

1

General information

Introduction

The 4006 and 4008 gas engines are a family of 6 and 8 cylinder turbocharged gas engines, designed by Perkins Engines Company Limited, Stafford, a world leader in the design and manufacture of high-performance gas engines. They form part of the 4000 Series range of engines.

Perkins approved assembly and quality standards, together with the latest technology, have been applied to the manufacture of your engine to give you reliable and economic power.

Most of the general information included in the relevant User's Handbook (Chapters 1 to 6) has not been repeated in this Workshop Manual. The two publications should be used together as references to the User's Handbook are made for certain operations.

When an anti-knock system is fitted refer to the Manual supplied by the manufacturer "Gas Engine Technology Bv".

To ensure that you use the relevant information for your specific engine type, refer to ["Engine identification" on page 3](#).

The purpose of this manual is to enable the operator to carry out routine servicing of the engine. Before undertaking any such work the relevant chapter should be read and completely understood.

Users are respectfully advised that, in the interests of safety, it is their responsibility to employ competent persons to operate, maintain and service the equipment.

The information contained within this manual is based on that available at time of going to print. In line with Perkins Engines Company Limited, Stafford policy of continual development and improvement, that information may change at any time without notice. The engine user should therefore ensure that he has the latest information before starting work.

Special tools are required to perform certain operations. A list of those required for the operations described in this manual is given in [Chapter 16, Special tools](#). Reference to the relevant special tools is also made at the beginning of each operation, along with those which are universally available (UA) and any additional specialist supplied equipment (SP) required.

Operators who are not equipped to undertake major repairs are urged to consult their Perkins distributor.

Torque settings and Wear and renewal limits for specific components are provided in [Chapter 2, Specifications](#). Reference should be made to these where indicated in the manual.

Oil change intervals may be changed according to operating experience by agreement with Perkins Engines Company Limited, Stafford and subject to oil analysis being carried out at regular intervals.

Read and remember the ["Safety precautions" on page 4](#). They are given for your own protection and must be observed at all times.

Continued

If any doubt exists regarding the installation, use or application of the engine, the Installation Manual should be consulted. For further advice contact the Applications department at Perkins Engines Company Limited, Stafford.

Please quote the engine type and serial number with all your enquiries. The type and serial number are on a plate fitted to the crankcase.

In addition to the general safety precautions, danger to both operator and engine are highlighted by the following conventions:

Warning! *This indicates that there is a possible danger to the person (or the person and engine).*

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

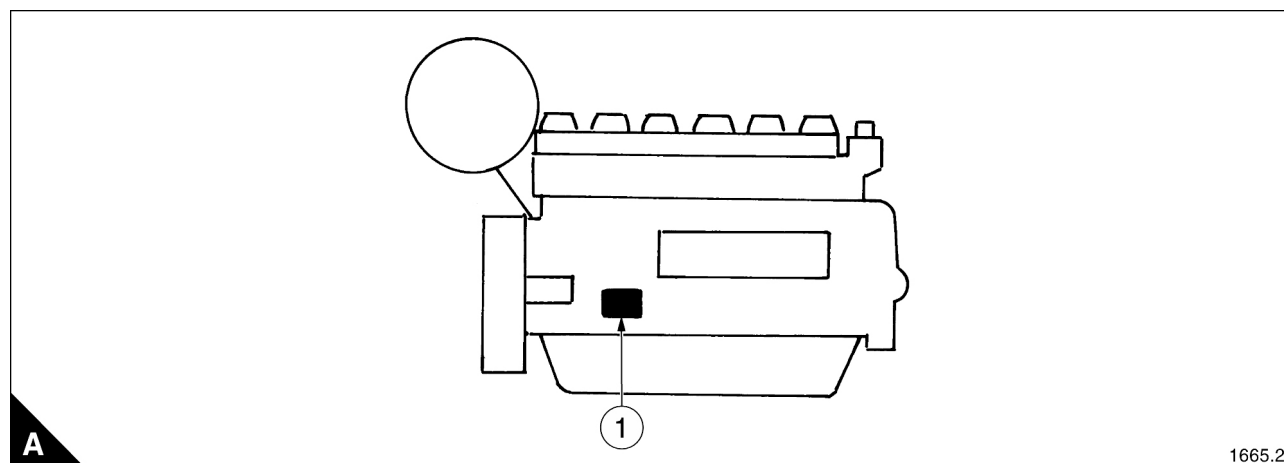
Note: Is used where the information is important, but there is not a danger.

Engine identification

The engine number and its build specification details are given on its data plate (A1) which is fitted to the right side of the crankcase by the oil filters.

A reference code and engine description is given in the table below.

Reference Code	Description
4006TESI 200 LC	6 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of 200g/GJ or less.
4006TESI 140 LC	6 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of less than 140g/GJ.
4006TESI 140 HC	6 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of less than 140g/GJ, and higher thermal efficiency than the 4006TESI 140 LC.
4006TESI 90 HC	6 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of less than 90g/GJ.
4008TESI 200 LC	8 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of 200g/GJ or less.
4008TESI 140 LC	8 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of less than 140g/GJ.
4008TESI 140 HC	8 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of less than 140g/GJ, and higher thermal efficiency than the 4006TESI 140 LC.
4008TESI 90 HC	8 cylinder, in-line, 4 stroke, turbocharged, spark ignition gas engine, with water based engine coolant and oil cooler, raw water pump and separate cooling system for charge air intercooler. With NOx emission of less than 90g/GJ.



Safety precautions

General

For safe and reliable operation of the engine it is very important that these safety precautions, and those **Warnings** and **Cautions** given throughout this manual, are observed, and where necessary the special tools indicated are used.

All safety precautions should be read and understood before operating or servicing the engine.

Improper operation or maintenance procedures are dangerous and could result in accidents, injury or death.

The operator should check before beginning an operation that all the basic safety precautions have been carried out to prevent accidents occurring.

You must also refer to the local regulations in the country of use.

Note: Some items only apply to specific applications.

Guards

- Ensure that guards are fitted over exposed rotating parts, hot surfaces, air intakes, belts or live electrical terminals (high and low tension).

Protection equipment

- Ensure that correct protection equipment is worn at all times.
- Always wear protective gloves when using inhibitors or anti-freeze, removing the pressure cap from the radiator or heat exchanger filler, changing the lubricating oil/filter or changing the electrolyte in the battery.
- Always wear ear protection when working in an enclosed engine room.
- Always wear suitable eye protection when using an air pressure line.
- Always wear protective boots when working on the engine.
- Always wear protective headgear when working on or underneath the engine.

Naked flames

- Ensure that no smoking or naked flames are lit when checking battery electrolyte, working in the engine room or when operating or servicing the engine.

Fuel/oil pipes

- Ensure that all pipes are regularly checked for leaks.
- Ensure that all pipes and the surrounding area are regularly checked for spilt oil (and cleaned up where necessary).
- Always apply suitable barrier cream to hands before any work is carried out.

Gas pipes

- Always check for gas/air mixture leaks.
- Ensure that the gas line and valves meet local safety standards.
- Ensure that the gas line pressure is correct.

Shutdown equipment

- Always test that the protection system is working correctly.
- When stopping the engine in case of overspeed, high water temperature or low oil pressure should be provided.
- For heat sensors, methane and smoke protectors should be provided (if applicable).
- Always be in a position to stop the engine (even remotely).

Start-up

- When working on the engine always ensure that the battery has been disconnected, and that any other means of accidental start-up has been disabled.
- Never start the engine with the governor linkage disconnected.
- Do not hold the stop lever in the run position when starting the engine.
- Always hold the stop lever in the stop position when cranking only.

Electrical equipment

- Always check that electrics are earthed to local safety standards.
- Always disconnect the electrical supply to the jacket water heater (if fitted) before working on the engine.
- Take care to prevent any danger of electric shock.
- Never re-adjust the settings of electronic equipment without reference to the Workshop Manual.

Freezing or heating components

- Always use heat resistant gloves and use the correct handling equipment.

Exhaust system

- Check the system for leaks.
- Ensure that the engine room is correctly ventilated.
- Check that all the guards are fitted.
- Check that the pipework allows the exhaust gas to escape upwards.
- Check that the pipework is supported.

Stopping the engine

1 Disengage the engine load.

2 Run the engine on NO LOAD for 5 to 7 minutes before stopping.

Note: This will allow the circulating lubricating oil to dissipate heat from the bearings, pistons, etc. It will also allow the turbochargers, which run at a very high speed, to slow down while there is still oil flow through the bearings.

