Identification and Specifications

General Specifications

Item	Specification
Engine Type	Peugeot XUD9AI, 4 cycle, water cooled, 4 cylinder, vertical in-line cylinders, single overhead cam, indirect injection, naturally aspirated.
Compression ratio	23.5 : 1
Governor:	Mechanical centrifugal type integral with fuel injection pump.
Governor Adjustment	3000 ± 50 RPM no load 1600 +100/–0 RPM idle speed
Engine Rotation	Counterclockwise when facing flywheel.
Crankshaft	Forged steel, induction hardened bearing surfaces, 5 main bearing supports.
Cylinder Block	Cast iron with integral cylinder liners.
Cylinder Head	Cast aluminum material with single overhead camshaft.
Timing Drive	The camshaft, water pump and fuel injection pump are driven from the front end of the crankshaft through belt drive.
Piston and Piston Rings	Pistons are aluminum alloy castings with free-floating wrist pin.
Lubrication	Full pressure feed by gear type pump.
Oil Filter	Full flow, cartridge type, paper element with bypass.
Oil Capacity	5 liters (5.3 qt.), including oil filter.
Lubricating Oil	API class CD SAE 15W-40
Oil Pressure	0.5 Bar (7 PSI) minimum
Fuel Requirements	No. 2 diesel fuel (ASTM No. 2-D).
Fuel Filter	Replaceable paper element.
Crankcase Ventilation	Connected to intake manifold with PCV valve.
Cooling System	Water is circulated through the cylinder block and head by a centrifugal water pump mounted at the front of the cylinder block. The water pump operates at 1.05 times engine speed. Water flow is 92 liters/min. at 2500 engine RPM.
Firing Order (NO. 1 CYL. IS ON FLYWHEEL END)	1 - 3 - 4 - 2
Electrical System	12 volt, negative ground, 55 AMP alternator with integral regulator. 12 volt - 1.4 Kw starter motor with integral solenoid, pinion shaft type.

Cylinder Head

Cylinder head height **h** is measured with the camshaft in place fitted with two bearing caps.

h is measured on the oil seal lip contact diameter (the largest diameter).

h nominal: 157.40 to 157.75 mm

Maximum permissible bow on bottom of cylinder head: 0.07 mm (camshaft must turn freely).

Maximum permissible gasket face machining: 1.4 mm in relation to the measured **h** nominal.

Cylinder heads machined undersize are stamped **R** in the area (**a**):

After machining gasket face, the following operations must be done:

1. Valve seat machining to re-establish correct recess (see Valve Recess in this section).

2. Replacement of swirl chambers by repair dimension and correction of their protrusion (see Swirl Chambers in this section).

3. Fitting of 0.4 mm thick compensation washers under the valve springs (to match cylinder head machining.

Cylinder heads manufactured with oversize camshaft bearings (+0.5) are stamped **1** in the area (**a**)

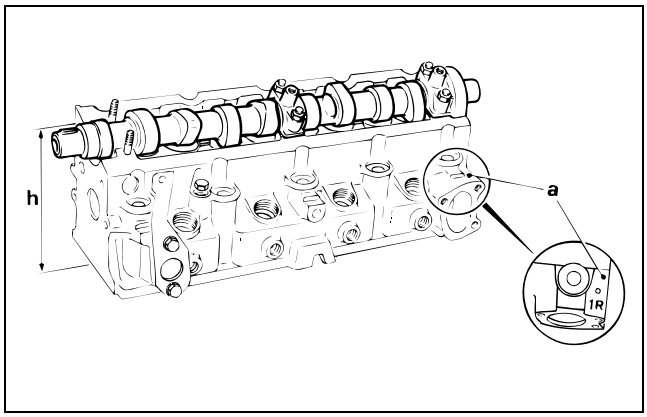

Figure 2

Cylinder Head Gasket

Thickness identification:

Units: mm

Identification (**c**)	Identification (**b**)	Thickness
No notch	2 notches	1.48
	3 notches	1.52
	4 notches	1.58
	5 notches	1.62

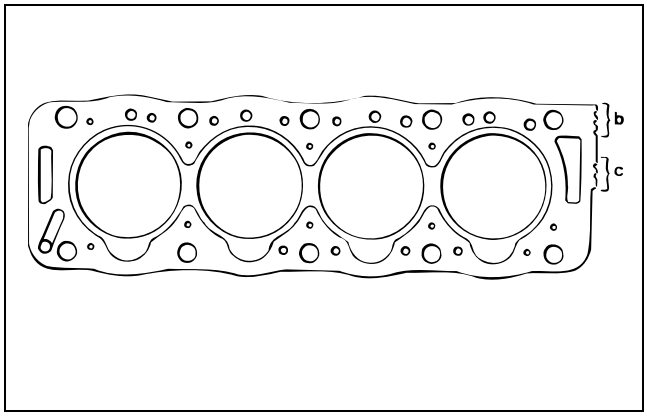

Figure 3

Camshaft

Camshafts with 0.5 mm oversize bearings* are identified by a yellow paint ring (**d**) between the cams of No. 1 cylinder.

* NOTE: These camshafts are installed only on exchange engines, and can be obtained on special order.

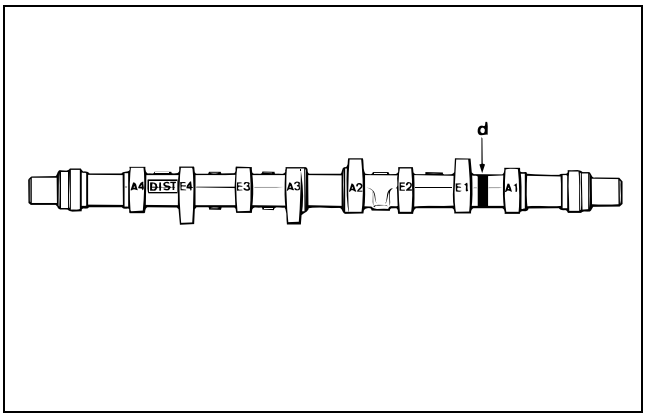

Figure 4

Valves

Units: mm

	Intake	Exhaust
Min. Length **l**	112.2	
ø**a** $^{+0}_{-0.015}$	8.005	7.985
ø**b** ± 0.1	38.5	33
a	90°	90°

Intake: Faces **x** and **y** can machined a maximum of 0.2 mm

Exhaust: No machining is permissible.

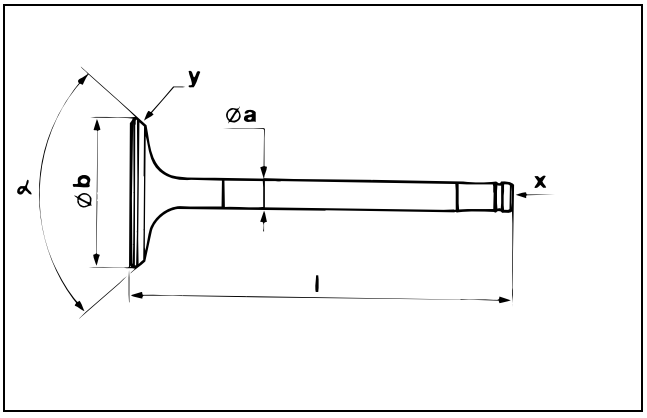

Figure 5

Valve Recess

Units: mm

	Intake	Exhaust
c	0.5 to 1.05	0.9 to 1.45

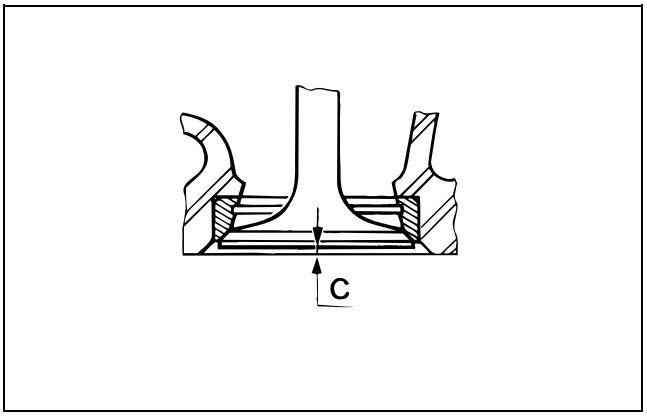

Figure 6

Valve Springs

Units: mm

	Spring
ød	29
P1: daN **e1**	18 42.4

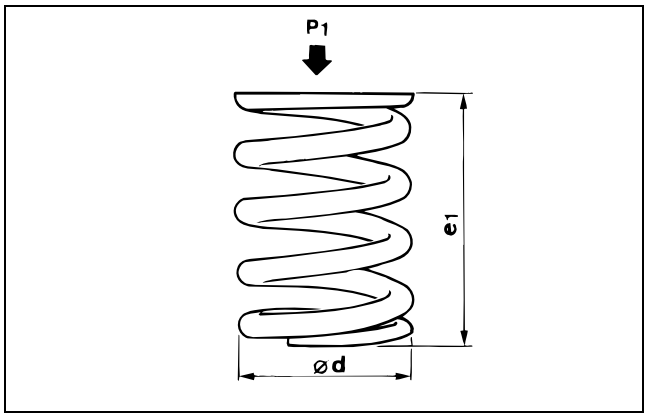

Figure 7

Valve Guides

Units: mm

	øf	øg	**h**	**j**	**øk**
Tolerance	0 – 0.011	+ 0.032 0	± 0.25	± 0.50	0 + 0.2
Production	14.02 14.13	13.981 14.051			
Repair 1	14.29	14.211	52.00	36.50	8.02
Repair 2	14.59	14.511			

øk is obtained by machining after fitting in the cylinder head

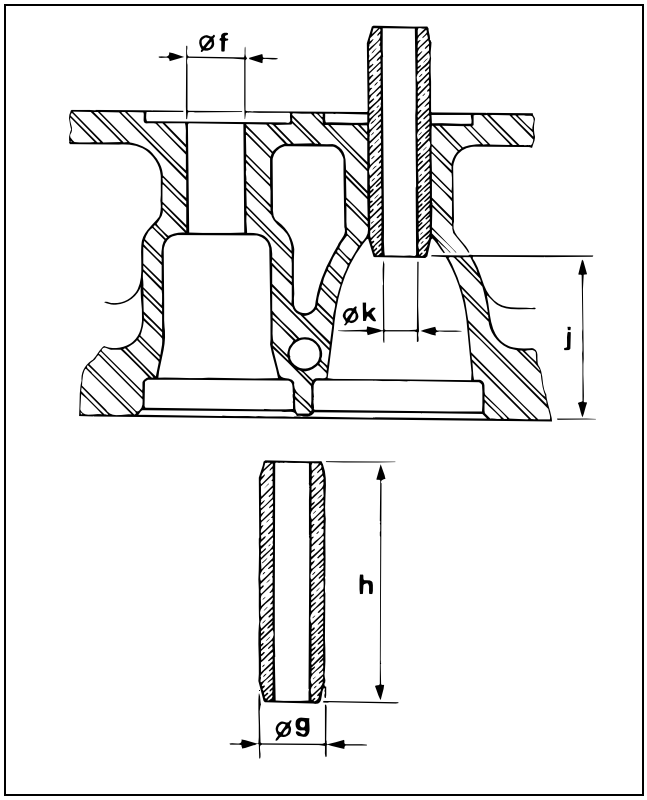

Figure 8

Valve Seats

Units: mm

Intake				
	øa	øb	**c**	**d**
Tolerance	0 – 0.025	± 0.025	0 – 0.1	± 0.15
Production	40.161 40.361	40 40.2	6.25 6.45	8.267 8.467
Repair 1	40.461	40.3	6.45	8.467
Repair 2	40.661	40.5	6.45	8.467

Units: mm

Exhaust				
	øa	øb	**c**	**d**
Tolerance	0 – 0.025	± 0.025	0 – 0.1	± 0.15
Production	34.137 34.337	34 34.2	6.05 6.25	8.15 8.35
Repair 1	34.437	34.3	6.25	8.35
Repair 2	34.637	34.5	6.25	8.35

After fitting valve seats into the cylinder head, machine them according to drawings (Fig. 9).

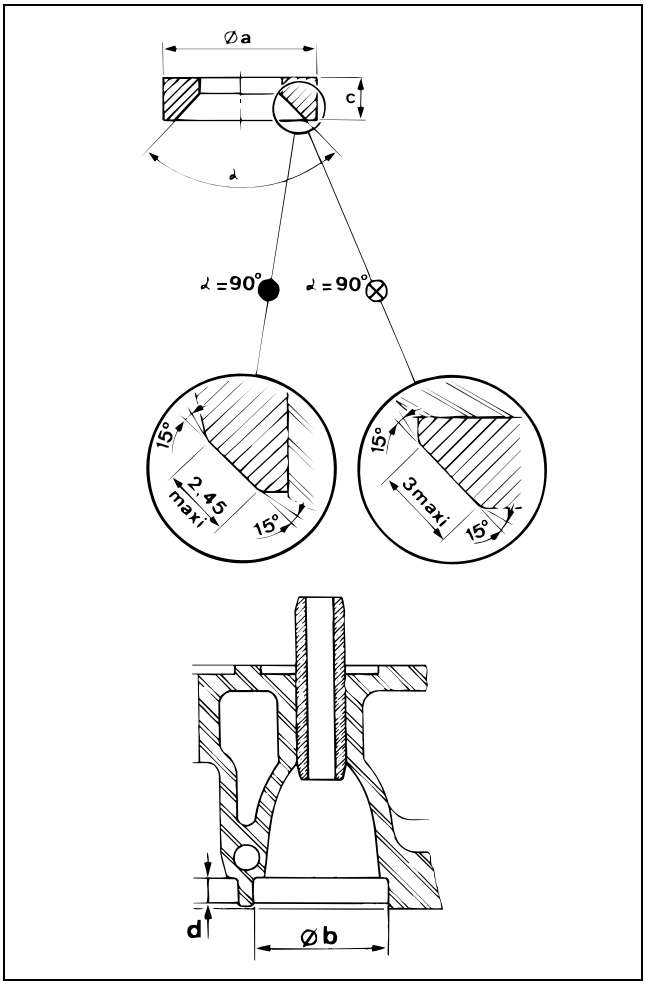

Figure 9

Swirl Chambers

Units: mm

	øe	øf	**g**	**h**
Tolerance	+ 0.099 – 0.060	+ 0.039 + 0	+ 0.020 – 0.025	+ 0.02 – 0.04
Production	32.05 32.25	32 32.2	4 4.1	3.9 4
Repair 1	32.45	32.4	4.2	4.1
Repair 2	32.65	32.6	4.3	4.2

The protrusion **j** must be between **0** and **0.03 mm**
Dimension **j** is obtained by machining faces (**x**) and (**y**)

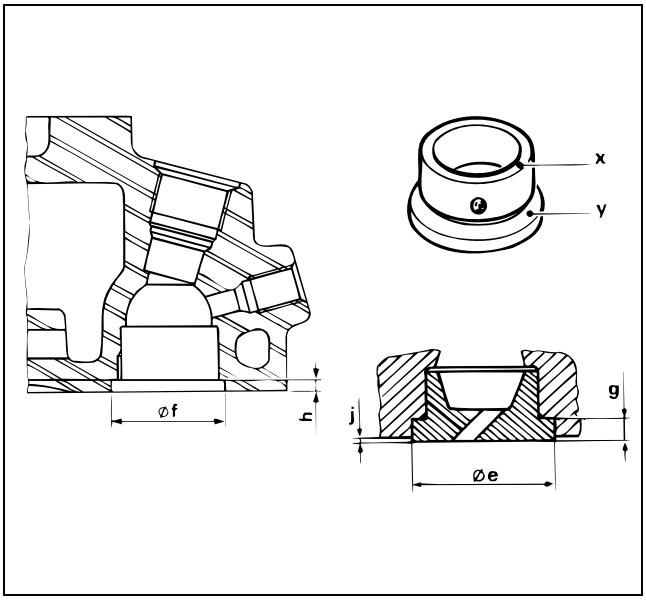

Figure 10

Cylinder / Piston Matching

Units: mm

	Identification (**x**)	CYLINDER ø**a** Tolerance: + 0.018 – 0	PISTON øb Tolerance: ± 0.009
Production	None	83	82.93
	A1	83.03	82.96
Repair 1	R1	83.20	83.13
Repair 2	R2	83.50	83.43
Repair 3	R3	83.80	83.73

NOTE: The piston ø**b** must be measured at dimension **c.**

C	25.00

NOTE: The repair dimension (**x**) is stamped on the cylinder block and pistons.

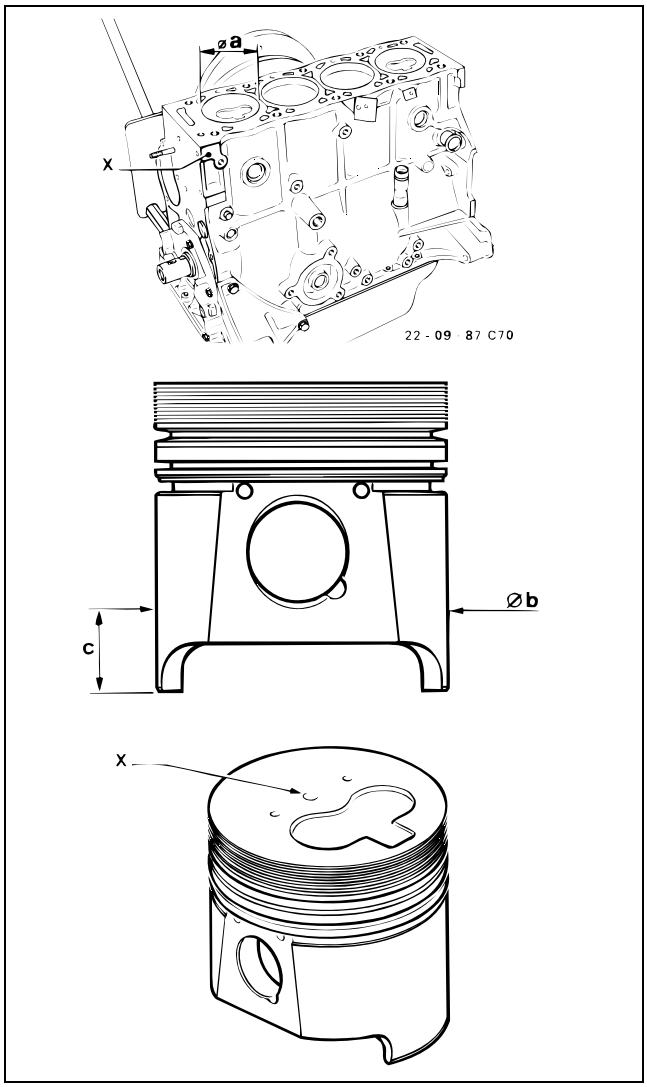

Figure 11

Piston Pin

Units: mm

Ø external	24.994 to 25
Ø internal	13.8 to 14.1

Crankshaft

Units: mm

Crank Pins and Journals				
	øa	b	**øc**	d
Tolerance	– 0 – 0.016	± 0.003	– 0 – 0.019	± 0.003
Production	50.00	1.827	60.00	1.842
Repair 1	49.70	1.977	59.70	1.992

NOTE: Repair 1 size connecting rod and main bearing shells can be identified by white paint (**1**) on the edge of the shell.

