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## INTRODUCTION

This Workshop Manual covers the Land Rover Ninety and One Ten range of vehicles. It is primarily designed to assist skilled technicians in the efficient repair and maintenance of Land Rover vehicles.

Using the appropriate service tools and carrying out the procedures as detailed will enable the operations to be completed within the time stated in the 'Repair Operation Times'.

The Manual has been produced in separate books; this allows the information to be distributed throughout the specialist areas of the modern service facility.

A table of contents in Book 1 lists the major components and systems together with the section and book numbers. The cover of each book details the sections contained within that book.

The title page of each book carries the part numbers required to order replacement books, binders or complete Service Manuals. This can be done through the normal channels.

## REFERENCES

References to the left- or right-hand side in the manual are made when viewing the vehicle from the rear. With the engine and gearbox assembly removed, the water pump end of the engine is referred to as the front.

To reduce repetition, operations covered in this manual do not include reference to testing the vehicle after repair. It is essential that work is inspected and tested after completion and if necessary a road test of the vehicle is carried out particularly where safety related items are concerned.

## DIMENSIONS

The dimensions quoted are to design engineering specification. Alternative unit equivalents, shown in brackets following the dimensions, have been converted from the original specification.

During the period of running-in from new, certain adjustments may vary from the specification figures given in this Manual. These adjustments will be re-set by the Distributor or Dealer at the After Sales Service, and thereafter should be maintained at the figures specified in the Manual.

## REPAIRS AND REPLACEMENTS

When replacement parts are required it is essential that only Land Rover parts are used.

Attention is particularly drawn to the following points concerning repairs and the fitting of replacement parts and accessories:

Safety features embodied in the vehicle may be impaired if other than Land Rover parts are fitted. In certain territories, legislation prohibits the fitting of parts not to the vehicle manufacturer's specification. Torque wrench setting figures given in the Repair Operation Manual must be strictly adhered to. Locking devices, where specified, must be fitted. If the efficiency of a locking device is impaired during removal it must be renewed. Owners purchasing accessories while travelling abroad should ensure that the accessory and its fitted location on the vehicle conform to mandatory requirements existing in their country of origin. The terms of the Owners Service Statement may be invalidated by the fitting of other than Land Rover parts.

All Land Rover parts have the full backing of the Owners Service Statement.

Land Rover Distributors and Dealers are obliged to supply only Land Rover service parts.

## POISONOUS SUBSTANCES

Many liquids and other substances used in motor vehicles are poisonous and should under no circumstances be consumed and should as far as possible be kept away from open wounds. These substances among others include antifreeze, brake fluid, fuel, windscreen washer additives, lubricants and various adhesives.

## FUEL HANDLING PRECAUTIONS

The following information provides basic precautions which must be observed if petrol (gasoline) is to be handled safely. It also outlines the other areas of risk which must not be ignored.

This information is issued for basic guidance only, and in any case of doubt appropriate enquiries should be made of your local Fire Officer.

## GENERAL

Petrol/gasoline vapour is highly flammable and in confined spaces is also very explosive and toxic.

When petrol/gasoline evaporates it produces 150 times its own volume in vapour, which when diluted with air becomes a readily ignitable mixture. The vapour is heavier than air and will always fall to the lowest level. It can readily be distributed throughout a workshop by air current, consequently, even a small spillage of petrol/gasoline is potentially very dangerous.

Always have a fire extinguisher containing FOAM CO<sub>2</sub> GAS, or POWDER close at hand when handling or draining fuel, or when dismantling fuel systems and in areas where fuel containers are stored.

Always disconnect the vehicle battery BEFORE carrying out dismantling or draining work on a fuel system.

Whenever petrol/gasoline is being handled, drained or stored, or when fuel systems are being dismantled all forms of ignition must be extinguished or removed, any head-lamps used must be flameproof and kept clear of spillage.

**NO ONE SHOULD BE PERMITTED TO REPAIR COMPONENTS ASSOCIATED WITH PETROL/GASOLINE WITHOUT FIRST HAVING HAD SPECIALIST TRAINING.**

## FUEL TANK DRAINING

**WARNING: PETROL/GASOLINE MUST NOT BE EXTRACTED OR DRAINED FROM ANY VEHICLE WHILST IT IS STANDING OVER A PIT.**

Draining or extracting petrol/gasoline from vehicle fuel tank must be carried out in a well ventilated area.

The receptacle used to contain the petrol/gasoline must be more than adequate for the full amount of fuel to be extracted or drained. The receptacle should be clearly marked with its contents, and placed in a safe storage area which meets the requirements of local authority regulations.

**WHEN PETROL/GASOLINE HAS BEEN EXTRACTED OR DRAINED FROM A FUEL TANK THE PRECAUTIONS GOVERNING NAKED LIGHTS AND IGNITION SOURCES SHOULD BE MAINTAINED.**

## FUEL TANK REMOVAL

On vehicles where the fuel line is secured to the fuel tank outlet by a spring steel clip, it is recommended that such **clips** are released before the fuel line is disconnected or the fuel tank unit is removed. This procedure will avoid the possibility of residual petrol fumes in the fuel tank being ignited when the clips are released.

As an added precaution fuel tanks should have a PETROL/GASOLINE VAPOUR warning label attached to them as soon as they are removed from the vehicle.

## FUEL TANK REPAIR

Under no circumstances should a repair to any tank involving heat treatment be carried out without first rendering the tank SAFE, by using one of the following methods:

**STEAMING:** With the filler cap and tank unit removed, empty the tank. Steam the tank for at least two hours with low pressure steam. Position the tank so that condensation can drain away freely, ensuring that any sediment and sludge not volatilised by the steam, is washed out during the steaming process.

**BOILING:** With the filler cap and tank unit removed, empty the tank. Immerse the tank completely in boiling water containing an effective alkaline degreasing agent or a detergent, with the water filling and also surrounding the tank for at least two hours.

After steaming or boiling a signed and dated label to this effect should be attached to the tank.

## SPECIFICATION

Purchasers are advised that the specification details set out in this Manual apply to a range of vehicles and not to any one. For the specification of a particular vehicle, purchasers should consult their Distributor or Dealer.

The Manufacturers reserve the right to vary their specifications with or without notice, and at such times and in such manner as they think fit. Major as well as minor changes may be involved in accordance with the Manufacturer's policy of constant product improvement.

Whilst every effort is made to ensure the accuracy of the particulars contained in this Manual, neither the Manufacturer nor the Distributor or Dealer, by whom this Manual is supplied, shall in any circumstances be held liable for any inaccuracy <sup>or</sup> the consequences thereof.

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# Special Service Tools

The use of approved special service tools is important. They are essential if service operations are to be carried out efficiently, and safely. The amount of time which they save can be considerable.

Every special tool is designed with the close co-operation of Land Rover Ltd., and no tool is put into production which has not been tested and approved by us. New tools are only introduced where an operation cannot be satisfactorily carried out using existing tools or standard equipment. The user is therefore assured that the tool is necessary and that it will perform accurately, efficiently and safely.

Special tools bulletins will be issued periodically giving details of new tools as they are introduced.

**All** orders and enquiries from the United Kingdom should be sent direct to V. L. Churchill. Overseas orders should be placed with the local V. L. Churchill distributor, where one exists. Countries where there is no distributor may order direct from V. L. Churchill Limited, PO Box 3 Daventry, Northants, England NN11 4NF.

The tools recommended in this Workshop Manual are listed in a multi-language, illustrated catalogue obtainable from Messers. V. L. Churchill at the above address under publication number 2217/2/84 or from Land Rover Ltd., under part number LSM0052TC from the following address, Land Rover Publication Service, P.O. Box 534, Erdington, Birmingham B24 OQS.

**DISMANTLE AND OVERHAUL****Special tools:—****Chain wheel extractor — RO 507231****Tappet guide remover — RO 530101A****\*Camshaft bearing remover — 274388****\* ” ” adaptor — 531760****\* ” ” guide plug — 274394****\* ” ” reamer — 274389****Cork-seal guide — 270304****Seal guide - rear main bearing — 18G 1344****Seal replacer - rear main oil seal — 18G 134 - 11****Diesel engine timing gauge — RO605863****Diesel engine timing gauge — MS67B****Clutch centralising tool — RO605022**

**\* Whilst these tools are now not obtainable, their use is described for workshops that have them available.**

Remove the engine from the vehicle. Clean the exterior and in the interests of safety and efficient working, secure the engine to a recognised engine stand.

**REMOVE ANCILLARY EQUIPMENT**

Before commencing, make a careful note of the position of brackets, clips, harnesses, pipes, hoses, filters and other miscellaneous items to facilitate re-assembly.

**Petrol engine**

1. Disconnect the spark plug leads, release the distributor clamp bolt and withdraw the distributor complete. Remove the adaptor plate held by three bolts.
2. Remove the inlet and exhaust manifolds complete with carburetter. Removal of the heat shield will facilitate this operation.

**Diesel engine**

3. Release the fuel pipes from the injectors.
4. Remove the nuts securing the injector pump and withdraw the pump and the short drive shaft.
5. Remove the induction and exhaust manifolds.
6. Remove the six bolts and withdraw the oil filter tube (early engines only). At the same time remove the two joint washers and the baffle plate with the timing pointer attached. Do NOT disturb the two bolts retaining the timing pointer. Later engines have a single plate with timing pointer.
7. Remove the vacuum pump.

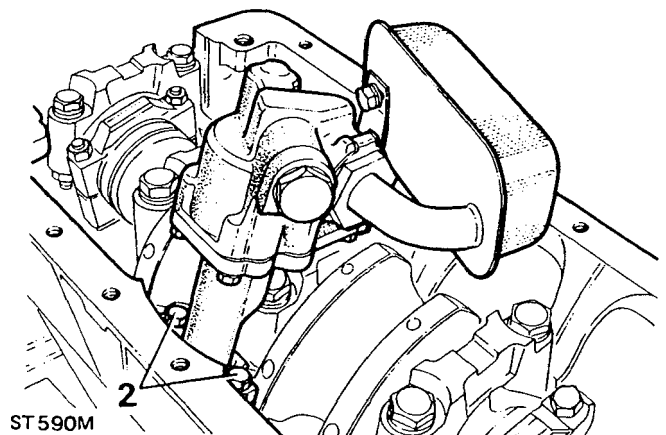
**Petrol and diesel engines**

8. Remove the six bolts and withdraw the rear side cover complete with fuel pump.
9. Remove the alternator and drive belt.
10. Remove the fan and pulley.
11. Remove the seven bolts and remove the water pump.
12. Drain the sump and remove the dipstick.
13. Remove the starter motor.
14. Restrain the flywheel, remove the crankshaft pulley nut and withdraw the pulley. (Bolt on later engines).
15. Evenly slacken and remove the clutch retaining bolts and withdraw the clutch assembly and centre plate.
16. Remove the two bolts and remove the oil filter assembly complete from the cylinder block. Remove the bowl retaining bolt, drain the oil and discard the element.
17. Remove the cylinder head.

**REMOVE AND OVERHAUL OIL PUMP**

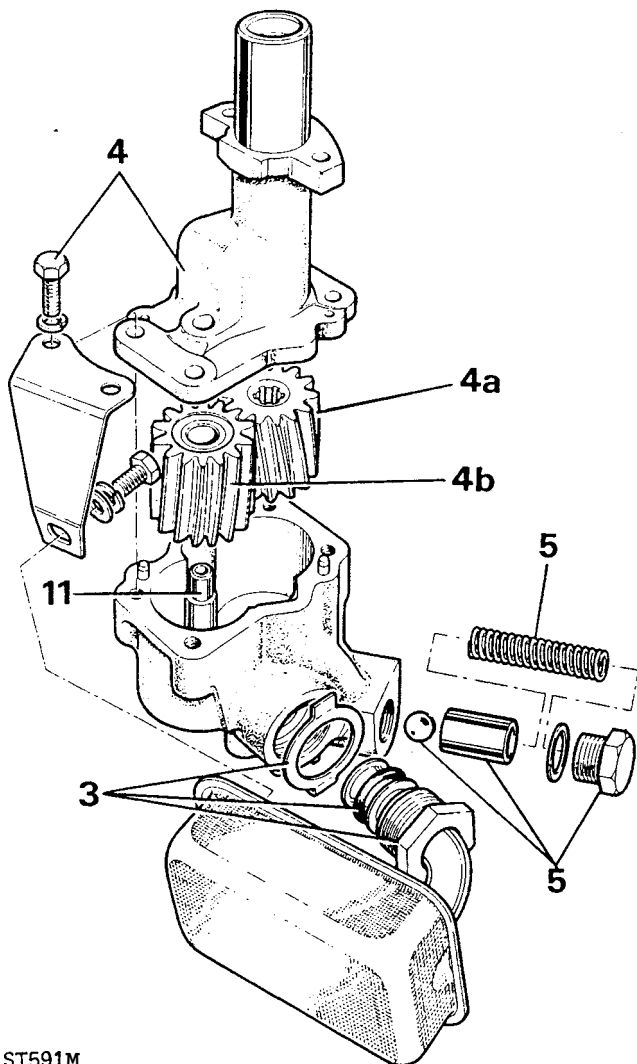
1. Remove the sump.
2. Bend back the lock washers and remove the two bolts securing the oil pump to the crankcase. Withdraw the oil pump complete with strainer and oil pump drive shaft.

continued



**Dismantle oil pump**

3. Bend back the lock washer and release the nut securing the strainer to the oil pump body and remove the strainer and sealing ring.
4. Remove four bolts and washers and lift off the oil pump cover and lift out the driven and idler gears.
  - (a) driven gear
  - (b) idler gear
5. Remove the oil pressure relief valve plug and sealing washer. Withdraw the relief valve spring, plunger and ball.

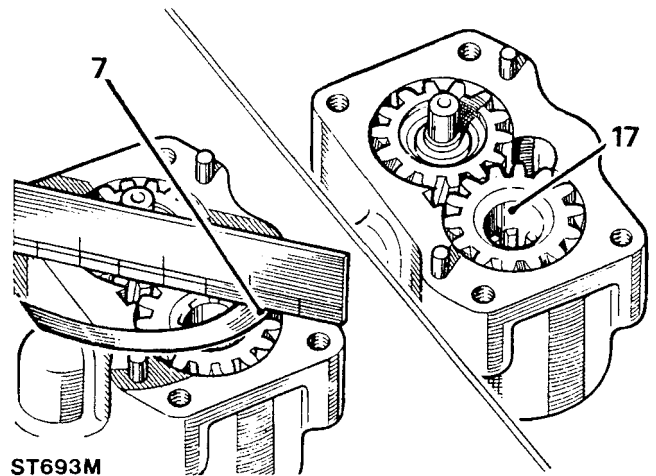


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**Overhaul the oil pump**

6. Examine the gears for wear, scores and pits. If the gears appear serviceable check for end-float as follows:

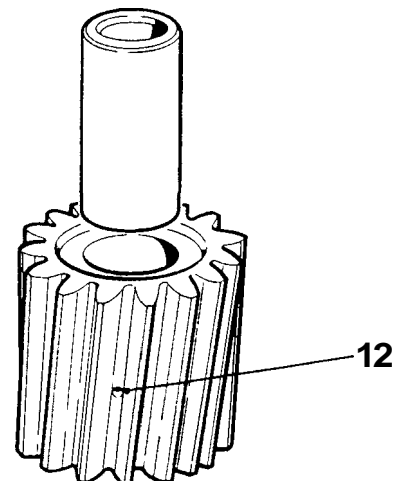
7. Clean the pump body and assemble the gears. Place a straight edge across the pump body face, as illustrated, and using a feeler gauge, measure the clearance between the body and gears. The correct clearances are as follows:
  8. Idler gear 0,07 to 0,15 mm (0.003 to 0.006 in).
  9. Driven gear 0,05 to 0,12 mm (0.002 to 0.005 in).



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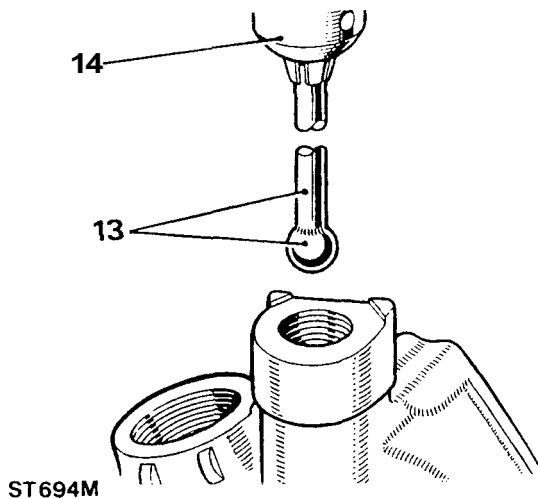
10. Gears must be renewed in pairs. A worn, but serviceable gear, must not be matched with a new one.
11. If necessary renew idler gear spindle by drilling-out the peened over end of the spindle so that the spindle can be withdrawn from the pump body. To ensure squareness when fitting the new spindle, assemble it into the pump body with the two gears. Fit the cover and secure with the four bolts. Support the pump body and peen over the end of the new spindle. Remove the cover and gears and check security of the spindle.
12. If worn, remove the idler gear bush and press in a replacement. Drill the lubrication hole 3,17 mm (0.125 in) and ream the bush to 12,7 mm (0.500 in) diameter.

continued



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13. A scored ball valve seat can be restored by using a locally made lapping tool by silver soldering a new ball (part number 3748) onto a length of suitable tube.
14. Install the tube in a drill and lap-in using coarse grinding paste. Finally hand-lap the seat with fine paste using the same diablo method as for lapping valves.
15. Thoroughly wash the pump body to remove all traces of grinding paste.

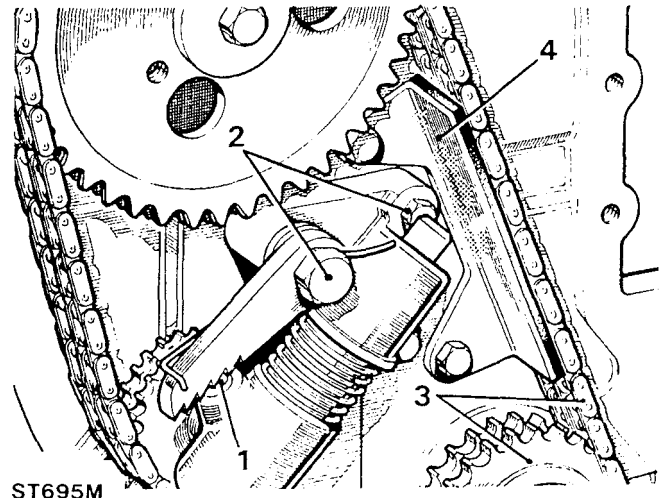


#### Assemble the oil pump

16. Fit the idler gear to the spindle.
17. Fit the driven gear with plain part of the bore uppermost. See illustration after instruction 9.
18. Smear the joint face of the body with jointing compound and fit the cover over the dowels and secure with the four bolts and spring washers.
19. Hold relief valve bore vertically and insert the ball followed by the plunger with the ball seat end first. Fit the spring, sealing washer and plug.
20. Fit the oil strainer sealing ring to the **pump** body followed by the lock washer and strainer. Tighten the strainer retaining nut so that when fitted the strainer is positioned parallel to the sump baffle plate. Secure the nut with the lock washer tab. Later engines are fitted with a bracket to locate the strainer.

#### REMOVE AND OVERHAUL THE TIMING CHAIN, SPROCKETS AND TENSIONER

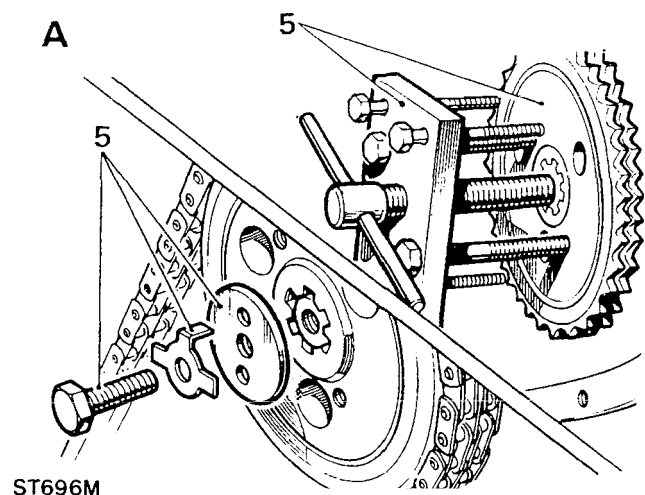
1. Remove the timing cover. Before removing the timing chain tensioner note the ratchet position in relation to the pawl which will give an indication of chain wear. If the last tooth of the ratchet is engaged with the pawl the chain is excessively worn and should be discarded.
2. Remove the ratchet pivot bolt, plain bolt and nut and withdraw the timing chain tensioner complete.
3. Remove the timing chain and crankshaft sprocket.
4. Remove timing chain damper.



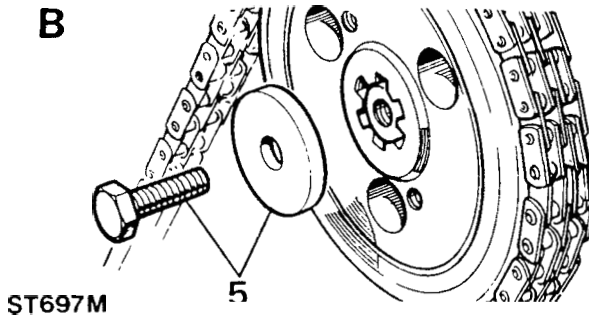
5. Remove the camshaft sprocket retaining bolt and washer. Withdraw the sprocket using chain wheel extractor 507231 or similar.

Illustration A shows the early retaining bolt and tab washer.

Illustration B shows the latest bolt and special washer.



continued

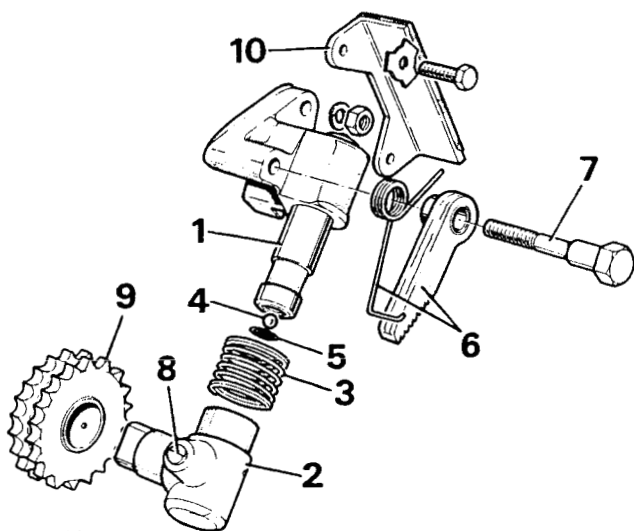


6. Examine the sprockets and discard if the teeth are worn.
7. Dismantle the tensioner assembly and discard any worn parts. In particular check the condition of the ratchet and pawl. Check the tension of the spring by comparing it with a new one. Examine the jockey wheel teeth for wear, and renew bush if worn.

#### Key to tensioner assembly

1. Piston assembly
2. Cylinder assembly
3. Cylinder spring
4. Ball
5. Ball retaining clip
6. Ratchet and spring
7. Ratchet pivot bolt
8. Pawl
9. Jockey wheel
10. Timing chain damper

8. Assemble the tensioner as illustrated and compress the assembly ready for fitting to the engine.



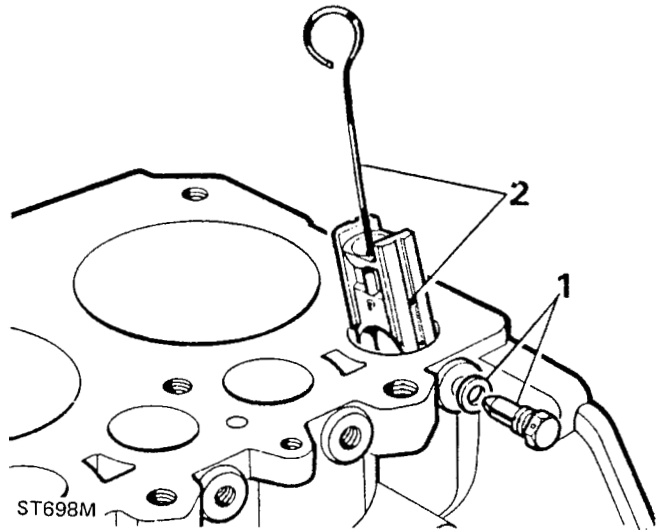
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## REMOVE TAPPETS, ROLLERS AND GUIDES

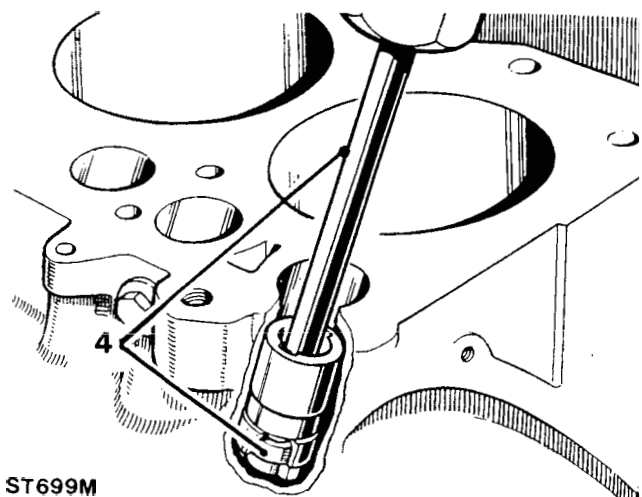
1. Remove the eight tappet guide locating bolts from the right-hand side of the cylinder block.

**CAUTION:** Do not remove the tappet guides before the rollers otherwise the rollers may fall behind the camshaft.

2. Using long nosed pliers or a suitable bent length of wire lift out the tappet slides and identify them with their respective guides for possible refitting.



3. Lift out the tappet rollers and mark the side facing the front of the engine for possible reassembly.
4. Lift out the tappet guides and retain with their respective slides and rollers. If the guides are difficult to remove use special tool 530101A.
5. Carefully examine all parts and discard any that are worn or damaged.

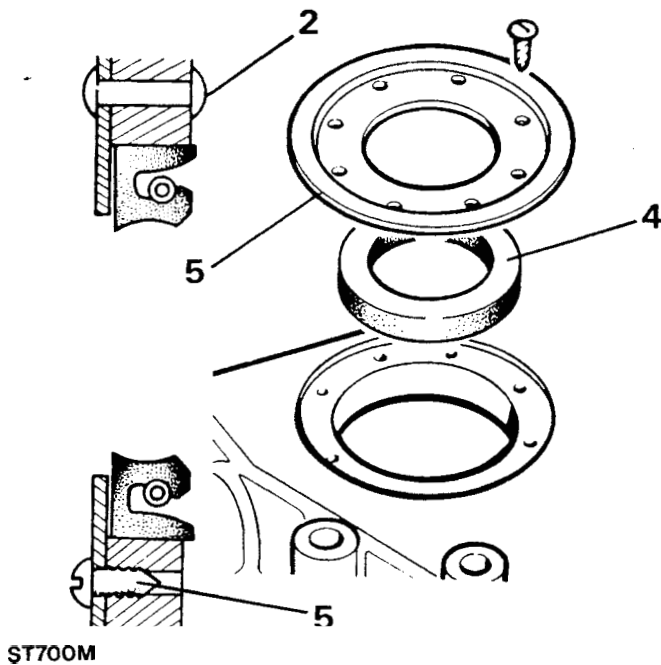


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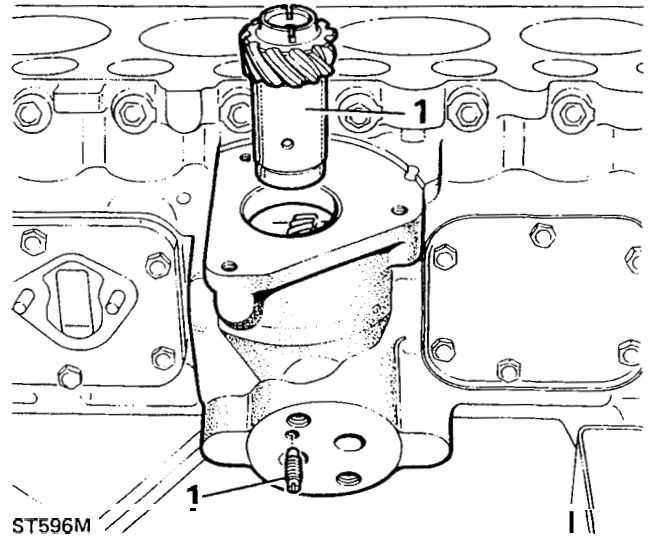


**RENEW TIMING COVER OIL SEAL**

1. On initial assembly of the engine the mud shield around the oil seal is rivetted in position but after removal in service the rivets are substituted with self tapping drive screws.
2. Drill out the rivets securing the oil seal mud shield.
3. Press out the oil seal and clean the mating surfaces.
4. Smear the outside diameter of a new oil seal with Hylomar PL 32-M jointing compound. Press the oil seal into the timing cover, lip side facing crankshaft.
5. Coat the drive screws with Hylomar and secure the mud shield.

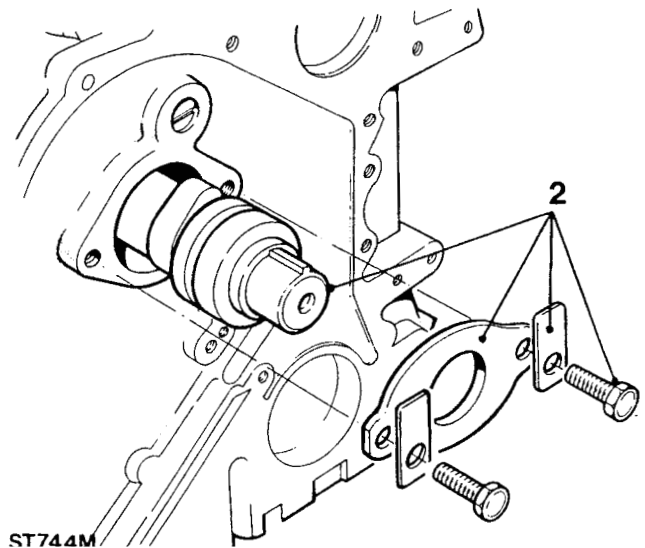
**REMOVE THE CAMSHAFT**

1. Remove the skew gear bush retaining screw and lift out the skew gear bush assembly. Also withdraw the distributor pump (diesel) or ignition distributor (petrol engine) drive coupling with the skew gear assembly.



2. Since the camshaft sprocket has already been removed, bend back the lock tabs, remove the two bolts and the camshaft thrust plate. Carefully withdraw the camshaft.

**NOTE: Lock tab washers are not used on later engines**

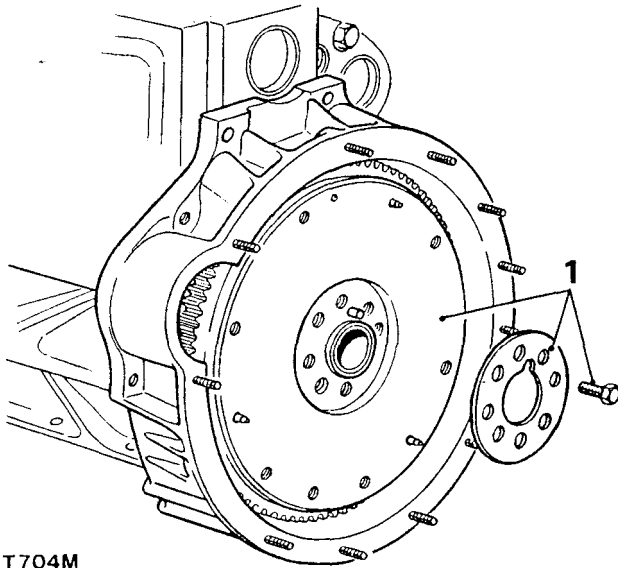
**Inspect the camshaft**

3. Discard the camshaft if any of the following visual defects are evident.
4. Scored, worn, pitted or chipped cams. Worn, corroded and discoloured journals. Worn and chipped gear teeth.

5. Check the journals for wear and if more than 0,050 mm (0.002 in) the shaft should be renewed.
6. Rest the camshaft between 'V' blocks and check for run-out with a dial indicator. If run-out is in excess of 0,050 mm (0.002 in) the shaft should be straightened or renewed.

### REMOVE AND OVERHAUL THE FLYWHEEL

1. Remove the flywheel retaining bolts and withdraw the flywheel and reinforcing plate.



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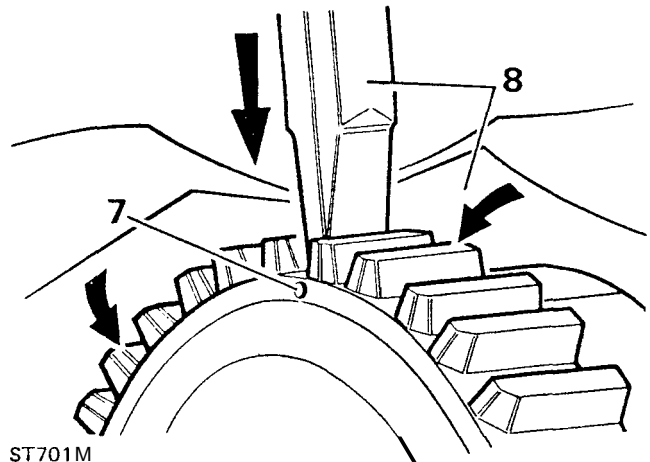
2. Wear or scores on the flywheel clutch face can be corrected by machining provided that the overall width of the flywheel is not reduced below the following dimensions:  
Petrol engines 34,72 mm (1.375 in).  
Diesel engines 36,96 mm (1.453 in).
3. Check that the flywheel has not been previously machined.
4. Examine the ring gear teeth and if chipped or worn the gear can be renewed.

### Reface the flywheel

5. Remove the clutch location dowels.
6. Machine the flywheel over the complete clutch face removing only the minimum material necessary to achieve a smooth flat surface parallel with the crankshaft mating face and within the above width dimensions and fit new dowels.

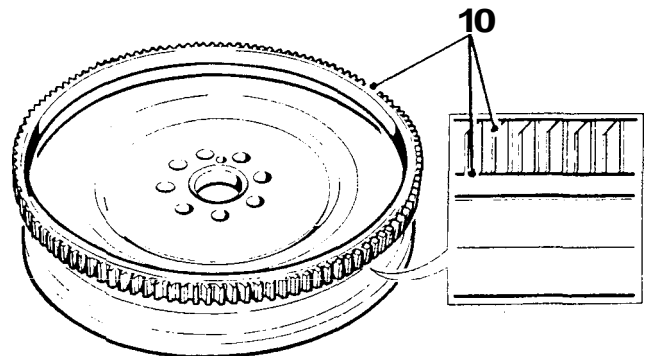
### Renew the ring gear

7. Drill a 8,0 mm ( $\frac{5}{16}$  in) hole between the root of any two teeth and the inner diameter of the starter ring deep enough to weaken the ring. Do not allow the drill to enter the flywheel.
8. Secure the flywheel in a soft jawed vice and cover it with a cloth to protect one from personal injury. Place a cold chisel above the drilled hole and strike it sharply to split the ring gear.



ST701M

9. Heat the new ring gear *uniformly* to between 225°C and 250°C but do not exceed the higher figure.
10. Place the flywheel, clutch face down, on a flat surface and locate the heated flywheel with the square edge of teeth downward towards the flywheel clutch face and chamfered edge of the teeth uppermost. This applies to both petrol and Diesel engines.
11. Press the starter ring firmly against the flange until the ring contracts sufficiently to grip the flywheel. Allow the ring gear to cool naturally. Do not hasten cooling in anyway.

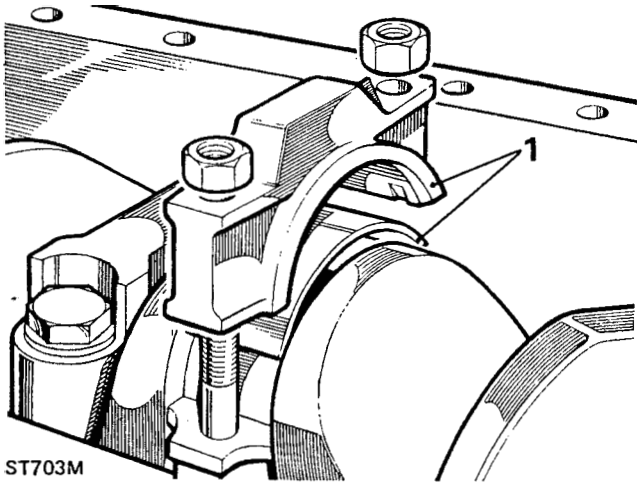


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**REMOVE THE CONNECTING-RODS AND PISTONS**

During the following instructions it is important that all components are kept in related sets and the pistons are identified with their respective bores.

1. Turn the crankshaft to bring the connecting-rod caps to an accessible position and remove each cap and lower shell in turn. Note that the connecting-rod caps are numbered one to four.

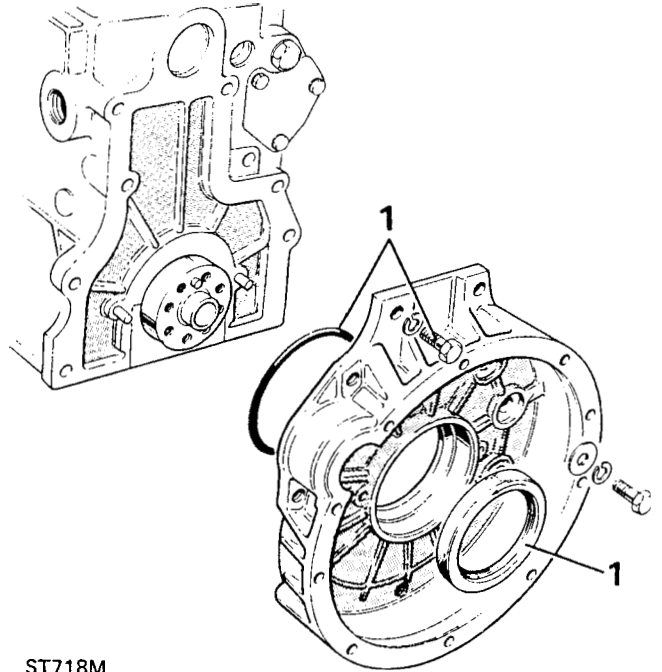


ST703M

2. **Push** each piston assembly up the bore and withdraw from the cylinder block. Assemble the caps and shell to the connecting-rods and place to one side for inspection with the cylinder block at a later stage.

**REMOVE, INSPECT AND OVERHAUL CRANKSHAFT**

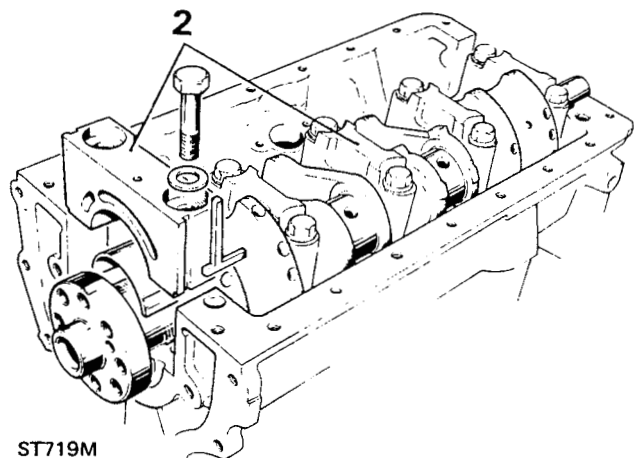
1. Remove the eight bolts securing the flywheel housing to the cylinder block and remove the housing and rear main bearing oil seal, and 'O' ring.



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2. Remove the main bearing caps and shells and lift out the crankshaft. Collect the bearing shells from the bearing saddles and the thrust washers from the centre saddle.

continued



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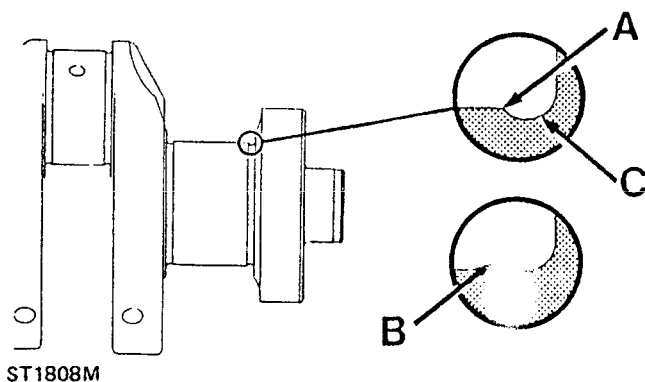
### Inspect crankshaft

3. Degrease the crankshaft and clear out the oil ways, which can become clogged after long service.
4. Examine visually, the crankpins and main bearing journals, for obvious wear, scores, grooves and overheating. A decision at this stage should be made as to whether the condition of the shaft is worth continuing with more detailed examination.
5. With a micrometer, measure and note the ovality and taper of each main bearing journal and crankpin as follows:
6. **Ovality** — Take two readings at right-angles to each other at various intervals.
7. **Taper** — Take two readings parallel to each other at both ends of the main bearing journal and crankpin.
8. To check for straightness, support the front and rear main bearing journals in 'V' blocks and position a dial indicator to check the run-out at the centre main bearing journal. Run-out must not exceed 0,076 mm (0.003 in) taking into account any ovality in the centre journal.

The maximum ovality must not exceed 0,040 mm (0.0015 in).  
The maximum permissible taper must not exceed 0,025 mm (0.001 in).

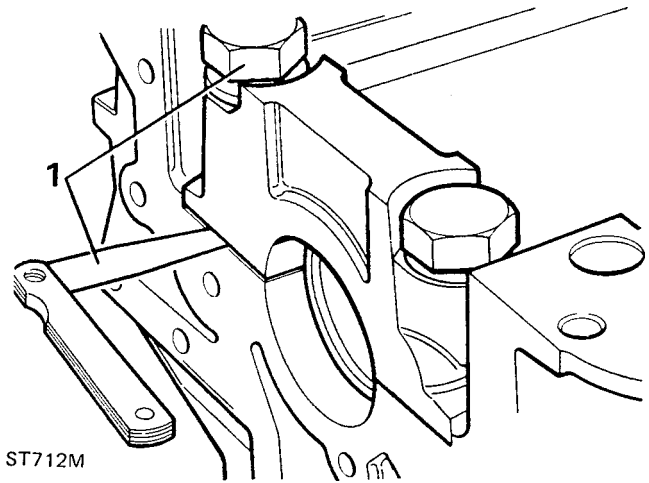
The overall allowable wear limit should not exceed 0,114 mm (0.0045 in) for main bearing journals and 0,088 mm (0.0035 in) for crankpins.  
A crankshaft worn beyond the limits of maximum taper, ovality and overall wear can be ground undersize for which bearing shells are available see data, book 1.

When grinding the crankshaft main bearing and crankpin journals, rotation of the grinding wheel and crankshaft must be in the same direction, anti-clockwise, viewed from the flywheel end of the crankshaft. Final finishing of the journals should be achieved by using a static tapping stone with the crankshaft rotating in a clockwise direction viewed from the flywheel end of the crankshaft. It is important to ensure that, when grinding, the stone travels beyond the edge of the journal 'A' to avoid formation of a step 'B' as illustrated. Also care must be taken not to machine or damage the fillet radii 'C'.



### EXAMINE AND OVERHAUL THE CYLINDER BLOCK

1. Degrease the cylinder block and carry out a thorough visual examination checking for cracks and damage. To check the main bearing caps and saddles for distortion. Fit the main bearing cap without bearing shells and tighten to the correct torque. Slacken and remove the bolt on one side of each bearing cap and check with a feeler gauge that no clearance exists at the joint face between the cap and saddle.



### Inspect cylinder bores

2. Measure the cylinder bores for ovality, taper and general wear, using any suitable equipment. However, an inside micrometer is best for checking ovality and a cylinder gauge for taper.
3. Check the ovality of each bore by taking measurement at the top of the cylinder just below the ridge at two points diametrically opposite. The difference between the two figures is the ovality of the top of the bore. Similar measurements should be made approximately 50 mm (2.0 in) up from the bottom of the bore so that the overall ovality may be determined.
4. The taper of each cylinder is determined by taking measurements at the top and bottom of each bore at right angles to the gudgeon pin line. The difference between the two measurements is the taper.
5. To establish maximum overall bore wear, take measurements at as many points possible down the bores at right angles to the gudgeon pin line. The largest recorded figure is the maximum wear and should be compared with the original diameter of the cylinder bore.

Maximum permissible ovality 0,127 mm (0.005 in).  
Maximum permissible taper 0,254 mm (0.010 in).  
Maximum permissible overall wear 0,177 mm (0.007 in).

continued

If the above figures are exceeded the cylinders must be rebored or sleeved depending upon the general condition of the bores and amount of wear. Alternatively, if the overall wear, taper and ovality are well within the acceptable limits and the original pistons are serviceable new piston rings may be fitted. It is important however, that the bores are deglazed, with a hone, to give a cross-hatched finish to provide a seating for the new rings. It is vital to thoroughly wash the bores afterwards to remove all traces of abrasive material.

### Inspect camshaft bearings

9. Measure the internal diameter of each camshaft bearing at several points using an internal micrometer. A comparison of the bearing diameters with those of the respective camshaft journals will give the amount of clearance. The bearings should be renewed if the clearance exceeds 0,0508 mm (0.002 in). Or, in any event, if they are scored or pitted.

### Fit cylinder sleeves

Cylinder bores that cannot be rebored can be restored by fitting sleeves to enable standard size pistons to be fitted. Sleeving one cylinder only will distort the adjacent bore so sleeving must be carried out in pairs, i.e. cylinders 1 and 2 or 3 and 4.

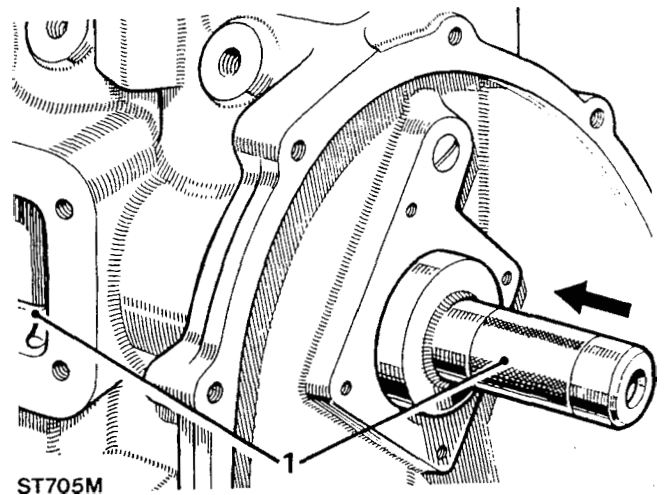
6. Machine the cylinder bores to accept the sleeves to  $94,425 \pm 0,012$  mm ( $3.7175 \pm 0.0005$  in). This will give the sleeve a 0,076 to 0,114 mm (0.003 to 0.0045 in) interference fit.
7. Press the sleeves squarely into the bore using a pressure of two to three tons. Excessive pressure could damage the sleeve and cylinder block. The sleeves must not be proud of the cylinder block top face or more than 2,5 mm (0.10 in) below the surface.
8. Bore and hone the sleeves to accommodate the pistons with the required clearances, see piston and connecting-rod examination.

### RENEW CAMSHAFT BEARINGS

The following special tools for this operation are no longer available from the suppliers. However, the operation is nevertheless described for workshops that have these tools in stock. If tools are not obtainable the work should be entrusted to line-boring specialists.

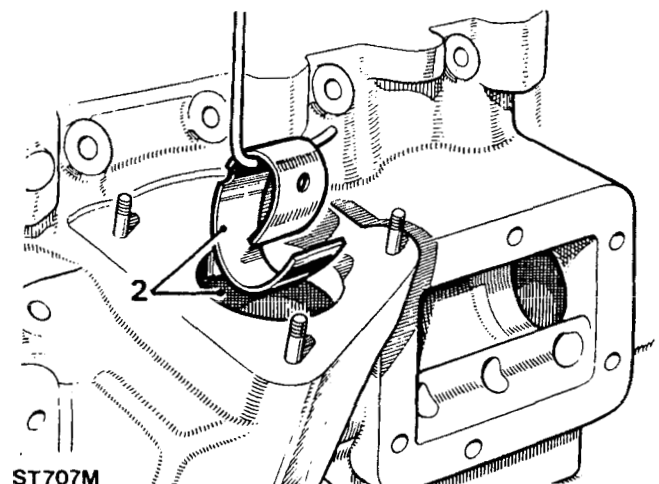
605975 Bearing drift and adaptor assembly comprising:  
274388 Bearing drift and  
531760 Adaptor.  
274389 Reamer for bearings which includes:  
274394 Guide plug.

1. Remove the rear bucket type plug and using special tool 274388 drift out the front and rear bearings and withdraw them through the side cover apertures.



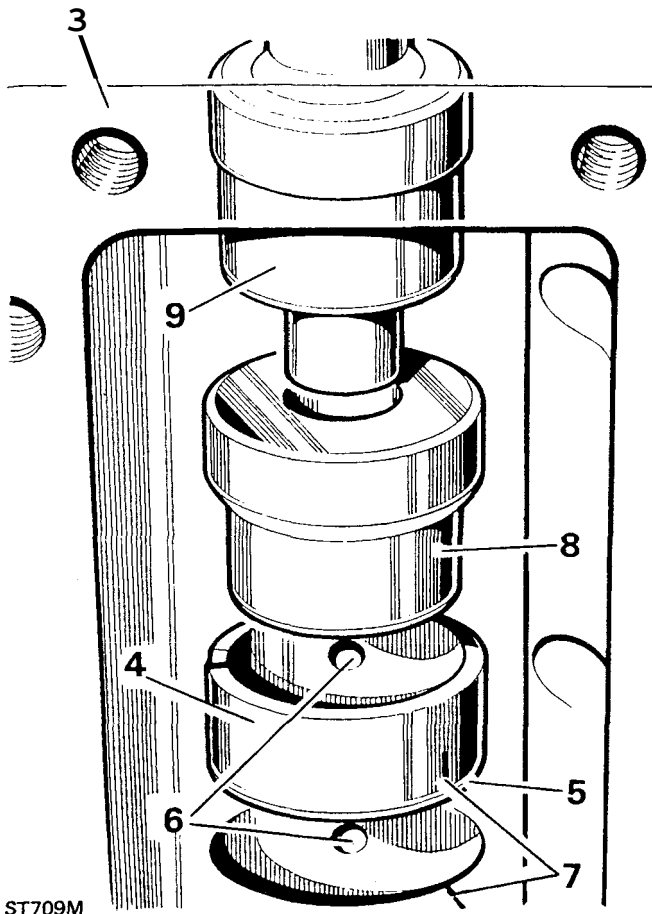
2. With the same tool, drift the two centre bearings into the distributor drive chamber and collapse them to assist withdrawal.

continued



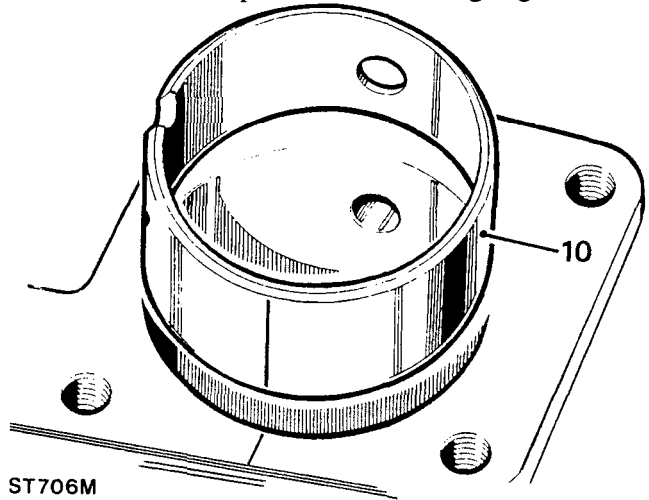
**NOTE: The two centre and rear bearings are of the same width, whereas the front bearing is wider and has an additional oil feed hole. Also ensure that before fitting the bearings the oil passages leading to the bearings are free of sludge and dirt.**

3. Position the cylinder block vertically, rear face down.
4. Place a new bearing into the front camshaft chamber and position it so that it is above the second bearing housing, counting from the front of the block.
5. The chamfer on the bearing edge must be towards the housing bore.
6. Align the oil hole in the bearing with the innermost oil feed drilling in the housing bore. Accuracy is essential otherwise misalignment of the oil holes may result and once the bearing is in place it cannot be rotated to correct any error.
7. Add pencil marks to the bearing outer diameter and the cylinder block adjacent to the housing to assist in checking alignment.
8. Having visually aligned the bearing, place inside it the special adaptor 531760.



9. Maintain the bearing in a level position. Pass the drift through the front bearing housing into the camshaft chamber so that it rests on top of the adaptor. Commence drifting the bearing into the block. Ensure that the bearing is not drifted in too far, and that the oil feed holes are correctly aligned.

10. Repeat the above instructions for the front bearing. Note that the front bearing is wider and has a small hole in addition to the large oil feed hole. This small hole aligns with a vertical drilling in the block, which in turn feeds a horizontal drilling for the tappet mechanism. Drift this bearing in so that the outer edge is just below the machined surface of the front face. This is to ensure that when the camshaft thrust plate is fitted it will not stand proud on the bearing edge.

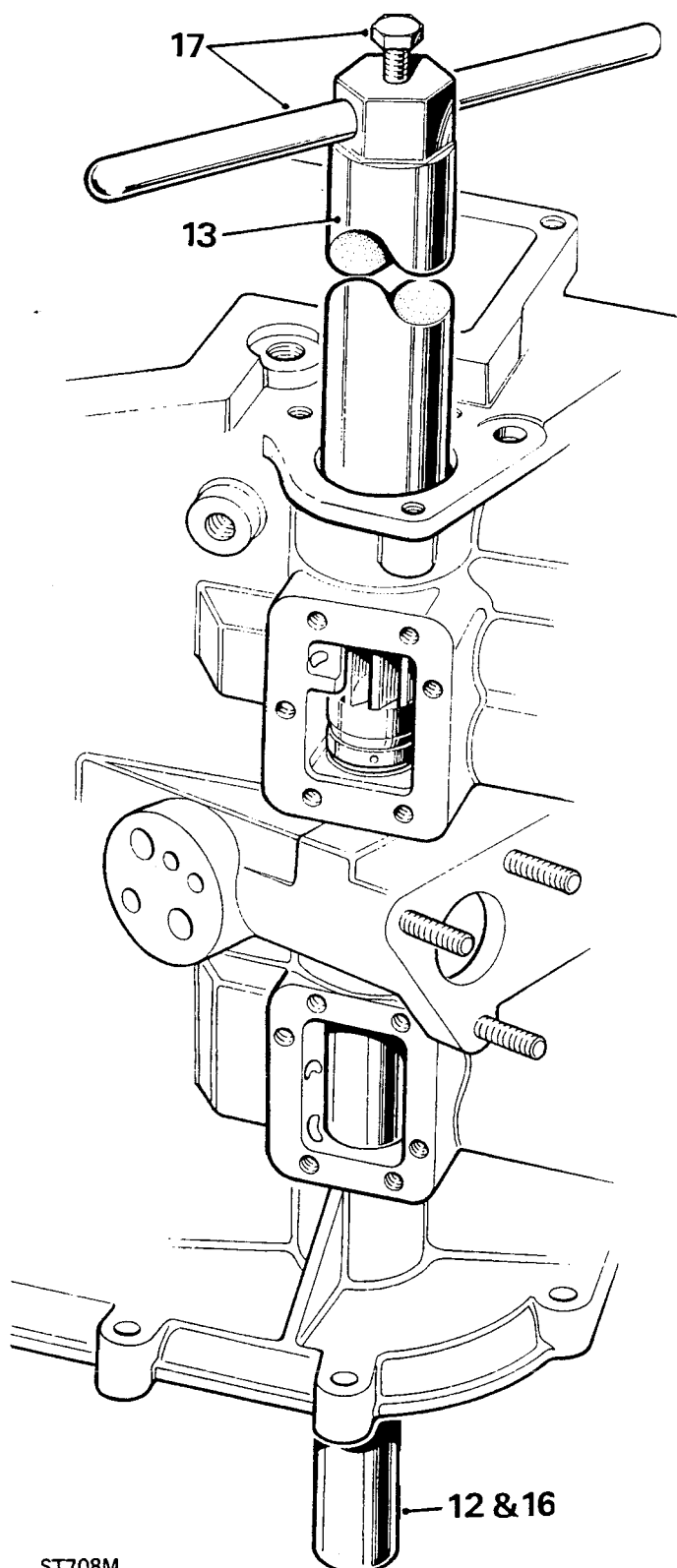


ST706M

11. Turn the cylinder block over so that the rear face is uppermost and repeat the foregoing procedures for the two remaining camshaft bearings. The bearings must now be reamed to size as follows: No lubricant is necessary for this operation since the best results are obtained when the bearings are cut dry.
12. Locate the guide plug 274394, into the front camshaft bearing and retain using the thrust plate screws, but do not tighten the screws at this stage.
13. Insert the reamer 274389 from the rear of the cylinder block, locating it through the guide plug at the front.
14. Locate the guide collar immediately in front of the reamer cutter into the rearmost bearing, then secure the screws retaining the guide plug at the front.
15. Position the cylinder block vertically, rear face uppermost and ream the rear and two centre bearings. As each bearing is cut the reamer should be held steady by the operator whilst an assistant, using a high pressure airline, blows away the white metal cuttings, before allowing the reamer to enter the next bearing.
16. Remove the guide plug 274394 and ream the front bearing.
17. Remove the reamer handle and bolt and withdraw the reamer, turning it in the same direction as tor cutting.
18. Remove the plugs from the ends of oil gallery passage and clean the gallery and oil feed passages to camshaft and crankshaft bearings, using compressed air. Refit the plugs and lock in position.

continued

19. The hexagon-headed plugs at the rear of the block should have new washers fitted, and their threads coated with a suitable jointing compound.
20. Thoroughly clean the cylinder block preferably using an airline to remove all traces of metal cuttings.



