



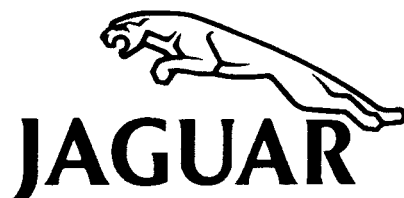
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JAGUAR CARS LIMITED COVENTRY



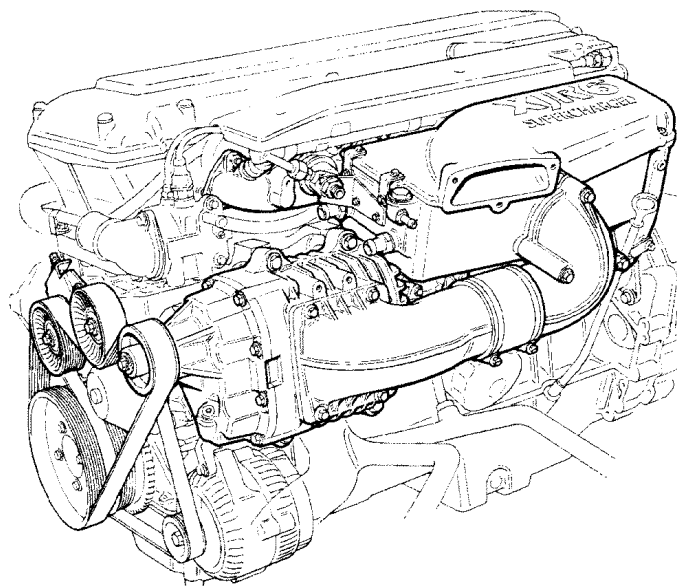
BY APPOINTMENT TO
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HIS ROYAL HIGHNESS THE PRINCE OF WALES
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AJ16 Engine Range Service Manual



Published by Product Development & Publications
Jaguar Cars Limited

Part of set - JJM 1004 12/ 50



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FOREWORD

This Service Manual has been designed to enable the skilled Jaguartechnician to correctly service and repair the range of Jaguar AJ16 in-line six-cylinder engines.

It assumes that the engine has been removed from the vehicle, in accordance with the Vehicle Service Manual, and is in a clean condition and all service tools and materials are available.

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



I. SERVICE TOOLS & EQUIPMENT

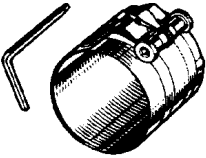
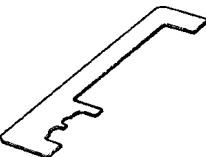
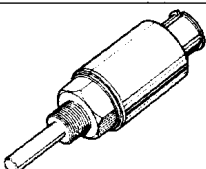
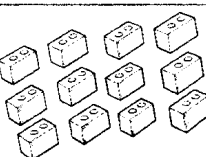
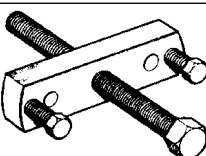
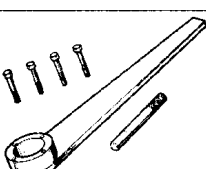
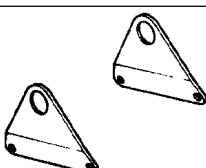
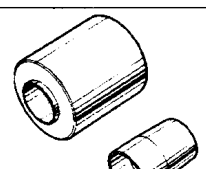
Illustration	Jaguar Number	Description	Notes
	18G 55A	Piston ring compressor	
	18G 1433	Camshaft timing tool	
	18G 1434	Jackshaft bushing remover / replacer	
	18G 1435	Camshaft dummy caps	
	18G 1436/A	Crank pulley remover and timing damper oil pressure simulator	
 not illustrated	18G 1431	Front pulley lock	
	18G 1437-1	Adapter	
	18G 1465	Engine lifting bracket	
	18G 1469	Auxiliary drive shaft seal replacer	



Illustration	Jaguar Number	Description	Notes
	JD 118	Auxiliary drive shaft seal remover	
	JD 128	Crank front seal remover	
	JD 129	Crank front seal replacer	
	JD 130	Chain link remover / replacer	
	JD 550-3	Crank rear seal replacer adapter	
	JD 6118C	Valve spring compressor	
	MS 53C	Engine support beam	
	MS 1519A	Valve spring compressor	



Illustration	Jaguar Number	Description	Notes
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	MS 1520-2	Adapter assembly for MS 1520	
not illustrated	YA 992	'Snap-On' Oil filter canister removal tool	

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Fixing	Tightening Torque (Nm)
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Fixing	Tightening Torque (Nm)
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Fixing	Tightening Torque (Nm)
Timing Cover	
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Generator adjuster to timing cover	8,5 - 11,5
Intermediate shaft blanking plate to timing cover	21,5 - 28,5
Sensor to timing cover	21,5 - 28,5
Timing cover to cylinder block	21,5 - 28,5



111. SERVICE MATERIALS

Description	Uses	Notes
Hylosil 102 sealant	Oil pick-up strainer to transfer housing	
	Thermostat housing to extension	
	Thermostat outer housing to inner housing	
	Timing cover to cylinder block	
Loctite 501 sealant	Transmission adapter to cylinder block	
	Oil pump drive-plate bolt	
	Oil pump front cover to body	
Loctite 542 sealant	Oil pump rear cover to body	
Loctite 573 sealant	Oil filter threaded insert to housing	
Tivoli Kay Adhesives No. 5696 sealant	Oil pump transfer housing to cylinder block	
	Exhaust system joints	



IV. SERVICE DATA

Engine Data

Application	Item	Specification
General	Number of cylinders	6
	Bore	91 mm
	Stroke	3,2 liter: 83 mm
		4,0 liter: 102 mm
	Cubic capacity	3.2 liter: 3239 cm³
		4.0 liter: 3980 cm³
	Compression ratio	3.2 liter: 10:1
4,0 liter: 10:1 (normally aspirated)		
4,0 liter: 8,5:1 (supercharged)		
Firing order	1,5,3,6,2,4 (No. 1 cylinder at crankshaft pulley end)	
Ignition timing		Fully mapped Lucas engine management system with digital ignition
Valve clearance	Intake and exhaust	0,30 to 0,36 mm
		Type Champion RC9YCC (except North America, normally aspirated engines) Champion RC12YCC (North America, for normally aspirated engines only)
	Gap	0,9 mm
On-plug ignition coil	Type	Diamond
	Number per vehicle	6
	Primary winding resistance	0,75 ohm
	Current consumption	0 to 6 A
Engine position sensor	Rotation	Clockwise (viewed from above)
	Firing order	1,5,3,6,2,4 (No. 1 cylinder at crankshaft pulley 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, normal operating temperature and with catalytic converter fitted)	0,5% CO maximum. For Swiss market only: 0,02% CO maximum, 70 ppm HC maximum
Idle speed (engine at normal operating temperature)	Manual transmission	700 RPM
	Automatic transmission	700 RPM (gear selector in neutral)
Compression pressure	Cylinder pressure	11,0 to 11,7 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	0,7 bar (maximum)
Cylinder block	Material	Aluminum alloy



Application	Item	Specification
Cylinder block bore diameter after honing	For piston grade F	90,990 to 90,998 mm
	For piston grade G	90,999 to 91,007 mm
	For piston grade H	91,008 to 91,016 mm
	+0.020 in.	91,513 to 91,526 mm
Cylinder head	Material	Aluminum alloy
Crankshaft	Material	3,2 liter: cast iron
		4,0 liter: forged steel
	Number of main bearings	7
	Main bearing type	Vandervell VP2C
	Journal diameter	Pink 76,210 to 76,220 mm
		White: 76.220 to 76,230 mm
		Green: 76,230 to 76,240 mm
	Thrust washer thickness	2,57 to 2,62 mm
	Permissible end float	0,10 to 0,28 mm
	Balancing	To within 15 gm cm (imbalance to be corrected by drilling up to four holes in each balance weight 95 mm diameter x 29 mm deep maximum)
	Diametrical clearance	-----
Crankpin diameter	-----	
	Blue: 52,990 to 53,000 mm	
Connecting rod	Length between centers	3,2 liter: 175,185 to 175,285 mm
		4,0 liter: 166,320 to 166,420 mm
	Bore for connecting rod bearing	56,731 mm
	Connecting rod bearing diametrical clearance	0,023 to 0,059 mm
	Connecting rod bearing side clearance	0,132 to 0,233 mm
Bore for small end bushing	26,975 to 27,000 mm	
Piston	Type	AE413P/PD (BS 1490-1988-LM13TF) phosphorus treated
	Skirt clearance	0,01 to 0,026 mm
Piston diameter	Grade F	90,972 to 90,980 mm
	Grade G	90,980 to 90,989 mm
	Grade H	90,990 to 90,998 mm
	+0.020 in.	91,480 to 91,506 mm
Piston ring	Number of compression rings	2
	Number of oil control rings	1
	Gap when fitted in bore	Top compression ring: 0,40 to 0,65 mm
		Second compression ring: 0,40 to 0,65 mm
Oil control ring: 0.30 to 0,55 mm		



Application	Item	Specification
Piston pin	Type	Chamfer locking
	Length	32 liter: 68,37 to 68,50 mm 4,0 liter: 77,12 to 77,25 mm
	Outside diameter	23,807 to 23,812 mm
	Inside diameter	14,30 to 14,81 mm
Camshaft	Material	Cast iron
	Number of journals	7
	Nominal lift	9,95 mm
	Permissible end float	0,13 mm
Valve		
	Valve stem diameter	Intake and exhaust: 6,947 to 6,960 mm
	Valve clearance	Intake and exhaust: 0,30 to 0,36 mm
Adjustment of valve clearance		
Valve Guide		mm
	Outside diameter	Standard - no groove: 10,993 to 11,005 mm 1st oversize - 1 groove: 11,043 to 11,055 mm (production only) 2nd oversize - 2 grooves: 11,143 to 11,155 mm 3rd oversize - 3 grooves: 11,293 to 11,305 mm
	Valve guide bore concentricity with	Within 0,025 mm (i.e. total indicator reading of 0,050 mm)
	Valve seat	44,50 to 44,75 degrees
	Clearance between valve stem and cam heel	6,80 to 7,11 mm (plus the valve clearance)
Valve seat insert outside diameter		Intake: 36,388 to 36,404 mm Exhaust: 32,868 to 32,884 mm
		Intake: 36,769 to 36,785 mm
Lappet		33,34 to 33,35 mm
	Diametrical clearance	0,02 to 0,05 mm
Valve spring	Free length	43,5 mm
Camshaft sprocket	Number of teeth	30
Crankshaft sprocket Intermediate sprocket		
		Outer: 20



Application	Item	Specification
Primary timing chain	Type	Endless duplex
	Number of pitches	80
	Pitch	9,525mm
	Roller diameter	6,35 mm
Secondary timing chain	Type	Endless duplex
	Number of pitches	86
	Pitch	9,525mm
	Roller diameter	6,35 mm
Oil pump chain	Type	Endless simplex
	Number of pitches	52
	Pitch	19,525mm
	Roller diameter	6,35 mm
	Deflection (at mid-point of free side)	2 to 4 mm (with a load of 50 N)
Oil filter	Type	Full flow disposable canister
Oil pressure (engine at normal operating temperature)	At idle speed	0,5bar (minimum)
	At 4000 RPM	4,83 bar (minimum)
Oil pump	Type	Rotor
	Rotor end float	0,1 mm
	Rotor lobe clearance	0,2 mm
Oil pressure relief valve	Sprocket shim sizes	0.005, 0.010 and 0.020 in.
	Outside diameter	17,95 to 17,98 mm
	Inside diameter	14,50 to 15,00 mm
	Overall length	35 mm
	Working length	30 mm
	Mandrel length	57 mm
	Mandrel diameter	11,11 mm
	Spring diameter	14,00 mm (mean)
	Spring: number of coils	26

Drive Belt Tensions

Application	Specification
Generator/ water pump drive belt (normally aspirated engines)	Burroughs method: new belt 556 to 578 N. Run for one minute, allow belt to cool and reset to the in-service setting. In service if tension falls below 356 N, reset at 511 to 534 N
	Clavis method: new belt 174 to 180 Hz. Run for one minute, allow belt to cool and reset to the in-service setting. In service if tension falls below 140 Hz, reset at 167 to 173 Hz. (Measuring point: mid-way between crankshaft and generator pulleys)
Generator/ water pump drive belt (4.0liter supercharged engine)	Burroughs method: new belt 560 to 600 N. Run for one minute, allow belt to cool and reset to the in-service setting. In service if tension falls below 335 N, reset at 405 to 445 N
	Clavis method: new belt 180 to 186 Hz. Run for one minute, allow belt to cool and reset to the in-service setting. In service if tension falls below 131 Hz, reset at 155 to 161 Hz. (Measuring point: mid-way between crankshaft and generator pulleys)



Application	Specification
Air conditioning compressor drive belt	<p>Burroughs method: new belt 556 to 578 N (no retensioning required). In service if tension falls below 245 N, reset at 378 to 400 N</p> <p>Clavis method: new belt 167 to 173 Hz (no retensioning required). In service if tension falls below 85 Hz, reset at 127 to 133 Hz. (Measuring point: mid-way between crankshaft and compressor pulleys)</p>
Supercharger drive belt	<p>Burroughs method: new belt 993 to 1033 N. Drive the vehicle for 10 minutes, allow the belt to cool to ambient (approximately one hour) and reset to the in-service setting. In service at 16000 kilometer (10000 mile) intervals, reset at 835 to 875 N with the belt cold. Renew belt at 48000 kilometer (30000 mile) intervals</p> <p>Clavis method: new belt 119 to 121 Hz. Drive the vehicle for 10 minutes, allow the belt to cool to ambient (approximately one hour) and reset to the in-service setting. In service at 16000 kilometer (10000 mile) intervals, reset at 111 to 113 Hz with the belt cold. Renew belt at 48000 kilometer (30000 mile) intervals. (Measuring point mid-way between crankshaft and supercharger pulleys)</p>





1. GENERAL DESCRIPTION

The engine is available as a 3,2 and 4,0 liter unit. A 4,0 liter supercharged version is also available. Fuel is supplied to each cylinder via an injector fed from a regulated fuel rail. 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 electrically operated 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 cast aluminum alloy with shrink fit dry cast iron cylinder sleeves.

The crankshaft is manufactured from cast iron for the 3,2 liter engine, forged steel for the 4,0 liter engine and is nitro-carburized to give a very high quality finish on the bearing surfaces and increase the life of the journals.

The crankshaft is supported by seven iron bearing caps having bearings, which are lead bronze on split steel backed shells with a lead indium overlay.

Crankshaft end-float is controlled by half thrust washers fitted on each side of the center main bearing journal. The connecting rods are manufactured from carbon manganese steel, forged in an 'H' section. The small end bushes are lead bronze with steel backing, machined to size after being pressed into the connecting rods. The connecting rod bearings are of a lead bronze alloy on split steel backed shells and with lead indium overlay.

The pistons are of monometal construction (aluminum) and have a spring assisted micro-land oil control ring situated below a barrel-faced internally tapered chrome plated compression ring and an externally stepped taper-faced secondary ring.

The pistons run on hardened steel piston pins offset from the center line of the piston towards the thrust face.

The cylinder head is cast from aluminum alloy with pent-roof shaped combustion chambers with cross-flow valve porting. Running directly in the cylinder head are two cast iron camshafts retained by machined aluminum caps. Each camshaft uses chilled cams to drive two valves per cylinder via chilled cast iron bucket tappets with shim adjustment. Control of each of the four valves per cylinder is maintained by single valve springs.

The camshafts are operated by a two stage 'duplex' chain drive from the crankshaft. Each stage is controlled by a hydraulic tensioner operating through a pivoted rubber-faced curved tensioner blade. The first stage incorporates a three point drive via the crankshaft, intermediate shaft and auxiliary shaft. The intermediate shaft is live and provides a 0.75 x crank speed drive through the timing cover. This drive access is blanked off. The 'live' auxiliary shaft is driven at crankshaft speed and is situated on the right hand side of the engine (looking from rear). In addition to driving the engine position sensor via a set of 2 : 1 reduction spiral gears, it provides an external drive for the power assisted steering pump at the rear. The second stage is a three point drive via the intermediate shaft and two camshafts. The 2:1 reduction ratio from crank speed is achieved by the combined ratio of the intermediate and camshaft sprockets sizes.

The oil pump is a rotor-type mounted on the underside of the front of the crankcase and driven by a 'simplex' chain from the crankshaft nose. The pump incorporates a built-in pressure relief valve. Below the line of the crankcase, but above the oil pan oil level are two windage trays; these prevent oil being sucked up and thrown into the crankcase thereby alleviating windage and power losses through oil surge.

At the rear of the crankshaft is a new design of lip-type PTFE oil seal which provides a high degree of oil retention. It also allows the use of higher engine speeds and easier serviceability.

1.2 Cylinder Head Design

The four valves per cylinder are smaller in diameter than on a conventional two valve per cylinder engine and have a greater combined effective area. They are also lighter and apply less stress to the operating gear. The design increases the power at high engine speeds and allows an efficient combustion of the fuel. It also allows the spark plug to be situated in its ideal central position which creates efficient combustion and consequently enhances fuel economy.

1.3 Crankcase Breather

Blow-by gases are recycled via the air intake system to maintain a crankcase depression and so prevent their escape to the atmosphere. A baffled vent from the camshaft cover is used for both full and part load breathing. For full load breathing, a connection is made direct to the clean side of the air filter upstream of the throttle disc. Part load breathing is provided by a spur off the full load pipe to downstream of the throttle disc via the water heated restrictor. In this way, a crankcase depression is maintained at all throttle settings.

1.4 Lubrication System

Oil is drawn from the oil pan via a gauze filter. Pressurized oil, having been regulated by a relief valve, is then fed via internal galleries on the left hand side of the cylinder block. Pressurized and filtered oil is fed into the main oil gallery, the seven main bearings are fed and thence via crankshaft drillings to the connecting rod bearings. The intermediate shaft, auxiliary shaft and camshaft bearings are pressure lubricated by means of internal drillings directly fed from the front of the main oil gallery. For some markets an oil cooler is fitted to vehicles with 4,0 liter supercharged engines.



1.5 Cooling System

The engine is liquid cooled by a mixture of water and anti-freeze circulating around the coolant passages. The coolant pump is mounted on the left hand side of the cylinder block and is driven from the crankshaft nose by a three point belt drive (which includes the generator). The pump is a fully assembled bolt-on unit. The coolant is fed into the cylinder block at two places via an external delivery pipe. The coolant is drawn from the cylinder head via a self-contained thermostat housing back to the radiator or recirculated according to the thermostat position.

7.6 Supercharger

The supercharger optionally available on the 4.0 liter engine is a Rootsblower type which gives better engine efficiency at part throttle conditions and responsive off-boost performance. The principal changes to the engine for the supercharged version are to the piston, valve timing, intake manifold and the additional drive to the supercharger. A lower compression ratio of 8.5:1 is used which provides the optimum balance between high speed performance and fuel economy.

The engine heat exchanger of the intercooler system is incorporated into the intake manifold. The blower incorporates an air by-pass system which improves efficiency under part throttle conditions. The by-pass valve is controlled by a vacuum actuator referenced to the intake manifold pressure.

2. SERVICE PROCEDURES

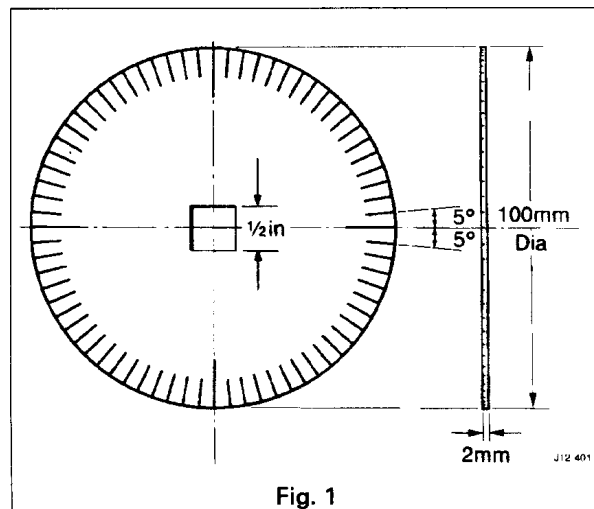
2.1 SPS Joint Control System

A feature of the engine is the use of the SPS joint control system on the cylinder head bolts, crankshaft main bearing bolts and connecting rod bearing nuts and bolts. This system ensures that the joints receive maximum clamp loading for a given fixing size and type of material by tightening the fixing to its particular yield point. This greatly helps to prevent premature cylinder head gasket failures.

CAUTION: All SPS fixings must be used only once. Discard fixings on removal and replace with new bolts/nuts every time a 'strip down' has been carried out.

Note: The SPS system in service requires the fixing to be set to a specific torque initially; it must then be rotated through 90 degrees exactly. The accuracy of this cannot be too high stressed. To obtain the correct setting, use Special Tool LST 122, or a self-manufactured tool using the dimensions illustrated (Fig. 1).

Note: See Torque Tightening Specifications in the Preliminary Pages for the correct torque figures.



2.2 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 any acid toxy cure system be used. Loctite sealants are 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 the faults relating to the engine which are most likely to be encountered. Reference is made to the Electrical Diagnostic Manual (EDM), which should be consulted where necessary. Faults related to the cooling system are dealt with in Section 4.1 and to the fuel system in Section 5.1 in the appropriate Vehicle Service Manual (VSM).