Units: mm

End Float		
	No. 2 Journal	Half Shell Thickness
	e	**f**
Tolerance	+ 0.05 0	± 0.025
Production	26.60	2.305
Repair 1	26.80	2.405
Repair 2	26.90	2.455
Repair 3	27.00	2.505

Units: mm

Oil Seal Contact Surface	
	øg
Tolerance	– 0 – 0.087
Production	90.00
Repair 1	89.80

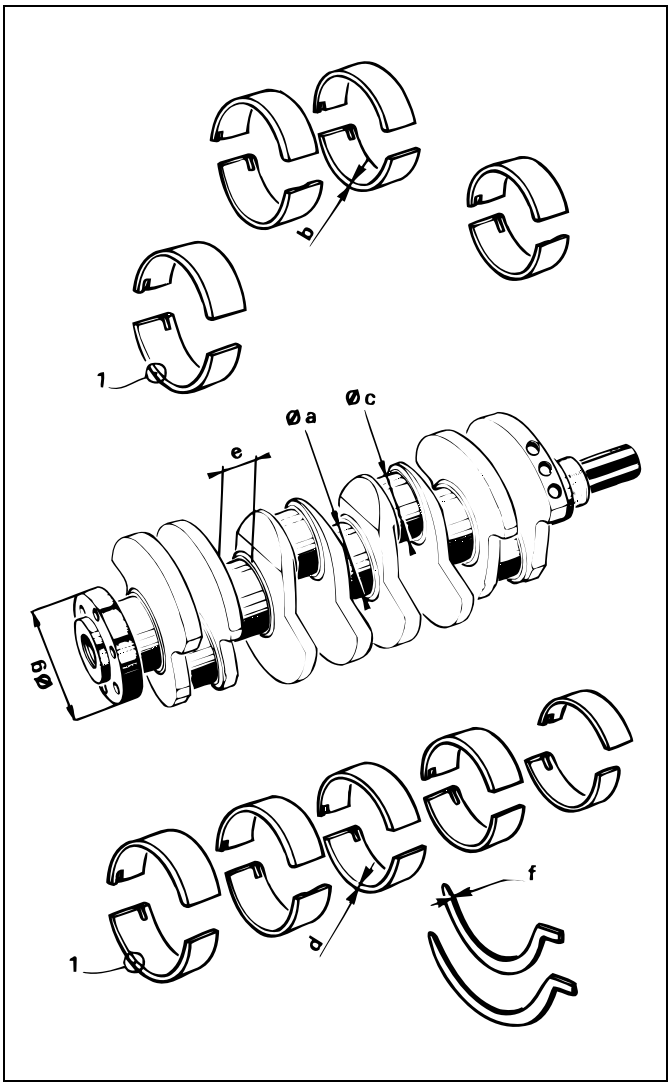

Figure 13

Tightening Torques

Part	Nm	Kgm	ft-lb
Connecting rod end caps	50	5	37
Camshaft bearing caps	17.5	1.8	13
Camshaft gear	40	4	30
Coolant pump	15	1.5	11
* Crankshaft pulley	40 + 60°	4 + 60°	30 + 60°
Cylinder head bolts pre-tightening * tightening	 30 70 +120°	 3 7 + 120°	 22 52 + 120°
Cylinder head cover	10	1	7
Flywheel	50	5	36
Glow plugs	22	2.2	16
Injector pump gear	47	4.7	33
Injector into Cylinder Head	90	9	66
Main bearing caps	70	7	52
Oil pump	20	2	15
Oil seal carrier, timing gear end	15	1.5	11
Sump to block	20	2	15
Timing belt tensioner	15	1.5	11
Water drain plug	25	2.5	18
Oil drain plug	37	3.7	27
Tension roller pin nut	17	1.7	12
Manifold screws	22	2.2	16
Alternator bracket	17	1.7	12

* NOTE: 40 + 60° is tighten to 40 Nm then an additional 60° (60 degrees) of rotation (one flat of bolt head)

Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Groundsmaster 455-D Parts Catalog. Some tools may also be available from a local supplier.

TOR4033 Overhaul Tool Set

This tool kit includes tools required for overhauling the engine. TOR4035 Tune-Up Set will also be required if overhauling the engine.

TOR80504A1 Extension (Fig. 24)
TOR80110H Indicator Holder (Fig. 25)
TOR80110DZ 2mm Shim Cutoff Gauge (Fig. 23)
TOR80504A2 Indicator Holder (Fig. 30)
TOR80110GY Extension Rod Adapter (Fig. 24)
TOR70153A1 Main Seal Installer (Fig. 18)
TOR70153A2 Main Seal Installer Shims (Fig. 19)
TOR70153C Rear Main Seal Installer (Fig. 20)
TOR70153D Front Cover Seal Installer (Fig. 21)

TOR4035 Tune-Up Set

This tool kit includes tools required for doing timing belt replacement, injection pump timing, injector removal and camshaft seal replacement.

TOR976697 Camshaft Seal Installer (Fig. 31)
TOR2437T Dial Indicator (Fig. 16)
TOR70153N Flywheel TDC Locator Pin (Fig. 22)
TOR80117AM Injector Pump
Timing Tool Kit (Fig. 26)
TOR80117EZ Crankshaft Rotating Wrench (Fig.27)
TOR80149 Injector Socket (Fig. 28)

TOR2437T Dial Indicator

This dial indicator may be used with TOR80110H, TOR80117AM and TOR80504A2 to accomplish any of the following tasks: for checking the protrusion of the swirl chambers, valve recess and measurement for cylinder head gasket selection, adjusting the timing of the injection pump and for checking the crankshaft and float.

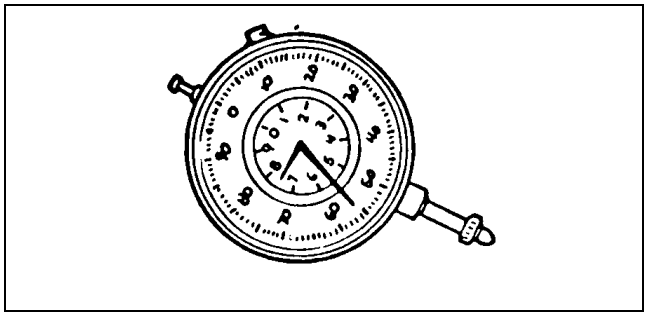

Figure 16

TOR4024T Valve Spring Compressor

This tool is used to compress valves for removal.

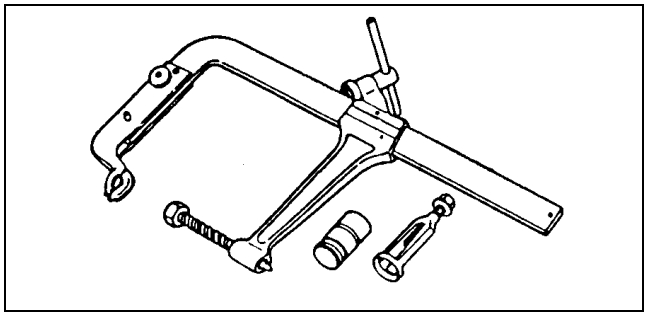

Figure 17

TOR70153A1 Main Seal Installer

Used to install the two side seals to the no. 1 main bearing cap.

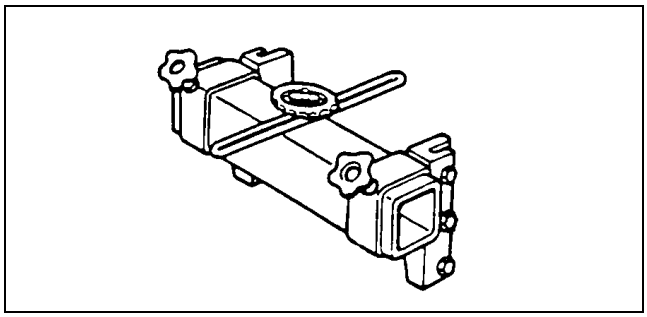

Figure 18

TOR70153A2 Shim Set

Used with main seal installer TOR70153A1.

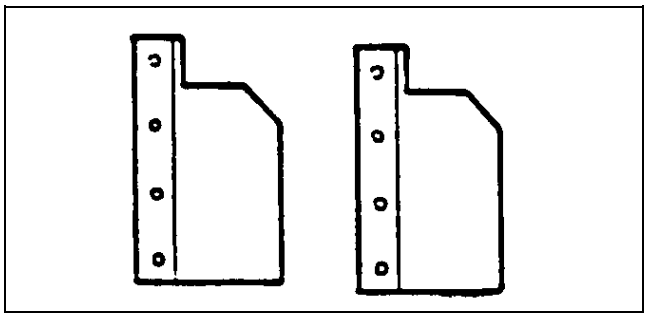

Figure 19

TOR70153C Rear Main Seal Installer

Used with a small hammer to install new rear main oil seal.

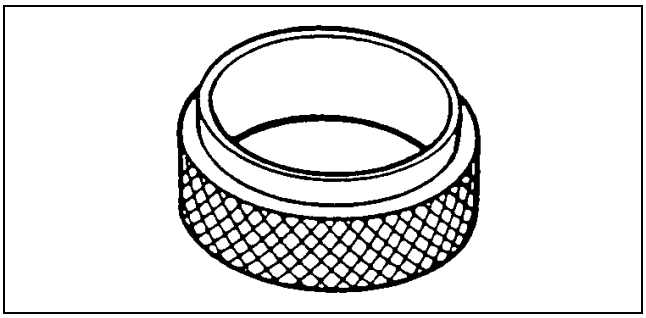

Figure 20

TOR70153D Front Cover Seal Installer

Used with a small hammer to install new front crankshaft seal.

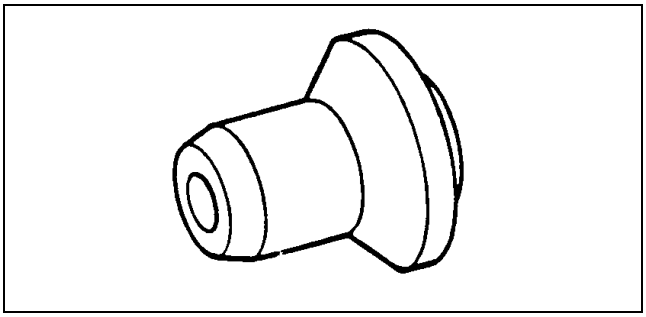

Figure 21

TOR70153N Flywheel T.D.C. Locator Pin

Used to set injection pump timing.

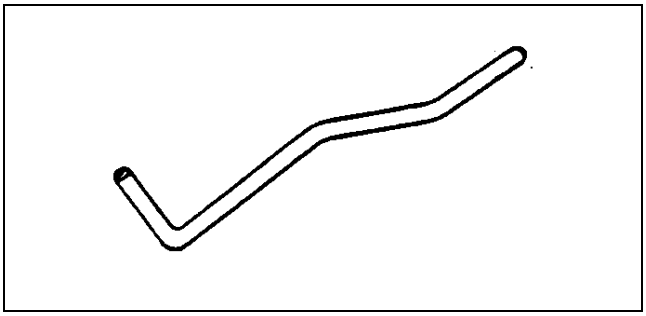

Figure 22

TOR80110DZ 2mm Shim Cut Off Gauge With Cut Off Shim

Used to gage and gut off new side seals to 2mm height.

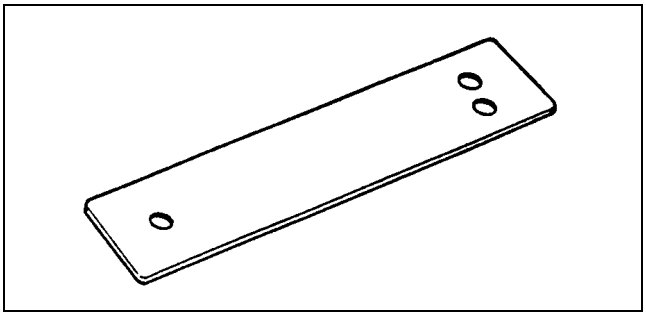

Figure 23

TOR80110GY Extension Rod and Adapter

Used with TOR 80504A1 and TOR80504A2 to check crankshaft end float.

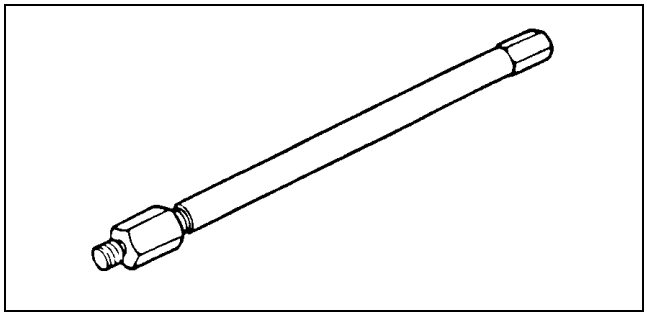

Figure 24

TOR80110H Indicator Holder

Block used to hold dial indicator to check protrusion of swirl chambers, valve recess and measurement for cylinder head gasket selection.

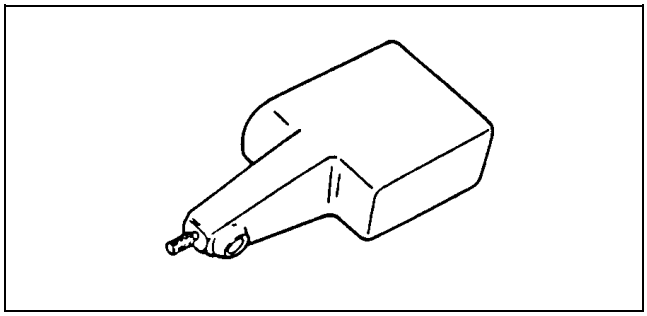

Figure 25

TOR80117AM Timing Tool Kit For Roto Diesel DPC Pump

Used with dial indicator to adjust timing of injection pump.

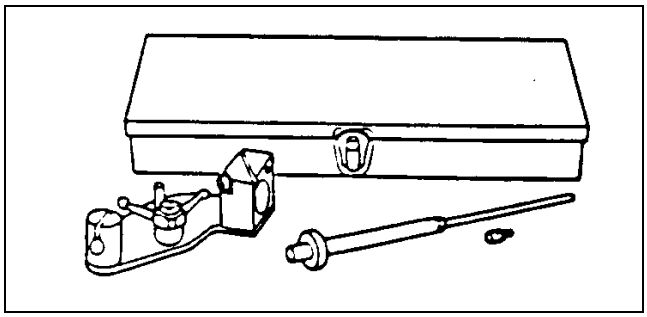

Figure 26

TOR80117EZ Crankshaft Rotating Wrench

Used with a 1/2" drive ratchet wrench to turn the crankshaft.

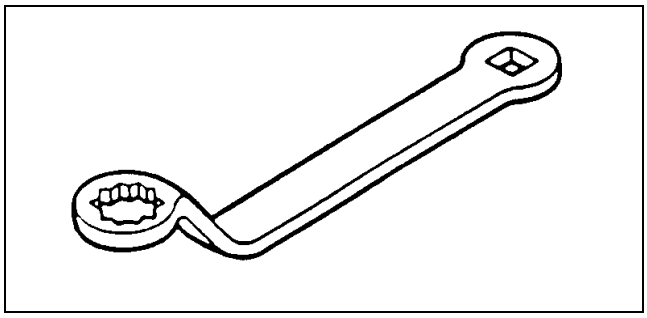

Figure 27

TOR80149 Injector Socket

Used to remove and install fuel injectors.

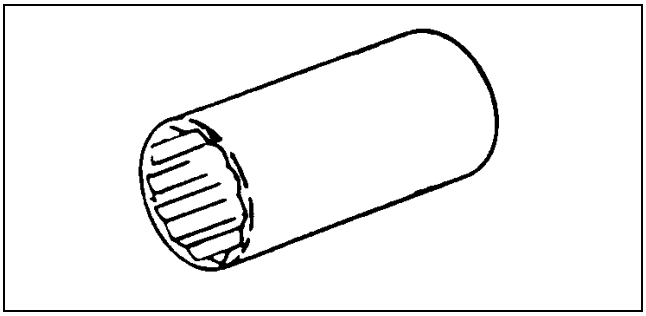

Figure 28

TOR80504A1 Extension

Used with TOR 80110GY and TOR 80504A2 to check crankshaft end float.

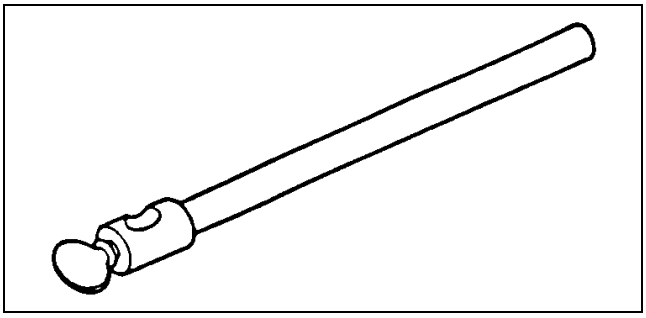

Figure 29

TOR 80504A2 Indicator Holder

Used with TOR80110GY and TOR 80504A1 to check crankshaft end float.