ST708M

### Check crankcase main bearings

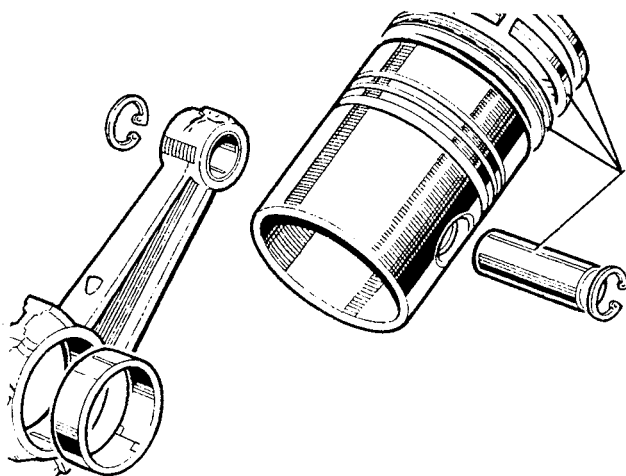
21. Discard scored, pitted, cracked and worn bearing shells.
22. To determine the maximum wear, assemble the main bearing shells and caps to the crankcase and tighten the bolts to the correct torque figure.
23. Using an inside micrometer, measure each bearing at several points and note the greatest figure. The maximum wear is the difference between this figure and the smallest diameter of the corresponding crankshaft journal. The main bearing running clearance is in the data section.
24. The bearing clearances may also be determined by using 'Plastigauge'. Since this method requires the crankshaft to be fitted to the crankcase, the procedure is described under engine assembly.

### PISTON AND CONNECTING-ROD INSPECTION

The following checks relating to pistons and rings must also be carried out prior to fitting new pistons to rebored and sleeved cylinder blocks.

Until it is decided if new components are required all parts must be kept in their related sets and the position of each piston to its connecting-rod should be noted.

1. Remove the piston rings and gudgeon pin from each piston and detach the connecting-rod.



ST710M

2. **Original pistons** — Decarbonise and degrease all components and carry out a visual examination of the pistons and rings and discard any which are unserviceable. Pistons which appear serviceable should be subjected to a more detailed examination described under 'New Pistons'.

continued

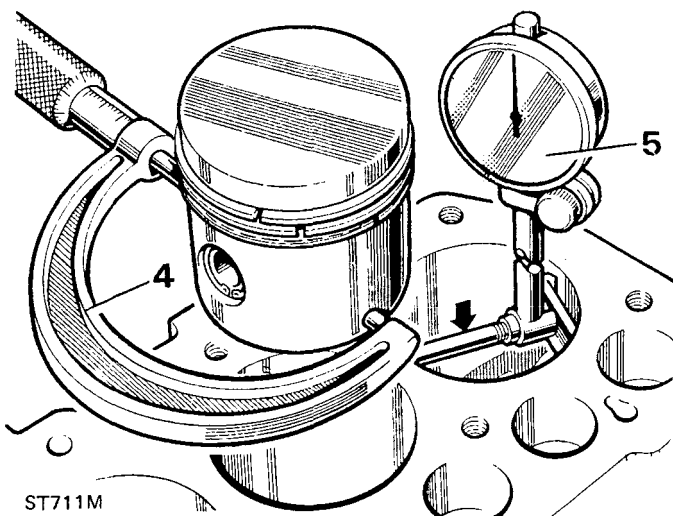
**3. New Pistons** — Original pistons fitted to new engines at the factory are specially graded to facilitate assembly. The grade letter on the piston crown should be ignored when ordering new pistons. Genuine Land Rover service standard size pistons are supplied 0,025 mm (0.001 in) oversize to allow for production tolerances on new engines. When fitting new pistons to a standard size cylinder block the bores must be honed to accommodate the pistons with the correct clearances. In addition Land Rover pistons are available 0,50 and 1,01 mm (0.020 and 0.040 in) oversize for fitting to rebored cylinder blocks.

Clearance limits for new standard size pistons in a standard cylinder bore measured at right angles to the gudgeon pin are in the "General specification data" section.

When taking the following measurements the cylinder block and pistons must be at the same temperature to ensure accuracy.

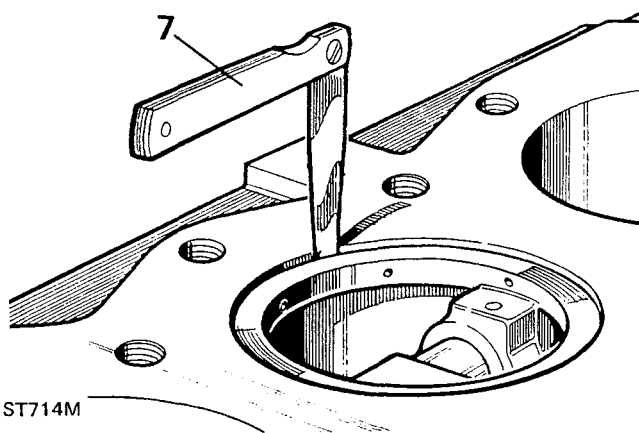
**NOTE: The illustration shows a petrol engine piston but the method is the same for the Diesel engine.**

4. Using a suitable micrometer measure the pistons at the bottom of the skirt at right angles to the gudgeon pin.
5. With an inside micrometer or cylinder gauge measure the diameter of the bore at approximately half-way down and note the reading.
6. The clearance is determined by subtracting the piston diameter from the bore diameter.



**NOTE: Early 2.25 Diesel pistons have a piston ring groove below the gudgeon pin. This has been deleted on later engines.**

7. If gauge equipment is not available the clearance can be assessed by placing a long, suitably sized, feeler gauge down the thrust side of the bore and inserting the appropriate piston, 'upside down', in the bore and position it with the gudgeon pin parallel to the crankshaft axis. Push the piston down the bore and stop at the tightest point and whilst holding the piston still, slowly withdraw the feeler gauge. If a steady resistance of approximately 2,5 kg (6 lbs) is felt, the clearance is satisfactory,



#### Inspect piston rings

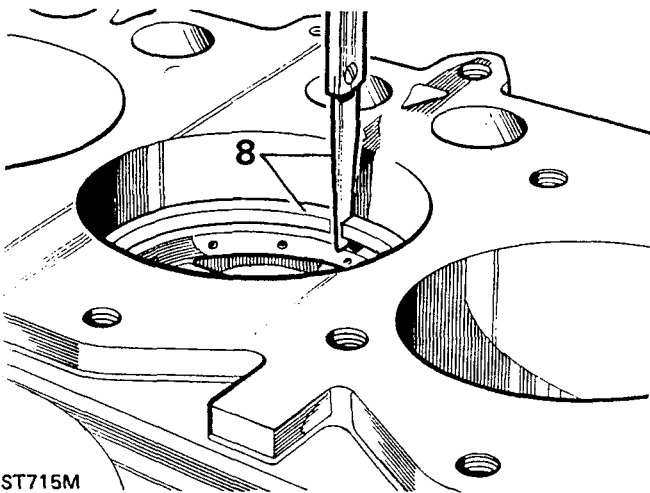
Normally when an engine is being overhauled the piston rings are discarded unless the pistons have been removed for a different purpose and the engine has only completed a small mileage. Before refitting the piston the rings should be examined for wear and damage. In addition the rings must be checked for side clearance in the pistons and gap in the bores. The latter two checks must be made when fitting new rings to new and used pistons.

8. **Check gap** When checking the ring gap in worn bores, but are nevertheless within the acceptable taper and ovality limits, the ring must be inserted squarely into the bottom of the bore at the lowest point of the piston travel. To ensure squareness of the ring push the ring down the bore to the correct position with a piston. With newly machined bores, the ring may be inserted squarely into any position in the bore.
9. Using an appropriate feeler gauge check the gaps of all the rings, in turn, including the oil control ring assembly.

The correct gaps are listed in the Data Section. If any gap is less than that specified, remove the ring, and file the ends square, whilst holding the ring in a filing jig or vice. Should any gap be excessively wide and not likely to close-up to within the specified limits when hot, an oversize ring should be fitted.

continued





ST715M

### Check piston ring side clearance

Petrol engine pistons have two compression rings and one oil control ring assembly. The diesel engine has three compression rings and one oil control ring assembly. The method of checking clearances are the same for both engines but the clearances are different.

It is important that clearances are correct. Rings that are too tight will bind when hot, impairing the radial pressure causing possible loss of compression. Excessive clearance will allow the rings to rock in the grooves and the resulting pumping action could cause excessive oil consumption and eventually broken rings.

**10. Diesel engine pistons** — Fit the oil control ring to the bottom groove (not groove in skirt). Fit the two unpolished rings with the word 'TOP' uppermost to the middle two grooves. Insert to polished chrome ring with the internal chamfer to the top groove with the word 'TOP' uppermost.

A ring groove is provided at the bottom of the diesel engine piston skirt for the fitment of an oil control ring in cases of excessive oil consumption on high mileage engines (early engines only).

**11 Petrol engine pistons** — Fit the oil control ring to the bottom groove. Fit the unpolished compression ring with the word 'TOP' uppermost to the second groove. Insert the polished chrome ring with an internal chamfer and the word 'TOP' uppermost to the top groove.

12. After fitting each ring, roll it around the piston groove to ensure that it is free and does not bind.

13. Using an appropriate feeler gauge check the clearance between the rings and piston grooves. Clearances in excess of 0,106 to 0,152 mm (0.004 to 0.006 in) are unacceptable and the ring and or the pistons should be renewed.

**NOTE:** Whilst the illustration shows a Diesel piston the method for the petrol is the same.

### Side clearance data — petrol engine

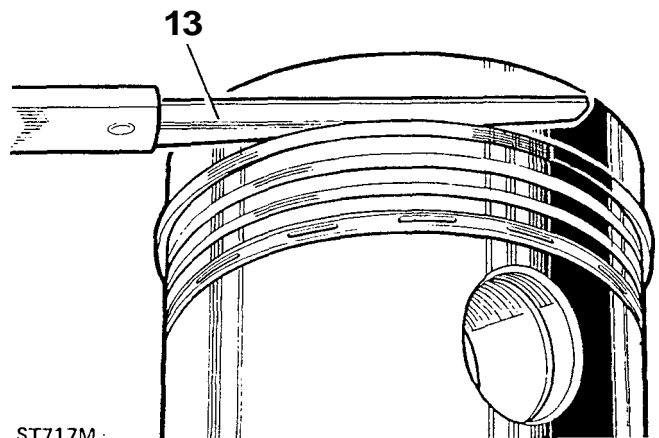
Compression rings — 0,046 to 0,097 mm (0.0018 to 0.0038 in).

Oil control ring — 0,038 to 0,089 mm (0.0015 to 0.0035 in).

### Side clearance — diesel engine

Compression rings — 0,06 to 0,11 mm (0.0025 to 0.0045 in).

Oil control ring — 0,038 to 0,064 mm (0.0015 to 0.0025 in).



ST717M

### Inspect gudgeon pins

14. Check the gudgeon pin for wear, cracks, scores and overheating.

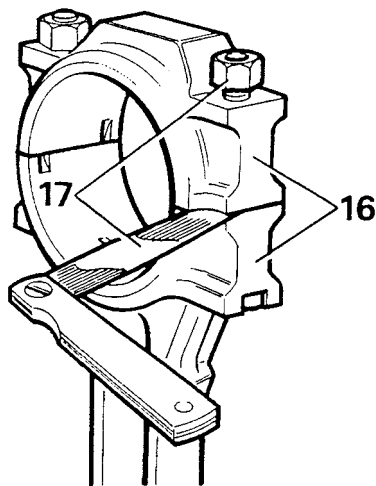
15. The gudgeon fit in the piston must be a tight push fit at a temperature of 68°F (20°C). Check the gudgeon pin for ovality and taper using a micrometer.

### Connecting-rod inspection

16 Check the connecting-rods and caps for distortion as follows; fit the correct cap, less the bearing shells, to each connecting rod as denoted by the number stamped near the joint faces. This number also indicates the crankshaft journal to which it must be fitted.

17 Tighten the nuts to the correct torque and release the nut on one side only. Check, with a feeler gauge, that no clearance exists between the joint faces. if there is a gap the connecting-rod is distorted and should be renewed.

continued



ST716M

18. Use an accurate connecting-rod alignment gauge to check the rods for bend and twist. The maximum allowable for both conditions must not exceed 0,127 mm (0.005 ins).
19. Examine and check the small-end bush for wear. If necessary renew the bush. The correct clearance of the gudgeon pin in the small-end bush is given in "General specification data".
20. When renewing a bush ensure that the oil hole in the bush lines up with the hole in the connecting-rod. Finish the bush to the correct size and clearance.
21. Connecting-rod bearings that are worn, pitted, scored and show signs of overheating must be discarded. If more than one of the bearings show these signs they must all be replaced. When fitting new or used bearings to reground (petrol engines only) or serviceable crankpins the clearances must be checked.

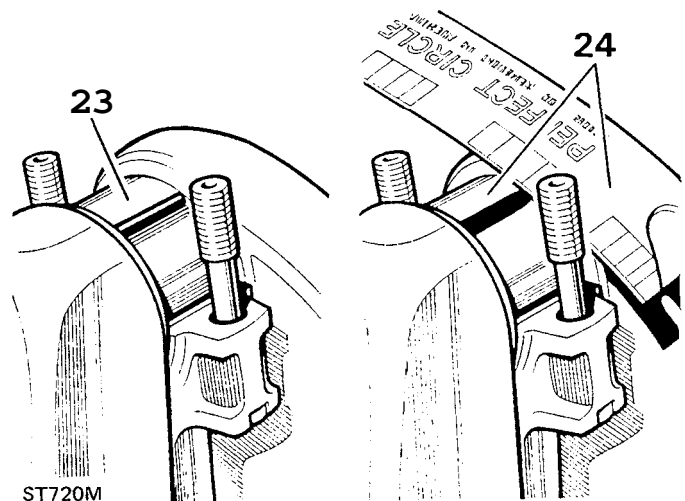
### Connecting-rod bearing nip and clearance

New bearing halves are supplied with a protective coating and must be degreased before fitting.

22. Fit the bearing halves to the connecting-rod and cap and secure the assembly with the correct torque. Slacken the nut on one side only and check the clearance between the joint faces with a feeler gauge. The clearance should be between 0,10 and 0,20 mm (0.004 and 0.008 in). The bearing nip can be adjusted by the selective assembly of the bearing shells which are available in slightly varying thicknesses. Do not file or machine the caps or rods to vary the bearing nip, Make a final check to prove the clearance by inserting a 0,063 (0.0025 in) shim paper between the crankpin and one half of the bearing and tightening to the correct torque. The connecting-rod should resist rotation and move freely with the shim paper removed.

As an alternative, the bearing clearances can be determined by using 'Plastigauge' which consists of a thin piece of plastic material a few hundreds of a millimeter or thousands of an inch in diameter. When the material is flattened by being squeezed between the bearing and crankpin the width of the plastic is measured by a scale gauge which indicates the clearance.

23. Wipe any oil from the crankpins and place a piece of 'Plastigauge' across the centre of the bearing in the connecting-rod cap. Assemble the rod to the appropriate crankpin and tighten to the correct torque. Do not rotate the connecting-rod or crankshaft during this operation.
24. Remove the connecting-rod cap and bearing shell and using the scale supplied measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds to the width of the 'Plastigauge' indicates the bearing clearance. The correct clearance with new or overhauled components is 0,019 to 0,063 mm (0.0007 to 0.0025 in).
25. Wipe off the 'Plastigauge' with an oily rag. Do not scrape off otherwise it may damage the crankpins.

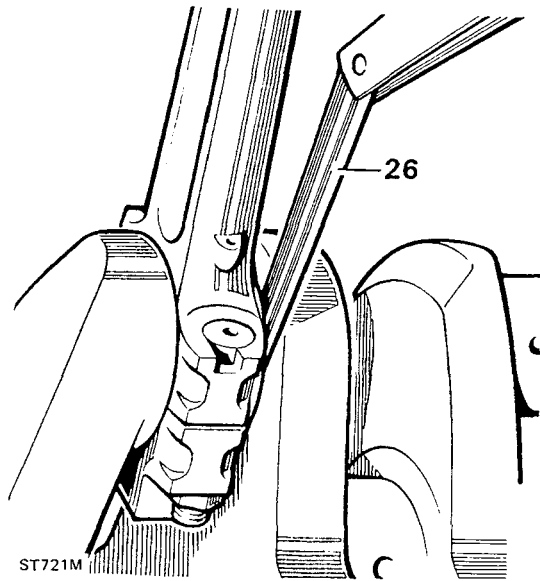


ST720M

### Connecting-rod end-float

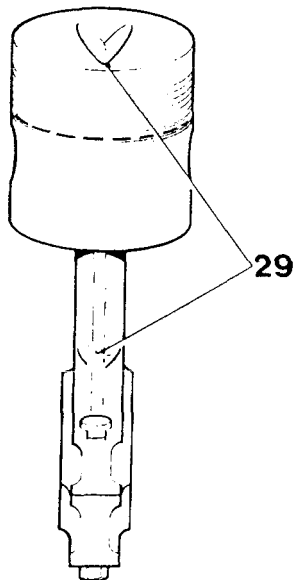
26. Fit the connecting-rods complete with bearings to their respective crankpins. Move the connecting-rod to one side and check the clearance, with a feeler, on the opposite side. The correct clearance is between 0,20 and 0,30 mm (0.007 and 0.012 in).

continued



### Assemble pistons to connecting-rods

27. Petrol engine pistons can be fitted either way round, except those that are being refitted to their original bores in which case they must be fitted to the connecting-rod in the same position in accordance with the mark made during removal.
28. Insert a circlip in one side of the gudgeon pin boss and assemble the piston to the connecting-rod with the gudgeon pin. Secure the assembly with a circlip on the opposite side of the piston.
29. Diesel engine pistons must only be fitted one way in relation to the connecting-rod. The piston must be assembled with the point of the 'V', on the piston crown, on the same side as the lubrication hole in the connecting-rod. Assemble the piston to the connecting-rod in the same manner as for the petrol engine.  
Place the piston and connecting-rod assemblies to one side ready for fitting to the cylinder block. It is good practice to renew the connecting-rod bolts and nuts.



ST722M

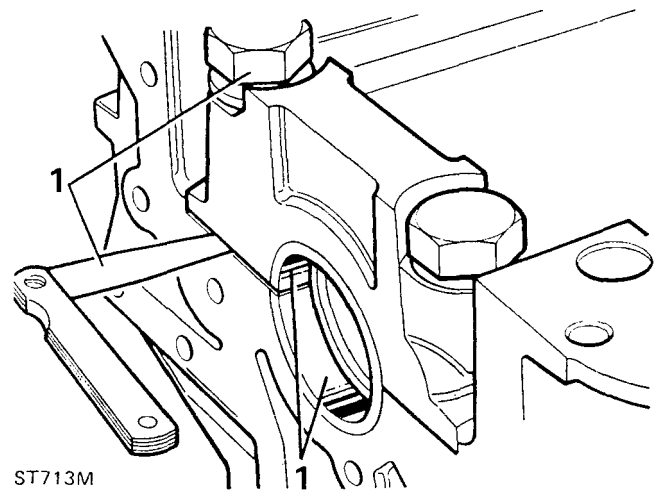
## ASSEMBLE ENGINE

### FIT CRANKSHAFT

#### Main bearing nip and clearance

New main bearing halves are supplied with a protective coating and must be degreased before fitting.

1. Fit the bearing halves in the crankcase saddles and caps and secure the caps to the crankcase and tighten to the correct torque. Slacken the bolts on one side of the caps only and, with a feeler gauge, check the gap between the joint faces. The clearance or nip must be within 0,10 to 0,15 mm (0.004 to 0.006 in). The bearing nip can be adjusted by selective assembly of the bearing halves available in varying thicknesses. Do not file or machine the caps or saddles to achieve the correct clearance. Note that the rear main bearings are wider than the remaining four.
2. To make a final check that the clearance is correct, leave the bearing halves in the crankcase saddles and carefully lower the crankshaft into position. Check each bearing in turn by inserting a 0,063 mm (0.0025 in) shim paper between the bearing cap and crankshaft journal and tighten the bolts to the correct torque. If the clearance is correct, there should be a slight increase in the resistance to rotation of the crankshaft.



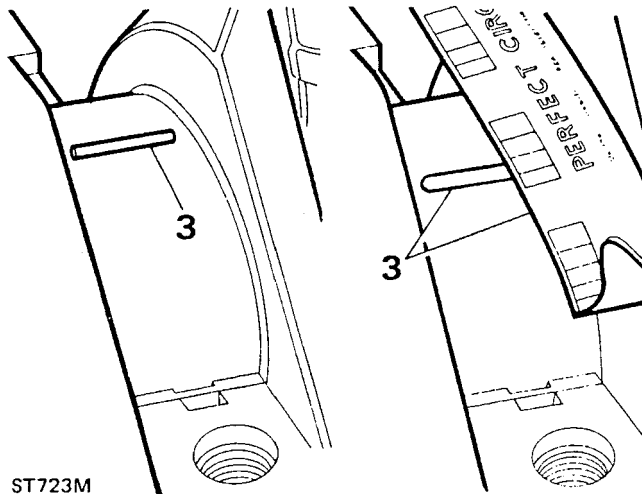
ST713M

As an alternative 'Plastigauge' may be used to check the clearance in the same manner as with the connecting-rod bearings. This material may also be used to determine the amount of wear in used bearings and journals.

continued

3. Locate the crankshaft in position on the upper bearing halves in the crankcase and wipe any oil from the journals since 'Plastigauge' is soluble in oil. Place a piece of 'Plastigauge' across the lower half of each crankshaft journal or lower bearing cap shell. Fit the cap and tighten to the correct torque. Remove the cap and bearing and using the scale supplied with the 'Plastigauge' measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds with the width of the 'Plastigauge' indicates the bearing clearance.

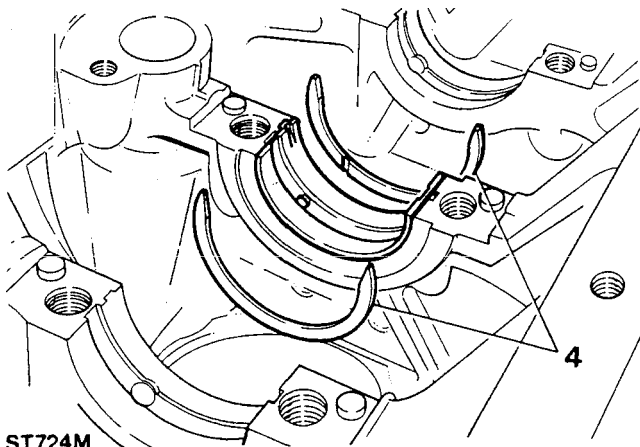
The correct clearance with new or overhauled components is included in "General specification data" section. If new bearings are being fitted use selective assembly to obtain the correct clearance. Wipe off, not scrape the 'Plastigauge' with an oily rag from the journals or bearings.



ST723M

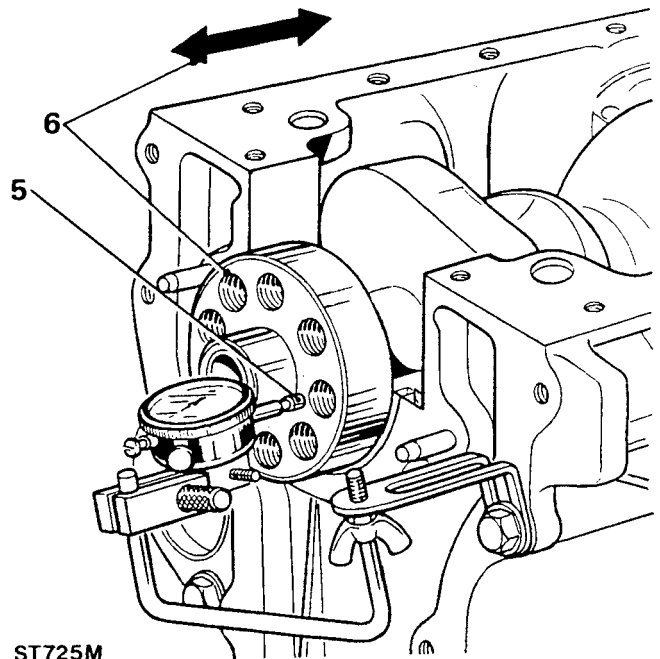
#### Adjust crankshaft end-float

4. Lift out the crankshaft and insert a standard size thrust washer both sides of the centre main bearing saddle with the grooves towards the crankshaft.



ST724M

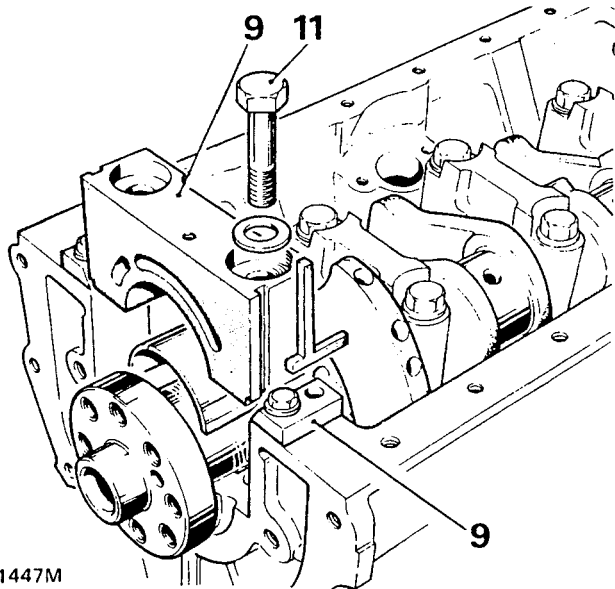
5. Place the crankshaft in position in the crankcase and mount a dial test indicator to read-off the end of the crankshaft. A feeler gauge may be used instead of an indicator.
6. Determine the end-float by moving the crankshaft away from the indicator and zero the dial. Move the crankshaft in the opposite direction and note the indicator reading. Alternatively measure the clearance with a feeler gauge. The end-float should be 0,05 to 0,15 mm (0.002 to 0.006 in).
7. If adjustment is required substitute with oversize thrust washers. Variation of thrust washer thickness at each side of crankshaft journal must not exceed 0,08 mm (0.003 in) to ensure that the crankshaft remains centralised.



ST725M

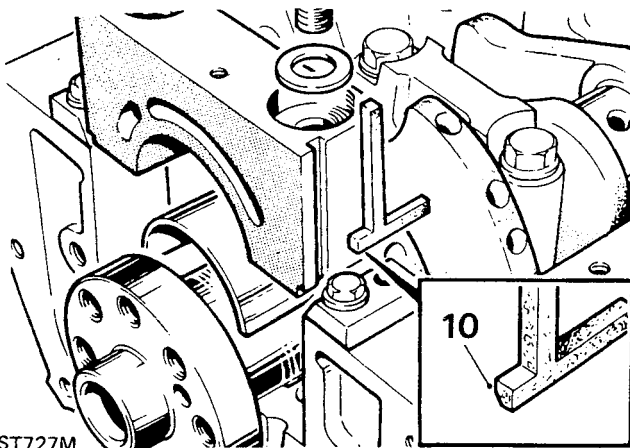
8. Lubricate the crankshaft main journals with clean engine oil and fit the appropriate bearing caps and lower shells to the crankcase with the exception of number five main bearing. Ensure that the caps locate properly over the dowels. Using new bolts and washers evenly tighten to the correct torque figure.

continued



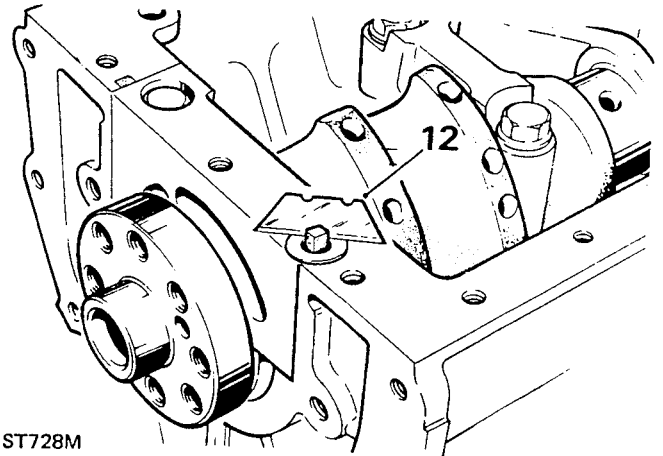
ST1447M

10. To prevent any cork seal material becoming trapped between the bearing cap and crankcase, chamfer the inner edge of the corks 0,40 to 0,80 mm ( $\frac{1}{64}$  to  $\frac{1}{32}$  in) wide as illustrated. Immerse the cork seals in engine oil and fit them to the bearing cap.



ST727M

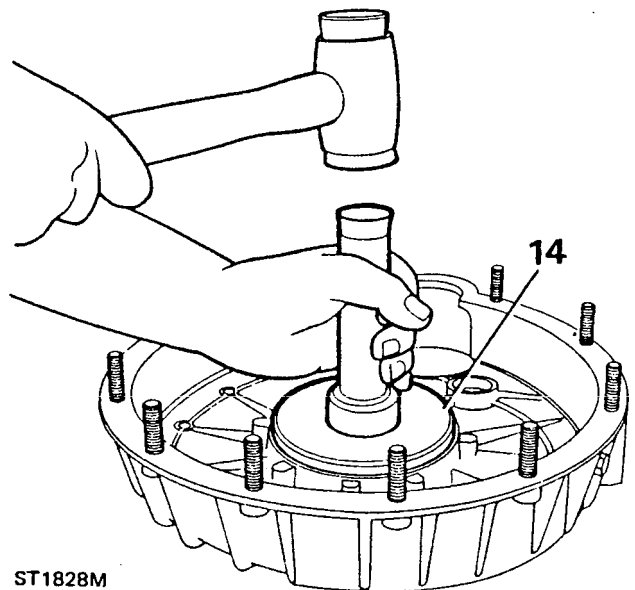
11. Fit the bearing cap and lower shell to the crankcase and secure with new bolts and washers and tighten to the appropriate torque.
12. To allow for shrinkage after fitting leave the cork seals standing proud of the crankcase-ump face. If possible delay the fitting of the sump for approximately twelve hours and leave the seal protruding 2,40 mm ( $\frac{3}{32}$  in) and then place a 6,350 mm ( $\frac{1}{4}$  in) washer over the seal and cut off the surplus. If it is necessary to fit the sump



ST728M

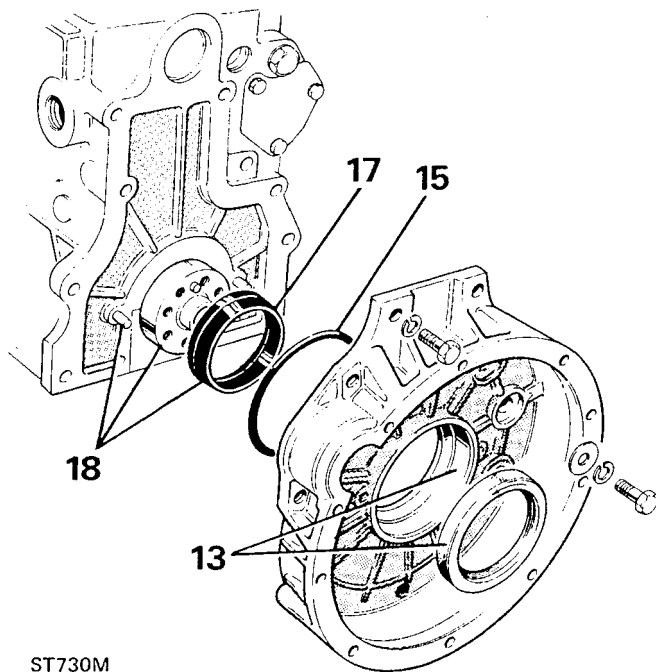
#### Fit rear main oil seal

13. Check that the crankshaft oil seal journal is undamaged and clean. Make sure the seal housing is clean and dry and free from burrs. Do not touch the seal lip and ensure that the outside diameter is clean and dry. The P.T.F.E. Seal Part No ETC 5369 which should be used, is supplied with a former to maintain the correct shape and must not be removed until the seal is to be fitted.
14. Using special seal replacer 18G 134-11 and with the lip side leading drive-in the seal as far as the tool allows. If the tool is not available fit the seal to the bottom of the housing to ensure squareness.



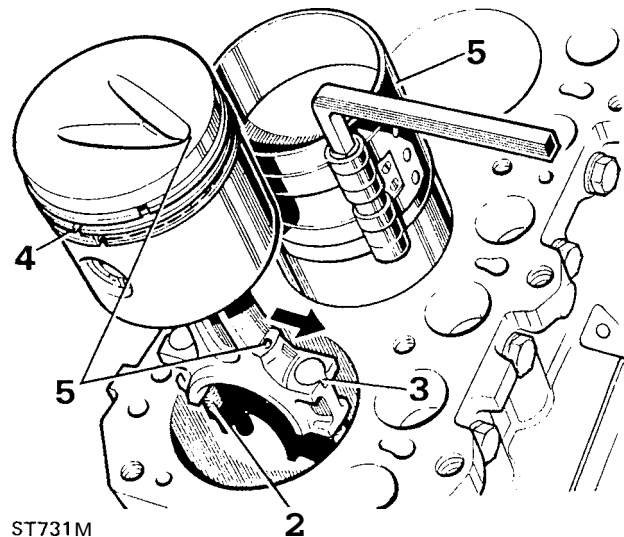
ST1828M

15. Fit the 'O' ring seal to the flywheel housing.
16. Examine the seal guide number 18G 1344 and repair any damage that could destroy the seal lip.
17. Lubricate the outside diameter of the seal guide and the seal journal with concentrated 'Oildag' in a 25% solution with clean engine oil.
18. Place the seal guide on the crankshaft flange and, using the two dowels protruding from the cylinder block rear face as a guide to ensure initial squareness, fit the flywheel housing and remove the seal guide. Secure the flywheel housing evenly tightening the retaining bolts.



ST730M

5. Lubricate the cylinder walls, piston rings and crankpins. Compress the piston rings with a suitable compressor tool and carefully lower the connecting-rod into the bore ensuring that the oil spray hole faces the camshaft side of the engine. With diesel engines the point of the arrow headed valve clearance indentation in the piston crown, and the oil spray hole must face the camshaft side of the engine.
6. Using a soft mallet, sharply tap the piston into the bore so that the whole of the piston is just below the surface of the cylinder block.

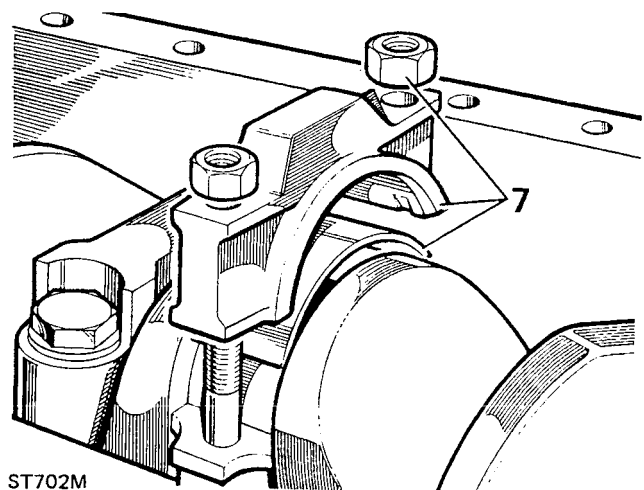


ST731M

7. Check that the bearing shell is properly located in the connecting-rod and pull the rod onto the crankpin. Locate the bearing shell correctly and fit the cap so that the identification numbers are together on the camshaft side of the engine. Fit and tighten new nuts to the correct torque figure. Repeat the foregoing instructions for fitting the remaining piston and connecting-rod assemblies.

### FIT THE CONNECTING-RODS AND PISTONS

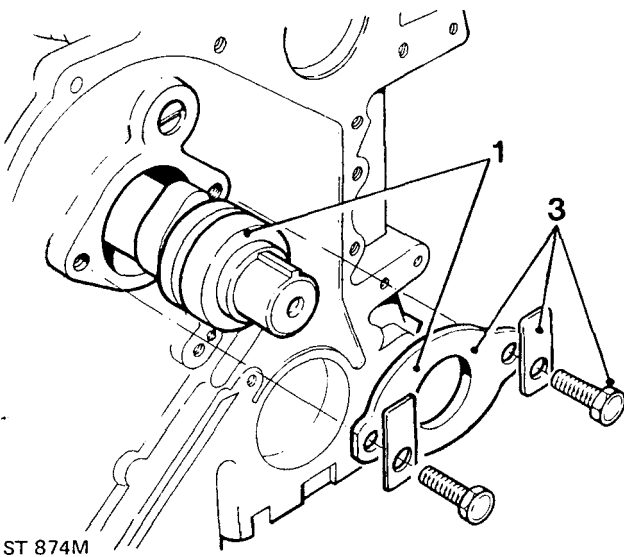
1. Turn the crankshaft to position numbers one and four crankpins at bottom dead centre to facilitate fitting the connecting-rods.
2. When fitting the connecting-rods and pistons ensure that the bolts do not foul and damage the crankpins. **As** a precaution it is recommended that rubber or soft plastic sleeves are placed over the threads.
3. The connecting-rod bolts have eccentric heads which locate in a recess in the connecting-rod. It is essential that the head of each **new** bolt is properly located before tightening.
4. Stagger the compression rings so that the gaps are equidistantly spaced round the piston but, so arranged, that no gap is positioned on the thrust side of the piston i.e. opposite the camshaft. Turn the oil control ring so that the gap is in line with the gudgeon pin.



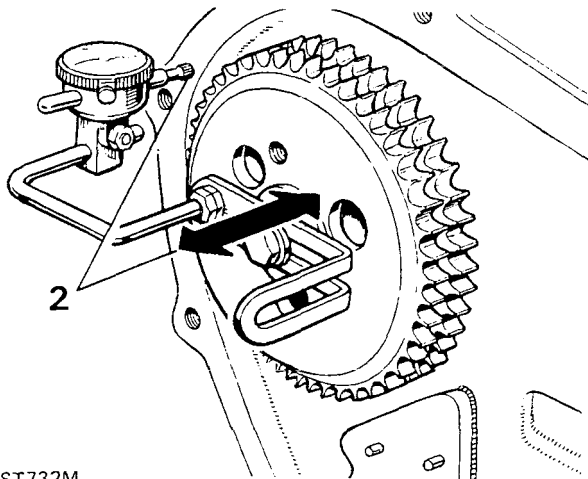
ST702M

**FIT THE CAMSHAFT**

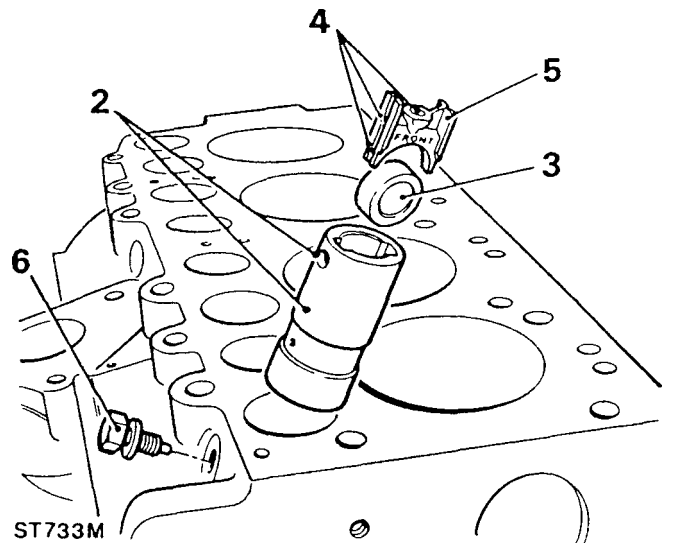
1. Lubricate the camshaft bearings and with care, insert the camshaft into the cylinder block. Temporarily secure a new thrust plate with the two bolts.



2. To check the camshaft end-float, fit the woodruff key and temporarily fit the camshaft chain wheel and mount a dial test indicator, as illustrated, so that the stylus rests in a loaded condition upon the machined face of the cylinder block. Zero the dial and move the camshaft back and forward and note the reading. The end-float should be within 0.06 to 0.13 mm (0.0025 to 0.0055 in). If the end-float is outside these limits, fit different thrust plates until the correct tolerance is achieved.
3. Remove the test indicator and chain wheel and secure the thrust plate with the two bolts and tab washers. (Tab washers omitted on later engines).

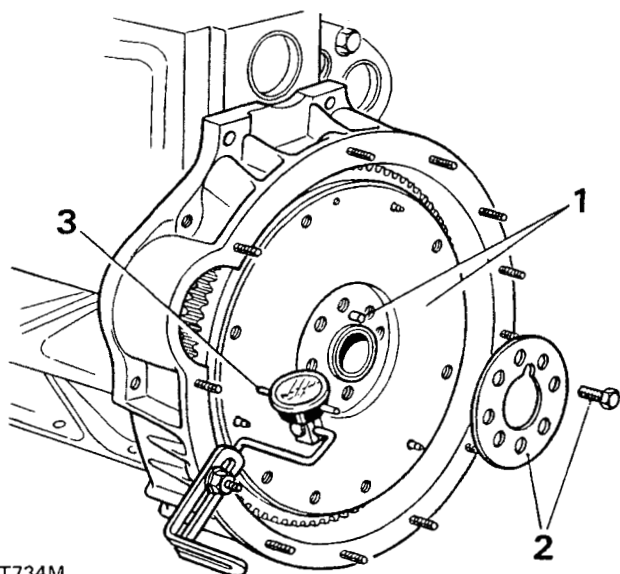
**FIT TAPPETS, GUIDES AND ROLLERS**

1. If the same parts are being refitted ensure that they are returned to their original positions. Ensure that the tappet slides move freely in the guides.
2. Insert the tappet guides into the cylinder block and align the locating screw holes.
3. Fit the tappet rollers ensuring that they are fitted in accordance with the marks made during removal. New rollers, however, may be fitted either way round.
4. Before fitting the tappet slides make sure the oilways are clear to the tappet bearing surface, the cross drilling and the oil feed to the push rod.
5. Insert the tappet slides with the word 'FRONT' towards the front of the engine.
6. Secure the tappet guides with NEW Micro encapsulated screws and tighten to the correct torque figure. Micro encapsulated screws should also be used on engines where the screws were originally wired for security.



**FIT THE FLYWHEEL**

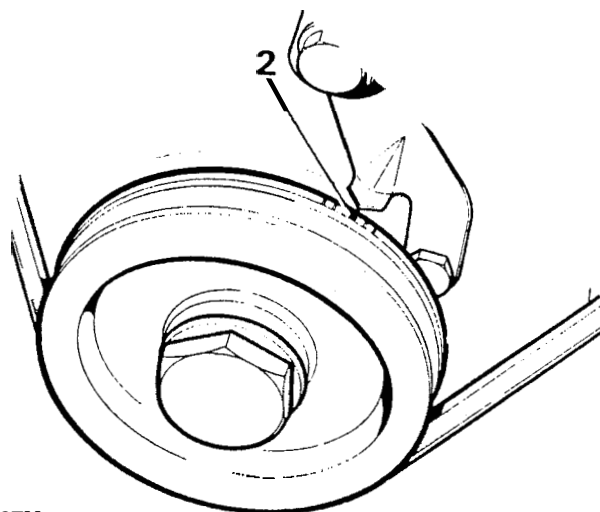
1. Examine the flywheel and crankshaft mating faces and remove any burrs or imperfections that could prevent the flywheel locating correctly. Check that the dowel is in position.
2. Offer up the flywheel to the crankshaft and secure with the reinforcing plate and retaining bolts. Evenly tighten the bolts to the correct torque figure.
3. To check the flywheel run-out, mount a dial test indicator so that the stylus rests, in a loaded condition, on the clutch pressure face at a radius of 114 mm (4.5 ins).
4. Turn the flywheel, and check that the run-out does not exceed 0,05 to 0,07 mm (0.002 to 0.003 in). Should the run-out be excessive, remove the flywheel, and check again for any irregularities on flywheel and crankshaft mating faces and dowel.



ST734M

**FIT CYLINDER HEAD AND ROCKER SHAFT ASSEMBLY****Petrol engine**

1. Temporarily fit the timing cover with pointer and crankshaft pulley.
2. Turn the crankshaft clockwise, in the normal running direction, to bring numbers one and four pistons to T.D.C. If the crankshaft is inadvertently turned beyond T.D.C. do not turn it back, but continue on round until the T.D.C. mark on the pulley coincides with the pointer on the timing cover. Do not allow the crankshaft to be moved again until the valves are timed.

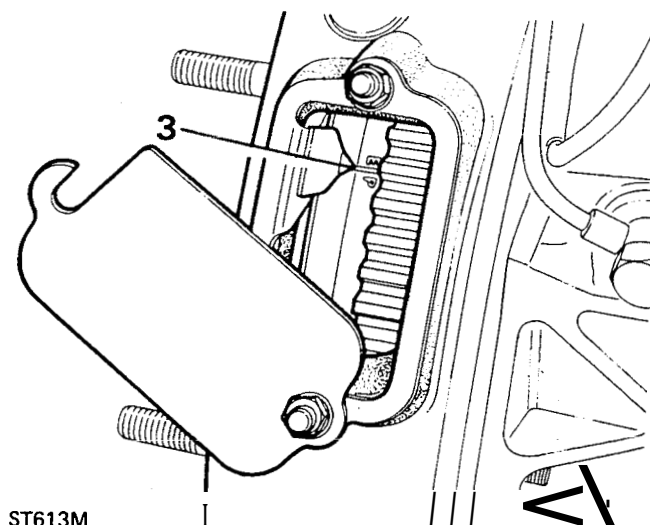


ST 927M

**Diesel engine**

3. Turn the crankshaft in a clockwise direction until the E.P. mark on the flywheel is in line with the pointer on the flywheel housing. The pointer on later engines has been omitted but can be obtained from Land Rover spares stockists under part number ERC 2250. If the crankshaft is inadvertently turned beyond the E.P. mark, do not turn it back but continue on round in a clockwise direction until the mark is exactly in-line with the pointer. To avoid serious damage to the valves and pistons once the cylinder head has been fitted, the crankshaft must not be rotated until the valves have been timed.

continued

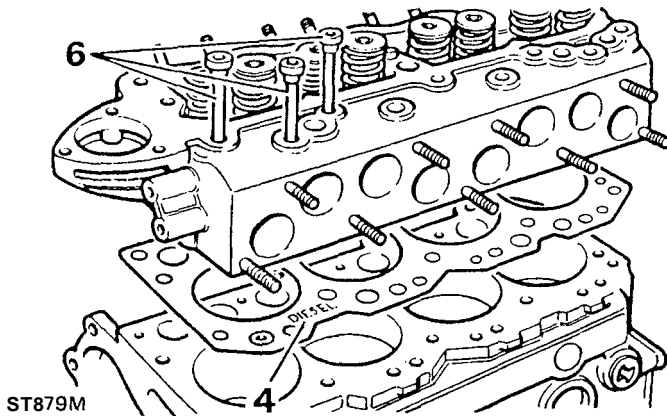


ST613M



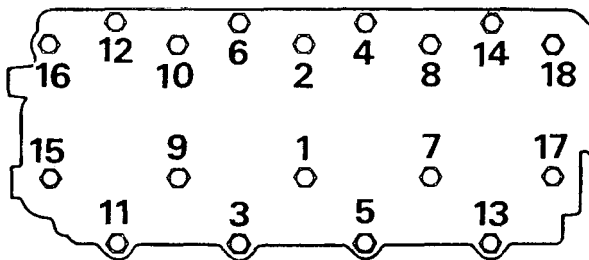
### Petrol and Diesel engines

4. Clean the cylinder head and cylinder block mating faces. Position a new cylinder head gasket on the cylinder block with the word 'Diesel' or 'Petrol' uppermost.
5. Lower the cylinder head onto the cylinder block using two long bolts to facilitate accurate positioning of the head.
6. Fit the cylinder head retaining bolts except those also used to secure the rocker shaft and leave finger-tight.
7. Insert the push rods ensuring that the ball end locates properly in the spherical seat in the tappet.
8. Whilst holding the rocker shaft assembly together, lower it into position making sure that the hollow dowels locate properly in the cylinder head. Also ensure that the rocker adjusting screw ball end locate in the push rods.
9. Fit the rocker shaft large retaining bolts and leave finger-tight.



ST879M

10. Tighten the cylinder head retaining bolts, evenly, to the correct torque figure in the sequence illustrated below.
11. Fit and tighten the rocker shaft, small bolts to the specified torque.



ST 880M

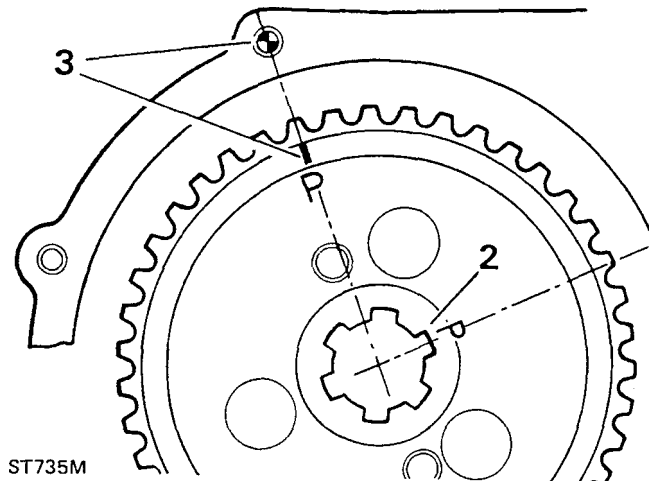


13. Do not allow the crankshaft to be turned, until the valves are timed.

### VALVE TIMING

#### Petrol engines

1. Check that numbers one and four pistons are still at T.D.C. and without disturbing the crankshaft, remove the pulley and timing cover.
2. One of the keyways in the camshaft sprocket is stamped with the letter 'P' and this must locate on the camshaft key.
3. Fit the camshaft chain wheel, as above, and rotate the camshaft in a clockwise direction until the tooth also marked with a letter 'P' is in line with the top stud hole as illustrated.



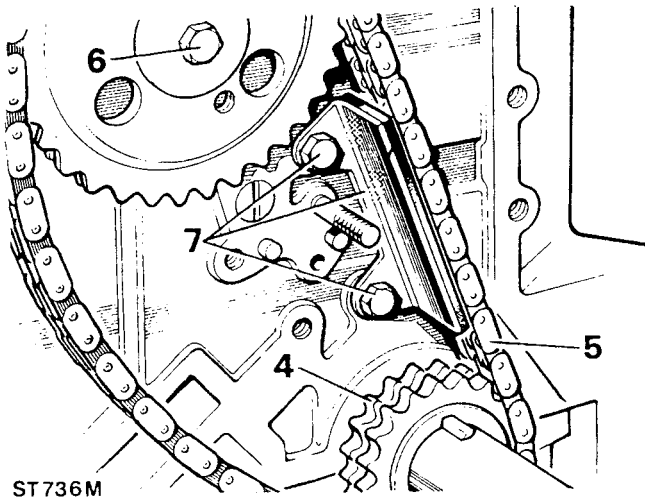
ST735M

4. Fit the crankshaft chain wheel with the large shoulder towards the cylinder block.
5. Without moving either chain wheel, fit the timing chain, keeping it taut on the drive side. If it is not possible to obtain a taut fit on the drive side of the chain with the chain wheel in the set position, withdraw the camshaft chain wheel without disturbing the camshaft, and refit the chain wheel on one of the alternative keyways. This procedure may be repeated until a taut chain is obtained on the drive-side with the camshaft and crankshaft in their previously set positions.
6. Secure the camshaft sprocket to the camshaft with a new special micro encapsulated treated bolt and tighten to the correct torque figure.

**NOTE: Early engines use an ordinary bolt and tab washer.**

7. Fit and adjust the timing chain damper so that there is a maximum clearance of 0,25 mm (0.010in) between the timing chain and damper. Tighten the retaining bolts and secure with new lock tabs.

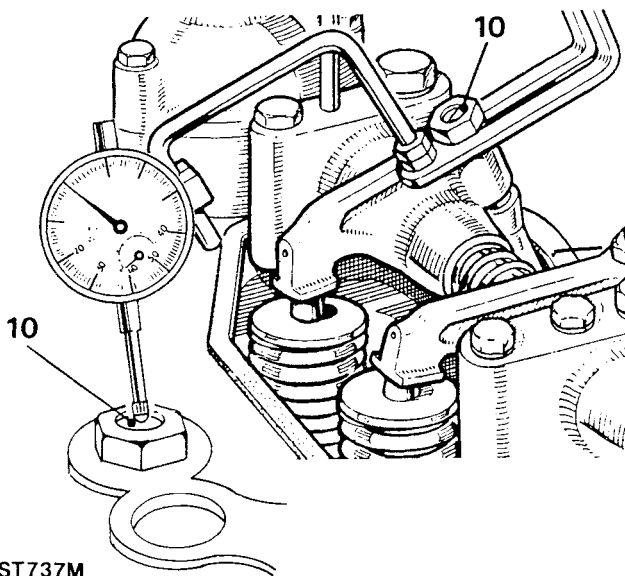
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ST736M

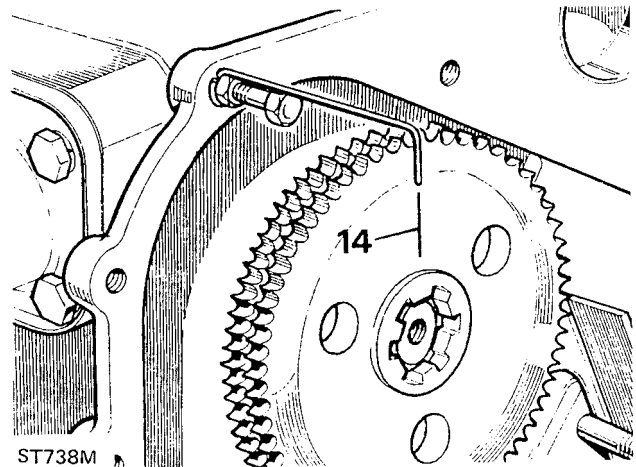
### Diesel engines

8. Maximum engine performance and efficiency depends upon the care and accuracy exercised during the following instructions.
9. Check that the E.P. mark on the flywheel is still exactly aligned with the pointer on the flywheel housing.
10. The valve timing is based upon the exhaust valve peak of number one cylinder. To determine the point at which the valve is fully open mount a dial test indicator, as illustrated, with the bracket attached to the number one exhaust valve rocker and the stylus resting, in a loaded condition on a cylinder head bolt head.



