

CHAPTER 1

THE ENGINE

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1:1 Description

The engine is an in-line, six-cylinder, single overhead camshaft unit with crossflow induction and exhaust. A section through a cylinder and valve gear is shown in **FIG 1:1**, a section through the engine timing gear in **FIG 1:2**. The camshaft is driven by roller chain from a sprocket on the crankshaft. The valves, set in line along each side of the light alloy cylinder head, operate in pressed-in valve guides. Cast iron valve seat inserts are provided at each valve position in the head. The valves are operated from the camshaft by means of rockers, an eccentric device being provided at each rocker tip to allow for valve clearance adjustment. The camshaft drives the distributor by means of a gear, and is provided with a special eccentric to operate the mechanical fuel pump.

The cylinder block is integral with the upper half of the crankcase, the lower half of which is formed by the oil sump. The light alloy pistons run directly in the crankcase bores, each piston being provided with two compression rings and a single oil control ring.

The counterbalanced crankshaft is a special steel casting. Crankshaft axial play is taken by a thrust bearing. The main and big-end bearings are provided with renewable shell-type inserts.

A rotor (Eaton type) oil pump driven by chain from the crankshaft sprocket draws oil from the sump beneath the engine and supplies it to the system under pressure. A relief valve is fitted to the system to limit the maximum oil pressure when the engine is cold. Pressure oil is fully filtered before being passed to the main oil gallery which runs along the lefthand side of the engine. From this point the oil is routed to the main and big-end bearings and to the camshaft and rocker shaft support bearings. The valve gear is lubricated by jets from an oil pipe and from oil draining from the rocker shaft and camshaft bearings, the pistons and cylinders being lubricated directly by supply jets and indirectly by oil splash from the big-end bearings.

1:2 Removing and refitting the engine

The normal operations of decarbonising and servicing the cylinder head can be carried out without the need for engine removal, as can the majority of engine servicing procedures, including the removal of piston and connecting rod assemblies. However, if crankshaft removal is necessary or if attention to the cylinder bores is required, engine removal will be necessary. For some overhaul work, certain special tools are essential and

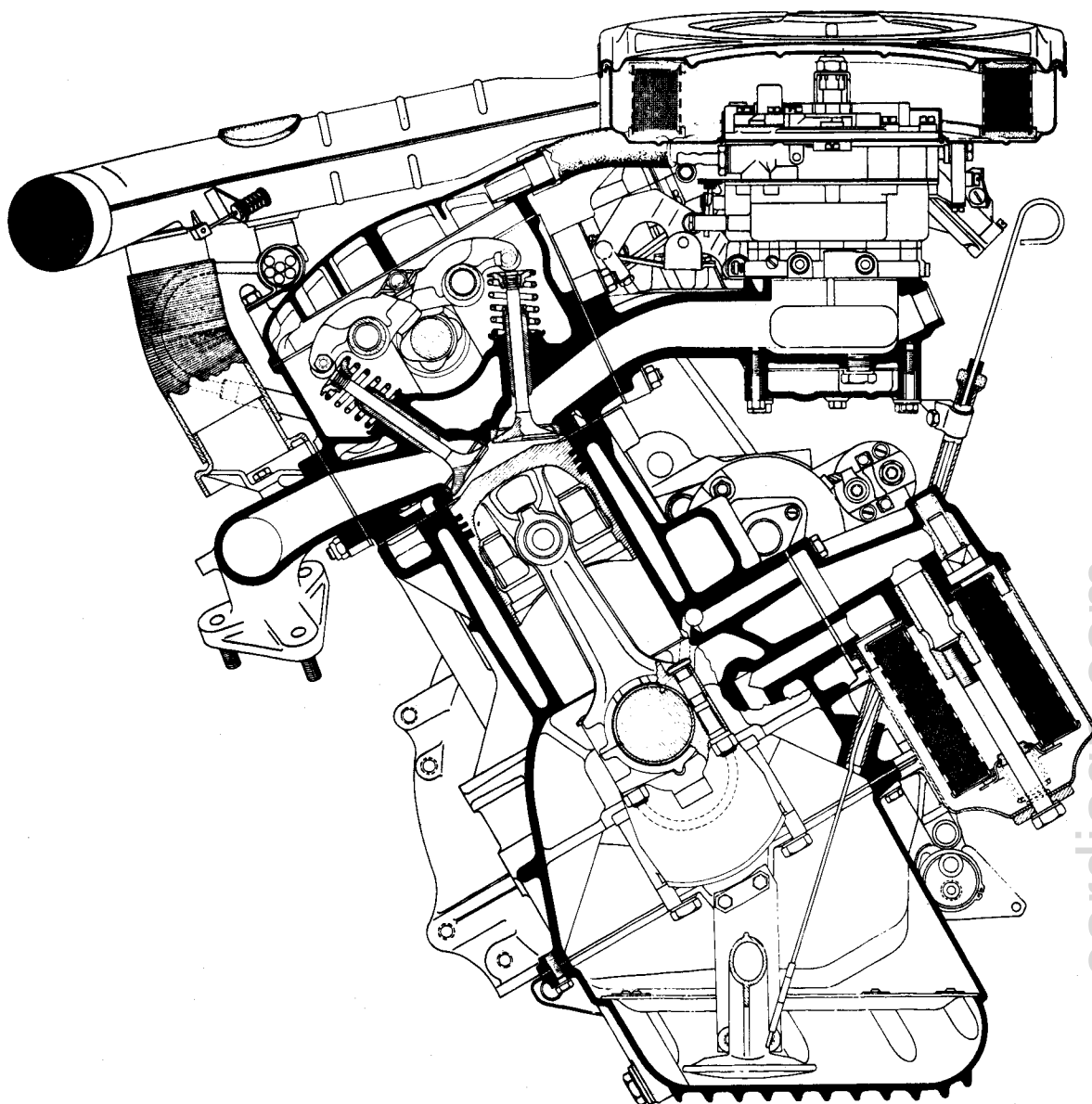


FIG 1:1 Section through engine cylinder, head and valve gear

the owner would be well advised to check on the availability of these factory tools or suitable substitutes before tackling the items involved. If the operator is not a skilled automobile engineer, it is suggested that much useful information will be found in **Hints on Maintenance and Overhaul** at the end of this manual and that it be read before starting work. It must be stressed that the lifting equipment used to remove the engine from the car should be sound, firmly based and not likely to collapse under the weight it will be supporting.

Owners of vehicles fitted with air conditioning (refrigeration) systems should consult a BMW

service station before attempting engine removal procedures, or any servicing procedure which involves the disconnecting or removal of system components or hoses, so that advice can be obtained concerning the discharging of the system. If the pressurised system is opened, liquid refrigerant will escape, immediately evaporating and instantly freezing anything it contacts. Uncontrolled release of the refrigerant will cause severe frostbite or possibly more serious injury if it contacts any part of the body. For this reason, all work involving air conditioning system

