Door switch	- Decayed room lamp - Time lag power window - Mark lamp left on warning - Door ajar warning - Key reminder warning	- Room lamp - Power window relay - Door lock actuator - Door lock relay - Buzzer - Chime bell - Door ajar indicator - Ignition key hole lamp
21		Wiper AUTO switch	- INT wiper coupling vehicle speed - Wiper coupling washer	- Wiper relay - Wiper motor - Buzzer
22		Speed sensor	- Auto door lock - INT wiper coupling vehicle speed - Parking brake warning - Door ajar warning	- Door lock relay - Door lock actuator - Wiper motor - Wiper relay - Chime bell - Parking brake indicator - Door ajar indicator
23		Defogger switch	- Defogger timer	- Defogger relay - Defogger indicator - Defogger timer

Code No.	Display	Related Device	Related System	Related Parts
31		Parking brake switch	- Parking brake warning	- Parking brake indicator
32		Tail lamp switch	- Mark lamp left on warning	- Buzzer - Door lock relay - Door lock actuator

[Note] · **If the flashing 'Door ajar warning indicator' displays normal code then STICS and all related systems are operating normal.**

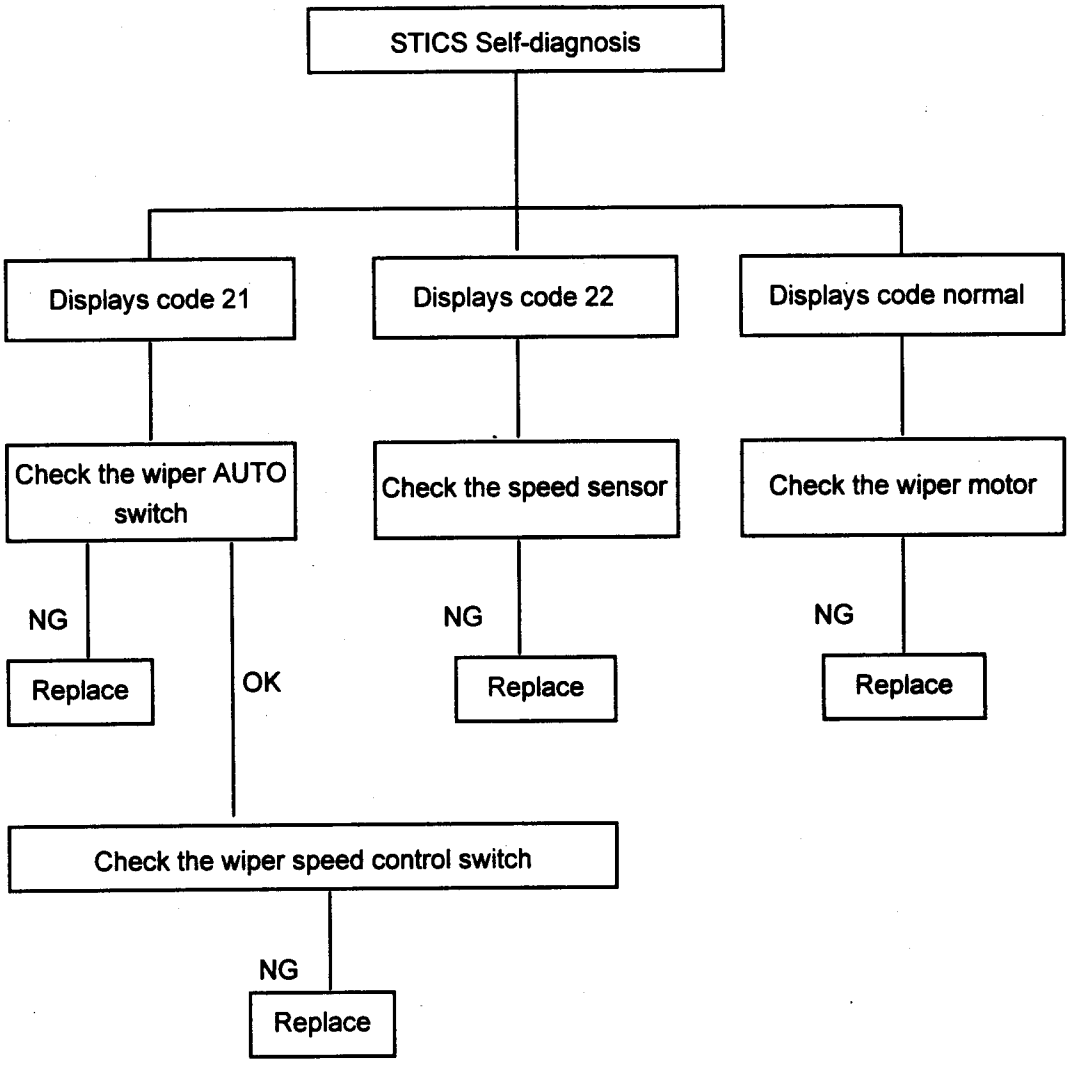
· **After reading malfunctioning code, check the wires and connectors for cuts and proper connections before change.**

· **Inspection**

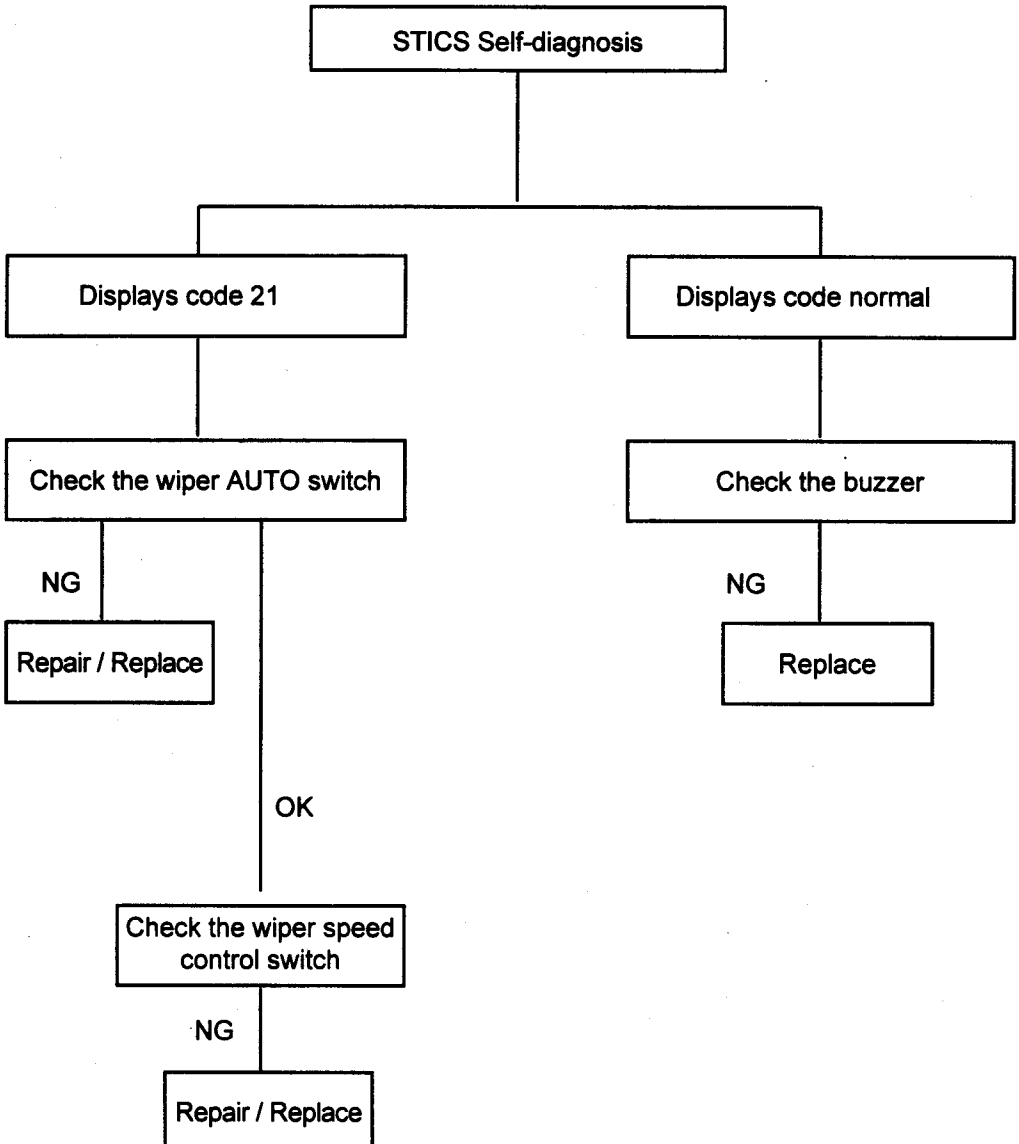
- **If malfunction code is displayed : malfunction of the input switches and sensors.**
- **If the code is not displayed : malfunction of the STICS unit.**
- **If normal code is displayed : malfunction of the relays, lamps, or actuators.**

Troubleshooting

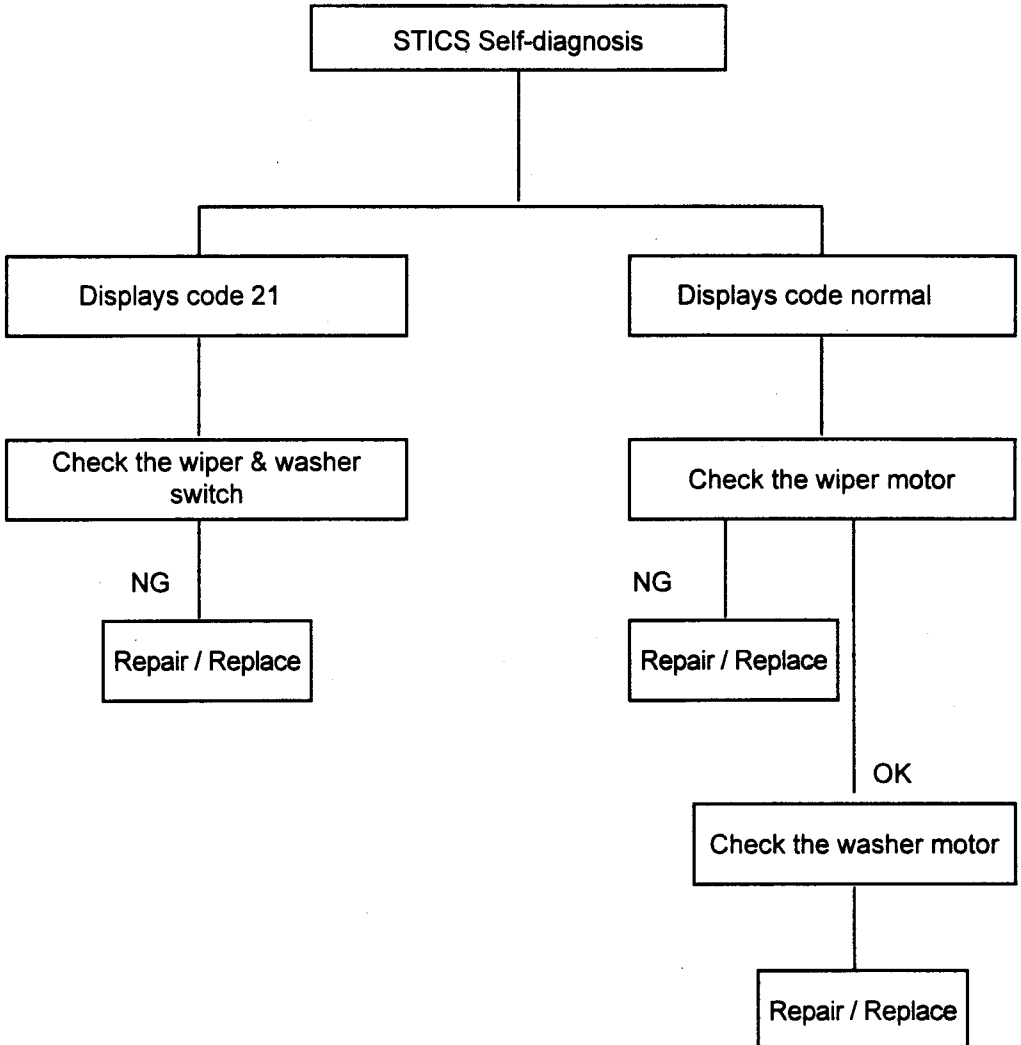
1) · Operation
   - Front wiper switch position : AUTO.
   · Trouble
   1. Wiping speed does not vary according to the wiper speed control switch operation.
   2. Wiping speed does not vary automatically according to vehicle speed.



2) · Operation
   - Front wiper switch position : AUTO
   · Trouble
   - When operating the wiper speed control switch toward 'FAST' or 'SLOW' continuously, the buzzer signal does not come out (there should be buzzer signal by terms of 0.1 sec.).

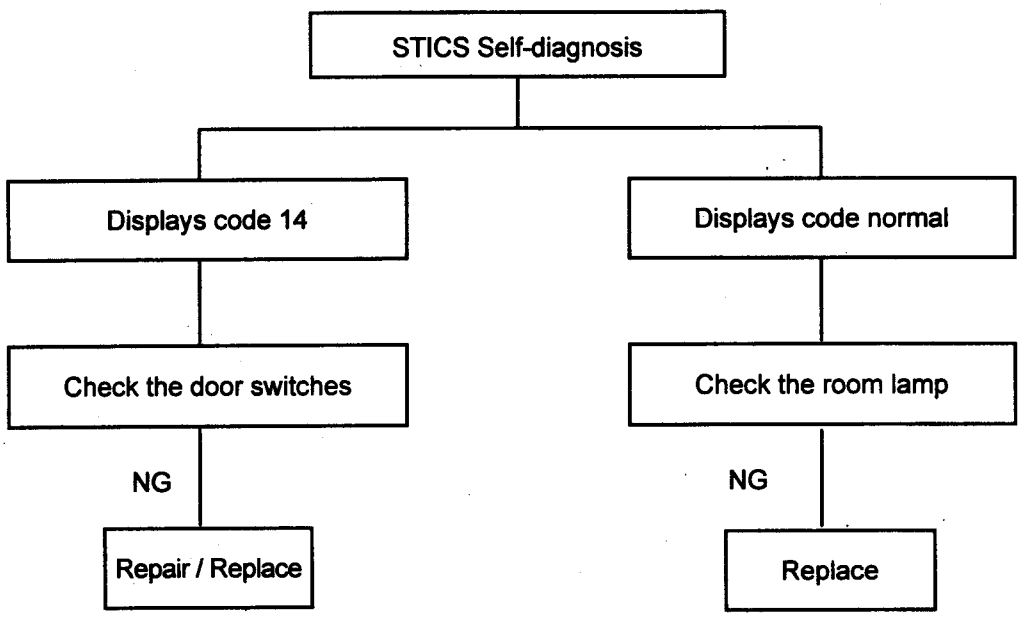


Operation
Ignition switch is ON position.
Trouble
Washer system does not operate normally. (Washer fluid does not come out, wipers do not operating, malfunctions in intermittent wiping.)



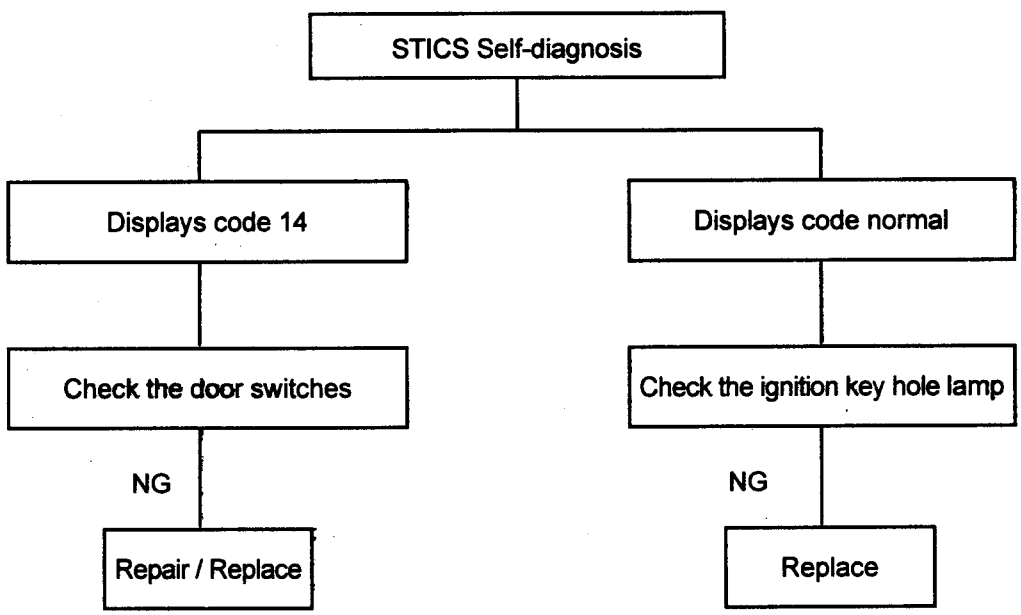
4) · Operation
- Room lamp switch is in DOOR position.

· Trouble
1. Room lamp does not turn on when open the door.
2. When close the door : - room lamp does not decay.
- room lamp does not turn off or turns off immediately.



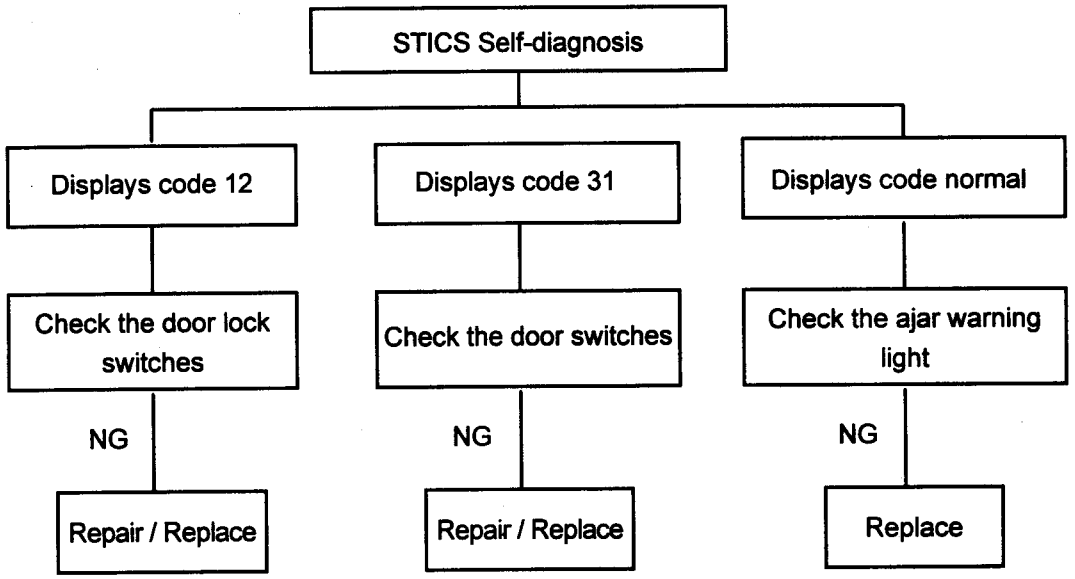
*** Room lamp will be considered as a load.**

5) · When open the driver's door, the ignition key hole lamp does not turn on.



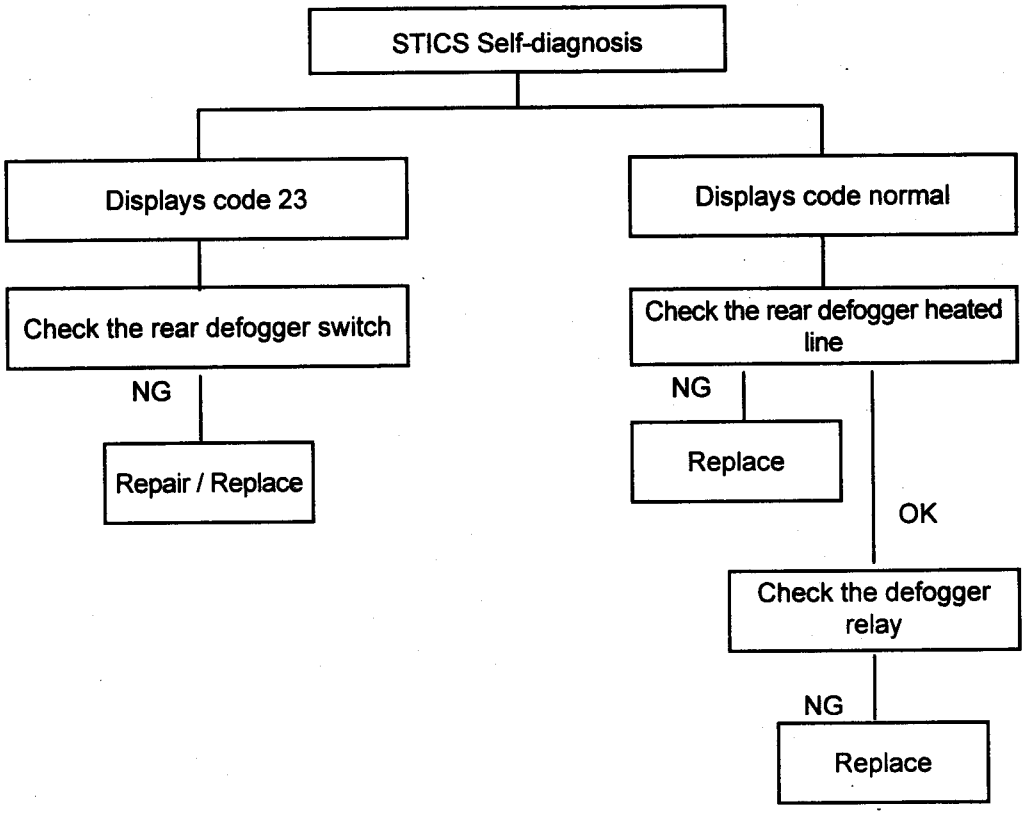
6) · Operation
- Door is opened.

· Trouble
1. The door ajar warning light does not come on.
2. The indicated door ajar warning light does not flashing when driving about 3 - 5km/h. (When open the door during driving.)



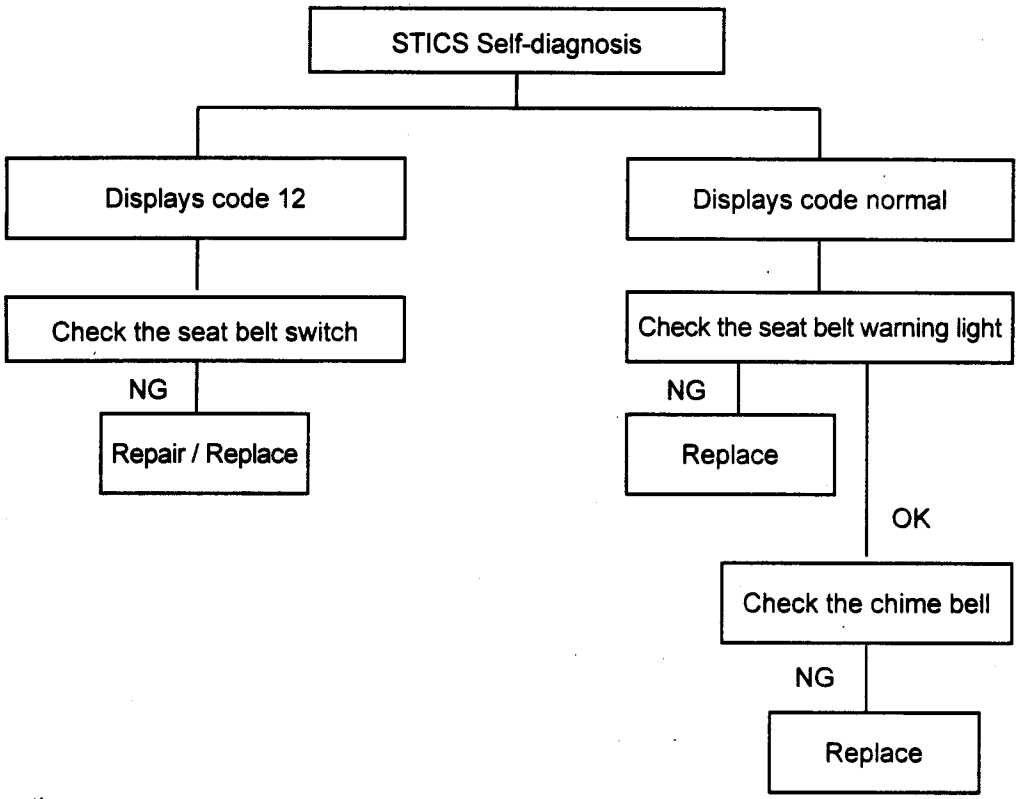
7) · Operation
- Ignition switch is ON position.

· Trouble
1. Rear defogger system does not operate.
2. Rear defogger operating time is abnormal.



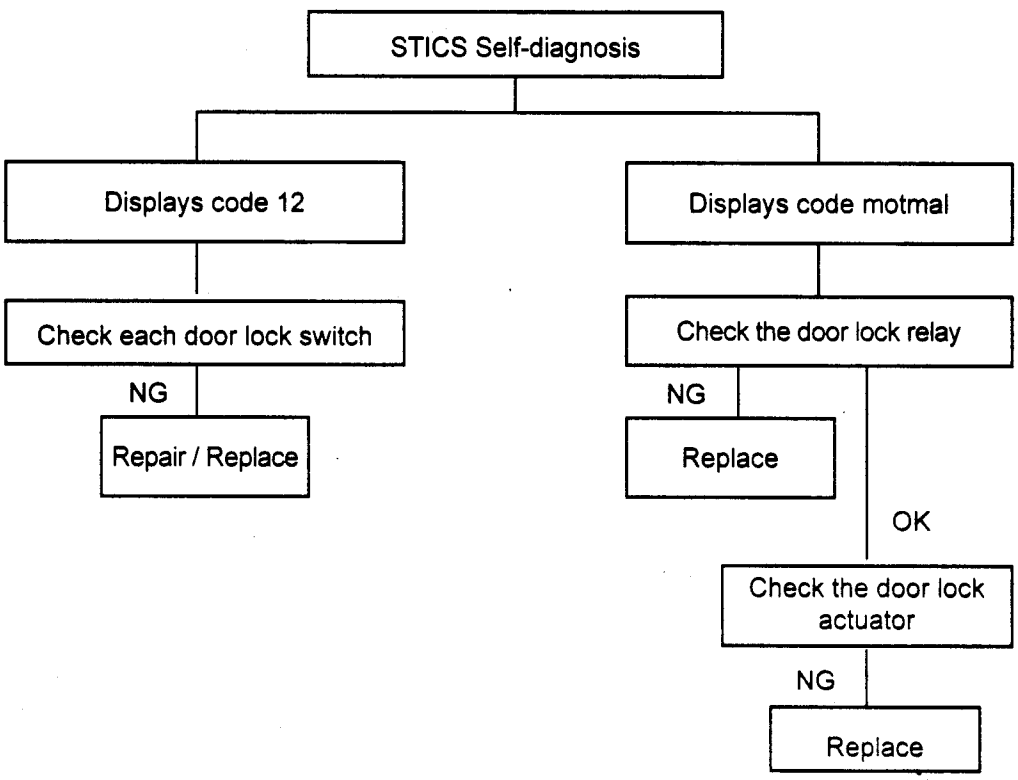
8) · Operation
- Ignition switch is ON position and seat belt is not worn.

· Trouble
- The seat belt warning light or chime bell is not operating. (In case of normal, it operates about 6 sec.)