ST737M

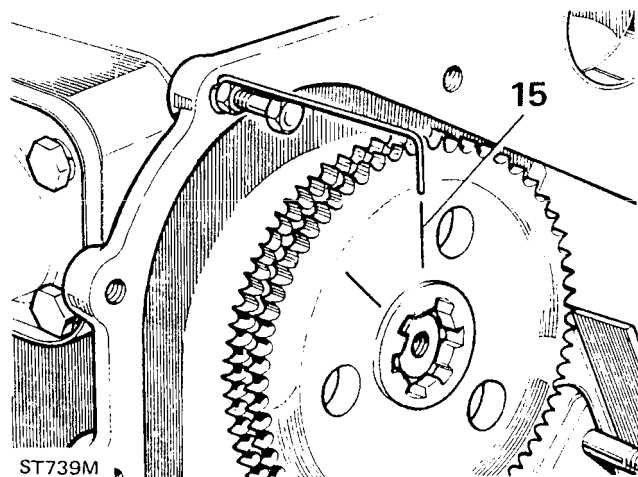
11. Manufacture a suitable pointer, and attach one end to the top bolt hole in the cylinder block and the pointer close to the camshaft chain wheel, as illustrated.
12. Turn the camshaft until the valve is fully open as indicated by maximum reading on the dial gauge.
13. Because the top of the cam is 'flat' the camshaft can be turned a further four degrees without movement of the dial gauge needle. Since an error of four degrees is not acceptable, the exact centre of the four degree period must be established, as follows.
14. Without moving the camshaft rub white chalk on the face of the chain wheel adjacent to the pointer. Zero the dial gauge and carefully turn the camshaft clockwise until the needle indicates 0,25 mm (0.010 in) which represents a point down the left-hand side of the cam lobe. Make a thin pencil mark, on the chalk, in line with the pointer.



ST738M

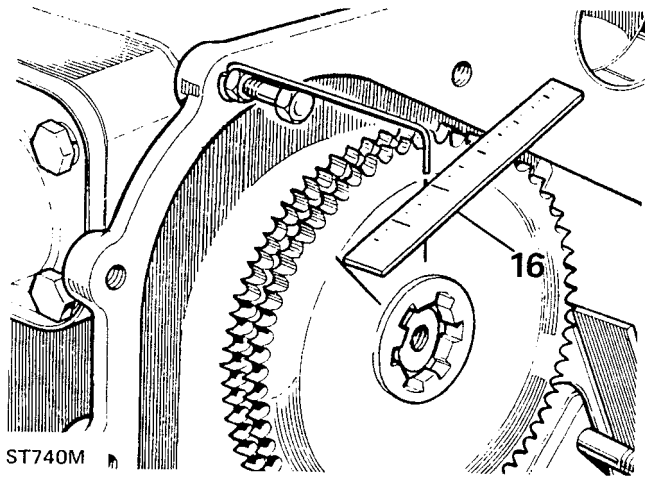
15. Turn the camshaft anti-clockwise and watch the needle move back to zero. Then continue turning until the needle indicates 0.25 mm (0.010 in) which represents a point down the right-hand side of the cam and make another mark in line with the pointer.

continued

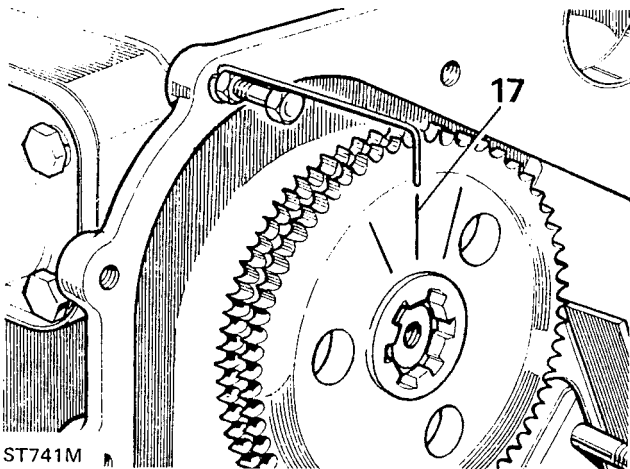


ST739M

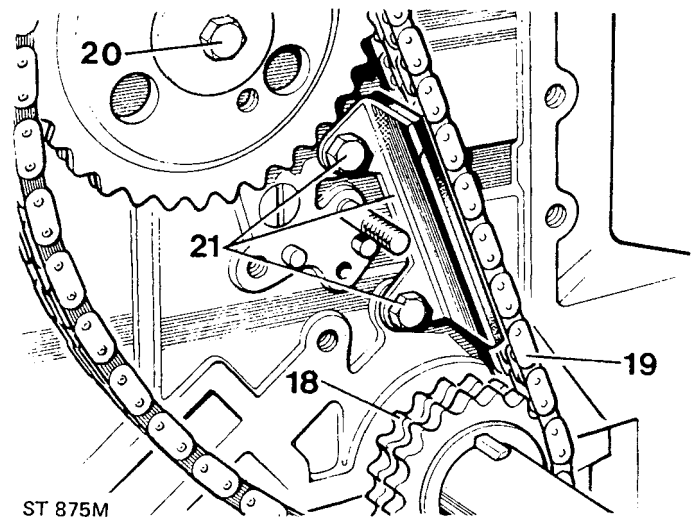
16. Using a rule, determine the exact mid-point between the two marks and make a third mark.



17. Remove the dial indicator, and turn the camshaft until the middle mark lines **up** with the pointer. The number one cylinder exhaust tappet roller should now be resting in the centre of the four degree flat period of the cam and the camshaft and crankshaft are in their correct relationship.

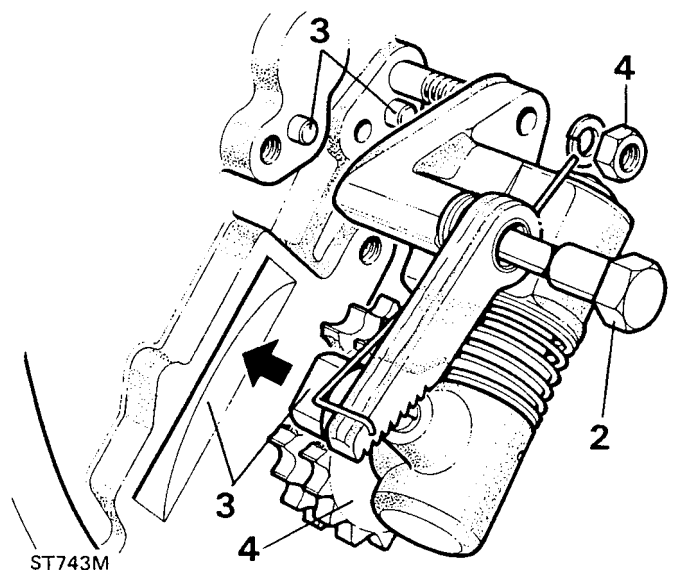


18. Fit the crankshaft chain wheel with the large shoulder towards the cylinder block.
19. Without moving the camshaft and crankshaft fit the timing chain keeping it taut on the drive side. Should it be impossible to obtain a taut fit, remove the chain wheel and position it in one of the five remaining keyways until the best position is obtained. It is preferable to choose a keyway which gives a slightly tight chain on the drive side rather than a slack one.
20. Secure the camshaft chain wheel to the camshaft with a new, special, micro encapsulated treated bolt and tighten to the correct torque figure — See Petrol engine.
21. Fit and adjust the timing chain damper so that there is a maximum clearance of 0,25 mm (0.010 in) between the timing chain and damper. Tighten the two bolts and secure with new lock tabs.



#### FIT TIMING CHAIN TENSIONER

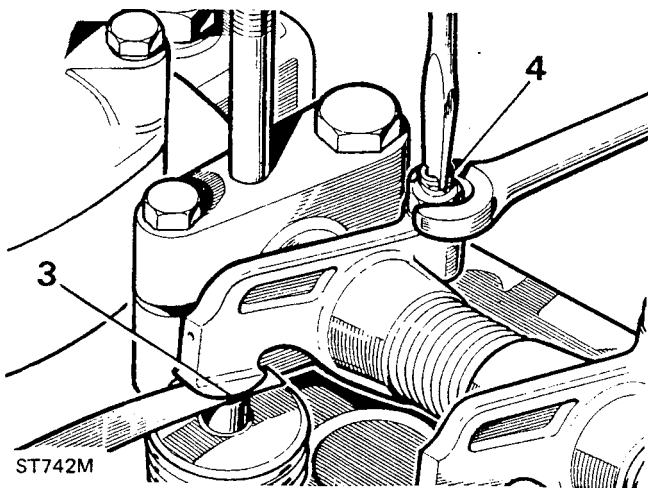
1. Assemble the timing chain tensioner in accordance with the illustration in "Dismantling".
2. Compress the assembly against the spring and fit to the engine whilst engaging the ratchet pivot bolt in the cylinder block.
3. Ensure that the piston housing locates on the dowels and single stud and the cylinder spigot fits into the milled slot in the cylinder block.
4. Allow the jockey wheel to take up the slack in the chain. Tighten the retaining nut and two bolts to secure the assembly. Do not rotate engine, see 'tappet adjustment'.



## ADJUST TAPPET CLEARANCES

### Petrol and diesel engines

1. If the crankshaft is rotated with excessive valve clearances, it is possible that the push rods may become dislodged from the tappet seating and fracture the tappet slide. To prevent damage, eliminate all clearance from any loose rockers before turning the crankshaft to adjust the clearances.
2. Turn the engine over until number eight valve (counting from front of engine) is fully open.
3. Using a 0,25 mm (0.010 in) feeler gauge check the clearance between the valve tip and rocker pad of number one valve.
4. Adjust the clearance by slackening the locknut and turning the tappet adjusting screw clockwise to reduce clearance and anti-clockwise to increase clearance. Recheck the clearance after tightening the lock nut.

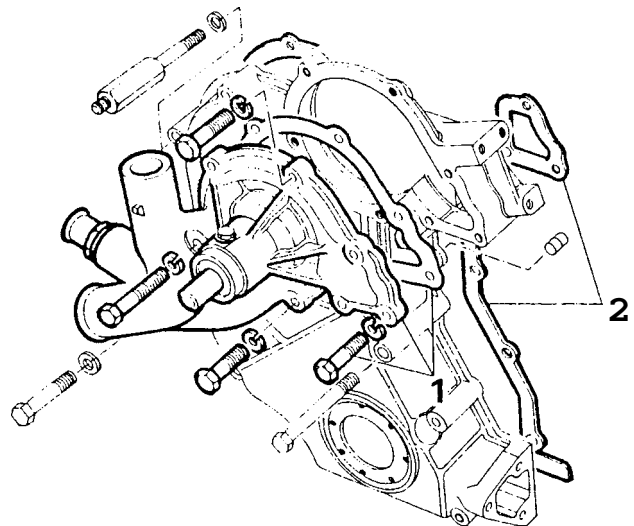


5. Continue to check and adjust the remaining tappets in the following sequence:

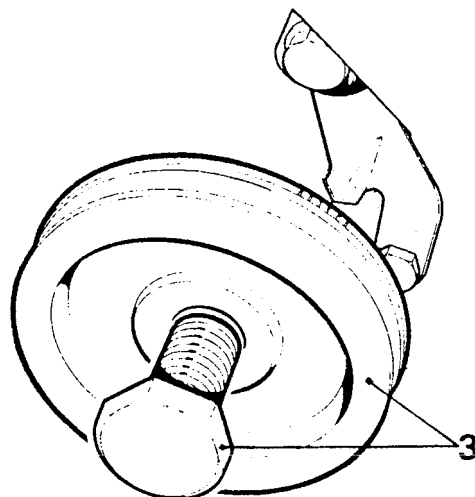
Set No. 3 tappet with No. 6 valve fully open.  
 Set No. 5 tappet with No. 4 valve fully open.  
 Set No. 2 tappet with No. 7 valve fully open.  
 Set No. 8 tappet with No. 1 valve fully open.  
 Set No. 6 tappet with No. 3 valve fully open.  
 Set No. 4 tappet with No. 5 valve fully open.  
 Set No. 7 tappet with No. 2 valve fully open.

## FIT TIMING COVER AND WATER PUMP

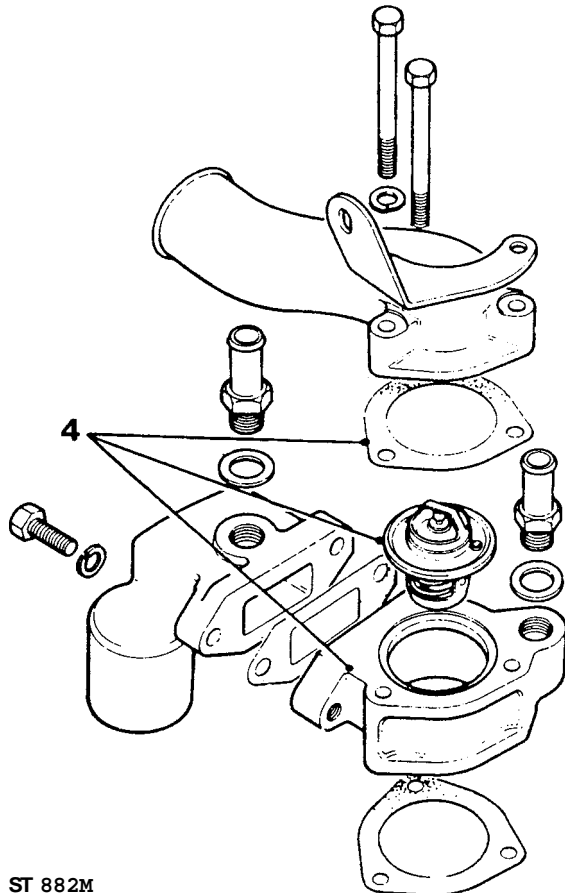
1. Using a new joint washer assemble the water pump to the front cover and loosely tighten the three retaining bolts.
2. Attach a new joint washer and water gallery joint to the timing cover and secure the cover together with the timing pointer (petrol engines only) and alternator link to the cylinder block with the fourteen bolts. Evenly tighten to the correct torque figure, including the water pump bolts.



3. Fit the crankshaft pulley and secure with the special washer and bolt. Tighten to the correct torque figure.



4. Fit the thermostat into its housing and using new joint washers secure the assembly, together with the elbow, to the cylinder head. Tighten the three bolts to the correct torque. Connect the thermostat elbow to the water pump with a new hose and secure with hose clips.

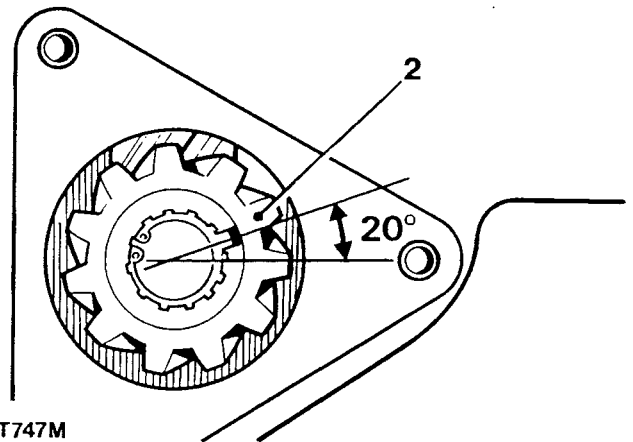


ST 882M

## FIT THE SKEW GEAR

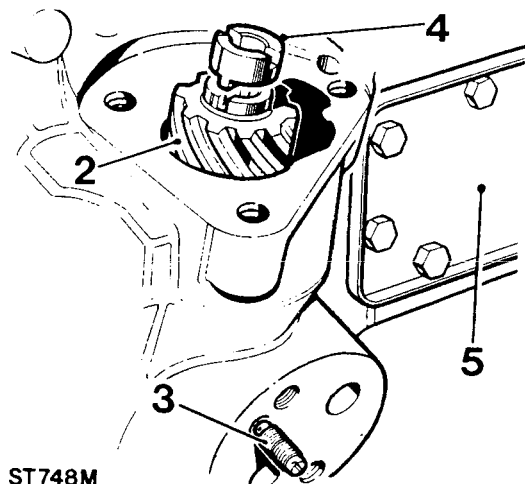
### Petrol engine

1. Turn the crankshaft to bring number one piston to T.D.C. with number four cylinder valves on the 'rock'. Check that the timing gear pointer coincides with the mark on the crankshaft pulley.
2. Lubricate and insert the skew gear assembly into mesh with the camshaft gear. Due to the helix angle of the teeth the gear will turn anti-clockwise as it slides into mesh. The broad master spline must be at  $20^\circ$  to the centre line when correctly seated, as illustrated, but it may take several attempts to achieve this.



ST 747M

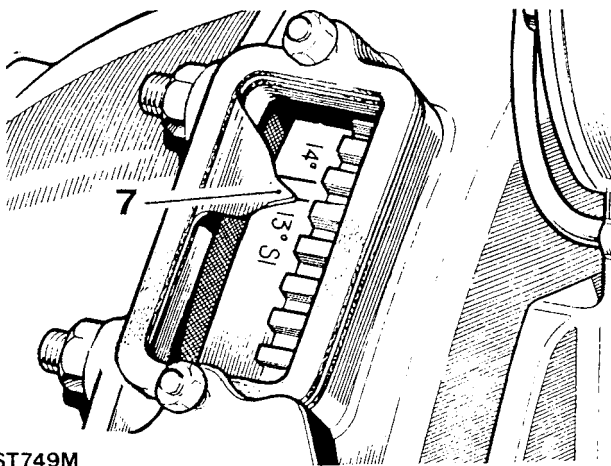
3. The skew gear assembly is located in its final position by a special screw. Without this screw the gear will go deeper into mesh resulting in an incorrect angle when the assembly is lifted up to locate the screw. The angle must therefore be checked again after the screw is fitted. Align the location hole in the bush and fit a new location screw into the cylinder block and re-check the angle.
4. Fit the distributor drive coupling, and ensure that it locates properly in the off-set slot of the skew gear.
5. Using a new joint washer, fit the side cover.



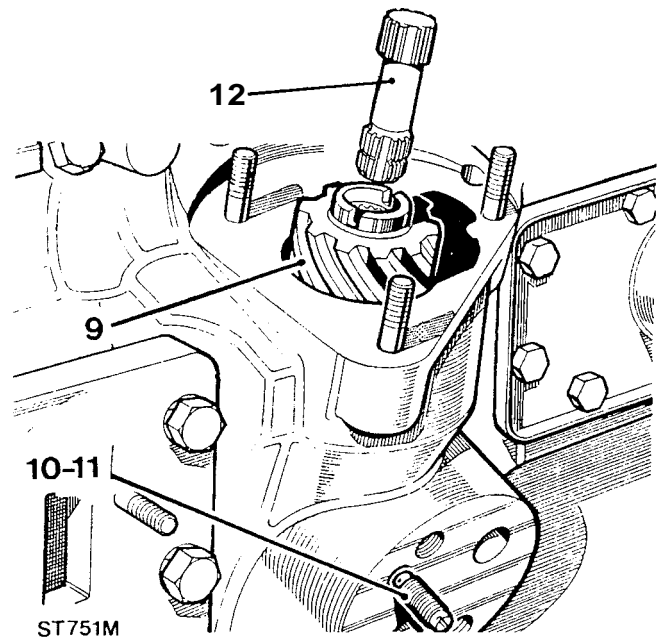
ST 748M

**Diesel engine**

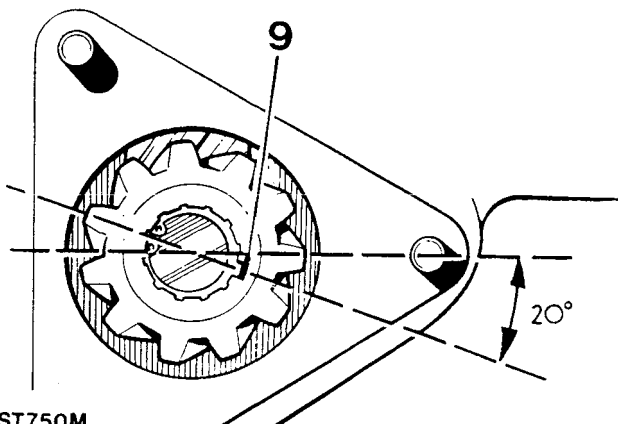
6. Turn the crankshaft in the direction of rotation until both valves of number one cylinder are closed and the piston is ascending the bore on the compression stroke.
7. Continue to turn the crankshaft until the timing pointer aligns with the 13° mark on the flywheel, that is 13° BTDC. This must be done carefully. If the flywheel is inadvertently turned too far and the timing mark goes past the pointer do not turn the flywheel back but repeat the operation.
8. Ensure that a correct line of vision is taken when lining up the timing marks. An incorrect line of vision can result in the timing being 1° to 2° out.



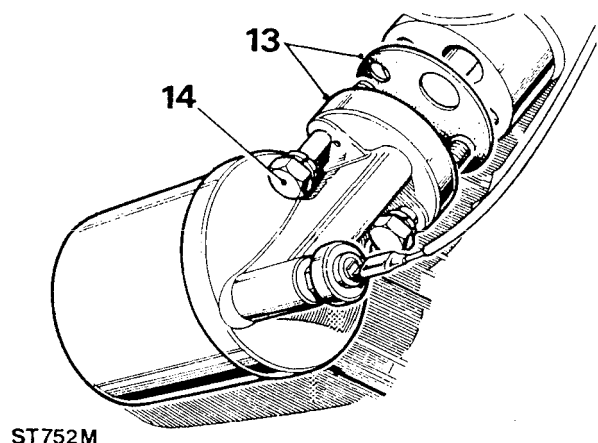
10. The skew gear assembly is located in its final position by a special screw. Without this screw the gear will go deeper into mesh resulting in an incorrect angle when the assembly is lifted up to locate the screw. The angle must therefore be checked again after the screw is fitted.
11. Align the location hole in the bush and fit a new location screw into the cylinder block and re-check the angle.
12. Fit D.P.A. pump drive shaft long-splined-end leading and locate the master spline in the corresponding spline in the skew gear.



9. Lubricate and insert the skew gear assembly into mesh with the camshaft gear. Due to the helix angle of the teeth the gear will turn anti-clockwise as it slides into mesh. The broad master spline must be at 20° to the centre line when correctly seated, as illustrated, but it may take several attempts to achieve this.

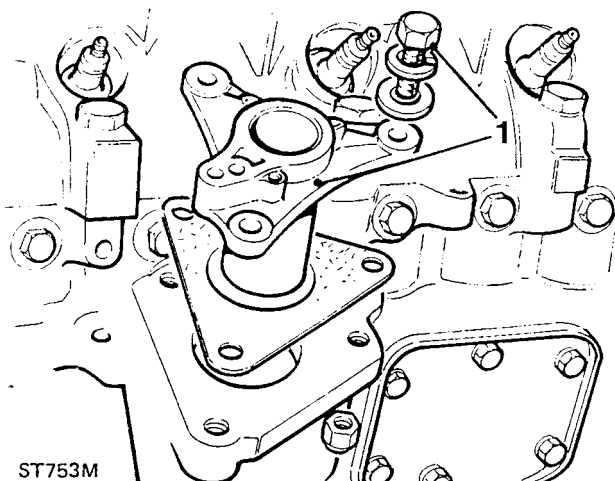
**Petrol and Diesel engines**

13. Using a new joint washer fit the oil filter housing, ensuring that the retaining bolts pass through the two small round holes in the joint washer.
14. Tighten the two retaining bolts evenly to the correct torque.

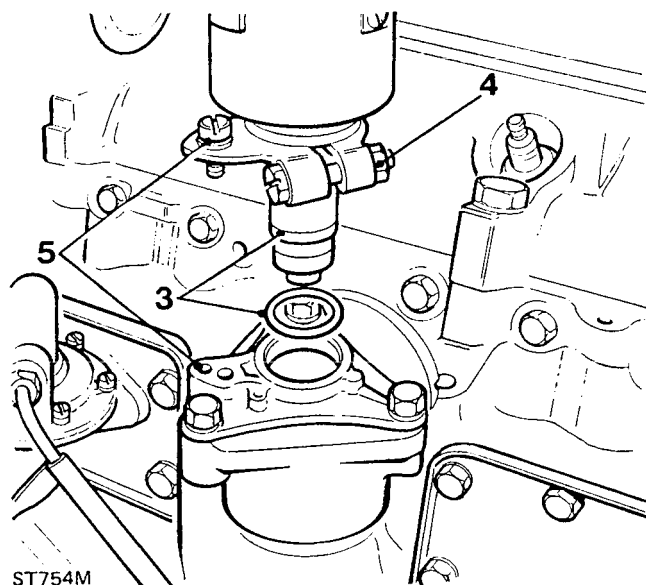


**FIT IGNITION DISTRIBUTOR**

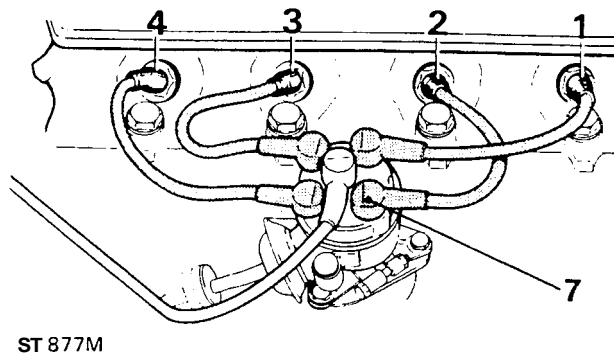
1. Fit the distributor adaptor plate using a new joint washer and evenly tighten the three retaining bolts to the correct torque figure.



2. Check that the distributor drive coupling, locates properly in the off-set slot of the skew gear.
3. Insert the distributor and "O" ring so that the vacuum unit faces towards the rear of the engine. Remove the cap and oscillate the rotor arm until the distributor drive shaft locates into the drive coupling slot thus enabling the distributor to be pushed fully home. The metal tip of the rotor arm should be in line with the electrode in the distributor cap that supplies electrical current to number one spark plug.
4. Temporarily tighten the distributor clamp bolt pending final ignition timing adjustment when the engine is fitted to the vehicle.
5. Secure the clamp to the adaptor plate with the single bolt.

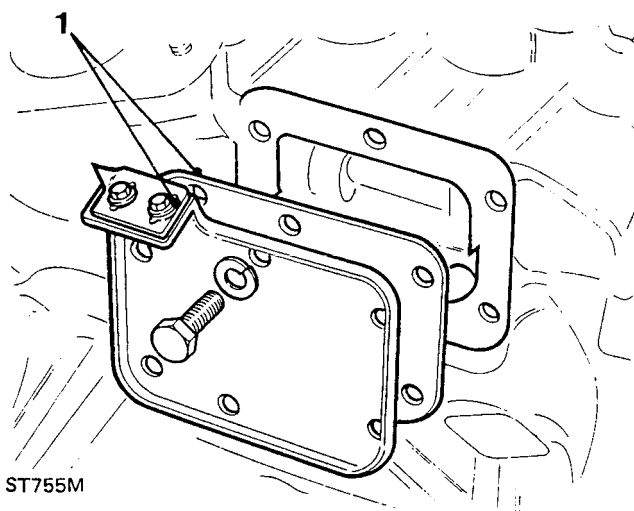


6. Fit the correct spark plugs and washers and tighten to the specified torque figure.
7. Fit the distributor cap and connect the H.T. leads to the spark plugs in the sequence illustrated.

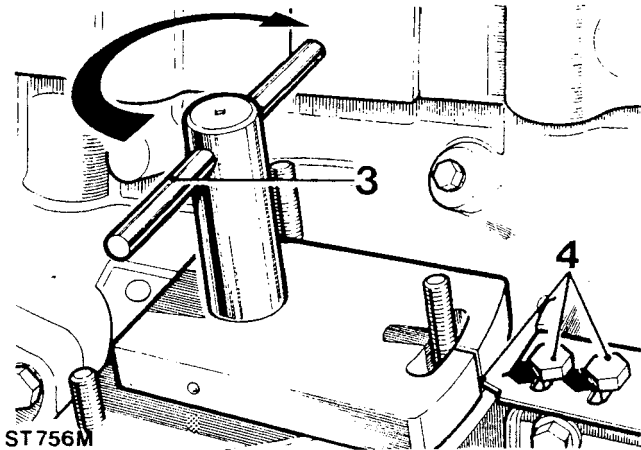
**FIT FUEL INJECTION PUMP****Using timing gauge 605863**

1. Using a new joint washer fit the camshaft front side cover with the timing pointer. Tighten the retaining bolts evenly to the correct torque.
2. Earlier engines with the side oil filter, employ a baffle plate, with two joint washers interposed between the side filter plate and the cylinder block.

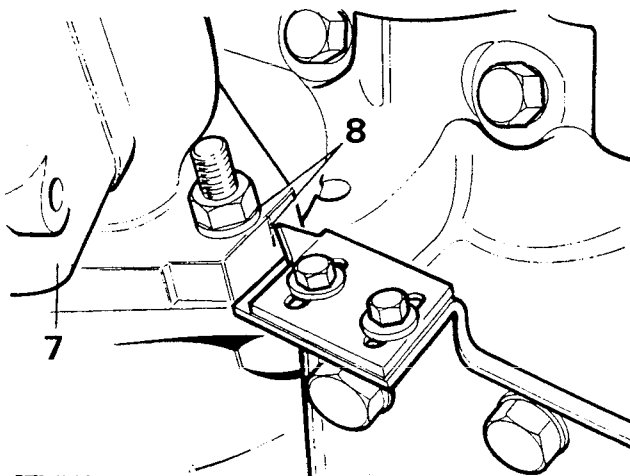
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3. Insert the timing gauge, 605863, into the driving gear, then twist gauge in a clockwise direction to take up backlash and any wear in the gears.
4. Hold in this position, then, if necessary, slacken off bolts retaining the timing pointer on the side of the cylinder block. Adjust pointer so that it coincides with the line on the timing gauge, as illustrated, then retighten the bolts and remove the timing gauge.



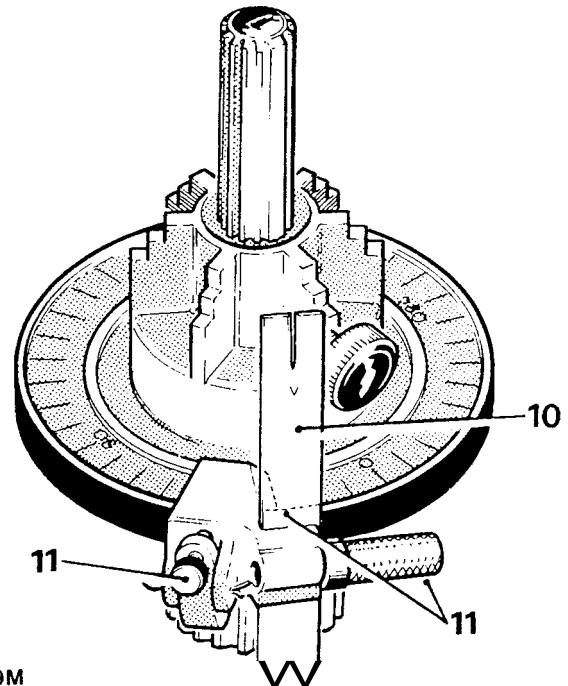
5. Rotate the driving gear on the distributor pump so that the master spline lines up with the master spline on the engine driving gear.
6. Check that the pump drive shaft is correctly located with the longer splines in the skew gear.
7. Fit the distributor pump to the engine engaging the master splines on the pump and the drive shaft. Do not tighten the fixings at this stage.
8. Align the vertical mark on the pump flange with the pump timing pointer, then tighten the pump fixings.



ST757M

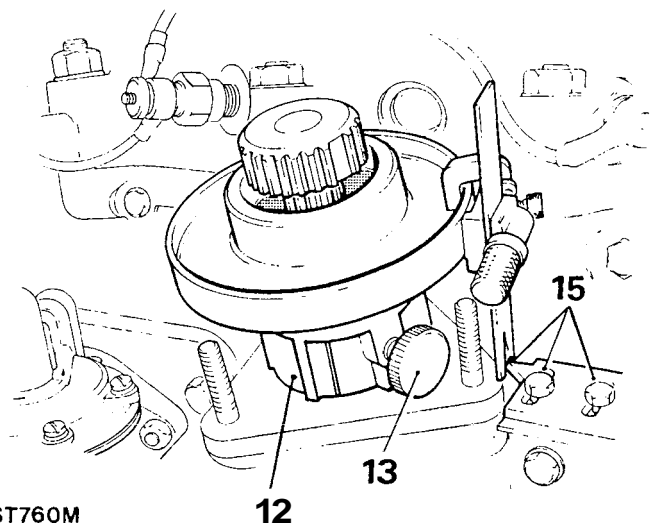
#### Using timing gauge MS 67B

9. Check that the drive shaft is correctly located with the longer splined-end in the skew gear.
10. Assemble the scribing arm of the timing gauge into the gauge body.
11. Set gauge by loosening knurled screws and sliding bracket around until chamfered edge aligns with the required angle of 22°, tighten knurled screw in this position.



ST759M

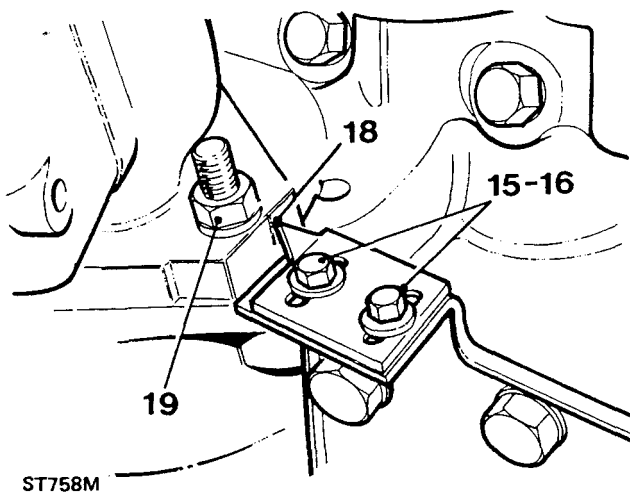
12. Insert the gauge into the vacant injection pump position and engage the gauge gear into injection pump drive splines.



ST760M



13. Release centre shaft retaining screw and slide the gauge body along centre shaft until body engages injection. pump drive gear hub. Lock shaft retaining screw.
14. Apply gentle clockwise pressure to take up backlash *or* wear in gears, retain in this position.
15. Slacken off timing pointer bolts. Adjust timing pointer so that it aligns with scribing arm on the gauge.
16. Tighten timing pointer bolts and remove the gauge.
17. Rotate driving gear on distributor pump so that master spline lines up with master spline on driving gear.
18. Fit pump to engine, ensuring that the timing mark on the pump flange coincides with the timing pointer.
19. Tighten the injection pump retaining nuts.



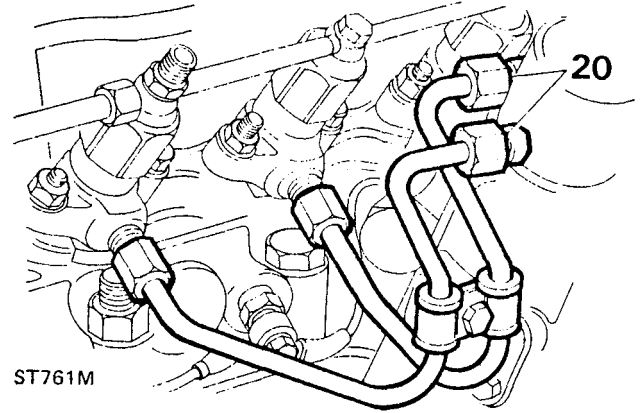
ST758M

**NOTE:** When the distributor pump is timed as detailed above, that is, with the timing pointer on the engine altered to take up backlash and wear on the gears, it ensures that optimum distributor pump timing is achieved.

Should there be any fall-off of power during the life of the engine, retiming the distributor pump to take up gear wear could well make a significant improvement to engine performance, provided the engine is generally in good condition.

continued

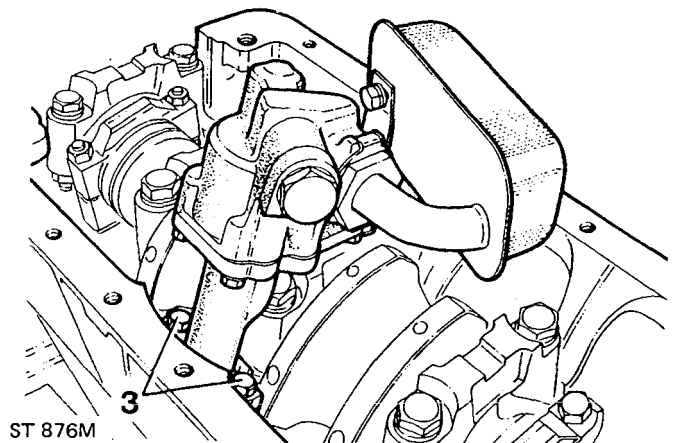
20. If the injectors have already been fitted, during cylinder head assembly, fit the injector feed pipes to the injector pump to prevent the ingress of dirt into the system. See FUEL SYSTEM - Section 19 for correct fitting of injectors.



ST761M

#### FIT OIL PUMP AND SUMP

1. Fit the longer splined end of the drive shaft into the oil pump.
2. Fit the oil pump and drive shaft to the crankcase, whilst revolving the shaft as necessary to engage the splines of the skew gear.
3. Using new lock washers, secure the pump to the crankcase tightening the bolts to the correct torque and bend over the lock tabs.
4. If necessary adjust the position of the strainer so that it is parallel to the sump baffle plate.

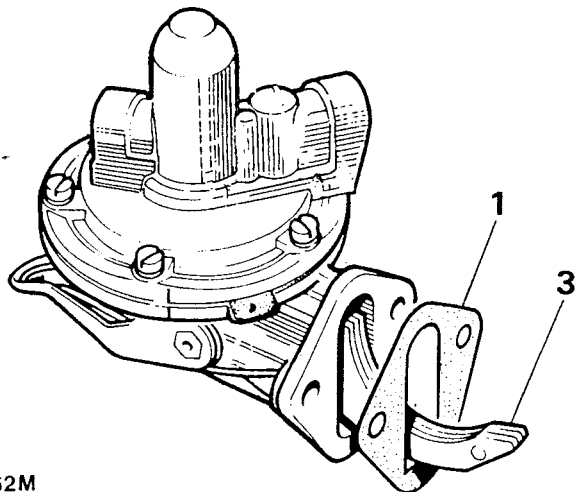


ST 876M

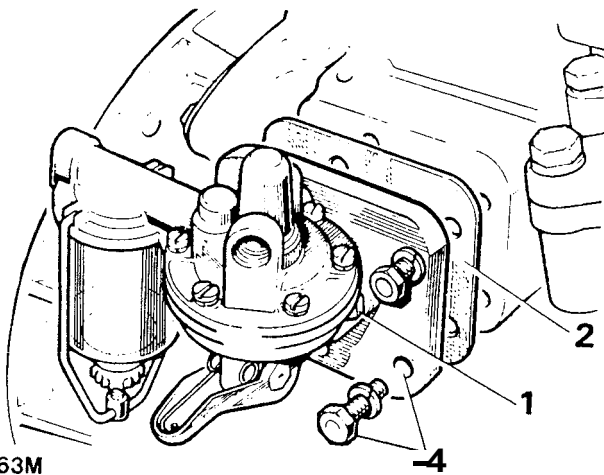
5. Clean the sump and crankcase mating faces and fit a new joint washer. Secure the sump with the twenty-one bolts and spring washers and one nut. Evenly tighten to the correct torque.

**FIT FUEL LIFT PUMP**

1. If the fuel lift was separated from the side cover, fit the pump to the cover first using a new joint washer and evenly tighten the retaining nuts.
2. Place a new cover plate joint washer in position and fit the cover and pump assembly to the cylinder block.
3. Ensure that the pump actuating lever rides on top of the camshaft.
4. Secure the cover, evenly tightening the retaining bolts.



ST762M



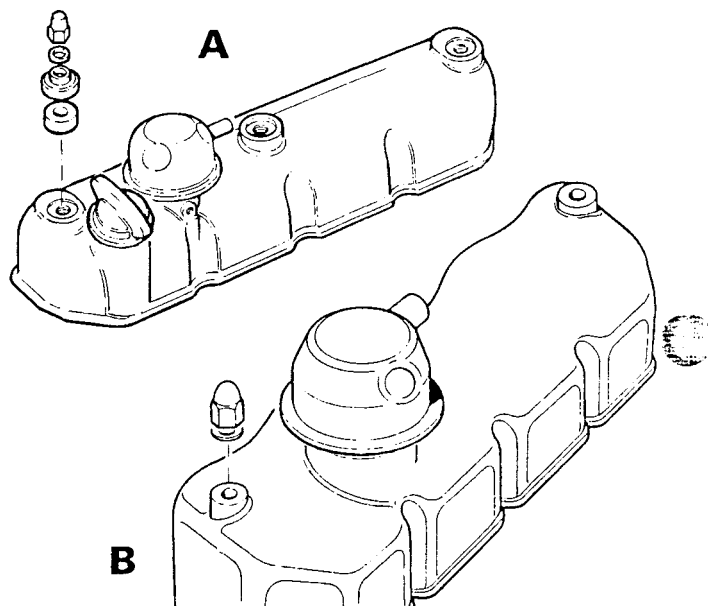
ST763M

**NOTE:** The illustration shows a petrol engine fuel pump but the fitting procedure is the same for the Diesel engine pump.

**FIT ROCKER COVER**

Clean the rocker cover and cylinder head faces and fit the cover using a new joint washer. Evenly tighten the dome headed nuts to the correct torque. Do not overtighten.

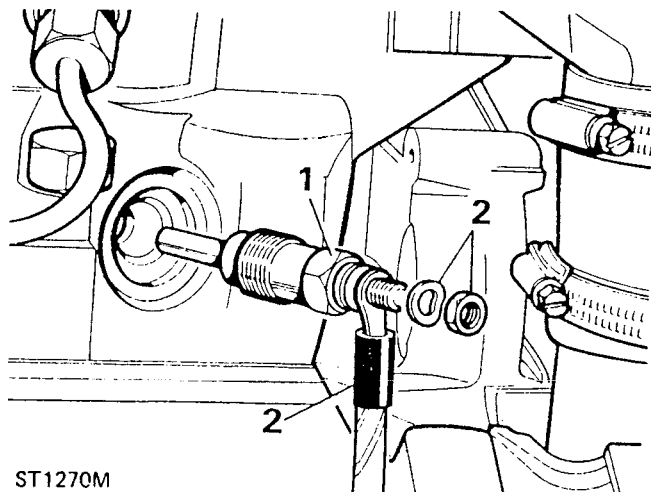
- A. Petrol engine  
B. Diesel engine



ST881M

**FIT HEATER PLUGS — Diesel engine**

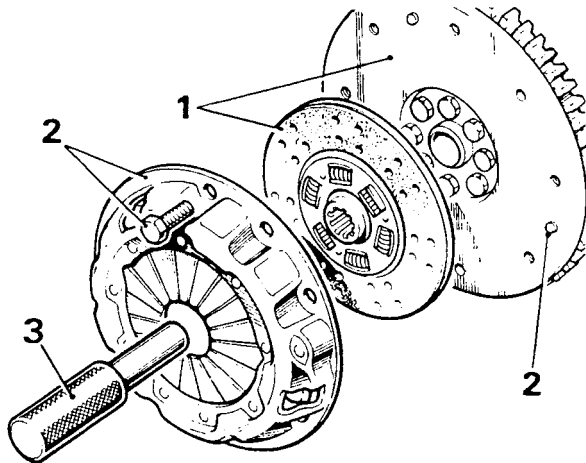
1. Clean and test the heater plugs as described in the maintenance Section. Fit the heater plugs and tighten to the correct torque according to the size of plug. Do not over tighten.
2. Fit the leads, washers and nuts as illustrated.



ST1270M

**FIT THE CLUTCH**

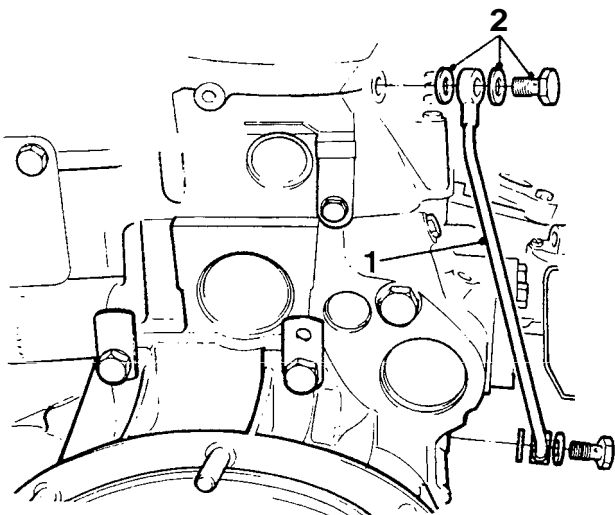
1. Clean the flywheel face and place the centre plate with the side marked 'Flywheel side' towards the flywheel.
2. Fit the clutch assembly locating it over the three dowels and loosely secure with the six bolts.
3. Centralise the centre plate using special tool RO 605022 or a spare primary shaft and tighten the six bolts evenly to the correct torque figure. Smear the splines of the centre plate with Molybdenum disulphide grease, such as Rocol MTS 1000.



ST764M

**FIT CYLINDER HEAD OIL FEED**

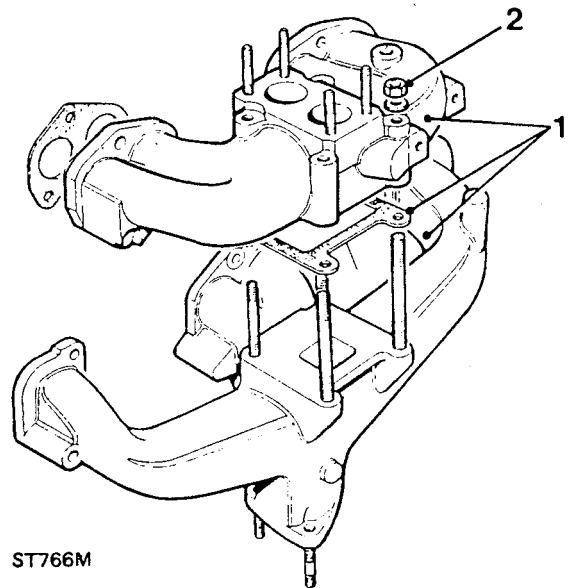
1. Connect the oil feed pipe, for lubrication of the rocker shaft assembly, to the cylinder head.
2. Secure with the two banjo bolts and four joint washers.



ST765M

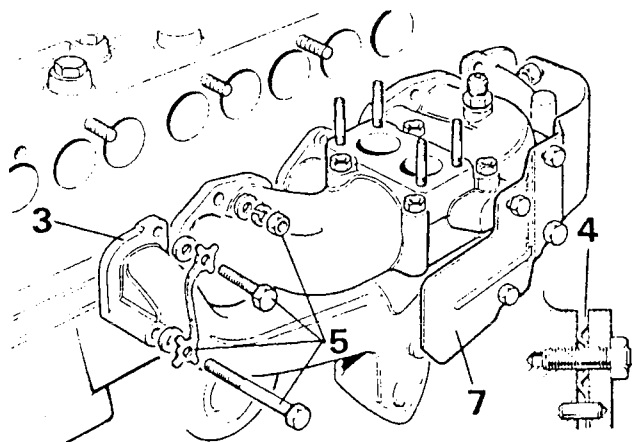
**FIT INLET AND EXHAUST MANIFOLDS****Petrol engine**

1. Using a new 'hot spot' joint washer assemble the inlet manifold to the exhaust manifold.
2. Secure with the four nuts and evenly tighten to the correct torque, then slacken off but retain the 'nip' of the four nuts.



ST766M

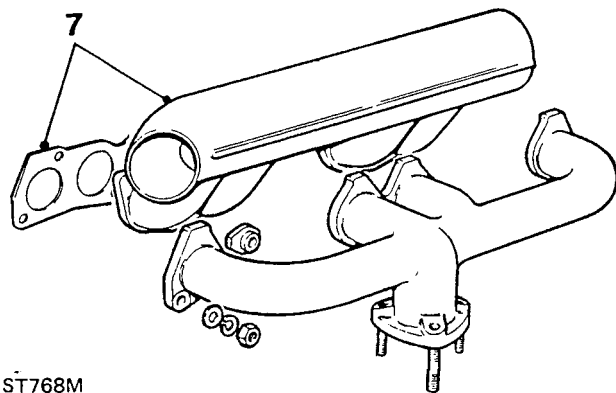
3. Coat the face of the exhaust manifold with Rocol anti-seize compound Foliac J166 (paste) and the corresponding face of the cylinder head.
4. Fit the joint washers of inlet manifold with the raised rings towards the cylinder head.
5. Fit and tighten the securing nuts and bolts to the correct torque including the two common bolts and clamps. Note the two outer bolts at both ends of the exhaust manifold have lock plates.
6. Finally tighten the four 'hot spot' joint nuts evenly to correct torque.
7. Fit the heat shield.



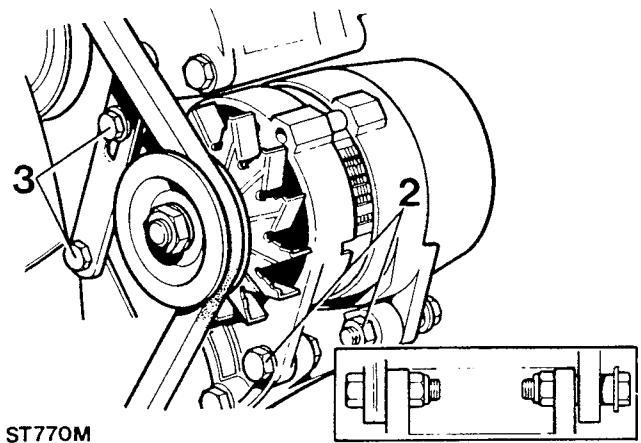
ST767M

**Diesel engine**

- Using a new gasket fit the manifolds and secure with the retaining nuts and clamps. Evenly tighten to the specified torque figure.

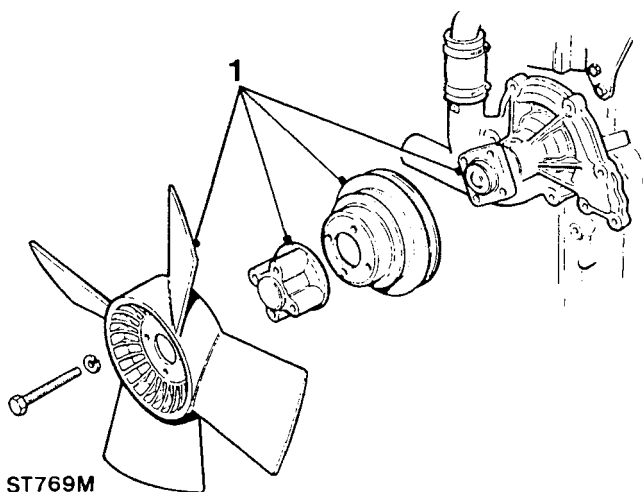


- Assemble the alternator to the engine bracket with the two pivot bolts, distance piece and washers, leaving the bolts slack.
- Fit the adjustment link to the timing cover and attach to alternator with the adjusting clamp bolt.

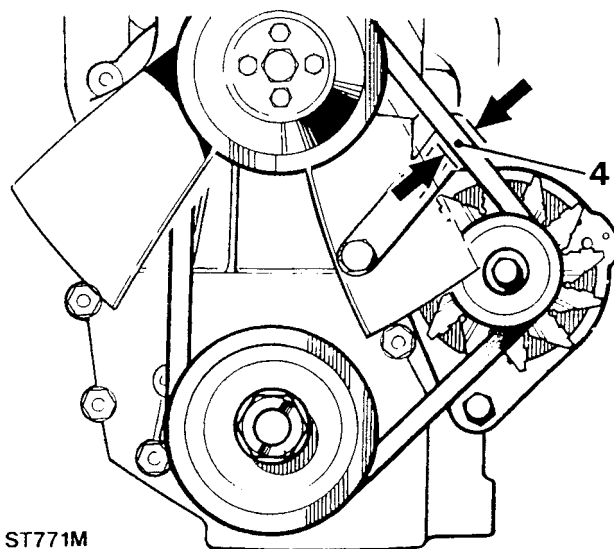


**FIT ALTERNATOR, PULLEY AND FAN BLADES**

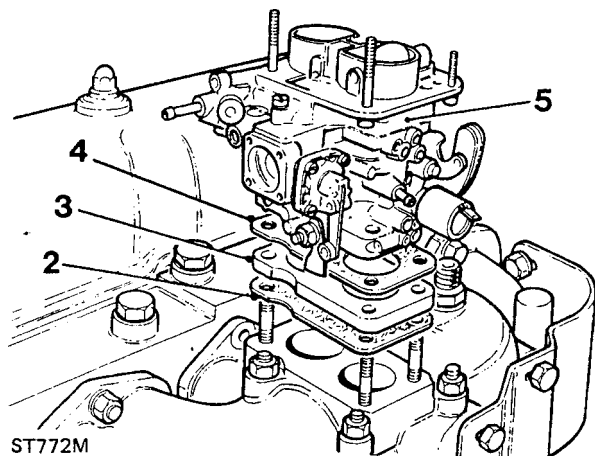
- Fit the pulley, spacer and fan blade assembly to the water pump shaft.



- Fit the drive belt and pivot the alternator away from the engine, but do not apply pressure to the stator or slip-ring end bracket or damage may result. Tighten the clamp bolt and with thumb pressure, check the belt tension between the Cr and alternator pulleys which should be 7 to 9 mm (¼ to ¾ in) at the mid-point.
- When the tension is correct fully tighten the clamp bolt and the pivot nuts and bolts.



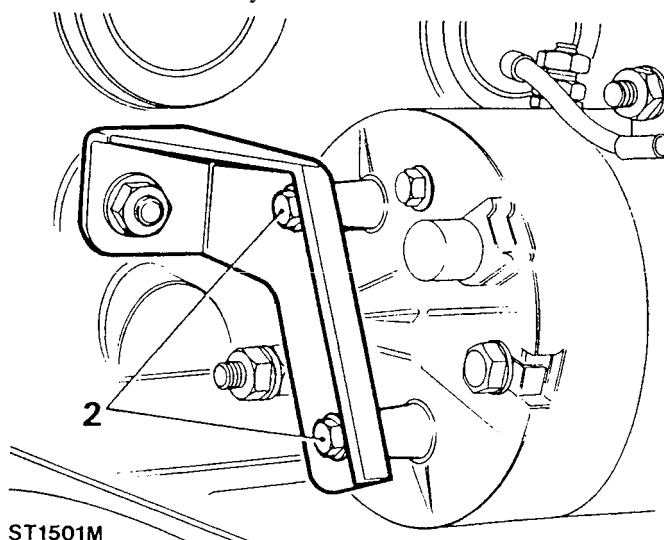
1. Clean the carburettor and manifold mating faces.
2. Place a joint washer, over the studs to the manifold.
3. Fit the packing piece.
4. Fit a second joint washer.
5. Fit the carburettor and secure with the four nuts and washers tightening evenly to the correct torque.



ST772M

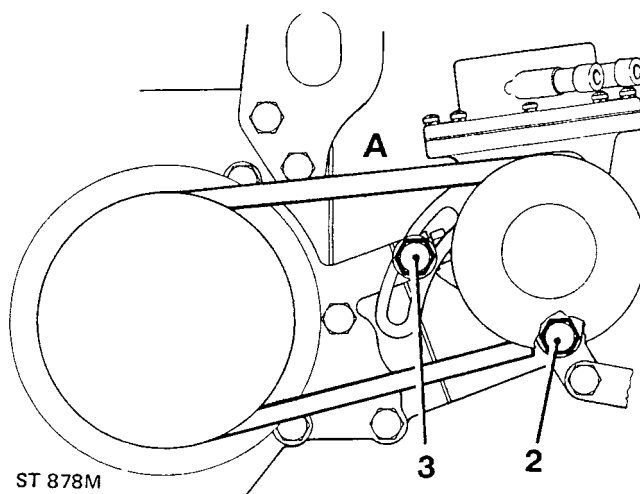
### FIT THE STARTER MOTOR

1. Secure the starter motor to the flywheel housing noting that the petrol engine starter is held by two studs, nuts and washers. The starter for the diesel engine is retained by one stud, one bolt and one nut and bolt. Tighten the fixings evenly to the correct torque.
2. In addition, the rear of the Diesel engine starter motor is secured by two bolts to a support bracket attached to the cylinder block.



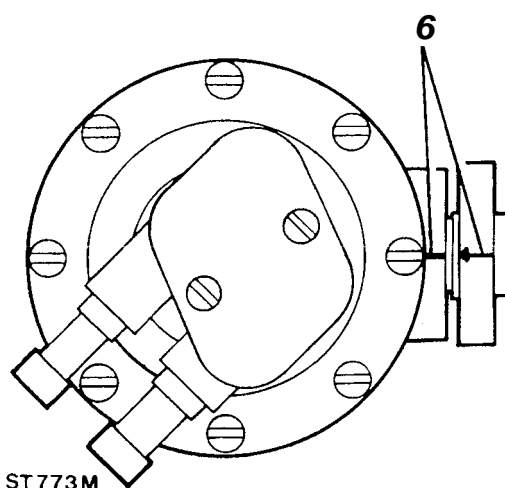
ST1501M

1. Fit the pump attachment bracket to engine with two bolts.
2. Secure pump to bracket with pivot bolt and nuts leaving it slack.
3. Fit the tensioning clamp bolt and drive belt. Tension the belt and tighten the clamp bolt.
4. Check that the belt can be deflected 12 mm (½ in) by thumb pressure, at the mid-point of its run (A).
5. Tighten the pivot bolt and nut and finally tighten the clamp bolt.



