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SECTION 1

ENGINE

SECTION 1A1(M162 ENGINE)

GENERAL ENGINE INFORMATION

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SPECIFICATIONS

ENGINE SPECIFICATIONS

Application			E32 Engine
Engine Model			M162.990
Displacement (CC)			3199
Cylinder (Bore x Stroke) (mm)			89.9 x 84.0
Fuel Injection / Ignition System			MSE 3.62S
Compression Ratio			10 : 1
Number of Cylinders			6
Camshaft Valve Arrangement			DOHC
Camshaft Drive Type			Chain-Driven
Max. Output (ps/rpm)			222 / 5500
Max. Torque (kg•m/rpm)			31.6 / 3750
Firing Order			1-5-3-6-2-4
Ignition Type			Distributorless Double Ignition
Ignition Timing			BTDC 8° ± 2°
Valve Timing	Intake	Open/Close	ATDC 11° / ABDC 34°
	Exhaust	Open/Close	BBDC 31° / BTDC 14°
Valve Clearance Adjustment			Automatic Control

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ENGINE SPECIFICATIONS (Cont'd)

Application	E32 Engine
Idle Speed (rpm)	700 ± 50
Fuel Injection Pressure (kg/cm²)	3 - 4
Oil Capacity (liter)	8.2
Lubrication Type	Forced by Gear Pump
Oil Filter Type	Full Flow with Paper Filter
Fuel	Unleaded Gasoline

MSE 3.62S/3.53S (Motorsteuer Elektronik : German)

MSE : Engine Control Electronic

3.62S : 6 Cylinder Version

3.53S : 4 Cylinder Version

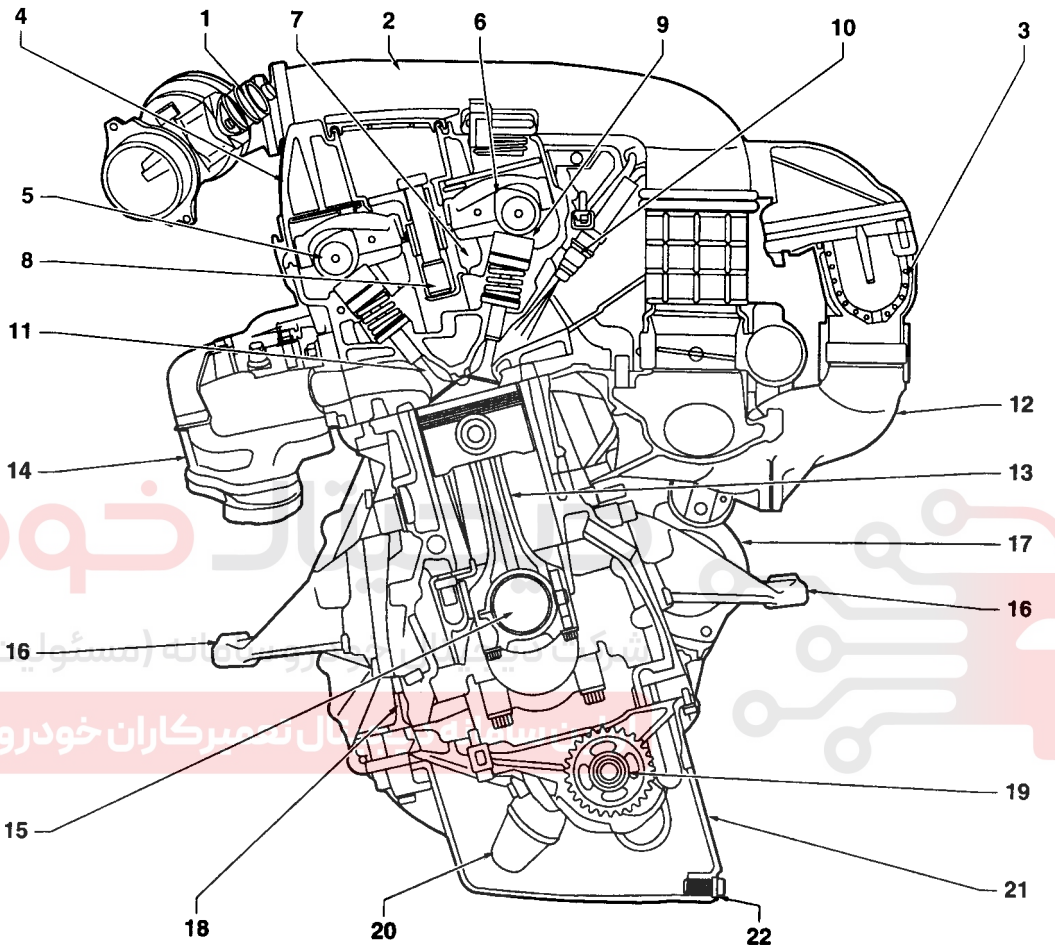
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COMPONENT LOCATOR

FRONT VIEW

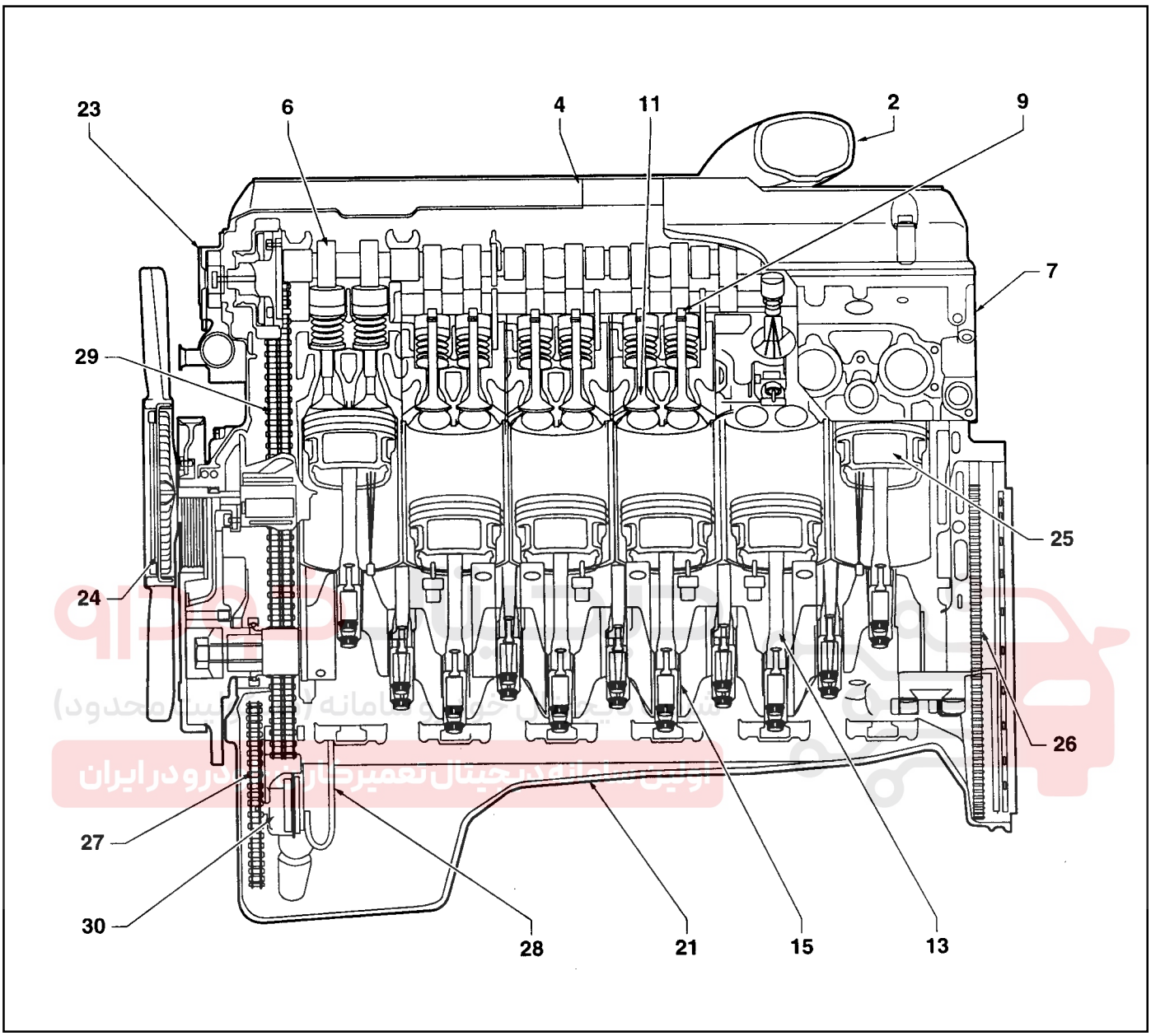


1 HFM Sensor
2 Intake Air Duct
3 Resonance Flap
4 Cylinder Head Cover
5 Exhaust Camshaft
6 Intake Camshaft
7 Cylinder Head
8 Spark Plug Connector
9 Valve Tappet
10 Injector
11 Exhaust Valve
12 Intake Manifold
13 Connecting Rod
14 Exhaust Manifold
15 Crankshaft
16 Engine Mounting Bracket
17 Starter
18 Crankcase
19 Oil Pump Sprocket
20 Oil Strainer
21 Oil Pan
22 Drain Plug

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SIDE VIEW



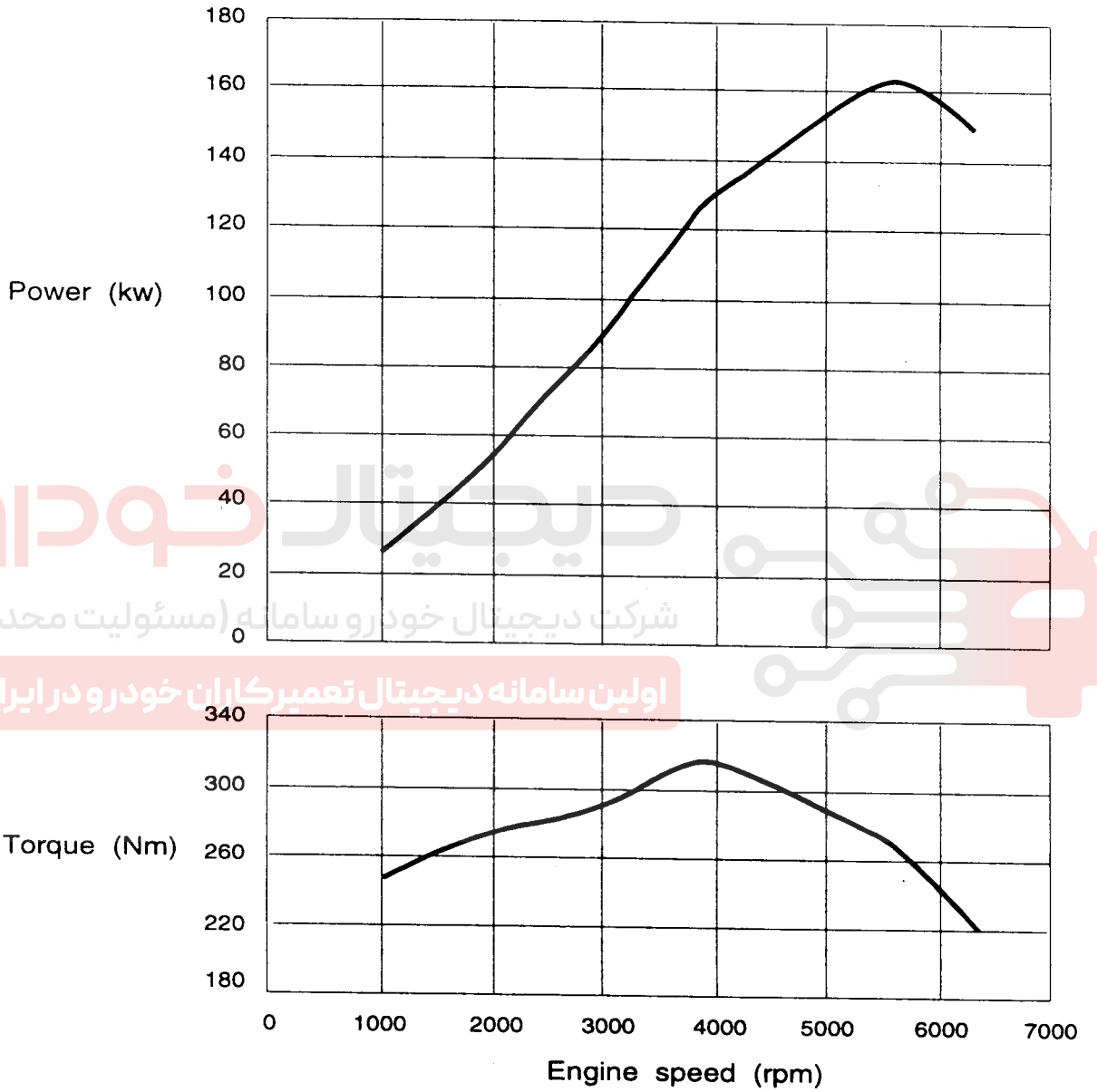
23 Camshaft Adjuster
24 Cooling Fan and Viscous Clutch
25 Piston
26 Flywheel of Drive Plate
27 Oil Pump Drive Chain
28 Oil Return Pipe
29 Timing Chain
30 Oil Pump

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PERFORMANCE CURVE

E32 ENGINE



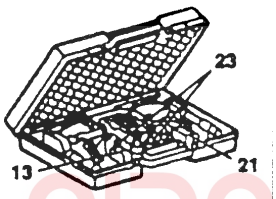
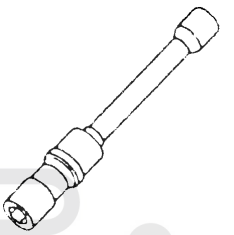
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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	000 589 10 99 01 Torque Wrench		001 589 65 09 00 Socket
	001 589 76 21 00 Compression Pressure Tester		119 589 01 09 00 Spark Plug Wrench

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DIAGNOSIS

OIL LEAK DIAGNOSIS

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedures may help you in locating and repairing most leaks.

Finding the Leak

1. Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
2. Identify where the fluid is leaking from.
   - 2.1 After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
   - 2.2 Wait a few minutes.
   - 2.3 You should be able to find the approximate location of the leak by the drippings on the paper.
3. Visually check around the suspected component. Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent.
   - 4.1 Clean the area well.
   - 4.2 Dry the area.
   - 4.3 Operate the vehicle for several miles at normal operating temperature and varying speeds.
   - 4.4 After operating the vehicle, visually check the suspected component.
   - 4.5 If you still cannot locate the leak, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditoins.
4. Visually inspect the suspected component. You should be able to trace the leak path over the white powder surface to the source.

Black Light and Dye Method

A dye and light kit is available for finding leaks, Refer to the manufacturer's directions when using the kit.

1. Pour the specified amount of dye into the engine oil fill tube.
2. Operate the vehicle normal operating conditions as directed in the kit.
3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined n order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

Gaskets

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The fasteners are tightened improperly or the threads are dirty or damaged.
- The flanges or the sealing surface is warped.
- There are scratches, burrs or other damage to the sealing surface.
- The gasket is damaged or worn.
- There is cracking or porosity of the component.
- An improper seal was used (where applicable).

Seals

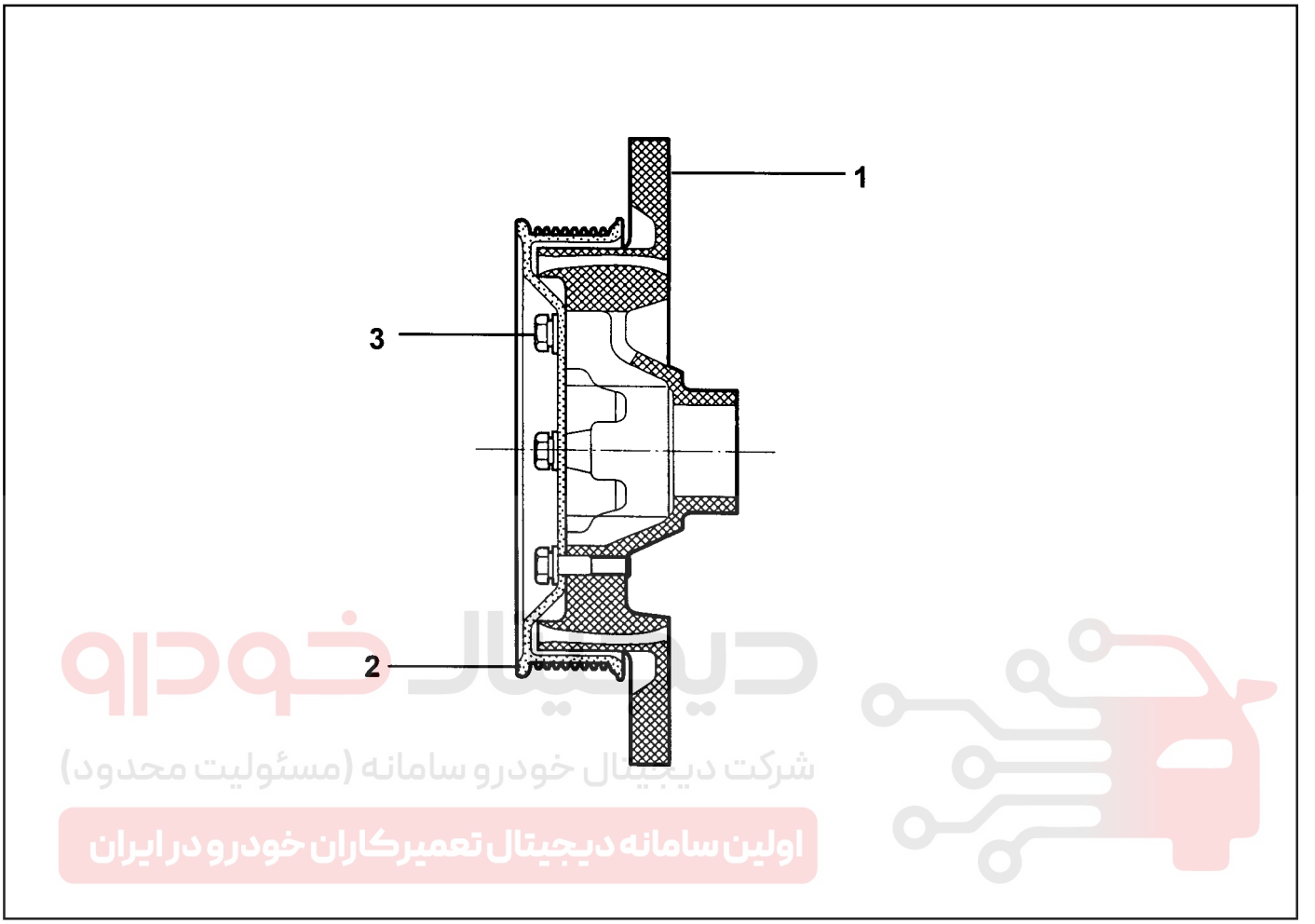
- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged (scratched, burred or nicked).
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the components.
- The shaft surface is scratched, nicked or damaged.
- A loose or worn bearing is causing excess seal wear.

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ENGINE CRANKING AT THE FRONT OF CRANKSHAFT

Preceding Work : Removal of cooling fan



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1 Vibration Damper Assembly
2 Crankshaft Pulley
3 Bolt ..... 8.6 ± 0.9 Nm

Notice

- Remove the negative ground cable before proceeding the work.
- Rotate the pulley in normal engine rotating direction when cranking.

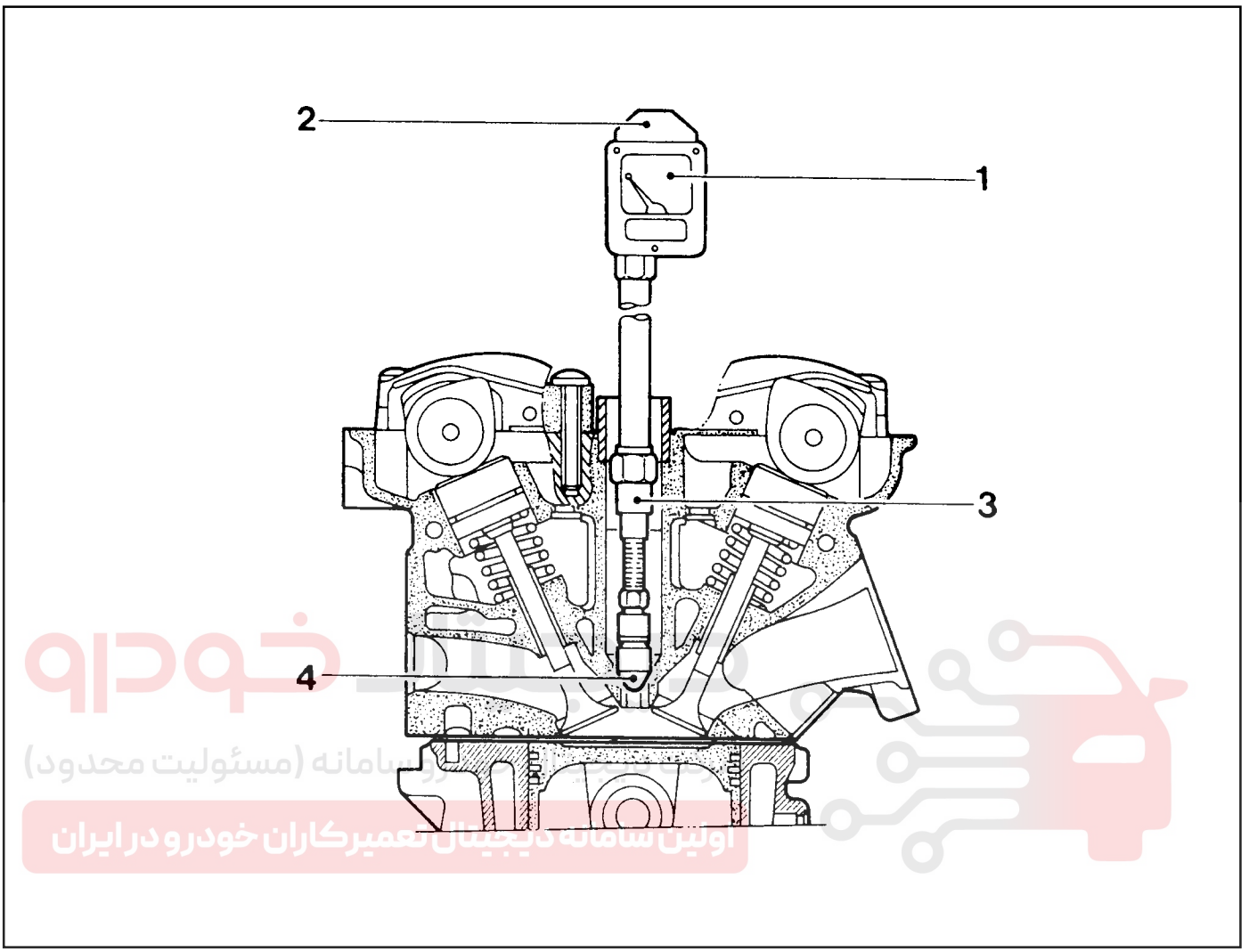
Tools Required

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

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COMPRESSION PRESSURE TEST



1 Compression Pressure Tester
2 Diagram Sheet
3 Adaptor
4 Sealing Cone

Tools Required

001 589 76 21 00 Compression Pressure Tester
119 589 01 09 00 Spark Plug Wrench

Standard Service Data

Compression Ratio		10 : 1
Normal Engine Temperature		80°C
Normal Compression Pressure	General	Min. 10 bar, Max. 14 bar
	Fuel Optimization	Min. 6 bar, Max. 10 bar
Permissible Pressure Difference Between Individual Cylinders		Max. 1.5 bar

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Measuring Procedure

1. Warm the engine up to normal operating temperature.
2. Remove the spark plugs.
3. Place the diagram sheet to compression pressure tester.
4. Connect the adaptor to compression pressure tester and install it into the spark plug hole.
5. Crank the engine approx. eight revolutions by using the start motor.
6. Compare the measurements of compression pressure tester with the specifications.
7. Measure the compression pressure of the other cylinders in the same way.
8. If measured value is not within the specifications, perform the cylinder pressure leakage test.

Notice

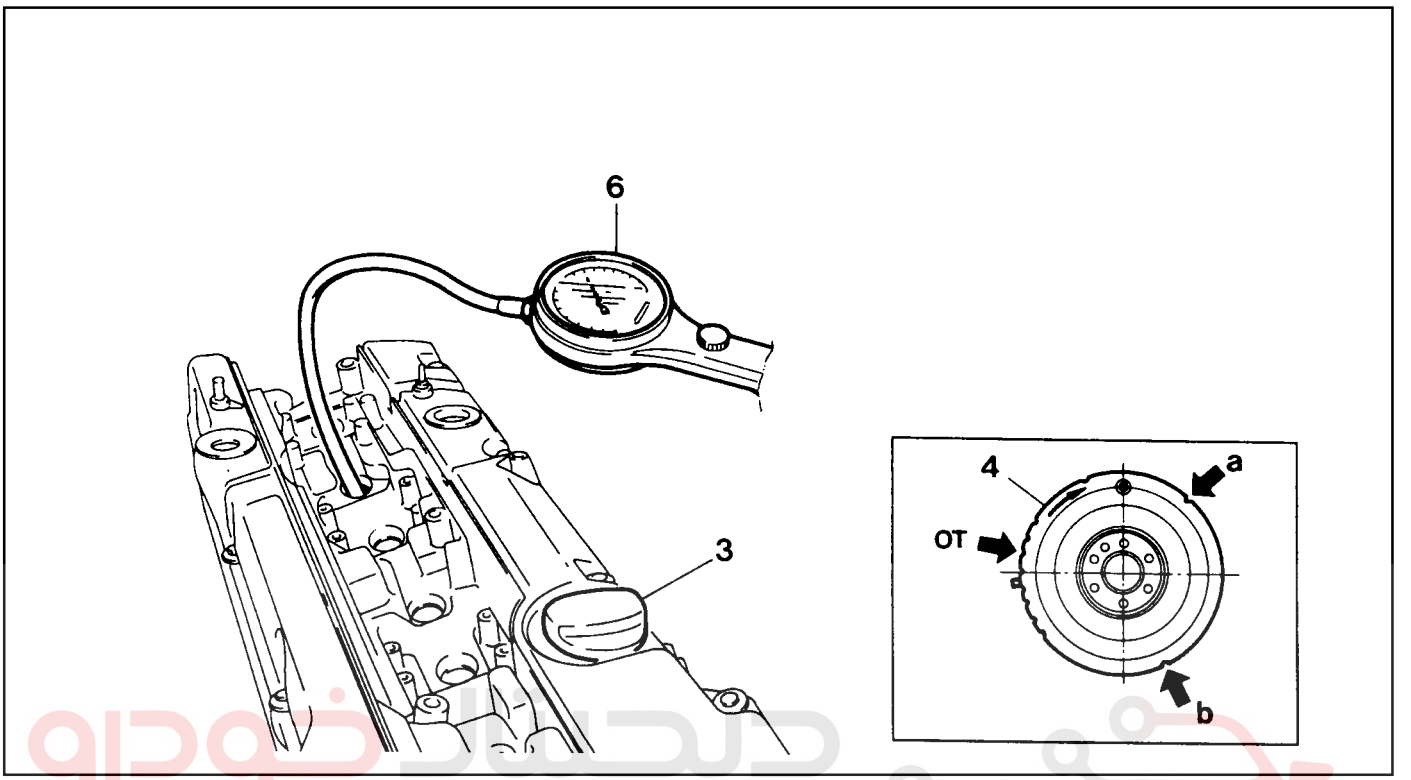
- Discharge the combustion residues in the cylinders before testing the compression pressure.
- Apply the parking brake before cranking the engine.

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CYLINDER PRESSURE LEAKAGE TEST



3 Engine Oil Filler Cap
4 Vibration Damper
6 Cylinder Pressure Leakage Tester with Connecting Hose

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Permissible Pressure Leakage

At Whole Engine	Max. 25 %
At Valve and Cylinder Head Gasket	Max. 10 %
At Piston and Piston Ring	Max. 20 %

Cylinder Number By Mark On Vibration Damper At TDC

TDC Mark	OT (TDC)	a (120°)	b (240°)
Cylinder Number	1, 6	2, 5	3, 4

Universal Tool

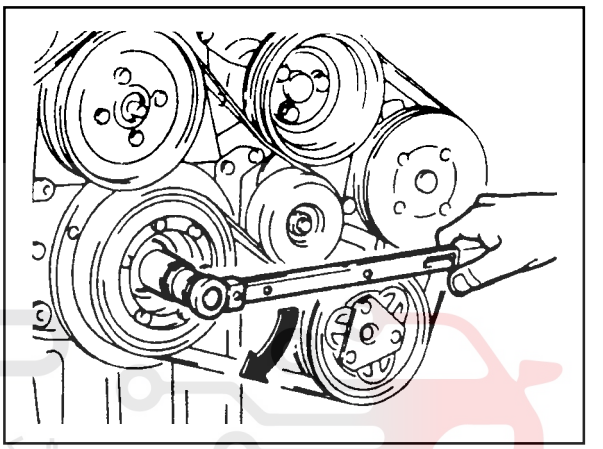
Cylinder Pressure Leakage Tester	Bosch, EFAW 210A Sun, CLT 228

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Leakage Test

1. Warm the engine up to normal operating temperature.
2. Disconnect the negative battery cable.
3. Remove the spark plugs.
4. Check the coolant level by opening the coolant surge tank cap and replenish if insufficient.
5. Open the engine oil filler cap.
6. Connect the tester to air pressure line and adjust the scale of tester.
7. Install the connecting hose to spark plug hole.
8. Position the piston of No.1 cylinder at TDC by rotating the crankshaft.



9. Connect the connecting hose to tester and measure the leakage volume after blowing up 5bar of compressed air.

   Notice

   Measure the leakage volume in the completely opening condition of throttle valve by pulling the acceleration cable.
10. Perform the pressure test according to the firing order.

    Notice

    Firing Order : 1 - 5 - 3 - 6 - 2 - 4
11. Compare the leakage pressure with the specifications.

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GENERAL INFORMATION

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousanths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of enigne oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation. Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when they were removed.

Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

ON-ENGINE SERVICE

Caution: Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

Notice: Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.

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SECTION 1

ENGINE

SECTION 1A2(M161 ENGINE)

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SPECIFICATIONS

ENGINE SPECIFICATIONS

Application			E23 Engine	E20 Engine
Engine Model			M161.970	M161.940
Displacement (CC)			2295	1998
Cylinder (Bore x Stroke) (mm)			90.9 x 88.4	89.9 x 78.7
Fuel Injection / Ignition System			MSE 3.53S	¬
Compression Ratio			10.4:1	9.6:1
Number of Cylinders			4	¬
Camshaft Valve Arrangement			DOHC	¬
Camshaft Drive Type			Chain-Driven	¬
Max. Output (ps/rpm)			149 / 5500	135 / 5500
Max. Torque (kg•m/rpm)			22.4 / 4000	19.3 / 4000
Firing Order			1-3-4-2	¬
Ignition Type			Distributorless	¬
Ignition Timing			BTDC 6° ± 2°	¬
Valve Timing	Intake	Open/Close	ATDC 19.25° / ABDC 28.76°	ATDC 13.15° / ABDC 13.57°
	Exhaust	Open/Close	BBDC 20.62° / BTDC 15.08°	BBDC 16.58° / BTDC 17.05°
Valve Clearance Adjustment			Automatic Control	¬

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ENGINE SPECIFICATIONS (Cont'd)

Application	E23 Engine	E20 Engine
Idle Speed (rpm)	750 ± 50	¬
Fuel Injection Pressure (kg/cm²)	3.2 - 4.2	¬
Oil Capacity (liter)	7.5	¬
Lubrication Type	Forced by Gear Pump	¬
Oil Filter Type	Full Flow with Paper Filter	¬
Fuel	Unleaded Gasoline	¬

MSE 3.62S/3.53S (Motorsteuer Elektronik : German)

MSE : Engine Control Electronic

3.62S : 6 cylinder version

3.53S : 4 cylinder version

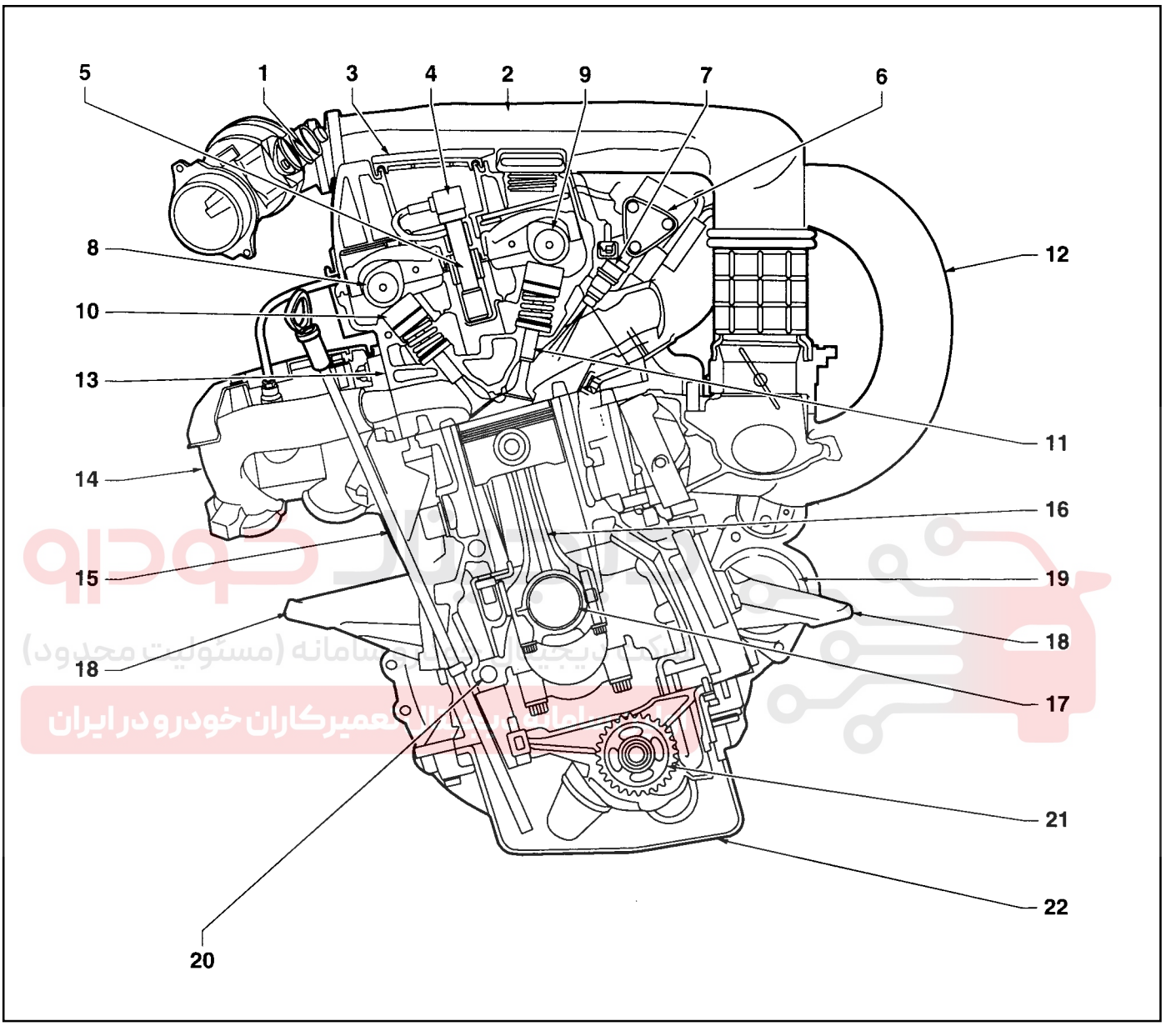
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COMPONENT LOCATOR

FRONT VIEW

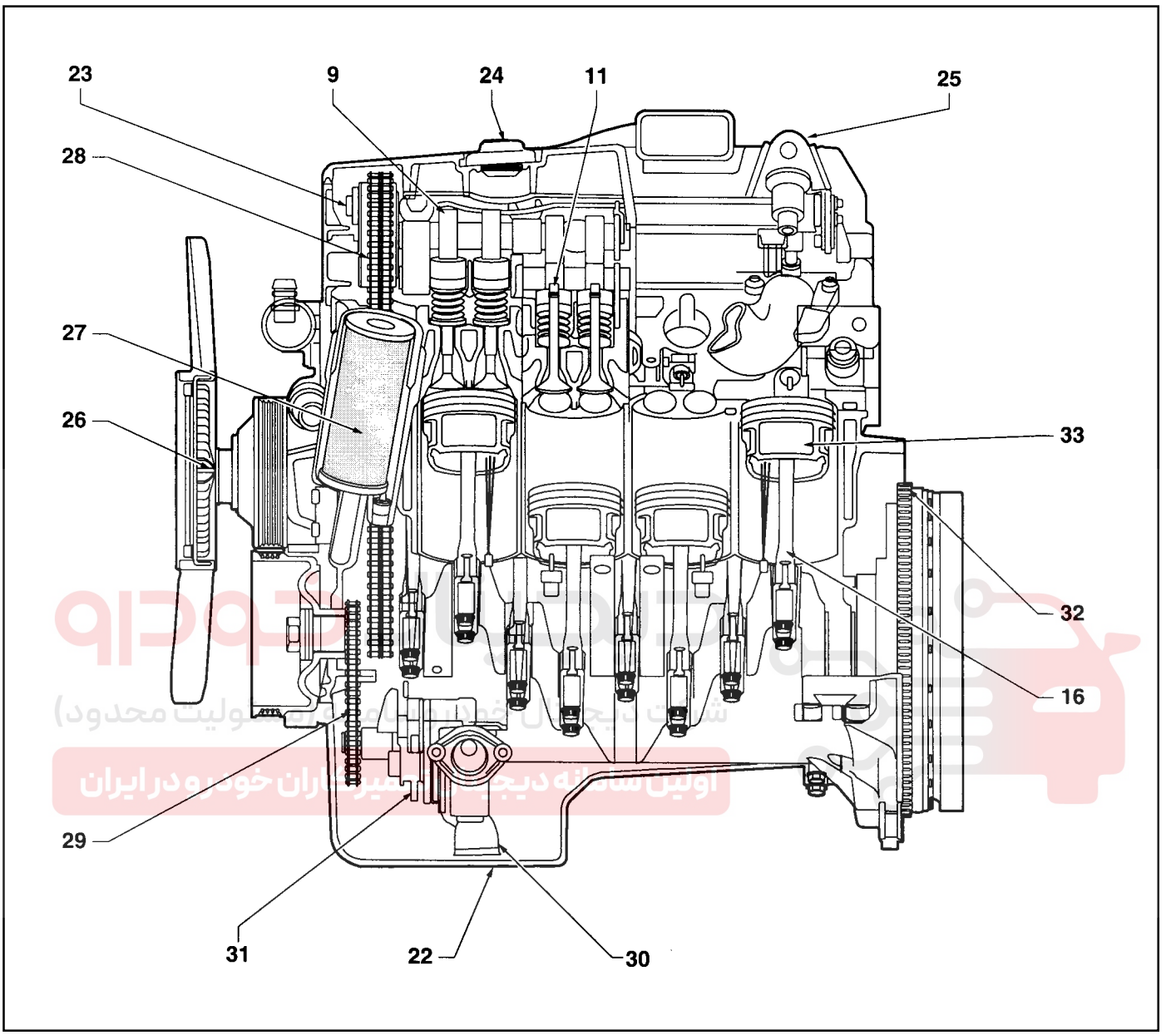


1 HFM Sensor
2 Intake Air Duct
3 Cylinder Head Cover
4 Ignition Coil
5 Spark Plug Connector
6 Fuel Distributor
7 Injector
8 Exhaust Camshaft
9 Intake Camshaft
10 Valve Tappet
11 Intake Valve
12 Intake Manifold
13 Cylinder Head
14 Exhaust Manifold
15 Dipstick Guide Tube and Gauge
16 Connecting Rod
17 Crankshaft
18 Engine Mounting Bracket
19 Starter
20 Crankcase
21 Oil Pump Sprocket
22 Oil Pan

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SIDE VIEW



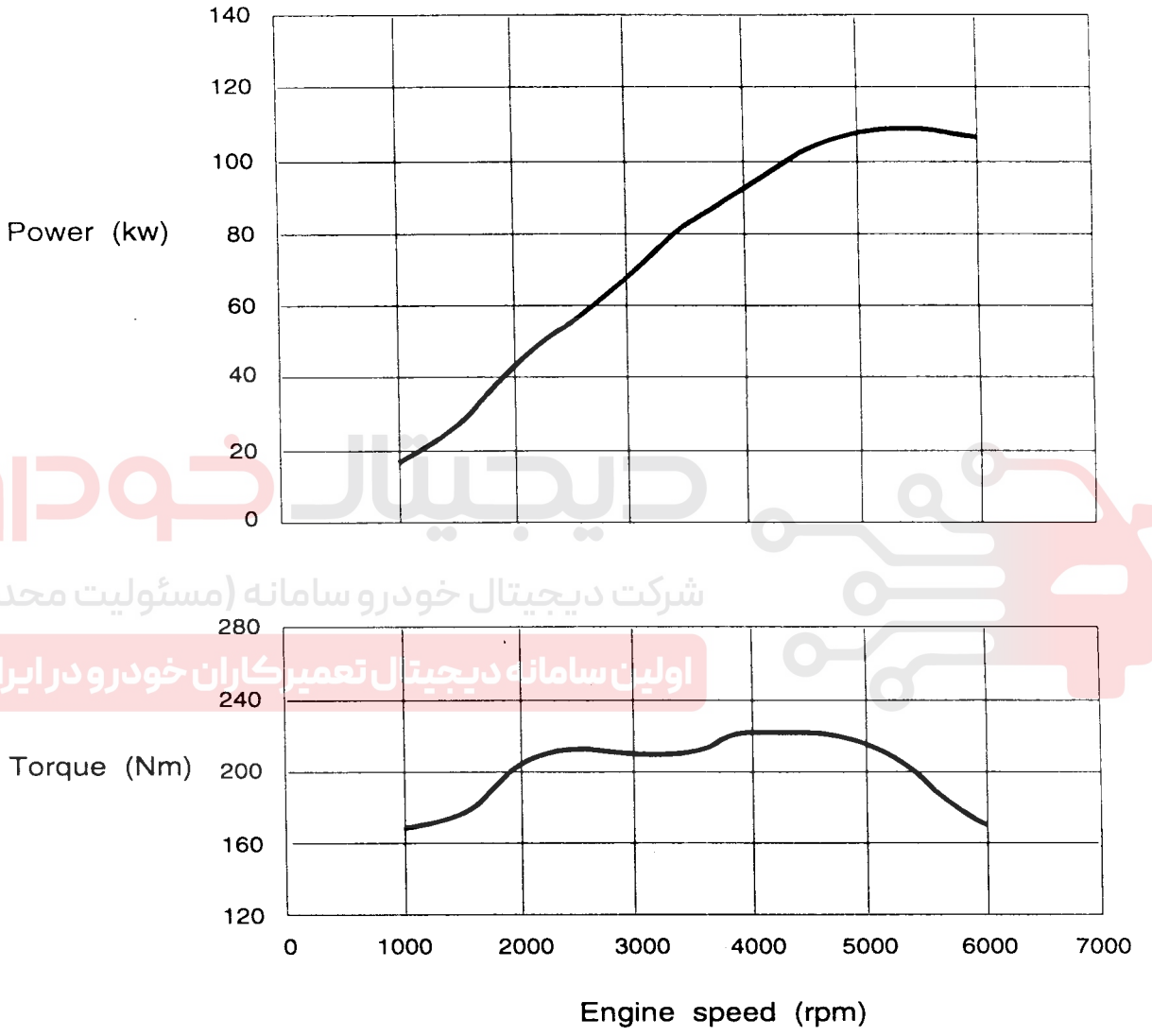
23 Camshaft Adjuster
24 Oil Filler Cap
25 Engine Hanger Bracket
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27 Oil Filter
28 Timing Chain
29 Oil Pump Drive Chain
30 Oil Strainer
31 Oil Pump
32 Ring Gear and Flywheel of Drive Plate
33 Piston

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PERFORMANCE CURVE

E23 ENGINE

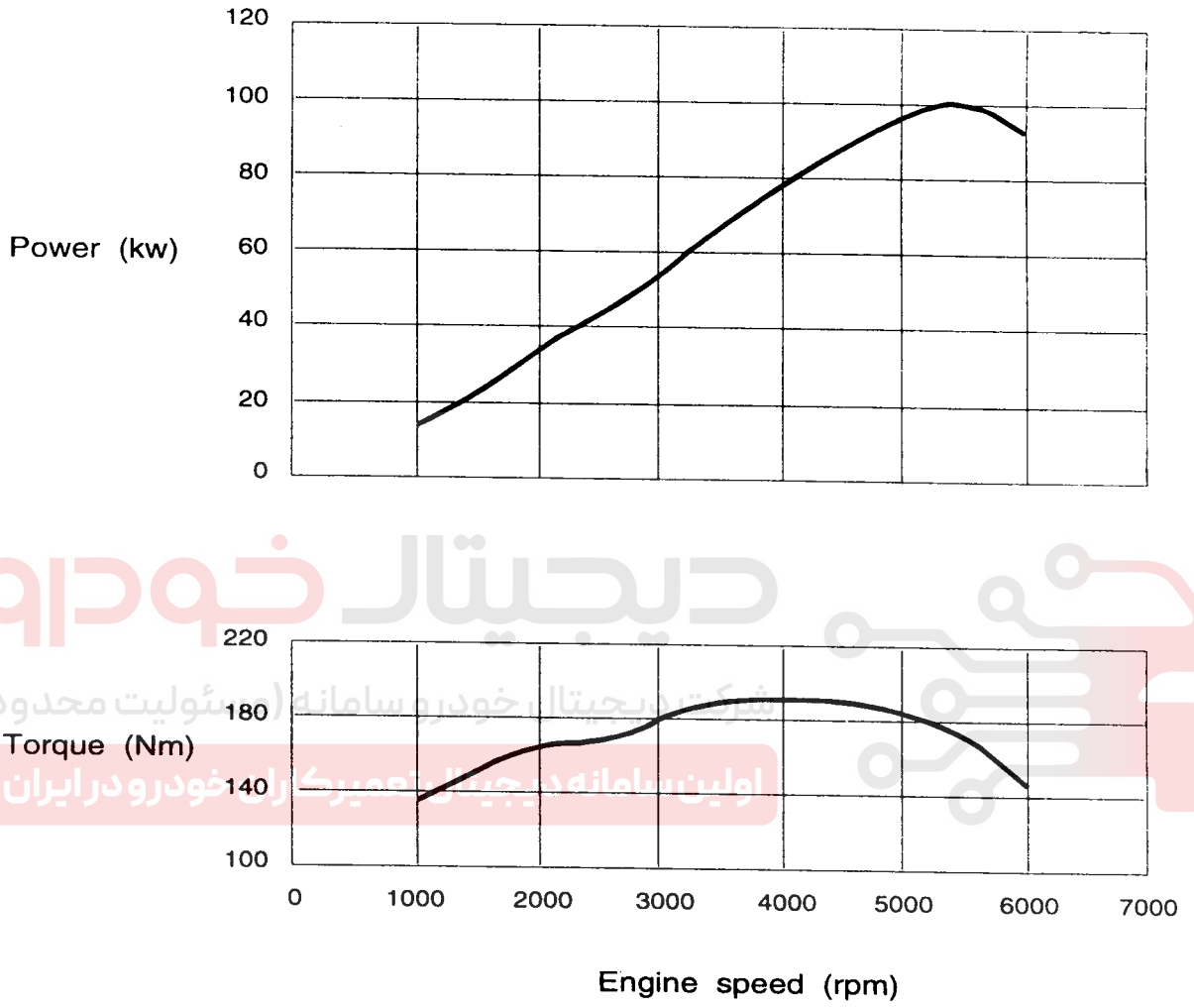


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E20 ENGINE

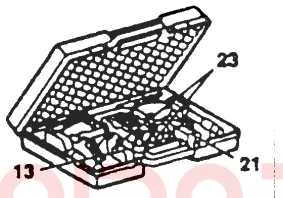
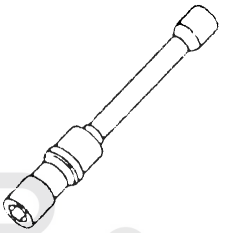


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SPECIAL TOOLS

SPECIAL TOOLS TABLE

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	001 589 76 21 00 Compression Pressure Tester		119 589 01 09 00 Spark Plug Wrench

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DIAGNOSIS

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2. Identify where the fluid is leaking from.
   - 2.1 After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
   - 2.2 Wait a few minutes.
   - 2.3 You should be able to find the approximate location of the leak by the drippings on the paper.
3. Visually check around the suspected component. Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent.
   - 4.1 Clean the area well.
   - 4.2 Dry the area.
   - 4.3 Operate the vehicle for several miles at normal operating temperature and varying speeds.
   - 4.4 After operating the vehicle, visually check the suspected component.
   - 4.5 If you still cannot locate the leak, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditoins.
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Black Light and Dye Method

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1. Pour the specified amount of dye into the engine oil fill tube.
2. Operate the vehicle normal operating conditions as directed in the kit.
3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined n order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

Gaskets

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The fasteners are tightened improperly or the threads are dirty or damaged.
- The flanges or the sealing surface is warped.
- There are scratches, burrs or other damage to the sealing surface.
- The gasket is damaged or worn.
- There is cracking or porosity of the component.
- An improper seal was used (where applicable).

Seals

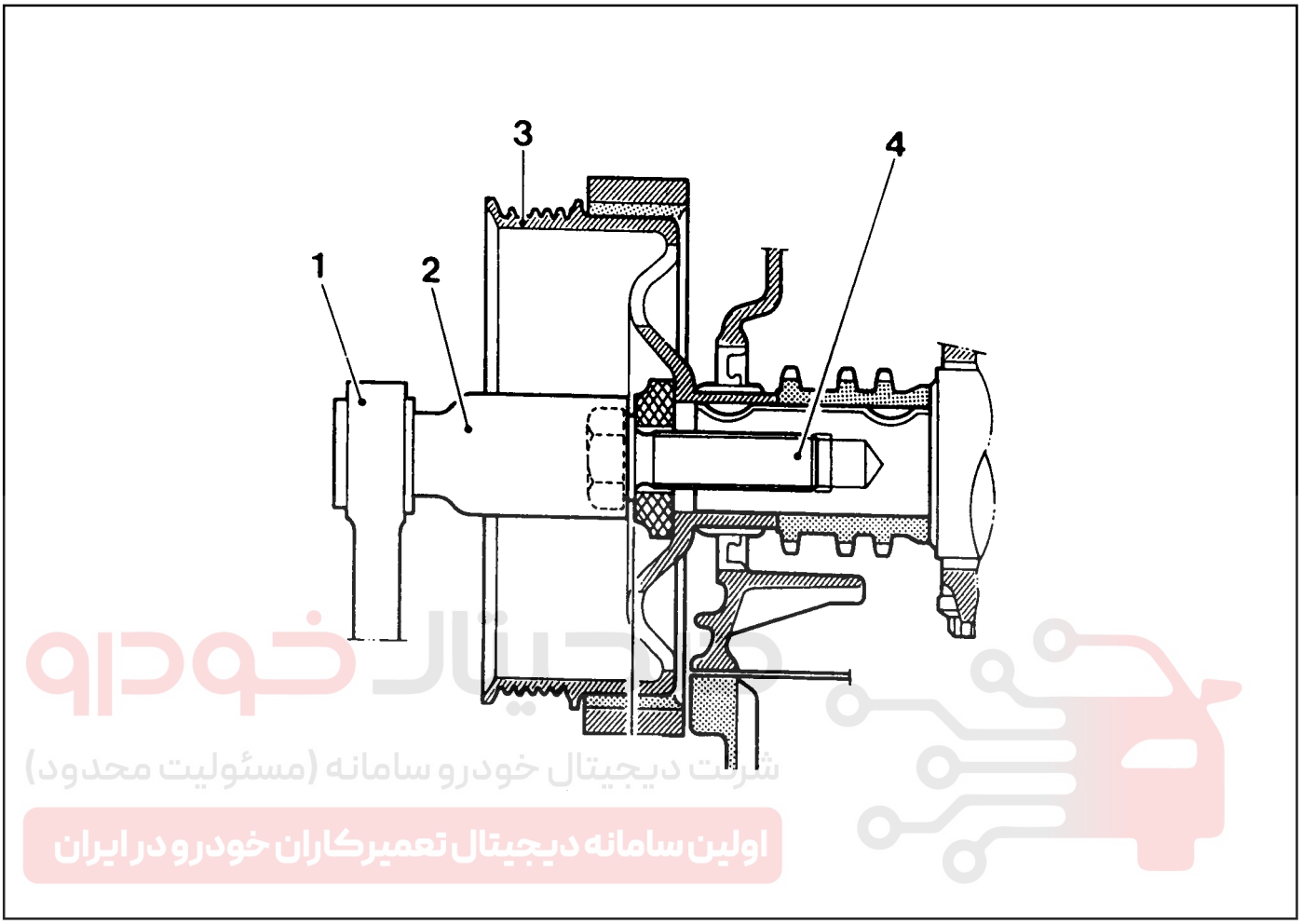
- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged (scratched, burred or nicked).
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the components.
- The shaft surface is scratched, nicked or damaged.
- A loose or worn bearing is causing excess seal wear.

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ENGINE CRANKING AT THE FRONT OF CRANKSHAFT

Preceding Work : Removal of cooling fan



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1 Torque Wrench
2 Socket
3 Vibration Damper Ass'y
4 Center Bolt (M18 ´ 55, 1piece)
..... 1st Step 200Nm + 20Nm
2nd Step 90° + 10°

Notice

- Remove the negative ground cable before proceeding the work.
- Rotate the pulley in normal engine rotating direction when cranking.

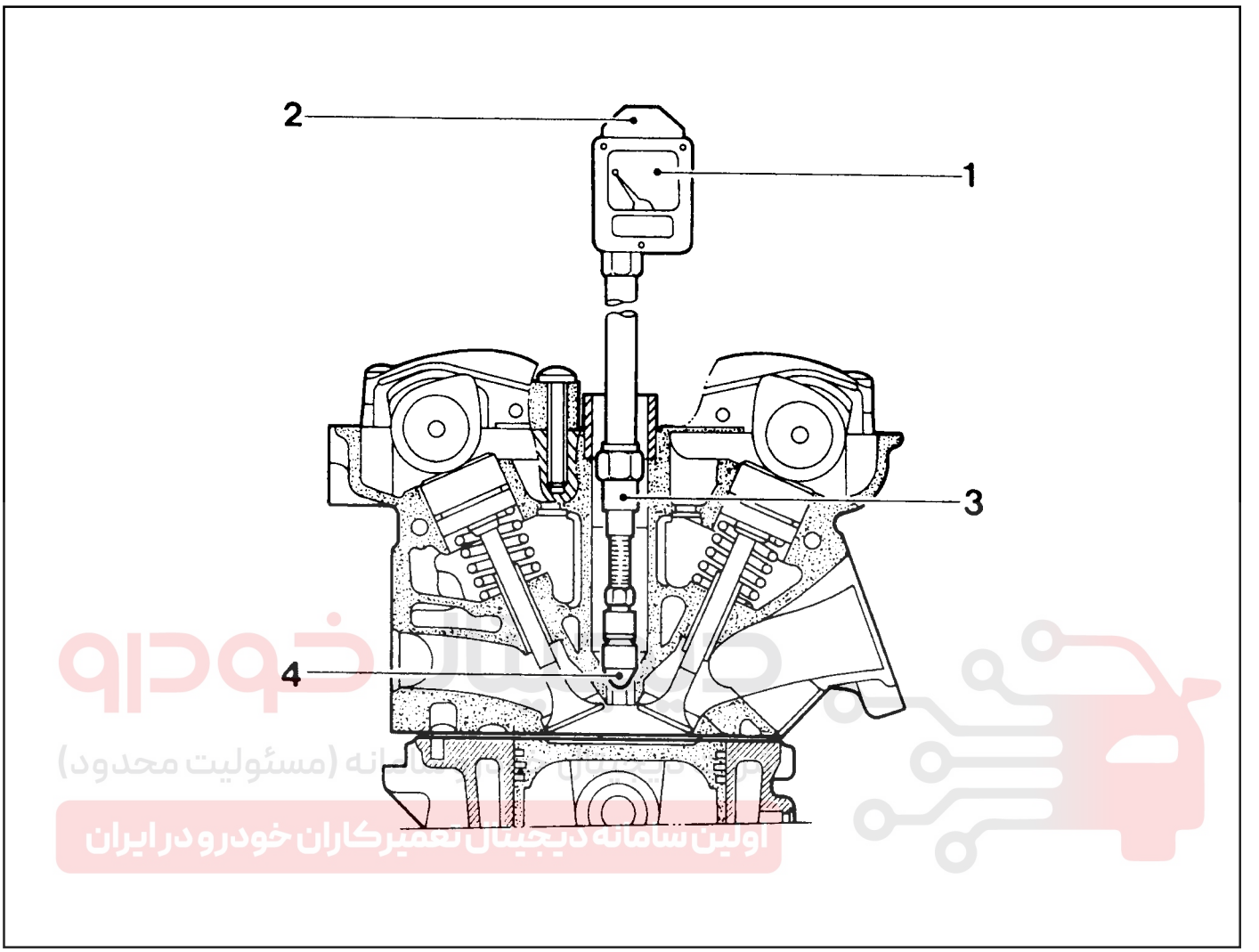
Tools Required

000 589 10 99 01 Torque Wrench
001 589 65 09 00 Socket

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COMPRESSION PRESSURE TEST



1 Compression Pressure Tester
2 Diagram Sheet
3 Adaptor
4 Sealing Cone

Tools Required

001 589 76 21 00 Compression Pressure Tester
119 589 01 09 00 Spark Plug Wrench

Standard Service Data

Compression Ratio		10.4, 9.6
Normal Engine Temperature		80°C
Normal Compression Pressure	E23 Engine(e = 10.4)	Min. 11 bar, Max. 15 bar
	E20 Engine(e = 9.6)	Min. 10.5 bar, Max. 14 bar
Permissible Pressure Difference Between Individual Cylinders		Max. 1.5 bar

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Measuring Procedure

1. Warm the engine up to normal operating temperature.
2. Remove the spark plugs.
3. Place the diagram sheet to compression pressure tester.
4. Connect the adaptor to compression pressure tester and install it into the spark plug hole.
5. Crank the engine approx. eight revolutions by using the start motor.
6. Compare the measurements of compression pressure tester with the specifications.
7. Measure the compression pressure of the other cylinders in the same way.
8. If measured value is not within the specifications, perform the cylinder pressure leakage test.

Notice

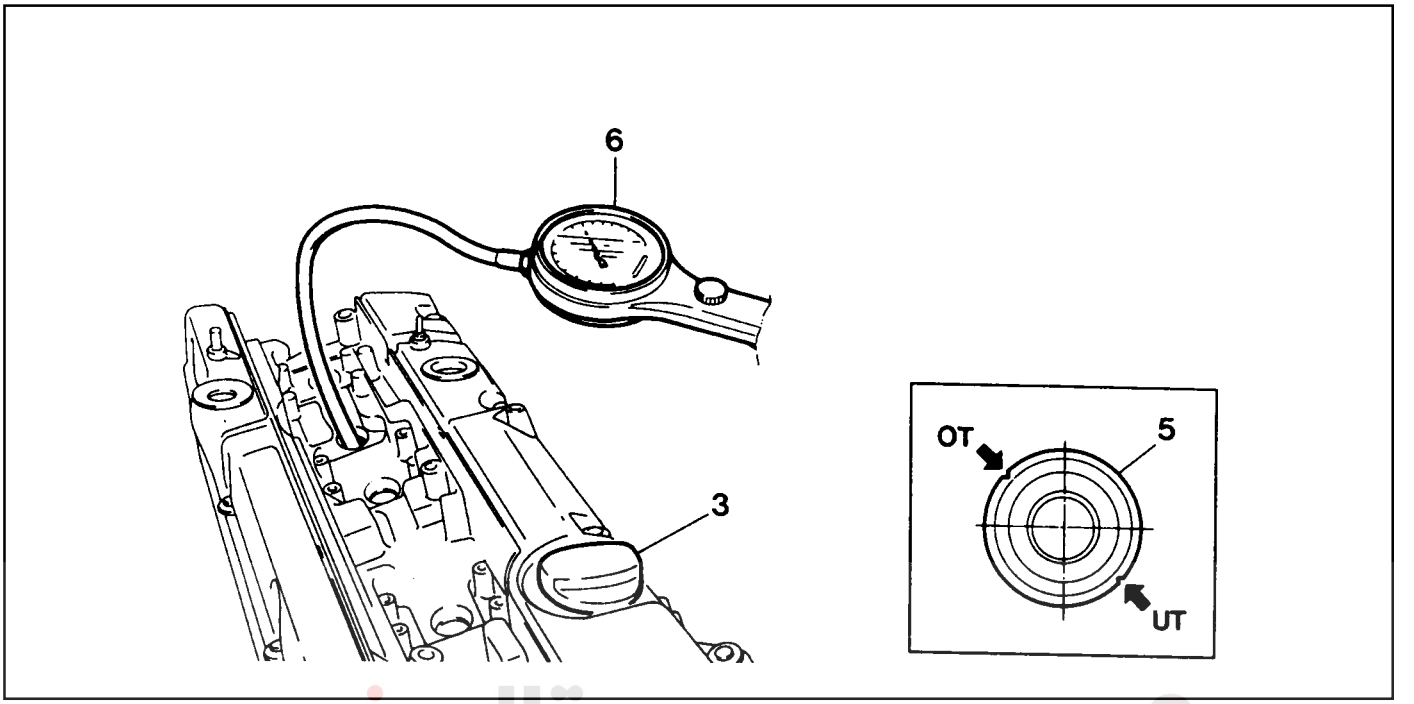
- Discharge the combustion residues in the cylinders before testing the compression pressure.
- Apply the parking brake before cranking the engine.

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CYLINDER PRESSURE LEAKAGE TEST



3 Engine Oil Filler Cap
5 Vibration Damper
6 Cylinder Pressure Leakage Tester with Connecting Hose

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Permissible Pressure Leakage

At Whole Engine	Max. 25 %
At Valve and Cylinder Head Gasket	Max. 10 %
At Piston and Piston Ring	Max. 20 %

Cylinder Number By Mark On Vibration Damper At TDC

TDC Mark	OT (TDC)	UT (BDC : 180°)
Cylinder Number	1, 4	2, 3

Universal Tool

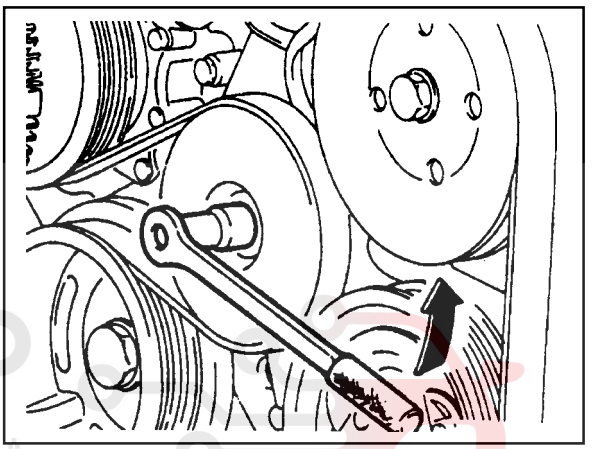
Cylinder Pressure Leakage Tester	Bosch EF AW 210A Sun, CLT 228

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Leakage Test

1. Warm the engine up to normal operating temperature.
2. Disconnect the negative battery cable.
3. Remove the spark plugs.
4. Check the coolant level by opening the coolant surge tank cap and replenish if insufficient.
5. Open the engine oil filler cap.
6. Connect the tester to air pressure line and adjust the scale of tester.
7. Install the connecting hose to spark plug hole.
8. Position the piston of No.1 cylinder at TDC by rotating the crankshaft.



9. Connect the connecting hose to tester and measure the leakage volume after blowing up 5bar of compressed air.

   Notice

   Measure the leakage volume in the completely opening condition of throttle valve by pulling the acceleration cable.
10. Perform the pressure test according to the firing order.

    Notice

    Firing Order : 1 - 3 - 4 - 2
11. Compare the leakage pressure with the specifications.

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GENERAL INFORMATION

CLEANLINESS AND CARE

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Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when they were removed.

Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

ON-ENGINE SERVICE

Caution: Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

Notice: Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.

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SECTION 1

ENGINE

SECTION 1A3(OM600 ENGINE)

GENERAL ENGINE INFORMATION

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SPECIFICATIONS

ENGINE SPECIFICATIONS

Application			OM662LA	OM661LA
Engine Type			Four-Stroke Diesel	Four-Stroke Diesel
Displacement (CC)			2874	2299
Cylinder (Bore x Stroke) (mm)			89 x 92.4	89 x 92.4
Fuel Injection / Ignition System			PES 5 M55 C320 RS 168	PES 5 M55 C320 RS 167
Compression Ratio			22:1	22:1
Number of Cylinders			5	4
Camshaft Valve Arrangement			SOHC	SOHC
Camshaft Drive Type			Chain-Drive	Chain-Drive
Max. Output (ps/rpm)			120 / 4000	101 / 4000
Max. Torque (kg•m/rpm)			25.5 / 4000	21.5 / 2400
Firing Order			1-2-4-5-3	1-3-4-2
Injection Timing			BTDC 18°± 10°	BTDC 18°± 10°
Valve Timing (at 2mm lift)	Intake	Open/Close	ATDC 11.33° / ABDC 17°	ATDC 11.33° / ABDC 17°
	Exhaust	Open/Close	BBDC 28° / BTDC 15.25°	BBDC 28° / BTDC 15.25°
Valve Clearance Adjustment			Automatic Control	Automatic Control

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ENGINE SPECIFICATIONS (Cont'd)

Application	OM 662 LA	OM661LA
Idle Speed (rpm)	720 - 820	750 - 850
Fuel Injection Pressure (bar)	135 - 143	135 - 143
Oil Capacity (liter)	8.0 - 9.5	6.5 - 8.0
Lubrication Type	Forced by Gear Pump	Forced by Gear Pump
Oil Filter Type	Combined Full-Flow and Partial Flow Filter	Combined Full-Flow and Partial Flow Filter
Fuel	Diesel	Diesel

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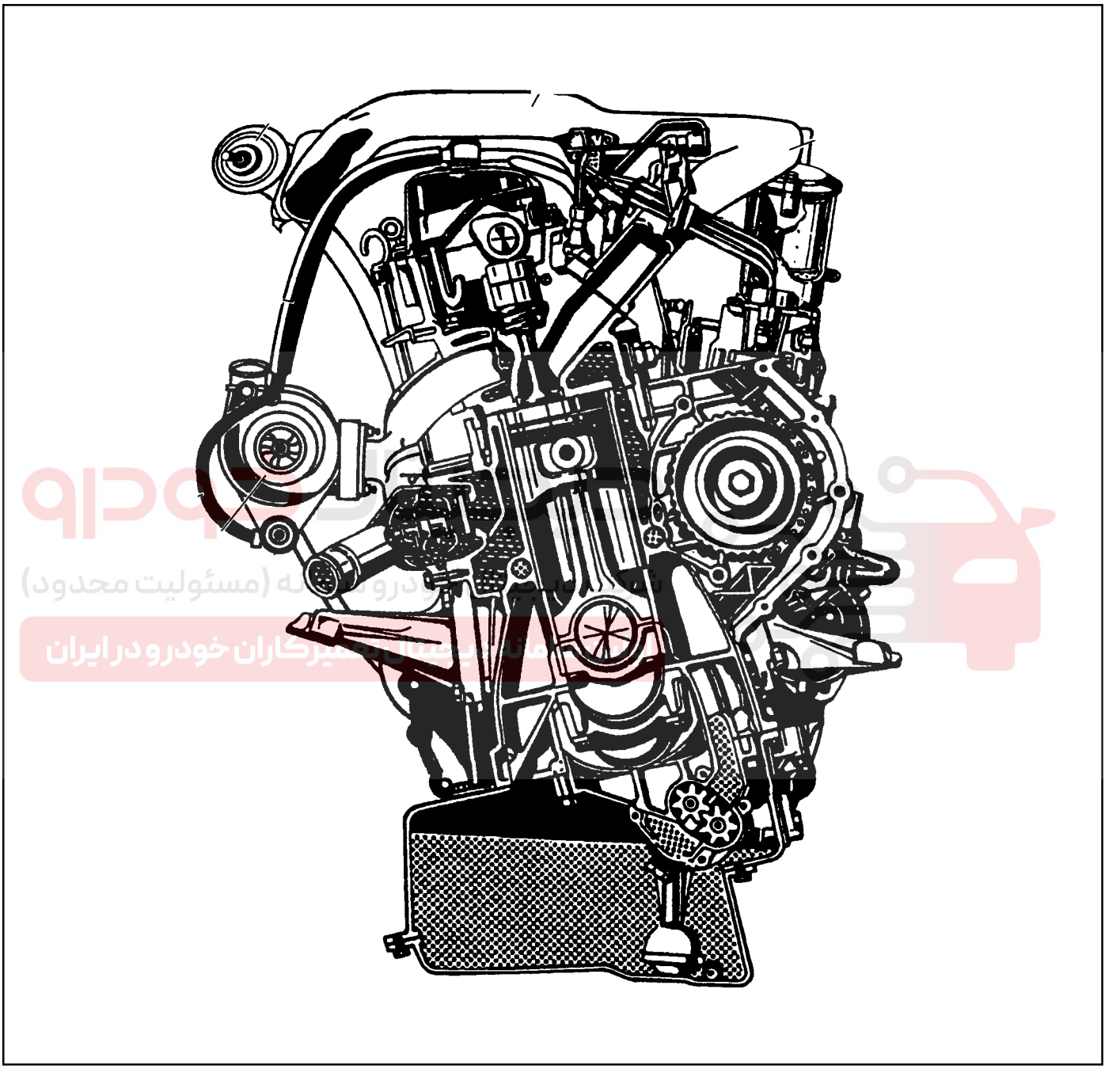
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SECTIONAL VIEW

OM662LA ENGINE

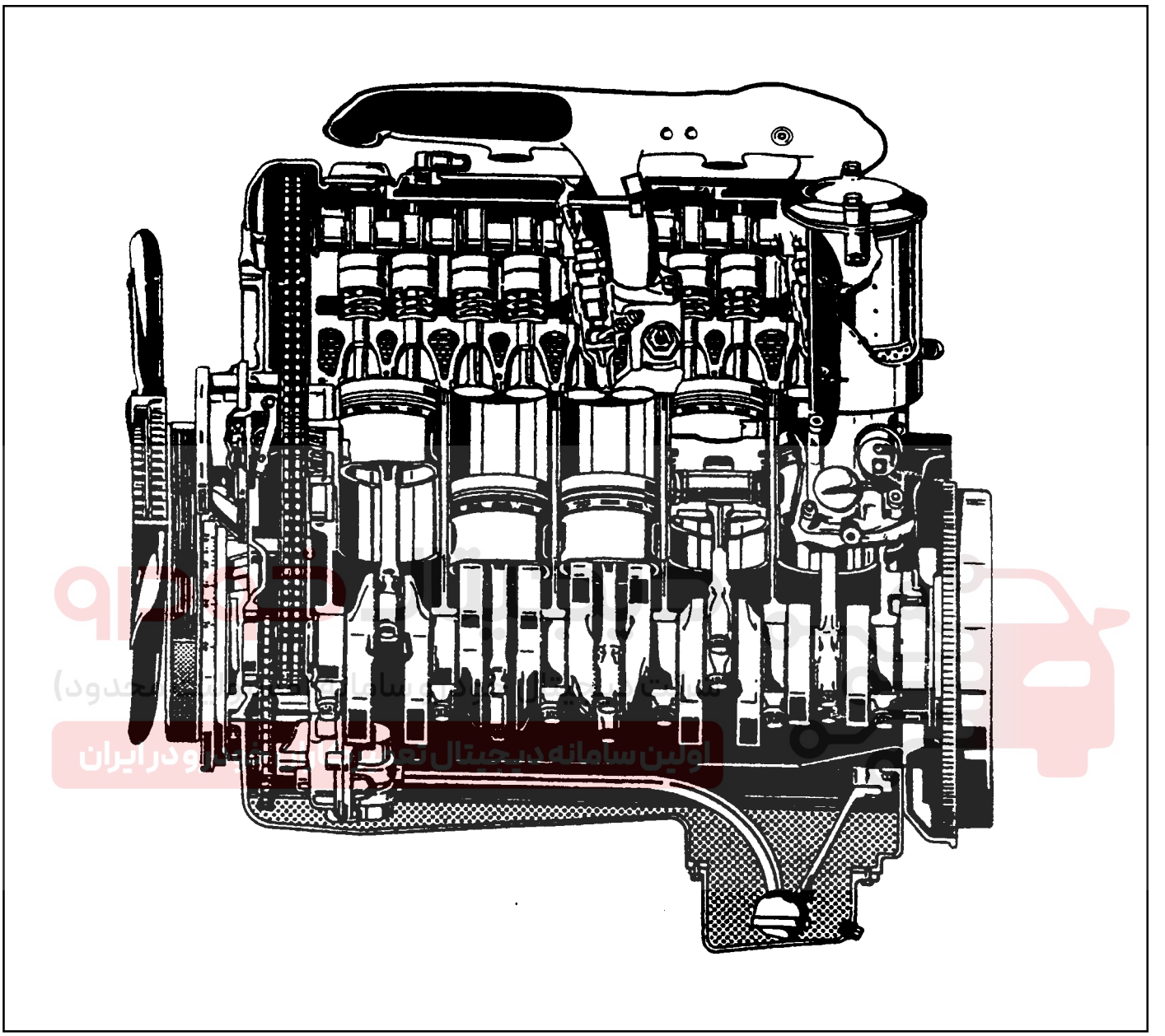
Front View



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Side View

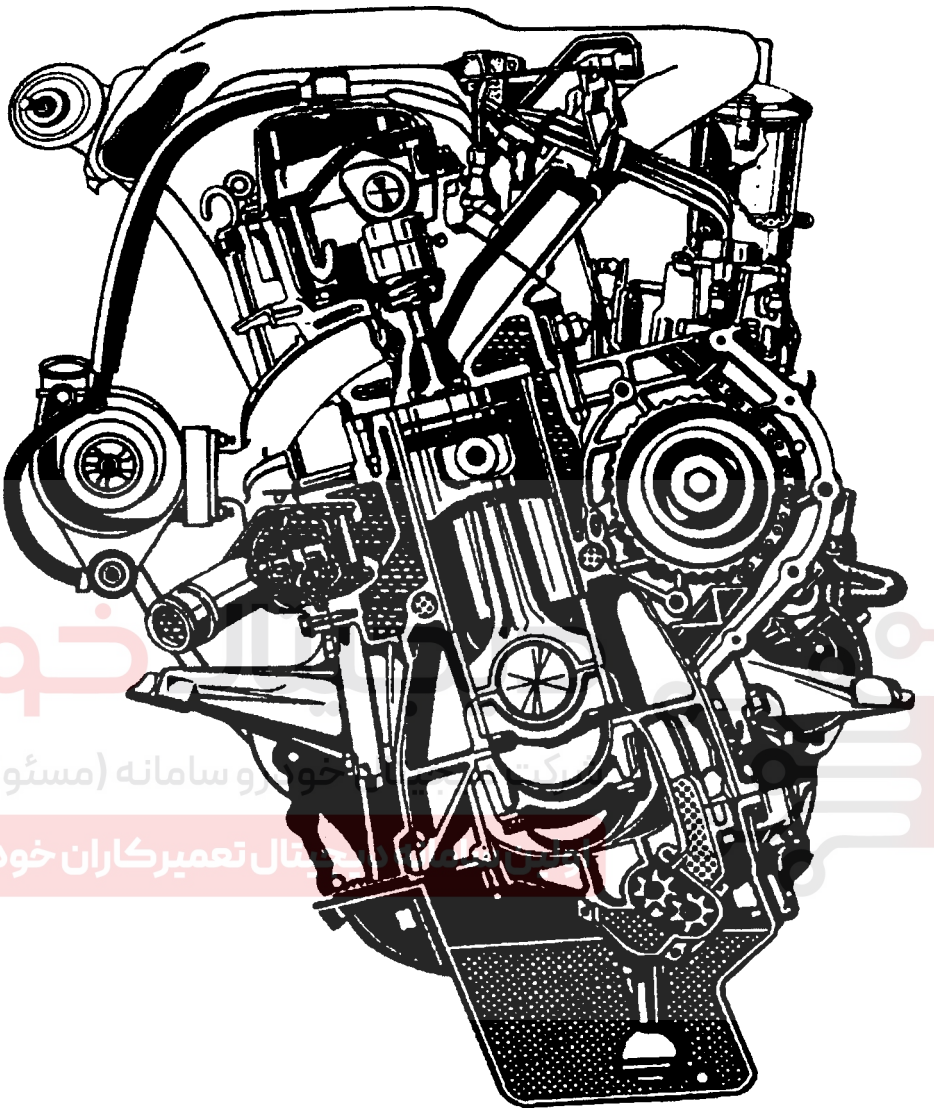


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OM661LA ENGINE

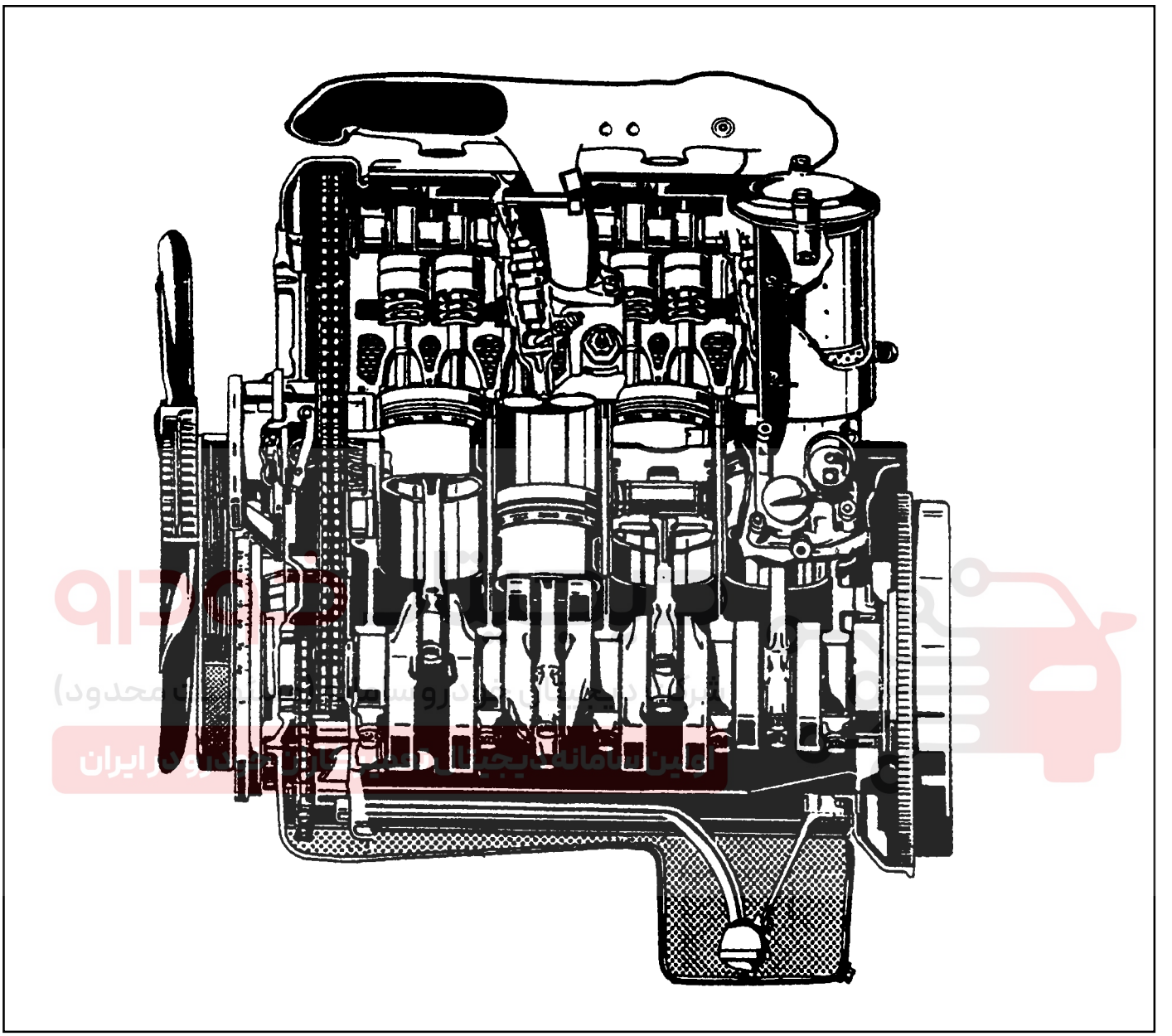
Front View



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Side View

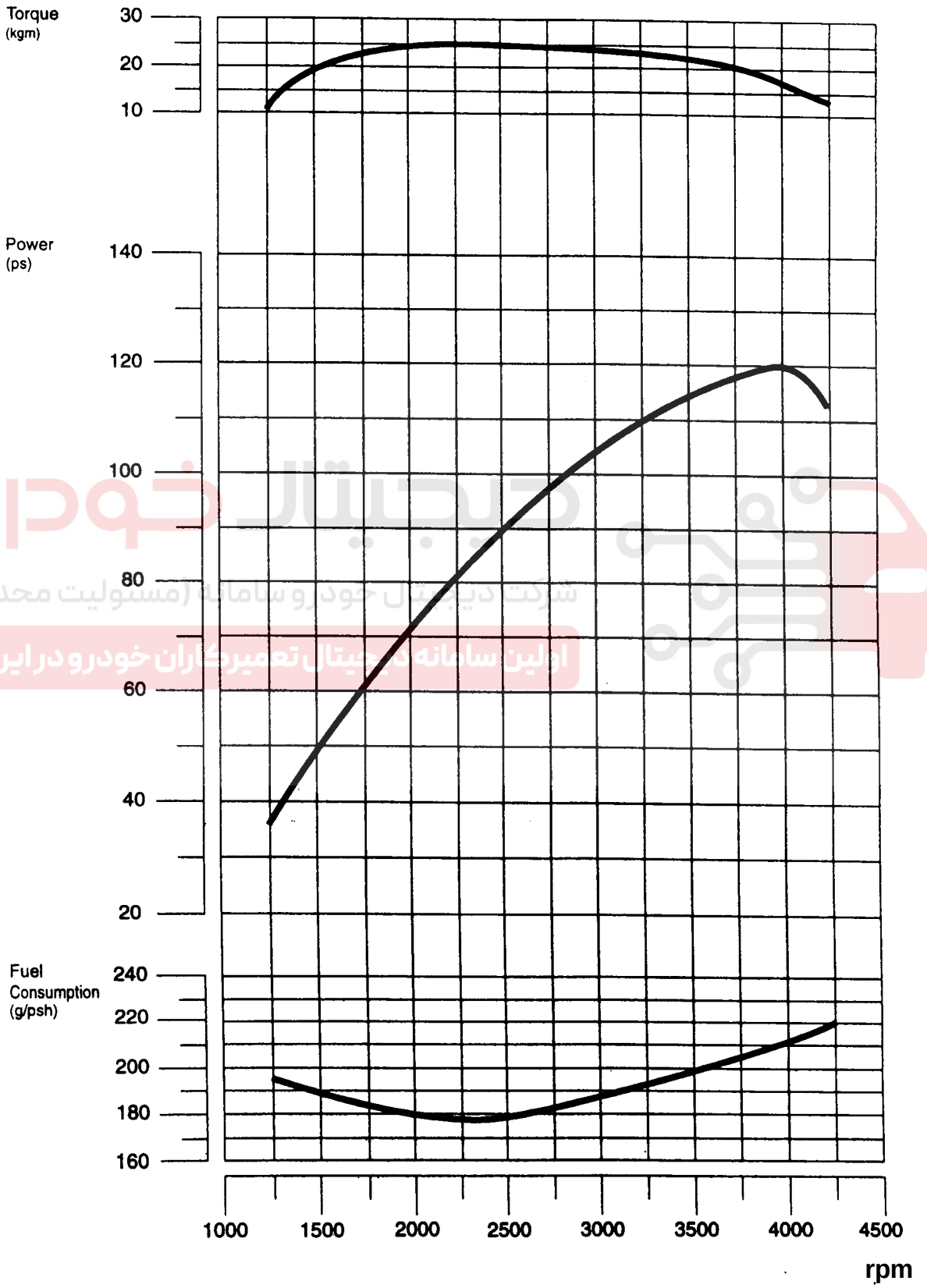


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PERFORMANCE CURVE

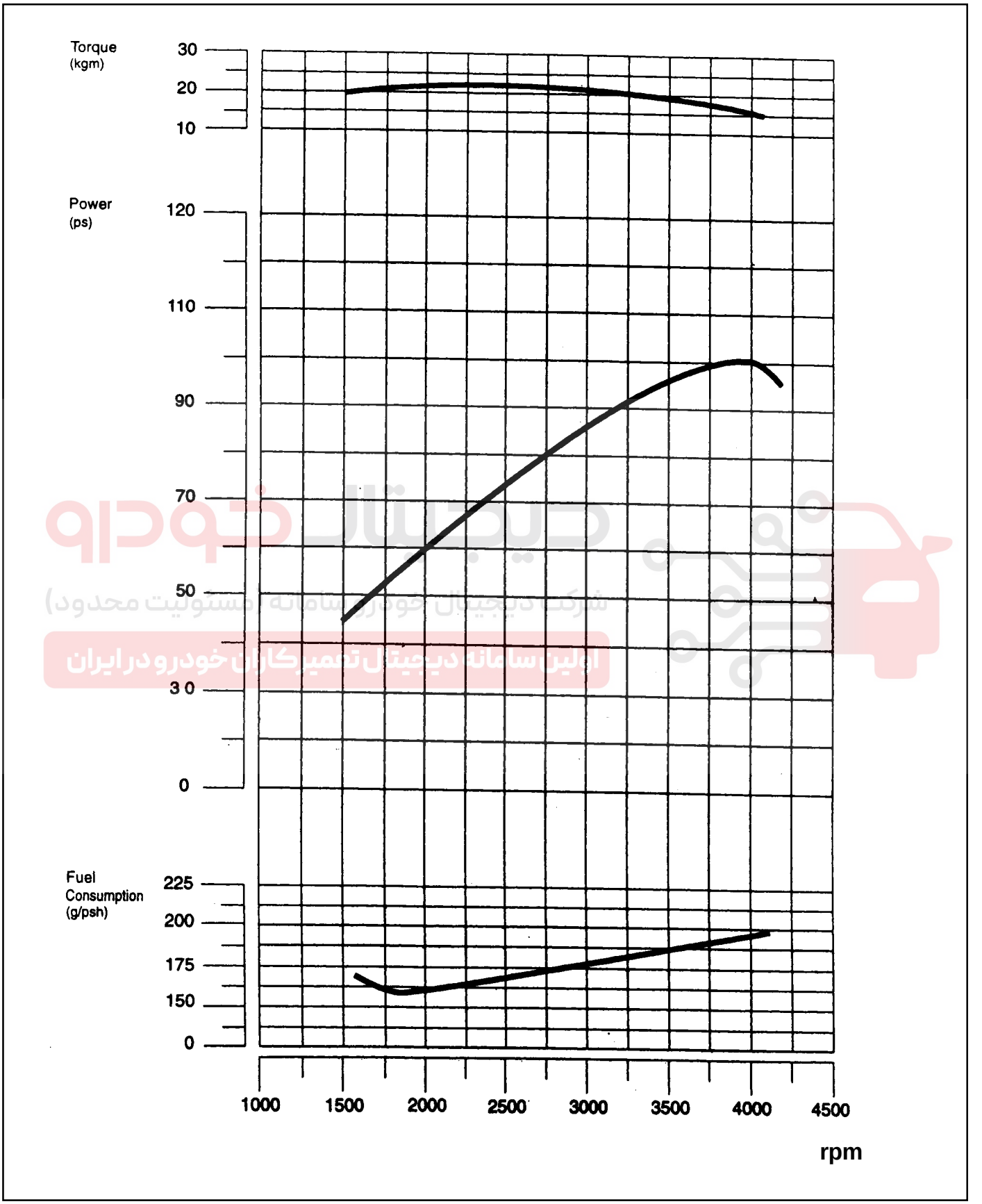
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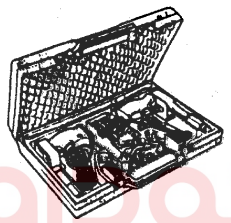
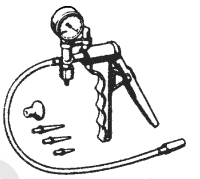


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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	000 589 10 99 01 Torque Wrench		001 589 65 09 00 Socket
	001 589 76 21 00 Compression Pressure Tester		001 589 73 21 00 Hand Vacuum Pump

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DIAGNOSIS

OIL LEAK DIAGNOSIS

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedures may help you in locating and repairing most leaks.

Finding the Leak

1. Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
2. Identify where the fluid is leaking from.
   - 2.1 After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
   - 2.2 Wait a few minutes.
   - 2.3 You should be able to find the approximate location of the leak by the drippings on the paper.
3. Visually check around the suspected component. Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent.
   - 4.1 Clean the area well.
   - 4.2 Dry the area.
   - 4.3 Operate the vehicle for several miles at normal operating temperature and varying speeds.
   - 4.4 After operating the vehicle, visually check the suspected component.
   - 4.5 If you still cannot locate the leak, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditions.
4. Visually inspect the suspected component. You should be able to trace the leak path over the white powder surface to the source.

Black Light and Dye Method

A dye and light kit is available for finding leaks, Refer to the manufacturer's directions when using the kit.

1. Pour the specified amount of dye into the engine oil fill tube.
2. Operate the vehicle normal operating conditions as directed in the kit.
3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined n order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

Gaskets

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The fasteners are tightened improperly or the threads are dirty or damaged.
- The flanges or the sealing surface is warped.
- There are scratches, burrs or other damage to the sealing surface.
- The gasket is damaged or worn.
- There is cracking or porosity of the component.
- An improper seal was used (where applicable).

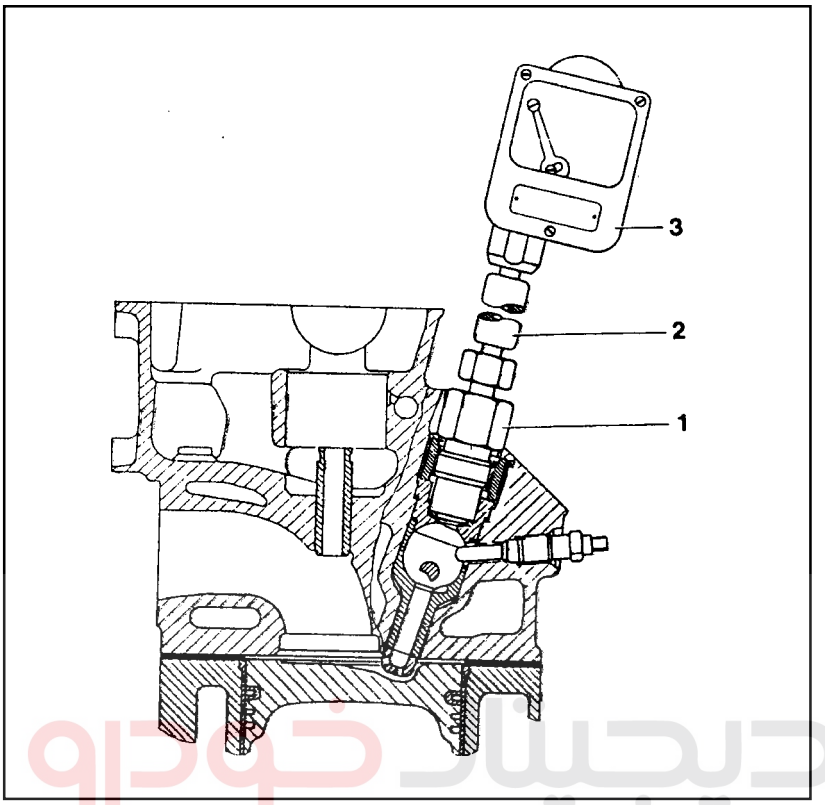
Seals

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged (scratched, burred or nicked).
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the components.
- The shaft surface is scratched, nicked or damaged.
- A loose or worn bearing is causing excess seal wear.

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COMPRESSION PRESSURE TEST



1 Test Adapter
2 Flexible Connector
3 Compression Pressure Recorder

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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°C

Tools Required

000 589 65 09 00 Socket
001 589 73 21 00 Hand Vacuum Pump

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Compression Pressure Measurement

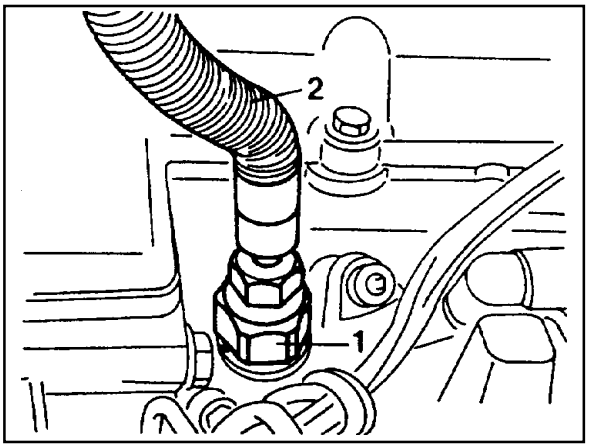
Notice

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

1. Run the engine to be the coolant temperature 80°C.
2. Remove the fuel injection nozzle.

Socket Wrench Insert 001 589 65 09 00

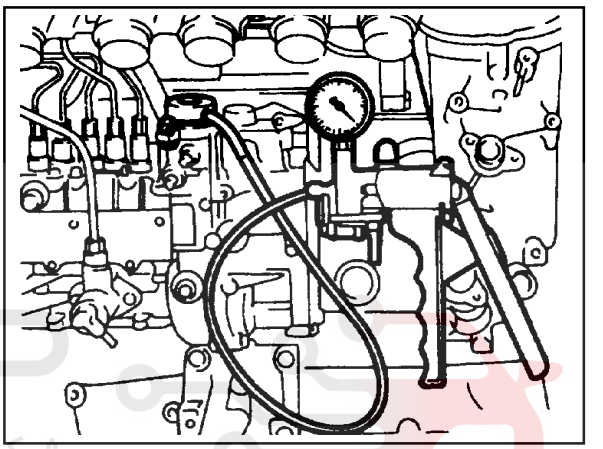
3. Install the test adapter (1) and connect the flexible connector (2) to the compression pressure recorder.



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 cylinder compression pressure in the same manner and compare it with service data.

Notice

If out of standard, do cylinder pressure leakage test.

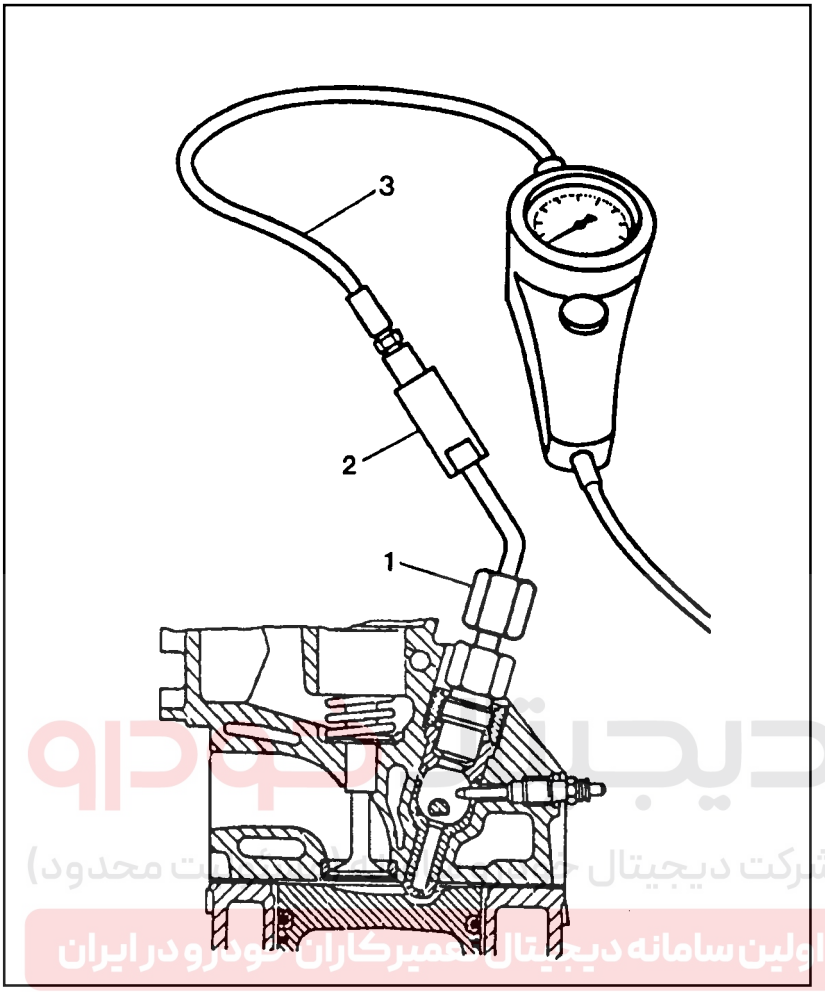
8. Remove the compression pressure recorder.
9. Install the fuel injection nozzle.

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CYLINDER PRESSURE LEAKAGE TEST



1 Connector
2 Connection Piece
3 Connection Hose

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Permissible Pressure Leakage (Engine at Normal Operating Temperature of 80°C)

At Whole Engine	Max. 25 %
At Valve and Cylinder Head Gasket	Max. 10 %
At Piston and Piston Ring	Max. 20 %

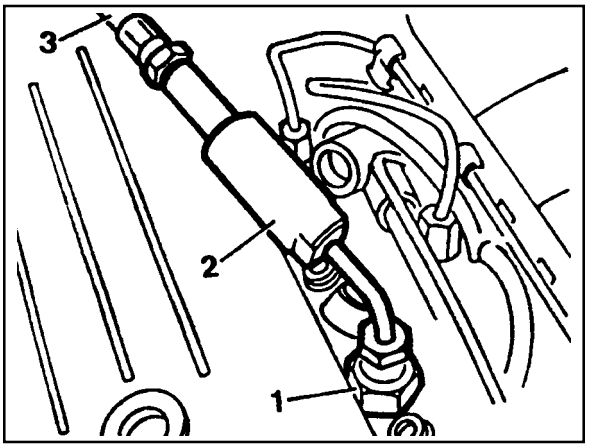
Commercial Tools

Cylinder Pressure Leakage tester	BOSCH, EFAW 210 A or SUN CLT 228
Connection Piece	BOSCH order no. 1 687 010 016

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Leakage Test



1. Run the engine to be the coolant temperature 80°C.
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)
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 662LA Engine : 1-2-4-5-3
    - OM 661LA Engine : 1-3-4-2
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.

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GENERAL INFORMATION

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Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

ON-ENGINE SERVICE

Caution: Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

Notice: Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.

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SECTION 1B1

M162 ENGINE MECHANICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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Power Steering Pump and A/C Bracket 1B1-19
Hydraulic Engine Mounting Insulator 1B1-22
Poly V-Belt 1B1-25
Tensioning Device 1B1-27
Poly V-Belt Inspection 1B1-29
Cylinder Head Cover 1B1-31
Cylinder Head Front Cover 1B1-33
Cylinder Head 1B1-35
Timing Gear Case Cover 1B1-38
Crankshaft Sealing Rear Cover 1B1-40
Belt Pulley and Vibration Damper 1B1-42
Crankshaft Front Radial Seal 1B1-45
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Camshaft 1B1-59
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Cylinder Bore 1B1-111
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Cylinder Head Mating Surface 1B1-115

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application		N·m
Power Steering Hydraulic Lines		35 - 40
A/C High Pressure and Liquid Hose		10 - 15
Radiator Support Menber Bolt		5 - 10
Fuel Supply and Return Hose to Fuel Distributor		21 - 25
Exhaust Manifold and Pipe		30
Propeller Shaft to Transmission		56 - 66
Engine Mounting Nut		50 - 60
Alternator Carrier Bolt		10 - 15
Belt Pulley Bolt		41.5 - 49.5
Steering Pump Bolt		22.5 - 27.5
A/C Bracket Bolt		22.5 - 27.5
Intake Air Duct Bolt		9 - 11
Ignition Cable Cover Bolt		9 - 11
Cylinder Head Cover Bolt		22.5 - 27.5
Camshaft Adjuster Bolt		9 - 11
Cylinder Head Front Cover Bolt		22.5 - 27.5
Flange Bolt in Exhaust Camshaft Sprocket		10 +90°
Cylinder Head Bolt		55 +90° +90°
Cooling Fan Bracket Bolt		22.5 - 27.5
Timing Gear Case Cover Bolt	M8	22.5 - 27.5
	M6	9 - 10
Crankshaft Rear Cover Bolt		9 - 10
Vibration Damper Center Bolt		200 +90°
Connecting Rod Bearing Cap Bolt		40 +90°
Flywheel Stretch Bolt		45 +90°
Amarture Bolt in Flywheel		35
Ring and Seal Cover Nut in Flywheel		9 - 11
Sprocket Bolt to Exhaust Camshaft		20 +90°
Camshaft Adjuster Flange Bolt		20 +90°
Intake Flange Shaft Bolt		20 / + 90°
Exhaust Camshaft Sprocket Bolt		20 / + 90°
Camshaft Bearing Cap Bolt		22.5 - 27.5

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FASTENER TIGHTENING SPECIFICATIONS (Cont'd)

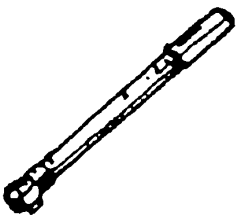
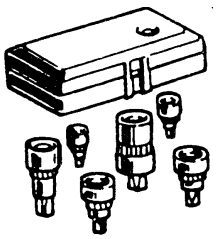
Application	N·m
Exhaust Camshaft Sproket Bolt	20 / +90°
Chain Tensioner Screw Plug	40
Chain Tensioner Assembly	72 - 88
Exhaust Camshaft Sprocket to Camshaft	20 / +90°
Oil Pump Sprocket Bolt	25 - 35
Tensioning Device Bolt	22.5 - 27.5
Water Pump Pulley	22.5 - 27.5
Upper Intake Manifold Bolt	22.5 - 27.5
Lower Intake Mainfold Bolt	22.5 - 27.5
Flange Bolt to Exhaust Mainfold	30
Exhaust Mainfold Nut to Stud Bolt	26 - 34
Rivet Nut in Exhuast Mainfold Hole	30
Pre-silencer Bolt	8 - 10
Oil Drain Plug	25
Oil Filter Cover	25
Oil Filter Bolt	22.5 - 27.5
Oil Pump Drive Sprocket Bolt	29 - 35
Oil Pump Mounting Bolt	22.5 - 27.5
Oil Strainer Bracket Bolt	9 - 11
Oil Pressure Relief Valve Screw Plug	50
Oil Dipstick Guide Tube Bolt	9 - 11
Oil Gallery Screw Plug	15

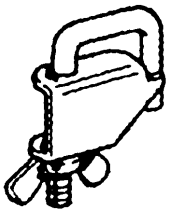
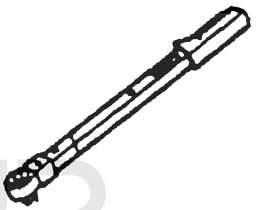
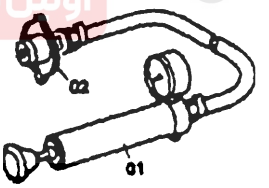
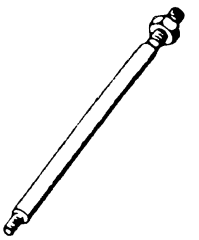
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SPECIAL TOOLS

SPECIAL TOOLS TABLE

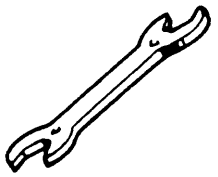
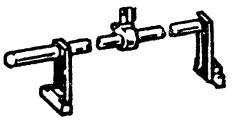
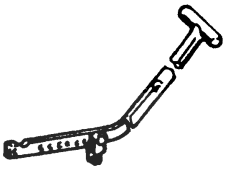
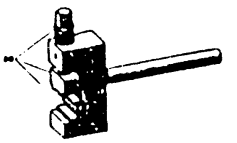
	000 589 10 99 01 Torque Wrench
	112 589 00 72 00 Oil Extractor
	001 589 66 21 00 Torque Wrench
	000 589 01 10 00 Box Wrench Insert

	000 589 40 37 00 Hose Clamp
	000 589 72 21 00 Torque Wrench
	124 589 15 21 00 Radiator Cap Testing Unit
	116 589 02 34 00 Screw-Fixed Pin

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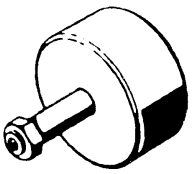
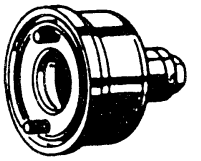
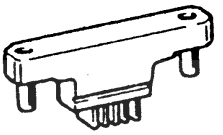
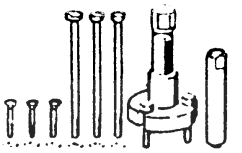
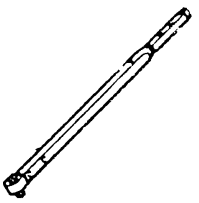
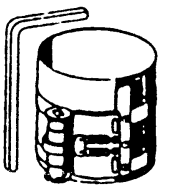
SPECIAL TOOLS TABLE (Cont'd)

	104 589 01 01 00 Spanner		111 589 01 59 00 Supporting Bar
	111 589 18 61 00 Lever Pusher		111 589 25 63 00 Thrust Piece
	116 589 06 63 00 Magnetic Finger		104 589 00 37 00 Pliers
	119 589 00 43 00 Drift		000 589 58 43 00 Chain Assembly

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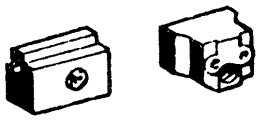
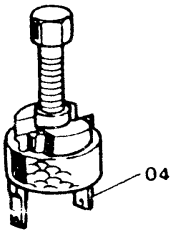
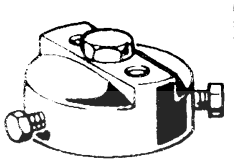
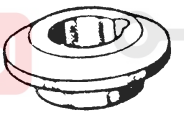
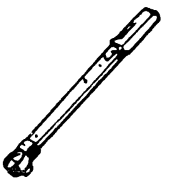
SPECIAL TOOLS TABLE (Cont'd)

	116 589 20 33 00 Sliding Hammer		601 589 03 43 00 Sleeve
	602 589 00 40 00 Engine Lock		103 589 00 33 00 Puller
	001 589 65 09 00 Socket Wrench Insert		000 589 88 33 00 Puller
	001 589 74 21 00 Torque Wrench		000 589 04 14 00 Clamping Strap

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SPECIAL TOOLS TABLE (Cont'd)

	103 589 01 63 00 Rivet Set		615 589 01 33 00 Caulking Bolt
	103 589 02 09 00 Oil Filter Socket Wrench		102 589 12 15 00 Drift
	102 589 00 15 00 Drift		601 589 03 14 00 Sleeve
	000 589 51 37 00 Clamping Strap		001 589 72 21 00 Torque Wrench

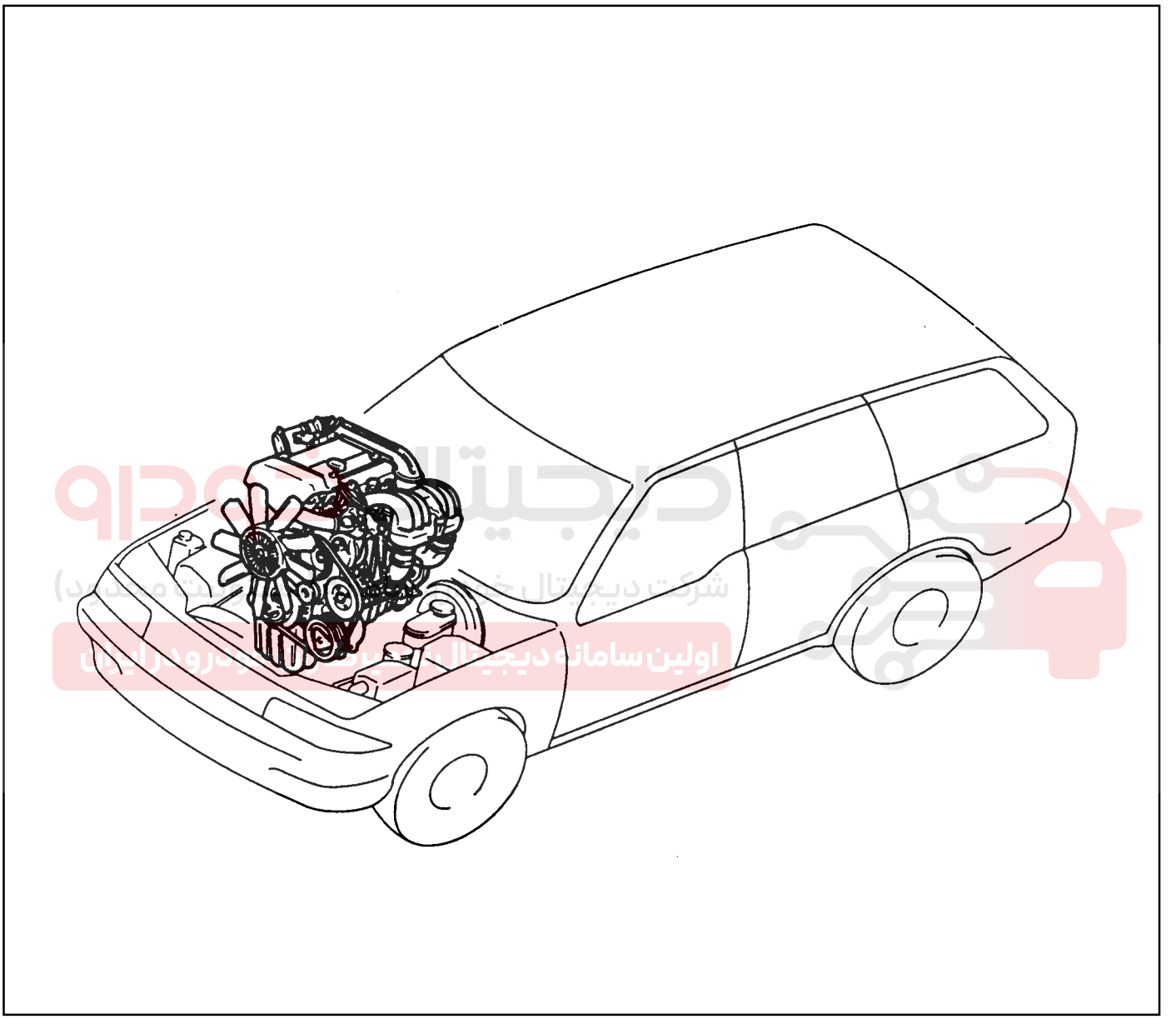
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

ENGINE ASSEMBLY



Tools Required

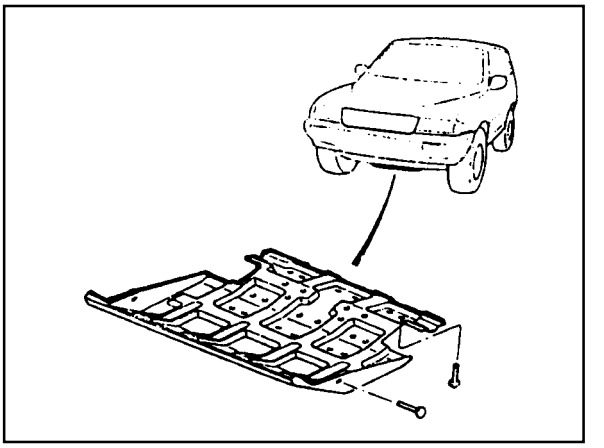
000 589 10 99 01 Torque Wrench
000 589 40 37 00 Hose Clamp
112 589 00 72 00 Oil Extractor

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Removal & Installation Procedure

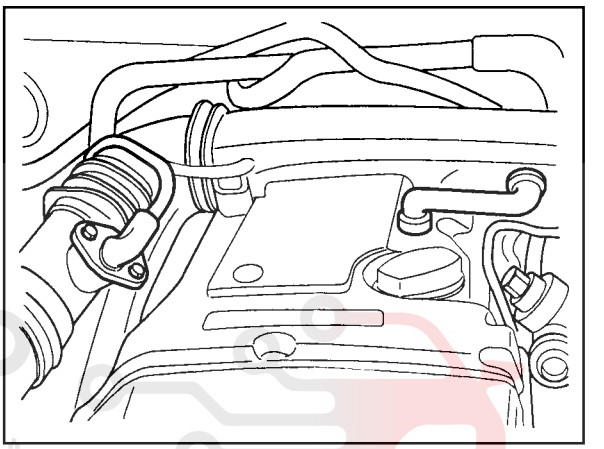
1. Disconnect the negative terminal of battery.
2. Remove the hood.
3. Remove the under cover.



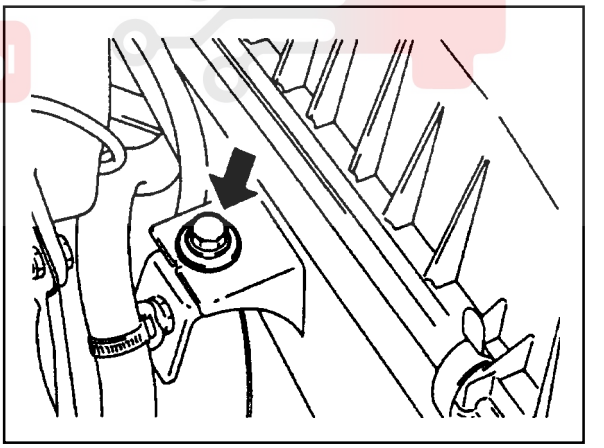
Installation Notice

Tightening Torque	28 - 47 Nm

4. Disconnect the coupling of HFM sensor and remove the air cleaner cross pipe.



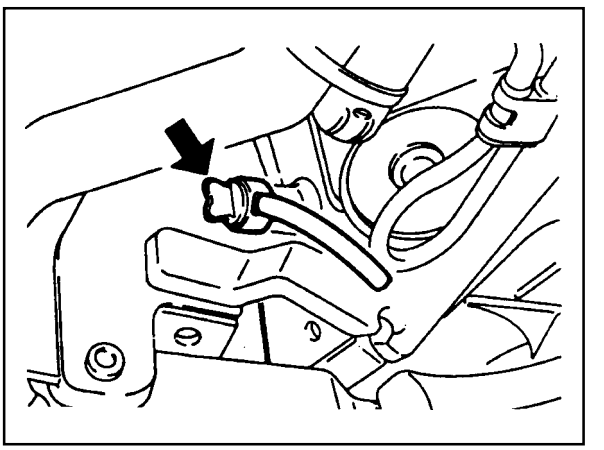
5. Remove the air cleaner cover. Remove the mounting bolts and air cleaner housing and element assembly.



6. Loosen the radiator drain cock and drain the coolant.

Notice

Open the coolant reservoir cap.



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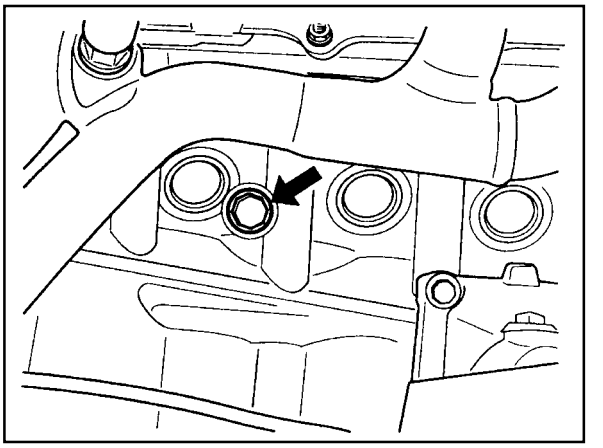
7. Loosen the cylinder block drain plug and then drain the coolant completely.

Installation Notice

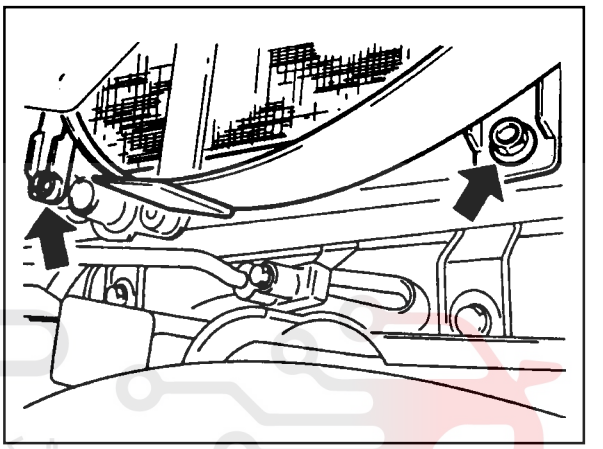
Tightening Torque	30 Nm

Notice

Replace the seal before installation of the drain plug.

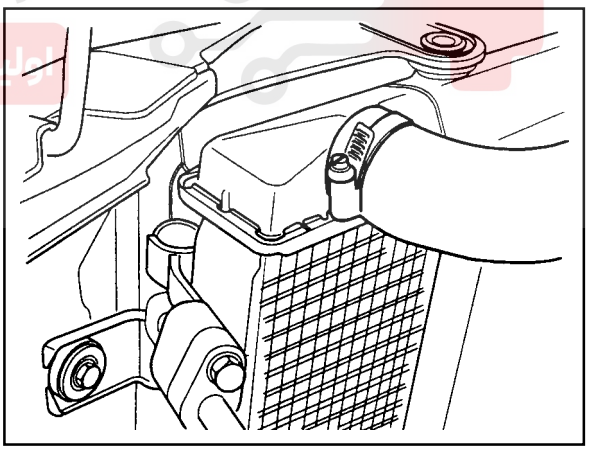


8. Remove the cooling fan shroud.

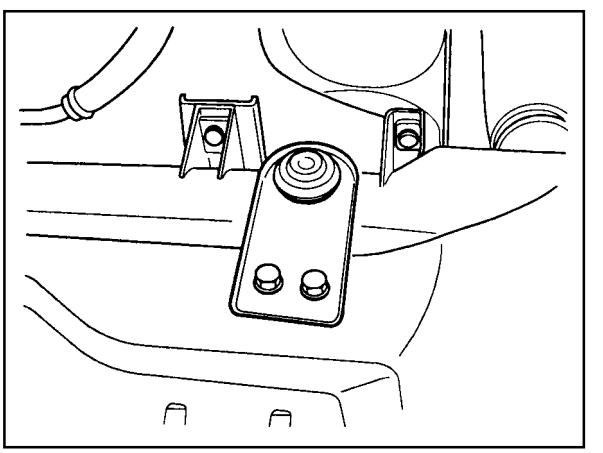


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9. Disconnect the each hose from radiator.



10. Remove the upper mounting bolts of radiator and then remove the radiator.



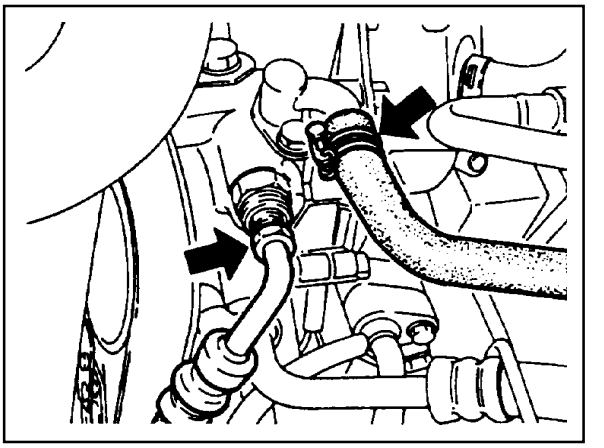
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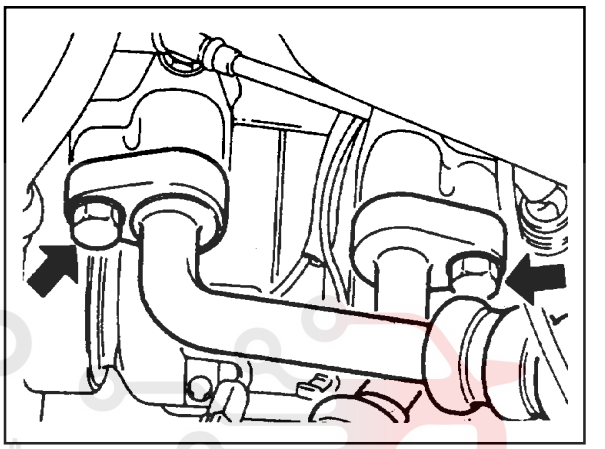
11. Remove the hydraulic pipe of power steering.

Notice

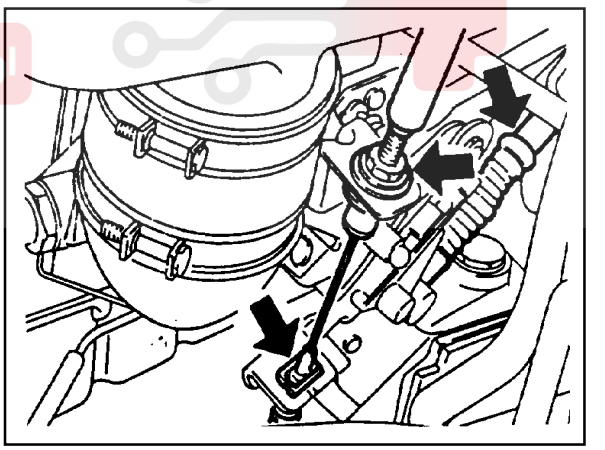
Completely drain the oil.



12. Discharge the refrigerant from A/C system, and disconnect the discharge pipe and suction pipe from the compressor.



13. Remove the acceleration control cable and automatic transmission pressure cable.



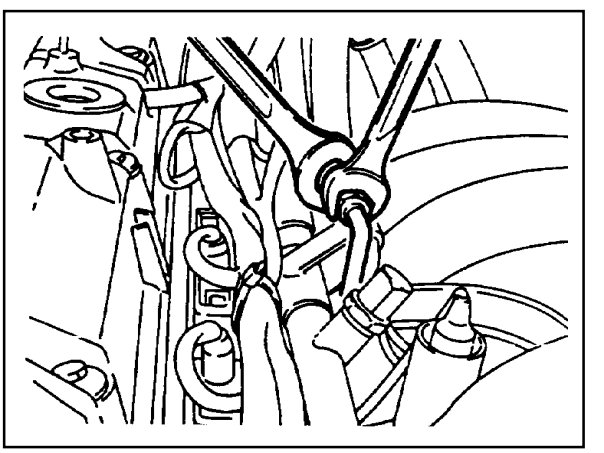
14. Remove the fuel feed and return line.

Notice

Before removing the fuel lines, release the pressure in the fuel system.

Installation Notice

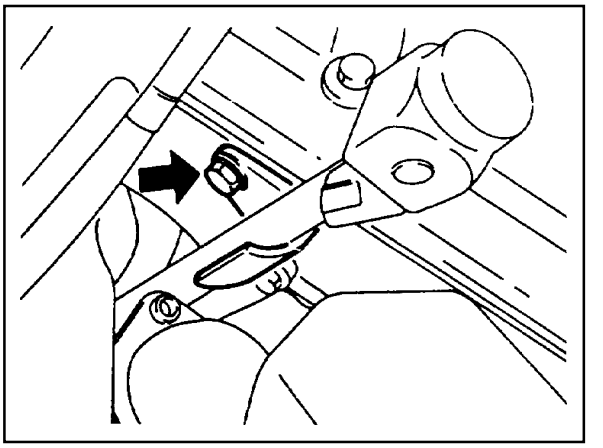
Tightening Torque	21 - 25 Nm



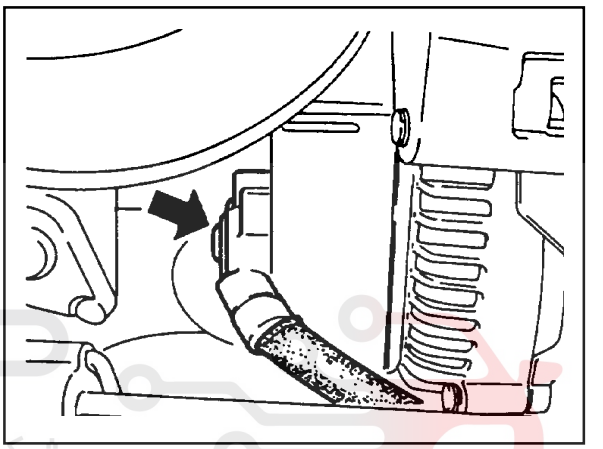
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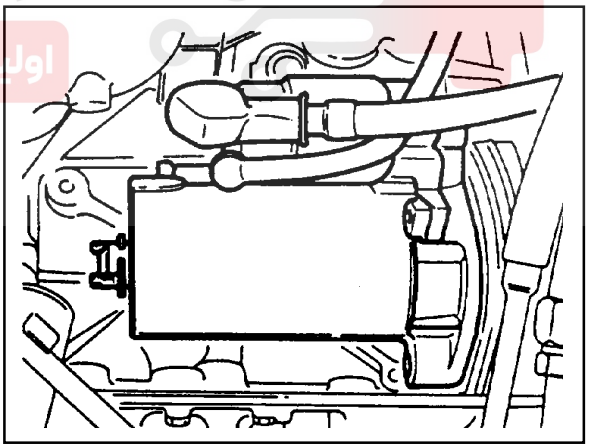
15. Remove the automatic transmission dipstick guide tube.



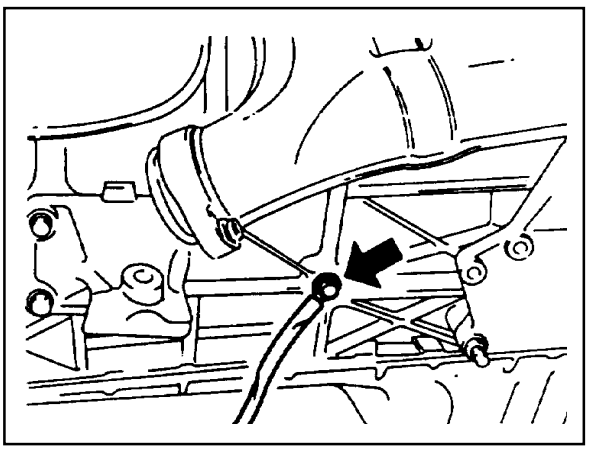
16. Disconnect the wire of alternator.



17. Disconnect the wire of starter motor and remove the starter motor.
18. Disconnect the engine main harness ground.



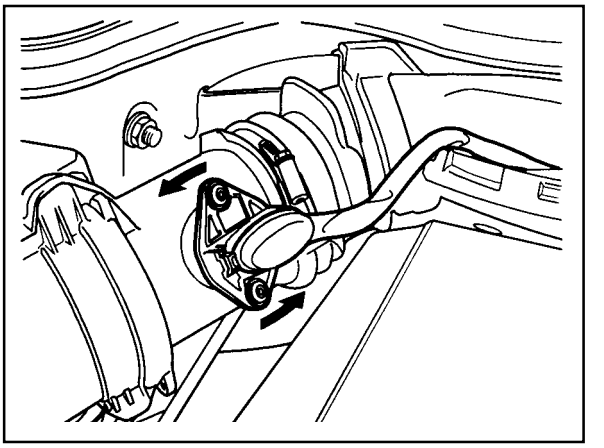
19. Disconnect the engine ground wire.



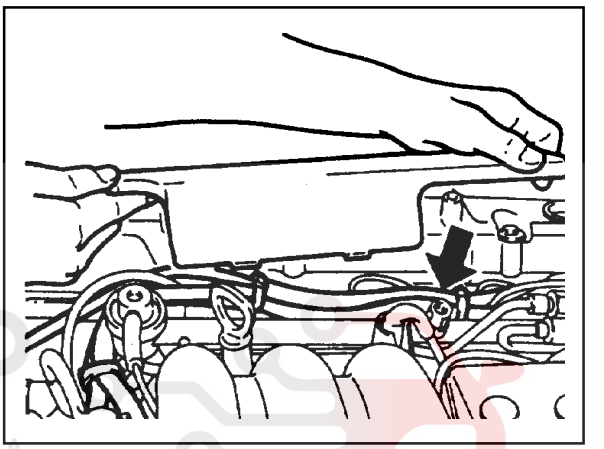
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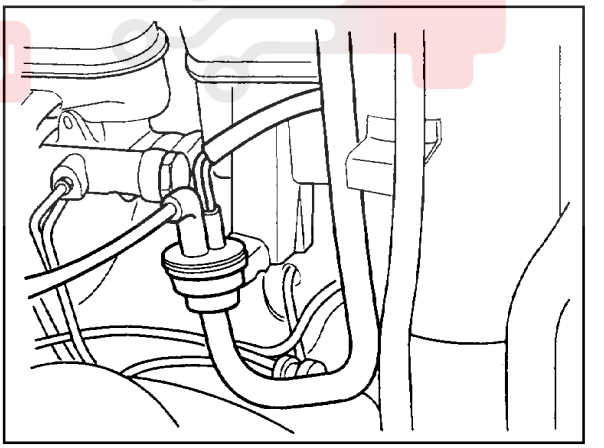
20. Disconnect following sensors connector.
    - HFM sensor.
    - Coolant temperature sensor.
    - 2 knock sensors.
    - Camshaft and crankshaft sensors.



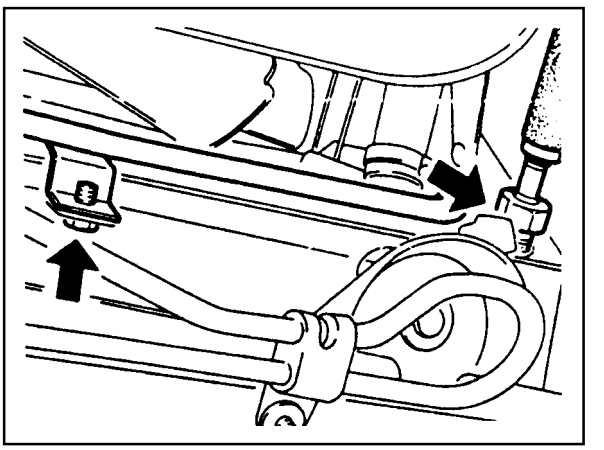
21. After removing the ignition coil cover, disconnect the ignition coil connector.
22. Remove the harness cover and disconnect the 6 injection valve connectors. Disconnect the main harness



23. Separate the hose toward engine from canister purge solenoid valve.



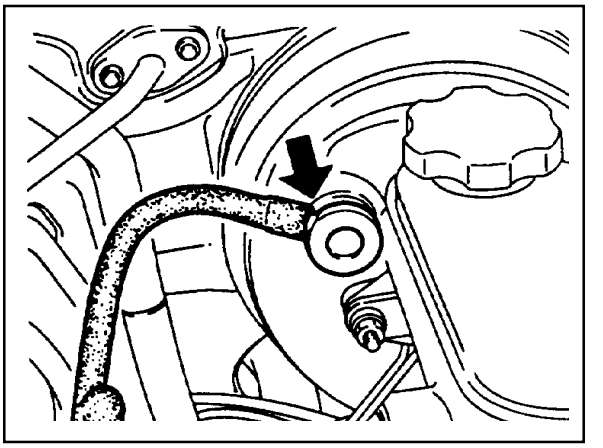
24. Remove the automatic transmission oil cooler line.



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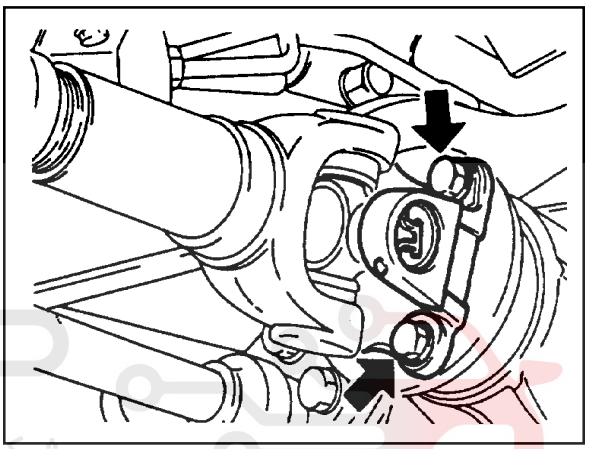
25. Separate the vacuum hose for brake booster.
26. Separate the other vacuum hoses.



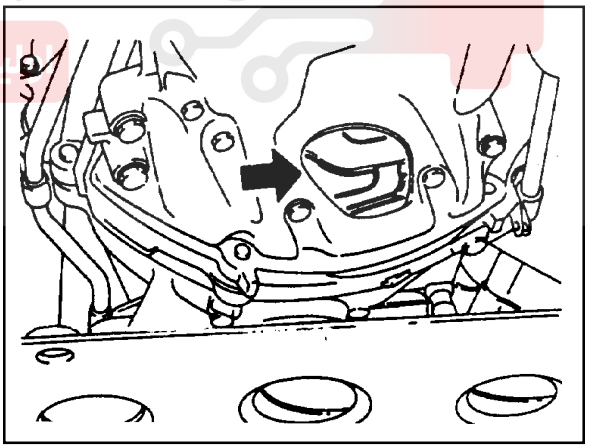
27. Remove the propeller shaft from the front axle.

Installation Notice

Tightening Torque	81 - 89 Nm



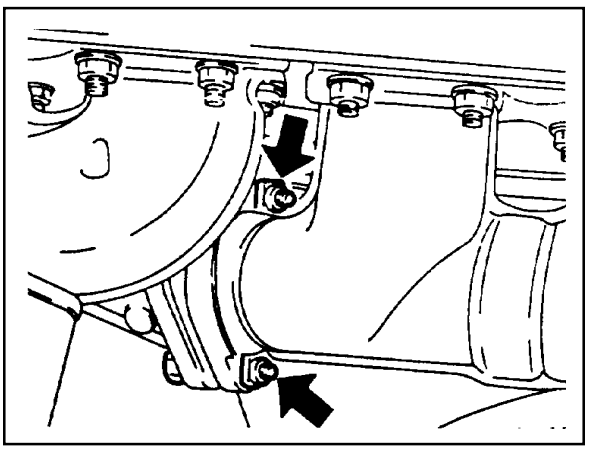
28. By rotating the crankshaft from the front of engine, remove the 6 torque converter mounting bolts from the engine ring gear plate.



29. Remove the exhaust manifold and exhaust pipe.

Installation Notice

Tightening Torque	30 Nm



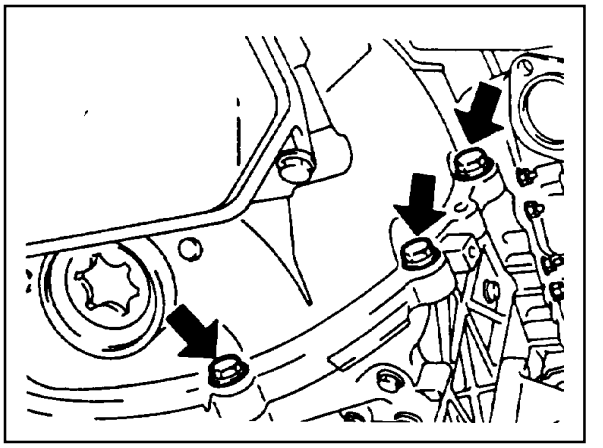
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30. Remove the transmission mounting bolts and separate the transmission from the engine.

Installation Notice

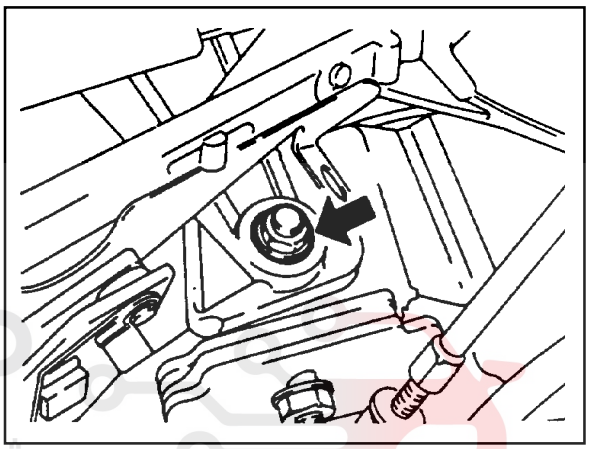
Tightening Torque	65 Nm



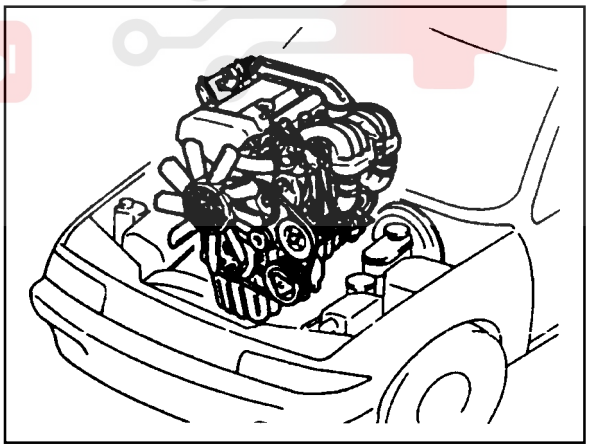
31. Remove the bolts for engine mounting bracket.

Installation Notice

Tightening Torque	50 - 75 Nm



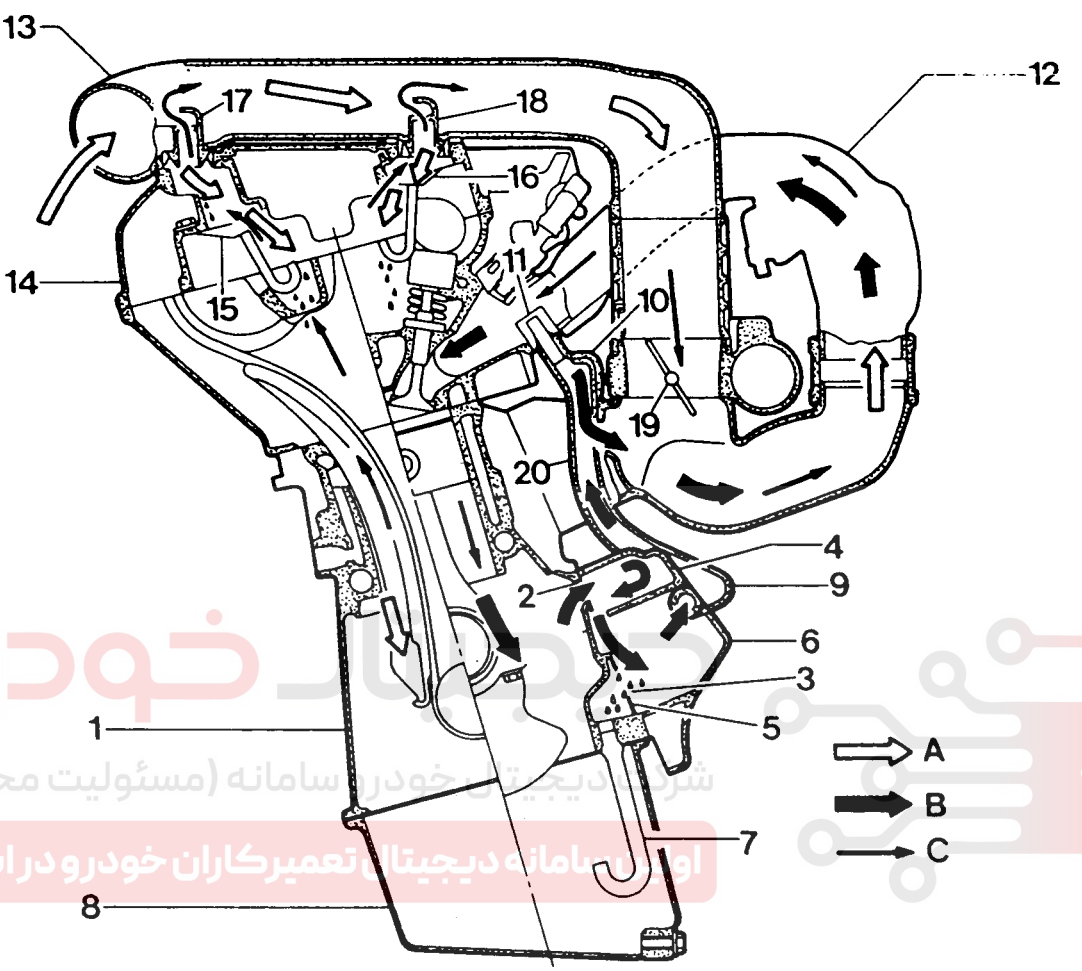
32. Hook the chain to the bracket of engine and by using a hoist or crane, carefully separate the engine assembly from the vehicle.
33. Installation should follow the removal procedure in the reverse order.



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CRANKCASE VENTILATION SYSTEM



1 Crankcase
2 Air Admission Port in Crankcase
3 Oil Drain Port
4 Filter
5 Gasket
6 A/C Bracket
7 Oil Drain Pipe
8 Oil Pan
9 Air Admission Line
10 Vent Line
11 Restriction Hole (Diameter = 2 mm)
12 Intake Manifold
13 Intake Air Duct (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

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Operation at Idling and Mid-Load

- It show that the throttle valve (19) is closed or very partially opened and the vacuum pressure in intake manifold is high.

  The blowby gas in the crankcase in partial load flows into the intake manifold through the vent line (20) after passing the air conditioner bracket (6) and the filter (4). The air reentered into the intake manifold will be dilluted on the flow through the restriction hole (11) in the vent line (10).

  The circulated engine oil is separated at the air conditioner bracket (6) and then returns into the oil pan through the drain pipe (7).

  The vacuum pressure generated at the crankcase sucks fresh air from intake air line(13) through the air admission and vent connection (17,18).

  The fresh air prevents engine oil from being contami-nated and the air admission and vent connection (17,18) is designed to control the rapid pressure changes in intake air line (13).

Operation at Full-Load

- The throttle valve (19) is fully opened.

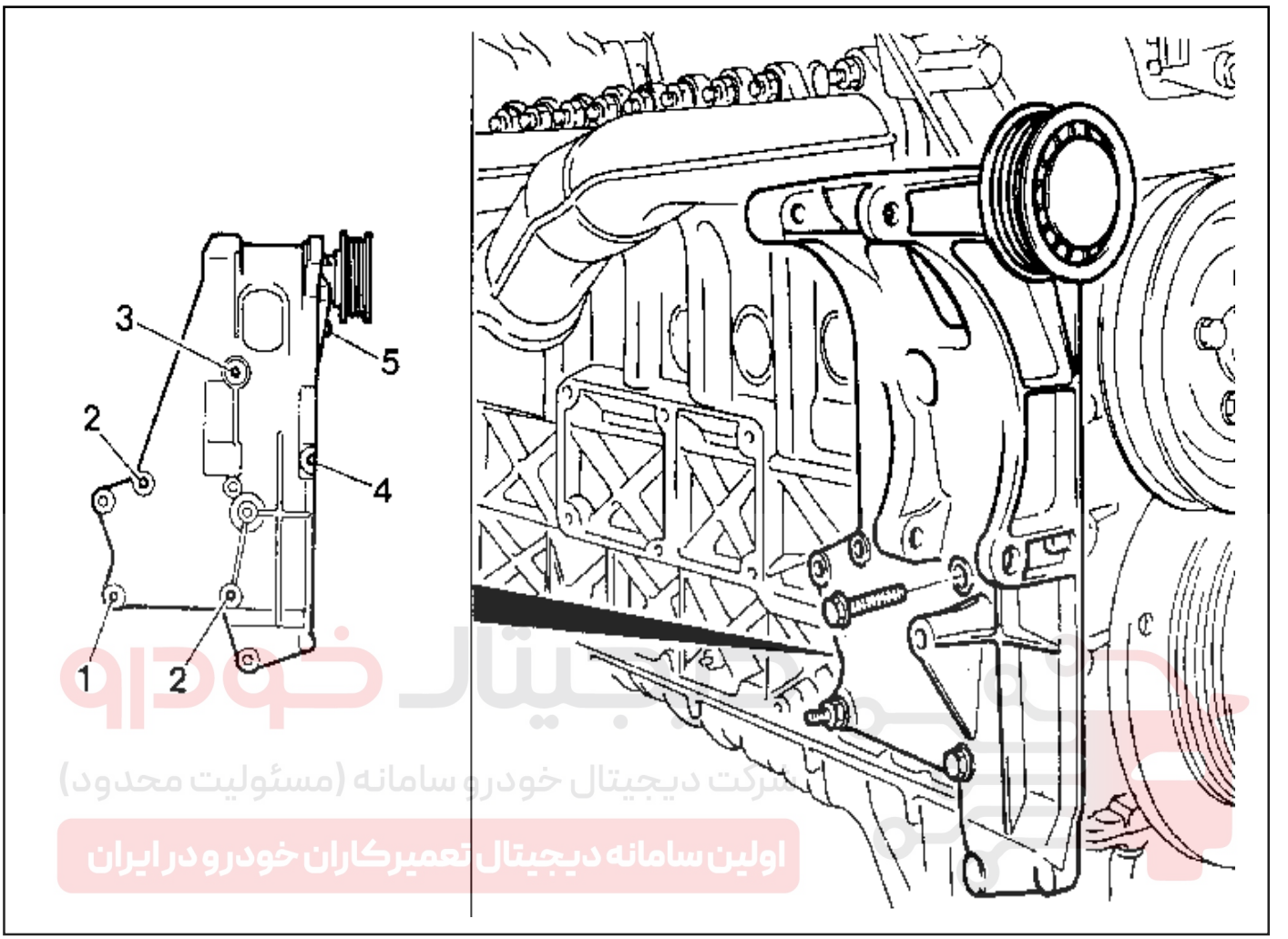
  All the blowby gases flow into the intake air duct (13) after passing through the oil separator (15,16) of the cylinder head cover (14) when fully loaded. This dilluted air will be supplied to the combustion chamber through the intake manifold (12).

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ALTERNATOR



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1	Nut (M8) ..... 22.5-27.5 Nm	4	Bolt (M8 x 70, 1 piece) ..... 22.5-27.5 Nm
2	Bolt (M8 x 30, 3 pieces) ..... 22.5-27.5 Nm	5	Bolt (M8 x 75, 1 piece) ..... 22.5-27.5 Nm
3	Bolt (M8 x 40, 1 piece) ..... 22.5-27.5 Nm		

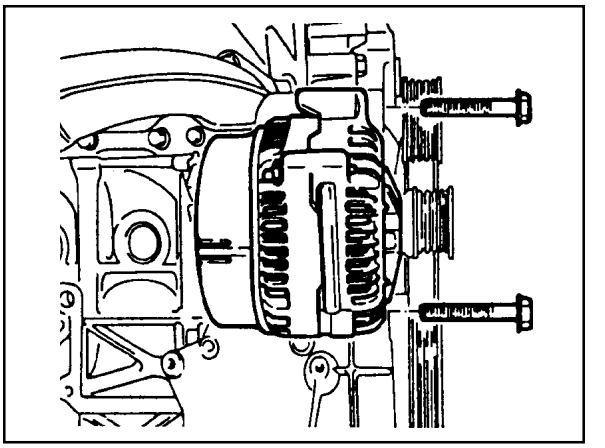
Removal & Installation Procedure

1. Remove the drive belt.
2. Remove the alternator.
3. Unscrew the alternator carrier bolts and remove the carrier.

Installation Notice

Tightening Torque	10 - 15 Nm

4. Installation should follow the removal procedure in the reverse order.

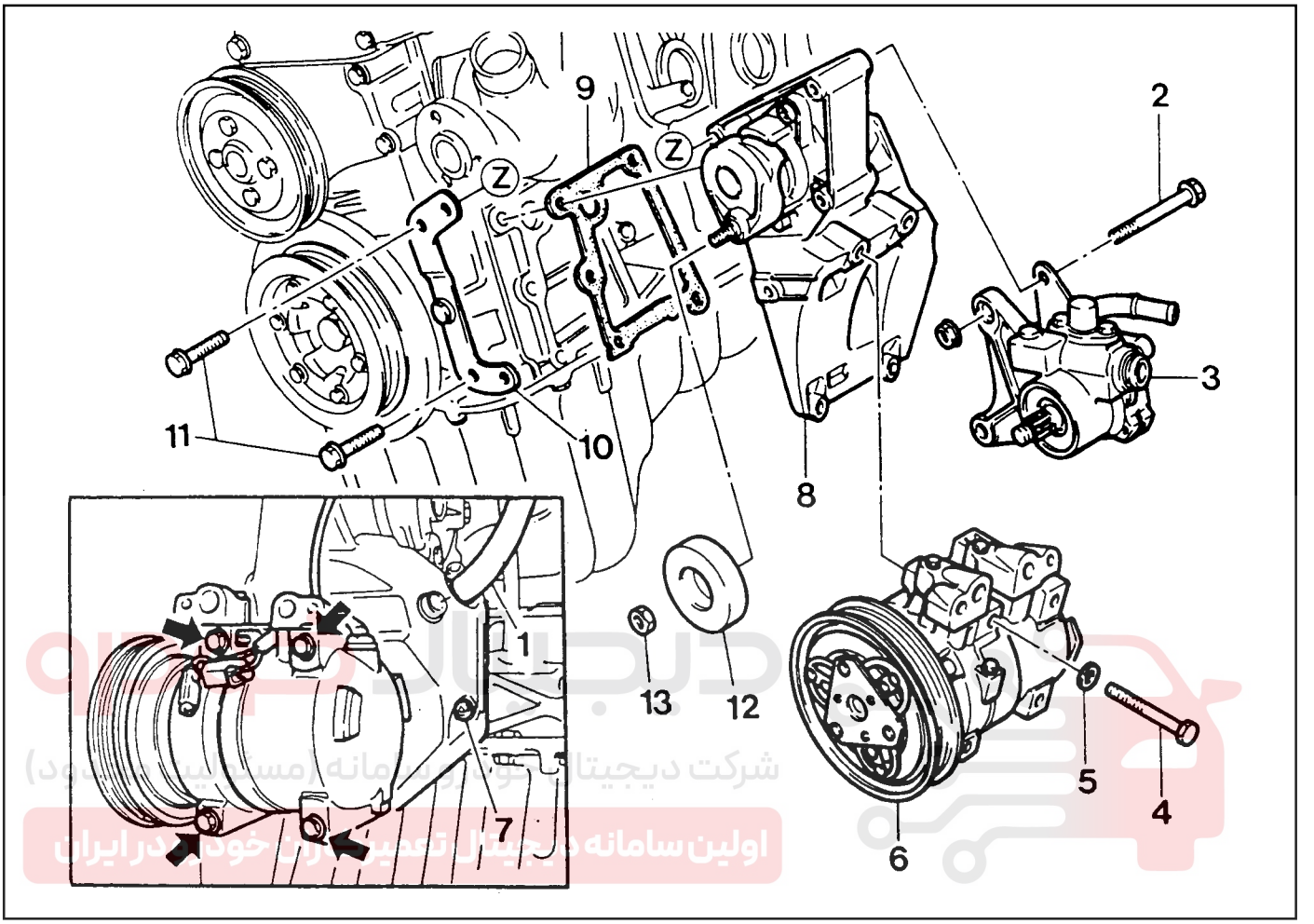


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POWER STEERING PUMP AND A/C BRACKET

Preceding Work : Removal of cooling fan and shroud



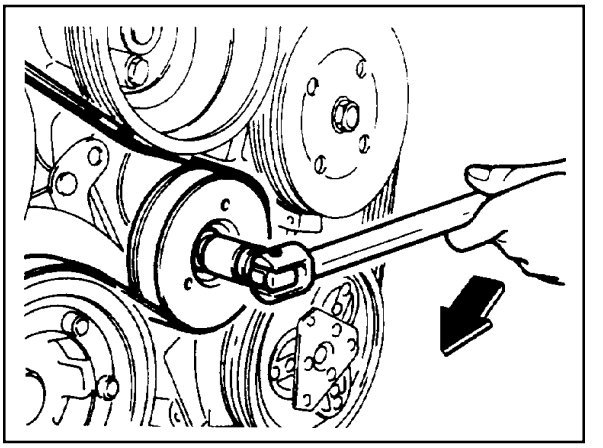
1	Vent Hose	
2	Bolt (M8 x 91, 2 pieces)	22.5-27.5 Nm
3	Power Steering Pump	
4	Bolt (M8 x 105, 4 pieces)	22.5-27.5 Nm
5	Washer	
6	A/C Compressor	
7	Bolt (M8 x 40, 3 pieces, M8 x 95, 2 pieces)	22.5-27.5 Nm
8	A/C Bracket	
9	Gasket	Replace
10	Bracket	
11	Bolt (M8 x 22, 2 pieces)	22.5-27.5 Nm
12	Tensioning Pulley	
13	Nut	40.5-49.5 Nm

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Removal & Installation Procedure

1. Remove the belt pulley.



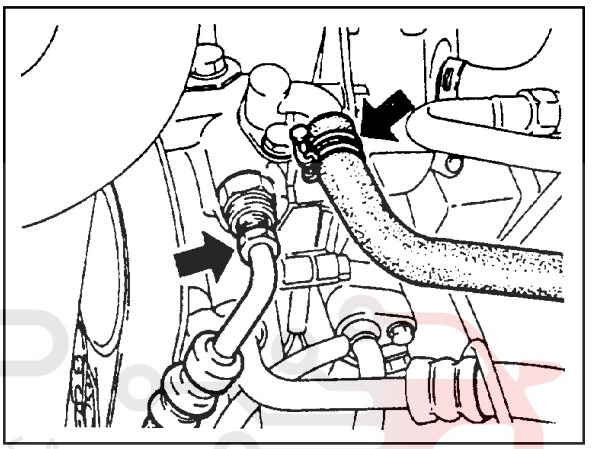
Installation Notice

Tightening Torque	40.5 - 49.5 Nm

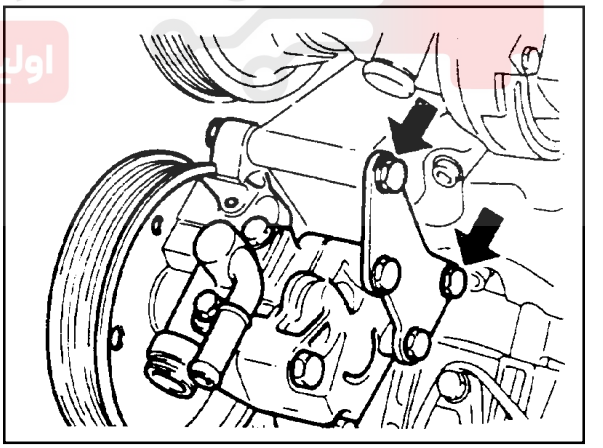
Notice

Pull the tensioning pulley clockwise as shown in the figure.

2. Disconnect the hydraulic pipe of the power steering pump and drain the oil.



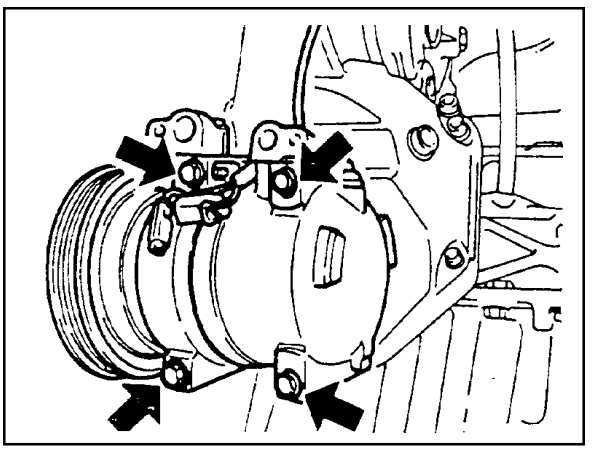
3. Unscrew the bolts (arrows) and remove the steering pump.



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

4. Remove the compressor after disconnecting the wiring connector and refrigerant pipe of A/C compressor.



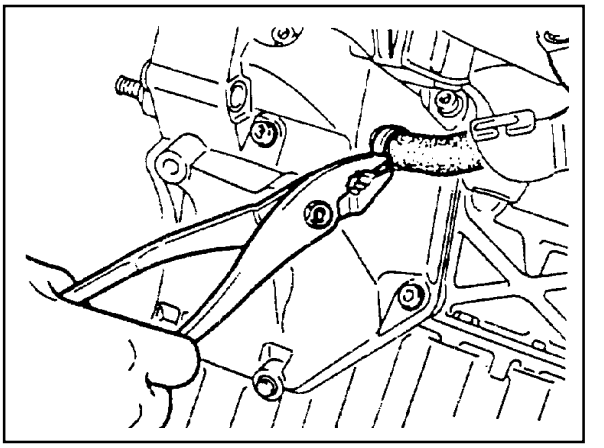
Notice

Discharge all the refrigerant before removing the pipes.

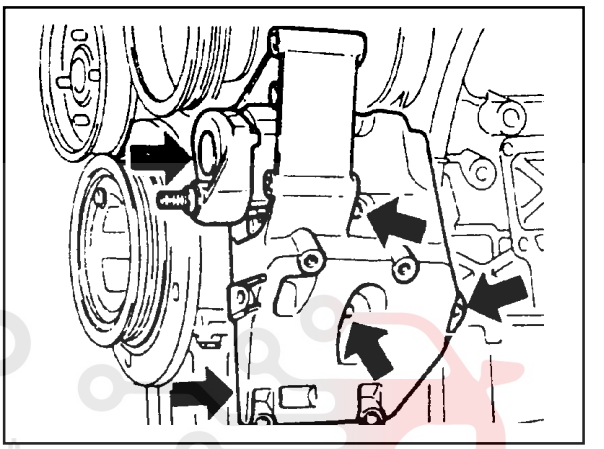
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5. Disconnect the vent hose from the A/C bracket.



6. Unscrew all the mounting bolts (arrows) and remove the A/C bracket and the gasket.



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

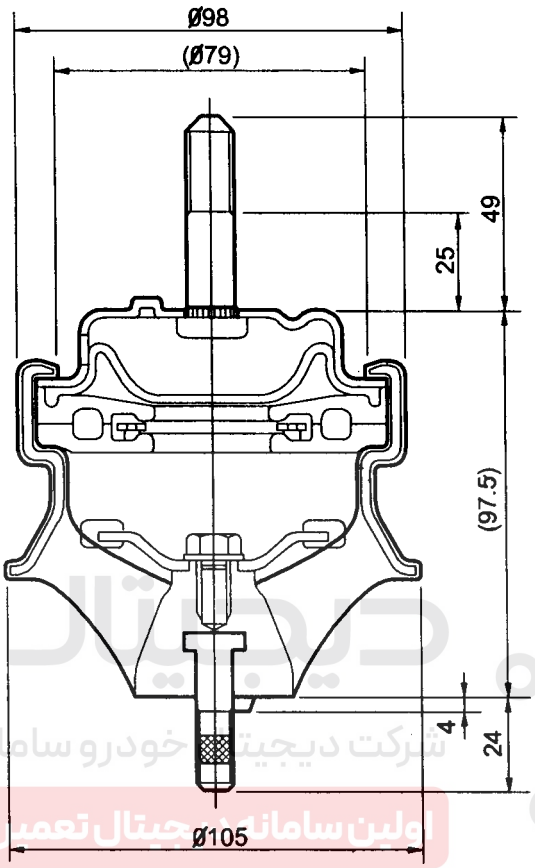
7. Clean the sealing surface.
8. Replace the gasket with new one.
9. Installation should follow the removal procedure in the reverse order.
10. Check the oil leakage by operating the engine after installation.

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HYDRAULIC ENGINE MOUNTING INSULATOR

Service Data

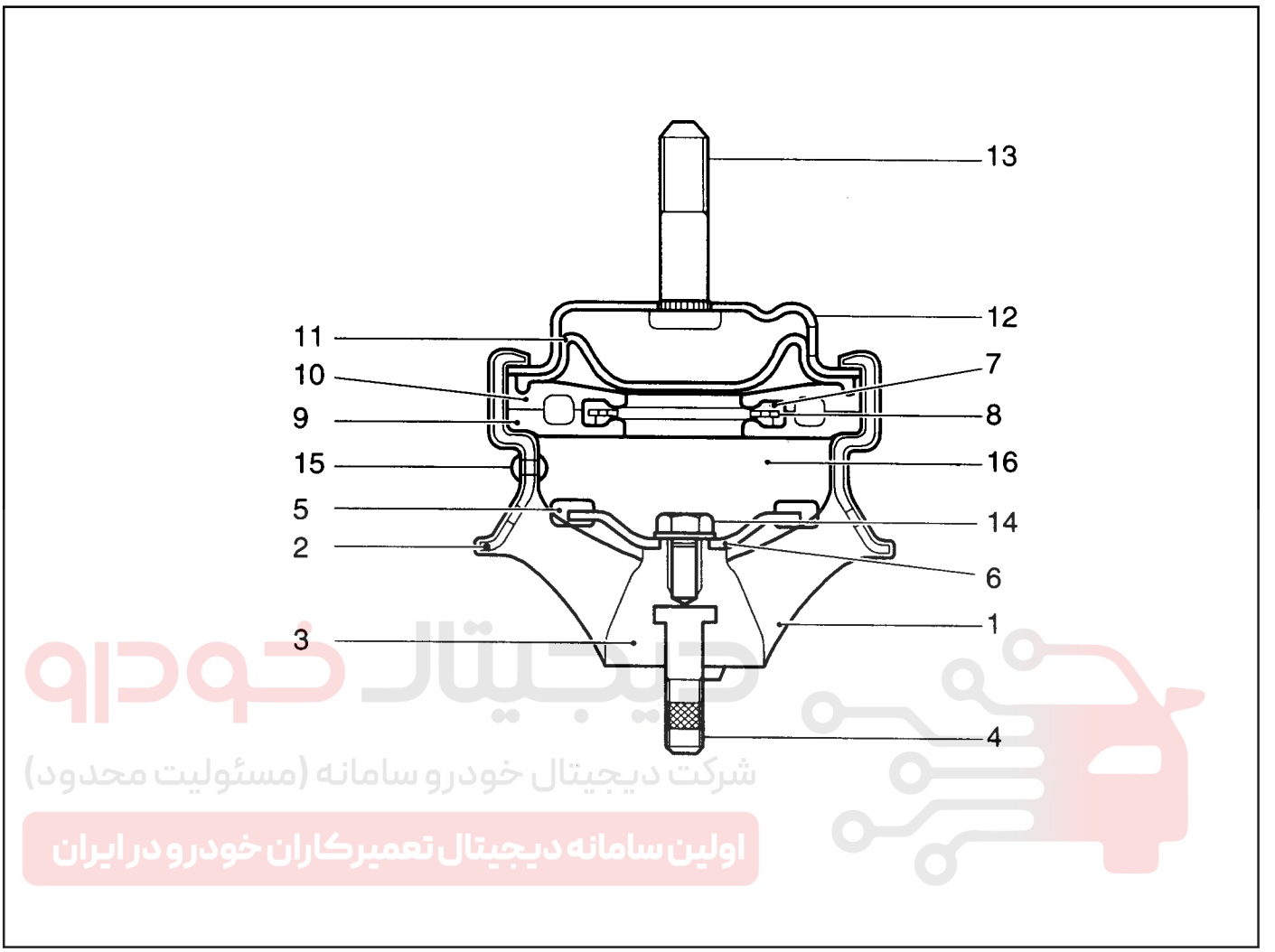


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Sectional View

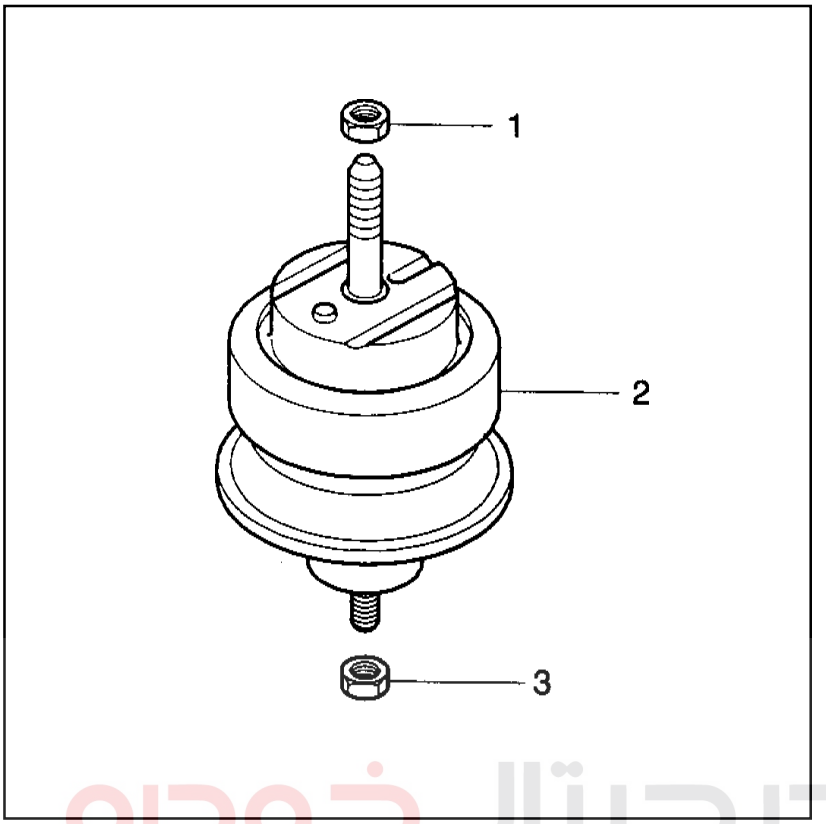


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1 Rubber Body
2 Brackek
3 Core
4 Lower Bolt
5 Rubber Plunger
6 Plunger Plate
7 Rubber
8 Plate
9 Lower Orifice
10 Upper Orifice
11 Diaphram
12 Cover Plate
13 Upper Bolt
14 Flange Bolt
15 Rivet
16 Fluid

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1 Upper Nut
2 Hydraulic Installor ..... 62-93 Nm
3 Lower Nut ..... 28-47 Nm

Removal and Installation Procedure

1. Unscrew the upper nut(1) on engine mounting and remove the engine.

   Installation Notice

Tightening Torque	62 - 93 Nm

2. Unscrew the lower nut(3) and remove the hydraulic engine mounting insulator.

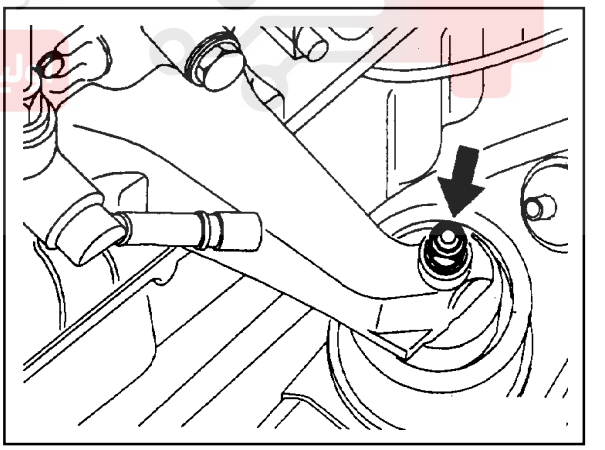
   Installation Notice

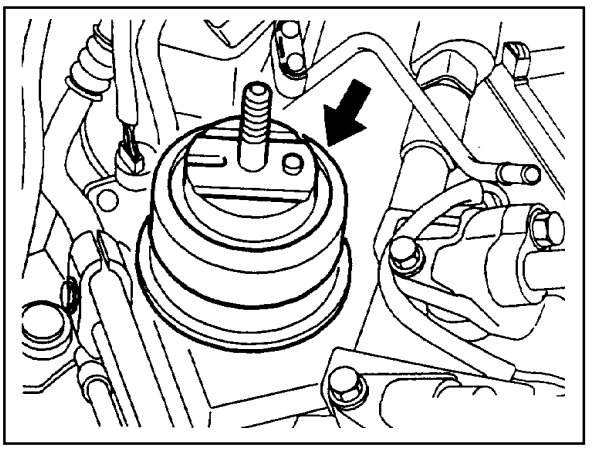
Tightening Torque	28 - 47 Nm

   Notice

   If the insulator is spotted with oil, replace the hydraulic insulator assembly.

3. Installation should follow the removal procedure in the reverse order.



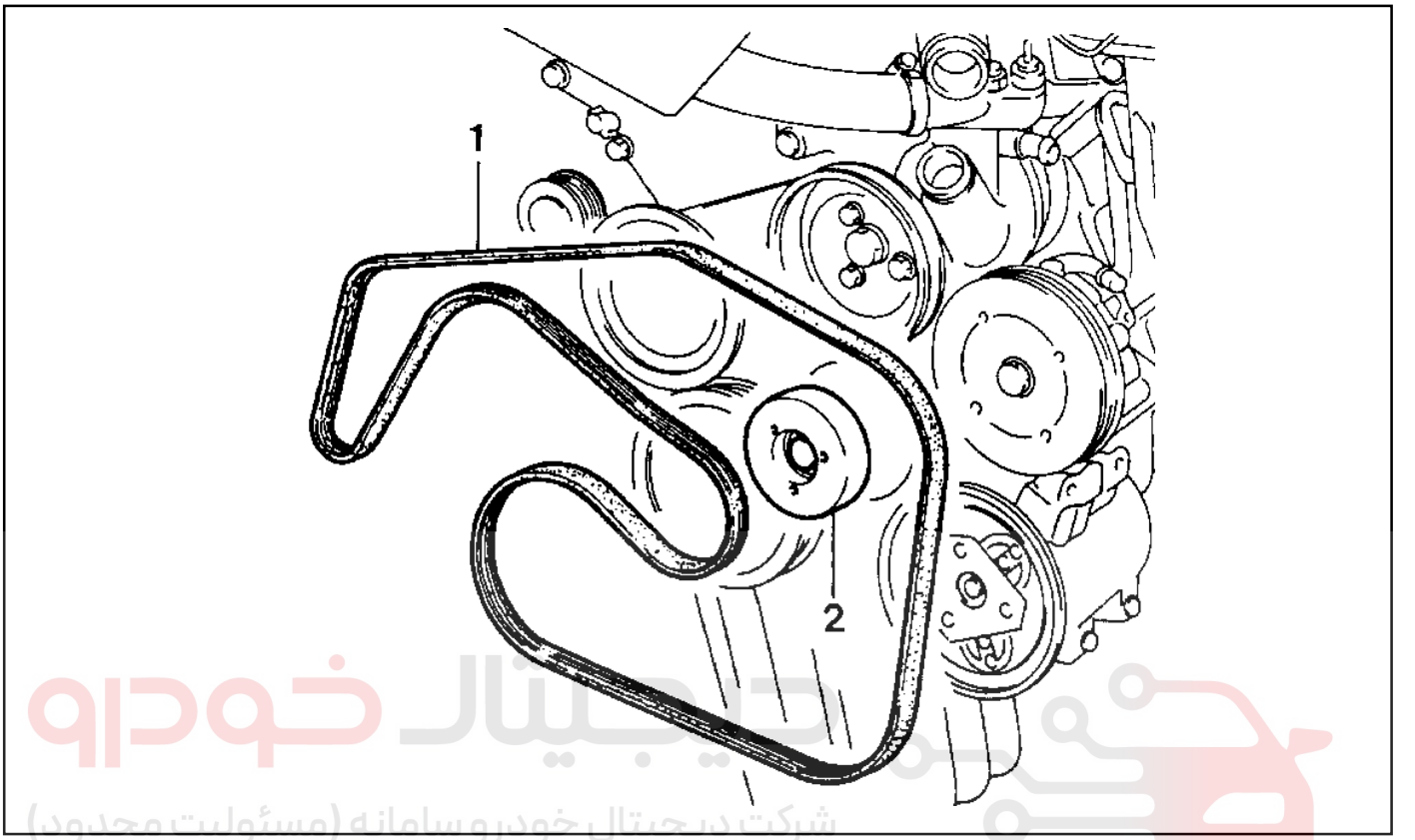


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POLY V - BELT

Preceding Work : Removal of cooling fan



1 Poly V-belt
2 Belt Tensioning Pulley

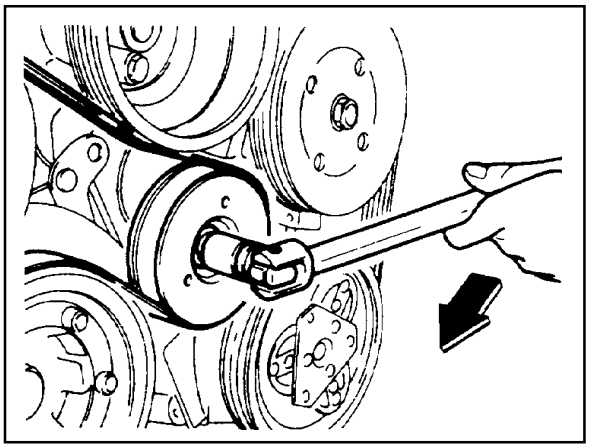
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Removal & Installation Procedure

1. Release the belt tension by turning the belt tensioning pulley nut clockwise.
2. Remove the poly v-belt.

   Notice

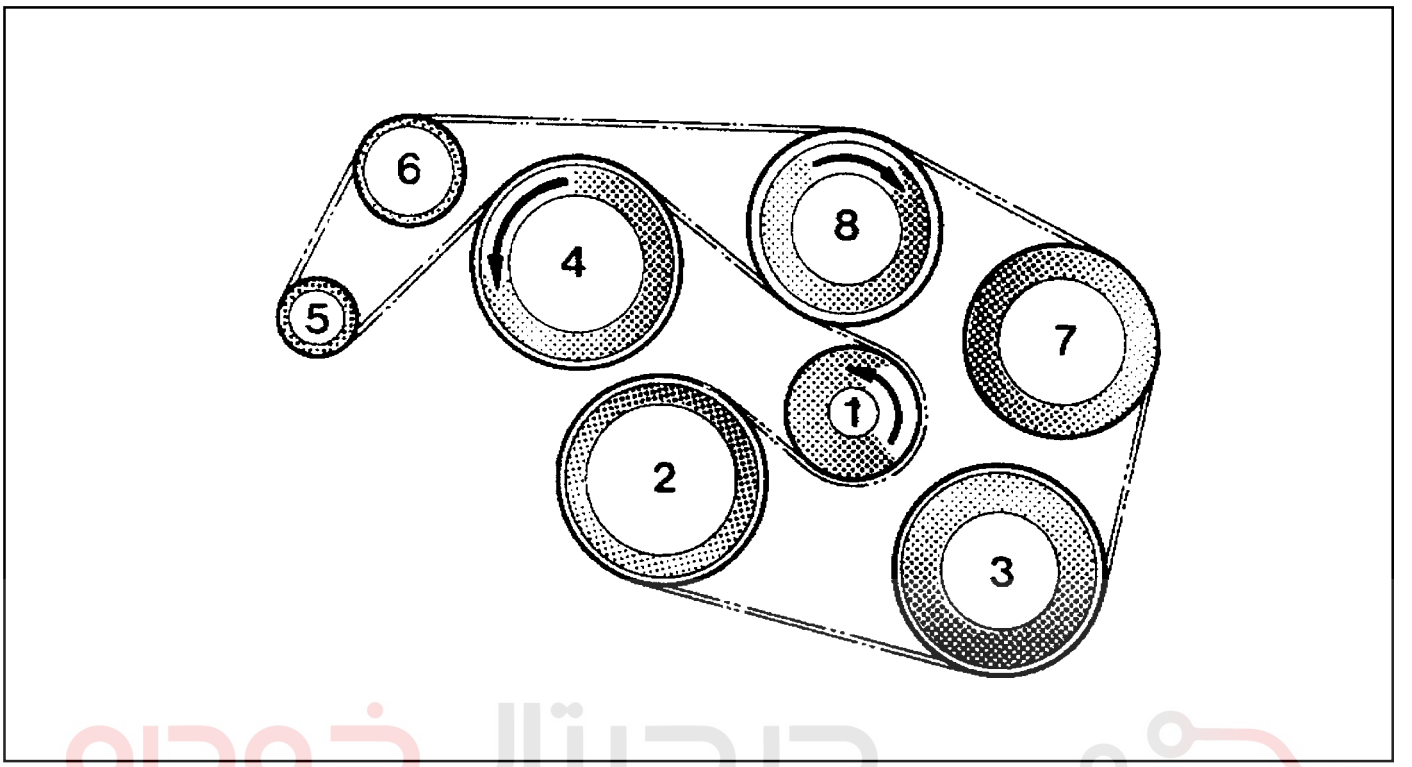
   Check the belt for damage and tensioning pulley bearing point for wear and replace them if necessary.
3. Install the belt by turning the nut of tensioning pulley clockwise.



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Poly V-Belt Arrangement



1 Belt Tensioning Pulley
2 Crankshaft Belt Pulley
3 A/C Compressor Pulley
4 Cooling Fan Pulley
5 Alternator Pulley
6 Idler
7 Power Steering Pump Pulley
8 Cooling Fan and Water Pump Pulley

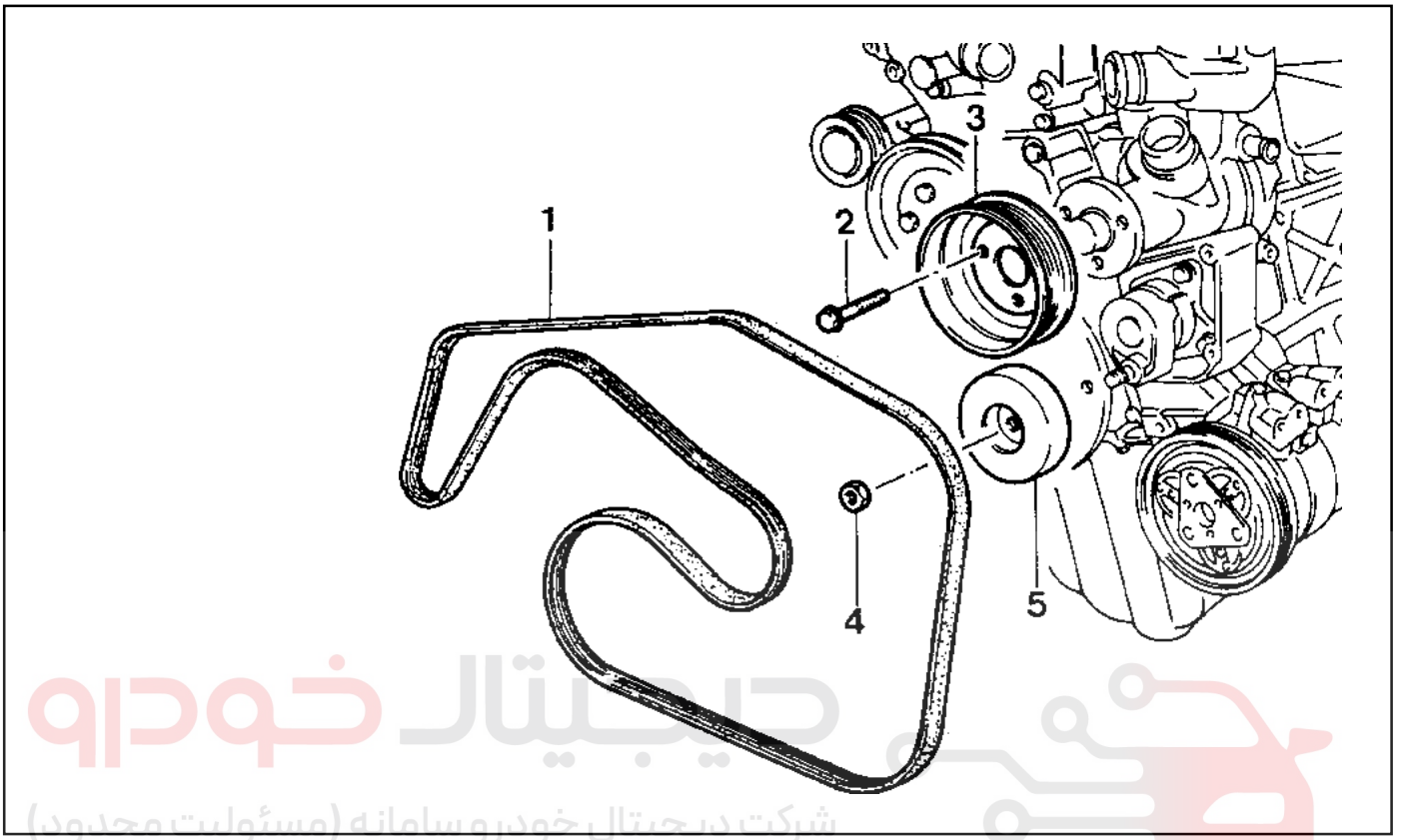
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TENSIONING DEVICE

Preceding Work : Removal of poly v-belt

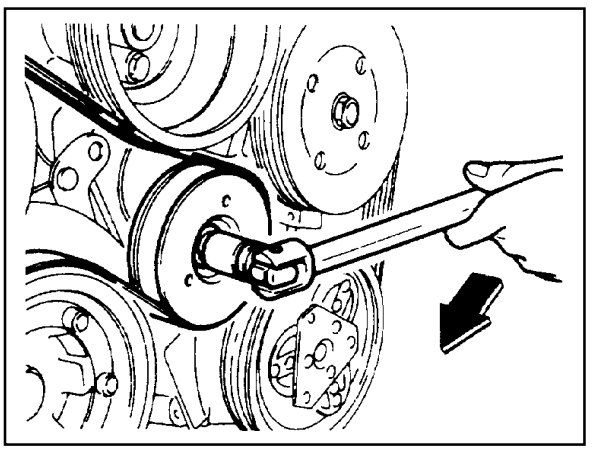


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1 Belt (L = 2245)
2 Bolt Combi(M8 x 14, 3 pieces) + Washer
..... 22.5-27.5Nm
3 Water Pump Pulley
4 Nut
5 Tensioning Pulley

Removal & Installation Procedure

1. Remove the poly v-belt.
2. Remove the tensioning pulley by turning its mounting nut counter clockwise as shown in figure.



Installation Notice

Tightening Torque	40.5 - 49.5 Nm

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3. Remove the 3 bolts (2) and remove the water pump pulley (arrow).

Installation Notice

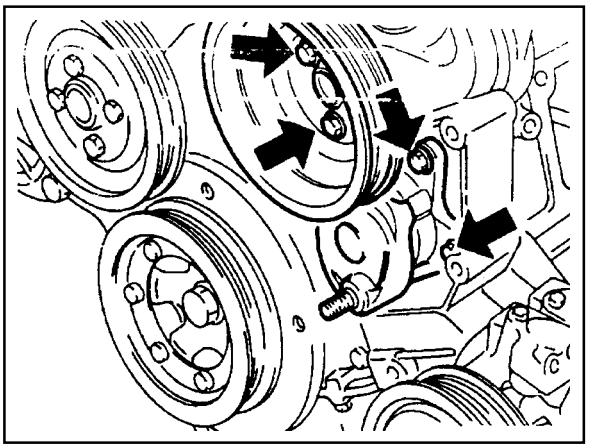
Tightening Torque	22.5 - 27.5 Nm

4. Remove the mounting bolts(M8 x 30, 3 pieces) at the tensioning device, and remove the tensioning device (arrow).

Installation Notice

Tightening Torque	26 - 32 Nm

5. Installation should follow the removal procedure in the reverse order.

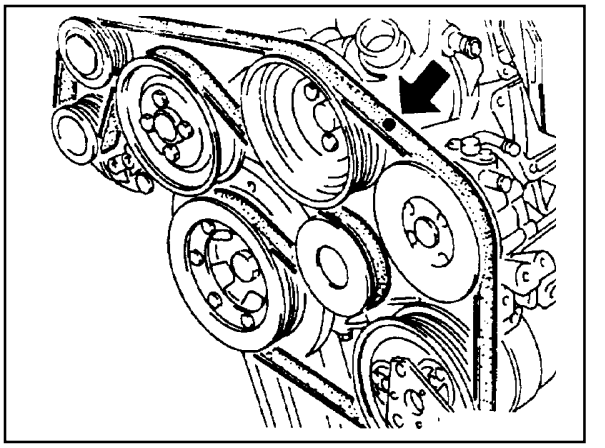


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POLY V - BELT INSPECTION

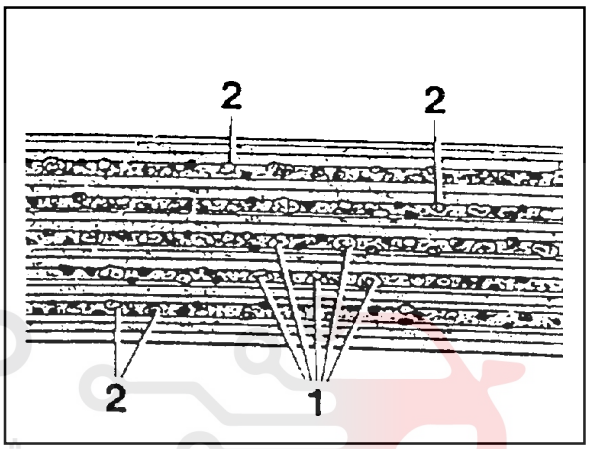


- Make marks on the belt with chalk.
- Rotate the engine and check the belt for damage.

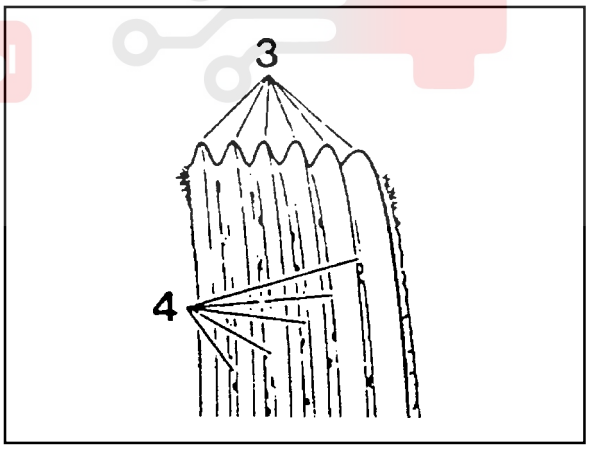
Notice

If one of the following types of damages is found, replace the belt.

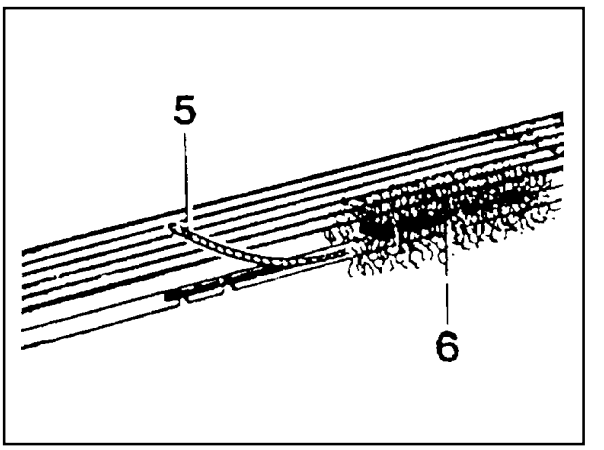
1. Rubber lumps in the base of rib.
2. Dirt or grit ingrained.



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



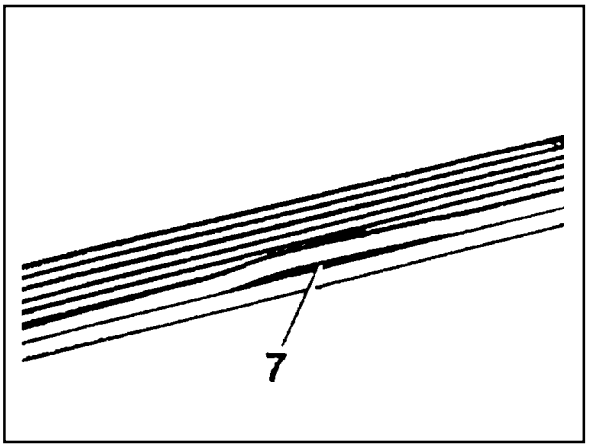
5. Cord torn out at the side.
6. Outer cords frayed.



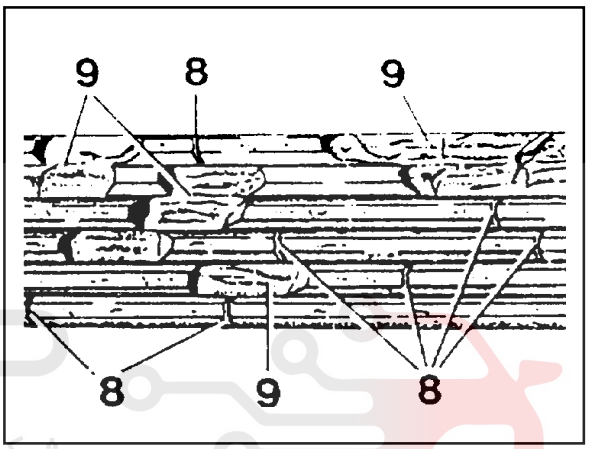
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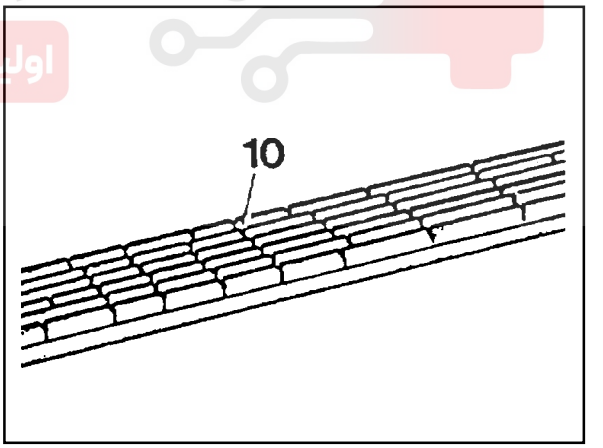
7. Rib detached from the base of belt.



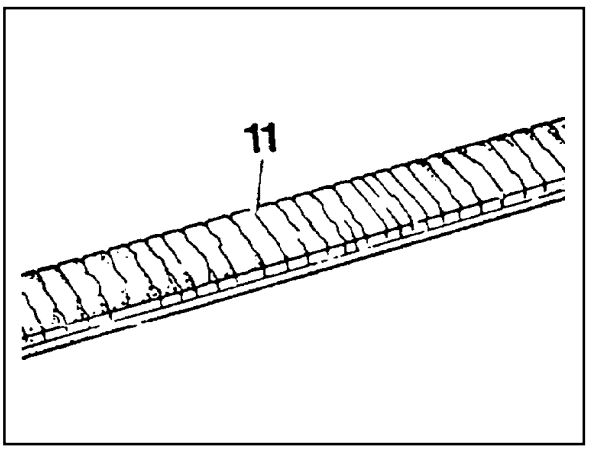
8. Splits across the rib.
9. Sections of rib torn out.



10. Splits across several ribs.



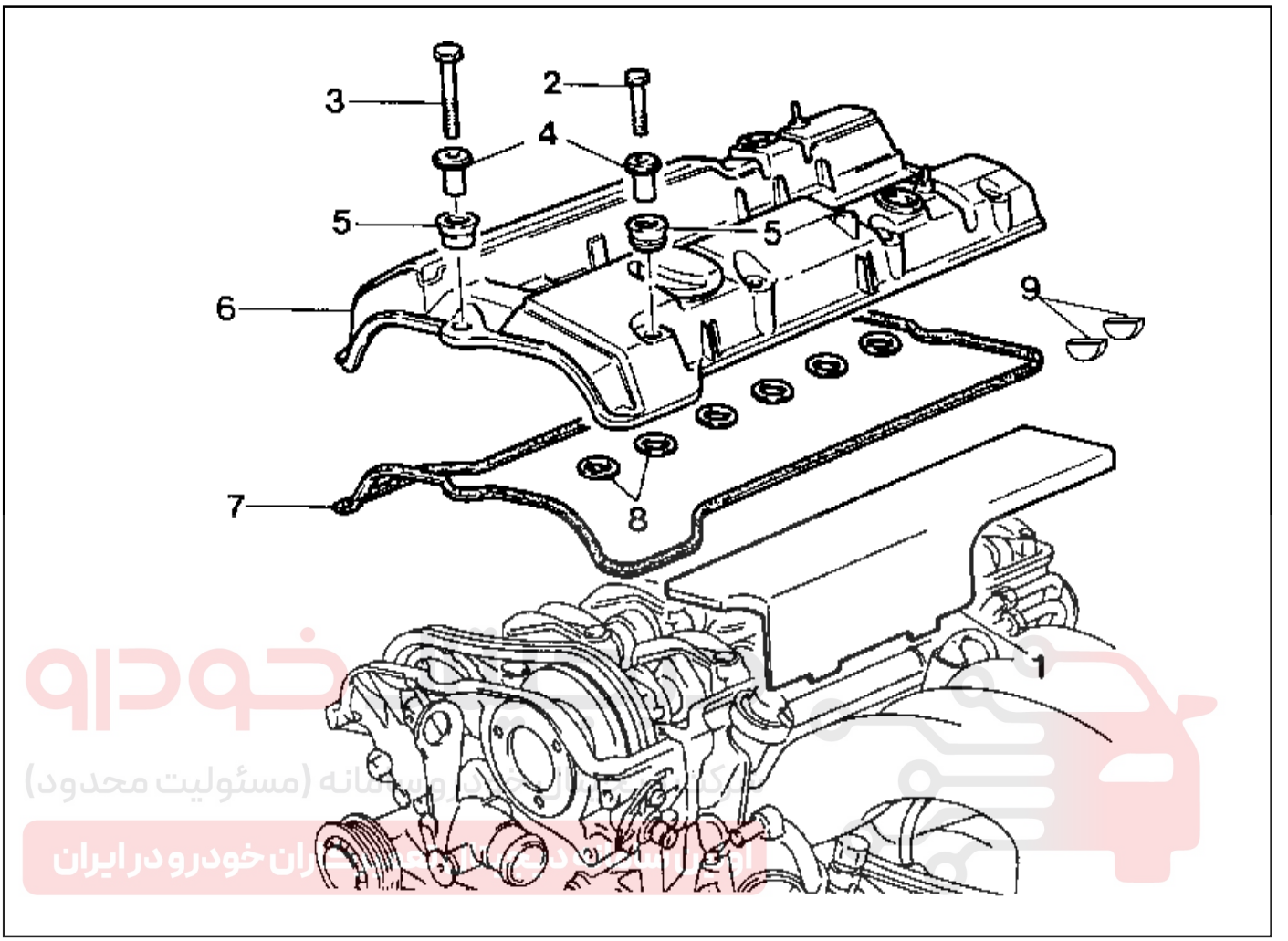
11. Splits across the back of the belt.



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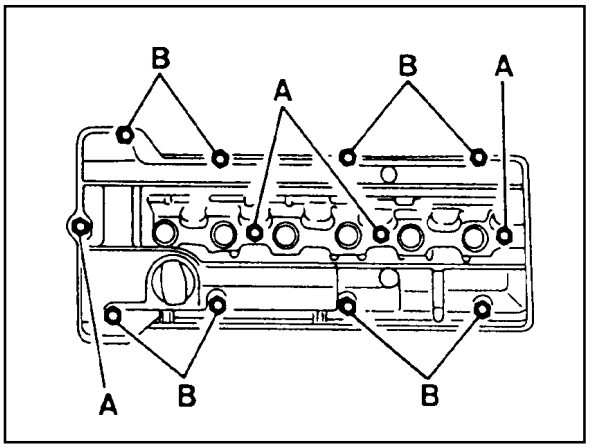
CYLINDER HEAD COVER



1 Ignition Cable Dust Cover
2 Bolt (M6 x 65, 8 pieces) ..... 9-11 Nm
3 Bolt (M6 x 50, 4 pieces) ..... 9-11 Nm
4 Spacer Sleeve
5 Thrust Piece
6 Cylinder Head Cover
7 Gasket ..... Replace
8 Spart Plug Hole Seal ..... Replace
9 Camshaft Seal ..... Replace

Composition of The Cylinder Head Cover Bolts

A. M6 x 50, 4 Pieces - Bolts + Washers
B. M6 x 65, 8 Pieces - Bolts + Washers

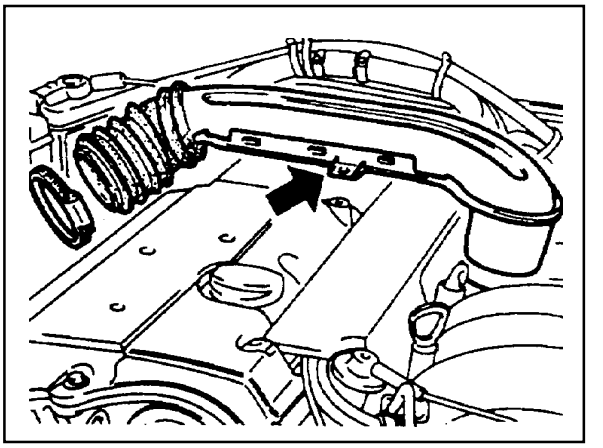


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Removal & Installation Procedure

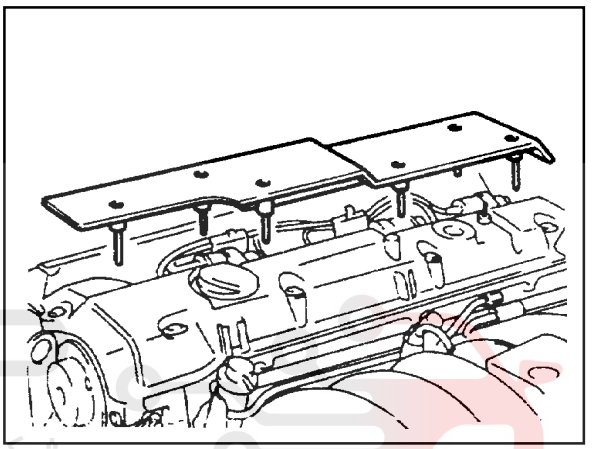
1. Remove the intake air duct.



Installation Notice

Tightening Torque	8 - 9 Nm

2. Remove the ignition cable cover.



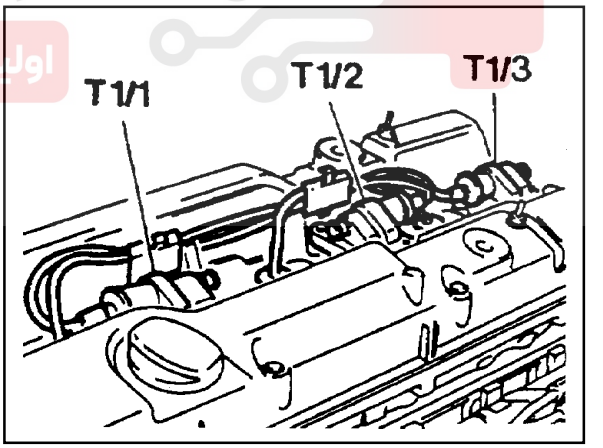
Installation Notice

Tightening Torque	9 - 10 Nm

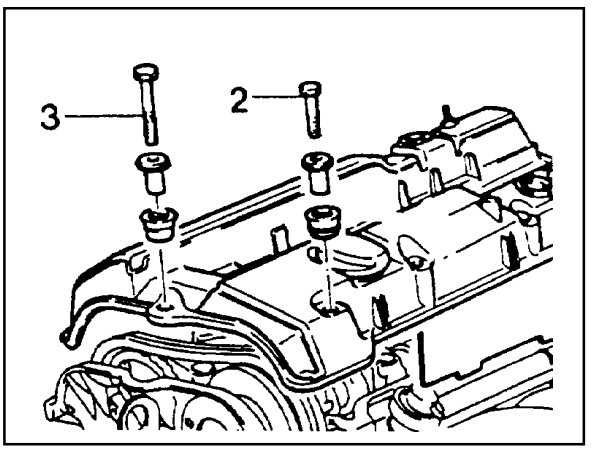
Notice

Unscrew the seven (M6 x 60) bolts and remove the ignition cable cover.

3. Remove the spark plug connector and ignition cable.



4. Unscrew all the bolts (2,3) and remove the head cover and the gasket.



Installation Notice

Tightening Torque	9 - 10 Nm

Notice

Replace the gasket with a new one if necessary.

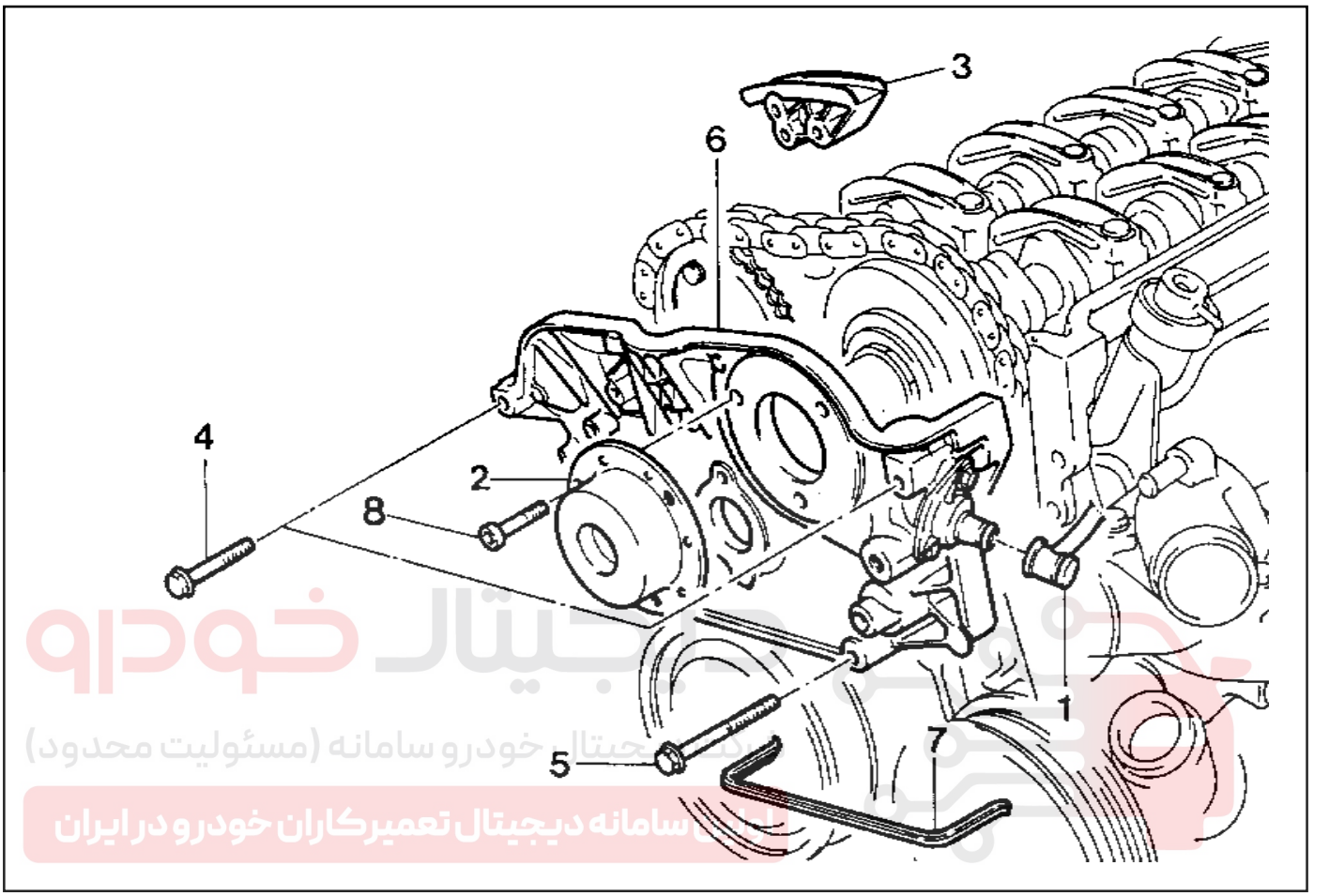
5. Installation should follow the removal procedure in the reverse order.
6. Check for oil leaks by operating the engine.

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CYLINDER HEAD FRONT COVER

Preceding Work : Removal of cylinder head cover
Removal of coolant connection fitting



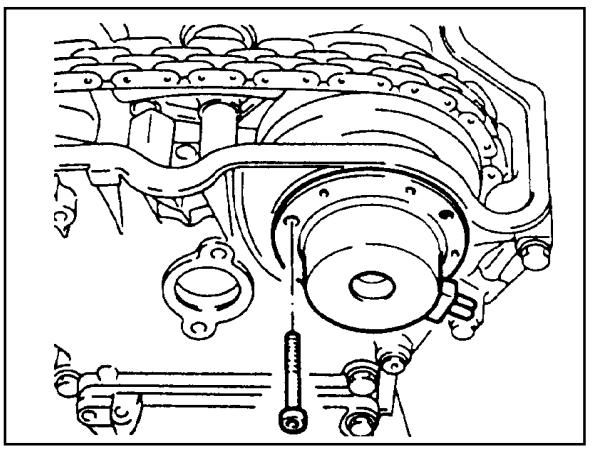
1 Camshaft Position Sensor
2 Magnet Assembly
3 Upper Guide Rail
4 Bolt (M6 x 60, 3 pieces) ..... 22.5-27.5 Nm
5 Bolt (M8 x 80, 3 pieces) ..... 22.5-27.5 Nm
6 Front Cover
7 Rubber Gasket ..... Replace
8 Bolt (M6 x 16, 3 pieces) ..... 9-11 Nm

Removal & Installation Procedure

1. Remove the magnet assembly.

Installation Notice

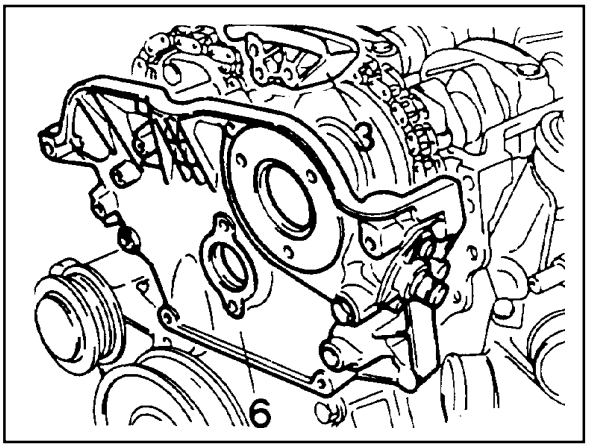
Tightening Torque	9 - 11 Nm



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2. Remove the cylinder head front cover (6).



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

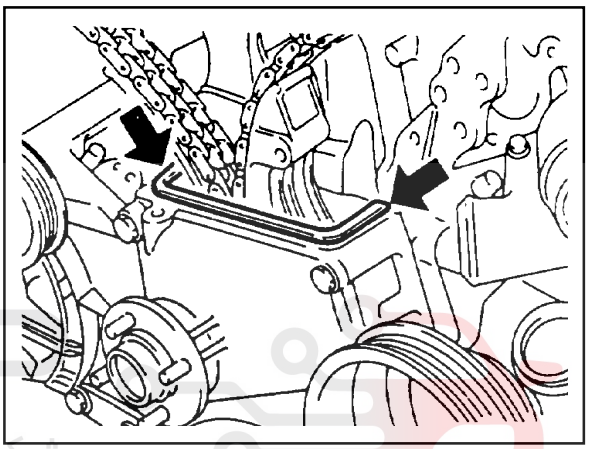
Apply the sealant at the mating surface of the cylinder head and the front cover.

3. Remove the upper guide rail pin and the guide rail (3).

Installation Notice

Install it while the chain tensioner is loose.

4. Remove the gasket (arrow).



Installation Notice

Replace the gasket with new one and apply the sealant.

5. Installation should follow the removal procedure in the reverse order.

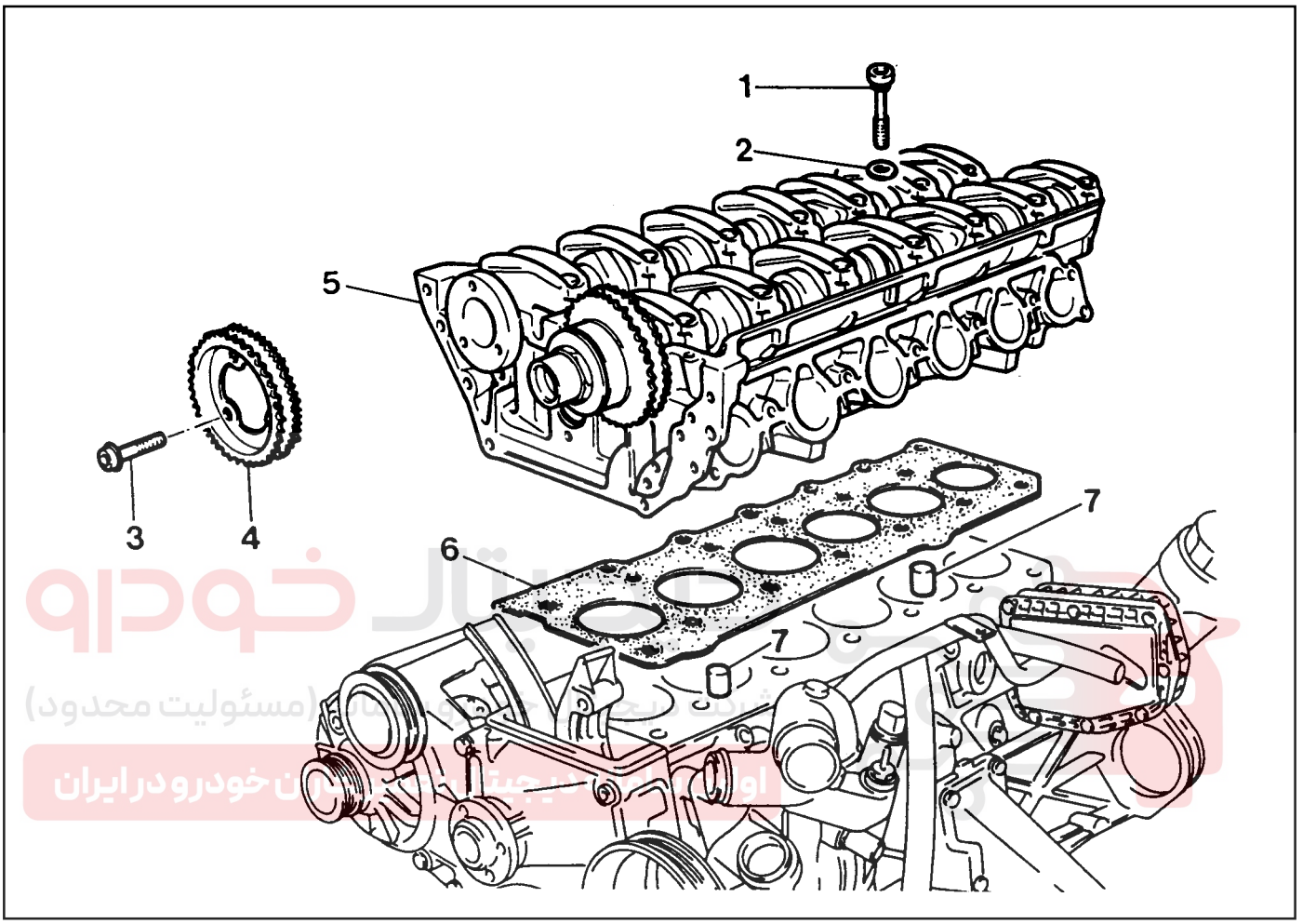
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CYLINDER HEAD

Preceding Work : Removal of cylinder head cover
Removal of cylinder head front cover
Removal of upper intake manifold



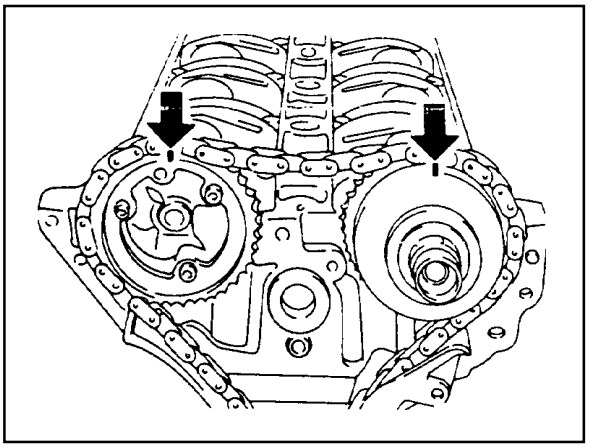
1 Cylinder Head Bolt (14 pieces)
..... 1st step 55 Nm
2nd step 90°
3rd step 90°
2 Washers (14 pieces)
3 Flange Bolts (3 pieces) ..... 1st step 20 Nm
2nd step 90°
4 Exhaust Camshaft Sprocket
5 Cylinder Head
6 Gasket ..... Replace
7 Dowel Sleeve

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Tools Required

000 589 01 10 00 Box Wrench Insert
116 589 02 34 00 Screw-fixed Pin
116 589 20 33 00 Sliding Hammer



Removal & Installation Procedure

1. Rotate the crankshaft so that the piston of number 1 cylinder is at TDC.

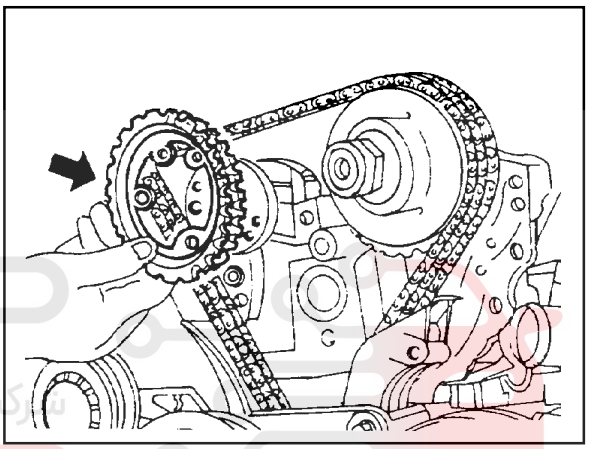
   Notice

   Rotate the crankshaft in the normal engine direction.
2. Put the alignment marks (arrows) on the timing chain and camshaft sprocket.
3. Drain the coolant from the crankcase.
4. Remove the three flange bolts in the exhaust camshaft sprocket.

   Installation Notice

Tightening Torque	1st step 18 - 22 Nm 2nd step 90° ± 5°

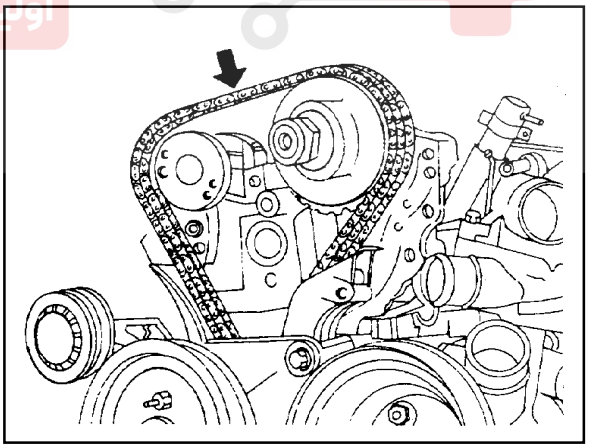
   Do not reuse the removed bolts.



5. Separate the chain from the camshaft sprockrt.

   Notice

   Be careful not to drop the chain into the timing case.

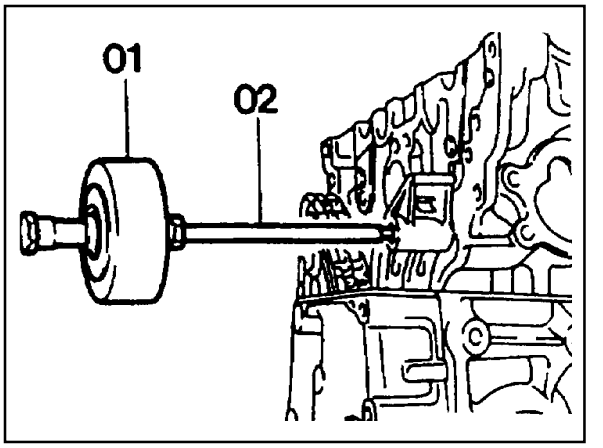


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6. Remove the guide rail fixing pin from the cylinder head using the sliding hammer (01) and the threaded pin (02).

Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00

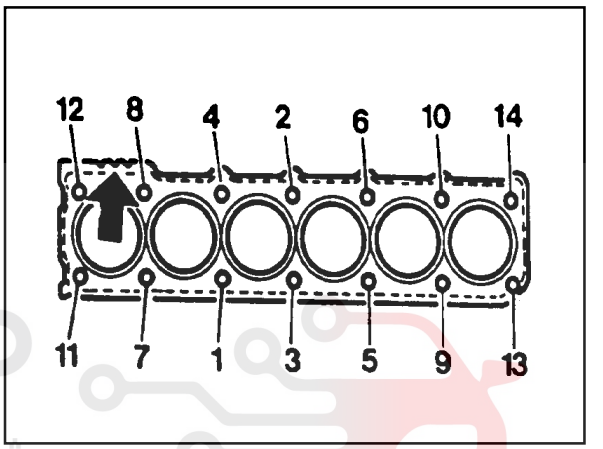


7. Remove the cylinder head bolts in numerical order.

Installation Notice

Tightening Torque	1st step 55 Nm 2nd step 90° 3rd step 90°

Box Wrench Insert 000 589 01 10 00

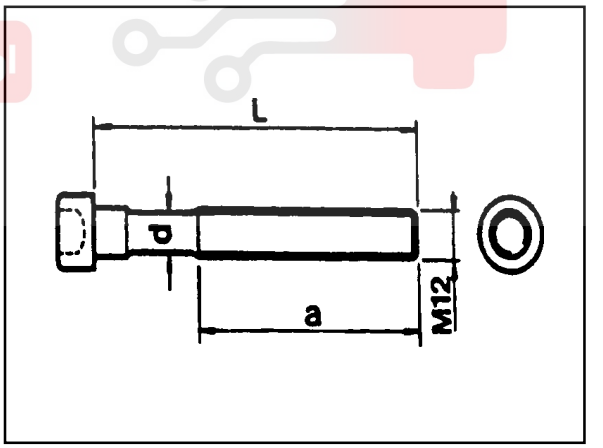


8. Check the length of the cylinder head bolt.

Installation Notice

Length (L)	New 160 ± 0.8 mm
	Max. 162 ± 0.7 mm

- Replace the bolt if the measured length exceed the max. length.
- Apply the oil to the thread surface of bolt.



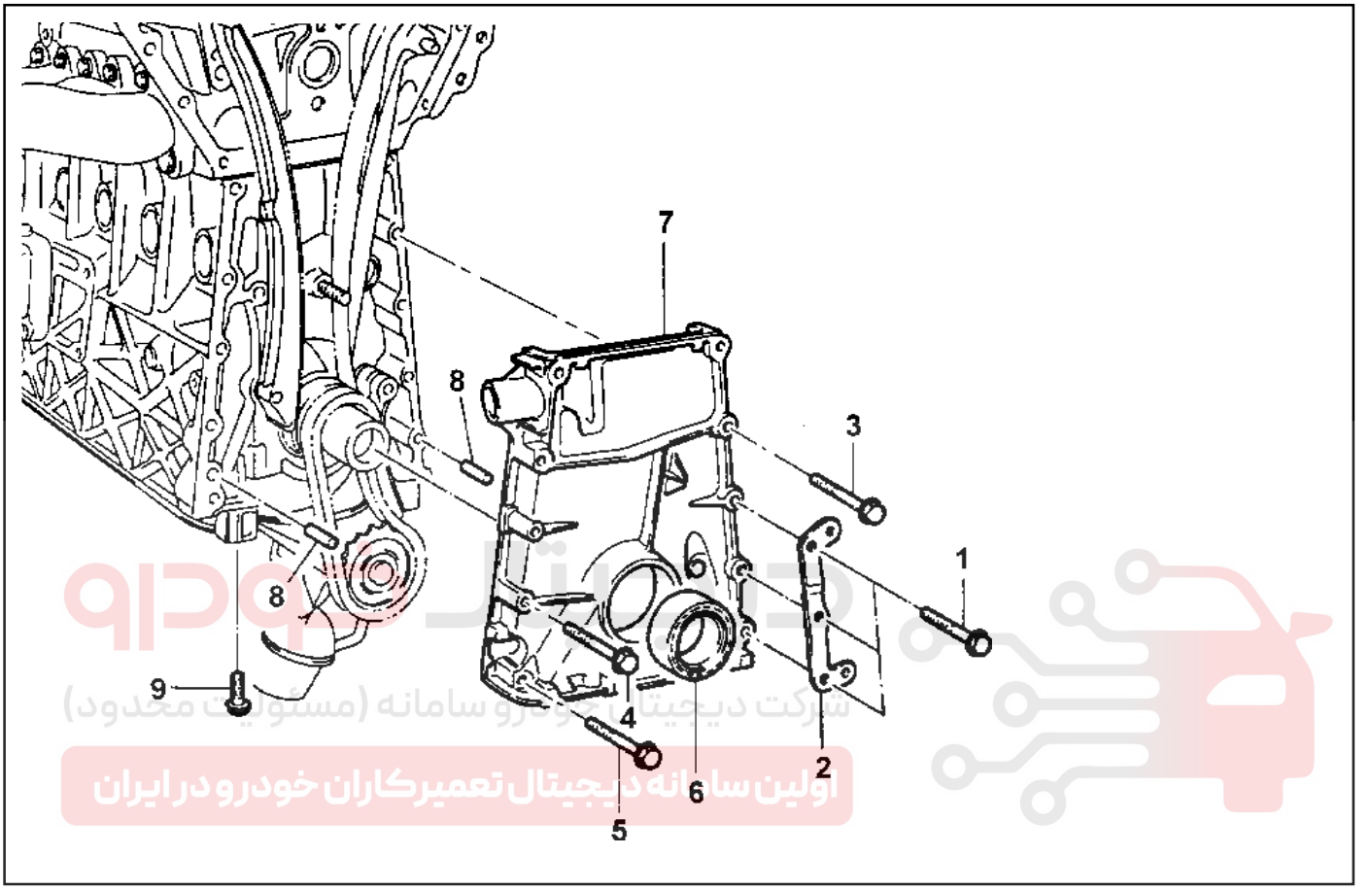
9. Carefully remove the cylinder head and check the mating surface.
10. Installation should follow the removal procedure in the reverse order.

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TIMING GEAR CASE COVER

Preceding Work : Removal of cylinder head front cover
Removal of alternator bracket
Removal of tensioning device
Removal of belt pulley and vibration damper



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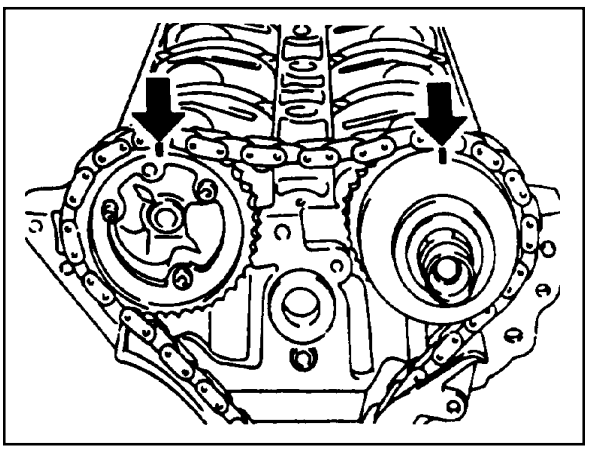
1 Bolt (M8 x 60, 3 pieces) ..... 22.5-27.5 Nm
2 A/C Bracket
3 Bolt (M8 x 65, 3 pieces) ..... 22.5-27.5 Nm
4 Bolt (M8 x 40, 1 piece) ..... 22.5-27.5 Nm
5 Bolt (M8 x 60, 1 piece) ..... 22.5-27.5 Nm
6 Seal
7 Timing Gear Case Cover
8 Roll Pin
9 Bolt (M6 x 22, 6 pieces) ..... 9-11 Nm

Removal & Installation Procedure

1. Put the alignment marks (arrows) on the timing chain and camshaft sprocket.
2. Unscrew the A/C bracket bolts (1) and remove the bracket.

Installation Notice

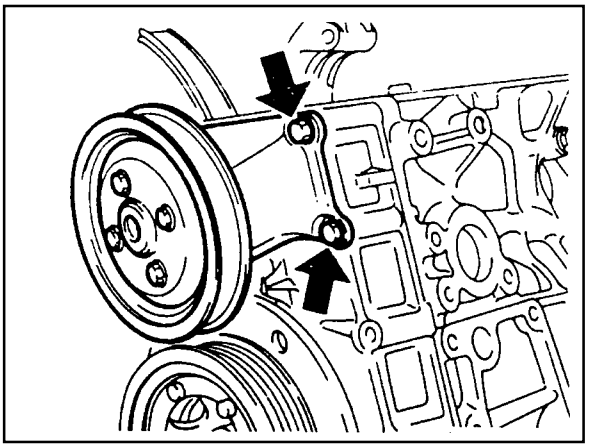
Tightening Torque	22.5 - 27.5 Nm



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3. Remove the cooling fan and the viscous clutch. Unscrew the three bolts from the cooling fan bracket and remove the bracket (arrows).



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

4. Remove the timing gear case cover after unscrewing the bolts (3) and (4) from the timing gear case cover and the bolt (9) from the oil pan.

Notice

Be careful not to damage the oil pan gasket.

Installation Notice

Tightening Torque	Bolt (3,4) 22.5 - 27.5 Nm
	Bolt (9) 9 - 11 Nm

- Apply the sealant after cleaning the timing gear case cover surface.
- Be careful not to stain the oil chamber of chain tensioner with the sealant.

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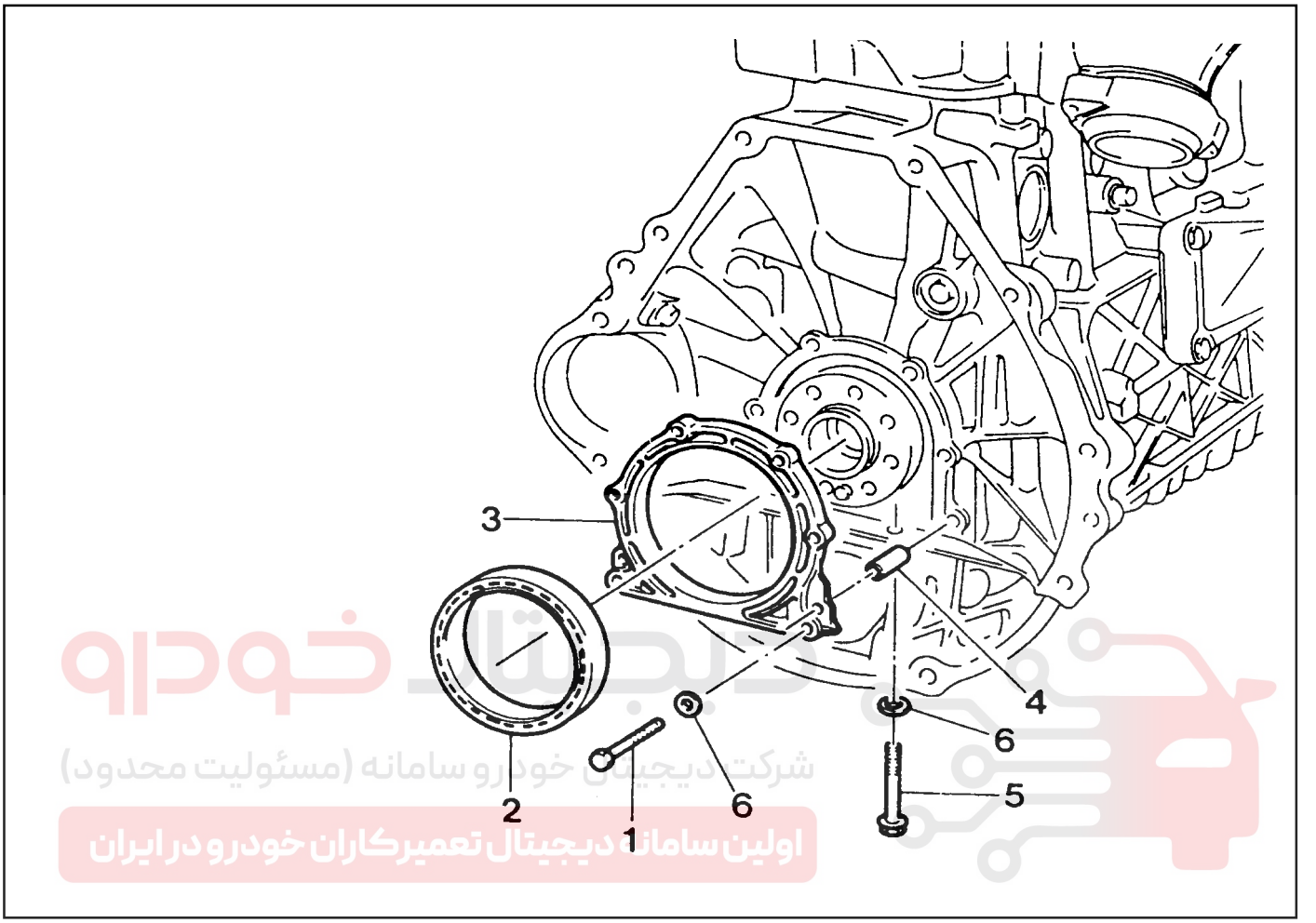
5. Installation should follow the removal procedure in the reverse order.
6. Warm up the engine and check for oil leaks.

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CRANKSHAFT SEALING REAR COVER

Preceding Work : Removal of the automatic transmission drive plate



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1 Bolt (M6 x 20, 6 pieces) ..... 9-11 Nm
2 Radial Shaft Seal
3 Rear Cover
4 Sleeve
5 Bolt (M6 x 85, 2 pieces) ..... 9-11 Nm
6 Washer

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Tools Required

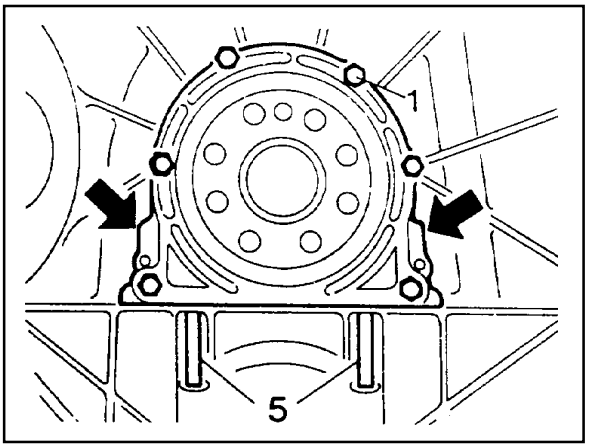
601 589 03 43 00 Sleeve

Removal & Installation Procedure

1. Unscrew the bolts (1) and (5) and remove the closing cover by pulling the rear cover lug (arrows).

   Notice

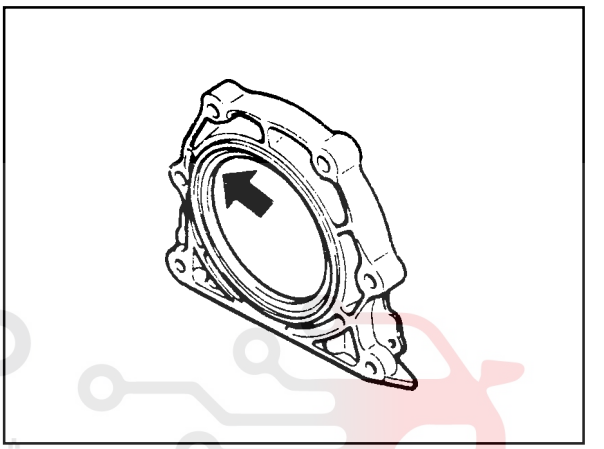
   Be careful not to damage the oil pan gasket.



2. Clean the sealing surface of the crankcase and the rear sealing cover.
3. Check the radial shaft seal and replace it if necessary.
4. Apply the Loctite 573 to the rear cover sealing surface.
5. Apply the engine oil to the dust lip of the radial shaft seal.

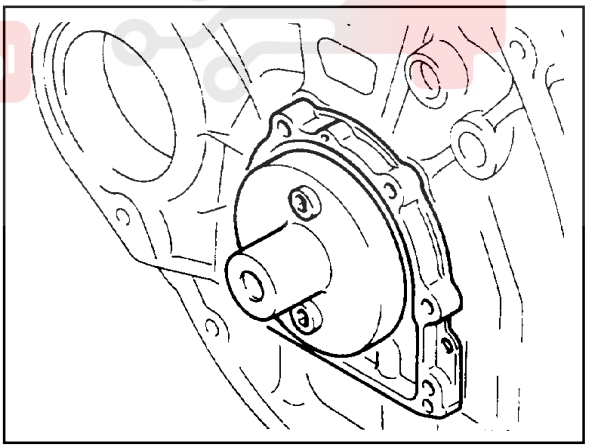
   Notice

   Do not use the grease.



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6. Using the special tool, press the radial shaft seal and the rear cover.

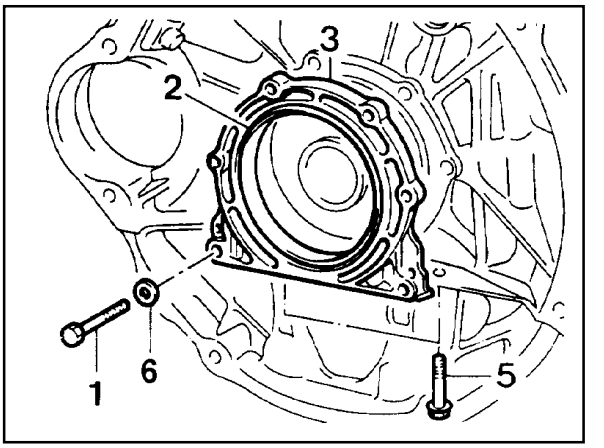


7. Tighten the rear cover bolt (1) and then tighten the oil pan bolt (5) as specified and remove the special tool.

   Installation Notice

Tightening Torque(Bolt 1,5)	9 - 11 Nm

Seal Assembler 601 589 03 43 00

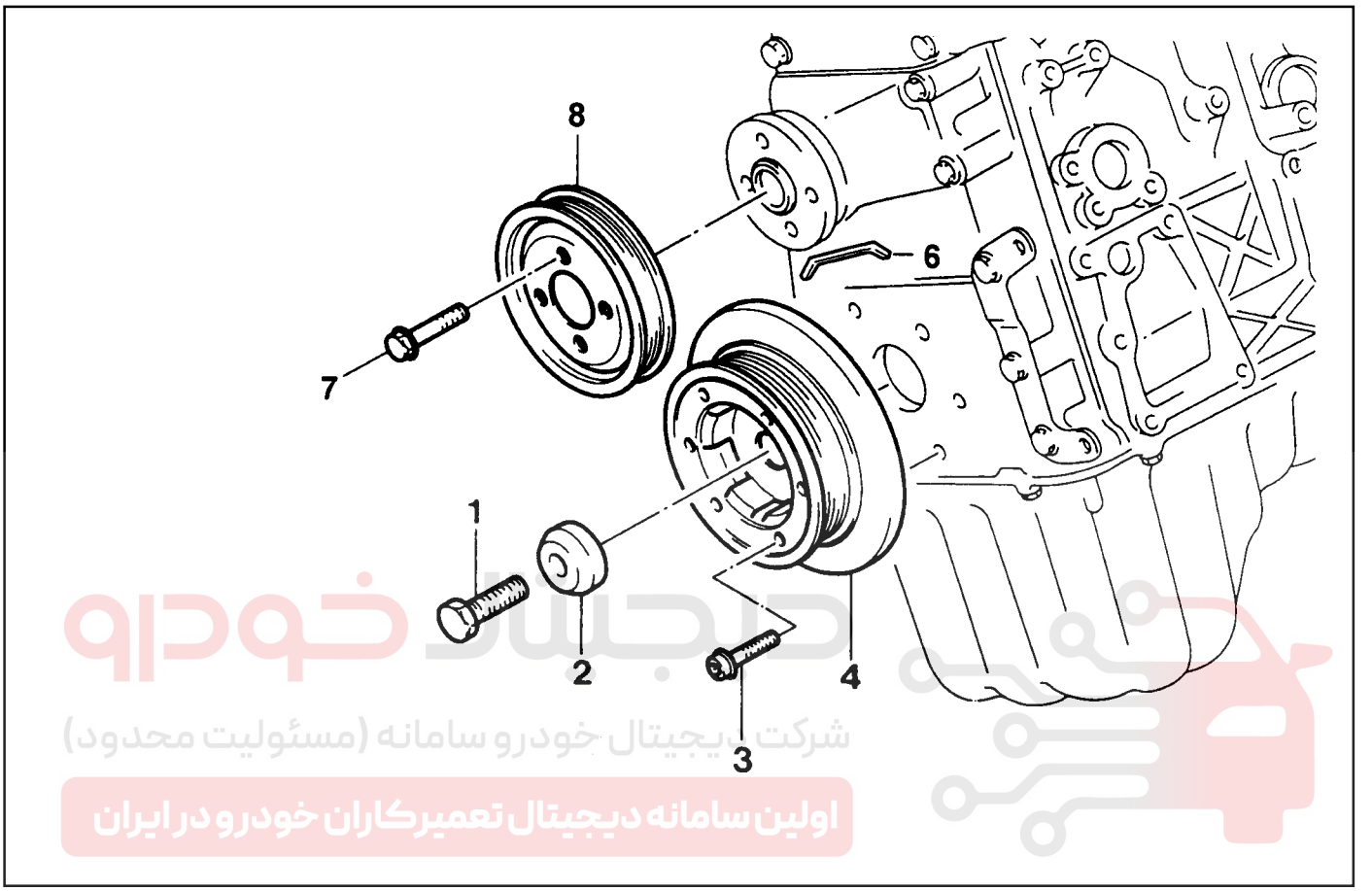


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BELT PULLEY AND VIBRATION DAMPER

Preceding Work : Removal of cooling fan and viscous clutch
Removal of fan shroud
Removal of drive belt



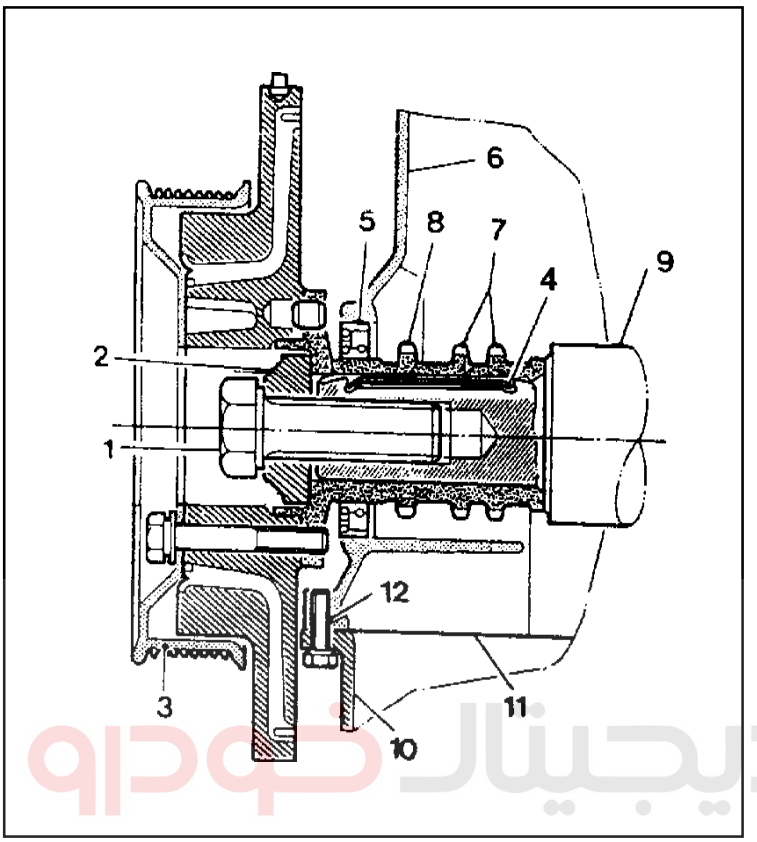
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1 Center Bolt (M18 x 50) ..... 1st step 200- 220 Nm
2nd step 90°+10°
2 Vibration Damper Disk
3 Bolt (M6 x 20, 6 pieces) ..... 7.7-9.5 Nm
4 Vibration Damper Assembly
5 Woodruff Key
6 Bolt (M6 x 12, 4 pieces) ..... 9-11 Nm
7 Cooling Fan Pulley

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Components



1 Center Bolt (M18 x 50)
2 Center Bolt Washer
3 Vibration Damper and Pulley Assembly
4 Key
5 Crankshaft Front Seal
6 Timing Gear Case Cover
7 Crankshaft Sprocket (Camshaft Driven)
8 Crankshaft Sprocket (Oil pump Driven)
9 Crankshaft
10 Oil Pan
11 Oil Pan Gasket
12 Oil Pan Mounting Bolt (M6 x 22)

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Service Data Standard

Permissble Deviation of The Vibration Damper	Radial Runout	0.6 mm
	Axial Runout	0.6 mm

Tools Required

103 589 00 33 00 Puller
001 589 65 09 00 Socket Wrench Insert
602 589 00 40 00 Engine Lock

Removal & Installation Procedure

1. Adjust the piston of number 1 cylinder to the TDC.



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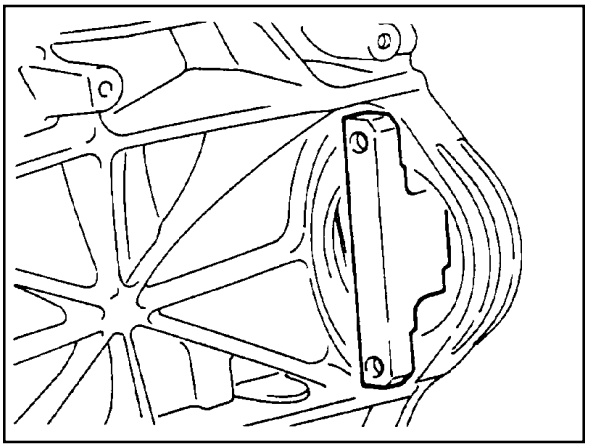
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2. Remove the start motor and install the engine lock to the flywheel ring gear.
3. Remove the center bolt.

Installation Notice

Tightening Torque	1st step 200 - 220 Nm 2nd step 90° +10°

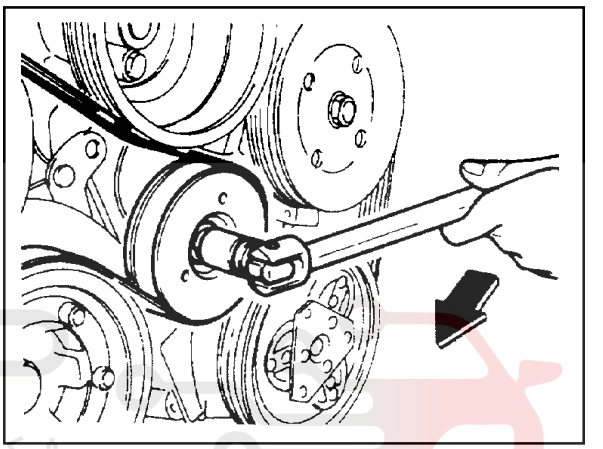
Engine Lock 602 589 00 40 00



4. Remove the vibration damper assembly using the puller.
5. Installation should follow the removal procedure in the reverse order.

Notice

If possible, don't separate the vibration damper and the pulley.



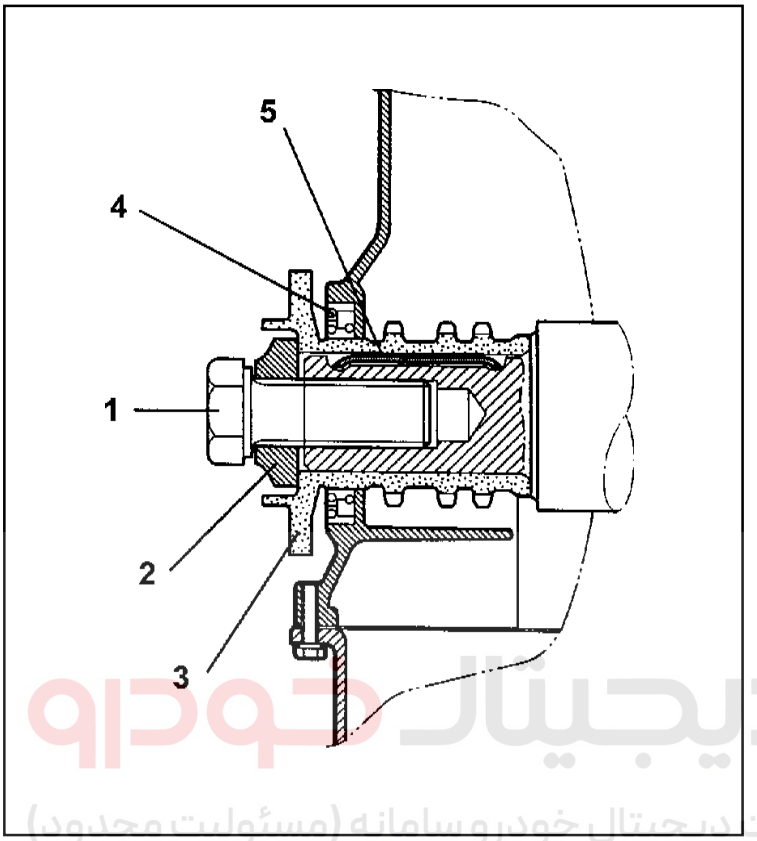
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CRANKSHAFT FRONT RADIAL SEAL

Preceding Work : Removal of belt pulley and vibration damper



1 Center Bolt (M18 x 50)
..... 1st step 200-220 Nm
2nd step 90° +10°
2 Center Bolt Washer
3 Sleeve (Special Tool)
4 Crankshaft Front Seal
5 Key

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Tools Required

601 589 03 14 00 Sleeve

Replacement Procedure

1. Remove the radial seal with a screw driver.

   Notice

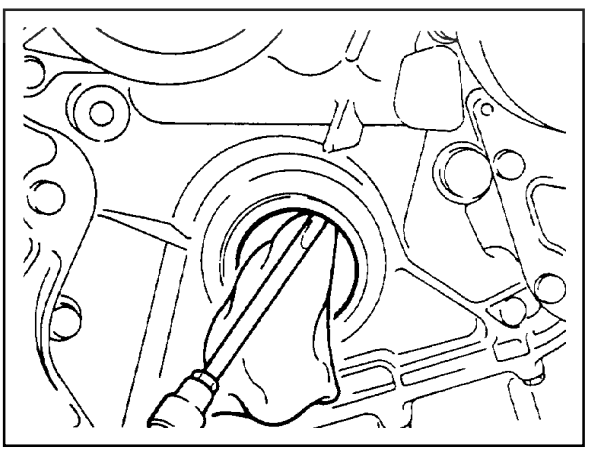
   Use a clean cloth not to damage the radial seal mounting hole and the crankshaft.

2. Coat the radial sealing lip with engine oil.
3. Using the sleeve, assemble the radial seal .
4. Align the sleeve groove and the woodruff key and tighten the center bolt until the center bolt and the damper disk stop in the movement.

   Installation Notice

Tightening Torque	1st step 200 - 220Nm 2nd step 90° + 10°

5. Remove the sleeve and install the belt pulley and the vibration damper.
6. Check for leaks while operating the engine.

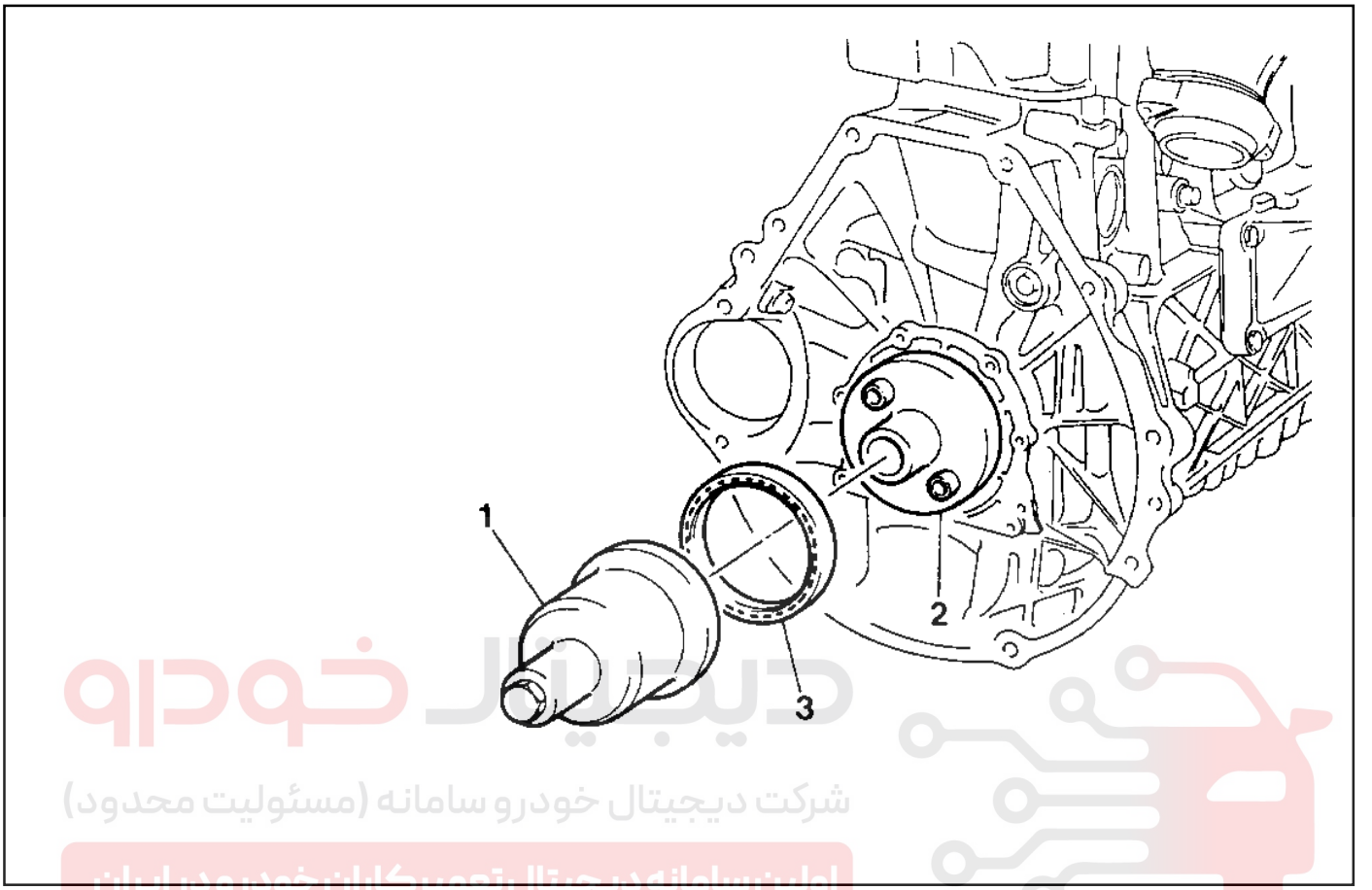


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CRANKSHAFT REAR RADIAL SEAL

Preceding Work : Removal of flywheel or drive plate



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1 Special Tool
2 Special Tool
3 Crankshaft Rear Seal

Tools Required

601 589 03 43 00 Sleeve

Replacement Proceudre

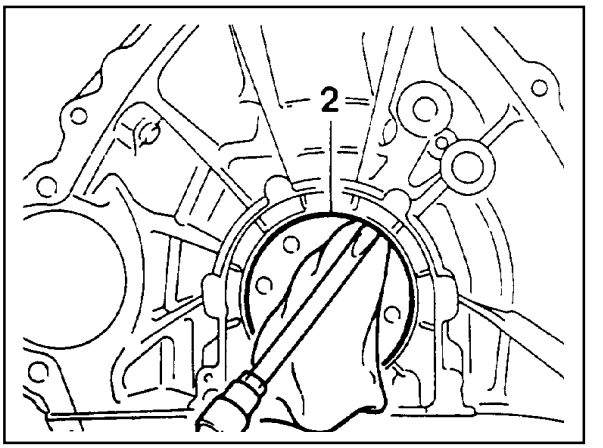
1. Remove the radial seal with a screw driver.

   Notice

   Use a clean cloth not to damage the radial seal mounting hole and the crankshaft.
2. Install the special tool (2) to the crankshaft.
3. Apply the engine oil on the special tool (2).

   Notice

   Do not use the grease.
4. Install the radial seal on the inner parts assembler.
5. Press in the special tool (1) until the radial seal is stopped.
6. Check for leaks while operating the engine.

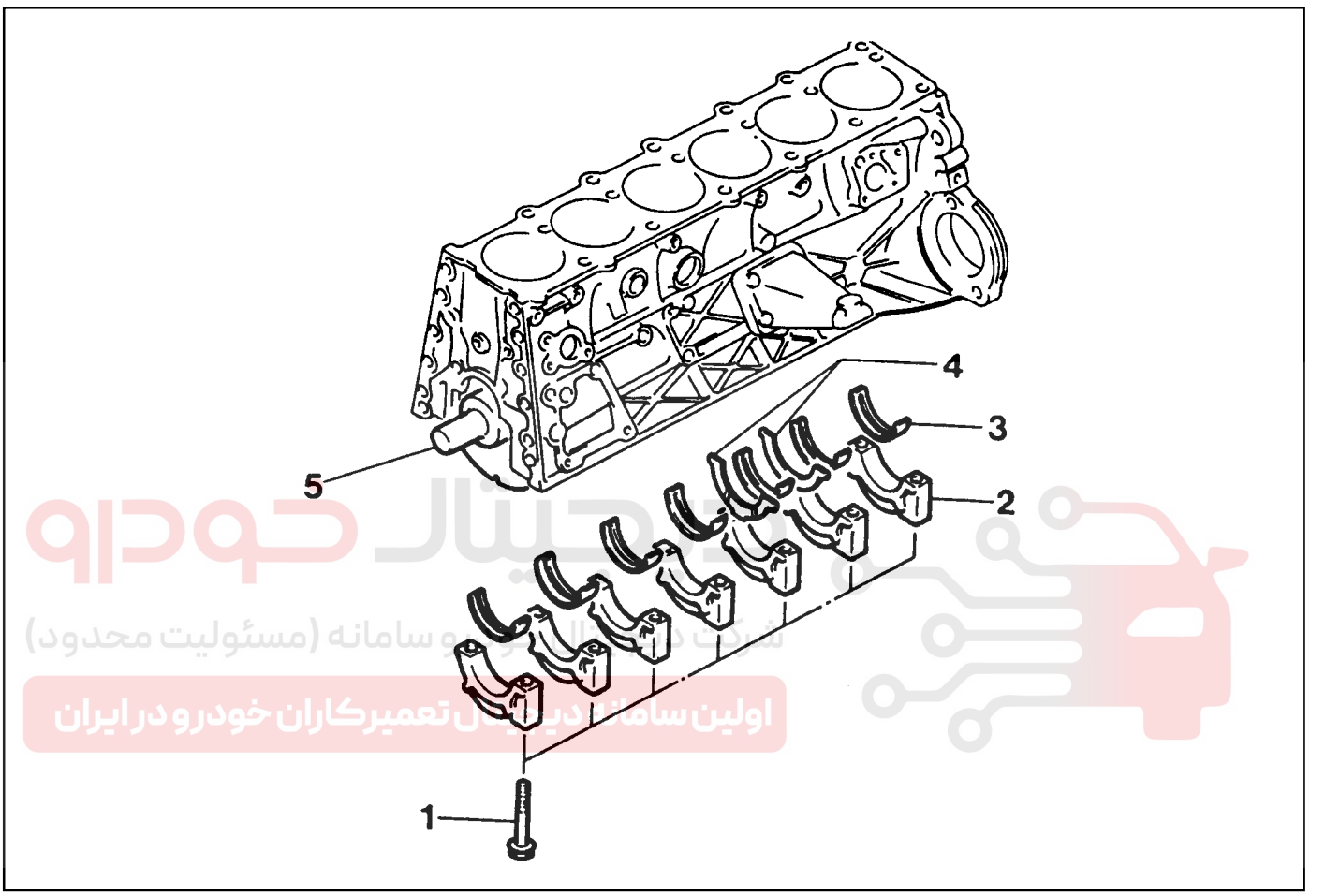


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CRANKSHAFT

Preceding Work : Removal of engine assembly
Removal of timing gear case cover
Removal of cylinder head
Removal of oil pump
Removal of oil shield

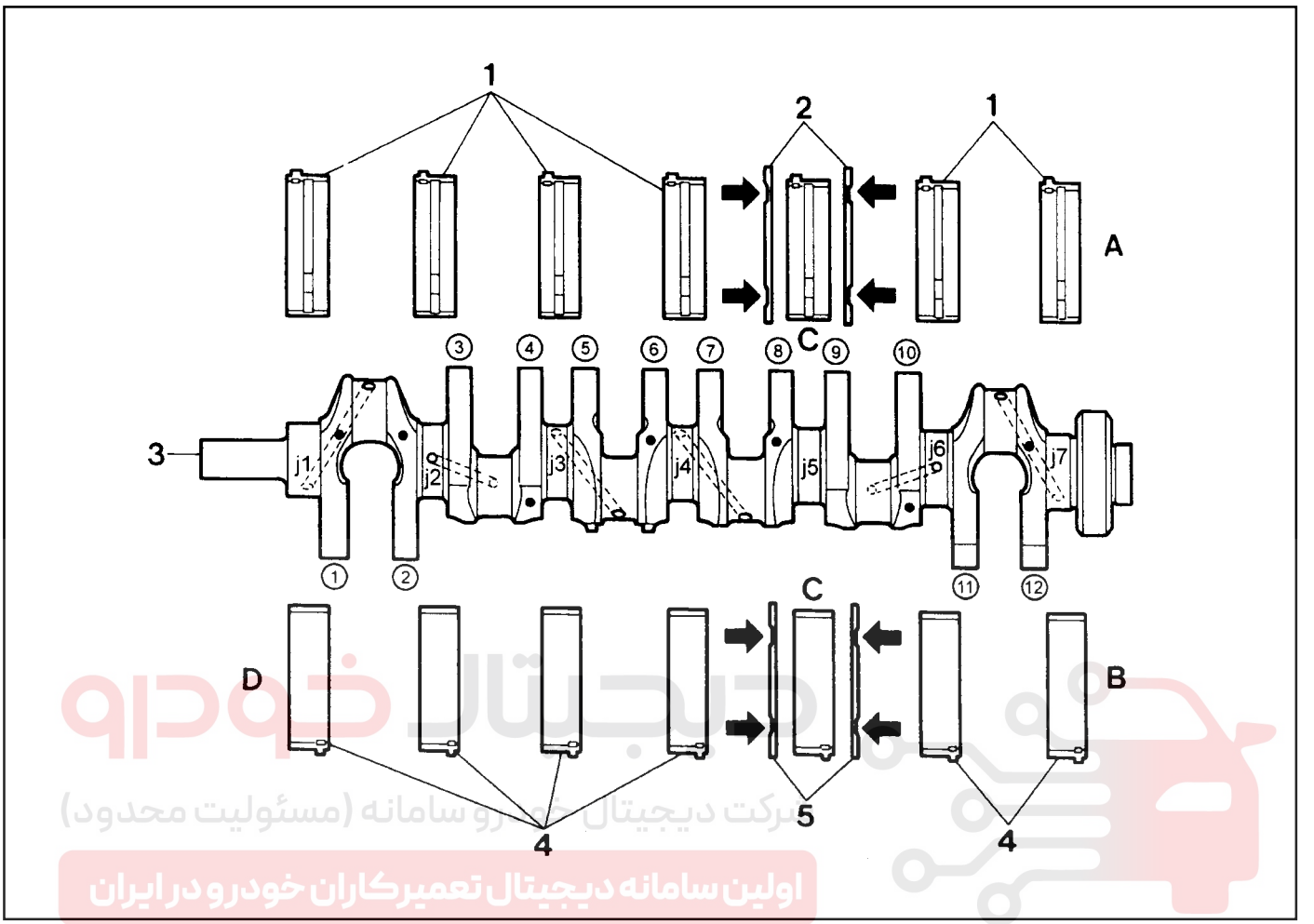


1 12-sided Stretch Bolt ..... 55 Nm x 90°, lubricate
2 Crank Shaft Bearing Cap
3 Crank Shaft Low Main Bearing
4 Lower Thrust Bearing
5 Crank Shaft

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Arrangement of the Thrust Bearing and the Main Bearing



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1 Upper Main Bearing
2 Upper Thrust Bearing
3 Crankshaft
4 Lower Main Bearing
5 Lower Thrust Bearing

A Crankcase Side
B Bearing Cap Side (Oil Pan Side)
C Axial Fit Bearing (Number 5 Bearing Point)
D Radial Bearing

① - ⑫ Weight Balance/Color Marking Point
j1 - j7 Journal Main Bearing #1 - #7
● Color Dot Marking

The color dot marking are put on the ①, ②, ④, ⑥, ⑧, ⑩, ⑫ and it indicates the diameter of crankshaft journal by color as below.

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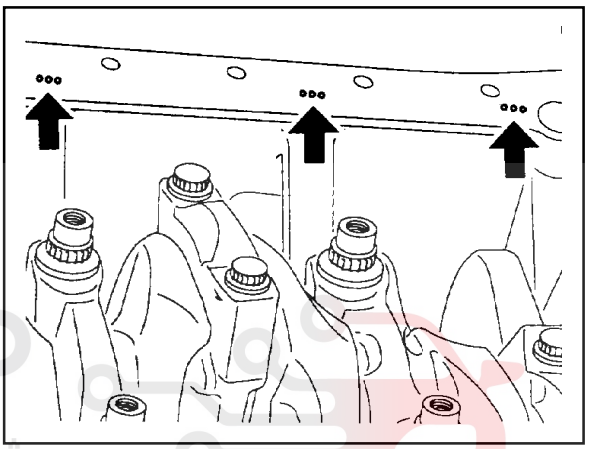
Color Dot Marking	Crankshaft Journal Diameter (mm)
Blue	57.960 - 57.965
Yellow	57.955 - 57.960
Red	57.950 - 57.955
White	57.945 - 57.950
Violet	57.940 - 57.945

Selection of Crankshaft Main Bearing

1. Crankcase Side

There are seven punching marks on the mating surface to oil pan. This mark is correspondent to the bearing distinguished by color. Select the relevant bearing according to the punching mark when repaired.

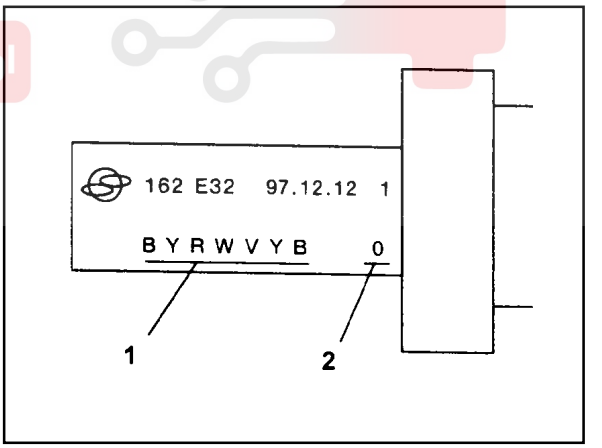
Punching Mark	Bearing Color Selected
▪	Blue
▪▪	Yellow
▪▪▪	Red



2. Crankshaft Bearing Cap Side

Select the crankshaft main bearing according to the marking letter on the crankshaft main journal when repaired.

Marking Letter	Bearing Color Selected
B	Blue
Y	Yellow
R	Red
W	White
V	Violet



Service Data

Unit : mm

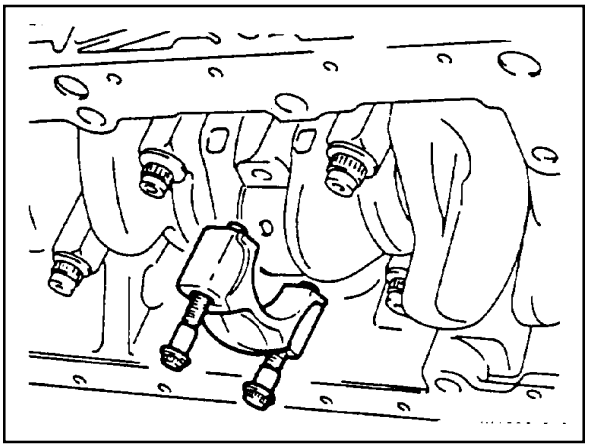
Crankshaft Standard and Repair Size	Crankshaft Bearing Journal Diameter	Crankshaft Bearing Diameter	Crankshaft Journal Width at fit bearing	Connecting Rod Bearing Journal Diameter	Connecting Rod Bearing Journal Width
Standard size	57.950-57.965	58	24.50-24.533	47.94-47.96	27.958-28.042
1st repair size	57.700-57.715			47.75	
2nd repair size	57.450-57.465		-	47.50	-
3rd repair size	57.200-57.215			47.25	
4th repair size	56.950-56.965			47.00	

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Removal & Installation Procedure

1. Unscrew the connecting rod bearing cap bolt and remove the bearing cap.

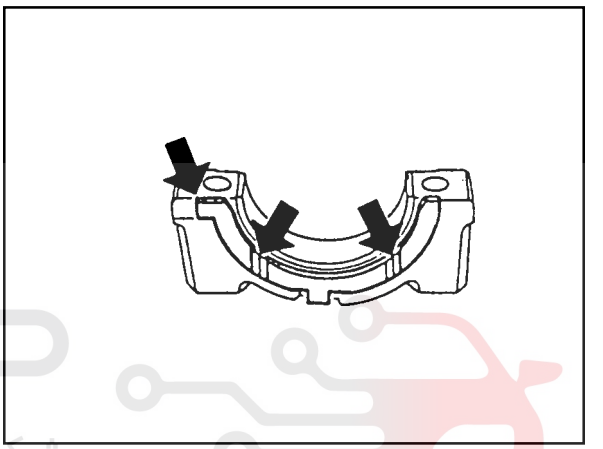


Installation Notice

Tightening Torque	40 Nm + 90°

- Make sure that the upper and lower bearing shells do not change each other.
- Coat the bearing shell with engine oil.
- Install the bearing cap according to the consecutive number.

2. Unscrew the crankshaft bearing cap bolts and separate the upper and lower bearing shells and thrust washers.



Installation Notice

Tightening Torque	55 Nm + 90°

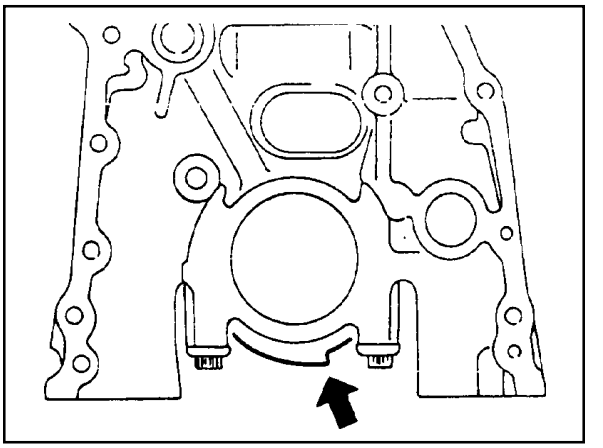
- Remove the bearing cap from front (pulley side) to rear.
- Make sure that the upper and lower bearing shells do not change each other and coat with engine oil.
- The oil grooves (arrows) in the thrust washers must face outward and insert the thrust bearing into the bearing cap.
- There are five kinds of thrust washers by thickness. Select the proper washer when repaired.

Part No. : 601 030 00 62 2.15 mm
Part No. : 601 030 01 62 2.20 mm
Part No. : 601 030 02 62 2.25 mm
Part No. : 601 030 03 62 2.30 mm
Part No. : 601 030 04 62 2.40 mm

3. Remove the crankshaft.
4. Installation should follow the removal procedure in the reverse order.
5. After completion of the installation, check for the rotating condition of the crankshaft.

Installation Notice

- Make sure the crankshaft bearing cap properly seated in place in the crankcase side. When perfectly installed, the projected part (arrow) locates in the left side (intake manifold side).
- Assemble so that the projected part of the cap and crankcase face the same direction.

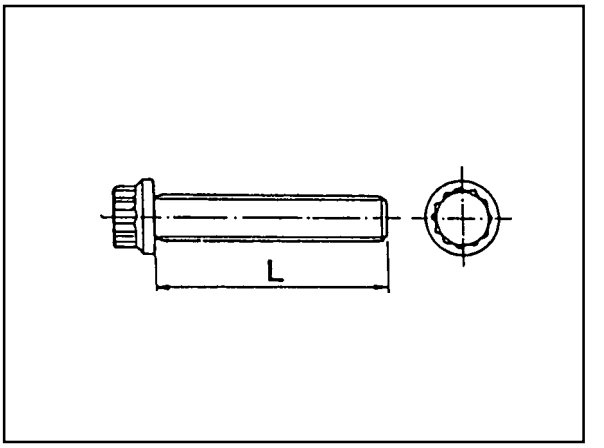


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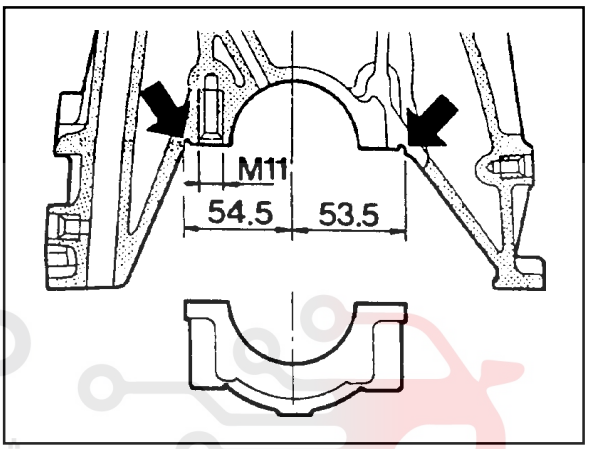
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Inspection

1. If the length 'L' of the crankshaft bearing cap bolt exceeds 63.8mm, replace it.



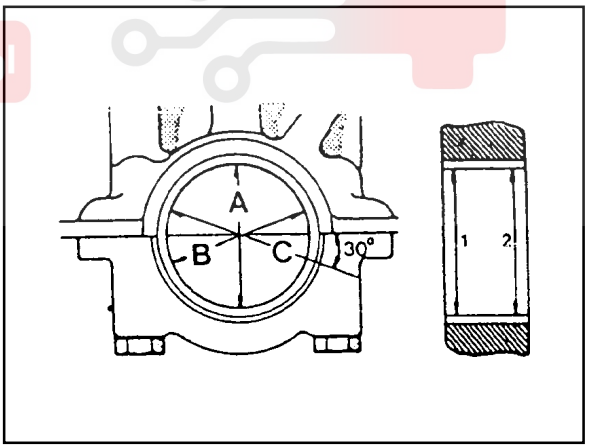
2. Make sure the crankshaft bearing cap is properly seated on the cylinder block (arrows).



3. Measure and record the inner diameter of the crankshaft bearing.

Notice

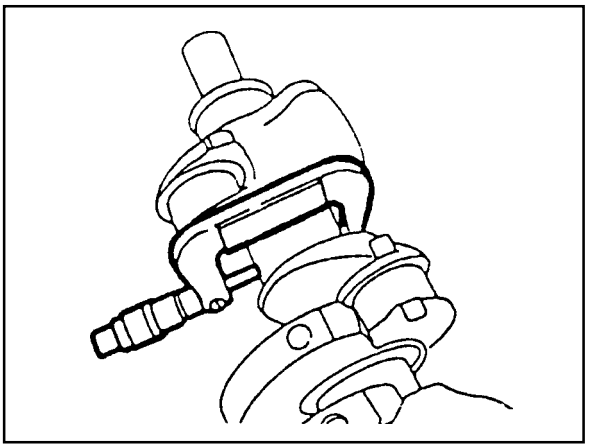
- Measure at 2 points (1, 2).
- Measure 'A','B'and 'C' as shown. If average value of 'B' and 'C'is less than value 'A', then the average value of 'B' and 'C' is actual average value. If average value of 'B' and 'C' is more than value 'A'is actual average value.



4. Measure and record the diameter of the crankshaft bearing journal.

Notice

- Record the mean value when measured at 3 points (A, B, C).
- Measure the inner diameter of bearing and the diameter of journal and if it is out of the standard data, replace the bearing shell.



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Service Data Standard (Crankshaft Main Bearing Gap)

Item	Measuring Position	Gap (mm)
Main Bearing Journal (NO. 1, 5, 7)	Radial	Static condition :0.015 - 0.039 Dynamic condition: 0.031 - 0.051 (Consider the expansion 0.011 - 0.016)
	Axial	0.010 - 0.254
Main Bearing Journal (NO. 3, 4, 6)	Radial	Static condition :0.011 - 0.039 Dynamic condition: 0.031 - 0.051 (Consider the expansion 0.015 - 0.022)
	Axial	0.010 - 0.254

(Connecting Rod Bearing Gap)

Item	Measuring Position	Gap (mm)
Connecting Rod Bearing	Radial	0.030 - 0.050

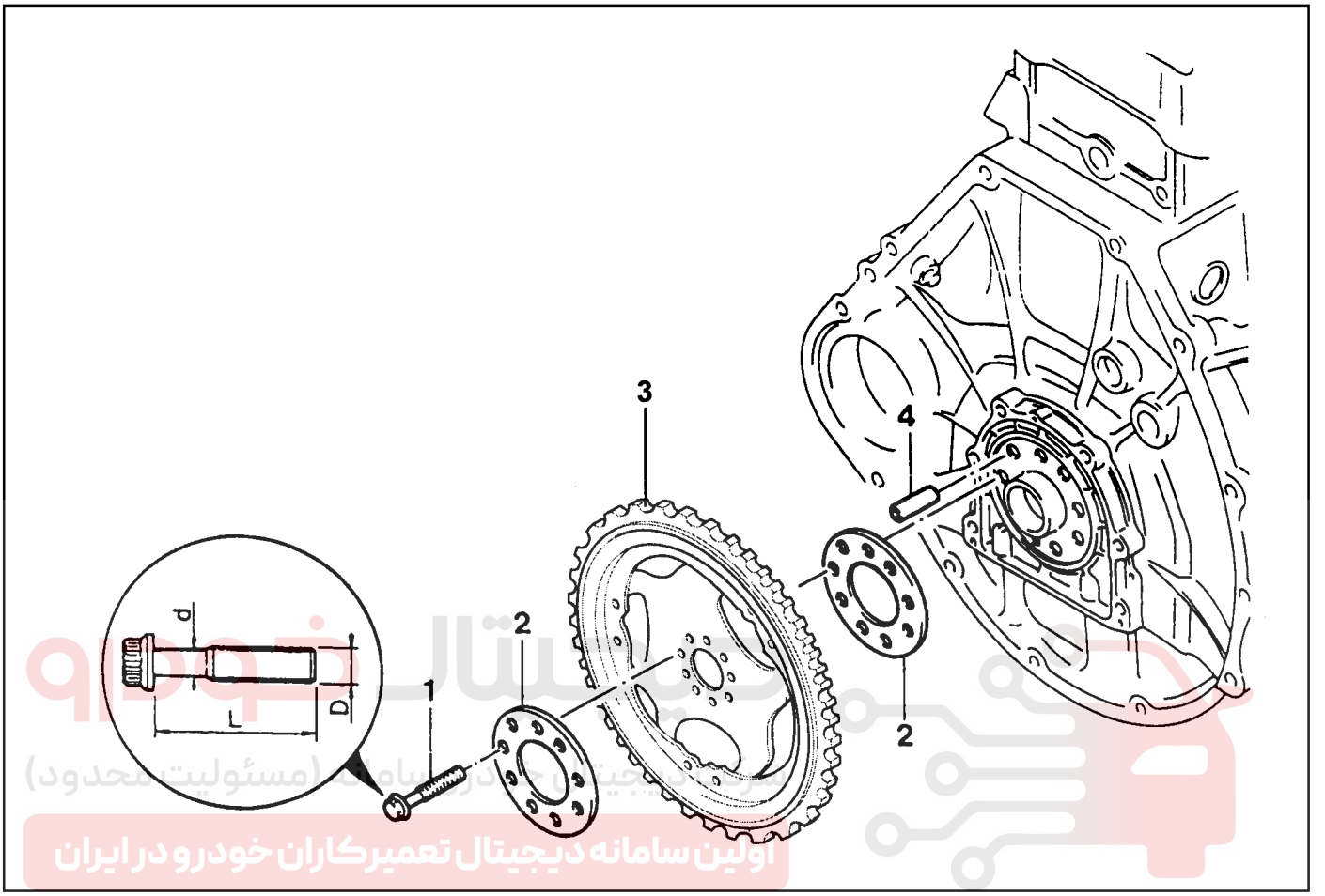
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FLYWHEEL / DRIVEN PLATE

Preceding Work : Removal of manual or automatic transmission



1 Flywheel Mounting Bolt (M10 x 22, 8 pieces)
..... 1st step 45+5 Nm
2nd step +90° +10°

2 Plate

3 Driven Plate (A/T)

4 Dowel Pin

Service Data Standard (Stretch Bolt)

Nominal Size	D	-	M x 1.5
Stretch Side Diameter	d	When New	8.5 - 0.2 mm
		Min. Diameter	8.0 mm
Bolt Length	L	When New	21.8 - 22.2 mm
Tightening Torque	1st step 50 Nm, 2nd step 90°		

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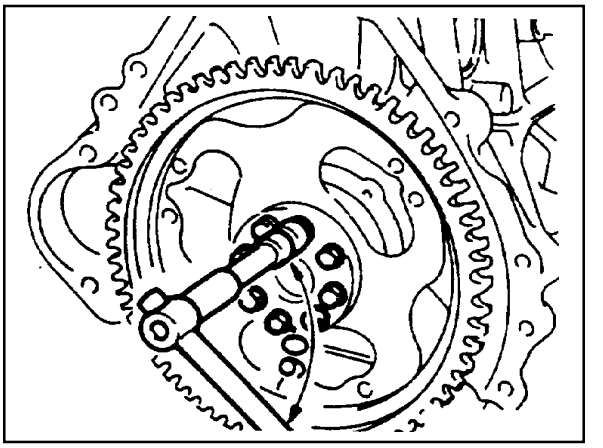
Removal & Installation Procedure

1. Unscrew the stretch bolt.

Installation Notice

Tightening Torque	1st step 45+5 Nm 2nd step 90° + 10°

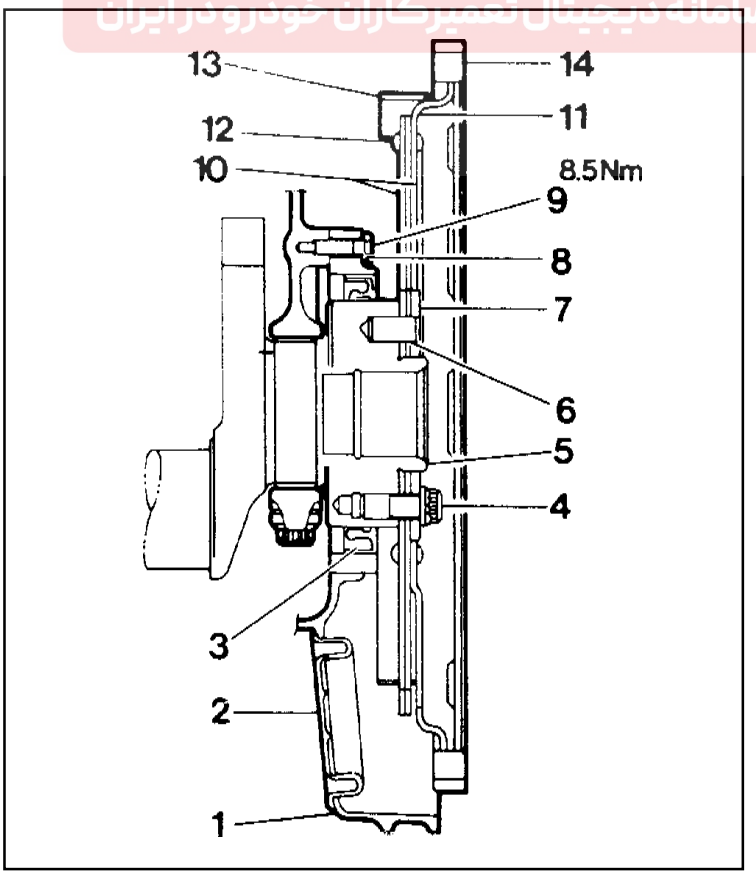
- Replace the bolt when the stretch side diameter (d) of the flywheel mounting bolt is less than 8.0mm.
- For the stretch bolt tightening, keep the socket wrench and Tommy-bar to be 90° and tighten as specified.



2. Remove the flywheel for manual transmission vehicles, or the driven plate (3), and plate (2) for Auto. transmission vehicle.
3. Installation should follow the removal procedure in the reverse order.

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Sectional View

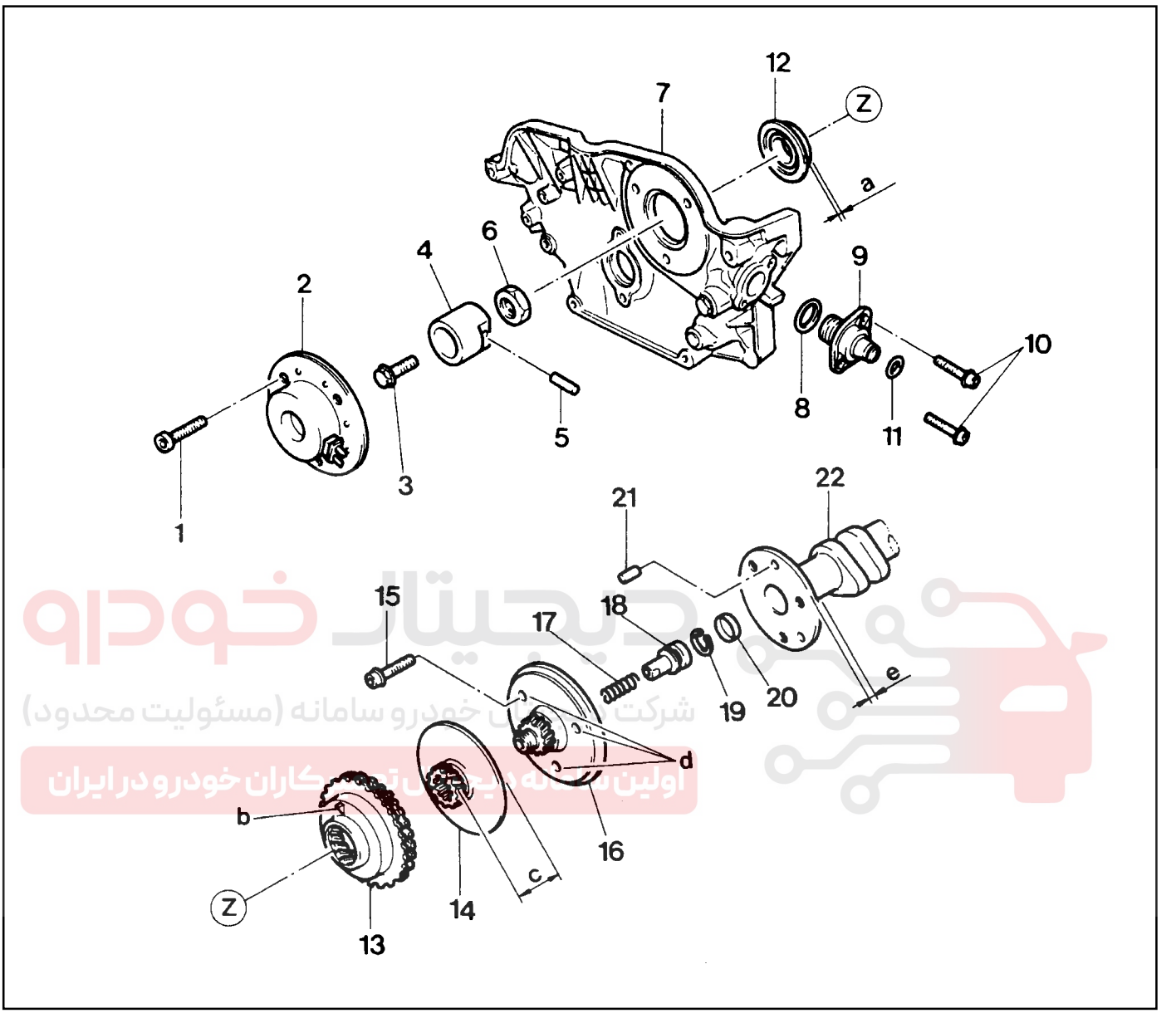


1 Oil Pan
2 Cover
3 Crankshaft Front Seal
4 Flywheel MTG Bolt
5 Crankshaft
6 Dowel Pin
7 Plate
8 TGCC
9 Bolt
10 Front Drive Plate
11 Rear Drive Plate
12 Rivet
13 Segment
14 Ring Gear

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CAMSHAFT ADJUSTER



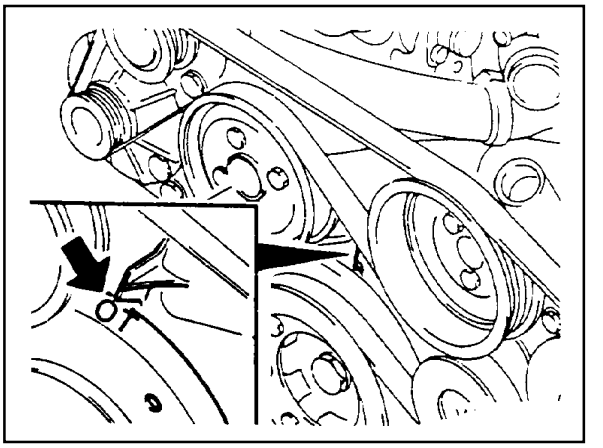
1 Bolt (M6 x 16, 3 pieces) ..... 9-11 Nm
2 Electromagnetic Actuator (2 Pin Connector)
3 Bolt ..... 35 Nm
4 Armature
5 Roll Pin
6 Nut (M20 x 1.5) ..... 60-70 Nm
7 Front Cover
8 Seal
9 Camshaft Position Sensor
10 Bolt (M6 x 16, 2 pieces) ..... 9-11 Nm
11 Seal
12 Seal Cover
13 Camshaft Sprocket and Position Indicator (b)
14 Adjuster piston
15 Flange bolt (M7 x 13, 3 pieces)
..... 1st step 18-22 Nm
2nd step 90° ± 5°
16 Flange Shaft
17 Compression Spring
18 Control Piston
19 Circlip
20 Oil Gallery
21 Pin
22 Intake Camshaft

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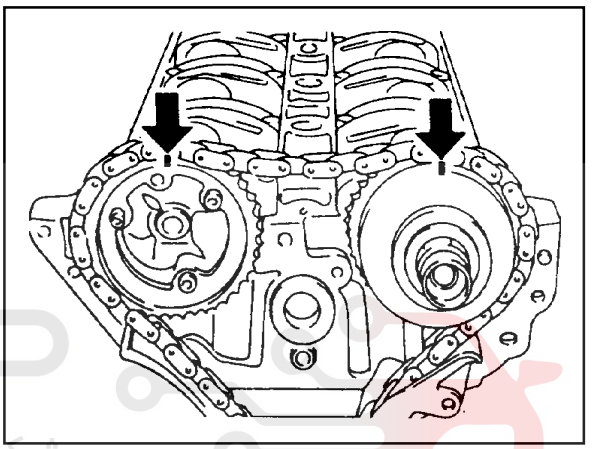
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Removal & Installation Procedure

1. Turn the crankshaft to the direction of engine rotation and position the no.1 cylinder piston at TDC which the camshaft is positioned at OT.



2. Remove the cylinder head front cover.
3. Paint the alignment marks (arrows) on the intake and exhaust camshaft sprocket and the timing chain.



4. Unscrew the bolt (3) from the armature (4) and remove the armature.

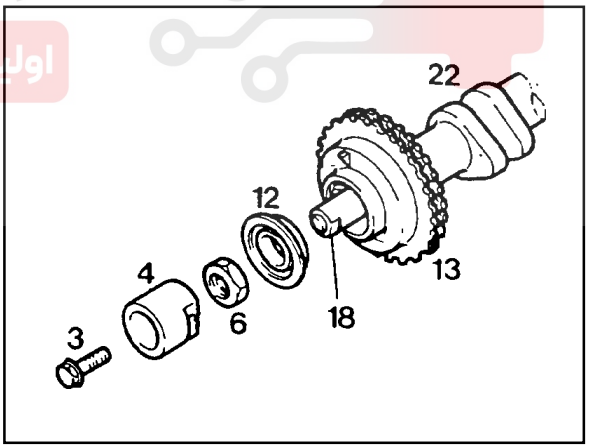
Installation Notice

Tightening Torque	35 Nm

5. Unscrew the nut (6) and remove the ring and seal cover (11).

Installation Notice

Tightening Torque	60 - 70 Nm



3 Bolt
4 Amarture
6 Nut (M20 x 1.5)
11 Seal Cover
12 Camshaft Sprocket
17 Control Piston
21 Intake Camshaft

6. Unscrew the sprocket bolt from the exhaust camshaft and remove the sprocket.

Installation Notice

Tightening Torque	1st step 18 - 22 Nm 2nd step 90° ± 5°

The sprocket bolt is designed to be used only once, so always replace with new one.

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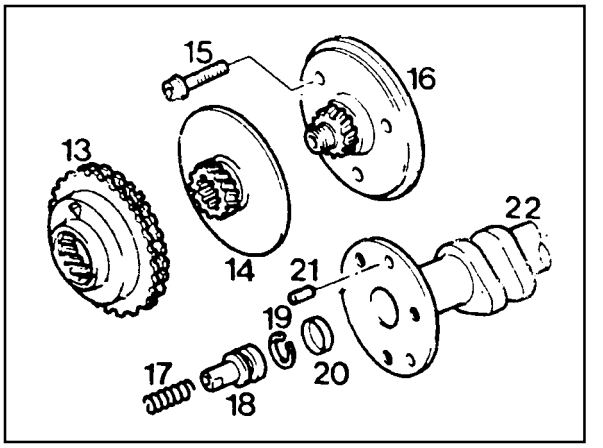
7. Remove the camshaft sprocket (13) and adjust piston (14), and remove the flange shaft (16) from the intake camshaft (22) after removing the bolt (15).

Installation Notice

Tightening Torque	1st step 18 - 22 Nm 2nd step 90° ± 5°

The sprocket bolt is designed to be used only once, so always replace with new one.

8. Installation should follow the removal procedure in the reverse order.
9. Adjust the camshaft timing.



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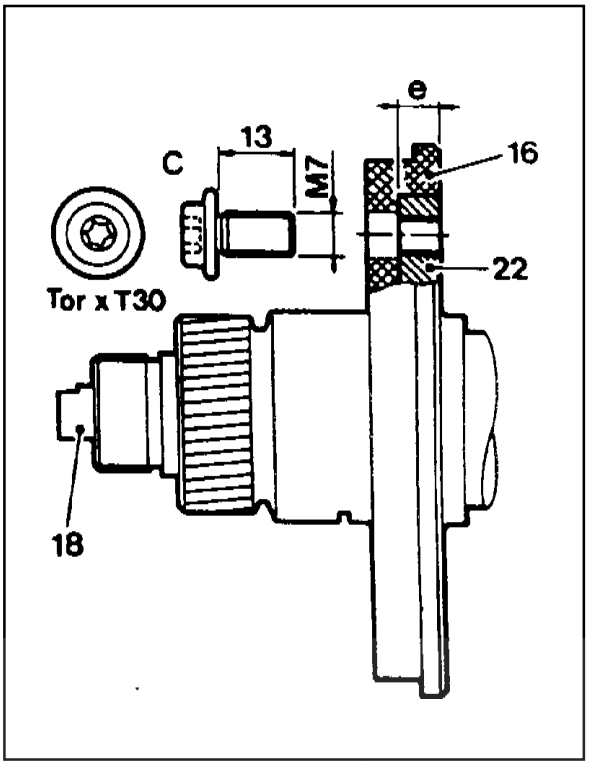
CAMSHAFT SPROCKET BOLT

Intake Flange Shaft Bolt

Tightening Torque	1st step 18 - 22 Nm 2nd step 90° ± 5°

Notice

The sprocket bolts are designed to be used only once, so always replace with new one.



C. M7 x 13 Collar Bolt Torx-T30
e. 6.8mm
16. Flange Shaft
18. Control Piston
22. Intake Camshaft

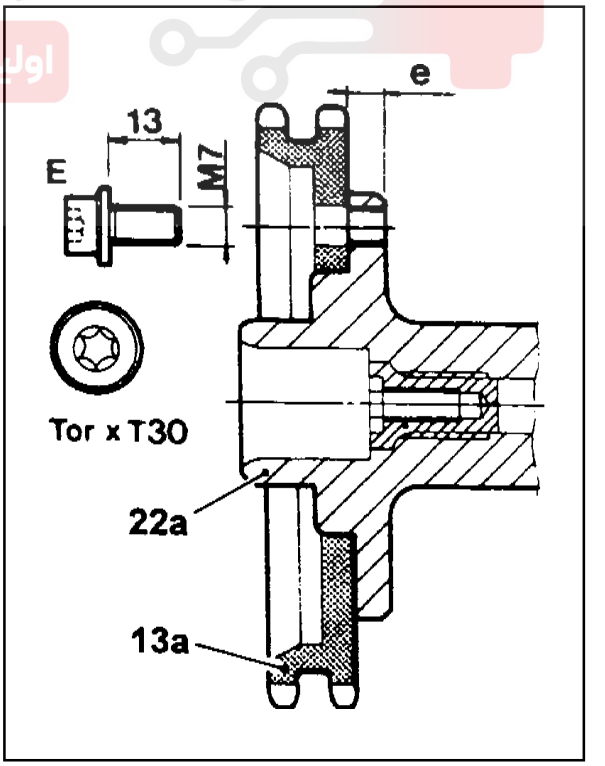
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Exhaust Camshaft Sprocket Bolt

Tightening Torque	1st step 18 - 22 Nm 2nd step 90° ± 5°

Notice

The sprocket bolts are designed to be used only once, so always replace with new one.