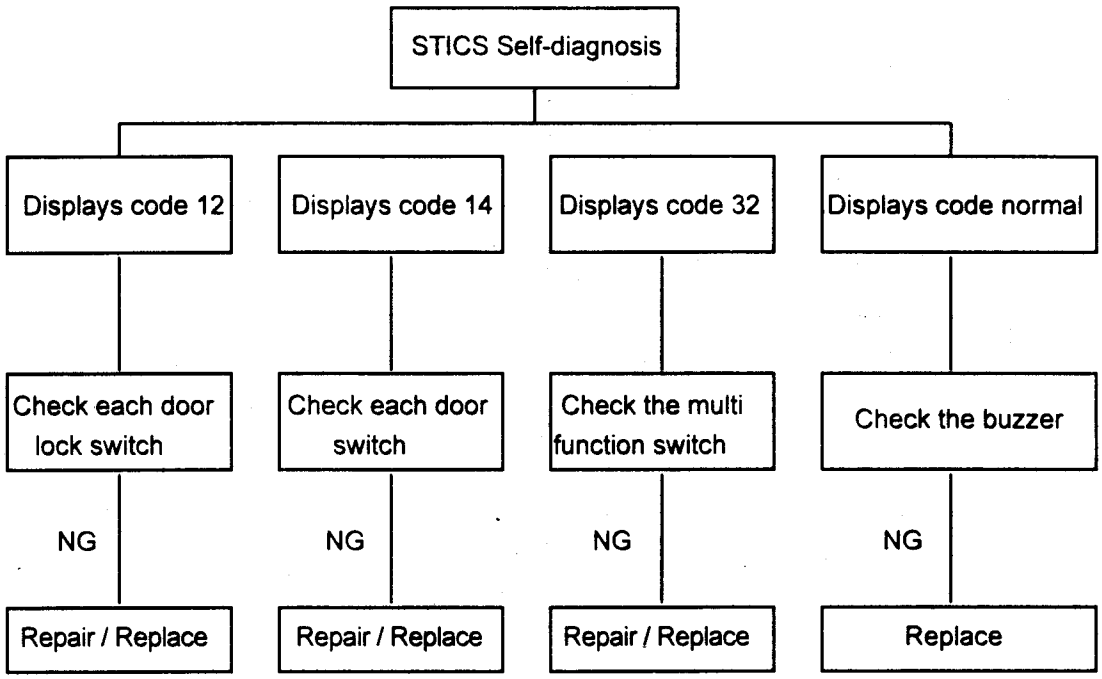
9) · Operation
- Operation of central door lock knob from the driver side.

· Trouble
- Remaining doors' central door lock system does not operate.



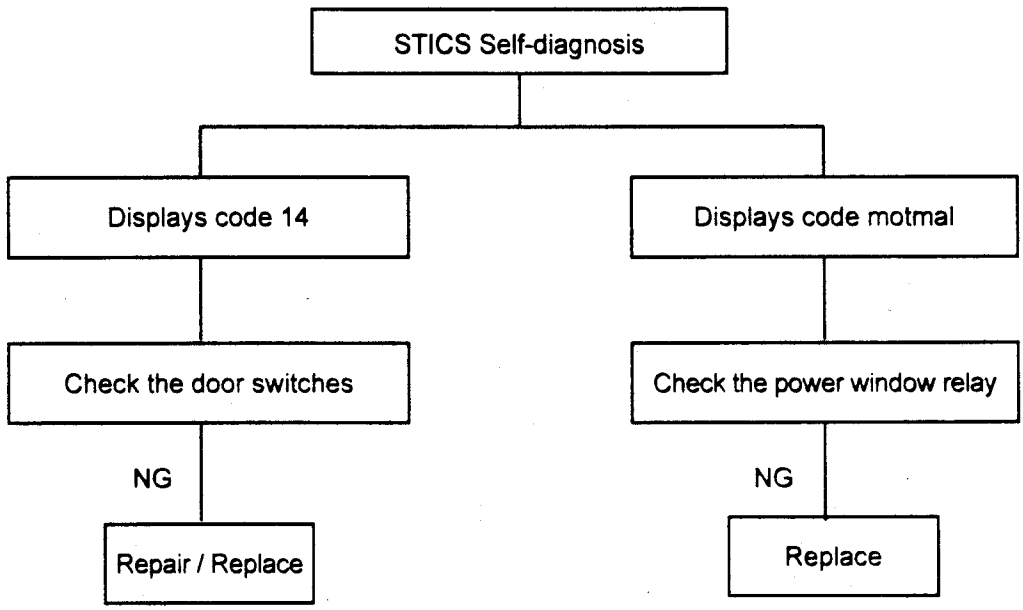
10) · Operation
- Opening the driver's door while the tail lamp switch is turned on and pulling out the key from the ignition switch.

· Trouble
1. The buzzer does not sound.
2. The driver's central door lock knob is operating.



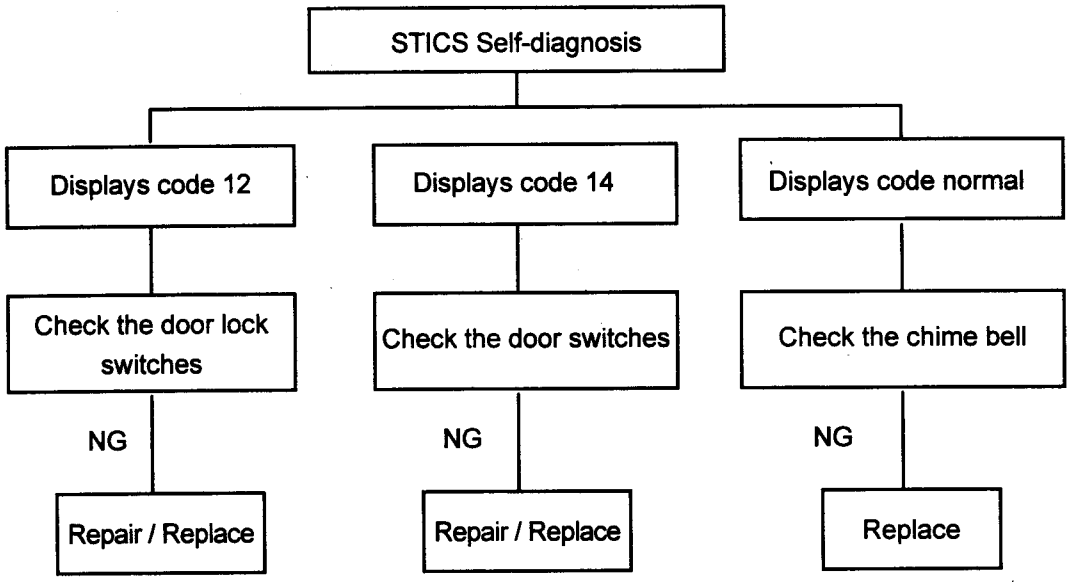
11) · Operation
- Operation of the power window after engine stopped.

· Trouble
1. Power window system does not operating during 30 sec. after engine stopped.
2. Power window operating time does not prolong when open the door.
(Power window system operates normally.)



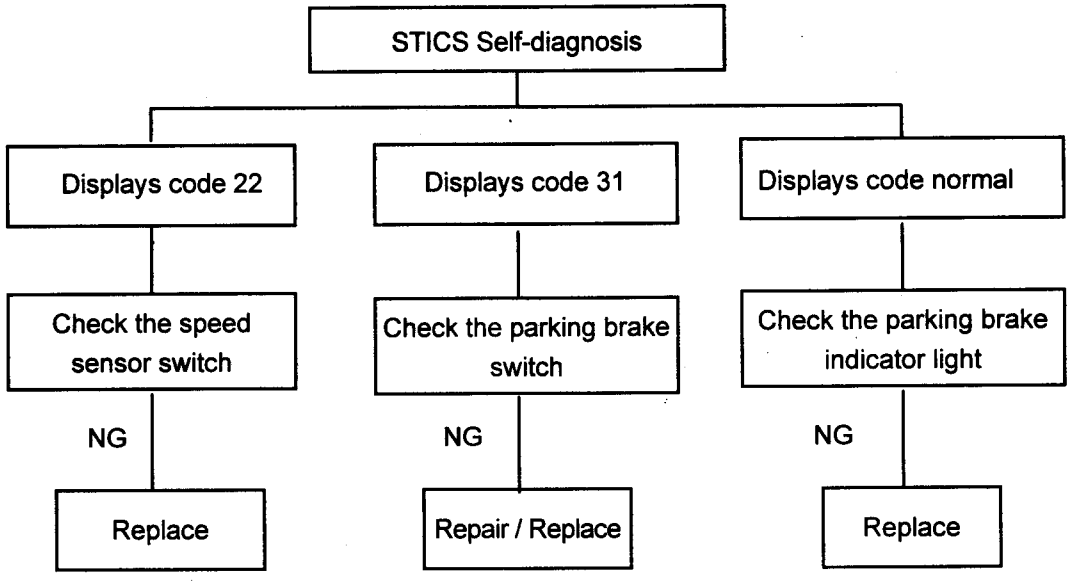
12) · Operation
- Opens the driver side door while the key is inserted into the ignition switch. (When the ignition switch is not ON position).

· Trouble
1. The chime bell does not sound.
2. Driver's door lock knob operates normally (When the ignition key hole lamp is on).



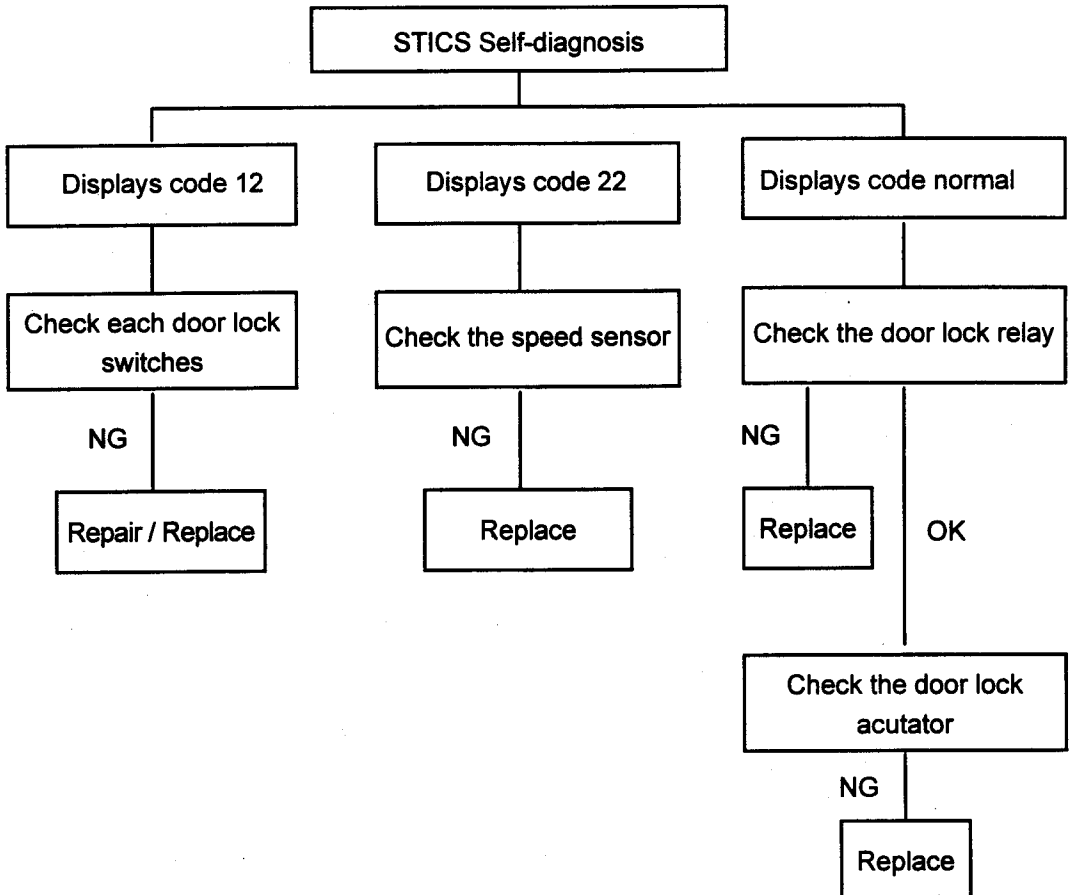
13) · Operation
- Parking brake is applied.

· Trouble
1. The parking brake indicator light does not come on.
2. The turned on parking brake indicator light does not flash when driving over 3 - 5km/h.

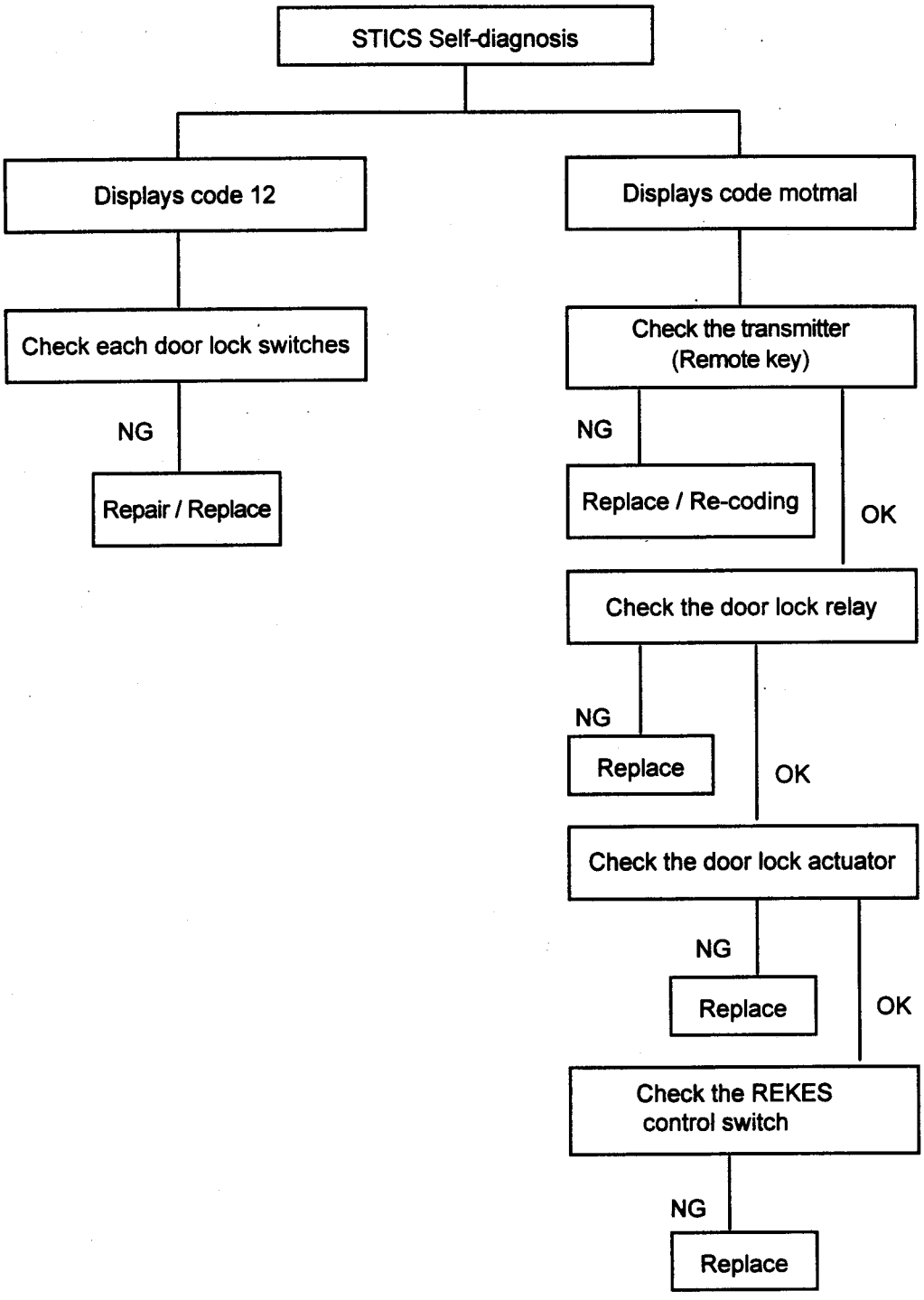


14) · Operation
- Driving the vehicle over 50km/h.

· Trouble
- Auto door lock system does not operate (Central door lock system is operating).

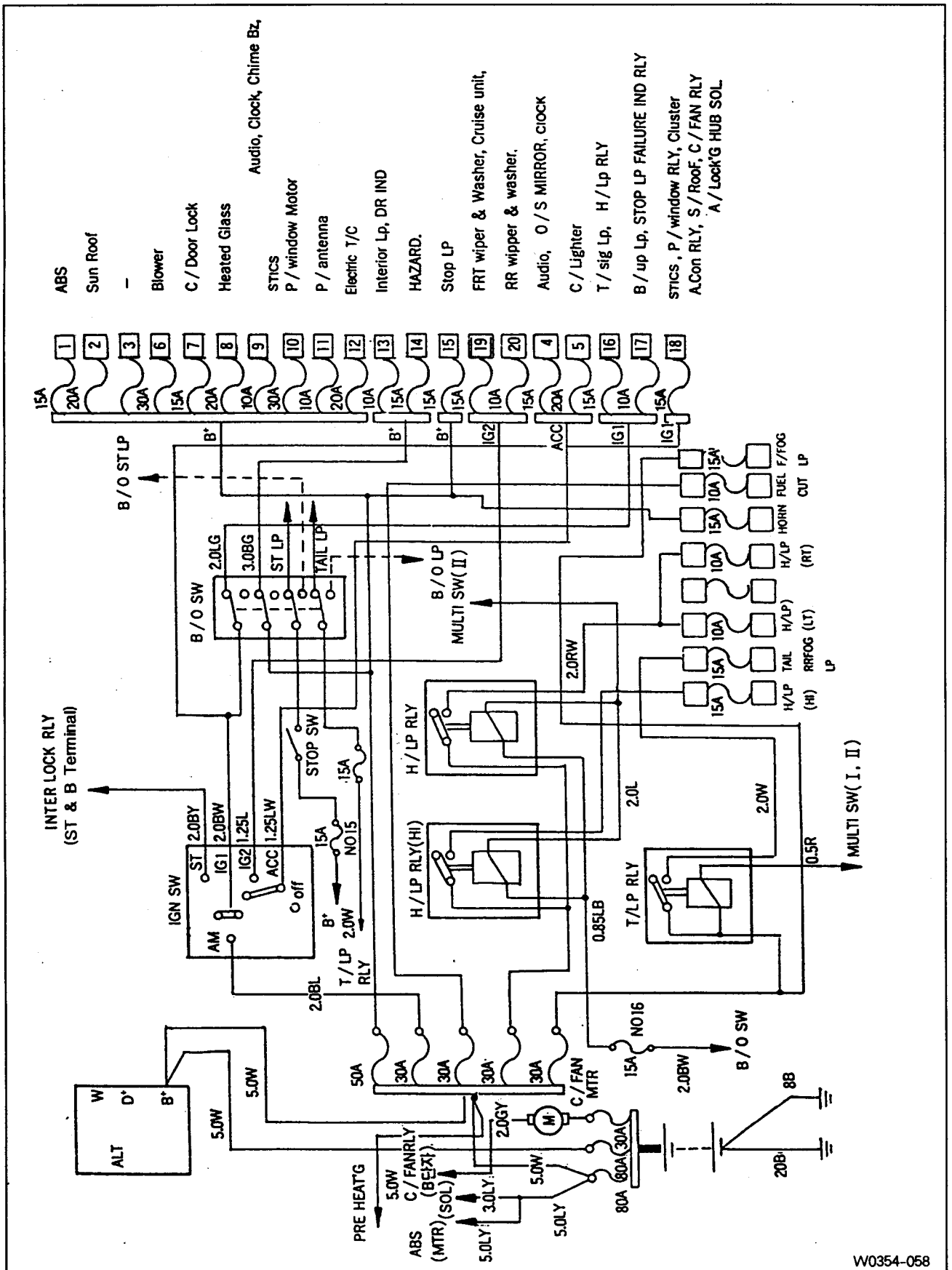


15) Remote keyless entry system (REKES) does not operate when the key is not inserted.



11. Wiring Diagram

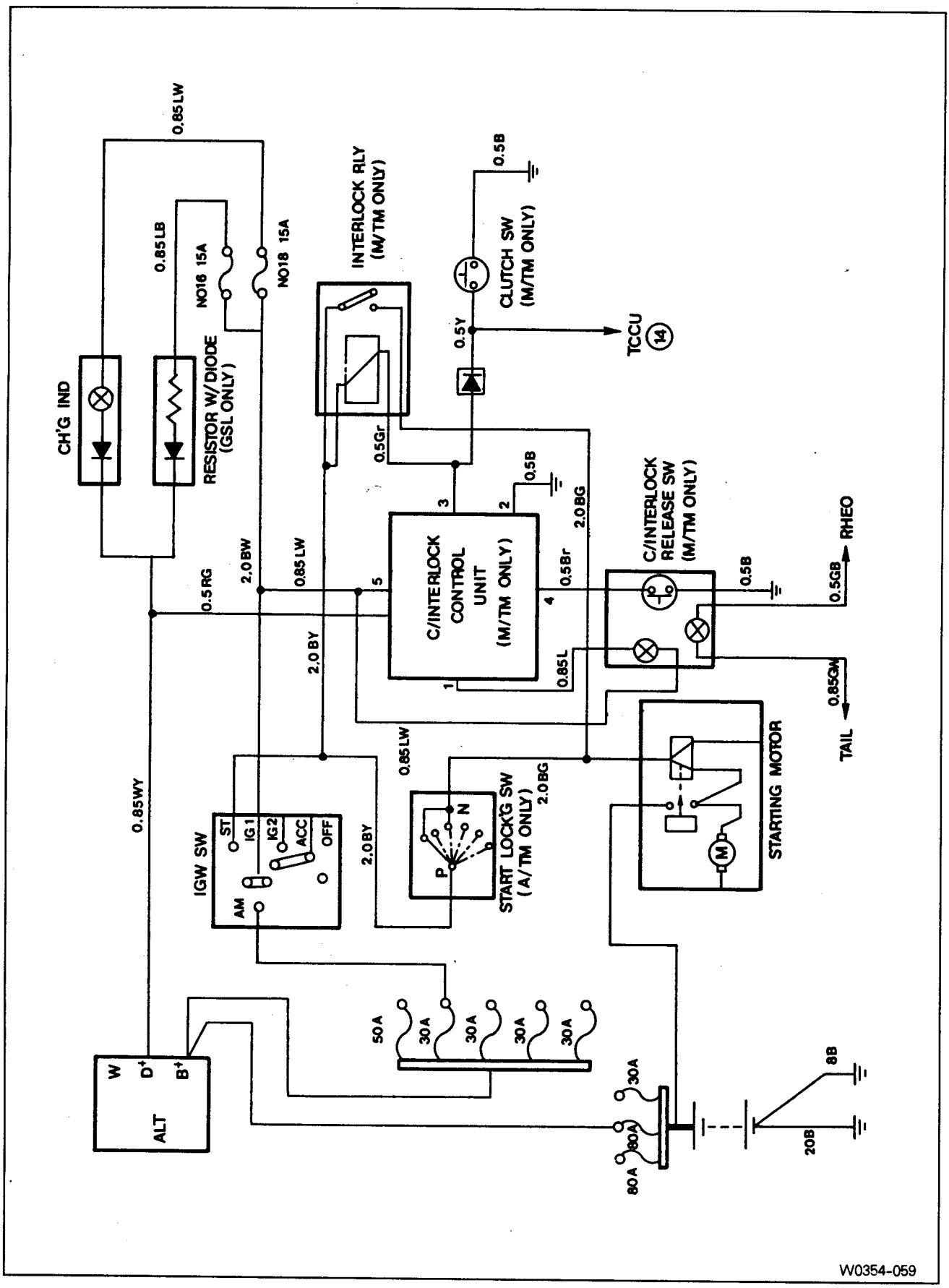
Power distribution



Wiring Diagram 2

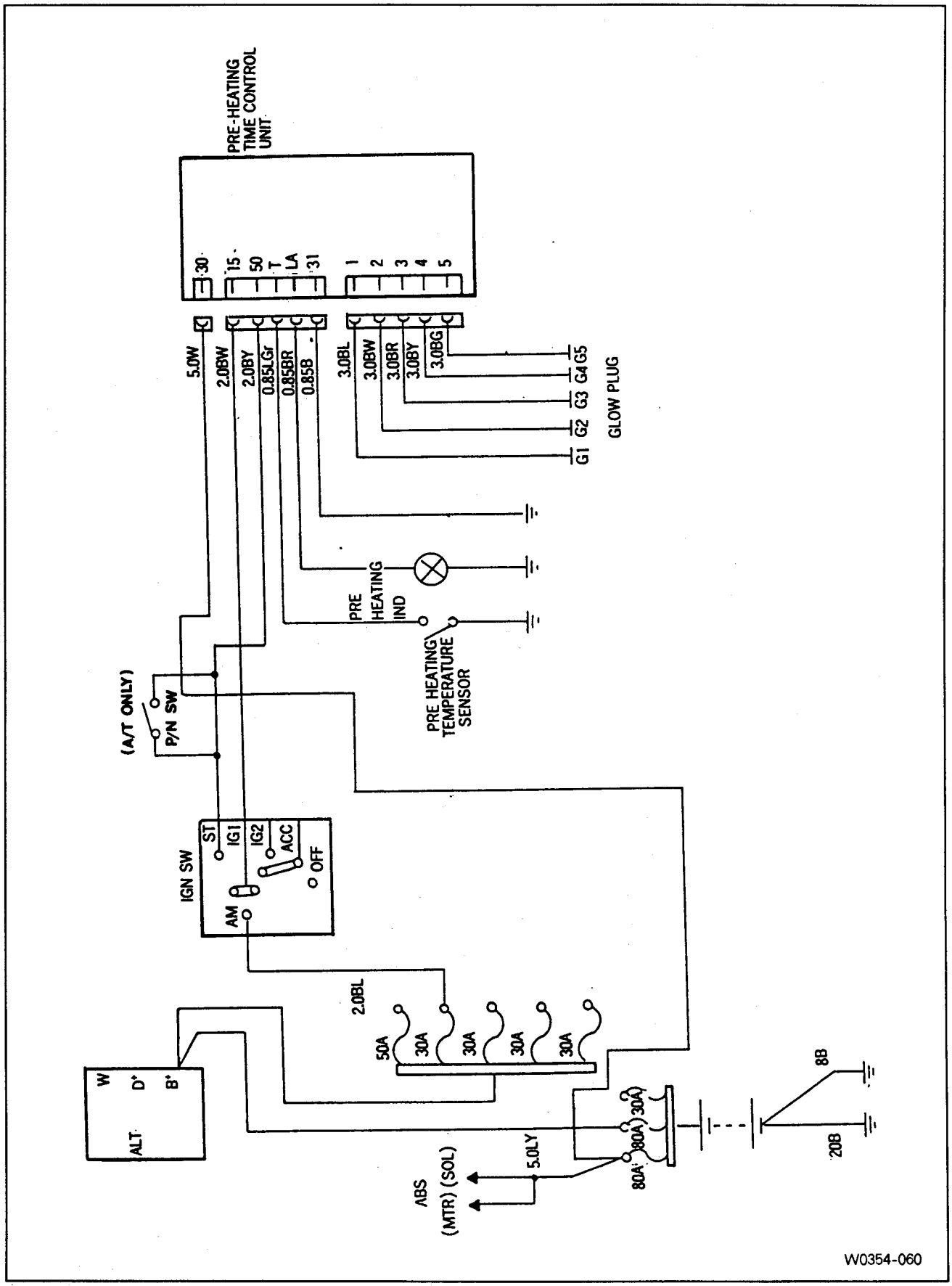
Power Supply	Fuse No.	Capacity	Connection
Battery	1	15A	ABS
	2	20A	Sun Roof
	3	—	—
	6	30A	Heater
	7	15A	Central Door Lock
	8	20A	Rear Defogger
	9	10A	Audio, Clock, Chime Bell, STICS
	10	30A	Power Window Motor
	11	10A	Power Antenna
	12	20A	4WD
	13	10A	Room Lamps, Door Lamps
	14	15A	Hazard Warning
	15	15A	Stop Lamps
ACC	4	15A	Clock, Audio, Outside Rear View Mirror
	5	20A	Cigar Lighter
IG 1	16	15A	Turn Signal Lamps, Head Lamp Relay
	17	10A	Back-up Lamps, Stop Lamp Failure Relay
	18	15A	STICS, Power Window Relay, Combination Meter, Air Conditioner Relay, Condenser Fan Relay, Auto Locking Hub Solenoid
IG 2	19	15A	Front Wiper and Washer
	20	10A	Rear Wiper and Washer