Ensure that the engine is stopped before performing any of the following operations:

- Changing the lubricating oil.
- Filling or topping up the cooling system.
- Beginning any repair work on the engine.
- Adjusting belts (where fitted).
- Adjusting bridge pieces / valve clearance.
- Changing spark plugs.
- Changing air or oil filters.
- Tightening any fixing bolts.

Flammable fluids

- Ensure that these are never stored near the engine.
- Ensure that they are never used near a naked light.

Clothing

- Do not wear loose clothing, ties, jewellery, etc.
- Always wear steel toe cap shoes/boots.
- Always wear the correct head, eye and ear protection.
- Always wear suitable overalls.
- Always replace a spillage contaminated overall immediately.

Lifting heavy components

- Always use the correct lifting equipment.
- Never work alone.
- Always wear a helmet, if the weight is above head height.

De-scaling solution

- Always wear both hand and eye protection when handling.
- Always wear overalls and correct footwear.

Waste disposal

- Do not leave oil covered cloths on or near the engine.
- Do not leave loose items on or near the engine.
- Always provide a fireproof container for oil contaminated cloths.

Note: Most accidents are caused by failure to observe basic safety precautions and can be prevented by recognising potentially dangerous situations before an accident occurs. While there are many potential hazards that can occur during the operation of the engine which cannot be always be anticipated, and thus a warning cannot be included to cover every possible circumstance that might involve a potential hazard, by following these basic principles the danger can be minimised.

Dangers from used engine oils

Prolonged and repeated contact with mineral oil will result in the removal of natural oils from the skin, leading to dryness, irritation and dermatitis. The oil also contains potentially harmful contaminants which may result in skin cancer.

Adequate means of skin protection and washing facilities should be readily available.

The following is a list of 'Health Protection Precautions', suggested to minimise the risk of contamination.

- 1 Avoid prolonged and repeated contact with used engine oils.
- 2 Wear protective clothing, including impervious gloves where necessary.
- 3 Do not put oily rags into pockets.
- 4 Avoid contaminating clothes, particularly underwear, with oil.
- 5 Overalls must be cleaned regularly. Discard unwashable clothing and oil impregnated footwear.
- 6 First aid treatment should be obtained immediately for open cuts and wounds.
- 7 Apply barrier creams before each period of work to aid the removal of mineral oil from the skin.
- 8 Wash with soap and hot water, or alternatively use a skin cleanser and a nail brush, to ensure that all oil is removed from the skin. Preparations containing lanolin will help replace the natural skin oils which have been removed.
- 9 Do NOT use petrol, kerosene, diesel fuel, thinners or solvents for washing the skin.
- 10 If skin disorder appears, medical advice must be taken.
- 11 Degrease components before handling if practicable.
- 12 Where there is the possibility of a risk to the eyes, goggles or a face shield should be worn. An eye wash facility should be readily available.

Environmental protection

There is legislation to protect the environment from the incorrect disposal of used lubricating oil. To ensure that the environment is protected, consult your Local Authority who can give advice.

Danger from 'fluorosilicone' (Viton) 'O' ring seals

All of the engines 'O' ring seals are made from fluorosilicone material.

It is a safe material under normal conditions of operation, but if it is burned the extremely dangerous hydrofluoric acid is produced.

If it is necessary to come into contact with components which have been burnt, follow the precautions below:

- Allow the components to cool.
- Use Neoprene gloves and a face mask.
- Wash the contaminated area with a calcium hydroxide solution and then with clean water.
- Disposal of gloves and components which are contaminated must be in accordance with local regulations.

Caution: *If there is contamination of the skin or eyes, wash the affected area with a continuous supply of clean water. Obtain immediate medical attention.*

Practical information for cleaning components

Use suitable gloves for protection when components are degreased.

Keep the work area clean and ensure that components are protected from dirt and debris. Ensure that dirt does not contaminate the fuel system.

Before a component is removed from the engine, clean around the component and ensure that all openings, disconnected hoses and pipes are sealed.

Remove, clean and inspect each component carefully. If it useable, put it in a clean dry place until needed. Ball and roller bearings must be cleaned thoroughly and inspected. If the bearings are usable, they must be flushed in low viscosity oil and protected with clean paper until needed.

Before the components are assembled, ensure that the area is free from dust and dirt as possible. Inspect each component immediately before it is fitted, wash all pipes and ports, and pass dry compressed air through them before connections are made.

2

Specifications

Basic engine data

The figures quoted are based on 6 and 8 cylinder vertical, water cooled turbocharged, intercooled engines, set to meet the requirements of ISO 3046/1.

For full technical specifications refer to the relevant engine Technical Data sheet.

Refer also to "Engine specifications" in Chapter 1 of the User's Handbook.

General

Engine model	4006TESI LC 4006TESI HC	4008TESI LC 4008TESI HC
Cycle	4 stroke spark ignition	
Configuration	In-line	
Bore	160 mm	
Stroke	190 mm	
Cubic capacity	22,921 litres	30,561 litres
Compression ratio	9.5:1 (LC), 11.5:1 (HC)	
Rotation	Anti-clockwise looking on flywheel end	
Firing order	1-5-3-6-2-4	1-4-7-6-8-5-2-3
Cylinder numbering	Cylinder 1 furthest from flywheel	
Injection timing	See engine nameplate	
Valve clearances (engine cold)	Exhaust and inlet 0,40 mm (0.016")	
Piston speeds	m/s (ft/min)	Engine rpm
	7,60 (1496)	1200
	9,50 (1870)	1500

Engine weight

Engine model	4006TESI LC 4006TESI HC	4008TESI LC 4008TESI HC
Dry weight (engine)	2420 kg	3350 kg
Dry weight (engine including charge cooler and wet exhaust manifolds)	2574 kg	3558 kg

Specific torque settings

Warning! It is essential that the correct length of screw or bolt is used. Insufficient thread may result in the thread being stripped. Excessive thread may result in bottoming in a blind hole or catching on adjacent components.

Cylinder head group

Description	Thread size	Torque tension	
		lbf ft	Nm
Cylinder head bolt ⁽¹⁾	M24	530	723
Rocker shaft capscrew and nut	M16	90	120
Rocker adjuster nut inlet/exhaust	M12	35	50
Rocker box capscrews	M10	50	70
Inlet manifold bolt	M10	35	50
Exhaust manifold bolt	M10	50	70
Turbocharger V-band clamp nuts	M8	8	11

⁽¹⁾ Cylinder head bolts to be lubricated under the heads, under the washers and on the threads with PBC (Poly-Butyl-Cuprysil) grease. All other bolt threads only to be lubricated with clean engine oil.

Crankcase and crankshaft groups

Description	Thread size	Torque tension	
		lbf ft	Nm
Main bearing bolt ⁽¹⁾	M24	580	783
Bolts sump to crankcase	M10	40	57
Connecting rod bolts ⁽¹⁾	M16	82	110
		and angle 60°	
Torsional vibration damper bolts	M12	120	160
Flywheel bolt	M16	250	340
TV Damper retaining plate	M16	250	340
Balance weight bolt	M16	250	340
Fan drive pulley bolts	M16	250	340
Piston cooling jet bolt	M10	7	10
Flywheel housing bolt	M10	35	50
Crankcase side bolts	M16	200	270

⁽¹⁾ Bolt and threads must be lubricated with clean engine oil.

Lubricating oil pump

Description	Thread size	Torque tension	
		lbf ft	Nm
Bolts, pump housing to gearcase plate	M10	35	50
Thin nut gear to drive shaft	M24	175	237

Camshaft group

Description	Thread size	Torque tension	
		lbf ft	Nm
Camshaft gear bolt	M12	110	150
Camshaft thrust plate bolt	M10	35	50
Camshaft follower housing capscrew	M10	50	70
Cam follower housing bolt	M10	35	50
Idler gear hub bolts	M10	35	50

Coolant pump (if fitted)

Description	Thread size	Torque tension	
		lbf ft	Nm
Pump drive gear nut	M24	170	230
Coolant inlet to oil cooler bolts	M10	35	50
Coolant outlet to gearcase bolts	M10	35	50

Oil pump

Description	Thread size	Torque tension	
		lbf ft	Nm
Pump drive gear nut	M24	170	230

Engine feet

Description	Thread size	Torque tension	
		lbf ft	Nm
Engine feet	M12	70	95

Governor

Description	Thread size	Torque tension	
		lbf ft	Nm
Control shaft mounting plate bolt	M10	35	50

Radiator fan drive (if fitted)

Description	Thread size	Torque tension	
		lbf ft	Nm
Fan drive pulley taper lock bush grub screw	$\frac{1}{2}$ " BSW	37	50
	$\frac{5}{8}$ " BSW	124	170

Battery charging alternator (if fitted)

Description	Thread size	Torque tension	
		lbf ft	Nm
Drive pulley taper lock bush grub screw	$\frac{3}{8}$ " BSW	14	20
Drive pulley nut	-	21	28

Ignition system

Description	Thread size	Torque tension	
		lbf ft	Nm
Spark plug	M18 x 1.5	35	50
Adaptor clamp capscrew - plug bush	M12	100	136
Gear cover to mounting plate stud	M10	35	47,5

General torque settings

Warning! It is essential that the correct length of screw or bolt is used. Insufficient thread may result in the thread being stripped. Excessive thread may result in bottoming in a blind hole or catching on adjacent components.