ST 878M

6. Turn the pump pulley so that the indicating marks on the pulley hub and pump body line up.
7. Remove the oil level plug and inject a recommended SAE 15W-50 oil up to the level of the hole. Refit the plug. See Maintenance Section.



ST773M

### MISCELLANEOUS ITEMS

Fit any other parts, if removed, such as engine mounting brackets, lifting eyes and the dipstick. Also any other items of non-standard equipment peculiar to the vehicle concerned.

Make a careful inspection of the engine and check that all plugs are fitted and properly tightened.

**REMOVE OVERHAUL AND REFIT****Special tools:****Drift inlet valve guides 274400****Drift exhaust valve guides 274401****Drift exhaust valve guide 600959****Drift inlet valve guide 601508****Seat cutters MS621 MS627****Insert replacer 530625**

Before the cylinder head can be removed the following ancillary items, common to petrol and diesel engines, need to be removed or disconnected for access and safety.

1. Disconnect the battery for safety.
2. Drain the cooling system.
3. Remove the bonnet.
4. Disconnect heater rail pipes and move aside.
5. Disconnect top hose from thermostat housing.
6. Disconnect heater control cables.
7. Release fan cowl from bracket attached to thermostat housing.
8. Disconnect lead from coolant temperature sensor.
9. Disconnect oil gallery pipe at rear of engine.
10. Disconnect coolant by-pass hose.
11. Disconnect the exhaust pipe from the manifold.

**The following items concern the petrol engine only**

12. Disconnect the air cleaner hose from the carburetter.
13. Disconnect brake vacuum hose from the manifold.
14. Disconnect mixture control cable from carburetter.
15. Disconnect throttle cable.
16. Disconnect fuel shut-off valve lead from carburetter.
17. Disconnect vacuum ignition advance pipe.
18. Remove H.T. leads from spark plugs.

**The following items concern only the diesel engine**

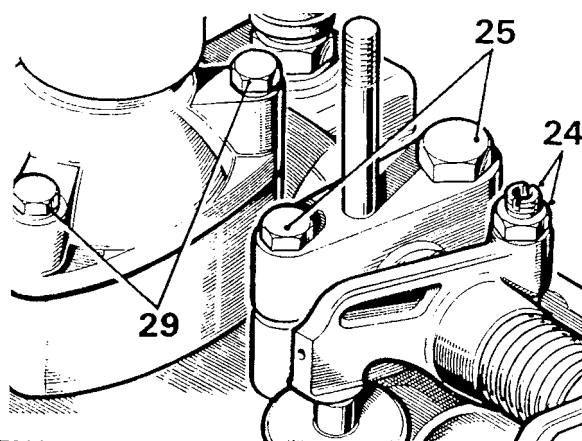
19. Disconnect the fuel spill return union connected to spill rail.
20. Disconnect injector supply pipes from the injectors.
21. Remove injectors complete with spill rail.
22. Disconnect air hose from manifold.
23. Disconnect the heater plug electrical connections.

**Remove the cylinder head**

The following instructions for removing and overhauling the cylinder head are common to petrol and diesel engines unless otherwise stated.

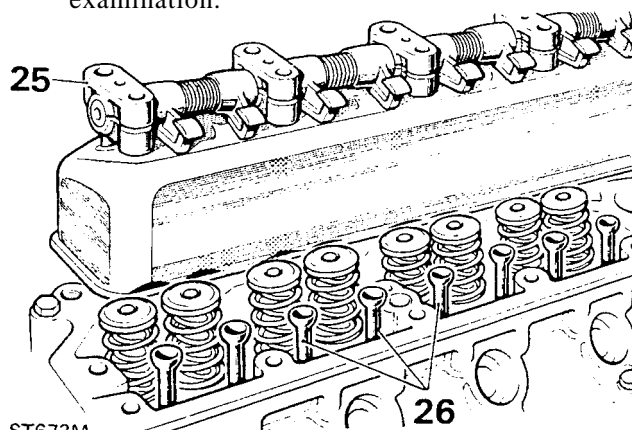
24. Remove the rocker cover and slacken the tappet screw lock nuts. Turn the adjusting screws to release them from the push rods.
25. Remove the rocker shaft retaining bolts, lift-off the rocker shaft assembly, invert it and secure it to the rocker cover studs to prevent the assembly from falling apart.

26. Withdraw the push rods and retain them in numbered sequence.
27. Evenly slacken the remaining cylinder head retaining bolts and lift-off the cylinder head complete with manifolds. Remove and discard the cylinder head gasket.



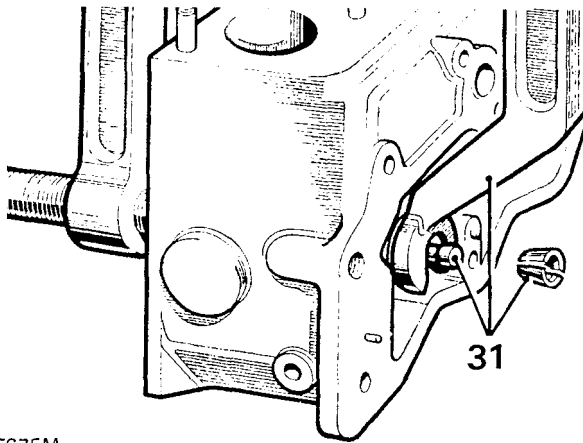
ST674M

28. Remove the eight bolts and three nuts and remove the inlet and exhaust manifolds complete with carburetter (petrol engine).
29. Remove three bolts and lift-off the thermostat housing, elbow and thermostat.
30. Remove spark plugs, (petrol engine) temperature sensor and engine lifting eyes.
31. Using valve spring compressor 276102 or a suitable alternative, remove the valve and spring assemblies, keeping them identified with their original locations for possible refitting. Discard the valve spring and valve guide oil seals. Remove carbon deposits from the valves and combustion chambers and degrease all parts ready for examination.



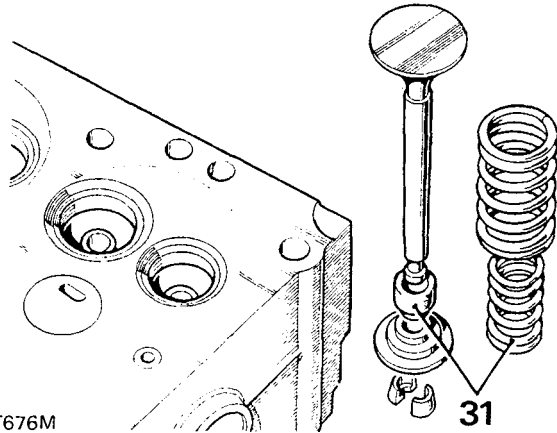
ST673M

continued



ST675M

34. To remove a hot plug, insert a thin soft metal drift through the injector shroud throat and tap the hot plug from the inside. Once removed a faulty hot plug cannot be restored and must be renewed.
35. If the injector shroud is damaged, drift the shroud out towards the injector bore.
36. Thoroughly clean out the combustion chamber. The hole in the side of the injector shroud is for manufacturing purposes only but at the same time can be used as a guide when refitting the shroud.
37. Smear a little oil on the shroud and insert into the cylinder head with the hole pointing towards the centre of the cylinder head, and drift into position.



ST676M

### EXAMINATION OF COMPONENTS

#### Petrol engine

32. Examine the cylinder head for cracks and distortion. Burnt, pitted and pocketed seats must be repaired.

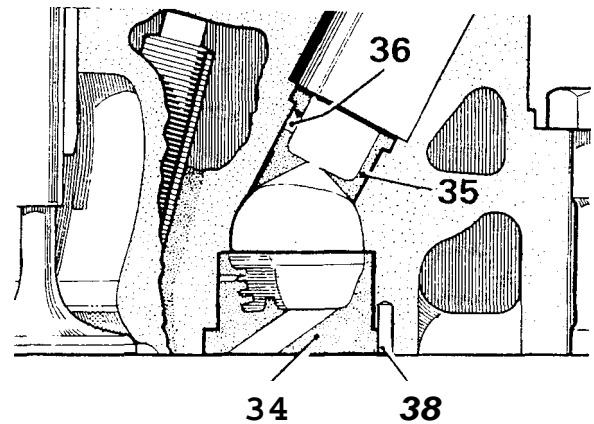
#### Diesel engine

33. Same as for petrol engine and in addition, worn or damaged exhaust seat inserts should be renewed, as described later.

### Hot plugs and injector shrouds — examine and renew

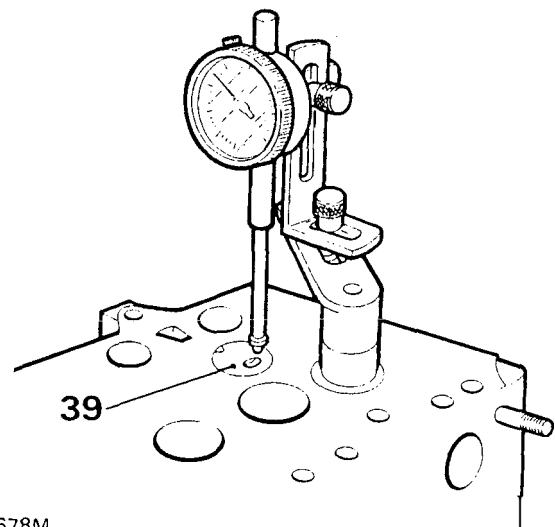
When carrying out normal top overhaul work on the cylinder head it is not necessary to remove either the injector shrouds or the hot plugs.

Small surface cracks in the hot plug, extending from the opening to approximately 8,0 mm (0.312 in) in length can be ignored. However if any severe cracks appear on the face of the hot plug, before attempting to remove it, closely inspect the cylinder head for signs of cracks, particularly between the inlet and exhaust valve seats. Such cracking indicates that the engine has overheated, usually through lack of coolant, and the cylinder head should be scrapped.



ST677M

38. Fit the hot plugs by tapping with a hide-faced mallet, and locate with a new roll pin. If the hot plugs are loose in the cylinder head they may be retained with a little grease.
39. When fitted, the hot plugs must be checked with a dial test indicator to ensure that they do not protrude above the level of the cylinder head face more than 0,025 mm (0.001 in) and are not recessed below the level of the cylinder head face more than 0,05 mm (0.002 in).



ST678M

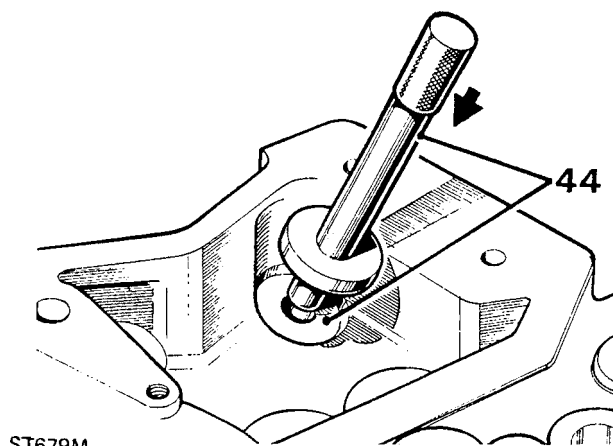
### Petrol and diesel engines

40. Check the valve guides for wear by inserting a new valve in the appropriate guide 8 mm above the seat. If movement across the head exceeds 0,15 mm (0.006 in) renew the guide.
41. Inspect the valves and discard any that are burnt, bent or distorted. Check the stems for wear by inserting in a new guide. If wear is excessive, discard the valve. Valve faces that are pitted or ridged but otherwise serviceable may be refaced.
42. Renew push rods that are bent or have worn or scored ball or socket ends.

### Renew push rod tube seals (Diesel only)

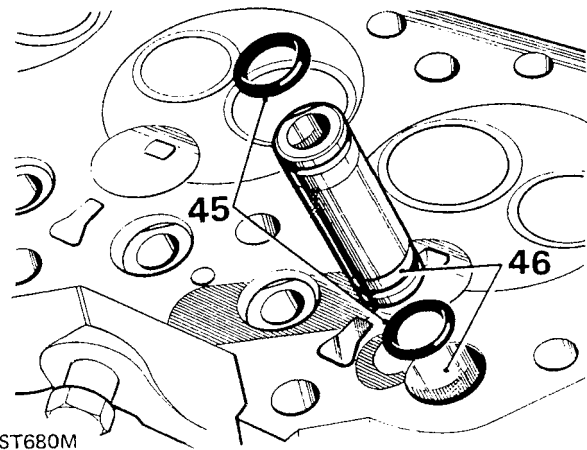
43. Whilst this is rarely necessary the procedure is nevertheless as follows.
44. Drive out the old push rod tubes using a suitable drift.

**NOTE:** Later engines are fitted with tubes without seals. See 2.5 litre Diesel engine for renewal.

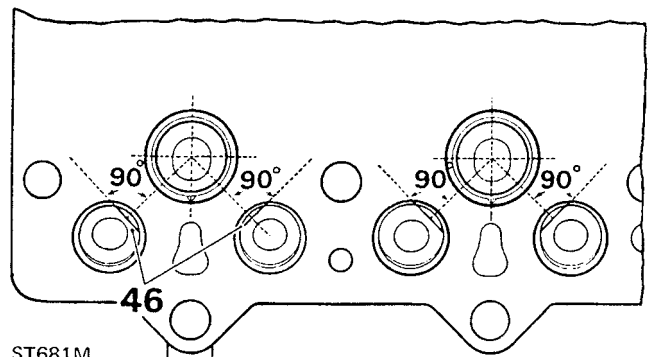


ST679M

45. Fit new sealing rings to new push rod tubes and smear with silicone MS4 grease.
46. Insert the new tubes, chamfered end first from the combustion chamber side. Align the flat on the push rod tube at right angles to an imaginary line between the centre of the push rod tube and centre of the hot plug.
47. Press the push rod tubes into position whilst maintaining the alignment. Also ensure that the chamfers on the tubes and in the cylinder head are fully engaged.



ST680M

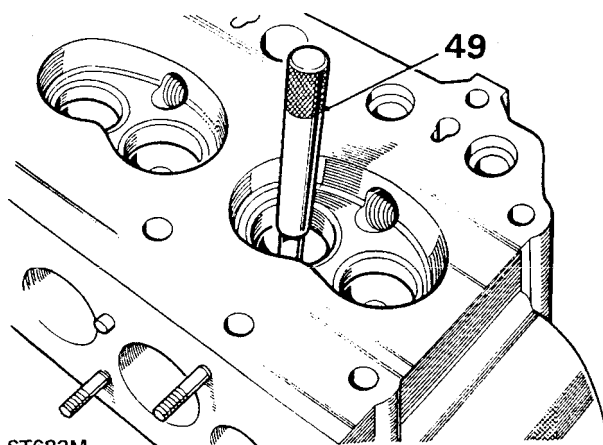


ST681M

### Renew valve guide

48. Support the cylinder head, combustion chamber uppermost on pieces of timber of sufficient thickness to allow clearance for the valve guides to be driven out.
49. Using special drift 274400 for inlet guides and 274401 for exhaust guides or suitable alternatives drive out the old guides from the combustion face side.

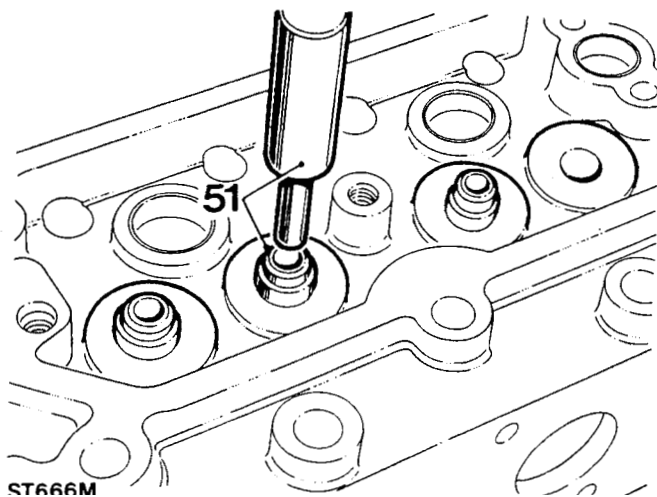
**NOTE:** The illustration shows a petrol engine cylinder head.



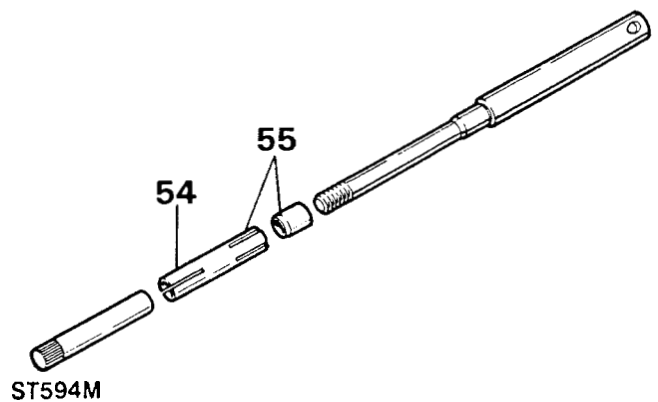
ST682M



50. Turn the cylinder head over so the combustion chambers face downwards. Since the inlet and exhaust valve guides are dimensionally different it is important that the correct guides are fitted to the appropriate ports.
51. Lubricate new guides with engine oil and using special drift 600959 for the exhaust and 601508 for the inlet valve guides or suitable alternatives, drive in the new guides until the shoulder is flush with the casting.

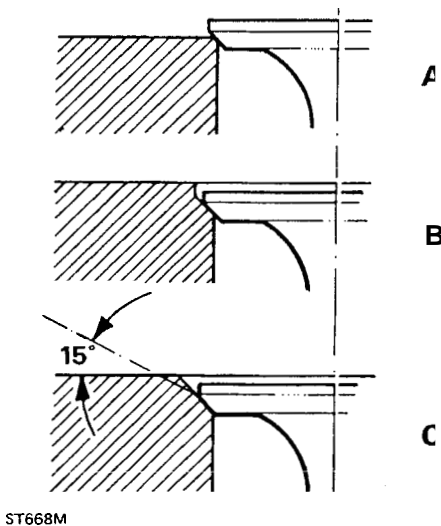


53. The special set of hand tools recommended for refacing include expandable pilots that fit tightly into new or worn guides to ensure that the valve seat is concentric with valve guide. The refacing tool has tungsten carbide cutters and can be used to cut a seat in a new exhaust seat insert.
54. Select the correct expandable collet for the valve guide concerned i.e. 8 mm for inlet guides and 8,5 mm for exhaust.
55. Loosely assemble the collet, expander and nuts. Ensure that the chamfered end of the expander is towards the collet.



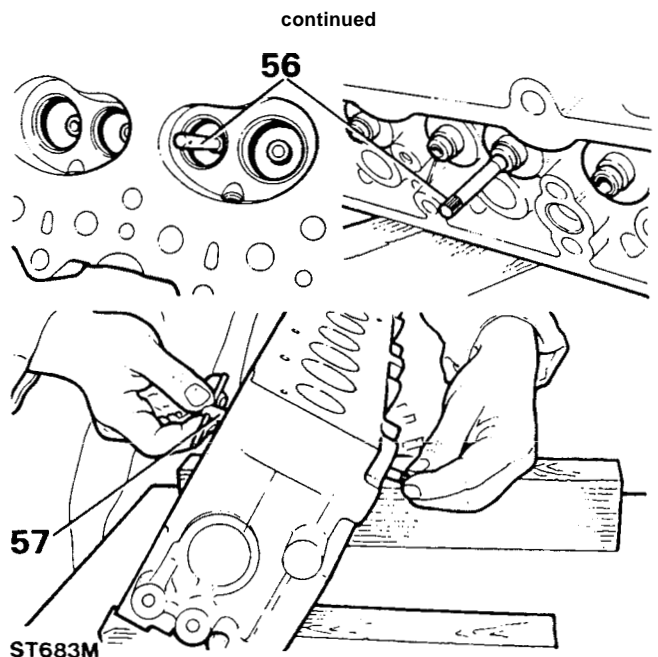
**Reface cylinder head valve seats**

52. Damaged or worn valve seats can be refaced provided they are not abnormally wide due to repeated refacing operations. See instruction 64.



A. Correctly seated valve  
 B. Undesirable condition  
 C. Method of rectification

56. Insert the assembled pilot into the valve guide from the combustion face side of the cylinder head until the shoulder contacts the valve guide and the whole of the collet is inside the valve guide.
57. Expand the collet in the guide by turning the tommy bar clockwise whilst holding the knurled nut.
58. Select the appropriate angled cutter for the seats to be cut.

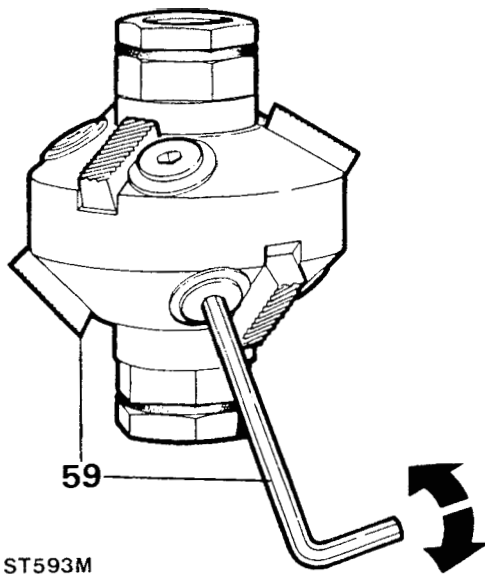


**NOTE:** MS 621 is a 45° and 15° cutter and MS 627 is 30° only.

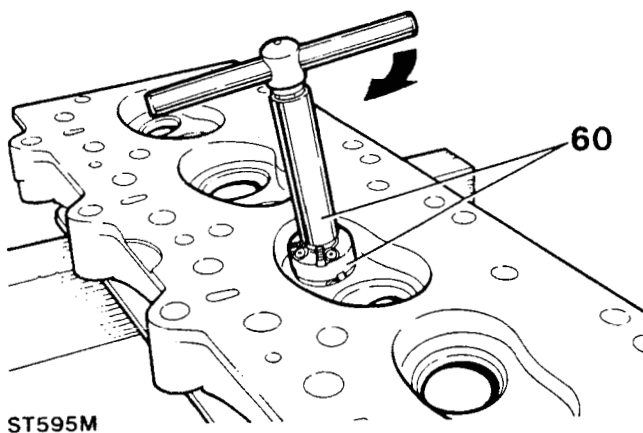
- A** — Petrol engine — inlet valve seat 30° + ¼°  
 exhaust valve seat 45° + ¼°
- B** — Diesel engine — inlet valve seat 45° + ¼°  
 exhaust valve seat 45° + ¼°

See illustrations following instruction 68.

59. Ensure that the cutter blades are correctly fitted to the cutter head with the angled end of the blade downwards facing the work, as illustrated. Check that the cutter blades are adjusted so that the middle of the blade contacts the area of material to be cut. Use the key provided in the hand set MS 76.



60. Fit the wrench to the cutter head and turn clockwise using only very light pressure. Continue cutting to approximately the centre of the existing seat.

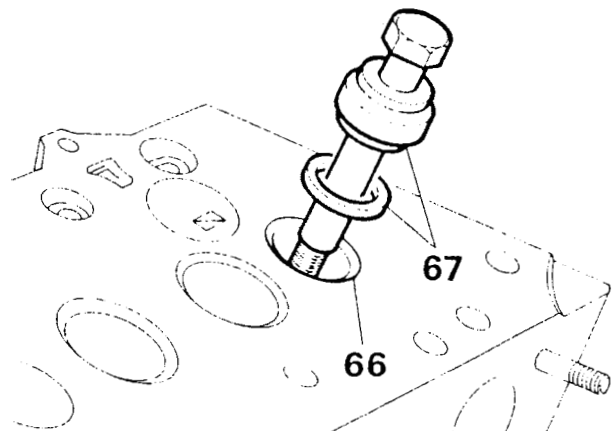


61. To check the effectiveness of the cutting operation use engineers' blue or a feeler gauge made from cellophane.

62. Smear a small quantity of engineers' blue round the valve seat and revolve a properly ground valve against the seat. A continuous fine line should appear round the valve. If there is a gap of not more than 12 mm it can be corrected by lapping.
63. Alternatively, insert a strip of cellophane between the valve and seat, hold the valve down by the stem and slowly pull out the cellophane. If there is a drag the seal is satisfactory in that spot. Repeat this in at least eight places. Lapping-in will correct a small open spot.
64. After several trueing-up or lapping-in operations valve seats may have an excessive width which can be reduced by obtaining special correction cutters which narrow the seat by removing metal from the top and bottom of the seat. A 60° cutter is recommended for bottom narrowing and for top narrowing use a 15° cutter (MS 621) for a 30° valve seat and a 30° cutter for a 45° seat. The same method of assembly and operation is used for correction cutters as for refacing cutters. Use very light pressure removing only the minimum material necessary. Once the seats have been reduced carry out the normal refacing operation as previously described.

#### Renew exhaust seat inserts (Diesel only)

65. Hold the cylinder head firmly in a vice, wear protective goggles and grind the old insert away until thin enough to be cracked and prised out. Take care not to damage the insert pocket.
66. Remove any burrs and swarf from the pocket. Failure to do this could cause the new insert to crack when being fitted.
67. Assemble the new insert to the replacer tool number 530625 so that the chamfered edge of the insert is leading. Using a suitable bolt and nut draw the insert into the cylinder head pocket. Cut a new 45° seat using cutter MS 621.



**Reface valve faces**

68. Valves that are satisfactory for further service can be refaced. This operation should be carried out using a valve grinding machine. Only the minimum of material should be removed from the valve face to avoid thinning of the valve edge. The valve is refaced correctly when all pits are removed and the face concentric with the stem.

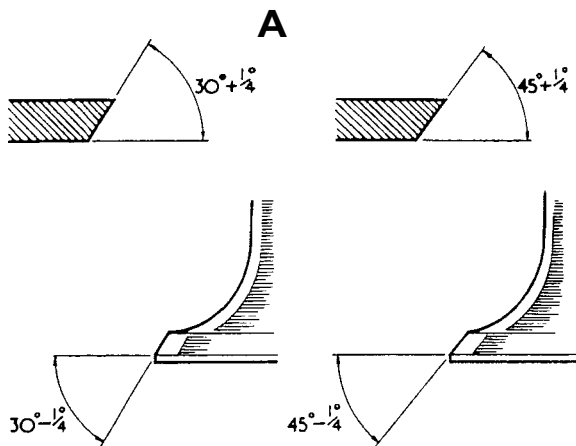
**Valve face angles:**

**A. Petrol engine**

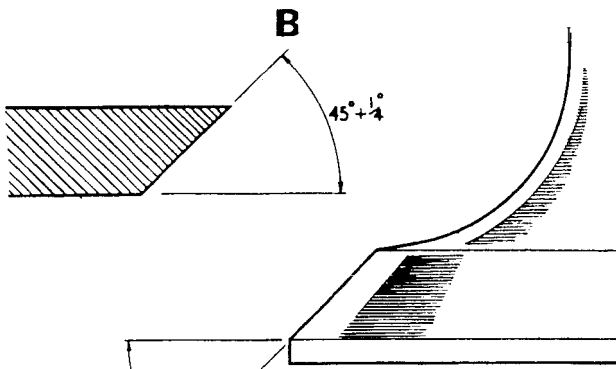
Inlet valve face —  $30^{\circ} - \frac{1}{4}^{\circ}$   
 Exhaust valve face —  $45^{\circ} - \frac{1}{4}^{\circ}$

**B. Diesel engine**

Inlet valve face —  $45^{\circ} - \frac{1}{4}^{\circ}$   
 Exhaust valve face  $45^{\circ} - \frac{1}{4}^{\circ}$



ST690M

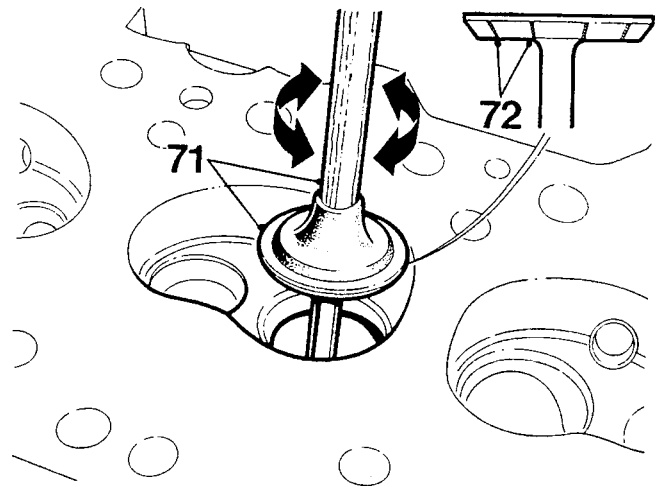


ST691M

**Lap-in valves**

69. To ensure a gas tight seal between the valve face and valve seat it is necessary to lap-in the appropriate valve to its seat. It is essential to keep the valve identified with its seat once the lapping-in operation has been completed. Remember that the inlet and exhaust valves in the petrol engine have different face angles.
70. Unless the faces to be lapped are in poor condition it should only be necessary to use fine valve lapping paste. Smear a small quantity of paste on the valve face and lubricate the valve stem with engine oil.
71. Insert the valve in the appropriate guide and using a suction type valve lapping tool employ a light reciprocating action while occasionally lifting the valve off its seat and turning it so that the valve returns to a different position on the seat.
72. Continue the operation until a continuous matt grey band round the valve face is obtained. To check that the lapping operation is successful, wipe off the valve paste from the valve and seat and make a series of pencil lines across the valve face. Inset the valve into the guide and while pressing the valve onto the seat revolve the valve a quarter turn a few times. If all the pencil lines are cut through no further lapping is required.
73. Wash all traces of grinding paste from the valves and cylinder head seats.

continued



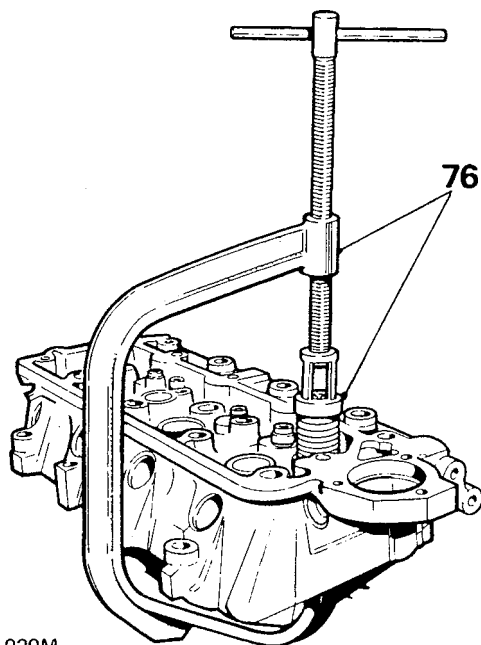
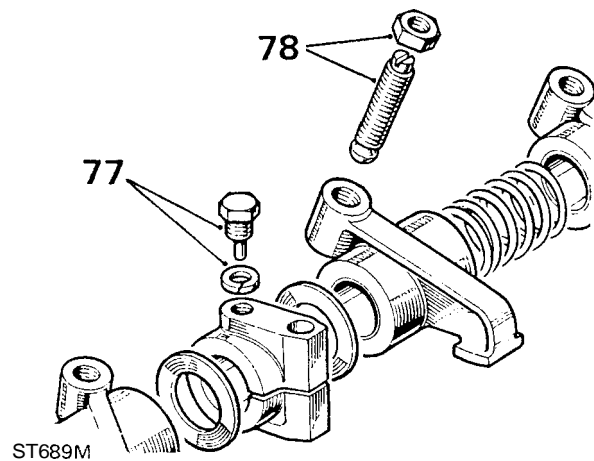
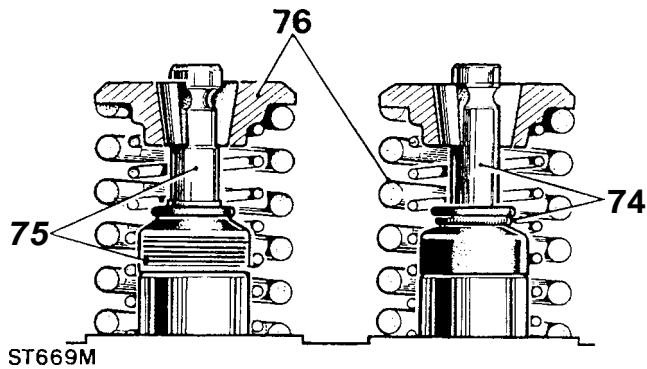
ST670M

**Assemble valves to cylinder head**

74. Insert the inlet valves into the guides and fit new oil seals with the plain exterior and circular spring. Ensure that the seal locates in the groove in the valve guide.
75. Insert the exhaust valves and fit the oil seals with the ridged exterior and no spring.

continued

76. Fit the double valve spring and retainer assembly to each valve in turn and using valve spring compressor, 18G106A with adaptor 18G106A/10 secure the assembly with the split collets.



ST 929M

### OVERHAUL ROCKER SHAFT ASSEMBLY

Most of the rocker shaft assembly components are not interchangeable between the petrol and diesel engines although the assembly method is the same.

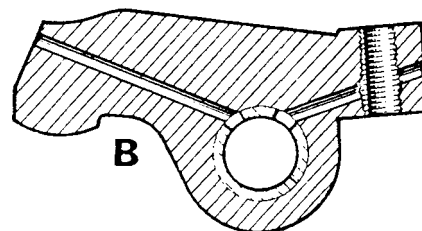
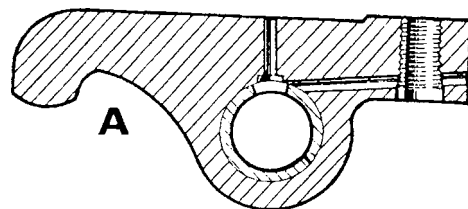
#### Dismantle and inspection

77. Remove the locating screw and washer from the number two rocker bracket and withdraw all the components from the rocker shaft. Note that on the petrol engine the locating screw also retains a splash plate.
78. Remove the locknuts and adjustment screws from the rockers.

79. Examine the rocker shaft for wear and discard if the bearing surface is worn more than 0,025 mm (0.001 in).  
Inspect the rockers and discard if the pads are worn. It is not permissible to grind pads in an attempt to reclaim the rockers.
80. Renew bushes if the clearance between shaft and bush is in excess of 0,101 to 0,127 mm (0.004 to 0.005 in).  
Press in replacements ensuring that the pre-drilled oil holes coincide with the holes in the rockers.

Illustration A. Cross section of petrol engine rocker.

Illustration B. Cross section of diesel engine rocker.



ST684M

81. Using a reamer finish the bushes to 13,4 mm + 0,02 mm (0.530 in + 0.001 in) and clear swarf from the oil holes.
82. Examine the ball-end of the adjusting screws and discard any that are worn. Regrinding is not permissible. Check the threads for damage and that the oil relief drilling is clear.

**Assemble rocker shaft assembly**

83. Check that the oil-ways in the rocker shaft are clear and fit number two rocker shaft bracket to the shaft and retain with the locating screw and washer. Note that the locating screw on petrol engines also secures the splash plate.
84. Using new spacers and springs, assemble the rockers and brackets to the shaft as illustrated, ensuring that the rockers move freely on the shaft. Note that the Diesel engine assembly has double spacers each side of the centre pedestal.

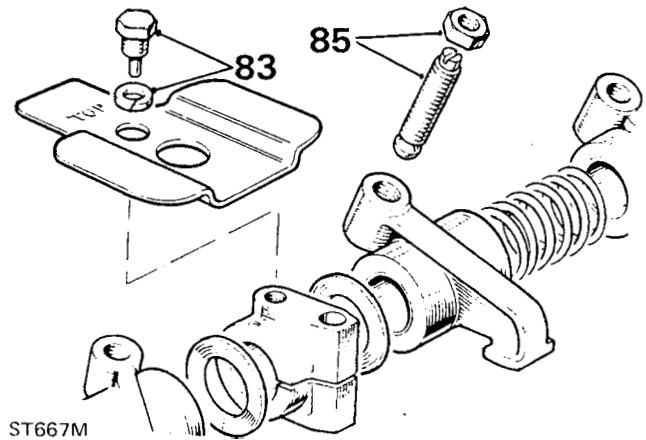
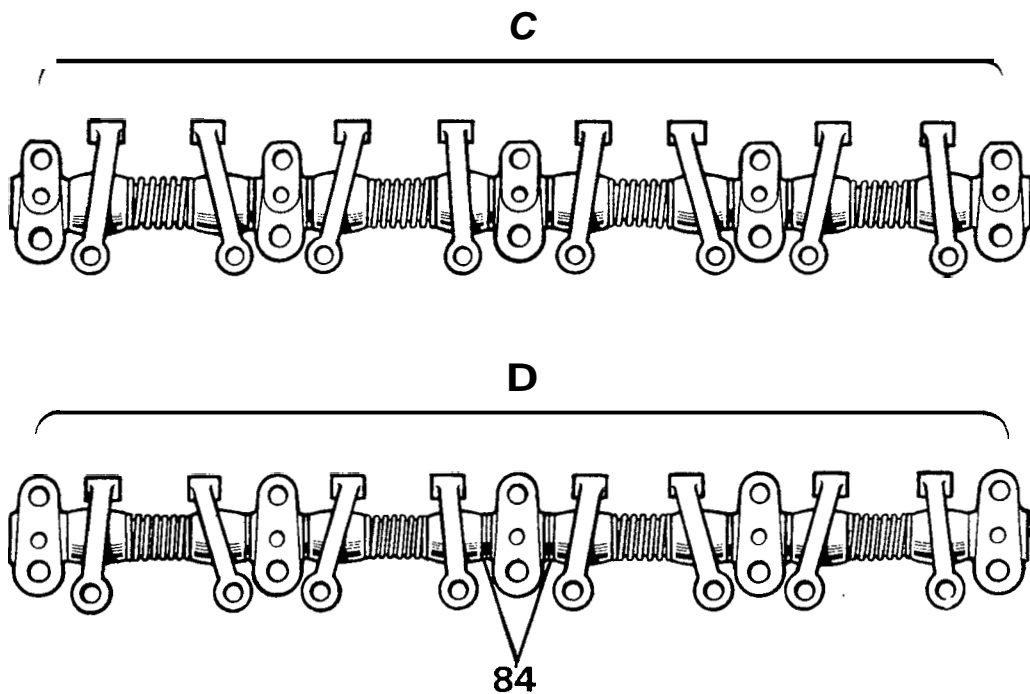


Illustration C. Petrol engine assembly.  
Illustration D. Diesel engine assembly

85. Fit the tappet adjustment screws and **lock** nuts to the rockers.
86. Invert the rocker assembly and locate it on the rocker cover to prevent it falling apart.

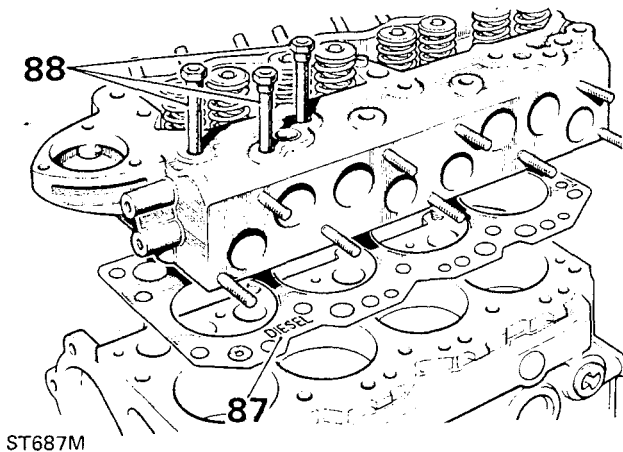
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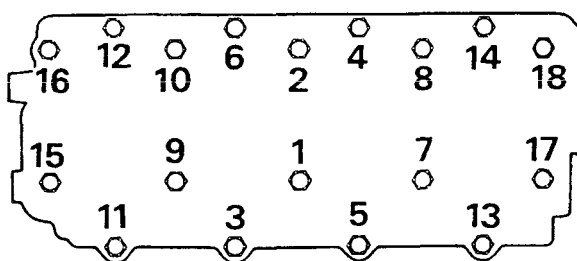
ST688M

**Fit the cylinder head**

87. Clean the cylinder head and cylinder block mating faces and fit a new gasket, dry, without grease or sealing compound. The gasket will have either 'DIESEL' or 'PETROL' stamped in the position illustrated and the gasket must be fitted with these uppermost.
88. Place the cylinder head in position and engage all the cylinder head bolts and washers except those used to secure the rocker assembly. **Use new bolts and ensure that the correct bolts for the petrol and diesel engine are fitted. They are not interchangeable.**



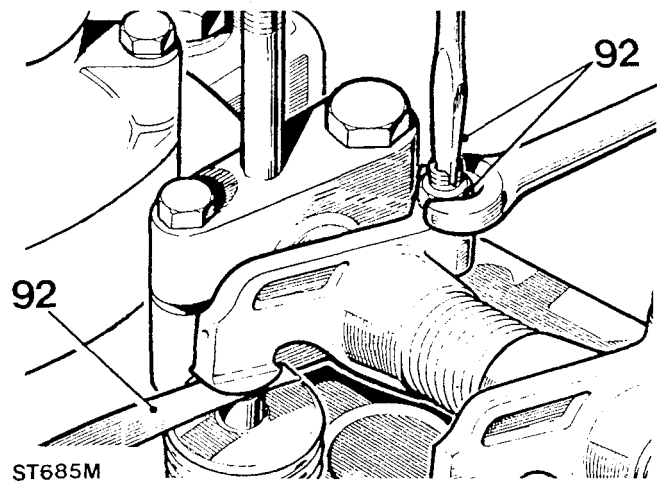
89. Insert the push rods into position ensuring that the ball-ends fit correctly into the spherical seats in the tappet slides.
90. Fit the rocker shaft assembly ensuring that the hole in the front and rear rocker bracket locates properly in the corresponding dowel in the cylinder head. Also, make sure that the ball-end of all the rockers fit into the spherical seats of the push rods. Evenly tighten the rocker shaft retaining bolts to the correct torque.
91. Tighten the cylinder head and rocker shaft securing nuts and bolts strictly in the sequence illustrated to avoid distortion of the cylinder head. Tighten to the torque figures given in the data section. The arrow points to the front of the engine



92. Adjust the tappet clearances for petrol and diesel engines, inlet and exhaust to 0,25 mm (0.010 in) as follows: Using a feeler gauge adjust the clearance by slackening the locknut and turning the tappet adjusting screw clockwise to reduce clearance and anti-clockwise to increase clearance.

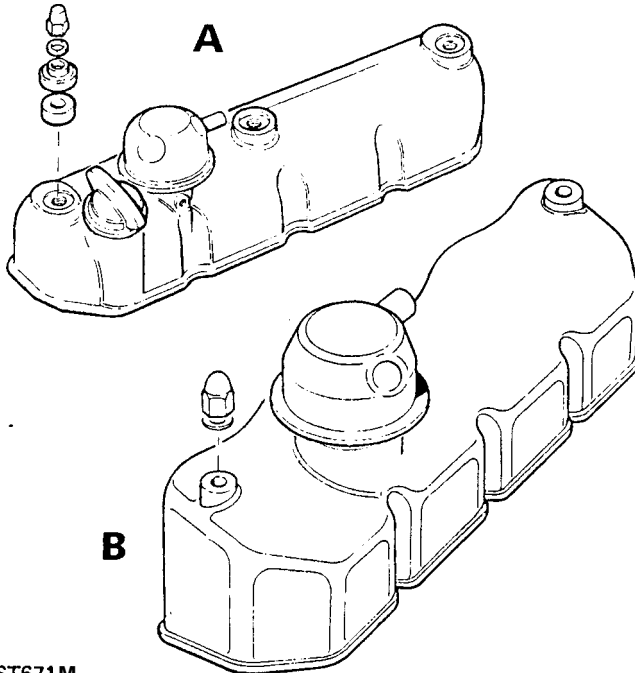
Set No. 1 tappet with No. 8 valve fully open.  
 Set No. 3 tappet with No. 6 valve fully open.  
 Set No. 5 tappet with No. 4 valve fully open.  
 Set No. 2 tappet with No. 7 valve fully open.  
 Set No. 8 tappet with No. 1 valve fully open.  
 Set No. 6 tappet with No. 3 valve fully open.  
 Set No. 4 tappet with No. 5 valve fully open.  
 Set No. 7 tappet with No. 2 valve fully open.

93. Recheck the clearances with the locknuts tightened and adjust as necessary.



94. Using a new gasket fit the rocker cover and secure with the rubbers, cups and dome nuts. Tighten to the correct torque figure. Do not over-tighten.

A. Petrol. B. Diesel

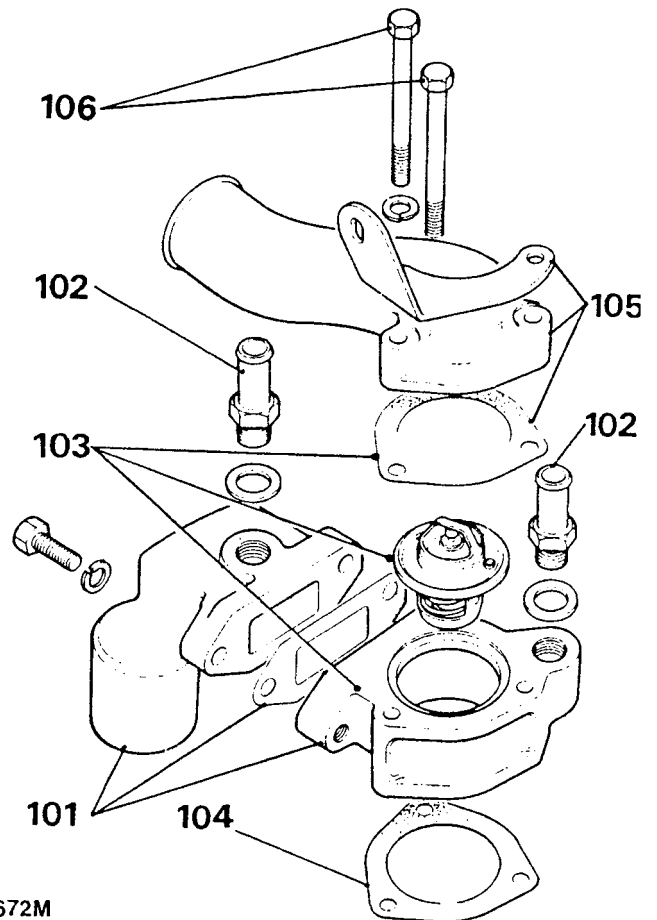


ST671M

95. Fit the inlet and exhaust manifolds complete with carburetter (petrol engine). See Engine overhaul.
96. Fit the air intake and exhaust manifolds (diesel engine). See Engine overhaul.
97. Fit the spark plugs (petrol engine).
98. Fit the injectors — see Diesel fuel system.
99. Fit the engine lifting eyes.
100. Fit the water temperature sensor.

#### Fit the thermostat housing assembly

101. Using a new joint washer secure the thermostat housing to the by-pass housing.
102. Fit the two hose adaptors.
103. Insert the thermostat into its housing.
104. Place a new joint washer on the cylinder head.
105. Using a new joint washer fit the thermostat cover and cowl mounting bracket.
106. Using the three bolts secure the complete assembly to the cylinder head. Note that one bolt is shorter and is fitted in-board.



ST672M

107. Refit or reconnect the items disturbed for access to the cylinder head.
108. Refill the cooling system when engine is refitted to vehicle.

## 2.5 LITRE PETROL ENGINE

SUPPLEMENT TO THE 2.25 LITRE PETROL  
ENGINE OVERHAUL PROCEDURES

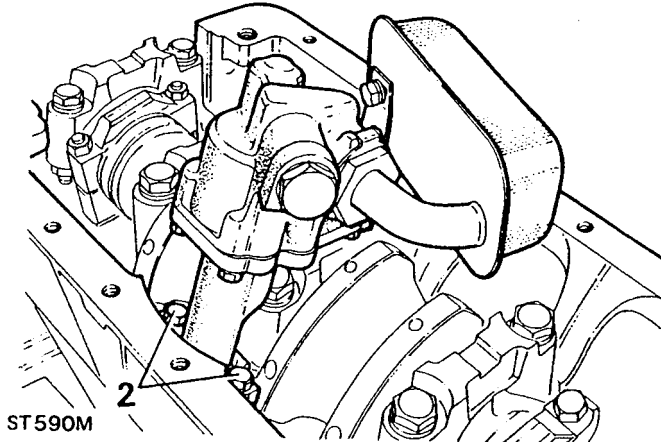
This Supplement should be used in conjunction with the 2.25 litre petrol engine overhaul procedures. Details of the differences between the 2.25 and 2.5 litre engines are listed below. Some of the new features were, however, introduced on later 2.25 petrol engines.

- o Capacity increased to 2495 cc by lengthening the piston stroke from 89 mm to 97 mm.
  - o Crankshaft and main bearings same as the 2.5 litre Diesel engine.
  - Oil squirt hole in connecting rods deleted.
  - o New pistons with controlled expansion skirts.
  - o Camshaft same as 2.5 litre Diesel engine.
  - o Camshaft sprocket similar to 2.25 litre petrol engine, but with a single keyway positioned to alter the exhaust valve peak from 109° to 104°.
  - o Inserts fitted to exhaust valve seats in cylinder head.
  - New timing chain tensioner assembly
  - Modified oil pump with gear having only ten teeth. Bush deleted from idler gear and ball omitted from the pressure relief valve.
  - o The 'O' ring seal between the flywheel housing and cylinder block deleted. Sealing now achieved by a bead of sealant on the flywheel housing mating face with the cylinder block.
  - o Sump joint washer deleted and a liquid sealant, RTV Hylosill 102, now used.
  - o The Lucas 45 D4 sliding contact distributor now used.
-



## REMOVE AND OVERHAUL OIL PUMP

1. Remove the sump.
2. Bend back the lock washers and remove the two bolts securing the oil pump to the crankcase. Withdraw the oil pump complete with strainer and oil pump drive shaft.

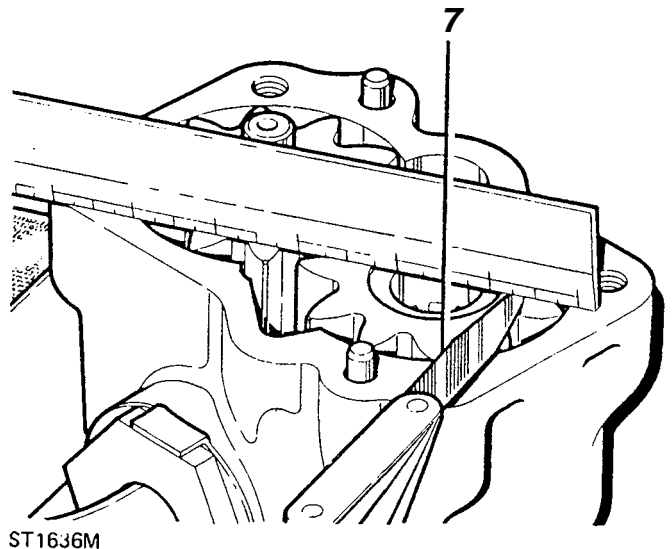
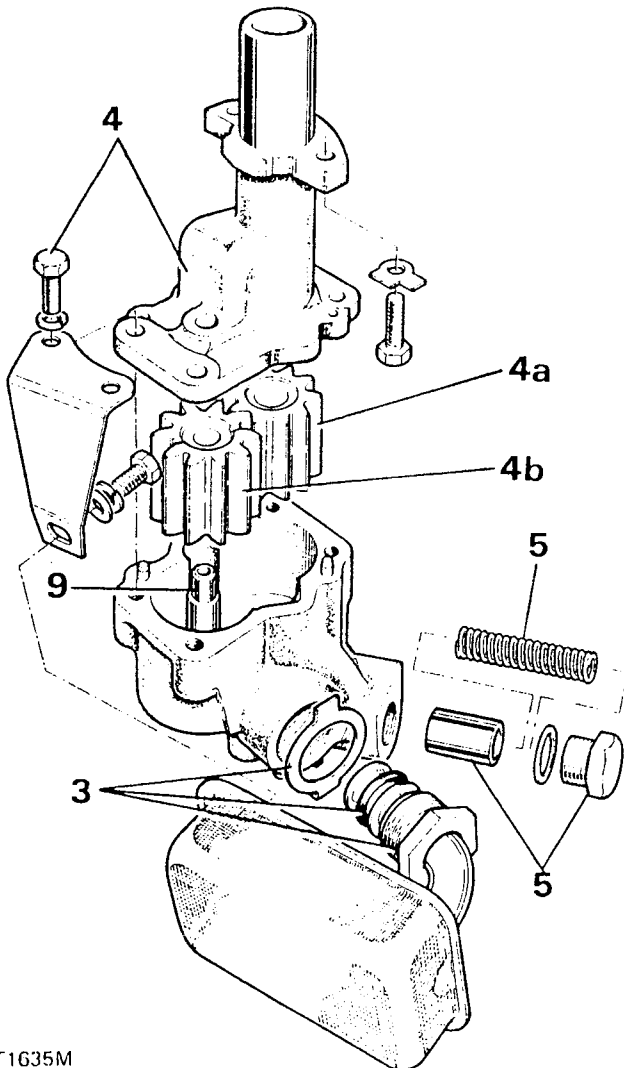


### Dismantle oil pump

3. Bend back the lock washer and release the nut securing the strainer to the oil pump body and remove the strainer and sealing ring.
4. Remove four bolts and washers and lift off the oil pump cover and lift out the driven and idler gears.
  - (a) driven gear
  - (b) idler gear
5. Remove the oil pressure relief valve plug and sealing washer. Withdraw the relief valve spring and plunger.

### Overhaul the oil pump

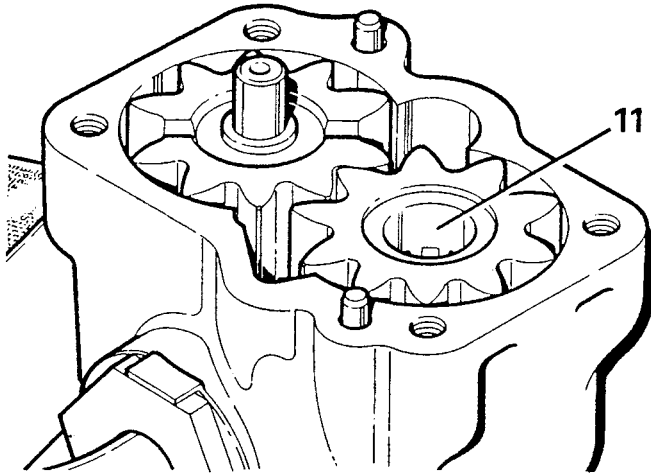
6. Examine the gears for wear, scores and pits. If the gears appear serviceable check for end-float as follows:
7. Clean the pump body and assemble the gears. Place a straight edge across the pump body face, as illustrated, and using a feeler gauge, measure the clearance between the body and gears and the backlash between the gears. The correct clearances are given in Data.



8. Gears must be renewed in pairs. A worn, but serviceable gear, must not be matched with a new one.
9. If necessary renew idler gear spindle by drilling-out the peened over end of the spindle so that the spindle can be withdrawn from the pump body. To ensure squareness when fitting the new spindle, assemble it into the pump body with the two gears. Fit the cover and secure with the four bolts. Support the pump body and peen over the end of the new spindle. Remove the cover and gears and check security of the spindle.

**Assemble the oil pump**

10. Fit the idler gear to the spindle.
11. Fit the driven gear with plain part of the bore uppermost. See illustration after instruction 9.

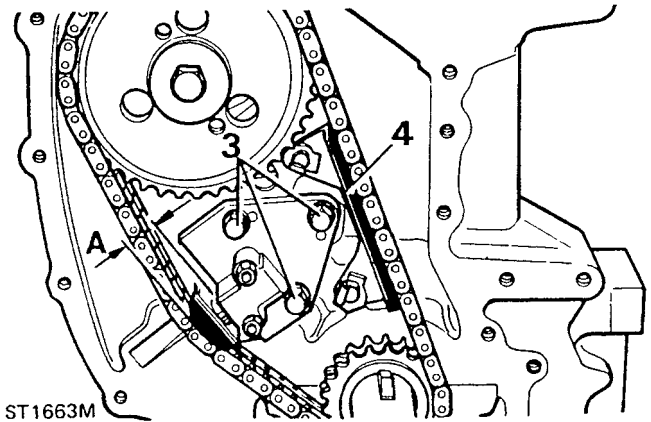


ST1637M

12. Smear the joint face of the body with jointing compound and fit the cover over the dowels and secure with the four bolts and spring washers.
13. Hold relief valve bore vertically and insert the plunger with the solid end first. Fit the spring, sealing washer and plug.
14. Fit the oil strainer sealing ring to the pump body followed by the lock washer and strainer. Tighten the strainer retaining nut so that when fitted the strainer is positioned parallel to the sump baffle plate. Secure the nut with the lock washer tab.