Starting and charging



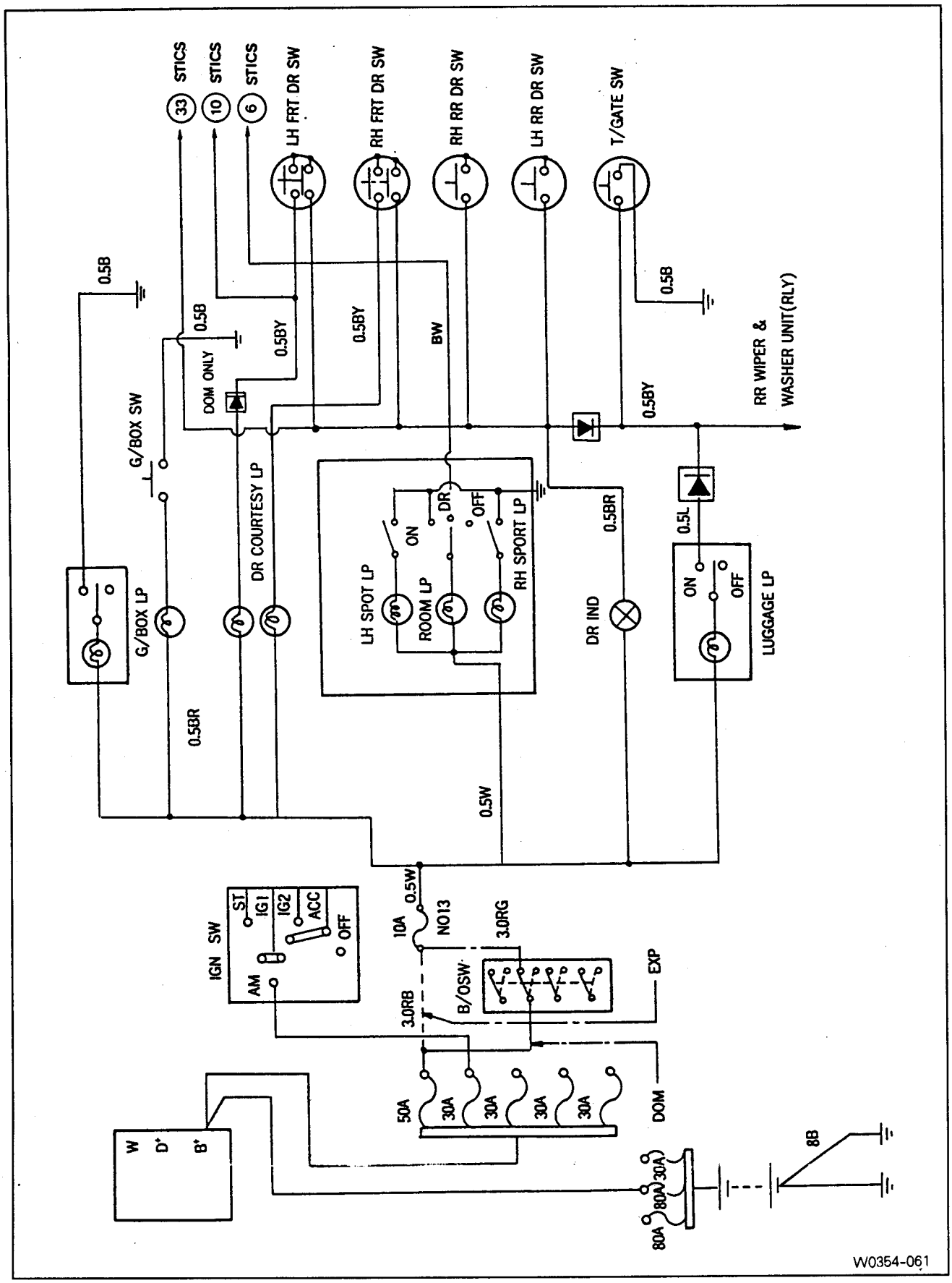
Wiring Diagram 4

Pre-heating system



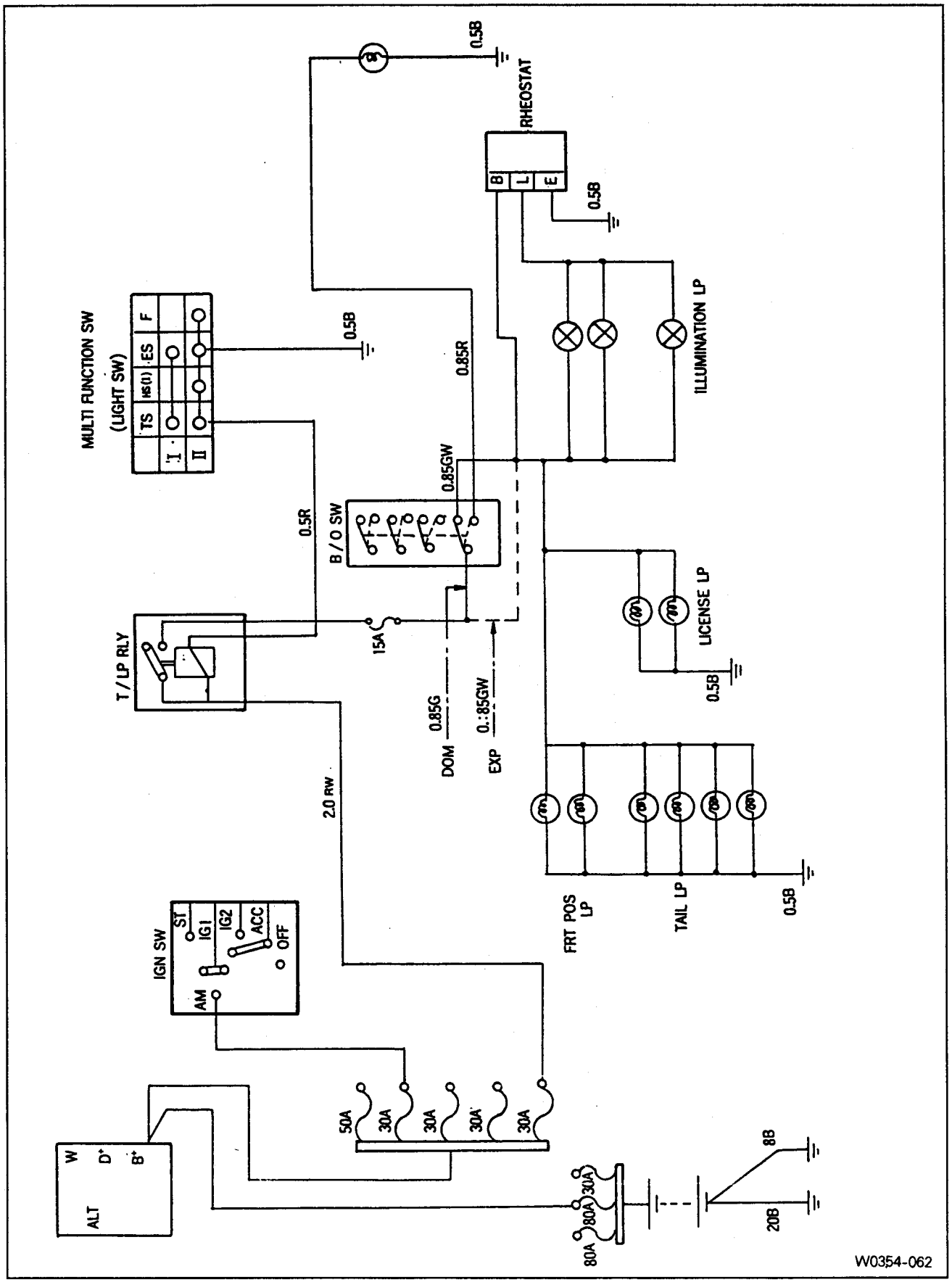
Wiring Diagram 5

Room lamps



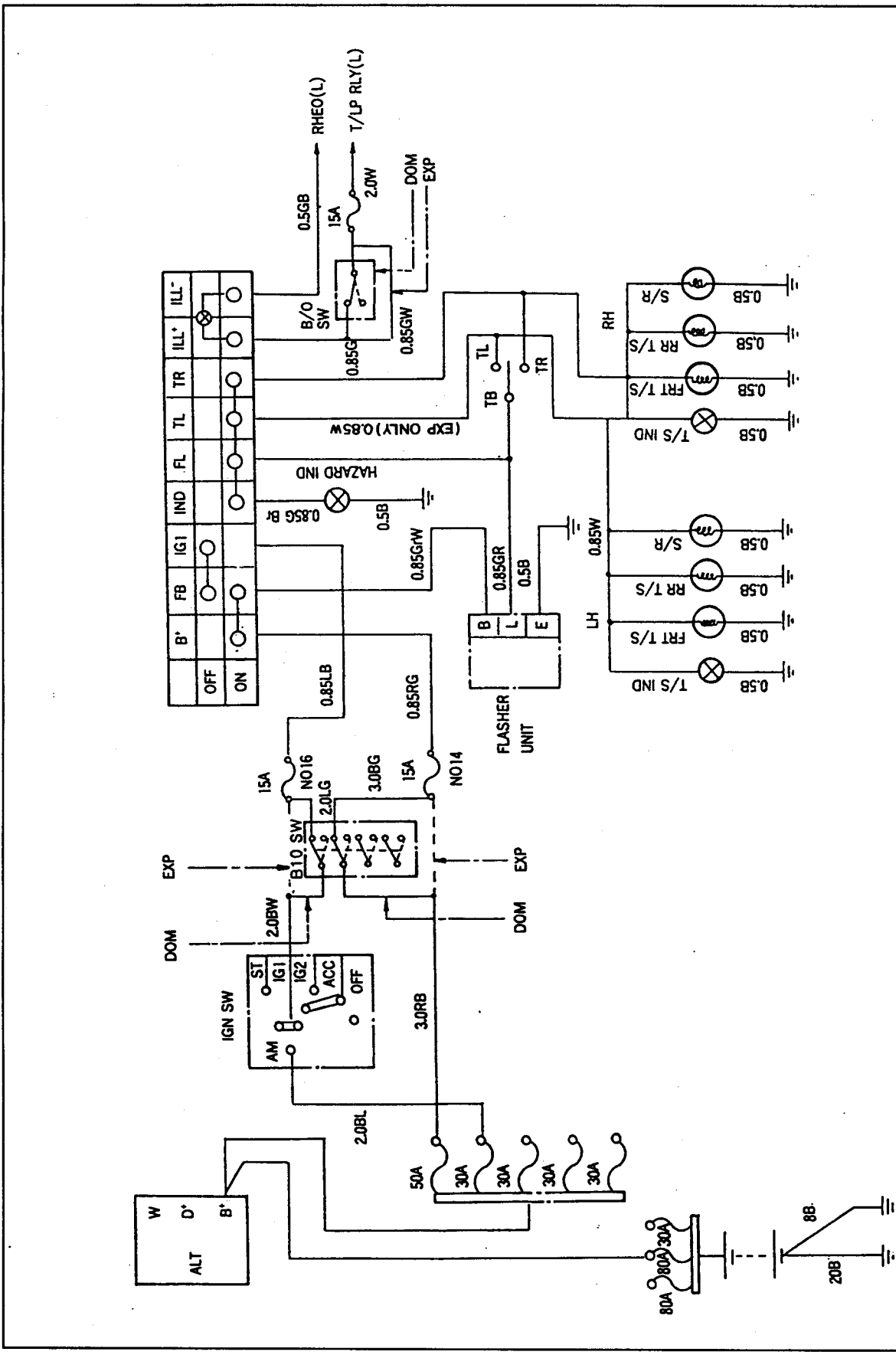
Wiring Diagram 6

Tail and blackout lamps



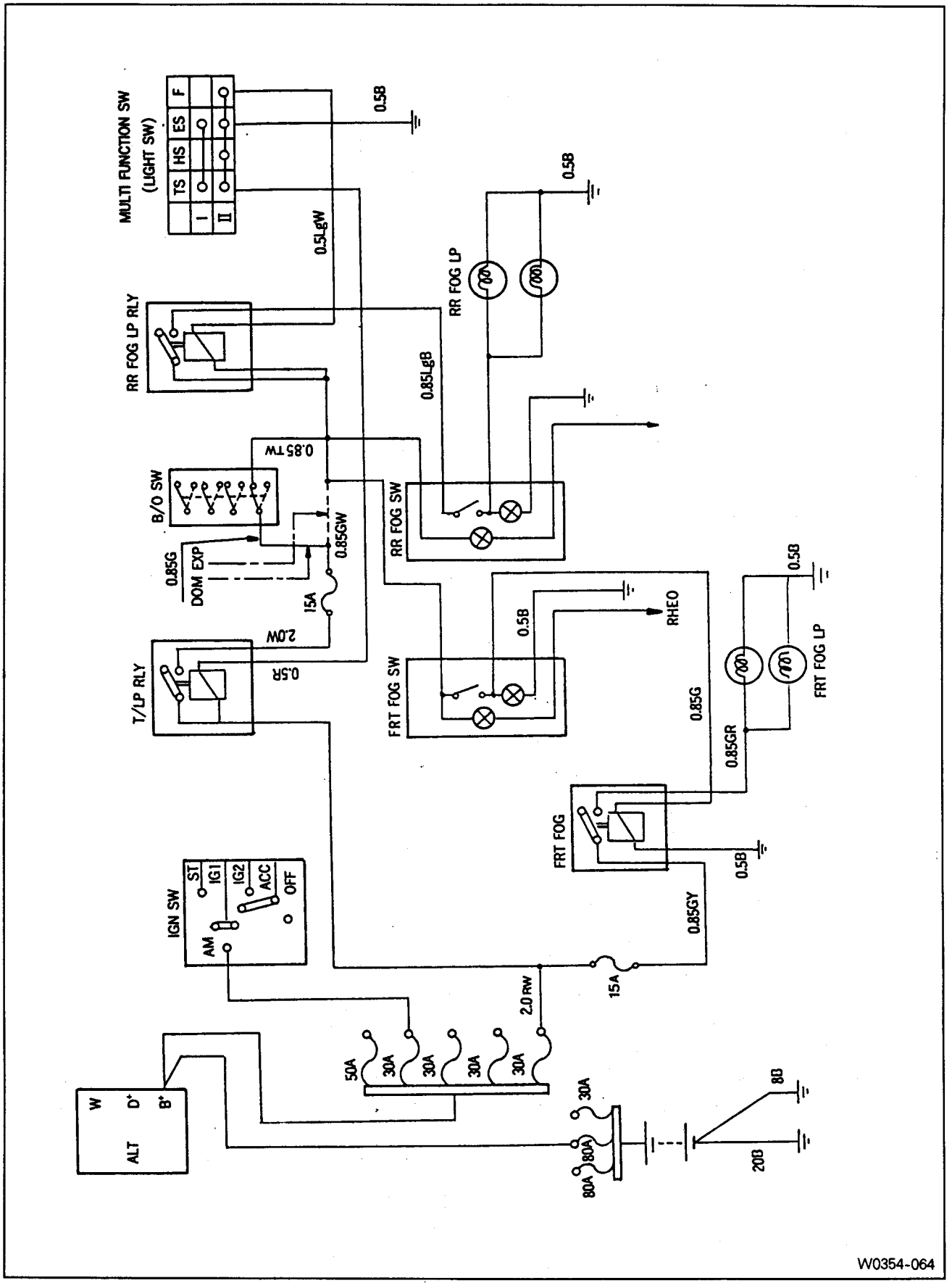
Wiring Diagram 7

Turn signal and hazard warning lamps

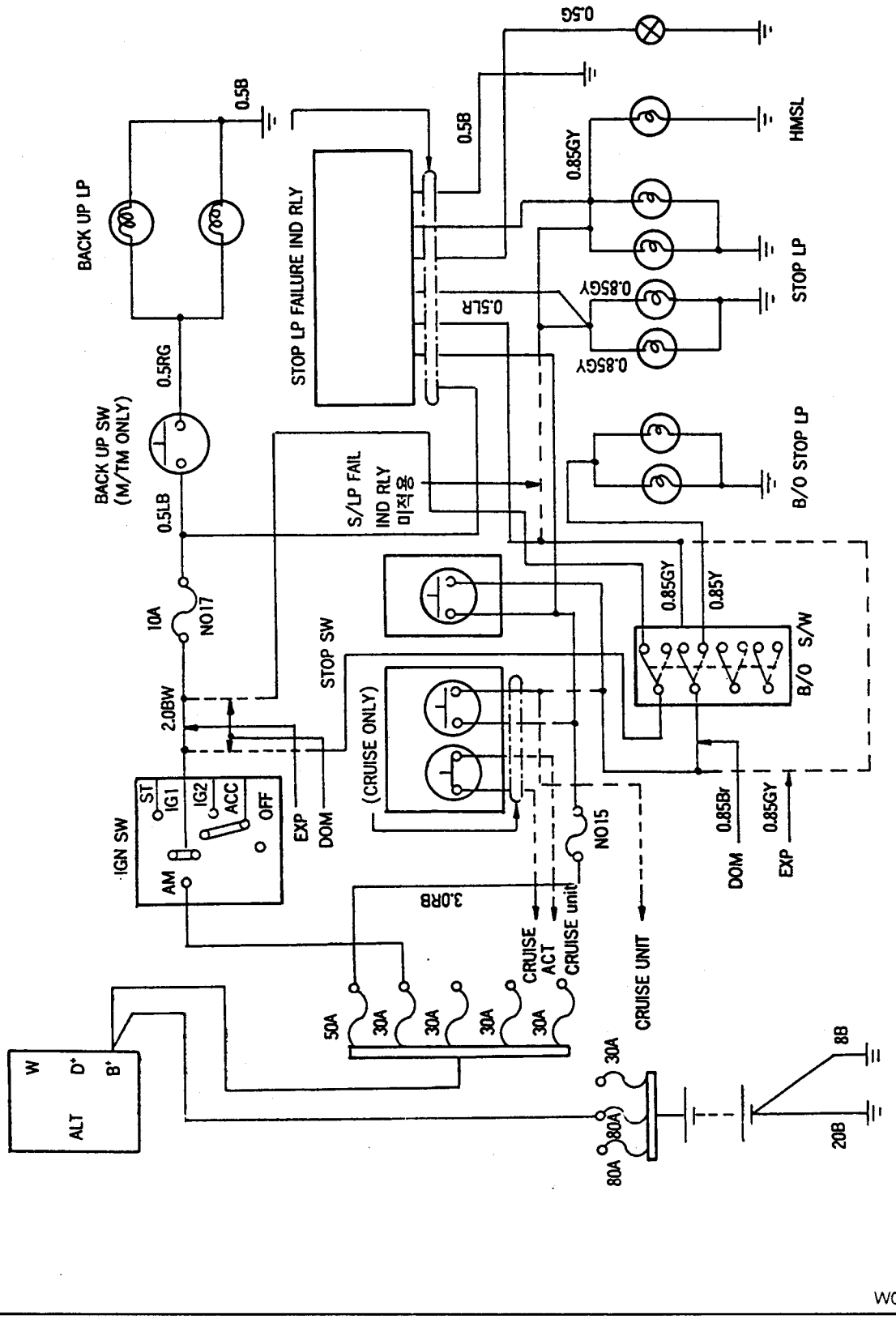


Wiring Diagram 8

Front and rear fog lamps

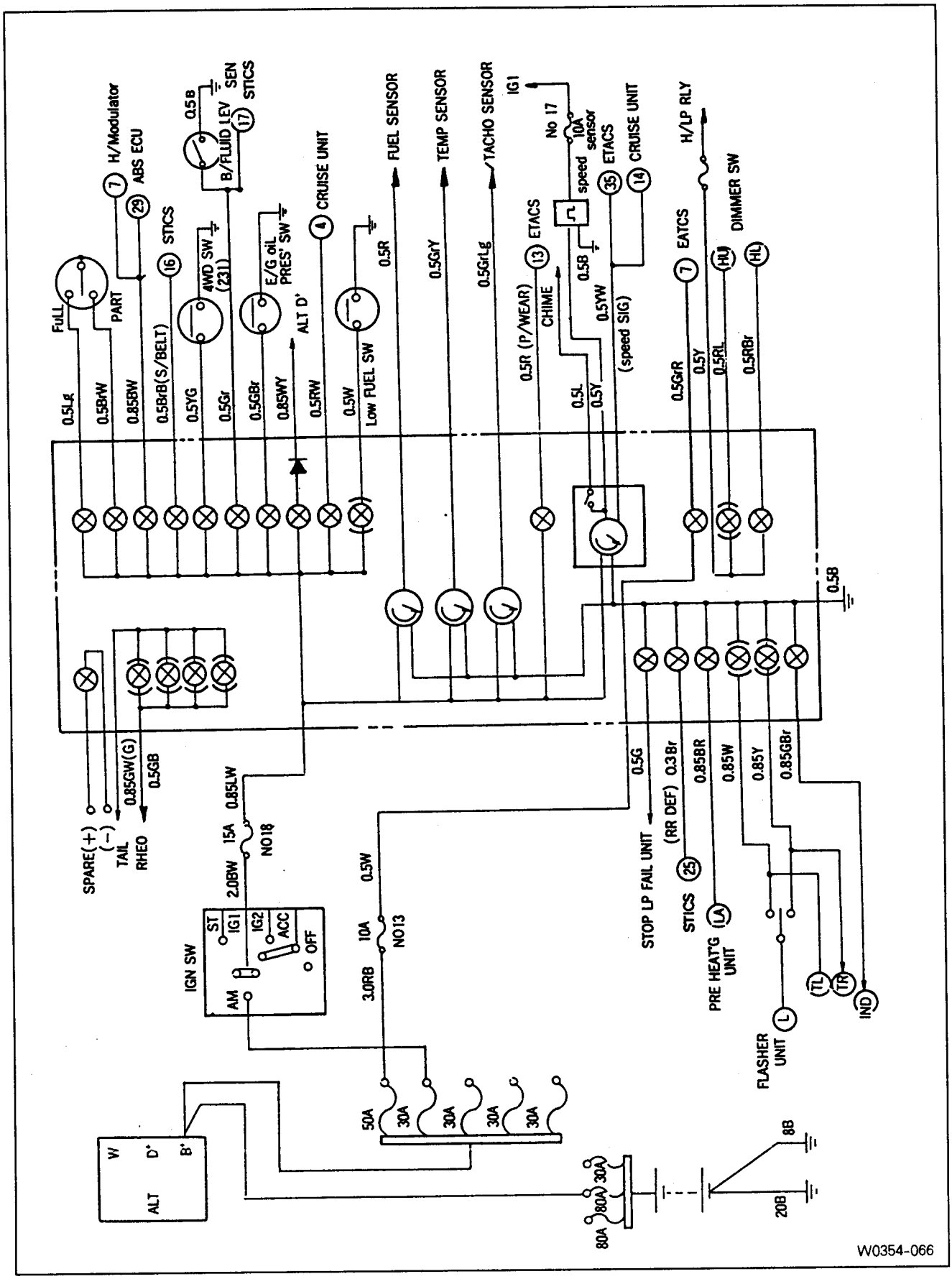


Back-up and stop lamps