3.2 Diagnostic Procedures

Symptom	Possible Cause	Check	Remedy
Engine does not start (fails to rotate)	Battery leads loose or terminals corroded	Check the condition of the 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	If the lights dim when ignition switch is operated, the starter may be jammed in starter ring. Check for loose and dirty connections to the starter motor	Remove starter motor, free off pinion and refit Clean and tighten connections
Engine rotates but will not fire	Starter motor speed too low	Check battery leads and terminals Check state of battery charge	Clean and tighten terminals Charge or renew battery as necessary
	Faulty ignition system	Refer to EDM Remove the spark plugs	Rectify as required Clean and re-gap the spark plugs, renew if worn out
	Fuel system defect		Refer to Fuel System fault finding in Section 5.1, VSM
Overheating			Refer to Section 4.1, VSM
Overheating at tick-over			Refer to Section 4.1, VSM
Too cold			Refer to Section 4.1, VSM
Loss of coolant			Refer to Section 4.1, VSM
Insufficient oil pressure	Oil requires changing	Check oil level and color	Change oil and filter
	Worn crankshaft journals	Listen for rumble or knock	Renew crankshaft
	Excessive crankshaft endfloat	Fit dial gauge and measure	Renew thrust washers
	Worn main bearing shells	Listen for rumble	Check crankshaft journals for wear and renew shells
	Worn oil pump	Remove oil pump and check the clearances	Renew oil pump
	Oil pressure relief valve sticking open	Remove valve and check for sticking	Renew valve
	Oil pressure relief valve spring too weak	Remove spring and check spring rates	Renew spring
	Insufficient oil in oil pan	Check oil level	Top-up as required
	Engine overheating		Refer to Overheating fault finding in Section 4.1, VSM
	Faulty gauge or sensor	Refer to EDM	Rectify as required
Incorrect grade oil (viscosity too low)	Check oil viscosity	Renew oil and filter	
Water in oil	Check oil level and check if oil is a milky white color Check for leaking head gasket	Renew oil and filter Renew head gasket	



Symptom	Possible Cause	Check	Remedy
Insufficient oil pressure (continued)	Cracked oil pump housing	Remove oil pan and visually check	Renew the pump
	Blocked oil pick-up pipe strainer	Remove oil pan and visually check	Remove oil pick-up pipe and clean strainer
	Oil pump pipe 'O' rings	Remove oil pan and pipes and check	Fit new 'O' rings
	Main oil gallery seals leaking or gallery blocked	Eliminate other possible causes	Fit new 'O' rings or clear oil gallery
Oil pressure too high	Relief valve stuck shut	Remove valve and check for sticking	Clean or renew the valve
	Wrong pressure relief valve	Remove spring and check the rate	Renew spring
	Incorrect grade engine oil (viscosity too high)	Check oil viscosity	Renew oil and filter
	Gauge or sensor fault	Refer to EDM	Rectify as required
	Engine temperature too low		Refer to Too Cold fault finding in Section 4.1, VSM
Burning oil	Worn cylinder bores	Check wear with a comparator	Rebore cylinders as necessary
	Worn valve guides	Insert valve in guide and check side movement	Renew valve guides as necessary
	Worn intake valve 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 leaking	Check for blue smoke from exhaust	Renew head gasket
	Incorrect grade of engine oil	Check oil viscosity	Renew oil and filter
Leaking oil (leaking)	Worn front oil seal	Wipe clean, run engine and visually check	Renew seal
	Worn rear oil seal	Wipe bell housing clean, run engine and visually inspect for cleanliness	Renew seal
	Leaking gaskets	Visual check	Renew gasket
	Cylinder block cracked	Visual check	Renew cylinder block
Excessive noise from valve gear	Excessive valve clearance	Check valve clearances	Adjust valve clearances
	Broken valve spring(s)	Remove valves and check springs	Renew as necessary
	Broken valve guide	Remove valves and check guides	Renew as necessary
	Broken valve seat insert	Remove valves and check 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 and for lack of lubrication	Adjust valve clearances. Refer to Insufficient Oil Pressure fault finding
	Worn camshaft drive chains, tensioners	Remove front timing cover and check for wear	Renew as necessary



Symptom	Possible Cause	Check	Remedy
Loisy chains	Low oil pressure	Take reading from oil pressure gauge when engine is hot	Refer to Insufficient Oil Pressure fault finding
	Tensioners not released	Remove camshaft cover and check tension of chain (top chain). Remove timing cover to check bottom chain tension	Insert 3 mm Allen key and turn tensioner anti-clockwise, compress tensioner to release bottom chain
	Chains worn	Visually check / remove and check for wear	Renew as necessary
	Sprockets worn	Visual check	Renew as necessary
	Tensioner worn	Visual check	Renew as necessary
Detonation (knock pinking)	Ignition timing too far advanced	Refer to EDM	Rectify as required
	Head gasket leaking	Check engine oil level and check for contamination of oil Pressure test cooling system and check for contamination of coolant in header tank	Renew head gasket
	Fuel / air mixture too weak Engine running too hot	Refer to EDM	Rectify as required Refer to Overheating fault finding in Section 4.1, VSM
	Valve timing incorrect	Check valve timing	Adjust valve timing
	Incorrect grade fuel	If all other checks OK, this could be the cause	Drain fuel tank and refill with correct grade fuel
Loss of power	Burned valves	Check cylinder compressions	Remove cylinder head and renew valves
	Sticking valves	Check cylinder compressions	Remove cylinder head and renew valves / guides or springs
	Poor engine tune	Refer to EDM	Rectify as required
	Insufficient valve clearance	Check valve clearance	Adjust as necessary
	Fuel injection fault		Refer to Fuel System fault finding in Section 5.1, VSM
	Low compression in cylinders	Check compressions	Rebore / re-ring as necessary
	Ignition fault	Refer to EDM	Rectify as required
	Valve timing incorrect	Check valve timing	Adjust valve timing
Partial seizure of engine	Remove spark plugs and rotate crankshaft	Overhaul engine as required	
Rough running at normal engine speed	Worn camshaft(s)	Remove camshaft(s) and check for wear	Renew camshaft(s)
	Incorrect grade fuel	If all other checks OK this could be the cause	Drain fuel tank and refill with correct grade fuel
	Sticking valves	Check cylinder compressions	Renew valve, springs or guides
	Broken valve springs	Check cylinder compressions and for bent valve stems	Renew valve springs and valves as required
	Piston fault	Check cylinder compressions	Renew pistons
	Leaking head gasket		Refer to Detonation Knock fault finding
	Valve burned out	Check cylinder compressions	Renew valve
	Valve seat burned out	Check cylinder compressions	Re-cut or renew valve seat
Ignition fault	Refer to EDM	Rectify as required	
Fuel injection fault		Refer to Fuel System fault finding in Section 5.1, VSM	



Symptom	Possible Cause	Check	Remedy
Rough running at normal engine speed (continued)	Air leaking into intake manifold	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 or manifold
	Leaking exhaust	Visual check	Repair leak or renew exhaust
Rough idle	Valve timing incorrect	Check valve timing	Adjust valve timing
	Incorrect ignition timing	Refer to EDM	Rectify as required
	Valve burned out	Check cylinder compressions	Renew valve
	Ignition fault	Refer to EDM	Rectify as required
Engine backfires	Fuel injection fault		Refer to Fuel System fault finding in Section 5.1, VSM
	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 and refer to EDM for analysis of exhaust gases	Remove the cylinder head and overhaul
	Ignition timing retarded	Refer to EDM	Rectify as required
	Incorrect valve timing	Check valve timing	Adjust valve timing
Engine spits back into air box	Valves not closing properly	Check valve clearances	Adjust valve clearances
	Excessively weak mixture	Check for wear or gum in valve guides	Renew guides or decarbonize the cylinder head
	Air leaking into intake manifold	Check for poor seating of valves	Overhaul the cylinder head
		Refer to EDM	Rectify as required
		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 intake tube or gasket
Engine fails to idle	Incorrect ignition timing	Refer to EDM	Rectify as required
	Valve clearances insufficient	Check clearances	Adjust clearances
	Cylinder head gasket leaking		Refer to Detonation Knock fault finding
	Blockage in exhaust system	Check for restrictions	Remove the restrictions or renew components as necessary



4. SERVICE OPERATIONS

4.1 Camshaft, Renew

SRO 12.13.01

- Remove camshaft cover, see Section 4.2.
- Drain the cooling system, see Section 4.1 in the appropriate Vehicle Service Manual.
- Rotate the engine and set No. 1 cylinder at TDC using Service Tool 18G 1433 (1 Fig. 1).
- Push back the lock tabs (1 Fig. 2) from the camshaft sprocket securing bolts (2 Fig. 2), and slacken off the bolts.
- Remove the upper chain tensioner valve clamp bolt (3 Fig. 2), remove the clamp (4 Fig. 2) and remove the valve (5 Fig. 2).
- Using a 3mm Allen key, wind back the tensioner (6 Fig. 2) (turn clockwise) until the snail engages in the park position. Remove the tensioner housing securing bolt (7 Fig. 2) and withdraw the tensioner assembly (8, 9 Fig. 2).
- Remove and discard the 'O' ring (9 Fig. 2) and gasket (10 Fig. 2).
- Remove the camshaft sprocket securing bolts and tab washers (1, 2 Fig. 2) and remove the sprockets (11 Fig. 2) (ensure that neither the bolts nor the tab washer drop into the timing case).

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

- Remove the cylinder head bolt from No. 2 cap, left-hand camshaft (1 Fig. 3).
- Remove No. 2 cap from the left-hand camshaft.
- Fit spacer tool 18G 1435 (2 Fig. 3) to the head.
- Fit and torque tighten the cylinder head bolt.
- Repeat the procedure for Nos 3, 4, 5 and 6 caps, left-hand camshaft (3 Fig. 3).
- Remove the cylinder head bolt from No. 7 cap, left-hand camshaft.
- Loosen in sequence the securing bolts from Nos 1 and 7 caps, until the left-hand camshaft is free. Lift the camshaft from the cylinder head and fit spacer tool 18G 1435 to No. 7 cylinder head bolt position (5 Fig. 3). Fit and torque tighten the bolt.
- Repeat the procedure for the right-hand camshaft.
- Clean all components and examine for wear and damage. Renew all worn or damaged components.
- Lubricate the new left-hand camshaft.
- Fit the camshaft at approximately TDC.
- Lubricate Nos 1 and 7 caps.
- Fit No. 1 cap but do not tighten the securing bolts. Remove No. 7 cap cylinder head bolt.
- Remove the spacer tool. Fit No. 7 cap but do not tighten the securing bolts.
- Finally tighten Nos 1 and 7 cap securing bolts in sequence. Remove No. 4 cap cylinder head bolt and remove the spacer tool. Lubricate and fit No. 4 cap.

CAUTION: The cylinder head bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

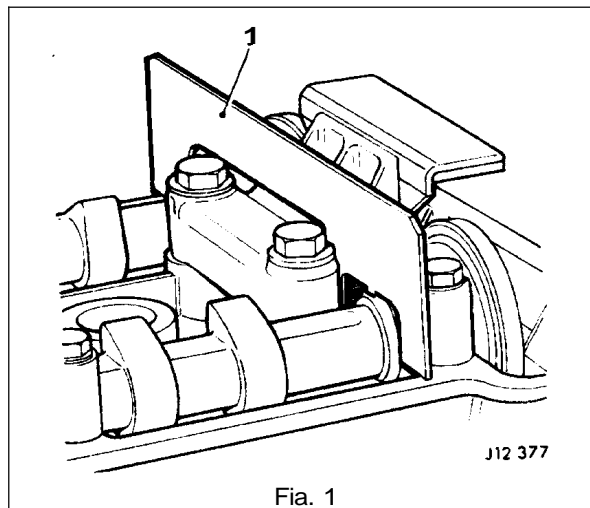


Fig. 1

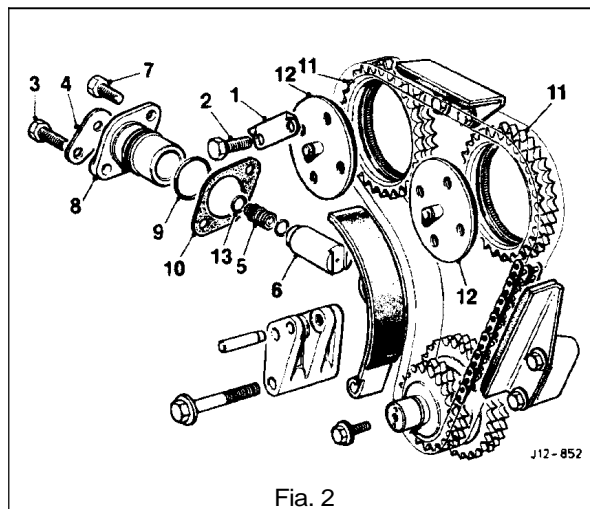


Fig. 2

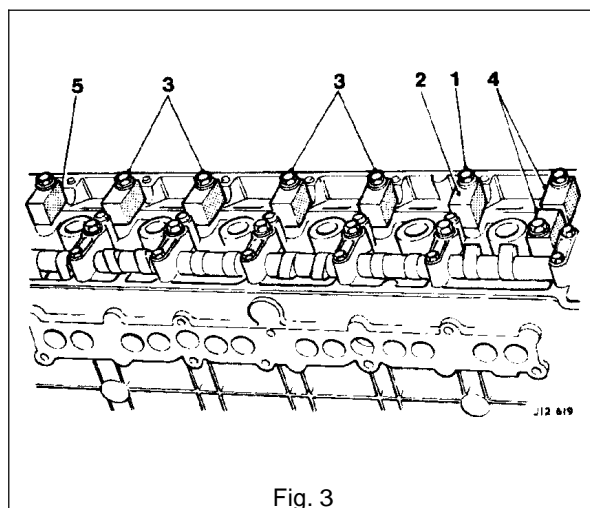


Fig. 3



- Fit and tighten No. 4 cap securing bolts.
- Fit and tighten No. 4 cap cylinder head bolt.

CAUTION: The cylinder head bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

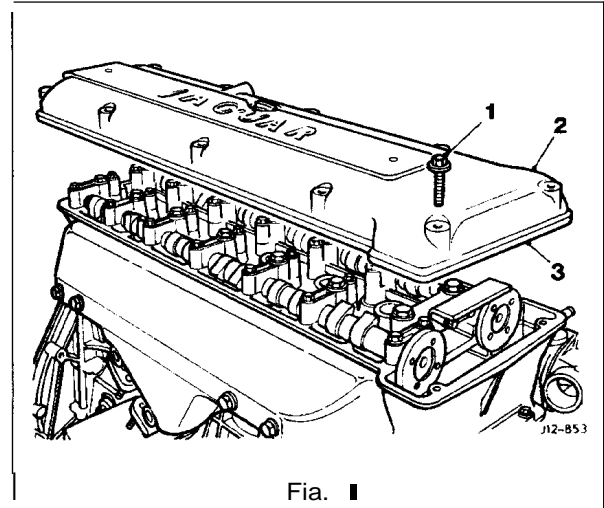
- Repeat the procedure for Nos 2, 3, 5 and 6 caps, left-hand camshaft.
- Set the left-hand camshaft to TDC.
- Repeat the procedure for the right-hand camshaft.
- Check and adjust valve clearances see Section 4.3.
- Refit the camshaft cover, see Section 4.2.



4.2 Camshaft Cover Gasket, Renew

SRO 12.29.39

- Remove the top cover and disconnect the on-plug coils from the spark plugs.
- Disconnect the camshaft cover breather hose.
- Remove the camshaft cover to cylinder head securing Screws (1 Fig.1), and remove the camshaft cover (2 Fig. 1).
- Remove and discard the camshaft cover gasket (3 Fig. 1).
- Clean the camshaft cover and cylinder head mating faces.
- Fit a new gasket to the camshaft cover.
- Refit the camshaft cover.
- Fit and tighten the camshaft cover securing screws.
- Reconnect the breather hose.
- Reconnect the on-plug coils to the spark plugs and fit the top cover.





4.3 Valve Clearance, Check and Adjust

SRO 12.29.48

- Remove camshaft cover, see Section 4.2.
- Rotate the engine as necessary to measure the valve clearances between the heel of the cam and the cam follower (Fig. 1). See Service Data in the Preliminary Pages for the correct valve clearances.
- Make a note of each clearance measurement.
- Should the clearances be incorrect, proceed as follows:
 - Rotate the engine and set No. 1 cylinder at TDC using Service Tool 18G 1433 (1 Fig. 2).
 - Push back the lock tabs (1 Fig. 3) from the camshaft sprocket securing bolts (2 Fig. 3).
 - Slacken off the bolts and tab washers.
 - Remove the upper chain tensioner valve clamp bolt (3 Fig. 3), remove the clamp (4 Fig. 3) and remove the valve (5 Fig. 3).
 - Using a 3 mm Allen key, wind back the tensioner (turn clockwise) until the snail engages in the park position.
 - Remove the tensioner housing securing bolt (7 Fig. 3) and remove the tensioner assembly (8, 9 Fig. 3).
 - Remove and discard the 'O' ring (9 Fig. 3) and gasket (10 Fig. 3).
 - Remove the camshaft sprocket securing bolts/tab washers (1, 2 Fig. 3) and remove the sprockets (11 Fig. 3).
 - Remove the cylinder head bolt from No. 2 cap, left-hand camshaft (1 Fig. 4).
 - Remove the cap securing bolts from No. 2 cap, left-hand camshaft.
 - Remove No. 2 cap from the left-hand camshaft.
 - Fit spacer tool 18G 1435 (2 Fig. 4) to the head.
 - Fit and torque tighten the cylinder head bolt.
 - Repeat the procedure for Nos 3, 4, 5 and 6 caps, left-hand camshaft (3 Fig. 4).
 - Remove the cylinder head bolt from No. 7 cap, left-hand camshaft.
 - Loosen in sequence the securing bolts from Nos 1 and 7 caps, until the left-hand camshaft is free. Lift the camshaft from the cylinder head and fit spacer tool 18G 1435 to No. 7 cylinder head bolt position (5 Fig. 4). Fit and torque tighten the bolt.
 - Repeat the procedure for the right-hand camshaft.

CAUTION: The cylinder head bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

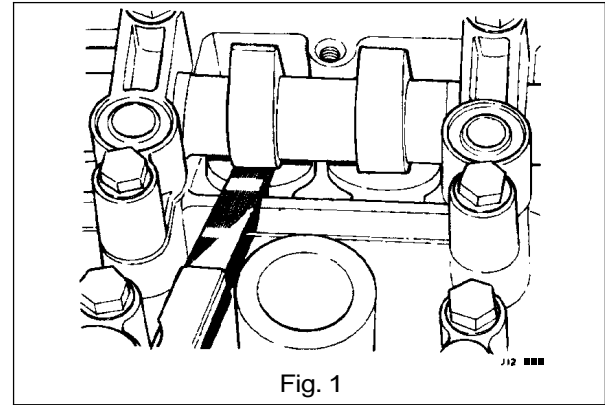


Fig. 1

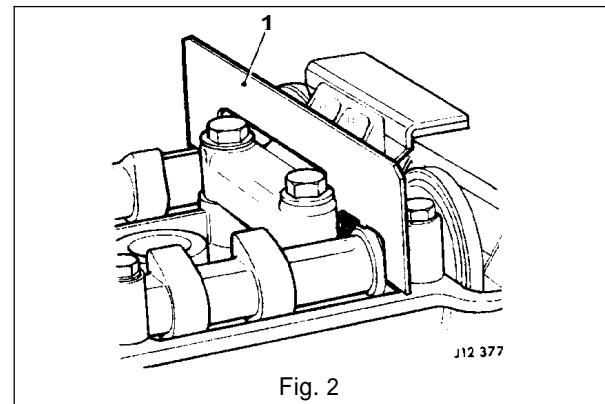


Fig. 2

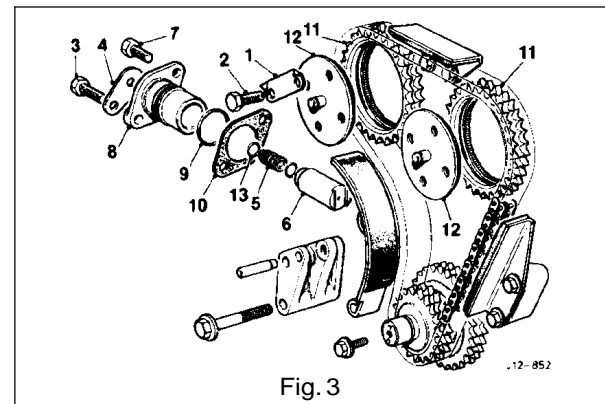


Fig. 3

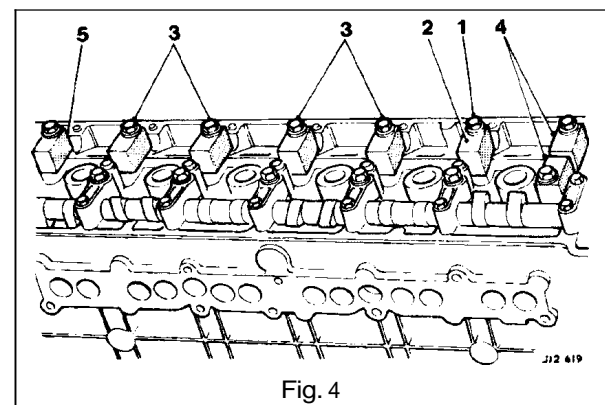


Fig. 4



- Move all the slack in the chain to the tensioner side.
- Fit upper chain tensioner tool 18G1436/A (2 Fig. 1). Fit and tighten the tool securing bolts (1 Fig. 1).
- Tension the cam chain.
- Remove the camshaft coupling (12 Fig. 2) from the sprocket (11 Fig. 2) and align the securing bolt holes. Fit the bolts (2 Fig. 2) and tab washers (1 Fig. 2), tighten the securing bolts and lock over the tabs.
- Repeat the procedure for the other sprocket.
- Slacken off the chain tensioner tool securing bolts (1 Fig. 1).
- Remove the tensioner tool.
- Clean the tensioner assembly and gasket faces.
- Fit a new housing gasket (10 Fig. 2). Fit and lubricate a new 'O' ring (9 Fig. 2).
- Fit the tensioner assembly (8, 9 Fig. 2) to the cylinder head. Fit and tighten the tensioner assembly securing bolt (3 Fig. 2).
- Fit but do not tighten the valve clamp bolt.
- Clean the valve assembly and fit new 'O' rings (13 Fig. 2). Lubricate the tensioner valve (5 Fig. 2). Using an Allen key, release the tensioner, by turning the Allen key anti-clockwise.
- Fit the tensioner valve (5 Fig. 2). Position the clamp (4 Fig. 2) over the valve.
- Tighten the clamp bolt (3 Fig. 2).
- Refit the camshaft cover, see Section 4.2.

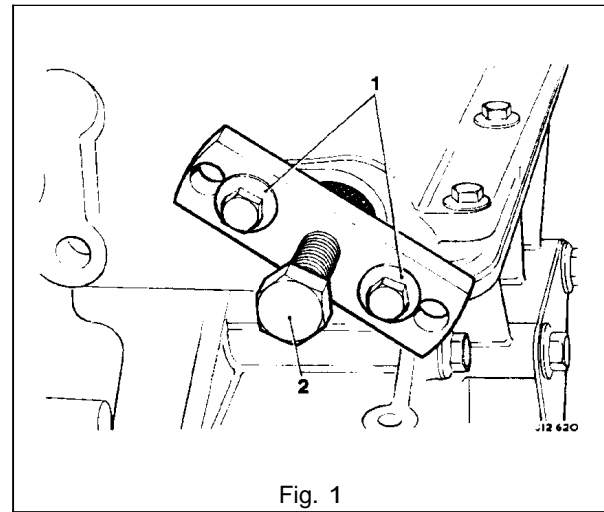


Fig. 1

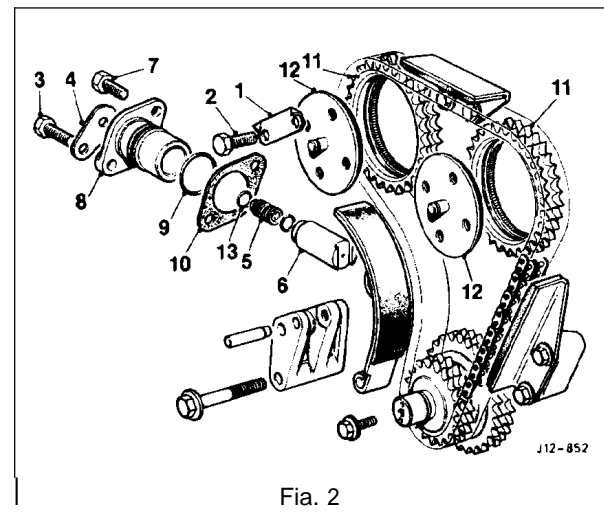


Fig. 2



4.4 Cylinder Head Gasket, Renew

SRO 12.29.01

Drain the cooling system, see Section 4.1 and depressurize the fuel system, see Section 5.1 (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.

- Rotate the engine to TDC No. 1 cylinder.
- Remove the camshaft cover, see Section 4.2.
- Push back the lock tabs and remove the camshaft sprocket securing bolts (2 Fig. 1). Remove the tab washers (1 Fig. 1).
- Remove the upper chain tensioner valve clamp bolt (1 Fig. 2), remove the clamp (2 Fig. 2) and remove the valve (3 Fig. 2).
- Using a 3 mm Allen key, wind back the tensioner (turn clockwise) until the snail engages in the park position.
- Remove the tensioner housing securing bolt (4 Fig. 2) and withdraw the tensioner assembly.
- Re-position the timing chain between the upper dampers.
- Fit an elastic band to retain the dampers and chain.
- Remove the cylinder head front securing bolts.
- Remove the remaining cylinder head securing bolts/nuts. Remove the upper static damper pedestal assembly and remove the cylinder head.
- Remove and discard the head gasket.
- Remove and discard the exhaust manifold sealing rings.
- Place the cylinder head on suitable blocks on a bench.
- Clean the cylinder head thoroughly and check the cylinder head and cylinder block for warping, bowing or cracks. Renew if defective.
- Fit a new cylinder head gasket.
- Fit the cylinder head assembly to the engine, ensure no hoses or cables are trapped.