The following torque tensions are general for metric coarse threads and for grade 8.8 steel.

Thread size (mm)	Torque tension	
	lbf ft	Nm
M8	21	28
M10	41	56
M10 (grade 12.9 steel only)	50	70

Note: These figures are based to BS3692.

Wear and renewal limits

Description of components	Design size		Wear limits	
	mm	in	mm	in
Cylinder heads	Service exchange unit recommended For reconditioning in a specialized workshop refer to Chapter 3, Cylinder head assembly			
Inlet and exhaust valve stem diameter	11,0145 11,0095	0.4336 0.4334	0,20	0.008
Valve spring free length	55,6	2.1889	55,6	2.1889
Piston ring gap				
Top compression ring - parallel and taper type	0,60	0.024	0,85	0.033
Second compression ring	0,60	0.024	0,85	0.033
Oil control ring	0,60	0.024	0,85	0.033
Piston ring groove width				
Top compression ring - taper type	<i>It is not possible to check a tapered ring groove</i>			
Top compression ring - parallel type	3,590 3,565	0.141 0.140	0,254	0.010
Second compression ring	3,565 3,540	0.140 0.139		
Oil control ring	6,065 6,040	0.2388 0.2378		
Gudgeon pin diameter	63,500 63,492	2.500 2.4997	0,15	0.0059
Small end bush bore	63,576 63,551	2.503 2.502		
Cylinder liner bore	160,025 160,000	6.300 6.299	0,125	0.005
Crankshaft				
Crankpin journal diameter	118,013 117,993	4.6462 4.6454	0,203	0.008
Main bearing journal diameter	120,59 120,57	4.7476 4.7470		
Crankshaft end float	0,51 0,13	0.020 0.005	0,55	0.022
Undersize crankshaft bearings	0,254 0,508	0.010 0.020	N/A	
Camshaft				
Camshaft journal diameter	91,960 91,933	3.6204 3.6194	0,25	0.010
Camshaft end float	0,25 0,10	0.010 0.004	0,30	0.012
Timing gears				
Idler gear end float	0,20 0,10	0.008 0.004	0,25	0.010
Backlash in timing gears	0,375 0,125	0.15 0.005	0,50	0.020

3

Cylinder head assembly

General information

In the event of failure, valve recession reaching an unacceptable limit or if the engine is undergoing a major overhaul, service exchange cylinder heads can be fitted.

Note: These must be supplied by your Perkins distributor as specialised equipment is needed to recondition them.

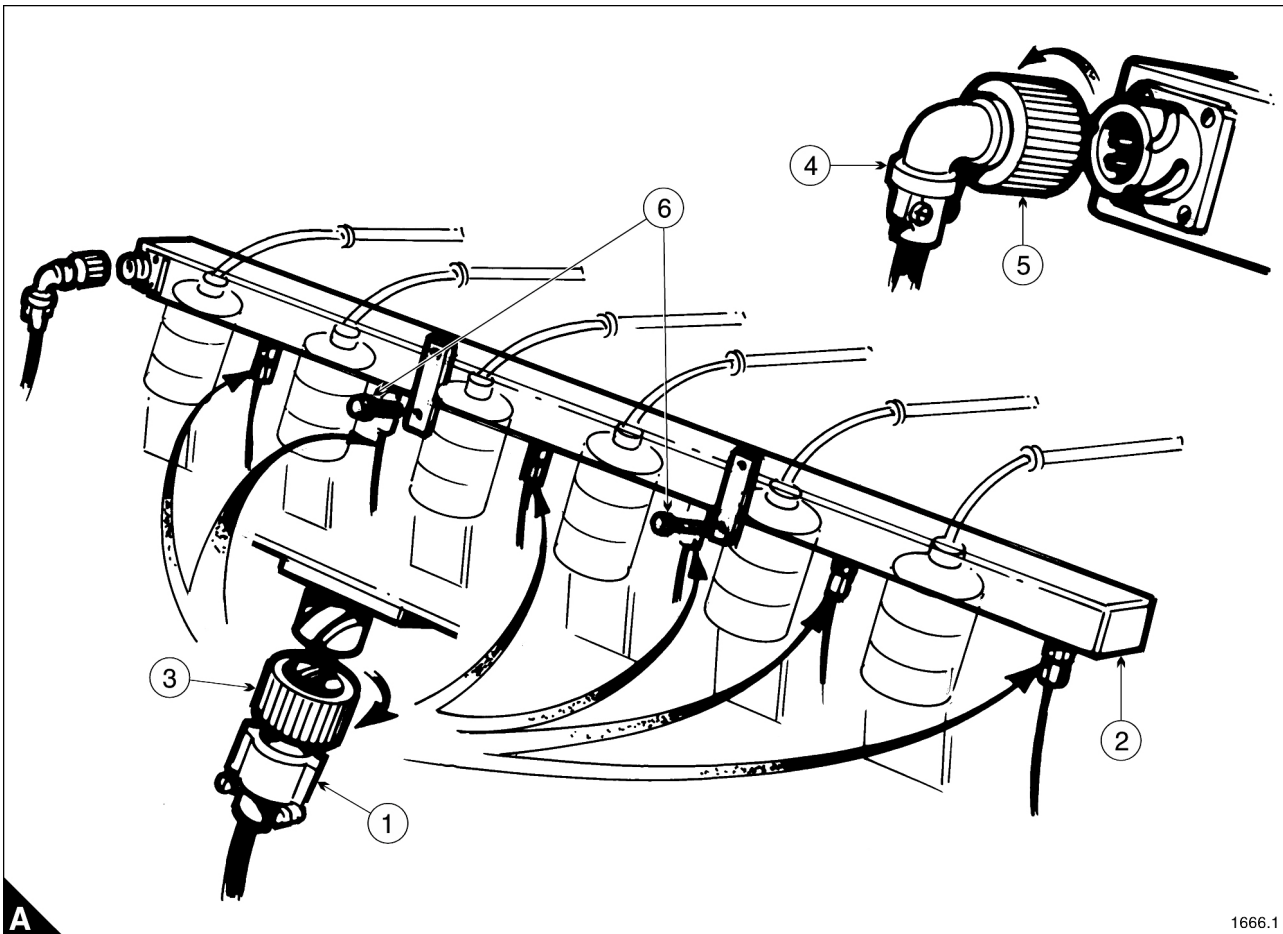
The inlet and exhaust manifolds, charge cooler, gas pipework etc need only be removed for major overhaul. An individual cylinder head can be removed, as can all of the cylinder heads, without removal of the manifolds etc, see [Operation 3-8](#).

Detonation sensor wiring rail (if fitted)

To remove and to fit

Operation 3-1**Warning!** Turn off the gas and isolate the engine.

- 1 Disconnect the six knock sensor leads (A1) from the wiring rail (A2) to release the plugs.
- 2 Turn the locking ring (A3) anti-clockwise and pull the plug from the rail.
- 3 Disconnect the control box power cable plug (A4) from the wiring rail (flywheel end of the engine) to release the plug. Turn the locking ring (A5) anti-clockwise and pull the plug from the rail.
- 4 Remove the retaining nuts and bolts (A6) from the sensor rail support brackets and lift the rail from the engine.
- 5 Refit the wiring rail. Tighten the retaining bolts (A6) by hand. Check alignment and torque the retaining bolts to 24 Nm (18 lbf ft).
- 6 Reconnect all sensor leads.