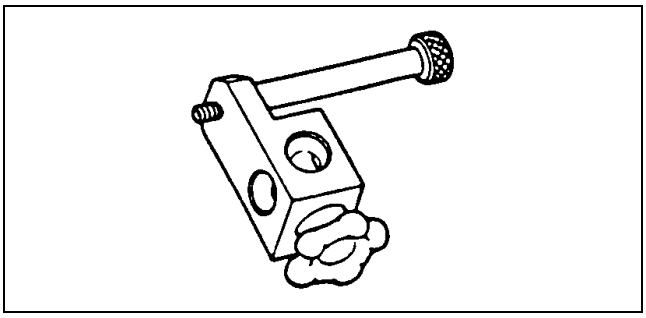

Figure 30

TOR976697 Camshaft Seal Installer

Used to install camshaft seal.

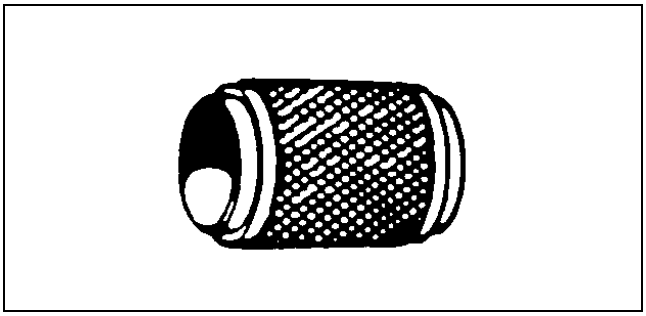

Figure 31

.0149 - Cylinder Head Separating Levers (Make Locally)

Used to remove cylinder head (qty. 2 required).

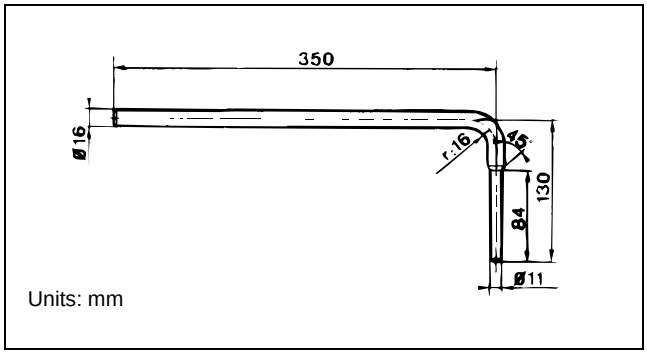

Figure 32

TOR70153H Injector Pump Gear Puller

Loosen the nut on the injector pump gear, then use this tool to loosen the pulley from the tapered shaft on the injector pump.

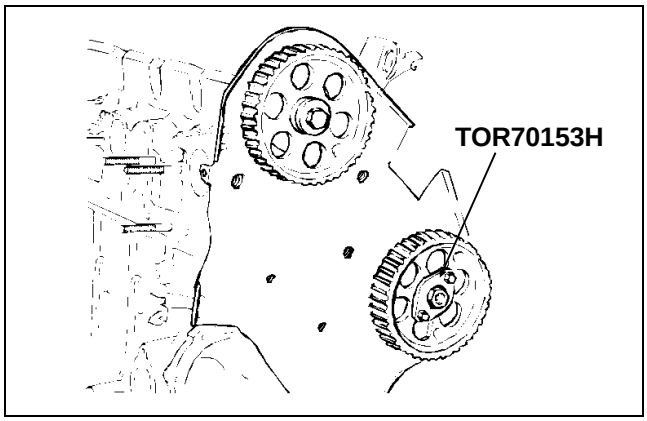

Figure 33

Adjustments

Valve Clearance Adjustment

(See Valve Clearance Adjustment in the Engine Overhaul Section.)

Engine Speed Adjustments

Maximum fuel flow and speed adjustments are sealed and should only be unsealed by a CAV Lucas ROTO-DIESEL service dealer.

Throttle Cable Adjustments

The throttle control lever at the operator's station must not touch the end of the slot during full range of motion from idle (SLOW) to full engine RPM (FAST).

Adjust throttle cable at injection pump so throttle lever on injection pump operates at full range of motion without throttle control lever at operator's station touching end of slot at either FAST or SLOW position.

Testing and Inspection

Injection Pump Timing

(See Timing of Injection Pump in the Engine Overhaul section.)

Glow Plug Test

CAUTION

Be careful while handling or testing glow plugs. Glow plugs become extremely hot. Accidental contact with the heated plug tip could cause personal injury.

1. Disconnect the wire lead(s) to the glow plug.

2. Remove the glow plug.

3. Inspect the glow plug for signs of a burnt glow plug end tube.

NOTE: If the metal of the glow plug end is melted, it is a sign of cylinder overheating.

4. Connect the positive (+) battery terminal to the glow plug terminal, and the negative (–) battery terminal to the plug body (Fig. 34). If the glow plug glows red-hot in 9 to 12 seconds, the glow plug is operating correctly. DO NOT leave on more than 20 seconds.

5. Replace any glow plugs that do not operate correctly.

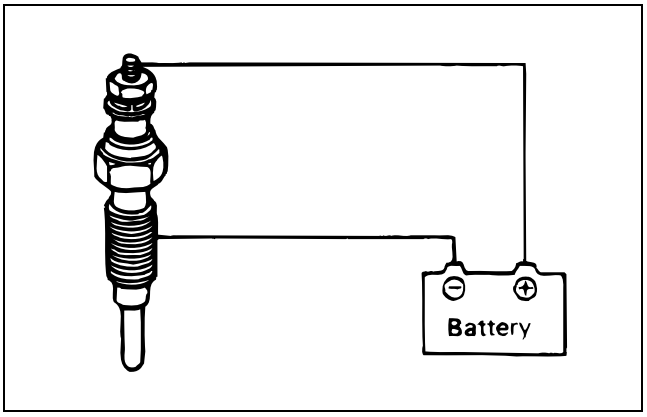

Figure 34

Compression Test

Minimum cylinder compression is 20 bar (290 psi) at 200 rpm (normal cranking speed). The engine should be warm - coolant temperature of 50^{o} C (120^{o} F).

IMPORTANT: DO NOT put oil into the combustion chamber before performing a compression test. Damage may result because of "hydraulic" forces acting upon the piston and connecting rod.

1. Remove the glow plug lead wires and glow plugs from all four cylinders.

2. Insert a compression gauge adapter into the glow plug hole.

3. Connect a high pressure compression gauge to the adapter.

4. Disconnect the fuel stop solenoid electrical connector or hold the fuel stop lever in the stop position to prevent fuel delivery during the compression test. This will prevent wash-down of the cylinders and inaccurate readings.

5. Crank the engine with the starter motor until you get a stable gauge reading.

6. If the pressure is less than 20 bar (290 psi) it will be necessary to find the cause of low compression.

7. Repeat the test for the other three cylinders. Difference between cylinders should be no more than 5 bar (70 psi).

8. Connect the fuel stop solenoid electrical connector.

9. Install the glow plugs.

Injector Tests

There are several tests to examine the condition of the injection nozzles. These tests require the use of a nozzle tester and nozzle tester adapter.

CAUTION

The nozzle tester forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.

To prevent possible injury, wear eye protection when operating the nozzle tester.

IMPORTANT: Always use fresh filtered fuel in the nozzle tester. Use of dirty fuel can damage the precision parts of the injector nozzle. It is a good practice to:

1. Bolt the tester securely to the test bench.

2. Use a drain pan to catch fuel.

3. Flush the adapter by pumping the handle of the tester slowly several times before attaching the nozzle to be tested.

Injection Pressure Test

The diesel engine requires that fuel be sprayed into the combustion chamber at a precise point in the compression stroke. The point at which this fuel injection occurs is determined by the injection timing. If the nozzle is defective, damaged or adjusted incorrectly, starting failures, low power output, or engine knocking can occur.

1. Securely fasten the nozzle to the adapter.

2. Pump the handle several times to purge air from the nozzle mechanism.

3. Allow pressure to dissipate before performing the test.

4. Operate the pump handle slowly and observe the gauge to determine the pressure at which the nozzle opens and the fuel is sprayed.

5. Verify that starting pressure is within the following limits:

"C" injectors 115 $\pm$ 5 bar or kg/cm^2 (1668 $\pm$ 70 psi)
"D" injectors 130 $\pm$ 5 bar or kg/cm^2 (1885 $\pm$ 70 psi)

6. Starting pressure can be adjusted by adding or removing shims from the nozzle. A 0.10 mm shim thickness will cause a 10 bar or kg/cm^2 (140 psi) starting pressure difference.

7. Repeat the test after installing shim to verify that a correct opening pressure has been obtained.

Chattering Test

Proper and free operation of the nozzle valve can be determined by the chattering test.

1. Securely fasten the nozzle to be tested to the adapter.

2. Operate the pump handle slowly (1 - 2 strokes per second). As the pump pressure reaches the starting pressure the nozzle valve will chatter or buzz as it opens and closes rapidly. A nozzle which does not chatter or buzz may be the result of a binding or bent nozzle valve.

Nozzle Leakage Test

A nozzle that leaks fuel from the nozzle orifice must be replaced.

1. Securely fasten the nozzle to the adapter.

2. Wipe all fuel from the nozzle.

3. Operate the pump until the pressure is approximately 20 bar or kg/cm^2 (280 psi) below opening pressure. Maintain this pressure to the nozzle.

4. Watch for leaks where the threaded nozzle body threads into the retaining nut. Leaks in this area would indicate a bad seat between the distance piece and/or the body or nozzle assembly.

5. If leakage occurs, verify that the body is tightly fastened in the retaining nut. If the leak continues, replace the nozzle.

6. While pressure is being applied, watch for an accumulation of fuel at the tip of the nozzle (Fig. 35). A small amount of fuel may be present due to a previous chattering test - this would be normal. If the fuel accumulates and drips down during the test (about ten seconds) the nozzle assembly is defective and must be replaced.

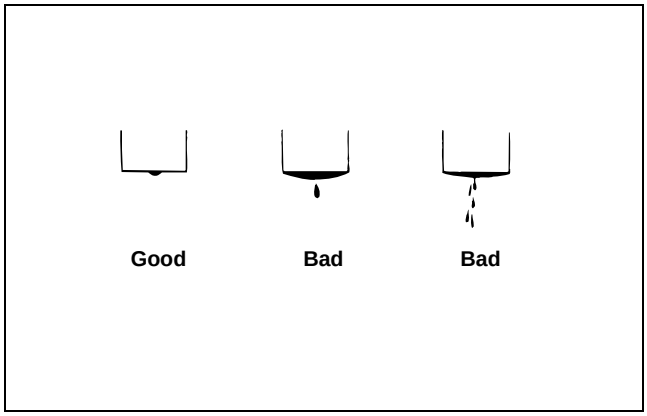

Figure 35

Spray Test

For proper combustion, the nozzle must effectively atomize the injected fuel.

1. Operate the pump handle quickly (4 - 6 strokes per second).

2. Observe the injector nozzle spray. The spray pattern should be finely atomized in a broad, straight stream (Fig. 36).

3. If the nozzle fails to spray properly, it must be cleaned, repaired or replaced.

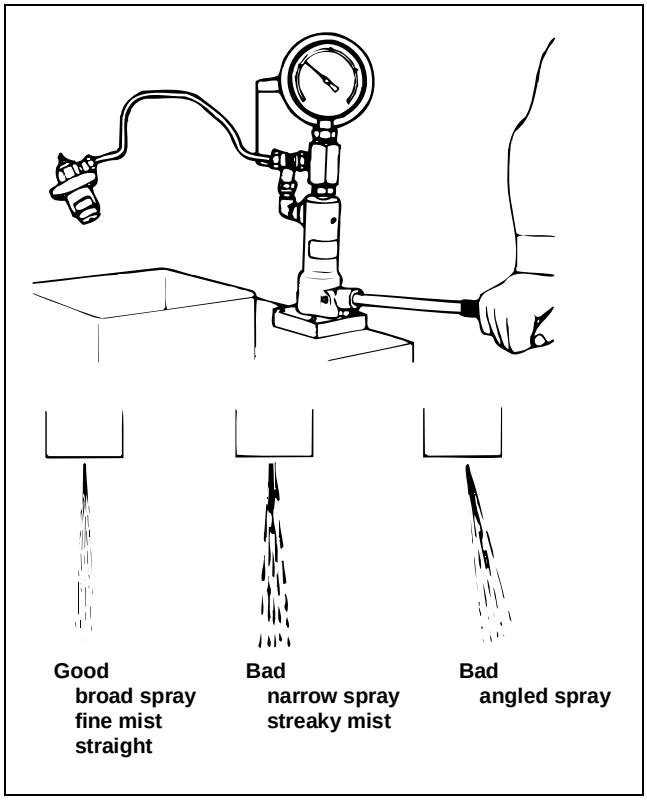

Figure 36

Injection Pump Testing

Calibration of fuel delivery volumes, pressure and distribution between pump barrels should be performed by a professional diesel engine service shop. Special test fixtures and equipment are required.

It is possible to determine if the fuel injection pump requires service through a process of elimination using other fuel system tests. The following test procedure will help isolate fuel system difficulties.

1. Make sure that fuel is being supplied to the injector pump.

2. Check the operating condition of the injection nozzles to make sure that the injection pressure is correct.

3. Make sure that the injection pump is providing sufficient fuel pressure to operate the nozzle by performing the following procedures:

A. Loosen the fuel delivery pipe from the number one nozzle.

B. Remove the nozzle from the cylinder head.

C. Connect the fuel delivery pipe to the nozzle assembly so the tip of the nozzle is pointed away from the engine. Tighten the fitting securely.

D. Put the throttle control in the FAST position. Turn the ignition key to the START position to crank the engine. Observe the nozzle.

CAUTION

The injection pump forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.

If the nozzle produces an atomized mist of fuel the injector pump for that cylinder is operating properly. Failure of the nozzle to inject fuel can indicate a injection pump cylinder that is not operating correctly.

5. Repeat the test for the other cylinders.

Thermostat Test

If the engine overheats or runs too cool, and a faulty thermostat is suspected, the thermostat should be tested.

1. Remove the thermostat.

2. Put the thermostat in a container of water with a thermometer and heat the water.

Starts to open at: 81° C (178° F)
7 mm (0.28 in.) full open at 88° C (190° F)

3. If the thermostat fails to open, only partially opens, or sticks, it should be replaced.

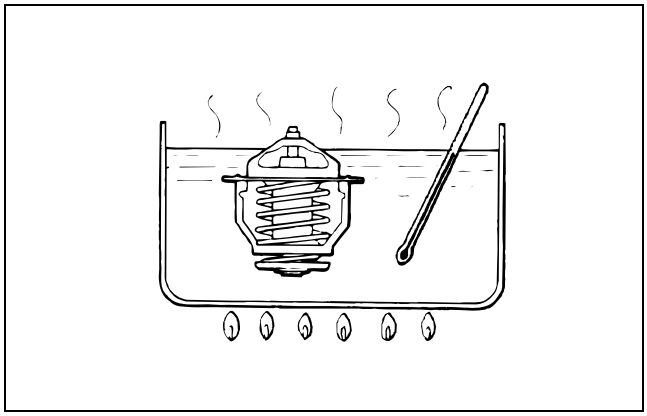

Figure 37

Fuel System Service

Priming Fuel System

1. Stop the engine. Unlatch and raise the hood

2. Fill the fuel tank.

3. Install a 3/16" hose over bleed screw. Put other end of hose into a container to catch fuel (Fig. 38).

4. Pump priming plunger until resistance is felt. Try to start engine. If engine does not start, go to step 5.

5.Loosen bleed screw a few turns. Pump priming plunger until a steady stream of fuel comes out of hole in bleed screw. When fuel stops foaming, tighten bleed screw during down stroke of priming plunger. Wipe up any spilled fuel.

NOTE: It may be necessary to bleed air out of the fuel line, between the fuel filter/water separator and the injection pump. To do this, loosen the fitting on the injection pump (Fig. 39) and pump priming plunger until a steady stream of fuel comes out of fitting. When fuel stops foaming, tighten the fitting during the down stroke of the priming plunger. Wipe up any spilled fuel.

NOTE: The high pressure fuel system is self-bleeding. It is not necessary to open the high pressure lines.

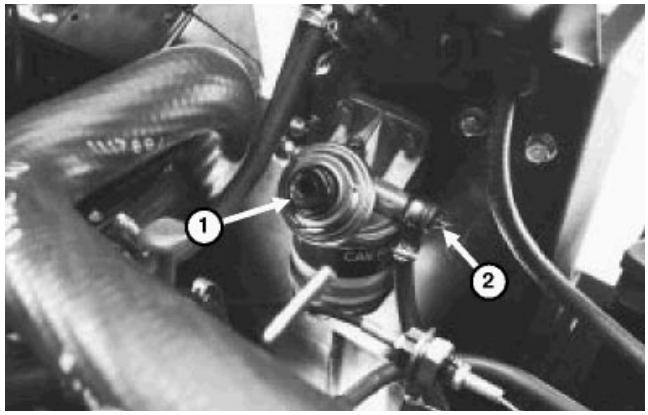

Figure 38

1. Primer plunger **2. Bleed screw**

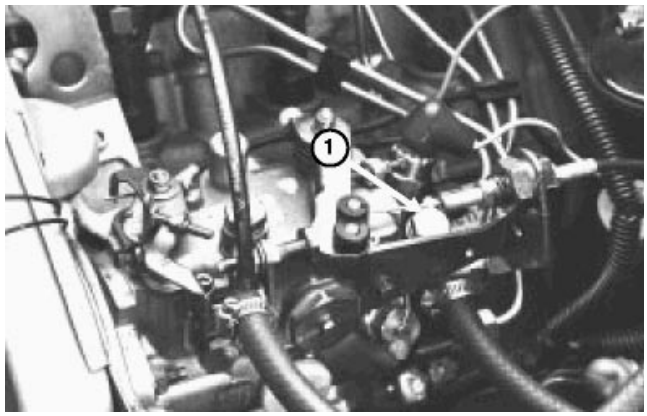

Figure 39

1. Injection pump fitting

Injection Pump Removal

(See Injection Pump Removal in the Engine Overhaul section.)

