



BY APPOINTMENT TO
HER MAJESTY QUEEN ELIZABETH II
MANUFACTURERS OF DAIMLER AND JAGUAR CARS
JAGUAR CARS LIMITED COVENTRY



BY APPOINTMENT TO
HER MAJESTY QUEEN ELIZABETH
THE QUEEN MOTHER
MANUFACTURERS OF DAIMLER AND JAGUAR CARS
JAGUAR CARS LIMITED COVENTRY

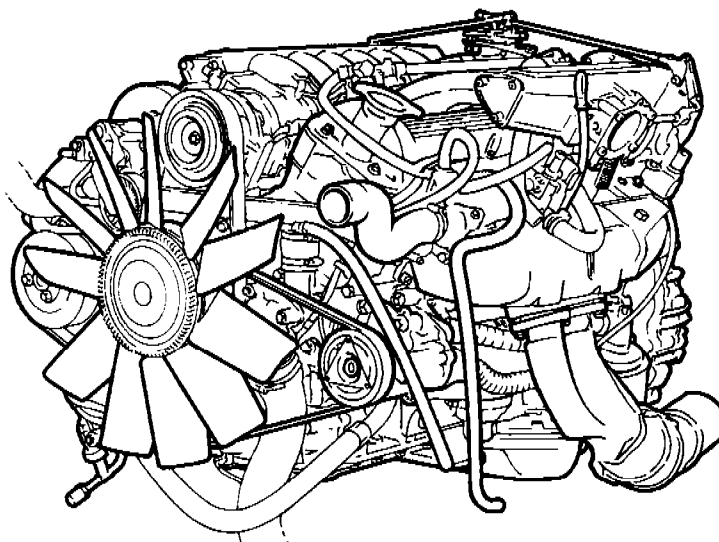


BY APPOINTMENT TO
HIS ROYAL HIGHNESS THE PRINCE OF WALES
MANUFACTURERS OF DAIMLER AND JAGUAR CARS
JAGUAR CARS LIMITED COVENTRY



JAGUAR

V12 Engine Service Manual



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FOREWORD

This Service Manual has been designed to enable the skilled Jaguar technician to correctly service and repair the Jaguar 6.0 liter V12 engine. It assumes that the engine is in a clean condition and that all service tools and materials are available.

Removal of the engine and transmission unit, if required, is covered in Section 3.2 of the appropriate Vehicle Service Manual.

An index can be found at the rear of the manual.



I. SERVICE TOOLS & EQUIPMENT

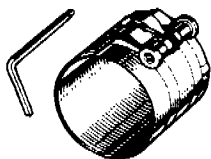
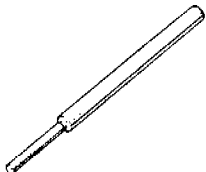
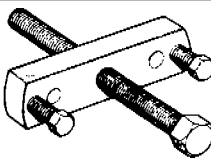
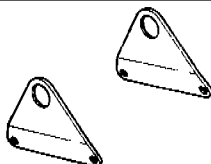
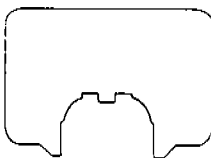
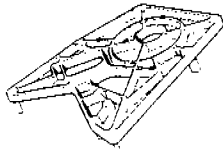
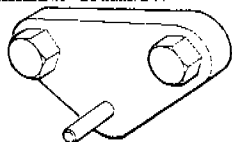
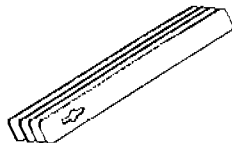
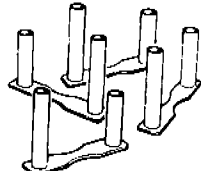
Illustration	Jaguar Number	Description	Notes
	18G 55A	Piston ring compressor	
	18G 1432	Valve guide remover / replacer	
	18G 1436/A	Crank pulley remover / timing damper oil pressure simulator	
	18G 1465	Engine lifting bracket	
	C3993	Camshaft timing jig	
	JD 38	Damper setting jig	
	JD 39	Jackshaft setting jig	
	JD 40	Camshaft sprocket retainer	
	JD 41	Cylinder sleeve retainers	



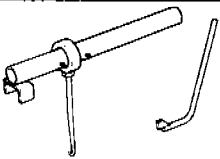
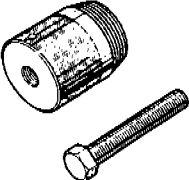
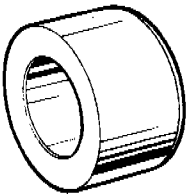
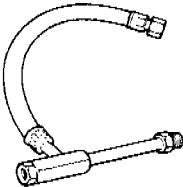
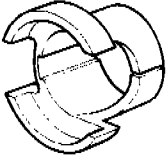
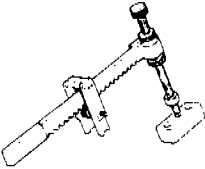
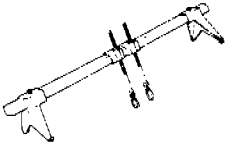
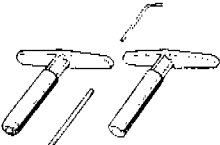
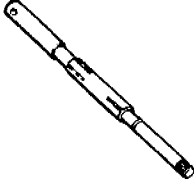
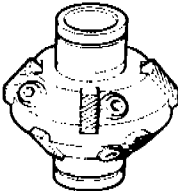
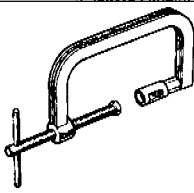
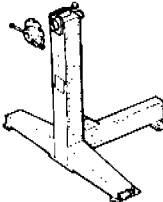
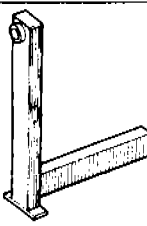
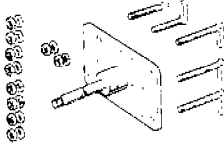
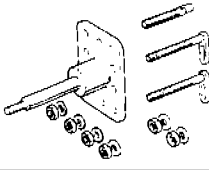
Illustration	Jaguar Number	Description	Notes
	JD 50	Timing chain tensioner retainer	
	JD 128	Crank front seal remover	
	JD 129	Crank front seal replacer	
	JD 181	Fuel injection pressure test kit	
	JD 183	Quick-fit pipe disconnecting tool (7/8in diameter)	
	JD 6118C	Valve spring compressor	
not illustrated	JD 6118C-2	Adapter for valve spring compressor	
	MS 53C	Engine support beam	
	MS 76B	Basic handle set	



Illustration	Jaguar Number	Description	Notes
	MS 150-8	Expandable pilot	
	MS 621	Valve seat adjustable cutter	
	MS 1519A	Valve spring compressor	
	MS 1520	Engine stand	
	MS 1520-1	Engine stand, add-on for V12 engine	
	MS 1520-2	Adapter assembly for MS 1520	
	MS 1520-3	Adapter assembly for MS 1520-1	
not illustrated	YA 992	'Snap-On' Oil filter canister removal tool	



II. TORQUE TIGHTENING SPECIFICATIONS

Fixing	Tightening Torque (Nm)
Air Cleaner	
Hose clamp, hose to air cleaner and elbow	3 – 4
Air Conditioning Compressor Mounting	
Adjuster sleeve to mounting bracket	22 – 28
Belt tension bracket to tappet block	17 – 23
Bracket to camshaft cover	22 – 28
Compressor to mounting plate	22 – 28
Air Injection Pump	
Adjuster bolt to pump	30 – 40
Adjuster screw to pump	22 – 28
Air pipe assembly setscrew	34 – 46
Air pipe to intake manifold	10,5 – 13,5
Check valve	30 – 40
Hose clamp, air pipe to check valve	2,5 – 3,5
Nyloc nut	22 – 28
Pump front mounting bracket bolt	17 – 23
Pump pivot bolt	22 – 28
Pump side mounting bracket bolt	34 – 46
Connecting Rod	
Connecting rod nut	50 – 60
Cooling System	
Coolant pump assembly screw	8,5 – 11,5
Coolant pump casing to timing cover	17 – 23
Coolant pump plate to timing cover	17 – 23
Coolant pump to cylinder block	22 – 28
Coolant pump to timing cover	17 – 23
Coolant rail to cylinder head	22 – 28
Cover plate / throttle spring anchor to cylinder head	22 – 28
Cylinder head lifting eye	22 – 28
Fan drive unit pulley nut	13 – 17
Fan drive unit pulley stud	17 – 23
Fan to fan drive unit	17 – 23
Heater offtake adapter	32 – 38
Hose clamp, bypass pipe to coolant pump	2,5 – 3,5
Hose clamp, idle speed control valve to tee piece on coolant housing	2,5 – 3,5
Idle speed control valve manifold to cylinder head	22 – 28
Inlet spout to coolant pump	17 – 23
Temperature switch to coolant rail	22 – 28
Crankshaft	
Damper bolt	180 – 220
Drive-plate to crankshaft	85 – 105
Pulley damper bolt	14 – 18
Timing disc setscrew	8,5 – 11,5
Turning plate to pulley	14 – 18



Fixing	Tightening Torque (Nm)
Cylinder Block	
Air injection pump connector bracket to cylinder block	5 – 7
3/8in UNF nut	34 – 46
Bearing cap to cylinder block (1/2in diameter stud)	23 – 31
Bearing cap to cylinder block (3/8in diameter short stud)	13 – 17
Bearing cap to cylinder block (3/8in diameter long stud)	13 – 17
Bearing cap to cylinder block (nut)	76,5 – 93,5
Cylinder head to cylinder block (7/16in diameter stud)	23 – 31
Cylinder head to cylinder block (3/8in diameter stud)	6 – 8
Oil filter face plug	5 – 7
Oil gallery rear plug	85 – 115
Undershield nut	76,5 – 93,5
Cylinder Head and Camshaft Cover	
Camshaft bearing cap stud	13 – 17
Camshaft bearing cap to tappet block	10,5 – 13,5
Camshaft cover bolt	17 – 23
Camshaft cover screw	8,5 – 11,5
Camshaft position sensor	5 – 7
Coupling assembly to camshaft	22 – 28
Cylinder head to cylinder block (domed nut)	64 – 78
Cylinder head to cylinder block (nut)	34 – 42
Cylinder head to timing cover	22 – 28
Exhaust manifold stud	13 – 17
Exhaust manifold to cylinder head	17 – 23
Intake manifold stud	13 – 17
Intake manifold to cylinder head	17 – 23
Tappet block to cylinder head (nut)	17 – 23
Tappet block to cylinder head (socket screw)	22 – 28
Tappet block to cylinder head (stud)	13 – 17
Dipstick Tube	
Dipstick tube to throttle body	4 – 5
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Chain tensioner setscrew	22 – 28
Damper assembly upper bracket bolt	22 – 28
Idler shaft retention	43 – 57
Sprocket to auxiliary shaft	10,5 – 13,5
Thrust plate to cylinder block	22 – 28
Upper chain tensioner bolt	22 – 28
Engine Mountings	
Heatshield to hydraulic mount	4 – 5
Exhaust Manifold	
3/8in diameter stud	13 – 17
Front heatshield setscrew	17 – 23
Rear heatshield setscrew	34 – 46
Fuel System	
Fuel rail to intake manifold	8,5 – 11,5



Fixing	Tightening Torque (Nm)
Generator Mounting	
Adjuster sleeve nut	34 – 46
Adjuster sleeve to adjuster bracket	17 – 23
Adjuster to generator	17 – 23
Cylinder block to timing cover bracket	43 – 57
Generator mounting bracket pivot bolt	34 – 46
Intake Manifold	
Cruise control bracket to intake manifold stud	10,5 – 13,5
Elbow to intake manifold	8,5 – 11,5
Intake manifold stud	2,5 – 3,5
Stub pipe to throttle housing	1,5 – 2,5
Throttle housing to intake manifold	4 – 5
Throttle stop screw locknut	4 – 5
Top cover mounting stud	2,5 – 3,5
Manifold Ends	
Intake manifold connector bracket screw	7 – 10
Manifold end connector assembly	13 – 17
Vacuum take-off screw	8,5 – 11,5
Oil Cooler	
Hose clamp, oil cooler hose to radiator cradle	7 – 10
Oil cooler pipe clamp plate nut	15,5 – 20,5
Oil cooler pipe connector	2,5 – 3,5
Oil cooler pipes to engine	17 – 23
Oil cooler to body	17 – 23
Oil Pump, Filter and Oil Pan	
Baffle plate to sandwich to cylinder block	22 – 28
Clamp bracket setscrew	13 – 17
Cover housing bolt	22 – 28
Cylinder block support bracket setscrew	50 – 70
Delivery elbow to oil pump	22 – 28
Oil filter canister	13 – 17
Oil filter head to cylinder block	22 – 28
Oil pan adapter setscrew	10,5 – 13,5
Oil pan drain plug	61 – 75
Oil pan sandwich blanking plate setscrew	10,5 – 13,5
Oil pan sandwich to cylinder block	22 – 28
Oil pan to oil pan sandwich	22 – 28
Oil pan to sandwich and cylinder block	22 – 28
Oil pipe bracket setscrew	22 – 28
Outlet elbow bolt	10,5 – 13,5
Pipe clamp to pillar nut	22 – 28
Pump assembly to cylinder block	22 – 28
Rear pipe bracket setscrew	22 – 28
Relief valve assembly	102 – 142
Suction elbow to oil pump	22 – 28
Taptite screw	5 – 7