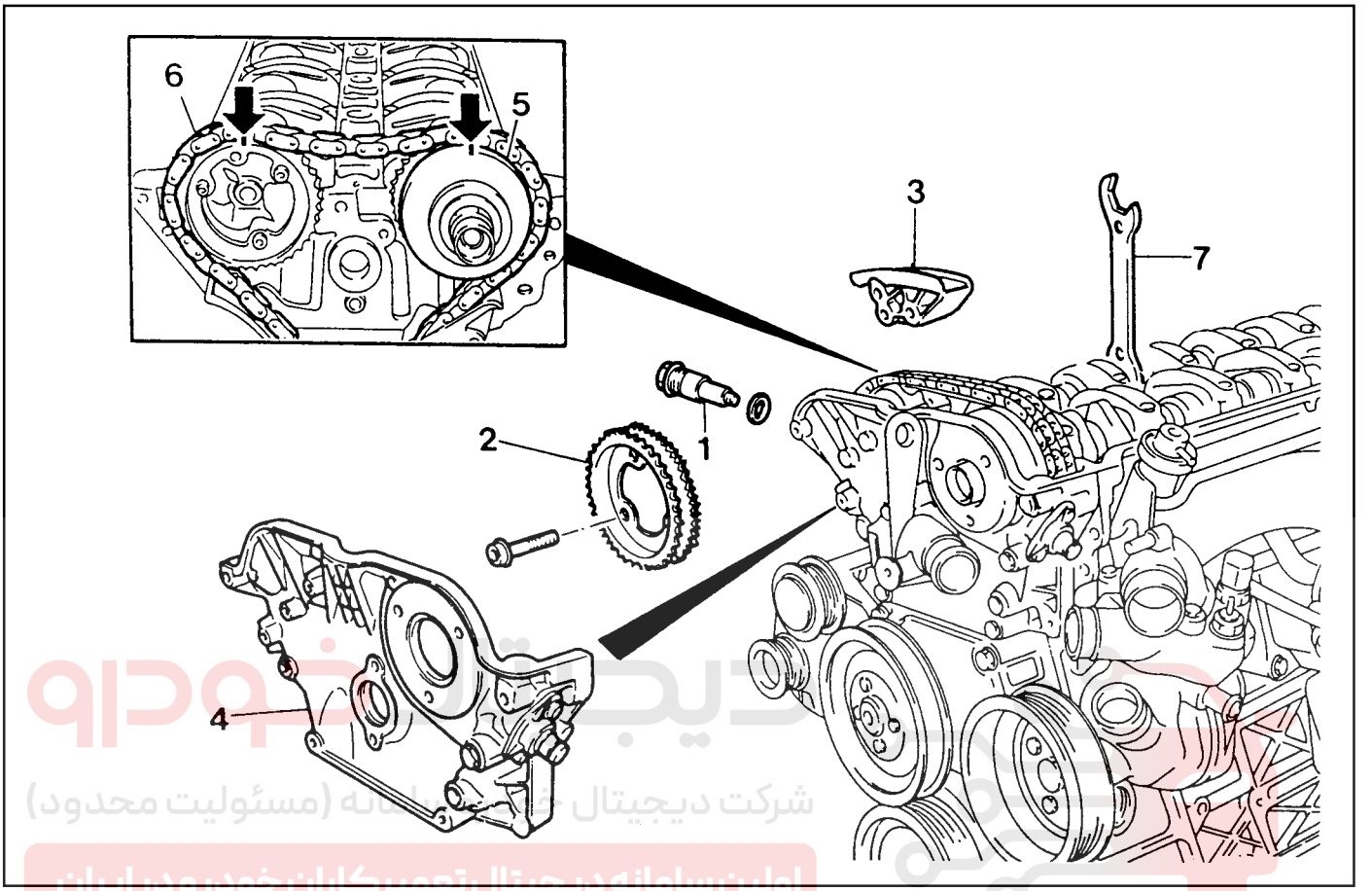
E. M7 x 13 Collar Bolt Torx-T30
e. 6.8mm
13a. Camshaft Sprocket
22a. Exhaust Camshaft

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CAMSHAFT

Preceding Work : Removal of cylinder head cover, removal of coolant connection fitting



1 Chain Tensioner Assembly ..... 72-88 Nm
2 Exhaust Camshaft Sprocket
3 Upper Guide Rail
4 Cylinder Head Front Cover
5 Intake Camshaft Sprocket
6 Chain
7 Wrench (Special Tool)

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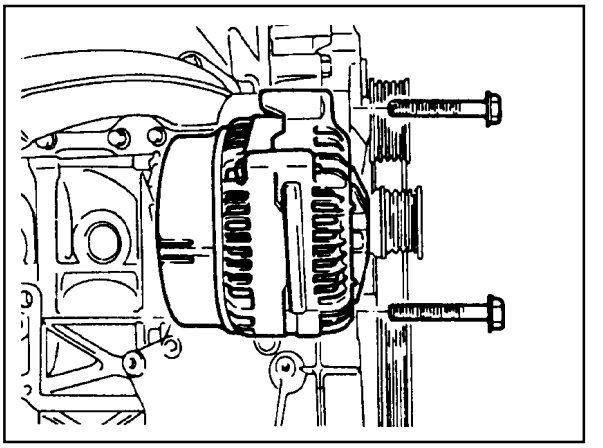
Tools Required

000 589 01 10 00 Box Wrench Insert

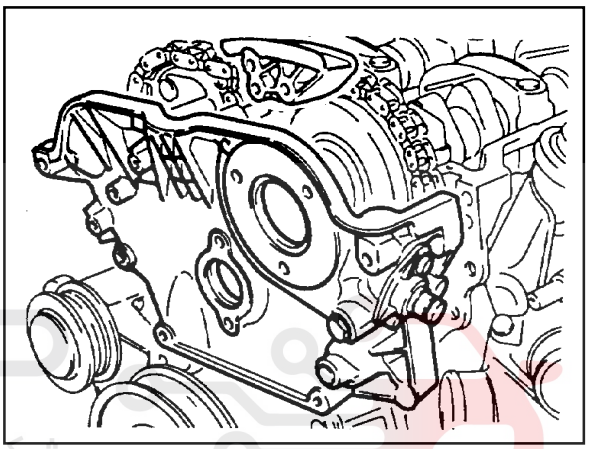
104 589 01 01 00 Spanner

Removal Procedure

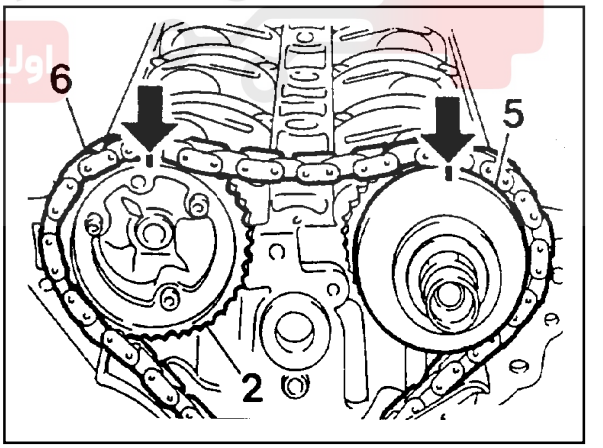
1. Turn the crankshaft and position the No. 1 cylinder piston at BTDC 30°.
2. Remove the alternator.
3. Remove the chain tensioner.



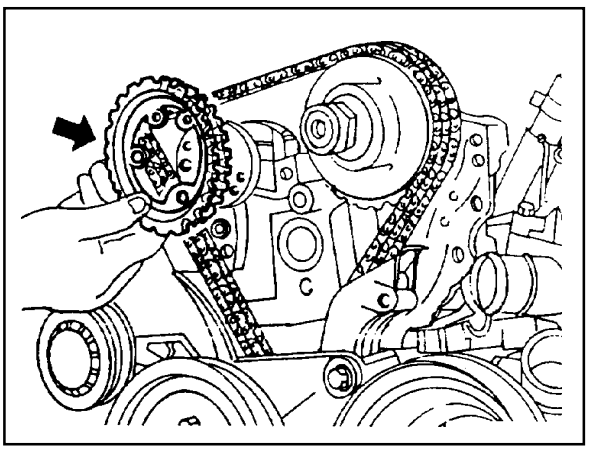
4. Remove the cylinder head front cover and the upper guide rail.



5. Put the alignment marks (arrows) on the camshaft sprocket (2, 5) and the timing chain (6).



6. Unscrew the exhaust camshaft sprocket bolt and remove the sprocket.
7. Separate the chain from the intake camshaft sprocket and put the chain not to be dropped into timing case.



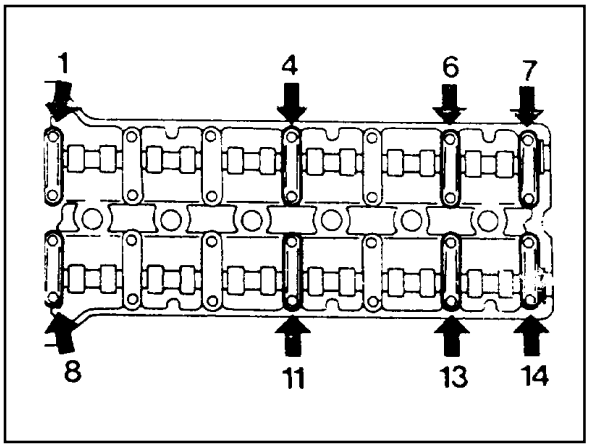
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8. Unscrew the intake side bolts (8, 11, 13, 14) and the exhaust side bolts (1, 4, 6, 7).
9. Loosen the remaining bolts and unscrew the intake and exhaust side camshaft bearing cap bolts.

   Notice

   Number the camshaft bearing cap bolts when removing them, so that they don't get mixed up.
10. Remove the intake and exhaust camshafts.



Installation Procedure

1. Turn the crankshaft and position the No. 1 cylinder piston at BTDC 30°.

   Notice

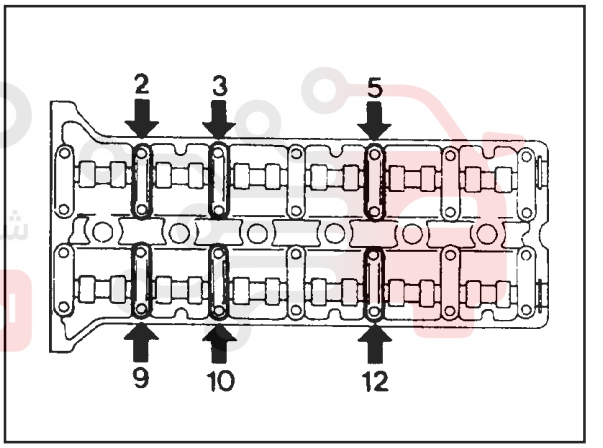
   Turn the crankshaft in the direction of engine rotation.

2. Install the exhaust camshaft bearing caps (2, 3, 5) and the intake camshaft bearing caps (9, 10, 12). Tighten the bolts with specified torque and install the remaining bearing caps.

   Notice

Tightening Torque	22.5 - 27.5 Nm

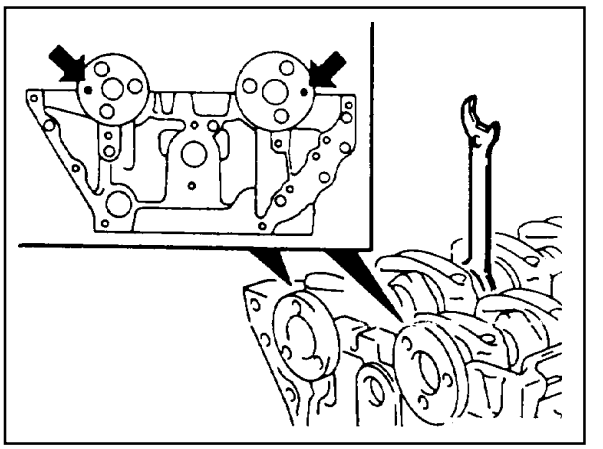
   Install the bearing caps according to the numbers on the bearing caps.



3. Turn the camshaft using the wrench (special tool) so that the intake camshaft adjustment hole lines up with the cylinder head upper side (3 o'clock direction at the intake, 9 o'clock direction at the exhaust).

   Notice

   Turn the crankshaft and adjust it to OT so that No. 1 cylinder's piston would be at TDC.



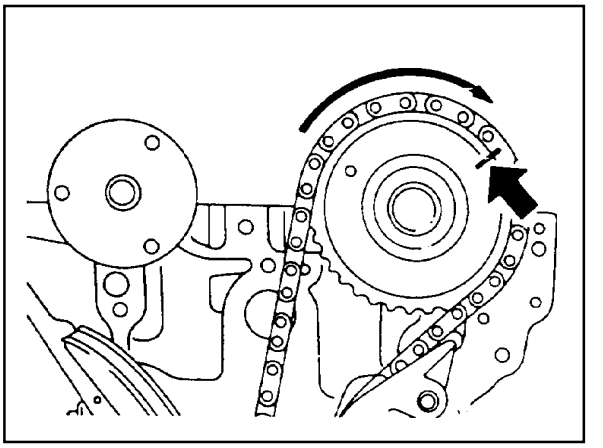
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4. Turn the intake camshaft adjuster to the direction of camshaft rotation by hard until it stops and then install the chain.

Notice

- Make sure that the camshaft sprocket and timing chain are aligned with marks.
- Intake camshaft adjuster should be in retarded position.

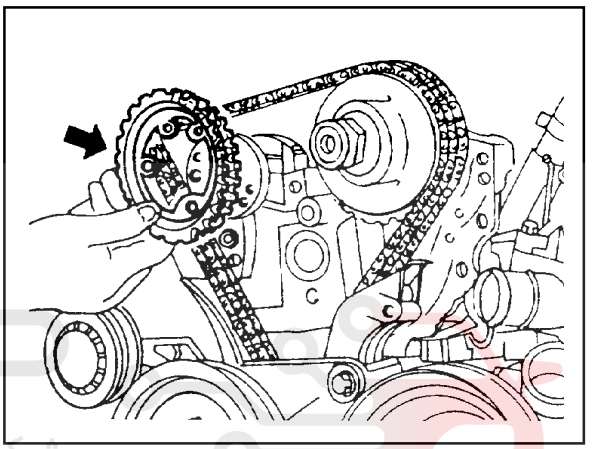


5. Install the chain on the exhaust sprocket and tighten the sprocket bolts.

Notice

Tightening Torque	1st step 18 - 22 Nm 2nd step 90° ± 5°

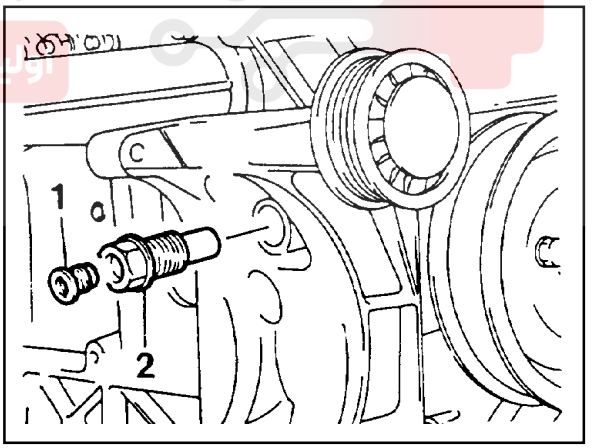
- Make sure that the camshaft sprocket and timing chain are aligned with marks.
- Replace the sprocket bolt with new one.



6. Install the chain tensioner and tighten it as specified.

Notice

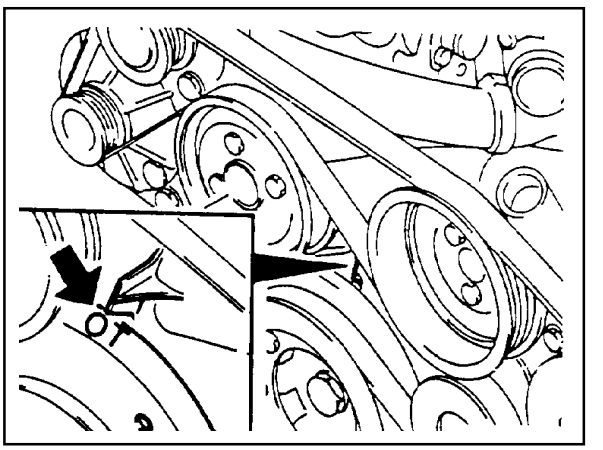
Tightening Torque	(1)	40 Nm
	(2)	72 - 88 Nm



7. Rotate the crankshaft 2 revolutions and check followings:
   - TDC of no. 1 cylinder : OT
   - Alignment between camshaft adjustment hole and cylinder head surface.
   - Alignments between timing chain and sprocket marks.

Notice

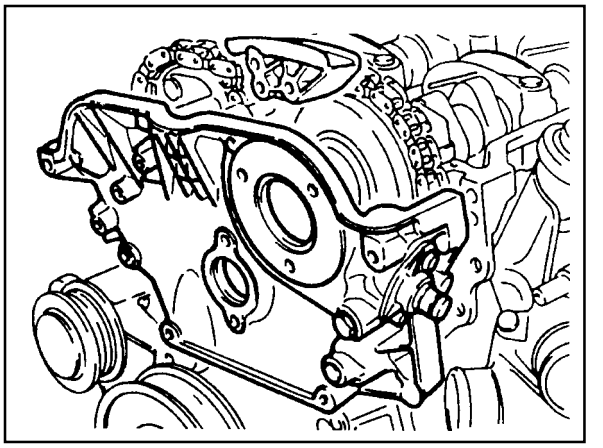
- Turn the crankshaft in the direction of engine rotation.
- Read just if not aligned.



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8. Install the upper guide rail and cylinder head front cover.
9. Install the alternator.



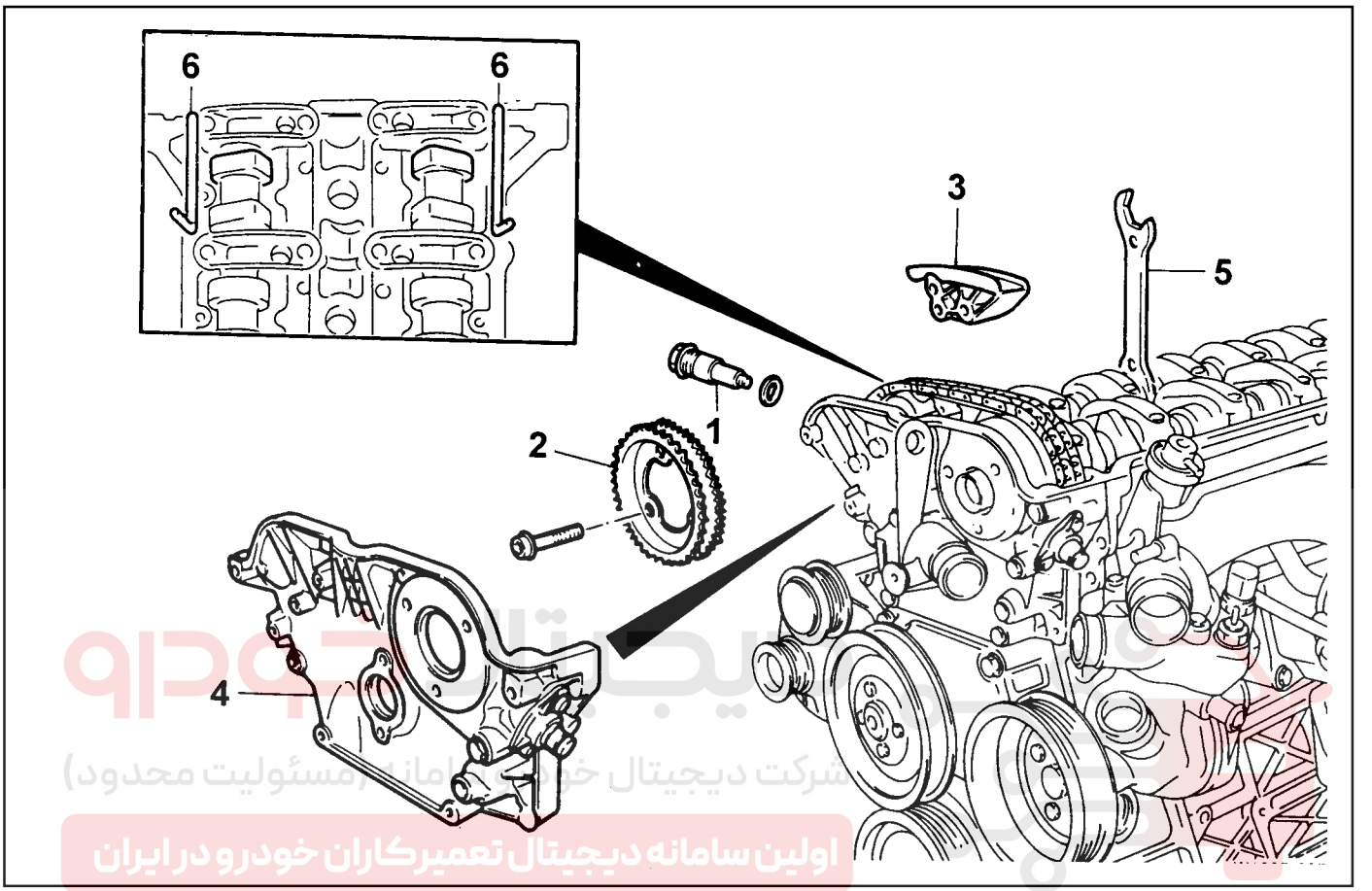
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CAMSHAFT TIMING POSITION

Preceding Work : Removal of cylinder head cover
Removal of cylinder head front cover



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1 Chain Tensioner Assembly
2 Exhaust Camshaft Sprocket
3 Upper Guide Rail
4 Cylinder Head Front Cover
5 Wrench (Special Tool)
6 Adjustment Hole Fitting Pin (f4.0 mm)

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Tools Required

104 589 01 01 00 Spanner

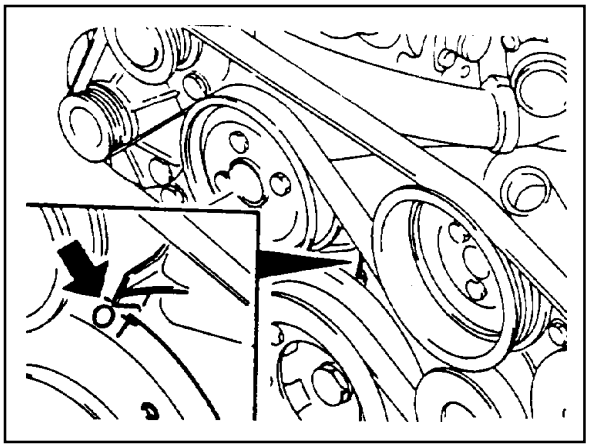
Inspection

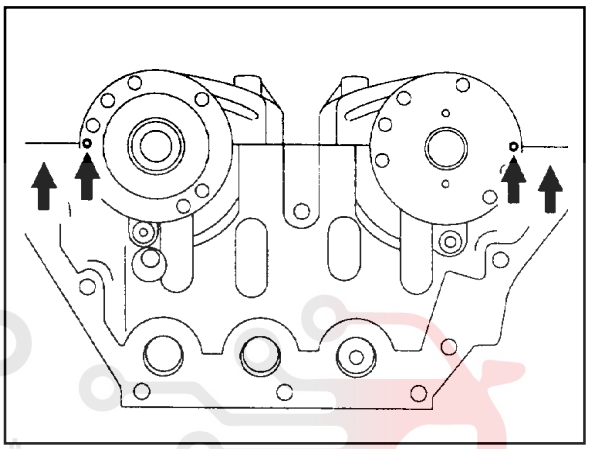
1. Position the No.1 cylinder piston to TDC (OT) by turning the crankshaft.

   Notice

   When the OT mark on vibration damper is aligned with timing gear case cover, the intake and exhaust cam of cylinder will make the slope to the center and will face up. In this way, the adjustment hole of the intake and exhaust camshaft will match in line with the cylinder head upper end, at 3 o'clock, and 9 o'clock direction each other.

2. Check the timing as below procedure;
   - Check if the camshaft adjustment hole is positioned to 3 o'clock direction at the intake side and to 9 o'clock direction at the exhaust side, respectively and align with the cylinder head mating surface.
   - At this condition, check if the OT mark on vibration damper aligns with the marker on the timing gear case.





Adjustment Procedure

1. Position the No.1 cylinder to BTDC 30° .
2. Remove the chain tensioner.
3. Remove the exhaust camshaft sprocket.
4. Align the intake and exhaust camshaft flange hole with the cylinder head upper surface.
   - Intake Side : 3 o'clock direction
   - Exhaust Side : 9 o'clock direction
5. Secure the intake and exhaust camshaft.
6. Position the piston of No.1 cylinder at TDC (OT) by turning the crankshaft.
7. Turn the camshaft adjuster of the intake camshaft to the left as much as possible (cam adjuster 'retarded' position).
8. Install the chain to the intake camshaft sprocket.

   Notice

   Timing chain must be placed on the guide rail in gear case cover.

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9. Install the chain to the exhaust camshaft sprocket and install it to the camshaft.

Installation Notice (Sprocket Bolt)

Tightening Torque	1st step 18 - 22 Nm 2nd step 90° ± 5°

The sprocket bolt is designed to be used only once, so replace with new one.

10. Install the chain tensioner.

Installation Notice

Tightening Torque	Screw Plug	40 Nm
	Tensioner Assembly	72 - 88 Nm

11. Check the camshaft timing.

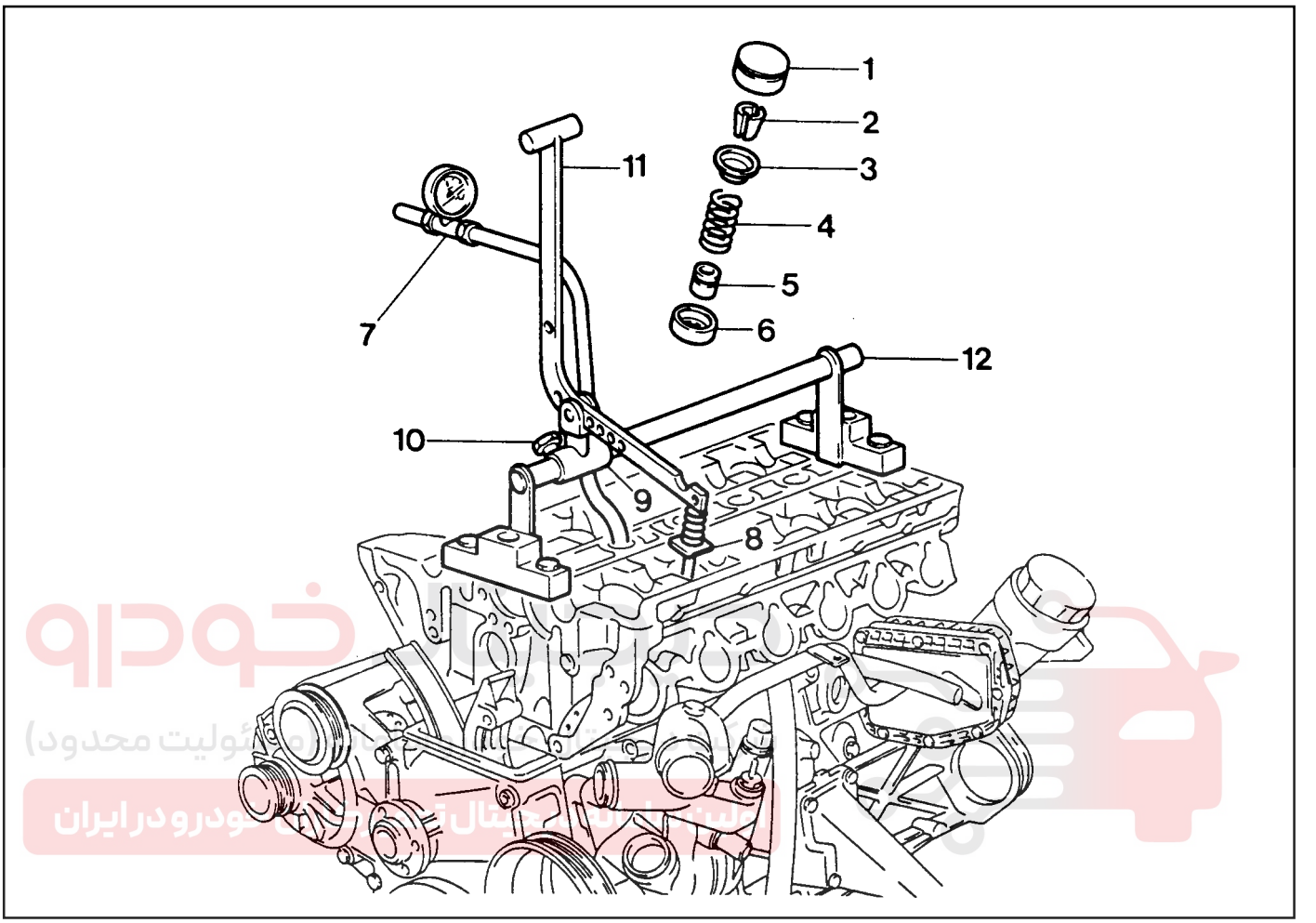
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VALVE SPRING

Preceding Work : Removal of camshaft
Removal of spark plug



1 Valve Tappet Assembly
2 Valve Cotter
3 Upper Retainer
4 Valve Spring ..... Check, Replace if necessary
5 Valve Stem Seal
6 Lower Retainer
7 Connecting Hose
8 Thrust Piece
9 Slide
10 Adjust Bolt
11 Lever Pusher
12 Supporting Bar

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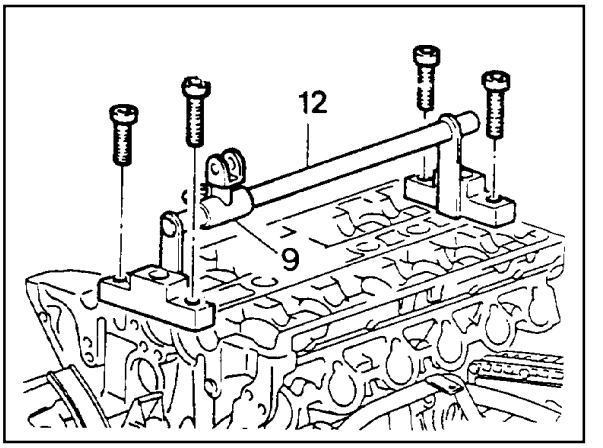
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Tools Required

111 589 01 59 00 Supporting Bar
111 589 18 61 00 Lever Pusher
111 589 25 63 00 Thrust Piece
116 589 06 63 00 Magnetic Finger

Removal & Installation Procedure

1. Place the supporting bar (12) and the slide (9) at the camshaft bearing cap (Nos 1 & 7/8&14) and tighten them with the bearing cap bolt.

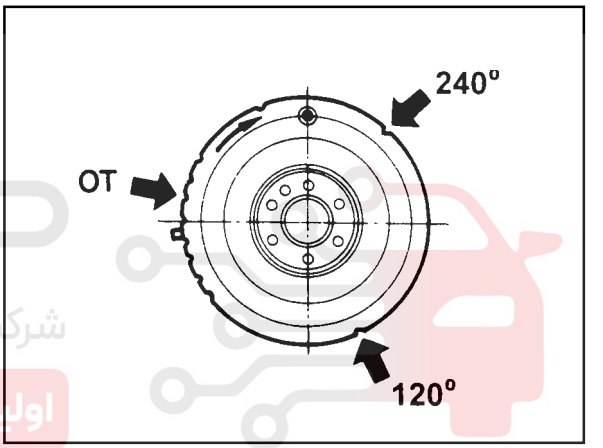


Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Supporting Bar 111 589 01 59 00

2. Turn the crankshaft to position the each cylinder piston at TDC.

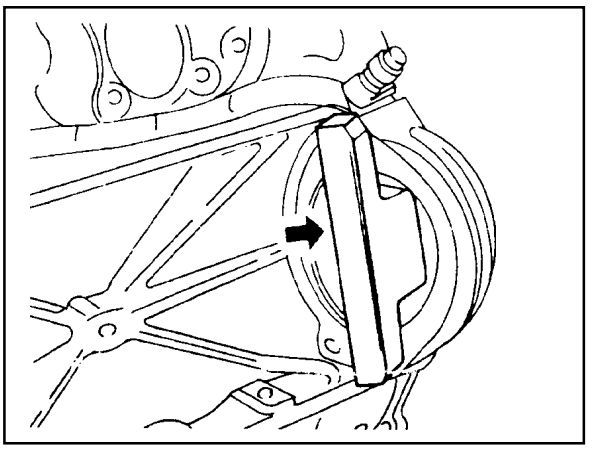


Mark on The Vibration Damper	Cylinder
OT	1, 6
120°	2, 5
240°	3, 4

Notice

- Remove the valve spring only at TDC.
- Always rotate the crankshaft by holding the chain to prevent from timing chain damage and tangling, and for smooth rotation.

3. Remove the valve tappet (1) using the magnetic finger.
4. Install the leakage tester connecting hose to the spark plug hole.
5. Install the engine lock to the ring gear to prevent the crankshaft from rotating.
6. Blow up with compressed air.

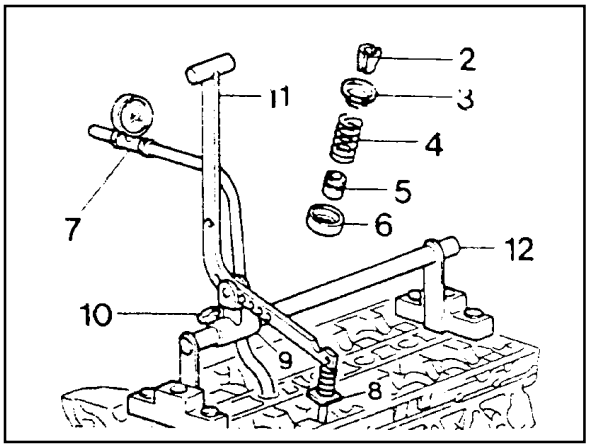


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8. Install the lever pusher (11) and the thrust piece (8) to the slide (9).

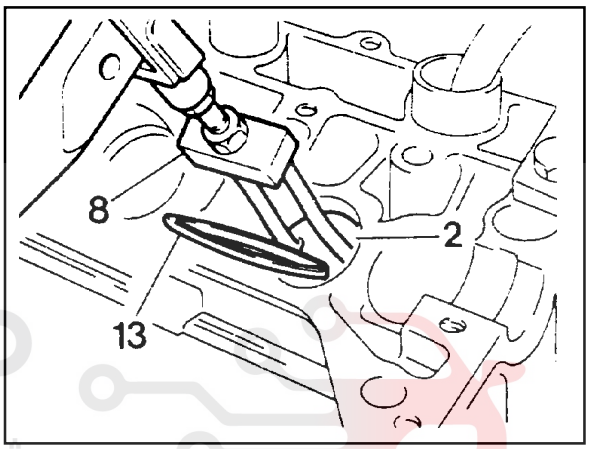
Lever Pusher 111 589 18 61 00



9. Mount the thrust piece (8) vertically to the valve spring retainer (3).
10. Make the thrust piece (8) and the slide (9) perpendicular to each other.
11. Secure the slide (9) by turning the adjust bolt (10).
12. Press the valve spring (4) by using the lever pusher (11).

13. Remove the valve cotter (2) using either the pincette (13) or magnetic finger.

Magnetic Finger 116 589 06 63 00



14. Remove the upper retainer (3) and the valve spring (4).
15. Remove the valve stem seal and replace if necessary.

Notice

Check the valve stem seal and replace if necessary.

16. Remove the lower retainer (6).

Notice

Check the retainer for damages and replace with a new one if necessary.

17. Installation should follow the removal procedure in the reverse order.

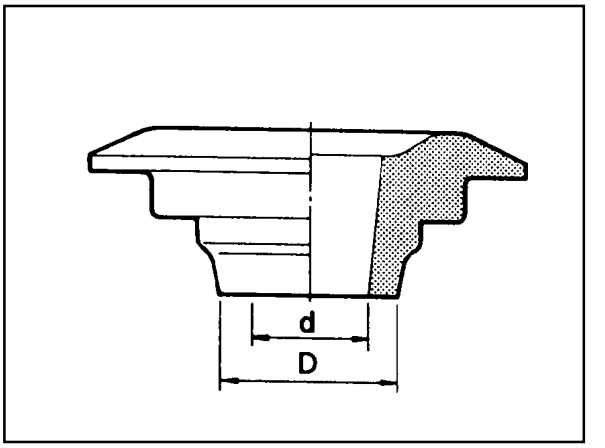
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Test (Upper and Lower Valve Tappet and Valve Cotter)

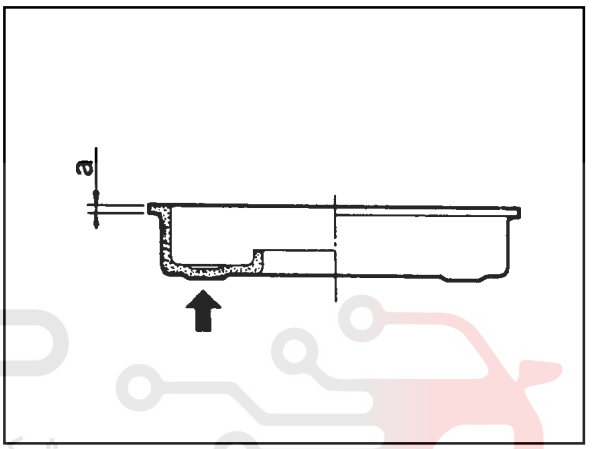
- Upper Valve Spring Retainer

Size (mm)	(d)	8.5
	(D)	12.3



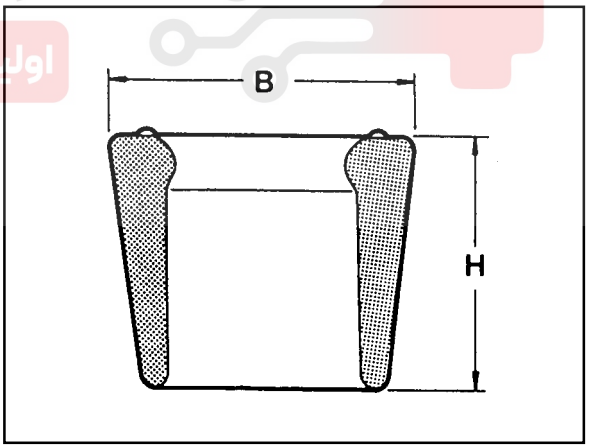
- Lower Valve Spring Retainer

Thickness (mm)	(a)	0.8 - 1.0



- Valve Cotter

Size (mm)	(B)	9.0
	(H)	9.2 - 9.8



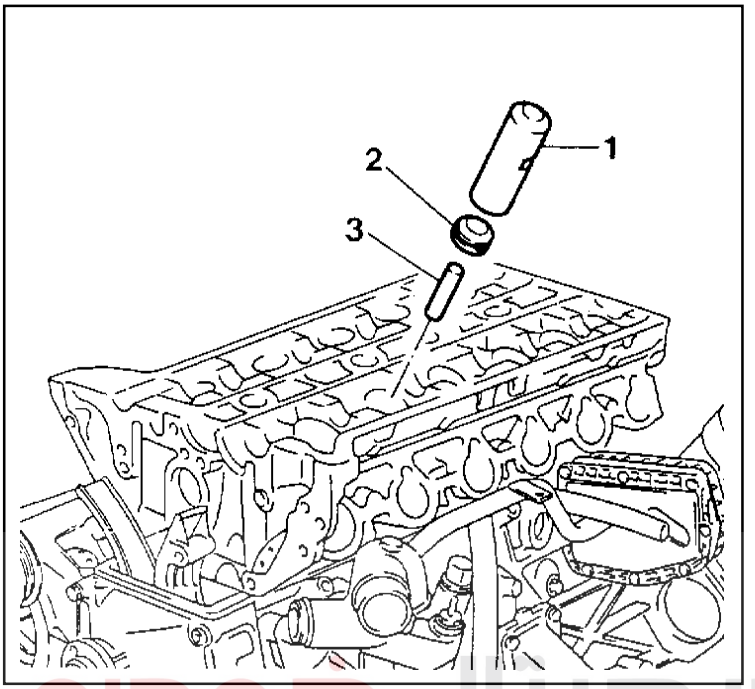
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VALVE STEM SEAL

Preceding Work : Removal of valve spring



1 Drift (Special Tool)
2 Valve Stem Seal
3 Protective Sleeve

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Tools Required

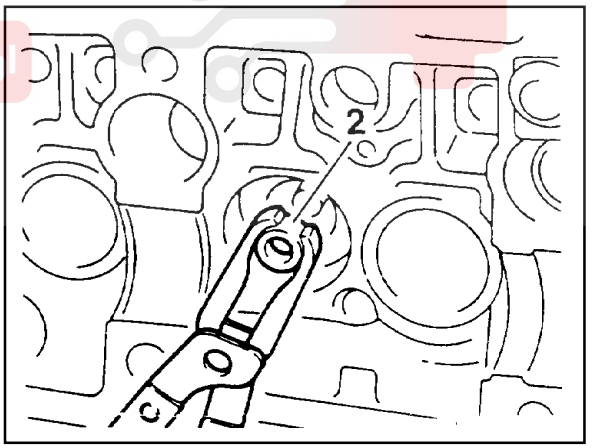
104 589 00 37 00 Pliers
119 589 00 43 00 Drift

Replacement Procedure

1. Remove the valve stem seal (2) using the pliers.

   Notice

   Check the valve stem seal for damage and replace if necessary.



Pliers 104 589 00 37 00

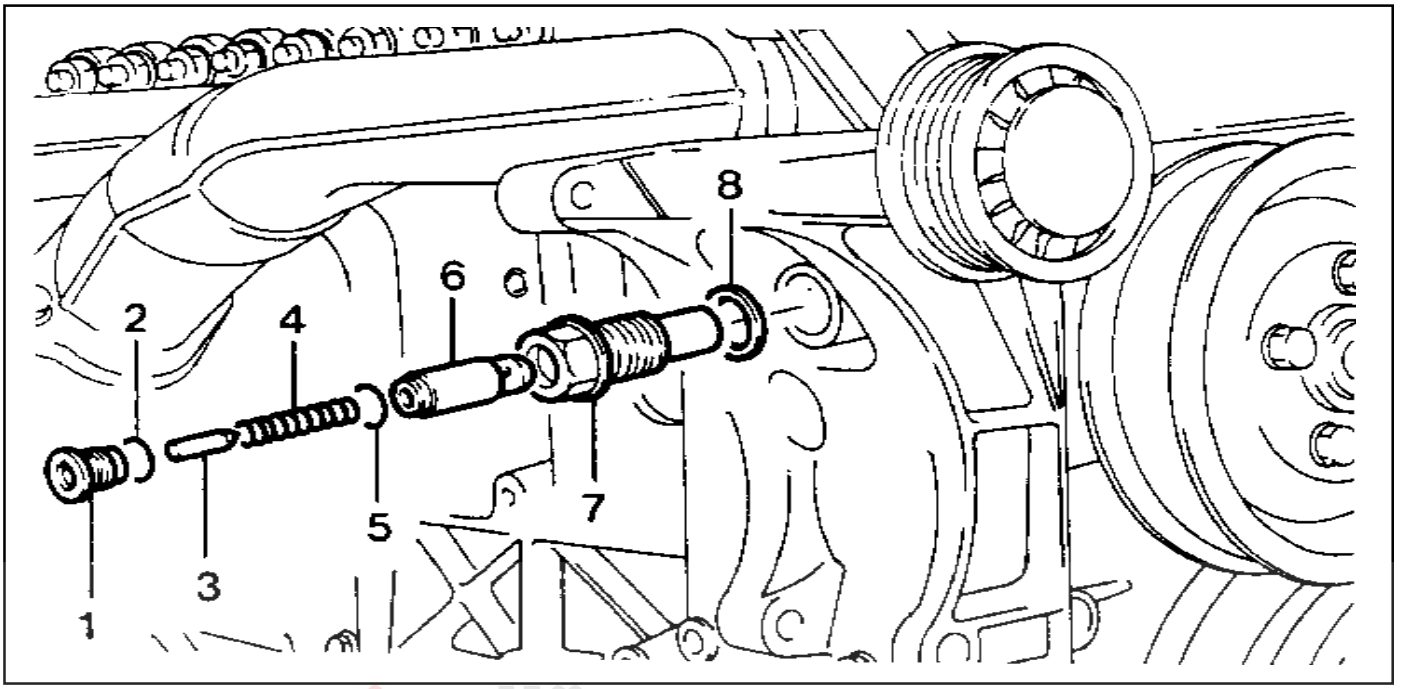
2. Coat the valve stem seal with oil and assemble it with the protective sleeve.
3. Insert the valve stem seal by pressing it with the drift.

Drift 119 589 00 43 00

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CHAIN TENSIONER



1	Screw Plug ..... 40 Nm	5	Snap Ring
2	Seal	6	Thrust Pin
3	Filler Pin	7	Chain Tensioner Housing ..... 72-88 Nm
4	Compression Spring	8	Seal

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Removal Procedure

1. Position the No.1 cylinder to TDC (OT).

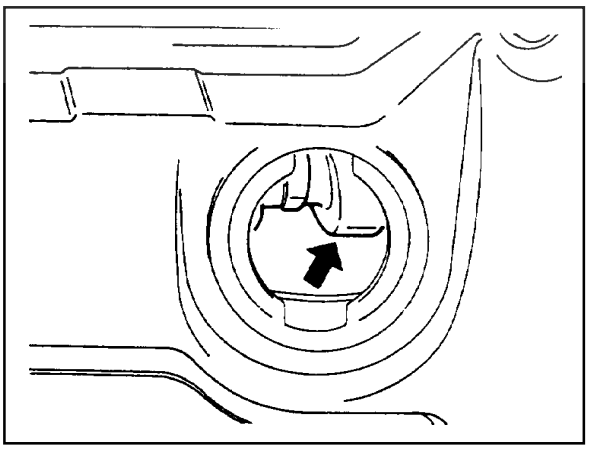
   Notice

   Remove the oil filler cap at adjustment position, and check whether the intake camshaft cam's lobe (arrow) stays in the upper side.

2. Cover the alternator with a clean cloth.
3. Release the tension by unscrewing the screw plug once.

   Notice

   In case that the tension is reduced by unscrewing the screw plug, reinstall after completely removing the chain tensioner. If the chain tensioner is tightened again without completely reducing its tension, then the detent spring doesn't return to the original position and the tension gets excedded.



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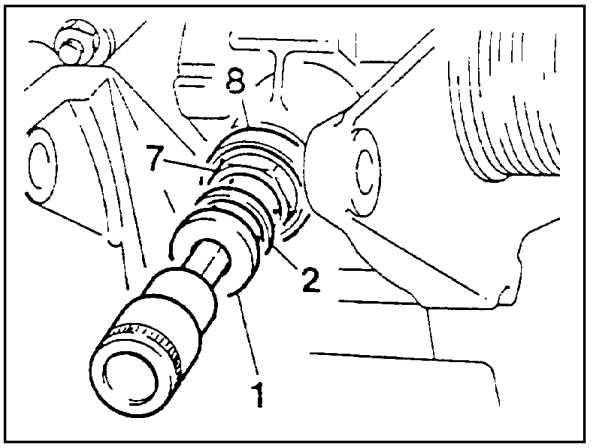
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4. Carefully unscrew the screw plug (1), and remove the seal (2).

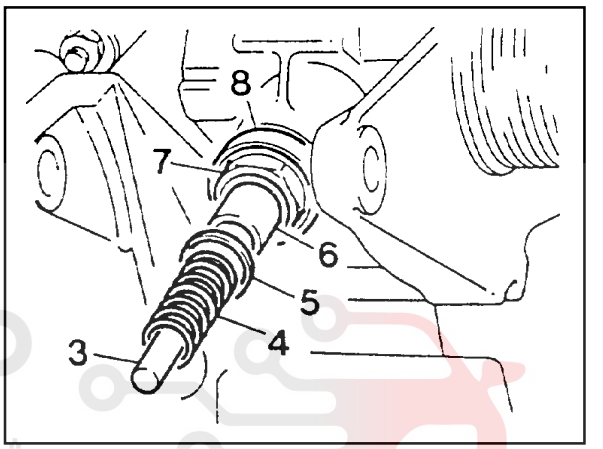
Notice

- For the removal of screw plug, 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.

5. Carefully remove the filler pin (3), compression spring (4), snap ring (5), and the thrust pin (6).



6. Remove the chain tensioner housing (7) and the seal (8).



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Installation Procedure

1. Connect the thrust pin (6) and the snap ring (5) to the chain tensioner housing (7).

Notice

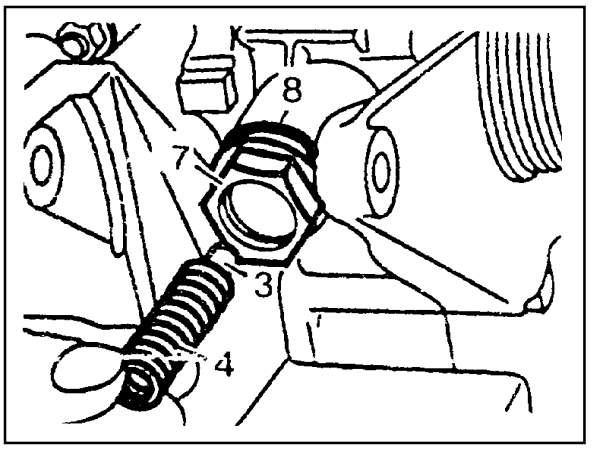
When connecting the thrust pin, push in the thrust pin far enough so that it doesn't protrude at the chain tensioner housing.

2. Install the chain tensioner housing (7), thrust pin (6), snap ring (5), and the seal (8).

Installation Notice

Tightening Torque	35 - 40 Nm

3. Insert the compression spring (4) with the filler pin (3) into chain tensioner housing.



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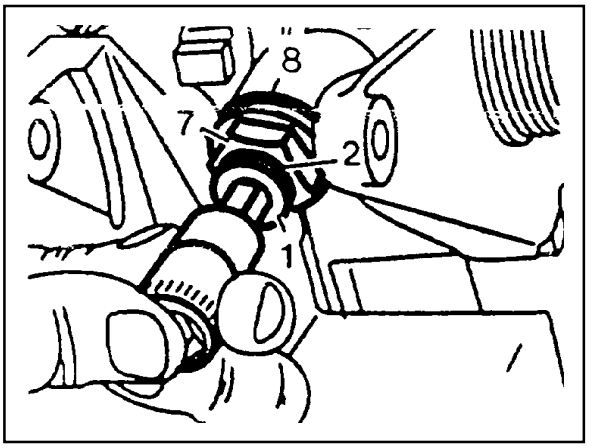
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4. Lightly apply the grease to the seal (2) and install the screw plug (1).

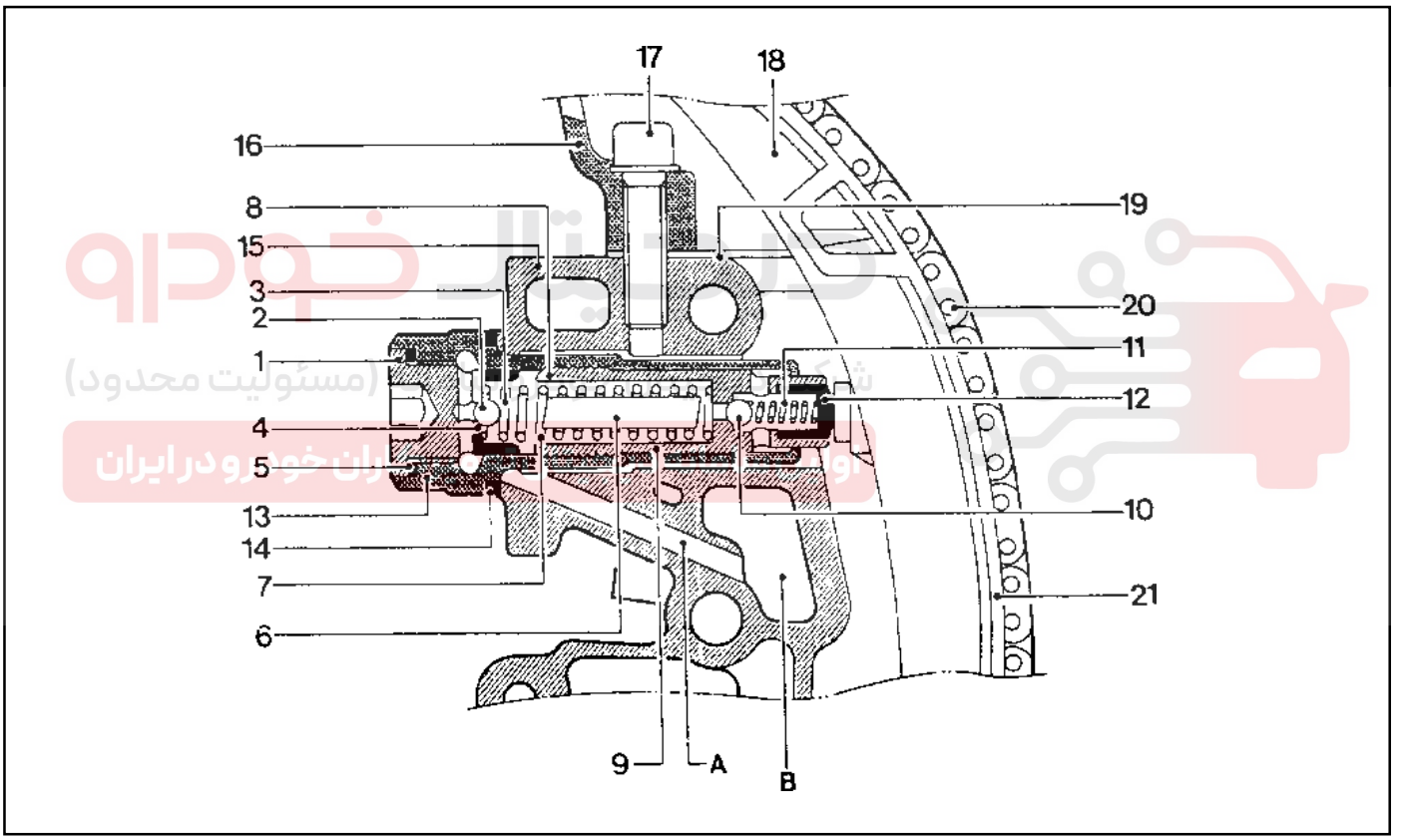
Installation Notice

Tightening Torque	40 Nm

5. Check for leaks by operating the engine.



Sectional View



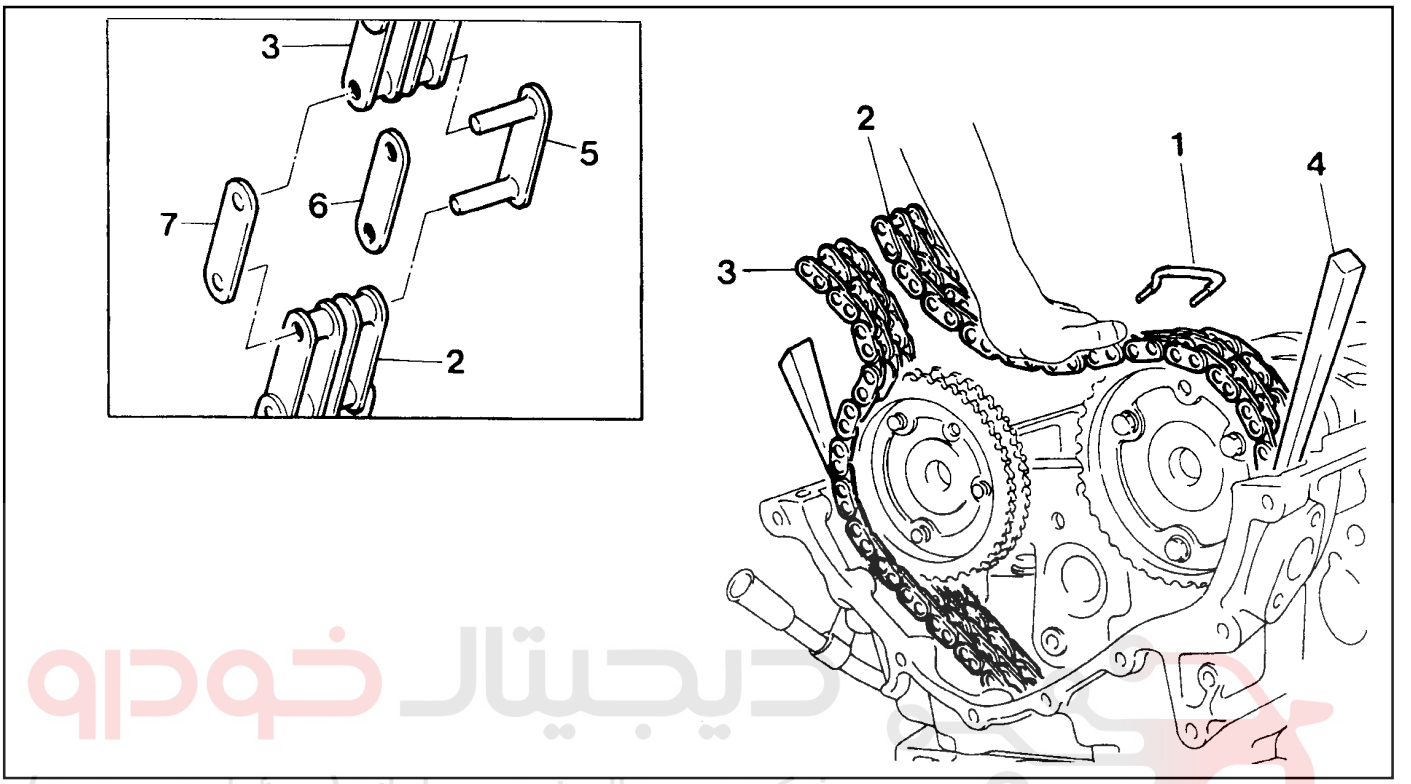
1 Screw Plug
2 Ball (Nonreturn Valve)
3 Compression Spring
4 Ball Guide
5 Seal (Aluminum)
6 Filler Pin
7 Compression Spring
8 Snap Ring
9 Thrust Pin
10 Ball (Nonreturn Valve)
11 Compression Spring
12 Thrust Piece
13 Chain Tensioner Housing
14 Seal
15 Timing Gear Case Cover
16 Cylinder Head
17 Bolt / Washer
18 Tensioning Rail
19 Cylinder Head Gasket
20 Timing Chain
21 Tensioning Rail Base (Sliding Surface)
A Oil Supply Hole
B Chain Tensioner Oil Storage Hole

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TIMING CHAIN

Preceding Work : Removal of cylinder head cover
Removal of spark plug



1 Pin
2 New Timing Chain
3 Timing Chain (Used)
4 Wedge
5 Link
6 Center Plate
7 Outer Plate

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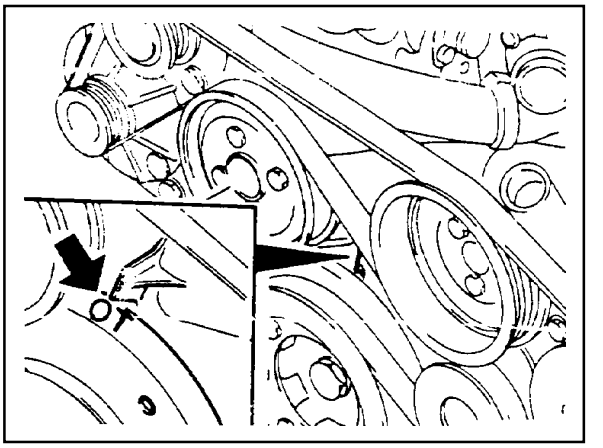
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Tools Required

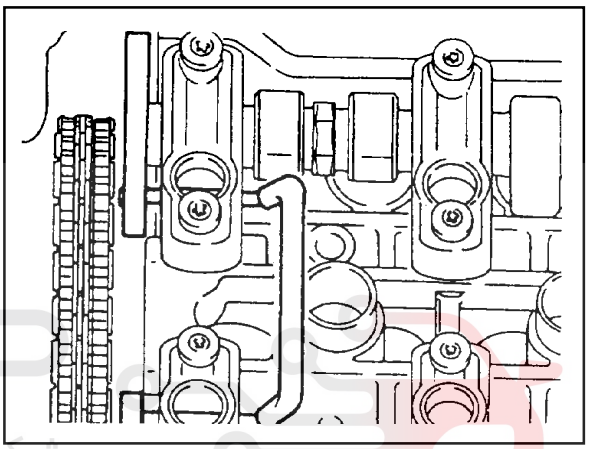
000 589 58 43 00 Chain Assembly
103 589 01 63 00 Rivet Set
001 589 72 21 00 Torque Wrench

Replacement Procedure

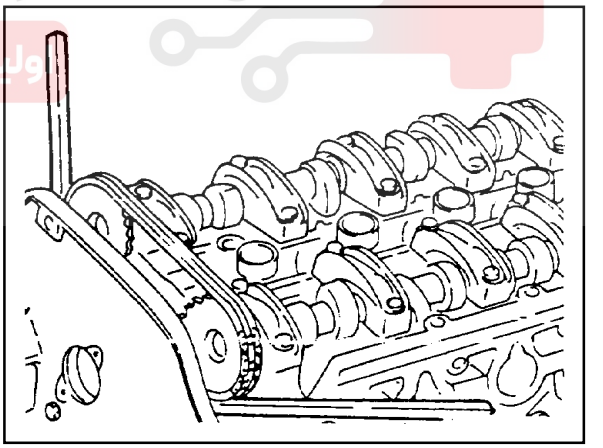
1. Position the No.1 cylinder to TDC (OT).



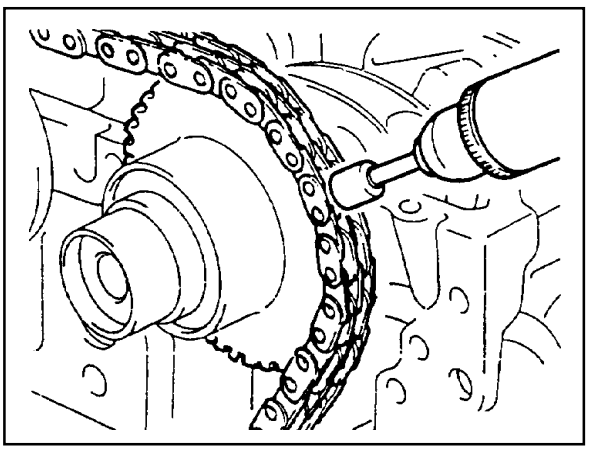
2. Insert the f4mm pin to the intake and exhaust camshaft flange not to rotate camshaft.
3. Remove the chain tensioner.



4. Mount the wedges to both sides of the camshaft sprocket as shown in the figure.



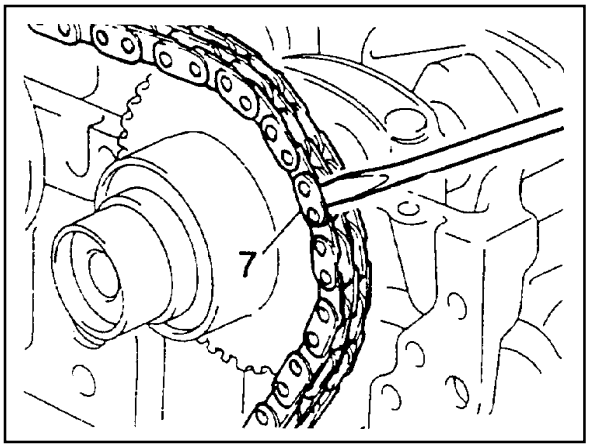
5. Cover the chain housing with a clean cloth, and grind off the timing chain pin from the intake camshaft sprocket with the grinder.



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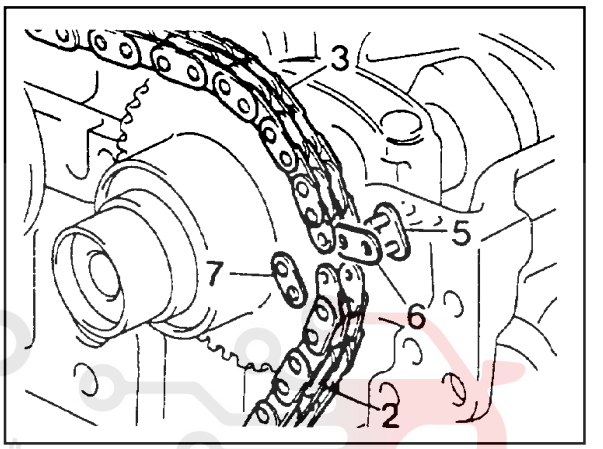
6. Remove the outer plate (7) with the screw driver and remove the link (5).



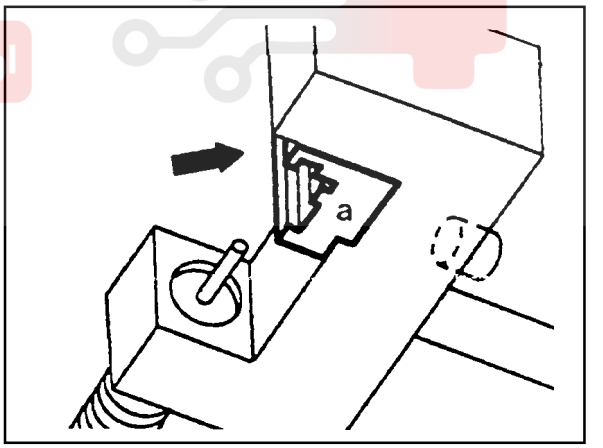
7. Connect the new timing chain (2) to the used timing chain (3) with the link (5), center plate (6, thickness 1.6mm), and the outer plate (7).
8. Rotate the crankshaft in the direction if engine revolution by pressing the new timing chain against the exhaust camshaft sprocket to prevent it to be tangled.

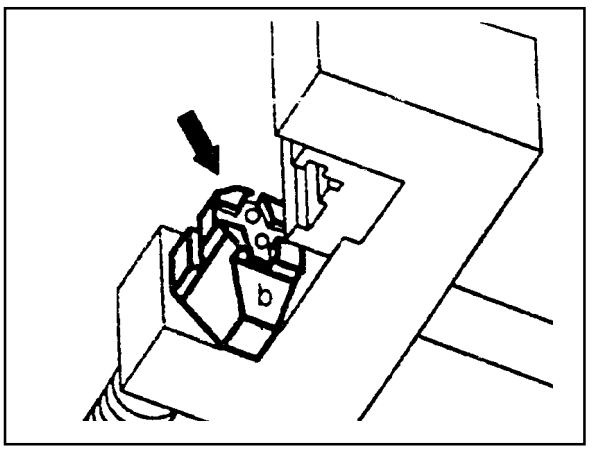
   Notice

   Be sure to remove the wedge before cranking the engine.
9. Take out the used timing chain out from the chain housing.
10. Connect both separators of the new timing chain with the link (5) and the center plate (6).



11. Install the jaw (a) and the thrust piece (b) to the assembly tool as shown in the figures.

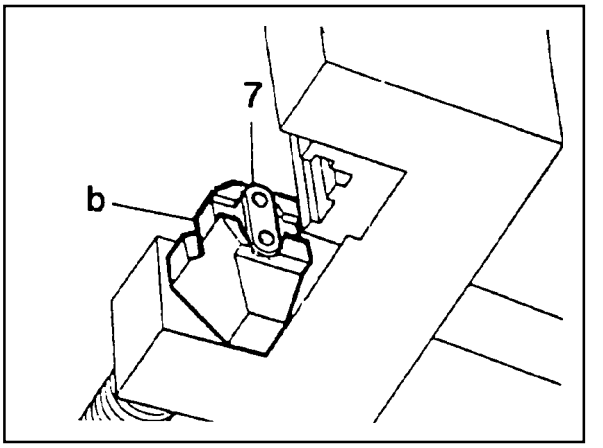




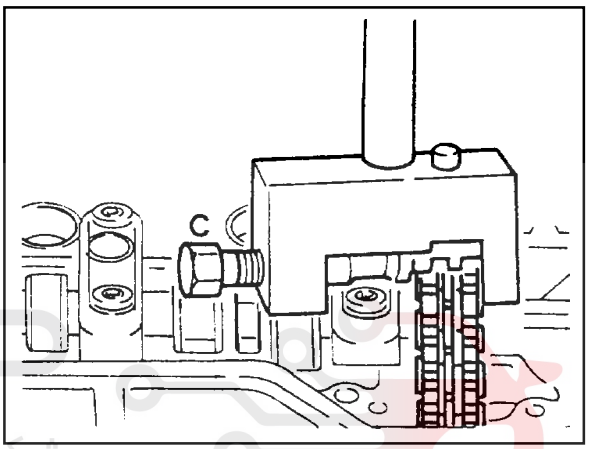
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12. Place the outer plate (7, thickness 1.2mm) inside the thrust piece (b).

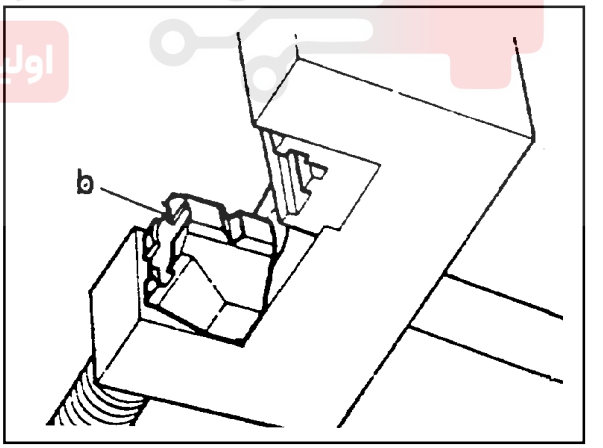


13. Install the assembly tool above the link and tighten the spindle (c) until a block is felt.
14. Place the assembly tool.



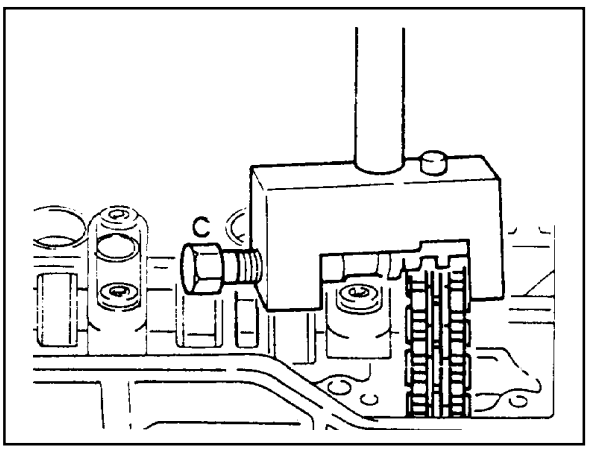
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15. Replace the thrust piece (b) as shown in the figure.



16. Install the assembly tool to the link pin and tighten the spindle (c).

Tightening Torque	30 Nm



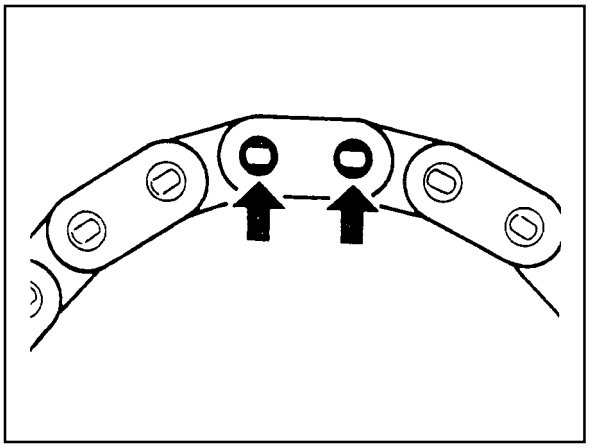
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17. Rivet the link pin.
    Check the condition and it again if necessary.
18. Install the chain tensioner.
    Installation Notice

Tightening Torque	Screw Plug	40 Nm
	Tensioner Assembly	72 - 88 Nm

19. Check the camshaft timing position.



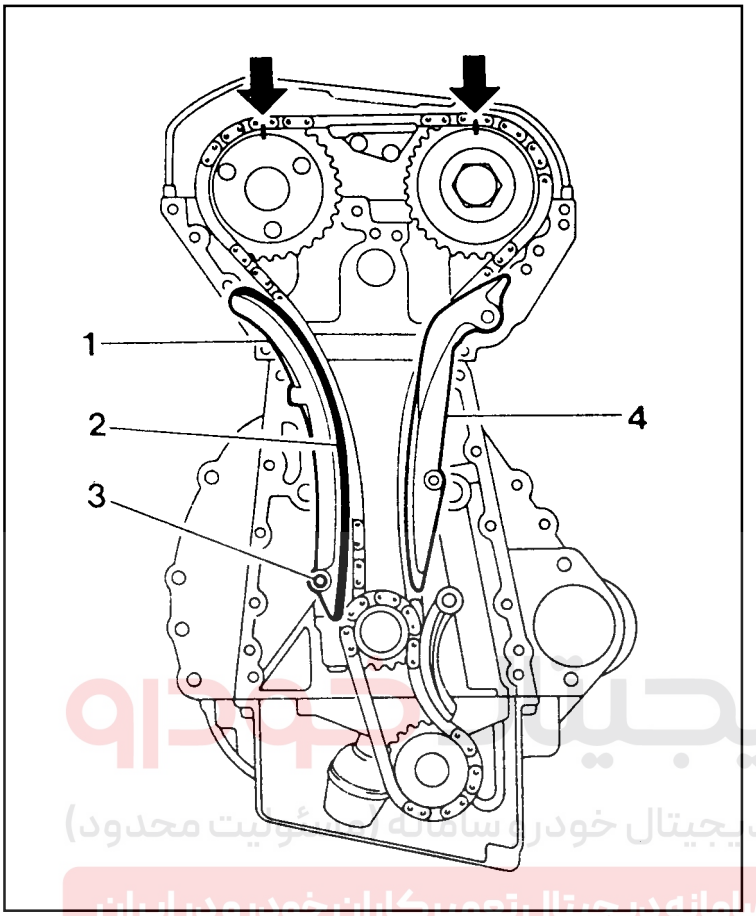
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TENSIONING RAIL

Preceding Work : Removal of timing gear case cover



1 Tensioning Rail
2 Plastic Guide
3 Tensioning Rail Pin
4 Guide Rail

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Removal & Installation Procedure

1. Put the assembly mark at the camshaft sprocket and the timing chain with the paint (arrow).
2. Remove the exhaust camshaft sprocket.
3. Remove the tensioning rail (1) from the tensioning rail pin (3).

   Notice

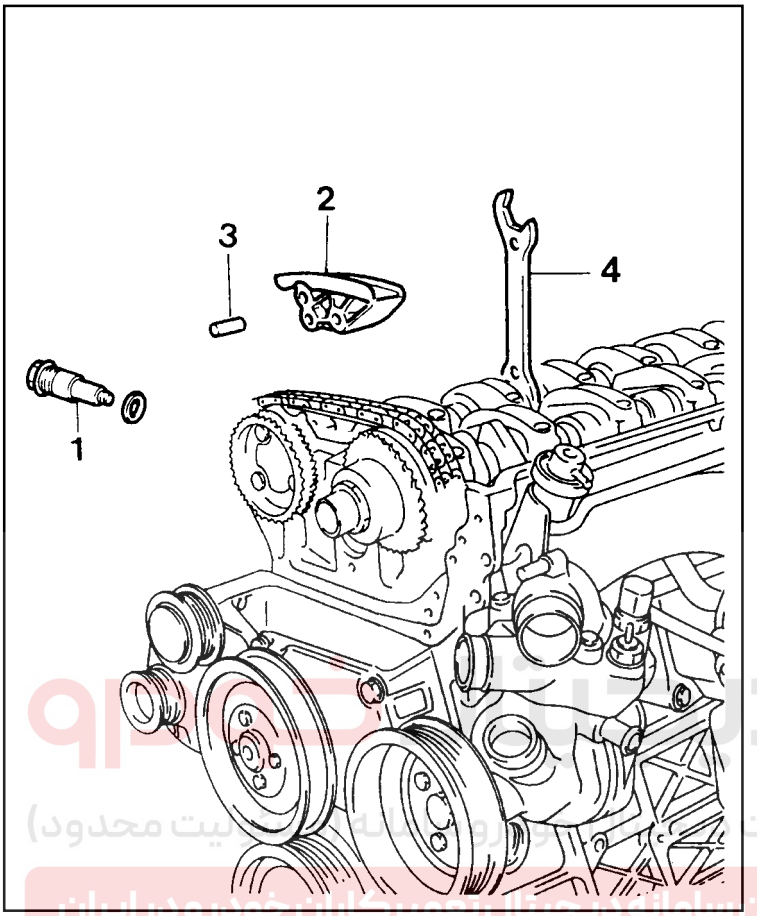
   - Replace the plastic guide (2) if it is damaged.
   - For installation, exactly align the plastic guide (2) with the tensioning rail (1).
4. Installation should follow the removal procedure in the reverse order.
5. Check the camshaft timing position.

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CYLINDER HEAD GUIDE RAIL

Preceding Work : Removal of cylinder head cover



1 Chain Tensioner
2 Upper Guide Rail
3 Upper Guide Rail Pin
4 Wrench (Special Tool)

Tools Required

104 589 01 01 00 Spanner

Removal & Installation Procedure

1. Remove the chain tensioner (1).
2. Turn the exhaust camshaft to the camshaft rotating direction using the wrench (4) and loosen the timing chain at upper guide rail (2).
3. Pull out the upper guide rail pin from the guide rail (2).
4. Turn the exhaust camshaft to the opposite direction of rotation using the wrench (4, special tool : 104 589 01 01 00).
5. Check for damages at the upper sliding rail and replace it if necessary. Install the upper guide rail pin.
6. Install the chain tensioner.

Installation Notice

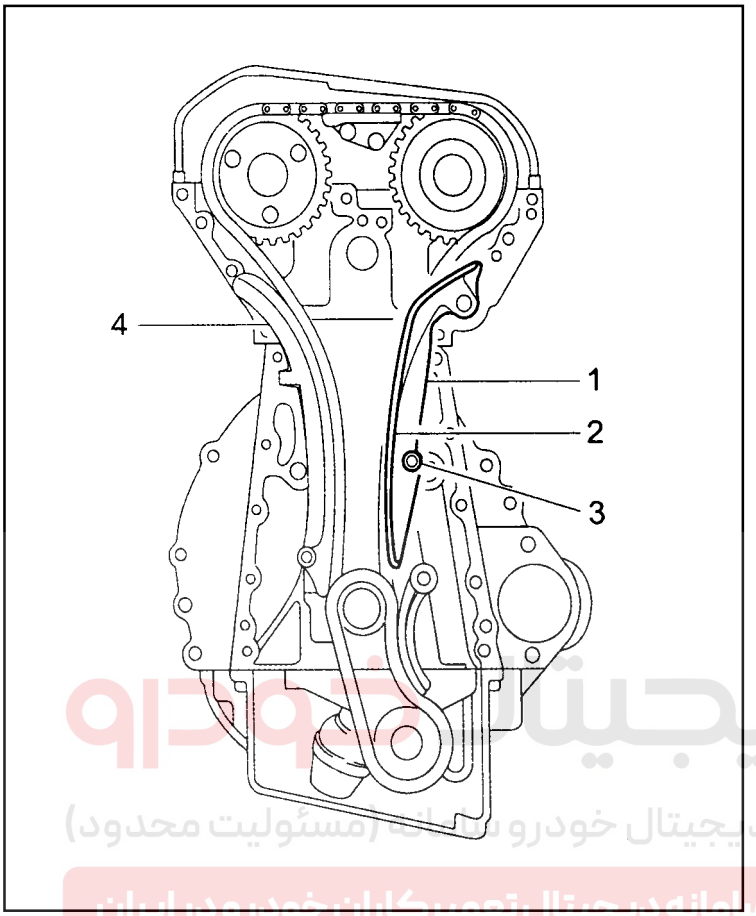
Tightening Torque	Screw Plug	40 Nm
	Tensioner Assembly	72 - 88 Nm

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CRANKCASE GUIDE RAIL

Preceding Work : Removal of timing gear case cover



1 Guide Rail
2 Plastic Guide
3 Guide Rail Pin
4 Tensioning Rail

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Removal & Installation Procedure

1. Put the assembly mark at the camshaft sprocket and the timing chain with the paint (arrow).
2. Remove the exhaust camshaft sprocket.
3. Remove the guide rail (1) from the guide rail pin (3).

   Notice

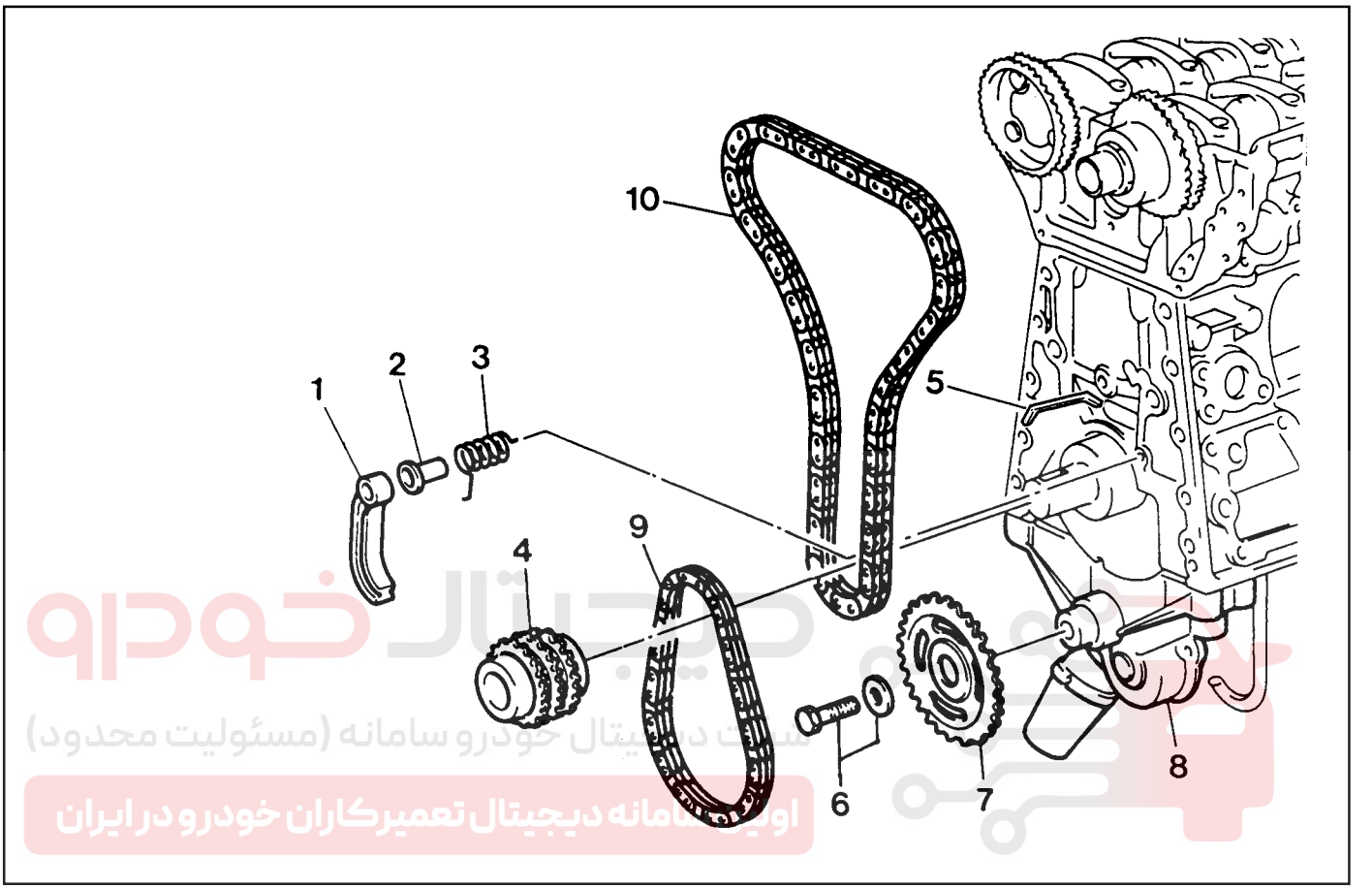
   - Replace the plastic guide (2) if damaged.
   - Connect the plastic guide (2) and the guide rail (1) by aligning them accurately when installing.
4. Installation should follow the removal procedure in the reverse order.
5. Check the camshaft timing position.

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CRANKSHAFT SPROCKET

Preceding Work : Removal of oil pan
Removal of tensioning rail
Removal of crank case guide rail



1 Oil Pump Chain Tensioner
2 Oil Pump Chain Bushing
3 Oil Pump Chain Spring
4 Crankshaft Sprocket
5 Key
6 Bolt (M8 x 20, 1 piece) / Washer ..... 29-35 Nm
7 Oil Pump Sprocket
8 Oil Pump
9 Oil Pump Roller Chain
10 Timing Chain

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Tools Required

615 589 01 33 00 Puller

Removal & Installation Procedure

1. Put the assembly mark at the crankshaft sprocket (4) and the timing chain (10) with the paint (arrow).

   Installation Notice

   Align the assembly marks on cranshaft sprocket and timing chain. Also, align the assembly marks on camshaft sprocket and timing chain when installing.

2. Unscrew the bolt (6) and remove the oil pump sprocket (7) from the oil pump.

   Installation Notice

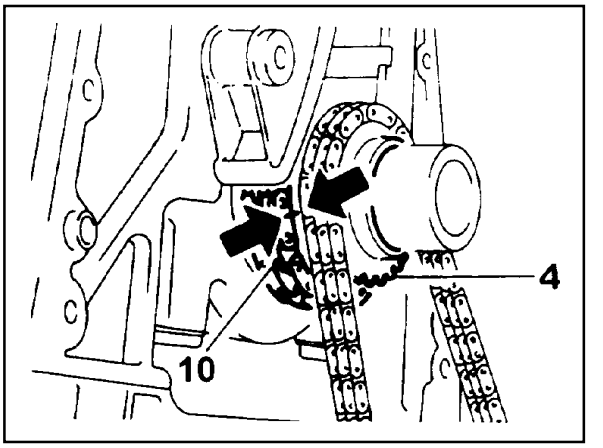
Tightening Torque	29 - 35 Nm

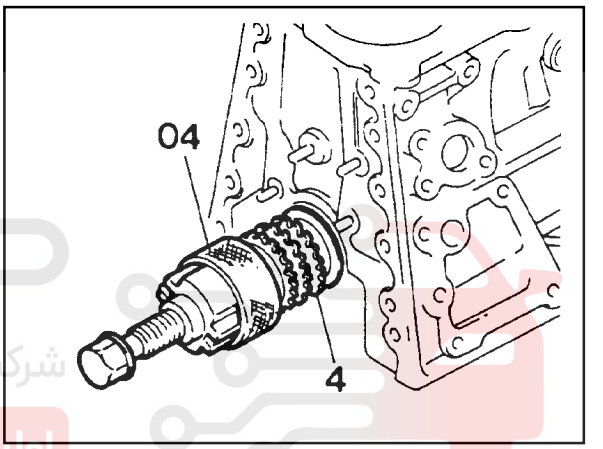
3. Remove the oil pump roller chain (9).
4. Remove the oil pump chain tensioner (1), oil pump chain bushing (2), and the oil pump chain spring (3).
5. Remove the crankshaft sprocket (4) using the puller (04, special tool).

   Notice

   - Make sure not to lose the crankshaft pulley key(5) when removing.
   - Install the crankshaft sprocket(4) after warming it up.

6. Installation should follow the removal procedure in the reverse order.





Puller (04) 615 589 01 33 00

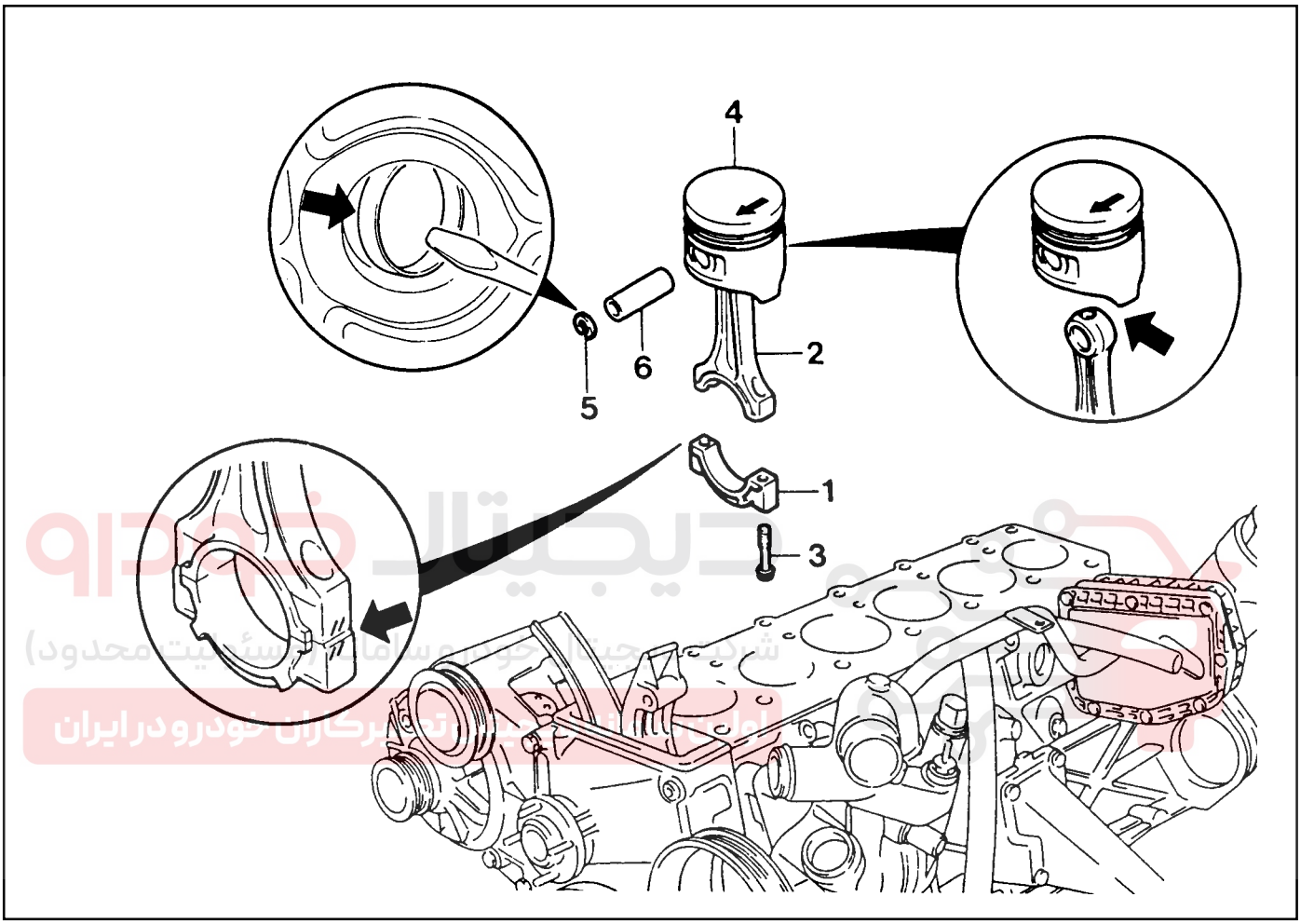
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PISTON

Preceding Work : Removal of engine
Removal of cylinder head
Removal of oil pan
Removal of oil pump
Removal of baffle plate



1 Connecting Rod Bearing Cap
2 Connecting Rod
3 Connecting Rod Bolt (M9 x 52, 12 pieces)
..... 1st step 40 Nm
2nd step 90° + 5°
4 Piston
5 Snap Ring
6 Piston Pin

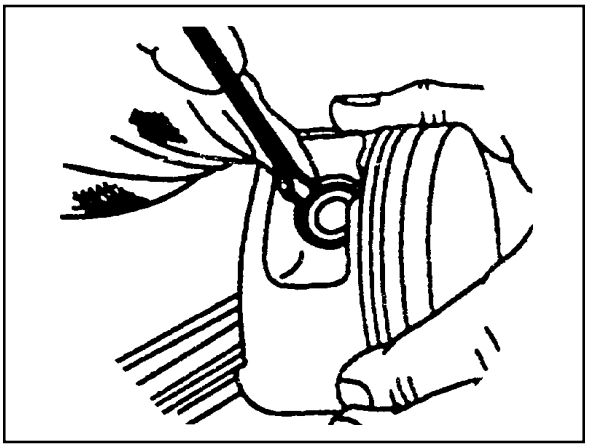
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Tools Required

001 589 72 21 00 Torqued Wrench

000 589 04 14 00 Clamping Strap



Removal Procedure

1. Unscrew the connecting rod bolt (3) and remove the cap.
2. Remove the connecting rod and the piston upward.

   Notice

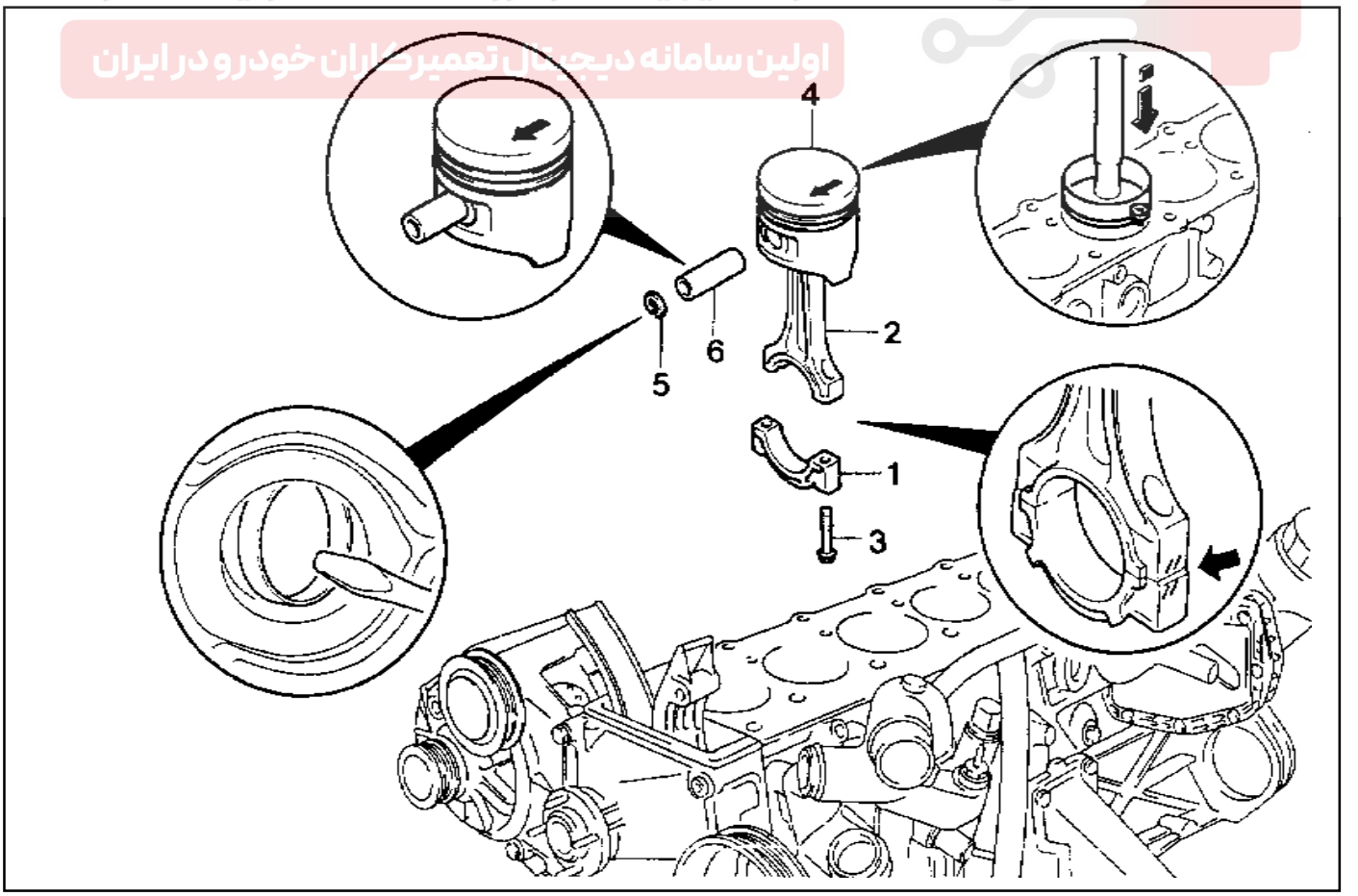
   Make sure that the bearing cap and shell are not changed each other.
3. Remove the snap ring (5) and pull out the piston pin (6).

   Notice

   Remove the snap ring using a clean cloth as shown in the right picture so that the piston, piston ring, and the snap ring don't get damaged.

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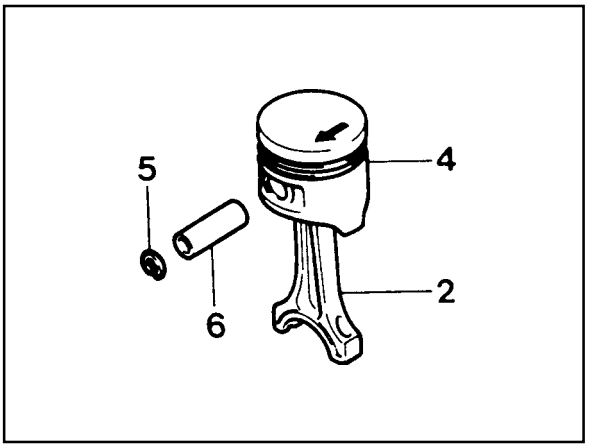
Installation Procedure



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1. Check the piston ring gap and apply the engine oil to the piston pin and the connecting rod bushing.
2. Connect the piston and the connecting rod by pressing in the piston pin (6) and install the snap ring to the groove.
3. Clean the cylinder bore, connecting rod bearing journal, connecting rod bearing shell and the piston and coat them with engine oil.
4. Install the piston ring using the tensioning strap(000 589 04 14 00).
5. Install the piston so that the arrow on the piston head faces to the forward of the vehicle.
6. After aligning the connecting rod and the bearing cap mark (// or a number), tighten the bolts.



Installation Notice

Tightening Torque	1st step 35 - 45 Nm 2nd step 90° + 5°

Apply the engine oil to the bearing cap upper and lower bearing shells.

7. Check if the crankshaft rotates without any trouble by rotating it.

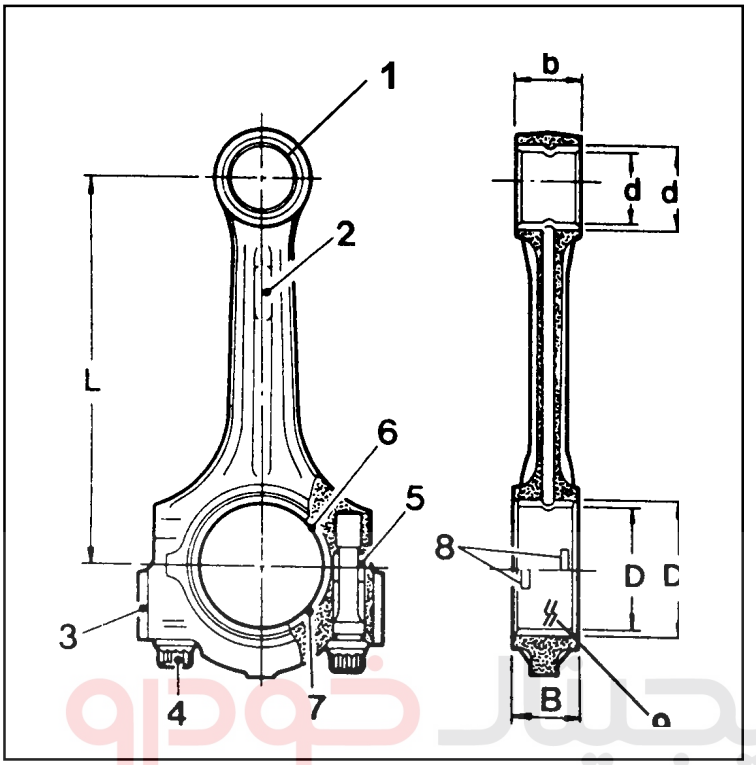
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CONNECTING ROD

Preceding Work : Removal of piston



1 Connecting Rod Bushing
2 Oil Gallery
3 Balance Weight
4 Connecting Rod Bolt
(M9 x 52, 12 m pieces) .. 1st step 40+5 Nm
2nd step 90°+10°
5 Fit Sleeve
6 Upper Connecting Rod Bearing
7 Lower Connecting Rod Bearing
8 BearingShell Lug
9 Marking [Indication(//) or Numbers]

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Service Data Standard

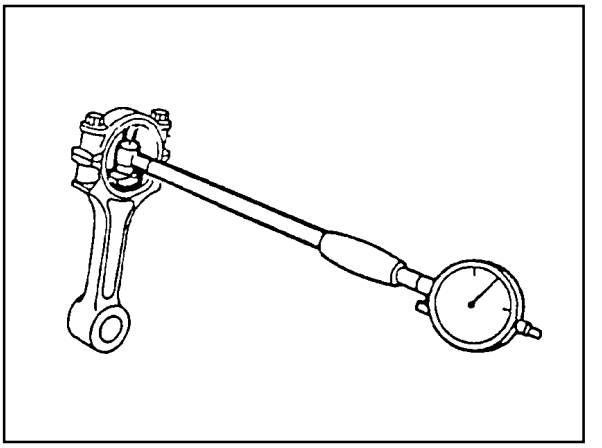
Distance (L) from The Connecting Rod Bearing Bore Center to The Bushing Bore Center	145 ± 0.05 mm
Width of The Connecting Rod (B) at Bearing Bore	21.940 - 22.000 mm
Width of The Connecting Rod (b) at Bushing Bore	21.940 - 22.000 mm
Basic Bore at The Bearing Shell (D1)	51.600 - 51.614 mm
Basic Bore at The Bushing (d1)	24.500 - 24.571 mm
Bushing Inner Diameter (d)	22.007 - 22.013 mm
Clearance Between The Piston Pin and The Bushing	0.007 - 0.018 mm
Peak-to-valley Height of Connecting Rod Bushing on Inside	0.005 mm
Permissible Wwist of Connecting Rod Bearing Bore to Connecting Rod Bushing Bore	0.15 mm
Permissible Deviation of Axial Paralleism of Connecting Rod Bearing Bore to Connecting Rod Bushing Core	0.07 mm
Permissible Deviation of Connecting Rod Bearing Bore from Concentricity	0.01 mm
Permissible Difference of Each Connecting Rod in Weight	0.4 g

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Inspection

1. Measure the basic bore of the connecting rod bearing.

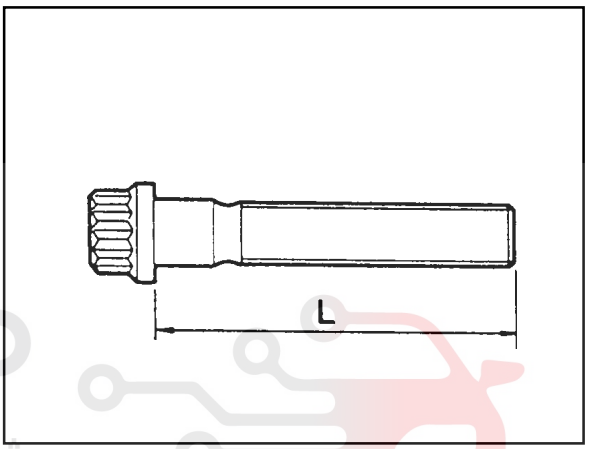


Notice

If the basic bore exceeds the value of 51.614mm, replace the bearing or check the connecting rod.

2. Check connecting rod bolts.

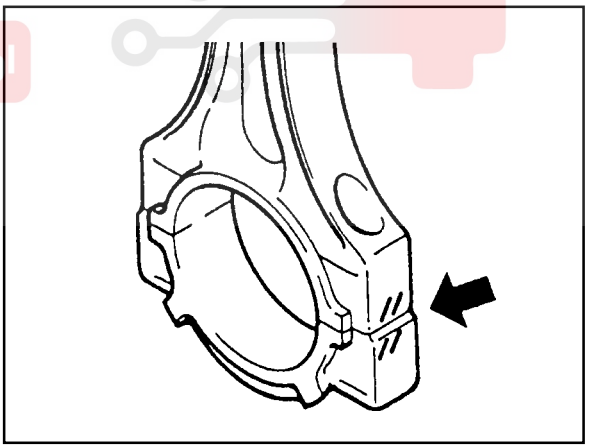
Length When New (L)	51.7 - 52 mm
Max. Length (L)	52.9 mm
Tightening Torque	1st step 40 + 5 Nm
	2nd step 90°+10°



Notice

If the length exceeds max. length, replace it.

3. Check the assembly mark(indication//or number:arrow) of the connecting rods and the bearing cap when installing.



Notice

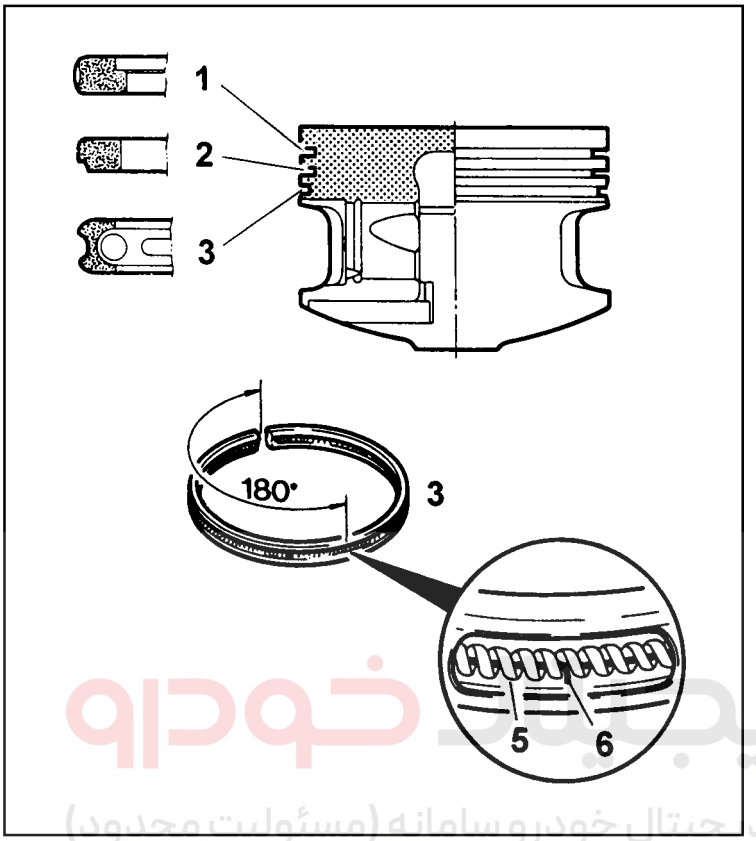
- Make sure it doesn't exceed over 4g with other connecting rods when replacing the connecting rods.
- Check if the connecting rod and the bearing cap are accurately seated on the groove when replacing the bearing.

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PISTON RING

Preceding Work : Removal of piston



1 Piston Compression Ring
2 Piston Compression Ring
3 Piston Oil Ring
4 -
5 Coil Spring and Control Ring
6 Hook Spring

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Tools Required

000 589 51 37 00 Clamping Strap

Replacement Procedure

1. Measure the piston ring's gap.

End Gap of The Piston Ring	Groove 1 0.20 - 0.40 mm
	Groove 2 0.20 - 0.40 mm
	Groove 3 0.20 - 0.45 mm
Gap Between The Piston and The Piston Ring	Groove 1 0.015 - 0.050 mm
	Groove 2 0.020 - 0.040 mm
	Groove 3 0.010 - 0.045 mm

Notice

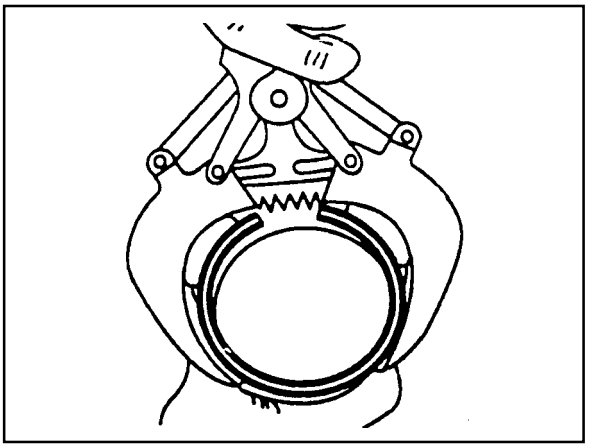
If out of specification, replace the piston ring.

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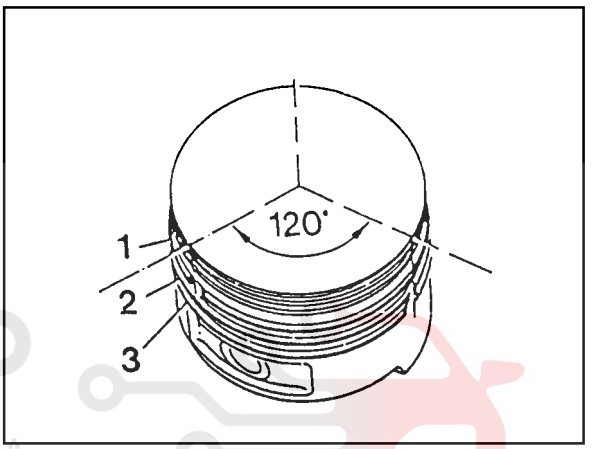
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2. Remove the piston ring with a pliers.

Clamping Strap 000 589 51 37 00



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.
4. Adjust the hook spring joint in the oil ring 180° away from the ring end.

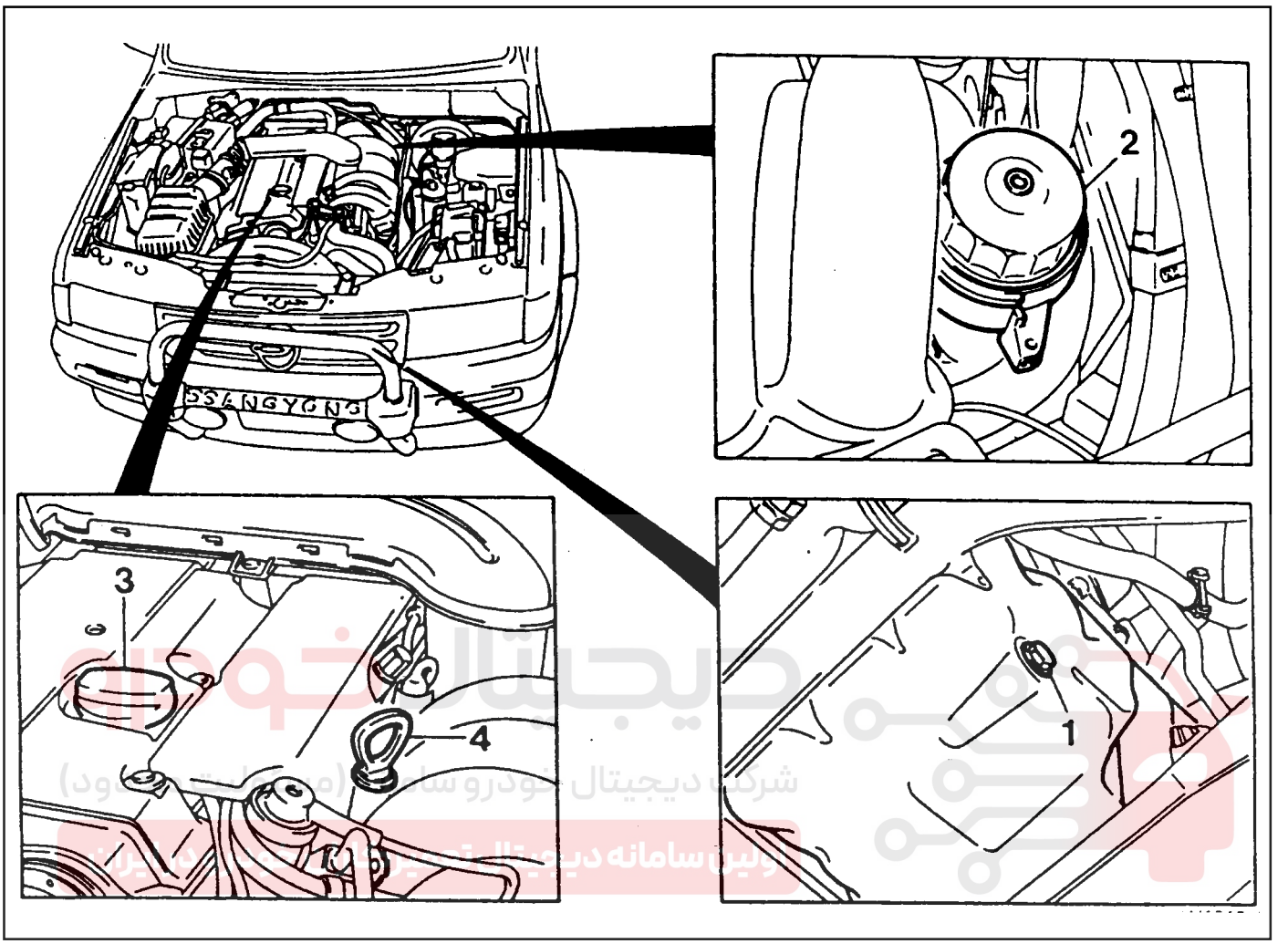


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ENGINE OIL SPECIFICATION



1 Drain Plug ..... 25 Nm
2 Oil Filter
3 Engine Oil Filler Cap
4 Dipstick Gauge

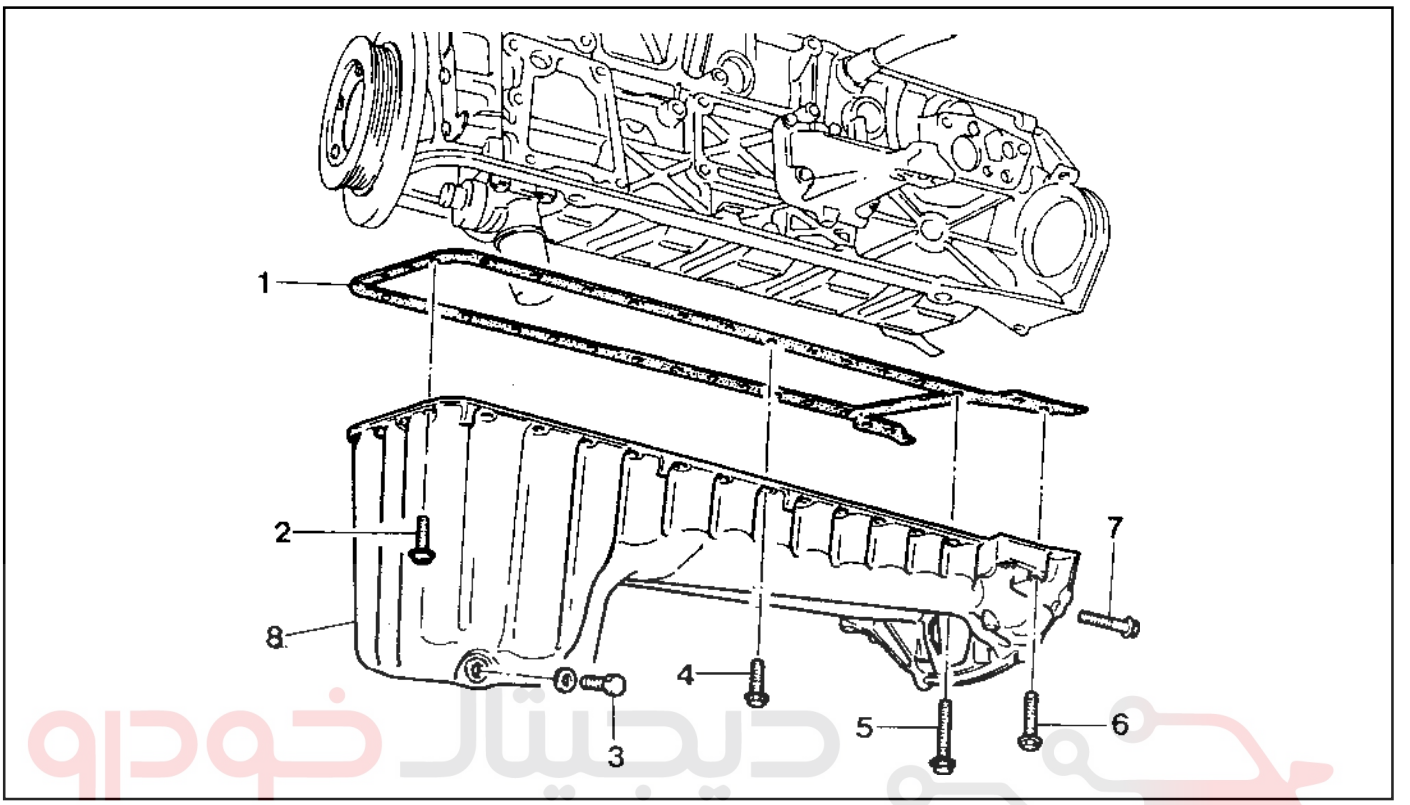
Specifications

Application	Descrition
Capacity	Min : 6.7L, Max : 8.2L
Quality	● API SH or above grade
	● ACEA : A2 or A3
	● Approved oil by MB Sheet 229.1
Viscosity	● Approved oil by MB Sheet 224.1
Replacemant	● Initial at 1000-1500km, Replace every 15000km

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OIL PAN



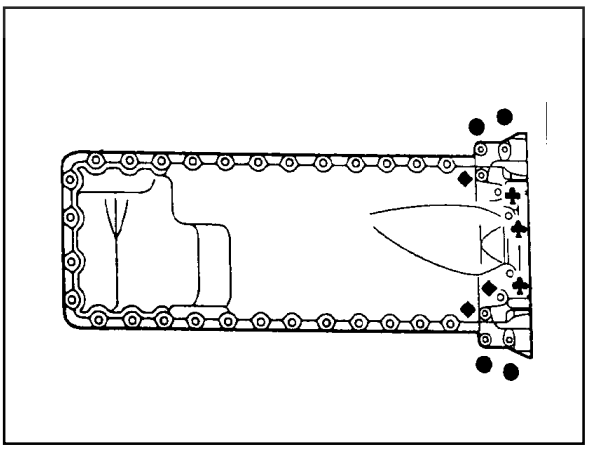
1	Gasket	Replace	5	Bolt (M6 x 85)	10 Nm
2	Bolt (M6 x 22, 6 pieces)	10 Nm	6	Bolt (M8 x 40)	25 Nm
3	Drain Plug (M6 x 20)	25 Nm	7	Bolt (M10)	40 Nm
4	Bolt (M6 x 20, 22 pieces)	10 Nm	8	Oil Pan	

Removal & Installation Procedure

1. Remove the drain plug and drain the oil completely.
2. Disconnect the electric connector from oil level switch.
3. Unscrew the bolts (10) for oil level switch and check the O-ring (11) for wear or damage. And replace it if necessary.
4. Unscrew the bolts and remove the oil pan and gasket.

   Notice

   Arrange the bolts according to each size.
5. Clean the inside of oil pan and sealing surface, then apply the sealant.
6. Replace the gasket with new one.
7. Install the oil pan with gasket, and tighten each bolt in specified torque.
8. Check for oil leaks while running the engine.

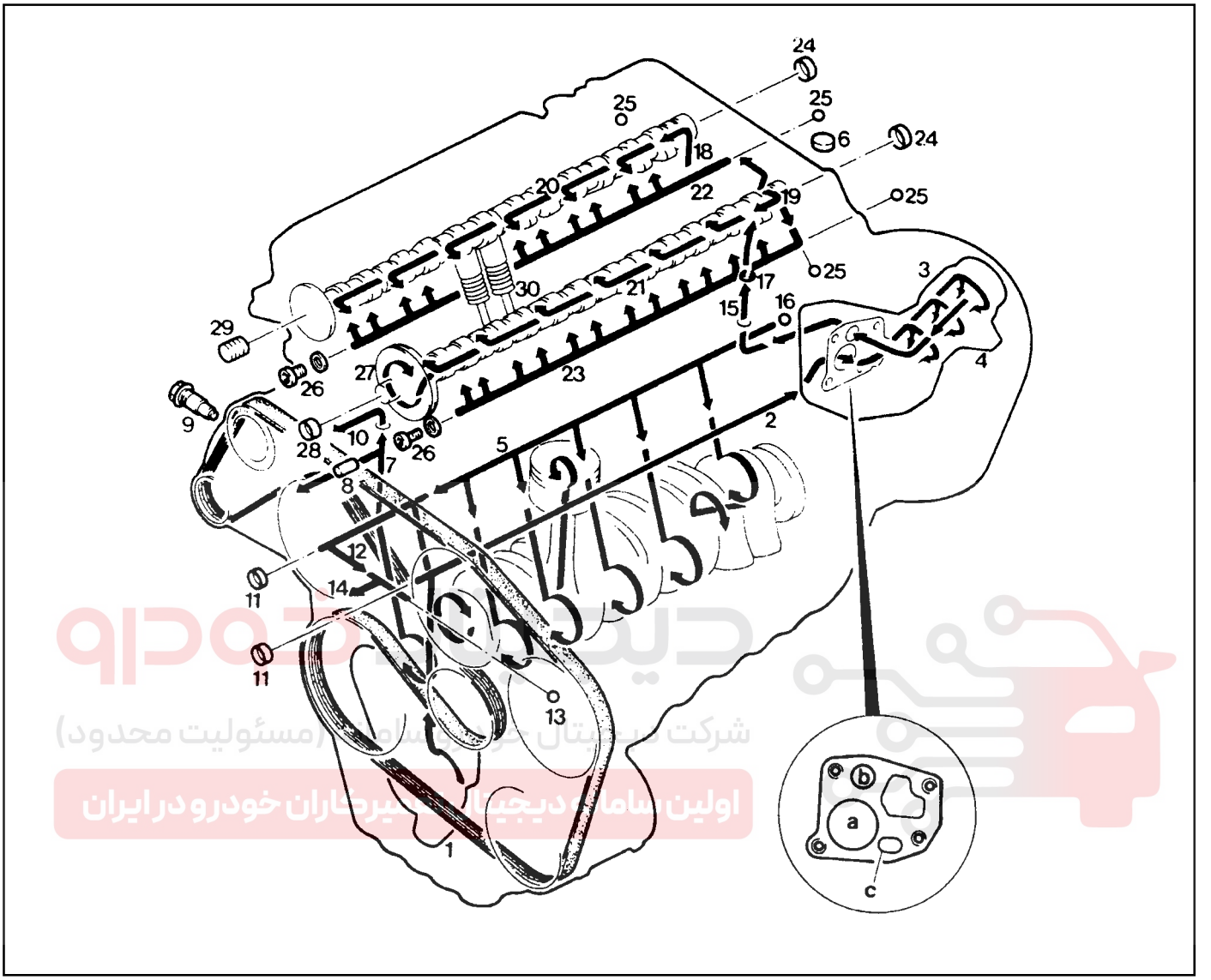


●	M8 X 40, 4 pieces
♣	M6 X 85, 3 pieces
◆	M6 X 35, 3 pieces
the rest	M6 X 20, 28 pieces

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Oil Circulation



1 Oil Pump
2 Oil Gallery (to oil filter)
3 Oil Filter
4 Oil Pressure Switch
5 Main Oil Gallery
6 Cylinder Head Closing Cover
7 Oil Gallery (At Chain Tensioner)
8 Oil Non-return Valve
9 Chain Tensioner
10 Vent (Chain Tensioner)
11 Front Closing Cover (f 17 mm)
12 Oil Gallery (Perpendicular to The Shaft)
13 Ball (f 6 mm)
14 Oil Spray Nozzle (Timing Chain)
15 Oil Gallery (At Cylinder Head)
16 Ball (f 15mm)
17 Oil Restriction Inner (f 4mm)
18 Oil Supply (To Exhaust Camshaft)
19 Oil Supply (To Intake Camshaft)
20 Oil Supply (To Exhaust Camshaft Bearing)
21 Oil Supply (To Intake Camshaft Bearing)
22 Oil Gallery (Oil Supply to Exhaust Valve Tappet)
23 Oil Gallery (Oil Supply to Exhaust Valve Tappet)
24 Camshaft Closing Cover
25 Ball (f 8 mm)
26 Screw Plug
27 Camshaft Adjuster
28 Front Closing Cover (Intake Camshaft)
29 Front Treaded Bushing (Exhaust Camshaft)
30 Valve tappet

a Oil Gallery (From Oil Pump to Oil Filter)
b Main Oil Gallery
c Oil Return Line (Oil Returns to the Oil Pan when Replacing the Filter Element)

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ENGINE OIL AND OIL FILTER ELEMENT

Tools Required

103 589 02 09 00 Oil Filter Socket Wrench

Replacement Procedure

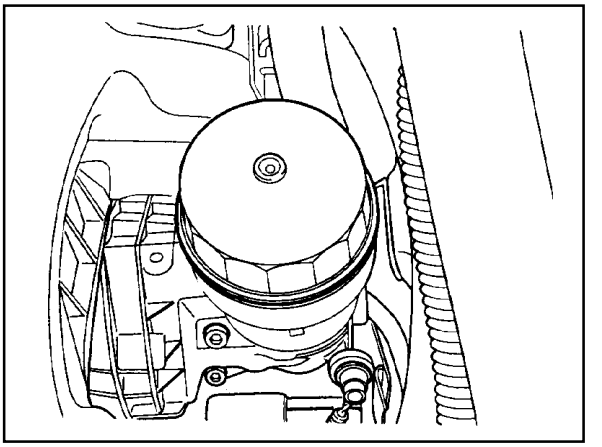
1. Install the socket wrench"7" (special tool : 103 589 02 09 00) on the oil filter cover (2).

   Notice

   Make the screw cover removable by tightening the bolt at the side of the socket wrench (special tool).
2. Install the wrench to the upper bolt in the socket wrench and remove the oil cover by turning it.
3. Remove the oil filter element.

   Notice

   Work with a cloth under the vehicle when removing the oil filter element to not drain the oil.



4. Remove the drain plug (arrow) and drain the engine oil.

   Notice

   Leave the oil filler cap open to ease the engine oil discharge.
5. Tighten the engine oil drain plug after cleaning it.

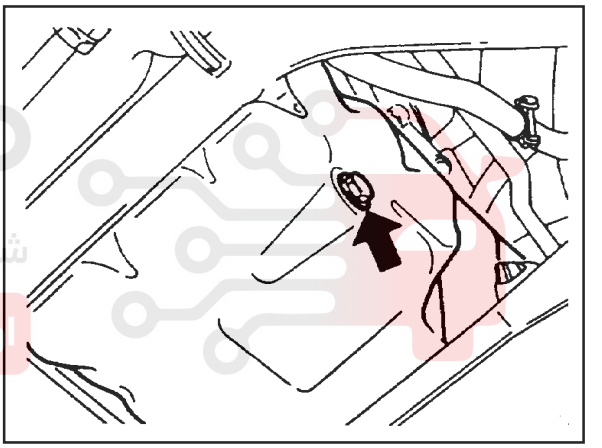
   Installation Notice

Tightening Torque	25 Nm

   Replace the seal washer with new one.
6. Replace the O-ring(5) in the oil filter cover with new one.

   Notice

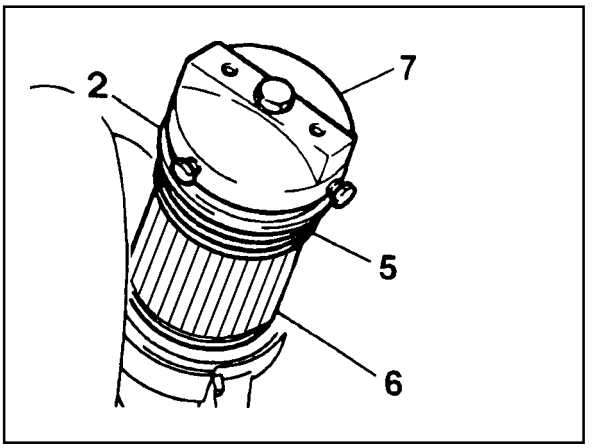
   Apply the engine oil to the O-ring.
7. Insert new oil filter element into the oil filter housing.



8. Temporarily tighten the oil filter cover (2). Install the socket wrench "7" (special tool : 103 589 02 09 00), and then completely tighten it.

   Installation Notice

Tightening Torque	25 Nm

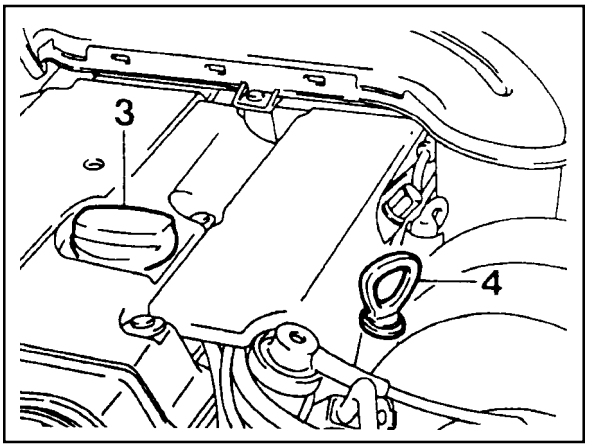


2 Oil Filter Cover
5 O-ring
6 Oil Filter Element
7 Special Tool (Socket Wrench)

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9. Fill up engine oil through the engine oil filler opening (3).
10. Check for oil leaks at normal engine temperature after starting the engine.
11. Stop the engine and wait 5 minutes.
    Check the oil level and fill up as specified if necessary.



3 Oil Filler Cap
4 Dipstick Gauge

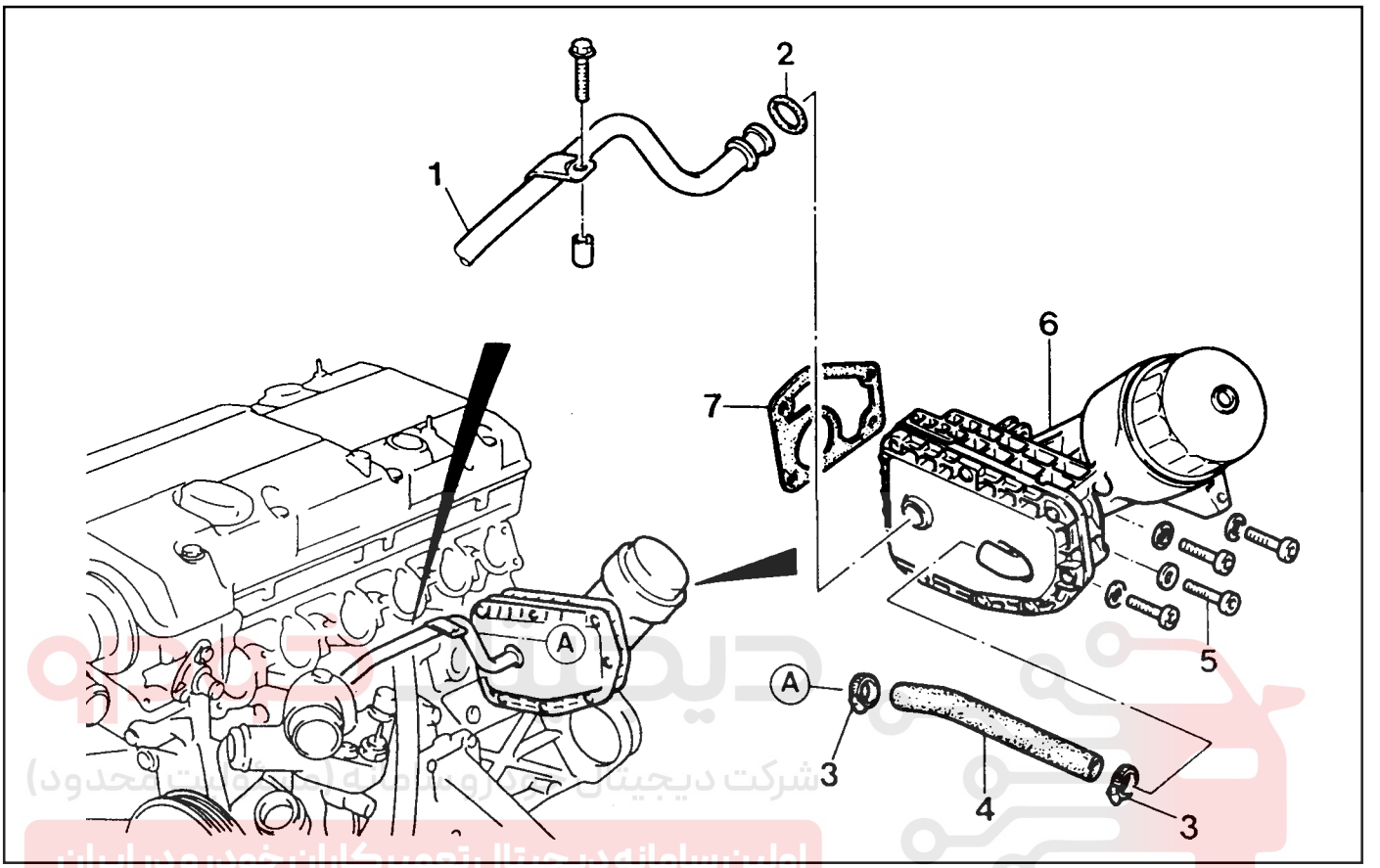
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OIL FILTER

Preceding Work : Removal of starter motor
Removal of upper intake manifold



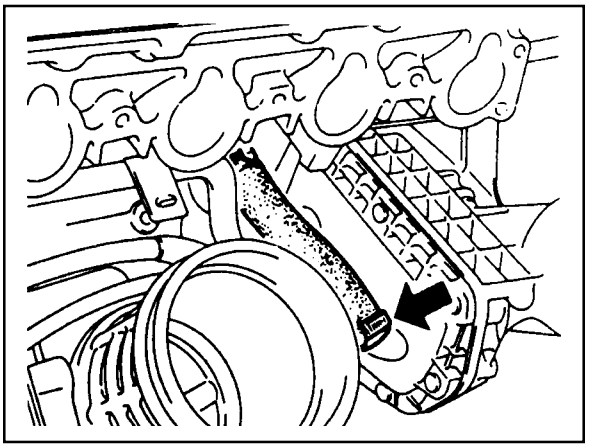
1 Coolant Line
2 O-ring ..... Replace
3 Clip
4 Hose
5 Bolt ..... 23 Nm
6 Oil Filter
7 Gasket ..... Replace

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Removal & Installation Procedure

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 Notice

Tightening Torque	23 Nm

Notice

Replace the oil filter gasket.

4. Installation should follow the removal procedure in the reverse order.
5. Check engine oil level.
6. Run the engine at idle and check the engine for leaks.

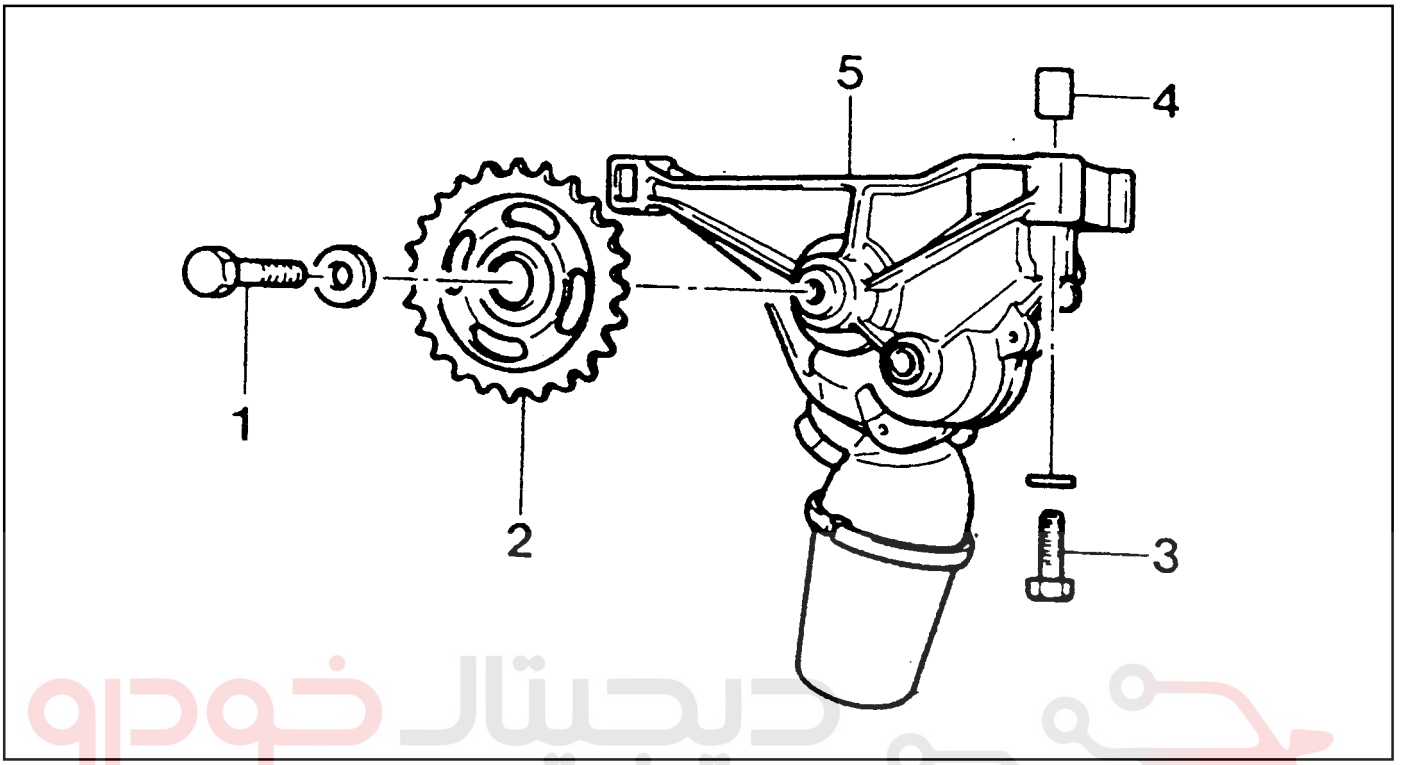
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OIL PUMP

Preceding Work : Removal of oil pan



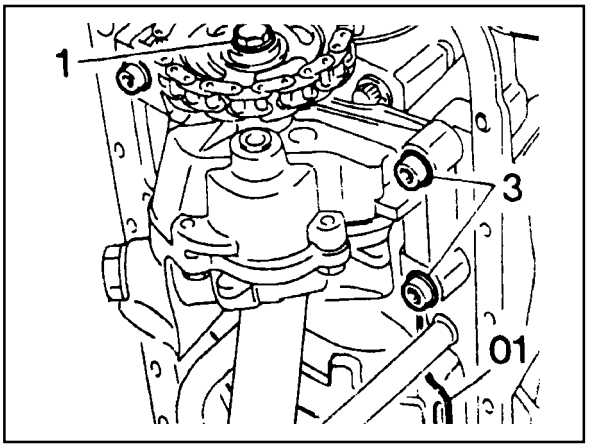
1 Bolt (M8 x 20, 1 piece) ..... 29-35 Nm
2 Sprocket (Oil Pump Drive)
3 Bolt (M8 x 35, 3 pieces) ..... 22.5-27.5 Nm
4 Spring Pin
5 Oil Pump

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Removal & Installation Procedure



1. Remove the bolt (1) from the oil pump drive sprocket (2) and separate the gear and the oil pump drive chain.

   Installation Notice

Tightening Torque	29 - 35 Nm

2. Unscrew the oil pump mounting bolts (3).

   Installation Notice

Tightening Torque	22.5 - 27.5 Nm

   Tighten the baffle plate and the oil pump with the two bolts in right side first, and then tighten the other bolt.

3. Unscrew the bolt (9) from the oil strainer bracket.

   Installation Notice

Tightening Torque	9 - 11 Nm

4. Remove the oil pump and oil strainer assembly.
5. Replace the strainer in oil pump if necessary.
6. Installation should follow the removal procedure in the reverse order.

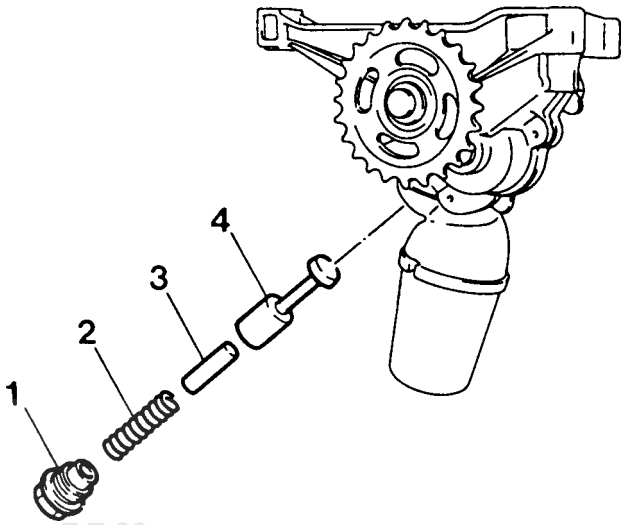
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OIL PRESSURE RELIEF VALVE

Preceding Work : Removal of oil pan



1 Screw Plug ..... 50 Nm
2 Compression Spring
3 Guide Pin
4 Piston

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Removal & Installation Procedure

1. Remove the screw plug (1).

Installation Notice

Tightening Torque	50 Nm

2. Remove the spring (2), guide pin (3) and the piston (4).
3. Installation should follow the removal procedure in the reverse order.

Notice

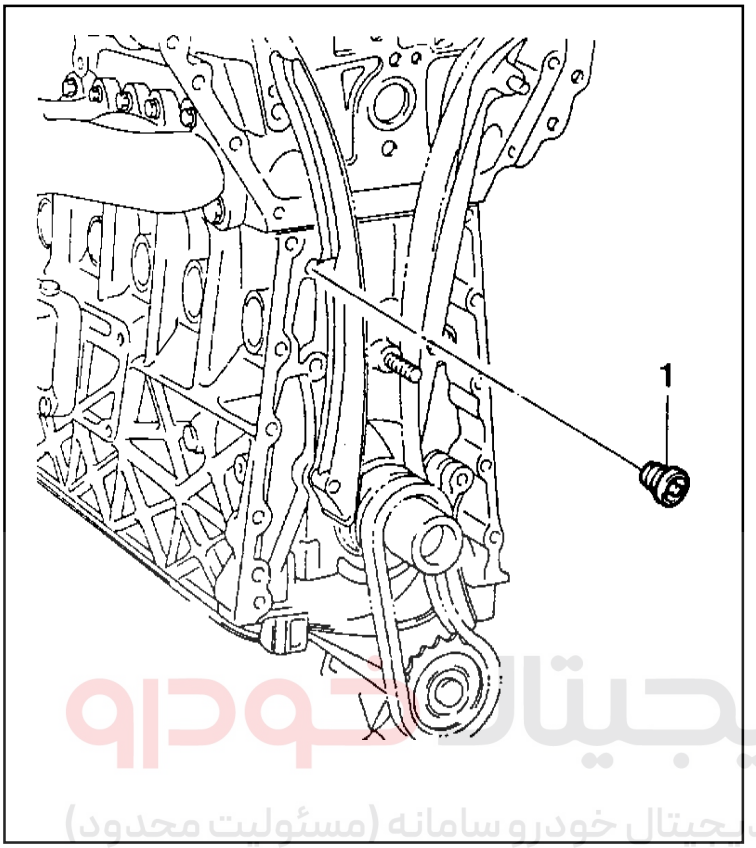
Don't use the seal for the screw plug.

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OIL NON-RETURN VALVE

Preceding Work : Removal of timing gear case cover



1 Oil Non-return Valve

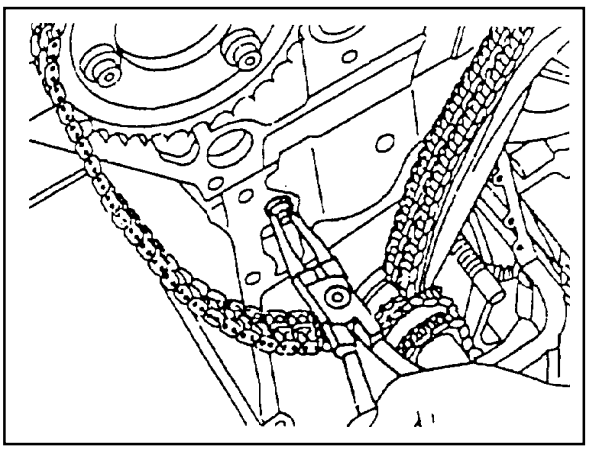
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Functions

The non-return valve prevents the oil in the chain tensioner from drying up. In other words, it stops oil-returning in order to prevent the oil in the chain tensioner from getting dry. As a result, the chain tensioner can be activated with oil in itself.

Replacement Procedure

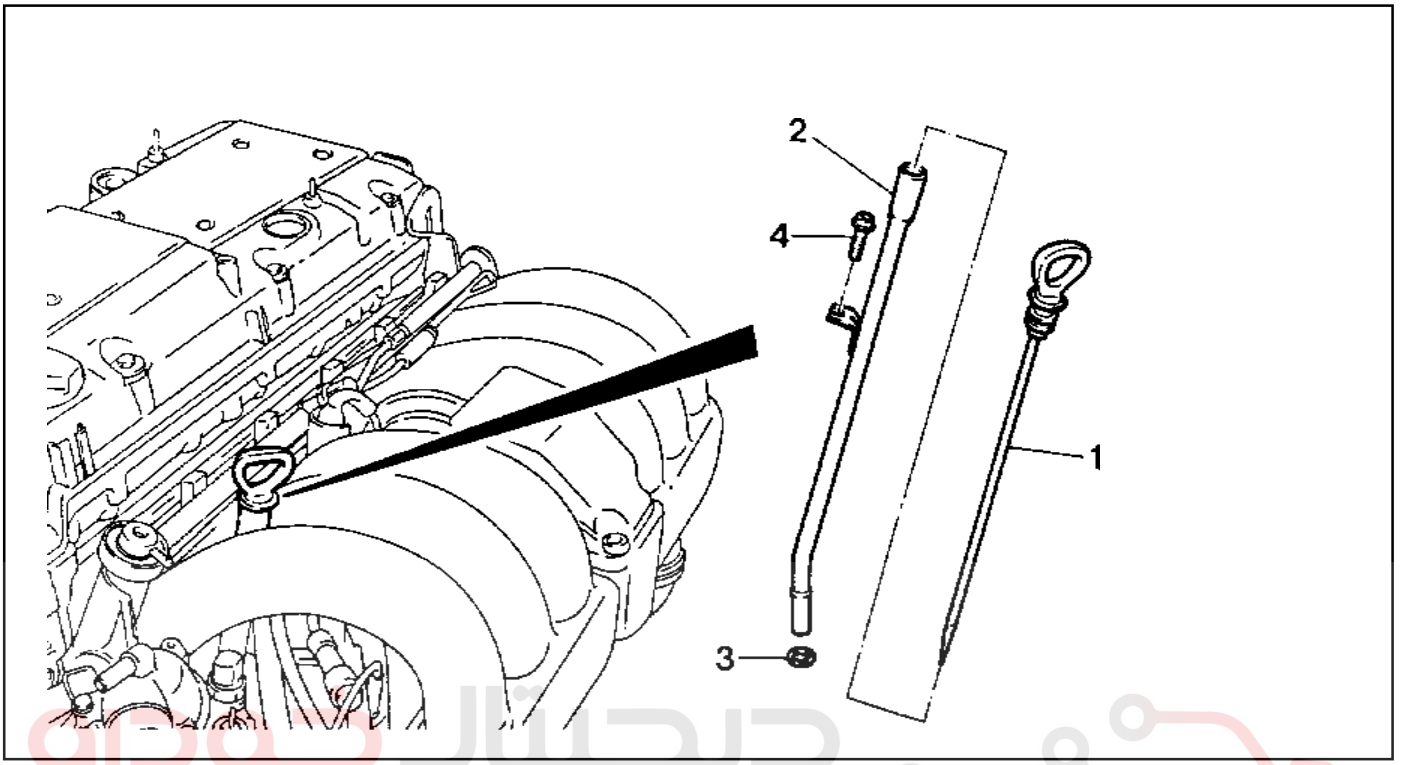
1. Remove the non-return valve using a pliers.
2. Insert new non-return valve with hand.



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OIL DIPSTICK GUIDE TUBE



1 Oil Dipstick Level Gauge
2 Oil Dipstick Guide Tube
3 O-ring
4 Bolt (M6 x 12, 1 piece) ..... 9-11 Nm

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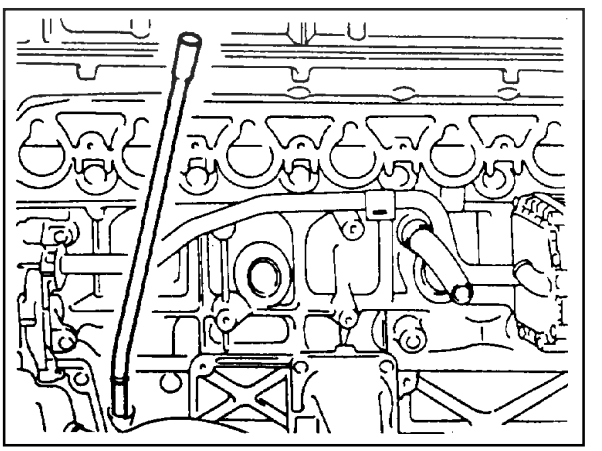
Removal & Installation Procedure

1. Pull out the oil dipstick level gauge (1).
2. Remove the bolt (4) in the upper intake manifold and remove the oil dipstick guide tube.

Installation Notice

Tightening Torque	9 - 11 Nm

3. Install new O-ring to the dipstick guide tube.
4. Installation should follow the removal procedure in the reverse order.
5. Check for leaks by starting the engine.



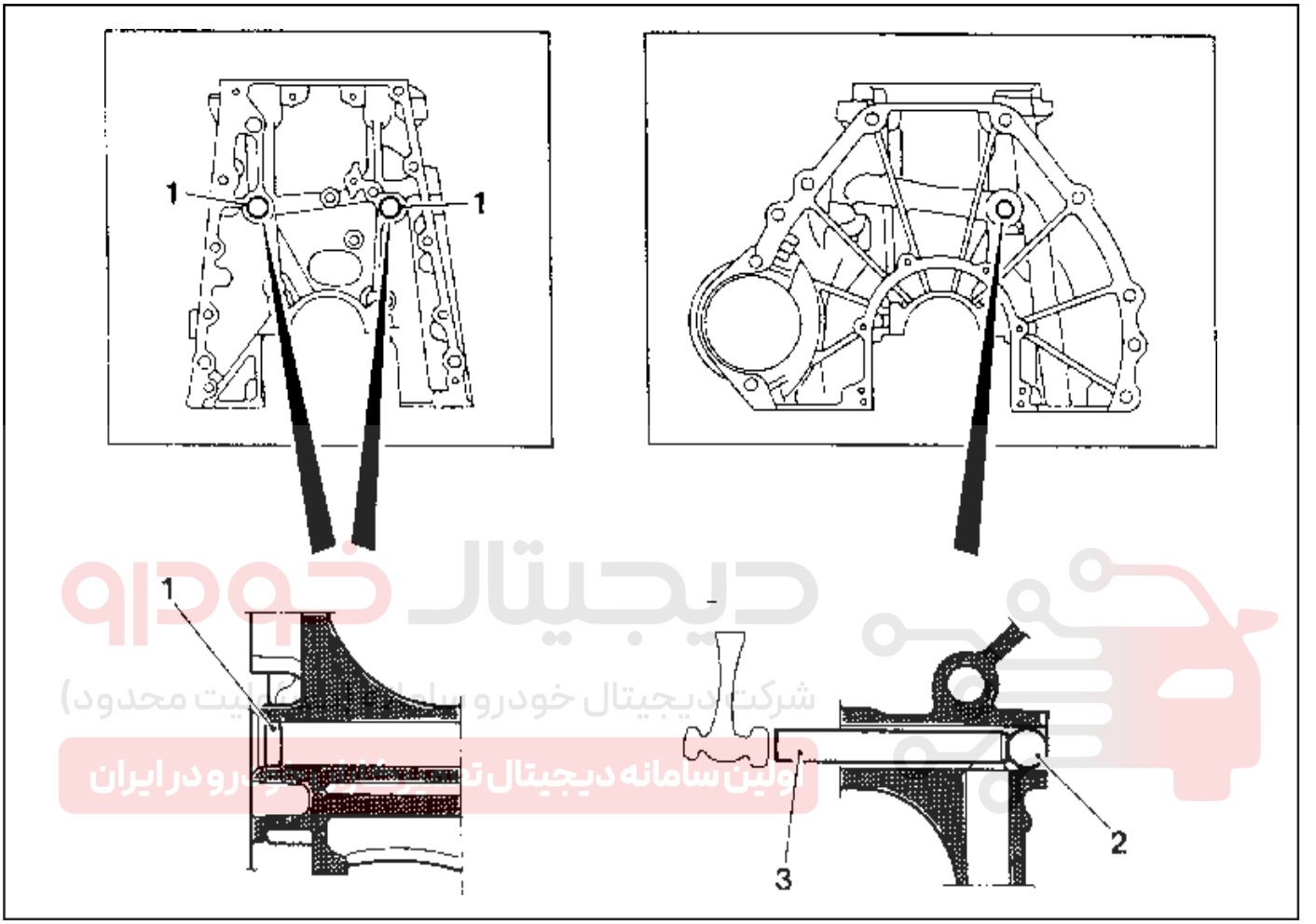
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UNIT REPAIR

OIL GALLERY IN CRANKCASE

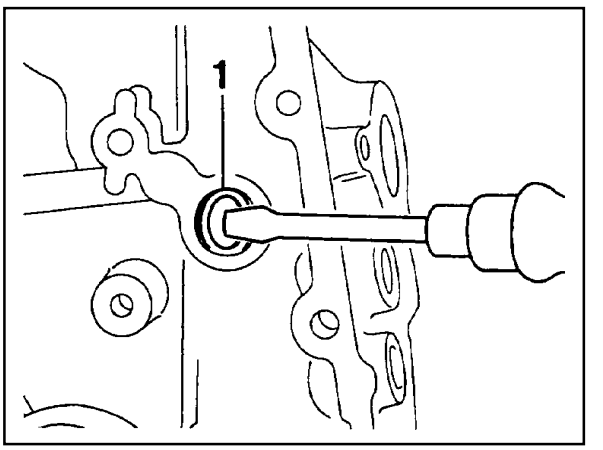
Preceding Work : Removal of crankshaft, removal of oil spray nozzle



1 Plug
2 Steel Ball
3 Round Bar ..... f11 x 750 mm

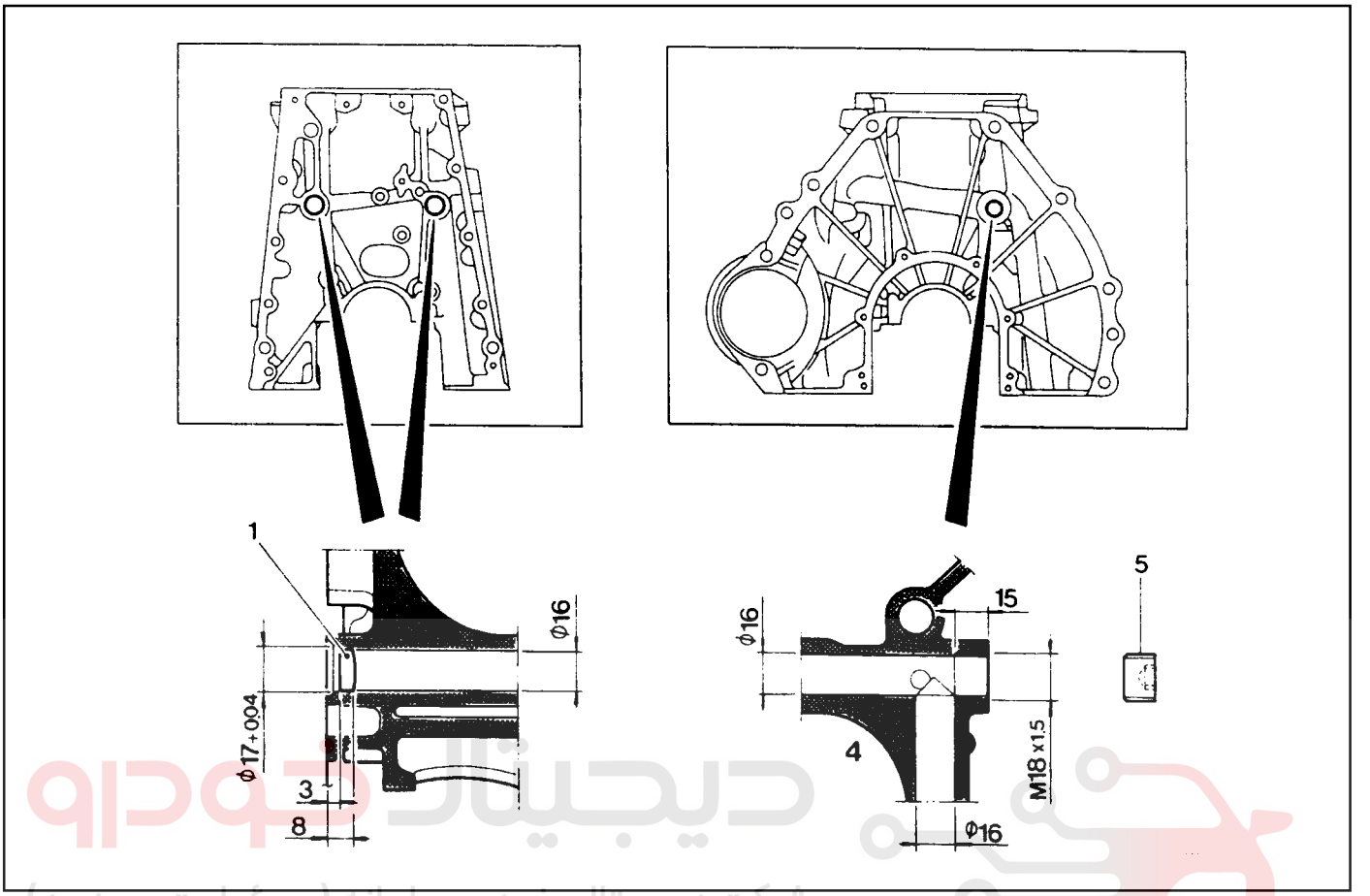
Cleaning Procedure

1. Remove the plug (1) with a screwdriver.
2. Using a round bar (3) and hammer, remove the steel ball (2).
3. Using the compressed air, blow into the oil galleries and clean it off.



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1 Plug ..... Replace
2 Main Oil Gallery
3 Screw Plug

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Tools Required

102 589 12 15 00 Drift

Sealing Procedure

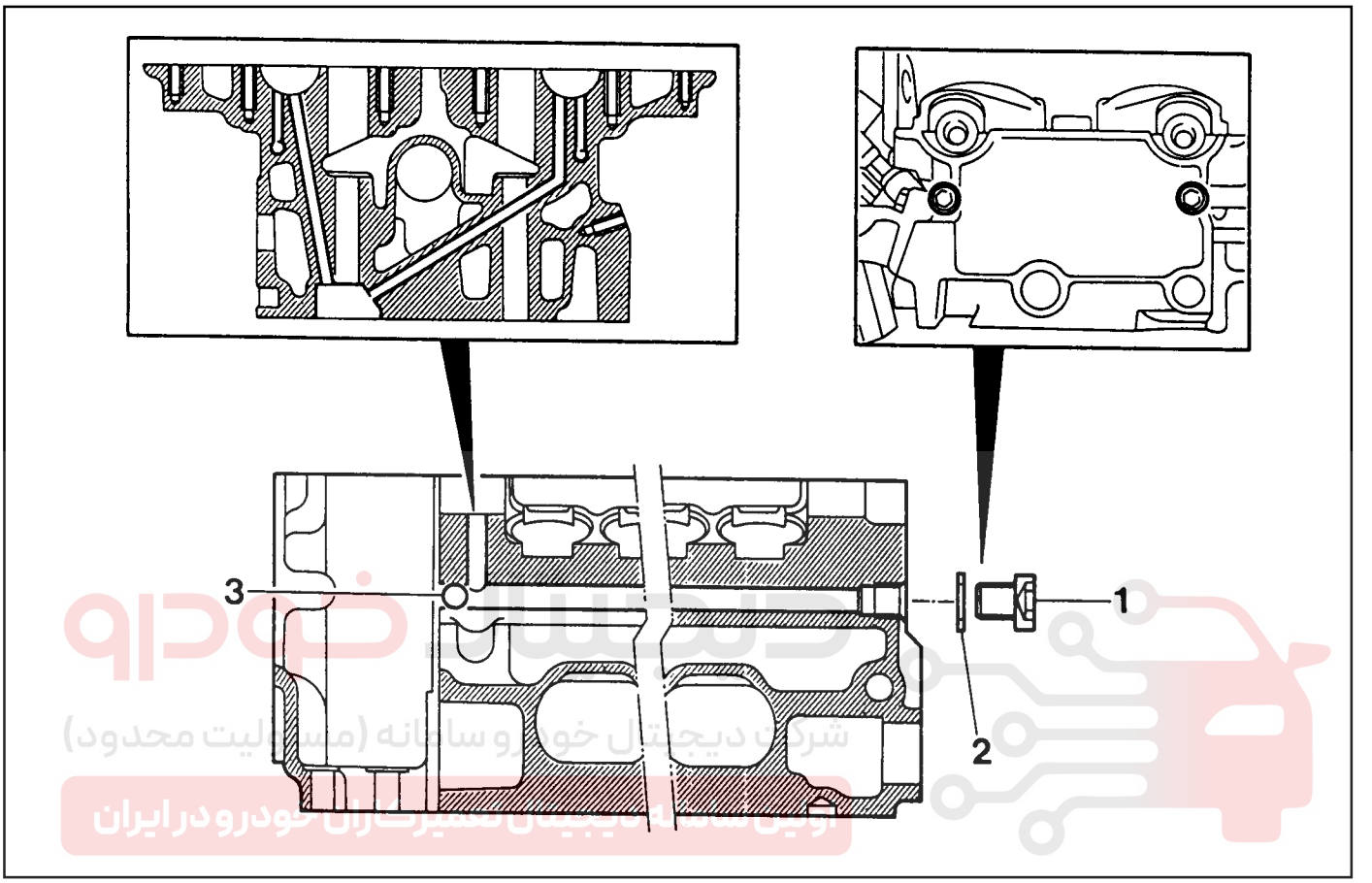
1. Enlarge the end of main oil gallery (4) to be diameter of 16mm, depth of 15mm.
2. Using an M16 x 1.5 thread (tap), make the thread at the end of main oil gallery (4).
3. Throughly clean the oil gallery with compressed air and tighten the screw plug (M16 x 1.5) after applying sealing bond on it.
4. Apply Loctite 270 on new plug and tighten to the hole until the drift is stopped after inserting new plug into the drift.

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OIL GALLERY IN CYLINDER HEAD

Preceding Work : Removal of cylinder head
Removal of camshaft
Removal of tappet



1 Screw Plug ..... 15 Nm
2 Seal
3 Steel Ball (f 8mm)

Cleaning Procedure

1. Remove the screw plug (1) and the seal (2).

Installation Notice

Tightening Torque	15 Nm

Replace the seal with new one.

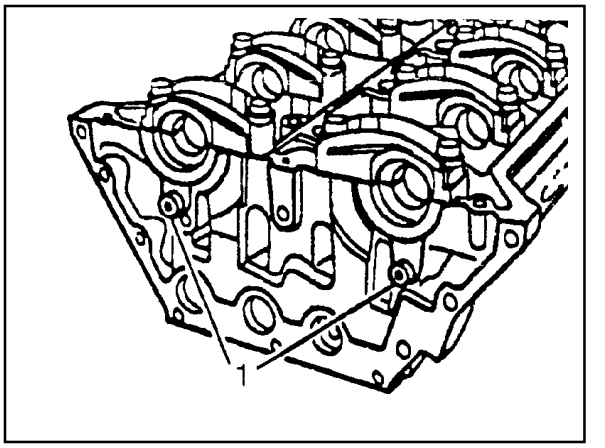
2. Clean the oil gallery using the compressed air.

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Sealing Procedure

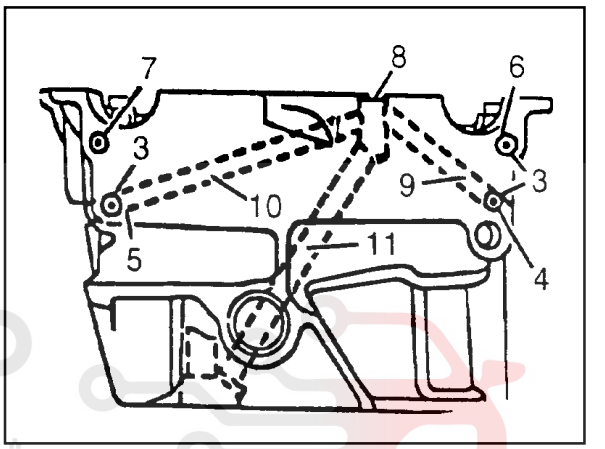
1. Remove the screw plug (1) and the seal.



Installation Notice

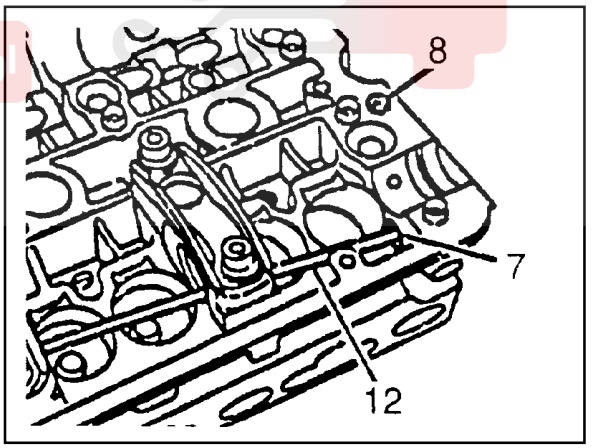
Tightening Torque	15 Nm

2. Remove the steel ball from the oil gallery (4), (5), (6) and (7) using the round bar (12, ƒ6 x 700 mm).

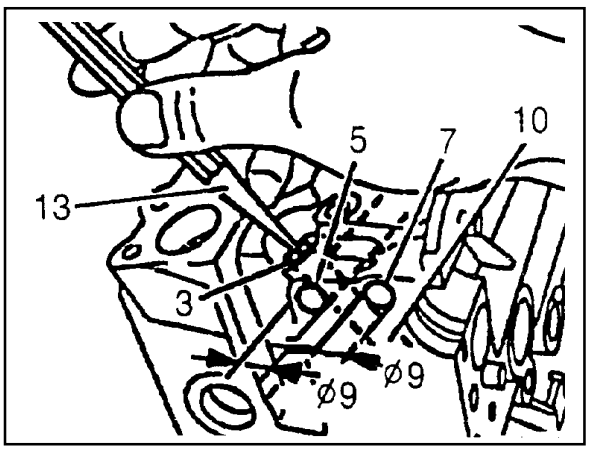


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3. Remove the plug (8) using the screw driver.



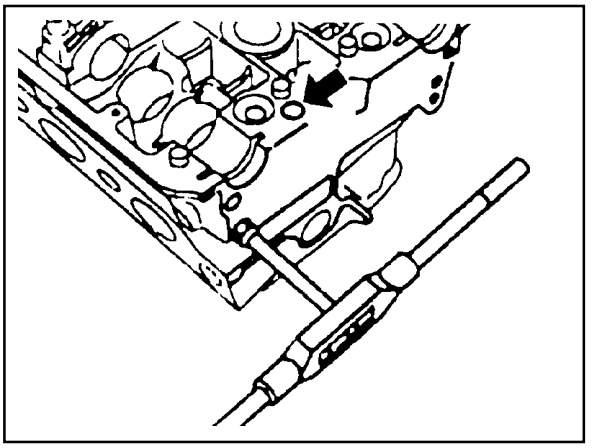
4. Enlarge the oil gallery at the rear of the cylinder head to be diameter 9mm, depth 8mm.
5. Tap in the steel ball (3) from the side to the oil gallery using the punch (13).
6. Pull out the steel ball (3) using the round bar (12).
7. Enlarge the oil gallery to be diameter 9mm, depth 8mm.



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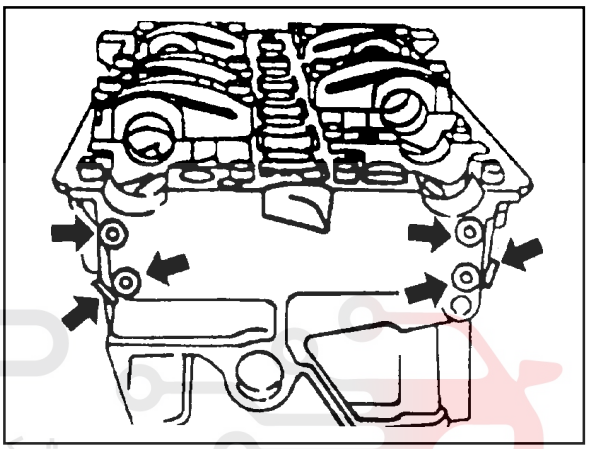
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8. Make a screw hole at the oil gallery using M10 x 1 thread.
9. All the oil gallery should be cleaned with the compressed air.
10. Apply the Loctite 270 to new plug and press in using a suitable drift (arrow).



11. Tighten the screw plug with the seal (arrow).

Screw Plug (Part No. 000 908 01 00 02)
Seal (Part No. 007 603 01 01 03)



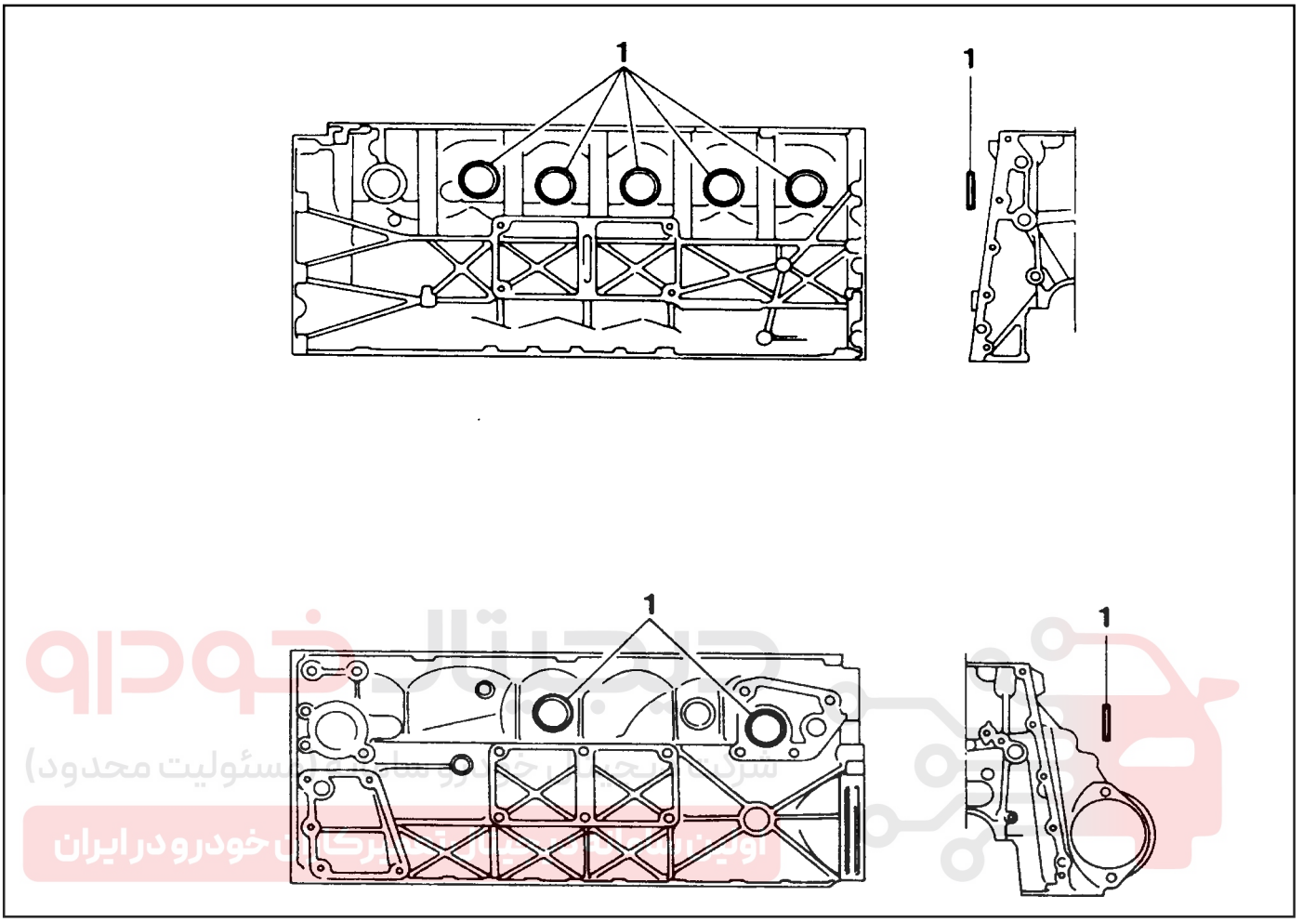
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CORE PLUGS IN CRANKCASE

Preceding Work : Draining of the coolant



1 Core Plug ..... Replace

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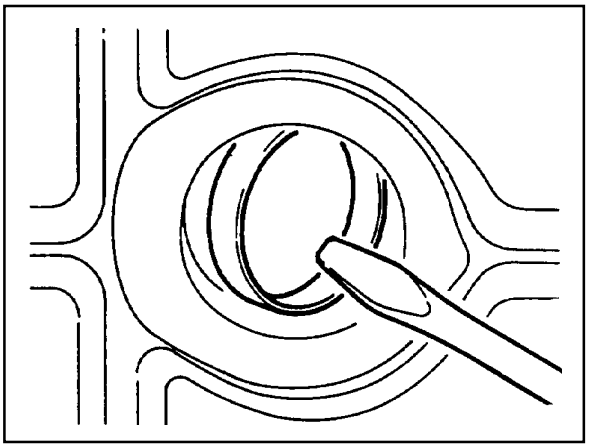
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Tools Required

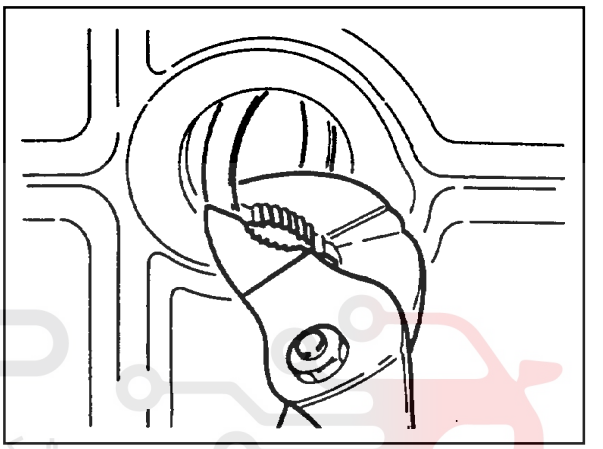
102 589 00 15 00 Drift

Replacement Procedure

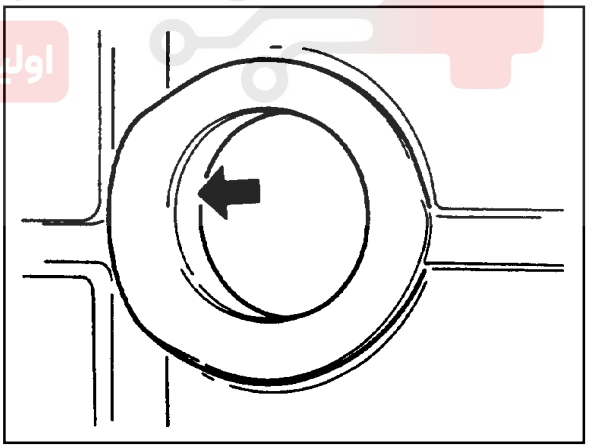
1. Remove the intake and exhaust manifolds.
2. Pull back the core plug until the end of one side comes out using the screw driver.



3. Pull out the plug carefully using a pliers.



4. Clean the sealing surface and apply Loctite 241.

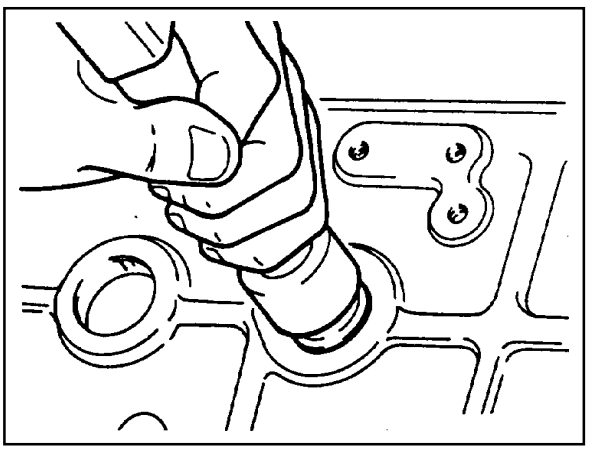


5. Press in new plug using a drift.

   Notice

   Wait for about 45minutes before filling the coolant so that the Loctite 240 hardens.

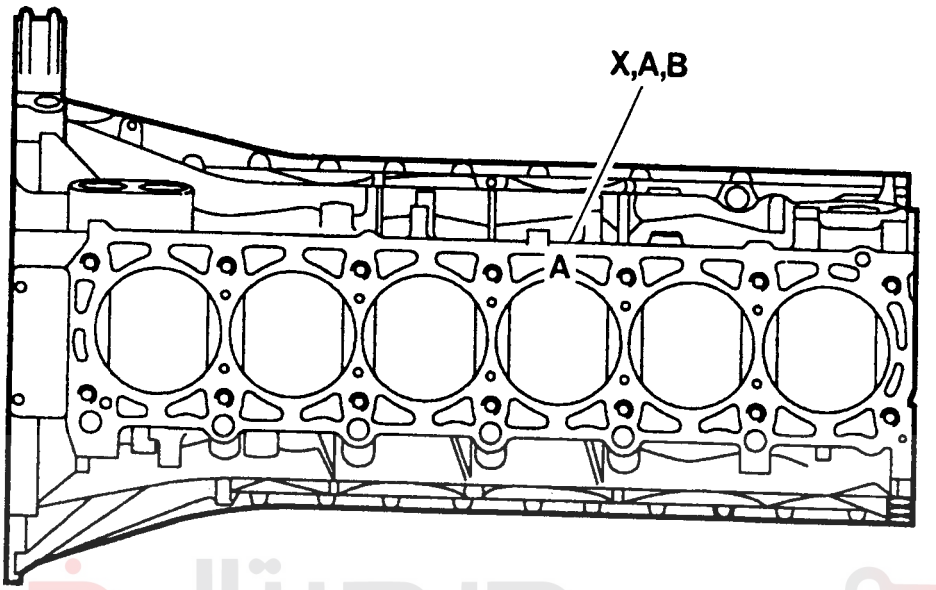
6. Warm up the engine and check the coolant for leaks.



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CYLINDER BORE



Group Code Letter and Cylinder Bore Size

Group Code Letter of Cylinder	Piston Type to be Used	Cylinder Bore Size (mm)
A	A or X	ƒ89.900 - ƒ90.906
X	A, X or B	ƒ89.906 - ƒ89.912
B	X or B	ƒ89.912 - ƒ89.918
X + 5	X + 5	ƒ89.950 - ƒ89.968
X + 10	X + 10	ƒ90.000 - ƒ90.018

Repair Size

Type	Group Code Letter[1)]	Cylinder Bore Size (mm)
Standard Size ƒ89.9	A	ƒ89.900 - ƒ90.906
	X	ƒ89.906 - ƒ89.912
	B	ƒ89.912 - ƒ89.918
1st Repair Size (Standard Size + 0.25)	A	ƒ90.150 - ƒ90.156
	X	ƒ89.156 - ƒ90.162
	B	ƒ90.162 - ƒ90.168
2nd Repair Size (Standard Size + 0.5)	A	ƒ90.400 - ƒ90.406
	X	ƒ90.406 - ƒ90.412
	B	ƒ90.412 - ƒ90.418

[1)] The group code letters are carved on the surface of the piston crown and in the mating surface of the crankcase.

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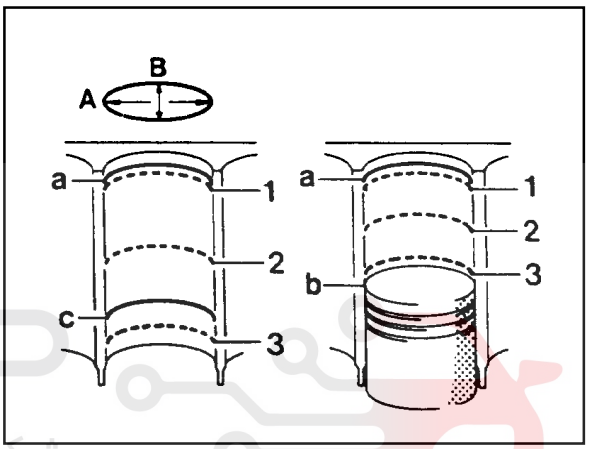
Service Data Standard

Wear Limit in Longitudinal and Transverse Direction		0.1 mm
Permissible Deviation of Cylinder Out-of-round	When new	0.007 mm
	Wear limit	0.05 mm
Permissible Deviation of Rectangular Cylinder Height (Except Chamfered Area)		0.05 mm
Basic Peak-to-valley Height After Final Honing and Brushing		0.003 - 0.006 mm
Chamfer Angle		60°
Honing Angle		50° ± 10°

Measurement of Cylinder Bore

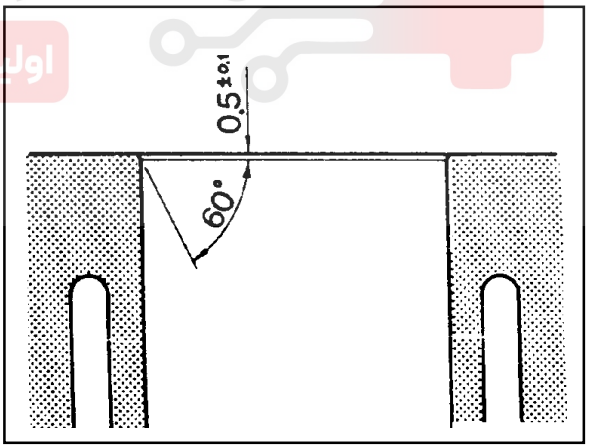
1. Clean the cylinder wall.
2. Using a internal diameter gauge, measure the bore size in axial and transverse direction at three points (1,2,3).

1,2,3. Measuring Points
A. Axial Direction
B. Transverse Direction
a. Location of the No.1 Piston Ring at TDC
b. Location of the Piston BDC
c. Location of the Oil Ring at BDC



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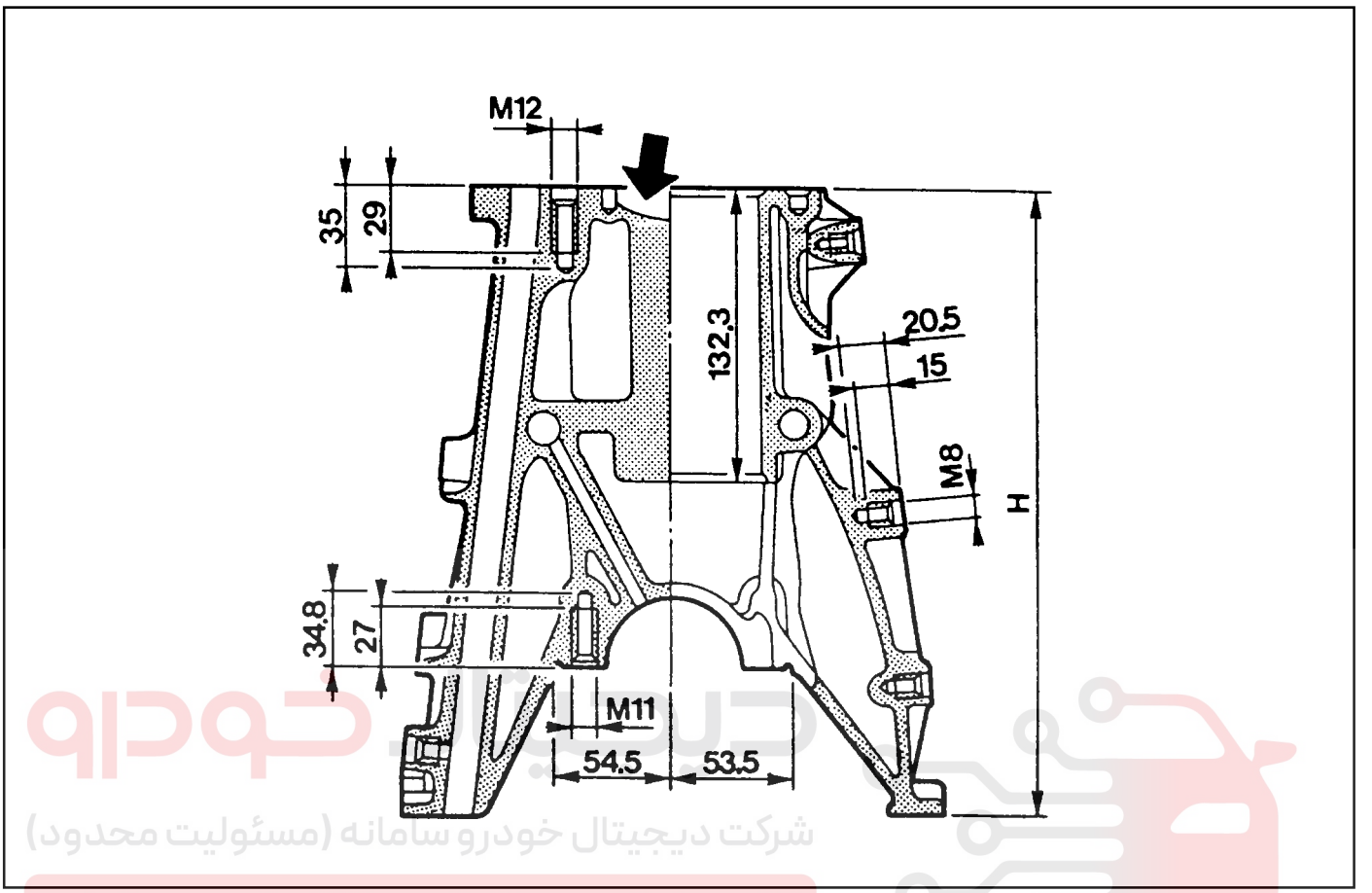
Chamfer Angle



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CRANKCASE MATING SURFACE



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Service Data Standard

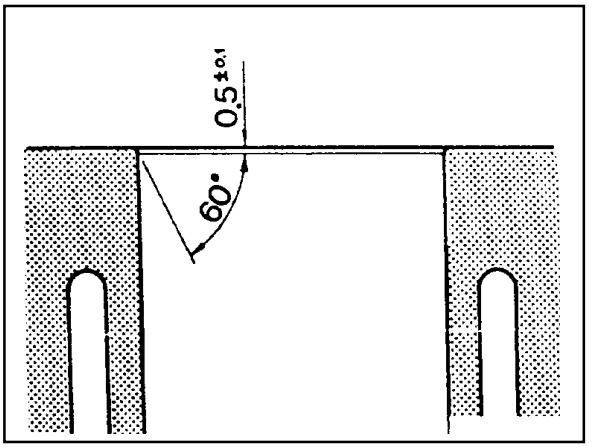
Height of The Crankcase “H” (When new)		282.25 - 282.35mm
Minimum Height After Milling		281.95mm
Flatness	Crankcase Upper Mating Surface	0.03mm
	Crankcase Lower Mating Surface	0.04mm
Permissible Deviation of Parallelism of The Upper to Lower Mating Surface	Axial Direction	0.1mm
	Transverse Direction	0.05mm
Peak-to-valley Height	Crankcase Upper Mating Surface	0.005 - 0.020mm
	Crankcase Lower Mating Surface	0.025mm

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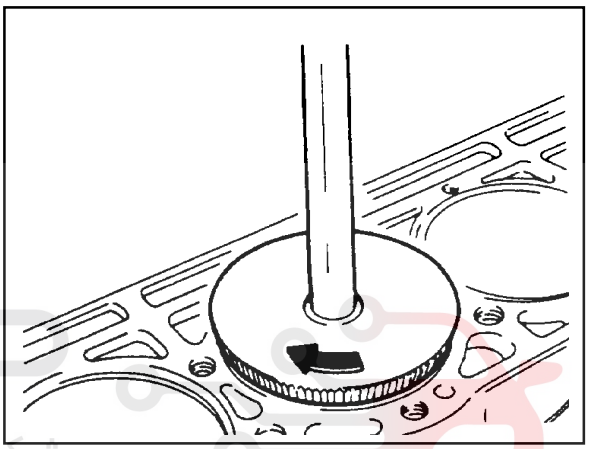
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Chamfering Procedure

1. Chamfer angle : 60°



2. Polish the lower chamfered area evenly with a grinder after finishing the chamfering with a suitable tool (e.g., hand milling cutter).



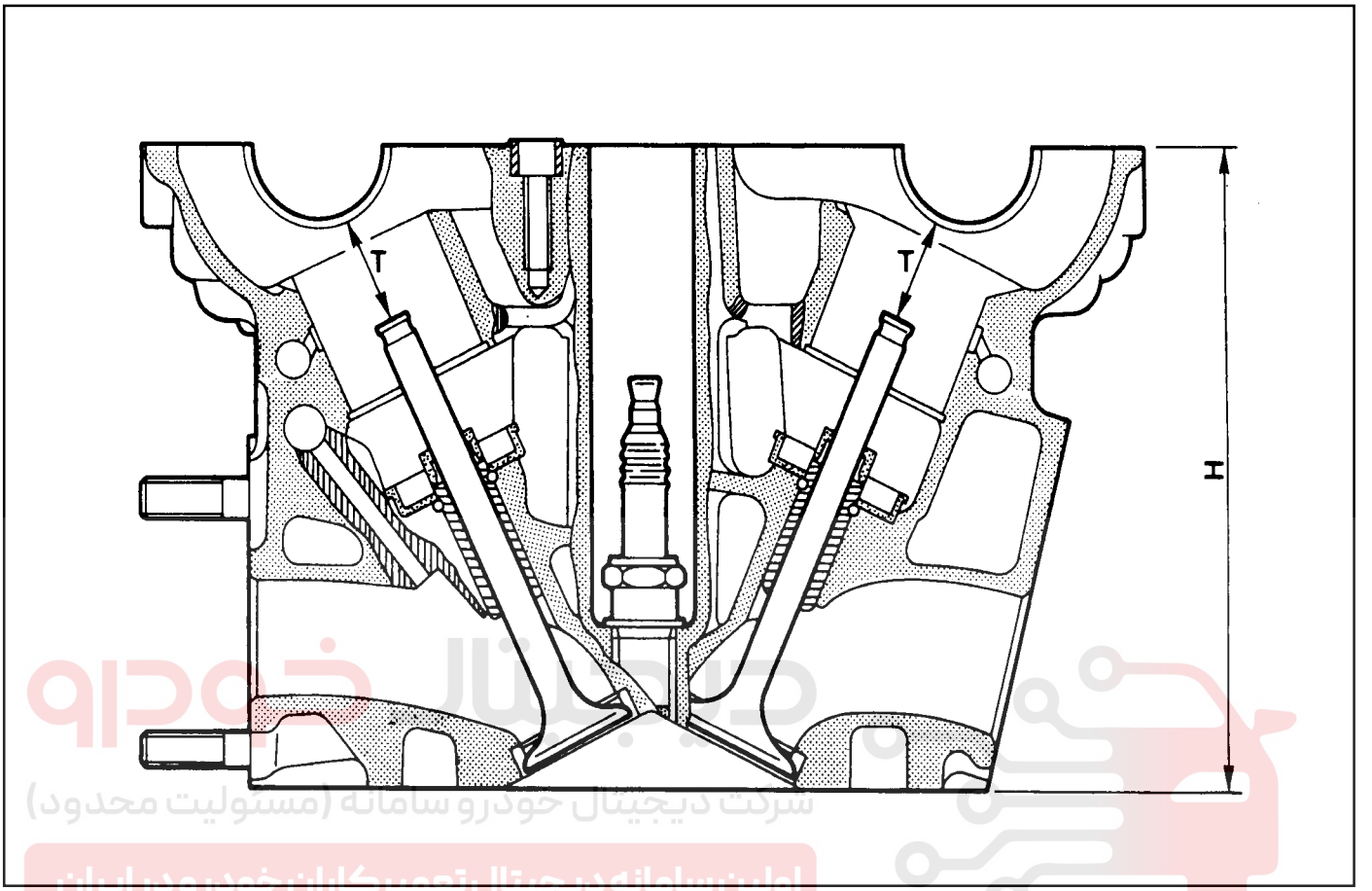
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CYLINDER HEAD MATING SURFACE

Preceding Work : Removal of valves



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Service Data Standard

Overall Height of Cylinder Head			135.9 - 136.0 mm
Minimum Height After Machining			135.5 mm
Flatness	Axial Direction		0.08 mm
	Transverse Direction		0.0 mm
Distance 'T' (Between Camshaft Bearing and Valve Stem)	Standard Size	Intake	24.21 - 24.75 mm
		Exhaust	22.21 - 22.75 mm
	Repair Size	Intake	23.96 - 24.51 mm
		Exhaust	21.96 - 22.51 mm

Notice

Do not exceed 0.4mm for the milling of the mating surface of crankcase and cylinder head.

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Measurement of Mating Surface

1. Measure the height (H) of the cylinder head (refer to *Service data standard*).
2. Check the mating surface of the cylinder head.
3. Mill the sharp edge of the combustion chamber.
4. Re-measure the height (H) of the cylinder head.
5. Seal the intake and exhaust valves.
6. Measure the dimension (T) between the camshaft bearing and the valve system (refer to *Service data standard*).
7. Mill the cylinder head valve seat (refer to *Service data standard*).

Universal Tool

Surface Grinding Machine	Sceledum, Type RTY Roaro Schio/Italy

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SECTION 1B2

M161 ENGINE MECHANICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application		N·m
Power Steering Hydraulic Lines		35 - 40
A/C High Pressure and Liquid Hose		10 - 15
Radiator Support Menber Bolt		5 - 10
Fuel Supply and Return Hose to Fuel Distributor		21 - 25
Exhaust Manifold and Pipe		30
Propeller Shaft to Transmission		56 - 66
Engine Mounting Nut		50 - 60
Alternator Carrier Bolt		22.5 - 27.5
Belt Pulley Bolt		41.5 - 49.5
Steering Pump Bolt		22.5 - 27.5
A/C Bracket Bolt		22.5 - 27.5
Intake Air Duct Bolt		9 - 11
Ignition Cable Cover Bolt		9 - 11
Cylinder Head Cover Bolt		9 - 11
Camshaft Adjuster Bolt		9 - 11
Cylinder Head Front Cover Bolt		22.5 - 27.5
Flange Bolt in Exhaust Camshaft Sprocket		10 +90°
Cylinder Head Bolt		55 +90° +90°
Cooling Fan Bracket Bolt		22.5 - 27.5
Timing Gear Case Cover Bolt	M8	22.5 - 27.5
	M6	9 - 10
Crankshaft Rear Cover Bolt		9 - 10
Vibration Damper Center Bolt		200 +90°
Connecting Rod Bearing Cap Bolt		40 +90°
Flywheel Stretch Bolt		45 +90°
Amarture Bolt in Flywheel		35
Ring and Seal Cover Nut in Flywheel		9 - 11
Sprocket Bolt to Exhaust Camshaft		20
		+90°
Camshaft Adjuster Flange Bolt		20
		+90°
Intake Flange Shaft Bolt		20 / + 90°
Exhaust Camshaft Sprocket Bolt		20 / + 90°
Camshaft Bearing Cap Bolt		22.5 - 27.5

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FASTENER TIGHTENING SPECIFICATIONS (Cont'd)

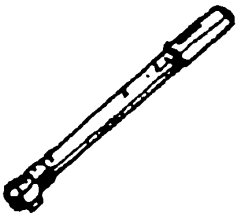
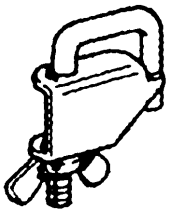
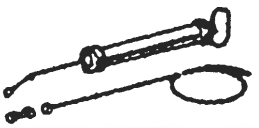
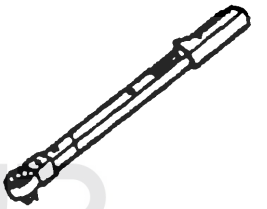
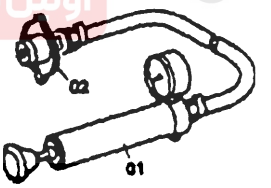
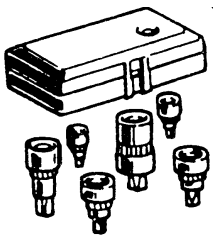
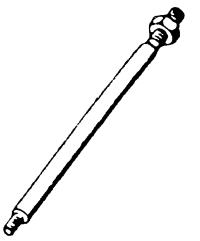
Application	N·m
Exhaust Camshaft Sproket Bolt	20 / + 90°
Chain Tensioner Screw Plug	40
Chain Tensioner Assembly	72 - 88
Exhaust Camshaft Sprocket to Camshaft	20 / + 90°
Oil Pump Sprocket Bolt	25 - 35
Tensioning Device Bolt	22.5 - 27.5
Water Pump Pulley	22.5 - 27.5
Upper Intake Manifold Bolt	22.5 - 27.5
Lower Intake Mainfold Bolt	22.5 - 27.5
Flange Bolt to Exhaust Mainfold	30
Exhaust Mainfold Nut to Stud Bolt	26 - 34
Rivet Nut in Exhuast Mainfold Hole	30
Pre-Silencer Bolt	8 - 10
Oil Drain Plug	25
Oil Filter Cover	25
Oil Filter Bolt	22.5 - 27.5
Oil Pump Drive Sprocket Bolt	29 - 35
Oil Pump Mounting Bolt	22.5 - 27.5
Oil Strainer Bracket Bolt	9 - 11
Oil Pressure Relief Valve Screw Plug	50
Oil Dipstick Guide tube Bolt	9 - 11
Oil Gallery Screw Plug	15

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SPECIAL TOOLS

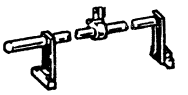
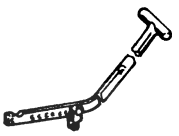
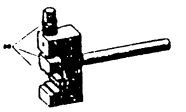
SPECIAL TOOLS TABLE

	000 589 10 99 01 Torque Wrench		000 589 40 37 00 Hose Clamp
	112 589 00 72 00 Oil Extractor		000 589 72 21 00 Torque Wrench
	001 589 66 21 00 Torque Wrench		124 589 15 21 00 Radiator Cap Testing Unit
	000 589 01 10 00 Box Wrench Insert		116 589 02 34 00 Screw-Fixed Pin

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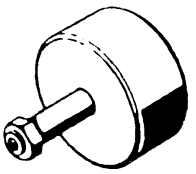
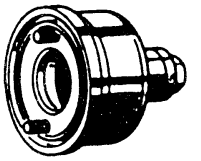
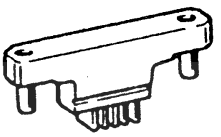
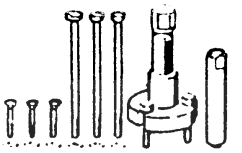
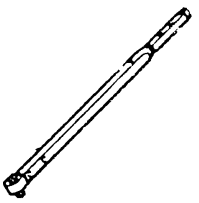
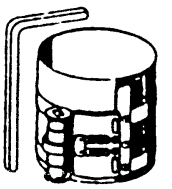
SPECIAL TOOLS TABLE (Cont'd)

	104 589 01 01 00 Spanner		111 589 01 59 00 Supporting Bar
	111 589 18 61 00 Lever Pusher		111 589 25 63 00 Thrust Piece
	116 589 06 63 00 Magnetic Finger		104 589 00 37 00 Pliers
	119 589 00 43 00 Drift		000 589 58 43 00 Chain Assembly

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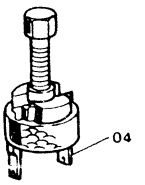
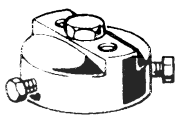
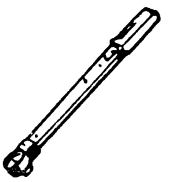
SPECIAL TOOLS TABLE (Cont'd)

	116 589 20 33 00 Sliding Hammer		601 589 03 43 00 Sleeve
	602 589 00 40 00 Engine Lock		103 589 00 33 00 Puller
	001 589 65 09 00 Socket Wrench Insert		000 589 88 33 00 Puller
	001 589 74 21 00 Torque Wrench		000 589 04 14 00 Clamping Strap

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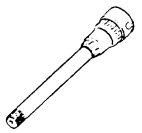
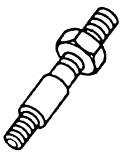
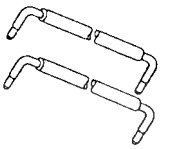
SPECIAL TOOLS TABLE (Cont'd)

	103 589 01 63 00 Rivet Set		615 589 01 33 00 Caulking Bolt
	103 589 02 09 00 Oil Filter Socket Wrench		102 589 12 15 00 Drift
	102 589 00 15 00 Drift		601 589 03 14 00 Sleeve
	000 589 51 37 00 Clamping Strap		001 589 72 21 00 Torque Wrench

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SPECIAL TOOLS TABLE (Cont'd)

	**617 589 00 10 00** **Wrench Socket**		**116 589 01 34 00** **Threaded Bolt**
	**104 589 00 40 00** **Holder**		**111 589 03 15 00** **Insert Pin**

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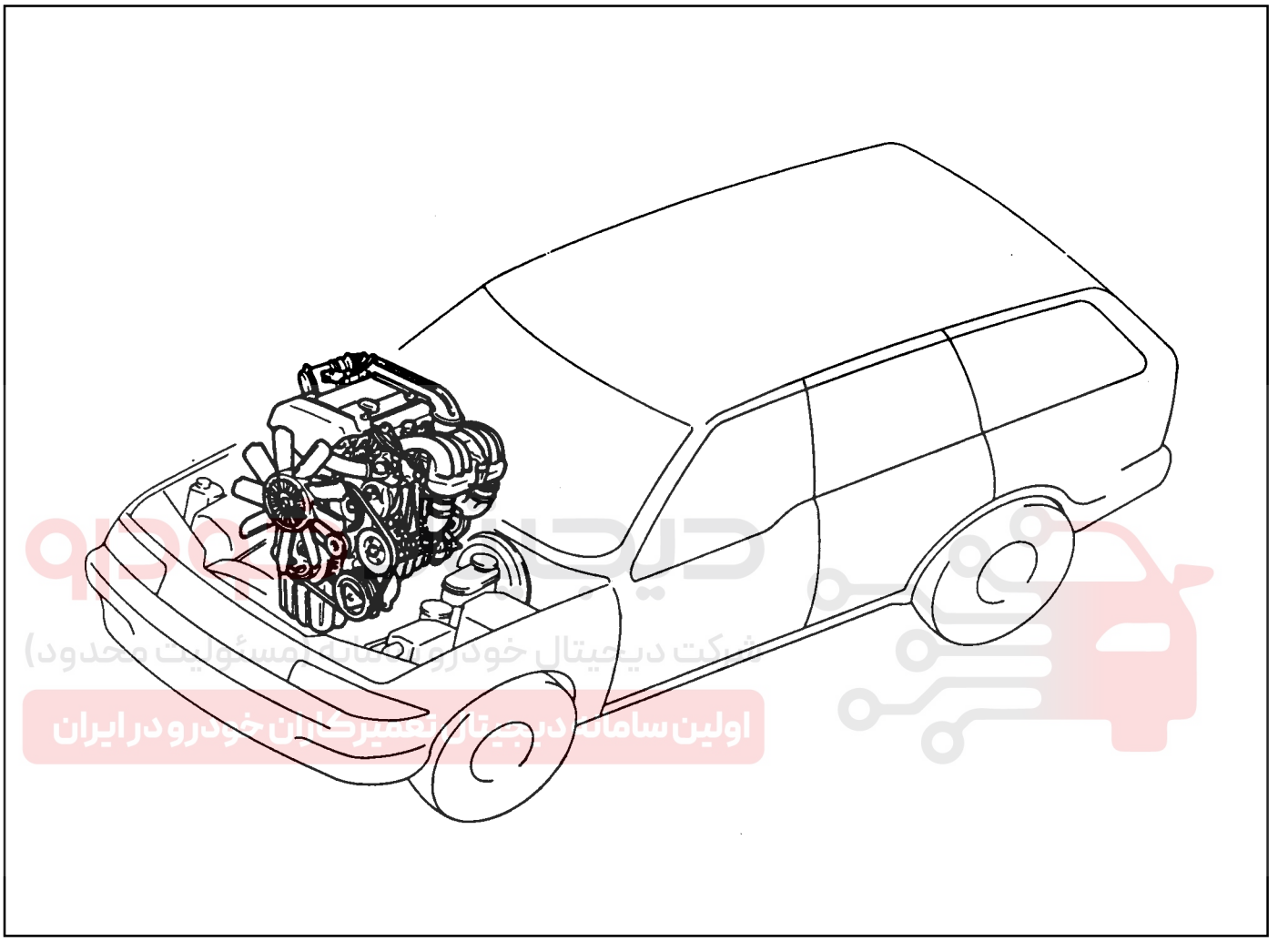
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

ENGINE ASSEMBLY



Tools Required

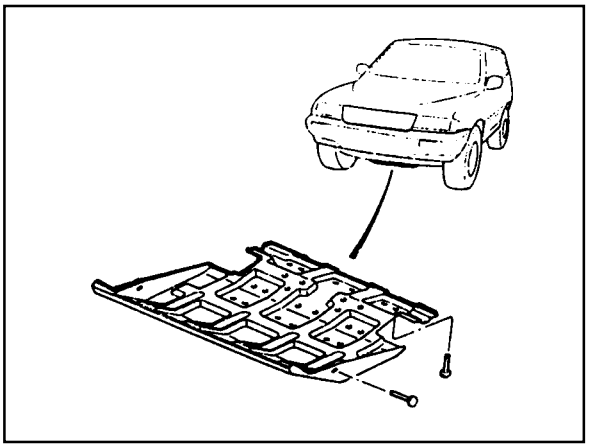
000 589 10 99 01 Torque Wrench
000 589 40 37 00 Hose Clamp
112 589 00 72 00 Oil Extractor

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Removal & Installation Procedure

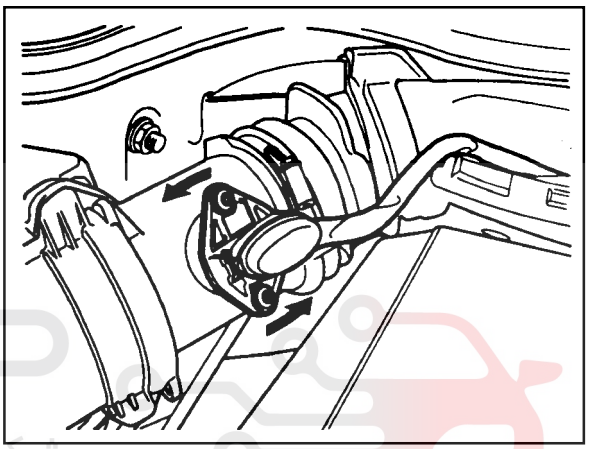
1. Disconnect the negative terminal of battery.
2. Remove the hood.
3. Remove the under cover.



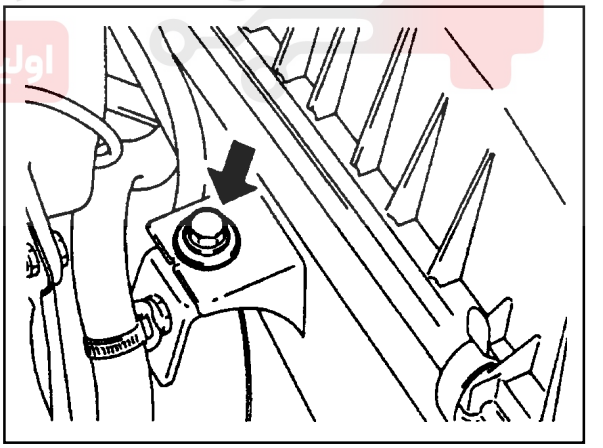
Installation Notice

Tightening Torque	28 - 47 Nm

4. Disconnect the coupling of HFM sensor and remove the air cleaner cross pipe.



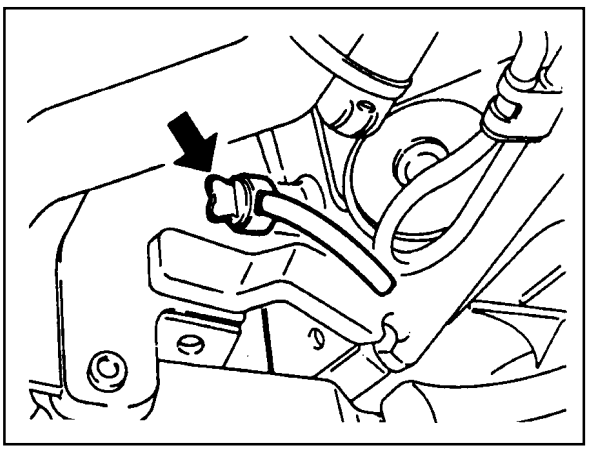
5. Remove the air cleaner cover. Remove the mounting bolts and air cleaner housing and element assembly.



6. Loosen the radiator drain cock and drain the coolant.

Notice

Open the coolant reservoir cap.



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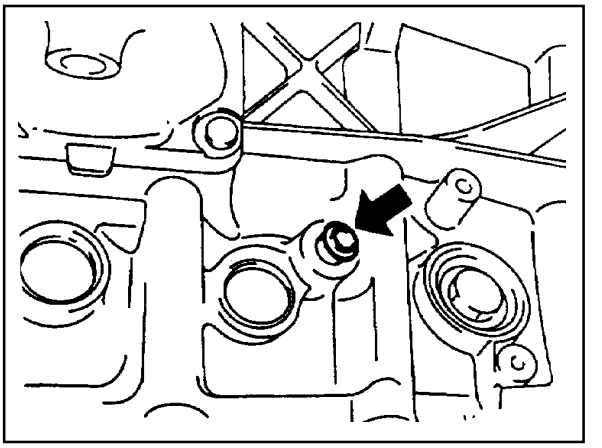
7. Loosen the cylinder block drain plug and then drain the coolant completely.

Installation Notice

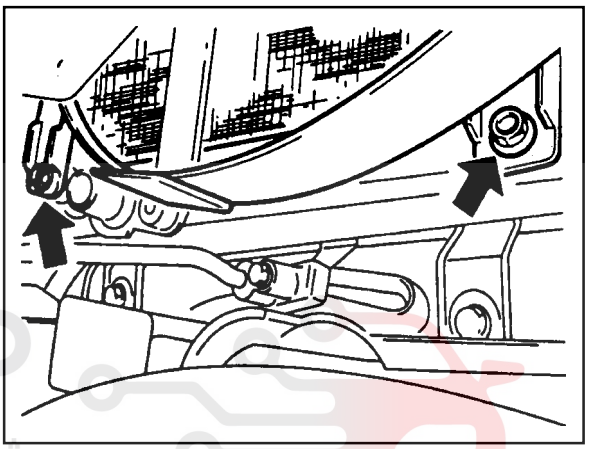
Tightening Torque	30 Nm

Notice

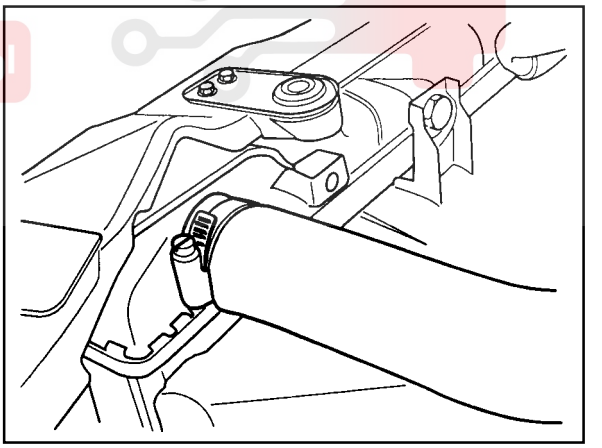
Replace the seal before installation of the drain plug.



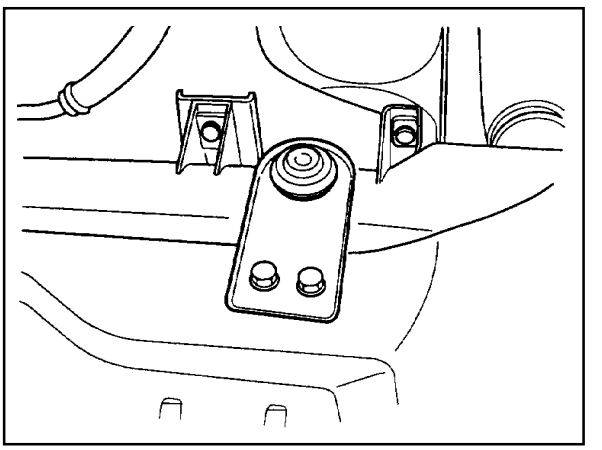
8. Remove the cooling fan shroud.



9. Disconnect the each hose from radiator.



10. Remove the upper mounting bolts of radiator and then remove the radiator.



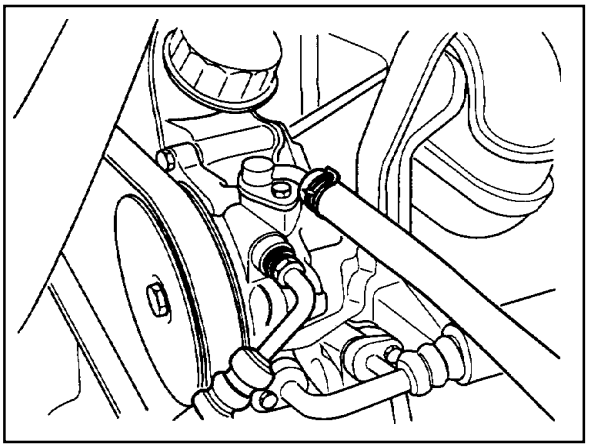
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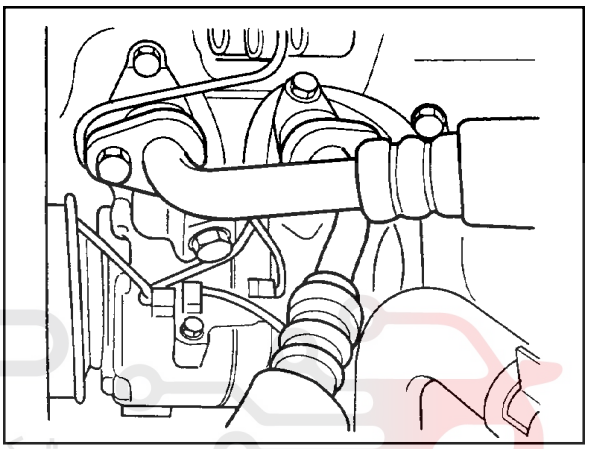
11. Remove the hydraulic pipe of power steering.

Notice

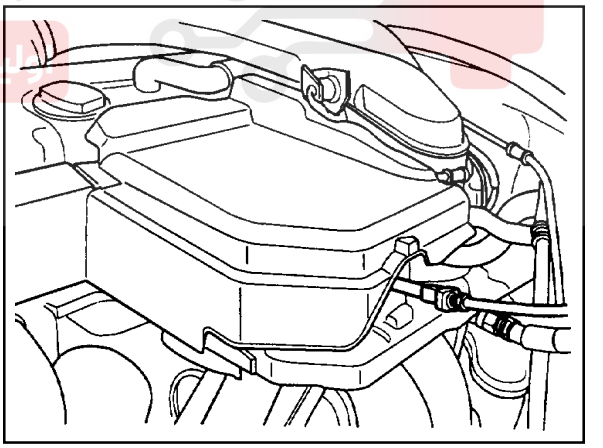
Completely drain the oil.



12. Discharge the refrigerant from A/C system, and disconnect the discharge pipe and suction pipe from the compressor.



13. Remove the acceleration control cable and automatic transmission pressure cable.



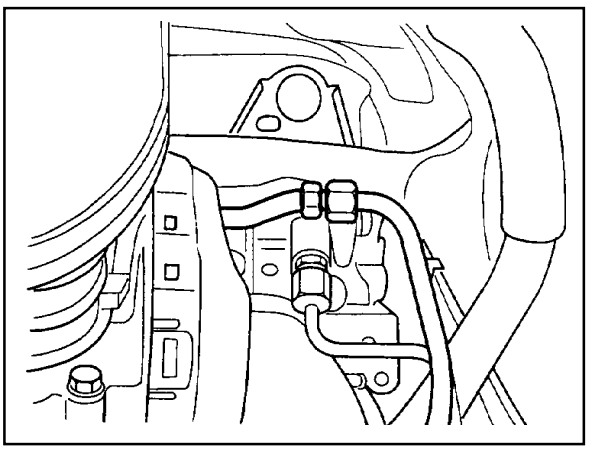
14. Remove the fuel feed and return line.

Notice

Before removing the fuel lines, release the pressure in the fuel system.

Installation Notice

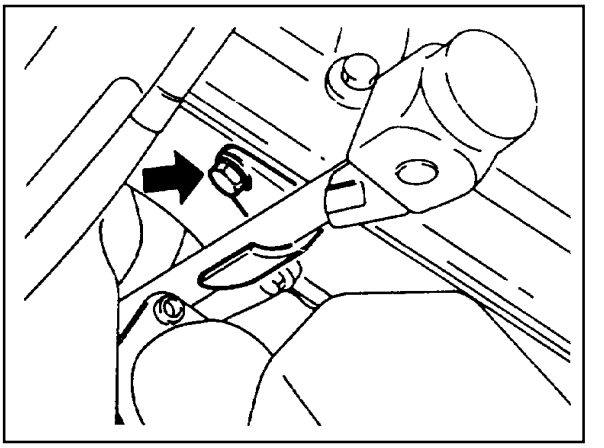
Tightening Torque	21 - 25 Nm



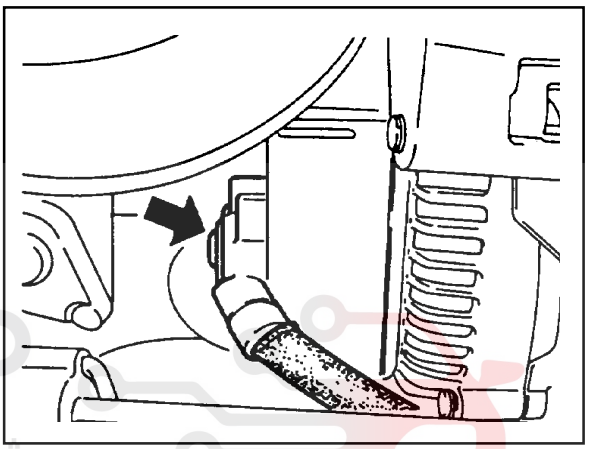
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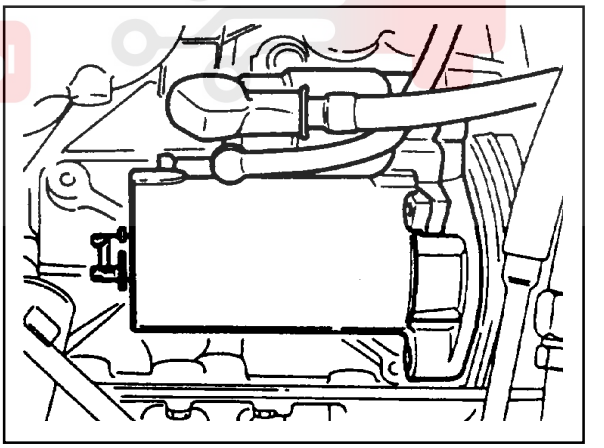
15. Remove the automatic transmission dipstick guide tube.



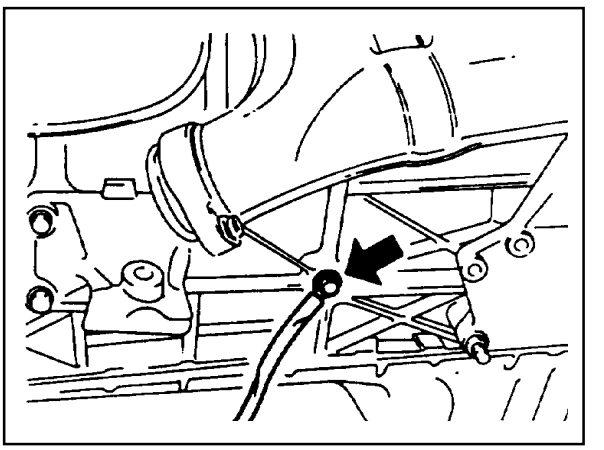
16. Disconnect the wire of alternator.



17. Disconnect the wire of starter motor and remove the starter motor.
18. Disconnect the engine main harness ground.



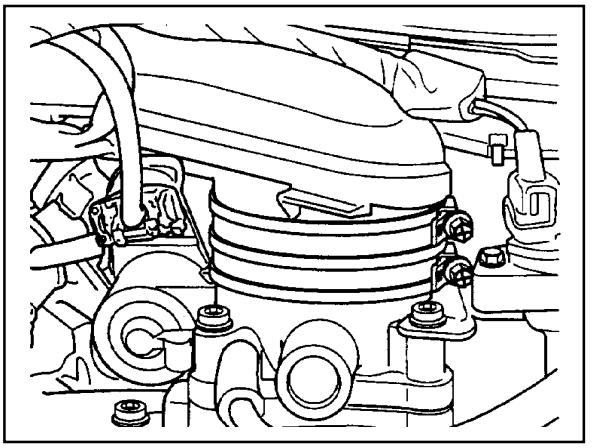
19. Disconnect the engine ground wire.



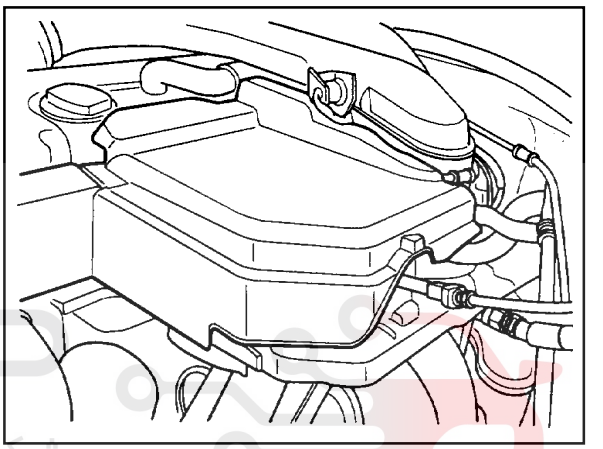
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20. Disconnect following sensors connector.
    - HFM sensor.
    - Coolant temperature sensor.
    - 2 knock sensors.
    - Camshaft and crankshaft sensors.

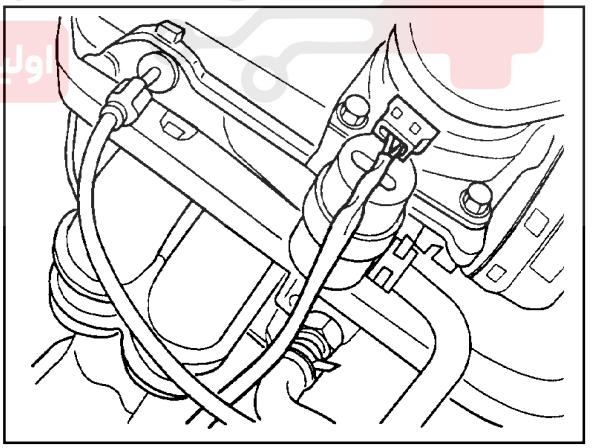


21. After removing the ignition coil cover, disconnect the ignition coil connector.
22. Remove the harness cover and disconnect the 6 injection valve connectors. Disconnect the main harness.

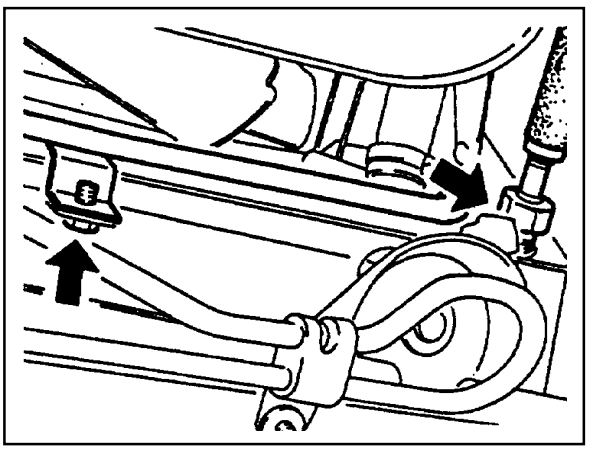


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23. Separate the hose toward engine from canister purge solenoid valve.



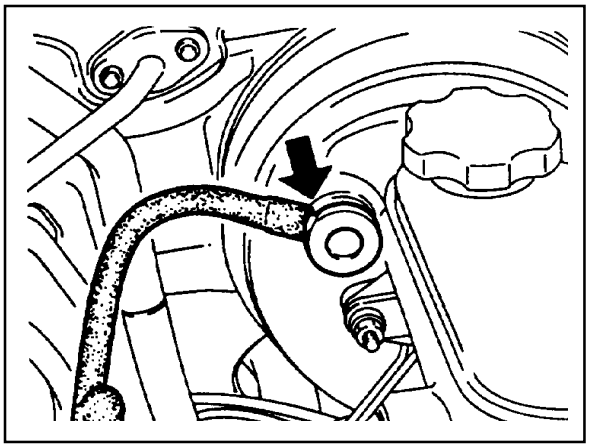
24. Remove the automatic transmission oil cooler line.



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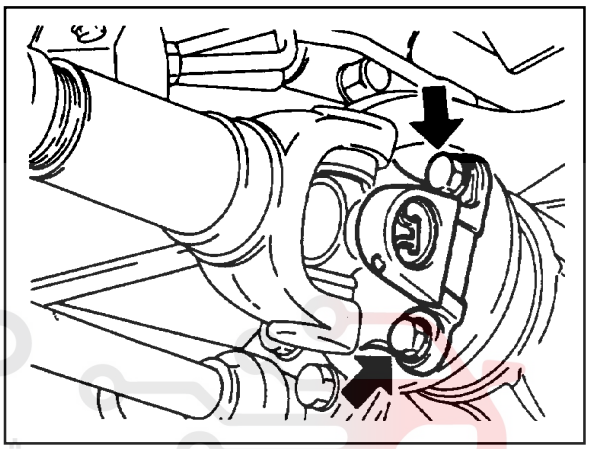
25. Separate the vacuum hose for brake booster.
26. Separate the other vacuum hoses.



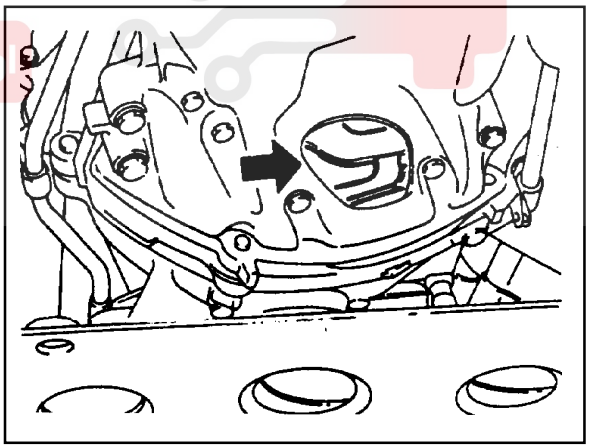
27. Remove the propeller shaft from the front axle.

Installation Notice

Tightening Torque	81 - 89 Nm



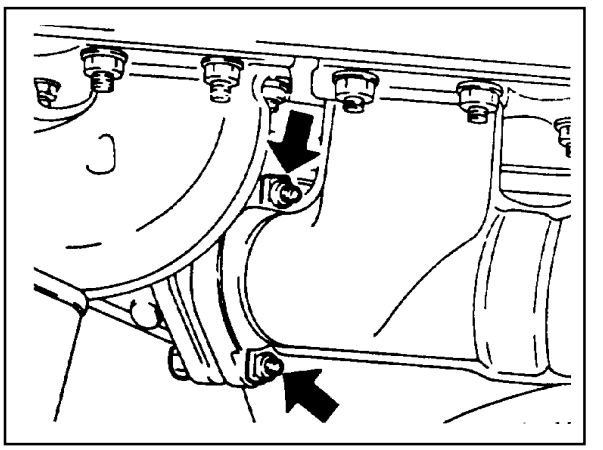
28. By rotating the crankshaft from the front of engine, remove the 6 torque converter mounting bolts from the engine ring gear plate.



29. Remove the exhaust manifold and exhaust pipe.

Installation Notice

Tightening Torque	30 Nm



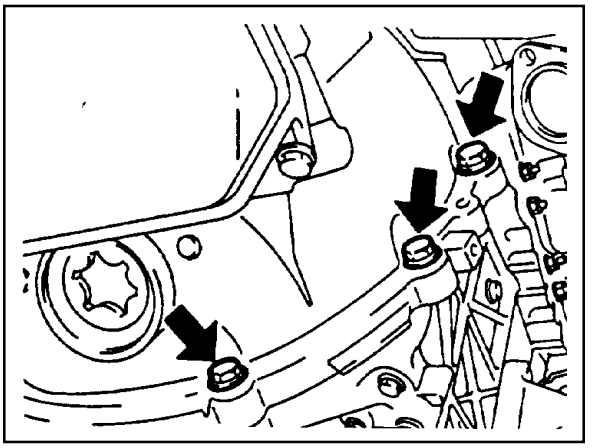
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30. Remove the transmission mounting bolts and separate the transmission from the engine.

Installation Notice

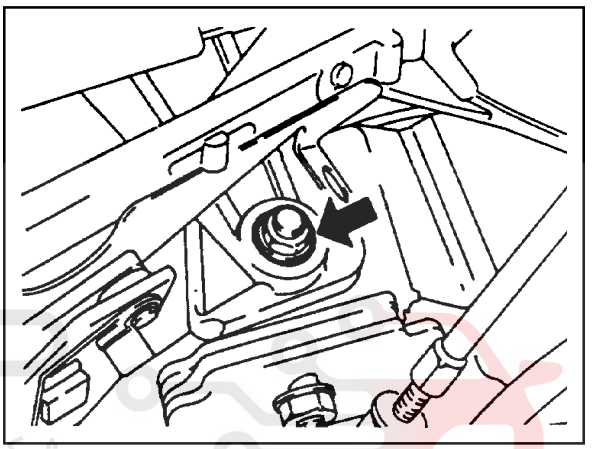
Tightening Torque	65 Nm



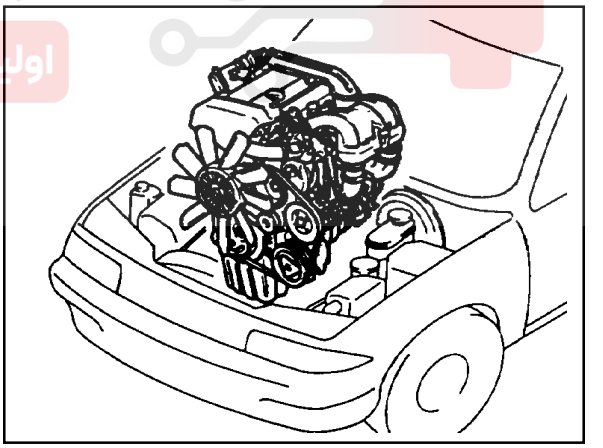
31. Remove the bolts for engine mounting bracket.

Installation Notice

Tightening Torque	50 - 75 Nm



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 should follow the removal procedure in the reverse order.

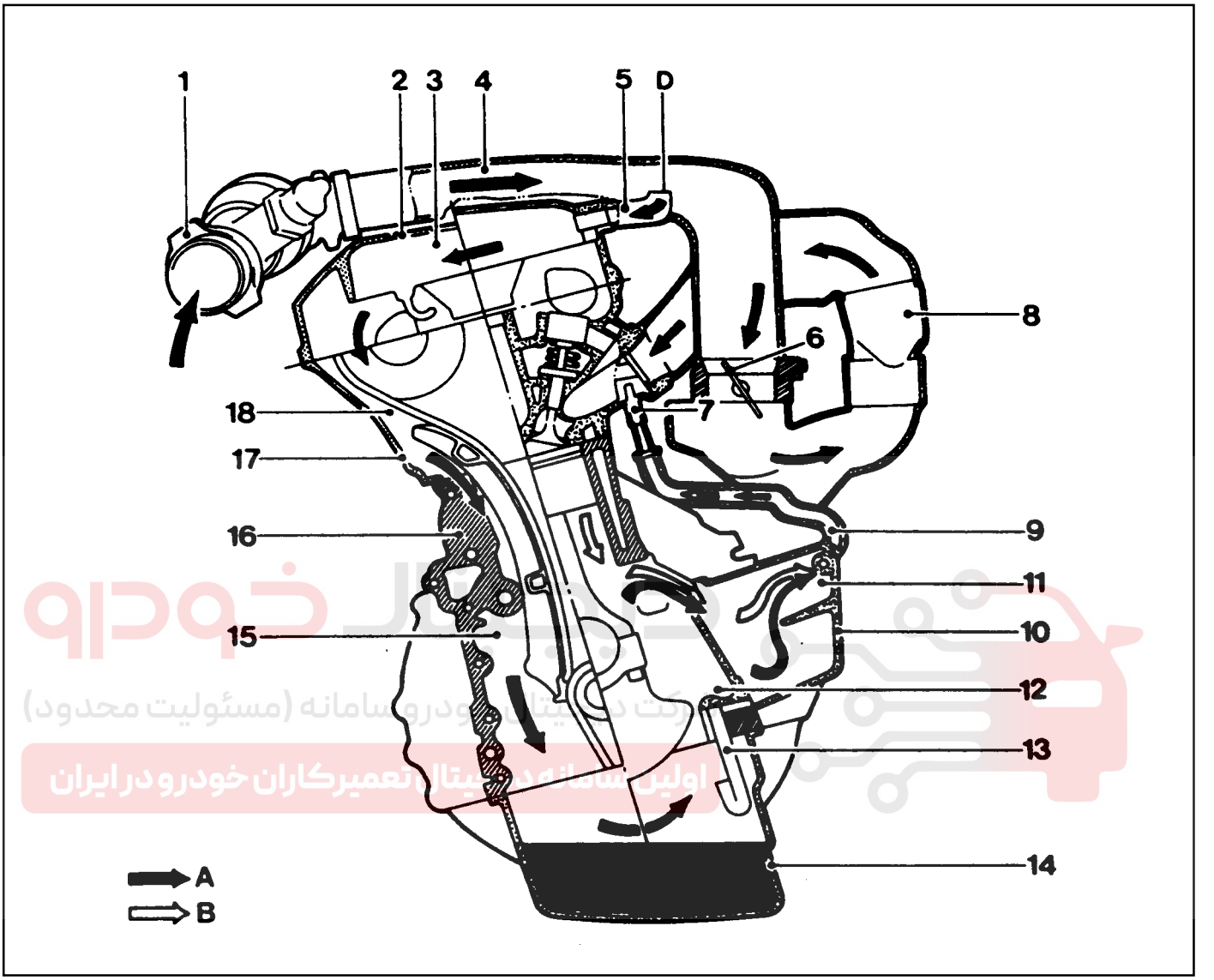


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CRANKCASE VENTILATION SYSTEM

Operation at Idling and Mid-Load



1 HFM Sensor
2 Cylinder Head Cover
3 Oil Spearation Chamber (Full-Load or Over Mid-Load)
4 Intake Air Duct (Cross Pipe)
5 Vent Line (Full-Load or Over Mid-Load)
6 Throttle Valve
7 Restrictor, Diameter 1.1mm (Mid-Load at Idling)
8 Intake Manifold
9 Vent Line (Mid-Load at Idling)
10 Air Conditioner Bracket
11 Oil Separation Chamber (Mid-Load at Idling)
12 Crank Chamber
13 Oil Return Pipe
14 Oil Pan
15 Timing Gear Case Cover
16 Crankcase
17 Chain Housing

A Fresh Air
C Blow-by Gas
D Vent Connection

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Operation at Idling and Mid-Load

- The throttle valve(6) is closed or very partially opened, and the vacuum pressure in intake manifold is high.

  The blow-by gas and the fresh air that is additionally supplied through the vent connection(D) in the crankcase in partial load gets supplied to the combustion chamber from the crank chamber(12) through the oil separation chamber(11), air-conditioner bracket(10), vent line(9), and restrictor(7) mounted to the cylinder head.

  The circulated engine oil returns to the oil pan through the oil return pipe(13) at the bottom of oil separation chamber(11).

  The fresh air gets supplied to the crank chamber(12) through the HFM sensor(1), intake air duct(4), vent line(5), oil separation chamber(3), chain housing(17), and the timing gear case cover(15).

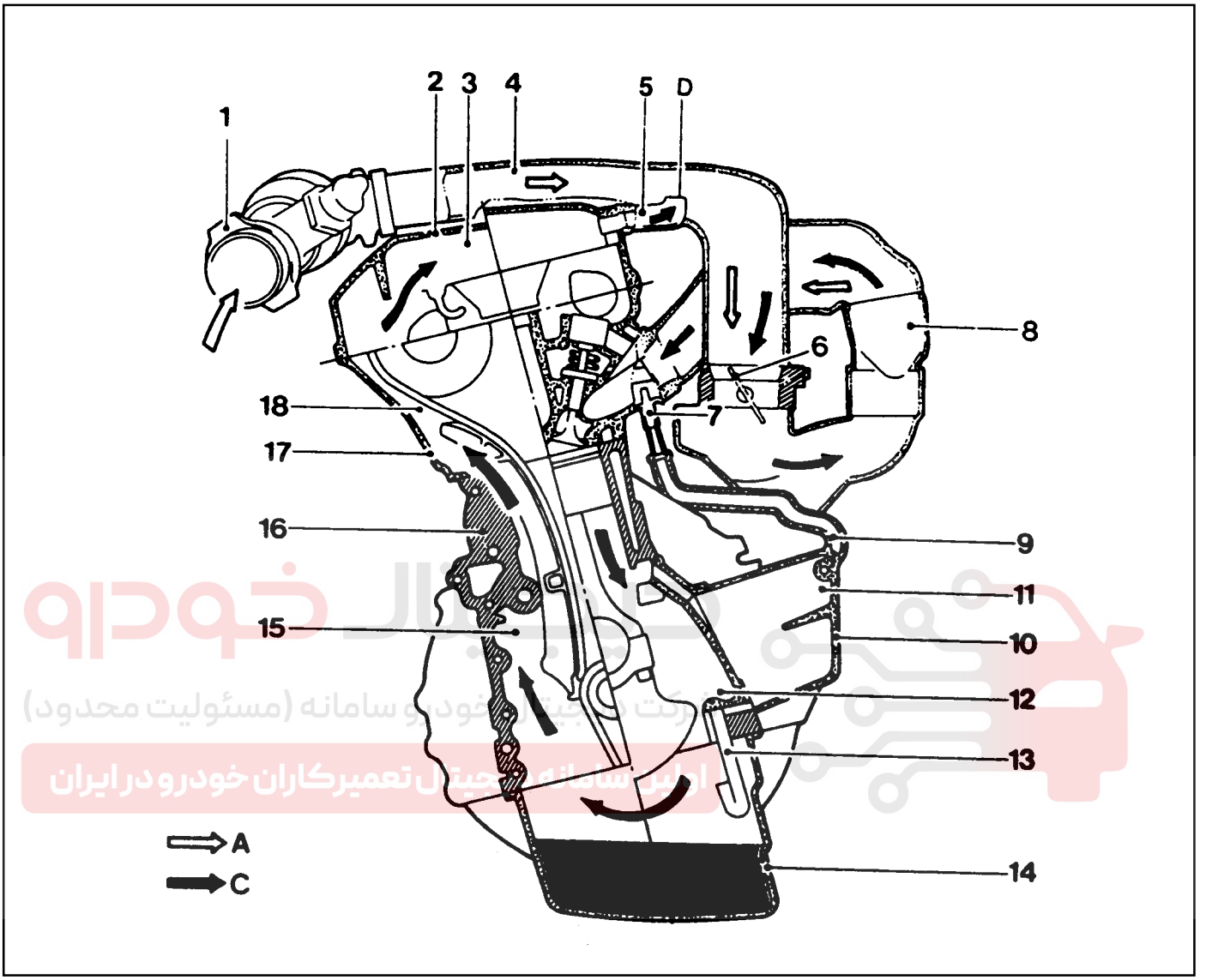
  The additional supply of the fresh air is needed to prevent from forming the residues of the engine oil.

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Operation When Full-Load at Partial Load



1 HFM Sensor
2 Cylinder Head Cover
3 Oil Spearation Chamber (Full-Load or Over Mid-Load)
4 Intake Air Duct (Cross Pipe)
5 Vent Line (Full-Load or Over Mid-Load)
6 Throttle Valve
7 Restrictor, Diameter 1.1mm (Mid-Load at Idling)
8 Intake Manifold
9 Vent Line (Mid-Load at Idling)
10 Air Conditioner Bracket
11 Oil Separation Chamber (Mid-Load at Idling)
12 Crank Chamber
13 Oil Return Pipe
14 Oil Pan
15 Timing Gear Case Cover
16 Crankcase
17 Chain Housing

A Fresh Air
C Blow-by Gas
D Vent Connection

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Operation When Full-Load at Partial Load

- The throttle valve (6) is partially opened or fully opened.

  The air flows very rapidly through the vent line(5)s connection(D) and the intake air duct when full-load at partial load.

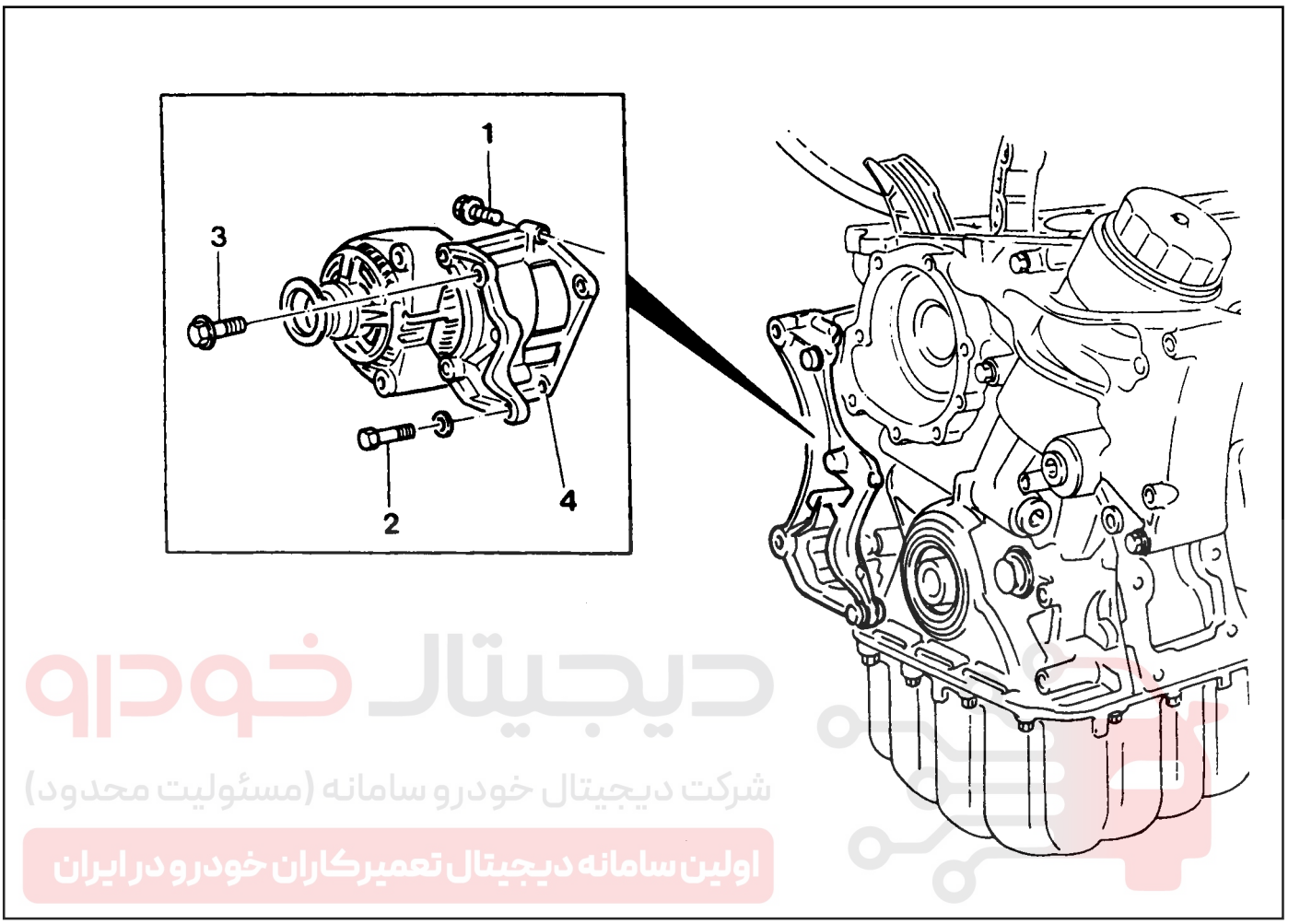
  Consequently, most of the low-by gases are supplied to the combustion chamber through the timing gear case cover(15), chain housing(17), oil separation chamber(3), vent line(5), throttle valve(6), and intake manifold(8).

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ALTERNATOR



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1 Bolt (M8 X 40, 3 pieces) ..... 22.5-27.5 Nm
2 Bolt (M8 X 70, 2 pieces) ..... 22.5-27.5 Nm
3 Bolt (M8 X 85, 1 piece) ..... 22.5-27.5 Nm
4 Alternator Bracket

Removal & Installation Procedure

1. Remove the drive belt.
2. Remove the alternator.
3. Unscrew the alternator carrier bolts (1,2,3) and remove the carrier (4).

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Notice

Apply 3Nm of torque when mounting the bolt (1); apply 25 ± 2.5Nm of torque when mounting the bolts (2), and (3); and then tighten the bolt (1) with 25 ± 2.5Nm of torque.

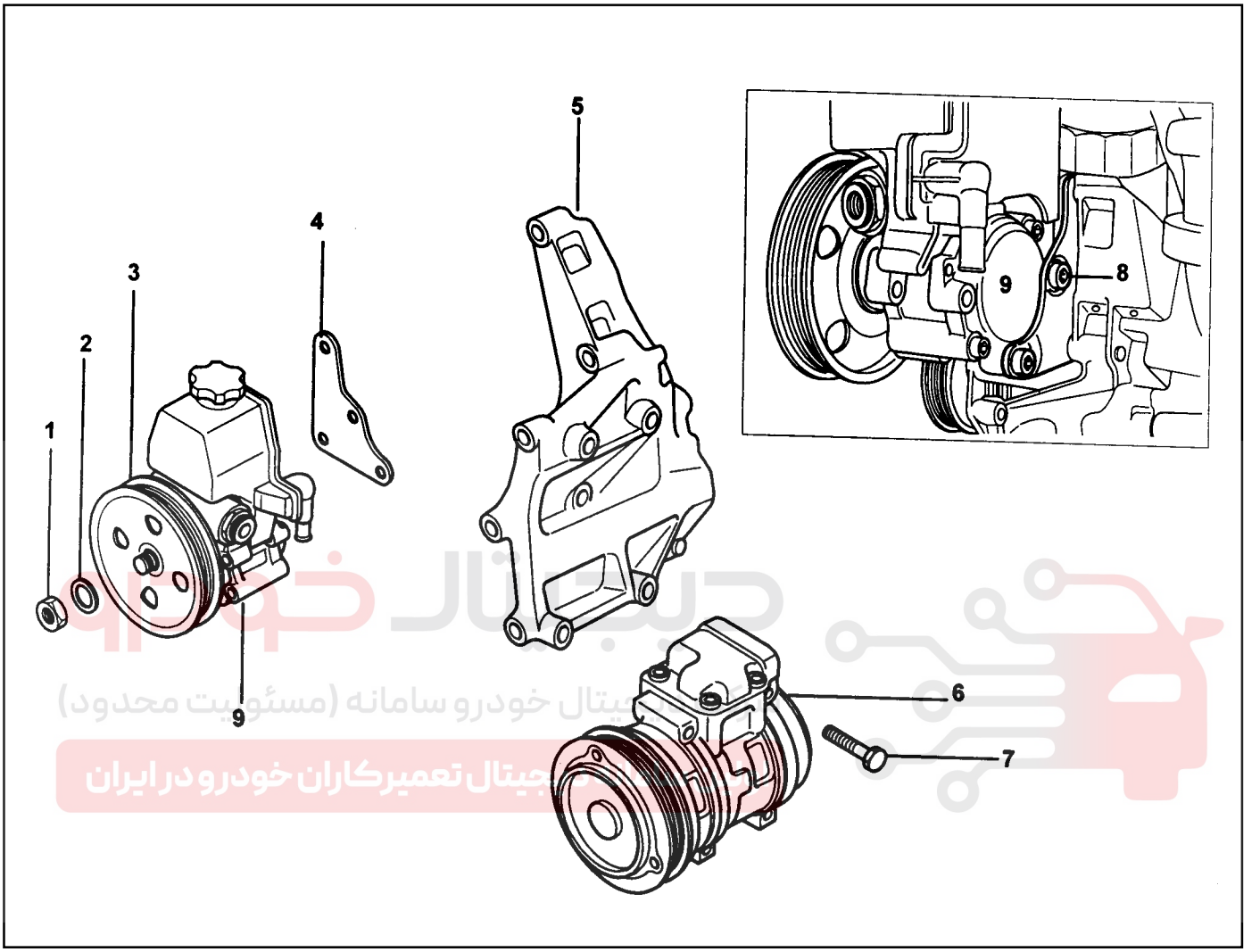
4. Installation should follow the removal procedure in the reverse order.

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POWER STEERING PUMP AND A/C BRACKET

Preceding Work : Removal of cooling fan and shroud
Removal of drive belt



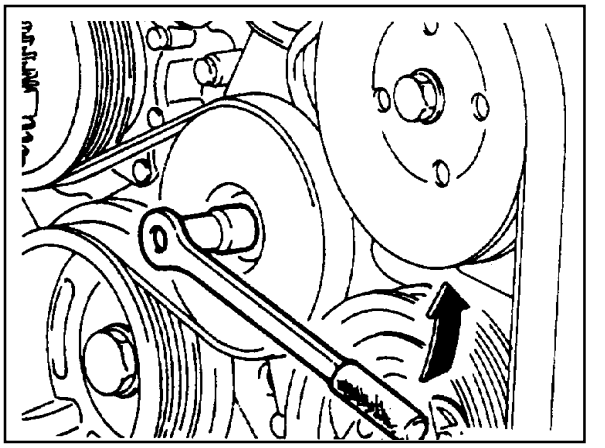
1 Nut ..... 35.2-28.8 Nm
2 Washer
3 Belt Pulley
4 Bolt (M8 X 91, 2 pieces) ..... 22.5-27.5 Nm
5 Power Steering Pump
6 Bracket
7 Washer
8 Bolt (M8 X 20, 2 pieces) ..... 22.5-27.5 Nm
9 Washer
10 Bolt (M8 X 105,4 pieces) ..... 22.5-27.5 Nm
11 A/C Compressor
12 Bolt (M8 X 50, 5 pieces, M8 X 80, 5 pieces) ..... 22.5-27.5 Nm
13 A/C Bracket
14 Vent Hose
15 Bracket Gasket ..... Replace

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Removal & Installation Procedure

1. Remove the belt pulley after removal of poly v-belt.



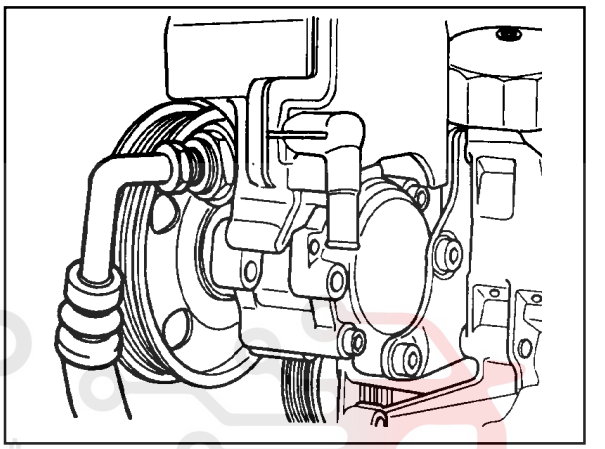
Installation Notice

Tightening Torque	40.5 - 49.5 Nm

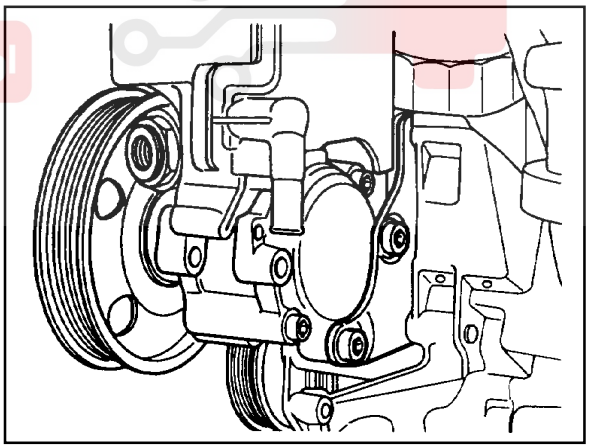
Notice

Pull the tensioning pulley counterclockwise as shown in the figure.

2. Disconnect the hydraulic pipe of the power steering pump and drain the oil.



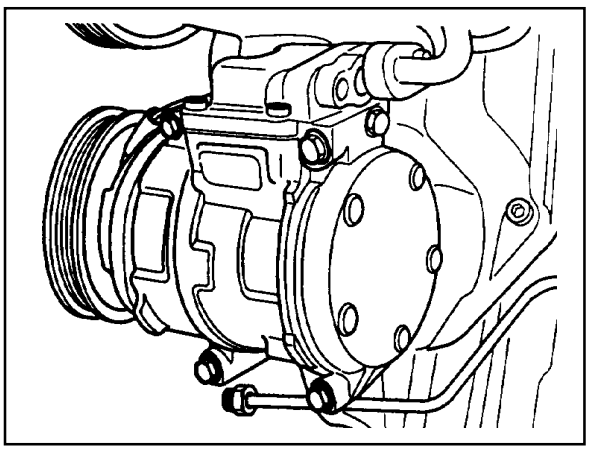
3. Unscrew the bolts (arrows) and remove the steering pump.



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

4. Remove the compressor after disconnecting the wiring connector and refrigerant pipe of A/C compressor.



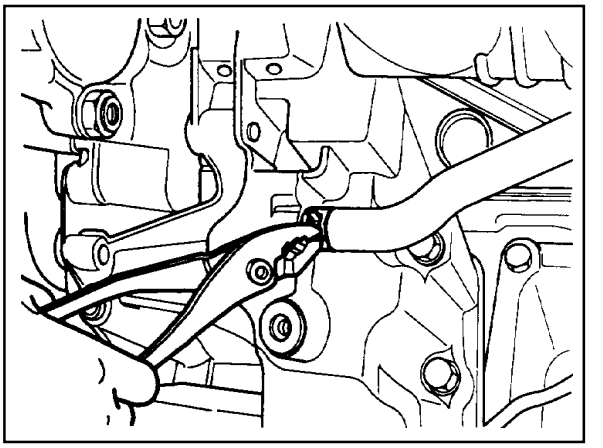
Notice

Discharge all the refrigerant before removing the pipes.

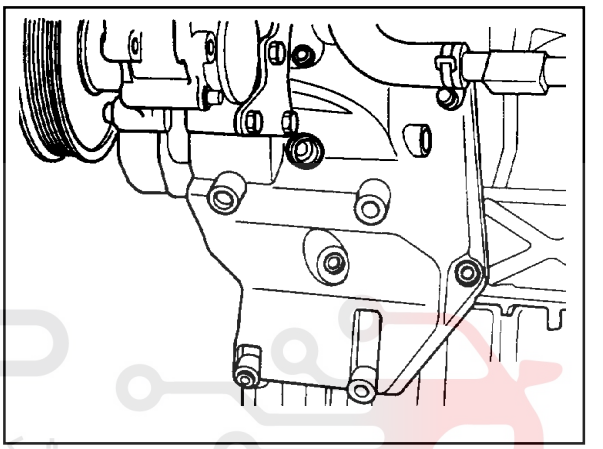
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5. Disconnect the vent hose from the A/C bracket.



6. Unscrew all the mounting bolts (arrows) and remove the A/C bracket and the gasket.



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

7. Clean the sealing surface.
8. Replace the gasket with new one.
9. Installation should follow the removal procedure in the reverse order.
10. Check the oil leakage by operating the engine after installation.

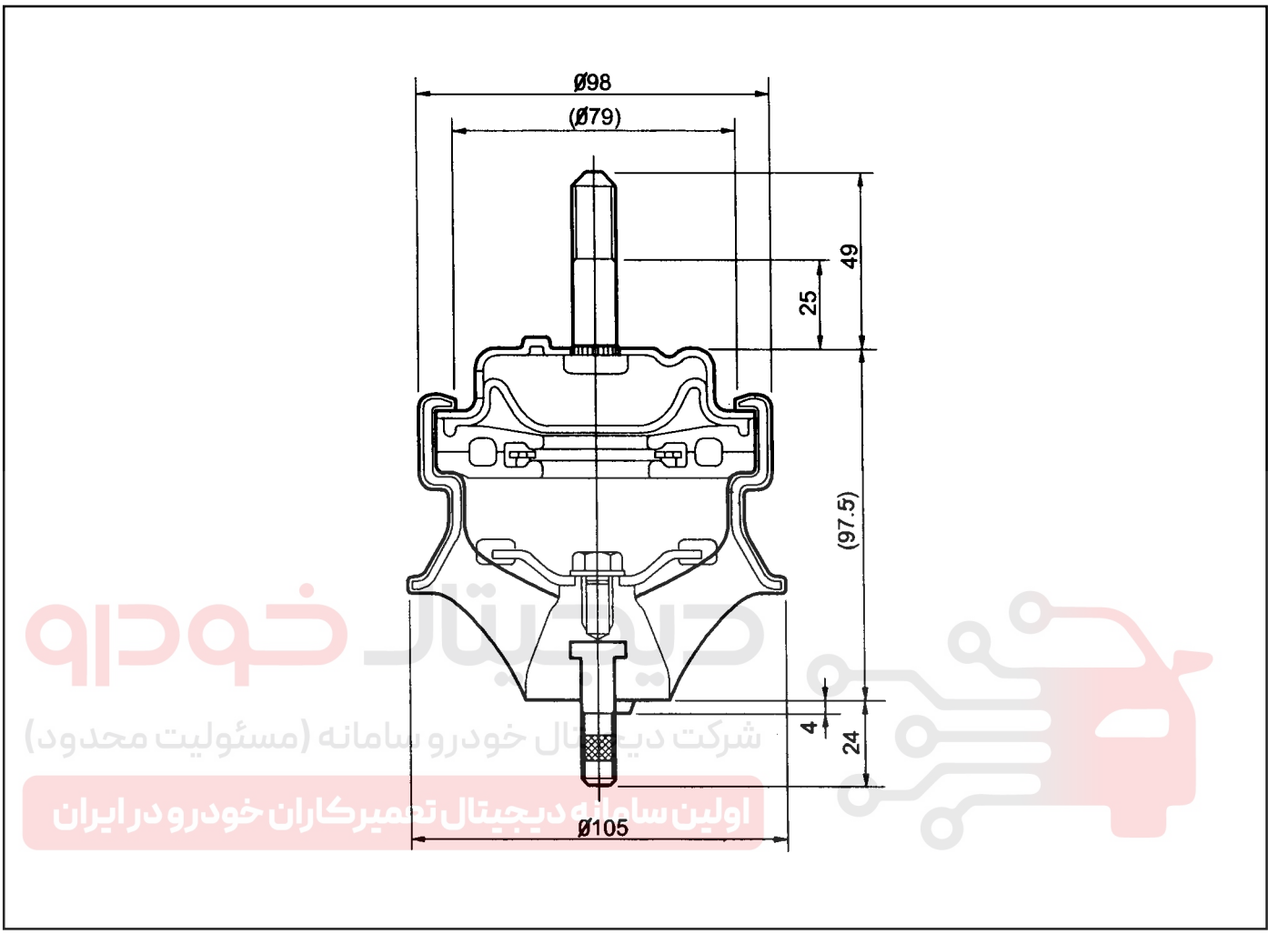
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HYDRAULIC ENGINE MOUNTING INSULATOR

Service Data

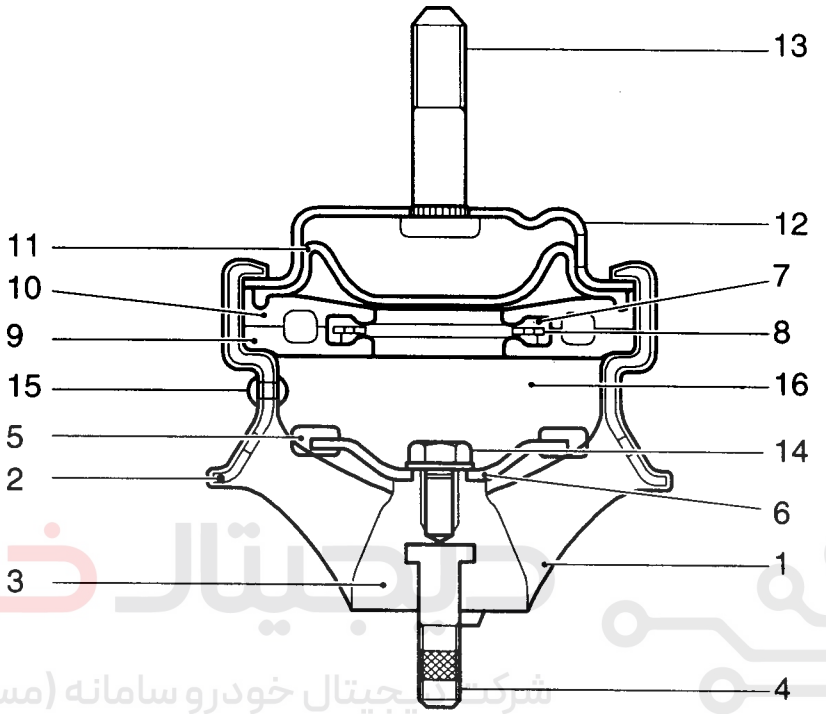


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Sectional View

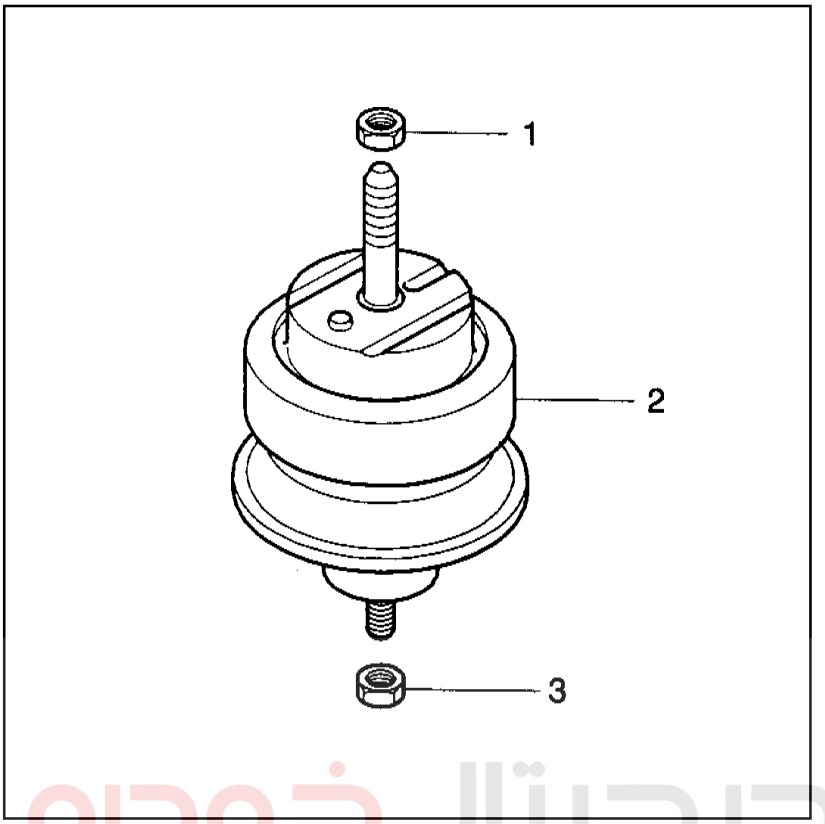


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1 Rubber Body
2 Brackek
3 Core
4 Lower Bolt
5 Rubber Plunger
6 Plunger Plate
7 Rubber
8 Plate
9 Lower Orifice
10 Upper Orifice
11 Diaphram
12 Cover Plate
13 Upper Bolt
14 Flange Bolt
15 Rivet
16 Fluid

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1 Upper Nut
2 Hydraulic Installer ..... 62~93 Nm
3 Lower Nut ..... 28~47 Nm

Removal and Installation Procedure

1. Unscrew the upper nut(1) on engine mounting and remove the engine.

Installation Notice

Tightening Torque	62 - 93 Nm

2. Unscrew the lower nut(3) and remove the hydraulic engine mounting insulator.

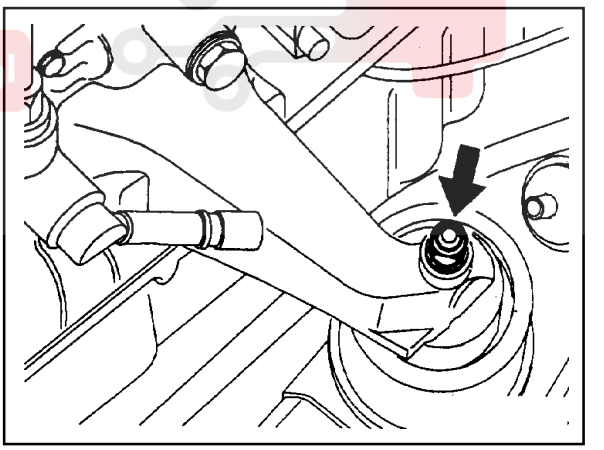
Installation Notice

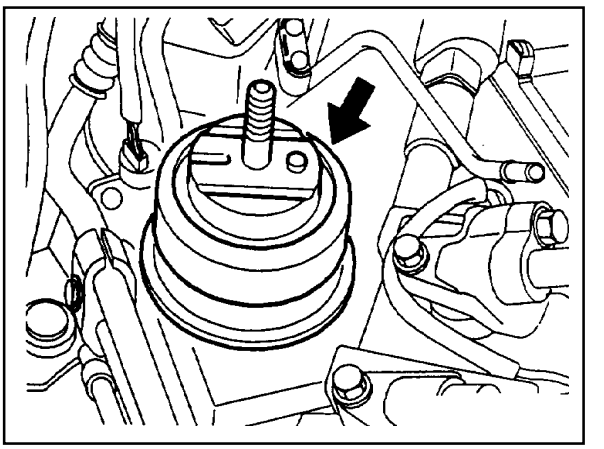
Tightening Torque	28 - 47 Nm

Notice

If the insulator is spotted with oil, replace the hydraulic insulator assembly.

3. Installation should follow the removal procedure in the reverse order.



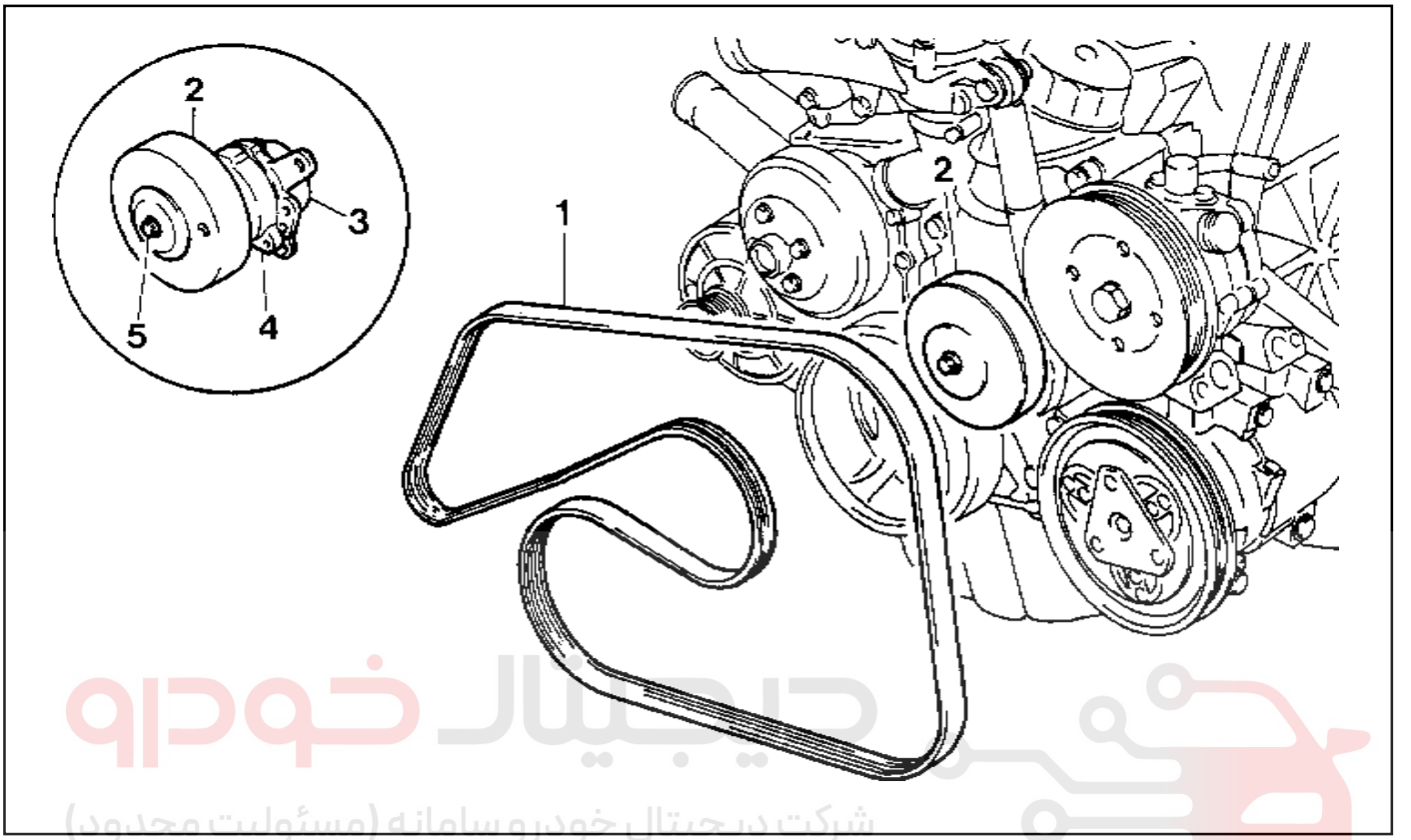


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POLY V-BELT

Preceding Work : Removal of cooling fan



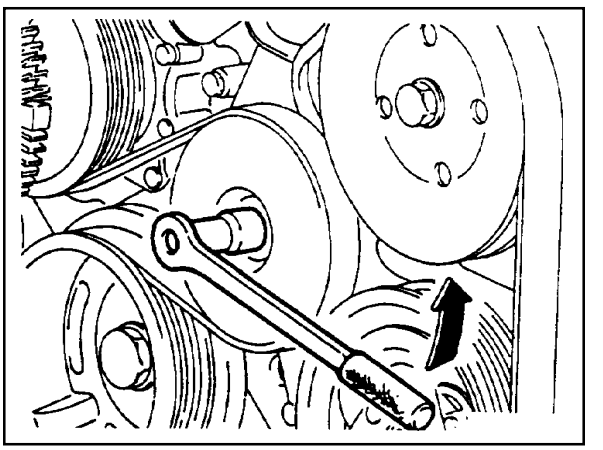
1 Poly V-belt (2,155 mm)
2 Belt Tensioning Pulley
3 Belt Tensioner

Removal & Installation Procedure

1. Release the belt tension by turning the stud on the cap with 12 sided wrench or spanner counterclockwise.
2. Remove the poly v-belt.

   Notice

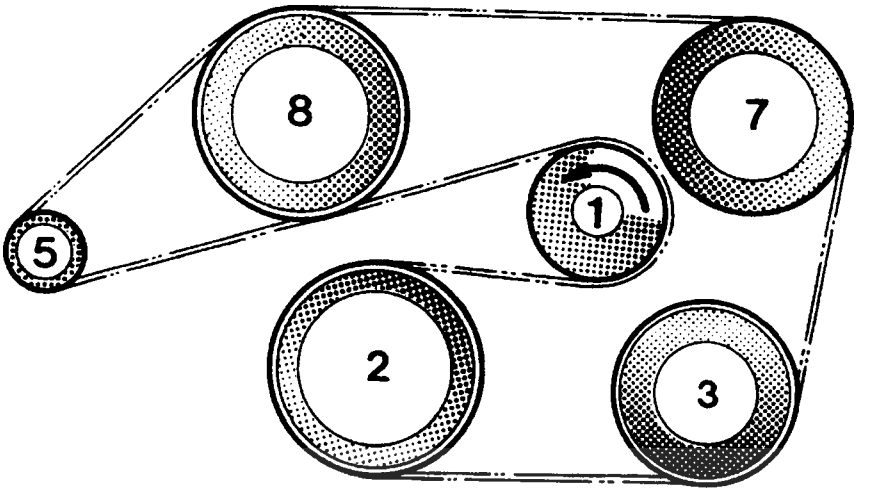
   Check the belt for damage and tensioning pulley bearing point for wear and replace them if necessary.
3. Install the belt after prying the tensioning pulley.



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Poly V-belt Arrangement



1 Belt Tensioning Pulley
2 Crankshaft Belt Pulley
3 A/C Compressor Pulley
5 Alternator Pulley
7 Power Steering Pump Pulley
8 Water Pump Pulley

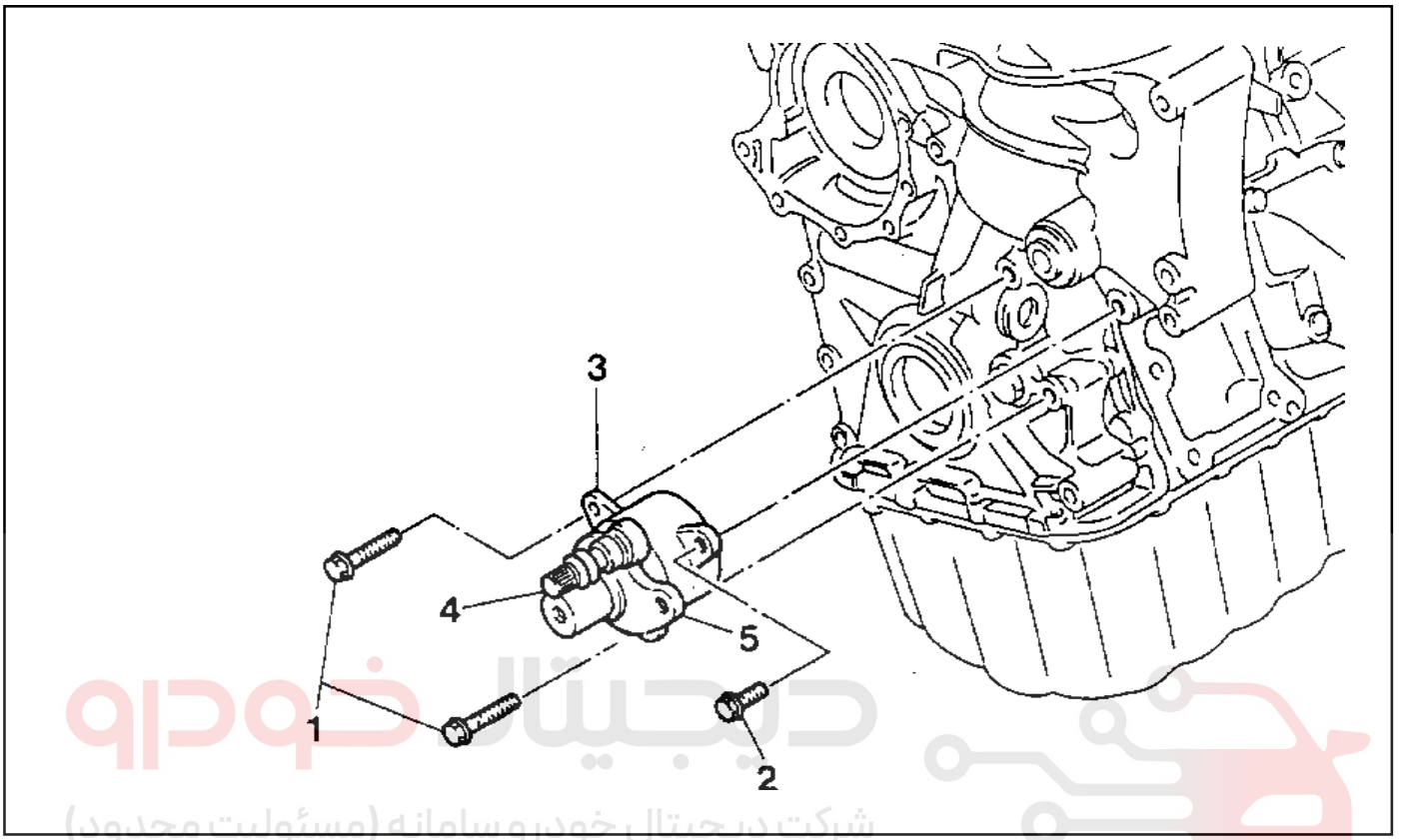
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TENSIONING DEVICE

Preceding Work : Removal of tensioning device shock absorber



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1	Bolt (M8 x 75, 2 pieces) + Washer ..... 22.5-27.5 Nm	3	Tensioning Device
2	Bolt (M8 x 25, 1 pieces) + Washer ..... 22.5-27.5 Nm	4	Stud bolt
		5	Tensioning Arm

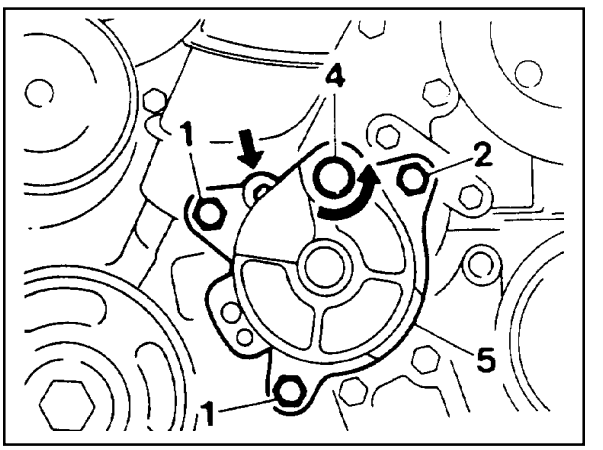
Removal & Installation Procedure

1. Turn the stud bolt to counterclockwise.
2. Insert the pin (111 589 01 15 00) into the hole in tensioning arm.
3. Unscrew the bolts (1, 2) and remove the tensioning device.

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

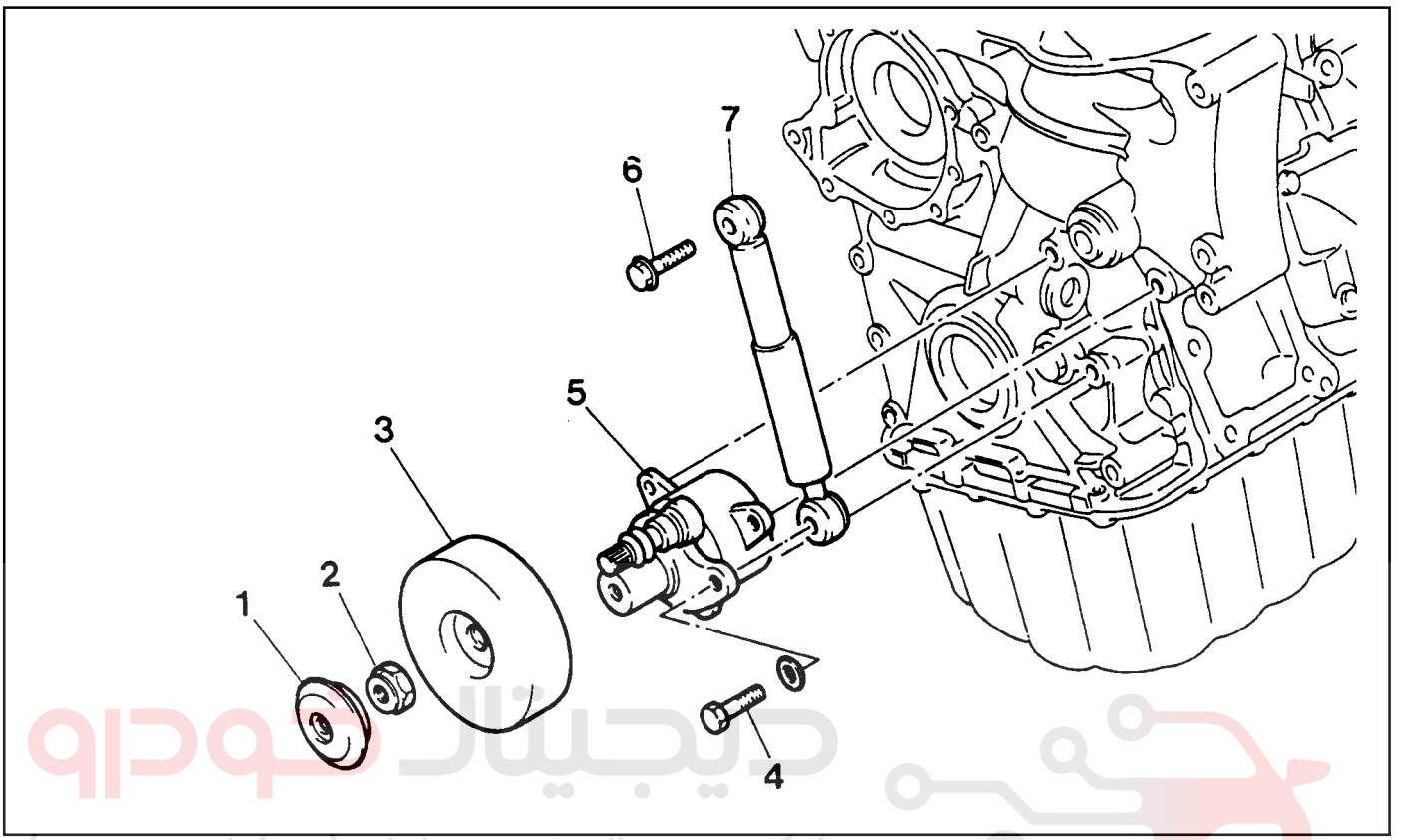
4. Installation should follow the removal procedure in the reverse order.



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TENSIONING DEVICE SHOCK ABSORBER



شرکت دیجیتال خودرو سامانه (مسئولیت محدود)

1 End Cover
2 Nut ..... 40.5-49.5 Nm
3 Tensioning Pulley
4 Bolt (M8 X 25) + Washer ..... 22.5-27.5 Nm
5 Tensioning Device
6 Bolt (M8 X 35) + Washer ..... 22.5-27.5 Nm
7 Shock Absorber

Removal & Installation Procedure

1. Remove the end cover (1).
2. Remove the nut (2) and remove the tensioning pulley (3).

Installation Notice

Tightening Torque	40.5 - 49.5 Nm

3. Unscrew the bolts (4,6) and remove the shock absorber (7).

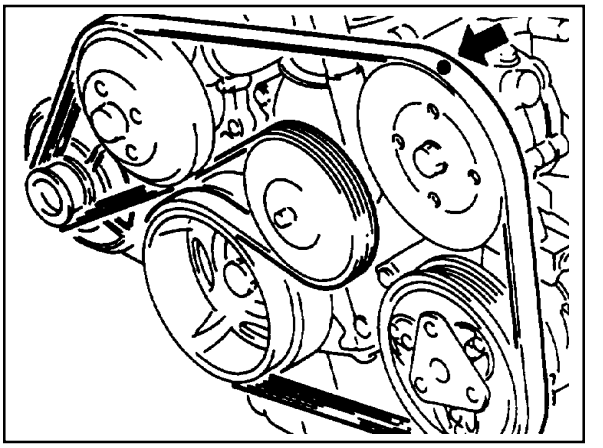
Installation Notice

Tightening Torque	22.5-27.5 Nm

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POLY V-BELT INSPECTION



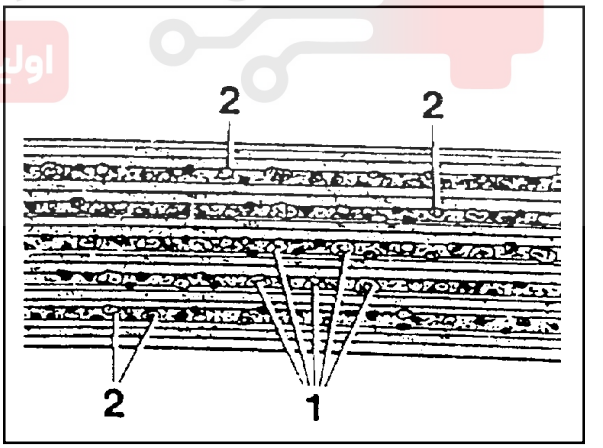
- Make marks on the belt with chalk.
- Rotate the engine and check the belt for damage.

Notice

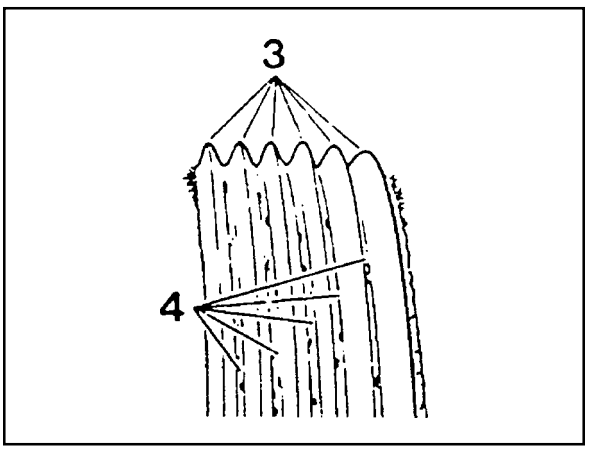
If one of the following types of damages is found, replace the belt.

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



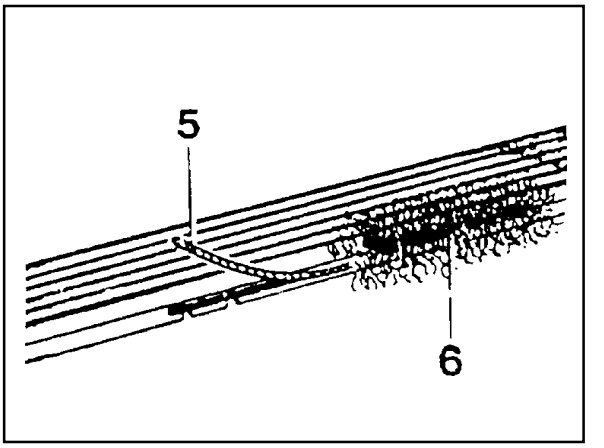
3. Pointed rib.
4. Belt cord visible in the base of rib.



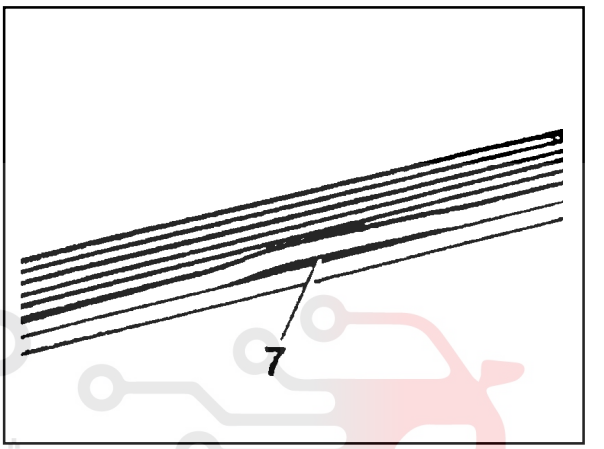
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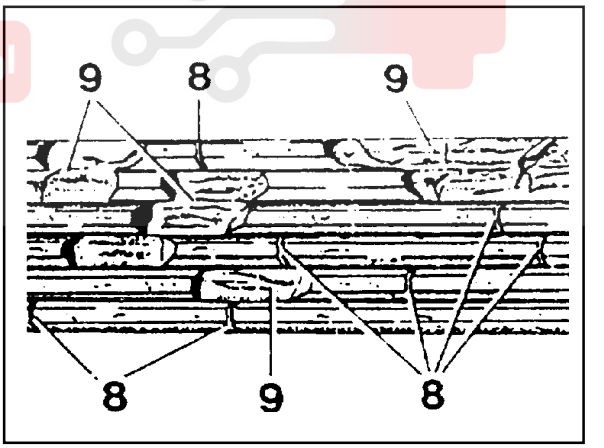
5. Cord torn out at the side.
6. Outer cords frayed.



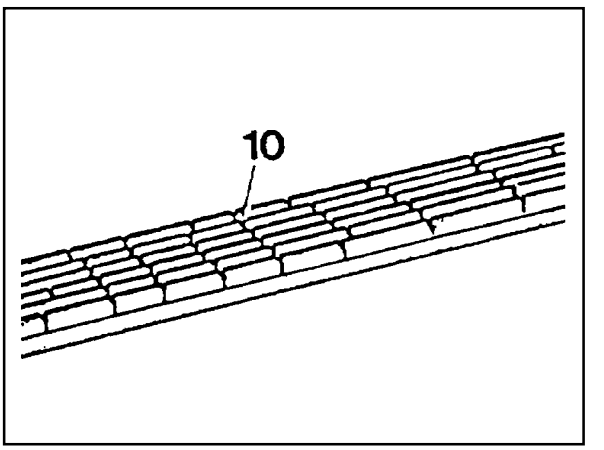
7. Rib detached from the base of belt.



8. Splits across the rib.
9. Sections of rib torn out.



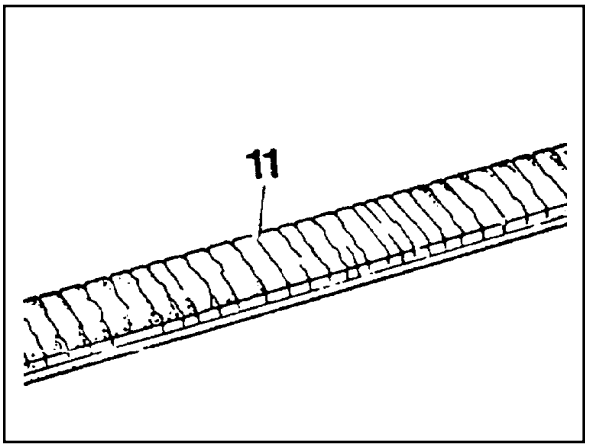
10. Splits across several ribs.



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11. Splits across the back of the belt.