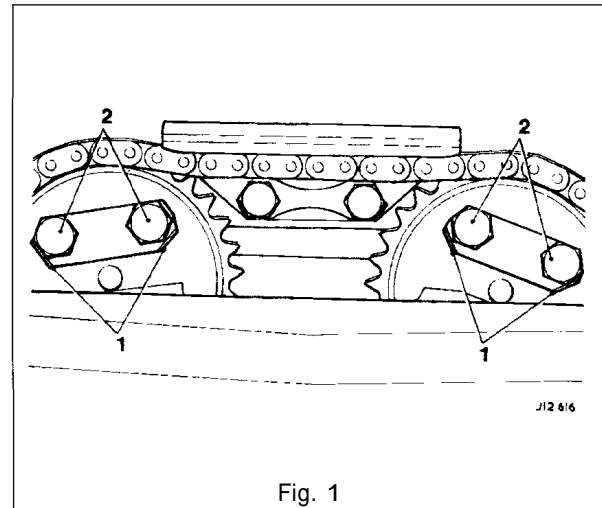


Fig. 1

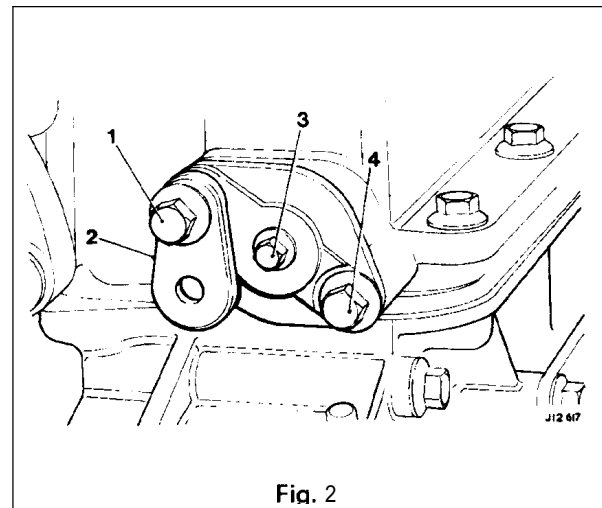


Fig. 2

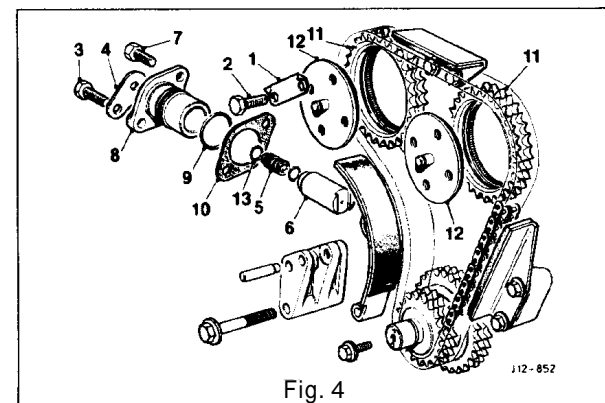
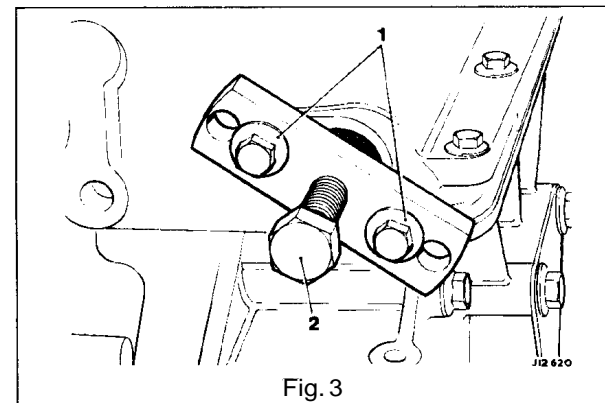
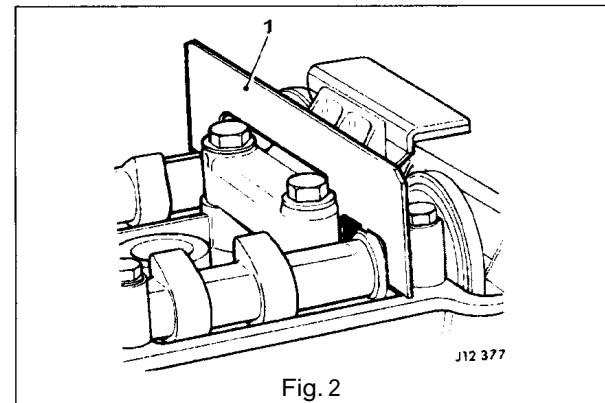
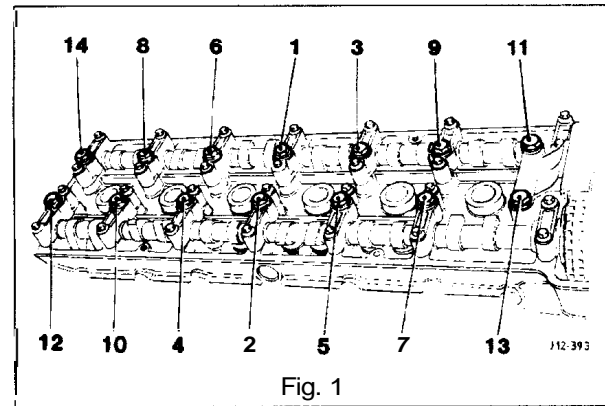


- Refit the upper static damper assembly.
- Tighten the cylinder head bolts with reference to the sequence shown in Fig. 1.

CAUTION: The cylinder head bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

Note: Ensure that the camshaft is still on TDC using Service Tool 18G 1433 (1 Fig. 2).

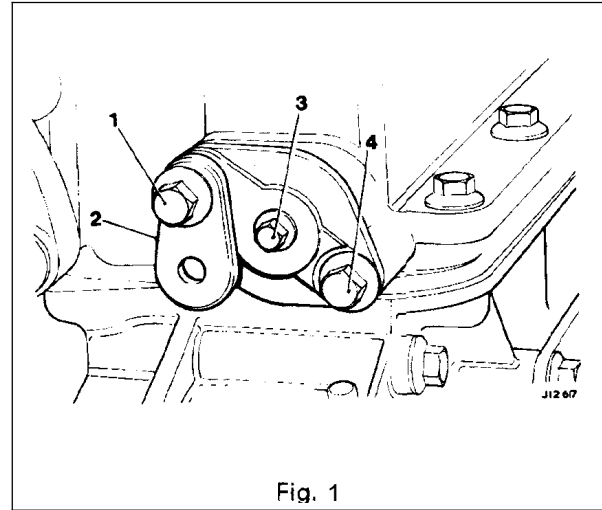
- Fit the harness clip and hose bracket to the cylinder head front securing bolts.
- Fit and tighten the front securing bolts.
- Check the camshafts are set at TDC using Service Tool 18G 1433 (1 Fig. 2).
- Raise the timing chain from between the upper dampers.
- Remove the elastic band.
- Re-position the chain over the camshafts.
- Fit and engage the sprockets to the chain and camshafts.
 - Move all the chain free play to the tensioner side.
 - Fit upper chain tensioner tool 18G 1436/A (2 Fig. 3).
 - Fit and tighten the tool securing bolts (1 Fig. 3).
- Tension the timing chain.
- Remove the camshaft coupling (12 Fig. 4) from the sprocket (11 Fig. 4) and align the securing bolt holes.
- Fit the tab washers (1 Fig. 4). Fit and tighten the securing bolts (2 Fig. 4). Lock over the tabs.
- Release the tension on the timing chain.
- Slacken off the upper chain tensioner tool securing bolts.
- Remove the upper chain tensioner tool 18G 1436/A (2 Fig. 3).
- Clean the tensioner assembly and gasket faces.
- Fit a new housing gasket (10 Fig. 4). Lubricate and fit a new 'O' ring (9 Fig. 4).
 - Fit the tensioner to the cylinder head.
 - Fit and tighten the tensioner assembly securing bolt (4 Fig. 3).
- Clean the valve assembly and fit new 'O' rings.
- Lubricate the tensioner valve.
- Using an Allen key, release the tensioner, i return the Allen key anti-clockwise.





- Fit the tensioner valve (3 Fig. 1). Position the clamp (2 Fig. 1) over the valve.
- Tighten the clamp bolt (1 Fig. 1).
- Fit the camshaft cover, see Section 4.2.

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 4.1 in the appropriate Vehicle Service Manual.





4.5 Cylinder Head, Overhaul

SRO 1229.19

- Remove the cylinder head, see Section 4.4.
- Place the cylinder head on suitable blocks on a bench.
- Remove the spark plugs and the intake and exhaust manifolds.
- Mark the position of the camshaft caps relative to the head, remove the cap securing bolts and remove the caps (1 Fig. 1).
- Remove the camshafts.
- Using a magnet, lift out the cam followers (1 Fig. 2).
- Support the valves using a wooden block.
- Remove the valve springs, using Service Tool MS 1519A, valve spring compressor.
- Retrieve the collars, collets and spring retaining plates.
- Remove the valves, noting the relationship between valve and guide to ensure correct pairing during re-assembly.
- Remove the seals from the intake valve guides and remove the cylinder head rear blanking plate.
- 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 0,25 mm may be removed by skimming the cylinder head.
- Taking care not to damage the inside surface of the combustion chambers, clean 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 guide using a suitable valve guide brush. Thoroughly wash the cylinder head to ensure that all loose carbon is removed and dry the cylinder 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. 3.
- 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.

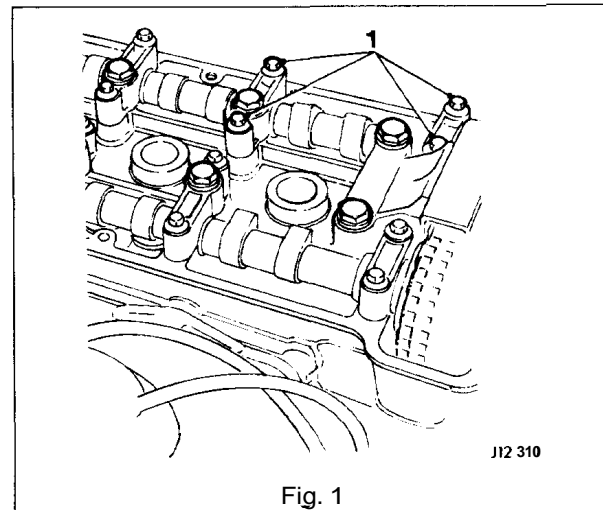


Fig. 1

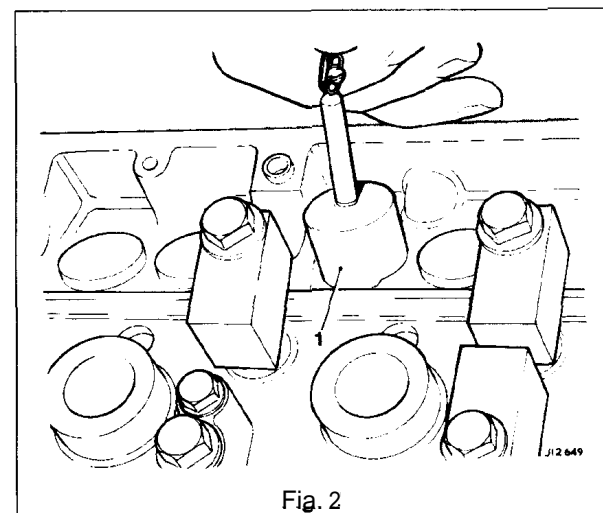


Fig. 2

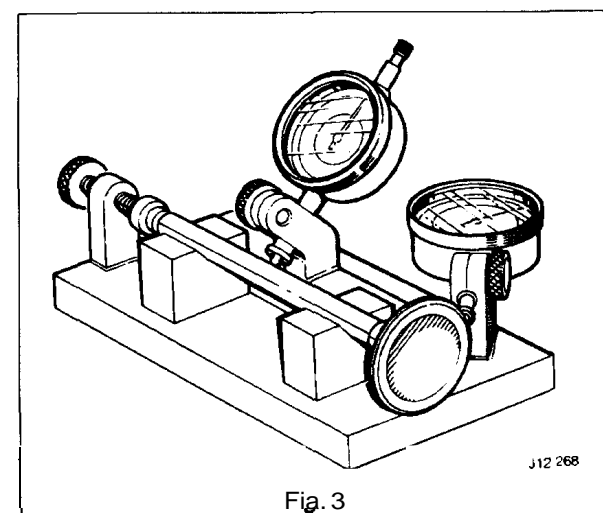


Fig. 3



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. 1 shows:
 - A - Correctly seated
 - B - Undesirable condition
 - C - Rectified condition

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 re-cut. Whenever valves are renewed the seats must be re-cut 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 (A Fig. 2) must not exceed 0,04 to 0,07 mm. Should the movement exceed this tolerance, the valve guide must be renewed. 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 drive 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 204 (Fig. 3). 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. 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 204. For correct valve seat angles see Service Data in the Preliminary Pages.

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.

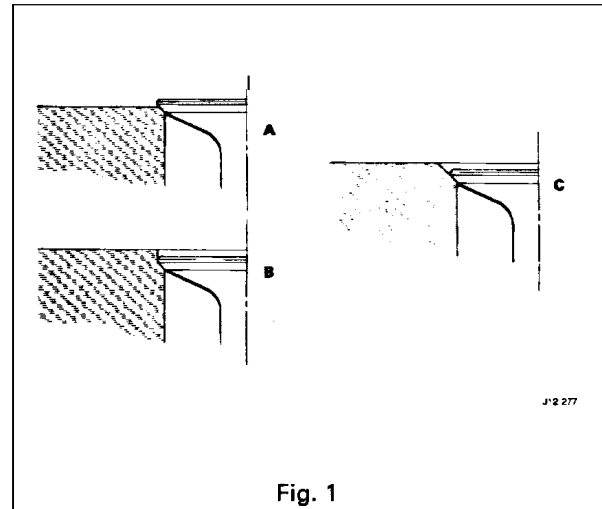


Fig. 1

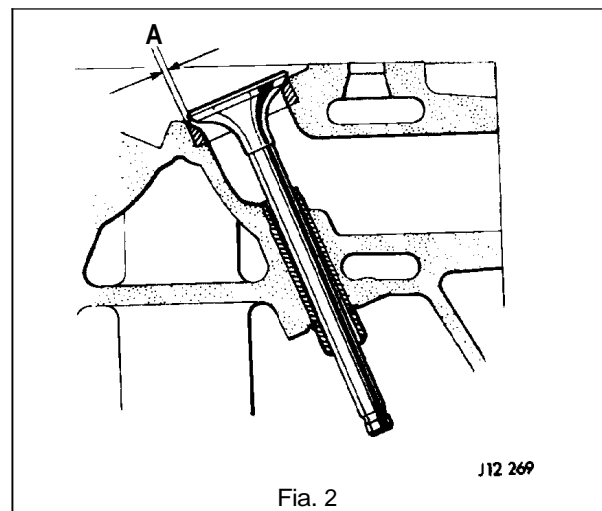


Fig. 2

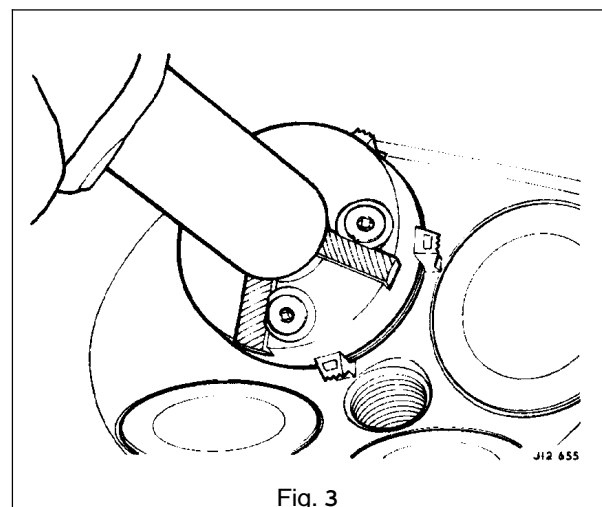


Fig. 3



- 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. Check for any sign of barreling on the side faces (Fig. 1). Renew all followers that are worn or suspect. Wash the valves, springs, collets, 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 Service Data in the Preliminary Pages, 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 'A' is smaller than the distance 'B', then 'A' must be renewed.

Note: 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 MS 1519A and insert the split collets.
- Refit the original shims (1 Fig. 4) in the valve collar recesses. (Ensure that the shims are seated correctly and fit the cam followers, see Section 4.3).

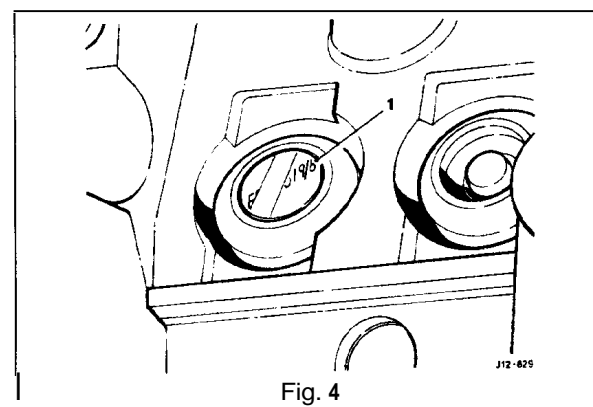
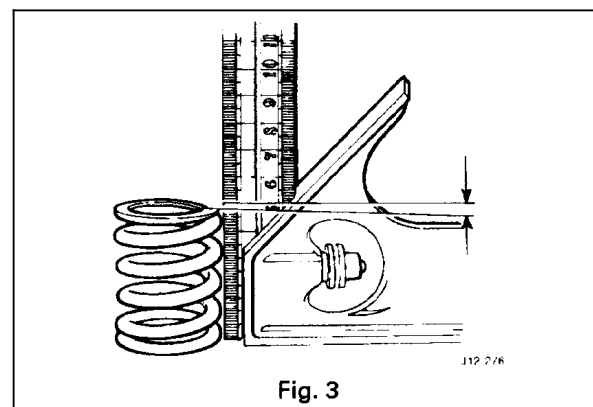
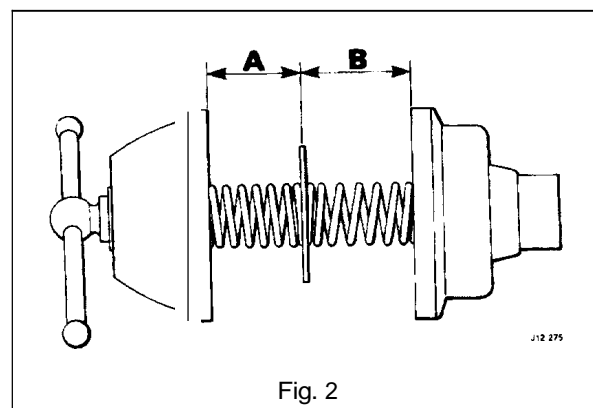
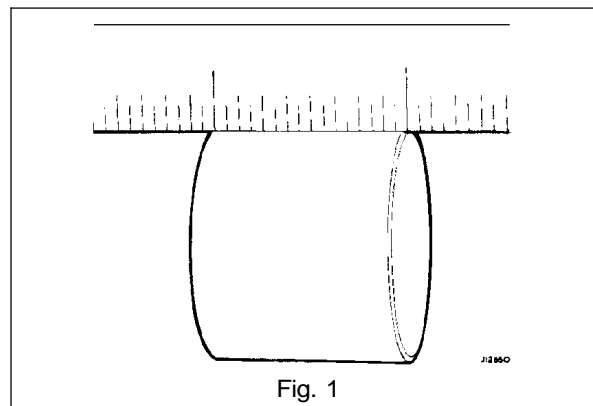
Note: If the cylinder head has been overhauled to the extent of having the valve seats recut, each shim should be 0.010 in. smaller than the original.

- Lubricate the camshafts and fit to the cylinder head, ensuring that they are fitted with the slots to the top. Fit the camshaft caps and torque tighten the securing bolts. Measure the valve clearance between the heel of the cam and the cam follower, turning the camshaft as necessary to measure all the clearances see Section 4.3.

Note: It is advisable to set the valve clearances to the upper limit to allow for the clamping effect experienced through torque tightening upon engine re-assembly.

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

- Clean the cylinder head thoroughly and check the cylinder head and cylinder block for warping, bowing or cracks.
- Fit the cylinder head, see Section 4.4.





4.6 Cylinder Head Casting, Renew

SRO 12.29.15

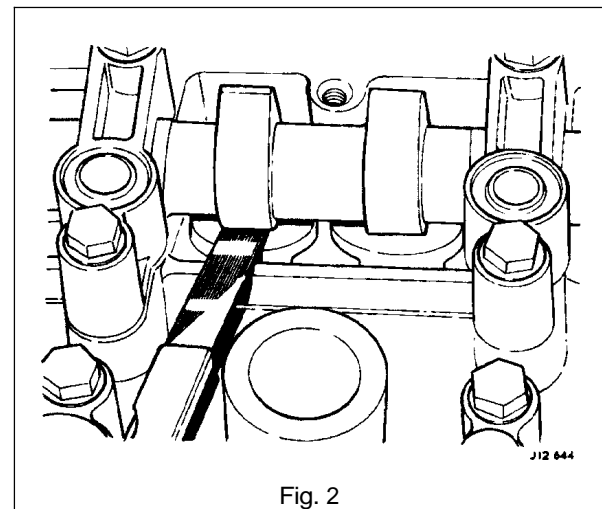
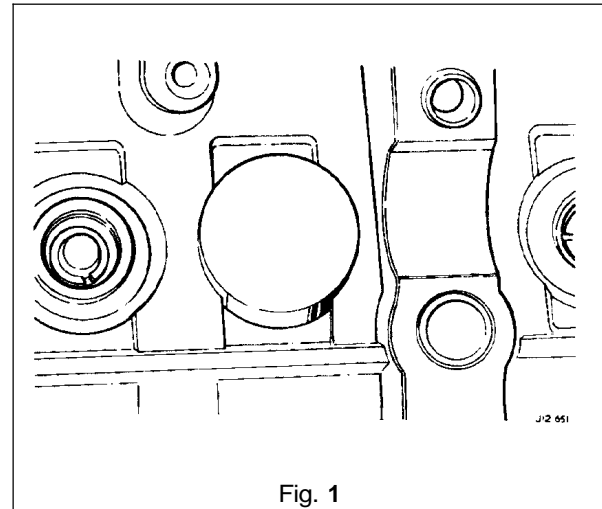
- Remove the cylinder head, see Section 4.4.
- Place the cylinder head on suitable blocks on a bench.
- Remove the spark plugs.
- Remove the intake valve camshaft cap securing bolts.
- Remove the camshaft caps.
- Remove the camshaft.
- Repeat the procedure for the exhaust camshaft.
- Remove the cam followers and shims, noting the positions for re-assembly.
- Remove the valves using Service Tool MS 1519A valve spring compressor.
- Remove the seals from the intake valve guides.
- Remove the rear blanking plate.
- Clean all components and examine for wear and damage.
 - Renew any worn or damaged parts as necessary.
- Clean thoroughly the new cylinder head casting.
- Refit the rear blanking plate to the new cylinder head.
- Smear fine grinding compound on to the face of one valve.
- Oil the valve stem.
- Fit the valve to the head.
- Lightly lap the valves into the seats, leaving a smooth finish to both surfaces.