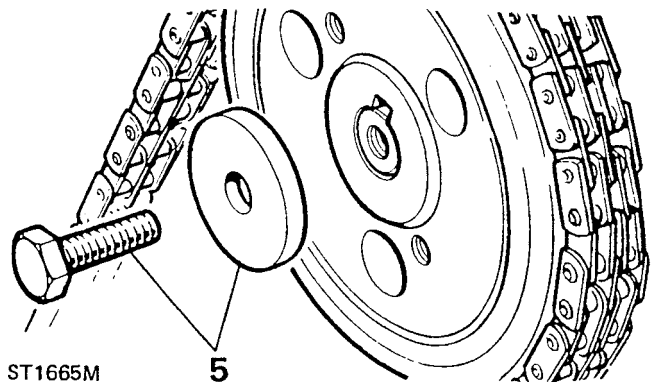
**REMOVE AND OVERHAUL THE TIMING CHAIN SPROCKETS AND TENSIONER**

1. Remove the bolts and withdraw the timing cover.
2. Before removing the timing chain tensioner check dimension 'A', which with a new chain and sprockets should be 14,22 mm (0.5 in) approximately. This will give an indication of chain wear. The dimension for a fully worn chain is 27 mm (1.06 in).
3. Remove the three bolts and whilst holding the pad inwards, to prevent it falling apart, remove the tensioner assembly.
4. Remove timing chain damper.



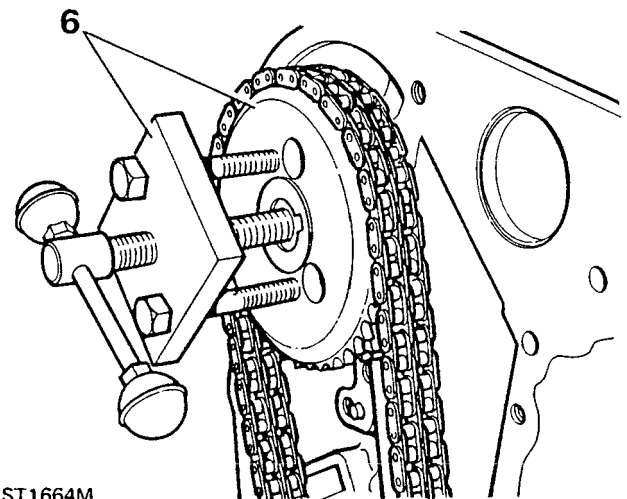
ST1663M

5. Remove the camshaft sprocket retaining bolt and washer.



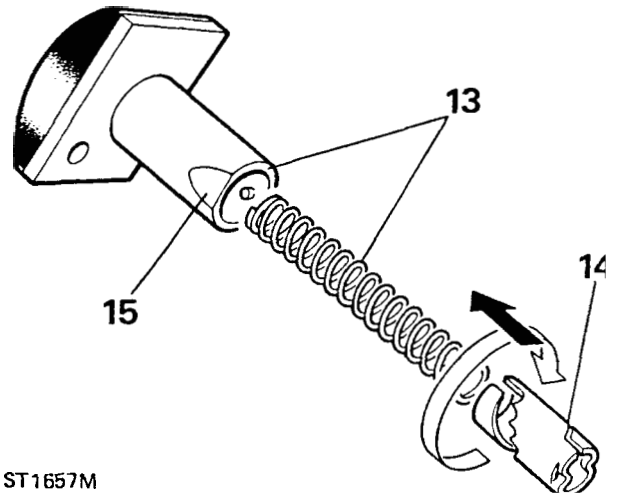
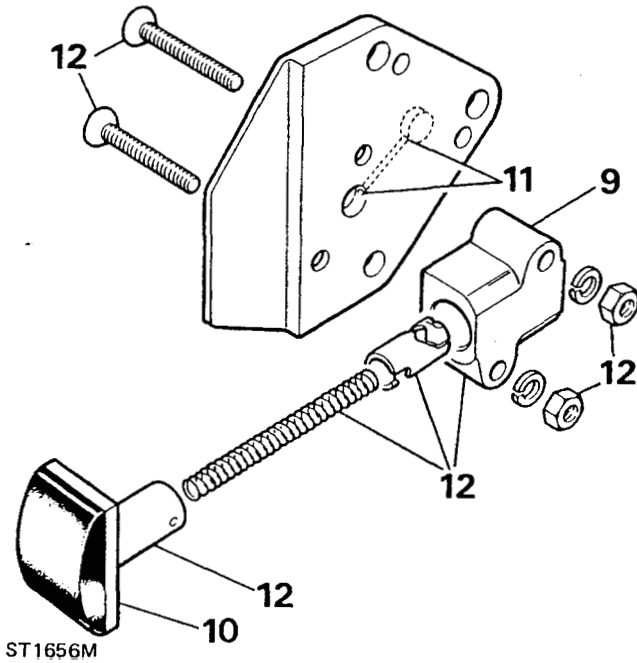
ST1665M

6. Withdraw the camshaft sprocket together with the timing chain and crankshaft sprocket. If necessary use special tool 507231.

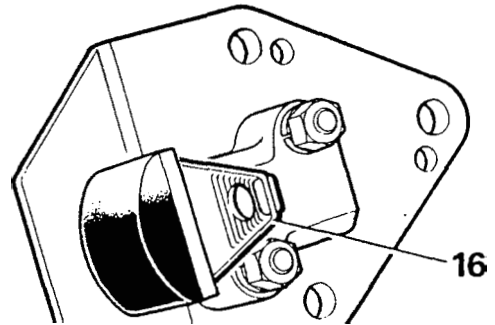


ST1664M

7. Examine the sprockets and discard if the teeth are worn.
8. Dismantle the tensioner assembly and discard if **any** of the parts are worn.
9. Examine the tensioner body and check that the oil inlet hole is clear.
10. Examine the slipper and check that the oil outlet hole is clear.
11. Check that the oil inlet and exit oil hole in the tensioner mounting plate is clear.



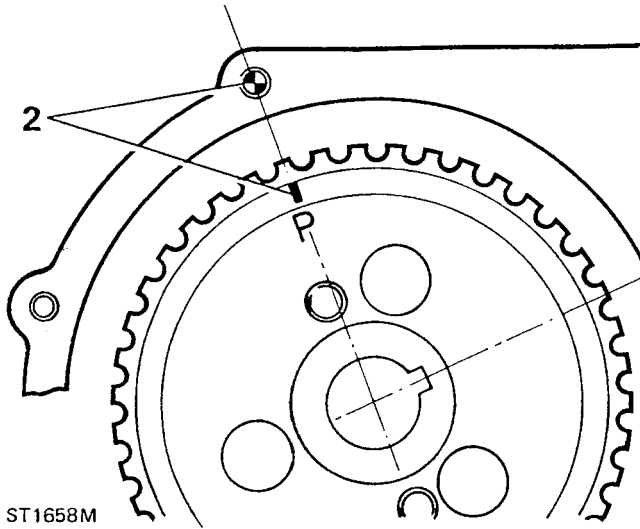
16. To prevent the tensioner releasing, insert a spacer approximately 2.3 mm thick between the tensioner body and back of the slipper prior to fitting to engine.



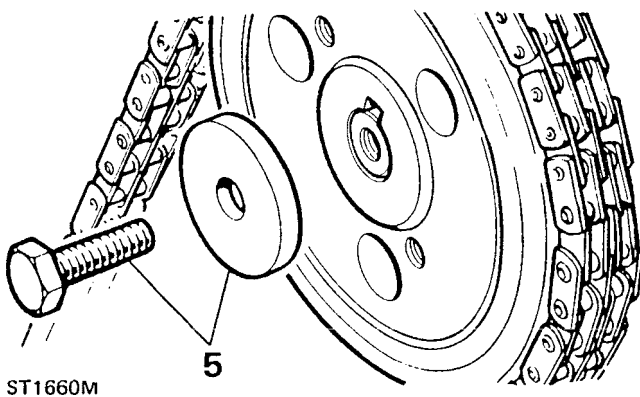
12. Assemble the tensioner **body** to the mounting plate with the two socket headed screws, spring washers and nuts.
13. Insert the spring into the slipper bore.
14. Fit the ratchet over the spring and against spring pressure, insert the ratchet into the slipper bore so that the groove in the ratchet locates over the small dowel inside the slipper bore. Push and turn the ratchet clockwise until it locks in the bore.
15. Insert the slipper assembly into the tensioner **body** ensuring that the small flat on the slipper shaft faces the mounting plate.

**VALVE TIMING**

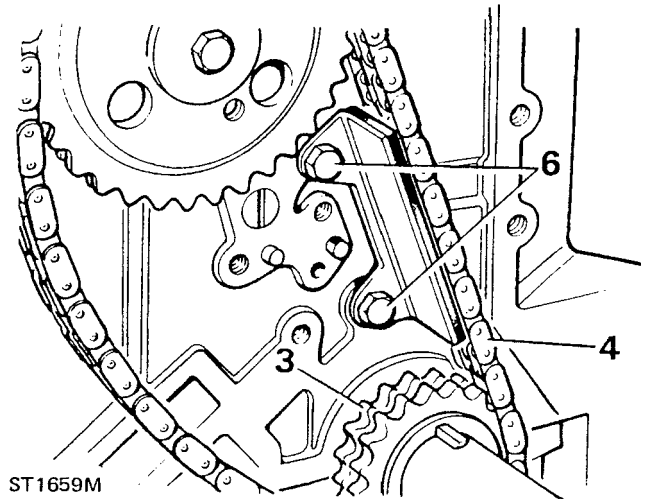
1. Check that numbers one and four pistons are still at T.D.C. and without disturbing the crankshaft, remove the pulley and timing cover.
2. Fit the camshaft sprocket temporarily and rotate the camshaft in a clockwise direction until the line on the tooth, also marked with a letter 'P' is in line with the top stud hole on the cylinder block as illustrated.



3. Remove the camshaft sprocket.
4. Encircle the camshaft and crankshaft sprockets with the timing chain and keeping it taut on the drive side and with the large shoulder of the crankshaft sprocket towards the cylinder block, fit the sprockets and chain assembly to the engine.
5. Secure the camshaft sprocket to the camshaft with a new special micro encapsulated treated bolt and tighten to the correct torque figure.

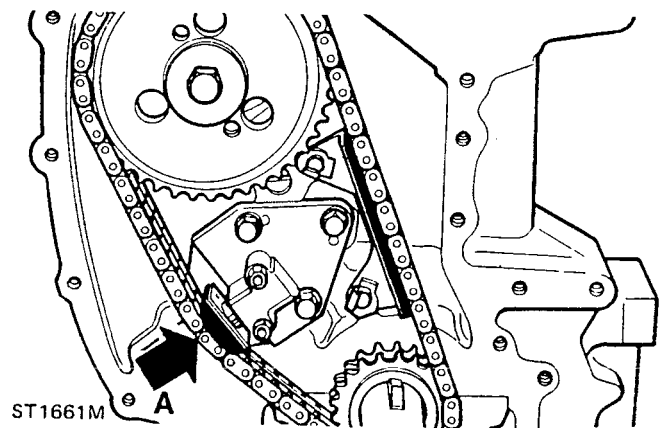


6. Fit and adjust the timing chain damper so that there is a maximum clearance of 0,25 mm (0.010 in) between the timing chain and damper. Tighten the retaining bolts and secure with new lock tabs.



**FIT TIMING CHAIN TENSIONER**

1. Fit the timing chain tensioner and mounting plate assembly to the cylinder block locating it over the two dowels.
2. Secure the assembly with the three bolts and evenly tighten.
3. Remove the spacer and to release the ratchet, to tension the chain, press the pad at point 'A'.



**RENEW EXHAUST VALVE SEAT INSERTS**

1. Hold the cylinder head firmly in a vice, wear protective goggles and grind the old insert away until thin enough to be cracked and prised out. Take care not to damage the insert pocket.
2. Remove any burrs and swarf from the pocket. Failure to do this could cause the new insert to crack when being fitted.

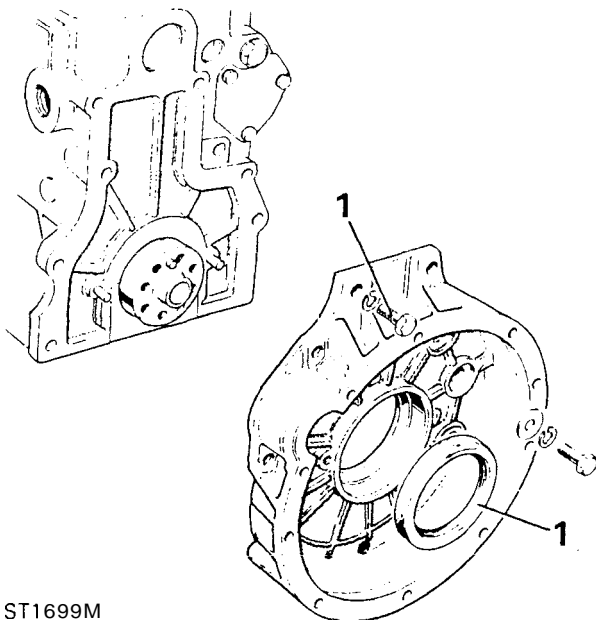
**NOTE:** Since no special tool is available for fitting a new insert, it is recommended that this work is entrusted to a cylinder head overhaul specialist.

**FITTING PISTONS AND CONNECTING RODS**

The deletion of the oil spray hole in the connecting rod precludes the necessity of fitting this towards the camshaft side of the engine. See page 18 instruction 5.

**REMOVE AND REFIT FLYWHEEL HOUSING AND REAR MAIN OIL SEAL**

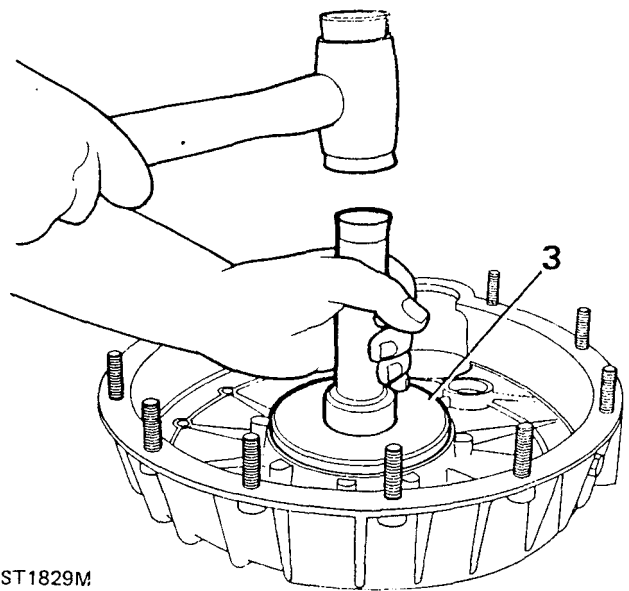
1. Remove the eight bolts securing the flywheel housing to the cylinder block and remove the housing and rear main bearing oil seal.



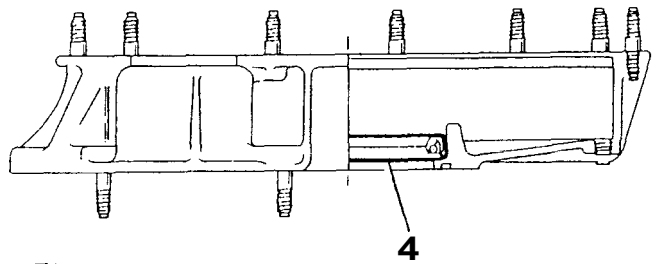
ST1699M

**Fit rear main oil seal and flywheel housing**

2. Check that the crankshaft oil seal journal is undamaged and clean. Make sure the seal housing is clean and dry and free from burrs. Do not touch the seal lip and ensure that the outside diameter is clean and dry.
3. The P.T.F.E seal Part No ETC 5369 which should be used is supplied with a former to maintain the correct shape and must not be removed until the seal is to be fitted.
4. Using special seal replacer 18G134-11 and with the lip side leading drive-in the seal as far as the tool allows. If the tool is not available fit the seal to the bottom of the housing to ensure squareness.



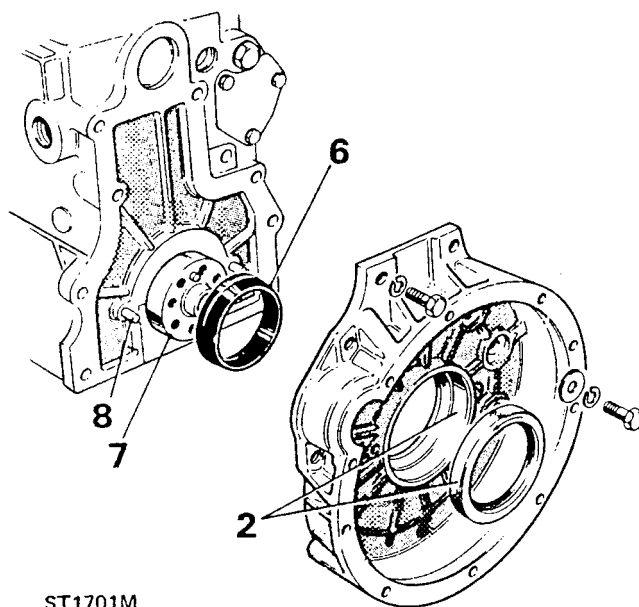
ST1829M



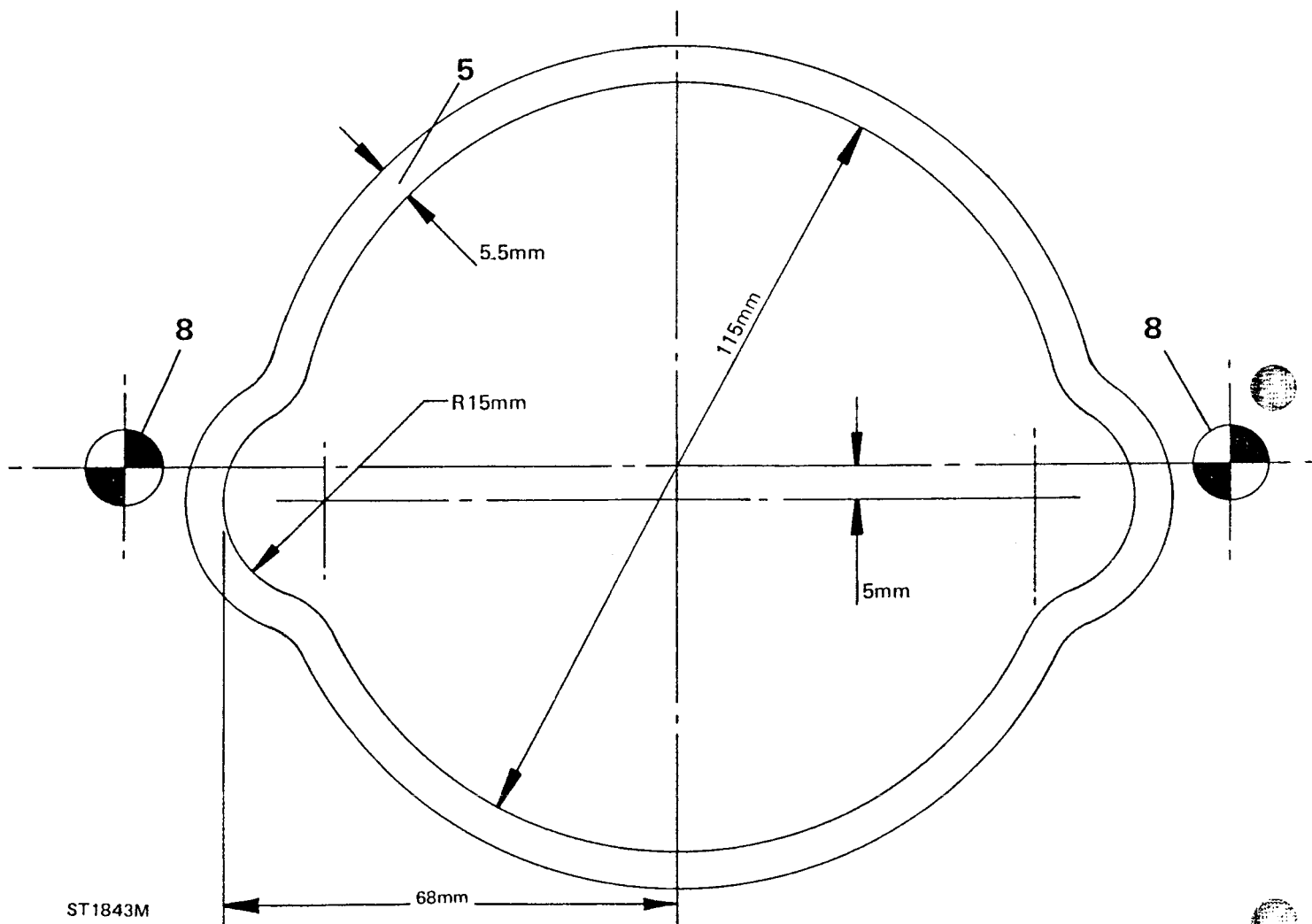
ST1842M

# 12 2.5 LITRE PETROL ENGINE

5. Apply a bead of Hylogrip 2000 sealant to the rear face of the flywheel housing to the dimensions and configuration as illustrated below. The illustration has been produced full size so that a template may be made to facilitate the application of the sealant. The bead should be 5,5 mm wide and 0,25 mm thick.
6. Examine the seal guide number 18G 1344 and repair any damage that could destroy the seal lip.
7. Lubricate the outside diameter of the seal guide and the seal journal with concentrated 'Oildag' in a 25% solution with clean engine oil.
8. Place the seal guide on the crankshaft flange and, using the two dowels protruding from the cylinder block rear face as a guide to ensure initial squareness, fit the flywheel housing and remove the seal guide. Secure the flywheel housing evenly tightening the retaining bolts.



ST1701M

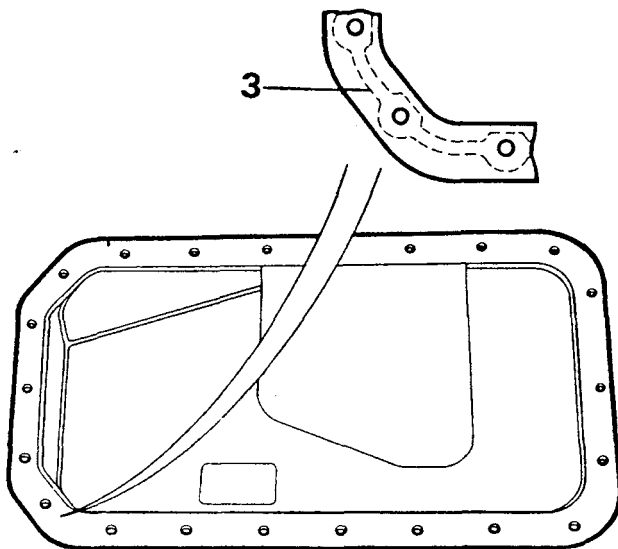


ST1843M

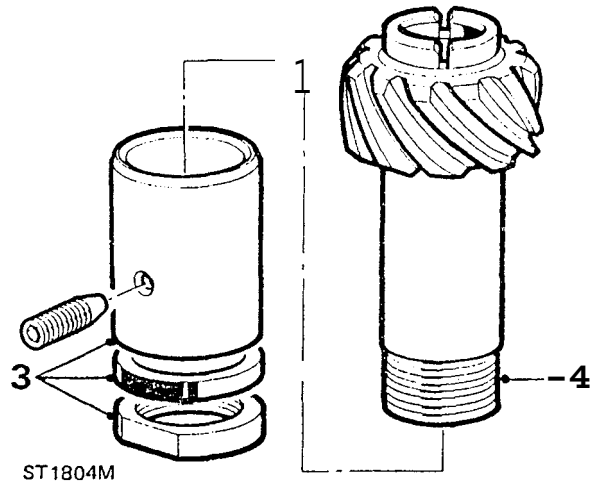
### FITTING SUMP

1. Clean the **sump** and cylinder block mating faces.
2. Apply a bead of RTV HYLOSILL 102 black approximately 7 mm wide to the cylinder block or sump mating face.
3. Fit the sump within 30 minutes of applying sealant and secure with the bolts and tighten evenly to the correct torque.

**NOTE:** RTV Liquid Sealant is available under part number RTC 3254 from Land Rover Parts and Equipment Ltd.



ST1836M

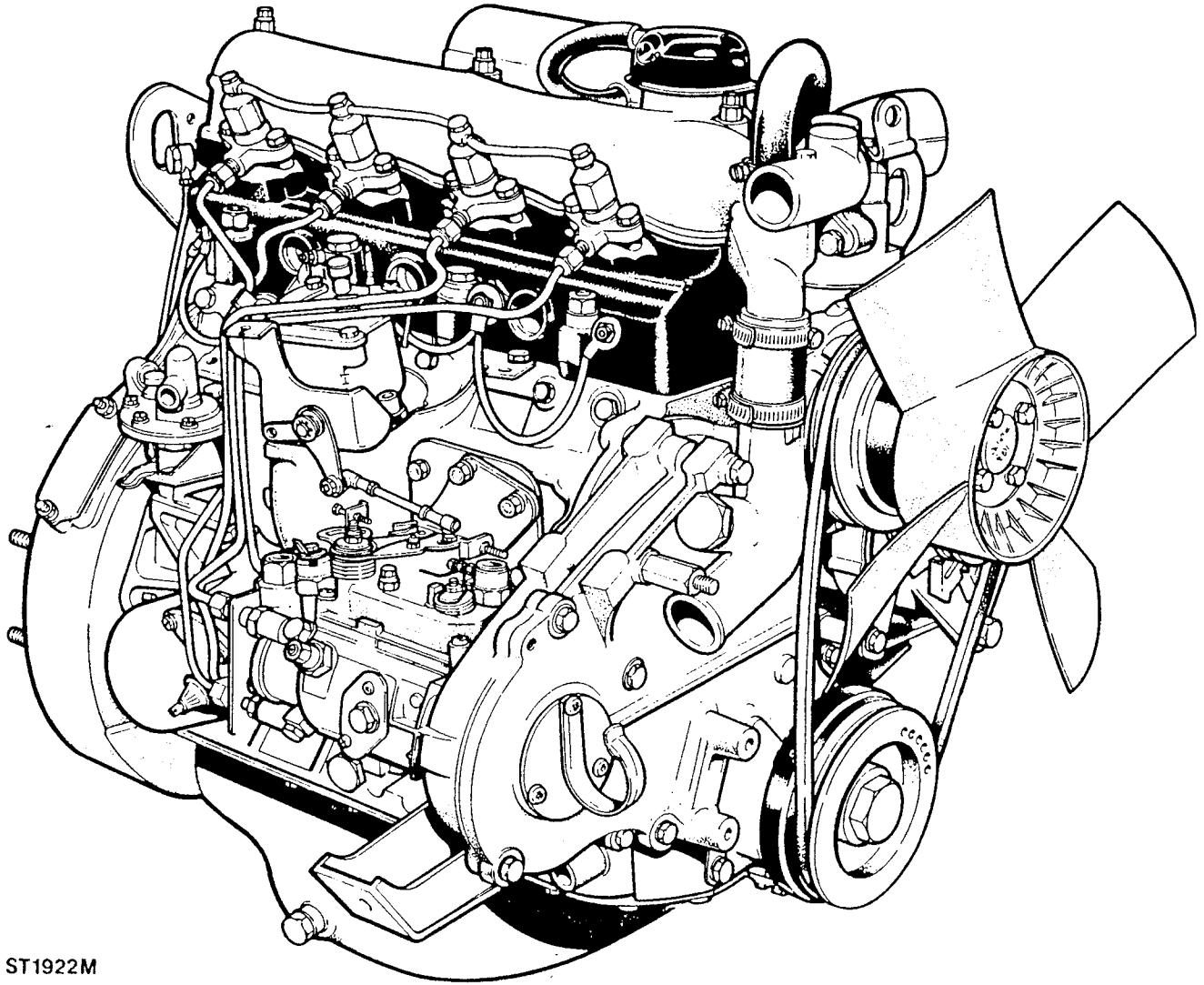


ST1804M

5. The gear should revolve freely in the bush with a clearance of 0,051 to 0,203 mm (0,001 to 0,007 in) between **thrust** washer and bush.

### SKEW GEAR

1. To renew the bush, hold the gear firmly in a vice without damaging the teeth. If possible insert a scrap drive shaft in the gear internal splines and grip the shaft.
2. Turn the locknut clockwise (left-hand thread) to remove and withdraw the thrust washer and bush.
3. Fit a new bush removing any burrs before hand and ensure that the location hole is towards the lower end of the gear.
4. Fit a new thrust washer, if the original is worn or scored. **Apply** Loctite 601 to the thread and fit the locknut turning anti-clockwise and tighten to 27 - 34 Nm (20 - 25 lbf. ft).



ST1922M

2.5 LITRE DIESEL ENGINE



**DISMANTLE AND OVERHAUL****Special tools:**

- 274400 — Drift inlet valve guides
- 274401 — Drift exhaust valve guides
- 600959 — Drift exhaust valve guide
- 601508 — Drift inlet valve guide
- MS621 — Seal cutter
- 530625 — Insert replacer
- RO605022 — Clutch centralising tool
- 270304 — Cork-seal guide
- 18G 1344 — Seal guide - rear main bearing
- 18G 134-11 — Seal replacer rear main oil seal
- 530102A — Crankshaft nut spanner
- 18G 1457/1 — Dist. pump remover
- 18G 1464/2/6 — Crankshaft pulley remover
- 18G 1456 — Crankshaft oil seal replacer
- 18G 1482 — Camshaft oil seal replacer
- 18G 1458 — Dist. pump timing tool
- MS47 — Press
- 18G705-1A — Collets
- LST107 — Flywheel timing pin

**REMOVE ANCILLIARY EQUIPMENT**

Remove the engine from the vehicle. Clean the exterior and in the interests of safety and efficient working, secure the engine to a recognised engine stand.

Before commencing, make a careful note of the position of brackets, clips, harnesses, pipes, hoses, filters and other miscellaneous items to facilitate re-assembly.

Removal of the following components is a reversal of the fitting procedure described in engine assembly.

1. Remove the alternator and mounting brackets.
2. Remove the power steering pump and bracket.
3. Remove the fan and pulley.
4. Remove the inlet and exhaust manifolds.
5. Disconnect and remove the fuel supply pipes from the injectors and D.P.S. pump and cover the ports.
6. Disconnect coolant by-pass hose from the water pump, release the seven bolts and remove the water pump.
7. Drain the sump and remove the dipstick.
8. Remove the starter motor.
9. Restrain the flywheel, remove the crankshaft pulley bolt and withdraw the pulley.
10. Evenly slacken and remove the clutch retaining bolts and withdraw the clutch assembly and centre plate.
11. Remove the two bolts and remove the oil filter assembly complete from the cylinder block. Unscrew the filter element and discard.
12. Remove the six bolts and withdraw the rear side plate complete with fuel pump.

**REMOVE AND OVERHAUL CYLINDER HEAD****Remove the cylinder head**

1. Remove injectors complete with spill rail.
2. Disconnect the heater plug electrical connections.
3. Remove the engine lifting brackets.
4. Disconnect oil gallery pipe at rear of engine.
5. Remove three bolts and lift-off the thermostat housing, elbow and thermostat.
6. Remove the rocker cover and slacken the tappet screw lock nuts. Turn the adjusting screws to release them from the push rods.
7. Remove the rocker shaft retaining bolts, lift-off the rocker shaft assembly, invert it and secure it to the rocker cover studs to prevent the assembly from falling apart, see instruction 25, page 34 2.25 litre Petrol and Diesel engine.
8. Withdraw the push rods and retain them in numbered sequence.
9. Evenly slacken the remaining cylinder head retaining bolts and lift-off the cylinder head.
10. Remove the engine lifting eyes.
11. Using valve spring compressor 276102 or a suitable alternative, remove the valve and spring assemblies keeping them identified with their original locations for possible refitting.
12. Discard the valve spring and valve guide oil seals. Remove carbon deposits from the valves and combustion chambers and degrease all parts ready for examination.

**Examine components**

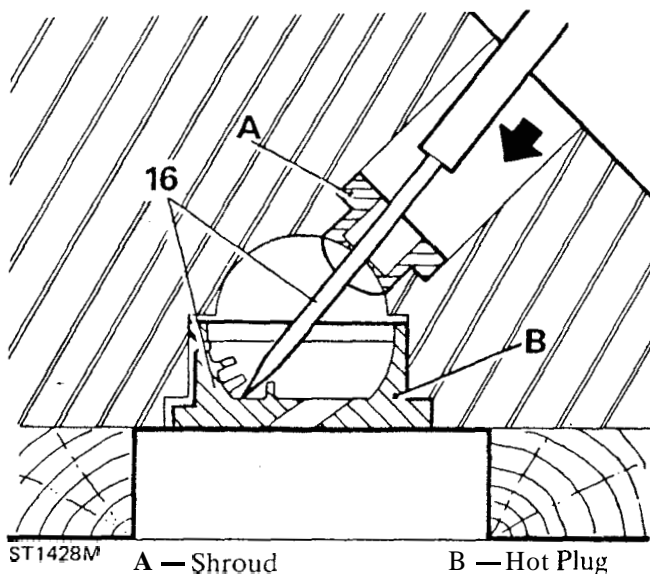
13. Examine the cylinder head for cracks and distortion.
14. Burnt, pitted and pocketed seats must be repaired.
15. In addition, worn or damaged valve seats should be renewed, as described later.

**Hot plugs and injector shrouds — examine and renew**

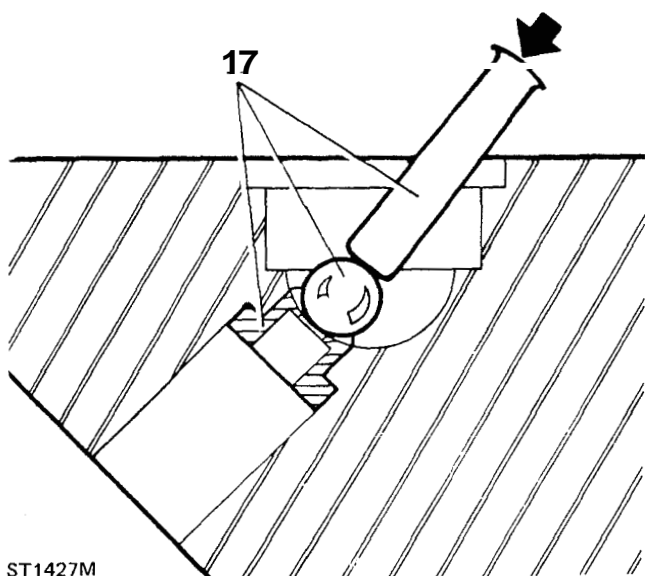
When carrying out normal top overhaul work on the cylinder head it is not necessary to remove either the injector shrouds or the hot plugs.

Small surface cracks in the hot plug, extending from the opening to approximately 8,0 mm (0.312 in) in length can be ignored. However, if any severe cracks appear on the face of the hot plugs before attempting to remove it, closely inspect the cylinder head for signs of cracks, particularly between the inlet and exhaust valve seats. Such cracking indicates that the engine has overheated, usually through lack of coolant, and the cylinder head should be scrapped.

16. To remove a hot plug support the cylinder head, face downwards on two pieces of timber and insert a thin soft metal drift through the injector shroud throat and tap the hot plug from the inside. Once removed, a faulty hot plug cannot be restored and must be scrapped.

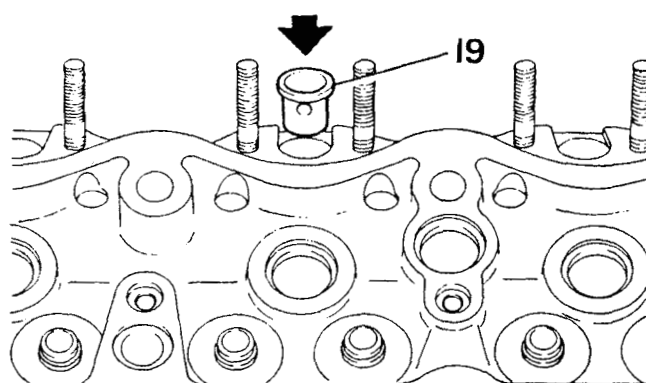


17. If the injector shroud is damaged using a 13 mm (1.05 in) ball bearing and drift, drift the shroud out towards the injector bore.



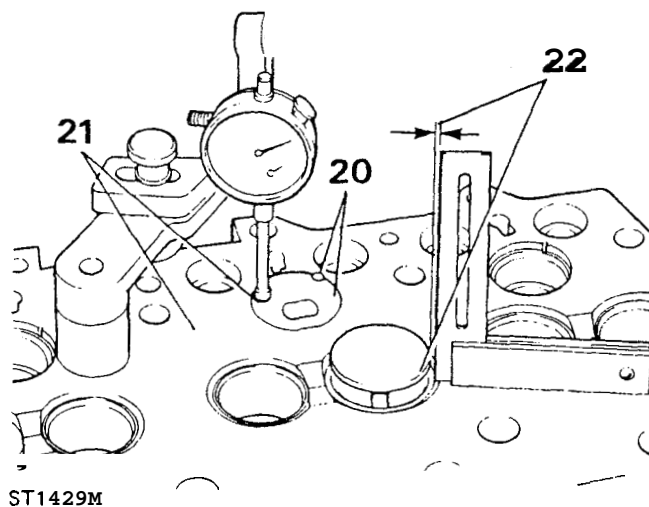
**Fitting shrouds**

18. Thoroughly clean out the combustion chamber. The hole in the side of the injector shroud is for manufacturing purposes only but at the same time can be used as a guide when refitting the shroud.
19. Turn the cylinder head face down. Smear a little oil on the shroud and insert into the cylinder head with the hole pointing towards the centre of the cylinder head, and drift into position.



**Fitting hot plugs**

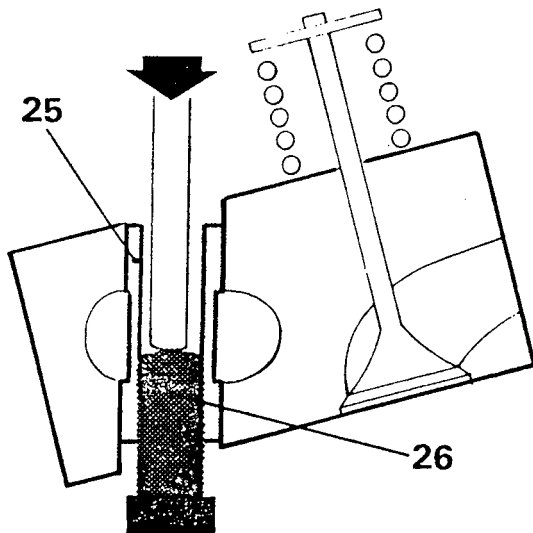
20. Fit the hot plugs by tapping with a hide-faced mallet, and locate with a new roll pin. If the hot plugs are loose in the cylinder head they may be retained with a little grease.
21. When fitted, the hot plugs must be checked with a dial test indicator to ensure that they do not protrude above the level of the cylinder head face more than 0,76 mm (0.003 in) and are not recessed below the level of the cylinder head face more than 0.025 mm (0.001 in).



22. Check the valve guides for wear by inserting a new valve in the appropriate guide 8 mm above the seat. If movement across the head exceeds 0,15 mm (0.006 in) renew the guide.
23. Inspect the valves and discard any that are burnt, bent or distorted. Check the stems for wear by inserting a new guide. If wear is excessive, discard the valve. Valve faces that are pitted or ridged but otherwise serviceable may be refaced.
24. Renew push rods that are bent or have worn or scored ball or socket ends.

Whilst this is rarely necessary the procedure is nevertheless as follows:

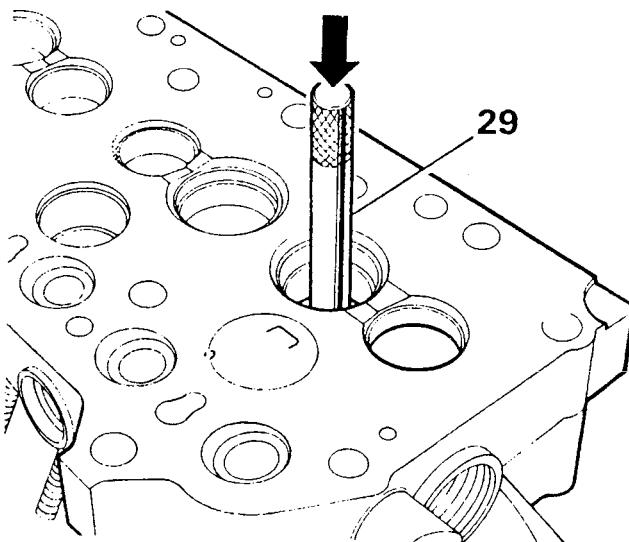
25. Using an 8 mm taper tap, cut a thread 30 mm (1,2 in) deep in the combustion face end of the tube to be removed.
26. Screw an appropriate bolt into the tube and press out the tube as illustrated.
27. Smear both ends of a new tube with silicone rubber sealant and press it into the cylinder head.



ST1444M

### Renew valve guides

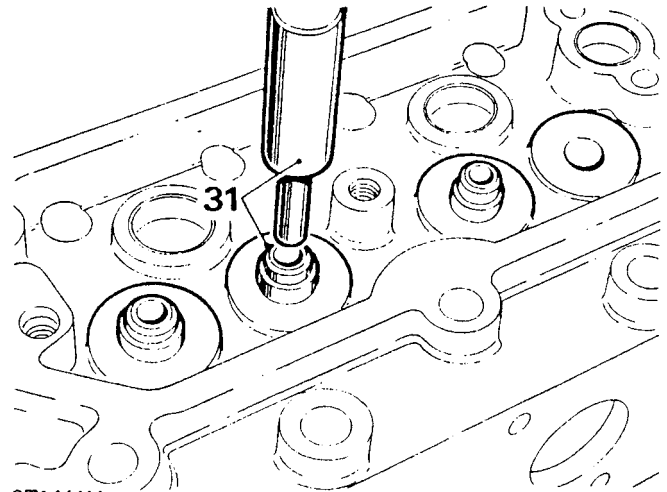
28. Support the cylinder head, combustion chamber uppermost on pieces of timber of sufficient thickness to allow clearance for the valve guides to be driven out.
29. Using special drift 274400 for inlet guides and 274401 for exhaust guides or suitable alternatives drive out the old guides from the combustion face side.



ST1438M

chambers face downwards. Since the inlet and exhaust valve guides are dimensionally different it is important that the correct guides are fitted to the appropriate ports.

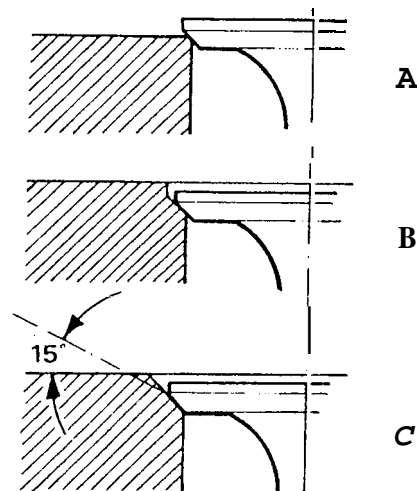
31. Lubricate new guides with engine oil and using special drift 600959 for the exhaust and 601508 for the inlet valve guides or suitable alternatives, drive in the new guides until the shoulder is flush with the casting.



ST1441M

### Reface cylinder head valve seats

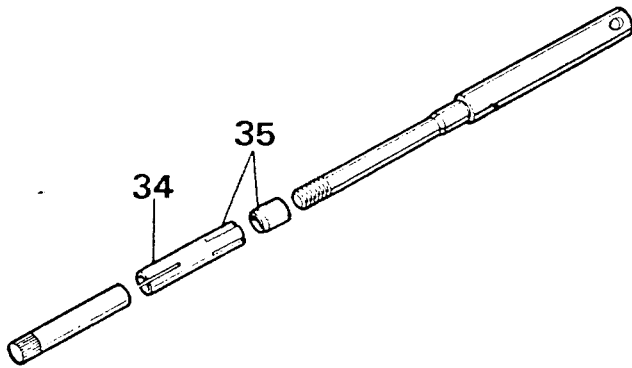
32. Damaged or worn valve seats can be refaced provided they are not abnormally wide due to repeated refacing operations. See instruction 43.



ST668M

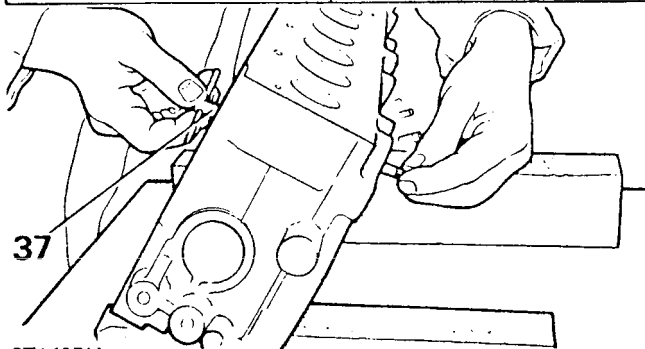
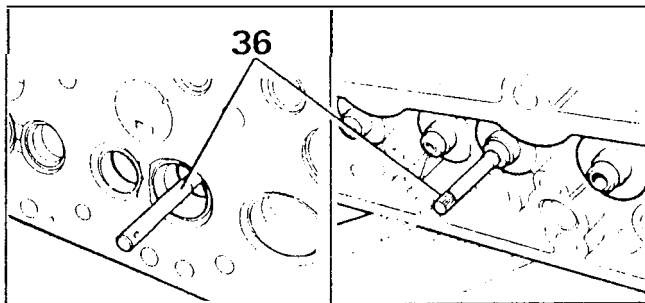
- A. Correctly seated valve
- B. Undesirable condition
- C. Method of rectification

- 33. The special set of hand tools recommended for refacing include expandable pilots that fit tightly into new or worn guides to ensure that the valve seat is concentric with valve guide. The refacing tool has tungsten carbide cutters and can be used to cut a seat in a new exhaust seat insert.
- 34. Select the correct expandable collet for the valve guide concerned i.e. 8 mm for inlet guides and 8,5 mm for exhaust.
- 35. Loosely assemble the collet, expander and nuts.



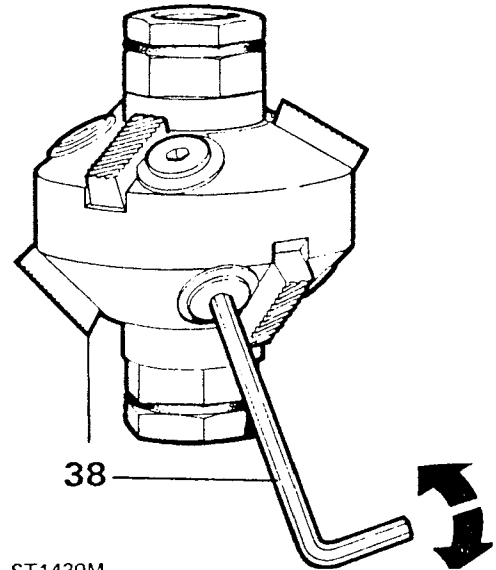
ST1440M

- 36. Insert the assembled pilot into the valve guide from the combustion face side of the cylinder head until the shoulder contacts the valve guide and the whole of the collet is inside the valve guide.
- 37. Expand the collet in the guide by turning the tommy bar clockwise whilst holding the knurled nut.



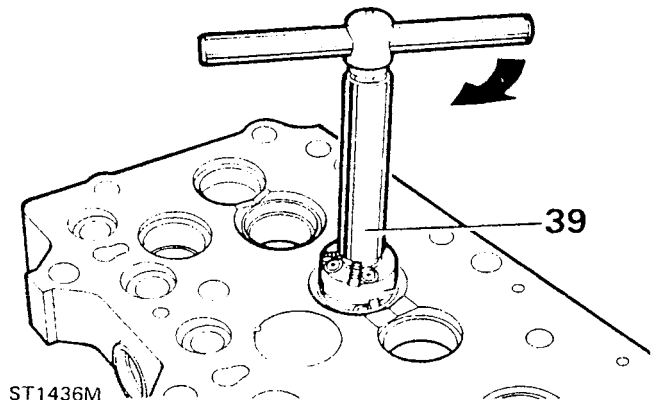
ST1437M

- 38. Use cutter MS 621 and ensure that the cutter blades are correctly fitted to the cutter head with the angled end of the blade downwards facing the work, as illustrated. Check that the cutter blades are adjusted so that the middle of the blade contacts the area of material to be cut. Use the key provided in the hand set MS 76.



ST1439M

- 39. Fit the wrench to the cutter head and turn clockwise using only very light pressure. Continue cutting to approximately the centre of the existing seat.



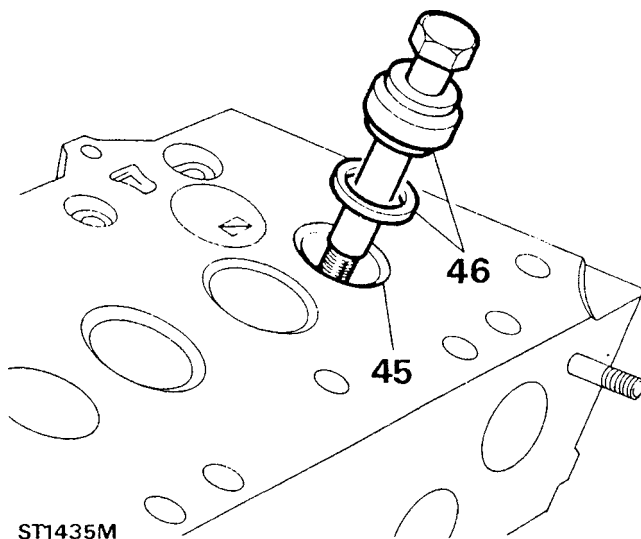
ST1436M

- 40. To check the effectiveness of the cutting operation use engineers' blue or a feeler gauge made from cellophane.
- 41. Smear a small quantity of engineers' blue round the valve seat and revolve a properly ground valve against the seat. A continuous fine line should appear round the valve. If there is a gap of not more than 0.2 mm it can be corrected by lapping.

42. Alternatively, insert a strip of cellophane between the valve and seat, hold the valve down by the stein and slowly pull out the cellophane. If there is drag the seal is satisfactory in that spot. Repeat this in at least eight places. Lapping-in will correct a small open spot.
43. After several trueing-up or lapping-in operations valve seats may have an excessive width which can be reduced by obtaining special correction cutters which narrow the seat by removing metal from the top and bottom of the seat. A 60° cutter is recommended for bottom narrowing and for top narrowing use a 30° cutter.

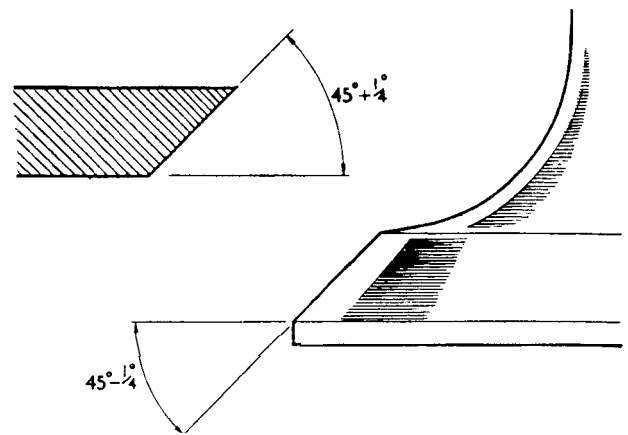
#### Renew inlet and exhaust seat inserts

44. Hold the cylinder head firmly in a vice, wear protective goggles and grind the old insert away until thin enough to be cracked and prised out. Take care not to damage the insert pocket.
45. Remove any burrs and swarf from the pocket. Failure to do this could cause the new insert to crack when being fitted.
46. Assemble the new exhaust insert to the replacer tool number 530625 so that the chamfered edge of the insert is leading. Using a suitable bolt and nut draw the insert into the cylinder head pocket.
47. Since no tool is available for the inlet seat, use a suitable adaptor to press-in the new seat. Cut a new 45° seat using cutter MS 621.



#### Reface valve seats

48. Valves that are satisfactory for further service can be refaced. This operation should be carried out using a valve grinding machine. Only the minimum of material should be removed from the valve face to avoid thinning of the valve edge. The valve is refaced correctly when all pits are removed and the face concentric with the stem.

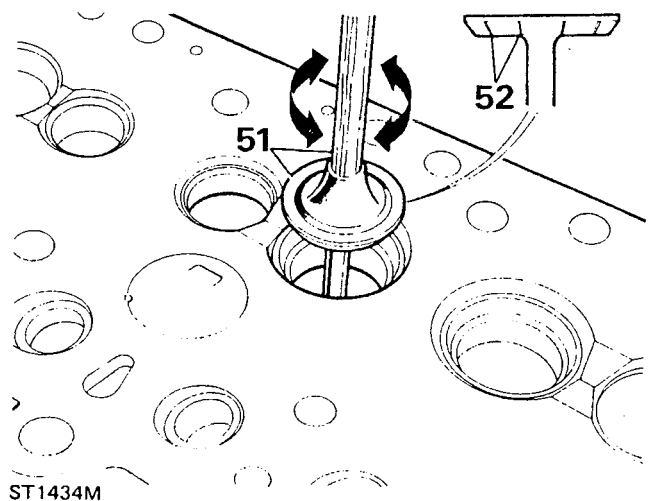


Inlet valve seat face —  $45^{\circ} + \frac{1}{4}^{\circ}$   
 Exhaust valve seat face —  $45^{\circ} + \frac{1}{4}^{\circ}$

Inlet valve face —  $45^{\circ} - \frac{1}{4}^{\circ}$   
 Exhaust valve face —  $45^{\circ} - \frac{1}{4}^{\circ}$

#### Lap-in valves

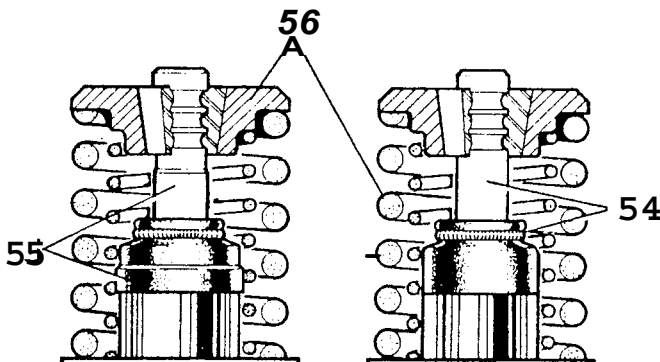
49. To ensure a gas tight seal between the valve face and valve seat it is necessary to lap-in the appropriate valve to its seat. It is essential to keep the valve identified with its seat once the lapping-in operation has been completed.
50. Unless the faces to be lapped are in poor condition it should only be necessary to use fine valve lapping paste. Smear a small quantity of paste on the valve face and lubricate the valve stem with engine oil.
51. Insert the valve in the appropriate guide and using a suction type valve lapping tool employ a light reciprocating action while occasionally lifting the valve off its seat and turning it so that the valve returns to a different position on the seat.



52. Continue the operation until a continuous matt grey band round the valve face is obtained. To check that the lapping operation is successful, wipe off the valve paste from the valve and seat and make a series of pencil lines across the valve face. Insert the valve into the guide and while pressing the valve onto the seat revolve the valve a quarter turn a few times. If all the pencil lines are cut through no further lapping is required.
53. Wash all traces of grinding paste from the valves and cylinder head seats.

#### Assembly valves to cylinder head

54. Insert the inlet valves into the guides and fit new oil seals with the plain exterior. Ensure that the seal locates in the groove in the valve guide.
55. Insert the exhaust valves and fit the oil seals with the stepped exterior. They are larger than the inlet valve seals.
56. Fit the double valve spring and cup to each valve in turn and using valve spring compressor, 276102 or a suitable alternative, secure the assembly with the multi-groove butting cotters.