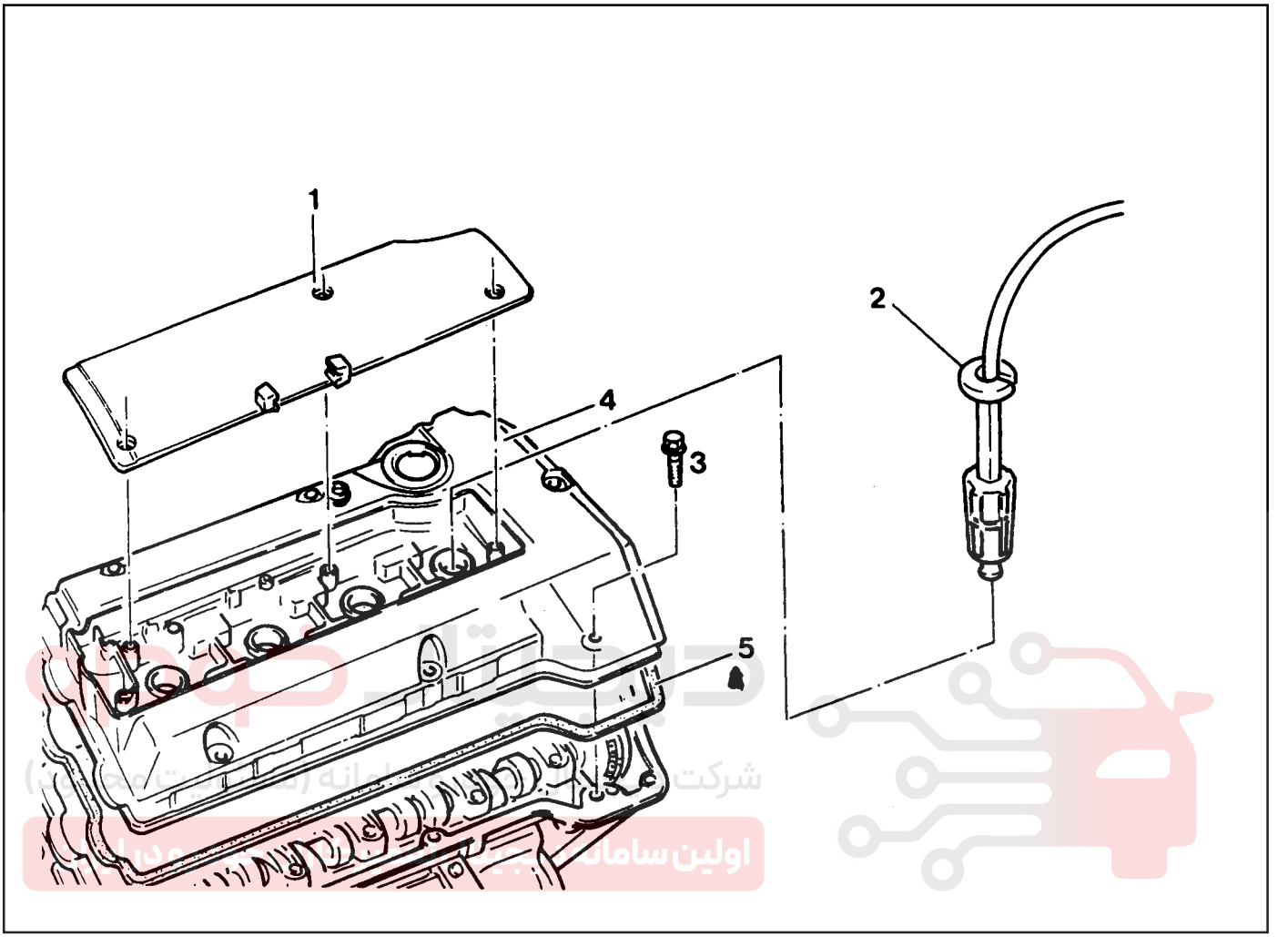


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CYLINDER HEAD COVER



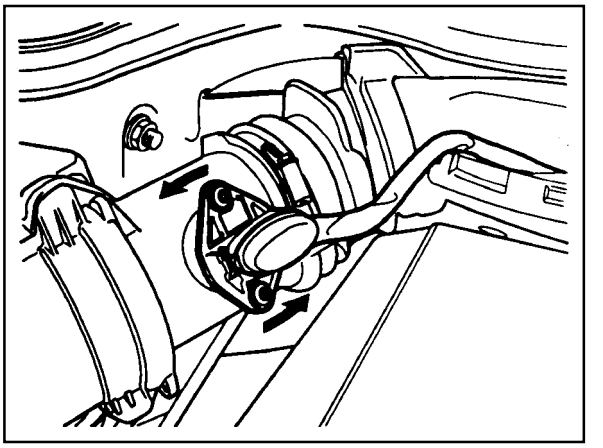
1 Ignition Coil Cover
2 Spark Plug Connector
3 Bolt (M6 X 45 : 4 pieces, M6 X 60 : 6 pieces) ..... 10 ± 1 Nm
4 Cylinder Head Cover
5 Gasket ..... Replace

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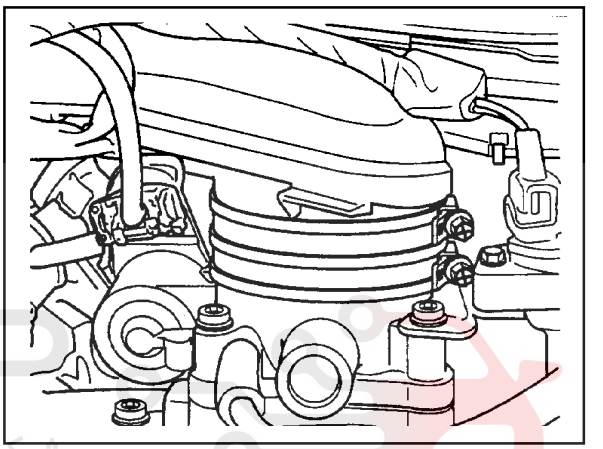
Removal & Installation Procedure

1. Remove the intake air duct.



Installation Notice

Tightening Torque	9 - 11 Nm



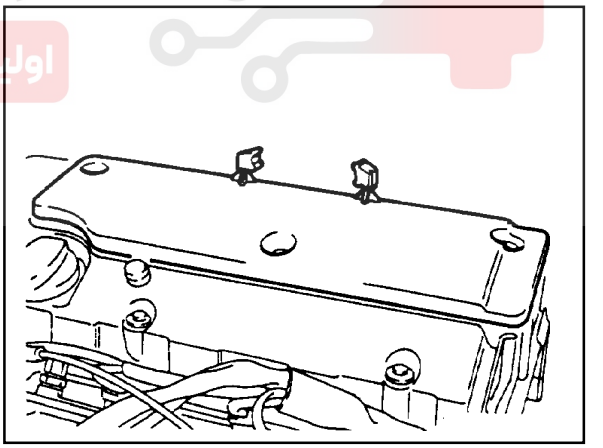
2. Remove the ignition coil cover.

Installation Notice

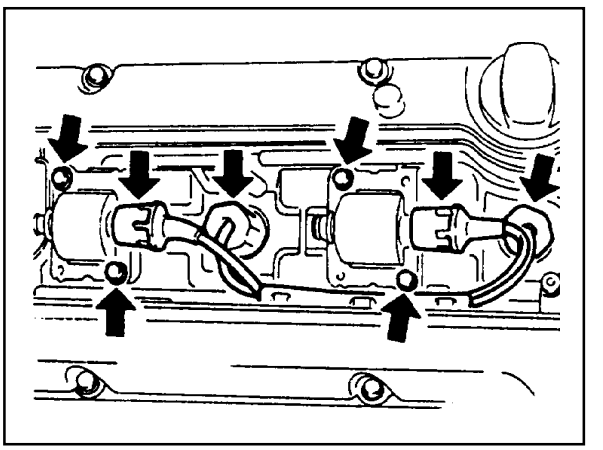
Tightening Torque	9 - 10 Nm

Notice

Release 3 screws from the ignition cover and remove the cover for M161 Engine coil.



3. Remove the spark plug connector and ignition cable.

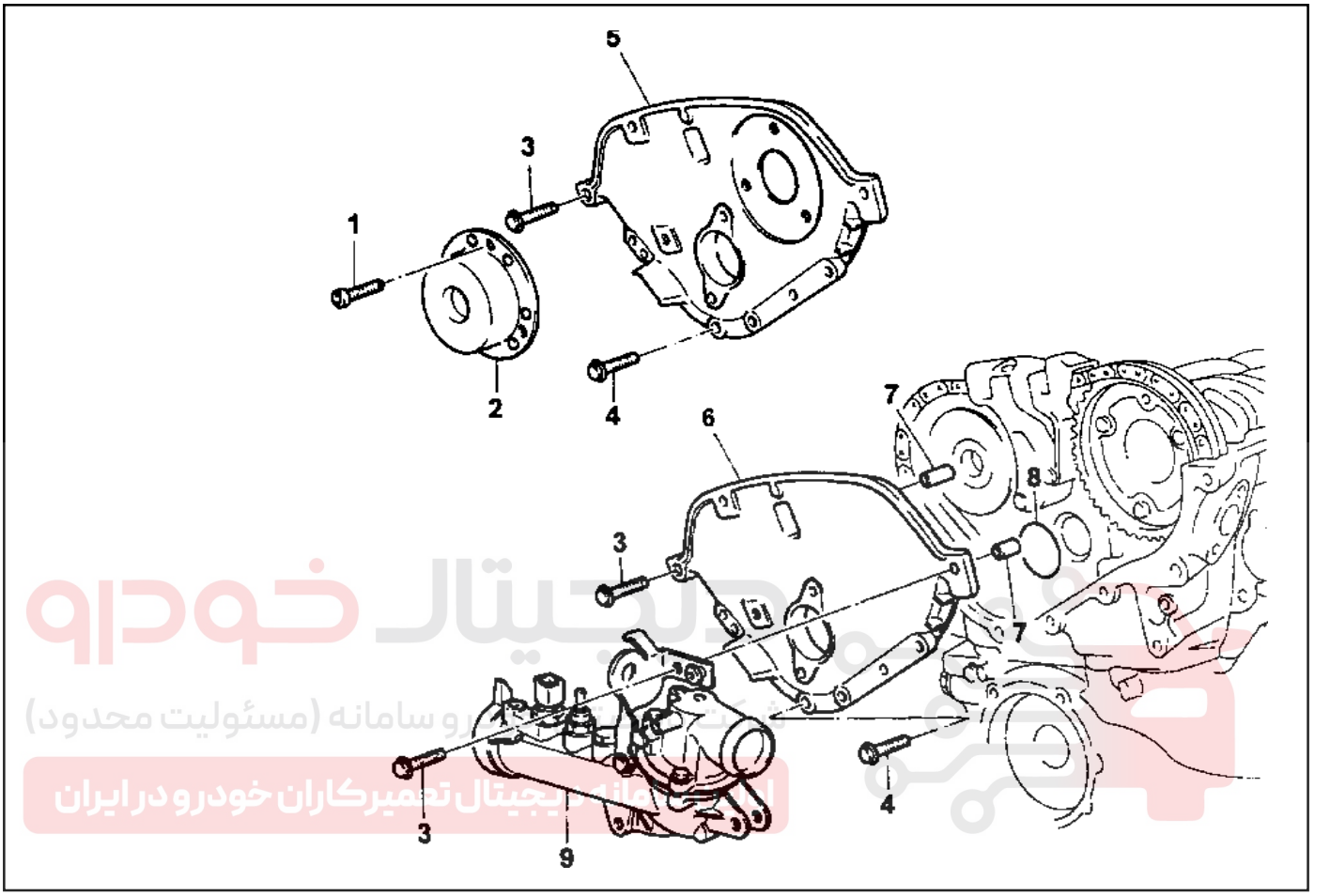


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CYLINDER HEAD FRONT COVER

Preceding Work : Removal of cylinder head cover
Removal of thermostat housing assembly
Removal of engine hanger bracket



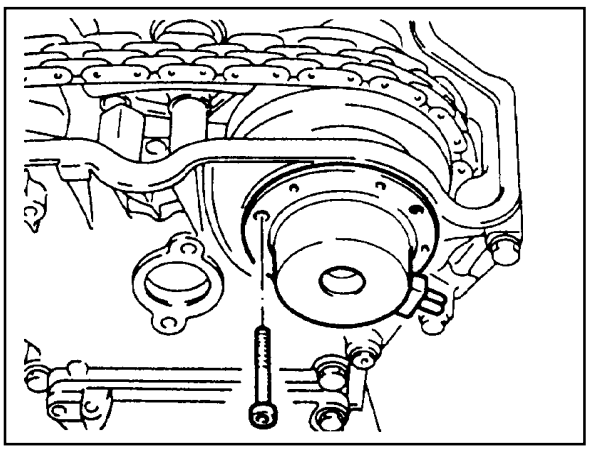
1 Bolt (M6 X 16, 3 pieces) ..... 9-11 Nm
2 Camshaft Adjuster
3 Bolt (M8 X 35, 2 pieces) ..... 22.5-27.5 Nm
4 Bolt (M6 X 22, 6 pieces) ..... 9-11 Nm
5 Front Cover (E23 : M161.973)
6 Front Cover (E20 : M161.943)
7 Sleeve
8 O-ring ..... Replace
9 Thermostat Housing

Removal & Installation Procedure

1. Disconnect the camshaft adjuster connector and remove the camshaft adjuster (E23 engine only).

Installation Notice

Tightening Torque	9 - 11 Nm



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2. Remove the cylinder head front cover.

   Installation Notice

Tightening Torque (3)	22.5 - 27.5 Nm
Tightening Torque (4)	9 - 11 Nm

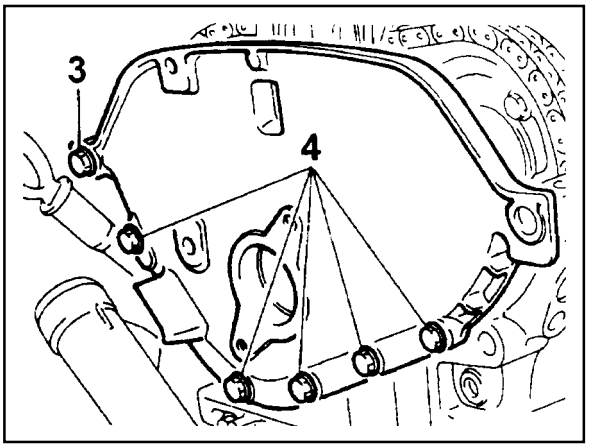
   Apply the sealant at the mating surface of the cylinder head and the front cover.

3. Remove the O-ring.

   Installation Notice

   Replace the O-ring with new one and apply the sealant.

4. Installation should follow the removal procedure in the reverse order.



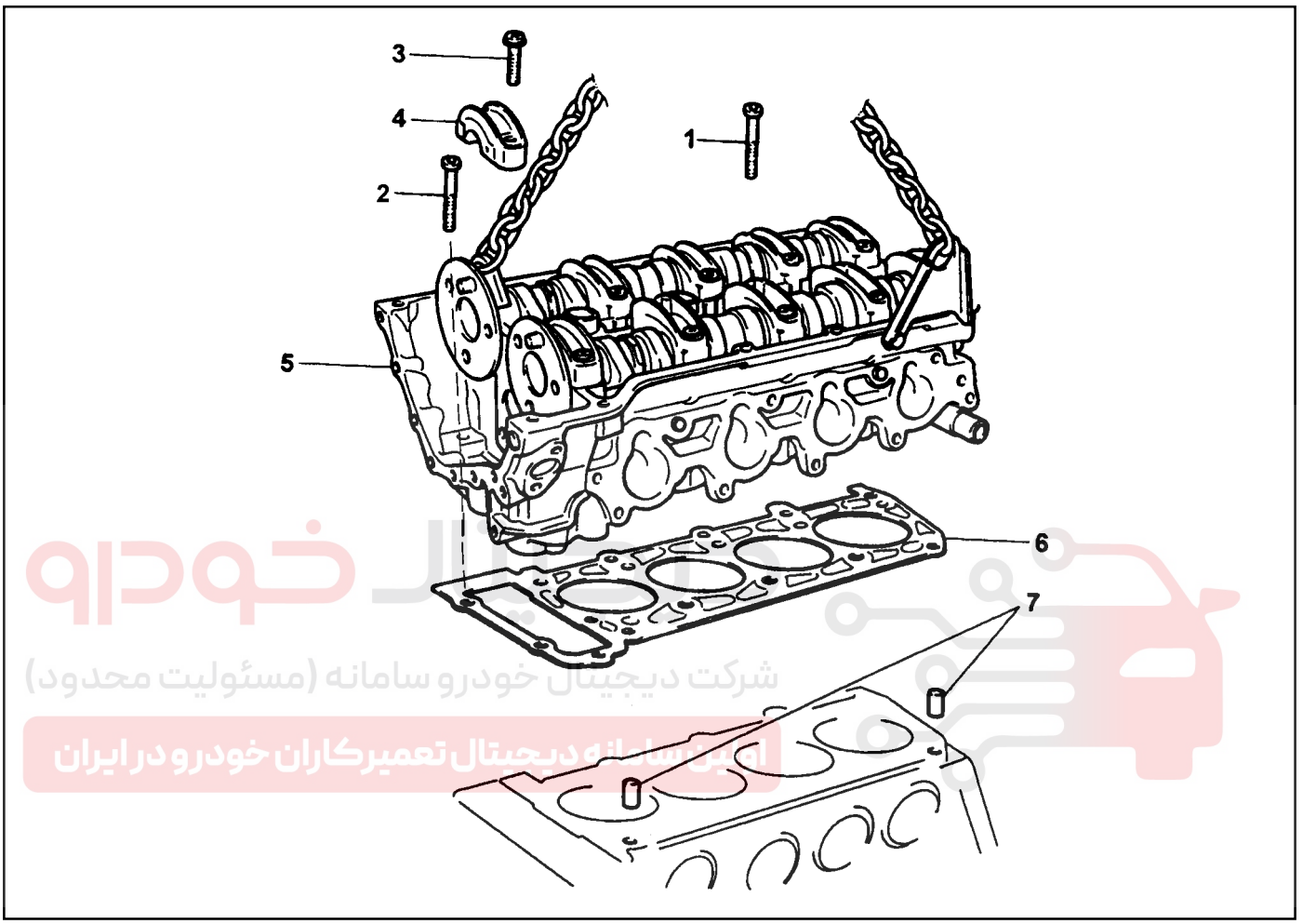
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CYLINDER HEAD

Preceding Work : Removal of cylinder head cover
Removal of cylinder head front cover
Removal of intake manifold
Removal of cylinder head lower line (intake manifold side)



1 Cylinder Head Bolt (M12 X 100, 10 pieces)
..... 1st step 55 Nm
2nd step 90° rotation added
3rd step 90° rotation added
3 Bolt (M8 X 35, 4 pieces) ..... 22.5-27.5 Nm
4 Camshaft Bearing cap ..... 22.5-27.5 Nm
5 Cylinder Head
6 Gasket ..... Replace
7 Dowel Sleeve ..... Note

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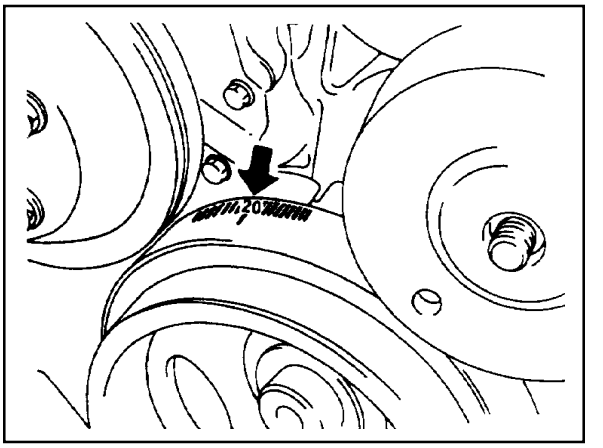
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Tools Required

617 589 00 10 00 Wrench Socket
116 589 20 33 00 Sliding Hammer
116 589 01 34 00 Threaded Bolt
001 589 66 21 00 Torque Wrence
104 589 00 40 00 Holder

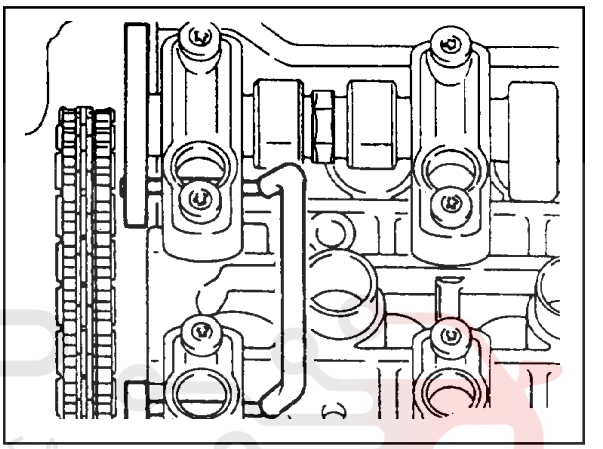
Removal & Installation Procedure

1. Rotate the crankshaft so that the piston of number 1 cylinder is at ATDC 20.



2. Put the pin into the camshaft bearing cap (number 1, 6).

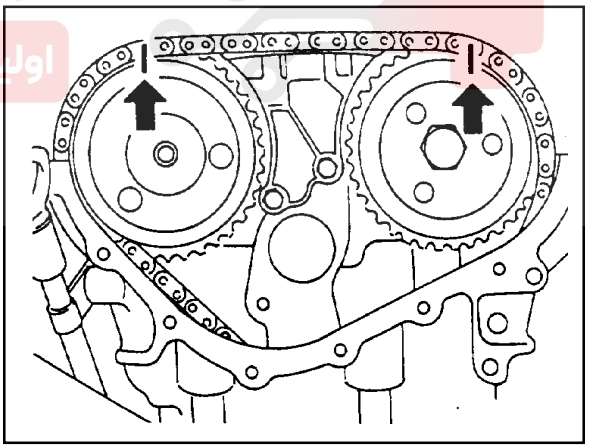
Pin 111 589 03 15 00



3. Put the alignment marks (arrows) on the timing chain and camshaft sprocket.
4. Remove the chain tensioner.

Installation Notice

Tightening Torque	72 - 88 Nm



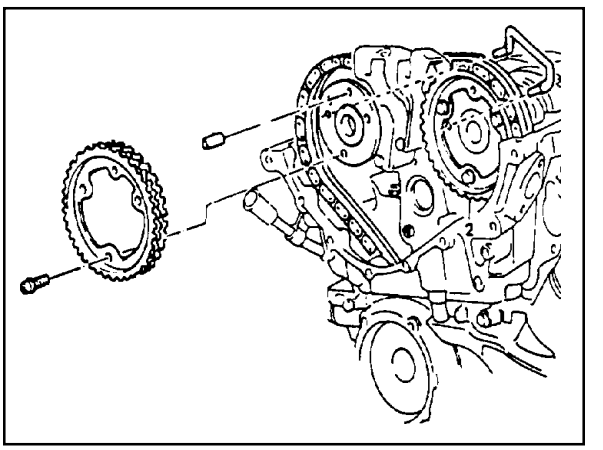
5. Remove the exhaust camshaft sprocket.

Installation Notice

Tightening Torque	1st step 18 - 22 Nm 2nd step 85° - 95°

Notice

The flange bolt is designed to be used only once, so always replace with new one.



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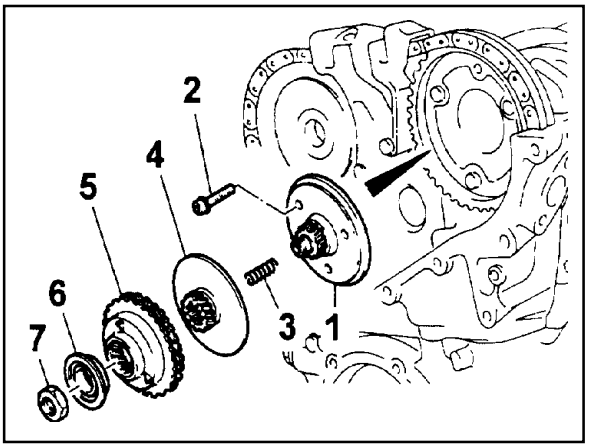
6. Remove the in take camshaft sprocket (E20 engine).
7. Remove the camshaft adjuster (E23, M161.970 engine).

Installation Notice (Flange Bolt)

Tightening Torque	1st step 18 - 22 Nm 2nd step 85° - 95°

Notice

The flange bolt is designed to be used only once, so always replace with new one.



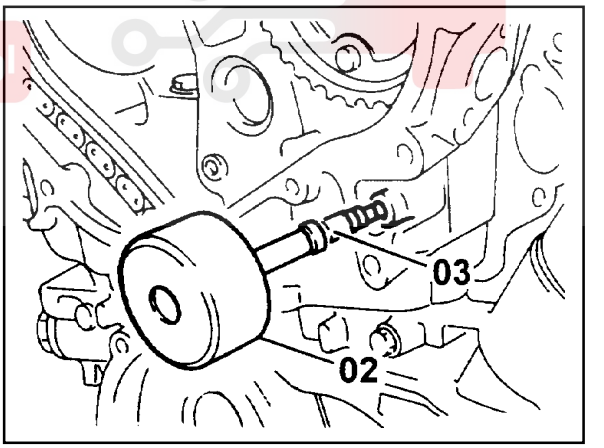
1 Flange Shaft
2 Flange Bolt
3 Campression Spring
4 Adjust Piston
5 Camshaft Sprocket
6 Seal Cover
7 Nut

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8. Remove the guide rail pin using the sliding hammer (02) and the threaded pin (03).

Notice

Apply the sealant on guide rail pin when installation.

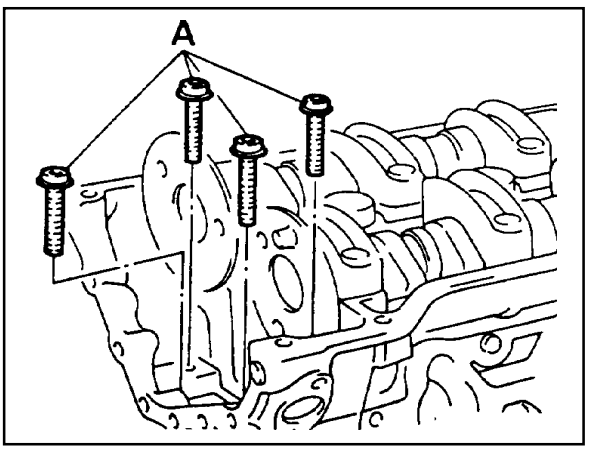


9. Unscrew the bolts (A).

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Bolt (A) : (M8 X 35, 4 pieces)



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10. Remove the cylinder head bolts in the reverse order of the numerics (No.10 ® No.1).

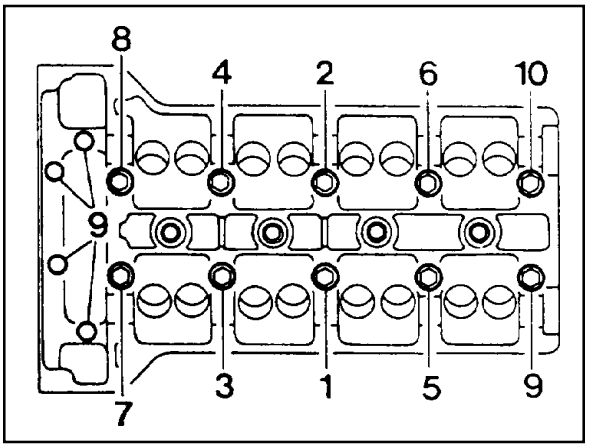
Installation Notice

Tighten the bolts as numerical order with specified torque (No.1 ® No.10).

Tightening Torque	1st step 55 ± 5 Nm 2nd step + 90° 3rd step + 90°

Notice

Operate during engine cooling.



11. Remove the No. 1 bearing cap of the exhaust camshaft.

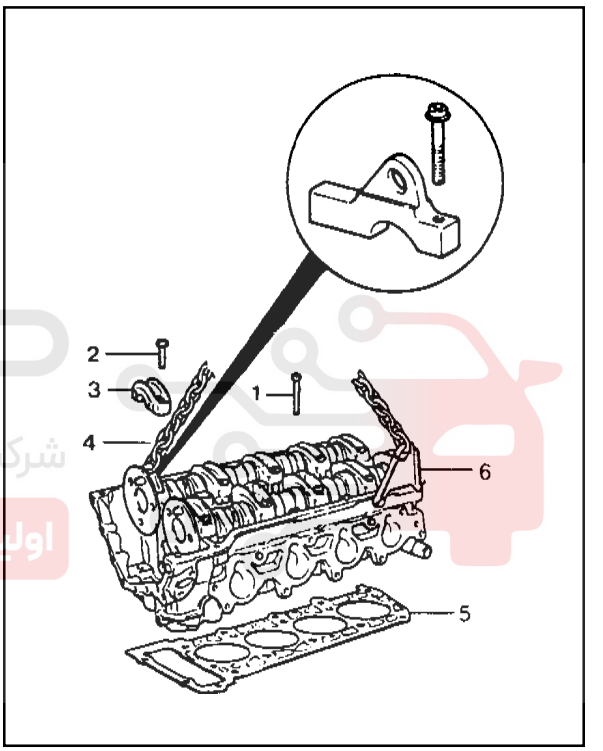
Installation Notice

Tightening Torque	22.5 - 27.5 Nm

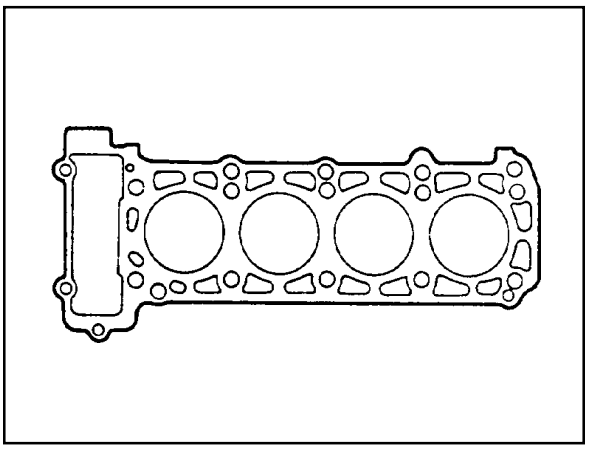
12. Install the special tool (05) on the bearing cap removed place and hook the engine hoist into them and remove the cylinder head carefully.

Holder 104 589 00 40 00

1 Cylinder Head Bolt
2 M8 X 35 Bolt & Washer
3 Bearing Cap
4 Engine Hoist
5 Gasket
6 Hanger Bracket



13. Check the cylinder head mating surface and clean the crankcase head bolt mounting hole.
14. Replace the cylind head gasket with new one.



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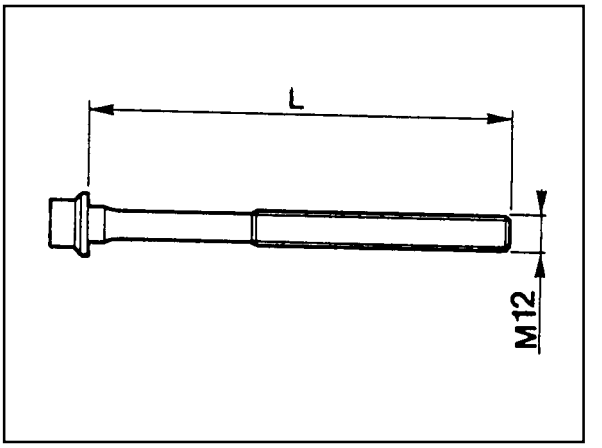
15. Check the length of the cylinder head bolt.

Tightening Torque	When New 100 mm
	Max. Length 105 mm

Notice

Replace the bolt if the measured length exceed the max. length.

16. Installation should follow the removal procedure in the reverse order.



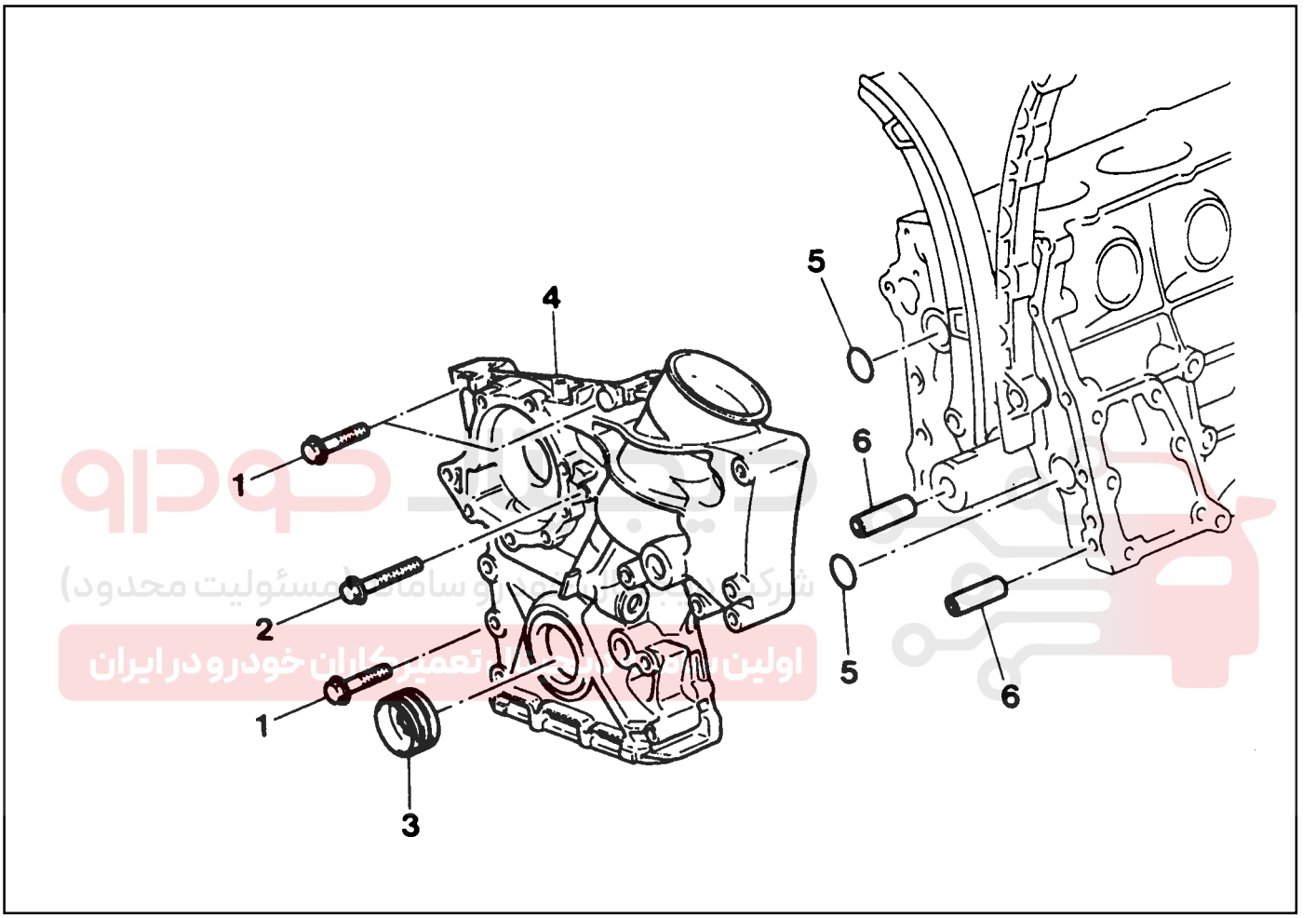
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TIMING GEAR CASE COVER

Preceding Work : Removal of viscous clutch
Removal of cylinder head front cover
Removal of tensioning device
Removal of water pump
Removal of oil filter element
Removal of oil pan
Removal of alternator bracker



1	Bolt (M8 X 60, 3 pieces) ..... 22.5-27.5 Nm	4	Timing gear case cover
2	Bolt (M8 X 75, 1 piece) ..... 22.5-27.5 Nm	5	O-ring
3	Seal	6	Sleeve

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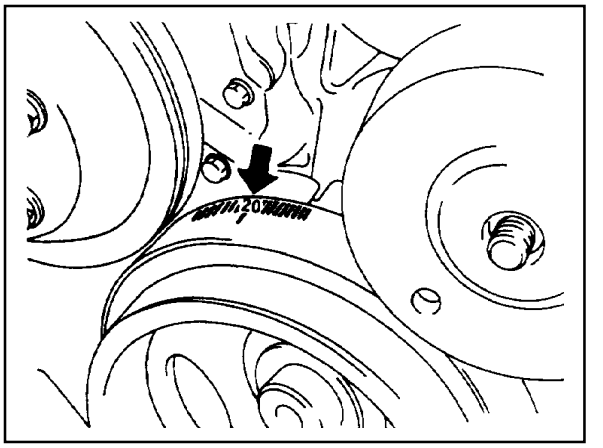
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Tools Required

001 589 72 21 00 Torque Wrench
116 589 20 33 00 Sliding Hammer
116 589 01 34 00 Threaded Bolt

Removal & Installation Procedure

1. Remove the power steering belt pulley and A/C compressor bracket.
2. Remove the oil line from power steering pump.
3. Rotate the crankshaft so that the piston of number, cylinder is at ATDC20°



4. Put the alignment marks (arrows) on the timing chain and camshaft sprocket.
5. Remove the chain tensioner.

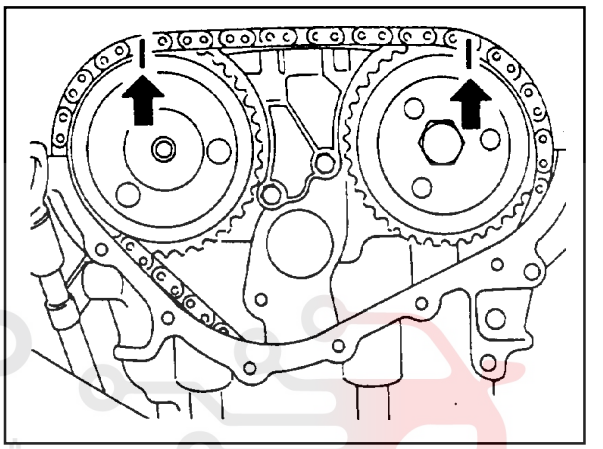
Installation Notice

Tightening Torque	78 - 88 Nm

6. Remove the intake and exhaust camshaft sprocket (remove the camshaft adjuster assembly in E23 engine).

Installation Notice

Tightening Torque	1st step 18 - 22 Nm
	2nd step 85° - 95°



Notice

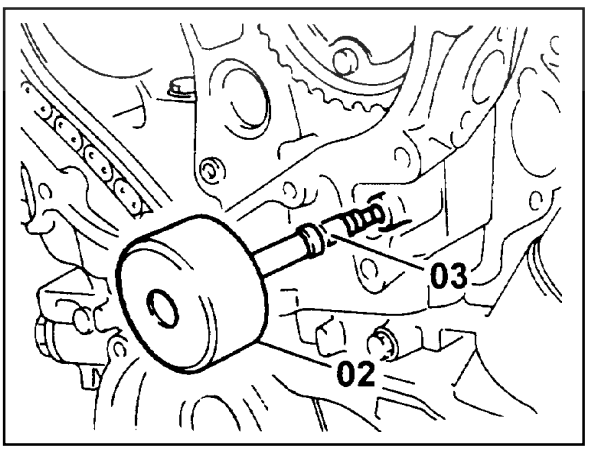
The flange bolt is designed to be used only once, so always replace with new one.

7. Remove the guide rail pin using the sliding hammer (02) and the threaded pin (03).

Notice

Apply the sealant on guide rail pin when installation.

Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00



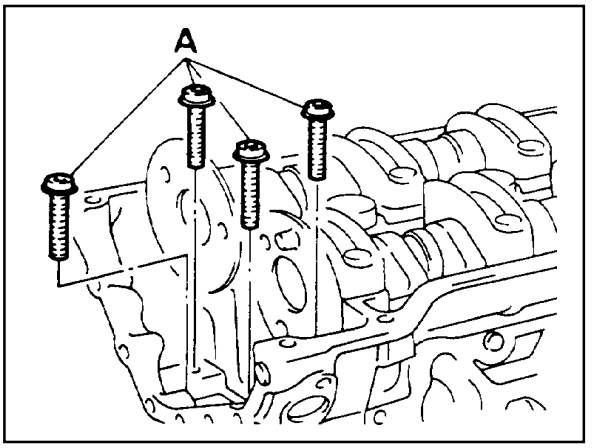
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8. Unscrew the bolts (A).

Installation Notice

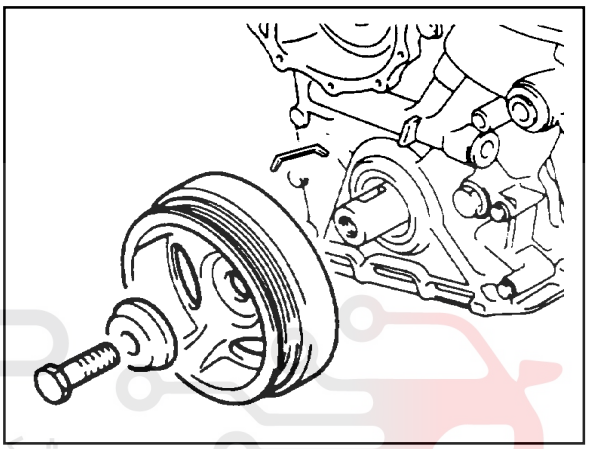
Tightening Torque	22.5 - 27.5 Nm



9. Remove the belt pulley and vibration damper.

Installation Notice (Center Bolt)

Tightening Torque	1st step 180 - 220 Nm 2nd step 80° - 100°



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10. Unscrew the bolts (1, 2) on timing gear case cover and remove the timing gear case cover.

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Notice

Be careful not to damage the cylinder head gasket.

11. Remove the radial shaft seal

Notice

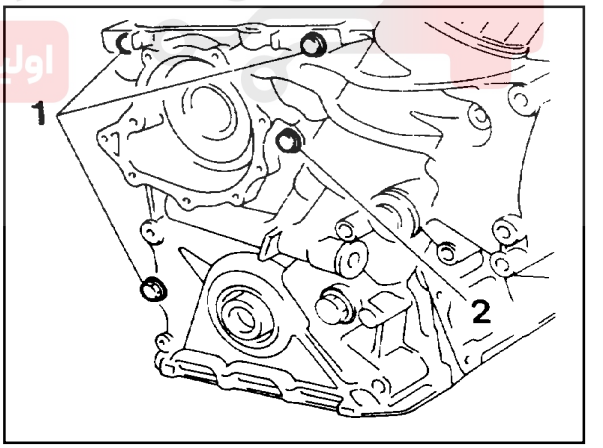
Installation note replace the seal with new one.

12. Clean the timing gear case cover and crankcase sealing surface.
13. Replace the O-ring with new one and apply the sealant on the sealing surface.

Notice

Be careful not to stain the oil chamber of chain tensioner with the sealant.

14. Installation should follow the removal precedure in the reverse order.
15. Warm up the engine and check for oil leaks.

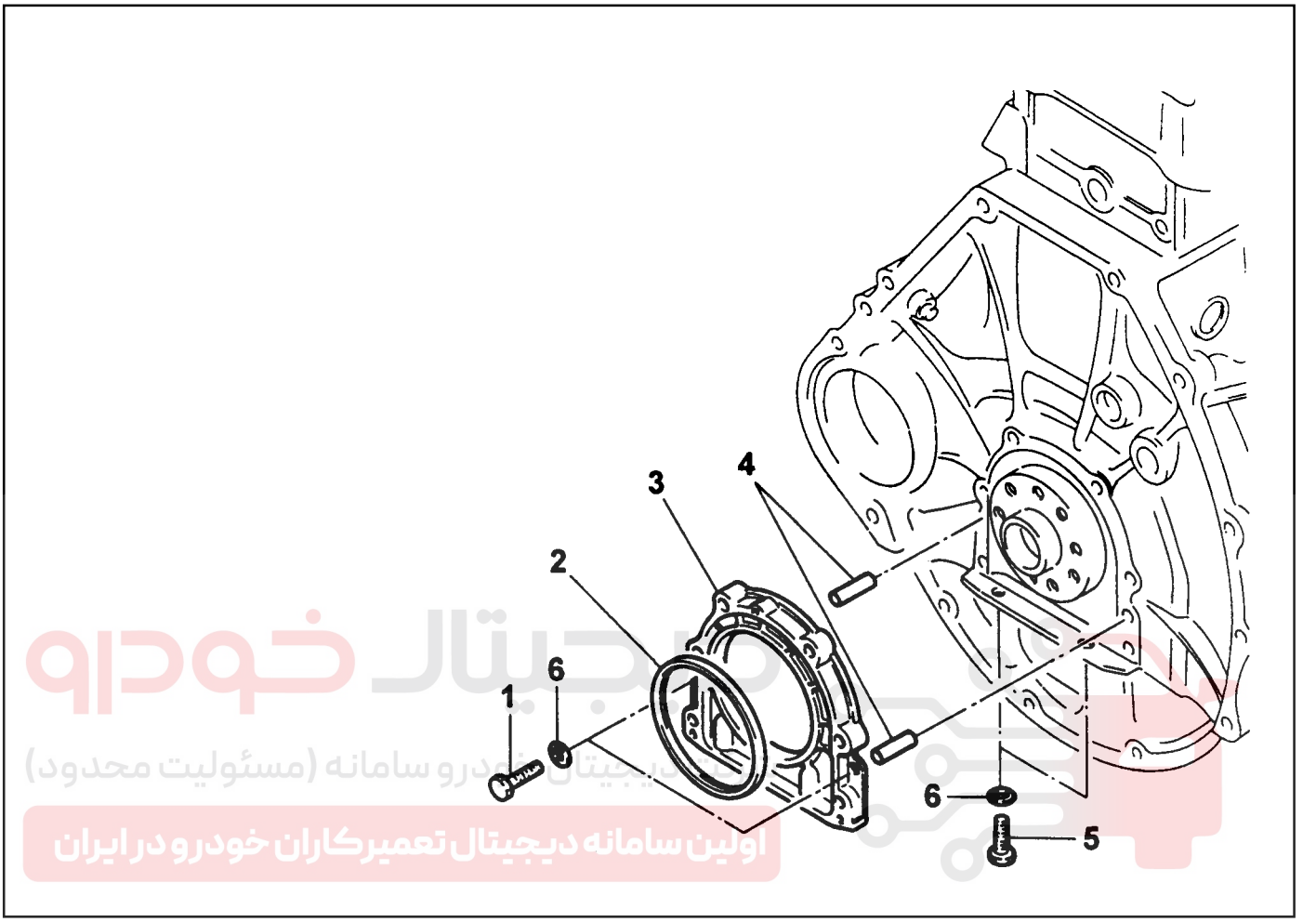


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CRANKSHAFT SEALING REAR COVER

Preceding Work : Removal of the automatic transmission drive plate or flywheel



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1 Bolt (M6 x 20, 6 pieces) ..... 9-11 Nm
2 Radial Shaft Seal
3 Rear Cover
4 Sleeve
5 Bolt (M6 x 85, 2 pieces) ..... 9-11 Nm
6 Washer

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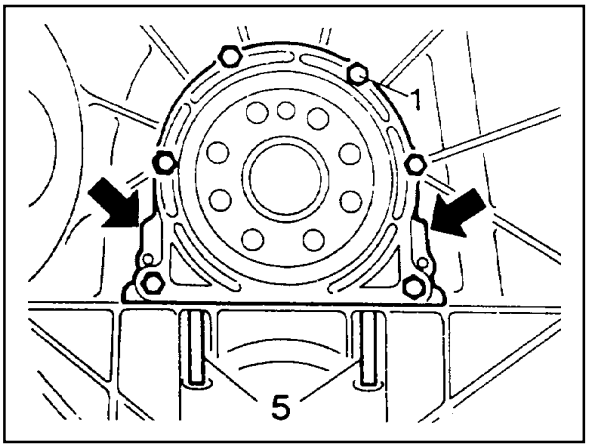
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Tools Required

601 589 03 43 00 Sleeve

Removal & Installation Procedure

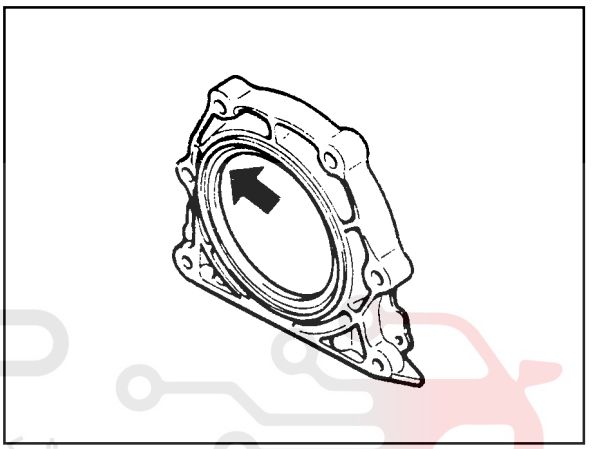
1. Unscrew the bolts (1) and (5) and remove the closing cover by pulling the rear cover lug (arrows).



Notice

Be careful not to damage the oil pan gasket.

2. Clean the sealing surface of the crankcase and the rear sealing cover.
3. Check the radial shaft seal and replace it if necessary.
4. Apply the Loctite 573 to the rear cover sealing surface.
5. Apply the engine oil to the dust lip of the radial shaft seal.

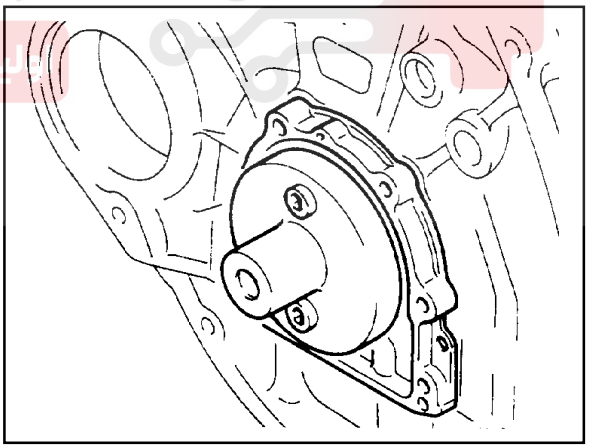


Notice

Do not use the grease.

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6. Using the special tool, press the radial shaft seal and the rear cover.

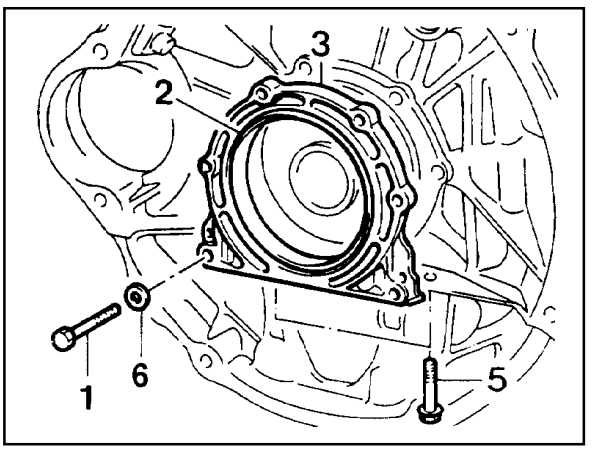


7. Tighten the rear cover bolt (1) and then tighten the oil pan bolt (5) as specified and remove the special tool.

Installation Notice

Tightening Torque(Bolt 1,5)	9 - 11 Nm

Seal Assembler 601 589 03 43 00

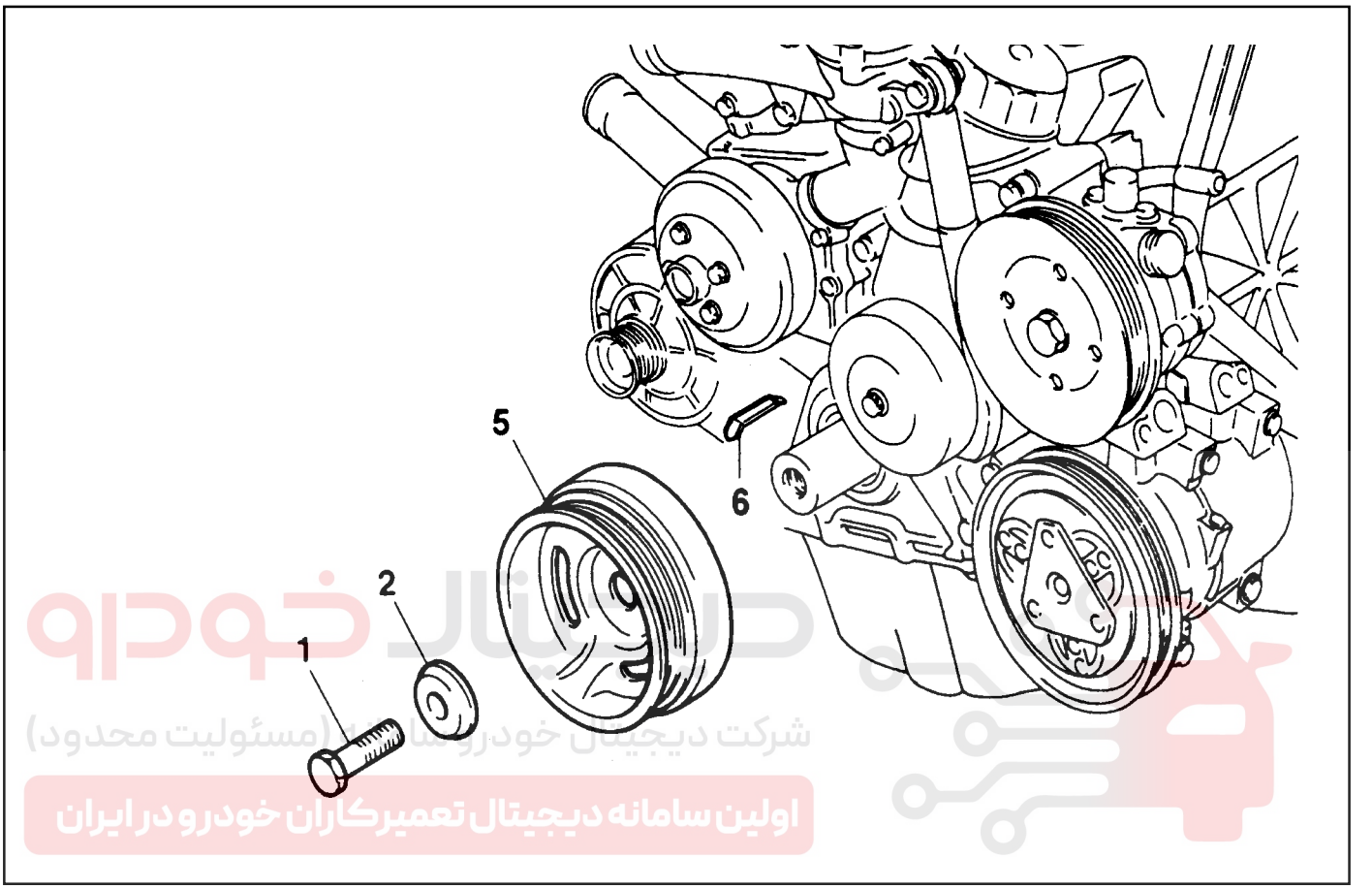


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BELT PULLEY AND VIBRATION DAMPER

Preceding Work : Removal of cooling fan and viscous clutch
Removal of fan shroud
Removal of drive belt



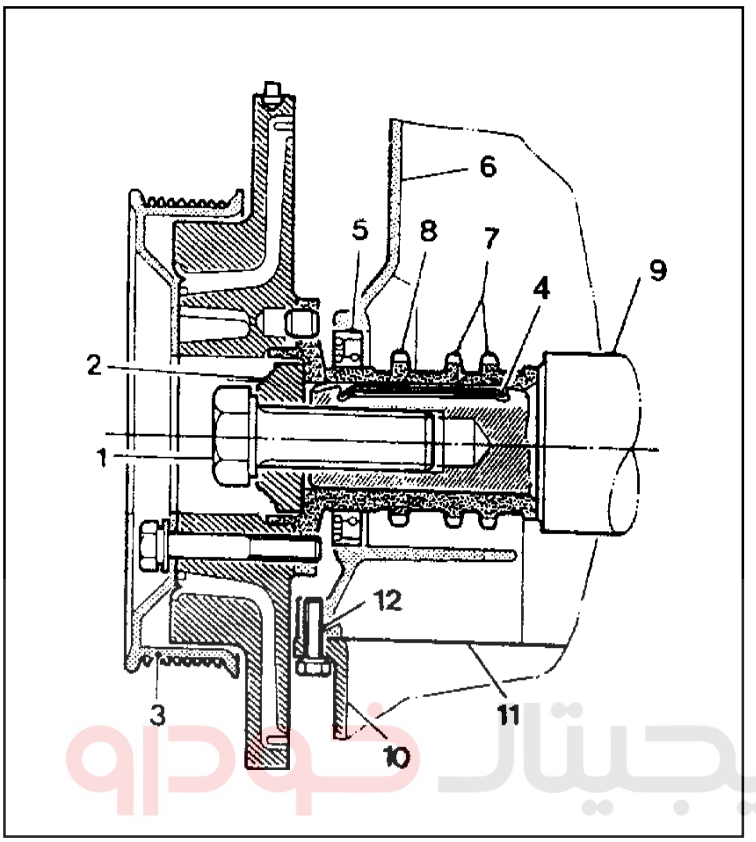
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1 Center Bolt
(M18 X 55) ..... 1st step 200-220 Nm
2nd step 90° + 10° rotation added
2 Vibration Damper Disk
5 Vibration Damper Assembly
6 Key

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Components



1 Center Bolt (M18 x 50)
2 Center Bolt Washer
3 Vibration Damper and Pulley Assembly
4 Key
5 Crankshaft Front Seal
6 Timing Gear Case Cover
7 Crankshaft Sprocket (Camshaft Driven)
8 Crankshaft Sprocket (Oil pump Driven)
9 Crankshaft
10 Oil Pan
11 Oil Pan Gasket
12 Oil Pan Mounting Bolt (M6 x 22)

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Service Data Standard

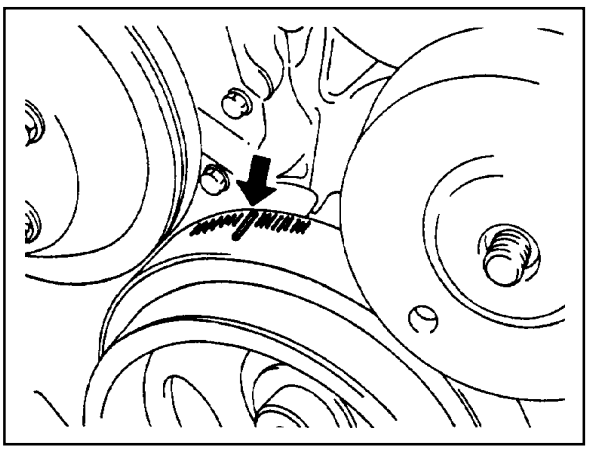
Permissble Deviation of The Vibration Damper	Radial Runout	0.6 mm
	Axial Runout	0.6 mm

Tools Required

103 589 00 33 00 Puller
001 589 65 09 00 Socket Wrench Insert
001 589 74 21 00 Puller
000 589 88 33 00 Torque Wrench
602 589 00 40 00 Engine Lock

Removal & Installation Procedure

1. Adjust the piston of number 1 cylinder to the TDC.



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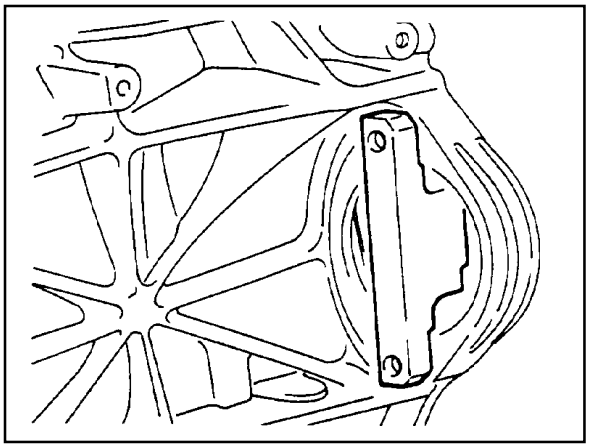
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2. Remove the start motor and install the engine lock to the flywheel ring gear.
3. Remove the center bolt.

Installation Notice

Tightening Torque	1st step 180 - 220 Nm 2nd step + 90°

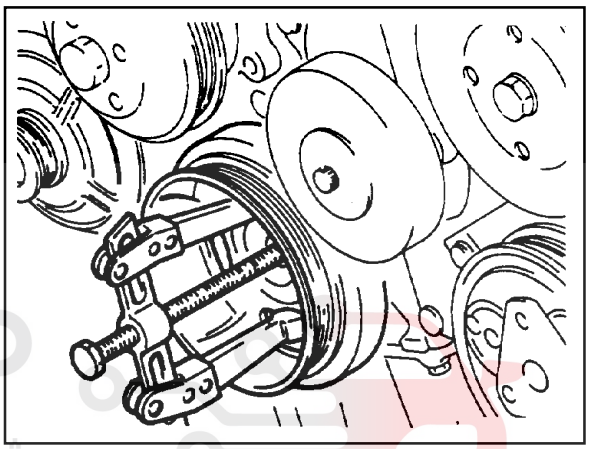
Engine Lock 602 589 00 40 00



4. Remove the vibration damper assembly using the puller.
5. Installation should follow the removal procedure in the reverse order.

Notice

If possible, don't separate the vibration damper and the pulley.



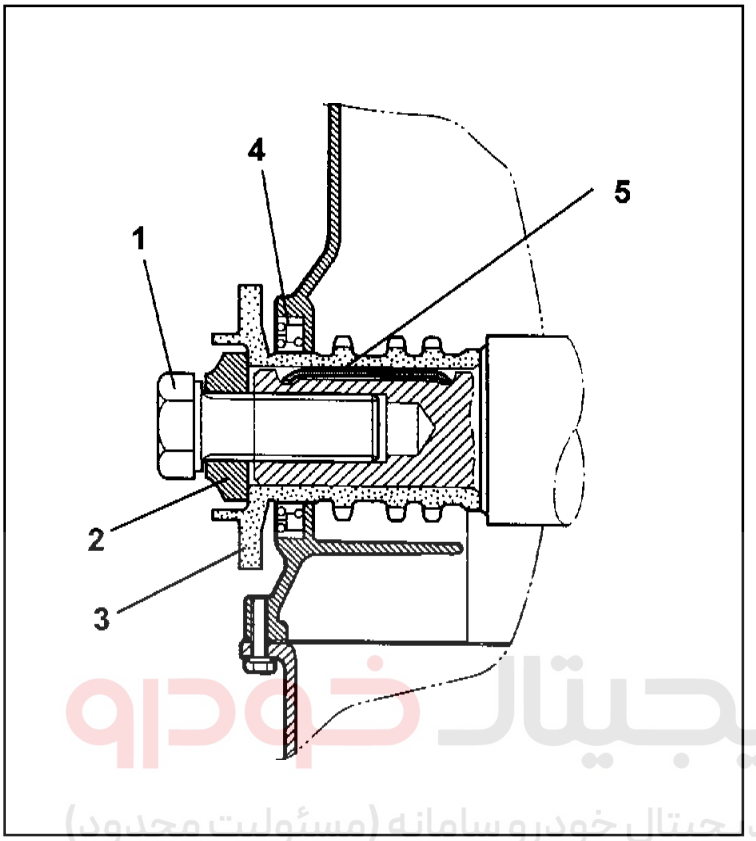
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CRANKSHAFT FRONT RADIAL SEAL

Preceding Work : Removal of belt pulley and vibration damper

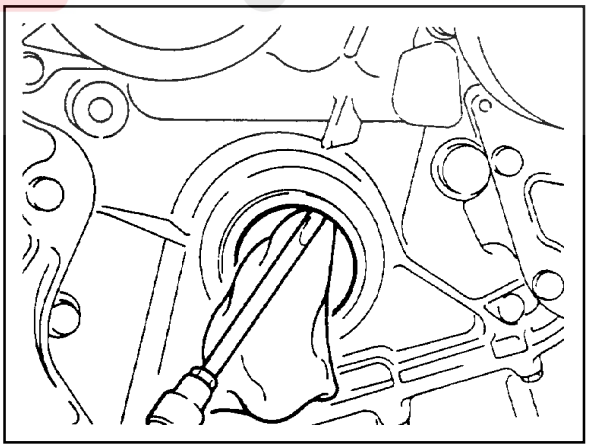


1 Center Bolt (M18 x 50)
..... 1st step 200-220 Nm
2nd step 90° +10°
2 Center Bolt Washer
3 Sleeve (Special Tool)
4 Crankshaft Front Seal
5 Key

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Tools Required

601 589 03 14 00 Sleeve



Replacement Procedure

1. Remove the radial seal with a screw driver.

   Notice

   Use a clean cloth not to damage the radial seal mounting hole and the crankshaft.

2. Coat the radial sealing lip with engine oil.
3. Using the sleeve, assemble the radial seal .
4. Align the sleeve groove and the woodruff key and tighten the center bolt until the center bolt and the damper disk stop in the movement.

   Installation Notice

Tightening Torque	1st step 200 - 220Nm 2nd step 90° + 10°

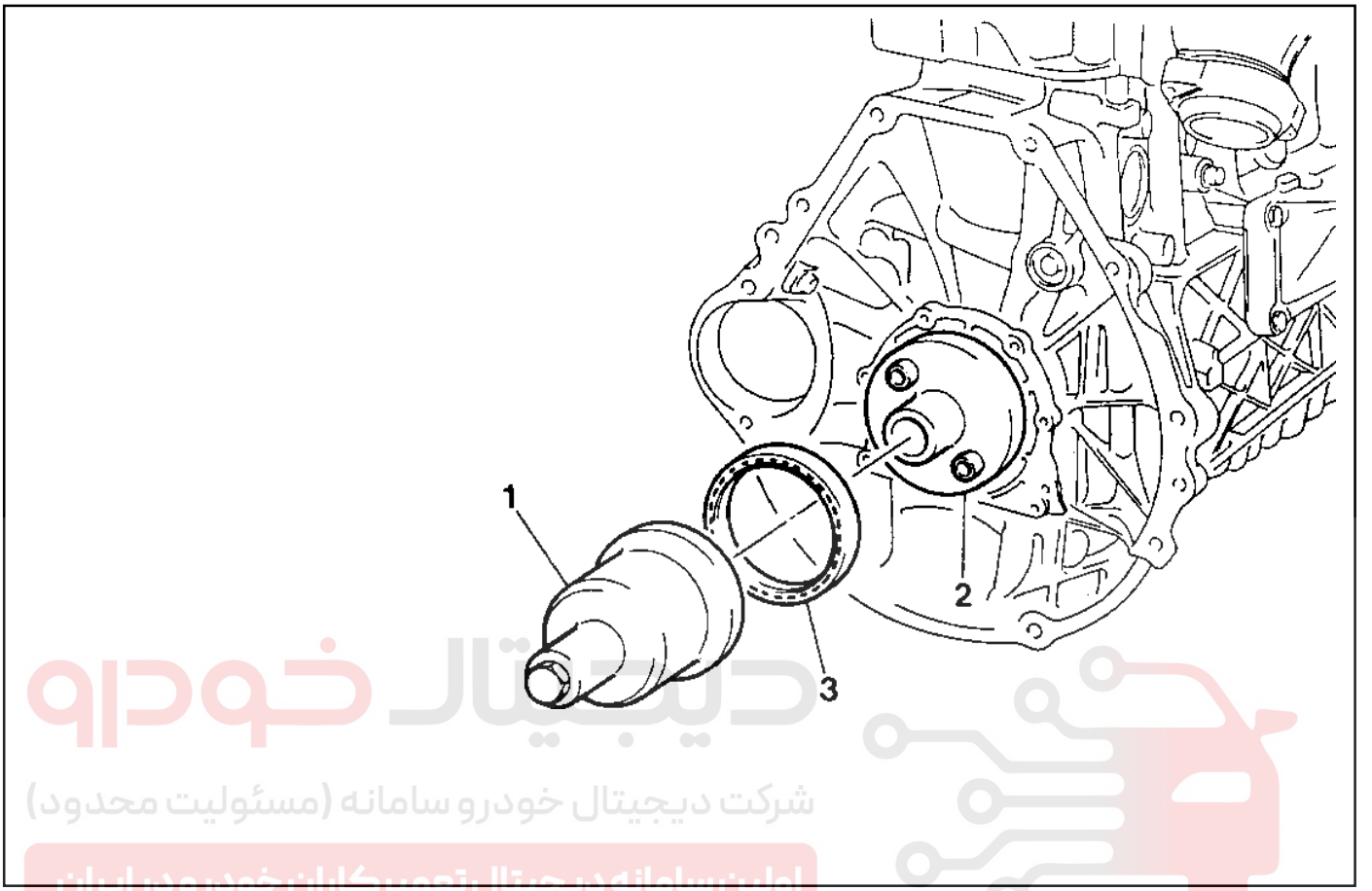
5. Remove the sleeve and install the belt pulley and the vibration damper.
6. Check for leaks while operating the engine.

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CRANKSHAFT REAR RADIAL SEAL

Preceding Work : Removal of flywheel or drive plate



1 Special Tool
2 Special Tool
3 Crankshaft Rear Seal

Tools Required

601 589 03 43 00 Sleeve

Replacement Proceudre

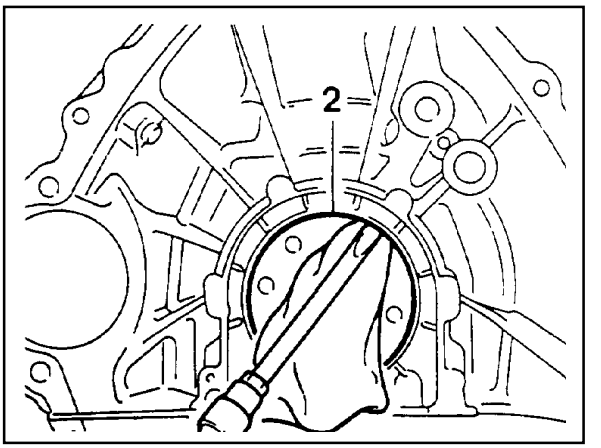
1. Remove the radial seal with a screw driver.

   Notice

   Use a clean cloth not to damage the radial seal mounting hole and the crankshaft.
2. Install the special tool (2) to the crankshaft.
3. Apply the engine oil on the special tool (2).

   Notice

   Do not use the grease.
4. Install the radial seal on the inner parts assembler.
5. Press in the special tool (1) until the radial seal is stopped.
6. Check for leaks while operating the engine.

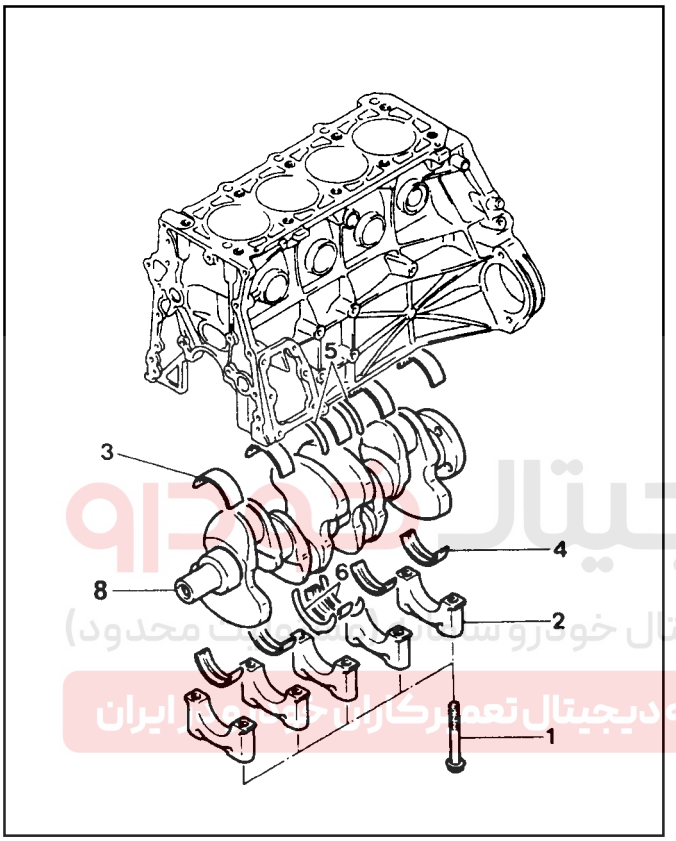


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CRANKSHAFT

Preceding Work : Removal of engine
Removal of cylinder head
Removal of timing gear case cover
Removal of crankcase sealing rear cover
Removal of oil pan
Removal of baffle plate
Removal of oil pump

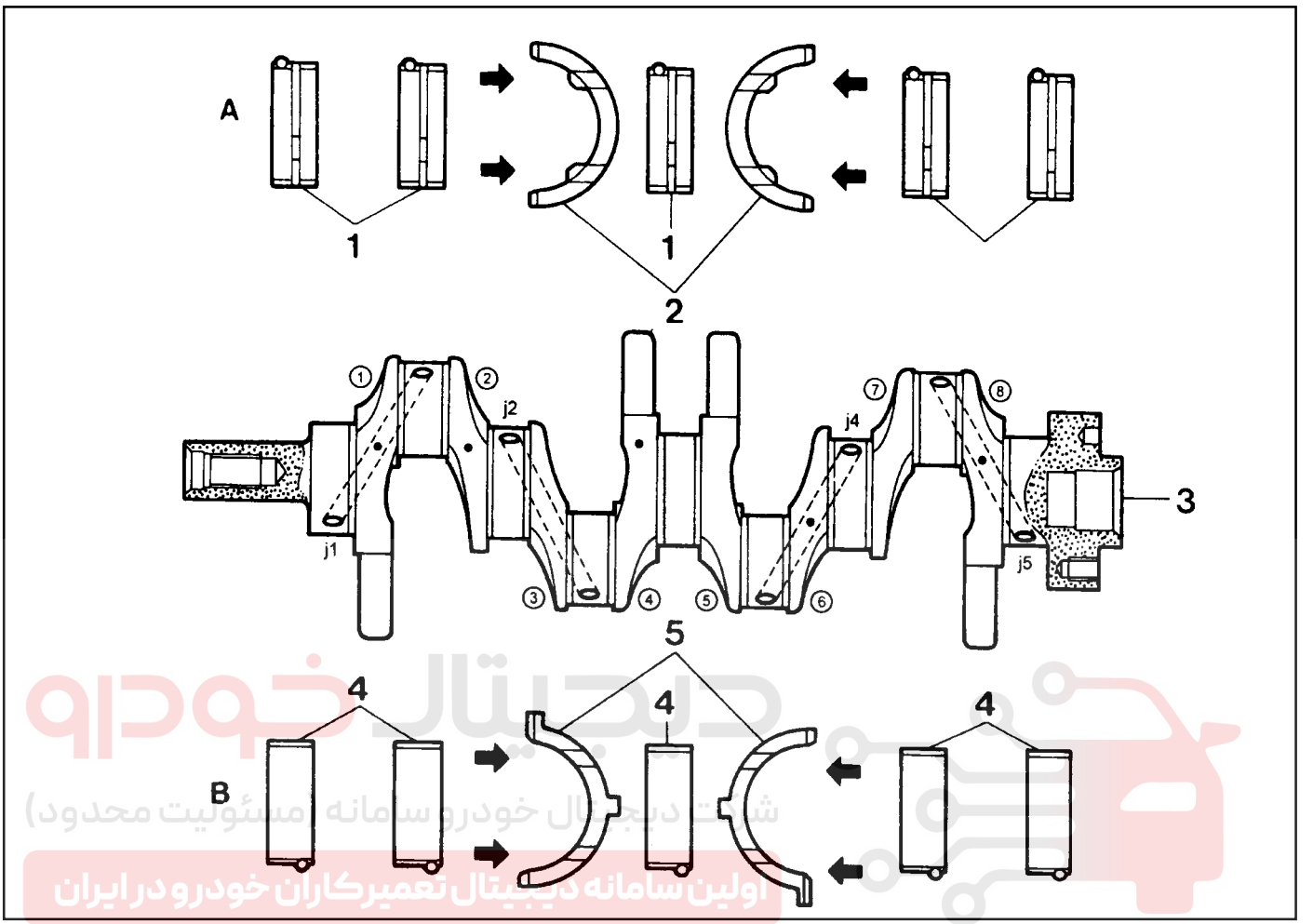


1 Bearing Cap Bolt
(M8 X 55-10 pieces) ..... 1st step 50-60 Nm
2nd step 90°+5° rotation added
2 Bearing Cap
3 Upper Main Bearing
4 Lower Main Bearing
5 Upper Thrust Bearing
6 Lower Thrust Bearing
8 Crank Shaft

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Arrangement of the Thrust Bearing and the Main Bearing



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1 Upper Main Bearing
2 Upper Thrust Bearing
3 Crankshaft
4 Lower Main Bearing
5 Lower Thrust Bearing

A Crankcase Side
B Bearing Cap Side (Oil Pan Side)

① - ⑧ Weight Balance/Color Marking Point
j1 - j5 Journal Main Bearing #1 - #5
● Color Dot Marking

The color dot marking are put on the ①, ②, ④, ⑥, ⑧, and it indicates the diameter of crankshaft journal by color as below.

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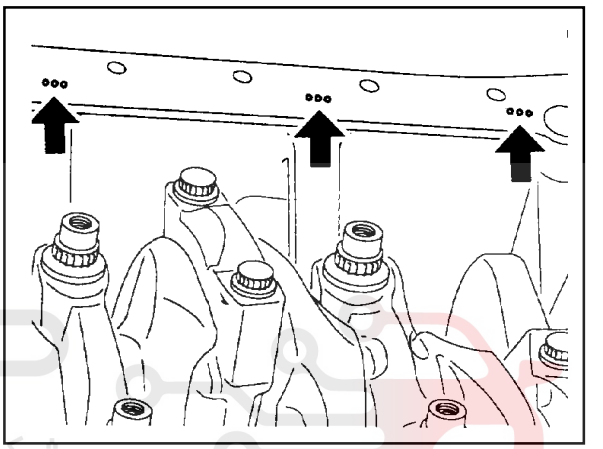
Color Dot Marking	Crankshaft Journal Diameter (mm)
Blue	57.960 - 57.965
Yellow	57.955 - 57.960
Red	57.950 - 57.955
White	57.945 - 57.950
Violet	57.940 - 57.945

Selection of Crankshaft Main Bearing

1. Crankcase Side

   There are seven punching marks on the mating surface to oil pan. This mark is correspondent to the bearing distinguished by color. Select the relevant bearing according to the punching mark when repaired.

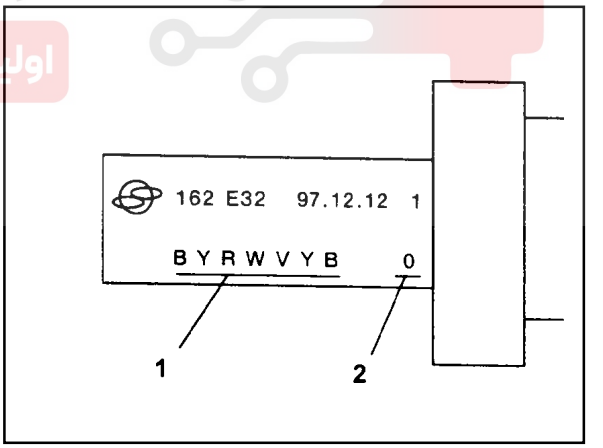
Punching Mark	Bearing Color Selected
▪	Blue
▪▪	Yellow
▪▪▪	Red



2. Crankshaft Bearing Cap Side

   Select the crankshaft main bearing according to the marking letter on the crankshaft main journal when repaired.

Marking Letter	Bearing Color Selected
B	Blue
Y	Yellow
R	Red
W	White
V	Violet



Service Data

Unit : mm

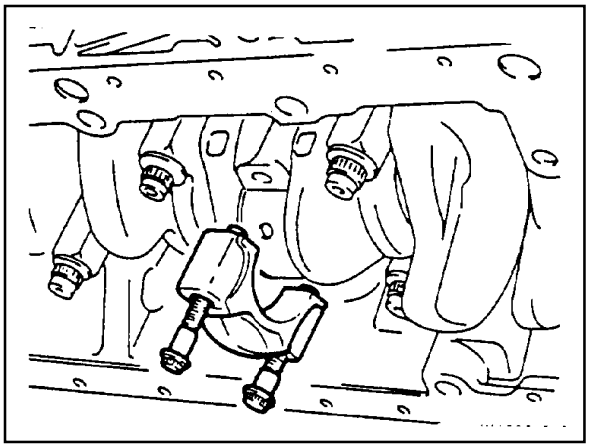
Crankshaft Standard and Repair Size	Crankshaft Bearing Journal Diameter	Crankshaft Bearing Diameter	Crankshaft Journal Width at fit bearing	Connecting Rod Bearing Journal Diameter	Connecting Rod Bearing Journal Width
Standard size	57.950-57.965	58	24.50-24.533	47.94-47.96	27.958-28.042
1st repair size	57.700-57.715	-	-	47.75	-
2nd repair size	57.450-57.465			47.50	
3rd repair size	57.200-57.215			47.25	
4th repair size	56.950-56.965			47.00	

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Removal & Installation Procedure

1. Unscrew the connecting rod bearing cap bolt and remove the bearing cap.

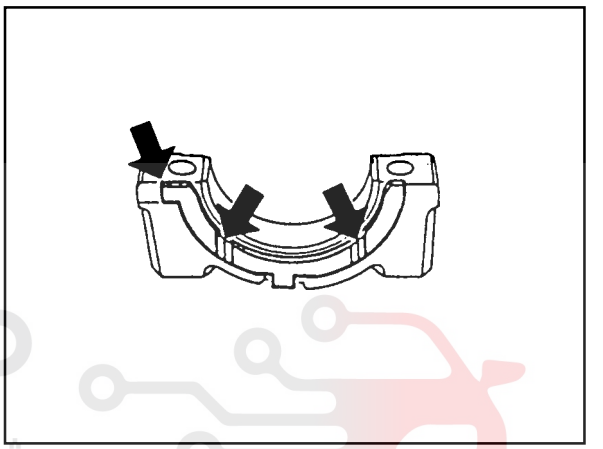


Installation Notice

Tightening Torque	40 Nm + 90°

- Make sure that the upper and lower bearing shells do not change each other.
- Coat the bearing shell with engine oil.
- Install the bearing cap according to the consecutive number.

2. Unscrew the crankshaft bearing cap bolts and separate the upper and lower bearing shells and thrust washers.



Installation Notice

Tightening Torque	55 Nm + 90°

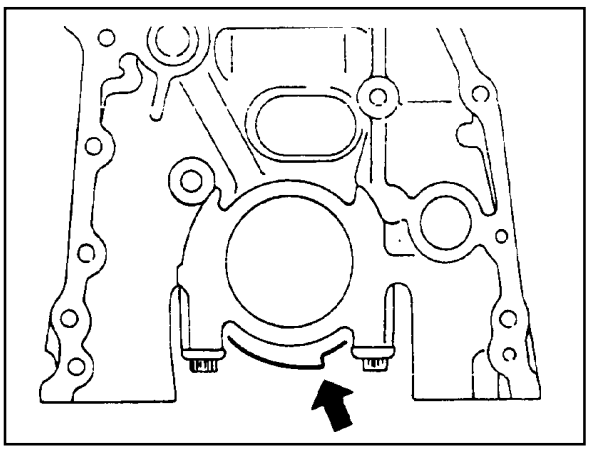
- Remove the bearing cap from front (pulley side) to rear.
- Make sure that the upper and lower bearing shells do not change each other and coat with engine oil.
- The oil grooves (arrows) in the thrust washers must face outward and insert the thrust bearing into the bearing cap.
- There are five kinds of thrust washers by thickness. Select the proper washer when repaired.

Part No. : 601 030 00 62 2.15 mm
Part No. : 601 030 01 62 2.20 mm
Part No. : 601 030 02 62 2.25 mm
Part No. : 601 030 03 62 2.30 mm
Part No. : 601 030 04 62 2.40 mm

3. Remove the crankshaft.
4. Installation should follow the removal procedure in the reverse order.
5. After completion of the installation, check for the rotating condition of the crankshaft.

Installation Notice

- Make sure the crankshaft bearing cap properly seated in place in the crankcase side. When perfectly installed, the projected part (arrow) locates in the left side (intake manifold side).
- Assemble so that the projected part of the cap and crankcase face the same direction.

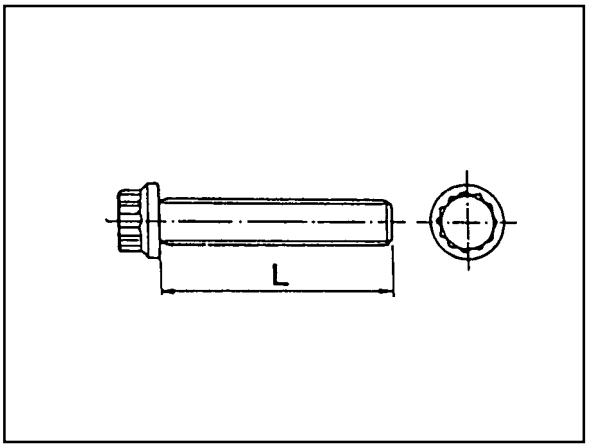


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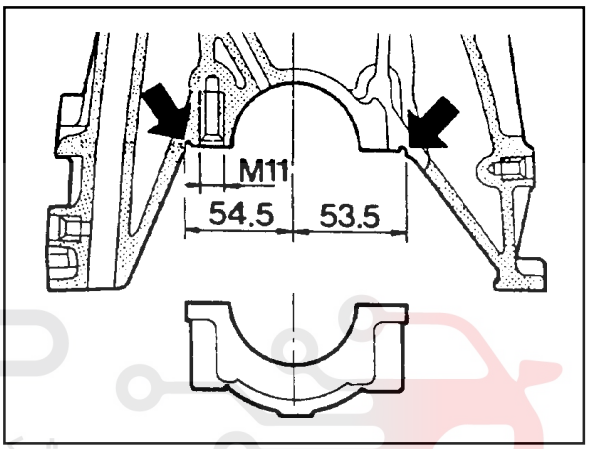
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Inspection

1. If the length 'L' of the crankshaft bearing cap bolt exceeds 63.8mm, replace it.



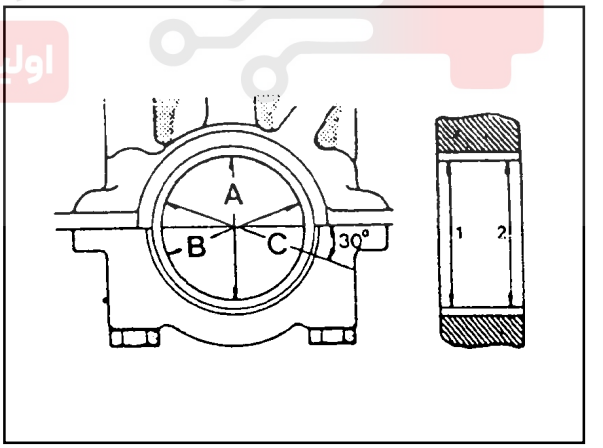
2. Make sure the crankshaft bearing cap is properly seated on the cylinder block (arrows).



3. Measure and record the inner diameter of the crankshaft bearing.

Notice

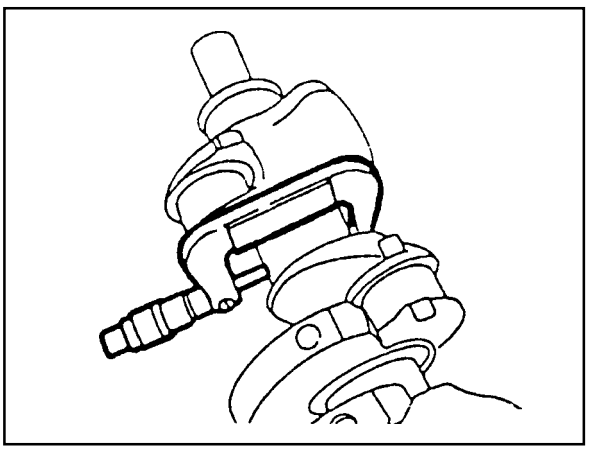
- Measure at 2 points (1, 2).
- Measure 'A','B'and 'C' as shown. If average value of 'B' and 'C'is less than value 'A', then the average value of 'B' and 'C' is actual average value. If average value of 'B' and 'C' is more than value 'A'is actual average value.



4. Measure and record the diameter of the crankshaft bearing journal.

Notice

- Record the mean value when measured at 3 points (A, B, C).
- Measure the inner diameter of bearing and the diameter of journal and if it is out of the standard data, replace the bearing shell.



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Service Data Standard (Crankshaft Main Bearing Gap)

Item	Measuring Position	Gap (mm)
Main Bearing Journal (NO. 1, 5, 7)	Radial	Static condition :0.015-0.039 Dynamic condition: 0.031-0.051 (Consider the expansion 0.011-0.016)
	Axial	0.010 - 0.254

(Connecting Rod Bearing Gap)

Item	Measuring Position	Gap (mm)
Connecting Rod Bearing	Radial	0.020 - 0.065

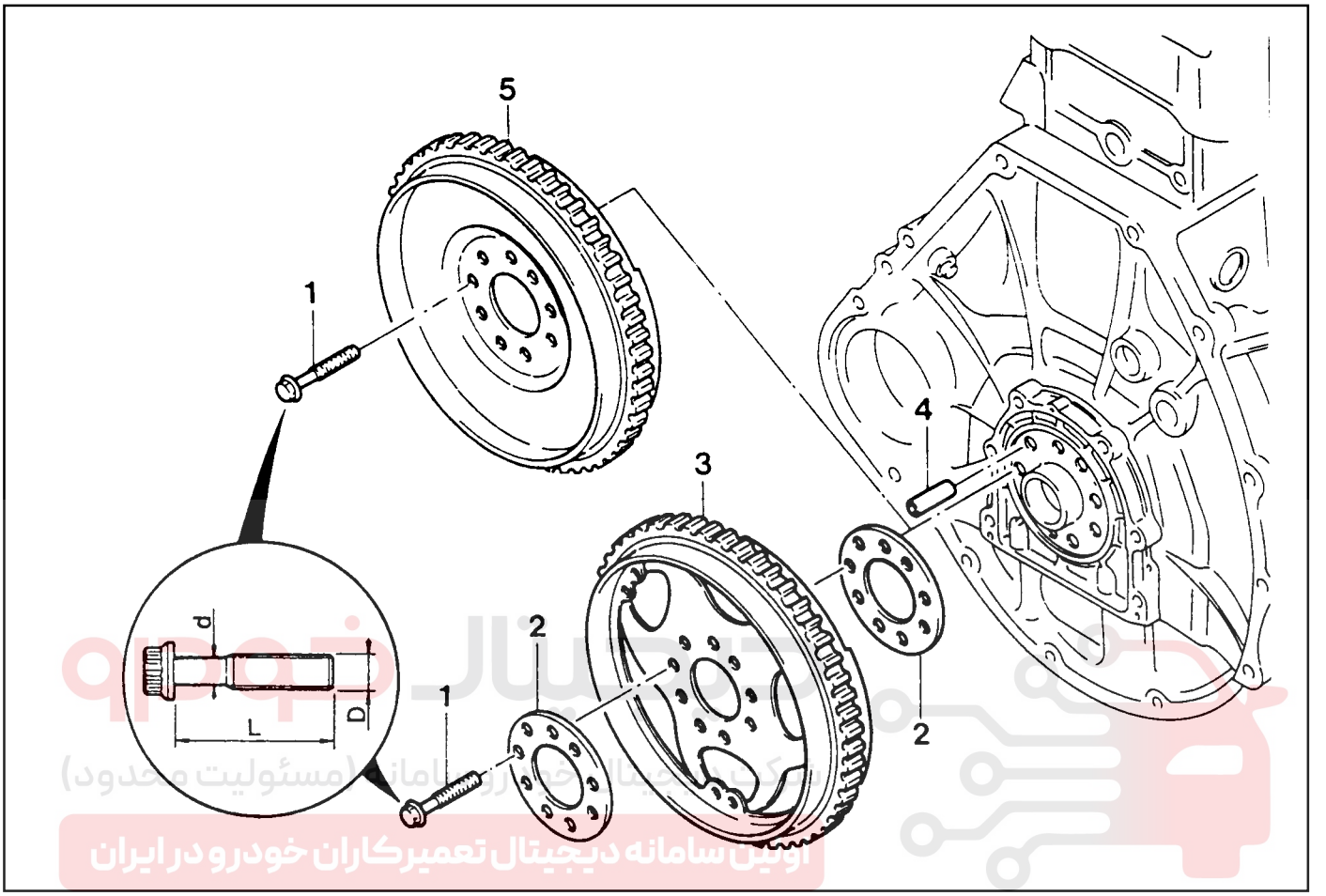
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FLYWHEEL/DRIVEN PLATE

Preceding Work : Removal of manual or automatic transmission



1 Flywheel Mounting Bolt
(M10 x 22, 8 pieces) ..... 1st Step 45 Nm
2nd Step 90°+10°
2 Plate
3 Driven Plate (A/T)
4 Dowel Pin
5 Flywheel (M/T)

Service Data Standard (Stretch Bolt)

Nominal Size	D	-	M x 1.5
Stretch Side Diameter	d	When New	8.5 - 0.2 mm
		Min. Diameter	8.0 mm
Bolt Length	L	When New	21.8 - 22.2 mm
Tightening Torque	1st step 50 Nm, 2nd step 90°		

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Removal & Installation Procedure

1. Unscrew the stretch bolt.

Installation Notice

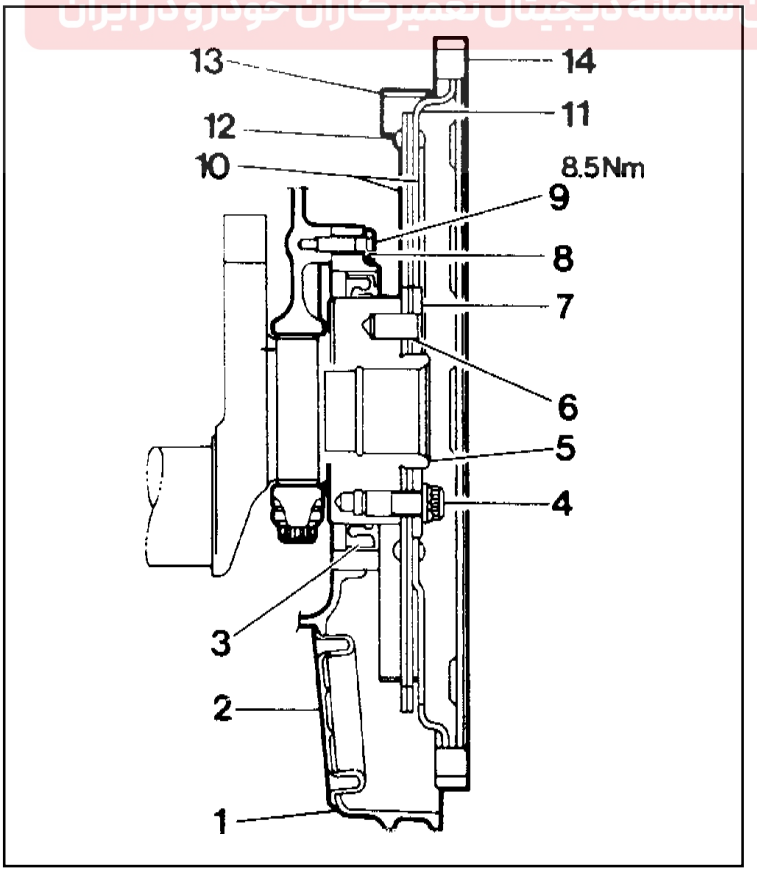
Tightening Torque	1st step 45 Nm 2nd step 90°+5°

- Replace the bolt when the stretch side diameter (d) of the flywheel mounting bolt is less than 8.0mm.
- For the stretch bolt tightening, keep the socket wrench and Tommy-bar to be 90° and tighten as specified.

2. Remove the flywheel for manual transmission vehicles, or the driven plate (3), and plate (2) for Auto. transmission vehicle.
3. Installation should follow the removal procedure in the reverse order.

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Sectional View

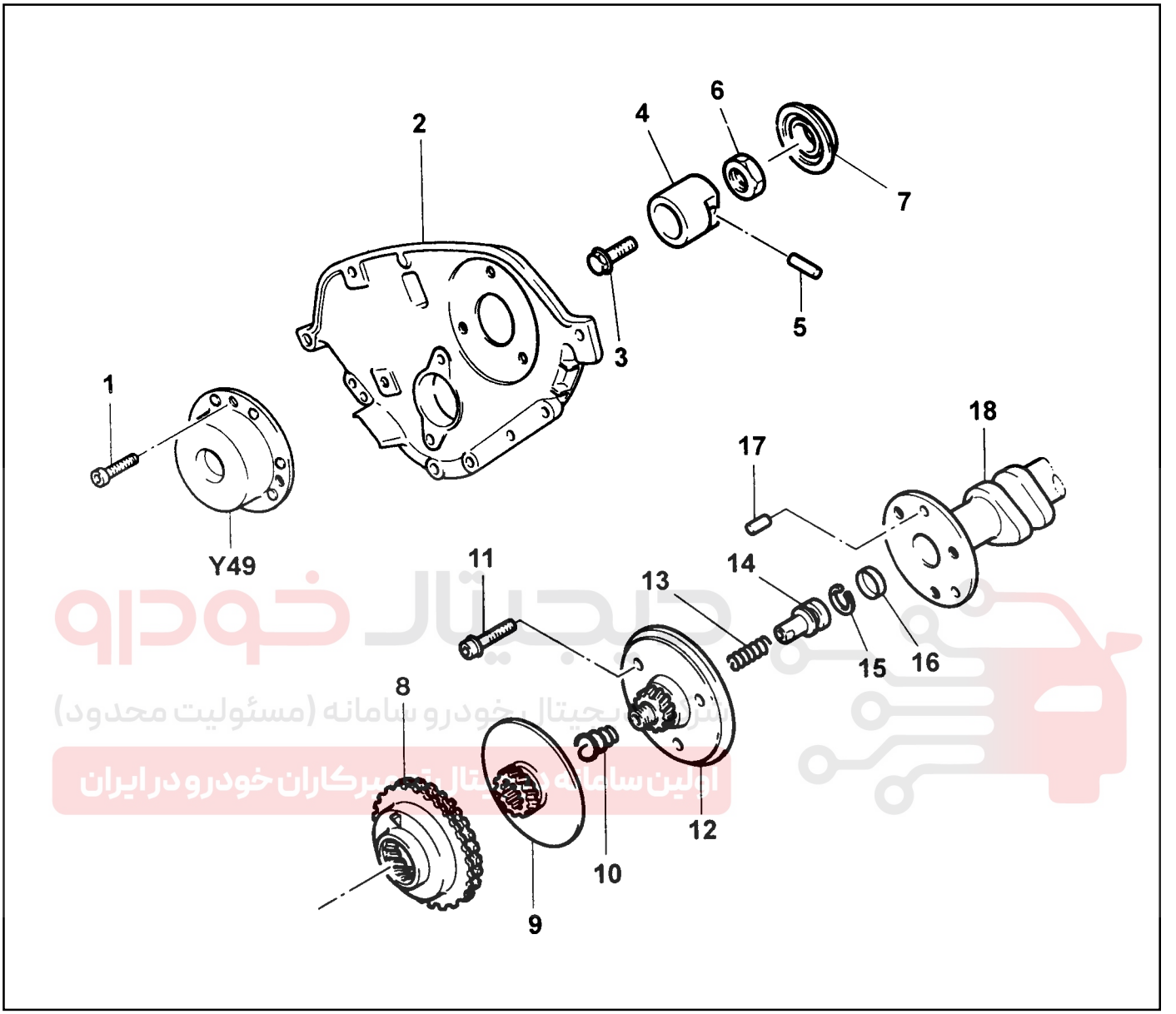


1 Oil Pan
2 Cover
3 Radial Seal
4 Bolt
5 Crankshaft
6 Dowel Pin
7 Washer (Thickness : 3.5 mm)
8 Washer
9 Bolt
10 Front Drive Plate
11 Rear Drive Plate
12 Rivet
13 Segment
14 Ring Gear

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CAMSHAFT ADJUSTER



1 Bolt (M6 X 16, 3 pieces) ..... 9-11 Nm
2 Cylinder Head Front Cover
3 Bolt ..... 35 Nm
4 Armature
5 Roll Pin
6 Nut (M20 X 1.5) ..... 60-70 Nm
7 Seal Cover
8 Camshaft Sprocket
9 Adjust Piston
10 Conical Spring
11 Flange Bolt
(M7 X 13, 3 pieces) ..... 1st Step 20±2 Nm
2nd Step 90° ± 5° Rotation Added
12 Flange Shaft
13 Compression Spring
14 Control Piston
15 Circlip
16 Oil Gallery
17 Straight Pin
18 Intake Camshaft
Y49 Magnetic Actuator (2-pin connector)

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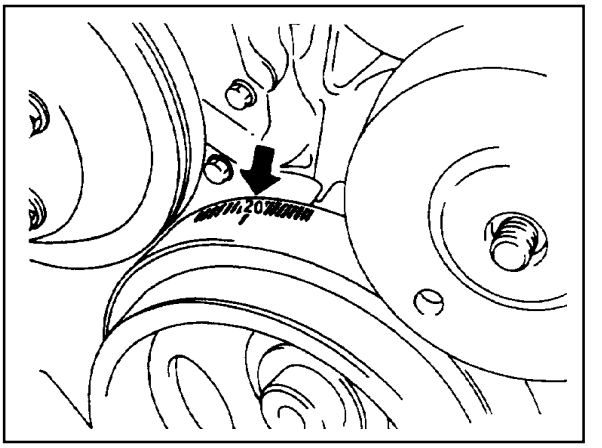
Removal & Installation Procedure

1. Turn the crankshaft and position the n0.1 cylinder piston at ATDC 20°.

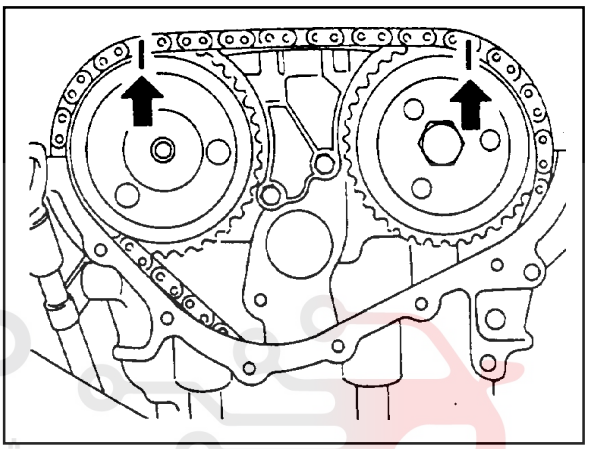
   Notice

   Turn the crankshaft in the direction of engine rotation.

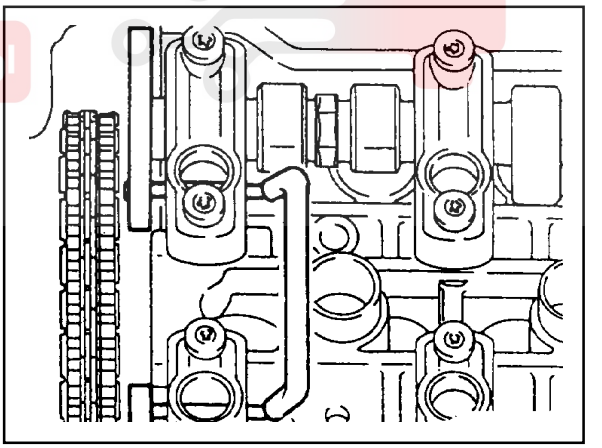
2. Remove the cylinder head front cover.



3. Put the alignment marks (arrows) on the camshaft sprocket and the timing chain.



4. Insert the insert pin into the no.1 and no.6 bearing cap hole on camshaft to secure intake and exhaust camshaft.
5. Remove the chain tensioner.



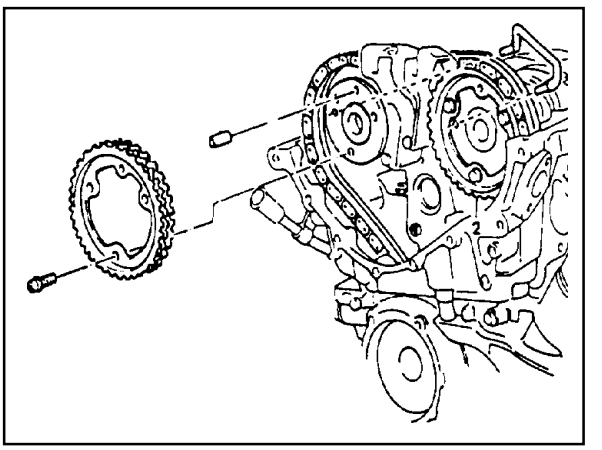
6. Unscrew the exhaust sprocket bolt and remove the exhaust camshaft sprocket.

   Installation Notice

Tightening Torque	1st step 20 Nm 2nd step 90°

   Notice

   The flange bolt is designed to be used only once, so always replace with new one.



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7. Unscrew the bolt (3) from the armature (4) and remove the roll pin, and remove the armature.

Installation Notice

Tightening Torque	35 Nm

8. Unscrew the nut (6) and remove the seal cover (7).

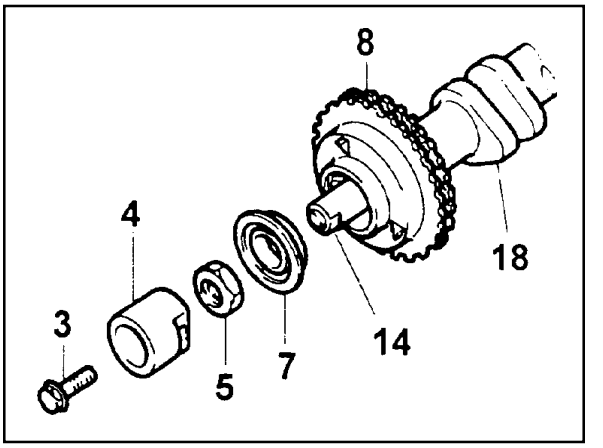
Installation Notice

Tightening Torque	60 - 70 Nm

Notice

Put the locking slot of nut toward armarture.

9. Take off the timing chain from intake camshaft sprocket.



10. Remove the cover (7), adjuster piston (9) and conical spring (10) from intake camshaft sprocket.
11. Unscrew the bolt (11) and remove the flange shaft.

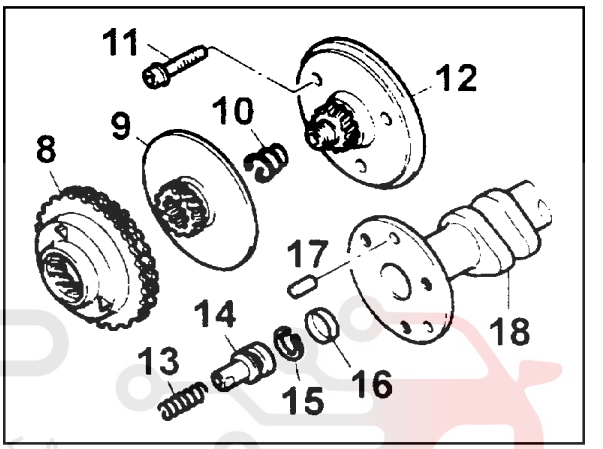
Installation Notice

Tightening Torque	1st step 20 Nm 2nd step + 95°

Notice

The flange bolt is designed to be used only once, so always replace with new one.

12. Installation should follow the removal procedure in the reverse order.
13. Check and adjust the camshaft timing.



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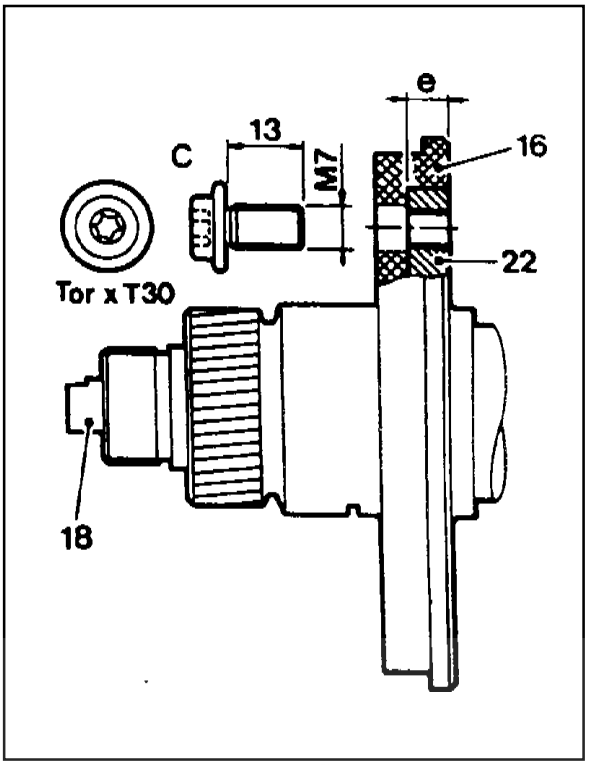
CAMSHAFT SPROCKET BOLT

Intake Flange Shaft Bolt

Tightening Torque	1st step 20 Nm 2nd step + 90°

Notice

The sprocket bolts are designed to be used only once, so always replace with new one.



C. M7 x 13 Collar Bolt Torx-T30
e. 6.8 mm
16. Flange Shaft
18. Control Piston
22. Intake Camshaft

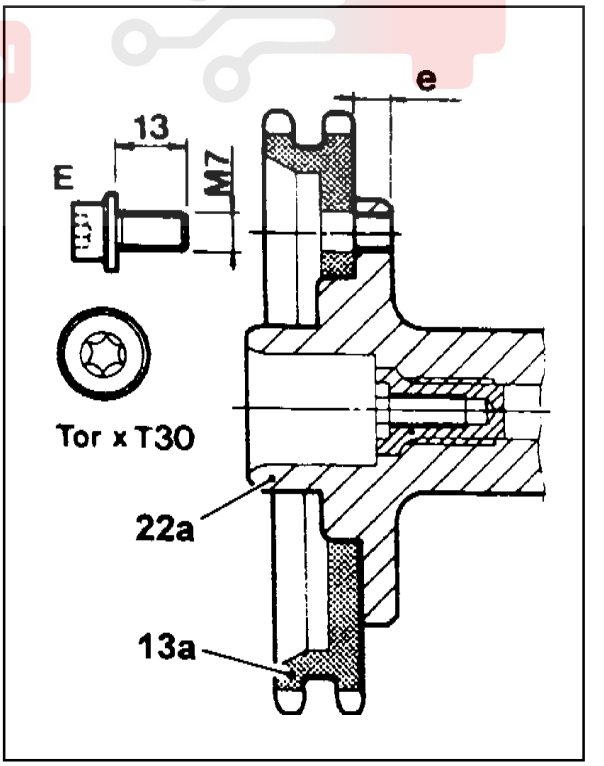
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Exhaust Camshaft Sprocket Bolt

Tightening Torque	1st step 20 Nm 2nd step + 90°

Notice

The sprocket bolts are designed to be used only once, so always replace with new one.



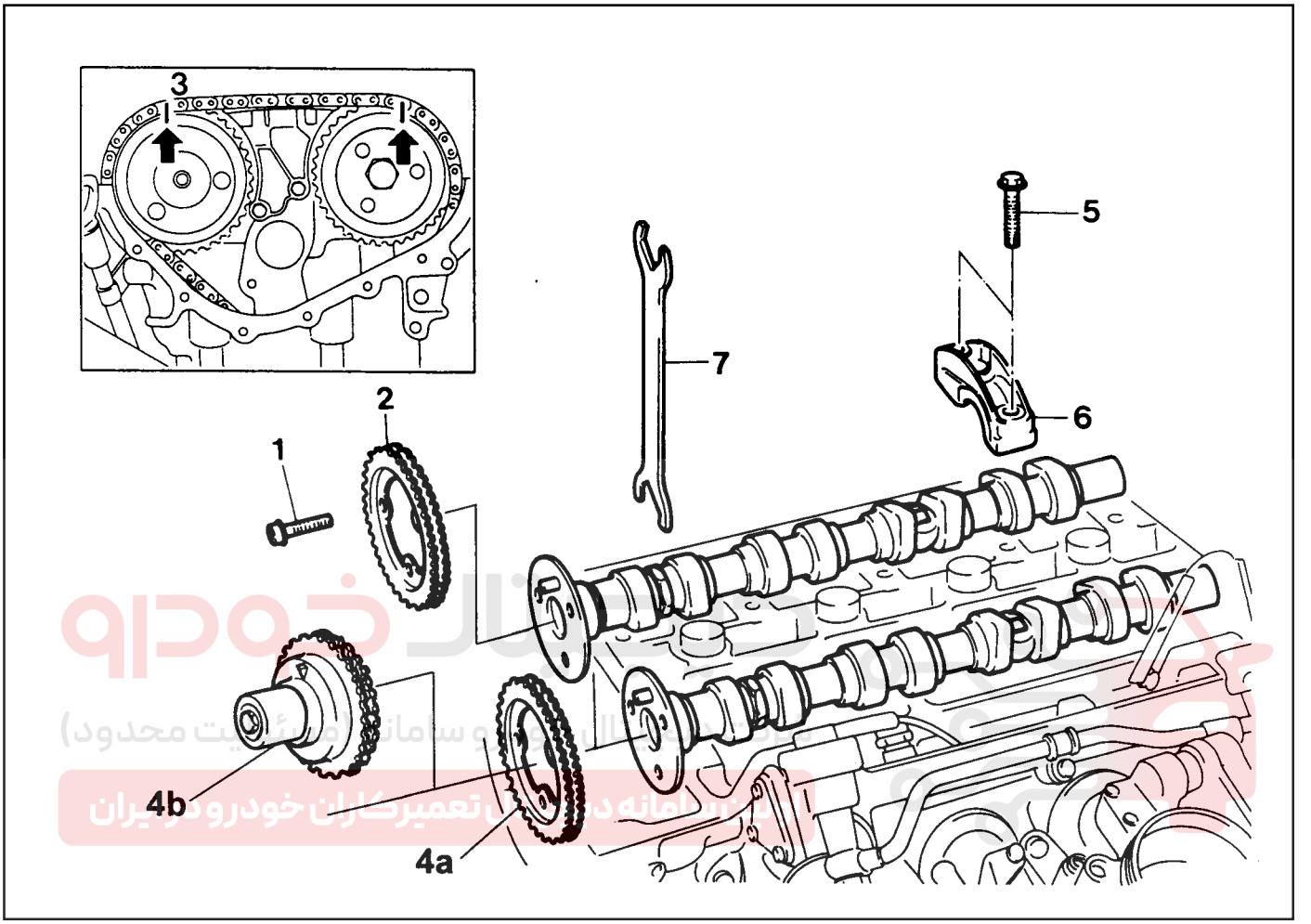
E. M7 x 13 Collar Bolt Torx-T30
e. 6.8 mm
13a. Camshaft Sprocket
22a. Exhaust Camshaft

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CAMSHAFT

Preceding Work : Removal of cylinder head cover
Removal of camshaft adjust actuator and cylinder head front cover



1 Bolt (M7 X 13, 3 pieces) ..... 1st Step 18-22 Nm
2nd Step 90°+ 5° Rotation Added
2 Exhaust Camshaft Sprocket
3 Timing Chain
4a Intake Camshaft Spocket (E20)
4b Camshaft Adjuster and Camshaft Sprocket (E23)
5 Bearing Cap Bolt (20 pieces) ..... 22.5-27.5 Nm
6 Camshaft Bearing Cap
7 Wrench (Special Tool)

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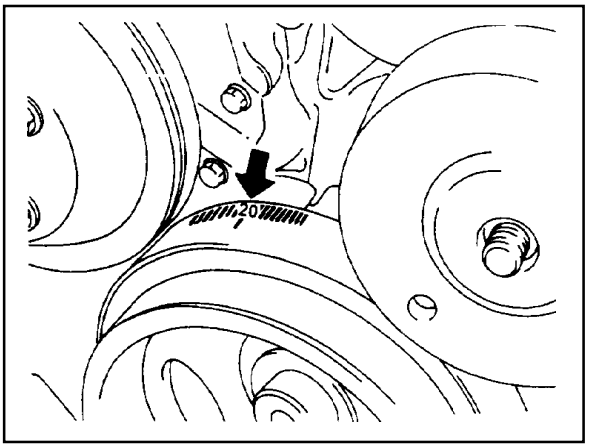
Tools Required

000 589 01 10 00 Box Wrench Insert

104 589 01 01 00 Spanner

Removal & Installation Procedure

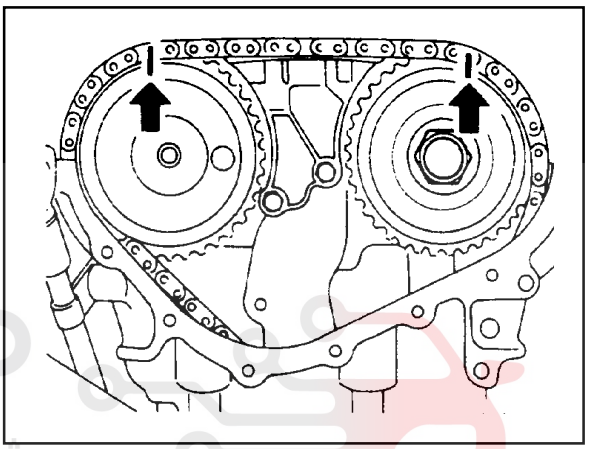
1. Turn the crankshaft and position the no.1 cylinder piston at ATDC20°.



2. Put the alignment marks (arrows) on the camshaft sprocket and the timing chain.
3. Remove the chain tensioner.

Installation Notice

Tightening Torque	Screw Plug	40 Nm
	Tensioner Assembly	72 - 88 Nm



4. Remove the exhoust camshaft sprocket.

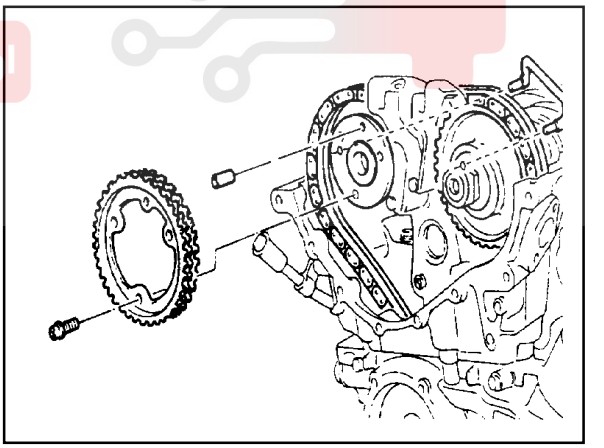
Installation Notice

Tightening Torque	1st step 35 - 45 Nm 2nd step 85° - 95°

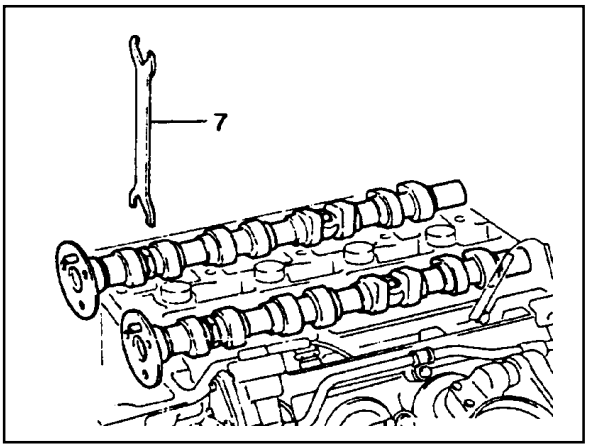
Notice

The sprocket bolt is designed to be used only once, so always replace with new one.

5. Take off the timing chain from intake camshaft sprocket, and secute it not to fall down into the timing gear case.



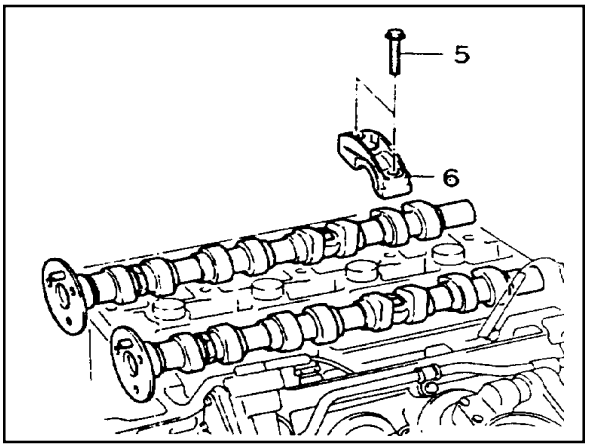
6. Using the wrench (7), turn the camshaft until there is no resistence in camshaft bearing area.



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7. Remove the bearing cap, and remove the intake and the exhaust camshaft.



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Notice

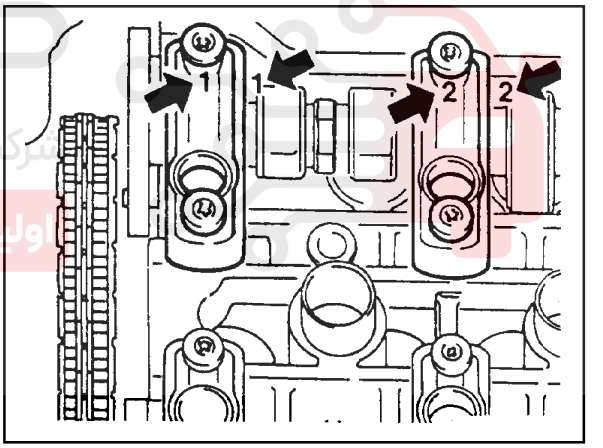
Check the numbers on the bearing cap not to be miked up.

8. Apply the engine oil on the valve tappet and camshaft bearing.
9. Installation should follow the removal procedure in the reverse order.

Notice

- Base circle of cam should cantact with the valve tappet.
- Install the camshaft bearing caps according to the numbers on the cylinder head cast and bearing cap.

10. Check the camshaft timing position.



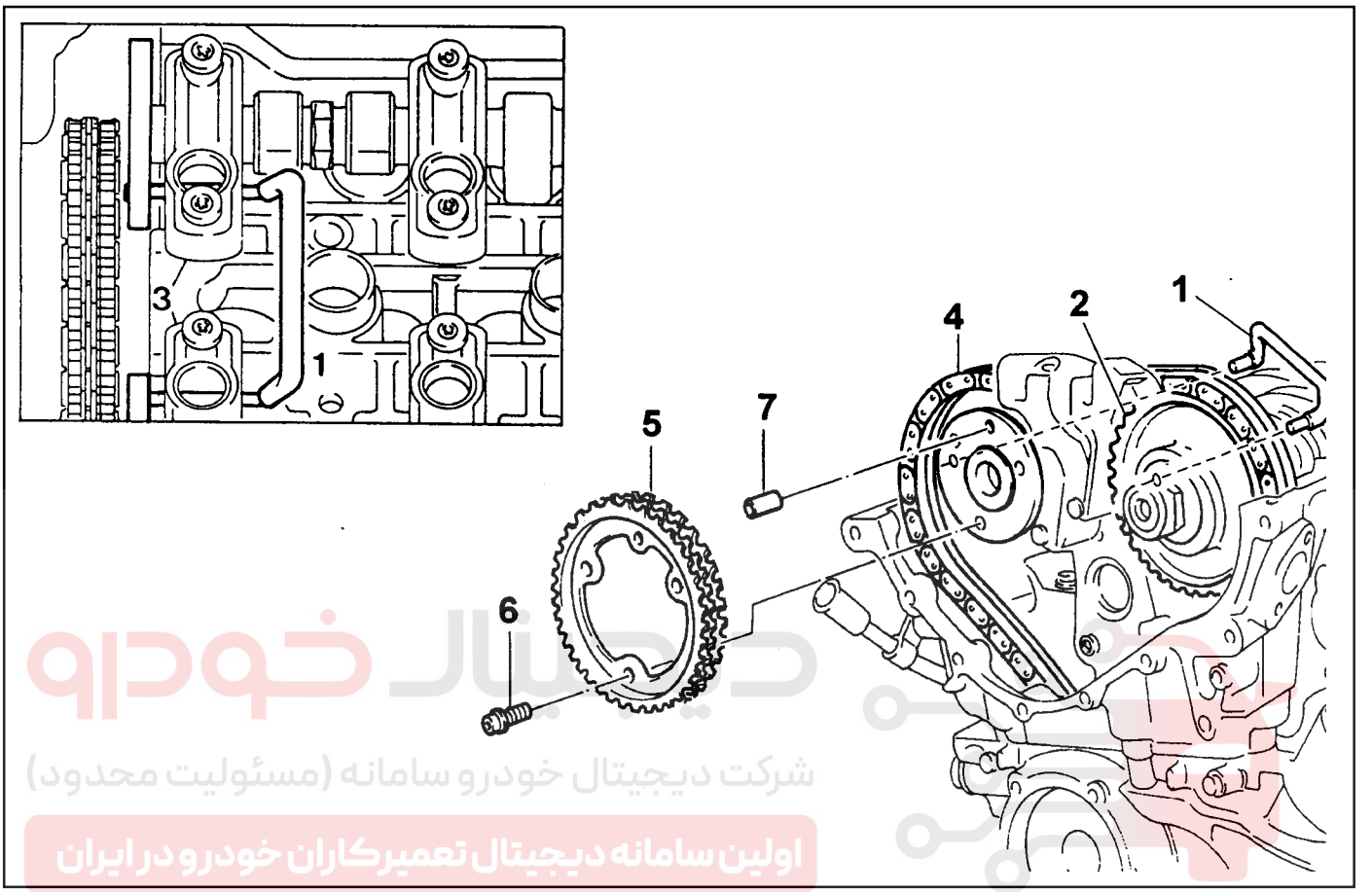
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CAMSHAFT TIMING POSITION

Preceding Work : Removal of cylinder head cover
Removal of cylinder head front cover



1 Insert Pin (ƒ6.5mm, Special Tool)
2 Intake Camshaft Sprocket
3 Camshaft Bearing Cap
4 Timing Chain
5 Exhaust Camshaft Sprocket
6 Bolt (M7 X 13, 3 pieces) ..... 1st step 20 ± 2 Nm
2nd step 90° ± 5° rotation added
7 Strate Pin

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Tools Required

104 589 01 01 00 Spanner

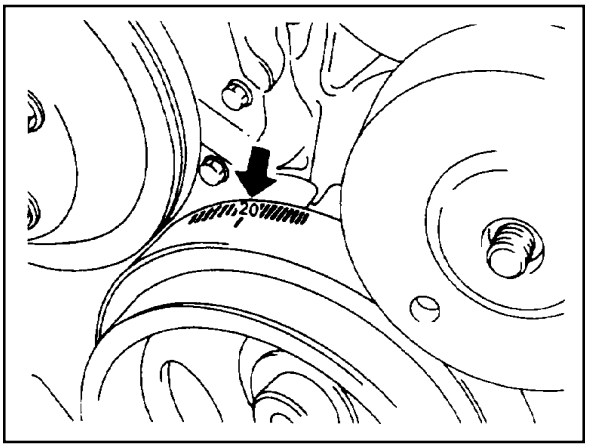
111 589 03 15 00 Insert Pin

Inspection Procedure

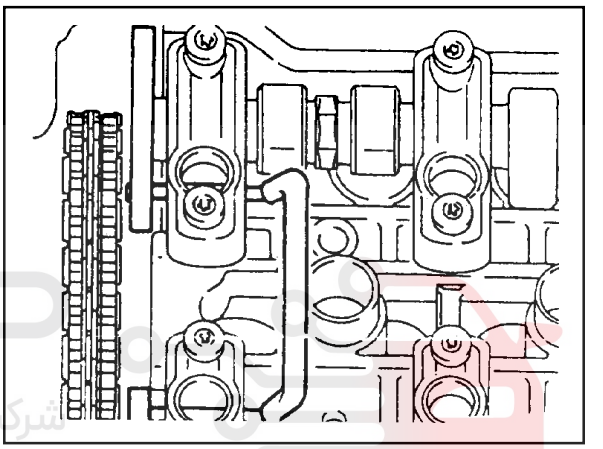
1. Position the NO.1 cylinder piston to ATDC 20° by turning the crankshaft

   Notice

   When the ATDC 20° mark on vibration damper is aligned with timing gear case cover, the intake and exhaust cam of cylinder will make the slope to the center and will face up. In this way, the insert hole in NO.1 and NO.4 camshaft bearing cap will match in line with the flange hole for camshaft sprocket.



2. Check the timing as below procedure;
   - Check if the insert pin (111 589 03 15 00) can be inserted into the NO.1 and NO.4 bearing cap hole.
   - At this condition, check if the ATDC 20° mark on vibration damper aligns with the marker on the timing gear case.



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Adjustment Procedure

1. Position the NO.1 cylinder to ATDC 20° .
2. Remove the chain tensioner.
3. Remove the exhaust camshaft sprocket.
4. Adjust the timing position with inserting the insert pin (*f*6.5mm, 111 589 03 15 00) into the NO.1 and NO.4 camshaft bearing cap hole and flange hole while rotating the camshaft by using wrench (104 589 01 01 00).
5. Install the chain to the intake camshaft sprocket.
6. Install the chain to the exhaust camshaft sprocket and tighten the bolt.

   Installation Notice

Tightening Torque	1st step 20 Nm 2nd step + 90°

   The sprocket bolt is designed to be used only once, so replace with new one.
7. Install the chain tensioner.

   Installation Notice

Tightening Torque	Screw plug	40 Nm
	Tensioner assembly	80 ± 8 Nm

8. Check the camshaft timing.

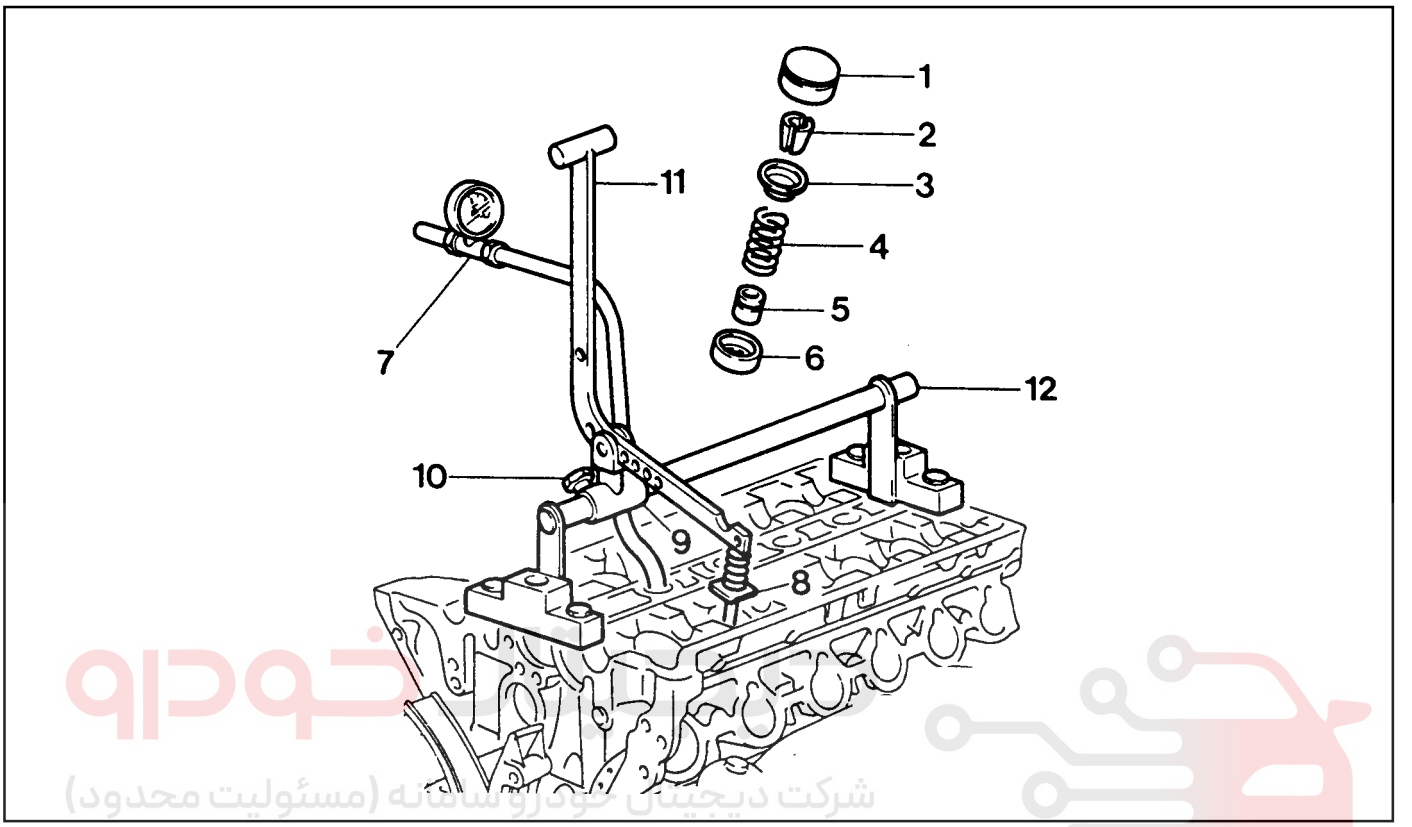
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VALVE SPRING

Preceding Work : Removal of camshaft
Removal of spark plug



1	Valve Tappet Assembly	7	Connecting Hose
2	Valve Cotter	8	Thrust Piece
3	Upper Retainer	9	Slide
4	Valve Spring ..... Check, Replace if necessary	10	Adjust Bolt
5	Valve Stem Seal	11	Lever Pusher
6	Lower Retainer	12	Supporting Bar

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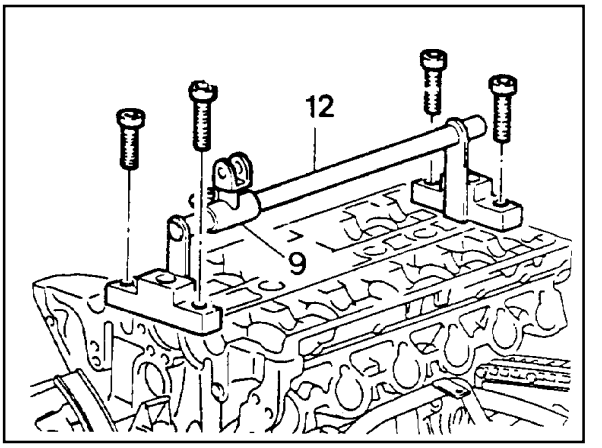
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Tools Required

111 589 01 59 00 Supporting Bar
111 589 18 61 00 Lever Pusher
111 589 25 63 00 Thrust Piece
116 589 06 63 00 Magnetic Finger

Removal & Installation Procedure

1. Place the supporting bar (12) and the slide (9) at the camshaft bearing cap (Nos 1 & 7/8&14) and tighten them with the bearing cap bolt.

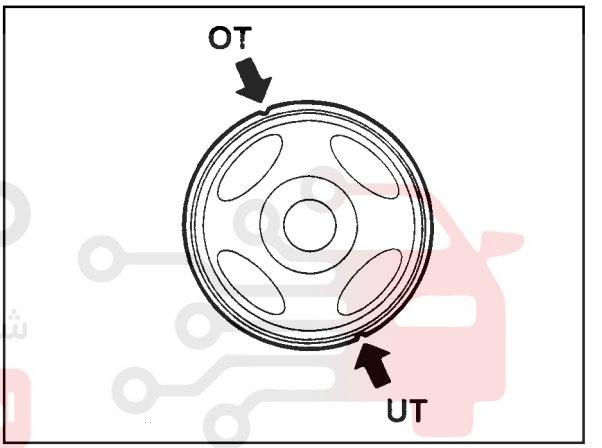


Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Supporting Bar 111 589 01 59 00

2. Turn the crankshaft to position the each cylinder piston at TDC.



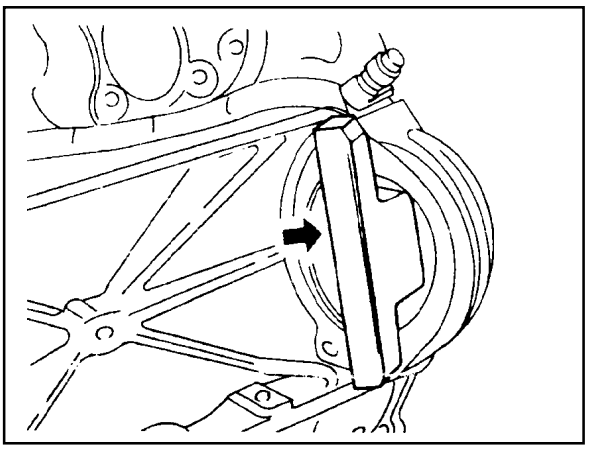
Mark on The Vibration Damper	Cylinder
OT	1, 4
UT	2, 3

Notice

- Remove the valve spring only at TDC.
- Always rotate the crankshaft by holding the chain to prevent from timing chain damage and tangling, and for smooth rotation.

3. Remove the valve tappet (1) using the magnetic finger.
4. Install the leakage tester connecting hose to the spark plug hole.

5. Install the engine lock to the ring gear to prevent the crankshaft from rotating.
6. Blow up with compressed air.

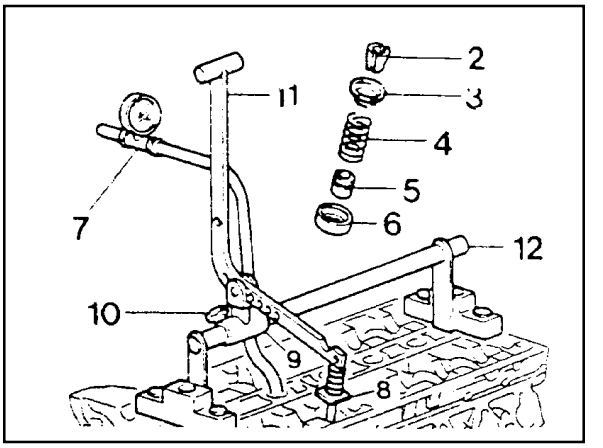


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8. Install the lever pusher (11) and the thrust piece (8) to the slide (9).

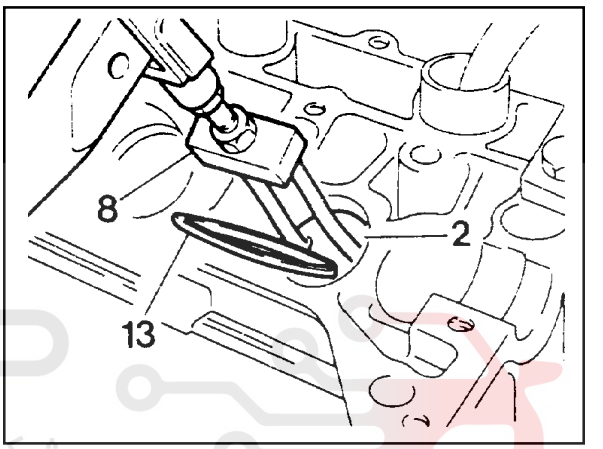
Lever Pusher 111 589 18 61 00



9. Mount the thrust piece (8) vertically to the valve spring retainer (3).
10. Make the thrust piece (8) and the slide (9) perpendicular to each other.
11. Secure the slide (9) by turning the adjust bolt (10).
12. Press the valve spring (4) by using the lever pusher (11).

13. Remove the valve cotter (2) using either the pincette (13) or magnetic finger.

Magnetic Finger 116 589 06 63 00



14. Remove the upper retainer (3) and the valve spring (4).
15. Remove the valve stem seal and replace if necessary.

Notice

Check the valve stem seal and replace if necessary.

16. Remove the lower retainer (6).

Notice

Check the retainer for damages and replace with a new one if necessary.

17. Installation should follow the removal procedure in the reverse order.

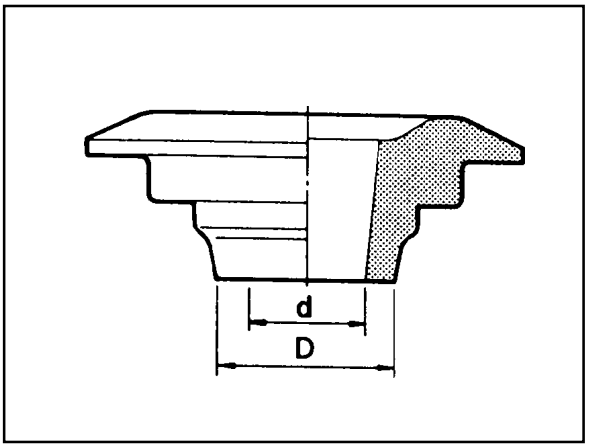
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Test (Upper and Lower Valve Tappet and Valve Cotter)

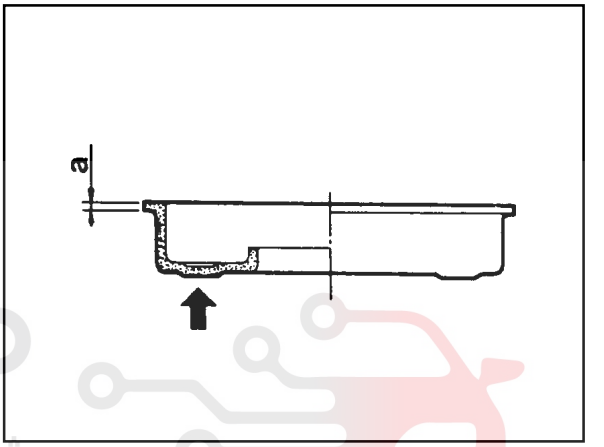
- Upper Valve Spring Retainer

Size (mm)	(d)	8.5
	(D)	12.3



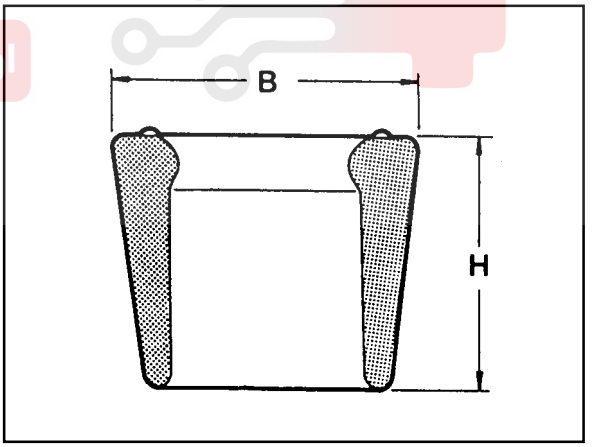
- Lower Valve Spring Retainer

Thickness (mm)	(a)	0.8 - 1.0



- Valve Cotter

Size (mm)	(B)	9.0
	(H)	9.2 - 9.8



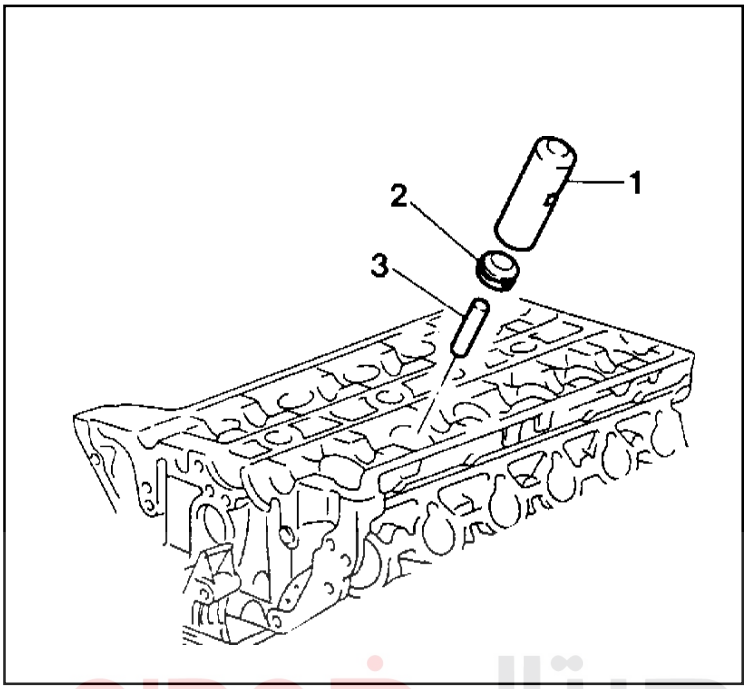
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VALVE STEM SEAL

Preceding Work : Removal of valve spring



1 Drift (Special Tool)
2 Valve Stem Seal
3 Protective Sleeve

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Tools Required

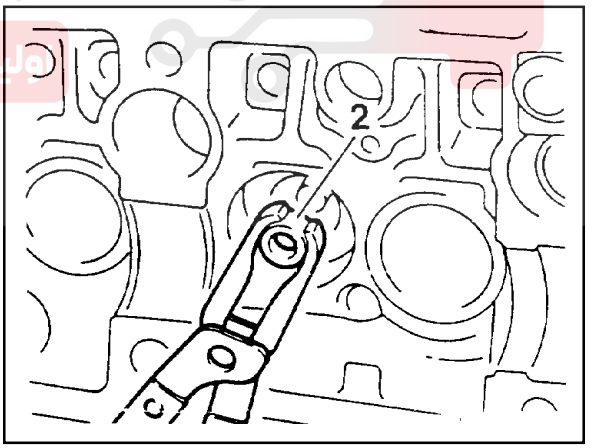
104 589 00 37 00 Pliers
119 589 00 43 00 Drift

Replacement Procedure

1. Remove the valve stem seal (2) using the pliers.

   Notice

   Check the valve stem seal for damage and replace if necessary.



Pliers 104 589 00 37 00

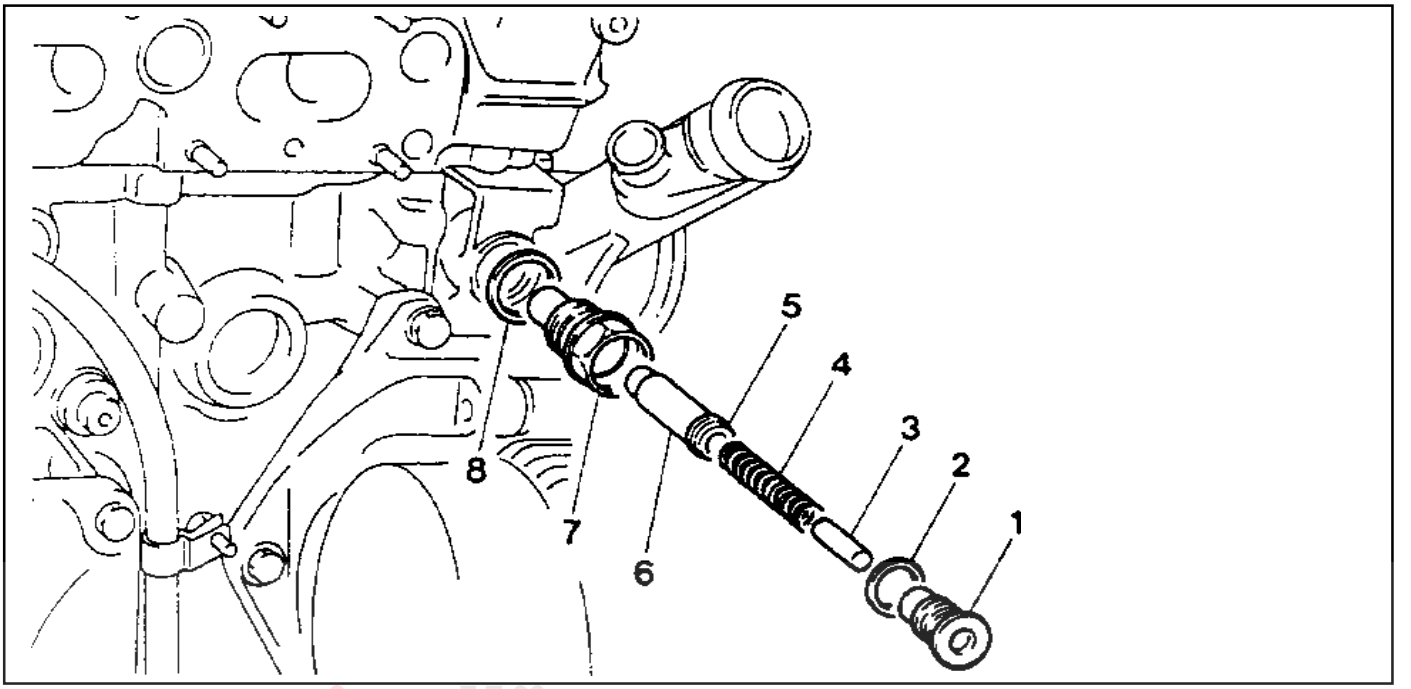
2. Coat the valve stem seal with oil and assemble it with the protective sleeve.
3. Insert the valve stem seal by pressing it with the drift.

Drift 119 589 00 43 00

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CHAIN TENSIONER



1 Screw Plug ..... 40 Nm
2 Seal
3 Filler Pin
4 Compression Spring
5 Snap Ring
6 Thrust Pin
7 Chain Tensioner Housing ..... 72-88 Nm
8 Seal

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Removal Procedure

1. Position the number 1 cylinder to ATDC 20°.

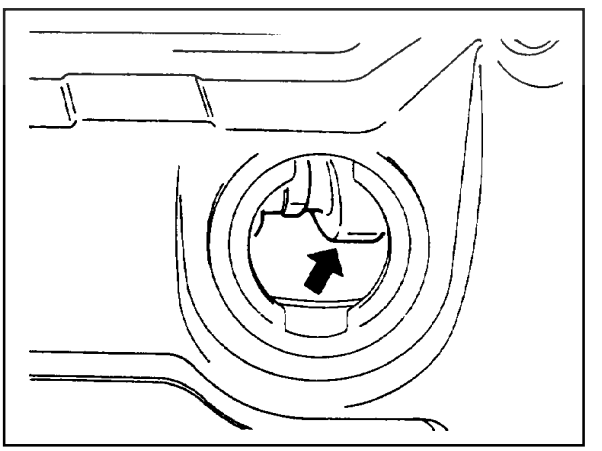
   Notice

   Remove the oil filler cap at adjustment position, and check whether the intake camshaft cam's lobe (arrow) stays in the upper side.

2. Cover the alternator with a clean cloth.
3. Release the tension by unscrewing the screw plug once.

   Notice

   In case that the tension is reduced by unscrewing the screw plug, reinstall after completely removing the chain tensioner. If the chain tensioner is tightened again without completely reducing its tension, then the snap ring doesn't return to the original position and the tension gets excedded.



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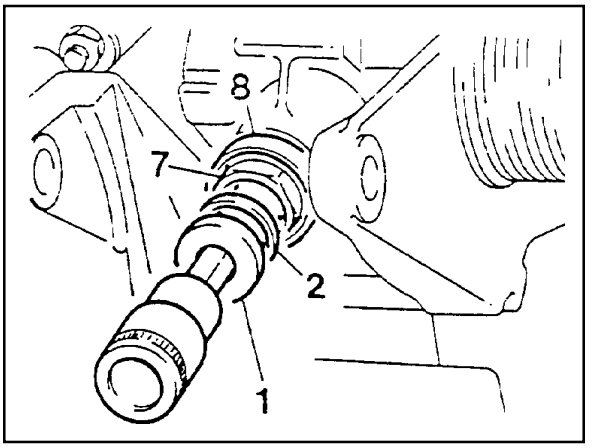
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4. Carefully unscrew the screw plug (1), and remove the seal (2).

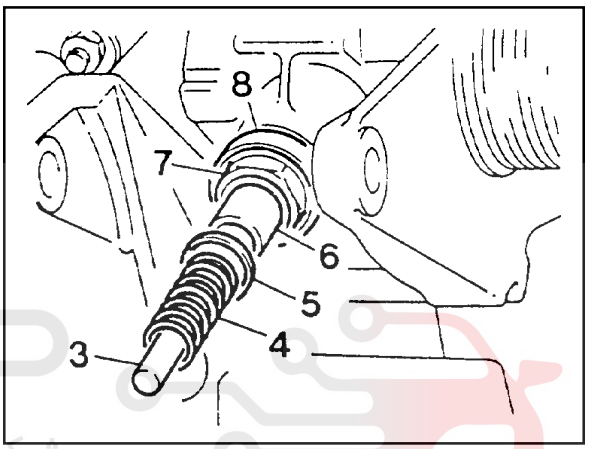
   Notice

   - For the removal of screw plug, 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.

5. Carefully remove the filler pin (3), compression spring (4), snap ring (5), and the thrust pin (6).



6. Remove the chain tensioner housing (7) and the seal (8).



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Installation Procedure

1. Connect the thrust pin (6) and the snap ring (5) to the chain tensioner housing (7).

   Notice

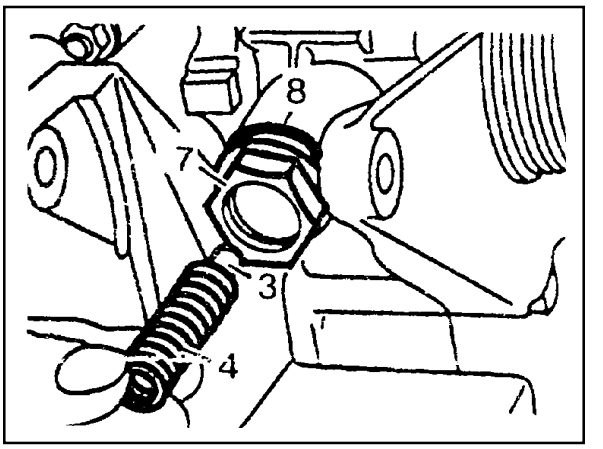
   When connecting the thrust pin, push in the thrust pin far enough so that it doesn't protrude at the chain tensioner housing.

2. Install the chain tensioner housing (7), Thrust pin (6), snap ring (5), and the seal (8).

   Installation Notice

Tightening Torque	72 - 88 Nm

3. Insert the compression spring (4) with the filler pin (3) into chain tensioner housing.



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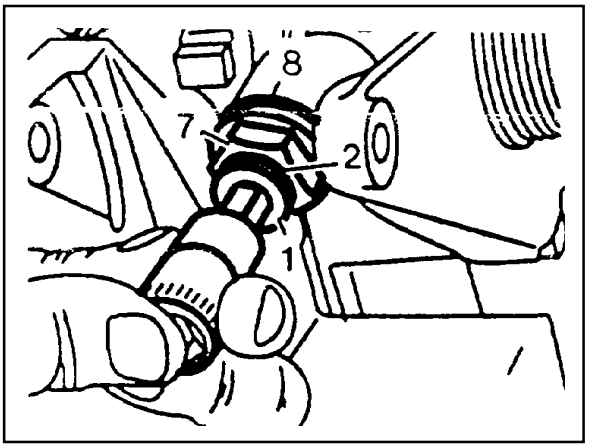
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4. Lightly apply the grease to the seal (2) and install the screw plug (1).

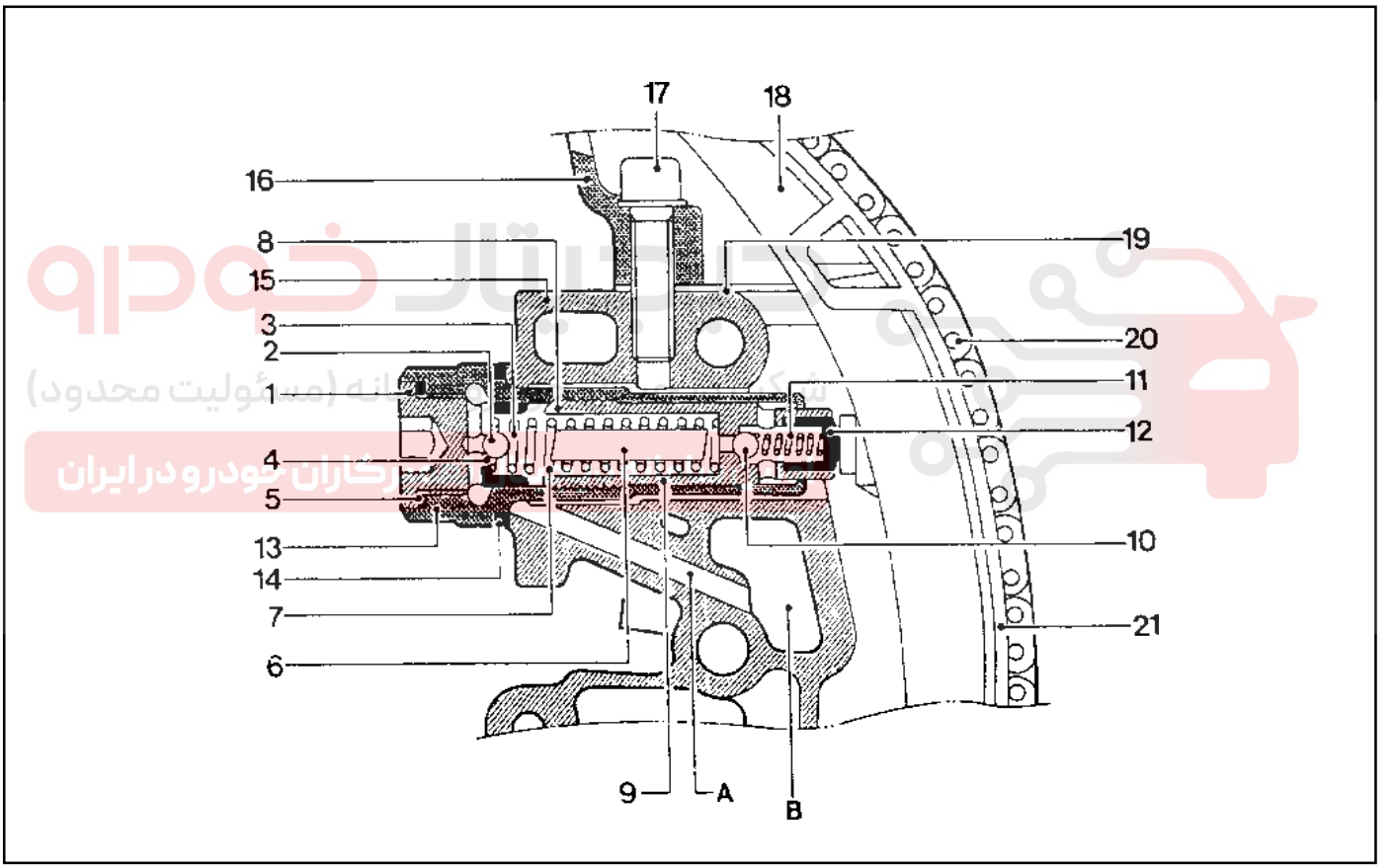
Installation Notice

Tightening Torque	40 Nm

5. Check for leaks by operating the engine.



Sectional View



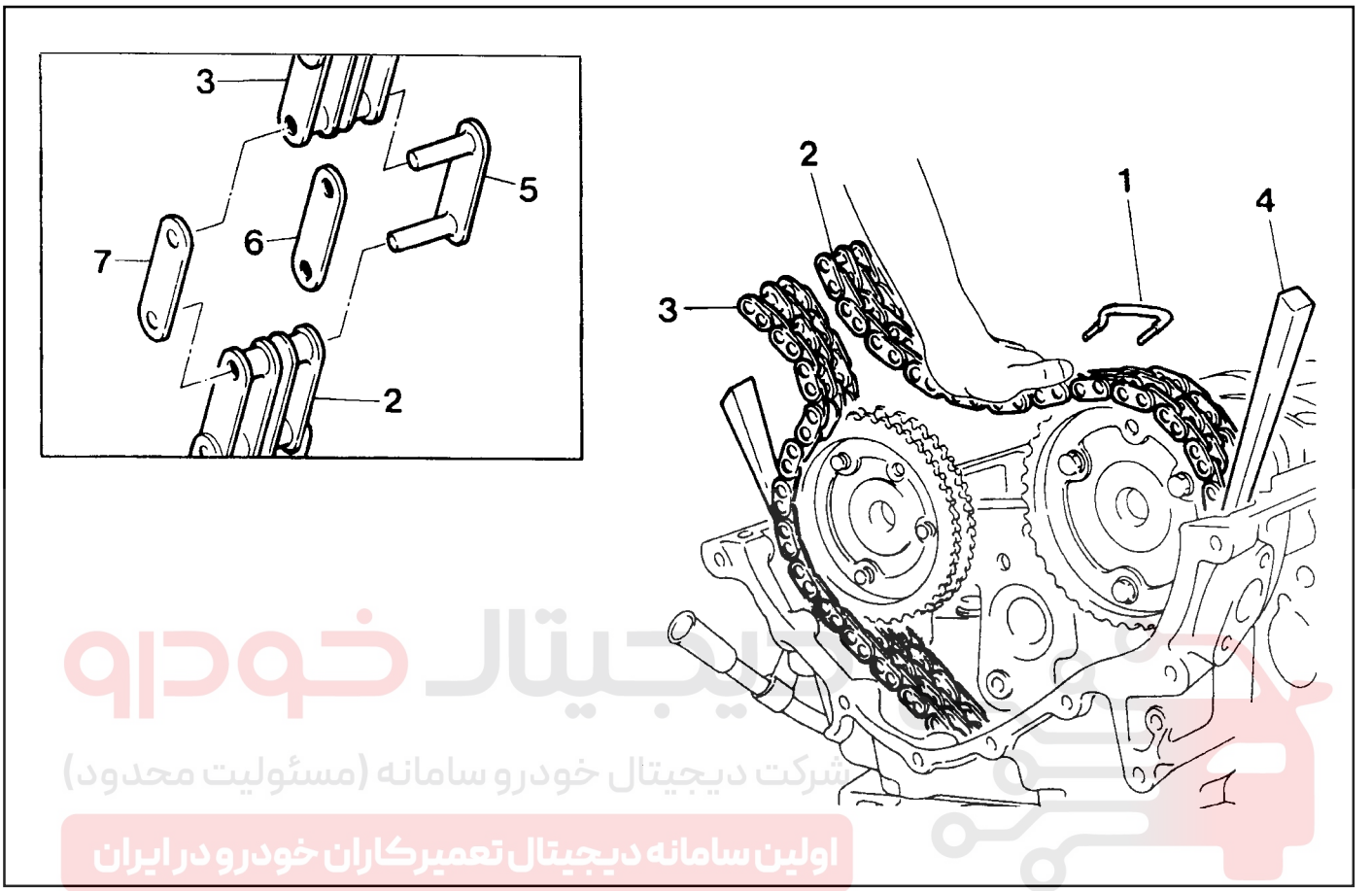
1 Screw Plug
2 Ball (Nonreturn Valve)
3 Compression Spring
4 Ball Guide
5 Seal (Aluminum)
6 Filler Pin
7 Compression Spring
8 Snap Ring
9 Thrust Pin
10 Ball (Nonreturn Valve)
11 Compression Spring
12 Thrust Piece
13 Chain Tensioner Housing
14 Seal
15 Timing Gear Case Cover
16 Cylinder Head
17 Bolt / Washer
18 Tensioning Rail
19 Cylinder Head Gasket
20 Timing Chain
21 Tensioning Rail Base (Sliding Surface)
A Oil Supply Hole
B Chain Tensioner Oil Storage Hole

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TIMING CHAIN

Preceding Work : Removal of cylinder head cover
Removal of spark plug



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1 Pin
2 New Timing Chain
3 Timing Chain (Used)
4 Wedge
5 Link
6 Center Plate
7 Outer Plate

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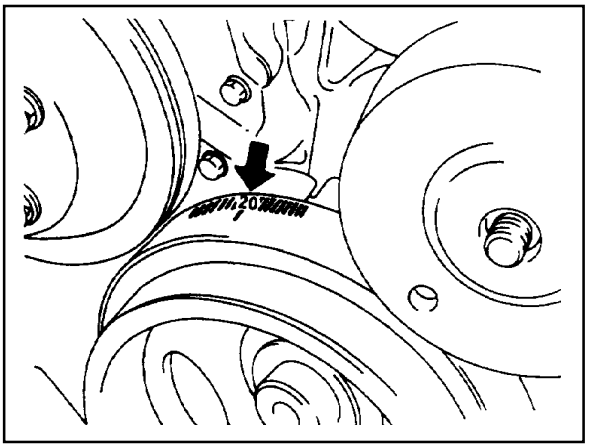
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Tools Required

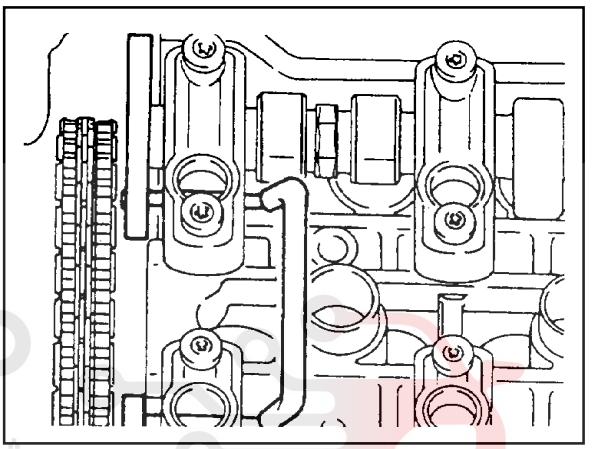
000 589 58 43 00 Chain Assembly
103 589 01 63 00 Rivet Set
001 589 72 21 00 Torque Wrench

Replacement Procedure

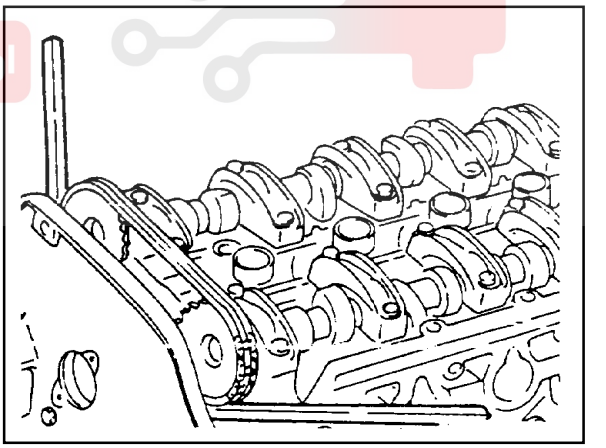
1. Position the NO.1 cylinder to ATDC 20°.



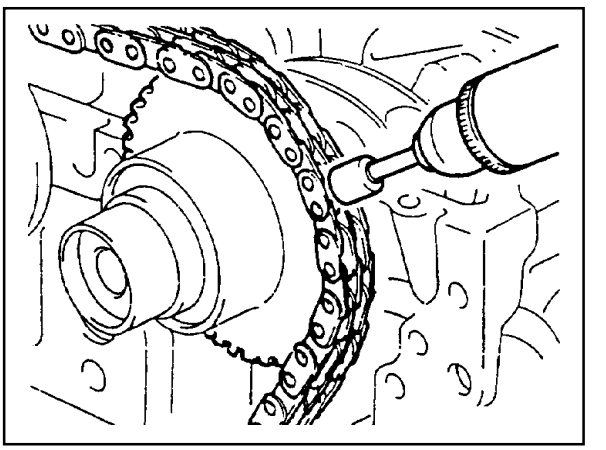
2. Insert the pin to the intake and exhaust camshaft flange.
3. Remove the chain tensioner.



4. Mount the wedges to both sides of the camshaft sprocket as shown in the figure.



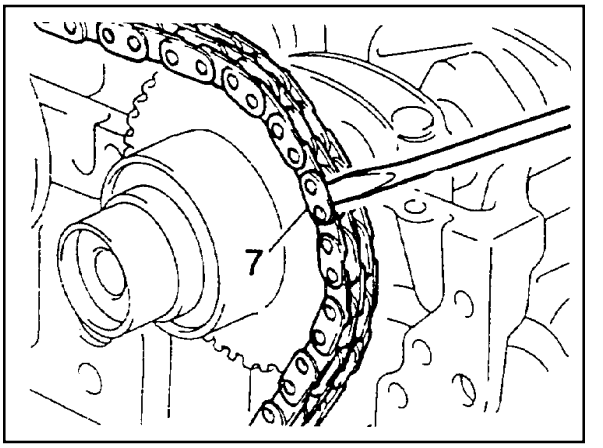
5. Cover the chain housing with a clean cloth, and grind off the timing chain pin from the intake camshaft sprocket with the grinder.



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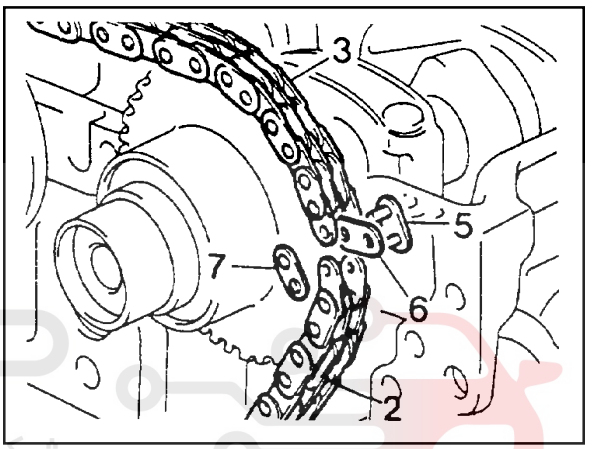
6. Remove the outer plate (7) with the screw driver and remove the link (5).



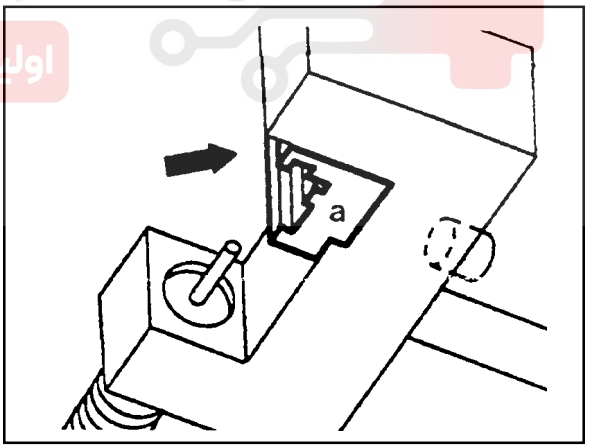
7. Connect the new timing chain (2) to the used timing chain (3) with the link (5), center plate (6, thickness 1.6mm), and the outer plate (7).
8. Rotate the crankshaft in the direction if engine revolution by pressing the new timing chain against the exhaust camshaft sprocket to prevent it to be tangled.

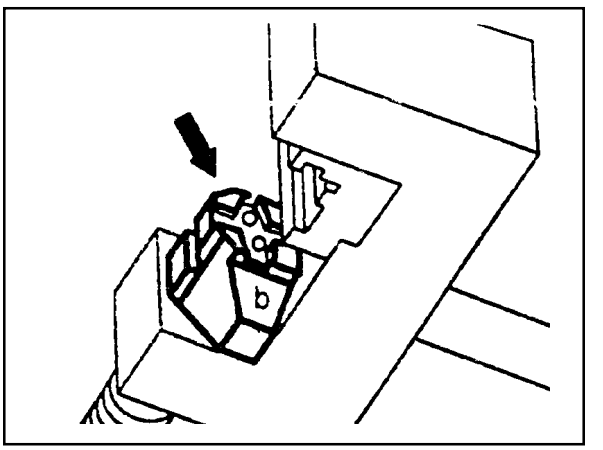
   Notice

   Be sure to remove the wedge before cranking the engine.
9. Take out the used timing chain out from the chain housing.
10. Connect both separators of the new timing chain with the link (5) and the center plate (6).



11. Install the jaw (a) and the thrust piece (b) to the assembly tool as shown in the figures.

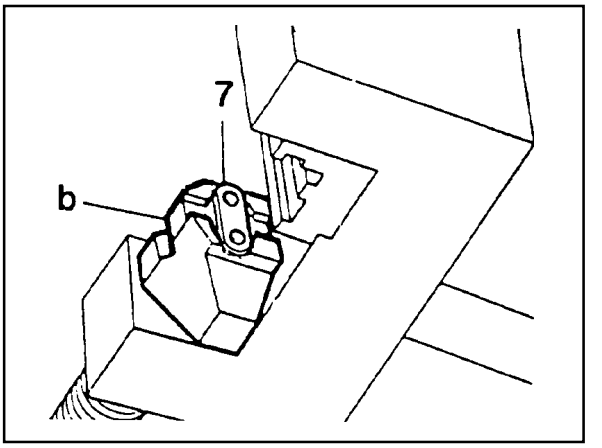




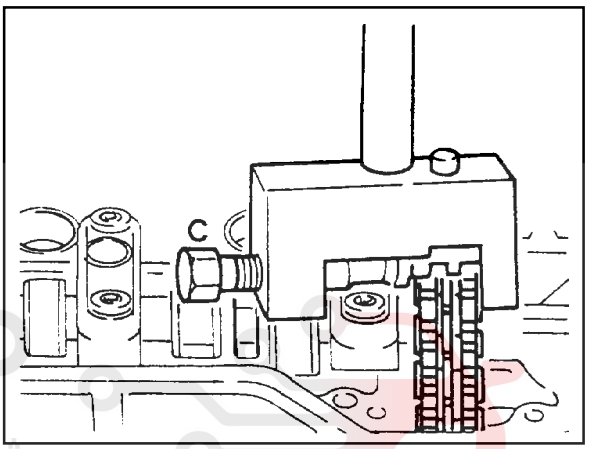
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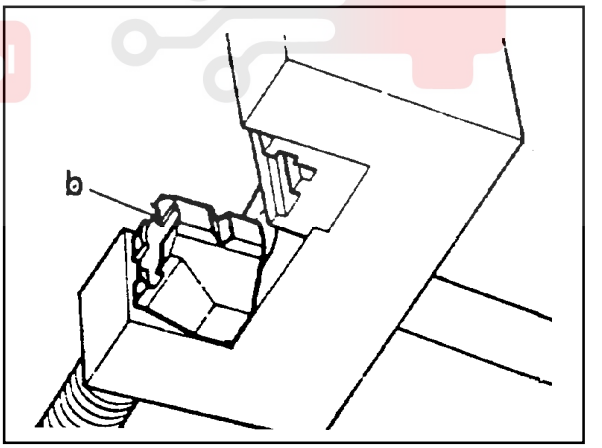
12. Place the outer plate (7, thickness 1.2mm) inside the thrust piece (b).



13. Install the assembly tool above the link and tighten the spindle (c) until a block is felt.
14. Place the assembly tool.

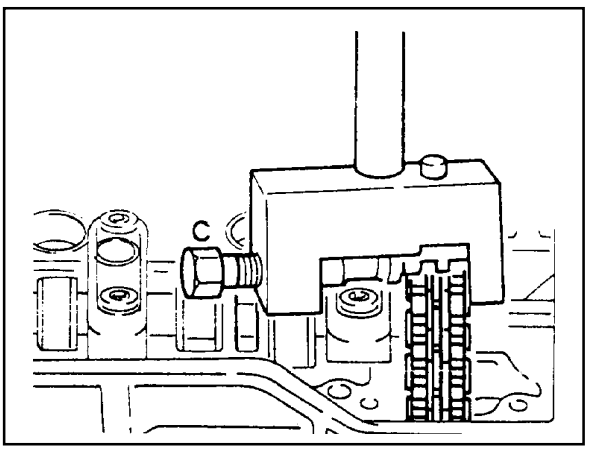


15. Replace the thrust piece (b) as shown in the figure.



16. Install the assembly tool to the link pin and tighten the spindle (c).

Tightening Torque	30 Nm



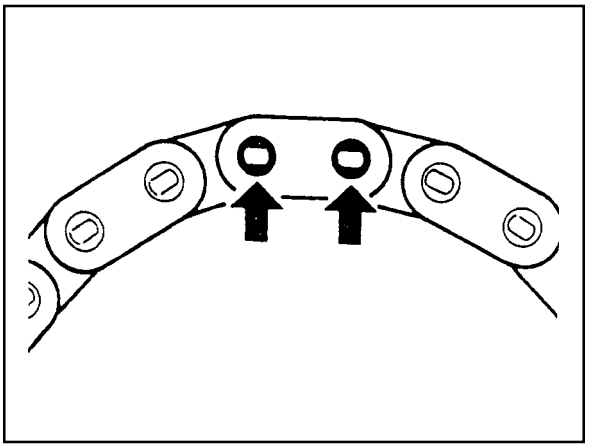
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17. Rivet the link pin.
    Check the condition and it again if necessary.
18. Install the chain tensioner.
    Installation Notice

Tightening Torque	Screw Plug	40 Nm
	Tensioner Assembly	72 - 88 Nm

19. Check the camshaft timing position.



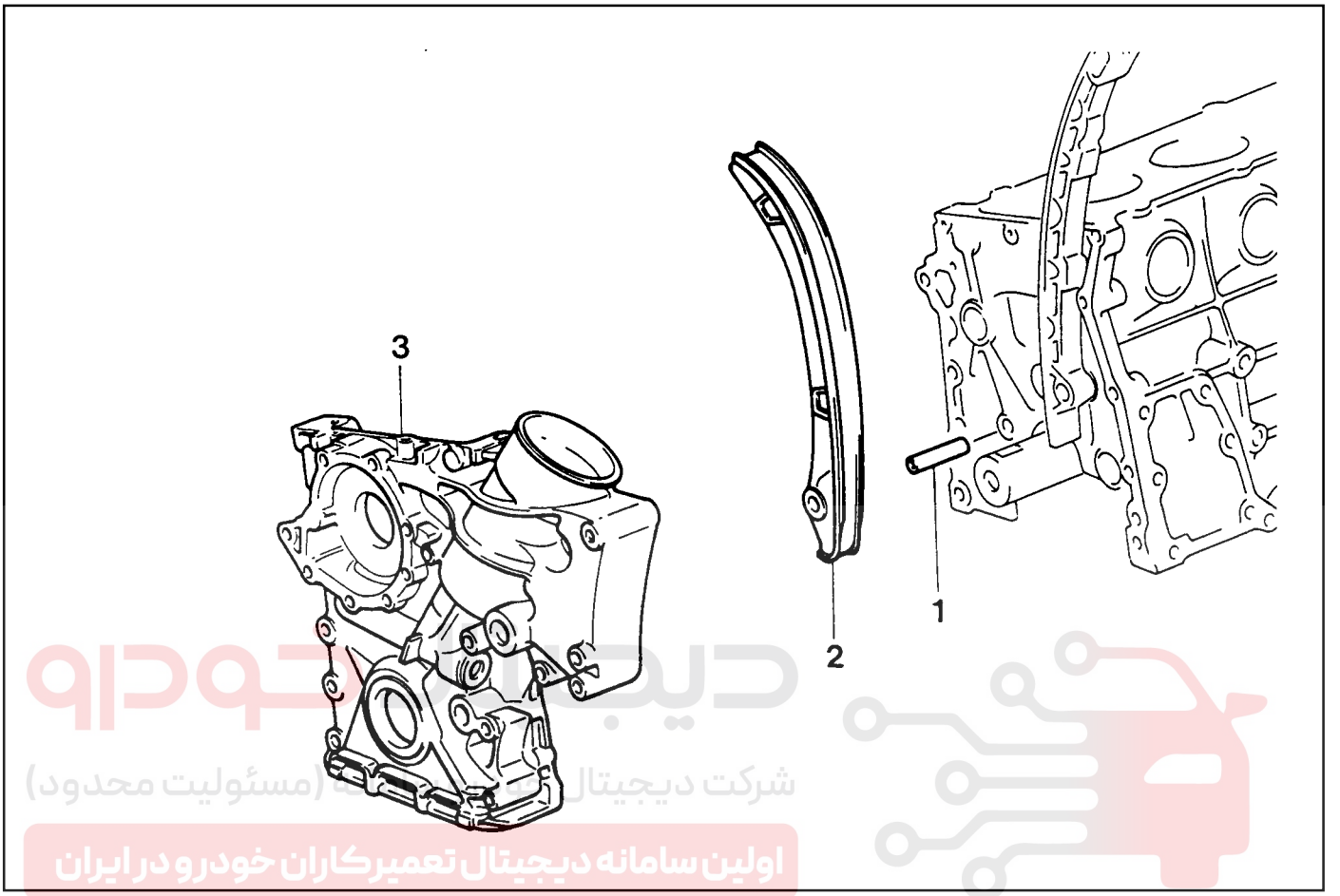
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TENSIONING RAIL

Preceding Work : Removal of cylinder head



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1 Sliding Rail Pin
2 Sliding Rail
3 Timing Gear Case Cover

Removal & Installation Procedure

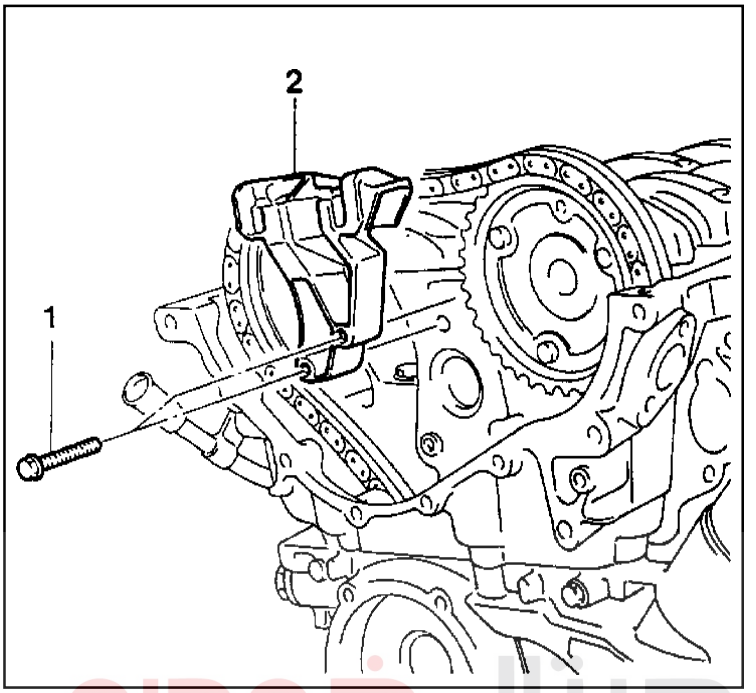
1. Remove the timing gear case cover (3).
   Notice
   Be careful not to damage the gasket.
2. Remove the sliding rail (1) from the sliding rail pin (2).
   Notice
   - Replace the plastic guide (2) if it is damaged.
   - For installation, exactly align the plastic guide (2) with the sliding rail (1).
3. Installation should follow the removal procedure in the reverse order.

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CYLINDER HEAD GUIDE RAIL

Preceding Work : Removal of cylinder head cover



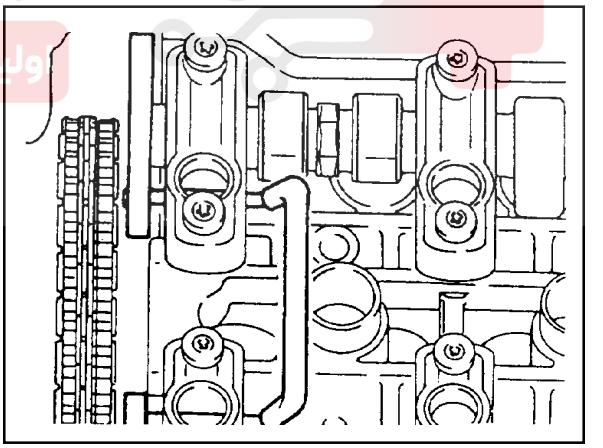
1 Bolt (M6 X 45, 2 pieces) ..... 9-11 Nm
2 Guide Rail

Removal & Installation Procedure

1. Position the number 1 cylinder to ATDC20° guide rail.
2. Install the pin (special tool : 111 589 03 15 00) into the no.1 and no.6 bearing cap hole.
3. Remove the chain tensioner.

Installation Notice

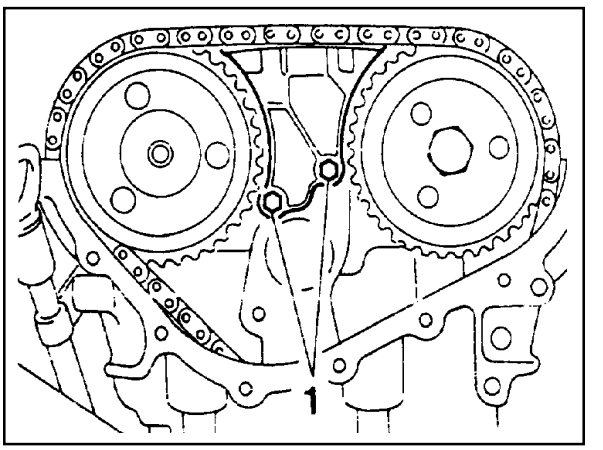
Tightening Torque	Screw Plug	40 Nm
	Tensioner Assembly	72 - 88 Nm



4. Unscrew the bolt (1) and remove the guide rail.

Installation Notice

Tightening Torque	9 - 11 Nm



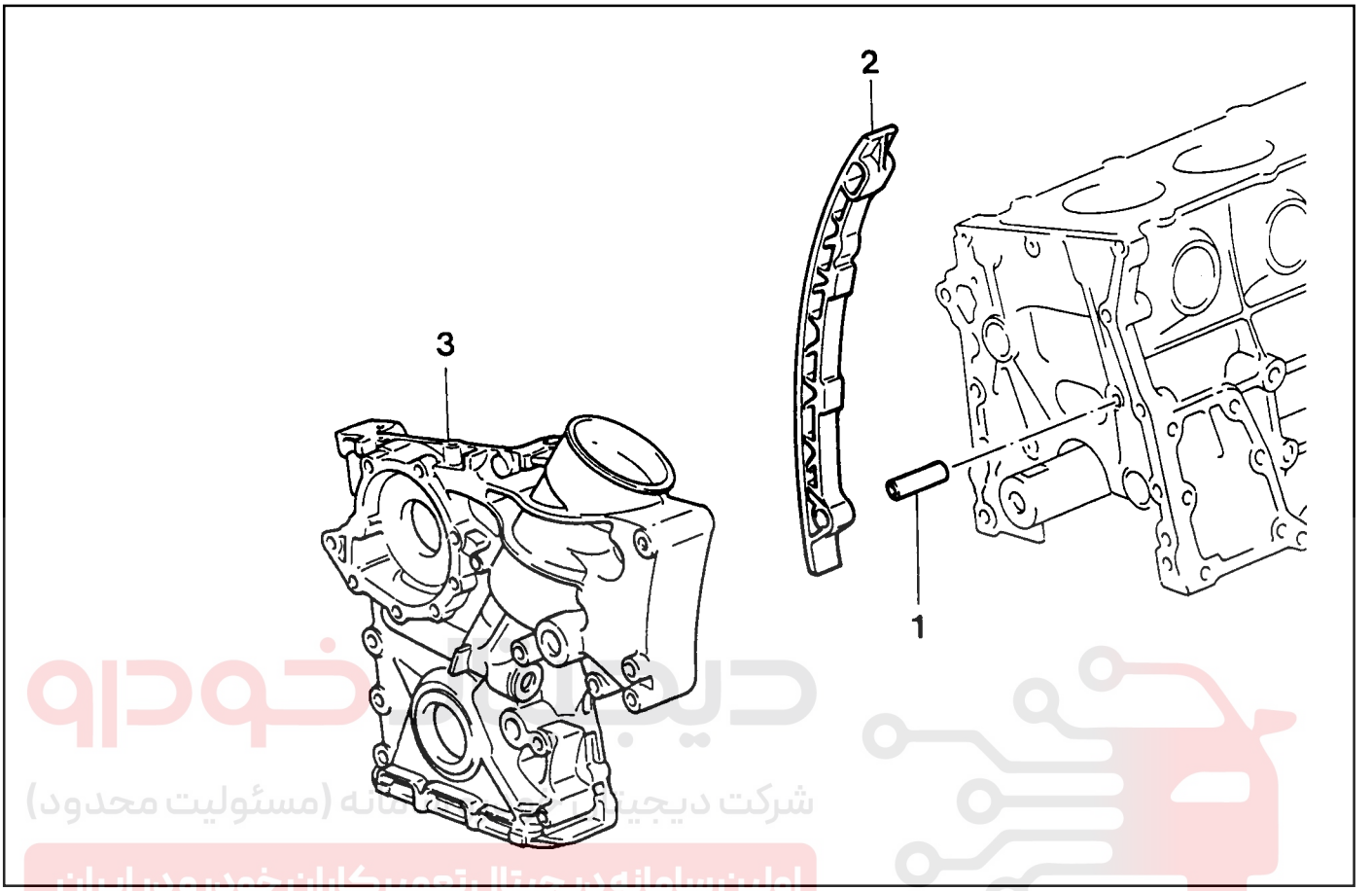
5. Installation should follow the removal procedure in the reverse order.

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CRANKCASE GUIDE RAIL

Preceding Work : Removal of timing gear case cover



1 Guide Rail Pin
2 Guide Rail
3 Timing Gear Case Cover

Removal & Installation Procedure

1. Remove the timing gear case cover (3).

   Notice

   Be careful not to damage the gasket when removing/ installing the timing gear case cover.

2. Remove the guide rail (2) from the guide rail pin(1).

   Notice

   - Replace the plastic guide (2) if damaged.
   - Connect the plastic guide (2) and the guide rail (1) by aligning them accurately when installing.

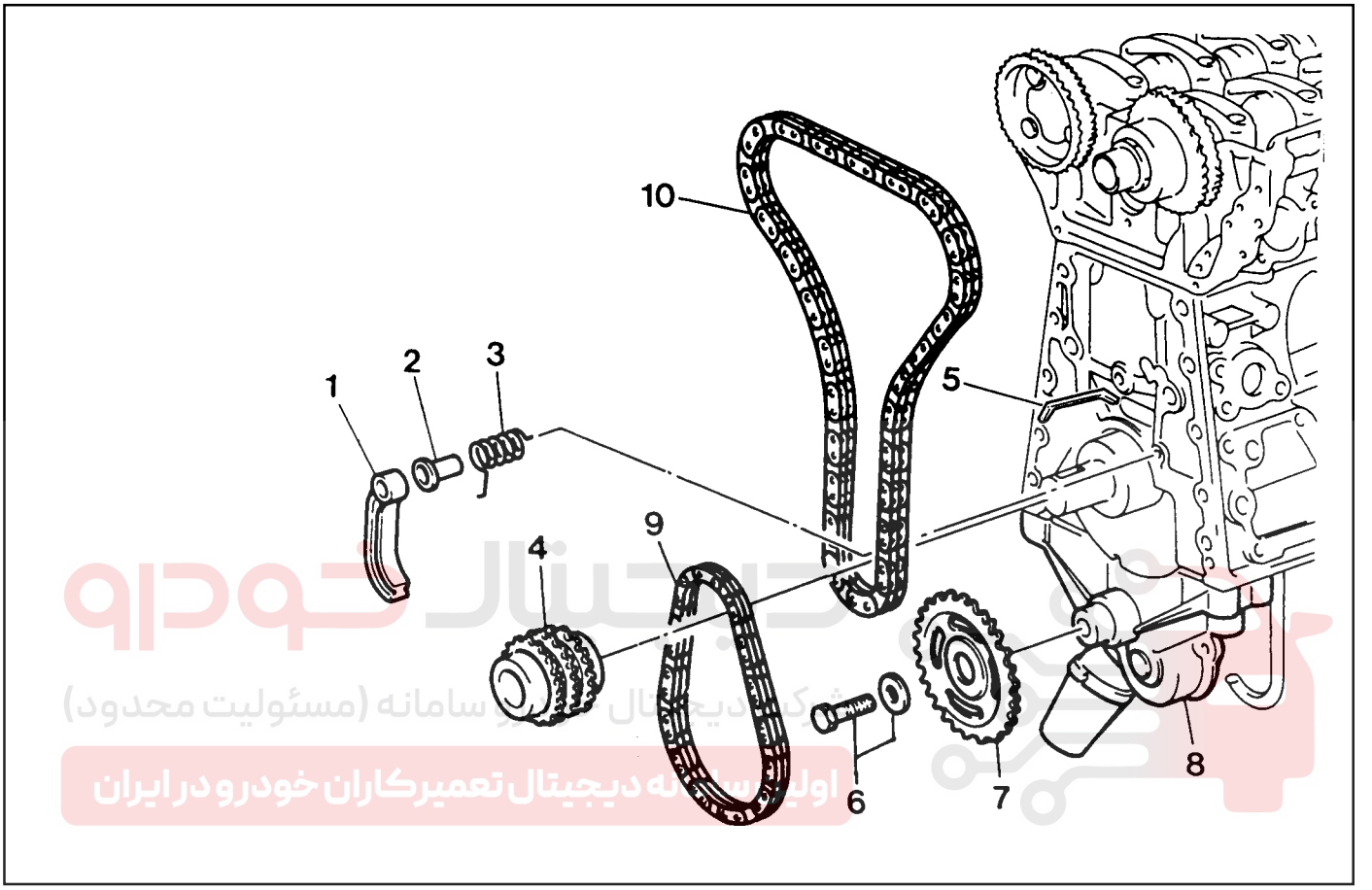
3. Installation should follow the removal procedure in the reverse order.

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CRANKSHAFT SPROCKET

Preceding Work : Removal of oil pan
Removal of tensioning rail
Removal of crank case guide rail
Removal of cylinder head



1 Oil Pump Chain Tensioner
2 Oil Pump Chain Spring
3 Oil Pump Chain Bushing (Pin)
4 Crankshaft Sprocket
5 Key
6 Bolt (M8 x 20, 1 piece) / Washer ..... 29-35 Nm
7 Oil Pump Sprocket
8 Oil Pump
9 Oil Pump Roller Chain
10 Timing Chain

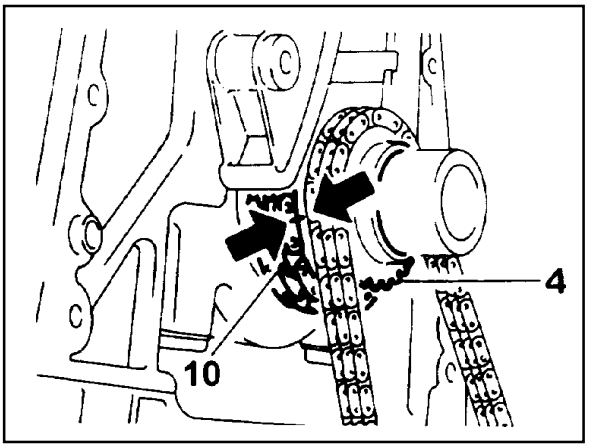
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Tools Required

615 589 01 33 00 Caulking Bolt

Removal & Installation Procedure



1. Put the assembly mark at the crankshaft sprocket (4) and the timing chain (10) with the paint (arrow).

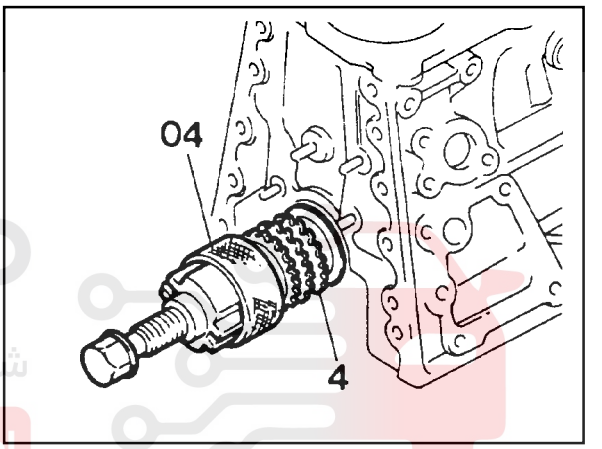
   Installation Notice

   Align the assembly marks on cranshaft sprocket and timing chain. Also, align the assembly marks on camshaft sprocket and timing chain when installing.

2. Unscrew the bolt (6) and remove the oil pump sprocket (7) from the oil pump.

   Installation Notice

Tightening Torque	29 - 35 Nm



3. Remove the oil pump roller chain (9).
4. Remove the oil pump chain tensioner (1), oil pump chain bushing (3), and the oil pump chain spring (2).
5. Remove the crankshaft sprocket (4) using the puller (04, special tool).

   Notice

   - Make sure not to lose the crankshaft pulley key (5) when removing.
   - Install the crankshaft sprocket (4) after warming it up.

6. Installation should follow the removal procedure in the reverse order.

Caulking (04) 615 589 01 33 00

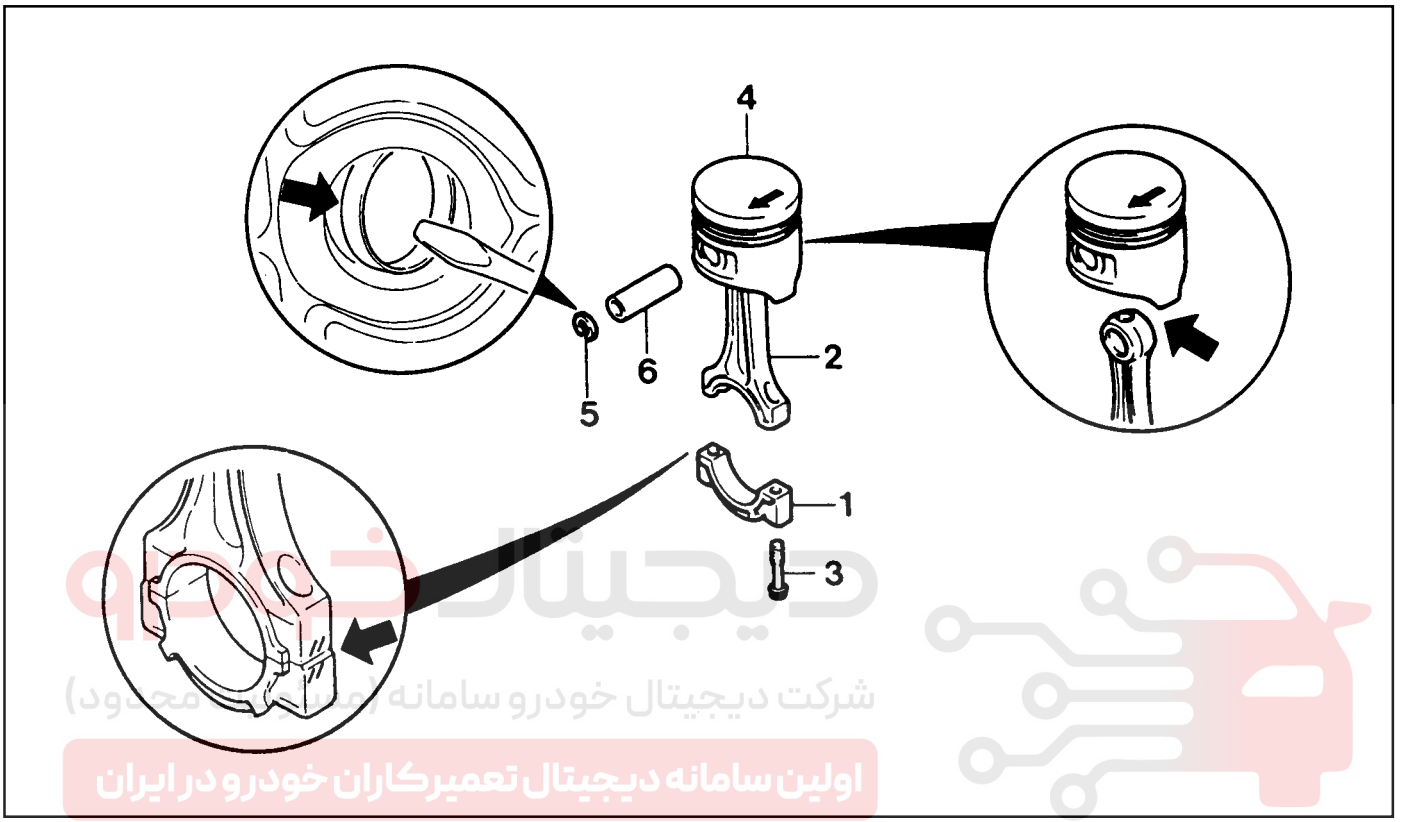
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PISTON

Preceding Work : Removal of engine
Removal of cylinder head
Removal of oil pan
Removal of oil pump
Removal of baffle plate



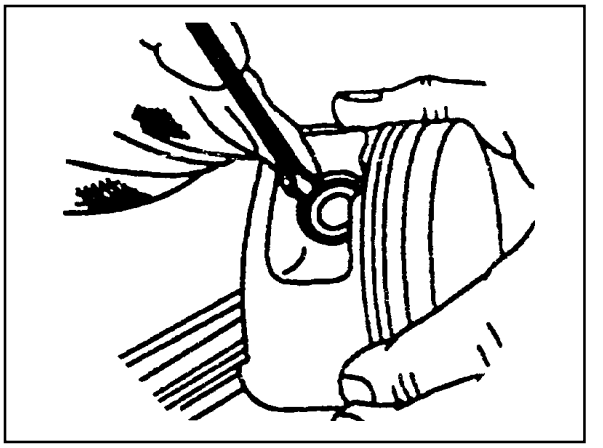
1 Connecting Rod Bearing Cap
2 Connecting Rod
3 Connecting Rod Bolt
(M9 x 52, 8 pieces) ..... 1st step 40 Nm
2nd step 90° +5°
4 Piston
5 Snap Ring
6 Piston Pin

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Tools Required

001 589 72 21 00 Torqued Wrench
000 589 04 14 00 Clamping Strap



Removal Procedure

1. Unscrew the connecting rod bolt (3) and remove the cap.
2. Remove the connecting rod and the piston upward.

   Notice

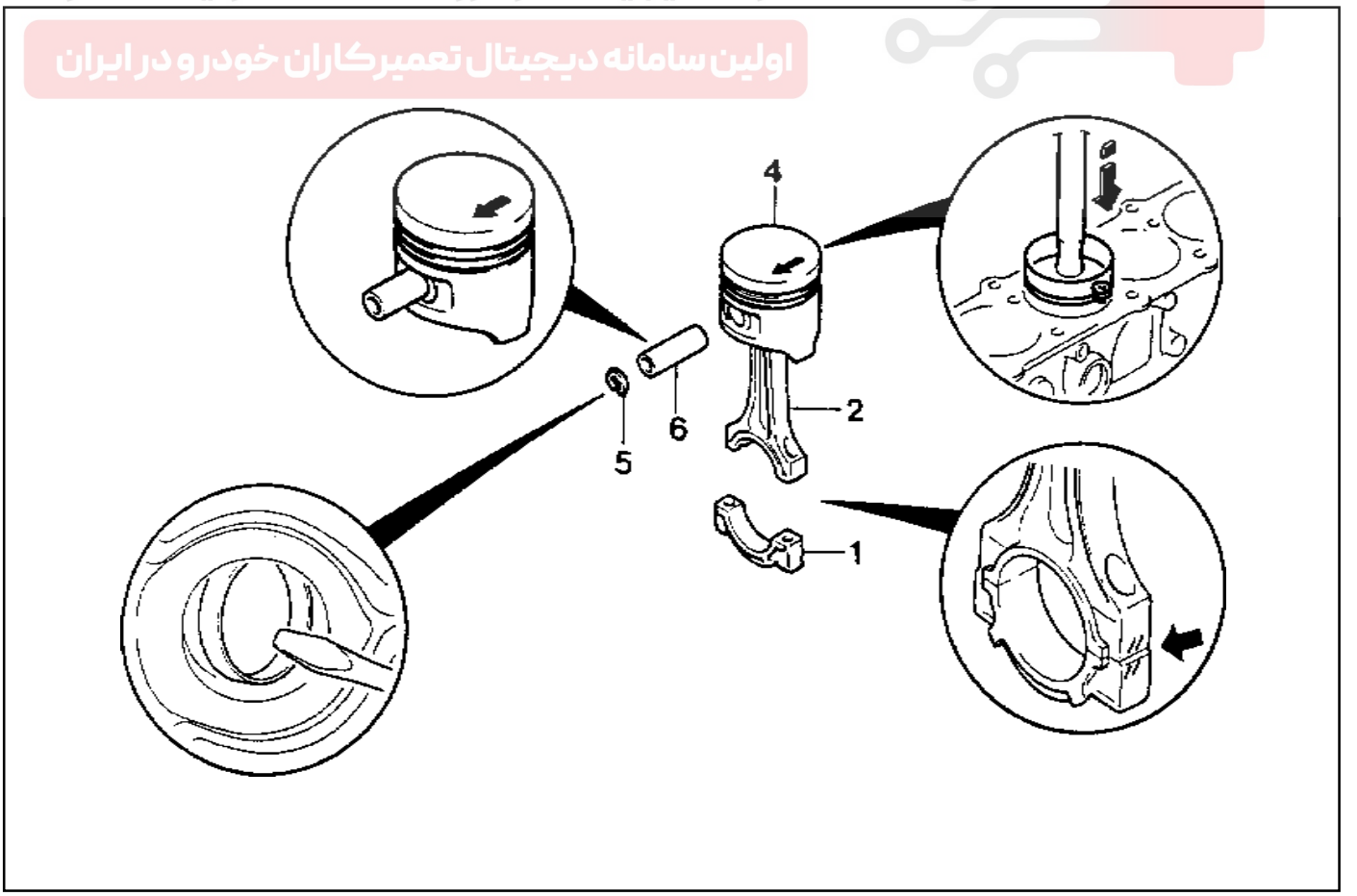
   Make sure that the bearing cap and shell are not changed each other.
3. Remove the snap ring (5) and pull out the piston pin (6).

   Notice

   Remove the snap ring using a clean cloth as shown in the right picture so that the piston, piston ring, and the snap ring don't get damaged.

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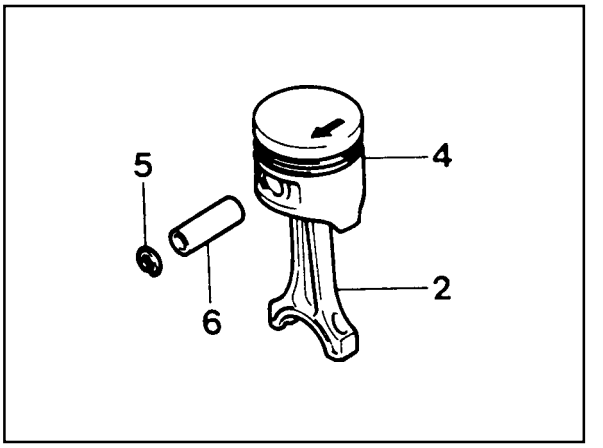
Installation Procedure



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1. Check the piston ring gap and apply the engine oil to the piston pin and the connecting rod bushing.
2. Connect the piston and the connecting rod by pressing in the piston pin (6) and install the snap ring to the groove.
3. Clean the cylinder bore, connecting rod bearing journal, connecting rod bearing shell and the piston and coat them with engine oil.
4. Install the piston ring using the tensioning strap(000 589 04 14 00).
5. Install the piston so that the arrow on the piston head faces to the forward of the vehicle.
6. After aligning the connecting rod and the bearing cap mark (// or a number), tighten the bolts.



Installation Notice

Tightening Torque	1st step 35 - 45 Nm 2nd step 90°+5°

Apply the engine oil to the bearing cap upper and lower bearing shells.

7. Check if the crankshaft rotates without any trouble by rotating it.

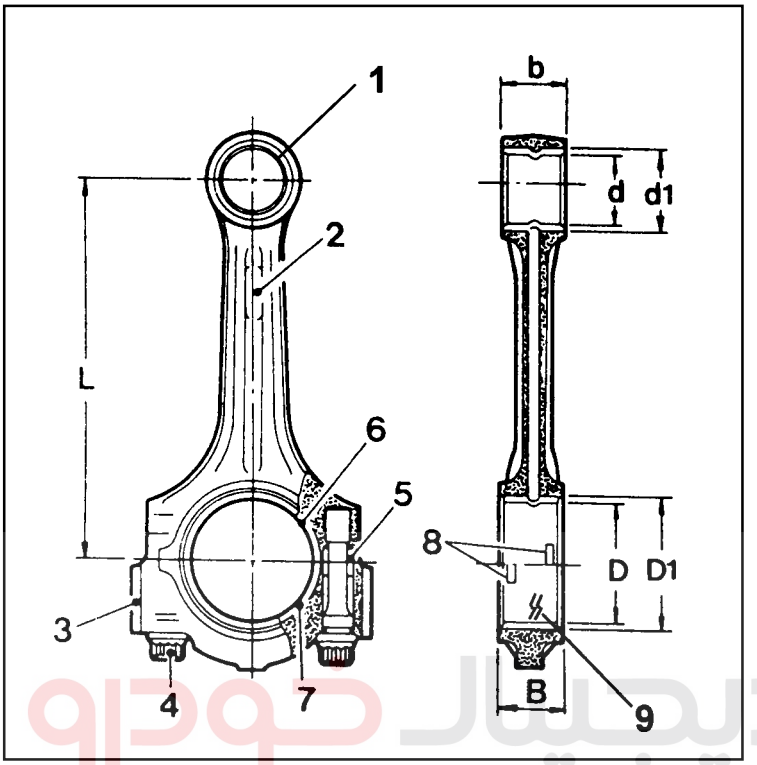
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CONNECTING ROD

Preceding Work : Removal of piston



1 Connecting Rod Bushing
2 Oil Gallery
3 Balance Weight
4 Connecting Rod Bolt
(M9 x 52, 8 pieces) ..... 1st step 40 Nm
2nd step 90°
5 Fit Sleeve
6 Upper Connecting Rod Bearing
7 Lower Connecting Rod Bearing
8 BearingShell Lug
9 Marking [Indication(//) or Numbers]

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Service Data Standard

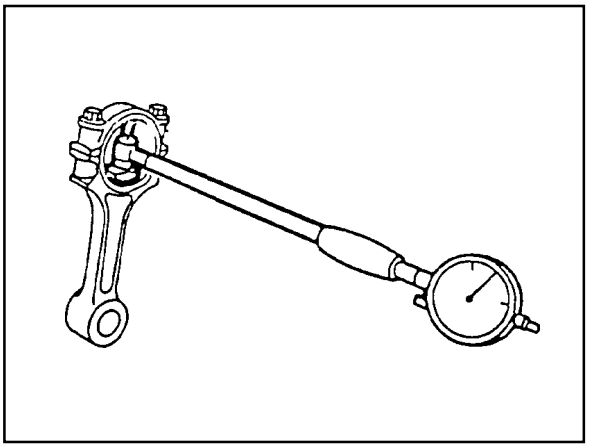
Distance (L) from The Connecting Rod Bearing to Bushing Bore Center	E20 : 154 mm E23 : 149 ± 0.05 mm
Width of The Connecting Rod (B) at Bearing Bore	21.940 - 22.000 mm
Width of The Connecting Rod (b) at Bushing Bore	21.940 - 22.000 mm
Basic Bore at The Bearing Shell (D1)	51.600 - 51.614 mm
Basic Bore at The Bushing (d1)	24.500 - 24.571 mm
Bushing Inner Diameter (d)	22.007 - 22.013 mm
Clearance Between The Piston Pin and The Bushing	0.007 - 0.018 mm
Peak-to-valley Height of Connecting Rod Bushing on Inside	0.005 mm
Permissible Wwist of Connecting Rod Bearing Bore to Connecting Rod Bushing Bore	0.1/100 mm
Permissible Deviation of Axial Paralleism of Connecting Rod Bearing Bore to Connecting Rod Bushing Bore	0.045/100 mm
Permissible Deviation of Axial Paralleism of Connecting Rod Bearing Bore from Concentricity	0.01 mm
Permissible Difference of Each Connecting Rod in Weight	0.4 g

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Inspection

1. Measure the basic bore of the connecting rod bearing.

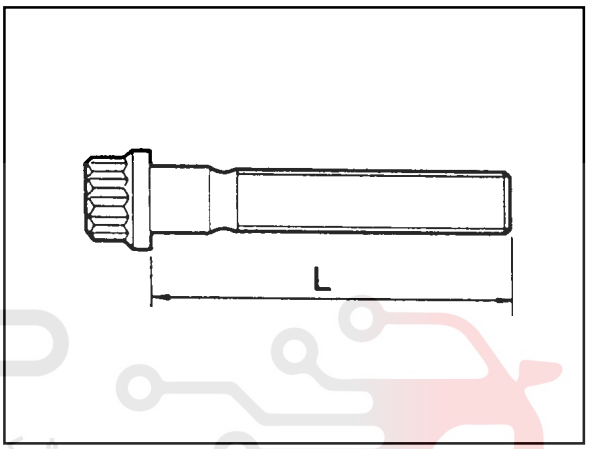


Notice

If the basic bore exceeds the value of 51.614mm, replace the bearing or check the connecting rod.

2. Check connecting rod bolts.

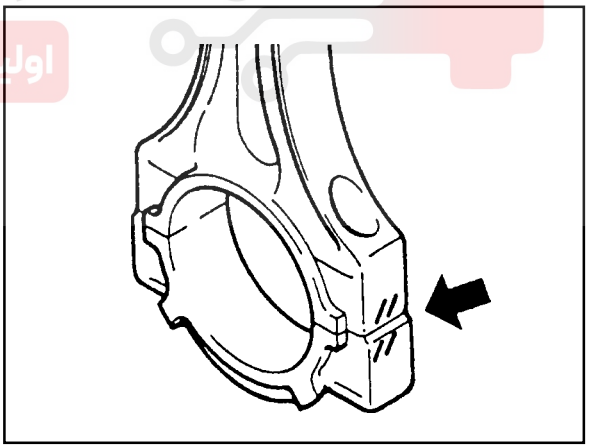
Length When New (L)	51.7 - 52 mm
Max. Length (L)	52.9 mm
Tightening Torque	1st step 40 + 5 Nm
	2nd step 90°+10°



Notice

If the length exceeds max. length, replace it.

3. Check the assembly mark(indication//or number:arrow) of the connecting rods and the bearing cap when installing.



Notice

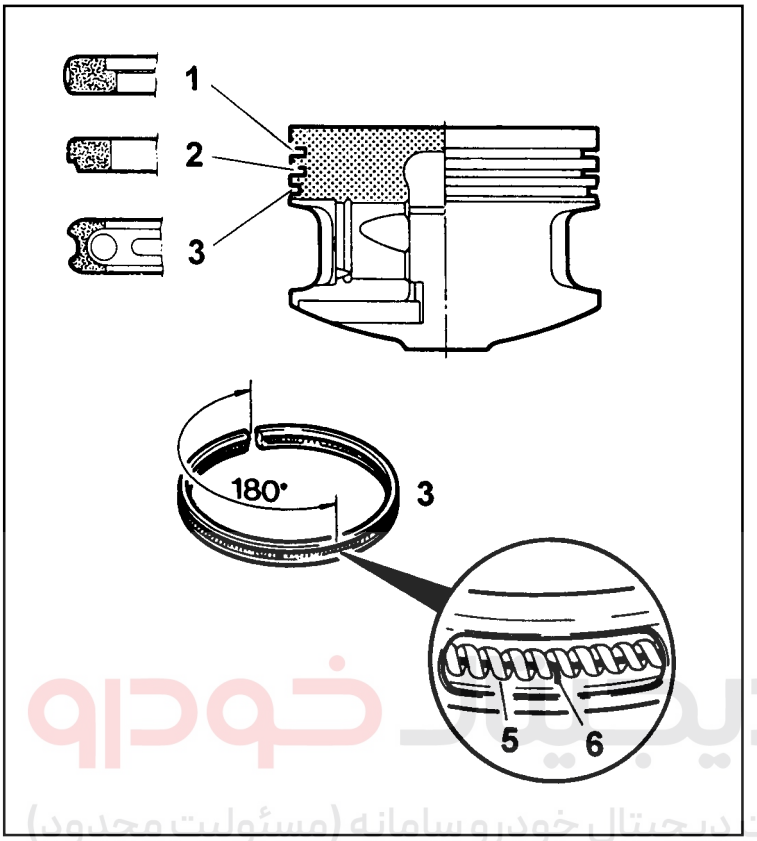
- Make sure it doesn't exceed over 4g with other connecting rods when replacing the connecting rods.
- Check if the connecting rod and the bearing cap are accurately seated on the groove when replacing the bearing.

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PISTON RING

Preceding Work : Removal of piston



1 Piston Compression Ring (Top Ring)
2 Piston Compression Ring (2nd Ring)
3 Piston Oil Ring
4 -
5 Spacer
6 Side Rail

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Tools Required

000 589 51 37 00 Clamping Strap

Replacement Procedure

1. Measure the piston ring's gap.

End Gap of The Piston Ring	Groove 1 0.20 - 0.40 mm
	Groove 2 0.20 - 0.40 mm
	Groove 3 0.20 - 0.45 mm
Gap Between The Piston and The Piston Ring	Groove 1 0.028 - 0.060 mm
	Groove 2 0.010 - 0.045 mm
	Groove 3 0.010 - 0.045 mm

Notice

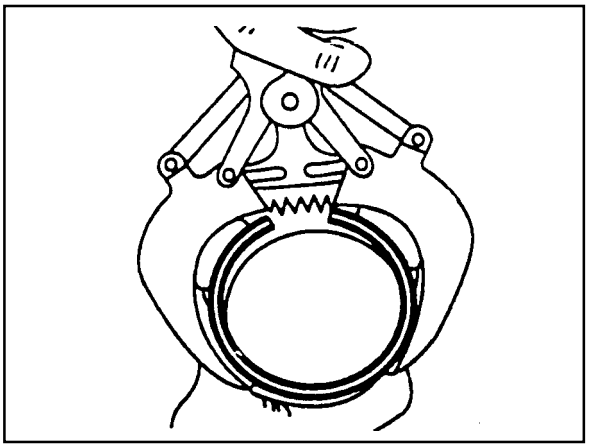
If out of specification, replace the piston ring.

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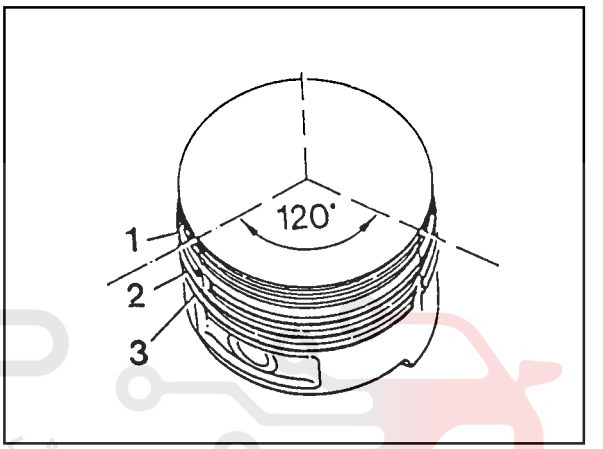
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2. Remove the piston ring with a pliers.

Clamping Strap 000 589 51 37 00



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.
4. Adjust the hook spring joint in the oil ring 180° away from the ring end.

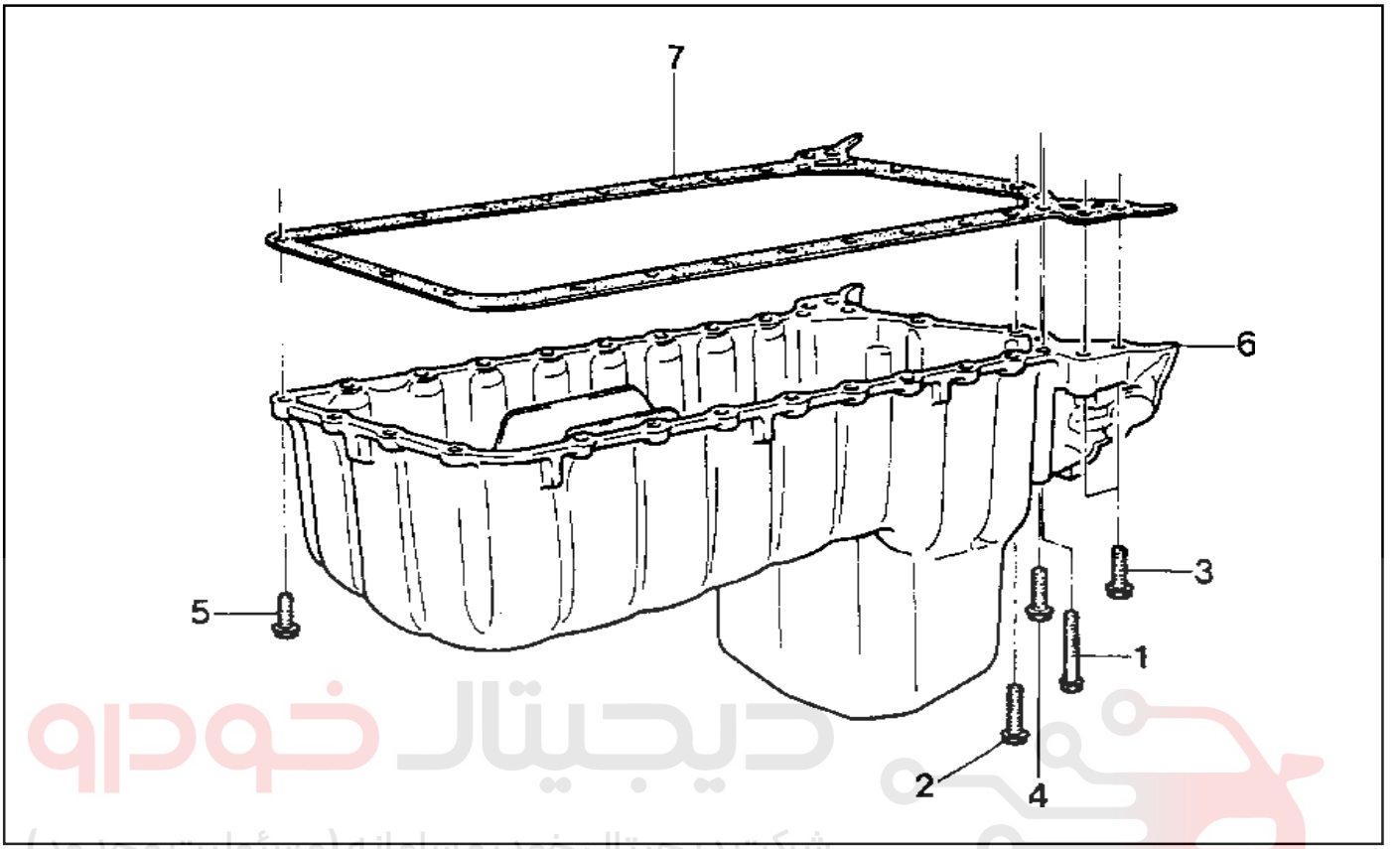


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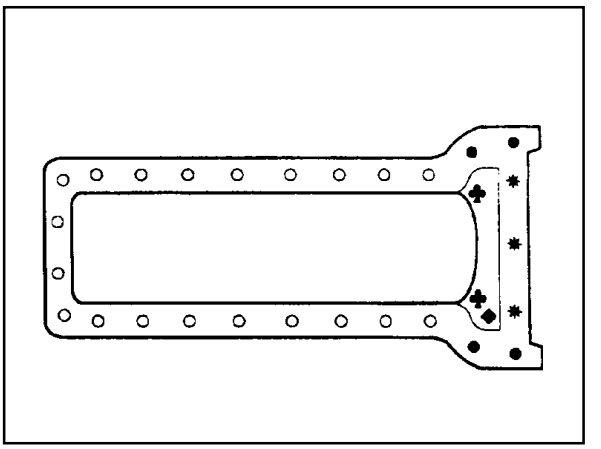
OIL PAN



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1 Bolt
2 Bolt
3 Bolt
4 Bolt
5 Bolt
6 Oil Pan
7 Gasket

1. Remove the drain plug and drain the oil completely.
2. Unscrew the bolts and remove the oil pan and gasket.
   Notice
   Arrange the bolts according to each size.
3. Clean the inside of oil pan and sealing surface, then apply the sealant.
4. Replace the gasket with new one.
5. Install the oil pan with gasket, and tighten each bolt in specified torque.
6. Check for oil leaks while running the engine.

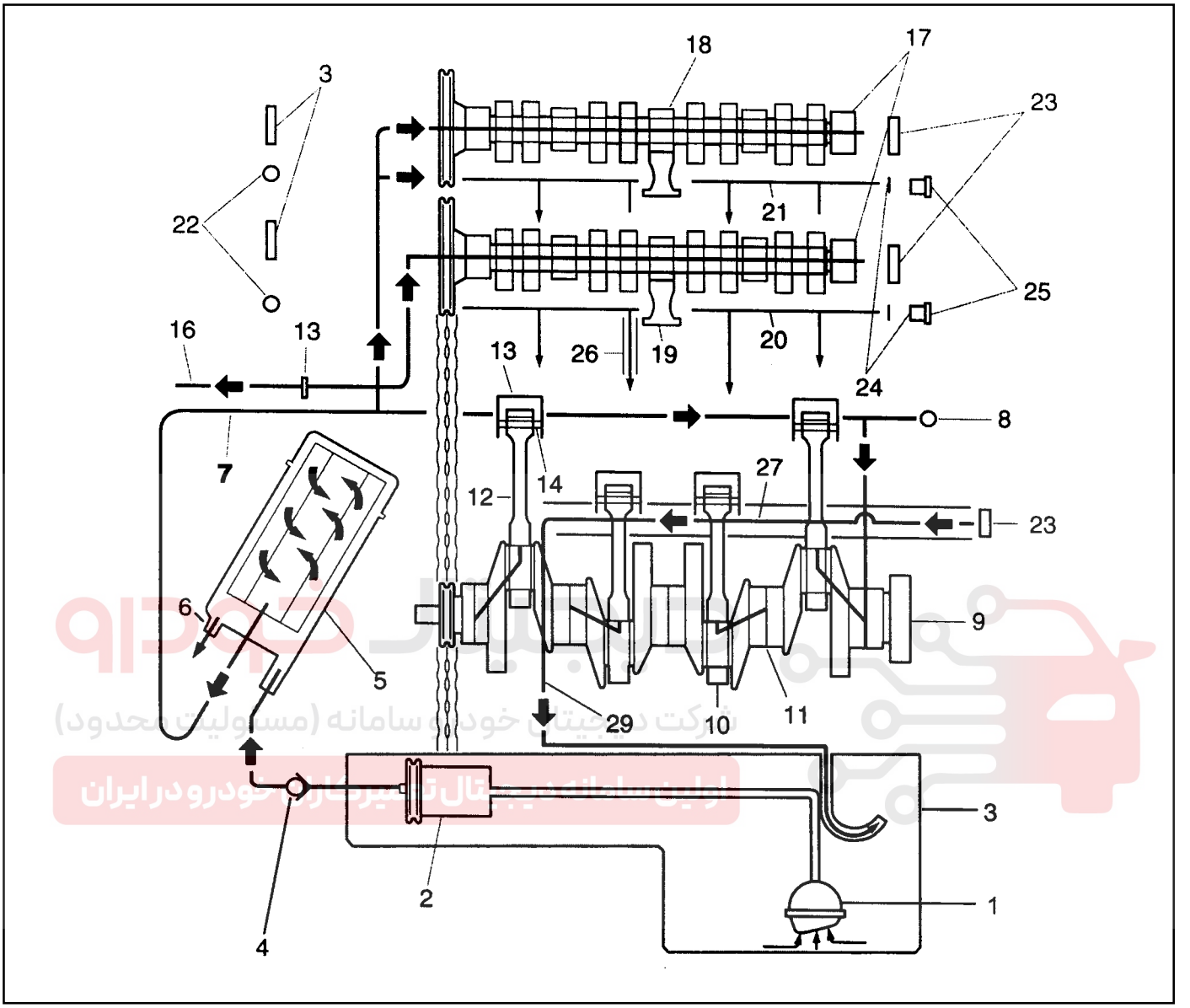


○ M8 X 40, 4 pieces
● M6 X 35, 1 pieces
♣ M6 X 100, 2 piece
★ M6 X 85, 3 pieces
◆ M6 X 20, 20 pieces

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Oil Circulation

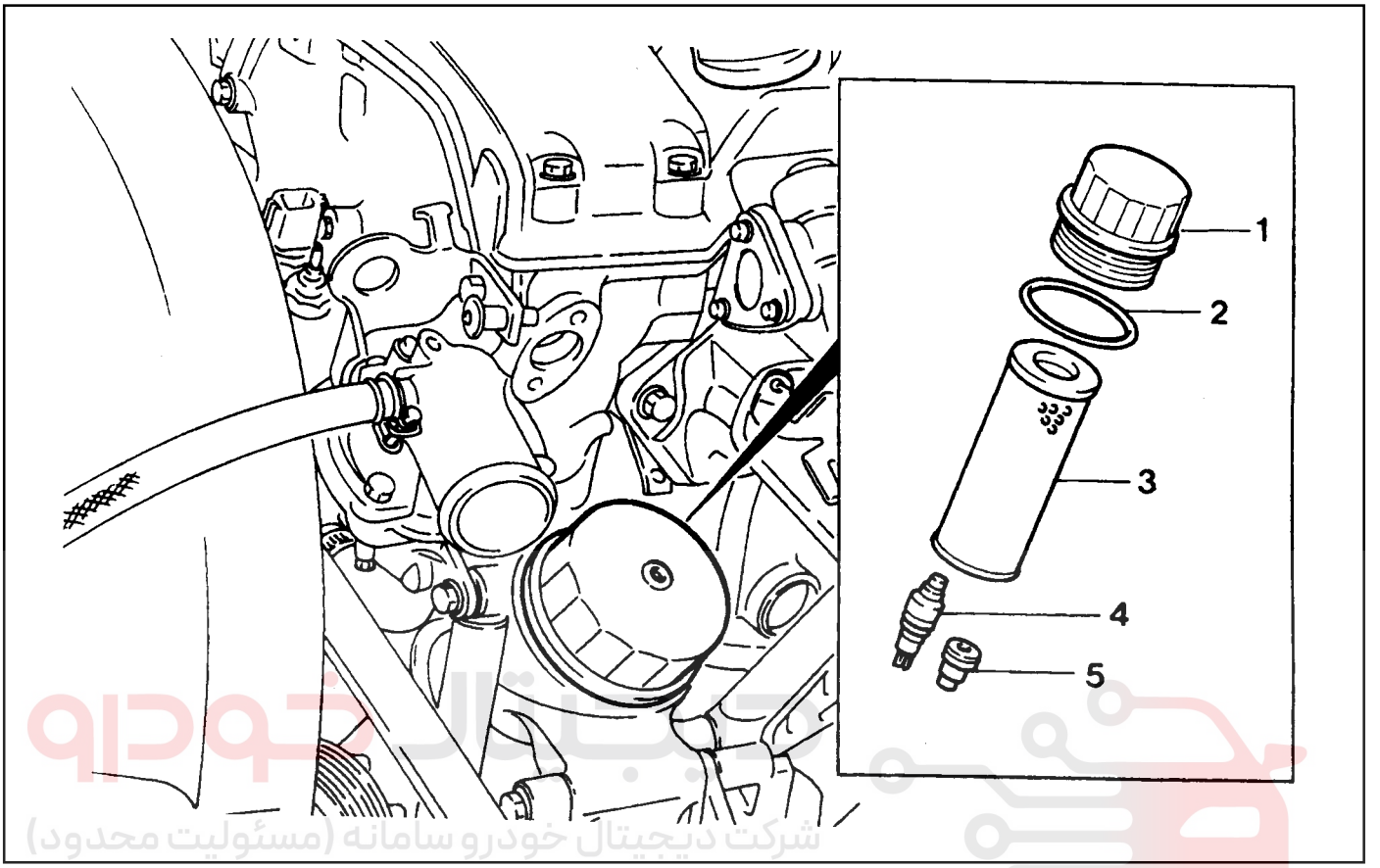


1 Oil Strainer
2 Oil Pump
3 Oil Pan
4 Oil Non-Return Valve
5 Oil Filter
6 Oil Filter Bypass Valve
7 Main Oil Gallery
8 Closing Ball (ƒ15mm)
9 Crankshaft
10 Connecting Rod Bearing
11 Crankshaft Bearing
12 Connecting Rod
13 Piston
14 Oil Spray (Piston Crown Area)
15 Non-Return Valve (Crankcase)
16 Oil Supply (To Chain Tensioner)
17 Camshaft
18 Cam Bearing
19 Valve
20 Oil Gallery (Supply Oil to Intake Tappet)
21 Oil Gallery (Supply Oil to Exhaust Tappet)
22 Ball (ƒ8mm)
23 Camshaft Plug
24 Seal
25 Screw Plug
26 Oil Return Gallery (Cylinder Head and Crankcase)
27 Oil Return Gallery (Crankcase)
28 End Cover (ƒ 20mm)
29 Oil Return Pipe

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ENGINE OIL AND OIL FILTER ELEMENT



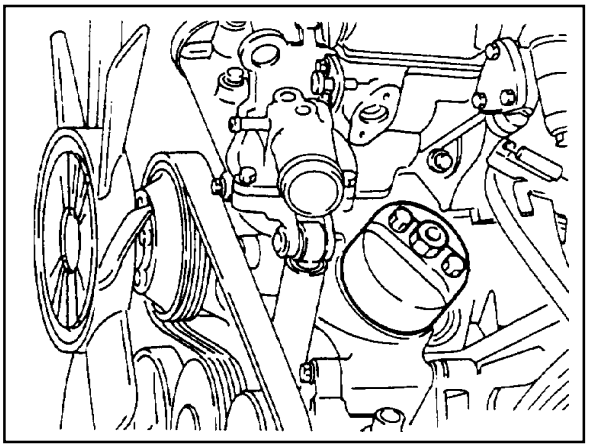
1 Oil Filter Cover ..... 25 Nm
2 O-ring ..... Replace
3 Oil Filter Element
4 Oil Drain Plug
5 Oil Filter Bypass Valve
6 Oil Filter Cap

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Tools Required

103 589 02 09 00 Oil Filter Socket Wrench



Replacement Procedure

1. Install the socket wrench"7" (special tool : 103 589 02 09 00) on the oil filter cover (2).

   Notice

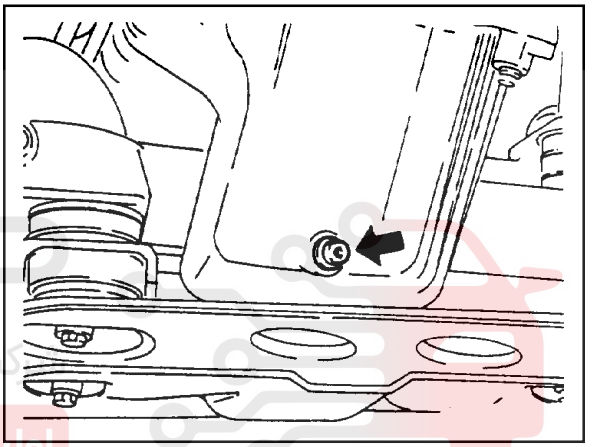
   Make the screw cover removable by tightening the bolt at the side of the socket wrench (special tool).
2. Install the wrench to the upper bolt in the socket wrench and remove the oil cover by turning it.
3. Remove the oil filter element.

   Notice

   Work with a cloth under the vehicle when removing the oil filter element to not drain the oil.
4. Remove the drain plug (1) and drain the engine oil.

   Notice

   Leave the oil filler cap (3) open to ease the engine oil discharge.



5. Tighten the engine oil drain plug after cleaning it.

   Installation Notice

Tightening Torque	25 Nm

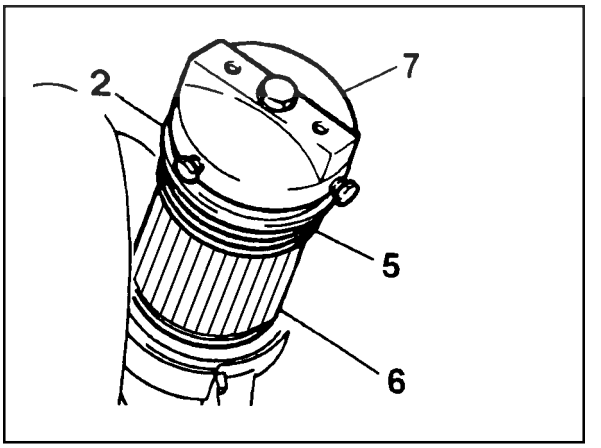
   Replace the seal washer with new one.
6. Replace the O-ring(5) in the oil filter cover with new one.

   Notice

   Apply the engine oil to the O-ring.
7. Insert new oil filter element into the oil filter housing.
8. Temporarily tighten the oil filter cover (2). Install the socket wrench "7" (special tool : 103 589 02 09 00), and then completely tighten it.

   Installation Notice

Tightening Torque	25 Nm



2 Oil Filter Cover
5 O-ring
6 Oil Filter Element
7 Special Tool (Socket Wrench)

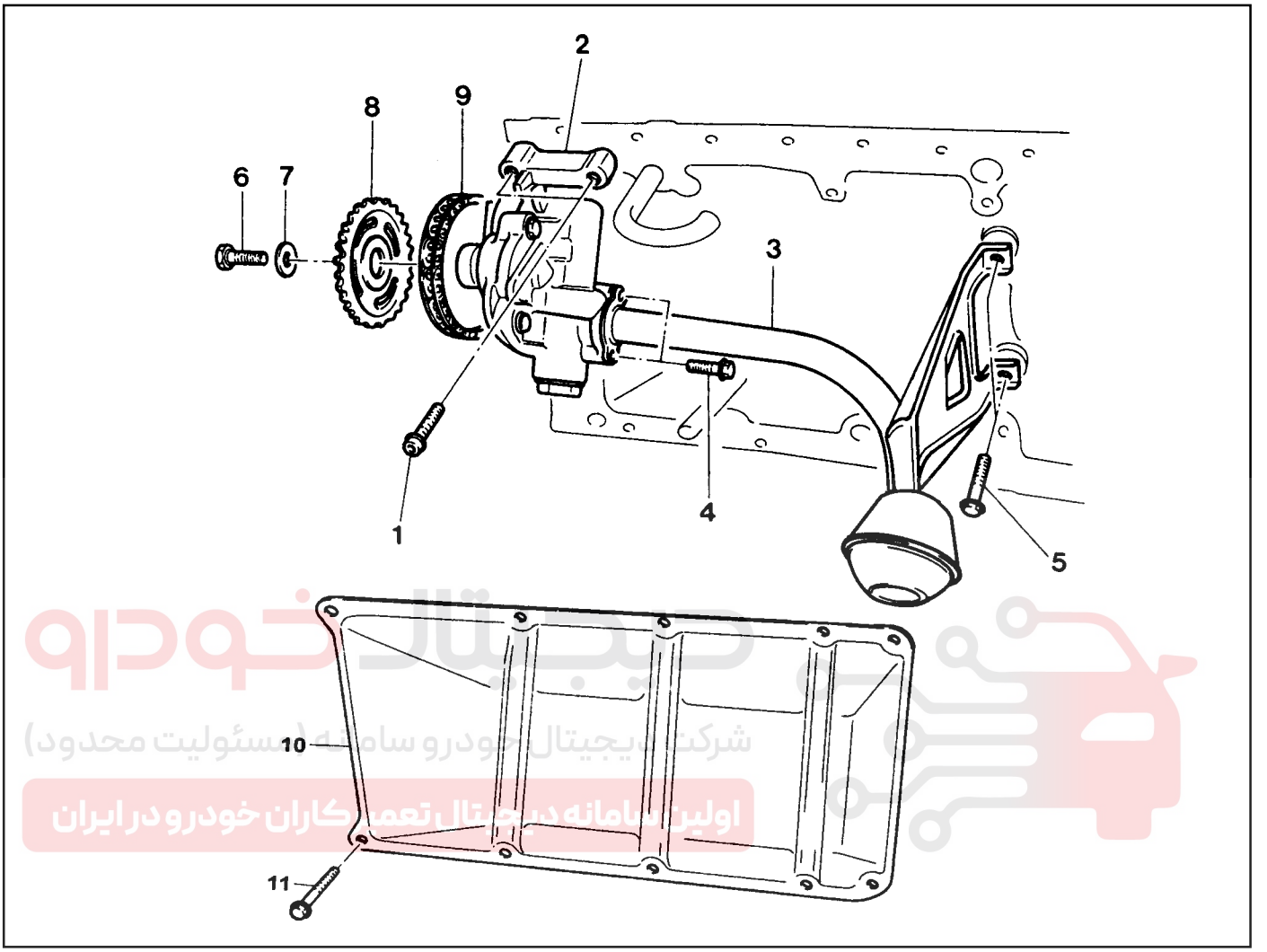
9. Fill up engine oil through the engine oil filler opening.
10. Check for oil leaks at normal engine temperature after starting the engine.
11. Stop the engine and wait 5 minutes.
    Check the oil level and fill up as specified if necessary.

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OIL PUMP

Preceding Work : Removal of oil pan



1 Bolt (M8 X 35, 3 piece) ..... 22.5-27.5 Nm
2 Oil Pump
3 Oil Strainer Assembly
4 Bolt (M6 X 12, 2 pieces) ..... 9-11 Nm
(In E23 Engine, These Bolts are Combined with Baffle Plate)
5 Bolt (M8 X 20, 1 pieces) ..... 29-35 Nm
6 Washer
7 Sprocket (Oil Pump Drive)
8 Chain (Oil Pump Drive)
9 Plate-Baffle
10 Bolt (M6 X 12, 6 piece) ..... 9-11 Nm
(E23 Engine Only : Baffle Plate Mounting Bolt)

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Removal & Installation Procedure

1. Unscrew the bolt (6) from the oil pump drive sprocket and separate the oil pump drive chain.

   Installation Notice

Tightening Torque	29 - 35 Nm

2. Unscrew the bolts (4,5) and remove the oil strainer assembly (3).

   Installation Notice

Tightening Torque	Bolt (4) 9 - 11 Nm
	Bolt (5) 9 - 11 Nm

   Insert the steel gasket into the oil pump and bolt (4) mounting surface.

3. Unscrew the six bolts (11) and remove the haffle plate.

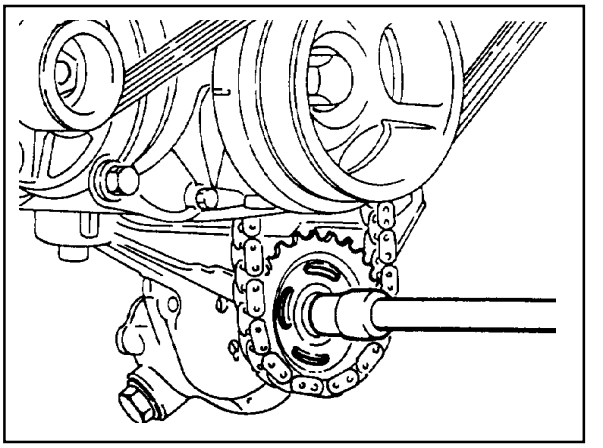
   Installation Notice

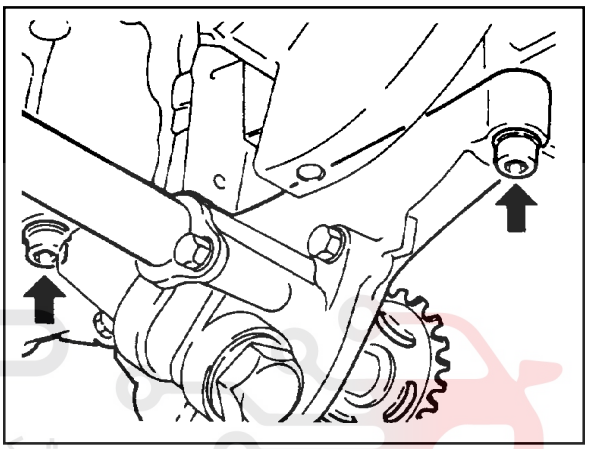
Tightening Torque	9 - 11 Nm

4. Unscrew the three bolt (1) and remove the oil pump.

   Installation Notice

Tightening Torque	22.5 - 27.5 Nm





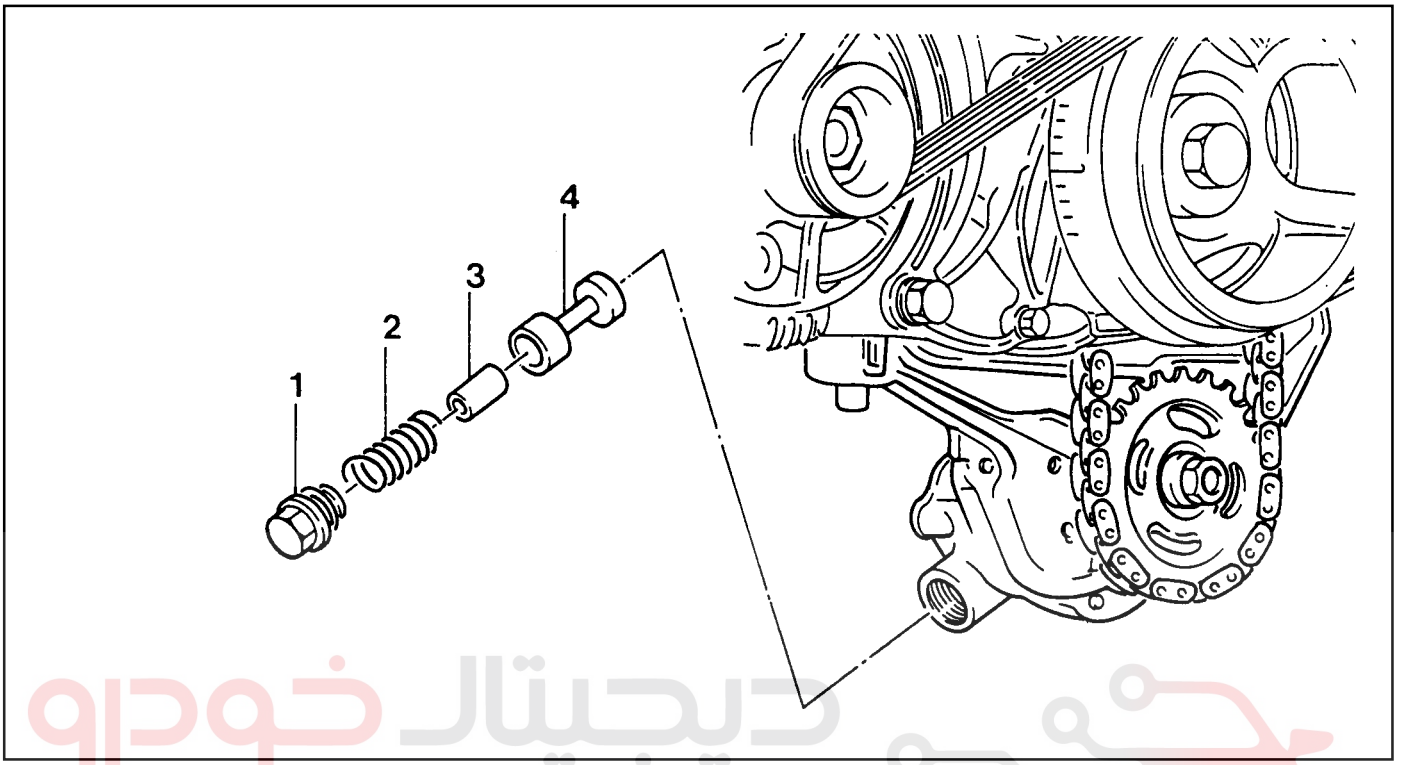
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OIL PRESSURE RELIEF VALVE

Preceding Work : Removal of oil pan



1 Screw Plug ..... 50 Nm
2 Compression Spring
3 Guide Pin
4 Piston

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Removal & Installation Procedure

1. Remove the screw plug (1).

Installation Notice

Tightening Torque	50 Nm

2. Remove the spring (2), guide pin (3) and the piston (4).
3. Installation should follow the removal procedure in the reverse order.

Notice

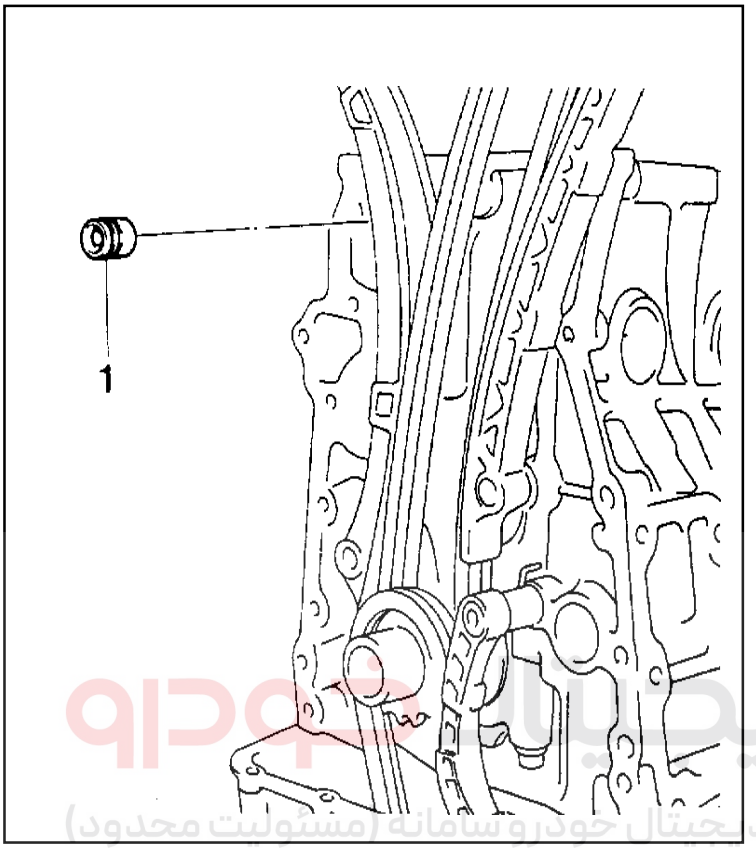
Don't use the seal for the screw plug.

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OIL NON-RETURN VALVE

Preceding Work : Removal of timing gear case cover



1 Oil Non-Return Valve

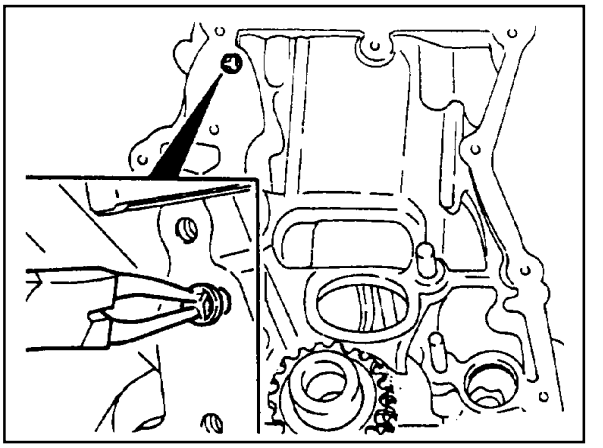
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Functions

The non-return valve prevents the oil in the chain tensioner from drying up. In other words, it stops oil-returning in order to prevent the oil in the chain tensioner from getting dry. As a result, the chain tensioner can be activated with oil in itself.

Replacement Procedure

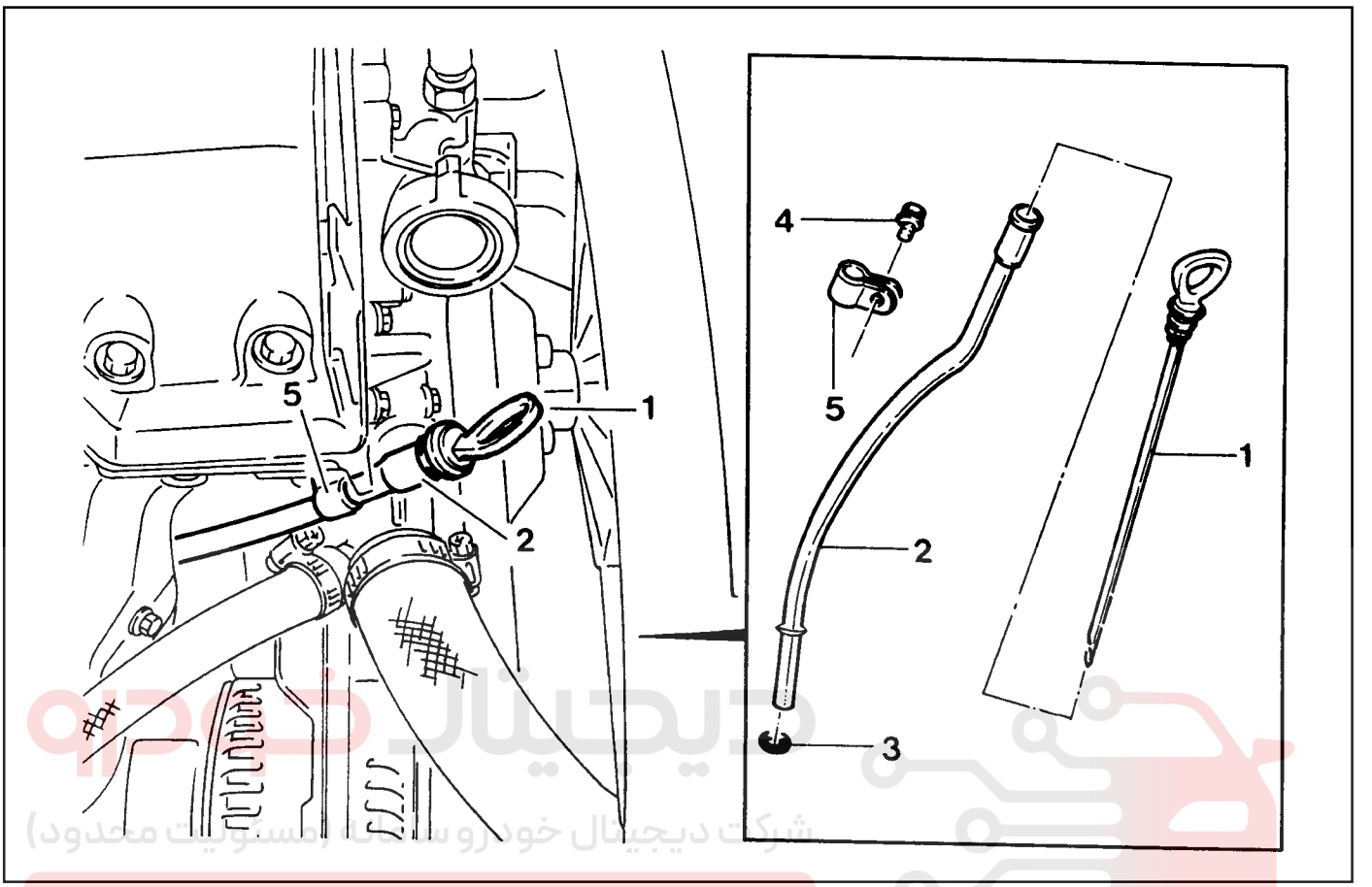
1. Remove the non-return valve using a pliers.
2. Insert new non-return valve with hand.



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OIL DIPSTICK GUIDE TUBE



1 Oil Dipstick Level Gauge
2 Oil Dipstick Guide Tube
3 O-ring
4 Bolt (M6 X 16, 1 piece) ..... 9-11 Nm
5 Clamp

Removal & Installation Procedure

1. Pull out the oil dipstick level gauge (1).
2. Unscrew the bolt (4) and remove the oil dipstick guide tube (2).

Installation Notice

Tightening Torque	9 - 11 Nm

It is very hard to remove the oil dipstick guide tube without special tool. If it is not necessary, do not remove the guide tube.

3. Installation should follow the removal procedure in the reverse order.
4. Check for leaks by starting the engine.

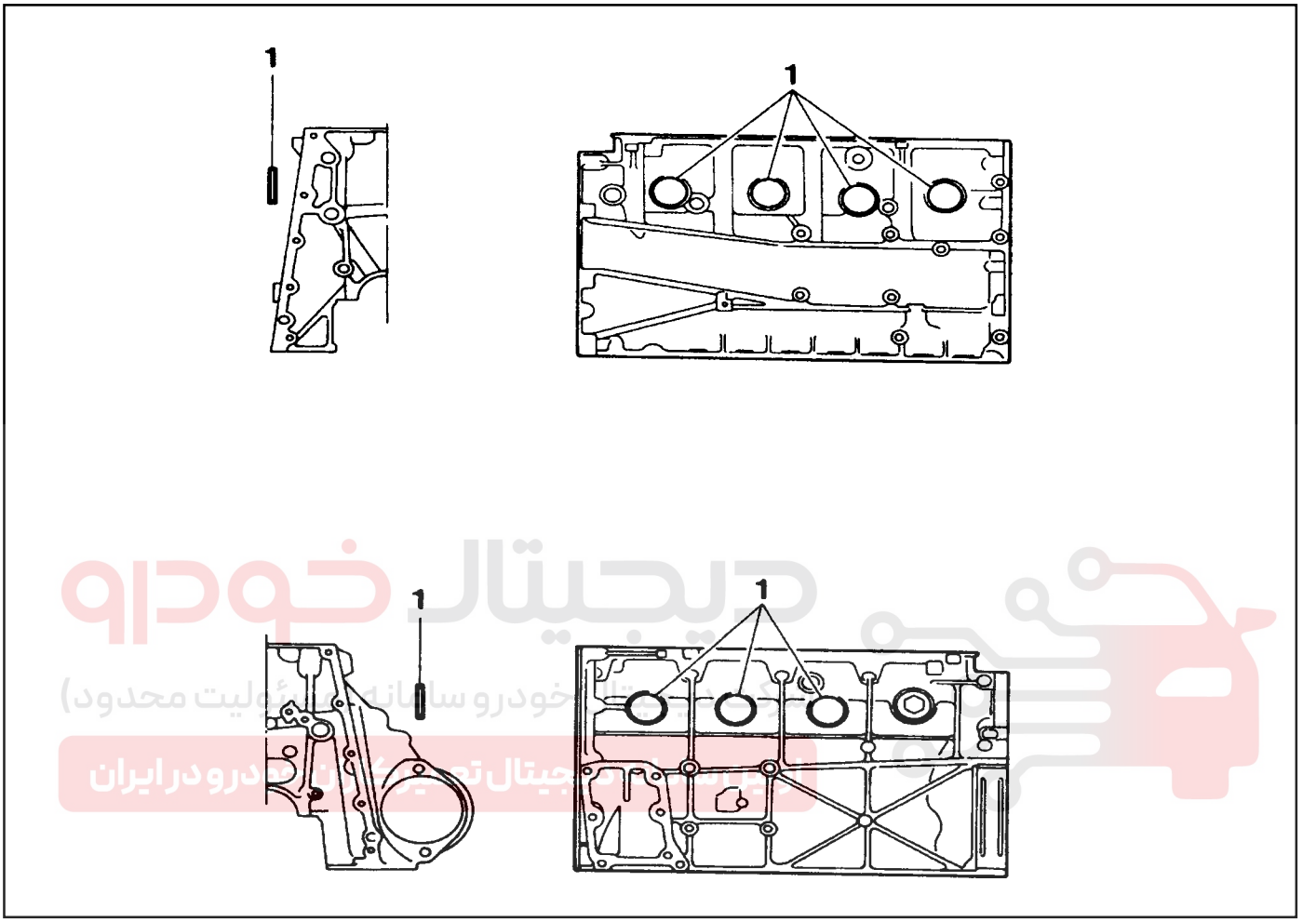
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UNIT REPAIR

CORE PLUGS IN CRANKCASE

Preceding Work : Draining of the coolant



1 Core Plug ..... Replace

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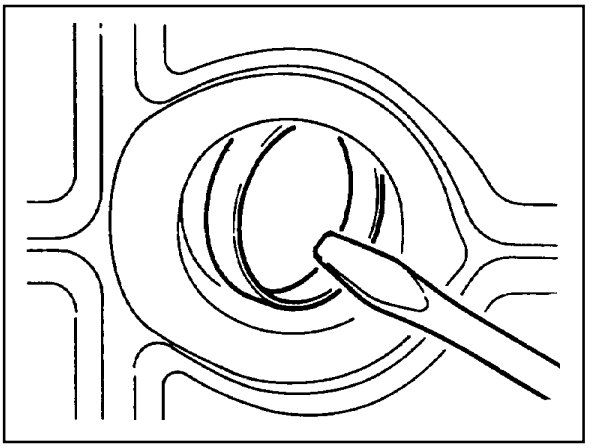
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Tools Required

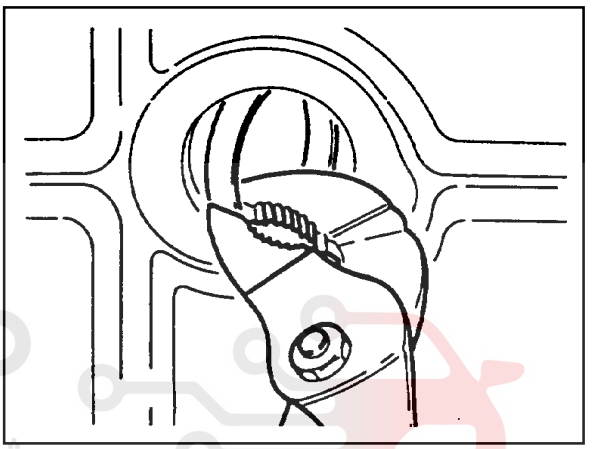
102 589 00 15 00 Drift

Replacement Procedure

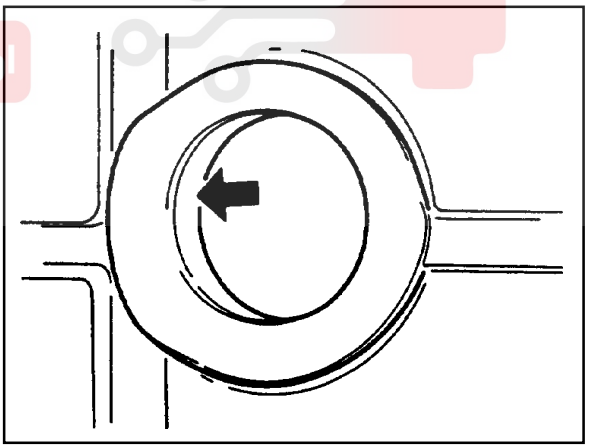
1. Remove the intake and exhaust manifolds.
2. Pull back the core plug until the end of one side comes out using the screw driver.



3. Pull out the plug carefully using a pliers.



4. Clean the sealing surface and apply Loctite 241.

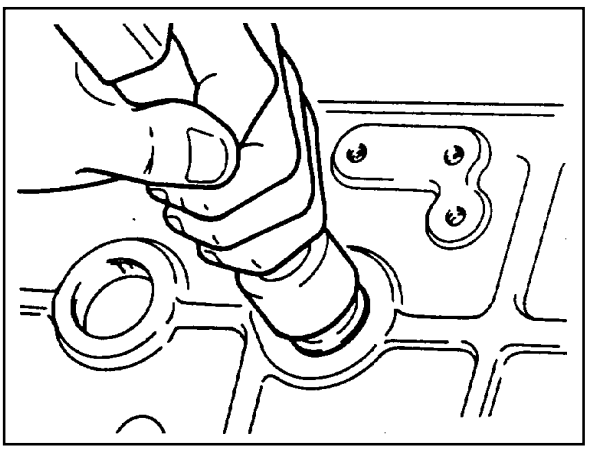


5. Press in new plug using a drift.

   Notice

   Wait for about 45minutes before filling the coolant so that the Loctite 241 hardens.

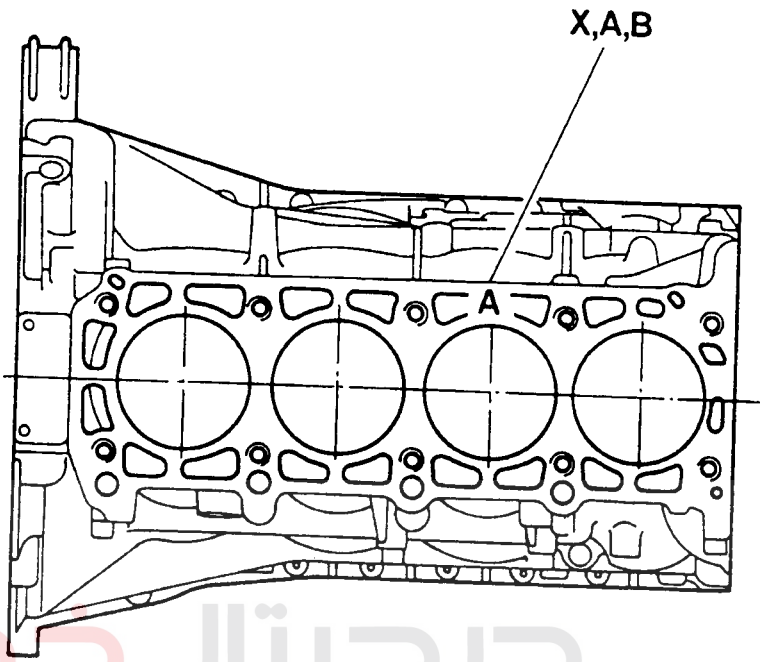
6. Warm up the engine and check the coolant for leaks.



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CYLINDER BORE



Group Code Letter and Cylinder Bore Size

Engine	Group Code Letter of Cylinder	Piston Type to be Used	Cylinder Bore Size (mm)
E23	A	A or X	ƒ90.906 - ƒ90.912
	X	A, X or B	ƒ90.906 - ƒ90.912
	B	X or B	ƒ90.912 - ƒ90.918
	X + 5	X + 5	ƒ90.950 - ƒ90.968
	X + 10	X + 10	ƒ91.000 - ƒ91.018
E20	A	A or X	ƒ89.900 - ƒ90.906
	X	A, X or B	ƒ89.906 - ƒ89.912
	B	X or B	ƒ89.912 - ƒ89.918
	X + 5	X + 5	ƒ89.950 - ƒ89.968
	X + 10	X + 10	ƒ90.000 - ƒ90.018

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Type	Group Code Letter[1)]	Cylinder Bore Size (mm)
Standard Size E20 : ⌀89.9 E23 : ⌀90.9	A	⌀89.900 - ⌀90.906
	X	⌀89.906 - ⌀89.912
	B	⌀89.912 - ⌀89.918
1st Repair Size (Standard Size + 0.25)	A	⌀90.150 - ⌀90.156
	X	⌀89.156 - ⌀90.162
	B	⌀90.162 - ⌀90.168
2nd Repair Size (Standard Size + 0.5)	A	⌀90.400 - ⌀90.406
	X	⌀90.406 - ⌀90.412
	B	⌀90.412 - ⌀90.418

[1)] The group code letters are carved on the surface of the piston crown and in the mating surface of the crankcase.

Service Data Standard

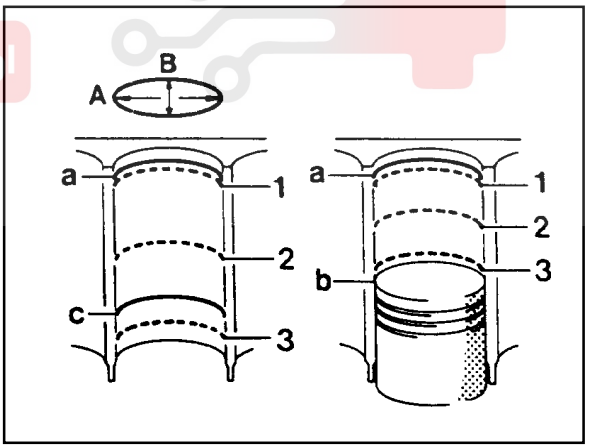
Wear Limit in Longitudinal and Transverse Direction		0.1 mm
Permissible Deviation of Cylinder Out-of-round	When new	0.007 mm
	Wear limit	0.05 mm
Permissible Deviation of Rectangular Cylinder Height (Except Chamfered Area)		0.05 mm
Basic Peak-to-valley Height After Final Honing and Brushing		0.003 - 0.006 mm
Chamfer Angle		75°
Honing Angle		50° ± 10°

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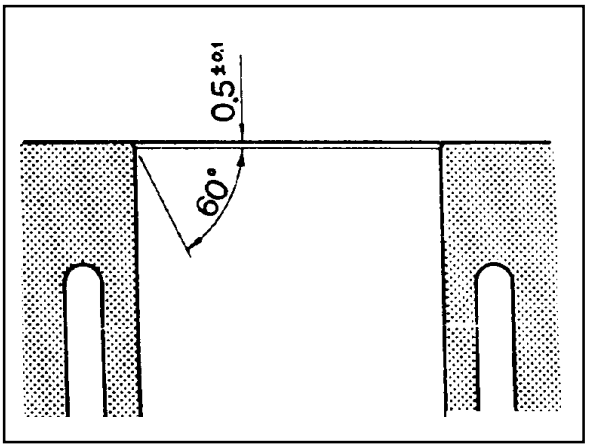
Measurement of Cylinder Bore

1. Clean the cylinder wall.
2. Using a internal diameter gauge, measure the bore size in axial and transverse direction at three points (1,2,3).

1,2,3 Measuring Points
A. Axial Direction
B. Transverse Direction
a. Location of the No.1 Piston Ring at TDC
b. Location of the Piston BDC
c. Location of the Oil Ring at BDC



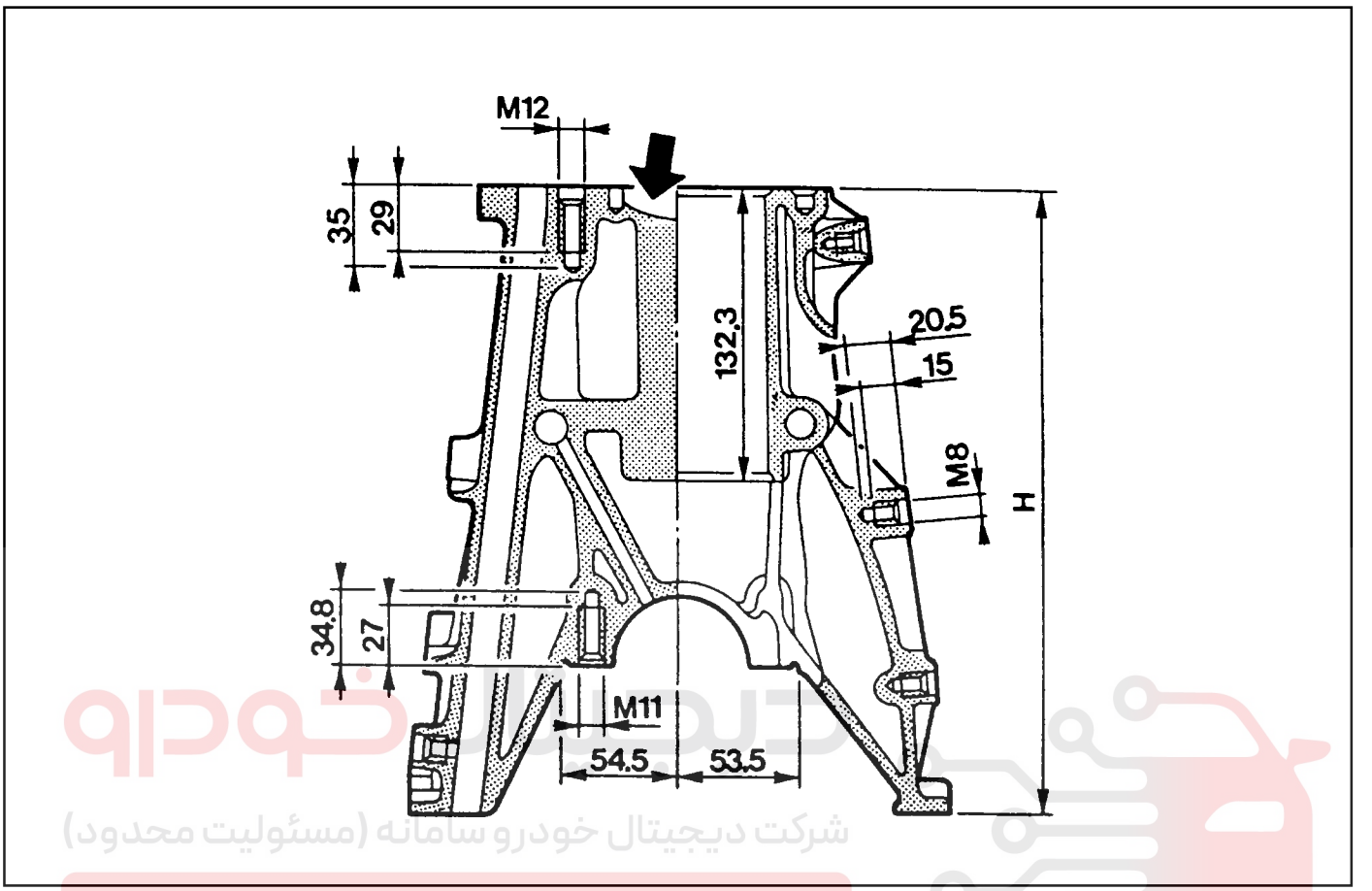
Chamfer Angle



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CRANKCASE MATING SURFACE



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Service Data Standard

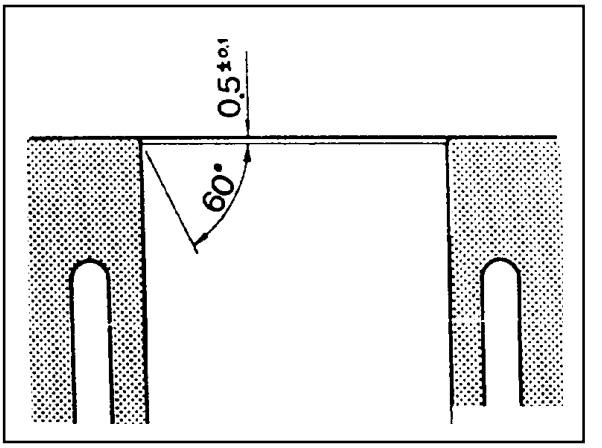
Height of the Crankcase “H” (When New)		289.35 - 289.45mm
Minimum Height After Milling		289.05mm
Flatness	Crankcase Upper Mating Surface	0.03mm
	Crankcase Lower Mating Surface	0.04mm
Permissible Deviation of Parallelism of the Upper to Lower Mating Surface	Axial Direction	0.1mm
	Transverse Direction	0.05mm
Peak-to-valley Height	Crankcase Upper Mating Surface	0.012 - 0.009mm
	Crankcase Lower Mating Surface	0.025 - 0.020mm

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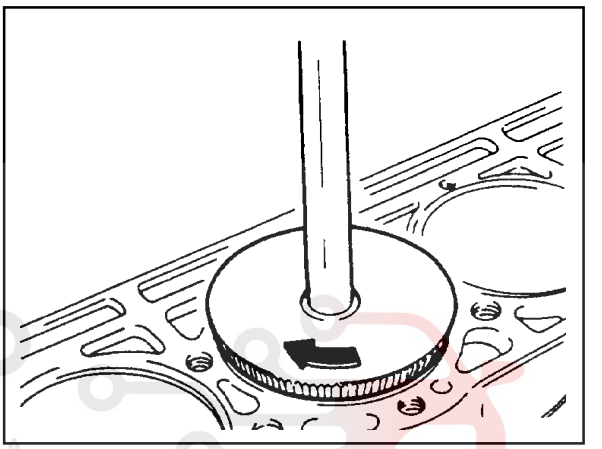
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Chamfering Procedure

1. Chamfer angle : 75°



2. Polish the lower chamfered area evenly with a grinder after finishing the chamfering with a suitable tool (e.g., hand milling cutter).



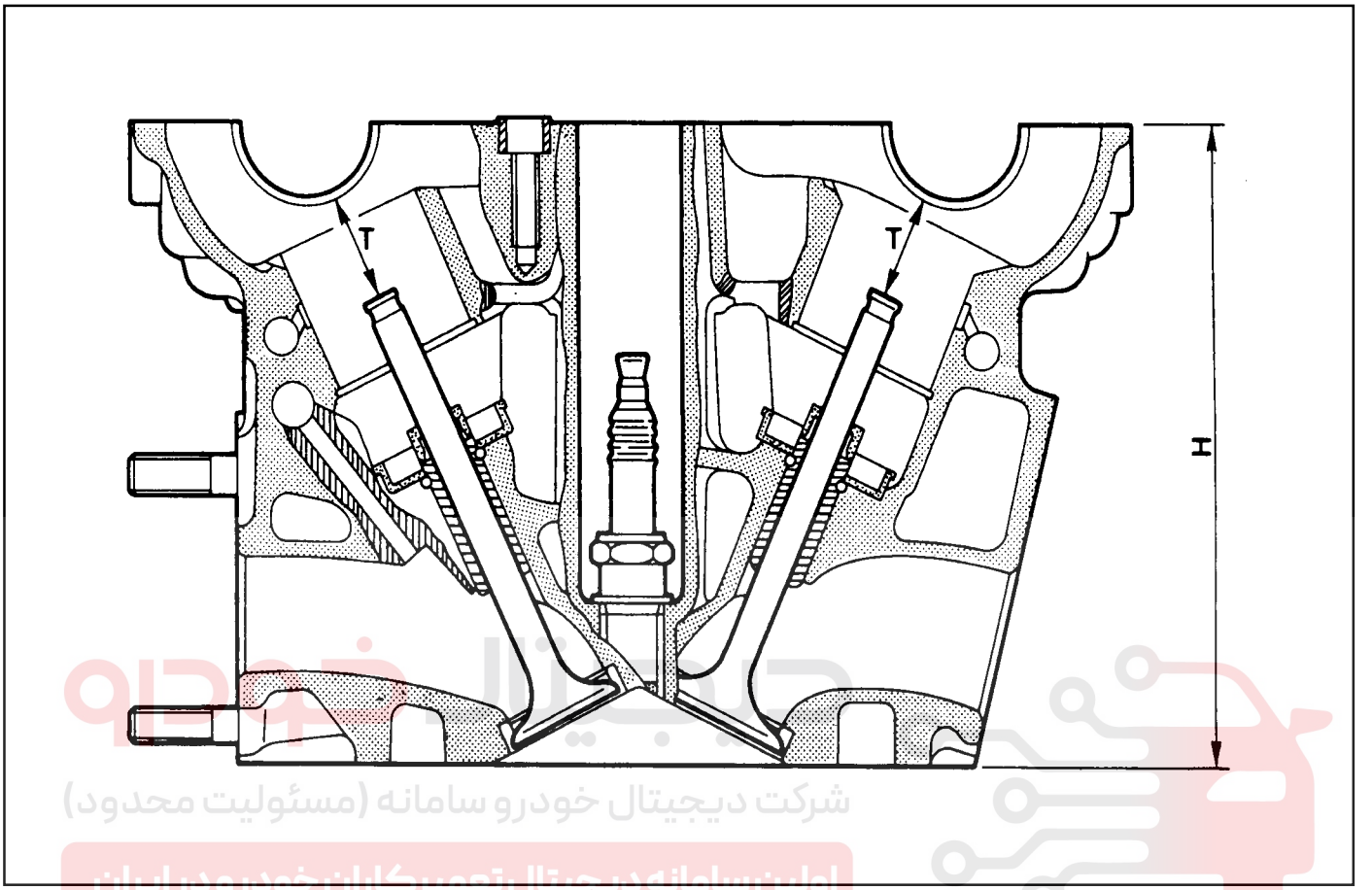
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CYLINDER HEAD MATING SURFACE

Preceding Work : Removal of valves



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Service Data Standard

Overall Height of Cylinder Head			135.9 - 136.0 mm
Minimum Height After Machining			135.5 mm
Flatness	Axial Direction		0.08 mm
	Transverse Direction		0.0 mm
Distance 'T' (Between Camshaft Bearing and Valve Stem)	Standard Size	Intake	24.21 - 24.75 mm
		Exhaust	22.21 - 22.75 mm
	Repair Size	Intake	23.96 - 24.51 mm
		Exhaust	21.96 - 22.51 mm

Notice

Do not exceed 0.4mm for the milling of the mating surface of crankcase and cylinder head.

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Measurement of Mating Surface

1. Measure the height (H) of the cylinder head (refer to *Service data standard*).
2. Check the mating surface of the cylinder head.
3. Mill the sharp edge of the combustion chamber.
4. Re-measure the height (H) of the cylinder head.
5. Seal the intake and exhaust valves.
6. Measure the dimension (T) between the camshaft bearing and the valve system (refer to *Service data standard*).
7. Mill the cylinder head valve seat (refer to *Service data standard*).

Universal Tool

Surface Grinding Machine	Sceledum, Type RTY Roaro Schio/Italy

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SECTION 1B3

OM600 ENGINE MECHANICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Engine Assembly

Application	N·m
Skid Plate Bolt	28 - 47
Drain Plug Bolt	30
Coolong Fan Shroud Bolt	3 - 7
Control Linkage Nut	8 - 18
Clutch Linkage Cylinder Nut	20 - 34
Exhaust Manifold Bolt	30
Propeller Shaft Bolt & Nut (Axle)	70 - 80
Propeller Shaft Bolt & Nut (T/C)	81 - 84
Engine Mounting Nut	50 - 75

Crankshaft Assembly

Application	N·m
Cooling Fan Belt Pulley Bolt	10
Socket Bolt	23
Tighten The Bolt	200 / 90°
End Cover Bolt	10
Crankshaft Bearing Cap Bolt	55 / 90°
Ball Bearing	45 / 90°
Camshaft Sprocket Bolt	25 / 90°
Oil Pump Sprocket Bolt	25

Piston

Application	N·m
Connecting Rod Bolt	35 / 90°

Flywheel

Application	N·m
12-Sided Stretch Bolt	45 / 90°

Cylinder Head

Application	N·m
Prechamber Threaded Ring	130
Cylinder Head Cover Bolt	10
Fuel Injsction Pipe Nut	18
Socket Bolt	25
Fuel Filter Pipe Bolt	25
Idle Pulley Bolt	23
Damper Bolt	21

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Cylinder Head

Application	N·m
Camshaft Bearing Cap Bolt	25
Camshaft Sprocket Bolt	25 / 90°
Exhaust Pipe Bolt& Nut	25
Chain Tensioner	80
Injection Nozzle	40
Intake Manifold Not	25
Injection Nozzle Pipe Not	18
Oil Dipstick Tube Bolt	10
Screw Plug M18 x 15	50

Cam Support & Shaft

Application	N·m
Stud Bolt	12
Exhaust Manifold Not	25
CamShaft Bearing Cap Bolt	25
12-Sided Bolt (M11)	25 / 90°

Timing Cover

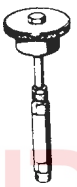
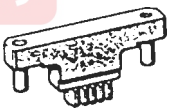
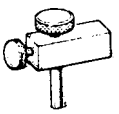
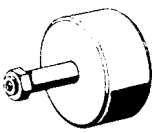
Application	N·m
Oil Pan Bolt-Socket Bolt	10
Oil Pan Bolt- M6	10
Oil Pan Bolt- M23	23
Belt Pulley Bolt	32
Guide Pulley Bolt	4
Guide Pulley Bracket Nut	23
Chain Tensioner	80
Tesioning Lever Bolt	23

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SPECIAL TOOLS

SPECIAL TOOLS TABLE

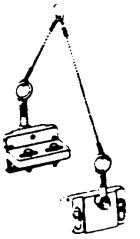
	603 589 00 09 00 Serration Wrench		603 589 00 40 00 Counter Holder
	657 589 03 63 00 Sliding Hammer		000 589 77 03 00 Box Wrench Insert
	601 589 00 66 00 Counter Sink		602 589 00 40 00 Engine Lock
	667 589 00 23 00 Height Gauge		116 589 20 33 00 Sliding Hammer

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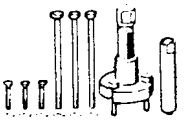
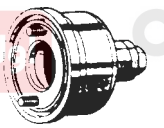
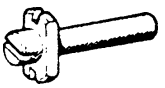
SPECIAL TOOLS TABLE (Cont'd)

	116 589 03 07 00 T Type Socket Wrench		115 589 34 63 00
	601 589 00 10 00 Cylinder Head Bolt 102		601 589 00 25 00
	102 589 12 15 00 (f 17) Drift		102 589 00 15 00 (f 34) Drift
	617 589 10 21 00 RI Sensor		601 589 05 14 00 Assembly Cage

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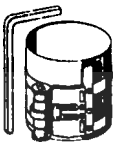
SPECIAL TOOLS TABLE (Cont'd)

	601 589 08 15 00 Drift		103 589 00 33 00 Puller
	001 589 53 21 00 Dial Gauge		601 589 03 14 00 Sleeve
	601 589 07 21 00 Depth Gauge		601 589 03 43 00 Oil Seal Assembler
	667 589 01 21 00 Fixing Device		366 589 00 21 05 Extension

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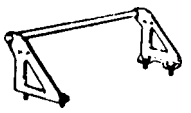
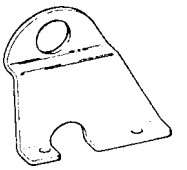
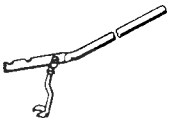
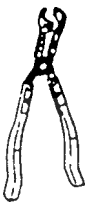
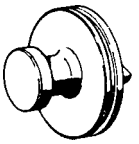
SPECIAL TOOLS TABLE (Cont'd)

	363 589 02 21 00 Dial Gauge Holder		116 589 07 15 00 Drift
	000 589 33 33 00 Counter Support		000 589 04 14 00 Tensioning Strap
	000 589 25 33 00 Internal Extractor		102 589 03 40 00 Magnetic Bar
	102 589 05 33 00 Puller		601 589 01 59 00 Assembling Board

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SPECIAL TOOLS TABLE (Cont'd)

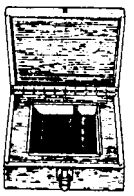
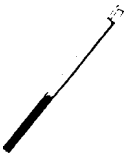
	601 589 02 59 00 Supporting Bridge		667 584 02 63 00 Supporting Bar
	667 589 00 31 00 Press Lever		104 589 00 37 00 Pliers
	116 589 06 63 00 Magnetic Finger		601 589 02 43 00 Drift
	603 589 01 40 00 Holding Wheel		000 589 10 68 00 Cylinder Brush

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SPECIAL TOOLS TABLE (Cont'd)

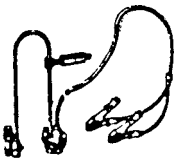
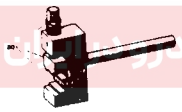
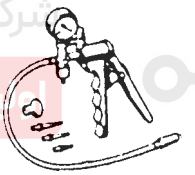
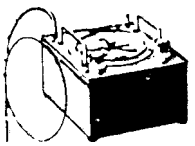
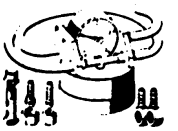
	601 589 02 23 00 Go/No Go Gauge		601 589 05 15 00 Drift (for Intake)
	105 589 03 15 00 Drift (for Intake)		601 589 06 15 00 Drift (for Exhaust)
	103 589 02 15 00 Drift (for Exhaust)		000 589 10 53 00 Reamer (for Exhaust)
	346 589 00 63 00 Super Cooling Box		000 589 21 53 00 Reamer (for Intake)

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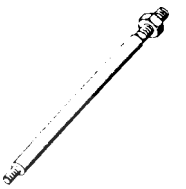
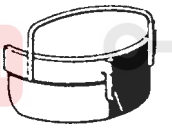
SPECIAL TOOLS TABLE (Cont'd)

	001 589 32 21 00 Dial Gauge		124 589 15 21 00 Tester
	001 589 53 21 00 Dial Gauge		667 589 02 21 00 TDC Pulse Generator
	000 589 58 43 00 Chain Assembling Device		501 589 73 21 00 Vacuum Pump
	201 589 13 21 00 Vacuum Tester		617 589 04 21 00 Tester

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SPECIAL TOOLS TABLE (Cont'd)

	000 589 14 21 00 Tester		601 589 00 08 00 Flange
	001 589 65 09 00 Serration Wrench		116 589 02 34 00 Thread Bolt
	000 589 00 68 00 Cleaning Set		667 589 04 63 00 Retaining Plate
	601 589 05 21 00 Looking Screw		617 589 08 21 00 Position Sensor

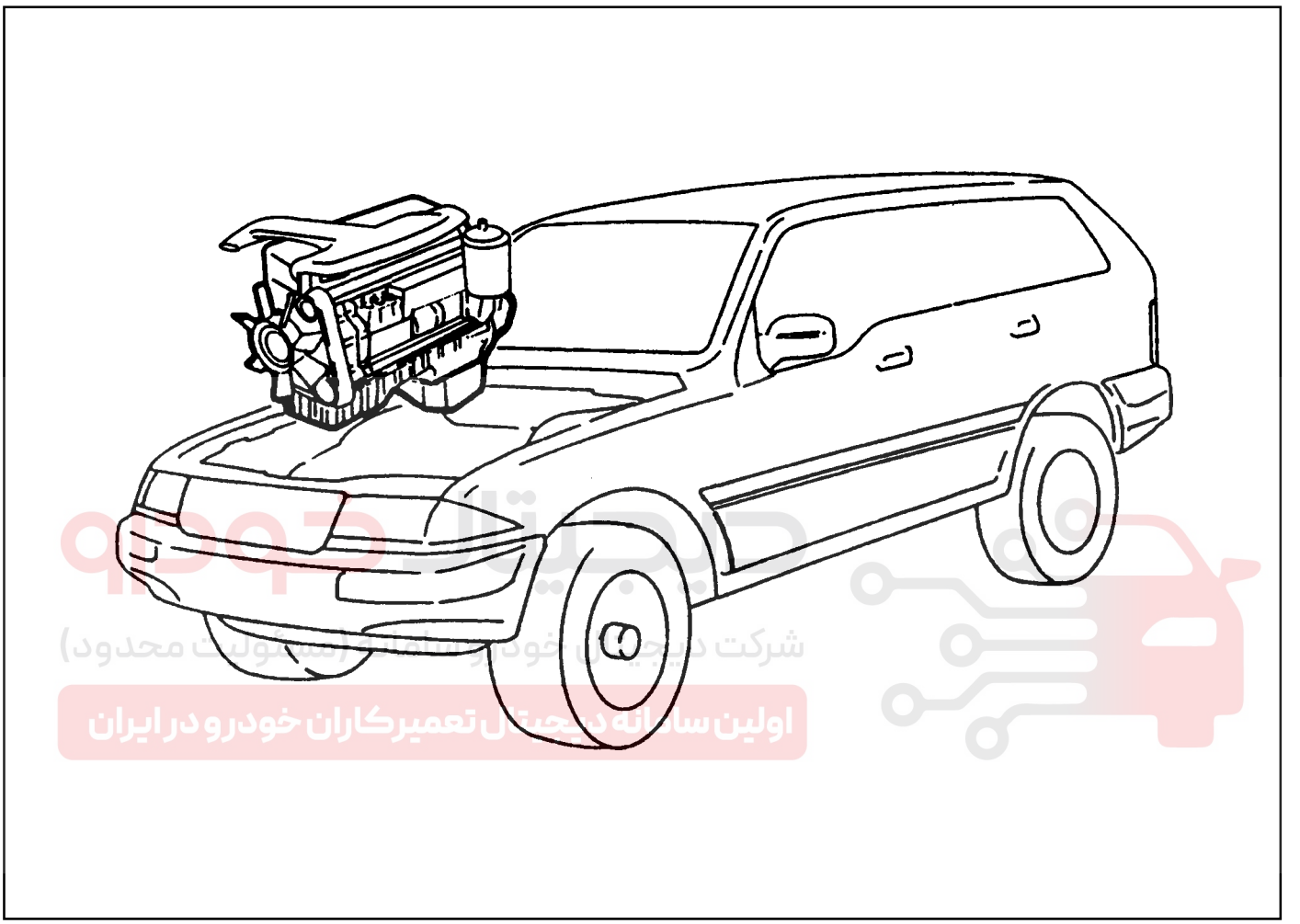
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ENGINE ASSEMBLY



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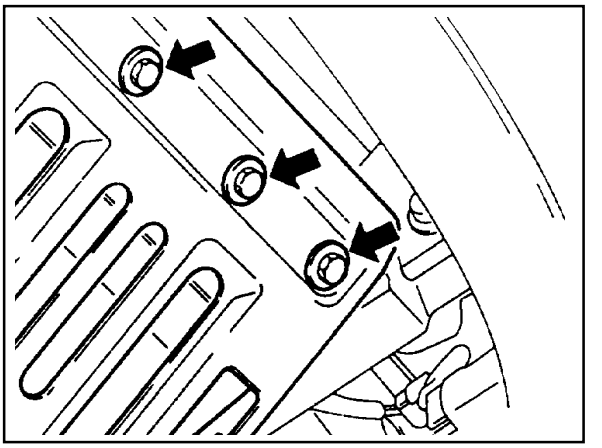
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Removal & Installation Procedure

1. Disconnect the negative terminal of battery.
2. Remove the hood.
3. Remove the skid plate.

Installation Notice

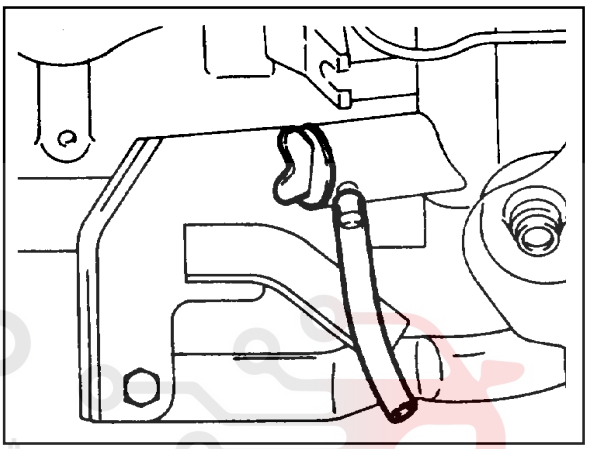
Tightening Torque	28 - 47 Nm



4. Remove the radiator drain cock and drain the coolant.

Notice

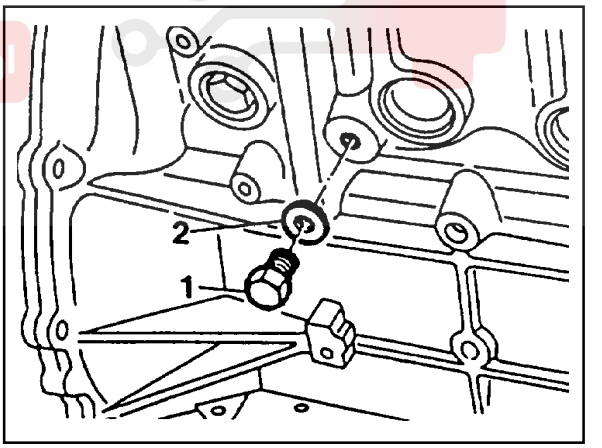
Open the coolant reservoir tank cap.



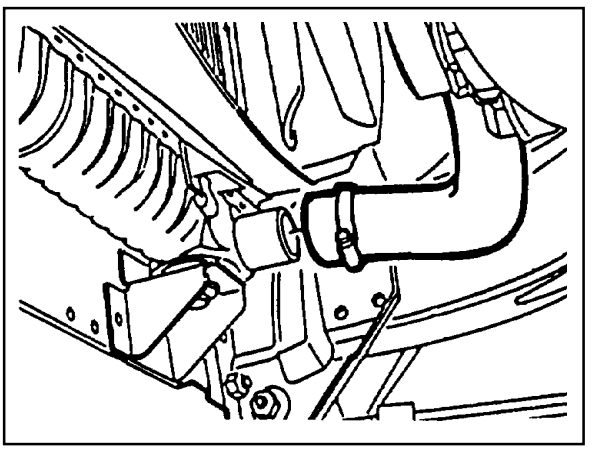
5. Remove the drain plug (1) and seal (2) from the cylinder block and drain the coolant completely.
6. After draining, replace the seal and reinstall the drain plug.

Installation Notice

Tightening Torque	30 Nm



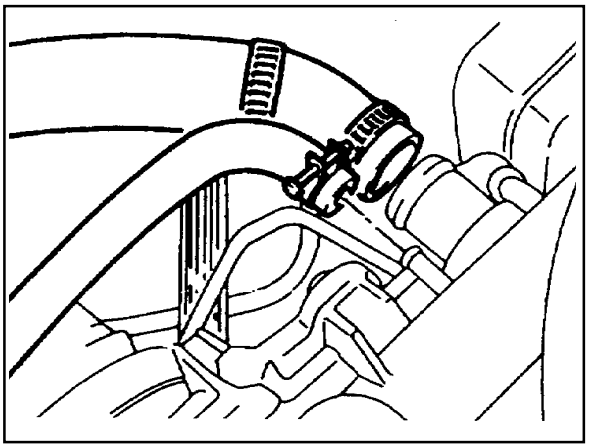
7. Disconnect the lower coolant hose from the radiator.