Fixing	Tightening Torque (Nm)
Power Steering	
Front and rear plates to mounting bracket	22 – 28
Pulley to pump	22 – 28
Pump to engine	22 – 28
Spark Plug and Ignition Coil	
Rear coil mounting bracket to camshaft cover	10,5 – 13,5
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Starter Motor	
Bracket clamp Taptite screw	3,5 – 4,5
Rear support bracket to cylinder block	34 – 46
Starter motor to cylinder block	31,5 – 42,5
Timing Cover	
Air pump mounting and adjuster bolt	22 – 28
Bearing housing to cylinder block (nut)	22 – 28
Bearing housing to cylinder block (stud)	13 – 17
Timing cover plate to cylinder block	22 – 28
Timing cover to cylinder block	22 – 28
Timing cover to cylinder head	13 – 17
Transmission Unit	
Automatic transmission unit to cylinder block	41 – 49



III. SERVICE MATERIALS

Description	Uses	Notes
Dow 111 silicone grease	Plug lead to spark plug	Or equivalent to Ford Motor Company Specification ESE-M1C171-A
Hylosil 102 sealant	Half moon seal to camshaft carrier	
	Filler cap 'O' ring	
Loctite 518 sealant	Camshaft carrier to cylinder head	
Tivoli Kay adhesive No. 5696 sealant	Exhaust system joints	
Vaseline (or Silicon 5000)	Top of oil filler tube	



IV. SERVICE DATA

Engine Data

Application	Item	Specification
General	Number of cylinders	12
	Cylinder bank arrangement	60 degree vee formation
	Bore	90,0 mm
	Stroke	78,5 mm
	Cubic capacity	5993 cm ³
	Compression ratio	11:1
	Firing order	1A,6B,5A,2B,3A,4B,6A,1B,2A,5B,4A,3B (No. 1 cylinder at crankshaft pulley end. Cylinder bank A is right-hand cylinder bank viewed from flywheel end)
Ignition timing		Fully mapped Nippondenso engine management system with electronic ignition
Spark plug	Type	NGK BR7 EF
	Gap	0,65 mm
Ignition coil	Type	Nippondenso DIS
	Number per vehicle	2
	Primary winding resistance	0,45 to 0,55 ohm
	Secondary winding resistance	11,5 to 15,5 kohm (at 20°C)
	Secondary winding open circuit voltage (at engine idle speed)	34 kV (minimum)
Plug lead resistance	Cylinder bank A	1A: 13,24 kohm
		2A: 11,64 kohm
		3A: 8,48 kohm
		4A: 7,40 kohm
		5A: 8,72 kohm
		6A: 14,00 kohm
	Cylinder bank B	1B: 8,72 kohm
		2B: 11,64 kohm
		3B: 7,92 kohm
		4B: 10,48 kohm
		5B: 15,96 kohm
		6B: 22,32 kohm
		(No. 1 cylinder at crankshaft pulley end. Bank A is right-hand bank viewed from drive-plate end)
Fuel injection equipment	Type	Micro-processor controlled engine management system
	Fuel pressure	3 bar
Exhaust Emission	Exhaust gas analyzer reading (at engine idle speed and normal operating temperature)	0,5% CO maximum (with catalytic converter fitted)
Idle speed (engine at normal operating temperature)	Automatic transmission	700 RPM (gear selector in neutral)



Application	Item	Specification
Compression pressure	Cylinder pressure	13,6 to 16,3 bar (with all spark plugs removed, throttle fully open, engine at operating temperature and a minimum cranking speed of 300 RPM)
	Differential pressure between cylinders	1,38 bar (maximum)
Cylinder block	Material	Aluminum alloy
	Main bearing line bore diameter	80,429 to 80,434 mm
Cylinder block nominal bore diameter after honing	For piston grade A	89,990 to 90,002 mm
	For piston grade B	90,005 to 90,018 mm
Cylinder sleeve	Type	Slip fit, wet sleeve
	Material	Cast iron
	Outside diameter (piston grades A and B)	97,99 to 98,01 mm
Cylinder head	Material	Aluminum alloy
	Combustion chamber	May design, two valves per cylinder
Crankshaft	Material	Cast iron
	Number of main bearings	7
	Main bearing type	Vandervell VP3
	Journal diameter	P (pink): 76,215 to 76,225 mm
		W (white): 76,225 to 76,235 mm
		G (green): 76,235 to 76,245 mm
	Thrust washer thickness	2,57 to 2,62 mm
	Permissible end float	0,075 to 0,279 mm
	Crankpin diameter	R (red): 58,405 to 58,415 mm
		Y (yellow): 58,415 to 58,425 mm
		B (blue): 58,425 to 58,435 mm
	Identification	Colour codes stamped on No.1 balance weight: F (front), journals 1 to 7 (P, W or G), crankpins 1 to 6 (R, Y or B)
Connecting rod	Length between centers	151,38 to 151,50 mm
	Bore for connecting rod bearing	62,000 to 62,014 mm
	Connecting rod bearing diametrical clearance	0,027 to 0,062 mm
	Connecting rod bearing side clearance	0,17 to 0,33 mm
	Bore for small end bushing	26,98 to 27,005 mm
Piston	Type	Solid skirt
	Skirt clearance	0,03 to 0,04 mm
Piston diameter	Grade A	89,960 to 89,972 mm
	Grade B	89,975 to 89,987 mm



Application	Item	Specification
Piston ring	Number of compression rings	2
	Number of oil control rings	1
	Gap when fitted in bore	Top compression ring: 0,30 to 0,55 mm
		Second compression ring: 0,30 to 0,50 mm
Piston pin	Oil control ring rails: 0,38 to 1,14 mm	
	Type	Fully floating
	Length	79,25 to 79,38 mm
	Outside diameter	Grade A (red): 23,809 to 23,812 mm Grade B (green): 23,806 to 23,809 mm
Camshaft	Material	Cast iron, chilled
	Number of journals	7
	Nominal lift	9,5 mm
	Permissible end float	0,13 mm
	Thrust load point	Front end of camshaft
Valve	Head diameter (at gauge point)	Intake: 41,15 to 41,40 mm
		Exhaust: 34,32 to 34,60 mm
	Valve face angle	Intake and exhaust: 45,25 degrees
	Valve stem diameter	Intake and exhaust: 7,854 to 7,866 mm
	Valve clearance	Intake and exhaust: 0,26 to 0,30 mm (0.010 to 0.012 in)
Adjustment of valve clearance	Method	Shims
	Shim sizes available	Between 0.085 in and 0.108 in (in increments of 0.005 in)
Valve guide	Material	Cast iron
	Length	Intake: 48,50 mm
		Exhaust: 43,82 mm
	Outside diameter	Standard – no groove: 12,72 to 12,75 mm
		First oversize – two grooves: 12,85 to 12,88 mm
		Second oversize – three grooves: 12,98 to 13,01 mm
	Valve guide bore concentricity with guide outside diameter	Within 0,025 mm (i.e. total indicator reading of 0,050 mm)
	Clearance between valve stem and cam heel	8,13 mm (plus the valve clearance)
Valve seat	Seating angle	44,50 to 44,75 degrees
	Valve seat insert outside diameter	Intake: 42,93 to 42,94 mm
		Exhaust: 38,17 to 38,18 mm
Tappet	Interference fit in cylinder head	Intake and exhaust: 0,09 mm
	Outside diameter	34,87 to 34,90 mm
Valve spring	Diametrical clearance	0,02 to 0,04 mm
		Outer: 53,4 mm Inner: 44,0 mm



Application	Item	Specification
Camshaft sprocket	Number of teeth	42
Crankshaft sprocket	Number of teeth	21
Idler sprocket	Number of teeth	21
Timing chain	Type	Endless duplex
	Number of pitches	180
	Pitch	9,525 mm
	Roller diameter	6,35 mm
Oil filter	Type	Full flow disposable canister
Oil pressure (engine at normal operating temperature)	At idle speed	0,5 bar (minimum)
	At 4000 RPM	4,0 bar (minimum)
Oil pump	Type	Gilardini Motorfides

Drive Belt Tensions

Application	Specification
Generator drive belt	Burroughs method: new belt 775 N. In service if tension falls below 230 N, reset at 400 N
	Clavis method: new belt 182 to 188 Hz. In service if tension falls below 119 Hz, reset at 137 to 143 Hz. (Measuring point: mid-way between pulleys)
Water pump / air injection pump drive belt	Burroughs method: new belt 650 N. In service if tension falls below 320 N, reset at 400 N
	Clavis method: new belt 169 to 175 Hz. In service if tension falls below 127 Hz, reset at 132 to 138 Hz. (Measuring point: mid-way between crankshaft and air injection pump pulleys)
Power assisted steering pump / air conditioning compressor drive belt	Burroughs method: new belt 790 N, rotate engine at least 3 times and reset at 790 N. In service if tension falls below 270 N, reset at 630 N
	Clavis method: new belt 117 Hz, rotate engine at least 3 times and reset to 117 Hz. In service if tension falls below 70 Hz, reset at 90 Hz. (Measuring point: mid-way between crankshaft and air conditioning compressor pulleys)



1. GENERAL DESCRIPTION

Set in a 60 degree 'Vee' formation, the engine has twelve cylinders – six in each bank – each with a bore of 90 mm and a stroke of 78,5 mm, giving an overall capacity of 5993 cubic centimeters. On each cylinder bank, a single overhead camshaft actuates two valves per cylinder. Fuel is supplied to each cylinder via an injector, fed from a regulated fuel rail. Clean air is supplied via paper element air cleaners on each cylinder bank. To comply with statutory regulations in some countries and to reduce emissions during the warm-up period, secondary air is delivered to the exhaust manifold by an engine-driven air injection pump. This improves oxidation until the catalytic converters are fully effective. All engine functions are controlled by an integrated engine management system, which incorporates the on-board diagnostic system (OBDII).

1.1 Construction

The skirted design crankcase is manufactured in aluminum alloy and its open top deck houses slip fit wet cast iron cylinder sleeves.

Housed in the crankcase is the cast iron crankshaft, which is nitro-carburize treated to give a very high quality finish on the bearing surfaces and help increase the life of the bearing journals. The crankshaft is supported by seven main bearing caps, which have bearings of lead bronze on split steel backed shells with a lead indium overlay. Any crankshaft end-float is controlled by half thrust washers fitted on each side of the center main bearing. The gears and pulleys which drive the timing chain and external drive belts are keyed on to the crankshaft nose and held captive by a single bolt fitted into the end of the crankshaft.

The 'H' section connecting rods are of forged steel and have small end bushes of lead bronze with steel backing, which are machined to size after being pressed into the connecting rod. Connecting rod bearings are made from lead bronze on split steel backed shells with lead indium overlay.

Pistons are manufactured from aluminum alloy and are fitted with three rings, two upper compression rings and one lower oil control scraper ring. The pistons run on hardened steel piston pins, which are offset from the center line of the piston towards the thrust face.

A major feature of the engine is the design of the aluminum alloy cylinder heads. The heads utilize the 'May Fireball' combustion chamber which by virtue of its design gives better fuel / air mixing and controlled, even burning. These 'lean burn' combustion qualities aid fuel economy and help to meet increasingly stringent emission regulations. The cylinder heads carry the tappet block (cam carrier) in which the single camshaft per cylinder bank runs directly, with two steel in-line valves per cylinder which run in cast iron guides. Each valve has two valve springs and is operated by the camshaft via a chilled cast iron bucket tappet and clearance-adjustment shim.

Manufactured in cast iron with chilled cams, the camshafts are retained by machined aluminum caps. The tappet block is manufactured in cast aluminum alloy and is topped by a cover of the same material.

Camshaft drive is by a single 'duplex' chain, which incorporates an idler sprocket in its drive line. Drive for the chain is provided by the crankshaft and chain tension is controlled by a tensioner blade and three damper blades.

Three external drive belts situated at the front of the engine are operated by pulleys mounted on the crankshaft nose. The three belts drive the following:

- Generator
- Air conditioning compressor and power steering pump
- Water pump / cooling fan and air injection pump.

Two windage trays are fitted below the crankcase which prevent oil being sucked up and thrown into the crankcase, thereby alleviating windage and power loss. Bolted on to the bottom of the crankcase is the aluminum sandwich plate, the front part of which forms the base of the engine, with the rear part opening out to let oil reach the pressed steel oil pan. The oil pan is bolted to the sandwich plate.

1.2 Full-flow Oil System

Oil is drawn from the oil pan via a gauze filter fitted in the suction pipe. Oil is fed under pressure via internal galleries in the cylinder block to the filter head where it is regulated by a relief valve. Any relief oil is returned directly to the suction side of the oil pump. The main oil flow is then directed to the oil filter, is again regulated and, in the event of a blockage in the system, is by-passed. After filtration, the main oil flow passes through a cooler via a regulator, to guard against blockage. After cooling, the main oil is fed into the main oil gallery for distribution to various parts of the engine. Filtered oil is directed under pressure from the main oil gallery to the seven main bearings and then by oil-ways in the crankshaft, to the connecting rod bearings. An oil feed pipe connected to the rear of the cylinder block drawing oil from the main gallery, feeds the camshaft bearings. The idler gear is lubricated with oil from the main gallery by oil-ways drilled at the front of block.



1.3 *Crankcase Breather*

'Blow-by' gases are recycled through the air intake system to maintain a crankcase depression, thus preventing their escape to the atmosphere. Both cylinder banks have identical full and part load breathers. The breather pipes are connected to the top cover plate between the two banks. The other ends of the full load breather pipes are connected to stub pipes on the intake hoses. The part load breather pipes consist of hoses taken from the full load breather hoses and are connected to the centre of the intake manifolds. In this way, a suitable depression is maintained at all throttle settings.