Note: Excessive lapping will groove the valve face, resulting in poor seating when hot.

- Clean the valve and seat.
- Repeat the procedure for the remaining valves.
- Fit a new seal to the intake valve guide.
- Lubricate the valve stem. Fit the valve to the guide. Fit the spring seat, spring and collar.
 - Fit Service Tool MS 1519A spring compressor to the valve.
 - Compress the valve spring, fit and seat the collets, and release the clamp.
- Repeat the procedure for the remaining valves.
 - Refit the shims.
 - Ensure that the shims are seated correctly.
- Lubricate and fit the cam followers (Fig. 1).
 - Lubricate the camshafts and bearings.
 - Fit the camshafts.
 - Fit the camshaft caps.
 - Fit and torque tighten the camshaft cap securing bolts.
 - Measure the valve clearance between the heel of the cam and the cam follower (Fig. 2), turning the camshaft as necessary to measure all the clearances, see Section 4.3.

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

- Clean the cylinder head thoroughly and check the cylinder head and cylinder block for warping, bowing or cracks. Renew if necessary.
- Fit a new cylinder head gasket.
- Fit the cylinder head assembly, see Section 4.4.





4.7 Piston and Connecting Rod, Engine Set, Renew

SRO 12.17.10

- Remove the engine and transmission unit from the vehicle, see Section 3.1 in the appropriate Vehicle Service Manual.
- Remove the transmission unit from the engine and fit the engine to a stand.
- Remove the cylinder head, see Section 4.4.
- Remove the oil pan, see Section 4.27.
- Remove the oil pump, see Section 4.31.
- Remove the windage trays securing bolts. Remove the windage trays (6 Fig. 1).
- Remove the connecting rod nuts (1 Fig. 2) in connecting rod pairs (1 & 6, 2 & 5, 3 & 4 cylinders) and remove the connecting rod bearing caps (2 Fig. 2). Note the position of the cap to connecting rod. Discard the connecting rod bearing nuts.
- Push the pistons up and through the top of the cylinder block.
- Remove the piston pin snap-rings (1 Fig. 3) from each piston, remove the piston pin (2 Fig. 3) and separate the piston (3 Fig. 3) from the connecting rod (4 Fig. 3).
- Check the connecting rods for out of balance, twist and bend. If any connecting rod is bent, twisted or out of balance with the other five, then the complete set must be renewed. Renew the connecting rod bearing bolts.

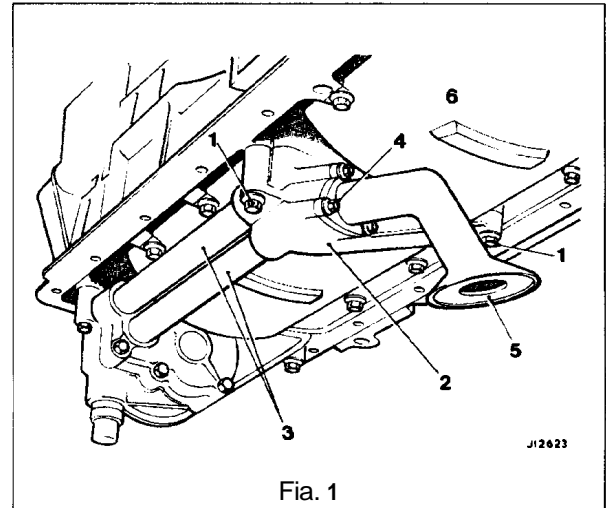


Fig. 1

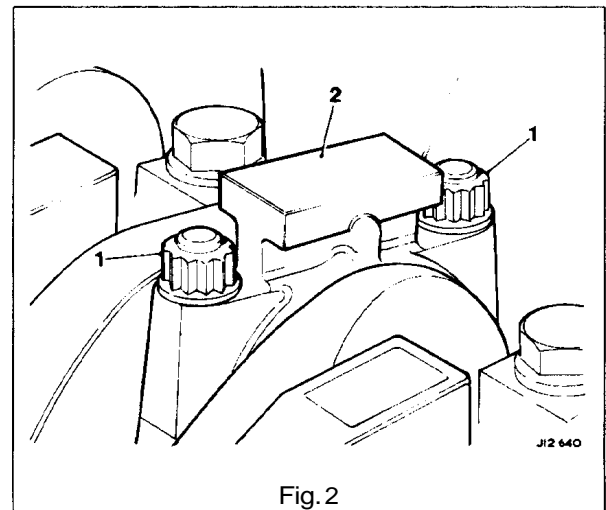


Fig. 2

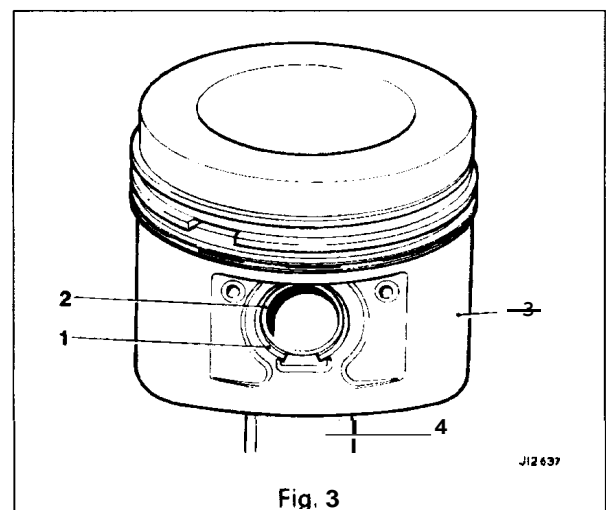


Fig. 3



- Insert each new piston ring into the cylinder bore (1 Fig. 1) ensuring they are square in the cylinders and check the gap using a strip gauge (2 Fig.1).
- If the gap is insufficient, then a small flat file or carborundum stone can be used on the butting ends of the ring. Ensure that after filing no burrs remain.

Note: Ensure that the rings are not inter-mixed after they have been gapped and that each piston / ring assembly is matched to its respective bore. If new piston rings are being fitted without reboring, deglaze the cylinder bores using a hone or glaze buster. This operation will not increase the size of the bores and will give the bores a cross-hatched finish

- Lubricate the small end bush and slide the piston pin through the new piston and connecting rod. Secure with new snap-rings. NEVER re-use old snap-rings.
- Fit the rings to the pistons ensuring that gaps are positioned as in (Fig. 2).
- Lubricate and compress the rings using Service Tool 18G 55A (Fig. 3).

Note: Ensure that each piston / ring assembly is matched to its respective bore.

- Insert the piston skirt into the bore and using a suitable implement, i.e. a wooden hammer shaft, gently tap the piston into the cylinder bore.
- Ensure that the connecting rod does not foul either the cylinder block or crankshaft.

Note: Ensure that each connecting rod and connecting rod bearing cap are correctly 'paired' for assembly.

- Lubricate and fit the connecting rod bearing shells to the connecting rod and the connecting rod bearing cap. Pull the connecting rod and bearing carefully onto the crankshaft and fit the connecting rod bearing cap to the rod.
- Fit and torque tighten the new connecting rod bearing nuts.

CAUTION: The connecting rod bearing nuts and bolts MUST be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

- Repeat the operation for the remaining five piston assemblies.
- Clean and fit the crankshaft windage trays and torque tighten the securing bolts.
- Refit the oil pump, see Section 4.31.
- Refit the oil pan, see Section 4.27.
- Refit the cylinder head, see Section 4.4.
- Remove the engine from the stand.
- Attach the transmission unit to the engine.
- Fit the engine / transmission unit to the vehicle, see Section 3.1 in the appropriate Vehicle Service Manual.

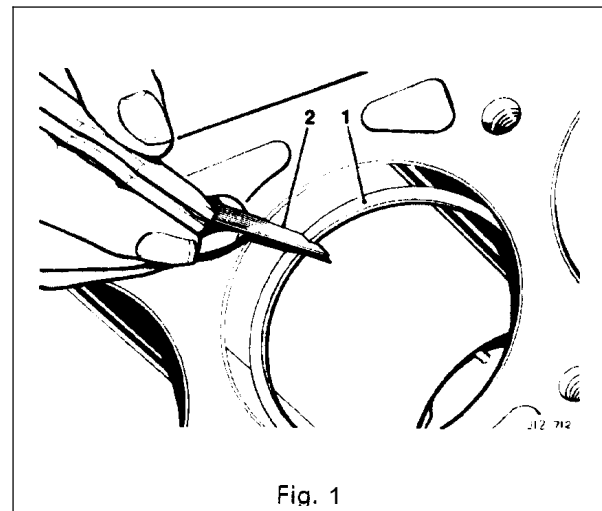


Fig. 1

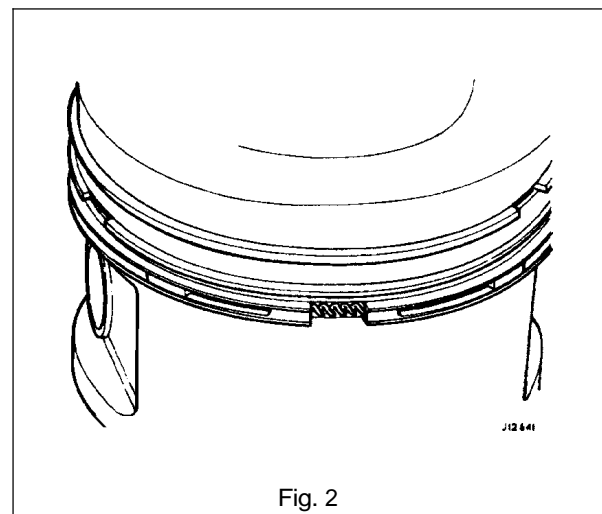


Fig. 2

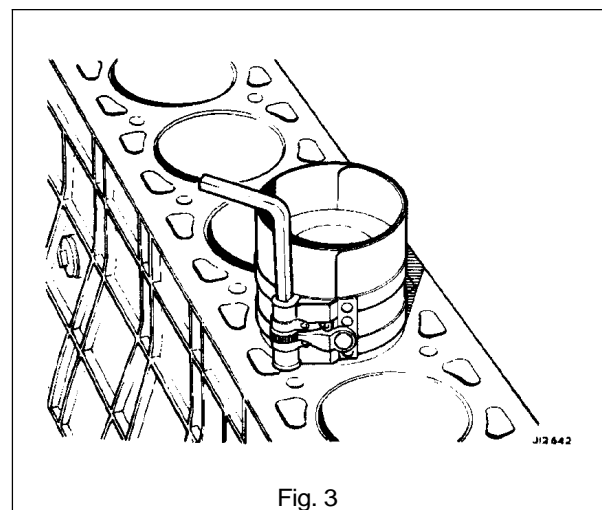


Fig. 3



4.8 ConnectingRod Bearing, Engine Set, Renew

SRO 12.17.16

Remove components as required for access and proceed as follows.

- Remove the oil pan, see Section 4.27.
- Remove the bolts securing the crankshaft windage trays (6 Fig. 1) to the cylinder block and remove the trays.
- Rotate the crankshaft for access to the first connecting rod.
- Remove the nuts (1 Fig. 2) securing the connecting rod bearing cap (2 Fig. 2) to the connecting rod and remove the cap and bearing assembly.
- Note the position of the cap relative to the connecting rod and also that they are numbered to each other (Fig. 3). Discard the connecting rod bearing nuts.

CAUTION: The connecting rod bearing nuts and bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

- Discard the bearing shell (3 Fig. 3), move the connecting rod and piston up the bore and remove the bearing shell from the connecting rod (2 Fig. 3).
- Remove the 'paired' bearing caps, 1-6, 2-5, 3-4, as in the previous description.
- Clean and polish the crankshaft journals, oil the new bearings and fit the two halves to the connecting rods.

Note: Ensure that the 'tag' (1 Fig. 3) on the shell is fully seated in the connecting rod.

- Oil the crankshaft journals.
- Pull one piston and connecting rod assembly down the bore and into position on its relative crankshaft journal.
- Fit a bearing shell to the 'notched' connecting rod bearing cap.

Note: Ensure that the 'tag' on the shell is fully seated in the connecting rod bearing cap, oil the shell and fit to the crankshaft / connecting rod assembly using new connecting rod bearing nuts.

- Refit the oil pan, see Section 4.27.

Replace the components removed for access.

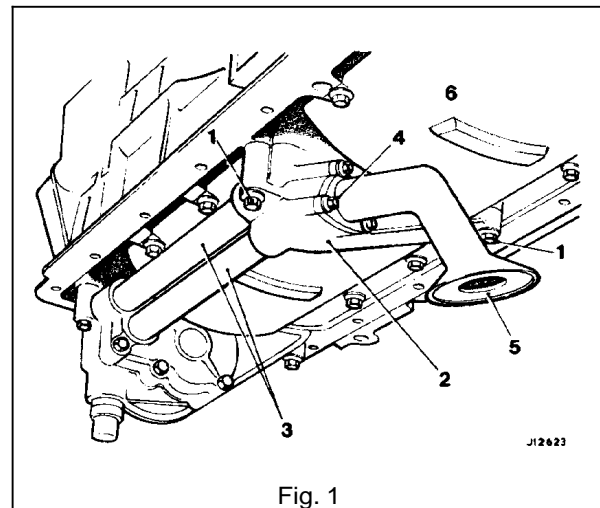


Fig. 1

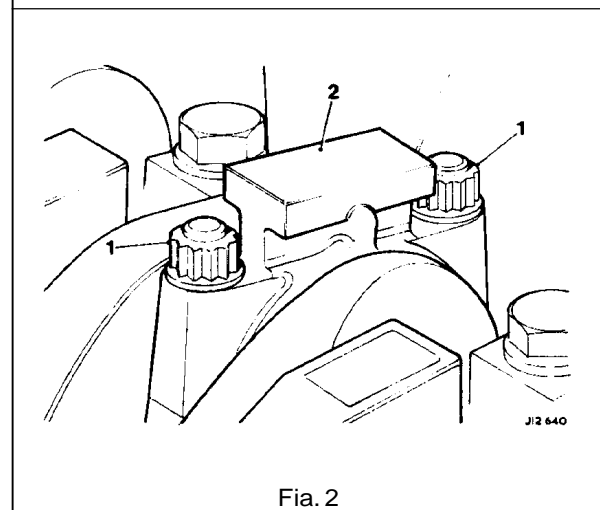


Fig. 2

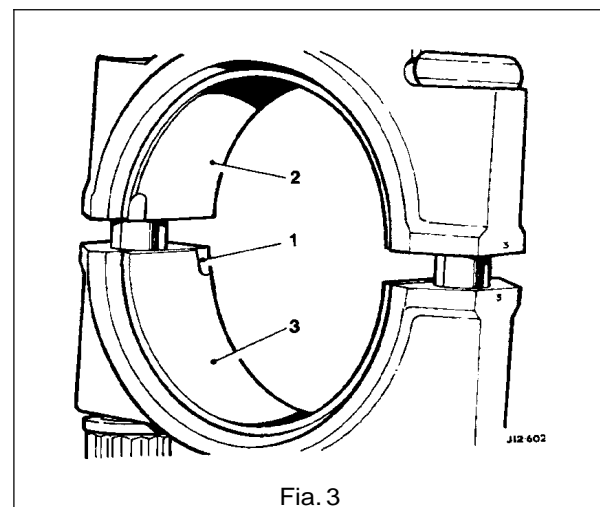


Fig. 3



4.9 Main Bearing, Engine Set, Renew

SRO 12.21.39

Remove components required for access and proceed as follows.

- Remove the oil pan see, see Section 4.27.
- Remove the oil pump, see Section 4.31.
- Remove the windage trays securing bolts and remove the windage trays (6 Fig. 1).
- Remove the bolts securing one of the main bearing caps to the cylinder block and remove the cap.
- Remove and discard the bearing shell from the cap and cylinder block.
- Clean the cylinder block and crankshaft.
- Polish the crankshaft journal and liberally coat with oil.
- Feed the new bearing shell into the cylinder block and ensure that the tag is fully seated in its location.
- Fit the other new bearing shell to the bearing cap. Oil the bearing and fit the cap assembly to the cylinder block.
- Fit and torque tighten the securing bolts.

CAUTION: The main bearing securing bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

Note: Ensure that the bearing cap is the correct way round, with the cap numbers corresponding to the numbers stamped on the oil pan mounting face (1 Fig. 2).

- Rotate the crankshaft to ensure that it is not being 'pinched' and will rotate freely.
- Repeat the procedure for the remaining six caps and shells.
- Mount a suitable dial gauge and check the crankshaft end-float, see Section 4.12.
- Recheck the end-float and if satisfactory, clean the main bearing cap and bearing and lubricate with clean engine oil.
- Refit the cap and bearing assembly, remove the dial gauge and torque tighten the main bearing cap securing bolts.

CAUTION: The main bearing securing bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

- Refit the windage trays to the cylinder block. Fit and tighten the securing bolts.
- Refit the oil pump, see Section 4.31.
- Refit the oil pan, see Section 4.27.

Replace the components removed for access.

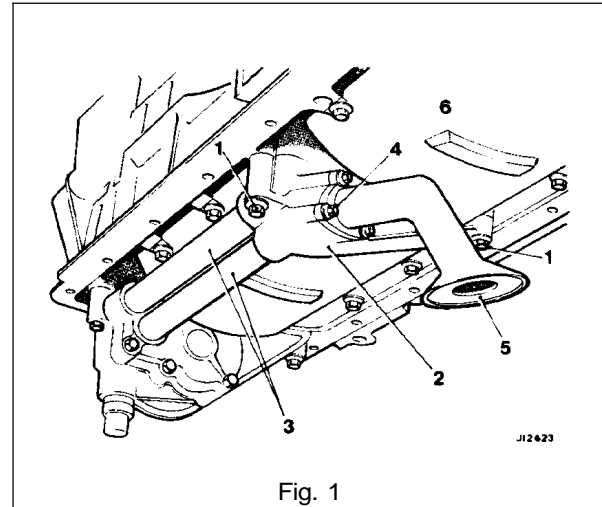


Fig. 1

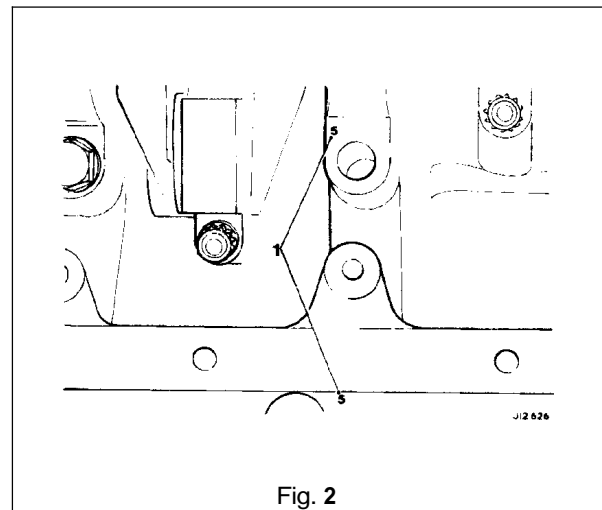


Fig. 2



4.10 Crankshaft, Renew

SRO 1221.33

- Remove the engine and transmission unit from the vehicle, see Section 3.1 in the appropriate Vehicle Service Manual.
- Detach the transmission unit from the engine.
- Fit the engine to a stand.
- Remove the cylinder head, see Section 4.4.
- Remove the crankshaft damper pulley assembly, see Section 4.11.
- Remove the oil pan, see Section 4.27.
- Remove the oil pump, see Section 4.31.
- Remove the flywheel (Manual), see Section 4.15, or remove the drive-plate (Automatic), see Section 4.16.
- Remove the timing cover.
- Remove the windage trays securing bolts (1 Fig. 1) and remove the windage trays (2 Fig. 1).
- Remove the timing chains - upper and lower and the upper and lower tensioners see Section 4.19.
- Remove the seal / crankshaft damper spacer, the woodruff key (1 Fig. 2), the crankshaft sprockets (2 Fig. 2) and the inner woodruff key.
- Remove the rear oil seal housing, see Section 4.14.
- Remove the connecting rod bearing nuts and remove the connecting rod bearing caps in pairs (1-6, 2-5, 3-4), turning the crankshaft for access as required. As each connecting rod bearing cap is removed, ensure that each connecting rod and connecting rod bearing cap are identified to each other for re-pairing during assembly.
- As each cap is removed, its relative connecting rod and piston assembly should be pushed up the bore, enabling the crankshaft to be rotated to remove the remaining caps. Care should be taken not to push the piston too far up the cylinder bore as this will release the piston rings.
- Ensuring that the main bearing caps are marked relative to the cylinder block (1 Fig. 3), remove the main bearing cap bolts and the bearing caps, and carefully lift out the crankshaft.
- Remove and discard the bearing shells and the thrust washers.
- Clean the bearing caps and the cylinder block main bearing housings.
- Fit the new bearing shell halves to the cylinder block and lubricate with clean engine oil.

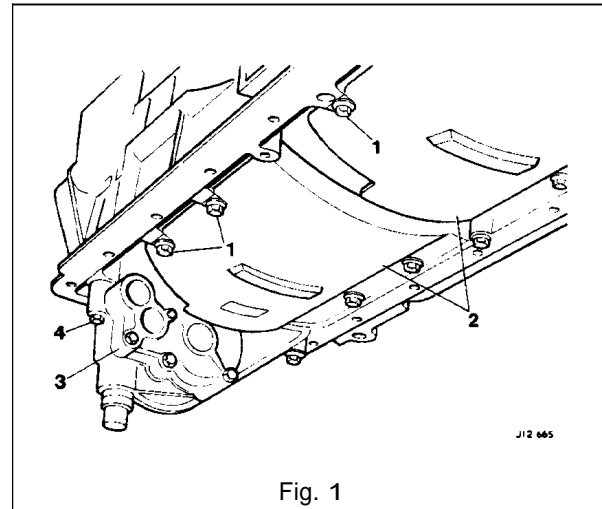


Fig. 1

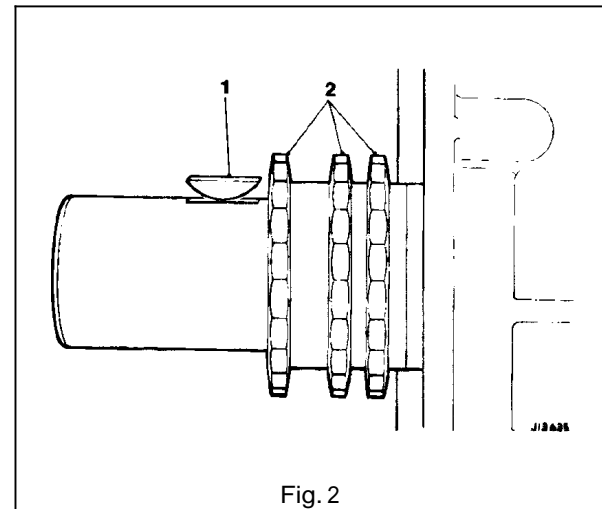


Fig. 2

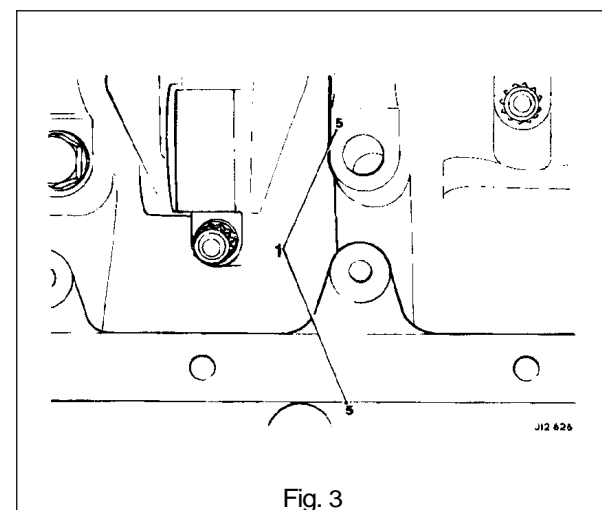


Fig. 3



- Clean and polish the crankshaft journals, lubricate and carefully assemble the crankshaft into the cylinder block, fit the thrust washers ensuring that the steel side of the washer is mated to the cylinder block (1 Fig. 1).
- Rotate the crankshaft to ensure that it turns freely.
- Fit the main bearing shells into the main bearing caps, lubricate and fit to the cylinder block.
- Start the securing bolts and carefully tap the main bearing caps to ensure they are seated to the cylinder block.
- Rotate the crankshaft to ensure that it still turns freely, pull down each bearing cap individually and torque tighten the securing bolts.
- Rotate the crankshaft between pulling down each bearing cap.
- Check and if necessary adjust the crankshaft end-float in accordance with Section 4.12.
- Renew the crankshaft rear oil seal, see Section 4.14.
- Fit a new bearing shell to the connecting rod, lubricate with clean engine oil and fit to the crankshaft.
- Fit a bearing shell to the connecting rod bearing cap, lubricate and fit to the connecting rod. Fit and torque tighten the nuts.
- Turn the crankshaft over ensuring that there are no 'tight' spots, and that the crankshaft rotates freely.
- Repeat this procedure for the remaining five cylinders.