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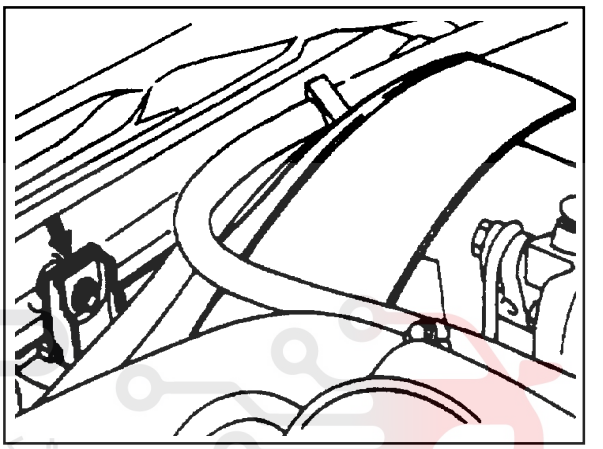
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8. Disconnect the upper coolant hose from the radiator.

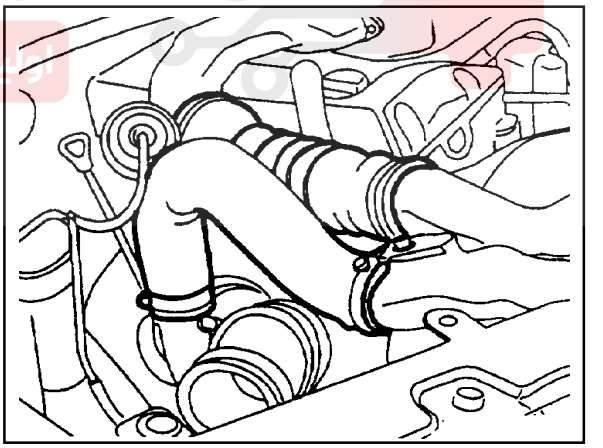


9. Loosen the bolt and remove the coolant pipe and cooling fan shroud.

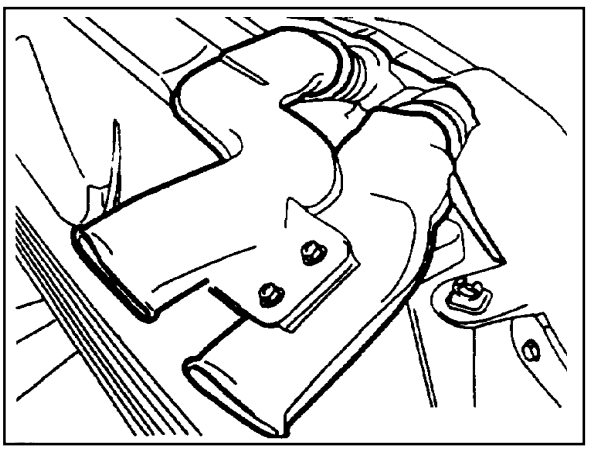
Tightening Torque	3 -7 Nm



10. Remove the hoses (air intake to intercooler, intercooler to intake duct).



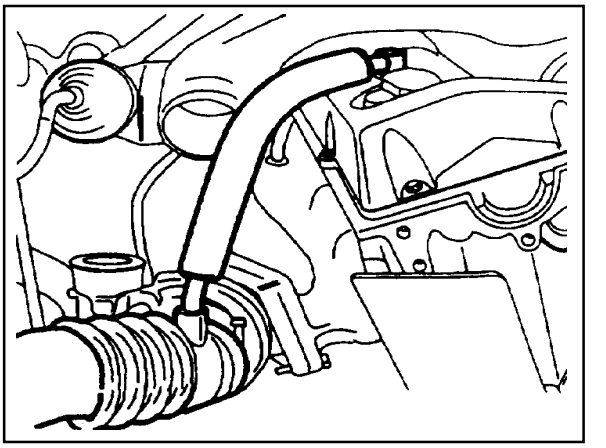
11. Remove the pipes connected to intercooler.



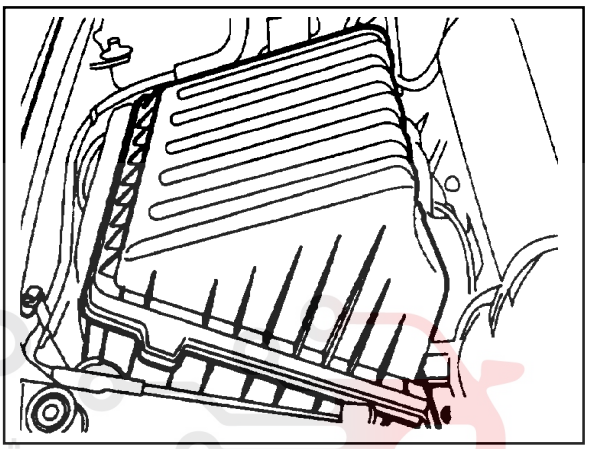
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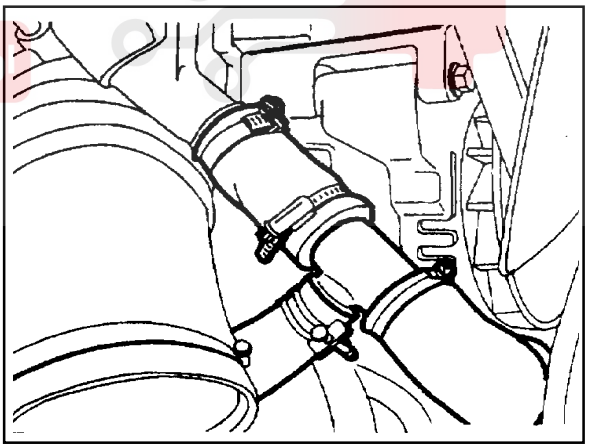
12. Remove the hose(air cleaner to turbocharger) with blow by hose.



13. Disconnect the air cleaner intake hose and remove the air cleaner cover and element.



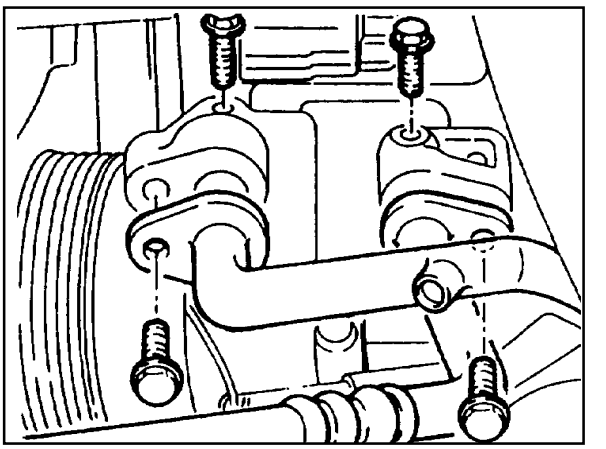
14. Disconnect the coolant hose from the water inlet.



15. Remove the air-conditioner lines from the compressor.

Notice

Evacuate the refrigerant before removal.



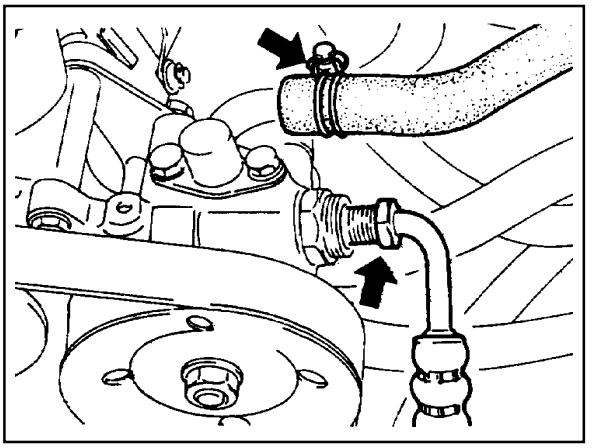
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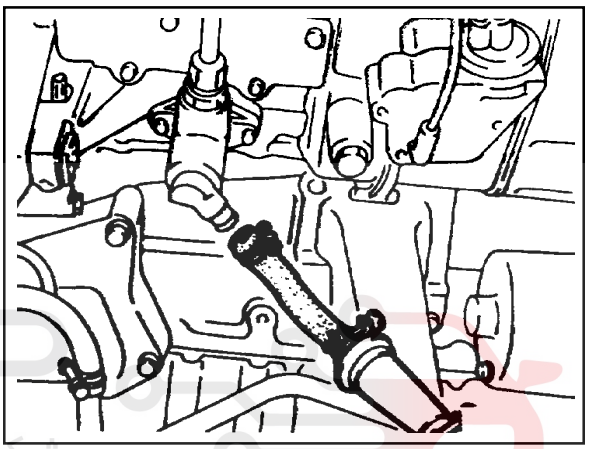
16. Remove the power steering pump lines.

    Notice

    Completely drain the fluid.

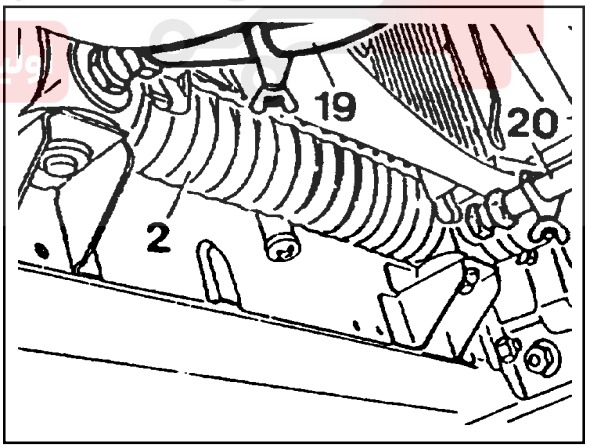


17. Disconnect the fuel feed line with prefilter from the feed pump on injection pump.

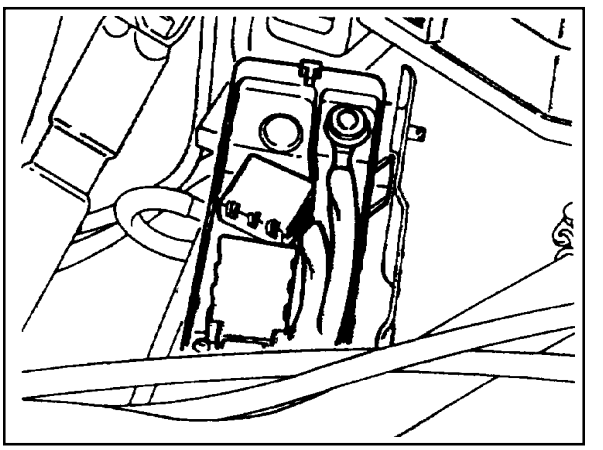


18. Vehicle with automatic transmission.

    Remove the hydraulic lines (19, 20) from oil cooler (2).



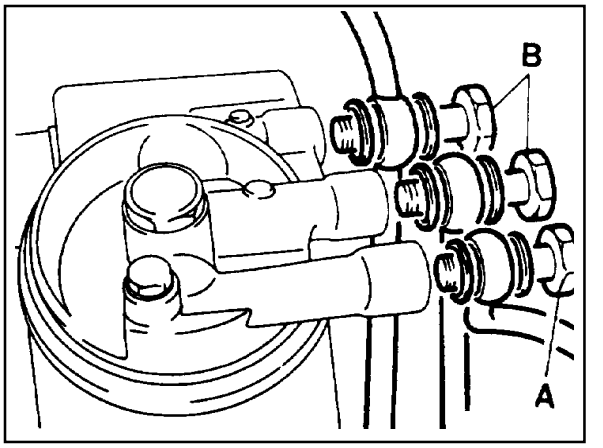
19. Disconnect the engine harness.
20. Disconnect the preheating time relay cable.



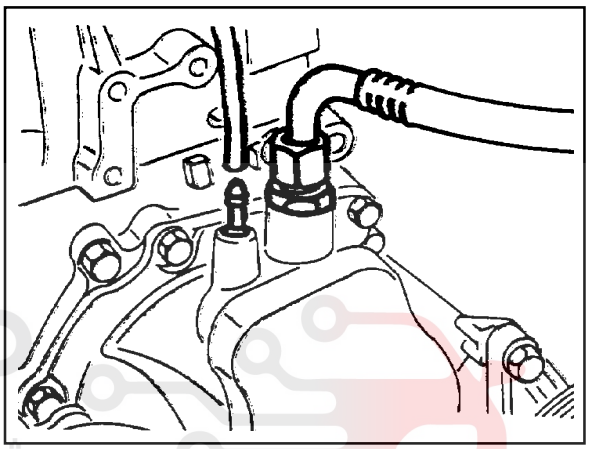
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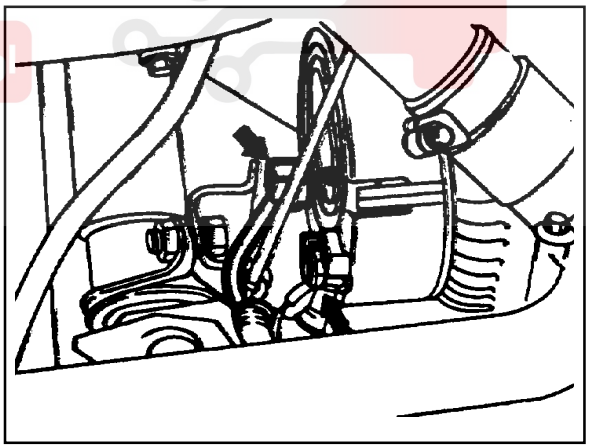
21. Remove the fuel lines from the fuel filter and cover the filter with plug.



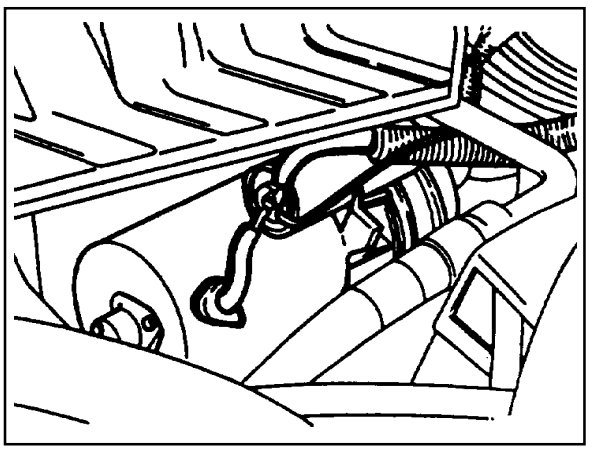
22. Disconnect the brake booster hose from vacuum pump.
23. Disconnect the other vacuum lines.



24. Disconnect the ground cable.
25. Disconnect the alternator wires.



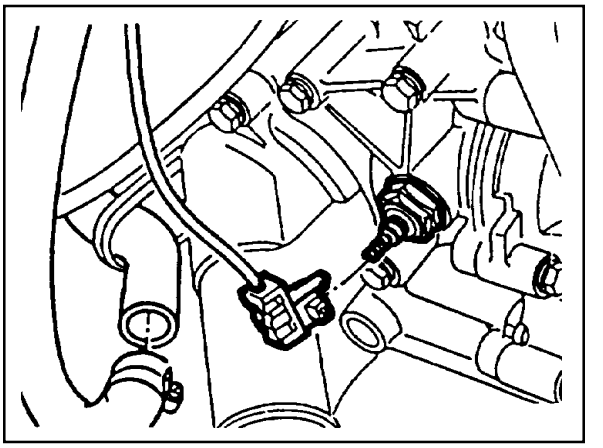
26. Disconnect the starter motor wires and remove the starter motor.



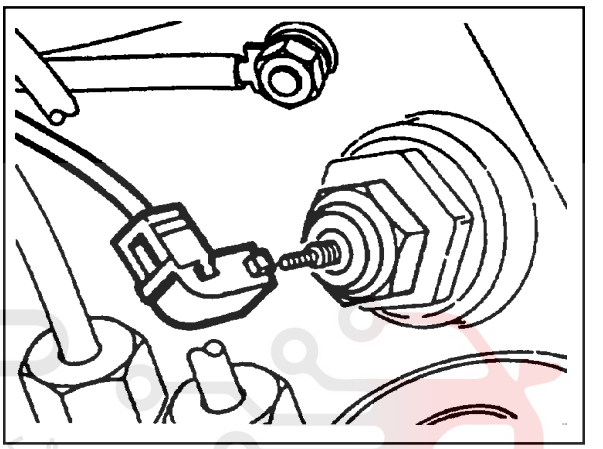
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27. Disconnect the preheating time relay sensor plug.



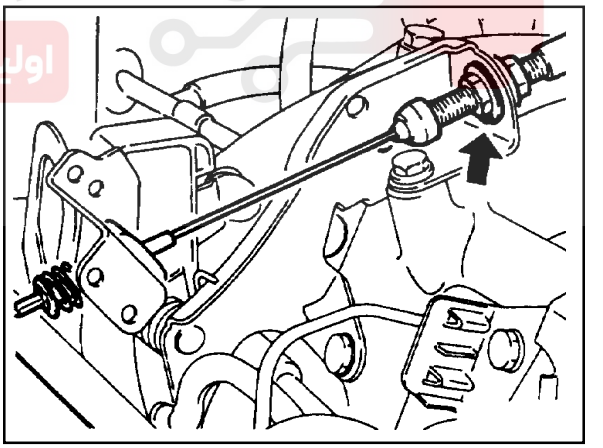
28. Disconnect the coolant temperature sensor plug.



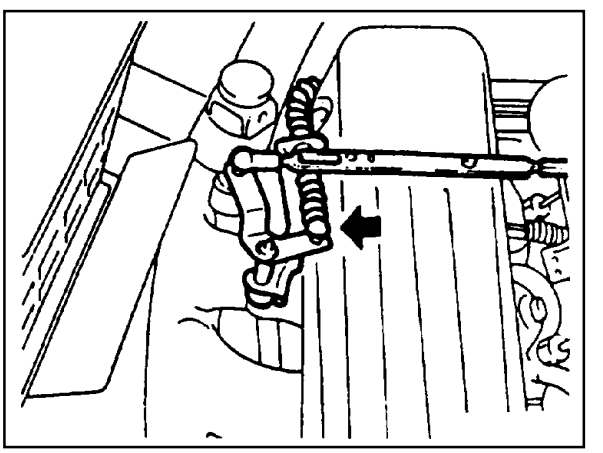
29. Disconnect the accelerator cable from the control linkage.

Installation Notice

Tightening Torque	8 - 18 Nm



30. Loosen the connection of control pressure cable (an arrow) used in auto transmission.



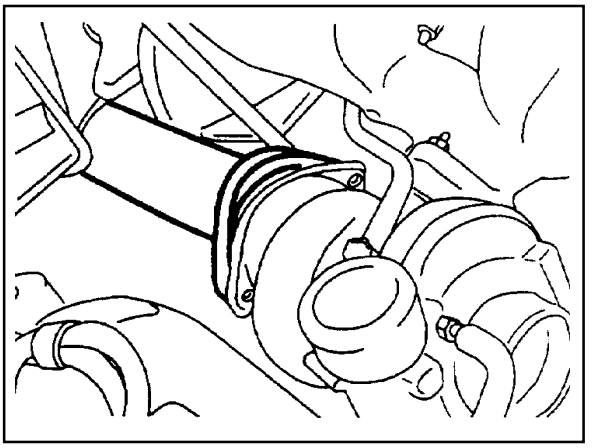
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31. Separate the exhaust pipe flange from the turbo charger.

Installation Notice

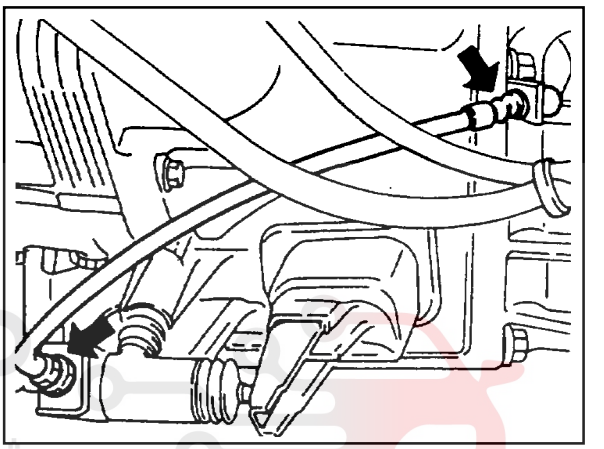
Tightening Torque	30 Nm



32. Loosen the installing bolt of clutch release cylinder and remove the clutch release cylinder.

Installation Notice

Tightening Torque	20 - 34 Nm



33. Disconnect the exhaust pipe flange from the exhaust manifold.

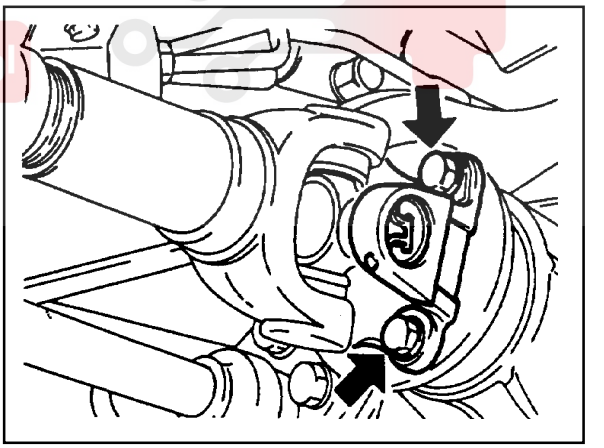
Installation Notice

Tightening Torque	30 Nm

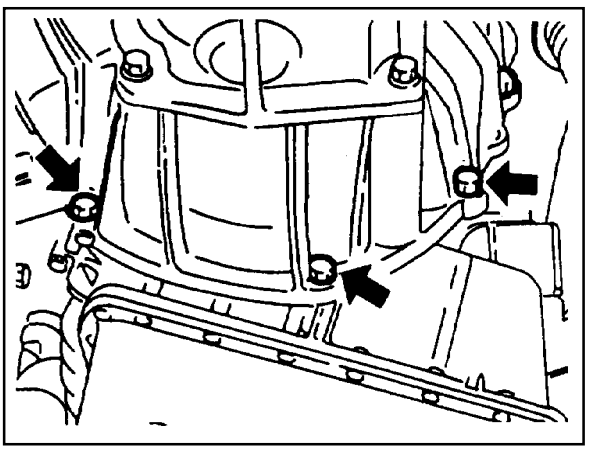
34. Remove the propeller shaft from the transmission.

Installation Notice

Tightening Torque	Axle 70 ~ 80 Nm
	T/C 81 ~ 89 Nm



35. Remove the shift control cable.
36. Remove the transmission.



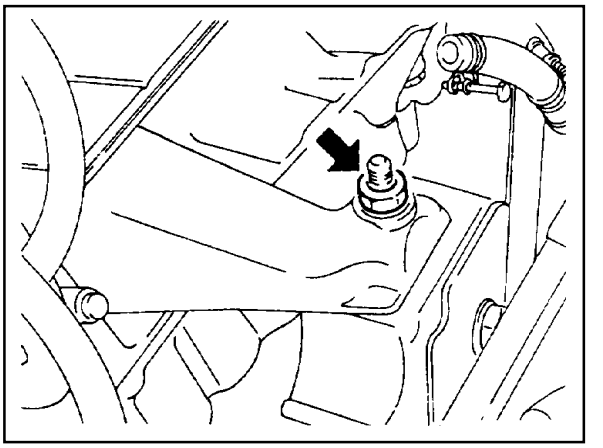
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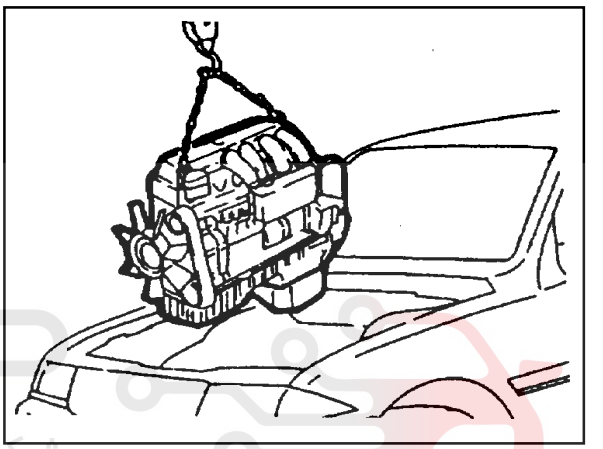
37. Loosen the engine mounting bracket nut.

Installation Notice

Tightening Torque	50 - 75 Nm



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



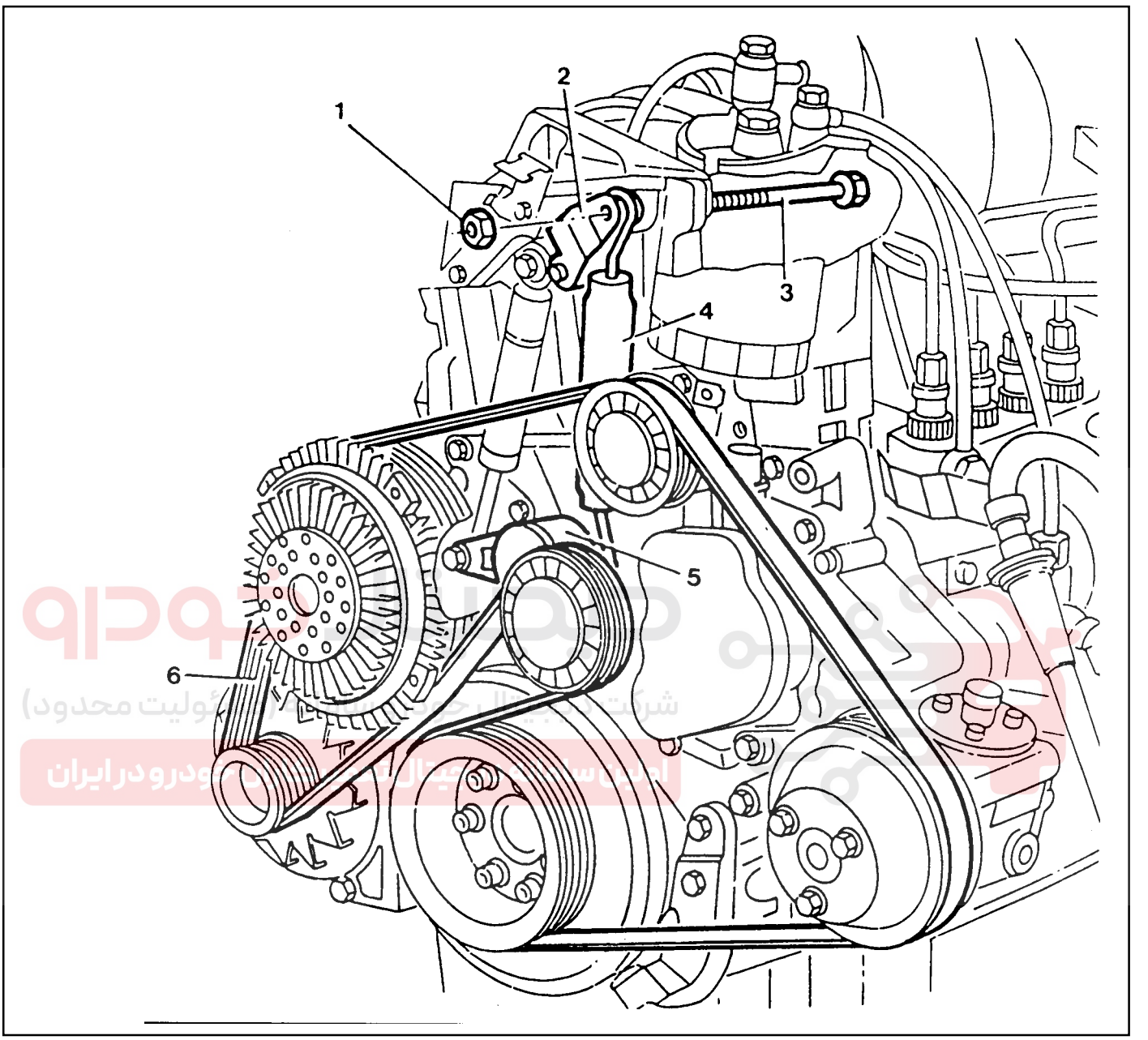
39. Installation should follow the removal procedure in the reverse order.

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POLY V-BELT



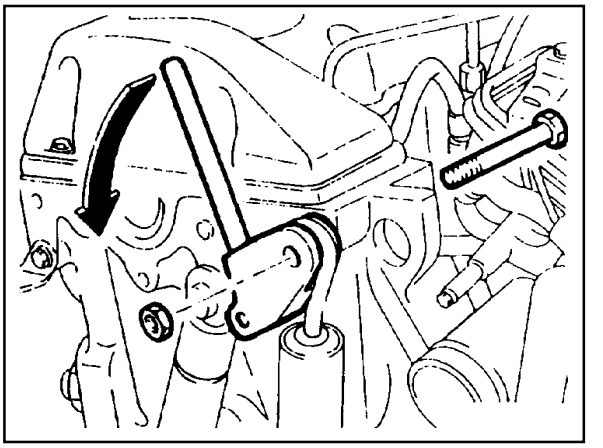
1 Nut 23Nm
2 Tensioning Lever
3 Bolt
4 Spring
5 Tensioning Lever
6 Poly V-Belt

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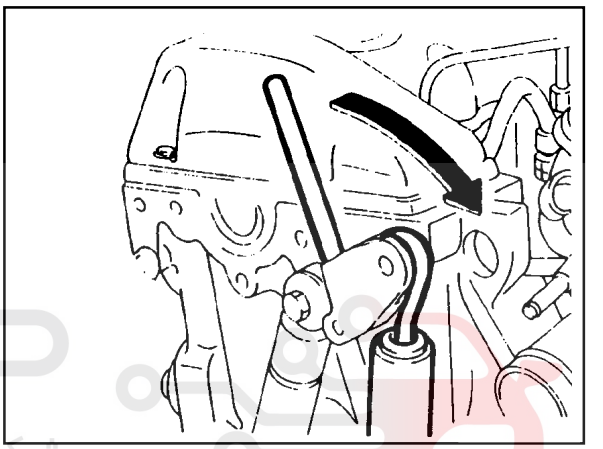
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Removal & Installation Procedure

1. Remove the nut.
2. Push the tensioning lever in direction of arrow with a rod (F12 ´ 180mm) and pull out the bolt to the rear.

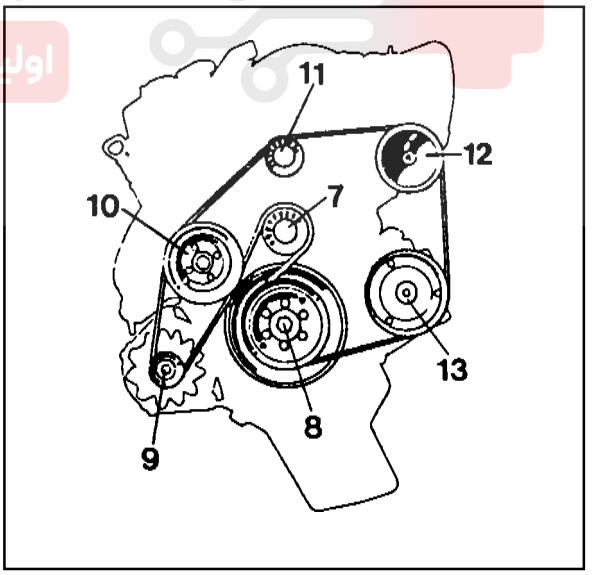


3. Push back the tensioning lever (arrow direction) to release the spring tension and remove the belt.



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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

Lengthe of Belt

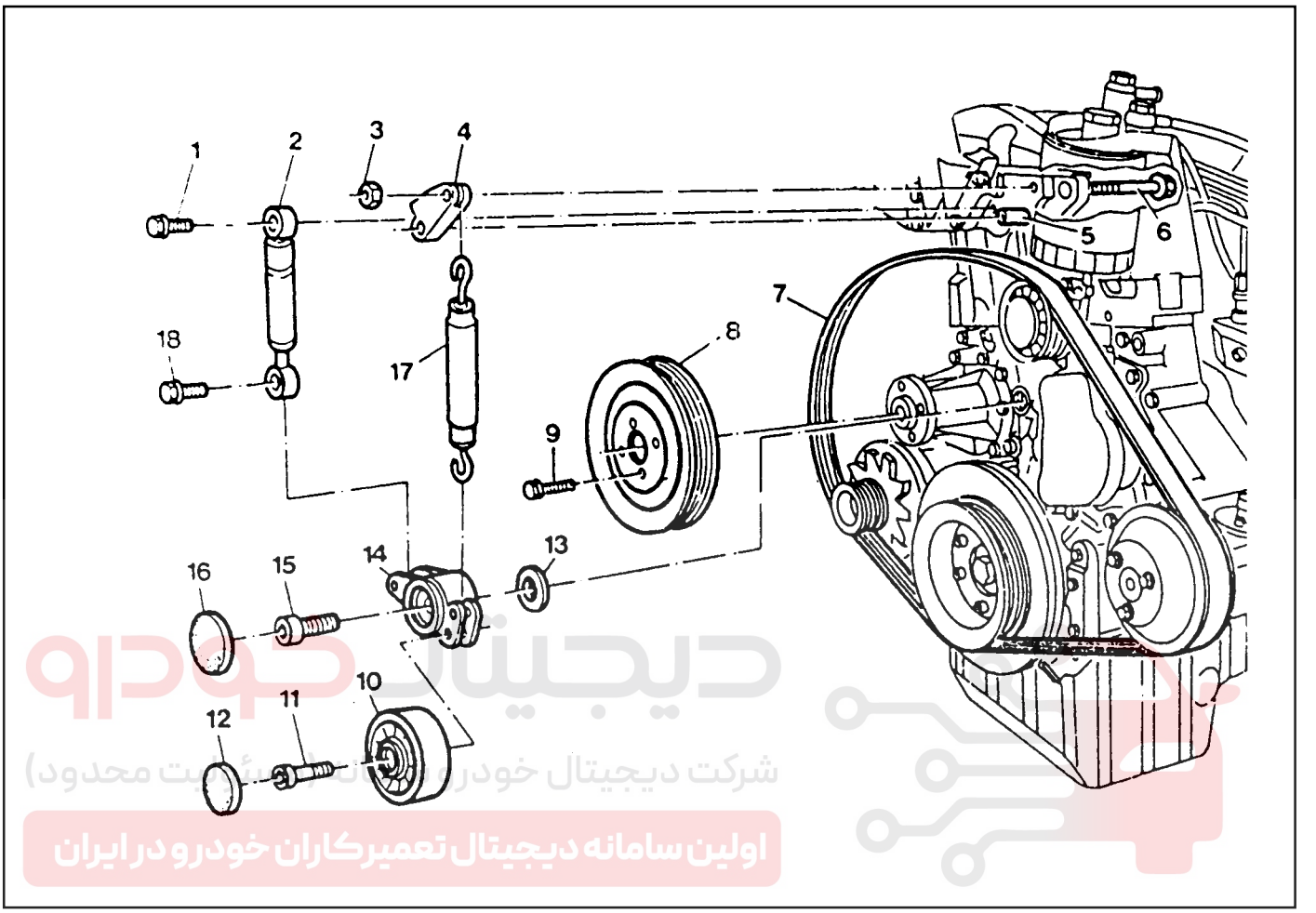
Length (L)	With Air Conditioner	2,100 mm
	Without Air Conditioner	2,040 mm

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TENSIONING DEVICE

Preceding Work : Removal of cooling fan



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1	Bolt	21Nm
2	Damper	
3	Nut	21Nm
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	20Nm

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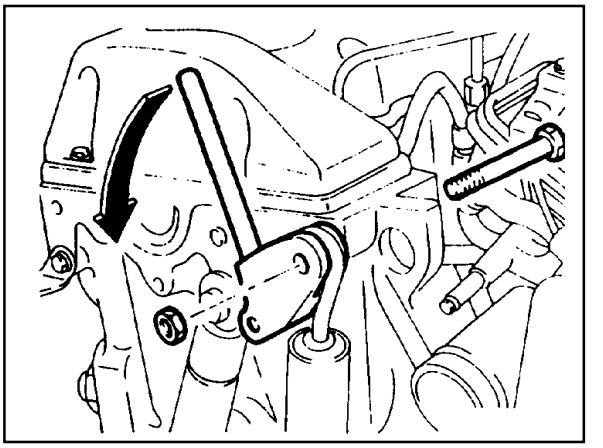
Removal & Installation Procedure

1. Remove the nut.

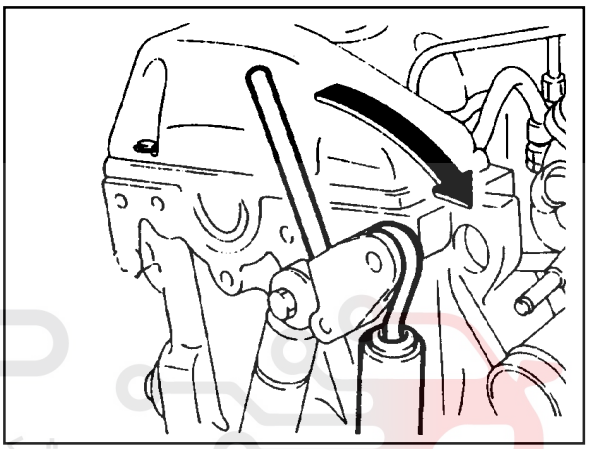
   Installation Notice

Tightening Torque	10 Nm

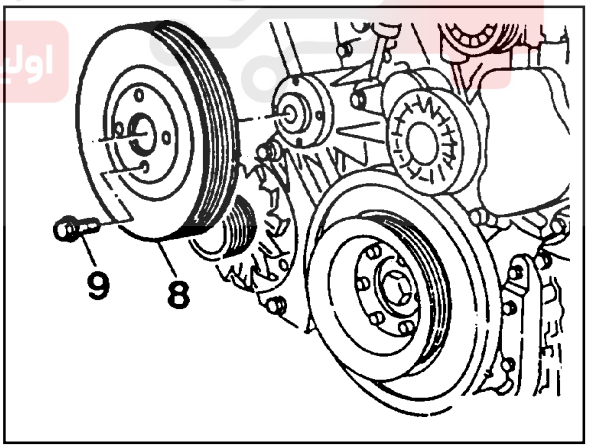
2. Push the tensioning lever in direction of arrow with a rod (F12 ´ 180mm) and push out the bolt to the rear.



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



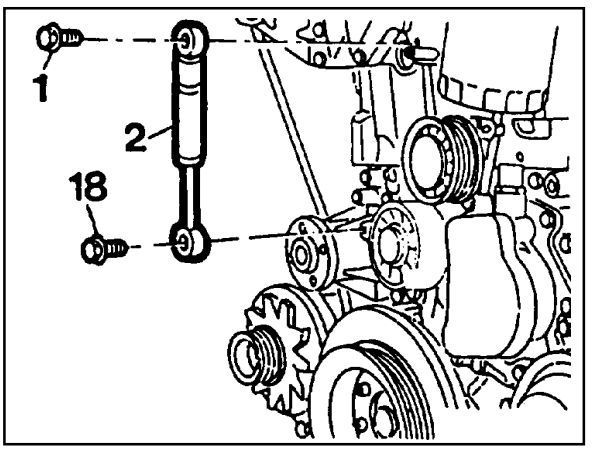
4. Remove the bolt (9) and then remove the belt pulley (8).



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

   Notice

   Pay attention to installation position of the damper.



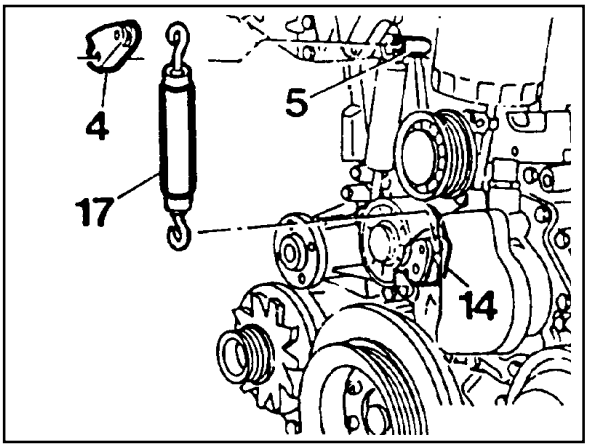
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6. Pull off the tensioning lever (4) from guide rail pin.
7. Remove the spring (17).

Installation Notice

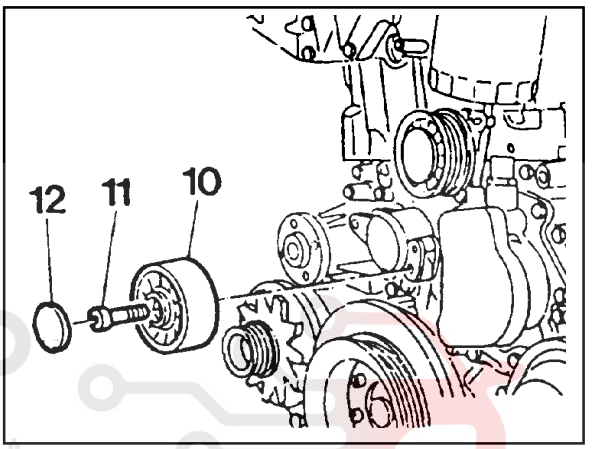
Insert spring (17) with color coding (blue/violet) facing up.



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

Installation Notice

Tightening Torque	29 Nm

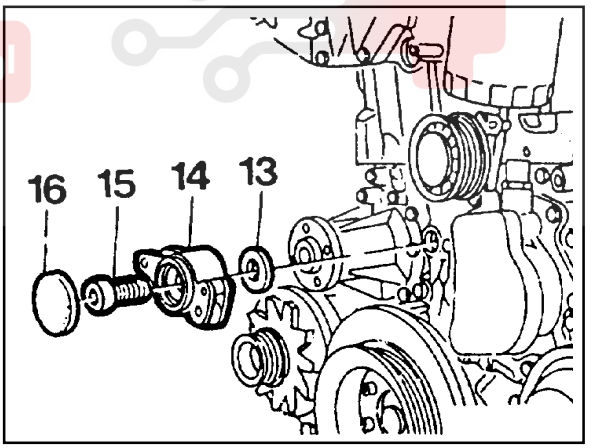


9. Pry off the closing cover (16) and remove the fit bolt (15).
10. Remove the tensioning lever (14) and washer (13).
11. Clean thread in the timing case cover and fit bolt.

Installation Notice

Apply Loctite on thread of fit bolt.

Tightening Torque	100 Nm



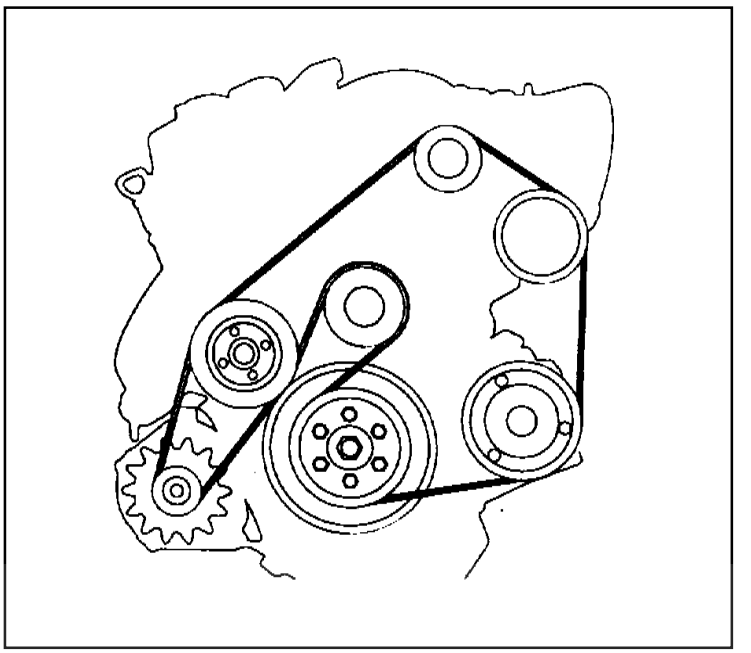
12. Installation should follow the removal procedure in the reverse order.

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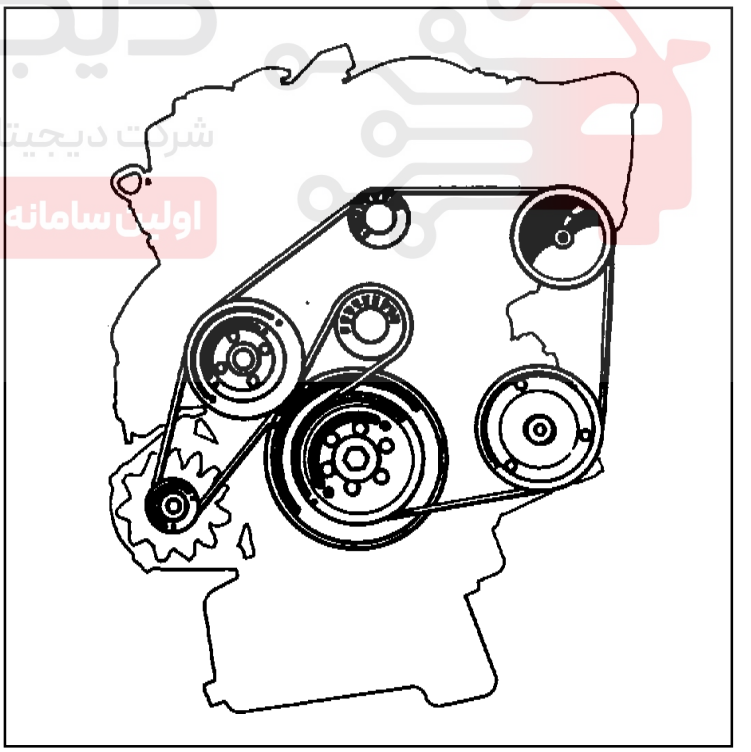
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POLY V-BELT ALIGNMENT & INSPECTION

Without Air Conditioner



With Air Conditioner



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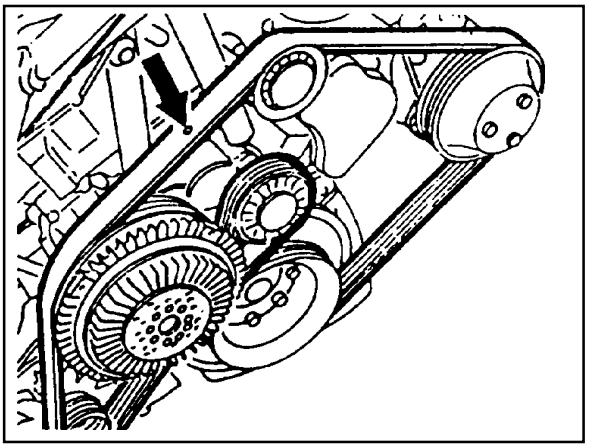
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Inspection Procedure

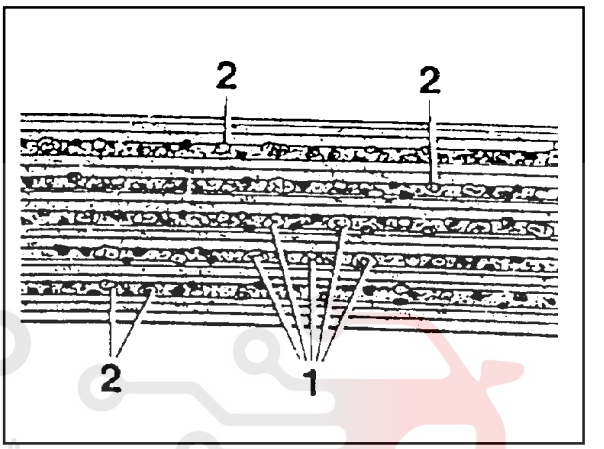
- Mark poly V-belt at a clearly visible point with chalk.
- Rotate the engine and check the belt.

Notice

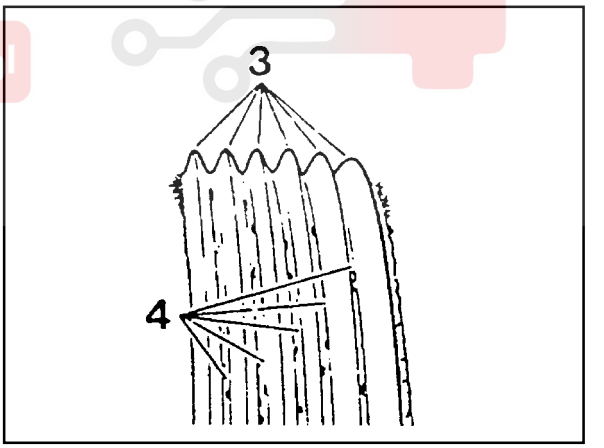
If one of the following types of damage is found, replace the belt.



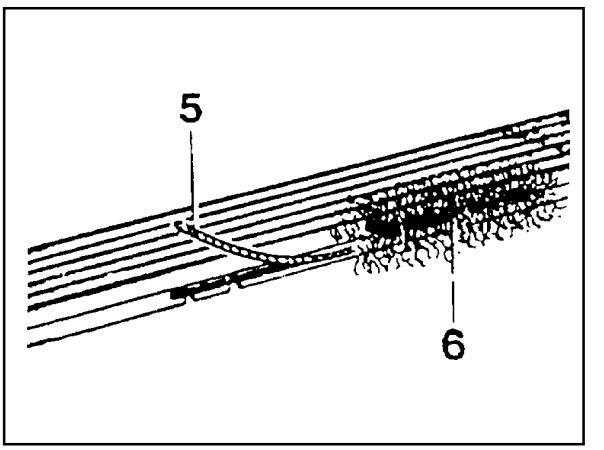
1. Rubber lumps in the base of rips.
2. Dirt or grit ingrained.



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



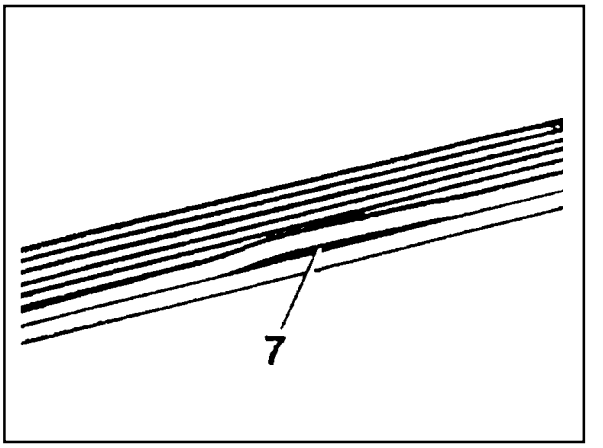
5. Cord torn out at the side.
6. Outer cords frayed.



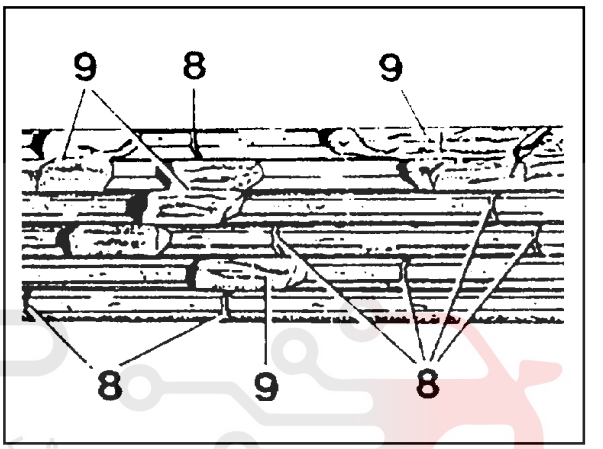
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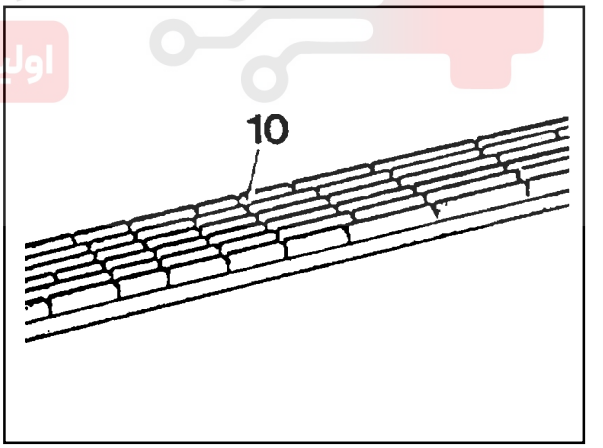
7. Belt detached from the base of rip.



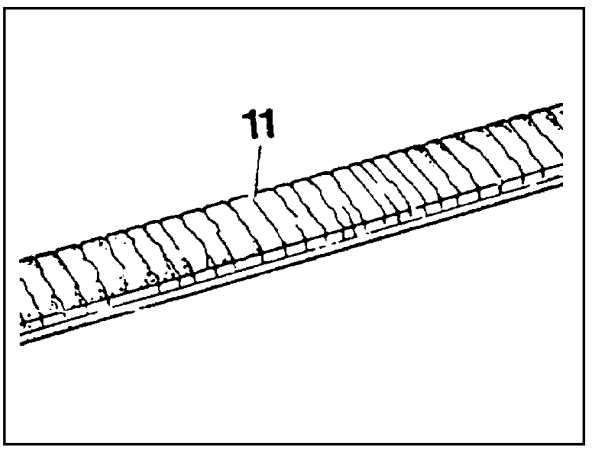
8. Splits across the rips.
9. Sections of rip torn out.



10. Splits across several rips.



11. Splits across the back.

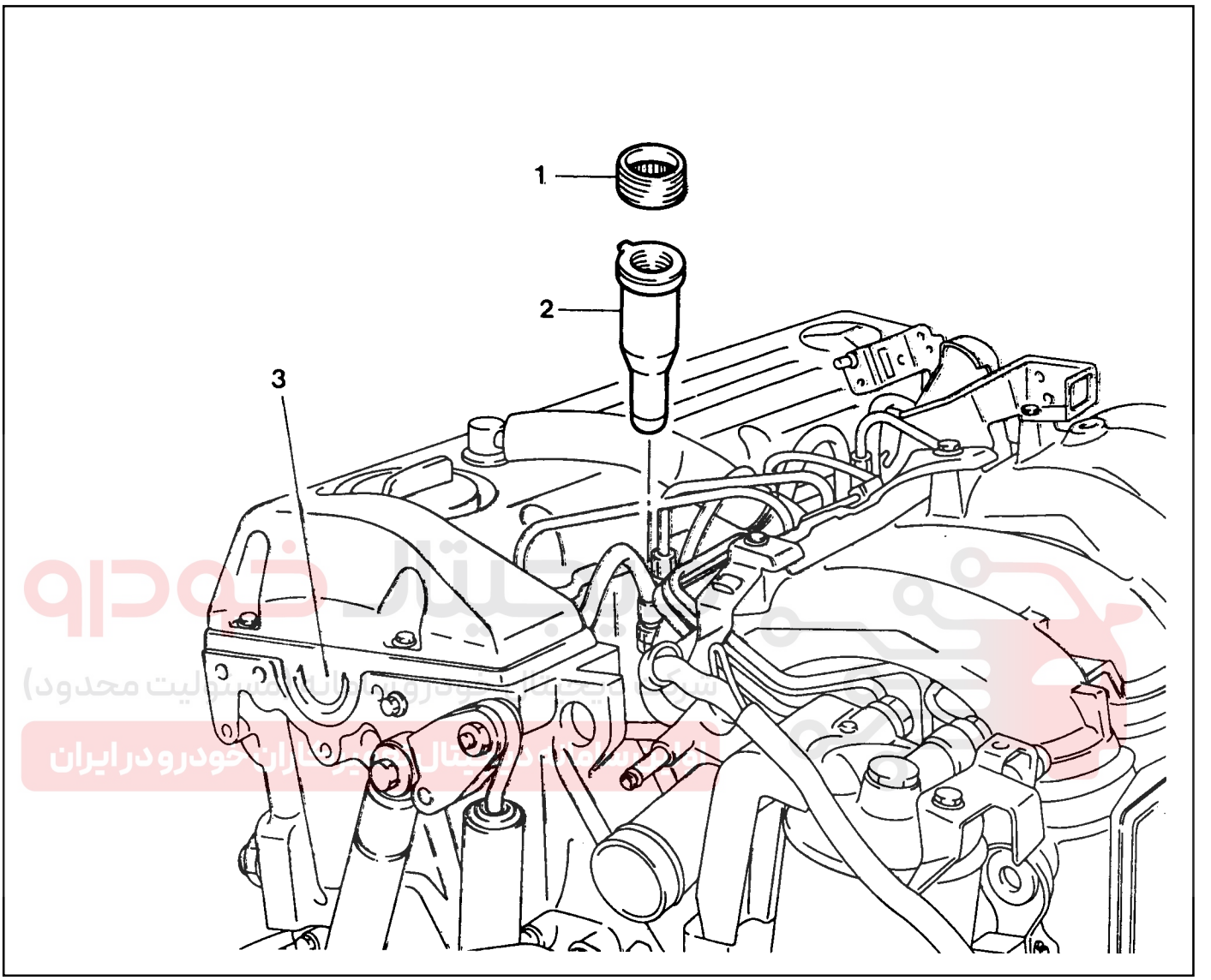


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PRECHAMBER

Preceding Work : Removal of glow plug
Removal of fuel injection nozzle



1 Threaded Ring ..... 130 Nm
2 Prechamber
3 Cylinder Head

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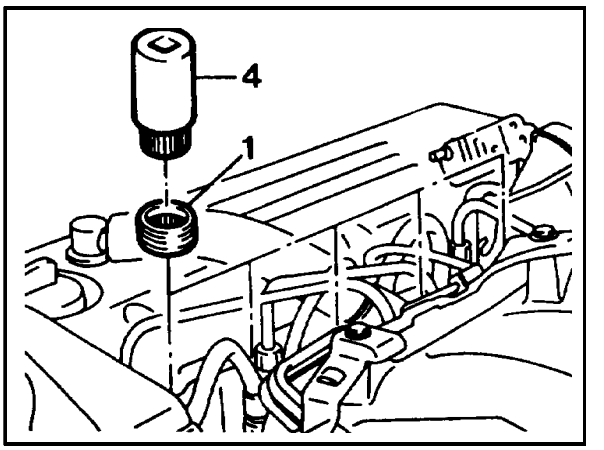
Tools Required

603 589 00 09 00 Serration Wrench
667 589 03 63 00 Sliding Hammer

Removal & Installation Procedure

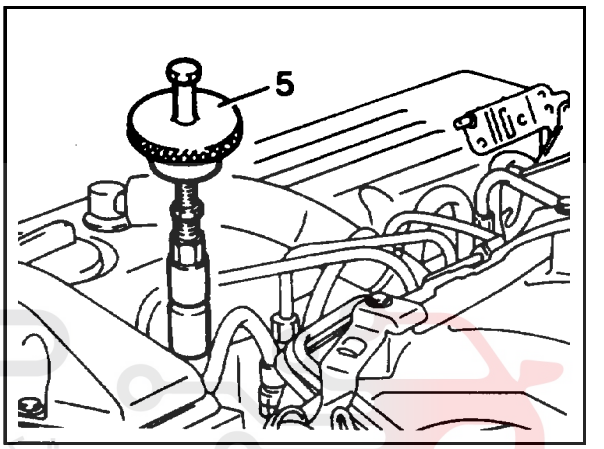
1. Using the serration wrench (4), remove the threaded ring (1).

Serration Wrench 603 589 00 09 00



2. Install the sliding hammer into the prechamber.

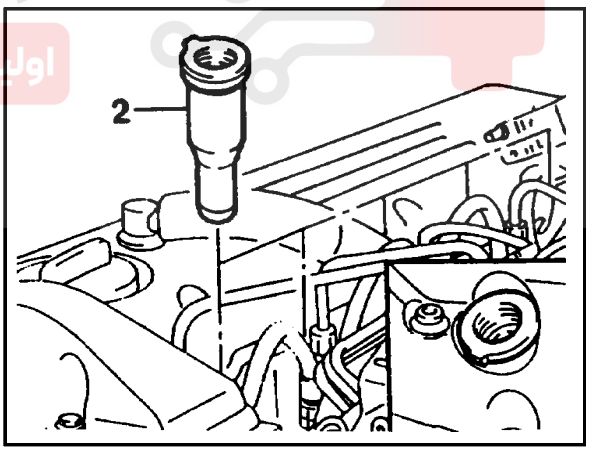
Sliding Hammer 667 589 03 63 00



3. Remove the perchamber (2).

Notice

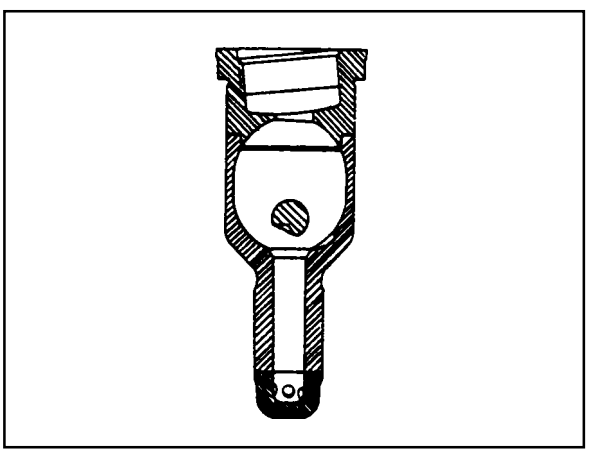
After removing the prechamber, cover over the bores with clean rag.



4. Inspect the prechamber.

Notice

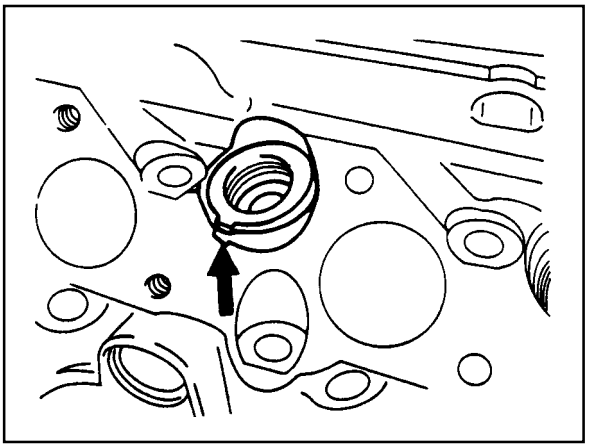
If the prechamber seats in the cylinder head are leaking or if the prechambers are replaced, the sealing surfaces in the cylinder head must be remachined.



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Assembly Procedure



Notice

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.

Notice

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 mm

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

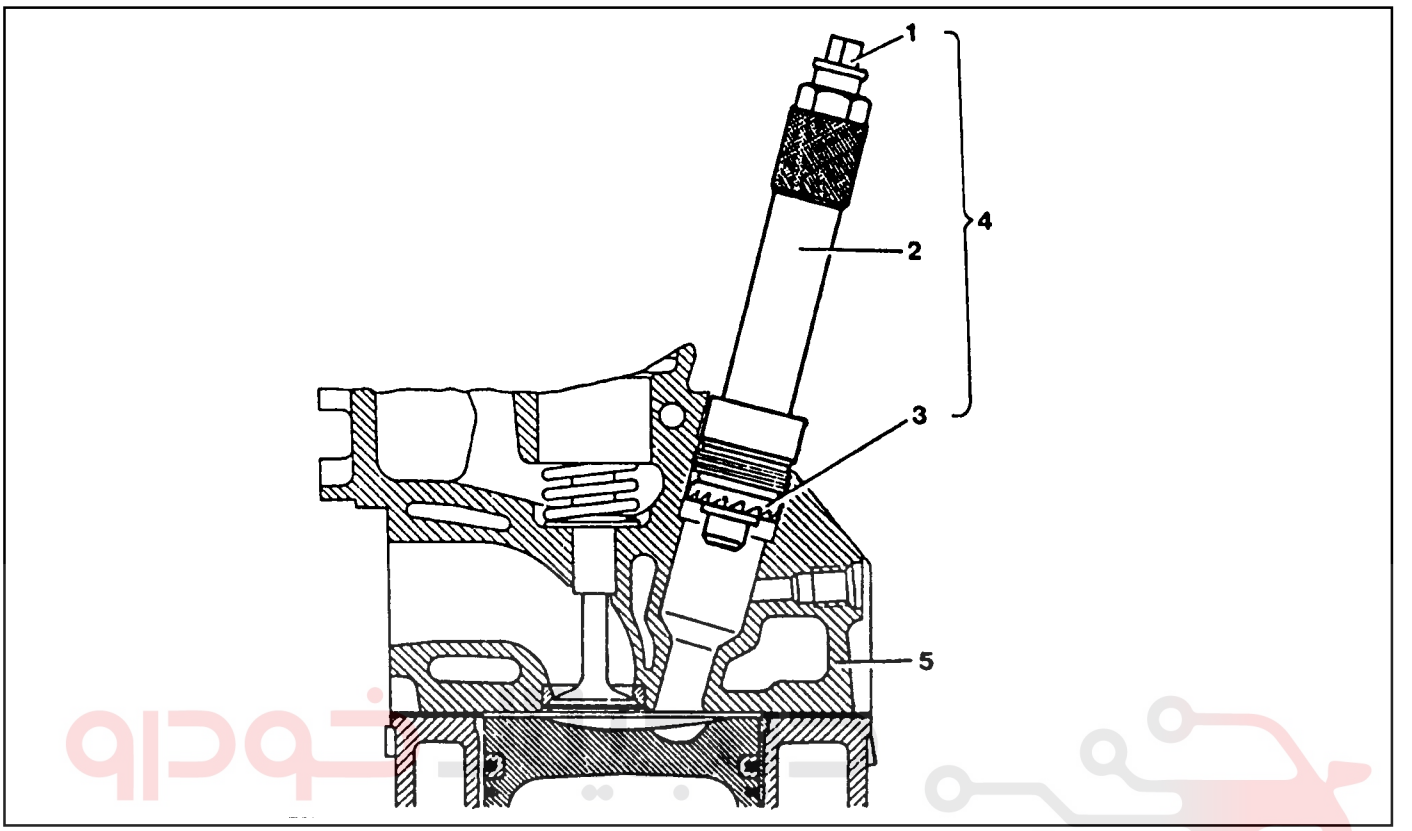
Tightening Torque	130 Nm

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MILLING OF PRECHAMBER SEALING SURFACE



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

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Tools Required

601 589 00 66 00 Counter Sink
667 589 00 23 00 Height Gauge

Milling of the Prechamber Sealing Surface

Notice

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.

Tightening Torque	0.3, 0.6, 1.0 mm

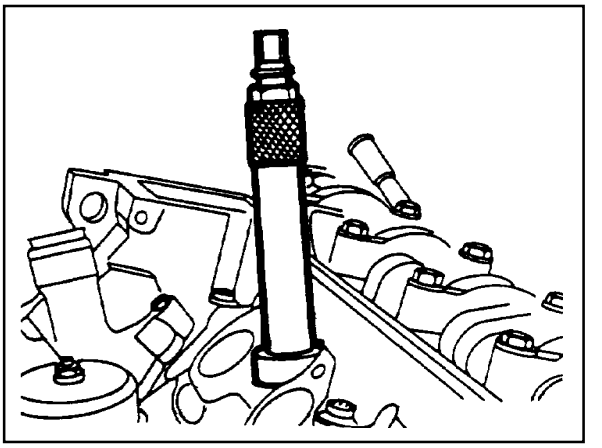
If a spacer ring is already fitted, or a marking is made on the cylinder head, the cylinder head must be removed and size ‘C’ measured if further remachining is necessary on a prechamber sealing surface.

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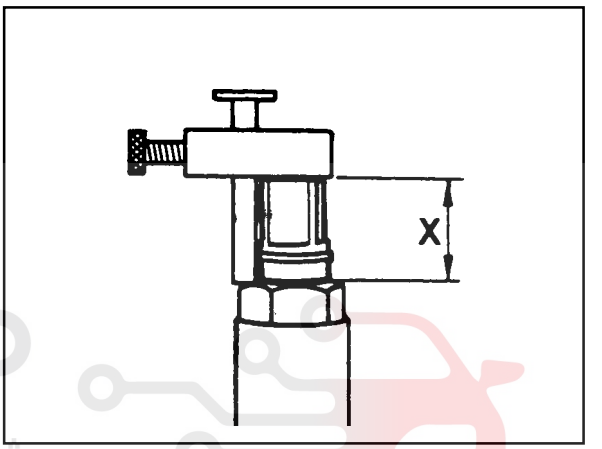
1. Remove the injection nozzle.
2. Remove the prechamber.
3. Cover the prechamber bore to avoid any chips dropping into the combustion chamber.
4. Remove the protective sleeve from the countersink and rotate the countersink into the prechamber bore to be machined as far as the stop.

Counter Sink 601 589 00 66 00

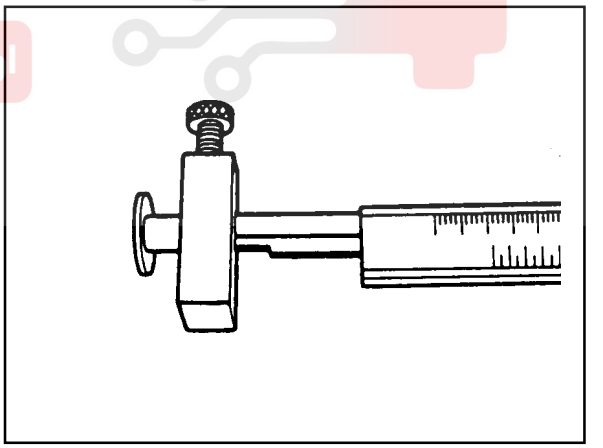


5. Maintain size ‘X’ from the top edge of mandrel to the top edge of the sleeve with the gauge.

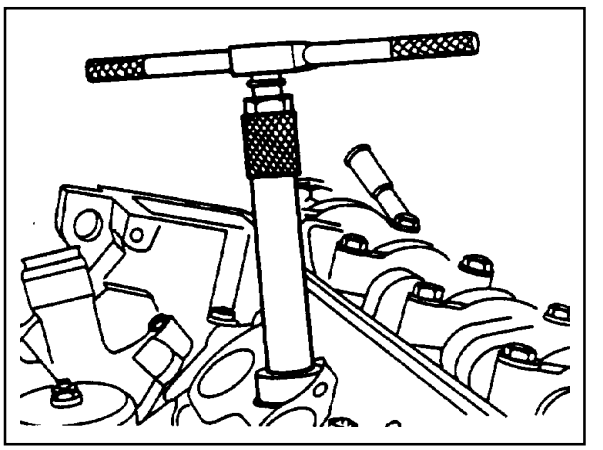
Height Gauge 667 589 00 23 00



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.



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

Ex

Size before machining	25.7 mm
Size after machining	25.5 mm

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.

Notice

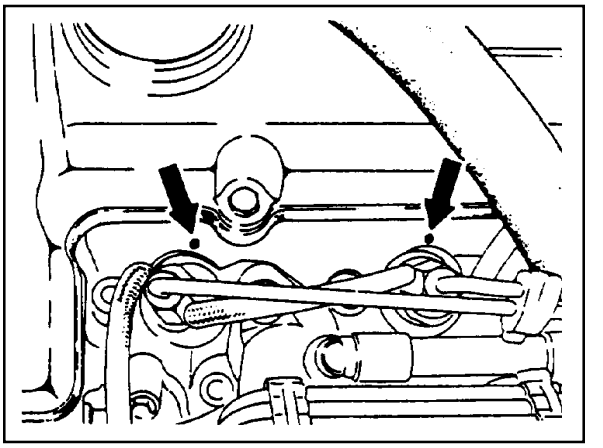
If the sealing surface is not completely flat, remachine the sealing surface.

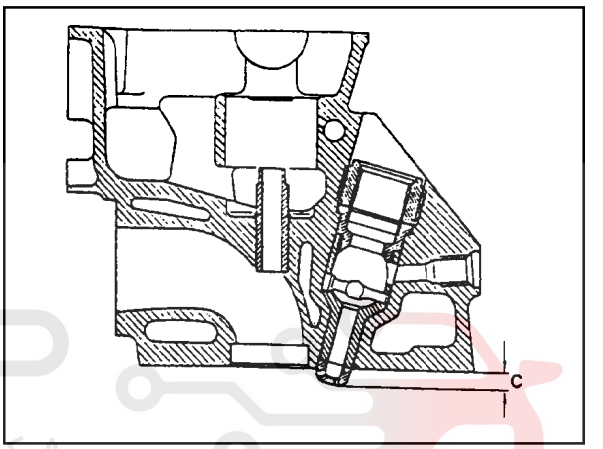
10. emove rag from the prechamber bore and crank the engine with starter motor to threw out any chips which may have got into the combustion chamber.
11. Insert the proper spacer ring into the prechamber sealing surface.
12. Punch a mark on the cylinder head above the prechamber sealing surface which has been machined.
13. Install the prechambers.

Notice

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

Normal Projection (c)	7.6 - 8.1mm



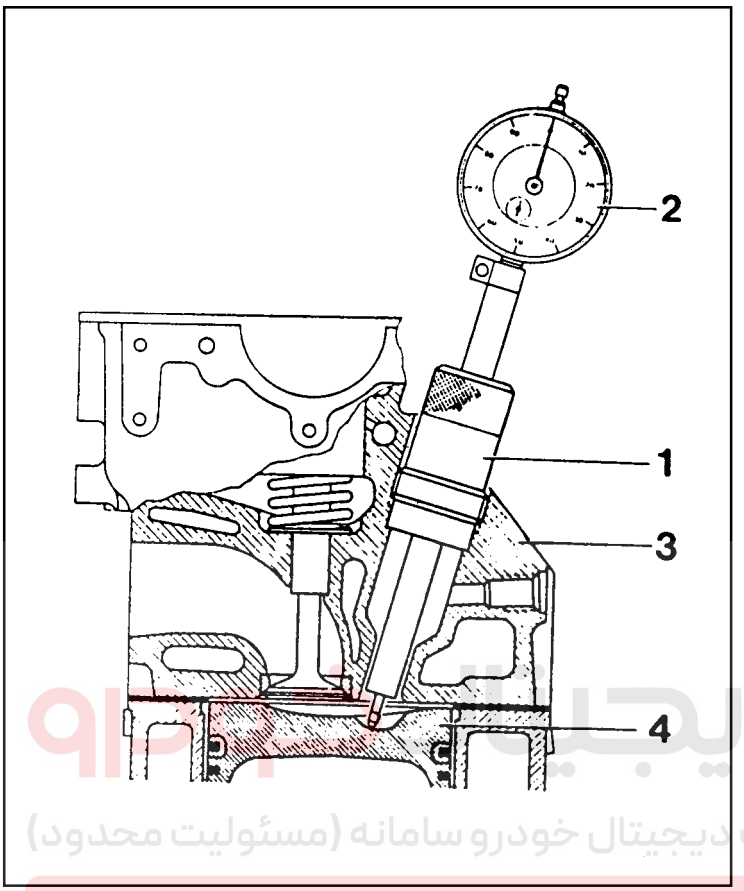


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TDC (TDC SENSOR BRACKET) SETTING

Preceding Work : Removal of No.1 cylinder prechamber



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

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Tools Service

001 589 32 21 00 Dial Gauge
601 589 07 21 00 Deqth Gauge
667 589 01 21 00 Fixing Device

Notice

- 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.

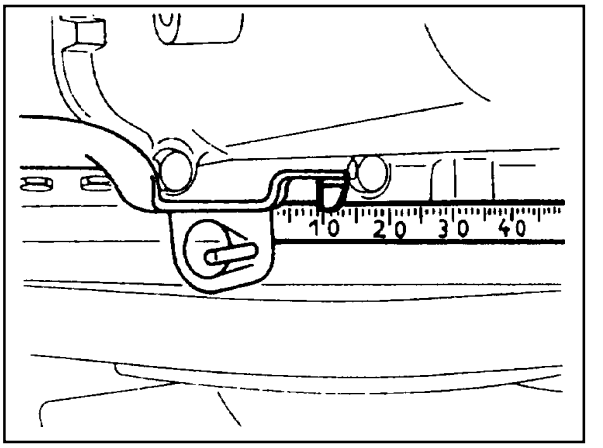
This is done by placing the magnetic dial holder on the mating surface of the crankcase.

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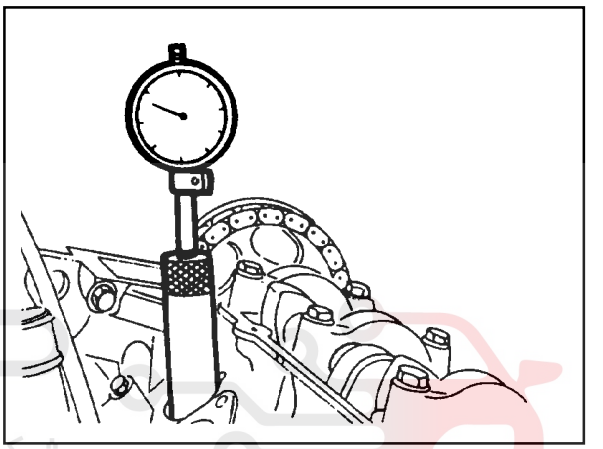
Setting (with cylinder head installed)

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).

   Notice

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

5. remove the 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.

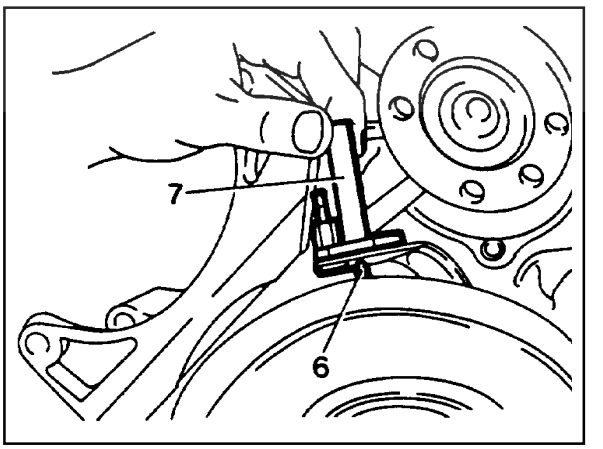
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7. Insert fixing device into the sensor bracket.

   Notice

   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	10 Nm

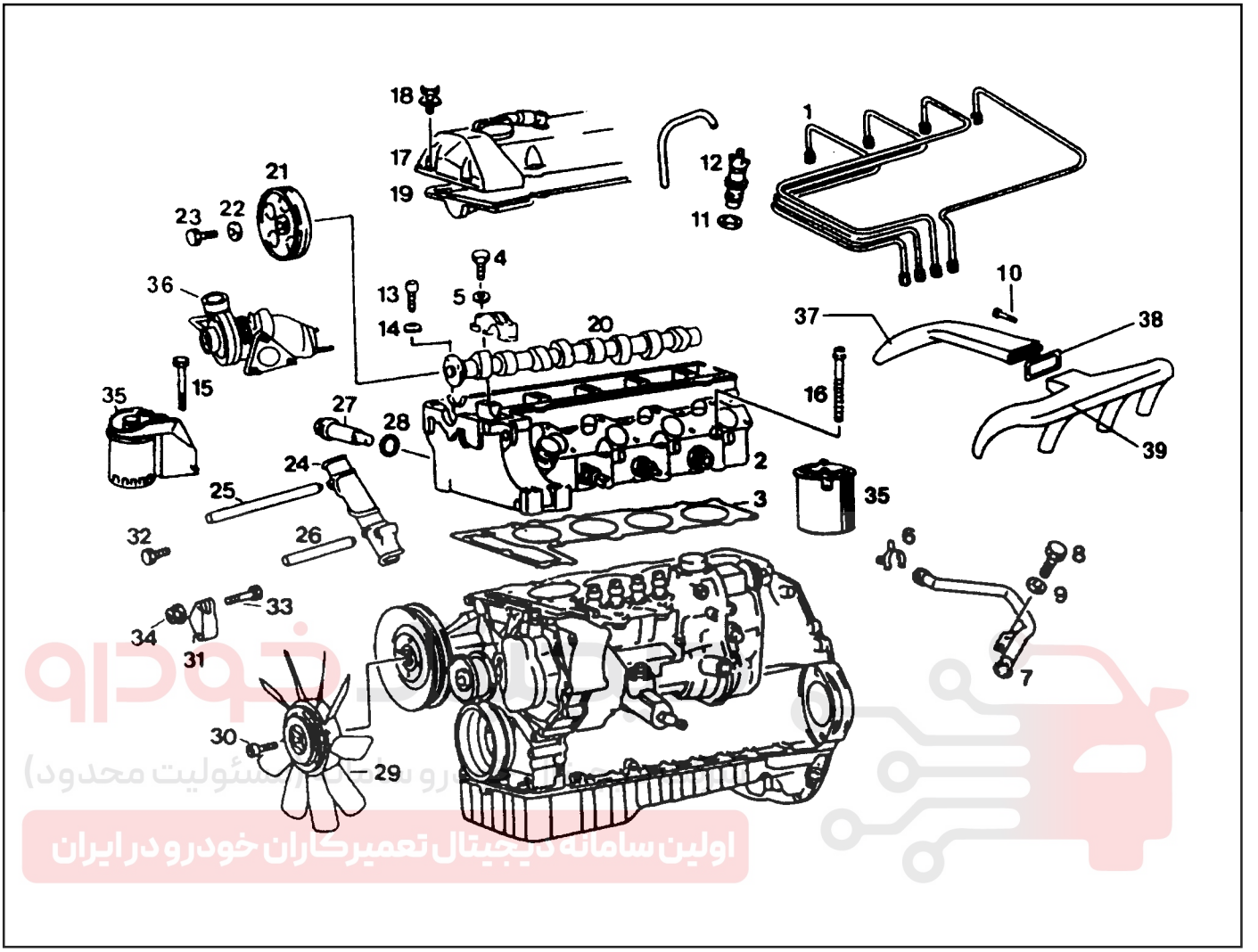
   Notice

   The timing mark on the damper must be positioned at ATDC 20.

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CYLINDER HEAD



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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	
11	Nozzle Washer	Replace
12	Fuel Injection Nozzle	35-40 Nm
13	Hexagon Socket Bolt	25 Nm
14	Washer	
15	Bolt	25 Nm
16	Cylinder Head Bolt	See Table
17	Cylinder Head Cover	
18	Bolt	10 Nm
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	80 Nm
28	Gasket	Replace
29	Cooling Fan	Check
30	Hexagon Socket Bolt	45 Nm
31	Tensioning Lever	
32	Bolt	25 Nm
33	Bolt	
34	Nut	23 Nm
35	Fuel Filter	
36	Turbo Charger	
37	Intake Duct	
38	Gasket	Replace
39	Intake Manifold	

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Tightening Torque

Cylinder Bolts (12-sided socket head) (Engine cold)	stage1	10 Nm
	stage2	35 Nm
	stage3	180°
M8 Cylinder Head Bolts		25 Nm

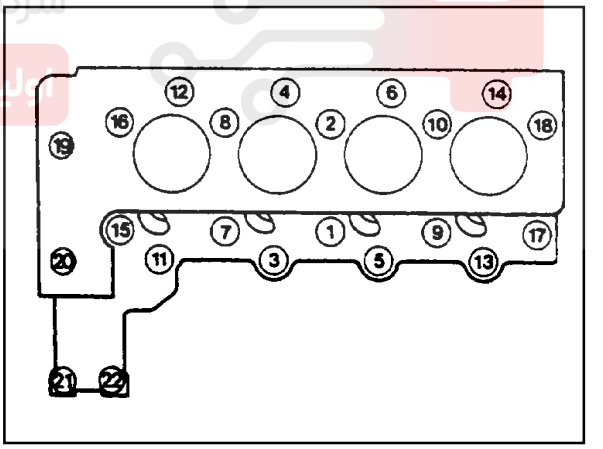
Tools Required

000 589 77 03 00 Box Wrench Insert
001 589 65 09 00 Socket Wrench Insert
102 589 03 40 00 Magnetic Bar
116 589 02 34 00 Threaded Pin
116 589 03 07 00 T Type Socket Wrench
116 589 20 33 00 Sliding Hammer
601 589 00 10 00 Cylinder Head Bolt Wrench
602 589 00 40 00 Engine Lock
603 589 00 40 00 Counter Holder

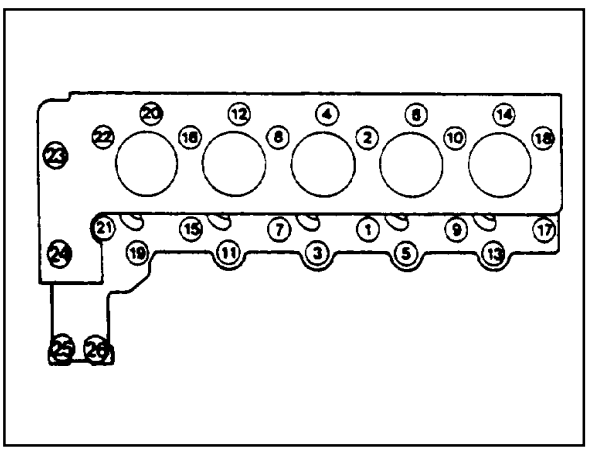
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Tightening Sequence for Cylinder Head Bolts

OM 662LA Engine



OM 661LA Engine



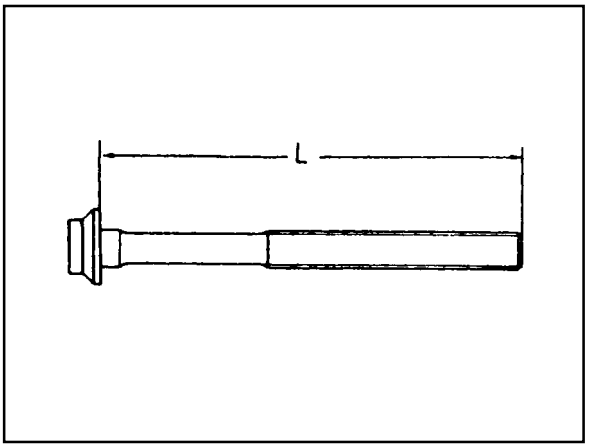
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Notice

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 lengthes indicated in the table.

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.

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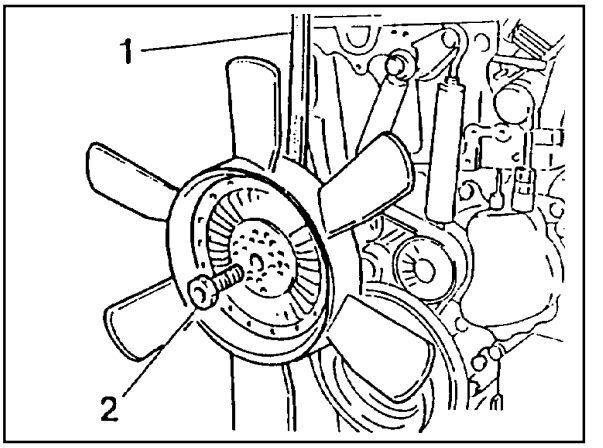
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Disassembly Procedure

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.

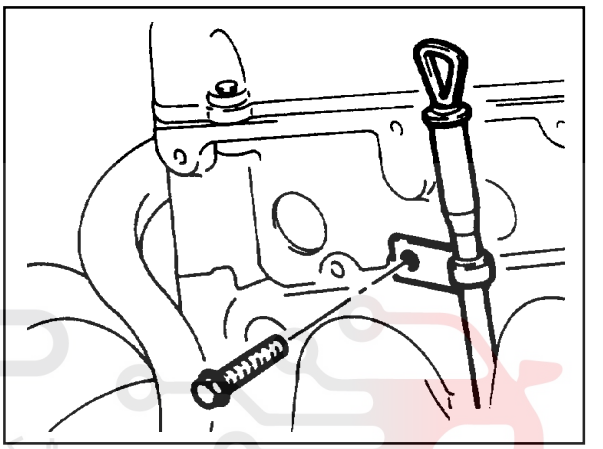
   Notice

   Keep the fan in vertical position.

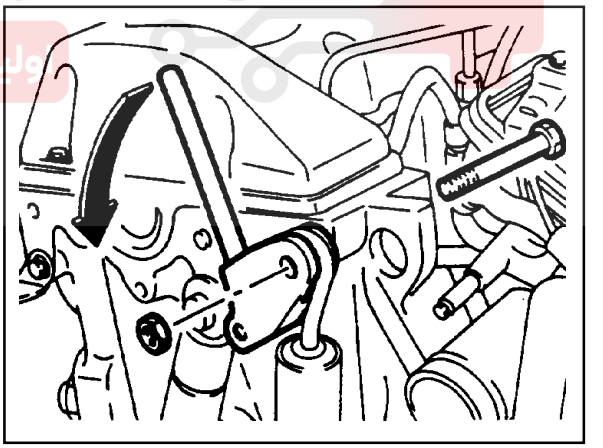


Counter Holder 603 589 00 40 00

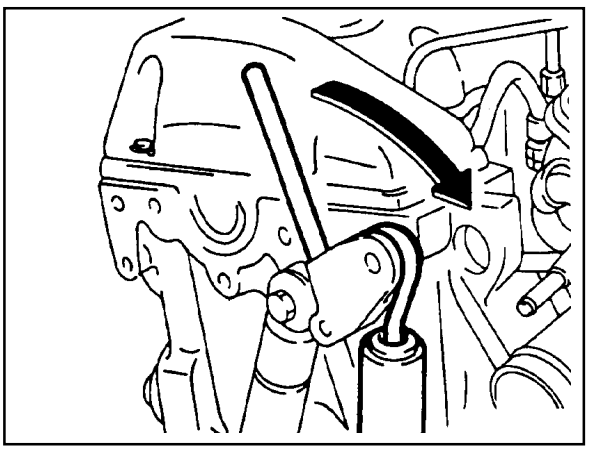
4. Remove the bracket oil dipstick tube.



5. Remove the nut.
6. Remove the nut on the tensioning lever and insert the rod(F12´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.



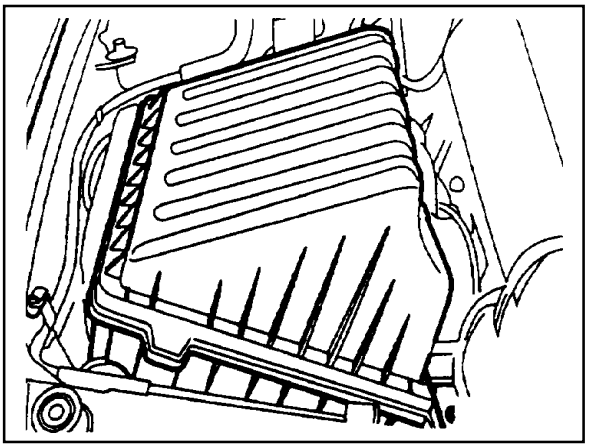
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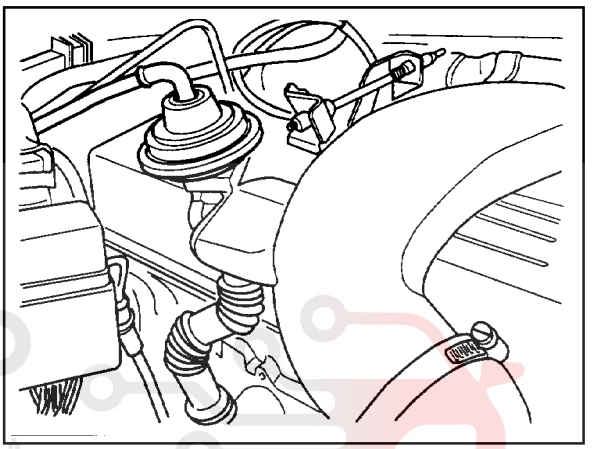
8. Remove the air cleaner cover and element and then remove the air cleaner housing.
9. Remove the oil return hose and plug.

Notice

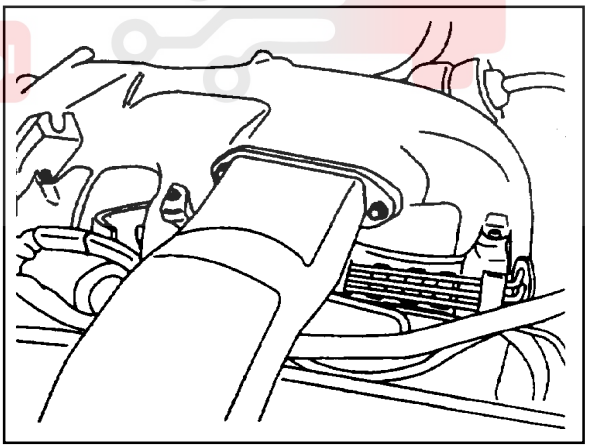
Cover them to prevent chips from coming into.



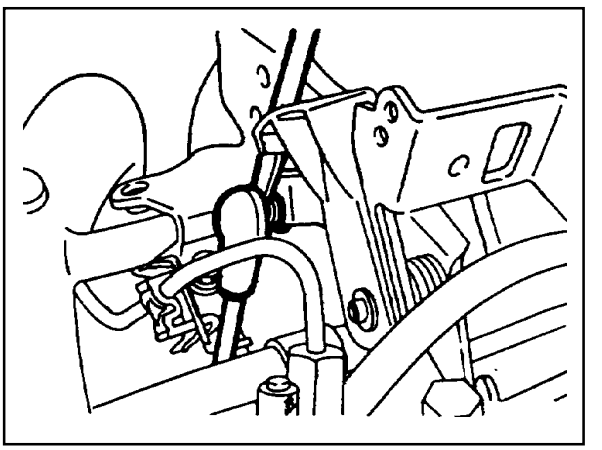
10. Unscrew the EGR pipe mounting bolts onto the exhaust manifold.
11. Remove the duct bracket from the cylinder head.



12. Unscrew the intake duct mounting bolts onto the intake manifold.



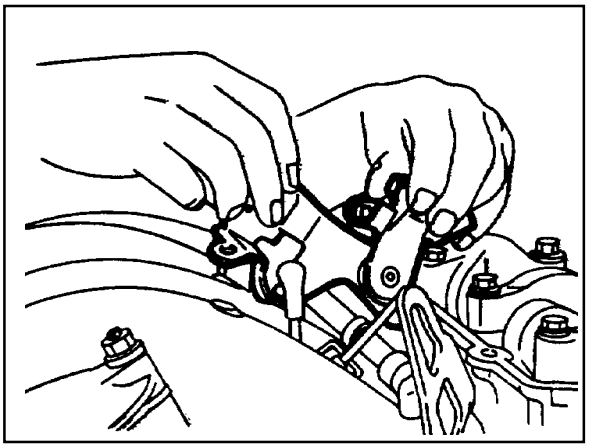
13. Separate the connecting rod from the control lever.



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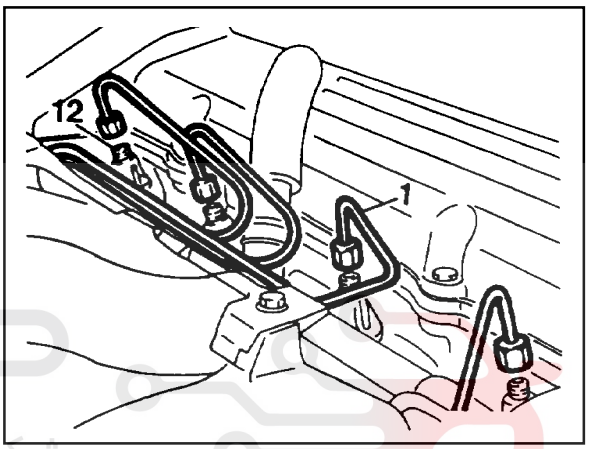
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14. Pull out the accelerator control linkage.



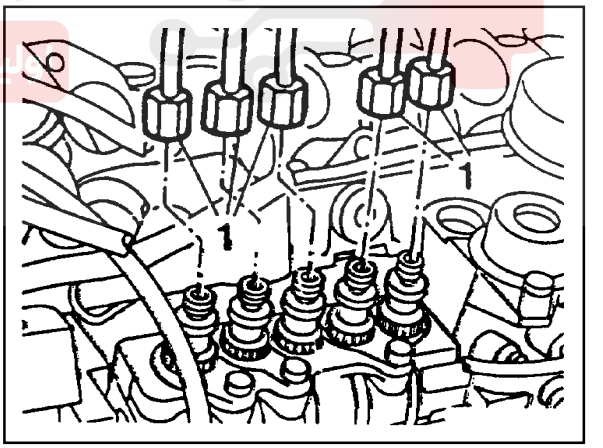
15. Remove the fuel injection line(1) from the fuel injection nozzle(12).

Box Wrench Inset 000 589 77 03 00

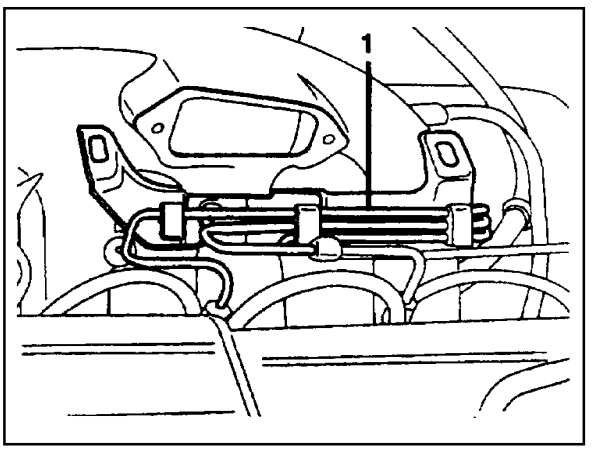


16. Remove the fuel injection line from the fuel injection pump.

Box Wrench Insert 000 589 77 03 00



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

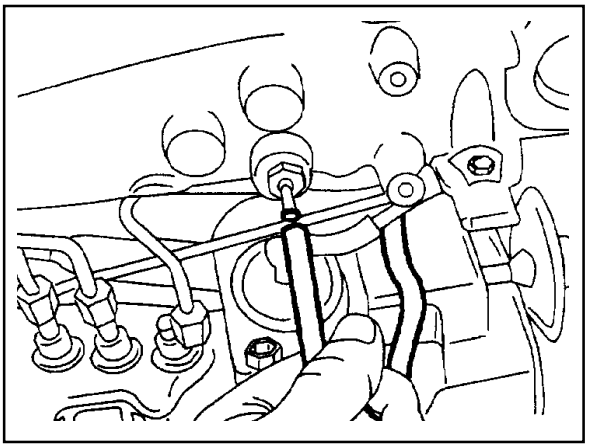


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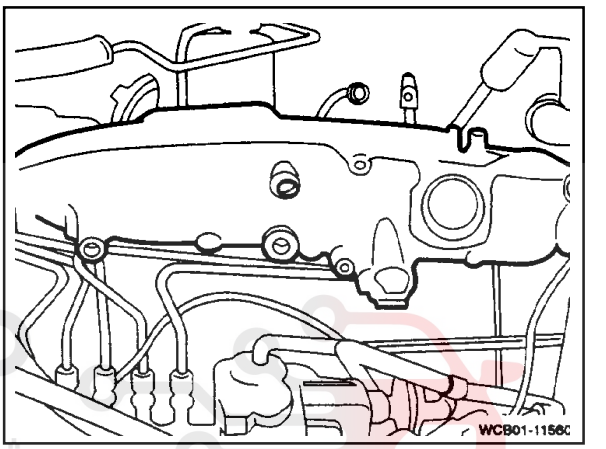
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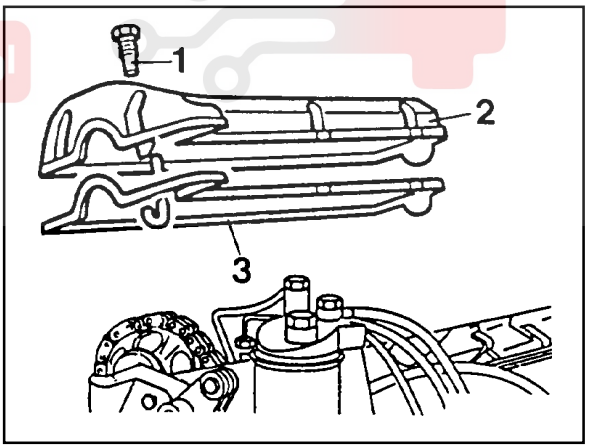
18. Disconnect the booster hose connected to intake manifold.



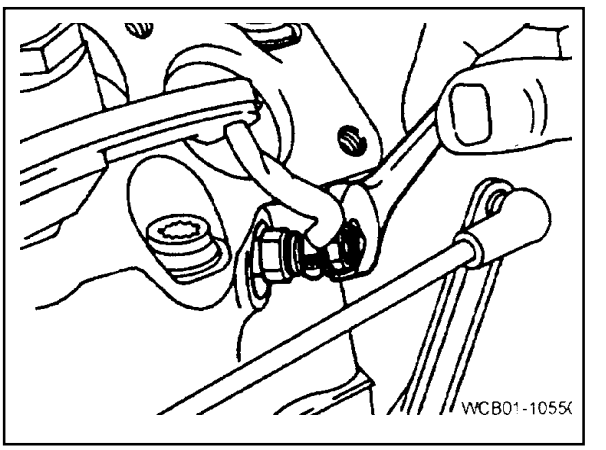
19. Remove the intake manifold and gasket.



20. Remove the cylinder head cover and gasket with the blow-by gas hose.



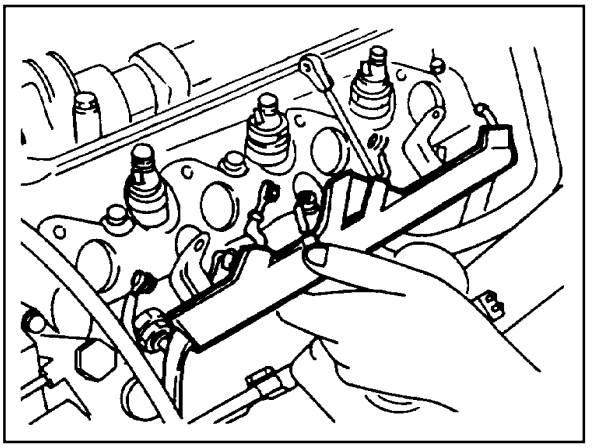
21. Disconnect the glow plug cables.



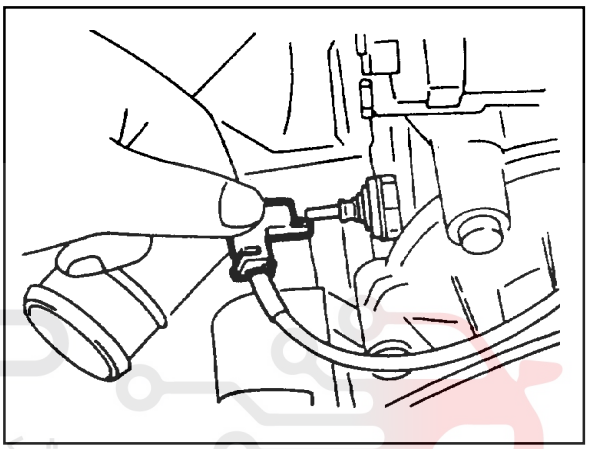
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22. Remove the cable channel.

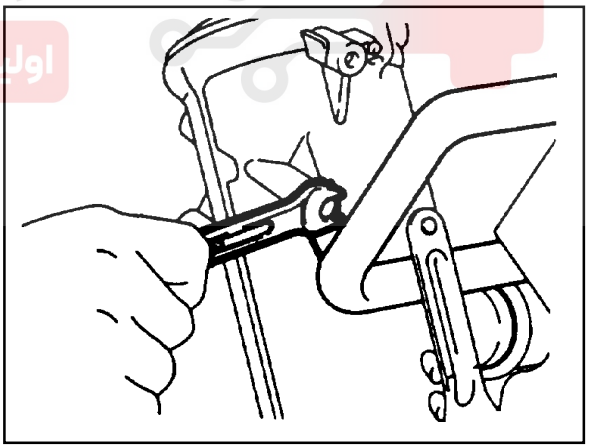


23. Disconnect the cables from the glow plug sensor and coolant temperature sensor.

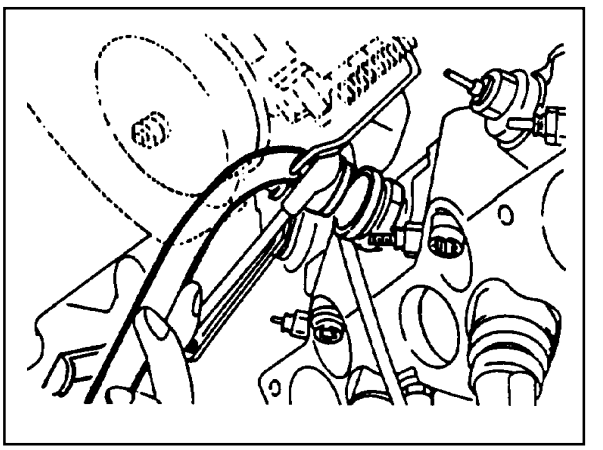


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24. Remove the heater pipe bracket from the oil filter.



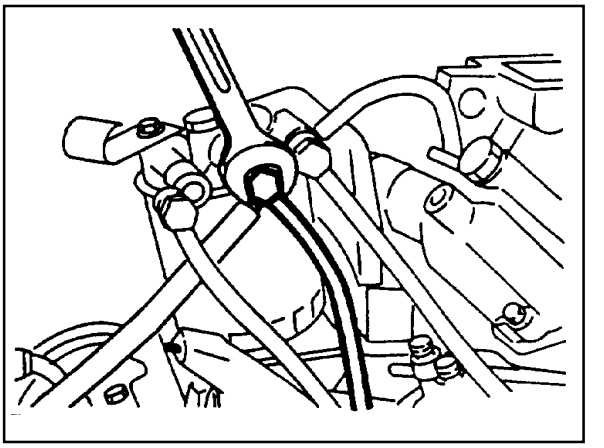
25. Pry off the clamp and push the heater feed pipe forward and then pull out the pipe.



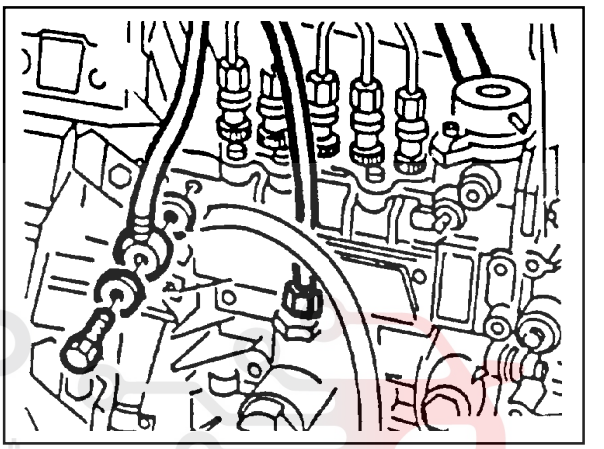
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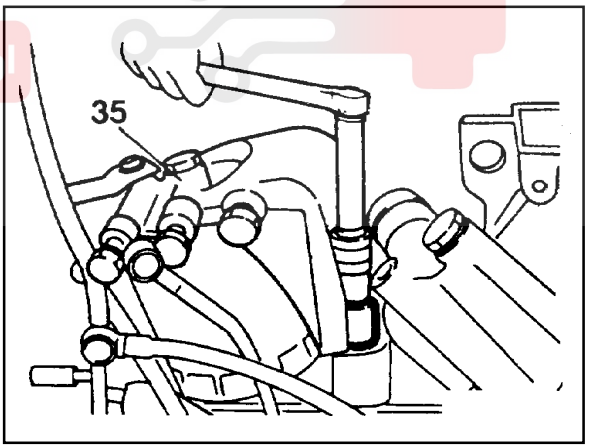
26. Disconnect the fuel lines from the fuel filter.



27. Disconnect the fuel lines from the injection pump.

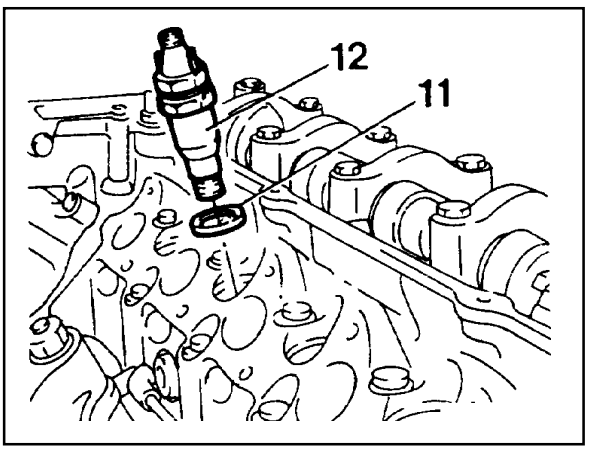


28. Remove the fuel filter(35).



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

Socket Wrench Insert 001 589 65 09 00



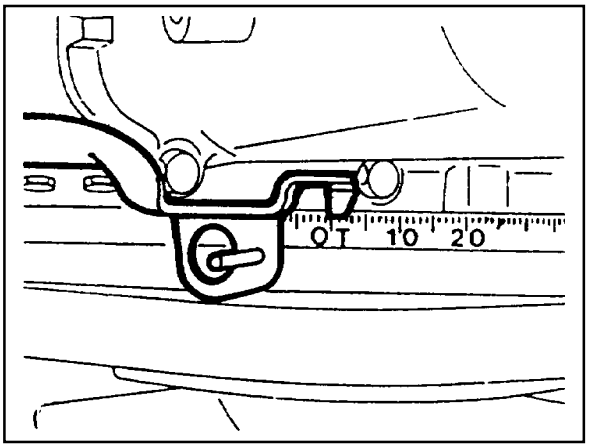
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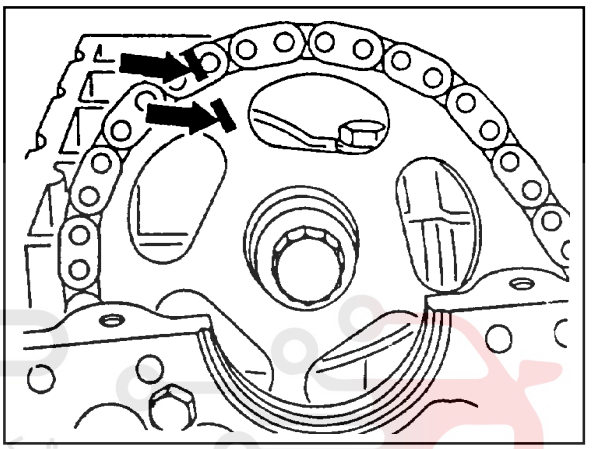
30. Rotate the crankshaft and set the no.1 cylinder at TDC.

Notice

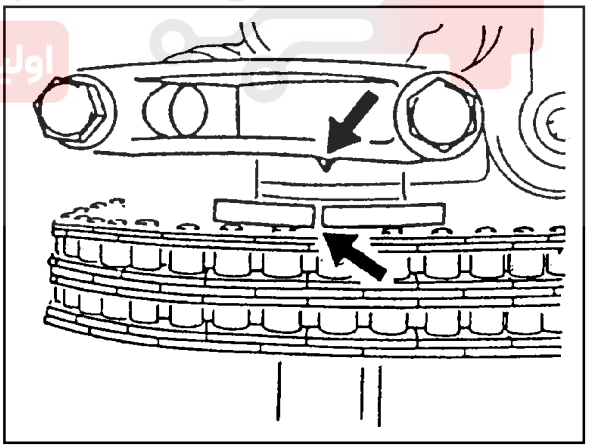
Do not rotate the crankshaft to the opposite direction of engine revolution.



31. Place alignment marks on the camshaft gear and timing chain.

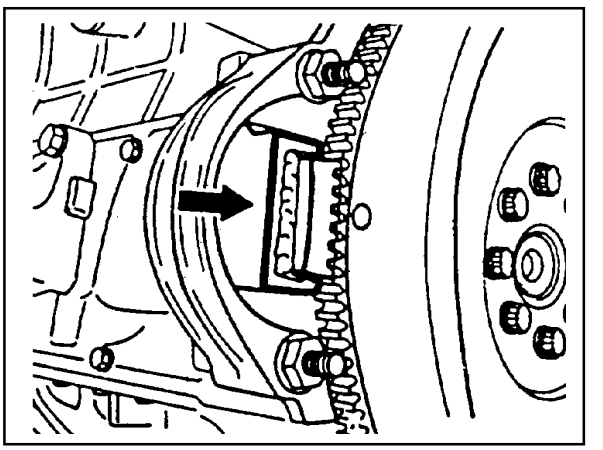


32. Ensure that the camshaft and the bearing cap marking are aligned.



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

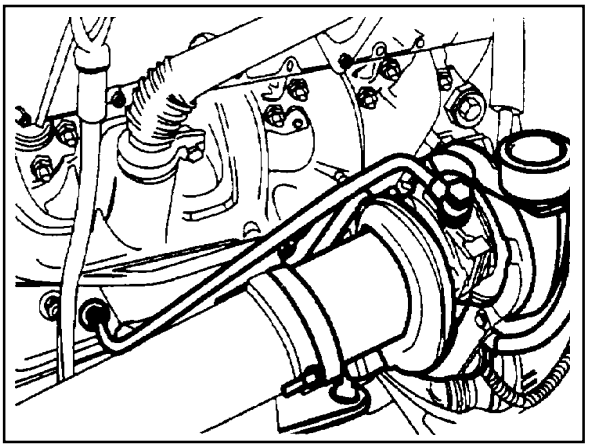
Engine Lock 602 589 00 40 00



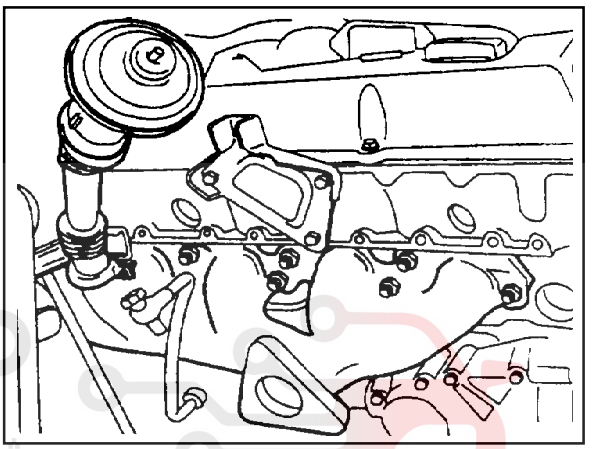
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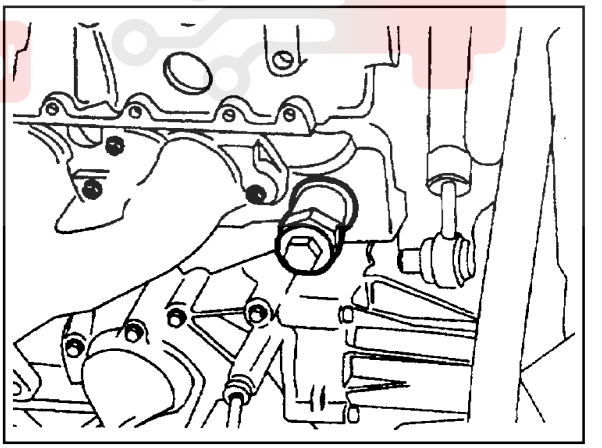
34. Remove the turbocharger.



35. Remove the exhaust manifold and gasket.



36. Remove the chain tensioner and seal.

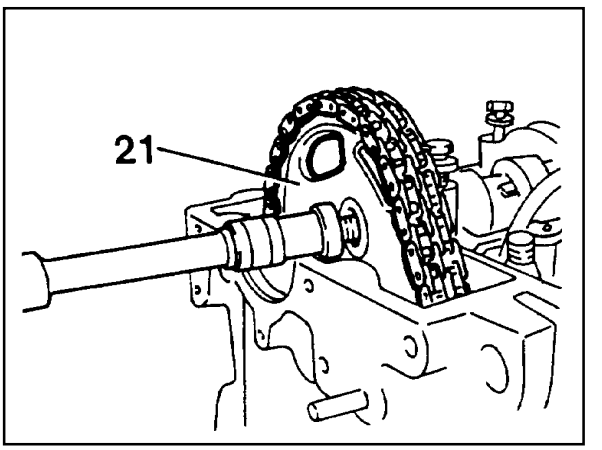


37. Remove the bolt and separate the drive sprocket(21).

Notice

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.



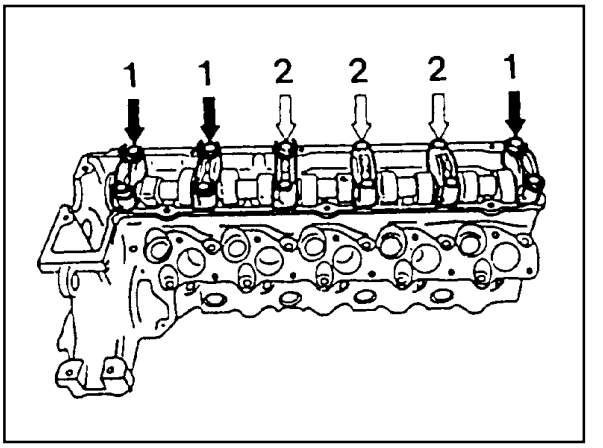
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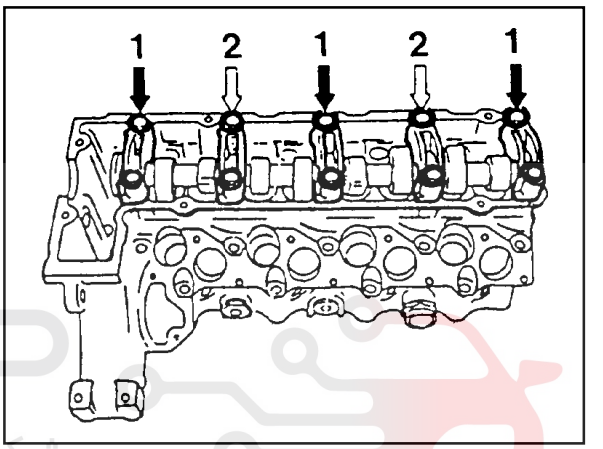
38. Remove the camshaft bearing cap bolts according to the numerical sequence.

Notice

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.



OM662LA

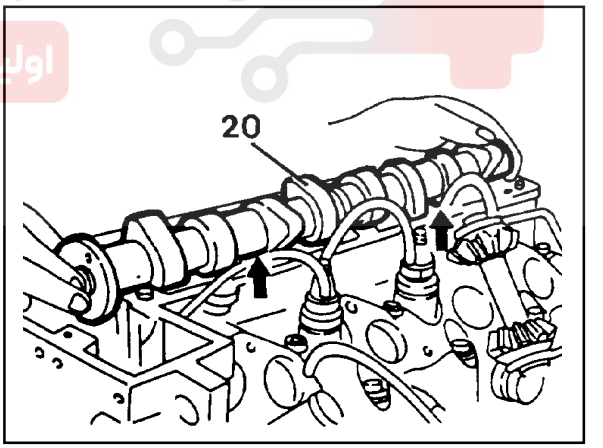


OM661LA

39. Remove the bearing caps and then pull out the camshaft(20) upward.

Notice

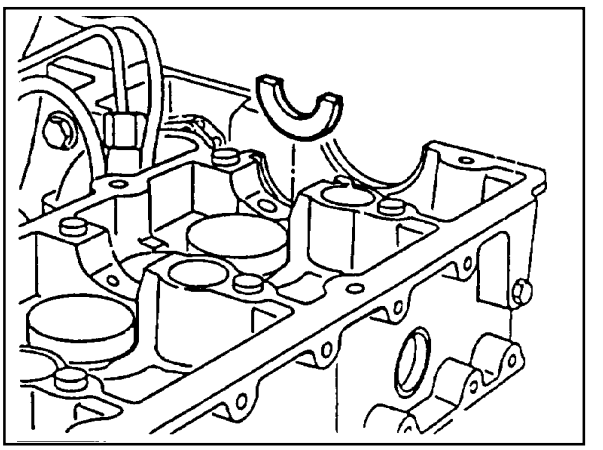
Be careful not to miss the locking washer.



40. Remove the locking washer.

Notice

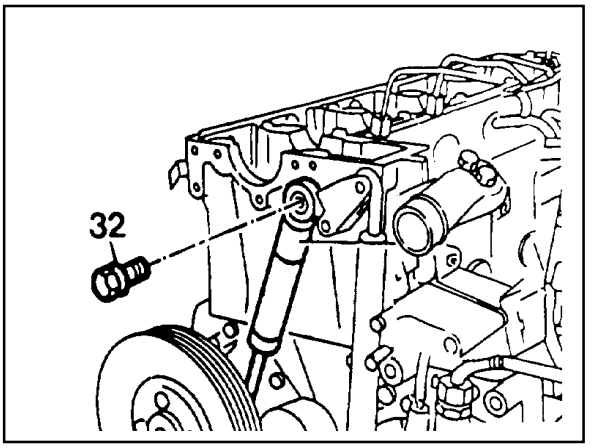
Check the locking washer and replace if necessary.



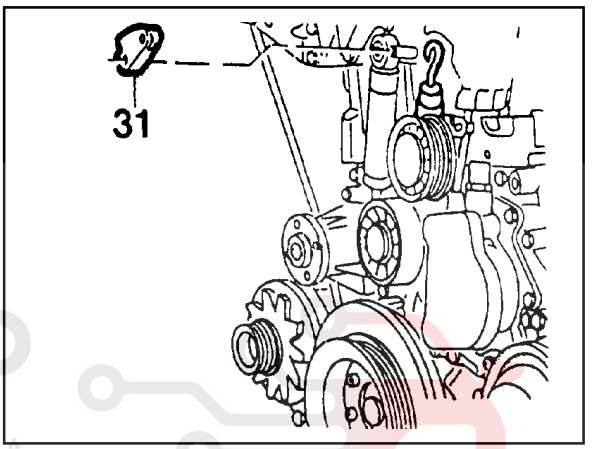
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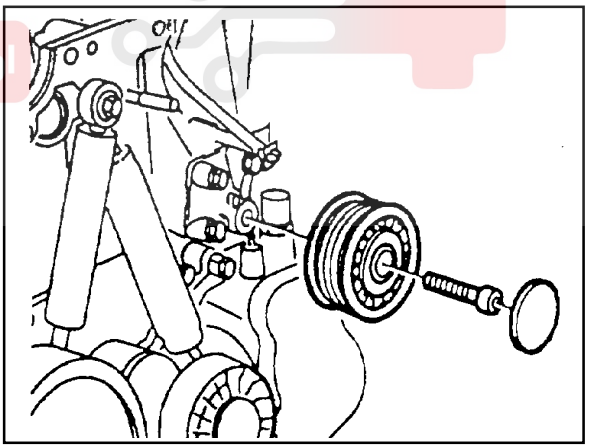
41. Remove the bolt(32).



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

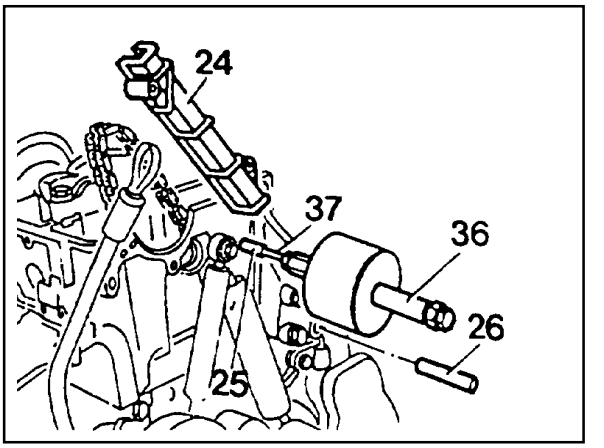


43. Pry off the closing cover. Remove the bolt and then remove the idle pulley.



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

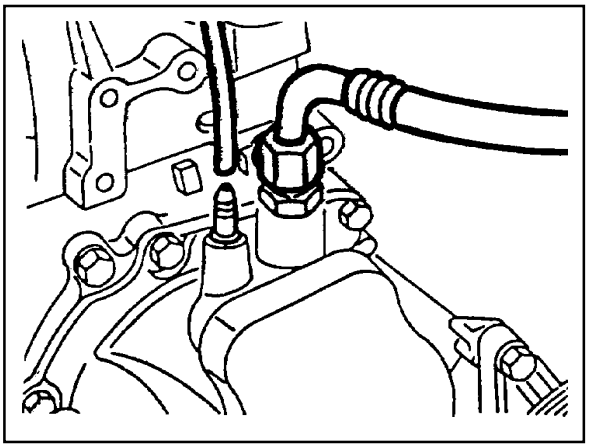
Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00



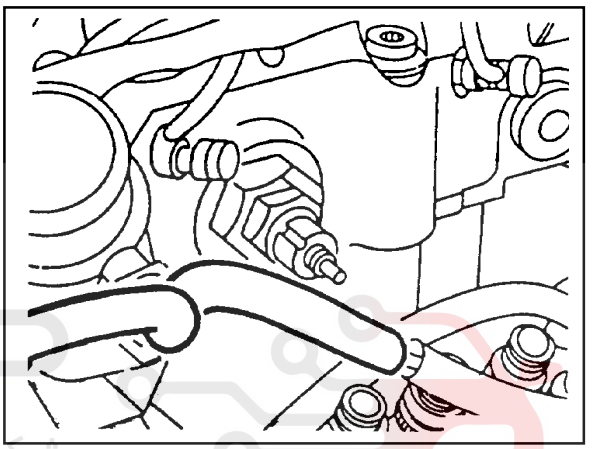
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45. Remove the vacuum line from the vacuum pump.

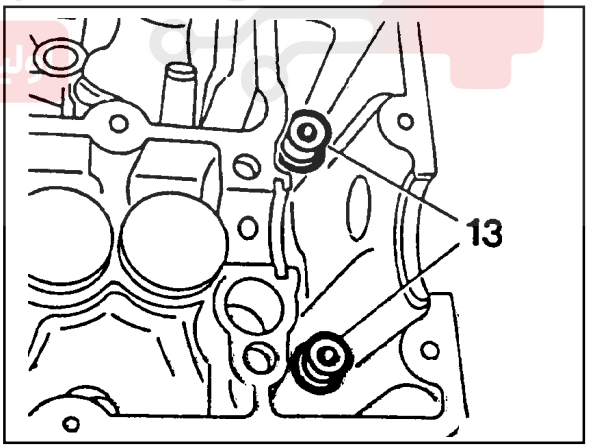


46. Disconnect the vacuum pipe from thermo valve.



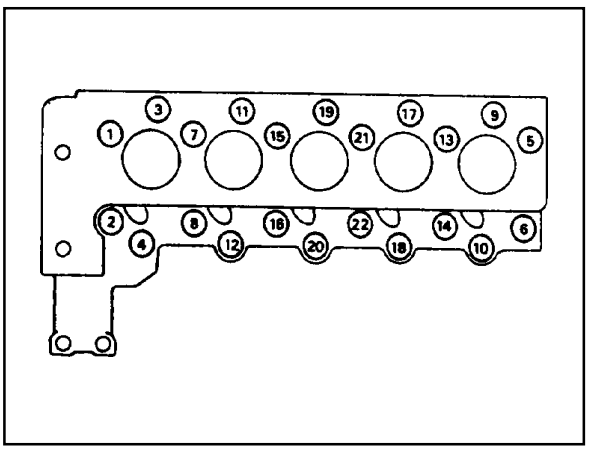
47. Remove the socket bolts(13) of the chain box.

T Type Socket Wrench 116 589 03 07 00
Magnetic Bar 102 589 03 40 00



48. Remove the cylinder head bolts in numerical se-quence.

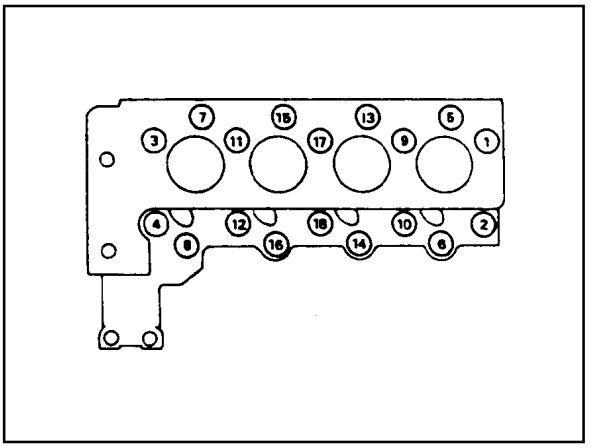
Cylinder Head Bolt Wrench 601 589 00 10 00



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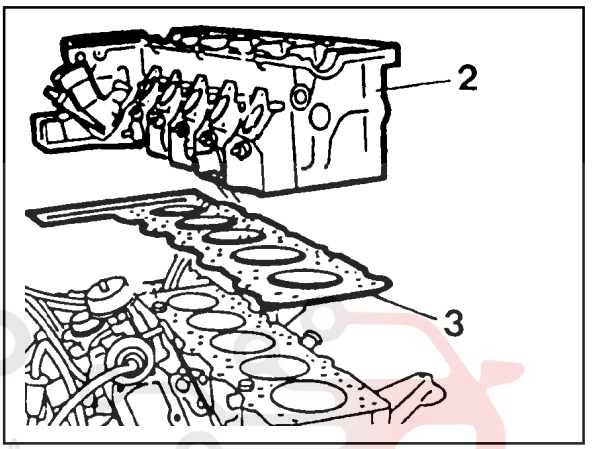
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49. Remove the cylinder head(2) and gasket(3).



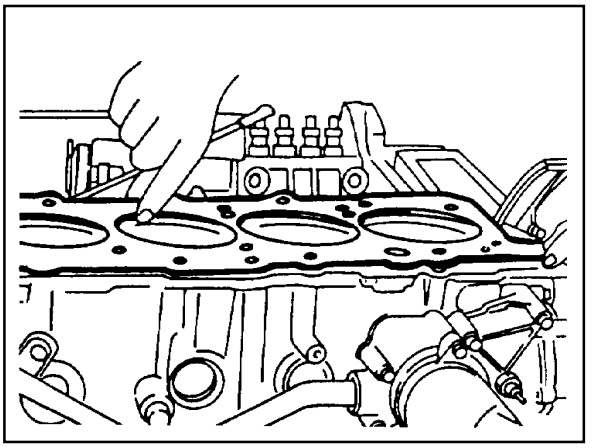
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Assembly Procedure

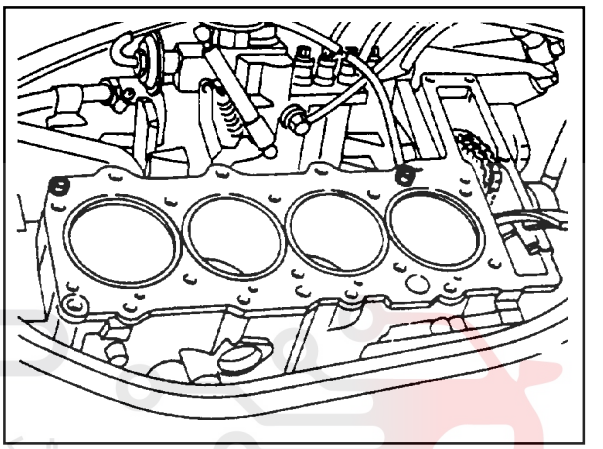
1. Replace the cylinder head gasket.



2. Install the cylinder head onto the crankcase.

   Notice

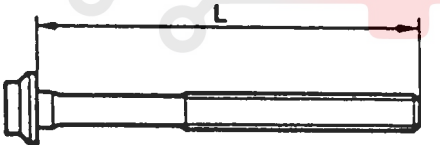
   Align the cylinder head holes with the guide pins.



3. Measure the length(L) of cylinder head bolts.

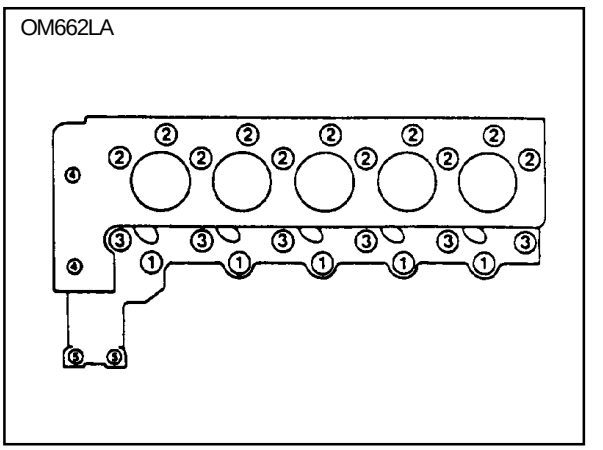
   Notice

   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

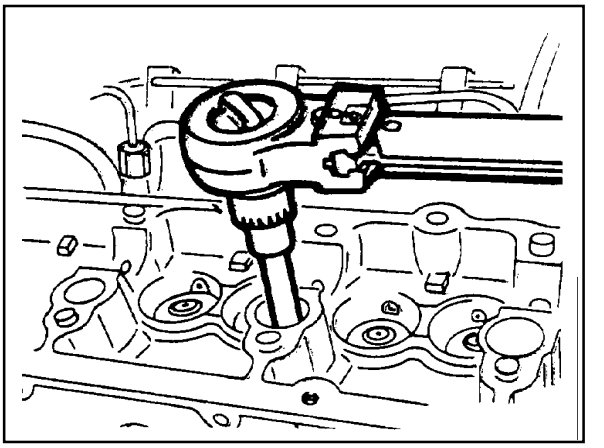
1 ..... M10 × 80
2 ..... M10 × 102
3 ..... M10 × 115
4 ..... M 8 × 50
5 ..... M 8 × 80

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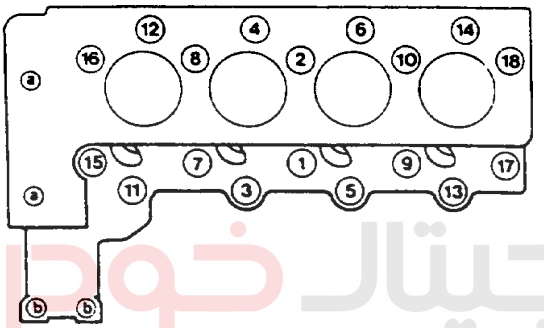
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5. Tighten the cylinder head bolts to specified torque and torque angle.

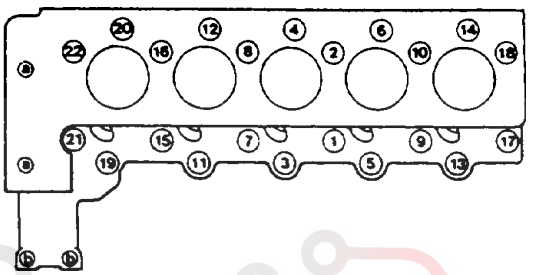
Stage 1	15 Nm
Stage 2	35 Nm
Torque angle	90°
Wait for	10 minutes
Torque angle	90°



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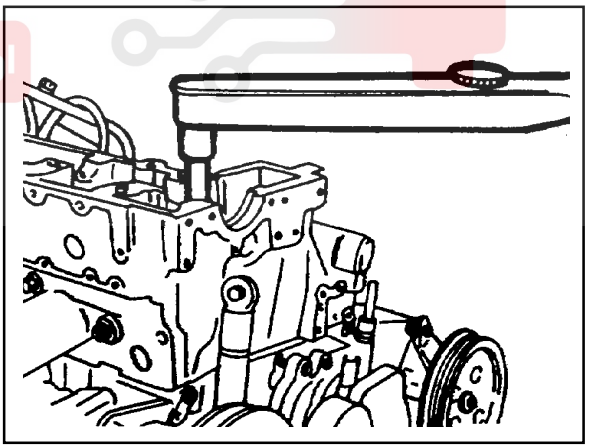
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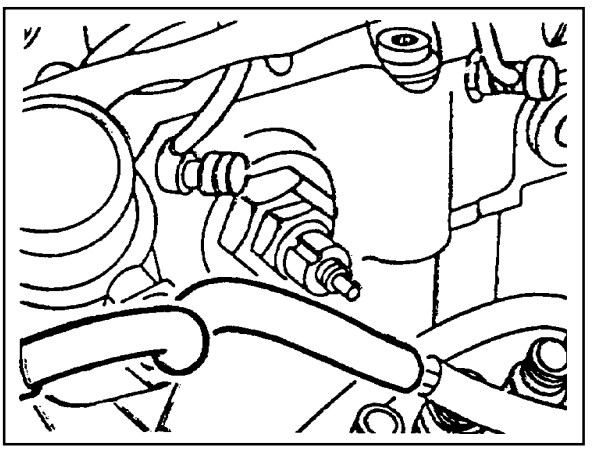
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6. Install the socket bolts in the chain box.

Tightening Torque	25 Nm



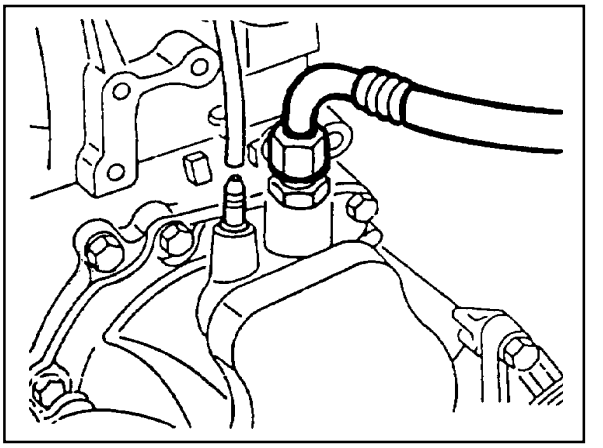
7. Connect the vacuum pipe to the thermo valve.



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8. Connect the vacuum lines to the vacuum pump.

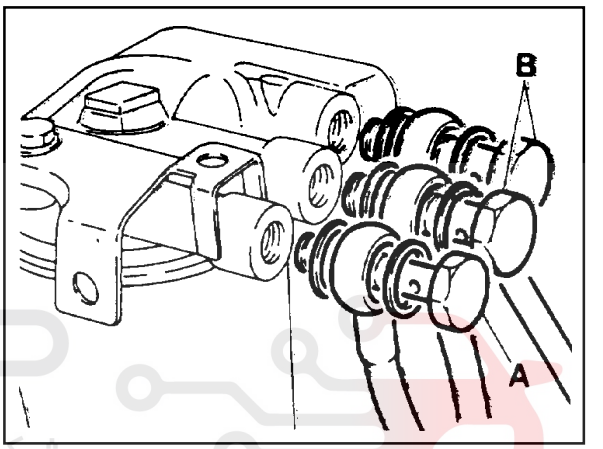


9. Install the fuel filter and connect the pipe.

Tightening Torque	25 Nm

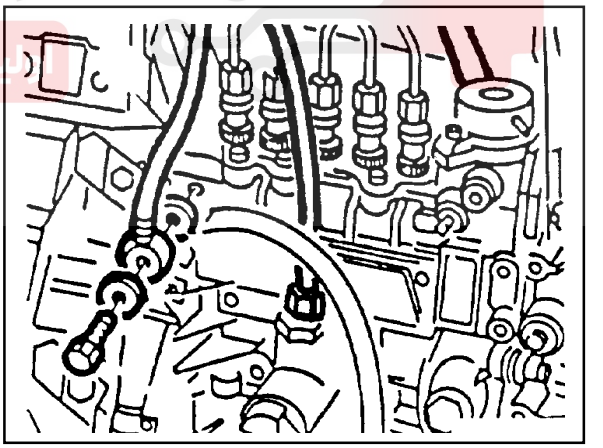
Notice

Be careful not to be confused the connections and hoses.



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10. Connect the fuel pipe to the injection pump.

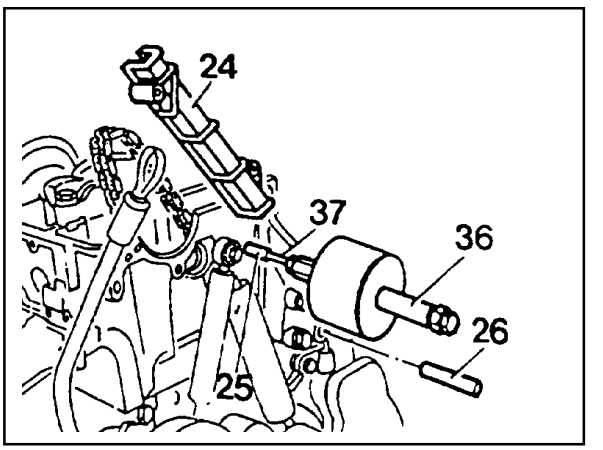


11. Install the sliding rail(24) and insert the sliding rail pins(25, 26).

Notice

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

Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00

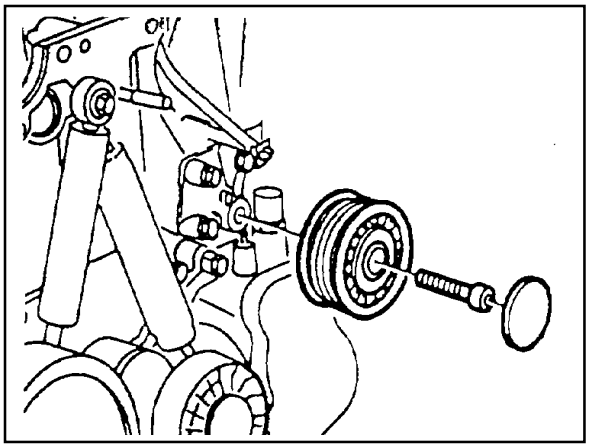


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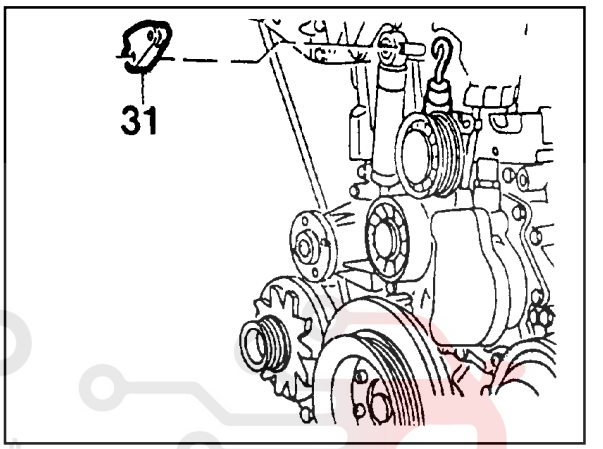
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12. Install the idle pulley and fit the closing cover.

Tightening Torque	25 Nm



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

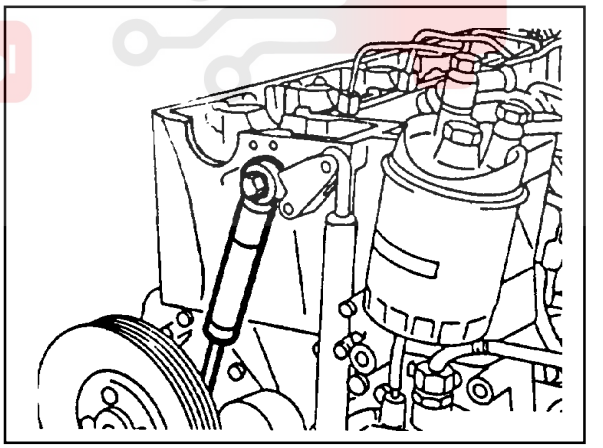


14. Install the damper.

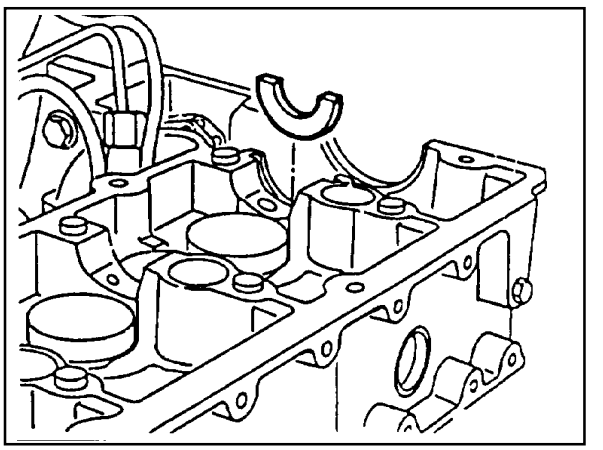
Tightening Torque	23 Nm

Notice

Insert the tensioning lever bolts onto the mounting hole.



15. Insert the locking washer.
16. Inspect the valve tappet and check that the tappet moves smoothly.



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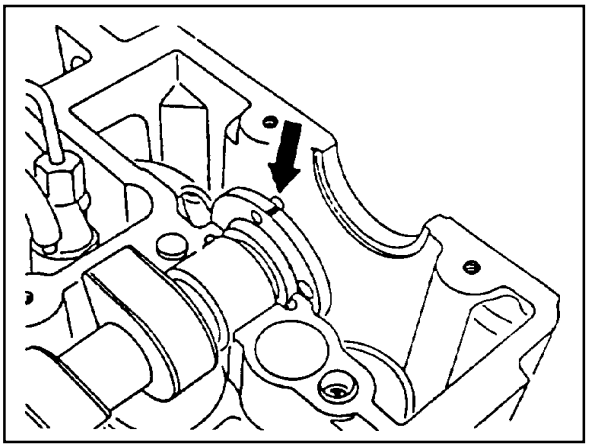
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17. Coat the camshaft with oil and install the camshaft on the cylinder head to be TDC mark(arrow) upward.
18. Measure the axial end play of the camshaft.

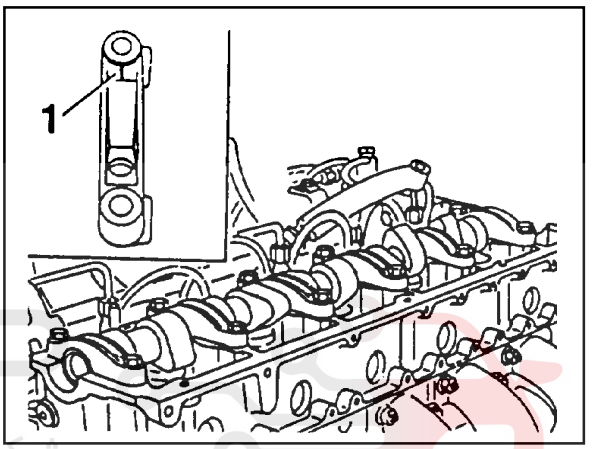
End Play	0.06 - 0.21mm

Notice

If out of standard, adjust it with the proper thickness of locking washer.



19. Install the bearing caps on the camshaft according to the number on the caps.

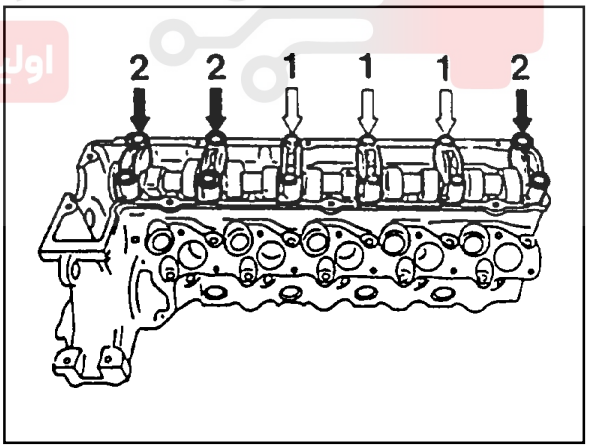


20. Tighten the bearing cap bolts according to the numerical sequence.

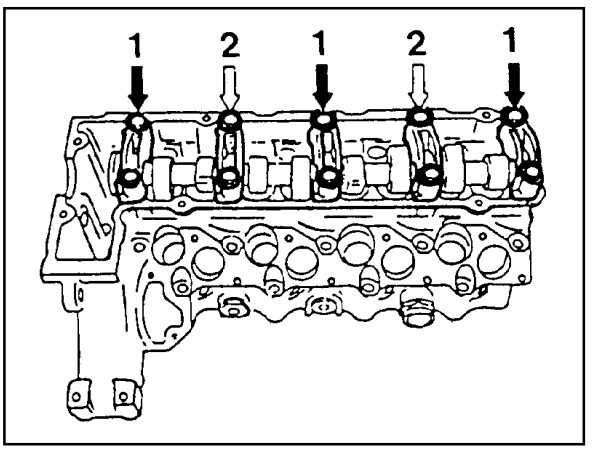
Tightening Torque	25 Nm

Notice

Tighten the No. 1 bolts(light arrow) first and then tighten the No. 2 bolts(dark arrow) stage by stage.



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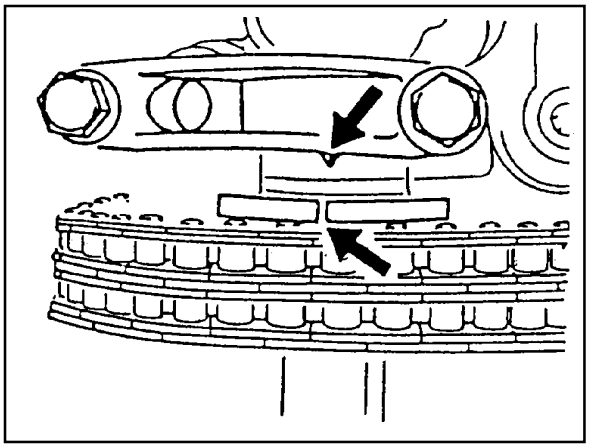
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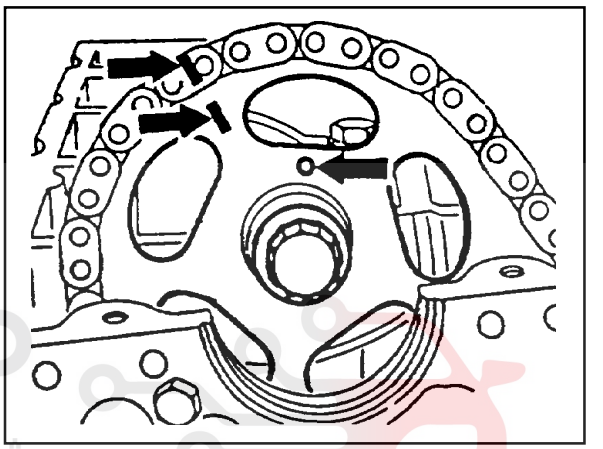
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21. Position the camshaft on marking and install the camshaft sprocket.

Notice

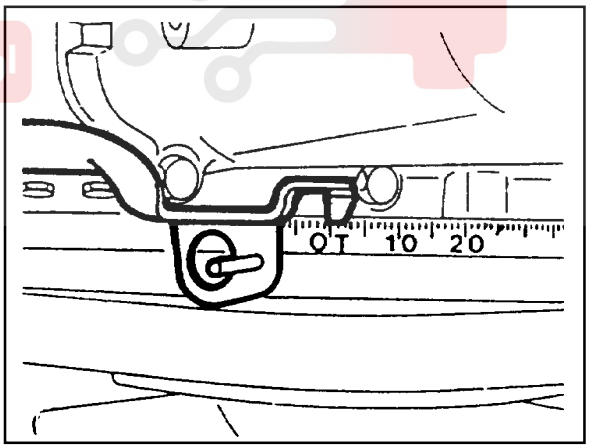
Align the alignment marks on the chain and sprocket.





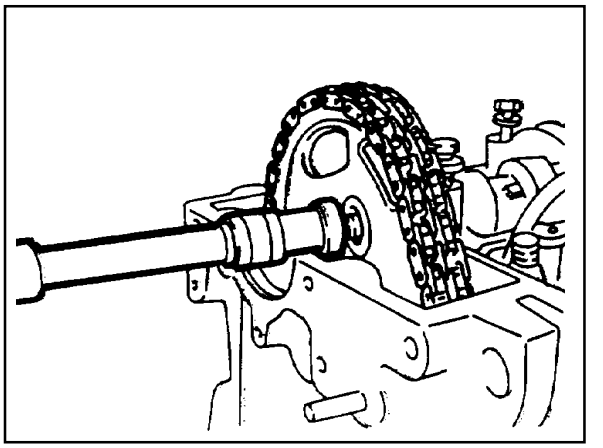
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22. Check the TDC position of the crankshaft.



23. Install the camshaft sprocket bolt.

Tightening Torque	25 Nm + 90°

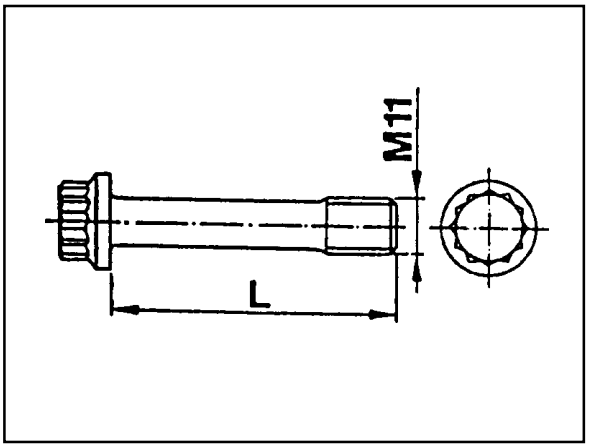


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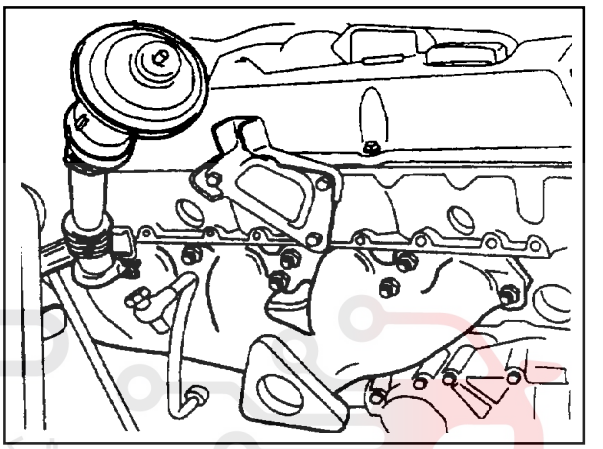
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Notice

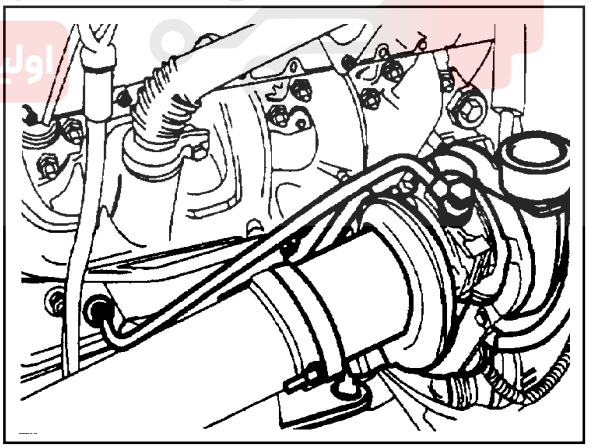
Measure the max. length 'L' and replace the bolt if it exceeds 53.6mm.



24. Install the exhaust manifold and gasket.

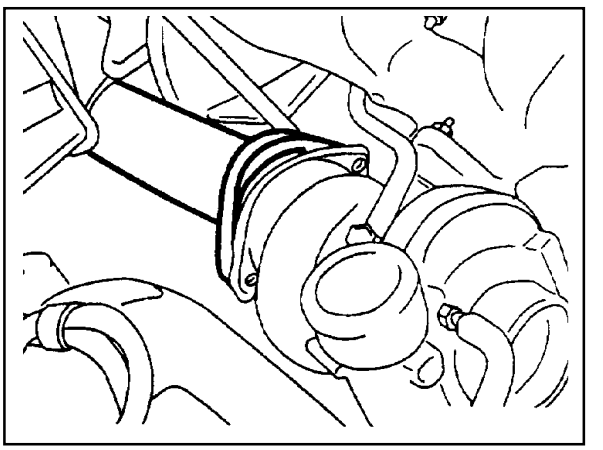


25. Install the turbocharger.



26. Install the exhaust pipe onto the turbocharger.

Tightening Torque	25 Nm

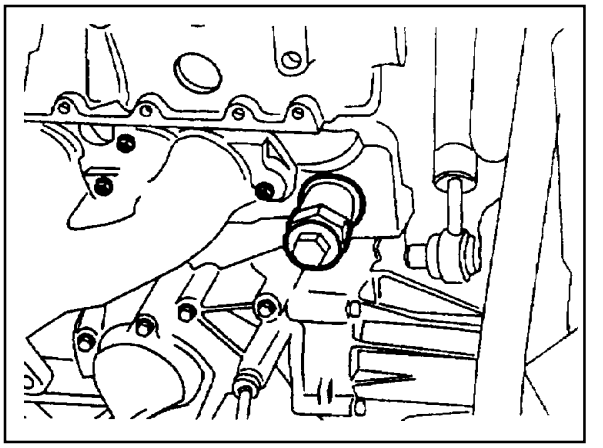


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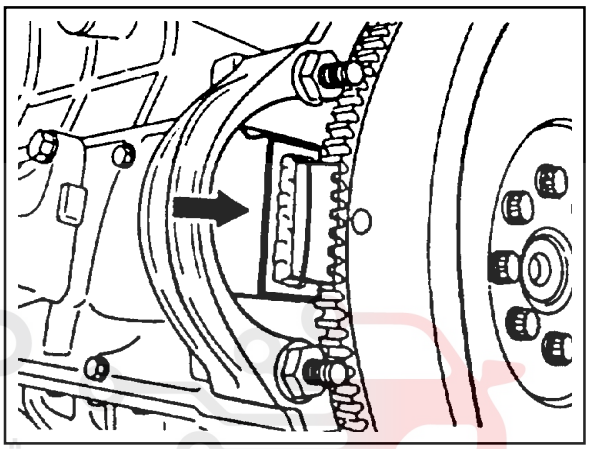
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27. Replace the seal and then install the chain tensioner.

Tightening Torque	80 Nm

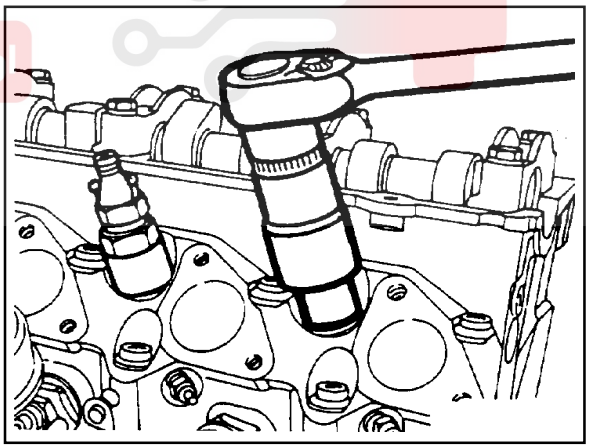


28. Remove the engine lock.

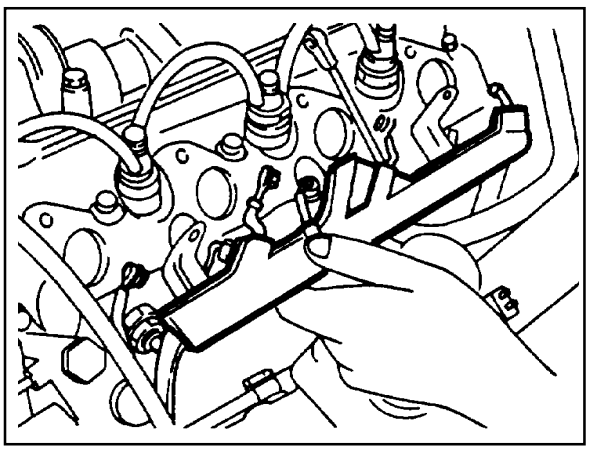


29. Insert the nozzle washer into the hole to face round part downward.
30. Install the fuel injection nozzle.

Tightening Torque	40 Nm



31. Connect the fuel hose.
32. Install the cable channel and connect the cables to glow plugs.

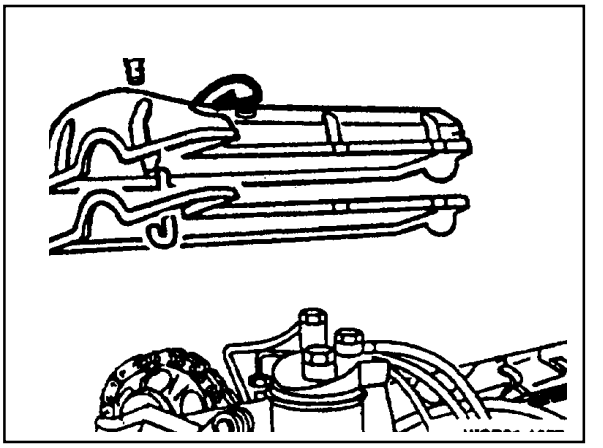


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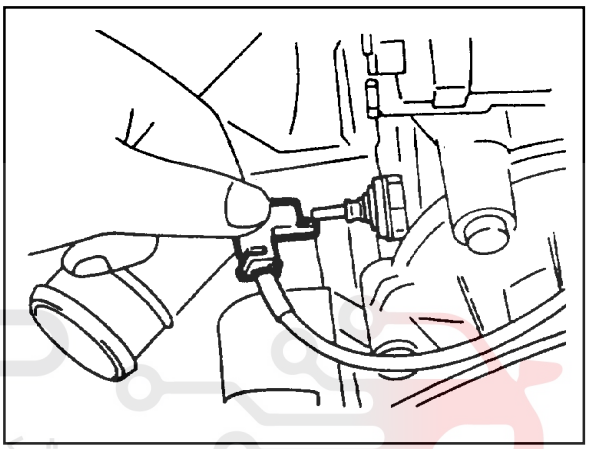
33. Replace the gasket and install the cylinder head cover.

Tightening Torque	10 Nm



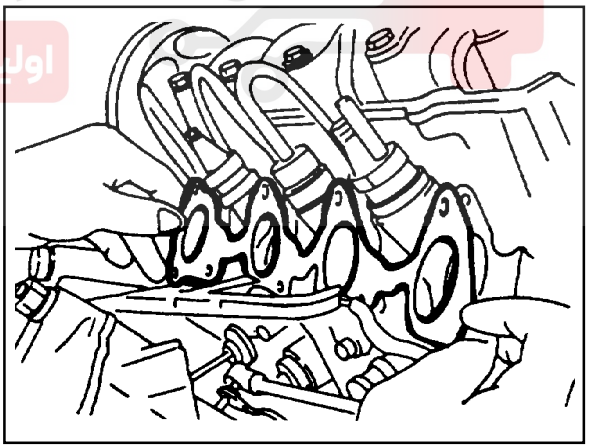
34. Install the blow-by hose.

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



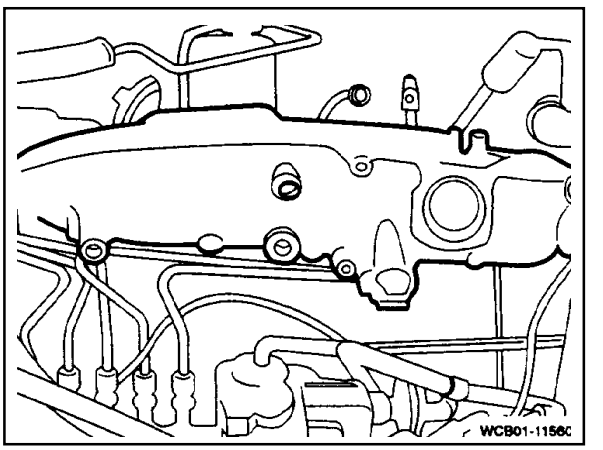
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36. Replace the intake manifold gasket.



37. Install the intake manifold.

Tightening Torque	25 Nm



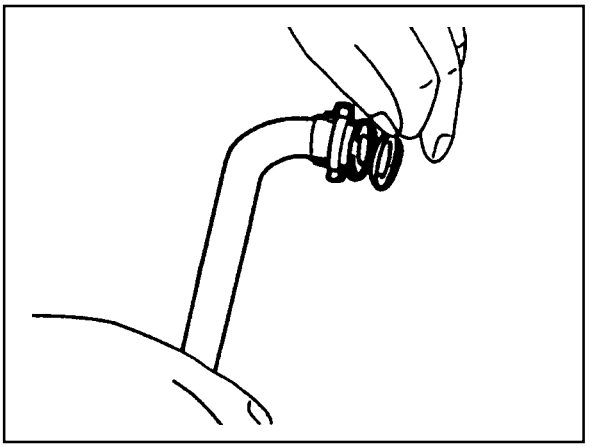
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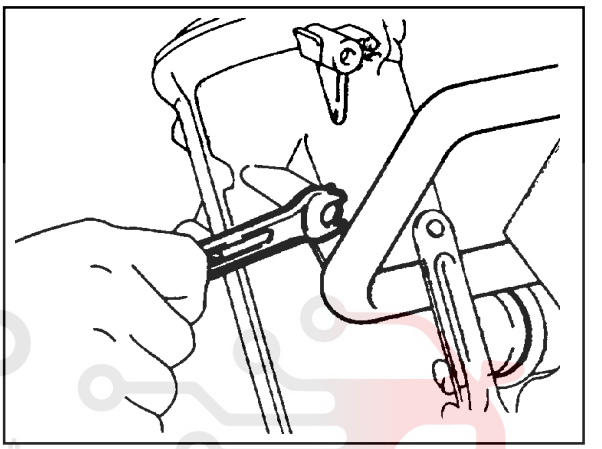
38. Replace the O-ring of heater feed pipe and install it to the cylinder head.

    Notice

    For installation, clean the hole.

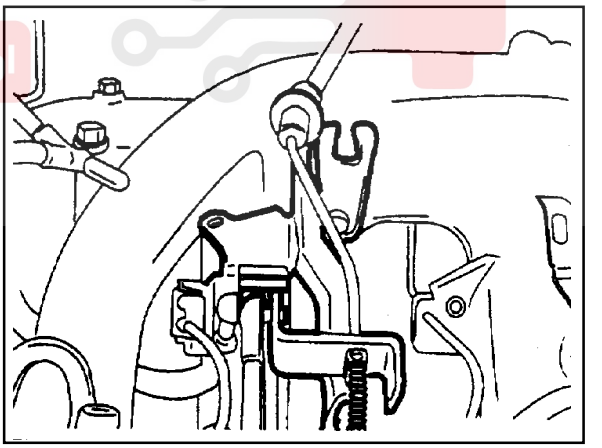


39. Install the bracket of heater feed pipe to the oil filter.

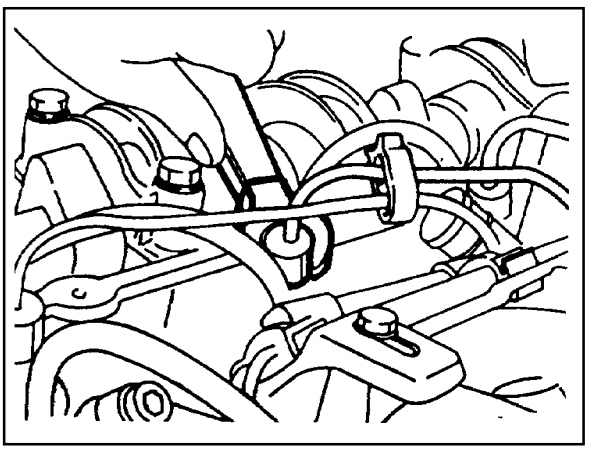


40. Install the fuel pipe and the accelerator control linkage.
41. Connect the fuel lines to the injection nozzles and to the injection pump.

    Box Wrench Insert 000 589 77 03 00



Tightening Torque	18 Nm



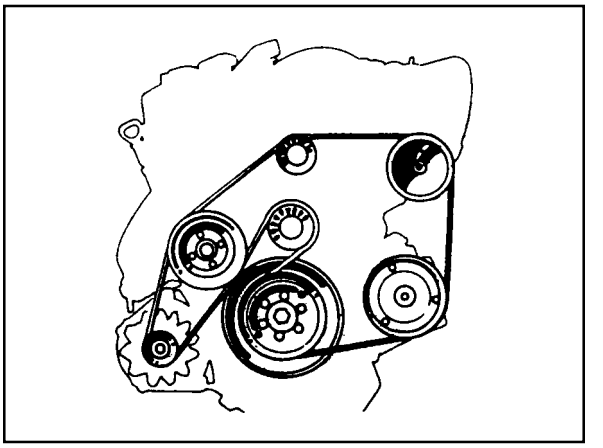
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42. Install the poly V-belt.

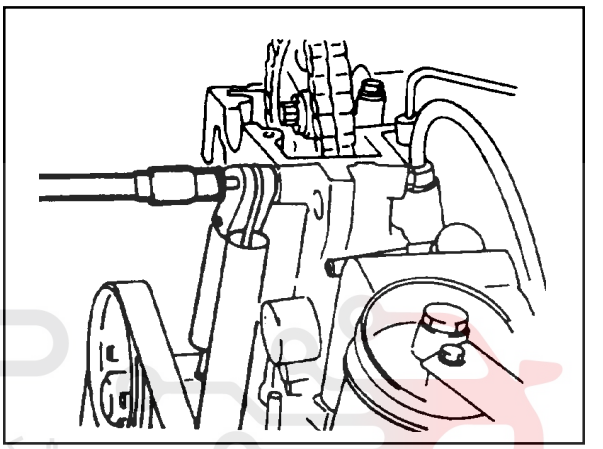
Notice

Be careful not to contaminate the belt.



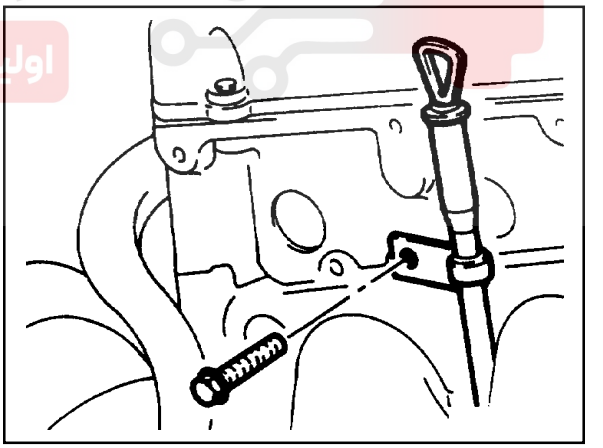
43. By inserting a rod into the tensioning lever upper hole and pulling the rod, install the bolt and then tighten the nut.

Tightening Torque	23 Nm

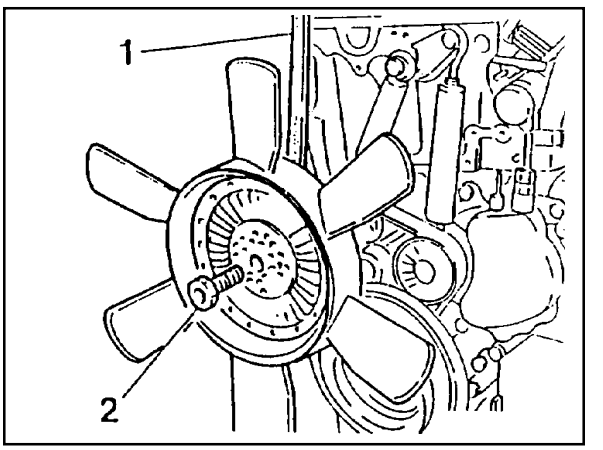


44. Install the oil dipstick tube bracket.

Tightening Torque	10 Nm



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

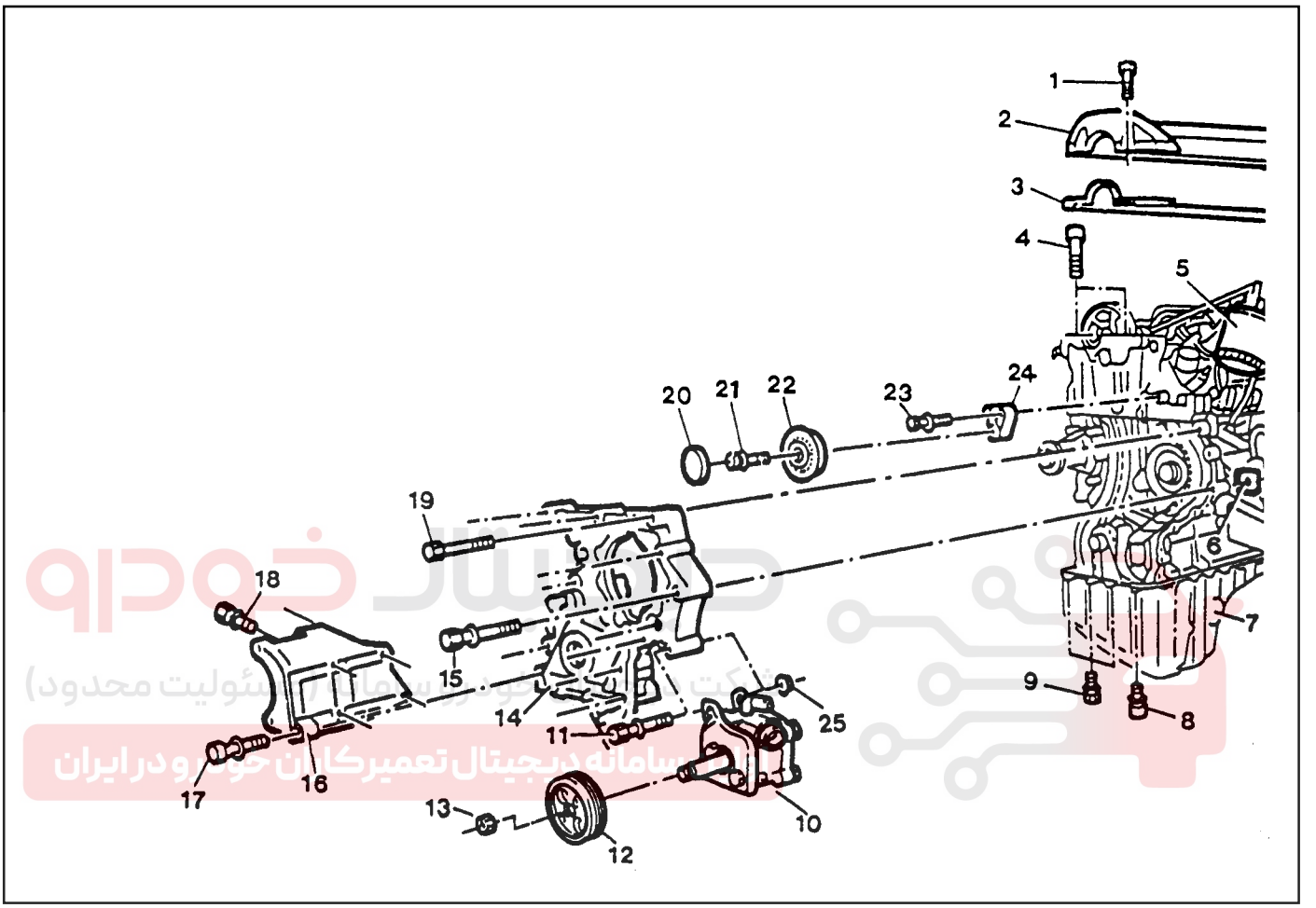


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TIMING CASE COVER

Preceding Work : Removal of the cooling fan
Rmoval of the V-belt tensioning device
Removal of the vibration damper and hub
Removal of the alternator



1	Bolt	10Nm
2	Cylinder Head Cover	
3	Gasket	Replace
4	Socket Bolt	25Nm
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	45Nm
18	Bolt	25Nm
19	Bolt	10Nm
20	Closing Cover	
21	Socket Bolt	23Nm
22	Guide Pulley	
23	Bolt	9Nm
24	Guide Pulley Bracket	
25	Nut	23Nm

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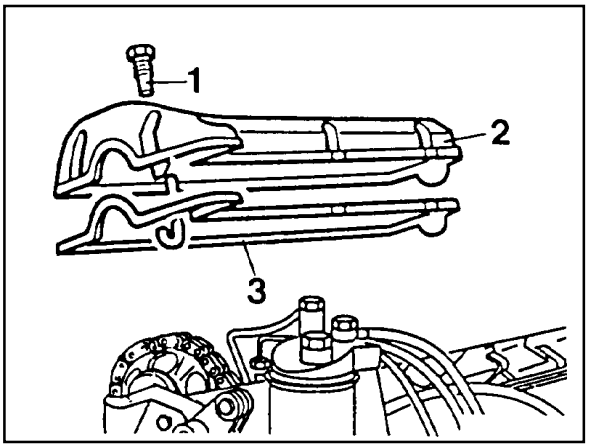
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Tools Required

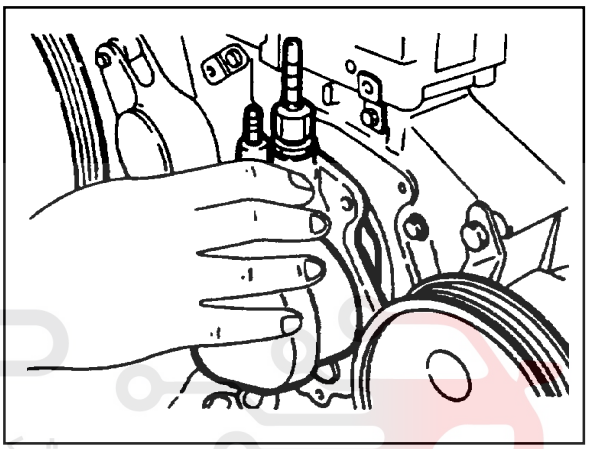
116 589 03 07 00 Socket Wrench

Removal Procedure

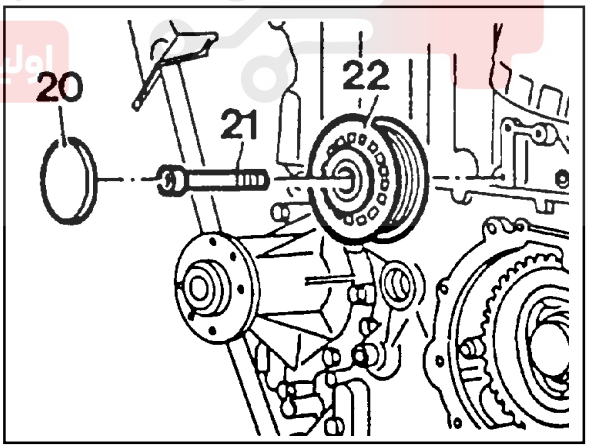
1. Remove the fan clutch and cooling fan belt pulley.
2. Drain the engine oil completely.
3. Remove the oil dipstick tube bracket bolts.
4. Remove the crankshaft pulley.
5. Loosen the bolt (1) and then remove the cylinder head cover (2) and gasket.



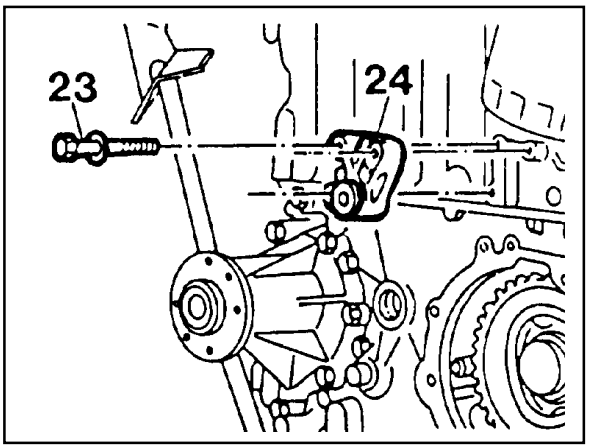
6. Remove the vacuum pump.



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



8. Remove the guide pulley bracket (24).



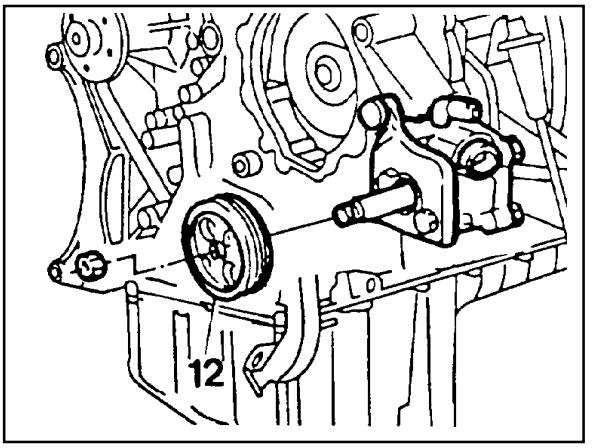
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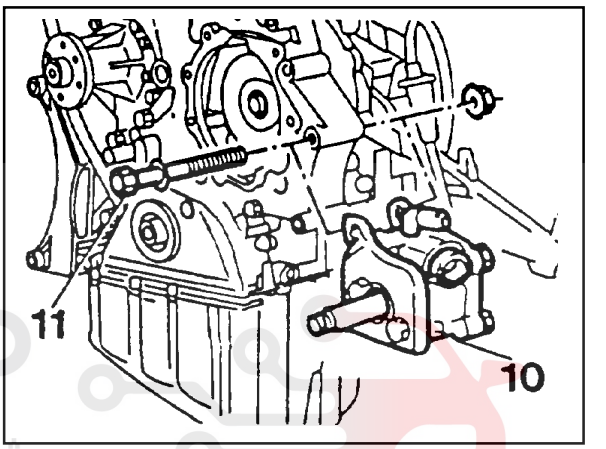
9. Disconnect the pipes of power steering pump and remove the belt pulley.

   Notice

   Be careful not to lose the key.

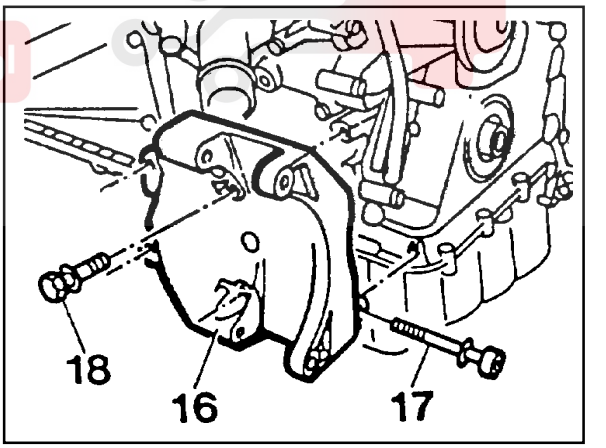


10. Remove the nut and pull out the bolt and then remove the power steering pump.

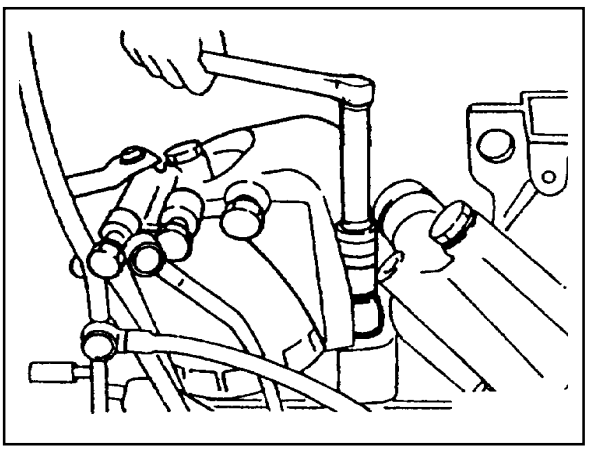


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11. Remove the alternator bracket (16).



12. Remove the fuel filter.

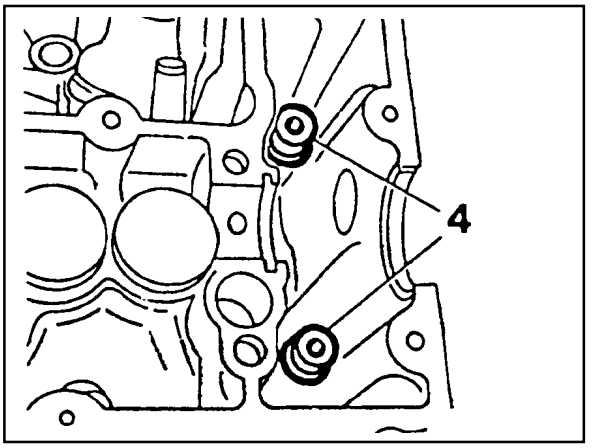


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13. Remove the camshaft.
14. Remove the socket bolts(4) in the chain box.

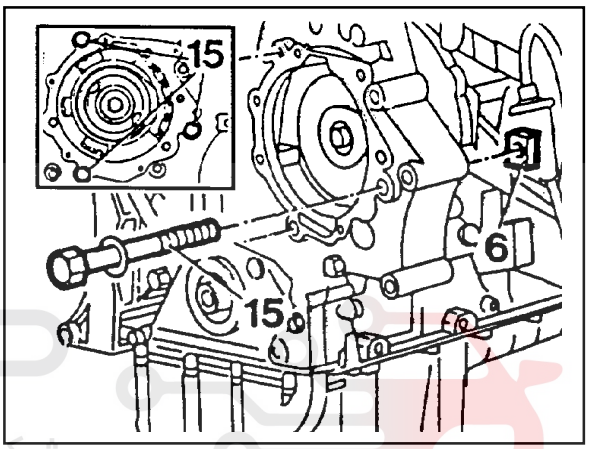
Socket Wrench 115 589 03 07 00



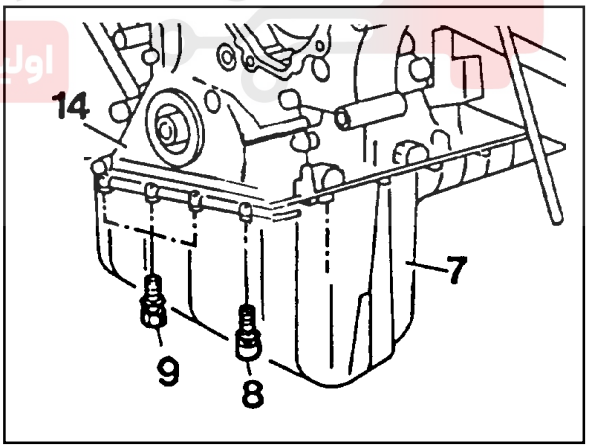
15. Remove the injection pump.

Notice

See the 'Removal of fuel injection pump'.



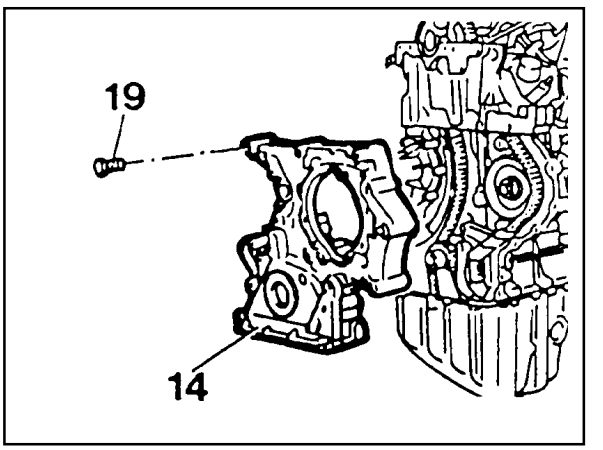
16. Remove the oil pan bolts (8, 9) in the area of the timing case cover (14).
17. Slightly loosen the remaining oil pan bolts.



18. Remove the timing case cover (19) bolts and then remove the timing case cover (14).

Notice

Be careful not to damage the cylinder head gasket or oil pan gasket.

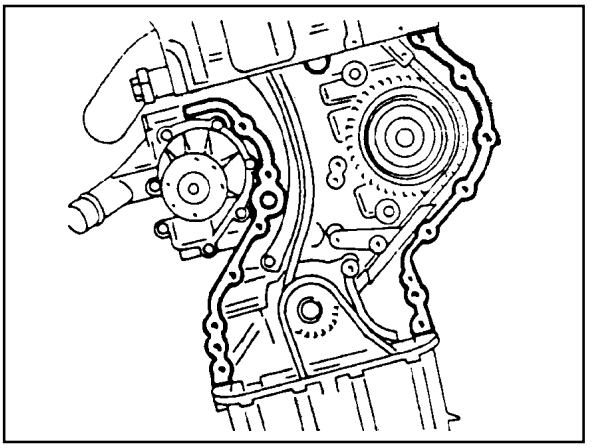


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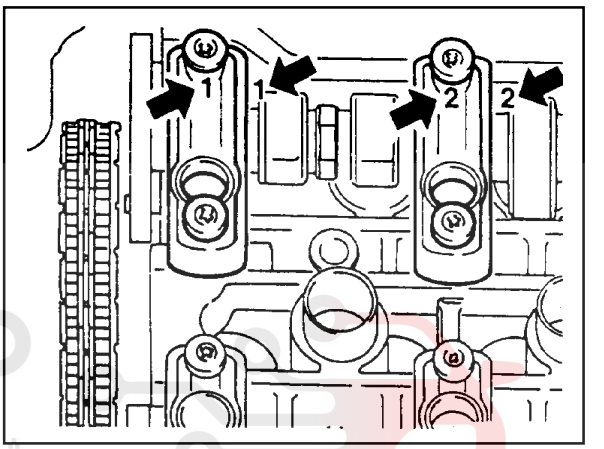
Installation Procedure

1. Thoroughly clean the sealing surface and apply sealant.



2. Install the timing case cover.

Tightening Torque	10 Nm



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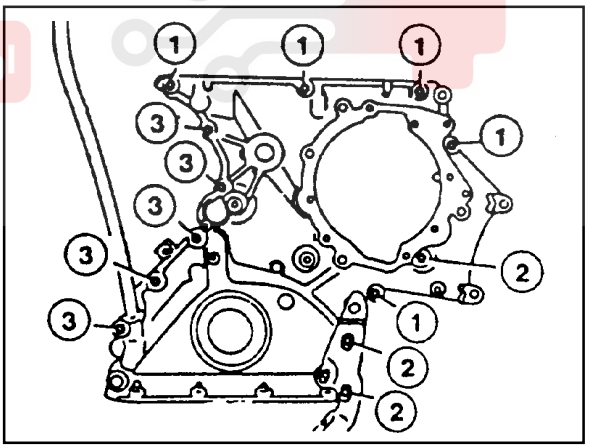
Notice

Bolts arrangement

1.M6 x 60

2.M6 x 70

3.M6 x 40

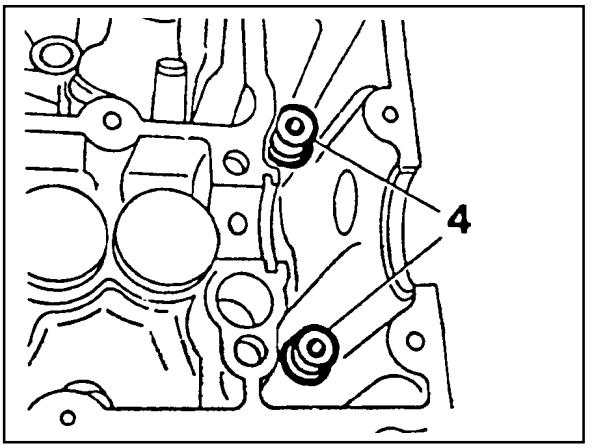


3. Tighten the socket bolts in the chain box.

Tightening Torque	23 Nm

4. Tighten the oil pan bolts.

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



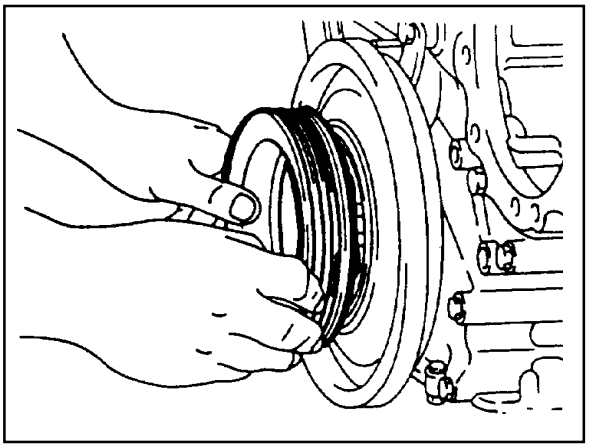
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5. Install the flange, vibration damper and crankshaft belt pulley.

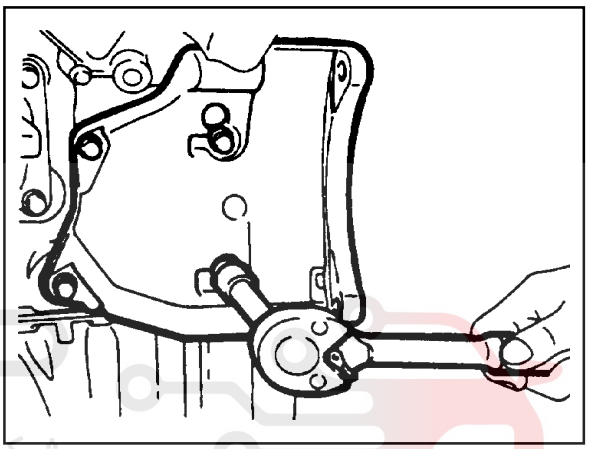
   Notice

   Replace front radial seal if necessary.



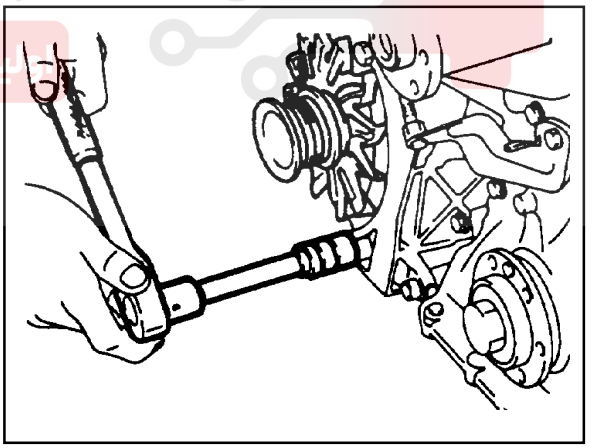
6. Install the alternator bracket.

Tightening Torque	Front	25 Nm
	Side	25 Nm



7. Install the alternator

Tightening Torque	Upper - 25 Nm
	Low - 25 Nm

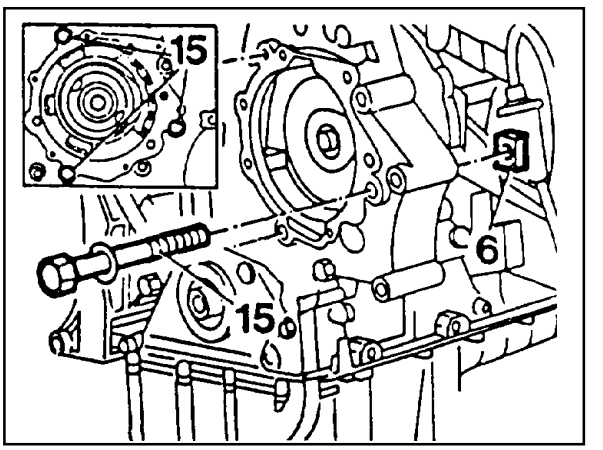


8. Install the cylinder head cover.

Tightening Torque	10 Nm

9. Tighten the injection pump mounting bolts.

Tightening Torque	23 Nm



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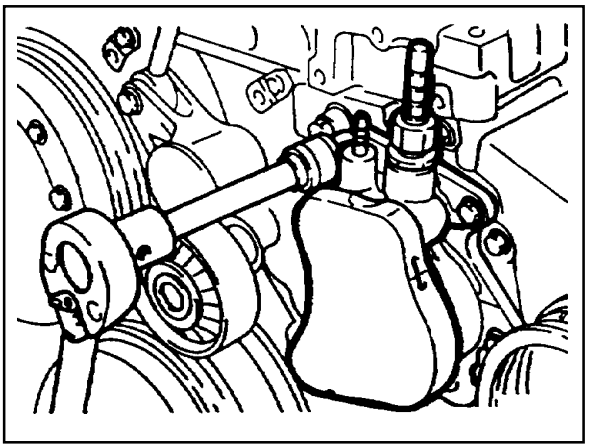
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10. Install the fuel filter.

Tightening Torque	25 Nm

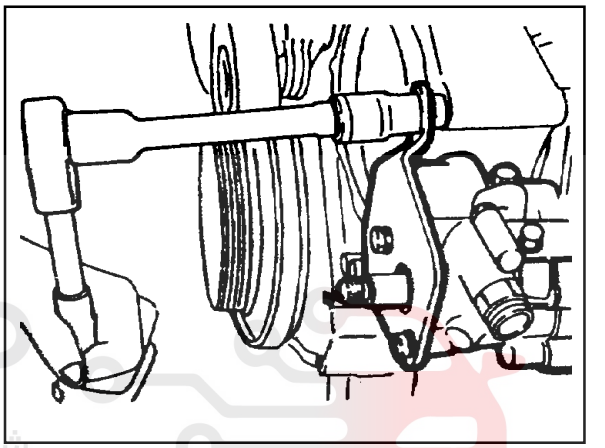
11. Install the vacuum pump.

Tightening Torque	10 Nm



12. Install the power steering pump.

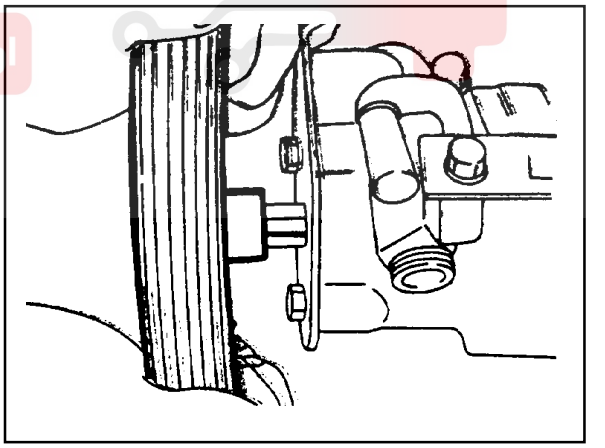
Tightening Torque	23 Nm



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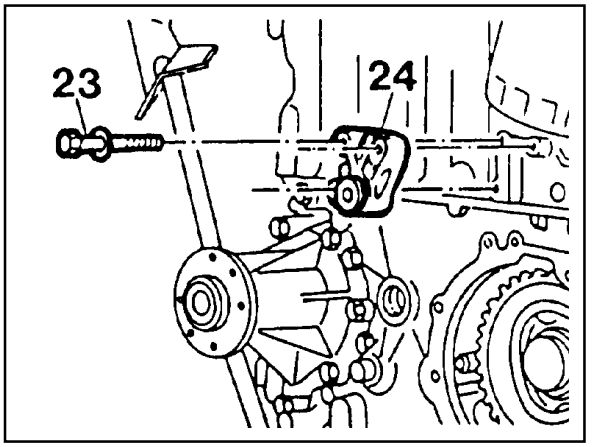
13. Install the power steering pump pulley.

Tightening Torque	32 Nm



14. Install the guide pulley bracket.

Tightening Torque	9 Nm

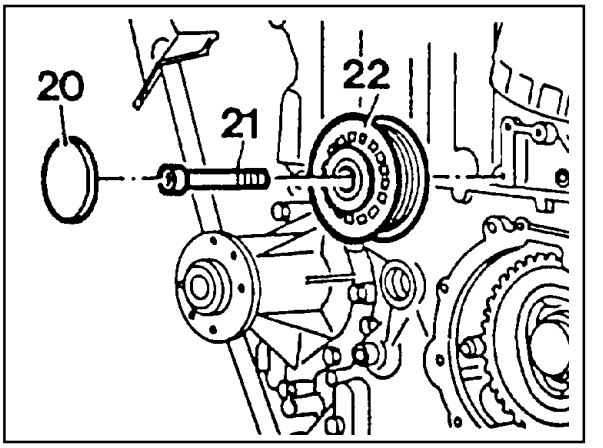


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15. Install the guide pulley (22) and fit the closing cover (20).

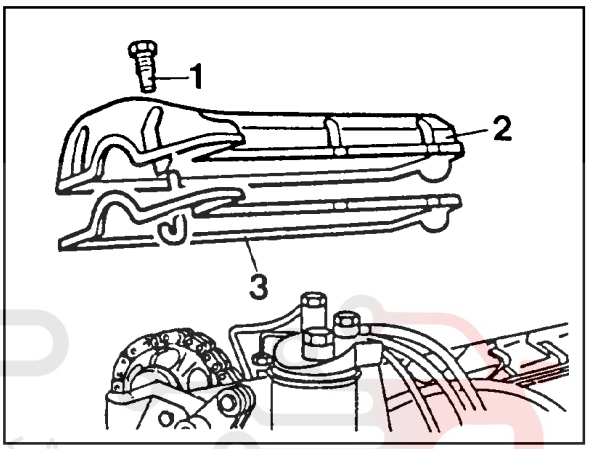
Tightening Torque	23 Nm



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

Tightening Torque	10 Nm

17. Install the cooling fan belt pulley and fan clutch.
18. Install the belt tensioning device and then install the belt.
19. Install the cooling fan.
20. Fill the engine oil and check oil leaks by running the engine.



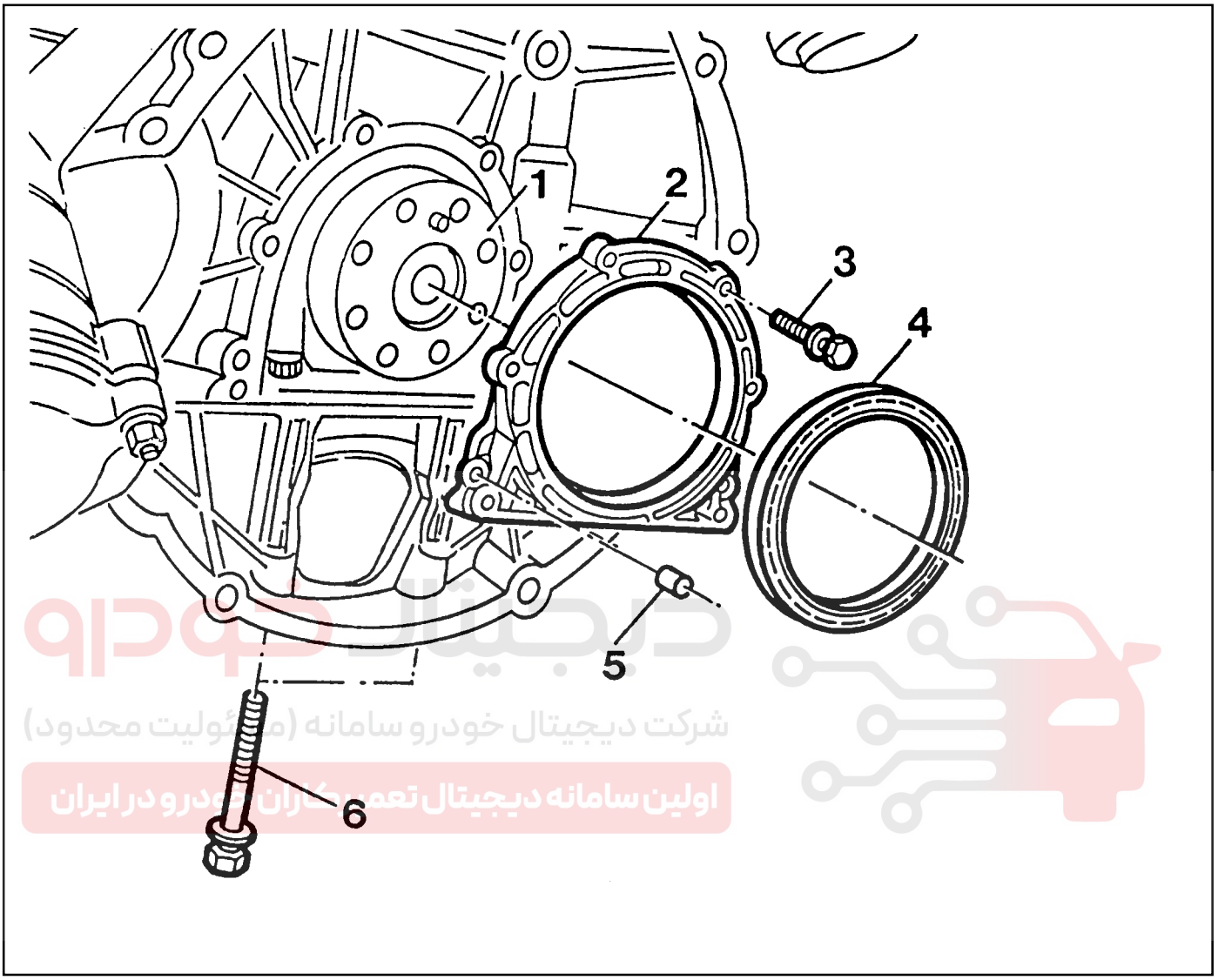
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CRANKSHAFT END COVER

Preceding Work : Removal of flywheel and driven plate.



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

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Tools Required

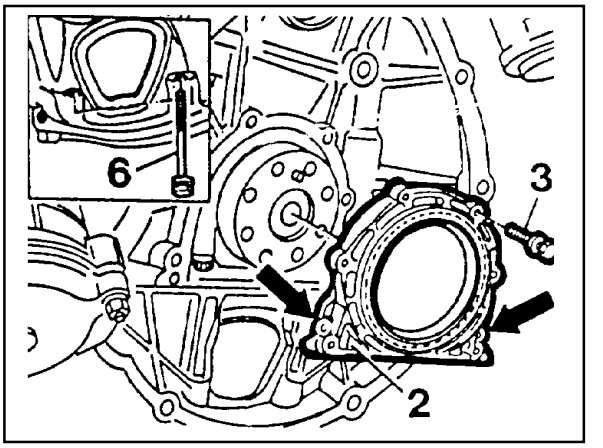
601 589 03 43 00 Oil Seal Assmbler

Removal Procedure

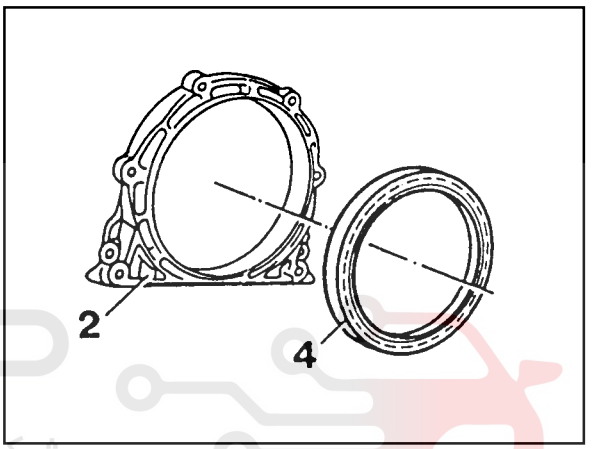
1. Remove the bolts (3, 6) from end cover, By pulling out the lugs (arrow), remove the cover.

   Notice

   Be careful not to damage the oil pan gasket.



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



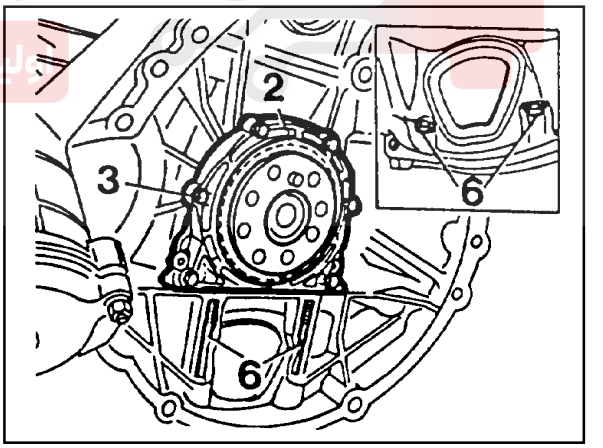
Installation Procedure

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	10 Nm

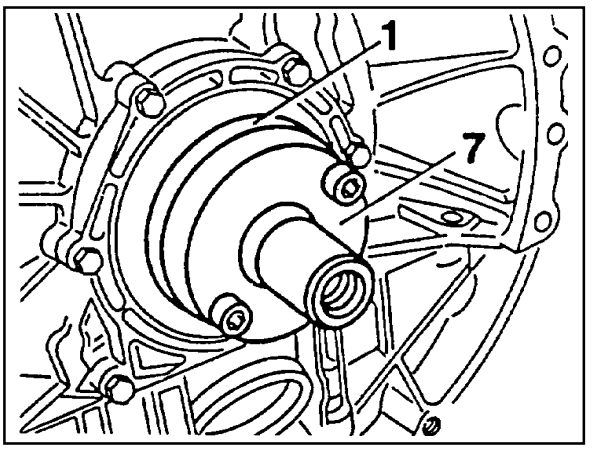
   Notice

   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



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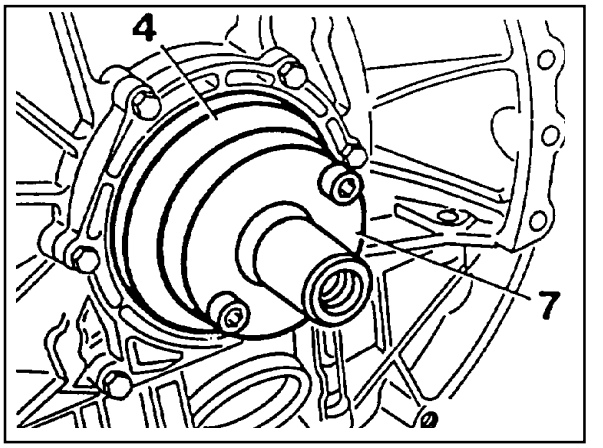
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5. Coat a little oil on the sealing lip of new radial seal and contacting surface.

Notice

Don't use grease.

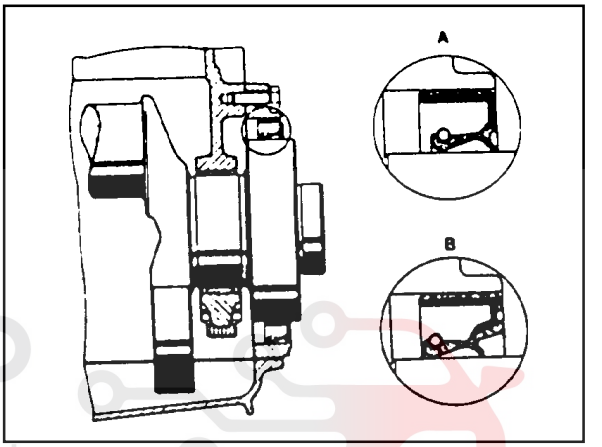
6. Insert the new radial seal (4) onto the oil seal assembler (7).



Notice

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

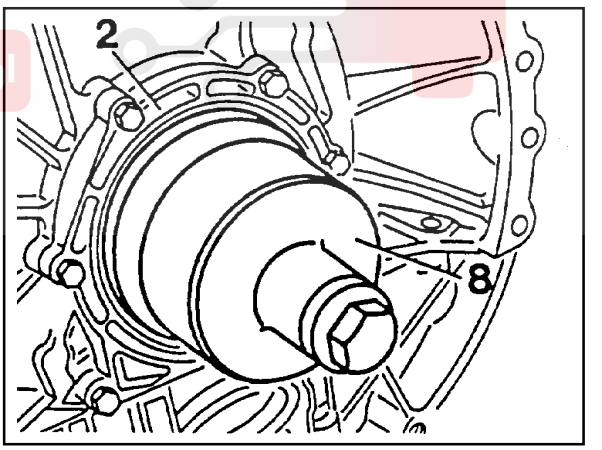


7. Install the outer oil seal assembler on he seal and by tightening the bolts, press the radial seal into the end cover as far as the stop.

Notice

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

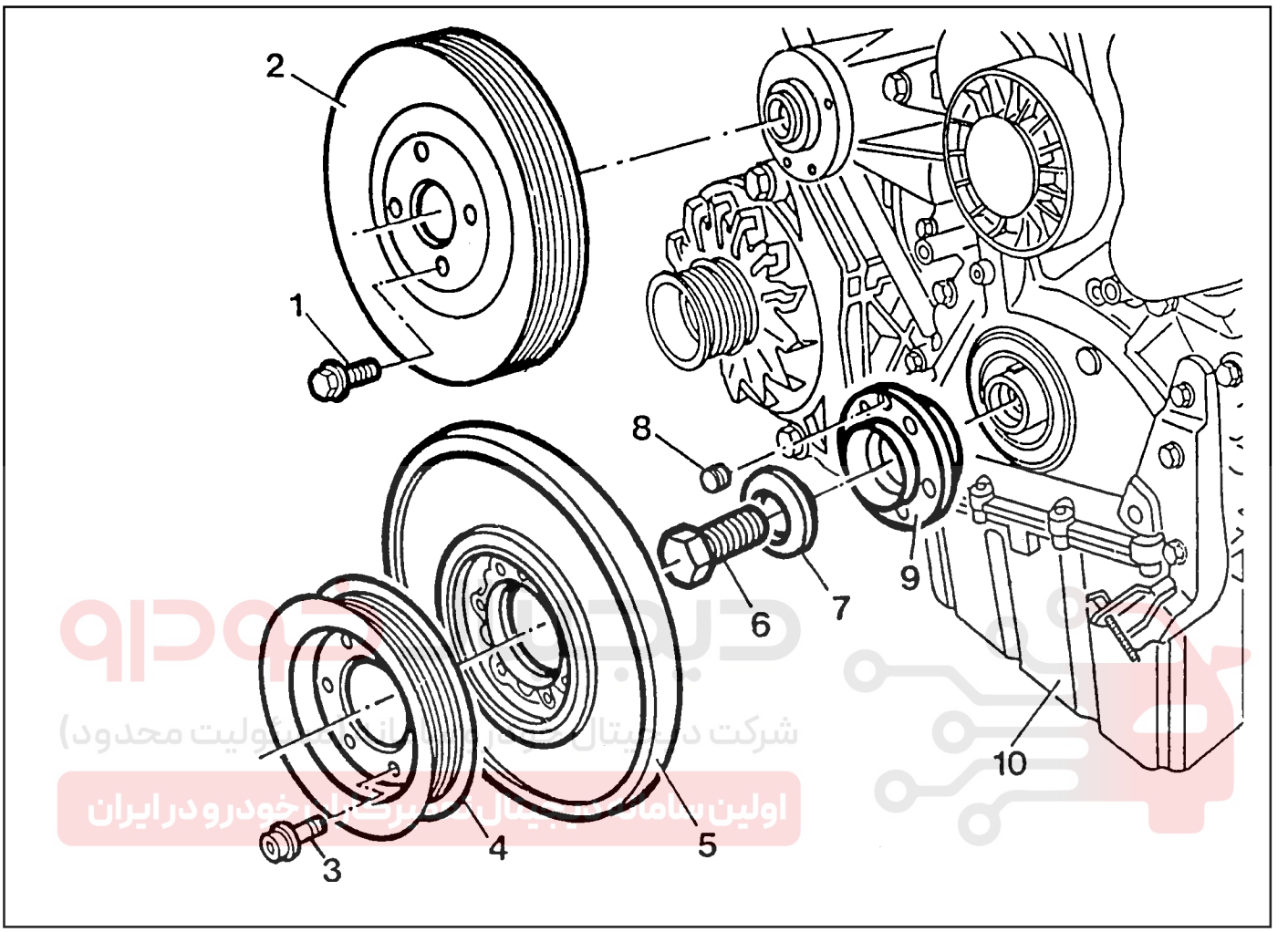


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VIBRATION DAMPER AND HUB

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

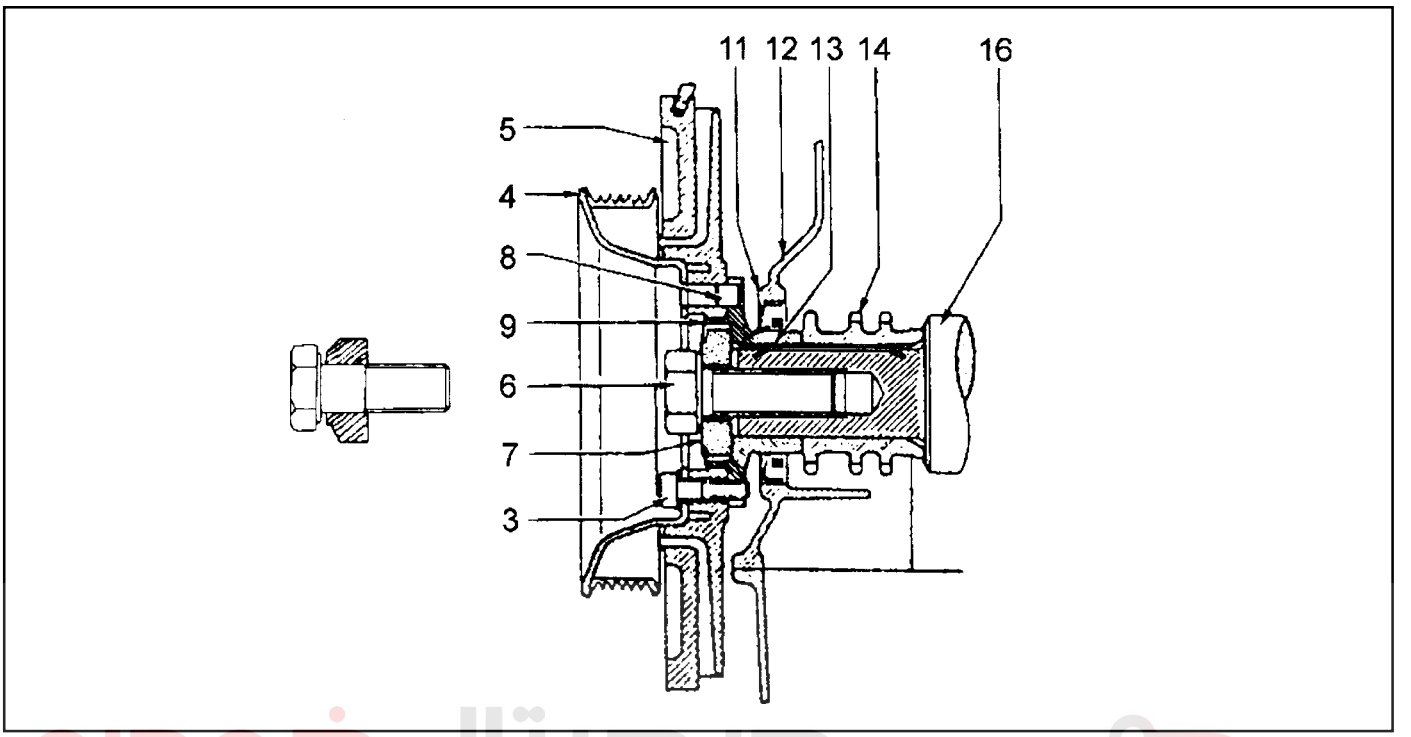


1	Bolt 10Nm	6	Bolt ..... 200Nm + 90°
2	Cooling Fan Belt Pulley	7	Washer
3	Socket Bolt 23Nm	8	Straight Pin
4	Crankshaft Belt Pulley	9	Hub
5	Vibration Damper	10	Oil Pan

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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 Gear Case Cover
13 Key
14 Crankshaft Sprocket
16 Crankshaft

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Notice

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

Tools Required

602 589 00 40 00 Engine Lock
103 589 00 30 00 Puller

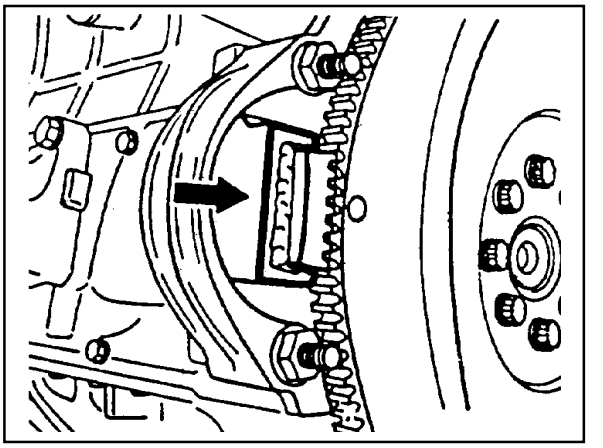
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Removal Procedure

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

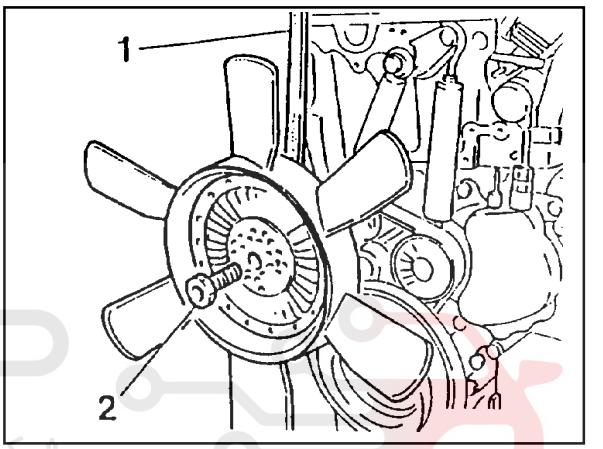
Engine Lock 602 589 00 40 00



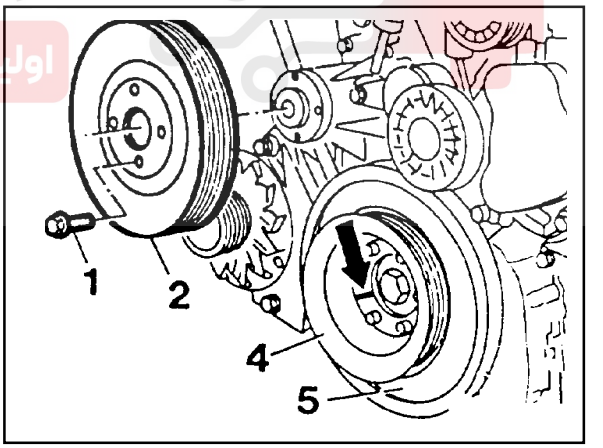
2. Remove the poly V-belt.
3. Remove the cooling fan.

Notice

Keep the fan in vertical position.



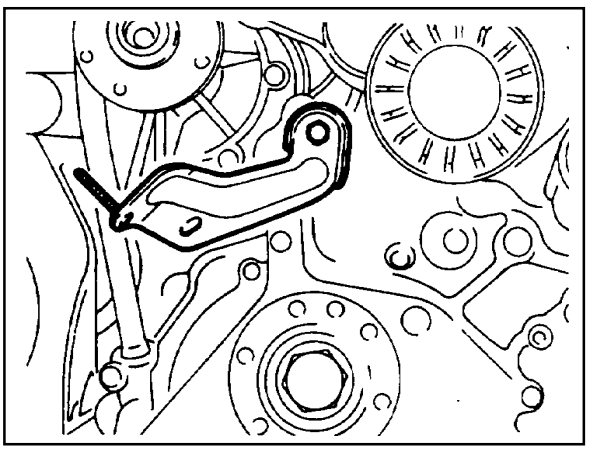
4. Remove the cooling fan belt pulley (2).
5. Place alignment marks (arrow) on the vibration damper (5) and crankshaft belt pulley (4).



6. Remove the timing sensor bracket.

Notice

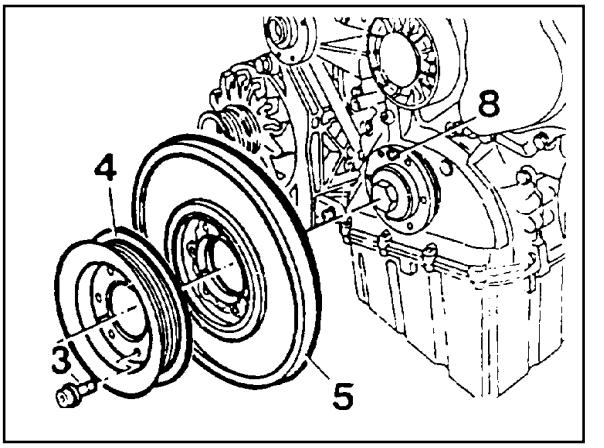
Remove if necessary.



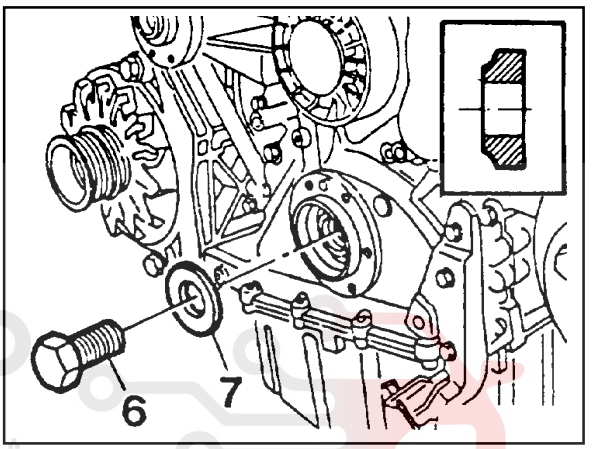
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7. Remove the socket bolts (3) and then remove the belt pulley (4) and vibration damper (5).



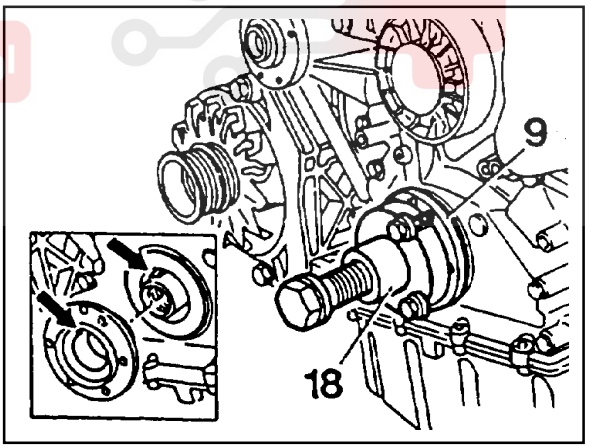
8. Remove the washer and bolt.



9. Remove the hub by using a puller.

Puller 103 589 00 33 00

10. Replace the radial seal.



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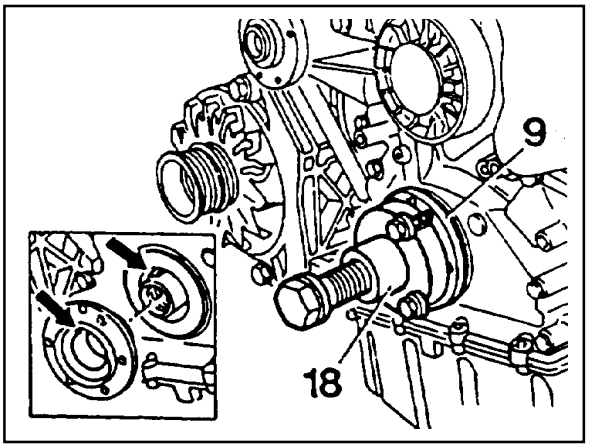
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Installation Procedure

1. Install the hub.

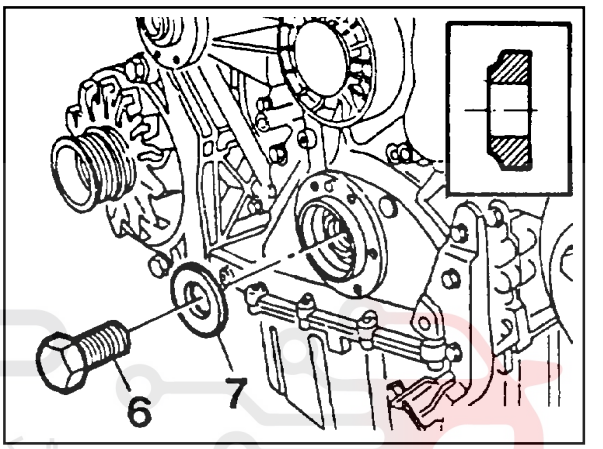
Notice

Exactly align the woodruff key and the groove of hub (arrow).



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

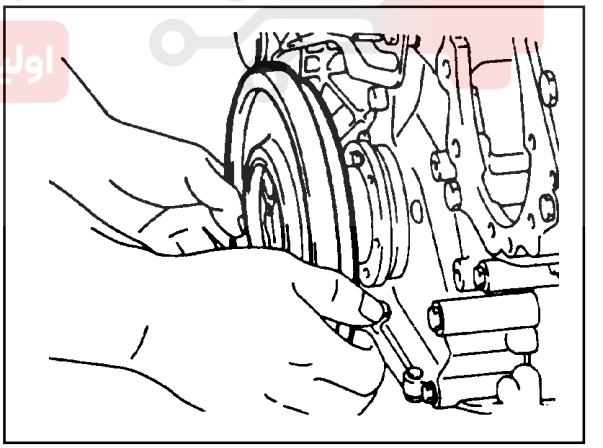
Washer (new) : 1 EA	200 Nm + 90°



3. Install the vibration damper.

Notice

Exactly align and insert onto the straight pin.

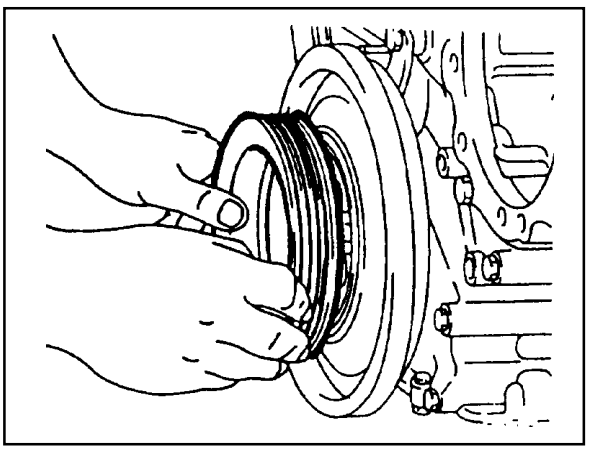


4. Install the belt pulley.

Tightening Torque	25 Nm

Notice

Align the alignment marks.



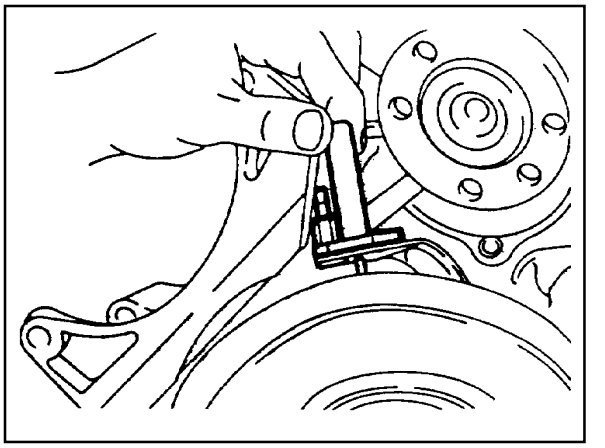
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5. Install the timing sensor bracket.

Notice

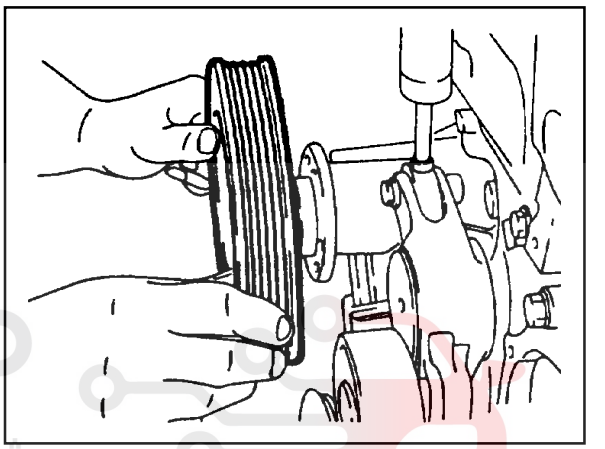
See the 'TDC setting'.



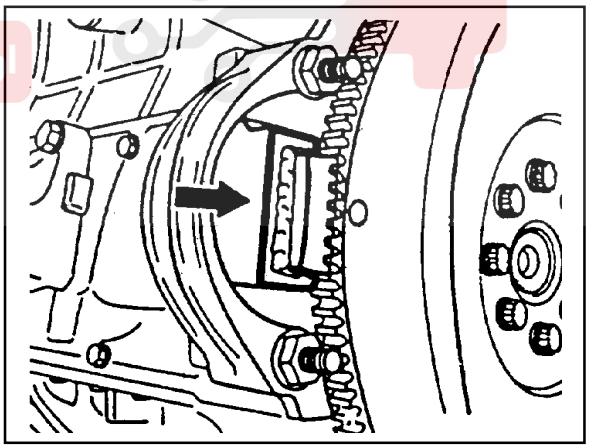
6. Install the cooling fan pulley.

Tightening Torque	10 Nm

7. Install the cooling fan.
8. Install the fan belt.



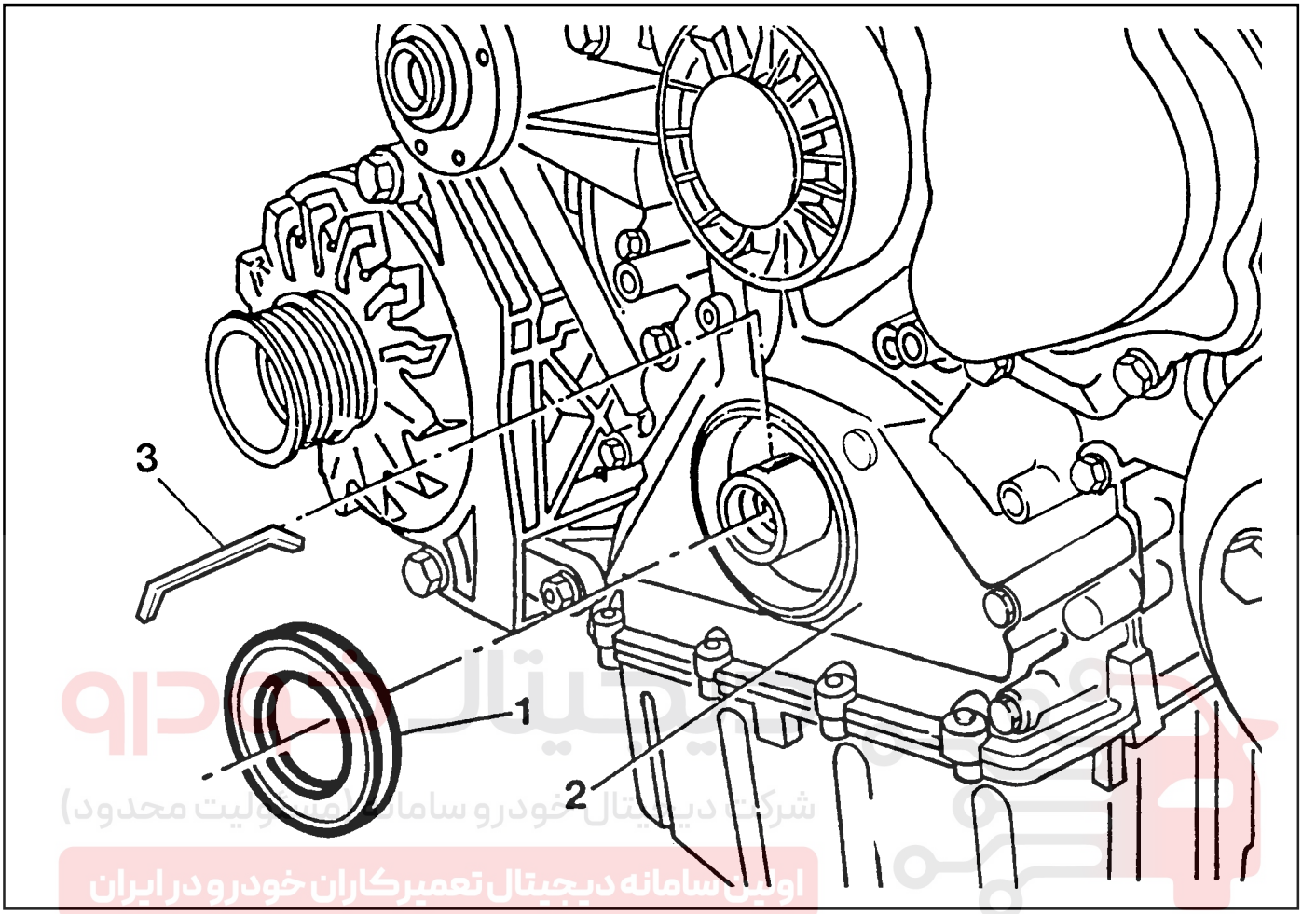
9. Remove the engine lock.



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CRANKSHAFT FRONT RADIAL SEAL



1 Radial Seal
2 Timing Case Cover
3 Woodruff Key

Tools Required

601 589 03 14 00 Sleeve

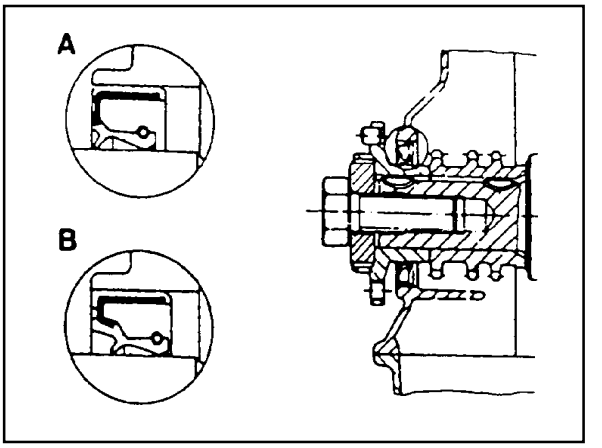
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Notice

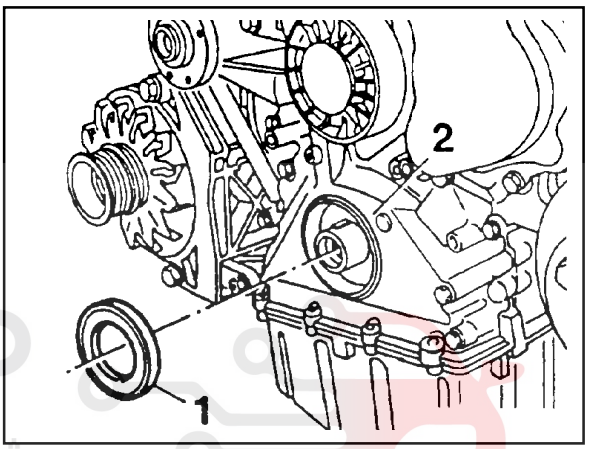
The sealing lip of the repair radial seal is offset to the inside by 2mm to ensure that is does not run in any groove which the standard radial seal may have left on the crankshaft flange.

A Standard Radial Seal
B Repair Radial Seal



Replacement Procedure

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.



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3. Coat a little oil on the sealing lip of new radial (1) and contact surface.

Notice

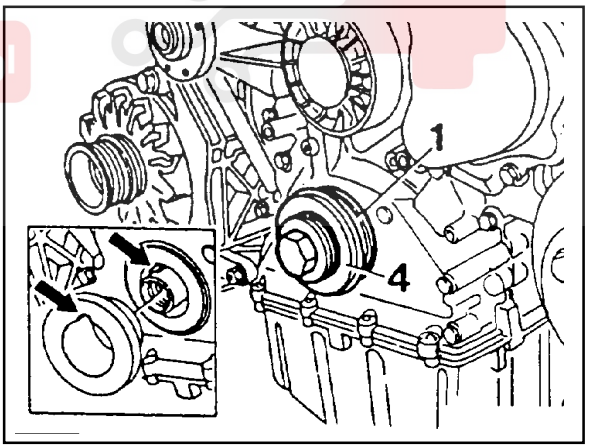
Don't use grease.

4. Install the radial seal (1) by using a sleeve (4).

Notice

Align the groove of sleeve and woodruff key(arrow).

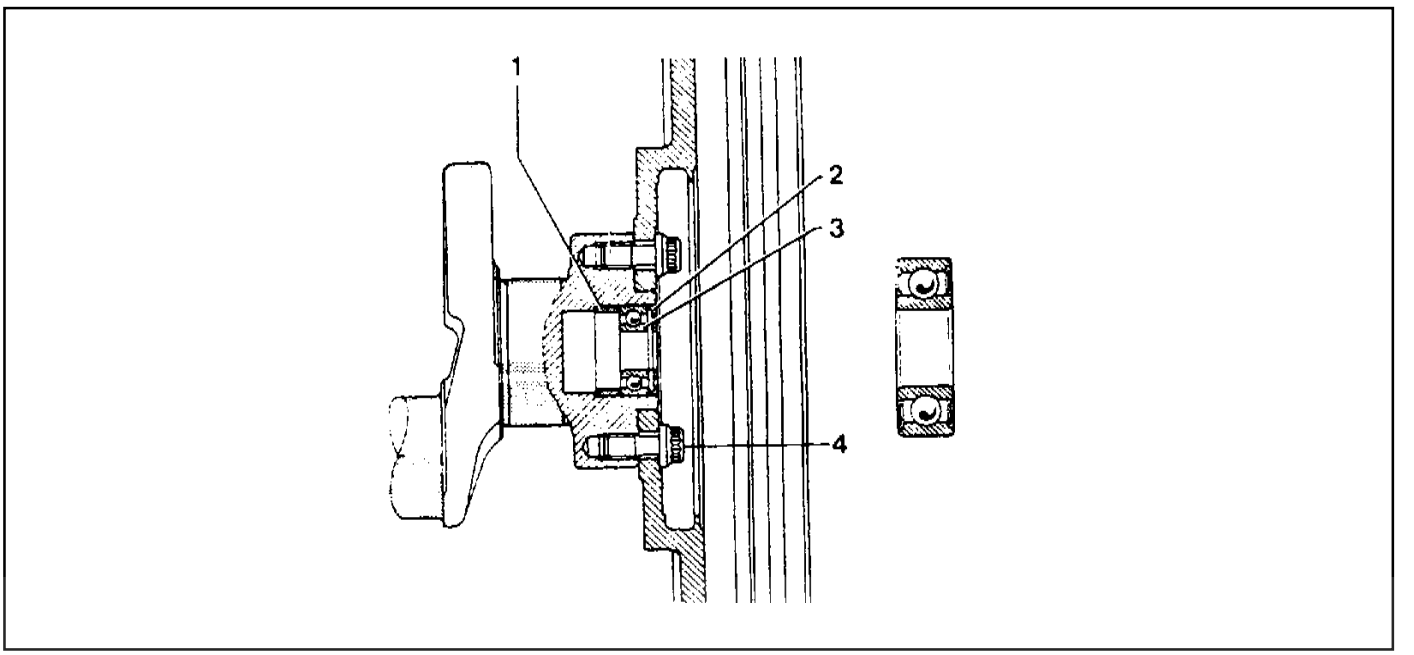
Sleeve 601 589 03 14



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CRANKSHAFT BALL BEARING



1	Spacer	3	Ball Bearing
2	Cover ..... Replace	4	Bolt ..... 45Nm + 90°

Notice

Manual transmission only.

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Tools Required

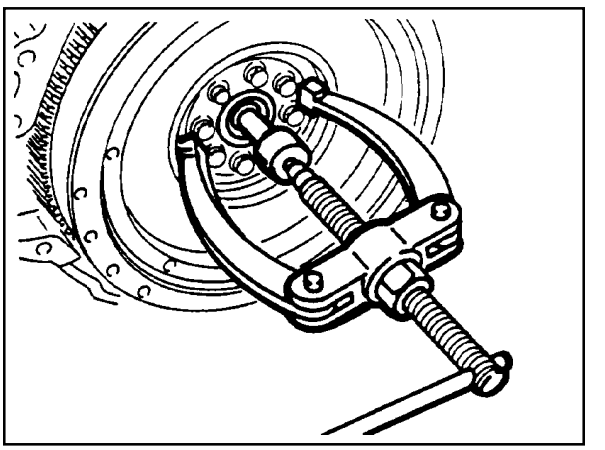
000 589 33 33 00 Counter Support

000 589 25 33 00 Internal Extractor

Removal & Installation Procedure

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



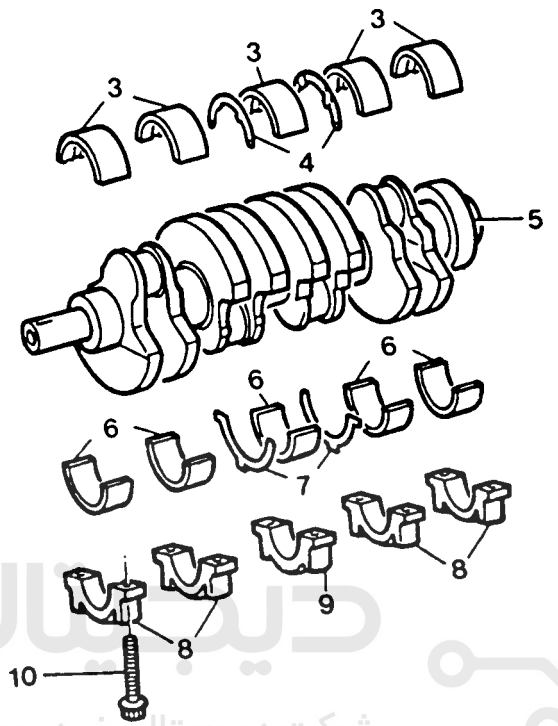
3. Apply Loctite 241 on the new ball bearing and then insert the ball bearing to be stopped at the spacer ring by using a proper mandrel.

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CRANKSHAFT

Preceding Work : Removal of the end cover
Removal of the piston
Removal of the crankshaft sprocket



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

Tools Required

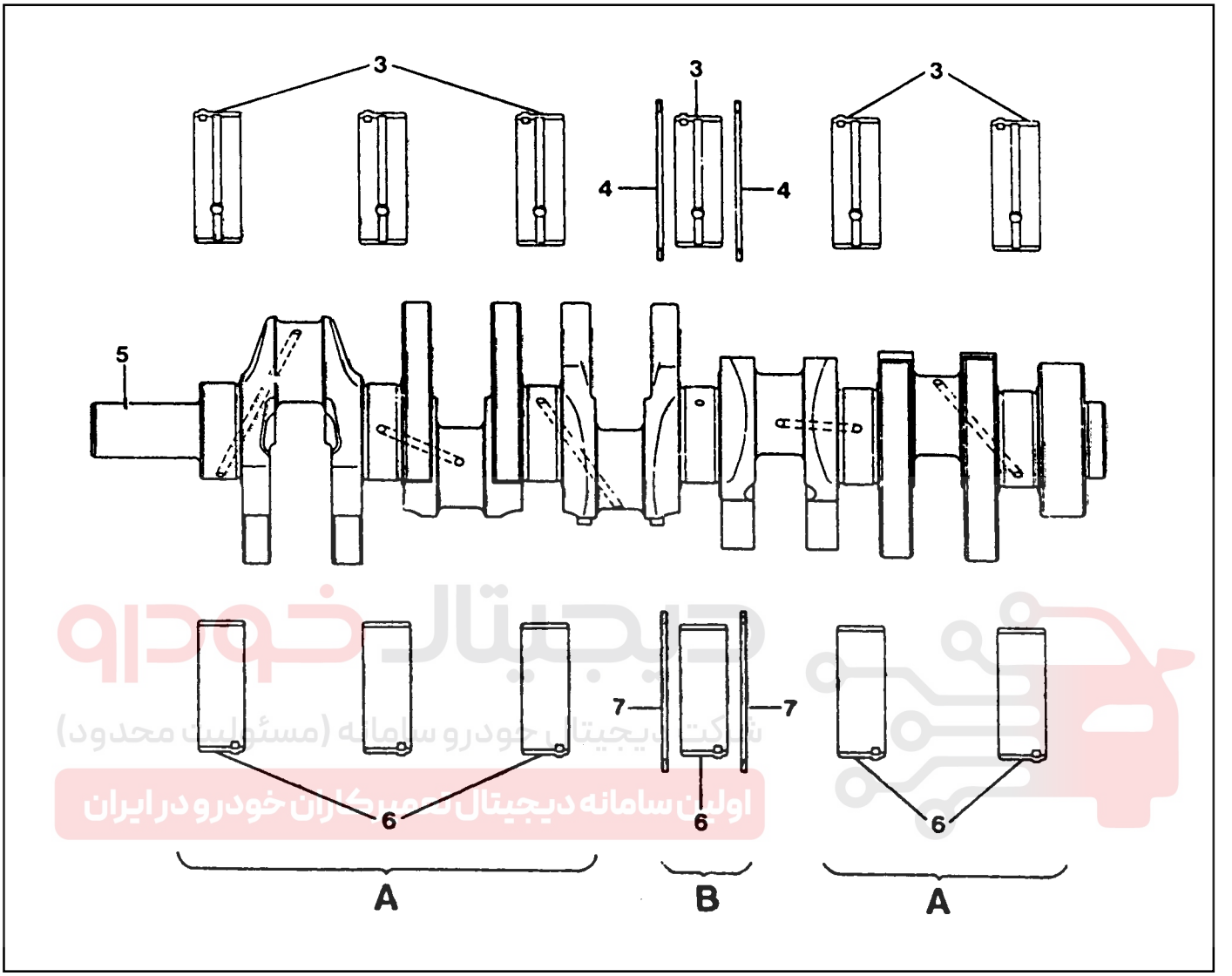
001 589 53 21 00 Dial Gauge
363 589 02 21 00 Dial Gauge Holder
366 589 00 21 05 Extension

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Thrust Washer and Bearing Arrangement

OM662LA Engine



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

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

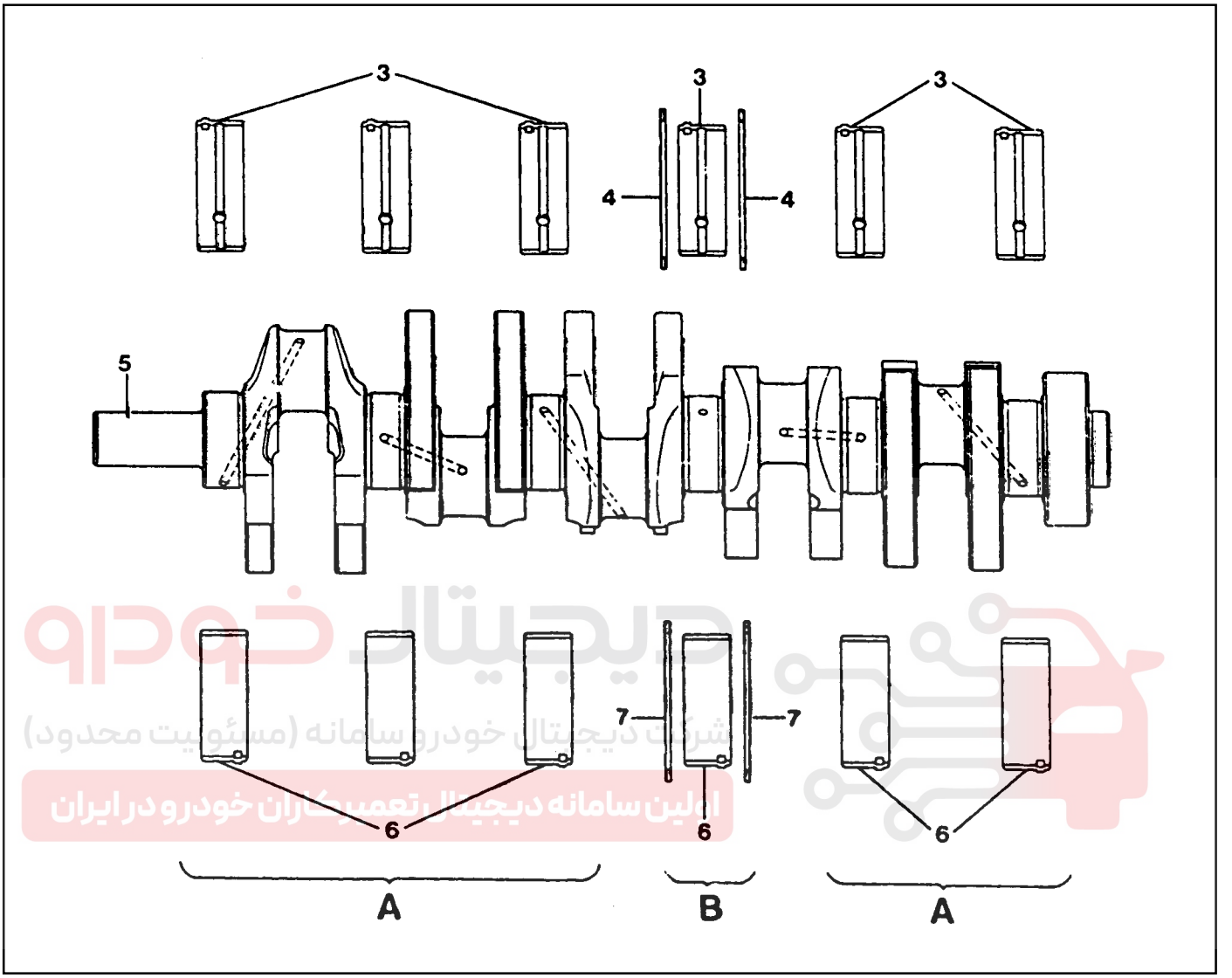
Notice

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

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OM661LA Engine



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

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

Notice

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

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Crankshaft Standard and Repair Sizes

mm

	Crankshaft bearing journal diameter	Thrust bearing journal width	Thrust bearing journal diameter
Standard size	50.950 - 57.965	24.500 - 24.533	47.950 - 47.965
		24.600 - 24.633	
Repair size 1	57.500 - 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

		Thrust bearing	Crankshaft 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 Bearings

mm

Fit bearing journal width	Thrust bearings 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 - 25.033	2.40

Notice

- Measure crankshaft axial clearance and adjust with proper thrust Bearing.
- The same thickness of washer must be installed on both sides of the fit bearing.

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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

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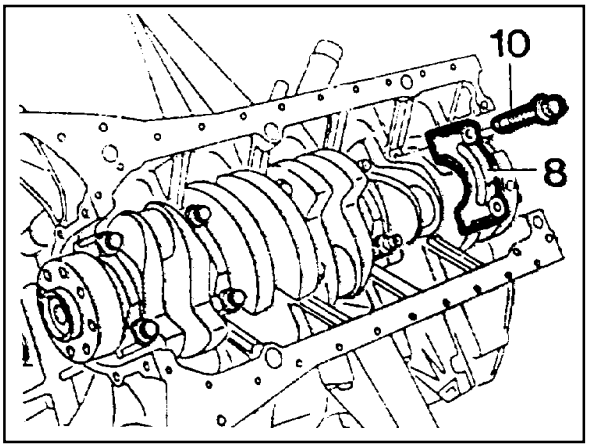
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Removal & Installation Procedure

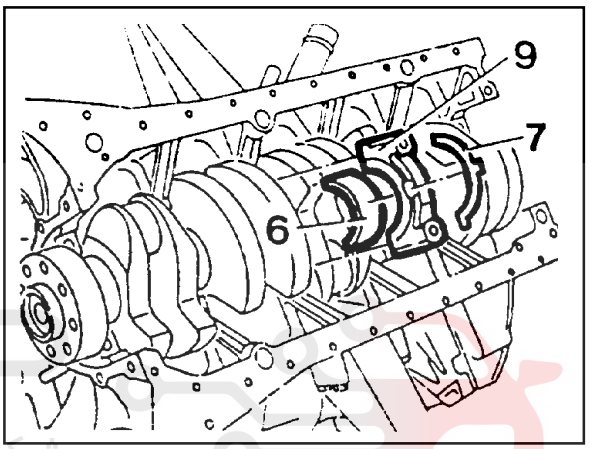
1. Remove the bearing cab bolt.
2. Remove the bearing caps (8).

Notice

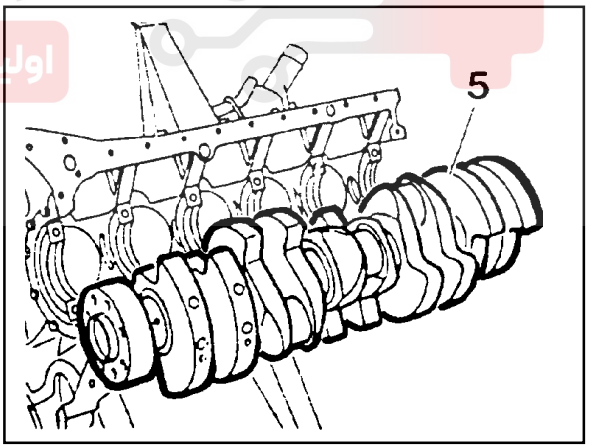
The crankshaft bearing caps are marked with stamped numbers. Remove the bearing cap from the vibration damper side.



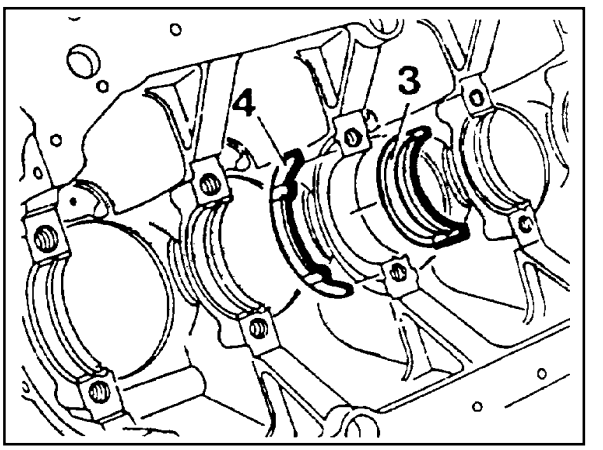
3. Remove the crankshaft bearing caps (9) and lower thrust bearings (7).
4. Remove the lower thrust bearings (6) from the bearing cap (9).



5. Remove the crankshaft (5).



6. Remove the upper thrust bearings(4).
7. Remove the upper bearing shells (3) from crankcase.



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8. Thoroughly clean the oil gallery.
9. Select a proper new bearing shells with reference to table.
10. Coat the new bearing shells with oil and insert into the crankcase and into the crankshaft bearing caps.

Notice

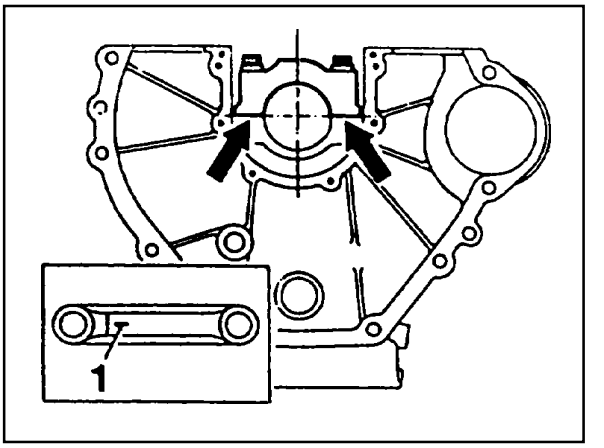
Do not mix up upper and lower crankshaft bearing shells.

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

Tightening Torque	35 - 40 Nm

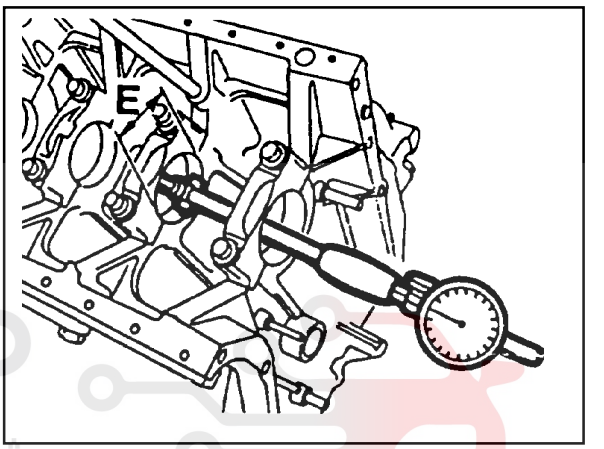
Notice

No. 1 is vibration damper side.

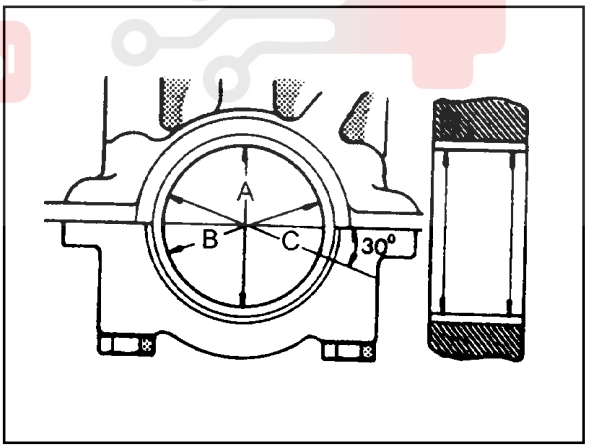


12. Measure crankshaft bearing diameters (E).

Extension 366 589 00 21 05



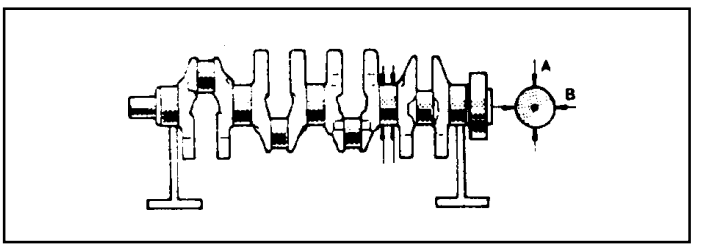
13. Measure at 3 points (A, B and C) and if the average value of B and C is less than A's value, the average value of B and C is the mean value and if more than A's value, A's value is the mean value.

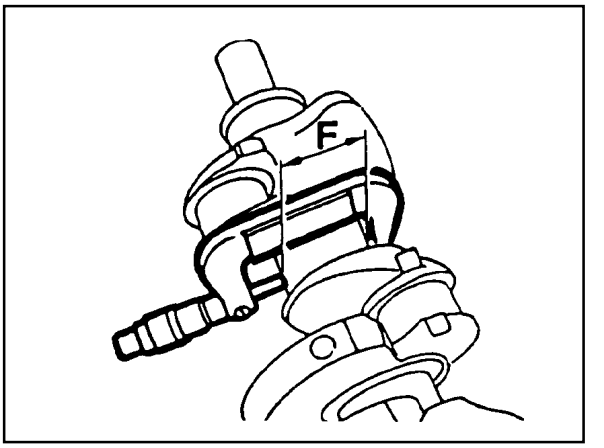


14. Measure crankshaft bearing journal diameter (F).

Notice

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





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

Clearance 'G'	0.027 - 0.051mm

Notice

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

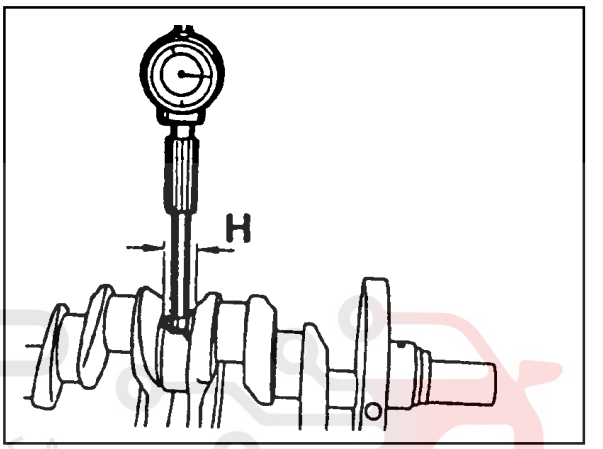
Clearance 'G' = 0.041mm

16. Remove the crankshaft bearing cap.

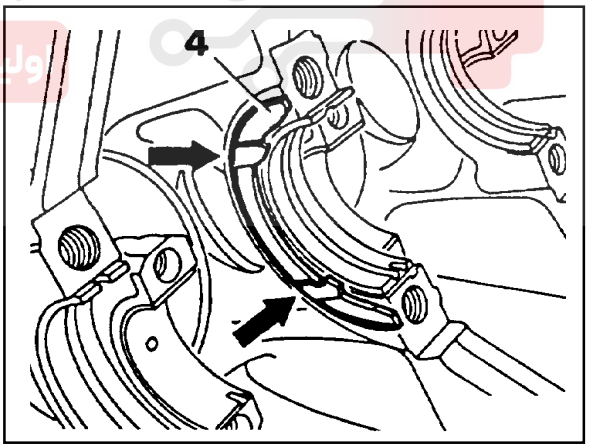
17. Measure width of thrust bearing journal (H) and adjust with proper thrust bearings (see table).

Notice

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



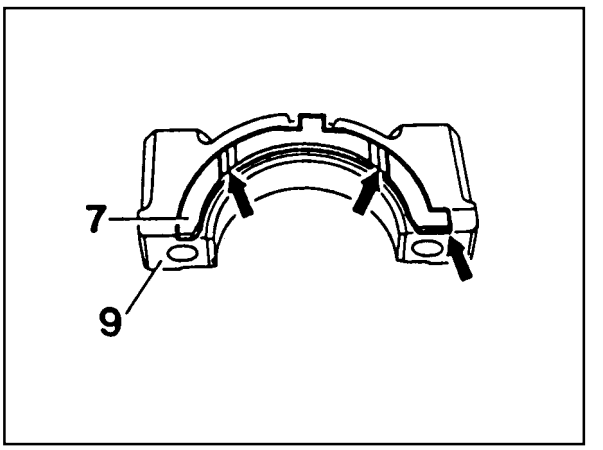
18. Coat the upper thrust bearing (4) with oil and insert into the crankcase so that the oil grooves are facing the crank webs (arrow).



19. Coat the lower thrust bearing (7) with oil and insert into the crankshaft bearing cap so that the oil grooves are facing the crank webs (arrow).

Notice

The retaining lugs should be positioned in the grooves (arrow).

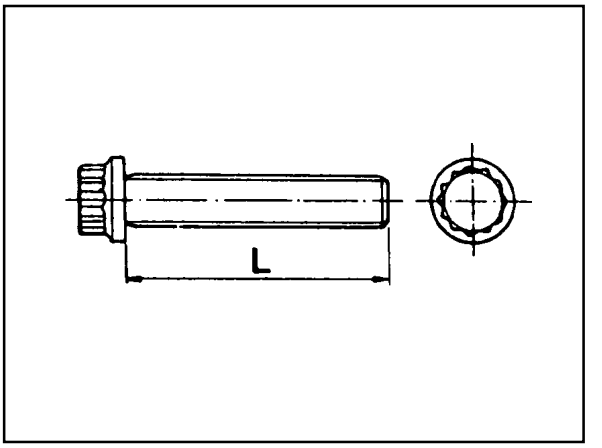


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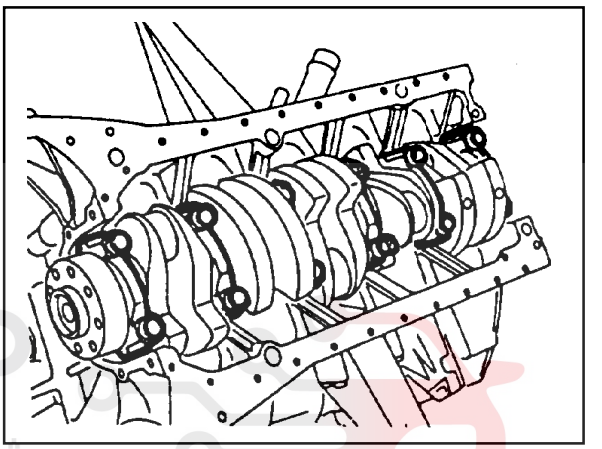
Notice

If the max. length of bolts(L) 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	55 Nm + 90°



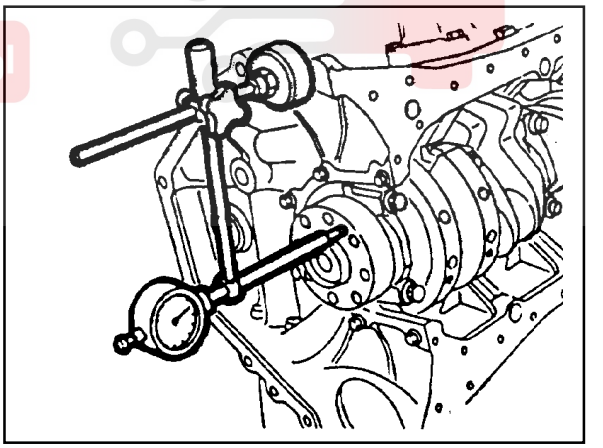
Notice

Install from No. 1 cap.

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22. Rotate the crankshaft with hand and check whether it rotates smoothly.
23. Measure crankshaft bearing axial clearance.

Clearance	0.100 - 0.245mm



Notice

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

Notice

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

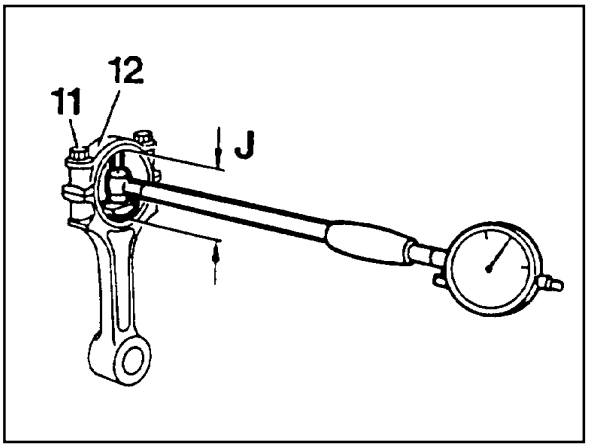
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24. Insert the new connecting rod bearing shells into the connecting rod and connecting rod bearing cap and tighten the 12-sided stretch bolts (11).

Tightening Torque	40 Nm + 90°

25. Measure inner diameter of connecting rod bearing.



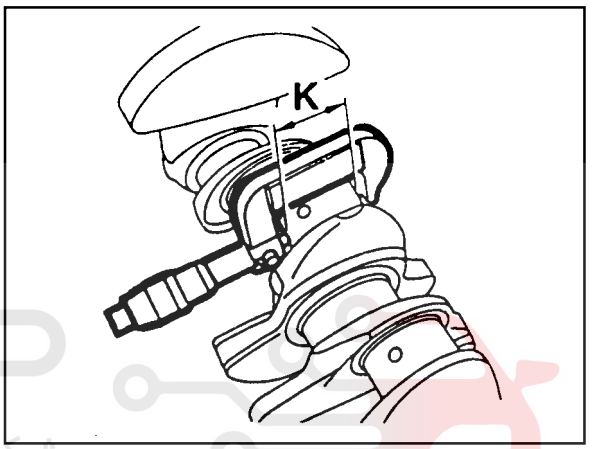
26. Measure connecting rod bearing journal diameter (K).

Notice

Refer to measurement of the crankshaft bearing journal diameter.

27. 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

Notice

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

28. Remove the connecting rod bearing cap.
29. Install the piston.
30. Rotate the crankshaft by hand and check whether it rotates smoothly.
31. 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.

Notice

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

32. Fill oil and run the engine and then check the oil pressure and oil level.

Notice

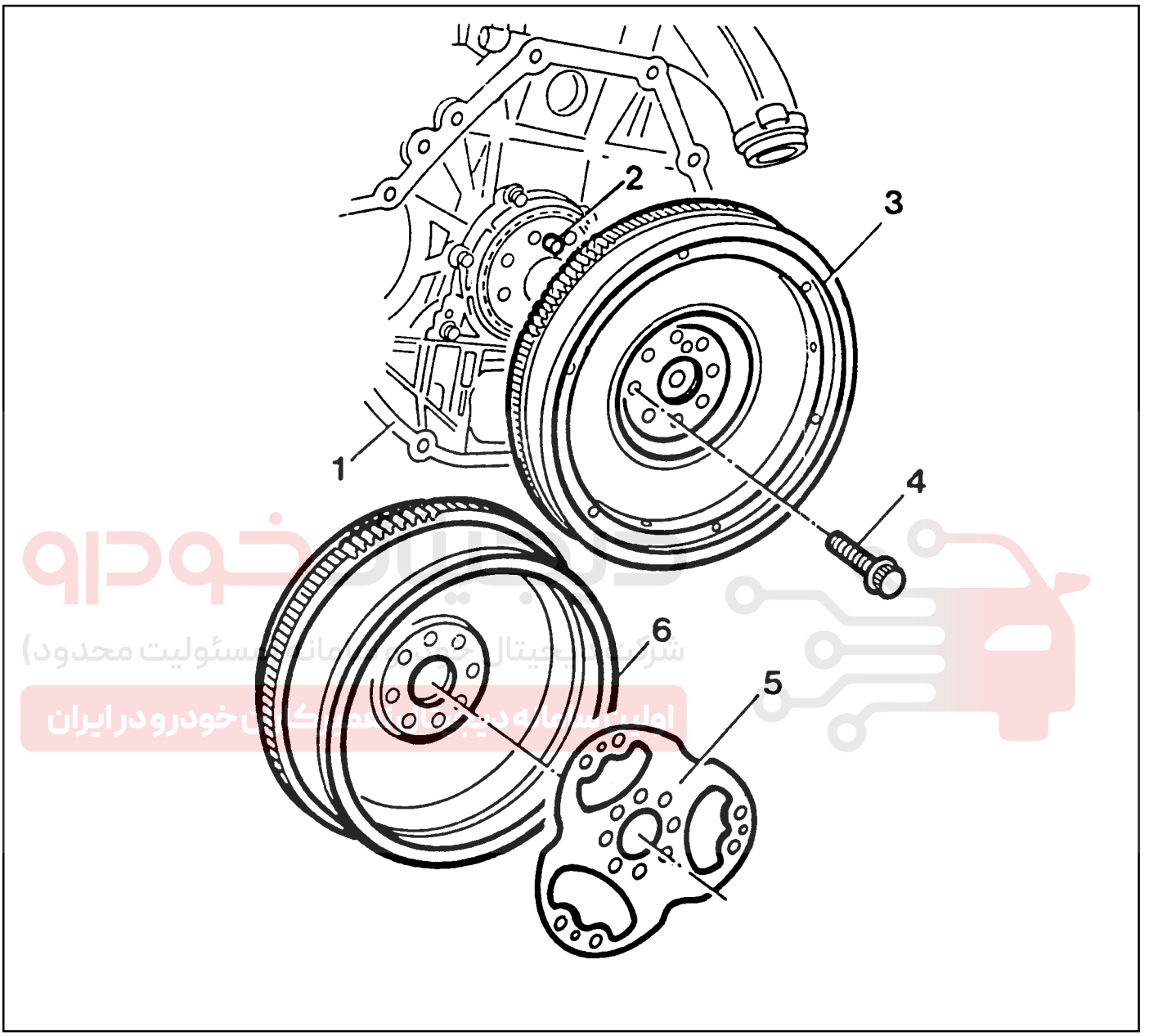
Install the original oil filter element and then change the engine oil and oil filter element after 1,000 - 1,500km.

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FLYWHEEL

Preceding Work : Removal of the transmission
Removal of the clutch

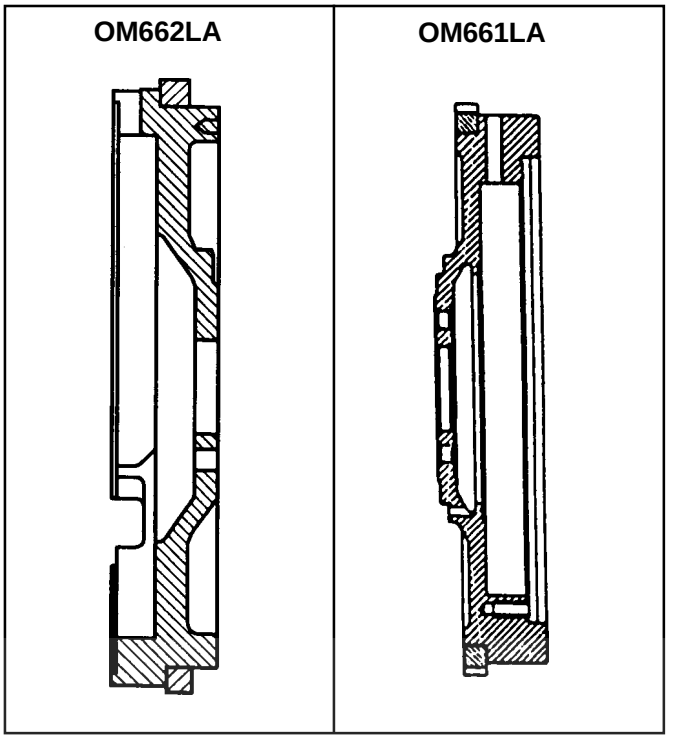


1 Oil Pan
2 Straight Pin
3 Flywheel
4 12-Sided Stretch Bolt ..... Check, 45Nm + 90°
5 Drive Plate (Automatic Transmission)
6 Flywheel (Automatic Transmission)

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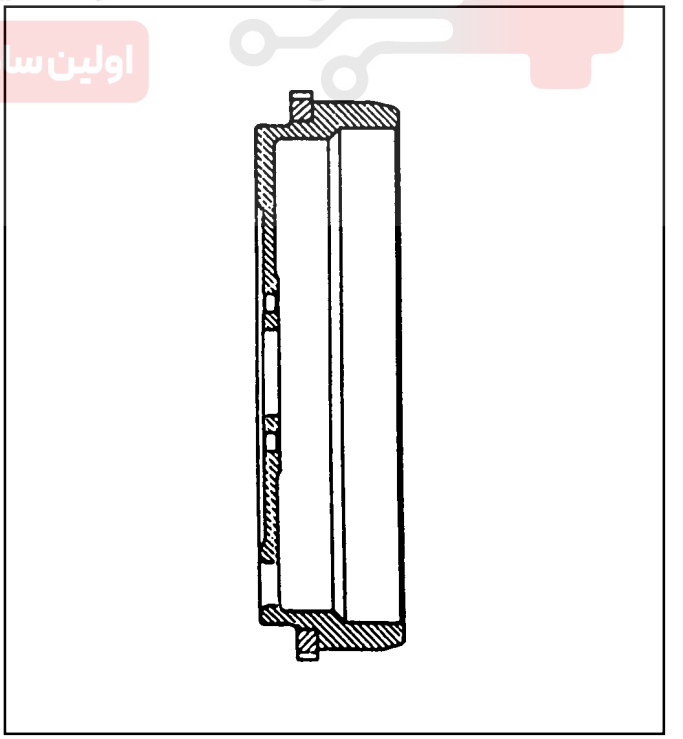
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- Manual transmission flywheel



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- Automatic transmission flywheel



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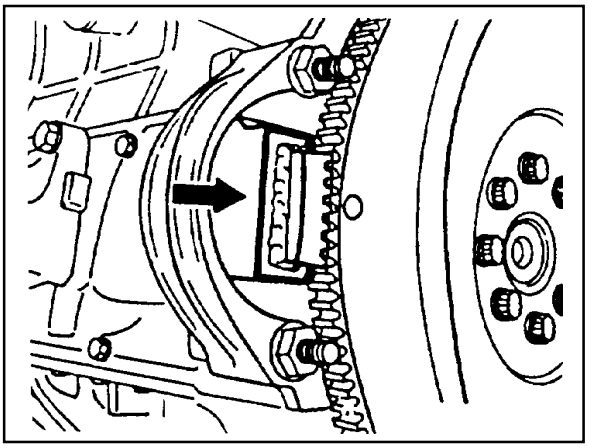
Tools Required

602 589 00 40 00 Engine Lock

Removal & Installation Procedure

1. Install the engine lock.

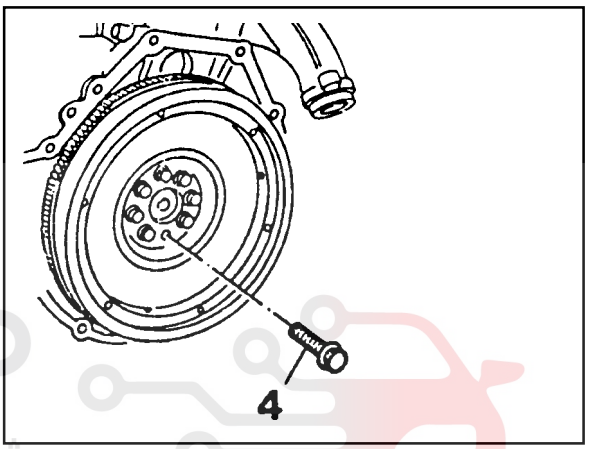
Engine Lock 602 589 02 40 00



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

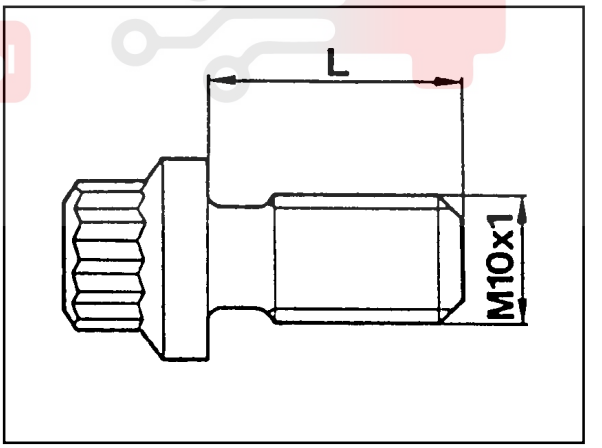
Installation Notice

Tightening Torque	45 Nm + 90°



Notice

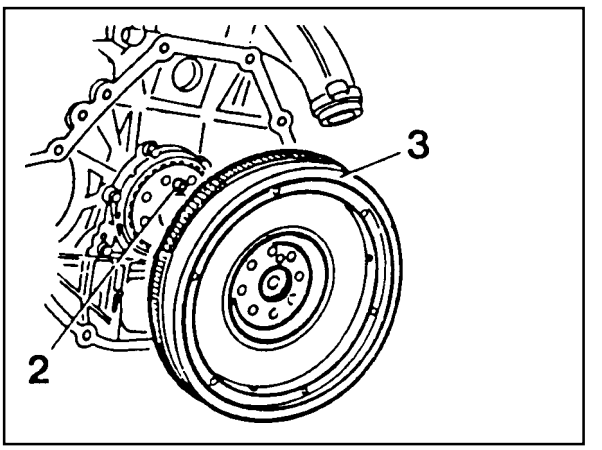
If the length 'L' of bolts exceeds 22.5mm, replace the bolts.



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

Installation Notice

Correctly align the position of dowel pin (2).



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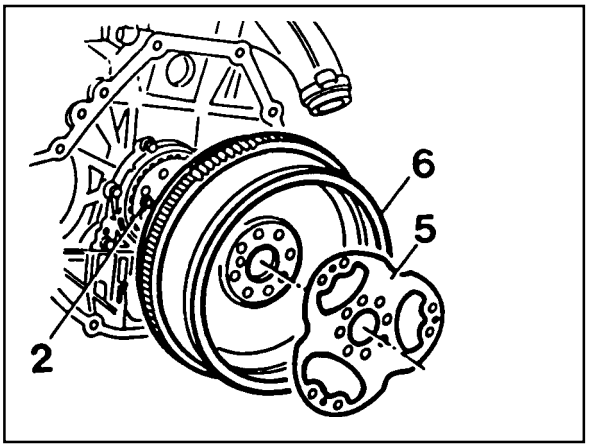
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4. Remove the flywheel (6) and driven plate (5), if equipped with automatic transmission.

   Installation Notice

   Correctly align the position of dowel pin (2).

5. Installation should follow the removal procedure in the reverse order.

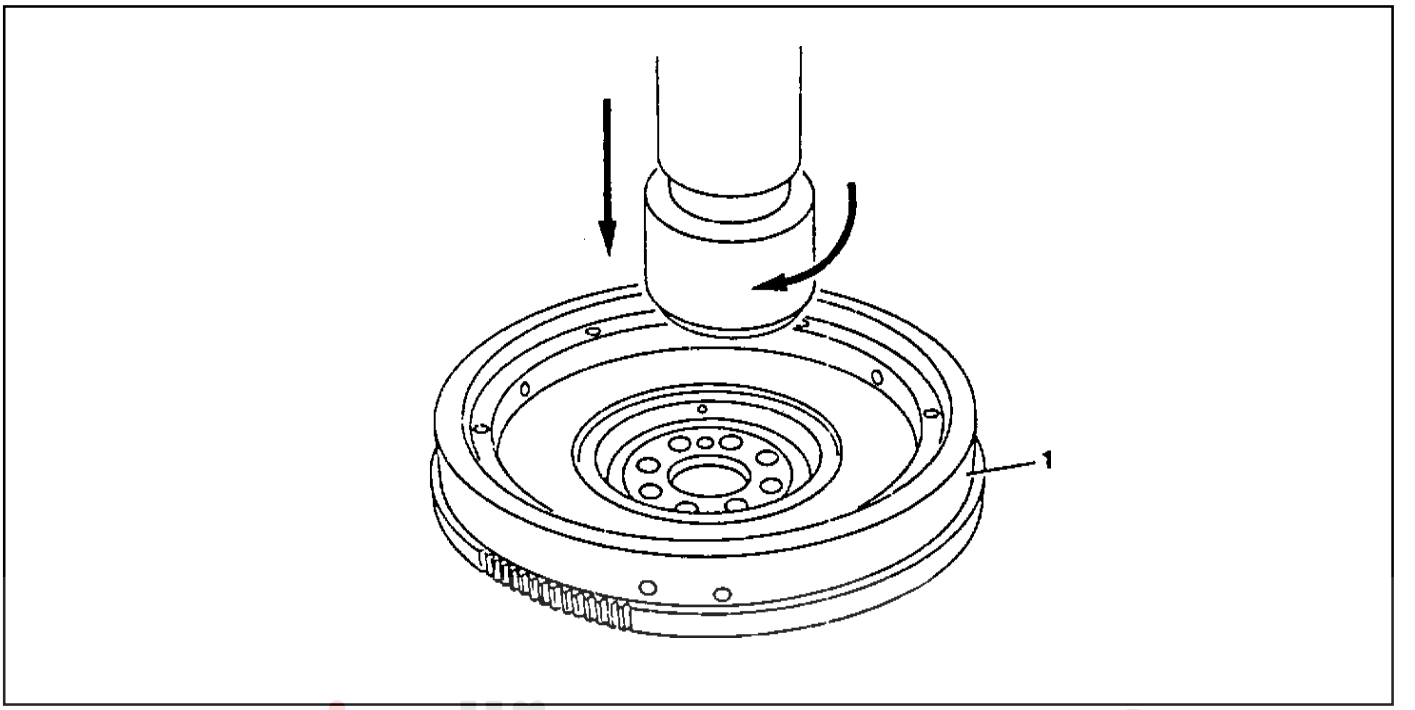


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MACHINING OF FLYWHEEL



1 Flywheel

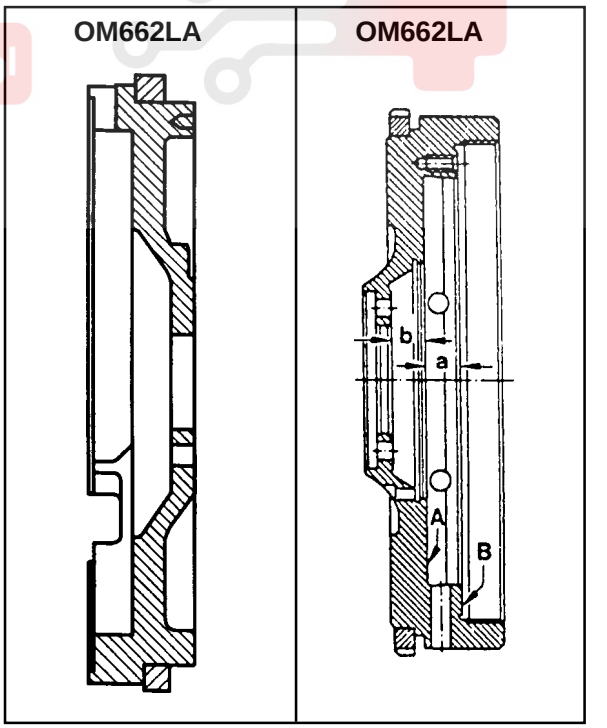
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Machining of Flywheel

Notice

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



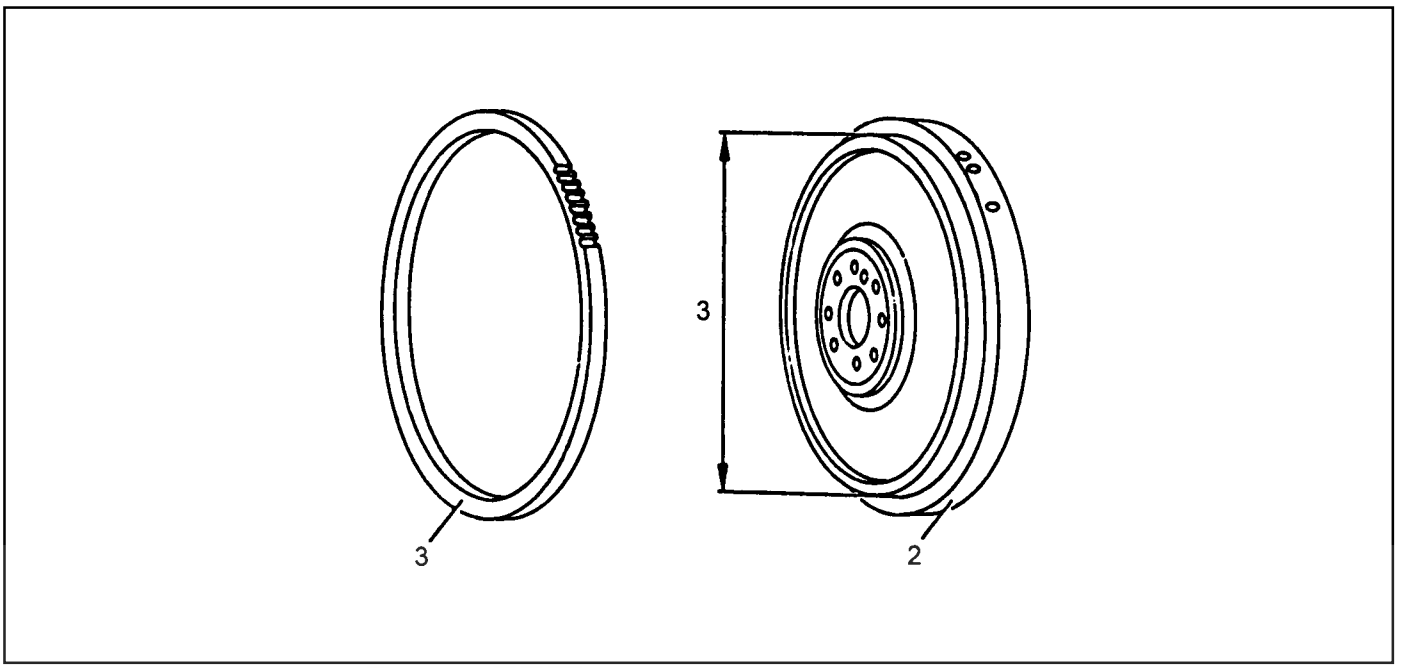
- When machining the clutch surface 'A', the mounting surface (B) for the clutch pressure plate should also be machined in accordance with 'A' to keep the distance 'a'.
- Do not machine under 'b' value.
- When machining, fix the flywheel exactly not to exceed the standard runout.

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FLYWHEEL RING GEAR

Preceding Work : Removal of flywheel



1 Ring Gear
2 Flywheel
3 Centering Collar Diameter

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Tools Required

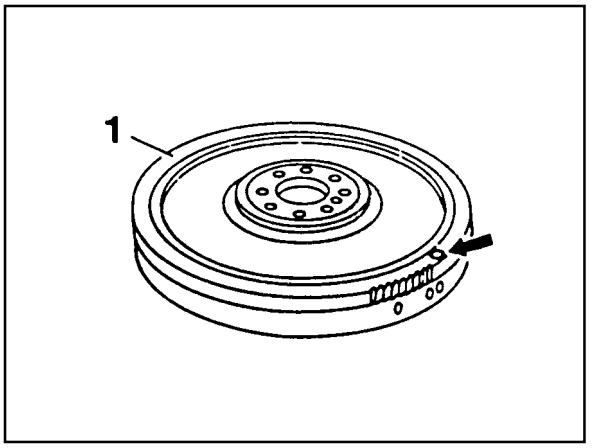
001 589 53 21 00 Dial Gauge
363 589 02 21 00 Dial Gauge Holder

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Replacement Procedure

1. Drill a hole into the ring gear (1) (arrow) and snap with a chisel.
2. Thoroughly clean the collar surfaces of ring gear.

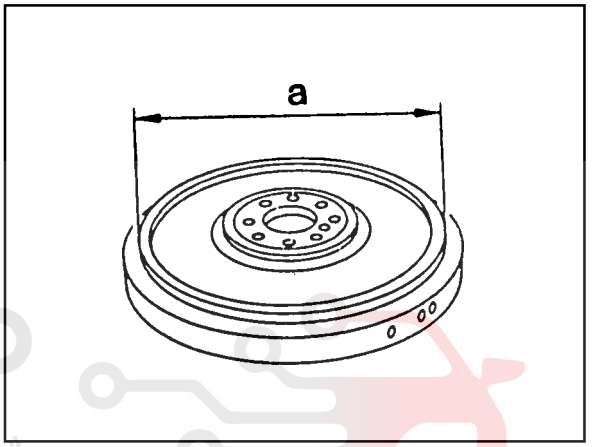


3. Measure diameter (a) of centering collar.

Diameter 'a'	275 + 0.5mm

Notice

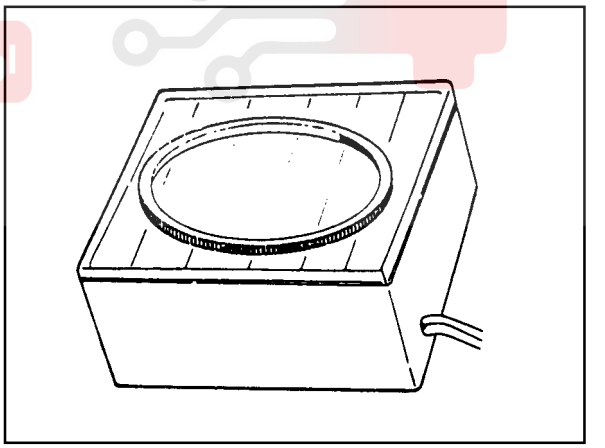
If out of standard, replace the flywheel.



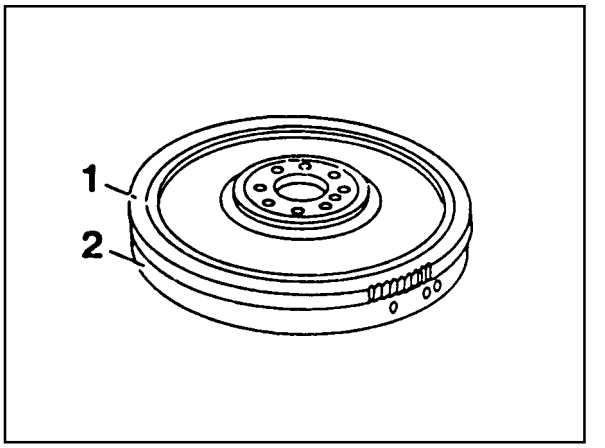
4. Heat up the new ring gear up to 220°C by using a heating device.