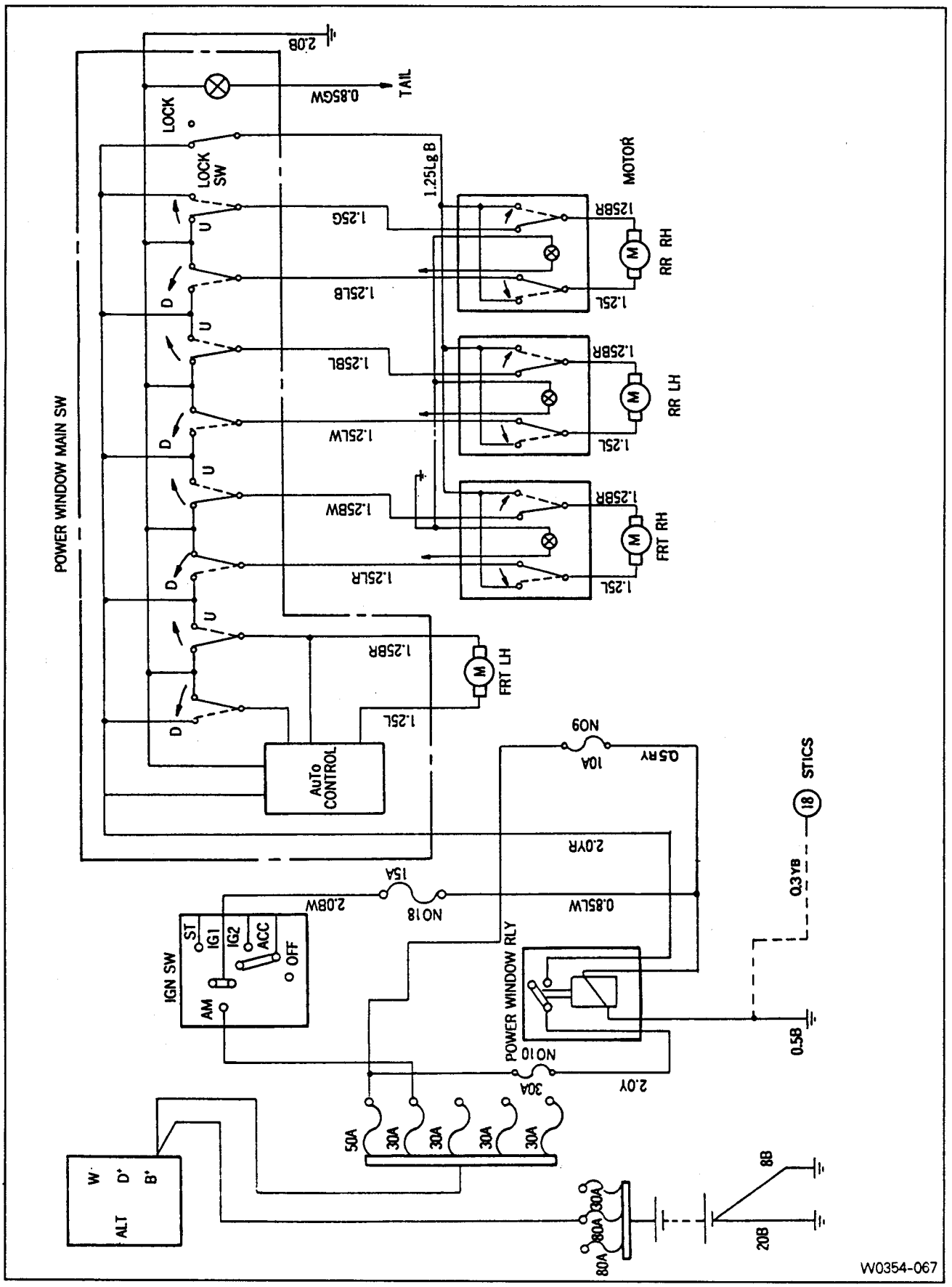
Wiring Diagram 10

Combination meter



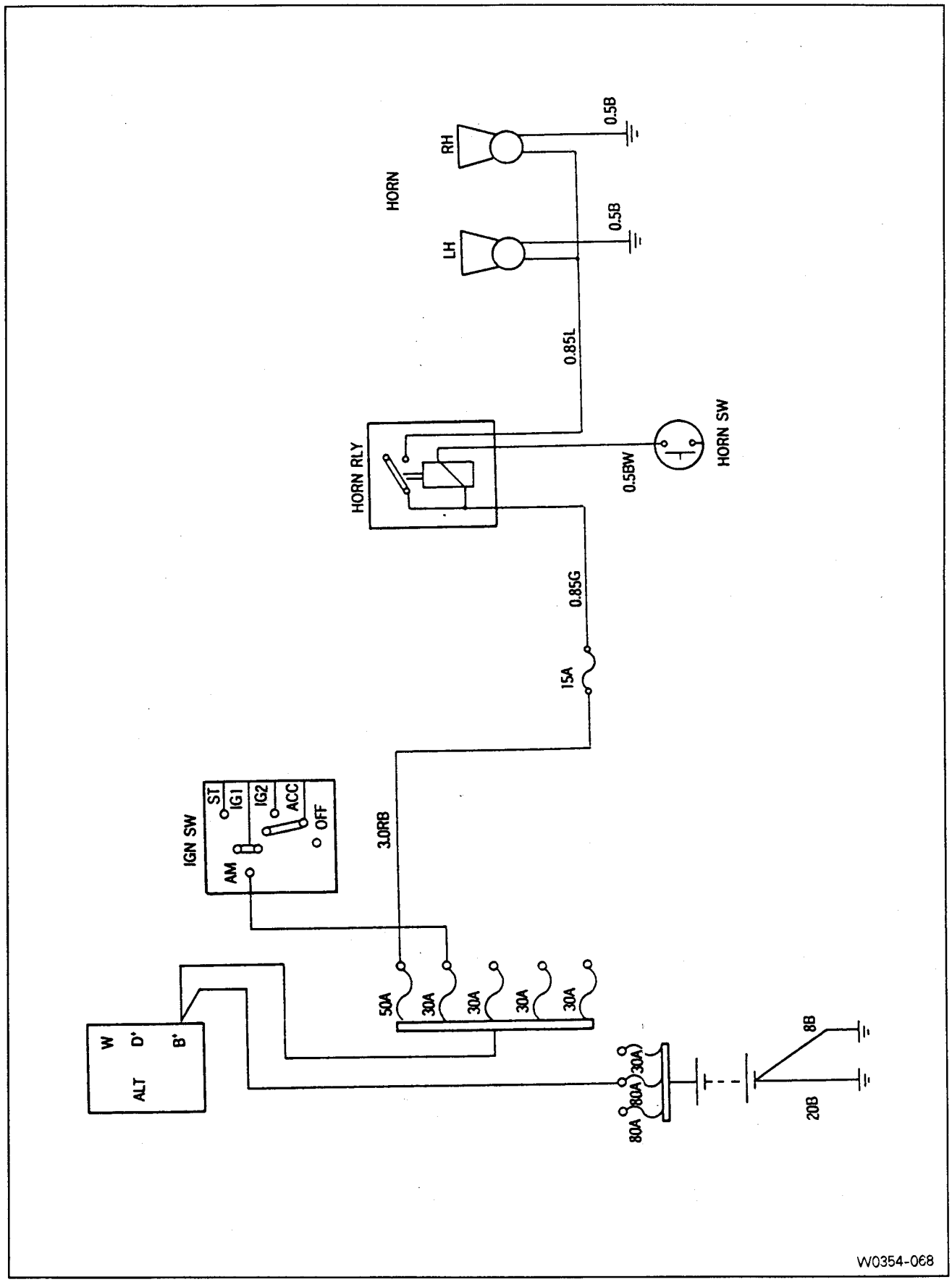
Wiring Diagram 11

Power windows



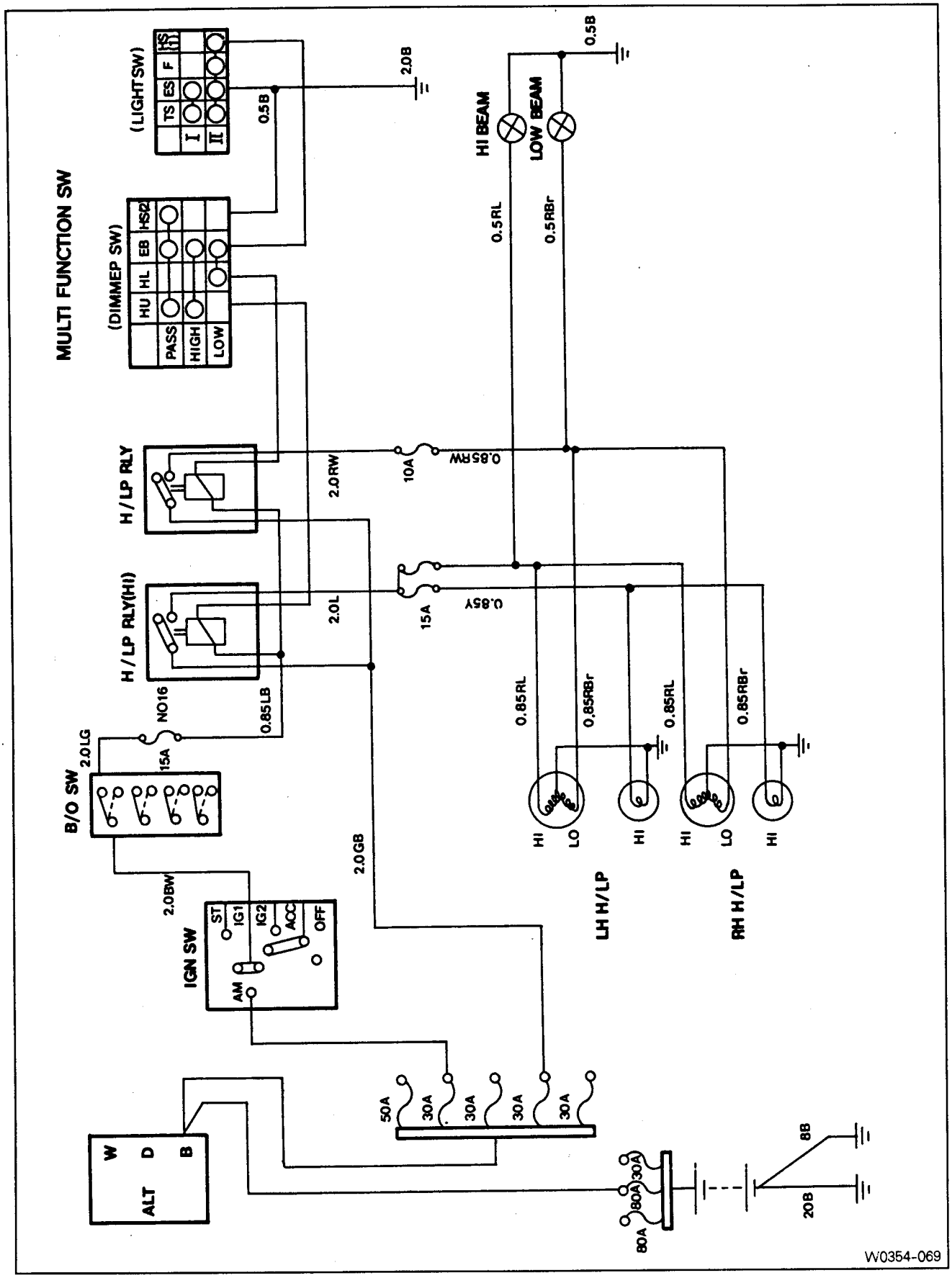
Wiring Diagram 12

Horns



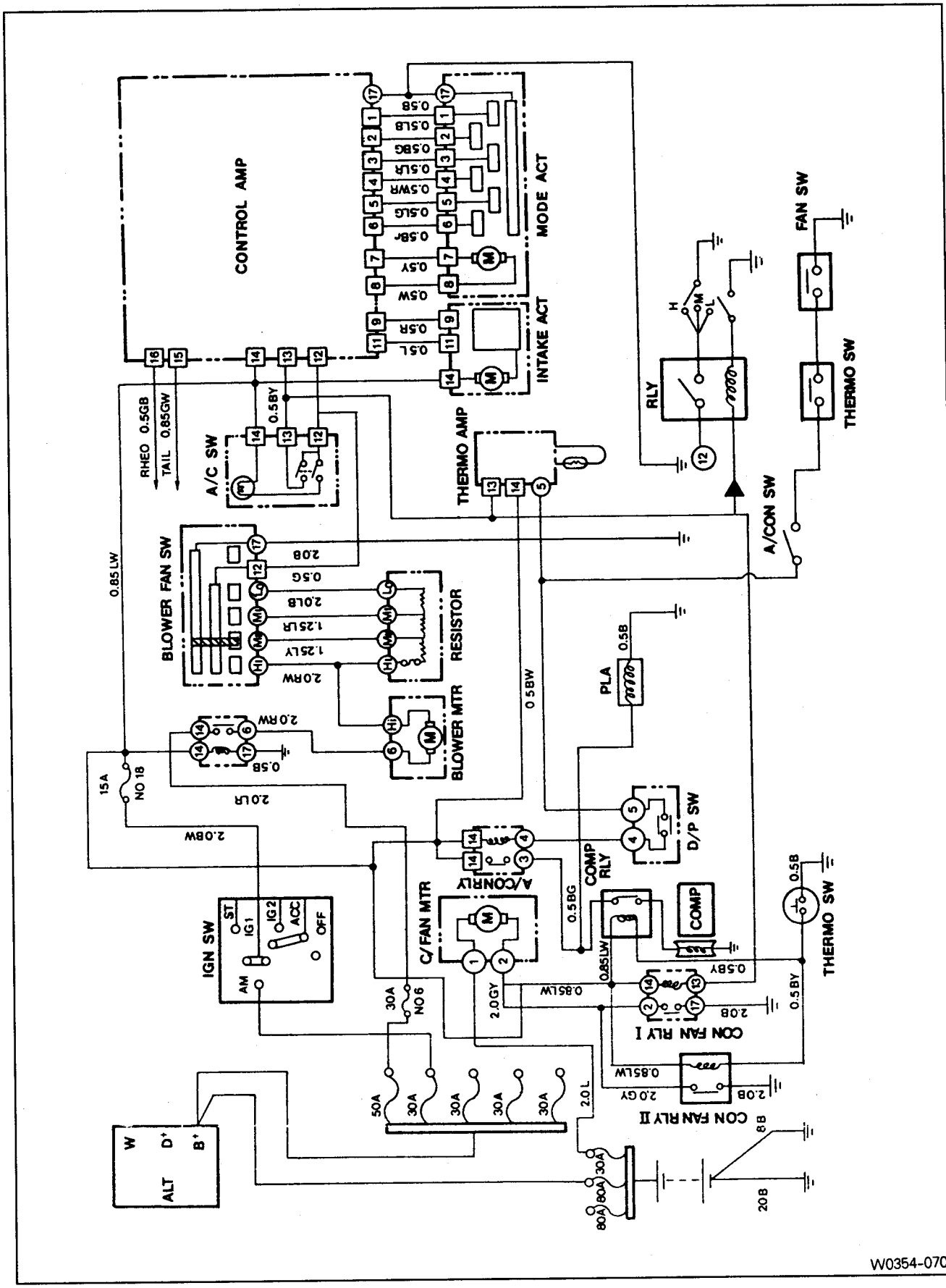
Wiring Diagram 13

Head lamps



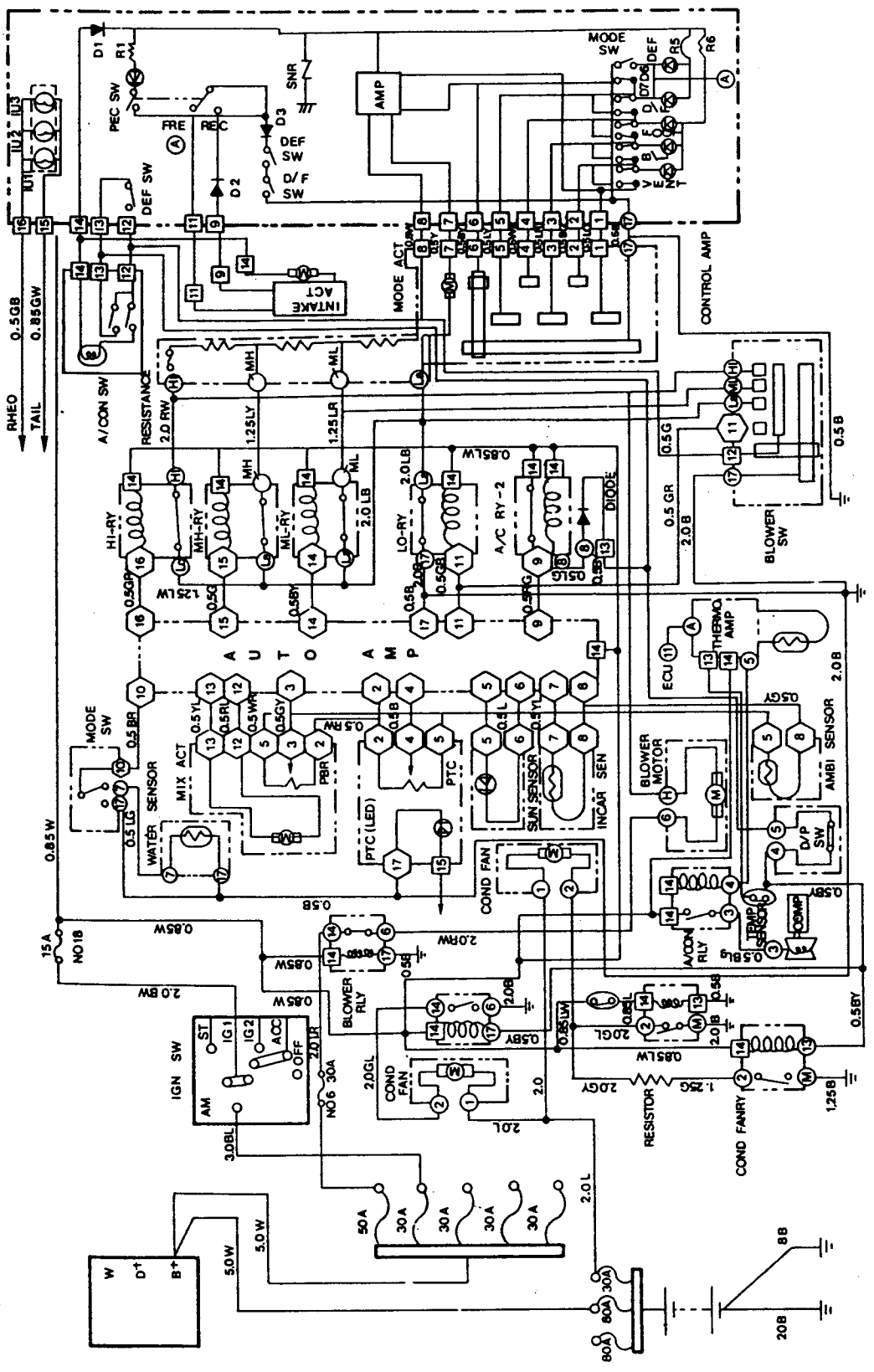
Wiring Diagram 14

Heater and air conditioner (Manual)



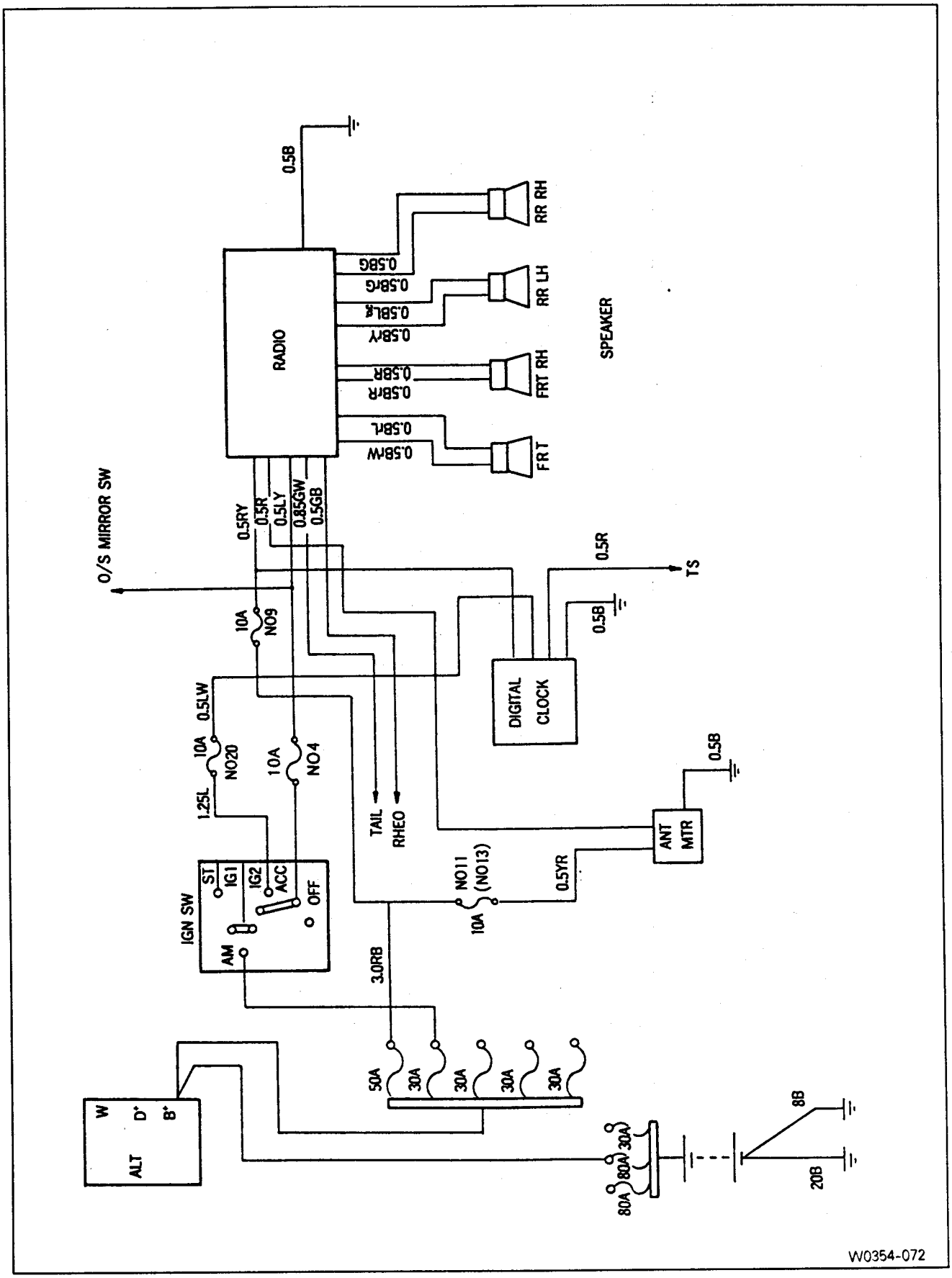
Wiring Diagram 15

Heater and air conditioner (Auto)