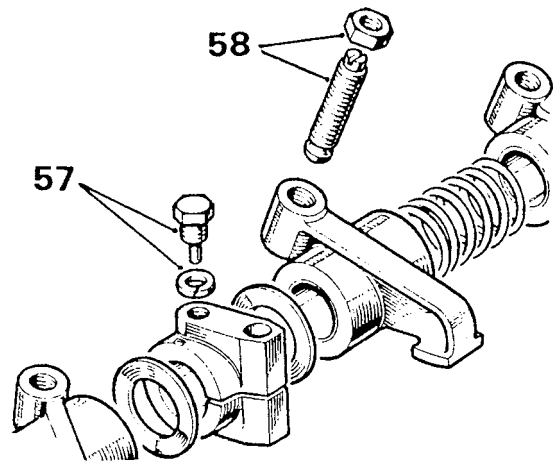


ST1430M

#### OVERHAUL ROCKER SHAFT ASSEMBLY

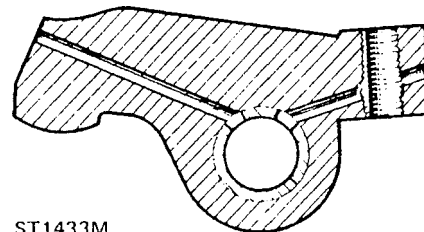
##### Dismantle and inspection

57. Remove the locating screw and washer from the number two rocker bracket and withdraw all the components from the rocker shaft.
58. Remove the locknuts and adjustment screws from the rockers.



ST1431M

59. Examine the rocker shaft for wear and discard if the bearing surface is worn more than 0,025 mm (0.001 in).
60. Inspect the rockers and discard if the pads are worn. It is not permissible to grind pads in an attempt to reclaim the rockers.
61. Renew bushes if the clearance between shaft and bush is in excess of 0,101 to 0,127 mm (0.004 to 0.005 in).
62. Press in replacements ensuring that the pre-drilled oil holes coincide with the holes in the rockers. The following cross section of a rocker shows the oil drillings.



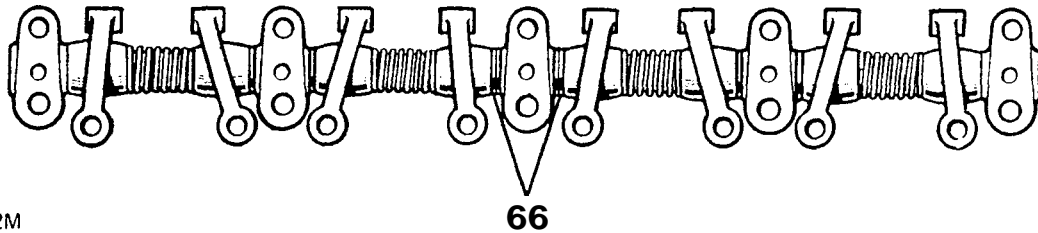
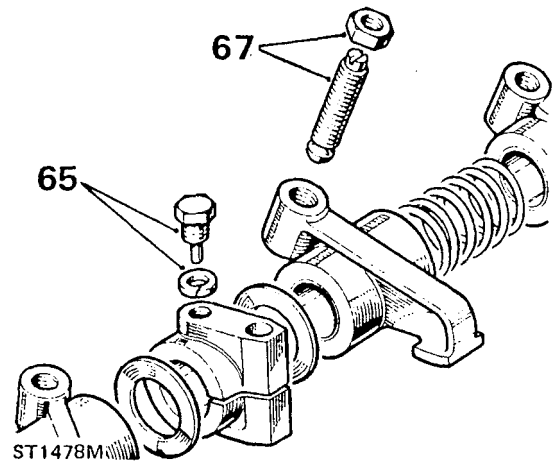
ST1433M

63. Using a  $\frac{17}{32}$  reamer 13,5 mm + 0,2 mm (0.530 in + 0.001 in) finish the bushes and clear swarf from the oil holes.
64. Examine the ball-end of the adjusting screws and discard any that are worn. Regrinding is not permissible. Check the threads for damage and that the oil relief drilling is clear.

##### Assemble rocker shaft assembly

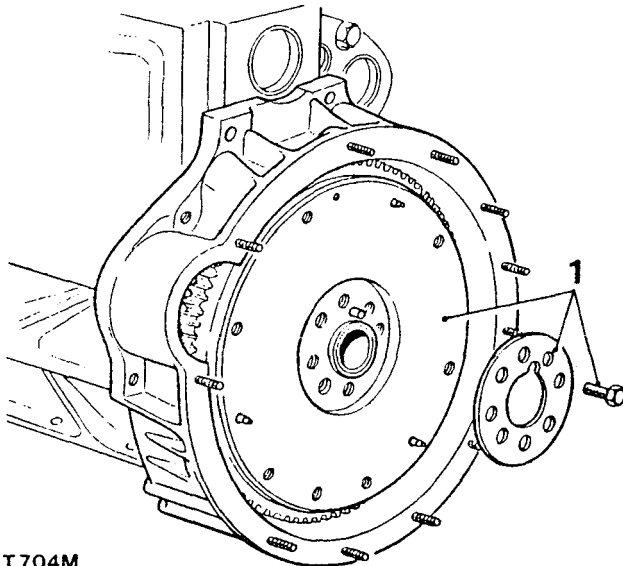
65. Check that the oil-ways in the rocker shaft are clear and fit number two rocker shaft bracket to the shaft and retain with the locating screw and washer.

66. Using new spacers and springs, assemble the rockers and brackets to the shaft as illustrated, ensuring that the rockers move freely on the shaft. Note that double spacers are fitted each side of the centre pedestal.
67. Fit the tappet adjustment screws and lock nuts to the rockers.
68. Invert the rocker assembly and locate it on the rocker cover to prevent it falling apart. Place the reconditioned cylinder head and rocker assembly to one side ready for fitting to the engine.



### REMOVE AND OVERHAUL THE FLYWHEEL

1. Remove the flywheel retaining bolts and withdraw the flywheel and reinforcing plate.



2. Wear or scores on the flywheel clutch face can be corrected by machining provided that the overall width of the flywheel is not reduced below 36,96 mm (1.453 in).
3. Check that the flywheel has not been previously machined.
4. Examine the ring gear teeth and if chipped or worn the gear can be renewed.

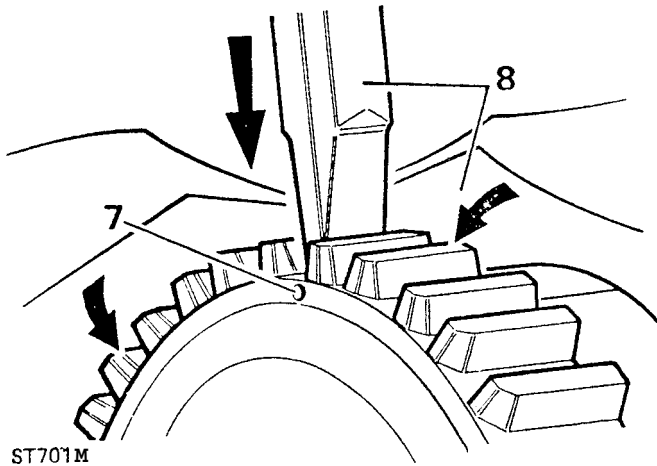
### Reface the flywheel

5. Remove the clutch location dowels.
6. Machine the flywheel over the complete clutch face removing only the minimum material necessary to achieve a smooth flat surface parallel with the crankshaft mating face and within the above width dimensions and fit new dowels.

### Renew the ring gear

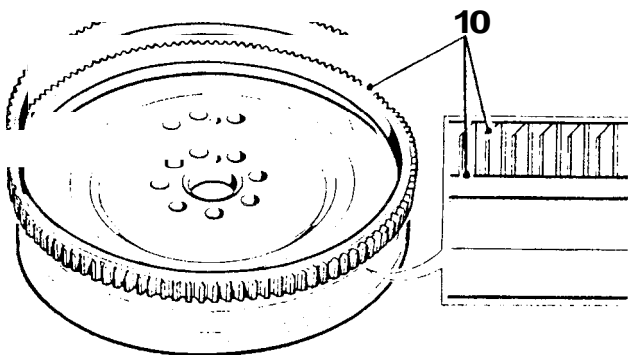
7. Drill a 8,0 mm ( $\frac{5}{16}$  in) hole between the root of any two teeth and the inner diameter of the starter ring deep enough to weaken the ring. Do not allow the drill to enter the flywheel.

8. Secure the flywheel in a soft jawed vice and cover it with a cloth to protect one from personal injury. Place a cold chisel above the drilled hole and strike it sharply to split the ring gear.



ST701M

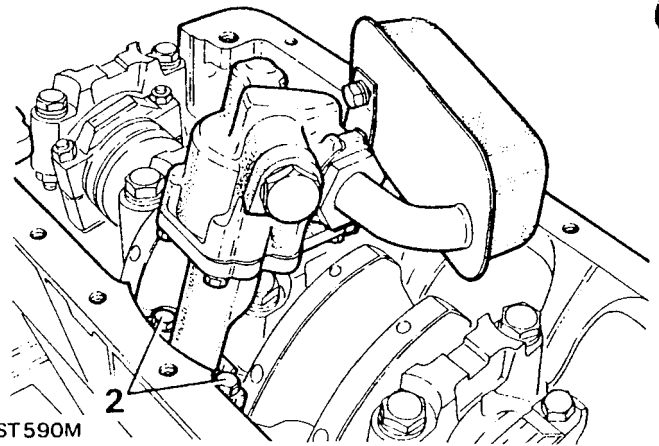
9. Heat the new ring gear uniformly to between 225°C and 250°C but do not exceed the higher figure.
10. Place the flywheel, clutch face down, on a flat surface and locate the heated flywheel with the square edge of teeth downward towards the flywheel clutch face and chamfered edge of the teeth uppermost.
11. Press the starter ring firmly against the flange until the ring contracts sufficiently to grip the flywheel. Allow the ring gear to cool naturally. Do not hasten cooling in anyway.



ST 928M

#### REMOVE AND OVERHAUL OIL PUMP — Early type

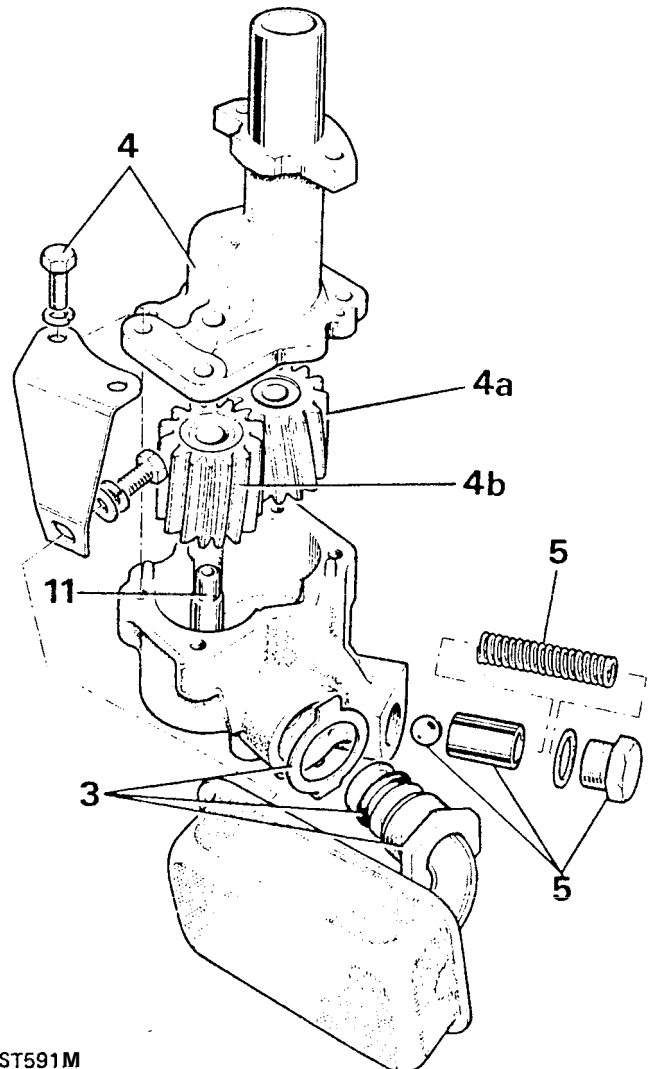
1. Remove the sump.
2. Bend back the lock washers and remove the two bolts securing the oil pump to the crankcase. Withdraw the oil pump complete with strainer and oil pump drive shaft.



ST590M

#### Dismantle oil pump

3. Bend back the lock washer and release the nut securing the strainer to the oil pump body and remove the strainer and sealing ring.
4. Remove four bolts and washers and lift off the oil pump cover and lift out the driven and idler gears.
  - (a) driven gear
  - (b) idler gear



ST591M

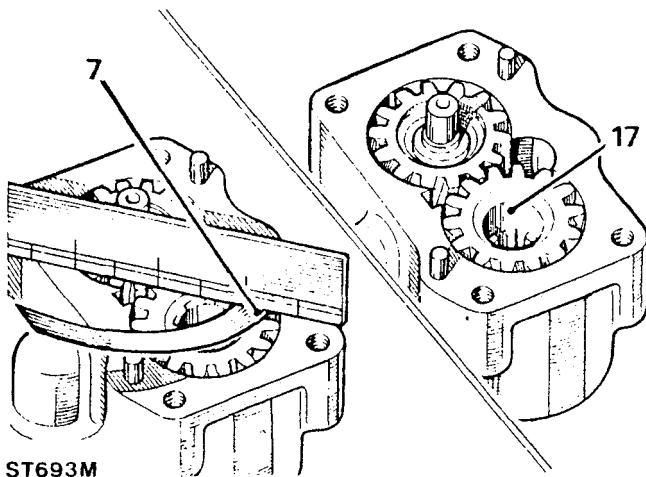


- Remove the oil pressure relief valve plug and sealing washer. Withdraw the relief valve spring, plunger and ball.

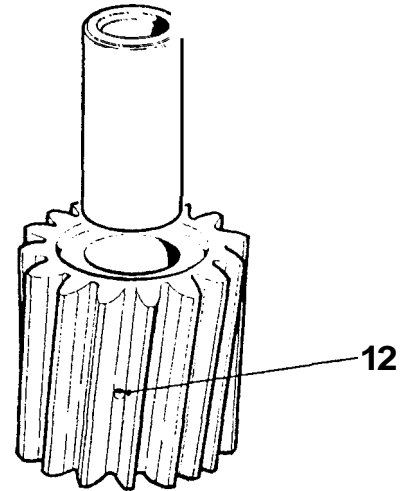
**NOTE: Later pumps have ten toothed gears and no relief valve ball.**

### Overhaul the oil pump

- Examine the gears for wear, scores and pits. If the gears appear serviceable check for end-float as follows:
- Clean the pump body and assemble the gears. Place a straight edge across the pump body face, as illustrated, and using a feeler gauge, measure the clearance between the body and gears. The correct clearances are as follows:
- Idler gear 0,07 to 0,015 mm (0.003 to 0.006 in).
- Driven gear 0,05 to 0,12 mm (0.002 to 0.005 in).

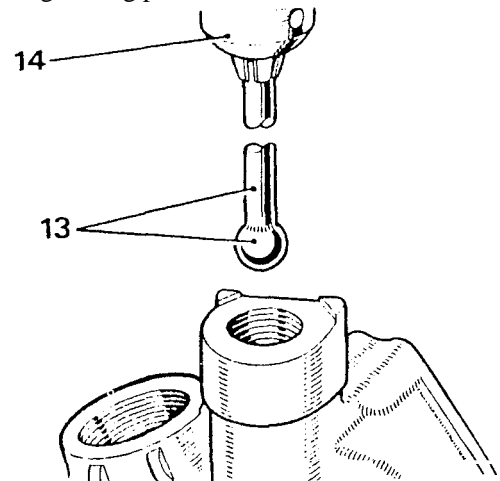


- Gears must be renewed in pairs. A worn, but serviceable gear, must not be matched with a new one.
- If necessary renew idler gear spindle by drilling-out the peened over end of the spindle so that the spindle can be withdrawn from the pump body. To ensure squareness when fitting the new spindle, assemble it into the pump body with the two gears. Fit the cover and secure with the four bolts. Support the pump body and peen over the end of the new spindle. Remove the cover and gears and check security of the spindle.
- If worn, remove the idler gear bush and press in a replacement. Drill the lubrication hole 3.17 mm (0.125 in) and ream the bush to 12,7 mm (0.500 in) diameter.



ST 911M

- A scored ball valve seat can be restored by using a locally made lapping tool by silver soldering a new ball (part number 3748) onto a length of suitable tube.
- Install the tube in a drill and lap-in using coarse grinding paste. Finally hand-lap the seat with fine paste using the same diabalo method as for lapping valves.
- Thoroughly wash the pump body to remove all traces of grinding paste.



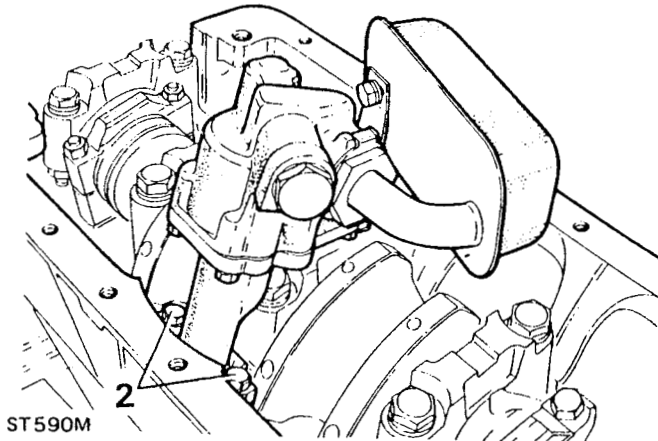
ST694M

### Assemble the oil pump

- Fit the idler gear to the spindle.
- Fit the driven gear with plain part of the bore uppermost. See illustration after instruction 9.
- Smear the joint face of the body with jointing compound and fit the cover over the dowels and the strainer bracket and secure with the four bolts and spring washers.
- Hold relief valve bore vertically and insert the ball followed by the plunger with the ball seat end first. Fit the spring, sealing washer and plug.
- Fit the oil strainer sealing ring to the pump body followed by the lock washer and strainer. Tighten the strainer retaining nut so that when fitted the strainer is positioned parallel to the sump baffle plate. Secure the nut with the lock washer tab.
- Secure the lower end of the bracket to the strainer with the single bolt, spring and plain washer.

**REMOVE AND OVERHAUL OIL PUMP — Later Type**

1. Remove the sump.
2. Bend back the lock washers and remove the two bolts securing the oil pump to the crankcase. Withdraw the oil pump complete with strainer and oil pump drive shaft.



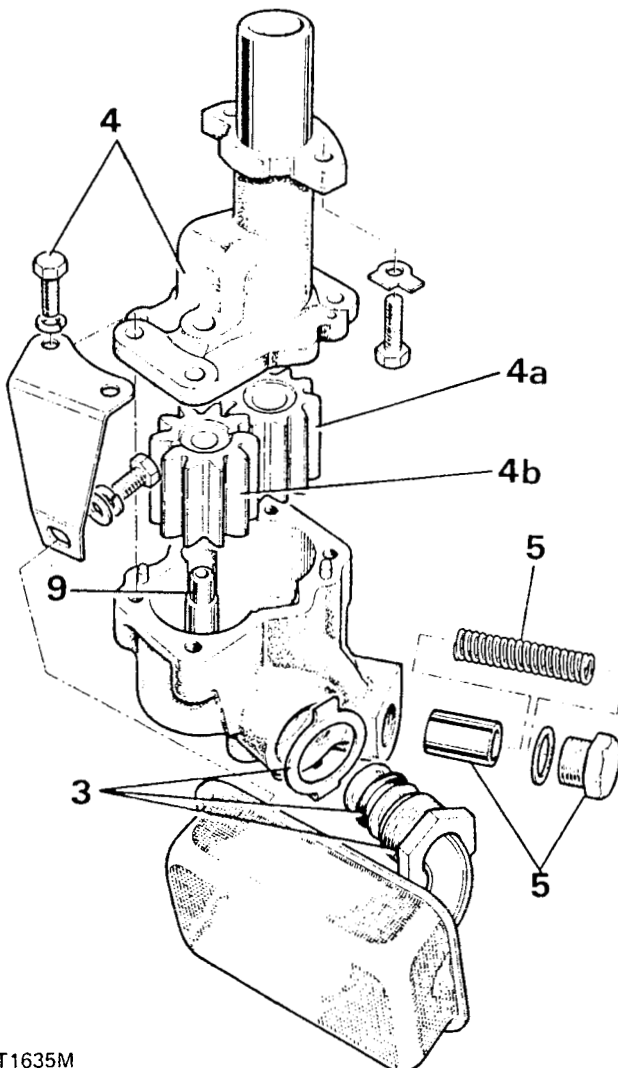
ST590M

**Dismantle oil pump**

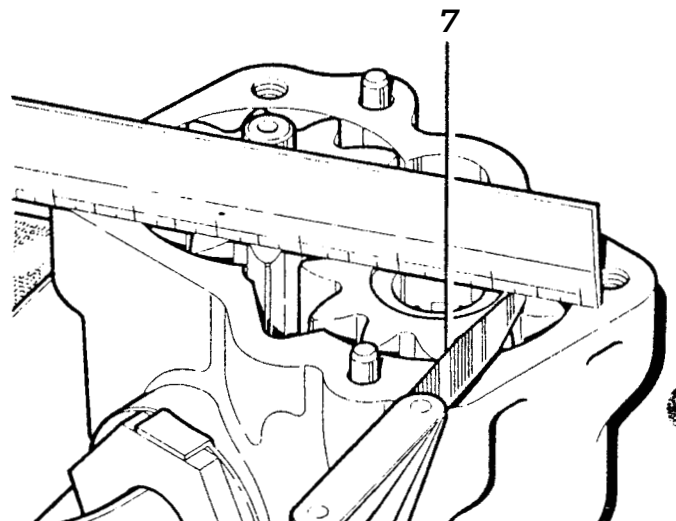
3. Bend back the lock washer and release the nut securing the strainer to the oil pump body and remove the strainer and scaling ring.
4. Remove four bolts and washers and lift off the oil pump cover and lift out the driven and idler gears.
  - (a) driven gear
  - (b) idler gear
5. Remove the oil pressure relief valve plug and sealing washer. Withdraw the relief valve spring and plunger.

**Overhaul the oil pump**

6. Examine the gears for wear, scores and pits. If the gears appear serviceable check far end-float as follows:
7. Clean the pump body and assemble the gears. Place a straight edge across the pump body face, as illustrated, and using a feeler gauge, measure the clearance between the body and gears. The correct clearances are given in the Data section 05 book one.



ST1635M



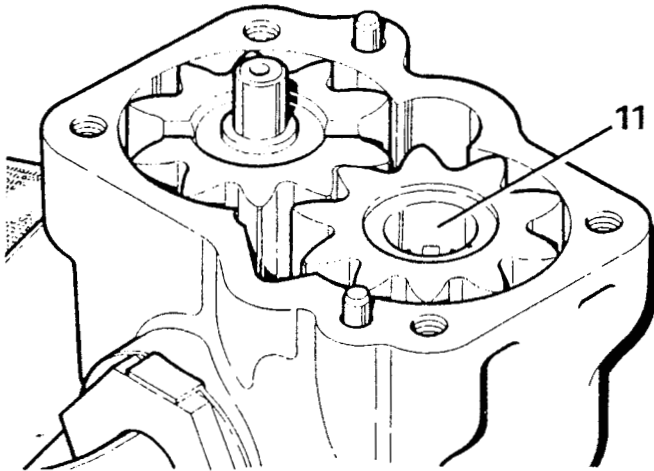
ST1636M

8. Gears must be renewed in pairs. A worn, but serviceable gear, must not be matched with a new one.
9. If necessary renew idler gear spindle by drilling-out the peened over end of the spindle so that the spindle can be withdrawn from the **pump** body. To ensure squareness when fitting the new spindle, assemble it into the pump body with the two gears. Fit the cover and secure with four bolts. Support the pump body and peen over the end of the new spindle. Remove the cover and gears and check security of the spindle.

continued

**Assemble the oil pump**

10. Fit the idler gear to the spindle.
11. Fit the driven gear with plain part of the bore uppermost.



ST1637M

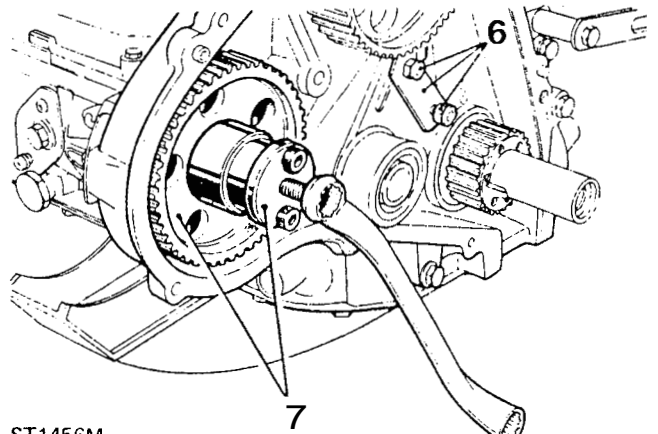
12. Smear the joint face of the body with jointing compound and fit the cover over the dowels and secure with the four bolts and spring washers.
13. Hold relief valve bore vertically and insert the plunger with the solid end first. Fit the spring, sealing washer and plug.
14. Fit the oil strainer sealing ring to the pump body followed by the lock washer and strainer. Tighten the strainer retaining nut so that when fitted the strainer is positioned parallel to the sump baffle plate. Secure the nut with the lock washer tab.

**REMOVE TIMING BELT, PULLEYS AND COVERS****Remove front cover**

1. Remove the four bolts and remove the front cover vent and wading plug bracket, gauze and gasket.
2. Remove nine timing cover bolts, but do not withdraw centre bolt from the cover since there is a fibre washer on the bolt behind the cover. Remove the cover and joint washer and retrieve the fibre washer.
3. Prise out the crankshaft seal.

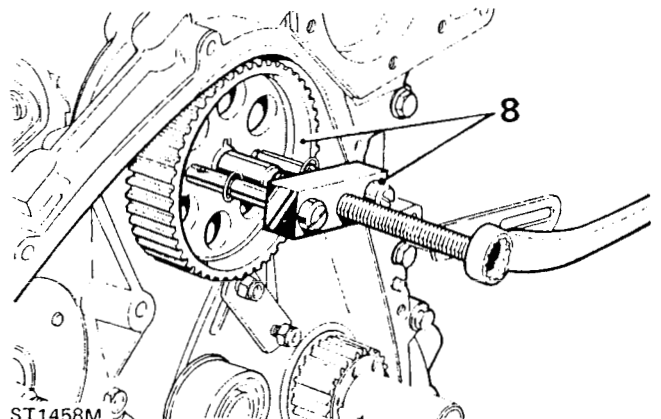
**Remove timing belt and pulleys**

4. Slacken and remove the camshaft retaining bolt, special washer and 'O' rings.
5. Slacken and remove the distributor pump timing pulley nut.
6. Slacken the belt tensioner clamp nuts and remove the belt. Remove the clamp nut and withdraw the tensioner assembly.
7. Use the centre part of special tool 18G1457/1 as illustrated, and withdraw the distributor pump pulley.



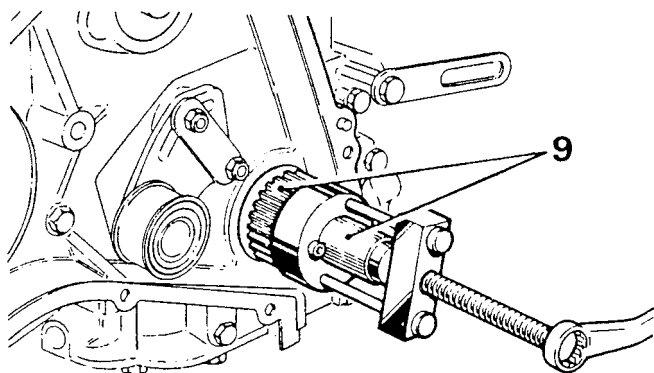
ST1456M

8. Use special puller tool 18G1464/2/6, as illustrated and withdraw the camshaft pulley.



ST1458M

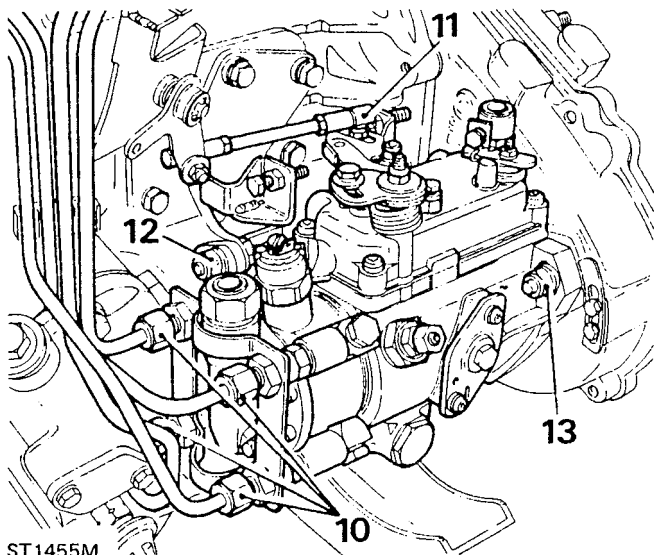
9. Withdraw the crankshaft pulley using complete tool 18G1464/2 and button 18G1464/5.



ST1457M

**Remove distributor pump (D.P.S. Pump)**

10. Remove the high and low pressure pipes from the D.P.S. pump and injectors. (If not already removed) and cover, not plug, the ports.
11. Disconnect the pump operating link from the lever on the bracket. (If not already removed).
12. Remove the nut and bolt securing the rear of the pump to the support bracket.
13. Remove the three nuts retaining the pump to the front cover and withdraw the pump and joint washer.



ST1455M

14. Remove the retaining bolts and remove the front cover and gaskets from the cylinder block. Prise out the old oil seals.

**KEY TO TIMING GEAR AND COVER ASSEMBLY**

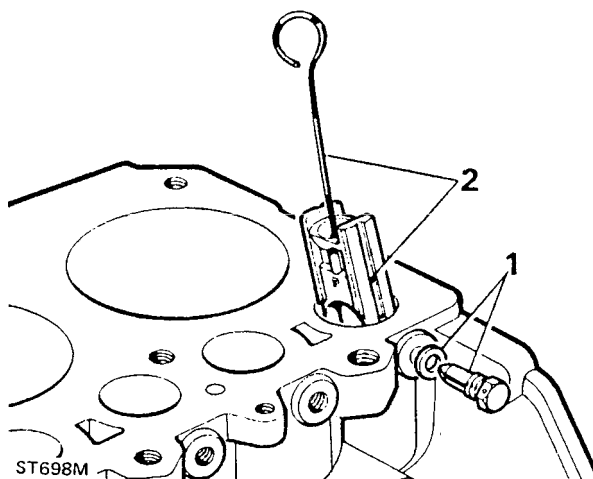
1. Fan blades
2. Spacer
3. Fan pulley
4. Special bolt — Later engines, starter dog early engines.
5. Crankshaft pulley
6. Wading plug
7. Timing cover vent
8. Inspection cover
9. Front cover plate
10. Front cover plate oil seal
11. Water pump
12. Water pump joint washer
13. Cover
14. Timing belt
15. D.P.S. pump pulley
16. Camshaft pulley
17. Jockey pulley (tensioner)
16. Coolant gallery joint washer
19. Front cover to cylinder block joint washer
20. Front cover plate joint washer
21. Camshaft front cover oil seal
22. Crankshaft cover oil seal
23. Triangular joint washer
24. Fibre washer

**REMOVE TAPPETS, ROLLERS AND GUIDES**

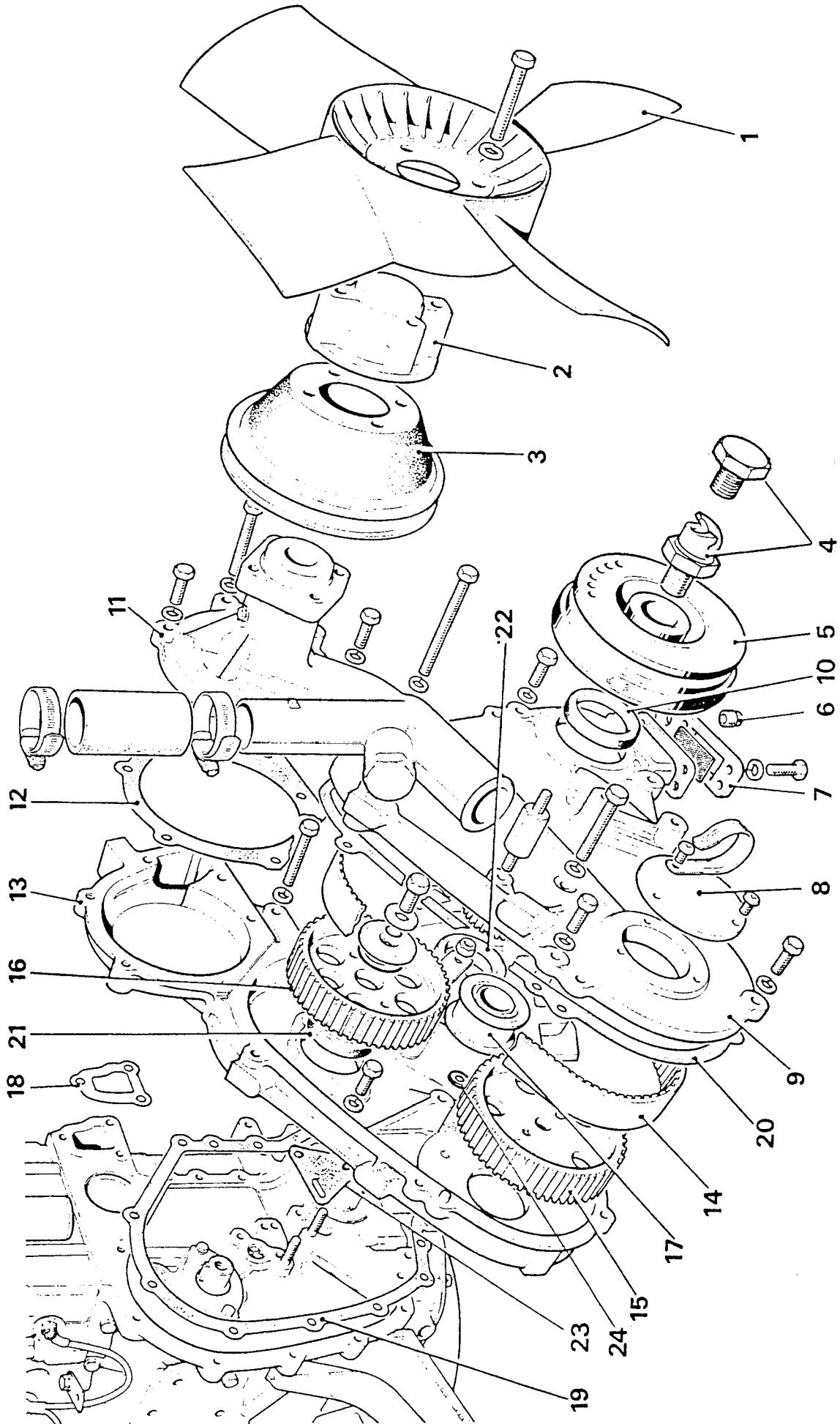
1. Remove the eight tappet guide locating bolts from the right-hand side of the cylinder block.

**CAUTION: Do not remove the tappet guides before the rollers otherwise the rollers may fall behind the camshaft.**

2. Using long nosed pliers or a suitable bent length of wire lift out the tappet slides and identify them with their respective guides for possible refitting.

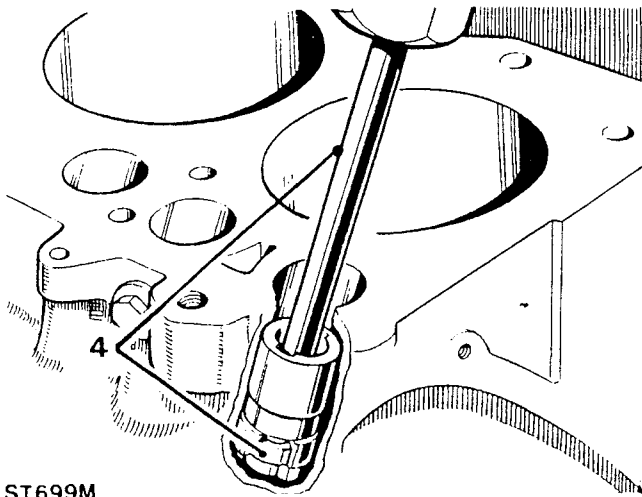


ST698M



ST599M

3. Lift out the tappet rollers and mark the side facing the front of the engine for possible reassembly.
4. Lift out the tappet guides and retain with their respective slides and rollers. If the guides are difficult to remove use special tool 530101A.
5. Carefully examine all parts and discard any that are worn or damaged.

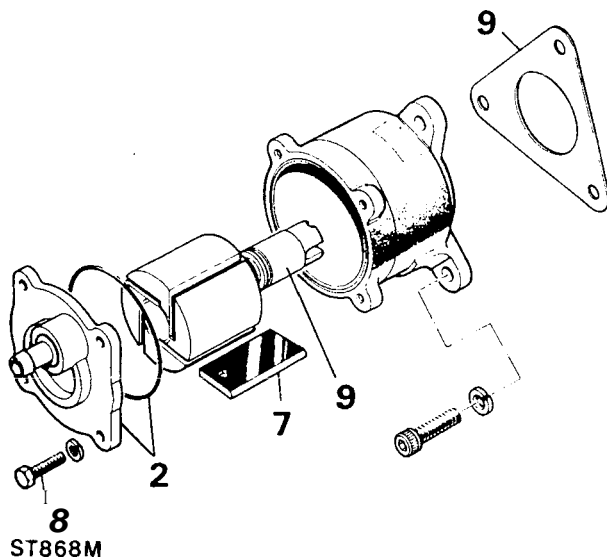


ST699M

### REMOVE AND OVERHAUL VACUUM PUMP

#### Dismantle

1. Remove the pump from the engine.
2. Remove the four bolts securing the end plate and withdraw the end plate and 'O' ring seal.
3. Tap the shaft-end of the rotor to remove it from the pump body.



ST868M

#### Examine

4. Inspect the components for wear and damage and renew as necessary.
5. To check the rotor to body clearance, fit the rotor to the body and with feeler gauges measure the clearance at the narrow point between the rotor and body. The correct clearance is 0,05 mm (0.002 in).
6. Check the clearance between the rotor and end plate by placing a straight across the body and with feeler gauges measure the clearance between the straight edge and rotor. The correct clearance should be 0,10 to 0,12 mm (0.004 to 0.005 in).

#### Assemble

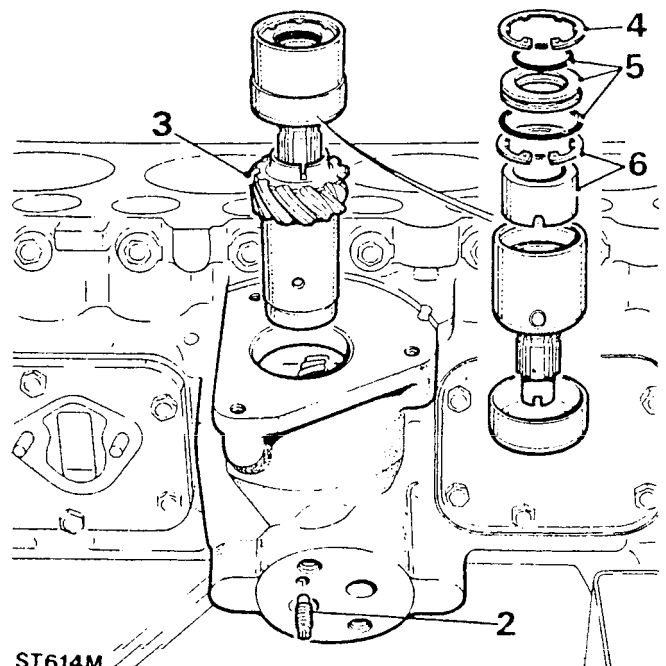
7. Fit the rotor blades to the rotor with the radius outwards and insert the rotor into the body.
8. Place a new 'O' ring seal in position in the body groove and fit the end plate and secure with the four bolts tightening evenly.
9. When fitting pump to engine use a new joint washer and ensure that the drive slot fits correctly over the coupling drive pin.

### REMOVE AND OVERHAUL SKEW GEAR COUPLING

The coupling can be overhauled without separating it from the skew gear.

#### Remove skew gear assembly

1. Remove the oil filter housing complete with filter and joint washer.
2. Remove the skew gear bush locating screw.
3. Using long-nosed pliers lift out the skew gear assembly.



ST614M

**Dismantle**

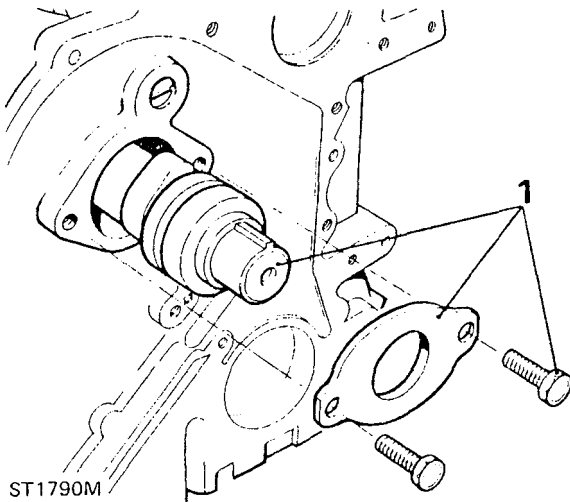
4. With circlip pliers remove the retaining circlip.
5. Withdraw the seal collar and remove the inner and outer seals.
6. Remove the lower circlip and withdraw the sleeve.

**Assemble**

7. Reassemble the coupling with any new parts necessary ensuring that the sleeve fits correctly over the lower cross-pin and secure with the circlip.
8. Lubricate and fit new seals to the collar and insert into the coupling and retain with the circlip. Make sure that the seals are properly located since damaged or misplaced seals could cause reduced engine oil pressure.

**REMOVE THE CAMSHAFT**

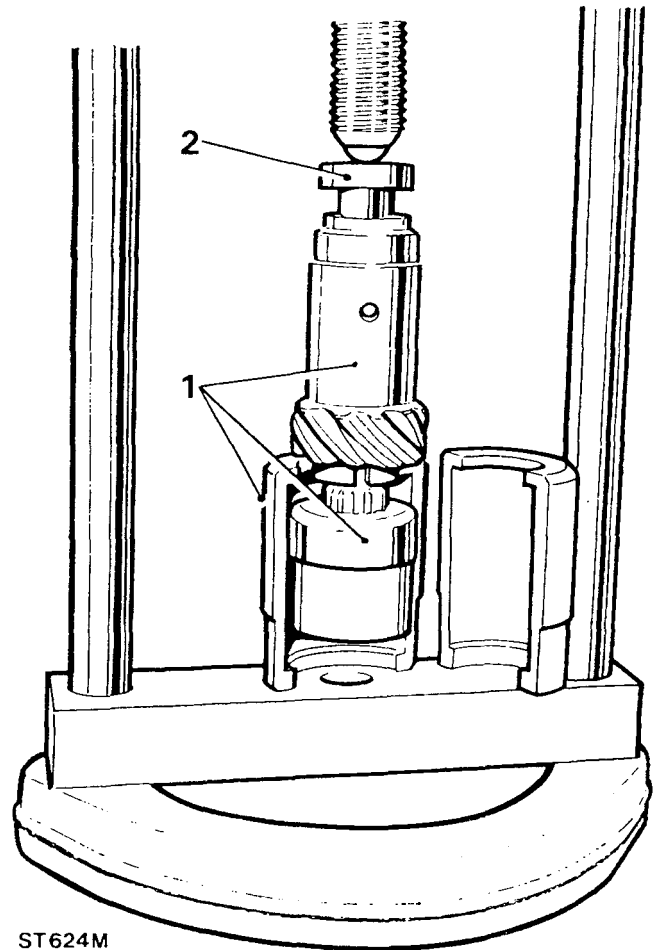
1. Since the camshaft sprocket has already been removed, remove the two bolts and the camshaft thrust plate and carefully withdraw the camshaft.

**Inspect the camshaft**

2. Discard the camshaft if any of the following visual defects are evident. Scored, worn, pitted or chipped cams. Worn, corroded and discoloured journals. Worn and chipped gear teeth.

**RENEW SKEW GEAR COUPLING****Dismantle**

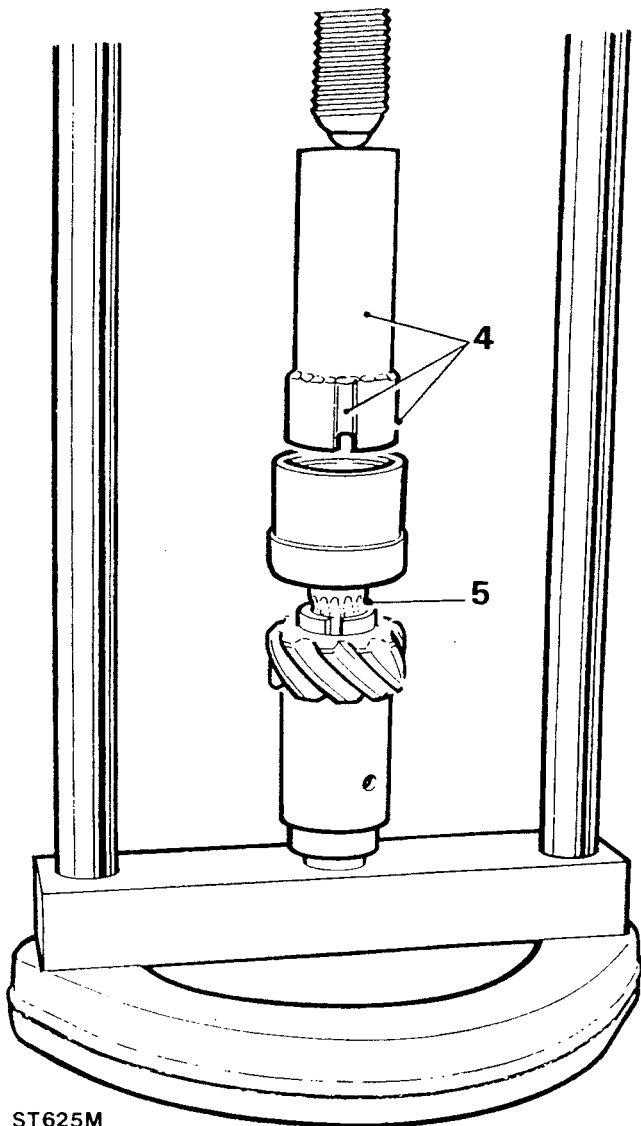
1. Position the skew gear and coupling assembly in a press and support it, as illustrated, with 18G705-1A or suitable metal bars.
2. Insert a suitable mandrel between the press ram and end of the coupling shaft and press out the coupling from the skew gear.

**Fit new coupling to skew gear**

3. Dismantle the new coupling, as described in 'Coupling Overhaul'. This is necessary, since in the assembled condition there is no suitable surface for the press tool to bear upon.

**NOTE:** See 2.5 litre petrol engine supplement for details of the latest skew gear bush retention.

- 4 Dismantle also the old coupling and use the sleeve to manufacture a suitable press tool. Use a round section file to increase the depth of the cross-pin slot so that it will not bear upon the cross-pin when used to press in the new coupling. Weld a suitable length of steel bar or tube to the sleeve to complete the tool.
- 5 Fill the annular groove round the splines of the coupling with silicone rubber sealant.
- 6 Assemble the skew gear and coupling with the manufactured press tool in position inside the coupling and place under the press and slowly press in the new coupling. Clean off surplus sealant and swarf from the internal splines of the skew gear.



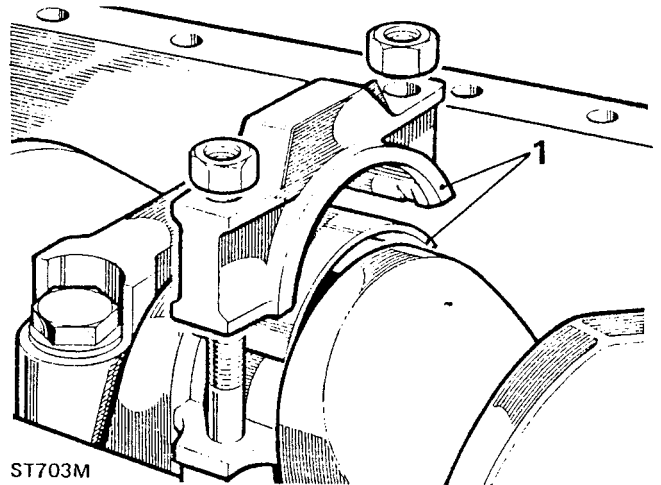
ST625M

7. Reassemble the new coupling as described under 'Coupling Overhaul'.

## REMOVE THE CONNECTING-RODS AND PISTONS

During the following instructions it is important that all components are kept in related sets and the pistons are identified with their respective bores.

1. Turn the crankshaft to bring the connecting-rod caps to an accessible position and remove each cap and lower shell in turn. Note that the connecting-rod caps are numbered one to four.

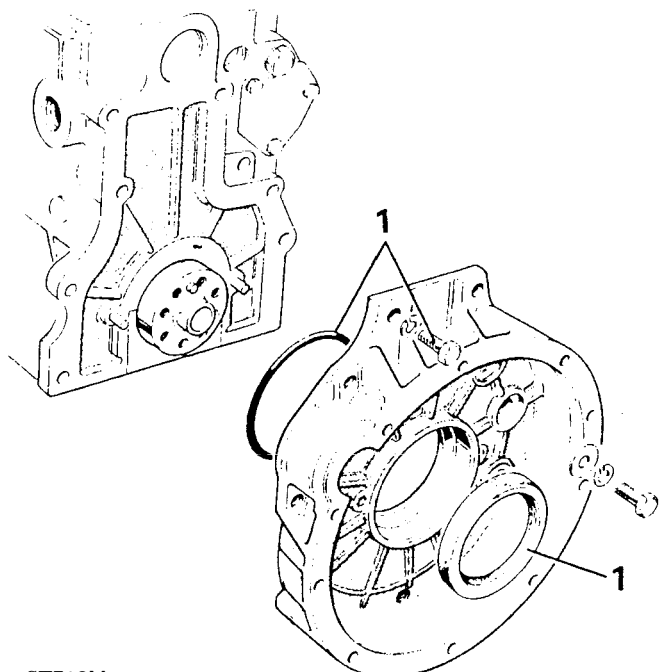


ST703M

2. Push each piston assembly up the bore and withdraw from the cylinder block. Assemble the caps and shells to the connecting-rods and place to one side for inspection with the cylinder block at a later stage.

## REMOVE AND INSPECT CRANKSHAFT

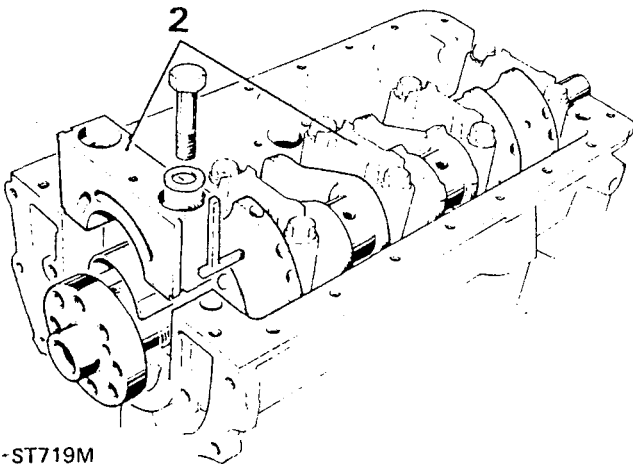
1. Remove the eight bolts securing the flywheel housing to the cylinder block and remove the housing and rear main bearing oil seal, and 'O' ring. The 'O' ring has been deleted on later engines.



ST718M



- Remove the main bearing caps and shells and lift out the crankshaft. Collect the bearing shells from the bearing saddles and the thrust washers from the centre saddle.



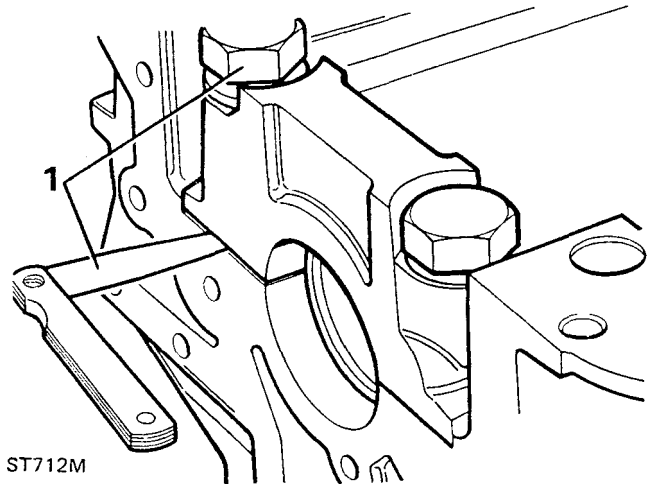
-ST719M

- Degrease the crankshaft and clear out the oil ways, which can become clogged after long service.
- Examine visually, the crankpins and main bearing journals, for obvious wear, scores, grooves and overheating. A decision at this stage should be made as to whether the condition of the shaft is worth continuing with more detailed examination.
- With a micrometer, measure and note the ovality and taper of each main bearing journal and crankpin as follows:
  - Ovality** — Take two readings at right angles to each other at various intervals.  
The maximum ovality must not exceed 0,040 mm (0.0015 in).
  - Taper** — Take two readings parallel to each other at both ends of the main bearing journal and crankpin.  
The maximum permissible taper must not exceed 0,025 mm (0.001 in).
- To check for straightness, support the front and rear main bearing journals in 'V' blocks and position a dial indicator to check the run-out at the centre main bearing journal. Run-out must not exceed 0,076 mm (0.003 in) taking into account any ovality in the centre journal.  
The overall allowable wear limit should not exceed 0,114 mm (0.0045 in) for main bearing journals and 0,088 mm (0.0035 in) for crankpins.  
A crankshaft worn beyond the limits of maximum taper, ovality and overall wear can be ground to 0.25 mm (0.010 in) under size.

**NOTE:** For regrinding information see page 8 2.25 litre petrol and Diesel engine overhaul.

## EXAMINE AND OVERHAUL THE CYLINDER BLOCK

- Remove the four jet tubes, see Engine assembly for illustrations and details.  
Degrease the cylinder block and carry out a thorough visual examination checking for cracks and damage. To check the main bearing caps and saddles for distortion. Fit the main bearing cap without bearing shells and tighten to the correct torque. Slacken and remove the bolt on one side of each bearing cap and check with a feeler gauge that no clearance exists at the joint face between the cap and saddle.



ST712M

### Inspect cylinder bores

- Measure the cylinder bores for ovality, taper and general wear, using any suitable equipment. However, an inside micrometer is best for checking ovality and a cylinder gauge for taper.
- Check the ovality of each bore by taking measurement at the top of the cylinder just below the ridge at two points diametrically opposite. The difference between the two figures is the ovality of the top of the bore. Similar measurements should be made approximately 50 mm (2.0 in) up from the bottom of the bore so that the overall ovality may be determined.
- The taper of each cylinder is determined by taking measurements at the top and bottom of each bore at right angles to the gudgeon pin line. The difference between the two measurements is the taper.
- To establish maximum overall bore wear, take measurements at as many points possible down the bores at right angles to the gudgeon pin line. The largest recorded figure is the maximum wear and should be compared with the original diameter of the cylinder bore.

Maximum permissible ovality 0,127 mm (0.005 in).  
Maximum permissible taper 0,254 mm (0.010 in).  
Maximum permissible overall wear 0,177 mm (0.007 in).

If the above figures are exceeded the cylinders must be rebored or sleeved depending upon the general condition of the bores and amount of wear. Alternatively, if the overall wear, taper and ovality are well within the acceptable limits and the original pistons are serviceable new piston rings may be fitted. It is important however, that the bores are deglazed, with a hone, to give a cross-hatched finish to provide a seating for the new rings. It is vital to thoroughly wash the bores afterwards to remove all traces of abrasive material.

#### inspect camshaft bearings

6. Measure the internal diameter of each camshaft bearing at several points using an internal micrometer. A comparison of the bearing diameters with those of the respective camshaft journals will give the amount of clearance. The bearings should be renewed if the clearance exceeds 0,0508 mm (0.002 in). Or, in any event, if they are scored or pitted. This work should only be entrusted to line boring specialists.

#### Check crankcase main bearings

7. Discard scored, pitted, cracked and worn bearing shells.
8. To determine the maximum wear, assemble the main bearing shells and caps to the crankcase and tighten the bolts to the correct torque figure.
9. Using an inside micrometer, measure each bearing at several points and note the greatest figure. The maximum wear is the difference between this figure and the smallest diameter of the corresponding crankshaft journal. The main bearing running clearance is in the data section.
10. The bearing clearances may also be determined by using 'Plastigauge'. Since this method requires the crankshaft to be fitted to the crankcase, the procedure is described under engine assembly.