Notice

Use temperature measuring chalk.



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



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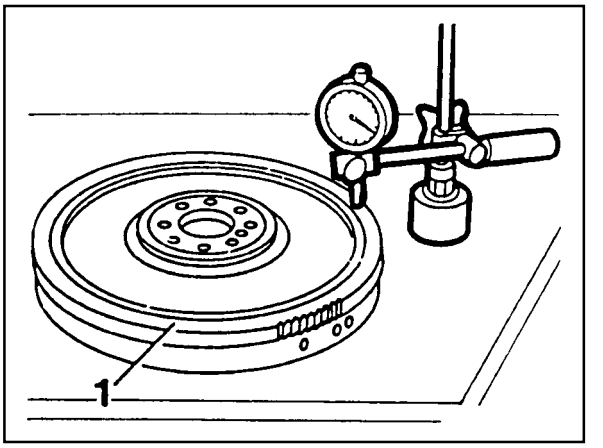
6. Measure axial runout of ring gear (1) on a surface plate.

Limit	Max. 0.4mm

Notice

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

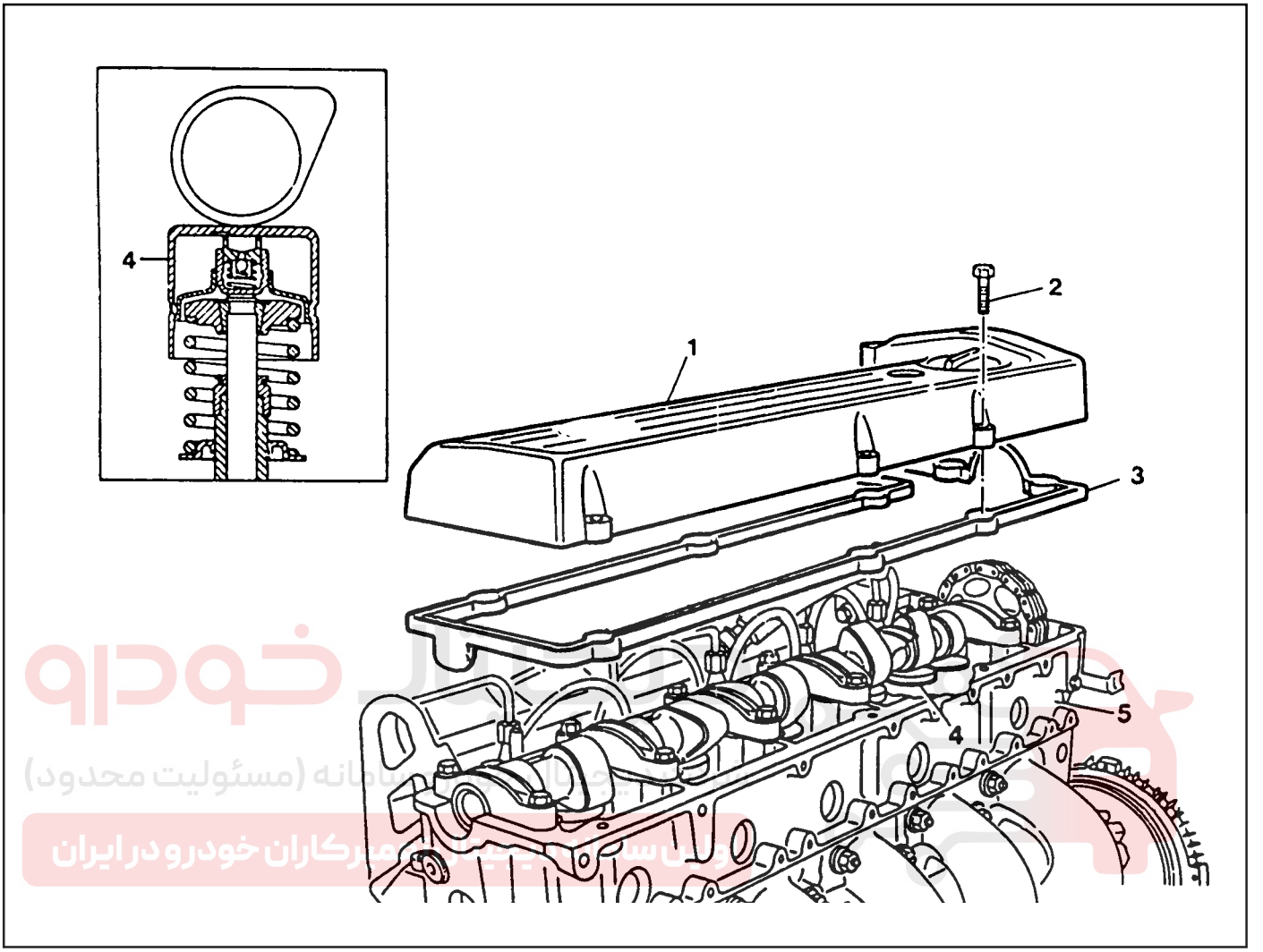


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HYDRAULIC VALVE CLEARANCE COMPENSATION ELEMENT CHECK

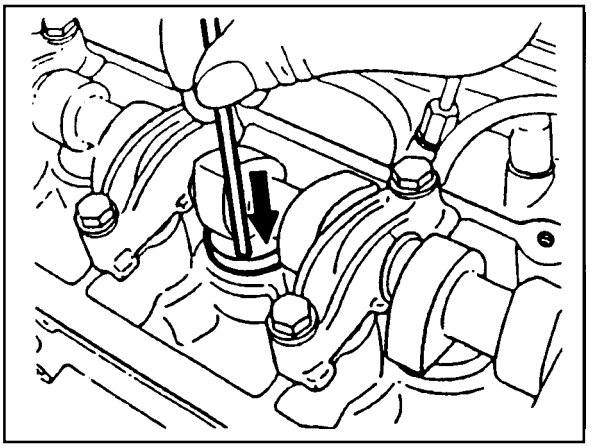


1 Cylinder Head Cover
2 Bolt 10Nm
3 Gasket ..... Replace
4 Valve Tappet
5 Cylinder Head

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Checking



Notice

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.

Notice

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.

Notice

- 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.

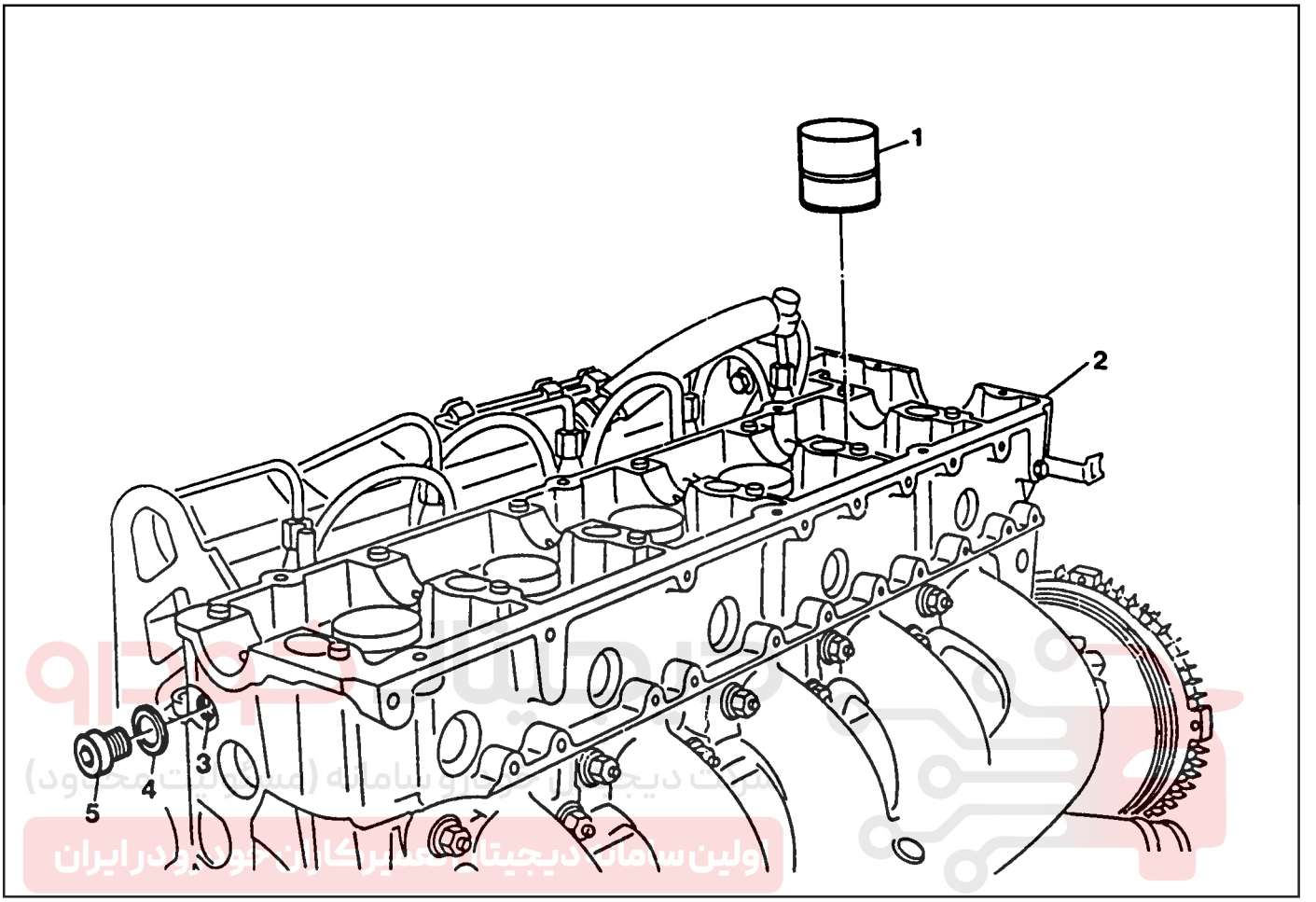
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VALVE TAPPETS

Preceding Work : Removal of camshaft



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

Tools Required

102 589 03 40 00 Magnetic Bar

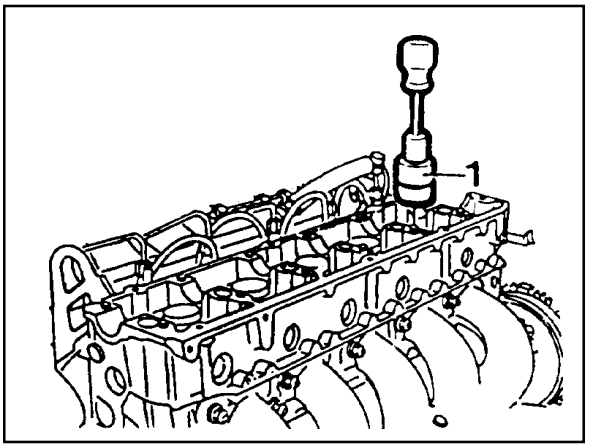
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Replacement Procedure

1. Pull out the valve tappet (1).

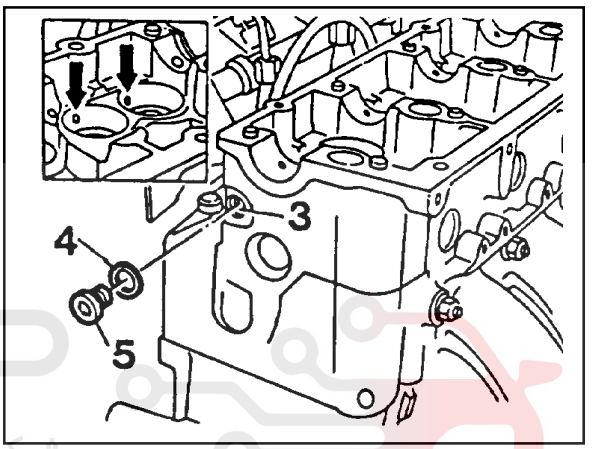
Magnetic Bar 102 589 03 40 00



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.

Notice

Coat the valve tappet with oil.



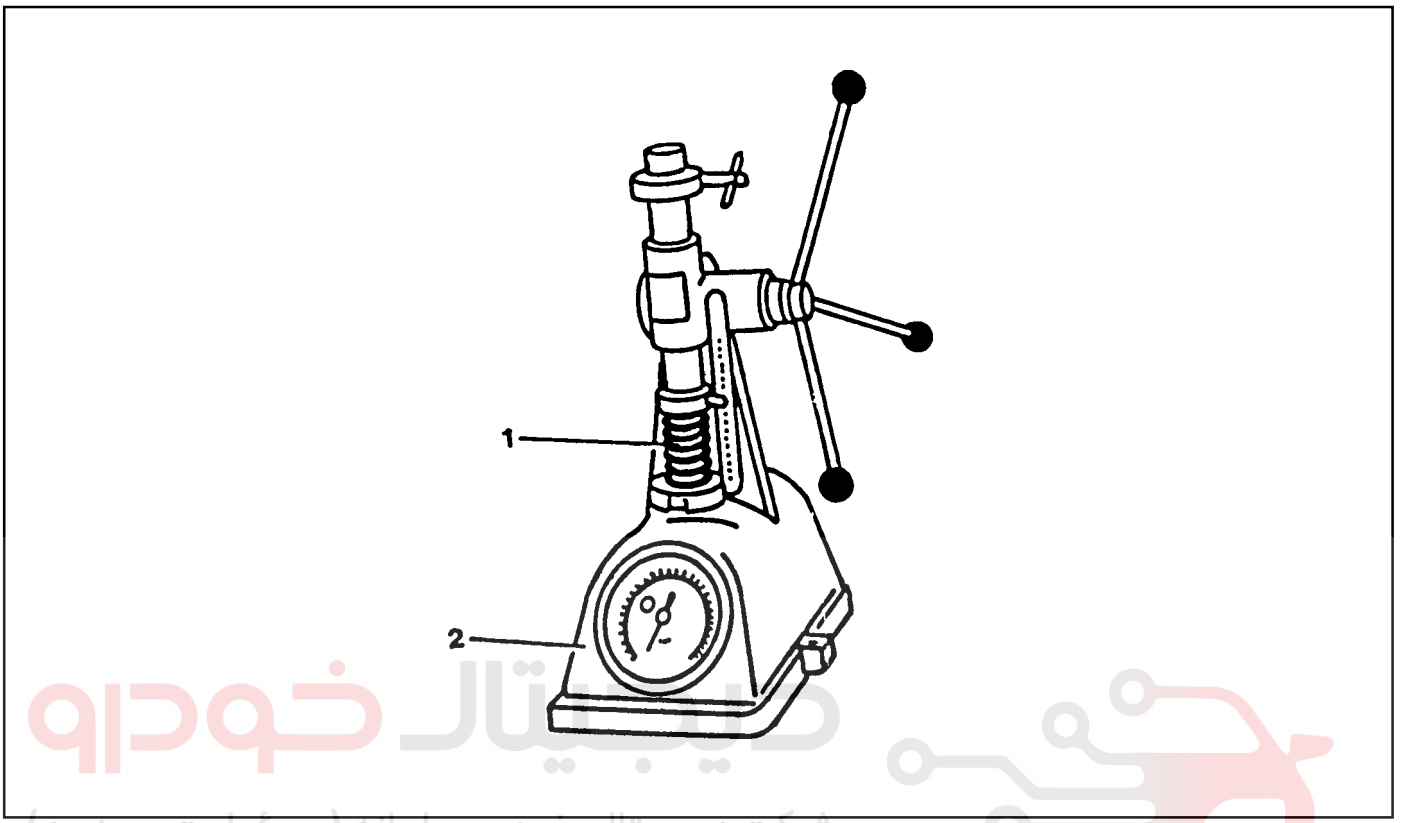
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VALVE SPRINGS CHECK

Preceding Work : Removal of valve spring



1 Valve Spring 2 Spring Scale

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Service Data

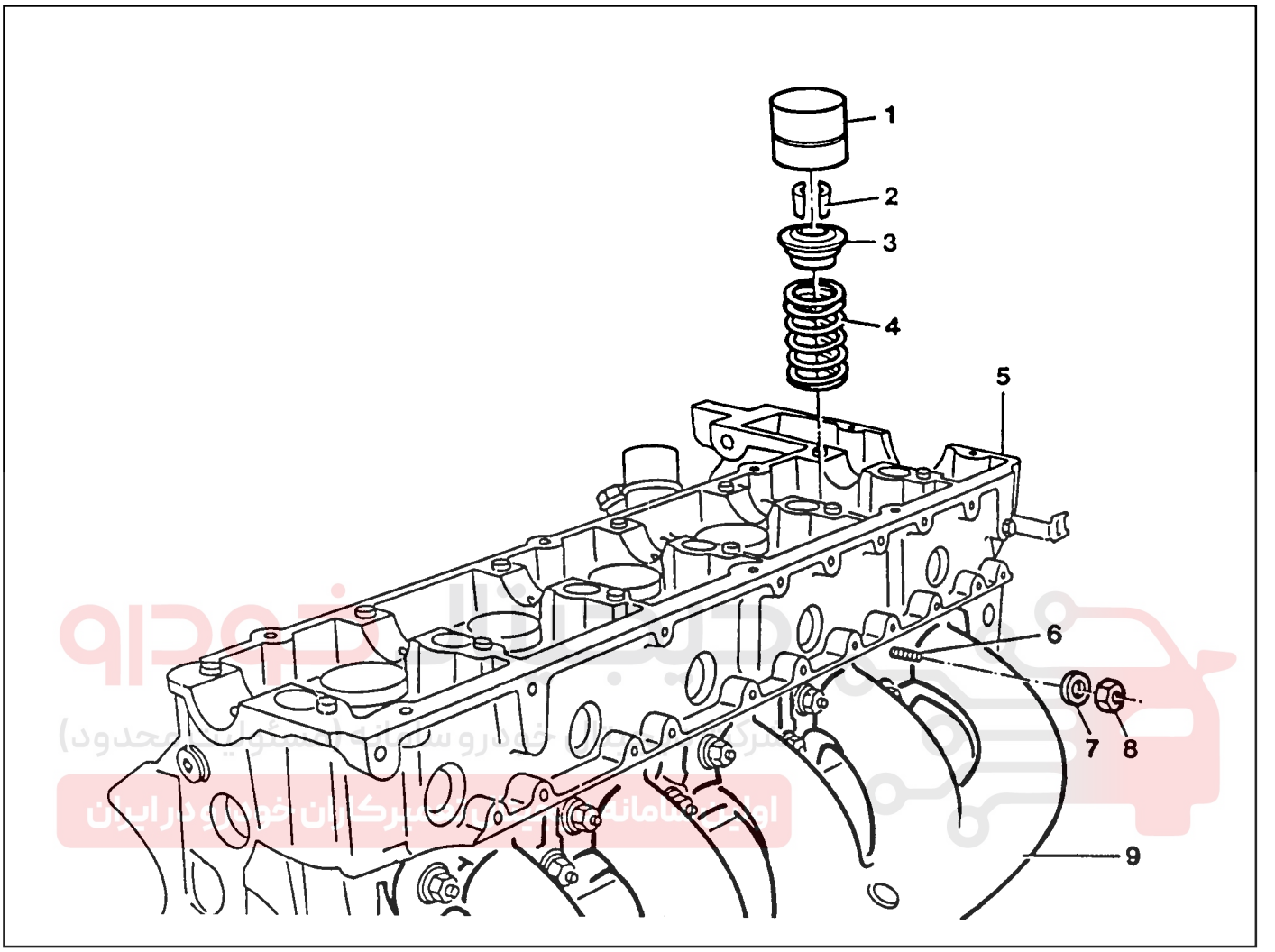
Outer diameter	Wire diameter	Free length	At preloaded		
			Length	Tension (new)	Limit
33.1mm	4.20mm	50.0mm	27mm	680 - 740N	612N

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VALVE SPRINGS (CYLINDER HEAD REMOVED)

Cylinder Head Removed



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

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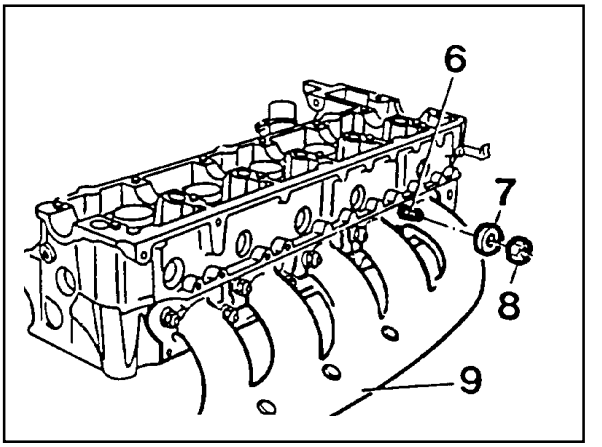
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Tools Required

102 589 03 40 00 Magnetic Bar
116 589 06 63 00 Magnetic Finger
601 589 01 59 00 Assembling Board
601 589 02 59 00 Supporting Bridge
667 589 00 31 00 Press Lever

Removal & Installation Procedure

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



Installation Notice

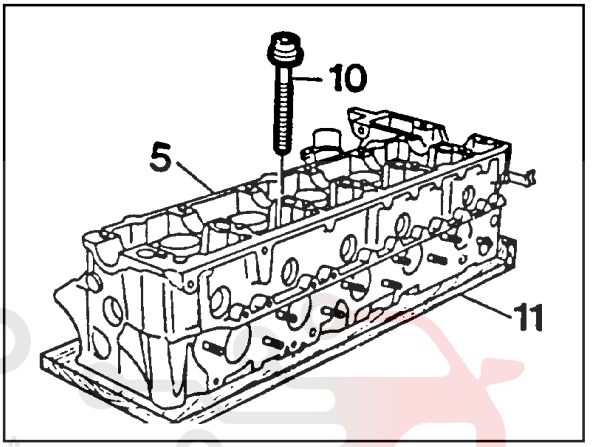
Check the stud bolt (6) for damage and replace if necessary.

Tighten Torque	12 Nm

Replace the gasket and tighten the nuts (8).

Tighten Torque	25 Nm

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



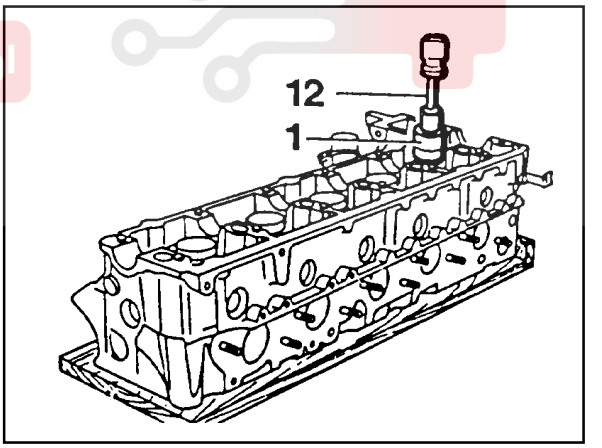
Assembling Board 601 589 01 59 00

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

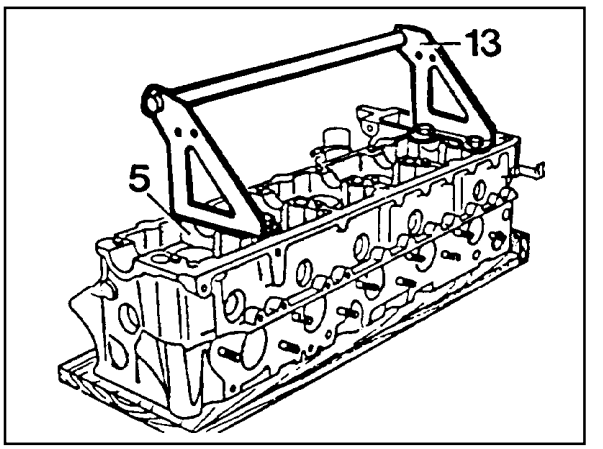
Notice

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



Magnetic Bar 102 589 03 40 00

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



Supporting Bridge 601 589 02 59 00

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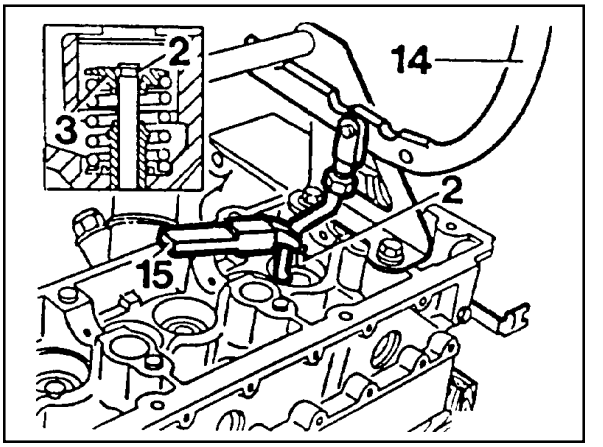
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5. Using the press lever (14), press the spring retainer downward and remove the valve cotters (2) with magnetic finger (15).

   Notice

   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

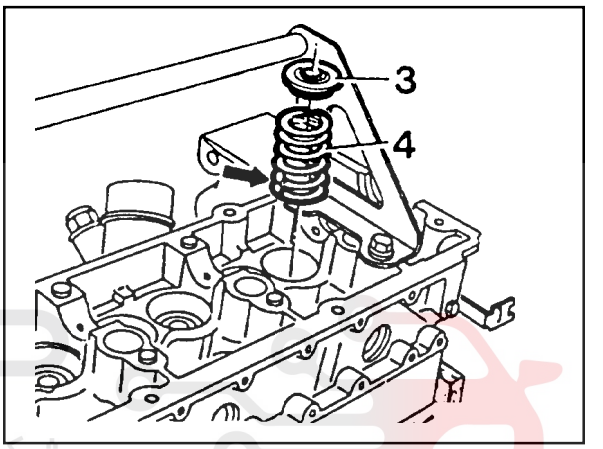


6. Remove the spring retainer (3) and spring (4).

   Installation Notice

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

7. Check the valve spring and replace if necessary.
8. Installation should follow the removal procedure in the reverse order.



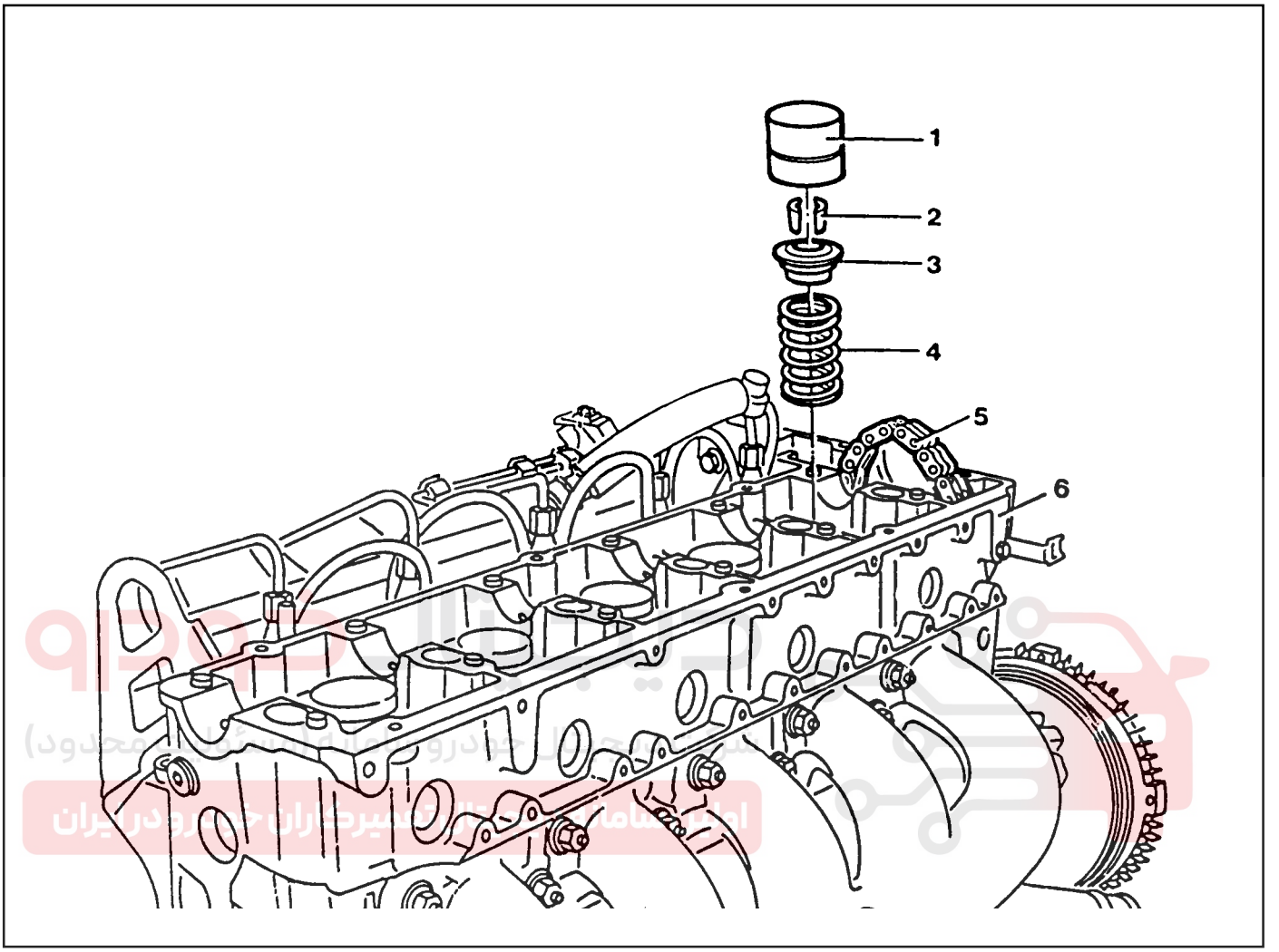
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VALVE SPRINGS (CYLINDER HEAD INSTALLED)

Preceding Work : Removal of camshaft



1 Valve Tappet
2 Valve Cotters
3 Spring Retainer
4 Valve Spring ..... Check, replace if necessary
5 Timing Chain
6 Cylinder Head

Notice

Remove the valve springs only when the piston is at TDC.

Tools Required

102 589 03 40 00 Magnetic Bar
116 589 06 63 00 Magnetic Finger
603 589 01 40 00 Holding Wheel
667 589 00 31 00 Press Lever
667 589 02 63 00 Supporting Bar

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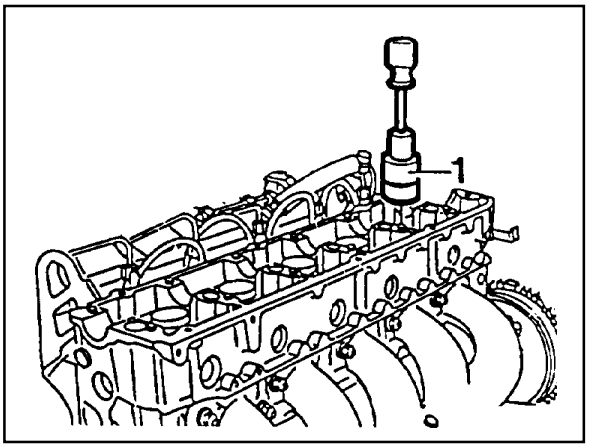
Removal & Installation Procedure

1. Remove the valve tappet (1) with magentic lifter.

   Notice

   Place the valve tappets upside down (open end upward)

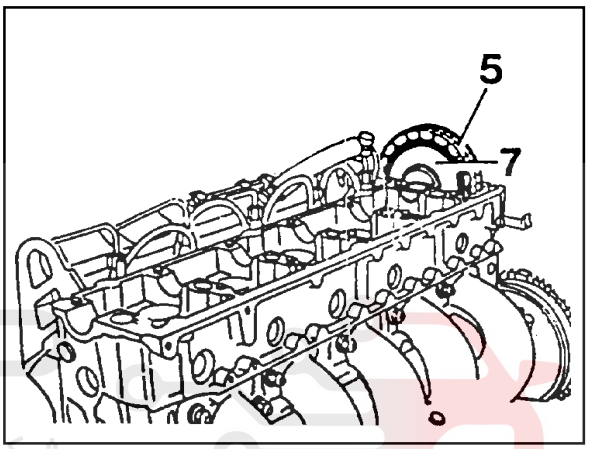
   Magentic Liter 102 589 03 40 00



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

   Holding Wheel 603 589 01 40 00

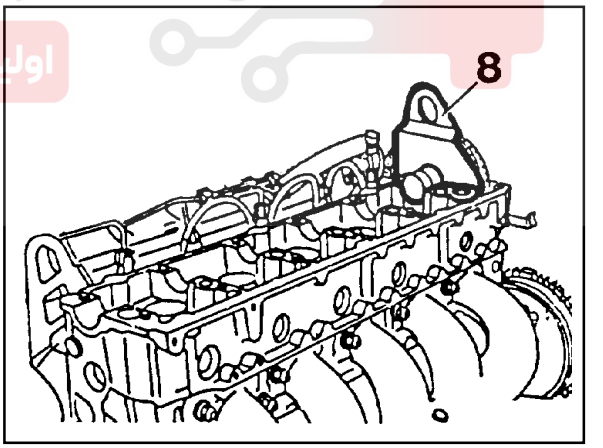
3. Position the piston of relevant cylinder at TDC.



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4. Install the supporting bar (8).

   Supporting Bar 667 589 02 63 00

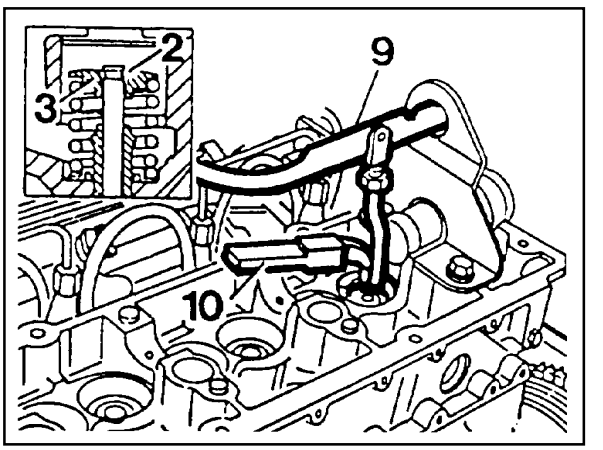


5. Using the press lever (9), press the spring retainer(3) downward and remove the valve cotters (2) with magnetic finger (10).

   Notice

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

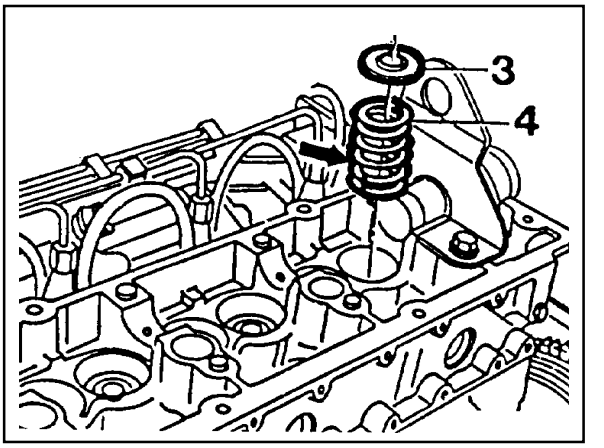
   Press Lever 667 589 00 31 00
   Magnetic Finger 116 589 06 63 00



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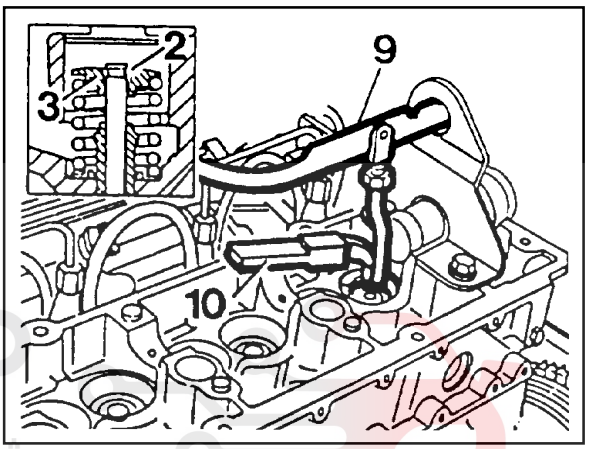
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6. Remove the spring retainer(3) and spring (4).
7. Check the valve spring and replace if necessary.
8. Insert valve spring (4) with the color coding (arrow) facing down and insert valve spring Retainer(3).



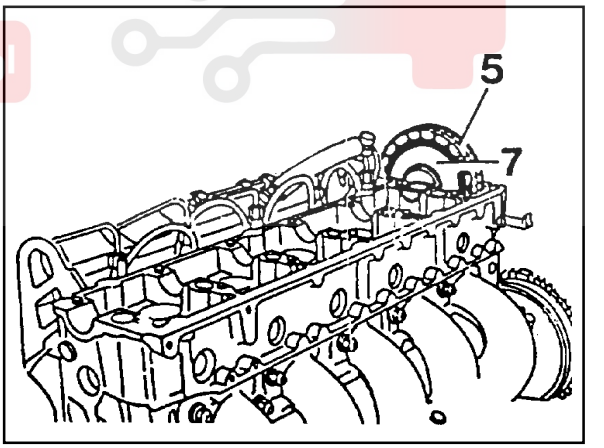
9. By press the spring retainer(3) with press lever (90), install the valve cotters with magnetic finger (10).

Press Lever 667 589 00 31 00
Magnetic Finger 116 589 06 63 00



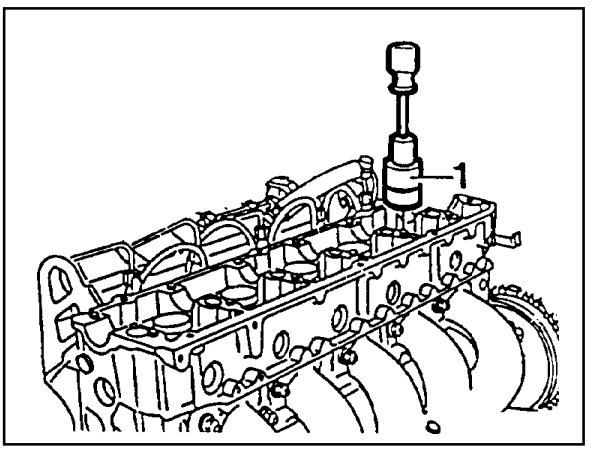
10. Remove the supporting bar.
11. Remove the holding wheel (7) from the timing chain (5).

Holding Wheel 603 589 01 40 00



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

Magnetic Bar 102 589 03 40 00

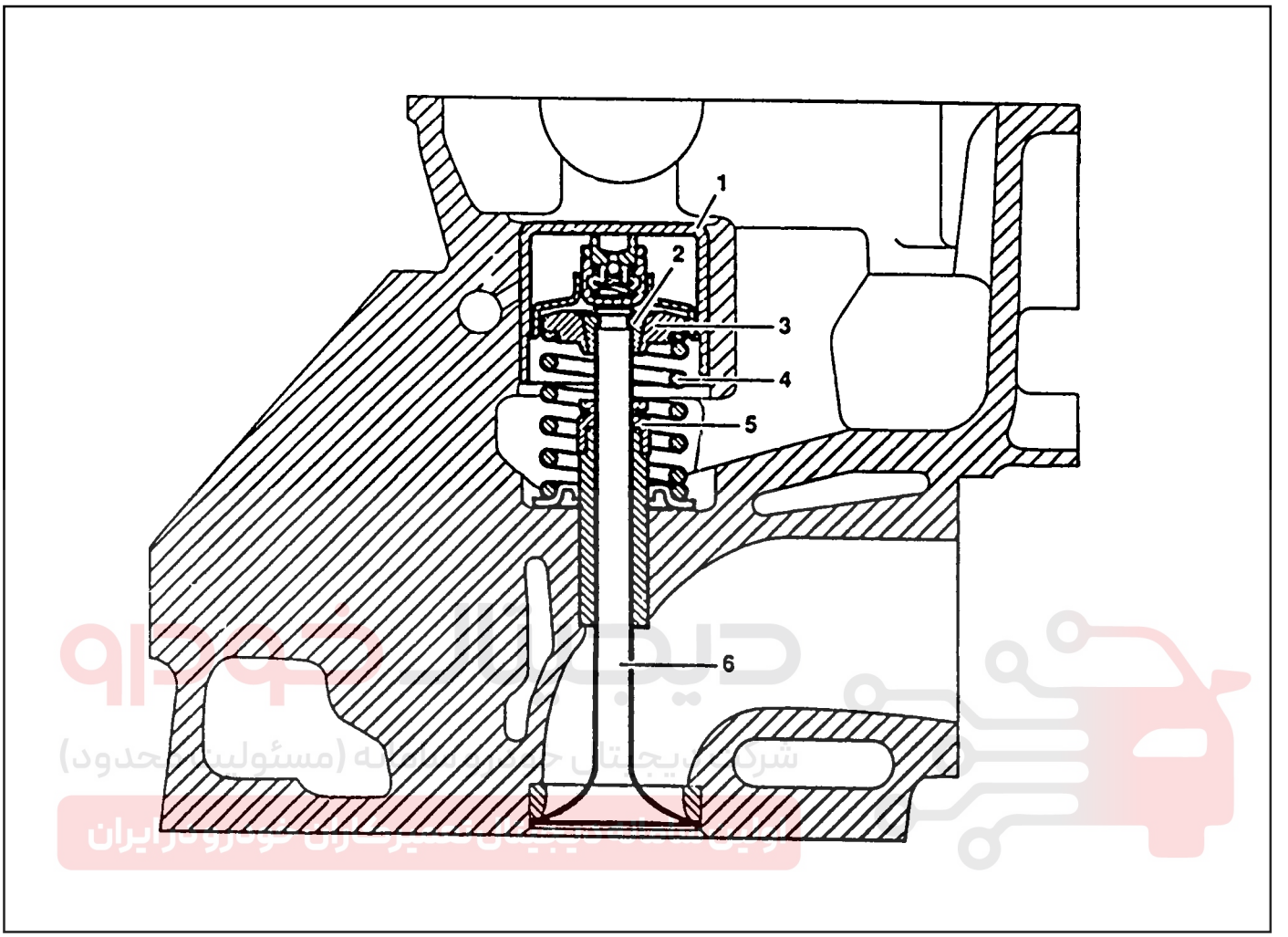


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VALVE STEM SEALS

Preceding Work : Removal of camshaft.



1 Valve Tappet
2 Valve Cotters
3 Spring Retainer
4 Valve Spring ..... Check, replace if necessary
5 Valve Stem Seal
6 Valve

Notice

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

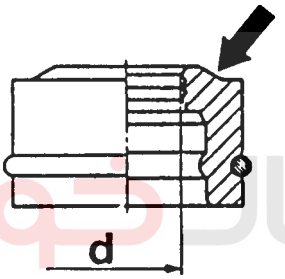
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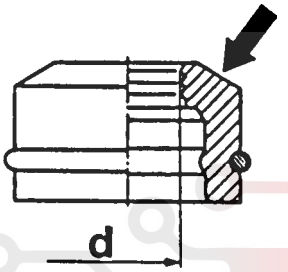
Tools Required

667 589 00 31 00 Press Lever
104 589 00 37 00 Pliers
102 589 03 40 00 Magnetic Lifter
603 589 01 40 00 Holding Wheel
601 589 02 43 00 Drift
116 589 06 63 00 Magnetic Finger
667 589 02 63 00 Supporting Bar

A : Intake valve stem seal



B : Exhaust valve stem seal



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

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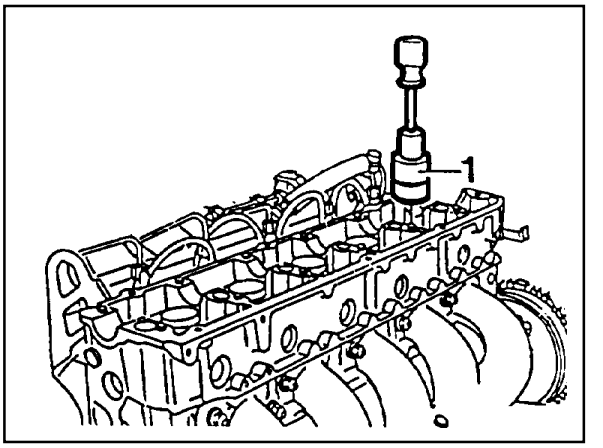
Replacement Procedure

1. Remove the valve tappet (1) with magnetic lifter.

   Notice

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

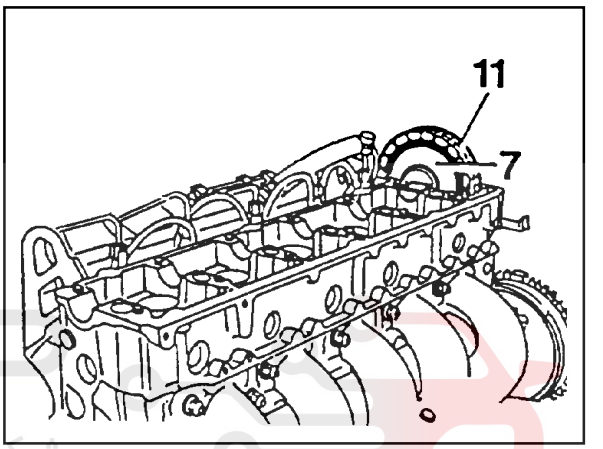
   Magnetic Lifter 102 589 03 40 00



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

   Holding Wheel 603 589 01 40 00

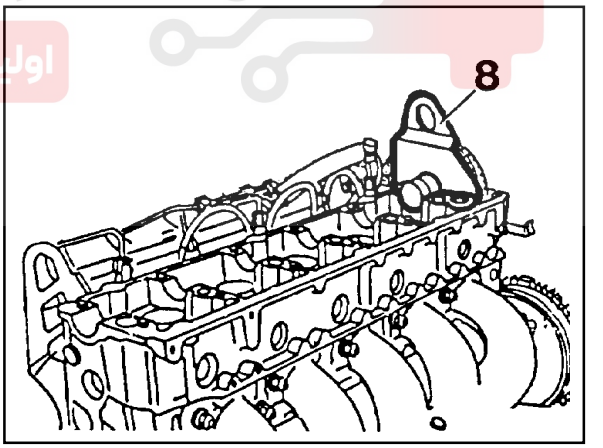
3. Position the piston of relevant cylinder at TDC.



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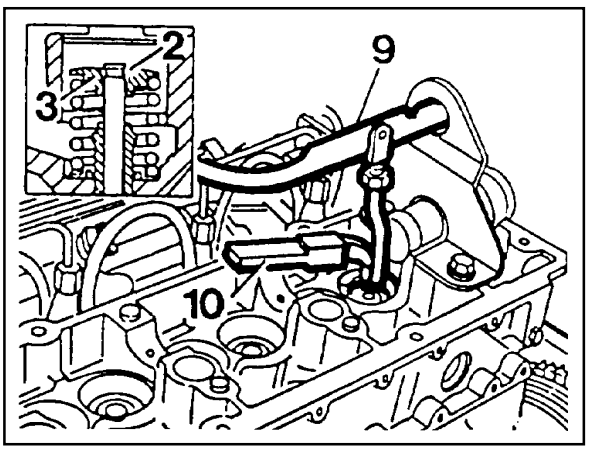
4. Install the supporting bar (8).

   Supporting Bar 667 589 02 63 00



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

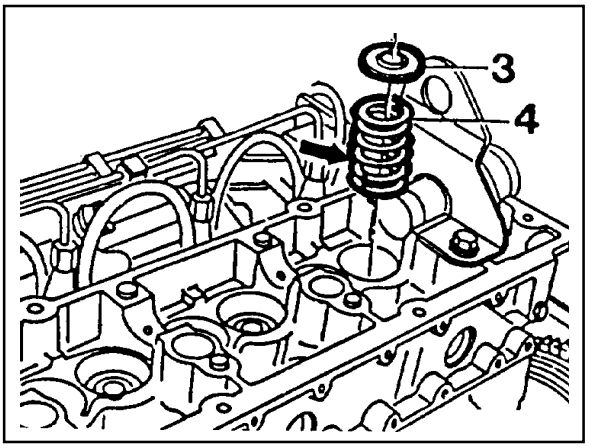
   Press Lever 667 589 00 31 00
   Magnetic Finger 116 589 06 63 00



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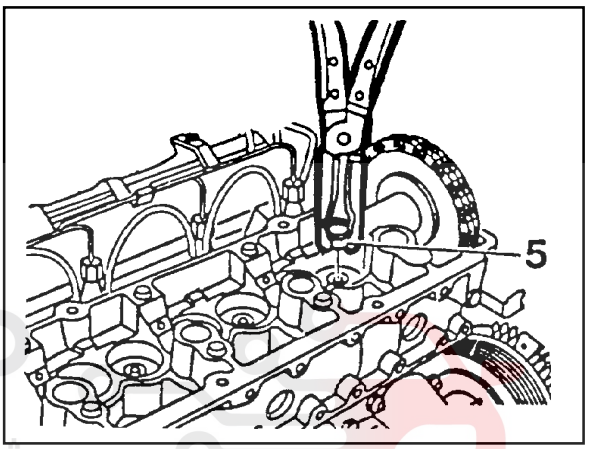
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6. Remove the spring retainer(3) and valve spring (4).



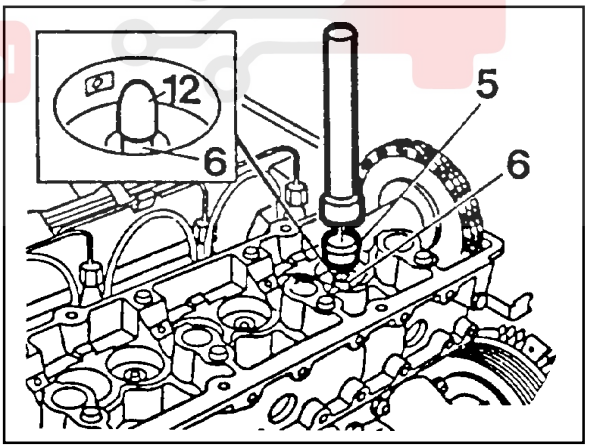
7. Remove the valve stem seal (5).

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

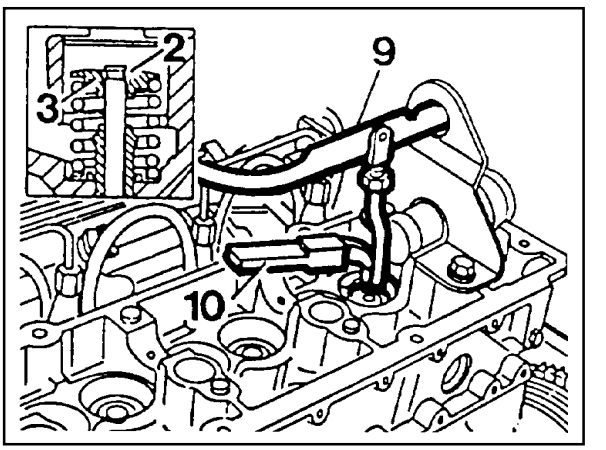


9. By pressing the spring seat with press lever (9), install the valve cotters(2) with magnetic finger (10).

Notice

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

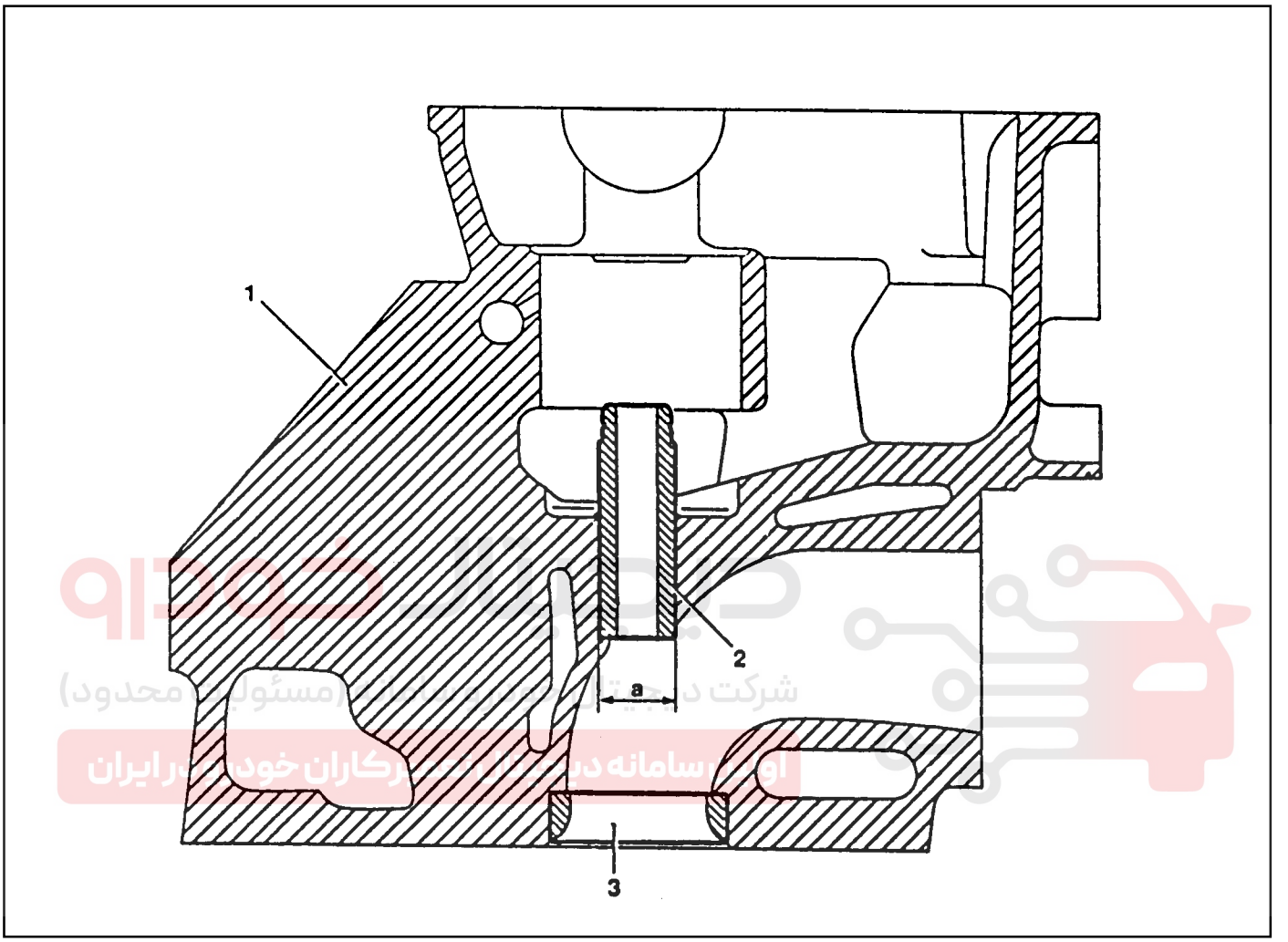


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CHECK AND REPLACEMENT OF VALVE GUIDES

Preceding Work : Removal of cylinder head
Removal of valve spring
Removal of valve



1 Cylinder Head
2 Valve Guide
3 Valve Seat Ring
a Basic Bore Diameter

Service Data

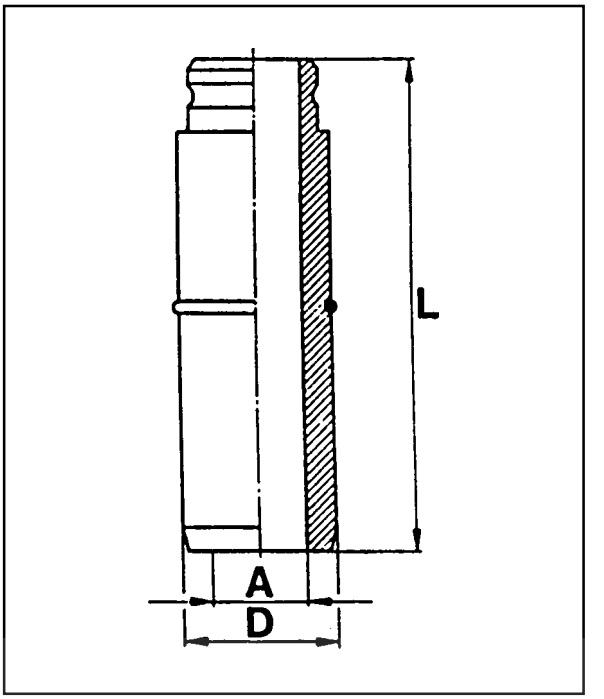
	Item	Outer Diameter 'D'	Color Code	Basic Bore Diameter 'a'	Overlap 'D' - 'a'	Valve Guide Inner Diameter 'A'	Length 'L'
Intake	Repair size 1	14.251	Red	14.200 - 14.211	0.029	8.000	39.5
	Repair size 2	14.440 - 14.451	White	14.400 - 14.411	- 0.051	- 8.030	
Exhaust	Repair size 1	14.240 - 14.251	Red	14.200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

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Notice

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



Tools Required

000 589 10 53 00 Reamer (for Exhaust)
000 589 10 68 00 Cylinder Brush
000 589 21 53 00 Reamer (for Intake)
102 589 00 23 00 GO / NO GO Gauge (for Intake)
103 589 02 15 00 Drift (for Exhaust)
103 589 03 15 00 Drift (for Intake)
117 589 03 25 00 GO / NO GO Gauge (for Exhaust)
346 589 00 63 00 Super Cooling Box
601 589 02 23 00 GO/NO GO Gauge
601 589 05 15 00 Drift (for Intake)
601 589 06 15 00 Drift (for Exhaust)

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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	102 589 00 63 00	B
Exhaust	(14.2mm)	102 589 08 63 00	B
Intake	115 589 01 53 00	601 589 15 63 00	A
Exhaust	(14.4mm)		B

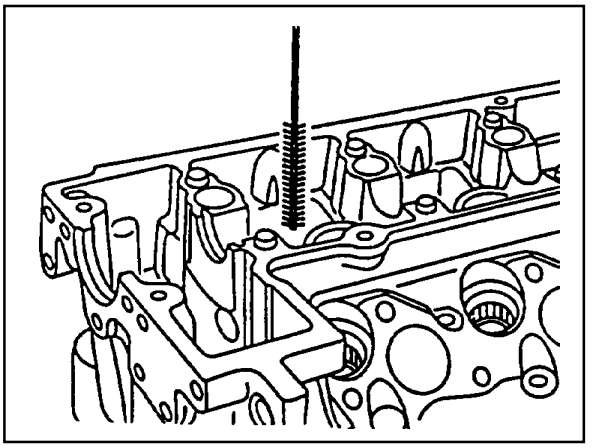
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Checking

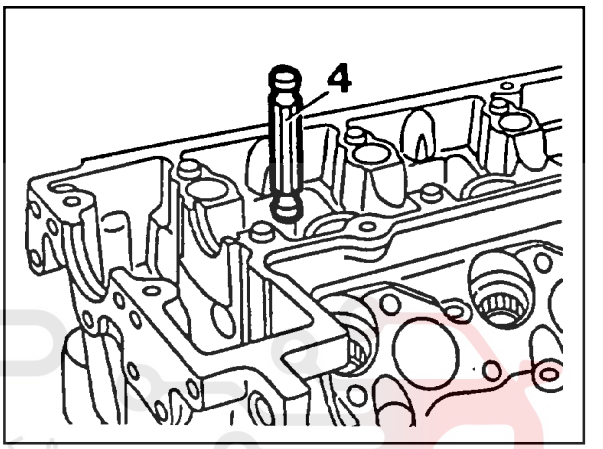
1. Thoroughly clean the valve guide bore using a cylinder brush.

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



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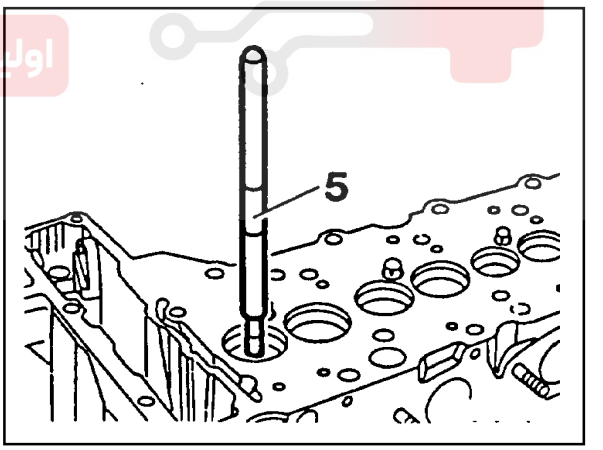
Replacement Procedure

1. Drive out the valve guide (2) by using a drift (5).

Notice

The valve guide must be driven out upward of the cylinder head.

Drift (for Intake) 103 589 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.

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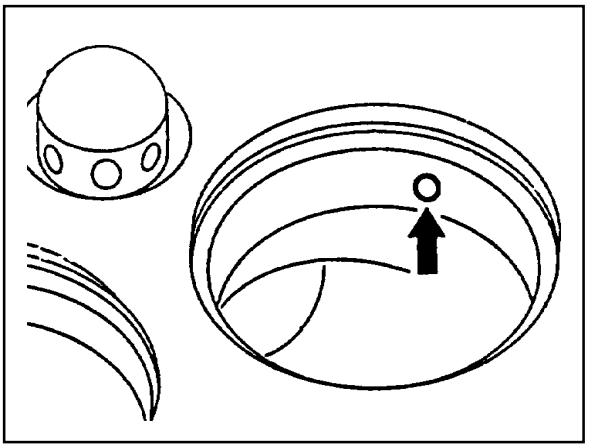
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4. Reaming basic bore in cylinder head (repair size).
   - Thoroughly remove carbon deposits in cylinder head.

     Notice

     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).

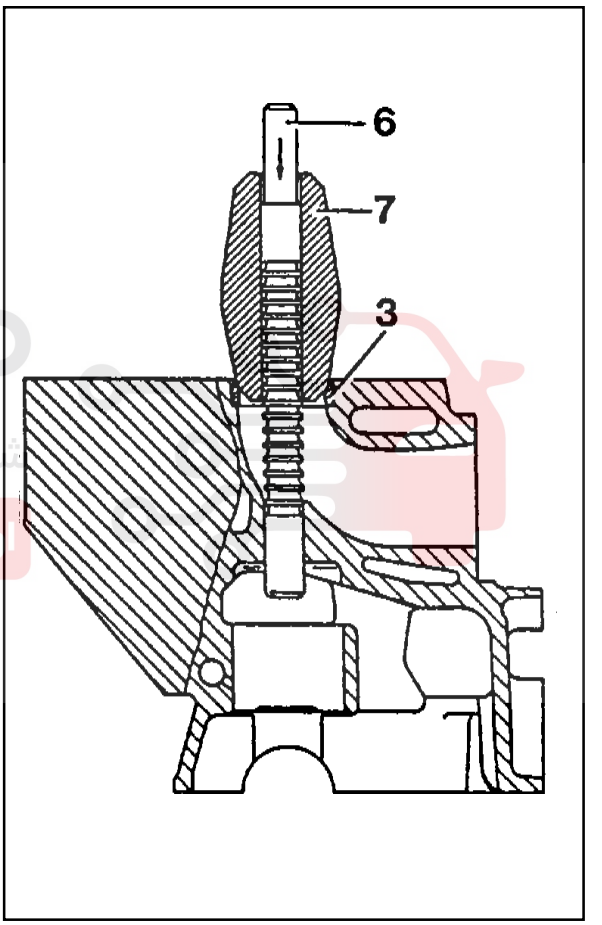
     Notice

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

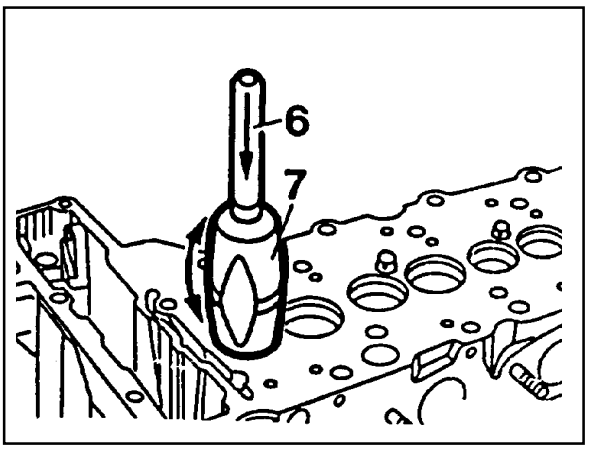
   - Lubricate the basic bore, guide sleeve and broaching tool with petroleum.
   - Push broaching tool (6) in broaching direction (arrow) into the guide sleeve (7) far enough so that the first cut of the broaching tool is positioned in the basic bore when guide sleeve is fitted onto the valve seat ring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

6. Broaching tool
7. Guide sleeve

See the 'standard data'



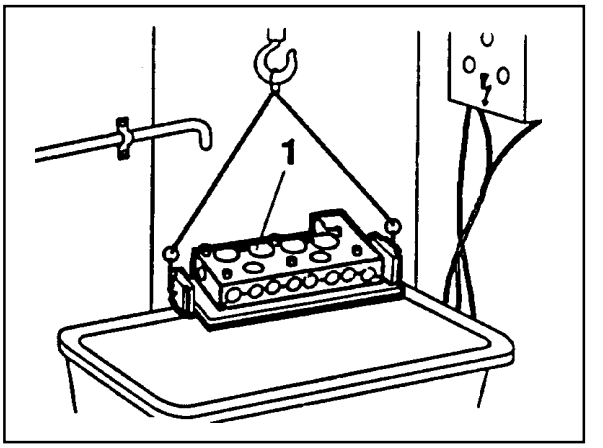
   - Center the guide sleeve (7) in the valve seat ring (3) by turning.
   - Knock through the broaching tool (6) with a plastic hammer (approx. 25g). and aluminum drift.



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5. Heat the cylinder head (1) in a wear tank to approx. 80°C.

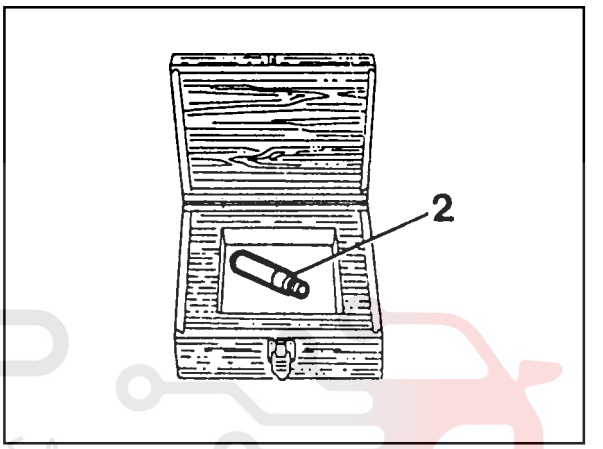


6. Cool down the new valve guide (2) with liquid nitrogen.

Notice

Do not touch the cooled valve guide by hand.

Super Cooling box 346 589 00 63 00

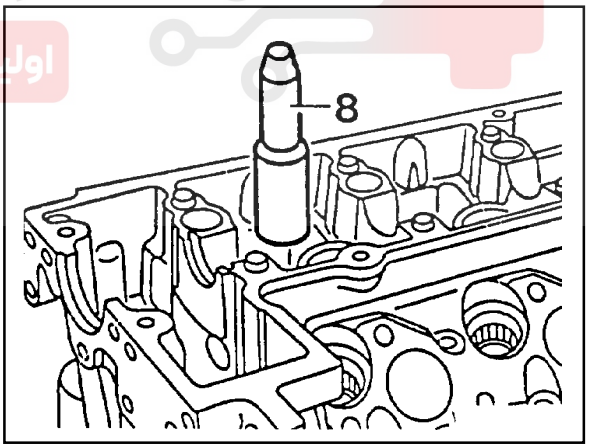


7. Drive in new valve guide with drift (8) until the wire ring makes contact.

Notice

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



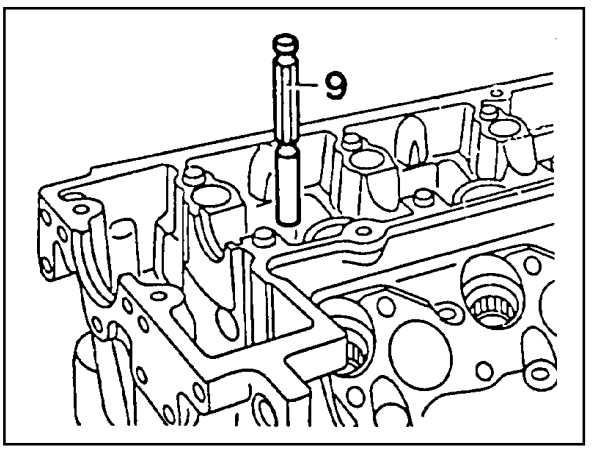
8. Check the valve guide bore with GO / NO GO gauge (9).

The GO side (marked '0') should just still drop. If the GO side cannot be inserted, the bore of valve guide should be reamed.

Notice

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



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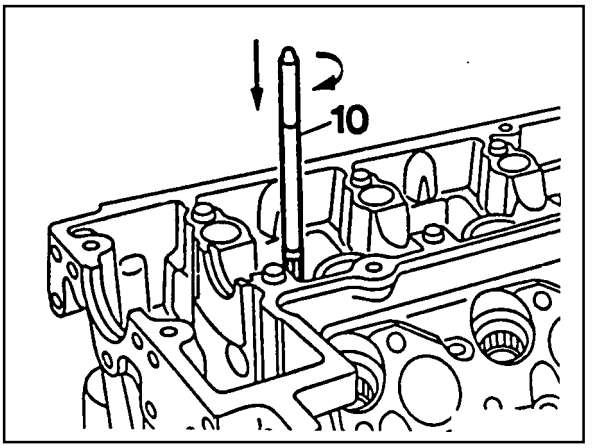
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9. If necessary, ream the valve guide bore evenly.

Notice

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



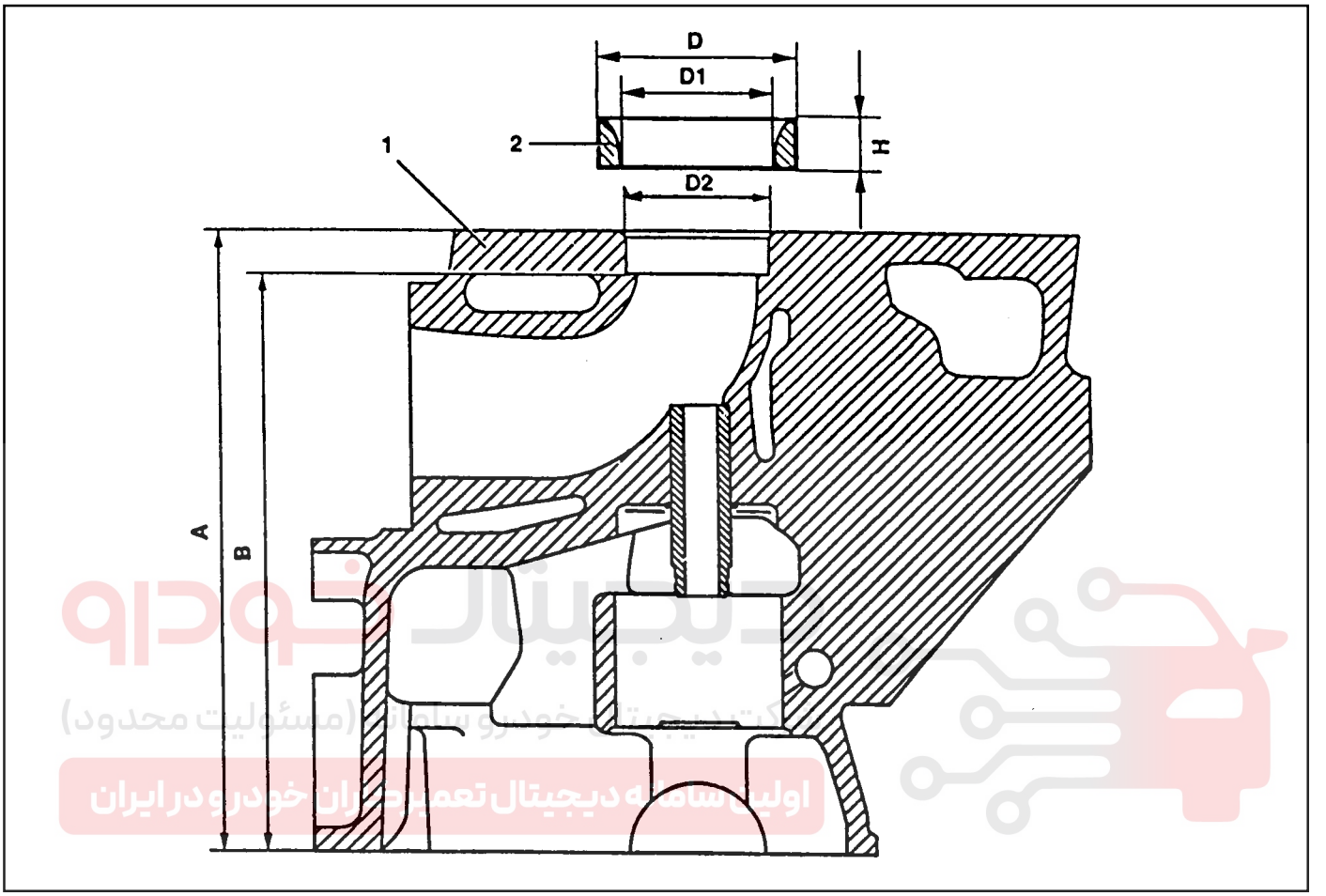
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VALVE SEAT RINGS

Preceding Work : Removal of valve
Checking of valve guide, replace if necessary
Removal of prechamber



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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

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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

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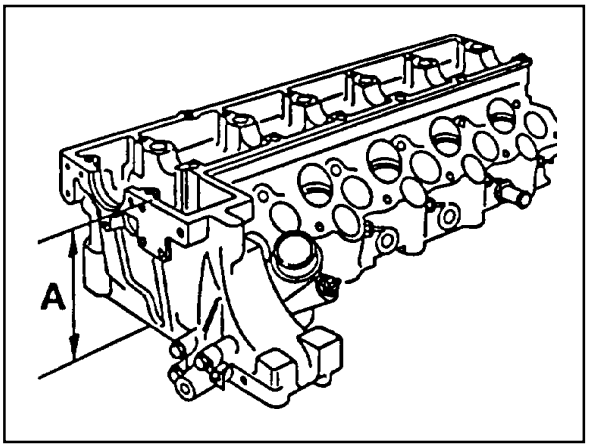
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Removal Procedure

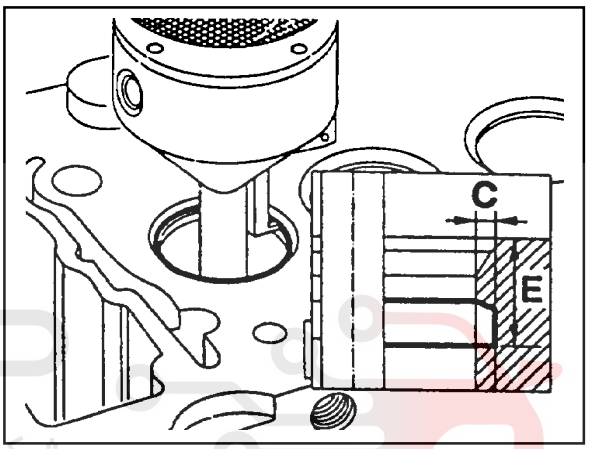
1. Measure dimension ‘A’.

Limit	142.5mm

2. Clamp the cylinder head with clamping device.

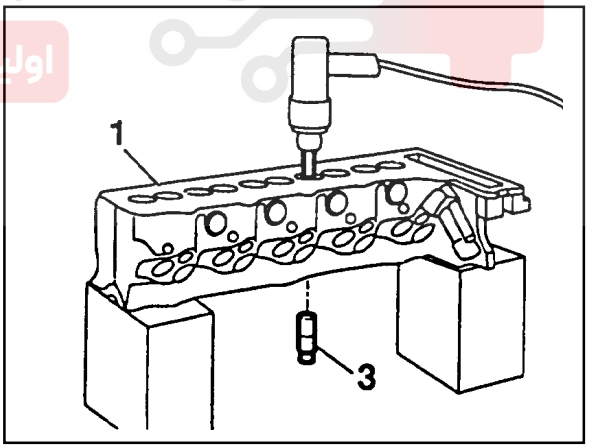


3. Cut groove into the valve seat ring so that dimension ‘C’ is approx. 2mm and dimension ‘E’ is approx. 6mm.



4. Remove the cylinder head from the clamping device and place it onto wooden blocks.
5. Remove the valve guide (3).

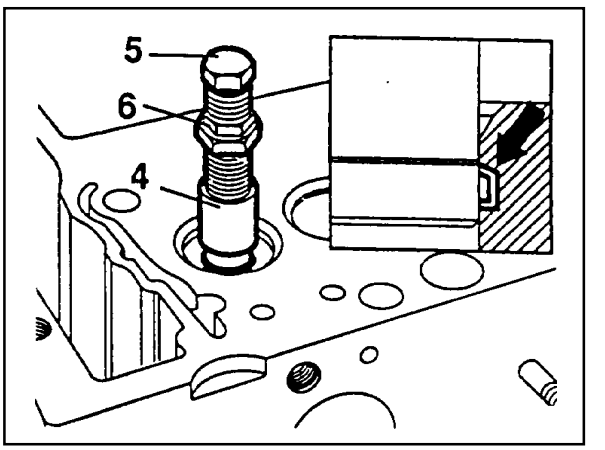
Drift (Intake) 8mm
Drift (Exhaust) 9mm



6. Insert the tensioning head (4) and extracted wedges(arrow) by turning the bolt (5).

   Notice

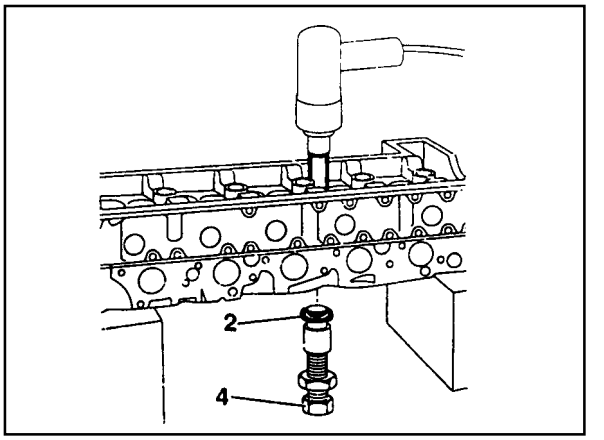
   Carefully tighten the bolt (5) otherwise the valve seat ring in the cylinder head will be excessively tensioned.
7. Lock the bolt (5) with nut (6).



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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.



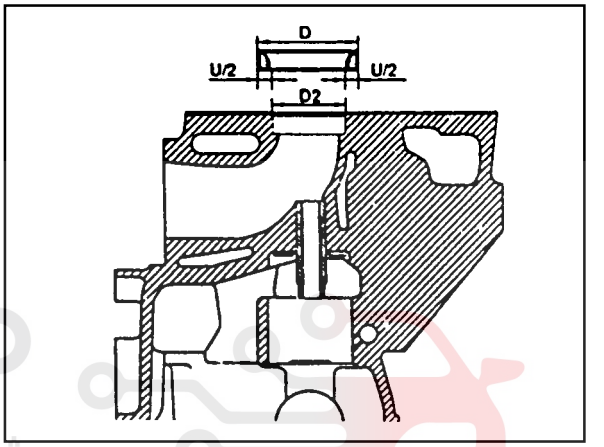
11. Measure the basic bore diameter (D2) and outer diameter (D) of the new valve seat ring (standard size).
12. Calculate the overlap value 'U' (D - D2).

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).

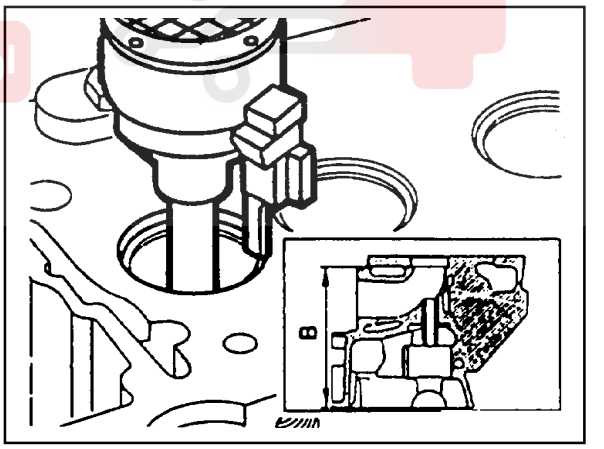
Notice

Maintain minimum value of 'B'.

- Machine the basic bore.

Limit

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



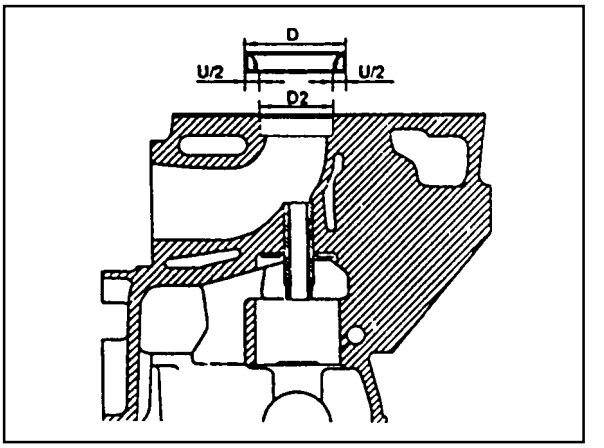
- Measure machined basic bore and outer diameter 'D' of valve seat ring (repair size).
- Measure the overlap 'U'

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

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

Overlap U = 0.120 mm

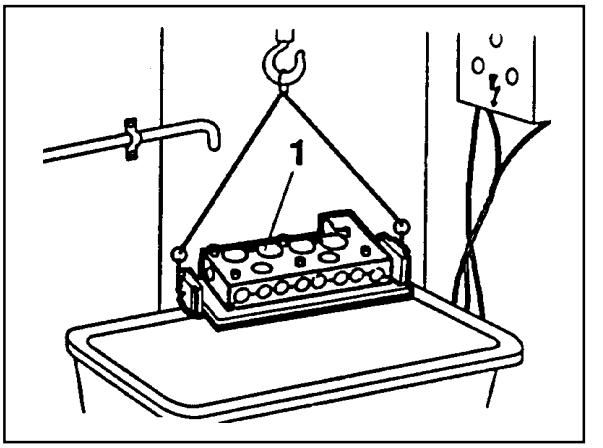
The basic diameter D2 must be machined by 0.020mm in order to get the required overlap value.



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

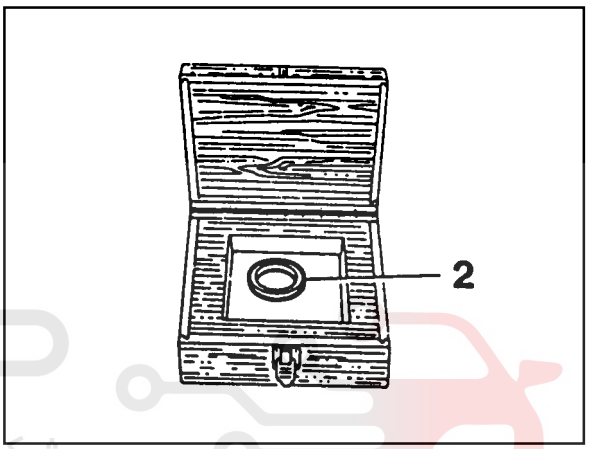


16. Cool down new valve seat ring (2) into the cooling box with liquid nitrogen.

Notice

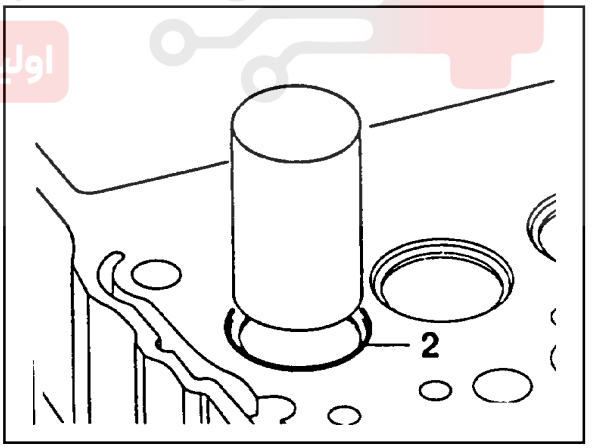
Do not touch the cooled valve seat rings with hand.

Super Cooling Box 345 589 00 63 00



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

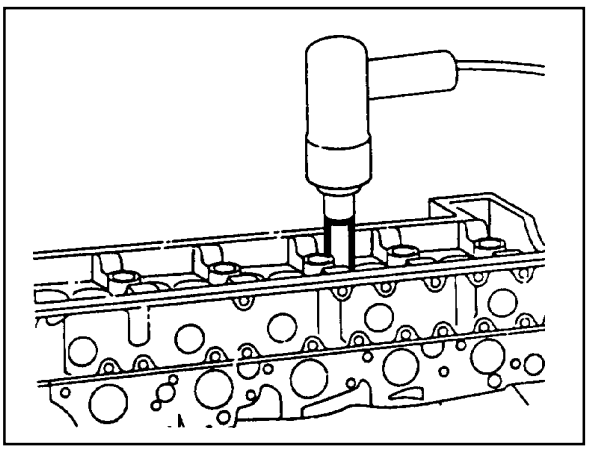


18. Install the valve guide (3) with a proper drift and assembling tool.

Notice

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

Drift (Intake) 8mm
Drift (Exhaust) 9mm



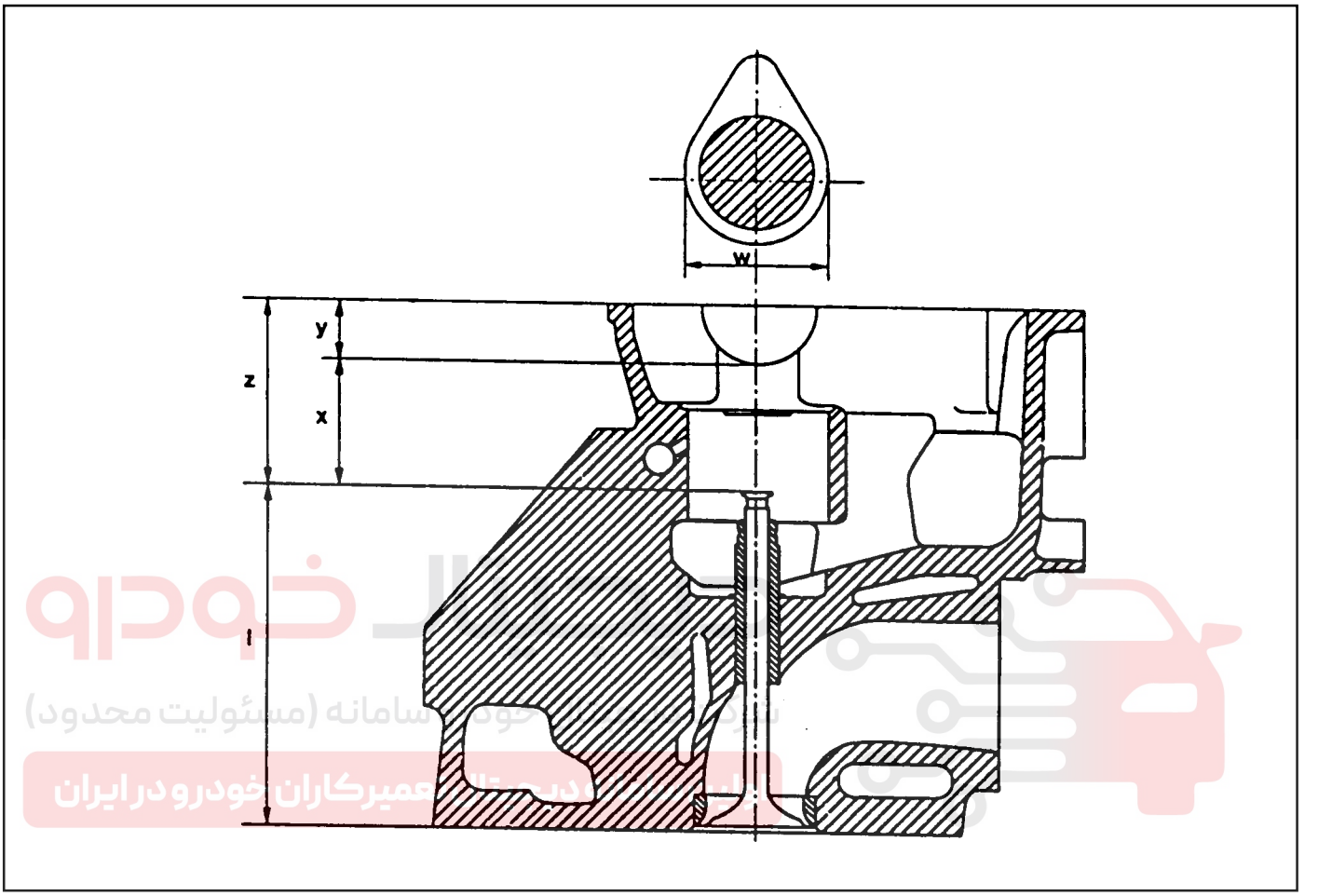
19. Machine the valve seats.

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CHECK AND MACHINING OF VALVES

Preceding Works : Removal of cylinder head
Removal of the vale spring
Removal of the valve

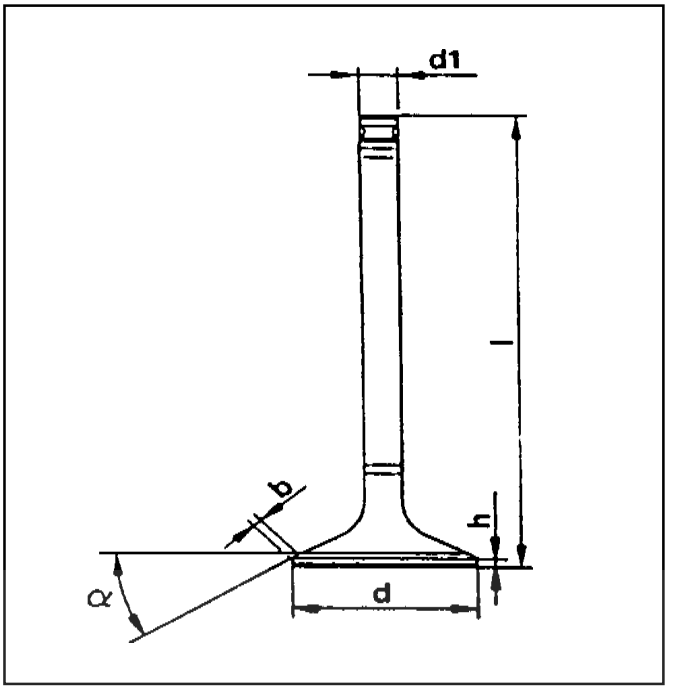


I Valve Length
W Camshaft Cam Basic Diameter
X Distance (Camshaft Basic Bore - Valve Stem)
Y Half Camshaft Basic Bore Diameter
Z Distance (Cylinder Head Cover Parting Surface - Valve Stem)

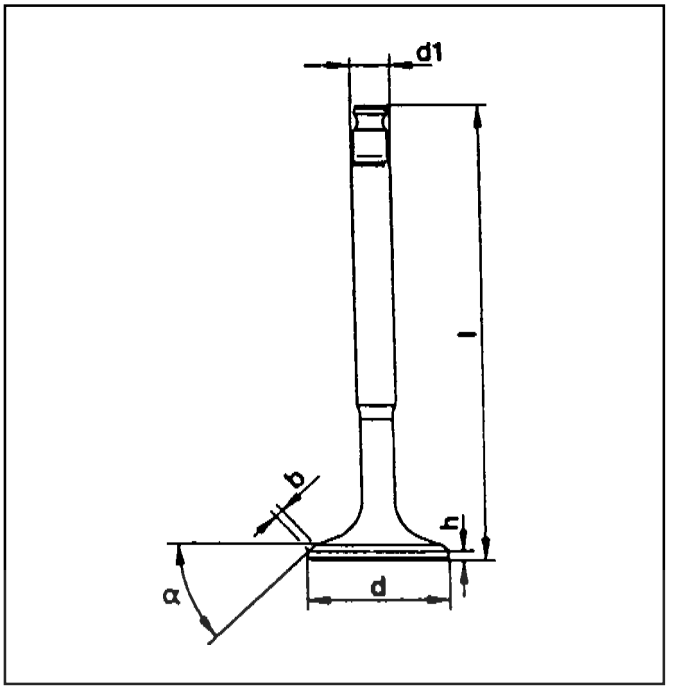
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Intake Valve



Exhaust Valve



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Item		Intake Valve	Exhaust Valve
Valve Disc Diameter ‘d’		37.90 - 38.10 mm	34.90 - 35.10 mm
Valve Disc Height ‘h’		1.7 mm	1.7 mm
Setting Angle “a” or Machining the Valve		45°	45°
Valve Stem Diameter ‘d1’		7.955 - 7.970 mm	9.945 - 8.960 mm
Valve Length ‘l’	Standard	106.20 - 106.60 mm	106.20 - 106.60 mm
	Repair	105.30 - 105.70	105.30 - 105.70 mm
Max. Permis Sible Runout at Valve Stem and Valve Seat		0.03 mm	0.03 mm

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 needed 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

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Tools Required

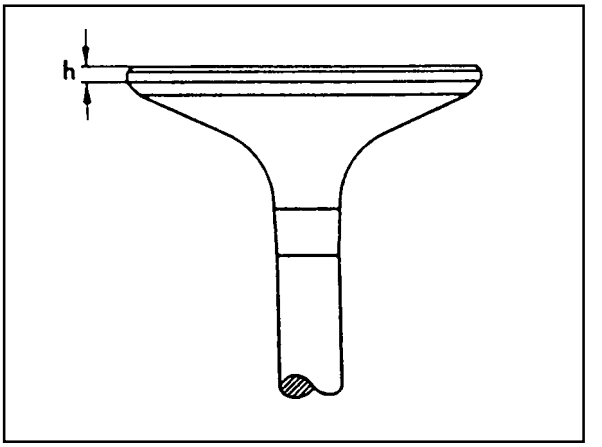
001 589 32 21 00 Dial Gauge

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’.

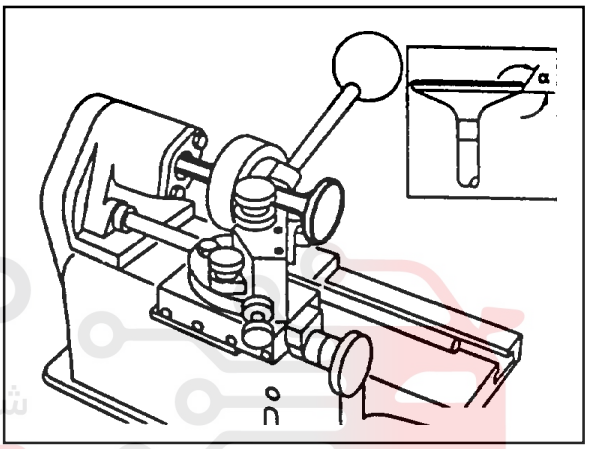


Service data	Intake	1.7 ± 0.15 mm
	Exhaust	1.7 ± 0.15 mm

3. Machine the valve.

   Notice

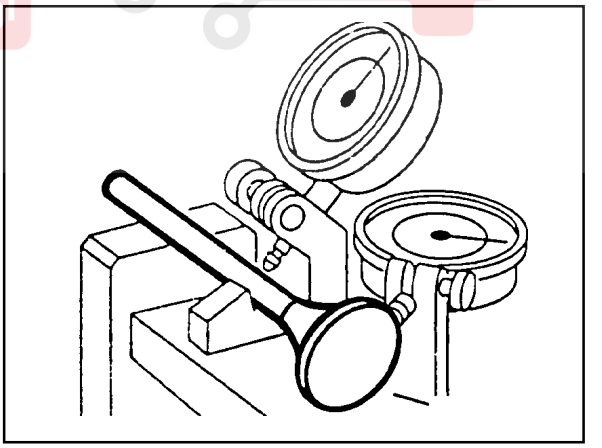
   Pay attention to setting angle ‘a’.



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

Limit	Max. 0.03mm

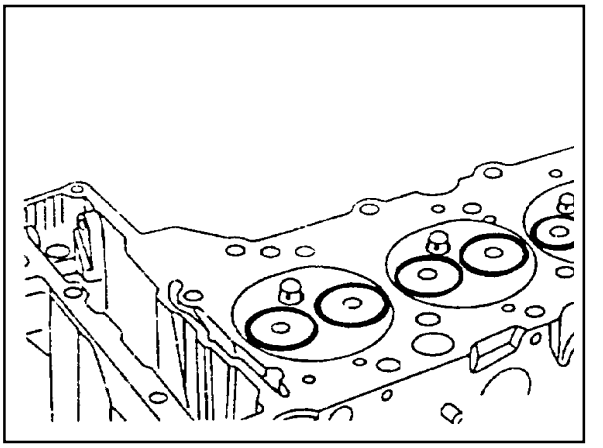
Dial Gauge 001 589 32 21 00



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5. Clean the vales, valve seats and valve guides.
6. Coat the valve stem with oil and insert it into valve guide.

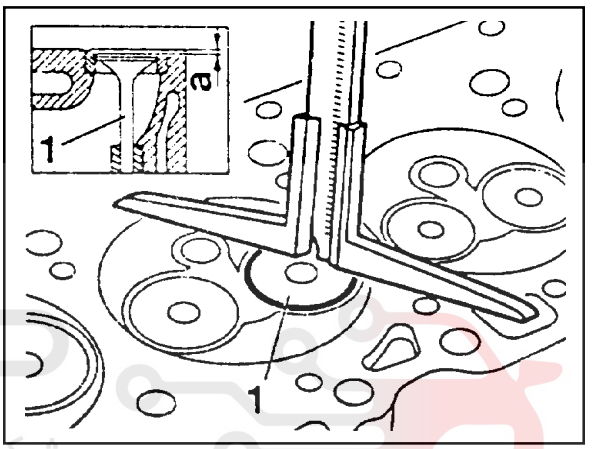


7. Insert the valves (1) into the valve guides according to marking.
8. Measure amount by which the valve arrears ‘a’.

Arrears ‘a’	0.1 - 0.7 mm

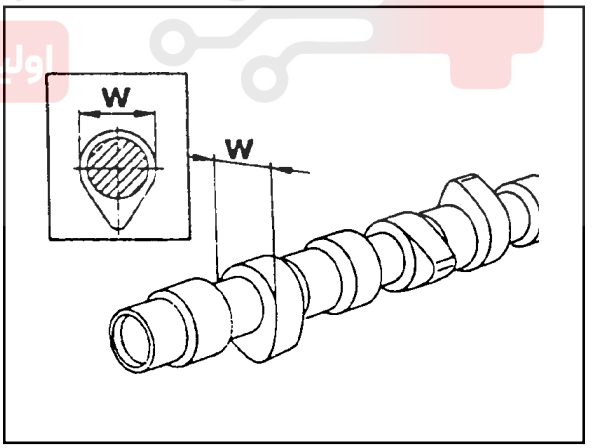
Notice

If out of standard, replace the valve seat ring.

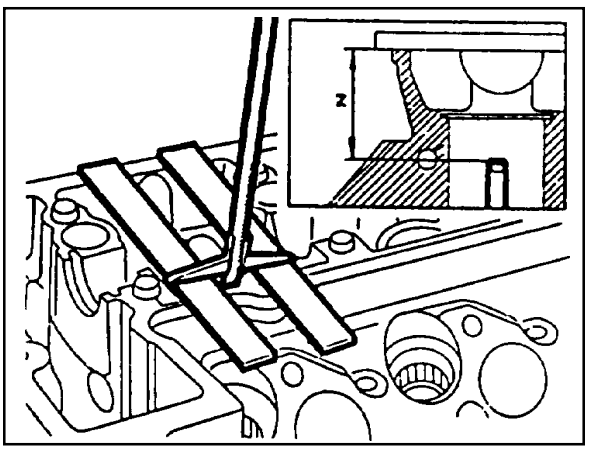


9. Measure camshaft cam basic diameter (w).

Diameter ‘w’	38 ± 0.2 mm or 37.6 ± 0.2 mm



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



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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’ = 38.2 mm
    Measured value ‘z’ = 36.5 mm
    Value ‘y’ = 15.5 mm

    ‘x’ = 36.5 - 15.5 = 21.0mm

    In this case according to ‘Matching valves’ table, the installed valve may be used.

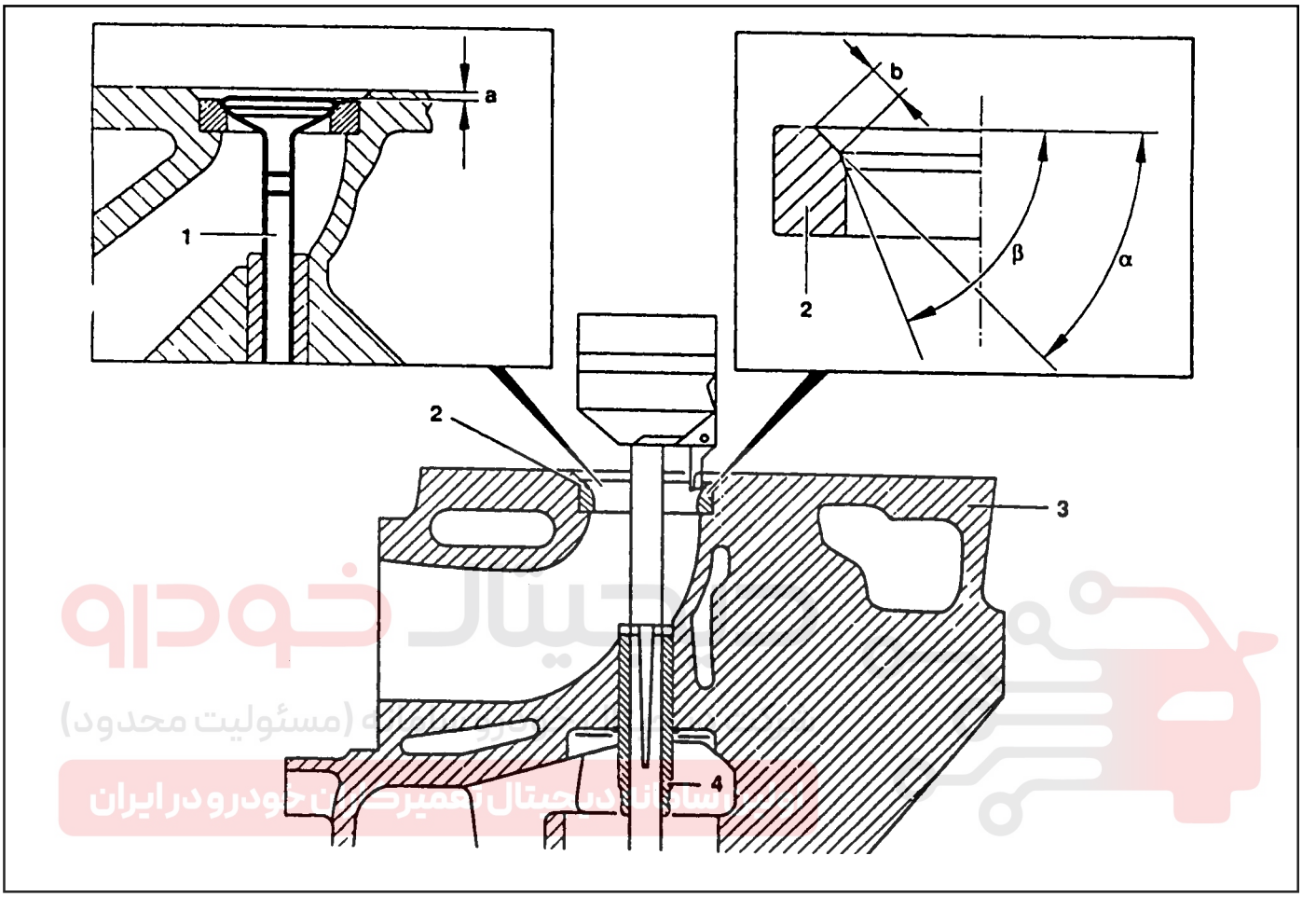
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MACHINING OF VALVE SEAT

Preceding Work : Removal of prechamber
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 Seat Angle
b Valve Seat Free Angle

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Service Data

Item		Intake	Exhaust
Valve Arrears ‘a’		0.1 - 0.7 mm	0.1 - 0.7 mm
Valve Seat Width ‘b’		1.2 - 1.7 mm	1.5 - 2.0 mm
Valve Seat Angle ‘a’		45°	45°
Valve Seat Free Angle ‘b’		65°	65°
Permissible Radial Runout		0.03 mm	0.03 mm
Valve Length ‘l’	Standard	106.20 - 106.60 mm	106.20 - 106.60 mm
	Repair	105.30 - 105.70 mm	105.30 - 105.70 mm

Matching Valves

	Camshaft cam basic dia. w = 38.0 ± 0.2 mm	Camshaft cam basic dia. w = 37.6 ± 0.2 mm	Valve to be used
Size (x)	19.5 - 20.3mm	19.5 - 20.1mm	Use machined valve, if needed use pair valve 1 = 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

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Commercial Tools

Cylinder Head Clamping Devie	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 Sat for Valves	Hunger D-8000 München 70 Order No. 217 93 601

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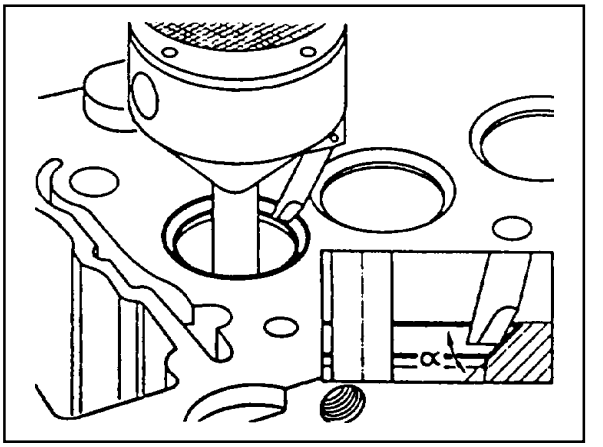
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Machining Procedure

Valve machining is required :

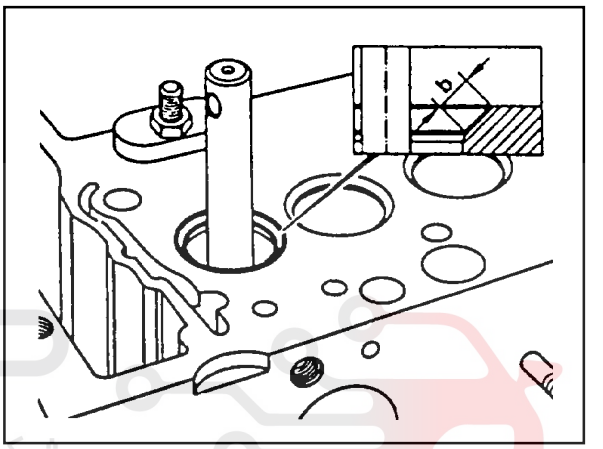
- When the valve is leaking.
- When replacing the valve.
- When replacing the valve guide.
- When replacing the valve seat or valve seat ring.

1. Machine the valve seat (a=45°).

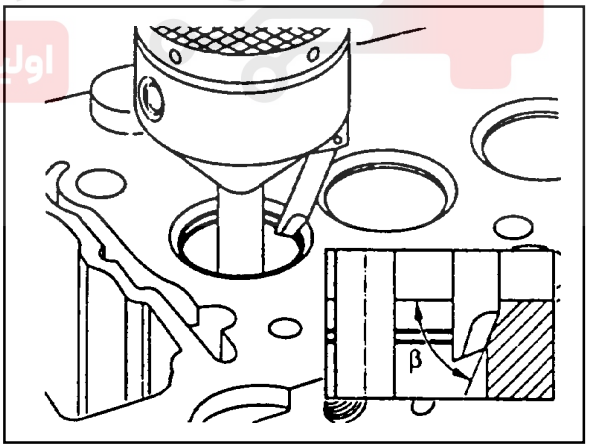


2. Measure valve seat width ‘b’.

Valve seat width ‘b’	Intake	1.2 - 1.7 mm
	Exhaust	1.5 - 2.0 mm

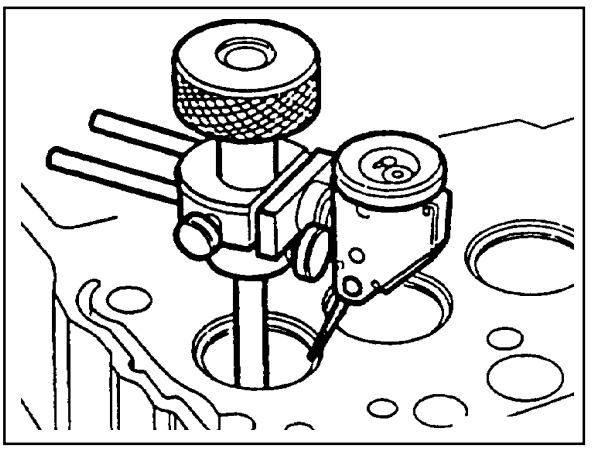


3. If the specification is exceeded, the valve seat width has to be corrected at the lower free angle of ‘b’=65°.



4. Measure radial runout.

Runout	Max. 0.03mm

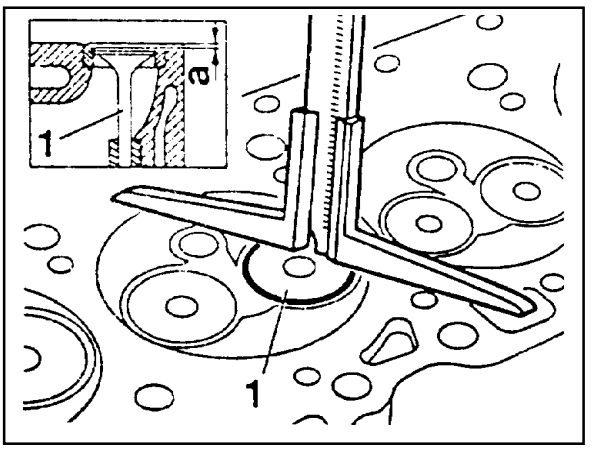


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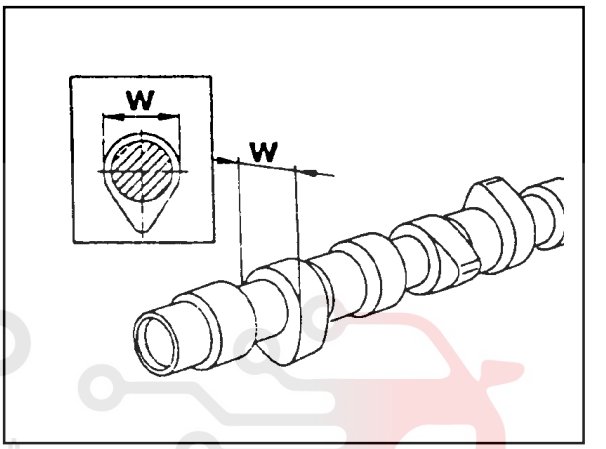
5. Insert the valve (1) into the valve guide according to marking and measure amount by which the valve arrears 'a'.

Arrears 'a'	0.1 - 0.7mm

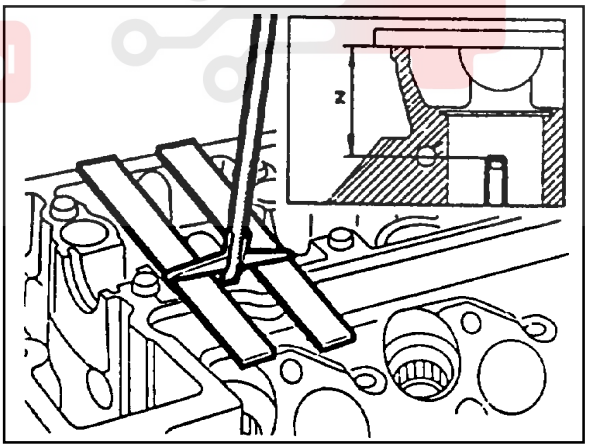


6. Measure camshaft cam basic circle diameter (w).

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

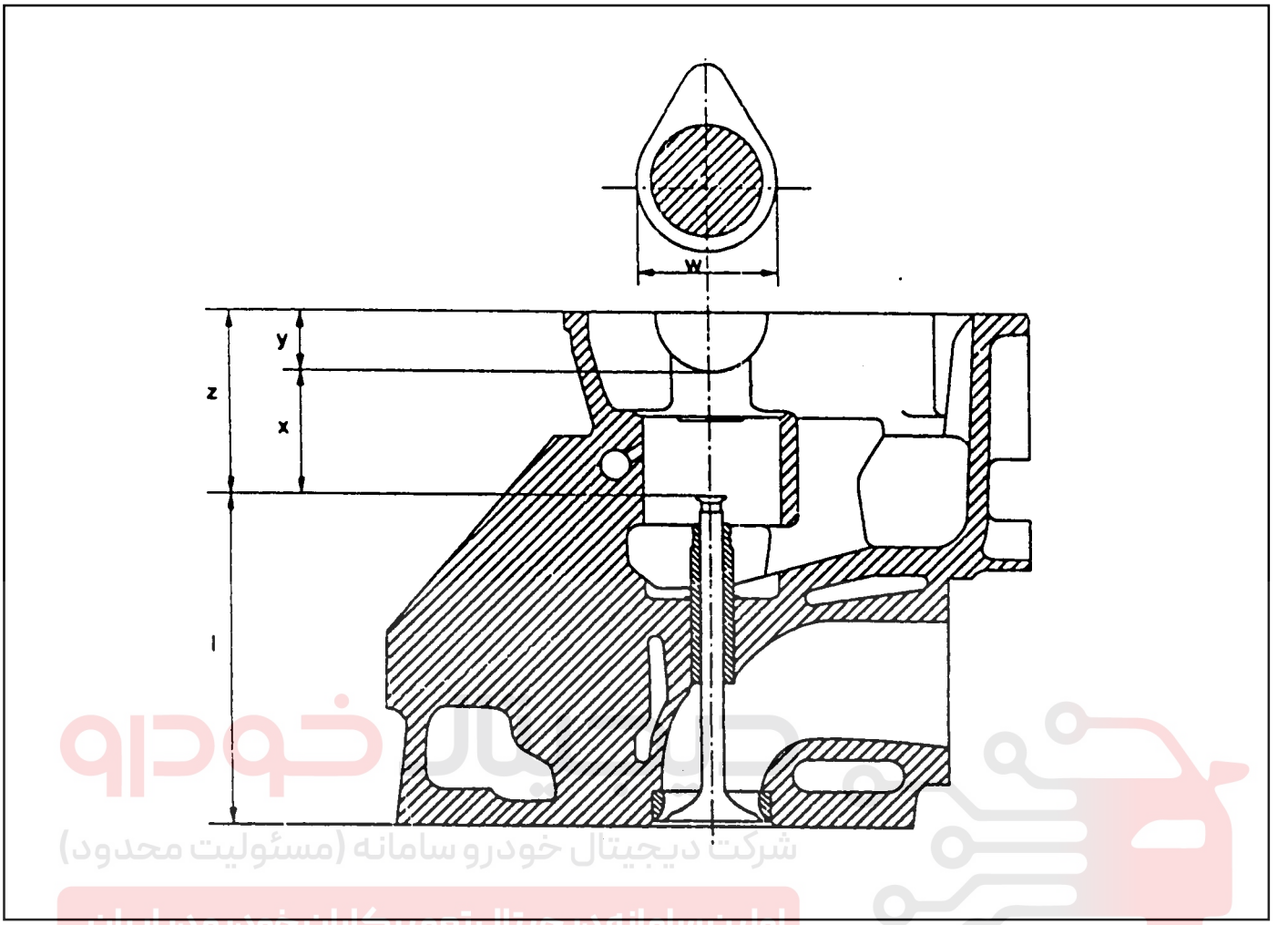


7. Measure distance 'z' (cylinder head cover parting surface - valve stem).



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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)

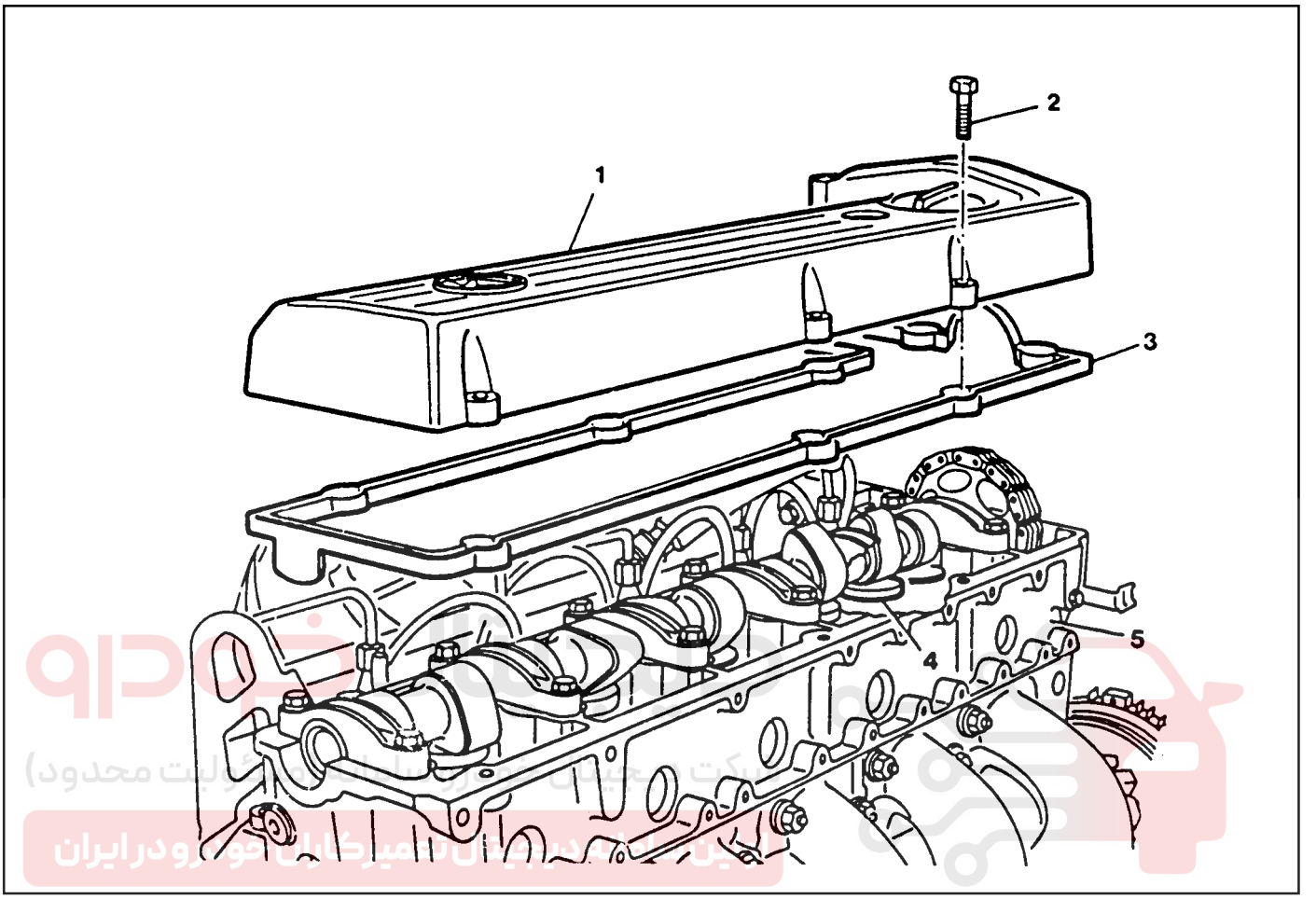
8. Measure ‘x’ (Camshaft basic bore - valve stem).
   ‘x’ = ‘z’ - ‘y’
9. Determine the valve to be used.
   (See ‘Matching valves’)
   Example) Measured value ‘w’ = 38.2 mm
   Measured value ‘z’ = 36.5 mm
   Value ‘y’ = 15.5 mm
   ‘x’ = 36.5 - 15.5 = 21.0 mm
   In the case of a camshaft cam basic circle diameter ‘w’ = 38.2mm and a distance ‘x’ = 21.0mm, the installed valve may be used.

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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 11.33°	ABDC 17°	BBDC 28°	BTDC 15.25°
After approx. 20,000km	ATDC 12°	ABDC 18°	BBDC 27°	BTDC 14°

*At 2mm of valve lifting stroke.

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Tools Required

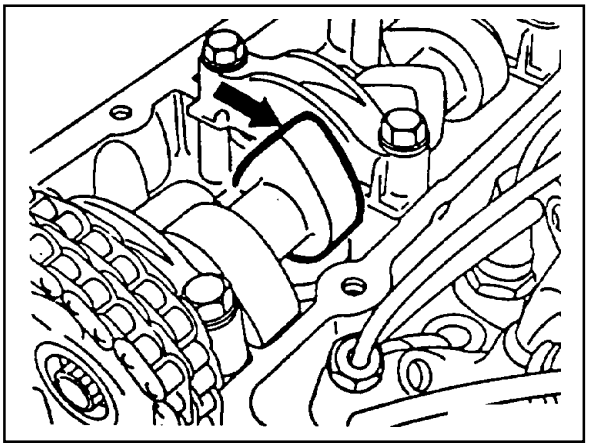
001 589 53 21 00 Dial Gauge

363 589 02 21 00 Dial Gauge Holder

366 589 00 21 05 Extension

Measurement Procedure

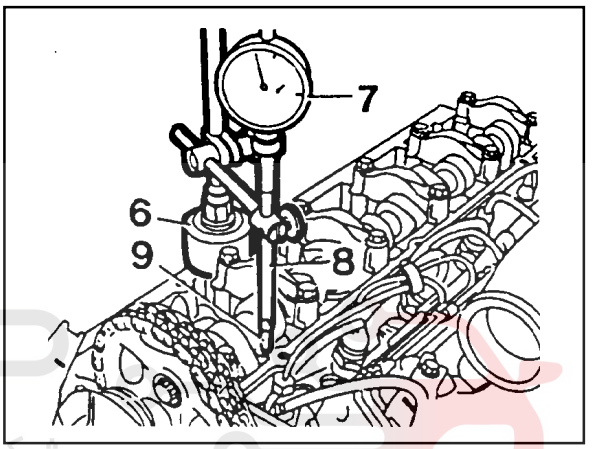
1. Remove the cylinder head cover.
2. Rotate the engine in the direction of engine rotation until the intake valve of NO. 1 cylinder is completely closed. The cam lobe faces up (arrow).



Notice

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.

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.

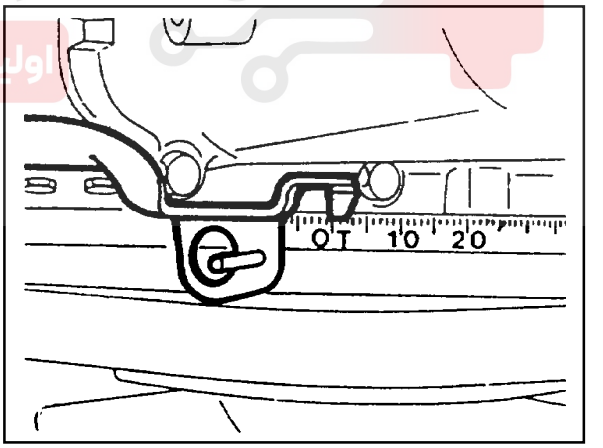


Notice

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

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.
6. Check the timing.



New	ATDC 11.33°
After approx. 20,000km	ATDC 12°

Notice

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.

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

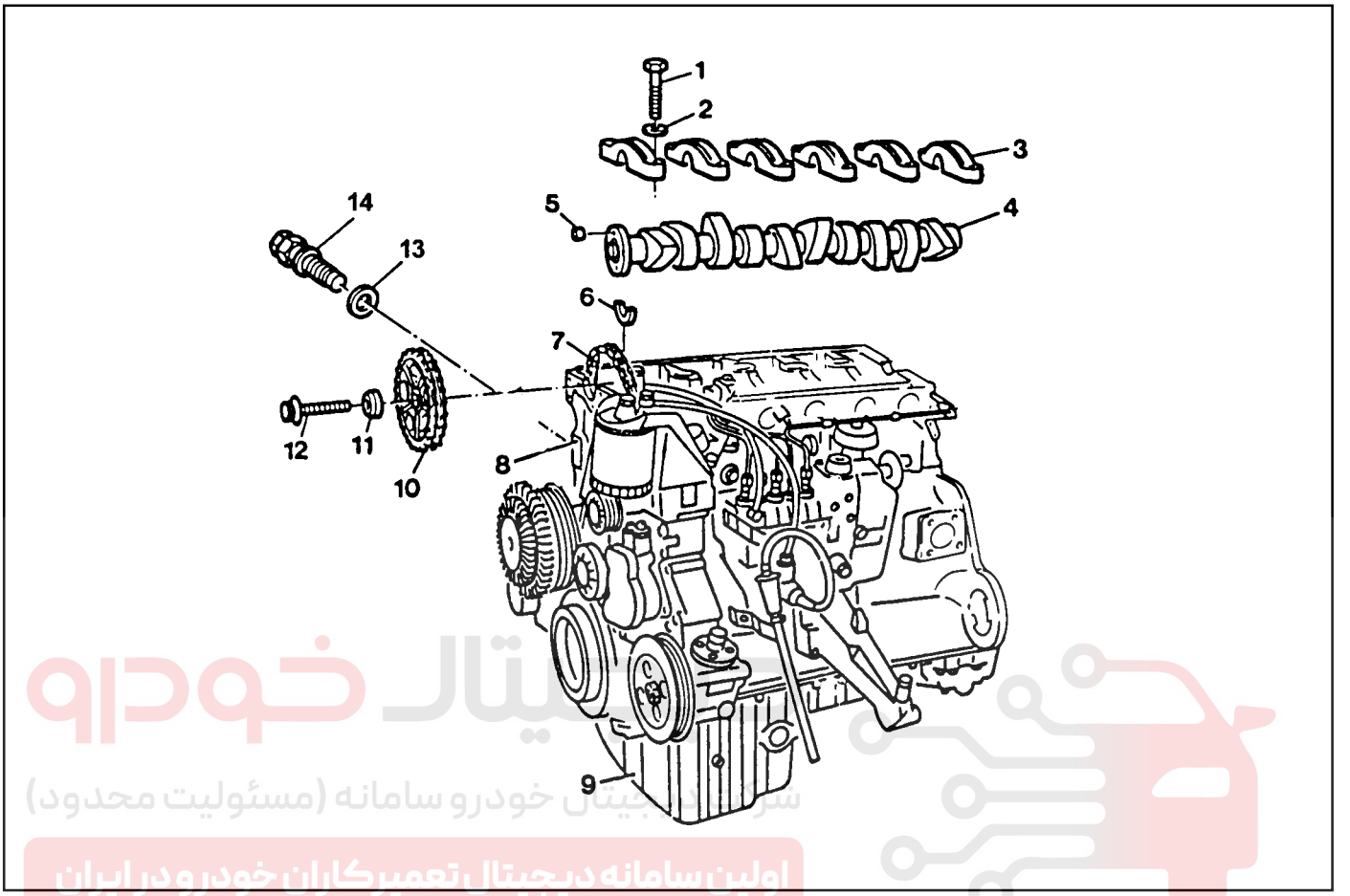
Tightening Torque	10 Nm

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CAMSHAFT

Preceding Work : Removal of cylinder head cover



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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

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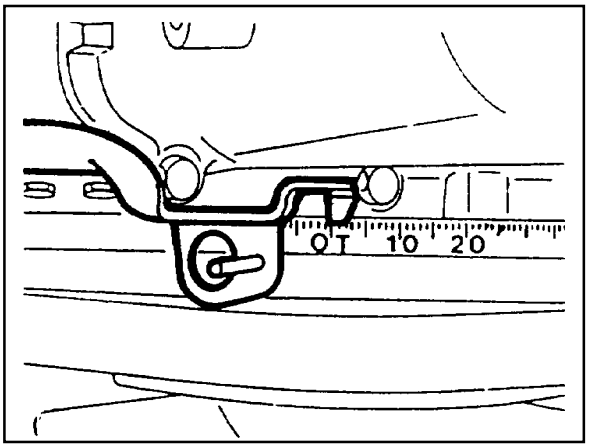
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Tools Required

602 589 00 40 00 Engine Lock

Removal Procedure

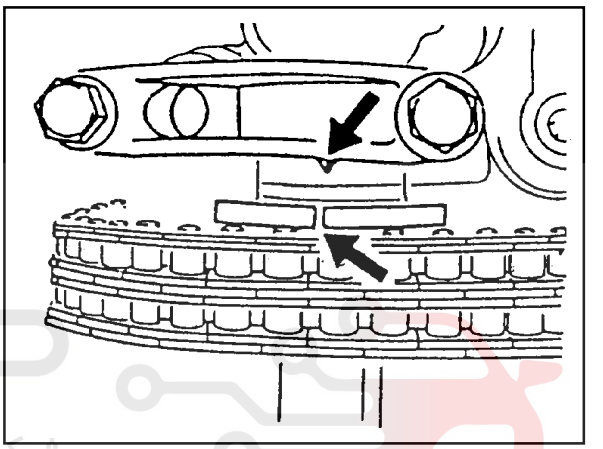
1. Rotate the crankshaft and position the piston of no.1 cylinder at TDC.



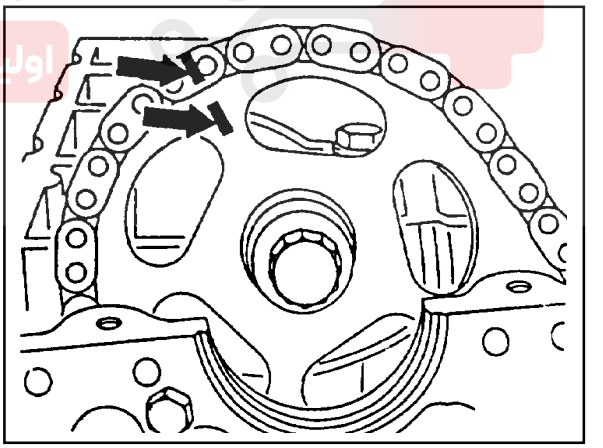
Notice

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.

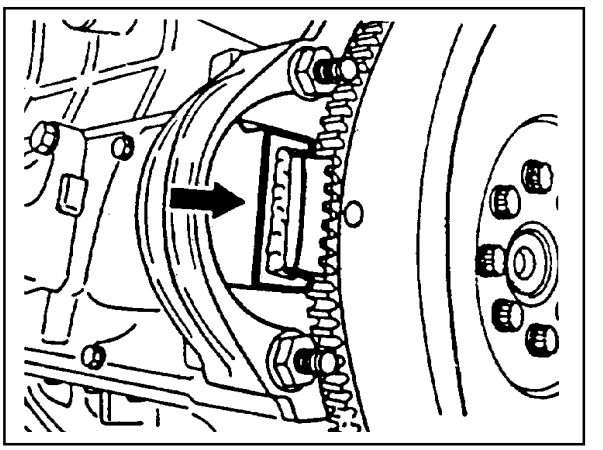


2. Place alignment marks on the camshaft sprocket and timing chain.



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

Engine Lock 602 589 00 40 00



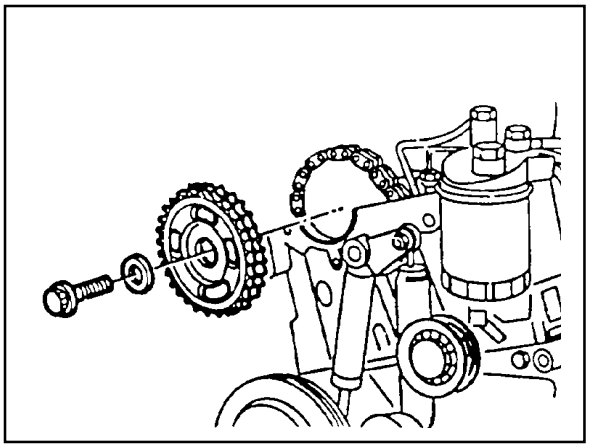
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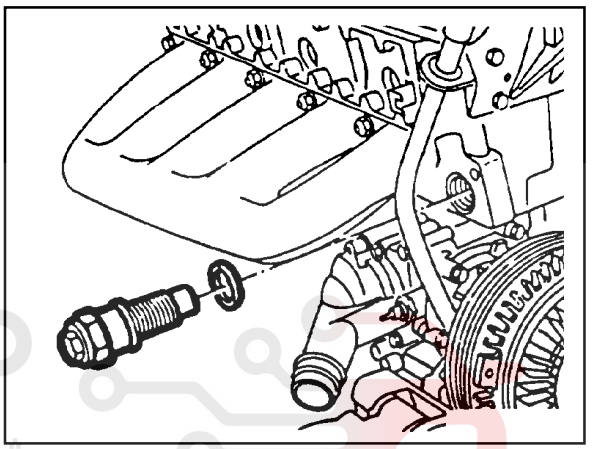
4. Remove the bolt and then remove the camshaft sprocket.

Notice

During removal, be careful not to drop the sprocket with chain. Remove the chain carefully and then pull out the sprocket.



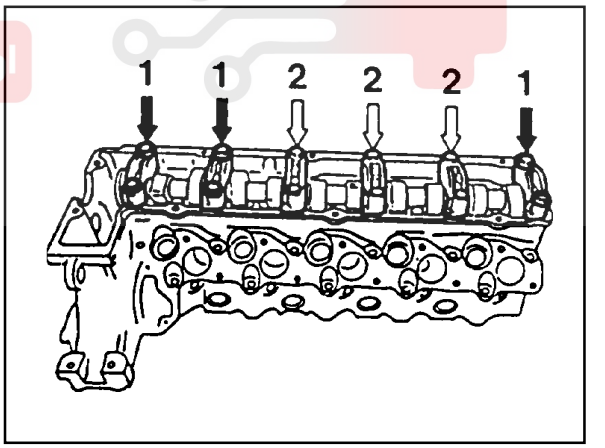
5. Remove the chain tensioner.



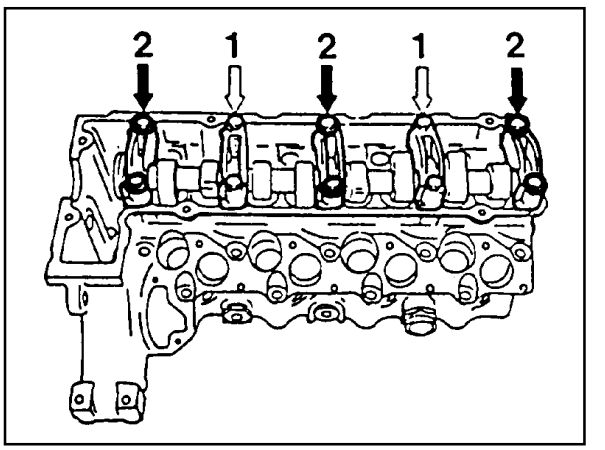
6. Remove the camshaft bearing cap bolts according to the removal order.

Notice

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.



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OM 661LA

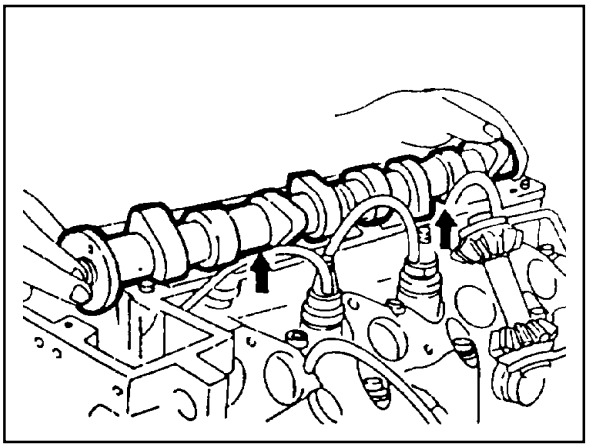
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7. Remove the camshaft bearing cap.
8. Pull off the camshaft.

Notice

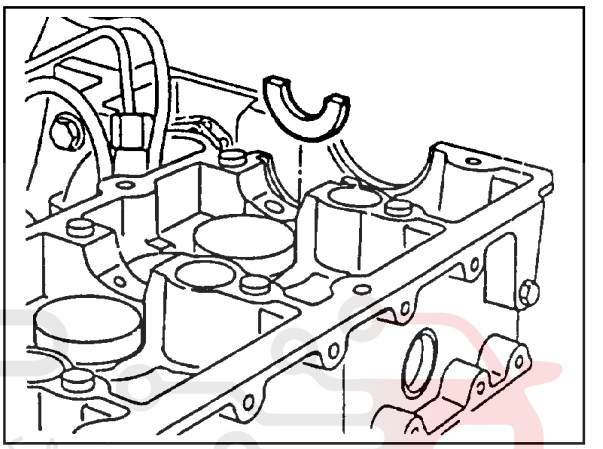
Be careful not to miss front locking washer.



9. Pull out the locking washer.

Notice

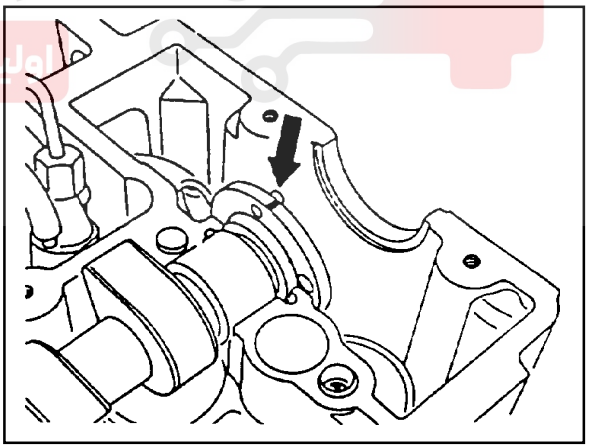
Check the condition of locking washer and replace if necessary.



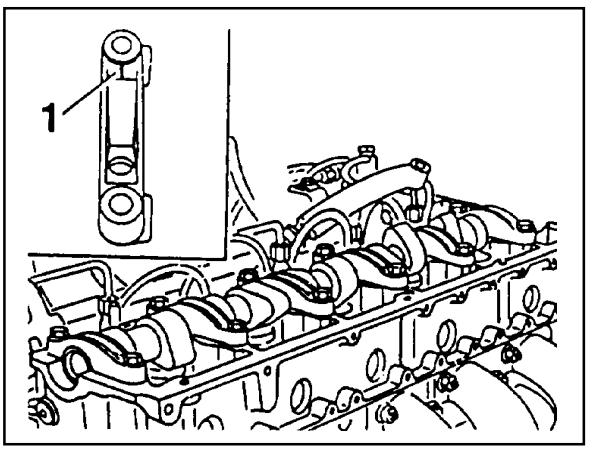
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Installation Procedure

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.).



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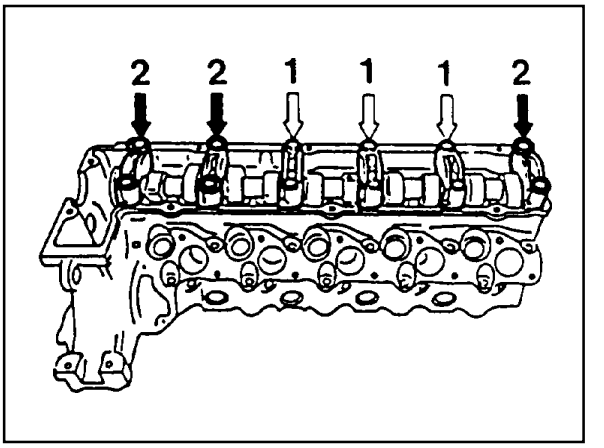
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5. Tighten the camshaft bearing cap bolts acccording to installation order.

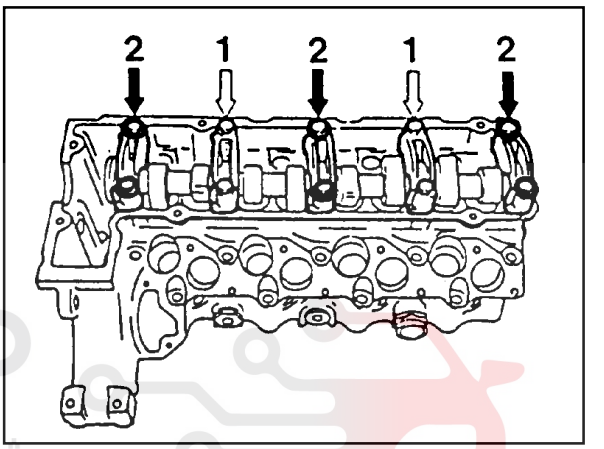
Tightening Torque	25 Nm

Notice

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



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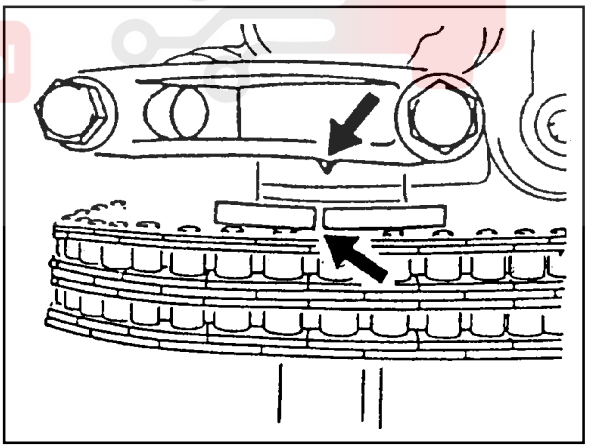
OM 661LA

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

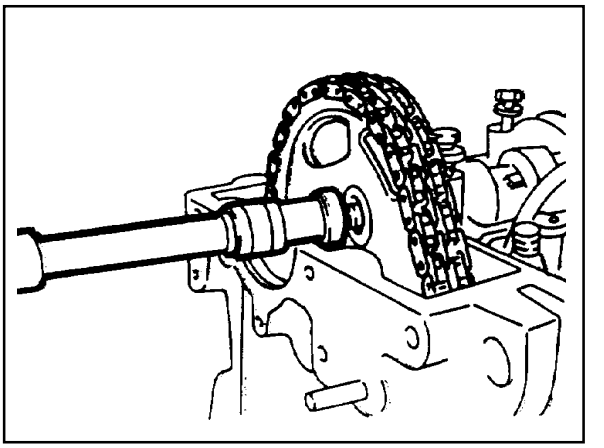
Notice

Align the alignment marks on the timing chain and sprocket.



7. Tighten the camshaft sprocket bolt.

Tightening Torque	25Nm + 90°

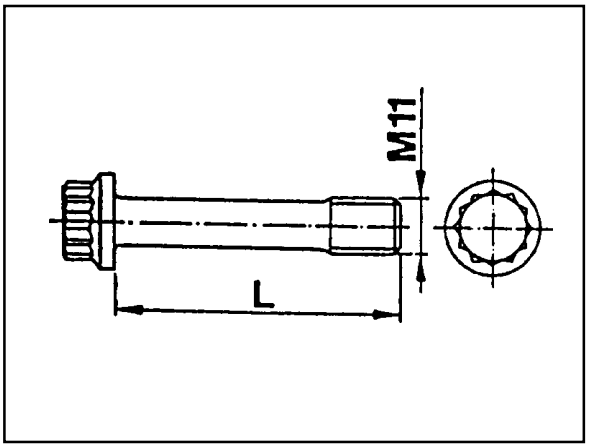


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Notice

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



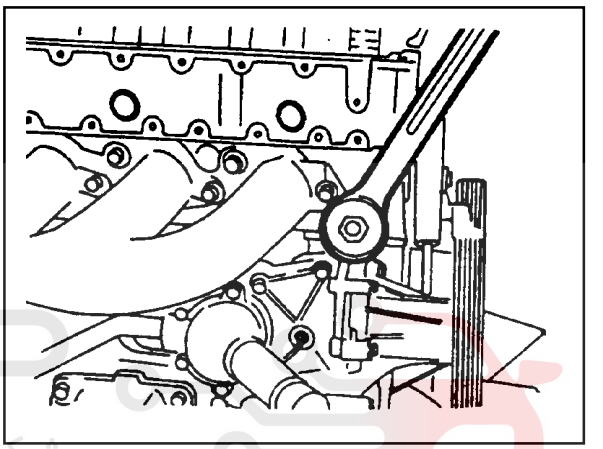
8. Install the chain tensioner.

Tightening Torque	80 Nm

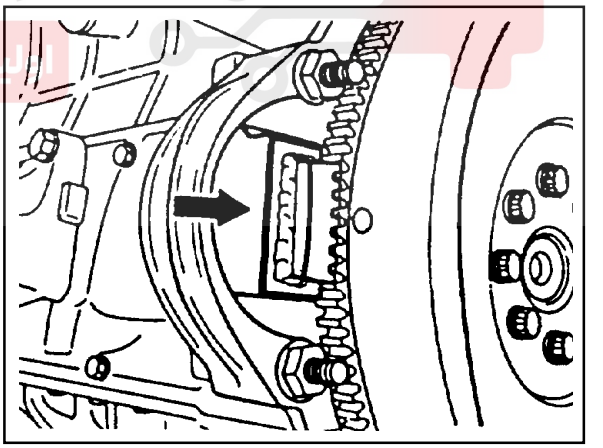
Notice

Replace the seal.

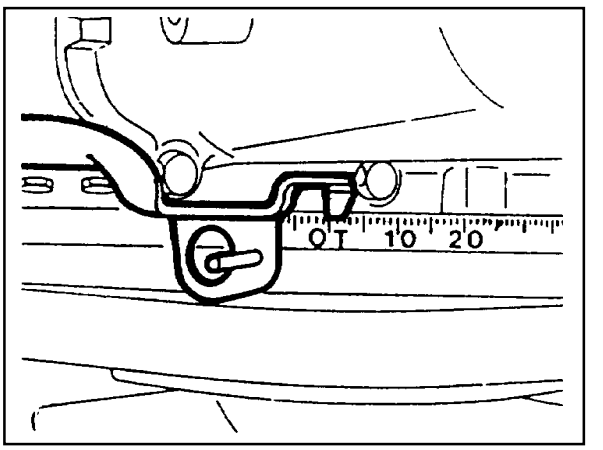
Before installation, by pumping in the oil approx. 10 times, fill the oil.



9. Remove the engine lock.



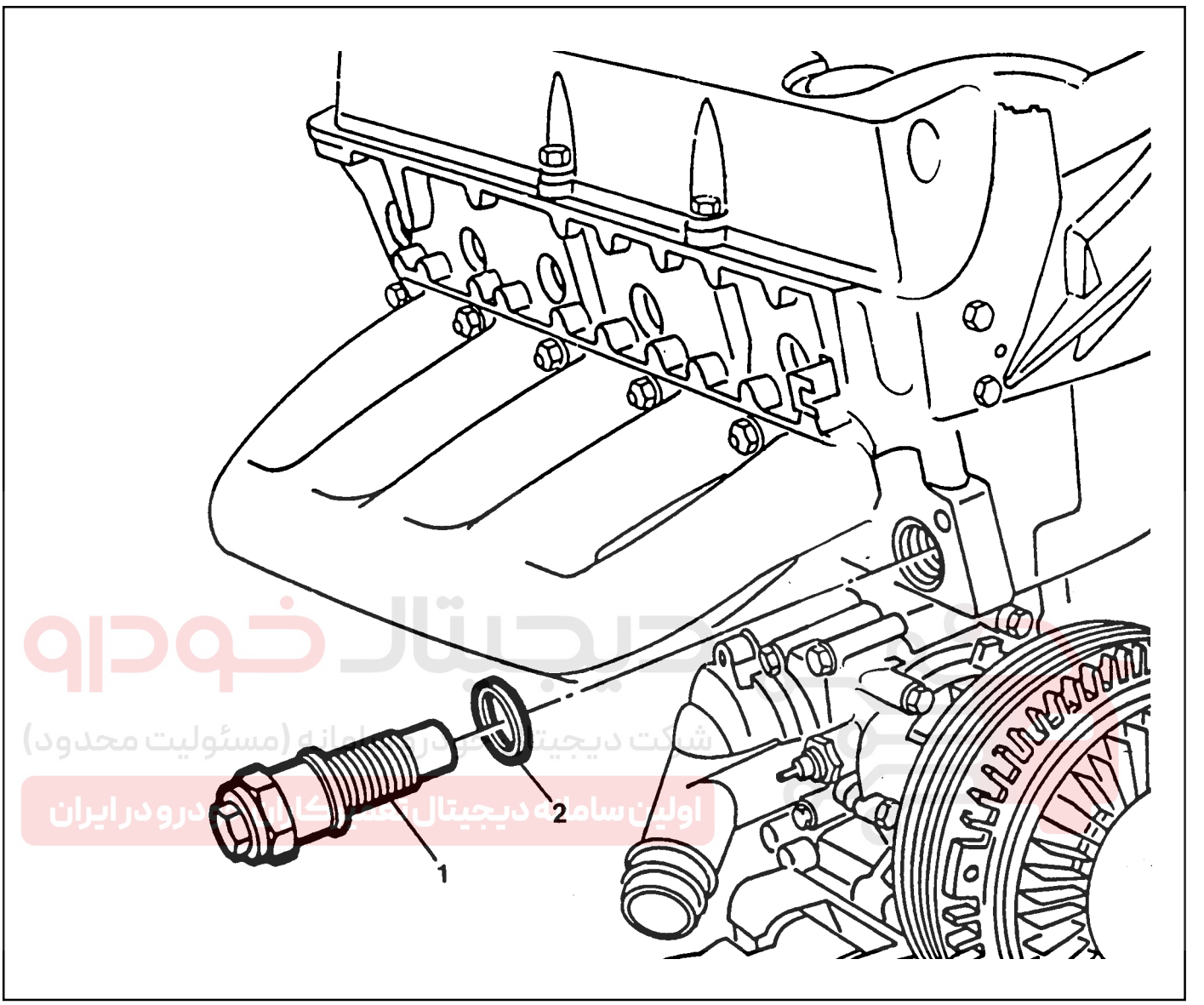
10. Check the TDC marking of OT on the crankshaft.



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CHAIN TENSIONER



1 Chain Tensioner 80Nm

2 Seal ..... Replace

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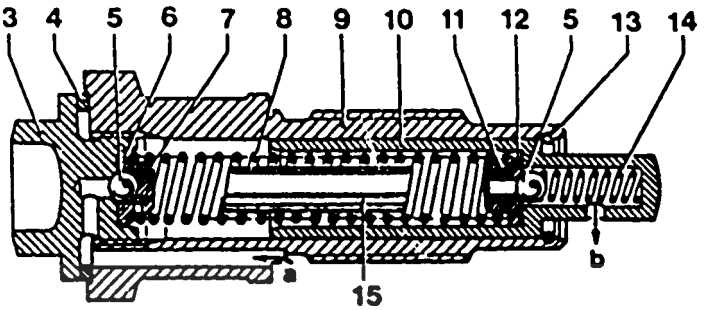
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Notice

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.



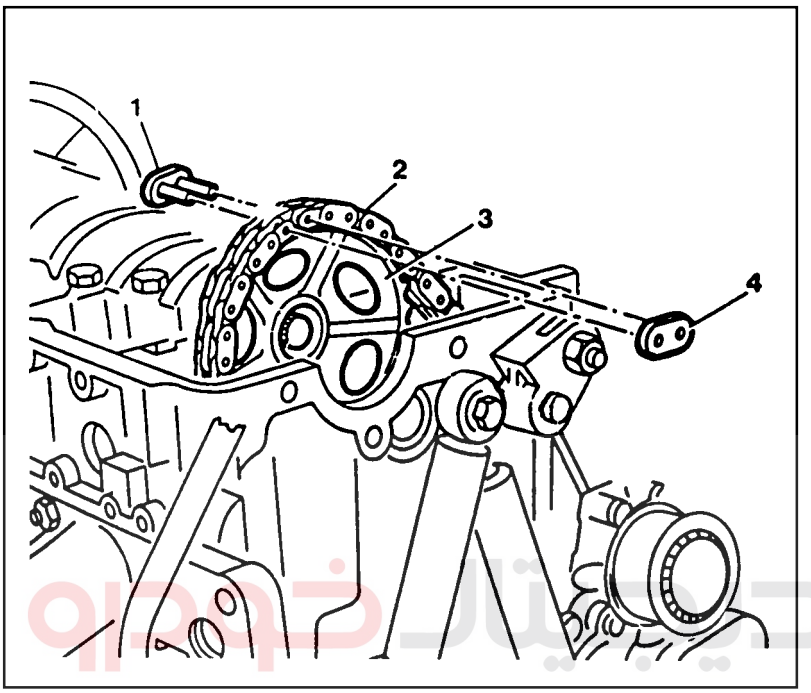
3	Screw Plug	11	Valve Disc
4	Aluminum Gasket	12	O-Ring
5	Ball	13	Snap Ring
6	Ball Guide	14	Compression Spring
7	Compression Spring	15	Filler
8	Compression Spring		
9	Housing	A	Feed Bore from Cylinder Head
10	Thrust Pin	B	To Oil Pan

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TIMING CHAIN

Preceding Work : Removal of glow plug
Removal of chain tensioner
Removal of cooling fan
Removal of cylinder head cover



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

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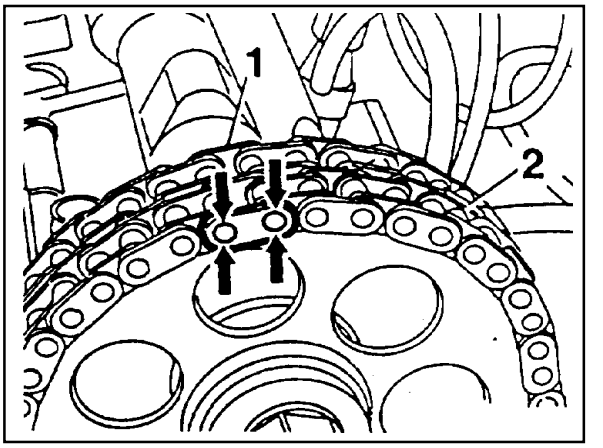
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Tools Required

000 589 58 43 00 Chain Assembling Device

Replacement Procedure

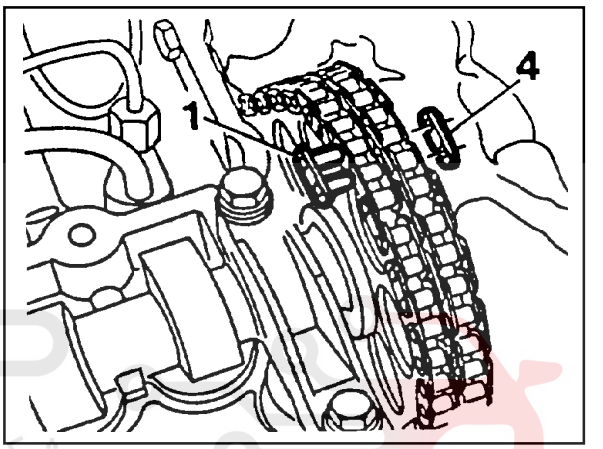
1. Cover over the chain box with cleaning rag and grind off both chain pins (arrow) at a chain link (1) of the timing chain.



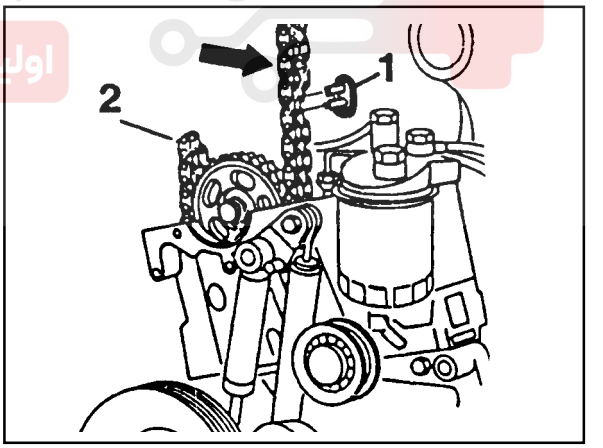
2. Remove the outer plate (4) and chain link (1).

   Notice

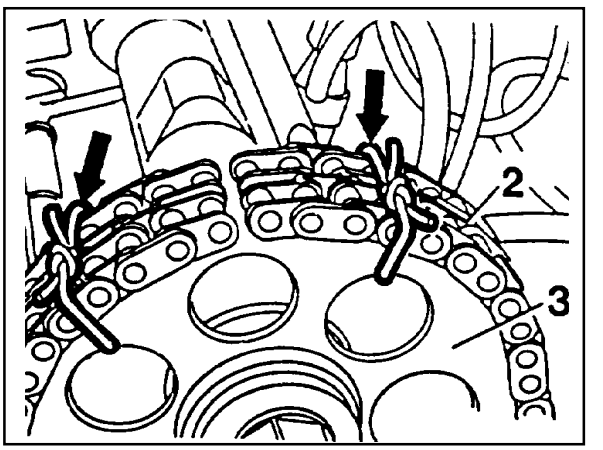
   Ensure that the ends of the timing chain do not drop into the chain box.



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).



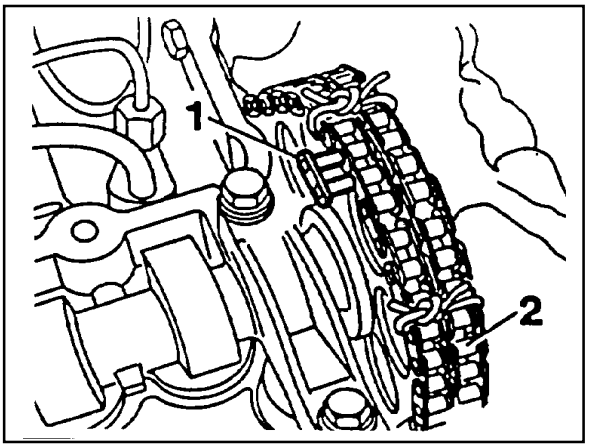
5. By rotating the crankshaft in the of engine rotation, pull out the old timing chain with installing the new timing chain.
6. Remove the old timing chain and hold the ends of the new timing chain to camshaft sprocket (3) with wire (arrow).



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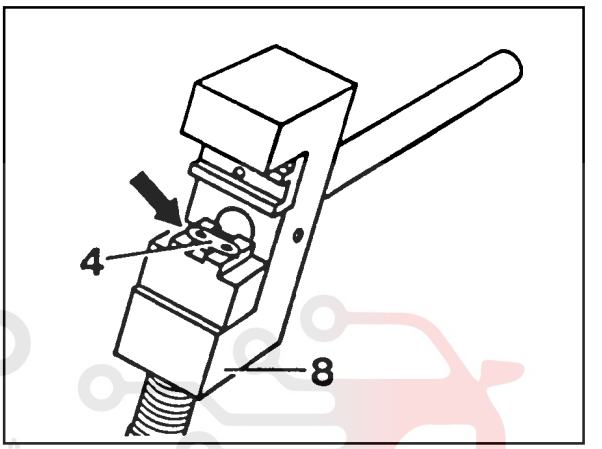
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7. Insert the new chain link (1) to connect the chain.

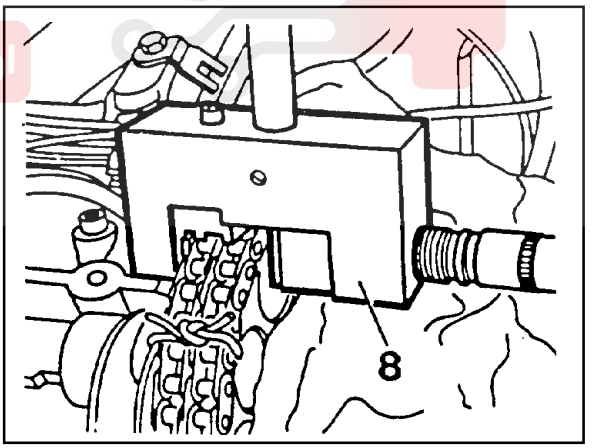


8. Insert the new outer plate (4) into the fitting tool (8) and then the outer plate will be held by a magnet.

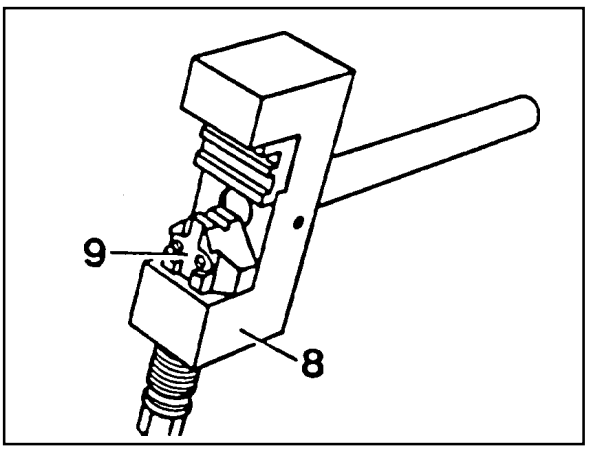
Chain Assembling Device 000 589 58 43 00



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



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

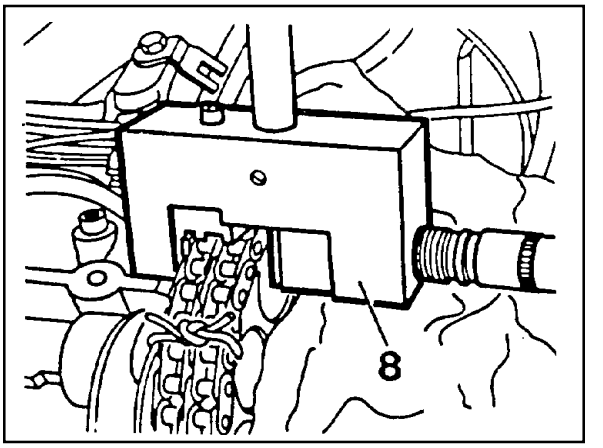


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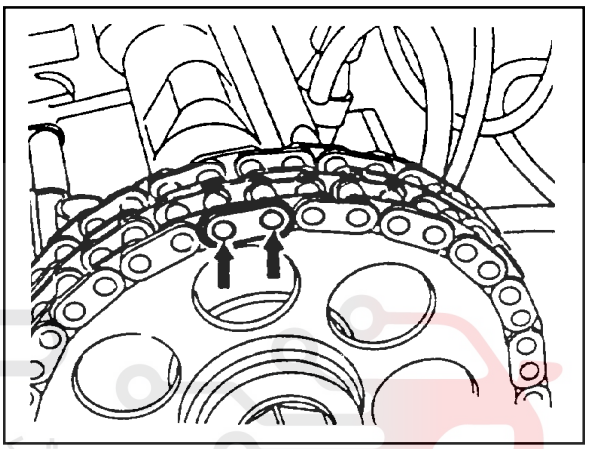
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11. Place the fitting tool (8) onto the chain link and rivet the chain pins one by one.

Tightening Torque	35 - 40 Nm

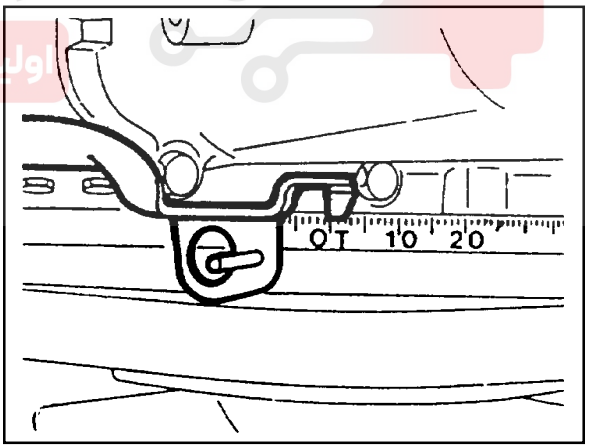


12. Check the riveting of chain pins and re-rivet if necessary.
13. Remove the wire.

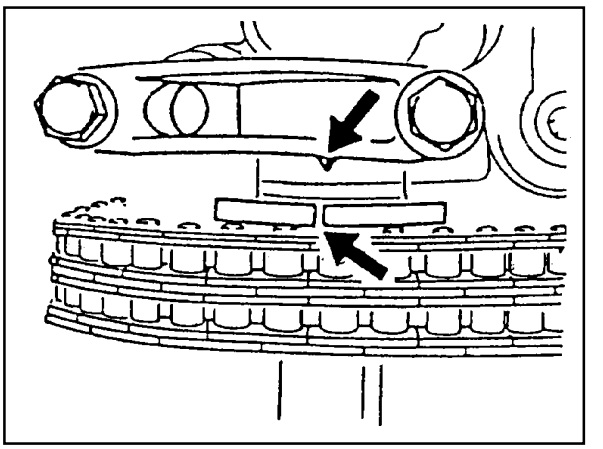


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14. Position the no.1 cylinder at TDC.



In this position, the marking 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.

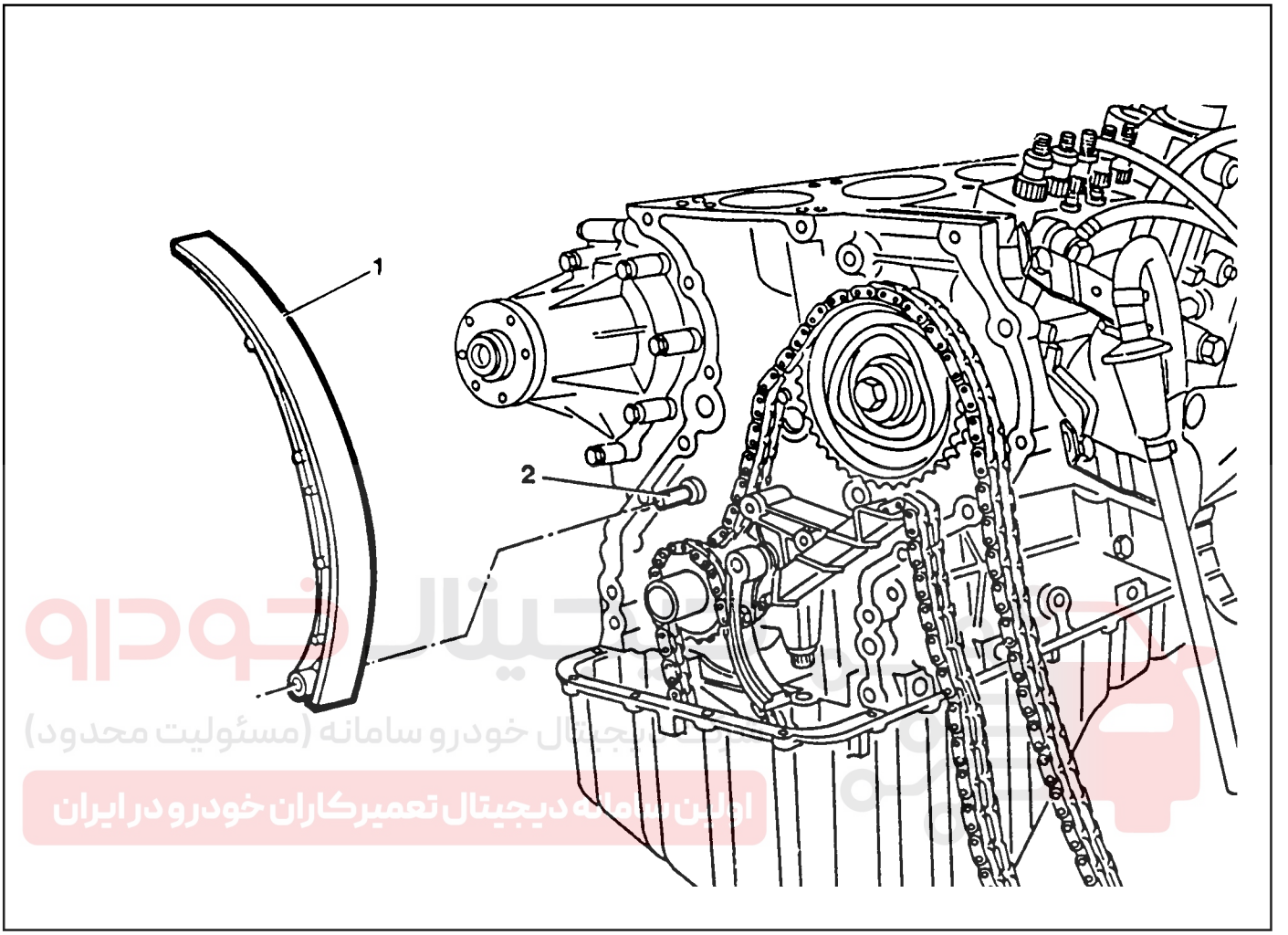


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TENSIONING RAIL

Preceding Work : Removal of cylinder head
Removal of timing case cover



1 Tensioning Rail

2 Bearing Pin

Notice

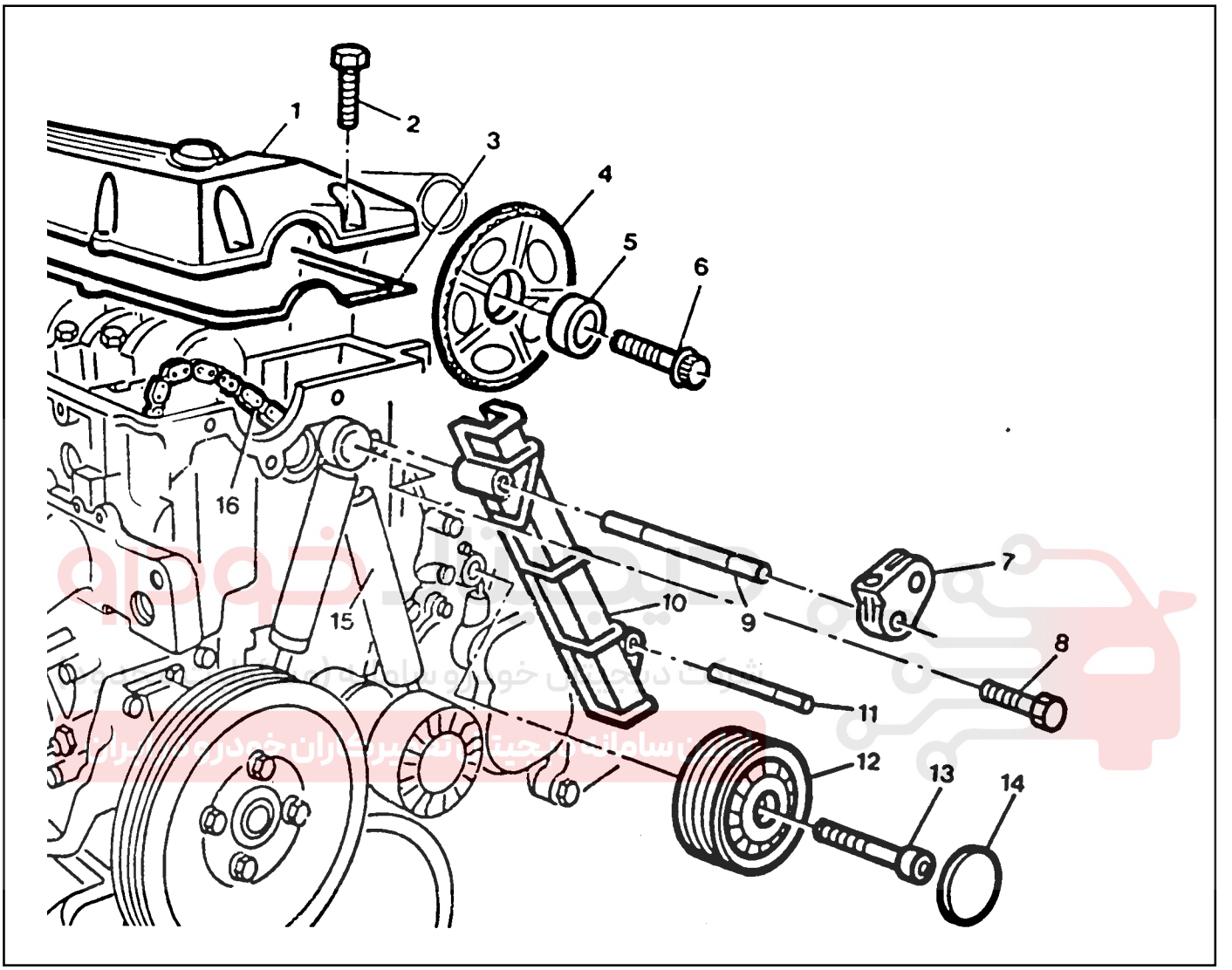
The plastic coating of the tensioning rail can not be replaced.

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CYLINDER HEAD GUIDE RAIL

Preceding Work : Removal of the cooling fan
Removal of poly V-belt
Removal of chain tensioner



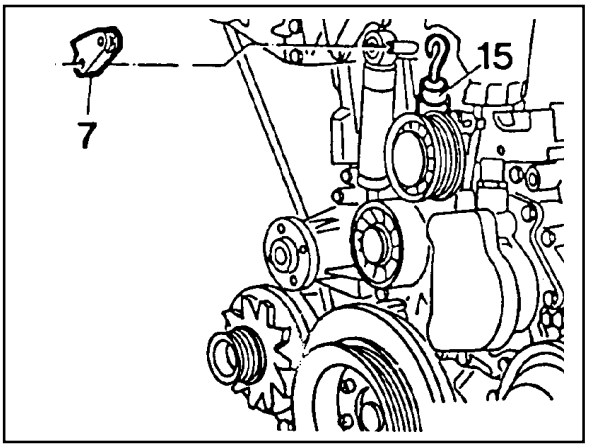
1 Cylinder Head Cover
2 Bolt 10Nm
3 Gasket ..... Replace
4 Camshaft Sprocket
5 Washer
6 12-Sided Bolt (M11) ..... Inspect, 25Nm + 90°
7 Tensioning Lever
8 Bolt 23Nm
9 Bearing Pin ..... Sealing Compound
10 Guide Rail
11 Bearing Pin
12 Guide Pulley
13 Socket Bolt 23Nm
14 Closing Cover
15 Spring
16 Timing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

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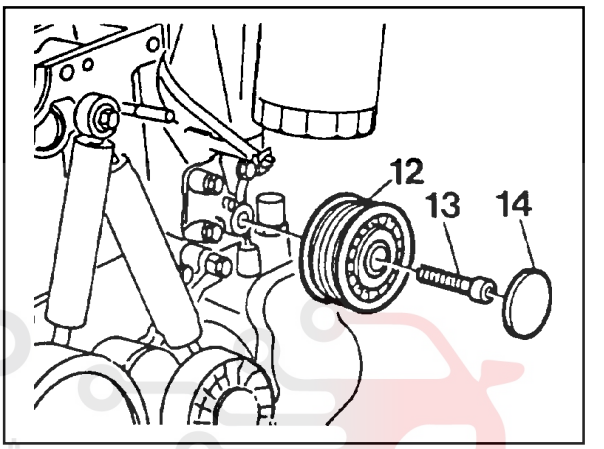
Tools Required

115 589 02 34 00 Sliding Hammer
116 589 20 33 00 Threaded Pin



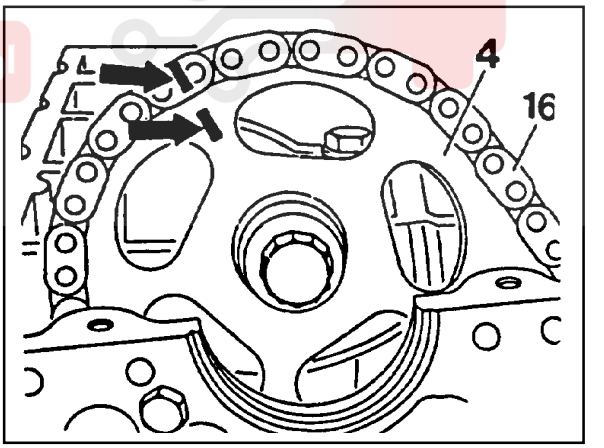
Removal Procedure

1. Removal the cylinder head cover.
2. Pull off the tensioning lever (7) and remove from the spring (15).

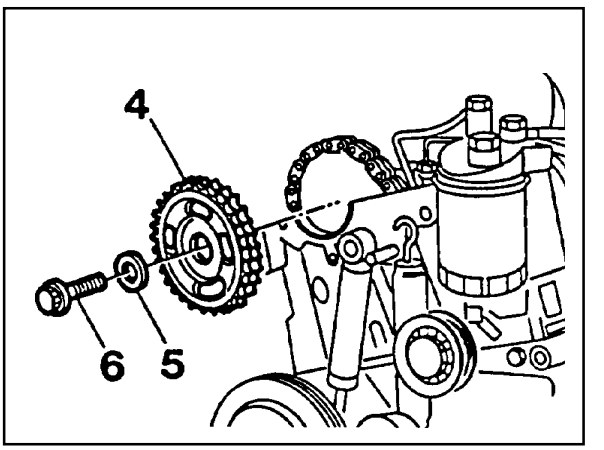


3. Pry off the closing cover (14) and remove the bolt (13) and then remove the guide pulley (12).

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



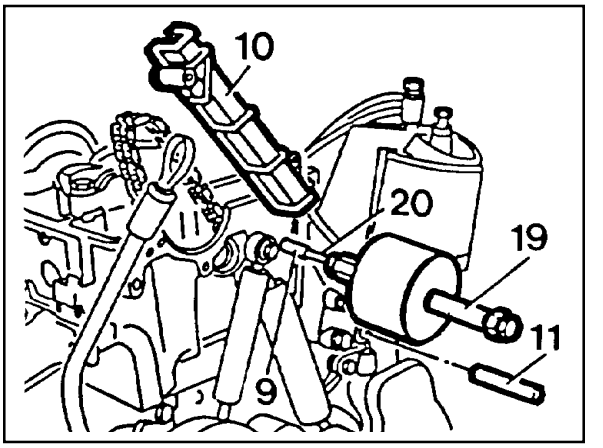
5. Remove the camshaft sprocket.

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

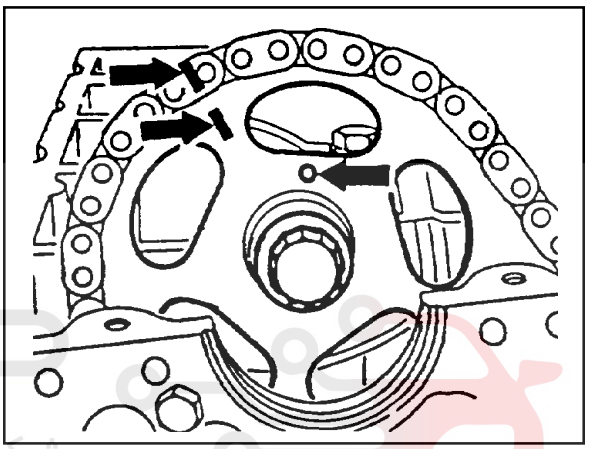
Sliding Hammer 116 589 20 33 00
Threaded Pin 116 589 02 34 00



Installation Procedure

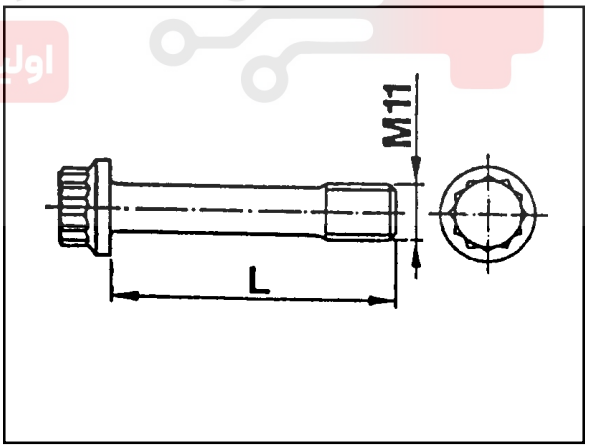
1. Apply collar of both bearing pins with sealing compound.
2. Position the guide rail and insert the bearing pins.
3. Install the camshaft sprocket.

Tightening Torque	10 Nm

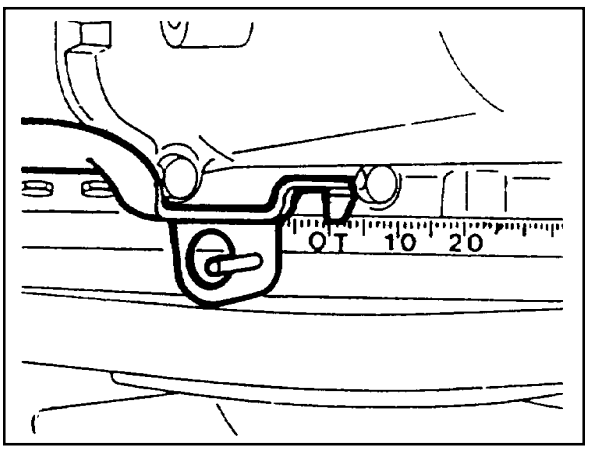


Notice

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



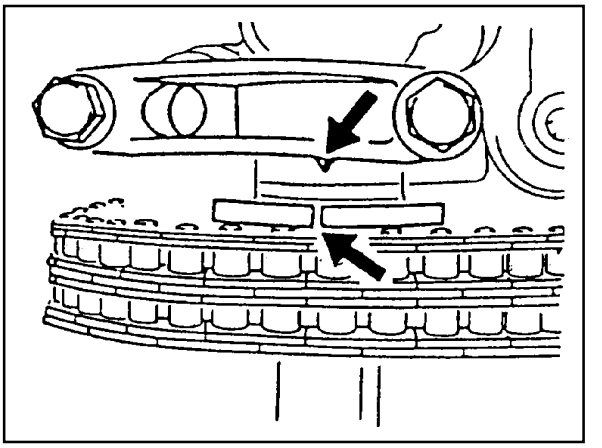
4. Position the no. 1 cylinder at the TDC of OT.



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



5. Install the guide pulley (12).

Tightening Torque	23 Nm

6. Attach the tensioning lever (7) to the spring (15) and install.
7. Replace the gasket and install the cylinder head cover.

Tightening Torque	10 Nm

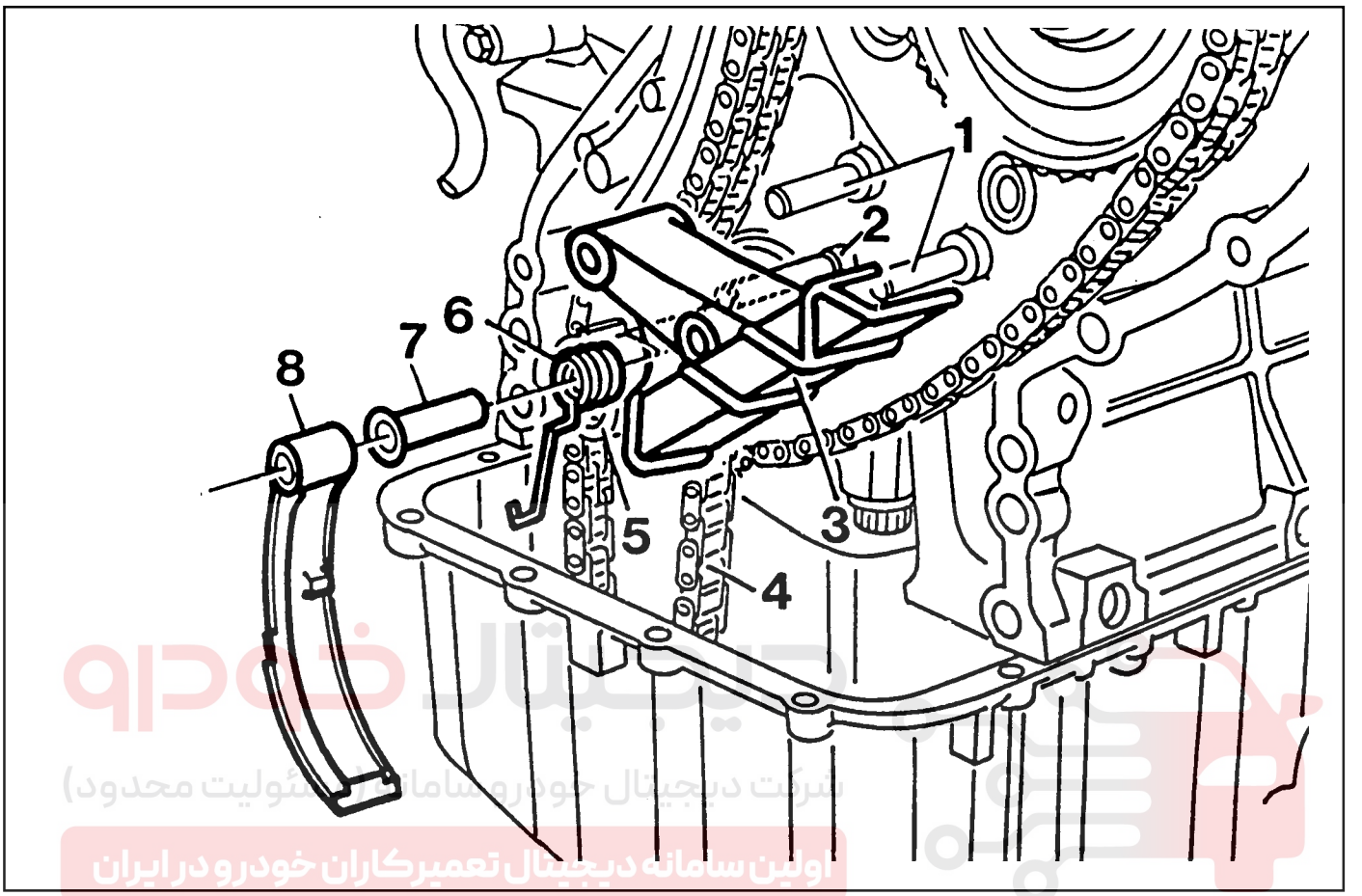
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TIMING CASE COVER GUIDE RAIL

Preceding Work : Removal of cylinder head cover



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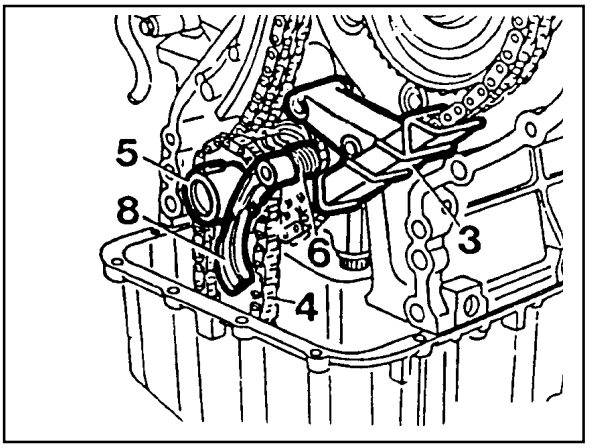
1 Bearing Pin
2 Bearing Pin
3 Guide Rail
4 Oil Pump Chain
5 Crankshaft
6 Spring
7 Bushing
8 Tensioning Lever

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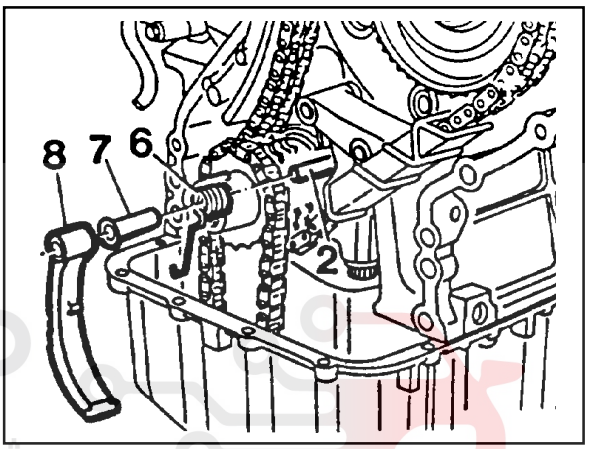
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Removal Procedure

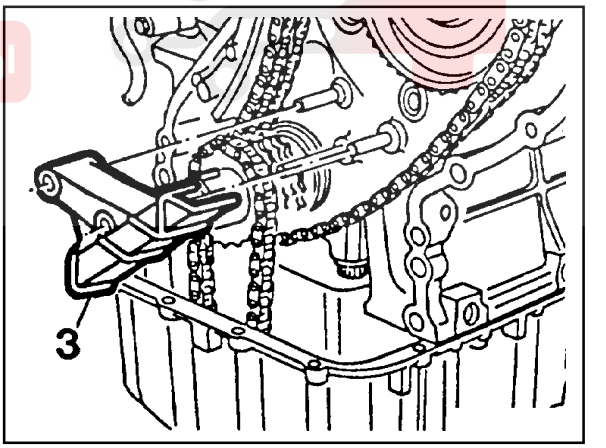
1. Pull out the tensioning lever (8) together with the spring (6) and guide rail (3) far enough until the tensioning lever has moved passed the oil pump chain (4) and is resting against the crankshaft (5)



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).



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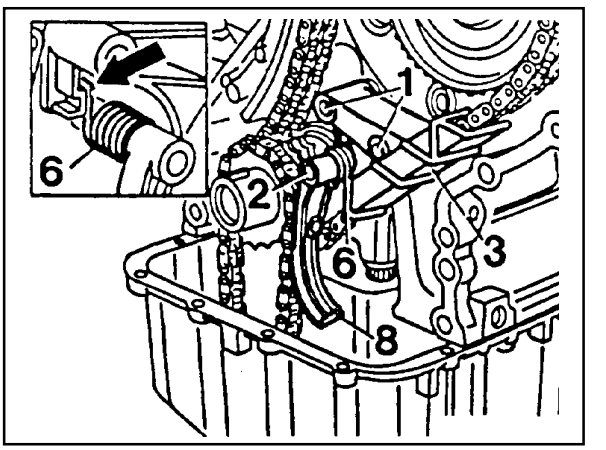
Installation Procedure

1. Install the guide rail (3). Attach the spring (6) to the guide rail and to the tensioning lever (8).

   Notice

   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).

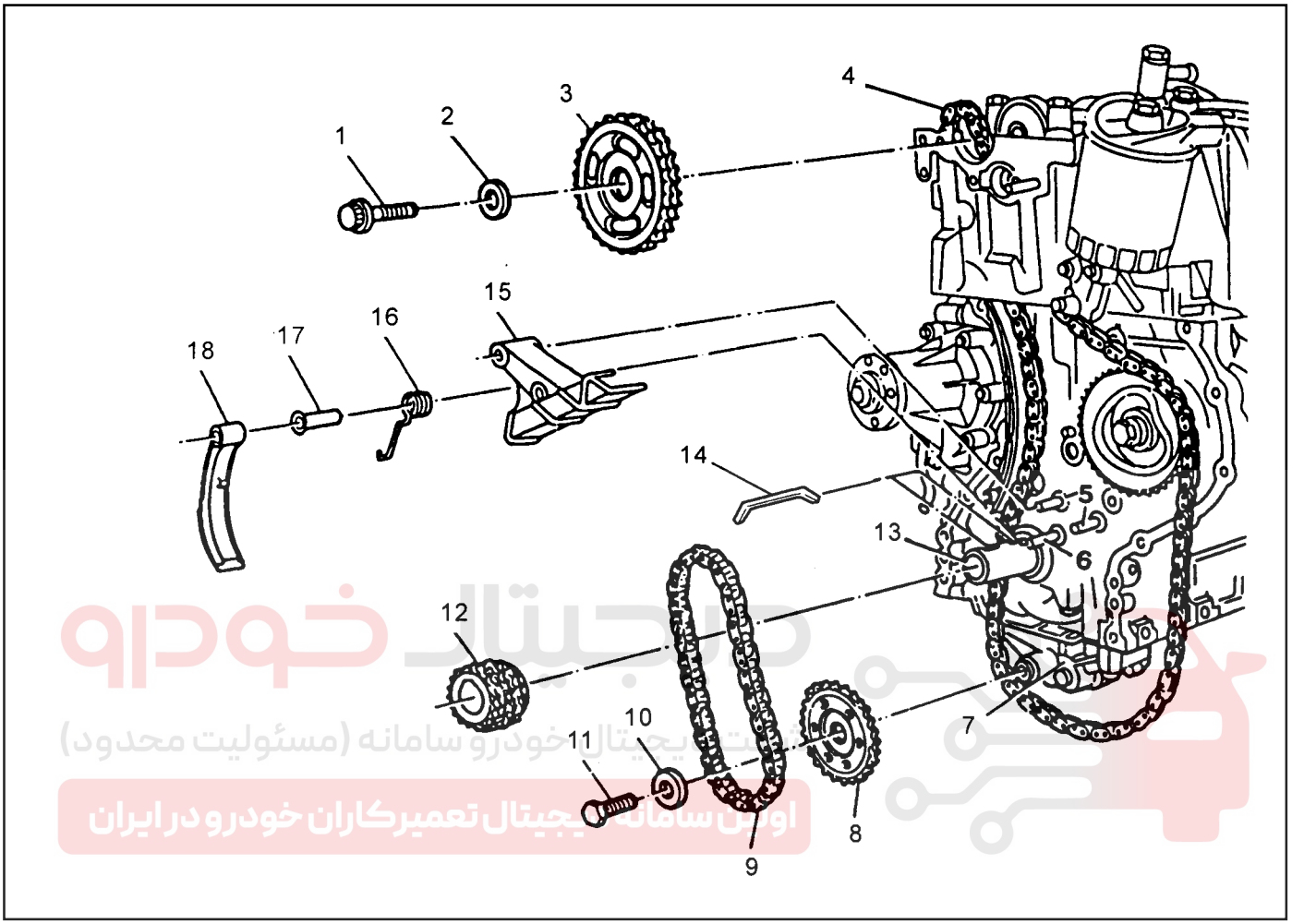


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CRANKSHAFT SPROCKET

Preceding Work : Removal of oil pan
Removal of timing case cover



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 25Nm
12 Crankshaft Sprocket
13 Crankshaft
15 Key
16 Guide Rail
17 Spring
18 Bushing
19 Tensioning Lever

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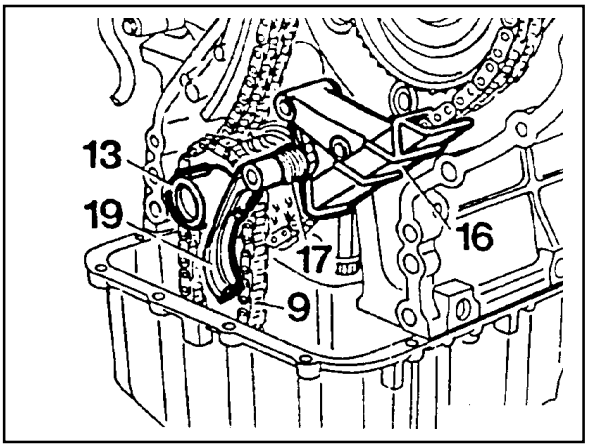
Special Tools

116 589 07 15 00 Drift

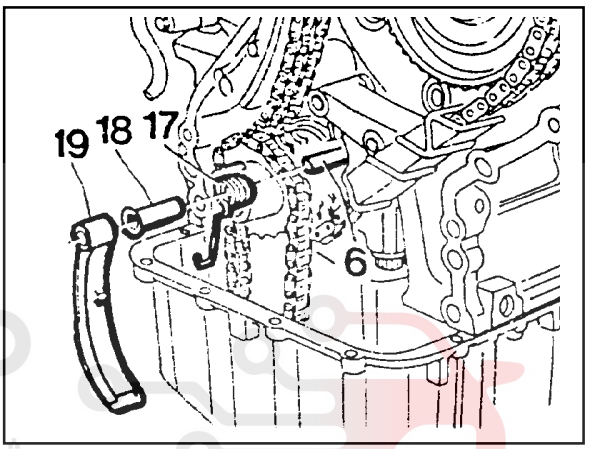
102 589 05 33 00 Puller

Removal Procedure

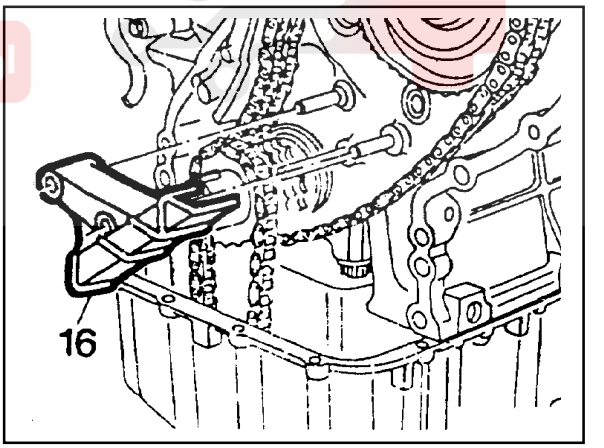
1. Pull out the tensioning lever (19) together with the spring (17) and guide rail (16) far enough until the tensioning lever has passed the oil pump chain (9) and is resting against the crankshaft (13).



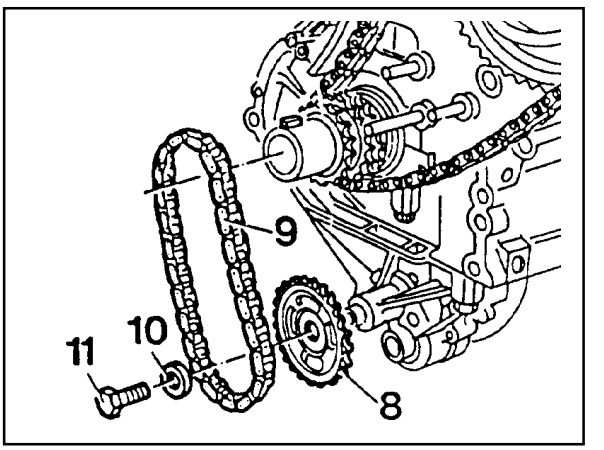
2. Pull out tensioning lever (19), spring (17) and bushing (18) from the bearing pin (6).



3. Pull out the guide rail (16).



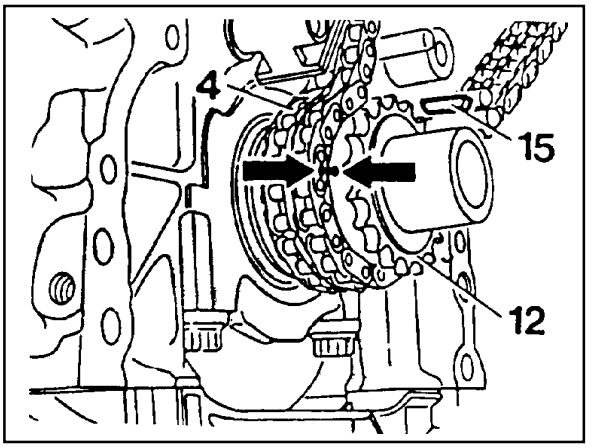
4. Remove the bolt(11) and then remove the washer (10), oil pump chin (9) and sprocket (8).



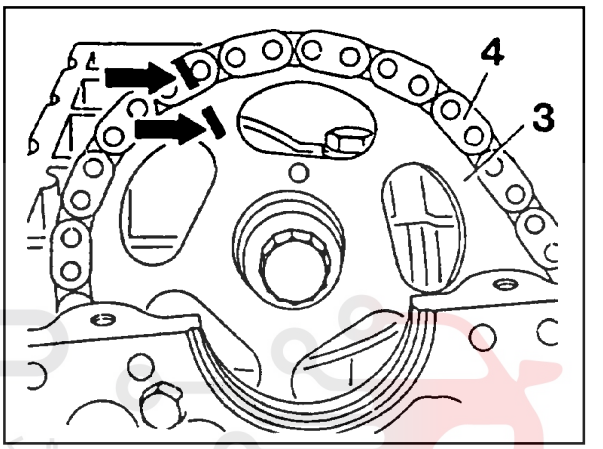
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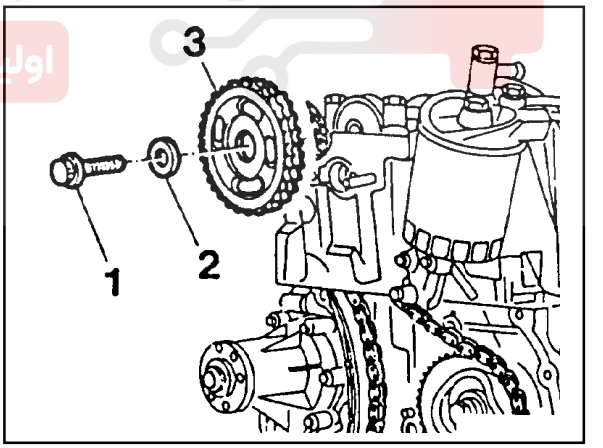
5. Place alignment marks (arrow) on the timing chain (4) and crankshaft sprocket (12).
6. Remove the woodruff key(15).



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

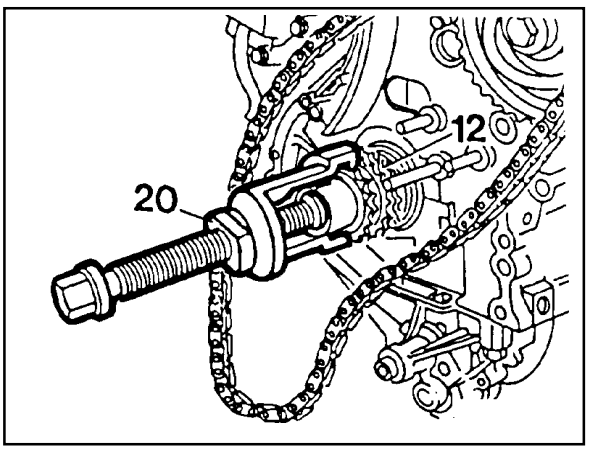


8. Remove the chain tensioner.
9. Remove the bolt (1) and then remove the washer (2) and camshaft sprocket (3).



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

Puller 102 589 05 33 00



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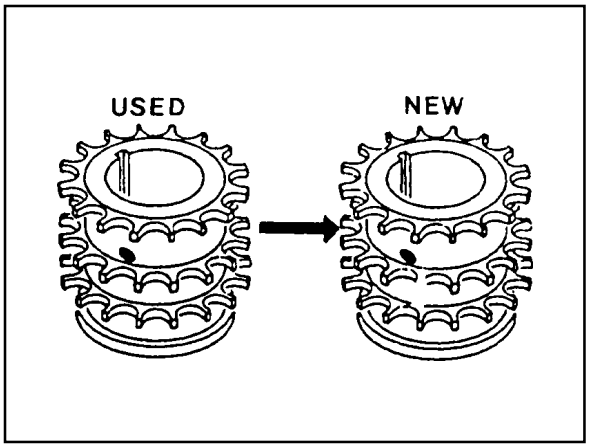
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Installation Procedure

1. Put the same alignment mark on the new crankshaft sprocket as in the old sprocket.

   Notice

   Check the timing chain, camshaft sprocket, injection pump timing sprocket, oil pump chain and oil pump sprocket for wear and replace if necessary.

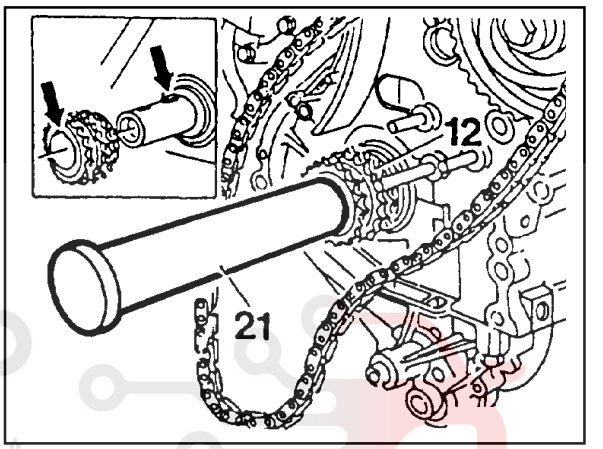


2. Install the new crankshaft sprocket (12) by using a drift (21).

   Notice

   Align the groove of sprocket and woodruff key (arrow) exactly.

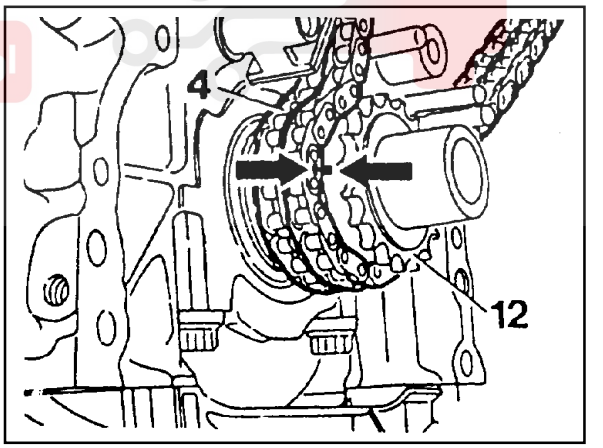
   Drift 116 589 07 15 00



3. Fit the timing chain (4) on the crankshaft sprocket (12).

   Notice

   Align the alignment marks (arrow) on the chain and sprocket.

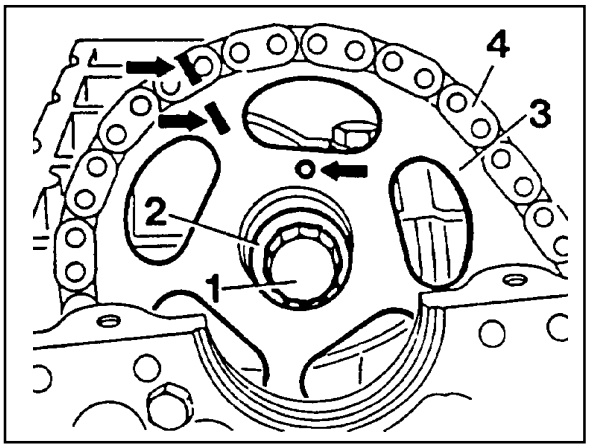


4. Install the camshaft sprocket (3).

Tightening Torque	25 Nm + 90°

   Notice

   Pay attention on the alignment marks and dowel pin (arrow).

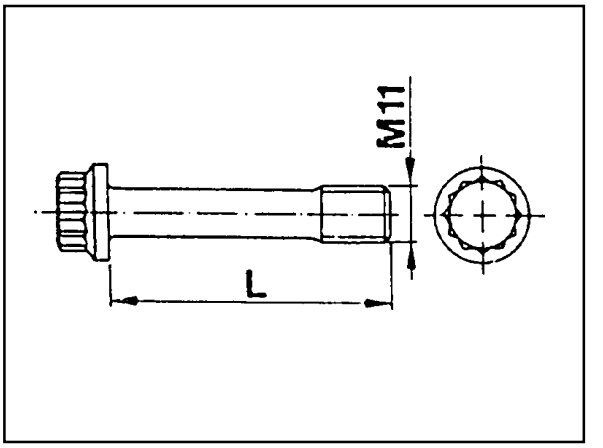


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Notice

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

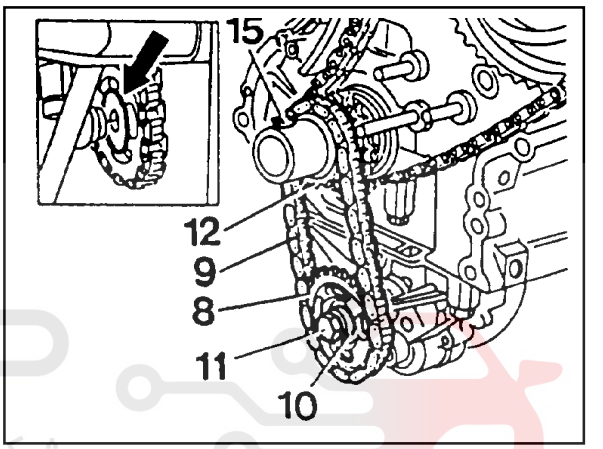


5. Fit the oil pump chain (9) on the crankshaft sprocket (12) and insert the oil pump sprocket (8) into the oil pump chain and then install it on the oil pump.

   Notice

   The curved side of the oil pump sprocket should face the oil pump.

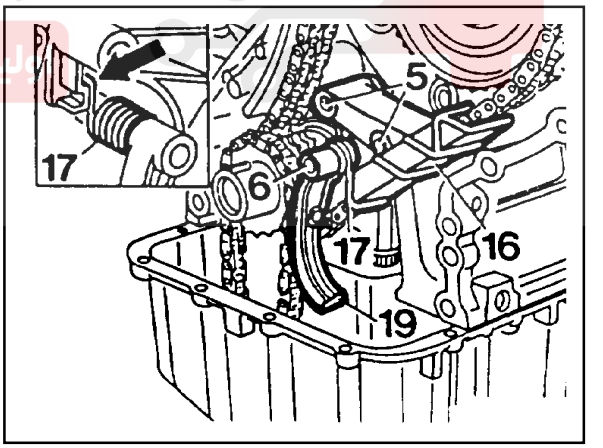
6. Insert the woodruff key (15).



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

   Notice

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

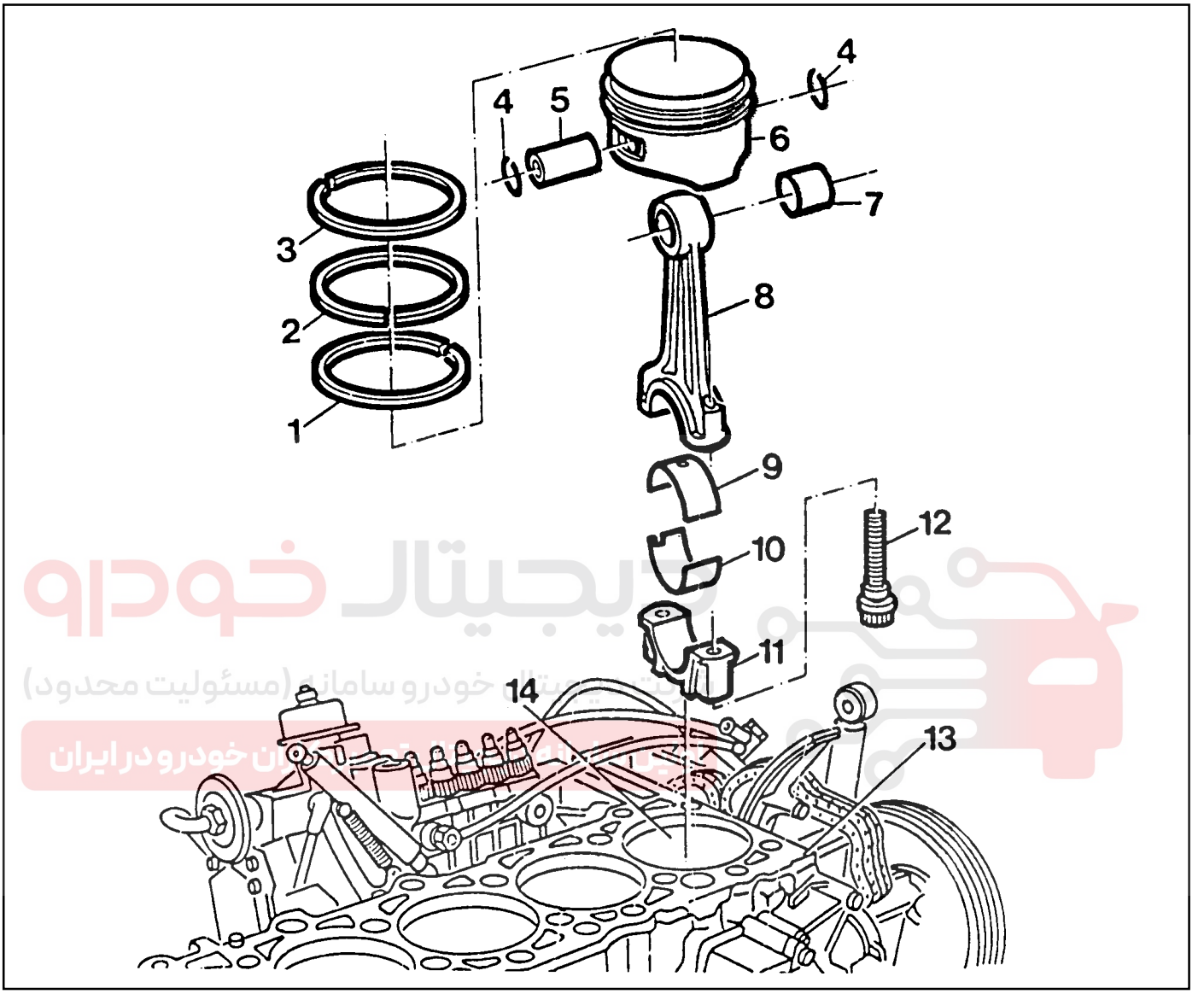


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PISTON

Preceding Work : Removal of the cylinder head
Removal of the oil pump



1 Oil Ring
2 2nd Ring
3 Top 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

Notice

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.

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Service Data

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

Connecting Rod Bolt Dimensions

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

Tools Required

000 589 04 14 00 Tensioning Strap
001 589 53 21 00 Dial Gauge
363 589 02 21 00 Dial Gauge Holder

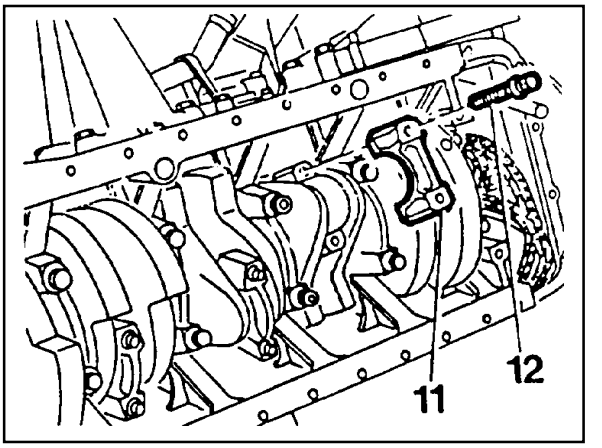
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Removal Procedure

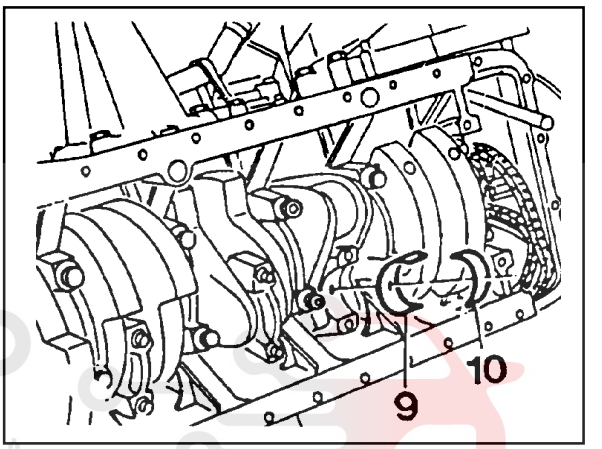
1. Remove combustion residues from the cylinder bores.
2. Remove the connecting rod bolts (12) and then remove the connecting rod bearing caps(11).



3. Remove the connecting rod bearing shells (9, 10).

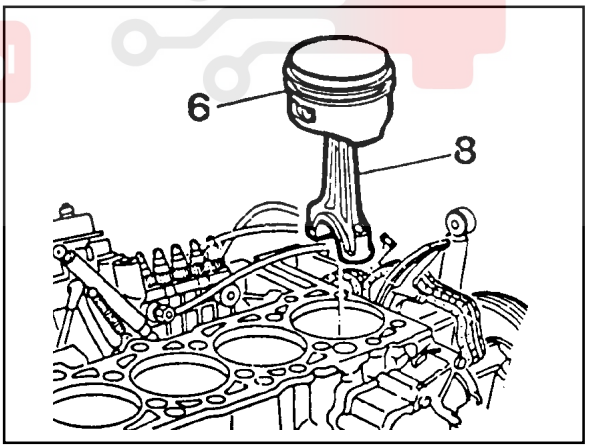
   Notice

   Be careful not mix the bearing caps and shells each other.

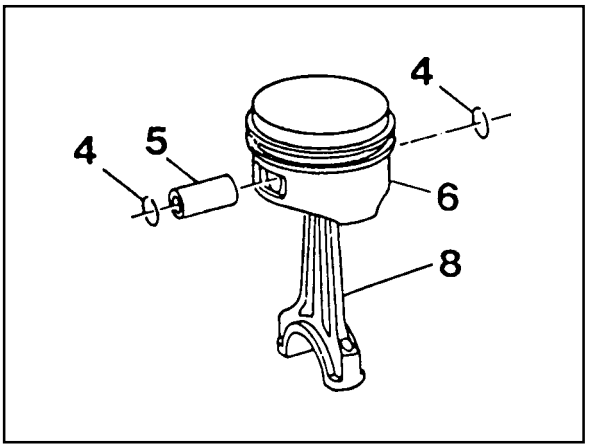


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4. Remove the piston (6) and connecting rod (8).



5. Remove the snap ring (4) and pull out the piston pin (5).
6. Separate the piston and connecting rod.

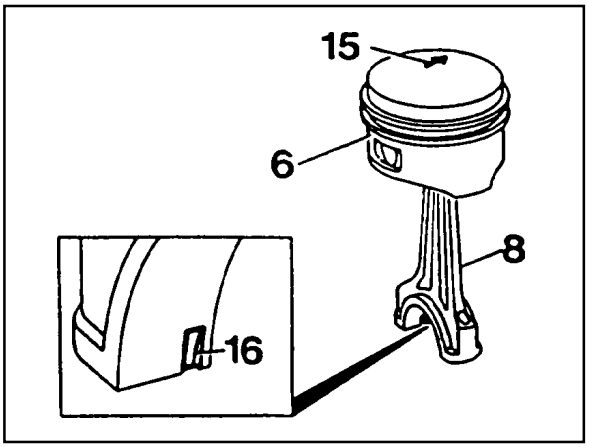


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Installation Procedure

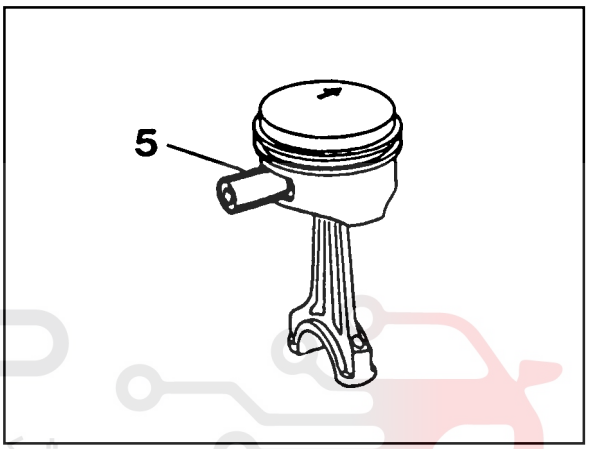
1. Fit the piston onto the connecting rod so that the arrow (15) and the locking slot (16) are facing in direction of the vehicle.



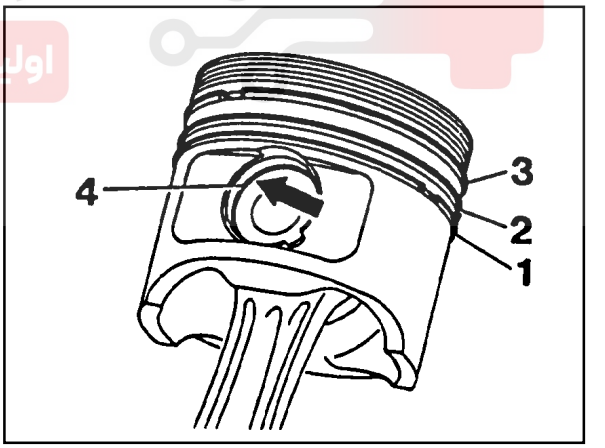
2. Coat the piston pin (15) with engine oil and insert it by hand.

   Notice

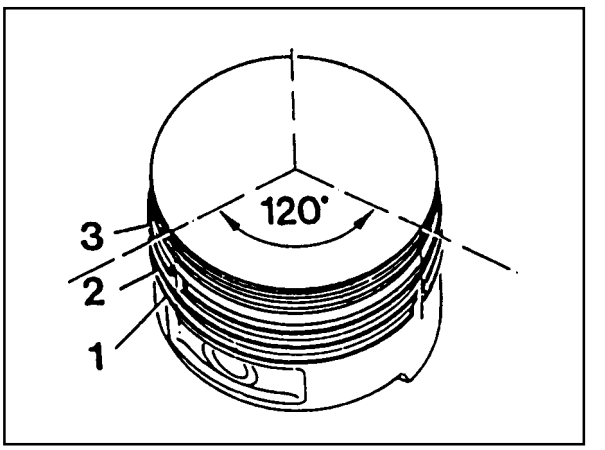
   Do not heat up the piston.



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.

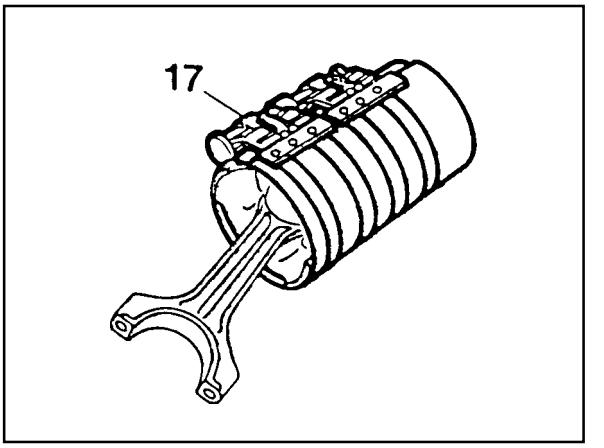


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6. Coat the cylinder bore, connecting rod bearing journal, connecting rod bearing shell and piston with oil.
7. Compress the piston rings with a tensioning strap (7).

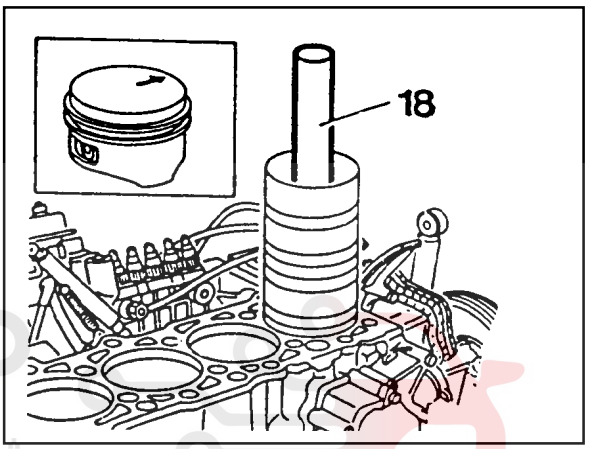
Tensioning Strap 000 589 04 14 00



8. Insert the piston assembly into the cylinder with a wooden stick (18).

Notice

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



9. Insert the connecting rod bearing shells (9, 10).

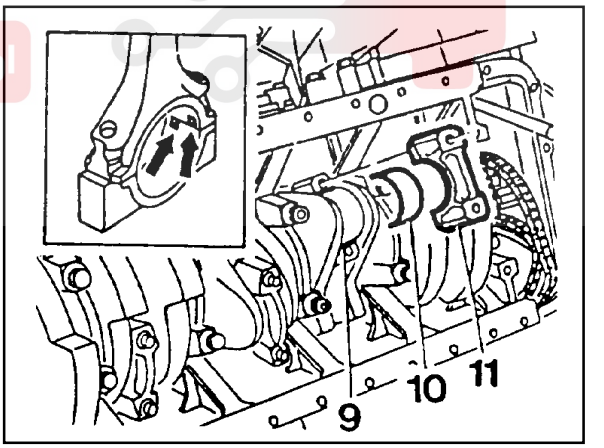
Notice

Be careful of the difference in upper and lower bearing shells and not to be changed.

10. Position the connecting rod bearings caps.

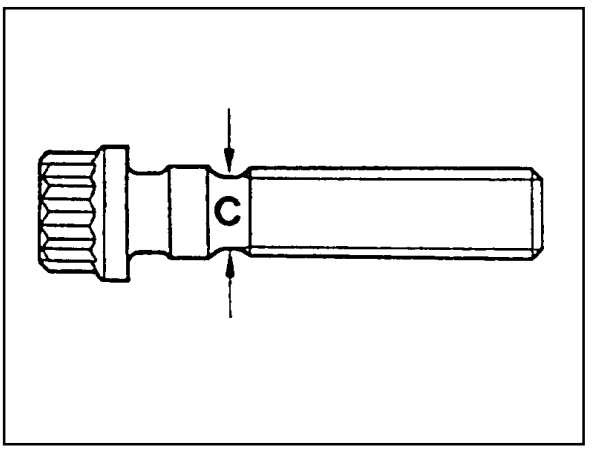
Notice

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

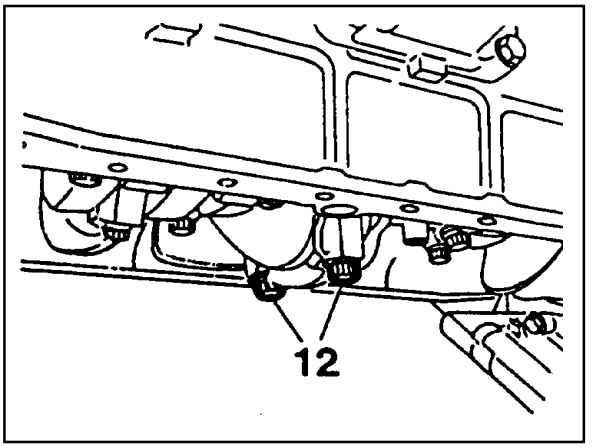


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12. Coat the bolts (12) with oil and then tighten the bolts.

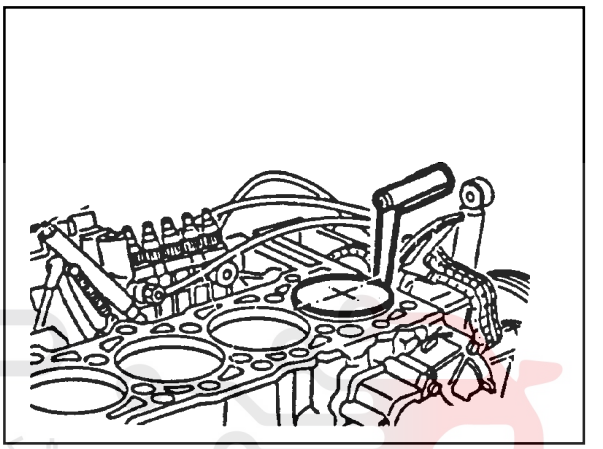
Tightening Torque	40Nm + 90°



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



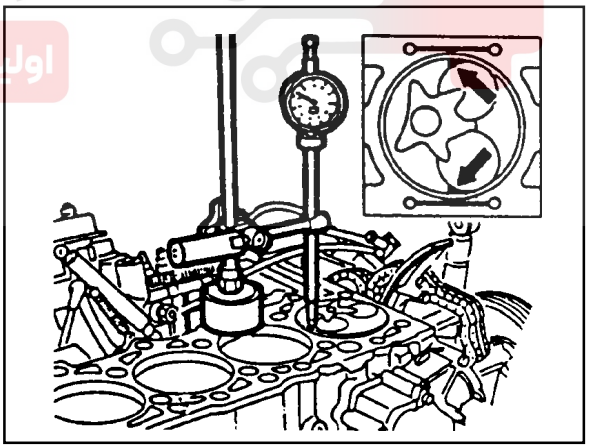
15. Position the piston at TDC and measure the distance between the piston crown and the crankcase surface.

Standard	Max. 0.965 mm

Notice

Measure at points marked.

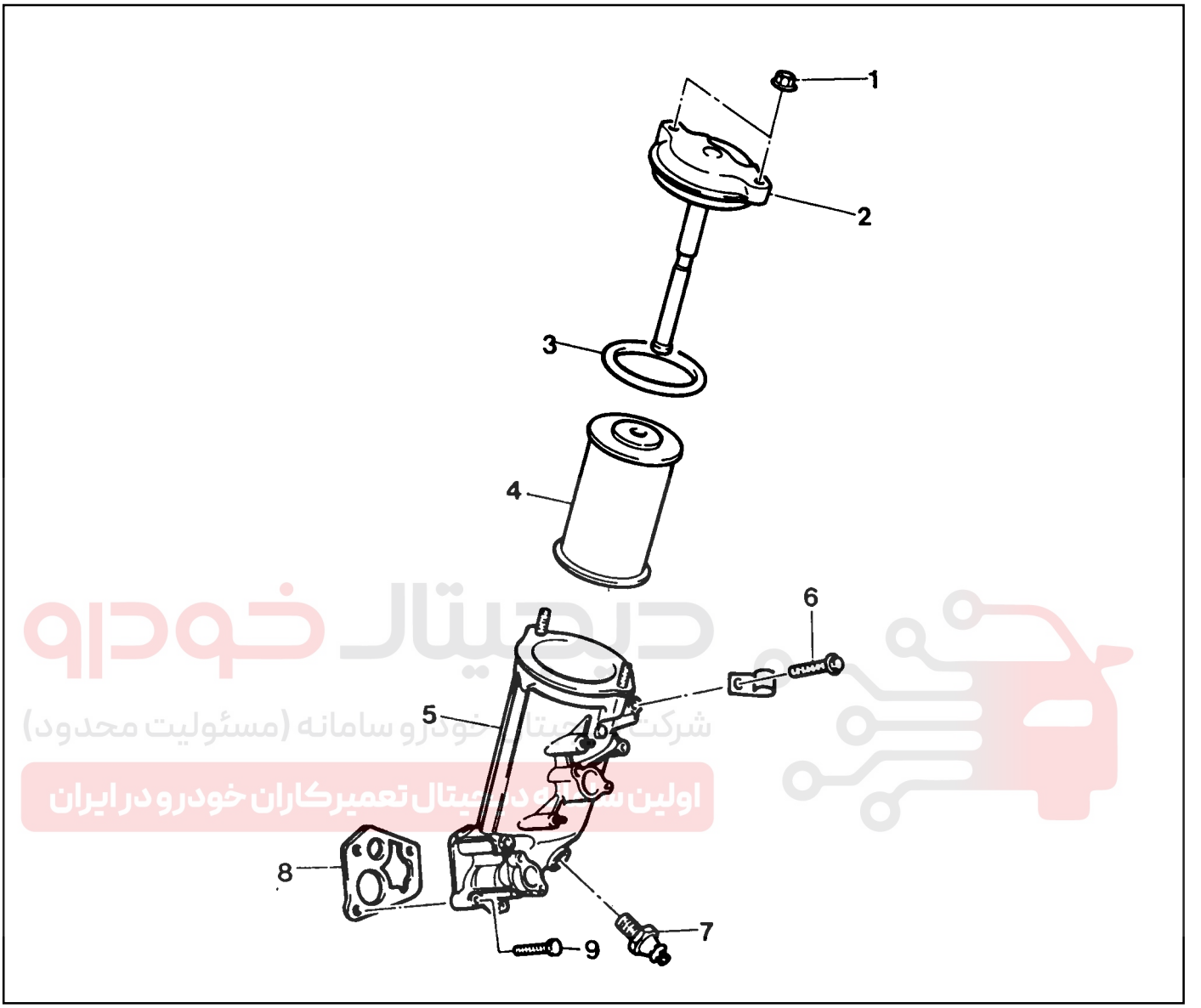
Dial Gauge 001 589 00 53 21
Dial Gauge Holder 363 589 02 21 00



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OIL FILTER



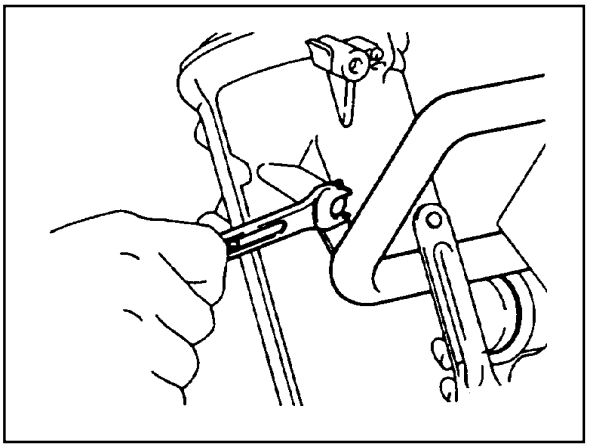
1	Nut ..... 25 Nm	6	Bolt (M8) 10Nm
2	Oil Filter ..... Cover	7	Oil Pressure Switch
3	O-Ring ..... Replace	8	Gasket
4	Oil Filter ..... Element Replace If necessary	9	Bolt ..... 25 Nm
5	Oil Filter Housing		

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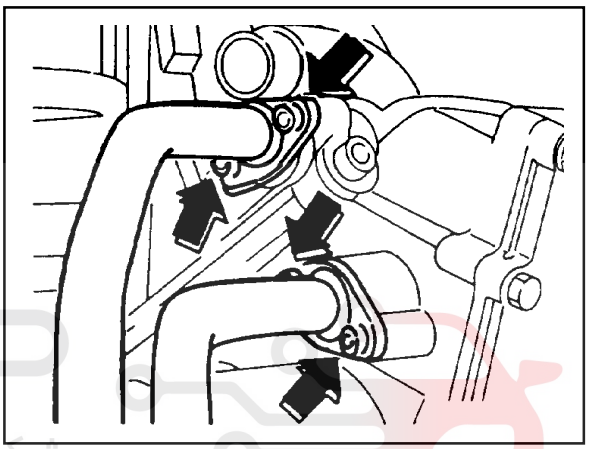
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Removal & Installation Procedure

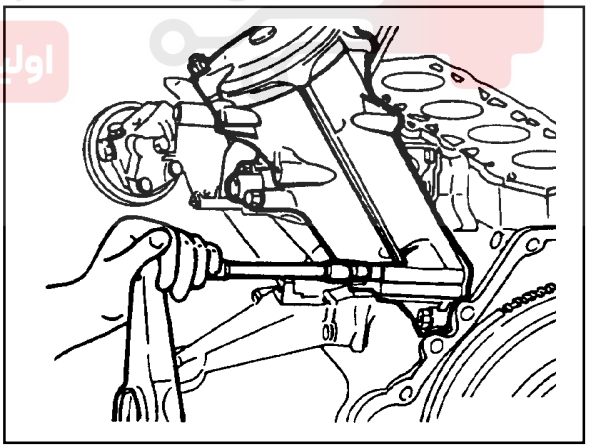
1. Remove the oil filter cover and then drain the oil.



2. Remove the oil pressure switch line.



3. Remove the oil filter housing.
4. Clean the sealing surface.
5. Installation should follow the removal procedure in the reverse order.



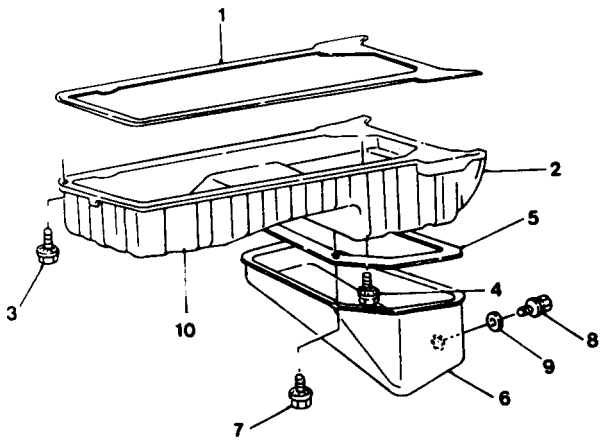
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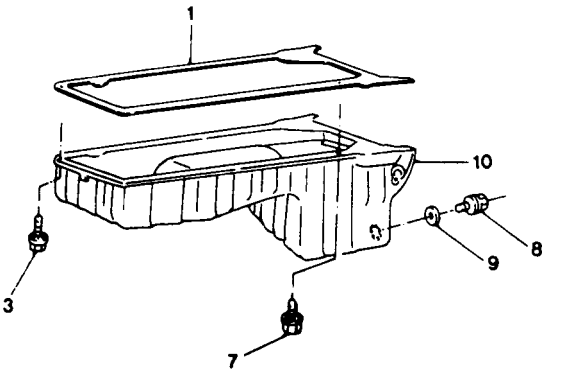
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OIL PAN

OM662LA



OM661LA



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

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*Remove and install as numerical sequence.

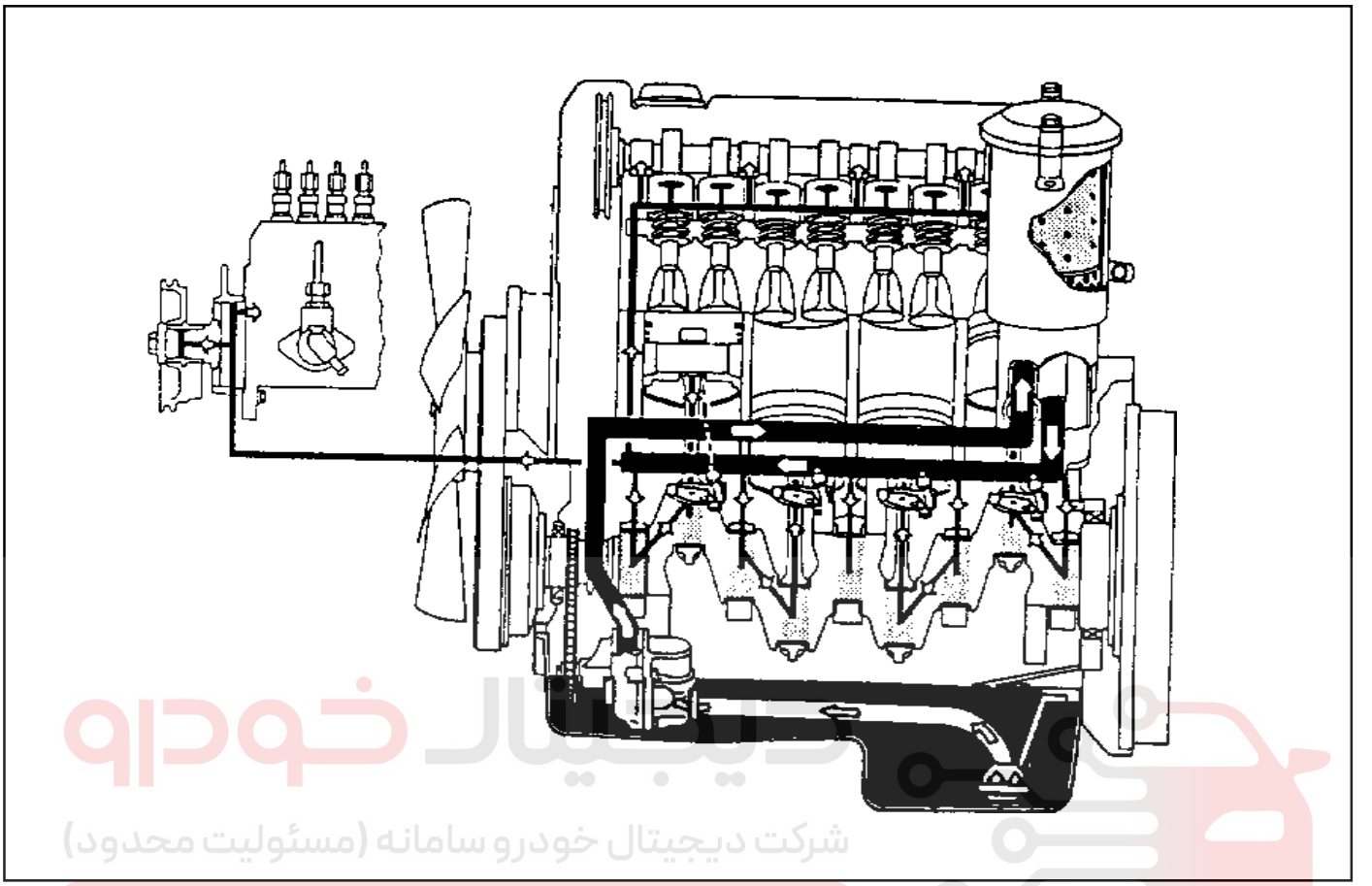
Notice

Replace the washer seal with new one.

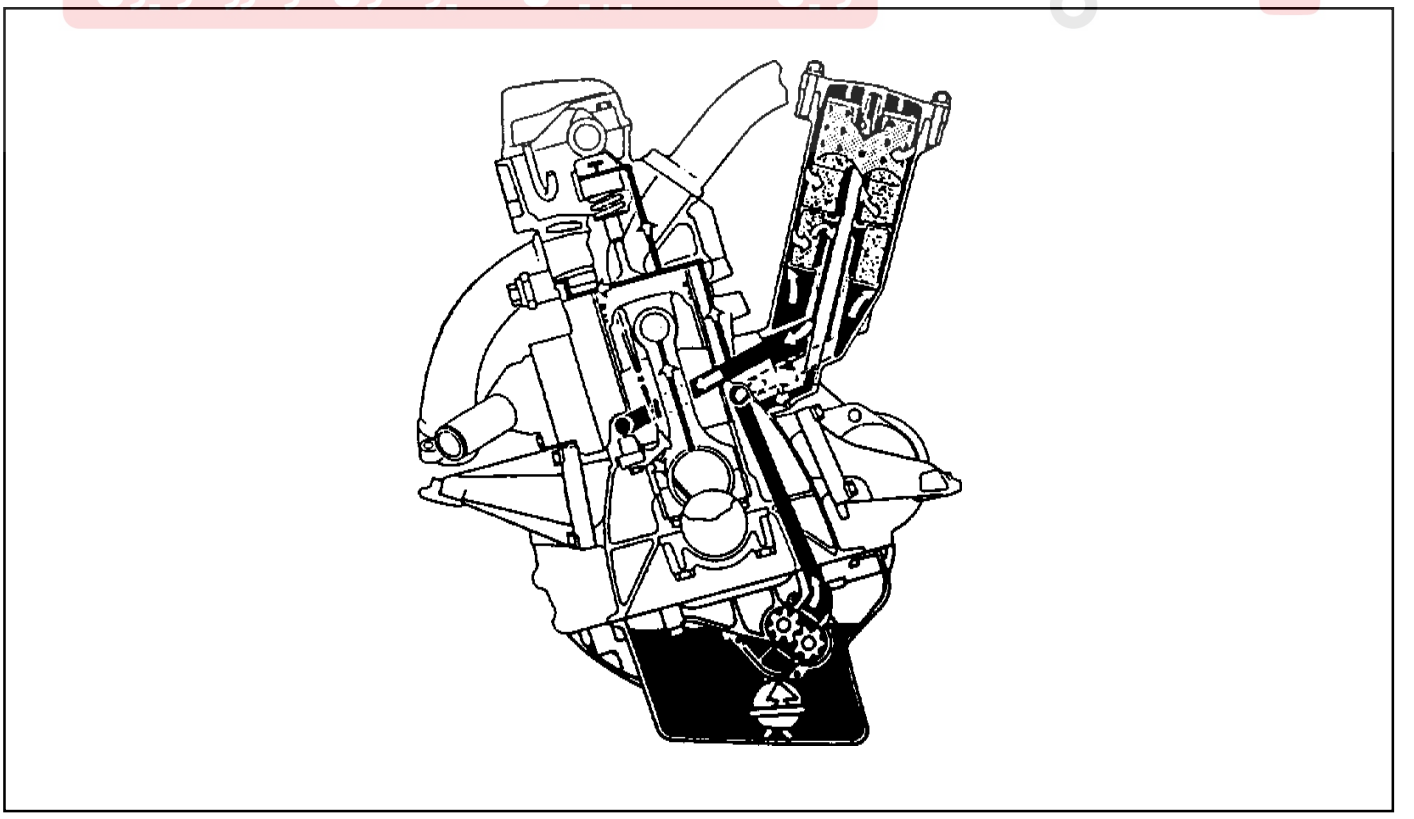
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Oil Circulation



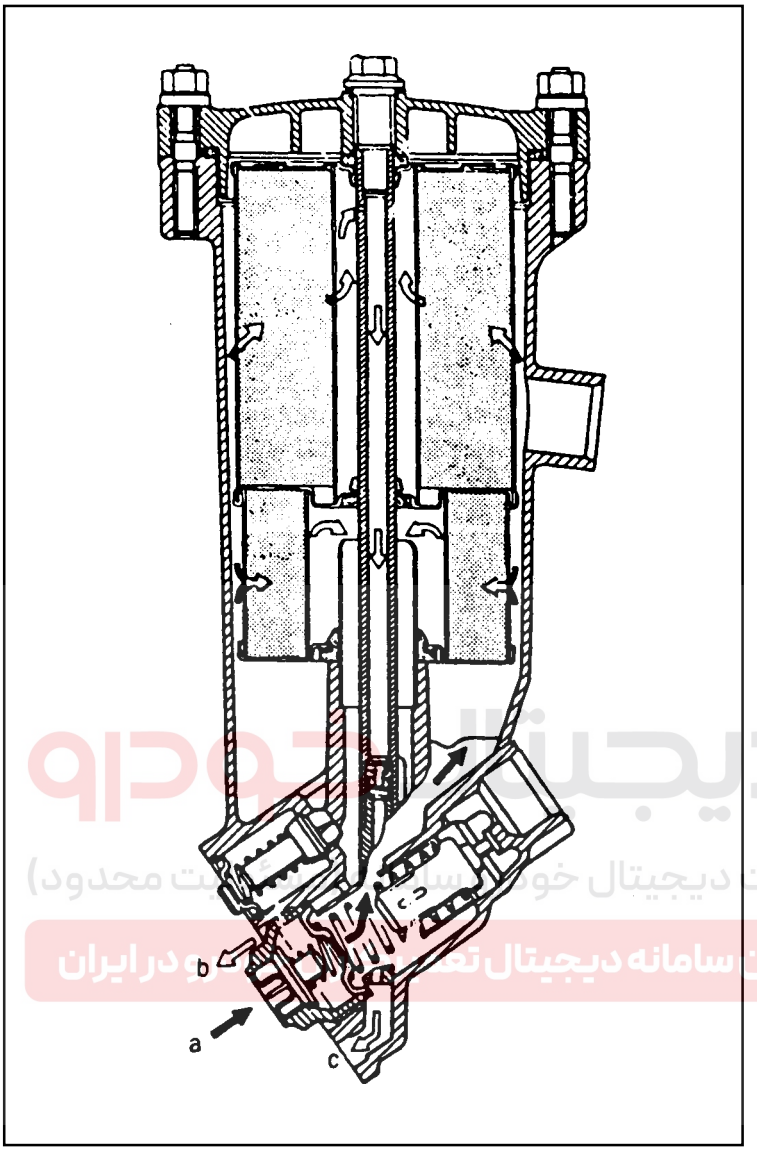
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Oil Filter

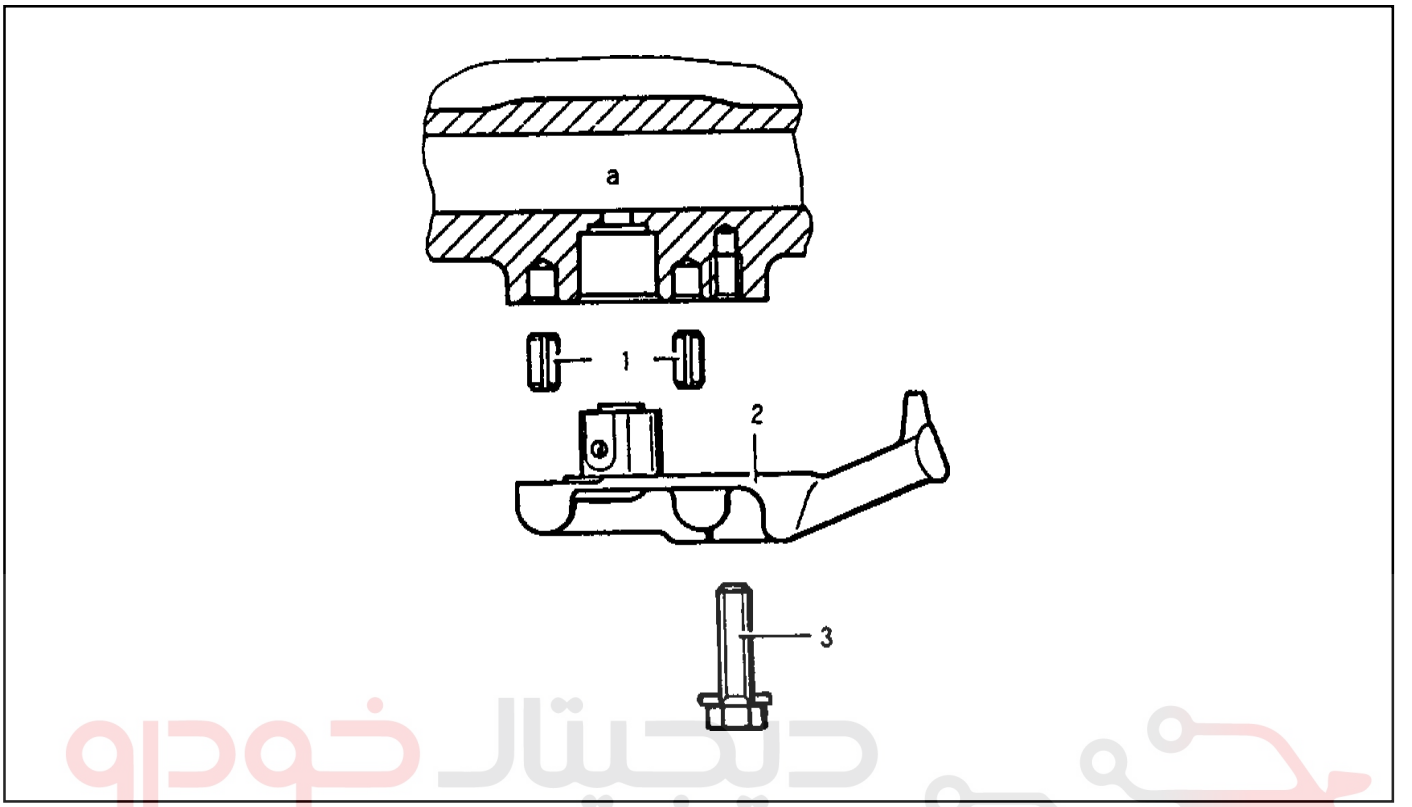


a From Oil Pump
b To Main Oil Gallery
c To Oil Pan

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OIL SPRAY NOZZLE

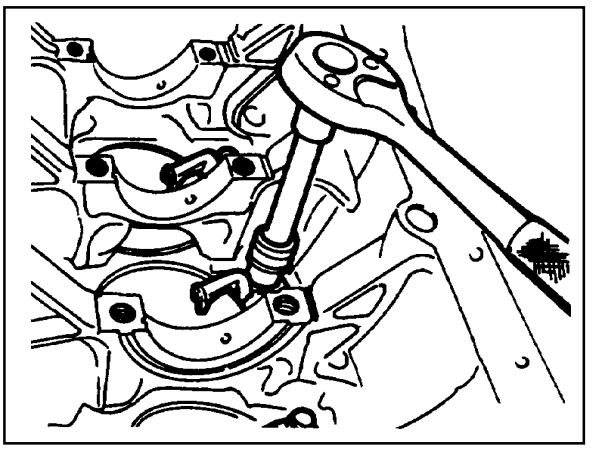


1 Fitting Sleeve
2 Oil Spray Nozzle
3 Combination Bolt ..... 10 Nm
A Oil Duct

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Disassembly Procedure

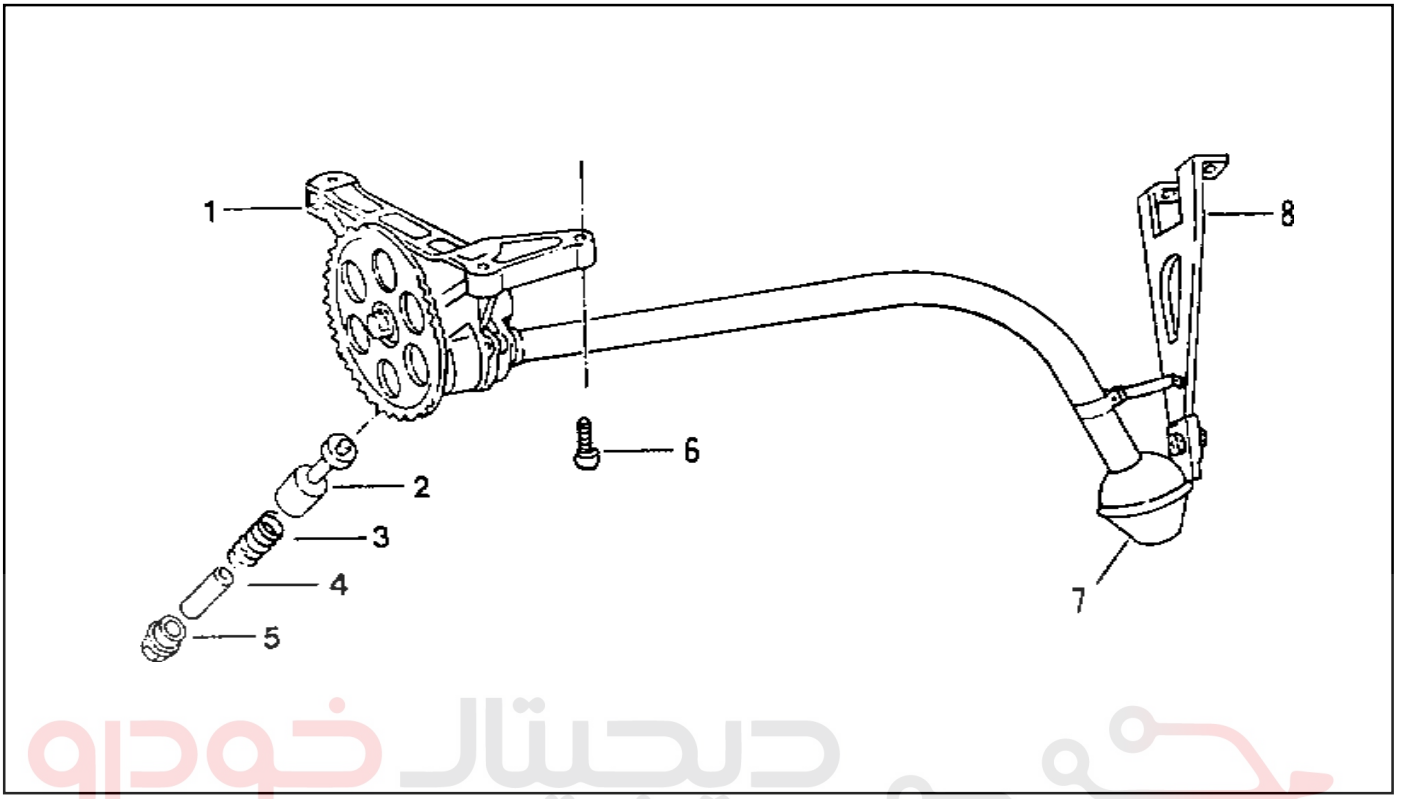
1. Remove oil pan or crankshaft.
2. Loose the bolt and then remove the nozzle.



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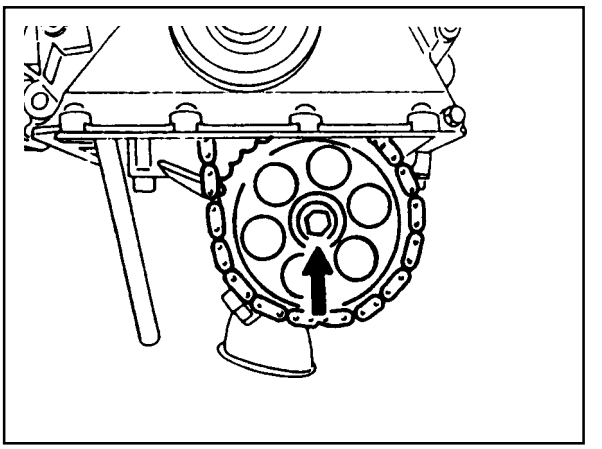
OIL PUMP



1	Oil Pump	5	Screw Plug ..... 50 Nm
2	Piston	6	Combination Bolt ..... 25 Nm
3	Pressure Spring	7	Oil Strainer
4	Guide Pin	8	Bracket

Disassembly Procedure

1. Remove the oil pan.
2. Unscrew the mounting bolt of spracket.

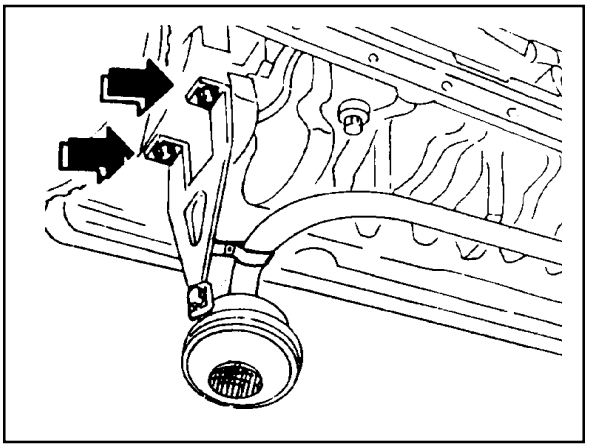


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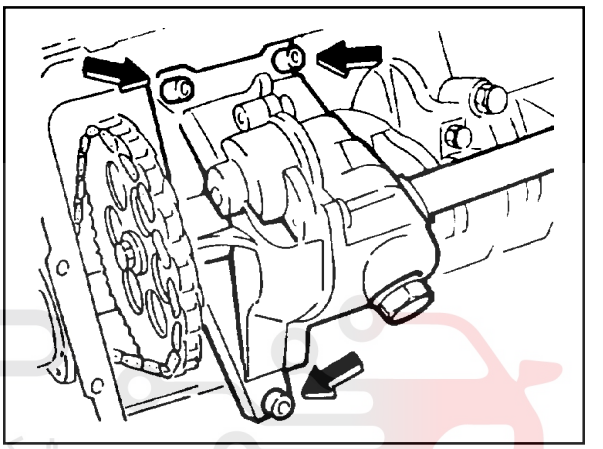
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3. Unscrew the oil strainer bracket bolt.

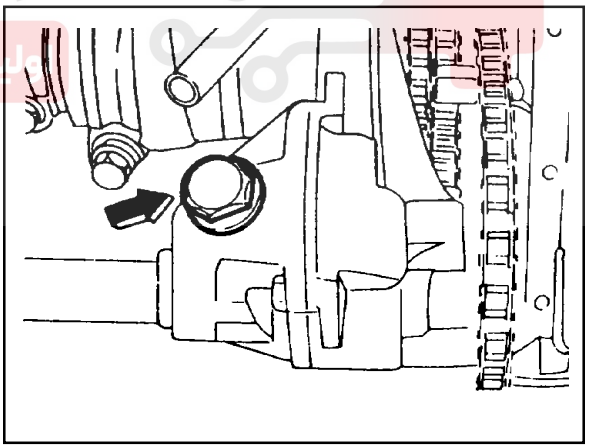
Tightening Torque	10 Nm



4. Remove the oil pump.



5. Unscrew the screw plug and remove the relief valve.
6. Installation should follow the removal procedure in the reverse order.



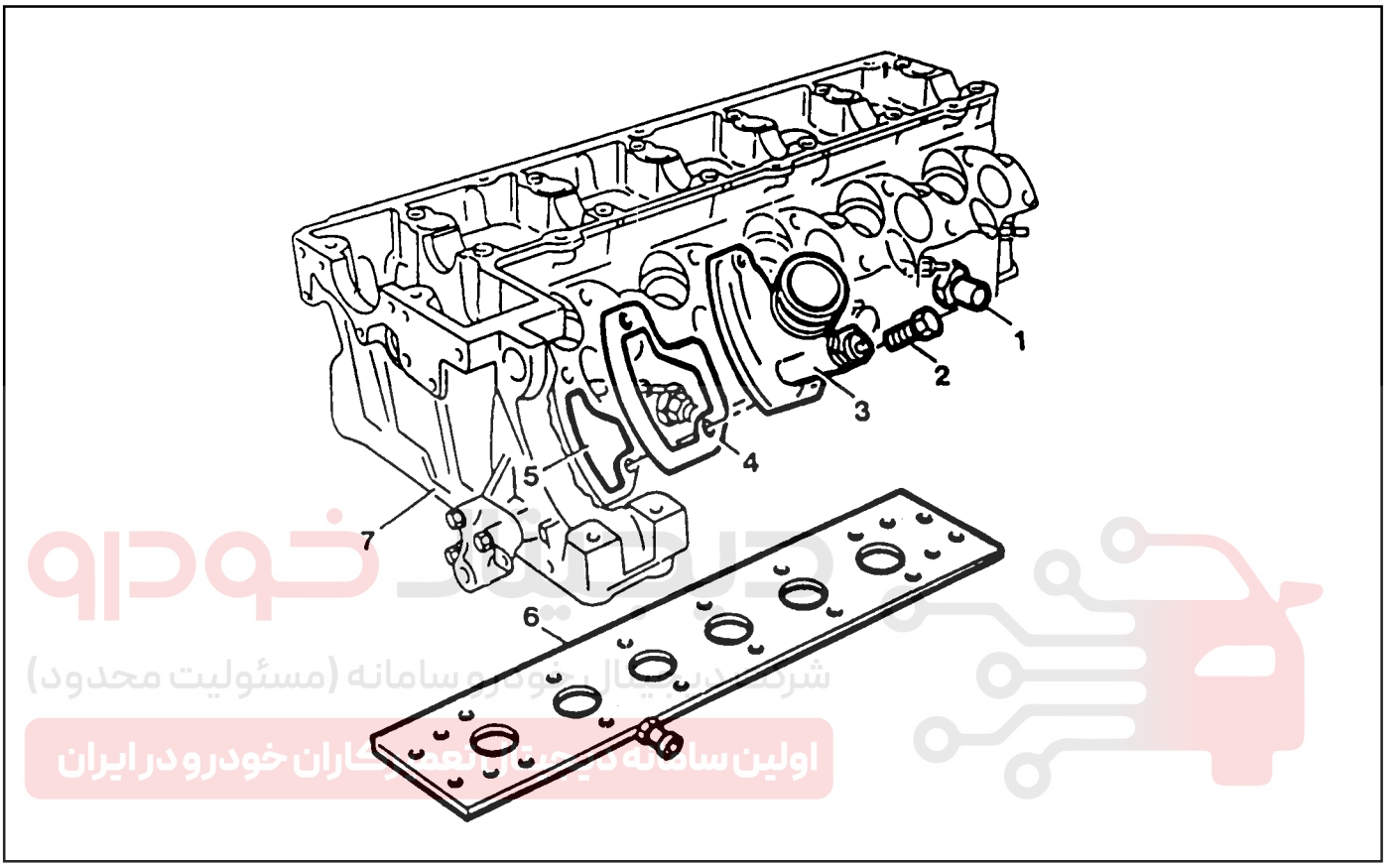
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UNIT REPAIR

CYLINDER HEAD PRESSURE LEAKAGE TEST

Preceding Work : Removal of the cylinder head
Removal of the exhaust manifold
Removal of the valve



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°C and pressurize with compressed airof 2 bar.

Notice

If air bubbles are seen, replace the cylinderhead.

Tools Required

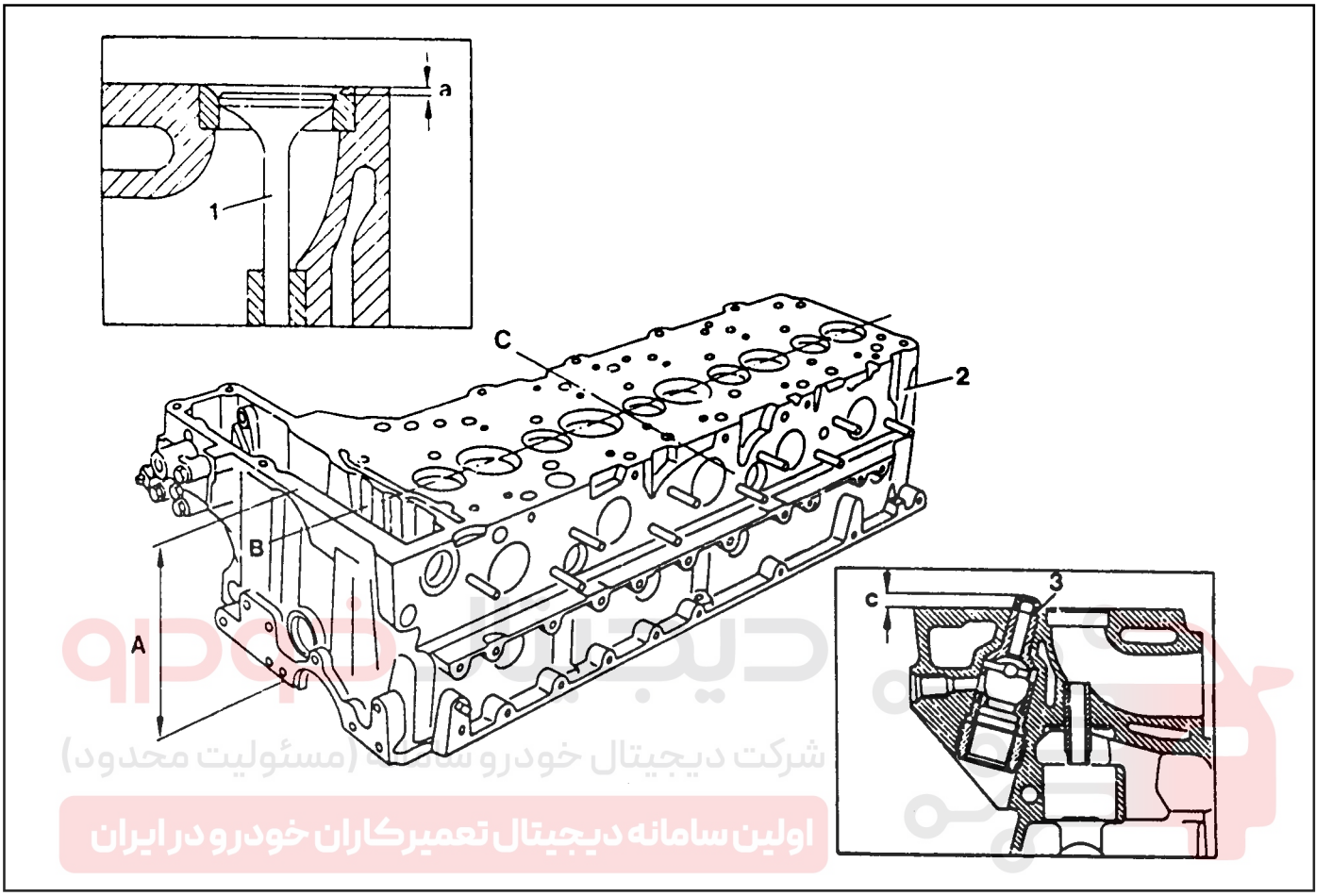
115 589 34 63 00 Pressure Measuring Plate
601 589 00 25 00 Suspension Device

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FACING CYLINDER HEAD MATING SURFACE

Preceding Work : Removal of prechamber
Cylinder head pressure leakage test



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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

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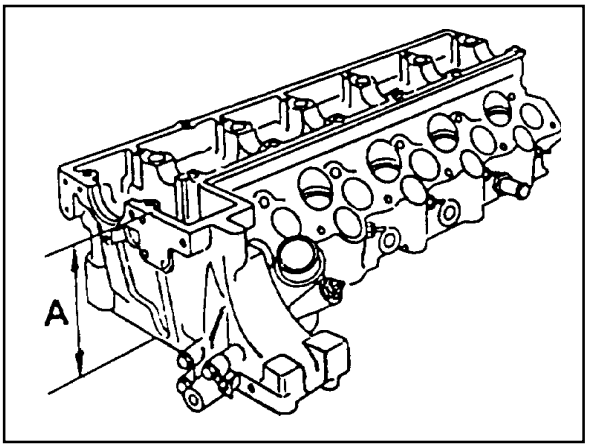
Measurement Procedure

1. Measure height 'A'.

Limit	142.5 mm

Notice

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

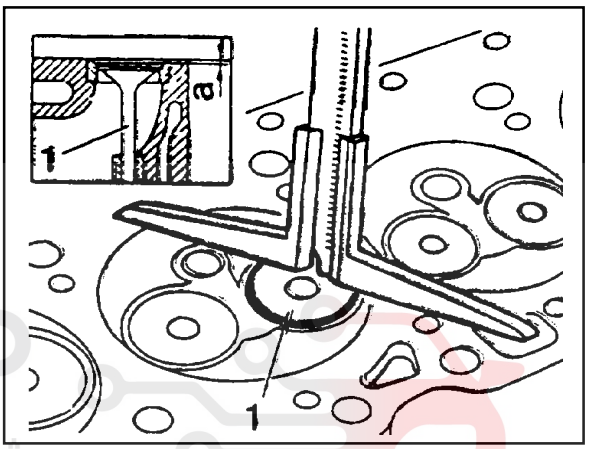


2. Insert the valve (1) and measure valve arrears 'a'.

Valve Arrears 'a'	0.1 - 0.7 mm

Notice

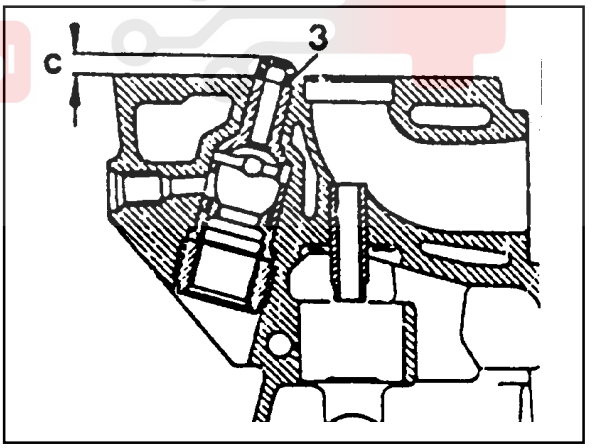
If out of standard, machine the valve seat.



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

Protrusion 'C'	7.6 - 8.1mm

4. Assemble the engine and check the valve timing.

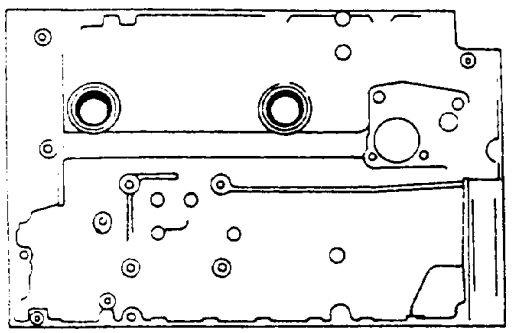


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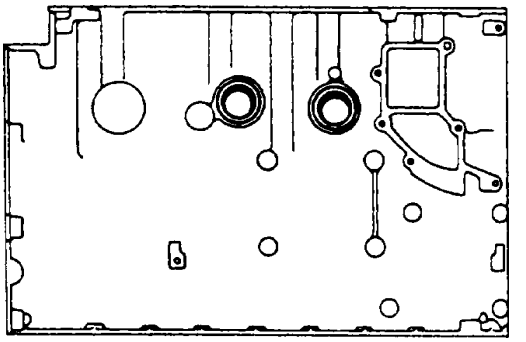
REPLACEMENT OF CRANKCASE CORE PLUG

Left



Core plug f34mm
OM661LA - 2EA
OM662LA - 3EA

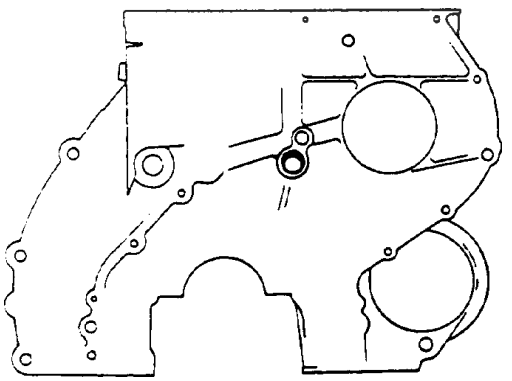
Right



Core plug f34mm
OM661LA - 2EA
OM662LA - 3EA

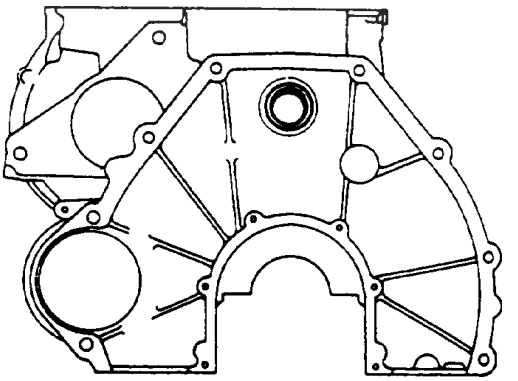
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Left



Core plug f17mm
OM661LA - 1EA
OM662LA - 1EA

Right



Core plug f34mm
OM661LA - 1EA
OM662LA - 1EA

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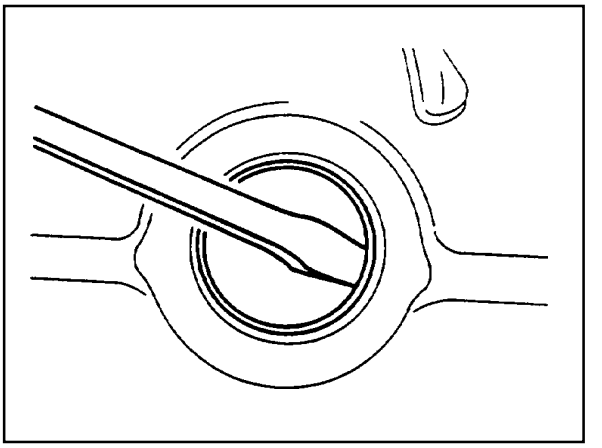
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Tools Required

102 589 00 15 00 Drift
102 589 12 15 00 Drift

Replacement Procedure

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°.

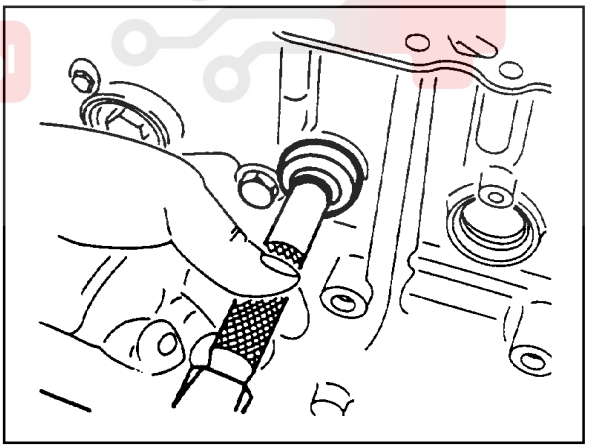


4. Pull out the core plug with pliers.



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 (F34)
Drift 102 589 12 15 00 (F17)



7. Install the removed parts and fill the coolant.

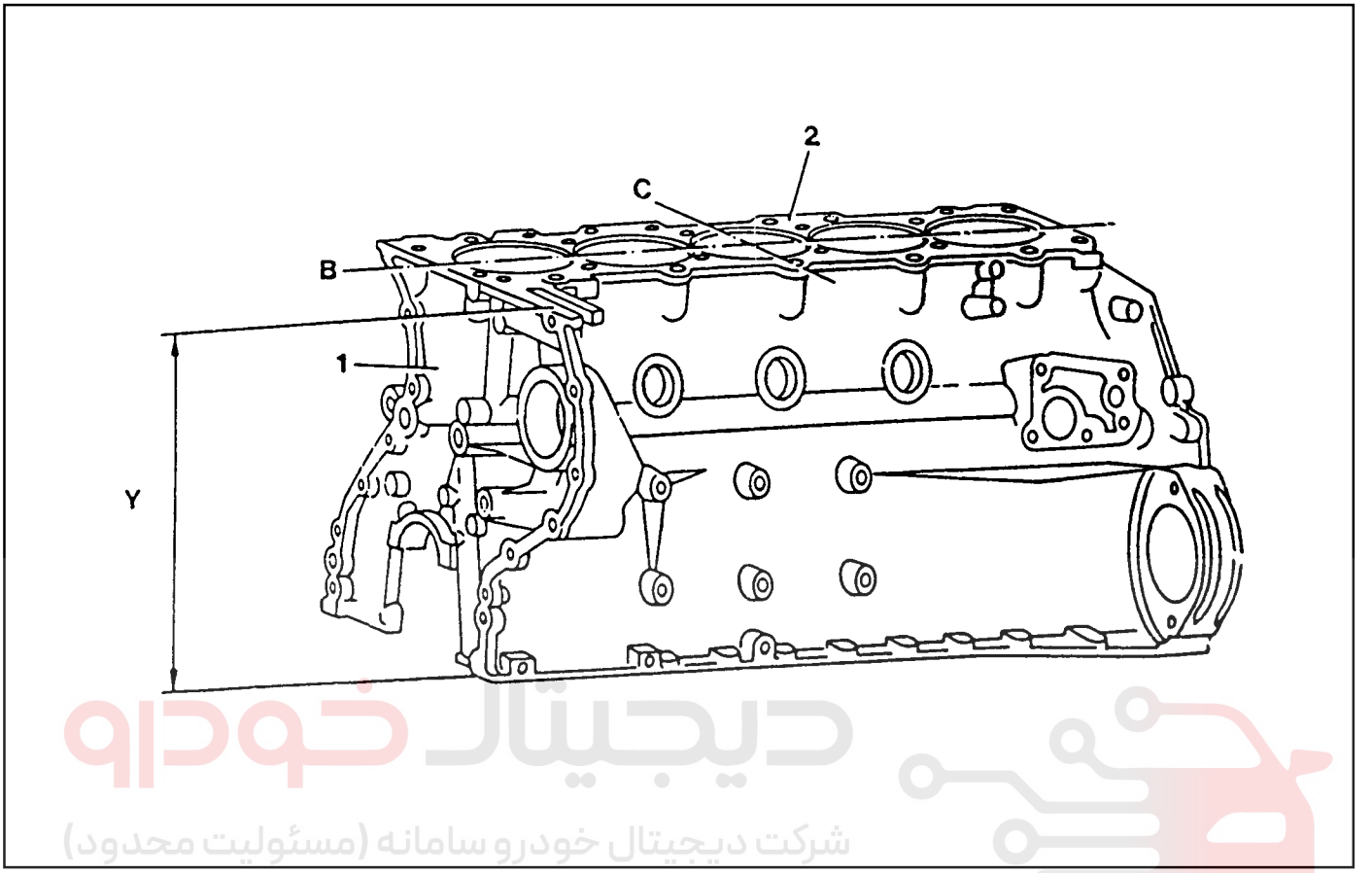
   Notice

   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.

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FACING CRANKCASE CONTACTING SURFACE



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1 Crankcase
2 Crankcase Contacting Surface

Y Height (crankcase upper surface - crankcase lower surface)

B Longitudinal Direction
C Transverse Direction
H Chamfer Height
b Chamfer Angle

Service Data

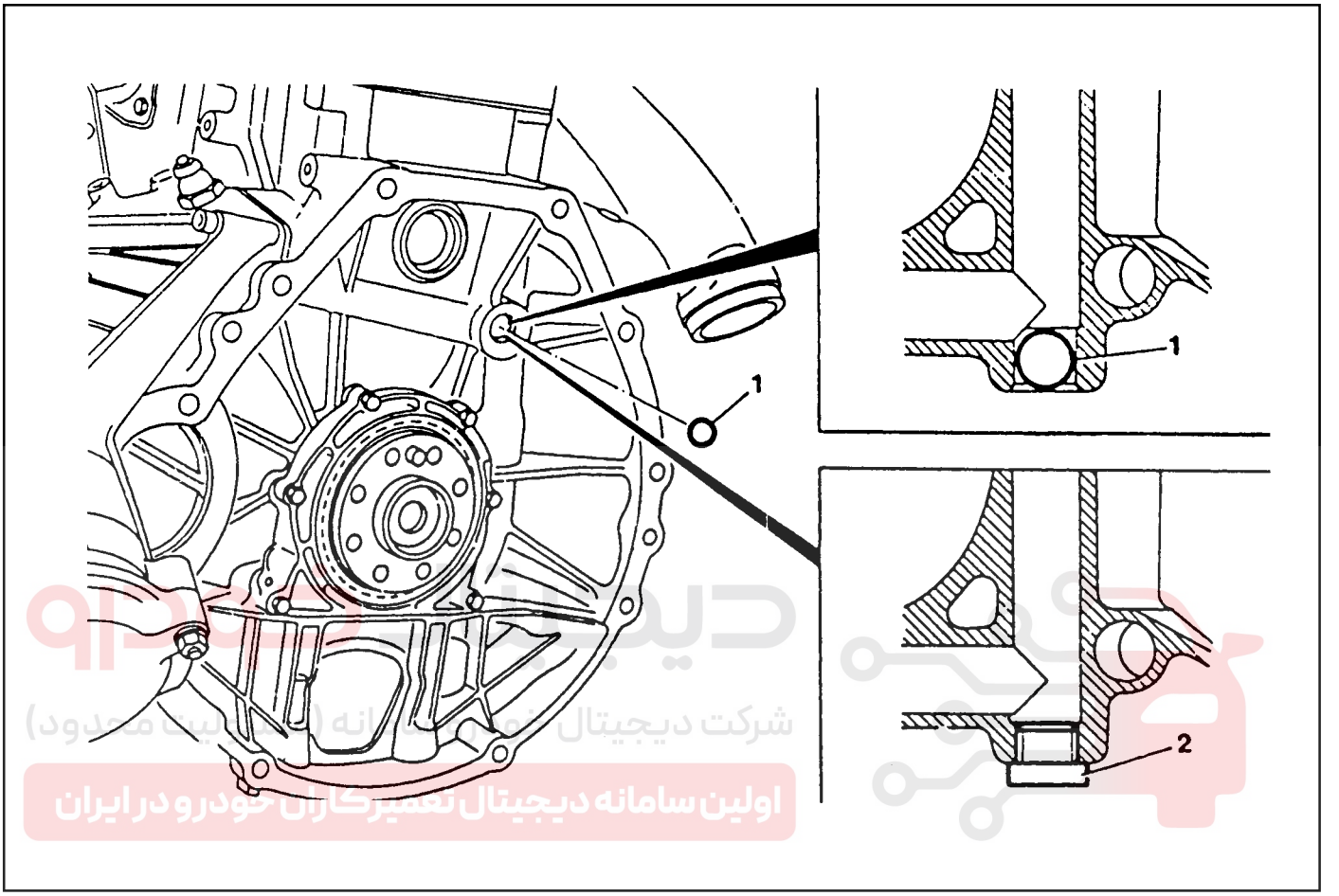
Height 'Y'		Min. 299.62 mm
Permissible unevenness of contacting surface	In longitudinal direction (B)	0.06 mm
	In transverse direction (C)	0.06 mm
Permissible roughness upper contacting surface		0.0006 - 0.0016 mm
Permissible variation of parallelism of crankcase upper surface to lower surface in longitudinal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

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OIL GALLERY STEEL BALL

Preceding Work : Removal of cooling fan
Removal of the coolant pump housing
Removal of the flywheel and driven plate



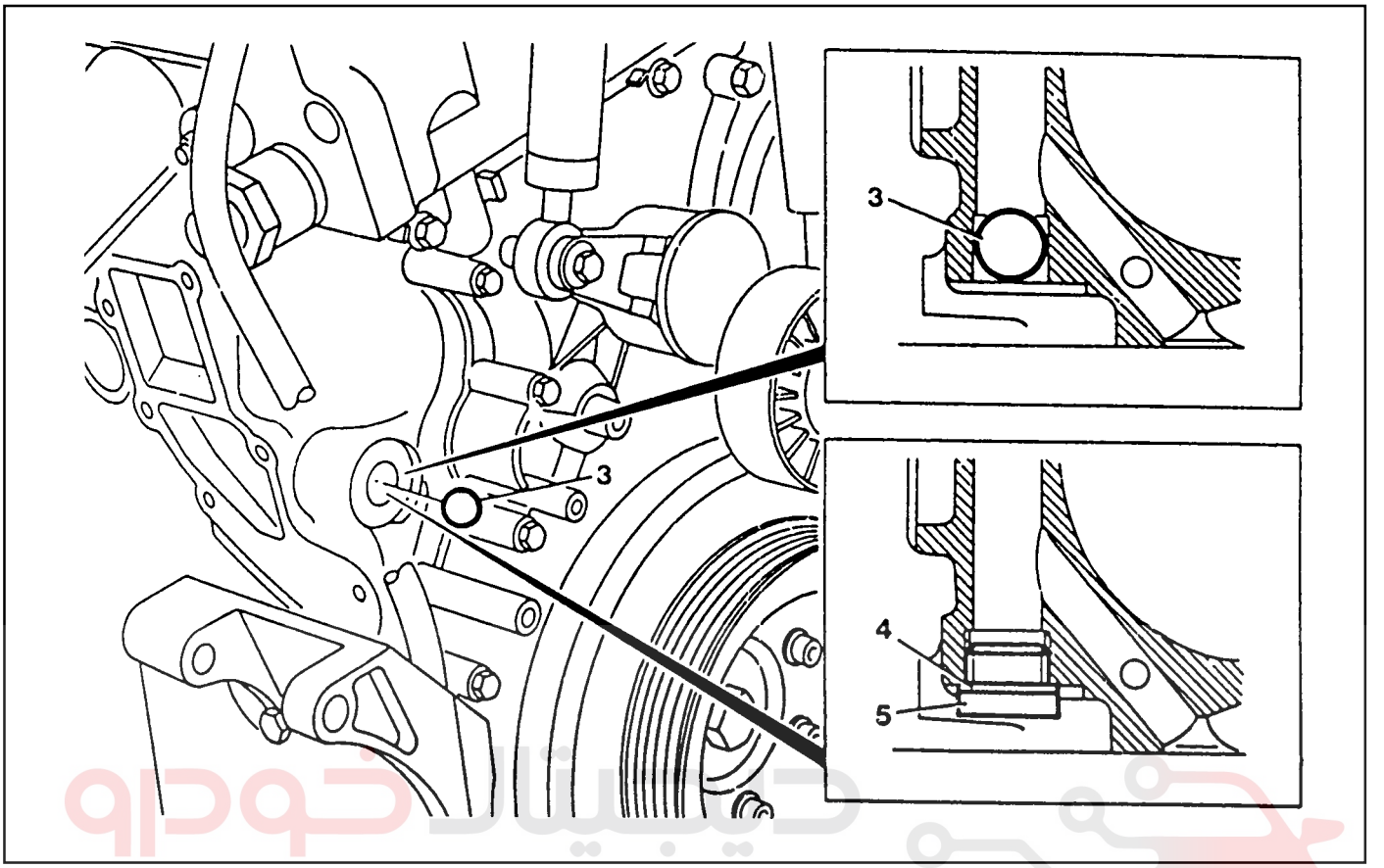
1 Steel Ball ..... f15mm 2 Screw Plug ..... Loctite 241,50Nm

Notice

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

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3 Steel Ball f17mm
4 Seal
5 Screw Plug 50Nm

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Notice

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

Tools Required

601 589 08 15 00 Drift

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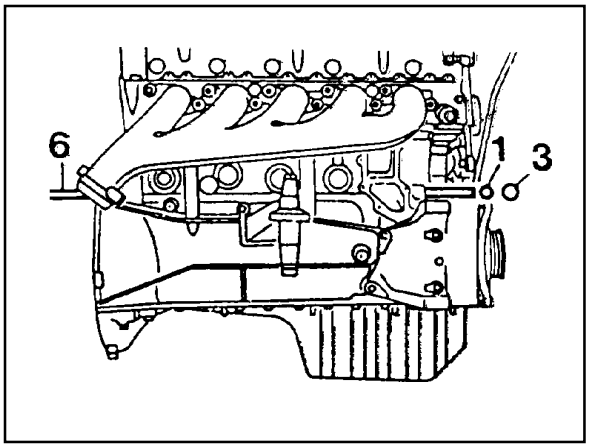
Removal & Installation Procedure

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).

   Notice

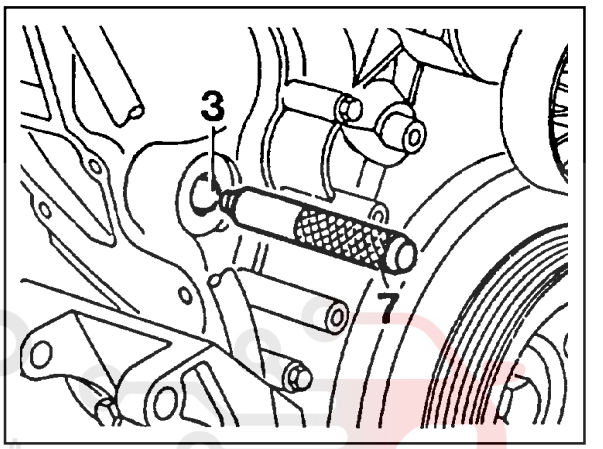
   Be careful not to damage the bores of the steel balls.

   6 Shop-made tool



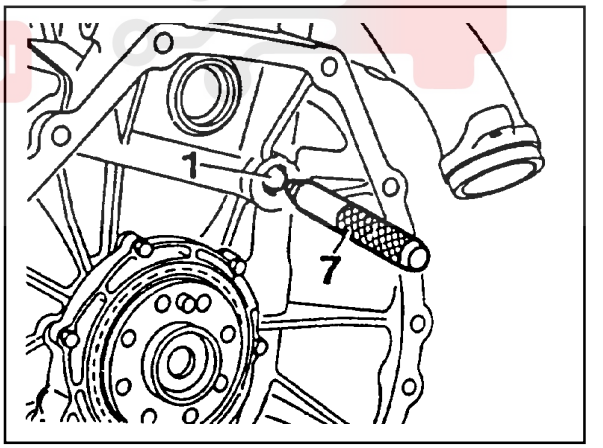
3. Thoroughly clean the bores of steel balls.
4. Place the steel ball (3) onto the drift (7) with a little grease and position to the bore and then tap until the drift stops.

   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 1500



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

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Installation of Screw Plug

Notice

If steel ball leaks again, install the screw plug.

1. Remove the steel ball.
2. Tap thread into the bores of the oil gallery.

Notice

Front bore : M18 ´ 1.5, depth 10mm

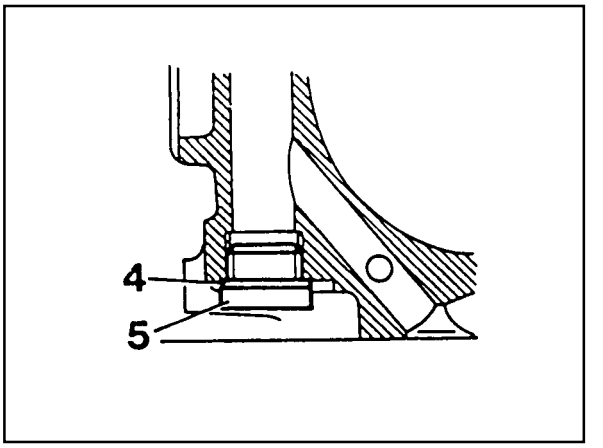
Rear bore : M16 ´ 1.5, depth 14mm

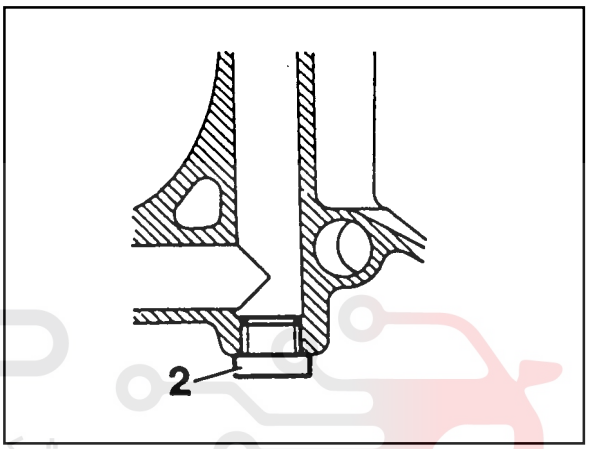
3. Thoroughly clean the oil gallery.
4. Tighten the front plug (5) with seal (4).

Tightening Torque	50 Nm

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

Tightening Torque	50 Nm



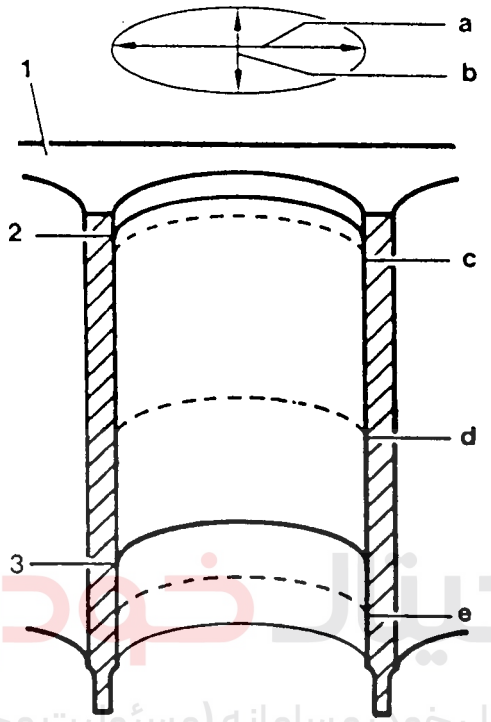


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CYLINDER BORE MEASUREMENT



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

1 Crankcase Contacting Surface
2 TDC of 1st Piston Ring
4 BDC of Ring

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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
	When new	0.01mm
Permissible deviation of cylinder shape	Wear limit	0.05mm
Honing angle		50° ± 10°

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SECTION 1D1

M162 ENGINE COOLING

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

GENERAL SPECIFICATIONS

Application		Description
Cooling Type		Water Cooling Forced Circulation
Radiator	Circulation Type	Double Cross Flow
	Radiation Capability	70,000 kcal/h
Dimension(Width´Height´Thickeness)		580 x 482 x 45 mm
Cooling Fan		*f* 460, Six Blades
Anti-Freeze Agent		ALUTEC - P78
Mixing Ratio of Anti-Freeze Agen with Water (Anti-Freeze Agent : Water)		50 : 50
Coolant Capacity		11.3 L
Reservoir Capacity		3.4 L
Cap Operating Pressure (Reservoir Tank Pressure Cap)		1.4 bar

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FASTENER TIGHTENING SPECIFICATIONS

Application	N·m
Coolant Drain Plug	30
Engine Hanger Bracket and Coolant Outlet Port Bolt	22.5 - 27.5
Thermostat Cover Bracket Bolt	9 - 11
Oil Cooler Pipe Line Bolt	9 - 11
Cooling Fan Bolt	9 - 11
Viscous Clutch Bolt	40.5 - 49.5
Automatic Transmission Oil Cooling Hose Bolt	3 - 7
Cooling Fan Shroud Bolt	3 - 7

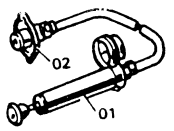
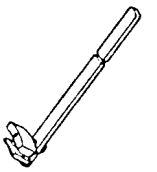
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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	**124 589 15 21 00** **Tester**		**603 589 00 40** **Counter Holder**

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DIAGNOSIS

SYSTEM LEAKAGE TEST

Tools Required

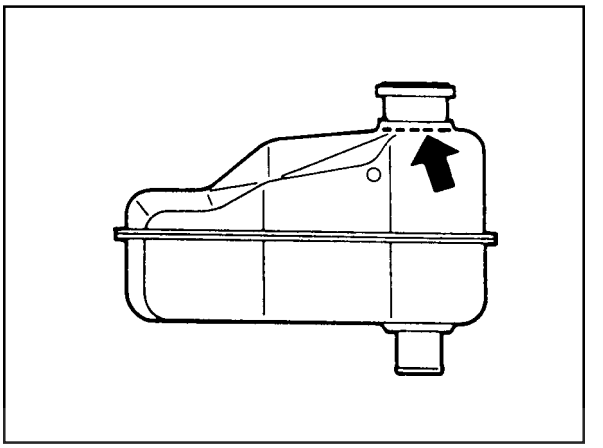
124 589 15 21 00 Tester

Test Procedure

1. Loosen the cap a little and release pressure and remove the cap.

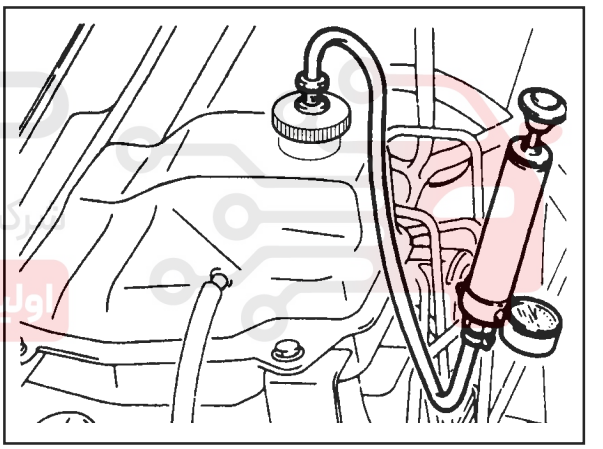
   Notice

   For the risk of scalding, cap must not be opened unless the coolant temperature is below 90°C.
2. Fill coolant up to upper edge (arrow) of reservoir.