Injection Pump Repair

NOTE: If the pump needs to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

IMPORTANT: Clean the injection pump and the area around the injection pump before removing or servicing it. DO NOT spray water onto a hot injection pump.

Injector Service

NOTE: If injectors need to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the warranty on the injectors.

Removal

1. Clean top of cylinder head and injection pipes.

2. Remove injection pipes (Fig. 57, Item 12).

3. Disconnect injector leakage pipe.

4. Remove the injectors (Fig. 58, Item 19) and retrieve the copper washer (Item 20) and flame trap washer (Item 21).

NOTE: Never disassemble injector before checking its operation.

Disassembly and Cleaning

1. Secure the injector body in a “V” type injector holder.

2. Remove the injector holder nut.

3. Remove the injector, spacer, push rod, pressure setting spring, adjusting shims and body.

4. Dip all parts in clean diesel fuel.

5. Clean nozzle and needle in clean diesel fuel.

6. De-carbon injector nozzle using a wooden spatula. Never use metallic objects, emery cloth or rags. Do not attempt to grind the needle on its seat. Clean each injector separately to matched parts are not mixed up. The needle should slide freely and fall in the nozzle by its own weight.

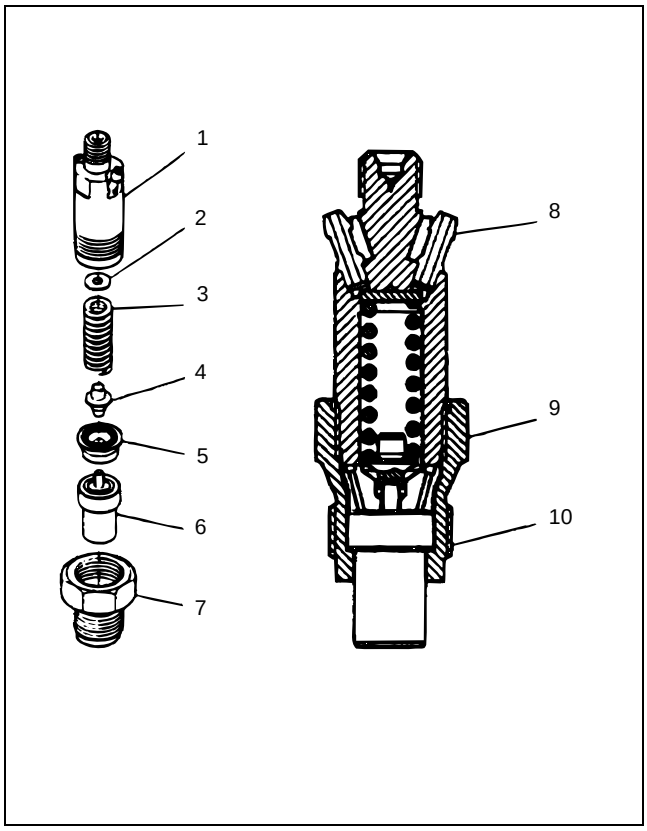

Figure 40

1. Body
2. Adjusting shim
3. Pressure setting spring
4. Push rod
5. 2-sealing face spacer
6. Injector
7. Injector nut
8. Leak return connectors
9. Injector holder nut
10. Thread

Assembly

1. Check all parts for condition and cleanliness. Oil parts before reassembly.

2. Secure the injector body in a “V” type injector holder.

3. Install the adjusting shims, spring, push rod, spacer and injector (Fig. 40, Items 2, 3, 4, 5, 6).

4. Install the injector holder nut (Fig. 28, Item 7) and tighten by hand.

5. Tighten injector nut to a torque of 10 Nm. Tighten the nut an additional 22° of rotation.

Installation

NOTE: Each time an injector is removed from the engine, new washers must be installed. Fire ring washer is installed with convex surface up.

1. Install new fire ring washers (Fig. 58, Item 21), convex surface facing up.

2. Install new copper washers (Fig. 58, Item 20).

3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).

1. Install new flame arrestor steel washer and copper gasket.

2. Install injector in cylinder head.

3. Install injection pipe unions on pump and injectors and tighten by hand.

4. Moderately tighten each union, 25 Nm (18 ft-lb) max., on pump and injector. Over-tightening will distort the end of the injector line.

5. Connect fuel return pipe.

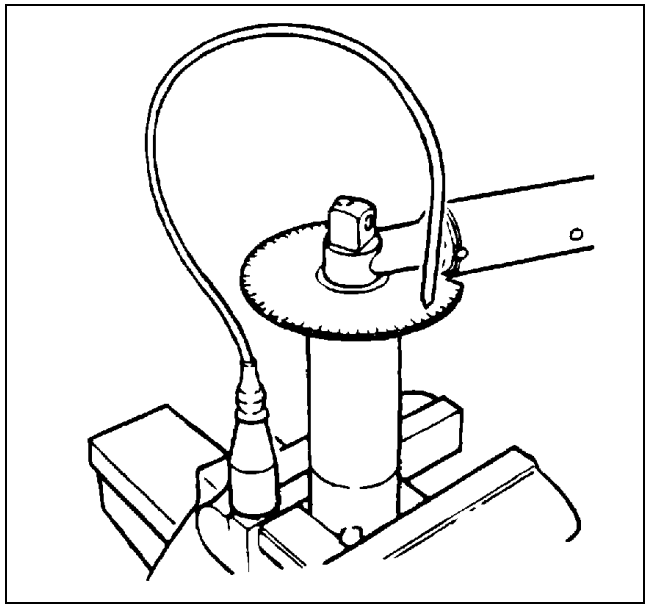

Figure 41

Timing Belt Replacement

Timing Belt Removal

IMPORTANT: Never install a used belt. When the timing belt is removed a NEW timing belt must be installed.

SPECIAL TOOLS REQUIRED:
Tune-Up Tool Set TOR 4035
1 ea. M8 x 125 x 40 Metric Bolt
2 ea. M8 x 125 x 35 Metric Bolt

1. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 42).

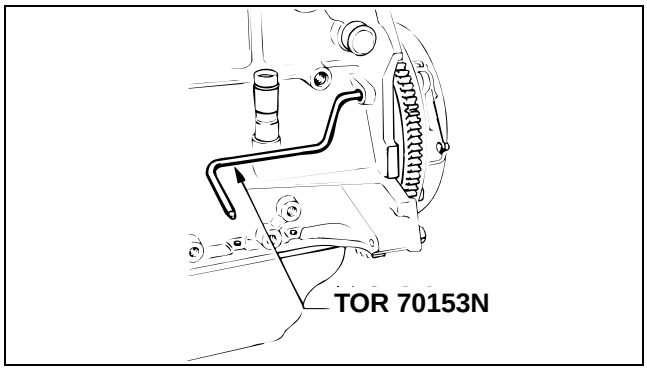

Figure 42

2. Remove the crankshaft pulley bolt (Fig. 43, Item 1) and the pulley. Note: The bolt is secured with thread locking compound and will be difficult to remove.

3. Remove cover attachment nut (Item 5), cover clips and timing belt covers (Item 2, 3 and 4) in the numbered order.

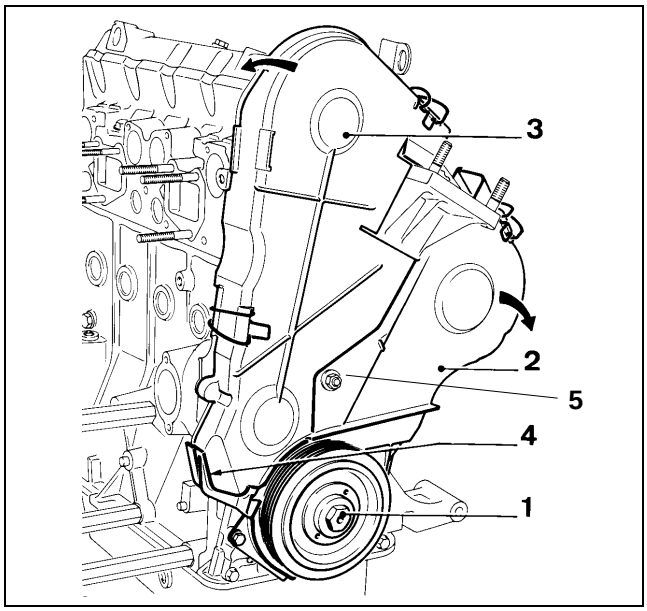

Figure 43

4. Re-install the crankshaft bolt (Fig. 44, Item 1) and the washer.

5. Lock the camshaft gear (Item 6) in position by installing an M8 x 125 x 40 bolt. Tighten finger tight.

6. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

IMPORTANT: To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened ONLY FINGER TIGHT.

NOTE: If the bolts in steps 5 and 6 cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed in steps 5 and 6.

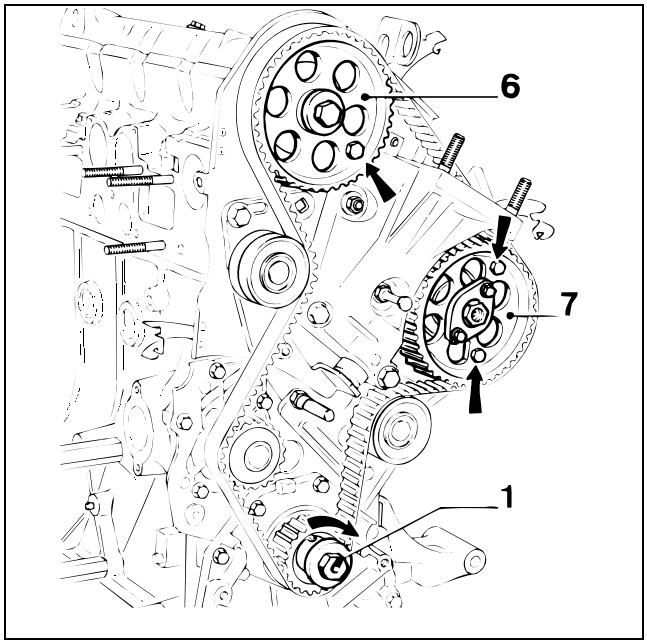

Figure 44

7. Loosen the nut (Fig. 45, Item 8) and the bolt (Item 9), securing the roller tensioner bracket (Item 10).

8. Rotate the roller tensioner bracket square (Item A) to compress the spring (Item 11).

9. Re-tighten the bolt (Item 9).

10. Remove the timing belt.

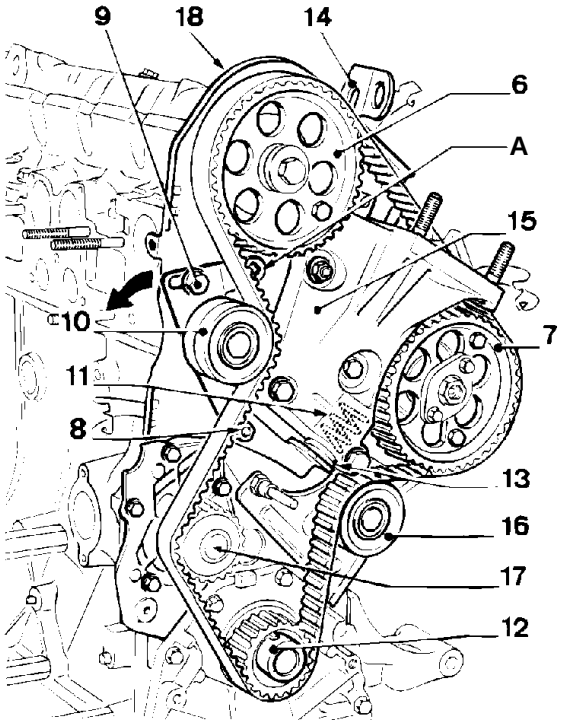

Figure 45

Timing Belt Installation

IMPORTANT: Never install a used belt. When the timing belt is removed a NEW timing belt must be installed.

1. Install the new timing belt, with the runs taut, in the following order (Fig. 46):

Crankshaft gear (Item 13)
Fixed roller (Item 11)
Injection pump gear (Item B)
Camshaft gear (Item C)
Tensioner roller (Item 17)
Coolant pump gear (Item 10).

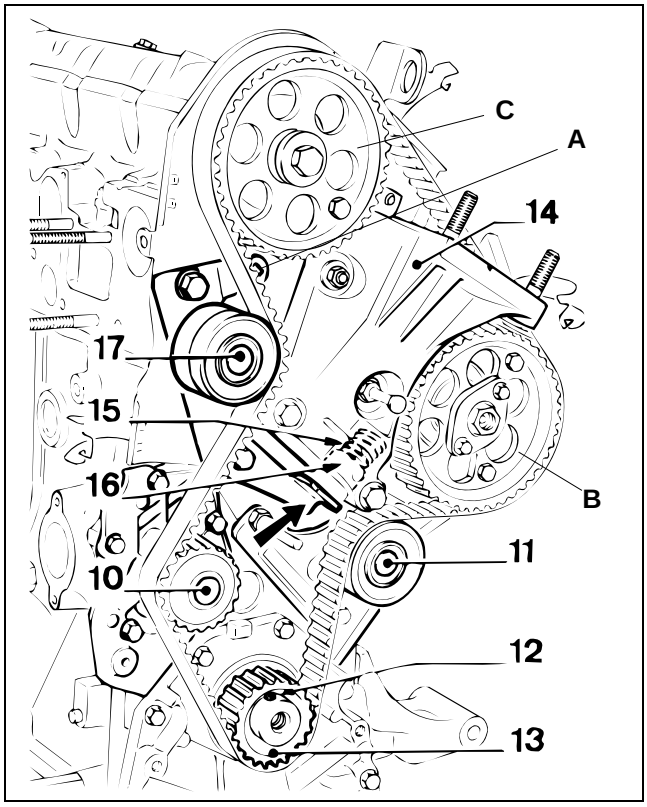

Figure 46

2. Loosen the bolt (Fig. 47, Item 18) and nut (Item 19) to release the tensioner roller. DO NOT use Item **A** to set tension. Tension on belt is only to be set by the spring (Fig. 46, Item 15) when tensioner plate is free to rotate.

3. Re-tighten the bolt (Item 18), then the nut (Item 19), when the belt is tensioned.

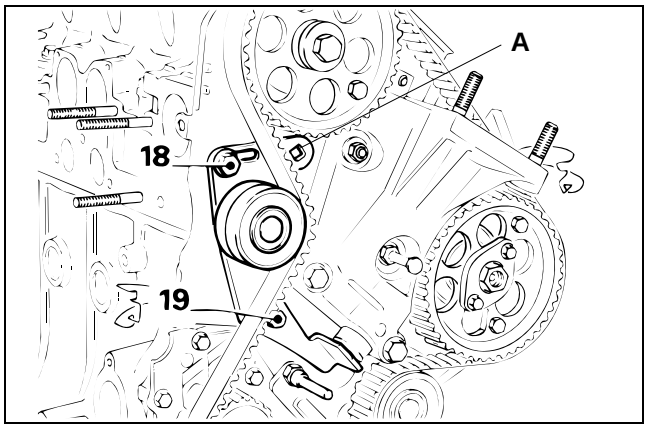

Figure 47

4. Remove the three gear locking bolts and TDC Lock Pin tool.

5. Turn the crankshaft two revolutions (clockwise).

6. Re-install the TDC Lock Pin tool TOR 70153 N and the three gear locking bolts.

IMPORTANT: If you can not install any one of the locking devices, repeat the Timing Belt Installation procedures from the beginning.

7. Loosen the bolt (Fig. 48, Item 18) and nut (Item 19) to release the tensioner roller.

8. Re-tighten the bolt (Item 18) then the nut (Item 19) to a torque of 17.5 Nm (13 ft-lb).

9. Remove the three gear locking bolts.

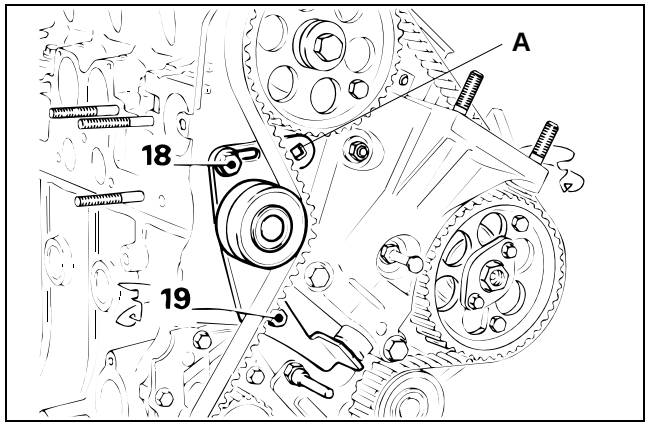

Figure 48

10. Install the covers (Fig. 49, Item 2, 3 and 4), cover clips and cover attachment nut (Item 5).

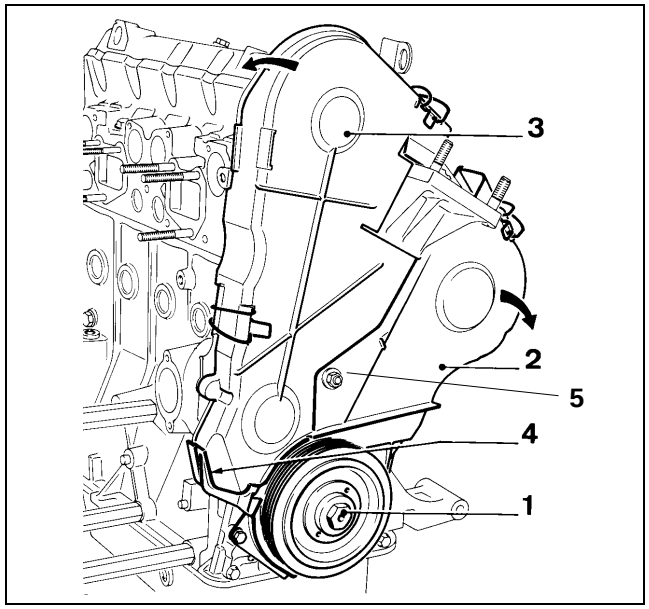

Figure 49

11. Install the pulley.

A. Clean with a brush and de-grease the threads of the bolt (Fig. 50, Item 1), the bearing faces of the washer (Item 2) and the head of the bolt (Item 1).