1.4 *Cooling System*

The engine is cooled in a conventional manner by the circulation of a solution of good quality anti-freeze and water. The water pump is mounted directly above the crankshaft and is belt driven from the crankshaft by a three point drive, which also drives the air injection pump. The coolant is fed into the cylinder block by external pipes and is drawn from the engine via a thermostat in each cylinder bank to the radiator, or directly returned to the engine if the coolant temperature is too low.

2. *SERVICE PROCEDURES*

2.1 *Sealants*

One of the specified sealants for use on this engine is the Marston compound known as Hylosil 102, a white amine cure system rubber. Should this not be available, an equivalent amine cure sealant must be used. Under no circumstances should an acidtoxy cure system be used. Loctite 518 sealant is also specified for certain applications. See Service Materials in the Preliminary Pages for the correct sealant for each application.



3. FAULT DIAGNOSIS

3.1 Introduction

The following diagnostic procedures are provided to assist properly qualified persons to identify and rectify those faults relating to the engine which are most likely to be encountered.

If an electrical fault is suspected, refer to Section 5.2 of the Electrical Diagnostic Manual (EDM). Certain predefined fault conditions cause a diagnostic trouble code (DTC) to be generated. In this case, refer to the procedure for that DTC. If no DTC is present, the EDM procedures can still be used by referring to the list of fault groups in the preliminary pages of Section 5.2. The group numbers for certain fault conditions are included in the table below. For instrumentation faults, refer to Section 15.2 of the EDM.

Faults related to the cooling system are dealt with in Section 4.2 of the appropriate Vehicle Service Manual (VSM).

3.2 Diagnostic Procedures

Symptom	Possible Cause	Check	Remedy
Overheating			Refer to Section 4.2, VSM
Overheating at tick-over			Refer to Section 4.2, VSM
Too cold			Refer to Section 4.2, VSM
Loss of coolant			Refer to Section 4.2, VSM
Engine does not start (fails to rotate)	Battery leads loose or terminals corroded	Check battery leads and terminals	Clean and tighten as necessary
	Battery discharged	Check condition of battery with hydrometer	Charge or renew battery as necessary
	Starter motor inoperative	Starter motor jammed or faulty	Free pinion or renew starter motor
		Check for loose and dirty connections to the starter motor	Clean and tighten connections
	Fault in starting circuits / control module(s)	Check wiring harnesses, ignition switch, crank relay, SLCM, BPU and ECM	Rectify wiring harness fault(s) / renew faulty component(s)
Engine does not start (will rotate)	Starter motor speed too low	Check battery leads and terminals	Clean and tighten as necessary
		Check condition of battery with hydrometer	Charge or renew battery as necessary
	Ignition system fault	Check spark plugs	Renew spark plugs
		Refer to Section 5.2, EDM (group 15)	Rectify as required
	Fuel system fault	Refer to Section 5.2, EDM (groups 6, 10 and 11)	Rectify as required
	Engine speed, or crankshaft position sensor fault	Refer to Section 5.2, EDM (groups 14A and 14C)	Rectify as required
Insufficient oil pressure	Throttle position sensor failed at wide open setting	Refer to Section 5.2, EDM (group 4)	Rectify as required
	Engine overheating		Refer to Section 4.2, VSM
	Oil requires changing	Check oil level and for contamination of oil	Change oil and filter
	Worn crankshaft journals	Listen for rumble or knock	Renew crankshaft
	Excessive crankshaft end-float	Fit dial gauge and measure	Renew thrust washers
	Worn main bearing shells	Listen for rumble or knock	Renew bearing shells
	Worn oil pump	Check pump clearances	Renew oil pump
	Relief valve sticking open	Check valve for sticking	Renew valve
	Relief valve spring too weak	Check spring rate	Renew spring



Symptom	Possible Cause	Check	Remedy
Insufficient oil pressure (continued)	Insufficient oil in oil pan	Check oil level	Top-up as required
	Oil viscosity too low	Check oil viscosity	Renew oil and filter
	Water in oil	Check oil level and for contamination of oil	Renew oil and filter
	Cracked oil pump housing	Check for leaking cylinder head gasket(s)	Renew head gasket(s)
	Blocked oil pick-up pipe strainer	Inspect pump housing	Renew pump
	Oil pump pipe 'O' ring seals leaking	Remove oil pan and visually check	Remove oil pick-up pipe and clean strainer
	Main oil gallery 'O' ring seals leaking or gallery blocked	Remove oil pan and pipes and check 'O' ring seals	Fit new 'O' rings
Oil pressure too high	Faulty gauge or sensor	Inspect oil gallery and 'O' ring seals	Fit new 'O' rings or clear oil gallery
	Engine temperature too low	Refer to Section 15.2, EDM	Renew gauge or sensor
	Relief valve stuck shut	Check valve for sticking	Refer to Section 4.2, VSM
	Wrong pressure relief valve	Check the spring rate	Clean or renew the valve
	Oil viscosity too high	Check oil viscosity	Renew spring
Burning oil	Faulty gauge or sensor	Refer to Section 15.2, EDM	Renew gauge or sensor
	Worn cylinder bores	Check bore wear	Rebore cylinders
	Worn valve guides	Insert valve in guide and check side movement	Renew valve guides as necessary
	Worn intake valve guide seals	Remove seals and check for splits or wear	Renew in sets
	Worn piston rings	Measure rings in bore	Renew rings in sets and rebore as necessary
	Cylinder head gasket(s) leaking	Check for blue smoke from exhaust	Renew head gasket(s)
Losing oil (leaking)	Incorrect oil viscosity	Check oil viscosity	Renew oil and filter
	Worn front oil seal	Visual check	Renew seal
	Worn rear oil seal	Visual check	Renew seal
	Leaking gasket(s)	Visual check	Renew gasket(s)
Noisy valve gear	Cylinder block cracked	Visual check	Renew cylinder block
	Excessive valve clearance	Check valve clearances	Adjust valve clearances
	Broken valve spring	Check valve springs	Renew as necessary
	Broken valve guide	Check valve guides	Renew as necessary
	Broken valve seat insert	Check valve seat inserts	Renew as necessary
	Lack of lubrication	Check oil pressure gauge reading	Refer to Insufficient Oil Pressure fault finding
	Valve clash	Check valve timing	Adjust valve timing
	Worn camshaft(s)	Check valve clearances	Adjust valve clearances
Noisy timing chains	Worn camshaft drive chains / tensioners	Lack of lubrication	Refer to Insufficient Oil Pressure fault finding
	Insufficient oil pressure	Remove front timing cover and check for wear	Renew as necessary
	Tensioners not released	Take oil pressure gauge reading with engine hot	Refer to Insufficient Oil Pressure fault finding
	Chains, sprockets or tensioners worn	Check chain tensioners	Release chain tensioners
		Visually check / remove and check for wear	Renew as necessary



Symptom	Possible Cause	Check	Remedy
Detonation knock (pinging)	Engine running too hot		Refer to Section 4.2, VSM
	Cylinder head gasket(s) leaking	Check oil level and for contamination of oil. Pressure-test cooling system and check for contamination of coolant in header tank	Renew head gasket(s). Change oil, filter and coolant as necessary
	Incorrect valve timing	Check valve timing	Adjust valve timing
	Incorrect ignition timing	If engine has been dismantled, examine sensors and timing disks / pegs for incorrect assembly	Rectify as required
	Incorrect grade fuel	Check fuel is as specified for vehicle	Drain fuel tank and refill with correct grade fuel
Loss of power	Fuel / air mixture too lean	Leak / blockage in fuel or air system	Rectify as required
		Refer to Section 5.2, EDM (groups 6 and 11)	Rectify as required
	Burned valves / valve seats	Check cylinder compressions	Renew valves / recut or renew valve seats as necessary
	Sticking valves	Check cylinder compressions	Renew valves, springs or guides as necessary
	Insufficient valve clearances	Check valve clearances	Adjust valve clearances
	Incorrect valve timing	Check valve timing	Adjust valve timing
	Low compression in cylinders	Check compressions	Rebore / re-ring as necessary
	Partial seizure of engine	Remove spark plugs and rotate crankshaft	Overhaul engine as necessary
	Worn camshaft(s)	Remove camshaft(s) and check for wear	Renew camshaft(s)
	Incorrect grade fuel	Check fuel is as specified for vehicle	Drain fuel tank and refill with correct grade fuel
	Fuel system fault	Refer to Section 5.2, EDM (groups 6, 10 and 11)	Rectify as required
Rough running at normal engine speed	Ignition system fault	Refer to Section 5.2, EDM (group 15)	Rectify as required
	Throttle position sensor fault	Refer to Section 5.2, EDM (group 4)	Rectify as required
	MAP sensor fault	Refer to Section 5.2, EDM (groups 1A and 1B)	Rectify as required
	Cylinder head gasket(s) leaking		Refer to Detonation Knock fault finding
	Sticking valves	Check cylinder compressions	Renew valves, springs or guides as necessary
	Broken valve springs	Check cylinder compressions and for bent valve stems	Renew valve springs and valves as necessary
	Piston fault	Check cylinder compressions	Renew pistons
	Burned valves / valve seats	Check cylinder compressions	Renew valves / recut or renew valve seats
	Leaking exhaust	Visual check	Repair leak or renew exhaust
	Air leaking into intake manifold(s)	Run engine and check for leaks / whistling. Spray 'Easy Start' around suspect area (the engine speed will increase if an air leak is present)	Renew gasket(s) or manifold(s)



Symptom	Possible Cause	Check	Remedy
Rough running at normal engine speed (continued)	Ignition system fault	Refer to Section 5.2, EDM (group 15)	Rectify as required
	Fuel system fault	Refer to Section 5.2, EDM (groups 6, 10 and 11)	Rectify as required
	Engine misfiring	Refer to Section 5.2, EDM (group 13)	Rectify as required
Rough idle	Incorrect valve timing	Check valve timing	Adjust valve timing
	Burned valves / valve seats	Check cylinder compressions	Renew valves / recut or renew valve seats
	Ignition system fault	Refer to Section 5.2, EDM (group 15)	Rectify as required
	Fuel system fault	Refer to Section 5.2, EDM (groups 6, 10 and 11)	Rectify as required
	Engine misfiring	Refer to Section 5.2, EDM (group 13)	Rectify as required
	Closed throttle position switch fault	Refer to Section 5.2, EDM (group 21)	Rectify as required
	Idle speed control fault	Refer to Section 5.2, EDM (group 20)	Rectify as required
Engine fails to idle	Evaporative emission control fault	Refer to Section 5.2, EDM (group 18)	Rectify as required
	Cylinder head gasket(s) leaking		Refer to Detonation Knock fault finding
	Insufficient valve clearances	Check valve clearances	Adjust valve clearances
	Blockage in exhaust system	Check for restrictions	Remove the restrictions or renew components as necessary
Engine backfires	Idle speed control fault	Refer to Section 5.2, EDM (group 20)	Rectify as required
	Air leakage into / from the exhaust system	Check for leaks or blows in the system	Repair leaks or renew system if necessary
	Leakage past valves and guides	Check for crankcase fumes	Renew valves and guides
	Incorrect valve timing	Check valve timing	Adjust valve timing
	Valves not closing properly	Check valve clearances	Adjust valve clearances
		Check for wear or gum in valve guides	Renew guides or decarbonize the cylinder heads
		Check for poor seating of valves	Renew valves / recut or renew valve seats
Engine spits back into air boxes	Ignition system fault	Refer to Section 5.2, EDM (group 15)	Rectify as required
	Air leaking into intake manifold(s)		Refer to Rough Running at Normal Engine Speed fault finding
	Fuel injection fault (excessively weak mixture)	Refer to Section 5.2, EDM (groups 6 and 11)	Rectify as required



4. SERVICE OPERATIONS

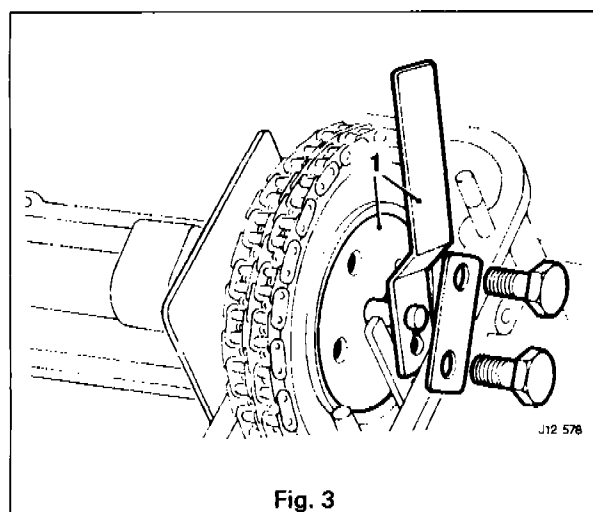
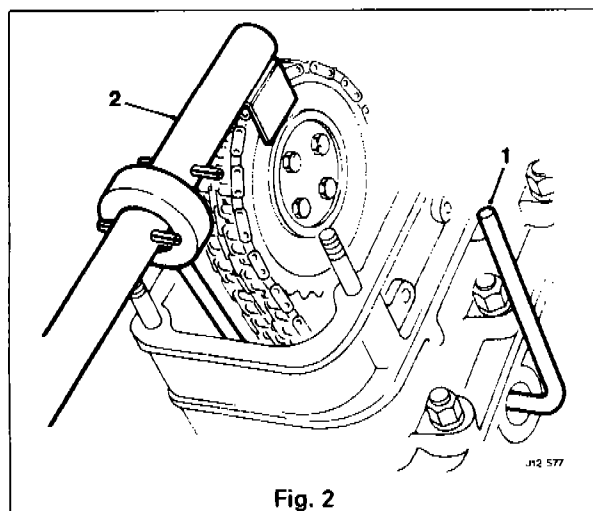
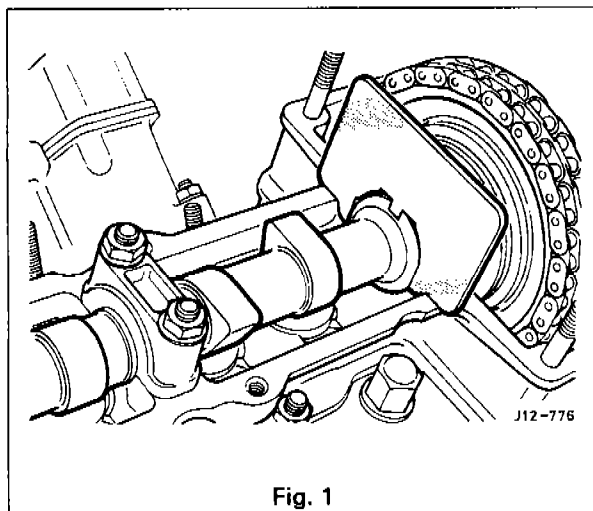
4.1 Camshaft, Renew

