Engine

Service Manual

Case G 4.0 and G 4.0T

4 Cylinder Diesel Engines

Bur 7-15480

June, 1999

Contents

General information 10

Introduction

This Service manual has been designed to provide assistance in the service and overhaul of these engines. For Service and overhaul procedures the assumption is made that the engine is removed from the machine, refer to Engine Removal in your Machine Service Manual.

Some of the illustrations used throughout this manual, may not exactly reflect your engine, they are to be used as a guide only.

Warning! *Read and remember the "Safety precautions". They are given for your protection and must be used at all times.*

When reference is made to the "left" or "right" side of the engine, this is as seen from the flywheel end of the engine.

Special and Shop Equipment tools have been made available and a list of these tools are given in section 23. Reference to the relevant Special and Shop Equipment tools are also made at the beginning of each operation.

Original setscrews or studs used in holes, which are open to the inside of the engine, have a sealant which is applied by the manufacturer. If the setscrew or stud is to be used again, the threads must be cleaned and a suitable sealant should be used on the threads.

Danger is indicated in the text by two methods:

Warning! *This indicates that there is a possible danger to the person.*

Caution: *This indicates that there is a possible danger to the engine.*

Note: *Is used where the information is important, but there is not a danger.*

Engine identification

The engine number is stamped on a label (A2) which is fastened to the left side of the cylinder block.

Code letters	Engine type
AK	Four cylinder, turbocharged
AP	Four cylinder, naturally aspirated
AQ	Four cylinder, turbocharged
AS	Four cylinder, naturally aspirated (103 mm cylinder bore)

An example of an engine number is:

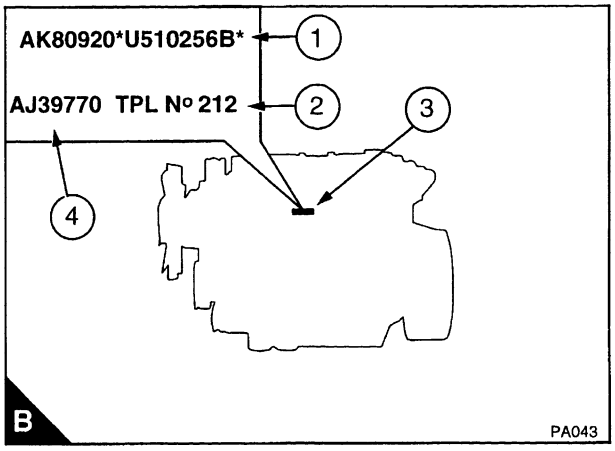
AQ12345U123456A

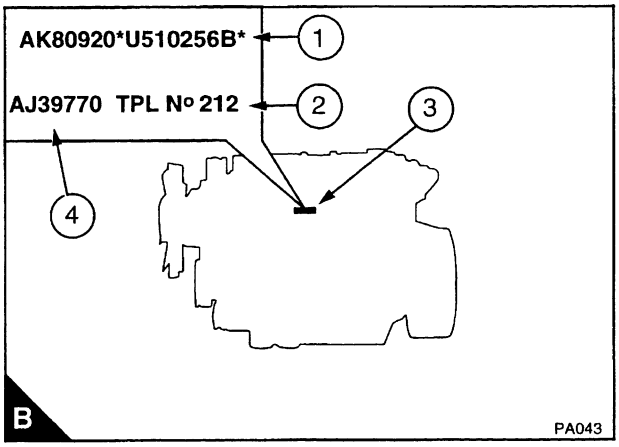
Note: *If you need parts, service or information for your engine, you must give the complete engine number to your Case Dealer. If there is a number in the area of the label marked TPL No, then this number must also be given to your Case Dealer.*

Other Identification labels installed to the Engine include:

An emissions legislation label (A3) on the side of the cylinder block.

A label (A1) with the fuel injection pump part number is located on the fuel injection pump.





If a short engine is installed two engine serial numbers and a TPL number on the engine serial number plate (B3), examples are shown above.

If parts are required for the short engine in service use serial number (B4). If parts which were moved from the original engine to the short engine are needed use the serial number (B1) and TPL number (B2).