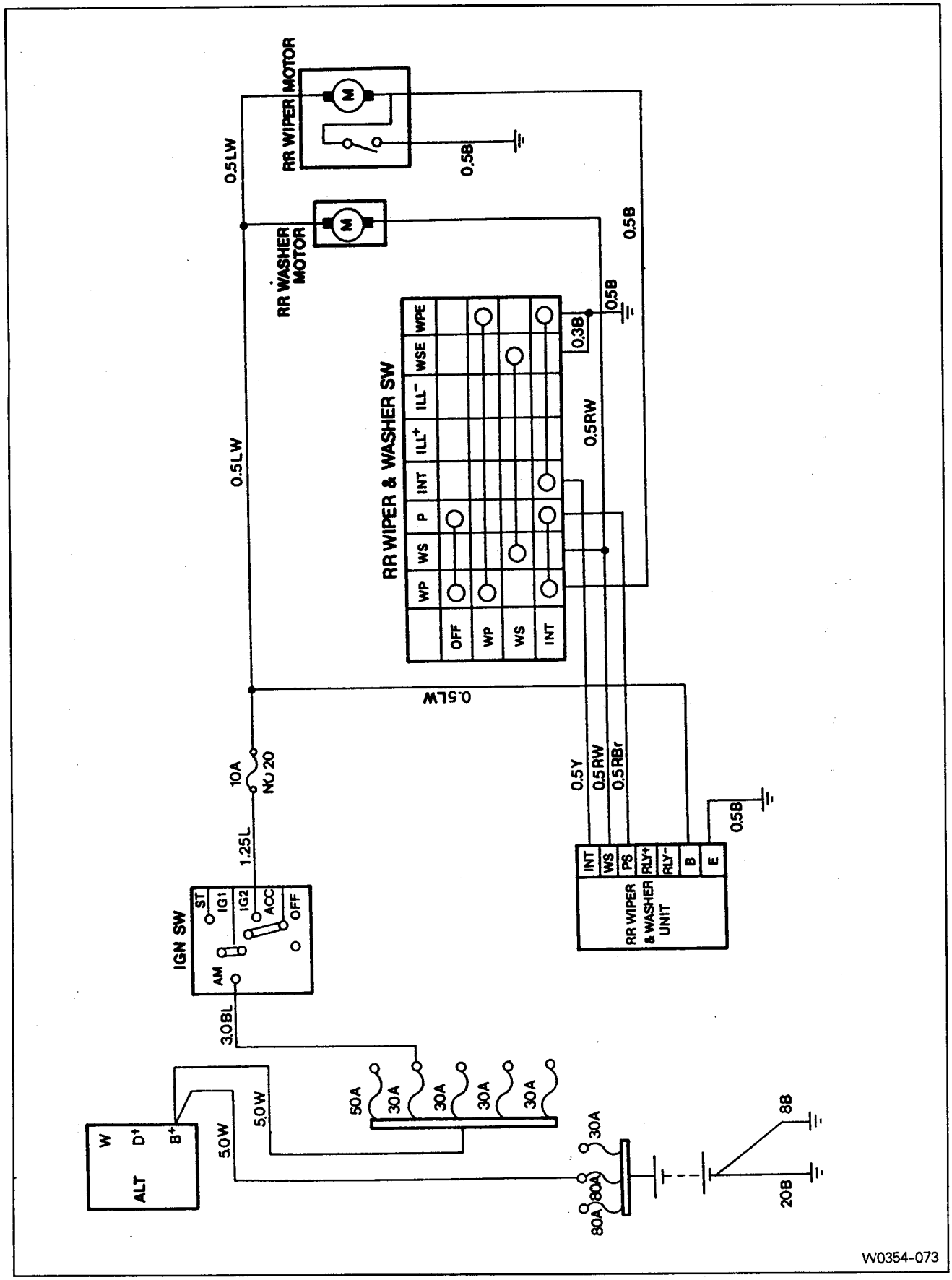
Wiring Diagram 16

Audio and clock



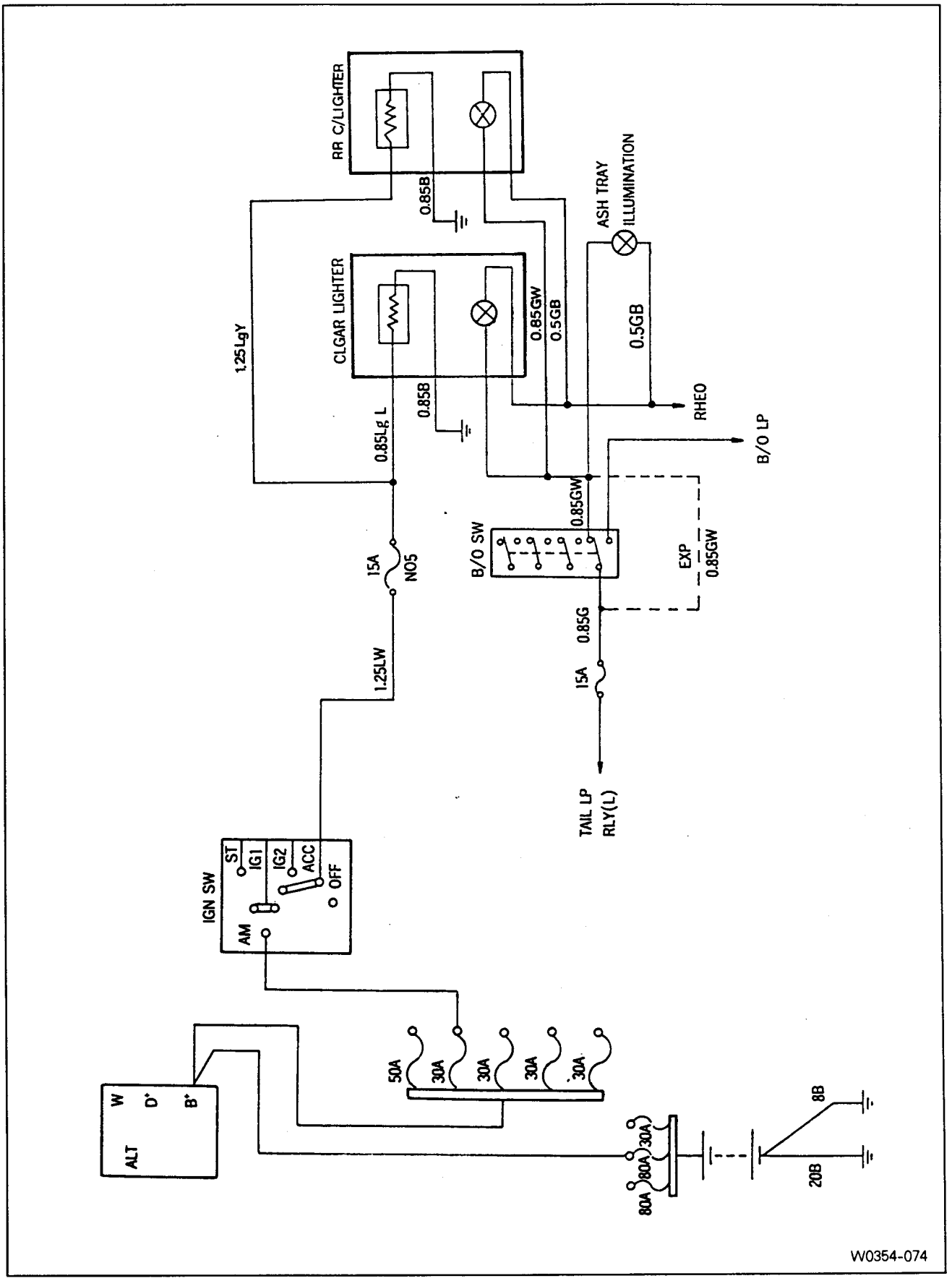
Wiring Diagram 17

Rear wiper and washer



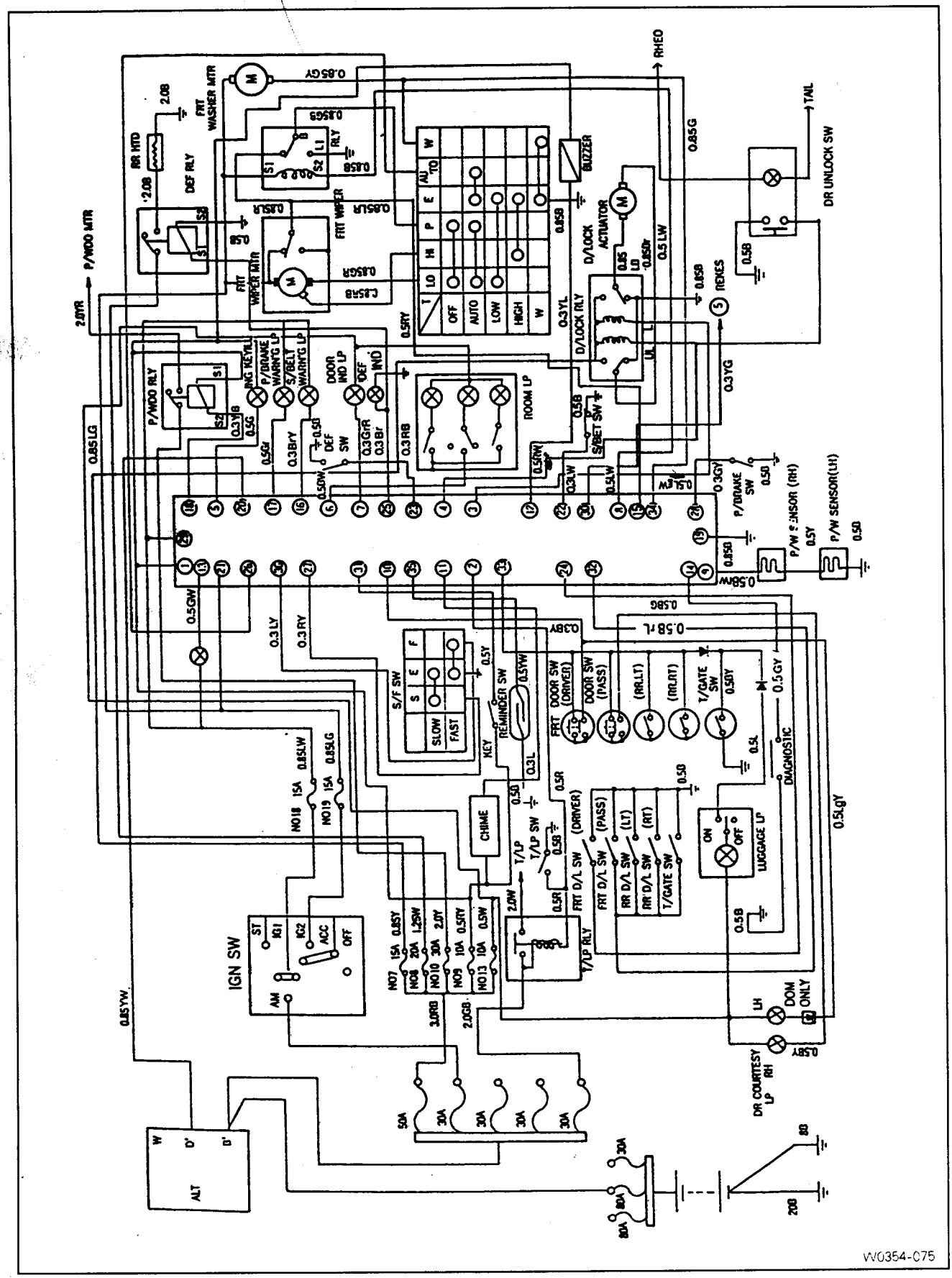
Wiring Diagram 18

Cigar lighter



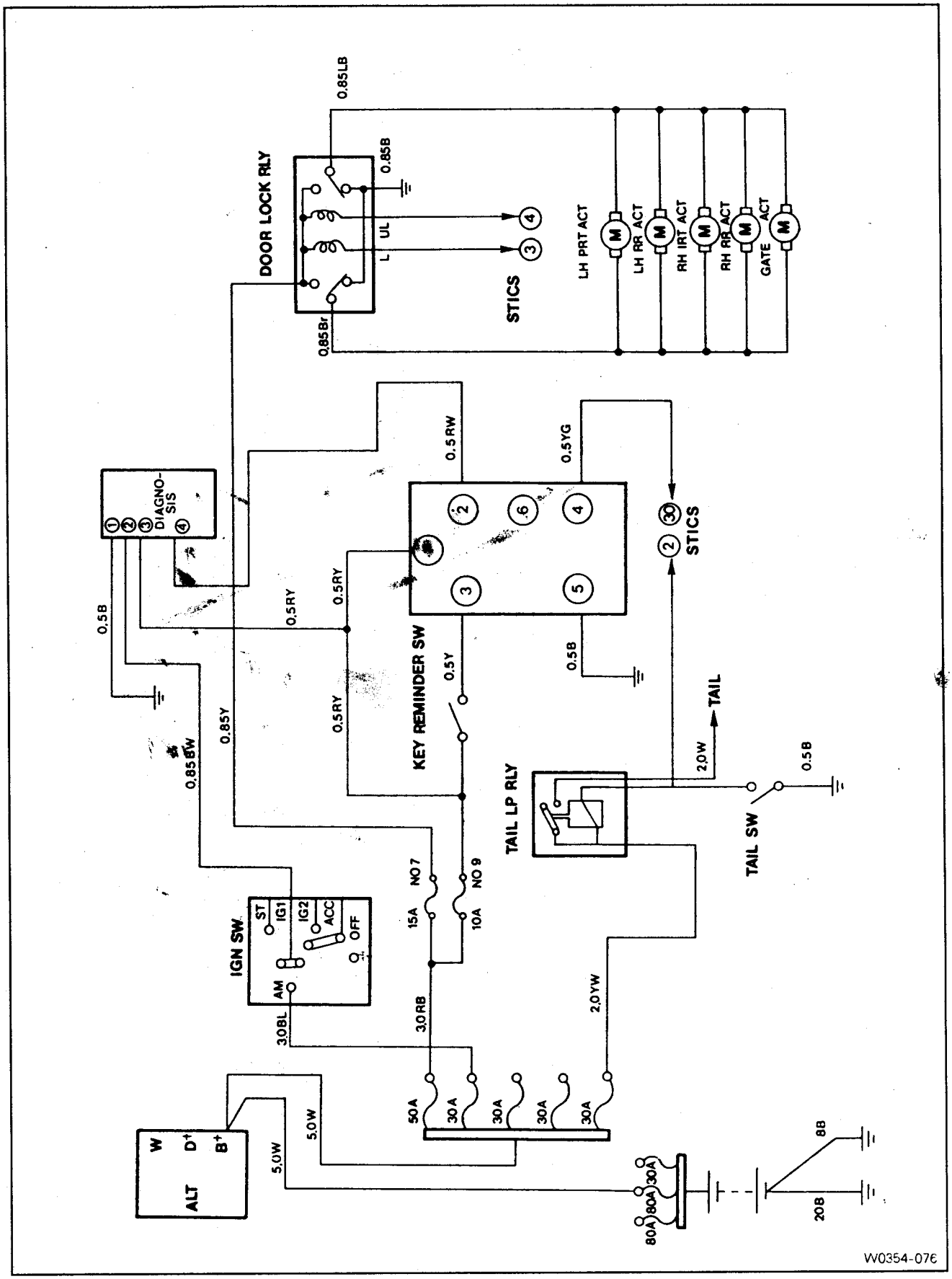
Wiring Diagram 19

STICS



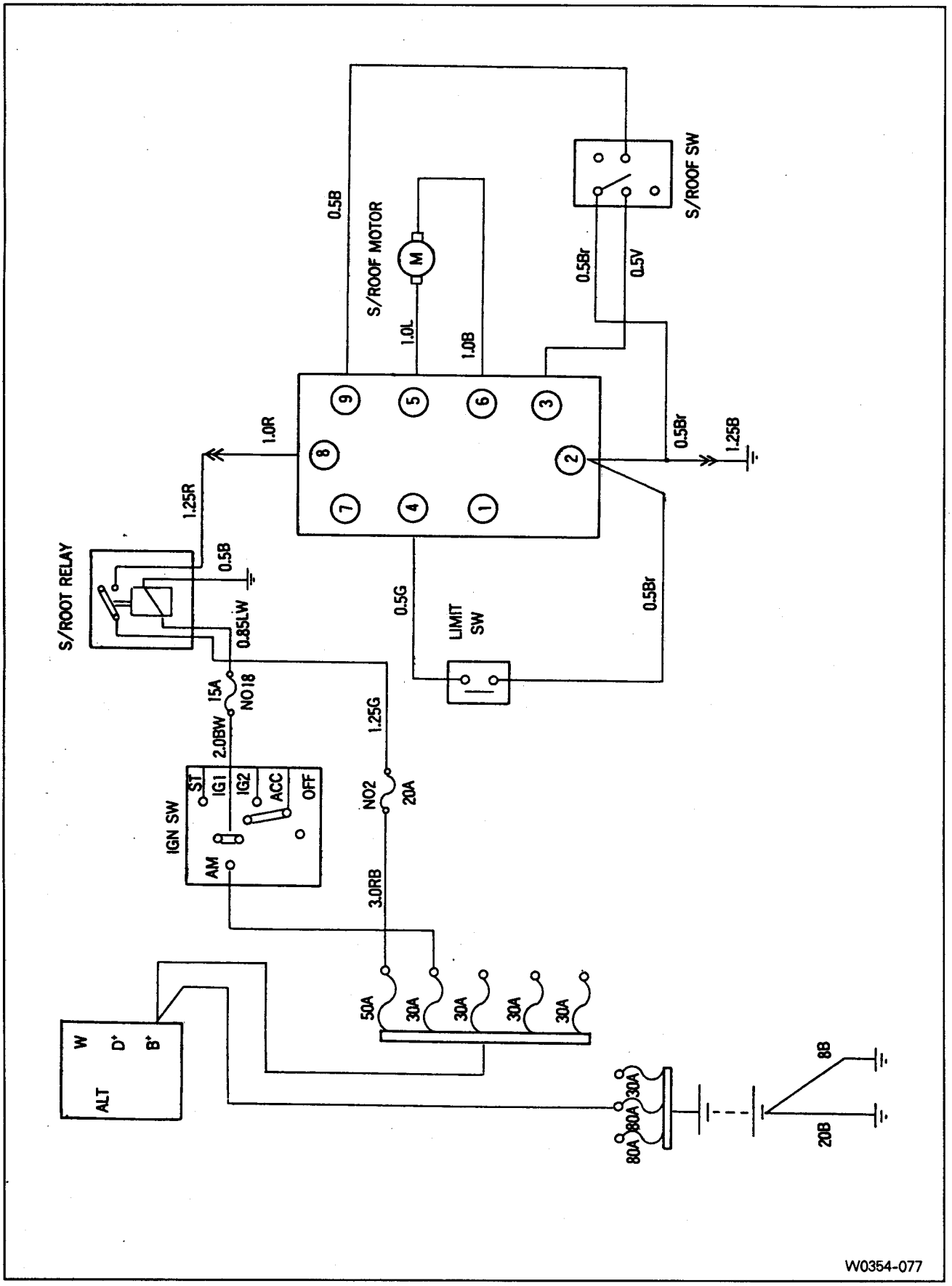
Wiring Diagram 20

REKES



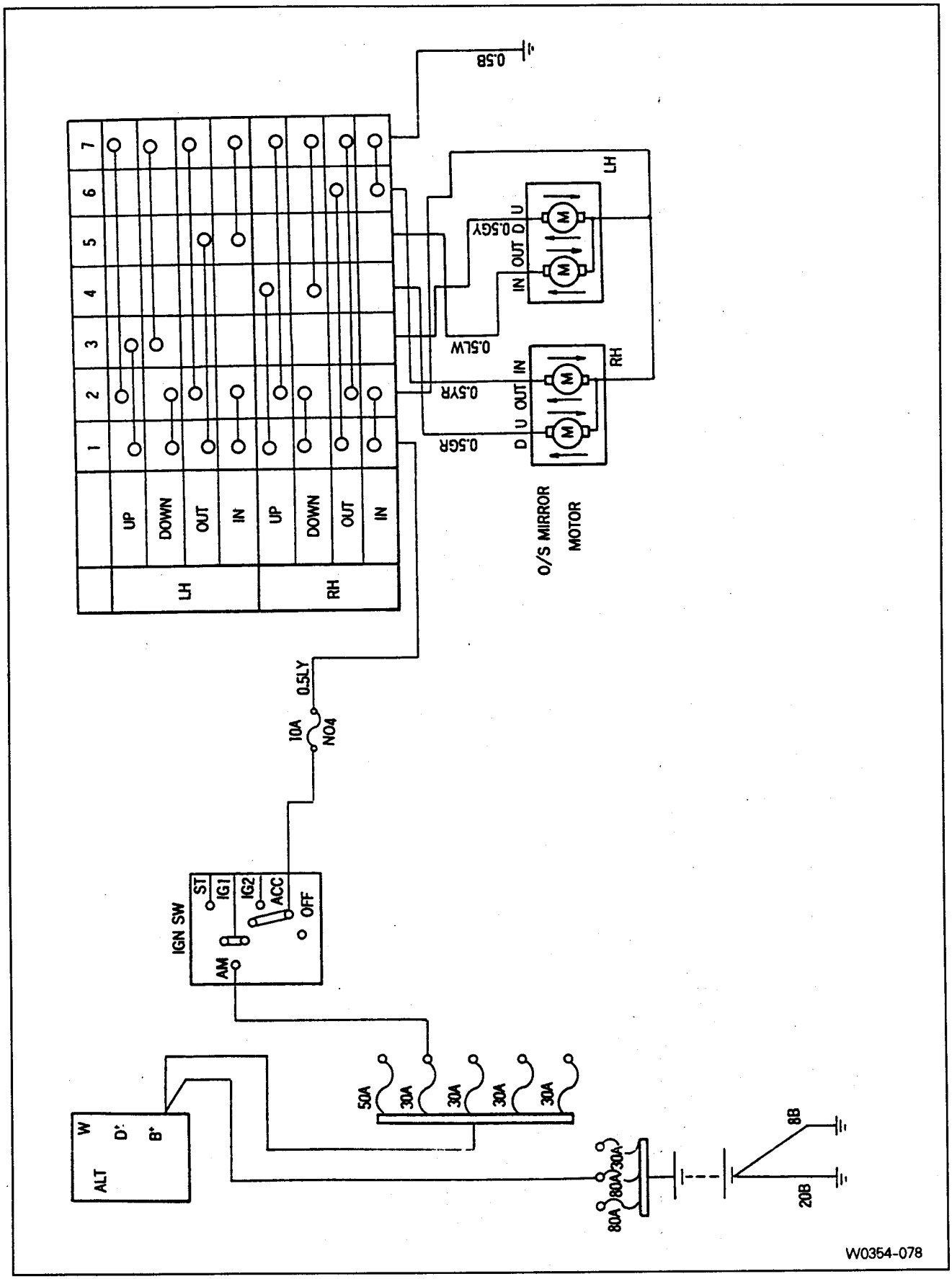
Wiring Diagram 21

Sun roof



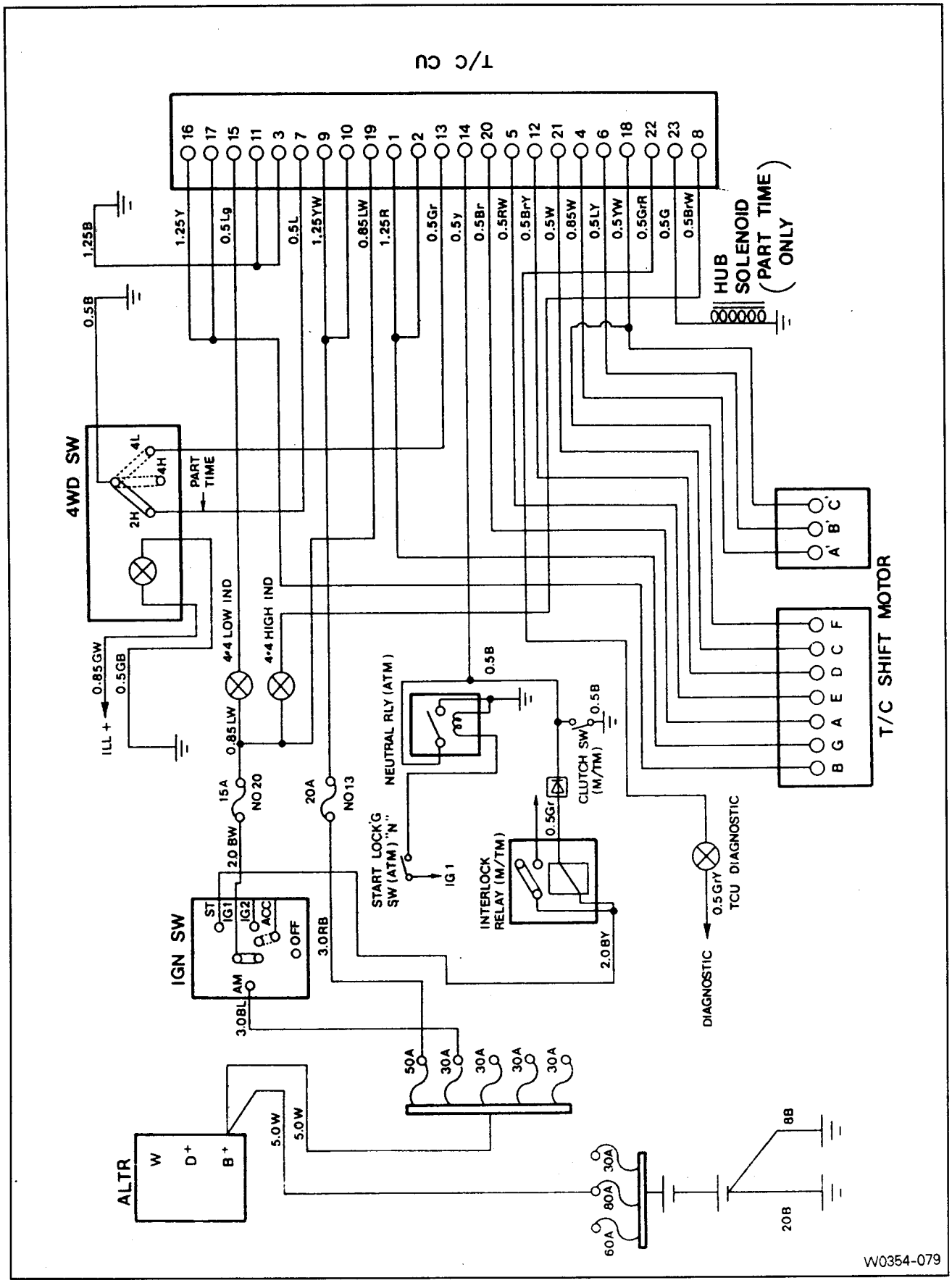
Wiring Diagram 22

Outside rear view mirror



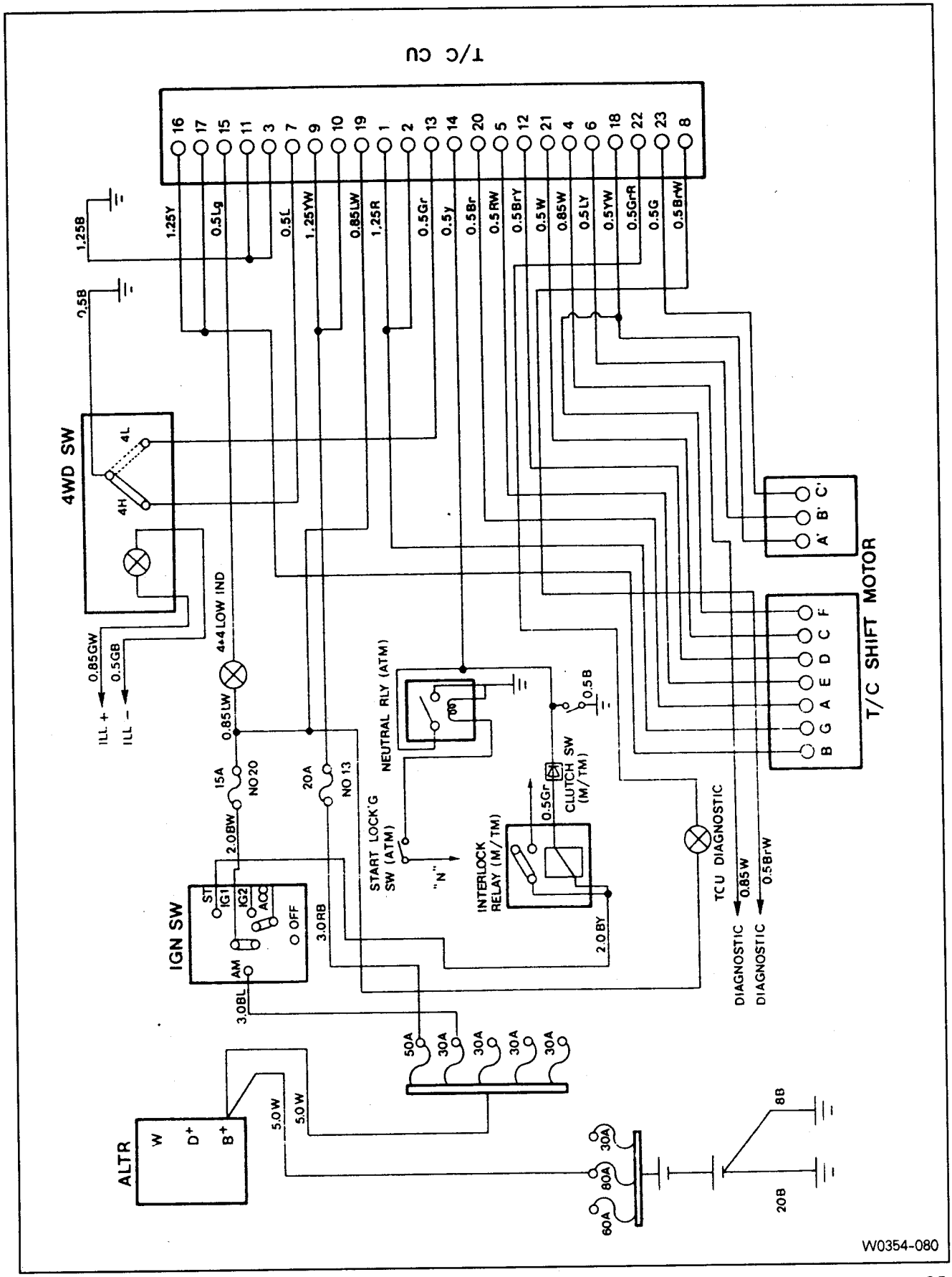
Wiring Diagram 23

Transfer case : Part-time (4408)



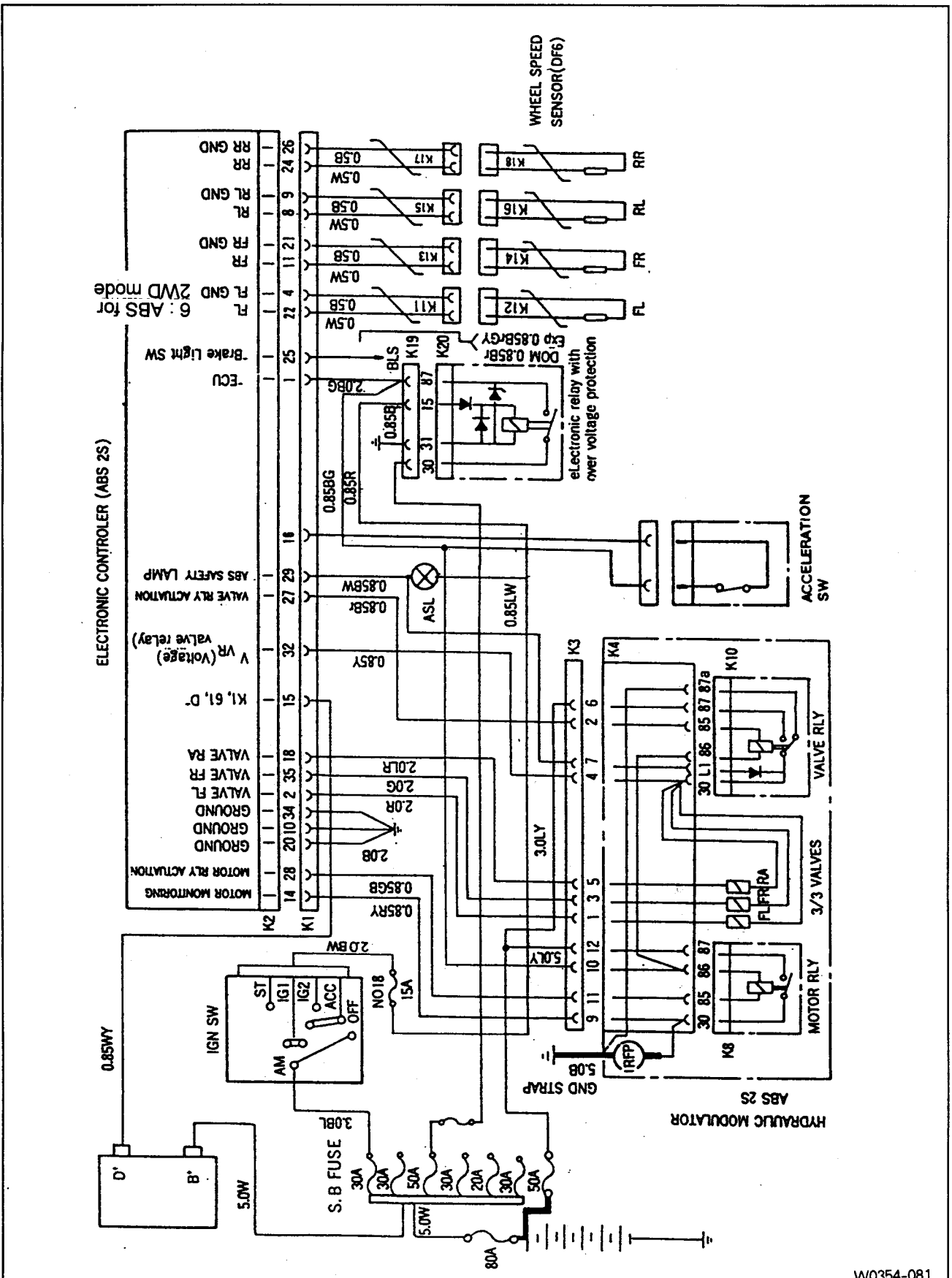
Wiring Diagram 24

Transfer case : Full-time (4421)