CAUTION: The connecting rod bearing nuts, bolts and main bearing securing bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

- Clean and inspect for wear or damage all the timing gears, chains, guides and tensioners.
- Renew any suspect component.
- Fit and seat the crankshaft sprocket woodruff key and fit the sprocket to the crankshaft.
- Refit the timing chains – upper and lower; and the upper and lower tensioners, see Section 4.19.
- Fit a dial gauge to the top of the cylinder block and turn the engine over until No. 1 and 6 pistons are at TDC (Fig. 2).
- Lubricate the upper chain and fit it to the intermediate sprocket.
- Fit an elastic band to retain the upper dampers and chain.
- Lubricate the oil pump drive chain, fit the chain to the crankshaft sprocket and lodge in the correct position.
- Renew the timing cover oil seal and refit the timing cover.
- Lubricate and fit the oil seal distance piece. Fit and seat the damper woodruff key.
- Refit the oil pump, see Section 4.31.
- Refit the flywheel (Manual), see Section 4.15, or refit the drive-plate (Automatic), see Section 4.16.
- Refit the oil pan, see Section 4.27.
- Refit the crankshaft damper/pulley assembly, see Section 4.11.
- Refit the cylinder head, see Section 4.4.
- Remove the engine from the stand and refit the transmission unit.
- Refit the engine/transmission unit to the vehicle, see Section 3.1 in the appropriate Vehicle Service Manual.

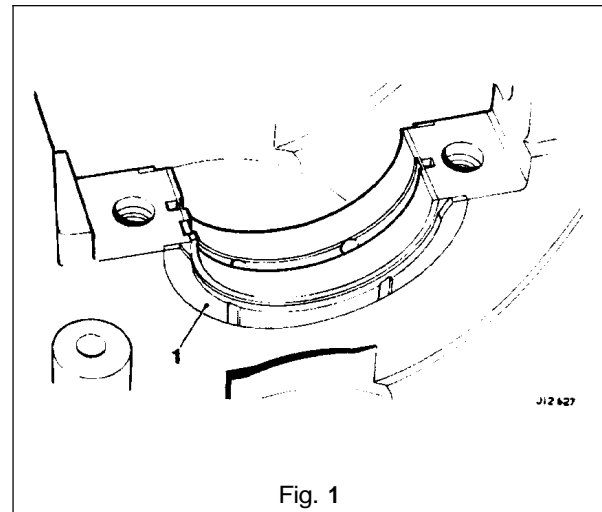


Fig. 1

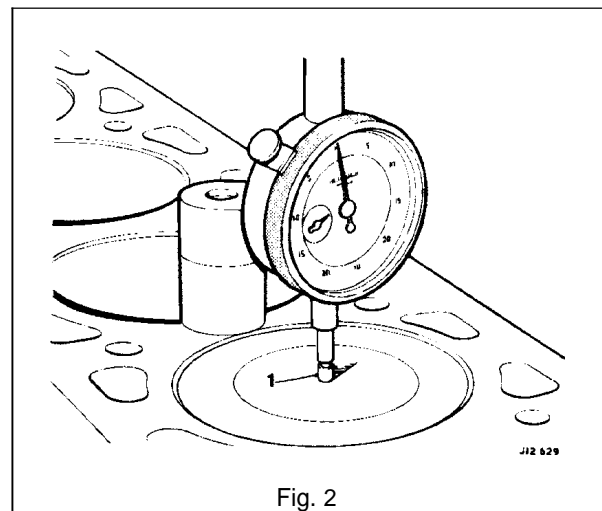


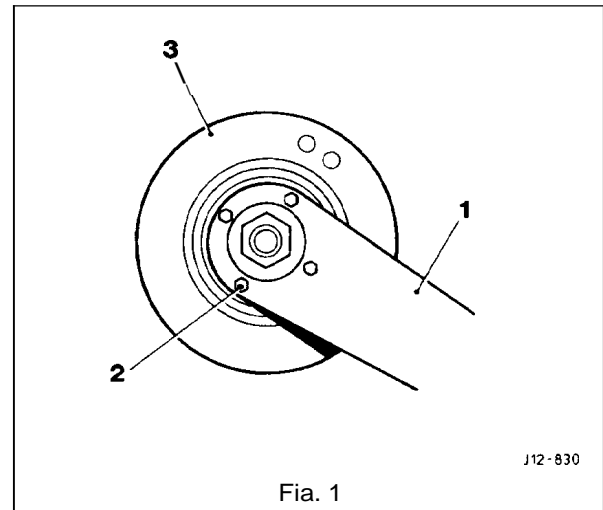
Fig. 2



4.11 Crankshaft Damper / Pulley Assembly, Renew

SRO 12.21.09

- Remove the air conditioning compressor drive belt.
- Remove the generator drive belt.
- Fit Service Tool 18G 1437 (1 Fig. 1) to the crankshaft pulley (3 Fig. 1) and tighten the securing bolts (2 Fig. 1).
- Wedge the tool against the crossmember.
- Remove the pulley retaining bolt.
- Remove Service Tool 18G 1437 from the pulley.
- Fit Service Tool 18G 1436/A to the pulley and tighten the securing bolts.
- Tighten the center bolt to withdraw the pulley from the crankshaft and remove the tool.
- Remove the timing plate securing bolts and remove the timing plate.
- Fit the timing plate to the new pulley and tighten the securing bolts.
- Fit the pulley to the engine, hand tighten the securing bolt and fit Service Tool 18G 1437.
- Wedge the tool against the front crossmember, torque tighten the securing bolt and remove Service Tool 18G 1437.
- Refit the generator drive belt.
- Refit the air conditioning compressor drive belt.





4.12 Crankshaft End-float, Check and Adjust

SRO 12.21.26

Remove components as required for access and proceed as follows.

- Remove the oil pan, see Section 4.27.
- Remove the oil pump pick-up pipes (3 Fig. 1), see Section 4.28.
- Remove the crankshaft windage trays (6 Fig. 1).
- Mount a suitable dial gauge and position the stylus on the crankshaft front pulley.
- Zero the gauge, and with the use of a suitable lever, measure the crankshaft end-float (Fig. 2). For the correct end-float, see Service Data in the Preliminary Pages.
- If the end-float exceeds the tolerances, remove the center main bearing cap, and renew the thrust washers.

Note: When refitting the thrust washers, ensure that the bearing face (grooved) (1 Fig. 3) and not the steel side contacts the crankshaft.

- Recheck the end-float and if satisfactory, clean the main bearing cap and bearing, lubricate with clean engine oil and fit the cap assembly to the cylinder block.
- Fit and torque tighten the securing bolts.

CAUTION: The main bearing securing bolts **MUST** be renewed during assembly and torque tightened as described in Section 21, SPS Joint Control System.

Note: Ensure that the bearing cap is the correct way round with the cap numbers corresponding to the numbers stamped on the oil pan mounting face.

- Rotate the crankshaft to ensure that it is not being 'pinched' and will rotate freely.
- Remove the dial gauge and torque tighten the main bearing cap. Refit the windage trays to the cylinder block and secure with the bolts.
- Refit the oil pump pick-up pipes, see Section 4.28.
- Refit the oil pan, see Section 4.27.
- Refit the oil filler / drain back tube.

Replace the components removed for access.

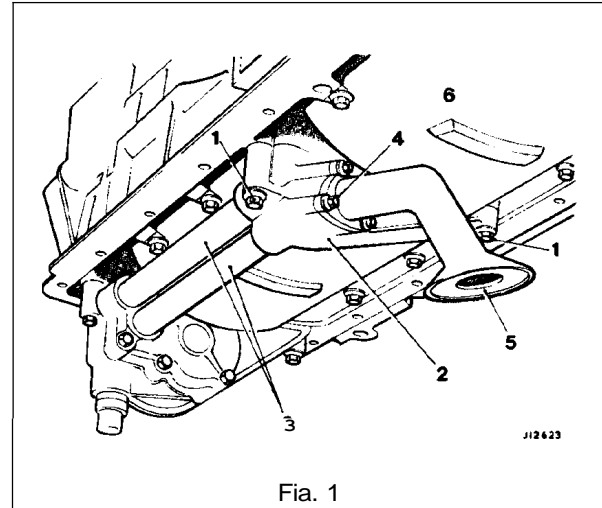


Fig. 1

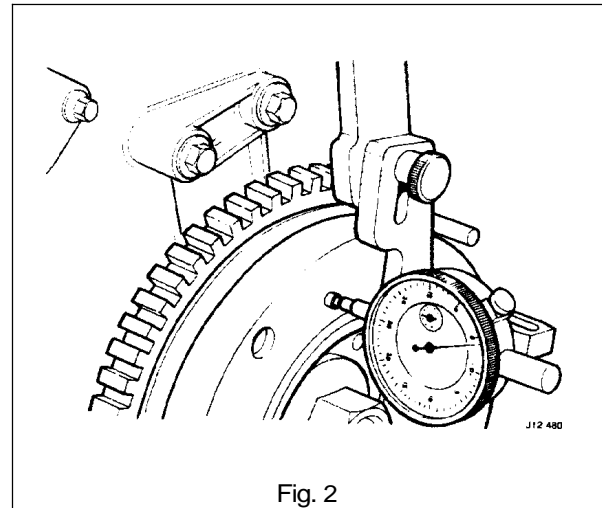


Fig. 2

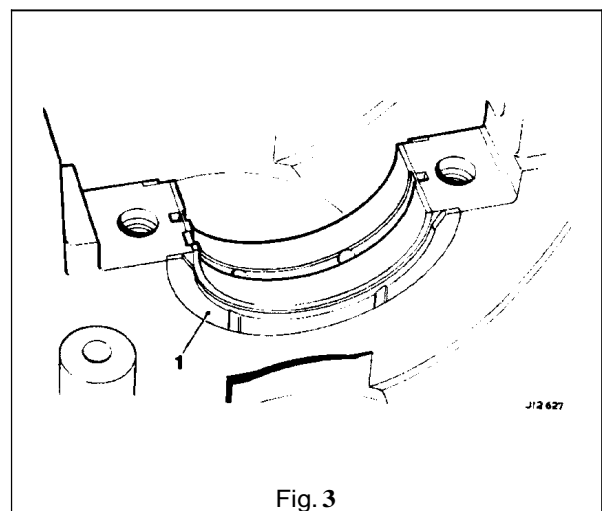


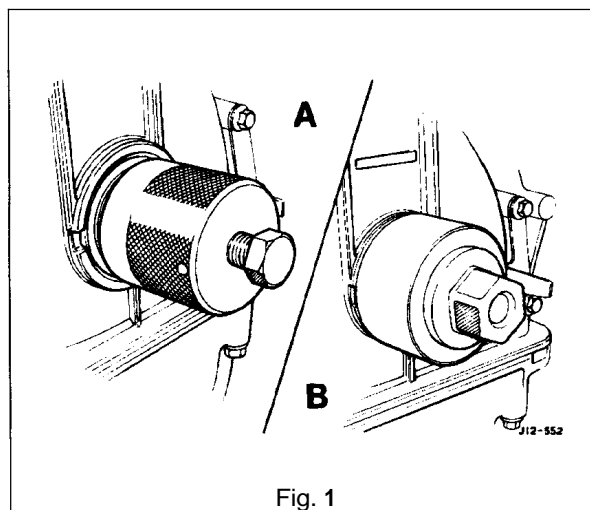
Fig. 3



4.13 Crankshaft Front Oil Seal, Renew

SRO 12.21.14

- Remove the crankshaft damper / pulley assembly, see Section 4.11.
- Remove the old oil seal from the timing cover using Service Tool JD 128 (A Fig. 1).
- Fit the new oil seal (prior to fitting the crankspacer) using Service Tool JD 129 and the crankshaft pulley bolt (B Fig. 1).
- Inspect the edges of the spacer for nicks, burrs and wear marks. Renew if necessary.
- Refit the crankshaft damper / pulley assembly, see Section 4.11.





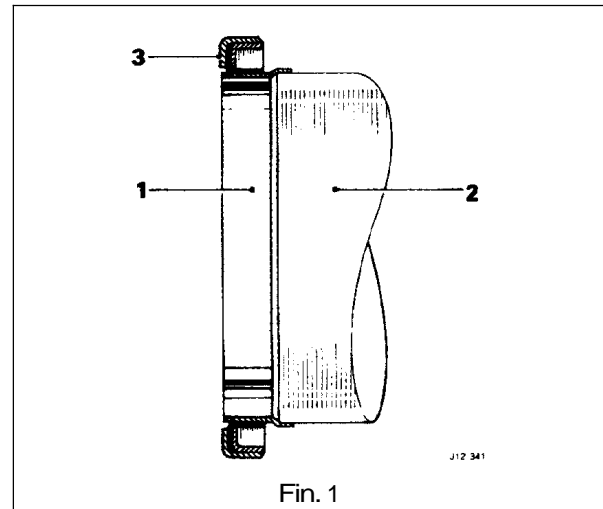
4.14 Crankshaft Rear Oil Seal, Renew

SRO 12.21.20

- Remove the flywheel (Manual), see Section 4.15, or the drive-plate (Automatic), see Section 4.16.
- Remove the transmission adapter securing bolts and remove the adapter.
- Carefully remove the old oil seal from the adapter, clean the adapter and lubricate the seal mounting face.

CAUTION: Do not remove the plastic 'O' ring protector from the new seal prior to fitting to the adapter.

- Fit the new seal (3 Fig. 1) to the adapter and apply sealant to the appropriate faces. See Service Materials in the Preliminary Pages.
- Locate the plastic 'O' ring protector (1 Fig. 1) on to the end of the crankshaft (2 Fig. 1).
- Push the rear seal housing (4 Fig. 1) over the crankshaft and up to the rear cylinder block face.
- Remove the plastic 'O' ring protector (1 Fig. 1).
- Fit and torque tighten the transmission adapter securing bolts.
- Refit the flywheel (Manual), see Section 4.15, or the drive-plate (Automatic), see Section 4.16.





4.15 Engine Flywheel, Renew

SRO 12.53.07

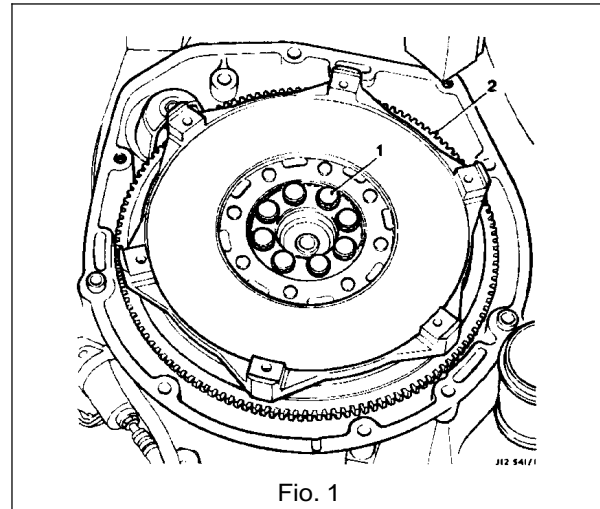
- Remove the transmission unit.
- Hold the flywheel in one position and remove the bolts securing the clutch cover to the flywheel.

CAUTION: Make a note of the position of any balance weights relative to the clutch cover.

- Remove the balance weights. Remove the clutch assembly.

WARNING: THE TWIN-MASS FLYWHEEL IS EXTREMELY HEAVY. ASSISTANCE WILL BE REQUIRED DURING REMOVAL / REFITTING.

- Remove the eight securing bolts (1 Fig. 1) and remove the flywheel (2 Fig. 1). Remove the needle roller race and fit to the new flywheel.
- Fit the new flywheel to the crankshaft and tighten the securing bolts to the recommended torque value.
- Fit the clutch assembly to the flywheel ensuring that the 'flywheel side' of the drive-plate faces the flywheel. Align the clutch with a dummy input shaft. Fit the balance weights to the clutch cover and torque tighten the securing bolts.
- Remove the dummy shaft.
- Fit the housing to the adapter plate, fit and torque tighten the securing bolts / nuts.
- Refit the transmission unit.

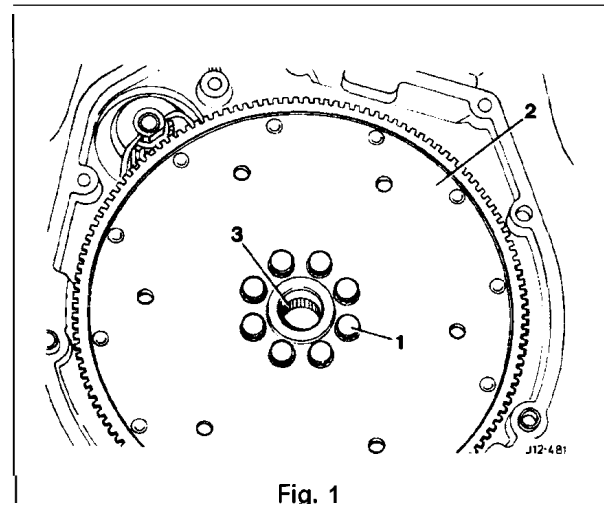




4.16 Engine Drive-plate, Renew

SRO 12.53.13

- Remove the transmission unit.
- Remove the drive-plate securing bolts (1 Fig. 1).
- Remove the drive-plate (2 Fig. 1).
- Check the crankshaft rear oil seal for leaking, renew as necessary, see Section 4.14.
- Fit the new drive-plate to the crankshaft. Fit and tighten the securing bolts.
- Refit the transmission unit.





4.17 Engine Rear/ Transmission Adapter Plate, Renew

SRO 12.53.03

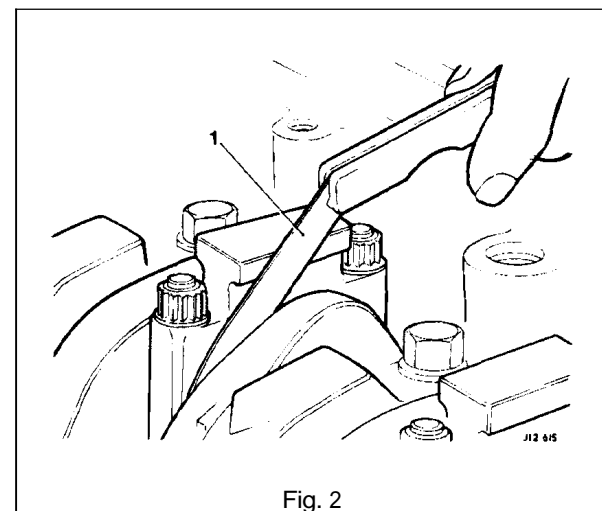
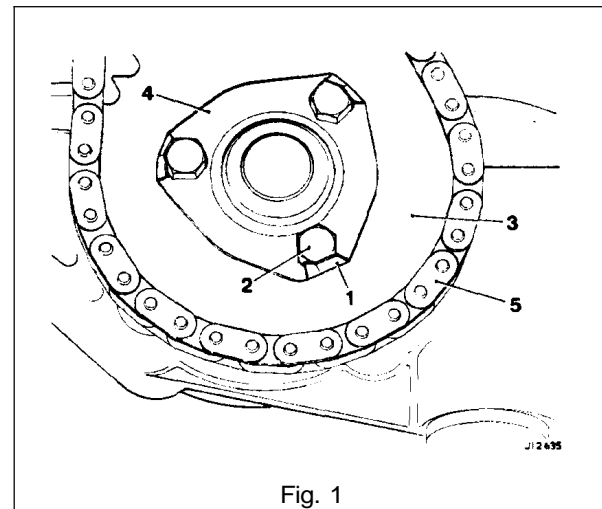
- Remove the engine flywheel (Manual), see Section 4.15, or the engine drive-plate (Automatic), see Section 4.16.
- Remove the lower bolt securing the starter motor and re-position the starter motor away from the adapter plate.
- Remove the adapter plate securing bolts and remove the adapter plate.
- Remove the dowel pegs and blanking plugs from the adapter plate.
- Discard the adapter plate.
- Fit the blanking plugs and dowel pegs to the new adapter plate.
- Fit the assembly to the rear of the engine and torque tighten the securing bolts.
- Re-position the starter motor to the adapter plate and secure with the lower bolt.
- Refit the engine flywheel (Manual), see Section 4.15, or the engine drive-plate (Automatic), see Section 4.16.



4.18 Engine Assembly, Overhaul

SRO 12.41.05

- Remove the engine and transmission unit, see Section 3.1 in the appropriate Vehicle Service Manual.
- Remove the transmission unit from the engine.
- Fit the engine to a stand.
- Place a drain tray below the cylinder block drain plug and drain any remaining coolant from the engine.
- Overhaul the cylinder head, see Section 4.5.
- Remove the oil pan, see Section 4.27.
- Remove the oil pump, see Section 4.31.
- Remove the windage trays.
- Clean all components, check for damage and wear and renew as required.
- Remove the rear oil seal housing, see Section 4.14.
- Remove the timing cover assembly.
- Remove the pedestal bolts and tab washer.
- Remove the pedestal / tensioner assembly and damper. Slacken off the oil pump drive chain damper securing bolts and move the damper clear of the chain. Push back the lock tabs (1 Fig. 1) and remove the securing bolts (2 Fig. 1) from the oil pump drive sprocket (3 Fig. 1).
- Remove the drive sprocket and shim pack.
- Remove the oil pump drive chain (5 Fig. 1), remove the elastic band from the upper dampers and remove the upper timing chain.
- Remove the lower tensioner securing bolts and remove the tensioner.
- Push back the lower chain fixed damper securing bolt lock tabs and remove the bolts.
- Remove the damper and tab washer.
- Repeat for the remaining fixed and pivot dampers and remove the lower chain and intermediate sprocket.
- Remove the crankshaft pulley spacer and the crankshaft pulley woodruff key.
- Remove the drive sprockets and woodruff keys from the crankshaft.
- Check all drive sprockets for wear, distortion and damaged teeth. Renew as required.
- Remove the power assisted steering pump assembly, see Section 10 in the appropriate Vehicle Service Manual and reposition away from the timing cover area.
- Renew the auxiliary shaft, see Section 4.24.
- Renew the auxiliary shaft bushes, see Section 4.19.
- Remove the oil pump drive chain damper.
- Remove the spacers from behind the damper.
- Remove the pistons and connecting rods and renew, see Section 4.7.
- Refit the connecting rod bearing shells to one connecting rod and cap and fit the rod to the crankshaft. Torque tighten the nuts and check the side clearance between the end face of the rod and the journal shoulder (Fig. 2) – see Service Data in the Preliminary Pages.
- Remove the connecting rod from the crankshaft.
- Repeat for the remaining five connecting rods.