B. Coat the threads of the bolt (Item 1) with thread lock LOCTITE. Install the bolt (Item 1) and washer (Item 2) and tighten to a torque of 40 Nm (30 ft-lb).

C. Tighten the bolt 60° further (one flat).

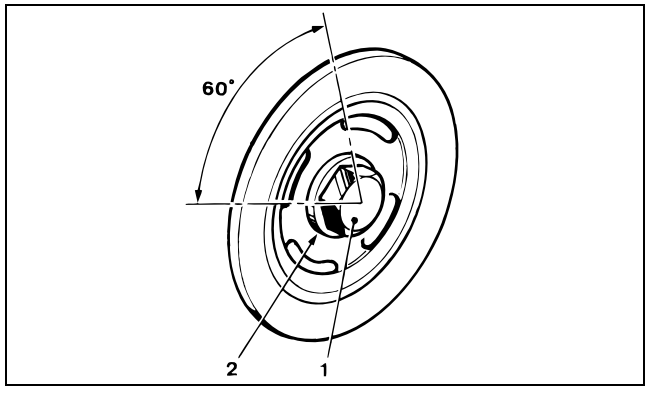

Figure 50

Injection Pump Timing

Timing of Injection Pump (Pump Mounted on Engine)

The adjustment position for start of injection varies on each pump (manufacturing tolerances). The adjustment position is given by measurement "X.XX" in one of three places on the pump (Fig. 51):

a. Tag on pump lever.
b. Bar code label
c. Inspection cap

NOTE: "PMH" in French = "TDC" in English.

1. Remove the cover attachment nut, cover clips and timing belt covers.

2. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 52).

3. Verify that the camshaft and injection pump gears are properly timed:

A. Lock the camshaft gear (Fig. 53, Item 6) in position with a M8 x 125 x 40 bolt. Tighten finger tight.

B. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

NOTE: If the locking bolts cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed.

IMPORTANT: To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened ONLY FINGER TIGHT.

4. Remove the three locking bolts (Fig. 53).

5. Remove the TDC Lock Pin tool TOR 70153N, then turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from the timing belt end).

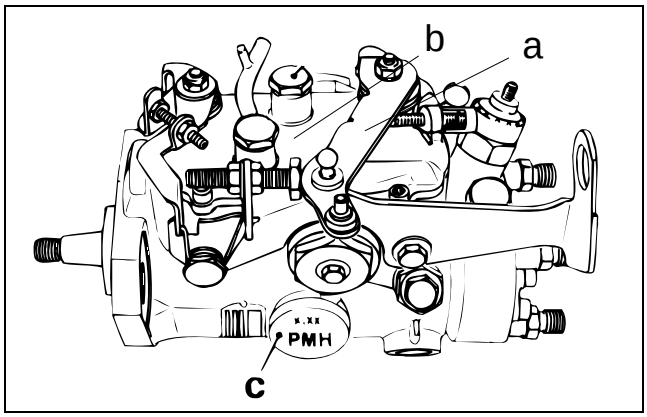

Figure 51

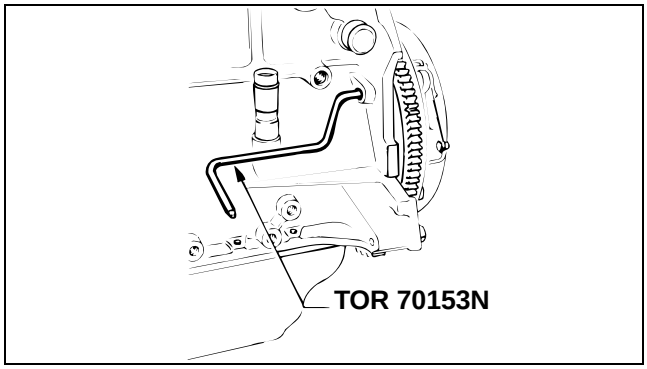

Figure 52

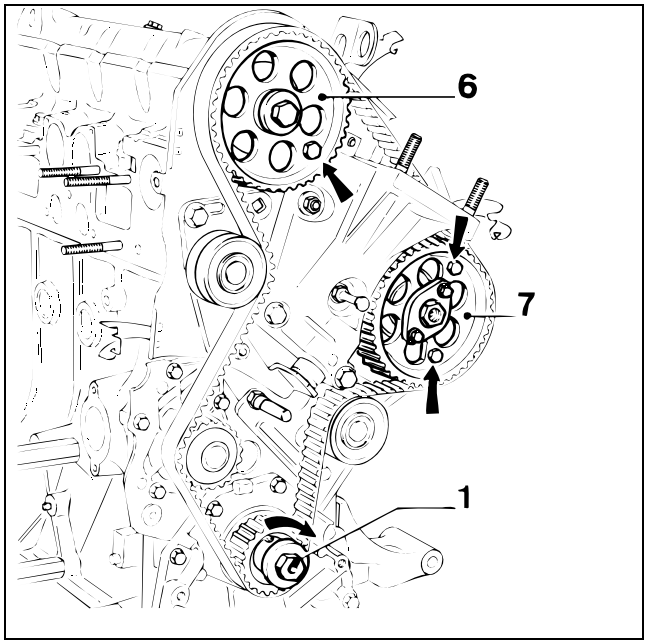

Figure 53

6. Clean the area around the pump timing plug (Fig. 54, Item d). Remove the pump timing plug.

7. Use Timing Tool Assembly TOR 80117 AM. Lubricate the timing rod (Fig. 55, Item 1) with Diesel fuel, then install the timing rod in the pump timing hole (Item d). Check to see that the rod moves freely in the bore.

8. Install the dial indicator (metric) on the indicator bracket (Item 2).

9. Install the indicator bracket with dial indicator on the plug boss. Set the dial indicator to “0.00 mm”.

10. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

11. The dial indicator should show the reading “X.XX” ±0.04 mm engraved on the injection pump. If adjustment is required, loosen the three bolts at the pump flange, one bolt at the rear, and the injection lines. Rotate the pump away from the engine, then slowly rotate the pump toward the engine in one smooth motion to obtain the reading “X.XX”. If you go to far and the reading is passed, stop. Again, rotate the pump away from the engine, then rotate the pump toward the engine in one smooth motion.

12. After obtaining the correct reading, be careful to keep the pump in position and tighten the pump bolts.

13. Remove the TDC Lock Pin tool TOR 70153 N.

14. Turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from timing belt end). Check that the indicator reads 0.00.

15. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

16. In this position the dial indicator mounted on the pump should read the value “X.XX” shown on the pump ±0.04 mm.

17. Check to make sure the three lock bolts fit in the cam pulley and injection pump pulley (Fig. 53).

18. Repeat steps 11 and 12 if necessary.

19. Remove TDC Lock Pin tool, three lock bolts, indicator and indicator bracket. Install pump cover plug.

20. Tighten injector lines.

21. Install timing belt covers, clips and attachment nut.

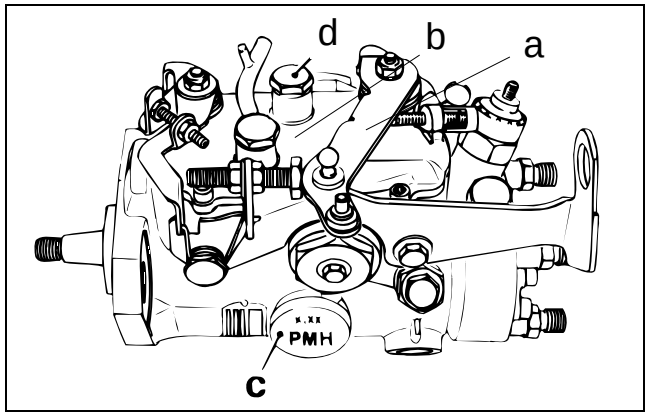

Figure 54

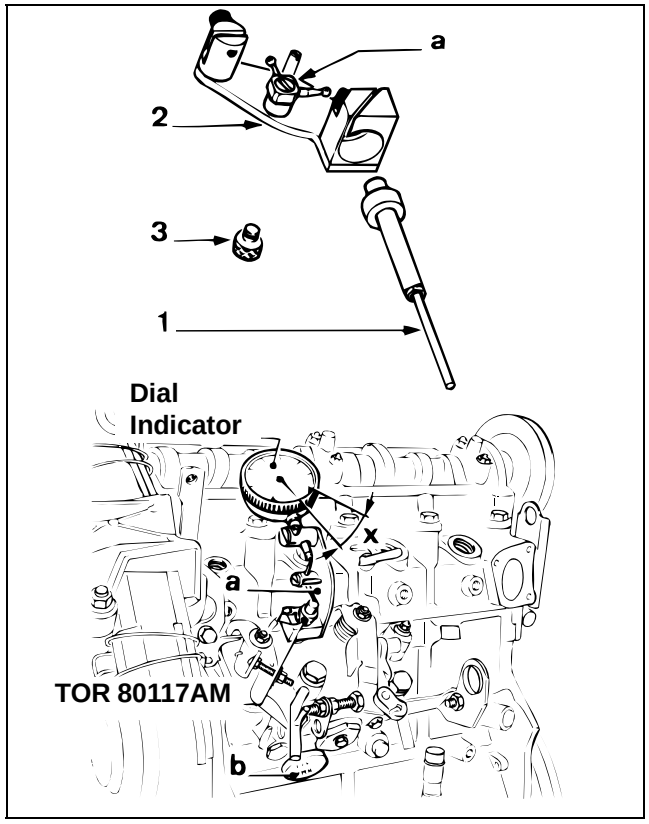

Figure 55

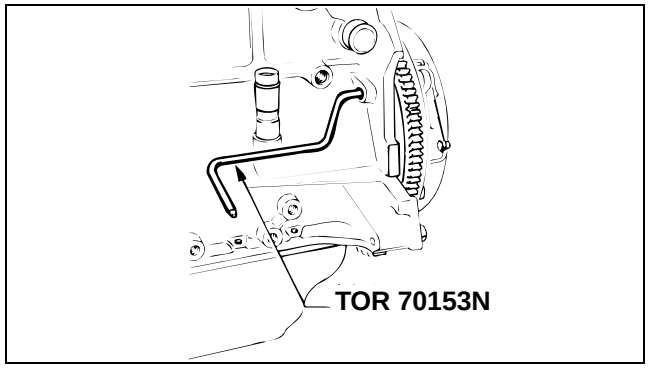

Figure 56

Preparation For Engine Repair

1. Before cleaning and disassembly, carefully check for problems that cannot be found after the engine has been cleaned or disassembled (e.g. oil leaks from cracked components, gaskets or loose fittings, damaged air cleaner or breather hoses that could cause cylinder wear, etc.). Make a note of any problems that you find.

2. Clean or wash the engine exterior thoroughly before disassembly.

IMPORTANT: Do not spray water on a hot engine. Injection pump seizure or other failures could result.

3. Do not disassemble or remove parts that do not require disassembly.

4. Disassemble the engine in proper order, arranging the parts the disassembled parts neatly. Apply clean engine oil to all disassembled parts to prevent rust.

5. Keep the work area clean; dirt causes engine failures.

6. Be very careful when working on fuel system components. Cover the work area with clean paper. Store components of the nozzles or injector pump in clean fuel oil. Do not allow components to strike each other or other objects. Wet hands with clean diesel fuel before handling these parts.

IMPORTANT: Apply clean engine oil to all surfaces when engine is assembled to prevent marking when engine is first started.

Cylinder and Cylinder Block Overhaul

Before removing any parts, disassembly or overhaul of the Peugeot engine, it is very important to understand the nature and probable cause of the problem that made an overhaul necessary.

When the engine trouble is caused by worn cylinders, rings or valves, one or more of the following symptoms will occur:

1. Low engine power, and a decrease in compression pressure.

2. Increased fuel consumption.

3. Increased lubricating oil consumption.

4. Poor engine starting.

5. Loud noises in the engine.

It is important to find the cause of the engine failure before beginning repair. Symptoms 2 and 4 in the above list can be a result of excessive fuel injection, improper injection timing, or nozzle and injection pump wear. Poor starting may be a result of electrical problems. Noises may be associated with a mechanical part outside the engine. Excess fuel or oil consumption may be the result of leaks. (See the Troubleshooting section.)

Another indicator of the need for an overhaul is oil consumption. Make sure the engine does not leak oil. when the oil consumption between the oil change maintenance interval is approximately 1-1/2 times normal (150%), engine overhaul should be considered.

With a good knowledge of how the engine operates, access to maintenance and compression test records, and information in the Troubleshooting section of this chapter, unnecessary disassembly and inspection can be eliminated.

Engine Removal and Installation

1. Put machine on a level surface and engage parking brake. Turn engine OFF and remove key from ignition switch. Allow engine and radiator to cool.

2. Open the hood. Disconnect hood stop cable from engine. Lower the hood. Remove left and right hinge plates. Lift hood off chassis.

3. Disconnect positive (+) and negative (–) battery cables from battery. Loosen battery securing bolt and remove battery.

4. Open the radiator cap. Open radiator drain valve or remove lower radiator hose and allow coolant to drain into a pan.

CAUTION

DO NOT open radiator cap or drain coolant if engine or radiator is hot. Pressurized, hot coolant can escape and cause burns.

5. Loosen hose clamps and disconnect upper and lower radiator hoses from engine and radiator.

6. Loosen hose clamp and remove fuel hose from injector pump. Plug end of fuel line to prevent fuel leakage. Disconnect injector return hose.

7. Loosen hose clamp and disconnect PCV hose from engine.

8. Disconnect and tag electrical wires that attach to the engine or engine components: alternator, starter motor and solenoid, ground cable, oil pressure switch, temperature gauge sender, thermoswitch, fuel stop (ETR) solenoid, glow plugs.

9. Disconnect drive coupling from flywheel end of engine.

10. Remove upper fan shroud from radiator.

11. Disconnect throttle cable from speed control lever on fuel injection pump. Loosen clamp and remove throttle cable and from engine bracket.

12. Remove fasteners securing engine to engine mounts.

13. Attach a short section of chain between the two lifting brackets on the engine. Connect hoist, or block and tackle chain at center of the short section of chain. One person should operate hoist or block and tackle and other person should help guide engine out of chassis. Remove engine from chassis. Be careful when removing engine to prevent damage to engine, radiator or other parts. Mount engine in an engine rebuilding stand.

14. Remove muffler, brackets, coolant expansion tank and accessories from engine as necessary. Drain oil from engine and remove engine oil filter.

Installing the Engine

1. To install the engine, perform steps 2- 14 of Removing the Engine in reverse order.

2. After disassembling or overhauling the engine, install a new oil filter. Replace this filter after the first 20 to 50 hours of operation.

3. Fill the engine with the correct oil. Fill the cooling system with a 50/50 solution of ethylene glycol anti-freeze, and clean, soft water. Check for oil and coolant leaks and repair as necessary.

Peugeot recommended Coolant/Antifreeze is available in 1 U.S. Gallon containers under Toro Part No. 93-7213.

IMPORTANT: The anti-freeze should contain no Borate and have a Ph of 7 to 8.5.

4. Adjust the throttle linkage.

Disassembly of External Components

1. Remove TDC sensor and clutch housing centering pin.

2. Mount the engine on a stand.

3. Lock the flywheel with TOR FD86 tool.

4. Remove exhaust manifold and inlet manifold.

5. Remove the coolant manifold.

6. Remove the alternator and belt.

7. Remove the oil filter (Fig. 57, Item 10).

8. Remove the injector pipes (Item 12).

9. Remove the glow plug leads.

10. Remove the crankcase breather pipes/oil filter/filter pipe assembly (Item 13).

11. Remove the oil pressure switch (Item 14).

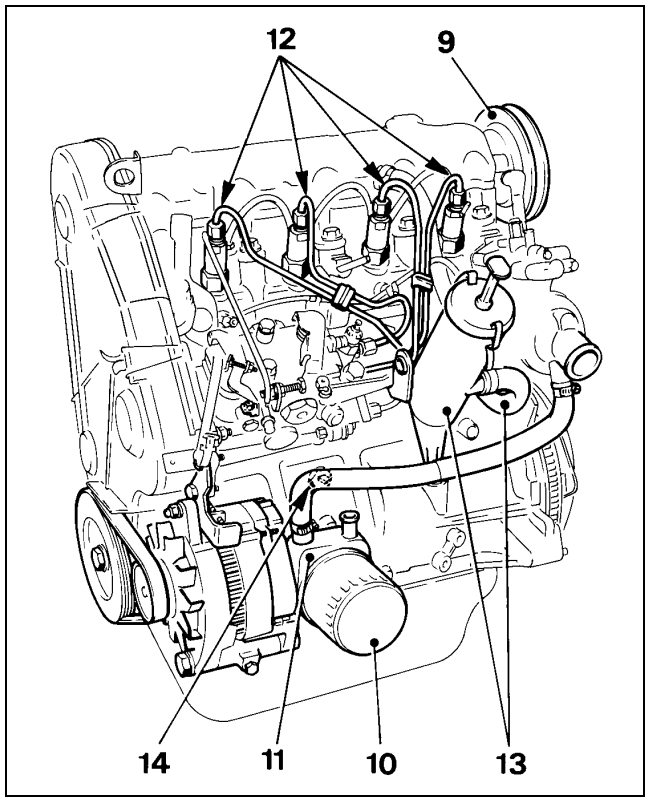

Figure 57

12. Remove the thermostat housing cover (Fig. 58, Item 17).

13. Remove the thermostat housing (Item 18).

14. Remove the injectors (Item 19) and retrieve the copper washer (Item 20), and flame trap washer (Item 21).

15. Remove the glow plugs (Item 22).

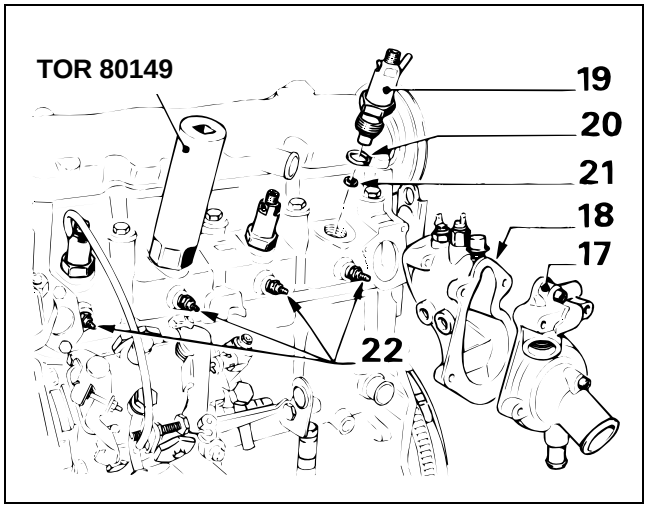

Figure 58

Injection Pump Removal

1. Remove the timing belt.

2. Use injector pump gear puller TOR70153H, to remove injector pump gear (Fig. 58a, Item 5).

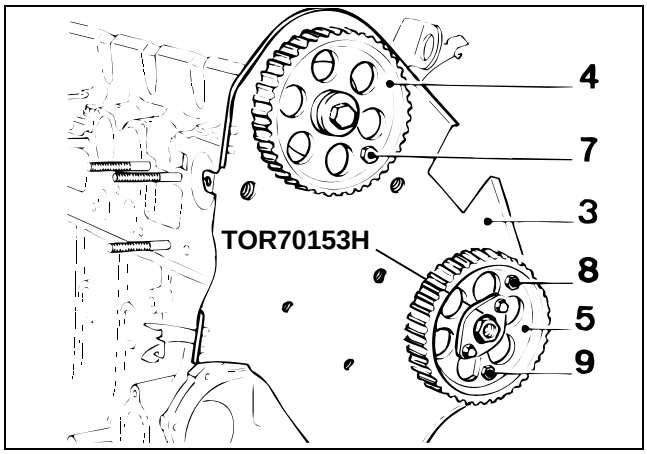

Figure 58a

3. Remove the injection pump (Fig. 58b, Item 19).

4. Remove bracket (Item 20).

NOTE: If the pump needs to be inspected or repaired it is recommended that is be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

IMPORTANT: Clean the injection pump and the area around the injection pump before removing or servicing it. DO NOT spray water onto a hot injection pump.