Safety

General safety precautions

These safety precautions are important. You must refer also to the local regulations in the country of use. Some items only refer to specific applications.

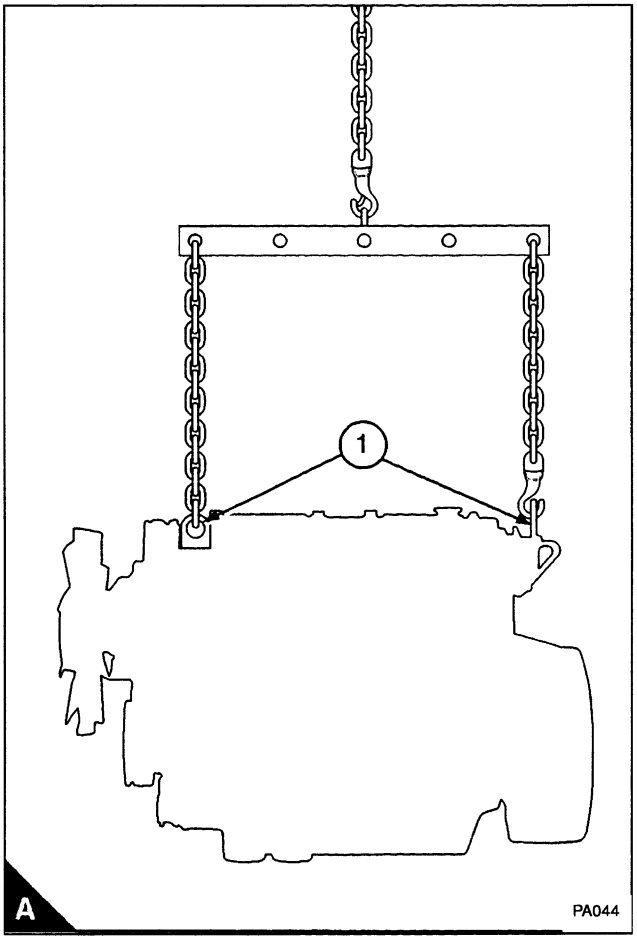
- Do not fill the engine with lubricating oil above the mark on the dipstick or damage could occur to the engine.
- If the lubrication system has been drained, the rocker gear and the camshaft reservoir must be lubricated before the engine is started or damage could occur to the engine.
- Only use these engines in the type of application for which they have been designed.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put fuel in the tank while the engine runs (unless it is absolutely necessary).
- Do not clean, add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme care must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Make sure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation. Warning! Some moving parts cannot be seen clearly while the engine runs.
- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Make sure that the engine is operated only from the operators position.
- If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets of clothing.
- Discard used lubricating oil in a safe place to prevent contamination.
- Make sure that the control lever of the transmission drive is in the "neutral" position before the engine is started.
- Use extreme care if emergency repairs must be made in adverse conditions.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes, see page 10.06.
- Read and use the instructions relevant to lift equipment which are given on page 10.05.
- Always use a safety cage to protect the operator when a component is to be pressure tested in a container of water. Install safety wires to secure the plugs which seal the hose connections of a component which is to be pressure tested.
- Do not allow compressed air to contact your skin. If compressed air enters your skin, obtain medical help immediately.
- Turbochargers operate at high speeds and at high temperatures. Keep fingers, tools and items away from the inlet and outlet ports of the turbocharger and prevent contact with hot surfaces.
- Do not clean an engine while it runs. If cold cleaning fluids are applied to a hot engine, certain components on the engine may be damaged.
- Install only genuine Case parts, supplied by Case Dealers.

Engine lifting equipment

The maximum dry weight of the engine is 500 kg (1100 lb).

Before the engine is lifted:

- Always use engine lifting equipment of the approved type and of the correct capacity to lift the engine. It is recommended that lifting equipment of the type shown in (A) is used to provide a vertical lift, directly above the engine lift brackets (A1). Never use a single lift bracket to raise an engine.
- Check the engine lift brackets for damage and that they are secure before the engine is lifted. The torque for the setscrews for the engine lift brackets is 44 Nm (33 lbf ft) 4,5 kgf m.
- To prevent damage to the rocker cover, make sure that there is clearance between the hooks and the rocker cover.
- Use lifting equipment or obtain assistance to lift heavy engine components such as the cylinder block, cylinder head, flywheel housing, crankshaft and flywheel.