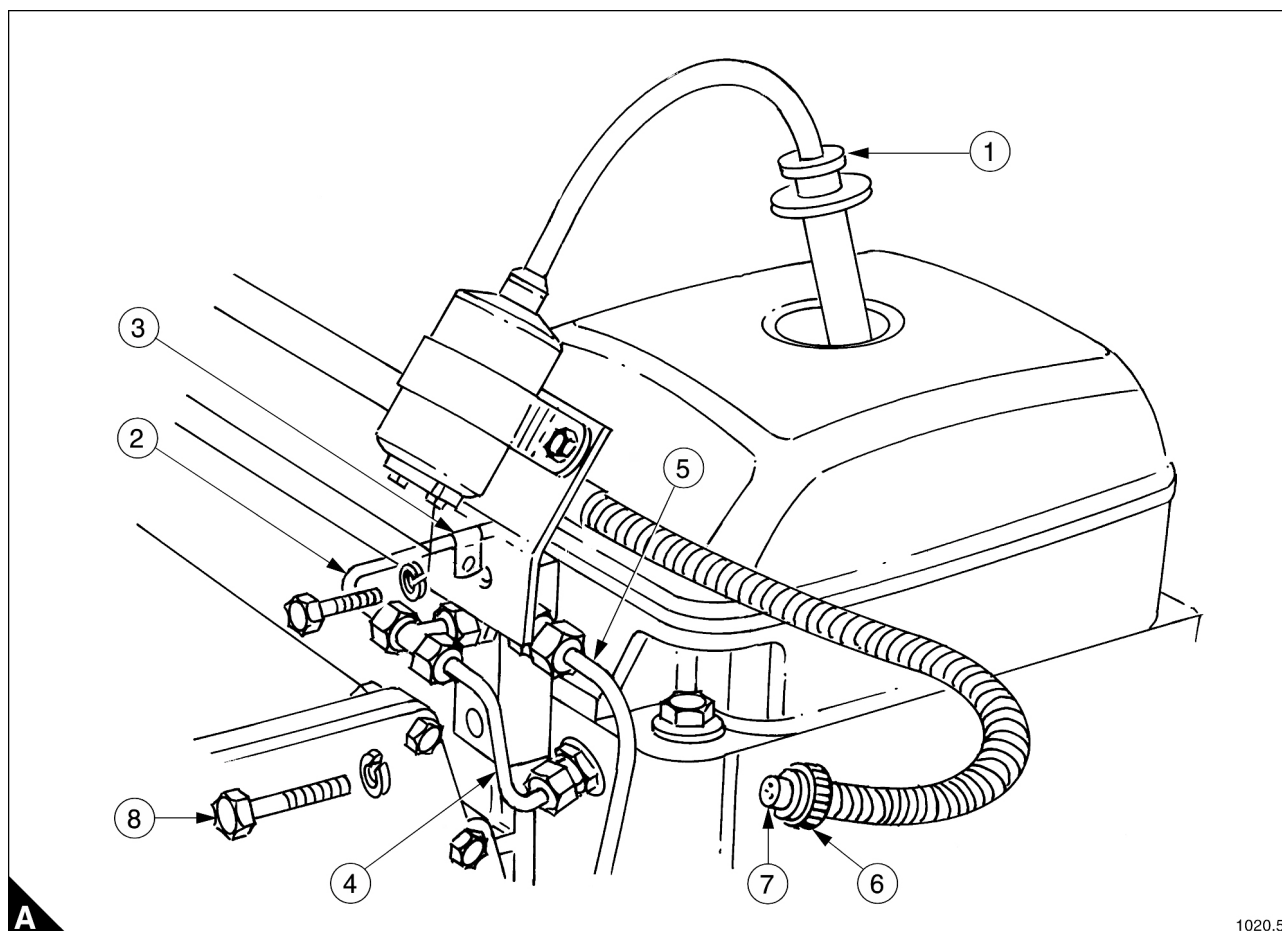
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Valve gear oil feed pipework and ignition coil support assembly

To remove

Operation 3-2**Note:** This assembly is removed when cylinder heads are changed or at major overhaul.

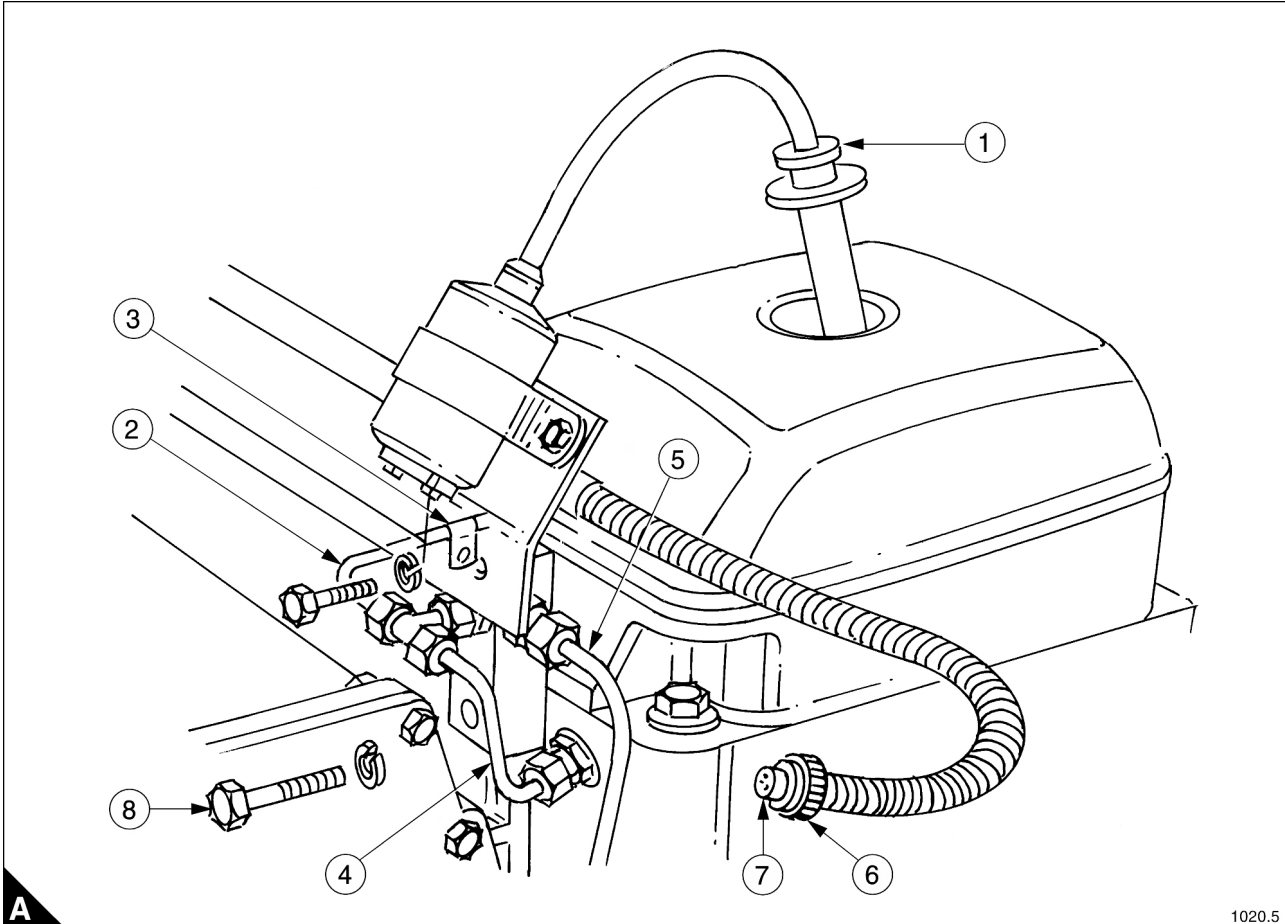
- 1 Disconnect the spark plug leads (A1).
- 2 Remove the rocker box oil feed pipe (A2) and its steady clip (A3).
- 3 Remove the valve guide oil feed pipe (A4).
- 4 Disconnect the oil rail feed pipe (A5).
- 5 Unscrew the retaining collar (A6) and pull the multi-pin plug (A7) from the Altronic unit mounted on the inlet manifold at the gearcase end of the engine.
- 6 Remove the oil feed post retaining bolts (A8) and lift off the oil feed rail and ignition coils as an assembly.



To fit

Operation 3-3

- 1 Refit the oil feed rail and ignition coils as an assembly.
- 2 Fit and tighten the oil feed post retaining bolts (A8) by hand. Check alignment and torque to 24 Nm (18 lbf ft).
- 3 Refit all oil feed pipework. Align individually and tighten by hand to ensure an oil tight connection.
- 4 Reconnect spark plug leads (A1).
- 5 Reconnect the multi-pin plug (A7) and screw the retaining collar (A6) hand tight.