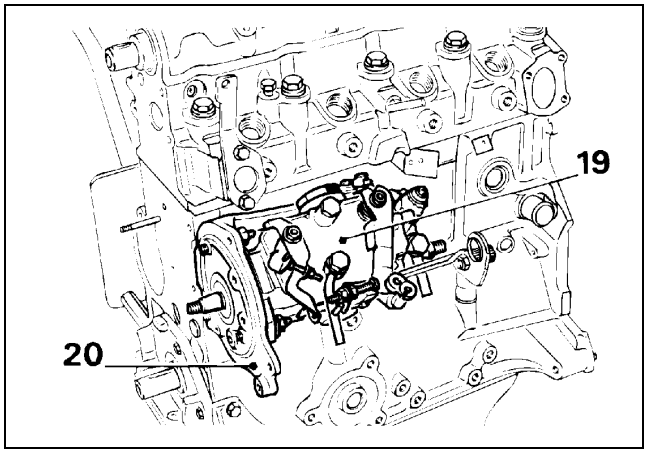

Figure 58b

Cylinder Head Removal

1. Remove the cylinder head cover.

2. Use a Torx head T55 tool to loosen the cylinder head bolts, working in a spiral from the outside. Remove the cylinder head bolts.

IMPORTANT: DO NOT pry at gasket surface to loosen cylinder head from block.

3. Use levers (0.0149) to release the cylinder head from the block.

4. Remove the cylinder head and gasket.

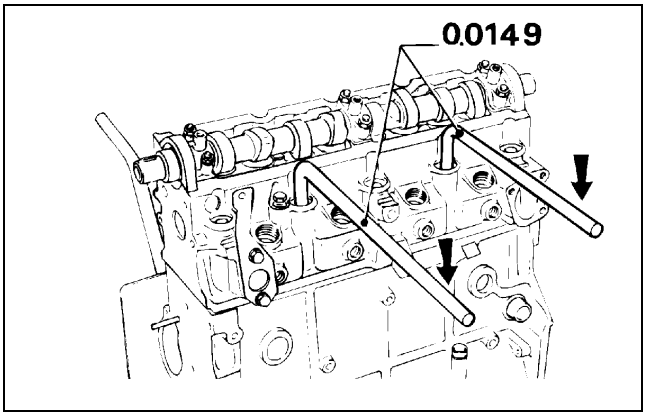

Figure 59

Oil Pump Removal

1. Remove the oil pan and gasket

IMPORTANT: Use solvent and a wood or plastic scraper to remove the silicone gasket material. Be careful not to damage the sealing face of the block.

2. Remove the bolts (Fig. 60, Item 1, 2, and 3).

3. Remove the seal carrier plate (Item 4).

IMPORTANT: The bolt (Item 1) is a special bolt that centers the pump in the correct location.

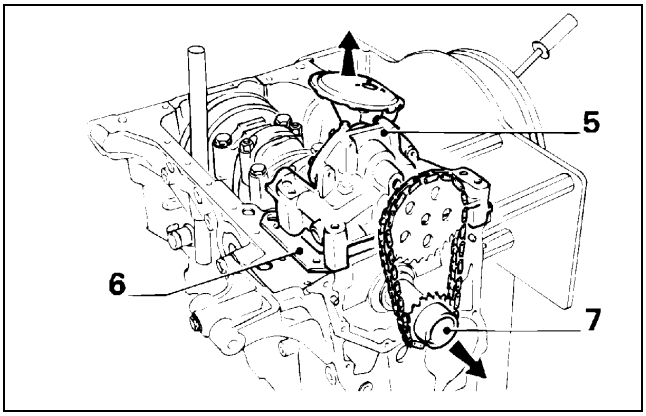

Figure 60

4. Remove the pump (Fig. 61, Item 5) / drive chain / crankshaft sprocket (Item 7) assembly. NOTE: Item 6 - spacer is not used on engines used in TORO machines.

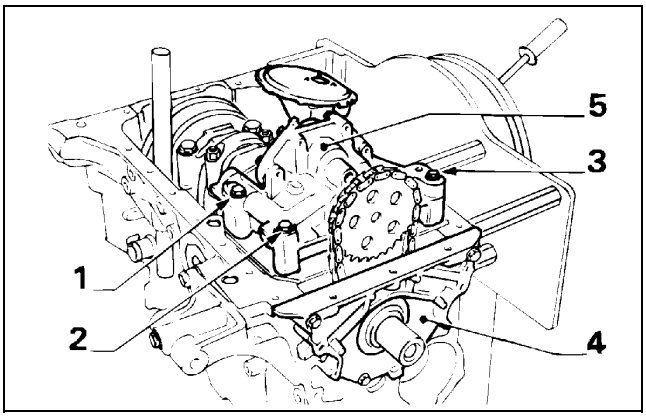

Figure 61

Crankshaft and Piston Removal

1. Remove flywheel locking tool.

2. Remove the connecting rod end caps (Fig. 62, Item 8), marking each cap for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

3. Remove the flywheel.

4. Remove the main bearing caps (Item 9) (marks are cast-in).

5. Retrieve end float washers with No. 2 cap.

5. Remove the oil seal (Fig. 63, Item 10).

6. Remove the end float washers (Item 11).

7. Remove the crankshaft.

8. Remove the main bearing shells.

9. Remove the piston/connecting rod assemblies, marking each piston and connecting rod for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

10. Remove the piston pin circlips and separate the pistons from the connecting rods.

11. Remove the plugs (Fig. 63 and 64, Item 12) from the oil galleries.

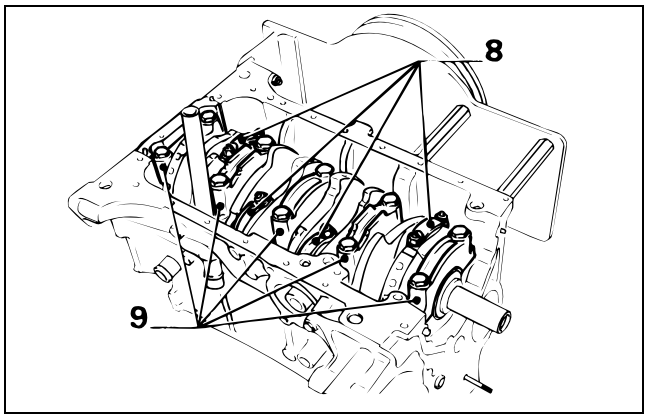

Figure 62

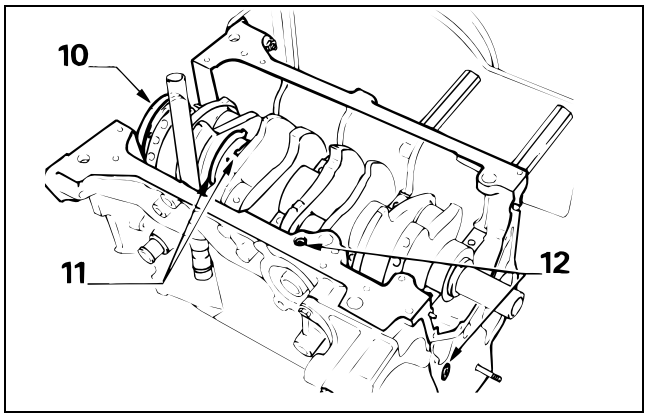

Figure 63

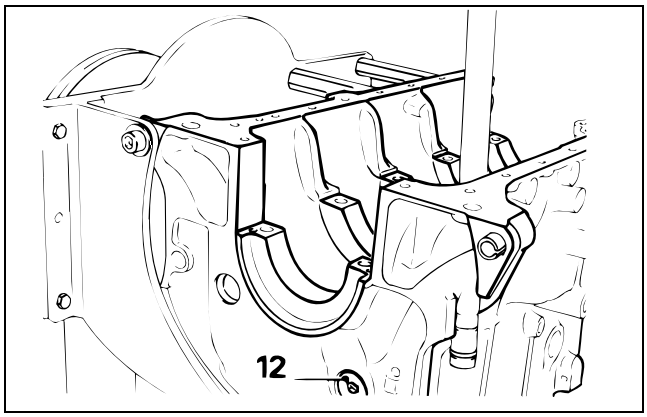

Figure 64

Cylinder Head Overhaul

1. Progressively slacken the camshaft bearing caps (Fig. 65, Item 1).

2. Remove the bearing caps (Item 1), oil seals (Item 2), camshaft (Item 3), tappets (Item 4) and adjustment shims (Item 5). Mark adjustment shims and tappets so they will be re-installed in the same location – #1 intake, #1 exhaust, #2 intake, #2 exhaust, etc.

NOTE: The shims are small and can stick to the tappets.

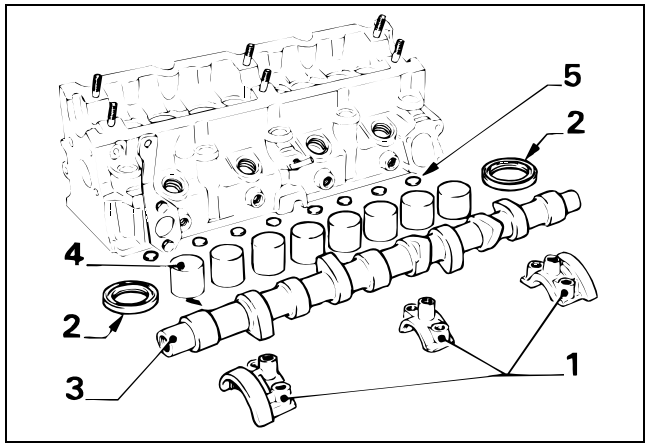

Figure 65

3. Use a valve compressor to remove the eight valves (Fig. 66).

4. Use a hammer and drift to remove the swirl chambers from the injector orifices, if necessary.

NOTE: Swirl chambers do not need to be removed unless cylinder head is to be machined or replaced.

5. Clean the cylinder head. Use a wooden scraper and gasket stripping solvent to clean the gasket face. DO NOT use a metal scraper.

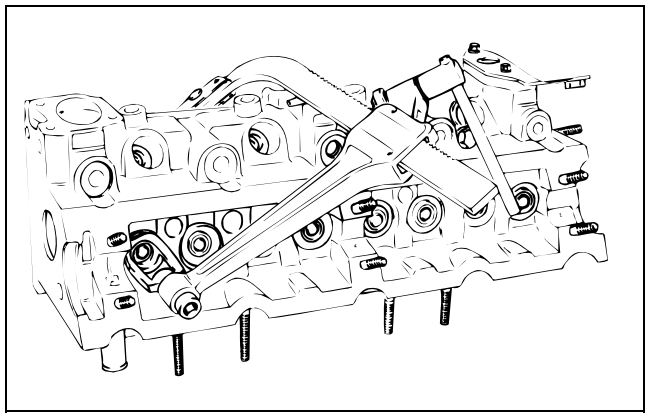

Figure 66

6. Check the gasket face for bow (flatness). Check corner to corner and side to side (Fig. 67).

Maximum bow: 0.7 mm.

7. Check the condition of the valve seats and guides, valve, valve springs, swirl chambers, camshaft, camshaft bearings and all tapped holes. (See Identification and Specifications section.)

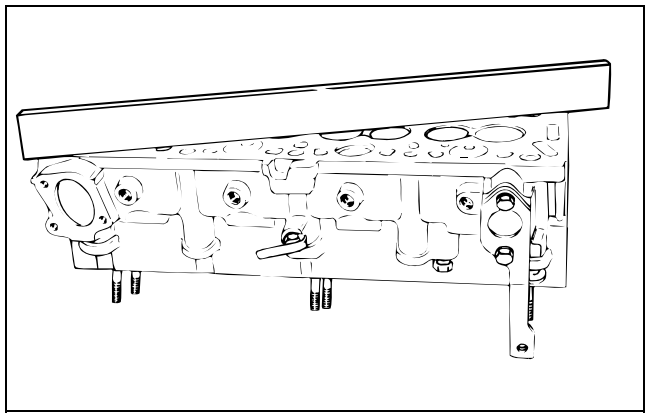

Figure 67

8. Check the protrusion of the swirl chambers (Fig. 68, A).

Protrusion: 0 to 0.03 mm

Achieve this dimension by machining faces (a) and (b).

9. Check the valve recess (B).

Exhaust: 0.9 to 1.45 mm
Inlet: 0.5 to 1.05 mm

Achieve this dimension by machining the valve seats.

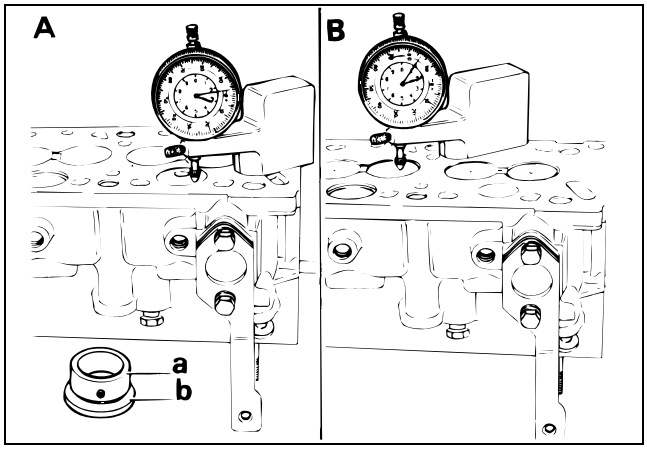

Figure 68

10. Lap in the valves.

11. Re-install the valves.

IMPORTANT: If the cylinder head has been machined, fit compensating washers under the valve springs. (See Identification and Specifications section.)

12. Install the shims as removed in step 2. If replacing cylinder head or if cylinder head has been machined, install a basic shim (Fig. 69, Item 6) (2.425 mm thick) to each valve stem and check that each shim is higher than the spring cup (Item c). If a shim is not higher than the cup, grind the top of the cup (Item c).

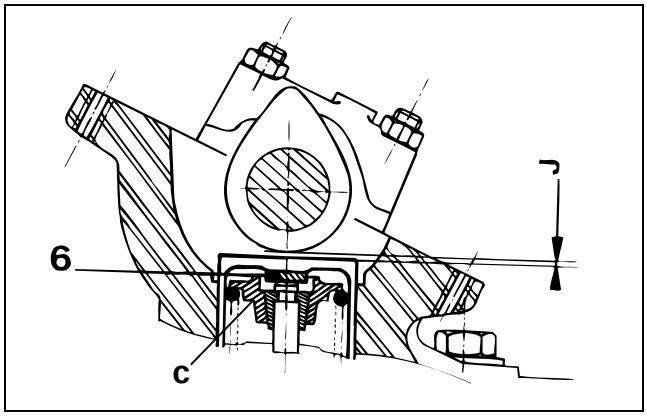

Figure 69

13. Re-install the tappets.

14. Oil the camshaft bearings.

15. Install the camshaft, with the **DIST** mark at the timing gear end.

16. Progressively tighten the bearing caps to a torque of 17.5 Nm (13 ft-lb). The bearing caps have cast-in markings for correct installation.

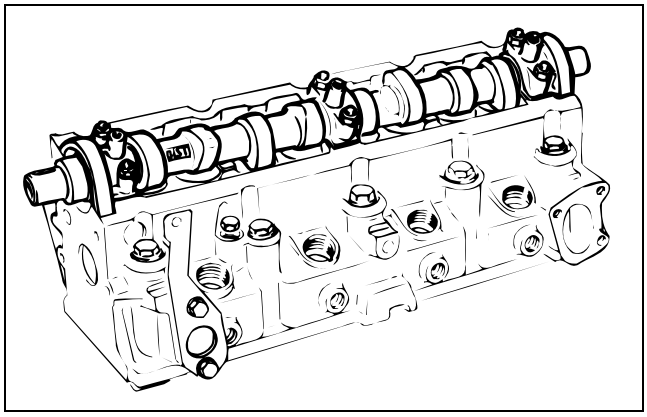

Figure 70

Crankshaft Installation

1. Put thread lock Loctite on the oil gallery plugs and install them in the cylinder block.

2. Install the grooved main bearing shells. (See Crankshaft in the Inspection and Specifications section for main bearing shell thickness.)