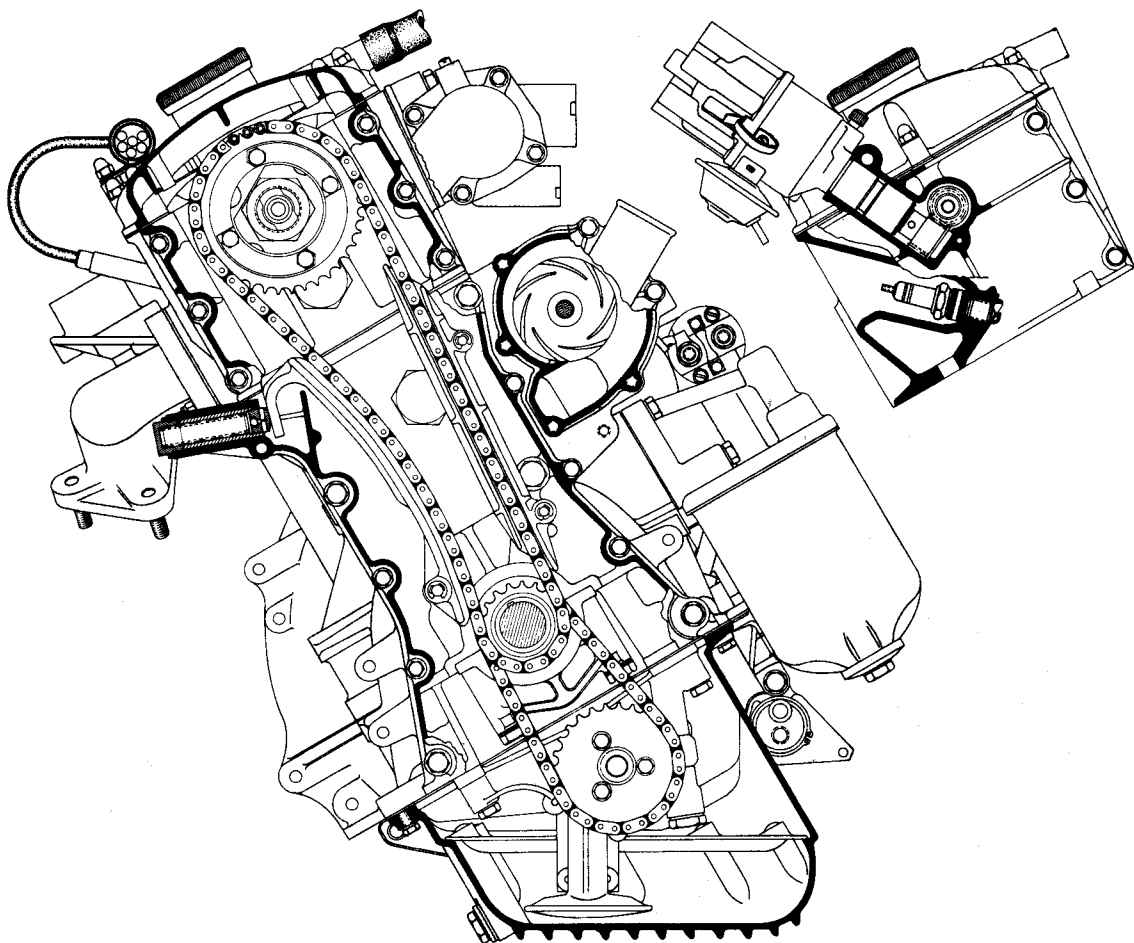


FIG 1:2 Section through engine valve timing gear

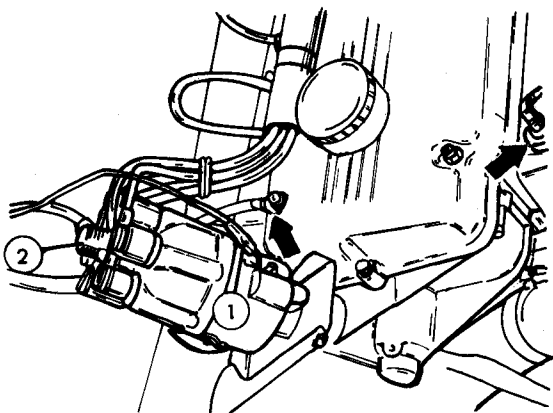


FIG 1:3 Disconnecting wiring and earth lead

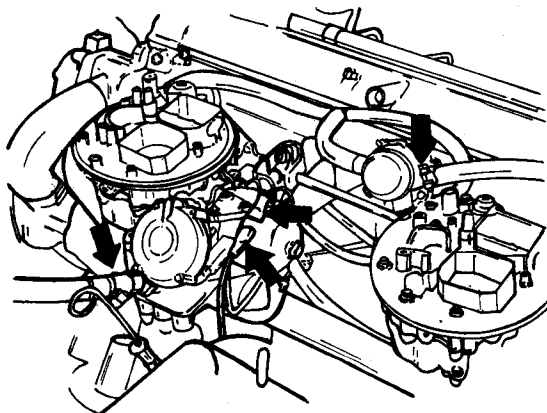


FIG 1:4 Disconnecting hoses and wiring

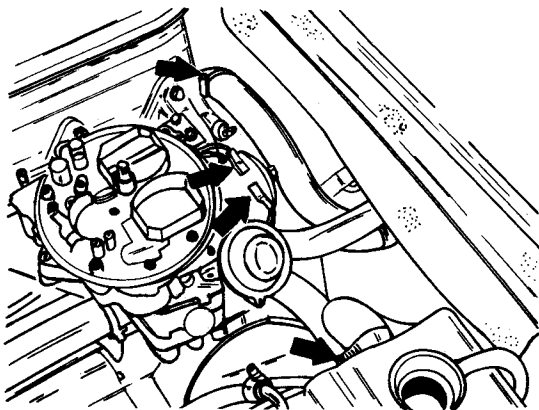


FIG 1:5 Disconnecting hoses and wiring

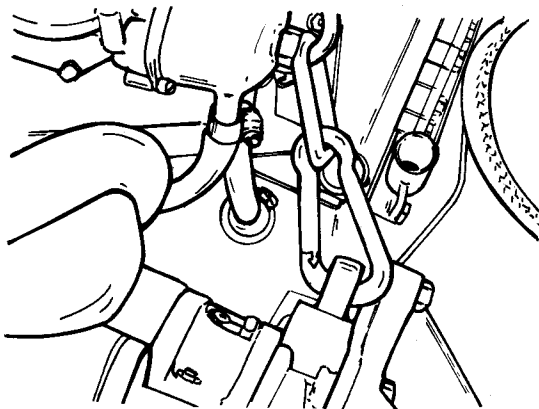


FIG 1:8 Engine rear lifting lug

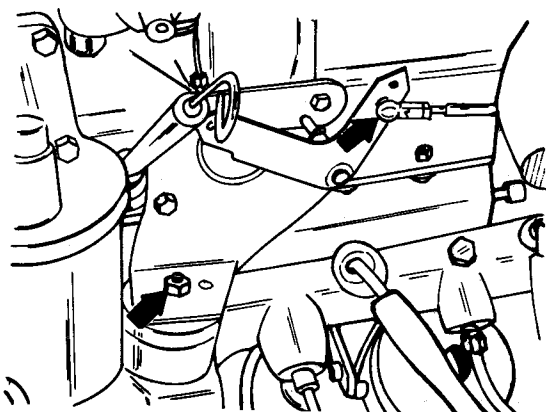


FIG 1:6 Disconnecting accelerator linkage and engine mounting

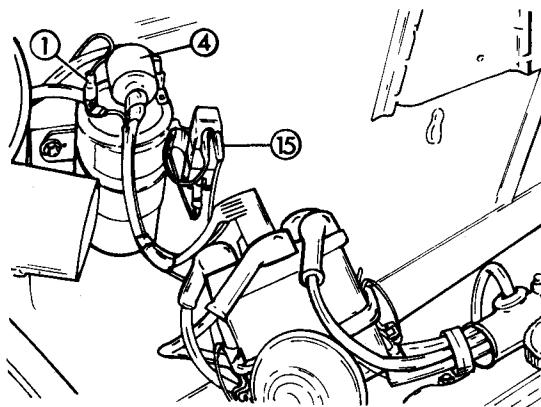


FIG 1:9 Disconnecting cables from coil

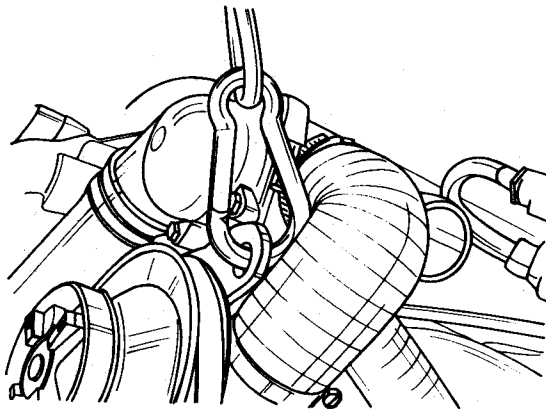


FIG 1:7 Engine front lifting lug

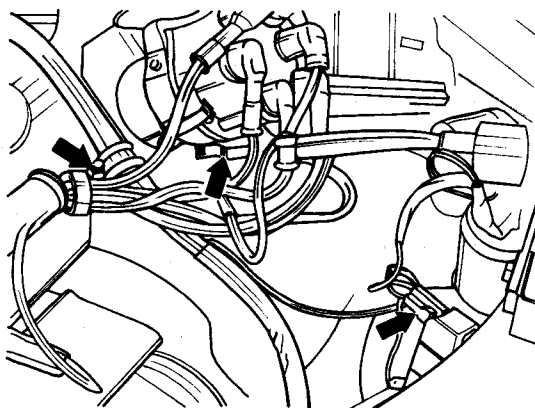


FIG 1:10 Cable plugs and clamp

components, apart from the servicing procedures described in Chapter 13, should be entrusted only to a BMW service station having the necessary special equipment and trained personnel.

Removal, models equipped with carburettors:

Disconnect the battery earth cable. Refer to **Chapter 13** and remove the bonnet, then to **Chapter 4** and remove the radiator. Remove the screenwash reservoir, then refer to **Chapter 2** and remove the air cleaner assembly.

Refer to **FIG 1:3** and disconnect cables 1 and 2 and the earth lead (arrowed) from the rocker cover. Refer to **Chapter 4** and remove the cooling fan. Refer to **FIG 1:4** and disconnect the vacuum hose, fuel hose and wiring connector (arrowed). Refer to **FIG 1:5** and disconnect wiring, earth cable and water hoses arrowed.

Refer to **Chapter 12** and disconnect the wiring from the starter solenoid and the wiring from the rear of the alternator. Refer to **FIG 1:6** and disconnect the accelerator linkage. Remove the lower cover panel from beneath the engine compartment, if fitted.

On models fitted with power steering, refer to **Chapter 10** and disconnect the power steering pump from its mountings without disconnecting the hoses. Support the pump by suitable means so that it is held clear of the engine.

Attach the lifting equipment to the lugs at the front and rear of the engine as shown in **FIGS 1:7** and **1:8**.

Refer to **Chapter 6** or **Chapter 7** and remove the transmission. On models fitted with manual transmission, remove the clutch slave cylinder and the clutch release arm and bearing as described in **Chapter 5**. Remove the reversing light lead and, if fitted, the clutch hydraulic hose from the retaining clips. Remove the nuts securing the lefthand and righthand engine mounting brackets to the mounting rubbers, then carefully lift the engine and swing out to the righthand side to remove.

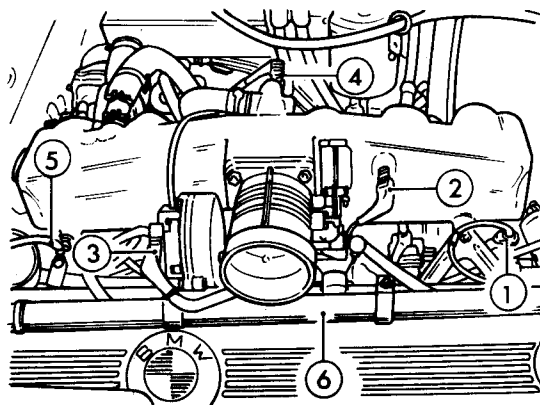


FIG 1:11 Cable connections and protective tube

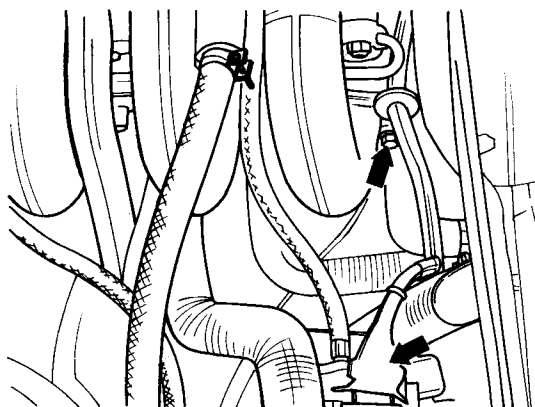


FIG 1:12 Cable support and plug

Refitting:

This is a reversal of the removal procedure, making sure that all component fixings are tightened to the specified torque figures.

Removal, models with fuel injection systems:

Remove the bonnet as described in **Chapter 13**. Disconnect the battery earth cable and remove the screenwash reservoir. Remove the air cleaner assembly as described in **Chapter 2** and the radiator as described in **Chapter 4**. Refer to **FIG 1:9** and pull cables 1 and 4 from the ignition coil and the white cable 15 from ballast resistor. When disconnecting cables, always pull on the plug connector and not on the cable itself.

Refer to **FIG 1:10** and disconnect the cable clamp from rocker cover and cable plug from distributor insert. Refer to **FIG 1:11** and disconnect cable 1 from injection valves, 2 from temperature sensor, 3 from throttle switch and 4 from starter valve. Disconnect cable 5 from air collector support and remove protective tube 6 from rocker cover. Remove plug from pressure sensor as shown in **FIG 1:12**. Refer to **FIG 1:13** and remove connecting plugs from main relay 7 and cold start relay 8. Refer to

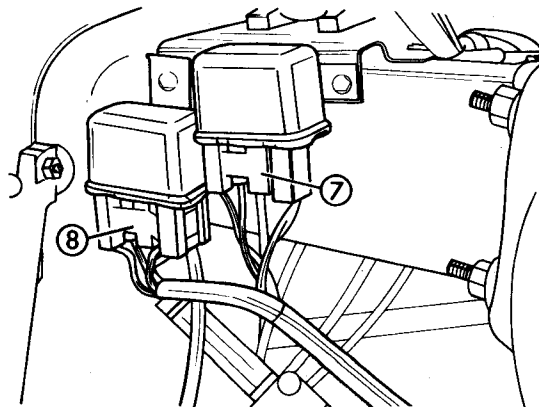


FIG 1:13 Relay connector plugs

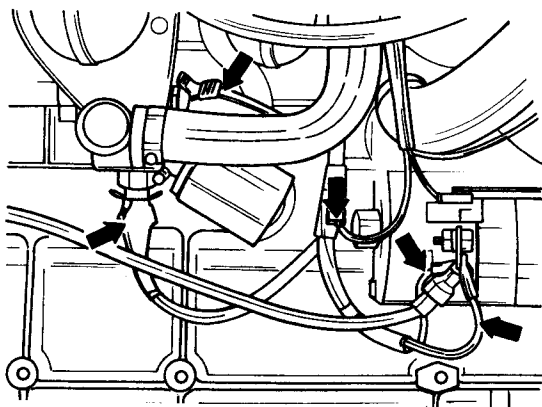


FIG 1:14 Switch, sensor and starter cable connections

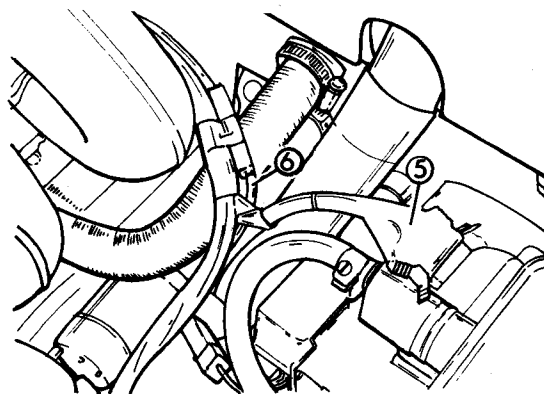


FIG 1:17 Cable and plug connections

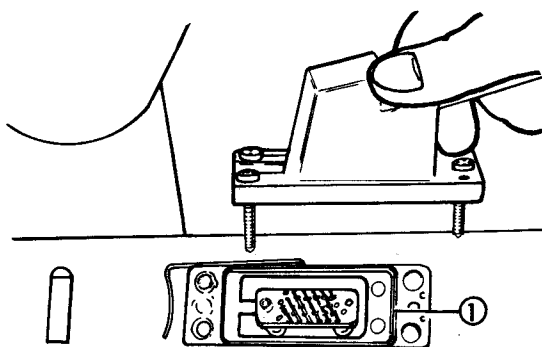


FIG 1:15 Removing loom plug

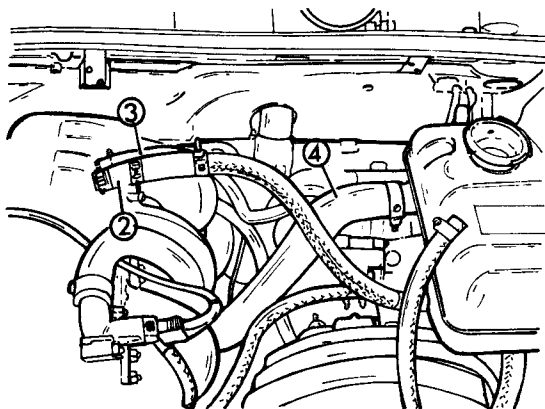


FIG 1:16 Hose connections

FIG 1:14 and disconnect cables from water temperature sensor, temperature retard switch and from starter motor connections.

If a loom plug is fitted, it should be removed as shown in FIG 1:15. Inspect rubber seal 1 and renew if damaged or perished. Note that plug connections must be in perfect condition, otherwise operational faults may result.

Refer to FIG 1:16 and disconnect hoses 2 and 3 from collector vessel and hose 4 from expansion tank. Refer to FIG 1:17 and disconnect plug 5 and connector 6. Disconnect the throttle linkage bars. Refer to FIG 1:18 and disconnect heater hoses 9 and 10. When refitting these hoses, note that plate 11 and the hoses must be pressed hard against the splashboard before tightening the clips. Disconnect the earth cable (arrowed) from the splashboard.

Refer to Chapter 12 and disconnect the alternator wiring. Refer to FIG 1:19 and remove fuel hose from regulator and pipes 13 and 14. Pull cable from temperature switch. Refer to Chapter 4 and remove the cooling fan. Remove the nut from the lefthand engine mounting, which is similar to that shown in FIG 1:6. Remove the cover panel from beneath the engine compartment. If power steering is fitted, refer to Chapter 10 and remove the pump, supporting it safely so that the hoses are not strained.

On models fitted with automatic transmission, remove the transmission as described in Chapter 7. On models with manual transmission, remove the transmission as described in Chapter 6 and the slave cylinder, clutch release arm and bearing as described in Chapter 5. Attach tool 7000 or other suitable lifting equipment to the front and rear lifting lugs as shown in FIGS 1:7 and 1:8. Make a final check to ensure that all wiring, hoses and control linkages have been disconnected from the engine assembly, then lift the engine and swing it to the right to remove from the engine compartment.

Refitting:

This is a reversal of the removal procedure, making sure that all component fixings are tightened to the specified torque figures.

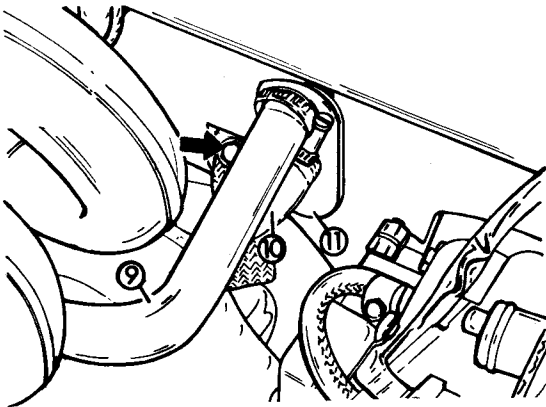


FIG 1:18 Heater hoses and earth cable

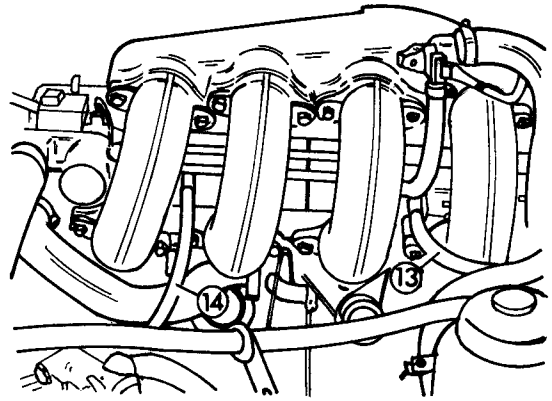


FIG 1:19 Fuel hose and switch cable connections

1:3 Removing and refitting cylinder head

Removal, models with fuel injection systems:

Disconnect the battery earth cable. Refer to **Chapter 4** and drain the cooling system. Loosen the clamp on the throttle butterfly manifold. Remove the air cleaner assembly, pulling the hose from the splashboard at the same time. Remove the screenwash reservoir.

Disconnect the wiring from the engine and associated components in the manner described in **Section 1:2** and as shown in **FIGS 1:10 to 1:14** inclusive.