CAUTION: The connecting rod bearing nuts, bolts and main bearing securing bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

- Ensuring that the main bearing caps are marked relative to the cylinder block, remove the main bearing cap bolts and remove the caps. Carefully lift out the crankshaft.
- Place the crankshaft on suitable blocks on a bench. Remove and discard the bearing shells and the thrust washers. Clean the cylinder block, crankshaft and bearing caps.
- Check the crankshaft journals for wear and ovality, for tolerances – see Service Data in the Preliminary Pages.
- If any of the dimensions are outside the stated tolerances, then the Crankshaft must be renewed.
- Fit suitable bolts to the oil gallery plugs and pull to remove (Fig. 1). Check all cylinder block oil galleries for cracks and blockages. Fit new 'O' rings to the oil gallery plugs, lubricate the 'O' rings and fit the plugs to the cylinder block oil galleries.
- Check all bearing housings for cracks, distortion and any signs of bearing movement, i.e. scoring or overheating, renew as necessary.
- Check the cylinder block / cylinder head mating surface for warping, bowing and cracks.
- Check the bore wear in the cylinder block with a suitable comparator (Fig. 2). This must be done in at least six positions in the bore (Fig. 3).

Note: Maximum bore wear normally occurs towards the top of the bore, across its thrust axis.

Note: If standard size replacement pistons are being fitted, they must be the same grade as the markings on the cylinder block.

Note: If new piston rings are being fitted without rebor-ing, de-glaze the cylinder bores using a hone or glaze buster. This operation will not increase the size of the bores and will give the bores a cross-hatched finish.

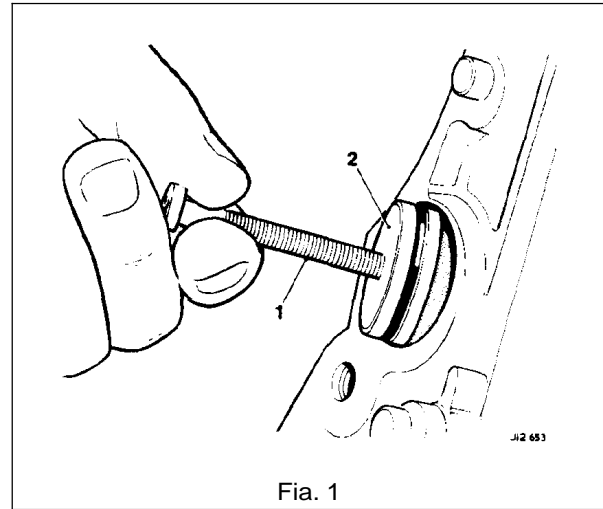


Fig. 1

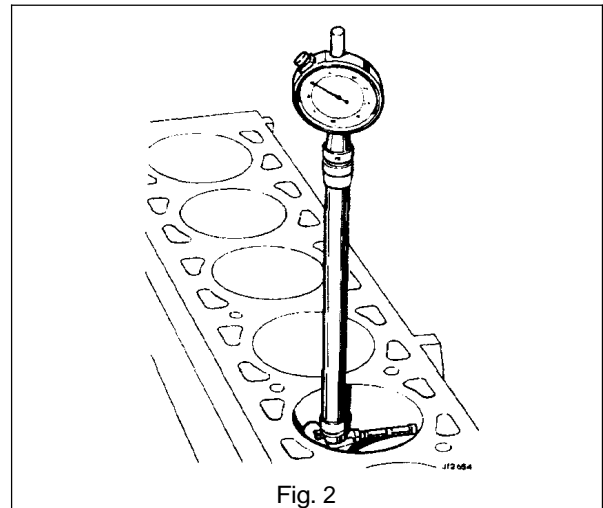


Fig. 2

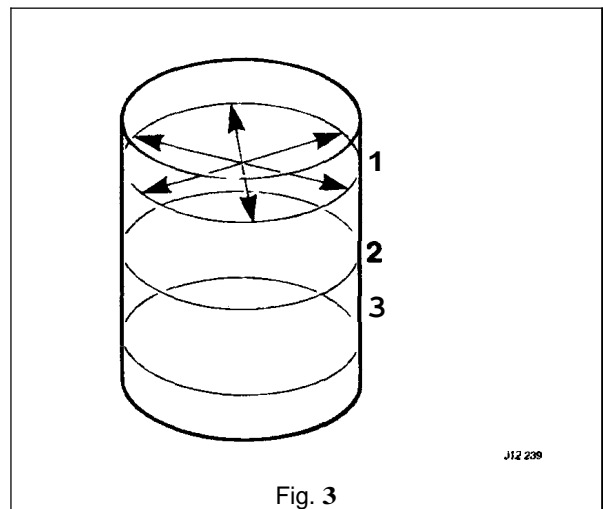


Fig. 3



- Insert each new piston ring into the cylinder bore, (1 Fig. 1) ensuring they are square in the cylinders and check the gap using a strip gauge (2 Fig. 1).
- If the gap is insufficient, then a small flat file or carborundum stone can be used on the butting ends of the ring. Ensure that after filing no burrs remain.

Note: Ensure that the rings are not inter-mixed after they have been gapped and that each piston/ring assembly is matched to its respective bore.

- Measure the piston skirt clearance using a long strip gauge. Insert the strip gauge down the right-hand side of the cylinder bore, insert the correct piston **INVERTED** into the bore (with the piston pin parallel to the axis of the crankshaft).

- Push the piston down the cylinder until it reaches its tightest point in the bore. At this point, withdraw the strip gauge; a steady resistance should be felt.

- If the tolerances are outside those given in Service Data in the Preliminary Pages, the pistons must be renewed as a complete set.

- Fit the new main bearing shell halves to the cylinder block and lubricate with clean engine oil.

- Clean and polish the crankshaft journals (remove any scratches with lapping tape, polishing in an anti-clockwise direction **ONLY**, against the crankshaft rotation), lubricate with clean engine oil and carefully assemble the crankshaft into the cylinder block.

- Fit the thrust washers ensuring that the grooved bearing face contacts the crankshaft (1 Fig. 2).

- Check the crankshaft rotates freely.

- Fit the remaining new bearing shell halves into the main bearing caps.

- Lubricate with clean engine oil.

- Fit the caps to the cylinder block.

- Start off the securing bolts (approximately 2 or 3 turns) and very gently tap the main bearing caps to ensure they are seated on the cylinder block.

- Check the crankshaft still rotates freely.

- Pull down each bearing cap individually and torque tighten the bolts.

- Check the crankshaft still rotates freely after pulling down each bearing cap.

- Check the crankshaft end-float, see Section 4.12.

- Fit new woodruff keys to the crankshaft, never re-use old ones.

- Fit the timing and oil pump sprockets to the crankshaft.

- Check the connecting rods for parallelism, twist and bend, using a suitable measuring jig (Figs. 3 and 4).

- If any connecting rod is unusable, then the complete set must be renewed.

- Lubricate the small end bush, slide the piston pin through the piston and connecting rod.

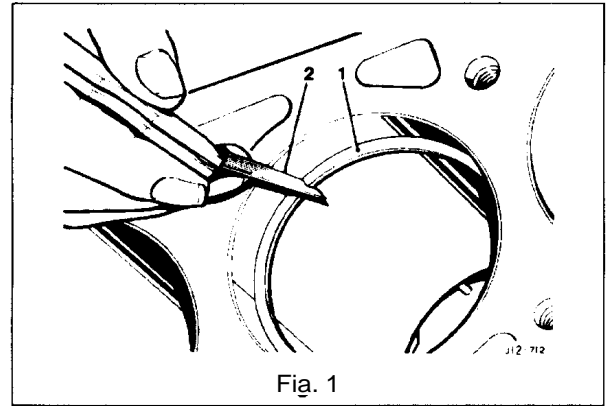


Fig. 1

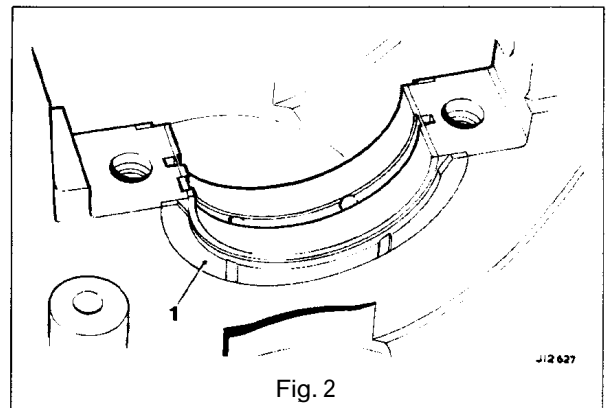


Fig. 2

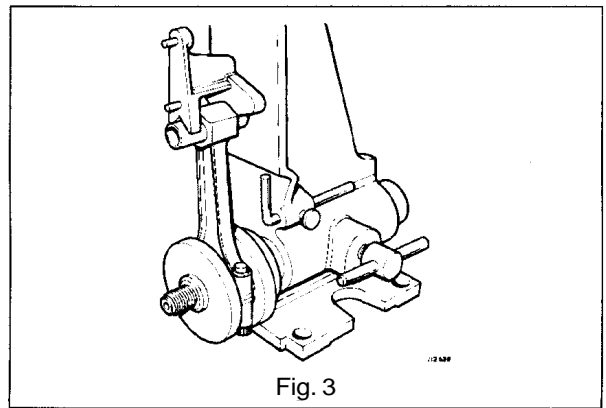


Fig. 3

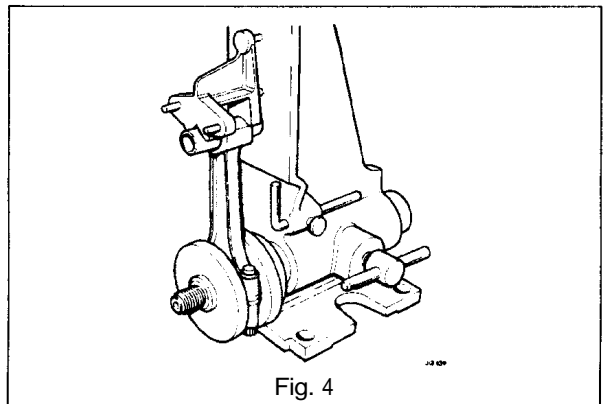


Fig. 4



Note: Pistons are marked 'FRONT'. Ensure that the marking faces the front of the engine.

- Secure with new snap-rings, never re-use old ones.
- Fit the rings to the pistons ensuring that gaps are positioned as shown in Fig. 1.
- Lubricate and compress the rings using Service Tool 18G 55A (Fig. 2).
- Insert the piston skirt into the bore and using a suitable implement such as a wooden hammer shaft, gently tap the piston into the cylinder bore.
- Ensure that the connecting rod does not foul either the cylinder block or camshaft.
- Lubricate (using clean engine oil) and fit the bearing shells to the connecting rod and the connecting rod bearing cap. Fit the rod to the crankshaft, and fit the connecting rod bearing cap to the connecting rod.

CAUTION: The connecting rod bearing nuts and bolts **MUST** be renewed during assembly and torque tightened as described in Section 2.1, SPS Joint Control System.

- Fit and tighten the connecting rod bearing nuts.
- Repeat the operation for the remaining pistons.
- Ensure crankshaft rotation during assembly.
- Clean and fit the windage trays. Fit and tighten the securing bolts.
- Remove the oil pump and overhaul, see Section 4.32. Refit when serviceable.
- Lubricate the lower timing chain. Fit the chain to the intermediate sprocket, fit the chain to the lower sprocket and then assemble the intermediate sprocket and chain to the cylinder block.
- Should the intermediate sprocket be worn or damaged, the assembly must be renewed.
- Fit the spacers to the lower pivoting damper and fit the assembly to the cylinder block.
- Fit the tab washer and securing bolts.
- Tighten the bolts and lock over the tabs.
- Renew the lower tensioner assembly, see Section 4.22.
- Fit a dial gauge to the top of the cylinder block and turn the engine over until No. 1 piston is at TDC (Fig. 3).
- Lubricate the upper chain with clean engine oil and fit to the intermediate sprocket.
- Fit an elastic band around the upper dampers to secure the chain.
- Renew the crankshaft front oil seal, see Section 4.13.
- Refit the timing cover.
- Lubricate and fit the oil seal distance spacer. Fit and seat the crankshaft pulley woodruff key.
- Renew the rear housing oil seal, see Section 4.14.
- Refit the oil pan, see Section 4.27.
- Refit the cylinder head, see Section 4.4.
- Remove the engine from the stand.
- Refit the transmission unit to the engine.
- Refit the engine / transmission unit to the vehicle, see Section 3.1 in the appropriate Vehicle Service Manual.

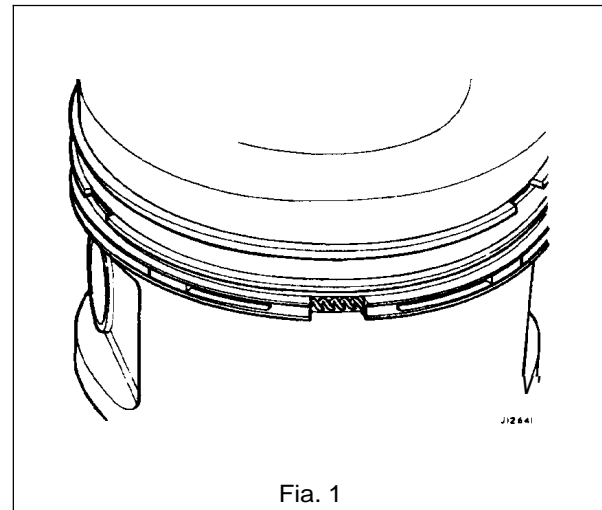


Fig. 1

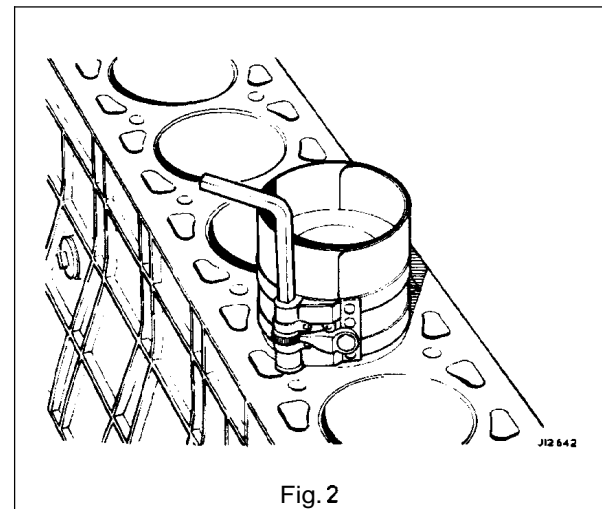


Fig. 2

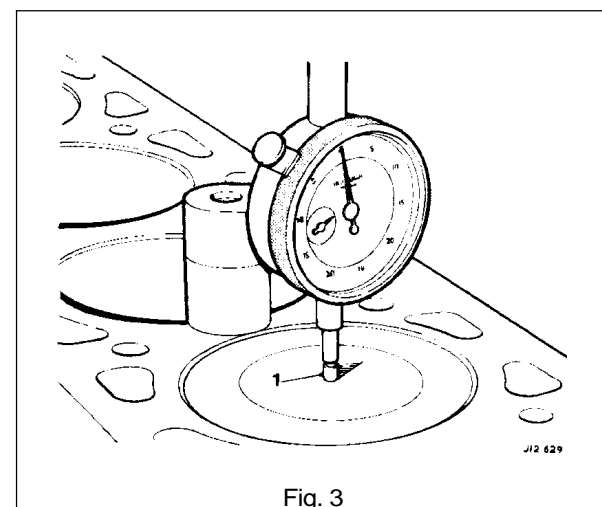


Fig. 3



4.19 Timing Chain, Gear and Tensioner, Engine Set, Renew

SRO 12.65.13

- Remove the timing cover.
- Remove the upper tensioner pedestal flanged securing bolts (3 Fig. 1).
- Remove the pedestal / tensioner assembly and chain damper (1 Fig. 1).
- Remove the tensioner pivot pin (2 Fig. 1) and remove the tensioner from the pedestal.
- Remove the flanged bolts (5 Fig. 1) securing the upper static damper and remove the damper (4 Fig. 1) and remove the damper pedestal and the upper timing chain (6 Fig. 1).
- Remove the lower timing chain tensioner securing bolts (11 Fig. 1) and remove the tensioner assembly (10, 12 Fig. 1).
- Remove the lower timing chain (8 Fig. 1) from the intermediate sprocket (9 Fig. 1).
- Remove the intermediate sprocket and bearing.
- Remove the bolts (16 Fig. 1) securing the oil pump drive chain damper and remove the damper (17 Fig. 1).
- Remove the flanged bolts securing the lower static damper (14 Fig. 1) and remove the damper (15 Fig. 1).
- Fit and tighten the bolt securing the crankshaft pulley. Fit Service Tool JD 130 chain link remover/ replacer (1 Fig. 2) to the master link (rotate the engine as necessary to align the link). Ensure the tool aligns to the master link, position the 'E' gate (2 Fig. 2) to the tool and seat behind the chain (3 Fig. 2).
- Fit and tighten the tool handle ensuring that the extractor cones (4 Fig. 2) line up with the link pins. Extract the link.
- Slacken the tool carefully ensuring that no components fall into the oil pan. Remove the oil pump chain.
- Remove the lower timing chain from the sprockets.
- Using a suitable drift, remove the crankshaft sprocket.
- Remove the power assisted steering pump assembly, see Section 10 in the appropriate Vehicle Service Manual.
- Remove the bolt securing the drive-plate. Remove the drive-plate.
- Remove the auxiliary shaft oil seal, see Section 4.25. Using right-angled snap-ring pliers, displace and remove the drive shaft snap-ring.
- Remove the drive shaft.
- Remove the drive shaft rear thrust washer.
- Fit Service Tool 18G 1434 to the bearing situated in the front of the cylinder block (2 Fig. 3). Locate the center peg. Tighten the tool nut to withdraw the bearing shell (1 Fig. 3).
- Remove the tool and shell assembly. Slacken off the tool nut and withdraw the center peg. Remove and discard the shell. Remove the blanking plate from the timing cover.
- Repeat the procedure to remove the timing cover and drive shaft housing bearing shells.

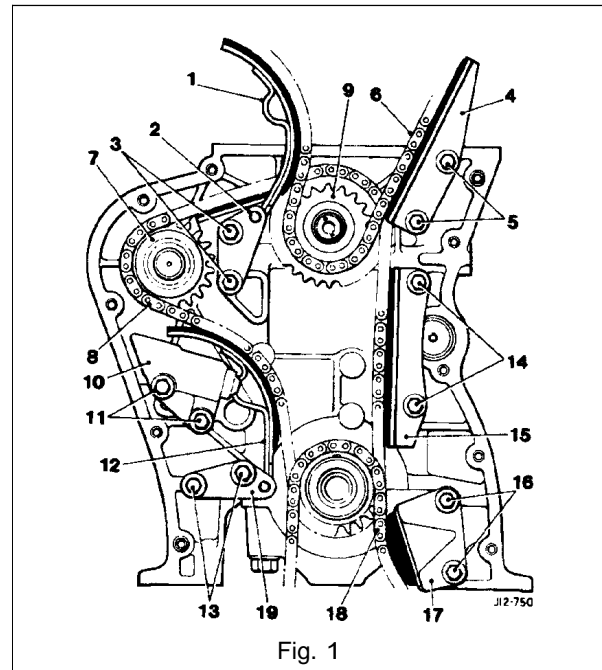


Fig. 1

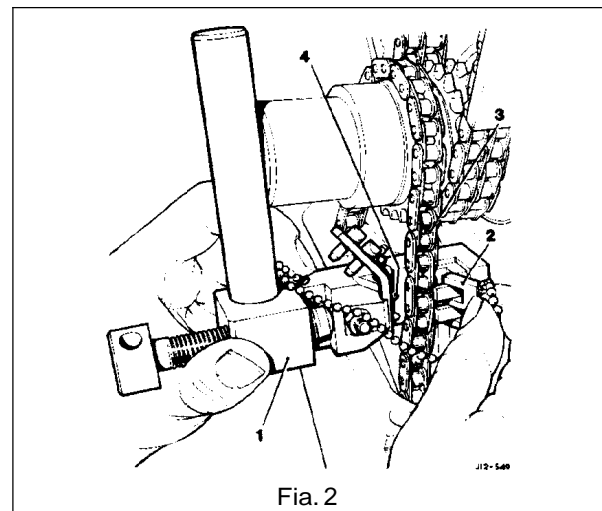


Fig. 2

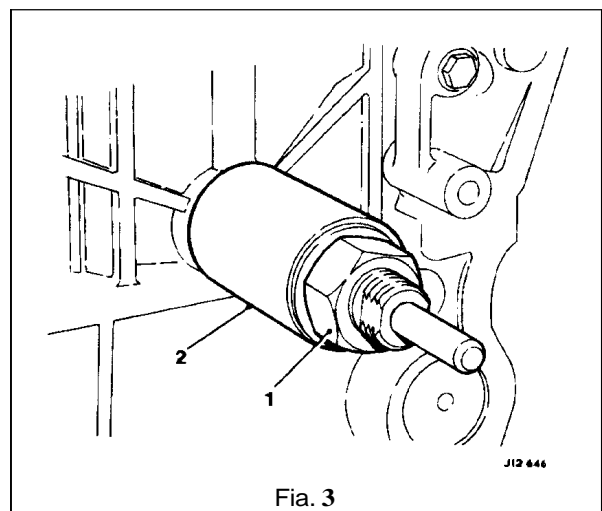


Fig. 3



- Clean all component parts and check for wear or damage, renew worn or damaged components as necessary. Check for wear and renew the auxiliary shaft bushes (1 Fig. 1) using Service Tool 18G 1434 (2 Fig. 1).
- Lubricate all bearing shells. Refit all shells using 18G 1434.

CAUTION: Ensure that the oil feed holes are lined up with the holes in the bearing shell (1 Fig. 2).