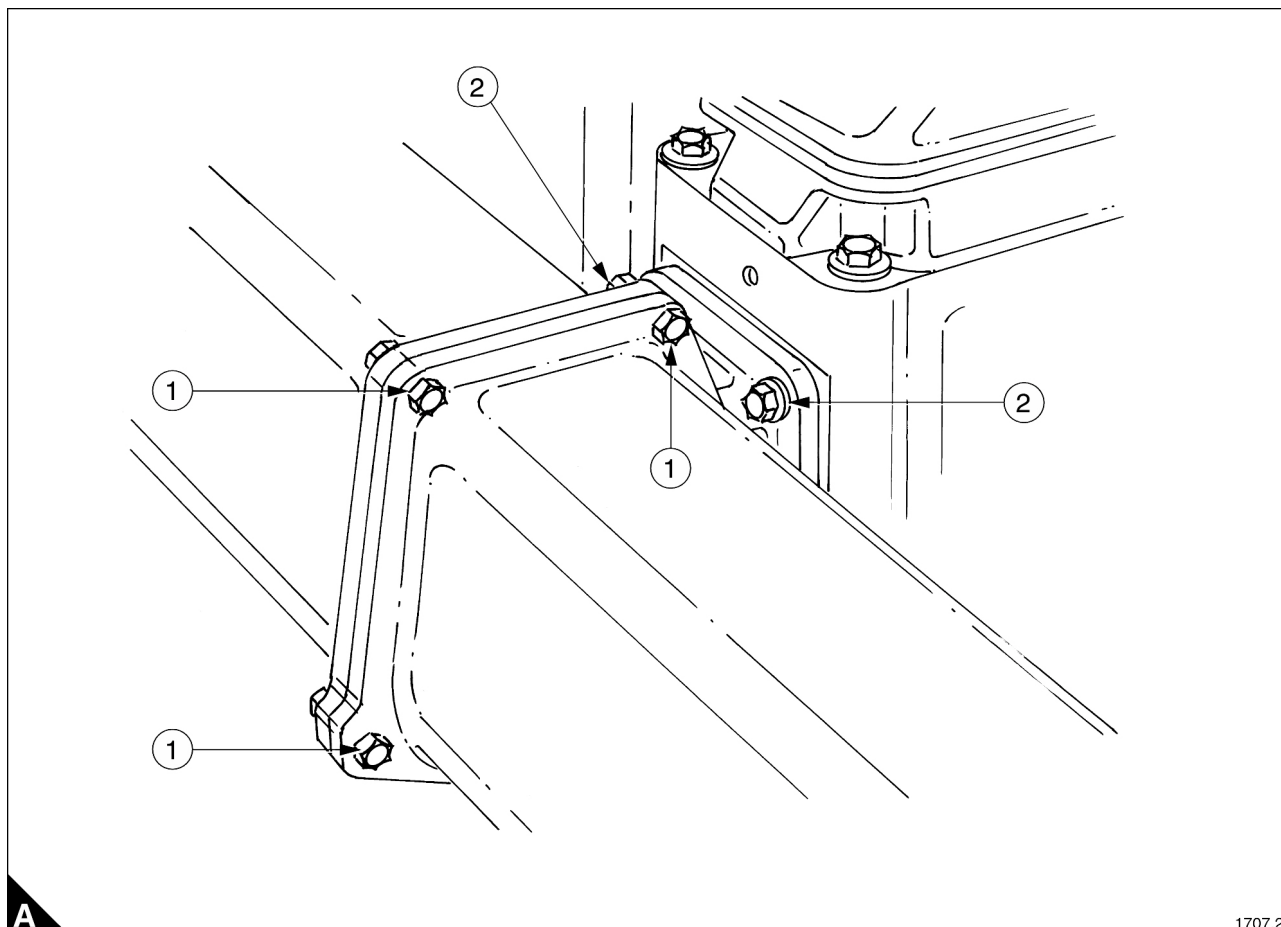
Inlet and exhaust manifolds

To remove the inlet manifolds

Operation 3-4

Note: The removal of the inlet manifolds is normally undertaken at major overhaul.

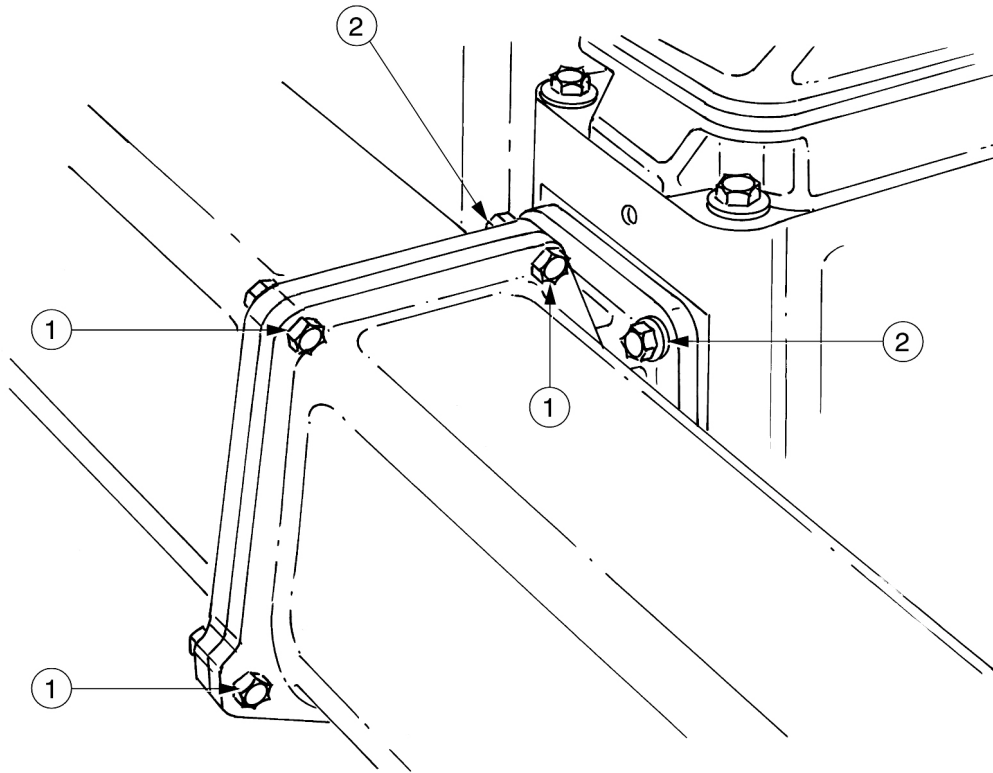
- 1 Remove the oil rail and ignition coil assembly, see [Operation 3-2](#).
- 2 Remove the gas pipework, regulator and ancillary equipment (refer to [Chapter 11, Gas system](#)).
- 3 Remove the charge cooler / inlet manifold assembly, see [Operation 9-3](#).
- 4 Remove the inlet manifold flange retaining bolts and nuts (A1).
- 5 Remove the inlet manifold to cylinder head retaining bolts (A2) and lift off the individual sections of manifold.



To fit the inlet manifolds

Operation 3-5

- 1 Refit the inlet manifold using new joints, with all retaining bolts hand tight.
- 2 Refit the charge cooler / inlet manifold assembly, see [Operation 9-3](#).
- 3 Tighten retaining bolts (A1) and (A2) to 50 Nm (35 lbf ft) pulling the assembly squarely together.
- 4 Refit the oil rail / ignition coil assembly, see [Operation 3-3](#).
- 5 Refit the gas pipework, regulator and ancillary equipment (refer to [Chapter 11, Gas system](#)).