3. Connect the special tool to the reservoir filler cap and apply 1.4 bar 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.

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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

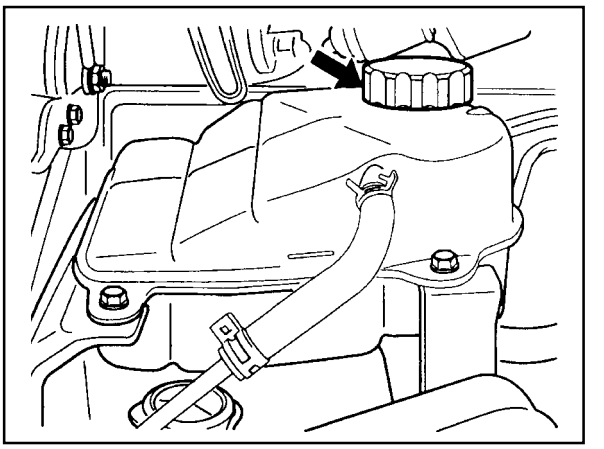
COOLANT DRAIN AND FILL UP

Draning & Filling up Procedure

1. Loosen the cap a little and release pressure and remove the cap.

   Notice

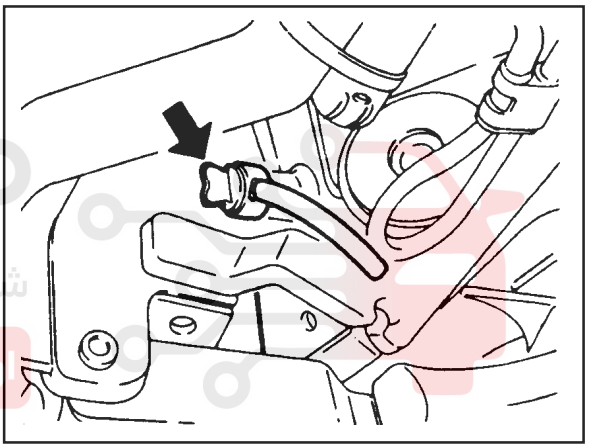
   For the risk of scalding, the cap must not be opened unless the coolant temperature is below 90°C.



2. Loosen the radiator lower drain cock and drain the coolant.

   Notice

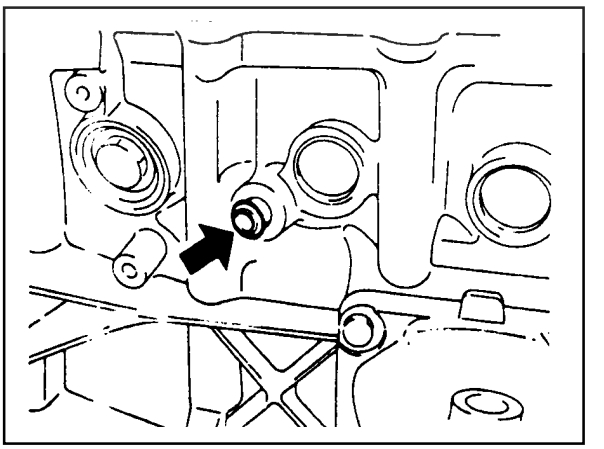
   Collect coolant by using a proper container.



3. Drain the coolant from the crankcase by inserting a hose (dia. 14mm) onto the drain bolt on the side of crankcase (exhaust manifold) and by loosening the plug.

   Notice

   - Just loosen the drain plug to drain the coolant and do not remove the plug completely.
   - Collect coolant by using proper container.



4. After complete draining of the coolant, remove the hose connector to drain plug and reinstall the drain plug.

   Installation Notice

Tightening Torque	30 Nm

5. Tighten the radiator lower drain cock.

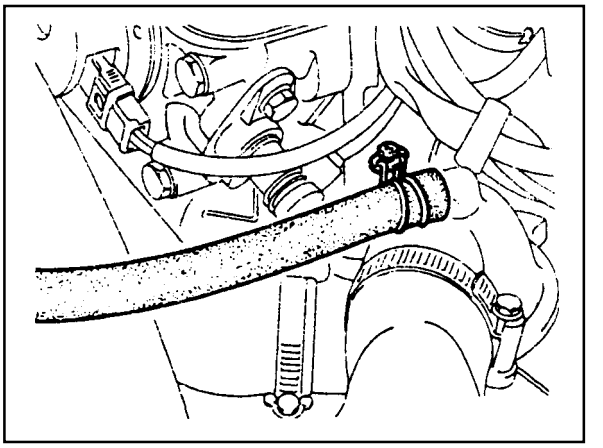
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6. Remove the de-aeration hose clamp in the coolant pump and remove the de-aeration hose.
7. Fill up the coolant through the coolant reservoir tank.

   Notice

   - Match the anti-freeze and the water ratio to 50 : 50.
   - Supplement the coolant until the coolant overflows to the deaeration hose.



8. Insert the de-aeration hose and completely tighten the clamp.
9. Check the coolant level in the coolant reservoir tank.
10. Warm up(until thermostat is opened) the engine and recheck the coolant level in the reservoir tank and fill up the coolant if necessary.

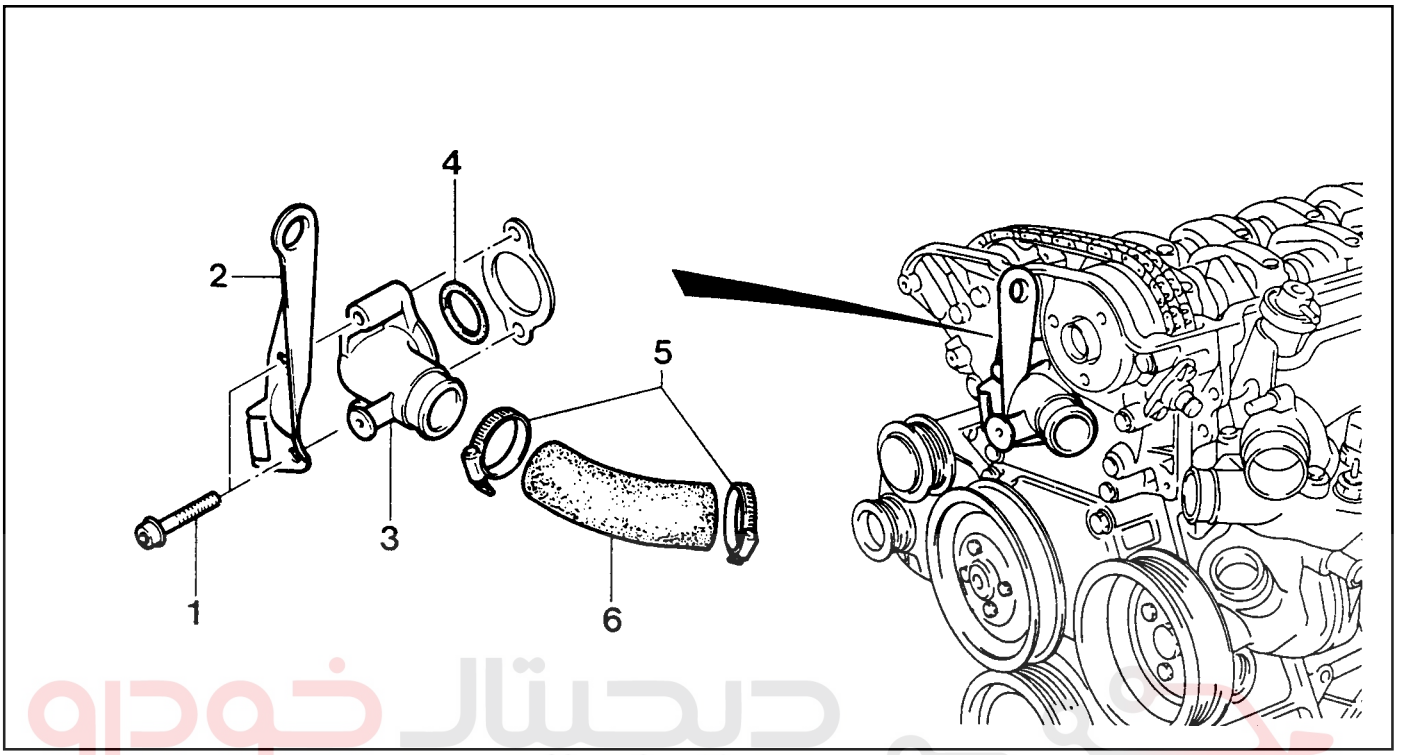
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COOLANT CONNECTION FITTING

Preceding Work : Removal of cooling fan shroud



1 Bolt (M8 X 100, 2 pieces) ..... 22.5-27.5 Nm
2 Engine Hanger Bracket
3 Coolant Outlet Port
4 O-ring
5 Hose Mounting Clamp
6 Hose

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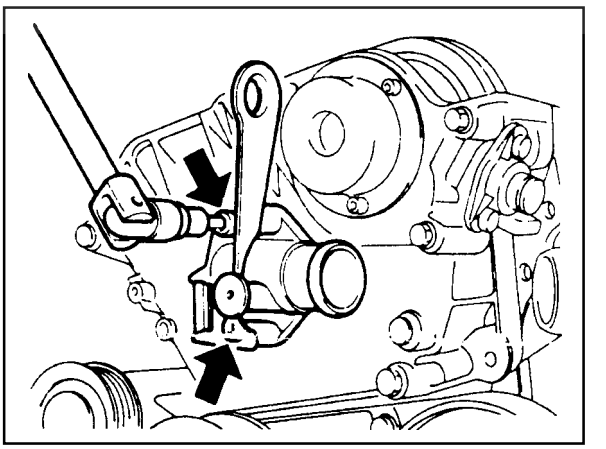
Removal & Installation Procedure

1. Drain coolant from the radiator.
2. Remove the hose mounting clamp (5) and disconnect the coolant hose (6).
3. Remove the two bolts (1), the engine hanger bracket (2) and coolant outlet port (3).

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Replace the O-ring with new one.



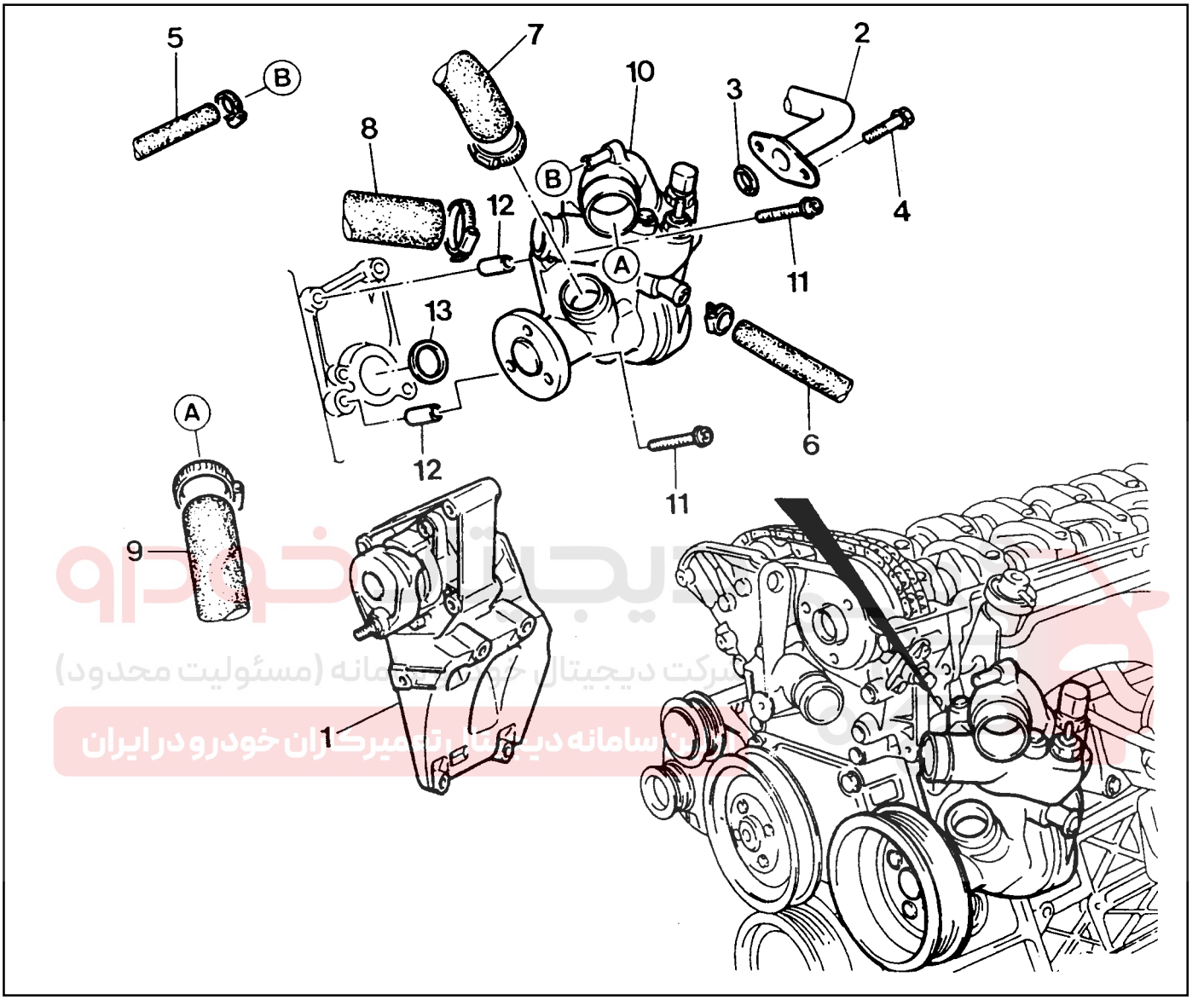
4. Installation should follow the removal procedure in the reverse order.
5. Fill up the coolant as specified.
6. Check the leaks in the cooling system.

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WATER PUMP

Preceding Work : Removal of V-belt
Removal of air admission housing

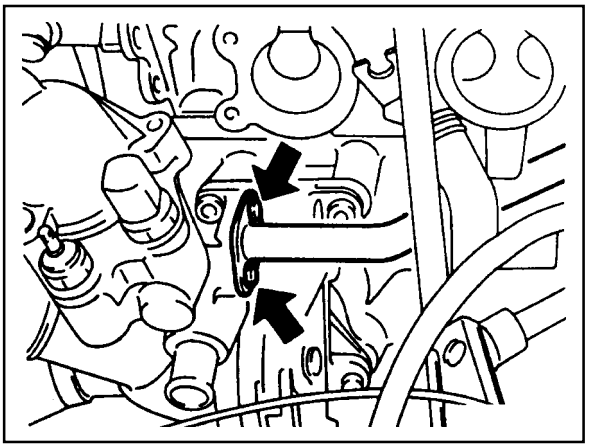


1 Air Admission Housing
2 Oil Cooler Pipe Line
3 Seal ..... Replace
4 Bolt ..... 9-11 Nm
5 Coolant Hose
6 Coolant Hose
7 Outlet Coolant Hose
8 Coolant Hose
9 Inlet Coolant Hose
10 Coolant Pump
11 Bolt ..... 21 Nm
12 Dowel Sleeve
13 Seal ..... Replace

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Removal & Installation Procedure



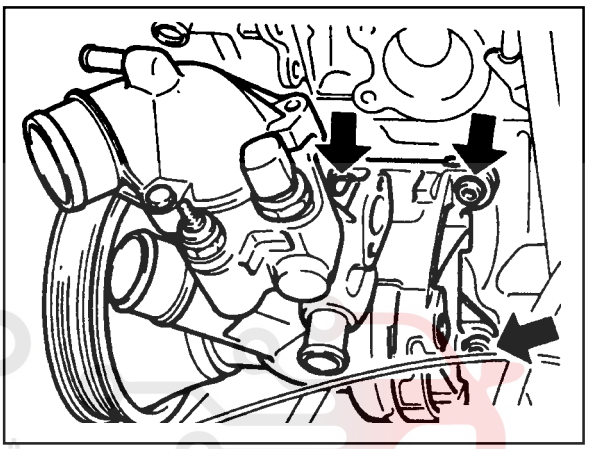
1. Drain the coolant.
2. Disconnect the coolant pump wire connector.
3. Loosen the hose clip and dsconnect all hoses from the coolant pump
4. Remove the coolant line bolts (4) and then remove the coolant line (2).

Installation Notice

Tightening Torque	9 - 11 Nm

Notice

Replace the seal (3).



5. Remove the mounting bolts (11) and carefully pull out coolant pump (10).

Installation Notice

Tightening Torque	21 Nm

Notice

Replace the seal (13).

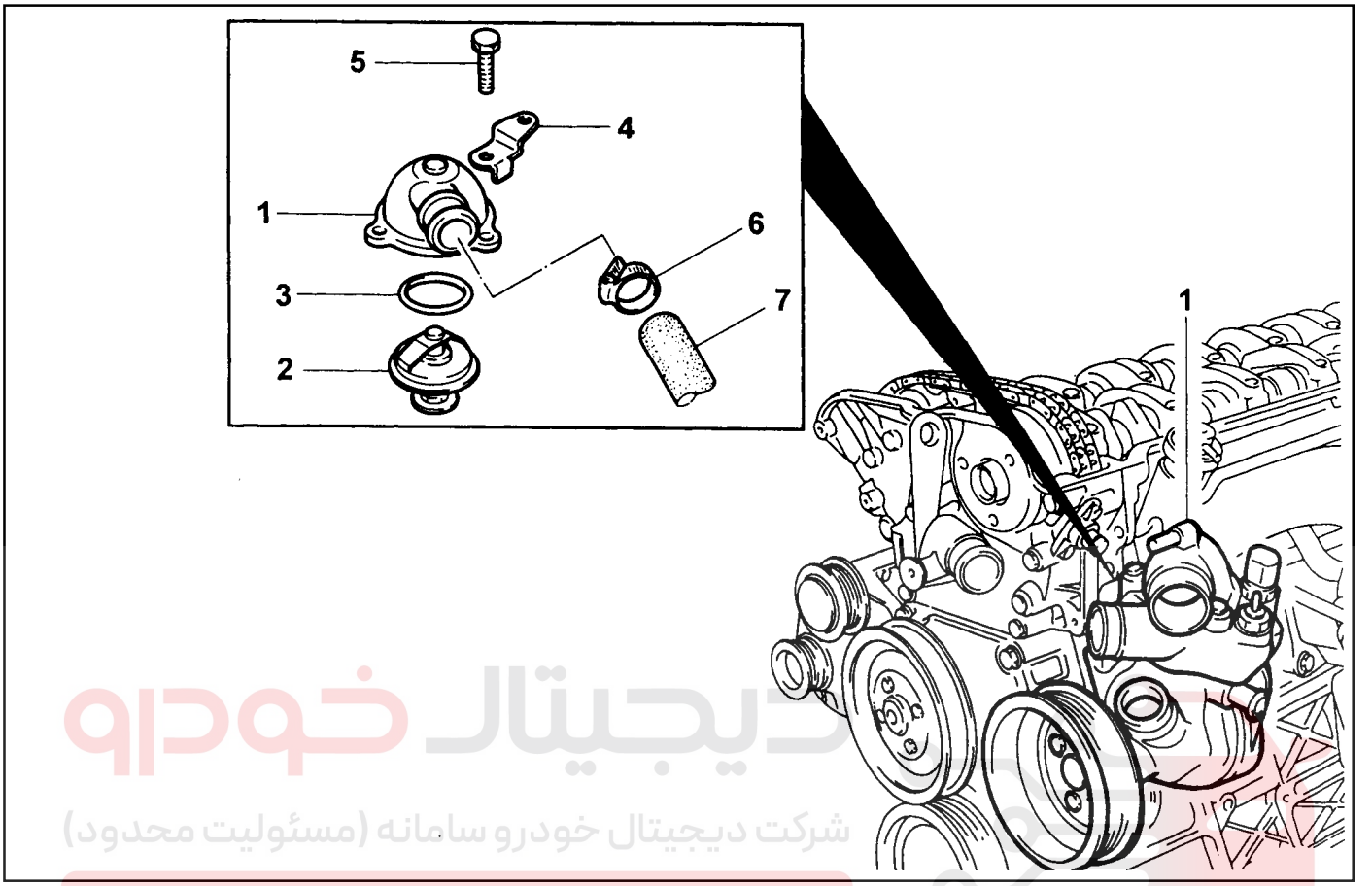
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6. Installation should follow the removal procedure in the reverse order.
7. Fill up coolant.
8. Do coolaing system leakage test

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THERMOSTAT



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1 Thermostat Cover
2 Thermostat
3 O-ring
4 Thermostat Cover Bracket
5 Bolt (M6 X 25, 3 pieces) ..... 9-11 Nm
6 Hose Mounting Clamp
7 Heater Hose

Removal & Installation Procedure

1. Drain the coolant from the radiator.
2. Loosen the hose mounting clamp (6) and remove the heater hose (7).
3. Unscrew the three bolts (5) and remove the thermostat cover bracket, thermostat cover and the thermostat in order.

Installation Notice

Tightening Torque	9 - 11 Nm

Do not separate the thermostat cover and thermostat.

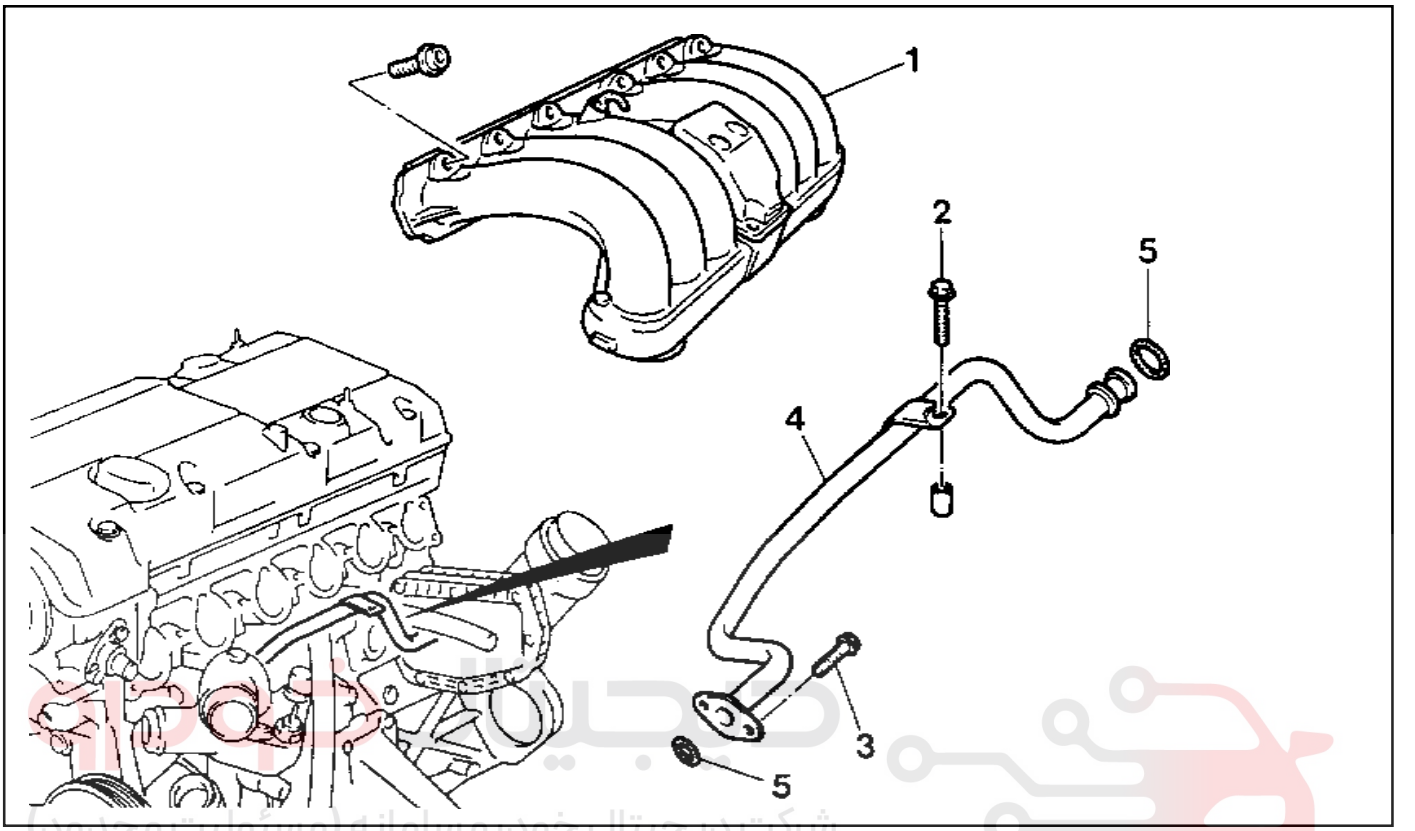
4. Replace the O-ring if necessary.
5. Check the leakage in the cooling system.

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OIL COOLER PIPE LINE

Preceding Work : Removal of upper intake manifold



1	Upper Intake Manifold	4	Oil Cooler Pipe Line
2	Bolt (M6 X 35, 1 piece) ..... 9-11 Nm	5	O-ring ..... Replace
3	Bolt (M6 X 16, 2 pieces) ..... 9-11 Nm		

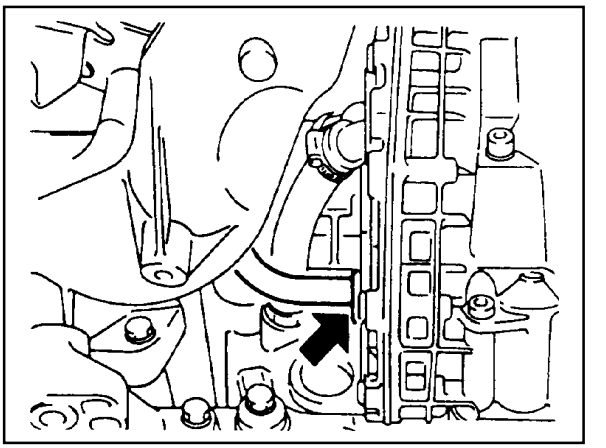
Removal & Installation Procedure

1. Drain the coolant.
2. Unscrew the bolts (2, 3) and remove the oil cooler pipe line (4). Replace the O-ring with new one.

Tightening Torque	9 - 11 Nm

Installation Notice

3. Installation should follow the removal procedure in the reverse order.
4. Fill up the coolant as specified.
5. Check the leaks in the cooling system.

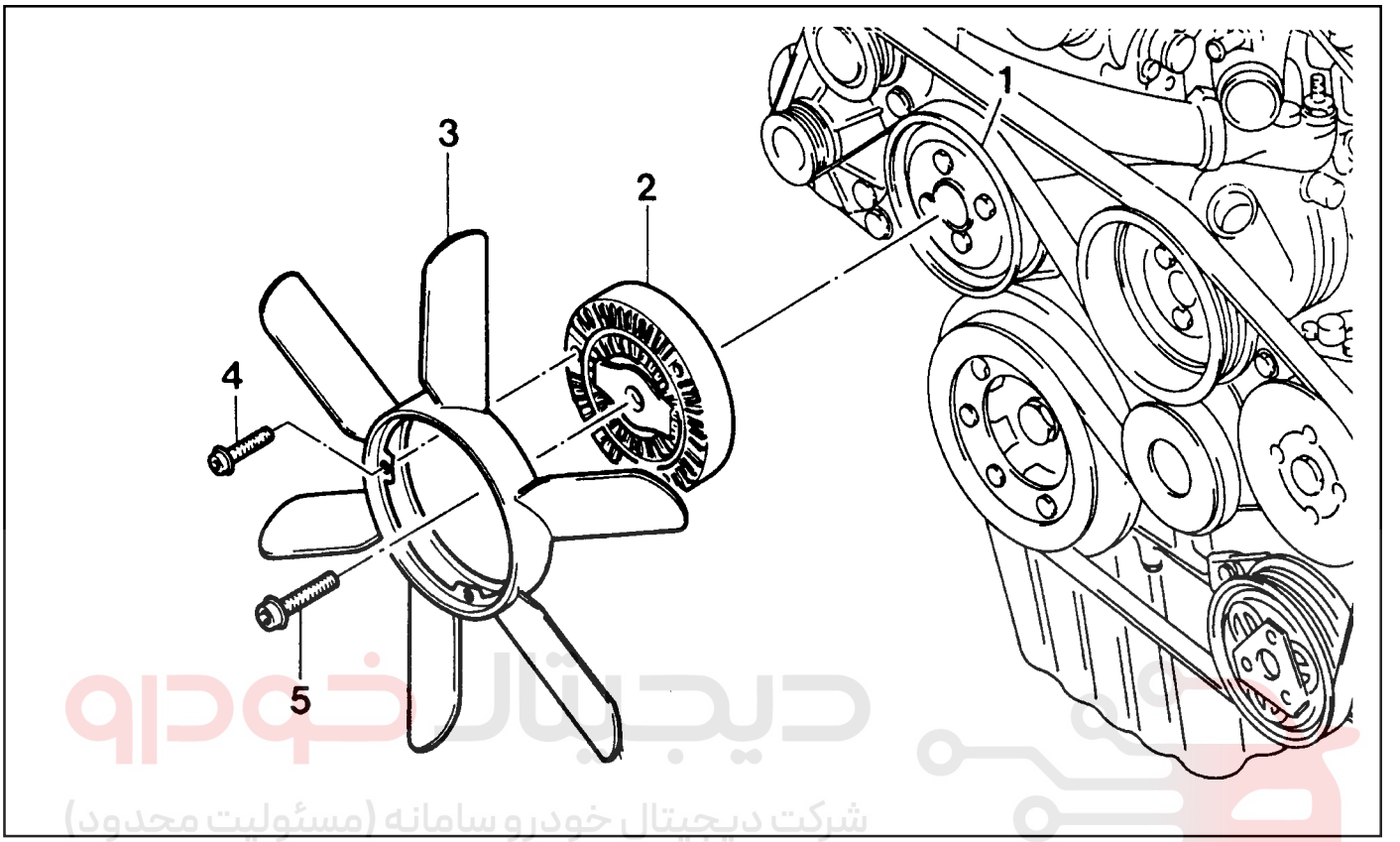


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COOLING FAN AND VISCOUS CLUTCH

Preceding Work : Removal of cooling fan shroud



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1	Cooling Fan Pulley	4	Bolt (M6 X 12, 4 pieces) ..... 9-11 Nm
2	Viscous Clutch	5	Bolt (M10 X 45, 1 piece) ..... 40.5-49.5 Nm
3	Cooling Fan		

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Tools Required

603 589 00 40 00 Counter Holder

Removal & Installation Procedure

1. Hold the cooling fan pulley using the counter holder (special tool : 603 589 00 40 00) and remove the cooling fan after unscrewing the four bolts (4).

   Installation Notice

Tightening Torque	9 - 11 Nm

2. Remove the bolt (5) from the viscous clutch and remove the viscous clutch from the cooling fan pulley.

   Installation Notice

Tightening Torque	40.5 - 49.5 Nm

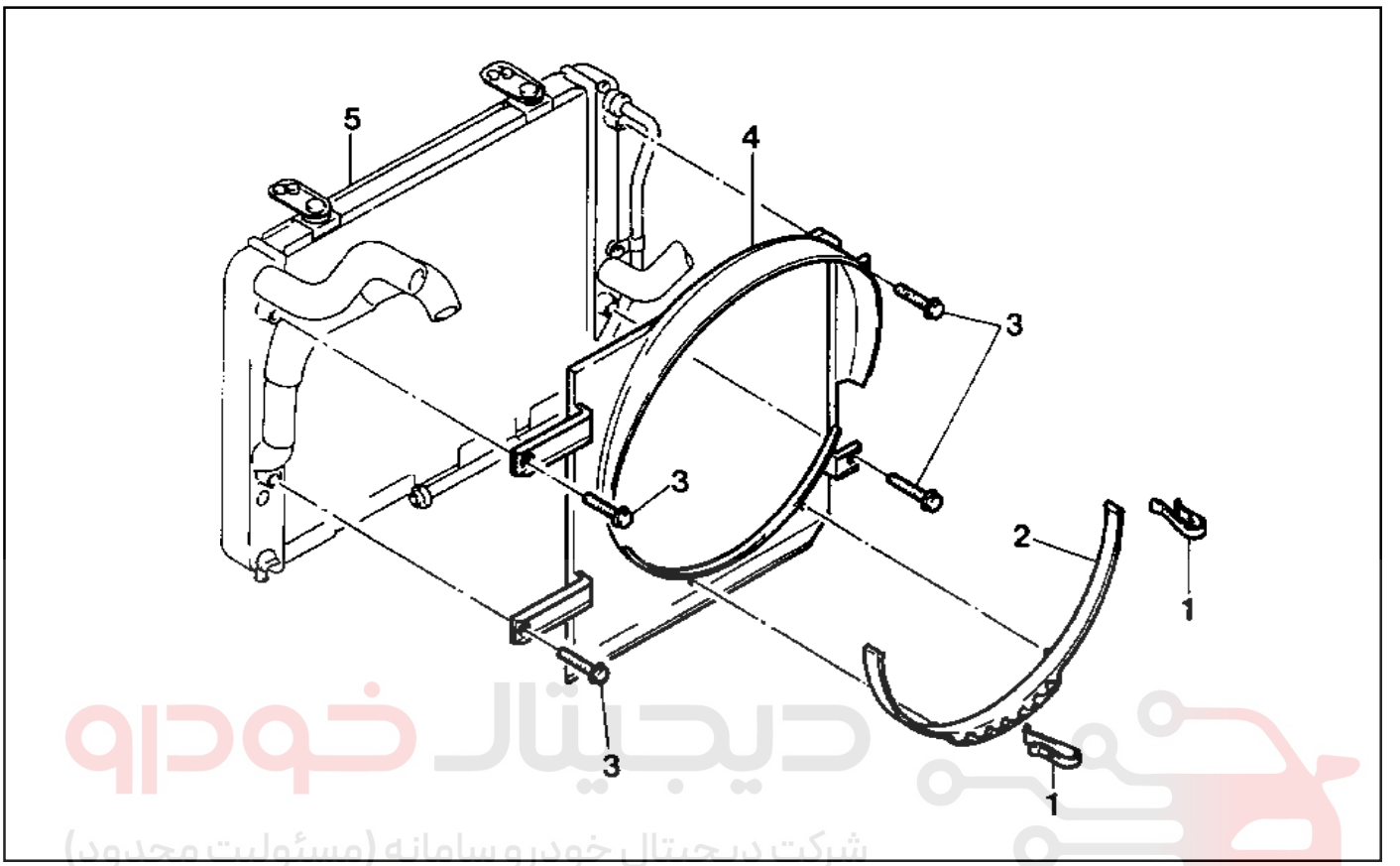
3. Installation should follow the removal procedure in the reverse order.

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COOLING FAN SHROUD



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1 Clip
2 Lower Fan Shroud
3 Bolt
4 Fan Shroud Assembly
5 Radiator

Removal & Installation Procedure

1. Pull out the 2 clips (1) from the fan shroud assembly.
2. Remove the lower fan shroud (2).

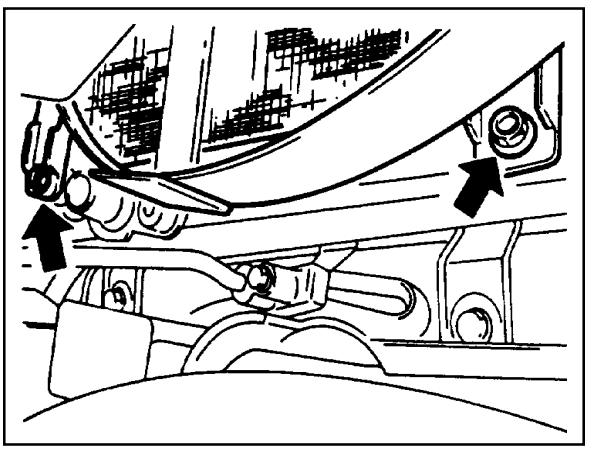
   Notice

   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).

Tightening Torque	7 Nm

Installation Notice

4. Installation should follow the removal procedure in the reverse order.

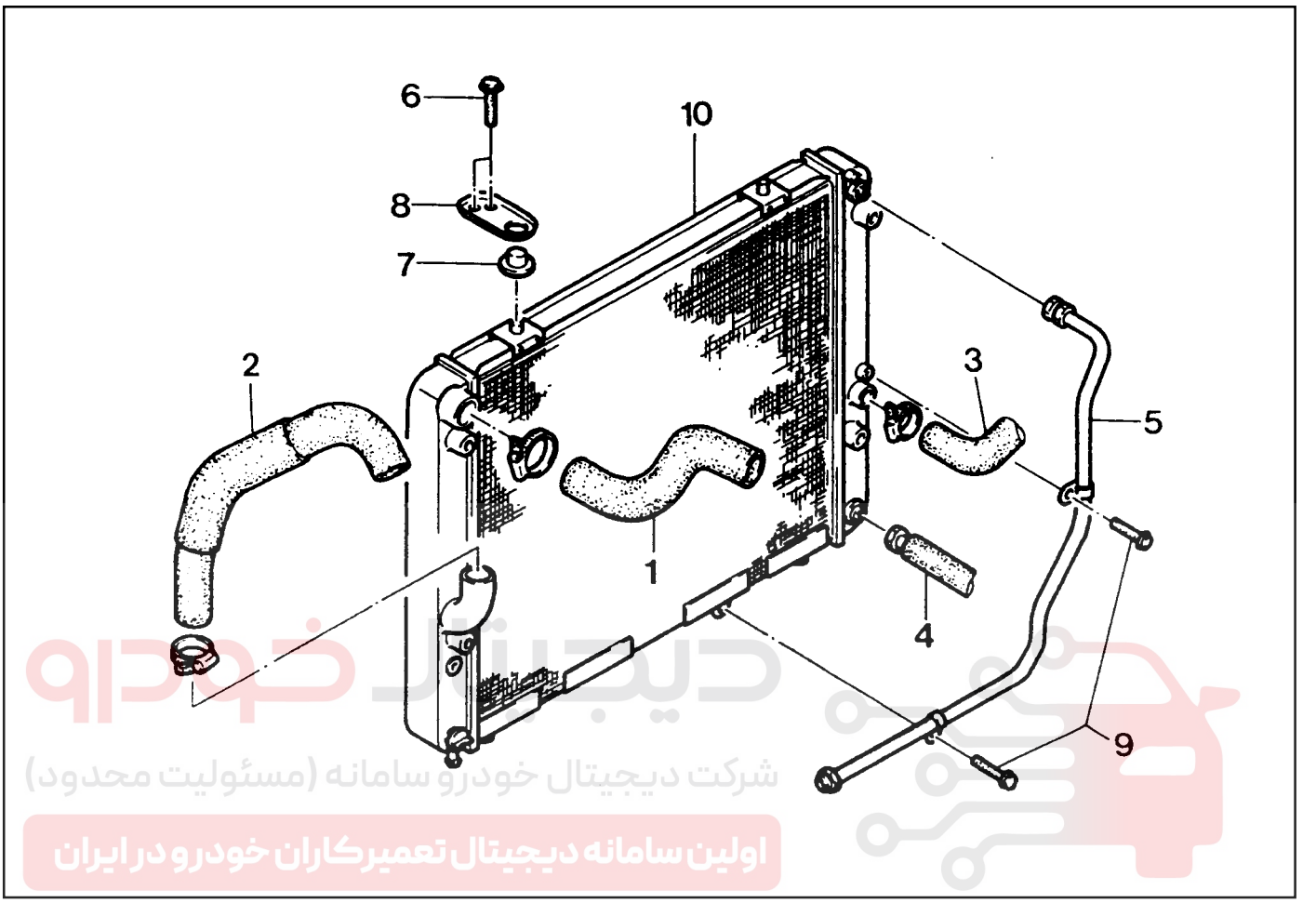


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RADIATOR

Preceding Work : Removal of cooling fan shroud



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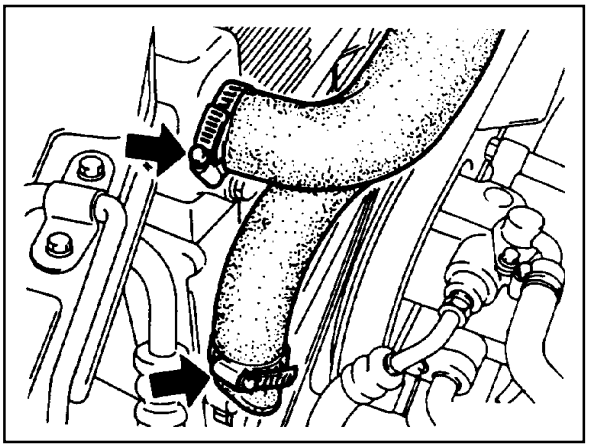
1 Radiator Inlet Coolant Hose
2 Radiator Outlet Coolant Hose
3 Make Up Coolant Hose
4 Automatic Transmission Oil Cooling Hose
5 Automatic Transmission Oil Cooling Line
6 Bolt
7 Insulator
8 Stopper
9 Bolt ..... 7 Nm
10 Radiator

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Removal & Installation Procedure

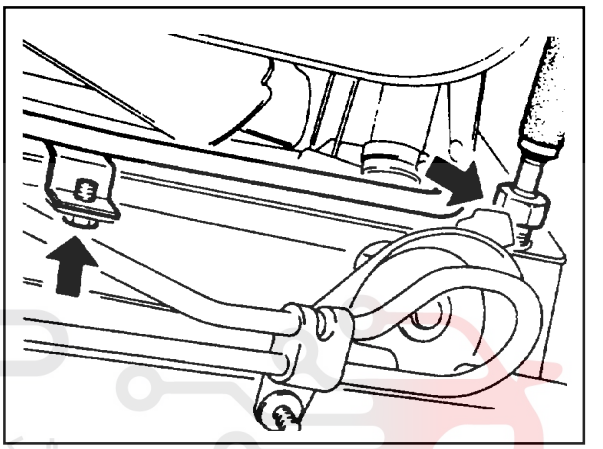
1. Drain coolant from the radiator.
2. Remove the coolant thermo connector from the radiator.
3. Remove the each coolant hoses.



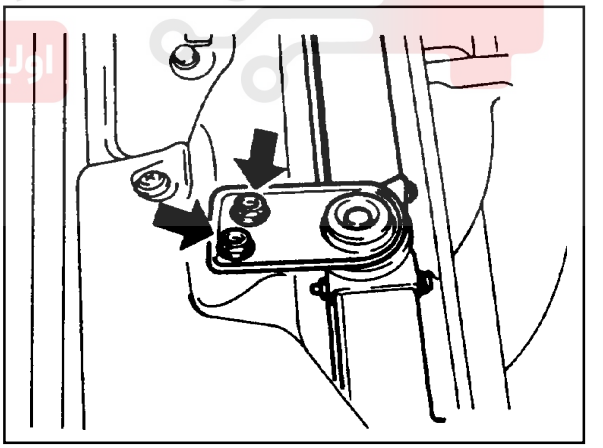
4. Remove the automatic transmission oil cooling hose.

Installation Notice

Tightening Torque	14 Nm



5. Remove the automatic transmission oil cooling line bolts and then remove the oil cooling line.
6. Remove the radiator upper mounting bolts and then remove the bracket and insulator.
7. Remove the radiator.
8. Check the radiator pin for crack, damage, leakage and bending and replace if necessary.
9. Installation should follow the removal procedure in the reverse order.
10. Do cooling system leakage test.



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SECTION 1D2

M161 ENGINE COOLING

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

GENERAL SPECIFICATIONS

Application		Description
Cooling Type		Water Cooling Forced Circulation
Radiator	Circulation Type	Down Flow
	Radiation	61,500 kcal/h
	Capability	58,000 kcal/h
Dimension(Width´Height´Thickeness)		680 x 415 x 25 mm
		680 x 415 x 28 mm
Cooling Fan		f460, 9 Blades
Anti-Freeze Agent		ALUTEC-P78, Dragon Power Coolant A
Mixing Ratio of Anti-Freeze Agen with Water (Anti-Freeze Agent : Water)		50 : 50
Coolant Capacity		10.5 L
Reservoir Capacity		3.4 L
Cap Operating Pressure (Reservoir Tank Pressure Cap)		1.4 bar

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FASTENER TIGHTENING SPECIFICATIONS

Application	N·m
Coolant Drain Plug	30
Engine Hanger Bracket and Coolant Outlet Port Bolt	22.5 - 27.5
Thermostat Cover Bracket Bolt	9 - 11
Oil Cooler Pipe Line Bolt	9 - 11
Cooling Fan Bolt	9 - 11
Viscous Clutch Bolt	40.5 - 49.5
Automatic Transmission Oil Cooling Hose Bolt	3 - 7
Cooling Fan Shroud Bolt	3 - 7

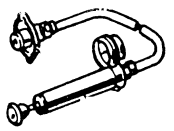
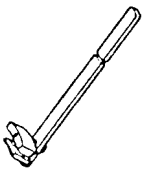
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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	124 589 15 21 00 Tester		603 589 00 40 Counter Holder
	111 589 02 01 00 Open End Wrench		111 589 00 40 00 Open End Wrench

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DIAGNOSIS

SYSTEM LEAKAGE TEST

Tools Required

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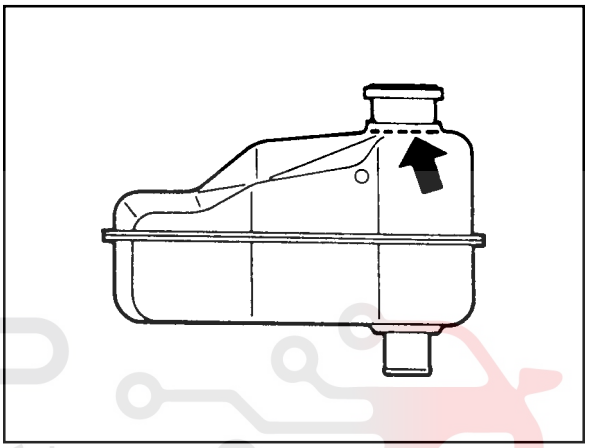
Test Procedure

1. Loosen the cap a little and release pressure and remove the cap.

   Notice

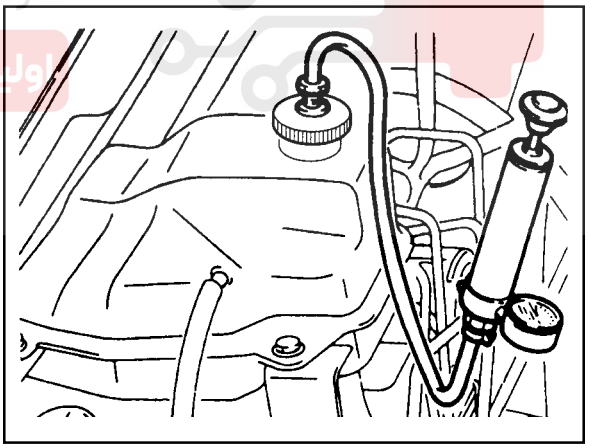
   For the risk of scalding, cap must not be opened unless the coolant temperature is below 90°C.

2. Fill coolant up to upper edge (arrow) of reservoir.



3. Connect the special tool to the reservoir filler cap and apply 1.4 bar 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.

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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

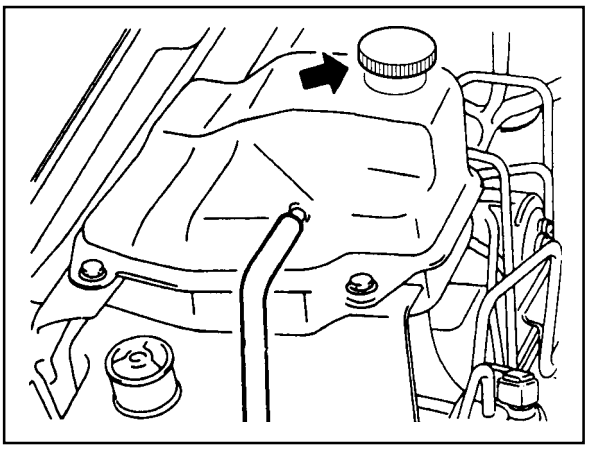
COOLANT DRAIN AND FILL UP

Draning & Filling up Procedure

1. Loosen the cap a little and release pressure and remove the cap.

   Notice

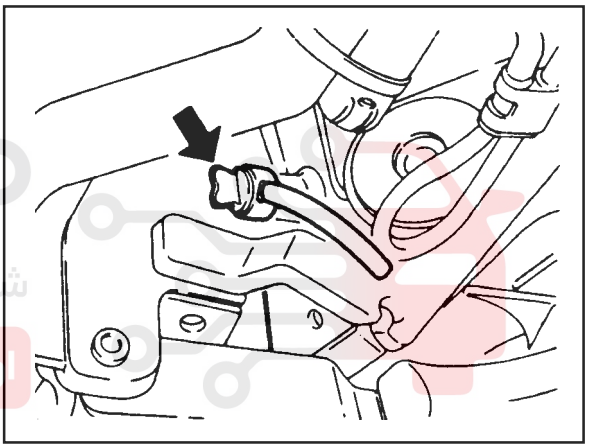
   For the risk of scalding, the cap must not be opened unless the coolant temperature is below 90oC.



2. Loosen the radiator lower drain cock and drain the coolant.

   Notice

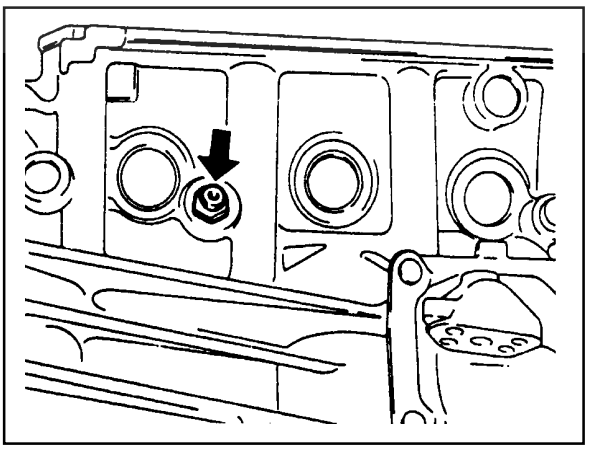
   Collect coolant by using a proper container.



3. Drain the coolant from the crankcase by inserting a hose (dia. 14mm) onto the drain bolt on the side of crankcase (exhaust manifold) and by loosening the plug.

   Notice

   - Just loosen the drain plug to drain the coolant and do not remove the plug completely.
   - Collect coolant by using proper container.



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4. After complete draining of the coolant, remove the hose connector to drain plug and reinstall the drain plug.

   Installation Notice

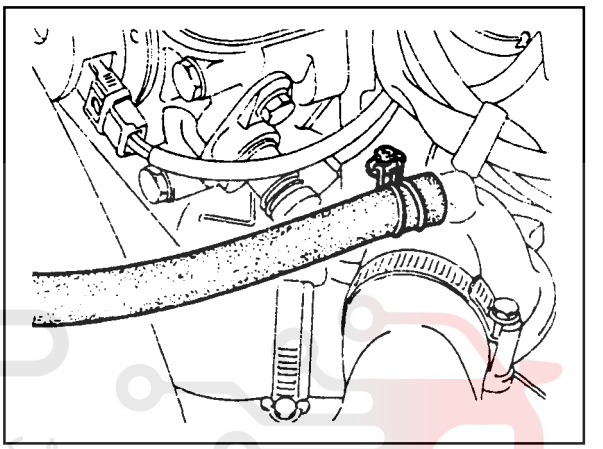
Tightening Torque	30 Nm

5. Tighten the radiator lower drain cock.

6. Remove the de-aeration hose clamp in the coolant pump and remove the de-aeration hose.
7. Fill up the coolant through the coolant reservoir tank.

   Notice

   - Match the anti-freeze and the water ratio to 50 : 50.
   - Supplement the coolant until the coolant overflows to the deaeration hose.



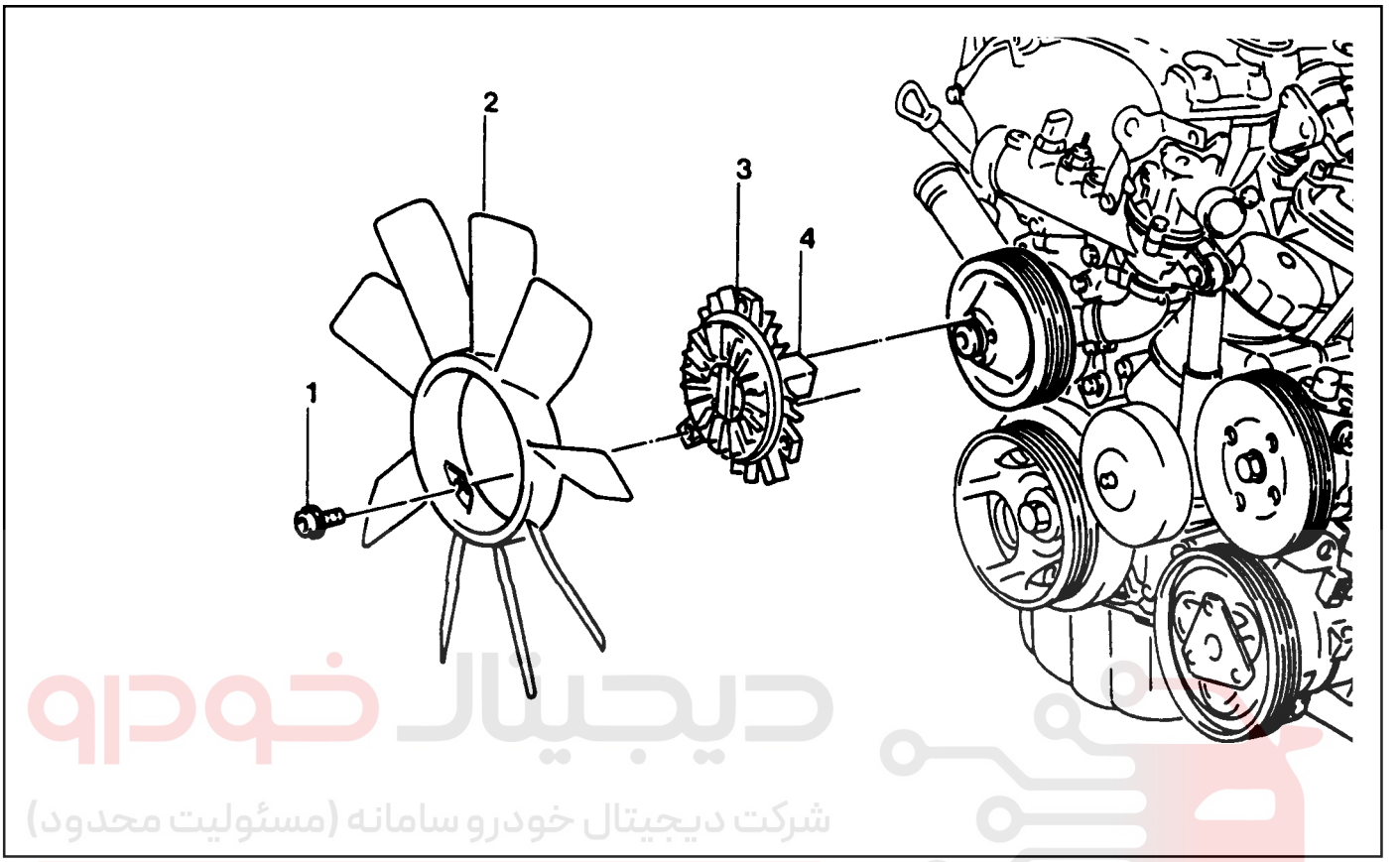
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8. Insert the de-aeration hose and completely tighten the clamp.
9. Check the coolant level in the coolant reservoir tank.
10. Warm up(until thermostat is opened) the engine and recheck the coolant level in the reservoir tank and fill up the coolant if necessary.

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COOLING FAN AND VISCOUS CLUTCH



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1 Bolt (M6 X 14, 3 piece) ..... 9-11 Nm
2 Cooling Fan
3 Viscous Clutch
4 Union Nut (Left Threaded Screw) ... 40.5-49.5 Nm

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Tools Required

111 589 02 01 00 Open End Wrench

111 589 00 40 00 Open End Wrench

Removal & Installation Procedure

1. Install the holder (special tool : 111 589 00 40 00) to the bolt at the pulley as shown in the right figure to hold the pulley.
2. Remove the viscous clutch using an open end wrench (special tool : 111 589 02 01 00).

   Installation Notice

Tightening Torque	40.5 - 49.5 Nm

   Notice

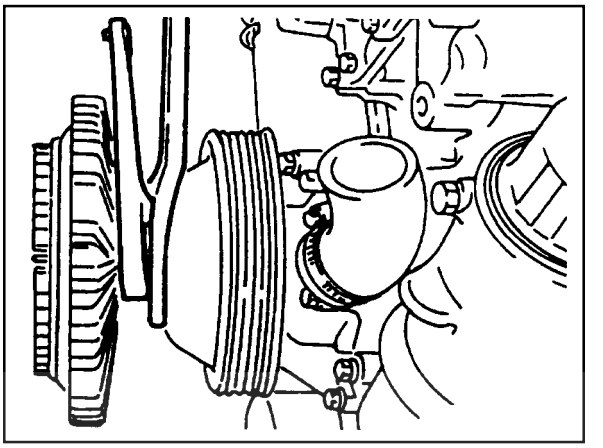
   The union nut is left threaded screw.
3. Remove the 3 bolts (1) from the viscous clutch and remove the cooling fan and the viscous clutch.

   Installation Notice

Tightening Torque	9 - 11 Nm

   Notice

   You may change the procedure (2) and (3) if necessary.
4. Installation should follow the removal procedure in the reverse order.



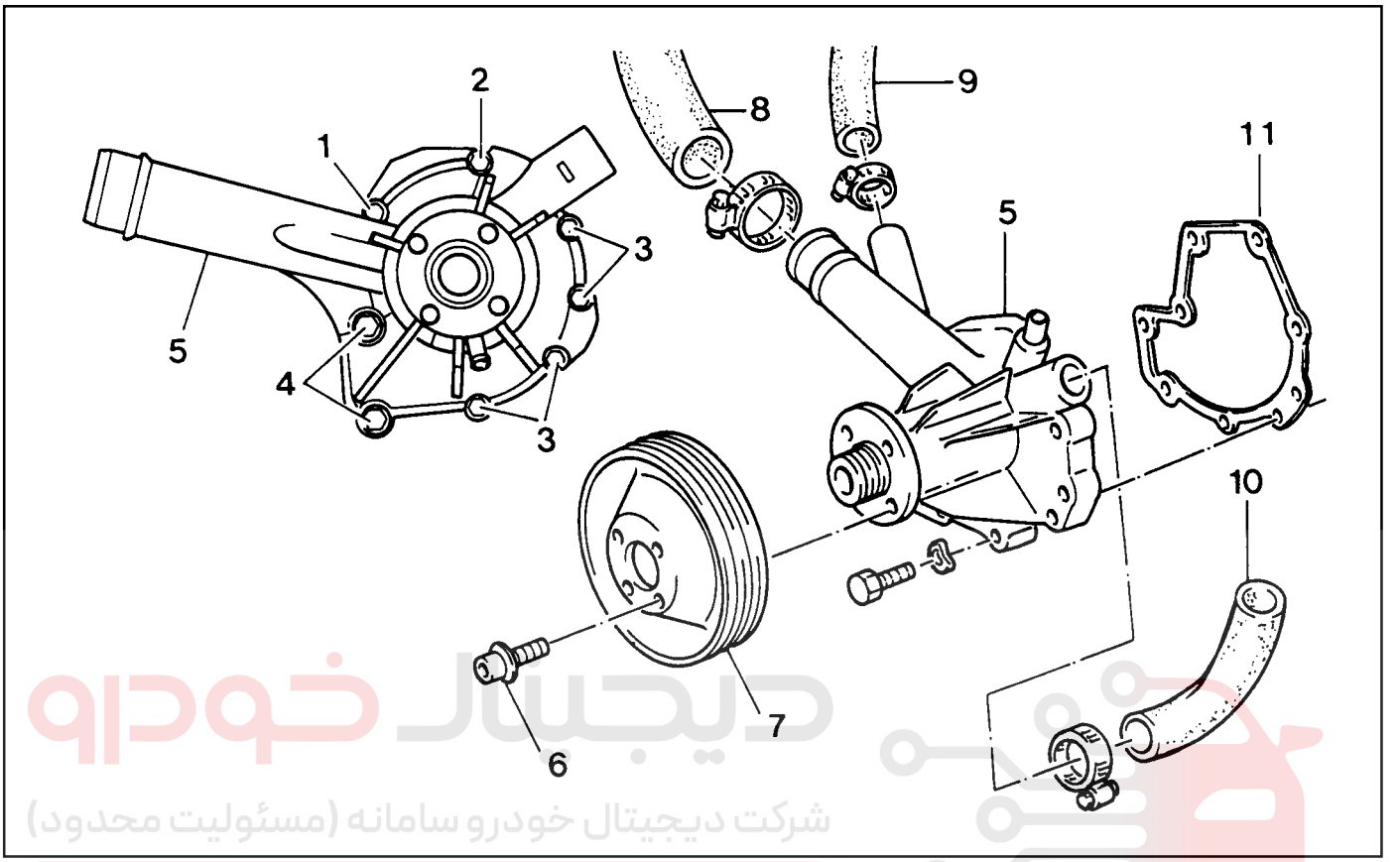
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COOLANT PUMP

Preceding Work : Removal of viscous clutch



1	Bolt (M6 X 45, 1 piece) ..... 9-11 Nm	7	Coolant Pump Pulley
2	Bolt (M6 X 95, 1 piece) ..... 9-11 Nm	8	Coolant Inlet Hose
3	Bolt (M6 X 25, 4 piece) ..... 9-11 Nm	9	Heater Hose
4	Bolt (M8 X 85, 2 piece) ..... 20.5-20.5 Nm	10	Coolant Bypass Hose
5	Coolant Pump Housing	11	Gasket
6	Bolt (M6 X 16, 4 piece) ..... 9-11 Nm		

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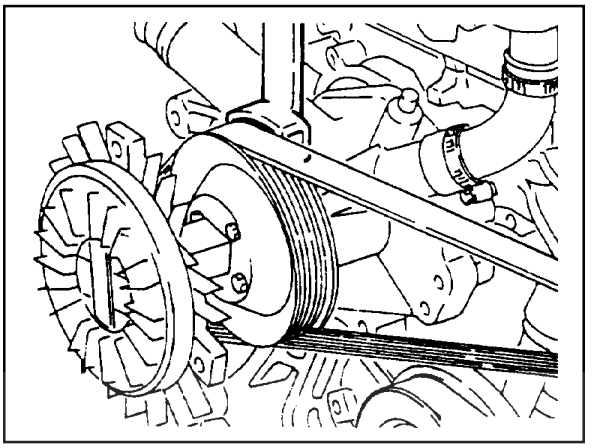
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Tools Required

124 589 15 21 00 Tester

Removal & Installation Procedure

1. Drain the coolant.
2. Disconnect the coolant hoses (8, 9, 10).
3. Tak off the drive belt.
4. Unscrew the four bolts (6) from coolant pump pulley and remove the pulley (7).



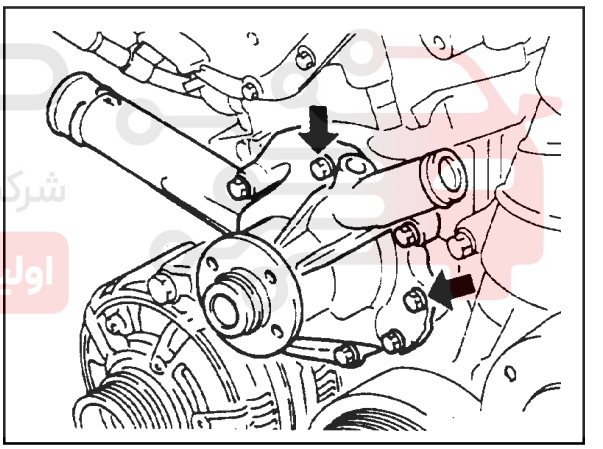
Installation Notice

Tightening Torque	9 - 11 Nm

Notice

Hold the pulley with special tool (603 589 00 40 00) while removing the pulley.

5. Unscrew the bolts (1, 2, 3, 4) from coolant pump housing (5) and remove the coolant pump.



Installation Notice

Tightening Torque	(1, 2, 3)	9 - 11 Nm
	(4)	22.5 - 27.5 Nm

6. Clean the sealing surface.
7. Replace the gasket with new one.

Notice

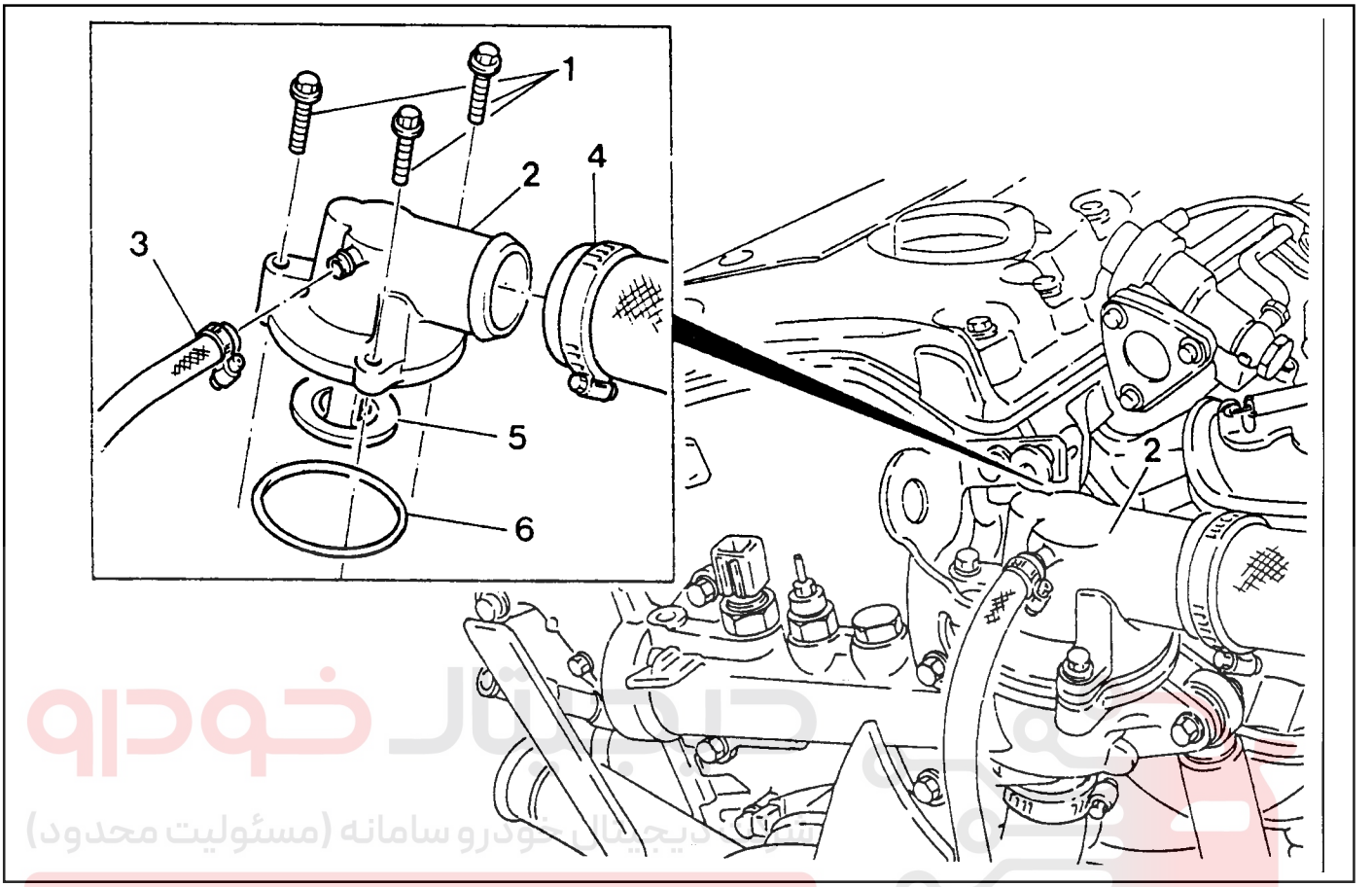
Apply the sealant when the sealing surface of coolant pump housing and coolant mounting area is clean.

8. Installation should follow the removal procedure in the reverse order.
9. Check for leaks by starting the engine.

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THERMOSTAT



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1 Bolt (M6 X 25, 3 pieces) ..... 9 -11 Nm
2 Thermostat Cover
3 De-aeration Hose
4 Coolant Outlet Hose
5 Thermostat
6 O-ring

Removal & Installation Procedure

1. Drain the coolant from the radiator.
2. Loosen the hose mounting clip and remove the coolant hose (3, 4).
3. Unscrew the three bolts (1) and remove the thermostat cover assembly from thermostat housing.

   Installation Notice

Tightening Torque	9 - 11 Nm

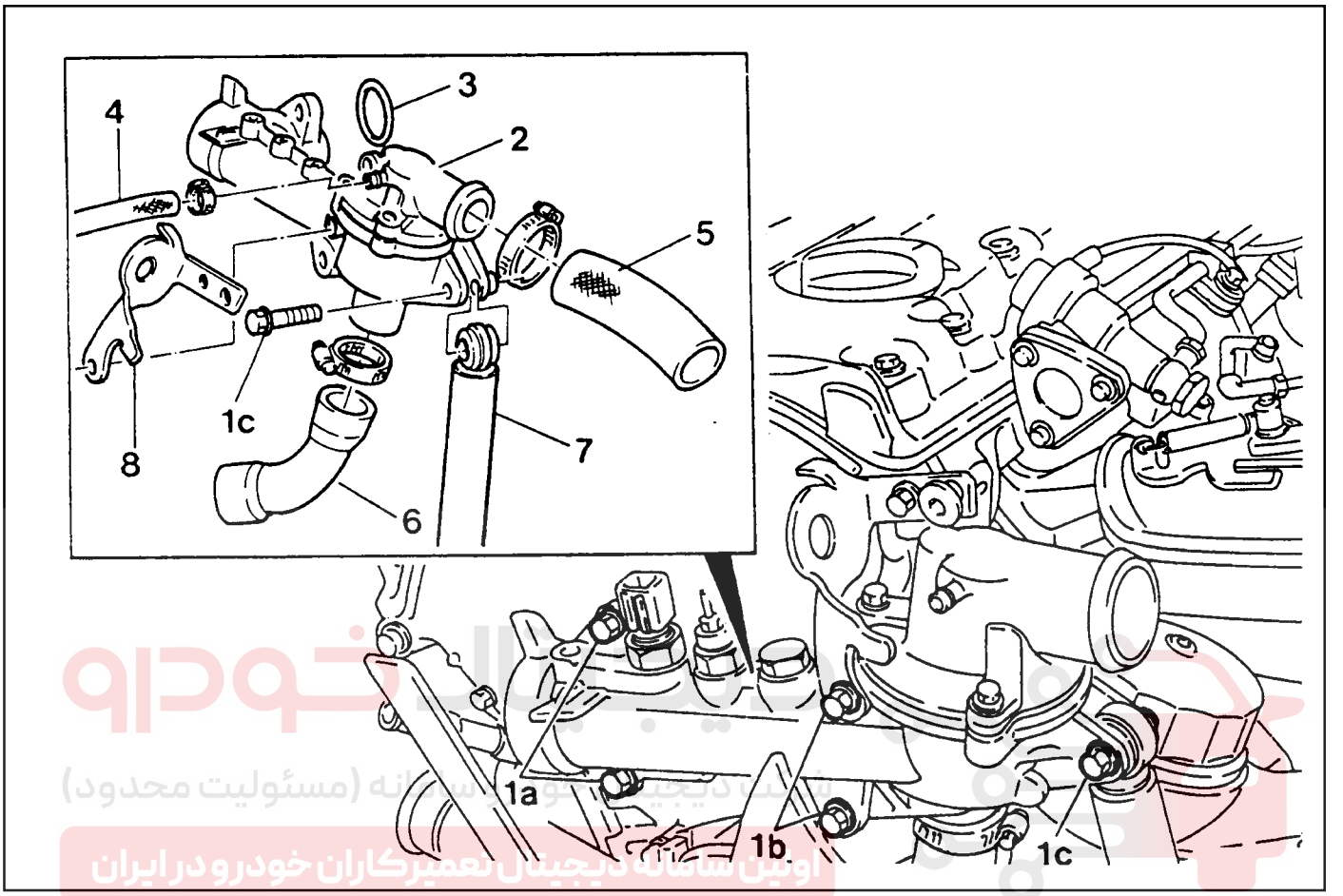
   Do not separate the thermostat cover and thermostat.
4. Replace the O-ring if necessary.
5. Check the leakage in the cooling system.

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THERMOSTAT HOUSING ASSEMBLY

Preceding Work : Removal of viscous clutch



1a	Bolt (M6 X 95, 2 pieces)	9-11 Nm
1b	Bolt (M8 X 75, 2 pieces)	22.5-27.5 Nm
1c	Bolt (M8 X 35, 1 piece)	22.5-27.5 Nm
2	Thermostat Housing Assembly	
3	O-ring	
4	De-aeration Hose	
5	Coolant Outlet Hose	
6	Coolant Bypass Hose	
7	Tensioning Device Shock Absorber	
8	Engine Hanger Brocket	

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Removal & Installation Procedure

1. Drain the coolant.
2. Remove the de-aeration hose (4), coolant outlet hose (5) and coolant bypass hose (6).
3. Disconnect the coolant temperature sensor connector.
4. Unscrew the bolt (1c) and pry off the tensioning device shock absorber (7).

   Installation Notice

Tightening Torque	22.5 - 27.5 Nm

5. Unscrow the bolts (1a, 1b) and remove the engine hanger bracket and thermostat housing.

   Installation Notice

Tightening Torque	(1a)	9 - 11 Nm
	(1b)	22.5 - 27.5 Nm

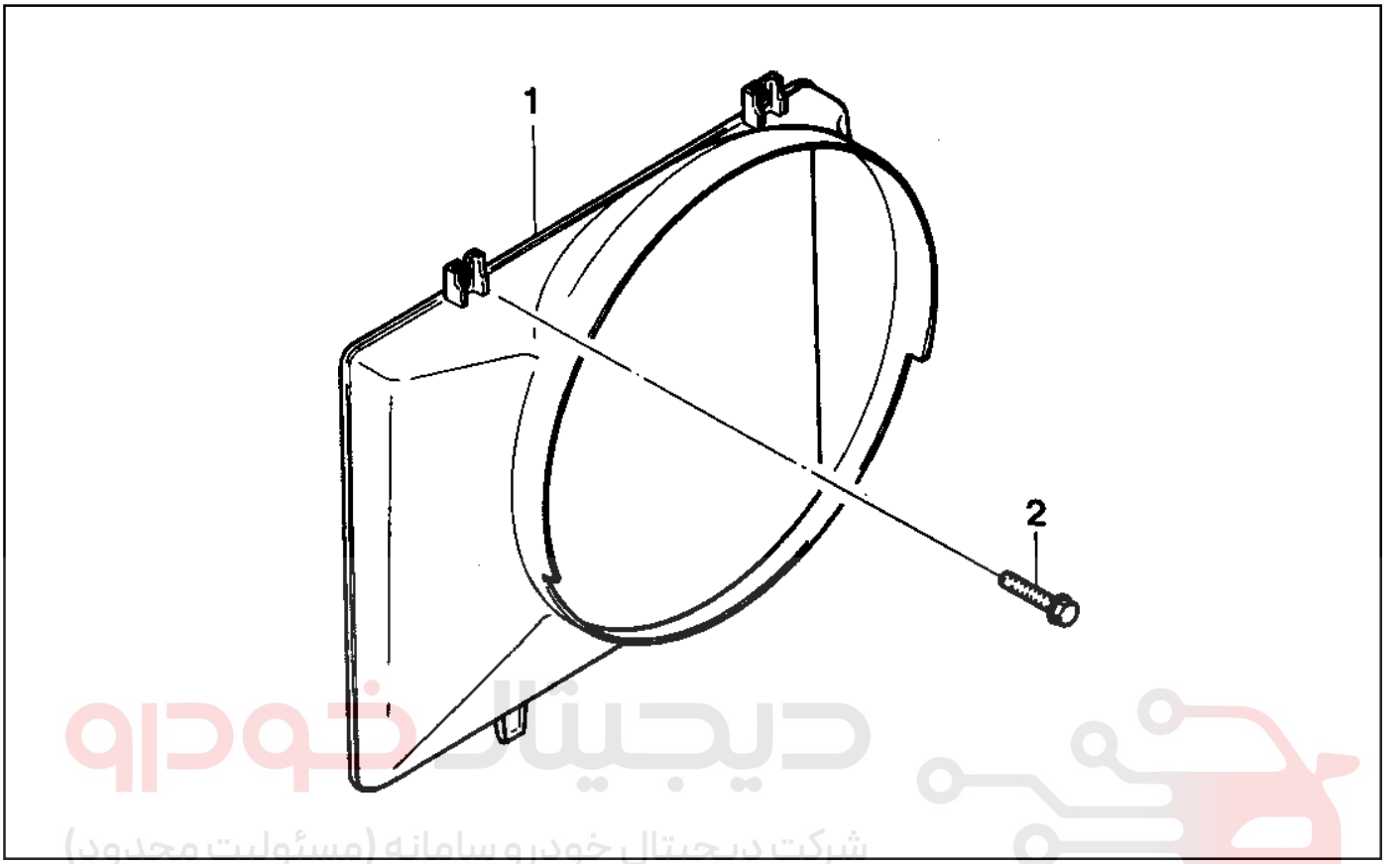
6. Replace the O-ring with new one.
7. Installation should follow the removal procedure in the reverse order.
8. Check for leaks in cooling system.

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REMOVAL AND INSTALLATION OF COOLING FAN SHROUD



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1 Fan Suroud Assembly 2 Bolt (M6 X 16, 2 pieces) ..... 3-7 Nm

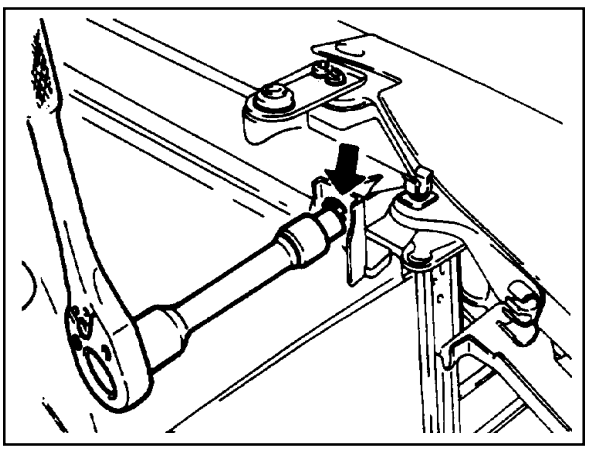
Removal & Installation Procedure

1. Unscrew two bolts from cooling fan shroud and remove the shrud.

Installation Notice

Tightening Torque	3 - 7 Nm

2. Installation should follow the removal procedure in the reverse order.

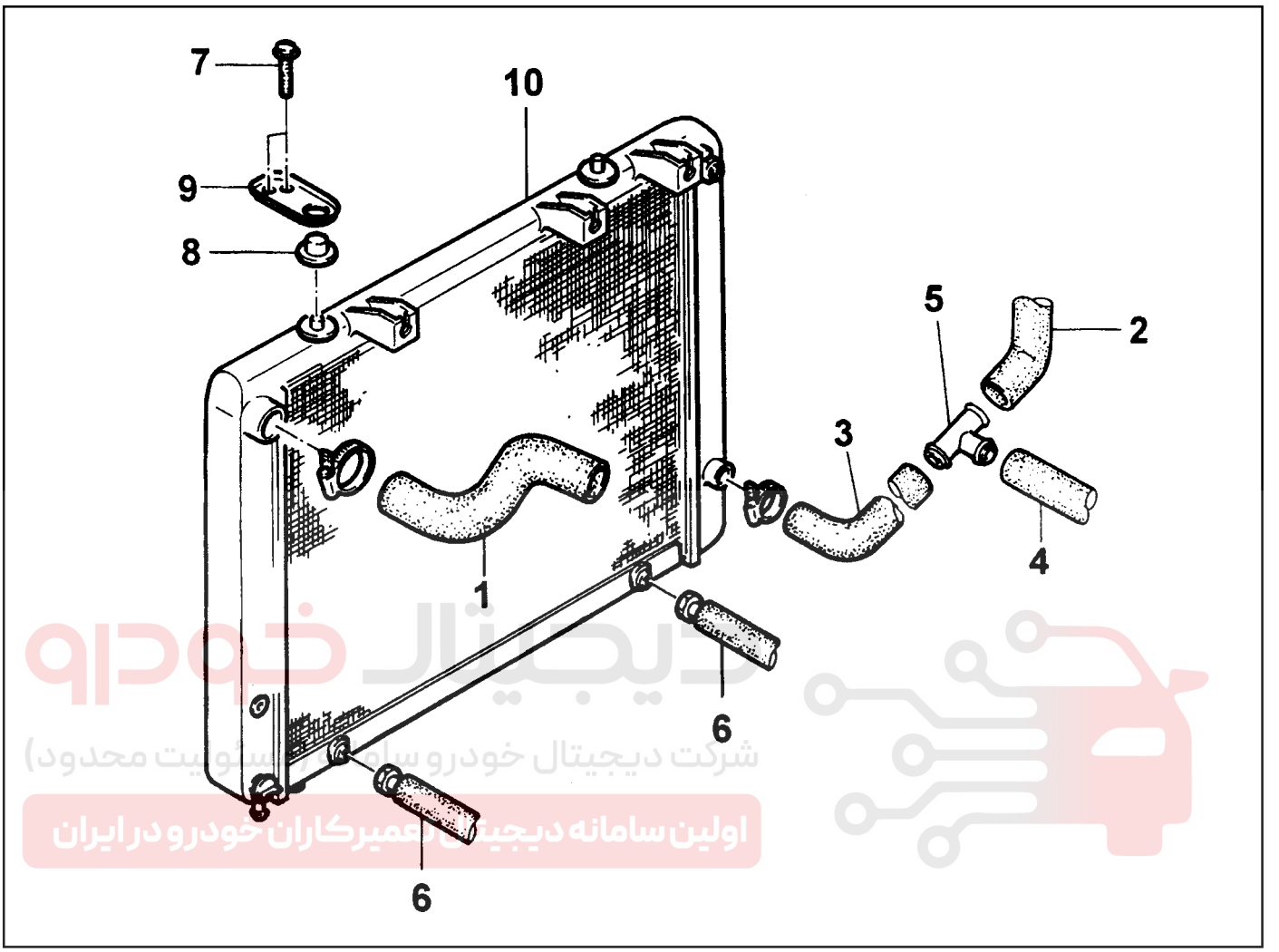


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REMOVAL AND INSTALLATION OF RADIATOR

Preceding Work : Removal of cooling fan shroud

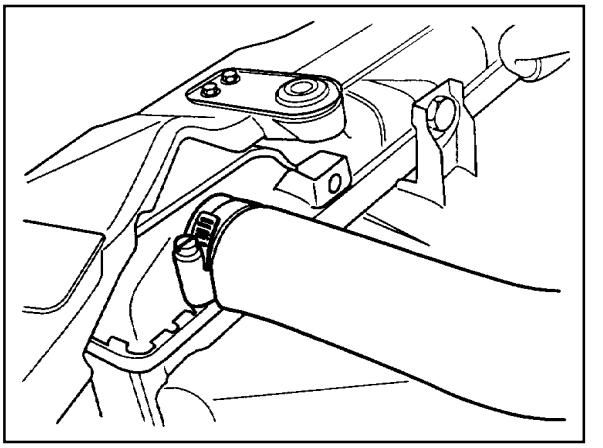


1 Inlet Hose
2 Hose (to Engine)
3 Hose (to 3-way Connector)
4 Make-up Hose (to Coolant Reservoir)
5 3-way Connector
6 Automatic Transmission Oil Cooling Hose (A/T Equippend Vehicle)
7 Bolt (M6 X 20, 4 pieces) ..... 3-7 Nm
8 Insulator
9 Radiator Bracket
10 Radiator

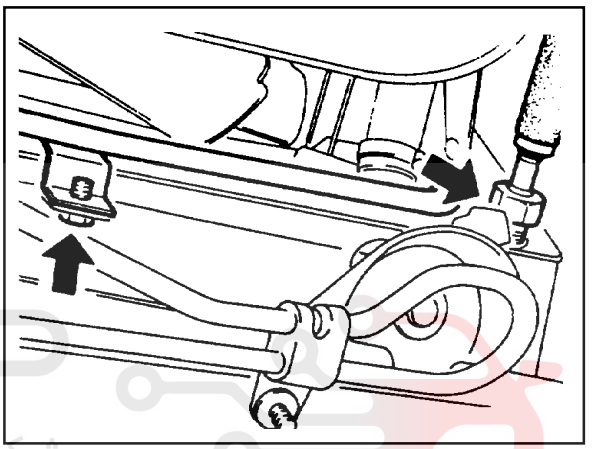
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Removal & Installation Procedure



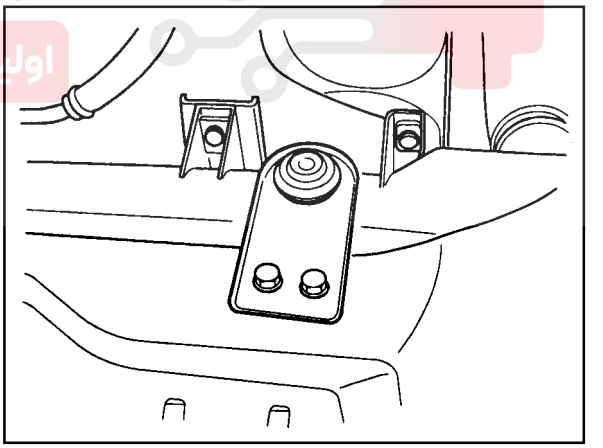
1. Drain coolant from the radiator.
2. Remove the coolant thermo connector from the radiator.
3. Remove the each coolant hoses.



4. Remove the automatic transmission oil cooling hose.

Installation Notice

Tightening Torque	14 Nm



5. Unscrew the bolts from radiator bracket and remove the bracket and insulator.

Installation Notice

Tightening Torque	3 - 7 Nm

6. Remove the radiator upper mounting bolts and then remove the bracket and insulator.
7. Remove the radiator.
8. Check the radiator pin for crack, damage, leakage and bending and replace if necessary.
9. Installation should follow the removal procedure in the reverse order.
10. Berform the cooling system leakage test.

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SECTION 1D3

OM600 ENGINE COOLING

Caution: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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Cooling Sub-System 1D3-14
Thermostat 1D3-16

SPECIFICATIONS

GENERAL SPECIFICATIONS

Application		Description
Coolant		ALUTEC P- 78
Mixing Ratio (Water : anticorrosion)		50 : 50
Capacity	662LA	10.5L - 11L
	661LA	9.5L - 10L

FASTENER TIGHTENING SPECIFICATIONS

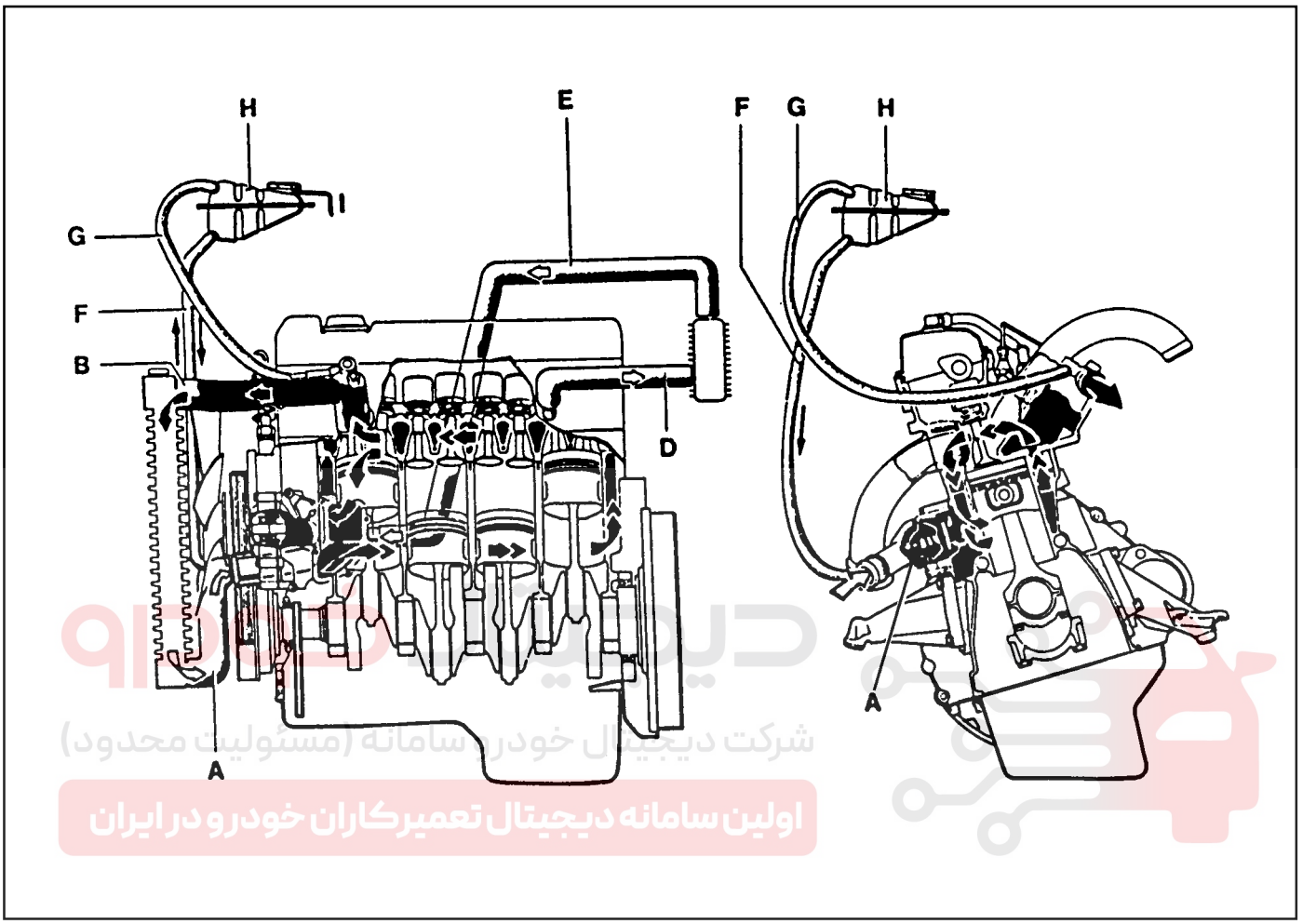
Application	N·m
Coolant Pump Bolt	10
Belt Pulley Bolt	10
Coolant Pump Housing Return Pipe Bolt	10
Thermostat Bolt	10
Cooling Fan Clutch Socket Bolt (Center)	45
Cooling Fan Clutch Socket Bolt (Side)	10
Radiator Bolt	3 - 7
Coolant Sub-tank Bolt	3 - 7

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DIAGNOSIS

COOLING CIRCULATION



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A Thermostat
B Radiator
D From Heater
E Hose
G Deaeration Line
H Reservoir

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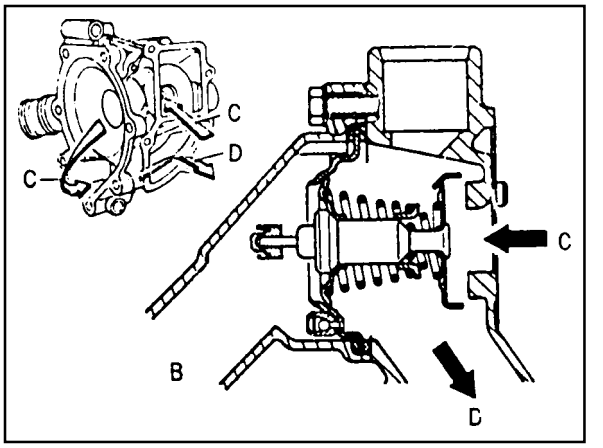
THERMOSTAT OPERATION

Operation

1. At warming up

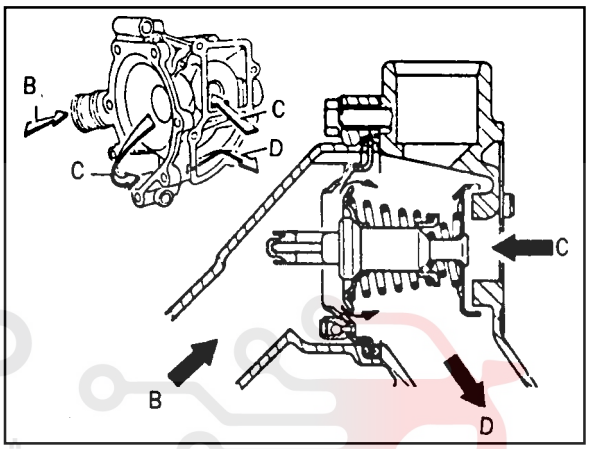
   Valve closes until temperature of coolant reaches to 85°C.

B. From Radiator
C. From Crankcase
D. To Crankcase



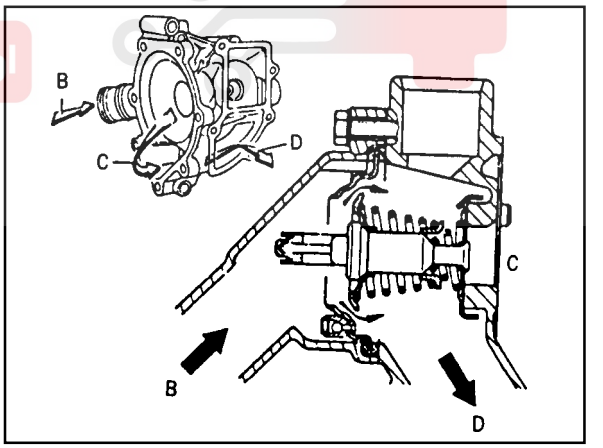
2. At partial opening.

   Valve opens partially as temperature of coolant is maintained between 85-100°C.



3. At full opening.

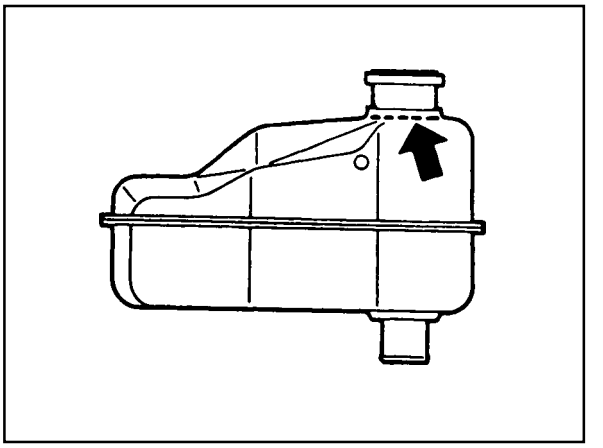
   Valve opens full as temperature of coolant is more then 100°C.



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COOLING SYSTEM LEAKAGE TEST



Tools Required

124 589 15 21 00 Tester

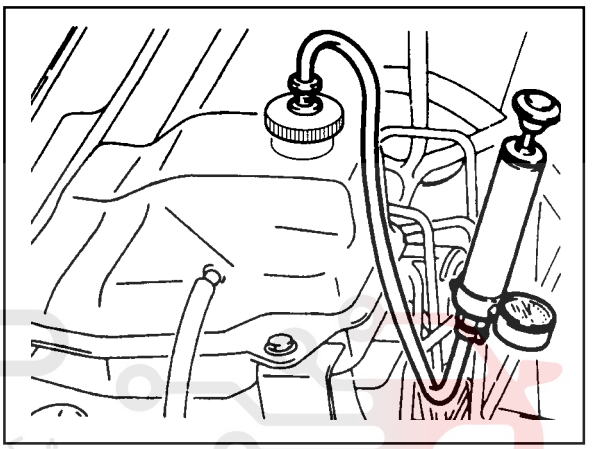
Test

1. Loosen the pressure cap by 1 notch and remove the cap after.

   Notice

   Do not remove radiator cap when coolant is above 90°C.
2. Add the coolant to the arrow mark of coolant reservoir.
3. Connect the special tool to the injector of reservoir and apply 1.4bar pressure.

   Tester 124 589 15 21 00
4. If the pressure on the tester drops, check the hose, pipe and leakage and, replace or retighten.



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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

DRAIN AND FILLING OF COOLANT

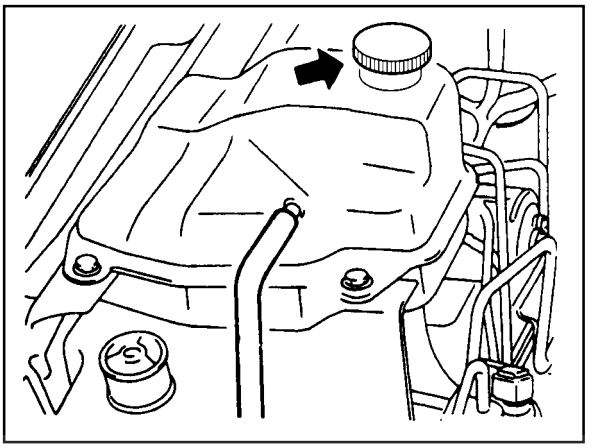
Preceding Work : Removal of skid plate

Drain / Filling

1. Loosen the pressure cap of reservoir by 1 notch and remove pressure and then loosen the cap.

   Notice

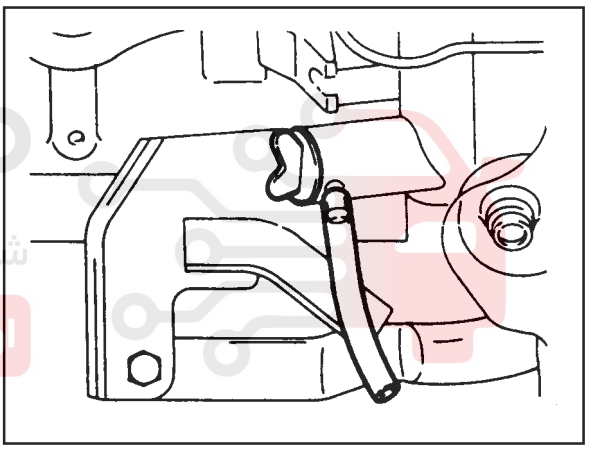
   Do not remove radiator cap when coolant is above 90°C.



2. Open the drain plug and drain the coolant.

   Notice

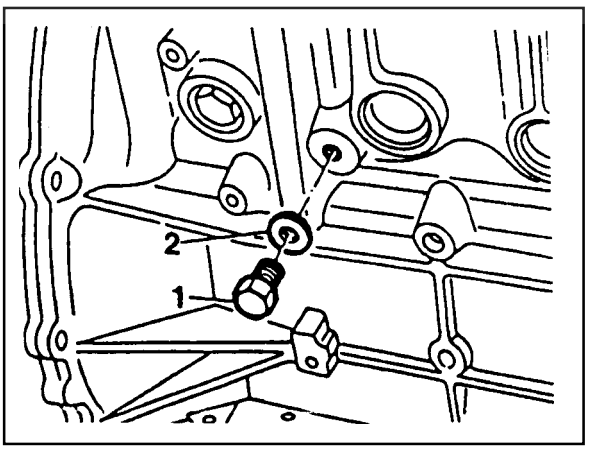
   Collect the coolant by using the proper bottle.



3. Remove the drain plug(1) and seal(2) of cylinder block and drain the coolant.
4. Replace the seal to new one and tighten the drain plug

   Installation Notice

Tightening Torque	30 Nm



5. Tighten the drain plug of the lower radiator.
6. Fill the coolant through coolant reservoir-tank.

   Notice

   - A proportion of 50% by volume of water / anticorrosion must be ensured

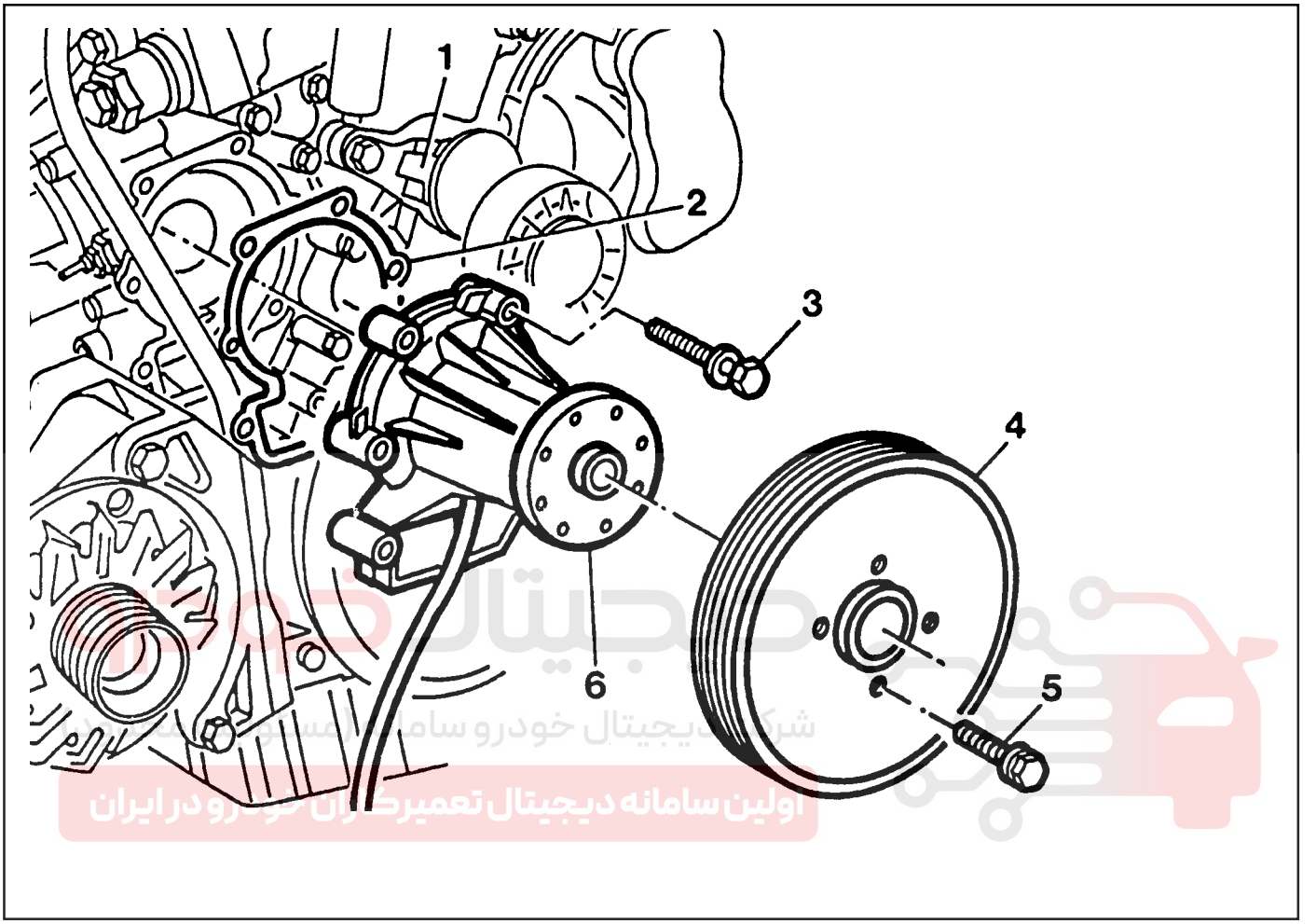
7. After engine is running at idle speed, check the level of coolant. If necessary, add enough specified coolant.

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COOLANT PUMP

Preceding Work : Removal of cooling fan
Removal of V-belt



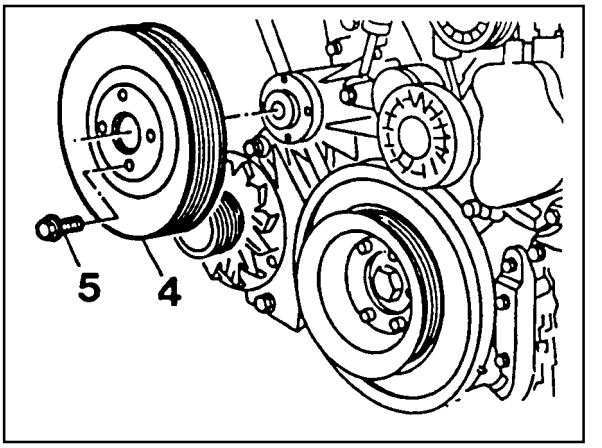
1 Tensioning Lever
2 Gasket ..... Replace
3 Bolt ..... 10 Nm
4 Belt Pulley
5 Bolt ..... 10 Nm
6 Coolant Pump

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Removal & Installation Procedure

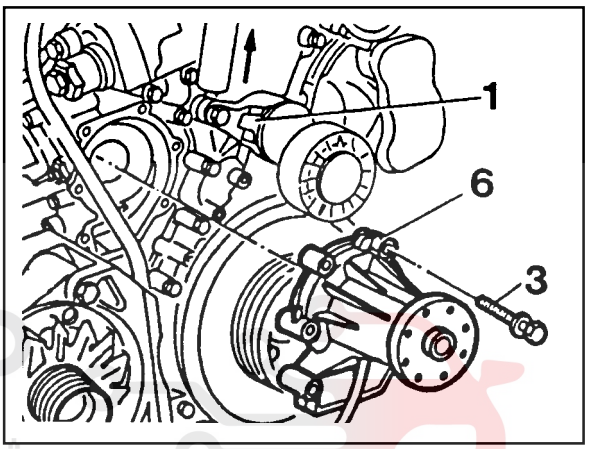
1. Loose the bolts(5) and remove the pulley (4).



Installation Notice

Tightening Torque	10 Nm

2. Loose the bolts (3).



Installation Notice

Tightening Torque	10 Nm

3. Pull the tensioning lever(1) to the arrow direction.
4. Remove the coolant pump(6).

Notice

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

5. Installation should follow the removal procedure in the reverse order.

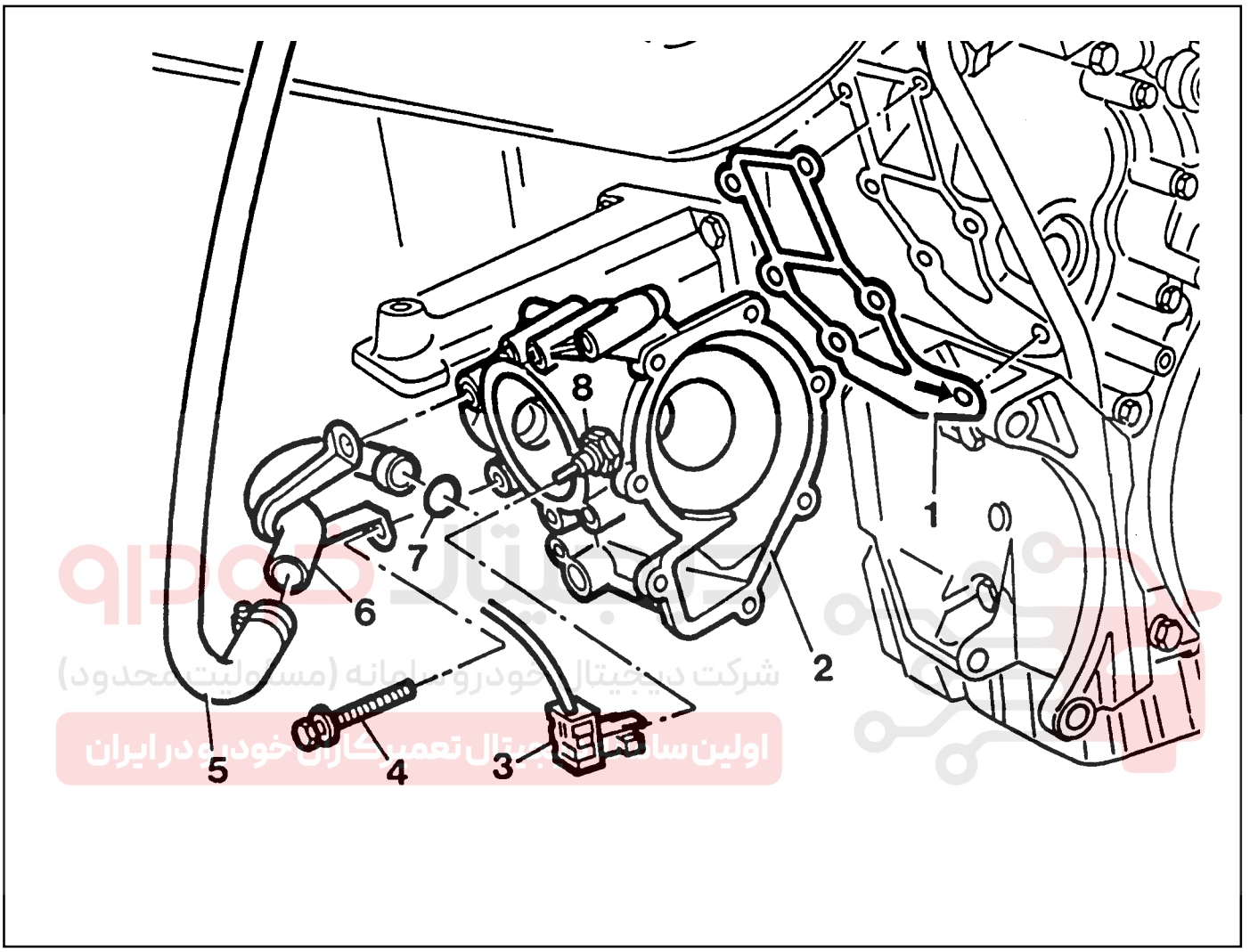
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COOLANT PUMP HOUSING

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



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

Notice

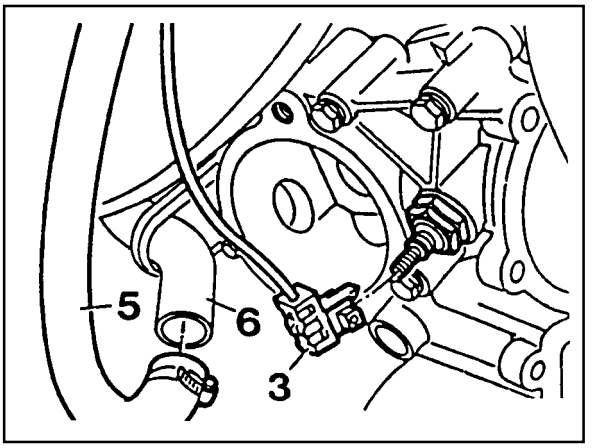
The bolt on the arrow should be installed last.

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Removal & Installation Procedure

1. Disconnect the connector(3).
2. Separate the coolant hose (5) and return pipe(6).



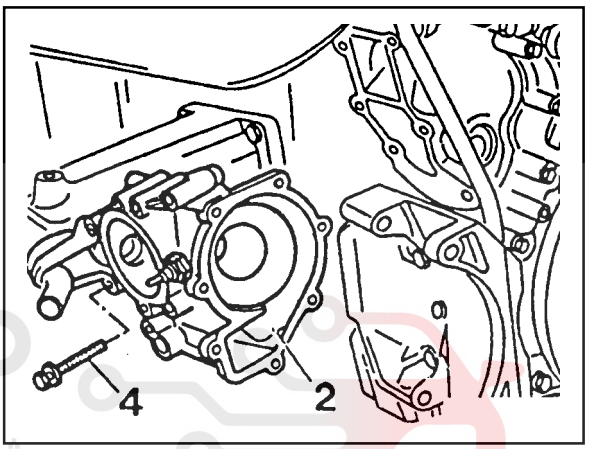
3. Remove the bolts(4) evenly.

Installation Notice

Tightening Torque	10 Nm

Notice

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



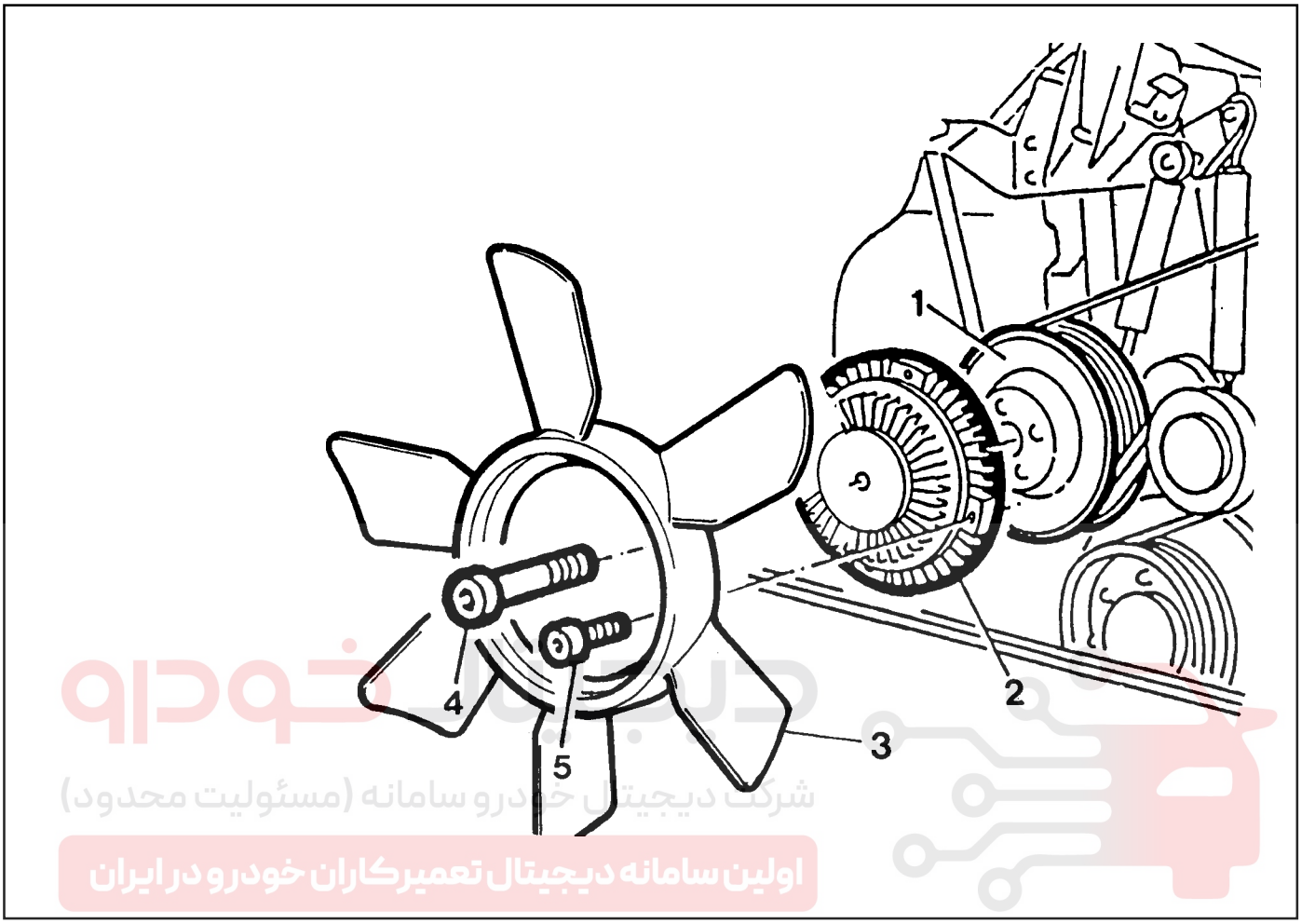
4. Remove the coolant pump housing(2).
5. Installation should follow the removal procedure in the reverse order.

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COOLING FAN CLUTCH



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

Tools Required

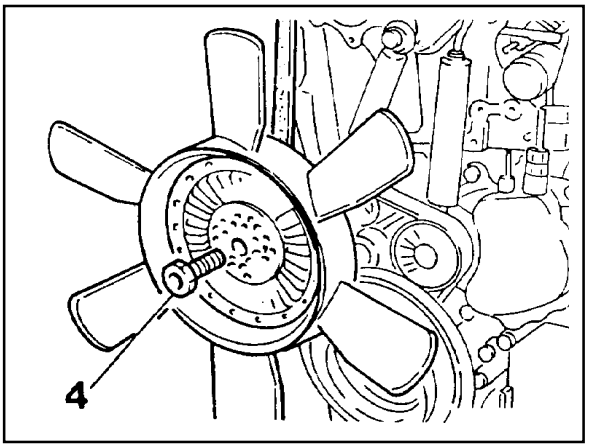
603 589 00 40 00 Counter Holder

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Removal & Installation Procedure

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



Counter Holder 603 589 00 40 00

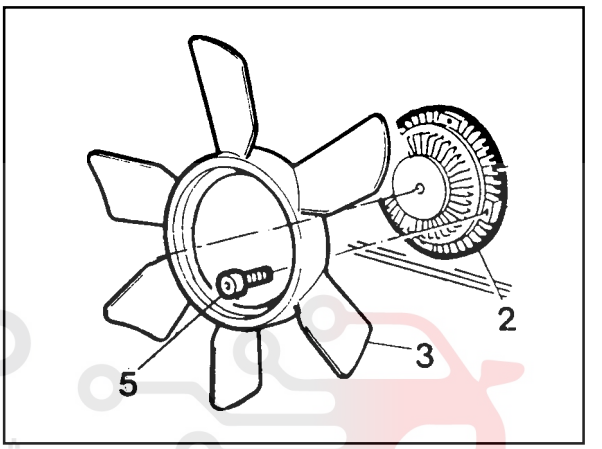
Installation Notice

Tightening Torque	45 Nm

2. Remove the socket bolt(5) and then remove the cooling fan(3) and fan clutch(2).

Notice

Keep the fan clutch vertically.



Installation Notice

Tightening Torque	10 Nm

3. Installation should follow the removal procedure in the reverse order.

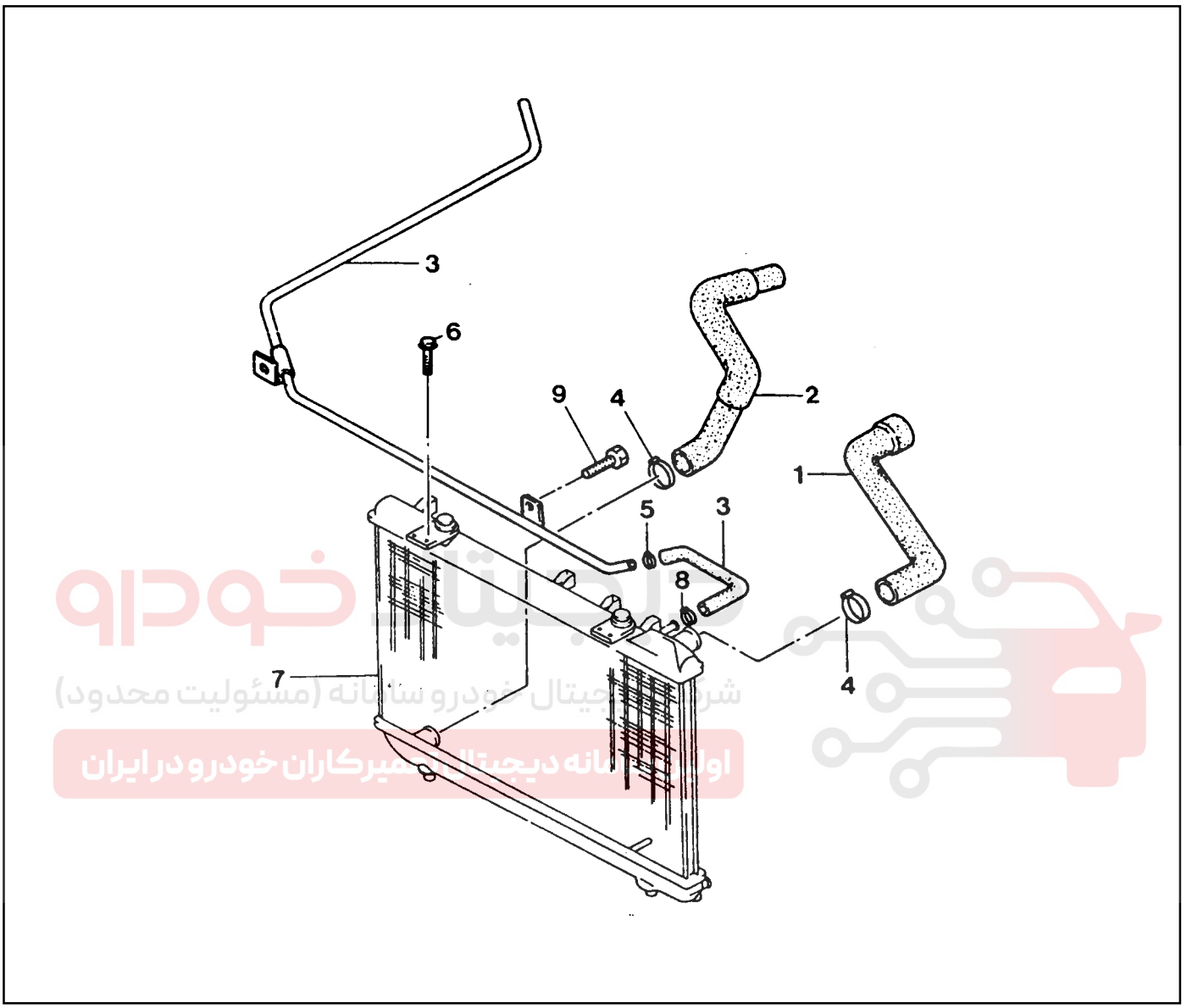
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RADIATOR

Preceding : Removal of cooling fan shroud

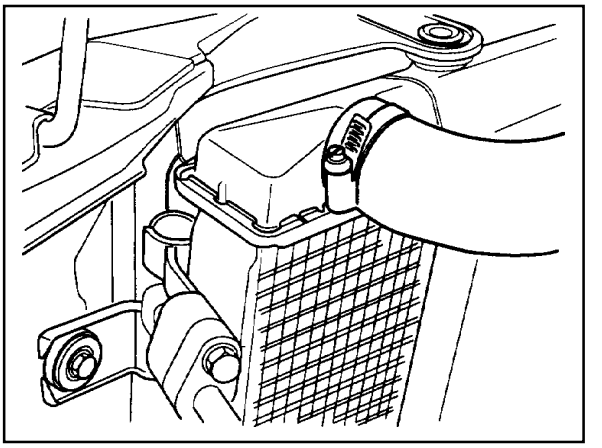


1 Radiator Inlet Hose ..... OM662LA : 220mm
..... OM661LA : 321mm
2 Radiator outlet Hose
3 Radiator Deaeration Tube & Hose
4 Clamp
5 Spring Clamp
6 Bolt ..... 3-7 Nm
7 Radiator
8 Spring Clamp
9 Bolt 3-7Nm

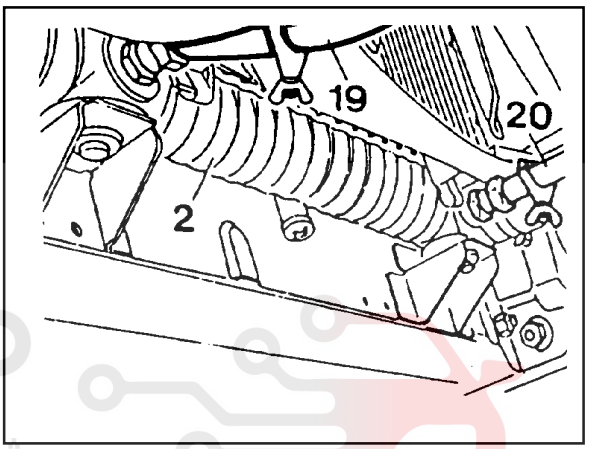
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Removal & Installation Procedure



1. Drain coolant from the radiator.
2. Remove the coolant thermoswich connector from radiator.
3. Remove the each coolant hose.

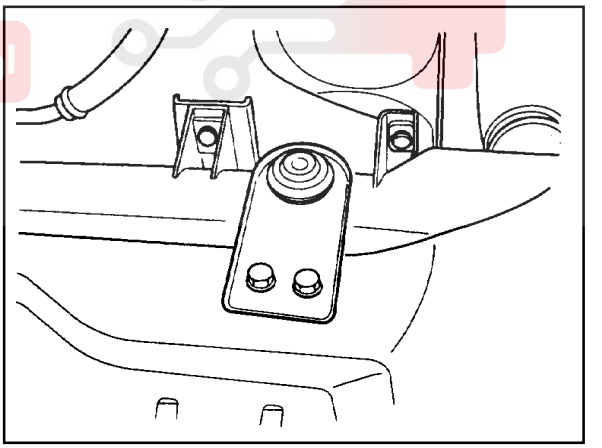


4. Remove the auto T/M oil cooling hose and cooling line.

Installation Notice

Tightening Torque	Hose : 29 - 40Nm

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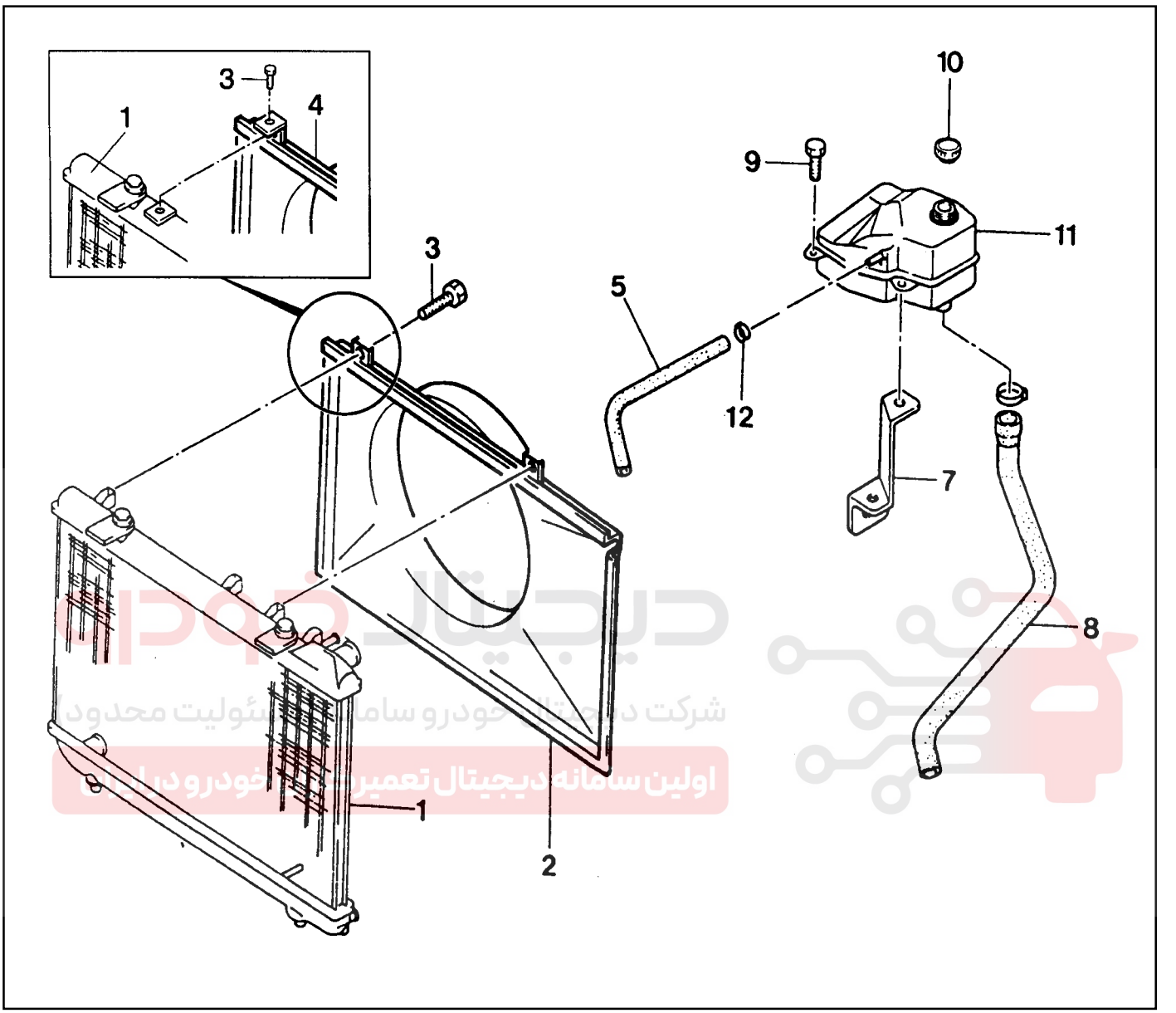


5. Loosen the radiator upper mounting bolt and remove the mounting stopper and insulator.
6. Remove the radiator.
7. Check the radiator pin for crack, leakage and bending and replace it if necessany.
8. Installation should follow the removal procedure in the reverse order.

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COOLING SUB-SYSTEM



1 Radiator
2 Cooling Fan Shroud
3 Bolt 3-7Nm
4 Cooling Fan Shroud
5 Radiator Deaieration Hose
7 Mounting Bracket
8 Make-up Cooling Hose
9 Bolt 3-7Nm
10 Cooling Reservoir-tank Cap
11 Cooling Reservoir-tank

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Removal & Installation Procedure

Cooling Fan Shroud

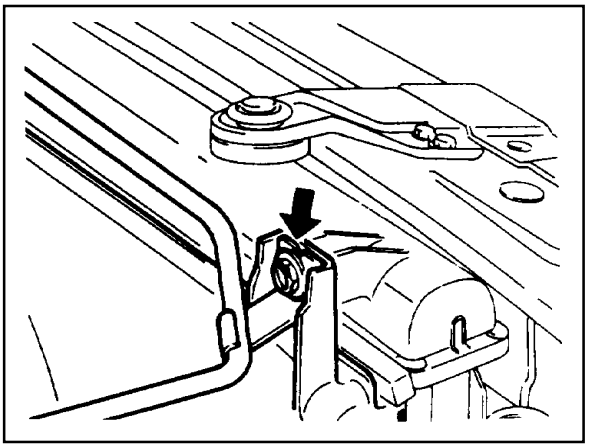
1. Remove the radiator deaeration hose and tube.

Installation Notice

Tightening Torque	3 - 7 Nm

Tightening torque 3-7Nm

2. Check the shroud.
3. Installation should follow the removal procedure in the reverse order.



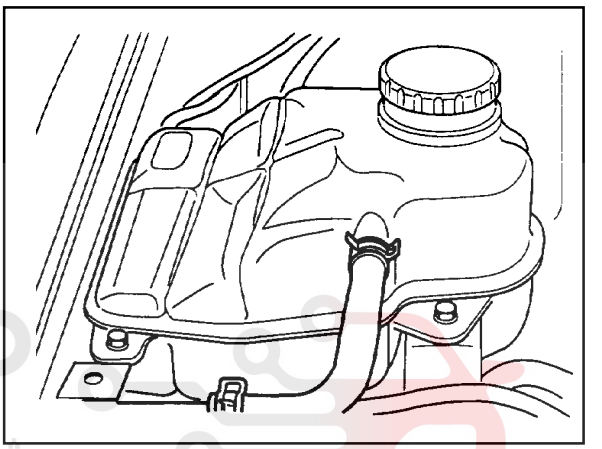
Coolant Sub-Tank

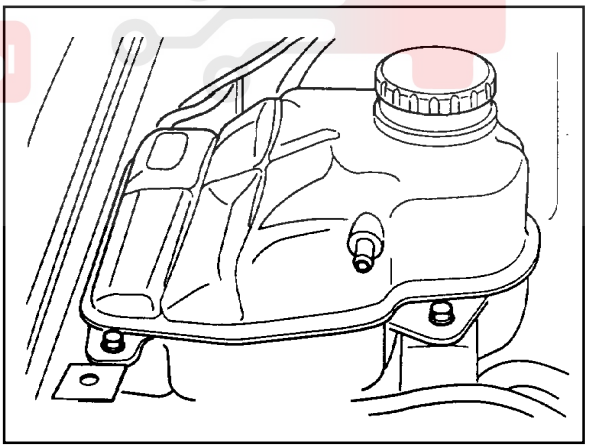
1. Drain the coolant from radiator.
2. Remove the each hose.
3. Loosen the mounting bolt of sub-tank and remove the coolant sub-tank.

Installation Notice

Tightening Torque	3 - 7 Nm

4. Installation should follow the removal procedure in the reverse order.

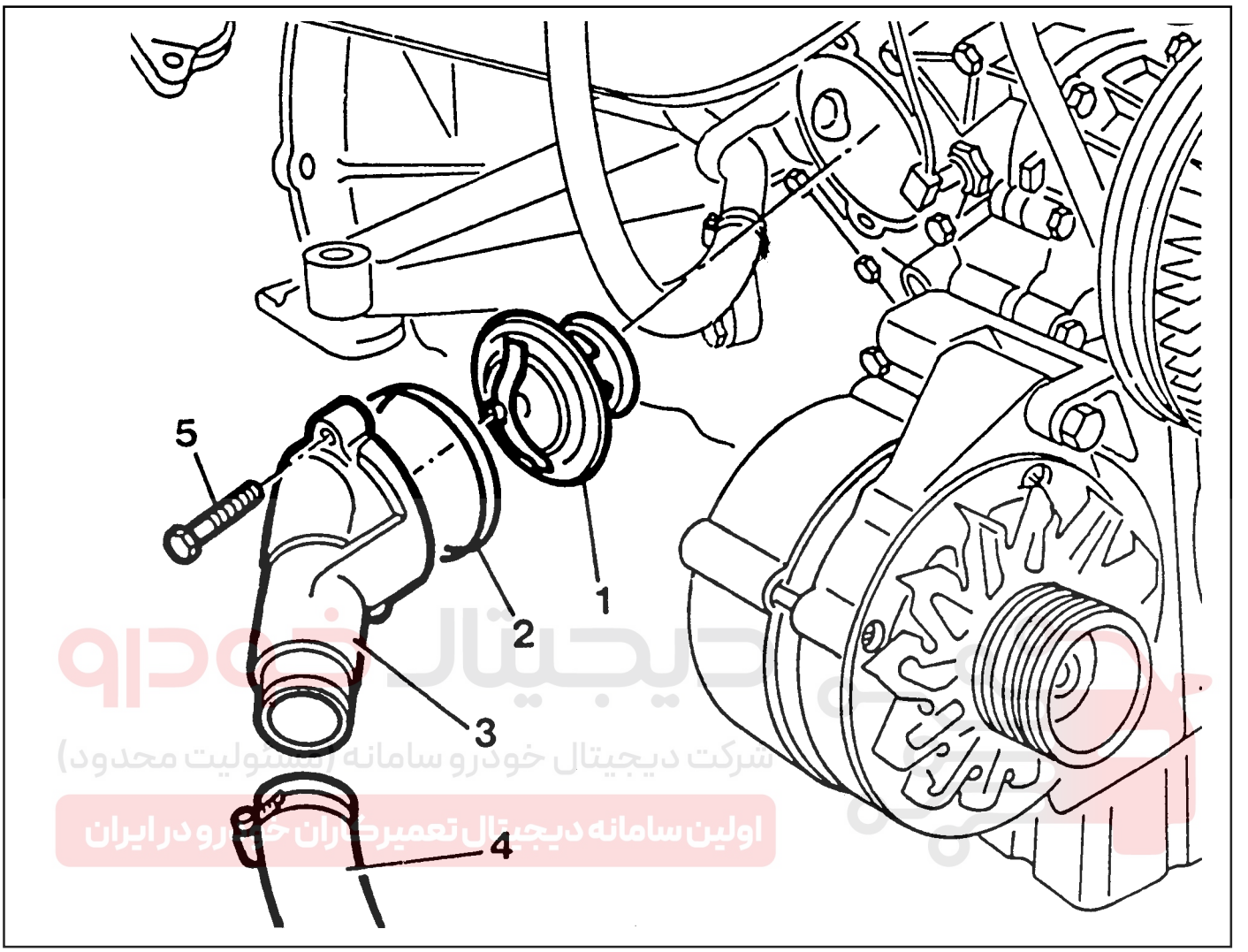




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THERMOSTAT



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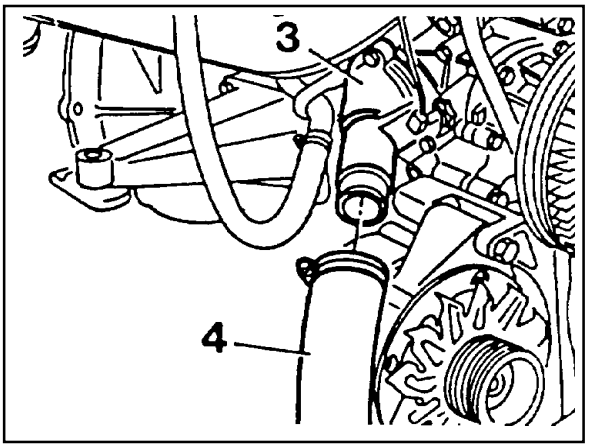
1 Thermostat
2 Seal ..... Replace
3 Thermostat Housing Cover
4 Coolant Hose
5 Bolt 10Nm

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Removal & Installation Procedure

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)

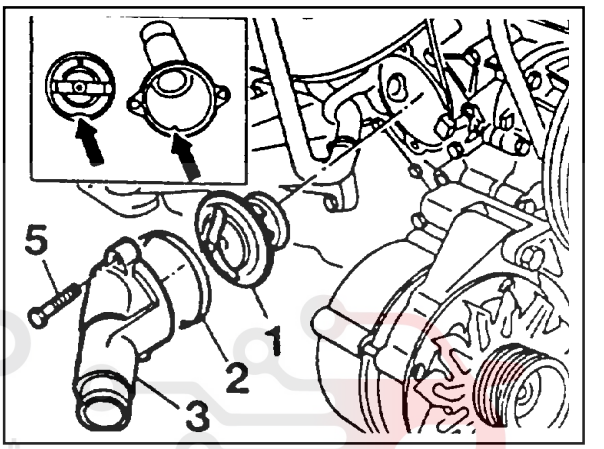
   Installation Notice

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

Tightening Torque	10 Nm

   Notice

   Replace the seal(2).



4. Installation should follow the removal procedure in the reverse order.

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SECTION 1E1

M162 ENGINE ELECTRICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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Unit Repair 1E1-12
Battery 1E1-12

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SPECIFICATIONS

ALTERNATOR SPECIFICATIONS

Application	Description
Output Voltage	12 - 14 V
Current	115 A
Resistance Between Rotor Core and Slip Ring	¥ W

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STARTING MOTOR SPECIFICATIONS

Application	Description
Voltage	12 V
Output Power	1.7 KW

BATTERY SPECIFICATIONS

Application	Description
Capacity	75 AH
Specific Gravity	^{3} 1.24
Max. Tolerance Between Cells	^{3} 0.04

FASTENER TIGHTENING SPECIFICATIONS

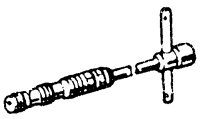
Application	N·m
Alternator Terminal B+Nut	14 - 18
Alternator Terminal D+Nut	4 - 5
Alternator Combinction Bolt	45 - 50
Battery Cable Nut on Starting Motor	12 - 15
Electric Wire Nut on Starting Motor	6 - 7
Starting Motor Mounting Nut	35 - 48
Battery Mounting Bracket Nut	12 - 18
Battery Negative Cable	12 - 18
Battery Positive Cable	12 - 18
Ignition Cable Cover Bolt	9 - 11
Ignition Cable Bolt	9 - 11
Spark plug	25 - 30

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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	**120 589 02 09 00** **Spark Plug Wrench**

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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

ALTERNATOR

Preceding Work : Removal of the drivebelt

Removal & Installation Procedure

1. Disconnect the negative battery terminal.
2. Unscrew the nut and disconnect the terminal (1).

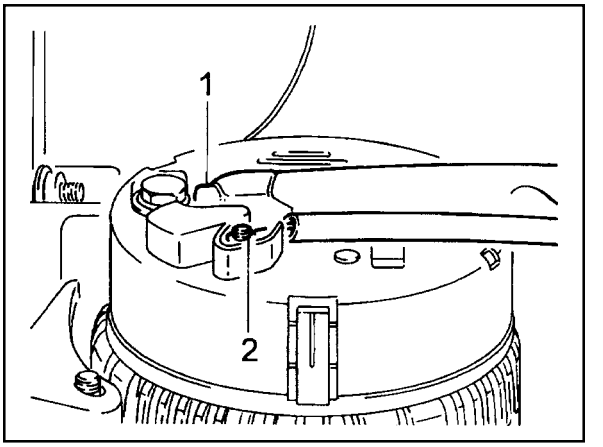
Installation Notice

Tightening Torque	14 - 18 Nm

3. Unscrew the nut and disconnect the terminal (2).

Installation Notice

Tightening Torque	4 - 5 Nm



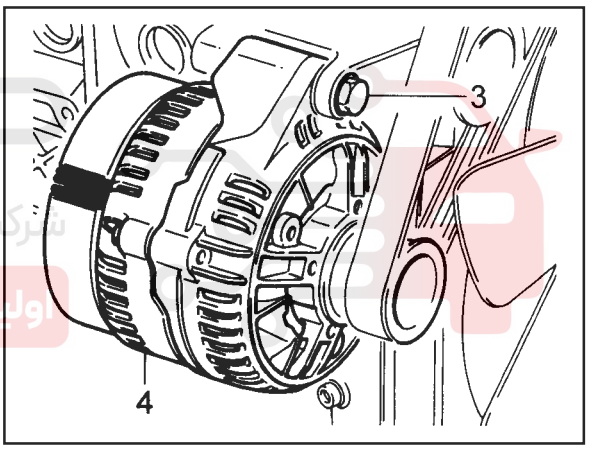
1 Terminal (B+)
2 Terminal (D+)

4. Unscrew the combination bolt (3).

Installation Notice

Tightening Torque	42 - 50 Nm

5. Remove the alternator.
6. Installation should follow the removal procedure in the reverse order.



3 Combination Bolt
4 Alternator

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STARTING MOTOR

Removal & Installation Procedure

1. Disconnect the ground cable.
2. Unscrew the nut and disconnect the battery cable(1).

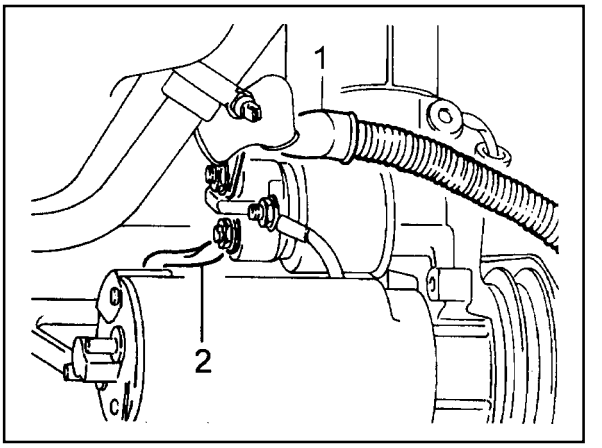
Installation Notice

Tightening Torque	12 - 15 Nm

3. Unscrew the nut and disconnect the engine electric wire (2).

Installation Notice

Tightening Torque	6 - 7 Nm



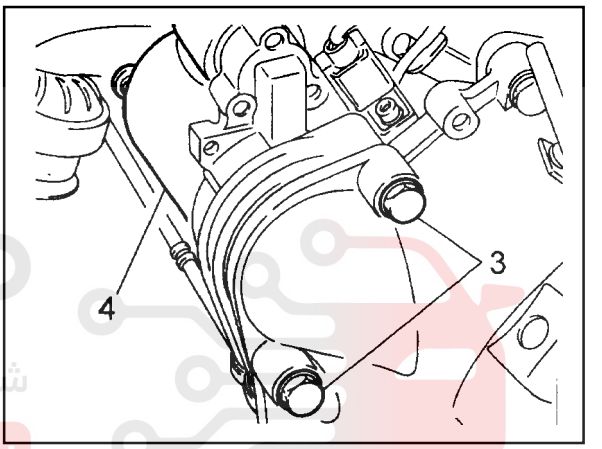
1 Battery Cable
2 Engine Electric Wire

4. Unscrew the mounting bolts (3) of starting motor.

Installation Notice

Tightening Torque	35 - 48 Nm

5. Remove the starting motor.
6. Installation should follow the removal procedure in the reverse order.



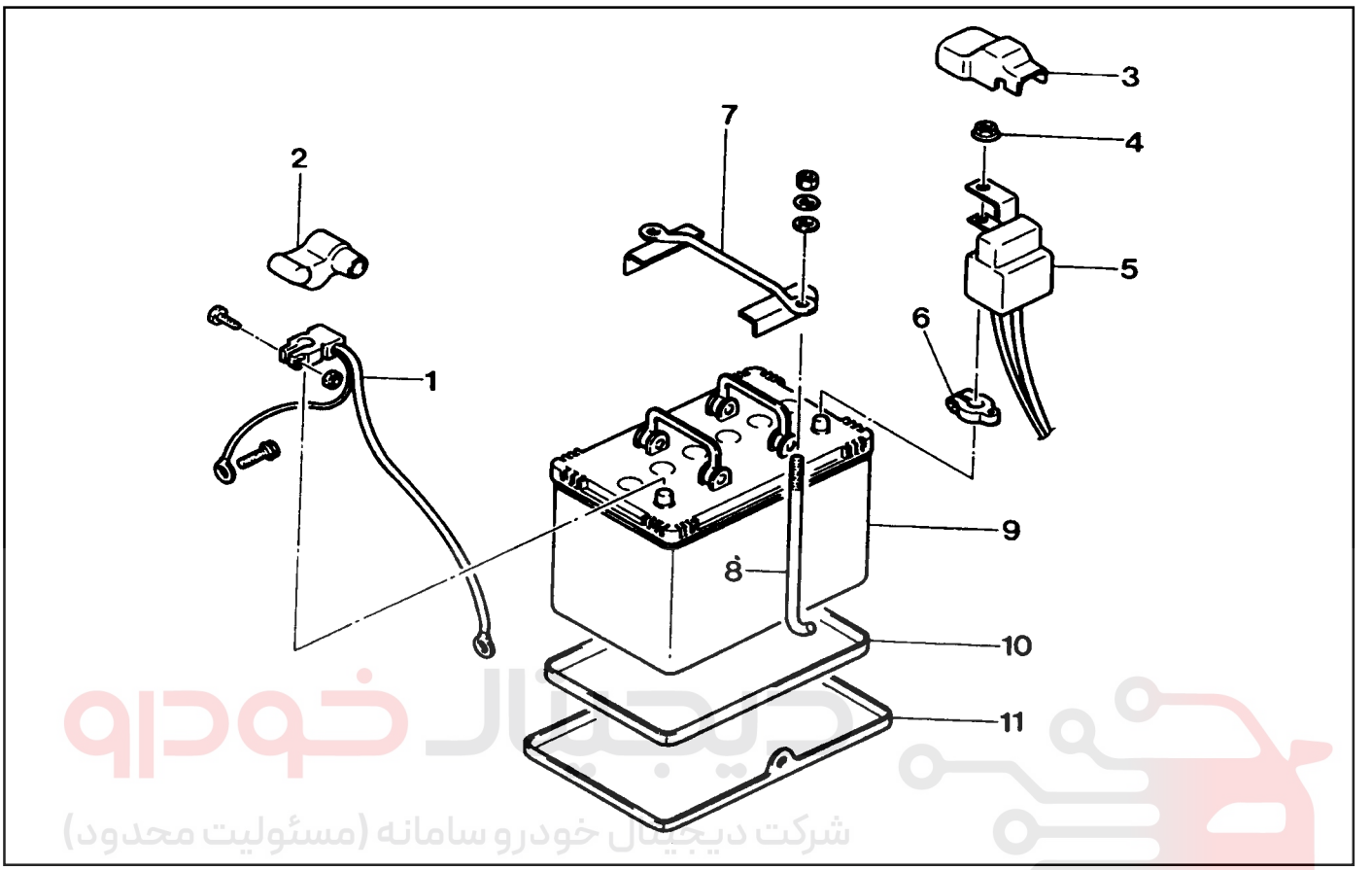
3 Fixing Bolt
4 Starting Motor

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BATTERY



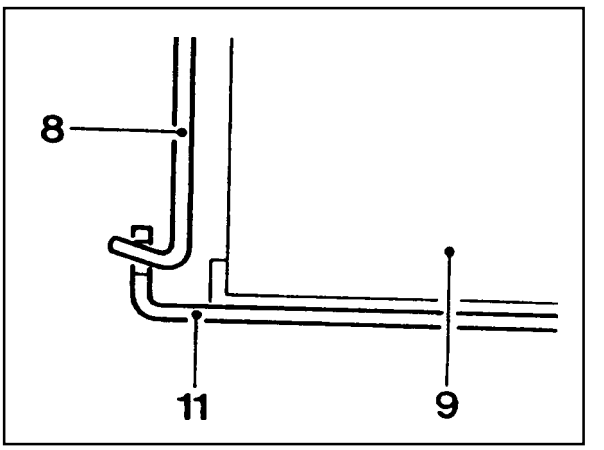
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1 Cable Terminal (-)
2 Cable Terminal Cap (-)
3 Cable Terminal Cap (+)
4 Nut
5 Fuseblink Box
6 Terminal (+)
7 Battery holddown Bracket
8 Battery Clamp Bolt
9 Battery
10 Sub Tray
11 Battery Tray

Removal & Installation Procedure

Notice

- Disconnect the battery negative cable first.
- Insert the clamp bolt (8) into the battery tray hole (11) from inside when installing.

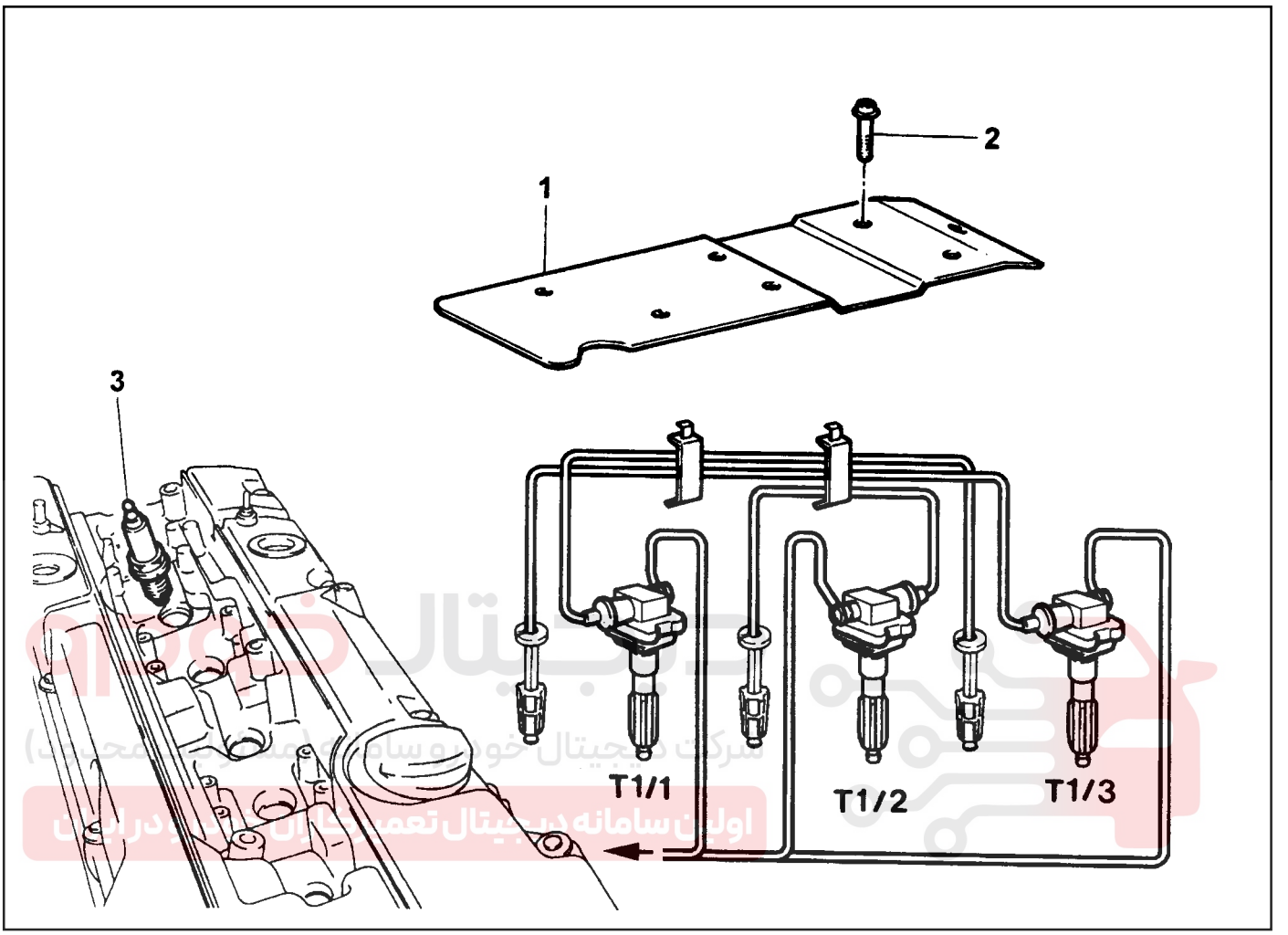


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SPARK PLUG

Preceding Work : Removal of intake air duct



1 Ignition Coil Cable Cover
2 Bolt (M6 X 60, 7 pieces) ..... 9-11 Nm
3 Spark Plug

T1/1 Ignition Coil : Cylinder 2 and 5
T1/2 Ignition Coil : Cylinder 3 and 4
T1/3 Ignition Coil : Cylinder 1 and 6

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Tools Required

120 589 09 00 Spark Plug Wrench

Replacement Procedure

1. Remove the seven bolts (2) and remove the ignition cable cover.

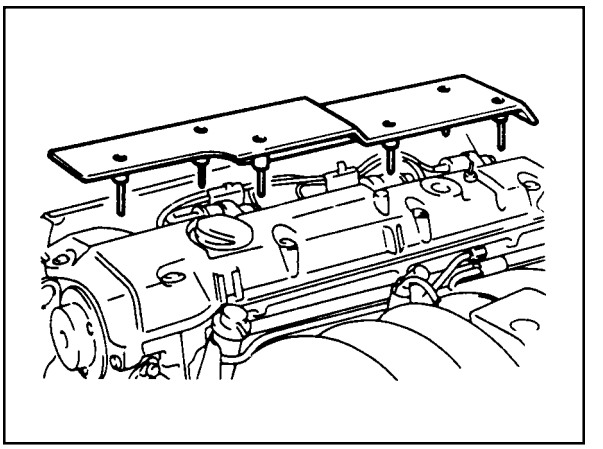
   Installation Notice

Tightening Torque	9 - 11 Nm

2. Remove the two bolts (M6 X 25) from each ignition cable and remove the ignition cable.

   Installation Notice

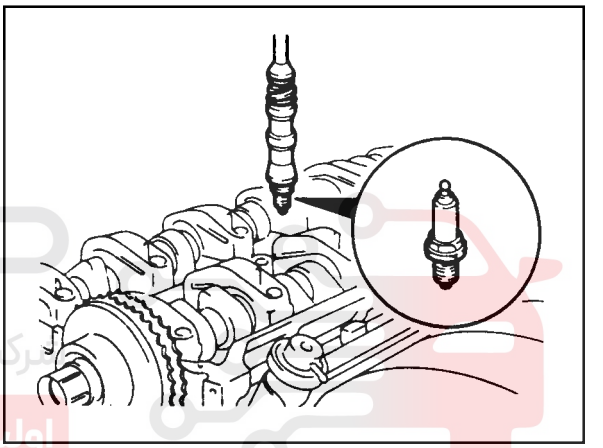
Tightening Torque	9 - 11 Nm



3. Remove the spark plug using the special tool.

   Installation Notice

Tightening Torque	9 - 11 Nm



Spark Plug Wrench 120 589 02 09 00

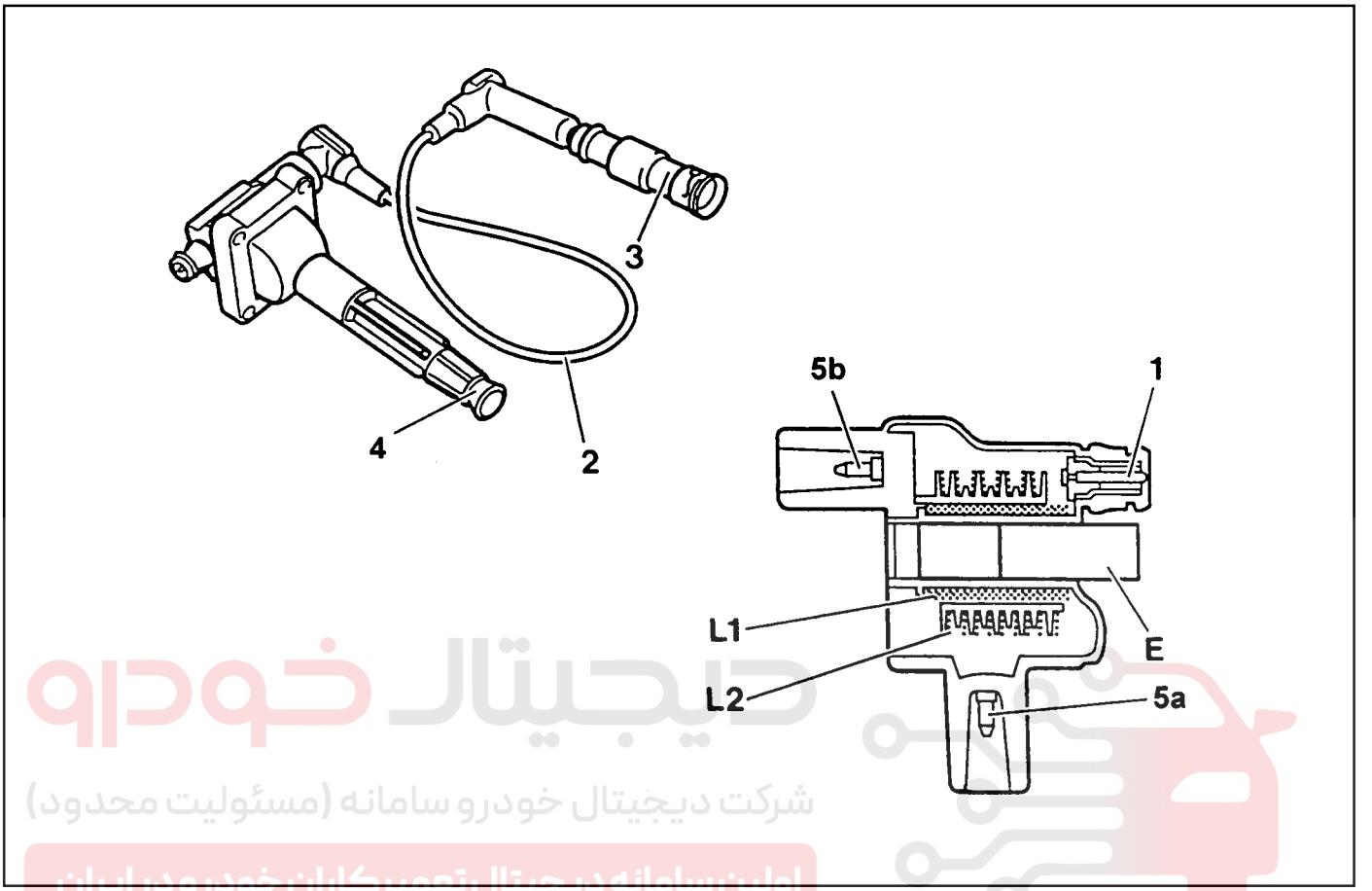
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IGNITION CABLE

Preceding Work : Removal of intake air duct



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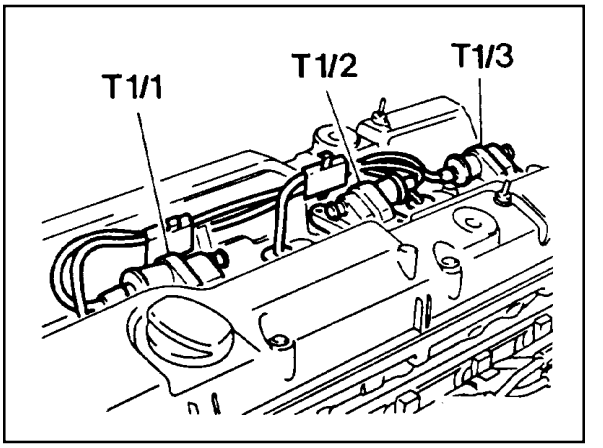
1	Control Cable Connection	5a, 5b	Secondary Voltage Connection
2	Ignition Cable	E	Iron Core
3	Spark Plug Connector	L1	Secondary Ignition Coil
4	Coupling Plug	L2	Primary Ignition Coil

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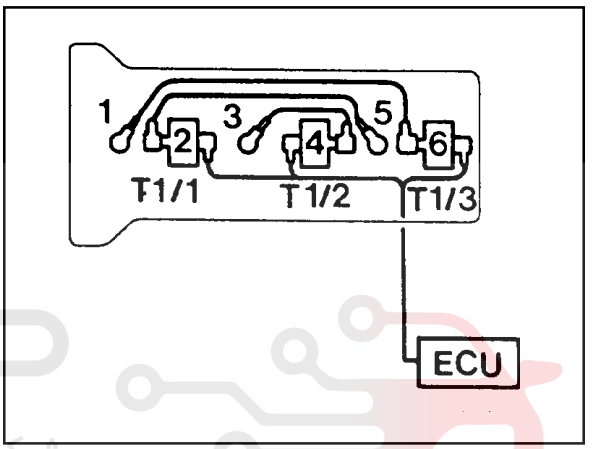
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Functions

1. Firing order : 1-5-3-6-2-4
2. The ignition cables 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 voltage (5a) is supplied to the No.2 cylinder spark plug through the spark plug connector. The secondary output voltage (5b) is supplied to the No.5 cylinder spark plug through the ignition cable. The guide pin (W) acts as a ground while the ignition cable is operated.



Removal & Installation Procedure

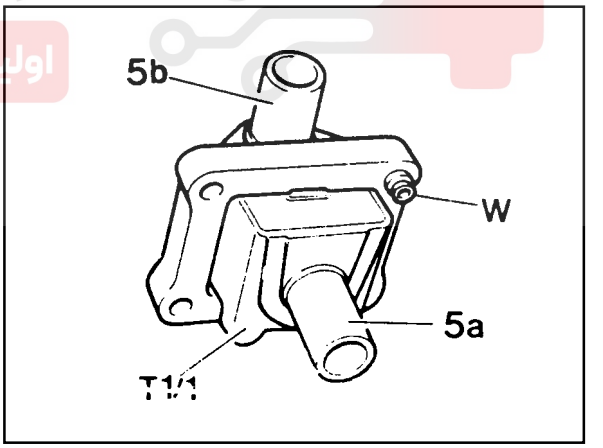
1. Disconnect the negative battery cable (1).
2. Remove the ignition cable connector from the ignition cable.
3. Disconnect the secondary spark plug connectors from the each spark plugs and remove the ignition cable.

Installation Notice

Tightening Torque	9 - 11 Nm

- Make sure that the ignition cables are correctly routed.
- Exactly install the ignition cable guide pin into the vehicle to be grounded.

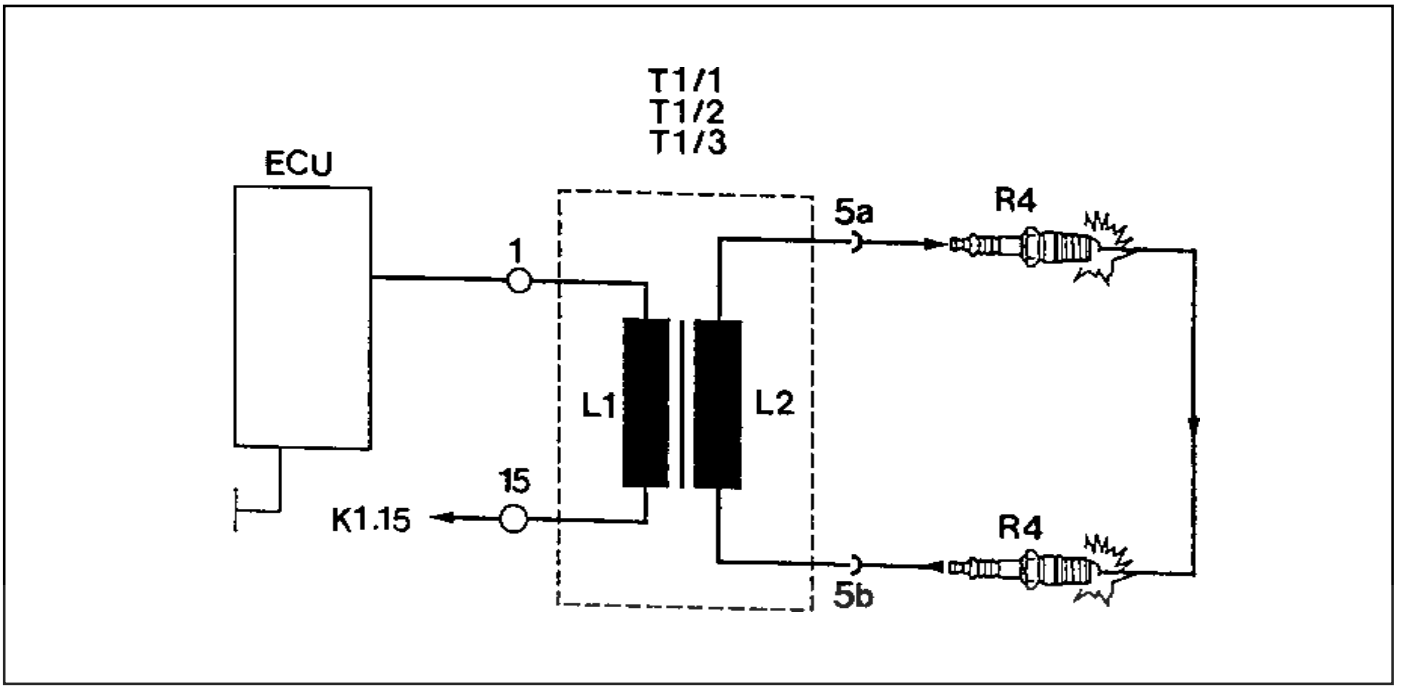
4. Installation should follow the removal procedure in the reverse order.



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Circuit Diagram



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Inspection & Maintenance Procedure (for MSE)

1. While the ignition switch is in 'OFF' position, remove the wiring connectors (1 and 15) from ignition coil and measure the primary resistance between terminal No.1 and No.15.

Specified Value	0.9 - 1.6 W (20°C)

Notice

If out of specified value, replace the ignition coil.

2. During engine cranking, measure primary voltage (T1/1) between ECU terminal No. 71 and No. 69.

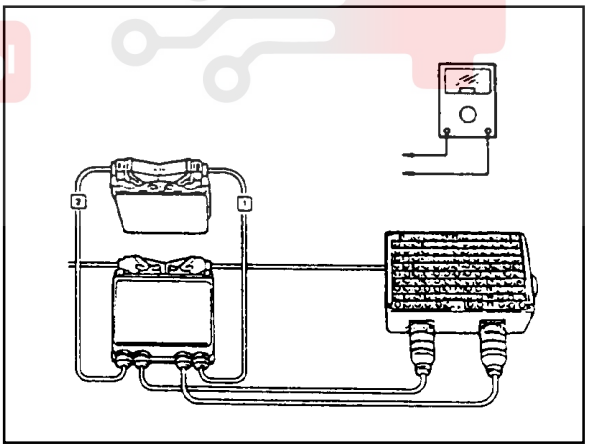
Specified Value	200 - 350 V

Notice

- Measure remaining cables.
  - T1/2 : No. 72 and 69.
  - T1/3 : No. 70 and 69.
- If out of specified value, check ignition cable and ECU.

3. Using a multi-tester, measure the secondary coil resistance between 5a and 5b.

Specified Value	6 - 8.5 kW

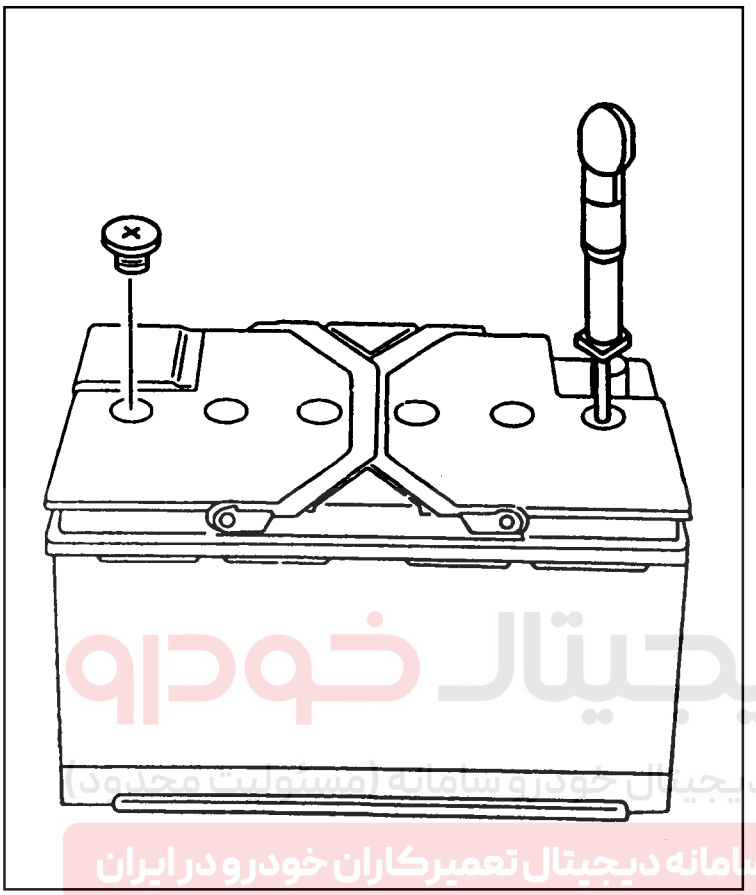


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UNIT REPAIR

BATTERY



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Inspection

Notice

- When charging the battery, do not leave the inflammable objects around it.
- When checking the electrolyte of battery, put on an eye protector and gloves.

1. Inspect the surface of the battery and replace if any defects were found on it.
2. Check if the specific gravity of the electrolyte is within the specified value.

Battery capacity(Ah)	85
Battery specific gravity	^{3} 1.24
Max. tolerance between cells	^{3} 0.04

Notice

- Replace the battery if the maximum tolerance of the electrolyte between cells is out of the specified value.
- Measure the specific gravity in the approx. 20°C of ambient temperature.

3. Replenish the electrolyte if necessary.

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SECTION 1E2

M161 ENGINE ELECTRICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

ALTERNATOR SPECIFICATIONS

Application	Description
Output Voltage	12 - 14 V
Current	115 A
Resistance Between Rotor Core and Slip Ring	¥ W

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STARTING MOTOR SPECIFICATIONS

Application	Description
Voltage	12 V
Output Power	1.2 KW

BATTERY SPECIFICATIONS

Application	Description
Capacity	90 Ah
Specific Gravity	^{3} 1.24
Max. Tolerance Between Cells	^{3} 0.04

FASTENER TIGHTENING SPECIFICATIONS

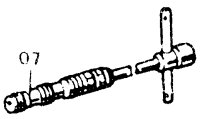
Application	N·m
Alternator Terminal B+Nut	14 - 18
Alternator Terminal D+Nut	4 - 5
Alternator Combinction Bolt	45 - 50
Battery Cable Nut on Starting Motor	12 - 15
Electric Wire Nut on Starting Motor	6 - 7
Starting Motor Mounting Nut	35 - 48
Battery Mounting Bracket Nut	12 - 18
Battery Negative Cable	12 - 18
Battery Positive Cable	12 - 18
Ignition Cable Cover Bolt	9 - 11
Ignition Cable Bolt	9 - 11
Spark plug	25 - 30

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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	**120 589 02 09 00** **Spark Plug Wrench**

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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

ALTERNATOR

Preceding Work : Removal of the drivebelt

Removal & Installation Procedure

1. Disconnect the negative battery terminal.
2. Unscrew the nut and disconnect the terminal (1).

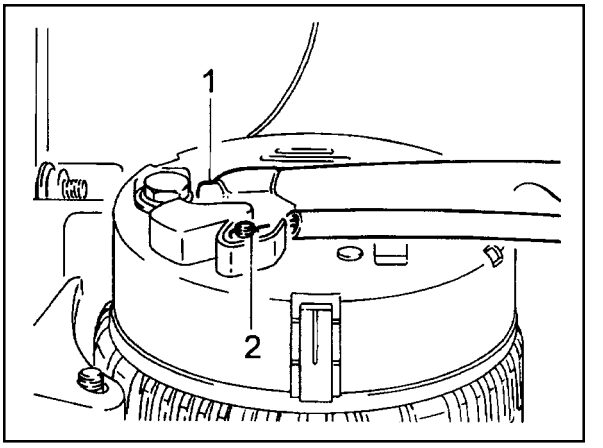
Installation Notice

Tightening Torque	14 - 18 Nm

3. Unscrew the nut and disconnect the terminal (2).

Installation Notice

Tightening Torque	4 - 5 Nm



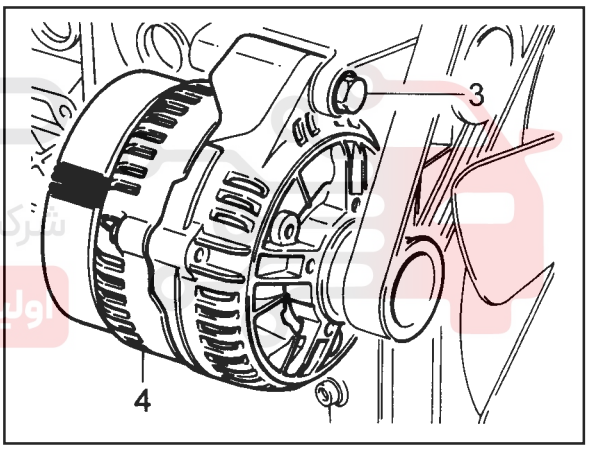
1 Terminal (B+)
2 Terminal (D+)

4. Unscrew the combination bolt (3).

Installation Notice

Tightening Torque	42 - 50 Nm

5. Remove the alternator.
6. Installation should follow the removal procedure in the reverse order.



3 Combination Bolt
4 Alternator

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STARTING MOTOR

Removal & Installation Procedure

1. Disconnect the ground cable.
2. Unscrew the nut and disconnect the battery cable(1).

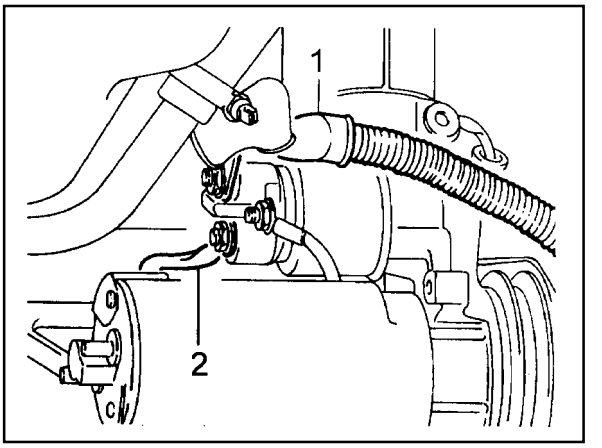
Installation Notice

Tightening Torque	12 - 15 Nm

3. Unscrew the nut and disconnect the engine electric wire (2).

Installation Notice

Tightening Torque	6 - 7 Nm



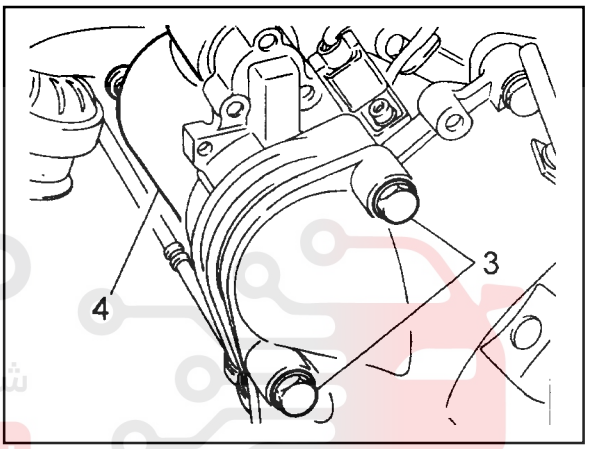
1 Battery Cable
2 Engine Electric Wire

4. Unscrew the mounting bolts (3) of starting motor.

Installation Notice

Tightening Torque	35 - 48 Nm

5. Remove the starting motor.
6. Installation should follow the removal procedure in the reverse order.



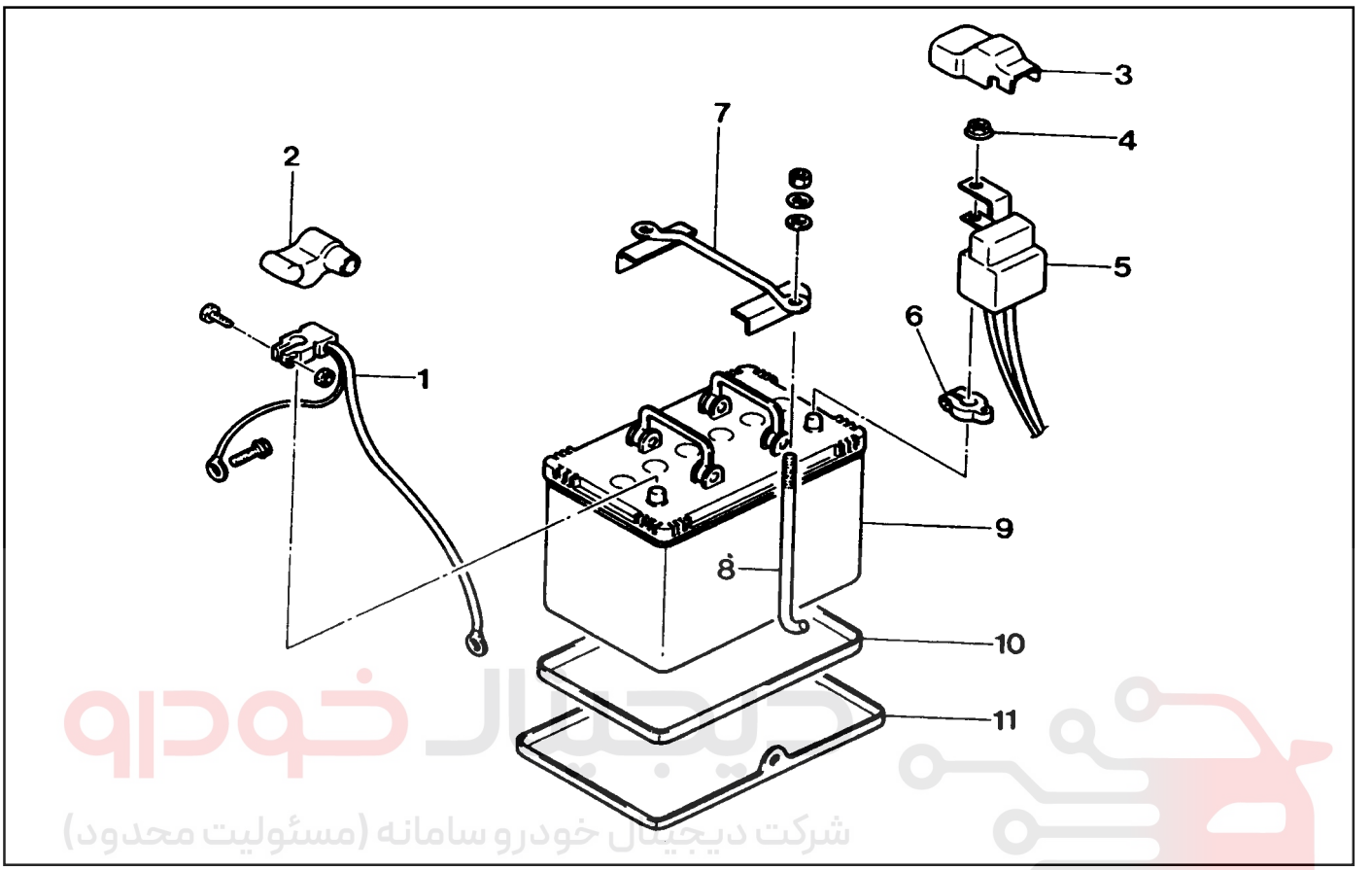
3 Fixing Bolt
4 Starting Motor

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BATTERY



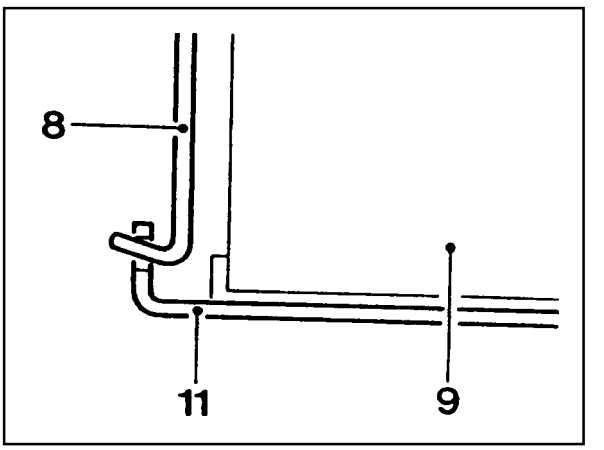
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1 Cable Terminal (-)
2 Cable Terminal Cap (-)
3 Cable Terminal Cap (+)
4 Nut
5 Fuseblink Box
6 Terminal (+)
7 Battery holddown Bracket
8 Battery Clamp Bolt
9 Battery
10 Sub Tray
11 Battery Tray

Removal & Installation Procedure

Notice

- Disconnect the battery negative cable first.
- Insert the clamp bolt (8) into the battery tray hole (11) from inside when installing.

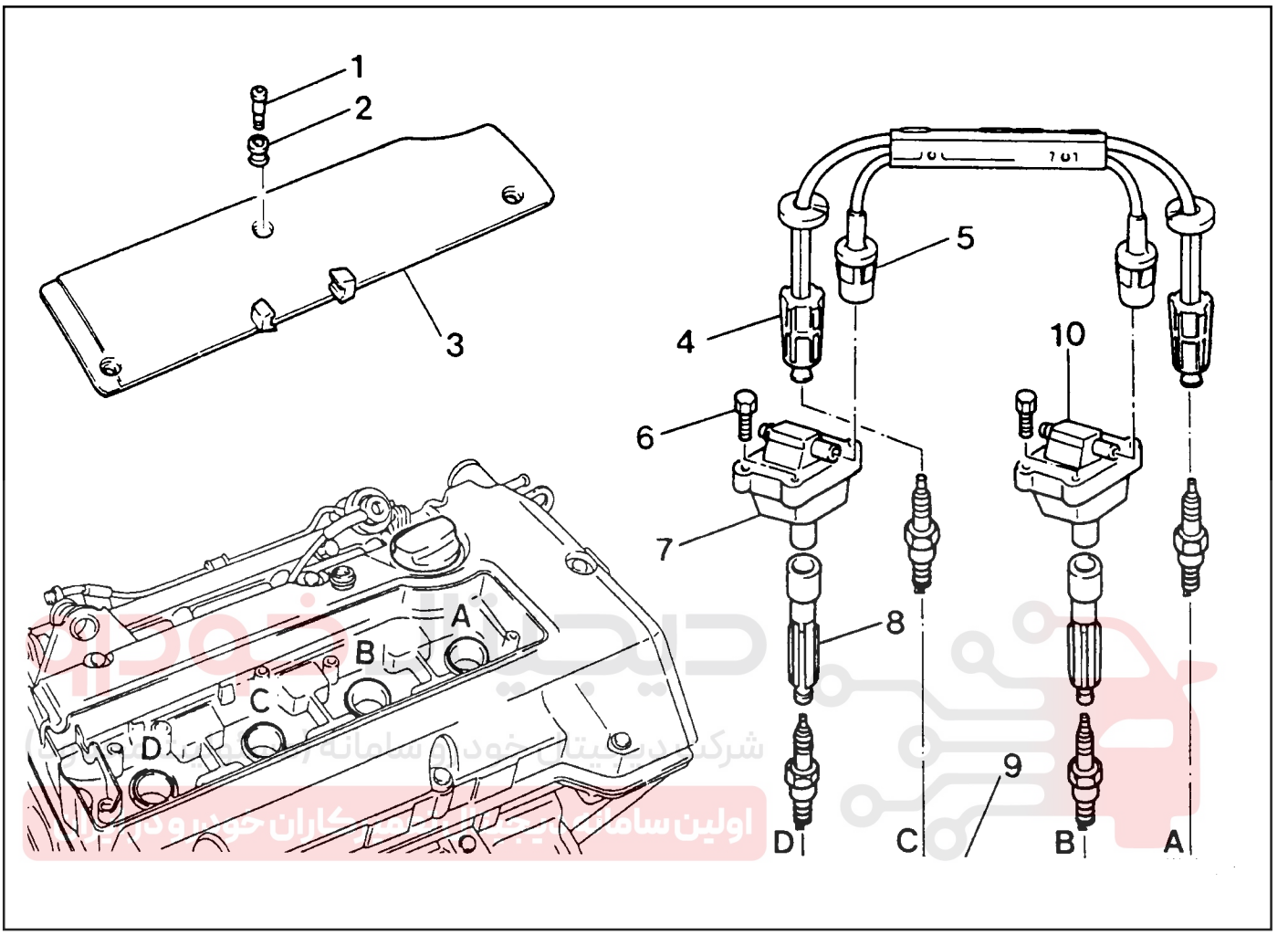


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SPARK PLUG

Preceding Work : Removal of intake air duct



1 Screw (3 pieces) ..... 9 - 11 Nm
2 Adaptor (3 pieces)
3 Ignition Coil Cable Cover
4 Spark Plug Connector
5 Ignition Coil Connector
6 Bolts (M6 X 25, 4 pieces) ..... 9 - 11 Nm
7 Ignition Coil (T1/1)
8 Coupling Plug
9 Spark Plug ..... 25 - 30 Nm
10 Ignition Coil (T1/2)

Tools Required

119 589 01 09 00 Spark Plug Wrence

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Replacement Procedure

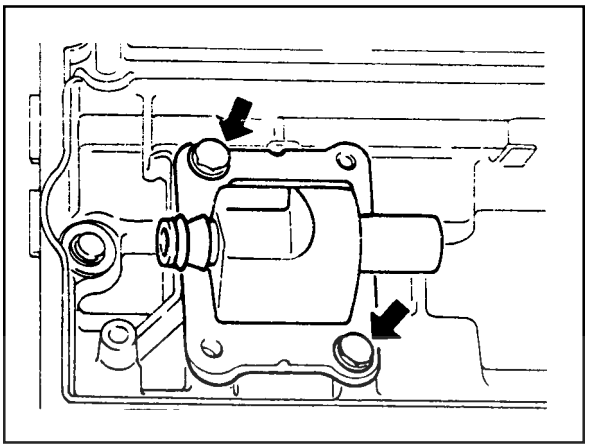
1. Unscrew the three screws(1) and remove the ignition coil cable cover

Installation Notice

Tightening Torque	9 - 11Nm

2. Disconnect the cable from ignition coil and spark plug.

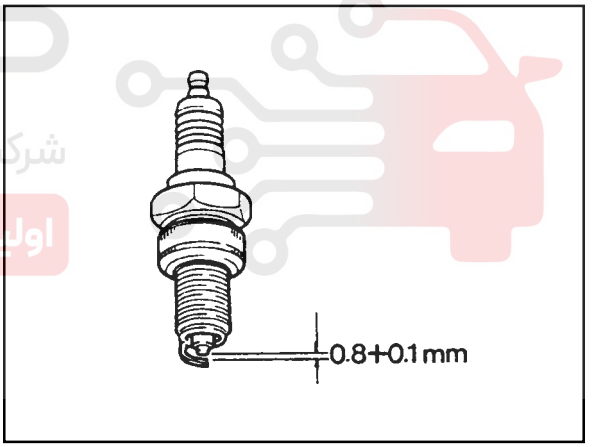
3. Unscrew two bolts(M6 X 25) from each ignition coil and remove the ignition coil(arrow) .



Installation Notice

Tightening Torque	9 - 11Nm

4. Using the special tool, remove the spark plug .



Installation Notice

Tightening Torque	25 - 30 Nm
Clearance	0.8 + 0.1 mm

Spark Plug Wrench 119 589 01 09 00

Notice

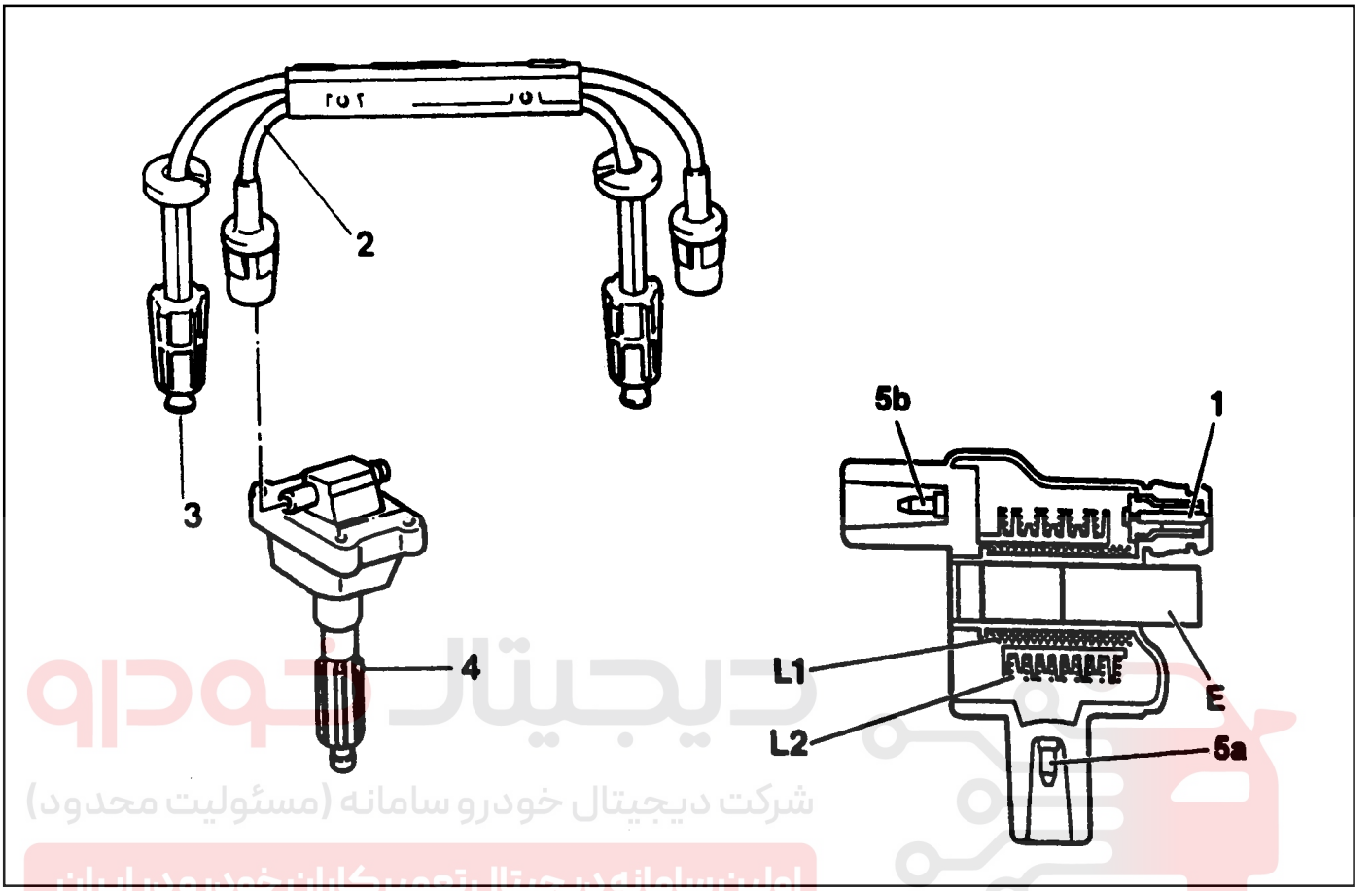
- Tighten the spark plug with specified torque.
- Install the ignition coil to number 2 and 4 cylinder, and connect the cable to number 1, 4 and 2, 3 cylinder
  - T1/1 : cylinder 1 and 4
  - T1/2 : cylinder 2 and 3

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IGNITION CABLE

Preceding Work : Removal of intake air duct



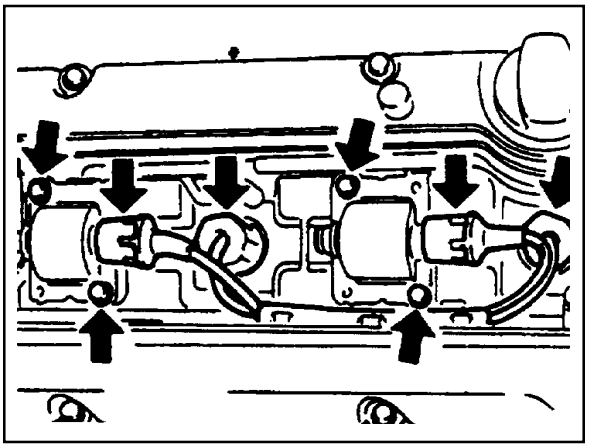
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1	Control Cable Connection	5a, 5b	Secondary Voltage Connection
2	Ignition Cable	E	Iron Core
3	Spark Plug Connector	L1	Secondary Ignition Coil
4	Coupling Plug	L2	Primary Ignition Coil

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Removal & Installation Procedure



1. Disconnect the battery negative cable.
2. Unscrew the 3 screws and remove the ignition cable duct cover.

Installation Notice

Tightening Torque	9 - 11 Nm

3. Seperate the cable from the ignition cable and the spark plug.
4. Remove the 2 bolts from each ignition cable and remove the ignition cables.

Installation Notice

Tightening Torque	9 - 11 Nm

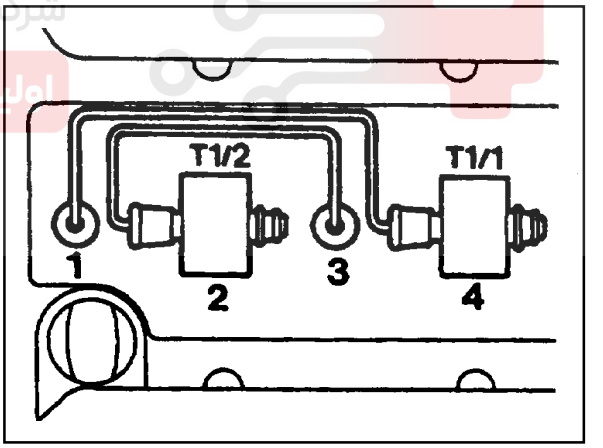
Install the ignition cable to the cylinder 2 and 4 and connect the cable from 1 to 4, and from 2 to 3.

- T1/1 : Cylinder 1 and 4
- T1/2 : Cylinder 2 and 3

5. Installation should follow the removal procedure in the reverse order.

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Ignition Cable and Cable Lay-out

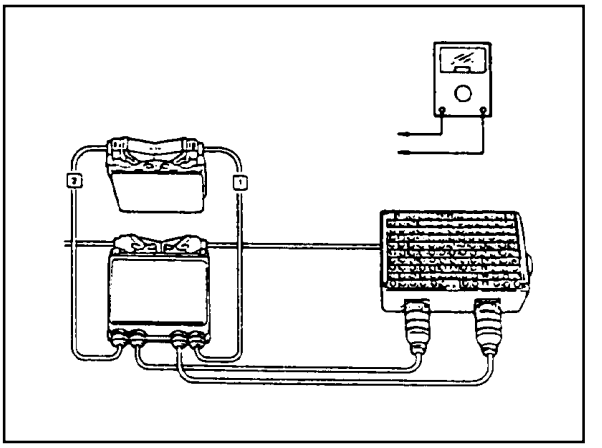


1. Firing Order : 1-3-4-2
2. T1/1 : Connect the cylinder 1 + 4
3. T1/2 : Connect the cylinder 2 + 3

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Inspection & Maintenance (for E2.3 MSE)



1. Measure the primary resistance between the cable terminals 1 and 15 after removing the ignition cable wiring connector (1 and 15) with ignition switch OFF.

   Notice

   Replace the ignition coil if out of the specified resistance.

Specified Value	0.9 - 1.6 W

2. Measure the primary voltage(T1/1) between the ECU terminals No.72 and No.69 during the engine cranking (starter motor activated).

Specified Value	200 - 350 V

   - T1/2 : between No.71 and No.69

   Notice

   Check the ignition cable and the ECU if out of the specified value.

3. Measure the secondary cable resistance between the ignition coil 5a and 5b using a multimeter.

Specified Value	6 - 8.5 KW

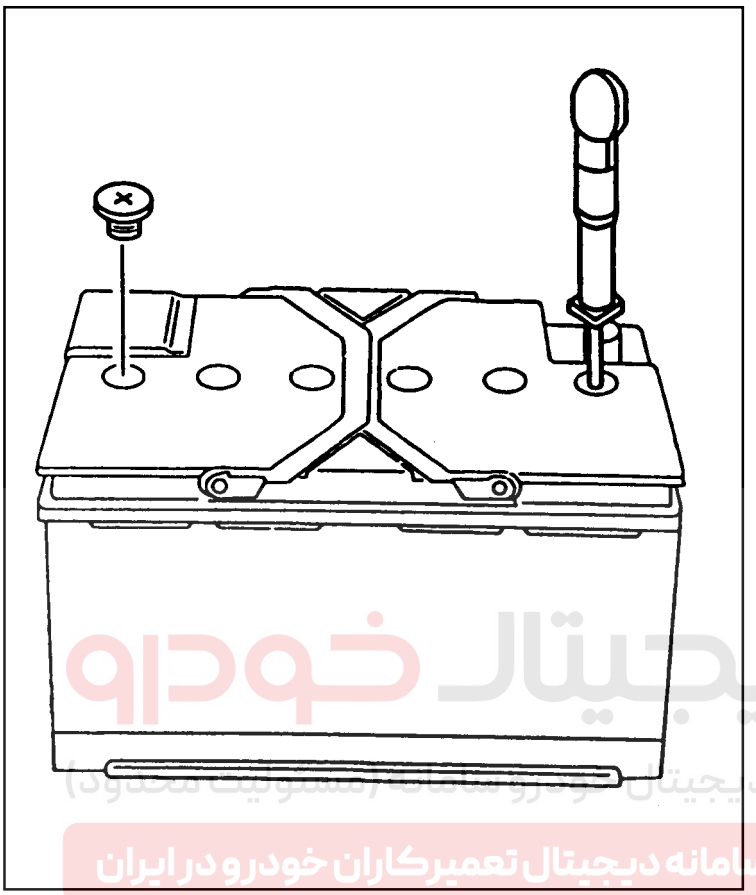
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UNIT REPAIR

BATTERY



Inspection

Notice

- When charging the battery, do not leave the inflammable objects around it.
- When checking the electrolyte of battery, put on an eye protector and gloves.

1. Inspect the surface of the battery and replace if any defects were found on it.
2. Check if the specific gravity of the electrolyte is within the specified value.

Battery Capacity(Ah)	75
Battery Specific Gravity	^{3} 1.24
Max. Tolerance between Cells	^{3} 0.04

Notice

- Replace the battery if the maximum tolerance of the electrolyte between cells is out of the specified value.
- Measure the specific gravity in the approx. 20°C of ambient temperature.

3. Replenish the electrolyte if necessary.

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SECTION 1E3

OM600 ENGINE ELECTRICAL

Caution: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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Starter Motor 1E3-8

SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Description
Alternator	12V - 75A
Starter	12V - 2.2kW
Glow Plug	11.5V

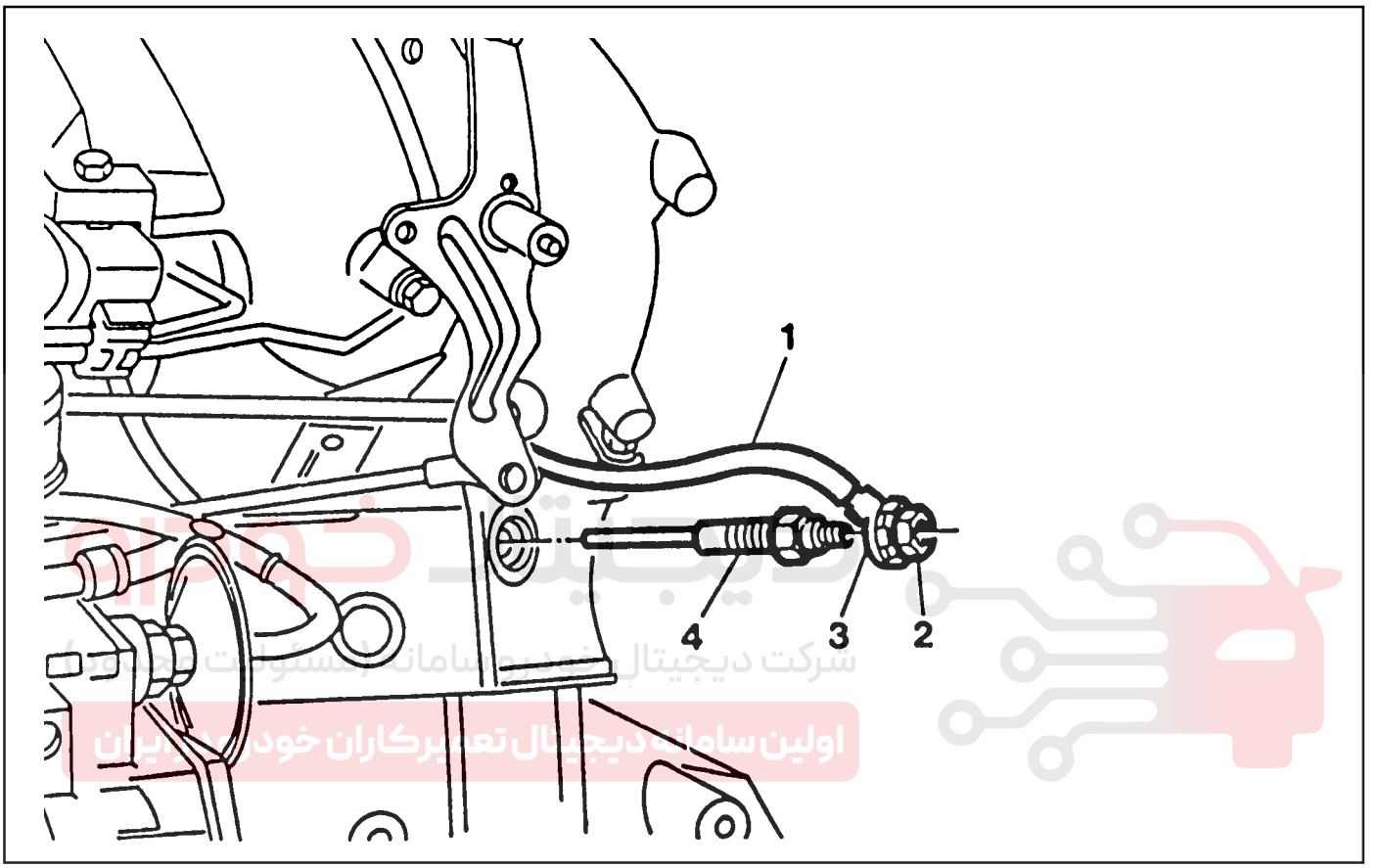
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

GLOW PLUG



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

Preheating System

General information

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

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

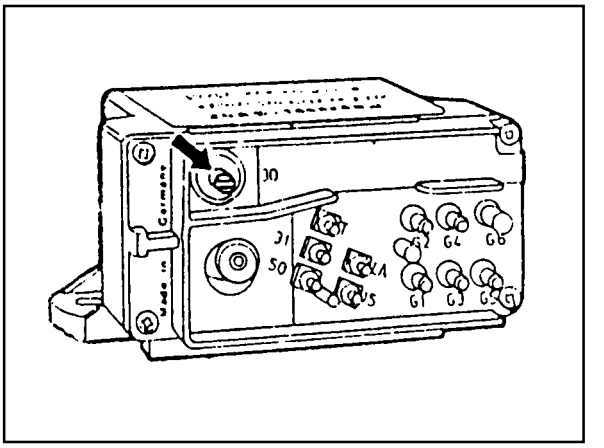
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1. Preheating time - control relay.

   Control relay functions as followings :

   - Switching of preheating current.
   - Indication of preheating finish.
   - Control of preheating sequence.
   - Indication of fault.



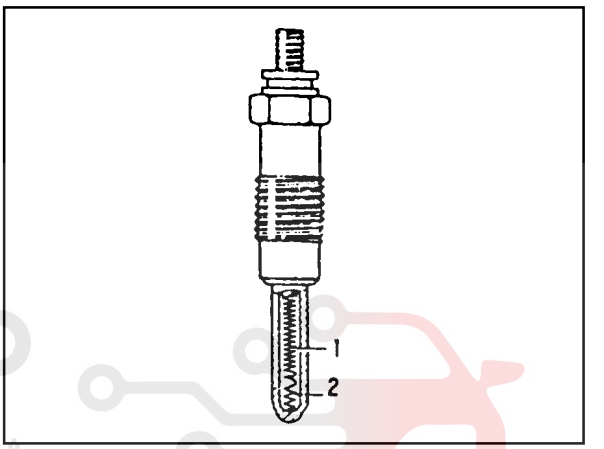
2. Coolant temperature sensor.

   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.



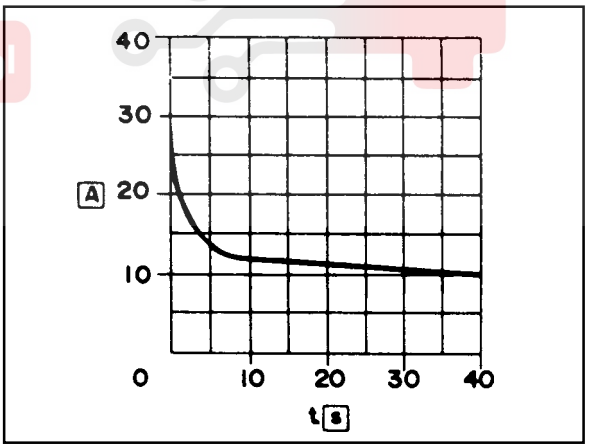
1. Control Coil
2. Heater Coil

4. Current and temperature of glow plug

   - Current of glow plug

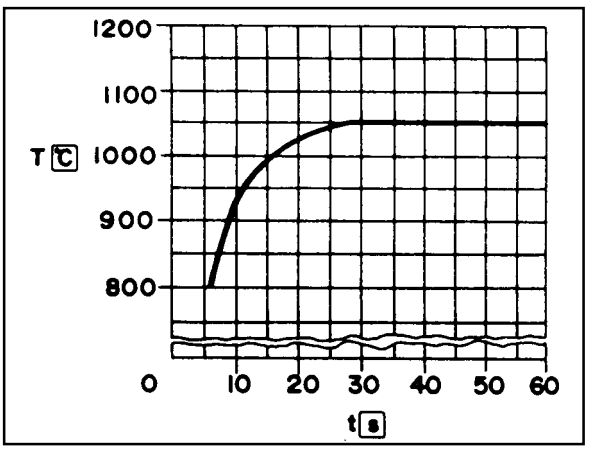
     While the preheating system operates, current of about 30A flows in each glow plug and temperature of heating coil rises very fast.

     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°C after about 9 seconds and up to 1,050°C after 30 seconds.



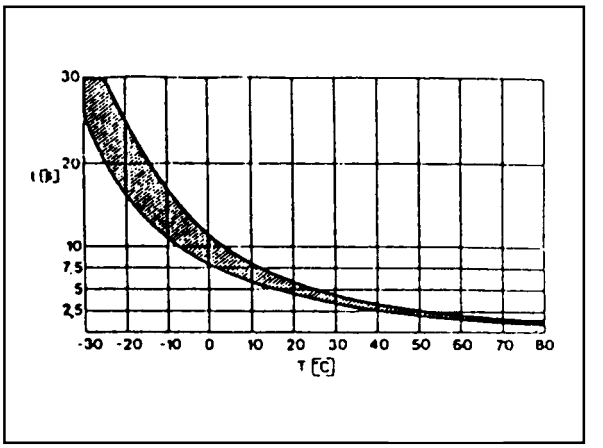
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Preheating System Operation

1. Preheating before start.

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



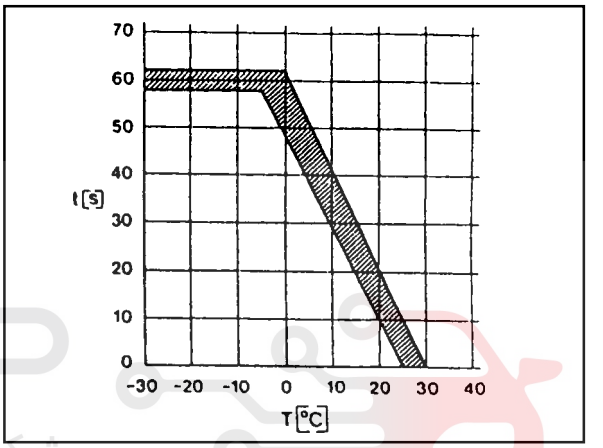
2. Preheating after start.

   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 on or several plugs are faulty.



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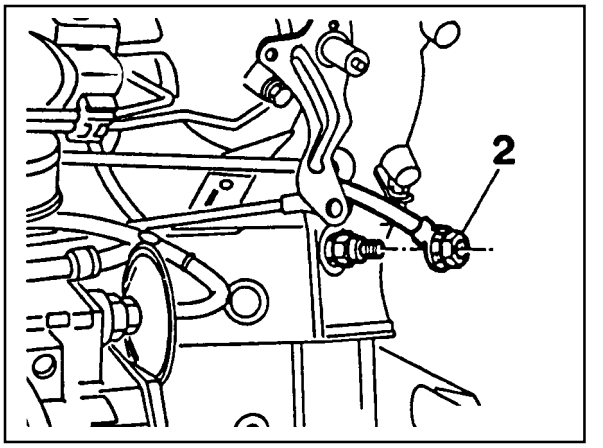
	Problem	Possible Cause
1	Glow indicator does not come on in preheating time and comes on after starting the engine.	- One or several glow are faulty
2	Glow indicator does not come on while preheating and after starting engine.	- Faulty glow indicator - Faulty circuit of glow indicator - Faulty control relay
3	Glow indicator does not 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
4	Glow indicator comes on after starting for about one minute.	- One or several glow plugs are faulty

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Removal & Installation Procedure

1. Disconnect the negative terminal of battery.
2. Remove the nut (2).

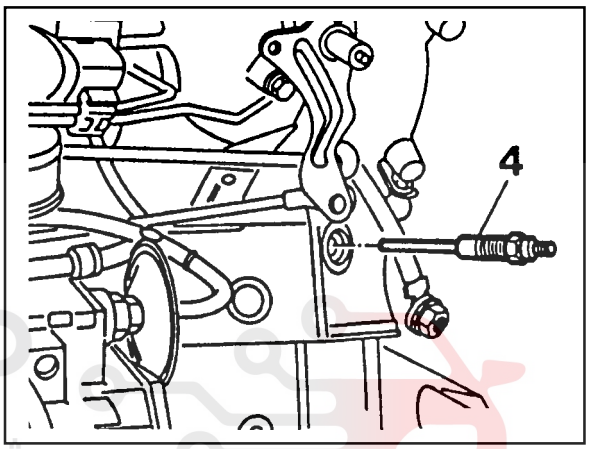


3. Remove the glow plug (4).
4. Install the glow plug (4).

Tightening Torque	20 Nm

5. Tighten the nut (2).

Tightening Torque	4 Nm



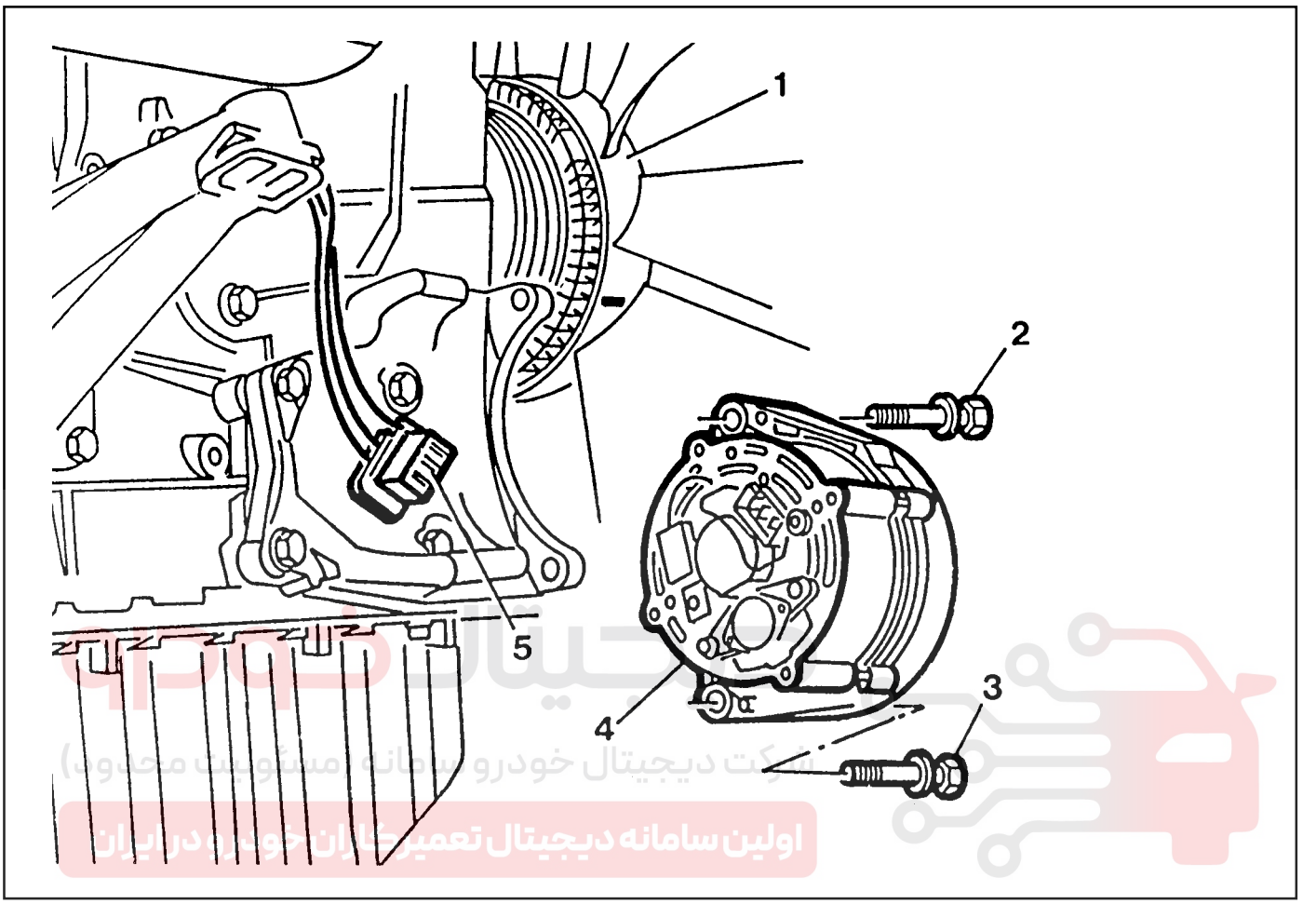
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ALTERNATOR

Preceding Work : Removal of poly V-belt



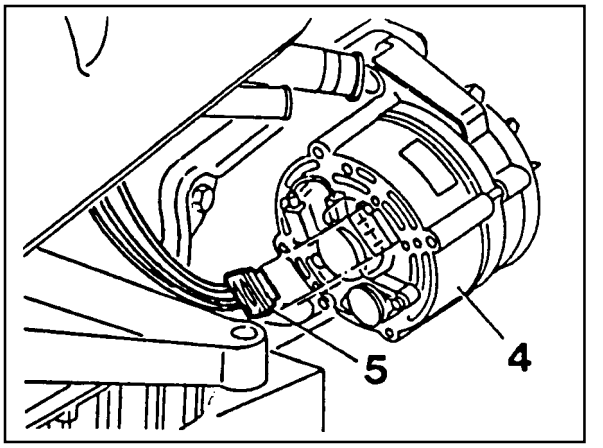
1 Cooling Fan
2 Bolt 45Nm
3 Bolt 45Nm
4 Alternator
5 Plug Connection

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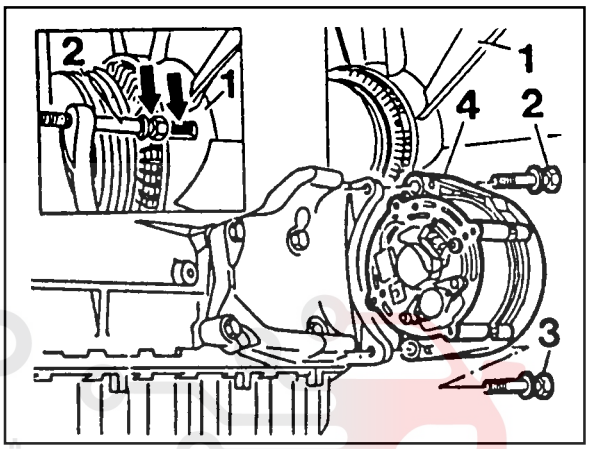
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Removal & Installation Procedure

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.

Tightening Torque	45 Nm

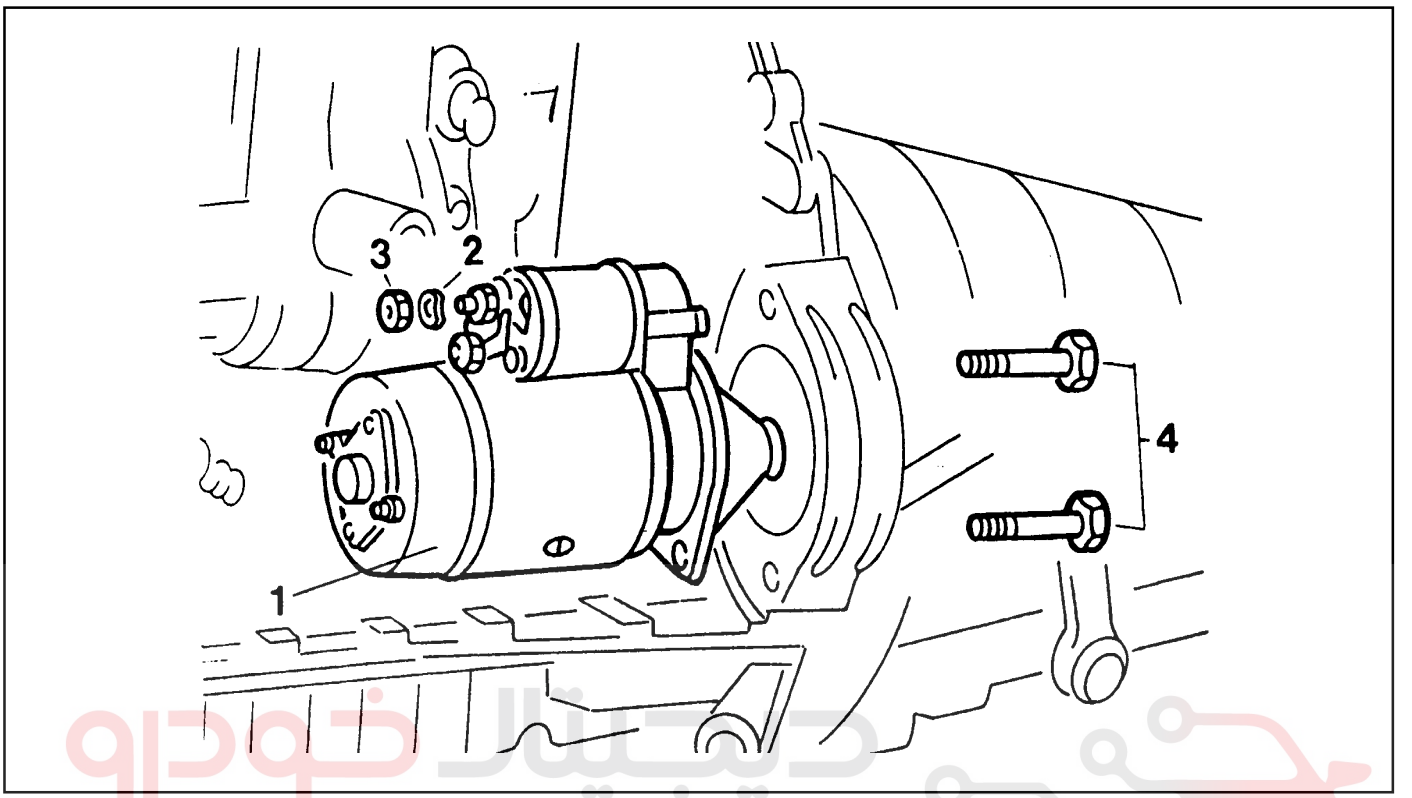
5. Installation should follow the removal procedure in the reverse order.

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STARTER MOTOR

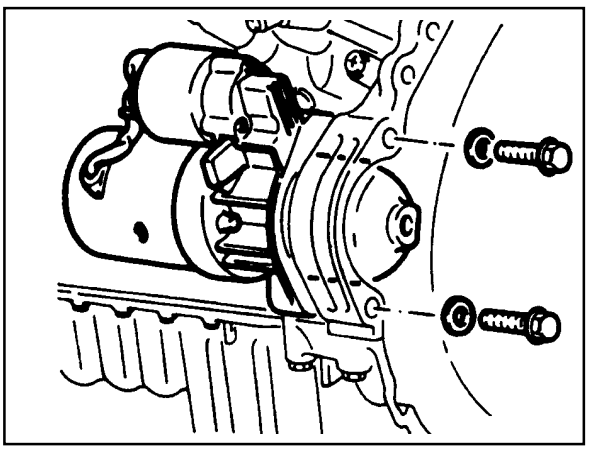


1	Starter Motor	3	Nut 15Nm
2	Washer	4	Bolt 48Nm

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Removal & Installation Procedure

1. Disconnect the battery terminals.
2. Disconnect the starter motor cable harnesses.
3. Remove the bolts and then remove the starter motor.
4. Installation should follow the removal procedure in the reverse order.



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SECTION 1F1

M162 ENGINE CONTROLS

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m
Fuel Return and Supply Line	25 - 30
Fuel Distributor Assembly Bolt	22.5 - 27.5
Pressure Test Connector	21.6 - 26.4
Fuel Inlet and Outlet Line	25 - 30
Fuel Filter Mounting Bracket Bolt	4 - 8
Crankshaft Position Sensor Bolt	9 - 11
Camkshaft Position Sensor Bolt	9 - 11
Knock Sensor Mounting Bolt	22.5 - 27.5
Coolant Temperature Bolt	18 - 22

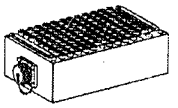
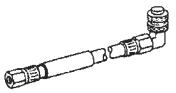
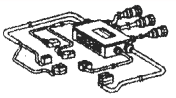
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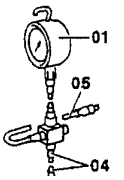
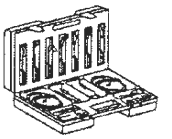
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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	129 589 00 21 00 Test Box
	119 589 04 63 00 Pressure Hose
	210 589 08 63 00 ECU Test Cable

	106 589 00 21 00 Pressure Tester
	210201Adaptor line

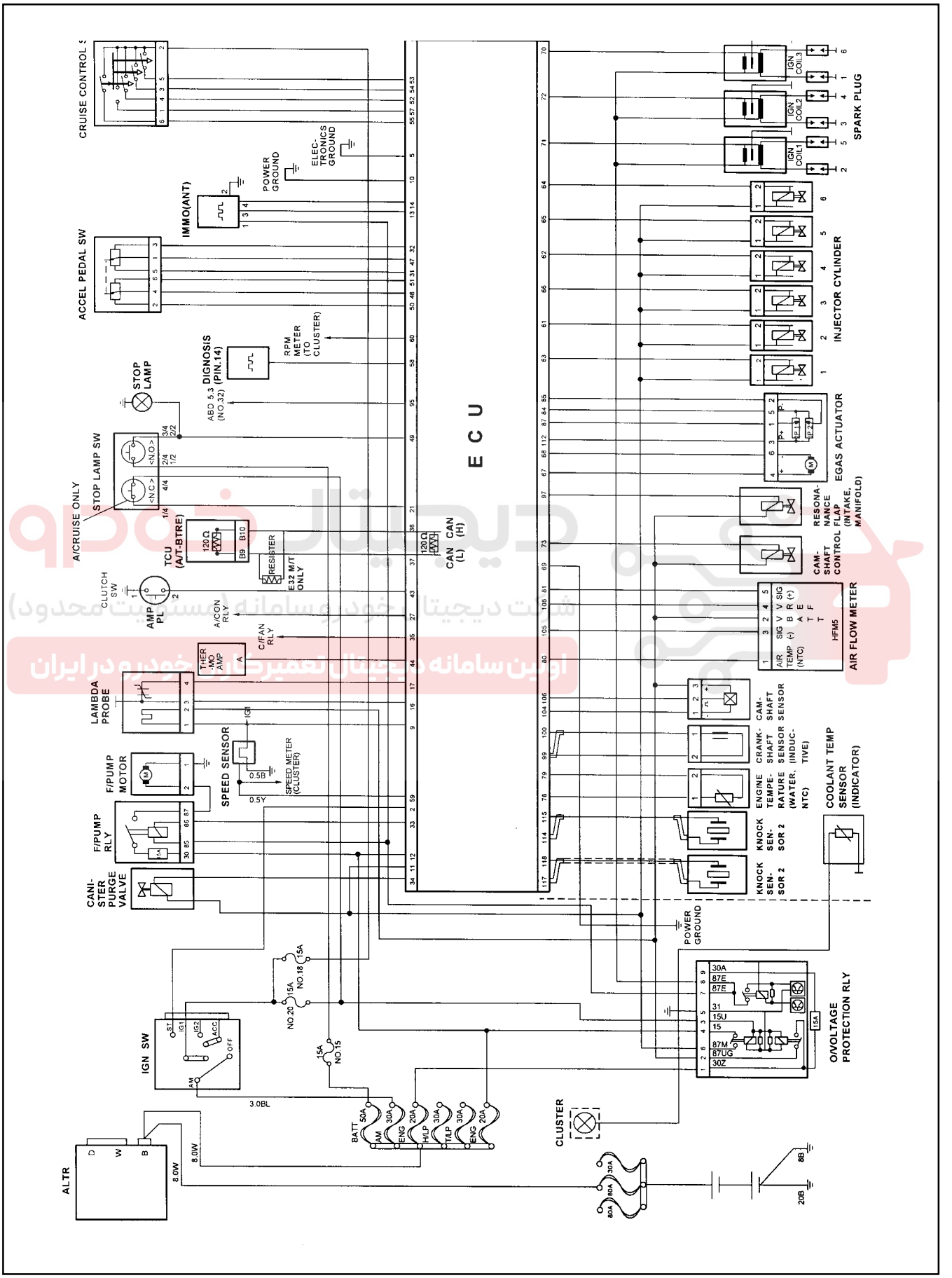
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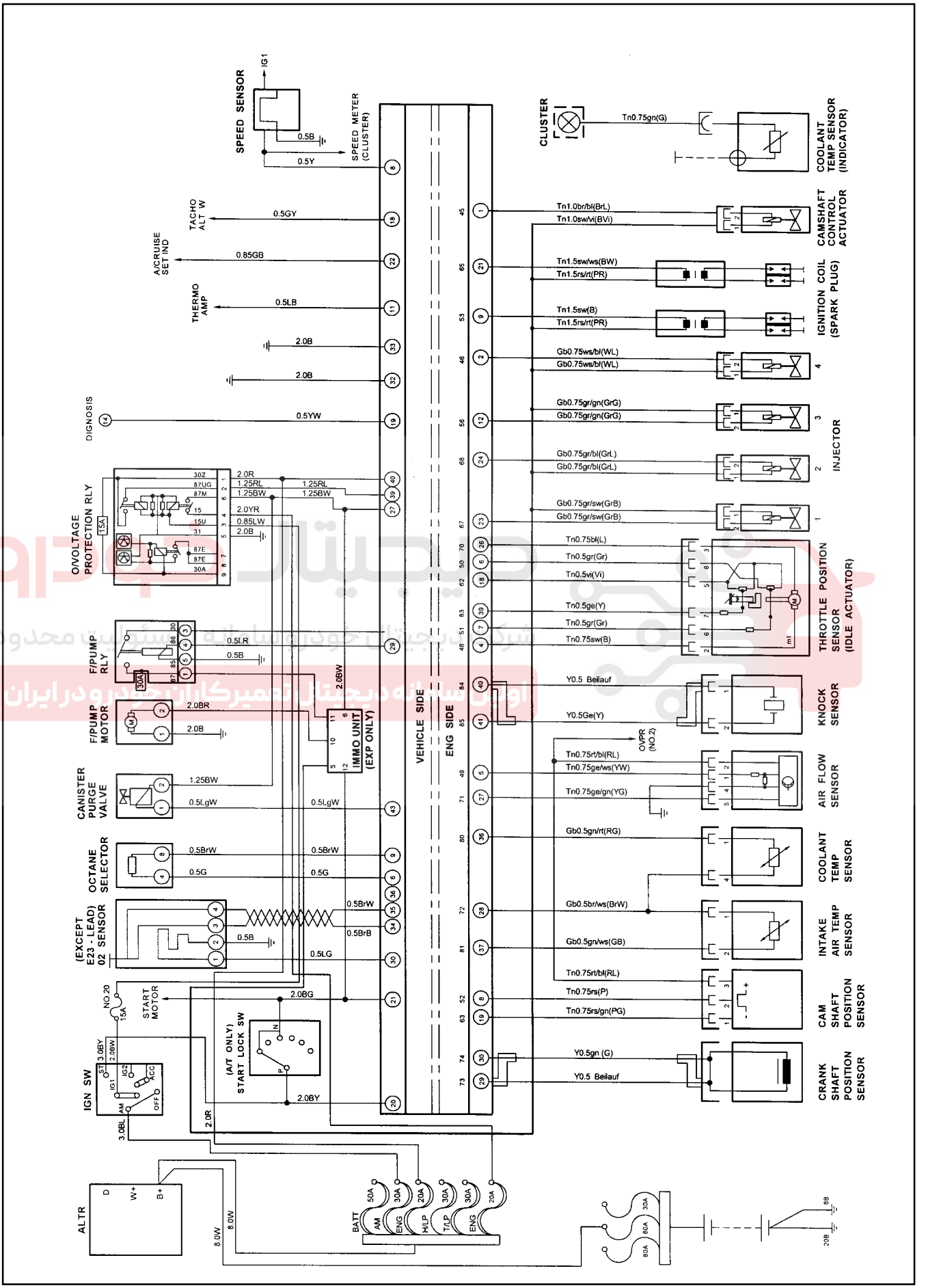
SCHEMATIC AND ROUTING DIAGRAMS

E32 ECU (HFM)



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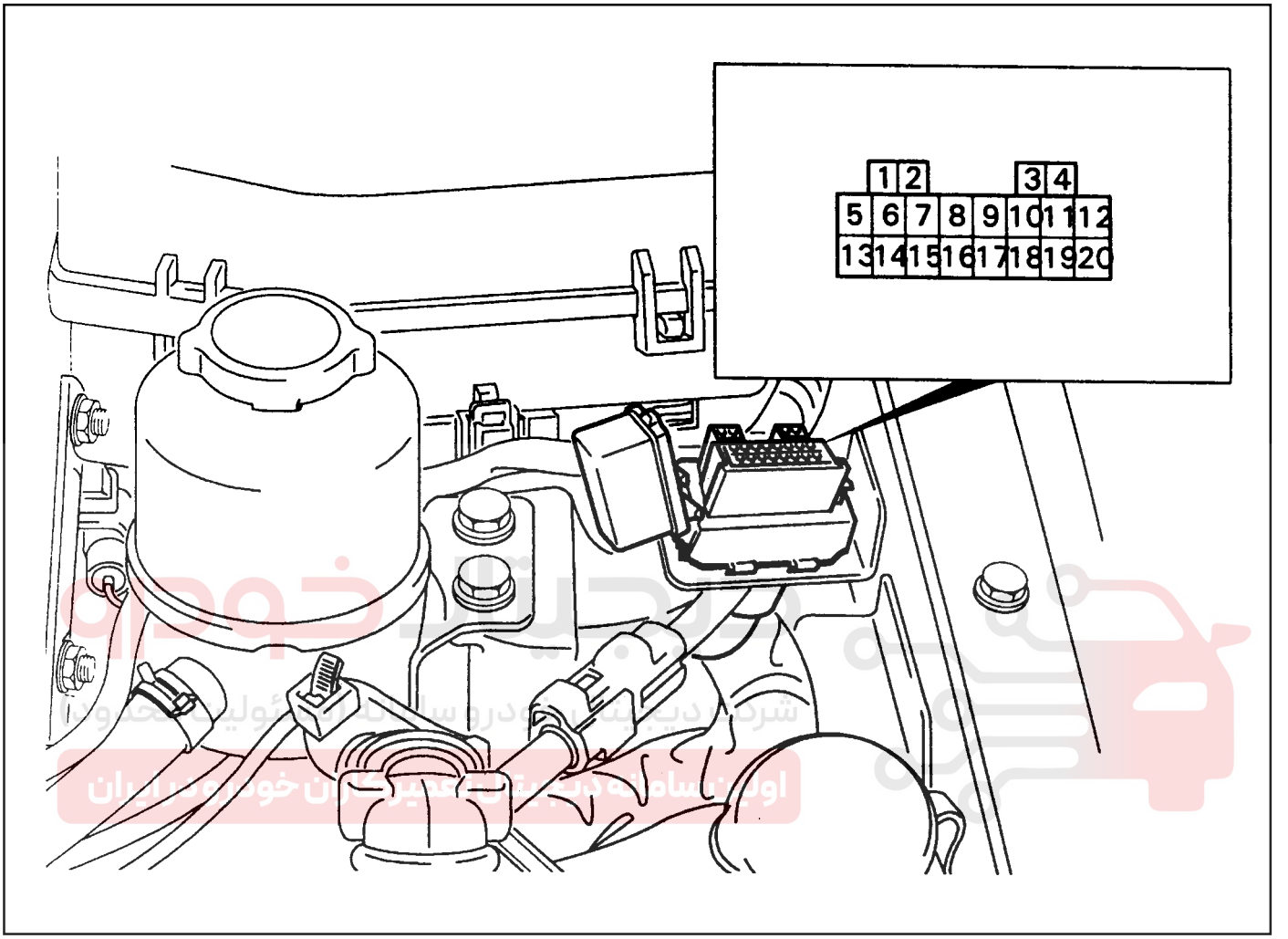


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DIAGNOSIS

SELF DIAGNOSIS SOCKET PIN NUMBERS AND DESCRIPTIONS



1 Ground
2 Ignition 1
3 Battery Power Supply (Fuse NO.17)
4 REKES :PIN 6
5 Engine Speed Signal :MSE PIN 60
6 TCCU(Part-time)
7 STICS(PIN 26)
8 -
9 -
10 Air Bag(PIN 20)
11 Remote Engine Start Unit(PIN 10)
12 -
13 Brake System
(ABS 5.3:PIN 11, ABS/ABD 5.3:PIN 46)
14 MSE 3.62S/3.53S(ECU Data Output:PIN 58)
15 TOD(PIN 20)
16 Immobilizer
17 -
18 TCU(PIN 23)
19 -
20 K-LINE(ECS:PIN 23)

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SELF DIAGNOSIS FAILURE CODE

Failure code	Description	Failure code	Description
00	Coolant temperature sensor open	41	Purge valve open/short
01	Coolant temperature sensor short	44	Condenser fan(HI) relay short(PWR)
02	Coolant temperature sensor signal failure	45	Condenser fan(HI) relay short(GND)
03	Intake temperature sensor open	56	No.1 knock sensor signal failure
04	Intake temperature sensor short	57	No.2 knock sensor signal failure
05	Intake temperature sensor signal failure	58	No.1 cylinder synchronization failure
08	Low battery voltage	59	-
09	HFM sensor signal failure	60	-
10	HFM sensor signal failure(Low)	62	Cluster S/W defectave
11	HFM sensor signal failure(High)	64	No ignition voltage output(No.1 ignition coil)
17	Crankshaft position sensor signal failure (no engine revolution signal)	65	No ignition voltage output(No.2 ignition coil)
		66	No ignition voltage output(No.3 ignition coil)
18	Crankshaft position sensor signal failure (rpm > max. value)	67	Crankshaft position sensor adaptation failure
		71	Start signal recognition failure
19	No.1 cylinder recognition failure	72	No.1 injector short(PWR)
20	Crankshaft position sensor signal failure (gab recognition failure)	73	No.1 injector open/short(GND)
		74	No.2 injector short(PWR)
21	Transmission coding failure	75	No.2 injector open/short(GND)
23	CAN communication failure : ASR	76	No.3 injector short(PWR)
24	-	77	No.3 injector open/short(GND)
25	Transponder signal failure	78	No.4 injector short(PWR)
26	CAN communication failure : TCU(A/T only)	79	No.4 injector open/short(GND)
27	CAN communication failure : TOD(E32 only)	80	High oxygen sensor voltage
29	-	81	Low oxygen sensor amplifying voltage
30	-	82	Oxygen sensor operating failure
31	CAN communication failure : communication initialization failure	83	Not excessive lean indication in oxygen sensor(during coasting)
34	Fuel pump relay short(PWR)	86	Oxygen sensor heater short(PWR)
35	Fuel pump relay open/short(GND)	87	Oxygen sensor heater open/short(GND)
40	Purge valve short	89	Low oxygen sensor voltage

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Failure code	Description	Failure code	Description
93	Short learning control failure	133	Cruise control acceleration failure
96	Lambda control failure (rich stop)	134	Cruise control deceleration failure
97	Lambda control failure (lean stop)	136	ECU failure(RAM)
98	Lambda idle adaptation failure(above rich threshold)	137	ECU failure(EPROM)
		139	Servo motor control output inter-ruption memory failure
99	Lambda idle adaptation failure(below lean threshold)		
		140	Servo motor open/short
100	learning control failure(rich, low load)	141	Unprogramed ECU with Immobilizer
101	learning control failure(lean, low load)	142	Uncoded ECU
102	learning control failure(rich, high load)	143	ECU failure(NVRAM checksum failure)
103	learning control failure(lean, high load)	144	ECU failure(coding ID checksum failure)
104	Low throttle position sensor(IP1) voltage	145	ECU failure(coding checksum failure)
105	High throttle position sensor(IP1) voltage	146	ECU failure(programing checkusm failure)
108	Low throttle position sensor(IP2) voltage	150	ABD input signal short(power)
109	High throttle position sensor(IP2) voltage	151	ABD input signal short(GND)
110	Throttle actuator learning data fault	160	Low pedal valve sensor SP1 voltage
116	Throttle actuator learning control failure	161	High pedal valve sensor SP1 voltage
117	Exceed fuel-cut safety time	162	Low pedal valve sensor SP2 voltage
119	Throttle valve return spring failure	163	High pedal valve sensor SP2 voltage
120	Cruise control interruption memory failure	164	Different pedal valve sensor signal(1,2)
121	Throttle actuator failure	167	Pedal valve sensor 1,2 failure
122	Pedal module position sensor signal failure	185	HFM sensor, and throttle position sensor failure
123	Different HFM signal with throttle potentiometer		
125	Both throttle potentiometer(IP1&IP2) failure	186	ECU failure(incompatible CPU)
126	IPS1 with IPS2	187	ECU failure(CPUs communication failure)
127	High permanent throttle signal	188	ECU failure(CPU(2) configuration failure)
129	Message counter failure® cruise control 'OFF'	189	ECU failure(CPU(2) fault)
130	Vehicle speed signal failure	190	ECU failure(CPU run time failure between CPUs)
131	Vehicle speed signal failure		
132	Cruise control lever failure	192	No.5 injector short(PWR)

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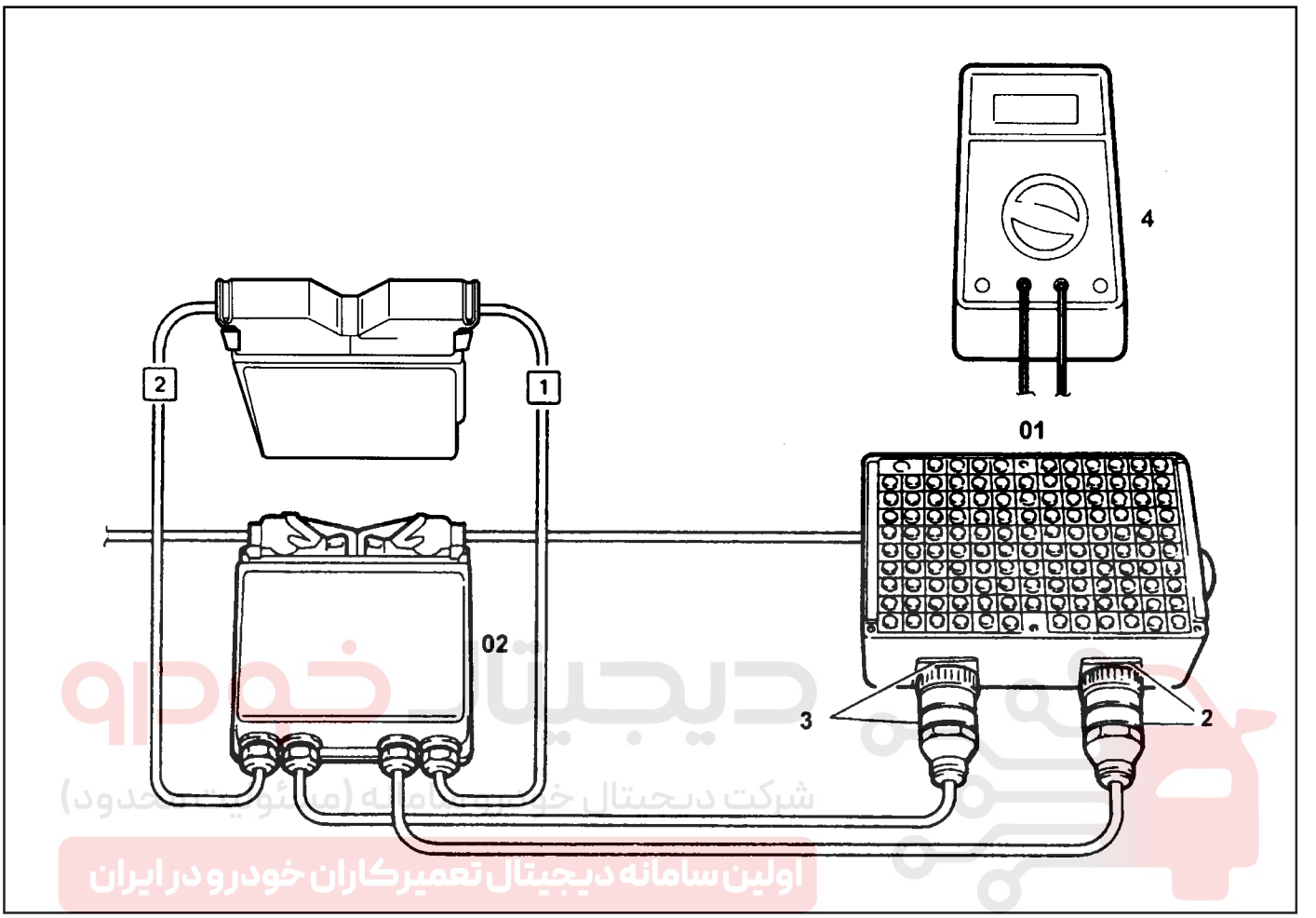
Failure code	Description	Failure code	Description
193	No.5 injector open/short(GND)	234	Control lever dual operation(CPU2)
194	No.6 injector short(PWR)	235	Control lever safety terminal failure(CPU2)
195	No.6 injector open/short(GND)	236	Unusual pedal position variation(CPU2)
198	Variable intake air valve short(PWR)	237	Unusal throttle position variation(CPU2)
199	Variable intake air valve open/short(GND)	238	Unusal throttle control data(CPU2)
226	Cam actuator short(PWR)	239	Unusal pedal position sensor(CPU2)
227	Cam actuator open/short(GND)	240	Throttle potentiometer fault(CPU2)
228	A/C compressor relay short(PWR)	241	Unusual CPU communication(CPU2)
229	A/C compressor relay open/short(GND)	242	Unusual CPU configuration(CPU2)
232	Over acceleration limit	243	AD converter failure(CPU2)
233	Over acceleration limit(CPU2)		

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TEST BOX CONNECTION



1 ECU
2 Test Coupling(No.1 - 60)
3 Test Coupling(No.61 - 120)
4 Multi-tester

01 Test Box
02 ECU Test Cable

Tools Required

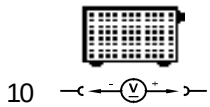
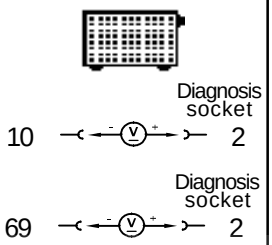
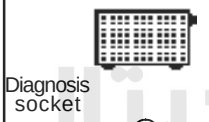
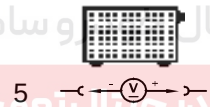
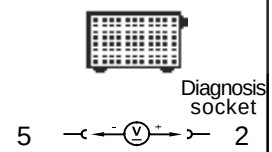
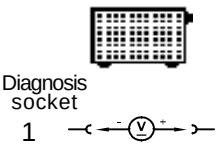
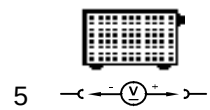
129 589 00 21 00 Test Box

210 589 08 63 00 ECU Test Cable

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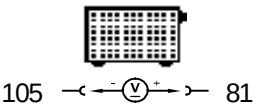
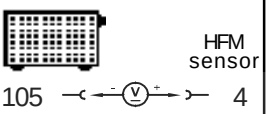
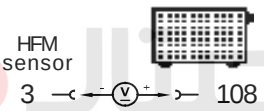
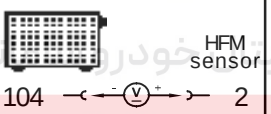
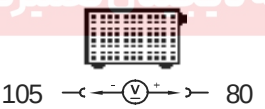
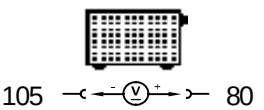
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FUEL INJECTION SYSTEM TEST (MSE3.62)

Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
08,	Þ 1.0	· **ECU:power supply** - terminal 30(TM.30)		· Ignition:ON	11 -14V	· Þ 1.1 · Þ 1.2
	Þ 1.1	· **Ground cable:** - Battery ground		· Ignition:ON	11 -14V	· Ground cable · Ground condition
	Þ 1.2	· **Power supply:** - terminal 30(TM.30)		· Ignition:ON	11 -14V	· Power supply cable
08,	Þ 2.0	· **ECU:power supply** - terminal 87(TM.87)		· Ignition:ON	11 -14V	· Þ 1.1 · Þ 2.1
	Þ 2.1	· **Ground cable** - Electronic ground		· Ignition:ON	11 -14V	· Ground cable
	Þ 2.2	· **Power supply:** - terminal 87(TM.87)		· Ignition:ON · Ignition:OFF	11 -14V < 1V	· Power supply cable · OVPR
	Þ 3.0	· **Start signal:** - terminal 50(TM.50)		· Engine:in Cranking	11 -14 (during engine cranking)	· Cable · Ignition switch

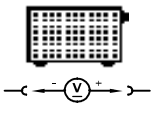
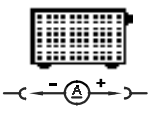
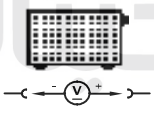
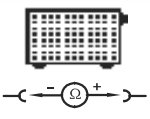
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
09, 10, 11,	Þ 4.0	· **HFM sensor signal**		· Ignition:ON	0.9 - 1.1V	· Þ 4.1 - 4.3 · Cable · External air inflow · HFM sensor
				· Engine:in Idle (Coolant temperature : > 70℃) : voltage value is increased when engine rpm is increased	1.3 - 1.7V	
	Þ 4.1	· **HFM sensor:** - 5V power supply		· Ignition:ON · HFM sensor connector removed	4.7 - 5.2V	· Cable · ECU coupling
	Þ 4.2	· **HFM sensor:** - 5V power supply		· Ignition:ON · HFM sensor connector removed	4.7 - 5.2V	· Þ 4.3 · Cable
	Þ 4.3	· **HFM sensor:** - 12V power supply		· Ignition:ON · HFM sensor connector removed	11 - 14V	· Cable · OVPR
03, 04, 05,	Þ 5.0	· **Intake air temperature sensor:** - Voltage		· Ignition:ON	℃ V 10 3.1 20 2.65 30 2.18 40 1.76 50 1.4 60 1.1 ± 5%	· Þ 5.1 · ECU
	Þ 5.1	· **Intake air temperature sensor:** - Resistance		· Ignition:OFF · No.2 ECU coupling removed	℃ W 10 3600 20 2420 30 1662 40 1166 50 853 60 600 ± 5%	· Cable · HFM sensor

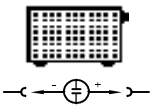
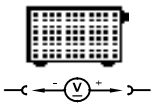
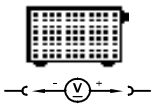
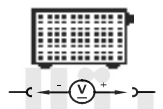
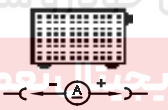
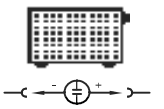
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
34,	Þ 6.0	· **Fuel pump relay:** - Operation	 33 — V — 11	· Ignition:ON (Fuel pump relay will operate for 1 - 2 seconds when the ignition switch is turned to "ON" after stopping the engine) · Engine:cranking	11 - 14V (approx.1-2sec.) 11 - 14V (Cranking or driving)	· Cable · Fuel pump relay
34, 35,	Þ 6.1	· **Fuel pump relay:** - Current consumption	 5 — A — 33	· Ignition:ON	0.1 - 0.3A	· Cable · Fuel pump relay · ECU
00, 01, 02, 06,	Þ 7.0	· **Coolant temperature sensor:** - Voltage	 79 — V — 78	· Ignition:ON	℃ V 20 3.57 80 1.22 100 0.78 ±5%	· Þ 7.1 · ECU
	Þ 7.1	· **Coolant temperature sensor:** - Resistance & cable	 79 — Ω — 78	· Ignition:OFF (Remove the No.2 coupling from ECU)	℃ W 20 2500 80 322 100 185 ±5%	· Þ 7.2 · Cable
	Þ 7.2	· **Coolant temperature sensor:** - Resistance	Coolant temperature sensor: 1 — Ω — 4	· Remove the connector from coolant temperature sensor and measure the resistance between No.1 and No.2 pin with multimeter.	· Þ refer to specified resistance value of 7.1	· Coolant temperature sensor

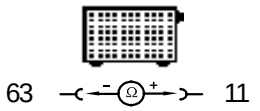
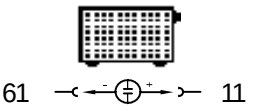
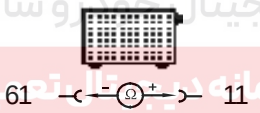
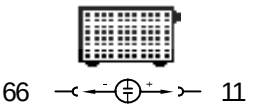
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
32, 33,	Þ 8.0	· **ECU:** - RPM signal output		· Engine:in cranking or idle	refer to figure 2	· Cable · ECU
		- Voltage		· Engine:in cranking or idle (above 5V in idling)	6.0 - 7.0 V	
80, 81, 82, 83, 89,	Þ 9.0	· **Oxygen sensor:** - Signal		· Keep the engine run above 2 minutes in over 80℃ of coolant temperature.	There will be a voltage fluctuation in the range of - 0.2 -1.0V	· ECU · Cable · Oxygen sensor
85, 86, 87,	Þ 10.0	· **Oxygen sensor:** - Heating function operated		· Keep the engine run above 2 minutes in over 80℃ of coolant temperature.	11 - 14 V	· ECU · Cable · Oxygen sensor
		- Current consumption		· Ignition:ON	0.2 - 2.0 A	
72, 73,	Þ 11.0	· **No.1 cylinder injector:** - Operating & injection time		· When the coolant temperature is approx. 20℃: - Engine:in cranking · When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	8.0 ms approx. 2.7 - 5.0ms approx. 14ms	· Cable · ECU · No.1 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor

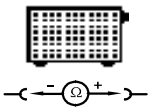
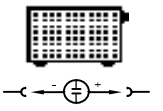
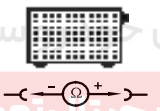
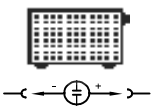
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		- Internal resistance (No.1 injector)	 63 11	· Ignition:OFF(injector temperature is 20℃)	14 - 17 W	
74, 75,	Þ 12.0	· **No.2 cylinder injector:** - Operating & injection time	 61 11	· When the coolant temperature is approx. 20℃: - Engine:in cranking · When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	8.0 ms approx. 2.7 - 5.0ms approx. 14ms	· Cable · ECU · No.2 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor
		- Internal resistance (No.2 injector)	 61 11	· Ignition:OFF(injector temperature is 20℃)	14 - 17 W	
76, 77,	Þ 13.0	· **No.3 cylinder injector:** - Operating & injection time	 66 11	· When the coolant temperature is approx. 20℃: - Engine:in cranking · When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	8.0 ms approx. 2.7 - 5.0ms approx. 14ms	· Cable · ECU · No.3 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor

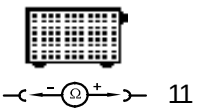
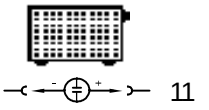
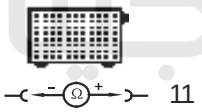
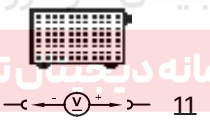
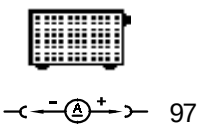
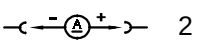
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		- Internal resistance (No.3 injector)	 66 11	· Ignition:OFF(injector temperature is 20℃)	14 - 17 W	
78, 79,	Þ 14.0	· **No.4 cylinder injector:** - Operating & injection time	 62 11	· When the coolant temperature is approx. 20℃: - Engine:in cranking · When the coolant temperature is approx. 80℃ - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	8.0 ms approx. 2.7 - 5.0ms approx. 14ms	· Cable · ECU · No.4 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor
		- Internal resistance (No.4 injector)	 62 11	· Ignition:OFF(injector temperature is 20℃)	14 - 17 W	
192, 193,	Þ 15.0	· **No.5 cylinder injector:** - Operating & injection time	 65 11	· When the coolant temperature is approx. 20℃: - Engine:in cranking · When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	8.0 ms approx. 2.7 - 5.0ms approx. 14ms	· Cable · ECU · No.5 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor

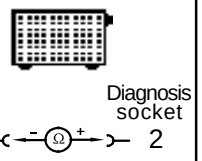
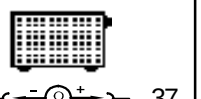
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		- Internal resistance (No.5 injector)	 65 — Ω — 11	· Ignition:OFF(injector temperature is 20℃)	14 - 17 W	
194, 195,	Þ 16.0	· **No.6 cylinder injector:** - Operating & injection time	 64 — ⏚ — 11	· When the coolant temperature is approx. 20℃: - Engine:in cranking · When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	8.0 ms approx. 2.7 - 5.0ms approx. 14ms	· Cable · ECU · No.6 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor
		- Internal resistance (No.6 injector)	 64 — Ω — 11	· Ignition:OFF(injector temperature is 20℃)	14 - 17 W	
198, 199,	Þ 17.0	· **Variable intake air valve (resonance flap switch valve)** - Operating	 97 — V — 11	· Engine:in cranking/ below 3500rpm · Engine:rpm > above 3500rpm	< 1V 11 - 15V	· ECU · Cable · Variable intake air valve
		- Current consumption	 69 — A — 97	· Ignition:ON	0.4 - 0.6A	
226, 227,	Þ 18.0	· **Camshaft actuator:** Current consumption	Camshaft actuator  1 — A — 2	· Engine : in idling - Coolant temperature : above 70℃ - Engine rpm : increase up to 2000 rpm	1 - 1.5 A	· ECU · Þ 18.1 · Þ 19.0

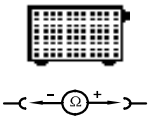
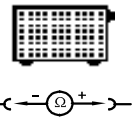
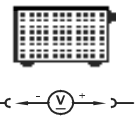
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 18.1	· **Camshaft actuator:** Solenoid resistance		· Ignition:OFF	8 - 12 W	· Cable · Camshaft actuator
226, 227,	Þ 19.0	· **Camshaft actuator:** Mechanical Actuation		· Engine:in idling - connect the bridge to the test box for approx. 10 seconds	Engine is unstable or stopped	· Mechanical failure of camshaft actuator
40, 41, 54,	Þ 20.0	· **Purge control valve:** - Operating		· Engine:in idling	The purge control valve should be operated after approx. 1minute. (refer to figure 5)	· ECU · Cable · Purge control valve
		- Current consumption		· Ignition:ON	0.3 - 0.5 A	
	Þ 21.0	· **Purge control valve:** - Vacuum control	Connect the vacuum gauge between the control valve and canister	· Engine:in idling/ normal operating temperature	Creating above 50mbar of vacuum after approx. 1 minute	· Vacuum line · Purge control valve
22,23, 24,26, 27,29, 30,31, 59,60,	Þ 22.0	· **CAN data bus**		· Ignition:OFF	55 - 65 W	· Data bus · Þ 22.1 · Þ 22.2

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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 22.1	· **CAN module resistance in ABS, ABD, ASR control unit**	 38 — Ω — 37	· Ignition:OFF - disconnect the coupling "No.1" from ECU.	115 - 125 W	· Cable · ABS, ABD, ASR control unit
22,23, 24,26, 27,29, 30,31, 59,60,	Þ 22.2	· **CAN module resistance in ECU control unit**	 38 — Ω — 37	· Ignition:OFF - disconnect the coupling "No.1" from ECU.	115 - 125 W	· ECU
	Þ 23.0	· **Diagnosis cable operating**	 5 — V — 58	· Ignition:ON	11 - 14 V	· ECU · Cable

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Reference Figures

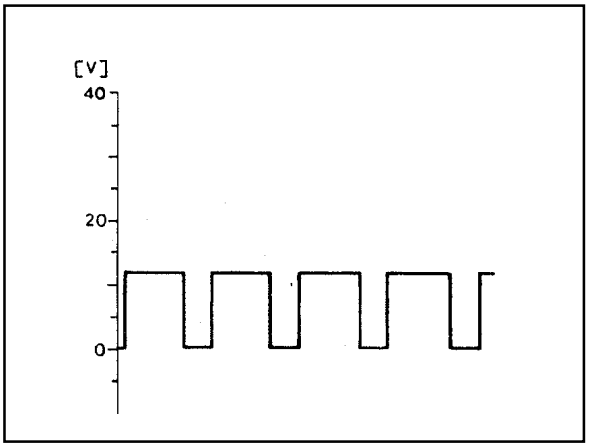


Figure2. RPM Sgnal Output

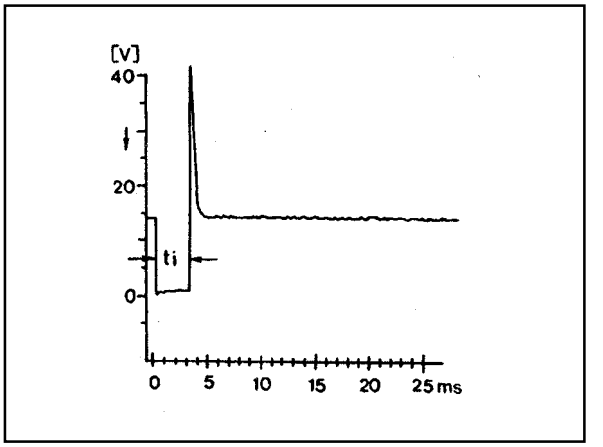


Figure 3. Injection Valve Wave(at idle speed)

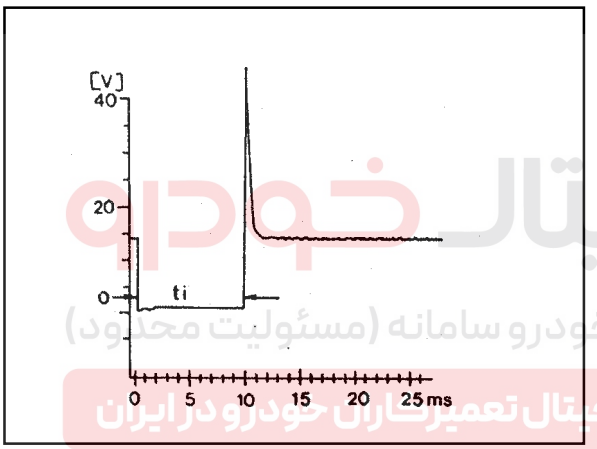


Figure 4. Injection Valve Wave(at sharp acceleration)

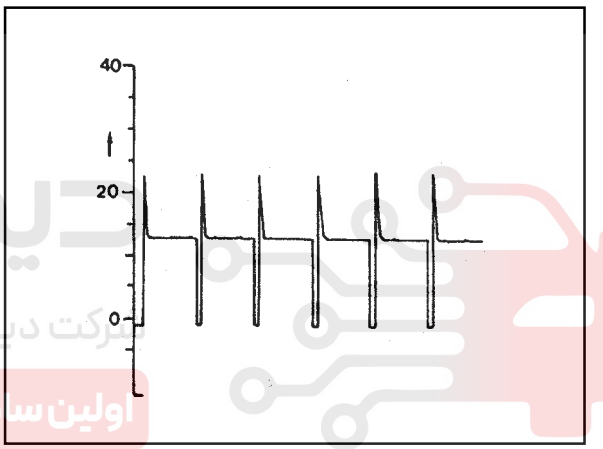
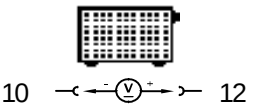
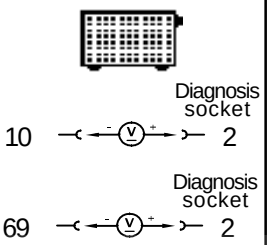
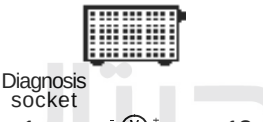
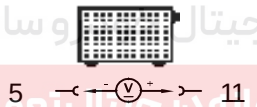
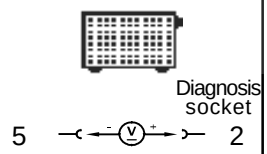
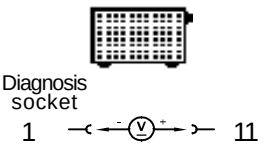
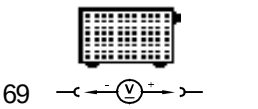


Figure 5. Purge Control Valve Operationg Wave

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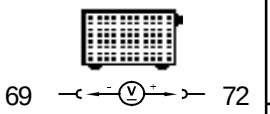
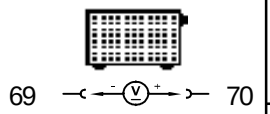
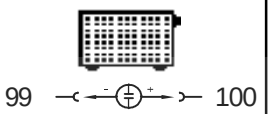
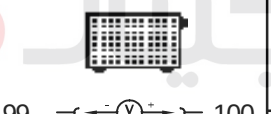
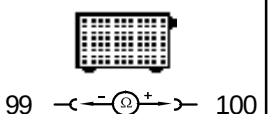
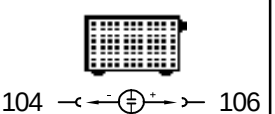
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IGNITION SYSTEM TEST

Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
08,		· **ECU:power supply** - terminal 30(TM.30)			11 - 14V	· Þ 1.1 · Þ 1.2
	Þ 1.1	· **Ground cable:** - Battery ground		· Ignition:ON	11 - 14V	· Ground cable · Ground condition (figure 1)
	Þ 1.2	· **Power supply:** - terminal 30(TM.30)		· Ignition:ON	11 - 14V	· Power supply cable · Fuse No.8
08,	Þ 2.0	· **ECU:power supply** - terminal 87(TM.87)		· Ignition:ON	11 -14V	· Þ 2.1 · Þ 2.2
	Þ 2.1	· **Ground cable** - Electronic ground		· Ignition:ON	11 - 14V	· Ground cable
	Þ 2.2	· **Power supply:** - terminal 87(TM.87)		· Ignition:ON	11 - 14V	· Power supply cable · OVPR
				· Ignition:OFF	< 1V	
64,	Þ 3.0	· **Ignition coil(T1/1)** - No.2,5 Cylinder		· Ignition:ON	11 - 14 V	· Cable · Ignition coil(T1/1) · Fuse No.17
				· Engine:in cranking	> 10 V	

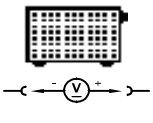
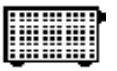
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
65,	Þ 4.0	· **Ignition coil(T1/2)** - No.3,4 Cylinder	 69 72	· Ignition:ON	11 -14 V	· Cable · Ignition coil(T1/2) · Fuse No.17
				· Engine:in cranking	> 10 V	
66,	Þ 5.0	· **Ignition coil(T1/3)** - No.1,6 Cylinder	 69 70	· Ignition:ON	11 -14 V	· Cable · Ignition coil(T1/3) · Fuse No.17
				· Engine:in cranking	> 10 V	
17, 18, 20, 67,	Þ 6.0	· **Crankshaft position sensor:** - Signal	 99 100	· Engine:in cranking · Engine:in idling	Measure the signal (refer to figure 6)	· Þ 6.1 · Increament failure in driven plate
		- Voltage (alternating)	 99 100	· Engine:in cranking	> 2.5 V -	
				· Engine: in idling	> 5 V - Voltage value is increased when engine rpm is increased	
17, 18, 20, 67,	Þ 6.1	· **Crankshaft position sensor:** - Resistance	 99 100	· Ignition:OFF - Disconnect the coupling "NO.2" from ECU	1050 - 1400w	· Cable · Crankshaft position sensor
19, 58,	Þ 7.0	· **Camshaft position sensor:** - Signal	 104 106	· Engine:in cranking	Measure the signal(refer to figure 7)	· Þ 7.1 · Cable · Camshaft position sensor

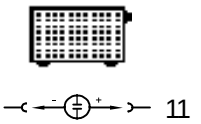
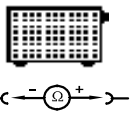
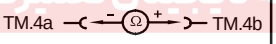
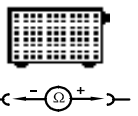
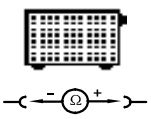
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		- Voltage (alternating)	 106 11	· Engine:in cranking	The value will be changed in 1.2 - 1.7 V	
	Þ 7.1	· **Camshaft position sensor** (E23 only) - Power supply	Camshaft position sensor  1 3	· Ignition:ON - Remove the connector from the Camshaft position sensor between No.1 terminal and No.3 terminal.	11 -14 V	· Cable · OVPR
64,	Þ 8.0	· **Ignition coil(T1/1)** - primary coil voltage (No.2 and 5 cylinder)	 71 11	· Engine:in cranking (starter operating) - Measuring range: 400 V - Time range: 100 % (using engine tester)	200 - 350 V	· Þ 8.1
	Þ 8.1	· **Connecting resistance of ignition coil between T1/ 1 and T1/2**	 71 72	· Ignition:OFF	0.9 - 1.6 W The resistance of ignition coil at 20 ℃ is approached 0.6W	· Cable · Ignition coil T1/1 · Ignition coil T1/2
65,	Þ 9.0	· **Ignition coil(T1/2)** - primary coil voltage (No.3 and 4 cylinder)	 72 11	· Engine:in cranking (starter operating) - Measuring range: 400 V - Time range: 100 % (using engine tester)	200 - 350 V	· Þ 9.1
	Þ 9.1	· **Connecting resistance of ignition coil between T1/ 2 and T1/1**	 72 71	· Ignition:OFF	0.9 - 1.6 W The resistance of ignition coil at 20 ℃ is approached 0.6W	· Cable · Ignition coil T1/1 · Ignition coil T1/2

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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
66,	Þ 10.0	· **Ignition coil(T1/3)** - primary coil voltage (No.1 and 6 cylinder)	 11	· Engine:in cranking (starter operating) - Measuring range: 400 V - Time range: 100 %	200 - 350 V	· Þ 10.1
	Þ 10.1	· **Connecting resistance of ignition coil between T1/ 3 and T1/2**	 70 72	· Ignition:OFF	0.9 - 1.6 W The resistance of ignition coil at 20 ℃ is approached 0.6W	· Cable · Ignition coil T1/3 · Ignition coil T1/2
64, 65, 66,	Þ 11.0	· **Ignition coil** (T1/1, T1/2, T1/3) - Secondary ignition voltage	Engine tester 	· Engine:in cranking - Select the ignition coil in order of T1/1, T1/2 - Measuring range: 20KV - Time range:100 %	8 - 20 KV	· Þ 11.1 · Ignition plug · ECU · High tension cable
	Þ 11.1	· **Ignition coil** (T1/1, T1/2, T1/3) - Secondary coil resistance	Ignition coil (T1/1, T1/2, T1/3)  TM.4a TM.4b	· Remove the high tension cable of T1/ 1, T1/2, T1/3.	6 - 8.5 KW	· Ignition coil T1/1 · Ignition coil T1/2 · Ignition coil T1/3
56,	Þ 12.0	· **Knock sensor 1** - Resistance (cylinder No1, 2, 3)	 117 118	· Ignition:OFF - Disconnect the coupling "No.2" from ECU.	> 10 MW	· Connecting condition · Cable · ECU
57,	Þ 13.0	· **Knock sensor 2** - Resistance (cylinder No.4, 5, 6)	 114 115	· Ignition:OFF - Disconnect the coupling "No.2" from ECU.	> 10 MW	· Connecting condition · Cable · ECU

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Reference Figures

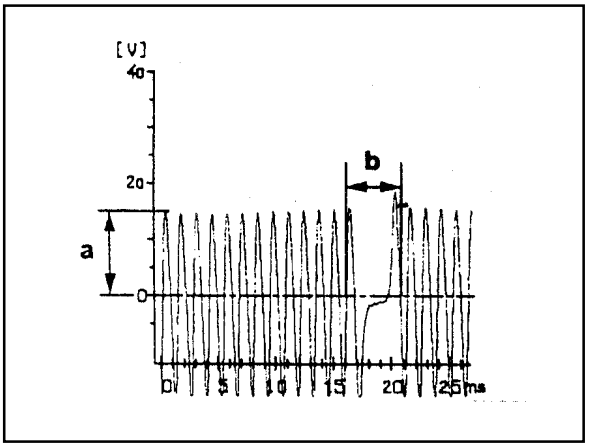


Figure 6. Crankshaft Position Sensor Signal
a Voltage
b Identifying the No.1 - 2 Missing Teeth

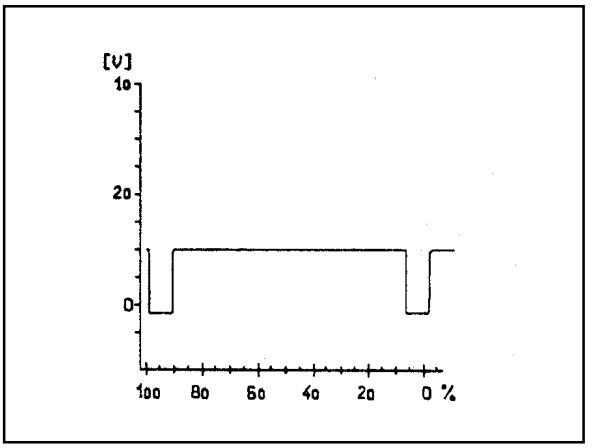


Figure 7. Camshaft Position Sensor Signal

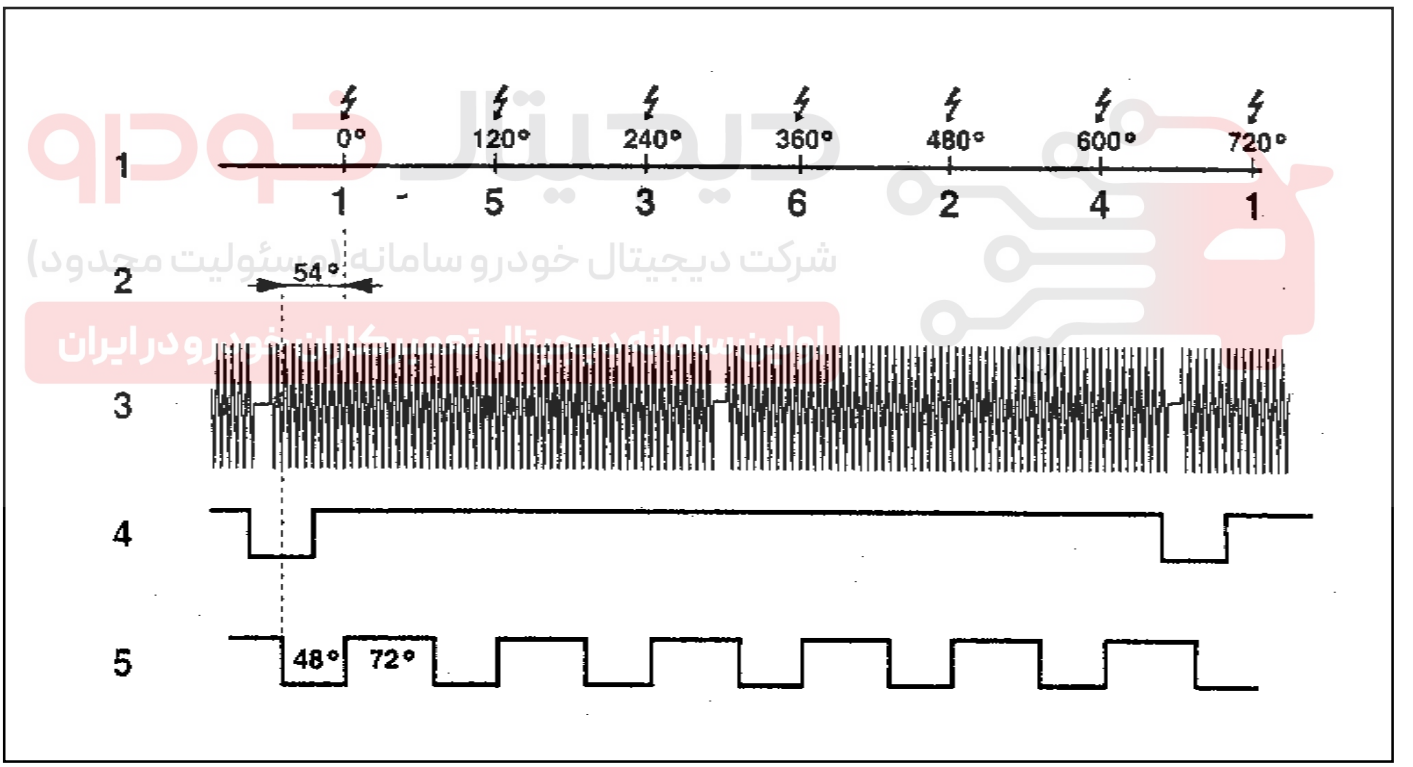
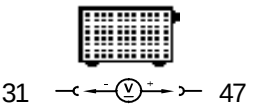
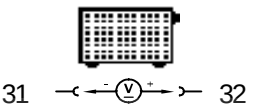
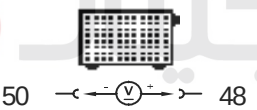
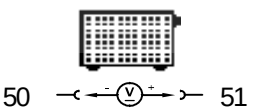
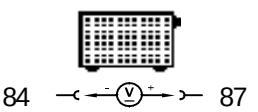


Figure 8. Signal Function
1 Crank Angle
2 Cylinder
3 Crankshaft Position Sensor Signal
4 Camshaft Position Sensor Signal
5 RPM Signal

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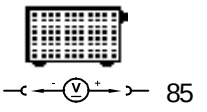
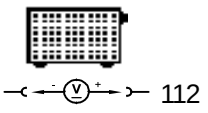
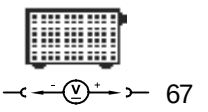
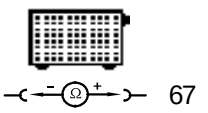
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IDLING CONTROL AND ELECTRONIC PEDAL SYSTEM TEST

Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
160, 161, 164, 167,	Þ 1.0	· **Pedal valve sensor:** - Signal (potentiometer 1)		· Ignition:ON · Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	0.3 - 0.7 V 4.3 - 4.8 V	· Þ 1.1 · Cable · Pedal valve sensor
	Þ 1.1	· **Pedal valve sensor:** - Power supply (potentiometer 1)		· Ignition:ON	4.75 - 5.25 V	· Cable · ECU
162, 163, 164, 167,	Þ 2.0	· **Pedal valve sensor:** - Signal (potentiometer 2)		· Ignition:ON · Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	0.1 - 0.4 V 2.1 - 2.5 V	· Þ 2.1 · Cable · Pedal valve sensor
	Þ 2.1	· **Pedal valve sensor:** - Power supply (potentiometer 2)		· Ignition:ON	2.25 - 2.75 V	· Cable · ECU
104, 105, 108, 109, 116, 119, 185,	Þ 3.0	· **Throttle valve actuator:** - Signal Throttle valve potentiometer 1		· Engine:in idling · Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	0.3 - 0.9 V 4.0 - 4.6 V	· Þ 3.1 · Cable · E-GAS actuator

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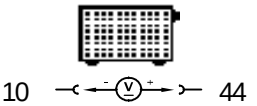
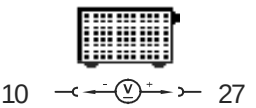
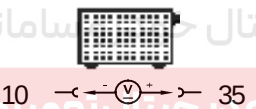
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		Throttle valve potentiometer 2	 84 85	· Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	4.0 - 4.6 V 0.3 - 0.9 V	
	Þ 3.1	· **Throttle valve actuator:** - Power supply(5V) Throttle valve potentiometer 1+2	 84 112	· Ignition:ON	4.75 - 5.25 V	· Cable · ECU
104, 105, 108, 109, 116, 119, 185,	Þ 4.0	· **Throttle valve actuator:** - Signal Throttle valve actuator motor voltage supply Throttle valve actuator motor resistance	 68 67  68 67	· Ignition:ON · Engine:in idling - Coolant temperature: >70 ℃ · Ignition:OFF	0.8 - 2.3 V The value will be changed in 1.0 - 2.5V. < 10 W	· ECU · Cable · E-GAS actuator

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AIR CONDITIONER CONTROL SYSTEM TEST

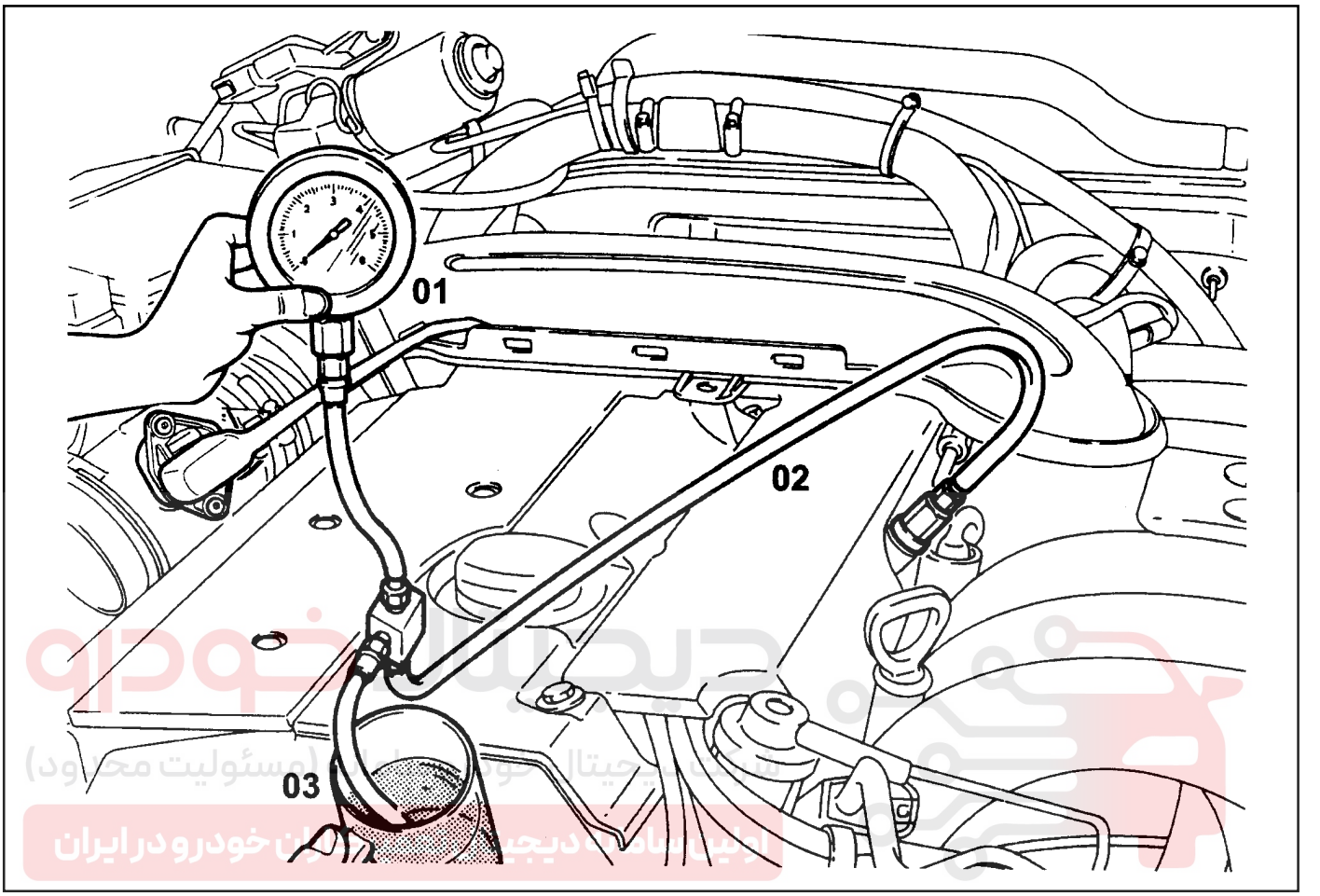
Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
44, 45,	Þ 1.0	· **Air conditioner signal:** - Input signal (input signal from thermo amplifier)		· Engine:In idling · Air conditioner switch : ON/OFF Air conditioner switch : OFF Air conditioner switch : ON	< 1 V 11 - 14 V	· Þ 5.1 · Cable · Thermo amp · Auto amp · Dual pressure switch · Air conditioner control panel
	Þ 1.1	· **Air conditioner compressor:** - Output signal		· Engine:In idling · Air conditioner switch : ON/OFF Air conditioner switch : OFF Air conditioner switch:ON	< 1 V 11 - 14 V	· Thermo amp · Auto amp · Dual pressure switch · Air conditioner control panel · ECU
	Þ 2.0	· **Condenser fan(HI) control:**		· Engine:In idling · Air conditioner switch : ON/OFF Air conditioner switch : OFF Air conditioner switch : ON Coolant temperature: above 105 ℃	11 - 14 V 11 - 14 V < 1 V	· Condenser fan relay · Fan motor · ECU

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FUEL PRESSURE AND INTERNAL LEAKAGE TEST

Preparation



01 Pressure Tester
02 Pressure Hose
03 Measuring Beaker

Connection of the Equipment

1. Turn the ignition switch to "OFF" position.
2. Remove the air cleaner cross pipe.
3. Remove the cap on fuel pressure test plug and connect the pressure hose and pressure tester.
4. Prepare the beaker for measuring the amount of fuel.

Tools Required

103 589 00 21 00 Pressure Tester
119 589 04 63 00 Pressure Hose

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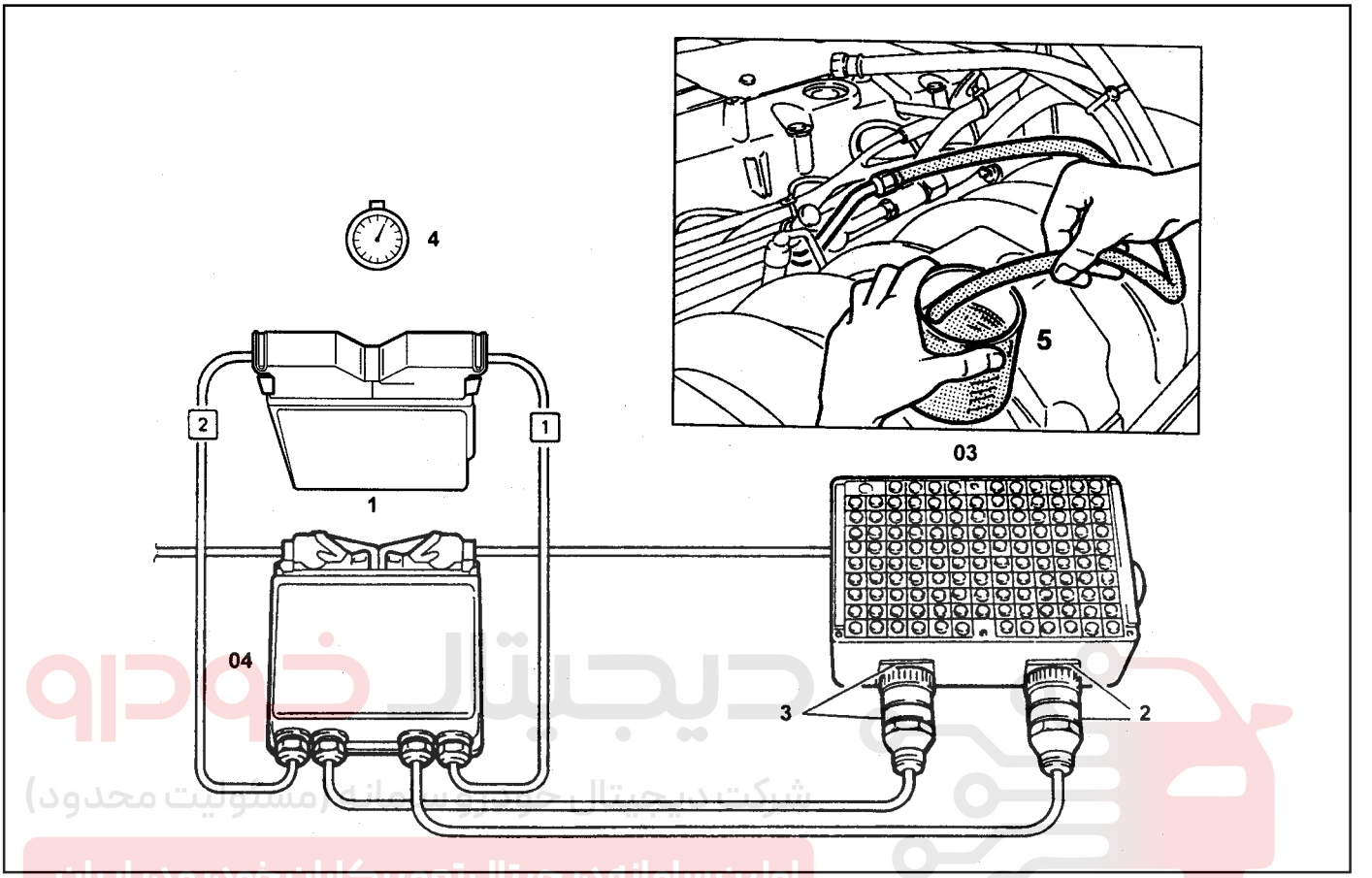
Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 1.0	· **Fuel pressure:in idling speed** - When the vacuum is applied	Connect the fuel pressure test plug to the pressure tester (refer to the flgure on previous page).	· Engine:in idling - Close the valve screw on pressure tester	3.2 - 3.6 bar	· Þ Fuel pump test · Fuel pressure regulator
	Þ 2.0	· **Fuel pressure:in idling speed** - When the vacuum is not applied	Connect the fuel pressure test plug to the pressure tester (refer to the flgure on previous page).	· Engine:in idling - Close the valve screw on pressure tester	3.7 - 4.2 bar	· Fuel pressure regulator
	Þ 3.0	· **Fuel system internal leakage:**	Connect the fuel pressure test plug to the pressure tester (refer to the flgure on previous page).	· Engine:stop	> 3.0 bar	· The pressure drops rapidly:non-return valve in fuel pump
				· After 30 minutes from engine stop	> 2.5 bar	· The pressure drops slowly: - Injector test - Fuel pressure regulator - O-ring

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FUEL PUMP TEST

Preparation



1 ECU
2 Test Coupling(No.1-60)
3 Test Coupling(No.61-120)
4 Stop Watch
5 Measuring Beaker
03 Test Box
04 ECU Test Cable

Connection of the Equipment

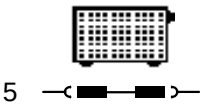
1. Turn the ignition switch to "OFF" position.
2. Connect the test box to the ECU.

Tools Required

103 589 00 21 00 Pressure Tester
210 589 00 99 00 Adaptor Line
129 589 00 21 00 Test Box
210 589 08 63 00 Ecu Test Cable

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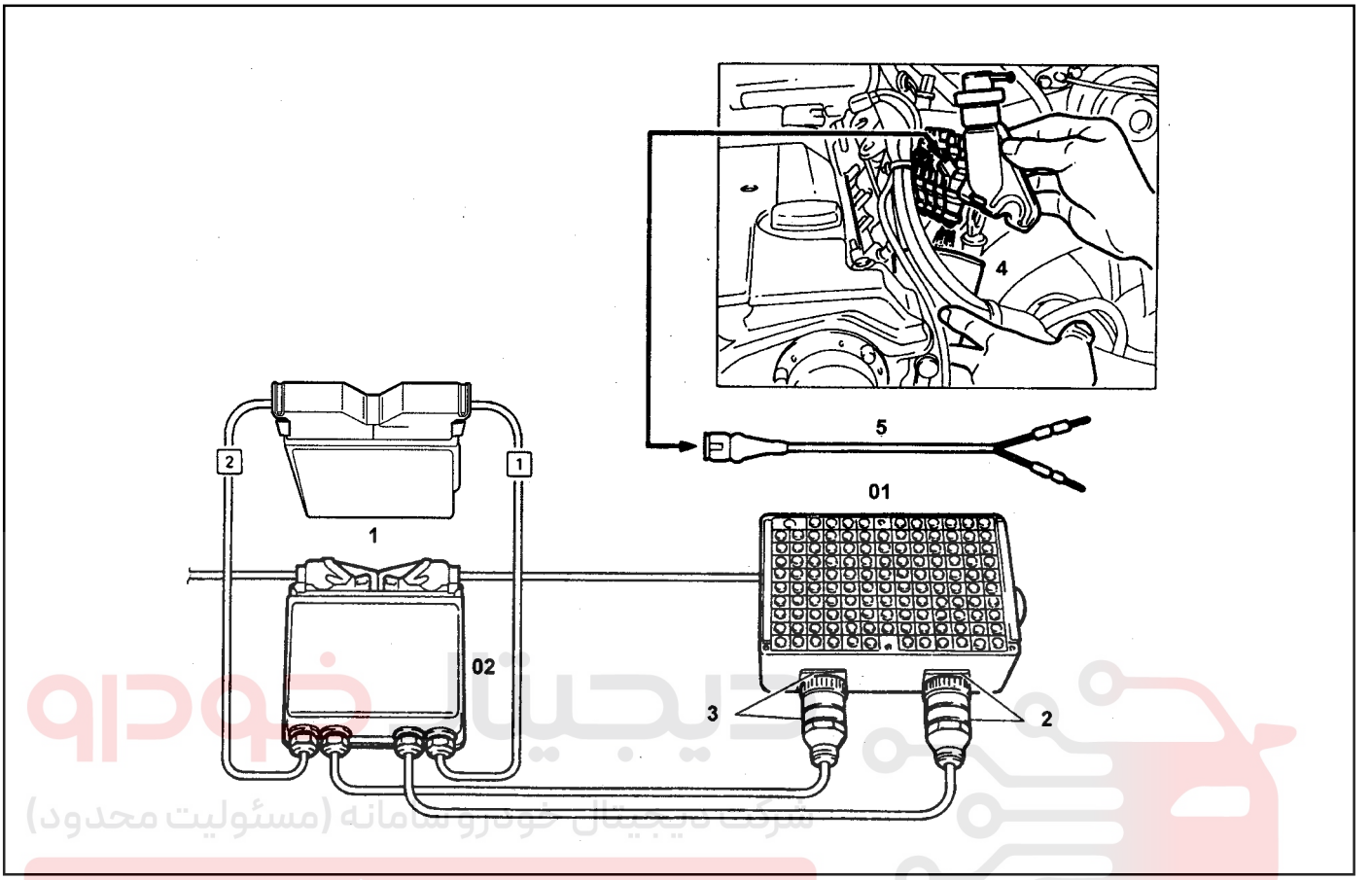
Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 1.0	· **Fuel pump:** - Fuel supply ratio	 5 — 33	· Ignition:ON - Disconnect the fuel return pipe and connect the host to beaker to collect the supplied fuel	1 liter of fuel supply for max. 35 seconds	· Þ 2.0 · Check the fuel line
	Þ 2.0	· **Fuel pump:** - Current consumption	Multi tester(DC current) 3 — 1	· Ignition:ON - Remove the fuel relay from the fuse and relay box in luggage compartment and connect the amperemeter between No.1 and No.3 in relay box(fuel pump relay removed position) for measuring current consumption	5 - 9 A	· Fuel pump

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INJECTOR TEST

Preparation



1 ECU
2 Test Coupling(No.1-60)
3 Test Coupling(No.61-120)
4 Measuring Beaker
5 Shop Made Cable
03 Test Box
04 ECU Test Cable

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Tools Required

129 589 00 21 00 Test Box

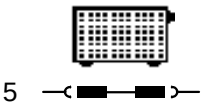
210 589 08 63 00 Ecu Test Cable

Connection of the Equipment

1. Connect the test box to the ECU as shown in the figure.
2. Remove the 2-pin coupling from injector.
3. Remove the fuel distributor and injector with a unit. At this time, do not remove the supply and return line.
4. Connect the shop made cable to the injector with a firing order.
5. Collect the fuel from injector.