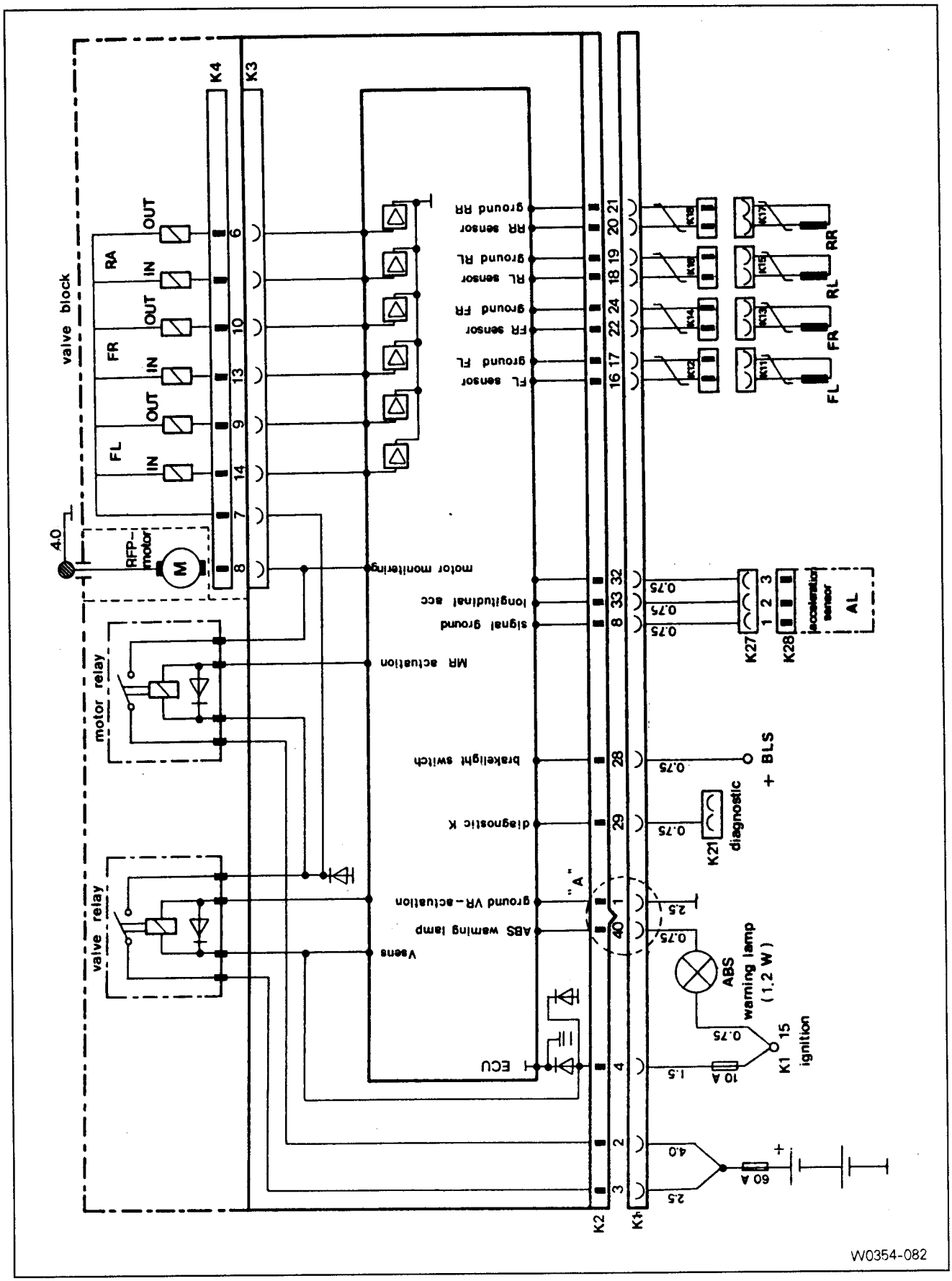
Wiring Diagram 25

ABS 2S



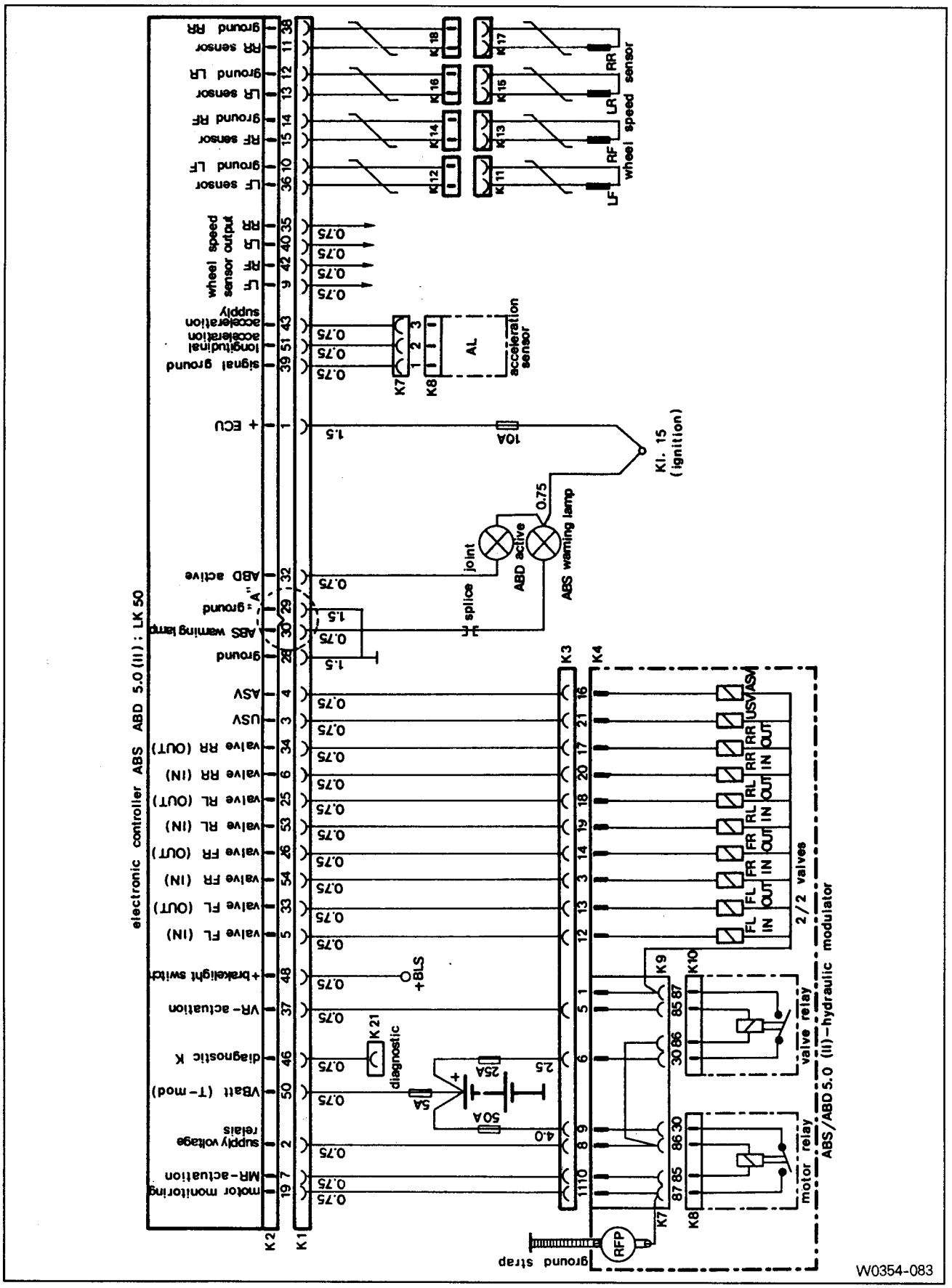
Wiring Diagram 26

ABS 5.0



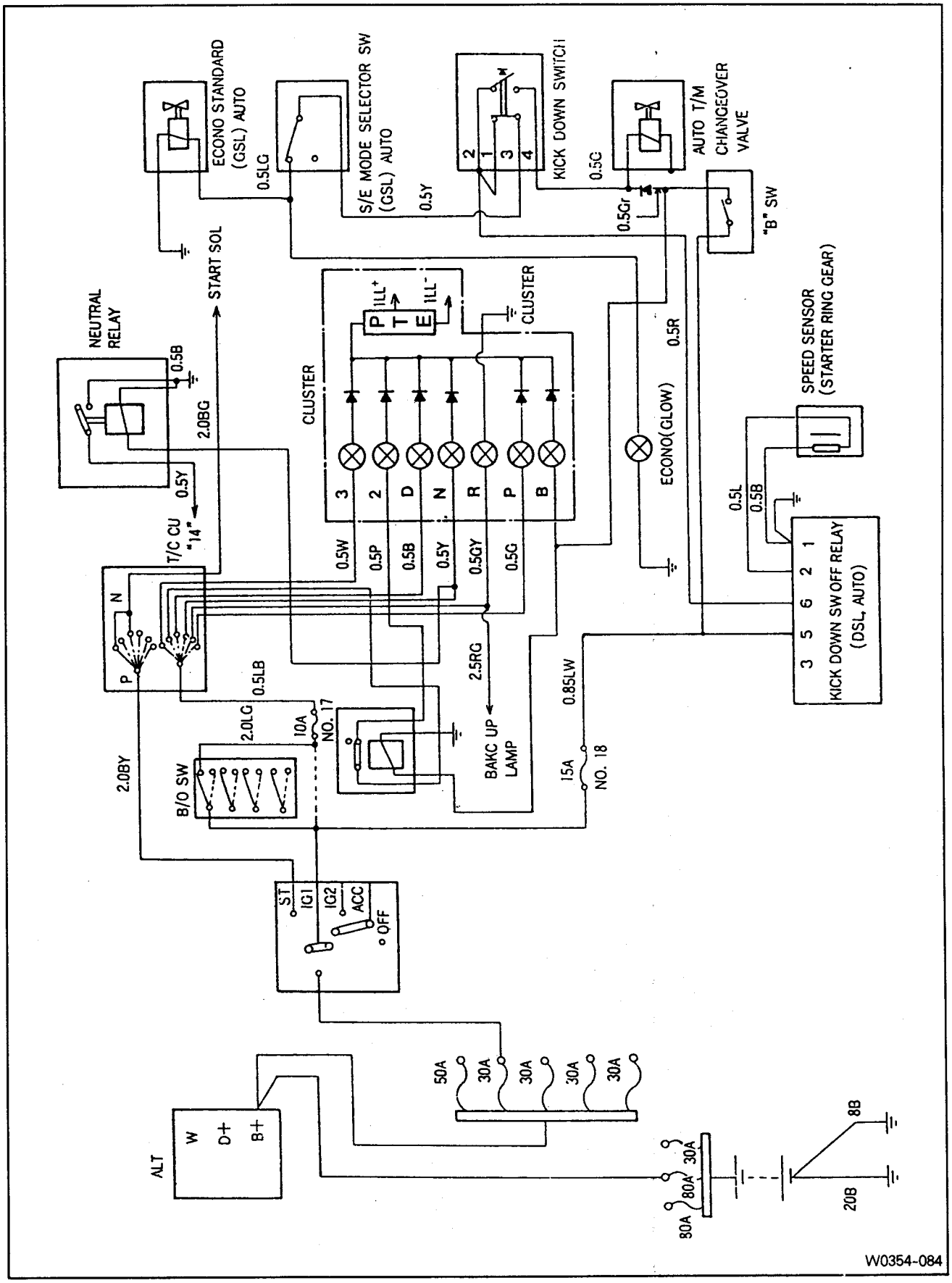
Wiring Diagram 27

ABS/ABD 5.0



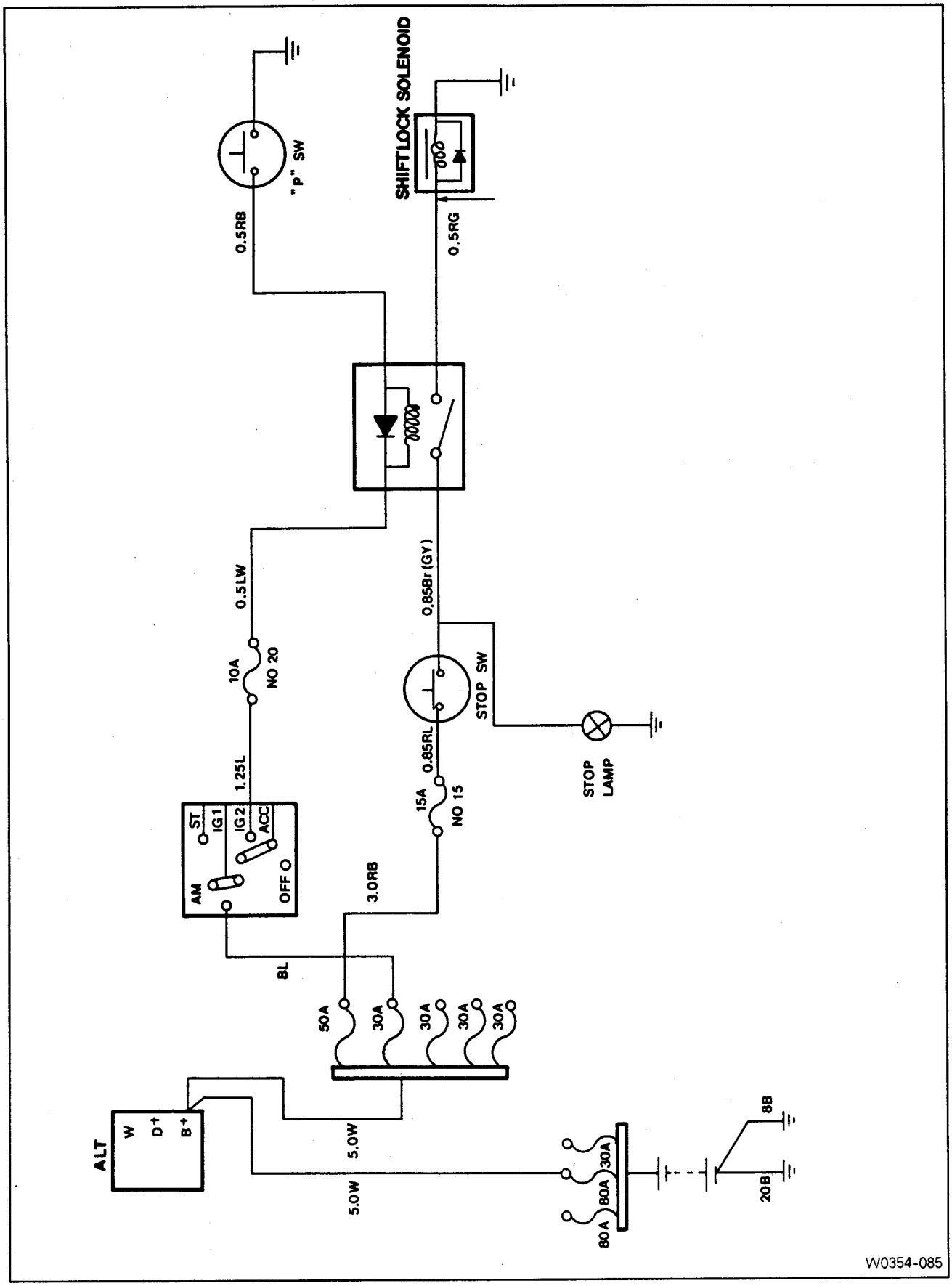
Wiring Diagram 28

Automatic transmission



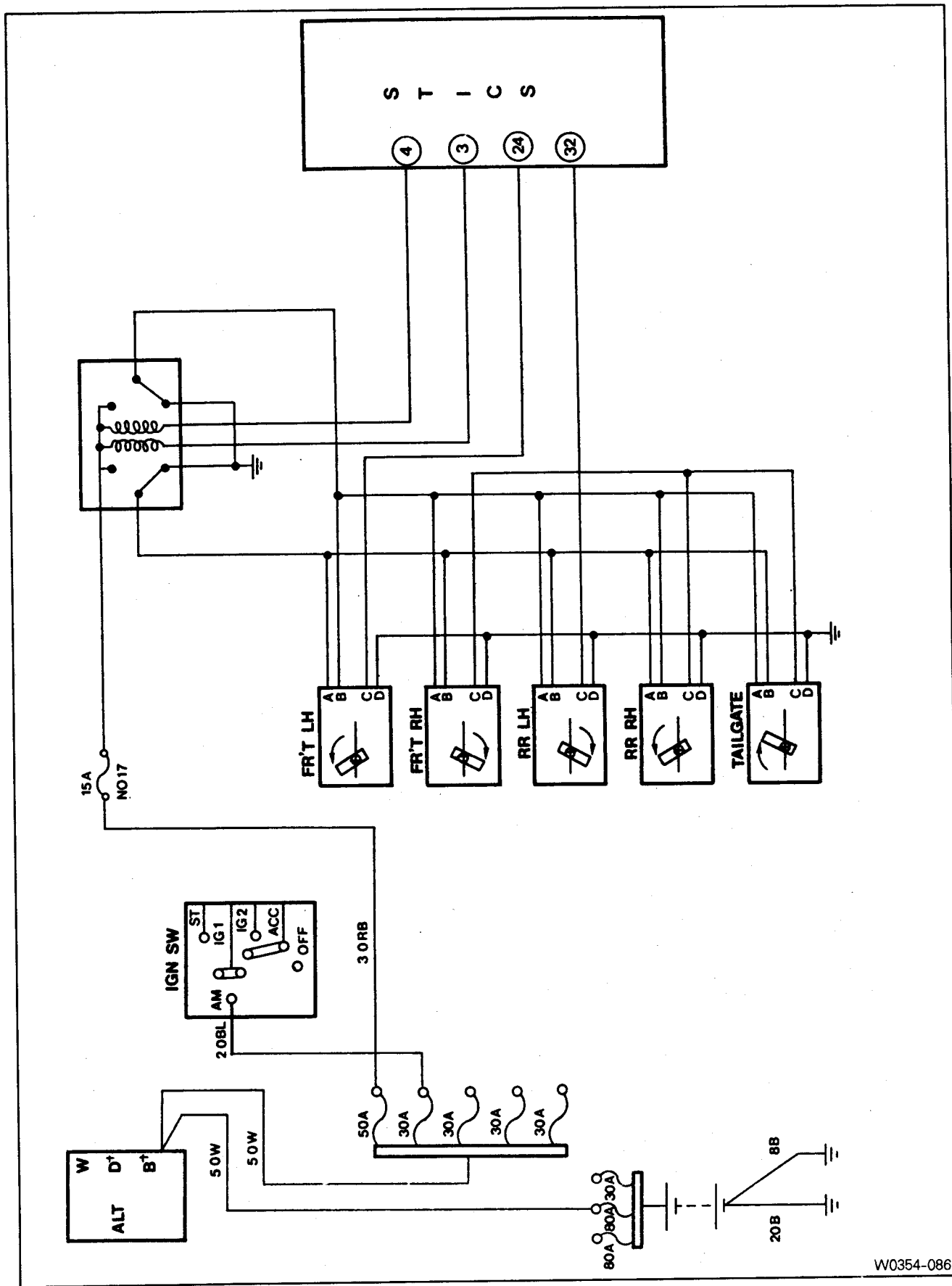
Wiring Diagram 29

Automatic transmission selector lever lock



Wiring Diagram 30

Central door lock



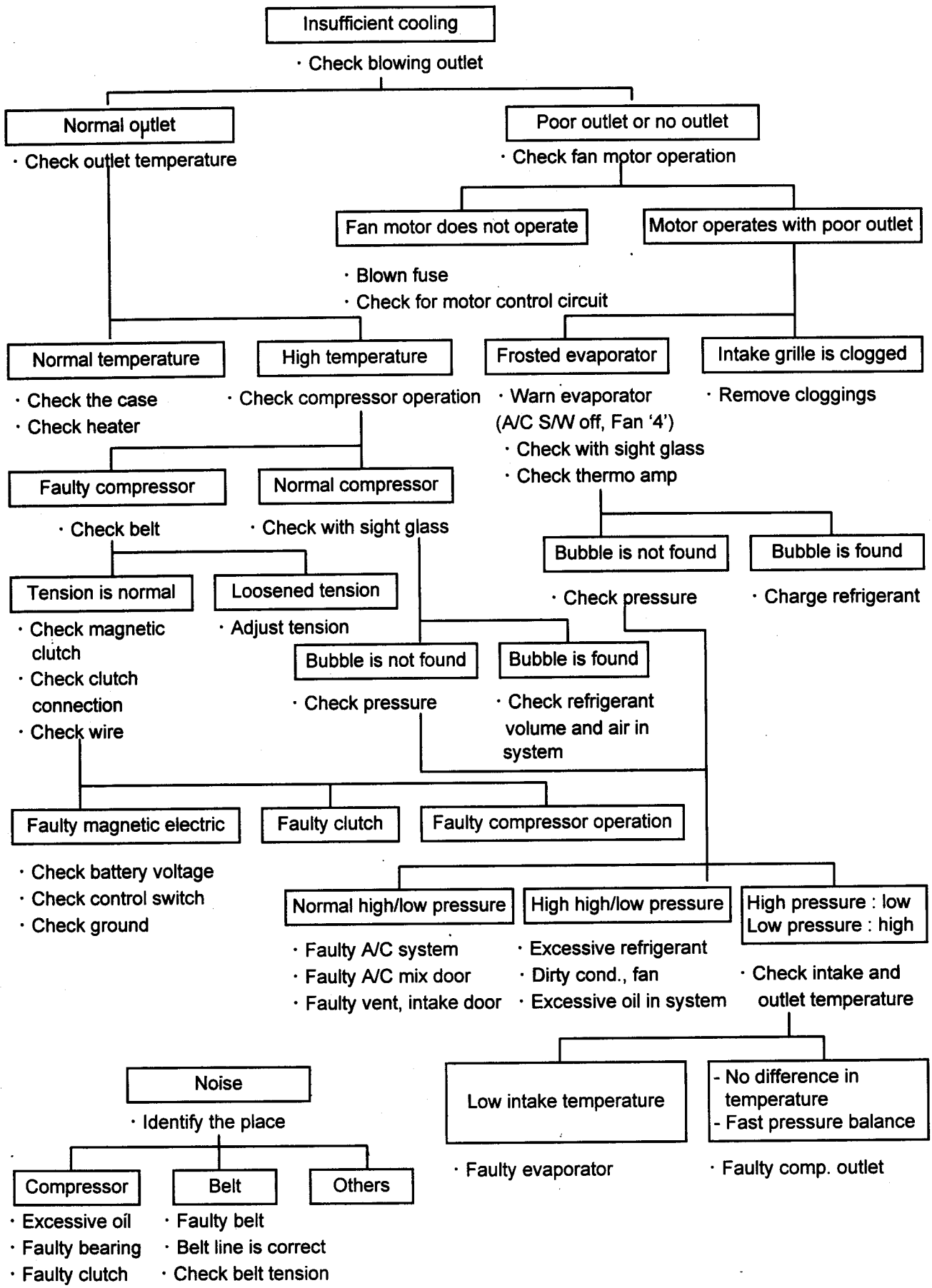
Wiring Diagram 31

1. General

Specifications

Cooling Capacity		Type	Air mix type
		Max. capacity	4,450kcal/h
		Max. blowing capacity	7.0M³/MIN.
		Refrigerant	R134a
		Refrigerant amount	650 ~ 750g
Heating Capacity		Max. capacity	4,500kcal/h
		Max. blowing capacity	7.0M³/MIN.
Compressor		Model	FK - II
		Type	Vane rotary type
		Output	140.5cc/rev.
		Oil	ZXL 200PG (PAG oil)
		Magnetic clutch output	45W
Condenser		Type	Parallel type (Multi Flow Condenser)
		Capacity	10,000 (11,500:MFC) kcal/h
		Condenser fan motor output	160W
Receiver Drier		Type	Aluminum type
		Capacity	1
		Desiccant	XH - 9 (35g)
	Dual pressure switch	High	OFF : 27±2kgf / ㎠G, ON : 6±2kgf / ㎠G
		Low	OFF : 1.8±0.2kgf / ㎠G, ON : 1.9±0.3kgf / ㎠G
Evaporator		Type	Tank laminated
		Expansion valve	Uniform external pressure type (1.5 RT)
		Resistance	4 stage (Coil resistance)
		Thermo amp	Sensor type OFF : 3℃, ON : 4℃

2. Troubleshooting



1) Defectives in fan motor circuit

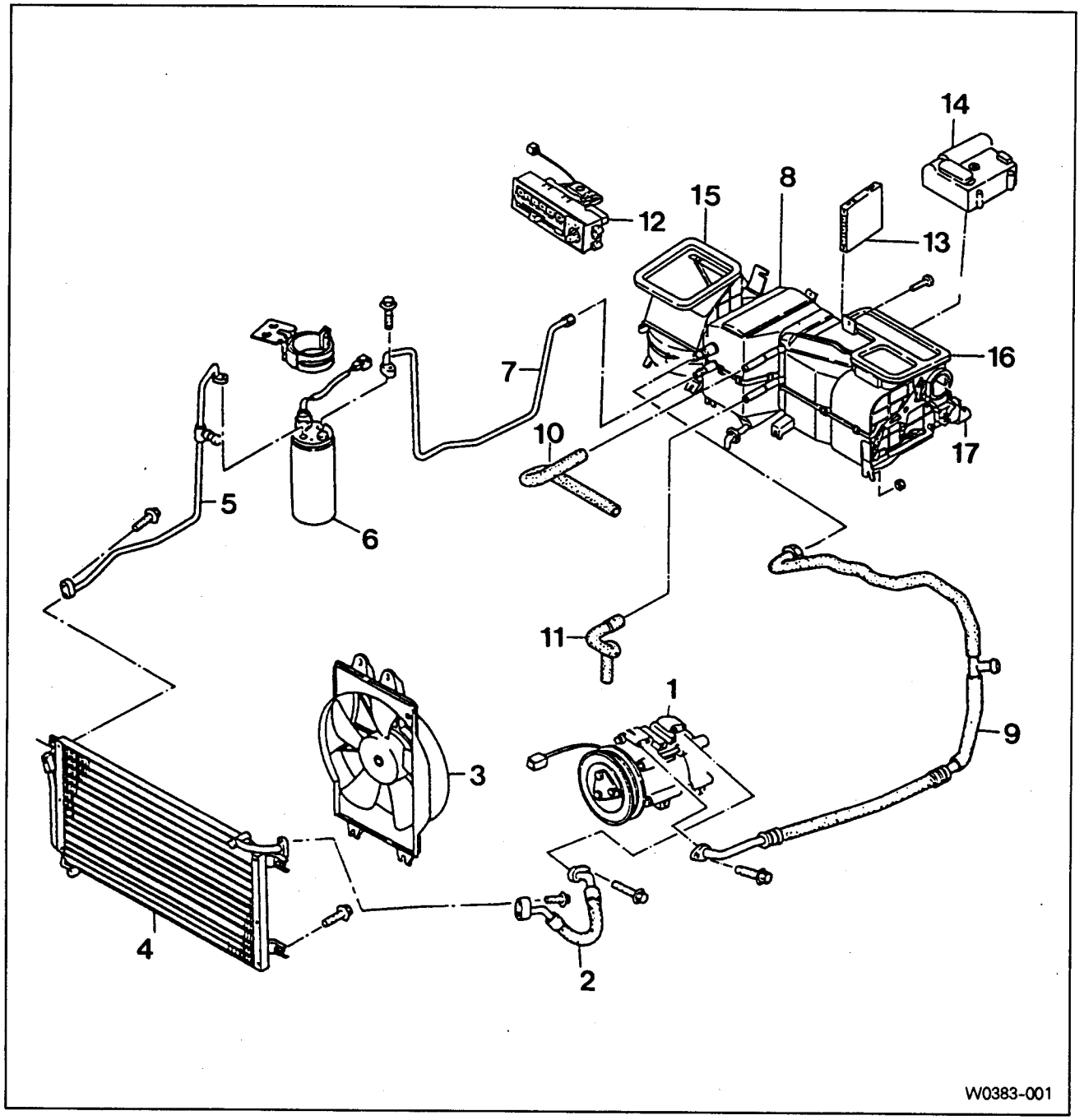
Problem	Possible Cause	Remedy
Fan motor does not run	Blown fuse	Check for short and replace fuse.
	Battery voltage is low	Check battery voltage.
	Faulty wiring	Check connectors' connection. Do not apply grease. This can cause voltage down.
	Faulty ground	Remove body painting and completely ground. Tighten ground bolts and make sure body ground connection.
Fan motor runs in '4' position only ('3', '2', '1' : does not run)	Blown resister temperature fuse	Replace resister.
	Air leakage in parts connection	Check heater, cooling unit and blower for proper connection.
Motor runs with poor blowing	Clogged or blocked intake grille	Clogged or blocked intake grille reduces blowing capacity.
Frosted evaporator	Faulty thermo amp	Frosted evaporator reduces cooling capacity. Off compressor and maximize blowing capacity.

2) Defectives in compressor circuit

Compressor does not run	Faulty high/low pressure	Check compressor magnet voltage supply.
	Faulty A/C relay	Replace A/C relay.
Magnetic clutch slips / idles	Oily clutch plate	Clean oily plate using cleaning agent.
	Low voltage	Charge battery or check for cause.
	Faulty electric connection or operation	Check wire continuity. Check A/C switch and fan switch for continuity and ground.
Magnetic clutch plays by hand only	Excessive clearance between clutch plate and clutch coil	Adjust clutch clearance (0.2~0.6mm).