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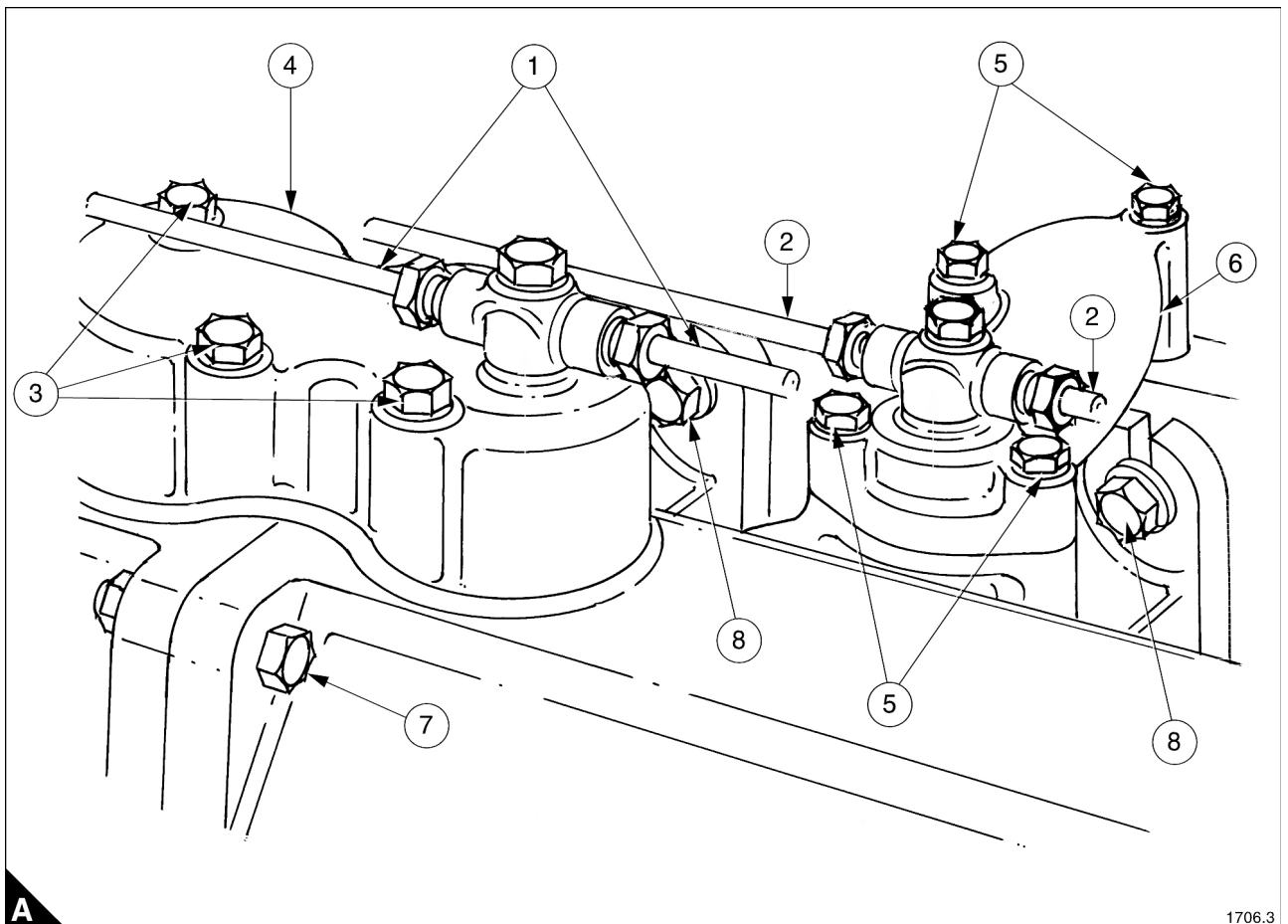
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To remove the exhaust manifolds

Operation 3-6

Note: The removal of the exhaust manifolds is normally undertaken at major overhaul.

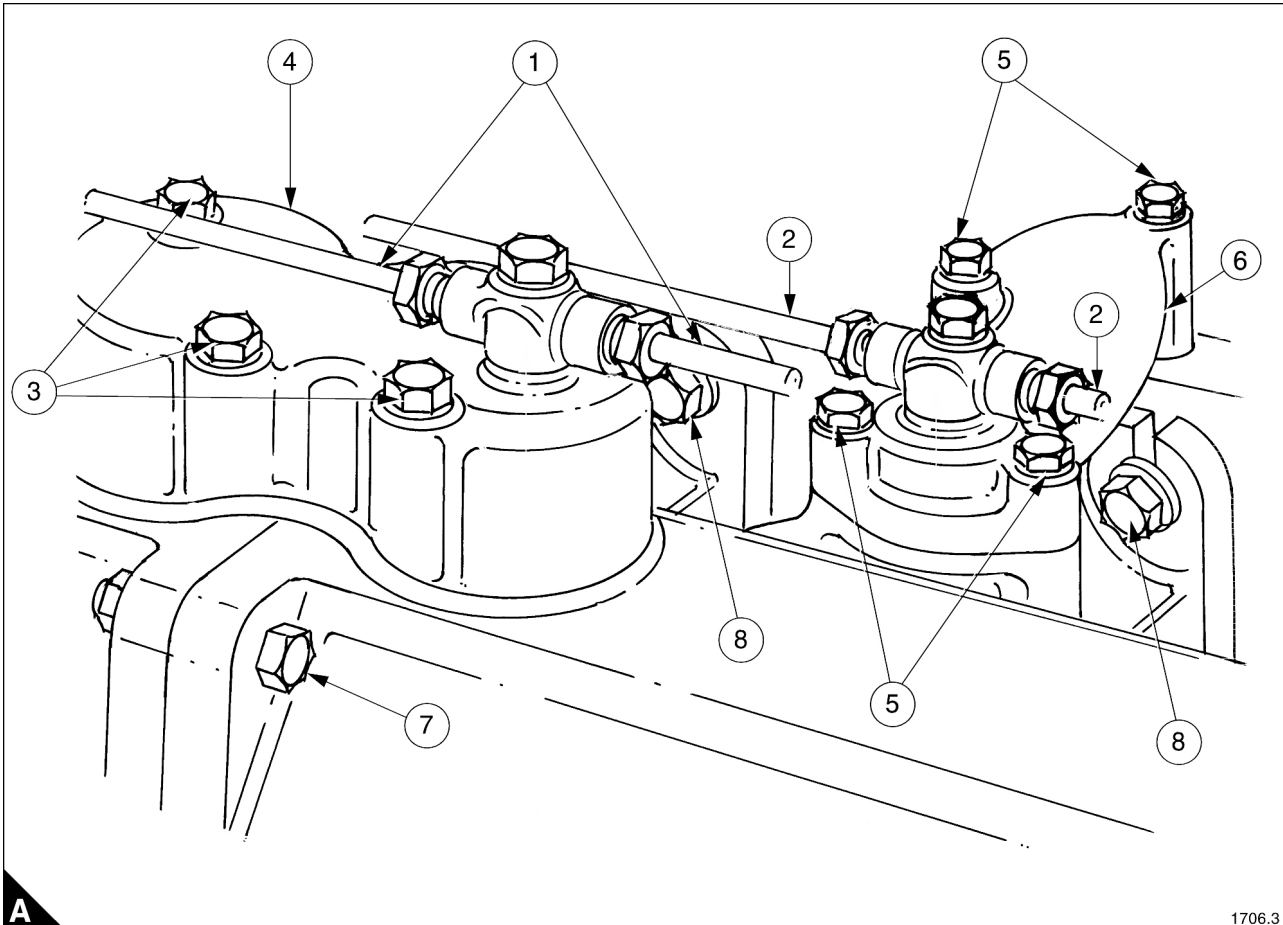
- 1 Remove the air vent pipework (A1) and (A2) from the exhaust manifold.
- 2 Remove the retaining bolts (A3) and lift off the coolant manifolds (A4).
- 3 Remove the retaining bolts (A5) and lift off the coolant pipes (A6).
- 4 Remove the exhaust manifold flange retaining bolts (A7)
- 5 Disconnect the turbocharger from the exhaust manifold, see [Operation 9-1](#).
- 6 Remove the exhaust manifold to cylinder head retaining bolts (A8) and lift off the individual sections of manifold.



To fit the exhaust manifolds

Operation 3-7

- 1 Fit the exhaust manifold using new joints with all retaining bolts hand tight.
- 2 Tighten the retaining bolts (A7) and (A8) to 70 Nm (50 lbf ft) pulling the assembly squarely together.
- 3 Fit the turbocharger to the exhaust manifold, see [Operation 9-1](#).
- 4 Fit the coolant pipes (A6) using new 'O' rings and tighten the retaining bolts (A5) to 50 Nm (35 lbf ft).
- 5 If the air vent unions have been removed, refit using a new copper sealing washer and torque the banjo bolts to 30 Nm (25 lbf ft).
- 6 Fit and tighten by hand the air vent pipework (A1) and (A2).