Disconnect the HT and LT leads from the coil and disconnect the LT connector and vacuum pipe at the distributor. Remove the distributor cap.

Refer to **FIG 1:20**. Detach the HT leads from the sparking plugs and remove the lead protector tube. Pull off the bleed hose. Slacken the rocker cover bolts in the reverse order to that shown in the illustration, then remove the rocker cover and gasket. Refer to **FIG 1:21** and disconnect hoses 5, 6, 7 and 8. Refer to **FIG 1:18** and disconnect heater hoses 9 and 10. Disconnect the heater hose from the expansion tank. Disconnect the oil pressure switch cable at the connector located close to hoses 9 and 10. Note that these hoses, together with plate 11, must be pressed hard against the splashboard when refitting.

Refer to **Chapter 3** and turn the engine to the firing point for No 1 cylinder. Refer to **FIG 1:22** and disconnect hoses by releasing clips 12 and 13, then pull off connector 14 and remove support bracket 15. Refer to **Section 1:6** and detach the camshaft sprocket. **Neither the crankshaft nor camshaft must be turned while the camshaft sprocket is disconnected, unless the head is completely removed, otherwise the valves may contact the pistons and cause serious internal damage.**

Refer to **FIG 1:23** and disconnect the throttle linkage and the intake preheating hose. Remove the clamp from the exhaust support at the gearbox, and loosen the triangular flanges on exhaust silencer. Disconnect the exhaust pipes at the manifold flanges. Note that when refitting the pipes to manifold flanges, new gaskets should be used and the stud threads should be smeared with Molycote paste.

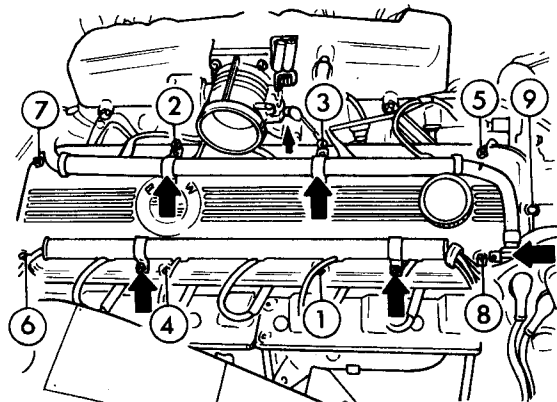


FIG 1:20 Rocker cover bolt tightening sequence. Fuel injection engine shown

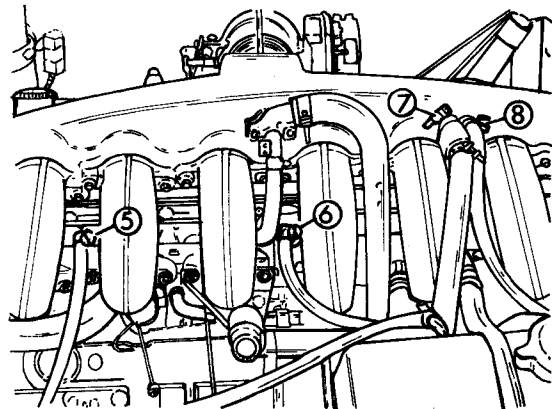


FIG 1:21 Disconnecting hoses

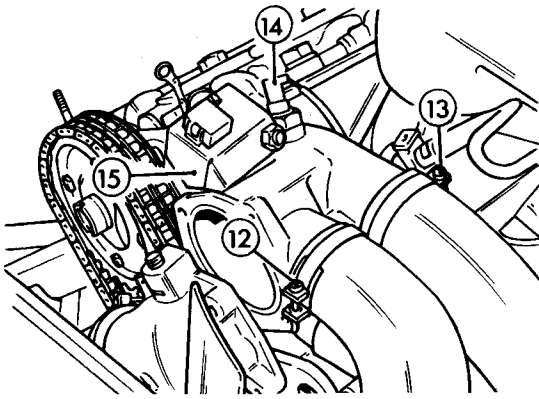


FIG 1:22 Hose clips, cable connector and support bracket

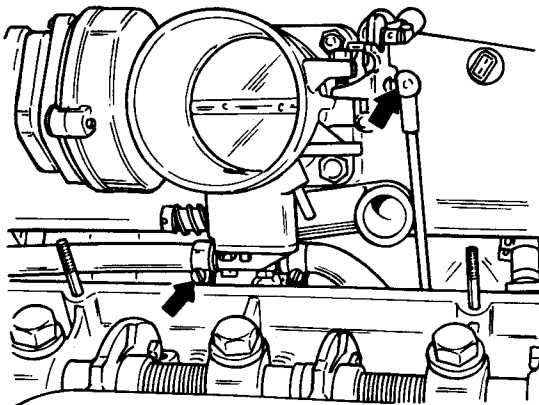


FIG 1:23 Throttle linkage and water hose

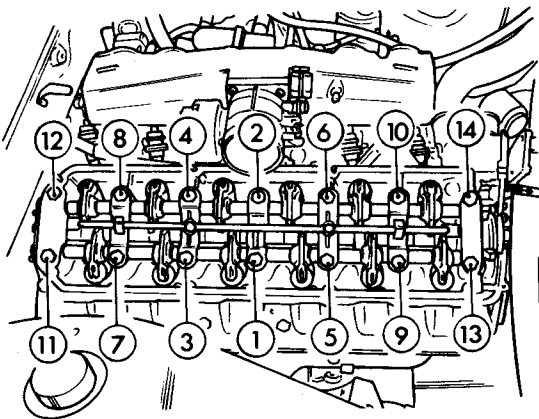


FIG 1:24 Cylinder head bolt tightening sequence

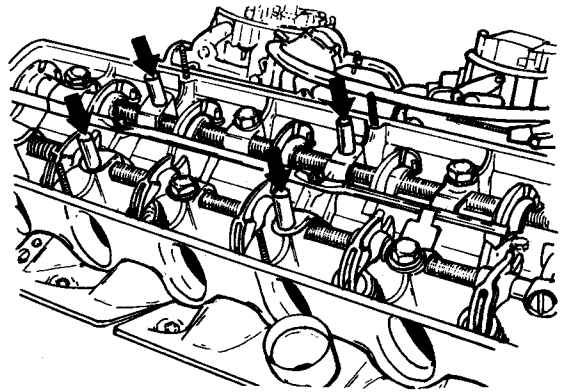


FIG 1:25 Installing guide pins

Slacken the cylinder head fixing bolts in the reverse order of that shown in FIG 1:24. Remove the bolts from the positions arrowed in FIG 1:25, then install suitable guide pins to prevent the rocker shafts from being displaced or distorted. Remove the remaining bolts and carefully lift off the cylinder head. Remove and discard the cylinder head gasket.

Refit the cylinder head as described later in this section.

Removal, models equipped with carburetters:

Disconnect the battery earth cable. Remove the air cleaner assembly. Refer to Chapter 4 and drain the cooling system. Refer to FIG 1:26 and remove hose 1 from fuel pump, disconnect throttle linkage rods 2 and pull off cables 3, 4, 5 and 6. Refer to FIG 1:27 and disconnect the vacuum hose and dipstick support as shown by the arrows. Refer to FIG 1:28 and disconnect hoses 7, 8, 9 and 10.

Refer to FIG 1:20. Disconnect the HT leads from the sparking plugs then remove the lead protector tube. Slacken the fixing bolts in the reverse order of that shown in the illustration then remove the bolts and detach the rocker cover.

Refer to Chapter 3 and turn the engine to the firing point for No 1 cylinder. Refer to Section 1:6 and detach the camshaft sprocket. **Neither the crankshaft nor camshaft must be turned while the camshaft sprocket is disconnected, unless the cylinder head is completely removed, otherwise the valves may contact the pistons and cause serious internal damage.**

Remove the exhaust pipe clamp from the gearbox and loosen the triangular flanges on the exhaust silencer. Disconnect the exhaust pipes from the manifolds. Note that, when refitting the pipes to manifold flanges, new gaskets should be used and the stud threads should be smeared with Molycote paste.

Loosen the cylinder head bolts in the reverse order of that shown in FIG 1:24, then remove the bolts from the positions arrowed in FIG 1:25 and insert suitable guide pins to prevent rocker shafts from being displaced or distorted. Remove the remaining bolts and lift off the cylinder head. Remove and discard the head gasket.

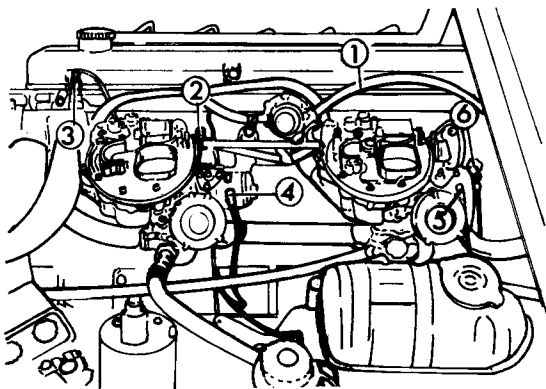


FIG 1:26 Disconnecting hose, linkage and cables

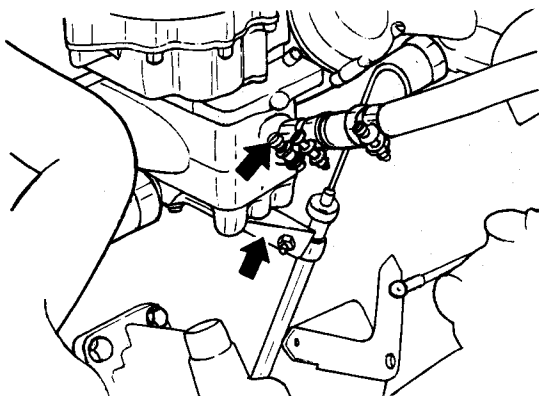


FIG 1:27 Vacuum hose and dipstick support

Refitting, all models:

The instructions concerning the correct alignment of camshaft and crankshaft must be observed, otherwise the valves may contact the pistons and cause serious internal damage.

If the crankshaft position has been disturbed, turn the crankshaft until piston No 1 (front) is at the top of its bore, with the ignition timing marks aligned at TDC as described in **Chapter 3**. Clean the joint faces of cylinder head and block, avoiding the use of sharp tools which would scratch the surfaces.

Make sure that the threaded holes for the cylinder head bolts in the block are clear of oil. If oil is present, the bolts may not exert sufficient pressure to hold the cylinder head down even though the correct torque figure is achieved. It is also possible for pressure on the oil to cause cracking of the cylinder block as the bolts are tightened.

Fit a new head gasket into position on the cylinder block, making sure that the gasket is the correct way up by checking that each hole in the gasket matches the appropriate bore in the block surface. Apply Atmosit or similar sealer to the gasket at the points circled in **FIG 1:29** only.

Before installing cylinder head, make sure that the camshaft is correctly aligned with the cam lobes for No 6 (rear) cylinder in the overlap position as described in **Section 1:4**. Fit the cylinder head carefully into position and install the cylinder head bolts through the vacant holes. Remove the guide pins and fit the remaining bolts. Tighten the bolts in the order shown in **FIG 1:24**, in three successive stages, of 3, 6.8 and 7.2kgm (22, 48 and 52lb ft).

Refit the remaining components in the reverse order of removal, following the instructions given in **Section 1:6** when installing the sprocket and chain assembly to the camshaft. Before installing the rocker cover, set the valve clearances as described in **Section 1:5**. Use a new rocker cover gasket and tighten the cover fixing bolts in the order shown in **FIG 1:20**. On models equipped with fuel injection systems, ensure that the earth cable is connected at point 5 and the loom clamp at point 9. On completion, refill the cooling system as described in **Chapter 4**, set ignition timing as described in **Chapter 3**, and carry out the idle speed adjustments given in **Chapter 2**.