- Fit the timing cover blanking plate to the timing cover. Fit and tighten the securing bolts.
- Lubricate and fit the auxiliary shaft to the housing.
- Lubricate and fit the thrust washer.
- Refit the auxiliary shaft snap-ring.
- Fit a new oil seal to the rear of the shaft.
- Fit and align the oil pump drive-plate to the auxiliary shaft.
- Apply sealant to the bolt securing the drive plate, fit and tighten the bolt. See Service Materials in the Preliminary Pages.
- Refit the power assisted steering pump, see Section 10 in the appropriate Vehicle Service manual.
- Fit the new sprocket to the crankshaft.
- Using a straight edge (2 Fig. 3), check the alignment of the oil pump drive sprocket (1 Fig. 3), and the crankshaft sprocket (4 Fig. 3).
- If the alignment is incorrect, proceed as follows:
 - Push back the lock tabs from one bolt securing the oil pump drive sprocket, and remove the bolt.
 - Rotate the sprocket. Push back the lock tabs from the second bolt, and remove the bolt.
 - Rotate the sprocket, push back the lock tabs and remove the remaining bolt.
 - Remove the tab washer and drive sprocket.
 - Remove the shims (3 Fig. 3). Calculate the thickness of shim(s) required for correct sprocket alignment.
 - Fit and tighten a dummy stud to the oil pump drive flange. Fit and align the shims to the flange. Fit and align the sprocket. Fit and align the new tab washer.
 - Fit and tighten the first sprocket securing bolt. **Do not lock over the tab washer at this stage.**
 - Rotate the sprocket for access.
 - Fit and tighten the second sprocket securing bolt. Lock over the tab washer.
 - Rotate the sprocket for access.
 - Remove the dummy stud. Fit and tighten the third sprocket securing bolt. Lock over the tab washer.
 - Rotate the sprocket for access.
 - Re-tighten the first securing bolt. Lock over the tab washer.
 - Re-check the sprocket alignment.
 - Re-adjust as necessary.
- Lubricate the new timing chain and position the chain over the auxiliary drive shaft and crankshaft sprocket.
 - Lubricate the oil pump drive chain.
 - Fit the drive chain to the oil pump sprocket.
 - Engage the drive chain to the crank sprocket.
 - Ensure that the drive chain ends are on the damper side of the sprockets.

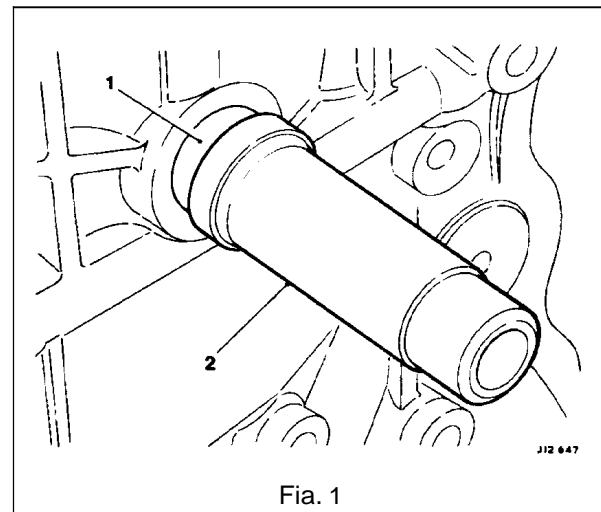


Fig. 1

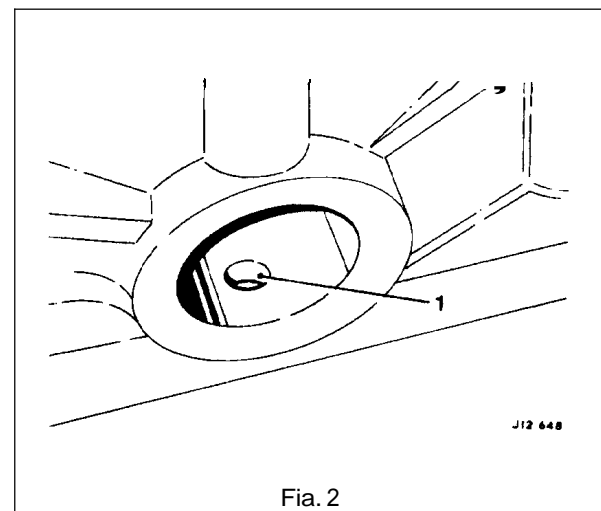


Fig. 2

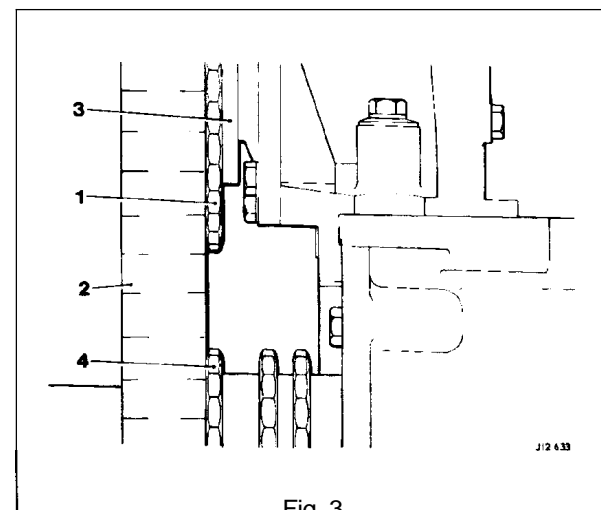
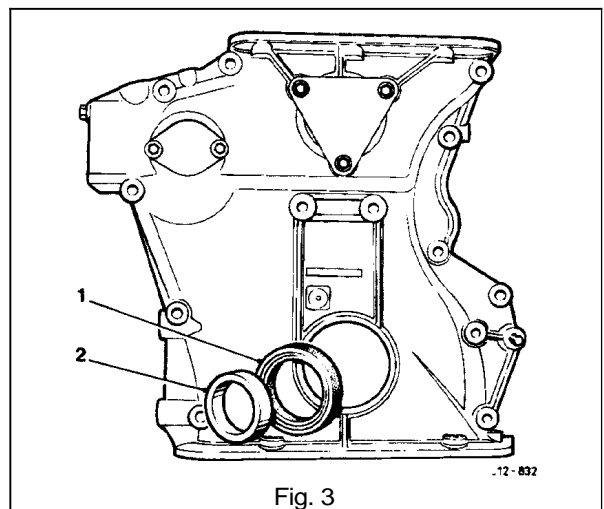
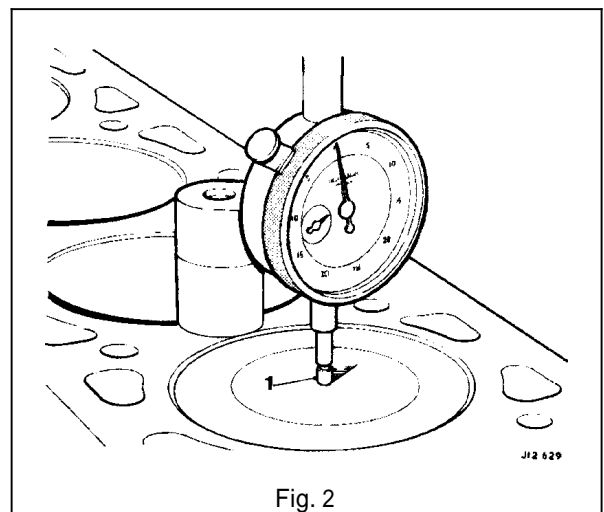
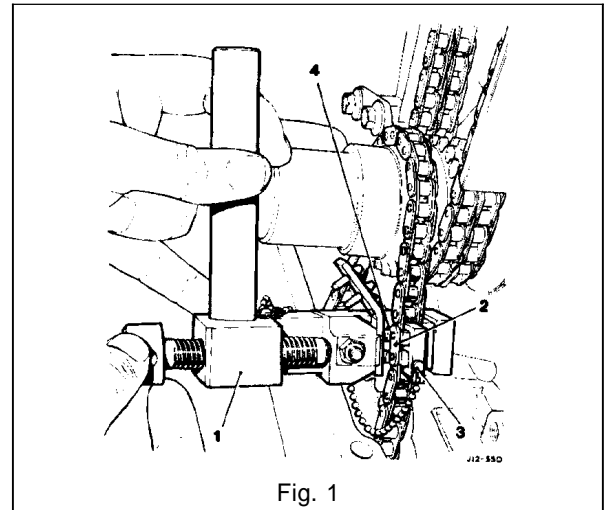


Fig. 3



- Fit a new link to the drive chain (2 Fig. 1).
- Fit and align a link plate to Service Tool JD 130 (1 Fig. 1). Ensure that the link and tool clamp holes are aligned. Fit the tool / link plate assembly to the drive chain.
- Fit the 'E' gate (3 Fig. 1) to the tool and chain link. Ensure that the chain is central to the tool. Tighten the tool center bolt, fully seating the plate on to the link.
- Slacken off the tool center bolt.
- Re-position the tool clamp (4 Fig. 1) away from the chain. Locate the link riveting head on to the clamp. Tighten the tool center bolt (finger tight, then further $\frac{1}{2}$ to $\frac{3}{4}$ turn). Slacken off the tool center bolt. Remove the tightening bar.
- Re-position the clamp away from the chain.
- Re-position the 'E' gate away from the tool / chain. Remove the tool retaining handle and remove the tool.
- Attach a dial test indicator to the top of the engine with the stylus resting on a piston. Rotate the engine and set No. 1 cylinder (Fig. 2) at TDC. Refit the lower static damper. Fit and tighten the securing bolts and lock over the tab washer. Fit the oil pump chain damper in position, do not tighten the securing bolts at this stage. Take any slack out of the chain using hand pressure to push the damper towards the center of the engine.
- Tighten the bolts securing the damper.
- Lubricate the intermediate sprocket bearing.
- Lift up the chain, engage the sprocket in the chain, and locate the sprocket into the bearing.
- Refit the lower tensioner assembly.
- Lubricate the upper timing chain.
- Refit the upper chain to the intermediate sprocket.
- Refit the upper static damper.
- Fit and tighten the securing bolts.
- Refit the upper tensioner.
- Renew the oil seal (1 Fig. 3) and refit the timing cover.





4.20 Timing Chain Damper, VehicleSet, Renew

SRO 12.65.48

- Remove the timing cover.
- Remove the upper tensioner pedestal flanged securing bolts (3 Fig. 1).
- Remove the pedestal / tensioner assembly and chain damper (1 Fig. 1).
- Remove the tensioner pivot pin (2 Fig. 1) and remove the tensioner from the pedestal.
- Remove the flanged bolts (5 Fig. 1) securing the upper static damper and remove the damper (4 Fig. 1) and remove the damper pedestal.
- Remove the lower timing chain tensioner securing bolts (11 Fig. 1) and remove the tensioner assembly (10, 12 Fig. 1).
- Remove the bolts (16 Fig. 1) securing the oil pump drive chain damper, remove the damper (17 Fig. 1).
- Remove the flanged bolts (14 Fig. 1) securing the lower static damper, and remove the damper (15 Fig. 1).
- Clean all component parts and check for wear or damage, renew worn or damaged components as necessary.
- Fit the oil pump chain damper in position, do not tighten the securing bolts at this stage. Take any slack out of the chain using hand pressure to push the damper towards the center of the engine and tighten the damper securing bolts.
- Refit the lower tensioner assembly.
- Refit the upper static damper. Fit and tighten these securing bolts. Refit the upper tensioner.
- Renew the timing cover oil seal and refit the timing cover.

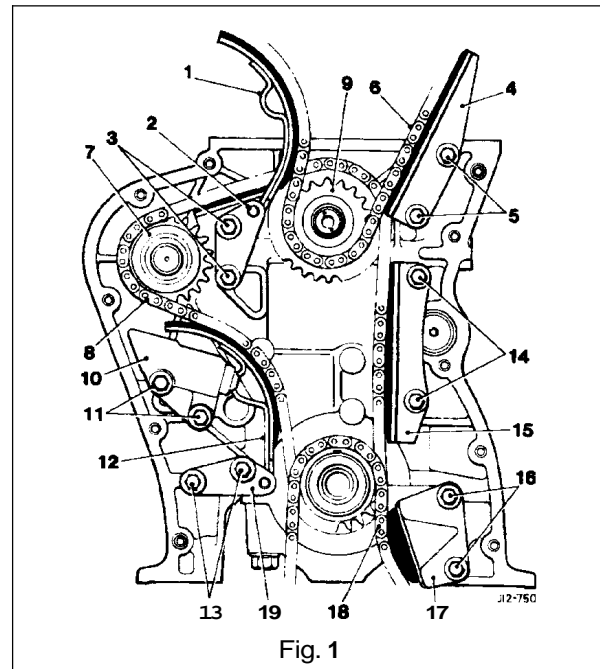


Fig. 1



4.21 Timing Chain Tensioner, Upper, Renew

SRO 12.65.29

- Remove the timing cover.
- Remove the upper timing chain (6 Fig. 1).
- Remove the flanged bolts (3 Fig. 1) securing the tensioner pedestal.
- Remove the pedestal / tensioner assembly and chain damper (1 Fig. 1).
- Remove the tensioner pivot pin (2 Fig. 1) and remove the tensioner from the pedestal.
- Clean the pivot pin.
- Fit a new tensioner to the pedestal and fit the tensioner pivot pin. Secure the tensioner with the flanged bolts.
- Align the damper to the tensioner and fit the damper / tensioner assembly to the engine.
- Ensure that the damper does not foul the auxiliary shaft sprocket.
- Finally tighten the securing bolts.
- Fit the new timing chain.
- Re-position the upper tensioner and temporarily secure to the upper dampers with an elastic band.
- Renew the timing cover oil seal and refit the timing cover.

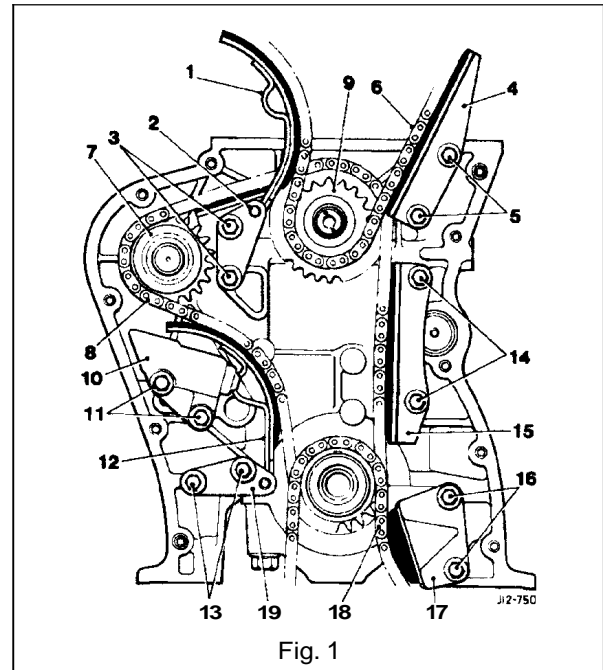


Fig. 1



4.22 Timing Chain Tensioner, Lower, Renew

SRO 12.65.30

- Remove the timing cover.
- Remove the upper timing chain (6 Fig. 1) and remove the flanged bolts (3 Fig. 1) securing the tensioner pedestal.
- Remove the pedestal / tensioner assembly and chain damper (1 Fig. 1).
- Remove the tensioner pivot pin (2 Fig. 1) and remove the tensioner from the pedestal.
- Remove the bolts (11 Fig. 1) securing the lower timing chain tensioner, and remove the tensioner assembly (10 Fig. 1).
- Remove the lower timing chain (8 Fig. 1).
- Clean the lower tensioner assembly, remove the ball valve (1 Fig. 2) and ensure that the base of the housing (2 Fig. 2) is clean.
- Check that the ball valve is free by shaking the assembly to ensure it rattles. If it does not, renew the valve assembly. If it does, renew and lubricate the 'O'ring (3 Fig. 2) and press the valve back into the housing. The ball free movement is 0,45–0,74 mm.
- Inspect the housing and the hydraulic tensioner piston (4 Fig. 2) for excessive wear or scoring. Also check that the oil hole (5 Fig. 2) is clear in the end of the piston.
- Lubricate the component parts with clean engine oil. Assemble the tensioner by pressing and twisting the snail clockwise until the pawl locks in the 'park' position. Fit the tensioner assembly to the cylinder block with the guide facing downwards.
- Fit but do not tighten the tensioner upper securing bolt, push the guide into the housing to release the base and align with the damper.
- Align the damper with the lower bolt hole, fit and tighten the lower bolt.
- Tighten the upper bolt, fill the tensioner oil reservoir with oil and work the tensioner to prime with oil.
- Fit the upper tensioner to the pedestal and fit the tensioner pivot pin, and secure with the flanged bolts (6 Fig. 2).
- Fit the lower static damper, and secure with the flanged bolts.

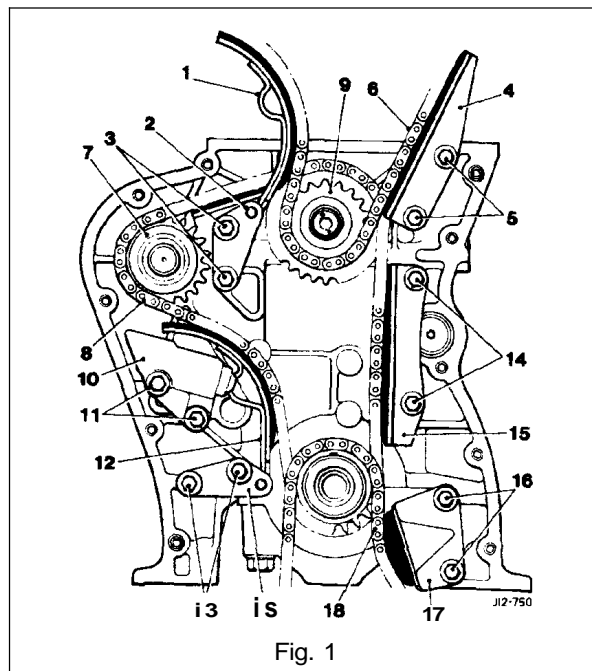


Fig. 1

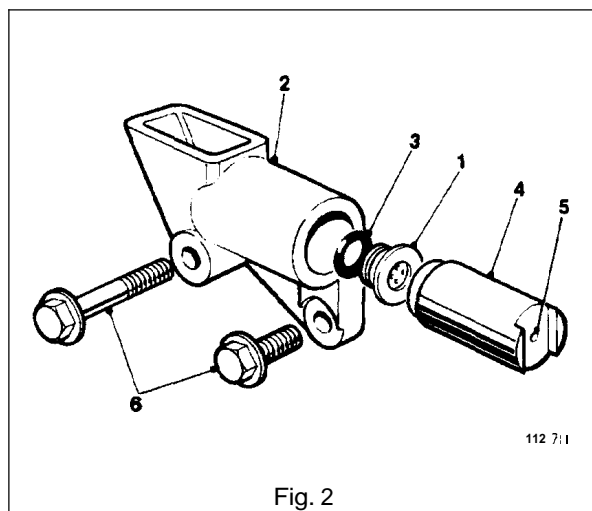


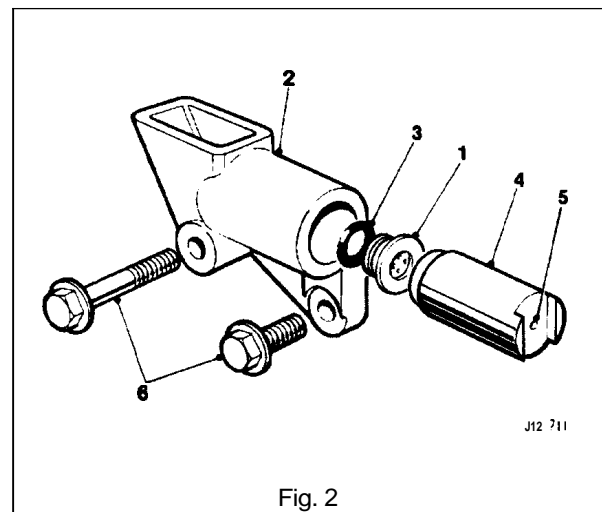
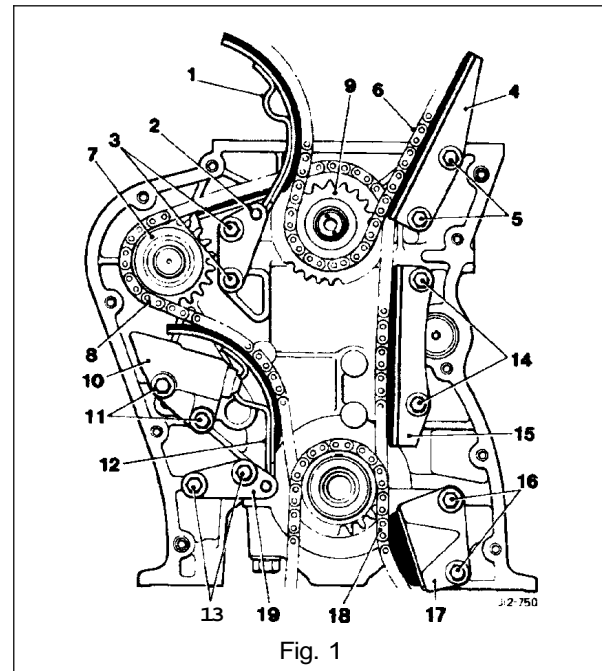
Fig. 2



4.23 Timing Sprocket, Intermediate, Renew

SRO 12.65.26

- Remove the timing cover.
- Remove the upper timing chain (6 Fig. 1) and remove the flanged bolts (3 Fig. 1) securing the tensioner pedestal.
- Remove the pedestal / tensioner assembly and chain damper (1 Fig. 1).
- Remove the tensioner pivot pin (2 Fig. 1) and remove the tensioner from the pedestal.
- Remove the bolts (11 Fig. 1) securing the lower timing chain tensioner and remove the tensioner assembly (10 Fig. 1).
- Remove the lower timing chain (8 Fig. 1).
- Remove the intermediate sprocket (9 Fig. 1).
- Examine all components (1-6 Fig. 2) for wear or damage.
- Renew worn or damaged parts as necessary.
- Fit the new intermediate sprocket.
- Fit the lower timing chain. Fit the guide assembly, valve and 'O' ring to the tensioner housing. Re-position the chain damper for access.
- Fit the tensioner assembly to the cylinder block with the guide facing downwards.
- Fit but do not tighten the tensioner upper securing bolt, push the guide into the housing to release the base and align with the damper.
- Align the damper with the lower bolt hole, fit and tighten the lower bolt.
- Tighten the upper bolt, fill the tensioner oil reservoir with oil and work the tensioner to prime with oil.
- Fit the upper tensioner to the pedestal and fit the tensioner pivot pin, and secure with the flanged bolts.
- Align the damper to the tensioner and fit the damper! tensioner assembly to the engine.
- Tighten the securing bolts.
- Refit the upper timing chain.
- Re-position the upper tensioner and temporarily secure to the upper dampers with an elastic band.
- Renew the timing cover oil seal and refit the timing cover.