To release the inlet and exhaust manifolds

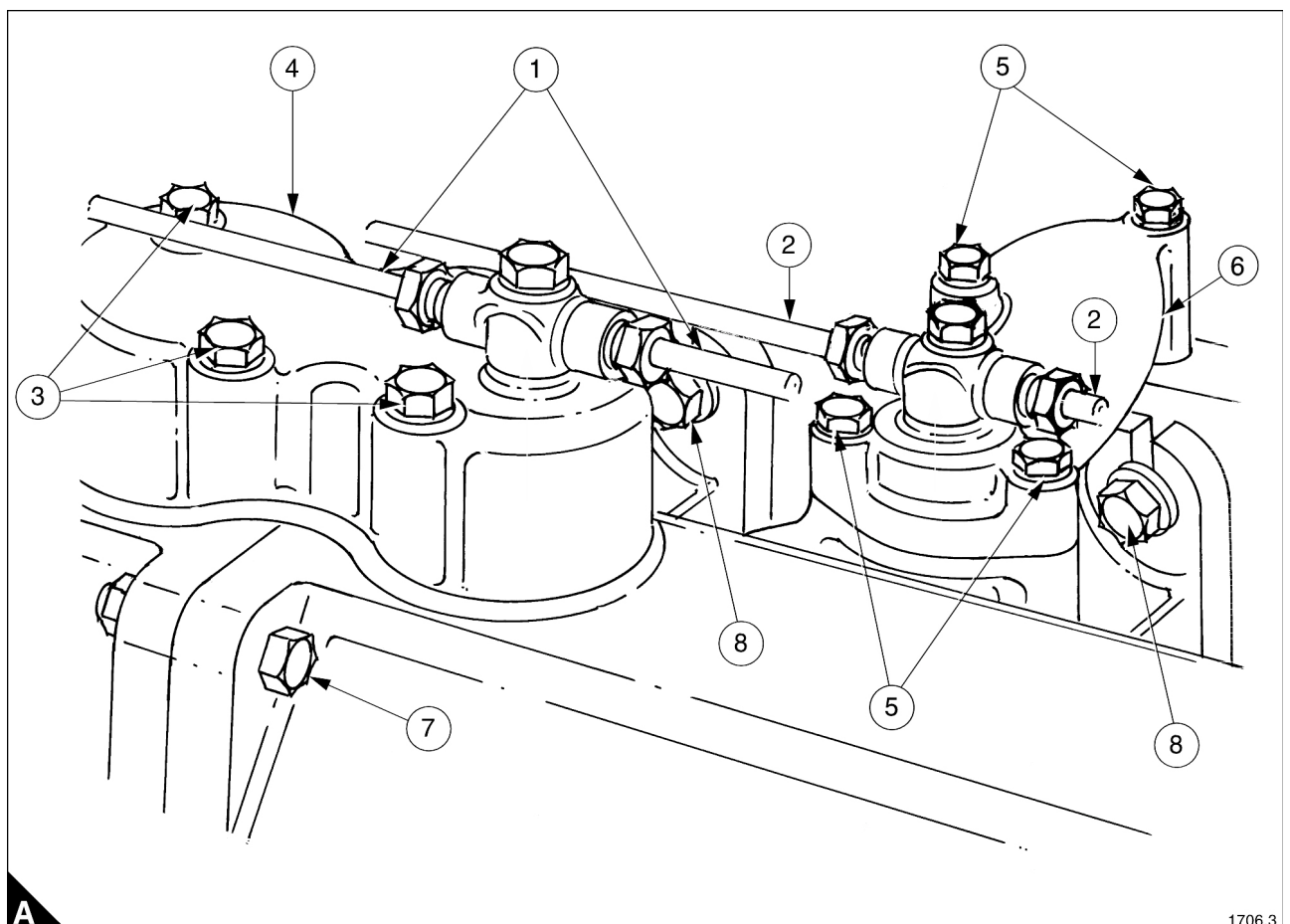
Operation 3-8

Note: It is possible to change all of the cylinder heads without removing the inlet and exhaust manifolds. Follow the procedure below, leaving the front and rear cylinder heads in position to support the manifolds. Change the cylinder heads in between, then the front and rear cylinder heads.

- 1 Drain the cooling system by removing the drain plug on the inlet side of the crankcase, flywheel end.
- 2 Remove the valve gear oil feed pipework and ignition coil support assembly, see [Operation 3-2](#).
- 3 Loosen the inlet manifold flange retaining bolts, see [Operation 3-4](#).
- 4 Remove the inlet manifold flange to cylinder head retaining bolts, see [Operation 3-4](#).
- 5 Remove the air vent pipework (A1) and (A2) from the exhaust manifold.
- 6 Remove the retaining bolts (A3) and lift off the coolant manifolds (A4).
- 7 Remove the retaining bolts (A5) and lift off the coolant pipes (A6).
- 8 Loosen the exhaust manifold flange retaining bolts (A7).
- 9 Remove the exhaust manifold flange to cylinder head retaining bolts (A8).

With the manifolds released from the cylinder heads and the manifold flange bolts loose, there will be sufficient clearance for cylinder head removal, see [Operation 3-13](#).

- 10 To retorque the retaining bolts refer to [Operation 3-5](#) for inlet manifolds and [Operation 3-7](#) for exhaust manifolds.

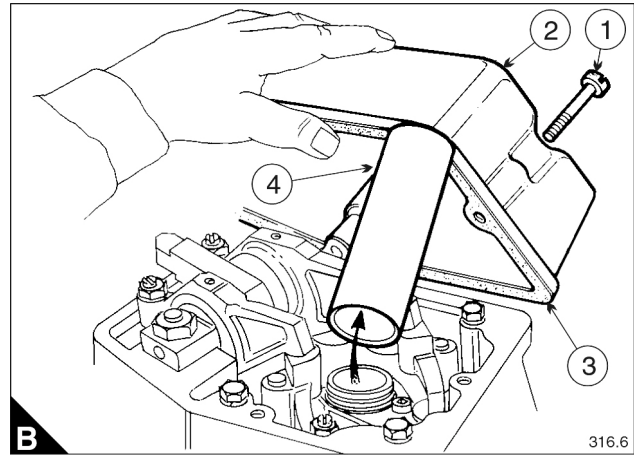
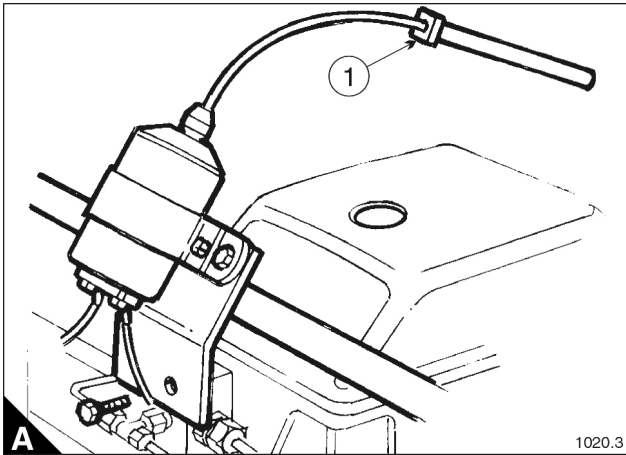


Rocker box and valve gear

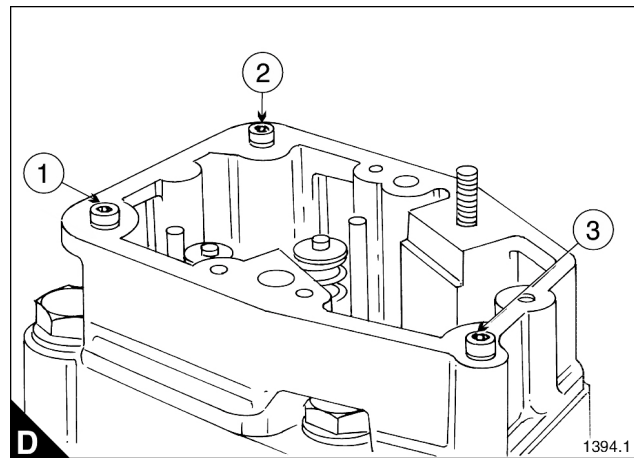
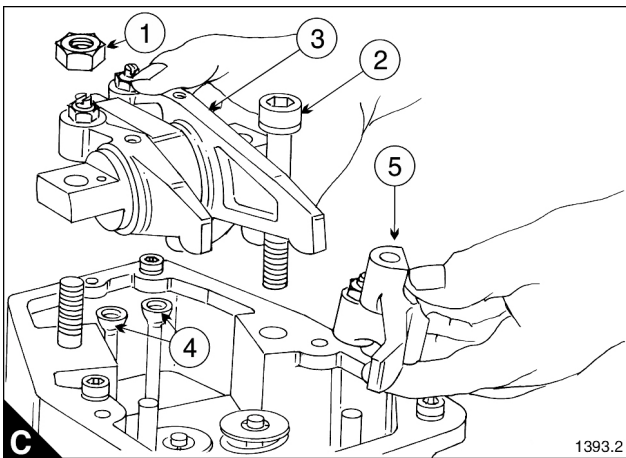
To remove

Operation 3-9

- 1 Remove the spark plug lead (A1).
- 2 Remove the four retaining screws (B1) from each rocker cover (B2).
- 3 Lift off the rocker cover and remove and discard the gasket (B3).
- 4 Pull the spark plug cover tube (B4) out of the cylinder head.