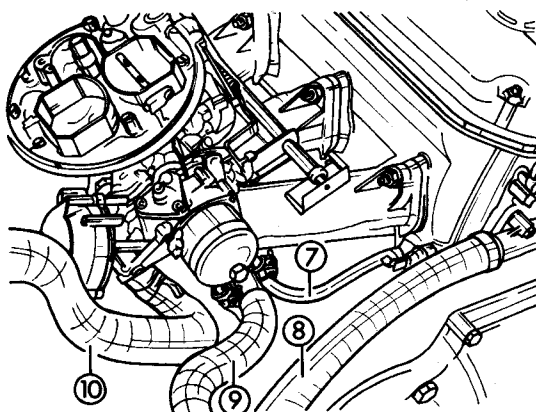


FIG 1:28 Disconnecting hoses

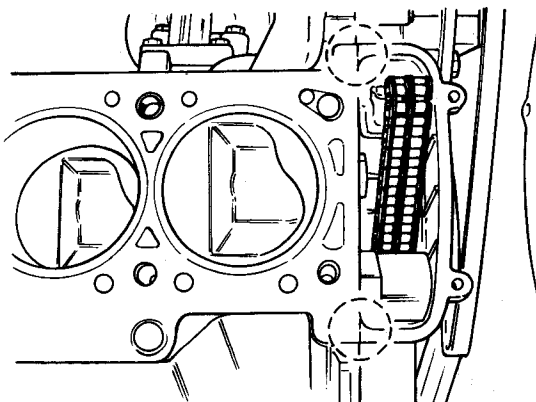


FIG 1:29 Sealant application points at head gasket

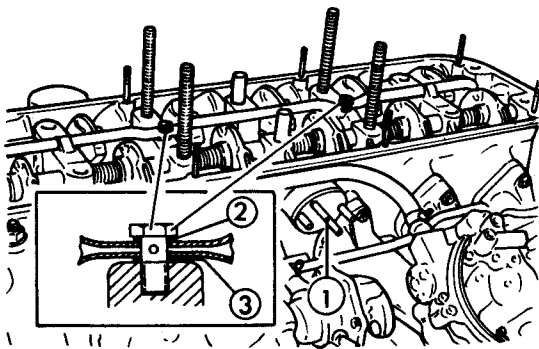


FIG 1:30 Pump pushrod 1 and oil pipe seals 2 and 3

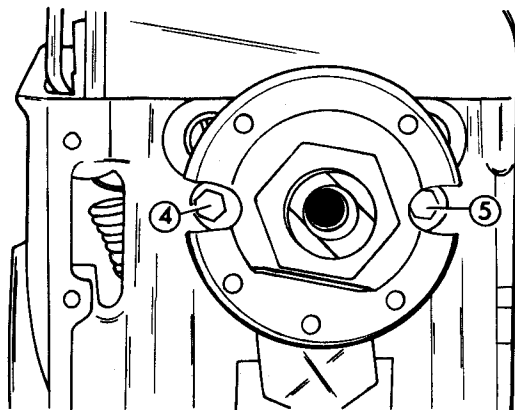


FIG 1:33 Camshaft guide plate screws

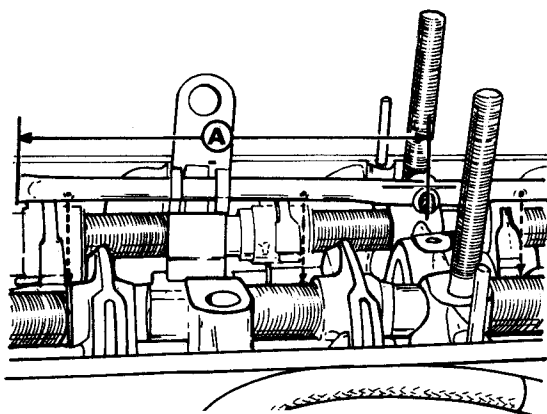


FIG 1:31 Oil pipe installation

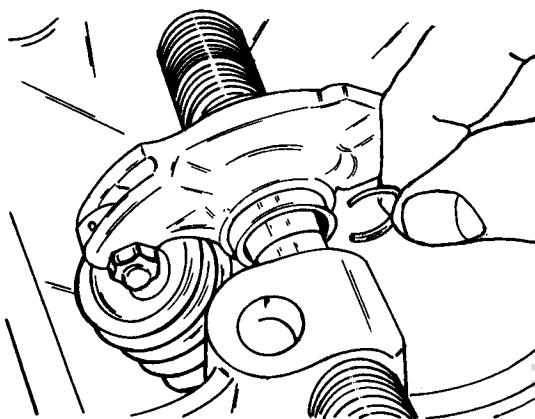


FIG 1:34 Rocker shaft circlip removal

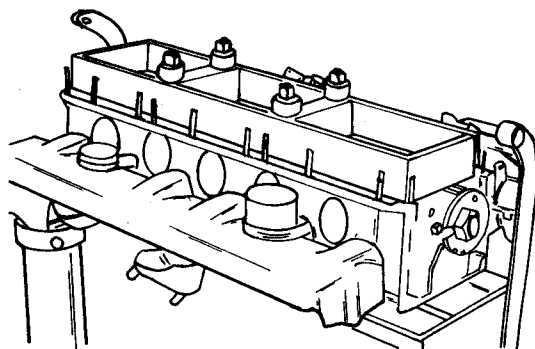


FIG 1:32 Compression frame installation

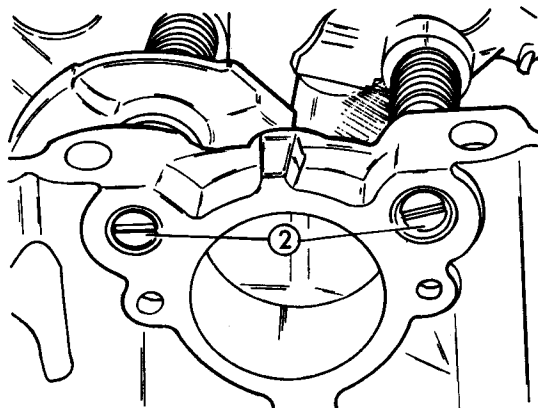


FIG 1:35 Rocker shaft locking bolts

After the engine has been given a trial run, allow it to cool down to approximately 35°C (95°F) then remove the rocker cover and retighten the cylinder head bolts as described previously. After the car has been driven for a distance of approximately 1000km (600 miles), the cylinder head bolts must again be retightened when the engine has cooled to the temperature stated. To do this, slacken each bolt a little before retightening to the specified torque figure, keeping to the correct procedure as described previously. Finally, check and if necessary reset valve clearances as described in **Section 1:5**.

1:4 Servicing head, valves and camshaft

Dismantling:

It is not necessary to remove the inlet or exhaust manifolds unless renewal of the manifolds or gaskets is required, but it is recommended that carburetters be removed from inlet manifolds to prevent damage. Support the head on suitable blocks of wood while work is carried out, to prevent damage to the light alloy surfaces. **Note that all valve gear components must be kept in the correct order for refitting in their original positions if they are not to be renewed.**

Refer to **FIG 1:30** and, on models fitted with mechanical fuel pump, remove the pump and pushrod 1. Remove the oil feed pipe, noting the correct positions of seals 2 and 3 for correct refitting. Note that the pipe must be refitted with the oil holes aligned to spray oil between the camshaft lobes and rocker tips at each valve position (see **FIG 1:31**) and that dimension **A** should be $180 \pm 0.5\text{mm}$ ($7.087 \pm 0.02\text{in}$), measured in a forward direction. Refer to **Chapter 3** and remove the distributor.

Refer to **Section 1:5** and set all valve clearances to the maximum possible, this being necessary to prevent subsequent damage to the valves. Attach compression frame 7003-1 and evenly tighten the fixings, as shown in **FIG 1:32**. The use of this tool is essential in order to compress the valve springs and relieve rocker pressure on camshaft lobes before removing camshaft and rocker shafts. When the tool is in position, handle the cylinder head carefully to prevent damage to the valves projecting from combustion chambers.

Remove the camshaft guide plate fixing screws shown at 4 and 5 in **FIG 1:33**, then carefully pull the camshaft assembly from the cylinder head.

To remove the rocker shafts, refer to **FIG 1:34**. Push back thrust rings and rocker arms then pull off circlips. Unscrew the locking bolts shown at 2 in **FIG 1:35**. Note that these bolts must be smeared with Loctite No 73 during reassembly. Rocker shafts must be removed using tool 7004 or other suitable slide hammer assembly as shown in **FIG 1:36**. Screw the tool into the rocker shaft and remove the locating pin. Operate the slide hammer to carefully pull the rocker shaft from the cylinder head, collecting springs 3 (see **FIG 1:37**), discs 4, rocker arms 5 and thrust rings 6 as they come free. Note the order of these components for correct reassembly. Remove the rear cover to allow removal of the rear rocker shafts as shown in **FIG 1:38**. Note the position of sealing disc 1 for correct reassembly and use a new gasket 2 of the correct type if the original is not in perfect condition.

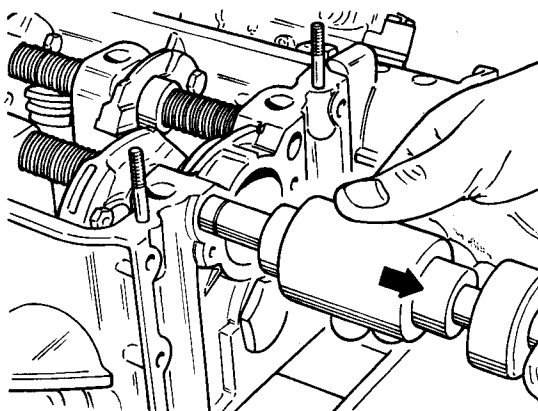


FIG 1:36 Rocker shaft removal

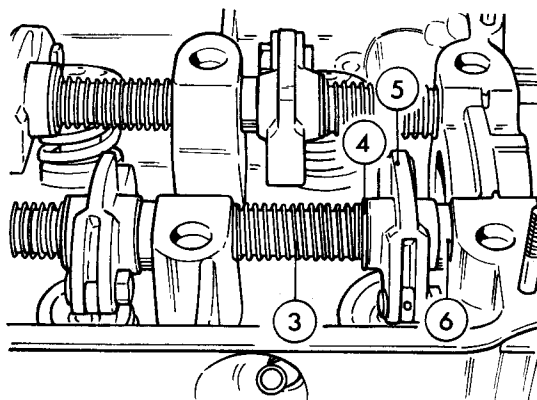


FIG 1:37 Locations of rocker gear components

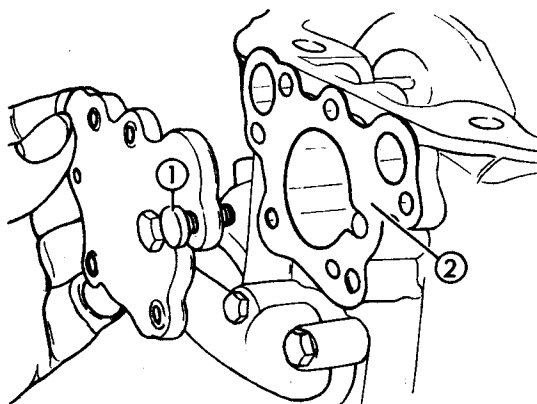


FIG 1:38 Rear rocker shaft cover removal

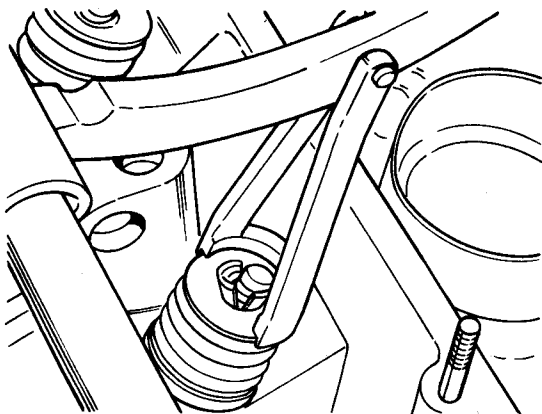


FIG 1 :39 Removing valve using spring compressor tool

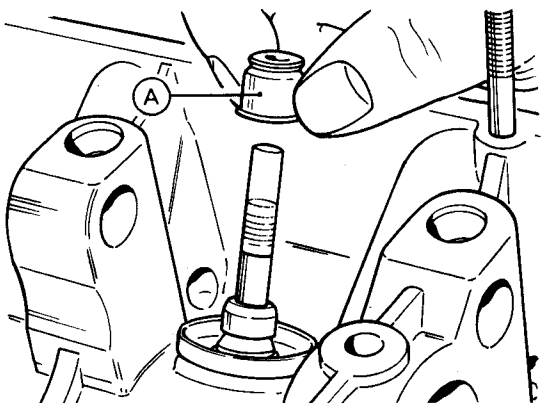


FIG 1 :40 Valve stem seal installation

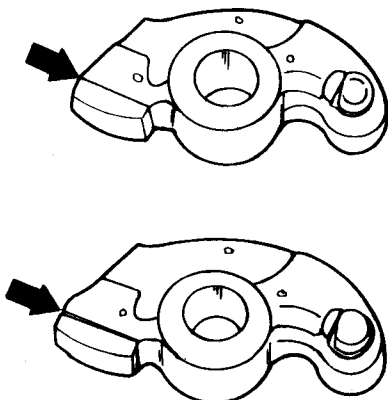


FIG 1 :41 Rocker arm cam followers

Remove the compression frame. Use a suitable spring compressor such as that shown in FIG 1:39 to remove the valve assemblies from the cylinder head. With the spring compressed, remove the split taper collets then remove the compressor tool and remove the valve springs and caps. Remove valve stem seals **A** as shown in FIG 1:40. Inspect the seals carefully and renew any found worn or damaged, as faulty seals can be responsible for high oil consumption. Note that the grooves in the valve stem should be covered with adhesive tape as shown in the illustration when installing the seals, to prevent damage. Remove any burrs or ridges from the upper part of the valve stems, then remove the valves from the cylinder head. Unless the valves are being renewed, store them in the correct order so that they may be refitted into the original bores from which they were removed.

Valves:

When the valves have been cleaned of carbon deposits, they must be inspected for serviceability. Valves with bent stems or badly burned heads must be renewed. Valves with pitted seats can be re-cut at a service station, but if they are too far gone for this remedial treatment, new valves will be required. Valves that are in serviceable condition can be ground to their seats as described later.

Valve guides:

Valve guides that are worn or scored must be renewed. As the guides must be pressed into or out of place, reamed, then the valve seat re-cut for concentricity, this work should be carried out by a service station having the necessary special equipment.

Valve seat inserts:

Valve seat inserts that are pitted or burned must be refaced or, if they are too far gone for remedial treatment, renewed. As either operation requires the use of special equipment, the work should be carried out by a service station. If the valve seat inserts are serviceable, they should be ground to the valves as described later.

Valve springs:

Test the valve springs by comparing with the data given in the **Appendix**, or by comparing their efficiency with that of new springs. To compare with a new spring, insert both old and new springs end to end with a metal plate between them into the jaws of a vice. If the old spring is weakened, it will close up first when pressure is applied. Take care that the springs do not fly out of the vice under pressure. Any spring which is distorted, or which is shorter or weaker than standard, should be renewed.

Rockers and shafts:

Check all rocker gear components for excessive wear, scoring or other damage and renew parts as necessary. Check the cam followers on the rocker arms as shown in FIG 1:41, renewing any rocker having a damaged or loose follower.

Camshaft and bearings:

Inspect the working surfaces of camshaft lobes and journals for signs of wear, damage or seizure. If the camshaft is to be renewed, refer to **FIG 1:42** and remove nut 1, lockplate 3, sprocket flange 2 and guide plate 4. Transfer parts 1, 2 and 4, together with a new lockplate 3, to the new camshaft.

Cylinder head:

Carefully clean the cylinder head and make sure that all oil and water passages are clear. Check the mating surface for flatness and for nicks or other damage. The mating surface of the head can be refaced at a service station, but if damage or distortion is too serious for this remedial work to be carried out satisfactorily, or if the head is cracked or otherwise damaged, a new cylinder head should be fitted. If the head is resurfaced, the upper timing case cover must also be machined by a similar amount.

Decarbonising and valve grinding:

Avoid the use of sharp tools which could damage the cylinder head or combustion chambers. Remove all traces of carbon deposits from the combustion chambers, inlet and exhaust ports and joint faces. If the pistons have not been removed and cleaned during previous engine dismantling, plug the oilways and waterways in the top surface of the cylinder block with pieces of rag to prevent the entry of dirt, then clean the carbon from the piston crowns, using a blunt instrument to avoid scratching.