SRO 12.13.02 – LEFT-HAND

SRO 12.13.03 – RIGHT-HAND

- Remove the camshaft covers, see Section 4.2.
- Remove the idler tensioning pulley assembly from the right-hand cylinder head.
- Rotate the engine to the cam removal position (TDC) until Timing Gauge C 3993 can be inserted into the recess in the camshaft (Fig. 1).
- Note the two uppermost camshaft sprocket retaining bolts. Remove Timing Gauge C 3993.
- Rotate the engine until the two LOWER camshaft sprocket retaining bolts on the relevant camshaft become accessible.
- Push back the lock tabs and remove the two retaining bolts (ensure that the tab washer or the bolts do not drop into the timing case).
- Rotate the engine to the camshaft removal position (TDC) and refit Timing Gauge C 3993.
- Slacken, but do NOT remove the two remaining camshaft sprocket retaining bolts.
- Remove the rubber grommet from the front of the right-hand timing cover and insert Service Tool JD 50 (Release Tool) (1 Fig. 2), and release the locking catch on the timing chain tensioner.
- Fit Service Tool JD 50 (Chain Tension Retainer) (2 Fig. 2) and retract the timing chain tensioner until the locking catch is engaged.
- Remove Service Tool JD 50.
- Remove the remaining two camshaft sprocket bolts and fit Service Tool JD 40 (1 Fig. 3) to retain the sprocket to the retainer plate.

CAUTION: Do not rotate the engine while the camshaft is disconnected.





- Gradually slacken off each camshaft cap securing nut (1 Fig. 1) two turns at a time until the valve springs are fully relaxed.
- Note the cap to carrier relationship.
- Remove the nuts / washers and lift off the bearing caps (2 Fig. 1), and remove the left-hand camshaft (3 Fig. 1).
- Clean and examine all components thoroughly.
- Replace worn or damaged components as necessary.
- Ensure that all oilways are clear.
- Lubricate the camshaft journals with clean engine oil.
- Fit the replacement camshaft to its carrier using Service Tool, Timing Gauge C 3993, to position the camshaft correctly (Fig. 2).
- Fit the bearing caps, washers and securing nuts, (1, 2 Fig. 1).
- Progressively tighten the securing nuts to the correct torque working from the center outwards. See Torque Tightening Specifications in the Preliminary Pages.
- Check that Timing Gauge C 3993 is in position.
- Engage the camshaft sprocket to the camshaft, and fit but do not fully tighten one retaining bolt and tab washer.
- Remove Service Tool JD 40.
- Fit the second retaining bolt to the tab washer, and secure the two bolts.
- Remove Service Tool C 3993.
- Rotate the engine and fit the remaining sprocket retaining bolts and tab washer.
- Repeat the procedure for the right-hand camshaft (if necessary).
- Fit Service Tool JD 50 (Chain Tension Retainer) and raise the timing chain tensioner slightly.
- Check and adjust the valve clearances, see Section 4.3.
- Lock over all the tabs.
- Insert Service Tool JD 50 (Release Tool) through the timing cover. Release the locking catch and allow the tensioner to expand.
- Remove both Service Tools.
- Check the valve clearances, see Section 4.3.
- Refit the rubber grommet to the front of the timing cover.
- Refit the camshaft covers, see Section 4.2.

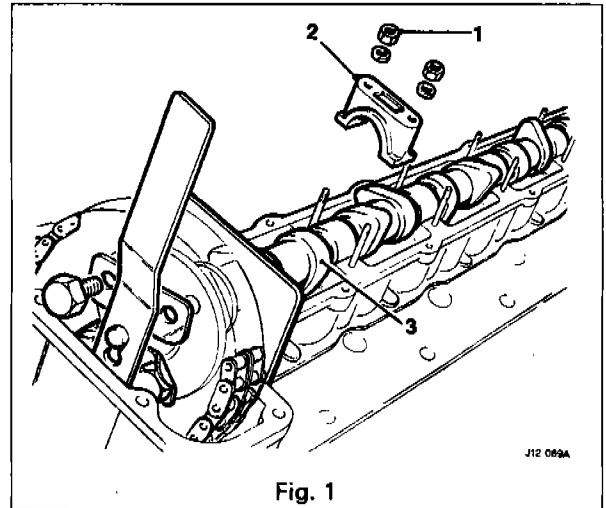


Fig. 1

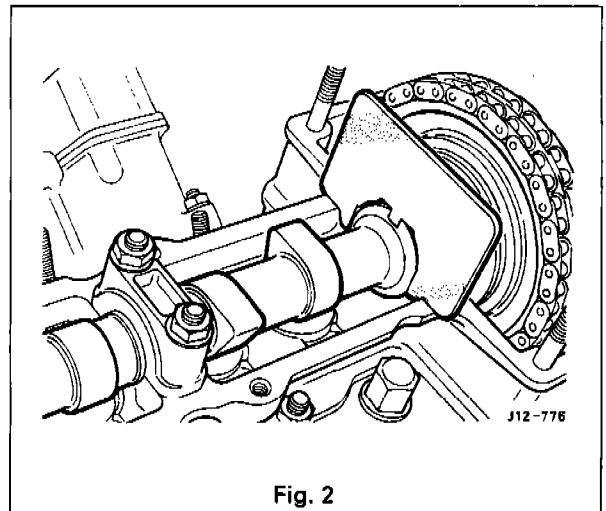


Fig. 2

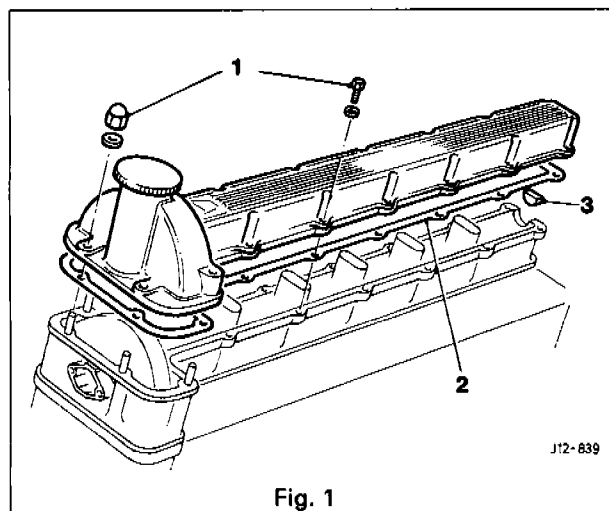


4.2 Camshaft Cover Gasket, Renew

SRO 12.29.43 – LEFT-HAND

SRO 12.29.44 – RIGHT-HAND

- Remove the engine cover, see Section 4.10.
- Remove the left-hand or right-hand intake manifold as required.
- For right-hand camshaft cover and engine set only:
 - Remove the idler tensioning pulley assembly from the right-hand cylinder head. Disconnect the air conditioning compressor multi-way connector.
 - Remove and reposition the compressor for access (do NOT disconnect the manifold or pipework).
- For right-hand and left-hand camshaft covers:
 - Remove the securing nuts and bolts (1 Fig. 1), and remove the camshaft cover.
 - Remove and discard the gasket (2 Fig. 1) and the half-moon seal (3 Fig. 1). Clean the mating faces and the half-moon seal seat.
 - Apply sealant to the half-moon seal (3 Fig. 1) and seat in position. See Service Materials in the Preliminary Pages.
 - Fit and align the new camshaft cover gasket, refit the camshaft cover and secure with nuts and bolts (1 Fig. 1).
- For right-hand camshaft cover and engine set only:
 - Refit the air conditioning compressor.
 - Reconnect the compressor multi-way connector, and refit the idler tensioning pulley assembly to the right-hand cylinder head.
- For right-hand and left-hand camshaft covers:
 - Refit the intake manifold.
 - Refit the engine cover, see Section 4.10.





4.3 Valve Clearance, Check and Adjust

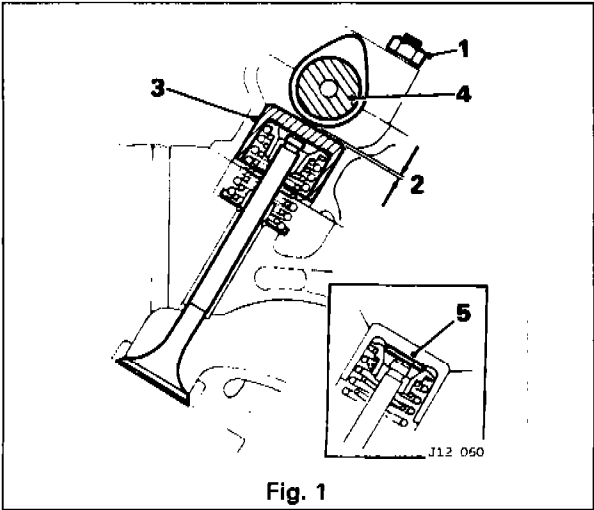
SRO 12.29.48

- Remove the camshaft covers, see Section 4.2.
- Rotate the engine as necessary and measure the valve clearances (2 Fig. 1) between the heel of the cam (4 Fig. 1) and the cam followers (3 Fig. 1).
- Make a note of each reading.
- Should the clearances be incorrect (see Service Data in the Preliminary Pages), proceed as follows:
- Remove the camshafts, see Section 4.1.
- Remove the cam followers (3 Fig. 1).
- Remove each shim (5 Fig. 1) in turn, check the size with a micrometer and note the reading.
- Calculate the size of shim required following the examples shown below.
- When the correct shim sizes have been obtained, refit shims and cam followers to the cam carrier.
- Lubricate the camshaft journals with clean engine oil.
- Refit the camshafts, see Section 4.1.
- Recheck the valve clearances.
- Refit the camshaft covers, see Section 4.2.

VALVE CLEARANCES

Excessive Clearance	inches
Size of existing shim	0.100
Plus the actual clearance noted	<u>0.019</u>
	0.119
Less the specified valve clearance	<u>0.013</u>
Required shim size =	0.106
Insufficient Clearance	inches
Size of existing shim	0.107
Plus the actual clearance noted	<u>0.010</u>
	0.117
Less the specified valve clearance	<u>0.013</u>
Required shim size =	0.104

Note: See Service Data in the Preliminary Pages for valve clearances and available valve shim sizes.





4.4 Cylinder Head, Overhaul

SRO 12.29.21

- Remove the cylinder head assemblies, see Section 4.11.

Note: Always support the cylinder heads on blocks of wood. This will prevent damage to the valves which, when open, protrude below the cylinder head face.

- Remove the spark plugs and exhaust manifolds from the cylinder head.
- Gradually slacken off each camshaft cap securing nut (two turns at a time) until the valve springs are fully relaxed.
- Note the cap to carrier relationship.
- Remove the nuts/washers (1 Fig. 1) and lift off the bearing caps (2 Fig. 1).
- Remove the camshaft (3 Fig. 1).
- Using a magnet, lift out the cam followers (1 Fig. 2).
- Remove the camshaft carrier and remove all traces of sealant from carrier and head faces.
- Remove the valve springs, using Service Tool JD 6118C and adapter JD 6118C-2 (Fig. 3).