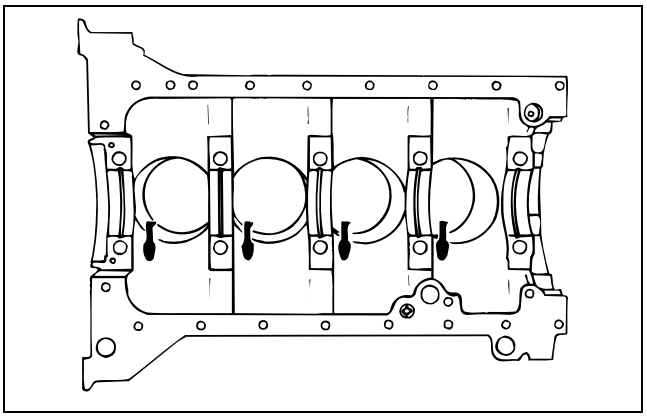

Figure 71

3. Install the crankshaft.

4. Install the no. 3, 4 and 5 main bearing caps.

5. Install the two end float half-washers (Fig. 72, Item 1), with the anti-friction faces towards the crankshaft.

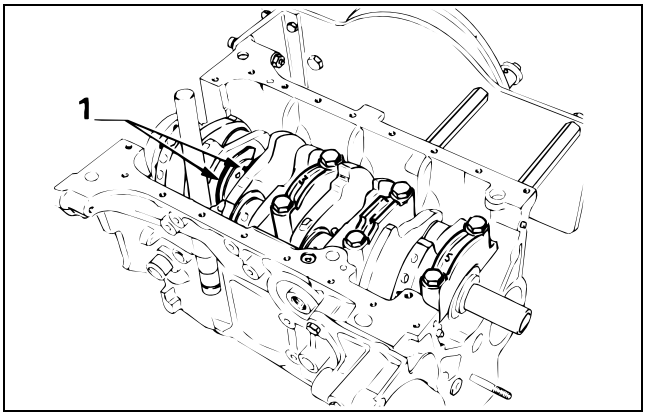

Figure 72

6. Install the no. 2 main bearing cap (Fig. 73, Item 2) with its two end float half-washers, with the anti-friction faces towards the crankshaft.

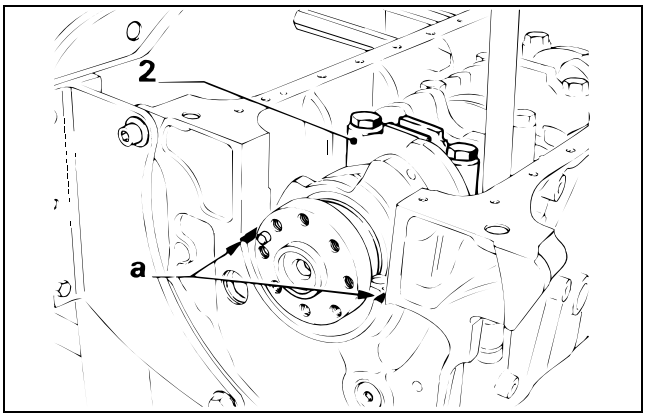

Figure 73

7. Check crankshaft end float (Fig. 74):

A. Install the dial indicator, using tools TOR 80110G1, TOR 80504 A1 and A2.

B. End float must be between 0.07 and 0.32 mm.

NOTE: For choice of half-washer thickness see Crankshaft in the Identification and Specifications section.

8. Apply a thin coat of Formetanch or Permatex No. 2 sealant to surface of block where bearing cap will mate (Fig. 73, Item a).

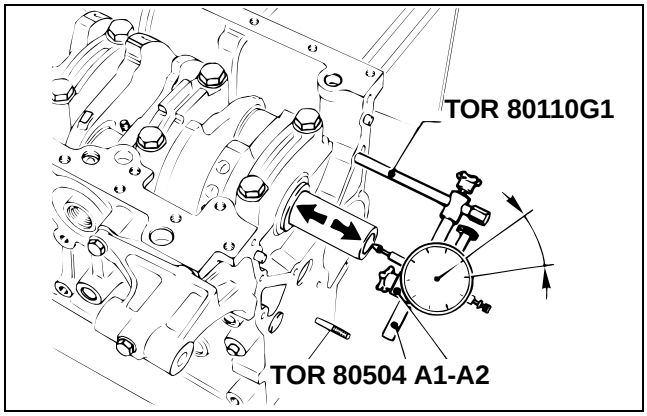

Figure 74

9. Install the two new side seals (Fig. 75, Item 3) to no. 1 main bearing cap.

10. Using a bolt and washer (Item 5), attach tool 80153 fitted with shims A2 to no. 1 main bearing cap (Item 4).

11. Adjust the height (**x**) of the shims.

x = 0.5 mm above flat on side of rear main cap

12. Oil the shims and the housing.

IMPORTANT: To avoid stretching the side seals, fit the cap as follows:

A. Engage it in its housing at 45°.

B. Straighten it.

C. Lower it slowly.

D. Tighten the two bearing cap bolts (Item 6) finger tight.

E. Remove the capscrew securing the tool to the main bearing cap and withdraw the tool horizontally.

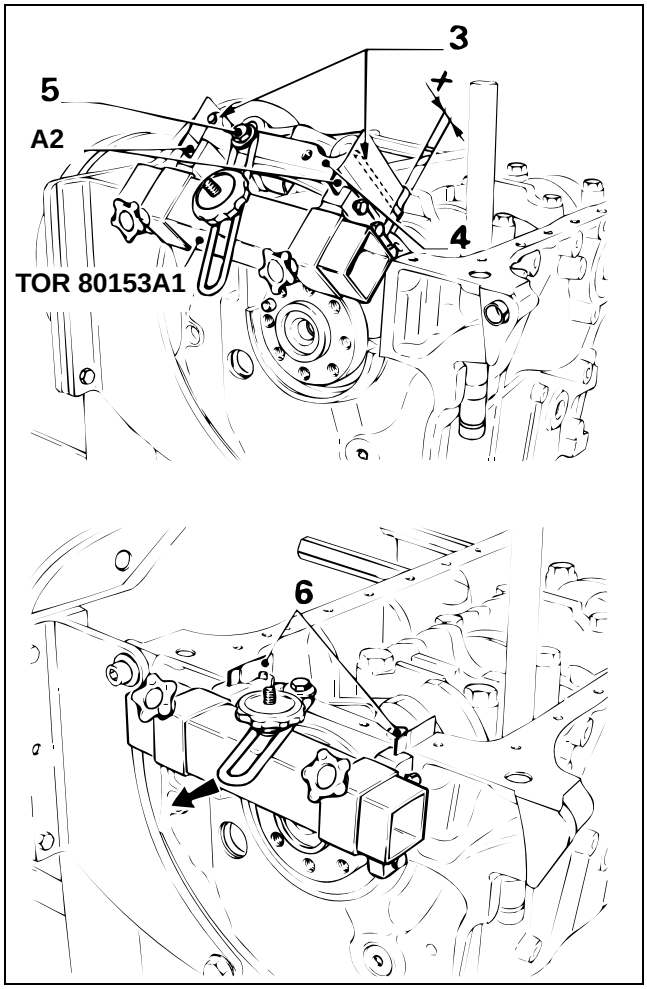

Figure 75

13. Tighten the bearing cap bolts to a torque of 70 Nm (52 ft-lb).

14. Using shim TOR 80110DZ, cut off the side seals so that they protrude 2 mm.

15. Check that the crankshaft rotates without tight spots.

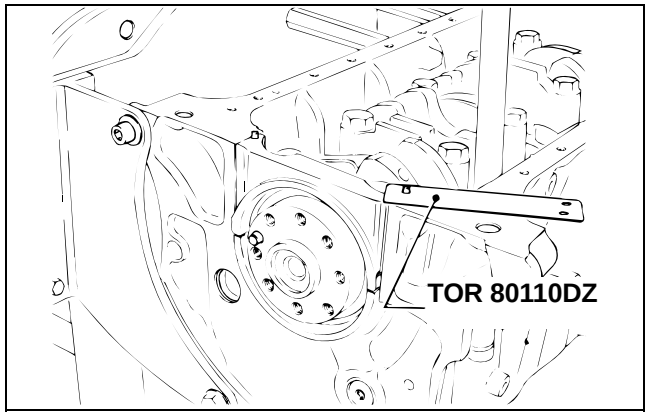

Figure 76

Pistons and Connecting Rod Assembly

1. Assemble the connecting rods and pistons with the bearing shell tab recess (Fig. 77, Item a) on the same side as the piston crown recess (Item b).

2. Use a piston rings pliers to install the piston rings:

NOTE: The marked face of the tapered ring must be towards the combustion chamber.

(1) – scraper ring
(2) – tapered ring
(3) – domed chrome ring

Space the ring gaps at 120° in relation to the scraper ring gap (Item c).

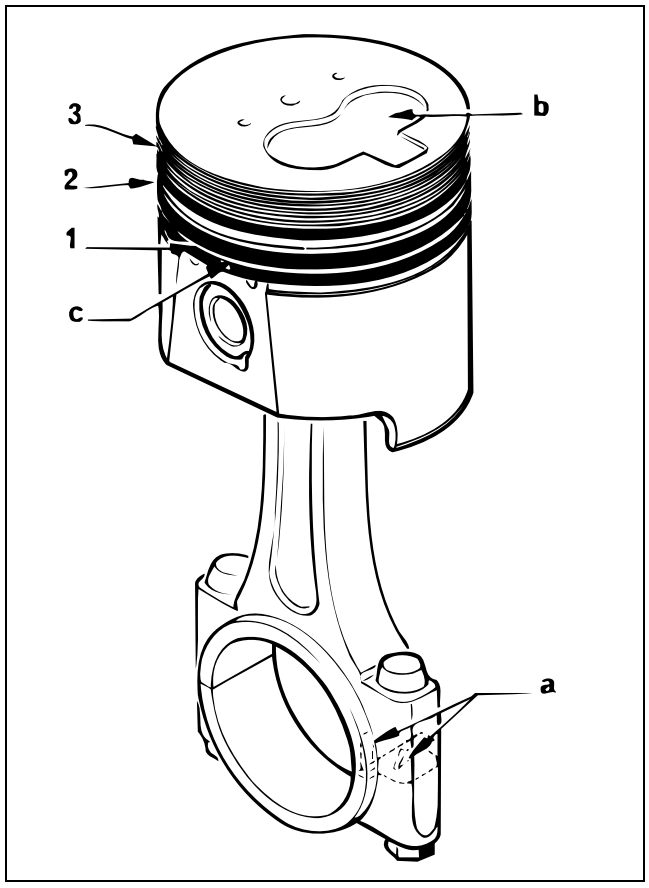

Figure 77

3. Oil the piston and tighten the piston ring clamp (Fig. 78, Item 4).

4. Remove the connecting rod end caps.

5. Install the pistons in the bores, matching the markings made when removed, and aligning the crown recess (Item a) on the oil filter side of the block.

6. Install the connecting rod end caps. Tighten the nuts to a torque of 50 Nm (37 ft-lb).

NOTE: For choice of bearing shell thickness, see Crankcase in Identification and Specifications section.

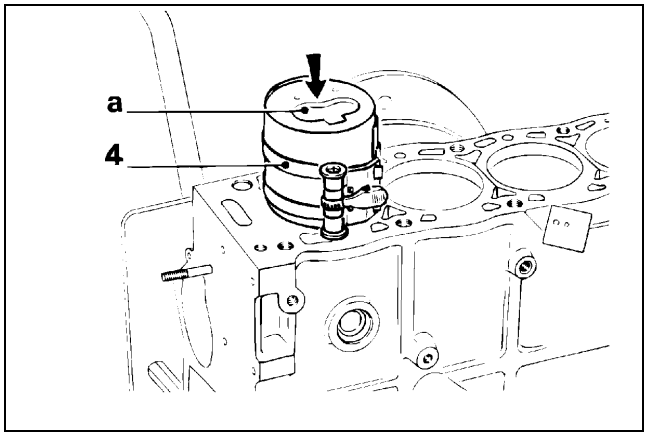

Figure 78

Oil Seal Installation

1. Put a new oil seal on tool TOR 70153 C.

2. Fit the seal by tapping it fully home with a mallet.

3. Withdraw the tool with a twisting movement.

4. Check that the visible lip of the seal is towards the outside.

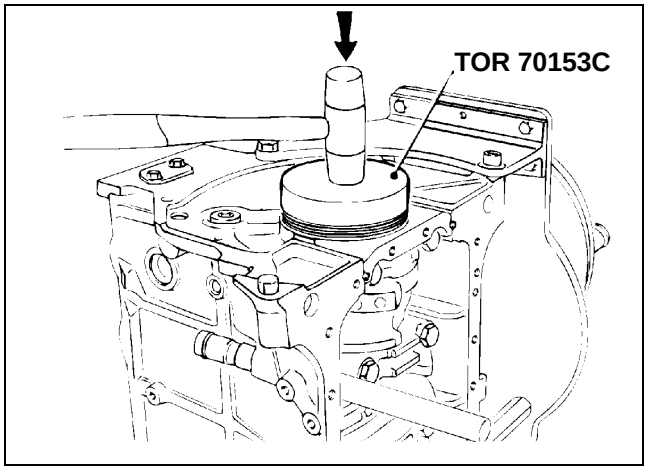

Figure 79

Oil Pump Installation

1. Install the key (Fig. 80, Item 6).

2. Install the pump (Item 7), drive chain and sprocket (Item 8) assembly.

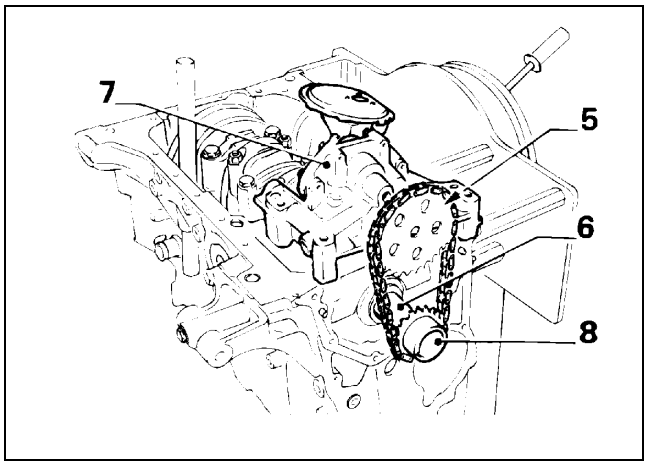

Figure 80

3. Install the special shoulder bolt (Fig. 81, Item 1) to center the pump in the proper location.

4. Install the other bolts and tighten the bolts (Item 1, 2, 3) to a torque of 20 Nm (15 ft-lb).

5. Install the seal carrier plate and a new gasket (Item 4) and tighten the bolts to a torque of 15 Nm (11 ft-lb).

6. Put a new oil seal on tool TOR 70153 D.

7. Install the seal by tapping it fully home with a mallet.

8. Apply Formetanch or Permatex No. 2 sealant as shown (Item a).

9. Install oil pan gasket:

XUD9A Engine: Install the oil pan gasket.

XUD9AI Engine: Apply silicone sealant to the oil pan using the pattern shown in Figure 81a. Wait 10 minutes before installing the oil pan to allow partial hardening of the gasket material.

10. Install the oil pan (Item 5).

11. Install the bolts (Item b).

NOTE: The two shorter bolts are installed into the main bearing cap.