To grind-in valves, use medium grade carborundum paste unless the seats are in very good condition, when fine grade paste can be used at once. Always finish with fine grade. A light spring under the valve head will assist in the operation and allow the valve to be lifted from its seat without releasing the grinding tool. Use a suction cup tool and grind with a semi-rotary movement. Allow the valve to rise off its seat occasionally by pressure of the spring under the head, then turn to a new position before resuming the grinding procedure.

Use paste sparingly. When both valve and insert mating seats have a smooth matt grey finish, clean away all traces of grinding compounds from port and valve.

Reassembly:

This is a reversal of the removal procedure, using the compression frame shown in **FIG 1:32**, to depress the valve springs before installing rocker shafts and camshaft. Rocker shafts must be installed so that the grooves in the shafts are properly positioned to allow for the fitting of cylinder head bolts. Install the camshaft and secure the guide plate, then check that the camshaft can turn freely. Before releasing the compression frame, turn the camshaft until the cam lobes for cylinder No 6 (rear) are pointing upwards by equal amounts, this being the valve overlap position when the inlet and exhaust valves will be opened equally by the cam lobes. The threaded hole in the camshaft flange must be aligned with the projection on the head as shown in **FIG 1:43**. Check camshaft end play, using feeler gauges between flange and guide plate as shown in **FIG 1:44**. The correct figure is 0.03 to 0.18mm (0.0012 to 0.007in). If the

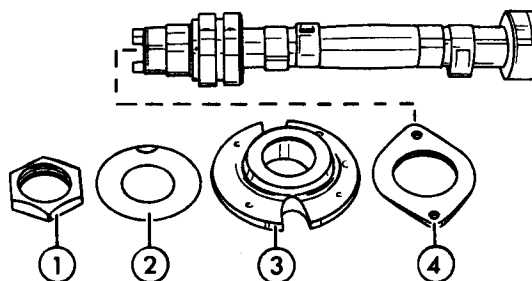


FIG 1:42 Camshaft components

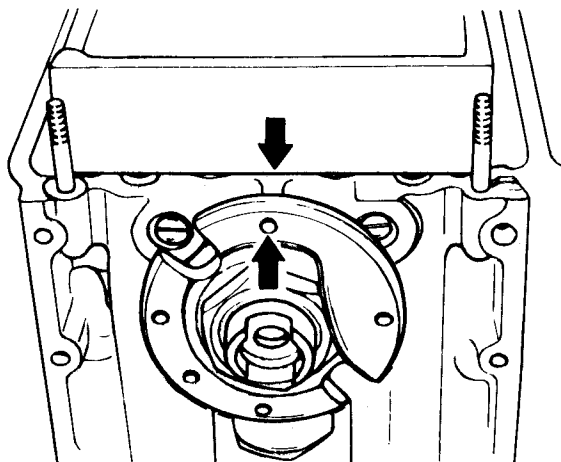


FIG 1:43 Camshaft alignment

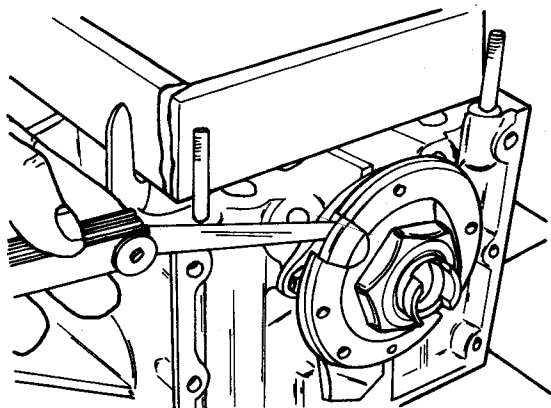


FIG 1:44 Checking camshaft end play

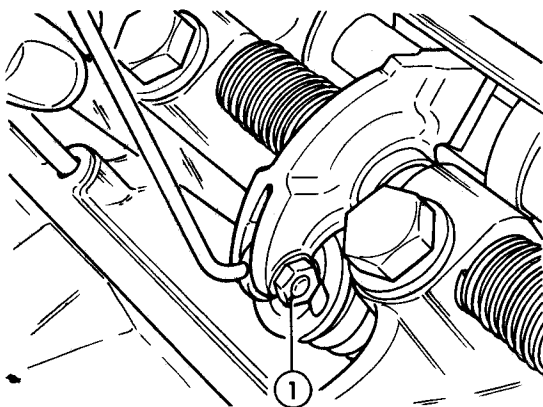


FIG 1:45 Valve clearance adjustment

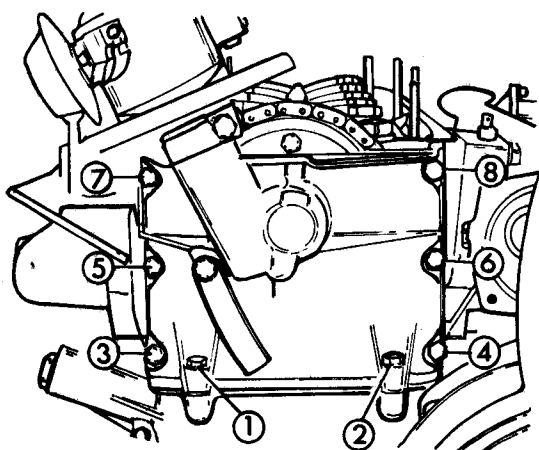


FIG 1:46 Upper timing case cover bolt tightening sequence

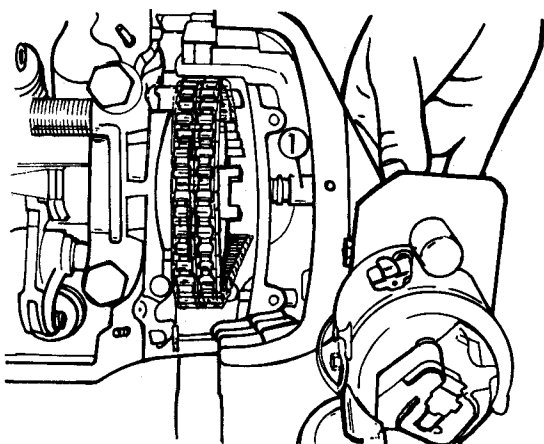


FIG 1:47 Upper timing case cover removal

upper figure is exceeded, a new guide plate should be fitted. Make sure that the camshaft is aligned properly as aligned previously before removing the compression frame.

1:5 Valve clearance adjustment

The correct adjustment of valve clearances is important as they affect engine timing and performance considerably. Excessive clearance will reduce valve lift and opening duration and reduce engine performance, causing excessive wear of the valve gear components and noisy operation. Insufficient or zero clearance will again affect engine timing and in some circumstances can hold the valve clear of its seat. This will result in much reduced performance due to lost compression and the possibility of burned valves and seats. Valve clearances should be checked at the intervals recommended in the manufacturer's service schedule as routine maintenance and, additionally, whenever the cylinder head has been serviced.

Adjustment must be made when the engine is cool, so a warm engine should be allowed to cool to a maximum coolant temperature of 35°C (95°F). Correct clearances under these conditions are 0.25 to 0.30mm (0.010 to 0.012in) for both inlet and exhaust valves.

Refer to **Section 1:3** and remove the rocker cover. The engine can be turned by means of tool 7008-1 which locks onto the timing chain where it passes over the camshaft sprocket, but if such a tool is not available the engine should be turned by pushing the car forwards in top gear (manual transmission), by pulling on the alternator drive belt, or by using a spanner on the crankshaft pulley nut. In all cases, the engine will be easier to turn if the sparking plugs are first removed. Turn the engine until the valves for No 6 (rear) cylinder are on the overlap, this being when both inlet and exhaust valves are equally depressed by the rockers. With the engine in this position, the piston in No 1 (front) cylinder will be at TDC on the compression stroke with the valves for that cylinder in the correct positions for checking and adjusting clearances. The engine should be turned in stages to bring the valves for Nos 6, 2, 4, 1, 5 and 3 to overlap positions in turn, when the valves for cylinders 1, 5, 3, 6, 2 and 4 respectively will be brought to the correct positions for checking and adjustment.

Use feeler gauges to check the clearance between the adjustment mechanism and valve stem as shown in **FIG 1:45**. No adjustment is necessary if the clearance is between the limits stated, but if not it should be reset by slackening locknut 1 and using a rod or other suitable tool to rotate the eccentric as necessary. A feeler of the correct thickness should slide smoothly in the gap, being neither tight nor loose. When clearance is correct, tighten the locknut and recheck. Repeat the adjustment at the opposite valve for the same cylinder before proceeding to the next pair of valves in the sequence stated previously. On completion, refit the rocker cover using a new gasket unless the original is in perfect condition. Tighten the rocker cover fixing bolts in the order shown in **FIG 1:20**.

1:6 Timing gear

It should not normally be necessary to renew the timing chain due to wear until the vehicle has covered

approximately 50,000km (30,000 miles), as the tensioner assembly maintains chain tension until the wear limit is reached. If excessive timing chain noise is noticed before this distance has been covered, the chain tensioner should be checked and bled as described later, before checking the chain for wear or damage.

It is necessary to remove both upper and lower timing case covers to remove the chain and lower sprocket. If the camshaft sprocket only is to be detached to allow for cylinder head removal, it is only necessary to remove the chain tensioner then remove the upper timing case cover for access to the sprocket fixing bolts. Note the warning given in **Section 1:3** concerning the correct alignment of camshaft and crankshaft to prevent damage to valves and pistons when the camshaft sprocket is detached.

Timing case cover removal:

Upper cover:

Refer to **Chapter 3** and remove the distributor cap, LT lead and vacuum pipe(s) from the distributor, then turn the engine until it is aligned at the firing point for No 1 cylinder. Refer to **Chapter 4** and detach the thermostat cover and remove the thermostat. Refer to **Section 1:3** and remove the rocker cover.

Slacken the fixing bolts in the order shown in **FIG 1:46**, then remove the bolts and detach the upper timing case cover complete with distributor and drive gear 1 as shown in **FIG 1:47**.

Before refitting the cover, check that the portion of the cylinder head gasket onto which the cover fits, is undamaged. If necessary, the cylinder head must be removed as described in **Section 1:3** and the gasket renewed. Apply Atmosit or similar sealant to the points indicated by the lower arrows in **FIG 1:48**. The engine and distributor must be set at the firing point for No 1 cylinder as described in **Chapter 3** and the distributor drive gear shown at 1 in **FIG 1:47** must be fitted so that it engages the slot in the camshaft without disturbing the settings. Refit the cover securing bolts and tighten bolts 1 and 2 gently (see **FIG 1:46**). Now fully tighten the remaining bolts in the order shown, then finally tighten bolts 1 and 2. Refit the remaining components in the reverse order of removal. On completion, check ignition timing as described in **Chapter 3**.

Lower cover:

Remove the upper timing case cover as described previously, then remove the chain tensioner piston as described later. Refer to **Chapter 4** and remove the alternator drive belt.

Remove the lower cover panel from beneath the engine, if fitted. Unscrew the fixing nut and use a suitable puller to remove the crankshaft pulley and damper assembly, noting the correct position of the locating key shown at 1 in **FIG 1:49**. To lock the engine when unscrewing the nut on manual transmission models, bottom gear should be selected and the handbrake fully applied. Alternatively, remove the cover plate from beneath the rear of the engine and use tool 6069 or similar to lock the flywheel against rotation. On automatic transmission models, the latter method should be employed, using tool 6069-1 or similar. Note that, if the hub of the damper is severely

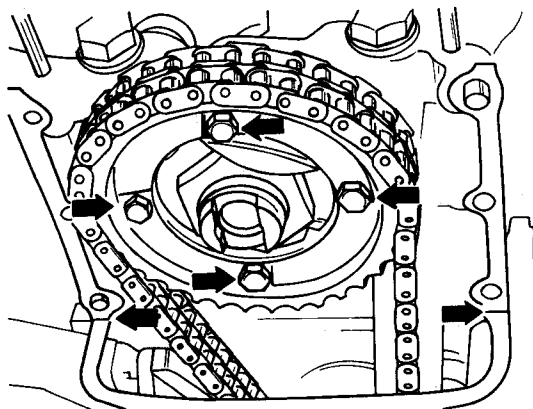


FIG 1:48 Camshaft sprocket bolts and sealant application points

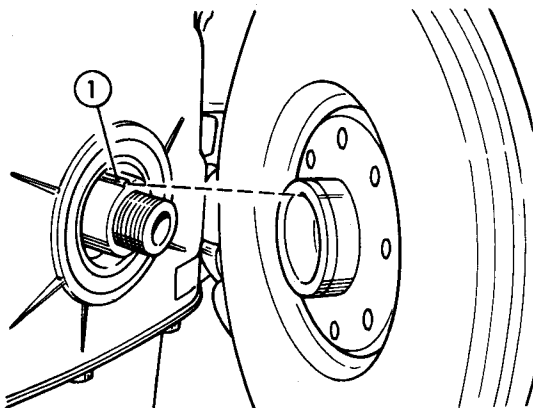


FIG 1:49 Removing crankshaft pulley and damper assembly

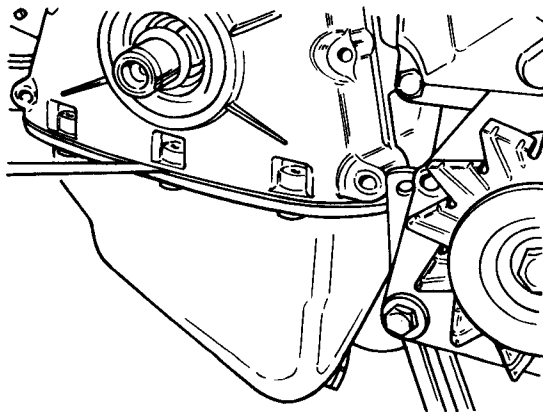


FIG 1:50 Separating lower cover from sump gasket

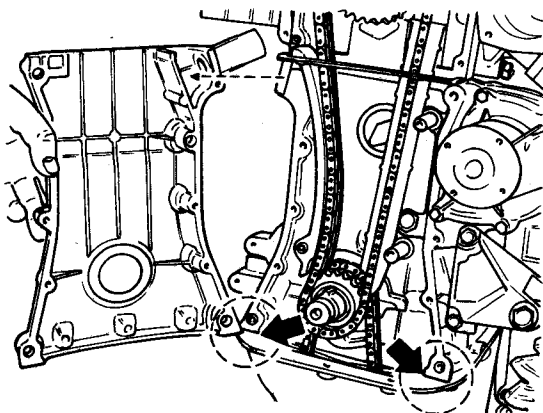


FIG 1:51 Lower timing case cover installation

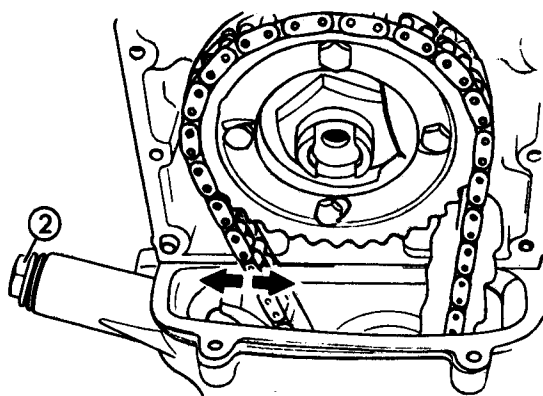


FIG 1:52 Chain tensioner plug 2

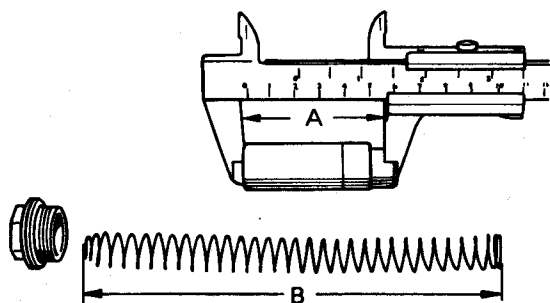


FIG 1:53 Length of piston A and spring B

scored, the seal should be located during reassembly so that the sealing lip makes contact in front of or behind the scored area.