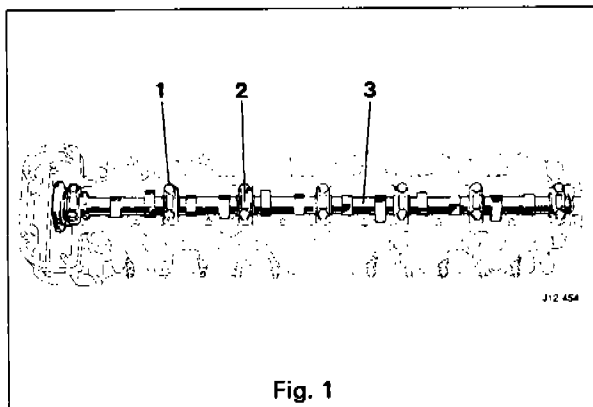


Fig. 1

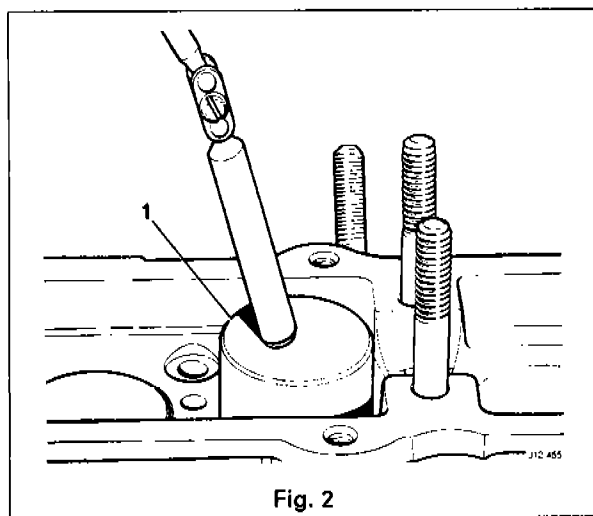


Fig. 2

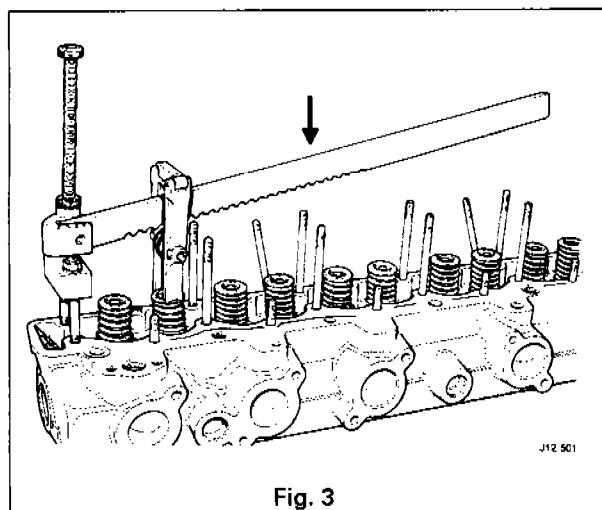


Fig. 3



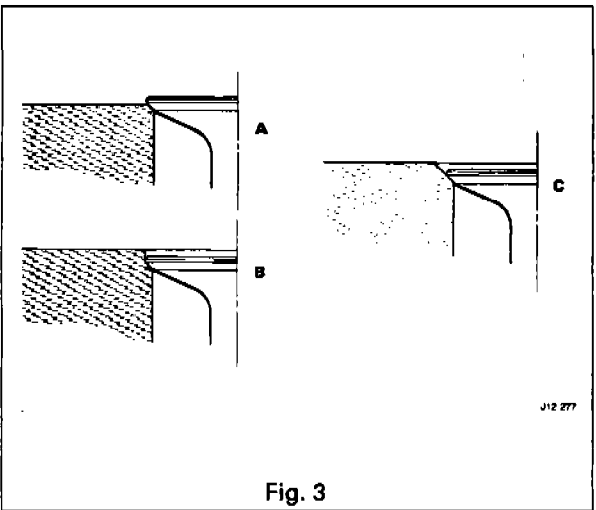
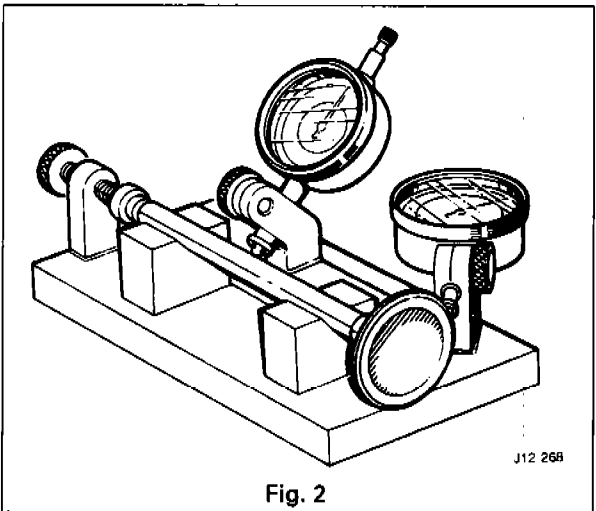
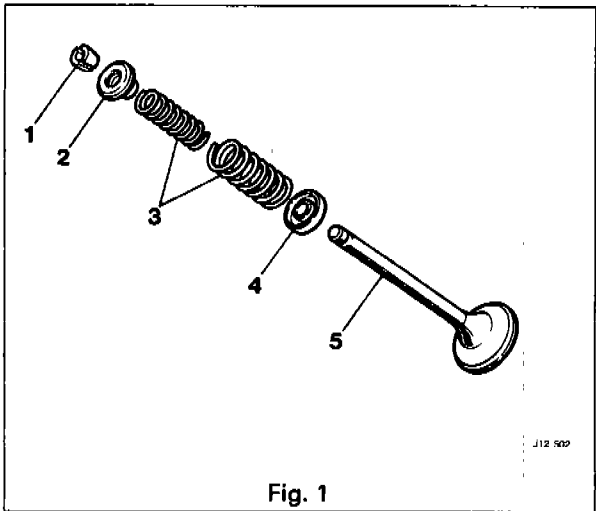
- Retrieve the collets (1 Fig. 1), collars (2 Fig. 1), and spring retaining plates (4 Fig. 1).
- Remove the valves (5 Fig. 1), noting the relationship between valve and guide to ensure correct pairing during re-assembly.
- Remove the seals from the intake valve guides.
- Clean all component parts.
- Check for wear and burning of valves or seats.
- Check the cylinder head face for distortion.
- If distortion is evident, a maximum of 0,025 mm may be removed by skimming the cylinder head.
- Taking care not to damage the inside surface of the combustion chambers, remove all traces of carbon from the intake and exhaust ports.

CAUTION: When using scrapers or wire brushes for removing carbon deposits, avoid scratching the valve faces and seats. A soft wire brush is the most suitable implement for this purpose.

- Clean all carbon and other deposits from the valve guides using a suitable valve guide brush.
- Thoroughly wash the cylinder head to ensure that all loose carbon is removed and dry the head with a high pressure air line.
- After cleaning and polishing each valve, examine the stems for straightness and wear, using a suitable dial gauge and vee-block see example at Fig. 2.
- Examine the valve faces for burns, pitting and distortion. Renew any valves that are excessively worn, bent, or too badly pitted to be salvaged by refacing.

Note: No attempt should be made to clean up a burnt or badly pitted valve face by extensive 'grinding in' of the valve to the seat.

- Lightly lap the valves into the seats with a fine grinding compound. The reseating operation should leave the finished surfaces smooth. Excessive lapping will groove the valve face resulting in a poor seat when the engine is hot.
- Fig. 3 shows:
 - 'A' – Correctly seated
 - 'B' – Undesirable condition
 - 'C' – Method of rectification.
- To test the valves for concentricity with their seats, coat the face of the valve with Prussian blue or similar and rotate the valve against the seat.
- If the valve face is concentric with the valve stem, a mark will be made all around the face.

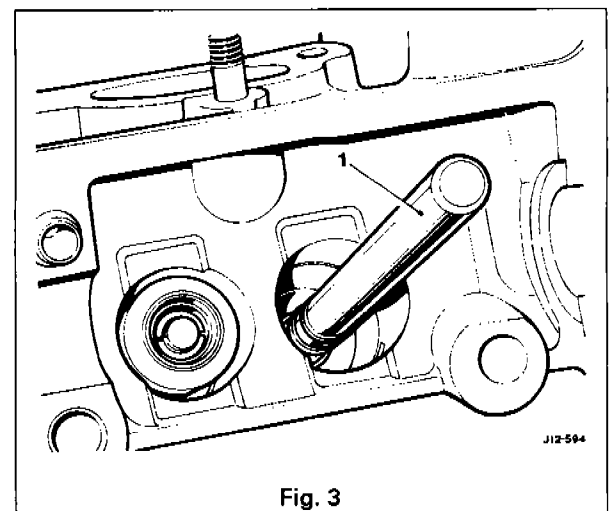
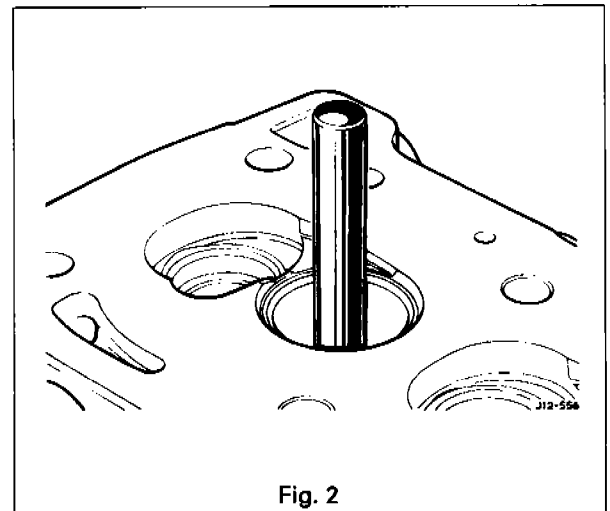
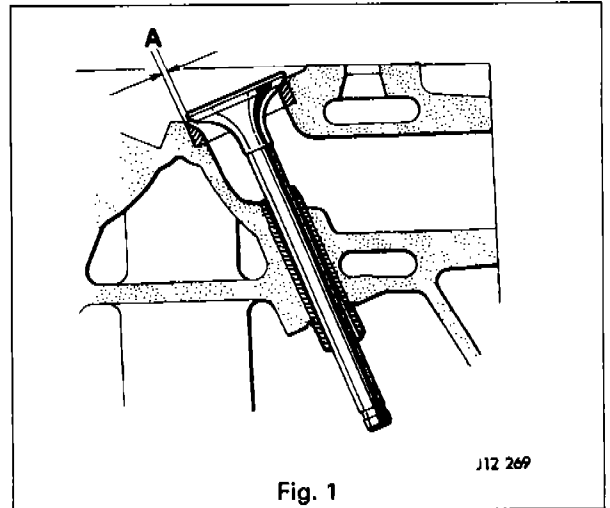




- Should a mark be made on only one side of the face, the face is not concentric with the valve stem.
- Clean the valve and again coat with Prussian blue and rotate the valve against the seat.
- Check that the valve guide is concentric with the valve seat, if not, the seat must be recut.
- Whenever valves are replaced, the seats must be recut prior to lapping of the valves.
- Check valve guide wear by inserting a new valve into the guide to be checked, lift it 6 mm from its seat and rock it sideways. Movement of the valve across its seat must not exceed 0,5 mm (A Fig. 1).
- Should the movement exceed this tolerance, the valve guide must be replaced. Use Service Tool 18G 1432 to drift out the old guide (Fig. 2). Ensure that the relevant valve guide is selected prior to fitting.
- When new guides are to be fitted they should always be one size larger than the old guide.
- Cylinder head bores will require reaming as follows:
 - Remove the old valve guide and ream the cylinder head to the relevant dimension. Immerse the cylinder head in boiling water for 30 minutes. Coat the guide with graphite grease, and, using Service Tool 18G 1432 (1 Fig. 3), drift in the guide from the camshaft side until the snap-ring is seated in the groove.

Note: The interference should not be sufficient to require the use of excessive force when fitting the guide.

- After fitting a valve guide, the valve seat must be recut using Service Tool MS 621.
- Examine the valve seat inserts for pitting or excess wear. If renewal is necessary, proceed as follows:
 - Remove the inserts by machining, leaving approximately 0,25 mm of metal which can easily be removed by hand without damaging the cylinder head.
 - Measure the diameter of the insert recess in the cylinder head.
 - Grind down the outside diameter of the new insert to a dimension 0,08 mm larger than the insert recess.
 - Heat the cylinder head for 30 minutes from cold to a temperature of 150°C (300°F).
 - Fit the insert ensuring that it beds evenly in the recess.
 - When the cylinder head has cooled, re-cut the valve seat using Service Tool MS 621.





Note: If new valve inserts have been fitted, the clearance between valve stem and cam must be checked. See Service Data in the Preliminary Pages.

- The dimension must be taken between the valve stem and the back of the cam.
- Should this dimension not be obtained, metal must be ground from the valve seat of the insert.

Note: Use only suitable grinding equipment.

- Remove only very small amounts of metal from the valve seat at one time before re-checking the clearance.
- Examine the cam followers for wear on the top face, these should be perfectly flat. Check for any sign of barreling on the side faces (Fig. 1). Replace all followers that are worn or suspect.
- Wash the valves, springs, collets, and cam followers and air dry.
- After the valve springs have been thoroughly washed, they must be examined for fatigue and distortion. Renew as necessary.
- Test the valve springs either by comparison with the figures given in DATA, or by comparison with a new valve spring (using a recommended valve spring testing machine).
- To test against a new valve spring, insert both valve springs end to end between the test equipment. Apply a load to partly compress the springs and measure their comparative lengths (Fig. 2).

Note: 'A' is the old spring.

- If the distance at 'A' is smaller than the distance at 'B', then 'A' must be replaced.
- Spring distortion is determined by positioning the spring upright on a surface plate and checking the squareness of each end with a set square (Fig. 3).
- All valve springs which have diminished in length and / or are not square must be renewed. Fit the valves into the guides and place the cylinder head on wooden blocks.
- Fit the valve spring seats, intake valve guide oil seals, springs and collars.
- Compress the springs using Service Tool JD6118C and insert the split collets.
- Apply sealant to the camshaft carrier's mating surface and refit the camshaft carrier. See Service Materials in the Preliminary Pages.