Viton seals

Some seals used in engines and in components installed to engines are made of Viton.

Viton is used by many manufacturers and is a safe material under normal conditions of operation.

If Viton is burned, a product of this burnt material is an acid which is extremely dangerous. Never allow this burnt material to come into contact with the skin or with the eyes.

If it is necessary to come into contact with components which have been burnt, make sure that the precautions which follow are used:

- Make sure that the components have cooled.
- Use Neoprene gloves and discard the gloves safely after use.
- Wash the area with calcium hydroxide solution and then with clean water.
- Disposal of components and gloves which are contaminated must be in accordance with local regulations.

If there is contamination of the skin or eyes, wash the affected area with a continuous supply of clean water or with calcium hydroxide solution for 15-60 minutes. Obtain immediate medical attention.

Specifications 11

Basic engine data 11A

Basic engine data

Cycle ..... Four stroke

Number of cylinders 4

Cylinder arrangement ..... In line

Firing order 1,3,4,2

Direction of rotation ..... Clockwise from the front

Induction system

AP and AS ..... Naturally aspirated

AK and AQ ..... Turbocharged

Cubic capacity

AK, AP, and AQ ..... 4 litres (243 in^3)

AS ..... 4,23 litres (258 in^3)

Compression ratio 17.25:1

Combustion system ..... Direct injection

Nominal bore

AK, AP, and AQ ..... 100 mm (3.94 in)

AS ..... 103 mm (4.05 in)

Stroke ..... 127 mm (5.00 in)

Valve tip clearances (cold):

- Inlet ..... 0,20 mm (0.008 in)

- Exhaust ..... 0,45 mm (0.018 in)

Lubricating oil pressure
(minimum at maximum engine speed and normal engine temperature)

AK, AP, and AQ ..... 280 kPa (40 lbf/ in^2) 2,5 kgf/cm^2

AS ..... 207 kPa (30 lbf/ in^2) 2,1 kgf/cm^2

Typical dry installed engine weight ..... 500 kg (1100 lb)

Recommended torques 11B

General information

Standard torques

Special torques

11B-02 RECOMMENDED TORQUES

General information

Thread sealant

When setscrews or studs are installed into holes which are tapped into the body of the engine, a suitable sealant should be used.

Case have introduced the use of Micro Encapsulated Anaerobic Sealant (M.E.A.S). fasteners. There is no requirement to use any other other jointing compound or sealant when the fasteners are installed into holes through oil or coolant galleries. The fasteners are identified by a red, blue, or other colour sealant around the fastener threads.

When M.E.A.S. sealed studs are used, make sure that the sealed end is installed into the cylinder head/cylinder block etc. Threaded holes must have a 1,59 mm (0.0625 in) 45° chamfer, to prevent the removal of M.E.A.S. sealant when new fasteners are installed. If the fasteners have to be removed and installed again, the threads must be cleaned and a suitable sealant applied.

Standard torques

Most of the torques on the engine are standard. Special torques are listed in the separate special torque tables. The standard torques listed in the tables below can be used when a special torque is not necessary. The torques below apply to components lubricated lightly with clean engine oil before they are installed.

Standard torques for setscrews and nuts

	Torque		
Thread size	Nm	lbf ft	kgf m
M6 x 1,00	9	7	0,9
M8 x 1,25	22	16	2,2
M10 x 1,50	44	33	4,5
M12 x 1,75	78	58	8,0
M14 x 2,00	124	91	12,6
M16 x 2,00	190	140	19,3

Standard torques for studs (metal end)

	Torque		
Thread size	Nm	lbf ft	kgf m
M6 x 1,00	5	4	0,5
M8 x 1,00	11	9	1,1
M10 x 1,25	18	14	1,8
M12 x 1,50	25	19	2,5

Standard torques for tube fittings, plugs, and adaptors

	Torque		
Thread size	Nm	lbf ft	kgf m
1/8 NPT	9	7	0,9
1/4 NPT	17	13	1,7
3/8 NPT	30	23	3,0
3/4 NPT	45	35	4,5

11B-04 RECOMMENDED TORQUES

Special torques

The torques below apply to components lubricated lightly with clean engine oil before they are fitted.