Remove the bolts securing the lower timing case cover to the cylinder block and remove the bolts between cover and front of sump. Slacken but do not remove the remaining sump bolts. Use a thin blade to carefully separate the timing case from the sump gasket at the front, as shown in FIG 1:50. Note that, if the sump gasket is damaged, the sump must be removed as described in Section 1:8 and the gasket renewed. Remove the timing case cover.

When refitting the cover, coat the joint faces between sump and crankcase with Atmosit or similar sealer, as shown by the lower arrows in FIG 1:51. Note that the pickup web for the tensioner piston must be located in the oil pocket indicated by the upper arrow. Install the timing cover to cylinder block fixing bolts and tighten gently, then fit the case to sump bolts and tighten these and the remaining sump bolts before finally tightening the timing case to block bolts. Tighten bolts alternately and evenly to avoid distortion. Refit the remaining components in the reverse order of removal.

Chain tensioner assembly:

Removal:

Remove the upper timing case cover as described previously. This is necessary for access to the oil pocket in order to bleed the tensioner when refitted. Unscrew the tensioner and plug shown in FIG 1:52, taking care to press it inwards as it comes free to prevent the powerful spring from flying out. Remove the spring and piston from the housing.

Before installing the tensioner assembly, refer to FIG 1:53 and check dimensions A and B. On earlier models, installed length A for the piston is 57.4mm (2.26in), modified on later models to 62mm (2.441in). Renew the piston if shorter than standard or if worn or damaged. Free length B of compression spring should be 155.5mm (6.122in). Renew the spring if significantly shorter than standard or if damaged or distorted. Note that the end of the spring with tapered coils should face towards the end plug. Refer to FIG 1:54 and use an air line to check that the vent slots 1 are not blocked. If the slots are blocked or have become displaced, press out the valve and clean the slots. When refitting the valve, do not block the slots with the perforated disc.

When refitting the tensioner, fit the piston spring and end plug then tighten the plug a few turns only, so that oil will be able to escape past the threads. Fill the oil pocket in the lower timing case cover with engine oil. Use a screwdriver to move the tensioner rail backwards and forwards as indicated by the arrows in FIG 1:52, until oil emerges past the end plug threads. This operation is essential to bleed air from the tensioner assembly. On completion, tighten the end plug fully then refit the remaining components in the reverse order of removal.

Timing chain removal:

Remove the upper and lower timing case covers as described previously. Release the lockplates and remove the four camshaft sprocket securing bolts (see FIG 1:48). **Neither the crankshaft nor camshaft must**

be turned while the camshaft sprocket is detached, unless the cylinder head is completely removed, otherwise the valves may contact the pistons and cause serious internal damage.

Remove the camshaft sprocket from the chain, then remove the chain from the crankshaft sprocket. Carefully swing the chain from the slide rail to the righthand side. Check the chain and sprockets for wear or damage which would dictate renewal. To remove the crankshaft sprocket, the oil pump sprocket must first be removed as described in **Section 1:9**. Remove the locating key and the 'O' ring seal, then pull the sprocket from the crankshaft using a suitable puller such as tool 7006. There is no need to install the 'O' ring when refitting the sprocket.

The timing chain should be installed in the reverse order of removal, making sure that the oil pump drive chain, if removed, is properly tensioned as described in **Section 1:9**. When installing camshaft sprocket, fit the sprocket to the chain so that locating pin 1 is at the eight o'clock position (see **FIG 1:55**). The hole in the sprocket must be aligned with the threaded hole in the camshaft and the projection on the cylinder head as shown by the upper arrow. Use new lockplates to secure the camshaft sprocket fixing bolts.

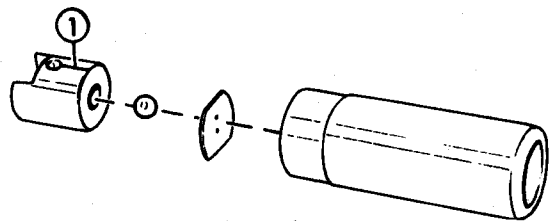


FIG 1:54 Tensioner piston components

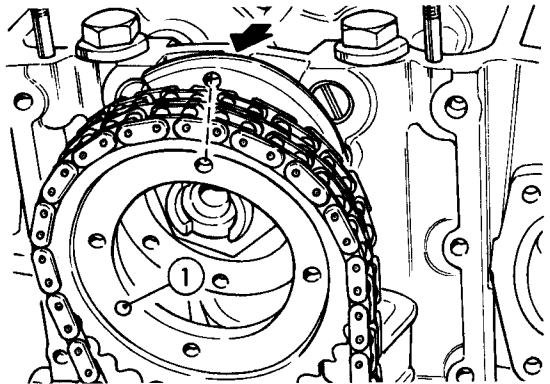


FIG 1:55 Camshaft sprocket alignment

1:7 External oil filter

The oil filter is of the renewable cartridge type and should be renewed at the intervals recommended in the manufacturer's service schedule. A section through the filter assembly is shown in **FIG 1:56**. Oil from the pump enters through passage 1, passes through the filter, then is supplied through passage 2 to the engine lubrication points. If the filter should become blocked and restrict oil flow, oil pressure will open relief valve 3 to effectively bypass the filter canister. This ensures that engine lubrication is maintained, albeit with unfiltered oil.

To renew the filter element, place a suitable container beneath the filter to catch oil spillage, then unscrew the central bolt and detach the canister. Remove and discard the filter element, then remove the rubber sealing ring from the mounting and discard. Clean any dirt or sludge from the inside of the canister, then install a new filter element. Fit a new sealing ring to the mounting, making sure that it seats properly in the groove and is not twisted. Refit the canister, making sure that it seats correctly on the seal, then tighten the fixing bolt. Turn the canister slightly while tightening, to ensure a good seal. Start the engine and allow to run for a few minutes while checking for oil leaks at the filter canister, then switch off and top up the engine oil as necessary to compensate for that used to fill the canister.

1:8 Sump removal and refitting

Removal:

Remove the lower cover panel from beneath the engine, if fitted. Drain the engine oil, collecting it in a clean container if it is to be re-used. Refer to **Chapter 9** and remove the anti-roll bar. Refer to **Chapter 4** and slacken the alternator mounting bolts.

If power steering is fitted, refer to **Chapter 10** and detach the power steering pump, leaving the hoses connected. Wire the pump away from the work area so that the hoses are not strained.

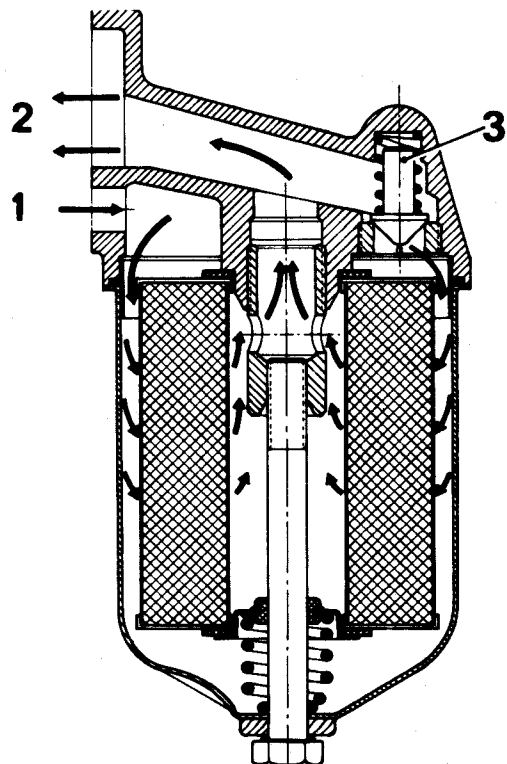


FIG 1:56 Section through oil filter assembly

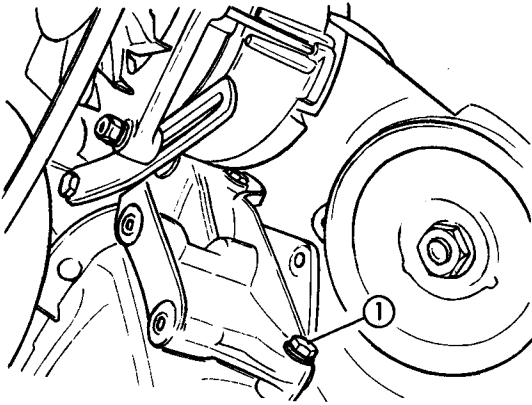


FIG 1:57 Bearing block fixing screw

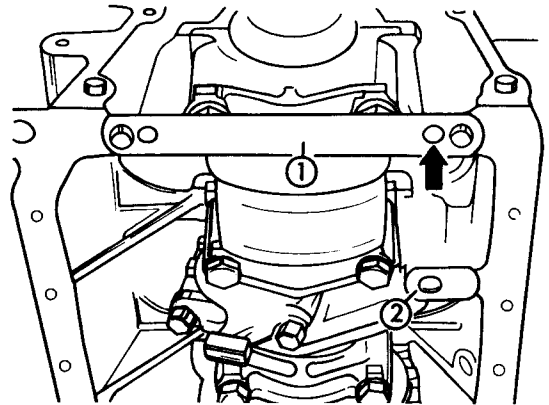


FIG 1:60 Oil pump mounting shims

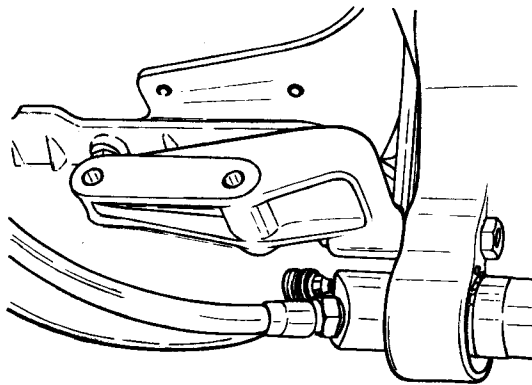


FIG 1:58 Detaching support bracket



FIG 1:59 Oil pump and strainer removal

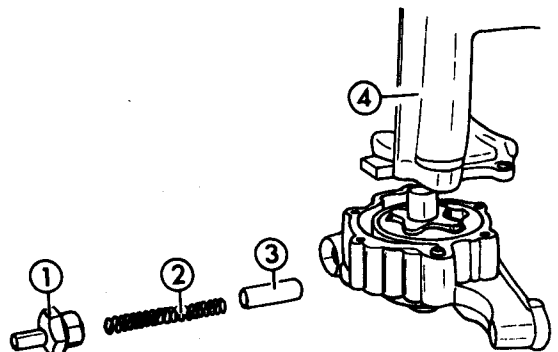


FIG 1:61 Oil pump components

Remove the oil level dipstick. Refer to **FIG 1:57** and remove screw 1 from the bearing block. Loosen the bearing block until access to the sump fixing bolts behind it can be gained. Partly detach the support bracket shown in **FIG 1:58** for access to the sump bolts behind the bracket. Remove all sump fixing bolts.

Turn the engine until the connecting rod big-end for No 6 cylinder is above the sump joint line. Lower the front of the sump, then turn the rear towards the support bracket and remove. Remove and discard the sump gasket.

Refitting:

This is a reversal of the removal procedure, using a new sump gasket. Make sure that the mating surfaces of sump and crankcase are clean. Coat the junctions between the timing case cover and crankcase at the front and between crankcase and rear cover at the rear, using Atmosit or other suitable sealant. Tighten the sump fixing bolts alternately and evenly to avoid distortion. Refit the dipstick and refill the sump with engine oil to the correct level. Check that the dipstick guide tube projects from the engine crankcase by $218 \pm 0.5\text{mm}$ ($8.583 \pm .020\text{in}$). If this dimension is incorrect, a false oil level reading will be obtained when the dipstick is used. Set drive belt tension as described in **Chapter 4**.