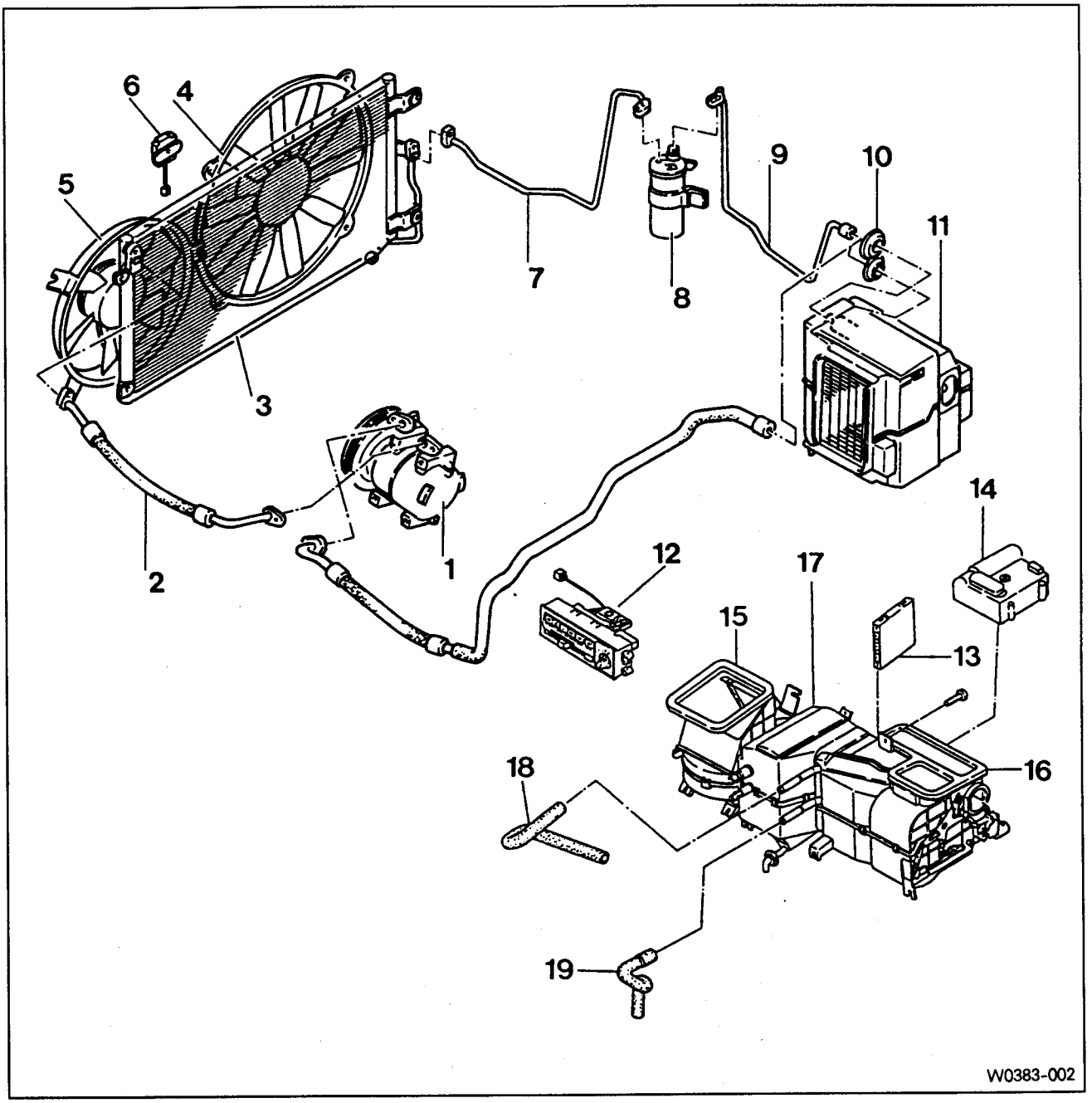
3. Heater and Air Conditioner System

[Diesel] - Components



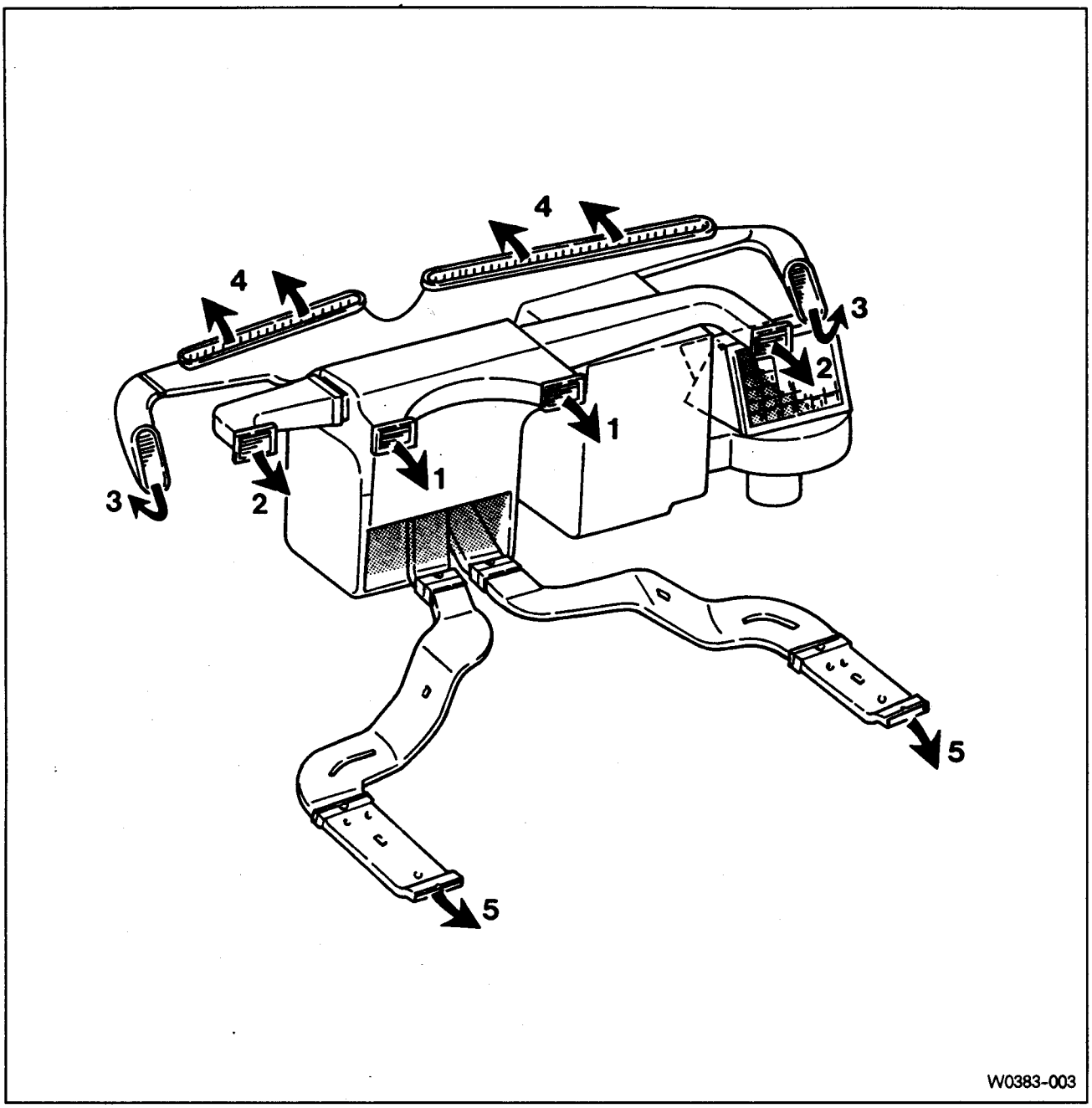
1. Compressor
2. High Pressure Hose
3. Condenser Fan
4. Condenser
5. Liquid Pipe (A)
6. Receiver Drier
7. Liquid Pipe (B)
8. Evaporator Assembly
9. Low Pressure Hose
10. Water Inlet Hose
11. Water Outlet Hose
12. Control Assembly
13. Heater Unit Amplifier
14. Mix Actuator Assembly
15. Blower Unit
16. Heater Unit
17. Mode Actuator Assembly

[Gasoline] - Components



1. Compressor
2. High Pressure Hose
3. Condenser
4. Main Condenser Fan
5. Auxiliary Condenser Fan
6. Condenser Fan Resister
7. Liquid Pipe (A)
8. Receiver Drier
9. Liquid Pipe (B)
10. Grommet
11. Evaporator Assembly
12. Control Assembly
13. Heater Unit Amplifier
14. Mix Actuator Assembly
15. Blow Unit
16. Heater Unit
17. Mode Actuator Assembly
18. Water Inlet Hose
19. Water Outlet Hose

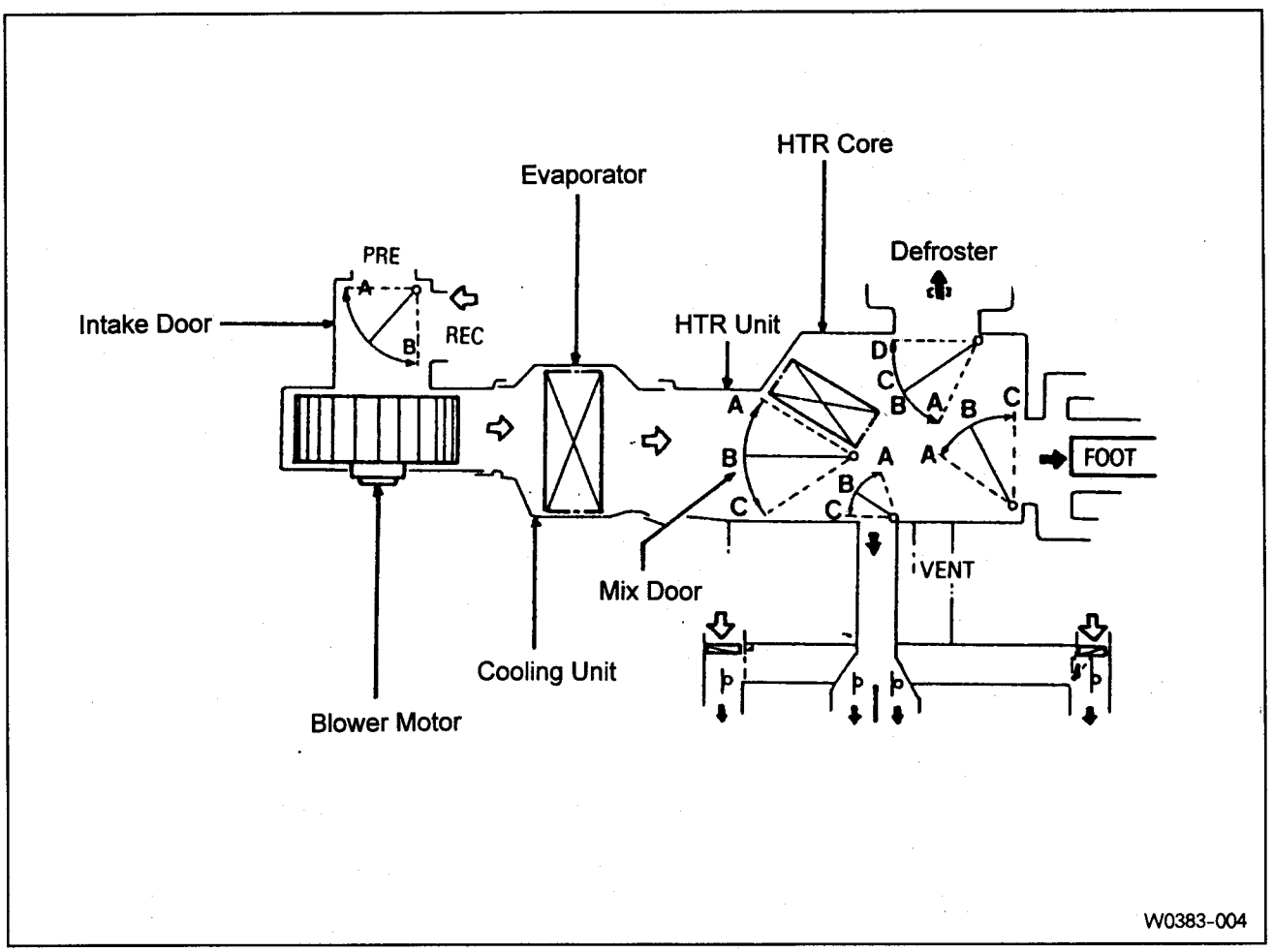
Ventilation



1. Front Duct
2. Side Duct
3. Side Defroster
4. Front Defroster
5. Floor Duct

Air Flow

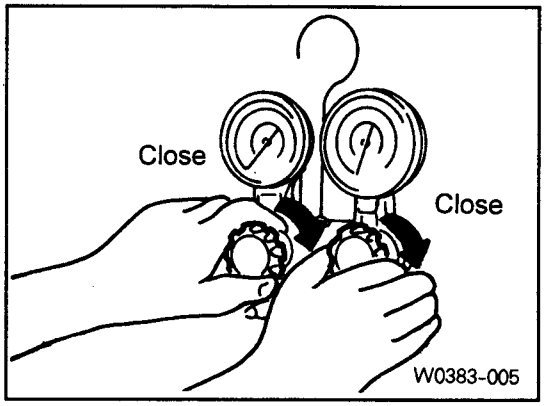
Switch / Door	Mode Switch					Recirculation Switch		Temperature Control Lever		
	VENT	B/L	FOOT	D/F	DEF	REC	FRE			
								COLD HOT [DSL] 20 25 30 [DSL/GSL]		
						INDI. On	INDI. Off			
VENT Door	A	B	C	C	C	—	—	—		
FOOT Door	C	B	A	B	C	—	—	—		
DEF Door	D	D	C	B	A	—	—	—		
INTAKE Door	—					A	B	—		
AIR MIX Door	—							A	B	C



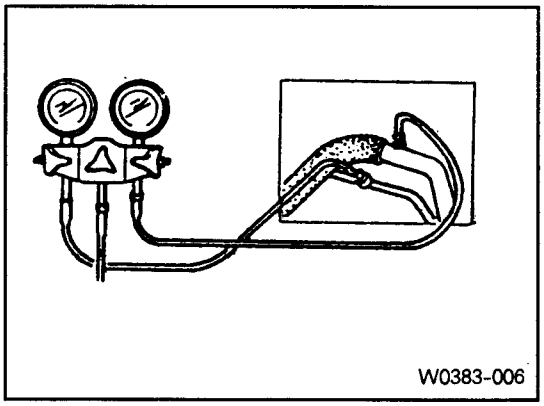
4. Refrigerant Charging

Installation of manifold gauge

1) Close both high/low pressure hand valve of gauge before installation of gauge to the charging valve.



2) Connect the low pressure hose of the gauge to the low pressure charging valve and the high pressure hose of the gauge to the high pressure charging valve. Tighten the hose nuts by hand.

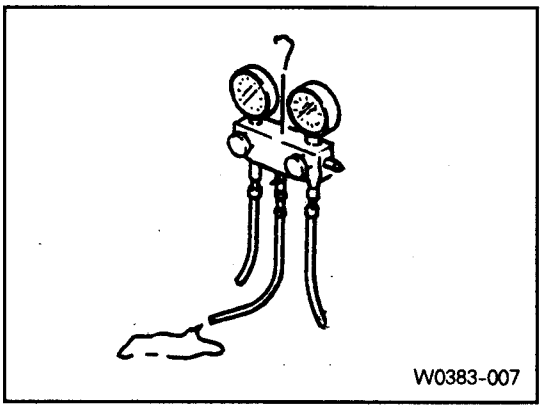


Discharging of refrigerant

1) Connect the manifold gauge to the charging valve.

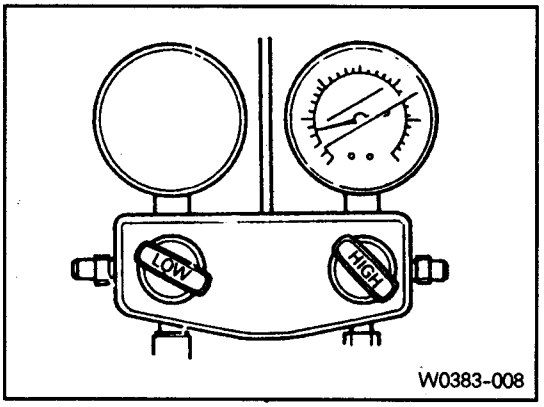
2) Place the free end of center hose in a shop towel.

3) Slowly open the high pressure hand valve and discharge refrigerant.
[Note] If refrigerant is allowed to escape too fast, compressor oil will be drawn out of the system.



4) After the high pressure gauge reading drops below 3.5kg/㎠, slowly open the low pressure valve.

5) When both high and low pressure gauges reading drops to 0 kg/㎠, discharging is completed.



Evacuating refrigeration system

1) Connect the manifold gauge to the charging valves.

2) Connect the center hose of the gauge to the vacuum pump.

3) Run the vacuum pump and open both high and low pressure hand valves.

4) Run the vacuum pump 15~20 minutes.

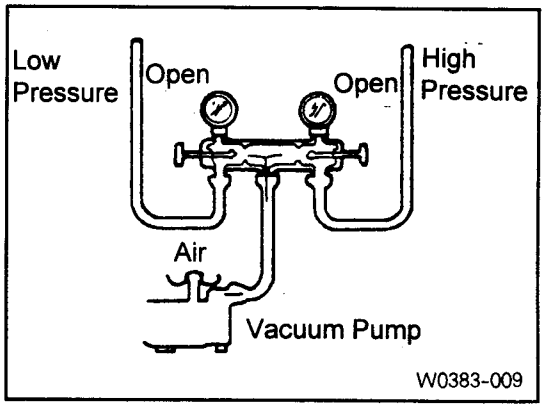
5) Check that both high and low pressure gauge reading is more than (-) 750mmHg of vacuum and close both valves.

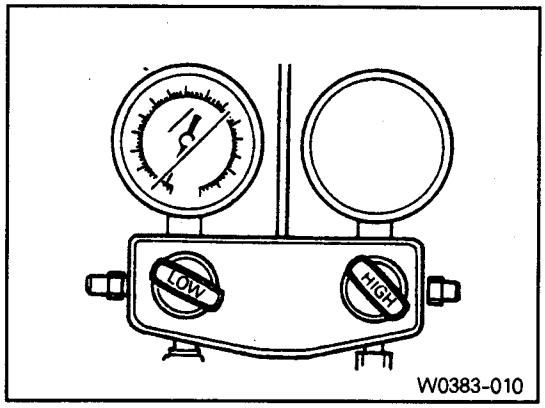
6) Stop the vacuum pump and wait about 5 minutes.

7) After 5 minutes, check that low pressure gauge reading is changed or not.

8) If low pressure gauge reading is changed, check the system for leaks and repair as necessary and repeat steps from 1) to 7).

9) If there are no changes in low pressure gauge reading, disconnect the vacuum pump.





Check for refrigerant leaks

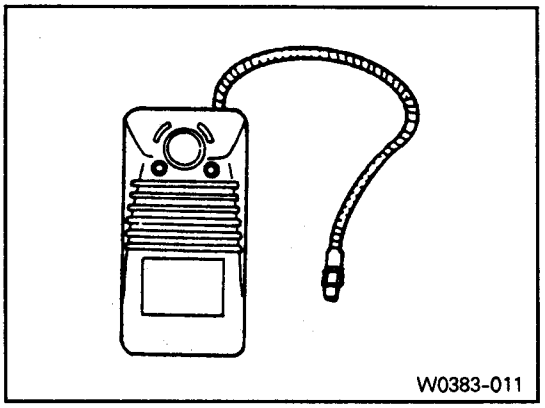
1) Connect the center hose of the gauge to the refrigerant tank.

2) Open the high pressure valve of the gauge to charge with refrigerant gas.

3) Charge until the low pressure gauge reads 1.0kg/㎠ and close the valve.

4) Using a gas leak detector, check the system for leaks.

5) If a leak is found, replace a O-ring or repair the faulty connection.



Charging refrigerant

1) Connect the manifold gauge to the charging valve and evacuate the system.

2) Connect the center hose of the gauge to the refrigerant tank.

3) Open the high pressure valve and charge the system with 350g of refrigerant.

4) Close the high pressure valve and start the engine and run the compressor.
   [Note] Never open the high pressure valve when the compressor is running. Refrigerant gas will be charged reverse.

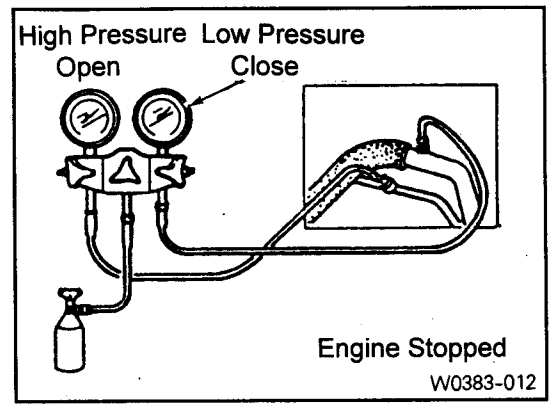
5) Slowly open the low pressure valve and charge the system with refrigerant.

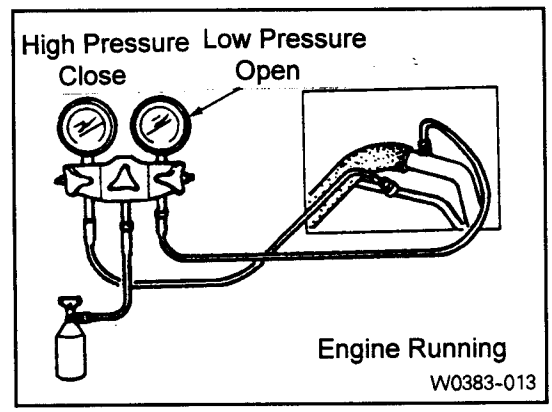
Standard	700 ± 50g

6) Close the low pressure valve after charging.

7) Using a receiver sight glass, check the system for free of any bubbles.

8) Stop the engine and disconnect the manifold gauge from the system.





Operation Check

1) Place a dry bulb thermometer to the front duct.

2) Place a psychrometer close to the inlet of the cooling unit (under the glove box).

3) Run the engine at 1,500 rpm.

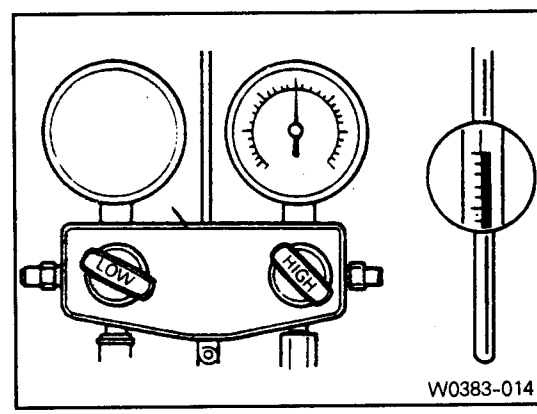
4) Set the blower switch at 'HI' and A/C switch 'ON'.

5) Set the temperature control lever at 'COOL'.

6) Set the air flow control at 'REC'.

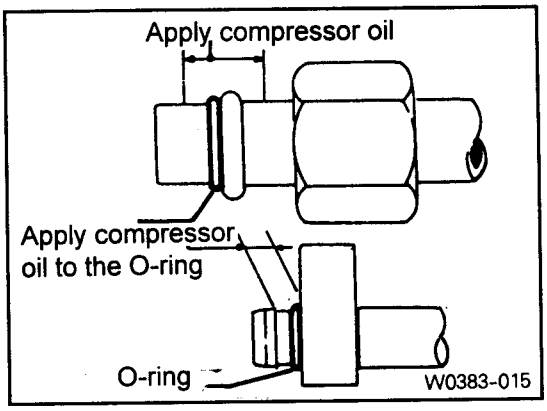
7) Check that air conditioning system is stabilized.

Temperature of air inlet	25~35℃
High pressure gauge reading	13.2~18.5kg/㎠

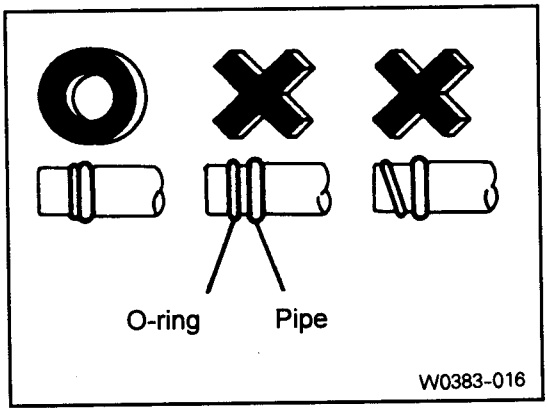


Replacement of refrigerant connection (O-ring type)

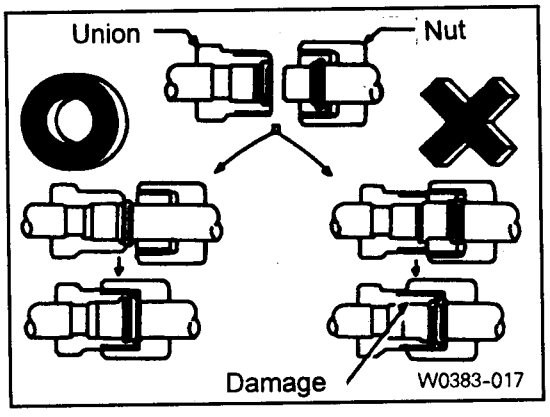
1) When connecting a O-ring type pipe, apply compressor oil to portions shown in illustration. Be careful not to apply oil to threaded portion.
[Note] Use specified compressor oil.



2) O-rings must be closely attached to inflated portion of pipe and always replace used O-rings.



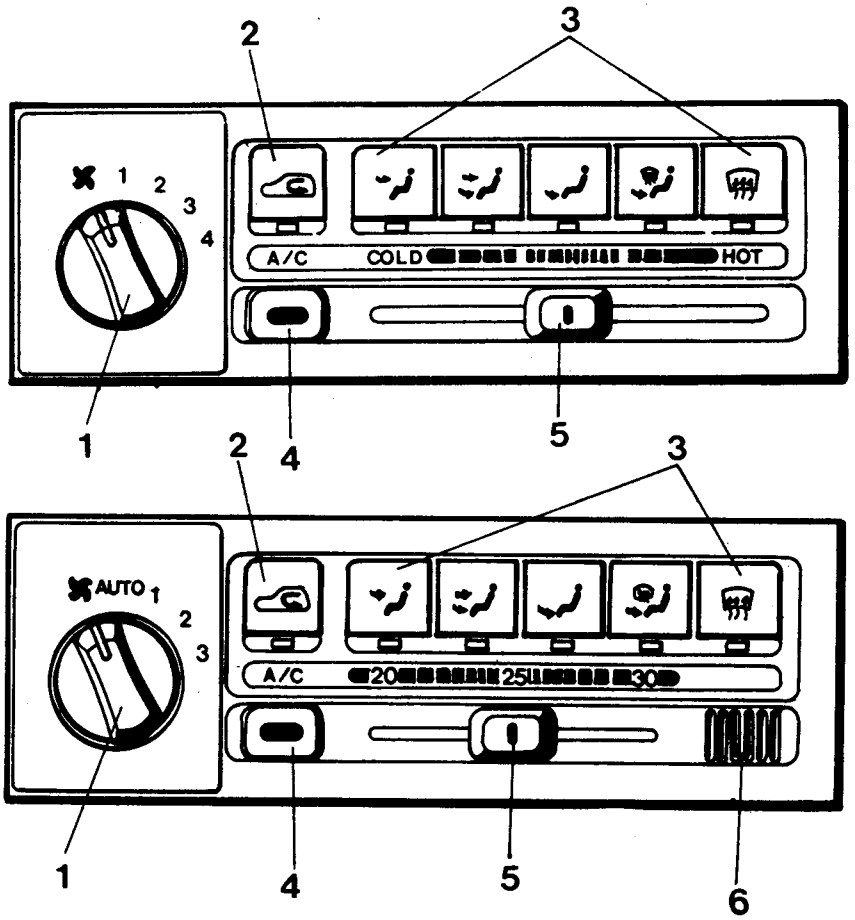
3) After inserting the pipe to the union, tighten the nut by hand as much as possible and tighten the nut to specified torque.