Description	Thread size	Torque		
		Nm	lbf ft	kgf m
Cylinder head assembly				
Setscrews, cylinder head (Engine types - AP and AQ)	1/2 UNF	(see	section	12A-07)
Setscrews, cylinder head (Engine type - AS)	1/2 UNF/M10	(see	section	12A-07)
Fasteners, rocker shaft brackets				
Aluminium brackets	M12	40	30	4,1
Cast iron and sintered steel brackets	M12	75	55	7,6
Cap nuts, rocker cover	M12	20	15	2,1
Setscrews, inlet manifold to cylinder head	M10	44	33	4,5
Nuts (cadnium plated), exhaust manifold to cylinder head	M10	33	24	3,3
Setscrews, engine lifting bracket	M10	44	33	4,5
Piston and connecting rod assembly				
Nuts, connecting rods	1/2 UNF	125	92	12,7
Setscrews, connecting rod	1/2 UNF	155	114	15,8
Banjo bolts, piston cooling jets (Turbocharged)	3/8 UNF	27	21	2,7
Crankshaft assembly				
Setscrews, main bearings	5/8 UNF	265	196	27,0
Setscrews, crankshaft pulley	7/16 UNF	115	85	11,8
Setscrews, rear oil seal housing to cylinder block	M8	22	16	2,2
Setscrew, bridge piece to cylinder block	M6	16	12	1,6
Capscrew, rear oil seal housing to bridge piece	M6	13	10	1,3
Torxscrew, rear oil seal housing to bridge piece	M8	18	13	1,9
Setscrew, idler gear hub of balancer unit	M12	93	68	9,5
Nut, drive gear of balance weight	1/2 UNF	82	60	8,4
Setscrews, rear cover of balancer frame	M10	54	40	5,5
Setscrews, oil transfer plate (balancer unit)	M12	30	22	3,1
Setscrews, oil pump to balancer frame	M8	27	20	2,8
Setscrews, balancer to cylinder block	M10	54	40	5,5

Special torque for setscrews and nuts

Description	Thread size	Torque		
		Nm	lbf ft	kgf m
Timing case and drive assembly	-	-	-	-
Setscrews timing case to cylinder block	M8	22	16	2,2
Setscrews timing case to cylinder block	M10	44	33	4,5
Setscrews, hub of idler gear	M10	44	33	4,5
Setscrews, camshaft gear	M12	95	74	9,5
Setscrews, timing case cover to timing case	M8	22	16	2,2
Nuts, timing case cover to timing case	M8	22	16	2,2
Cylinder block	-	-	-	-
Setscrews installed istead of piston cooling jets	3/8 UNF	27	21	2,7
Fuel system				
Nuts, high-pressure fuel tubes	M12	22	16	2,2
Bolt banjo, leak-off connection	M8	9	7	0,9
Gland nut, injector	-	30	23	3,0
Setscrews, for the gear of the fuel injection pump	M10	28	20	2,8
Torx screws, for timing plater	M5	9	7	0,9
Setscrews, fuel lift pump	M8	22	16	2,2
Nuts for flange of fuel injection pump	M8	28	20	2,8
Locking screw of DP 200 fuel injection pump	10 A/F	10	7	1
Lubrication system				
Plug, lubricating oil sump	3/4 UNF	34	25	3,5
Setscrews, cover for oil pump	M8	28	21	2,9
Fasteners, lubricating oil sump	M8	22	16	2,2
Cooling system				
Fan drive assembly mounting nut (Engine type - AP, AQ, and AS)	M8	22	16	2,2
Setscrews, fan	M8	20-27	15-20	2,0-2,7
Connector, oil cooler to oil filter head	3/4 UNF	58	42	5,8
Setscrews, coolant pump to timing case	M8	22	16	2,2
Screw, cassette type cooler to oil filter head	3/4 UNF	37	29	3,7