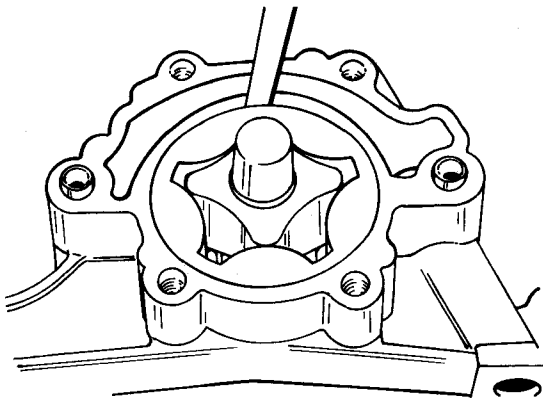


FIG 1 : 62 Checking clearance between outer rotor and body

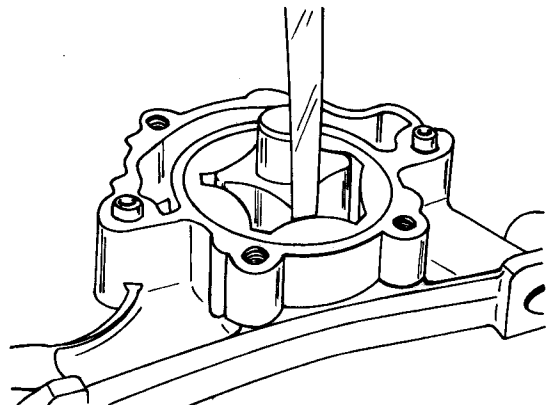


FIG 1 : 63 Checking clearance between inner and outer rotors

1:9 Oil pump and strainer

Removal:

Remove the sump as described in **Section 1:8**. Refer to **FIG 1:59**. Remove sprocket 1 and detach the pump fixing bolts arrowed, then remove the pump and strainer from the crankcase. Collect the front and rear mounting shims.

Refitting:

This is a reversal of the removal procedure, but chain tension must be correctly adjusted. To do this, front and rear shims 1 and 2 must be installed between pump mounting flanges and crankcase as shown in **FIG 1:60**. Note the correct location of oil hole arrowed in shim 1. Shims must be of equal thickness front and rear and added until the pump drive chain can be pressed inwards slightly with gentle thumb pressure at a point midway between sprockets. When correct, slacken the strainer support plate upper mounting bolts and move the plate up or down as necessary so that the pick-up pipe is not strained, then retighten the bolts. Refit the sump as described in **Section 1:8**.

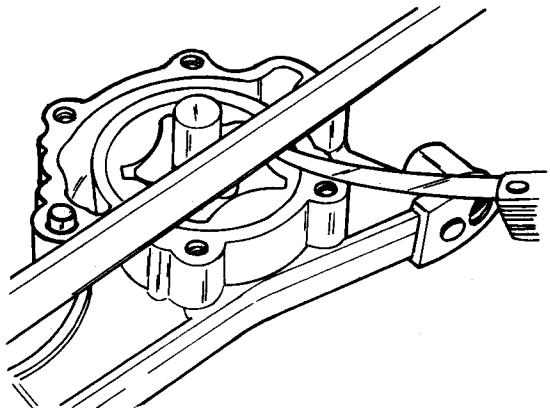


FIG 1 : 64 Checking clearance between rotors and housing

Oil pump overhaul:

Remove the pump as described previously. Refer to **FIG 1:61** and unscrew threaded union 1. Remove spring 2 and piston 3. Remove pump cover and strainer assembly 4.

Use feeler gauges to check pump internal clearances. Check clearance between outer rotor and body as shown in **FIG 1:62**, which should be $0.1 \pm 0.025\text{mm}$ ($0.004 \pm 0.001\text{in}$). If maximum permitted clearance is exceeded, renew the pump body. Check clearance between inner and outer rotors as shown in **FIG 1:63**, which should be 0.12 to 0.30mm (0.0047 to 0.0118in). Excessive clearance will dictate renewal of both rotors. Check clearance between top surface of rotors and housing face, using a straightedge as shown in **FIG 1:64**. This should be 0.050 to 0.091mm (0.002 to 0.0036in). If clearance is excessive, renew the pump housing.

To remove the rotors, use a suitable puller to pull off the outer flange. Never attempt to drive or lever off the

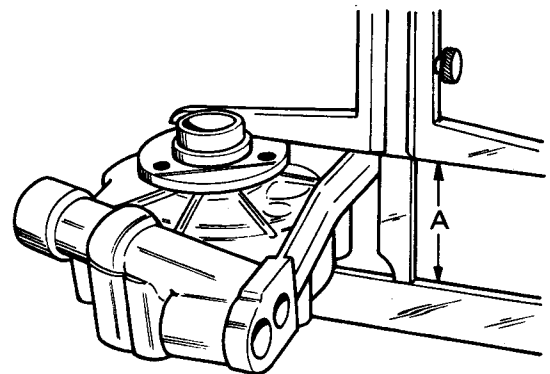


FIG 1 : 65 Checking flange and rotor installation

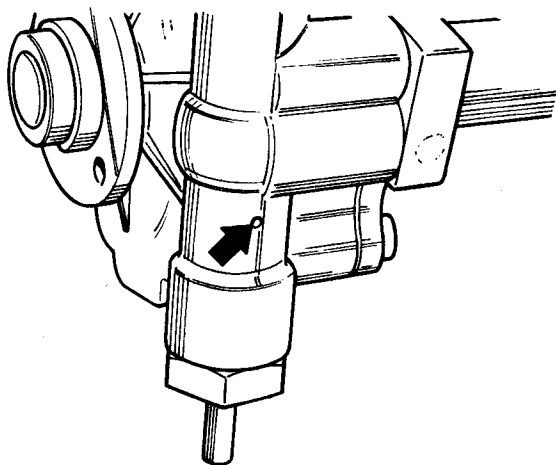


FIG 1:66 Oil pump vent hole

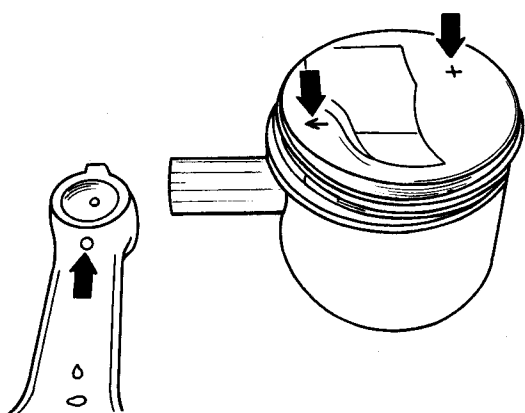


FIG 1:67 Piston, gudgeon pin and connecting rod

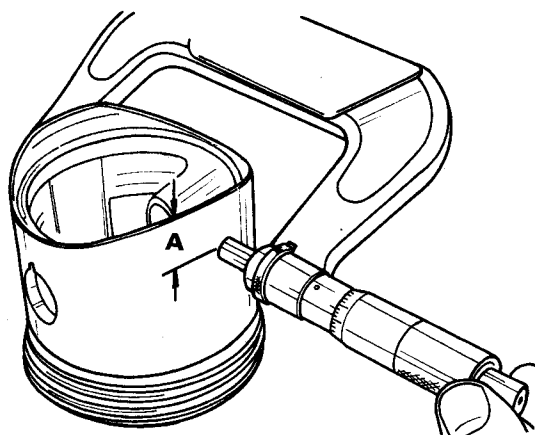


FIG 1:68 Measuring piston diameter

flange. When installing, press into position until distance **A** between flange and inner rotor is $44.3 \pm 0.1\text{mm}$ ($1.744 \pm 0.004\text{in}$) as shown in FIG 1:65. Some pump units are provided with a vent hole as shown in FIG 1:66. If so, it is important to ensure that the hole is clear.

On completion, clean the oil pick-up pipe and strainer, then reassemble the oil pump in the reverse order of dismantling. Refit the pump as described previously.

1:10 Pistons and connecting rods

Removal:

Remove the cylinder head as described in Section 1:3 and the sump as described in Section 1:8. If the car is raised for access to the underside, support it safely on floor stands.

The connecting rods and caps are numbered 1 to 6 from the front of the engine. Turn the crankshaft as necessary to bring each connecting rod in turn to the lower position, then remove nuts and detach the caps and shell bearing. Note that all components must be kept in the correct order for refitting in their original positions if they are not to be renewed.

Push the piston and connecting rod assembly upwards and remove through the top of the bore, then remove the upper shell bearing from the connecting rod. Repeat the operation described to remove each assembly in turn. Note that, when refitting the assemblies, a suitable ring compressor should be used when entering rings into cylinder bores, and that pistons and big-end bearing shells should be lubricated with engine oil.

Remove the gudgeon pins to separate pistons from connecting rods. Note that gudgeon pins must be fitted in their original positions as they are matched to the pistons. The oil hole in the small-end of the connecting rod must face towards the front of the engine, together with the arrow on the piston crown (see FIG 1:67). The other mark on the piston will be either a plus (+) or minus (-) sign which indicates the weight group of the piston. Replacement pistons must be of the same group as the original.

Pistons and rings:

Clean carbon deposits from the piston crowns, then gently ease the rings from their grooves and remove them over the tops of the pistons. Keep all parts in the correct order, if not to be renewed. Clean carbon from the piston ring grooves, for which job a piece broken from an old piston ring ground to a chisel point will prove an ideal tool. Inspect the pistons for score marks or any sign of seizure, which would dictate renewal.

Check the cylinder bores for score marks and remove glaze and carbon deposits. Badly scored or worn surfaces will dictate a rebore to accept new pistons, this being a specialist job.

Check the clearance of each piston in its bore, measuring the outside diameter of the piston at distance **A** from the lower skirt at right angles to the gudgeon pin bore, FIG 1:68. For Mahle pistons, dimension **A** should be 20.5mm (0.807in) for 2500 models and 15mm (0.591in) for all other models. For KS pistons, **A** should be 26.25mm (1.033in) for 2500 models, 24.05mm (0.947in) for all 2800 and 3.0 models and 14.9mm

(0.587in) for 3.3L models. For Nural pistons, **A** should be 16.2mm (0.638in) for all models. For Alcan pistons, **A** should be 18.5mm (0.728in) for 2800 models, 21.4mm (0.843in) for 3.0S models and 17.5mm (0.689in) for 3.0Si models.

Use an internal measuring gauge to check the maximum diameter of cylinder bores, measuring at top, bottom and centre. Calculate the maximum clearance of each piston in its bore from the measurements taken and compare with the figures given in **Technical Data**. Excessive clearance will dictate the fitting of new pistons of the same size or, possibly, reboring of the cylinders to accept oversize pistons, which is a specialist job.

Fit the piston rings one at a time into the bore from which they were removed, pushing them down into the bore with the correct inverted piston to ensure squareness. Measure the gap between the ends of the ring while it is positioned in the bore, using feeler gauges as shown in **FIG 1:69**. This clearance should be within the limits for the appropriate ring given in **Technical Data**. Hold each of the rings in turn in the piston groove from which it was removed as shown in **FIG 1:70**, then measure the side clearance in the groove with feeler gauges. This clearance should be within the limits for the appropriate ring given in **Technical Data**. If the clearance measurements in either test are at or near the wear limits, new rings should be fitted. If the fitting of new rings does not cure excessive ring to groove clearance, new pistons also will be required. Excessive ring clearance can be responsible for high oil consumption and poor engine performance.

Check the gudgeon pins for wear, scoring or pitting and renew complete with piston if necessary. Gudgeon pins should be a thumb push fit in the small-end bores. If excessive clearance is caused by wear of the small-end bush, a new bush can be installed and reamed to size. As press equipment is necessary to remove and install bushes, the work should be carried out at a service station.

Carefully fit the piston rings to the pistons as shown in **FIG 1:71**, noting that the 'Top' mark on each ring must be uppermost. Space the ring gaps at 180° intervals around the piston.

Connecting rods:

A connecting rod that is damaged in any way should be renewed. Check rods for bending or twisting, any such condition dictating realignment on special equipment at a service station, or renewal if the condition cannot be rectified.

If there has been a big-end bearing failure, the crankpin must be examined for damage and for transfer of metal to its surface. The oilway in the crankshaft must be checked to ensure that there is no obstruction. Big-end bearing clearance can be checked by the use of Plastigage, which is the trade name for a precisely calibrated plastic filament. The filament is laid across the bearing to be measured for working clearance as shown in **FIG 1:72**, the bearing cap fitted and the nuts tightened to the specified torque. The bearing is then dismantled and the width of the flattened filament measured with the scale supplied with the material. The figure thus measured is the actual bearing clearance. Both main and big-end bearing clearances are measured in a similar manner.