Tightening torque (O-ring)

Outer Diameter	Material	Tightening Torque
9.52mm	Aluminum	10~20 Nm
12.70mm	Aluminum	15~25 Nm
15.88mm	Aluminum	10~30 Nm

5. Heater and Air Conditioner Control Box

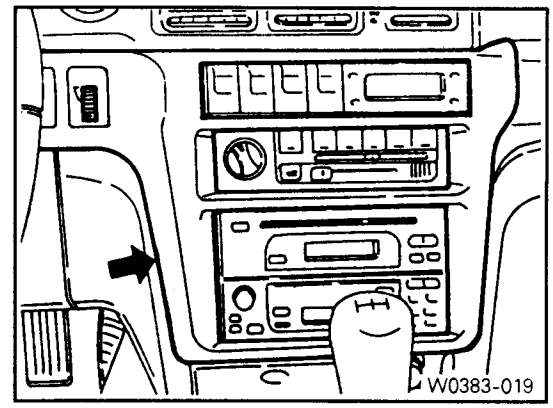


W0383-018

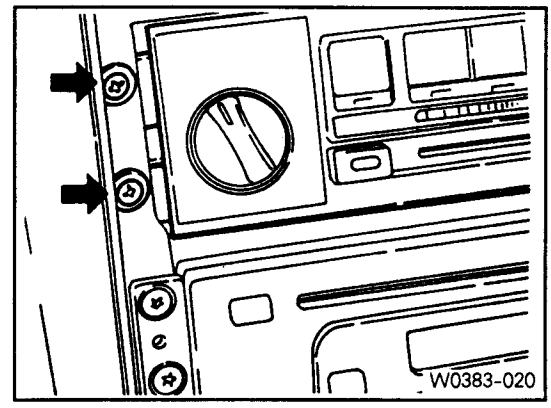
1. Blower Switch
2. Recirculation Switch
3. Mode Switch
4. A/C Switch
5. Temperature Control Lever
6. In-vehicle Sensor

Removal · Installation

1) Remove the switch panel.
[Note] Be careful not to damage the switch panel.

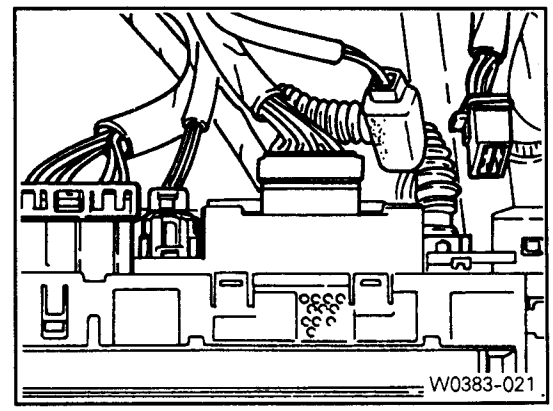


2) Remove the fixing screws (4 screws) of the control box.



3) Disconnect the wire connectors and remove the control box.

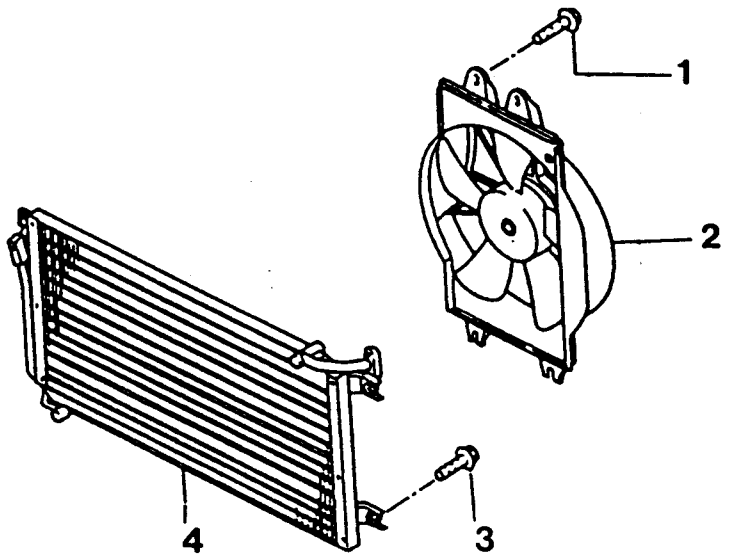
4) Installation is reverse order of the removal.



6. Removal and Installation of Condenser

Preceding work : Removal of the radiator

[Diesel]

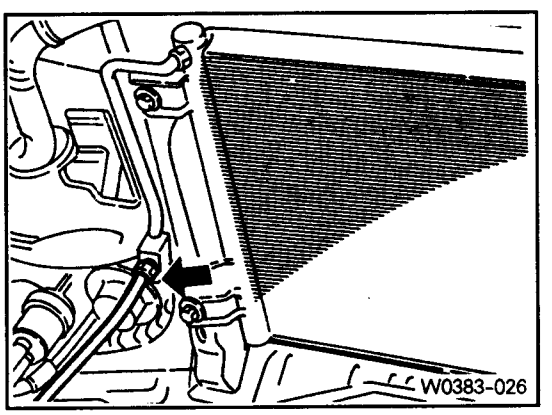


W0383-022

1. Bolt
2. Condenser Fan
3. Bolt
4. Condenser

Removal · Installation

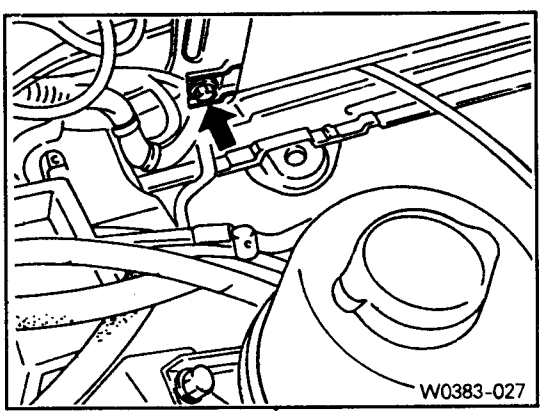
1) Disconnect the inlet and outlet pipes of condenser.
[Note] Before disconnection, evacuate the refrigerant from the system.



W0383-026

2) Remove the mounting bolts (4bolts) and condenser assembly.

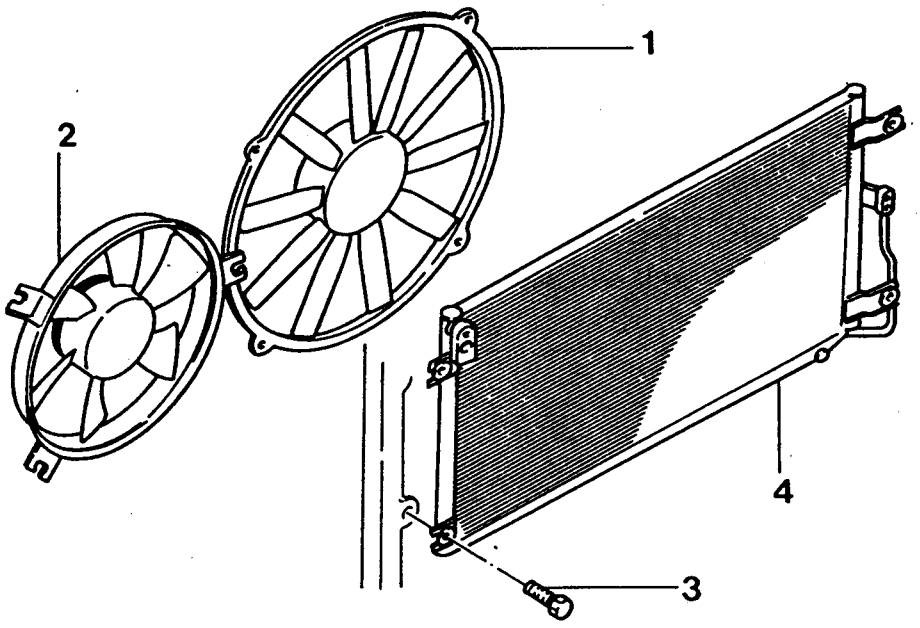
3) Installation is reverse order of the removal .



W0383-027

Preceding work : Removal of the radiator

[Gasoline]

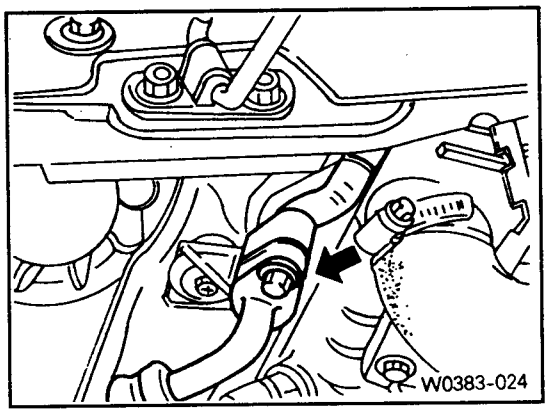


W0383-023

1. Main Condenser Fan
2. Auxiliary Condenser Fan
3. Bolt
4. Condenser

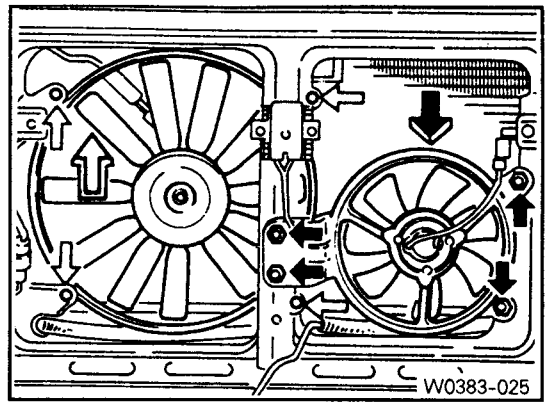
Removal · Installation

1) Disconnect the inlet and outlet pipes of condenser.
   [Note] Before disconnection, evacuate the refrigerant from the system.



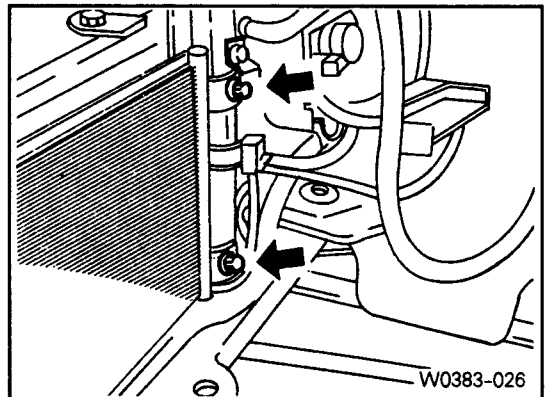
W0383-024

2) Remove the main condenser fan and auxiliary condenser fan from the shroud.

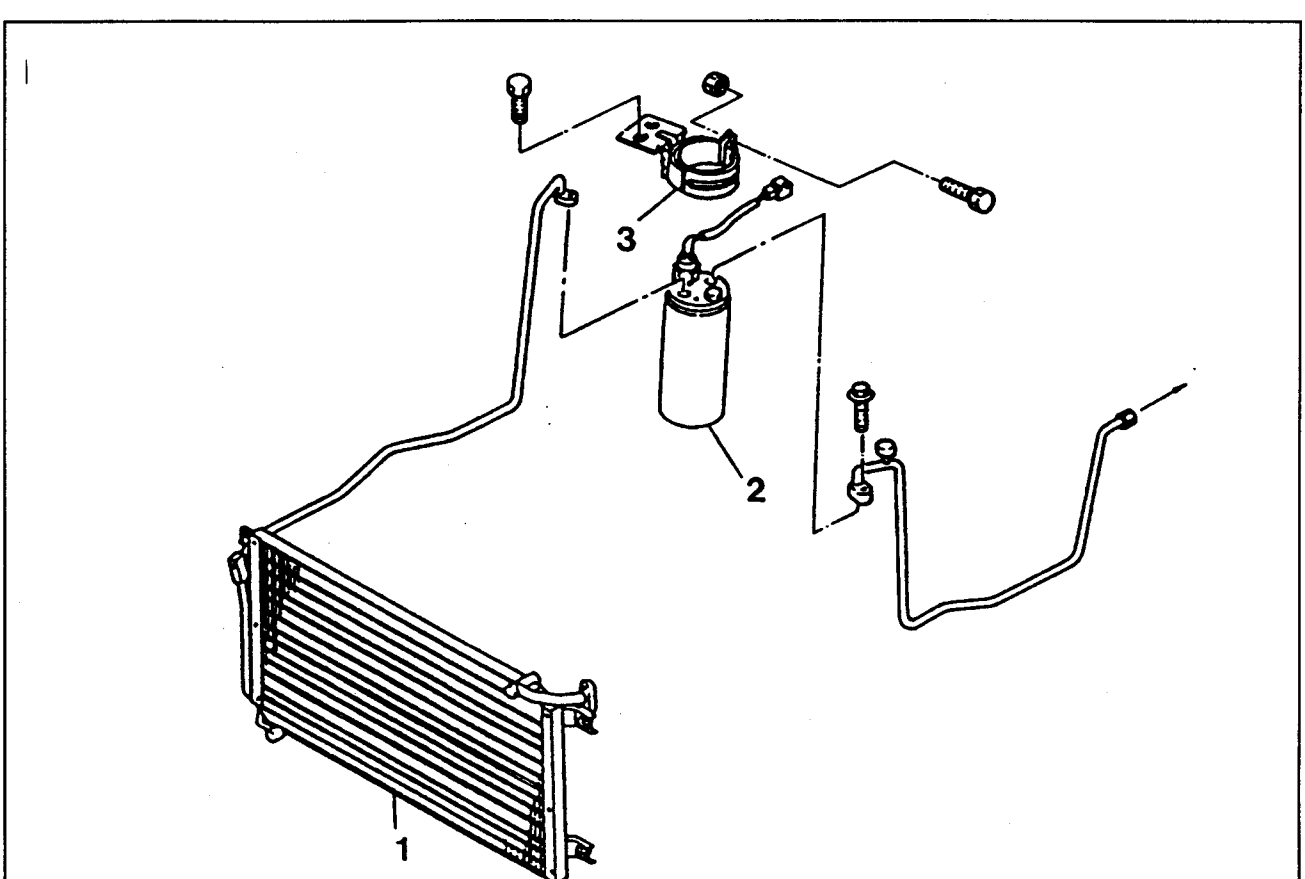


3) Remove the mounting bolts (4bolts) and condenser assembly.

4) Installation is reverse order of the removal.



7. Removal and Installation of Receiver Drier

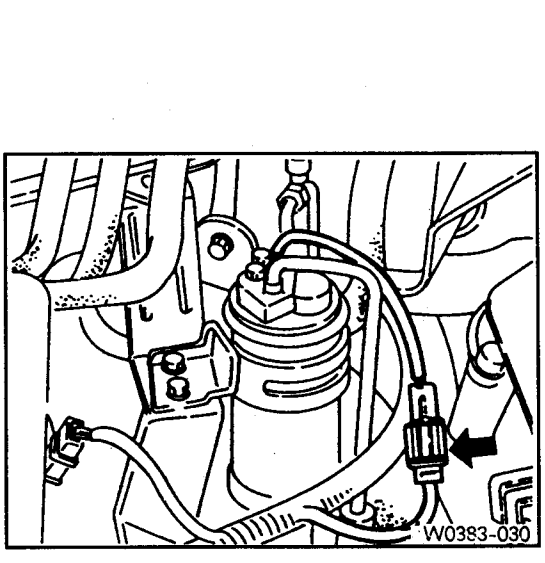


1. Condenser
2. Receiver Drier
3. Bracket

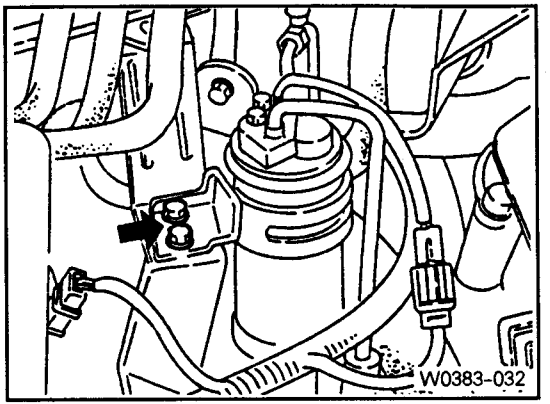
Removal · Installation

1) Disconnect the dual pressure switch connector from the receiver drier.

2) Discharge refrigerant from the system.

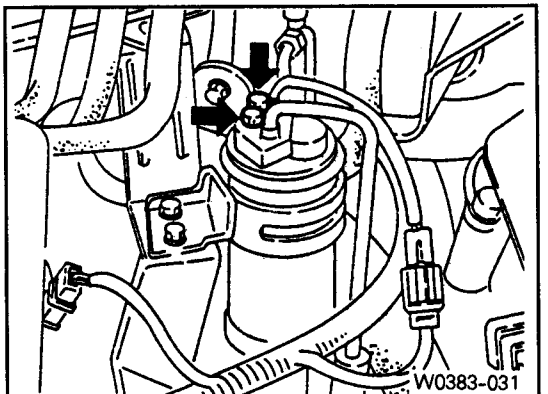


3) Remove the high pressure pipe from the inlet / outlet of receiver drier.

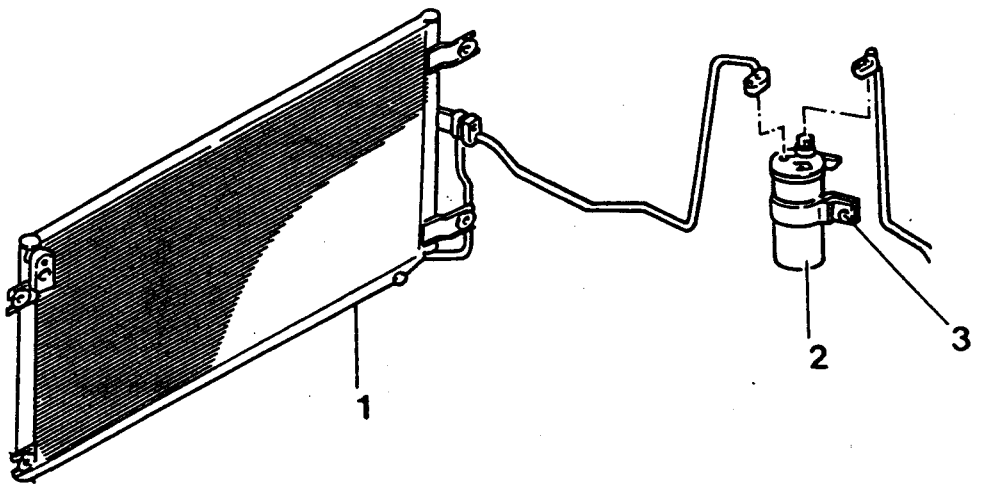


4) Remove the bracket bolts and remove the receiver drier.

5) Installation is reverse order of the removal.



[Gasoline]



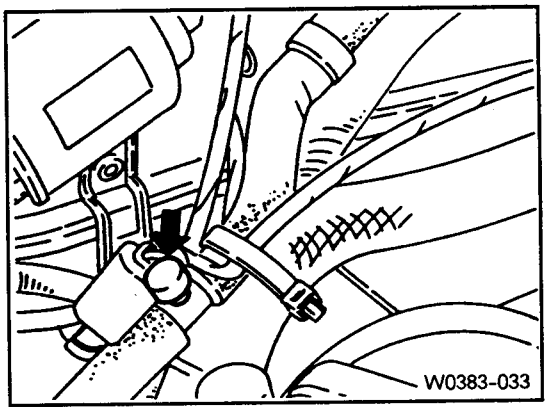
W0383-029

1. Condenser
2. Receiver Drier
3. Bracket

Removal · Installation

1) Disconnect the dual pressure switch connector from the receiver drier.

2) Discharge refrigerant from the system.

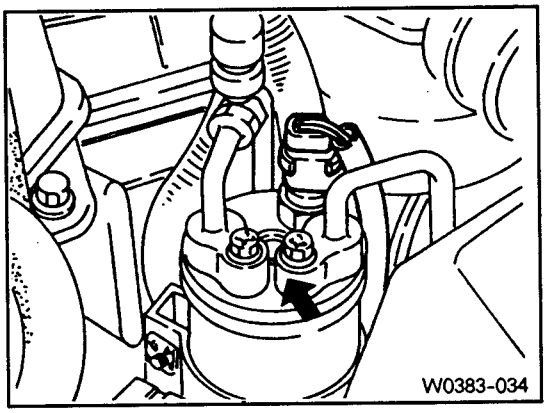


W0383-033

3) Disconnect the high pressure pipe from the inlet / outlet of receiver drier.

4) Remove the bracket bolts and remove the receiver drier.

5) Installation is reverse order of the removal.

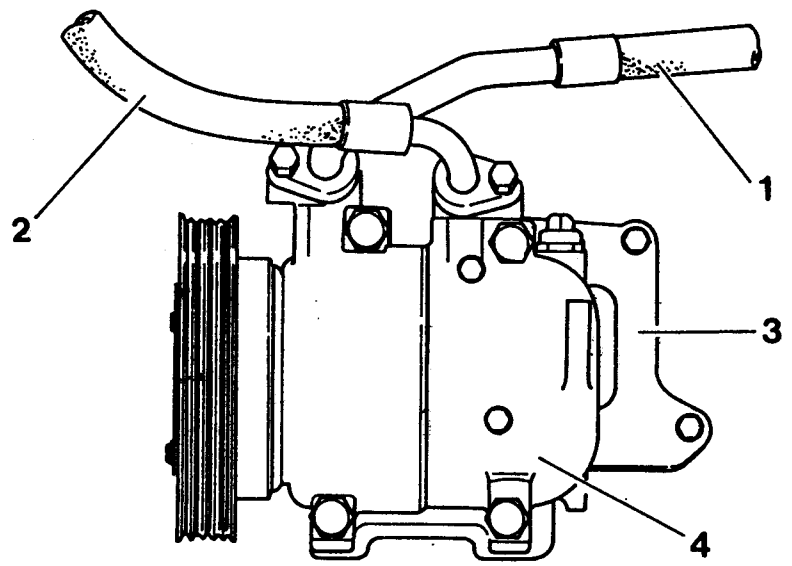


W0383-034

8. Removal and Installation of Compressor

Preceding work : Removal of the poly V-belt

[Diesel]



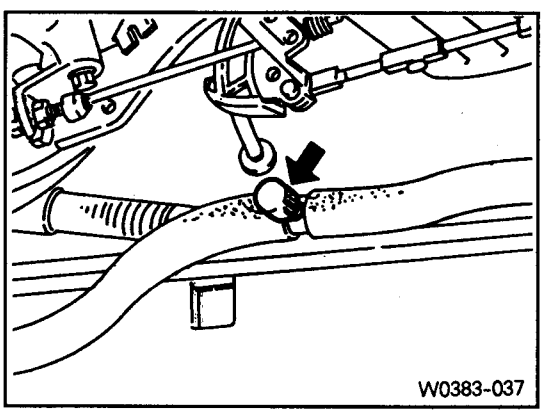
W0383-035

1. Low Pressure Pipe
2. High Pressure Pipe
3. Compressor Bracket
4. Compressor

Removal · Installation

1) Disconnect the negative (-) terminal from the battery.

2) Discharge refrigerant from the system.
[Note] By connecting a manifold gauge, discharge the air conditioner system.

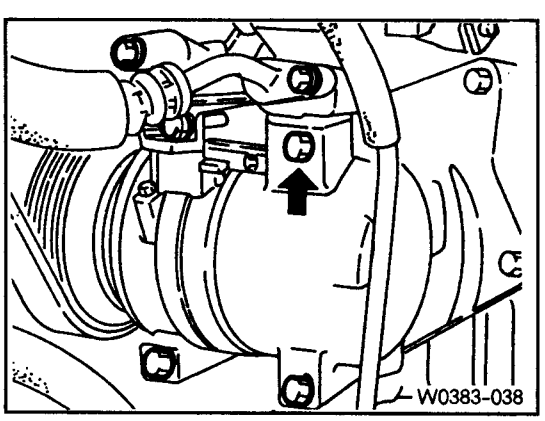


W0383-037

3) Disconnect the high / low pressure pipe and wire connectors.

4) Remove the mounting bolts from the compressor bracket and remove the compressor.
[Note] Place the removed compressor in vertical position.

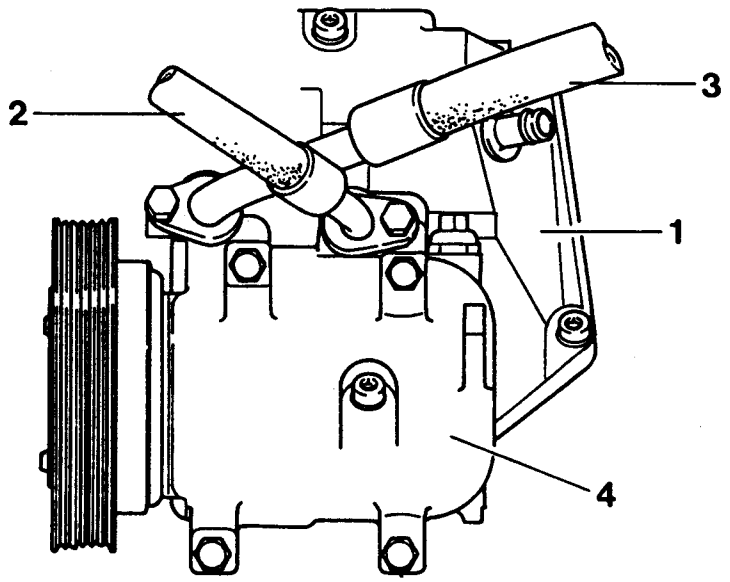
5) Installation is reverse order of the removal.



W0383-038

Preceding work : Removal of the poly V-belt

[Gasoline]



W0383-036

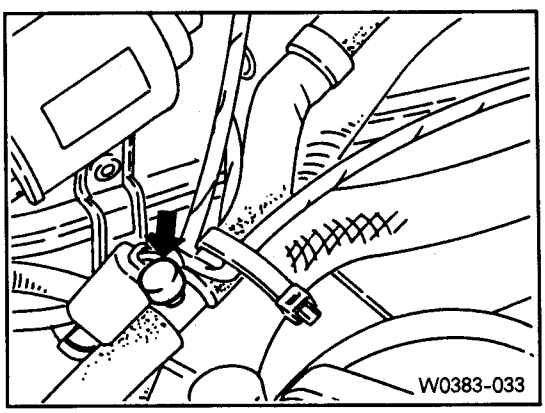
1. Combination Support
2. High Pressure Pipe
3. Low Pressure Pipe
4. Compressor

Removal · Installation

1) Disconnect the negative (-) terminal from the battery.

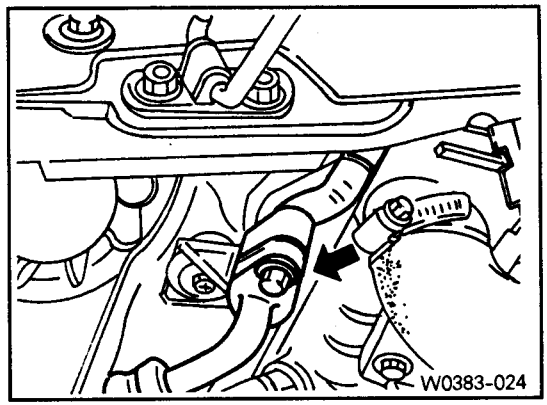
2) Discharge refrigerant from the system.

[Note] By connecting a manifold gauge, discharge the air conditioner system.



W0383-033

3) Disconnect the high / low pressure pipe and wire connectors.



4) Remove the mounting bolts from the combination support and remove the compressor.
[Note] Place the removed compressor in vertical position.

5) Installation is reverse order of the removal.