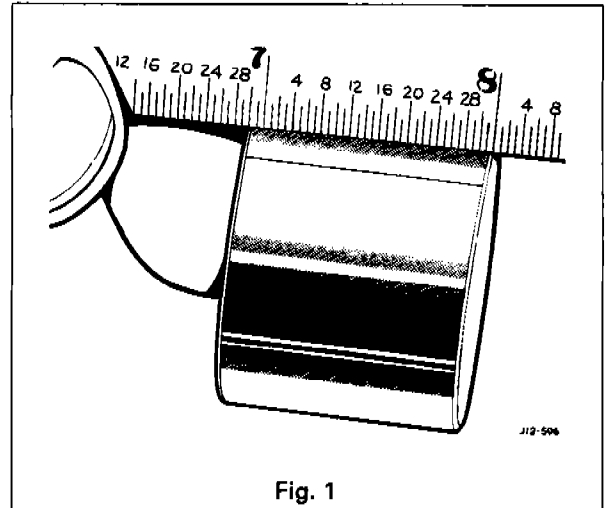


Fig. 1

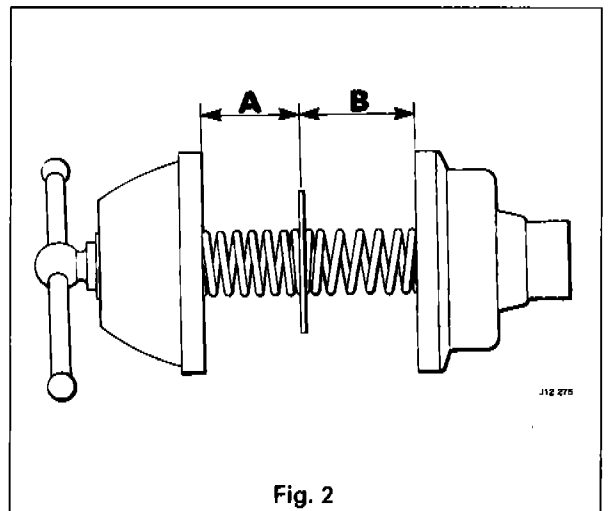


Fig. 2

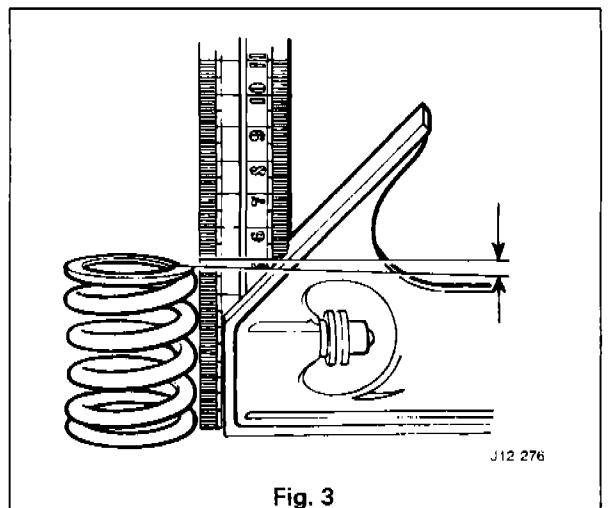


Fig. 3



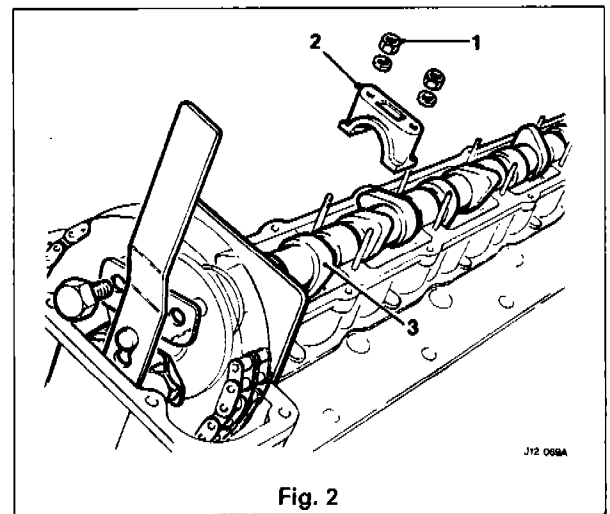
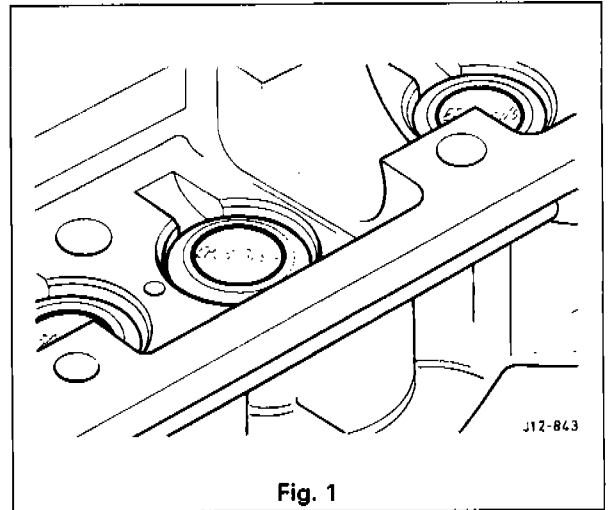
- Refit the original shims in the valve collar recesses (1 Fig. 1).
- Ensure that the shims are seated correctly, and fit the cam followers.

Note: If the cylinder head has been overhauled to the extent of having the valve seats recut, each shim should be 0.010 in. smaller than the original.

- Lubricate the camshaft and fit to the camshaft carrier ensuring that it is fitted with the slot to the top.
- Fit the bearing caps, washers and securing nuts (1, 2 Fig. 2).
- Progressively tighten the securing nuts to the correct torque working from the center outwards. See Torque Tightening Specifications in the Preliminary Pages.
- Check and adjust the valve clearances. See Section 4.3.

Note: A final check of the valve clearances should be done when the cylinder head is fitted and tightened to the cylinder block.

- Clean the cylinder head thoroughly and check the cylinder head and cylinder block for warping, bowing or cracks.
- Ensure that the cylinder head and block mating faces are clean and all oil / water galleries are not obstructed.
- Repeat the overhaul procedure for the right-hand cylinder head.
- Refit the cylinder head assemblies, see Section 4.11.





4.5 Spark Plug Insert Fitting

SRO 12.29.78

- Remove the appropriate cylinder head, see Section 4.11.

Note: Always support the cylinder heads on blocks of wood. This will prevent damage to the valves which, when open, protrude below the cylinder head face.

- Remove the valves, see Section 4.4.
- Bore out the stripped thread to 19,05 mm diameter and tap out to 16 UNF – 2B (Dimension 'A' Fig. 1).
- Counter-bore to 24,13 mm (Dimension 'B').
- Dimension 'C' = 22,23 mm.
- Dimension 'D' = 14,22 mm – 14,48 mm.
- Dimension 'E' = 10,78 mm.
- Dimension 'F' = 15,75 mm.
- Dimension 'G' = 11,81 mm – 11,94 mm.
- Fit the screwed insert ensuring that it sits firmly at the bottom of the thread.
- Drill and ream a 3,17 mm diameter hole 2,83 mm deep, between the side of the insert and the head.
- Drive in a locking pin and secure by peening the edge of the insert and the locking pin.
- Dimension 'H' = 10,16 mm (Fig. 2).
- Refit the valves, see Section 4.4.
- Refit the appropriate cylinder head, see Section 4.11.

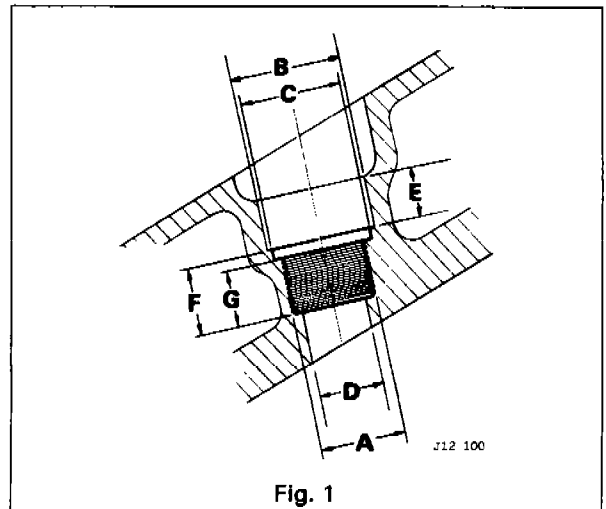


Fig. 1

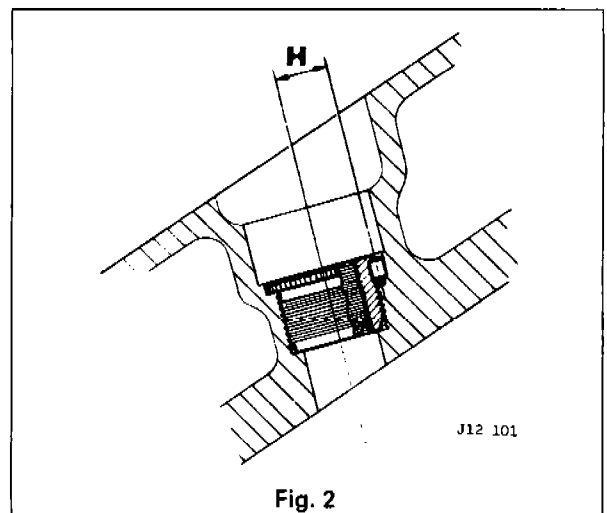


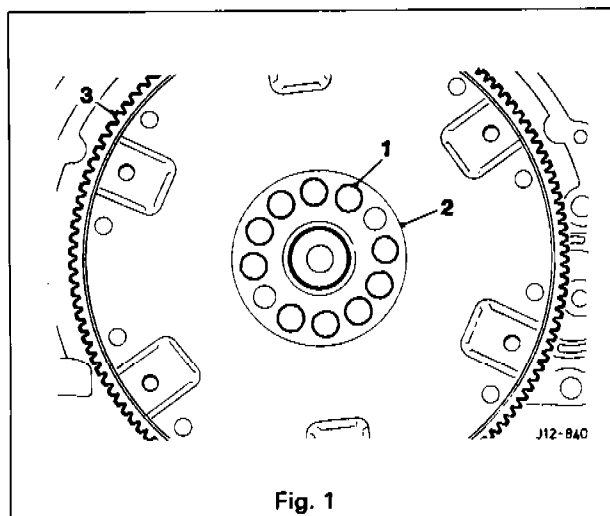
Fig. 2



4.6 Drive-plate, Renew

SRO 12.53.13

- Remove the torque converter.
- Fit a suitable wedge to prevent the drive-plate rotating and remove the drive-plate securing bolts (1 Fig. 1) and discard them.
- Remove the drive-plate and the reinforcing ring.
- Clean and examine all components, renew as necessary.
- Thoroughly clean all mating faces.
- Fit the replacement drive-plate and the reinforcing ring, and secure with the bolts.
- Refit the torque converter.





4.7 Crankshaft Damper and Pulley, Renew

SRO 12.21.01

- Remove the drive belts.
- Remove the pulley securing bolts (1, 2 Fig. 1) and withdraw the crank turning plate (3 Fig. 1), spacers (4 Fig. 1) and the pulley (5 Fig. 1).
- Fit a suitable wedge to the drive-plate, and remove the crankshaft damper bolt (6 Fig. 1). Alternatively, Service Tool 18G 1205 with longer screws and spacers may be used (Fig. 2).
- Use Service Tool 18G 1436A to remove the crankshaft damper assembly (Fig. 3).
- Remove the timing disc (7 Fig. 1) from the damper (8 Fig. 1).
- Clean and examine all components for wear and damage, and renew as necessary.
- Fit the timing disc (7 Fig. 1) to the replacement damper (8 Fig. 1) with the roll pin (9 Fig. 1) and secure with the screws (10 Fig. 1).
- Fit the damper assembly to the crankshaft nose, and secure with the damper bolt (6 Fig. 1).
- Fit the pulley (5 Fig. 1) and the crank turning plate (3 Fig. 1) and secure with the securing bolts and spacers (1, 2, 4 Fig. 1).
- Refit the drive belts.