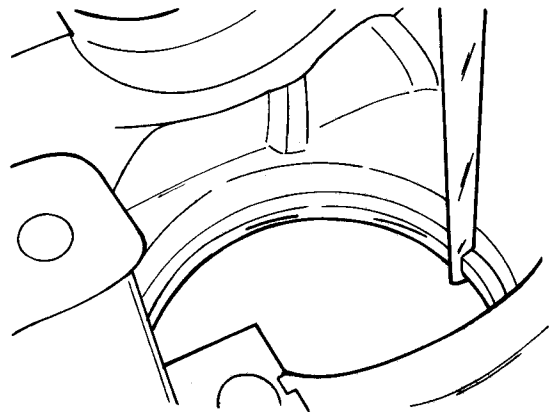


FIG 1:69 Checking piston ring end gap

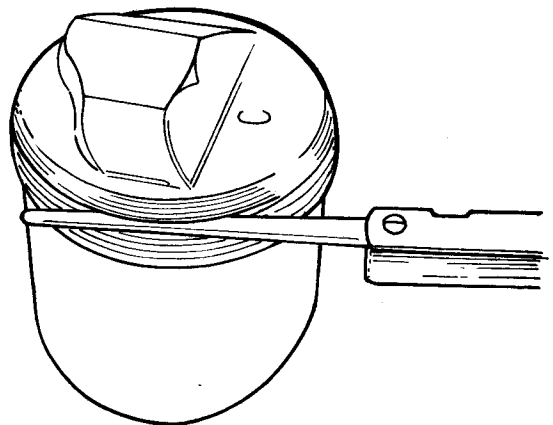


FIG 1:70 Checking piston ring side clearance

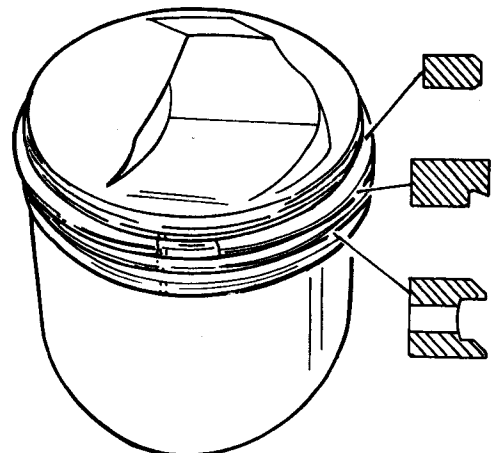


FIG 1:71 Piston ring installation

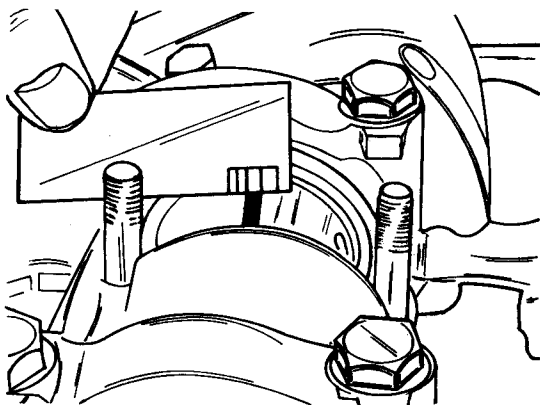


FIG 1:72 Checking bearing clearance

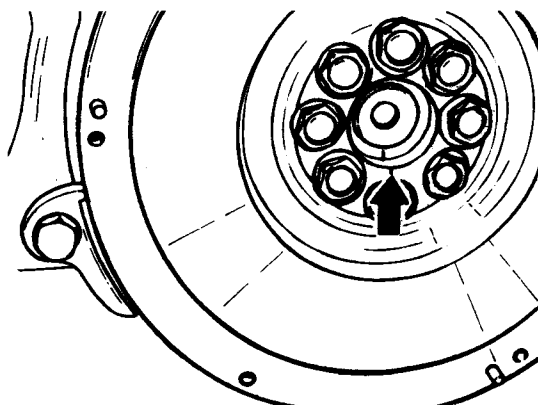


FIG 1:74 Flywheel installation

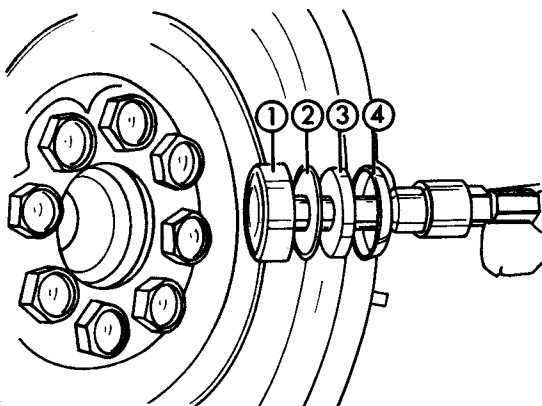


FIG 1:73 Pilot bearing removal

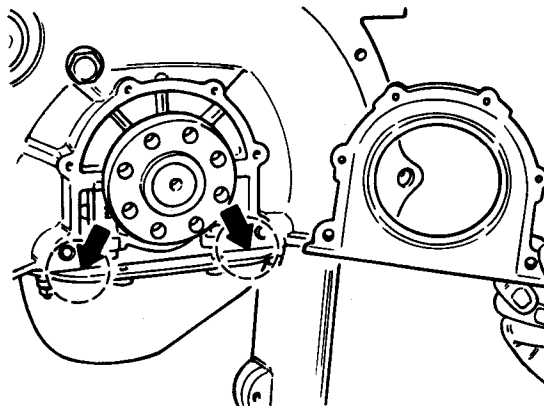


FIG 1:75 Crankcase rear cover installation

Note that each bearing must be measured separately and none of the remaining bearing caps must be fitted during the operation. The bearing surfaces must be clean and free from oil and the crankshaft must not be turned during the measuring procedure. The point at which the measurement is taken must be close to the respective dead centre position and no hammer blows must be applied to the bearing or cap.

Place a length of plastic filament identical to the width of the bearing on the crankshaft journal, then fit the main or big-end bearing cap with shell bearings and tighten to the specified torque. Remove the cap and measure the width of the flattened filament with the scale supplied to obtain the running clearance for that bearing. The clearance limits are given in **Technical Data**. If the bearing running clearance is too high, new bearing shells of the correct type must be fitted and the clearance rechecked. If undersize bearings are to be fitted to take up crankshaft wear, the crankshaft journals must be factory-reground, so the crankshaft should be taken to a BMW service station for attention. Early type crankshaft bearing shells were provided with an oil hole, later shells being provided with an oil pocket. When renewing shell bearings, always use the later type.

1:11 Flywheel and pilot bearing

Pilot bearing renewal:

Remove the clutch as described in **Chapter 5** or the automatic transmission as described in **Chapter 7**. Using a Kukko extractor or similar, remove the ball-bearing complete with cover plate, felt ring and cap as shown in **FIG 1:73**.

Install the bearing in the reverse order of removal, packing bearing 1 with good quality high melting point grease. Insert the cover plate 2 with embossed side outwards and soak felt ring 3 in hot tallow before installation. Tap bearing cap 4 into place until it seats firmly. On completion, refit the clutch as described in **Chapter 5** or the automatic transmission as described in **Chapter 7**.

Flywheel removal:

Remove the clutch as described in **Chapter 5** or the automatic transmission as described in **Chapter 7**. On models without flywheel locating sleeves, mark the installed position of the flywheel relative to the crankshaft as shown by the arrow in **FIG 1:74**. Use tool 7007 or other suitable means to lock the flywheel against

rotation, then loosen the mounting bolts. Support the weight of the flywheel, then remove the bolts and detach the flywheel from the crankshaft, together with torque converter drive plate in the case of automatic transmission models. Note that the flywheel is mounted with special expansion bolts which must be used once only, so discard the bolts and obtain new ones to replace them.

If the flywheel ring gear is damaged, it can be renewed, but as it is shrunk onto the flywheel and the new gear must be accurately heated before installation, the work should be carried out by a service station.

Refit the flywheel, including drive plate for automatic transmission models, in the reverse order of removal, using new expansion bolts. Coat the bolt threads with Loctite LT red and install them finger tight, then tighten alternately and evenly to the specified torque.

1:12 Crankshaft oil seals

Front seal renewal:

Remove the crankshaft pulley and damper assembly as described in the instructions for lower timing case cover removal in **Section 1:6**. Lever out the seal, taking care not to damage the housing. Drive the new seal squarely into position, making sure that the lips run in front of or behind any scored areas on the damper hub.

Rear oil seal renewal:

Drain the engine oil. Remove the flywheel as described in **Section 1:11**. Refer to **Section 1:8** and loosen but do not remove the sump fixing bolts. Refer to **FIG 1:75**. Carefully lever the sump gasket away from the crankcase rear end cover, then remove the fixing bolts and detach the cover. Note that, if the sump gasket is damaged, the sump must be removed and the gasket renewed. Carefully drive the oil seal from the end cover and discard. Press the new oil seal into the end cover as shown in **FIG 1:76** until it seats firmly.

Install the rear cover and remaining components in the reverse order of removal, coating the junctions between end cover and sump with Atmosit or similar sealant at the points arrowed in **FIG 1:75**.

1:13 Crankshaft removal and refitting

Removal:

Remove the engine as described in **Section 1:2**, then remove the clutch assembly on manual transmission models as described in **Chapter 5**. Remove the cylinder head as described in **Section 1:3**, the timing chain as described in **Section 1:6**, the oil pump as described in **Section 1:9** and the crankshaft end cover as described in **Section 1:12**.

Invert the cylinder block and remove the big-end bearing caps as described in **Section 1:10**. Push the piston and connecting rod assemblies into the bores sufficiently to clear the crankshaft journals. Before removing the crankshaft, check crankshaft axial play which should be 0.085 to 0.174mm (0.0035 to 0.007in). If axial play is excessive, the crankshaft guide bearing should be renewed, referring to **Section 1:10** to select bearing shells with the correct running clearance.

Note that the crankshaft bearing caps are numbered 1 to 6 from front to rear of the engine for correct installation. Remove the bearing caps and lower bearing shells,

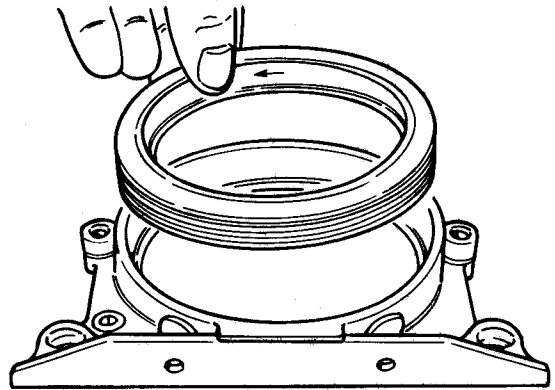


FIG 1:76 Rear oil seal installation

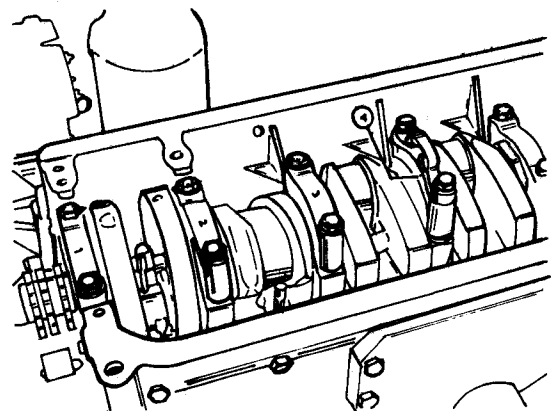


FIG 1:77 Crankshaft removal

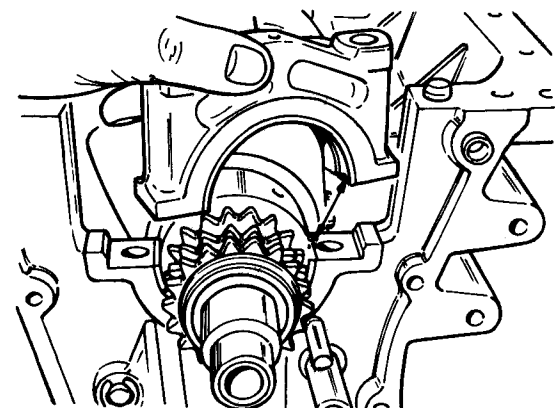


FIG 1:78 Main bearing cap installation

keeping the shells in the correct order for refitting in their original positions if they are not to be renewed. Lift the crankshaft from the crankcase and collect the upper bearings, keeping these in the correct order also (see **FIG 1:77**).

If there has been a crankshaft bearing failure, the journal must be checked for damage and for transfer of metal to its surface. The oilways in the crankshaft must be checked to ensure that there is no obstruction. Main bearing clearance can be checked by the use of Plastigage, in the manner described in **Section 1:10**. If there is any doubt about the condition of the crankshaft it should be taken to a specialist for more detailed checks.

Refitting:

Refit the crankshaft in the reverse order of removal, making sure that the bearing shells and main bearing caps are refitted in their original positions. Make sure that the grooves in the caps and crankcase are correctly aligned as shown in **FIG 1:78**. Lubricate the bearing shells with engine oil before installation.

1:14 Fault diagnosis

(a) Engine will not start

- 1 Defective coil
- 2 Faulty distributor capacitor
- 3 Dirty, pitted or incorrectly set contact points
- 4 Ignition wires loose or insulation faulty
- 5 Water on spark plug leads
- 6 Battery discharged, corrosion of terminals
- 7 Faulty or jammed starter
- 8 Sparking plug leads wrongly connected
- 9 Vapour lock in fuel pipes
- 10 Defective fuel pump
- 11 Overchoking or underchoking
- 12 Blocked fuel filter or carburettor jet
- 13 Leaking valves
- 14 Sticking valves
- 15 Valve timing incorrect
- 16 Ignition timing incorrect

(b) Engine stalls

- 1 Check 1, 2, 3, 4, 5, 10, 11, 12, 13 and 14 in (a)
- 2 Sparking plugs defective or gaps incorrect
- 3 Retarded ignition
- 4 Mixture too weak
- 5 Water in fuel system
- 6 Petrol tank vent blocked
- 7 Incorrect valve clearances

(c) Engine idles badly

- 1 Check 2 and 7 in (b)
- 2 Air leak at manifold joints
- 3 Carburettor adjustment wrong
- 4 Air leak in carburettor
- 5 Over-rich mixture
- 6 Worn piston rings
- 7 Worn valve stems or guides
- 8 Weak exhaust valve springs

(d) Engine misfires

- 1 Check 1, 2, 3, 4, 5, 8, 10, 12, 13, 14, 15 and 16 in (a)
- 2 Weak or broken valve springs

(e) Engine overheats (see Chapter 4)

(f) Compression low

- 1 Check 13 and 14 in (a); 6 and 7 in (c); and 2 in (d)
- 2 Worn piston ring grooves
- 3 Scored or worn cylinder bores

(g) Engine lacks power

- 1 Check 3, 10, 11, 12, 13, 14, 15 and 16 in (a); 2, 3, 4 and 7 in (b); 6 and 7 in (c); and 2 in (d). Also check (e) and (f)
- 2 Leaking joint washers or gaskets
- 3 Fouled sparking plugs
- 4 Automatic advance not working

(h) Burned valves or seats

- 1 Check 13 and 14 in (a); 7 in (b); and 2 in (d). Also check (e)
- 2 Excessive carbon round valve seats and head

(j) Sticking valves

- 1 Check 2 in (d)
- 2 Bent valve stem
- 3 Scored valve stem or guide
- 4 Incorrect valve clearances

(k) Excessive cylinder wear

- 1 Check 11 in (a)
- 2 Lack of oil
- 3 Dirty oil
- 4 Piston rings gummed up or broken
- 5 Badly fitting piston rings
- 6 Connecting rod bent

(l) Excessive oil consumption

- 1 Check 6 and 7 in (c); and check (k)
- 2 Ring gaps too wide
- 3 Oil return holes in piston choked with carbon
- 4 Scored cylinders
- 5 Oil level too high
- 6 External oil leaks

(m) Crankshaft and connecting rod bearing failure

- 1 Check 2 in (k)
- 2 Restricted oilways
- 3 Worn journals or crankpins
- 4 Loose bearing caps
- 5 Extremely low oil pressure
- 6 Bent connecting rod

(n) Internal water leakage (see Chapter 4)

(o) Poor water circulation (see Chapter 4)

(p) Corrosion (see Chapter 4)

(q) High fuel consumption (see Chapter 2)

(r) Engine vibration

- 1 Loose alternator or other belt driven component
- 2 Engine mountings loose or defective
- 3 Misfiring due to mixture, ignition or mechanical faults