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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 1.0	· **Injector:** - Leakage test	 5 — 33	· Ignition:ON - Remove the fuel distributor and fuel injector with a unit.	There should be no leaks and later drops from the injector	
	Þ 2.0	· **Injector:** - Function test and spray pattern check	 5 — 33	· Ignition:ON - Connect the shop made cable to the injector - Collect the spraying fuel with a beaker - Connect the shop made cable to No.21(+) and No.3 (-) terminal in test box	The spray pattern of the injector most show in the figure 10.	· Injector

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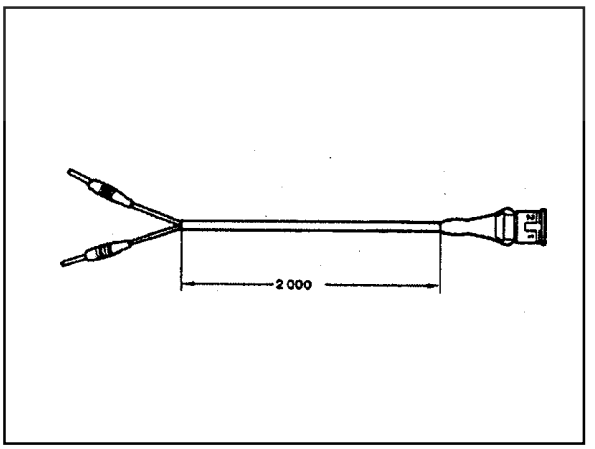


Figure 9. Shop Made Cable

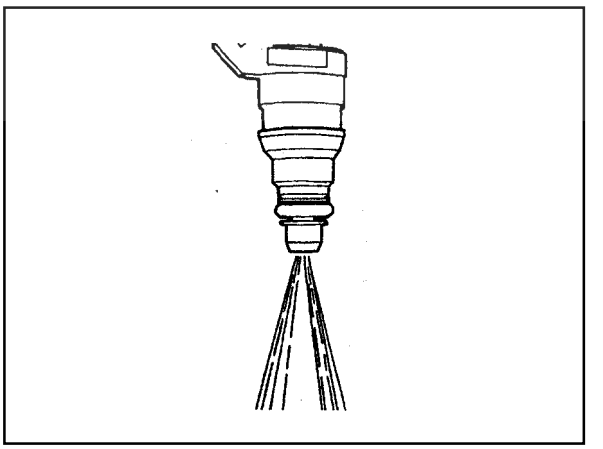


Figure 10. Fuel Injector Normal Spary Pattern

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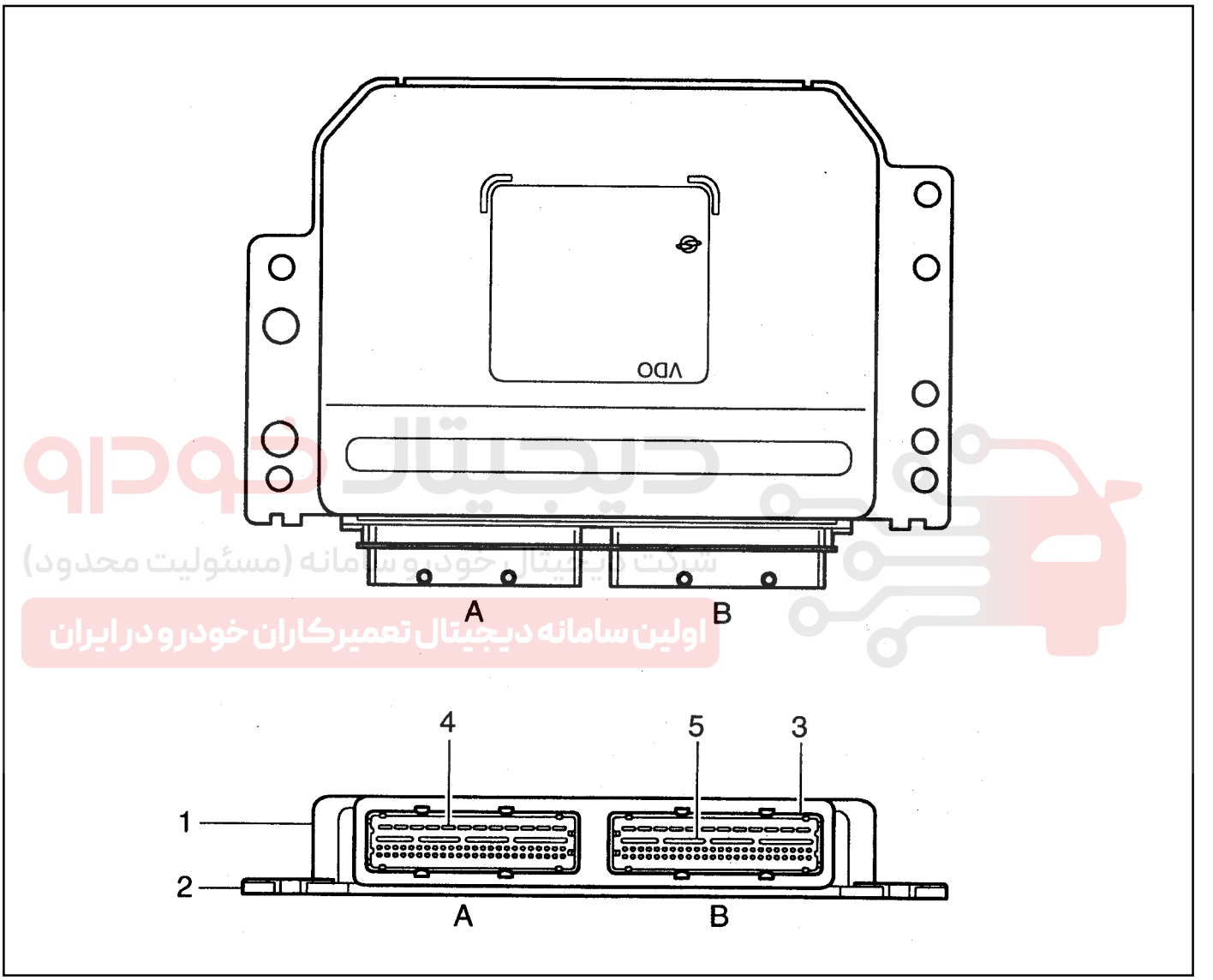
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

ECU

Appearance



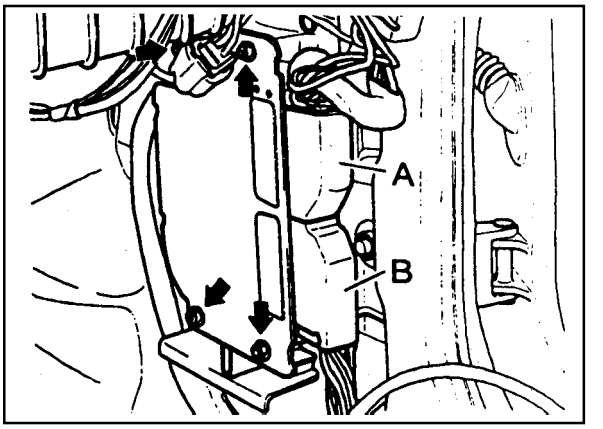
1 Cover
2 Plate
3 Connector
4 Flat Pin
Vehicle Side : No. 1 - 12
Engine Side : No. 61 - 72
5 Pin
Vehicle Side : No. 13 - 60
Engine Side : No. 73 - 120
A Vehicle Side Connector : Black
B Engine Side Connector : Gray

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Location

Engine ECU is located at the inside of cowl side trim in right bottom of instrument panel of passenger side.



Removal & Installation Procedure

1. Turn the ignition switch to "OFF" position.
2. Disconnect the battery negative cable
3. Remove the cowl side trim form passenger side.
4. Unscrew four securing nuts for ECU from mounting bracket.

Installation Notice

Tightening Torque	9 - 11 Nm

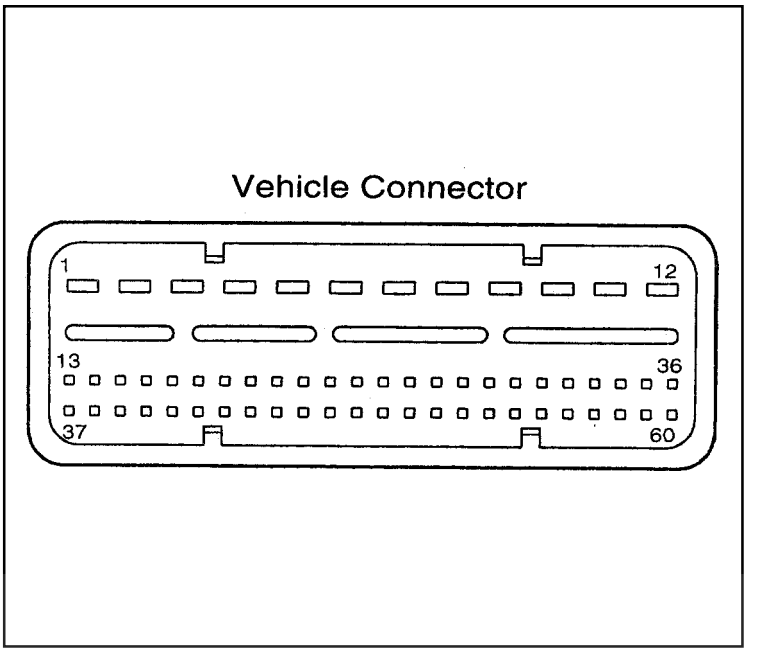
5. Pulling out the ECU from bracket.
6. Disconnect the vehicle side coupling(B).
7. Installation should follow the removal procedure in the reverse order.

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ECU Pin Numbers and Descriptions



Vehicle Connector

Pin No.	Description	Abbreciation
1	-	-
2	Starter motor TM.50	TM.50
3	-	-
4	-	-
5	Electronic ground	GND
6	-	-
7	-	-
8	-	-
9	Lambda probe 1 heating	LSH1
10	Power ground TM.31	TM.31
11	V-BATTERY TM.87	TM.87
12	V-BATTERY TM.30	TM.30
13	Immobilizer crypto read	WFS I/O
14	Immobilizer crypto write	WFS O
15	-	-
16	Lambda probe 1 ground	GND
17	Lambda probe 1 signal	LS1
18	-	-
19	-	-
20	-	-

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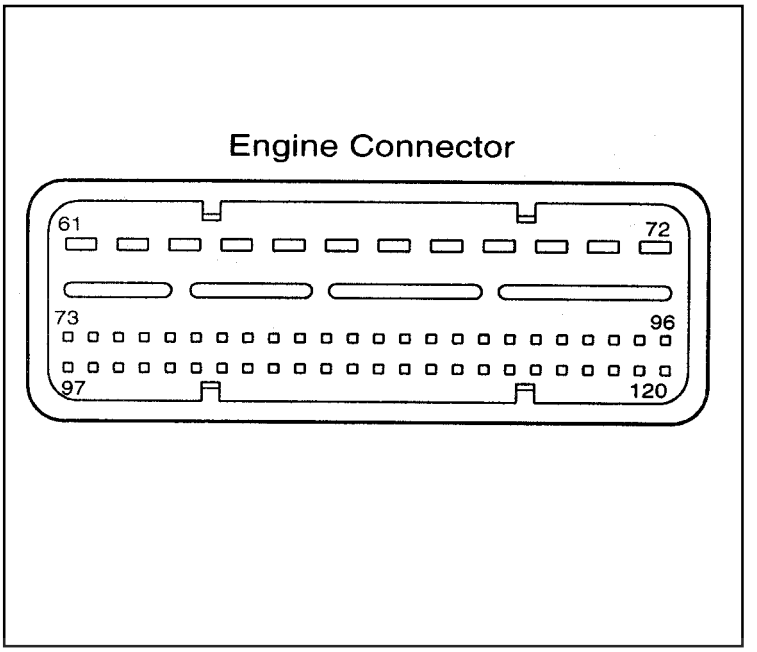
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Pin No.	Decription	Abbreciation
21	Brake switch	BRS
22	-	-
23	-	-
24	-	-
25	-	-
26	-	-
27	Air conditioning clutch relay	KLIKU
28	-	-
29	-	-
30	-	-
31	Pedal potentiometer 1 ground	GND
32	Pedal potentiometer 1 supply	SP1+5V
33	Fuel pump relay	KP
34	Tank purge valve	TEV
35	Engine fan (H1)	ML
36	-	-
37	CAN-Low	CAN L
38	CAN-High	CAN H
39	-	-
40	-	-
41	-	-
42	-	-
43	Clutch switch	KPI
44	Air conditioning	KLIMA
45	Electronic traction signal	KLIMA
46	-	-
47	Pedal potentiometer 1 signal	SP1S
48	Pedal potentiometer 2 signal	SP2S
49	Brake light switch	BLS
50	Pedal potentiometer 2 ground	GND
51	Pedal potentiometer 2 supply	SP2+2.5V
52	Cruise accelerate/Set	S+B
53	Cruise resume	WA
54	Cruise decelerate/Set	S-B
55	Cruise safety contact switch	KSK
56	-	-
57	Cruise off switch	AUS
58	Diagnostics (k-line)	DIAG
59	Vehicle speed signal	V-SIG
60	Engine speed signal	TN-SIG

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Engine Connector

Pin No.	Decription	Abbreciation
61	Injector-cylinder 2	EV5
62	Injector-cylinder 4	EV6
63	Injector-cylinder 1	EV1
64	Injector-cylinder 6	EV4
65	Injector-cylinder 5	EV2
66	Injector-cylinder 3	EV3
67	E-GAS motor plus	M+
68	E-GAS motor minus	M-
69	Power ground TM.31	TM.31
70	Ignition coil cylinder 1+6	ZSC16
71	Ignition coil cylinder 2+5	ZSA25
72	Ignition coil cylinder 3+4	ZSB34
73	Camshaft control	NWS
74	-	-
75	-	-
76	-	-
77	-	-
78	Engine coolant temperature	MT
79	Temperature ground	GND
80	Intake air temperature	LT

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Pin No.	Description	Abbreciation
81	Hot film air mass signal	HFM
82	-	-
83	-	-
84	E-GAS potentiometer ground	-
85	E-GAS potentiometer 2 signal	IP2S
86	-	-
87	E-GAS potentiometer 1 signal	IP1S
88	-	-
89	-	-
90	-	-
91	-	-
92	-	-
93	-	-
94	-	-
95	-	-
96	-	-
97	Intake manifold resonance flap	SRV
98	-	-
99	Crankshaft sensor ground	KW-
100	Crankshaft sensor signal	KW+
101	-	-
102	-	-
103	-	-
104	Camshaft sensor ground	NOWE-
105	Hot film air mass ground	GND
106	Camshaft sensor signal	NOWE+
107	-	-
108	Hot film air mass supply	V-REF.HFM
109	-	-
110	-	-
111	-	-
112	E-GAS potentiometer supply	V-REF.DK
113	-	-
114	Knock sensor 2 ground	GND
115	Knock sensor 2 signal	KS2
116	-	-
117	Knock sensor 1 ground	GND
118	Knock sensor 1 signal	KS1
119	-	-
120	-	-

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Application

Pin No.	Description	Abbreviation	E32 ENG, 4speed A/T (BTRA)	E32 ENG, 5speed M/T	Remarks
1	-	-	-	-	
2	Starter motor TM.50	TM.50	●	●	
3	-	-	-	-	
4	-	-	-	-	
5	Electronic ground	GND	●	●	
6	-	-	-	-	
7	-	-	-	-	
8	-	-	-	-	
9	Lambda probe 1 heating	LSH1	●	●	
10	Power ground TM.31	TM.31	●	●	
11	V-BATTERY TM.87	TM.87	●	●	
12	V-BATTERY TM.30	TM.30	●	●	
13	Immobilizer crypto read	WFS I/O	●	●	
14	Immobilizer crypto write	WFS O	●	●	
15	-	-	-	-	
16	Lambda probe 1 ground	GND	●	●	
17	Lambda probe 1 signal	LS1	●	●	
18	-	-	-	-	
19	-	-	-	-	
20	-	-	-	-	
21	Brake switch	BRS	○	○	
22	-	-	-	-	
23	-	-	-	-	
24	-	-	-	-	
25	-	-	-	-	
26	-	-	-	-	
27	Air conditioning clutch relay	KLIKU	●	●	
28	-	-	-	-	
29	-	-	-	-	
30	-	-	-	-	

●: Standard, ○: Option

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Pin No.	Description	Abbreviation	E32 ENG, 4speed A/T (BTRA)	E32 ENG, 5speed M/T	Remarks
31	Pedal potentiometer 1 ground	GND	●	●	
32	Pedal potentiometer 1 supply	SP1+5V	●	●	
33	Fuel pump relay	KP	●	●	
34	Tank purge valve	TEV	●	●	
35	Engine fan	ML	●	●	
36	-	-	-	-	
37	CAN-Low	CAN L	●	●	
38	CAN-High	CAN H	●	●	
39	-	-	-	-	
40	-	-	-	-	
41	-	-	-	-	
42	-	-	-	-	
43	Clutch switch	KPL	○	○	
44	Air conditioning	KLIMA	●	●	
45	Electronic traction signal(ABD)	ETS	○	○	
46	-	-	-	-	
47	Pedal potentiometer 1 signal	SP1S	●	●	
48	Pedal potentiometer 2 signal	SP2S	●	●	
49	Brake light switch	BLS	○	○	
50	Pedal potentiometer 2 ground	GND	●	●	
51	Pedal potentiometer 2 supply	SP2+2.5V	●	●	
52	Cruise accelerate/Set	S+B	○	○	
53	Cruise resume	WA	○	○	
54	Cruise decelerate/Set	S-B	○	○	
55	Cruise safety contact switch	KSK	○	○	
56	-	-	-	-	
57	Cruise off switch	AUS	○	○	
58	Diagnostics(K-line)	DIAG	●	●	
59	Vehicle speed signal	V-SIG	●	●	
60	Engine speed signal	TN-SIG	●	●	

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Pin No.	Description	Abbreviation	E32 ENG, 4speed A/T (BTRA)	E32 ENG, 5speed M/T	Remarks
61	Injector-cylinder 2	EV5	●	●	
62	Injector-cylinder 4	EV6	●	●	
63	Injector-cylinder 1	EV1	●	●	
64	Injector-cylinder 6	EV4	●	●	
65	Injector-cylinder 5	EV2	●	●	
66	Injector-cylinder 3	EV3	●	●	
67	E-GAS motor plus	M+	●	●	
68	E-GAS motor minus	M-	●	●	
69	Power ground TM.31	TM.31	●	●	
70	Ignition coil cylinder 1+6	ZSC16	●	●	
71	Ignition coil cylinder 2+5	ZSA25	●	●	
72	Ignition coil cylinder 3+4	ZSB34	●	●	
73	Camshaft control	NWS	●	●	
74	-	-	-	-	
75	-	-	-	-	
76	-	-	-	-	
77	-	-	-	-	
78	Engine coolant temperature	MT	●	●	
79	Temperature ground	GND	●	●	
80	Intake air temperature	LT	●	●	
81	Hot film air mass signal	HFM	●	●	
82	-	-	-	-	
83	-	-	-	-	
84	E-GAS potentiometer ground	GND	●	●	
85	E-GAS potentiometer 2 signal	IP2S	●	●	
86	-	-	-	-	
87	E-GAS potentiometer 1 signal	IP1S	●	●	
88	-	-	-	-	
89	-	-	-	-	
90	-	-	-	-	

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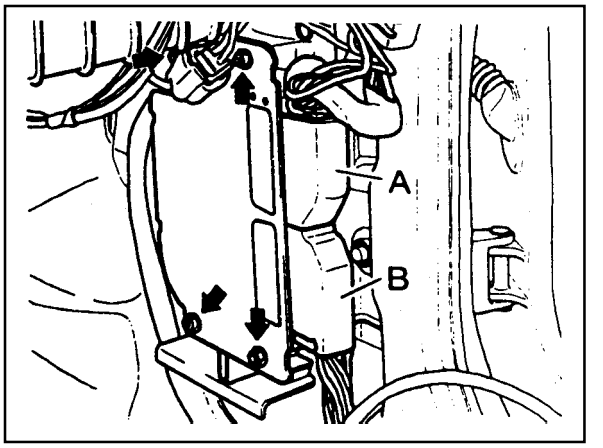
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Pin No.	Description	Abbreviation	E32 ENG, 4speed A/T (BTRA)	E32 ENG, 5speed M/T	Remarks
91	-	-	-	-	
92	-	-	-	-	
93	-	-	-	-	
94	-	-	-	-	
95	-	-	-	-	
96	-	-	-	-	
97	Intake manifold resonance flap	SRV	●	●	
98	-	-	-	-	
99	Crankshaft sensor ground	KW-	●	●	
100	Crankshaft sensor signal	KW+	●	●	
101	-	-	-	-	
102	-	-	-	-	
103	-	-	-	-	
104	Camshaft sensor ground	NOWE-	●	●	
105	Hot film air mass ground	GND	●	●	
106	Camshaft sensor signal	NOWE+	●	●	
107	-	-	-	-	
108	Hot film air mass supply	V-REF.HFM	●	●	
109	-	-	-	-	
110	-	-	-	-	
111	-	-	-	-	
112	E-GAS potentiometer supply	V-REF.DK	●	●	
113	-	-	-	-	
114	Knock sensor 2 ground	GND	●	●	
115	Knock sensor 2 signal	KS2	●	●	
116	-	-	-	-	
117	Knock sensor 1 ground	GND	●	●	
118	Knock sensor 1 signal	KS1	●	●	
119	-	-	-	-	
120	-	-	-	-	

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Removal & Installation Procedure



- **when removing the ECU only**

1. Turn the ignition switch to "OFF" position.
2. Disconnect the negative battery cable.
3. Disconnect the couplings from ECU.
4. Unscrew the left and right bolt (3) on bolt (1) and auxiliarly bracket and remove the auxiliarly bracket from the bracket assembly (2).

Installation Notice

Tightening Torque	(1)	6 - 8 Nm
	(3)	5 - 7 Nm

5. Unscrew the four bolts (5) and disconnect the ECU (6) from the bracket assenbly.

Installation Notice

Tightening Torque	5 - 7 Nm

6. Installation should follow the removal procedure in the reverse order.

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- **When Removing the ECU with ABS or ABS/ASR Unit**

1. Turn the ignition switch to "OFF" position.
2. Disconnect the negative battery cable.
3. Disconnect the couplings from ECU.
4. Disconnect the coupling from ABS or ABS/ASR unit.
5. Unscrew the bolt (1) and the left and right flange nuts.

Tightening Torque	6 - 8 Nm

6. Remove the ECU with ABS or ABS/ASR unit assembly.
7. Unscrew the left and right bolt (3) on the auxiliary bracket and remove the auxiliary bracket from the bracket assembly.

Installation Notice

Tightening Torque	5 - 7 Nm

8. Unscrew the bolts (5) and disconnect the ECU (6) from the bracket assenbly.

Installation Notice

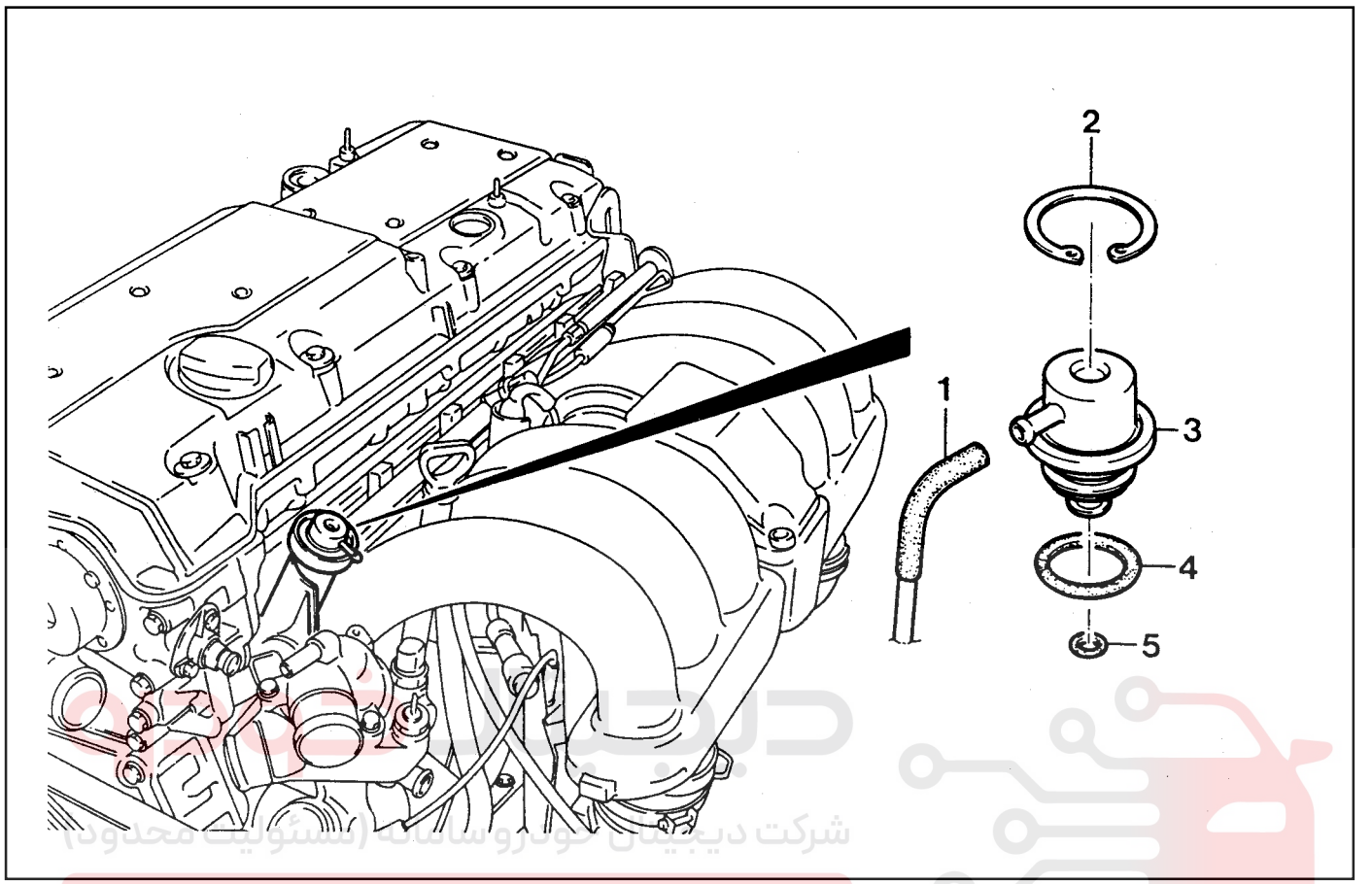
Tightening Torque	5 - 7 Nm

9. Installation should follow the removal procedure in the reverse order.

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FUEL PRESSURE REGULATOR



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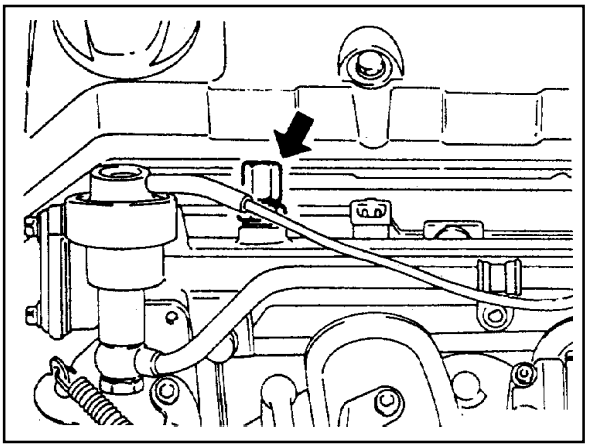
1 Vacuum Hose
2 Circlip
3 Fuel Pressure Regulator
4 O-ring ..... replace
5 O-ring ..... replace

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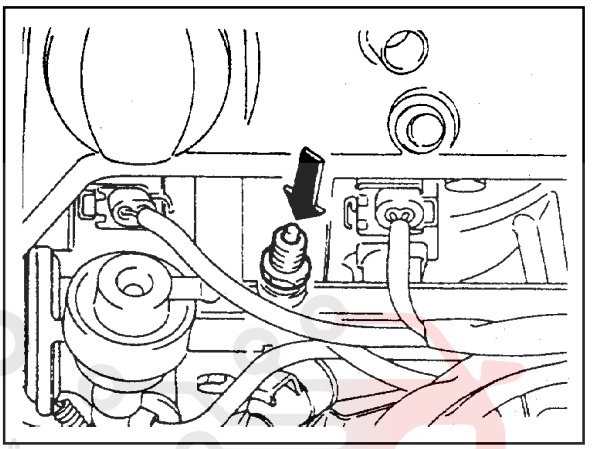
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Removal & Installation Procedure

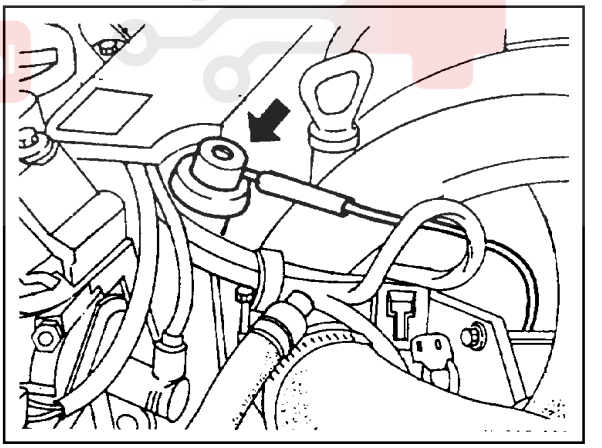
1. Remove the fuel pressure test connector.



2. Discharge the pressure in fuel supply system by pressing the service valve.



3. Disconnect the vacuum hose.
4. Disconnect the circlip and remove the fuel pressure regulator.
5. Apply the oil to O-ring lightly and then replace it.
6. Installation should follow the removal procedure in the reverse order.
7. Check for fuel pressure and internal leaks by operating the engine.



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Function of the Fuel Pressure Regulator

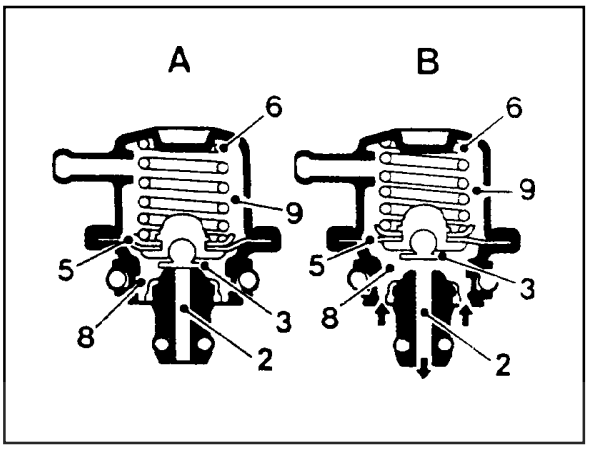
The fuel pressure regulator maintains the fuel pressure in the fuel line with the pressure of 3.2 bars to 3.8 bars according to the intake manifold pressure. This operating pressure cannot be changed, and the fuel injection volume will be only determined by the injection time. Over supplied fuel returns to the fuel tank through the return line.

<Operating at full load>

There is no negative pressure applied to the spring chamber(9) during the full load, and it is separated from the fuel chamber(8) by the diaphragm(5).

When the fuel pressure goes up, the diaphragm forces the compression spring(6) in the direction of compression . At this moment, the valve(3) sticks to the diaphragm by the fuel pressure, and the fuel return line(2) opens. The fuel over supplied returns to the fuel tank through the return line.

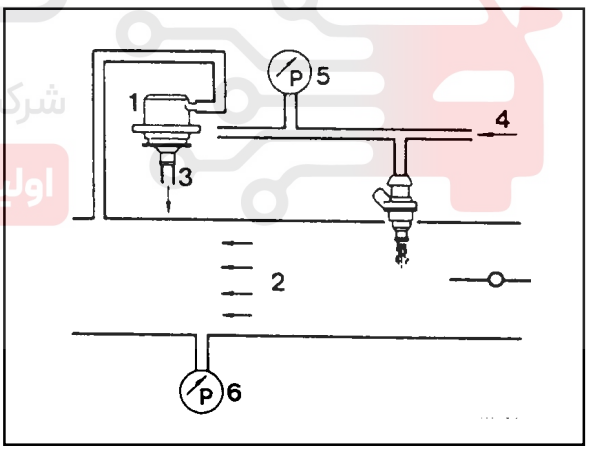
2. Fuel return line
3. Valve
5. Diaphragm
6. Compression Spring
8. Fuel Chamber
9. Spring Chamber



A. Valves Closed
B. Valves Opened

The pressure difference between the fuel pressure and the intake manifold is about 3.8 bars during the full load.

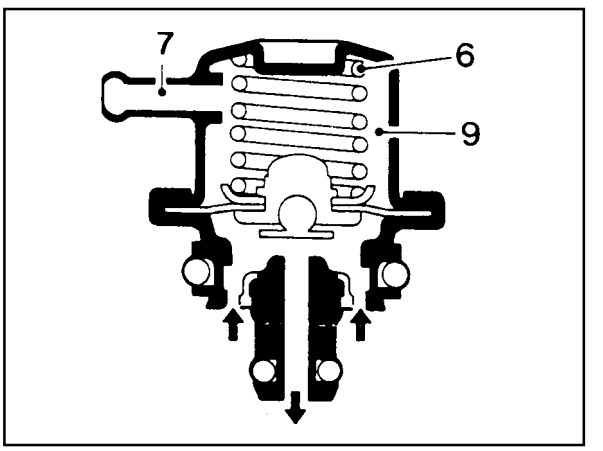
1. Fuel Pressure Regulator
2. Intake Manifold
3. Fuel Return(to fuel tank)
4. Fuel Supply(form fuel pump)
5. Fuel Pressure(approx. 3.8 bars)
6. Intake Manifold Negative Pressure(0 bar)



<Operating at Idle and partial load>

The spring chamber(9) is connected to the intake manifold with the vacuum hose at the intake pipe connection(7). The negative pressure generated in the intake manifold activates the diaphragm, and thus the fuel pressure gets reduced to the rate of the operating extent of the diaphragm by the intake manifold's negative pressure.

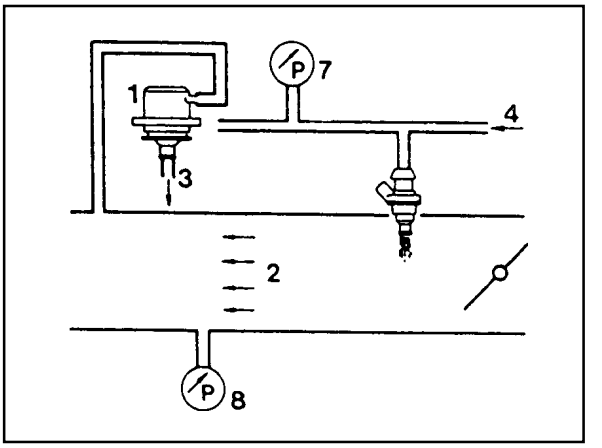
Consequently, the fuel pressure in the fuel distributor changes by the intake manifold's negative pressure, and the injector's fuel pressure gets reduced independently to the throttle valve's position. Thus, the fuel injection volume can only be determined according to the injector's injecting duration.



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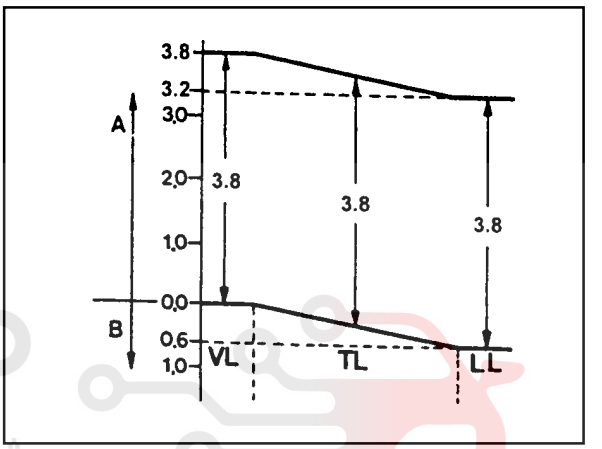
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The pressure difference between the fuel pressure and the intake manifold is approx. 3.2 bars during idling.



1. Fuel Pressure Regulator
2. Intake Manifold
3. Fuel Return(to fuel tank)
4. Fuel Supply(from fuel pump)
7. Fuel Pressure(approx. 3.2 bars)
8. Intake Manifold Negative Pressure(0.6 bars)

<Fuel Pressure Diagram>



A. Fuel pressure
B. Intake Manifold Negative Pressure
LL. Idling
TL. Partial load
VL. Full load

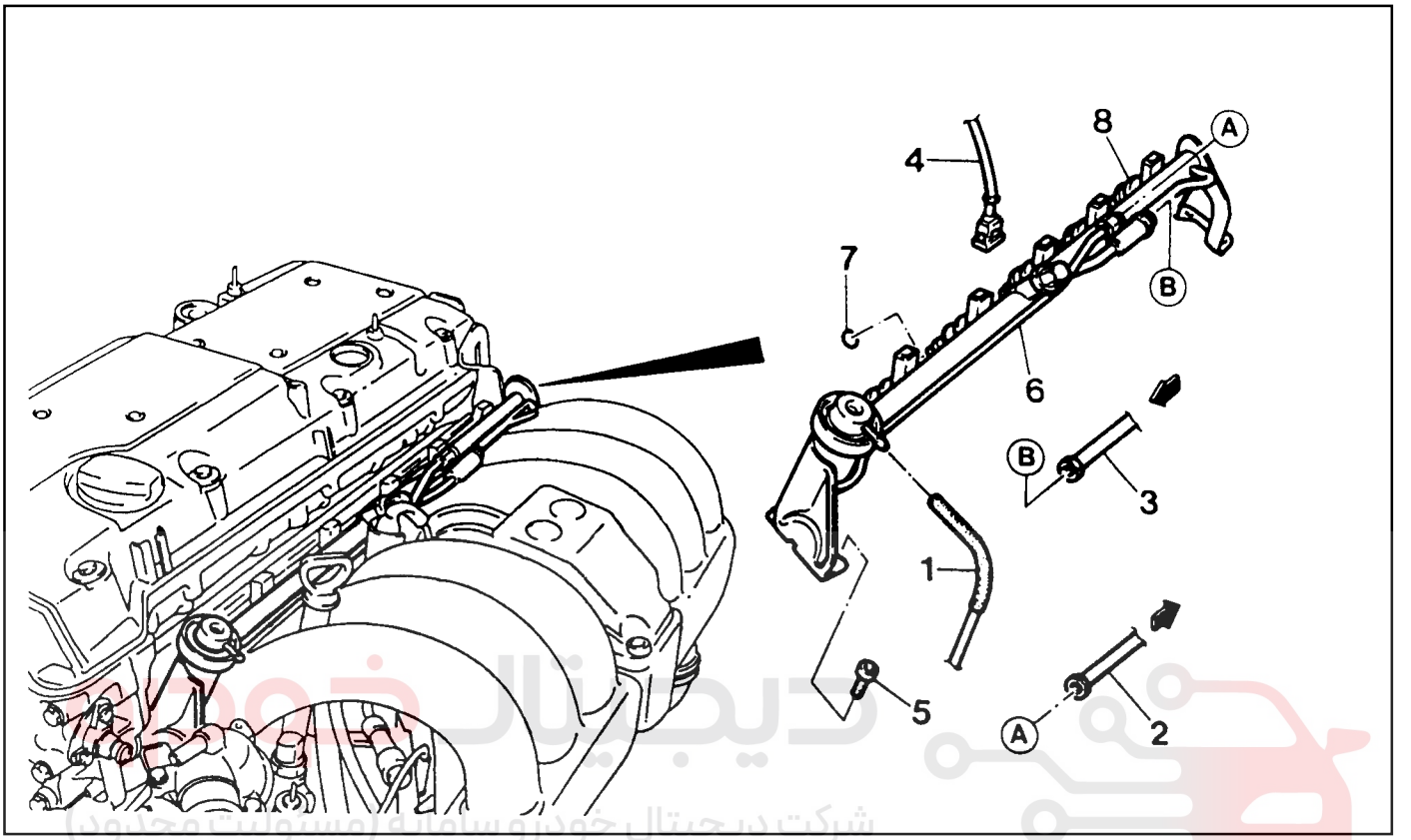
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FUEL DISTRIBUTOR

Preceding Work : Removal of intake air duct



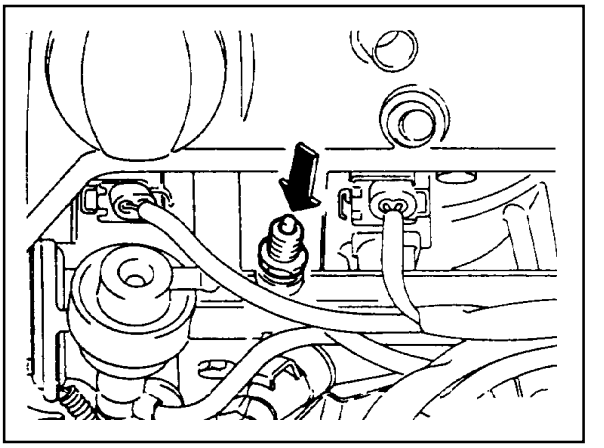
1	Vacuum Hose		5	Bolt (M8 X 50)	22.5-27.5 Nm
2	Fuel Return Line	25-30Nm	6	Fuel Distributor	
3	Fuel Supply Line	25-30Nm	7	O-ring	Replace if damaged
4	Injector Connector		8	Injector	

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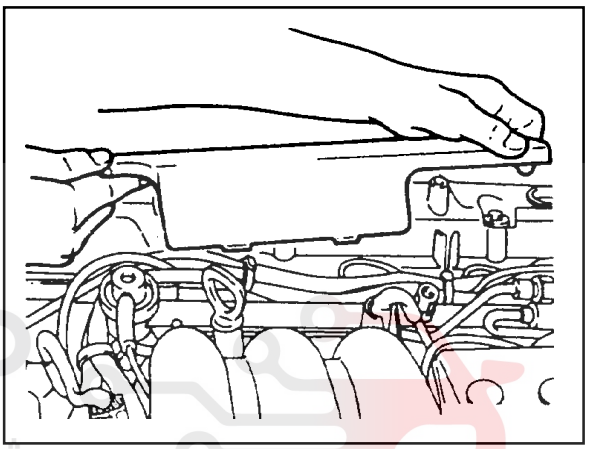
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Removal & Installation Procedure

1. Discharge the fuel pressure from the fuel pressure test connector.
2. Disconnect the battery ground cable.
3. Disconnect the vacuum hose from the fuel pressure regulator.



4. Remove the cable guide.

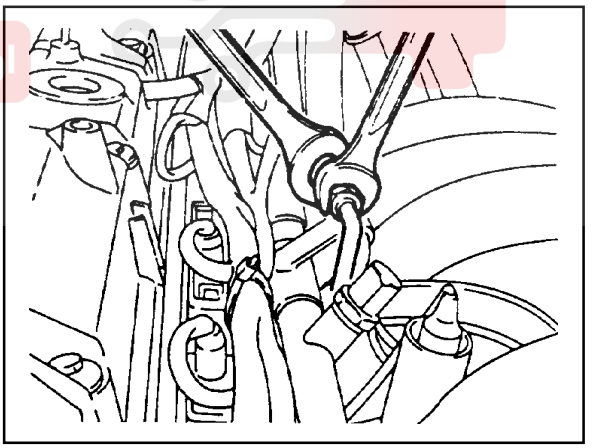


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5. Remove the fuel return and supply line.

Notice

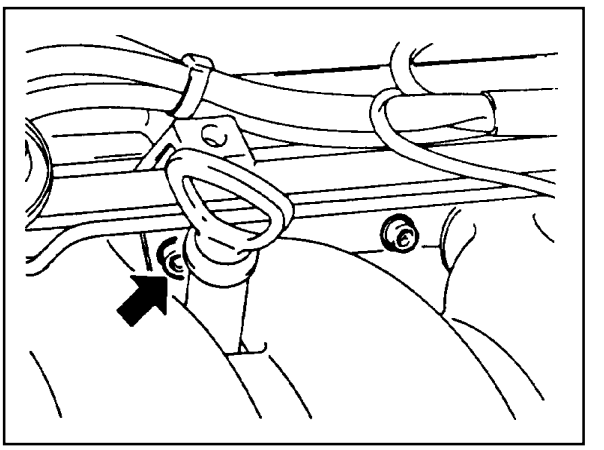
- For removal, cover around parts with cloths not to be stained by fuel.
- In case of checking the injector only, do not remove the fuel return and supply line.



Installation Notice

Tightening Torque	25 - 30 Nm

6. Remove the six injector connectors.
7. Remove the two left and two right bolts and one center bolt of the fuel distributor assembly from the intake manifold.



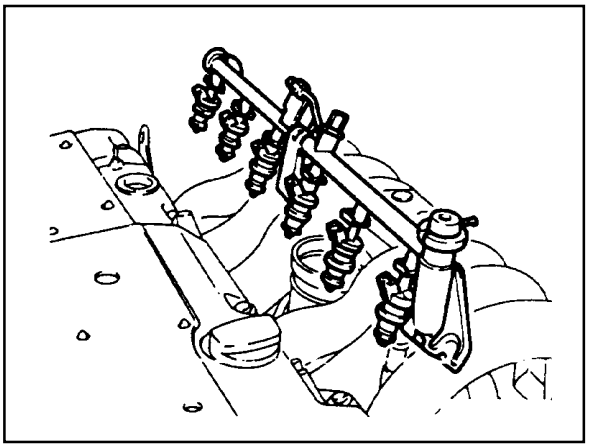
Installation Notice

Tightening Torque	22.5 - 27.5 Nm

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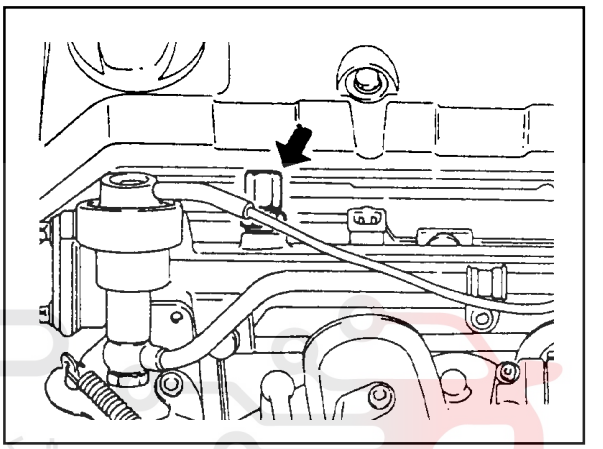
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8. Remove the injectors and the fuel distributor carefully.
9. Installation should follow the removal procedure in the reverse order.
10. Check for fuel pressure and internal leakage by operating the engine.



Fuel Pressure Test

1. Turn the ignition switch to "OFF" position.
2. Remove the fuel pressure test connector.

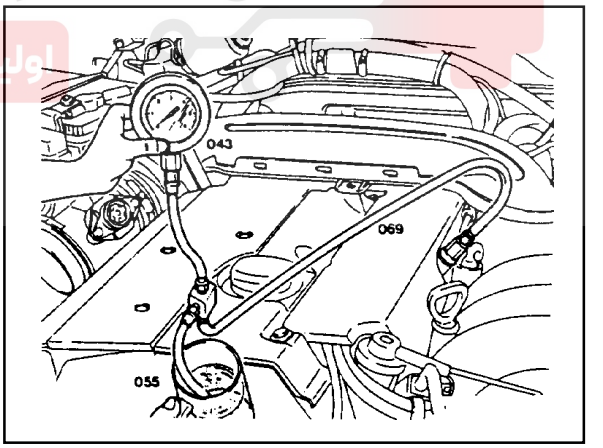


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3. Connect the fuel pressure gauge to the fuel pressure test connector.
4. Test the fuel pressure at idling by operating the engine.

Vacuum Hose Connected (bar)	3.2 - 3.6
Vacuum Hose Disconnected (bar)	3.7 - 4.2

5. Replace the pressure regulator diaphragm if out of the specification.



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Internal Leakage Test

1. Connect the fuel pressure gauge to the fuel pressure test connector.
2. Stop the engine for approx. 30 minutes and then check the fuel pressure changes.

Pressure Change	Possible Cause
Fuel pressure drops slowly	· Fuel leakage at the injector • Faulty fuel pressure regulator's diaphragm and O-ring.
Fuel pressure drops rapidly	• Faulty check valve in the fuel pump.

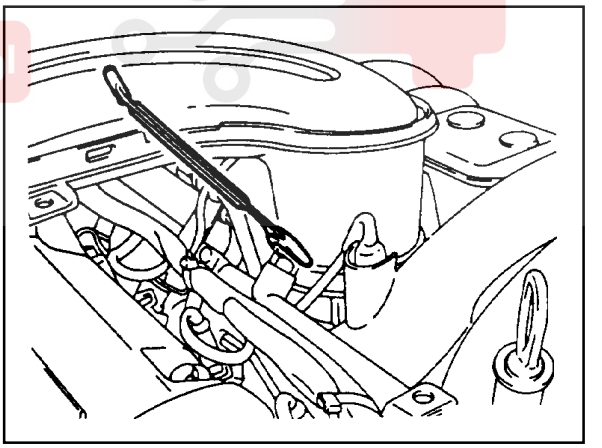
3. If there is no change in fuel pressure and maintain the following pressure over 30 minutes, it is normal.

Fuel Pressure(bar)	≥2.5

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Discharging the pressure in fuel system

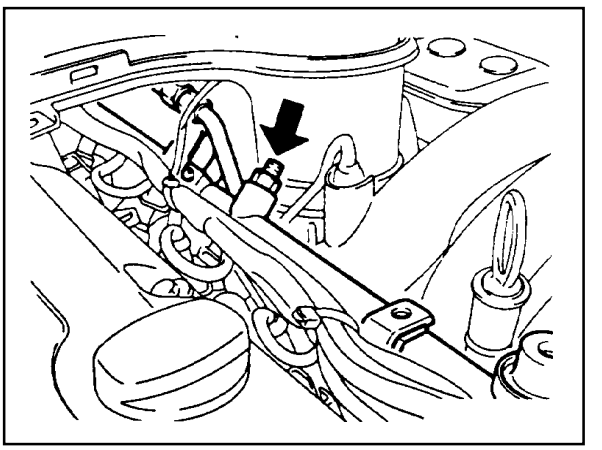
1. Remove the fuel pressure test connector.



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

2. Remove the fuel pressure in fuel system by pressing the service valve with a clean, pointy tool.



Notice

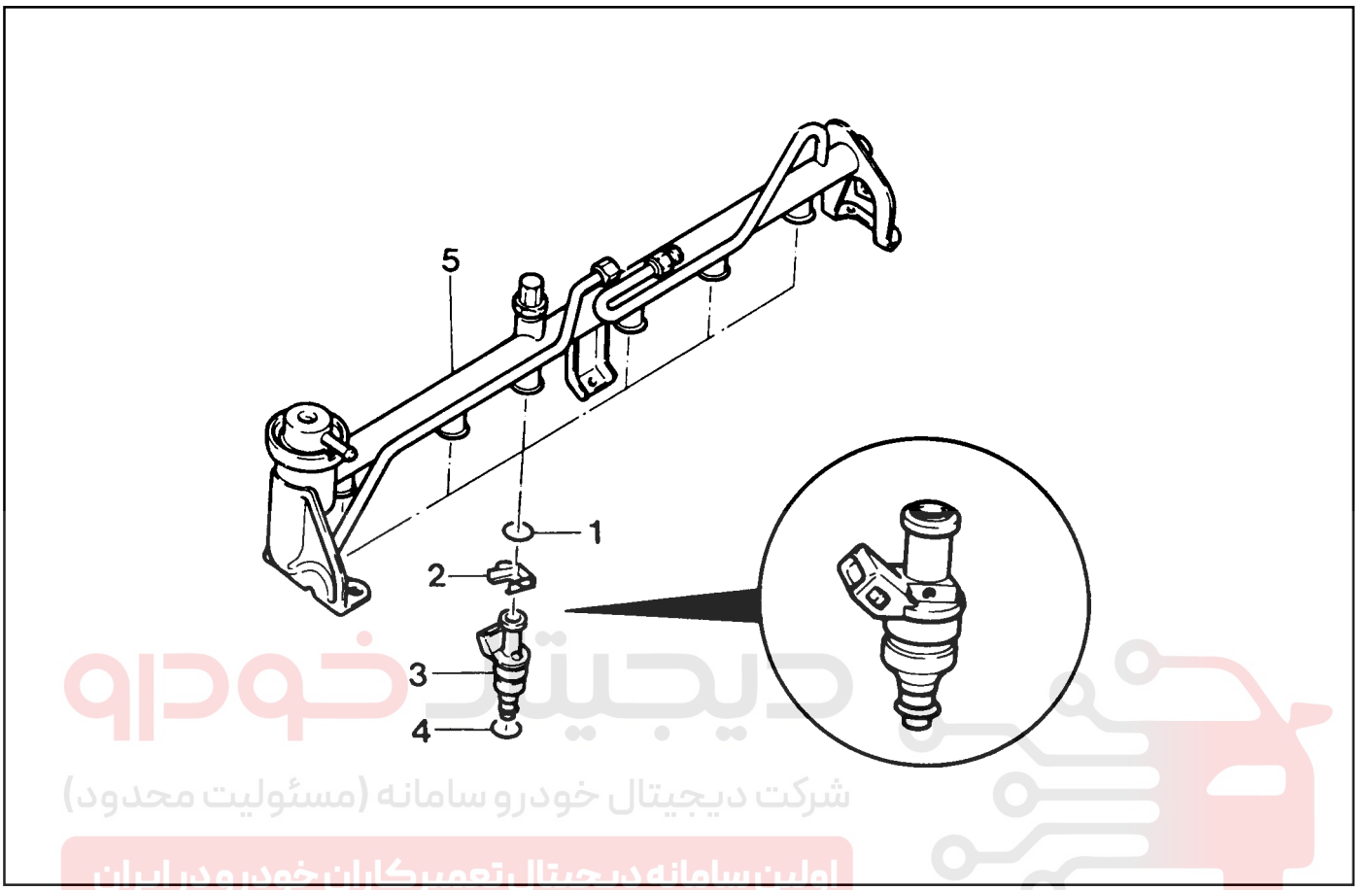
Place a cloth so that the fuel doesn't stain around.

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INJECTOR

Preceding Work : Removal of fuel distributor



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1 O-ring ..... rplace, if damaged
2 Injector Bracket
3 Injector
4 O-ring ..... replace, if damaged
5 Fuel Distributor

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Removal & Installation Procedure

1. Remove the O-ring.
   Check for damage and replace it if necessary.
2. Remove the injector bracket from the injector.

   Installation Notice

   Exactly seat the anti-twist lock into the square groove in injector.
3. Separate the injector from the fuel distributor.

Inspection & Maintenance

Inspection of the Injector operation and spray pattern

1. Connect the contact box to the ECU.
2. Connect the shop made test plug to the injector and place it into the tank.
3. Position the ignition switch to ON.
4. Connect the pin 63(+) and 69(-) of the contact box with a test cable.
5. Check the injector spray pattern.

   Notice

   Replace the injector if the injector spray pattern is abnormal or the fuel doesn't inject.

Injector Resistance Inspection

1. Remove the injector connector.
2. Measure the injector coil resistance using a resistance tester.

Specified Value	14 - 17 W

Notice

Replace the injector if the measured values is out of the specified values. Check the connector and wire connection between the ECU and the injector if the measured values are normal.

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The Injector Spray Pattern Check

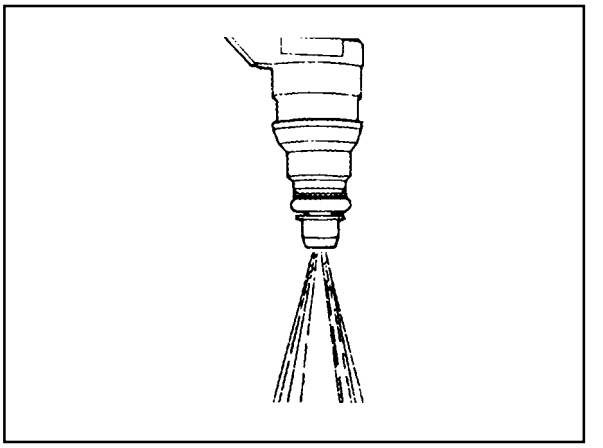
1. Connect the test box (129 589 00 21 00) to the ECU.
2. Disconnect the connector from connector.
3. Disconnect the fuel distributor and injector with a unit from engine without removing the fuel supply and return line.

   Notice

   Prepare the beaker for taking the poping fuel.
4. Connect either end of shop made cable to the injector.
5. Connect the other end of shop made cable to the No.21 (+:63)and No.3(-:69) terminal of the test box.
6. Turn the ignition switch to "ON" position.
7. Check the injector for normal spray pattern as shown in the figure. Check injector for leaks or later drops.

   Notice

   Refer to fuel injector test of engine diagnosis in this section for detailed information.

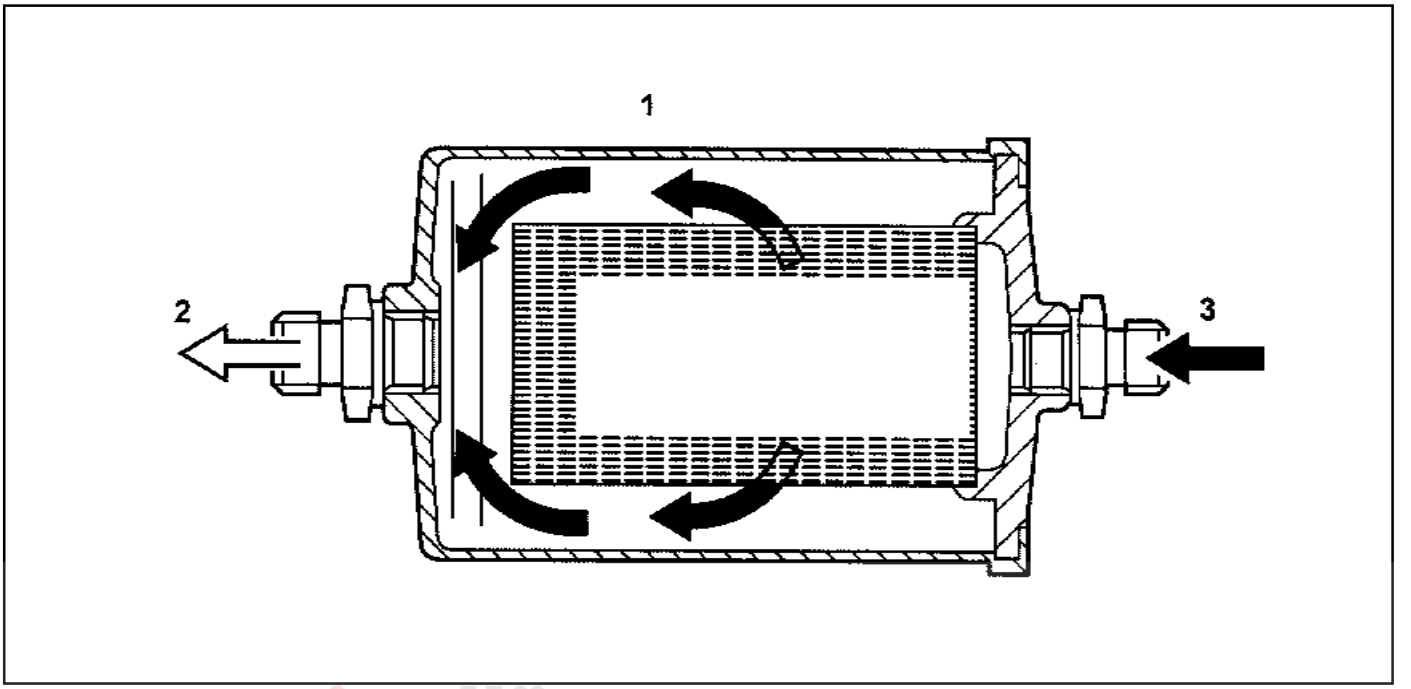


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FUEL FILTER



1 Fuel Filter
2 Outlet
3 Inlet

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Removal & Installation Procedure

1. Open the fuel tank cap and remove the fuel tank pressure.
2. Remove the fuel at (2) and in (3).

Installation Notice

Tightening Torque	25 - 30 Nm

3. Remove the mounting bracket bolt (4) and remove the fuel filter (1).

Installation Notice

Tightening Torque	4 - 8 Nm

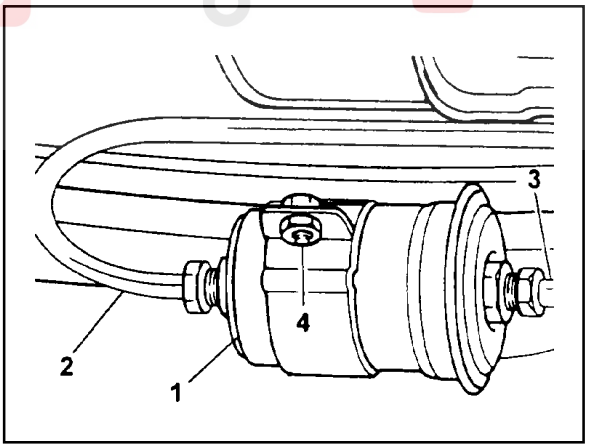
Notice

Place the fuel pump pad. There may be a corrosion due to the contact between the fuel filter and the bracket.

4. Check for leaks by operating the engine.

Notice

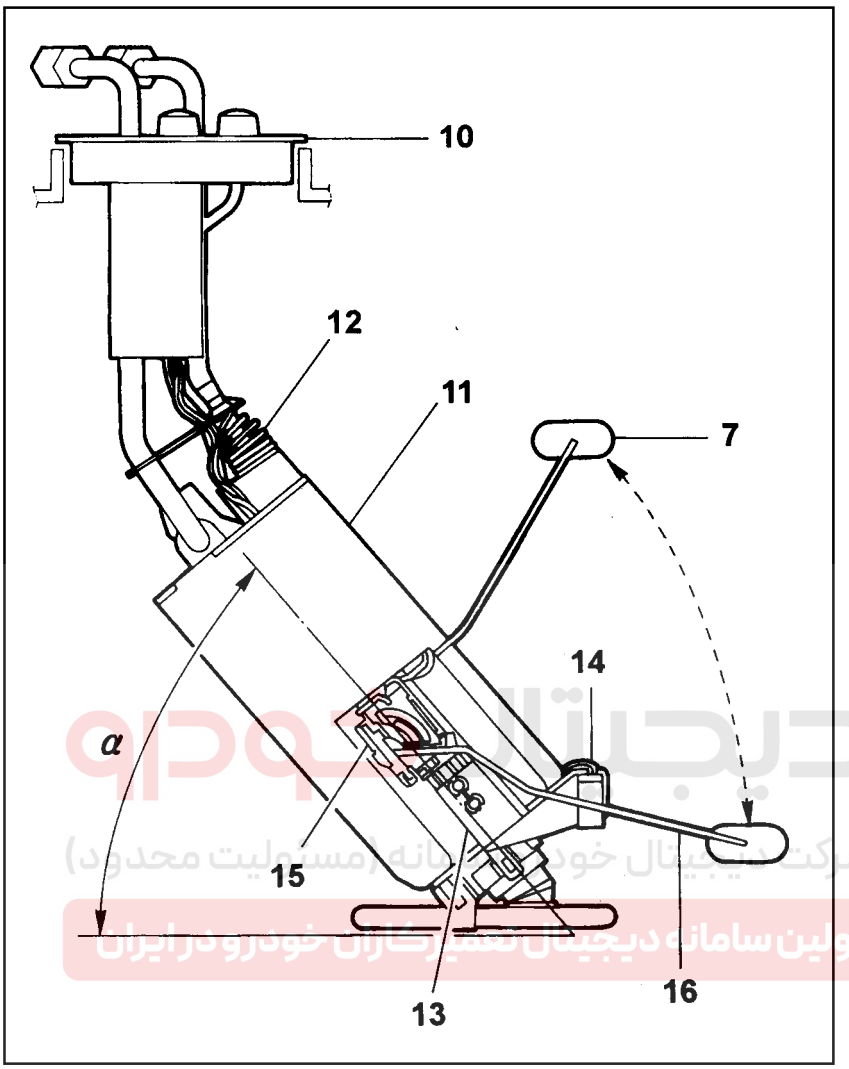
Installation should follow the removal procedure in the reverse order.



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FUEL PUMP



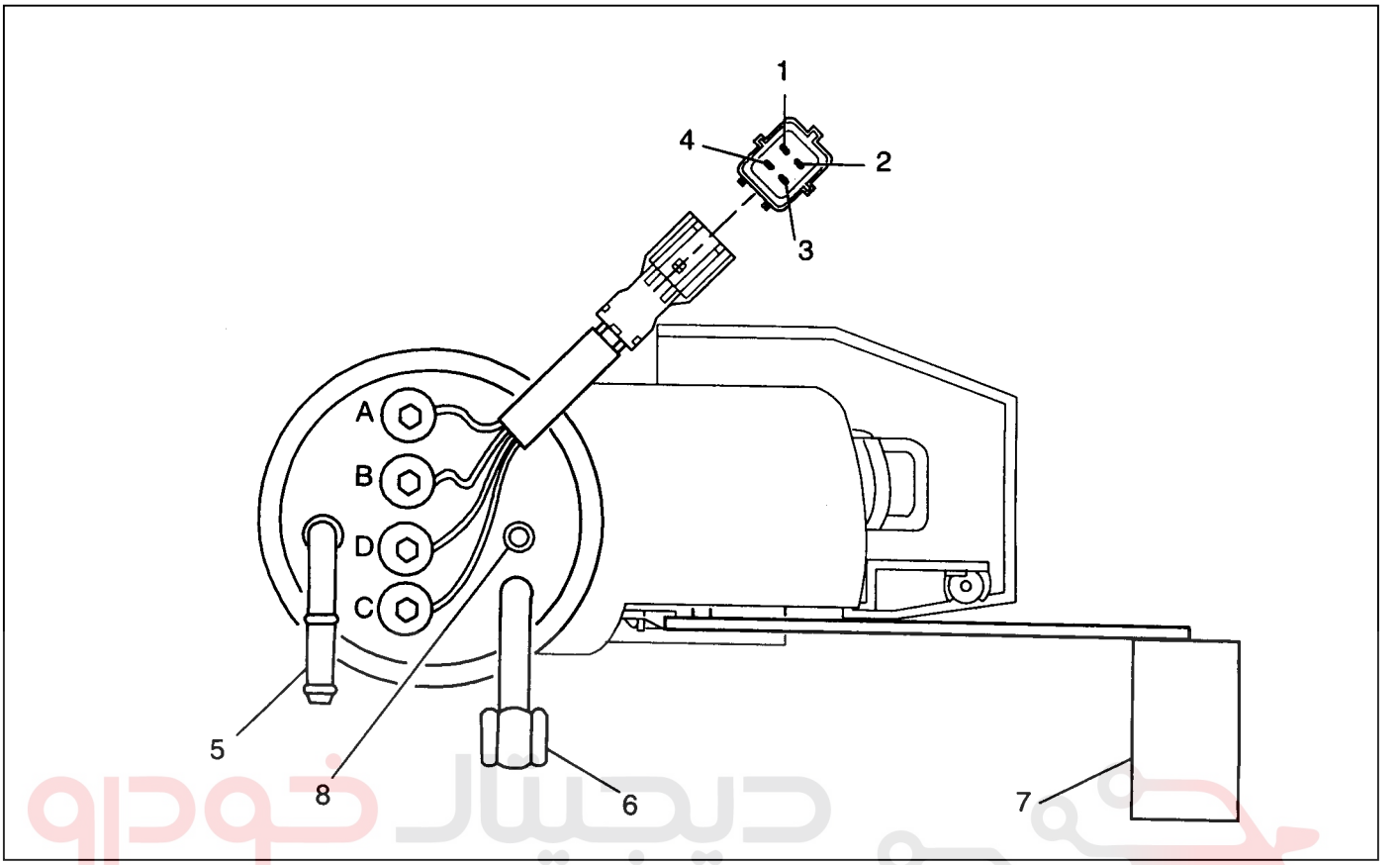
1 Reservoir Tank
2 Fuel Sensor (float/arm)
3 Resistance
4 Wiring Connector
5 Fuel Supply Pipe
7 Float
10 Flange and Harness Assembly
11 Fuel Pump
12 Spring
13 Thermister Housing
14 Thermister
15 Resistor Card and Wiper
16 Float Arm

Requirements for Fuel Pump

Item	Specified Value	Item	Specified Value
System Pressure	3.8 bar	Minimum Delivery at 8V	30 Litre/Hr
Maximum Pressure	8.5 bar (12 V)	Operating Voltage	8 V
Minimum Pressure	5.0 bar (12 V)	Maximum Allowable Current	7.5 A
Nominal Voltage	12 V	Ambient Temperature	-30 ~ +70°C
Minimum Amount of Fuel Supply	114 Liter/Hr (12 V, 3.8 bar, -30 ~ +70°C)	Maximum Amount of Fuel Supply	165 Liter/Hr (12V, 3.8 bar, -30 ~ +70°C)

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1 Fuel Pump Connector Wiring
2 Fuel Return Pipe
3 Fuel Supply Pipe
4 Bolts
5 Fuel Return Pipe
6 Fuel Supply Pipe
7 Float
8 Ground Stud (Sender "-")

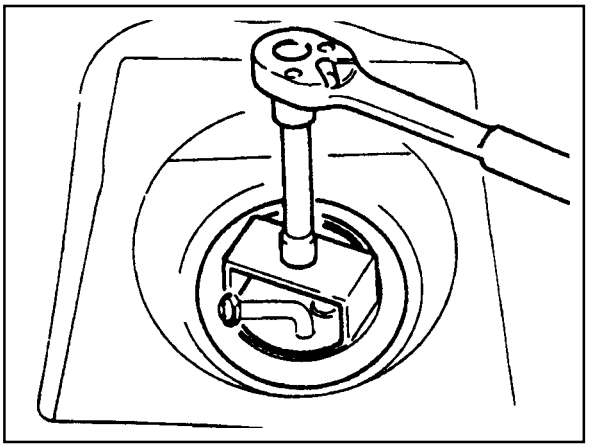
Harness Location & Connector		COLOR	USE
1	A	Pump "+"	2.0 BR
2	B	Thermister "+"	0.5 W
3	C	Ground	2.0 B
4	D	Sender Unit "+"	0.5 RY

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Tools Required

661 589 00 46 00 Cap Remover



Removal & Installation Procedure

1. Disconnect the negative battery cable.
2. Disconnect the harness connector (1).
3. Disconnect the fuel supply (6) and return (5) pipes.
4. Using a special tool, Unscrew the eight fuel retaining bolts and remove the pump from fuel tank.

Notice

Check the condition of the seal and replace if necessary.

Drain the fuel before removing the pump.

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Measure the Fuel Delivery From the Fuel Pump

1. Disconnect the return pipe from fuel distributor and insert the appropriate hose into it.
2. Place the hose end into the beaker with the minimum capacity of 1Liter.
3. Turn the ignition switch to "ON" position.
4. Connect the terminal No.33 and No.5 of ECU with a service wire.
5. Measure the fuel delivery from the fuel pump.

Specifed Value	1Liter/max.35sec.

Notice

Check the fuel filter and fuel line when the fuel delivery is not within specified value.

Measure the Current Consumption of Fuel Pump

1. Remove the fuel pump relay from fuse and relay box in trunk, and turn the ignition switch to "ON" position.
2. Using a multi-tester, measure the current consumption by connecting the terminal No.1 and No.3 of pump.

Specifed Value	5 - 9A

Notice

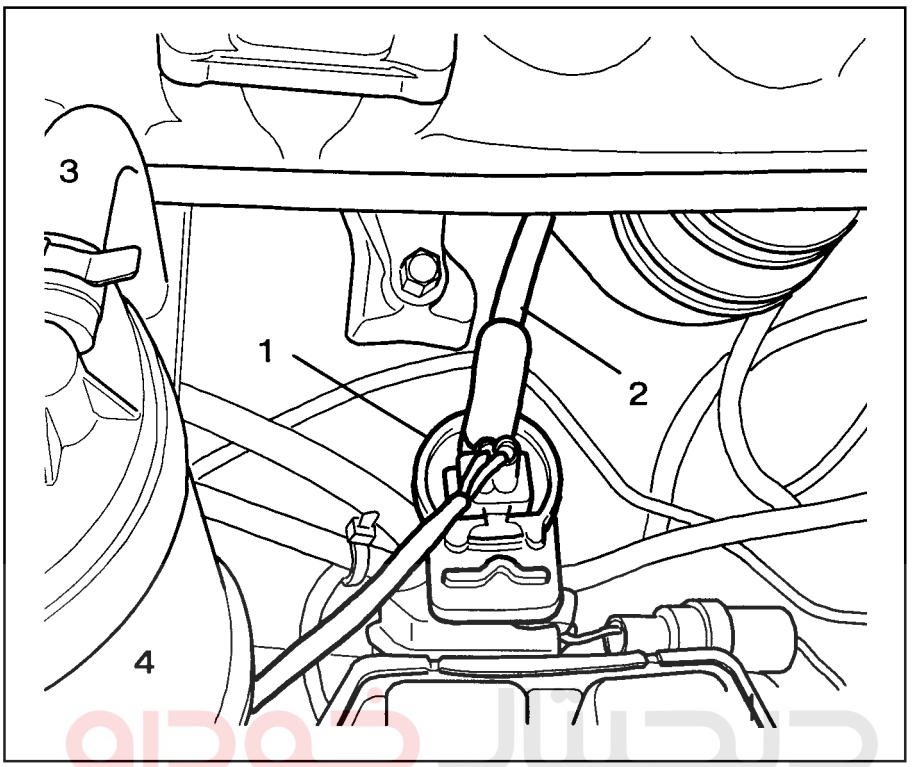
Replace the fuel pump relay if the measured value is over 9A.

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PURGE SWITCHOVER VALVE



1 Purge Switchover Valve
2 Line to Engine
3 Line to Canister
4 Canister

Functions

The fuel vaporization control system is installed to inhibit the fuel vaporized gas from discharging into the atmosphere. The fuel vaporized gas that is accumulated in the canister abstracts through the purge switchover valve purification during the engine combustion (except the decreasing mode) and coolant temperature of over 80℃. For this reason, the ECU transacts the engine speed, air inflow quantity, coolant temperature, and intake temperature.

The purge switchover valve is activated by the ECU frequency according with the engine rotating speed to adjust the purification rate. The purification rate is determined by the continuous valve opening interval.

The purge switchover valve is activated by the ECU for the following conditions :

- Coolant temperature of over 80℃
- Engine speed of over 1000rpm
- 2 Minutes after starting
- When the fuel cut-off mode is not activated

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Test

1. Maintain the normal temperature and idling state by operating the engine.
2. Connect the ECU terminal No.11 and No.34 and check for normal operation through the output waves using the scanner.

   Notice

   Test during purge control switchover valve operation after the minimum of 1 minute after the engine turned on.
3. Connect the ECU terminal No.34 and No.10 and check for current consumption during the ignition switch ON.

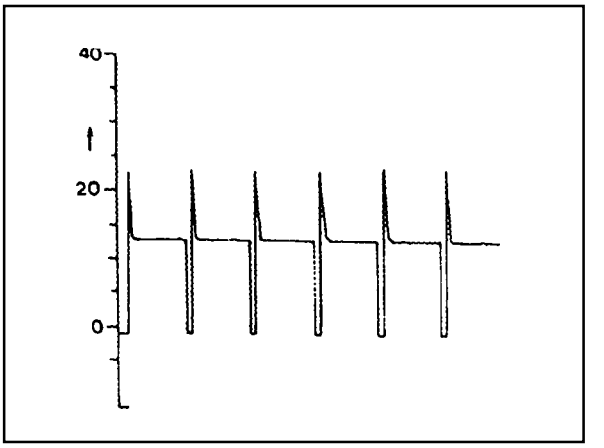
Specified Value	0.3 - 0.5

4. Remove the line to canister and measure the pressure with the vacuum pressure gauge.

Specified Value	> 50mbar (after approx. 1min.) purge switchover valve operates at this time

Notice

Test while at normal temperature and at idling state by operating the engine.



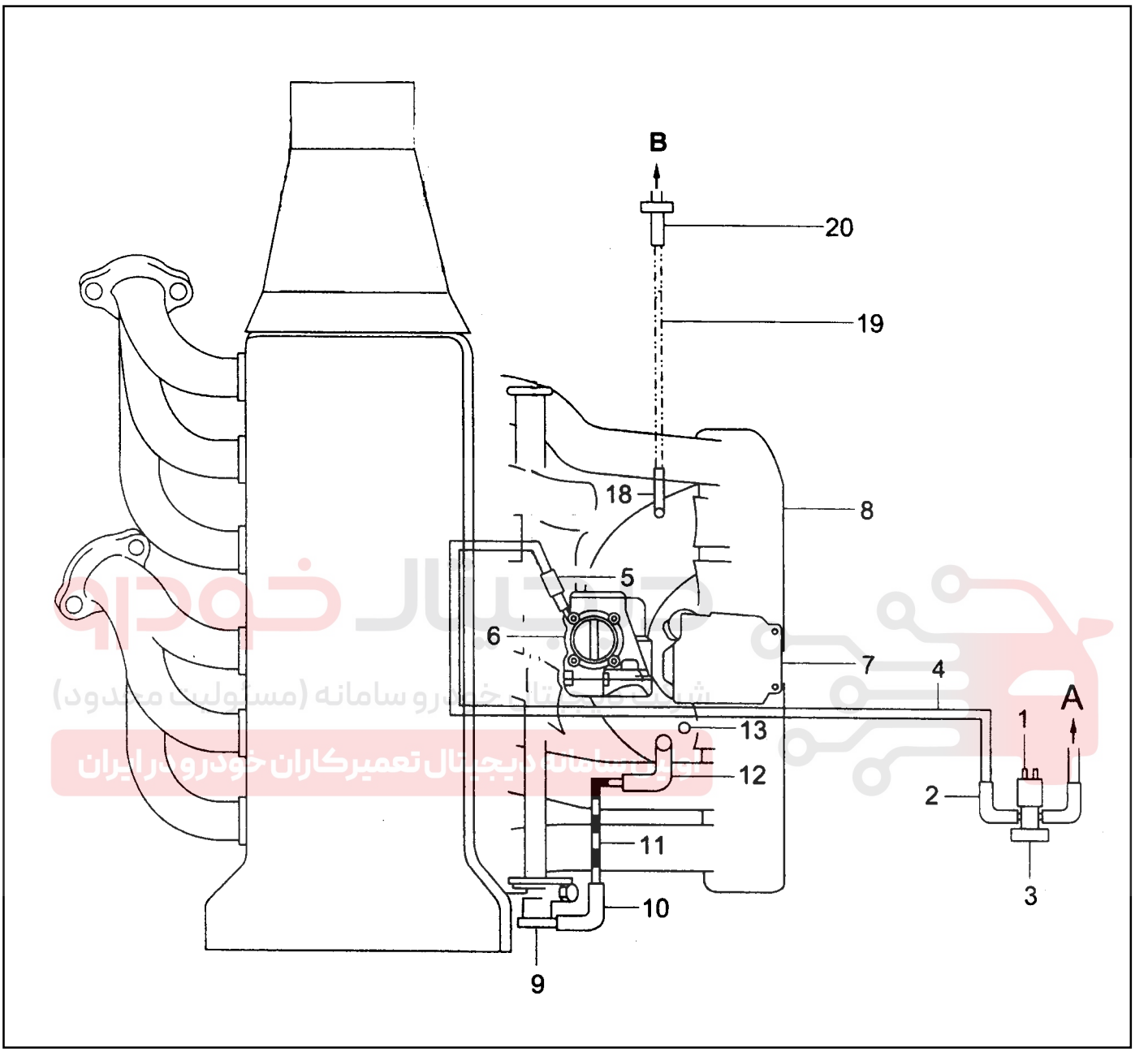
Purge switchover valve output wave

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VACUUM SYSTEM

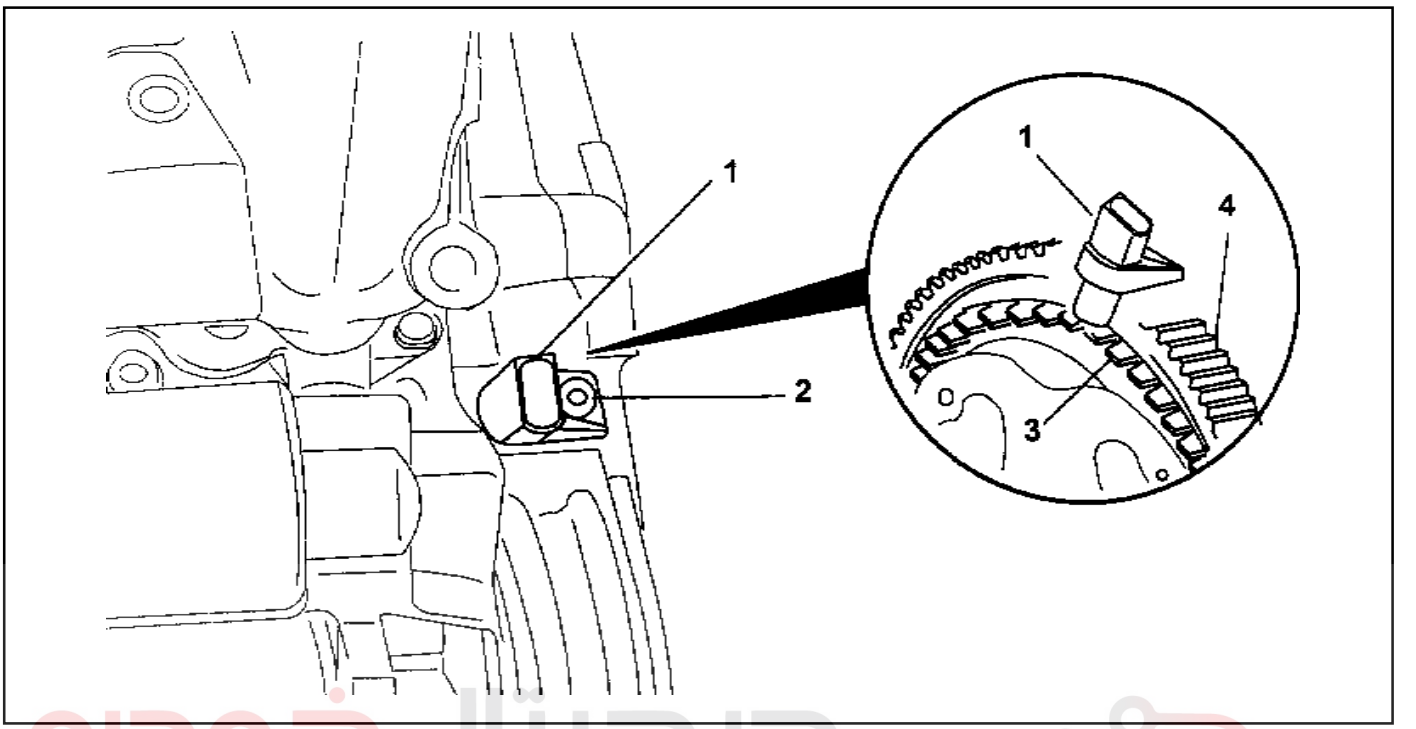


1 Purge Control Valve
2 Molded Hose
3 Insulator
4 Fuel Tube
5 Molded Hose
6 Idle Regulator
7 Resonance Flap
8 Intake Manifold
9 Fuel Pressure Regulator
10 Vacuum Line Rubber Hose
11 Vacuum Tube(Gray, 270mm)
12 Molded Hose
13 Rubber Cap
18 Rubber Hose
19 Vacuum Tube(Brown or Black, 770mm)
20 Rubber Hose
A To Canicter

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CRANKSHAFT POSITION SENSOR



1 Crankshaft Position Sensor
2 Bolt (M6 X 14) ..... 9 -11Nm
3 Segment
4 Flywheel

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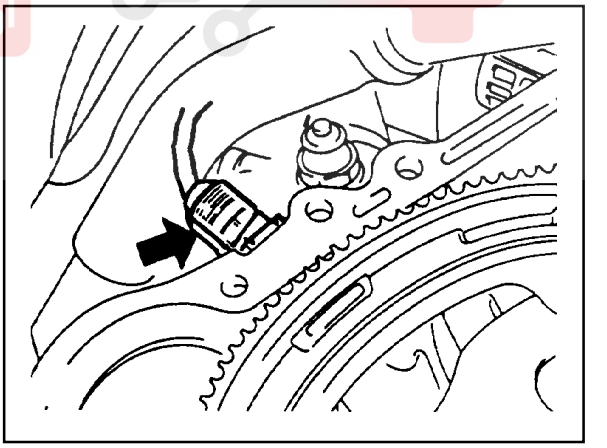
Removal & Installation Procedure

1. Disconnect the wiring connector at the crankshaft position sensor.
2. Unscrew the bolt and remove the crankshaft position sensor unit.

Installation Notice

Tightening Torque	9 -11Nm

3. Installation should follow the removal procedure in the reverse order.



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Crankshaft Position Sensor Resistance Inspection

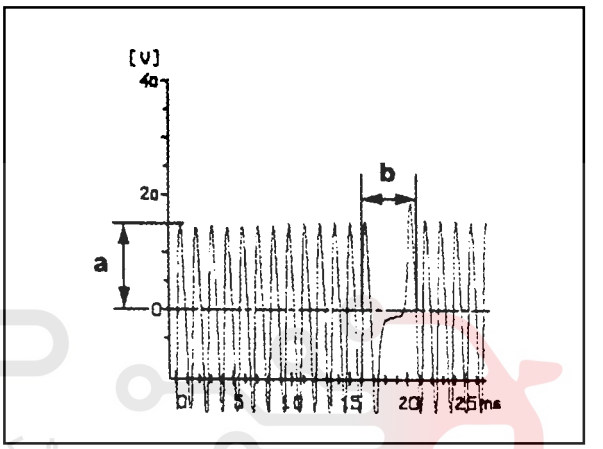
1. Disconnect the coupling "E" of ECU while the ignition switch is in "OFF" position.
2. Measure the resistance between the coupling terminal pin No.99 and No.100 using a multimeter.

Specified Value	1050 - 1400 W

Notice

Measure the insulator resistance of the crankshaft position sensor if out of the specified value.

Crankshaft Position Sensor Output Wave Inspection



1. Connect the test box to the ECU.
2. Measure the output wave between the ECU terminals No.99 and No.100 using the scanner or the oscilloscope while engine cranking (starter motor activated).

Notice

Check the segment or crankshaft position sensor and air gap if cannot get the output wave as shown in the figure.

Crankshaft Position Sensor Insulator Resistance Inspection

1. Disconnect the engine coupling from ECU while the ignition switch is in "OFF" position.
2. Measure the resistance between the coupling terminal pin No.100 and No.69.

Specified Value	> 20kW

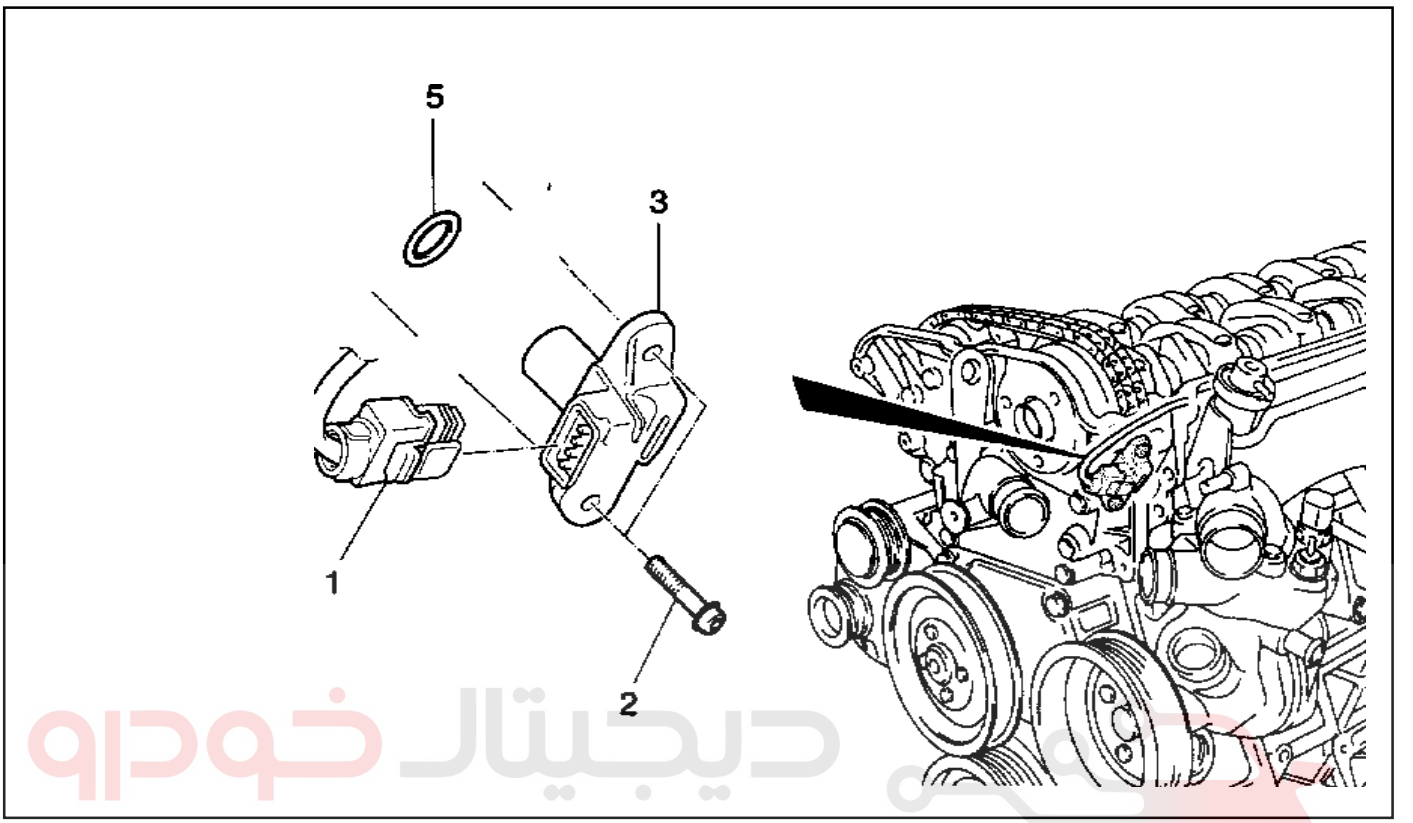
Notice

Measure the check and ground terminal of the crankshaft position sensor if out of the specified value.

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CAMSHAFT POSITION SENSOR



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1 Bolt (M6 X 14) 9-11Nm
2 Camshaft Position Sensor
3 Shim
5 O-ring

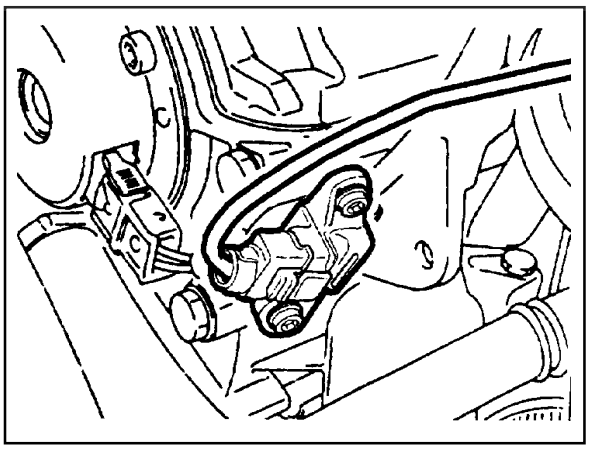
Removal & Installation Procedure

1. Disconnect the wiring connector from the camshaft position sensor.
2. Unscrew the bolt (2) and remove the camshaft position sensor.

Installation Notice

Tightening Torque	9 - 11 Nm

3. Check the clearance and replace the shim if necessary.
4. Check the O-ring for damage and replace it if necessary.
5. Installation should follow the removal procedure in the reverse order.



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Camshaft Position Sensor Signal Voltage Inspection

1. Connect the test box to the ECU.
2. Measure the voltage between the ECU terminal No.11 and No.106 while the engine speed is at idle.

Specified Value	1.2 - 1.7 V

Notice

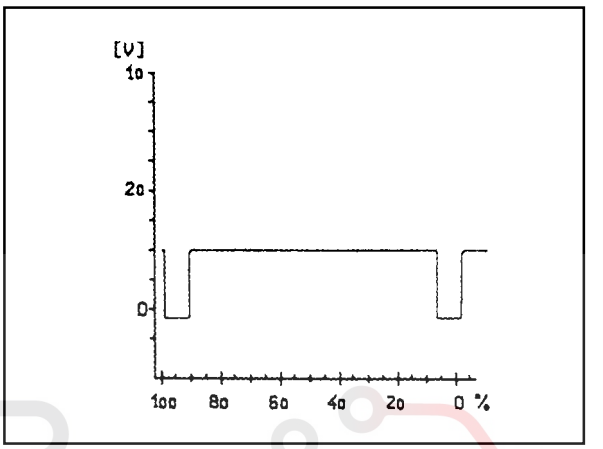
The signal voltage will be changed in the range of 1.2 - 1.7V.

Camshaft Position Sensor Output Wave Inspection

1. Connect the test box to the ECU.
2. Measure the output wave between the ECU terminal No.104 and No.106 using the scanner or the oscilloscope while the engine speed is at idle.

Notice

Replace the camshaft position sensor if cannot get the output wave as shown in the figure.



Camshaft Position Sensor Power Supply Inspection

1. Turn the ignition switch to 'ON' position.
2. Disconnect the camshaft position sensor connector.
3. Measure the voltage between the No.1 and No.3 pin of camshaft position sensor while the ignition switch is in "ON" position.

Specified Value	11 - 14 V

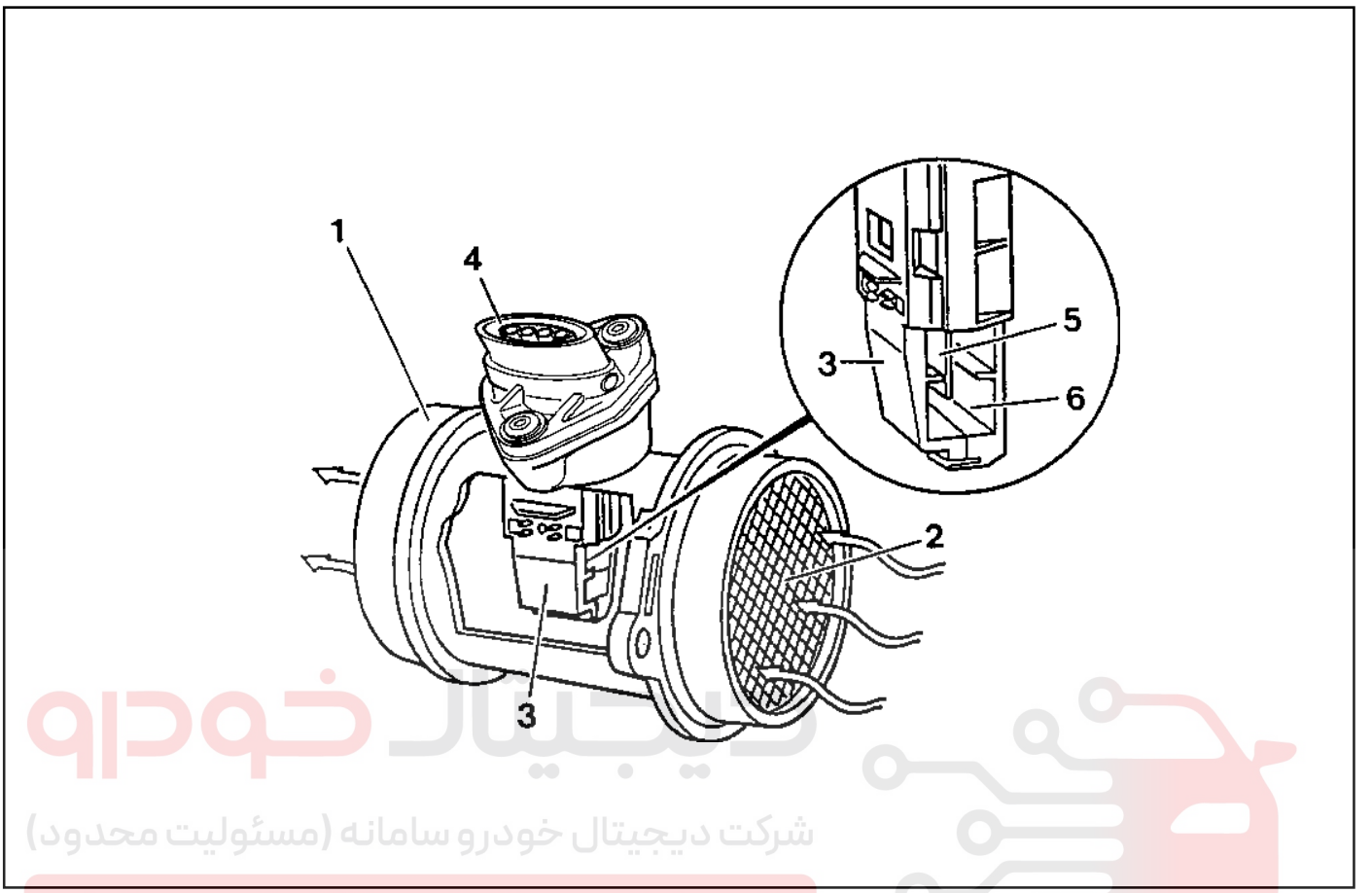
Notice

If the measured value is not within the specified value, check the cable.

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HOT FILM AIR MASS (HFM) SENSOR



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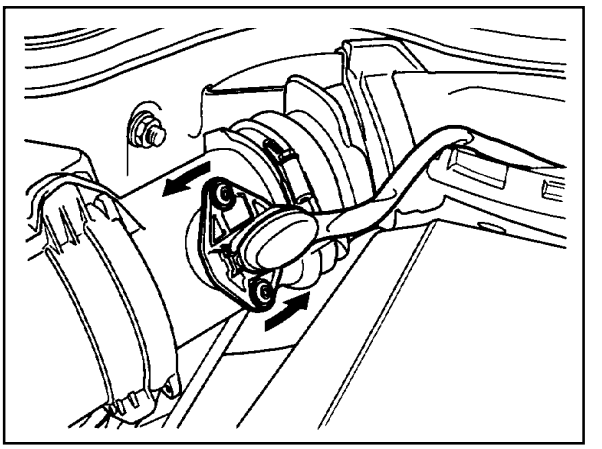
1 Housing
2 Protector Net
3 Electronic Housing
4 Connector
5 Hot film Sensor
6 Measuring Port

Removal & Installation Procedure

1. Turn the HFM sensor coupling in the direction shown in the figure in the right so that it gets separated from the contact surface.

   Notice

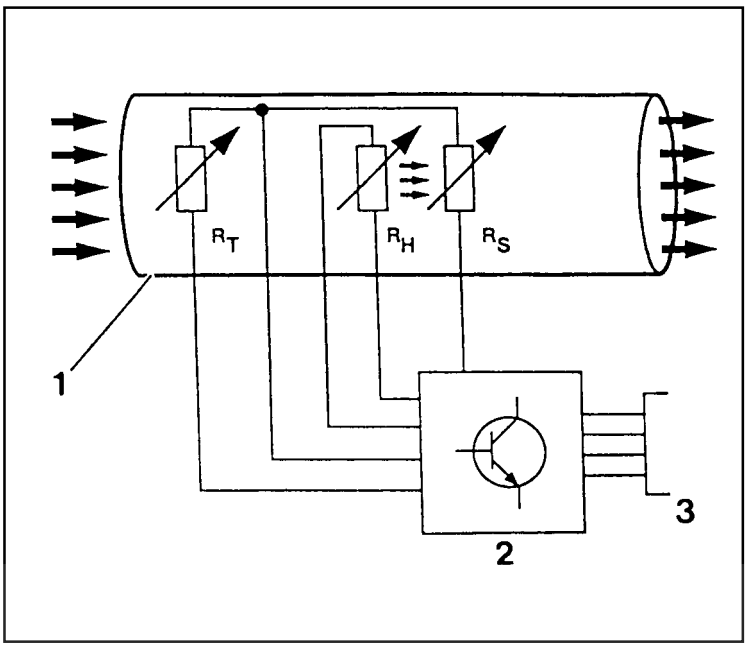
   Make sure the HFM sensor coupling connects completely with the contact surface Installation.
2. Remove the clip with a screw driver.
3. Pry off two tensioning clamps.
4. Remove the HFM sensor.
5. Installation should follow the removal procedure in the reverse order.



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Circuit Diagram



1 Housing
2 Electronic Housing
3 Connector

R_H : Heat Resistance
R_T : Temperature Resistance
R_S : Sensor Resistance

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HFM Sensor Input Voltage Inspection

1. Measure the HFM sensor signal voltage between the ECU terminal No.103 and No.104.

Specified Value (coolant temperature is over 70°C)

Iginition"ON"	0.9 - 1.1 V
Engine at Idle	1.3 - 1.7 V

If the measured value is not within the specified value, the possible cause may be in cable or HFM sensor in itself. Perform the 5V power supply inspection procedures.

HFM Sensor 5V Power Supply Inspection

1. Measure the voltage between the HFM sensor No.108(+) and No.105(-) after removing the HFM sensor connector.

Specified Value	4.7 - 5.2 V

If the measured value is not within the specified value, the possible cause may be in cable or ECU coupling.

2. Measure the voltage between the HFM sensor wining connector terminal No.3 pin(-) and No.4 after removing the HFM sensor connector.

Specified Value

Specified Value	4.7 - 5.2 V

If the measured value is not within the specified value, the possible cause may be in cable or over voltage protection relay.
Perfrom the 12V power supple inspection procedures.

HFM Sensor 12V Power Supply Inspection

1. Measure the voltage between the HFM sensor wiring connector 1G No.2 pin(+) and No.104 after removing the HFM sensor connector.

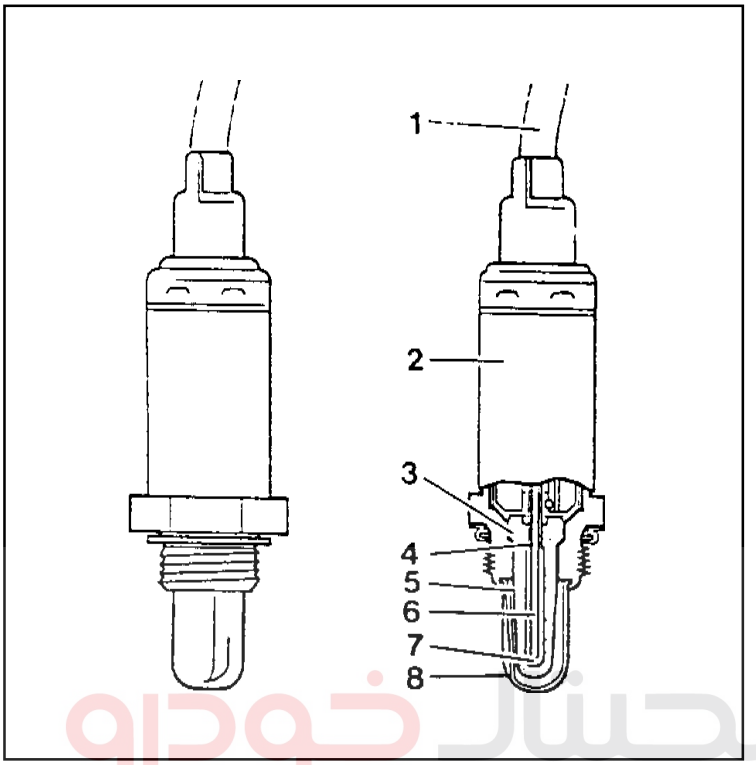
Specified Value	11 - 14 V

If the measured value is not within the specified value, the possible cause may be in cable or over voltage protection relay.

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OXYGEN SENSOR

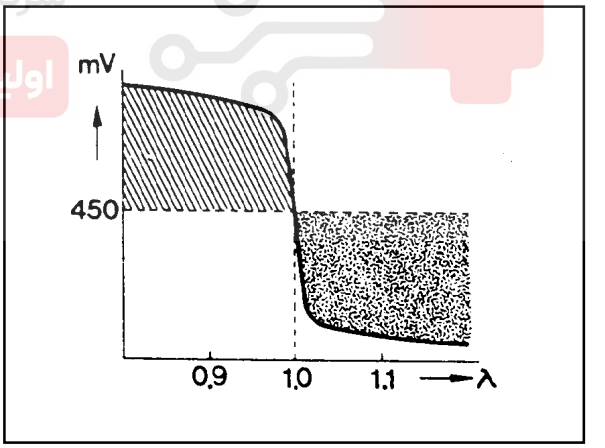


1 Electricity Wire
2 Oxygen Sensor Housing
3 Sensor Ceramic
4 Electrode (Internal)
5 Electrode (External)
6 Heating Coil
7 Open Space
8 Protector Tube

Functions

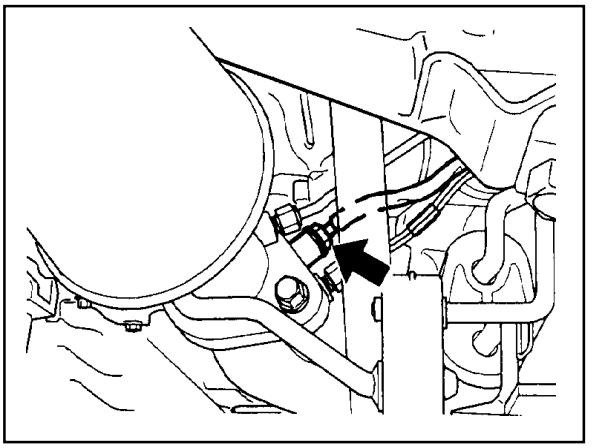
The oxygen sensor optimizes the combustion (Air-Fuel Ratio 14.7:1) and resets the Air-fuel ratio in the ECU after sensing the amount of oxygen from the exhaust gases to diminish the exhaust gases.

- Rich(<1) above approx. 450mV
- Lean(>1) below approx. 450mV



Locatoin of Sensor

Oxygen sensor is located on the front exhaust pipe.



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Oxygen Sensor Signal Voltage Inspection

1. Measure the oxygen sensor signal voltage between the ECU terminal No.11 and No.9. Maintain the engine speed ia at idle while the coolant temperature is over 80°C.

Specified Value	-0.2 - 1.0 V

If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECU.

Oxygen Sensor Heating Voltage Inspection

1. Measure the oxygen sensor heating voltage between the ECU terminal No.11 and No.9. Maintain the engine speed ia at idle while the coolant temperature is over 80°C.

Specified Value	11 - 14

If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECU.

Oxygen Sensor Heating Current Consumption Inspection

1. Measure the oxygen sensor heating current consumption between the ECU terminal No.9 and No.5 while the ignition switch is in "ON" position.

Specified Value	0.2 - 2.0 A

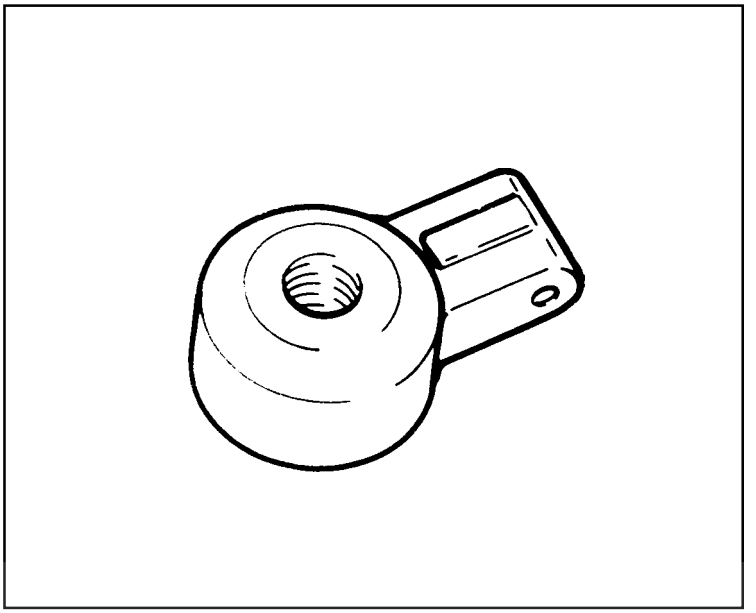
If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECU.

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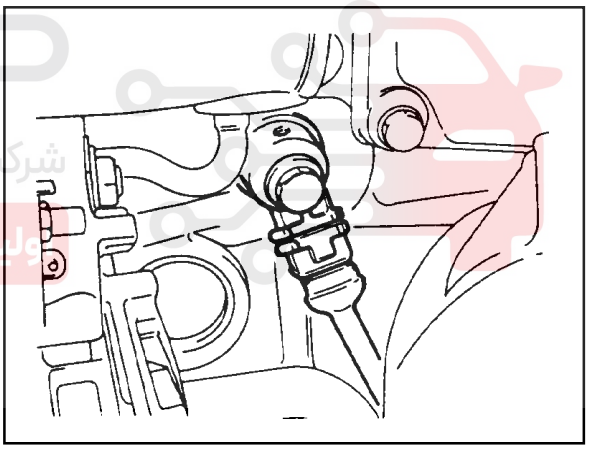
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KNOCK SENSOR



Functions

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 the signal and the retards firing point.



Removal & Installation Procedure

1. Disconnect the knock sensor connector from the intake manifold bracket.
2. Unscrew the mounting bolt (M8 X 28) from the knock sensor installed on the cylinder block and remove the knocking sensor.

Installation Notice

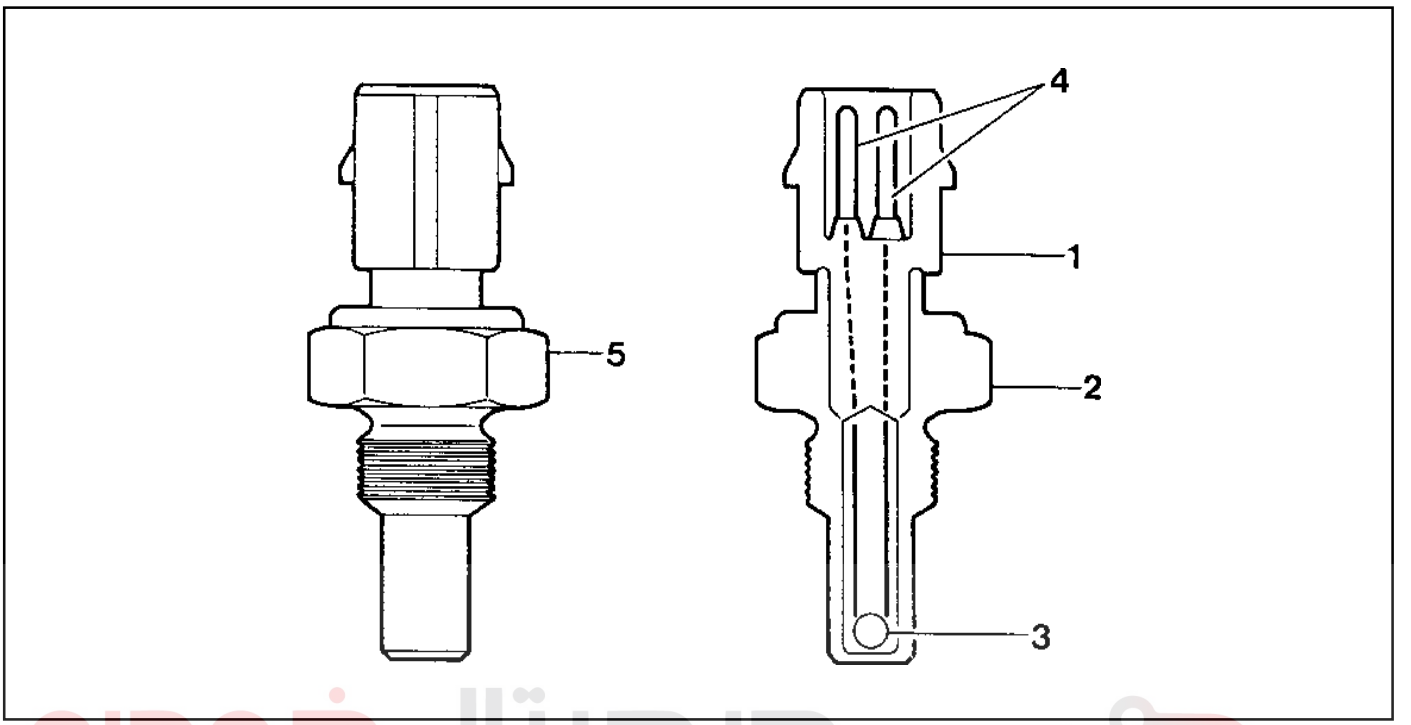
Tightening Torque	22.5 - 27.5 Nm

3. Installation should follow the removal procedure in the reverse order.

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COOLANT TEMPERATURE SENSOR



1 Artificial Resin Housing
2 Metal Housing
3 NTC (negative temperature coefficient) Resistor
4 Connector
5 Coolant Temperature Sensor

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Removal & Installation Procedure

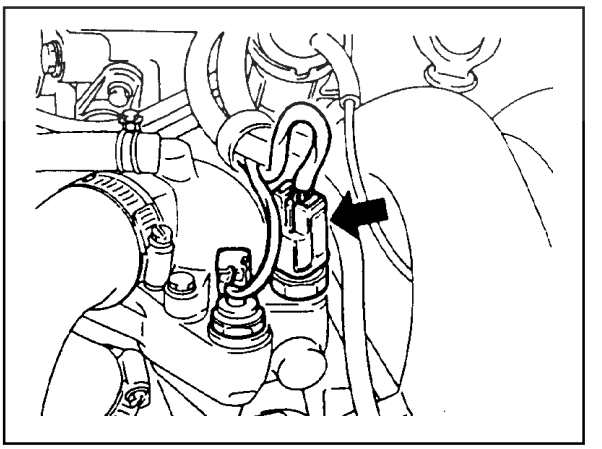
1. Remove the pressure by opening the pressure cap in the coolant subtank.
2. Disconnect the connector and remove the coolant temperature sensor.

   Installation Notice

Tightening Torque	18 - 22 Nm

   Replace the seals with new one.

3. Installation should follow the removal procedure in the reverse order.
4. Check for leaks at each connections after starting the engine.

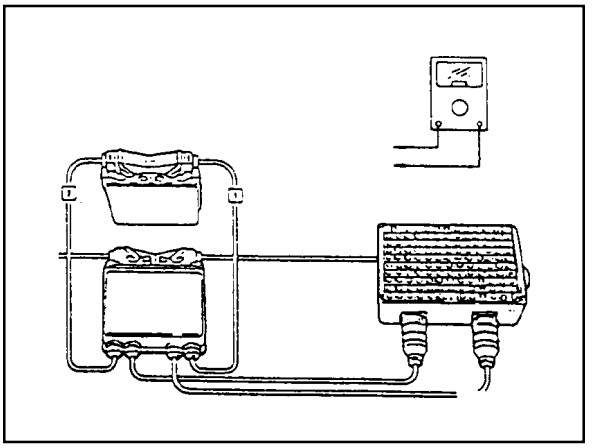


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Inspection

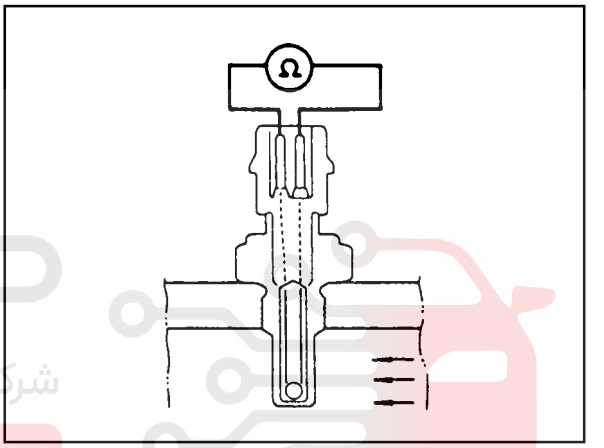
1. Measure the coolant sensor input voltage between the ECU terminal No.79 and No.78 while the ignition switch in "ON" position.



Temperature (°C)	Voltage (V)
20	3.57
30	1.22
40	0.78

allowable error :±5%

2. Measure the resistance between the coolant temperature sensor terminal No.1 and No.4 with the coolant temperature sensor disconnected.



Temperature (°C)	Resistance (W)
20	2,500
30	322
40	185

allowable error :±5%

Notice

Replace wiring and coolant temperature sensor if out of specified value.

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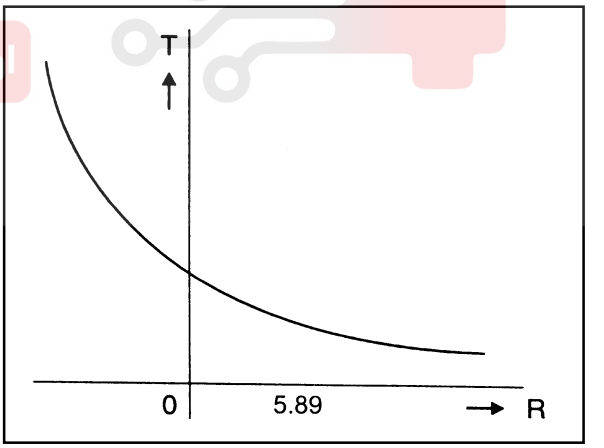
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Service Data

Temperature(°C)	Resistance(W)	Voltage(V)	Temperature(°C)	Resistance(W)	Voltage(V)
-40	48,550	4.8991	60	594	1.8632
-30	27,000	4.8214	70	434	1.5132
-20	15,670	4.7001	80	322	1.2179
-10	9,450	4.5215	90	243	0.9775
0	5,890	4.4273	100	185	0.7806
10	3,790	3.9562	110	143	0.6255
20	2,500	3.5714	120	111.6	0.5020
30	1,692	3.1426	130	88.0	0.4044
40	1,170	2.6959	140	71.2	0.3323
50	826	2.2618	-	-	-

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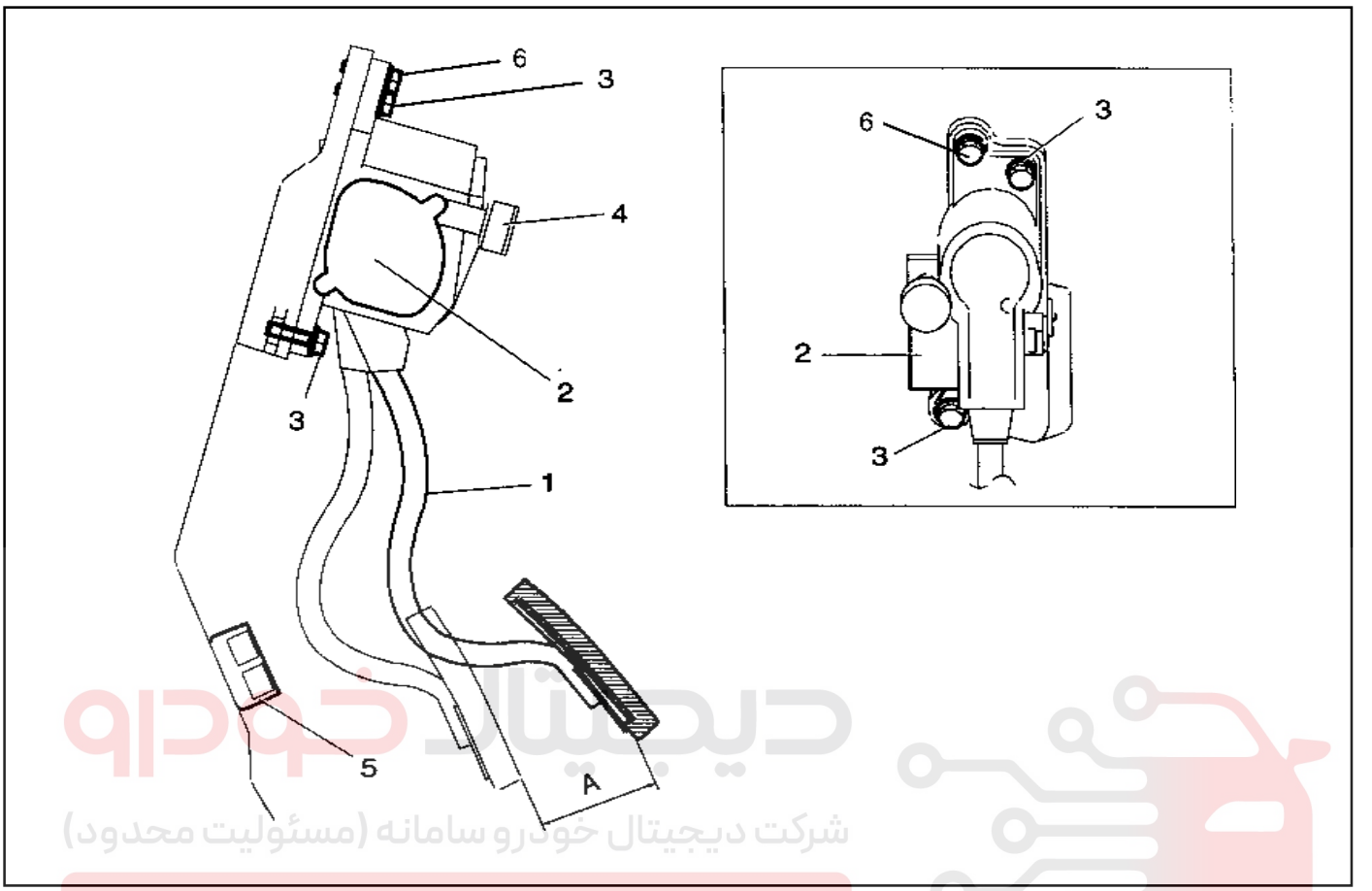
Resistance characteristic curve according to the coolant temperature



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ACCELERATOR PEDAL MODULE



1 Accelerator pedal
2 Accelerator pedal Sensor
3 Bolts (2 Pieces) ..... 4-8 Nm
4 6-Pin Connector
5 Kick down Switch
6 Nut (1 piece) ..... 4-8 Nm

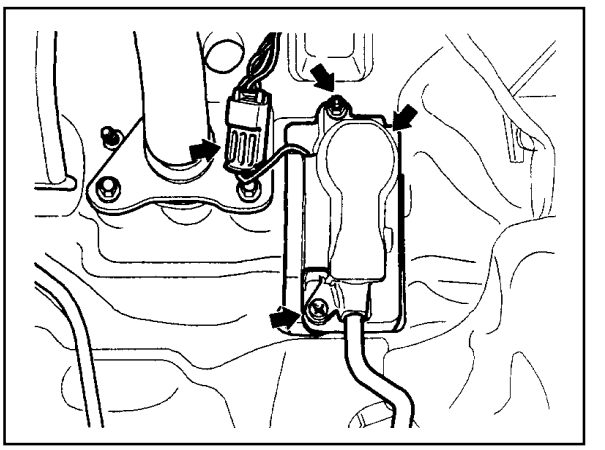
Removal and Installation Procedure

1. Disconnect the 6-pin connector(arrow).
2. Unscrew the 2 bolts (3) / 1 nut (6) and remove the pedal and sensor assembly.

Installatoin Notice

Tightining Torque	4 - 8 Nm

2. Installation should follow the removal procedure in the reverse order.



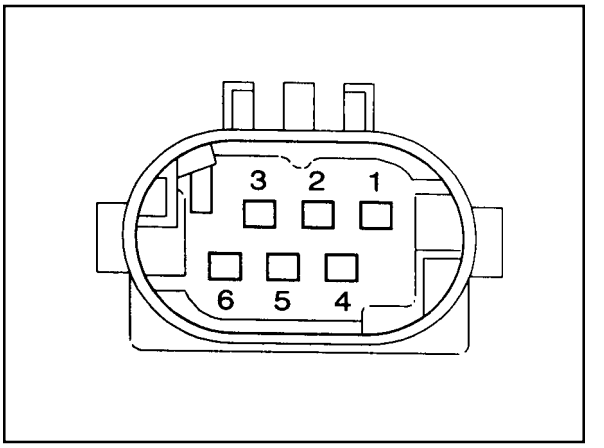
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Accelerator Pedal Sensor Connector(Sensor Side)

Potentiometer 1.
- Pin no. 3 :Red
- Pin no. 1 :Yellow
- Pin no. 5 :Brown

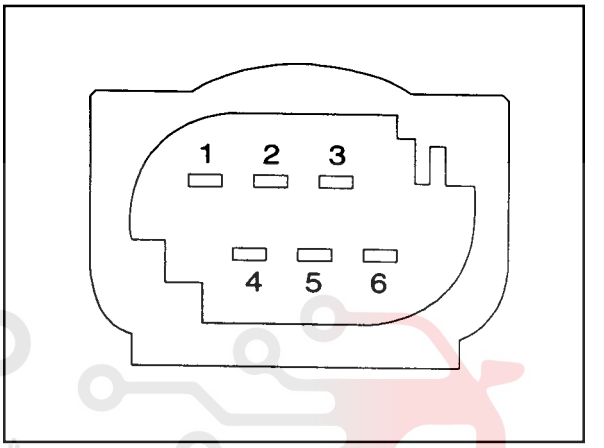
Potentiometer 2.
- Pin no. 6 :Violet
- Pin no. 4 :Green
- Pin no. 2 :White



Accelerator Pedal Sensor Connector(Vehicle Side)

Potentiometer 1.
- Pin no. 3 :Red-Black
- Pin no. 1 :Blue-Green
- Pin no. 5 :Yellow-Green

Potentiometer 2.
- Pin no. 6 :Green
- Pin no. 4 :Blue-Red
- Pin no. 2 :LightGreen

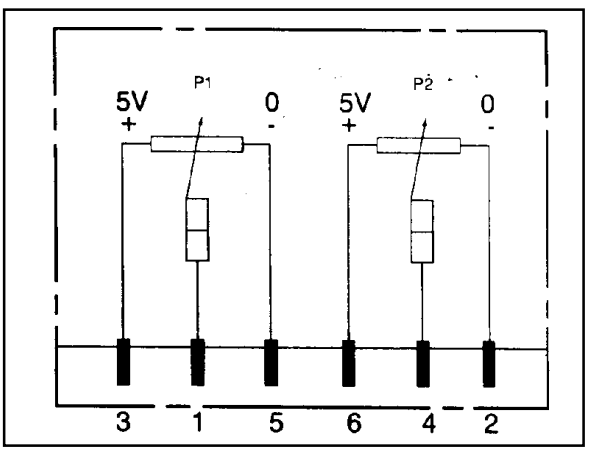


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Function

Pin no. 3	Potentiometer 1, Power Supply(+)
Pin no. 1	Potentiometer 1, Signal
Pin no. 5	Potentiometer 2, Ground
Pin no. 6	Potentiometer 2, Power Supply(+)
Pin no. 4	Potentiometer 2, Signal
Pin no. 2	Potentiometer 2, Ground

Circuit Diagram



Potentiometer 1.
Potentiometer 2.

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SECTION 1F2

M161 ENGINE CONTROLS

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m
Fuel Return and Supply Line	25 - 30
Fuel Distributor Assembly Bolt	22.5 - 27.5
Pressure Test Connector	21.6 - 26.4
Fuel Inlet and Outlet Line	25 - 30
Fuel Filter Mounting Bracket Bolt	4 - 8
Crankshaft Position Sensor Bolt	9 - 11
Camkshaft Position Sensor Bolt	9 - 11
Knock Sensor Mounting Bolt	22.5 - 27.5
Coolant Temperature Bolt	18 - 22

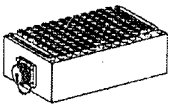
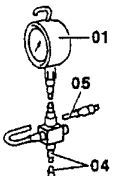
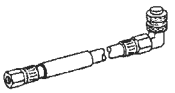
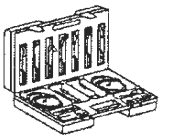
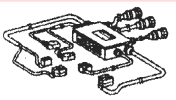
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SPECIAL TOOLS

SPECIAL TOOLS TABLE

	129 589 00 21 00 Test Box
	106 589 00 21 00 Pressure Tester
	119 589 04 63 00 Pressure Hose
	210201 Adaptor Line
	210 589 08 63 00 ECU Test Cable

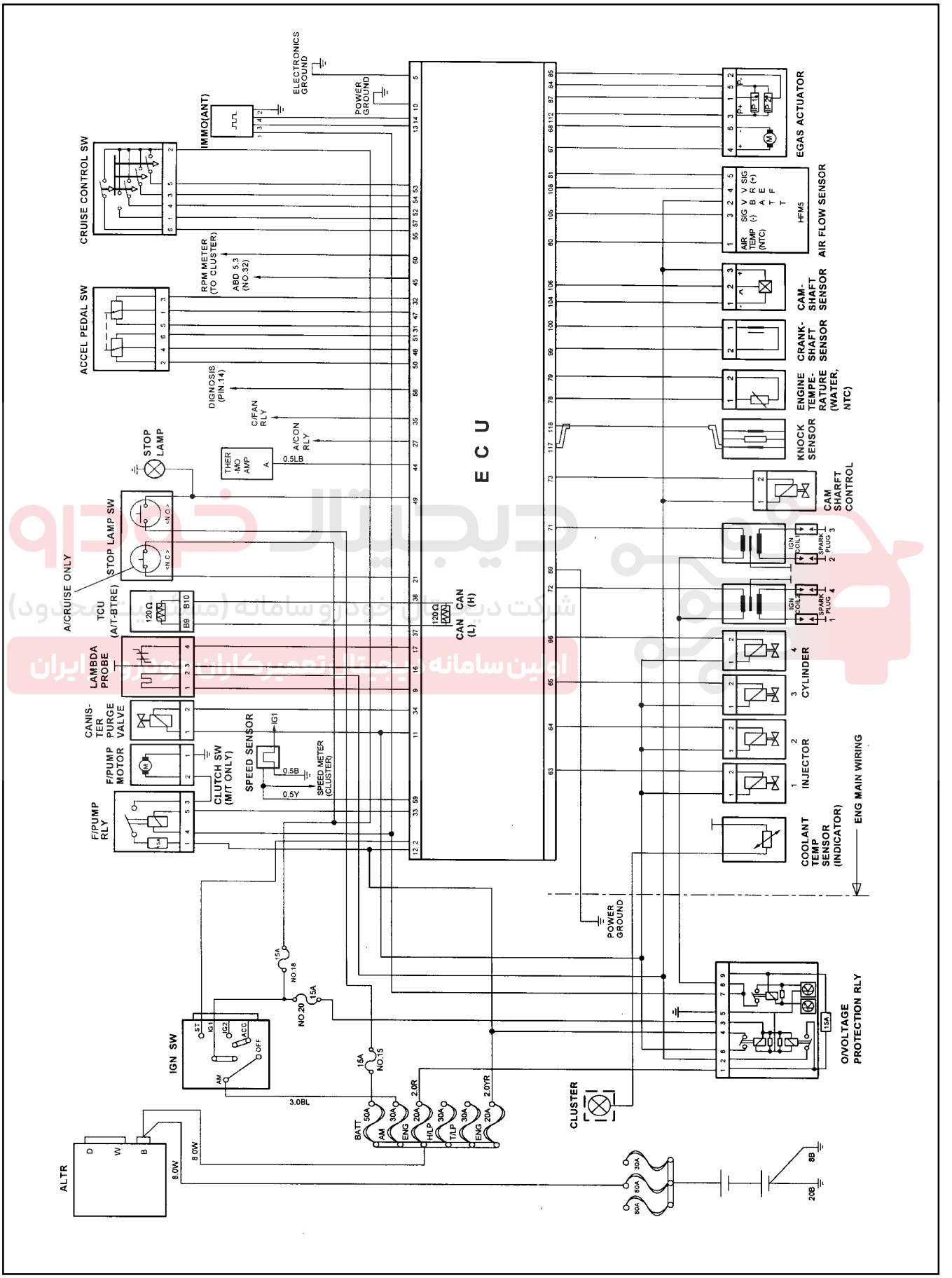
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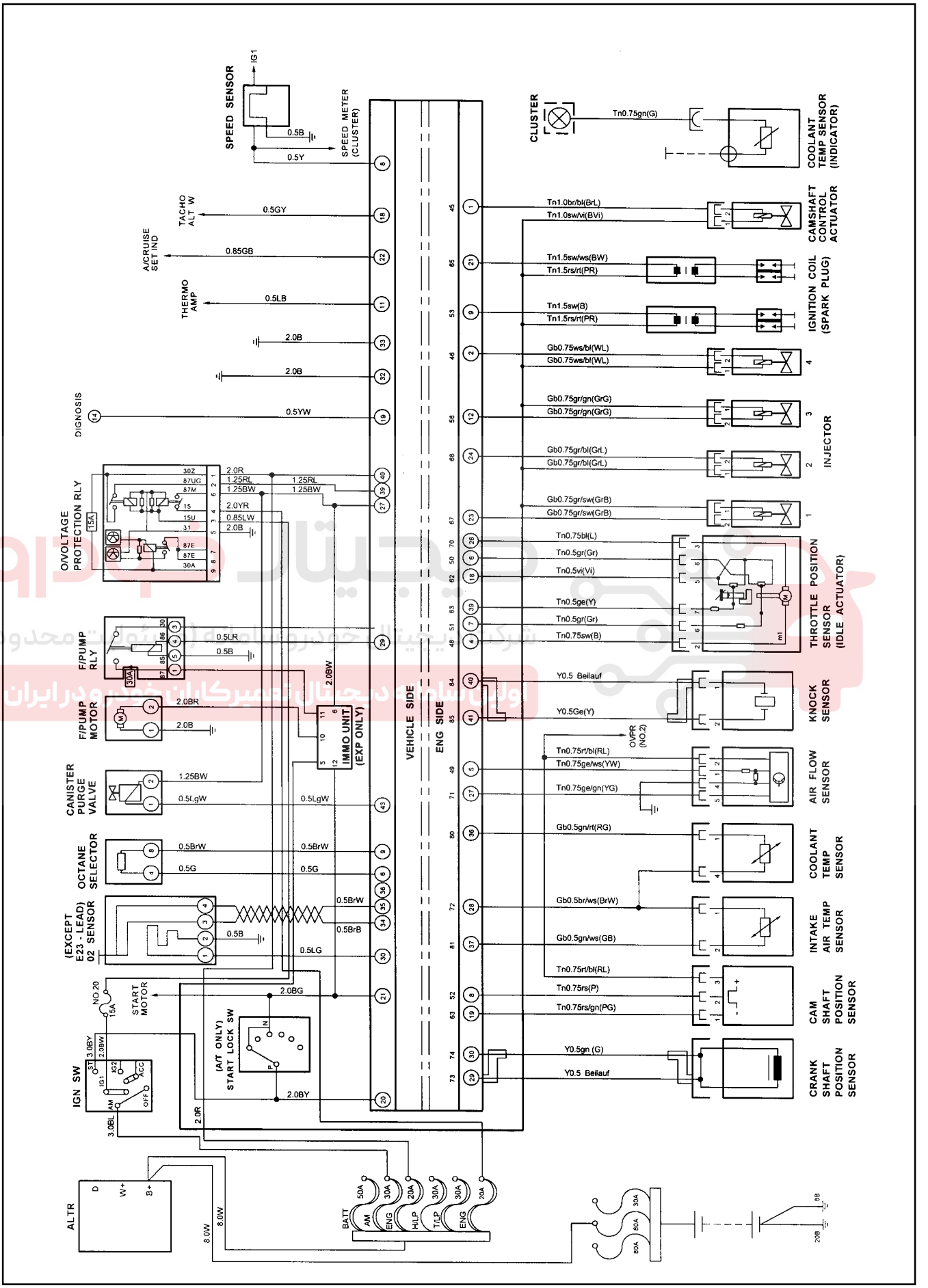
SCHEMATIC AND ROUTING DIAGRAMS

E23 ECU (MSE)



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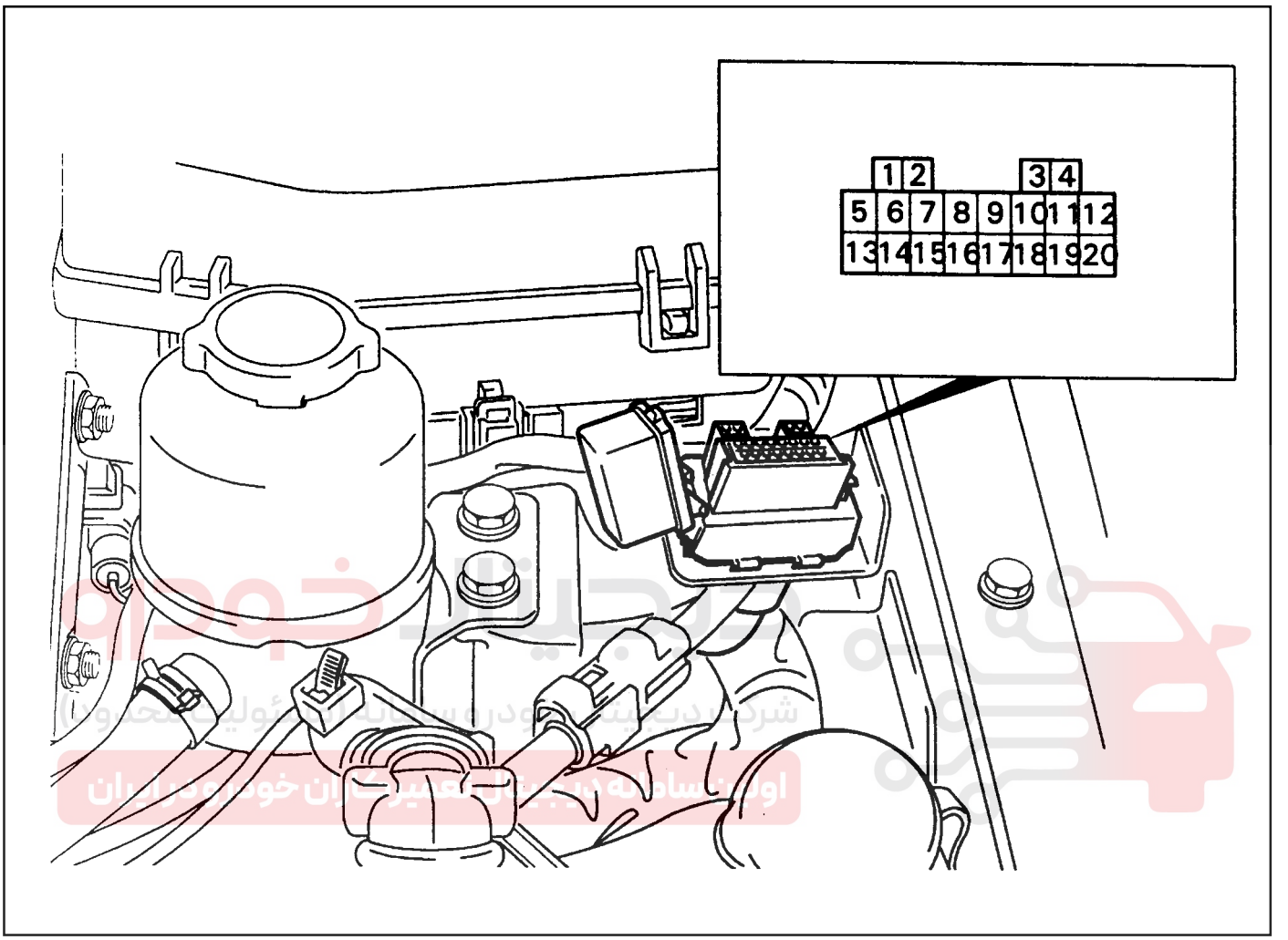


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DIAGNOSIS

SELF DIAGNOSIS SOCKET PIN NUMBERS AND DESCRIPTIONS



1 Ground
2 Ignition 1
3 Battery Power Supply (Fuse NO.17)
4 REKES :PIN 6
5 Engine Speed Signal :MSE PIN 60
6 TCCU(Part-time)
7 STICS(PIN 26)
8 -
9 -
10 Air Bag(PIN 20)
11 Remote Engine Start Unit(PIN 10)
12 -
13 Brake System
(ABS 5.3:PIN 11, ABS/ABD 5.3:PIN 46)
14 MSE 3.62S/3.53S(ECU Data Output:PIN 58)
15 TOD(PIN 20)
16 Immobilizer
17 -
18 TCU(PIN 23)
19 -
20 K-LINE(ECS:PIN 23)

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SELF DIAGNOSIS FAILURE CODE (FOR E23 ENG)

Failure code	Description	Failure code	Description
00	Coolant temperature sensor open	64	No ignition voltage output(NO.1 ignition coil; 1, 4cylinder)
01	Coolant temperature sensor short		
02	Coolant temperature sensor signal failure	65	No ignition voltage output(NO.2 ignition coil; 2, 3cylinder)
03	Intake temperature sensor open		
04	Intake temperature sensor short	67	Cranshaft position sensor adaption failure
05	Intake temperature sensor signal failure	71	Start signal recognition failure
08	Low battery voltage	72	No.1 injector short(PWR)
09	HFM sensor signal failure	73	No.1 injector open/short(GND)
10	HFM sensor signal failure (Low)	74	No.2 injector short(PWR)
11	HFM sensor signal failure (High)	75	No.2 injector open/short(GND)
17	Crankshaft position sensor signal failure (no engine revolution signal)	76	No.3 injector short(PWR)
		77	No.3 injector open/short(GND)
18	Crankshaft position sensor signal failure (rpm > max. value)	78	No.4 injector short(PWR)
		79	No.4 injector open/short(GND)
19	No.1 cylinder recognition failure	80	High oxygen sensor voltage
20	Crankshaft position sensor signal failure (gab recognition failure)	81	Low oxygen sensor amplifying voltage
		82	Oxygen sensor operating failure
21	Transmission coding failure	83	Not excessive lean indication in oxygen sensor(during coasting)
25	Transponder signal communication failure		
26	CAN communication failure : TCU(A/T only)	86	Oxygen sensor heater short(power)
31	CAN communication failure : communication initialization failure	87	Oxygen sensor heater open/short(GND)
		89	Low oxygen sensor voltage
34	Fuel pump relay short(PWR)	93	Short learning control failure
35	Fuel pump relay open/short(GND)	96	Lambda control failure (rich stop)
40	Purge valve short	97	Lambda control failure (lean stop)
41	Purge valve open/short	98	Lambda idle adaptation failure(above rich threshold)
44	Condenser fan(HI) relay short(PWR)		
45	Condenser fan(HI) relay short(GND)	99	Lambda idle adaptation failure(below lean threshold)
56	No.1 knock sensor signal failure		
58	No.1 cylinder synchronization failure	100	learning control failure(rich, low load)

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Failure code	Description	Failure code	Description
101	learning control failure(lean, low load)	140	Servo motor open/short
102	learning control failure(rich, high load)	141	Unprogramed ECU with Immobilizer
103	learning control failure(lean, high load)	142	Uncoded ECU
104	Low throttle position sensor(IP1) voltage	143	ECU failure(NVRAM checksum failure)
105	High throttle position sensor(IP1) voltage	144	ECU failure(coding ID checksum failure)
108	Low throttle position sensor(IP2) voltage	145	ECU failure(coding checksum failure)
109	High throttle position sensor(IP2) voltage	146	ECU failure(programing checkusm failure)
110	Throttle actuator learning data fault	150	ABD input signal short(power)
116	Throttle actuator learning control failure	151	ABD input signal short(GND)
117	Exceed fuel-cut safety time	160	Low pedal valve sensor SP1 voltage
119	Throttle valve return spring failure	161	High pedal valve sensor SP1 voltage
120	Cruise control interruption memory failure	162	Low pedal valve sensor SP2 voltage
121	Throttle actuator failure	163	High pedal valve sensor SP2 voltage
122	Pedal module position sensor signal failure	164	Different pedal valve sensor signal(1,2) SP1 with SP2
123	Defferent HFM signal with throttle potentiom-eter	167	Pedal valve sensor 1,2 failure
125	Both throttle potentiomenter(IP1 & IP2) failure	185	HFM sensor, and throttle position sensor failure
		186	ECU failure(incompatible CPU)
126	Different IPS1 with IPS2	187	ECU failure(CPUs communication failure)
127	High permanent throttle signal deviation	188	ECU failure(CPU(2) configuration failure)
129	Message counter fault ® cruise control “OFF”	189	ECU failure(CPU(2) fault)
130	Vehicle speed signal failure	190	ECU failure(CPU run time failure between CPUs)
131	Vehicle speed signal failure		
132	Cruise control lever failure	192	-
133	Cruise control acceleration failure	193	-
134	Cruise control deceleration failure	194	-
136	ECU failure(RAM)	195	-
137	ECU failure(EPROM)	198	-
139	Servo motor control output inter-ruption memory failure	199	-
		226	Cam actuator short(PWR)

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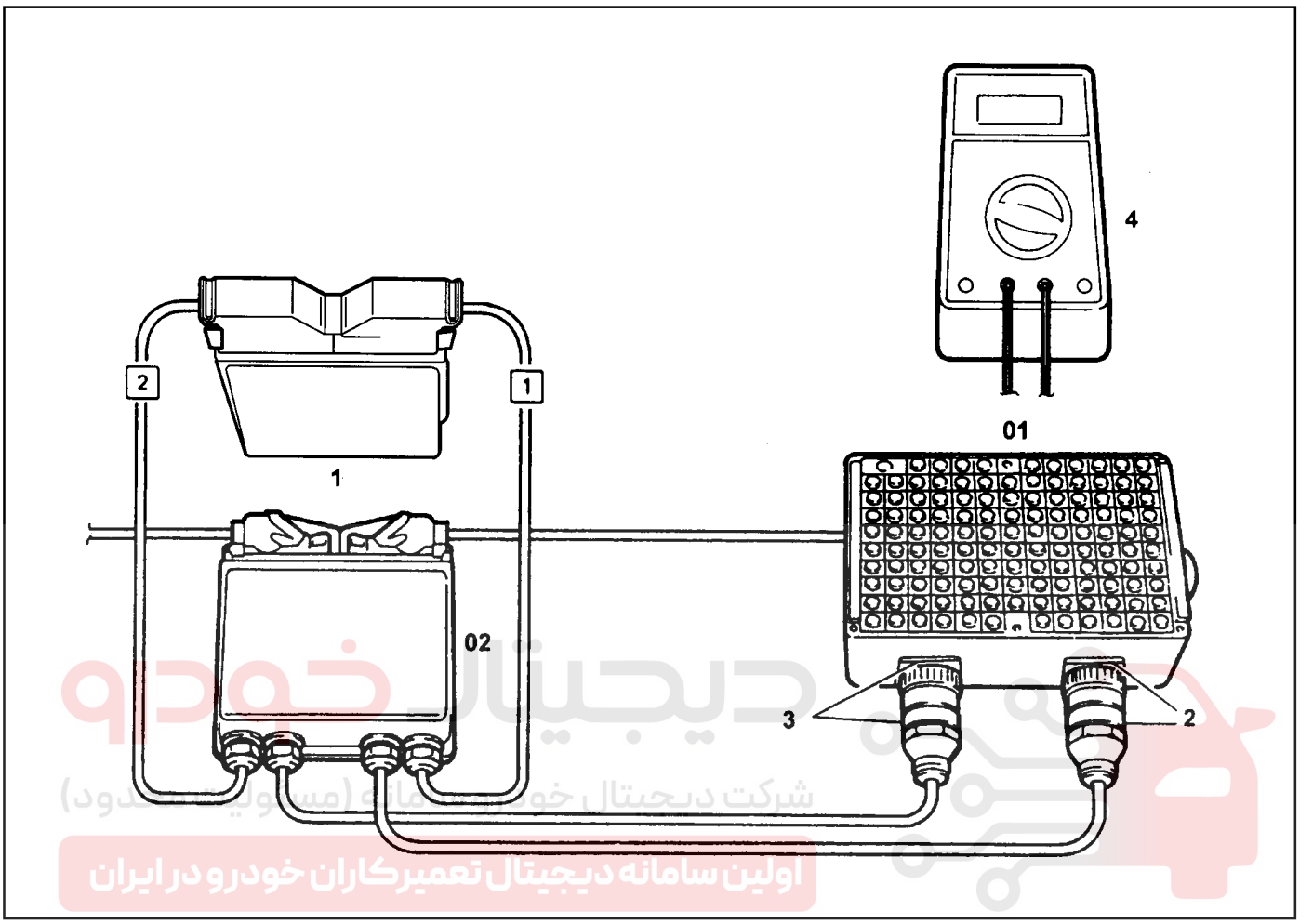
Failure code	Description	Failure code	Description
227	Cam actuator open/short(GND)	242	Unusual CPU configuration(CPU2)
228	A/C compressor relay short(PWR)	243	AD converter failure(CPU2)
229	A/C compressor relay open/short(GND)	244	Pedal position sensor setpoint fault berween CPU1 and CPU2
232	Decel limit defected by CPU2		
233	Accel limit defected by CPU2	245	Position setpoint fault berween CPU1 and CPU2
234	Cruise control lever double input(CPU2)		
235	Cruise control lever safety terminal failure(CPU2)	246	-
		247	Idle controller setpoint fault berween CPU1 and CPU2
236	Unusual pedal position variation(CPU2)		
237	Unusual throttle position variation(CPU2)	248	AD converter overflow degected by CPU2
238	Unusual throttle control data(CPU2)	249	ROM fault degected by CPU2
239	Unusual pedal position sensor(CPU2)	250	RAM fault degected by CPU2
240	Throttle potentiometer fault(CPU2)	251	Cycle monitor fault degected by CPU2
241	Unusual CPU communication(CPU2)		

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TEST BOX CONNECTION



1 ECU
2 Test Coupling(No.1 - 60)
3 Test Coupling(No.61 - 120)
4 Multi-tester

01 Test Box
02 ECU Test Cable

Tools Required

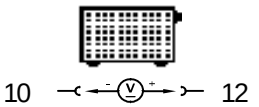
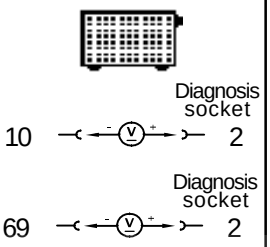
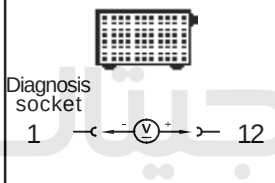
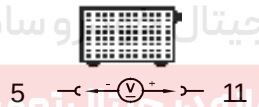
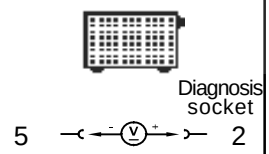
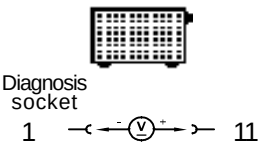
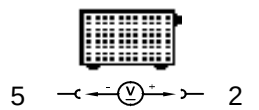
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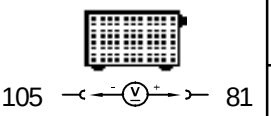
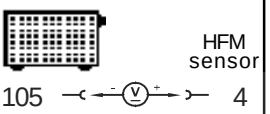
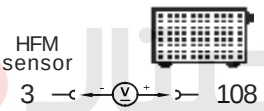
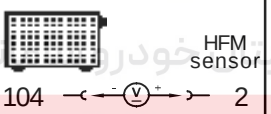
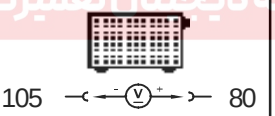
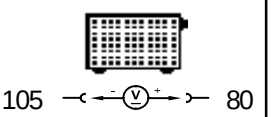
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FUEL INJECTION SYSTEM TEST

Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
08,	Þ 1.0	· **ECU:power supply** - terminal 30 (TM.30)		· Ignition:ON	11 -14V	· Þ 1.1 · Þ 1.2
	Þ 1.1	· **Ground cable:** - Battery ground		· Ignition:ON	11 -14V	· Ground cable · Ground condition
	Þ 1.2	· **Power supply:** - terminal 30 (TM.30)		· Ignition:ON	11 -14V	· Power supply cable
08,	Þ 2.0	· **ECU:power supply** - terminal 87 (TM.87)		· Ignition:ON	11 -14V	· Þ 1.1 · Þ 2.1
	Þ 2.1	· **Ground cable** - Electronic ground		· Ignition:ON	11 -14V	· Ground cable
	Þ 2.2	· **Power supply:** - terminal 87 (TM.87)		· Ignition:ON · Ignition:OFF	11 -14V < 1V	· Power supply cable · OVPR
	Þ 3.0	· **Start signal:** - terminal 50 (TM.50)		· Engine:in Cranking	11 -14 (during engine cranking)	· Cable · Ignition Swith

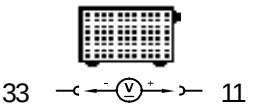
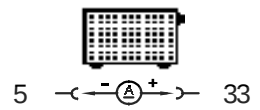
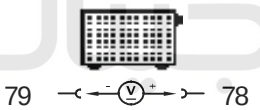
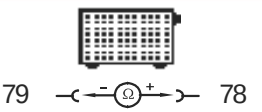
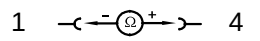
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
09, 10, 11,	Þ 4.0	· **HFM sensor signal**		· Ignition:ON	0.9 - 1.1V	· Þ 4.1 - 4.3 · Cable · External air inflow · HFM sensor
				· Engine:in Idle (Coolant temperature : > 70℃)	1.3 - 1.7V : voltage value is increased when engine rpm is increased	
	Þ 4.1	· **HFM sensor:** - 5V power supply		· Ignition:ON · HFM sensor connector removed	4.7 - 5.2V	· Cable · ECU coupling
	Þ 4.2	· **HFM sensor:** - 5V power supply		· Ignition:ON · HFM sensor connector removed	4.7 - 5.2V	· Þ 4.3 · Cable
	Þ 4.3	· **HFM sensor:** - 12V power supply		· Ignition:ON · HFM sensor connector removed	11 - 14V	· Cable · OVPR
03, 04, 05,	Þ 5.0	· **Intake air temperature sensor:** - Voltage		· Ignition:ON	℃ V 10 3.1 20 2.65 30 2.18 40 1.76 50 1.4 60 1.1 ±5%	· Þ 5.1 · ECU
	Þ 5.1	· **Intake air temperature sensor:** - Resistance		· Ignition:OFF · No.2 ECU coupling removed	℃ W 10 3600 20 2420 30 1662 40 1166 50 853 60 600 ±5%	· Cable · HFM sensor

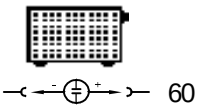
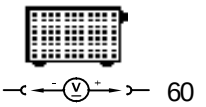
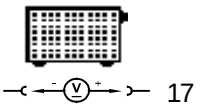
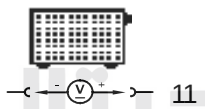
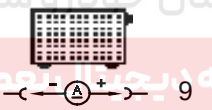
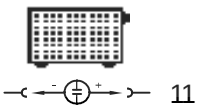
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
34, 35,	Þ 6.0	· **Fuel pump relay:** - Operation		· Ignition:ON (Fuel pump relay will operate for 1 - 2 seconds when the ignition switch is turned to "ON" after stopping the engine) · Engine:cranking	11 - 14V (approx.1-2sec.) 11 - 14V (Cranking or driving)	· Cable · Fuel pump relay · ECU
	Þ 6.1	· **Fuel pump relay:** - Current consumption		· Ignition:ON	0.1 - 0.3A	· Cable · Fuel pump relay · ECU
00, 01, 02, 06,	Þ 7.0	· **Coolant temperature sensor:** - Voltage		· Ignition:ON	℃ V 20 3.57 80 1.22 100 0.78 ±5%	· Þ 7.1 · ECU
	Þ 7.1	· **Coolant temperature sensor:** - Resistance & cable		· Ignition:OFF (Remove the No.2 coupling from ECU)	℃ W 20 2500 80 322 100 185 ±5%	· Þ 7.2 · cable
	Þ 7.2	· **Coolant temperature sensor:** - Resistance	Coolant temperature sensor: 	· Remove the connector from coolant temperature sensor and measure the resistance between No.1 and No.2 pin with multimeter.	· Þ refer to specified resistance value of 7.1.	· Coolant temperature sensor

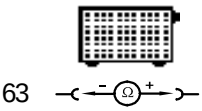
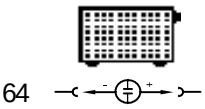
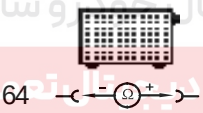
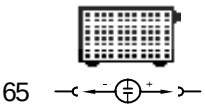
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
32, 33,	Þ 8.0	· **ECU:** - RPM signal output		· Engine:in cranking or idle	refer to figure 2	· Cable · ECU
		- Voltage		· Engine:in cranking or idle (above 5V in idling)	6.0 - 7.0 V	
80, 81, 82, 83, 89,	Þ 9.0	· **Oxygen sensor:** - Signal		· Keep the engine run above 2 minutes in over 80℃ of coolant temperature	There will be a voltage fluctuation in the range of - 0.2 -1.0V.	· ECU · Cable · Oxygen sensor
85, 86, 87,	Þ 10.0	· **Oxygen sensor:** - Heating function operated		· Keep the engine run above 2 minutes in over 80℃ of coolant temperature.	11 - 14 V	· ECU · Cable · Oxygen sensor
		- Current consumption		· Ignition:ON	0.2 - 2.0 A	
72, 73,	Þ 11.0	· **No.1 cylinder injector:** - Operating & injection time		· When the coolant temperature is approx. 20℃: - Engine:in cranking · When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	8.0 ms approx. 2.7 - 5.0ms approx.14ms	· Cable · ECU · No.1 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor

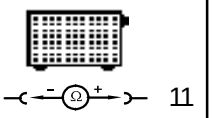
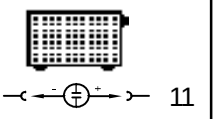
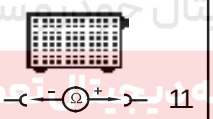
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		- Internal resistance (No.1 injector)	 63 11	· Ignition:OFF (injector temperature is 20℃)	14 - 17 W	
74, 75,	Þ 12.0	· **No.2 cylinder injector:** - Operating & injection time	 64 11	· When the coolant temperature is approx. 20℃: - Engine:in cranking	8.0 ms	· Cable · ECU · No.2 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor
				· When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration (full throttle) (refer to figure 3 and 4)	approx. 2.7 - 5.0ms approx.14ms	
		- Internal resistance (No.2 injector)	 64 11	· Ignition:OFF (injector temperature is 20℃)	14 - 17 W	
76, 77,	Þ 13.0	· **No.3 cylinder injector:** - Operating & injection time	 65 11	· When the coolant temperature is approx. 20℃: - Engine:in cranking	8.0 ms	· Cable · ECU · No.3 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor
				· When the coolant temperature is approx. 80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	approx. 2.7 - 5.0ms approx.14ms	

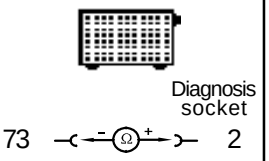
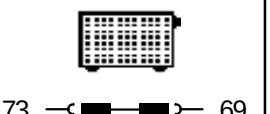
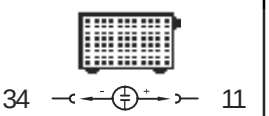
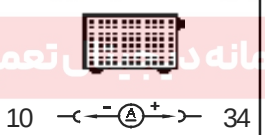
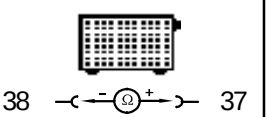
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		- Internal resistance (No.3 injector)	 65 — 11	· Ignition:OFF (injector temperature is 20℃)	14 - 17 W	
78, 79,	Þ 14.0	· **No.4 cylinder injector:** - Operating & injection time	 66 — 11	· When the coolant temperature is approx.20℃: - Engine:in cranking	8.0 ms	· Cable · ECU · No.4 Injector · Coolant temperature sensor · Oxygen sensor · Intake air temperature sensor
				· When the coolant temperature is approx.80℃: - Engine:at idling speed - Engine:at sharp acceleration(full throttle) (refer to figure 3 and 4)	approx. 2.7 - 5.0ms approx.14ms	
		- Internal resistance (No.4 injector)	 66 — 11	· Ignition:OFF (injector temperature is 20℃)	14 - 17 W	
226, 227,	Þ 15.0	· **Camshaft actuator:** Current consumption	Camshaft actuator 1 — 2	· Engine : using a test cable(102 589 63 00) in idling, measure the current consumption with below condition - Coolant temperature : above 70℃ - Engine rpm : increase up to 2000 rpm	1 - 1.5 A	· ECU · Þ 15.1 · Þ 16.0

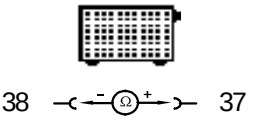
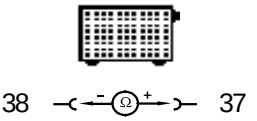
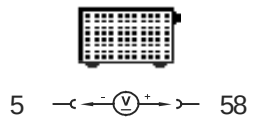
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 15.1	· **Camshaft actuator:** Solenoid resistance (E23 only)		· Ignition:OFF	8 - 12 W	· Cable · Camshaft actuator
226, 227,	Þ 16.0	· **Camshaft actuator:** Mechanical actuation (E23 only)		· Engine:in idling	Engine is unstable or stopped.	· Mechanical failure of camshaft actuator
40, 41, 54,	Þ 17.0	· **Purge control valve:** - Operating		· Engine:in idling	The purge control valve should be operated after approx. 1minute. (refer to figure 5)	· ECU · Cable · Purge control valve
		- Current consumption		· Ignition:ON	0.2 - 0.4 A	
40, 41, 54,	Þ 18.0	· **Purge control valve:** - Vacuum control	Connect the vacuum gauge between the control valve and canister	· Engine:in idling/ normal operating temperature	Creating above 50mbar of vacuum after approx. 1 minute	· Power supply cable · OVPR
22,23, 24,26, 27,29, 30,31, 59,60,	Þ 19.0	· **CAN data bus**		· Ignition:OFF	55 - 65 W	· Data bus · Þ 19.1 · Þ 19.2

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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 19.1	· **CAN module resistance in ABS, ABD, ASR control unit**	 38 — Ω — 37	· Ignition:OFF - disconnect the coupling"No.1" from ECU	115 - 125 W	· Cable · ABS, ABD, ASR control unit
	Þ 19.2	· **CAN module resistance in ECU control unit**	 38 — Ω — 37	· Ignition:OFF - disconnect the coupling"No.1" from ECU	115 - 125 W	· ECU
	Þ 20.0	· **Diagnosis cable operating**	 5 — V — 58	· Ignition:ON	11 - 14 V	· ECU · Cable

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Reference Figures

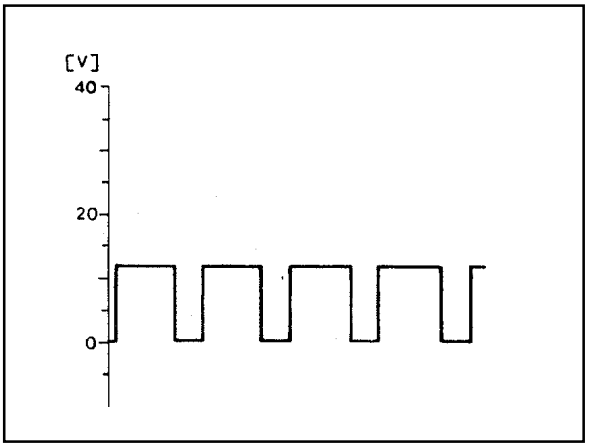


Figure1. RPM Sgnal Output

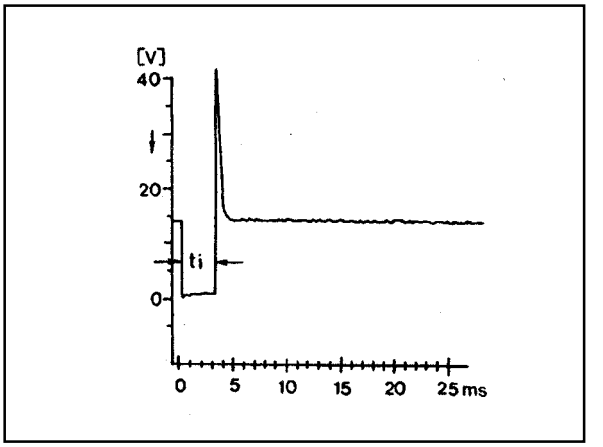


Figure 2. Injection Valve Wave(at idle speed)

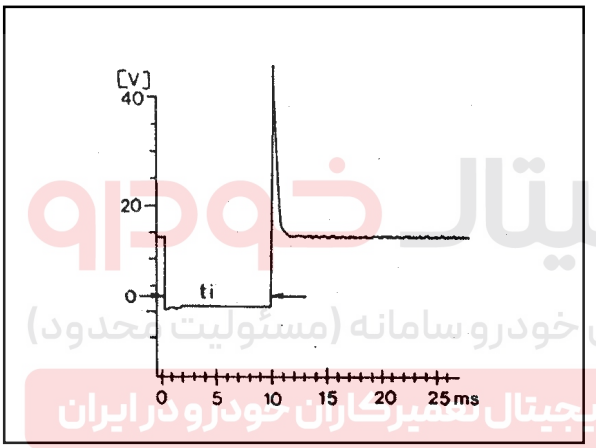


Figure 3. Injection Valve Wave(at sharp acceleration)

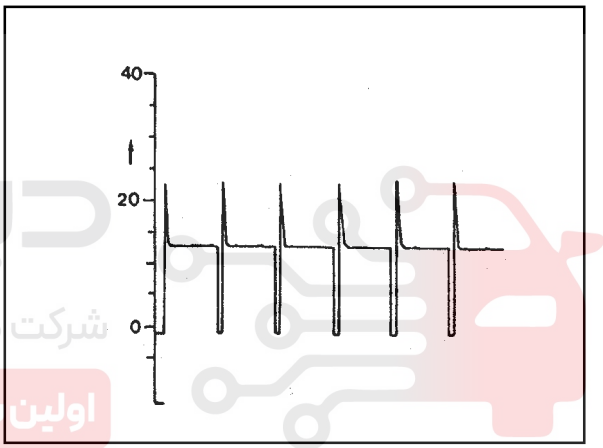
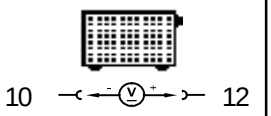
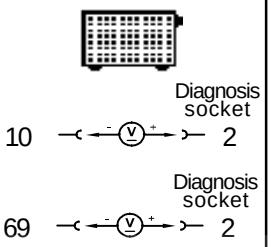
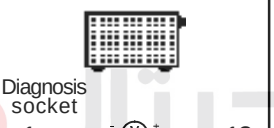
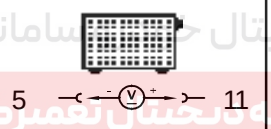
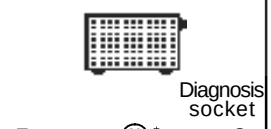
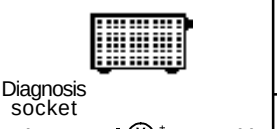
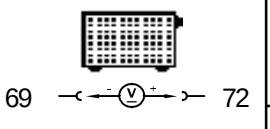


Figure 4. Purge Control Valve Operationg Wave

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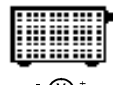
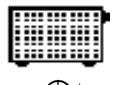
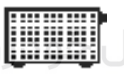
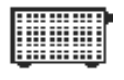
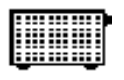
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IGNITION SYSTEM TEST

Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
08,	Þ 1.0	· **ECU:power supply** - terminal 30 (TM.30)		· Ignition:ON	11 - 14V	· Þ 1.1 · Þ 1.2
	Þ 1.1	· **Ground cable:** - Battery ground		· Ignition:ON	11 - 14V	· Ground cable · Ground condition (figure 1)
	Þ 1.2	· **Power supply:** - terminal 30 (TM.30)		· Ignition:ON	11 - 14V	· Power supply cable
08,	Þ 2.0	· **ECU:power supply** - terminal 87 (TM.87)		· Ignition:ON	11 -14V	· Þ 2.1 · Þ 2.2
	Þ 2.1	· **Ground cable** - Electronic ground		· Ignition:ON	11 - 14V	· Ground cable
	Þ 2.2	· **Power supply:** - terminal 87 (TM.87)		· Ignition:ON · Ignition:OFF	11 - 14V < 1V	· Power supply cable · OVPR
64,	Þ 3.0	· **Ignition coil(T1/1)** - No.1,4 Cylinder		· Ignition:ON · Engine:in cranking	11 - 14 V > 10 V	· Cable · Ignition coil(T1/1) · Fuse No.17

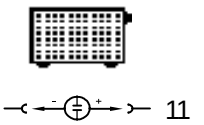
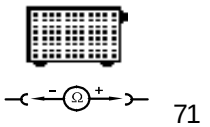
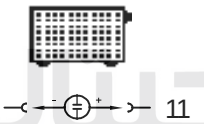
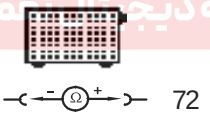
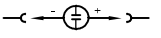
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
65,	Þ 4.0	· **Ignition coil(T1/2)** - No.2,3 Cylinder	 69 — 71	· Ignition:ON	11 -14 V	· Cable · Ignition coil(T1/2) · Fuse No.17
				· Engine:in cranking	> 10 V	
17, 18, 20, 67,	Þ 5.0	· **Crankshaft position sensor:** - Signal	 99 — 100	· Engine:in cranking	Measure the signal (refer to figure 6)	· Increament failure in driven plate · Þ 5.1
				· Engine:idling		
		- Voltage (alternating)	 99 — 100	· Engine:in cranking	> 2.5 V -	
				· Engine:idling	> 5 V -	
	Þ 5.1	· **Crankshaft position sensor:** - Resistance	 99 — 100	· Ignition:OFF - Disconnect the coupling “No.2” from ECU (engine side coupling).	1050 - 1400W	· Cable · Crankshaft position sensor
19, 58,	Þ 6.0	· **Camshaft position sensor:** (E23 only) - Signal	 104 — 106	· Engine:in cranking	Measure the signal(refer to figure 8)	· Þ 6.1 · Cable · Camshaft position sensor
		- Voltage (alternating)	 106 — 11	· Engine:in cranking	The value will be changed in 1.2 - 1.7 V.	
	Þ 6.1	· **Camshaft position sensor** (E23 only) - Power supply	Camshaft position sensor  1 — 3	· Ignition:ON - Remove the connector from the camshaft position sensor	11 -14 V	· Cable · OVPR

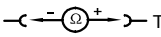
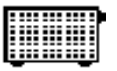
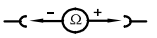
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
64,	Þ 7.0	· **Ignition coil(T1/1)** - Primary coil voltage (No.1 , 4 cylinder)		· Engine:in cranking (starter operating) - Measuring range: 400 V - Time range: 100 % (using engine tester)	200 - 350 V	· Þ 7.1
	Þ 7.1	· **Connection ignition coil between T1/ 1 and T1/2**		· Ignition:OFF	0.9 - 1.6 W The resistance of ignition coil at 20℃ is approached 0.6W.	· Cable · Ignition coil T1/1 · Ignition coil T1/2
65,	Þ 8.0	· **Ignition coil(T1/2)** - Primary coil voltage (No.2 , 3 cylinder)		· Engine:in cranking (starter operating) - Measuring range: 400 V - Time range: 100 % (using engine tester)	200 - 350 V	· Þ 8.1
	Þ 8.1	· **Connection ignition coil between T1/ 1 and T1/2**		· Ignition:OFF	0.9 - 1.6 W The resistance of ignition coil at 20℃ is approached 0.6W.	· Cable · Ignition coil T1/1 · Ignition coil T1/2
64, 65,	Þ 9.0	· **Ignition coil** (T1/1, T1/2) - Secondary ignition voltage	Engine tester 	· Engine:in cranking - Select the ignition coil in order of T1/1, T1/2 - Measuring range : 20KV - Time range : 100%	8 - 20 KV	· Þ 9.1 · Ignition plug · ECU · High tension cable

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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 9.1	· **Ignition coil** (T1/1, T1/2) - Secondary coil resistance	Ignition coil (T1/1, T1/2) TM.4a  TM.4b	· Remove the high tension cable of T1/1, T1/2	6 - 8.5 KW	· Ignition coil T1/1 · Ignition coil T1/2
56,	Þ 10.1	· **Knock sensor** - Resistance	 117  118	· Ignition:OFF - Disconnect the coupling "No.2" from ECU.	> 10 MW	· Connecting condition · Cable · ECU

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Reference Figures

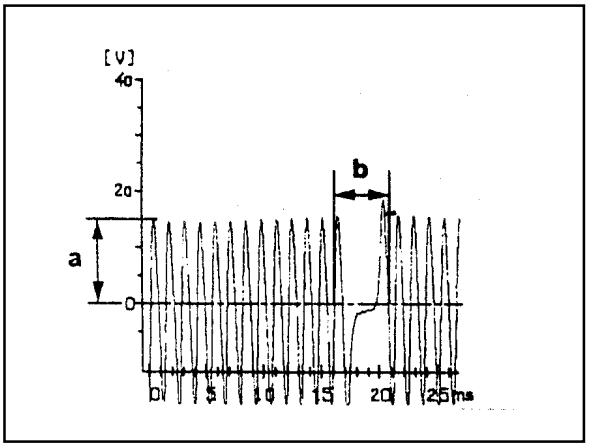


Figure 5. Crankshaft Position Sensor Signal
a Voltage
b Identifying the No.1 - 2 Missing Teeth

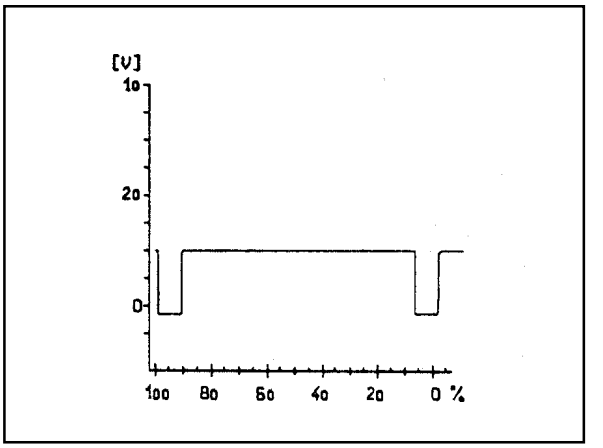


Figure 6. Camshaft Position Sensor Signal

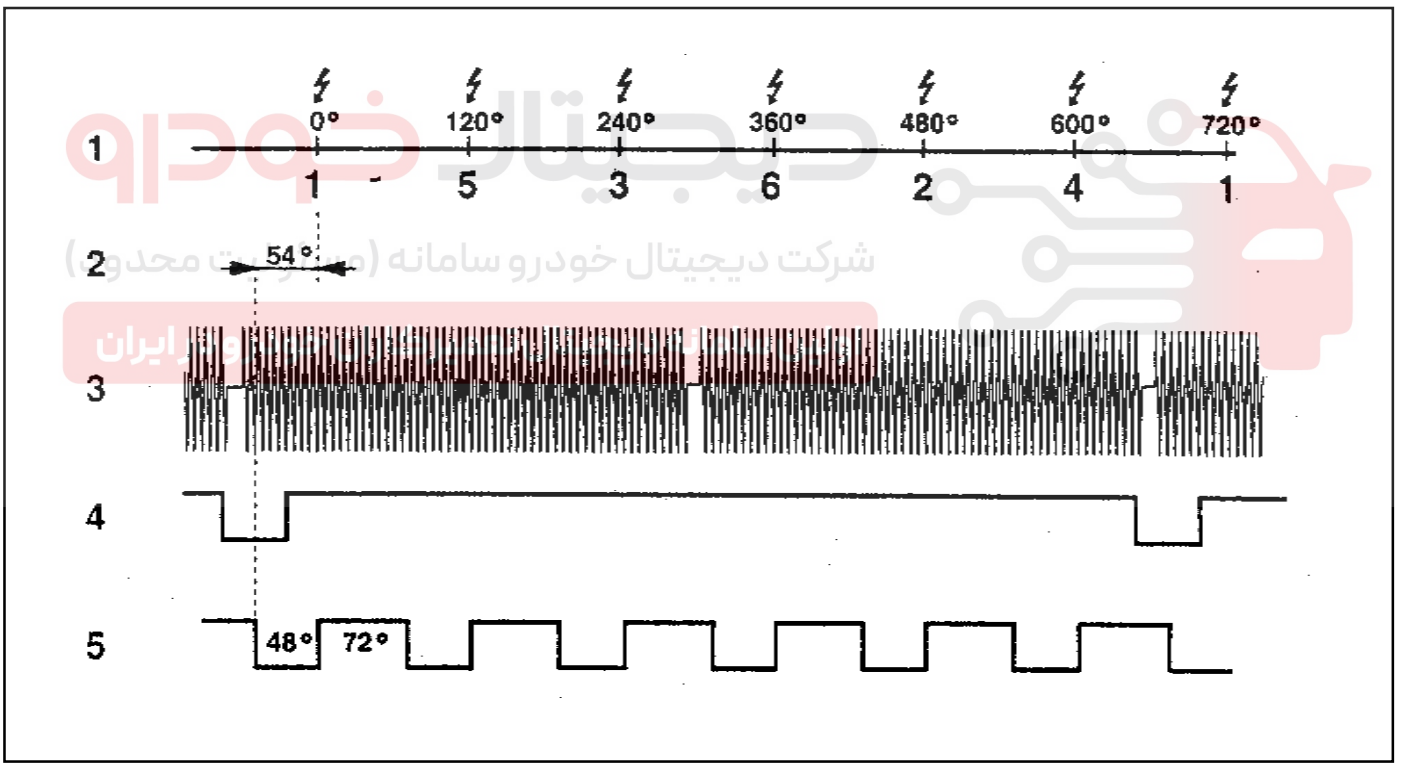
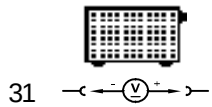
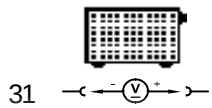
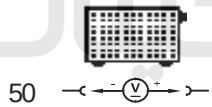
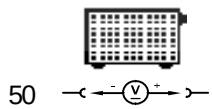
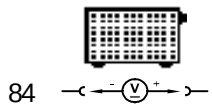


Figure 7. Signal Function
1 Crank Angle
2 Cylinder
3 Crankshaft Position Sensor Signal
4 Camshaft Position Sensor Signal
5 RPM Signal TNA

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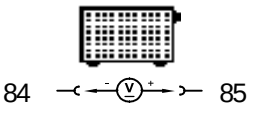
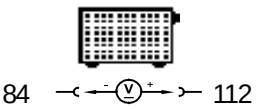
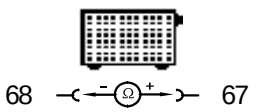
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IDLING CONTROL AND ELECTRONIC PEDAL SYSTEM TEST

Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
160, 161, 164, 167,	Þ 1.0	· **Pedal valve sensor:** - Signal (potentiometer 1)		· Ignition:ON · Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	0.2 - 0.5 V 4.3 - 4.8 V	· Þ 1.1 · Cable · Pedal valve sensor
	Þ 1.1	· **Pedal valve sensor:** - Power supply (potentiometer 1)		· Ignition:ON	4.75 - 5.25 V	· Cable · ECU
162, 163, 164, 167,	Þ 2.0	· **Pedal valve sensor:** - Signal (potentiometer 2)		· Ignition:ON · Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	0.1 - 0.4 V 2.1 - 2.5 V	· Þ 2.1 · Cable · Pedal valve sensor
	Þ 2.1	· **Pedal valve sensor:** - Power supply (potentiometer 2)		· Ignition:ON	2.25 - 2.75 V	· Cable · ECU
104, 105, 108, 109, 116, 119, 185,	Þ 3.0	· **Throttle valve actuator:** - Signal Throttle valve potentiometer 1		· Engine:in idling · Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	0.3 - 0.9 V 4.0 - 4.6 V	· Þ 3.1 · Cable · E-GAS actuator

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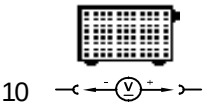
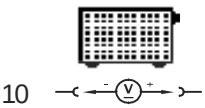
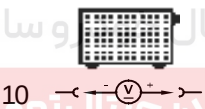
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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
		Throttle valve potentiometer 2		· Position of accelerator pedal: - Closed throttle position - Full throttle with kick down	4.0 - 4.6 V 0.3 - 0.9 V	
	Þ 3.1	· **Throttle valve actuator:** - Power supply Throttle valve potentiometer 1+2		· Ignition:ON	4.75 - 5.25 V	· Cable · ECU
104, 105, 108, 109, 116, 119, 185,	Þ 4.0	· **Throttle valve actuator:** - Signal Throttle valve actuator motor voltage supply Throttle valve actuator motor resistance	 	· Ignition:ON · Engine:in idling - Coolant temperature: > 70 °C · Ignition:OFF	0.8 - 2.3 V The value will be changed in 1.0 - 2.5V. < 10 W	· ECU · Cable · E-GAS actuator

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AIR CONDITIONER CONTROL SYSTEM TEST

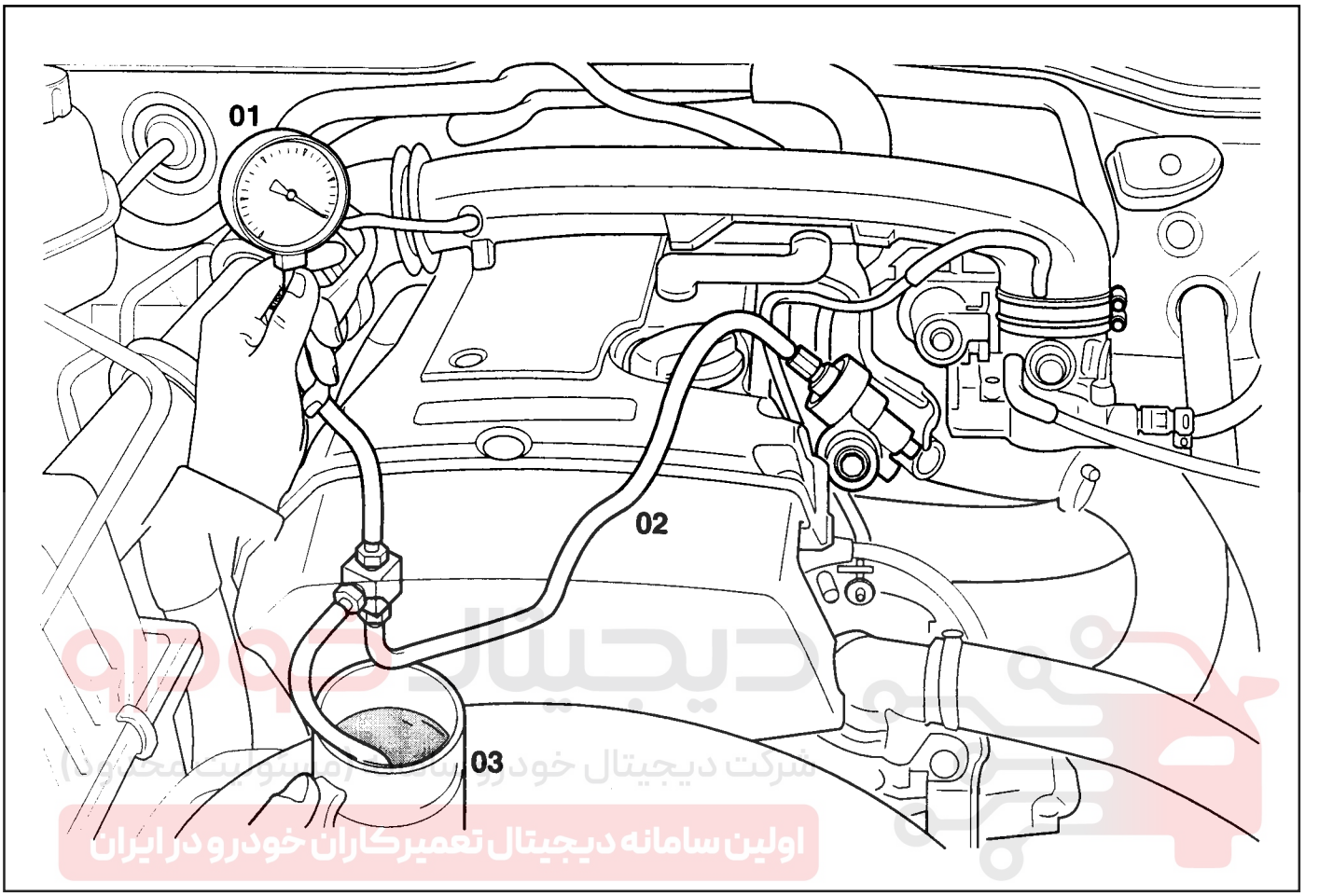
Failure code	Test step	Item	Checking method	Requirement	Specified value	
44, 45,	Þ 1.0	· **Air conditioner signal:** - Input signal (input signal from thermo amplifier)		· Engine:In idling · Air conditioner switch:ON/OFF Air conditioner switch:OFF Air conditioner switch:ON	< 1 V 11 - 14 V	· Þ 5.1 · Cable · Thermo amp · Auto amp · Dual pressure switch · Air conditioner control panel
	Þ 1.1	· **Air conditioner compressor:** - Output signal		· Engine:In idling · Air conditioner switch:ON/OFF Air conditioner switch:OFF Air conditioner switch:ON	< 1 V 11 - 14 V	
	Þ 2.0	· **Condenser fan(HI) control:**		· Engine:In idling · Air conditioner switch:ON/OFF Air conditioner switch:OFF Air conditioner switch:ON Coolant temperature: above 150 ℃	11 - 14 V 11 - 14 V < 1 V	

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FUEL PRESSURE AND INTERNAL LEAKAGE TEST

Preparation



01 Pressure Tester
02 Pressure Hose
03 Measuring Beaker

Connection of the Equipment

1. Turn the ignition switch to "OFF" position.
2. Remove the air cleaner cross pipe.
3. Remove the cap on fuel pressure test plug and connect the pressure hose and pressure tester.
4. Prepare the beaker for measuring the amount of fuel.

Tools Required

103 589 00 21 00 Pressure Tester
119 589 04 63 00 Pressure Hose

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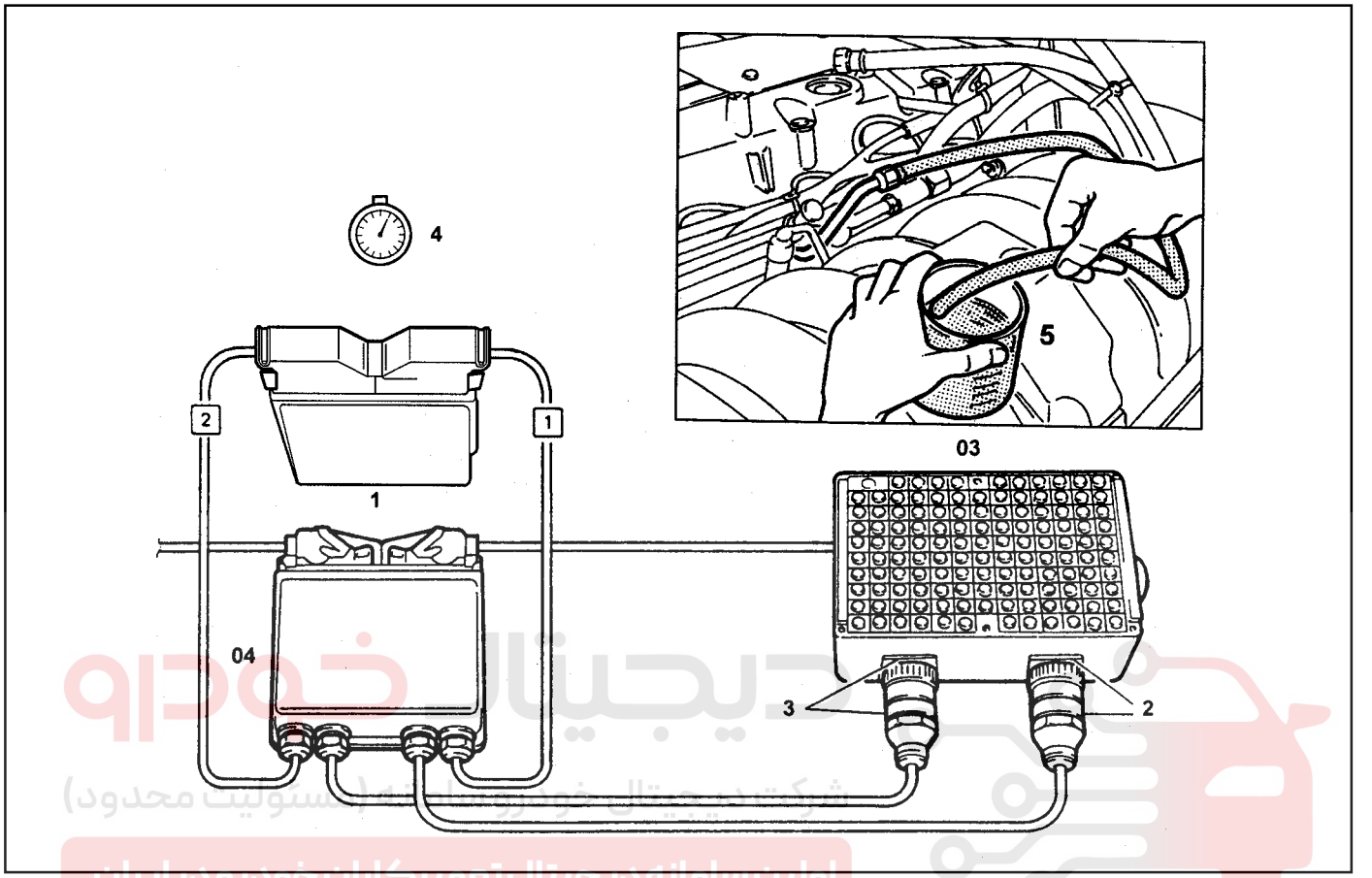
Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 1.0	· **Fuel pressure:in idling speed** - When the vacuum is applied	Connect the fuel pressure test plug to the pressure tester (refer to the flgure on previous page).	· Engine:in idling - Colse the valve screw on pressure tester	3.2 - 3.6 bar	· Þ Fuel pump test · Fuel pressure regulator
	Þ 2.0	· **Fuel pressure:in idling speed** - When the vacuum is not applied	Connect the fuel pressure test plug to the pressure tester (refer to the flgure on previous page).	· Engine:in idling - Colse the valve screw on pressure tester	3.7 - 4.2 bar	· Þ Fuel pump test · Fuel pressure regulator
	Þ 3.0	· **Fuel system internal leakage:**	Connect the fuel pressure test plug to the pressure tester (refer to the flgure on previous page).	· Engine:stop	> 3.0 bar	· The pressure drops rapidly:non-return valve in fuel pump
				· After 30 minutes from engine stop	> 2.5 bar	· The pressure drops slowly: - Injector test - Fuel pressure regulator - O-ring

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FUEL PUMP TEST

Preparation



1 ECU
2 Test Coupling(No.1-60)
3 Test Coupling(No.61-120)
4 Stop Watch
5 Measuring Beaker
03 Test Box
04 ECU Test Cable

Connection of the Equipment

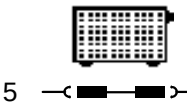
1. Turn the ignition switch to "OFF" position.
2. Connect the test box to the ECU.

Tools Required

103 589 00 21 00 Pressure Tester
210 589 00 99 00 Adaptor Line
129 589 00 21 00 Test Box
210 589 08 63 00 Ecu Test Cable

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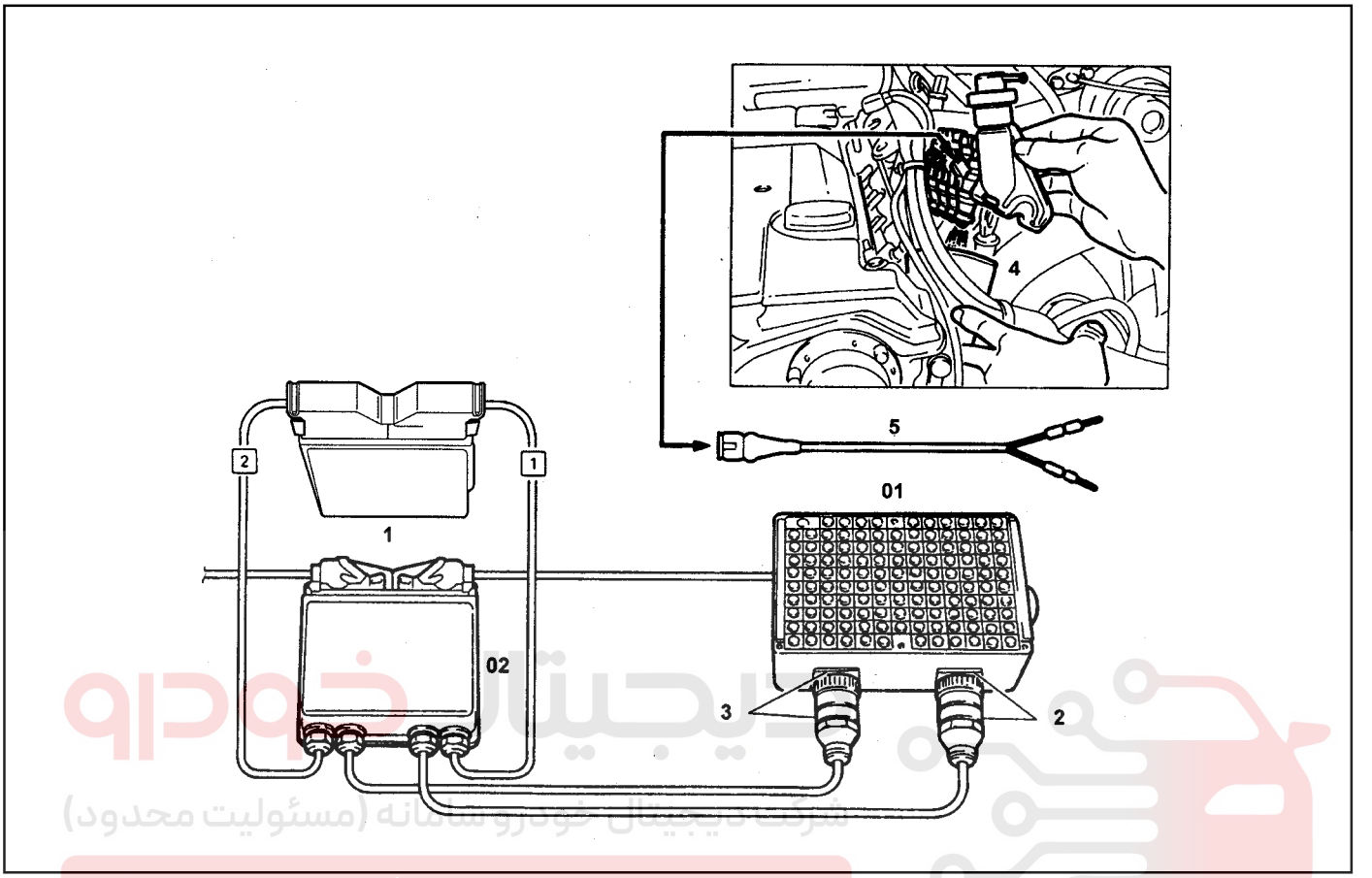
Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 1.0	· **Fuel pump:** - Fuel supply ratio	 5 33	· Ignition:ON - Disconnect the fuel return pipe and connect the host to beaker to collect the supplied fuel	1 liter of fuel supply for max. 35 seconds	· Þ 2.0 · Fuel line
	Þ 2.0	· **Fuel pump:** - Current consumption	Multi tester(DC current)  3 1	· Ignition:ON - Remove the fuel relay from the fuse and relay box in luggage compartment and connect the amperemeter between No.1 and No.3 in relay box(fuel pump relay removed position) for measuring current consumption	5 - 9 A	· Fuel pump

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INJECTOR TEST

Preparation



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1 ECU
2 Test Coupling(No.1-60)
3 Test Coupling(No.61-120)
4 Measuring Beaker
5 Shop Made Cable
03 Test Box
04 ECU Test Cable

Connection of the Equipment

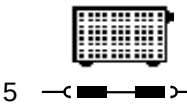
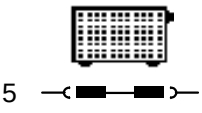
1. Connect the test box to the ECU as shown in the figure.
2. Remove the 2-pin coupling from injector.
3. Remove the fuel distributor and injector with a unit. At this time, do not remove the supply and return line.
4. Connect the shop made cable to the injector with a firing order.
5. Collect the fuel from injector.

Tools Required

129 589 00 21 00 Test Box
210 589 08 63 00 ECU Test Cable

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Failure code	Test step	Item	Checking method	Requirement	Specified value	Possible cause
	Þ 1.0	· **Injector:** - Leakage test	 5 — 33	· Ignition:ON - Remove the fuel distributor and fuel injector with a unit.	There should be no leaks and later drops from the injector	· Þ 2.0 · Injector
	Þ 2.0	· **Injector:** - Function test and spray pattern check	 5 — 33	· Ignition:ON - Connect the shop made cable to the injector. - Collect the spraying fuel with a beaker - Connect the shop made cable to No.11(+) and No.5 (-) terminal in test box.	The spray pattern of the injector most show in the figure 10	· Injector

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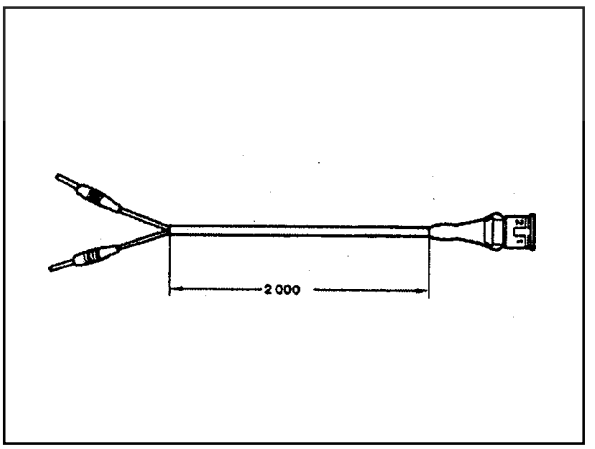


Figure 8. Shop Made Cable

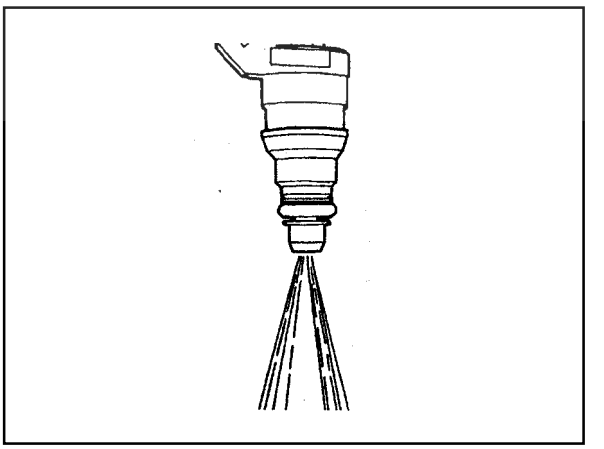


Figure 9. Fuel Injector Normal Spary Pattern

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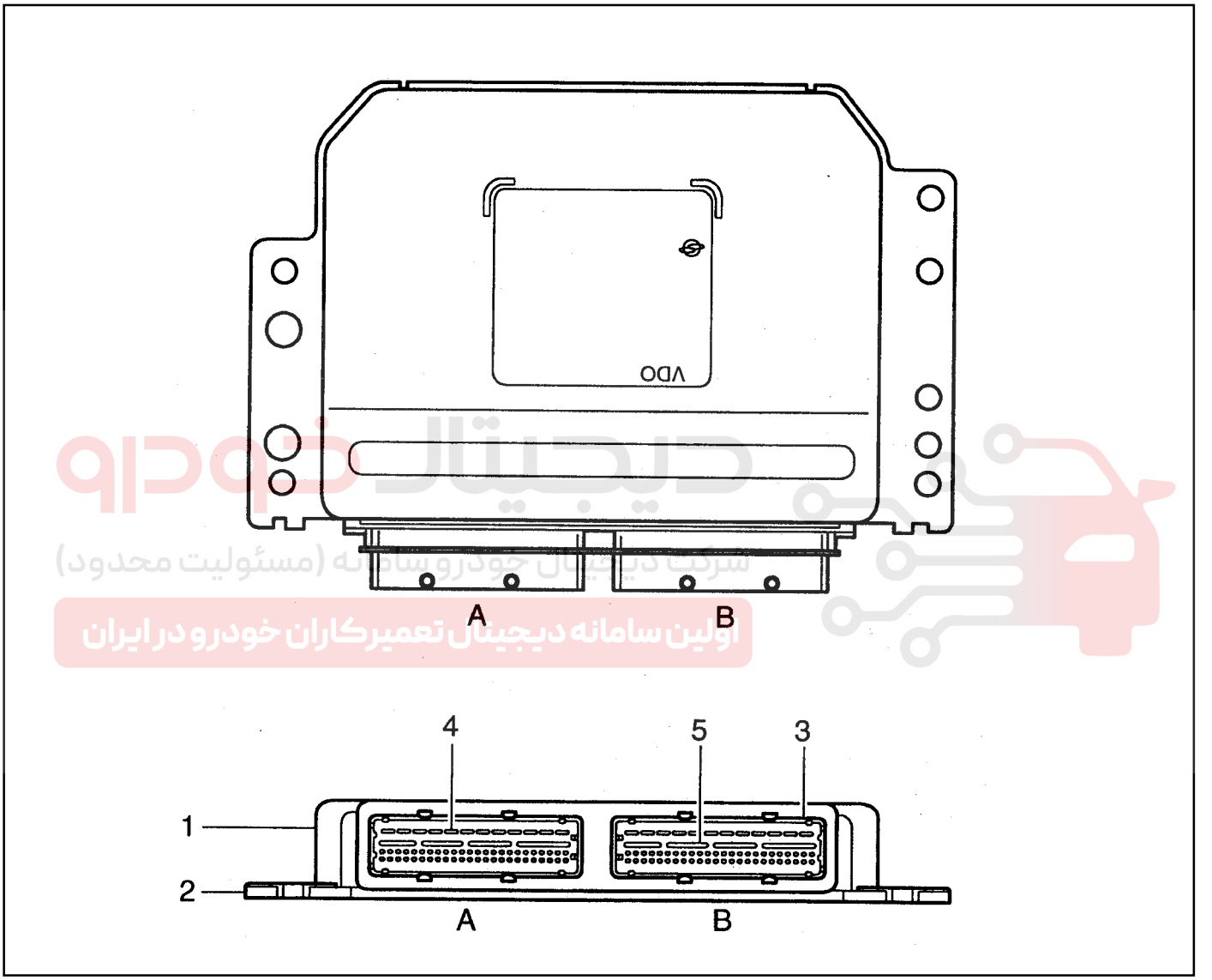
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

ECU

Appearance



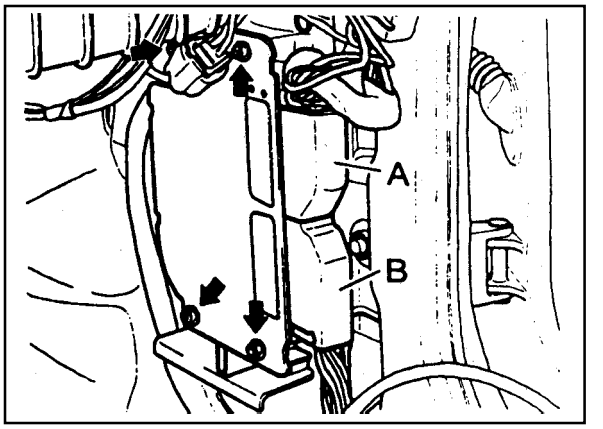
1 Cover
2 Plate
3 Connector
4 Flat pin
Vehicle side : number 1 - 12
Engine side : number 61 - 72
5 Pin
Vehicle side : number 13 - 60
Engine side : number 73 - 120
A Vehicle Connector : Black
B Engine Connector : Gray

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Location

Engine ECU is located at the inside of cowl side trim in right bottom of instrument panel of passenger side.



Removal & Installation Procedure

1. Turn the ignition switch to "OFF" position.
2. Disconnect the battery negative cable
3. Remove the cowl side trim form passenger side.
4. Unscrew four securing nuts for ECU from mounting bracket.

Installation Notice

Tightening Torque	9 - 11 Nm

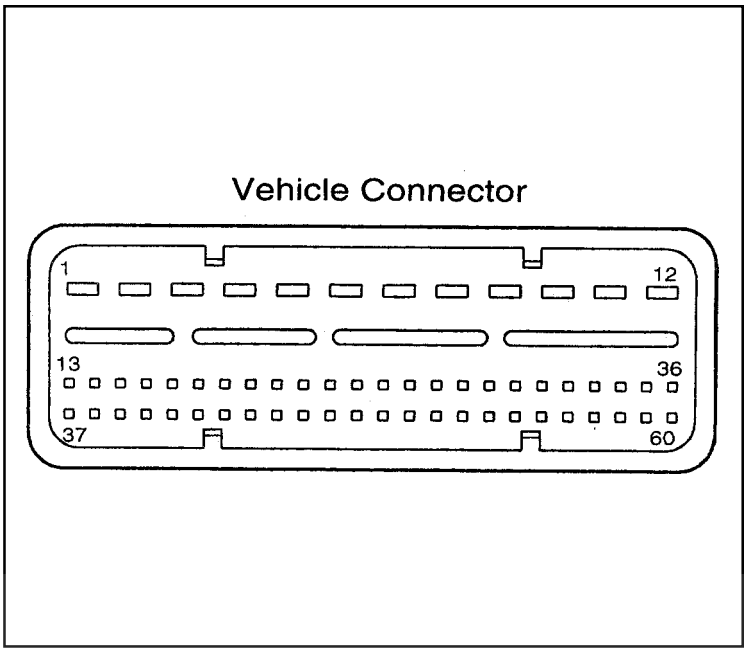
5. Pulling out the ECU from bracket.
6. Disconnect the vehicle side coupling(B).
7. Installation should follow the removal procedure in the reverse order.

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ECU Pin Numbers and Descriptions



Vehecle Connector

Pin No.	Description	Abbreviation
1	-	-
2	Starter motor TM.50	TM.50
3	-	-
4	-	-
5	Electronic ground	GND
6	-	-
7	Lambda probe 2 heating	LSH2
8	-	-
9	Lambda probe 1 heating	LSH1
10	Power ground TM.31	TM.31
11	V-BATTERY TM.87	TM.87
12	V-BATTERY TM.30	TM.30
13	Immobilizer crypto read	WFS I/O
14	Immobilizer crypto write	WFS O
15	-	-
16	Lambda probe 1 ground	GND
17	Lambda probe 1 signal	LS1
18	-	-
19	Lambda probe 2 ground	GND
20	Lambda probe 2 signal	LS2

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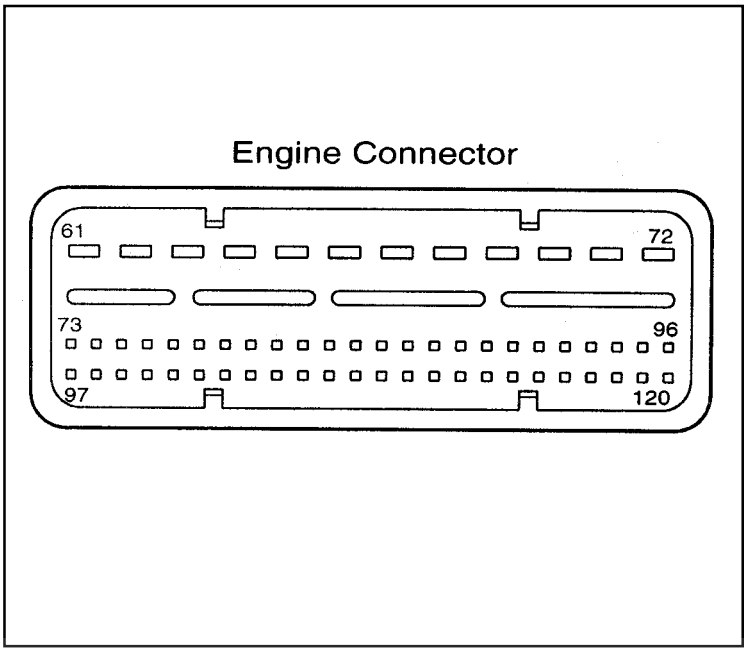
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Pin No.	Description	Abbreviation
21	Brake switch	BRS
22	-	-
23	-	-
24	-	-
25	-	-
26	-	-
27	Air conditioning clutch relay	KLIKU
28	-	-
29	-	-
30	-	-
31	Pedal potentiometer 1 ground	GND
32	Pedal potentiometer 1 supply	SP1+5V
33	Fuel pump relay	KP
34	Tank purge valve	TEV
35	Engine fan(High)	ML
36	-	-
37	CAN-Low	CAN L
38	CAN-High	CAN H
39	-	-
40	-	-
41	-	-
42	-	-
43	-	KPI
44	Air conditioning	KLIMA
45	Electronic traction signal	ETS
46	-	-
47	Pedal potentiometer 1 signal	SP1S
48	Pedal potentiometer 2 signal	SP2S
49	Brake light switch	BLS
50	Pedal potentiometer 2 ground	GND
51	Pedal potentiometer 2 supply	SP2+2.5V
52	Cruise accelerate/Set	S+B
53	Cruise resume	WA
54	Cruise decelerate/Set	S-B
55	Cruise safety contact switch	KSK
56	-	-
57	Cruise off switch	AUS
58	Diagnostics(K-Line)	DIAG
59	Vehicle speed signal	V-SIG
60	Engine speed signal	TN-SIG

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Engine Connector

Pin No.	Description	Abbreviation
61	-	-
62	-	-
63	Injector-cylinder 1	EV1
64	Injector-cylinder 2	EV4
65	Injector-cylinder 3	EV2
66	Injector-cylinder 4	EV3
67	E-GAS motor plus	M+
68	E-GAS motor minus	M-
69	Power ground TM.31	TM.31
70	-	-
71	Ignition coil cylinder 2+3	ZSB23
72	Ignition coil cylinder 1+4	ZSA14
73	Camshaft control	NWS
74	EGR (Exhaust Gas Recirculation)	EGR
75	-	-
76	Second air pump relay	SLP
77	-	-
78	Engine coolant temperature	MT
79	Intake air temperature ground	GND
80	Intake air temperature	LT

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Pin No.	Description	Abbreviation
81	Hot film air mass signal	HFM
82	-	-
83	Pressure sensor supply	V-REF.PS
84	E-GAS potentiometer ground	-
85	E-GAS potentiometer 2 signal	IP2S
86	-	-
87	E-GAS potentiometer 1 signal	IP1S
88	-	-
89	-	-
90	-	-
91	-	-
92	-	-
93	-	-
94	-	-
95	-	-
96	-	-
97	-	-
98	-	-
99	Crankshaft sensor ground	KW-
100	Crankshaft sensor signal	KW+
101	-	-
102	Intake manifold pressure signal	PSAUG
103	Intake manifold pressure ground	GND
104	Camshaft sensor ground	NOWE-
105	Hot film air mass ground	GND
106	Camshaft sensor signal	NOWE+
107	-	-
108	Hot film air mass supply	V-REF.HFM
109	-	-
110	-	-
111	-	-
112	E-GAS potentiometer supply	V-REF.DK
113	-	-
114	-	-
115	-	-
116	-	-
117	Knock sensor 1 ground	GND
118	Knock sensor 1 signal	KS1
119	-	-
120	-	-

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Application

Pin No.	Description	Abbreviation	E23 ENG, 5speed A/T	E23 ENG, 4speed A/T
1	-	-	-	-
2	Starter motor TM.50	TM.50	●	●
3	-	-	-	-
4	-	-	-	-
5	Electronic ground	GND	●	●
6	-	-	-	-
7	Lambda probe 2 heating	LSH2	-	-
8	-	-	-	-
9	Lambda probe 1 heating	LSH1	●	●
10	Power ground TM.31	TM.31	●	●
11	V-BATTERY TM.87	TM.87	●	●
12	V-BATTERY TM.30	TM.30	●	●
13	Immobilizer crypto read	WFS I/O	●	●
14	Immobilizer crypto write	WFS O	●	●
15	-	-	-	-
16	Lambda probe 1 ground	GND	●	●
17	Lambda probe 1 signal	LS1	●	●
18	-	-	-	-
19	-	-	-	-
20	-	-	-	-
21	Brake switch	BRS	○	○
22	-	-	-	-
23	-	-	-	-
24	-	-	-	-
25	-	-	-	-
26	-	-	-	-
27	Air conditioning clutch relay	KLIKU	●	●
28	-	-	-	-
29	-	-	-	-
30	-	-	-	-

●: Standard, ○: Option

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Pin No.	Description	Abbreviation	E23 ENG, 5speed A/T	E23 ENG, 4speed A/T
31	Pedal potentiometer 1 ground	GND	●	●
32	Pedal potentiometer 1 supply	SP1+5V	●	●
33	Fuel pump relay	KP	●	●
34	Tank purge valve	TEV	●	●
35	Engine fan	ML	●	●
36	-	-	-	-
37	CAN-Low	CAN L	●	●
38	CAN-High	CAN H	●	●
39	-	-	-	-
40	-	-	-	-
41	-	-	-	-
42	-	-	-	-
43	-	-	-	-
44	Air conditioning	KLIMA	●	●
45	Electronic traction signal(ABD option only)	ETS	○	○
46	-	-	-	-
47	Pedal potentiometer 1 signal	SP1S	●	●
48	Pedal potentiometer 2 signal	SP2S	●	●
49	Brake light switch(Cruisel option only)	BLS	○	○
50	Pedal potentiometer 2 ground	GND	●	●
51	Pedal potentiometer 2 supply	SP2+2.5V	●	●
52	Cruise accelerate/Set(Cruisel option only)	S+B	○	○
53	Cruise resume(Cruisel option only)	WA	○	○
54	Cruise decelerate/Set(Cruisel option only)	S-B	○	○
55	Cruise safety contact switch(Cruisel option only)	KSK	○	○
56	-	-	-	-
57	Cruise off switch(Cruisel option only)	AUS	○	○
58	Diagnostics(K-Line)	DIAG	●	●
59	Vehicle speed signal	V-SIG	●	●
60	Engine speed signal	TN-SIG	●	●

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Pin No.	Description	Abbreviation	E23 ENG, 5speed A/T	E23 ENG, 4speed A/T
61	-	-	-	-
62	-	-	-	-
63	Injector-cylinder 1	EV1	●	●
64	Injector-cylinder 2	EV4	●	●
65	Injector-cylinder 3	EV2	●	●
66	Injector-cylinder 4	EV3	●	●
67	E-GAS motor plus	M+	●	●
68	E-GAS motor minus	M-	●	●
69	Power ground TM.31	TM.31	●	●
70	-	-	-	-
71	Ignition coil cylinder 2+3	ZSB23	●	●
72	Ignition coil cylinder 1+4	ZSA14	●	●
73	Camshaft control	NWS	●	●
74	-	-	-	-
75	Second air pump relay	-	-	-
76	-	SLP	○	○
77	Engine coolant temperature	-	-	-
78	Temperature ground	MT	●	●
79	Intake air temperature	GND	●	●
80	Hot film air mass signal	LT	●	●
81	-	HFM	●	●
82	-	-	-	-
83	E-GAS potentiometer ground	-	-	-
84	E-GAS potentiometer 2 signal	-	●	●
85	-	IP2S	●	●
86	E-GAS potentiometer 1 signal	-	-	-
87	-	IP1S	●	●
88	-	-	-	-
89	-	-	-	-
90		-	-	-

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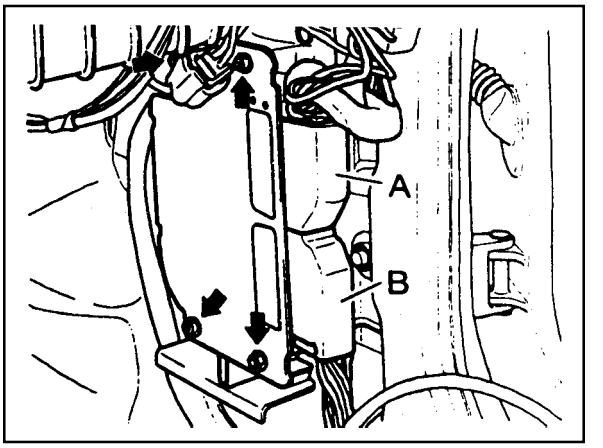
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Pin No.	Description	Abbreiation	E23 ENG, 5speed A/T	E23 ENG, 4speed A/T	E23 ENG, 4speed A/T
91	-	-	-	-	-
92	-	-	-	-	-
93	-	-	-	-	-
94	-	-	-	-	-
95	-	-	-	-	-
96	-	-	-	-	-
97	-	-	-	-	-
98	-	-	-	-	-
99	Crankshaft sensor ground	KW-	●	●	●
100	Crankshaft sensor signal	KW+	●	●	●
101	-	-	-	-	-
102	-	-	-	-	-
103	-	-	-	-	-
104	Camshaft sensor ground	NOWE-	●	●	●
105	Hot film air mass ground	GND	●	●	●
106	Camshaft sensor signal	NOWE+	●	●	●
107	-	-	-	-	-
108	Hot film air mass supply	V-REF.HFM	●	●	●
109	-	-	-	-	-
110	-	-	-	-	-
111	-	-	-	-	-
112	E-GAS potentiometer supply	V-REF.DK	●	●	●
113	-	-	-	-	-
114	-	-	-	-	-
115	-	-	-	-	-
116	-	-	-	-	-
117	Knock sensor 1 ground	GND	●	●	●
118	Knock sensor 1 signal	KS1	●	●	●
119	-	-	-	-	-
120	-	-	-	-	-

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Removal & Installation Procedure



- **When removing the ECU only**

1. Turn the ignition switch to "OFF" position.
2. Disconnect the negative battery cable.
3. Disconnect the couplings from ECU.
4. Unscrew the left and right bolt (3) on bolt (1) and auxiliarly bracket and remove the auxiliarly bracket from the bracket assembly (2).

Installation Notice

Tightening Torque	(1)	6 - 8 Nm
	(3)	5 - 7 Nm

5. Unscrew the four bolts (5) and disconnect the ECU (6) from the bracket assenbly.

Installation Notice

Tightening Torque	5 - 7 Nm

6. Installation should follow the removal procedure in the reverse order.

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- **When Removing the ECU with ABS or ABS/ASR Unit**

1. Turn the ignition switch to "OFF" position.
2. Disconnect the negative battery cable.
3. Disconnect the couplings from ECU.
4. Disconnect the coupling from ABS or ABS/ASR unit.
5. Unscrew the bolt (1) and the left and right flange nuts.

Tightening Torque	6 - 8 Nm

6. Remove the ECU with ABS or ABS/ASR unit assembly.
7. Unscrew the left and right bolt (3) on the auxiliary bracket and remove the auxiliary bracket from the bracket assembly.

Installation Notice

Tightening Torque	5 - 7 Nm

8. Unscrew the bolts (5) and disconnect the ECU (6) from the bracket assenbly.

Installation Notice

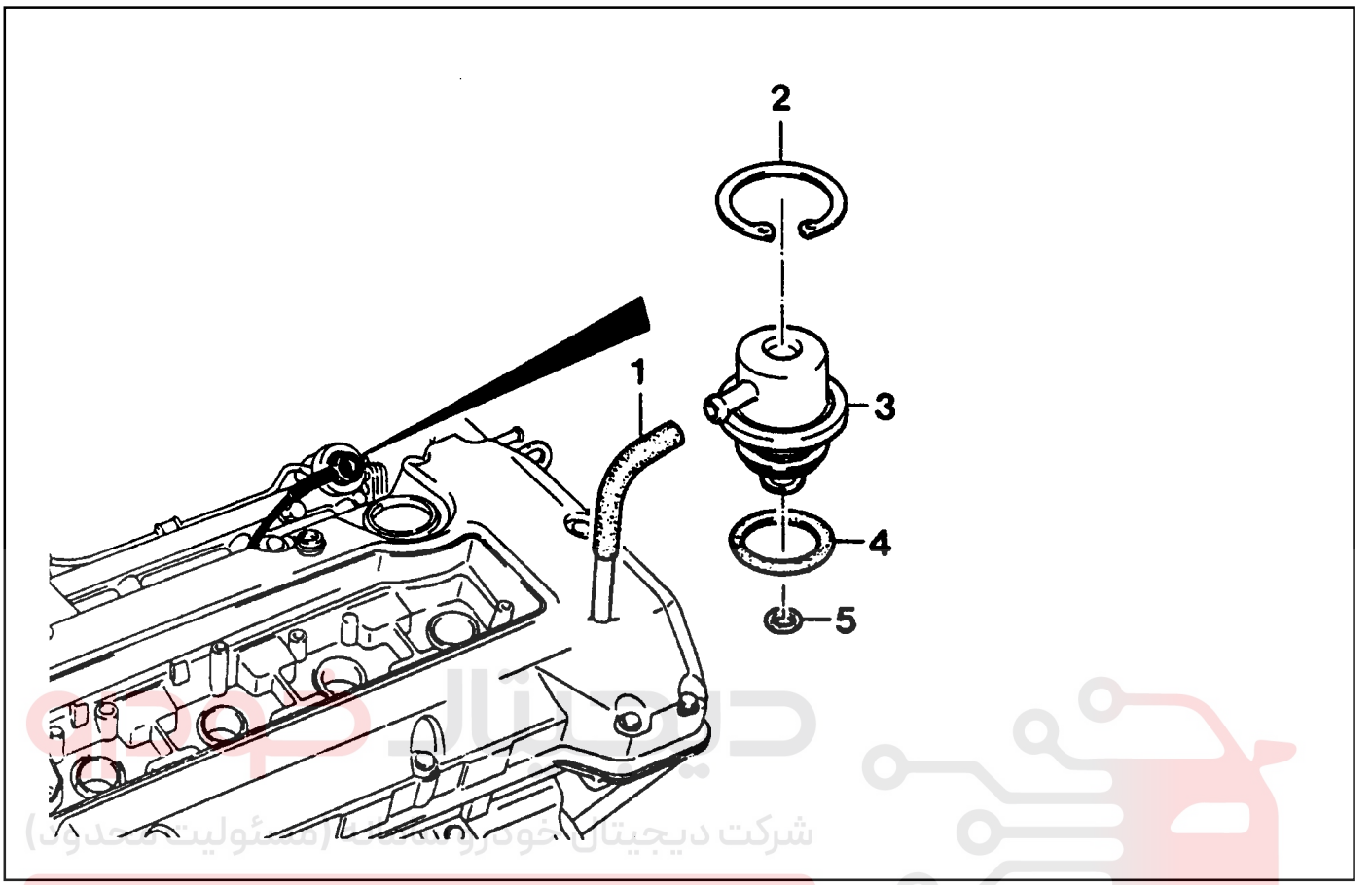
Tightening Torque	5 - 7 Nm

9. Installation should follow the removal procedure in the reverse order.

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FUEL PRESSURE REGULATOR



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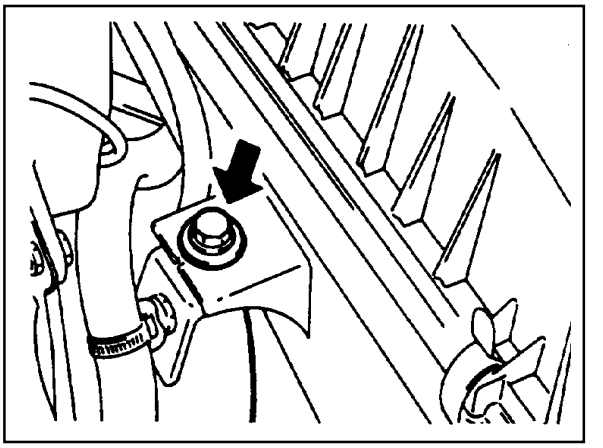
1 Vacuum Hose
2 Circlip
3 Fuel Pressure Regulator
4 O-ring ..... replace
5 O-ring ..... replace

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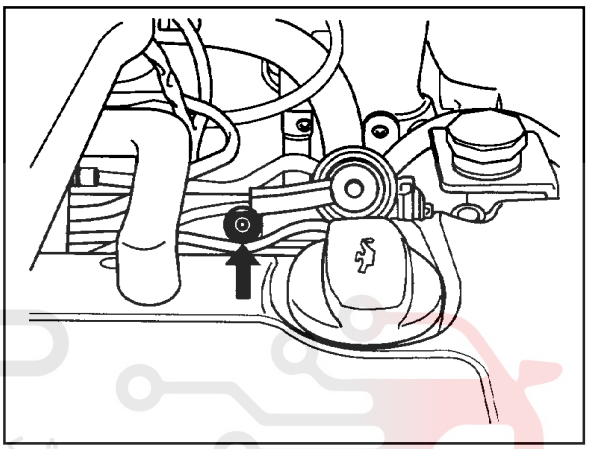
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Removal & Installation Procedure

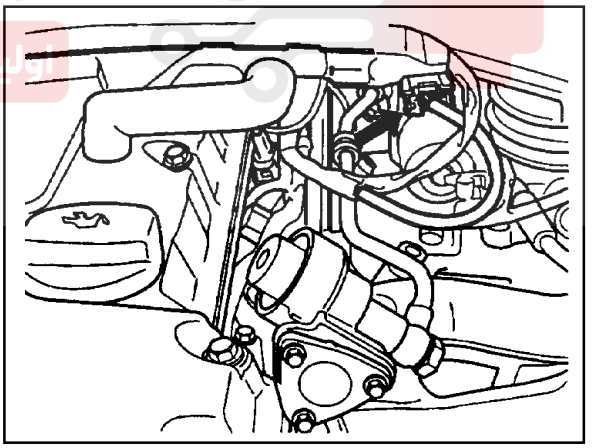
1. Remove the fuel pressure test connector.



2. Discharge the pressure in fuel supply system by pressing the service valve.



3. Disconnect the vacuum hose.
4. Disconnect the circlip and remove the fuel pressure regulator.
5. Apply the oil to O-ring lightly and then replace it.
6. Installation should follow the removal procedure in the reverse order.
7. Check for fuel pressure and internal leaks by operating the engine.



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Function of the Fuel Pressure Regulator

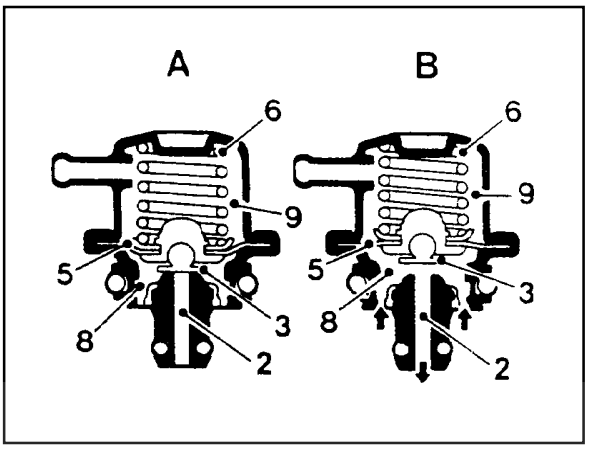
The fuel pressure regulator maintains the fuel pressure in the fuel line with the pressure of 3.2 bars to 3.8 bars according to the intake manifold pressure. This operating pressure cannot be changed, and the fuel injection volume will be only determined by the injection time. Over supplied fuel returns to the fuel tank through the return line.

<Operating at full load>

There is no negative pressure applied to the spring chamber(9) during the full load, and it is separated from the fuel chamber(8) by the diaphragm(5).

When the fuel pressure goes up, the diaphragm forces the compression spring(6) in the direction of compression . At this moment, the valve(3) sticks to the diaphragm by the fuel pressure, and the fuel return line(2) opens. The fuel over supplied returns to the fuel tank through the return line.

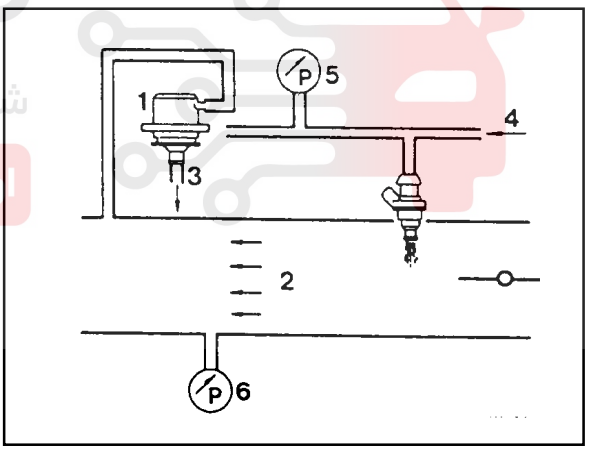
2. Fuel return line
3. Valve
5. Diaphragm
6. Compression Spring
8. Fuel chamber
9. Spring Chamber



A. Valves Closed
B. Valves Opened

The pressure difference between the fuel pressure and the intake manifold is about 3.8 bars during the full load.

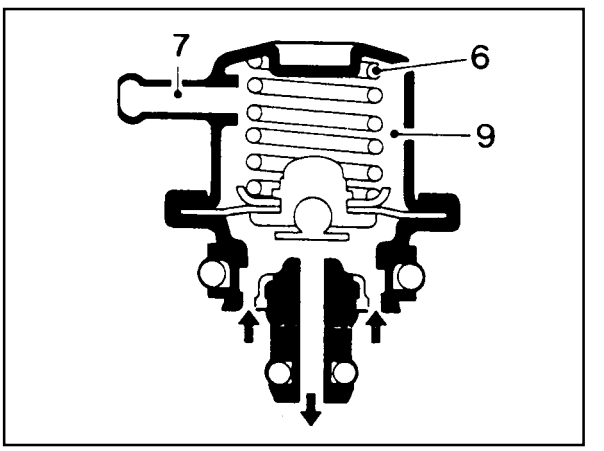
1. Fuel pressure Regulator
2. Intake Manifold
3. Fuel return(to fuel tank)
4. Fuel supply(form fuel pump)
5. Fuel pressure(approx. 3.8 bars)
6. Intake Manifold Negative Pressure(0 bar)



<Operating at Idle and partial load>

The spring chamber(9) is connected to the intake manifold with the vacuum hose at the intake pipe connection(7). The negative pressure generated in the intake manifold activates the diaphragm, and thus the fuel pressure gets reduced to the rate of the operating extent of the diaphragm by the intake manifold's negative pressure.

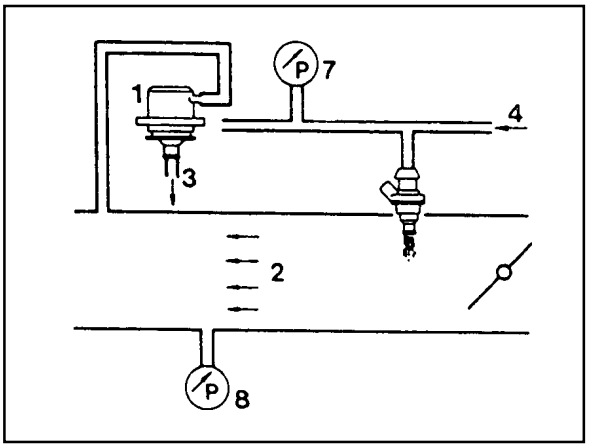
Consequently, the fuel pressure in the fuel distributor changes by the intake manifold's negative pressure, and the injector's fuel pressure gets reduced independently to the throttle valve's position. Thus, the fuel injection volume can only be determined according to the injector's injecting duration.



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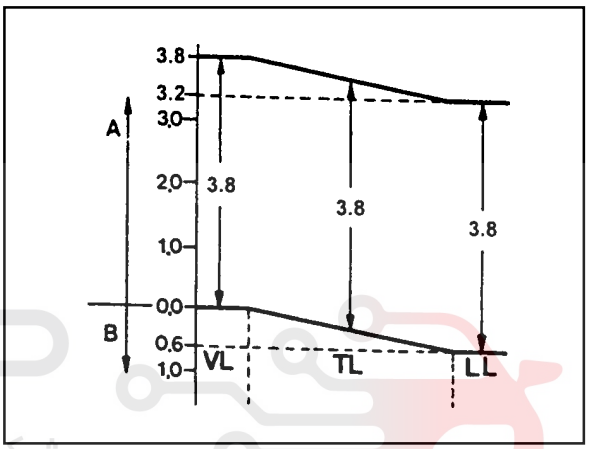
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The pressure difference between the fuel pressure and the intake manifold is approx. 3.2 bars during idling.



1. Fuel pressure Regulator
2. Intake Manifold
3. Fuel Return(to fuel tank)
4. Fuel Supply(from fuel pump)
7. Fuel Pressure(approx. 3.2 bars)
8. Intake Manifold Negative Pressure(0.6 bars)

<Fuel Pressure Diagram>



A. Fuel pressure
B. Intake Manifold Negative Pressure
LL. Idling
TL. Partial load
VL. Full load

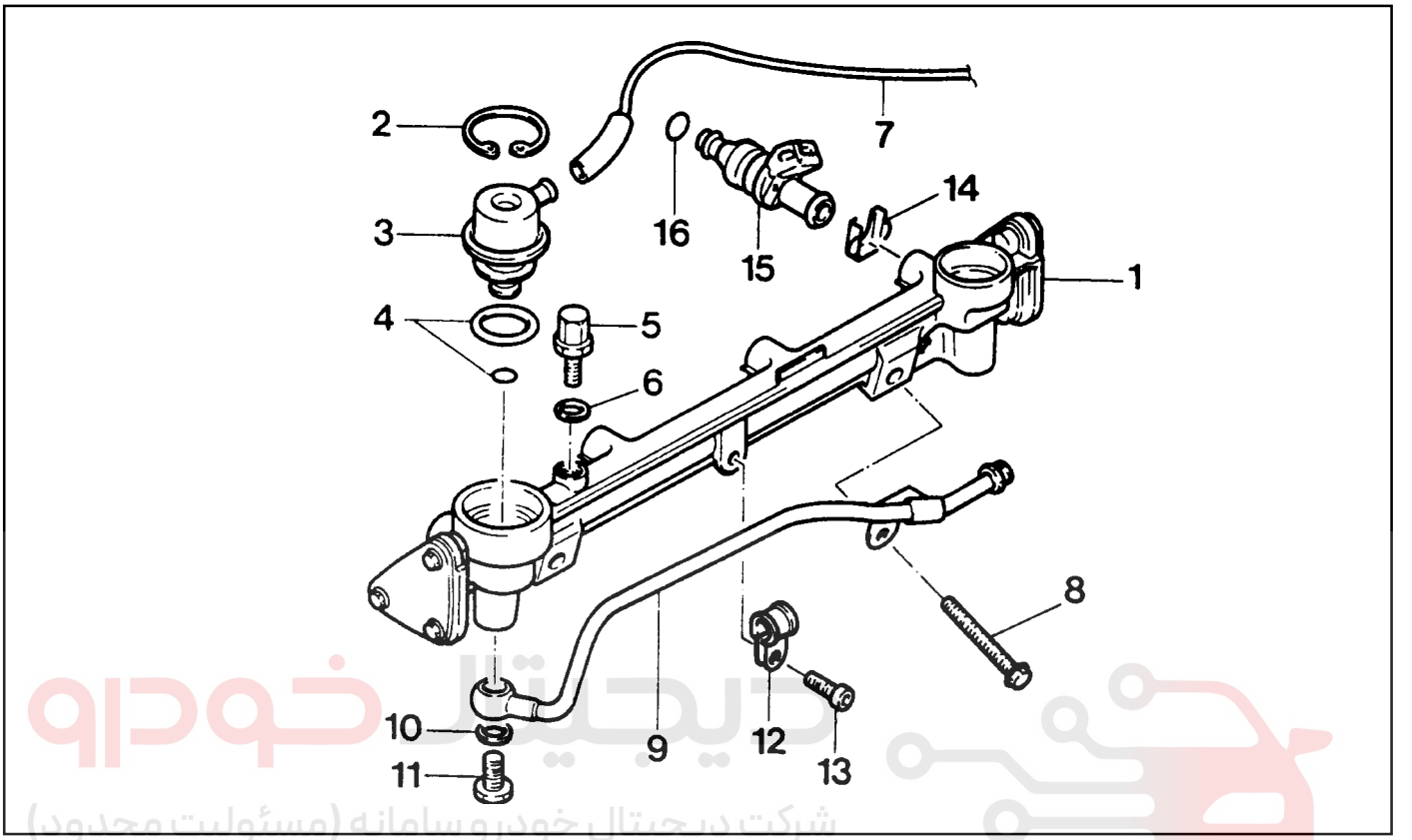
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FUEL DISTRIBUTOR

Preceding Work : Removal of intake air duct



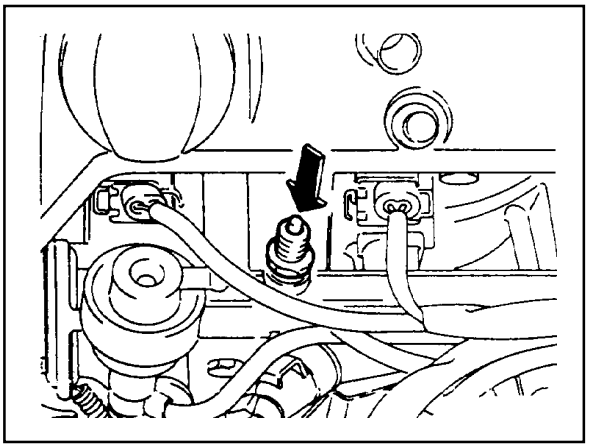
1 Fuel Distributor
2 Circlip
3 Fuel Pressure Regulator
4 O-ring
5 Fuel Pressure Test Connector
6 Seal Ring
7 Vacuum Hose
8 Combination Bolt (M8 X 120) ..... 22.5-27.5 Nm
9 Fuel Return Line
10 Seal Ring
11 Hollow Bolt ..... 22.5-27.5 Nm
12 Clamp
13 Bolt (M8 X 22) ..... 9-11 Nm
14 Injector Bracket
15 Injector
16 O-ring

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Removal & Installation Procedure

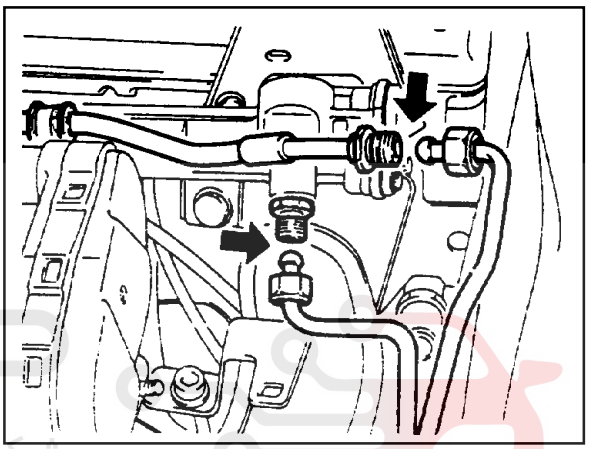
1. Discharge the fuel pressure from the fuel pressure test connector by pushing service valve (arrow).



2. Disconnect the battery ground cable.
3. Disconnect the vacuum hose from the fuel pressure regulator.
4. Disconnect the cable from ignition coil.
5. Remove the fuel return and supply line.

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

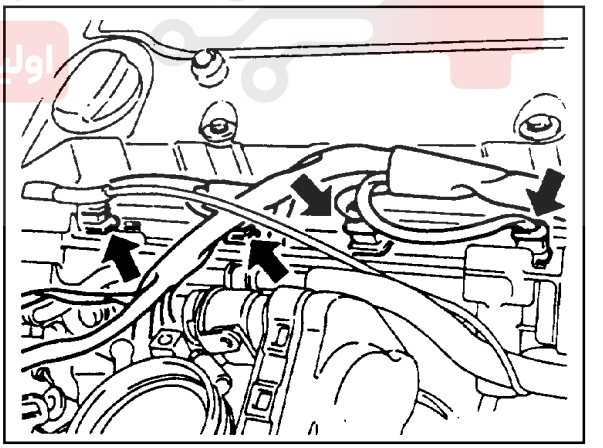


Notice

- For removal, cover around parts with cloths not to bestained by fuel.
- In case of checking the injector only, do not remove the fuel return and supply line.

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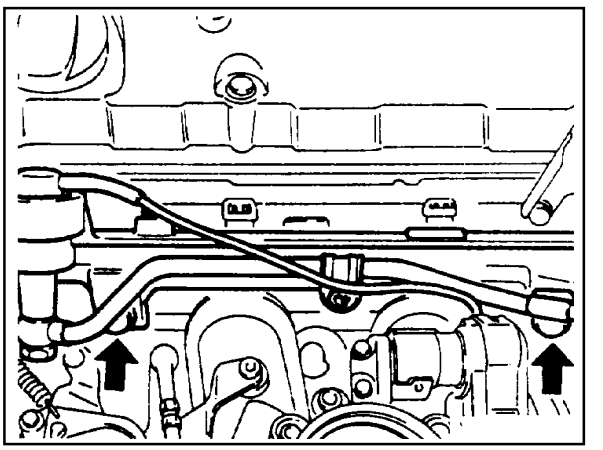
6. Remove the four injector connectors (arrows).



7. Unscrew the two combination bolts (8).

Installation Notice

Tightening Torque	22.5 - 27.5 Nm



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8. Pull out the injector from intake manifold and remove the fuel distributor.

   Notice

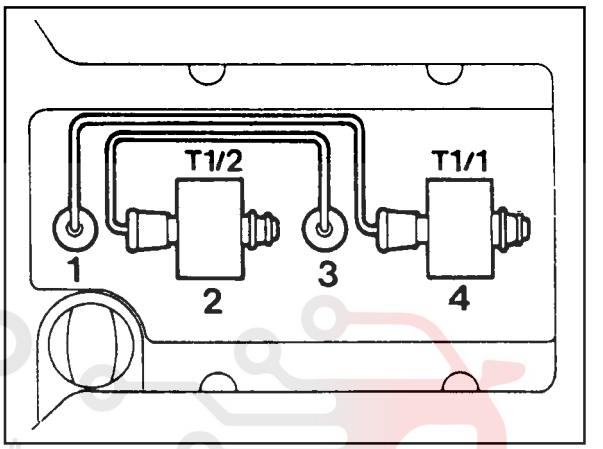
   Replace the injector O-ring with new one.

9. Installation should follow the removal procedure in the reverse order.

10. Check for fuel pressure and internal leakage by operating the engine.

Ignition Coil & Cable

- Ignition coil T1/1 No.1 cylinder + No.4 cylinder
- Inition coil T1/2 No.1 cylinder + No.4 cylinder



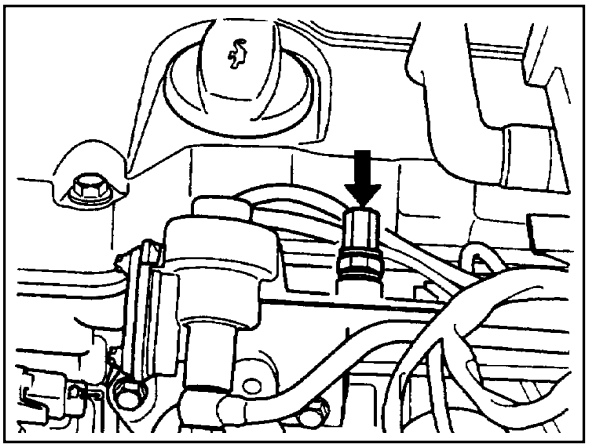
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Fuel Pressure Test

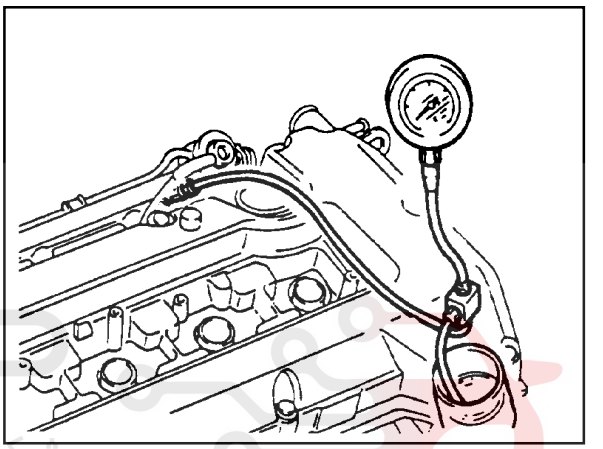
1. Turn the ignition switch to "OFF" position.
2. Remove the fuel pressure test connector.



3. Connect the fuel pressure gauge to the fuel pressure test connector.
4. Test the fuel pressure at idling by operating the engine.

Vacuum Hose Connected (bar)	3.2-3.6
Vacuum Hose Disconnected (bar)	3.7-4.2

5. Replace the pressure regulator diaphragm if out of the specification.



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Internal Leakage Test

1. Connect the fuel pressure gauge to the fuel pressure test connector.
2. Stop the engine for approx. 30 minutes and then check the fuel pressure changes.

Pressure Change	Possible Cause
Fuel pressure drops slowly	· Fuel leakage at the injector • Faulty fuel pressure regulator's diaphragm and O-ring.
Fuel pressure drops rapidly	• Faulty check valve in the fuel pump.

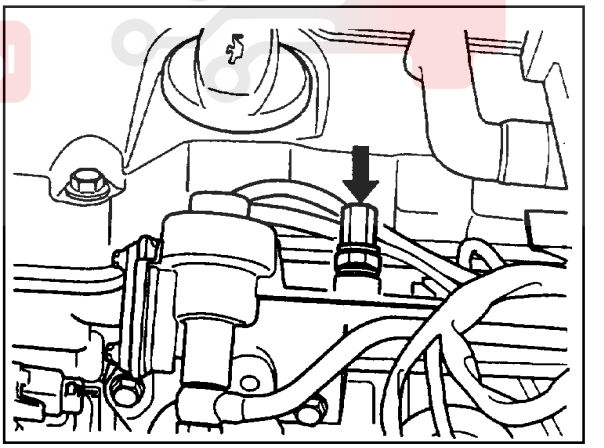
3. If there is no change in fuel pressure and maintain the following pressure over 30 minutes, it is normal.

Fuel Pressure(bar)	≥2.5

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Discharging the pressure in fuel system

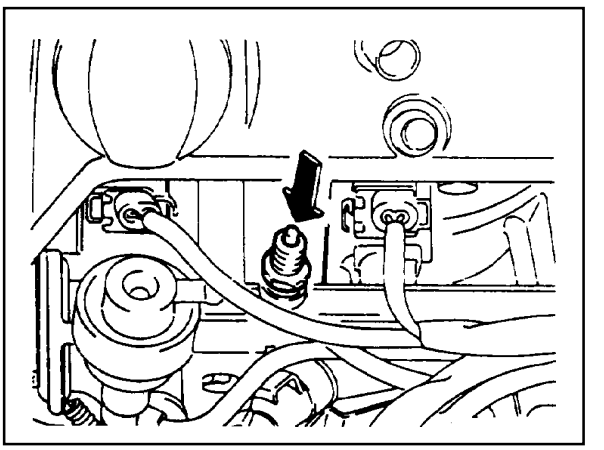
1. Remove the fuel pressure test connector.



Installation Notice

Tightening Torque	22.5 - 27.5 Nm

2. Remove the fuel pressure in fuel system by pressing the service valve with a clean, pointy tool.



Notice

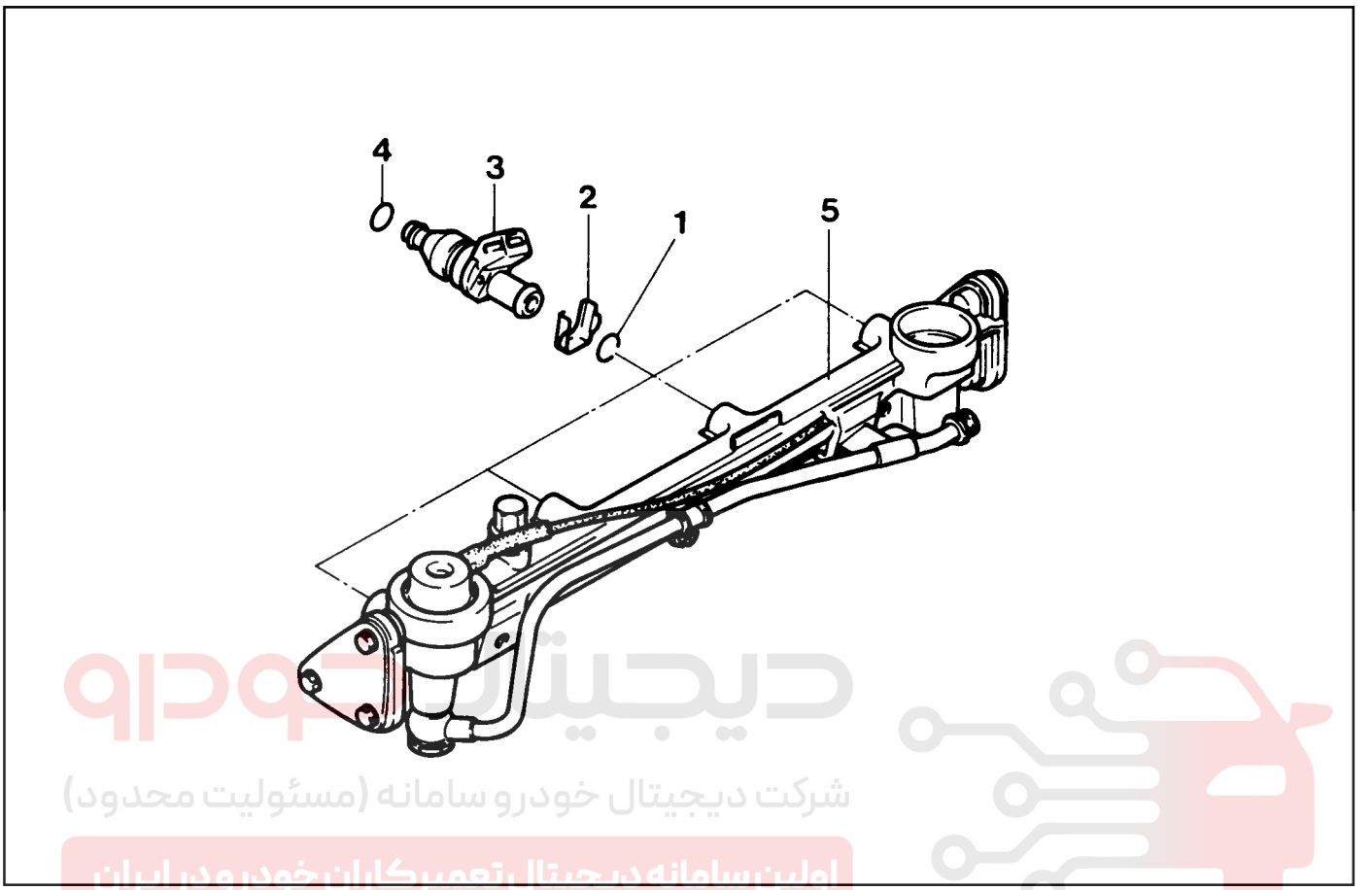
Place a cloth so that the fuel doesn't stain around.

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INJECTOR

Preceding Work : Removal of fuel distributor



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1 O-ring ..... Replace, if damaged
2 Injector Bracket
3 Injector
4 O-ring ..... Replace, if damaged
5 Fuel Distributor

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Removal & Installation Procedure

1. Remove the O-ring.
   Check for damage and replace it if necessary.
2. Remove the injector bracket from the injector.

   Installation Notice

   Exactly seat the anti-twist lock into the square groove in injector.
3. Separate the injector from the fuel distributor.

Inspection & Maintenance

Inspection of the Injector operation and spray pattern

1. Connect the contact box to the ECU.
2. Connect the shop made test plug to the injector and place it into the tank.
3. Position the ignition switch to ON.
4. Connect the pin 63(+) and 69(-) of the contact box with a test cable.
5. Check the injector spray pattern.

   Notice

   Replace the injector if the injector spray pattern is abnormal or the fuel doesn't inject.

Injector Resistance Inspection

1. Remove the injector connector.
2. Measure the injector coil resistance using a resistance tester.

Specified Value	14 - 17 W

Notice

Replace the injector if the measured values is out of the specified values. Check the connector and wire connection between the ECU and the injector if the measured values are normal.

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The Injector Spray Pattern Check

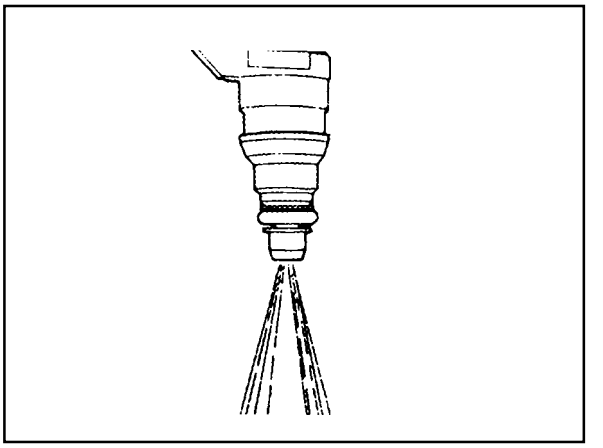
1. Connect the test box (129 589 00 21 00) to the ECU.
2. Disconnect the connector from connector.
3. Disconnect the fuel distributor and injector with a unit from engine without removing the fuel supply and return line.

   Notice

   Prepare the beaker for taking the poping fuel.
4. Connect either end of shop made cable to the injector.
5. Connect the other end of shop made cable to the (+:63) and (-:69) terminal of the test box.
6. Turn the ignition switch to "ON" position.
7. Check the injector for normal spray pattern as shown in the figure. Check injector for leaks or later drops.

   Notice

   Refer to fuel injector test of engine diagnosis in this section for detailed information.

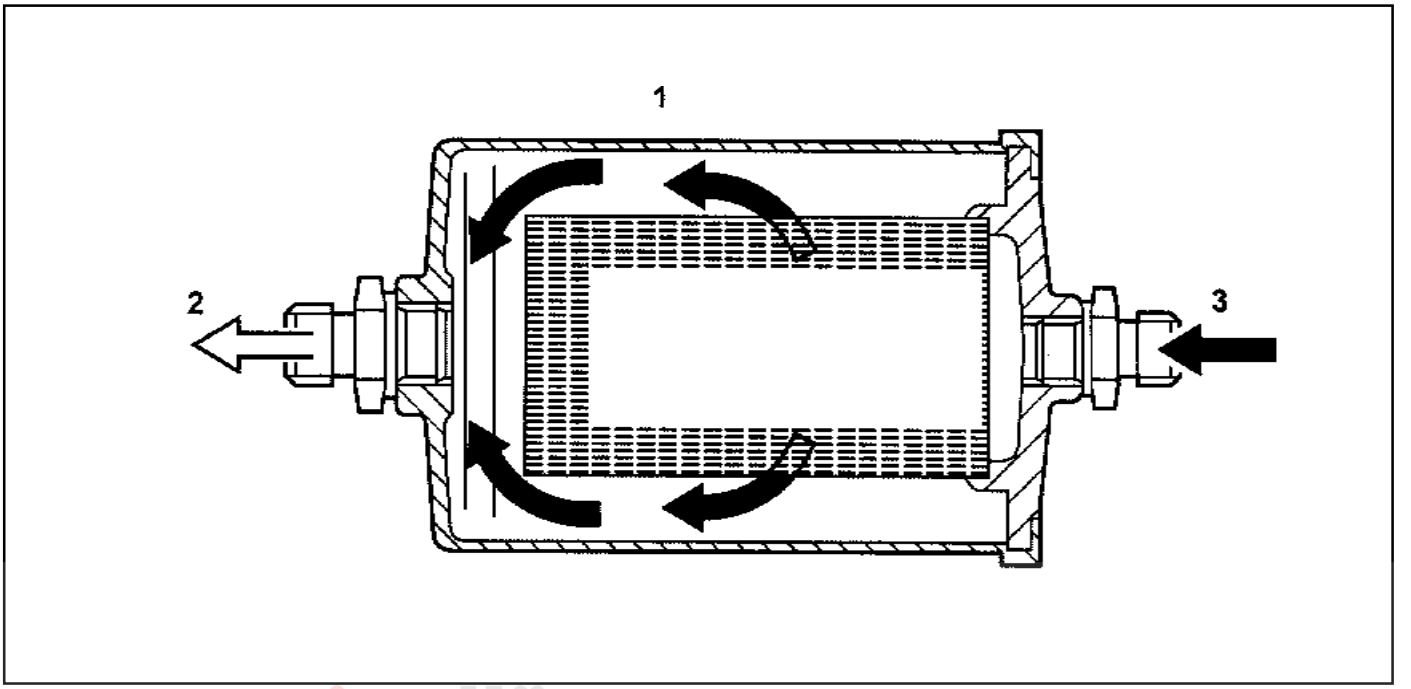


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FUEL FILTER



1 Fuel Filter
2 Outlet
3 Inlet

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Removal & Installation Procedure

1. Open the fuel tank cap and remove the fuel tank pressure.
2. Remove the fuel out (2) and in (3).

Installation Notice

Tightening Torque	25 - 30 Nm

3. Remove the mounting bracket bolt (4) and remove the fuel filter (1).

Installation Notice

Tightening Torque	4 - 8 Nm

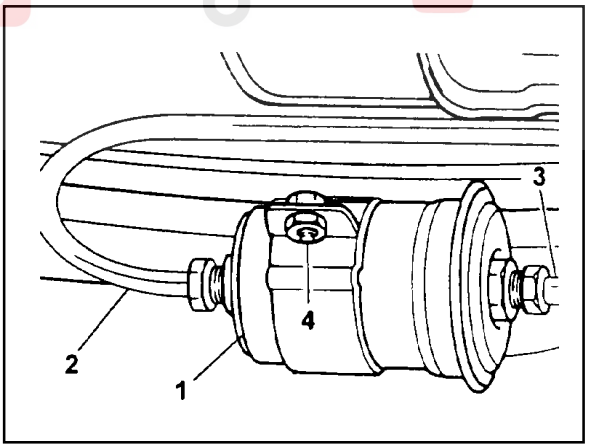
Notice

Place the fuel pump pad. There may be a corrosion due to the contact between the fuel filter and the bracket.

4. Check for leaks by operating the engine.

Notice

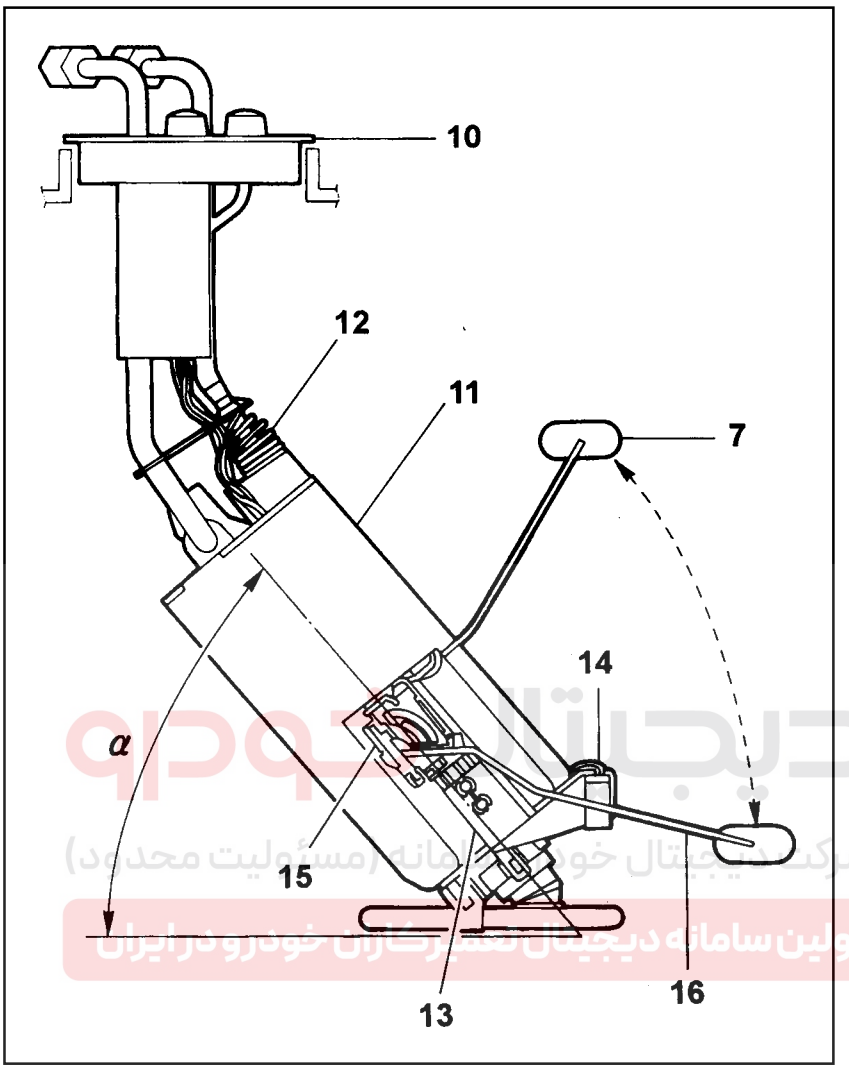
Installation should follow the removal procedure in the reverse order.



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FUEL PUMP



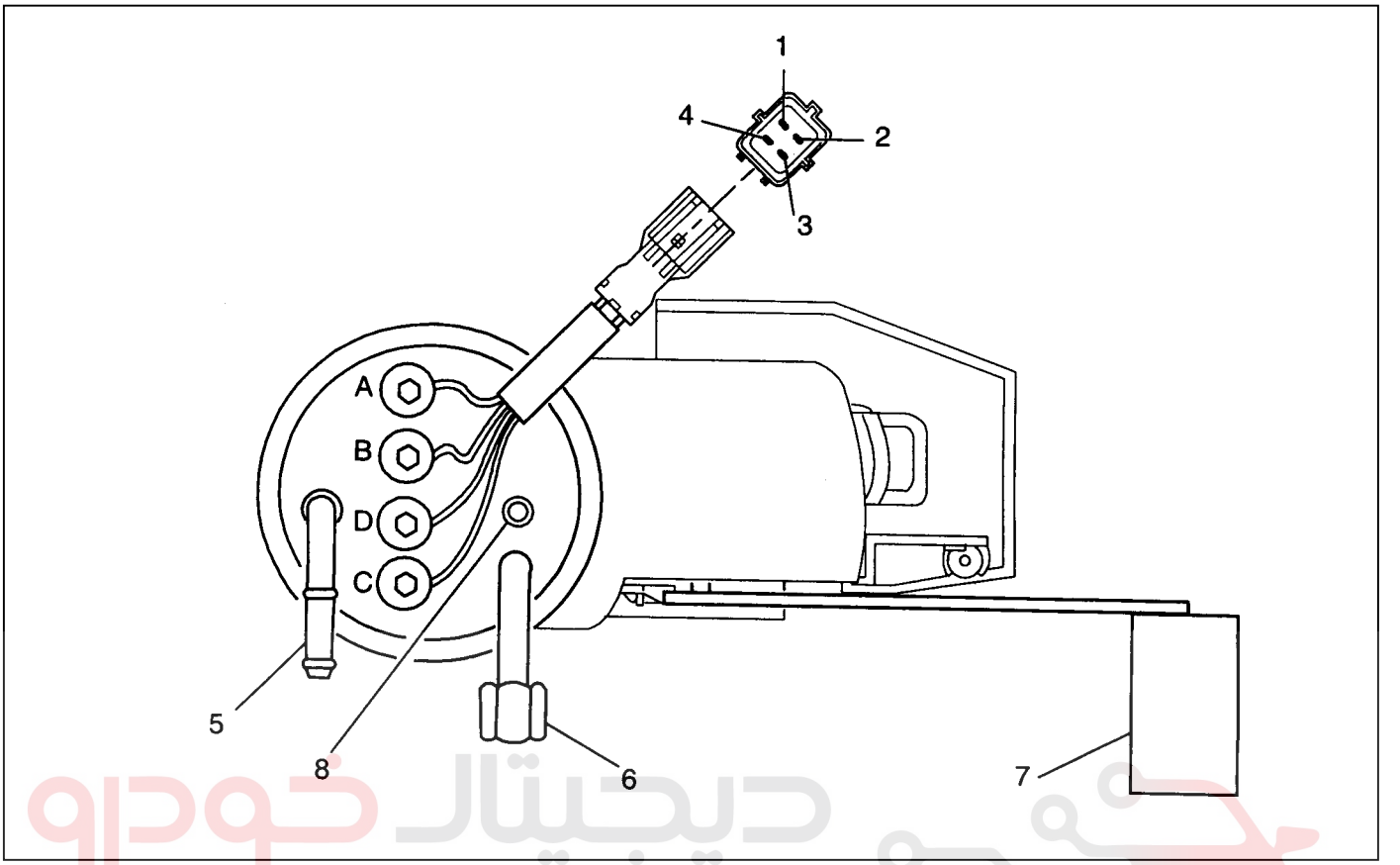
1 Reservoir Tank
2 Fuel Sensor (float/arm)
3 Resistance
4 Wiring Connector
5 Fuel Supply Pipe
7 Float
10 Flange and Harness Assembly
11 Fuel Pump
12 Spring
13 Thermister Housing
14 Thermister
15 Resistor Card and Wiper
16 Float Arm

Requirements for Fuel Pump

Item	Specified Value	Item	Specified Value
System pressure	3.8 bar	Minimum delivery at 8V	30 Litre/Hr
Maximum pressure	8.5 bar (12 V)	Operating voltage	8 V
Minimum pressure	5.0 bar (12 V)	Maximum allowable current	7.5 A
Nominal voltage	12 V	Ambient temperature	-30 ~ +70°C
Minimum amount of fuel supply	114 Liter/Hr (12 V, 3.8 bar, -30 ~ +70°C)	Maximum amount of fuel supply	165 Liter/Hr (12V, 3.8 bar, -30 ~ +70°C)

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1 Fuel Pump Connector Wiring
2 Fuel Return Pipe
3 Fuel Supply Pipe
4 Bolts
5 Fuel Return Pipe
6 Fuel Supply Pipe
7 Float
8 Ground Stud (Sender "-")

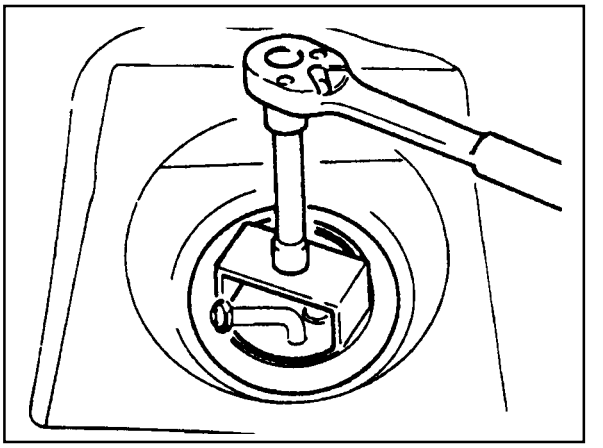
Harness Location & Connector		COLOR	USE
1	A	Pump "+"	2.0 BR
2	B	Thermister "+"	0.5 W
3	C	Ground	2.0 B
4	D	Sender Unit "+"	0.5 RY

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Tools Required

661 589 00 46 00 Cap Remover



Removal & Installation Procedure

1. Disconnect the negative battery cable.
2. Disconnect the harness connector (1).
3. Disconnect the fuel supply (6) and return (5) pipes.
4. Using a special tool, Unscrew the eight fuel retaining bolts and remove the pump from fuel tank.

Notice

Check the condition of the seal and replace if necessary.

Drain the fuel before removing the pump.

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Measure the Fuel Delivery From the Fuel Pump

1. Disconnect the return pipe from fuel distributor and insert the appropriate hose into it.
2. Place the hose end into the beaker with the minimum capacity of 1Liter.
3. Turn the ignition switch to "ON" position.
4. Connect the terminal No.33 and No.5 of ECU with a service wire.
5. Measure the fuel delivery from the fuel pump.

Specifed Value	1Liter/max.35sec.

Notice

Check the fuel filter and fuel line when the fuel delivery is not within specified value.

Measure the Current Consumption of Fuel Pump

1. Remove the fuel pump relay from fuse and relay box in trunk, and turn the ignition switch to "ON" position.
2. Using a multi-tester, measure the current consumption by connecting the terminal No.1 and No.3 of pump.

Specifed Value	5 - 9A

Notice

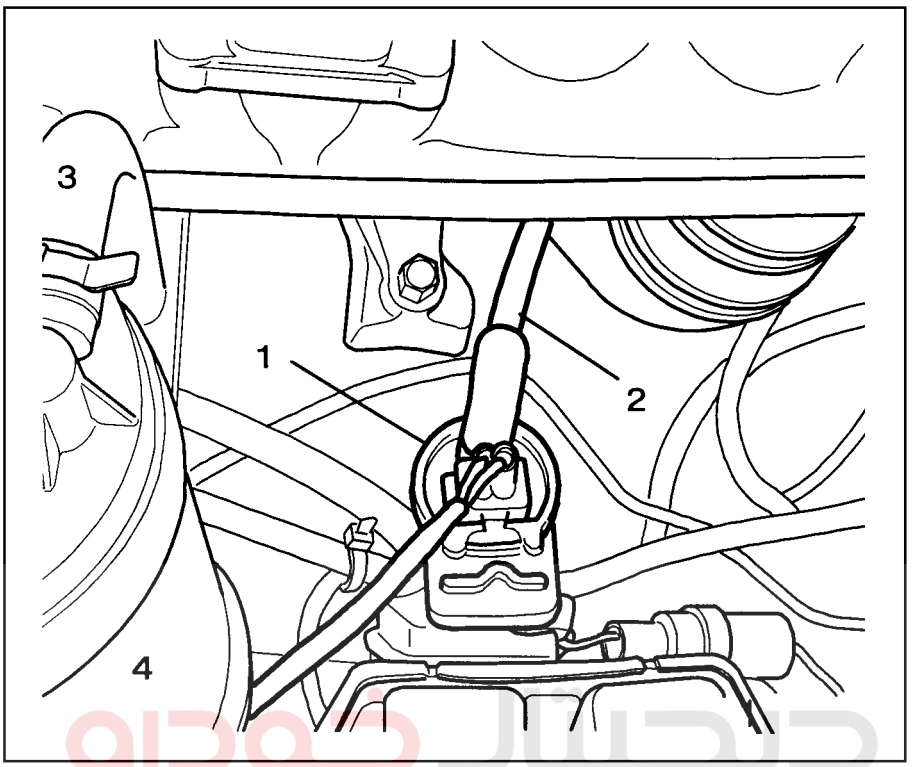
Replace the fuel pump relay if the measured value is over 9A.

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PURGE SWITCHOVER VALVE



1 Purge Control valve
2 Line to engine
3 Line to canister
4 Canister

Functions

The fuel vaporization control system is installed to inhibit the fuel vaporized gas from discharging into the atmosphere. The fuel vaporized gas that is accumulated in the canister abstracts through the purge switchover valve purification during the engine combustion (except the decreasing mode) and coolant temperature of over 80℃. For this reason, the ECU transacts the engine speed, air inflow quantity, coolant temperature, and intake temperature.

The purge switchover valve is activated by the ECU frequency according with the engine rotating speed to adjust the purification rate. The purification rate is determined by the continuous valve opening interval.

The purge switchover valve is activated by the ECU for the following conditions :

- Coolant temperature of over 80℃
- Engine speed of over 1000rpm
- 2 Minutes after starting
- When the fuel cut-off mode is not activated

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Test

1. Maintain the normal temperature and idling state by operating the engine.
2. Connect the ECU terminal No.11 and No.34 and check for normal operation through the output waves using the scanner.

   Notice

   Test during purge control switchover valve operation after the minimum of 1 minute after the engine turned on.
3. Connect the ECU terminal No.34 and No.10 and check for current consumption during the ignition switch ON.

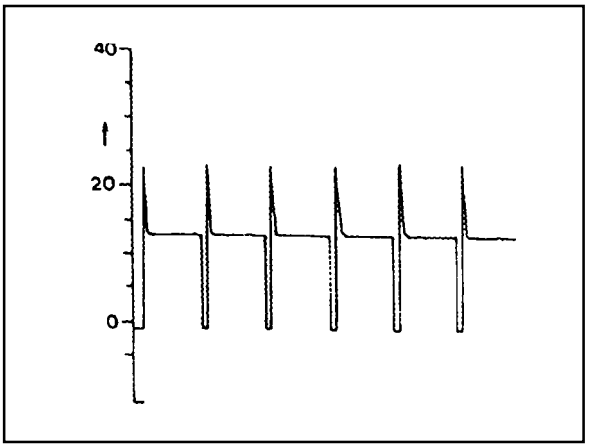
Specified Value	0.3 - 0.5

4. Remove the line to canister and measure the pressure with the vacuum pressure gauge.

Specified Value	> 50mbar (after approx. 1min.) purge switchover valve operates at this time

Notice

Test while at normal temperature and at idling state by operating the engine.



Purge switchover valve output wave

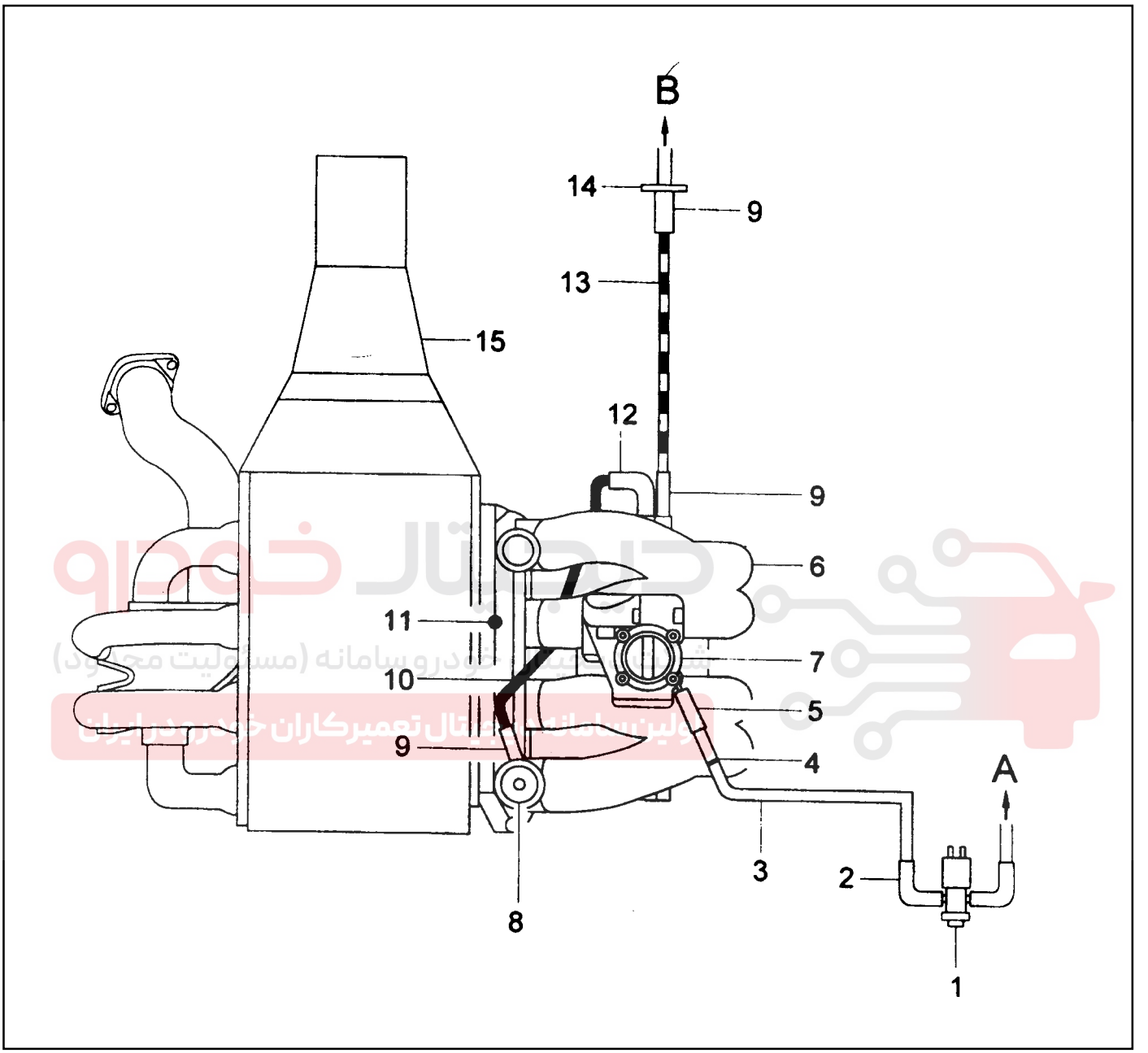
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VACUUM SYSTEM

Manual Transmission

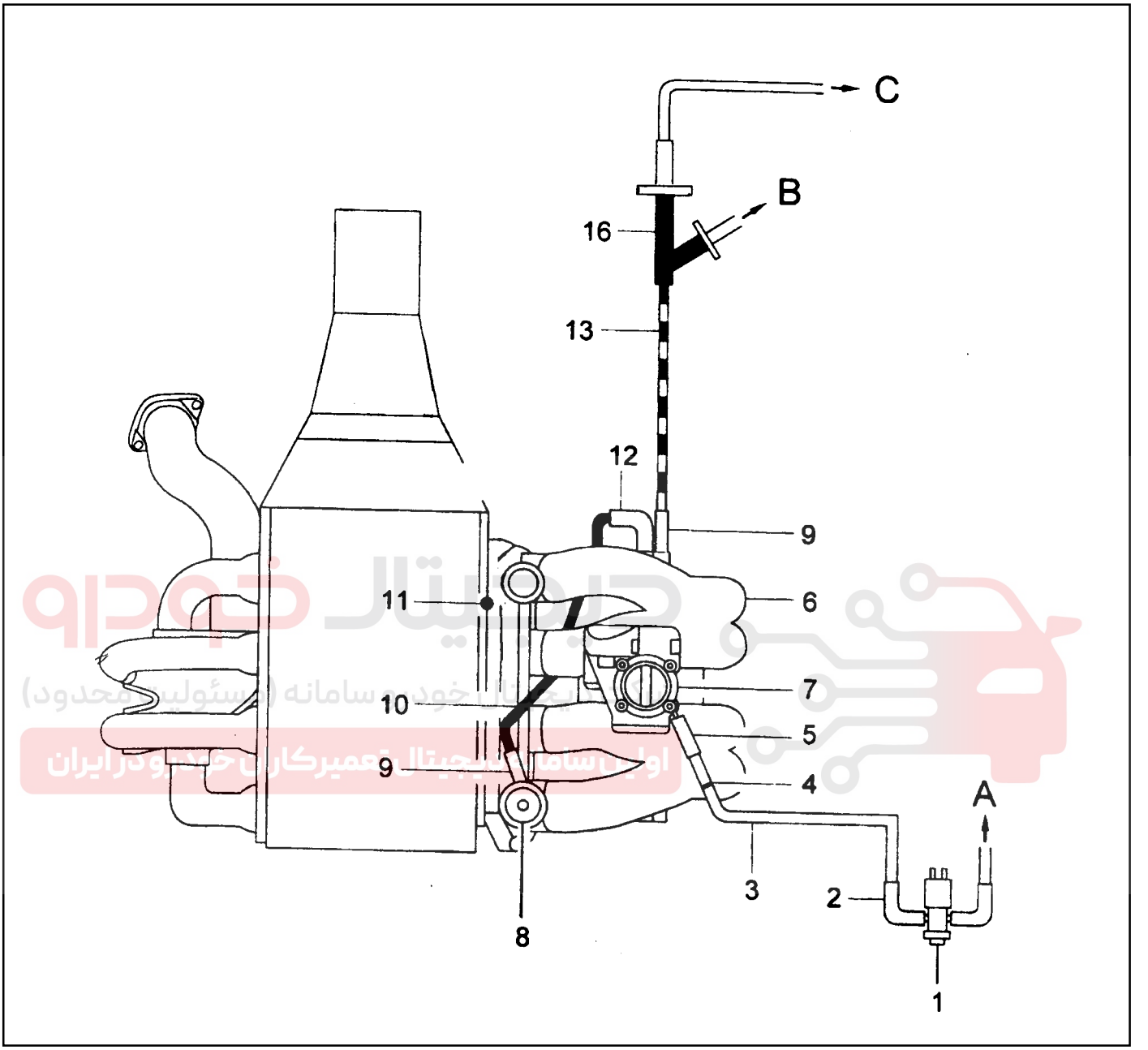


1 Purge Switchover Valve
2 Molded Hose
3 Fuel Tube (270 mm)
4 Clamp
5 Molded Hose
6 Intake Manifold
7 Throttle Body
8 Fuel Pressure Regulator
9 Vacuum Line Rubber Hose (40 mm)
10 Vacuum Tube (Gray, 540 mm)
11 Rubber Cap
12 Molded Hose
13 Vacuum Tube (Brown)
14 Connector

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Automatic Transmission



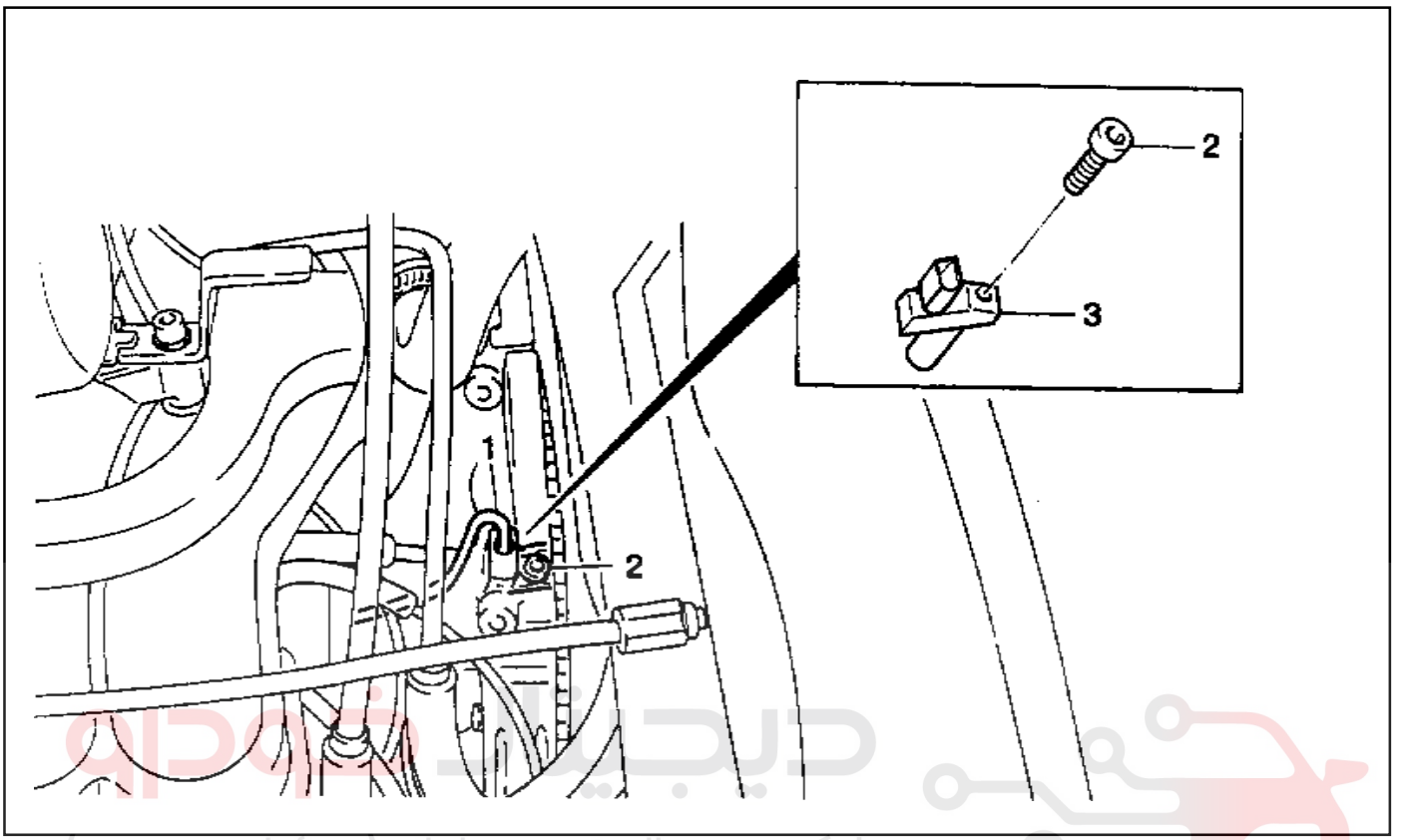
15 Manual Transmission
16 Distributor

A. To Canister
B. To Auto Locking Hub

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CRANKSHAFT POSITION SENSOR



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1 Crankshaft Position Sensor (connector)
2 Bolt (M6 X 14) ..... 9-11 Nm
3 Sensor Unit

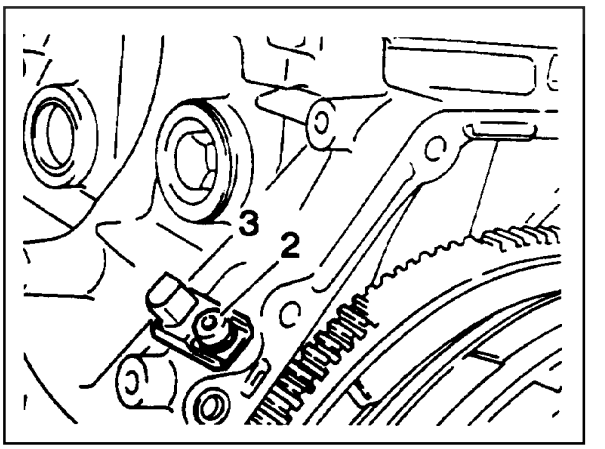
Removal & Installation Procedure

1. Disconnect the wiring connector at the crankshaft position sensor.
2. Unscrew the bolt (2) and remove the crankshaft position sensor unit (3).

Installation Notice

Tightening Torque	9 - 11 Nm

3. Installation should follow the removal procedure in the reverse order.



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Crankshaft Position Sensor Resistance Inspection

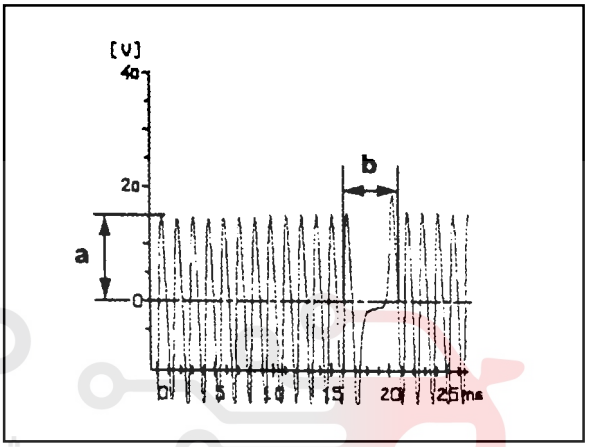
1. Disconnect the coupling "E" of ECU while the ignition switch is in "OFF" position.
2. Measure the resistance between the coupling terminal pin No.99 and No.100 using a multimeter.

Specified Value	1050 - 1400 W

Notice

Measure the insulator resistance of the crankshaft position sensor if out of the specified value.

Crankshaft Position Sensor Output Wave Inspection



1. Connect the test box to the ECU.
2. Measure the output wave between the ECU terminals No.99 and No.100 using the scanner or the oscilloscope while engine cranking (starter motor activated).

Notice

Check the segment or crankshaft position sensor and air gap if cannot get the output wave as shown in the figure.

Crankshaft Position Sensor Insulator Resistance Inspection

1. Disconnect the engine coupling from ECU while the ignition switch is in "OFF" position.
2. Measure the resistance between the coupling terminal pin No.100 and No.69.

Specified Value	> 20kW

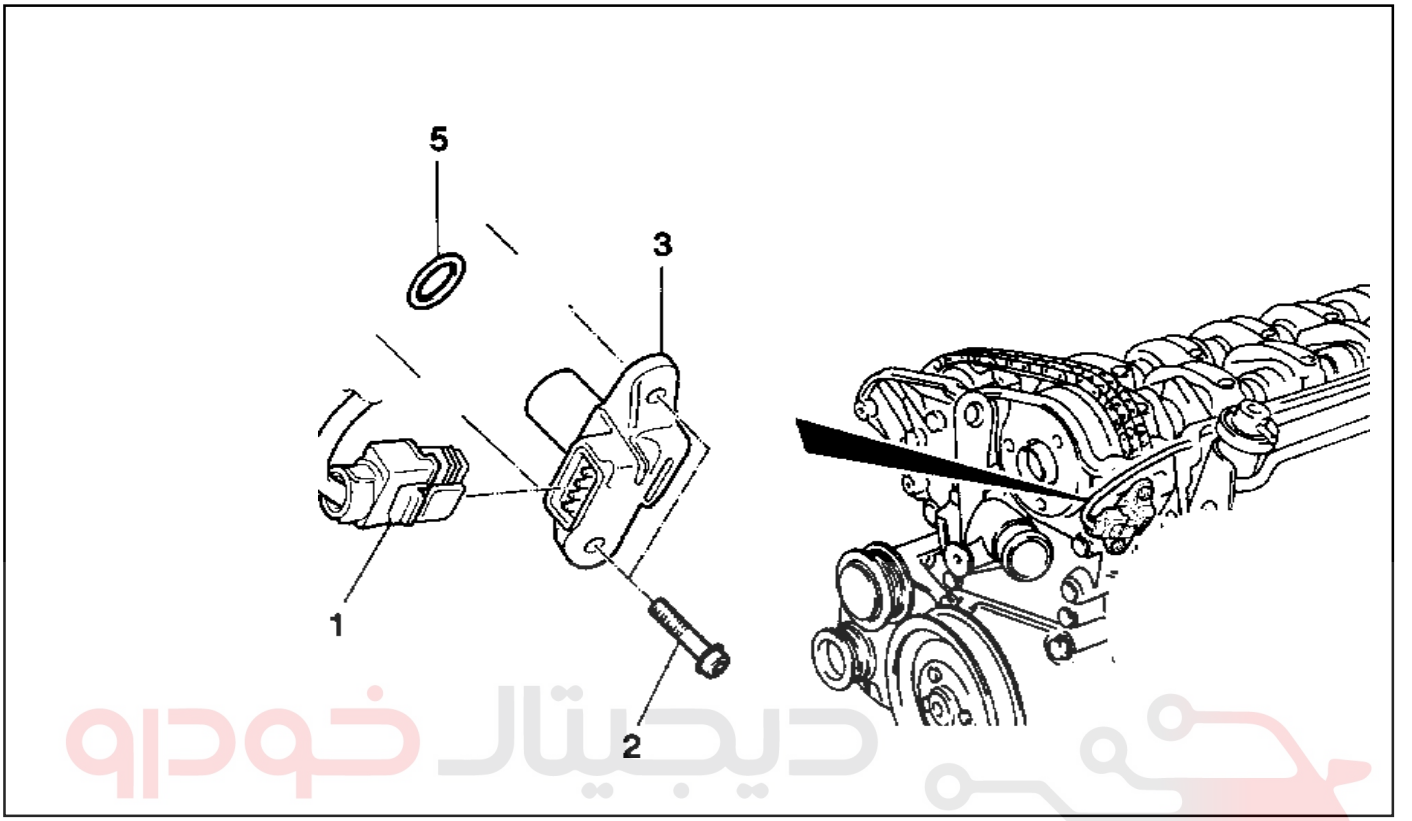
Notice

Measure the check and ground terminal of the crankshaft position sensor if out of the specified value.