#### Fit cylinder sleeves

Cylinder bores that cannot be rebored can be restored by fitting sleeves to enable standard size pistons to be fitted. Sleeving one cylinder only will distort the adjacent bore so sleeving must be carried out in pairs, i.e. cylinders 1 and 2 or 3 and 4.

11. Machine the cylinder bores to accept the sleeves to  $94,425 + 0,012$  mm ( $3,7175 + 0,0005$  in). This will give the sleeve a 0,076 to 0,114 mm (0.003 to 0.0045 in) interference fit.

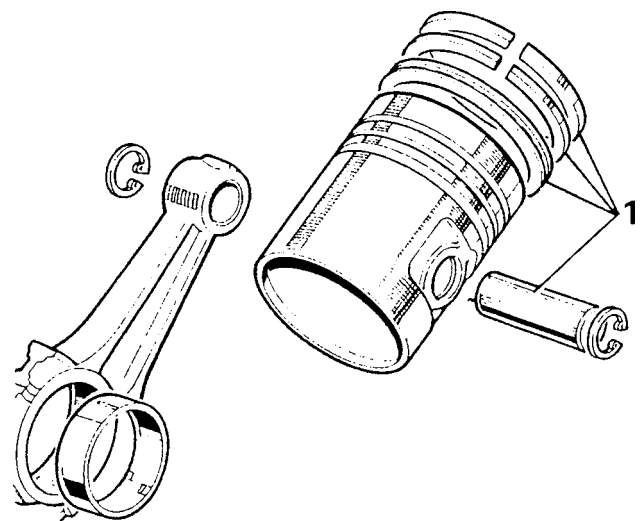
12. Press the sleeves squarely into the bore using a pressure of two to three tons. Excessive pressure could damage the sleeve and cylinder block. The sleeves must not be proud of the cylinder block top face or more than 2,54 mm (0,10 in) below the surface.
13. Bore and hone the sleeves to accommodate the pistons with the required clearances, see piston and connecting-rod examination.

#### PISTON AND CONNECTING-ROD INSPECTION

The following checks relating to pistons and rings must also be carried out prior to fitting new pistons to rebored and sleeved cylinder blocks.

Until it is decided if new components are required all parts must be kept in their related sets and the position of each piston to its connecting-rod should be noted.

1. Remove the piston rings and gudgeon pin from each piston and detach the connecting-rod.



ST1452M

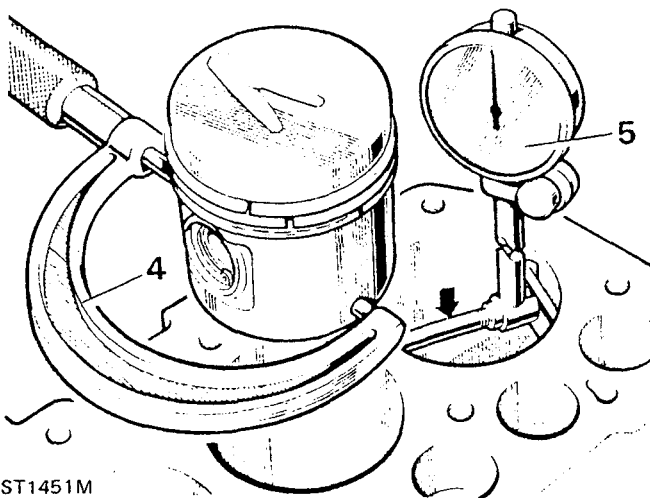
2. **Original pistons** — Decarbonise and degrease all components and carry out a visual examination of the pistons and rings and discard any which are unserviceable. Pistons which appear serviceable should be subjected to a more detailed examination described under 'New Pistons'.

3. **New Pistons** — Original pistons fitted to new engines at the factory are specially graded to facilitate assembly. The grade letter on the piston crown should be ignored when ordering new pistons. Genuine Land Rover service standard size pistons are supplied 0,025 mm (0.001 in) oversize to allow for production tolerances on new engines. When fitting new pistons to a standard size cylinder block the bores must be honed to accommodate the pistons with the correct clearances. In addition Land Rover pistons are available 0,50 and 1,01 mm (0.020 and 0.040 in) oversize for fitting to rebored cylinder blocks.

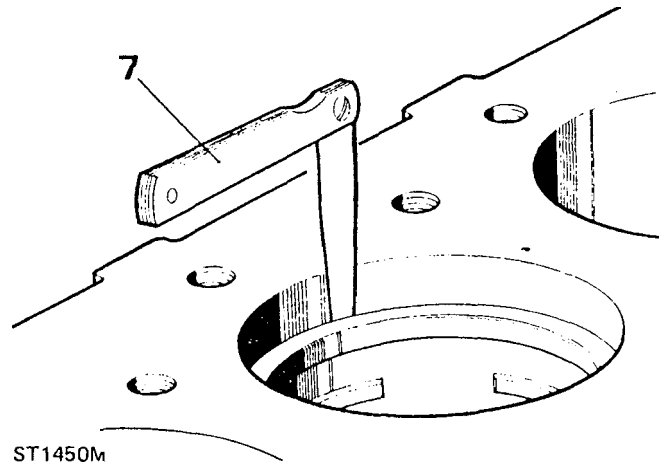
Clearance limits for new standard size pistons in a standard cylinder bore measured at right angles to the gudgeon pin are in the "General specification data" section.

When taking the following measurements the cylinder block and pistons must be at the same temperature to ensure accuracy.

4. Using a suitable micrometer measure the pistons at the bottom of the skirt at right angles to the gudgeon pin.
5. With an inside micrometer or cylinder gauge measure the diameter of the bore at approximately half-way down and note the reading.
6. The clearance is determined by subtracting the piston diameter from the bore diameter.



7. If gauge equipment is not available the clearance can be assessed by placing a long, suitably sized, feeler gauge down the thrust side of the bore and inserting the appropriate piston, 'upside down', in the bore and position it with the gudgeon pin parallel to the crankshaft axis. Push the piston down the bore and stop at the tightest point and whilst holding the piston still, slowly withdraw the feeler gauge. If a steady resistance of approximately 2,5 kg (6 lbs) is felt, the clearance is satisfactory.



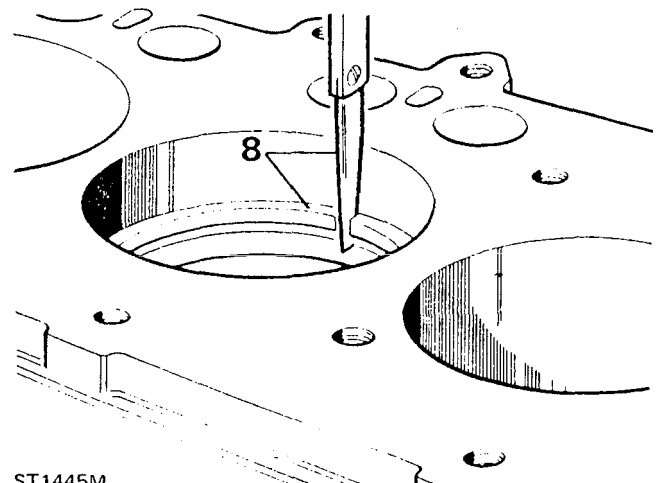
ST1450M

### Inspect piston rings

Normally when an engine is being overhauled the piston rings are discarded unless the pistons have been removed for a different purpose and the engine has only completed a small mileage. Before refitting the piston the rings should be examined for wear and damage. In addition the rings must be checked for side clearance in the pistons and gap in the bores. The latter two checks must be made when fitting new rings to new and used pistons.

8. **Check gap** When checking the ring gap in worn bores, but are nevertheless within the acceptable taper and ovality limits, the ring must be inserted squarely into the bottom of the bore at the lowest point of the piston travel. To ensure squareness of the ring push the ring down the bore to the correct position with a piston. With newly machined bores, the ring may be inserted squarely into any position in the bore.
9. Using an appropriate feeler gauge check the gaps of all the rings, in turn, including the oil control ring assembly.

The correct gaps are listed in the Data Section. If any gap is less than that specified, remove the ring, and file the ends square, whilst holding the ring in a filing jig or vice. Should any gap be excessively wide and not likely to close-up to within the specified limits when hot, an oversize ring should be fitted.



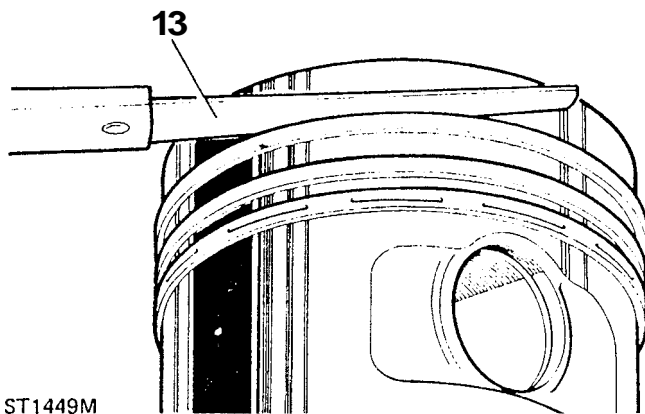
ST1445M

### Check piston ring side clearance

10. It is important that clearances are correct. Rings that are too tight will bind when hot, impairing the radial pressure causing possible loss of compression. Excessive clearance will allow the rings to rock in the grooves and the resulting pumping action could cause excessive oil consumption and eventually broken rings.
11. Fit the oil control ring to the bottom groove. Fit the unpolished compression ring with the word 'TOP' uppermost to the second groove. Insert the polished chrome ring with an internal chamfer and the word 'TOP' uppermost to the top groove.
12. After fitting each ring, roll it round the piston groove to ensure that it is free and does not bind.
13. Using an appropriate feeler gauge check the clearance between the rings and piston grooves. Clearances in excess of 0,012 to 0,152 mm (0.004 to 0.006 in) are unacceptable and the ring and or the pistons should be renewed.

Compression rings — 0,06 to 0,011 mm (0.0025 to 0.0045 in).

Oil control ring — 0,038 to 0,064 mm (0.0015 to 0.0025 in).



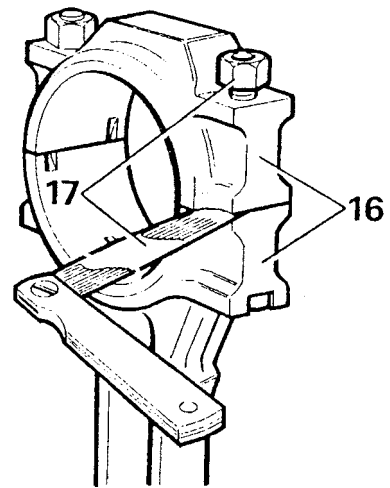
ST1449M

### Inspect gudgeon pins

14. Check the gudgeon pin for wear, cracks, scores and overheating.
15. The gudgeon pin fit in the piston must be tight push fit at a temperature of 68°F (20°C). Check the gudgeon pin for ovality and taper using a micrometer.

### Connecting-rod inspection

16. Check the connecting-rods and caps for distortion as follows; fit the correct cap, less the bearing shells, to each connecting-rod as denoted by the number stamped near the joint faces. This number also indicates the crankshaft journal to which it must be fitted.
17. Tighten the nuts to the correct torque and release the nut on one side only. Check, with a feeler gauge, that no clearance exists between the joint faces. If there is a gap the connecting-rod is distorted and should be renewed.



ST716M

18. Use an accurate connecting-rod alignment gauge to check the rods for bend and twist. The maximum allowable for both conditions must not exceed 0,127 mm (0.005 in).
19. Examine and check the small-end bush for wear. If necessary renew the bush. The correct clearance of the gudgeon pin in the small-end bush is given in "General specification data".
20. When renewing a bush ensure that the oil hole in the bush lines **up** with the hole in the connecting-rod. Finish the bush to the correct size and clearance.
21. Connecting-rod bearings that are worn, pitted, scored and show signs of overheating must be discarded. If more than one of the bearings show these signs they must all be renewed. When fitting new or used bearings to serviceable crankpins the clearances must be checked.

### Connecting-rod bearing nip and clearance

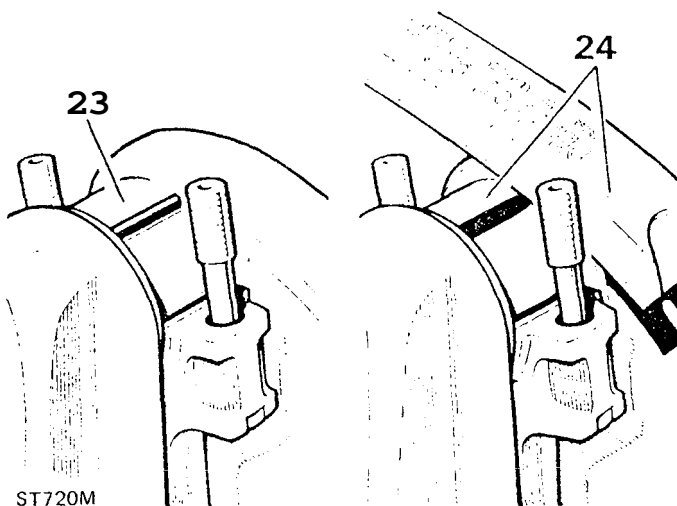
New bearing halves are supplied with a protective coating and must be degreased before fitting.

22. Fit the bearing halves to the connecting-rod and cap and secure the assembly with the correct torque. Slacken the nut on one side only and check the clearance between the joint faces with a feeler gauge.

The clearance should be between 0,10 and 0,20 mm (0.004 and 0.008 in). The bearing nip can be adjusted by the selective assembly of the bearing shells which are available in slightly varying thicknesses. Do not file or machine the caps or rods to vary the bearing nip. Make a final check to prove the clearance by inserting a 0,063 (0.0025 in) shim paper between the crankpin and one half of the bearing and tightening to the correct torque. The connecting-rod should resist rotation and move freely with the shim paper removed.

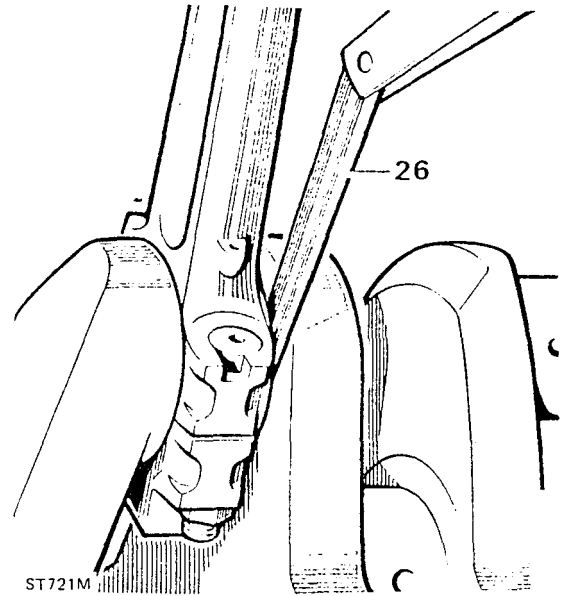
As an alternative, the bearing clearances can be determined by using 'Plastigauge' which consists of a thin piece of plastic material a few hundredths of a millimeter or thousandths of an inch in diameter. When the material is flattened by being squeezed between the bearing and crankpin the width of the plastic is measured by a scale gauge which indicates the clearance.

23. Wipe any oil from the crankpins and place a piece of 'Plastigauge' across the centre of the bearing in the connecting-rod cap. Assemble the rod to the appropriate crankpin and tighten to the correct torque. Do not rotate the connecting-rod or crankshaft during this operation.
24. Remove the connecting-rod cap and bearing shell and using the scale supplied measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds to the width of the 'Plastigauge' indicates the bearing clearance. The correct clearance with new or overhauled components is 0,019 to 0,063 mm (0.0007 to 0.0025 in).
25. Wipe off the 'Plastigauge' with an oily rag. Do not scrape off otherwise it may damage the crankpins.



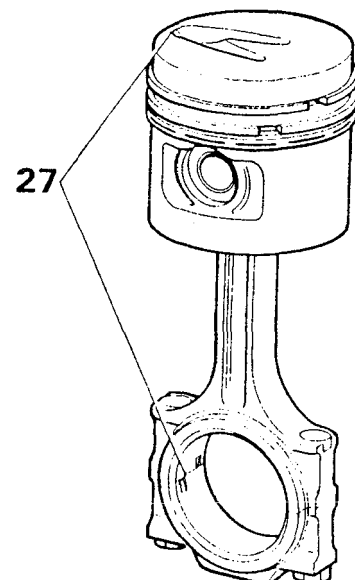
### Connecting-rod end-float

26. Fit the connecting-rods complete with bearings to their respective crankpins. Move the connecting-rod to one side and check the clearance, with a feeler, on the opposite side. The correct clearance is between 0,20 and 0,30 mm (0.007 and 0.012 in).



### Assemble pistons to connecting-rods

27. The piston must be assembled with the point of the 'V', on the piston crown, on the same side as the bearing shell location slots in the connecting-rod.
28. Insert a circlip in one side of the gudgeon pin boss and assemble the piston to the connecting-rod with the gudgeon pin. Secure the assembly with a circlip on the opposite side of the piston.



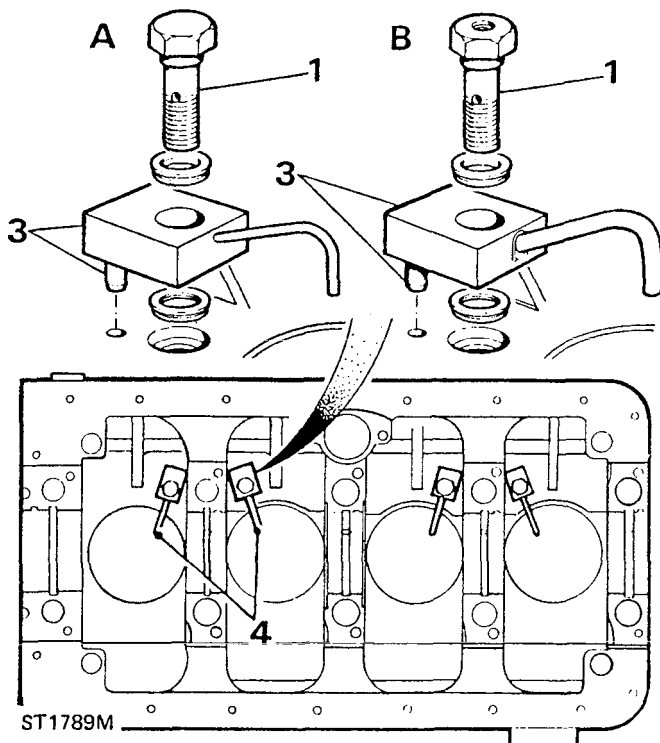
## ASSEMBLE ENGINE

## ASSEMBLE JET TUBES TO CYLINDER BLOCK

Oil jet tubes are fitted to lubricate the pistons and bores directly from the main oil gallery.

1. The jet tubes are 'Handed' and can only be fitted one way. It is important to note that the jet retaining 'bolt' contains a non-return valve and therefore on no account must an ordinary bolt be used.
2. Clean the recess in the cylinder block using an air line, if available, to remove any swarf.
3. Assemble and fit the jet tube assemblies as illustrated ensuring that the pegs locate in the holes in the cylinder block, and that the larger diameter washer fits under the bolt head.
4. Before tightening the retaining bolts ensure that the small squirt pipes do not foul the crankshaft or pistons. Firmly tap the jet tube assemblies down onto the cylinder block, thus ensuring that the locating dowel is fully home and avoiding any sideways distortion on the retaining bolt. Use a tube slightly larger than the bolt head. The old bolt should be discarded and a new bolt fitted.
5. When the crankshaft and pistons have been fitted slowly turn the crankshaft and check that no fouling occurs.

A. Early Type B. Latest Assembly.

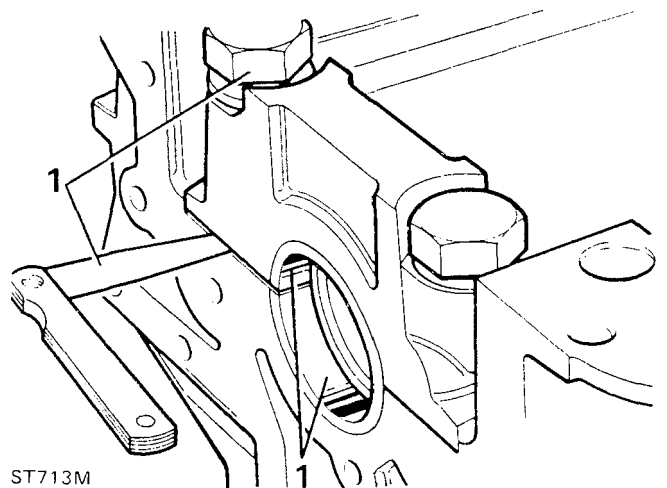


## FIT CRANKSHAFT

## Main bearing nip and clearance

New main bearing halves are supplied with a protective coating and must be degreased before fitting.

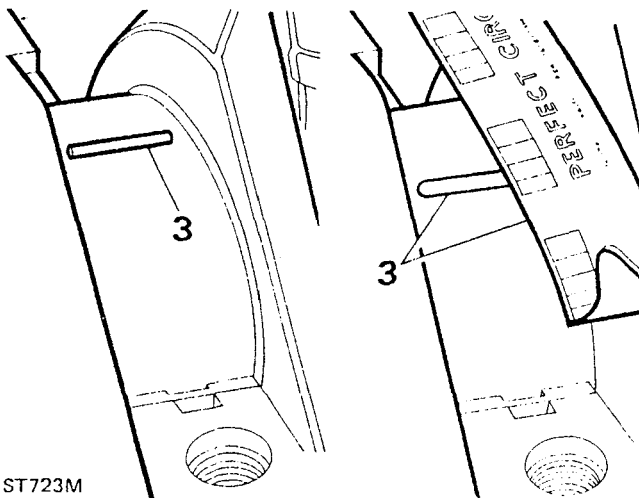
1. Fit the bearing halves in the crankcase saddles and caps and secure the caps to the crankcase and tighten to the correct torque. Slacken the bolts on one side of the caps only and, with a feeler gauge, check the gap between the joint faces. The clearance or nip must be within 0,10 to 0,15 mm (0.004 to 0.006 in). The bearing nip can be adjusted by selective assembly of the bearing halves available in varying thicknesses. Do not file or machine the caps or saddles to achieve the correct clearance. Note that the rear main bearings are wider than the remaining four.
2. To make a final check that the clearance is correct, leave the bearing halves in the crankcase saddles and carefully lower the crankshaft into position. Check each bearing in turn by inserting a 0,063 mm (0.0025 in) shim paper between the bearing cap and crankshaft journal and tighten the bolts to the correct torque. If the clearance is correct, there should be a slight increase in the resistance to rotation of the crankshaft.



As an alternative 'Plastigauge' may be used to check the clearance in the same manner as with the connecting-rod bearings. This material may also be used to determine the amount of wear in used bearings and journals.

3. Locate the crankshaft in position on the upper bearing halves in the crankcase and wipe any oil from the journals since 'Plastigauge' is soluble in oil. Place a piece of 'Plastigauge' across the lower half of each crankshaft journal or lower bearing cap shell. Fit the cap and tighten to the correct torque. Remove the cap and bearing and using the scale supplied with the 'Plastigauge' measure the flattened 'Plastigauge' at its widest point. The graduation that most closely corresponds with the width of the 'Plastigauge' indicates the bearing clearance.

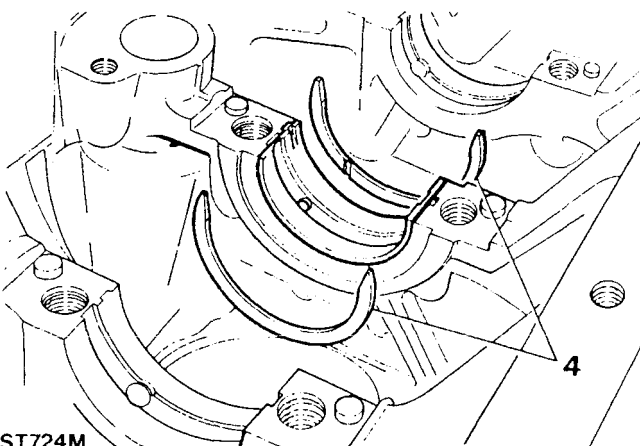
The correct clearance with new or overhauled components is included in "General specification data" section. If new bearings are being fitted use selective assembly to obtain the correct clearance. Wipe off, not scrape the 'Plastigauge' with an oily rag from the journals or bearings.



ST723M

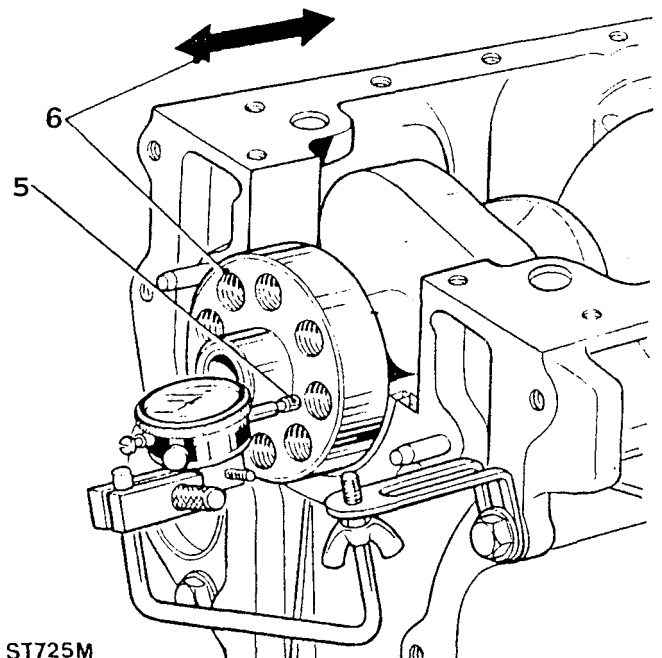
#### Adjust crankshaft end-float

4. Lift out the crankshaft and insert a standard size thrust washer both sides of the centre main bearing saddle with the grooves towards the crankshaft.



ST724M

5. Place the crankshaft in position in the crankcase and mount a dial test indicator to read-off the end of the crankshaft. A feeler gauge may be used instead of an indicator.
6. Determine the end-float by moving the crankshaft away from the indicator and zero the dial. Move the crankshaft in the opposite direction and note the indicator reading. Alternatively measure the clearance with a feeler gauge. The end-float should be 0,05 to 0,15 mm (0.002 to 0.006 in).
7. If adjustment is required substitute with oversize thrust washers. Variation of thrust washer thickness at each side of crankshaft journal must not exceed 0,08 mm (0.003 in) to ensure that the crankshaft remains centralised.

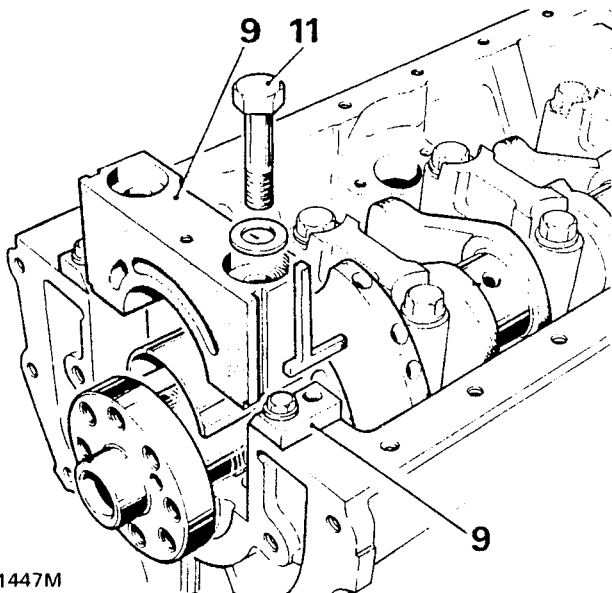


ST725M

8. Lubricate the crankshaft main journals with clean engine oil and fit the appropriate bearing caps and lower shells to the crankcase with the exception of number five main bearing. Ensure that the caps locate properly over the dowels. Using new bolts and washers evenly tighten to the correct torque figure.

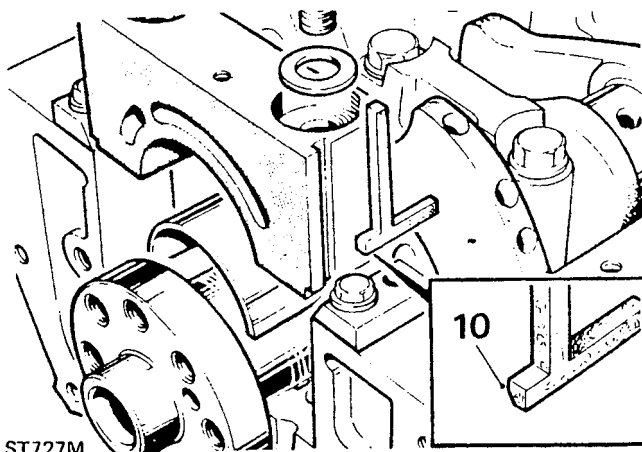
#### Fit rear main bearing cap

9. Ensure that number five main bearing cap is clean and free from old cork seal material. Attach the cork seal guides number 270304 to the crankcase, as illustrated, and ensure that they are parallel to the crankcase edge.



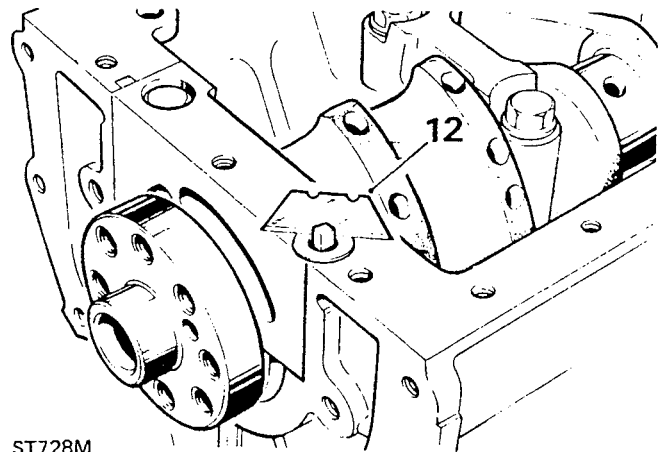
ST1447M

10. To prevent any cork seal material becoming trapped between the bearing cap and crankcase, chamfer the inner edge of the corks 0,40 to 0,80 mm ( $\frac{1}{64}$  to  $\frac{1}{32}$  in) wide as illustrated. Immerse the cork seals in engine oil and fit them to the bearing cap.



ST727M

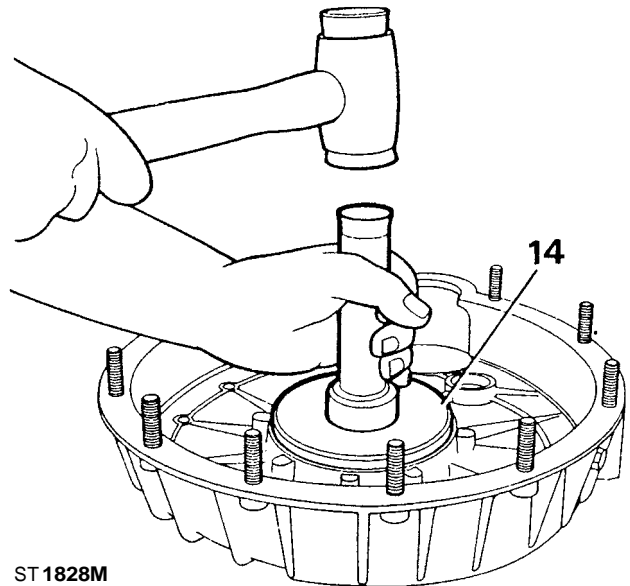
11. Fit the bearing cap and lower shell to the crankcase and secure with new bolts and washers and tighten to the appropriate torque.
12. To allow for shrinkage after fitting leave the cork seals standing proud of the crankcase sump face. If possible delay the fitting of the sump for approximately twelve hours and leave the seal protruding 2,40 mm ( $\frac{3}{32}$  in) and then place a 6.350 mm ( $\frac{1}{4}$  in) washer over the seal and cut off the surplus. If it is necessary to fit the sump immediately, trim the seals off leaving 0,80 mm ( $\frac{1}{32}$  in) proud, that is, the thickness of the above washer. Apply Hylomar SQ32M to the protruding end of the seals.



ST728M

**Fit rear main oil seal**

13. Check that the crankshaft oil seal journal is undamaged and clean. Make sure the seal housing is clean and dry and free from burrs. Do not touch the seal lip and ensure that the outside diameter is clean and dry. The P.T.F.E Seal Part No. ETC 5369 which should be used is supplied with a former to maintain the correct shape and must not be removed until the seal is to be fitted.
14. Using special seal replacer 18G 134-11 and with the lip side leading drive-in the seal as far as the tool allows. If the tool is not available fit the seal to the bottom of the housing to ensure squareness.



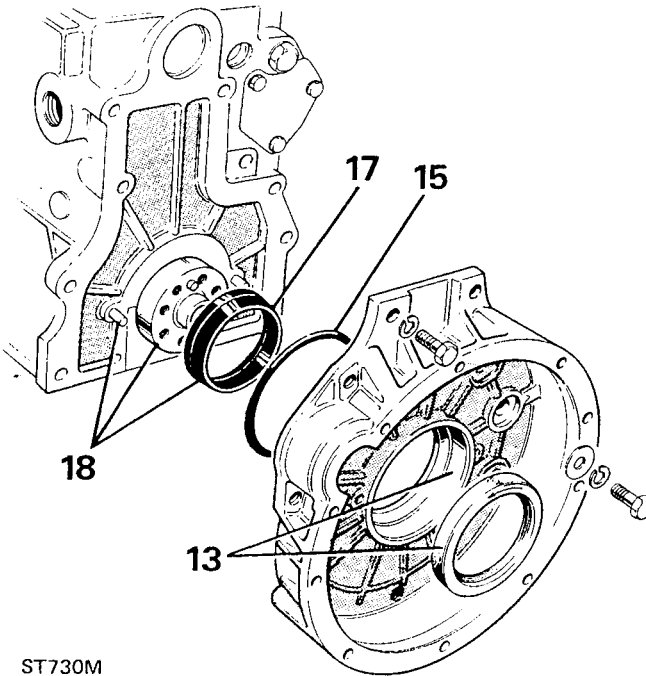
ST1828M

**Fit flywheel housing — Early engines**

15. Fit the 'O' ring seal to the flywheel housing.
16. Examine the seal guide number 18G 1344 and repair any damage that could destroy the seal lip.
17. Lubricate the outside diameter of the seal guide and the seal journal with concentrated 'Oildag' in a 25% solution with clean engine oil.



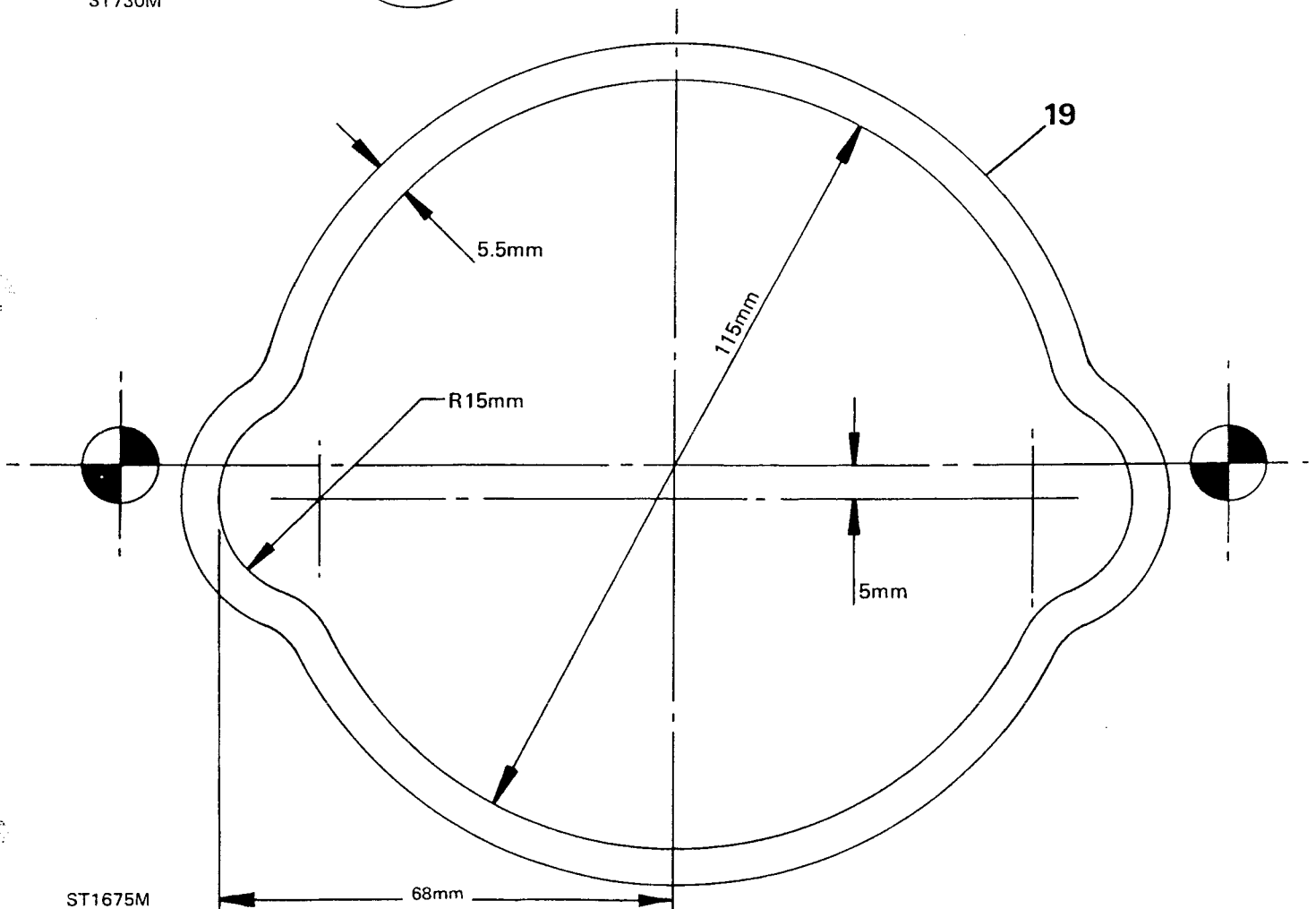
18. Place the seal guide on the crankshaft flange and, using the two dowels protruding from the cylinder block rear face as a guide to ensure initial squareness, fit the flywheel housing and remove the seal guide. Secure the flywheel housing evenly tightening the retaining bolts.



ST730M

#### Fit flywheel housing — Later engines

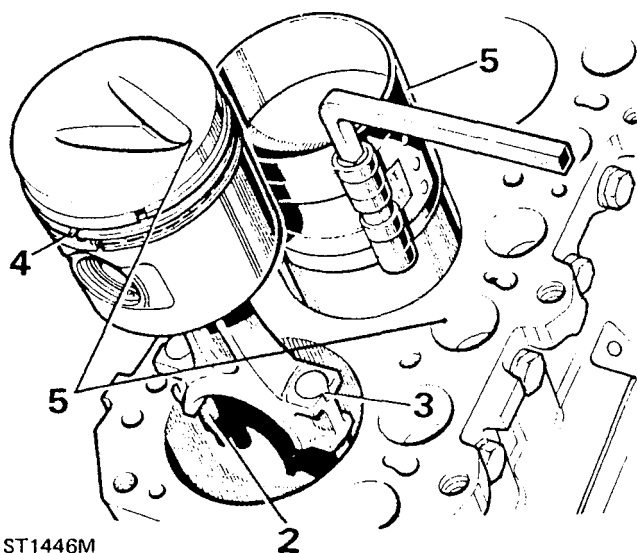
19. In place of the 'O' ring seal a bead of Hylogrip 2000 sealant must be applied to the rear face of the flywheel housing to the dimensions and configuration as illustrated below. The illustration has been produced full size so that a template may be made to facilitate the application of the sealant. The bead should be 5,5 mm wide and 0,25 mm thick.
20. Fit the housing following instructions 17 to 19.



ST1675M

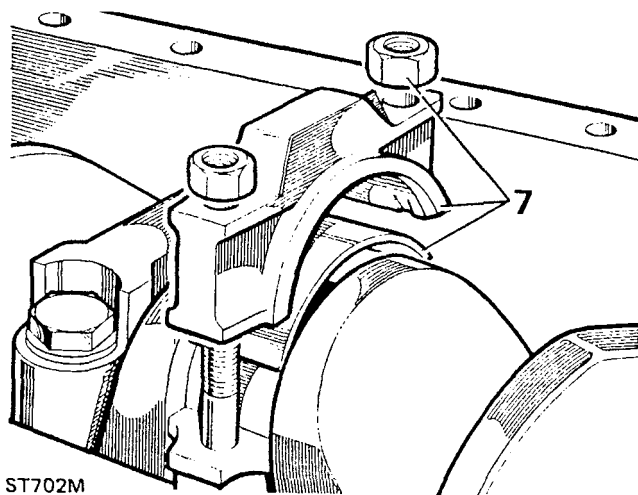
**FIT THE CONNECTING-RODS AND PISTONS**

1. Turn the crankshaft to position numbers one and four crankpins at bottom dead centre to facilitate fitting the connecting-rods.
2. When fitting the connecting-rods and pistons ensure that the bolts do not foul and damage the crankpins. **As** a precaution it is recommended that rubber or soft plastic sleeves are placed over the threads.
3. The connecting-rod bolts have essentric heads which locate in a recess in the connecting-rod. It is essential that the head of each new bolt is properly located before tightening.
4. Stagger the compression rings so that the gaps are equidistantly spaced round the piston but, so arranged, that no gap is positioned on the thrust side of the piston i.e. opposite the camshaft. Turn the oil control ring so that the gap is in line with the gudgeon pin.
5. Lubricate the cylinder walls, piston rings and crankpins. Compress the pistons rings with a suitable compressor tool and carefully lower the connecting-rod into the bore ensuring that the piston is assembled in accordance with instruction 27 under "Assemble pistons to connecting-rods". Also the point of the arrow headed valve clearance indentation in the piston crown, must face the camshaft side of the engine.
6. Using a soft mallet, sharply tap the piston into the bore so that the whole of the piston is just below the surface of the cylinder block.



ST1446M

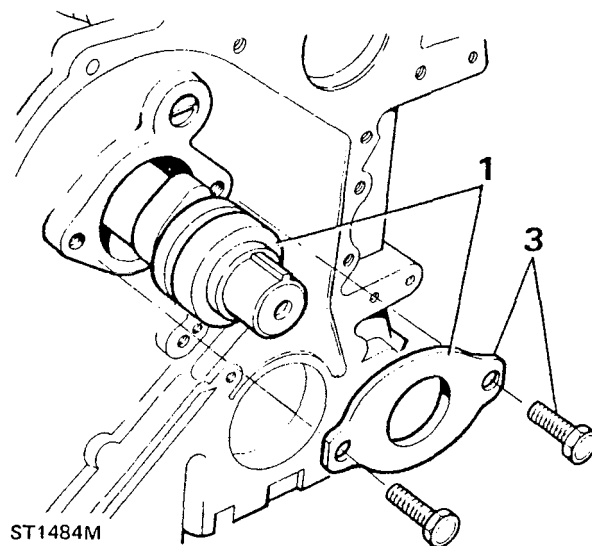
7. Check that the bearing shell is properly located in the connecting-rod and pull the rod onto the crankpin. Locate the bearing shell correctly and fit the cap so that the identification numbers are together on the camshaft side of the engine. Fit and tighten new nuts to the correct torque figure. Repeat the foregoing instructions for fitting the remaining piston and connecting-rod assemblies.



ST702M

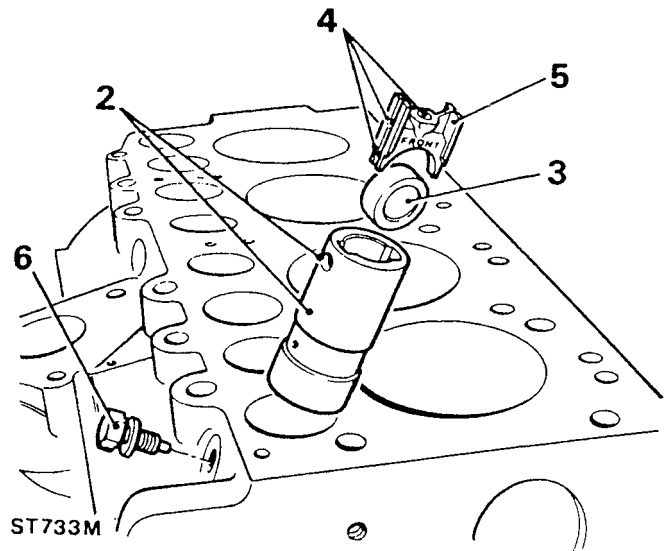
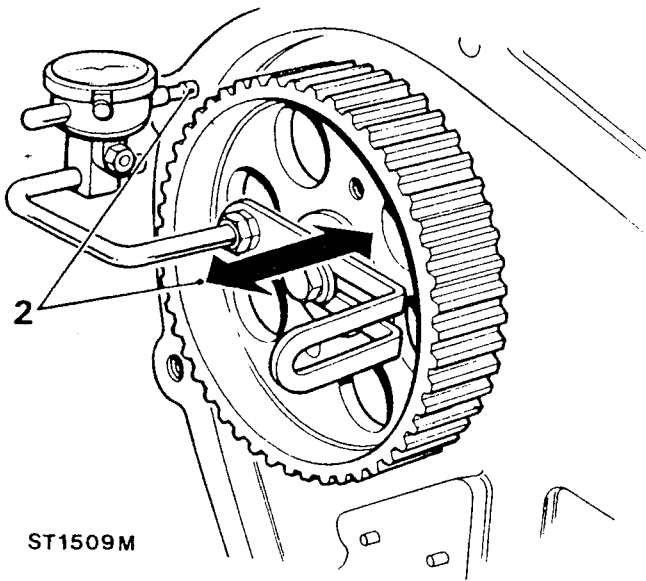
**FIT THE CAMSHAFT**

1. Lubricate the camshaft bearings and with care, insert the camshaft into the cylinder block. Temporarily secure a new thrust plate with the two bolts.



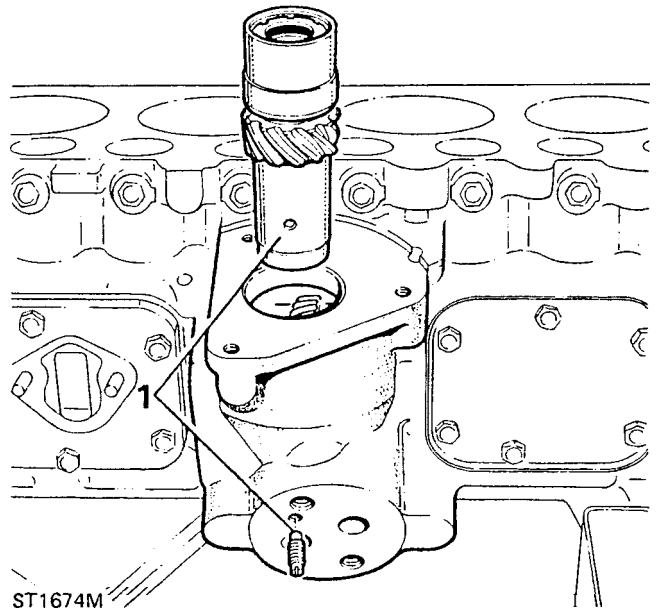
ST1484M

- To check the camshaft end-float, fit the woodruff key and temporarily fit the cam-shaft pulley and mount a dial test indicator, as illustrated, so that the stylus rests in a loaded condition upon the machined face of the cylinder block. Zero the dial and move the camshaft back and forward and note the reading. The end-float should be within 0,06 to 0,13 mm (0.0025 to 0.0055 in). If the end-float is outside these limits, fit different thrust plates until the correct tolerance is achieved.
- Remove the test indicator and pulley, and secure the thrust plate with the two bolts.



#### FIT THE SKEW GEAR

- Lubricate and insert the skew gear and coupling assembly into mesh with the camshaft gear. Align the location hole in the bush and fit a new location screw into the cylinder block.



#### FIT TAPPETS, GUIDES AND ROLLERS

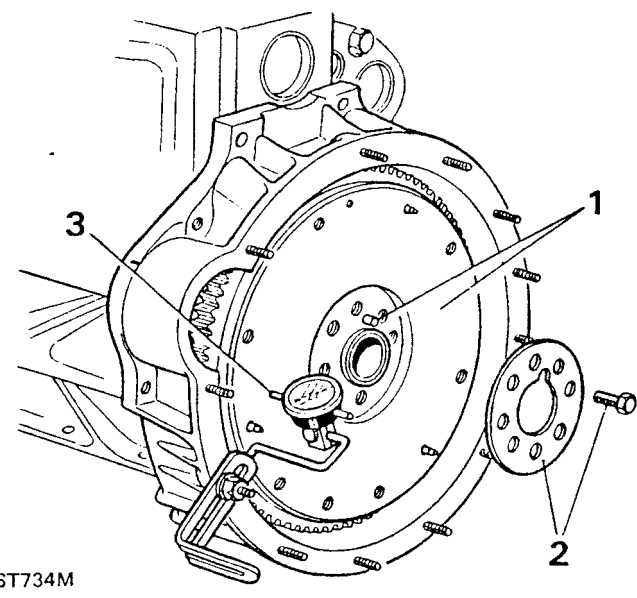
- If the same parts are being refitted ensure that they are returned to their original positions. Ensure that the tappet slides move freely in the guides.
- Insert the tappet guides into the cylinder block and align the locating screw holes.
- Fit the tappet rollers ensuring that they are fitted in accordance with the marks made during removal. New rollers, however, may be fitted either way round.
- Before fitting the tappet slides make sure the oilways are clear to the tappet bearing surface, the cross drilling and the oil feed to the push rod.
- Insert the tappet slides with the word 'FRONT' towards the front of the engine.
- Secure the tappet guides with NEW Micro encapsulated screws and tighten to the correct torque figure. Micro encapsulated screws should also be used on engines where the screws were originally wired for security.

#### FIT THE FLYWHEEL

- Examine the flywheel and crankshaft mating faces and remove any burrs or imperfections that could prevent the flywheel locating correctly. Check that the dowel is in position.

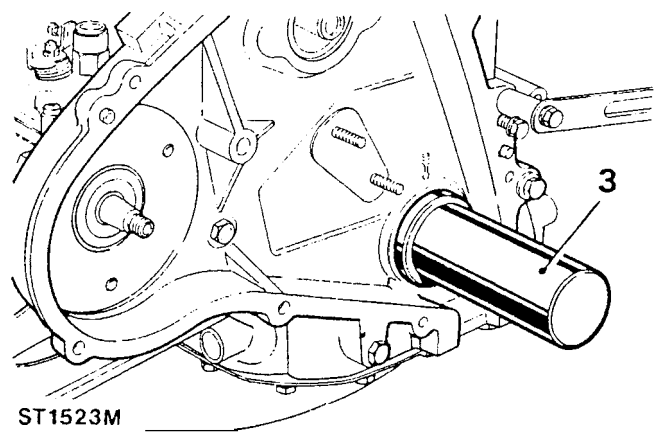
continued

2. Offer **up** the flywheel to the crankshaft and secure with the reinforcing plate and retaining bolts. Evenly tighten the bolts to the correct torque figure.
3. To check the flywheel run-out, mount a dial test indicator so that the stylus rests, in a loaded condition, on the clutch pressure face at a radius of 114 mm (4.5 in).
4. Turn the flywheel, and check that the run-out does not exceed 0.05 to 0.07 mm (0.002 to 0.003 in). Should the run-out be excessive, remove the flywheel, and check again for irregularities on flywheel and crankshaft mating faces and dowel.



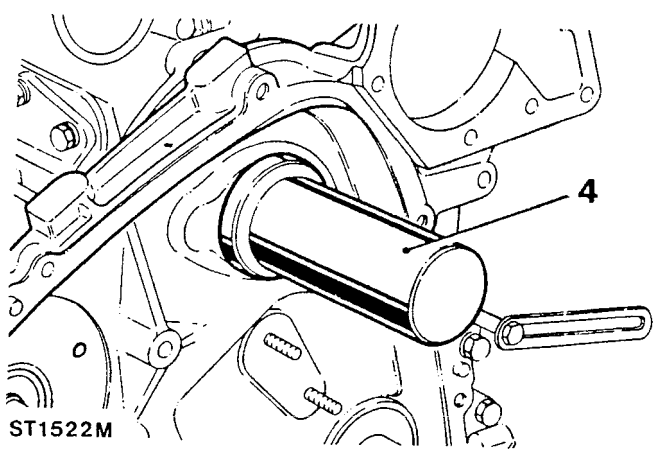
**Rear cover — crankshaft seal**

3. With the lip side leading drive in the new seal using special tool 18G 1456, until the seal is approximately 0,5 mm below the inner face of the cover.



**Front cover — camshaft seal**

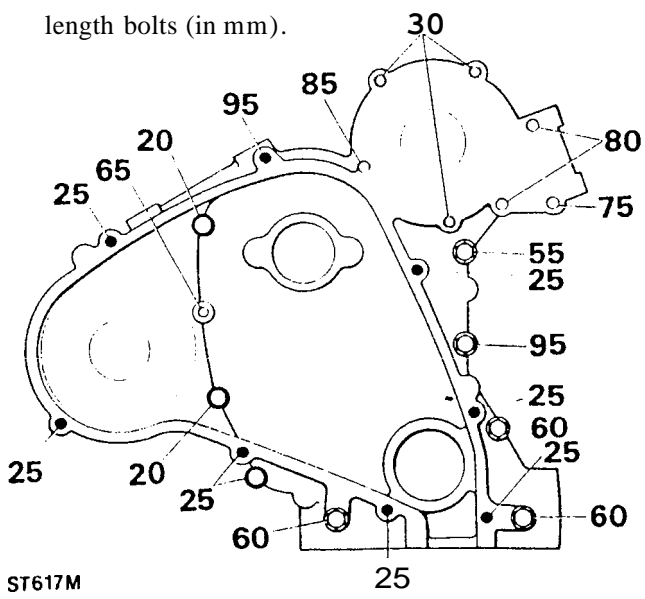
4. Drive in a new seal, lip side leading until flush or approximately 1.0 mm below the inner surface using special tool 18G1482.



continued

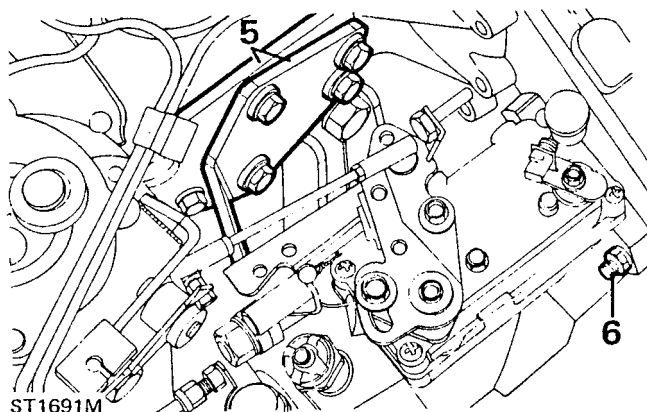
**FIT TIMING FRONT COVER, SEALS AND PULLEYS**

1. Fit new cover joint, triangular gasket, and water gallery gasket, to the cylinder block.
2. Fit and secure the rear cover with the eight bolts referring to the chart for location of the various length bolts (in mm).

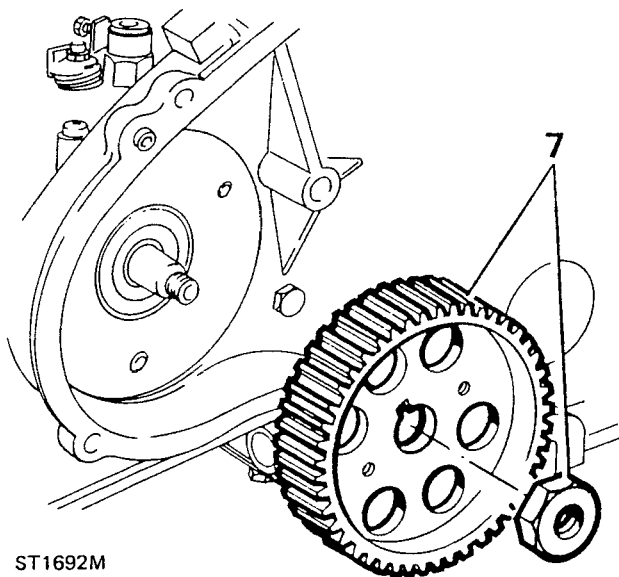


### Fit distributor pump (D.P.S.)

5. Fit the camshaft front inspection cover complete with the D.P.S. pump rear support bracket. Using a new joint washer evenly tighten the six bolts.
6. Fit pump joint washer and loosely secure pump to cover with the three nuts and to the rear support bracket with the single nut and bolt. Position the pump so that the retaining studs are midway in the flange slots.