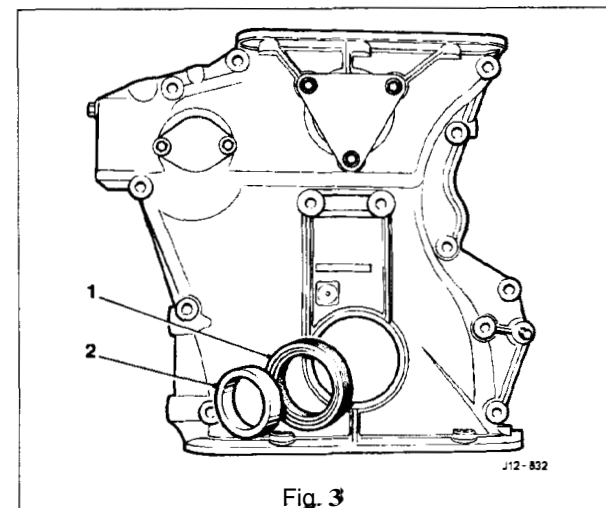
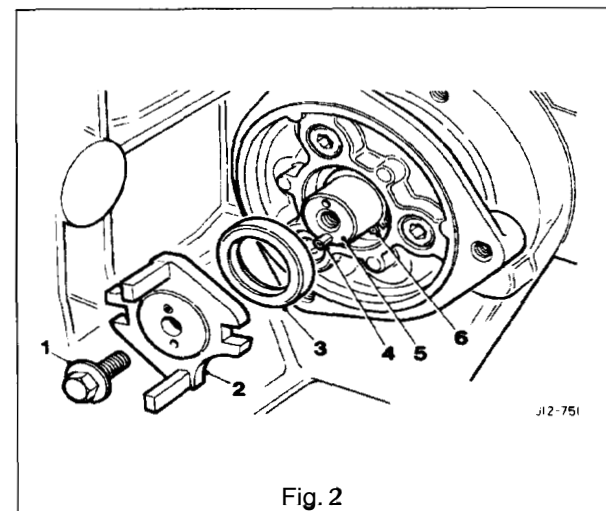
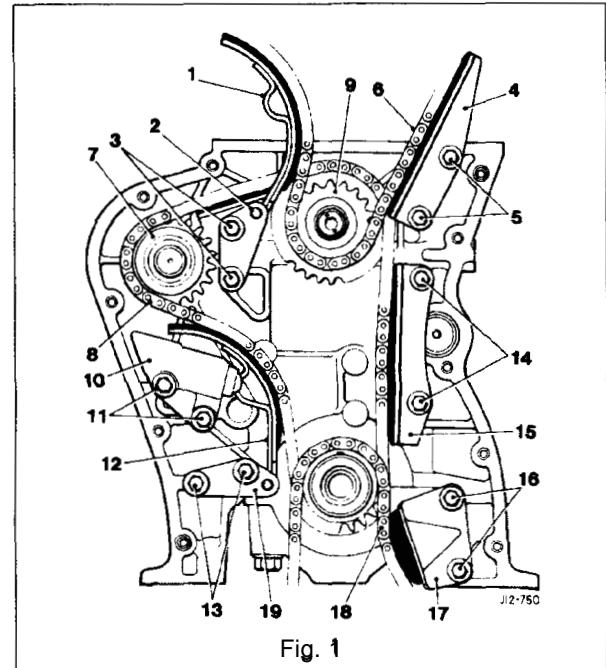




4.24 Auxiliary Shaft, Renew

SRO 12.10.30

- Remove the timing cover.
 - Remove the pulley woodruff key and remove the oil seal spacer from the crankshaft.
 - Remove the flanged bolts (3 Fig. 1) securing the tensioner pedestal.
 - Remove the pedestal / tensioner assembly and chain damper (1 Fig. 1).
 - Remove the tensioner pivot pin (2 Fig. 1) and remove the tensioner from the pedestal. Clean the pivot pin.
 - Remove the flanged bolts (5 Fig. 1) securing the upper static damper. Remove the damper (4 Fig. 1) and upper timing chain (6 Fig. 1).
 - Remove the bolts (11 Fig. 1) securing the chain tensioner and remove the assembly (17 Fig. 1).
 - Remove the power assisted steering pump assembly, see Section 10 in the appropriate Vehicle Service manual
 - Remove the pump drive coupling.
 - Remove the flanged bolt (1 Fig. 2) and the drive-plate (2 Fig. 2).
 - Using Service Tool JD 118, remove the auxiliary shaft rear oil seal (3 Fig. 2) from its housing.
 - Using right-angled snap-ring pliers remove the snap-ring (5 Fig. 2) securing the drive shaft (4 Fig. 2).
 - Lift the timing chain (8 Fig. 1) from the sprocket (7 Fig. 1), remove the shaft / sprocket assembly and retrieve the thrust washer.
 - Clean all component parts and check for wear or damage. Renew worn or damaged parts as necessary. Clean the auxiliary bearing housing.
 - Check for wear and if necessary change the auxiliary shaft bushes.
 - Refit the housing with new gasket. Fit and tighten the securing bolts.
 - Lubricate the shaft and refit the to the housing, engaging the chain with the gear as it is fitted. Lubricate and fit the thrust washer and secure with the snap-ring.
 - Renew the auxiliary shaft rear oil seal, see Section 4.25.
 - Refit the power assisted steering pump assembly, see Section 10 in the appropriate Vehicle Service manual.
 - Refit the lower chain tensioner, see Section 4.22.
 - Refit the upper chain tensioner, see Section 4.21.
 - Renew the oil seal (1 Fig. 3) and refit the timing cover.





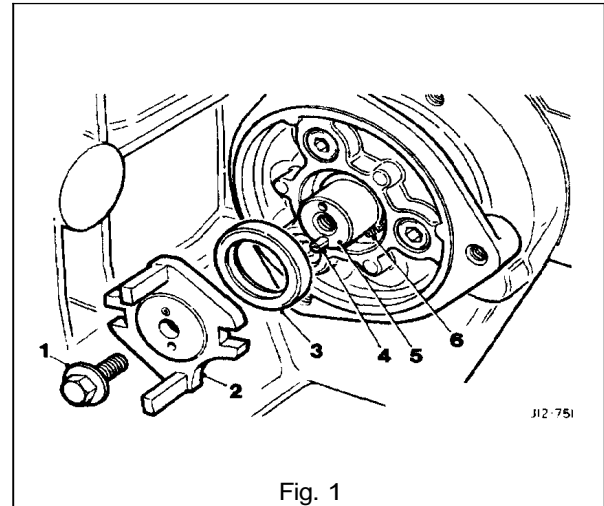
4.25 Auxiliary Shaft Rear Seal, Renew

SRO 12.10.32

- Remove the power assisted steering pump assembly, see Section 10 in the appropriate Vehicle Service Manual.
- Remove the pump drive coupling.
- Remove the flanged bolt (1 Fig.1) and the drive-plate (2 Fig. 1).
- Using Service Tool JD 118, remove the auxiliary shaft rear oil seal (3 Fig. 1) from its housing.

Note: Under no circumstances must the plastic insert be removed prior to fitting the seal.

- Using Service Tool 18G 1469 fit and fully seat the auxiliary shaft oil seal.
- Refit the power steering pump drive-plate and secure with its bolt.
- Refit the power assisted steering pump assembly, see Section 10 in the appropriate Vehicle Service Manual.

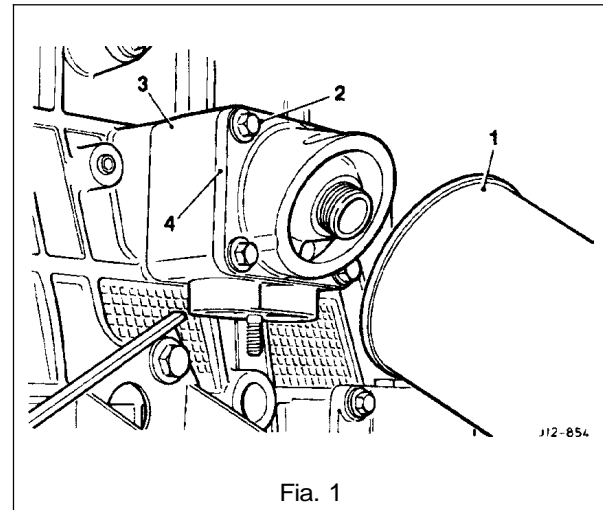




4.26 Oil Filter Head Gasket, Renew

SRO 12.60.03

- Place a drain tray under the oil filter.
- Remove the oil filter cartridge (1 Fig. 1).
- If the vehicle is fitted with an oil cooler, remove the oil cooler pipe clamp nut and clamp. Note the position of and disconnect the pipes from the oil supply housing.
- Remove and discard the 'O' rings. Remove the filter head securing bolts (2 Fig. 1).
- Remove the inner (3 Fig. 1) and outer (4 Fig. 1) housings.
- Thoroughly clean the housings, the oil cooler pipes (if fitted) and the cylinder block face.
- Apply sealant to the outer housing, align the inner housing with the outer housing and fit the securing bolts to the housing assembly. See Service Materials in the Preliminary Pages. Align the assembly to the aperture in the cylinder block, fit and tighten the securing bolts.
- If the vehicle is fitted with an oil cooler, fit new 'O' rings to the oil cooler pipes. Lubricate and connect the pipe to the housing.
- Fit the clamp plate and fit a new oil filter.
- Fill the engine with oil to the correct level, see Section 3.1 in the appropriate Vehicle Service Manual.





4.27 Oil Pan Gasket, Renew

SRO 12.60.38

Remove components as required for access and proceed as follows.

- Drain the engine oil, see Section 3.1 in the appropriate Vehicle Service Manual.
- Remove all but two oil pan bolts (1 Fig. 1).
- Remove the bell housing to oil pan bolts.
- Remove the two remaining oil pan bolts and lower the oil pan (2 Fig. 1).
- Clean all components and examine for damage and wear. Renew any damaged components. Discard the oil pan gasket.

Note: If renewing the oil pan, transfer all components to the new oil pan.

- Clean the gasket face on the cylinder block.
- Fit new oil pan gasket.
- Lift the oil pan into position, fit and torque tighten the securing bolts.
- Fill the engine with oil to the correct level, see Section 3.1 in the appropriate Vehicle Service Manual.

Replace the components removed for access.

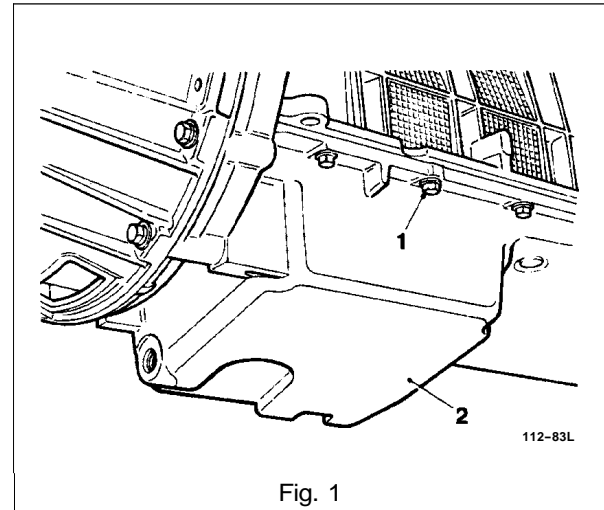


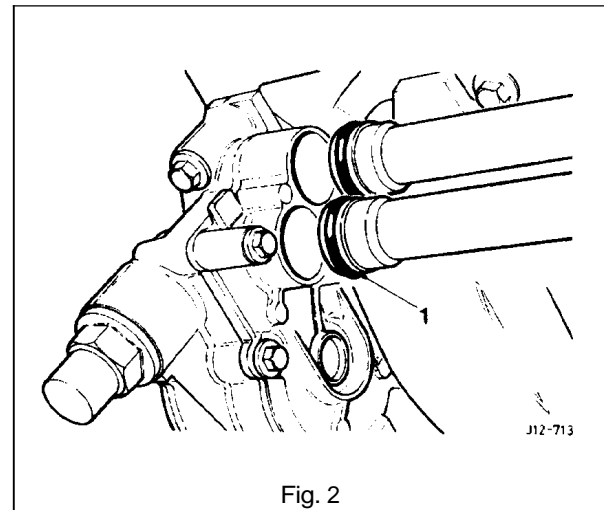
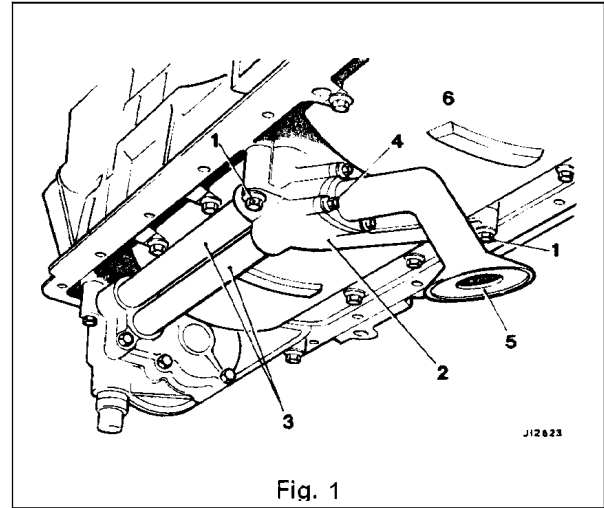
Fig. 1



4.28 Oil Pump Pipe 'O' Rings, Renew

SRO 12.60.27

- Remove the oil pan, see Section 4.27.
- Place a suitable drain tray under the oil transfer housing area and remove the transfer housing / pick-up pipe (1, 2, 4, 5 Fig. 1).
- Remove the oil pump pick-up pipes (3 Fig. 1).
- Remove and discard the 'O' rings. Clean the transfer housing and oil pipes.
- Carefully fit new 'O' rings (lubricated with petroleum jelly) to the oil pipes (1 Fig. 2) and refit the pipes to the oil pump.
- Fit the transfer housing to the engine. Fit and tighten the securing bolts.
- Refit the oil pan, see Section 4.27.

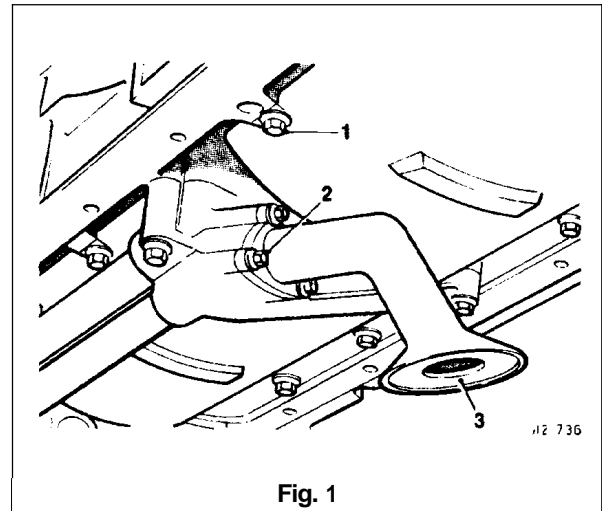




4.29 Oil Pick-up Strainer, Renew

SRO 12.60.20

- Remove the oil pan, see Section 4.27.
- Remove the bolts securing the rear windage tray (1 Fig. 1) to the cylinder block and remove the tray.
- Remove the three bolts (2 Fig. 1) securing the strainer and remove the strainer (3 Fig. 1).
- Clean all components and examine for damage and wear.
- Apply sealant to the replacement strainer, and fit and secure to the housing with the bolts. See Service Materials in the Preliminary Pages.
- Refit the rear windage tray to the cylinder block and secure with the bolts.
- Refit the oil pan, see Section 4.27.





4.30 Oil Pressure Relief Valve Assembly, Renew

SRO 12.60.56

- Remove the oil pan, see Section 4.27.
- Remove oil pressure relief valve screw cap (1 Fig. 1) and collect spring (2 Fig. 1), valve (4 Fig. 1), and mandrel (3 Fig. 1).
- Check the valve spring and mandrel for wear, scoring or pitting, renew if damaged.
- Measure the components against the specifications listed in Service Data in the Preliminary Pages.
- If any of the components are suspect, they must be renewed.
- Lubricate and assemble the mandrel, spring and valve.
- Fit and tighten the relief valve screw cap.
- Refit the oil pan, see Section 4.27.

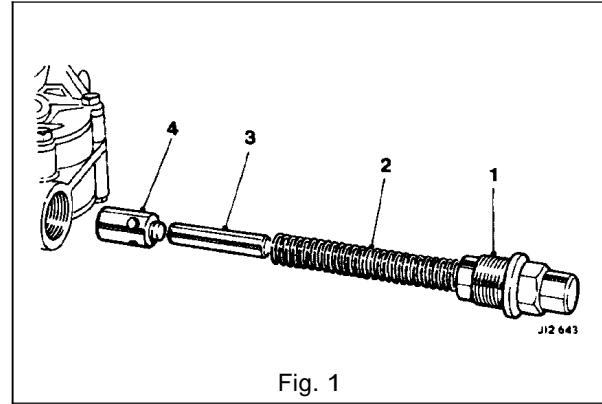


Fig. 1



4.31 Oil Pump, Renew

SRO 12.60.26

- Remove the oil pan, see Section 4.27.
- Place a drain tray under the transfer housing. Remove the housing bolts and housing (1, 2 Fig. 1).
- Remove the pick-up pipes (3 Fig. 1), push back the lock tabs (1 Fig. 2) and remove the pump sprocket bolts (2 Fig. 2).
- Remove the oil pump drive sprocket (3 Fig. 2), tab washer (4 Fig. 2) and shims.
- Remove the oil pump securing bolts and remove the pump.
- Remove the pressure relief valve cap, spring, mandrel and valve (1-4 Fig. 3).
- Clean the mating face in the cylinder block, the relief valve assembly, sprocket and shims.
- Lubricate the relief valve assembly, assemble into new pump, tighten the cap.
- Fit the new oil pump to the engine and tighten these securing bolts.
- Move the drive chain as far rearward as possible, fit a shim pack of 0.015in. thickness to the oil pump flange (3 Fig. 4), align the bolt holes, fit the drive sprocket and two securing bolts. Using a straight edge (2 Fig. 4), check the alignment of the oil pump drive sprocket (1 Fig. 4) and crankshaft sprocket (4 Fig. 4).
- Remove and refit the pump drive sprocket and adjust the value of shim thickness as required in order to align the sprockets.
- When the alignment is satisfactory, remove the pump sprocket. Fit the chain and shims to the sprocket, fit to the oil pump. Fit the tab washer and securing bolts. Tighten the bolts and lock over the tabs.
- Ensure that the tension of the oil pump drive chain is correct, see Service Data in the Preliminary Pages. Adjust by slackening the tensioner securing screws, tapping the tensioner inwards to increase the tension, and securing in position when the tension is correct.
- Fit new 'O rings to the oil pump pick-up pipes.
- Lubricate and refit the pipes to the pump.
- Fit and seat the transfer housing. Fit and tighten the securing bolts.
- Refit the oil pan, see Section 4.27.

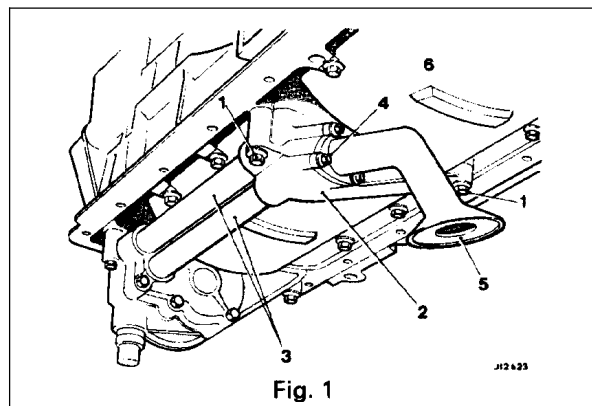


Fig. 1

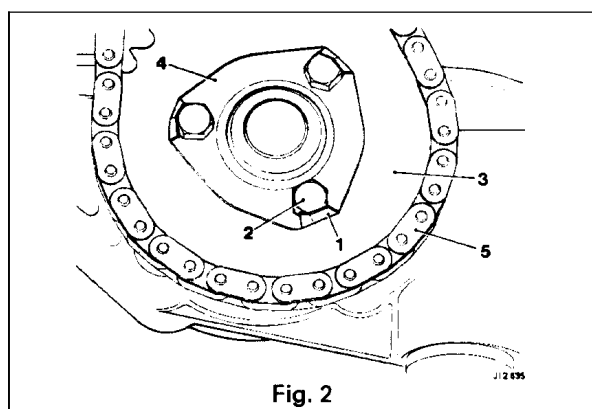


Fig. 2

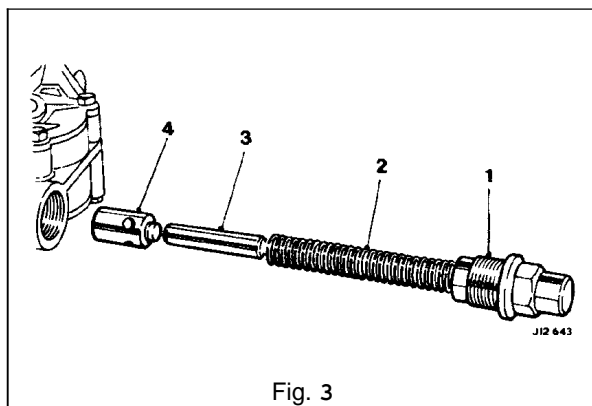


Fig. 3

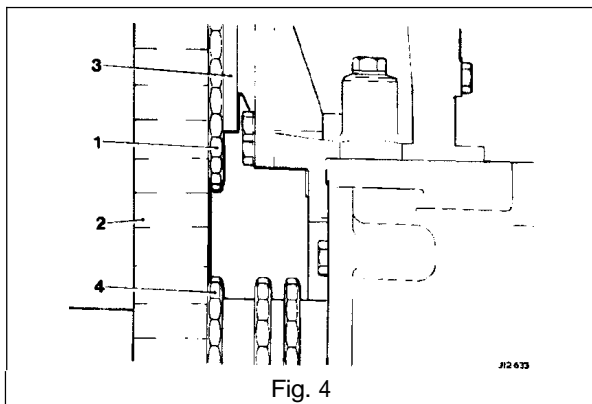


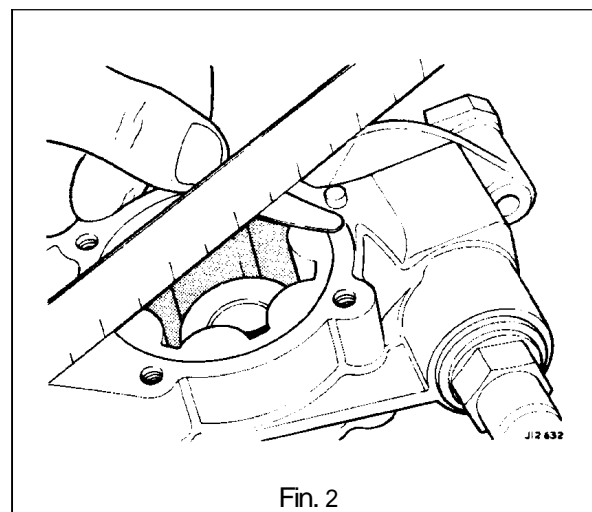
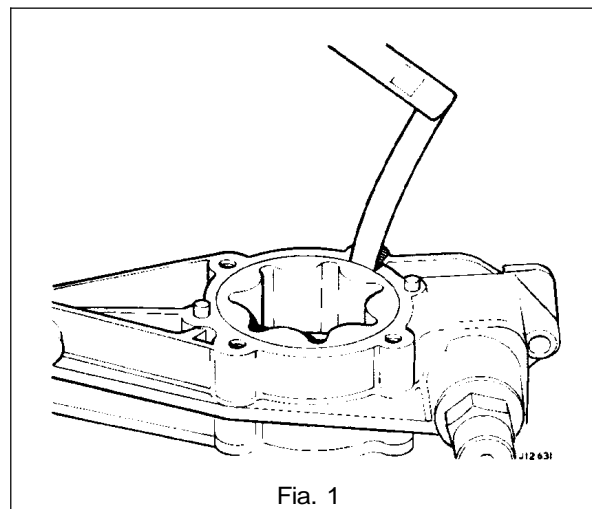
Fig. 4



4.32 Oil Pump, Overhaul

SRO 12.60.32

- Remove the oil pump, see Section 4.31.
- Remove the bolts securing the pump body.
- Remove the pump body, pump outer rotor, backplate securing bolts, the backplate and the bearing shell.
- Clean all component parts of the pump.
- Check all the clearance and components for undue wear (Fig. 1) and (Fig. 2). Check tolerances, see Service Data in the Preliminary Pages.
- Fit the bearing shell to the housing.
- Apply sealant to the backplate gasket face, fit the backplate and securing bolts. See Service Materials in the Preliminary Pages.
- Fit the outer rotor.
- Lubricate the relief valve assembly and assemble into the pump.
- Tighten the relief valve cap.
- Refit the oil pump, see Section 4.31.



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