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CAMSHAFT POSITION SENSOR



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1	Bolt (M6 X 14) 9-11Nm	3	Shim
2	Camshaft Position Sensor	5	O-ring

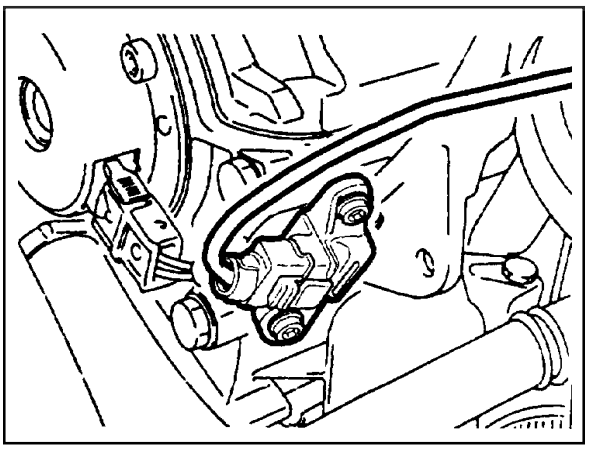
Removal & Installation Procedure

1. Disconnect the wiring connector from the camshaft position sensor.
2. Unscrew the bolt (2) and remove the camshaft position sensor.

Installation Notice

Tightening Torque	9 - 11 Nm

3. Check the clearance and replace the shim if necessary.
4. Check the O-ring for damage and replace it if necessary.
5. Installation should follow the removal procedure in the reverse order.



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Camshaft Position Sensor Signal Voltage Inspection

1. Connect the test box to the ECU.
2. Measure the voltage between the ECU terminal No.11 and No.106 while the engine speed is at idle.

Specified Value	1.2 - 1.7 V

Notice

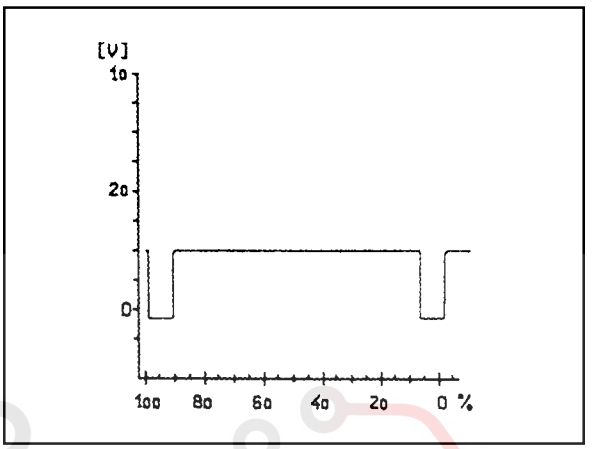
The signal voltage will be changed in the range of 1.2~1.7V.

Camshaft Position Sensor Output Wave Inspection

1. Connect the test box to the ECU.
2. Measure the output wave between the ECU terminal No.104 and No.106 using the scanner or the oscilloscope while the engine speed is at idle.

Notice

Replace the camshaft position sensor if cannot get the output wave as shown in the figure.



Camshaft Position Sensor Power Supply Inspection

1. Turn the ignition switch to 'ON' position.
2. Disconnect the camshaft position sensor connector.
3. Measure the voltage between the No.1 and No.3 pin of camshaft position sensor while the ignition switch is in "ON" position.

Specified Value	11 - 14 V

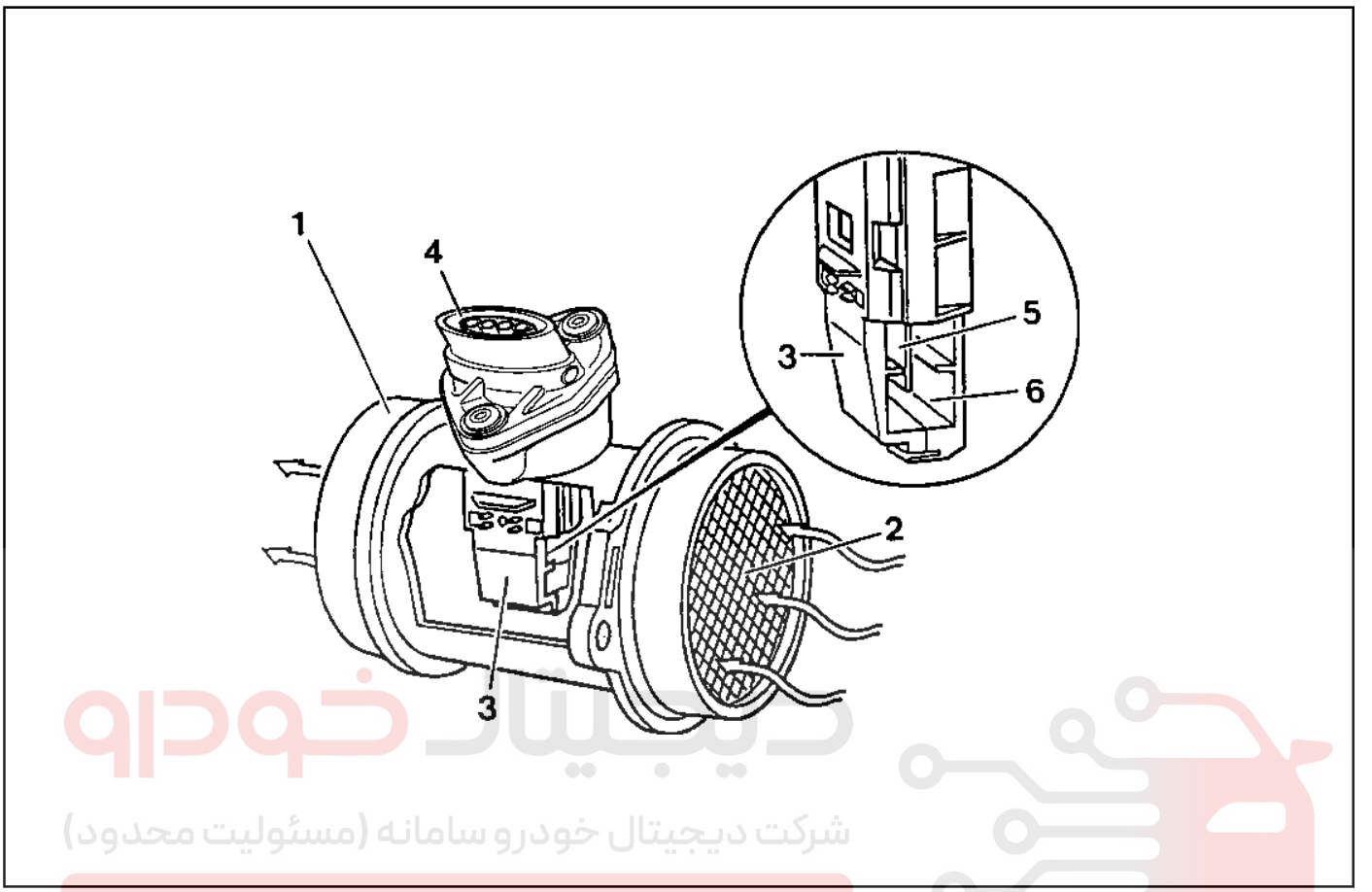
Notice

If the measured value is not within the specified value, check the cable.

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HOT FILM AIR MASS (HFM) SENSOR



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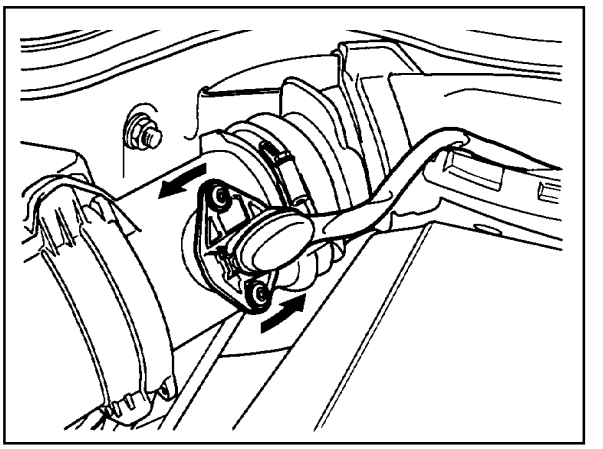
1 Housing
2 Protector Net
3 Electronic Housing
4 Connector
5 Hot film Sensor
6 Measuring Port

Removal & Installation Procedure

1. Turn the HFM sensor coupling in the direction shown in the figure in the right so that it gets separated from the contact surface.

   Notice

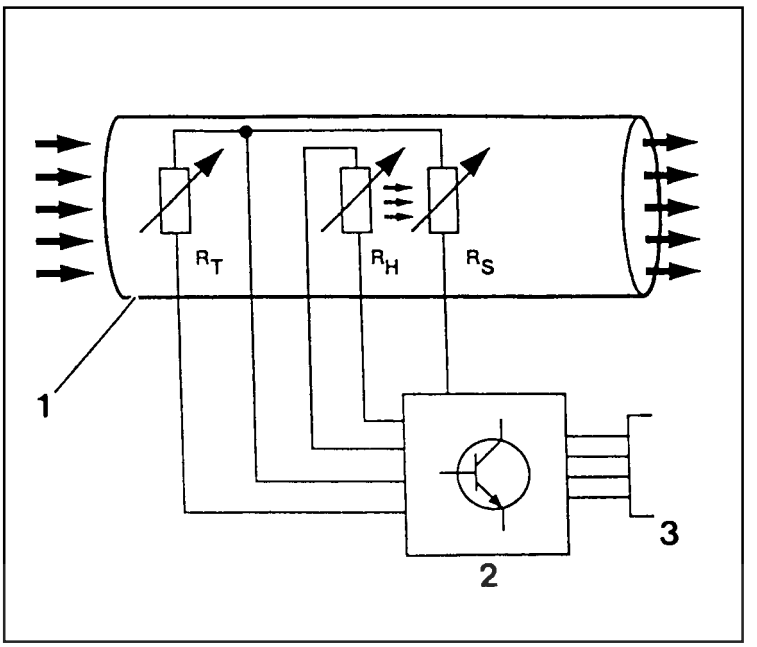
   Make sure the HFM sensor coupling connects completely with the contact surface Installation.
2. Remove the clip with a screw driver.
3. Pry off two tensioning clamps.
4. Remove the HFM sensor.
5. Installation should follow the removal procedure in the reverse order.



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Circuit Diagram



1 Housing
2 Electronic Housing
3 Connector

R_H : Heat Resistance
R_T : Temperature Resistance
R_S : Sensor Resistance

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HFM Sensor Input Voltage Inspection

1. Measure the HFM sensor signal voltage between the ECU terminal No.81 and No.105.

Specified Value (coolant temperature is over 70°C)

Iginition"ON"	0.9 - 1.1 V
Engine at idle	1.3 - 1.7 V

If the measured value is not within the specified value, the possible cause may be in cable or HFM sensor in itself. Perform the 5V power supply inspection procedures.

HFM Sensor 5V Power Supply Inspection

1. Measure the voltage between the HFM sensor No.108(+) and No.105(-) after removing the HFM sensor connector.

Specified Value	4.7 - 5.2 V

If the measured value is not within the specified value, the possible cause may be in cable or ECU coupling.

2. Measure the voltage between the HFM sensor wining connector terminal No.3 pin and No.102(+) after removing the HFM sensor connector.

Specified Value

Specified Value	4.7 - 5.2 V

If the measured value is not within the specified value, the possible cause may be in cable or over voltage protection relay.

Perfrom the 12V power supple inspection procedures.

HFM Sensor 12V Power Supply Inspection

1. Measure the voltage between the HFM sensor wining connector 1G No.2 pin(+) and No.3 after removing the HFM sensor connector.

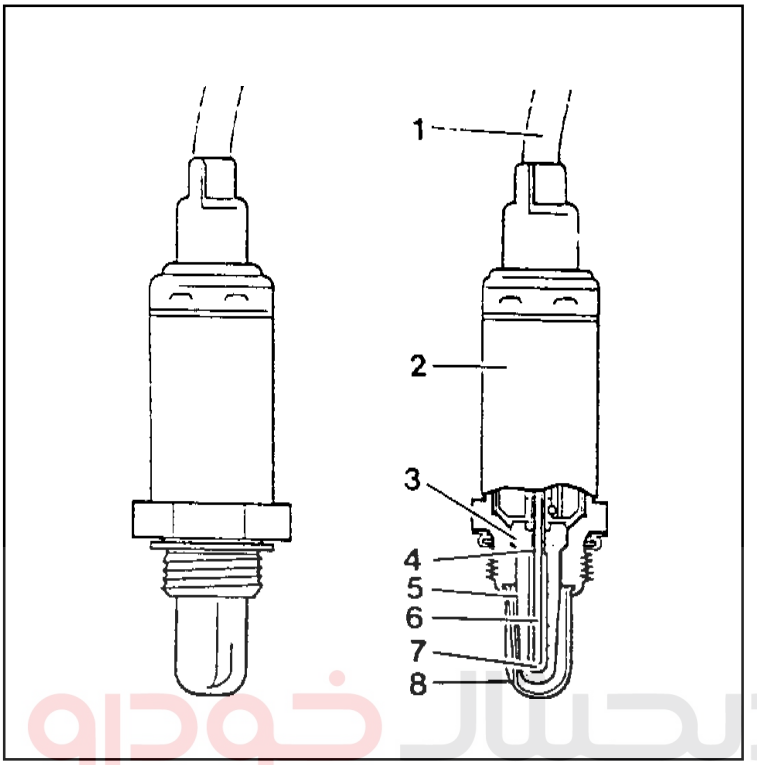
Specified Value	11 - 14 V

If the measured value is not within the specified value, the possible cause may be in cable or over voltage protection relay.

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OXYGEN SENSOR

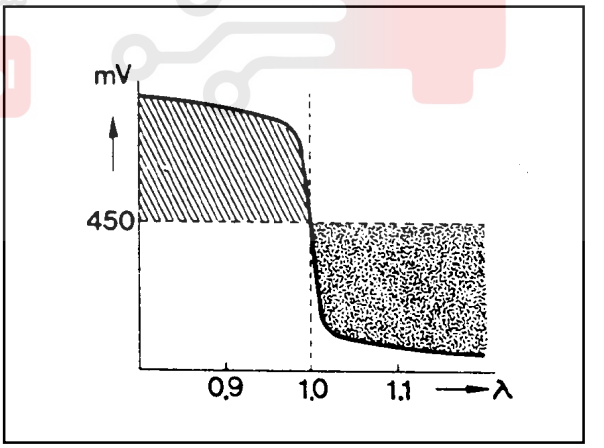


1 Electricity Wire
2 Oxygen Sensor Housing
3 Sensor Ceramic
4 Electrode (Internal)
5 Electrode (External)
6 Heating Coil
7 Open Space
8 Protector Tube

Functions

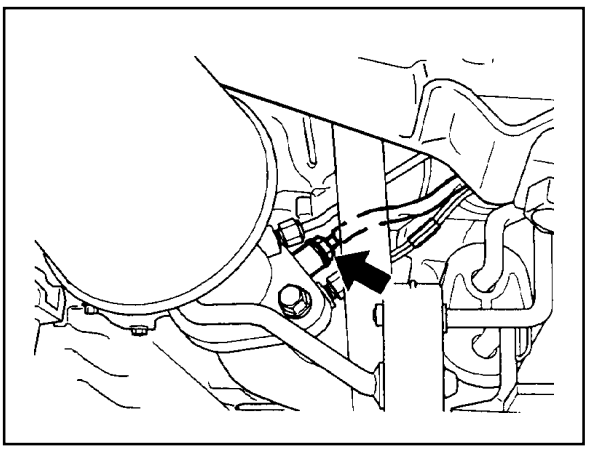
The oxygen sensor optimizes the combustion (Air-Fuel Ratio 14.7:1) and resets the Air-fuel ratio in the ECU after sensing the amount of oxygen from the exhaust gases to diminish the exhaust gases.

- Rich(<1) above approx. 450mV
- Lean(>1) below approx. 450mV



Locatoin of Sensor

Oxygen sensor is located on the front exhaust pipe.



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Oxygen Sensor Signal Voltage Inspection

1. Measure the oxygen sensor signal voltage between the ECU terminal No.11 and No.9. Maintain the engine speed ia at idle while the coolant temperature is over 80°C.

Specified Value	-0.2 - 1.0 V

If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECU.

Oxygen Sensor Heating Voltage Inspection

1. Measure the oxygen sensor heating voltage between the ECU terminal No.11 and No.9. Maintain the engine speed ia at idle while the coolant temperature is over 80°C.

Specified Value	11 - 14

If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECU.

Oxygen Sensor Heating Current Consumption Inspection

1. Measure the oxygen sensor heating current consumption between the ECU terminal No.9 and sensor heating(+) line while the ignition switch is in "ON" position.

Specified Value	0.2 - 2.0 A

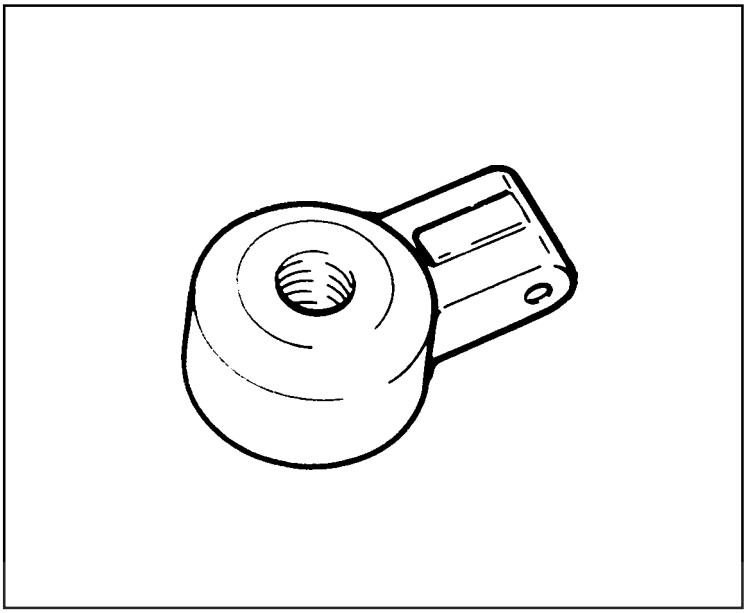
If the measured value is not within the specified value, the possible cause may be in cable, oxygen sensor or ECU.

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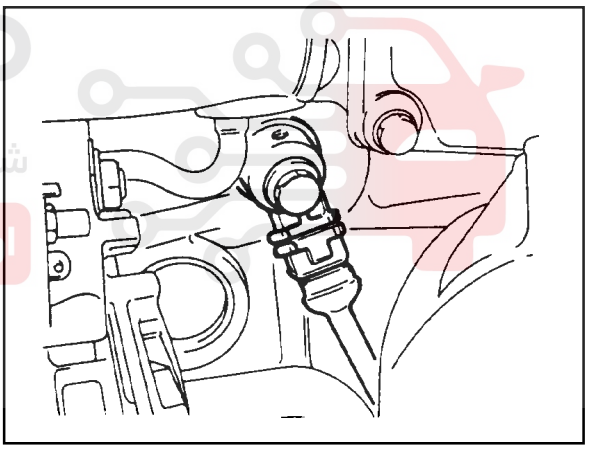
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KNOCK SENSOR



Functions

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 the signal and the retards firing point.



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Removal & Installation Procedure

1. Disconnect the knock sensor connector from the intake manifold bracket.
2. Unscrew the mounting bolt (M8 X 28) from the knock sensor installed on the cylinder block and remove the knocking sensor.

Installation Notice

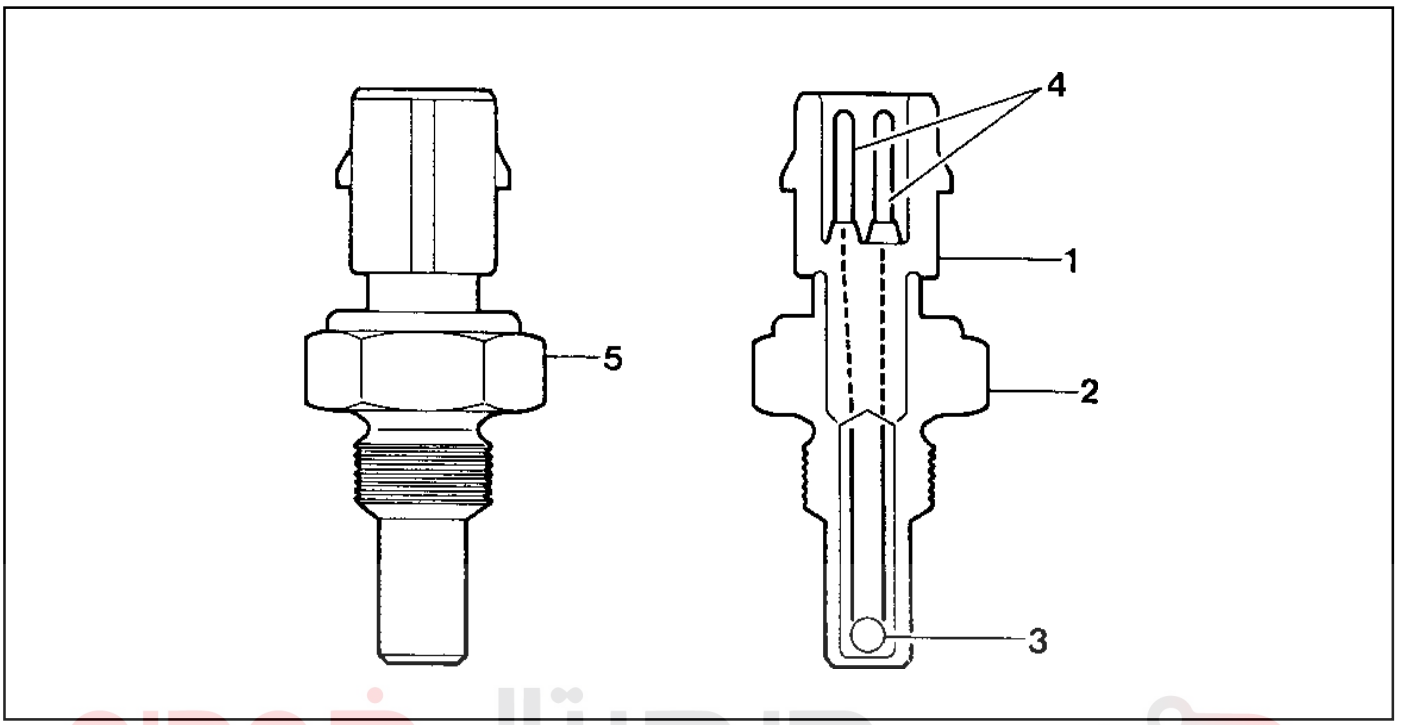
Tightening Torque	22.5 - 27.5 Nm

3. Installation should follow the removal procedure in the reverse order.

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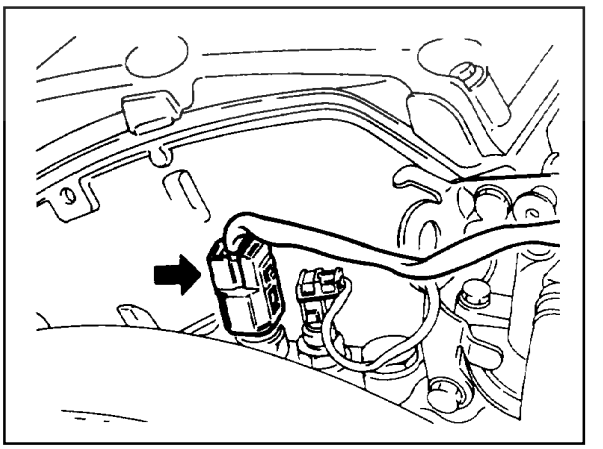
COOLANT TEMPERATURE SENSOR



1 Artificial Resin Housing
2 Metal Housing
3 NTC (negative temperature coefficient) Resistor
4 Connector
5 Coolant Temperature Sensor

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Removal & Installation Procedure



1. Remove the pressure by opening the pressure cap in the coolant subtank.
2. Disconnect the connector and remove the coolant temperature sensor.

   Installation Notice

Tightening Torque	18 - 22 Nm

   Replace the seals with new one.

3. Installation should follow the removal procedure in the reverse order.
4. Check for leaks at each connections after starting the engine.

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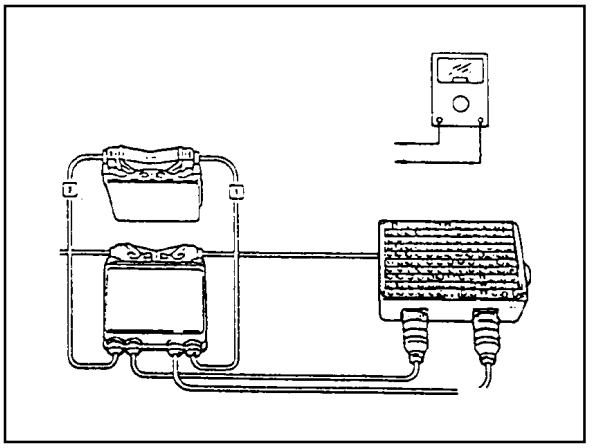
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Inspection

1. Measure the coolant sensor input voltage between the ECU terminal No.79 and No.78 while the ignition switch in "ON" position.

Temperature (°C)	Voltage (V)
20	3.57
30	1.22
40	0.78

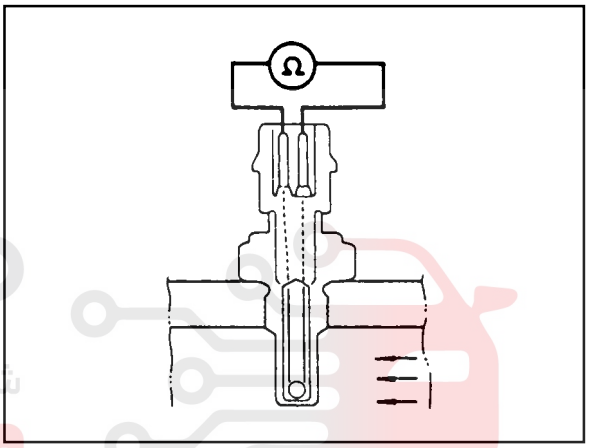
allowable error :±5%



2. Measure the resistance between the coolant temperature sensor terminal No.1 and No.4 with the coolant temperature sensor disconnected.

Temperature (°C)	Resistance (W)
20	2,500
30	322
40	185

allowable error :±5%



Notice

Replace wiring and coolant temperature sensor if out of specified value.

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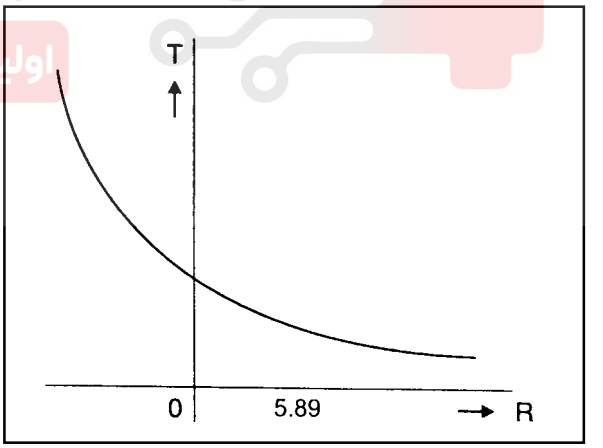
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Service Data

Temperature(℃)	Resistance(W)	Voltage(V)	Temperature(℃)	Resistance(W)	Voltage(V)
-40	48,550	4.8991	60	594	1.8632
-30	27,000	4.8214	70	434	1.5132
-20	15,670	4.7001	80	322	1.2179
-10	9,450	4.5215	90	243	0.9775
0	5,890	4.4273	100	185	0.7806
10	3,790	3.9562	110	143	0.6255
20	2,500	3.5714	120	111.6	0.5020
30	1,692	3.1426	130	88.0	0.4044
40	1,170	2.6959	140	71.2	0.3323
50	826	2.2618	-	-	-

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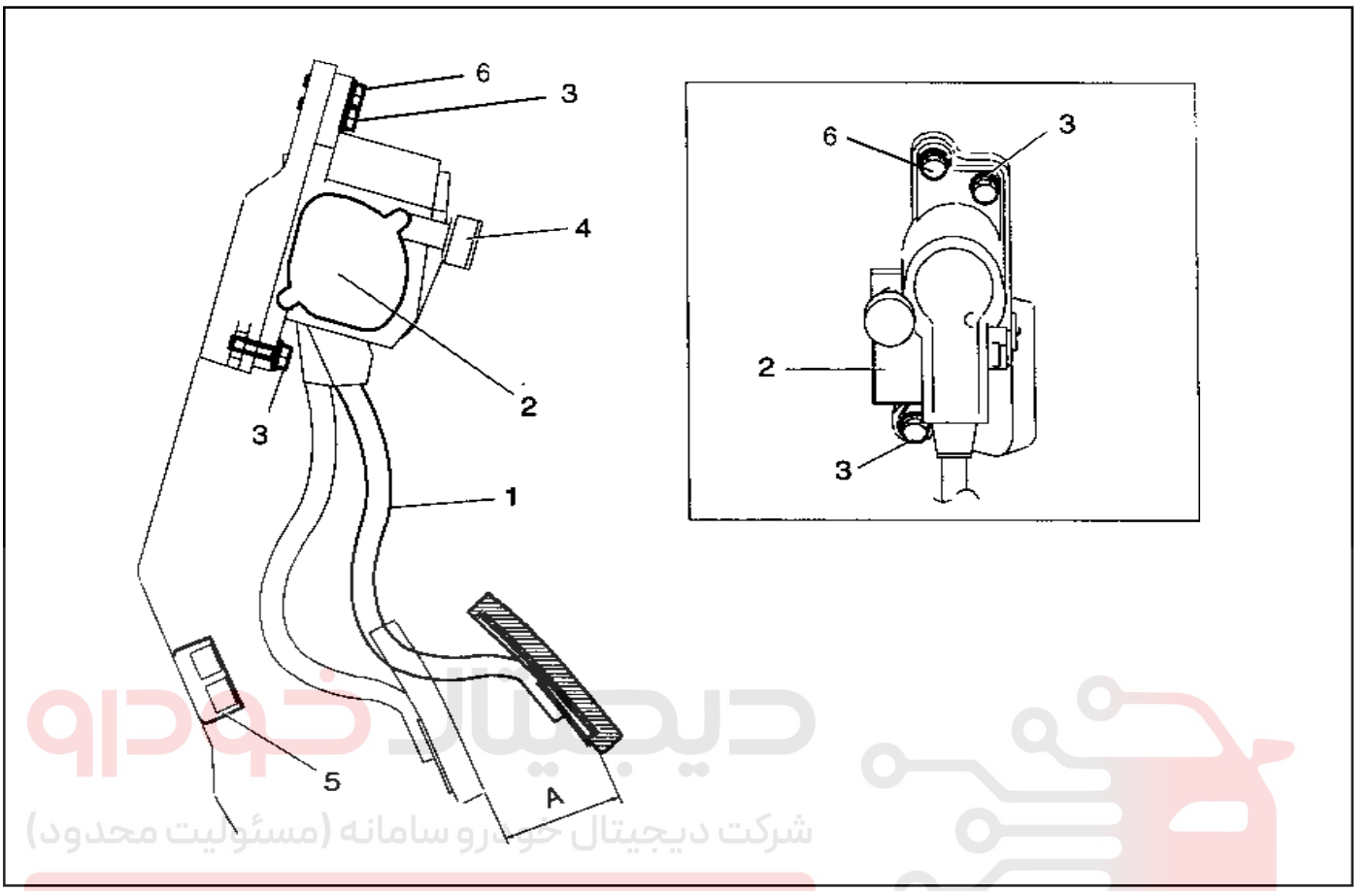
Resistance characteristic curve according to the coolant temperature



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ACCELERATOR PEDAL MODULE



1 Accelerator pedal
2 Accelerator pedal Sensor
3 Bolts (2 Pieces) ..... 4-8 Nm
4 6-Pin Connector
5 Kick down Switch
6 Nut (1 piece) ..... 4-8 Nm

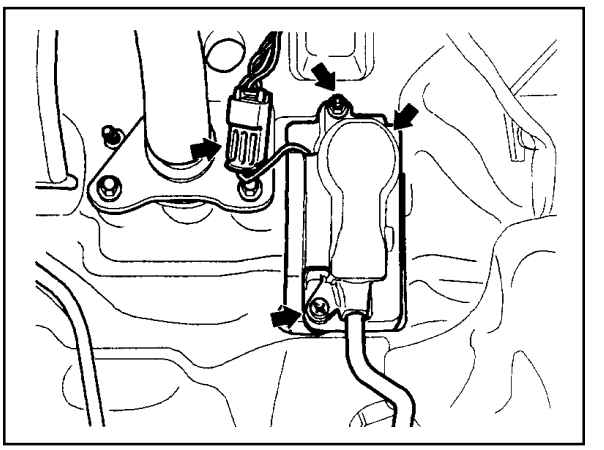
Removal and Installation Procedure

1. Disconnect the 6-pin connector(arrow).
2. Unscrew the 2 bolts (3) / 1 nut (6) and remove the pedal and sensor assembly.

Installatoin Notice

Tightining Torque	4 - 8 Nm

2. Installation should follow the removal procedure in the reverse order.



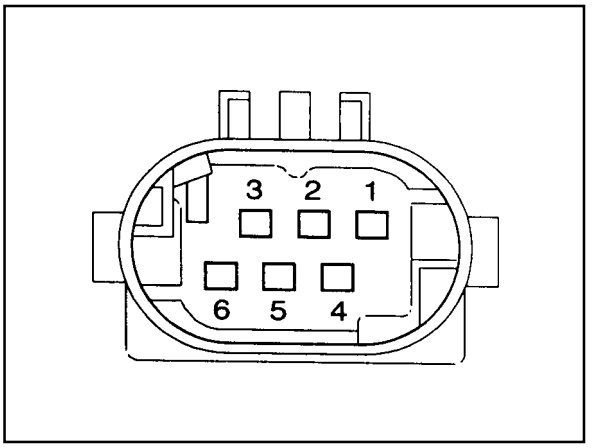
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Accelerator Pedal Sensor Connector(Sensor Side)

Potentiometer 1.
- Pin no. 3 :Red
- Pin no. 1 :Yellow
- Pin no. 5 :Brown

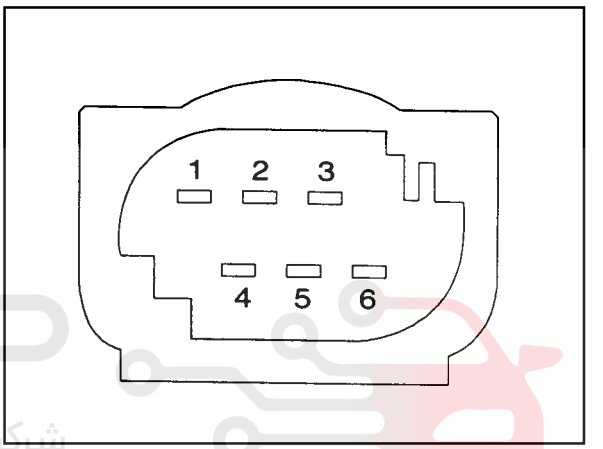
Potentiometer 2.
- Pin no. 6 :Violet
- Pin no. 4 :Green
- Pin no. 2 :White



Accelerator Pedal Sensor Connector(Vehicle Side)

Potentiometer 1.
- Pin no. 3 :Red-Black
- Pin no. 1 :Blue-Green
- Pin no. 5 :Yellow-Green

Potentiometer 2.
- Pin no. 6 :Green
- Pin no. 4 :Blue-Red
- Pin no. 2 :LightGreen

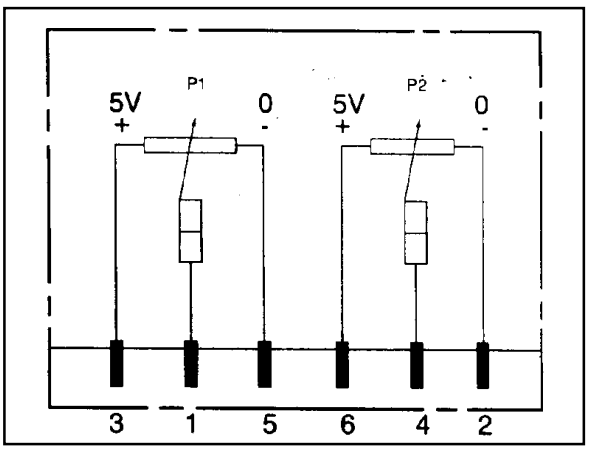


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Function

Pin no. 3	Potentiometer 1, Power Supply(+)
Pin no. 1	Potentiometer 1, Signal
Pin no. 5	Potentiometer 2, Ground
Pin no. 6	Potentiometer 2, Power Supply(+)
Pin no. 4	Potentiometer 2, Signal
Pin no. 2	Potentiometer 2, Ground

Circuit Diagram



Potentiometer 1.
Potentiometer 2.

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SECTION 1F3

OM600 ENGINE CONTROLS

Caution: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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Vacuum Pump 1F3-13
Vacuum Unit Replacement 1F3-15
Idle Speed Adjustment 1F3-16
Fuel Pump Test 1F3-18
Fuel Pump 1F3-21
Injection Nozzle Test 1F3-22
Injection Nozzles 1F3-25
Injection Nozzle Repair 1F3-27
Removal and Installation of Injection Timing Device 1F3-30
Injection Timing Device 1F3-35
Start of Delivery Test (Position Sensor, RIV Method) 1F3-37
Fuel Injection Pump 1F3-46

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N·m
Fuel Tank Mounting Nut	28 - 47
Fuel Pump Pressure Line	13
Fuel Injection Nozzle	35 - 40
Fuel Injection Pipe	18
Nozzle Tensioning Nut	80
Screw Plug	30
Left-Hand Thread Bolt	46

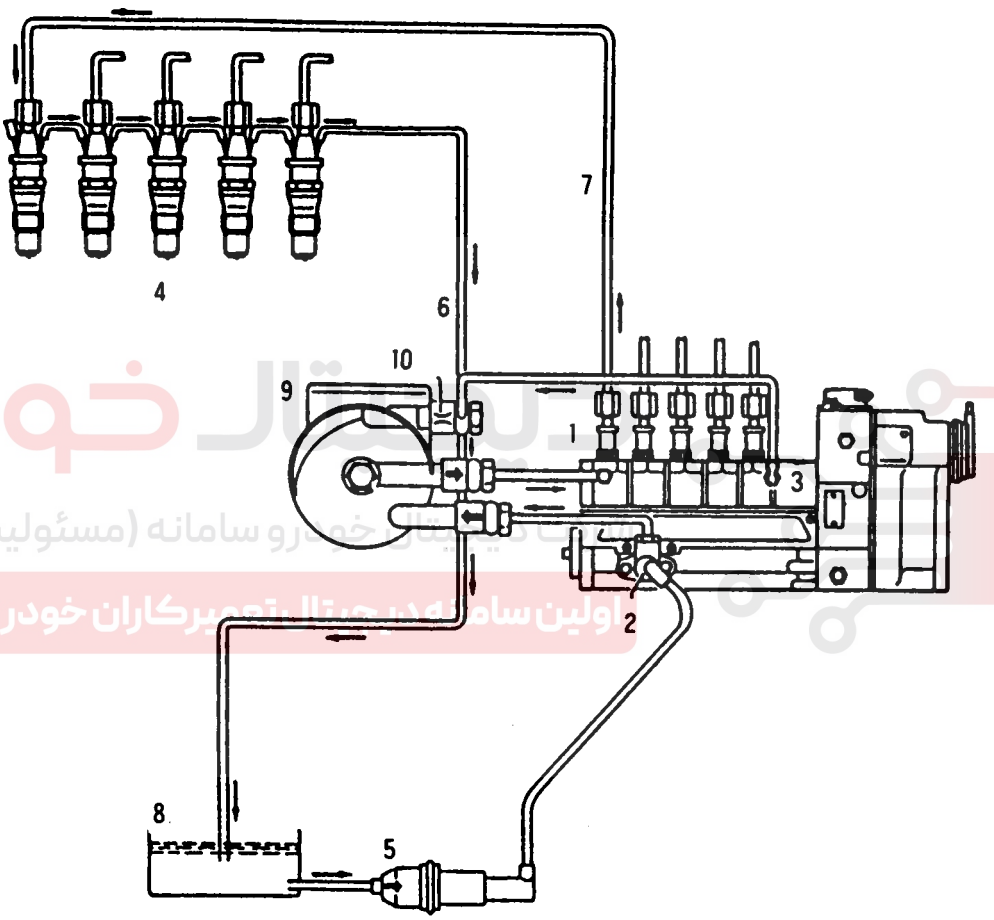
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

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

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FUEL INJECTION PUMP CODING

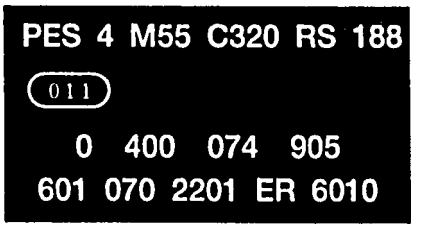
Model Code

OM661 LA Engine	PES 4M 55C 320 RS 167
OM662 LA 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 (5EA)
M	Pump Size
55	Element Diameter
C	Modification Letter
320	Assembly Number
R	Direction of Rotation (clockwise)
S188	Special Version

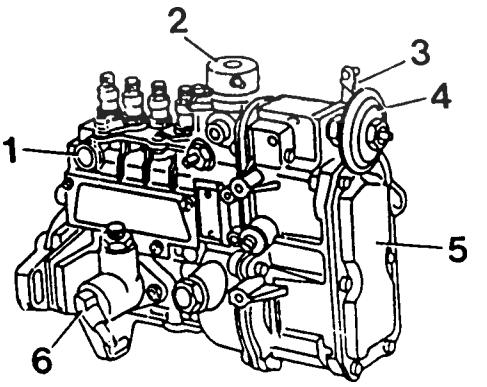


RSF	**Governor**
R	Governor
S	Coil Spring
F	Drive Governor

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Component Location

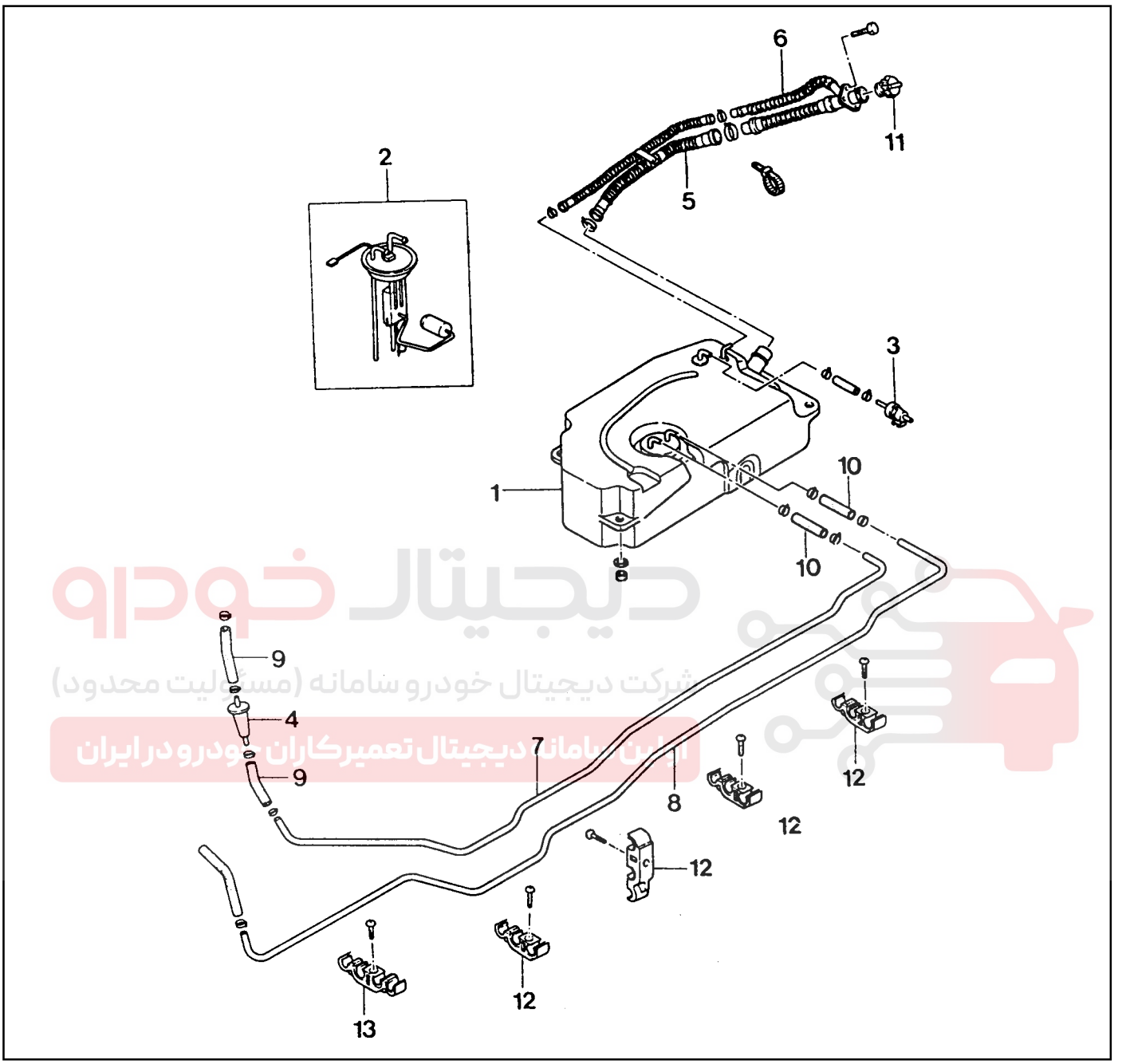
1. Fuel Injection Pump
2. Vacuum Unit (Stop Unit)
3. Control Lever
4. PLA Vacuum Unit (Idle Speed Adjustment)
5. Governor
6. Fuel Pump



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FUEL TANK

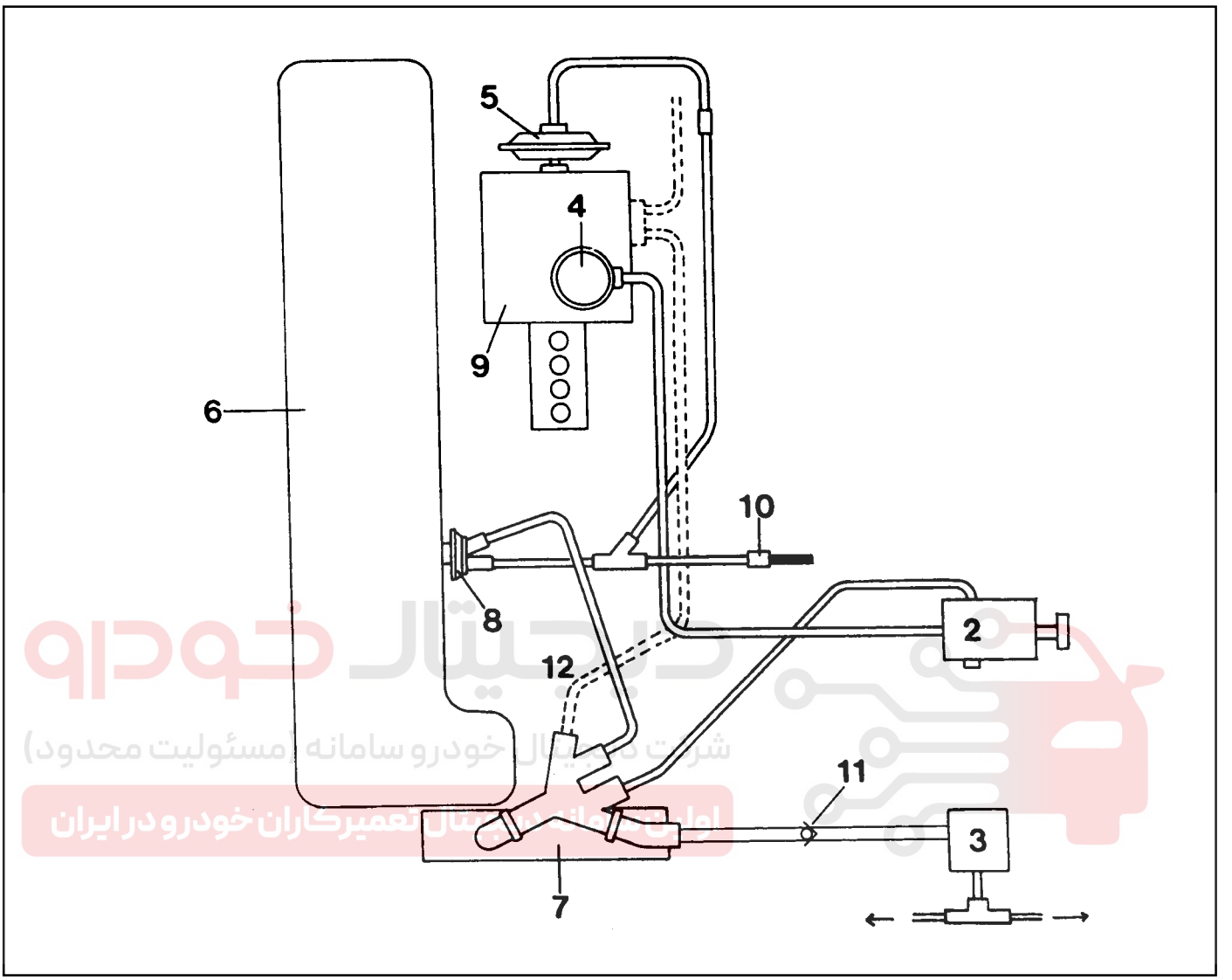


1 Fuel Tank
2 The Sender of Fuel Tank
3 2-way Check Valve
4 Pre Filter
5 Front Fuel Filler Neck
6 Rear Fuel Filler Neck
7 Fuel Supply Tube
8 Fuel Return Tube
9 Filter Hose
10 Fuel Tank Hose
11 Fuel Filler Cap
12 Clip
13 Clip

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VACUUM CONTROL SYSTEM TEST



2 Engine Cut-Off Valve (Ignition Key Switch)
3 Auto-locking Hub Solenoid Valve
4 Engine Stop Valve 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)

Test Data

Idle Speed Increase	At least 100 rpm at approx. 500mbr
Permissible Pressure Drop of System	400 - 500mbar approx. 1 min.

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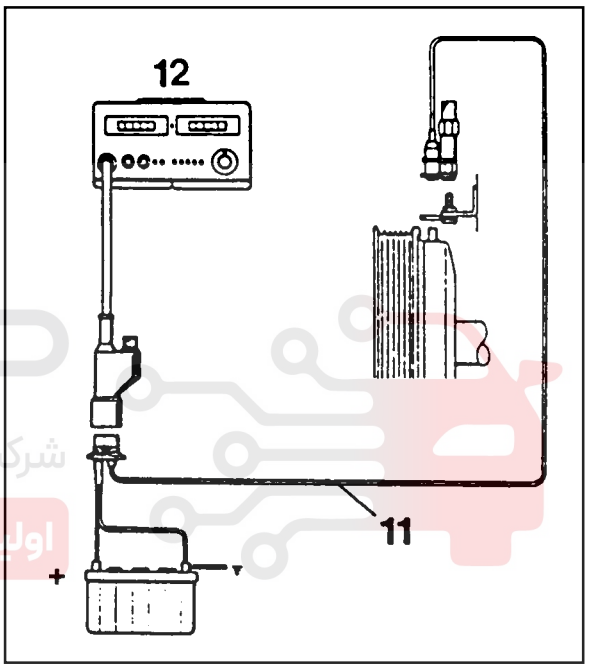
Tools Required

001 589 73 21 00 Vacuum Pump
201 589 13 21 00 Vacuum Tester
667 589 00 21 00 TDC pulse generator

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 Eichenfeldstrabe 1 - 3 D-8150 Holzkirchen

Tester Connection



11 TDC Pulse Sender Unit
12 Digital Tester

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Test step 1

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

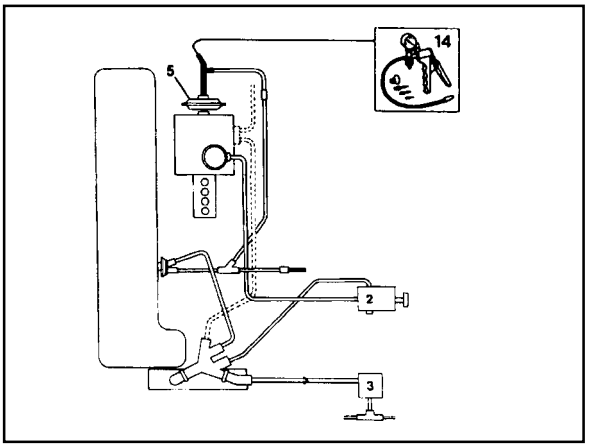
Vacuum ≧ 500 mbar

YES

NO

Lines and connections leaking.
Faulty PLA vacuum unit.

(Remove the connection hose from vacuum pump)



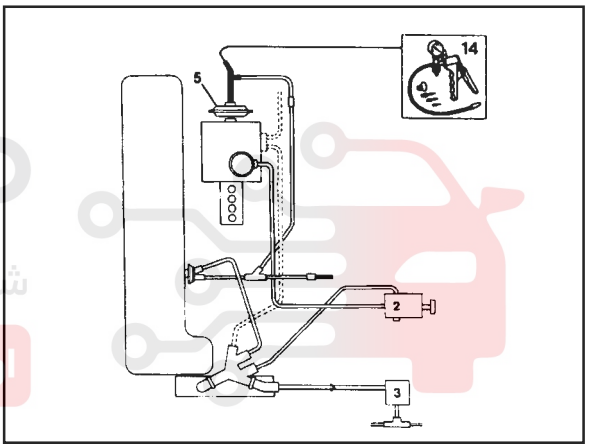
Connect vacuum pump (14) direct to PLA vacuum unit (5) and pressurize with vacuum.

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

YES

NO

Faulty PLA vacuum unit



(Coolant Temperature 30°C)

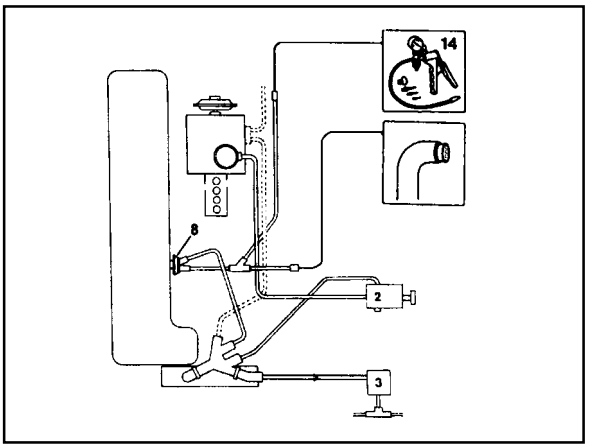
Stop the engine Seal the air admission line with plug. Connect the vacuum pump to line to thermovalve and pressurize the line with vacuum.

Vacuum is built up.

YES

NO

Lines and connectors leaking.
Faulty thermovalve.



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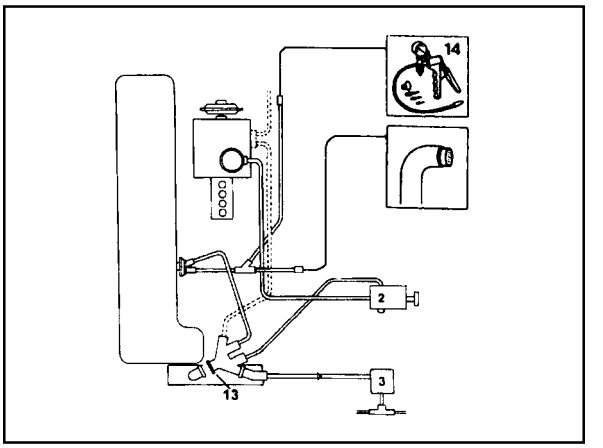
Detach line downstream of air admission filter (13).

Vacuum drops.

YES

NO

Faulty thermovalve



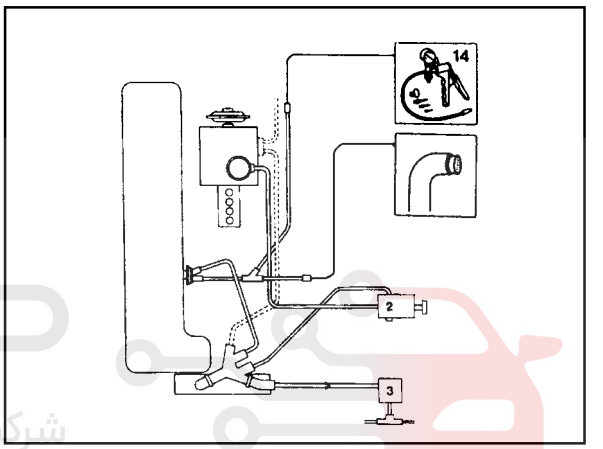
Fit the line onto air admission filter. Built up vacuum with vacuum pump. Detach the plug from air admission line.

Vacuum drops.

YES

NO

Faulty filter with restriction.



Go to test step 2.

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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°C of the thermovalve.

YES

NO

Faulty thermovalve.
Defective filter with restriction.

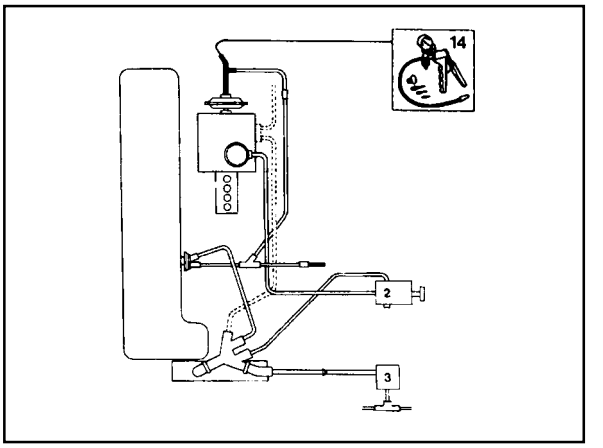
Stop the engine. Detach the filter with restriction.

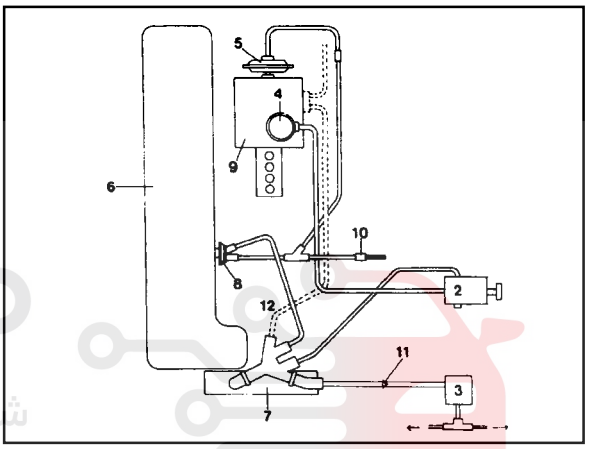
Filter with restriction is clear.

YES

NO

Defective filter with restriction.



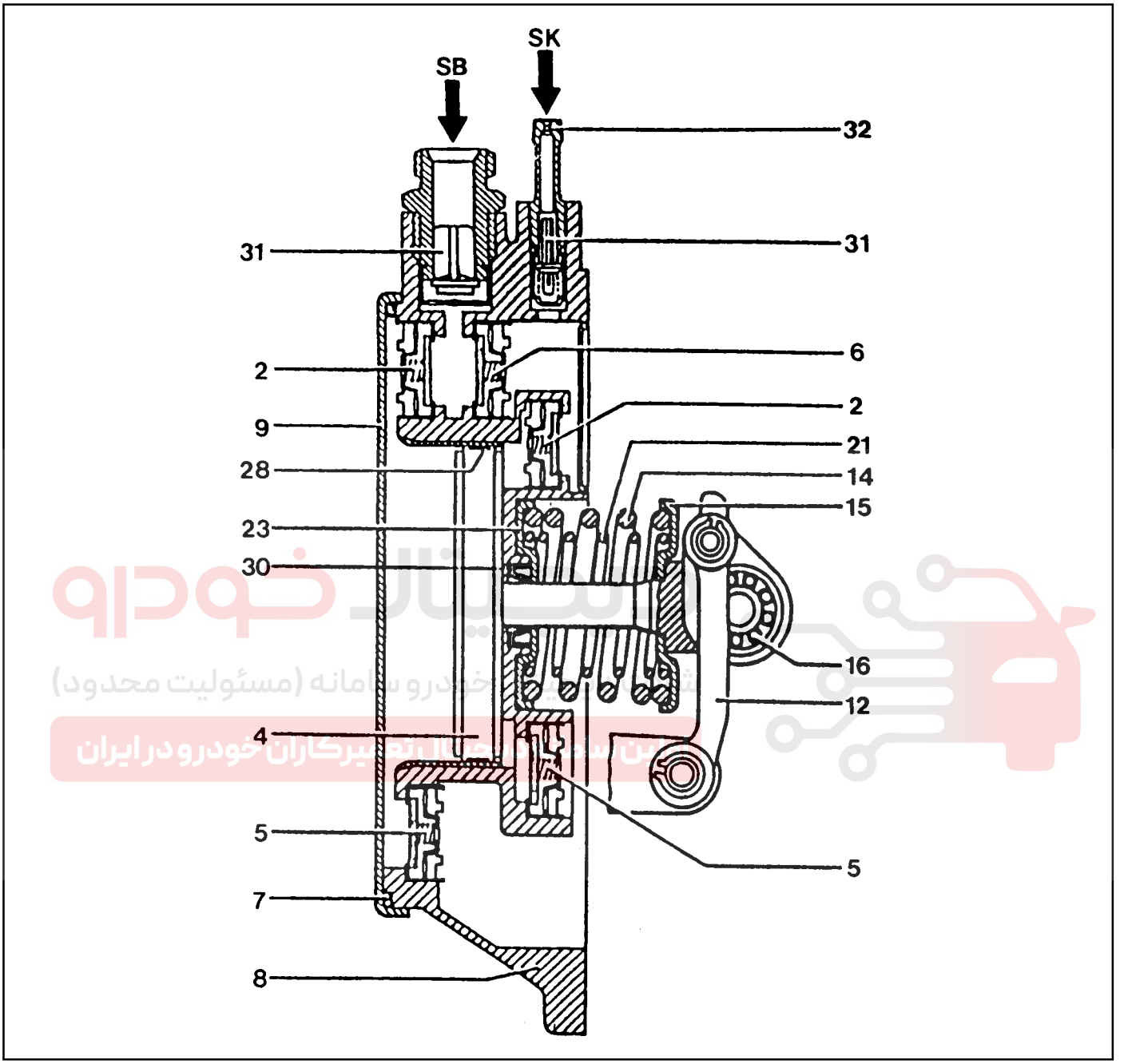


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VACUUM PUMP (SECTIONAL VIEW)

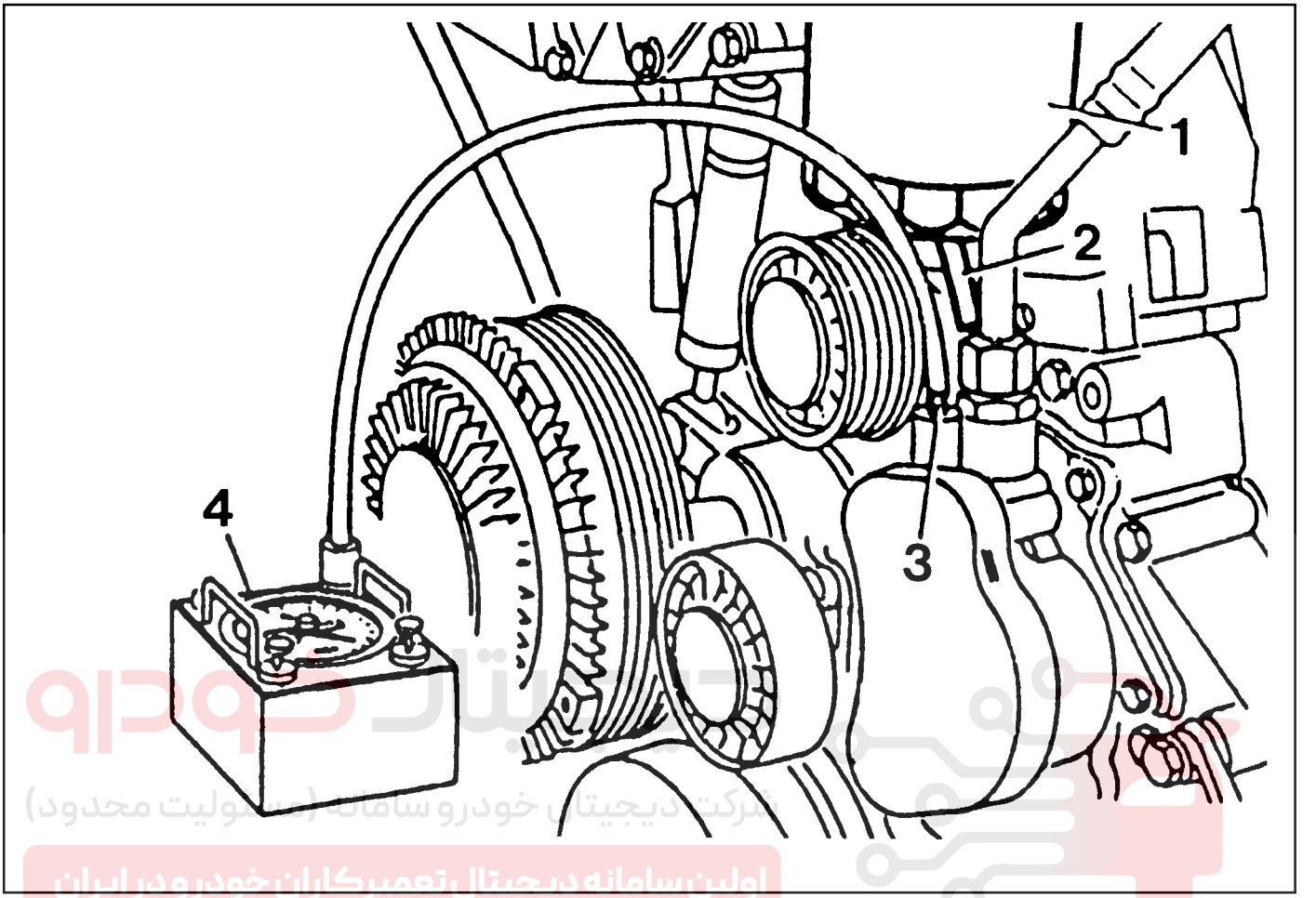


2	Suction Valve	16	Roller Cam
4	Piston	17	Piston Rod
5	Pressure Valve	21	Inner Return Spring
6	Safety Valve	23	Upper Spring Retainer
7	O-Ring	28	Piston Ring
8	Pump Housing	30	Seal Ring
9	Pump Cover	31	Oil Return Valve
12	Lever	32	Restrictor
14	Outer Return Spring	SB	To Brake Booster
15	Inner Spring Retainer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

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VACUUM PUMP TEST



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

Tools Required

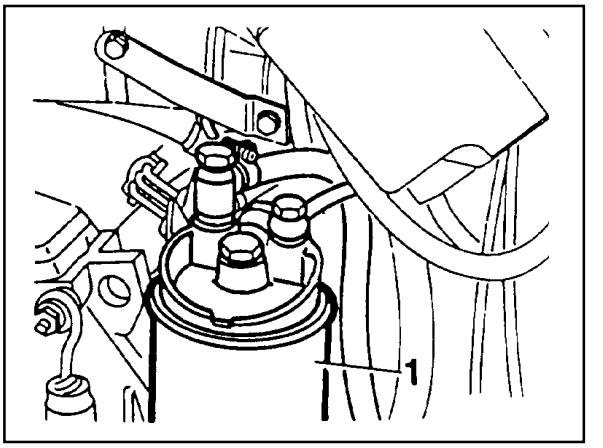
201 589 13 21 00 Vacuum Tester

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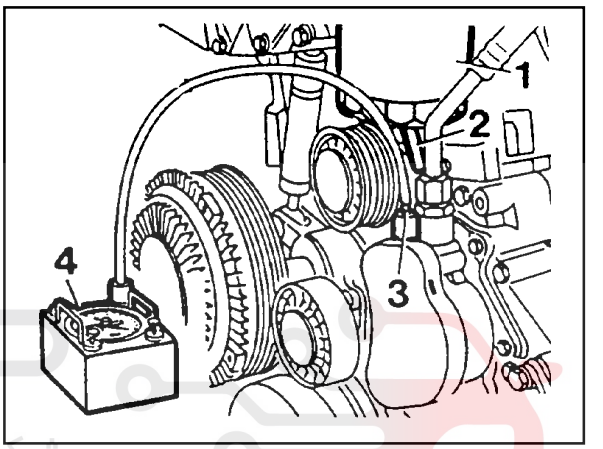
Test Procedure

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 pressure after 30 sec.

Standard	> 70 mbar

Notice

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.

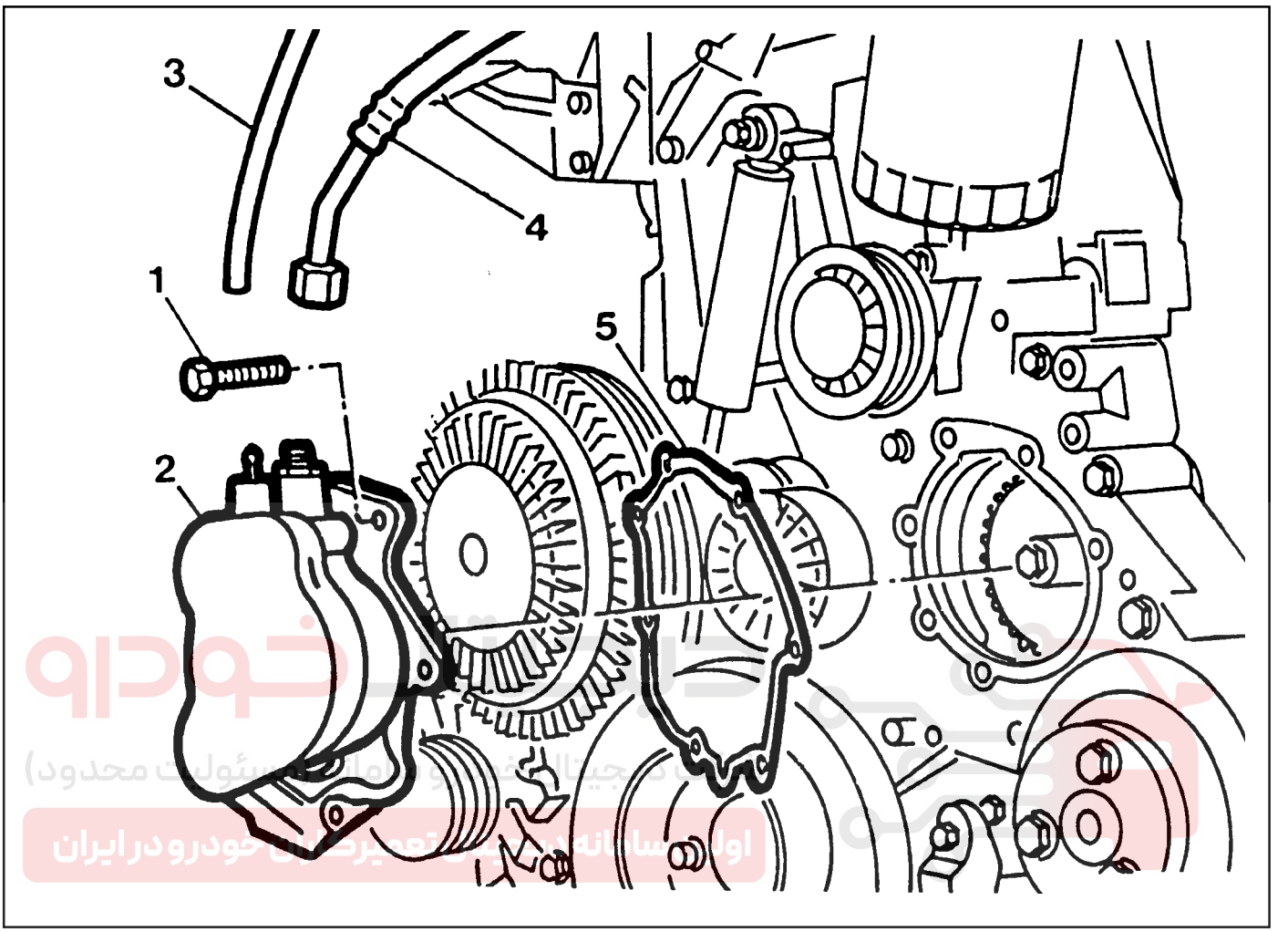
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VACUUM PUMP

Preceding Work : Remove the poly V-belt



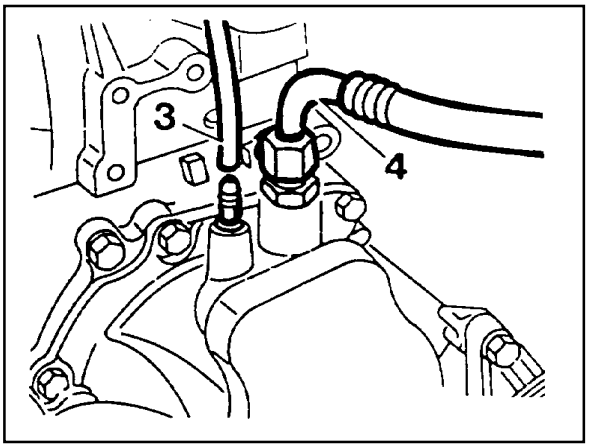
1 Bolt 10Nm
2 Vacuum Pump
3 Vacuum Line (Ancillaries)
4 Vacuum Line (Brake Booster)
5 Gasket ..... Replace

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Removal & Installation Procedure

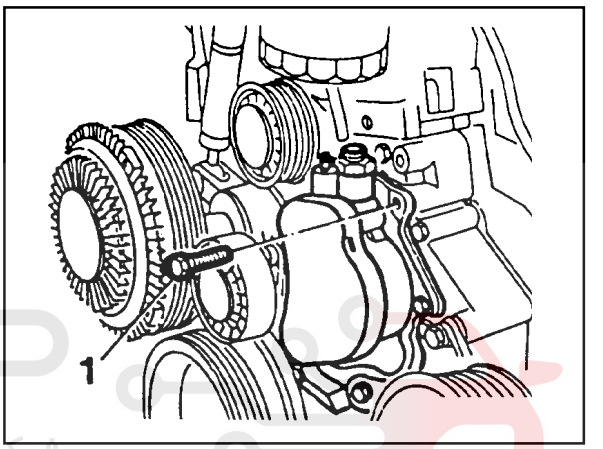
1. Remove the vacuum line (3, 4).



2. Remove the bolts (1) evenly.

   Notice

   If necessary, rotate the engine until the pressure on the tappet of the vacuum pump is released.



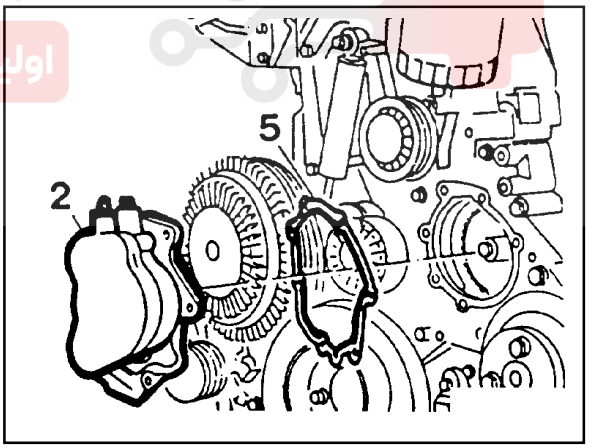
3. Remove the vacuum pump (2).
4. Install the vacuum pump (2).

Tightening Torque	10 Nm

   Notice

   Clean the gasket residues of sealing surface of vacuum pump and replace the gasket(5).

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

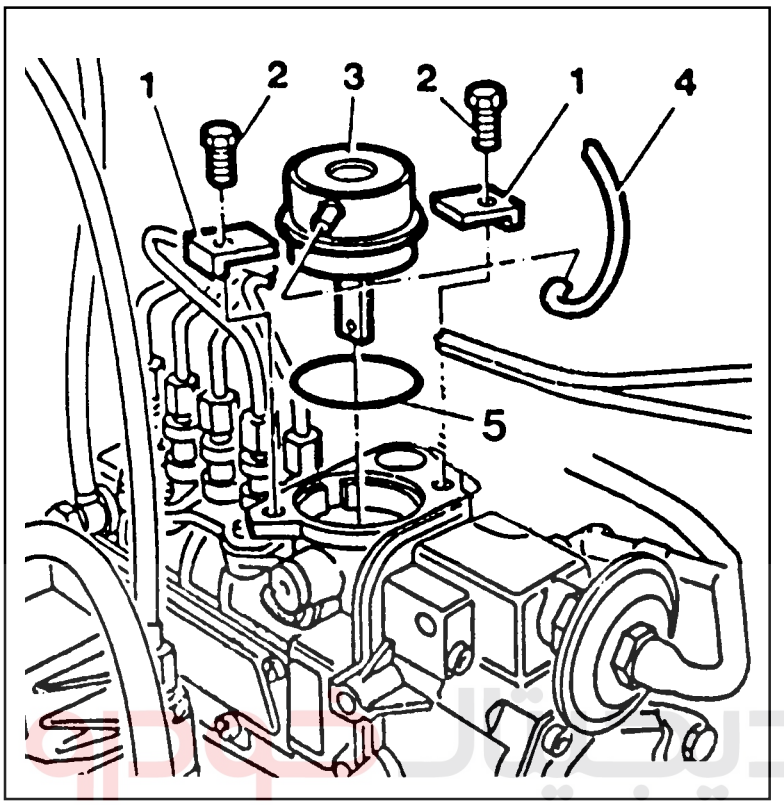


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VACUUM UNIT REPLACEMENT



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

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IDLE SPEED ADJUSTMENT

Service Data

Engine	Idle Speed
OM661LA Engine	750 - 850 rpm
OM662LA Engine	720 - 820 rpm

Tools Required

667 589 00 21 00 TDC Pulse Generato

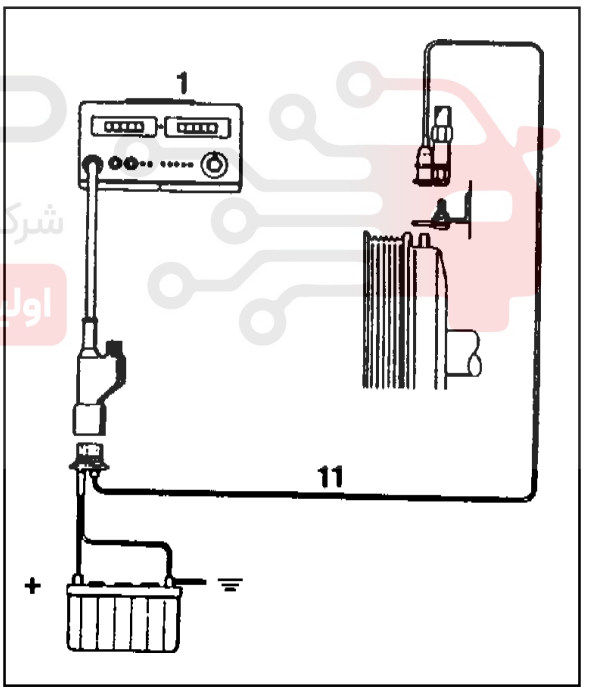
Commercial Tool

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

Adjustment Procedure

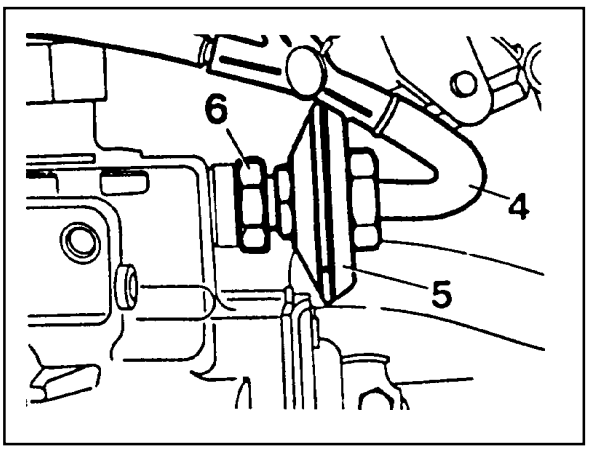
1. Connect the digital tester (1) and TDC pulse sender unit (11).
2. Run the engine and warm up the coolant to 60~80°C.

TDC pulse generator 667 589 02 21 00



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

OM 661LA Engine	750 - 850rpm
OM 662LA Engine	720 - 820rpm



Notice

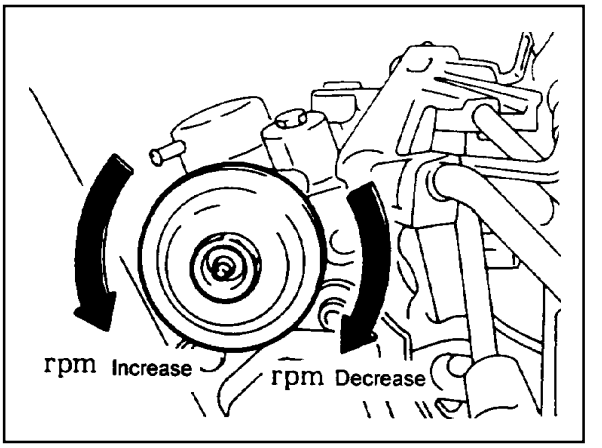
To adjust idle speed, loosen the locking nut (6) of PLA unit.

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5. Ensure 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



Notice

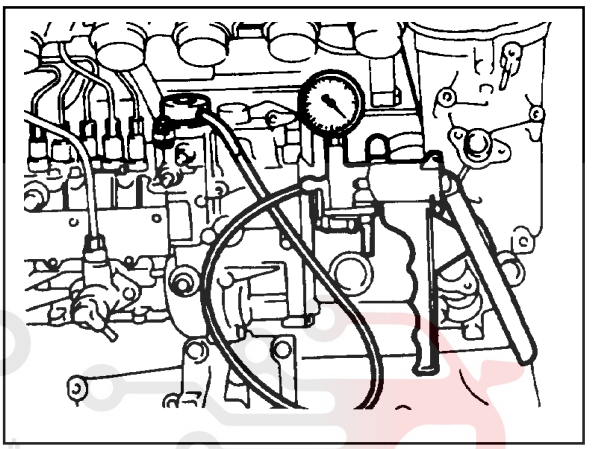
Do not rotate the PLA unit over ½ turn from the position marking. If do, idle spring in the governor will be severely damaged.

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

Notice

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

7. 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

8. Connect the vacuum line (4).
9. Switch on all ancillaries and check the idle speed.

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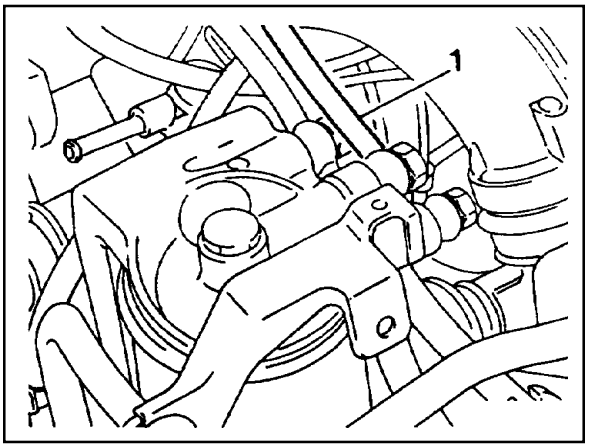
FUEL PUMP TEST

Notice

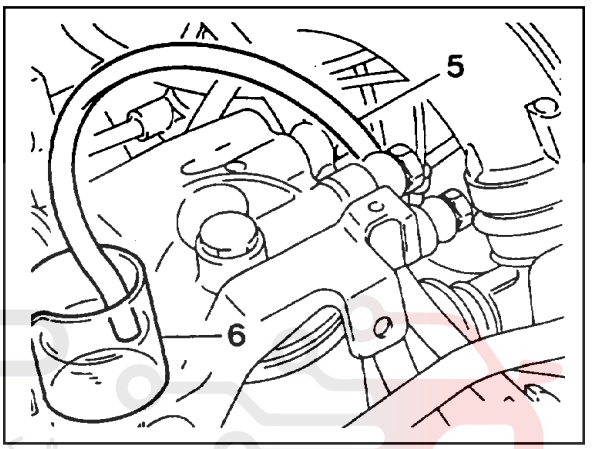
Before test, replace the fuel filter cartridge and fuel prefilter.

Fuel Feed Test

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

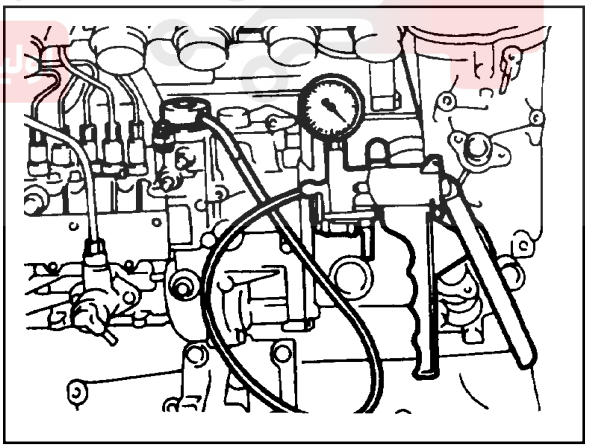


2. Insert the plastic hose (5) and put the end into the measuring beaker (6).



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.

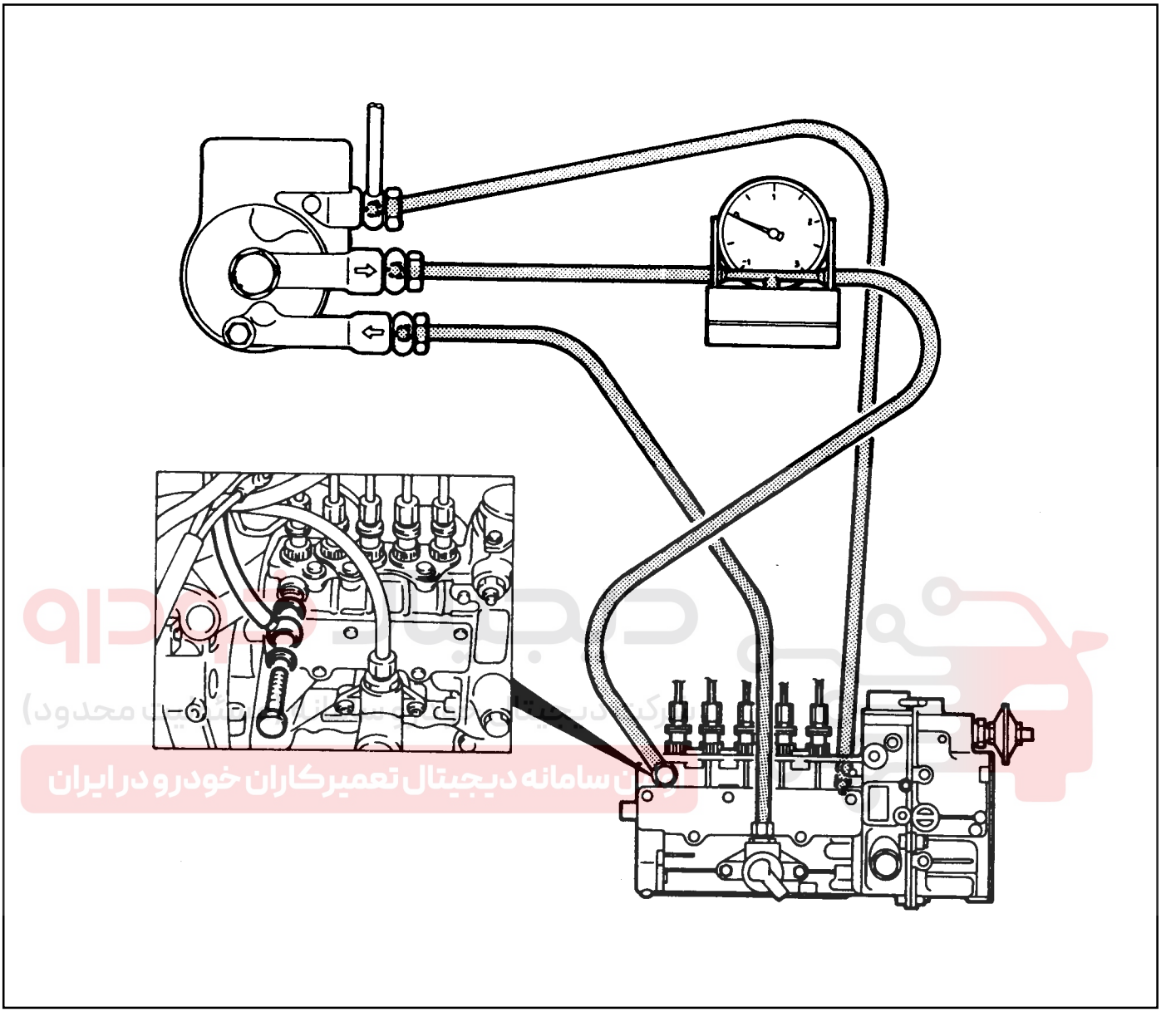
Min. volume	150cm^3 for 30 seconds



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Fuel Pressure Test



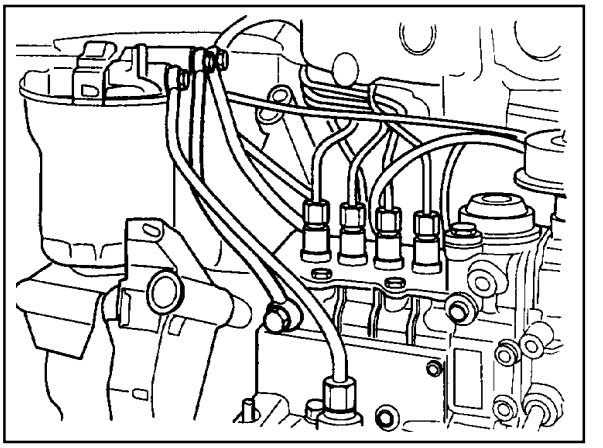
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Tools Required

617 589 04 21 00 Tester

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).



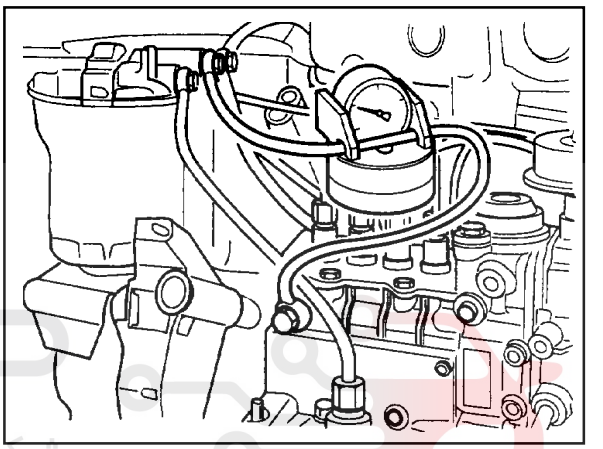
4. Start the engine and read off the fuel pressure on tester (5).

Notice

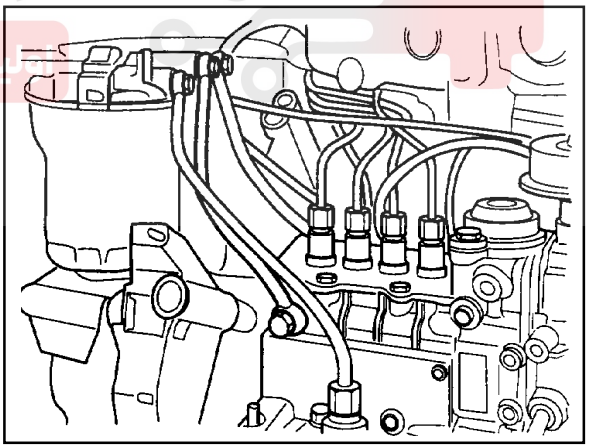
At Idle Speed	> 0.3bar
At Full load	> 0.5bar

If out of standard, replace the fuel feed pump.

Tester 617 589 04 21 00



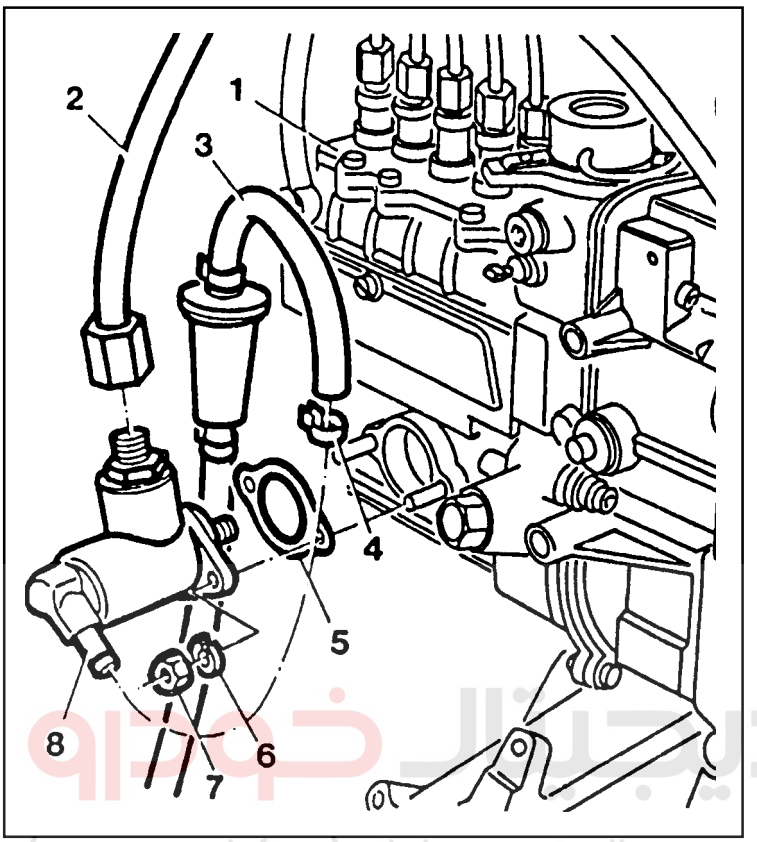
5. Stop the engine.
6. Remove the tester.
7. Replace the seal and connect the fuel line (2).



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FUEL PUMP



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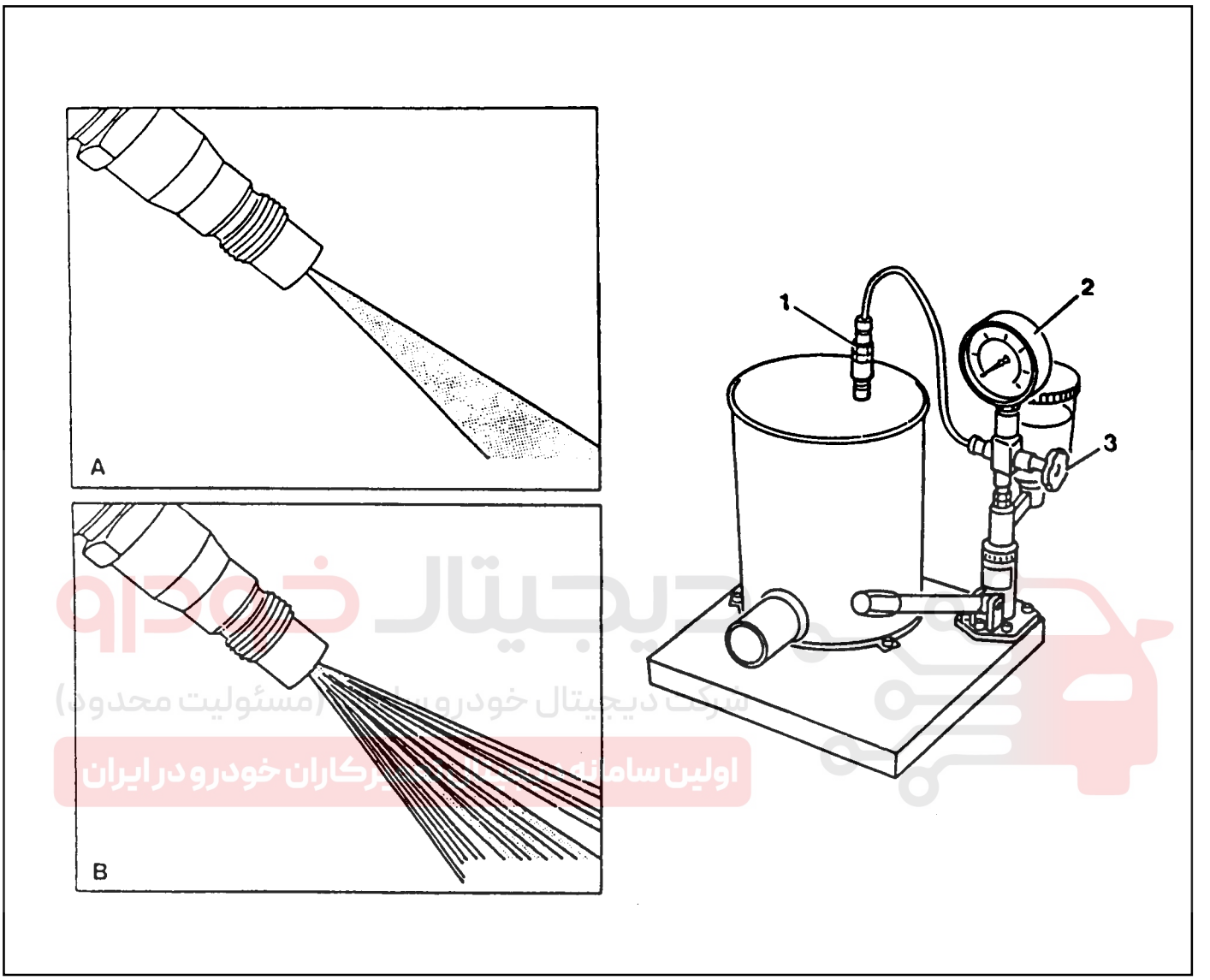
1 Fuel Injection Pump
2 Pressure Line 13Nm
3 Suction Line
4 Hose Clip ..... Replace
5 Gasket ..... Replace
6 Spring Lock Washer
7 Hexagon Nuts
8 Fuel Pump

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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

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Tools Required

000 589 14 27 00 Tester

Notice

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 :

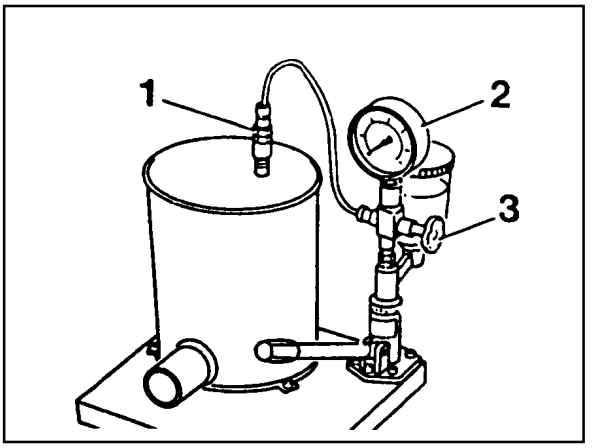
   Slowly operate the hand lever at tester (approx. 1 stroke per second). The nozzle must spray with a gentle chattering.

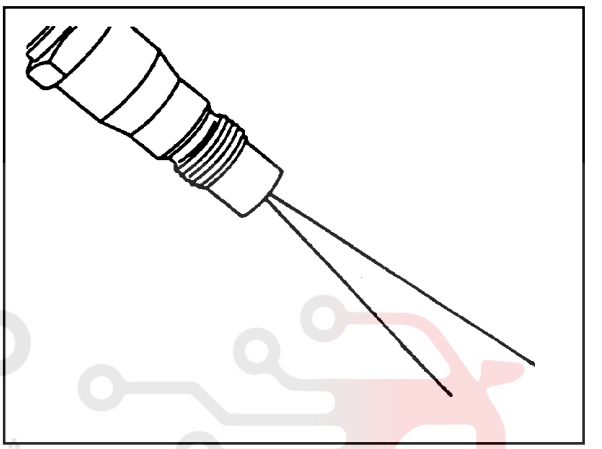
4. Spray pattern test :

   Operate the hand lever at tester rapidly (approx. 2~3 strokes per second).

   - Good

     The spray pattern shows closed and well atomized.



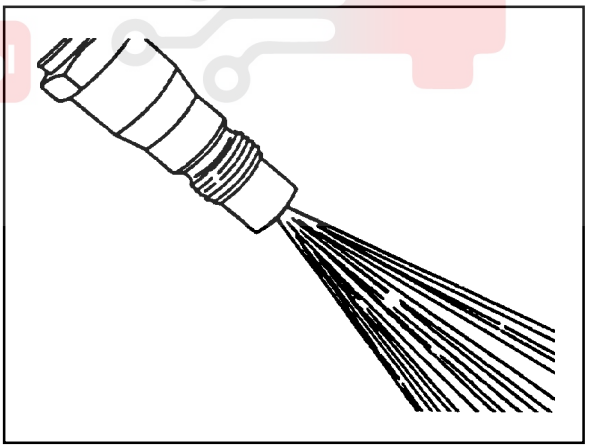


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   - Poor

     The spray pattern shows split, too wide and stringy.

     (Repair the fuel injection nozzle)



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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

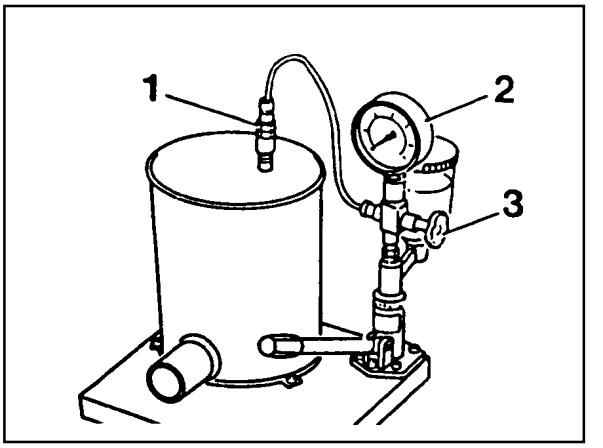
   Notice

   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.

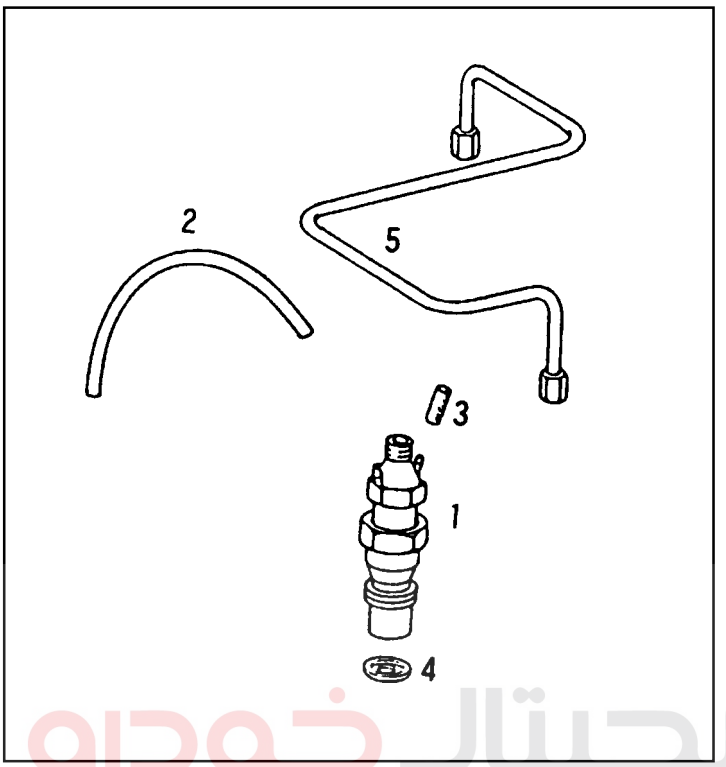


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INJECTION NOZZLES



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

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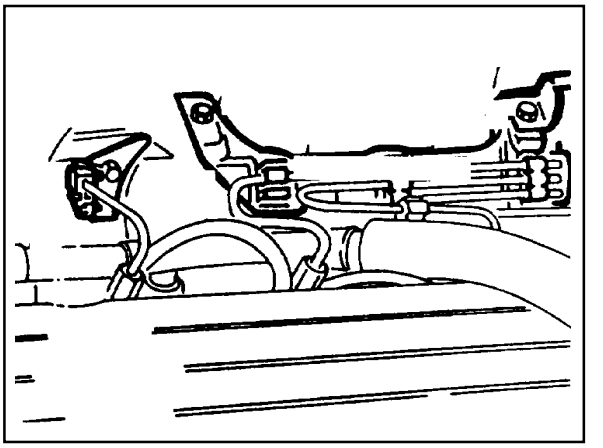
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Tools Required

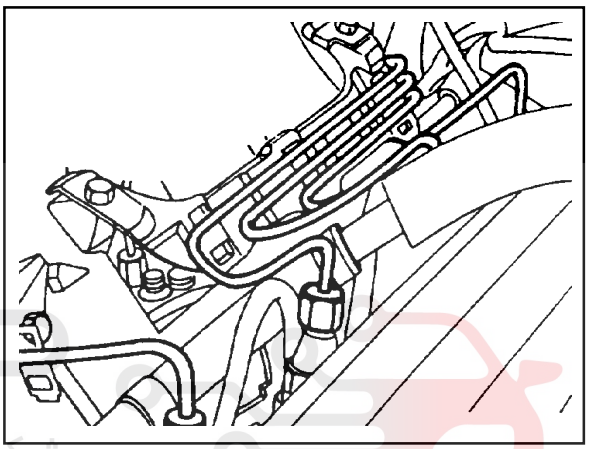
001 589 65 09 00 Serration Wrench

Removal & Installation Procedure

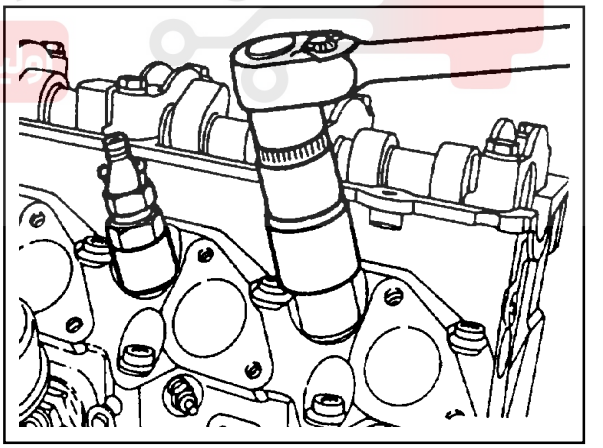
1. Remove the plastic clip from the injection pipe
2. Remove the fuel return hose.



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

Notice

Replace the washers.

5. Installation should follow the removal procedure in the reverse order.

Notice

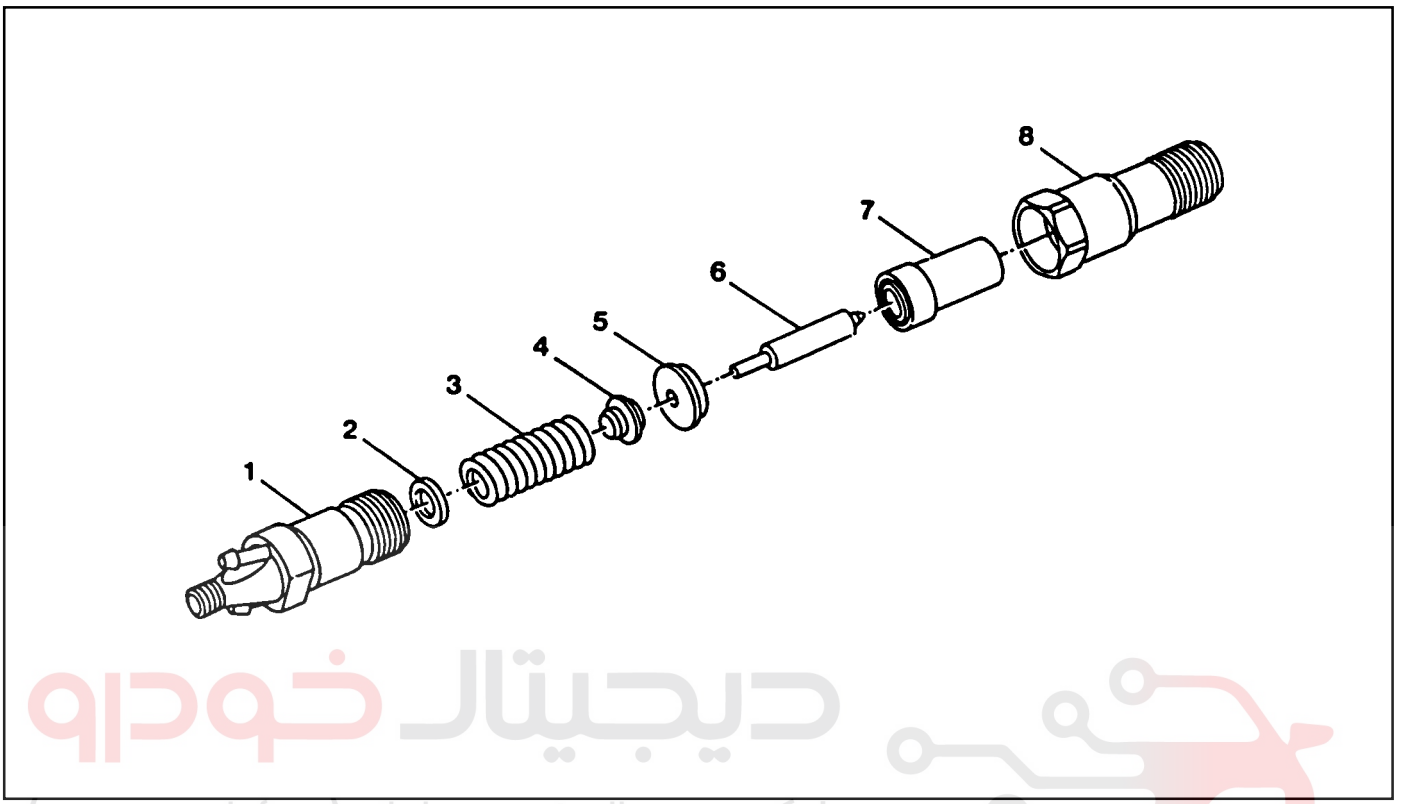
Pay attention to the installation position of new nozzle washer and tightening torque

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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

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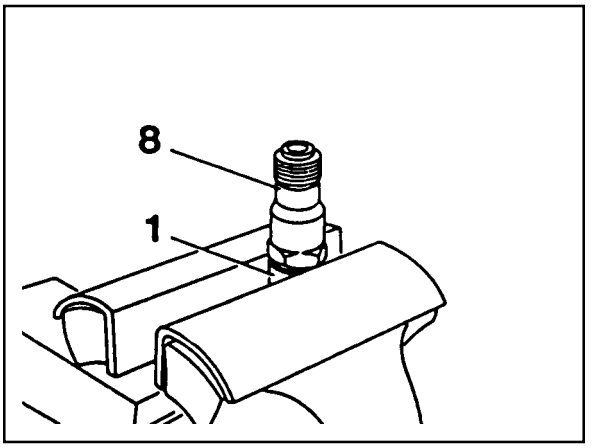
Tools Required

001 589 65 09 00 Socket Wrench Insert

000 589 00 68 00 Cleaning Set

Repair Procedure

1. Clamp the nozzle holder (1) in a vice and remove the nozzle tensioning nut (8).



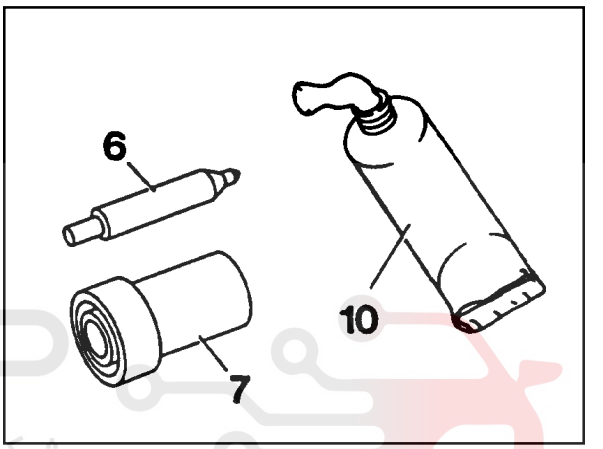
Notice

Use protective jaws for clamping.

2. Disassemble the fuel injection nozzle.

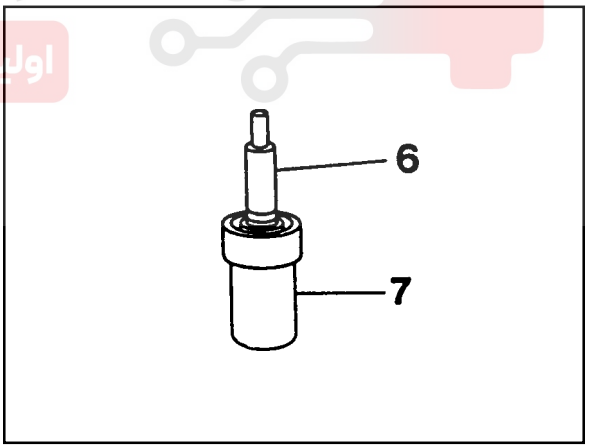
Socket Wrench Insert 001 589 65 09 00

3. Clean the nozzle needle (6) and nozzle body (7) with an abradant.
4. Clean the nozzle seat with cleaning cutter.



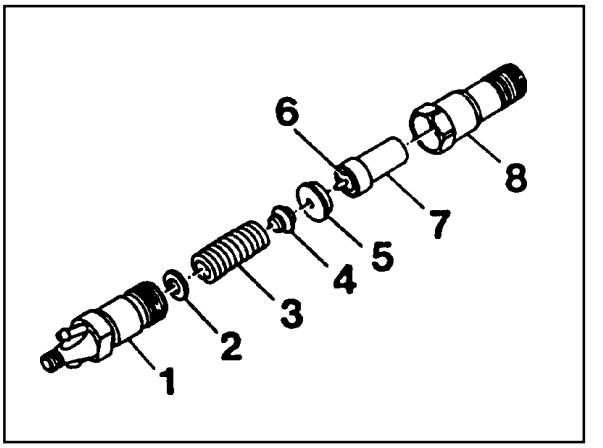
Cleaning Set 000 589 00 68 00

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	80 Nm



Notice

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

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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).

Notice

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

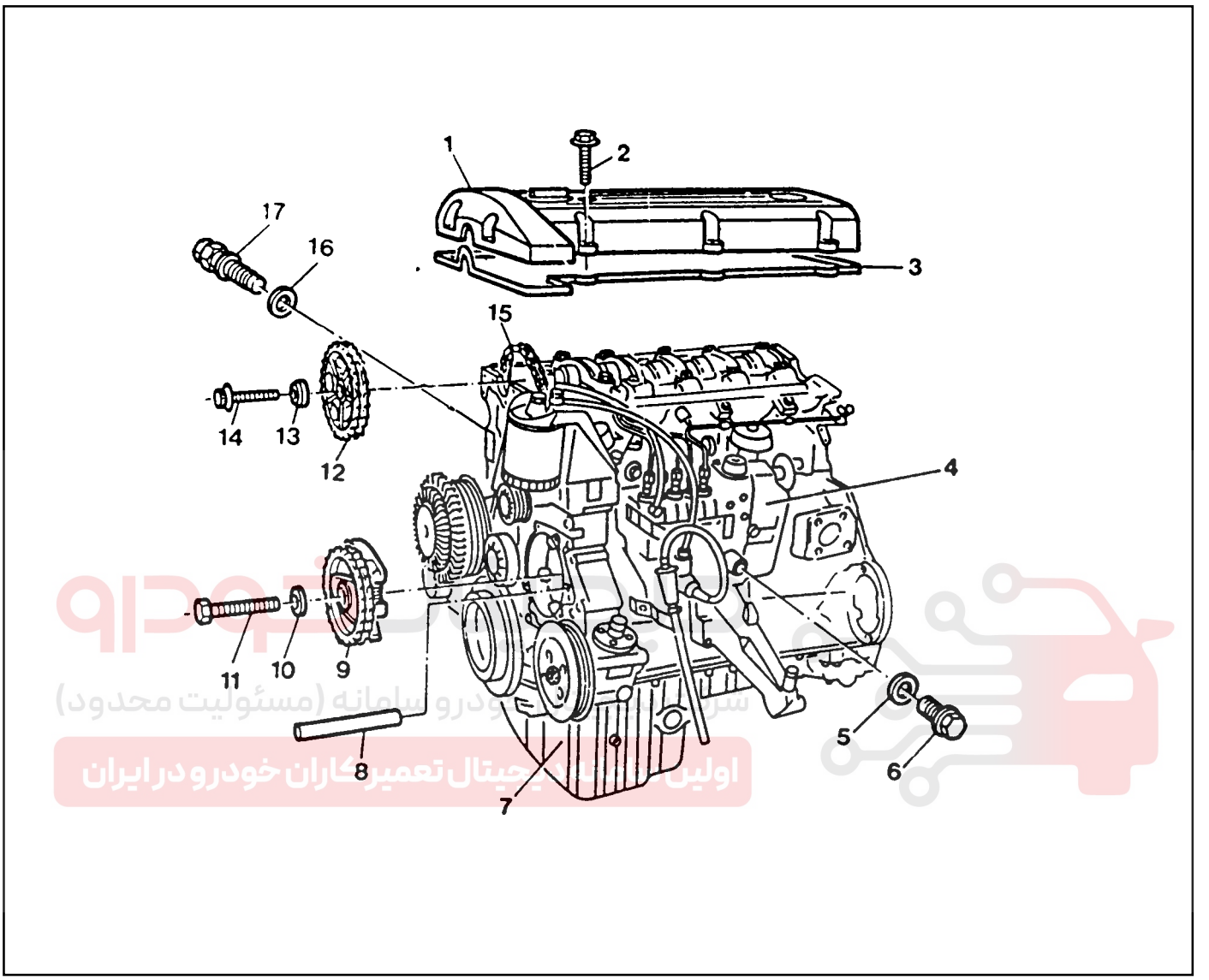
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REMOVAL AND INSTALLATION OF INJECTION TIMING DEVICE

Preceding Work : Removal of vacuum pump



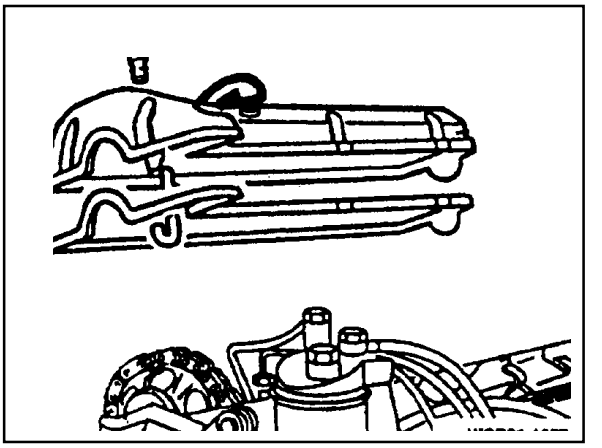
1 Cylinder Head Cover
2 Bolt 10Nm
3 Gasket ..... Replace
4 Fuel Injection Pump
5 Seal ..... Replace
6 Screw Plug 30Nm
7 Oil Pan
8 Locking Pin
9 Injection Timing Device
10 Washer
11 Bolt (Left-Hand Thread) 46Nm
12 Camshaft Sprocket
13 Washer
14 12-Sided Stretch Bolt ..... Check, 25Nm + 90°
15 Timing Chain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

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Tools Required

601 589 00 08 00 Flange
601 589 05 21 00 Locking Screw
116 589 20 33 00 Sliding Hammer
116 589 02 34 00 Threaded Bolt
667 589 04 63 00 Retaining Plate



Removal & Installation Procedure

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

Installation Notice

Tightening Torque	10 Nm

Notice

Replace the gasket.

Rotate the engine 1 revolution by hand and check TDC marking of the crankshaft and camshaft.

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2. Loosen the camshaft sprocket bolt (14).

Notice

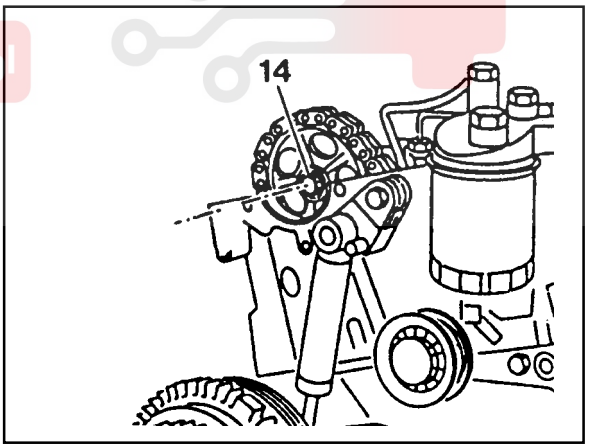
Do not remove the bolt.

Installation Notice

Tightening Torque	25Nm + 90°

Notice

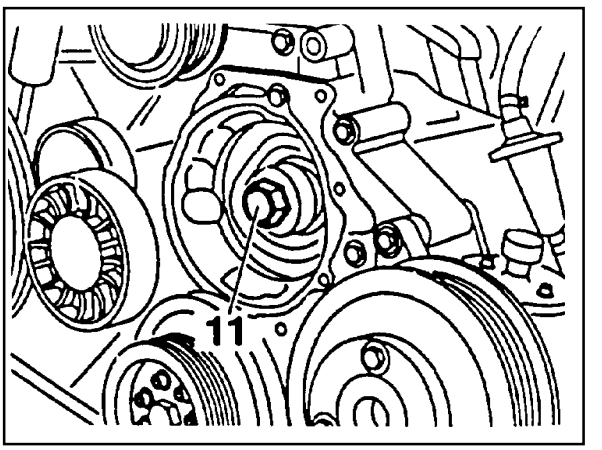
If max. length of bolt exceeds 53.6mm, replace it.



3. Loosen the bolt (11) (left-hand thread).

Notice

Do not remove the bolt.



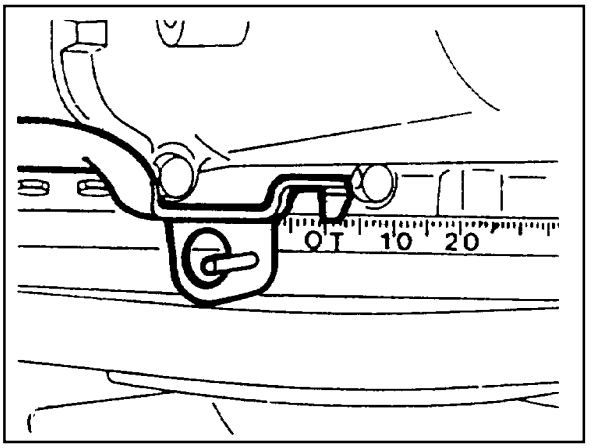
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4. Position the no.1 cylinder at ATDC 15°.

   Notice

   Do not rotate the engine with camshaft sprocket bolt or opposite direction of the engine rotation.



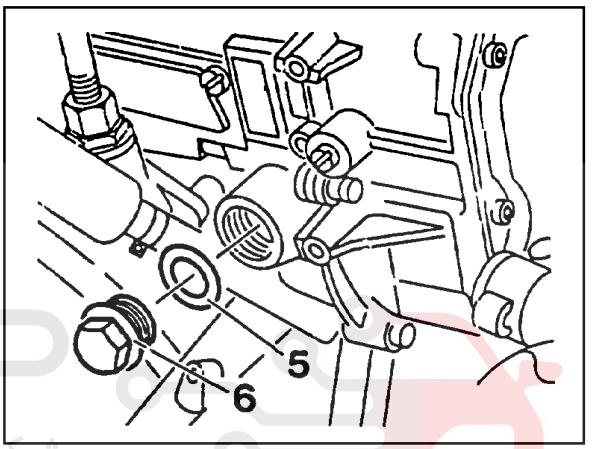
5. Remove the plug (6) and seal (5) from the fuel injection pump and collect oil in a suitable vessel.

   Installation Notice

Tightening Torque	30 Nm

   Notice

   Replace the seal.

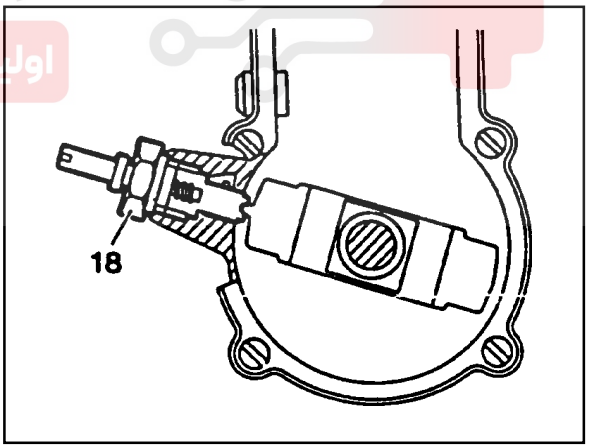


6. Install the locking screw (18) into the injection pump.

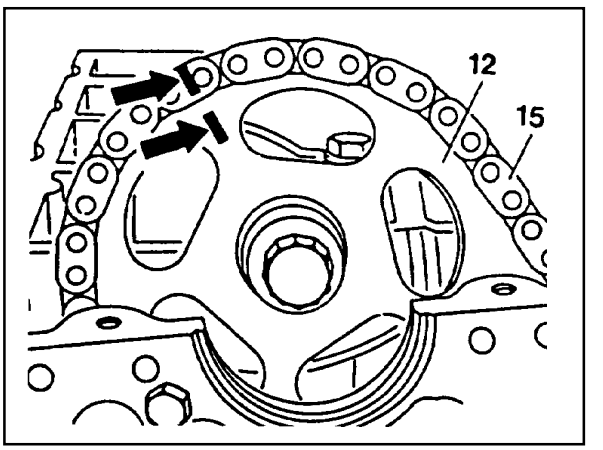
   Notice

   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



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



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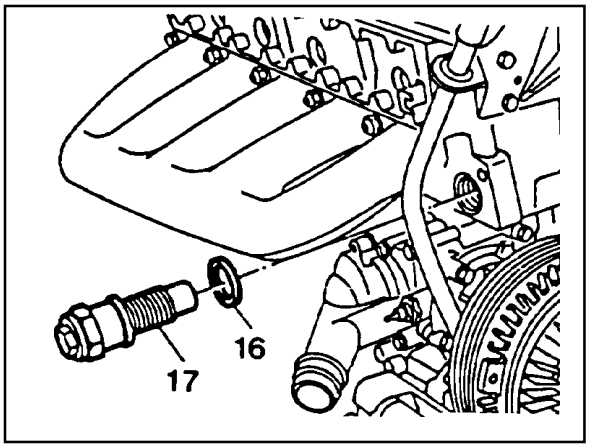
8. Remove the chain tensioner (17).

Installation Notice

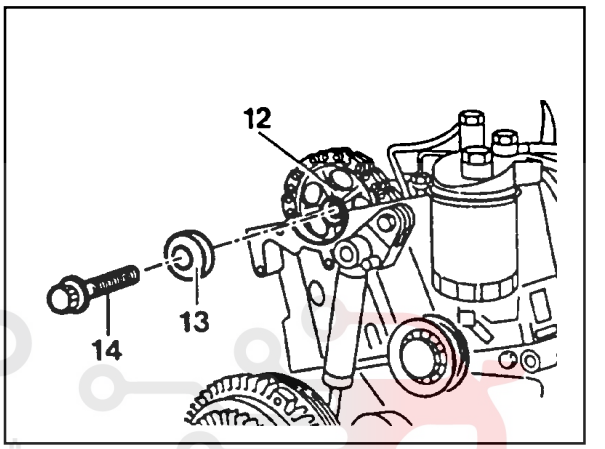
Tightening Torque	80 Nm

Notice

Replace the seal (16).



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



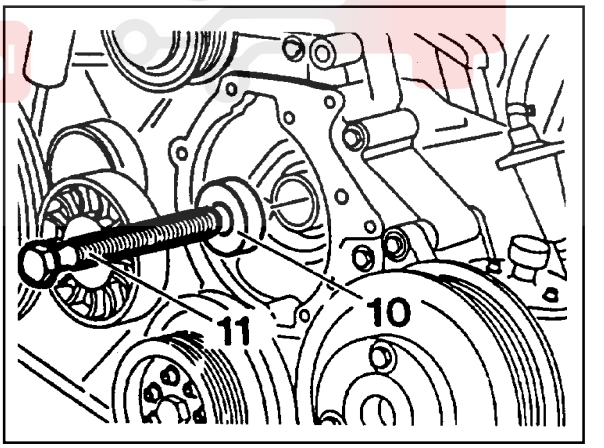
10. Pull out the bolt (11) and washer (10).

Notice

Be careful that the bolt is left-hand thread.

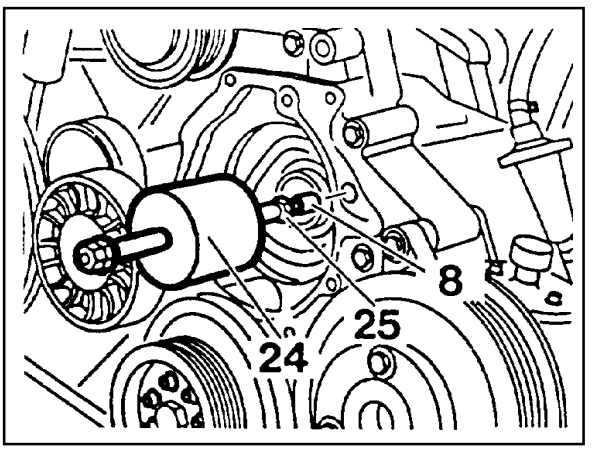
Installation Notice

Tightening Torque	46 Nm



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

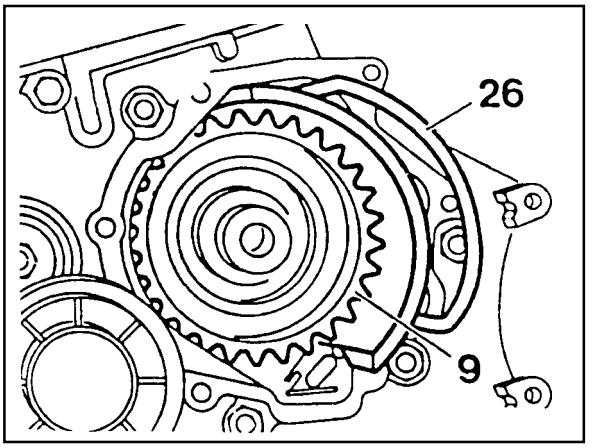


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12. Push back the timing chain with retaining plate (26) and remove the injection timing device (9).

Retaining Plate 667 589 04 63 00



13. Installation should follow the removal procedure in the reverse order.
14. After assembling the engine, check start of delivery and adjust if necessary.

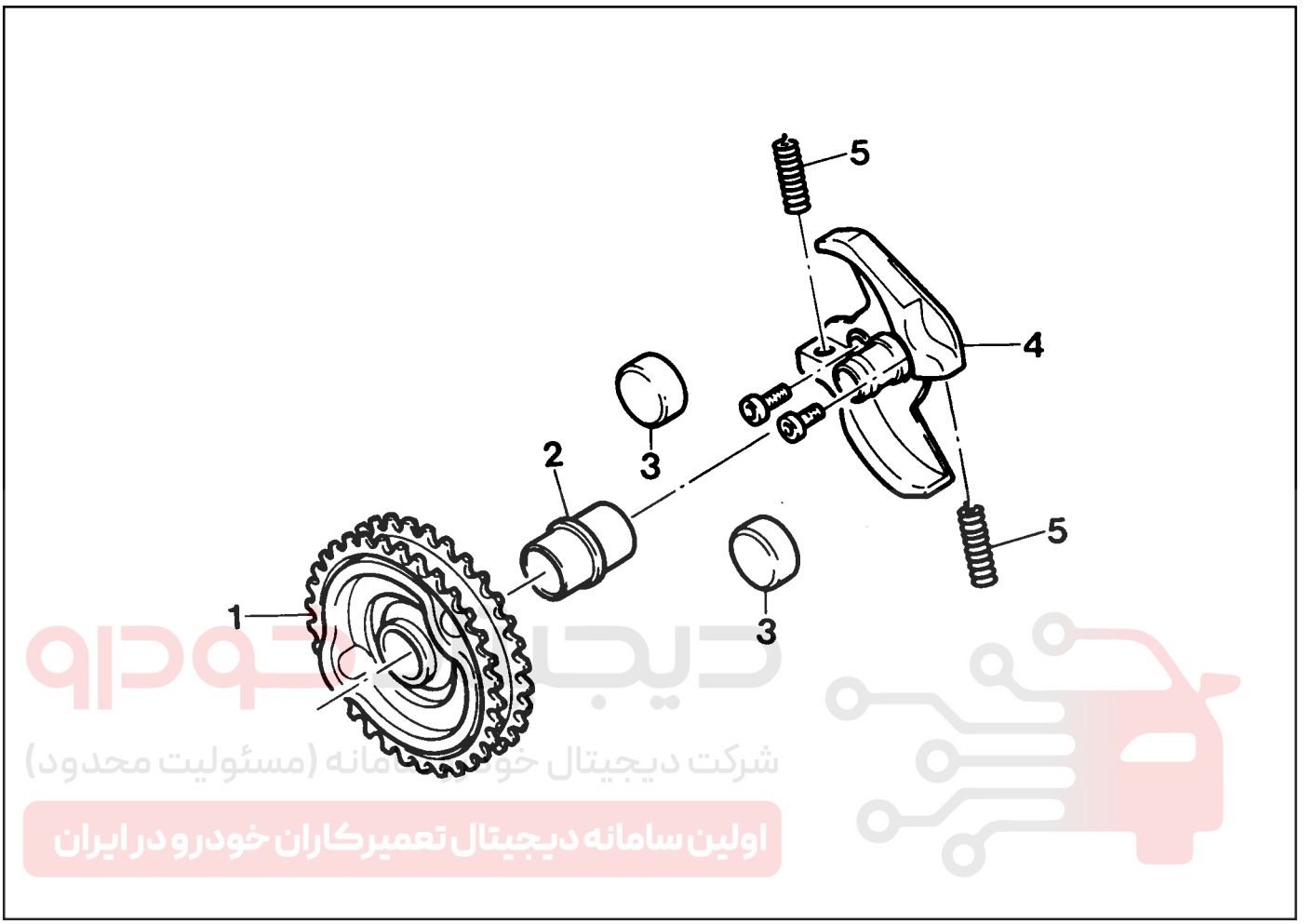
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INJECTION TIMING DEVICE

Preceding Work : Removal of injection timing device



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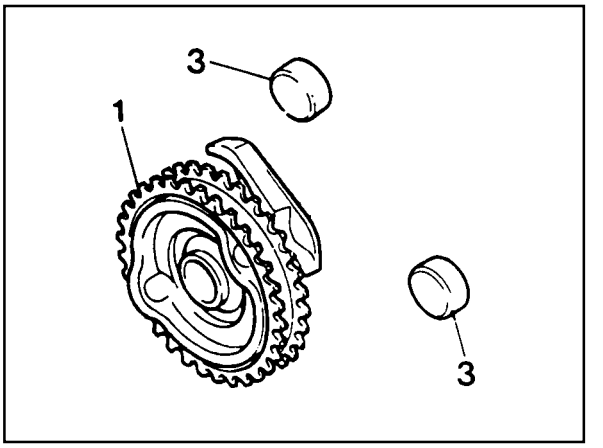
1 Cam Sprocket ..... Check
2 Bushing ..... Check
3 Governor Weights
4 Segment Flange and Drive Hub
5 Compression Springs

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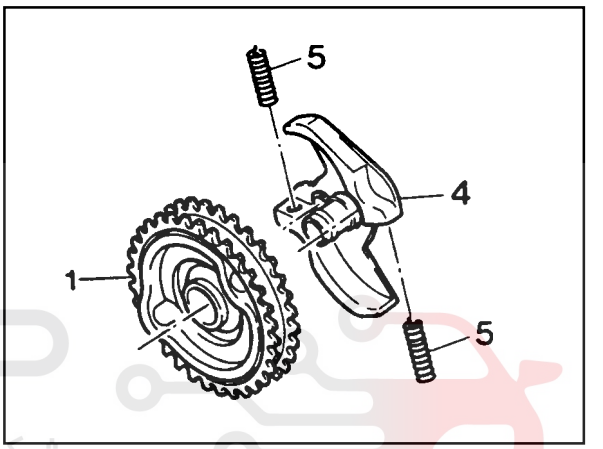
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Disassembly & Assembly

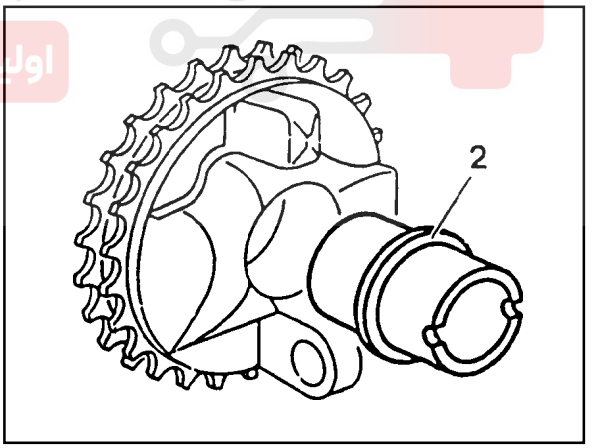
1. Remove the governor weights (3).



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



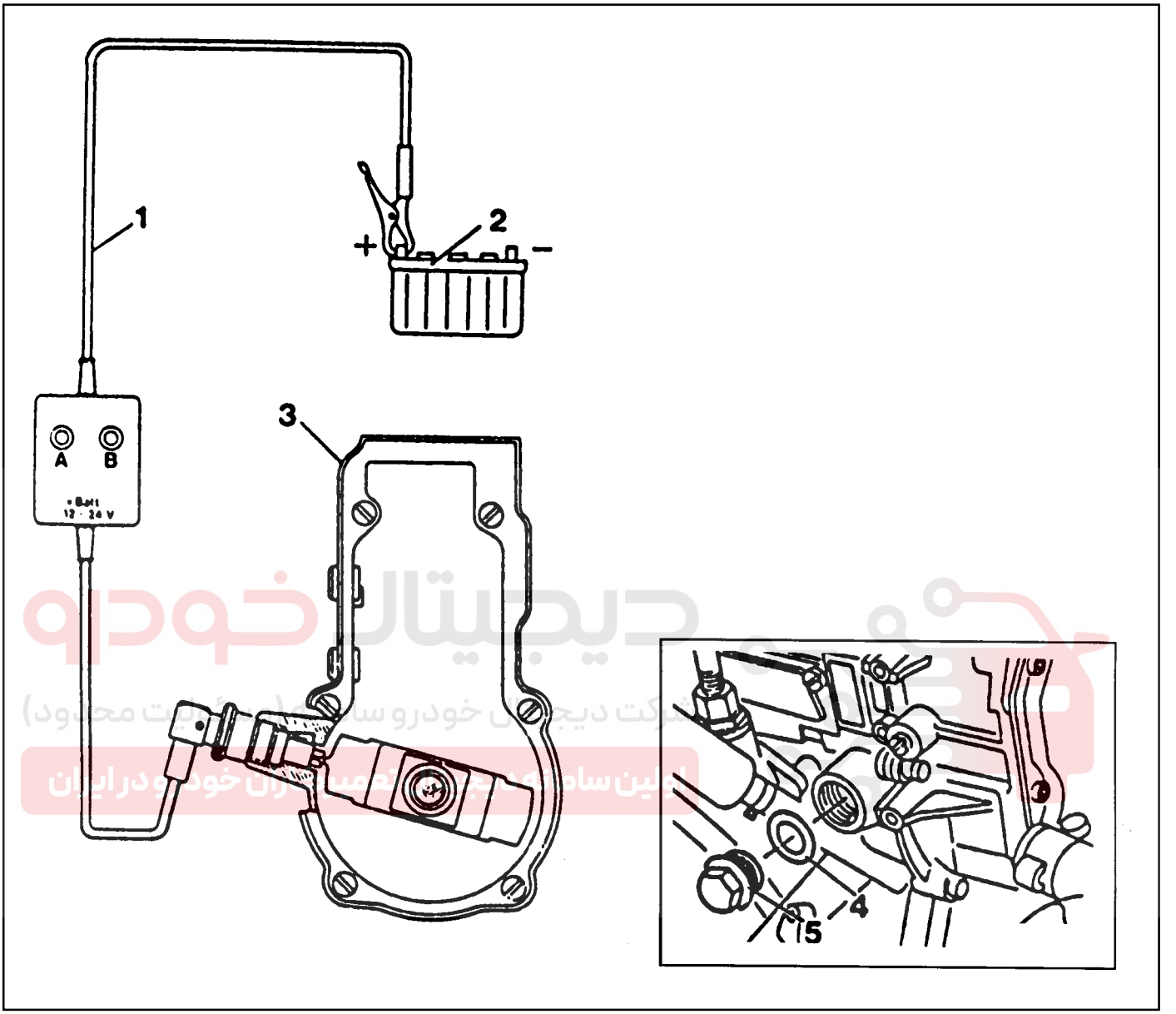
3. Knock out the bushing with a proper drift.
4. Installation should follow the removal procedure in the reverse order.



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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)	ATDC 14° - 16°

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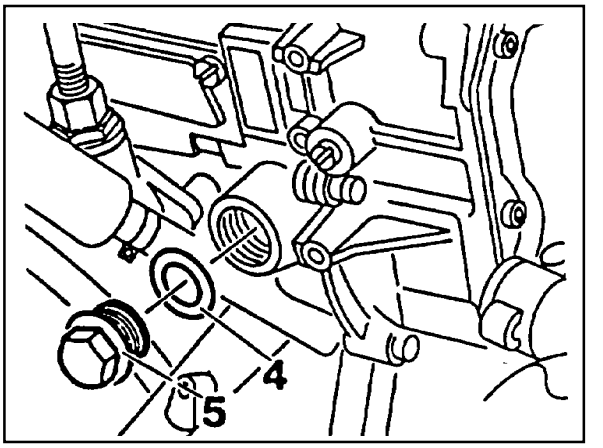
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Tools Required

617 589 08 21 00 Position Sensor

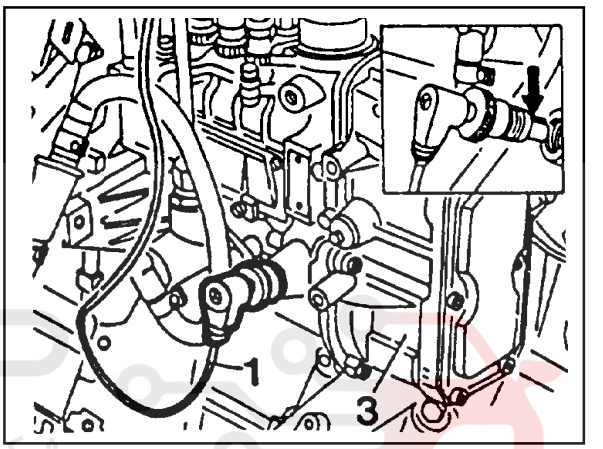
Test Procedure

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

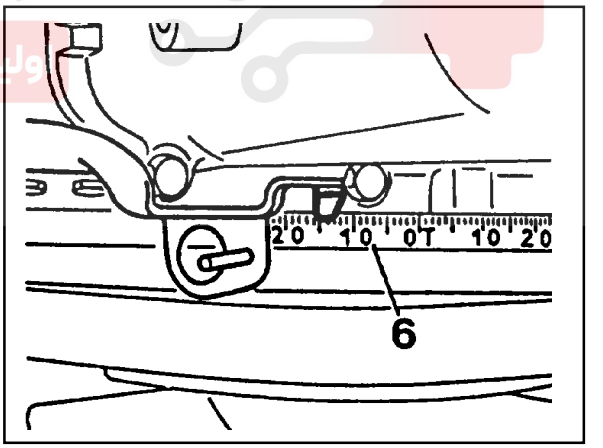


4. Rotate the crankshaft by hand (in direction of engine rotation) until the lamp ‘B’ lights up. Rotate the crankshaft carefully further until both lamps ‘A and B’ come on. In this position, check the RI value on the crankshaft vibration damper.

Specification	ATDC 14° - 16°

Notice

If only lamp ‘A’ lights up, repeat the test and if out of specification, adjust start of delivery.

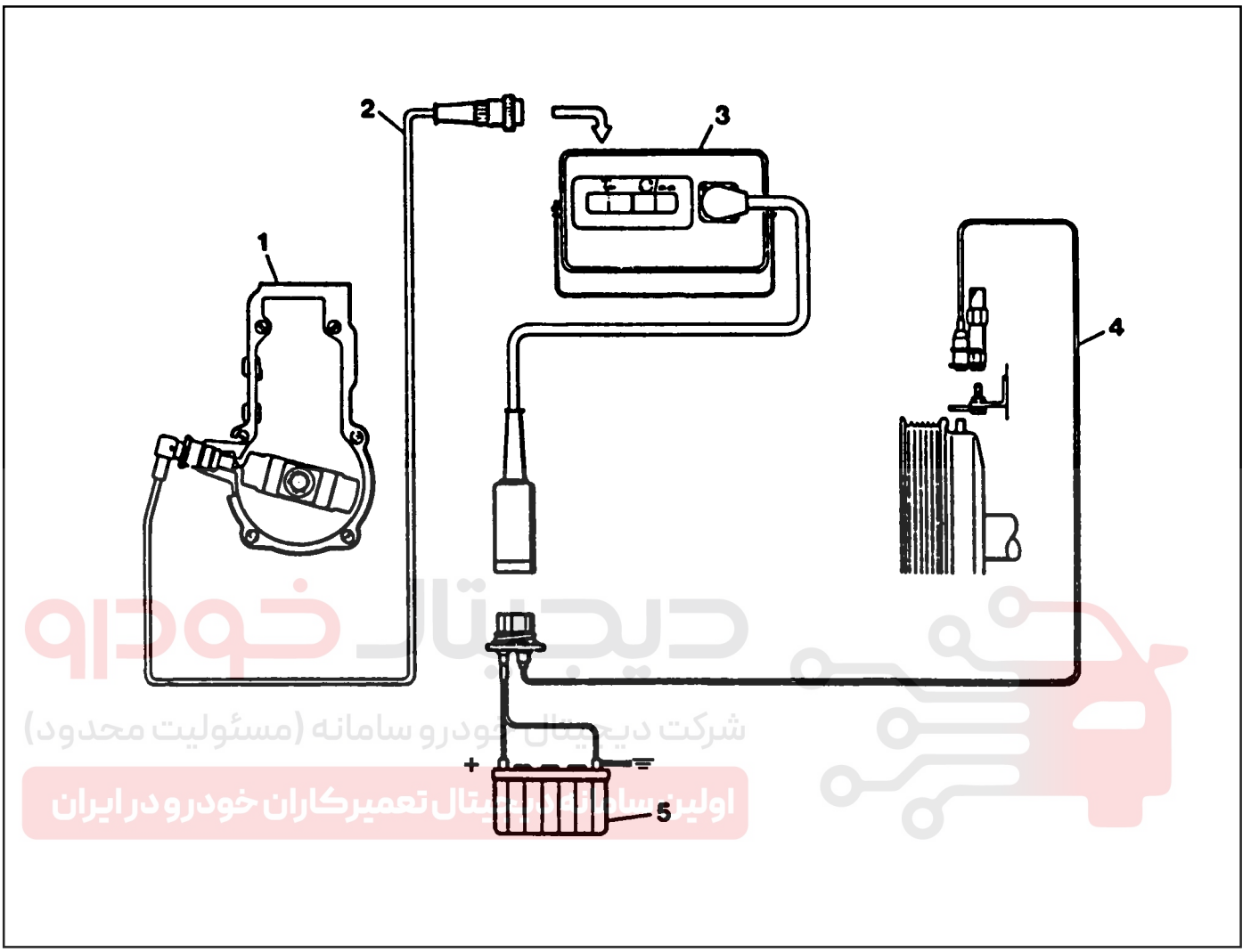


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Digital Tester, RIV Method

(Connection Diagram for Testers Without Adapter)



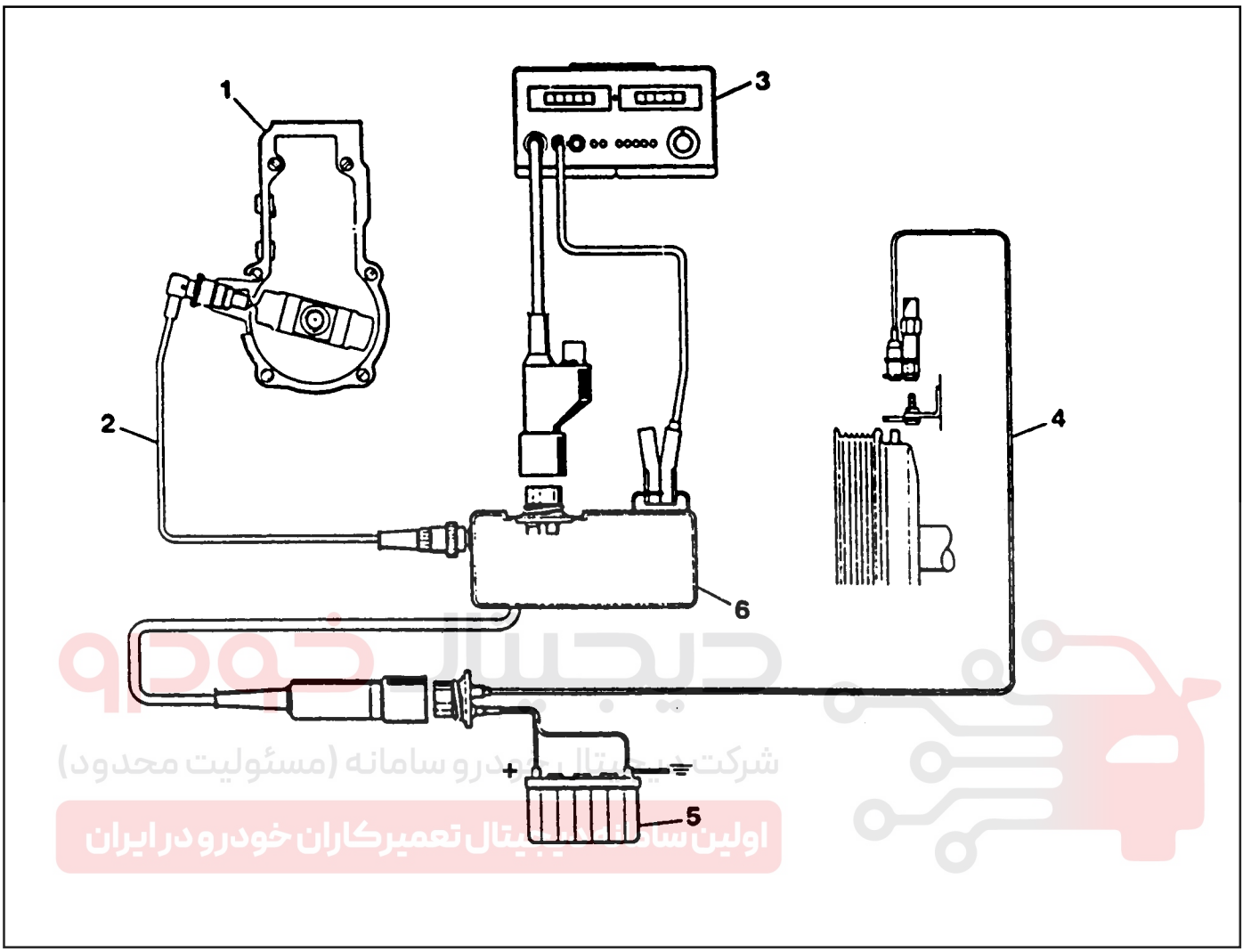
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1 Fuel Injection Pump
2 RI Sensor
3 Digital Tester
4 TDC Pulse Sender Unit
5 Battery

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(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)	ATDC 14° - 16°
Idle Speed	OM661LA : 720 - 820 rpm, OM662LA : 750 - 850 rpm

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Tools Required

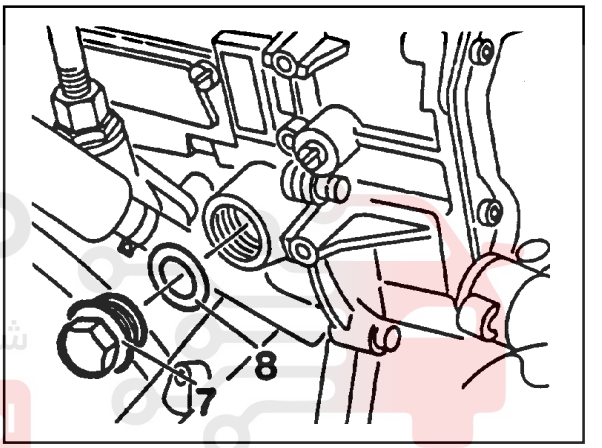
617 589 09 21 00 RI Sensor
617 589 10 21 00 Timing Tester
667 589 00 21 00 TDC Pulse Generator

Commercial Tools

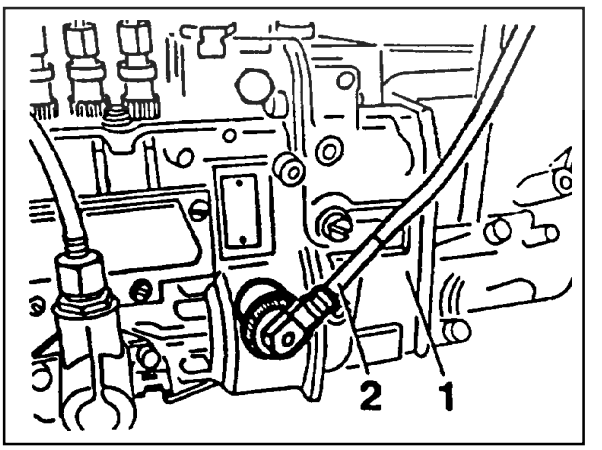
Item		Tools
Digital Tester	With Pulse Generator	Bosch, MOT 001.03
		Hartmann & Braun, EOMT3
	Without Pulse Generator	Bosch, ETD 019.00
		Sun, DIT 9000
		ALV, Diesel - Tester 875

Test Procedure

1. Remove the screw plug (7) and seal (8) 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 14° - 16°

Notice

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.
8. Check engine oil level and adjust if necessary.

Tightening Torque	30 Nm

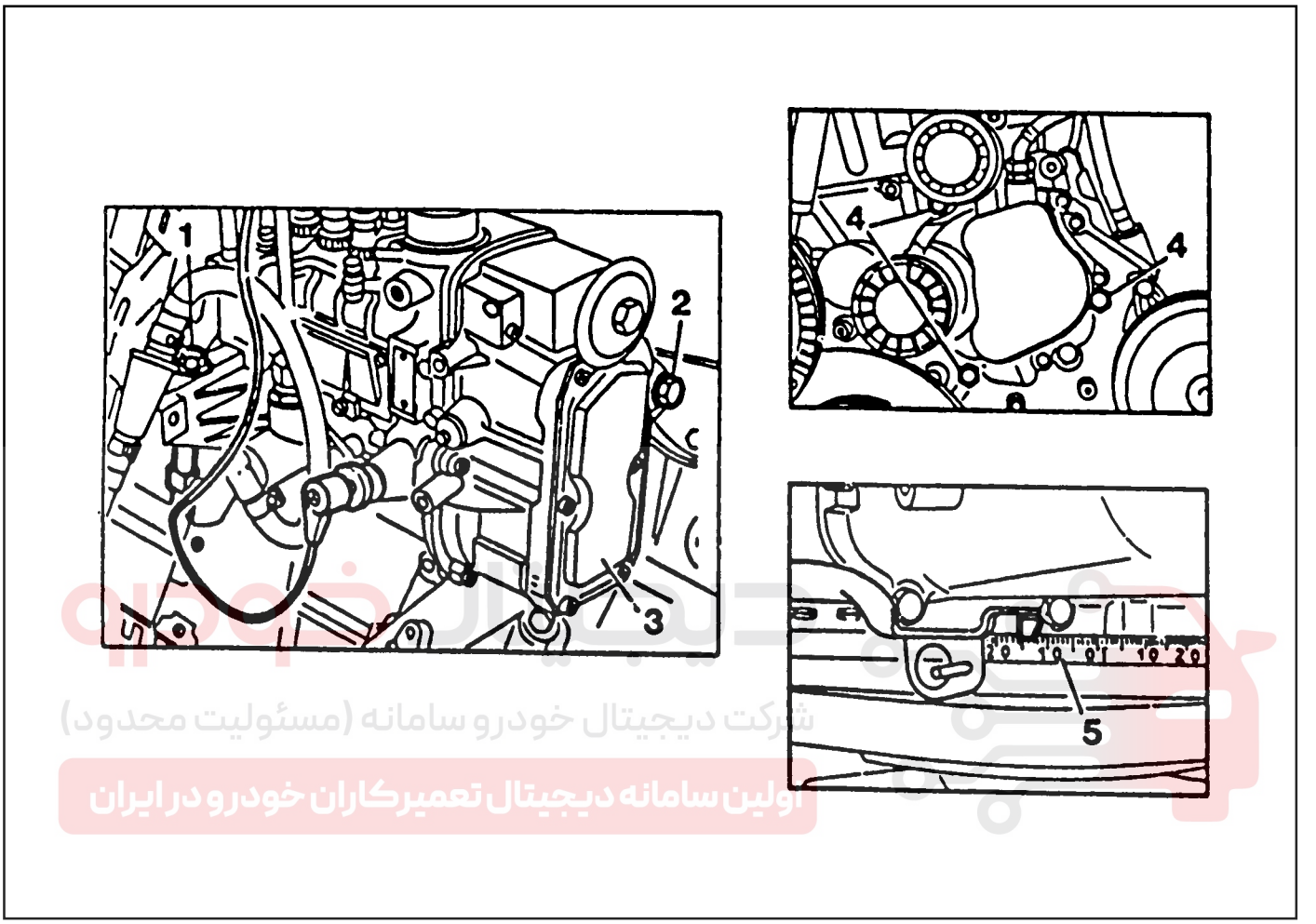
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After Testing

Preceding Work : Start of delivery test

Position Sensor (RIV method)



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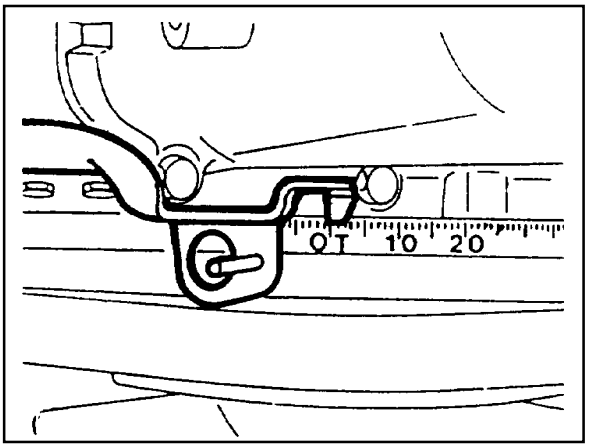
1 Adjusting Screw
2 Bolt 23Nm
3 Fuel Injection Pump
4 Bolt 23Nm
5 Scale ..... RI start of delivery = 14° - 16° ATDC

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Tools Required

617 589 08 21 00 Position Sensor



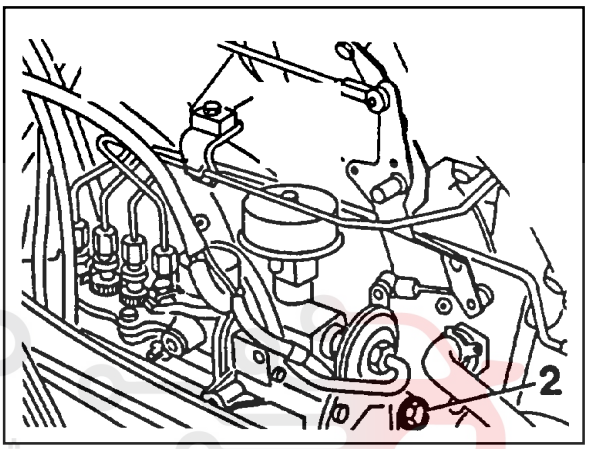
Adjustment Procedure

1. Position the No. 1 cylinder at ATDC 15°

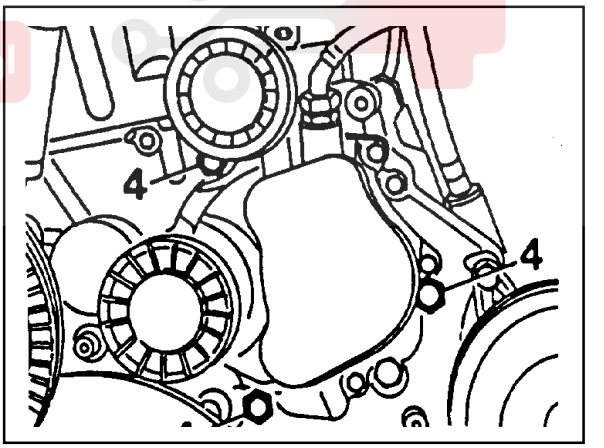
   Notice

   Do not rotate the engine in opposite direction of engine rotation.

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



3. Remove the bolt (4).

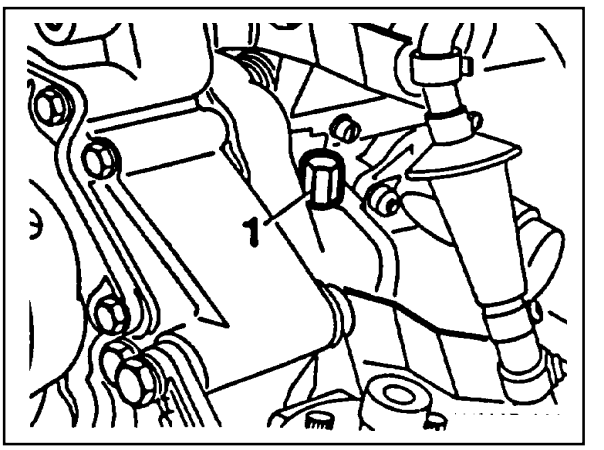


4. Turn the adjusting screw (1) until both lamps ‘A’ + ‘B’ on the position sensor light up.

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

   Notice

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



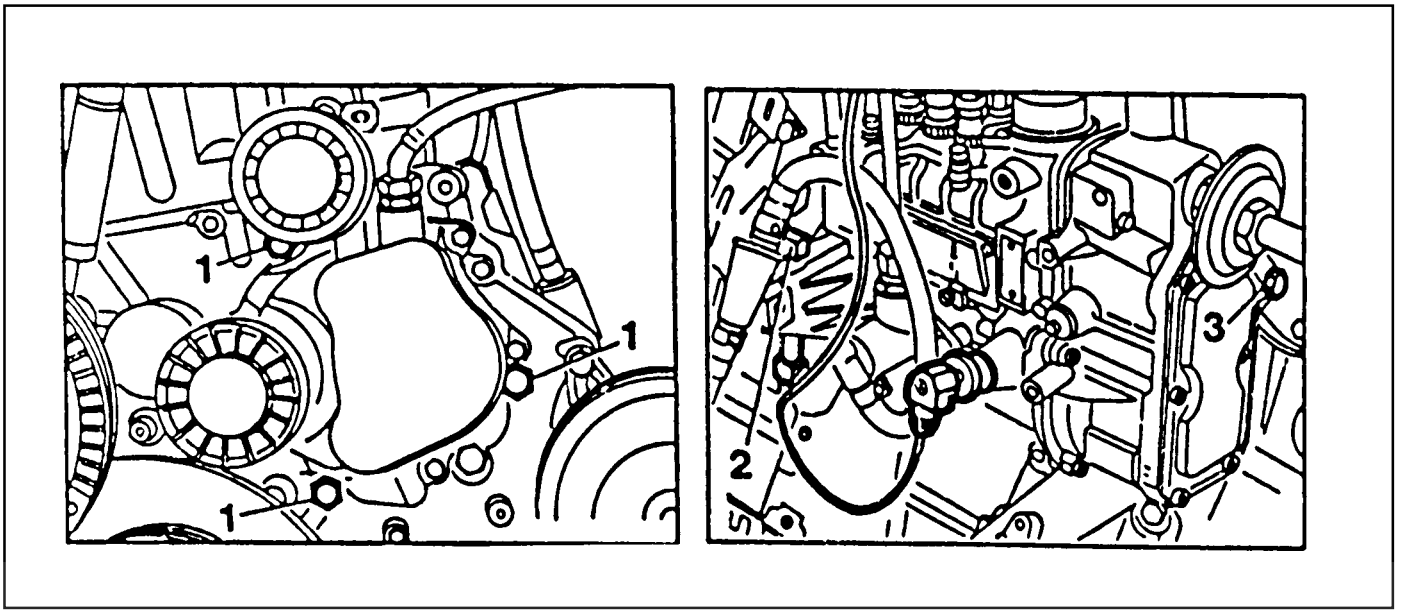
Position Sensor 617 589 08 21 00

5. After adjusting, retighten all the bolt to the specified torque.

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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

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Service Data

Start of Delivery (RIV)	ATDC 14° - 16°
Ldling Speed	OM661LA : 720 - 820 rpm, OM662LA : 750 - 850 rpm

Tools Required

617 589 09 21 00 Rl Sensor
617 589 10 21 00 Timing Tester
667 589 00 21 00 TDC Pulse Generator

Commercial Tools

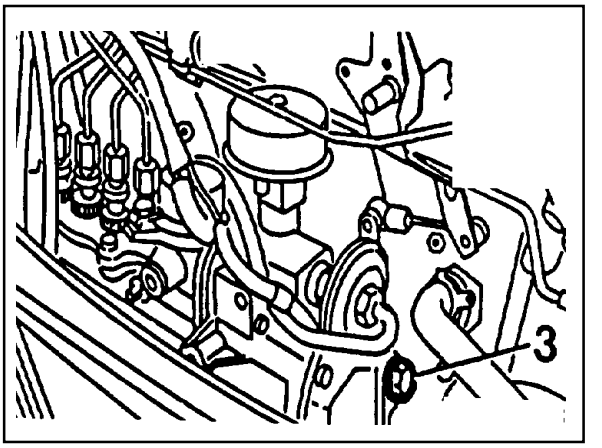
Item		Tools
Digital Tester	With Pulse Generator	Bosch, MOT 001.03
		Hartmann & Braun, EOMT3
	Without Pulse Generator	Bosch, ETD 019.00
		Sun, DIT 9000
		ALV, Diesel - Tester 875

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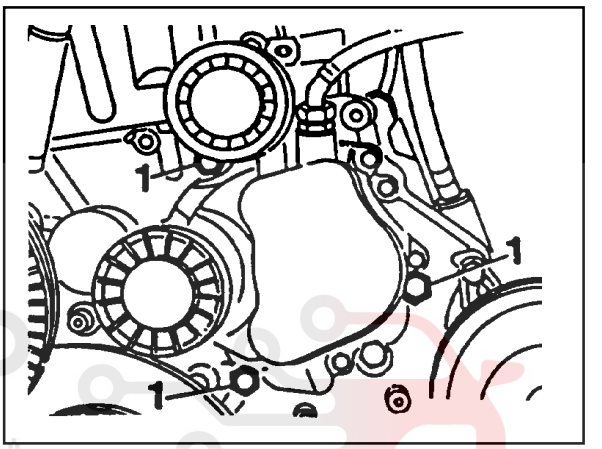
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Adjustment Procedure

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

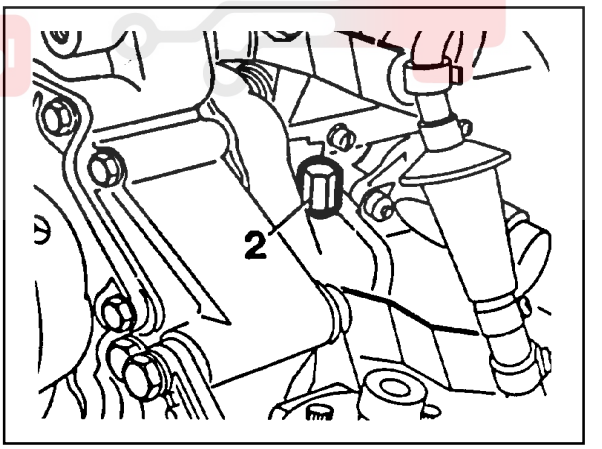


2. remove the bolts (1) at the timing case cover.



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

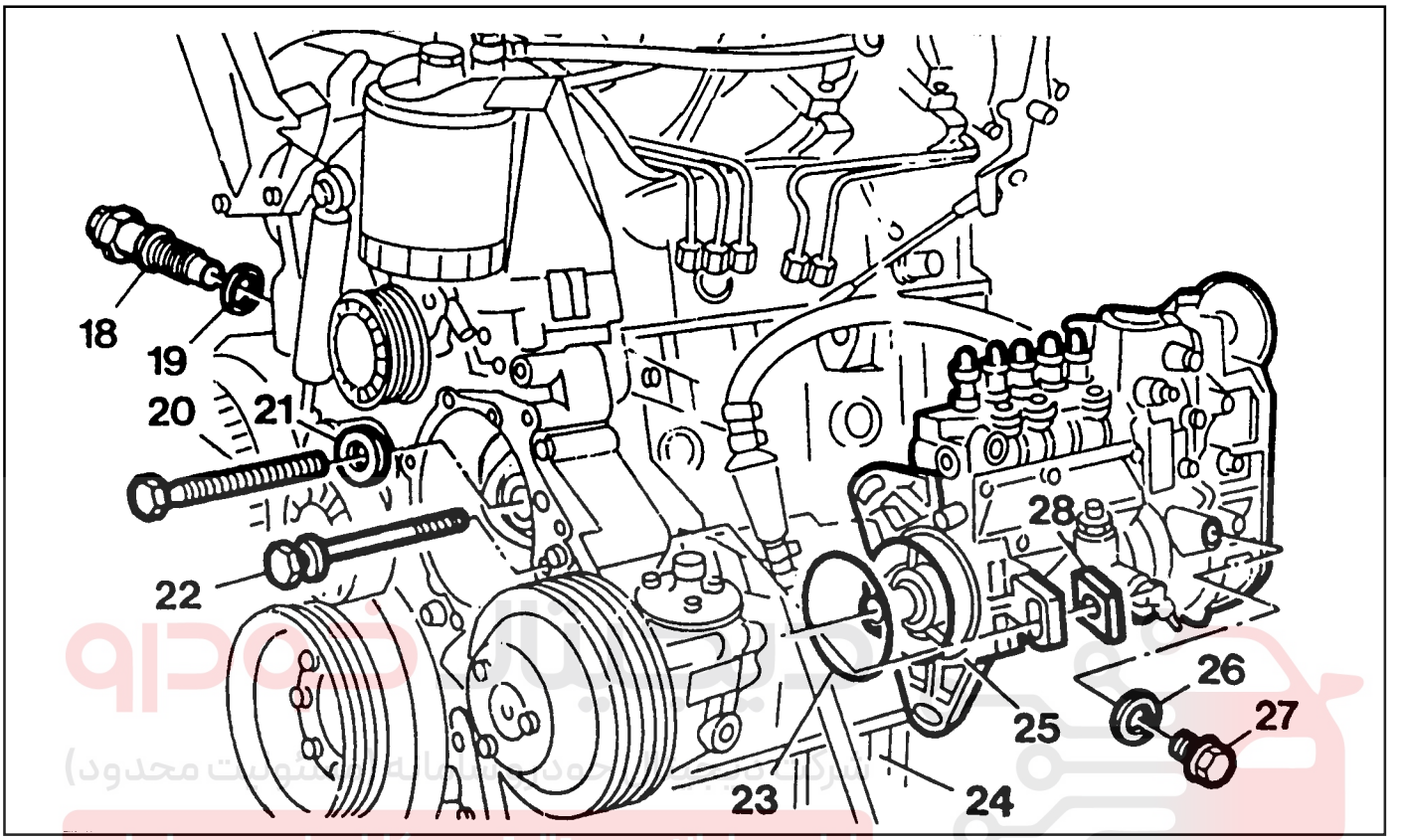


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FUEL INJECTION PUMP

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



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

Tools Required

000 589 77 03 00 Box Wrench Insert
601 589 00 08 00 Flange
601 589 05 21 00 Locking Screw
601 589 05 14 00 Assembly CageRemoval

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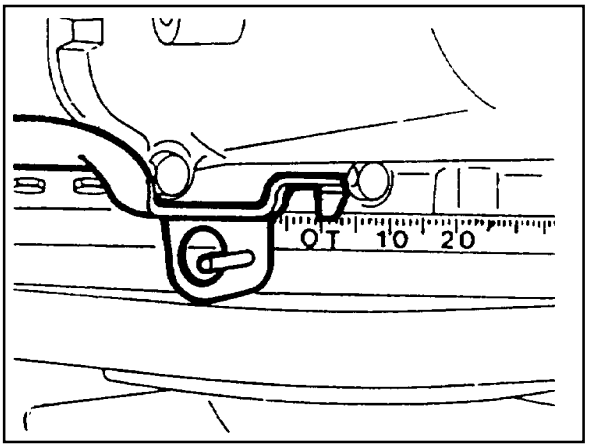
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Removal Procedure

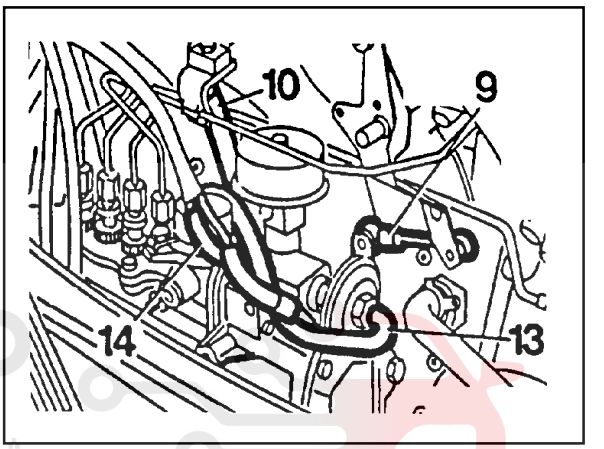
1. Position then no.1 cylinder at 15° ATDC.

   Notice

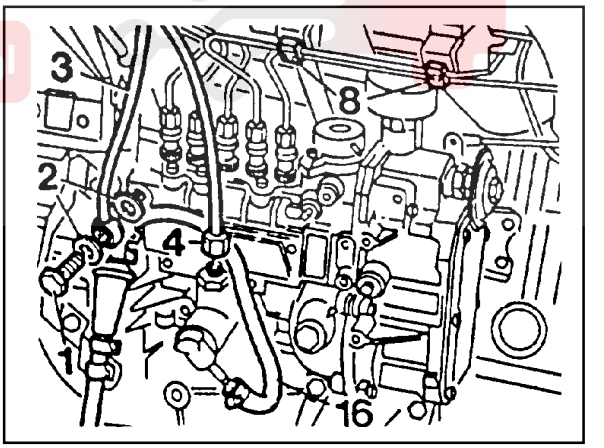
   Do not rotate the engine in opposition direction of engine rotation.



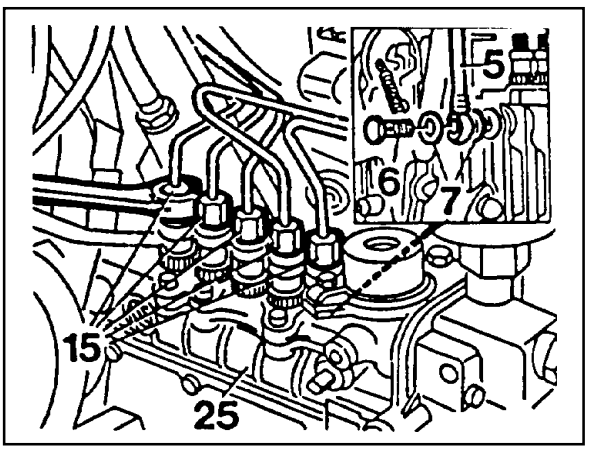
2. Remove the connecting rod (9).
3. Disconnect the vacuum lines (13, 14).
4. Remove the accelerator control damper (10).
   (Manual transmission vehicle)



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).



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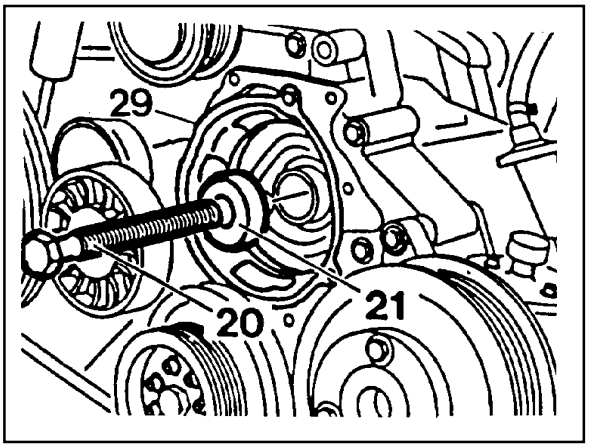
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10. Install the assembly cage (29) and remove the bolt (20) and pull off the washer (21).

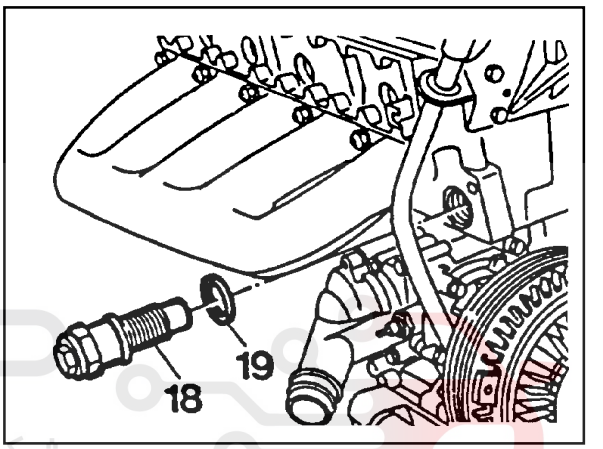
Notice

Be careful that the bolt (20) is left hand thread.

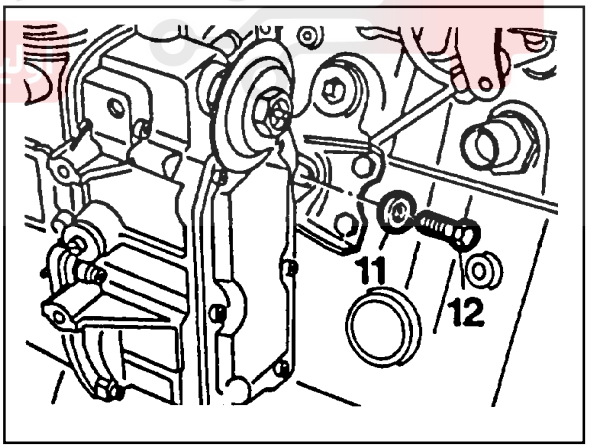
Assembly Cage 601 589 05 14 00



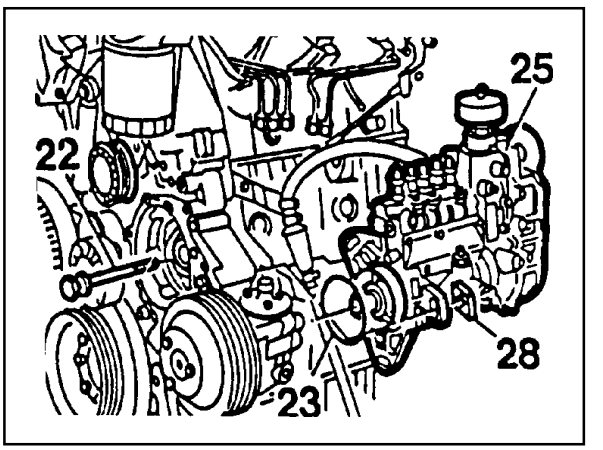
11. Remove the chain tensioner (18) and seal (19).



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



13. Remove the bolt (22) and pull off the square nut (28).
14. Pull out the fuel injection pump (25) and seal (23).

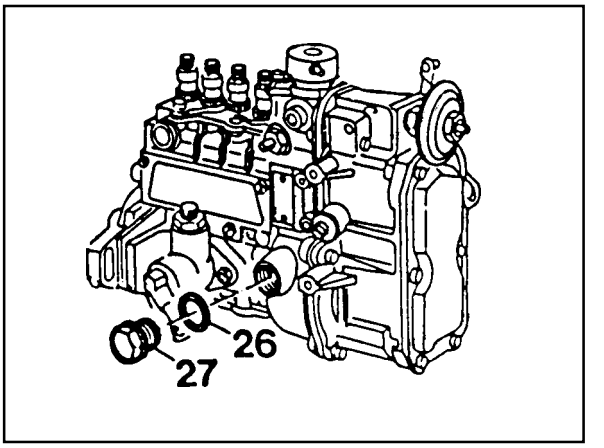


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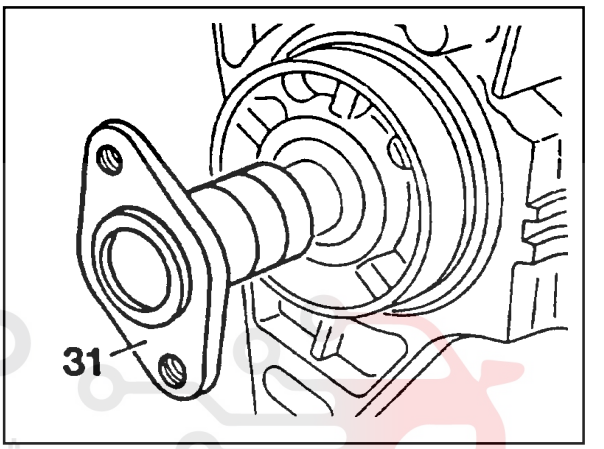
Installation Procedure

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 hole.

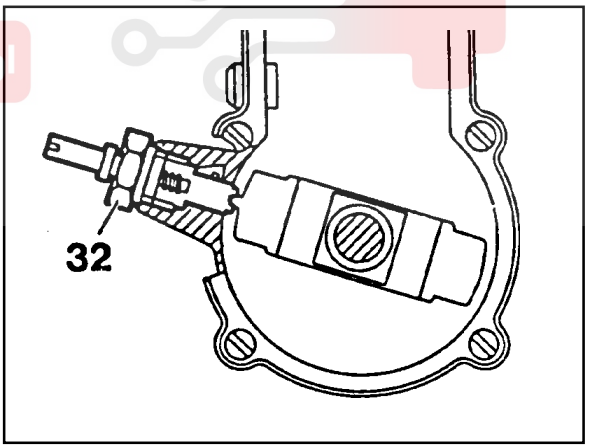
Flange 601 589 00 08 00



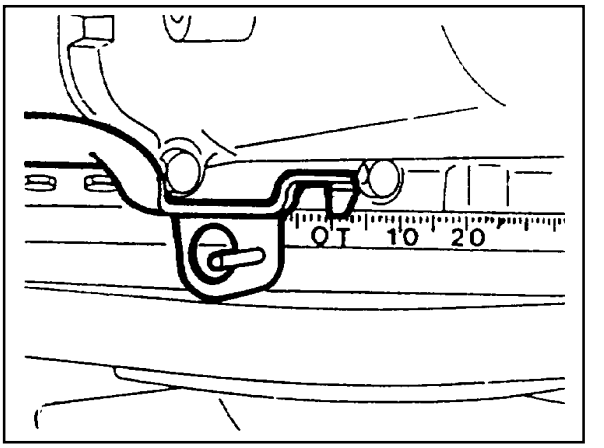
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3. Tighten the locking screw.

Locking Screw 601 589 05 21 00



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



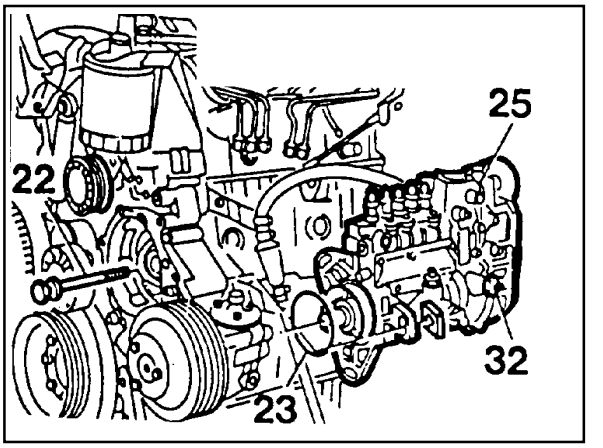
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5. Coat the new seal (23) with engine oil and install it.
6. Insert the fuel injection pump (25) and tighten the bolts (22).

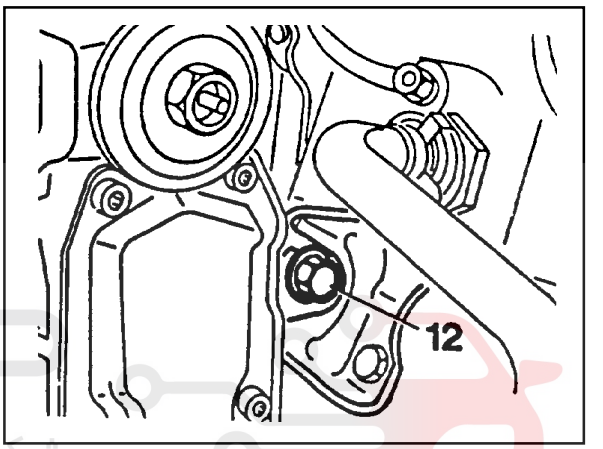
Tightening Torque	23 Nm

7. Remove the locking screw (32).



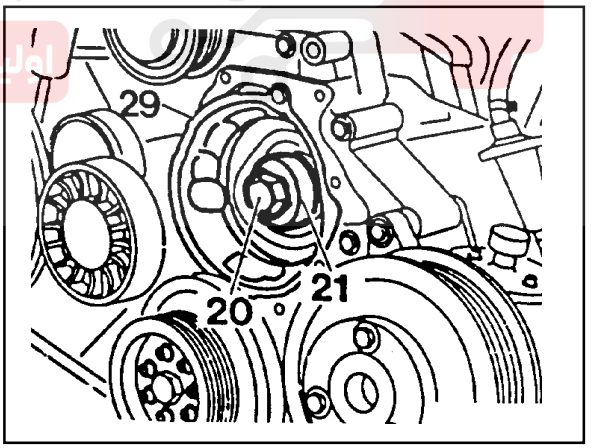
8. Tighten the bolt(12).

Tightening Torque	23 Nm



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

Tightening Torque	46 Nm



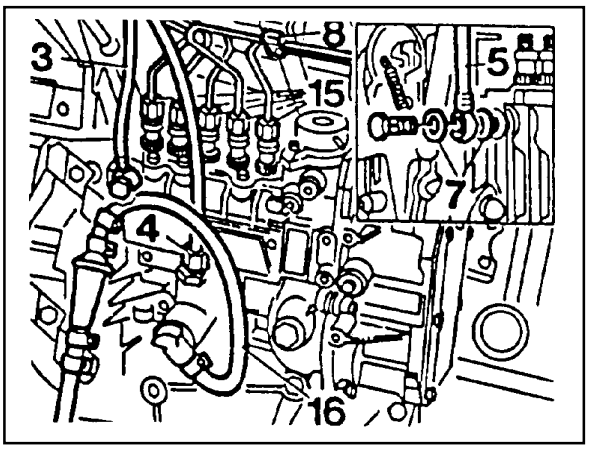
10. Connect the fuel pipes

Return Line	46 Nm
Fuel Injection Line	18 Nm
Fuel feed Line	13 Nm
Suction and Pressure Line	13 Nm

Notice

Replace the seal.

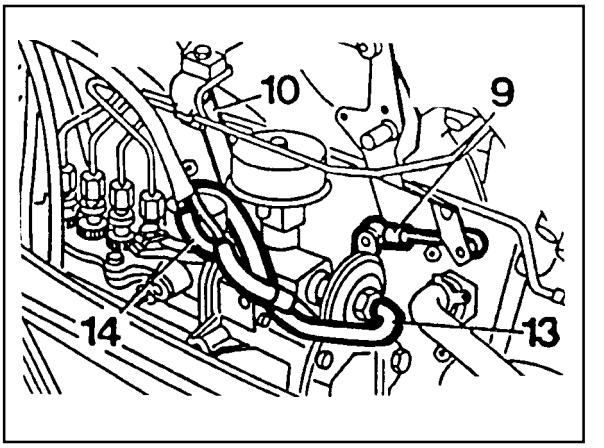
Box Wrench Insert 000 589 77 03 00



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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.



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SECTION 1G1

M162 ENGINE INTAKE & EXHAUST

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Intake Manifold 1G1-5
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Exhaust Manifold 1G1-9

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m
Air Cleaner Housing Cover Nut	9 - 11
Intake Manifold Bolt (M8 x 20)	22.5 - 27.5
Intake Manifold Bolt (M8)	22.5 - 27.5
Exhaust Mainfold Stud Bolt	9.5 - 12.5
Exhaust Pipe Nut (Engine)	15 - 28
Exhaust Pipe Bolt	28 - 47

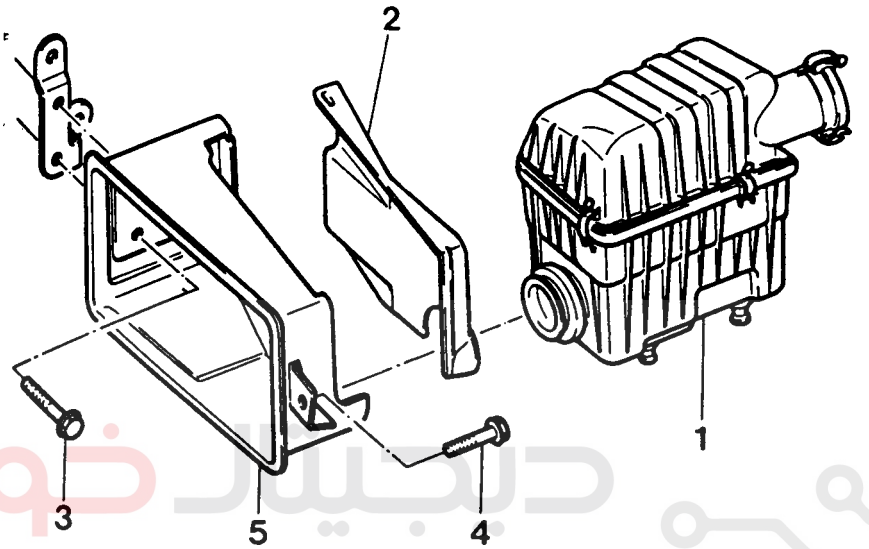
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

AIR CLEANER



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1 Air - Cleaner Assembly
2 Air - Cleaner Shield Upper Cover
3 Blot
4 Blot
5 Air Intake Shield

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Removal & Installation Procedure

1. Release the clamp securing HFM sensor and air cleaner.
2. Disengage the air cleaner assembly and HFM sensor assembly.
3. Unserew the mounting bolt(6) from the bracket.

   Installation Notice

Tightening Torque	22.5 - 27.5 Nm

4. Release the clamp from air cleaner assembly housing and remove the cover.
5. Remove the air cleaner assembly.
6. Remove the air cleaner housing from insulator.

   Notice

   Make sure the air cleaner to be seated in insulator.
7. Disengage the air duct hose and air cleaner housing and remove the housing.
8. Remove the air duct hose.
9. Unscrew the two bolts(7) from air inlet duct.

   Installation Notice

Tightening Torque	8 - 9 Nm

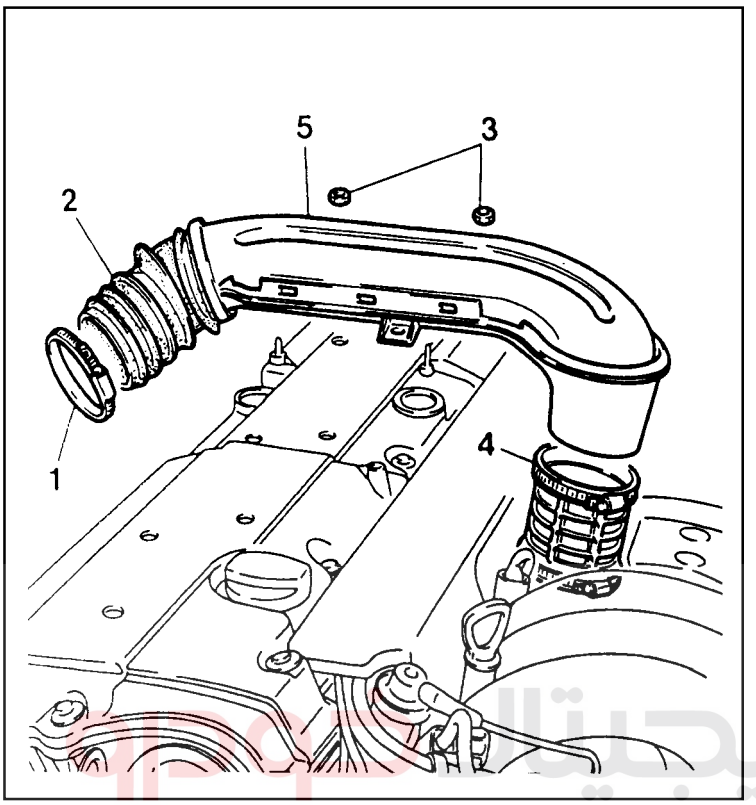
10. Remove the air inlet duct.
11. Installation should follow the removal procedure in the reverse order.

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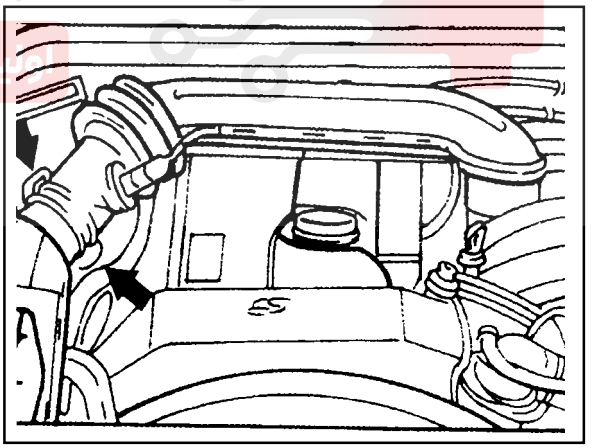
INTAKE AIR DUCT



1 Clamp
2 Sleeve
3 Nut
4 Clamp
5 Intake Air Duct

Removal & Installation Procedure

1. Remove the clamp (1) and disconnect the HFM sensor.
2. Remove the nut (3) (arrow).

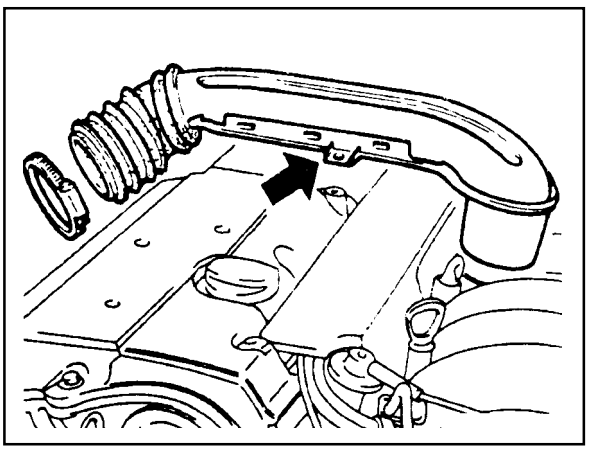


3. Remove the clamp (4).
4. Remove the intake air duct (5) carefully.

Installation Notice

Exactly seat the pin of intake air duct onto the crankcase ventilation rubber mount.

5. Installation should follow the removal procedure in the reverse order.

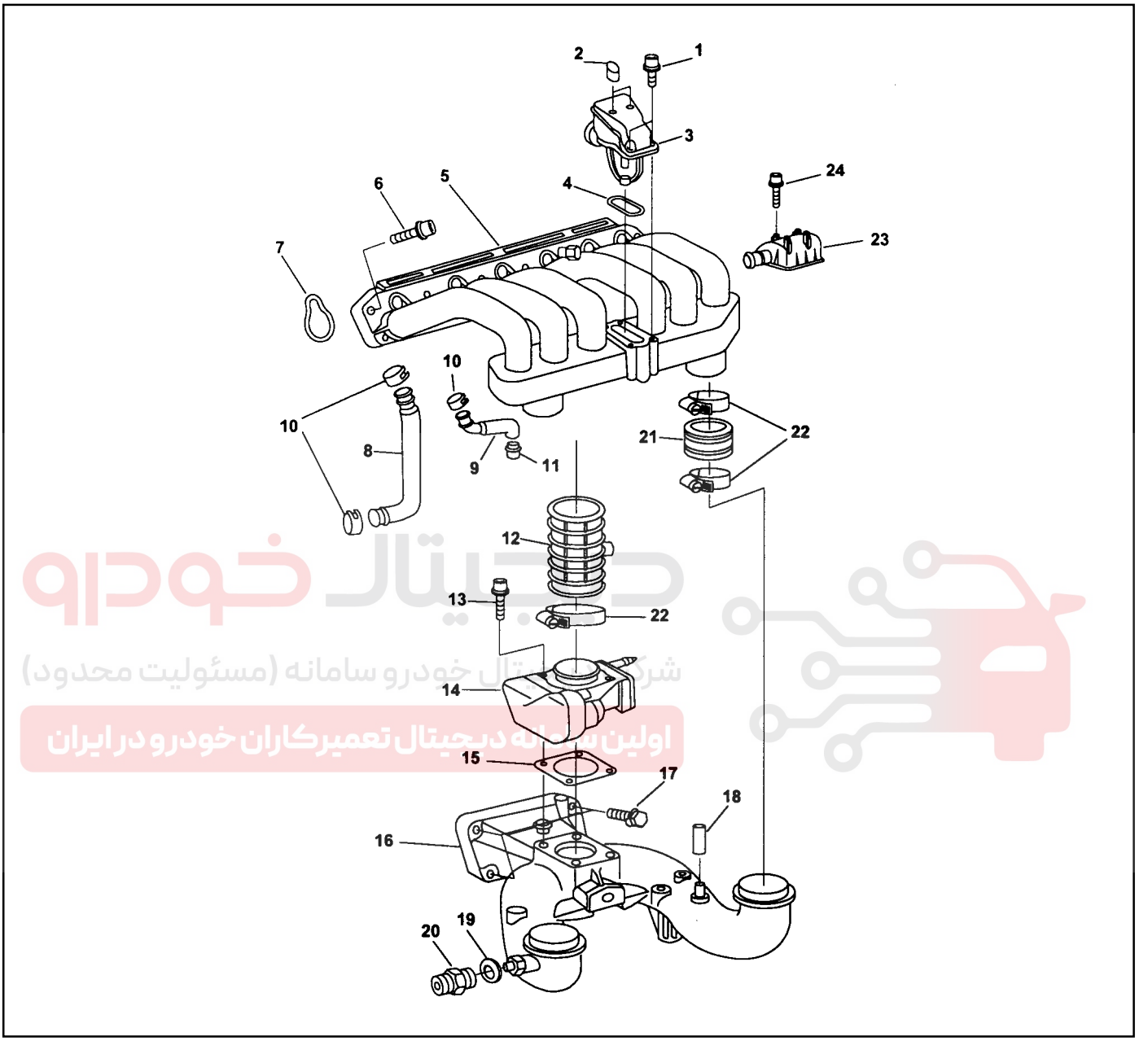


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INTAKE MANIFOLD

Preceding Work : Removal of fuel distributor and injection valve



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1 Bolt (M6 X 40, 4 pieces) ..... 9-11 Nm
2 Softcap
3 Resonance Flap
4 Gasket ..... Replace
5 Upper Intake Manifold
6 Bolt (M8 x 50, 9 pieces) ..... 22.5-27.5 Nm
7 Gasket ..... Replace
8 Blow-by Hose
9 Blow-by Hose
10 Clamp
11 Blow-by Nipple
12 Inlet Air Housing
13 Bolt (M6 x 40, 4 pieces) ..... 9-11 Nm
14 Throttle Body - Electric
15 Gasket ..... Replace
16 Lower Intake Manifold .....
17 Bolt (M8 x 40, 4 pieces) ..... 22.5-27.5 Nm
18 Nipple ..... Replace
19 Seal Ring
20 Connection House
21 Clamp
22 Noise Damper Assembly
23 Tapping Screw

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Removal & Installation Procedure

- **Upper Intake Manifold**

1. Disconnect the vacuum hose (8,9).
2. Loosen the clip (22).
3. Remove the upper intake manifold (5) after unscrewing the bolt (6).

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Notice

Check the gasket and replace it if necessary.

4. Installation should follow the removal procedure in the reverse order.

- **Lower Intake Manifold**

Preceding work : removal of upper intake manifold

1. Remove the hose of brake booster vacuum line and idle speed connector.
2. Disconnect the hot water inlet pipe from the bottom of lower intake manifold.
3. Unscrew the bolt (17) and remove the lower intake manifold (16).

Installation Notice

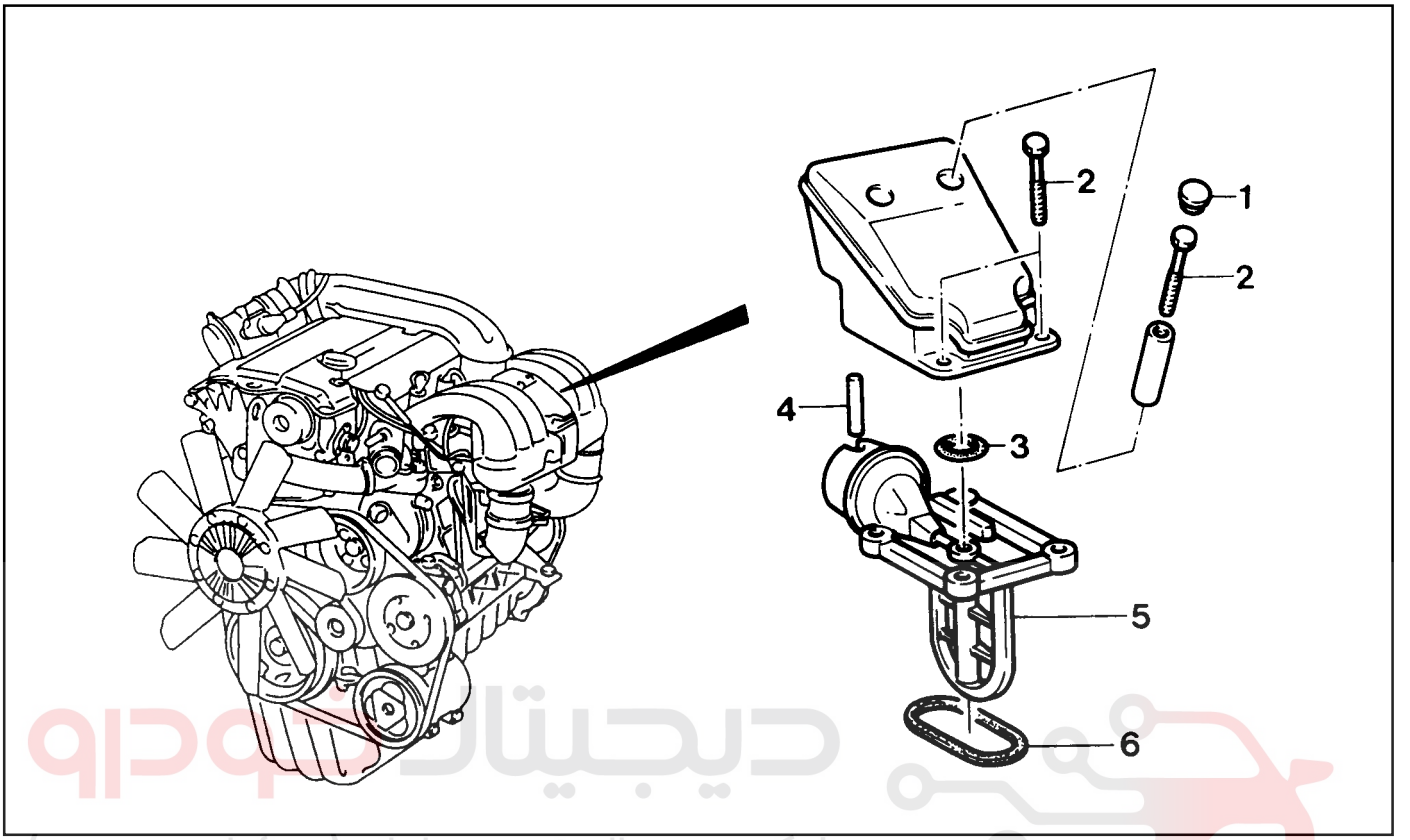
Tightening Torque	22.5 - 27.5 Nm

4. Start the engine and check for leaks at each connection part.

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RESONANCE FLAP



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1 Soft Cap (2)
2 Bolt (M6 x 25, 4 pieces) ..... 9-11 Nm
3 O-ring
4 Vacuum Hose
5 Resonance Flap
6 Gasket ..... Replace

Removal & Installation Procedure

1. Remove the 2 soft caps (1).
2. Remove the upper resonance flap coupling after removing 4 bolts (2).

   Notice

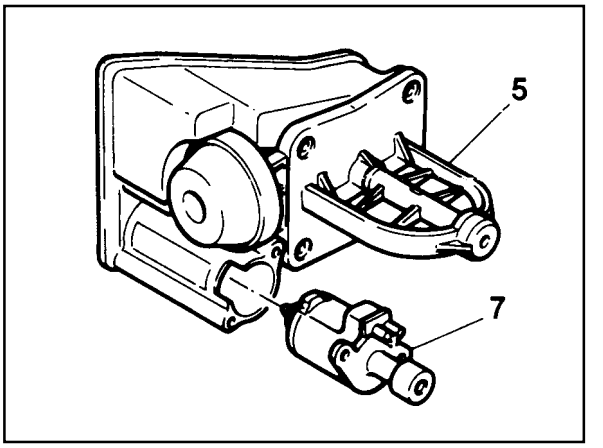
   Connect carefully the vacuum hose (4) for installation.
3. Check the O-ring (3) and replace it if necessary.
4. Remove the lower resonance flap (5).
5. Replace the gasket (6).
6. Installation should follow the removal procedure in the reverse order.

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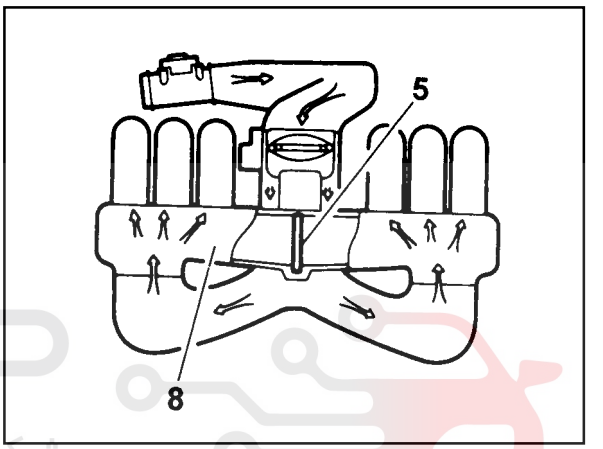
Function Description

A pneumatically actuated resonance flap (5) is located on the intake manifold, and will be opened and closed by load, which operates resonance flap according to engine and controlled by ECU and rpm.



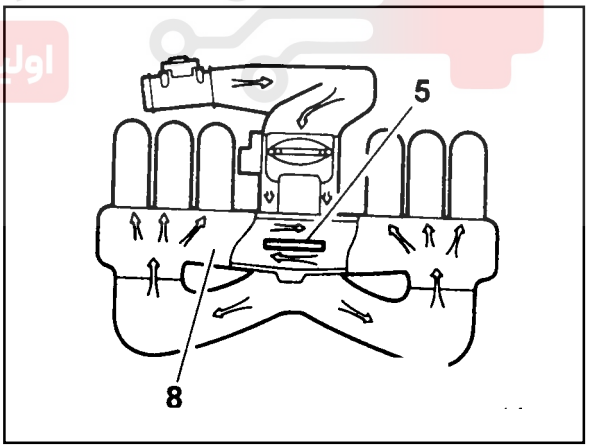
1. **Resonance flap closed (at idle/partial load : less than 3,800/rpm)**

   The switch valve (7) will be adjusted by ECU and resonance falp will be colosed. By increasing air flow passage through dividing intaking air flow toward both air collection housing (8). This leads to a signficant increase in the torque in the lower speed range.



2. **Resonance flap open (at full load : over 3,800/rpm)**

   The switch valve (7) will not be adjusted by ECU and resonance falp (5) will be open. The colllected air in the air collection housing (8) will not be divided and intaking air passage will be shorten.

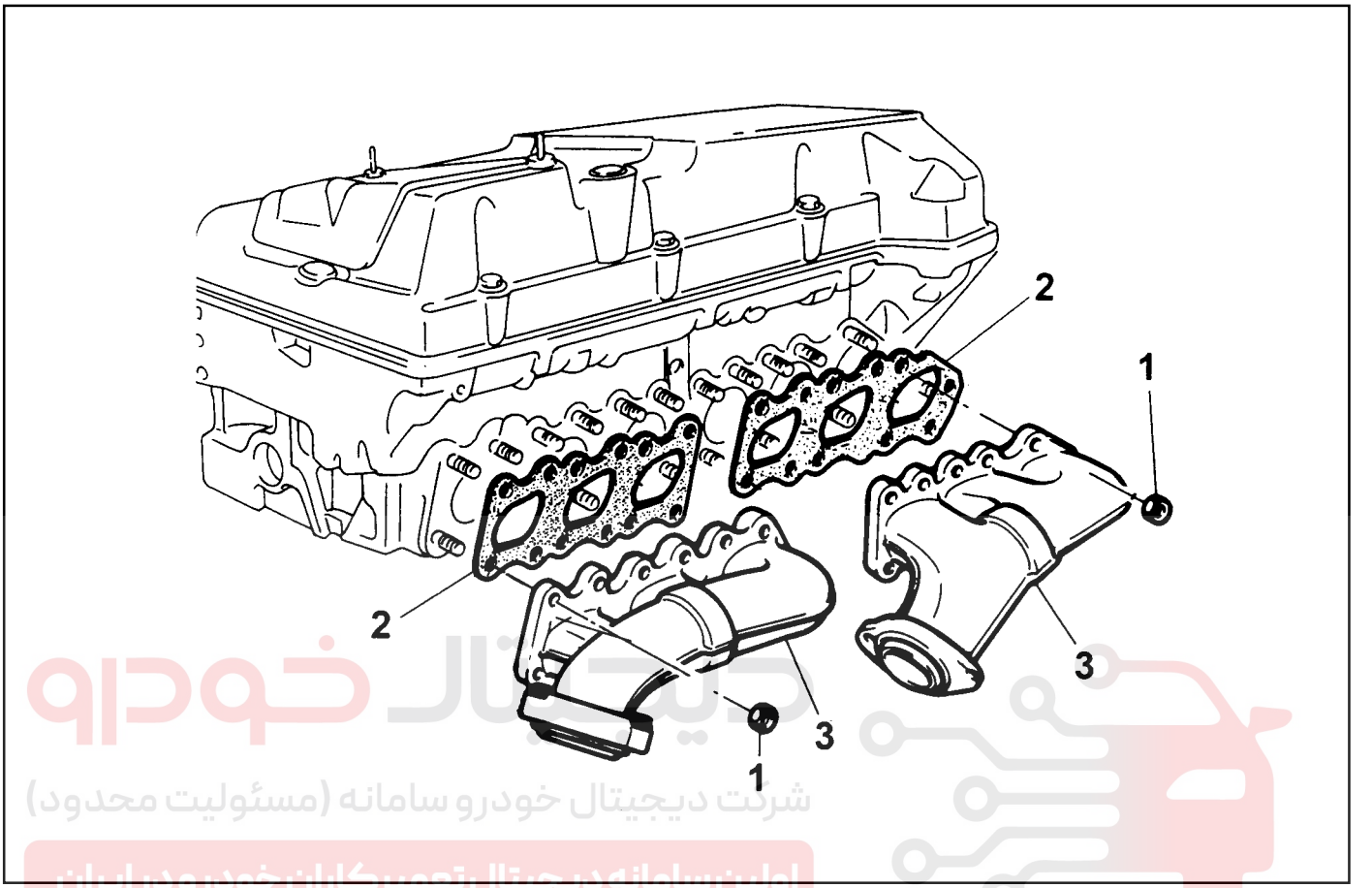


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EXHAUST MANIFOLD

Preceding Work : Removal of air cleaner



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1 Nut ..... 36-44 Nm
2 Gasket ..... Replace
3 Exhaust Manifold

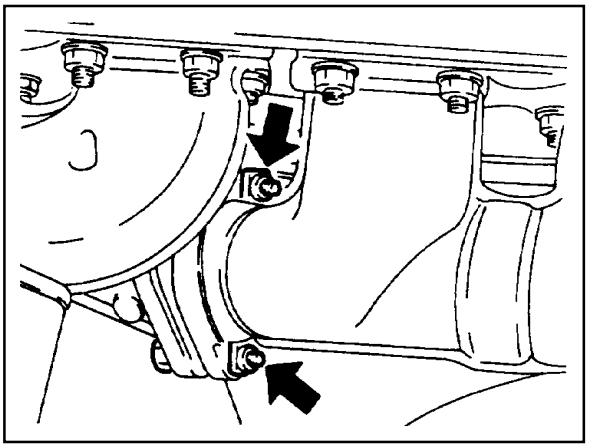
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Tools Required

103 589 01 39 00 Caulking Bolt

Removal & Installation Procedure



1. Remove the flange bolt from the exhaust manifold, and disconnect the front exhaust pipe.

   Installation Notice

Tightening Torque	30 Nm

   Notice

   Check for nut damages and replace the nut if necessary.

2. Remove the 23 nuts (1) from the stud bolt, and remove the exhaust manifold.

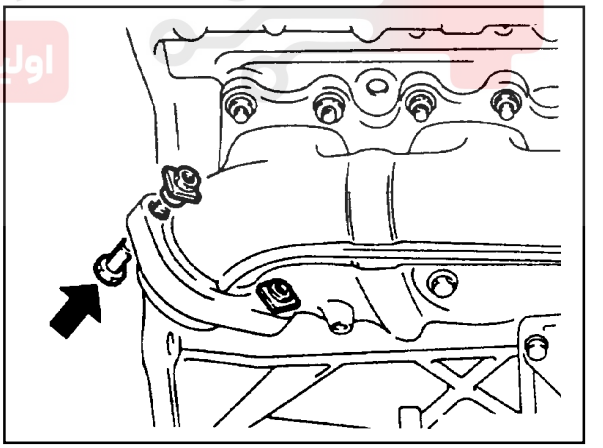
   Installation Notice

Tightening Torque	26 - 34 Nm

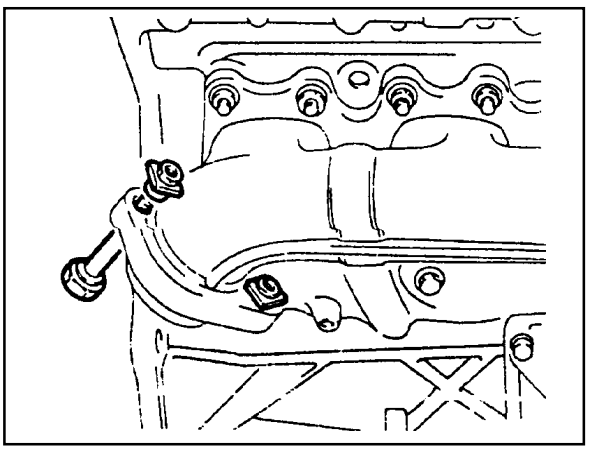
3. Replace the gasket (2).
4. Installation is reverse order of the removal.

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Replacement of Rivet Nut



1. Pull out the rivet nut from the connecting point of the exhaust manifold and the exhaust pipe using a proper bolt (arrow).



2. Insert a new rivet nut into the exhaust manifold hole, and tighten with a special tool (Caulking Bolt).

   Installation Notice

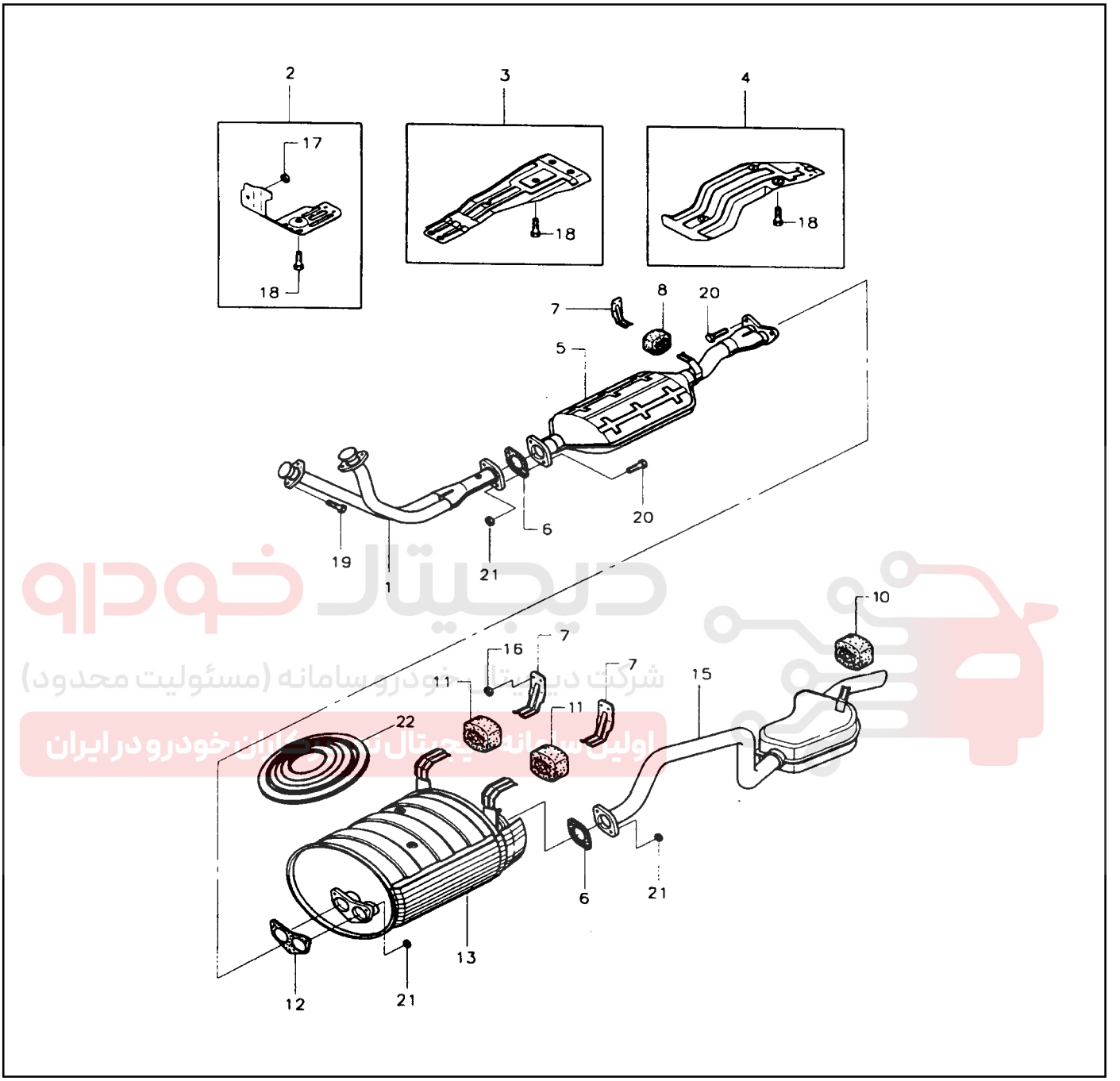
Tightening Torque	30 Nm

Caulking Bolt 103 589 01 39 00

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Removal and Installation of Exhaust Line



1	Exhaust Manifold	
2	Rivet Nut	
3	Bolt	30 Nm
4	Front Pipe	
5	Oxygen Sensor	
6	Bolt	28-47 Nm
7	Rubber Pad	
8	Catalytic Converter	
9	Gasket	Replace
10	Nut	
11	Gasket	Replace
12	Rubber Pad	
13	Nut	28-47 Nm
14	Center Muffler	
15	Rubber Pad	
16	Tail Muffler	
17	Gasket	Replace
18	Nut	28-47 Nm

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SECTION 1G2

M161 ENGINE INTAKE & EXHAUST

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Intake Air Duct 1G2-5
Intake Manifold 1G2-7
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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m
Air Cleaner Housing Cover Nut	9 - 11
Intake Manifold Bolt (M8 x 20)	22.5 - 27.5
Intake Manifold Bolt (M8)	22.5 - 27.5
Exhaust Mainfold Stud Bolt	9.5 - 12.5
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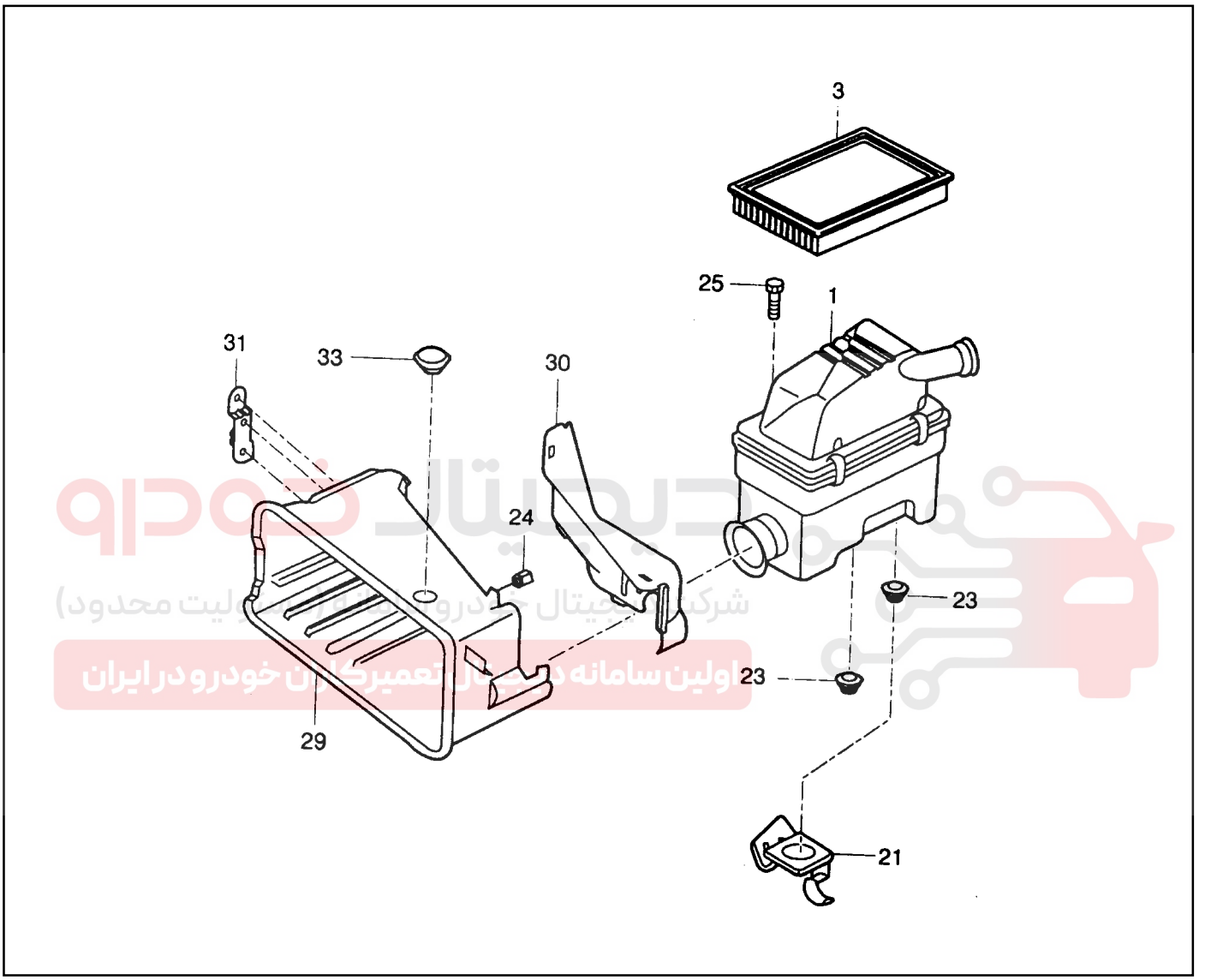
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

AIR CLEANER



1 Air Cleaner Assembly
2 Element Assembly
3 Insulator
4 Air Duct Hose
5 Air Inlet Duct
6 Bolt (M8 × 30) ..... 22.5-27.5 Nm
7 Bolt (M6 × 35) ..... 9-11 Nm

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Removal & Installation Procedure

1. Release the clamp securing HFM sensor and air cleaner.
2. Disengage the air cleaner assembly and HFM sensor assembly.
3. Unserew the mounting bolt(6) from the bracket.

   Installation Notice

Tightening Torque	22.5 - 27.5 Nm

4. Release the clamp from air cleaner assembly housing and remove the cover.
5. Remove the air cleaner assembly.
6. Remove the air cleaner housing from insulator.

   Notice

   Make sure the air cleaner to be seated in insulator.
7. Disengage the air duct hose and air cleaner housing and remove the housing.
8. Remove the air duct hose.
9. Unscrew the two bolts(7) from air inlet duct.

   Installation Notice

Tightening Torque	8 - 9 Nm

10. Remove the air inlet duct.
11. Installation should follow the removal procedure in the reverse order.

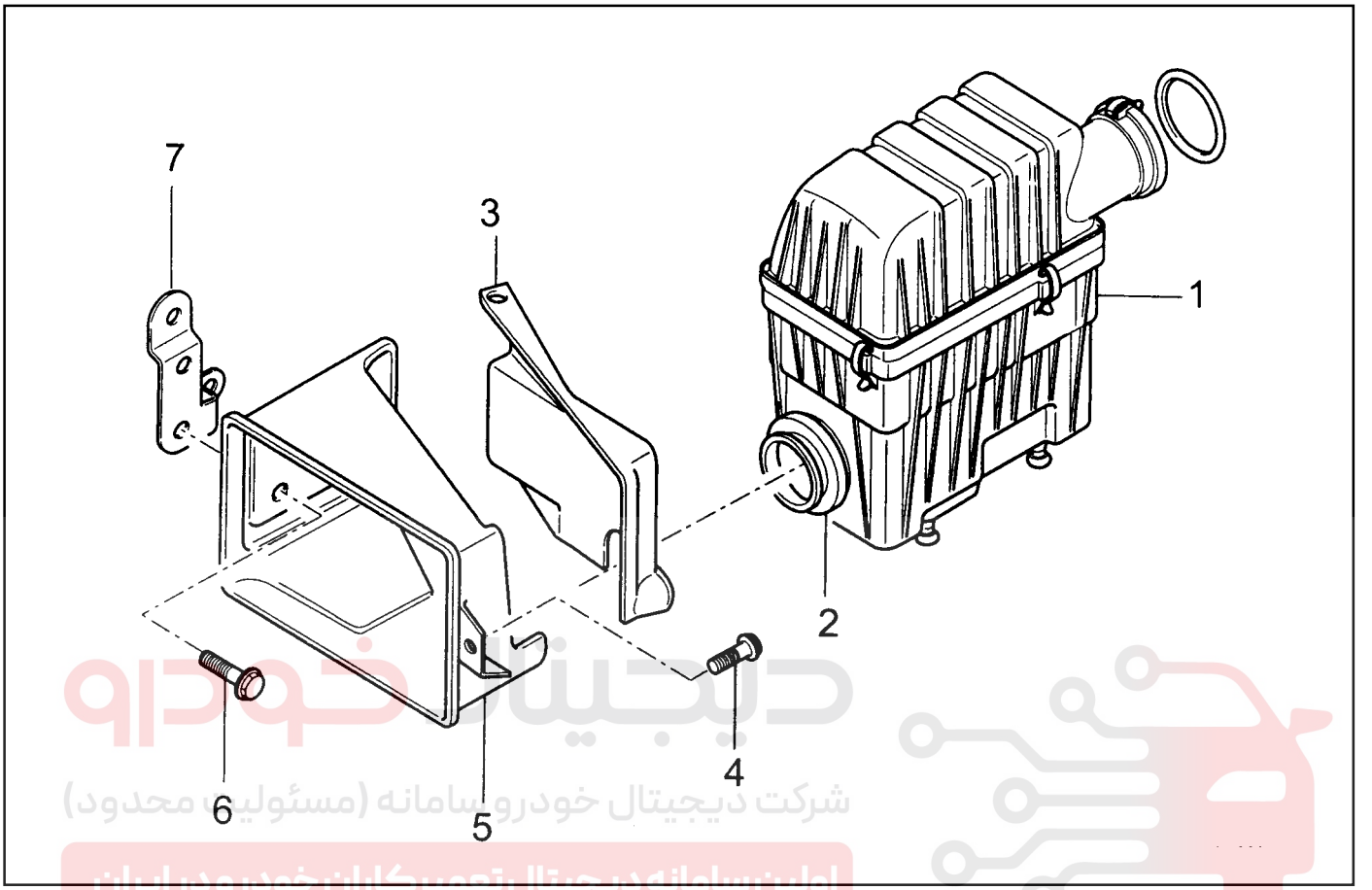
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AIR INTAKE SHIELD

Preceding Work : Removal of air cleaner



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1 Air Cleaner
2 Gasket
3 Air Intake Shield Upper Cover
4 Bolt
5 Air Intake Shield
6 Bolt
7 Bracket

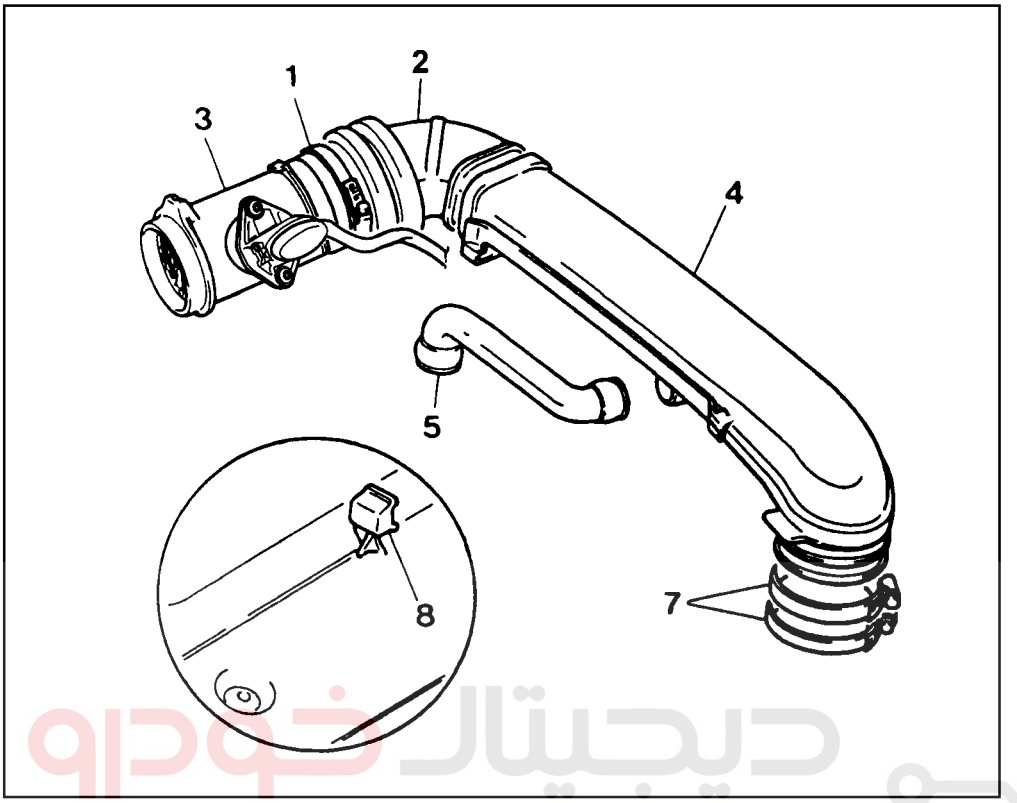
Removal & Installation Procedure

1. Remove the upper cover (3) from the air intake shield (5) upper mounting pin.
2. Remove the bolts (4 and 6).
3. Remove the air intake shield (5).
4. Installation should follow the removal procedure in the reverse order.

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INTAKE AIR DUCT

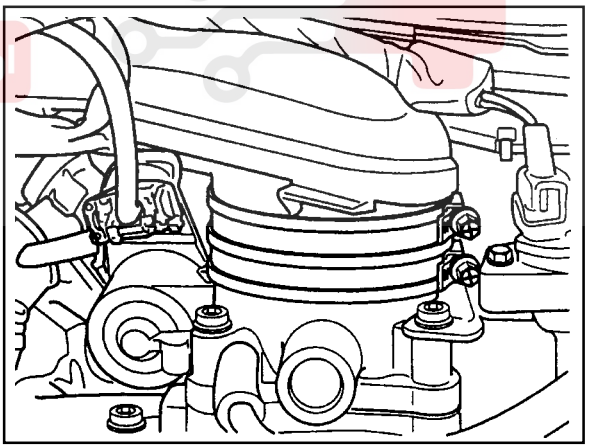


1 Clamp
2 Sleeve
3 HFM Sensor
4 Intake Air Duct
5 Blow-by Hose
7 Clamp(2 pieces)
8 Intake Air Duct Mounting Bracket

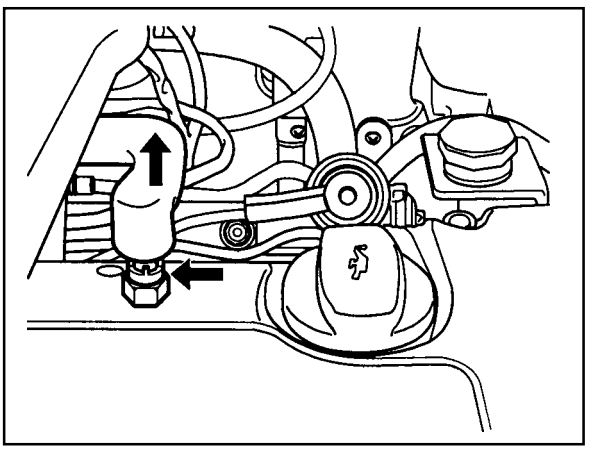
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Removal & Installation Procedure

1. Release the clamp (1) and intake air duct.



2. Remove the Blow-by hose (5) (arrow).



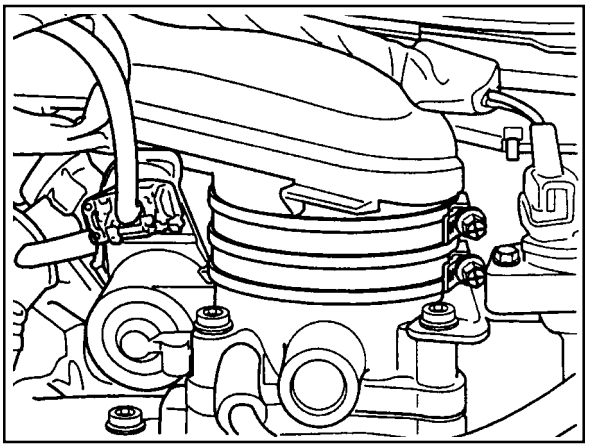
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3. Release the clamp (7) and remove the intake air duct.

   Notice

   Completely fit the intake air duct with the mounting bracket (8).



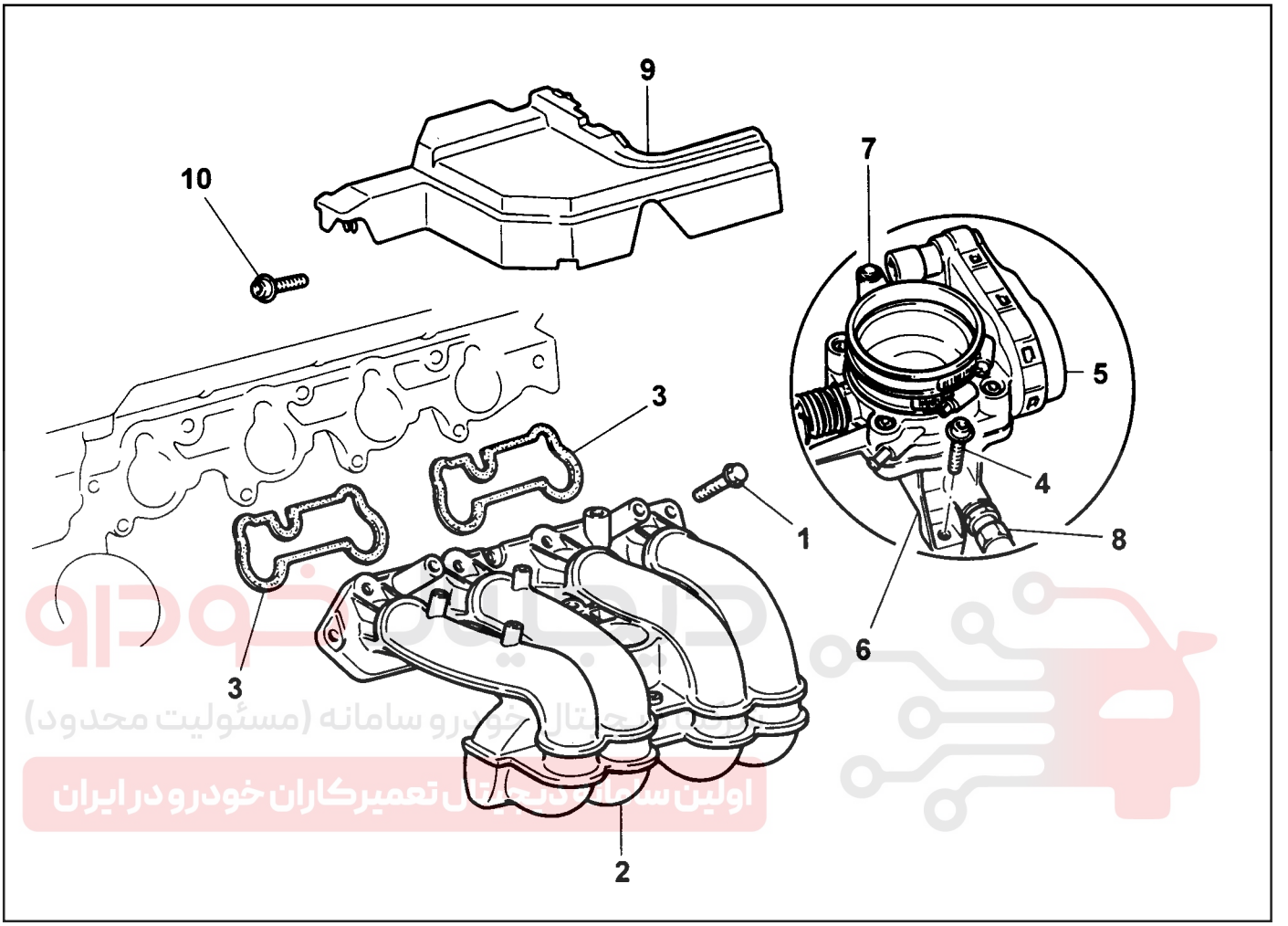
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INTAKE MANIFOLD

Preceding Work : Removal of intake air duce
Removal of fuel distributor and injector



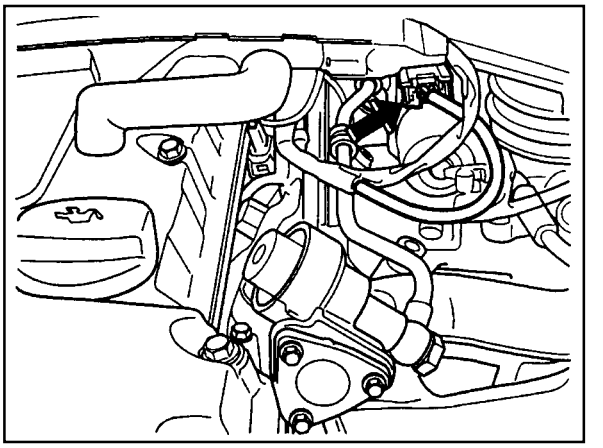
1	Bolt (M6 X 40, 6 pieces) ..... 22.5-27.5 Nm	5	Idle Regulator
2	Intake Manifold	6	Intermediate Flange
3	Gasket (2 pieces) ..... Replace	7	Bolt (M6 X 35, 4 pieces) ..... 9-11 Nm
4	Bolt (M8 X 40, 3 pieces) ..... 22.5-27.5 Nm	8	Connection Piece With Seal Ring ..... 36-44 Nm

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Removal & Installation Procedure

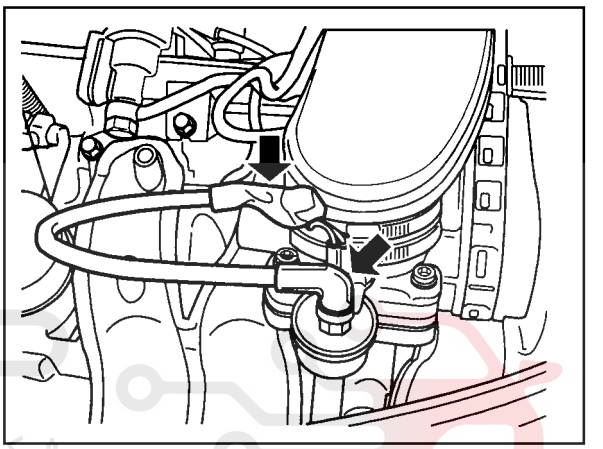
1. Disconnect the battery ground cable.
2. Remove idle speed control plug connector (arrow).



3. Disconnect the brake booster vacuum line and other vacuum lines.
4. Disconnector the rod from bearing bracket assembly and remove the connection piece (8).

Installation Notice

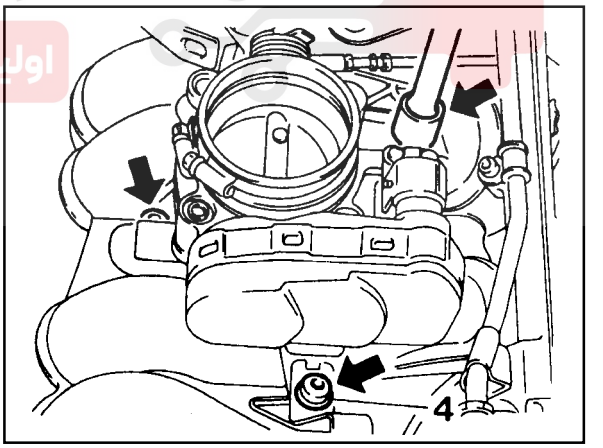
Tightening Torque	36 - 44 Nm



5. Unscrew the three bolts (4) and remove the idle regulator and intermediate flange (6).

Installation Notice

Tightening Torque	22.5 - 27.5 Nm



6. Unscrew the two bolts (M8 X 16) and remove the support assembly (arrow).

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

7. Unscrew the intake manifold assembly mounting bolts (1) and remove the intake manifold and gasket.

Installation Notice

Tightening Torque	22.5 - 27.5 Nm

Notice

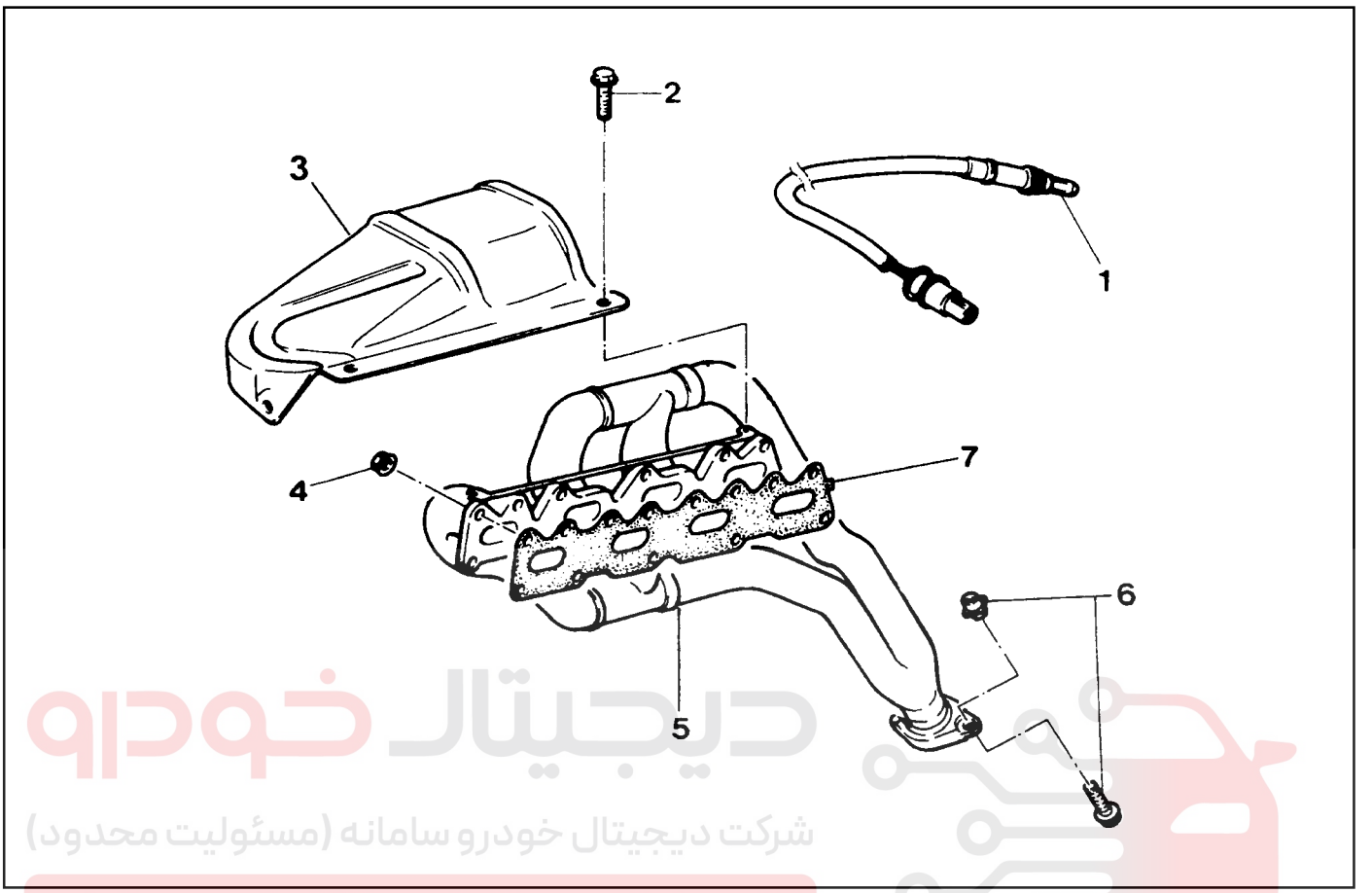
Replace the gasket with new one.

8. Installation should follow the removal procedure in the reverse order.
9. Start the engine and check for leaks in each connection.

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EXHAUST MANIFOLD



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1 Oxygen Sensor ..... 49.5-60.5 Nm
2 Bolt (4 pieces) ..... 9-11 Nm
3 Upper Cover
4 Nut (11 pieces) ..... 31.5-38.5 Nm
5 Exhaust Manifold
6 Flange Bolt & Exhaust Pipe Mounting Nut ..... 30 Nm
7 Gasket ..... Replace

Removal & Installation Procedure

1. Remove the oxygen sensor if necessary.

Installation Notice

Tightening Torque	49.5 - 60.5 Nm

2. Unscrew the bolt (2) and remove the exhaust manifold upper cover (3).
3. Unscrew the flange bolt (6) of front exhaust pipe and separate the front exhaust pipe.

Installation Notice

Tightening Torque	30 Nm

Notice

Check the exhaust pipe mounting nut, and replace it with new one if necessary.

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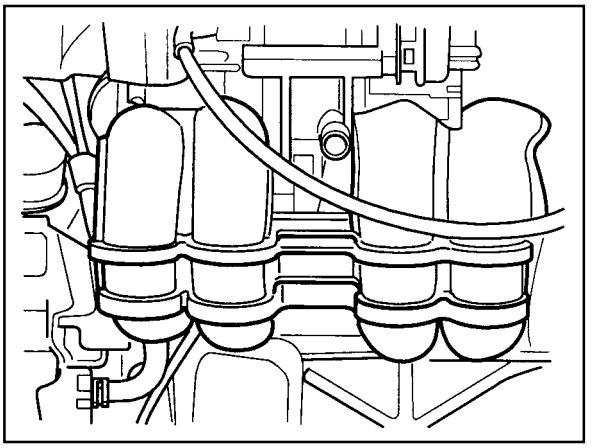
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4. Unscrew the eleven nuts (4) and remove the exhaust manifold (5) and gasket (7).

   Installation Notice

Tightening Torque	31.5 - 38.5 Nm

5. Replace the gasket (7) with new one.
6. Installation should follow the removal procedure in the reverse order.

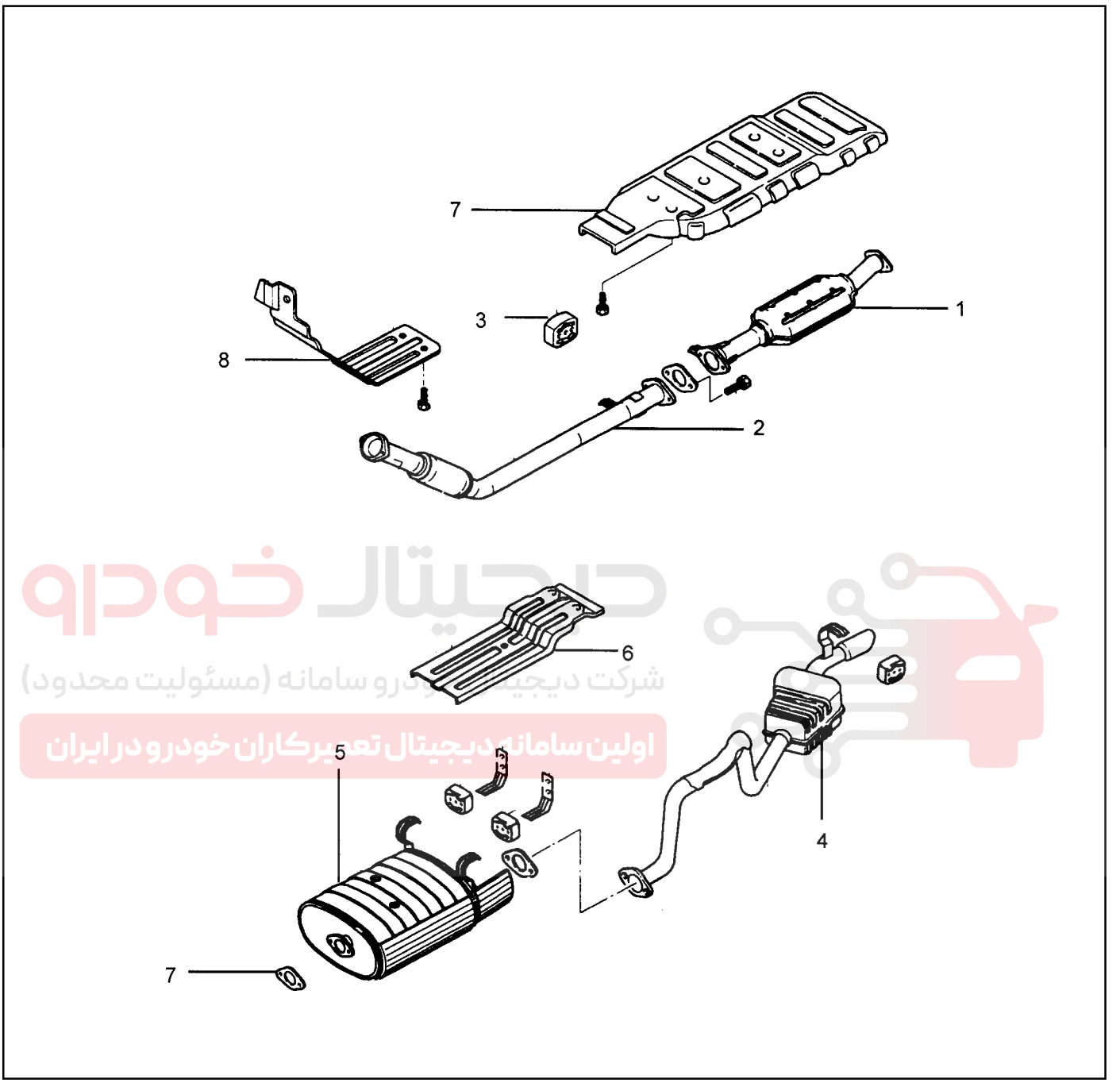


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Removal and Installation of Exhaust Line



1 Heat Protector-Floor
2 Pipe Assembly-Front Exhaust
3 Gasket
4 Heat Protector-Rear Exhaust
5 Road Assembly-Muffler Mounting Rear
6 Heat Pro-Tector Dash
7 Heat Pro-Tector Floor
8 Heat Pro-Tector Rear Exhaust

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SECTION 1G3

OM600 ENGINE INTAKE & EXHAUST

Caution: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

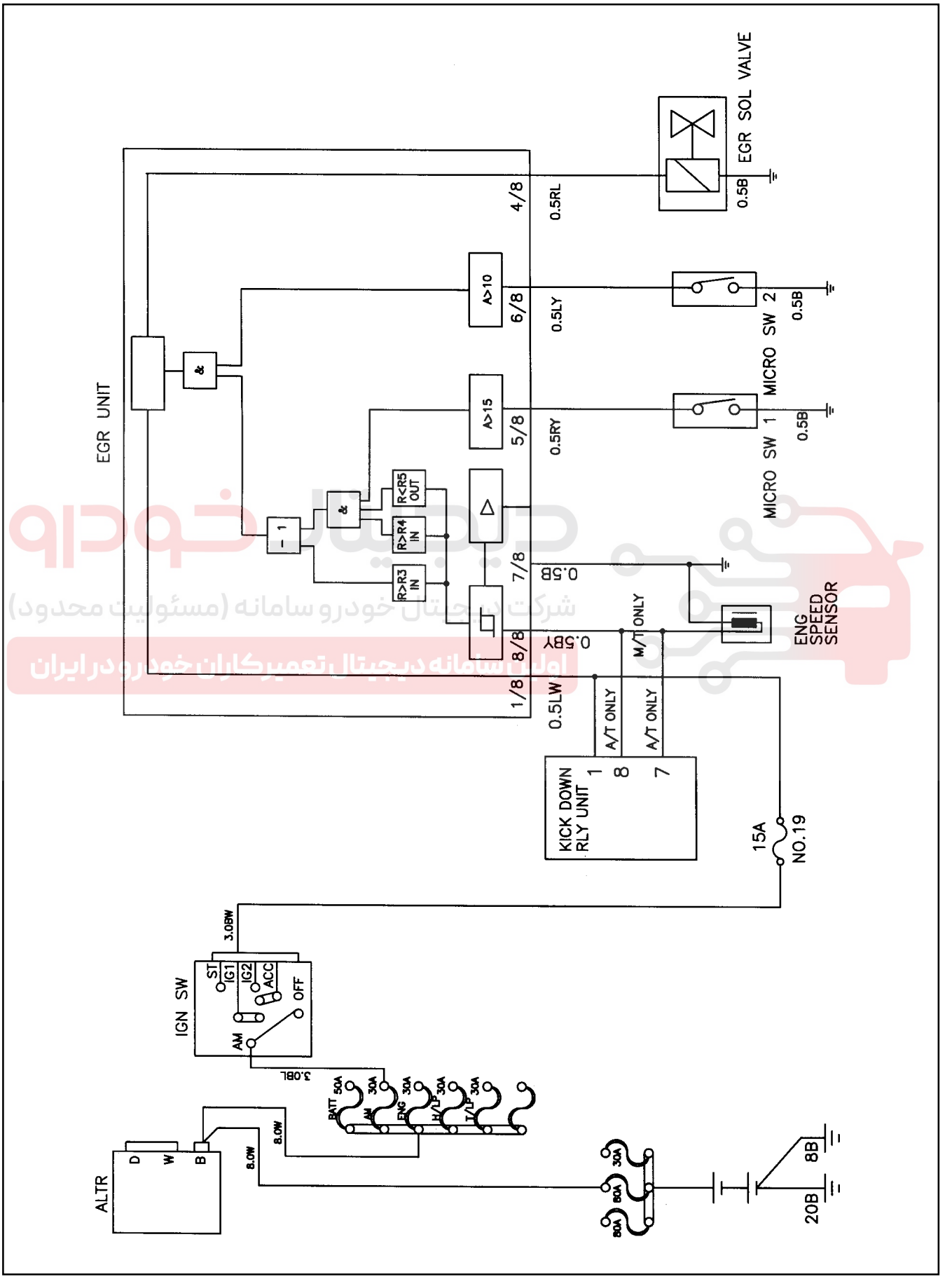
Application	N·m
Air Cleaner Housing Cover Nut	9 - 11
Intake Manifold Bolt (M8 x 20)	22.5 - 27.5
Intake Manifold Bolt (M8)	22.5 - 27.5
Exhaust Mainfold Stud Bolt	9.5 - 12.5
Exhaust Pipe Nut (Engine)	15 - 28
Exhaust Pipe Bolt	28 - 47

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SCHEMATIC AND ROUTING DIAGRAMS

EGR CIRCUIT



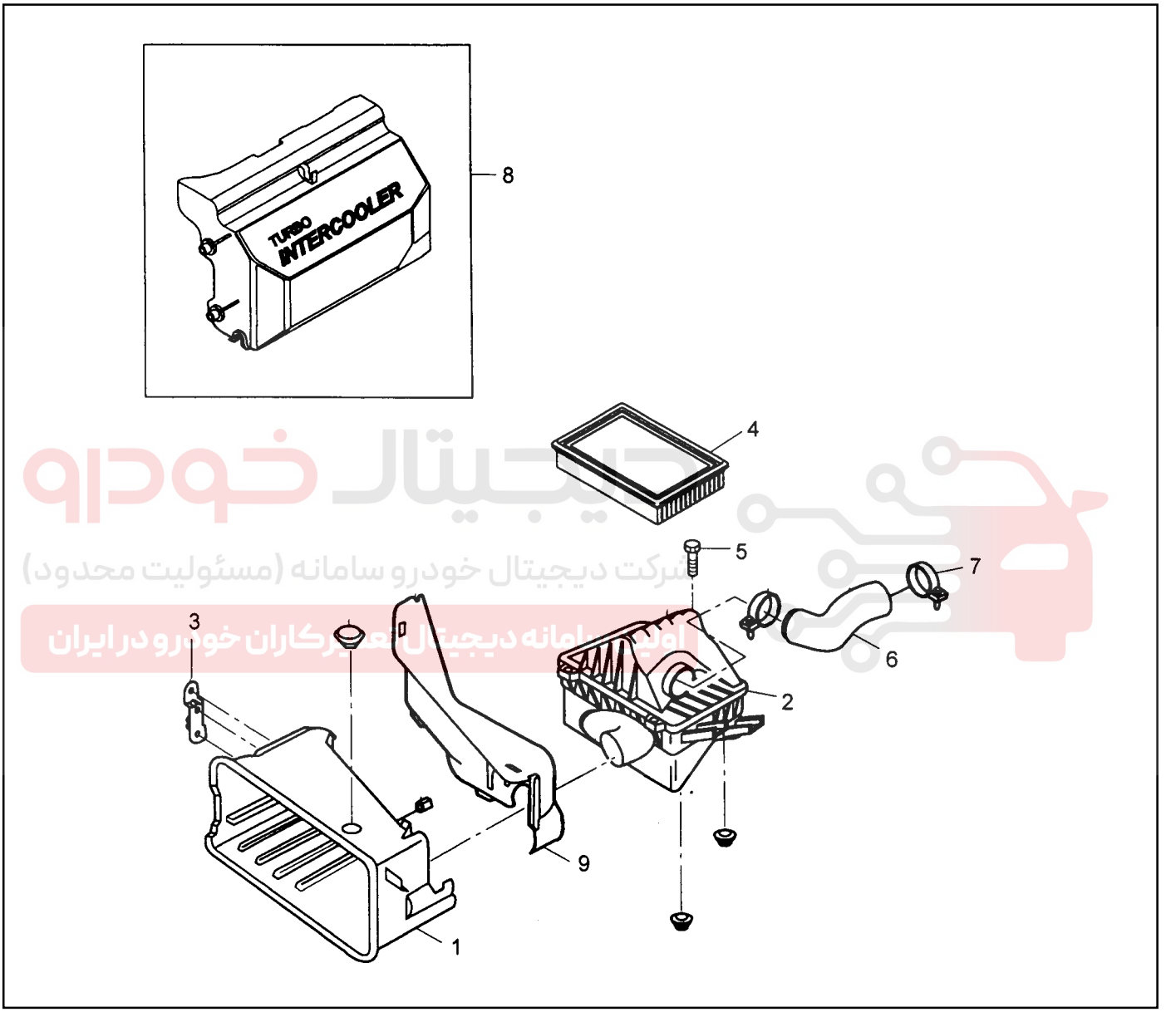
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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

AIR CLEANER AND INLET DUCT & HOSE

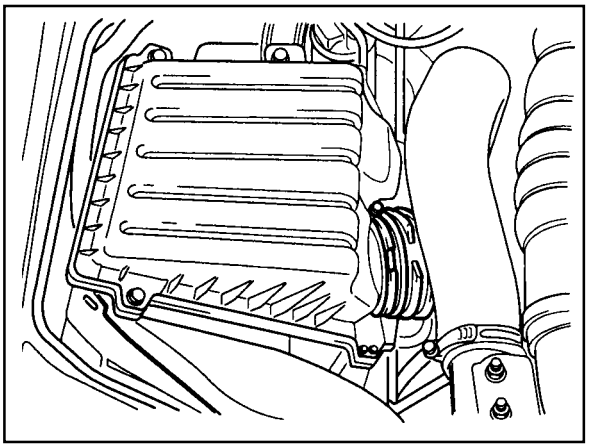


1 Air Intake Shield Assembly
2 Air Cleaner Assembly
3 Mounting Bracket
4 Air Cleaner Element ..... Clean : 20,000km
Replace : 60,000km
5 Bolt 9-11Nm
6 House
7 Clamp
8 Engine Cover Assembly (Turbo)
9 Mounting Bracket

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Removal & Installation Procedure



1. Loosen the air duct hose clamp and then remove the air cleaner and air duct hose.
2. Disconnect the air cleaner housing cover clamp and remove the cover and element.

Operating Interval	Clean	every 20,000km
	Replace	every 60,000km

3. Loosen the nut (4EA) and remove the air cleaner housing from the intake manifold.

Tightening Torque	9 - 11 Nm

Notice

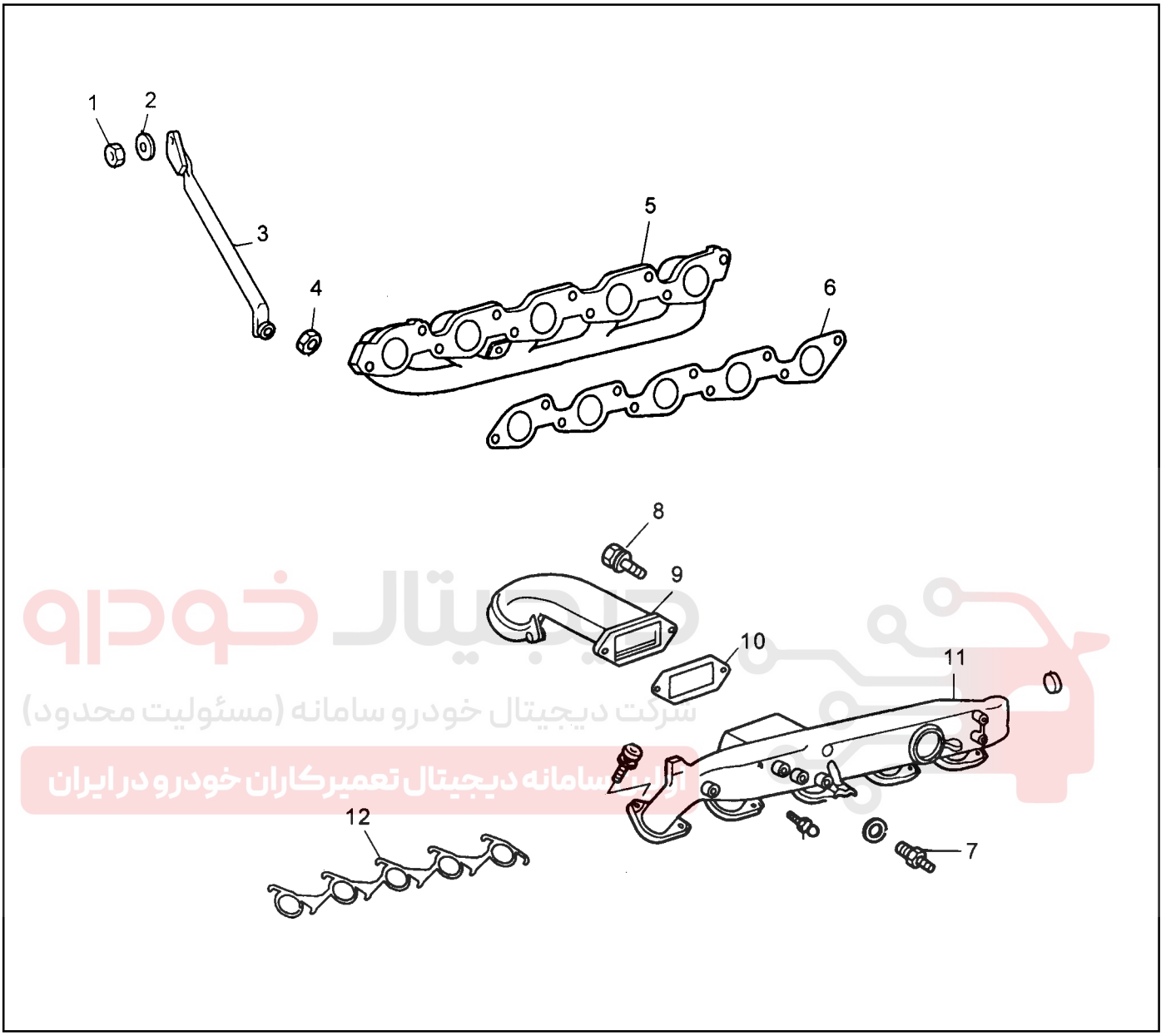
Do not fold the rubber.

4. Loosen the clamp and remove the air duct hose.
5. Loosen the mounting nut and bolt.
6. Remove the air inlet duct and hose.
7. Installation should follow the removal procedure in the reverse order.

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INTAKE AND EXHAUST MANIFOLD

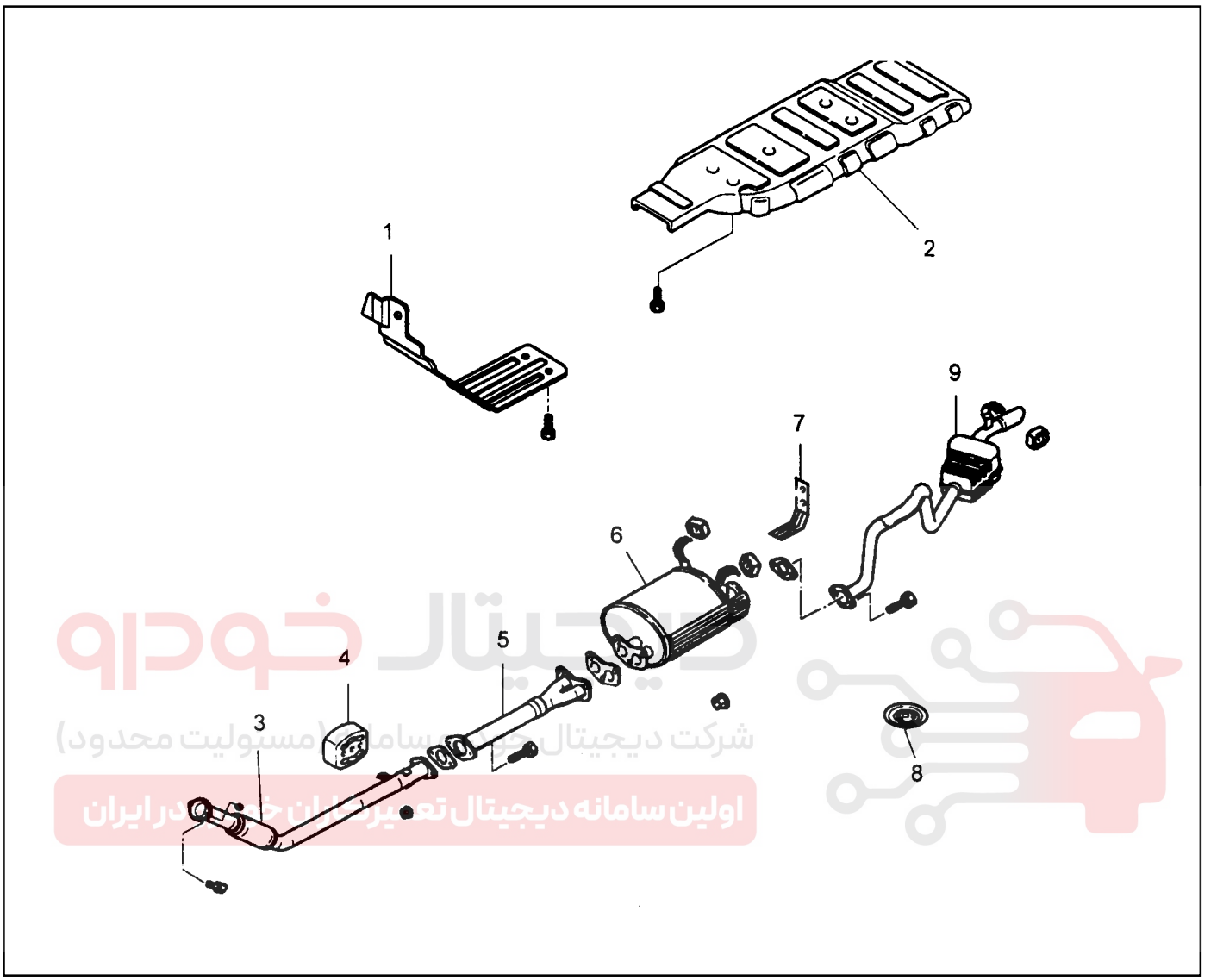


1	Nut	22.5-27.5 Nm
2	Washer	
3	Support Assembly Bar	
4	Nut	22.5-27.5 Nm
5	Exhaust Manifold Assembly	
6	Exhaust Gasket	
7	Stud Bolt	9.9-12.1 Nm
8	Bolt (M8)	22.5-27.5 Nm
9	Intake Duct	
10	Intake Duct Gasket	
11	Intake Manifold	
12	Intake Gasket	

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Exhaust Line



1 Heat Protector Assembly
2 Heat Protector Floor
3 Exhaust Front Pipe Assembly
4 Ring
5 Exhaust Rear Pipe Assembly
6 Muffler
7 Mounting
8 Heat Protector Front Floor
9 Tail Exhaust Pipe Assembly

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Removal & Installation Procedure

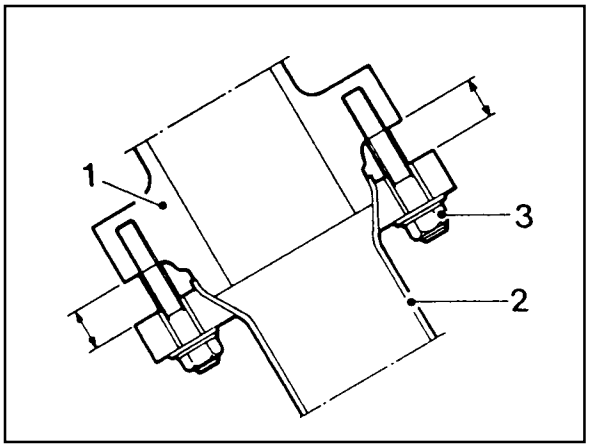
1. Remove the bolt from the exhaust manifold and then remove the front exhaust pipe.

Installation Notice

Tightening Torque	15 - 18 Nm

Notice

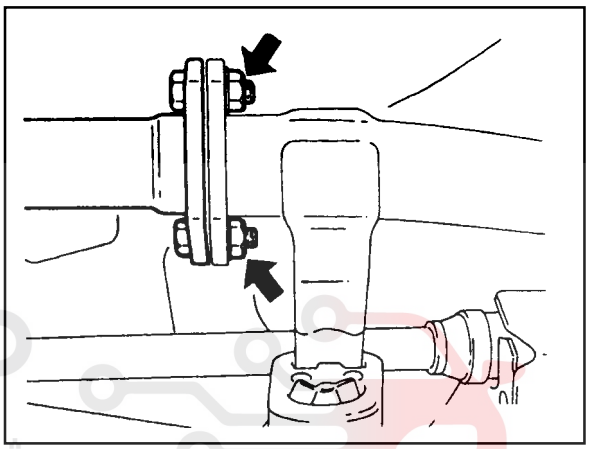
When tightening the nut(3), maintain the clearance between exhaust manifold(1) and front exhaust pipe.



2. Remove the nut from the front of center muffler and then remove the front exhaust pipe.

Installation Notice

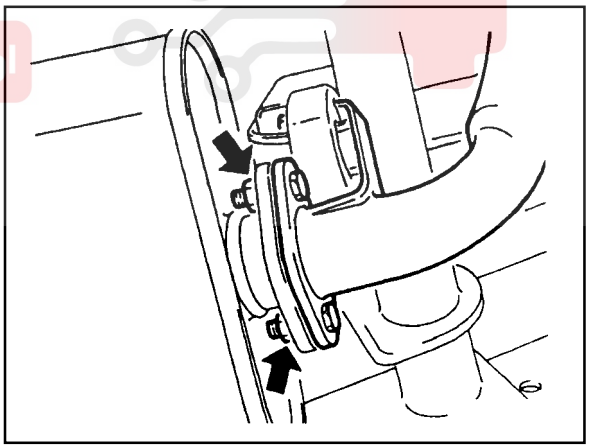
Tightening Torque	28 - 47 Nm



3. Remove the nut from the rear of center muffler and then remove the tail muffler.

Installation Notice

Tightening Torque	28 - 47 Nm

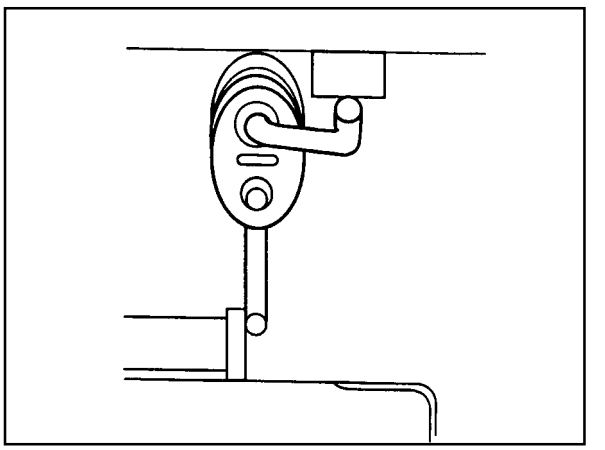


4. Remove the muffler mounting hanger from the rubber pad and remove the center muffler and tail muffler.

Notice

Check the gasket, if necessary, replace the new one.

5. Installation should follow the removal procedure in the reverse order.

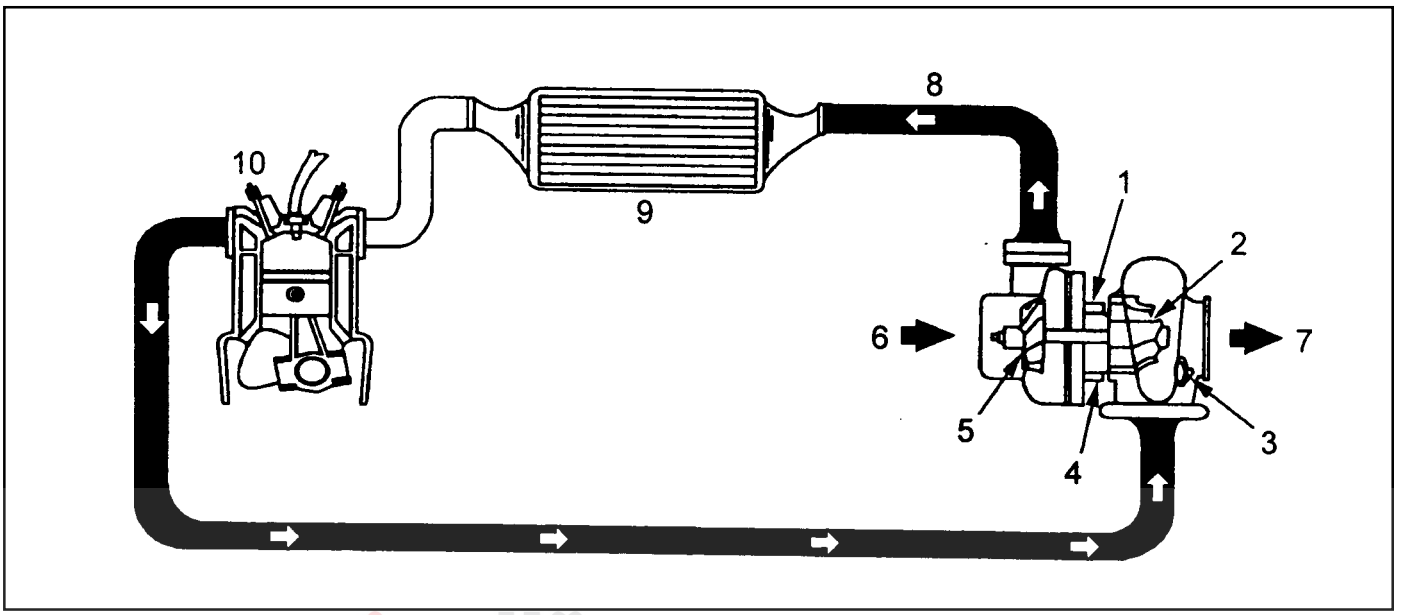


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TURBOCHARGER

CHARGE AIR SYSTEM DIAGRAM



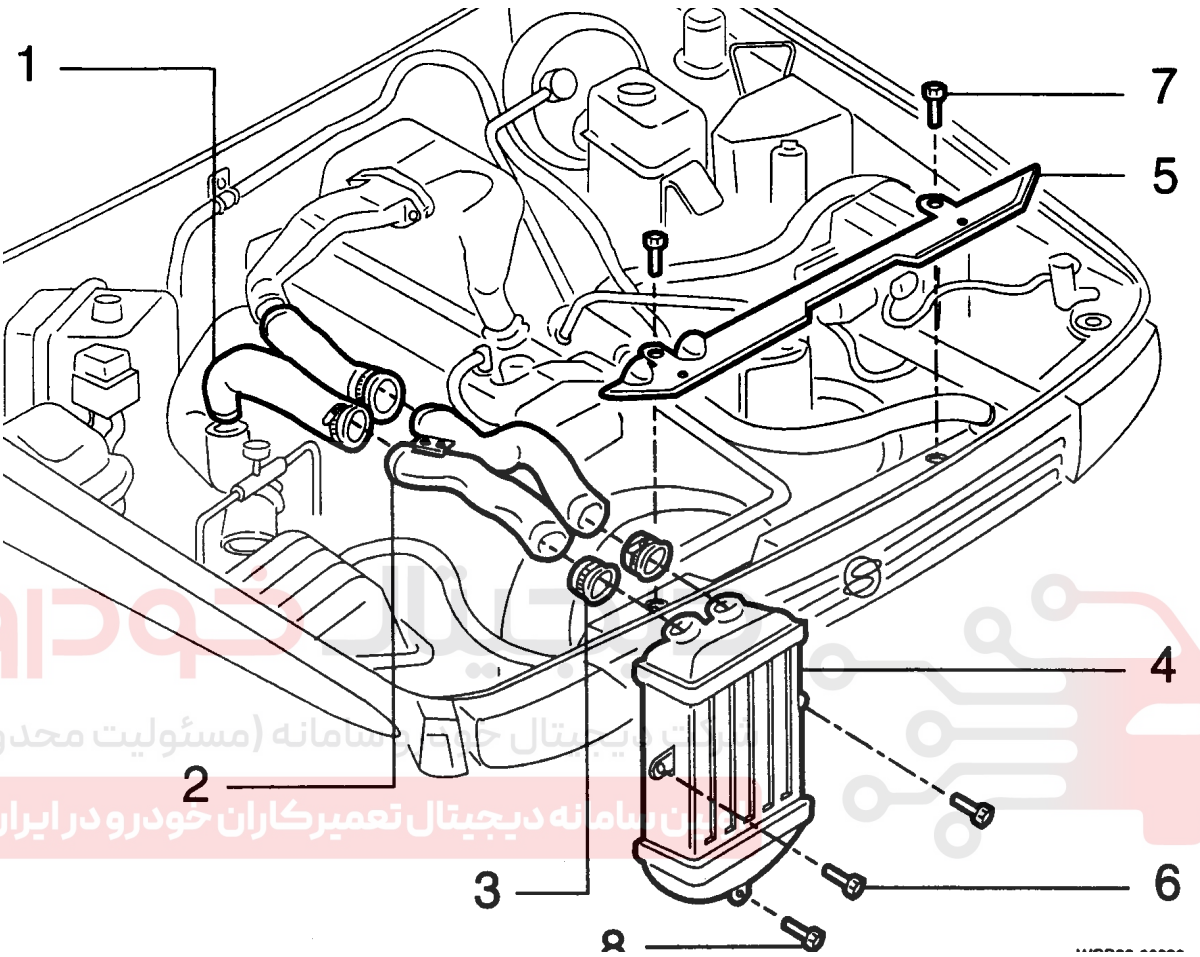
1 Turbocharger Oil Inlet
2 Turbine Wheel
3 Waste Gate
4 Oil Outlet
5 Compressor Wheel
6 Air Inlet
7 Exhaust Gas Outlet
8 Compressed Air Flow
9 Intercooler
10 Cylinder

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INTERCOOLER



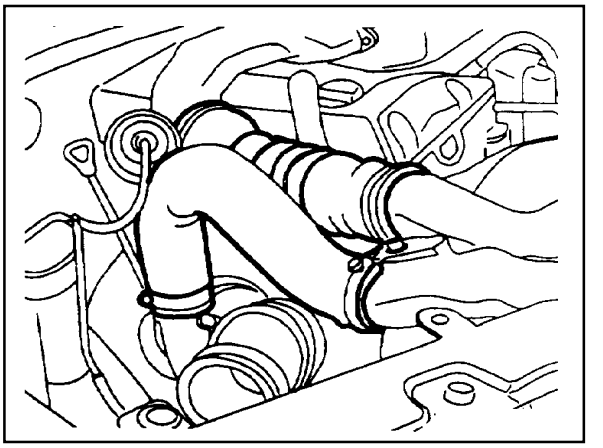
1 Hoses
2 Pipes
3 Hoses
4 Intercooler
5 Cover
6 Bolts
7 Screws
8 Bolts

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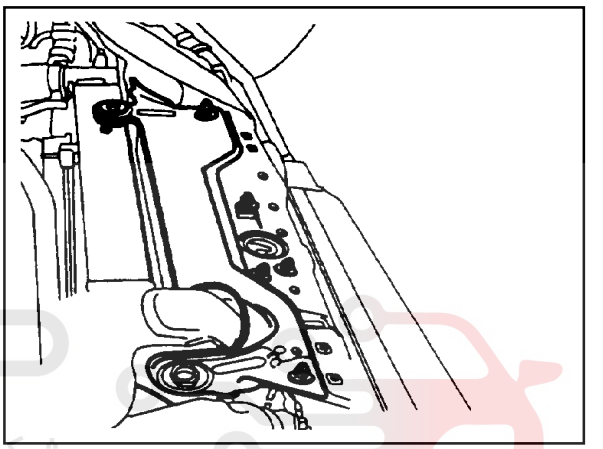
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Removal & Installation Procedure

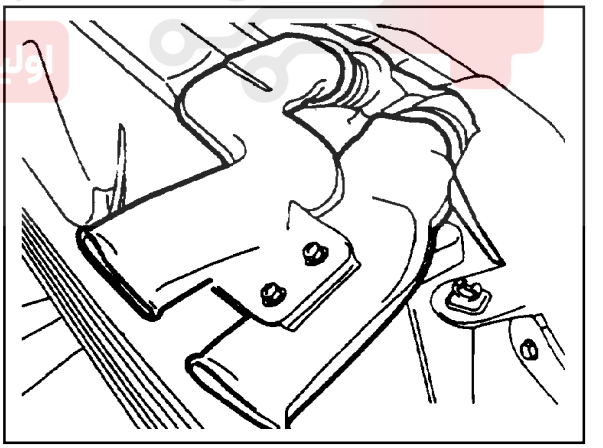
1. Remove the hose connected to turbocharger and intake duct.



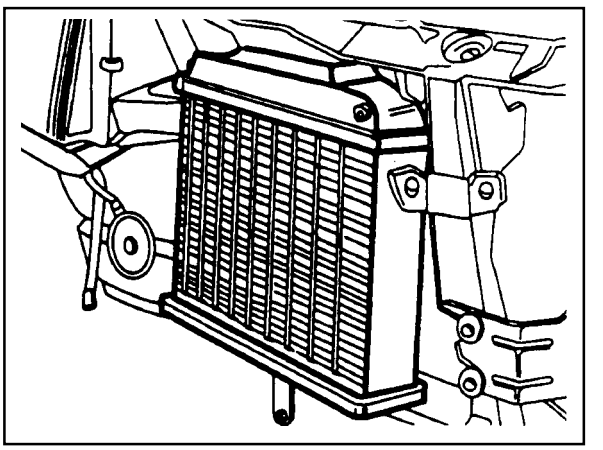
2. Remove the protective cover.



3. Loosen the clamps and remove the pipe and hose connected to intercooler.



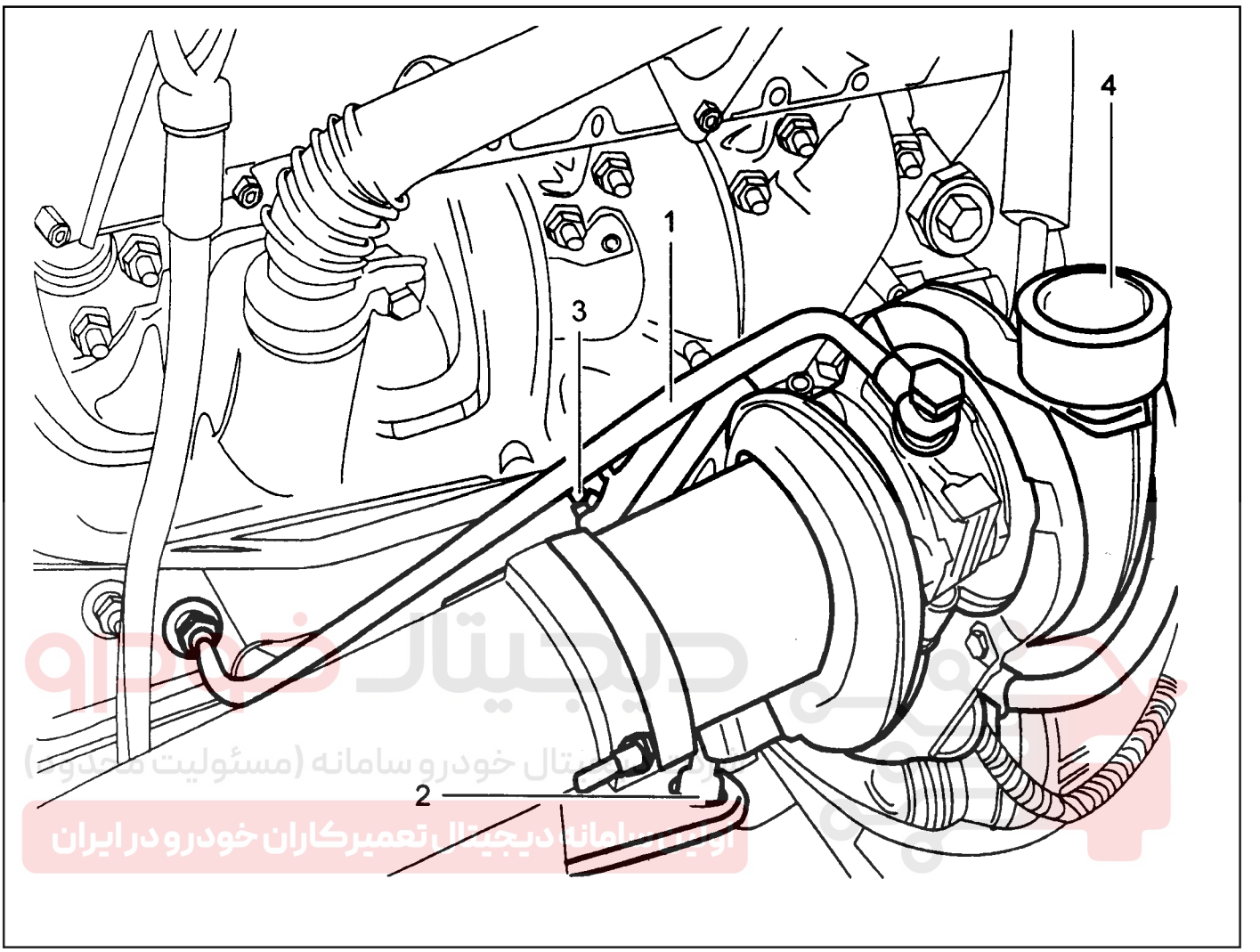
4. Unscrew the mounting bolts and remove the intercooler.
5. Installation should follow the removal procedure in the reverse order.



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TURBOCHARGER ASSEMBLY



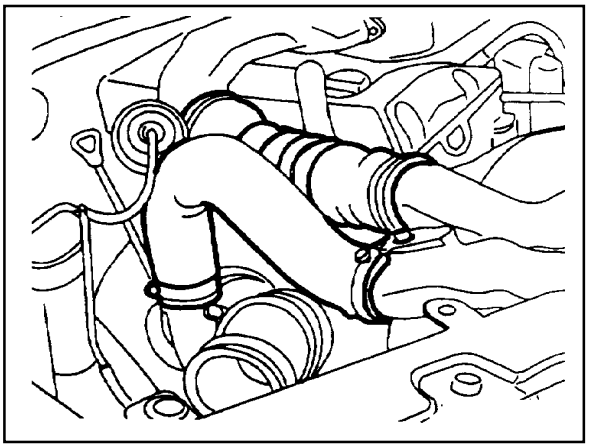
1 Oil Supply Line
2 Oil Return Line
3 Nuts
4 Turbocharger

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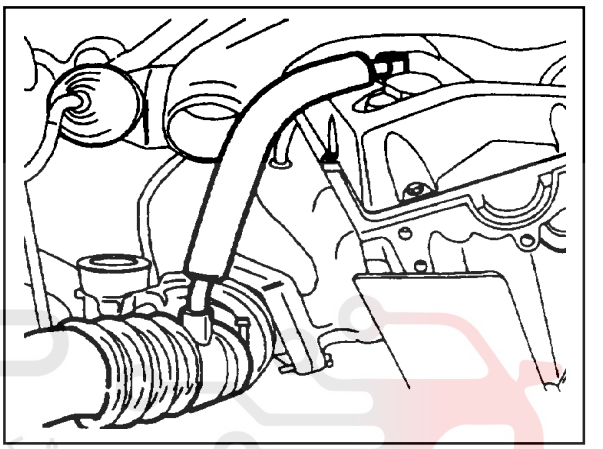
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Removal & Installation Procedure

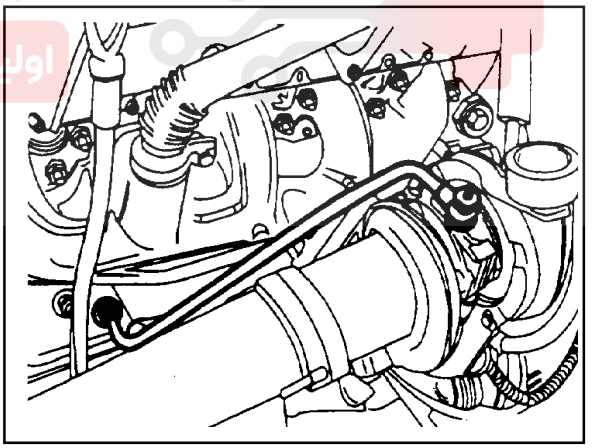
1. Remove the 2 hoses connected to intercooler.



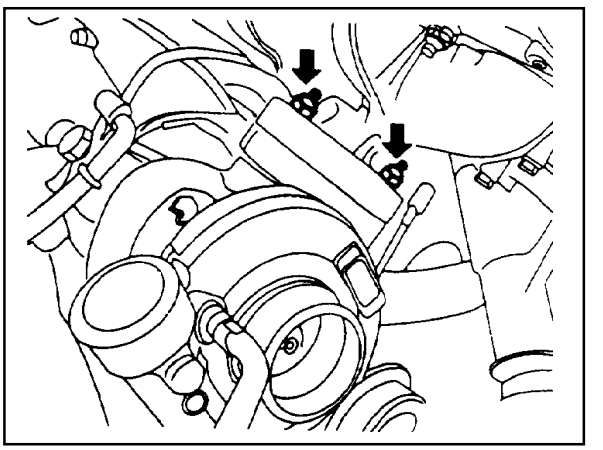
2. Remove the hose(air cleaner to turbocharger) with blow by hose.



3. Disconnect the oil supply pipe.
4. Remove the oil return pipe.
5. Remove the support assembly.



6. Remove the 3 nuts(arrows).



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