- 5 Remove the nut (C1) and the capscrew (C2) retaining the rocker shaft. Lift off the rocker assembly (C3) and take out the push rods (C4), plus the inlet and exhaust rocker bridges (C5), marking them for reassembly.
- 6 Remove the rocker box retaining capscrews (D1) to (D3) in the order shown. Remove the rocker box.

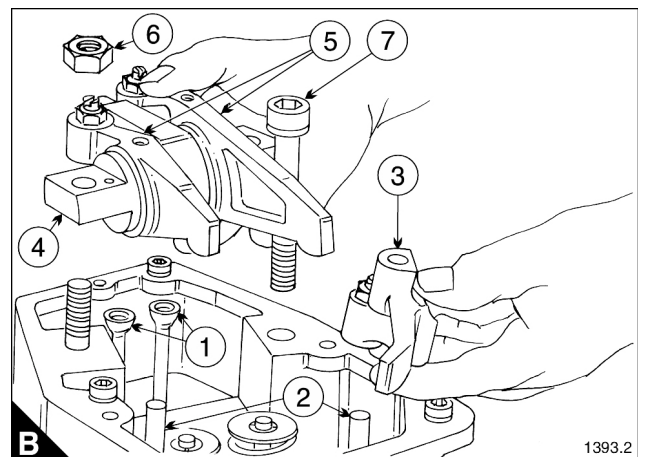
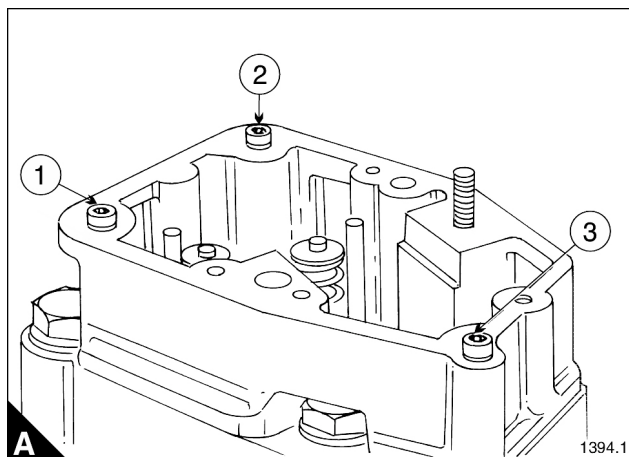


Note: To free the rocker cover and rocker box from the jointing material a light blow with a soft faced hammer may be necessary.

To fit

Operation 3-10

- 1 Fit a new rocker box sealing joint to the cylinder head.
- 2 Fit the rocker box, locating it onto the dowels in the cylinder head face.
- 3 After lubricating the thread fit the rocker box locating capscrews (A1) to (A3) and washers finger tight.
- 4 Lubricate the bearing surfaces of the push rods and fit them. Check they are located in the cam followers (B1).
- 5 Lubricate the bridge piece guide pillars (B2) and fit the bridge pieces (B3).
- 6 Lubricate the rocker shaft (B4) then fit the rockers (B5).
- 7 Fit the rocker assembly to the rocker box, checking the rockers are located in the push rods.
- 8 Lubricate the threads and fit the locating nut (B6) and the capscrew (B7). Tighten them down hand tight, checking that the push rods remain located on the rockers.
- 9 Torque the nut (B6) and capscrew (B7) to 120 Nm (90 lbf ft) then the rocker box capscrews to 70 Nm (50 lbf ft) in the order shown (A1) to (A3).
- 10 Set bridge pieces, valve clearances, spark plug tube, rocker cover etc, see pages 47-51 in the User's Handbook.

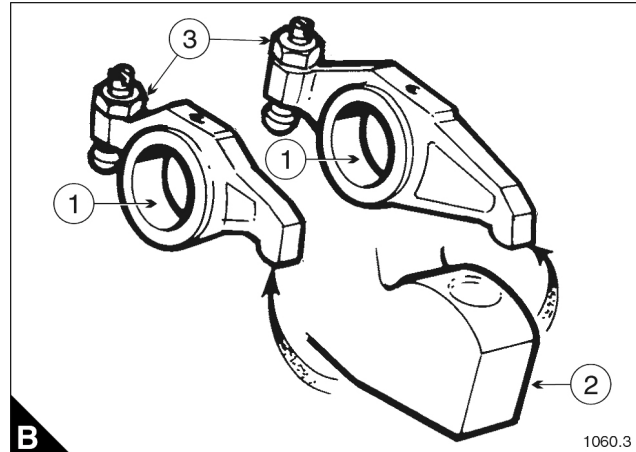
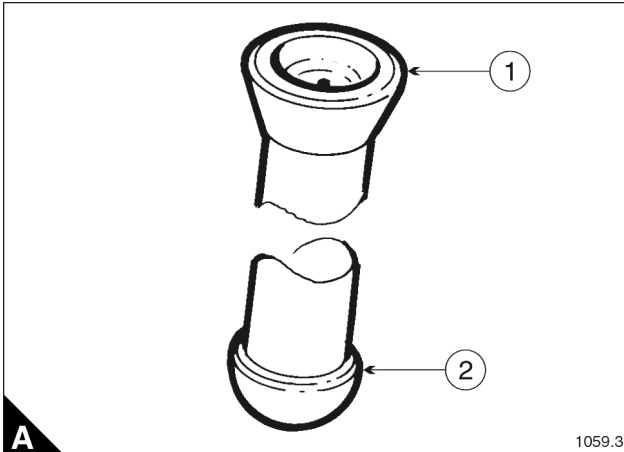


Rocker assembly

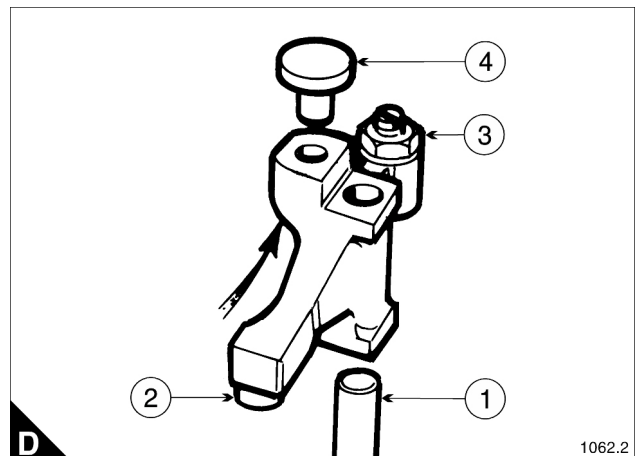
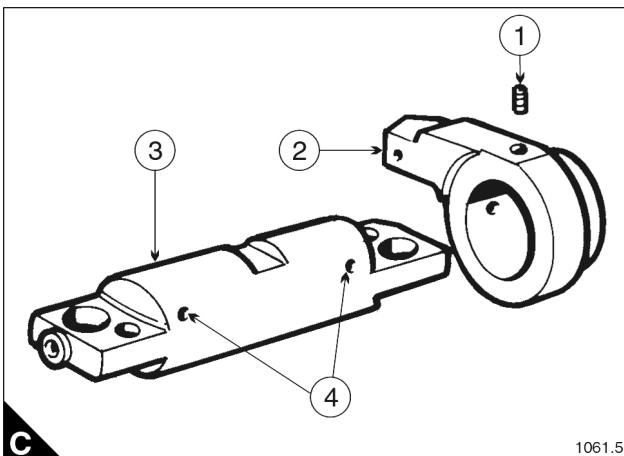
To inspect

Operation 3-11

- 1 Check the push rods are straight and the cup end (A1) and spherical end (A2) are smooth surfaced and concentric with no chips or cracks.
 - 2 Slide the rockers from the rocker shaft. Check the bearing surface (B1) is free from scoring.
 - 3 Check the contact patch (B2) on each rocker is not indented or chipped.
- Note:** A small indentation may be removed with an oil stone, carefully following the radius.
- 4 Check the adjuster screws (B3) and their locknuts are undamaged.



- 5 Remove the grub screw (C1) and slide the spacer/oil jet (C2) from the rocker shaft (C3). Check the rocker shaft for scoring.
 - 6 Check the oil galleries in the rocker shaft (C4) and the oil jet (C2) are clear.
 - 7 Check the bridge piece and its guide pillar (D1).
 - 8 Check the valve contact patch (D2) is not indented or chipped.
- Note:** A small indentation may be removed with an oil stone.
- 9 Check the equalizing screw (D3) and its locknut are undamaged.
 - 10 Check the bridge piece pressure pad (D4) for wear in the form of a deep indentation. If the pressure pad is worn it must be replaced, see [Operation 3-12](#).





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