11B-06 RECOMMENDED TORQUES

Description	Thread size	Torque		
		Nm	lbf ft	kgf m
Flywheel and housing				
Setscrews, flywheel to crankshaft	1/2 UNF	105	77	10,7
Setscrews, flywheel housing to cylinder block	M10	44	33	4,5
- Head stamped 8.8	M12	75	55	7,6
- Head stamped 10.9	M10	63	46	6,4
- Head stamped 8.8	M12	115	85	11,7
Aspiration system				
Nuts, Turbocharger to manifold	M10	44	33	4,5

Compression test data 11C

11C-02 COMPRESSION TEST DATA

Compression test data

Tests have shown that many factors affect compression pressures. Battery and starter motor condition, ambient conditions and the type of gauge used can give a wide variation of results for a given engine.

It is not possible to give accurate data for compression pressure, but tests have shown that the results should be within 2000/3500 kPa (300/500 lbf/in^2) 21,0/35,0 kgf/cm^2 for diesel engines.

Compression tests should only be used to compare between the cylinders of an engine. If one or more cylinders vary by more than 350 kPa (50 lbf/in^2) 3,5 kgf/cm^2, then those cylinders may be faulty. Compression tests should not be the only method used to show the condition of an engine, but they should be used together with other symptoms and tests.

How to do a compression test

Caution: *Before the compression test, make sure that the battery is in good condition and that it is fully charged. Also make sure that the starter motor is in good condition.*

1 Make sure that the valve tip clearances are set correctly.

2 Remove the injectors.

3 Install a suitable gauge into the injector hole of the cylinder to be tested.

4 Make sure that the engine cannot start:

Disconnect the stop solenoid.

Operate the starter motor and note the pressure indicated on the gauge.

5 Repeat for each cylinder.

Cylinder head assembly 12

12A-02 CYLINDER HEAD ASSEMBLY

General description

In a diesel engine there is little carbon deposit and for this reason the number of hours run is no indication of when to overhaul a cylinder head assembly. The factors which indicate when an overhaul is necessary are how easily the engine starts and its general performance.

The cylinder head assembly has two valves installed for each cylinder, each installed with single valve springs.

The ports for the inlet and exhaust are on the right side of the cylinder head.

The face angle of the valves are:

Naturally aspirated .....45° inlet and exhaust

80 and 90 hp ..... 30° inlet, 45° exhaust

100 hp.....45° inlet and exhaust

The valves move in sintered steel guides which can be replaced. The exhaust valve guide has a counterbore to prevent seizure of the valve stem caused by a build up of carbon under the head of the valve. Both valve stems are installed with oil seals that install over the top of the valve guides.

The engines have steel valve seat inserts installed in the cylinder head for both inlet and exhaust valves.

Rocker cover

To remove and to install **12A-01**

To remove

1 Disconnect the breather hose.

2 Remove the cap nuts, washers, sealing washers and washers from the top of the rocker cover.

3 Remove the rocker cover and gasket.

Caution: *When the rocker cover is installed, the cap nuts are tightened onto the nuts of the rocker brackets. During removal of the cap nuts, it is possible to loosen the nuts of the rocker brackets. The nuts of the rocker brackets should be tightened to the correct torque every time the cover is removed.*

To install

1 Check the sealing washers for the cap nuts.

Warning! *The rocker cover gasket may be made from viton, read the safety precautions in section 10 for viton seals.*