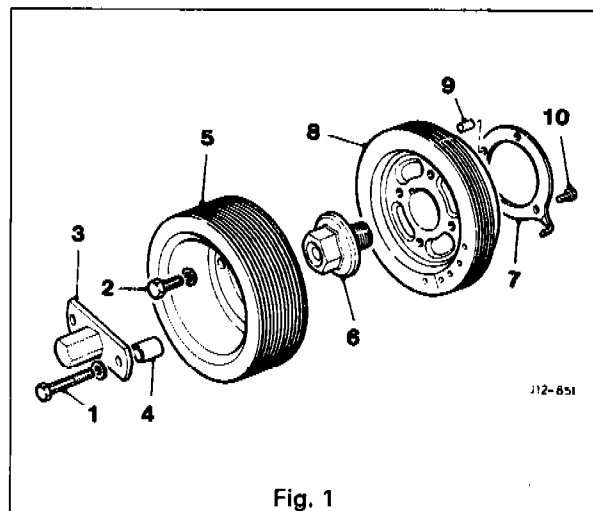


Fig. 1

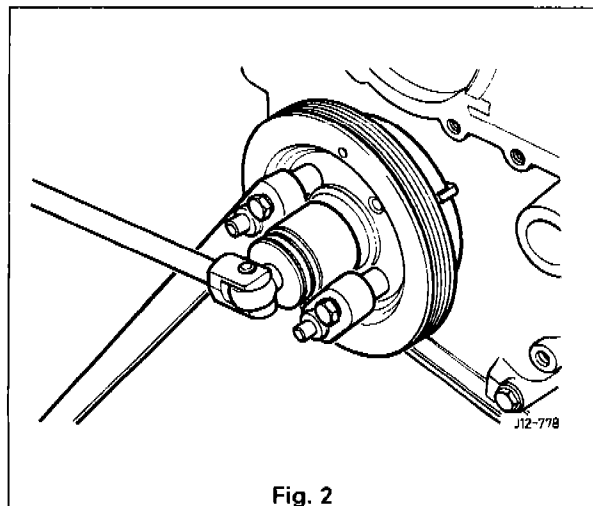


Fig. 2

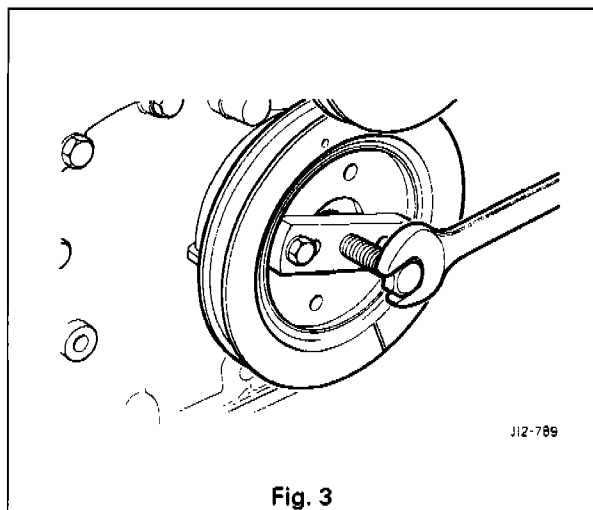


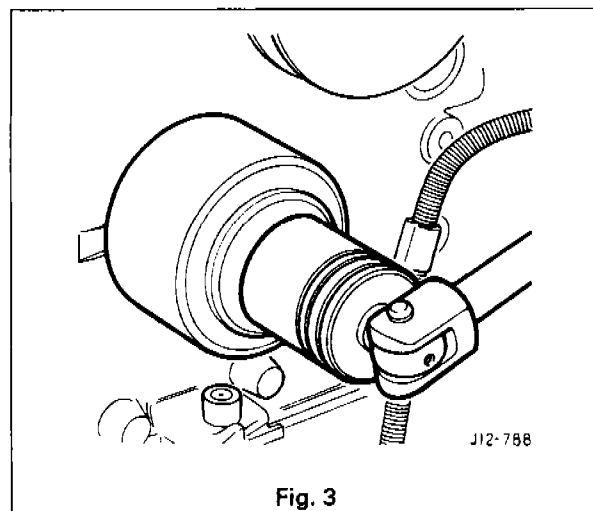
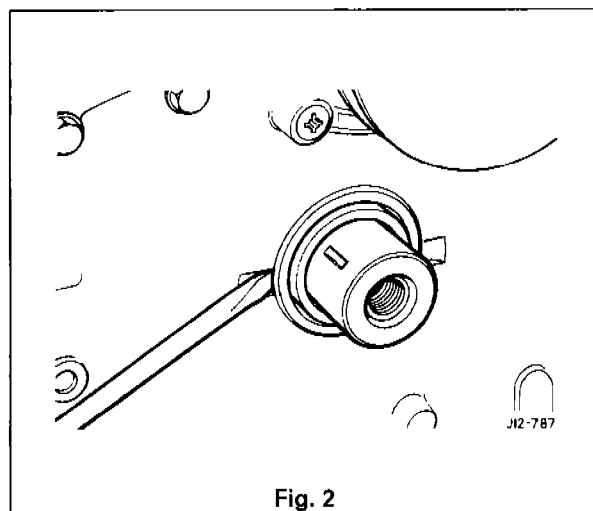
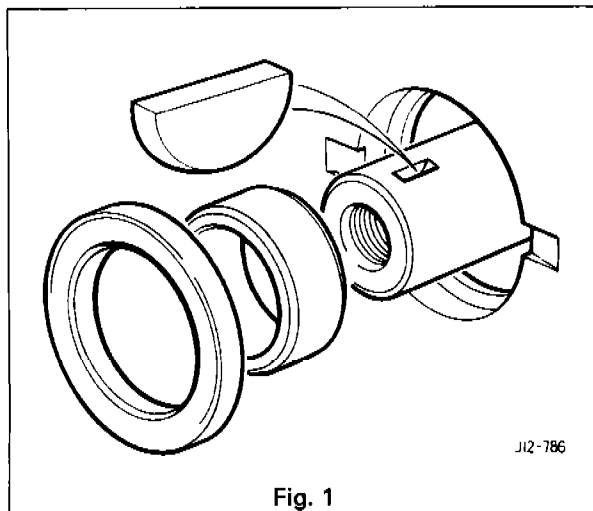
Fig. 3



4.8 Crankshaft Front Oil Seal, Renew

SRO 12.21.14

- Remove the crankshaft damper assembly and pulley, see Section 4.7.
- Remove the crank damper woodruff key (Fig. 1).
- Prize the seal from the timing cover using a screwdriver (Fig. 2).
- Discard the seal and withdraw the crankshaft spacer (Fig. 1).
- Examine all components for wear and damage, and renew as necessary. Ensure that the seal recess is absolutely clean.
- Smear the new seal with clean engine oil.
- Position the seal squarely in the recess and seat using Service Tool JD 129, and crank bolt (Fig. 3).
- Refit the crankshaft spacer and the woodruff key.
- Refit the crankshaft damper assembly and pulley, see Section 4.7.





4.9 Crankshaft Rear Oil Seal, Renew

SRO 12.21.20

- Remove the drive-plate, see Section 4.6.
- Clean and lubricate the exposed surfaces of the crankshaft and the inside surfaces of the tool body, (removal / installation tool – JD 163) with clean engine oil.
- Locate the tool body on the crankshaft to abut the seal rear face, which is located flush with the rear of the crankcase.
- Align both holes through the tool body with the threaded holes in the crankshaft rear flange, screw both bolt assemblies (2 Fig.1) into them to lock the tool body to the crankshaft.
- Place the center punch (1 Fig.1) through one of the tool body's outer three holes and note the distance by which the shoulder of the punch stands proud.
- Using a hammer (Fig.1), penetrate the seal (up to 2 mm); determine this from the distance noted in the previous operation.

CAUTION: Do not exceed 2 mm depth.

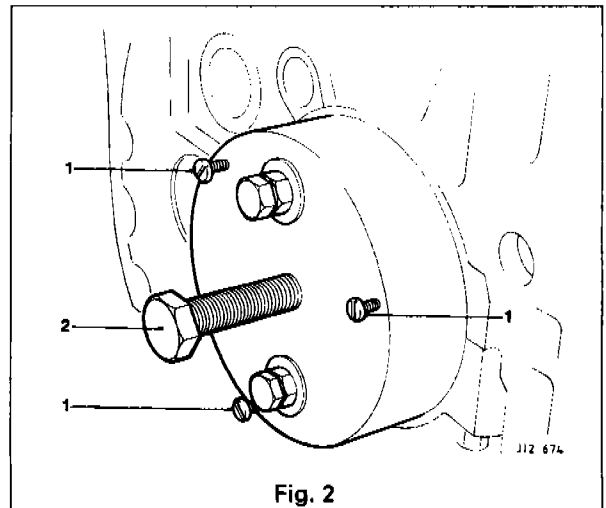
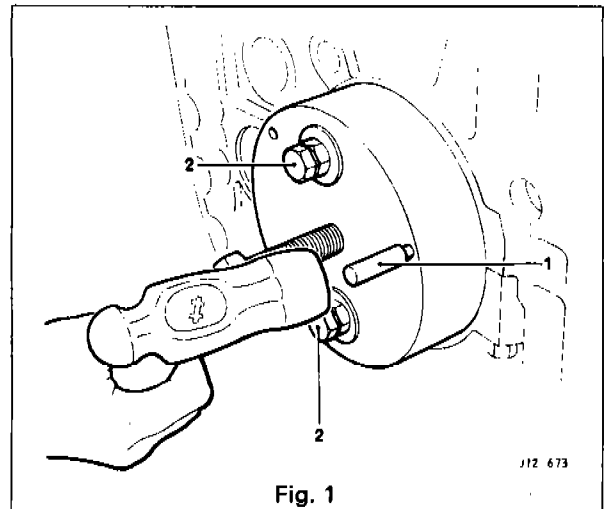
- Remove the punch and insert the self-tapping screw (1 Fig. 2); turning it no more than $1\frac{1}{2}$ turns.
- Repeat the procedure for inserting the two other screws.

CAUTION: Do not exceed 2 turns or the screw may break.

- Remove the two bolt assemblies, so that the center bolt (2 Fig. 2) can be turned clockwise to extract the seal.
- Remove and discard the seal from the tool.
- Clean the surface of the crankshaft and ensure it is smooth and free of damage. Lubricate the surface with clean engine oil.
- Fit the new seal squarely onto the crankshaft using the guide supplied with the seal.

CAUTION: The seal guide must not be separated from the seal prior to fitment or it will be rendered unsuitable for use.

- Refit the tool body onto the crankshaft to abut the seal rear face. Align the holes through the tool body with the threaded holes in the crankshaft flange, insert both bolt assemblies and screw them in until the bolts 'bottom'.
- Remove the seal guide. Tighten the nuts / washers alternately against the tool face, $\frac{1}{2}$ turn at a time, until the seal casing is driven into its location in the crankcase by the front rim of the tool.
- Remove the bolt assemblies, and remove the body of the tool from the crankshaft.
- Refit the drive-plate, see Section 4.6.





4.10 Engine Cover, Renew

SRO 12.29.93

- Release the throttle cable outer locknut (Fig. 1) and remove the outer cable from the throttle bracket.
- Release and remove the turn-fasteners securing the engine cover (Fig. 2) to the fuel rail.

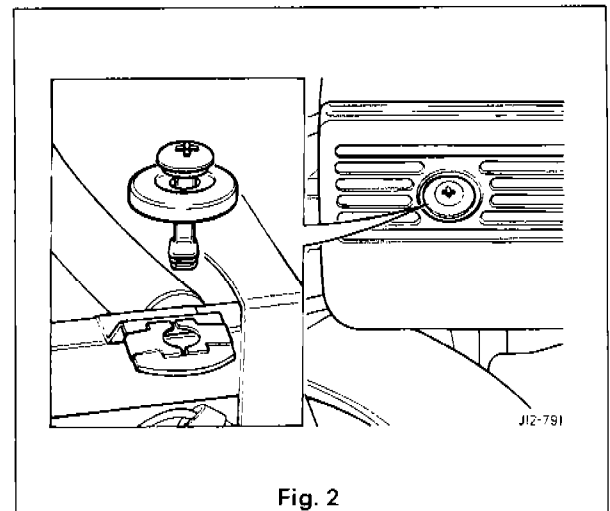
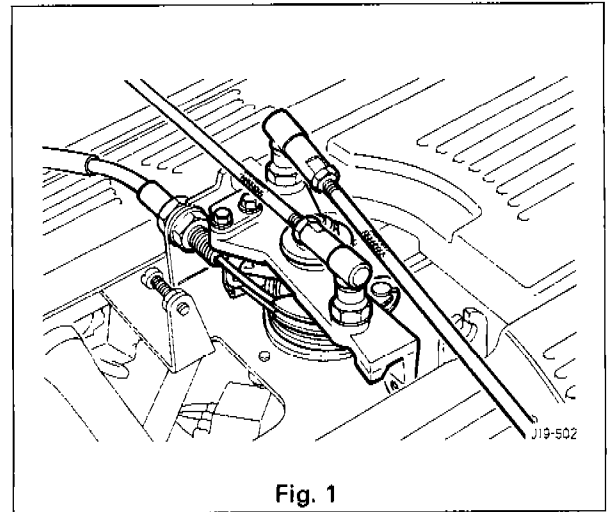
Note: To release, turn the fastener a quarter of a turn.

- Remove and discard the engine cover.
- Remove the turn-fastener receptacles from the fuel rail and discard the receptacles.
- Fit new turn-fastener receptacles to the fuel rail.
- Place the engine cover in position and fit the turn-fasteners.

Note: To fit, press the fastener into position with firm thumb pressure.

- Position the throttle outer cable on the throttle bracket and tighten the cable outer locknut.

Note: If this procedure is followed, the original throttle setting is maintained.





4.11 Cylinder Head Gasket, Renew

SRO 12.29.02 – LEFT-HAND

SRO 12.29.03 – RIGHT-HAND

Drain the cooling system, see Section 4.2 and depressurize the fuel system, see Section 5.2 (these sections are in the appropriate Vehicle Service Manual). Disconnect the exhaust system with the vehicle supported on axle stands. Remove components as required for access to the cylinder head and proceed as follows.

- Remove the sprocket from the camshaft, see Section 4.12.
- Remove the front cover securing nuts.
- Release the cylinder head retaining nuts, $\frac{7}{16}$ in. domed and $\frac{3}{8}$ in., and remove the cylinder head – assistance may be required.

Note: During the cylinder head removal, reposition the camshaft oil feed pipe for access.

Note: Always support the cylinder head on blocks of wood. This will prevent damage to the valves which, when open, protrude below the cylinder head face.