12. Tighten the bolts (Item b) to a torque of 20 Nm (15 ft-lb).

13. Wait a minimum of 1 hour for the oil pan gasket to harden before filling with oil.

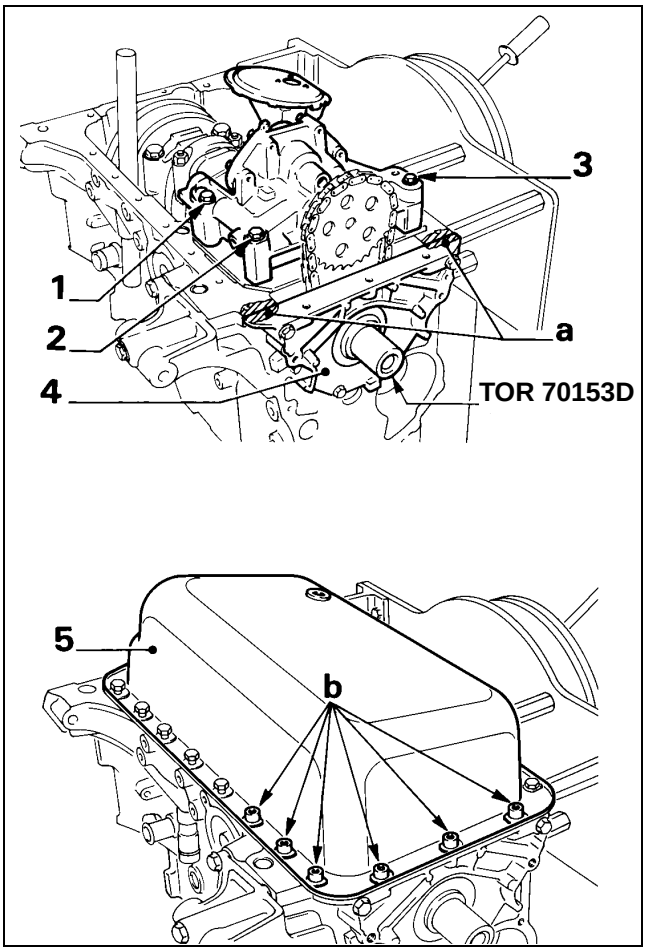

Figure 81

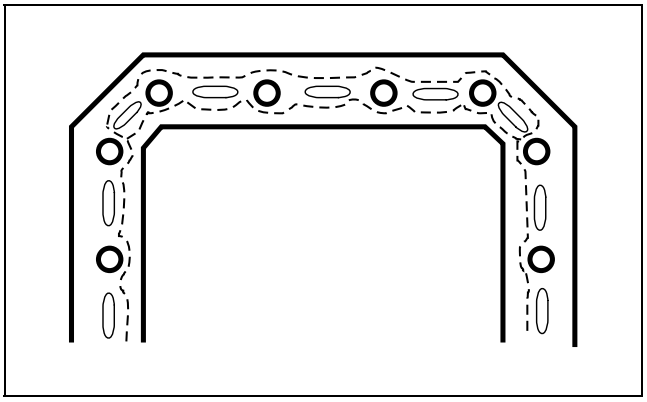

Figure 81a

Flywheel Installation

1. Install the flywheel. Put Locket thread lock on the flywheel mounting bolts.

2. Install a TORFD86 flywheel locking tool.

3. Tighten the flywheel bolts to a torque of 50 Nm (37 ft-lb).

4. Remove the flywheel locking tool.

Cylinder Head Gasket Selection

1. Install the dial indicator on support TOR 80110 H and zero it on a surface plate.

2. Turn the crankshaft and measure the protrusion of each piston at TDC.

3. Note the maximum protrusion (Fig. 82, Item d).

4. Select a cylinder head gasket of suitable thickness.

Units: mm

Piston protrusion (**d**)	Thickness identification
0.56 to 0.71	2 notches
0.71 to 0.75	3 notches
0.75 to 0.79	4 notches
0.79 to 0.83	5 notches

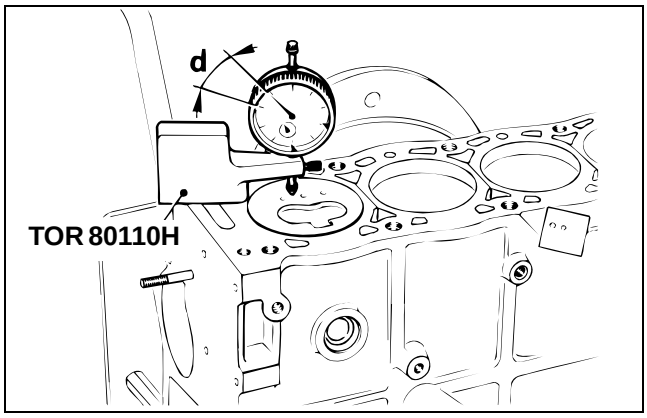

Figure 82

Cylinder Head Installation

1. Turn the crankshaft to put the pistons at mid-stroke with damper pulley key (Fig. 83, Item 6) at the 9 o'clock position.

2. Clean the tapped holes in the cylinder block (12 x 150 thread).

3. Install the centralizing dowel (Item 7).

4. Install a new head gasket (dry).

5. Install the cylinder head.

6. Carefully clean the threads of the cylinder head bolts with a brush.

7. Coat the bolt threads and washer contact faces with MOLYKOTE G RAPID.

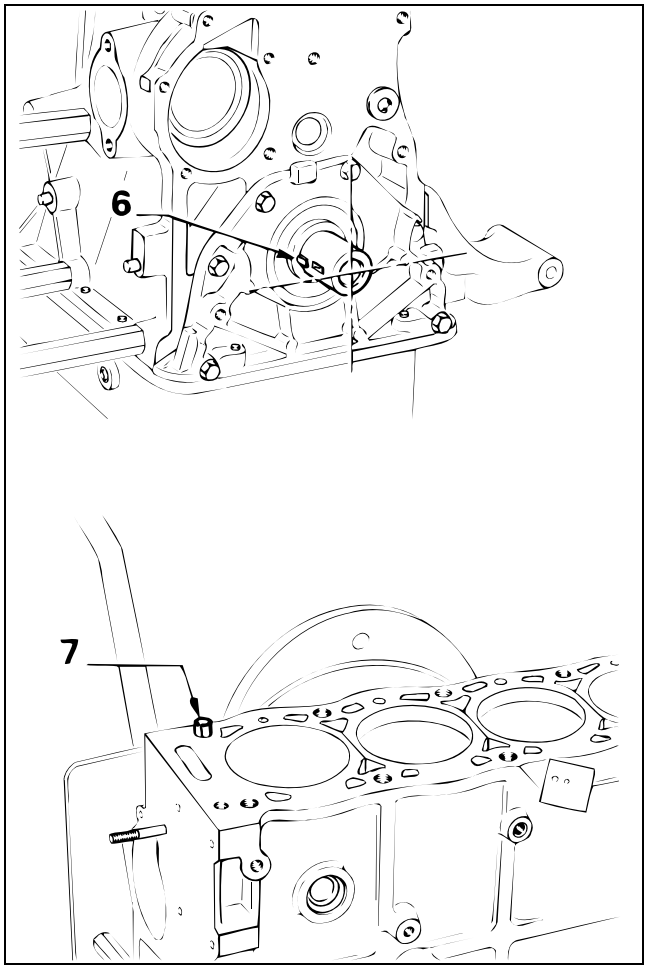

Figure 83

Cylinder Head Tightening

1. Install new washers on the bolts.

2. Pre-tighten the bolts in the order shown (Fig. 84) to a torque of 30 Nm (22 ft-lb).

3. Tighten the bolts in the order shown to a torque of 70 Nm 52 ft-lb).

4. Tighten each bolt in the order shown an additional 120° ± 2°.

NOTE: The special cylinder head bolts (Item B) do not require re-tightening. The bolts can be removed and re-installed 5 times before replacing with new bolts.

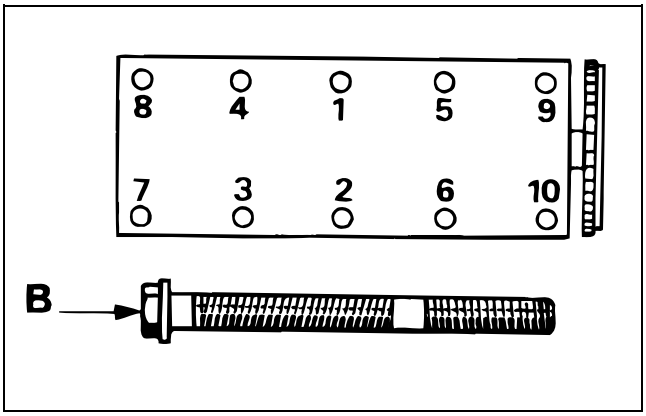

Figure 84

Valve Clearance Adjustment

NOTE: If all valve parts are re-installed in their original location it should not be necessary to adjust valve clearance, unless the head has been machined or valves ground.

1. Install the camshaft gear. (Fig. 85, Item 1).

2. Check the valve clearance:

Units: mm

	Running Clearance
Inlet	0.15
Exhaust	0.30
Tolerance	± 0.04

Set “on the rock”	Inlet 4, Exhaust 4	Inlet 1, Exhaust 1
Check	Inlet 1, Exhaust 1	Inlet 4, Exhaust 4
	Inlet 2, Exhaust 3	Inlet 3, Exhaust 2

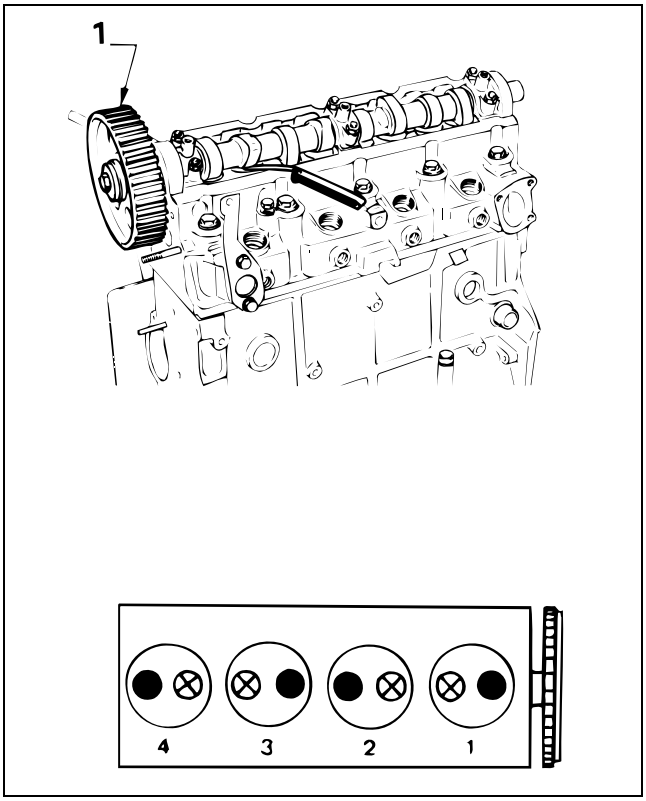

Figure 85

3. Remove the camshaft gear (Fig. 86, Item 1).

4. Remove the camshaft bearing caps (Item 2).

5. Remove the camshaft (Item 3).

6. Remove the tappets (Item 4).

7. Remove the basic shims (Item 5).

8. Determine the shim thickness to be fitted for each valve. Example:

Units: mm

	No. 1 Intake valve
Specified clearance	0.15
Clearance measured	0.25
Difference	+ 0.10
Shim installed	2.425 *
Shim to be installed	2.50
Clearance obtained	0.175

* Basic shim

9. Install the shims as determined in step 8.

10. Install the tappets.

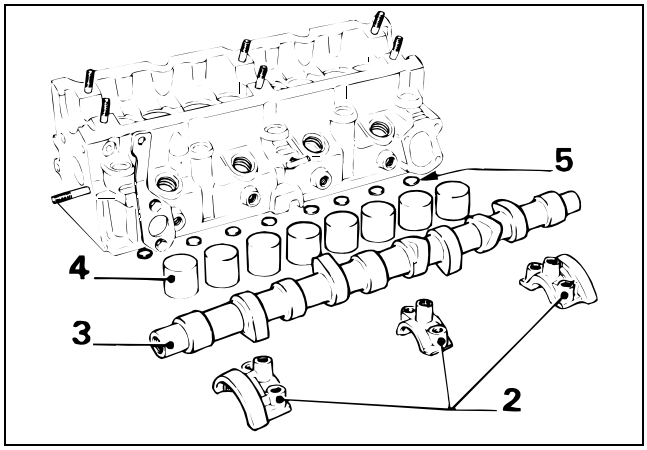

Figure 86

11. Apply a thin coat of Formetanch or Permatex No. 2 sealant to each end of the bearing housing at (Fig. 87, Item a).

12. Apply MOLYKOTE G RAPID to the bearing surfaces on the camshaft.

13. Install the camshaft (Item 3) with the DIST marking at the timing gear end.

14. Install the camshaft bearing caps (Item 2) as shown by cast-in markings.

15. Progressively tighten the bearing caps to 17.5 Nm (13 ft-lb).

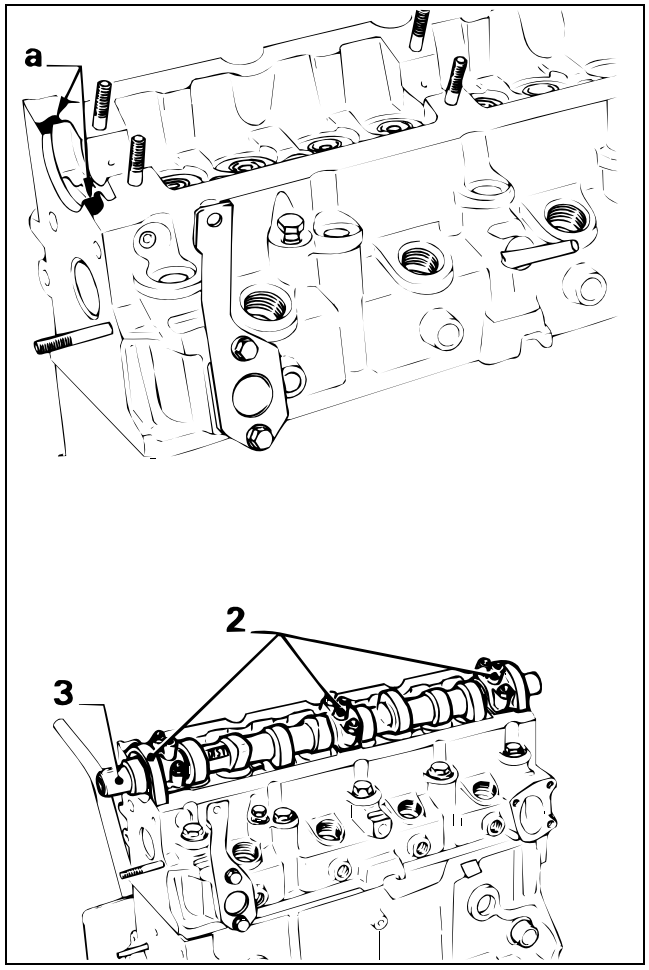

Figure 87

16. Install a new oil seal on tool TOR 976697 on the side where the inner flange is the farthest away (Fig. 88).

17. Use a camshaft gear or pulley bolt to install the two camshaft oil seals.

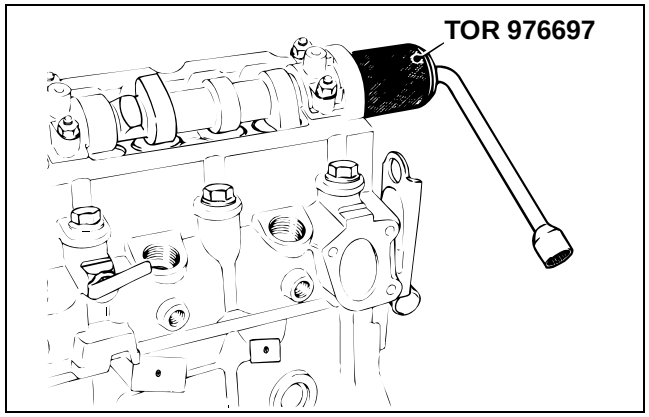

Figure 88

Assembly of External Components

1. Install new fire ring washers (Fig. 89, Item 1), convex surface facing up.

2. Install new copper washers (Item 2).

3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).

4. Install the pre-heat plugs (Item 4) and tighten to a torque of 22 Nm (16 ft-lb).

5. Install the thermostat housing (Item 5) and cover (Item 6), fitted with a new thermostat and gasket.

6. Install the cylinder head cover (Item 7), and tighten to a torque of 10 Nm (7 ft-lb).

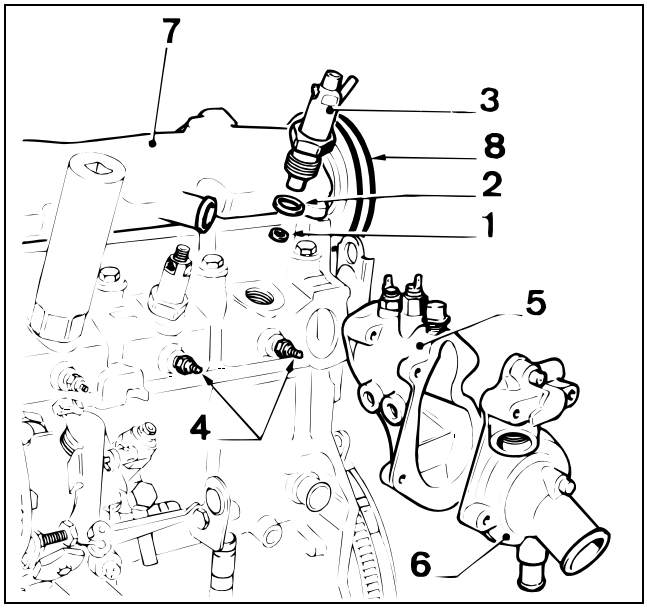

Figure 89

7. Install the pre-heat plug wires.

8. Install the breather pipe assembly, with oil filler pipes and filler orifice (Fig. 90, Item 13).

9. Install the injector pipes (Item 12).

10. Install the oil pressure switch (Item 14) and tighten to a torque of 27.5 Nm (20 ft-lb).

11. Install a new oil filter (Item 10). (See Break-in Engine After Overhaul.)

12. Install the alternator and alternator belt.

13. Install the water inlet housing.

14. Install the exhaust manifold with new seals.

15. Install the intake manifold.

16. Remove the engine from the stand.

17. Install the clutch housing centering pin.

18. Install the TDC sensor.

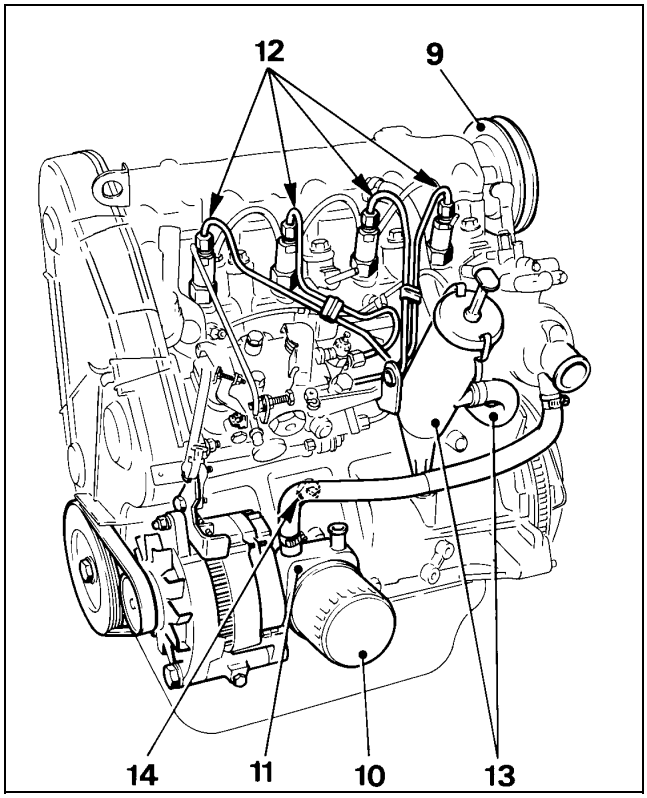

Figure 90

Break-in Engine After Overhaul

After disassembling or overhauling the engine, install the a new oil filter. Replace this filter with a new filter after the first 20 to 50 hours of operation.