2 Check the condition of the rocker cover gasket. If necessary, the gasket can be removed and replaced.

3 Clean the gasket face of the cylinder head and install the rocker cover.

4 Install in the following order the washers, sealing washers, washers and cap nuts.

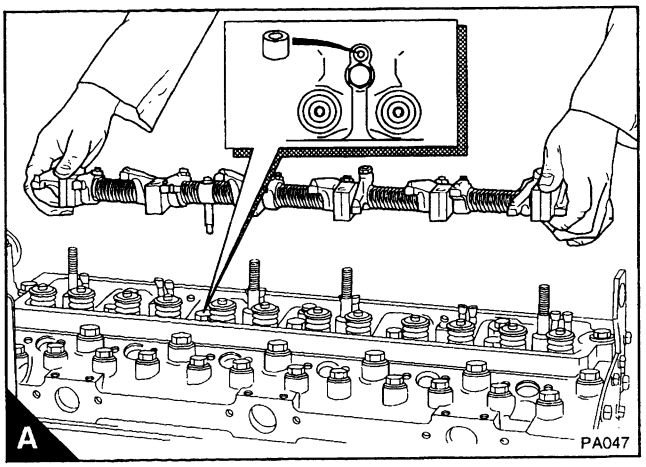
Caution: *Damage to the sealing washer can occur if the cap nut is not tightened centrally through the sealing washer and the rocker cover. If the sealing washer is damaged, it must be replaced.*

5 Tighten the rocker cover cap nuts to 20 Nm (15 lbf ft) 2,1 kgf m.

6 Install the breather hose.

Rocker assembly

To remove and to install **12A-02**



To remove

1 Remove the rocker cover, operation 12A-01.

2 Release evenly and gradually the fasteners of the rocker shaft brackets; begin with the end brackets and move toward the centre. Remove the fasteners and lift off the rocker assembly.

3 Remove the rubber oil seal (A) from the oil supply connection or from the oil supply hole in the cylinder head.

To install

1 Install a new rubber oil seal (A) in the oil supply hole in the cylinder head.

2 Check that the push rods are installed correctly in the sockets of the tappets. Install the rocker assembly; make sure that the oil supply connection is installed correctly into the oil seal. Check that the ends of the adjustment screws are install correctly in the sockets of the push rods.

3 Install the fasteners of the rocker shaft brackets and tighten the fasteners evenly and gradually; begin with the inner fasteners and work towards the end fasteners. Tighten the fasteners evenly to 75 Nm (55 lbf ft) 7,6 kgf m.

4 Check and adjust the valve tip clearances, see operation 12A-05.

Rocker assembly

To disassemble and to assemble **12A-03**

To disassemble

1 Remove the circlips from both ends of the rocker shaft. Make sure that the ends of the rocker shaft are not damaged. Release the location screw (A1) for the oil supply connection.

2 Disassemble the assembly and make a note of the position of each component to make sure that they can be assembled more easily.

To assemble

1 Make sure that the oil holes in the rocker shaft and in the rocker levers are not restricted.

2 Lubricate the components with clean engine lubricating oil before assembly. Assemble the components in the correct order (A) with the arrows (A2) on the pedestals in the position shown. Make sure that the location screw (A1) for the oil supply connection is installed correctly in the rocker shaft. Install the circlips to the ends of the rocker shaft.

To inspect and to correct **12A-04**

To inspect

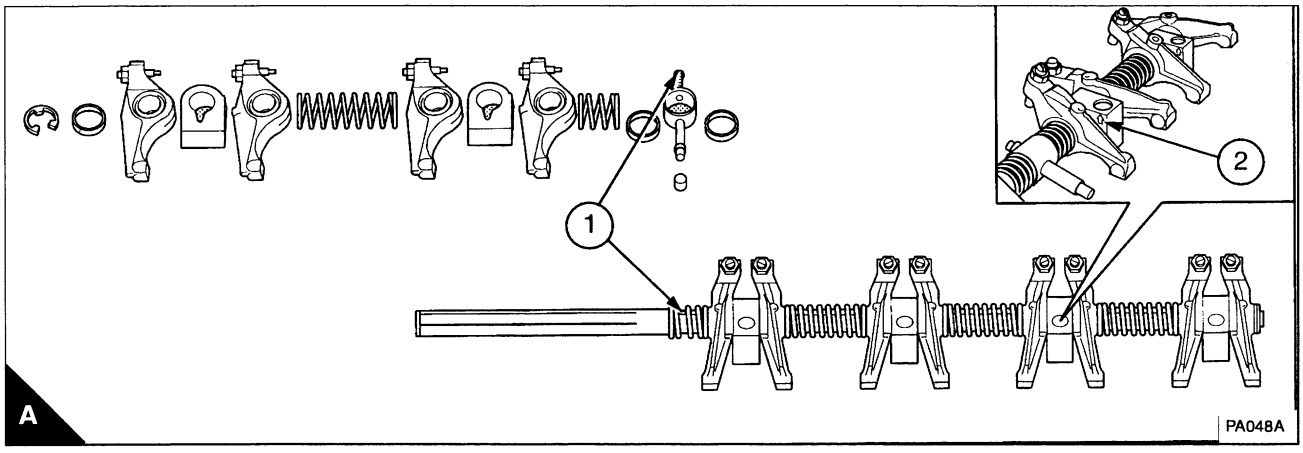
1 Clean and inspect all the components for wear and any other damage. Check the clearance of the rocker levers on the rocker shaft. If the clearance is larger than 0,13 mm (0.005 in), replace the rocker lever bushing and/or the rocker shaft.