- Remove and discard the cylinder head gasket.
- Fit cylinder sleeve retainers, Service Tool JD 41 (Fig. 1).
- Remove the breather housing to cylinder head gasket and water rail to cylinder head gaskets.

Note: Clean all jointing faces. Always fit new gaskets and seals on assembly.

- Check that the other camshaft is still at TDC using Service Tool C 3933 (Fig. 2).
- Remove the cylinder sleeve retainers Special Tool JD 41, (Fig. 1).
- Fit and align the new cylinder head gasket.
- Fit and align the cylinder head ensuring that no pipes, cables or harnesses are trapped – assistance may be required.
- Fit and tighten the cylinder head securing nuts with reference to the sequence shown in Fig. 3. See Service Data in the Preliminary Pages for the correct torque figures.

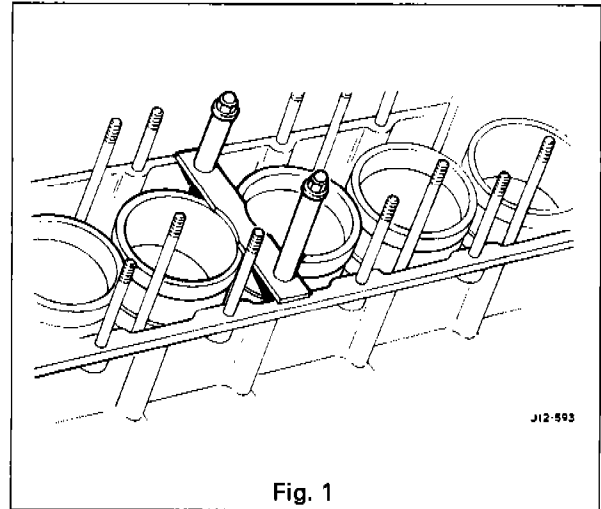


Fig. 1

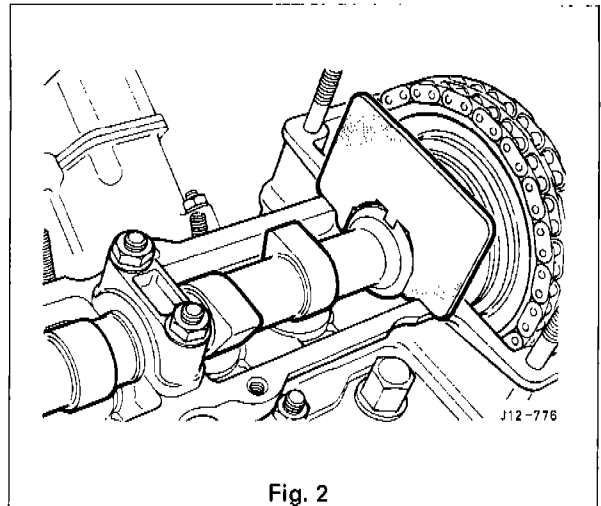


Fig. 2

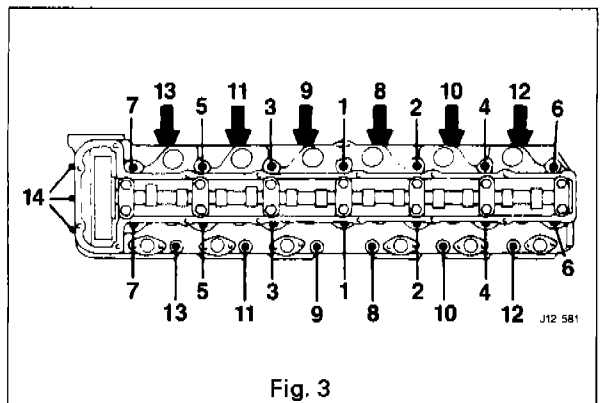
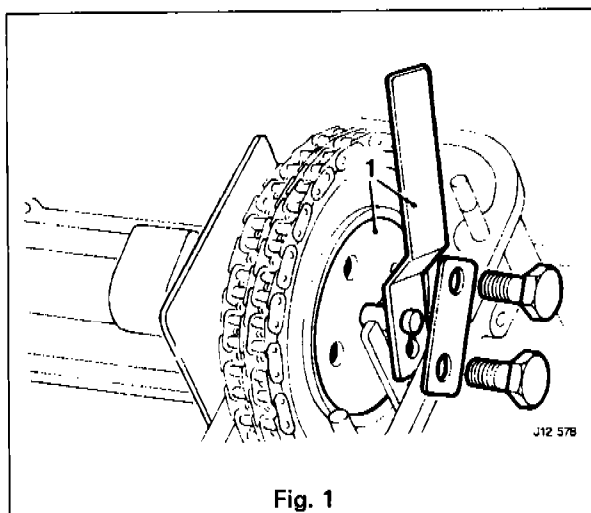


Fig. 3



- Fit and tighten the cylinder head to front cover securing nuts.
- Remove the sprocket retaining tool – Service Tool JD 40 (1 Fig. 1).
- Refit the sprocket to the camshaft, see Section 4.12.
- Check, and if necessary adjust, the valve clearances, see Section 4.3.
- Refit the rubber grommet to the front cover.

Replace the components removed for access and reconnect the exhaust system with the vehicle supported on axle stands. Fill the system with coolant, see Section 4.2 in the appropriate Vehicle Service Manual.

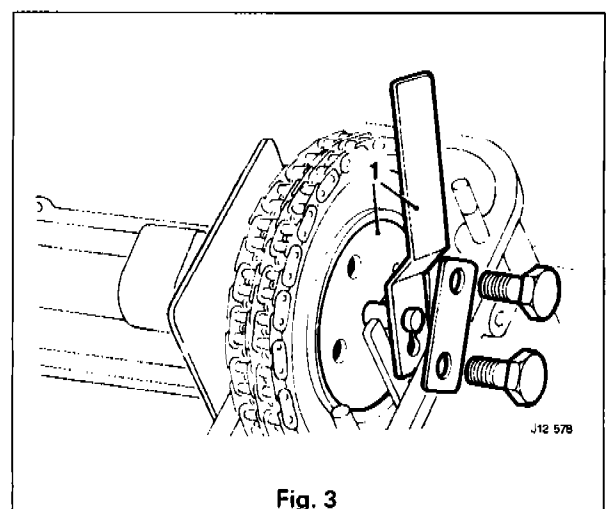
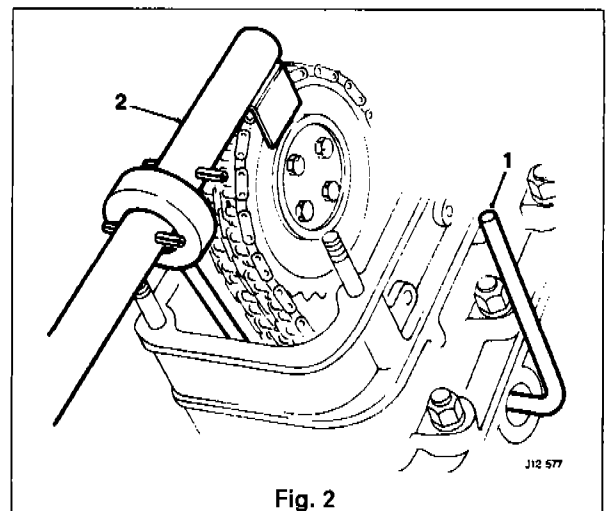
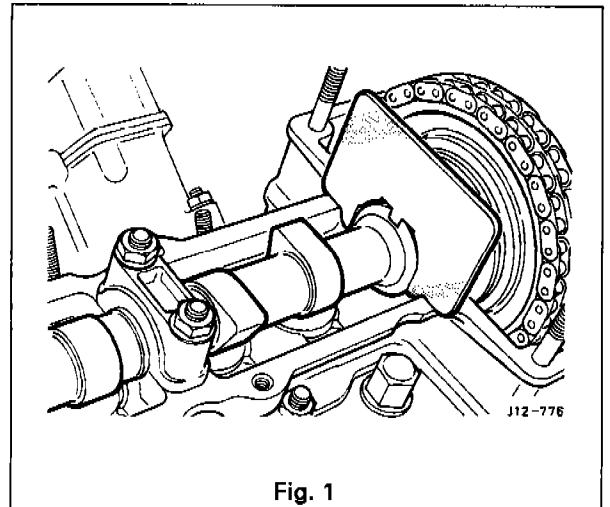




4.12 Camshaft Sprocket, Renew

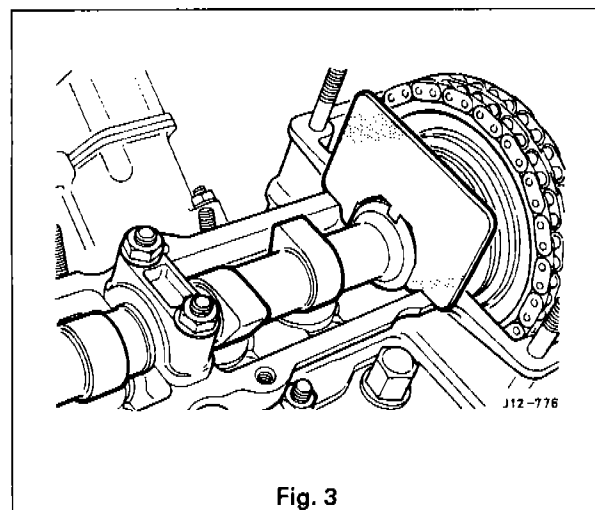
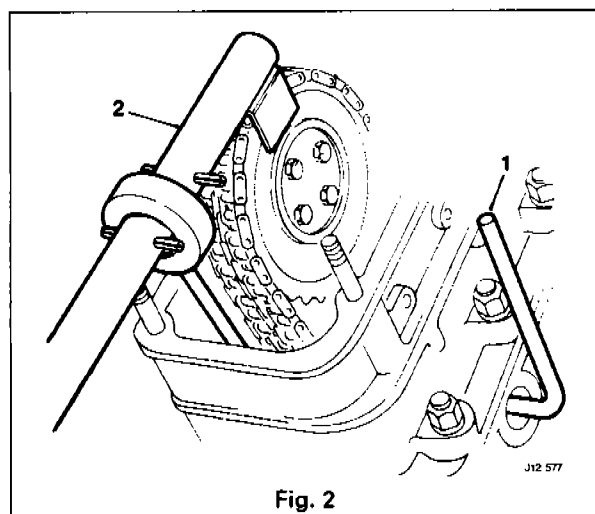
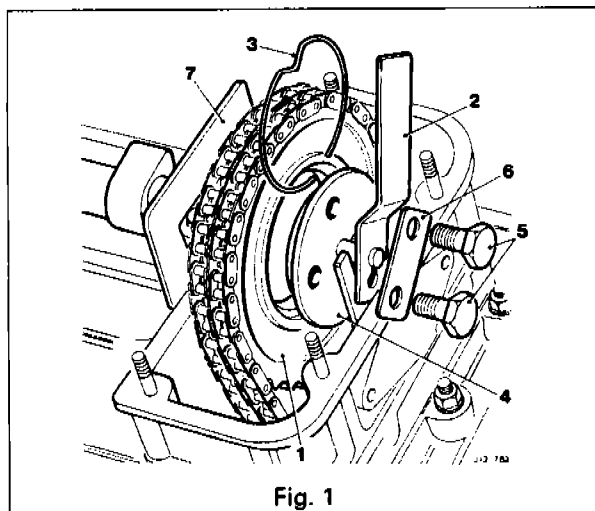
- Rotate the crankshaft until the required camshaft is 180° from TDC, and remove two camshaft securing bolts (ensure that neither the bolts nor the tab washer drop into the timing case).
- Rotate the crankshaft until the camshaft is at TDC and align using Service Tool C3993 (Timing Gauge) (Fig. 1).
- Slacken but do NOT remove, the two remaining bolts.
- Remove the rubber grommet from the right-hand front of the timing cover, insert Service Tool JD 50 (1 Fig. 2), and release the locking catch on the timing chain tensioner.
- Fit Service Tool JD 50 (Chain Tension Retainer) (2 Fig. 2) to the right-hand camshaft, and retract the timing chain tensioner until the locking catch is engaged.
- Remove Service Tools JD 50.
- Remove the remaining two left-hand camshaft sprocket bolts and fit Service Tool JD 40 (1 Fig. 3) to secure the sprocket to the retainer plate.

CAUTION: Do not rotate the engine while the camshaft is disconnected.





- Engage the camshaft sprocket (1 Fig. 1) to the camshaft.
- Release the chain tension by fitting Service Tool JD 50 (chain tension retainer) (2 Fig. 2), raising the timing chain tensioner slightly, and then inserting Service Tool JD 50 (Release Tool) (1 Fig. 2) through the timing cover and releasing the locking catch which allows the tensioner to expand.
- Remove both Service Tools.
- Check that the camshaft is still at TDC using Service Tool C 3933 (Fig. 3).
- Remove the snap-ring (3 Fig. 1).
- Reposition the coupling (4 Fig. 1) to align the retaining holes, and refit the snap-ring (3 Fig. 1).
- Fit but do not fully tighten one retaining bolt (5 Fig. 1) and new tab washer (6 Fig. 1).
- Fit the second retaining bolt to the tab washer, and secure the two bolts.
- Remove the timing gauge, Service Tool C 3993 (Fig. 3).
- Rotate the engine and fit the remaining sprocket retaining bolts and new tab washer.
- Lock over all the tabs.
- Re-check the camshaft timing, using Service Tool C 3993 (Fig. 3).





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