To correct

1 To replace the rocker lever bushing, press out the old bushing with a suitable mandrel.

2 Align the lubrication hole of the new bushing on the same side as the rocker lever lubrication hole and press the bushing into position.

3 Ream the bushing in the rocker lever to give a clearance on the rocker shaft of 0,03/0,09 mm (0.001/0.004 in). Clean thoroughly the bushing and check that the oil hole is free from debris.

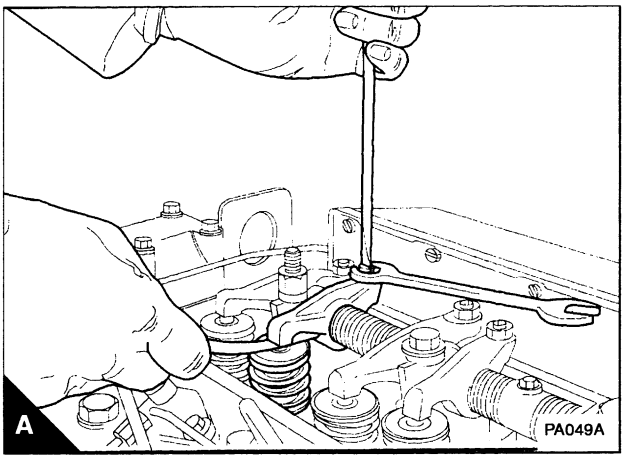


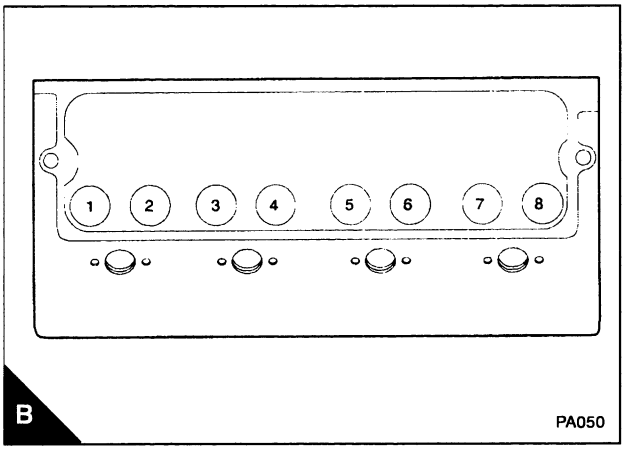
Valve tip clearances

To check and to adjust **12A-05**

Notes:

- The valve tip clearance is measured between the top of the valve stem and the rocker lever (A). With the engine hot or cold, the correct clearances are 0,20 mm (0.008 in) for the inlet valves and 0,45 mm (0.018 in) for the exhaust valves. The valve positions are shown at (B).
- The sequence of valves from number 1 cylinder is shown in the table below. Number 1 cylinder is at the front of the engine.





1 Rotate the crankshaft in the normal direction of rotation until the inlet valve (B7) of number 4 cylinder has just opened and the exhaust valve (B8) of the same cylinder has not closed completely. Check the clearances of the valves (B1 and B2) of number 1 cylinder and adjust them, if necessary.

2 Set the valves (B3 and B4) of number 2 cylinder as indicated above for number 4 cylinder. Then check / adjust the clearances of the valves (B5 and B6) of number 3 cylinder.

3 Set the valves (B1 and B2) of number 1 cylinder. Then check / adjust the clearances of the valves (B7 and B8) of number 4 cylinder.

4 Set the valves (B5 and B6) of number 3 cylinder. Then check / adjust the clearances of the valves (B3 and B4) of number 2 cylinder.

Cylinder and Valve number	1		2		3		4	
	1	2	3	4	5	6	7	8
Valve I = Inlet E = Exhaust	I	E	I	E	I	E	I	E

Valve springs

To change the valve springs (with cylinder head installed) **12A-06**

Shop Equipment Tools:

Valve spring compressor, PD.6118B

Stud adaptor used with PD.6118B, PD.6118-7

Setscrew adaptor used with PD.6118B, PD.6118-8

Note: *Steps 1 to 12 refer to a change of valve springs for a single cylinder.*

Warning! *Wear eye protection during this operation.*

1 Remove the rocker cover, operation 12A-01.

2 Rotate the crankshaft in the normal direction of rotation until the inlet valve of the relevant cylinder has just opened and the exhaust valve has not fully closed. In this position the piston will be at approximately top dead centre (TDC).

3 Remove the rocker assembly, operation 12A-02.

4 Install the valve spring compressor (A1) and the relevant adaptor (A2 or A3).

5 Compress the valve spring and remove the valve keepers. Make sure that the valve spring is compressed squarely or damage to the valve stem can occur.

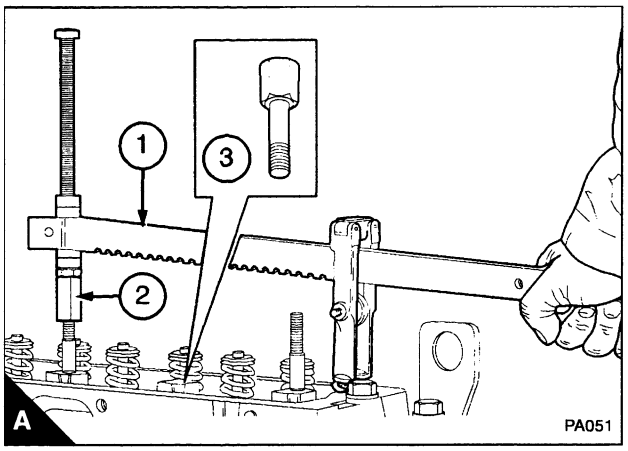
Caution: *Do not rotate the crankshaft while the valve springs are removed.*

6 Release the valve spring compressor and remove the valve spring caps and valve spring.

Caution: *The outer diameter of the exhaust valve guide is 1 mm larger than the inlet valve guide. To prevent leakage past the inlet valve stem it is important that the larger exhaust valve seal is not installed onto the inlet guide. The seals have a colour code for identification.*

7 Install new valve stem seals on the valve guides. Make sure that the red seal is installed to the exhaust valve and green seal is installed to the inlet valves.

8 Put the new valve springs in position.



Continued

9 Install the valve spring caps.

Caution: *Make sure that the valve spring is compressed squarely or damage may occur to the valve stem.*

10 Install the valve spring compressor, compress the valve spring and install the valve keepers. Remove the valve spring compressor.

11 Install the rocker assembly, operation 12A-02.

12 Check the valve tip clearances, operation 12A-05.

13 Install the rocker cover, operation 12A-01.

Note: *If other or all of the valve springs are to be changed, they can be changed two cylinders at a time. The sets of cylinders are 1 and 4, 2 and 3.*

If the rocker assembly has been removed, piston TDC can be found as follows:

1 Install the valve spring compressor and compress the valve springs to open the valve.

2 Rotate the crankshaft, by hand, in the normal direction of rotation until the piston touches the valve.

3 Continue to rotate the crankshaft, and at the same time, release pressure on the valve spring compressor until the piston is at TDC (A).