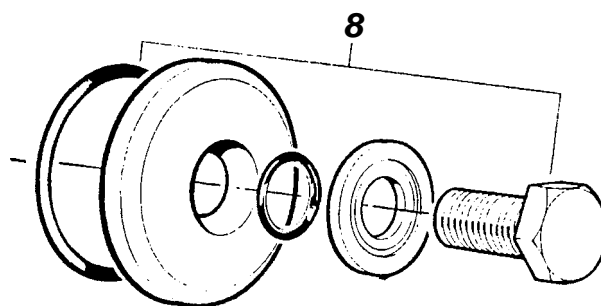


7. Fit D.P.S. pump pulley, and loosely secure with the nut.



### Fit camshaft pulley

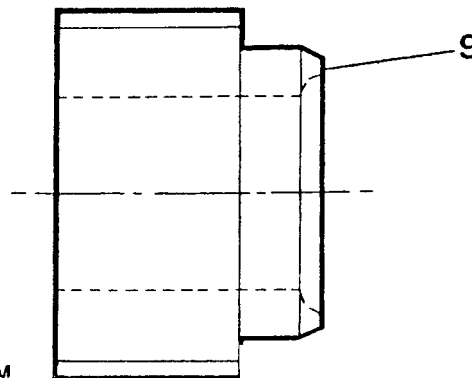
8. Fit pulley, boss towards engine, and loosely secure with special washer, 'O' rings, plain washer and new bolt. DO NOT drive pulley onto camshaft. Draw pulley on with a slave 10 mm diameter metric bolt, plain washer and nut.



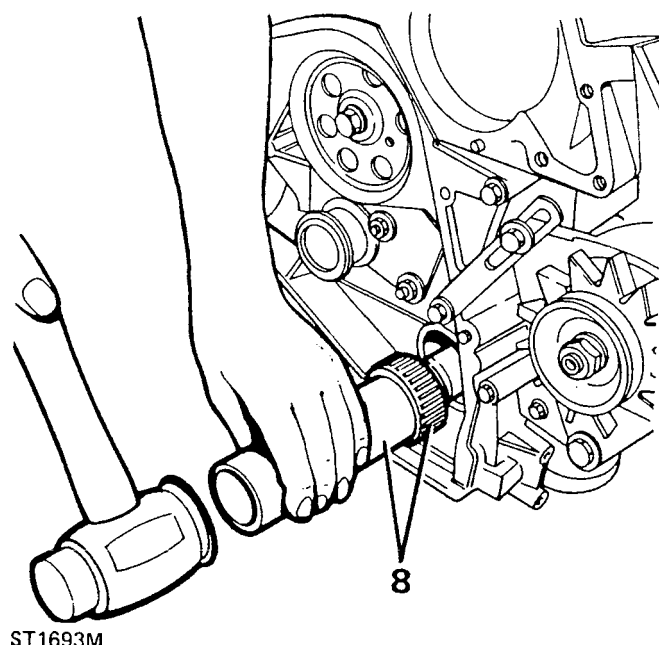
ST1521M

### Fit crankshaft timing pulley

9. Apply Loctite 518 to the pulley face as illustrated; do not allow sealant to contact chamfered face. Lightly oil the crankshaft and pulley bore and fit the pulley, with timing dot outwards, and drive into position using a suitable tube as a drift.



ST1921M

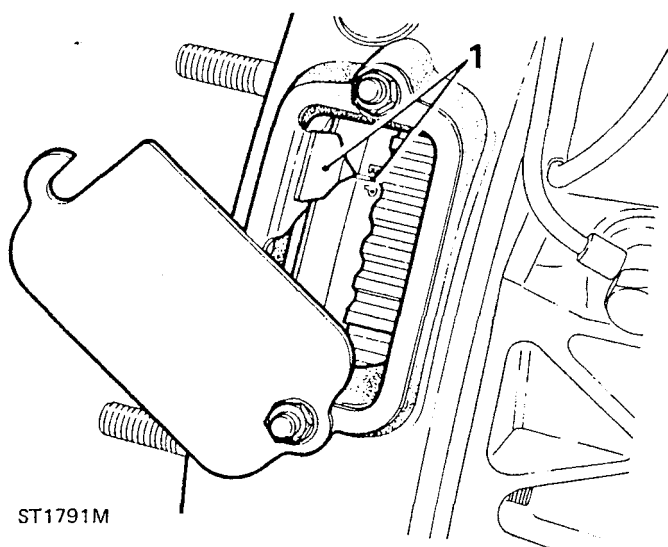


ST1693M

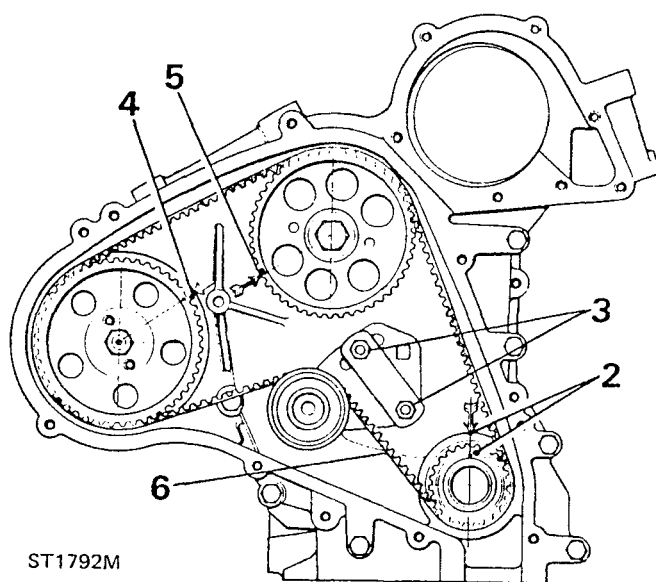
**TIME D.P.S. PUMP AND VALVES — Early Engines**

The D.P.S. pump and valves are timed using the exhaust valve peak of number one cylinder. On early engines the exhaust peak position is determined by the relationship of a line, marked E.P. on the flywheel periphery and a timing pointer on the flywheel housing. The pointer is available under Part Number ERC 2250.

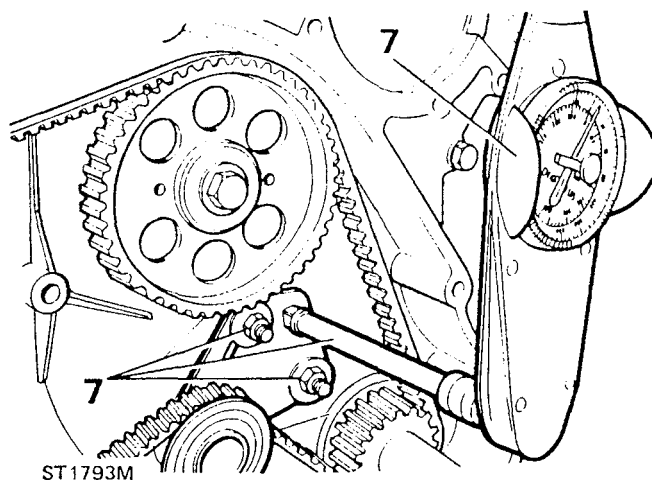
1. Turn the crankshaft in a clockwise direction until the E.P. mark on the flywheel lines-up exactly with the pointer. If the crankshaft is inadvertently turned beyond the E.P. mark do not turn it back but continue on round in a clockwise direction until the mark and pointer coincide exactly.



2. Check that the dot on the crankshaft pulley and the cast-on arrow on the rear cover line-up.
3. Fit the timing belt tensioner assembly and loosely secure with the two nuts (strap deleted on later models).
4. Turn the D.P.S. pump pulley clockwise until the dot lines up exactly with arrows in the rear cover.
5. Similarly, turn the camshaft pulley clockwise so that the dot coincides exactly with the cast-on arrow.
6. Fit the timing belt over the crankshaft pulley and whilst keeping the belt under tension, by hand, run the belt over the camshaft pulley. If the belt does not quite mate with the grooves, turn the pulley clockwise the necessary amount. Feed the belt over the pump pulley and if necessary turn the pulley clockwise to locate in the grooves. Keeping a firm grip on the belt pass it over the tensioner wheel.



7. Set a dial type torque wrench to 29,0 to 23,5 Nm (21 to 17 lbs ft) and whilst holding it vertically, insert the drive peg into the square hole in the tensioner base plate. Tension the belt and tighten the clamp nuts to the correct torque.

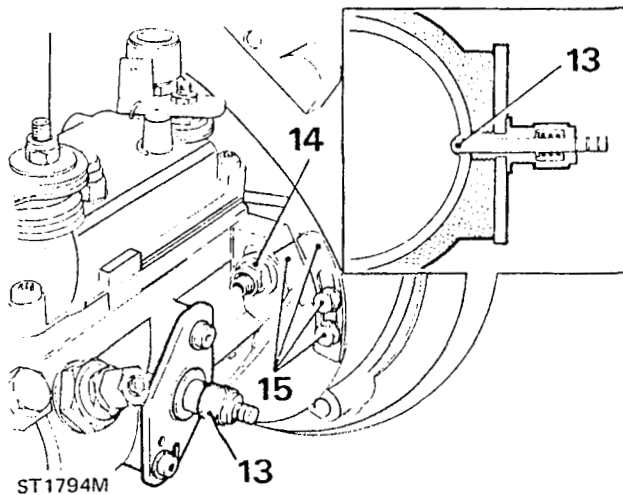


8. Rotate the engine TWO complete revolutions.
9. Slacken the tensioner clamp nuts.
10. Tension the belt again as described in instruction 7 and tighten the clamp nuts to the correct torque.

**CAUTION: The double tensioning procedure is imperative, otherwise the belt could fail resulting in serious engine damage. See CAUTION Page 84 and "Care of belts".**

11. Rotate the crankshaft until, the E.P. mark on the flywheel and the pointer line-up.
12. Check that the dots on the pump and camshaft pulleys coincide exactly with their respective arrows. If there is any misalignment the procedure must be repeated.

13. Remove the plug from the side of the D.P.S. pump and insert gauge tool 18G 1458 and if necessary rotate the pump body until the gauge can be fully inserted and screwed home indicating that the inner disc is centrally positioned with the hole.
14. Evenly tighten the three nuts securing the pump to the cover and the single nut and bolt to the support bracket.
15. Align timing pointer on rear of cover, with the scribed line on the pump flange and tighten the two screws. If a new pump is being fitted and there is no scribed line, scribe a line in the centre of the machined area on the pump flange. Align the timing pointer and tighten the screws. On later engines the timing pointer has been deleted and instruction 15 can be ignored.

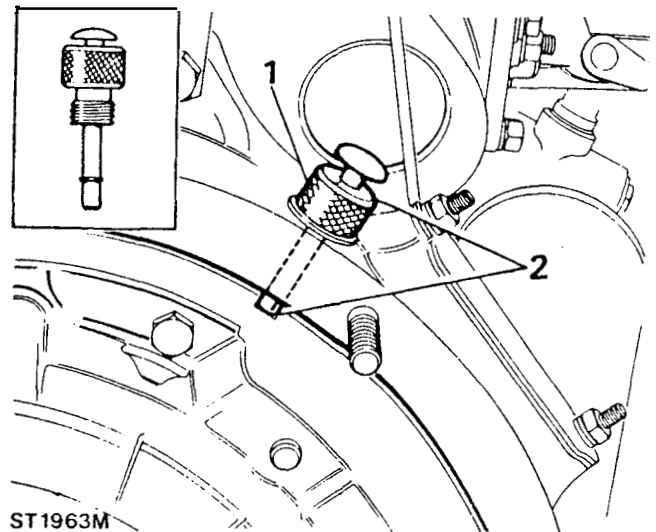


16. Tighten the D.P.S. pump timing pulley nut and the camshaft pulley retaining bolt to the correct torque.
17. Remove the timing pointer from the flywheel housing, close the cover and secure with the two nuts.

#### Time D.P.S. PUMP AND VALVES — Later Engines with slot in flywheel for determining the E.P.

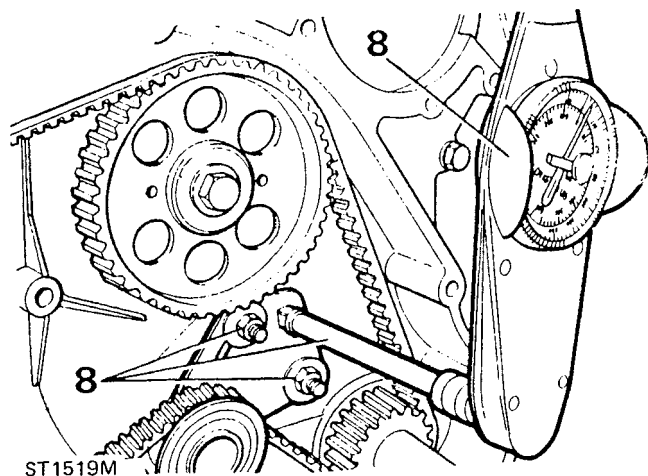
The D.P.S. pump and valves are timed using the exhaust valve peak of number one cylinder. This is determined on later engines by the relationship of a slot in the flywheel periphery and a plugged hole in the flywheel housing through which a flywheel timing pin, special tool number LST 107, is inserted.

1. Remove the plug from the flywheel housing and fit the body of special tool LST 107 without the pin.
2. Turn the crankshaft in a clockwise direction until the E.P. slot in the flywheel is in-line with the hole in the flywheel housing. If the crankshaft is inadvertently turned beyond the E.P. slot, do not turn the crankshaft back but continue on round in a clockwise direction until the pin of the special tool can be fully located in the flywheel slot.

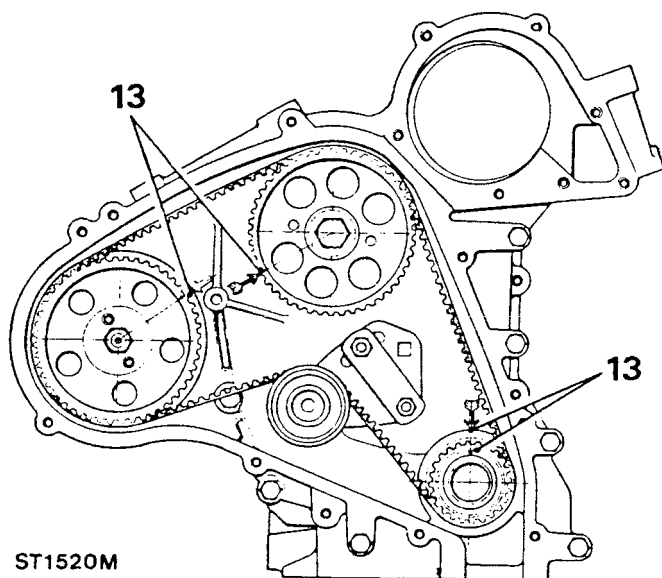


3. Fit the timing belt tensioner assembly and loosely secure with the two nuts.
4. Turn the D.P.S. pump pulley clockwise until the dot on the pulley lines-up exactly with the cast-on arrow inside the front cover.
5. Similarly, turn the camshaft pulley clockwise until the dot lines-up with the cast-on arrow in the front cover.
6. Fit a new timing belt over the crankshaft pulley and whilst keeping the belt under tension, by hand, run the belt over the camshaft pulley. Should the belt not quite mate with the grooves, turn the pulley clockwise the necessary amount. Feed the belt over the D.P.S. pump pulley and if necessary turn the pulley clockwise to locate in the grooves. Keeping a firm grip on the belt, pass it over the tensioner jockey pulley.
7. Withdraw the special tool timing pin from the flywheel slot.
8. Set a dial type torque wrench to 20.0 to 23.5 Nm (21 to 17 lbs ft) and whilst holding it vertically, insert the drive peg into the square hole in the tensioner base plate. Tension the belt and tighten the clamp nuts to the correct torque.
9. Rotate the crankshaft TWO complete revolutions.
10. Slacken the tensioner clamp nuts.
11. Tension the belt again as described in instruction 8 and tighten the clamp nuts to the correct torque.

**CAUTION:** The double tensioning procedure is imperative otherwise the belt could fail resulting in serious engine damage. Also, if a new belt is not attainable and it is necessary to refit the old belt it should be only torqued to 19-24 Nm (14-18 lbs ft).

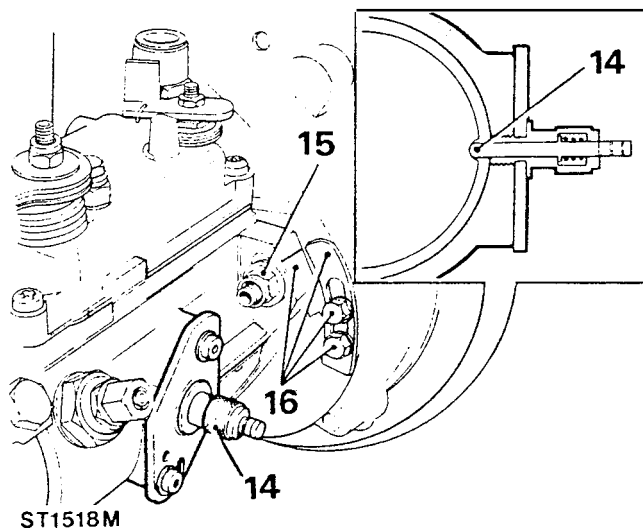


12. Rotate the crankshaft until the pin of the special timing tool can, once again, be inserted into the flywheel E.P. slot.
13. Check that the dots on the camshaft and D.P.S. pump pulleys coincide exactly with their respective cast-on arrows on the rear cover. Should there be any misalignment the foregoing procedure must be repeated.



14. Remove the plug from the side of the D.P.S. pump and insert special tool 18G 1458 and if necessary rotate the pump body until the tool can be fully inserted and screwed home indicating that the inner disc is centrally positioned with the hole.

15. Evenly tighten the three nuts securing the pump flange to the rear cover and the single nut and bolt to the rear support bracket.
16. Align the timing pointer on the rear of the cover with the scribed line on the pump flange and tighten the two screws. If a new pump is being fitted and there is no scribed line, scribe one in the centre of the machined area on the flange. Align the pointer and tighten the screws. Remove the special tool 18G 1458 and refit plug. The timing pointer has been deleted on later engines.



17. Remove the special tool LST 107 and refit the plug to the flywheel housing.
18. Tighten the D.P.S. pump pulley nut and the camshaft pulley retaining bolt to the correct torque.

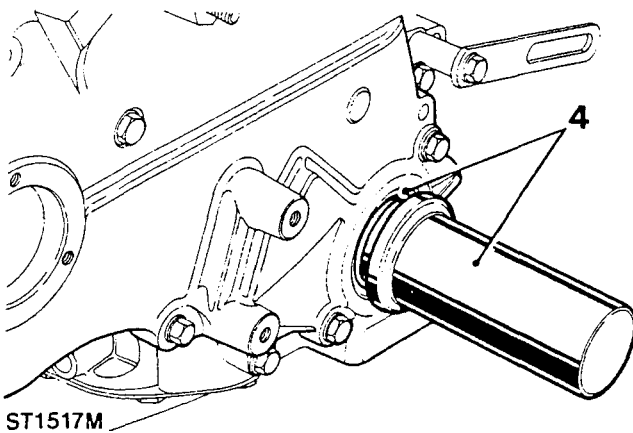
#### Care of belts

1. Drive belts must be stored on edge on a clean flat surface and in such a manner that bends are not less than 2 in (50 mm) radius.
2. When a belt is handled, it must not be bent at an acute angle or an arc of less than 1 in (25 mm) in diameter, as damage may be caused to the glass fibre reinforcement and premature failure then result.
3. During use, a belt develops a wear pattern, therefore, if it is to be re-used, before removal, mark the direction of rotation, using soft chalk or a similar marker, and refit the belt so that it runs in the original direction.
4. Belts must be dry and **FREE FROM ANY OIL OR OTHER FLUID CONTAMINATION.**
5. Do not turn the crankshaft by applying leverage to the camshaft pulley or its retaining bolt.
6. To remove a belt always use clean hands, or a recommended tool — **NEVER** use a lever.



### FIT FRONT COVER WATER PUMP AND CRANKSHAFT PULLEY

1. Place a new joint washer in position and insert the centre 65 mm long bolt into the cover with the fibre washer on the inside.
2. Fit the cover over the dowels and secure with the remaining various length bolts in accordance with the chart. See "Fit timing rear cover, seals and pulleys". Tighten evenly to the correct torque.
3. Fit the vent cover gauze and gasket and secure with the four bolts.
4. Fit a new crankshaft seal. Using special seal replacer tool 18G 1456 and with the lip side leading, drive in the seal up to the shoulder.

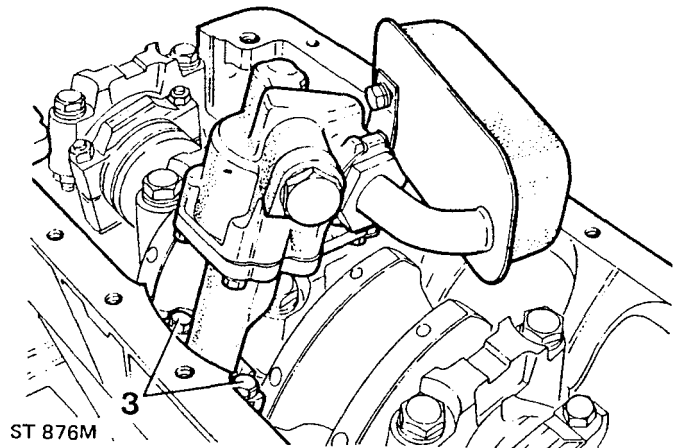


#### Fit water pump and crankshaft pulley

5. Place a new joint washer in position and offer up the water pump. Fit the different length bolts in accordance with the diagram and evenly tighten to the correct torque.
6. Fit the crankshaft pulley and secure with the special washer and bolt. Tighten to the correct torque figure.

### FIT OIL PUMP AND SUMP

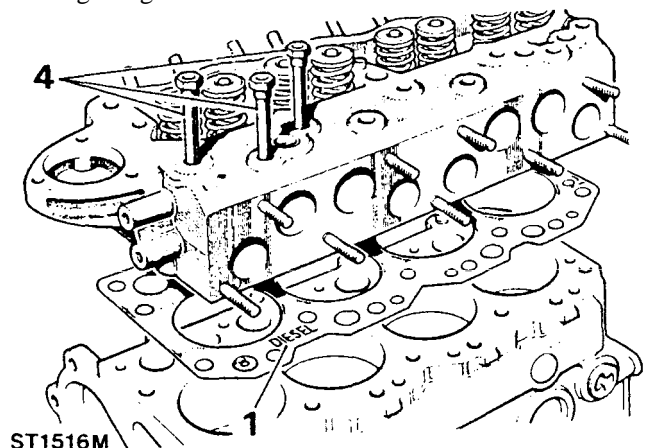
1. Fit the longer splined end of the drive shaft into the oil pump.
2. Fit the oil pump and drive shaft to the crankcase, whilst revolving the shaft as necessary to engage the splines of the skew gear.
3. Using new lock washers, secure the pump to the crankcase tightening the bolts to the correct torque and bend over the lock tabs.
4. If necessary adjust the position of the strainer so that it is parallel to the sump baffle plate.



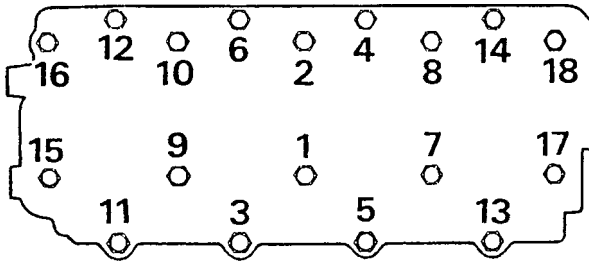
5. Clean the sump and crankcase mating faces and fit a new joint washer. Later engines without a joint washer, apply a bead of RTV HYLOSILL 102 black 7 mm wide to the sump or cylinder block. Secure the sump with the twenty-one bolts and spring washers and one nut. Evenly tighten to the correct torque.

### FIT CYLINDER HEAD AND ROCKER SHAFT ASSEMBLY

1. Clean the cylinder head and cylinder block mating faces. Position a new cylinder head gasket on the cylinder block with the word 'Diesel' uppermost.
2. Lower the cylinder head onto the cylinder block using two long bolts to facilitate accurate positioning of the head.
3. Fit the cylinder head retaining bolts except those also used to secure the rocker shaft and leave finger-tight.
4. Insert the push rods ensuring that the ball end locates properly in the spherical seat in the tappet.
5. Whilst holding the rocker shaft assembly together, lower it into position making sure that the hollow dowels locate properly in the cylinder head. Also ensure that the rocker adjusting screw ball end locate in the push rods.
6. Fit the rocker shaft large retaining bolts and leave finger-tight.



7. Tighten the cylinder head retaining bolts, evenly, to the correct torque figure in the sequence illustrated below.
8. Fit and tighten the rocker shaft, small bolts to the specified torque.

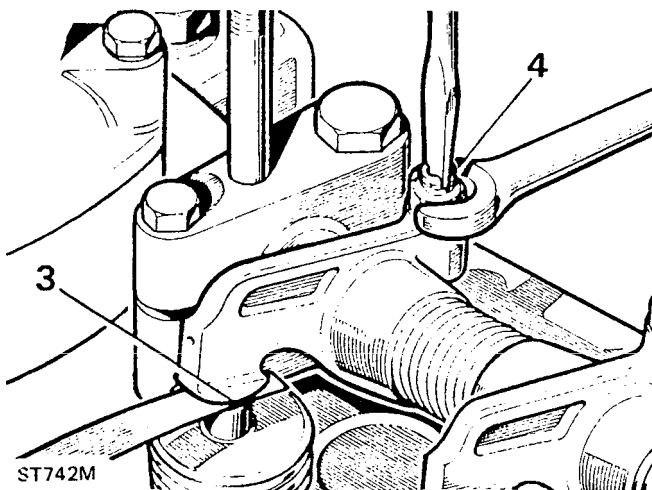


ST 880M



**ADJUST TAPPET CLEARANCES**

1. If the crankshaft is rotated with excessive valve clearances, it is possible that the push rods may become dislodged from the tappet seating and fracture the tappet slide. To prevent damage, eliminate all clearance from any loose rockers before turning the crankshaft to adjust the clearances.
2. Turn the engine over until number eight valve (counting from front of engine) is fully open.
3. Using a 0,25 mm (0.010 in) feeler gauge check the clearance between the valve tip and rocker pad of number one valve.
4. Adjust the clearance by slackening the lock nut and turning the tappet adjusting screw clockwise to reduce clearance and anti-clockwise to increase clearance. Recheck the clearance after tightening the lock nut.



ST742M

5. Continue to check and adjust the remaining tappets in the following sequence:

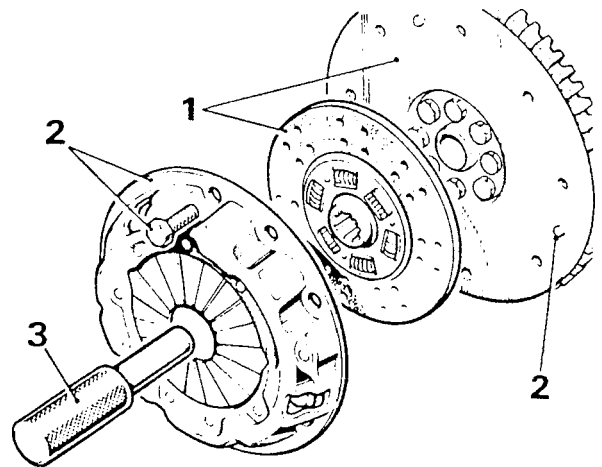
- Set No. 3 tappet with No. 6 valve fully open.
- Set No. 5 tappet with No. 4 valve fully open.
- Set No. 2 tappet with No. 7 valve fully open.
- Set No. 8 tappet with No. 1 valve fully open.
- Set No. 6 tappet with No. 3 valve fully open.
- Set No. 4 tappet with No. 5 valve fully open.
- Set No. 7 tappet with No. 2 valve fully open.

**Fit the rocker cover**

6. Using a new gasket, fit the rocker cover and secure with the dome nuts and washers. Tighten evenly to the correct torque. Do not overtighten.

**FIT THE CLUTCH**

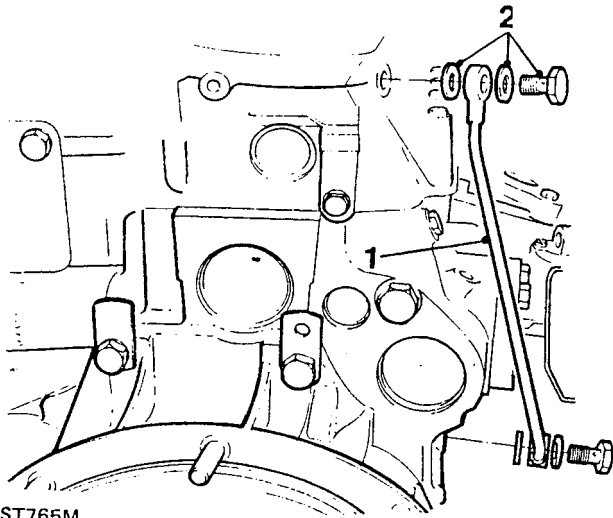
1. Clean the flywheel face and place the centre plate with the side marked 'Flywheel side' towards the flywheel.
2. Fit the clutch assembly locating it over the three dowels and loosely secure with the six bolts.
3. Centralise the centre plate using special tool RO 605022 or a spare primary shaft and tighten the six bolts evenly to the correct torque figure. Smear the splines of the centre plate with Molybdenum disulphide grease, such as Rocol MTS 1000.



ST764M

**FIT CYLINDER HEAD OIL FEED**

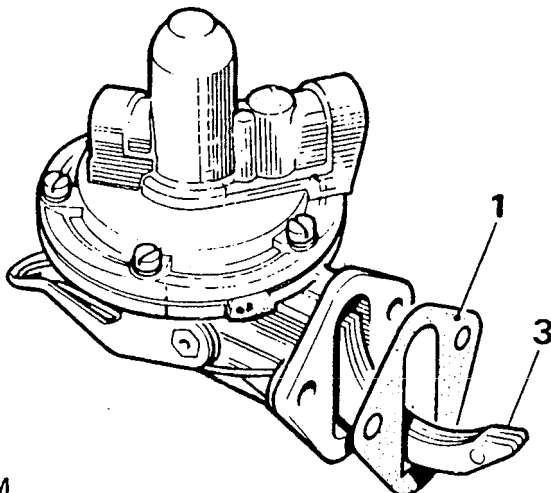
1. Connect the oil feed pipe, for lubrication of the rocker shaft assembly, to the cylinder head
2. Secure with the two banjo bolts and four joint washers.



ST765M

**FIT FUEL LIFT PUMP**

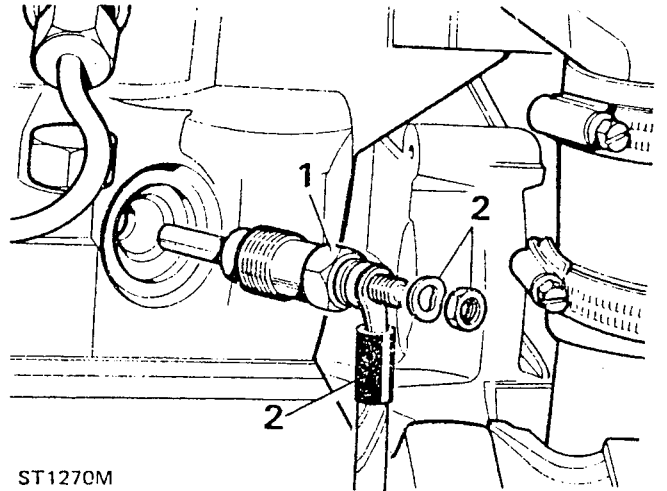
1. If the fuel lift was separated from the side cover, fit the pump to the cover first using a new joint washer between the pump flange and rear cover, evenly tighten the retaining nuts.
2. Place a new cover plate joint washer in position and fit the cover and pump assembly to the cylinder block.
3. Ensure that the pump actuating lever rides on top of the camshaft.
4. Secure the cover, evenly tightening the retaining bolts.



ST762M

**FIT HEATER PLUGS**

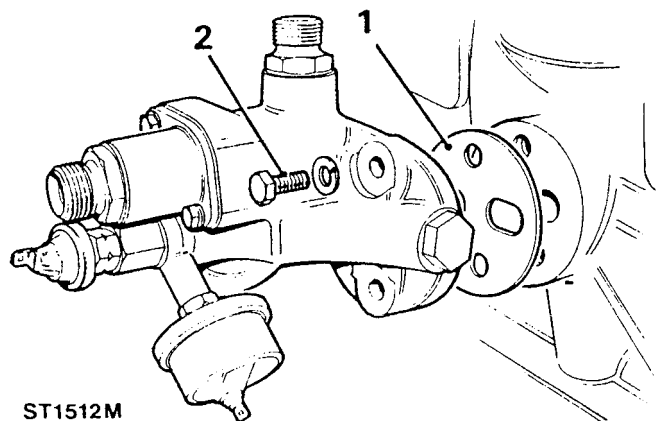
1. Clean and test the heater plugs as described in the maintenance Section. Fit the heater plugs and tighten to the correct torque. Do not over tighten.
2. Fit the leads, washers and nuts as illustrated, ensuring that each cable eyelet is fitted vertically downwards to prevent heat from cylinder head damaging the cable insulation.



ST1270M

**FIT OIL FILTER AND ADAPTOR**

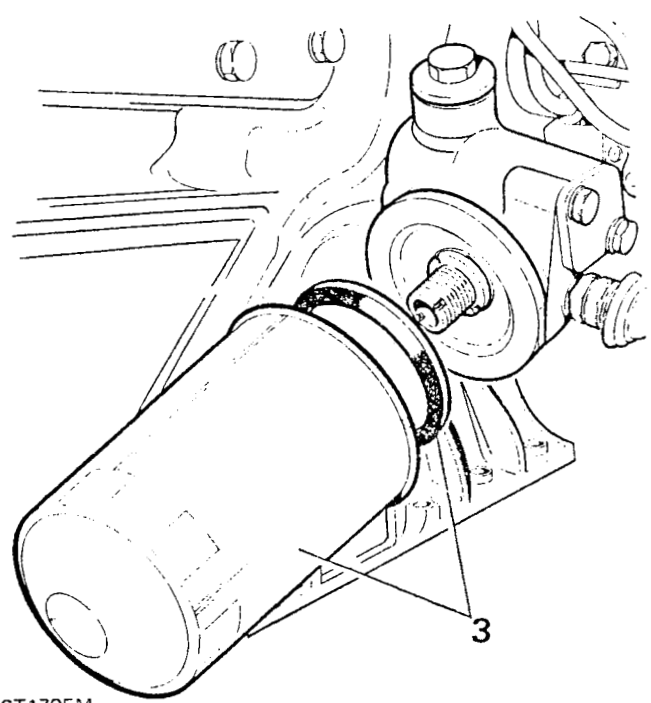
1. Using a new joint washer fit the oil filter adaptor. Ensure that the retaining bolts pass through the two small round holes in the joint washer.
2. Tighten the two retaining bolts evenly to the correct torque.



ST1512M

3. Smear a little clean engine oil on the rubber washer of the new filter, then screw the filter on clockwise until the rubber sealing ring touches the machined face, then tighten a further half turn by hand only. Do not overtighten. See Maintenance Operations, section 10.

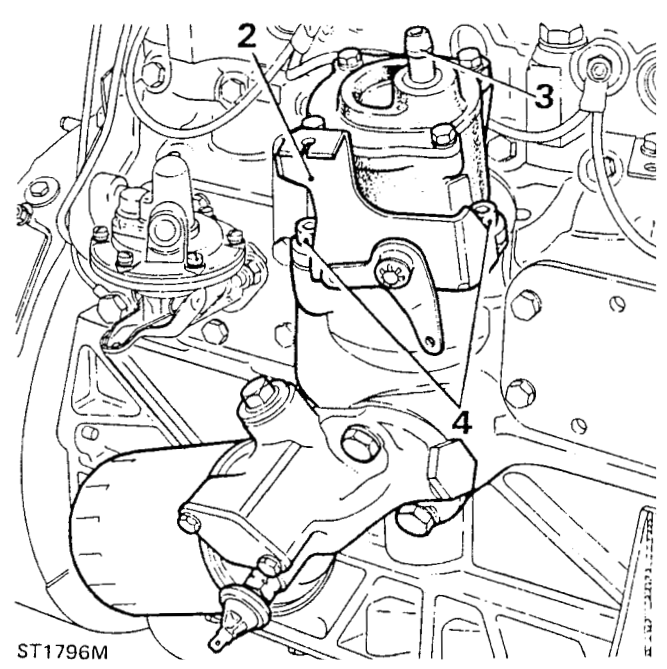
continued



ST1795M

**FIT VACUUM PUMP**

1. Place a new joint washer on the cylinder block face.
2. Fit the D.P.S. pump control bracket.
3. Insert the vacuum pump drive shaft into the skew gear coupling ensuring that the shaft engages properly over the cross pins in the coupling. The hose connection should be towards the front of the engine.
4. Secure the pump and control bracket to the cylinder block with the three socket headed screws.

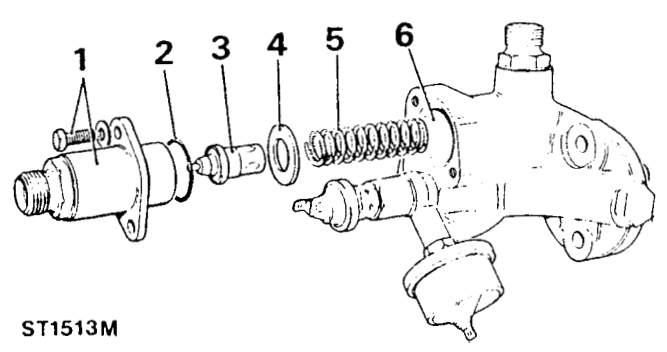


ST1796M

**RENEW OIL TEMPERATURE THERMOSTAT**

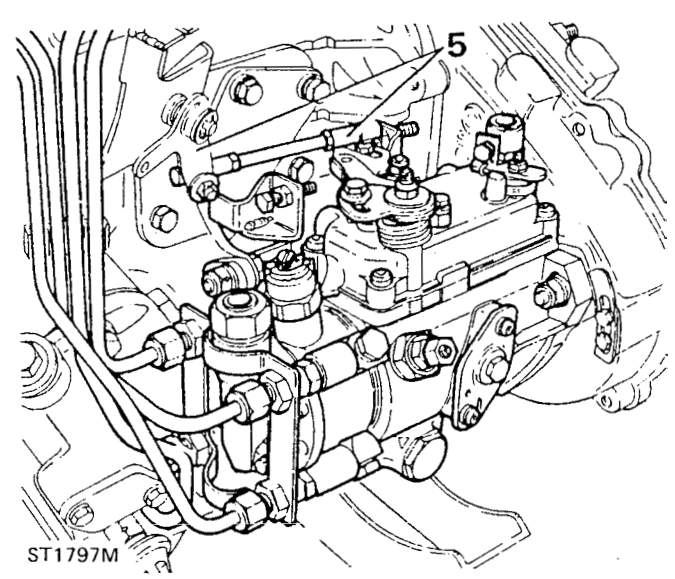
Used when an oil cooler is fitted.

1. Remove the two bolts and carefully withdraw the thermostat extension housing.
2. Remove the 'O' ring.
3. Withdraw the thermostat.
4. Remove the washer.
5. Remove the spring.
6. Clean the adaptor housing with lint-free cloth.
7. Fit the spring and washer.
8. Fit a new thermostat with the pin uppermost.
9. Fit the extension housing using a new 'O' ring. Ensure that the pin protruding from the thermostat locates in the hole in the extension housing.
10. Secure the housing with the two bolts and washers.



ST1513M

5. Connect the D.P.S. pump control rod to the control bracket lever.



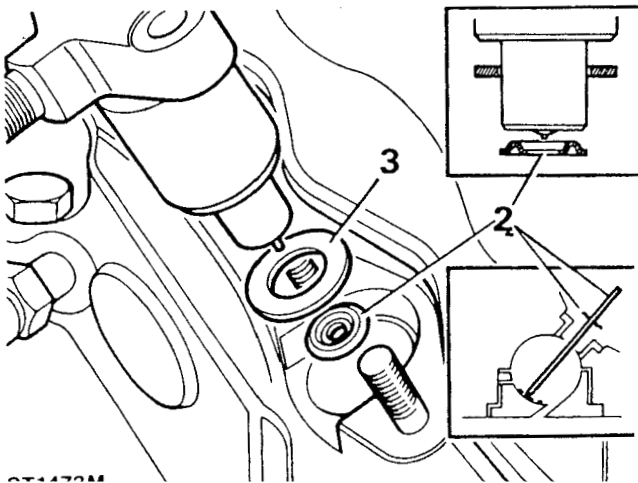
ST1797M

## FIT THE FUEL INJECTORS AND PIPES

### Fit the injectors

The steel sealing washer fitted below the injector nozzle is to ensure that combustion does not take place around the nozzle body and cause it to overheat. A washer which has been used more than once, or an incorrectly fitted washer may cause the nozzle to overheat and result in that cylinder misfiring.

1. Ensure that the new washers are separated from each other and are clean.
2. Use a length of thin welding wire to guide one washer only into each port with the domed side toward the injector as illustrated. Ensure that only one washer is fitted to each port.

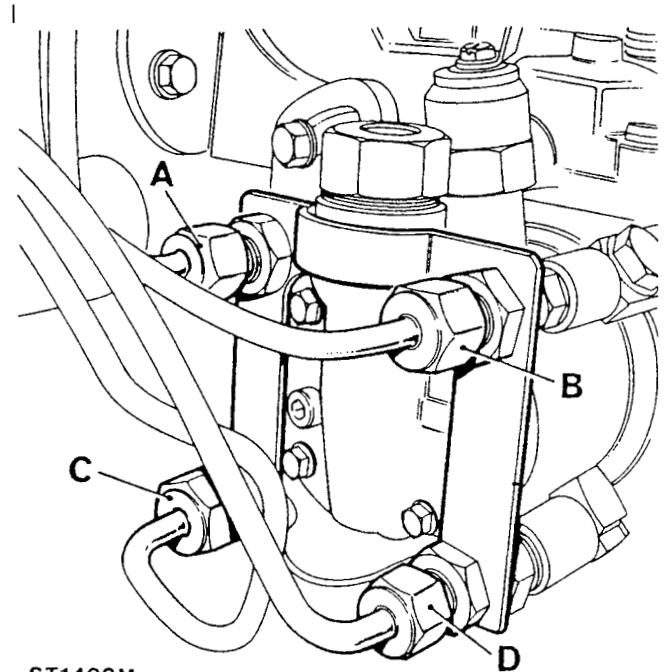


ST1470M

3. Lightly grease the copper washer into position on each injector before fitting to the cylinder head.
4. Fit the injector and evenly tighten the retaining nuts to the correct torque. Uneven or overtightening of the injector nuts could distort the nozzle and cause misfiring when normal running temperature is reached.

### Fit the injector pipes

2. Fit the injector pipes to the injectors and D.P.S. pump. Counting from the front of the engine connect the pipes as follows:
  - A. To number 1 injector.
  - B. To number 2 injector.
  - C. To number 3 injector.
  - D. To number 4 injector.
 Do not overtighten the union nuts.

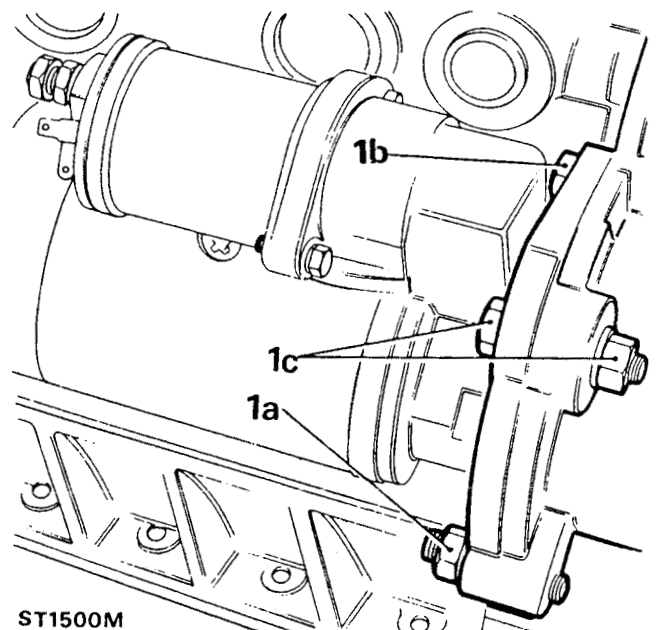


ST1499M

## FIT THE STARTER MOTOR

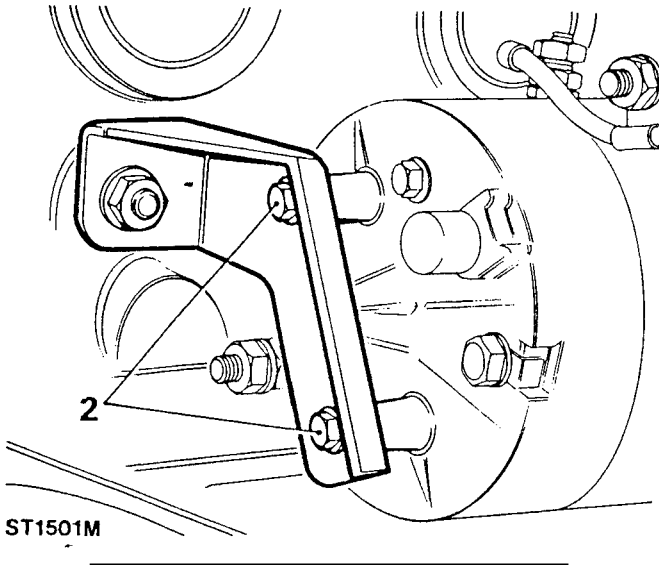
1. Fit the starter motor to the flywheel housing and secure with:
  - a) one stud and nut
  - b) one single bolt
  - c) one nut and bolt.
 Evenly tighten to the correct torque.

continued

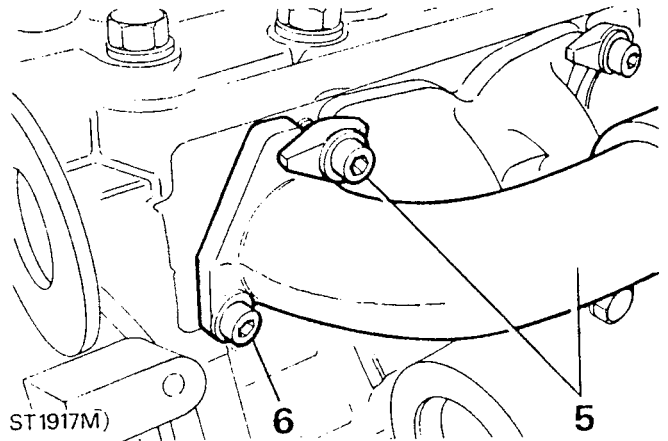


ST1500M

- Secure the rear of the motor to the bracket with two bolts and tighten to the correct torque.

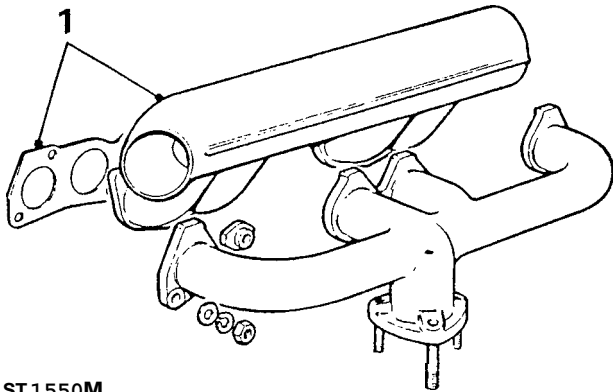


- Fit the exhaust manifold, three lower retaining bolts and tighten to the correct torque.
- Fit the turbo charger and prime the turbo-charger lubrication system, see Fitting Turbo-Charger, Instruction No. 20. Section 19.



**FIT THE AIR INTAKE AND EXHAUST MANIFOLDS**

- Using a new gasket fit the manifolds and secure with the retaining nuts and clamps. Evenly tighten to the specified torque figure.
- Connect the breather hose to the oil filler cap.

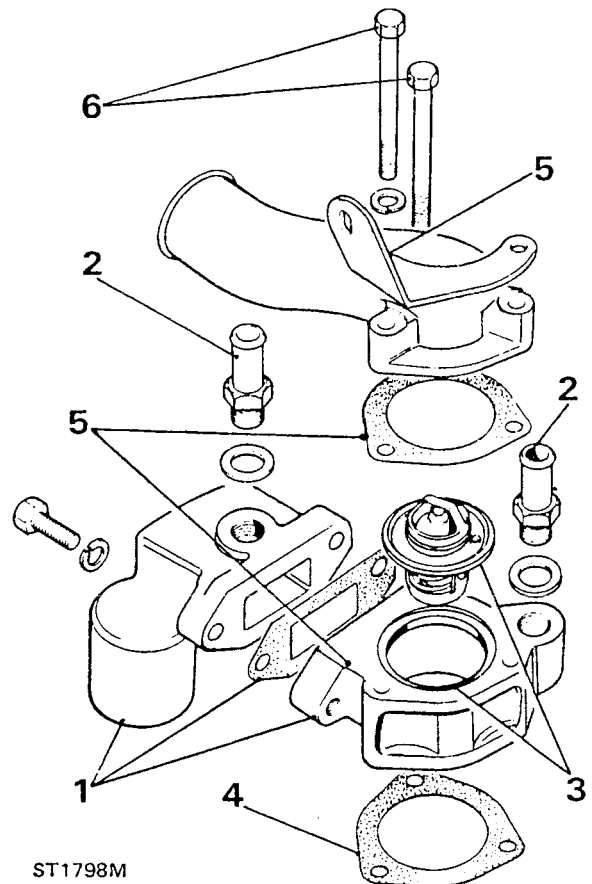
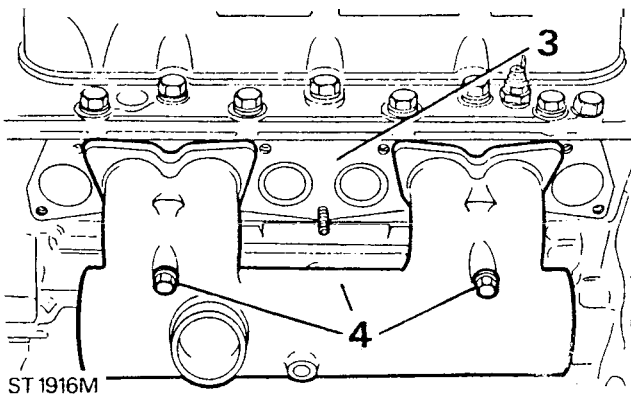


**FIT THE THERMOSTAT HOUSING ASSEMBLY**

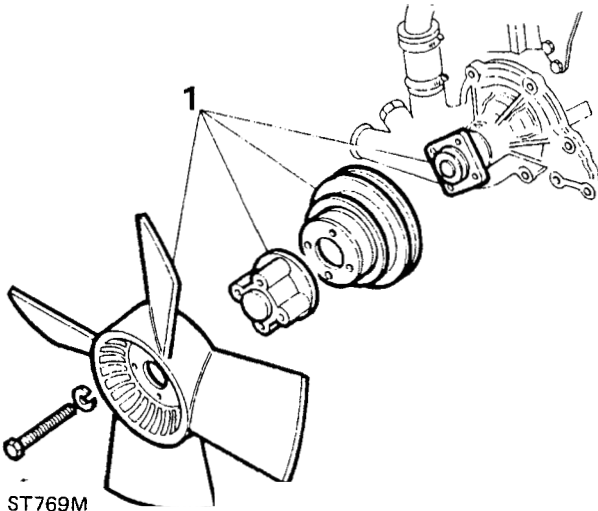
- Using a new joint washer secure the thermostat housing to the by-pass housing — early engines only, later engines the two housings are combined as an integral casting.
- Fit the two hose adaptors.
- Insert the thermostat into its housing.
- Place a new joint washer on the cylinder head mating face.
- Using a new joint washer fit the thermostat cover and cowl mounting bracket.
- With the three long bolts secure the complete assembly to the cylinder head. Note that one bolt is shorter and is fitted in-board.

**Turbo-charged engines**

- Fit a new gasket to the cylinder head.
- Fit the air intake manifold and evenly tighten the bolts to the correct torque.



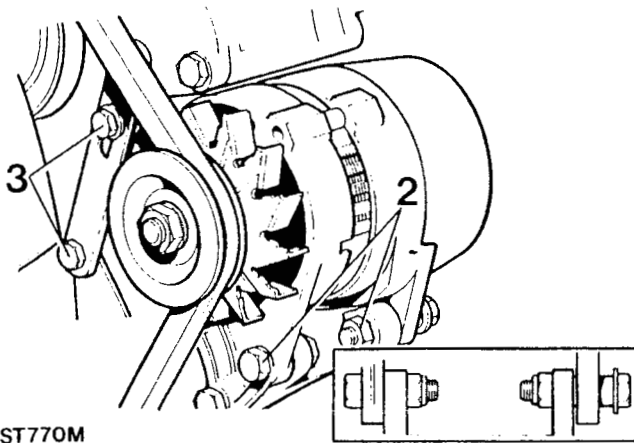
- Fit the exhaust manifold and secure with the four socket headed bolts and clamps.



ST769M

**FIT ALTERNATOR — 12 VOLT**

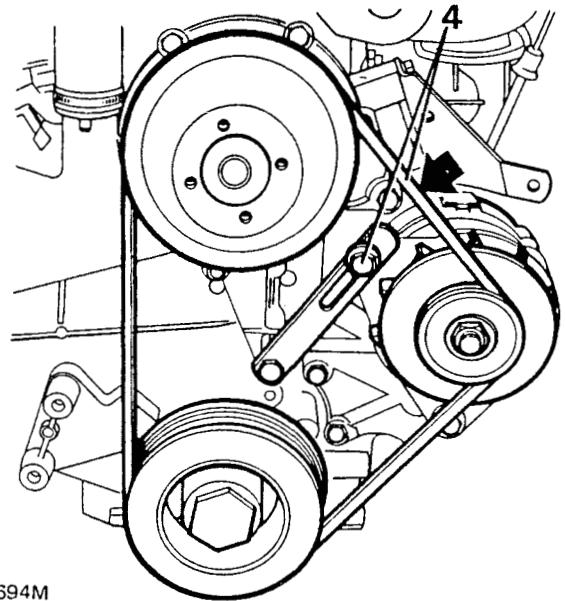
1. Fit adjustment link to front cover.
2. Assemble the alternator to the engine bracket with the two pivot bolts, distance piece and washers, leaving the bolts slack.
3. Fit the adjustment link to the timing cover and attach to alternator with adjusting clamp bolt.



ST770M

**Adjust belt tension**

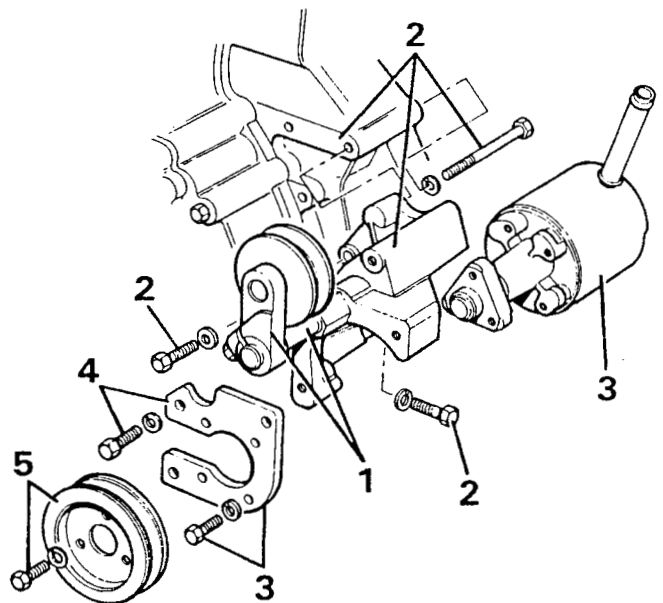
4. Fit the drive belt and pivot the alternator away from the engine, but do not apply pressure to the stator or slip-ring end bracket or damage may result. Tighten the clamp bolt and with thumb pressure, check the belt tension between the fan and alternator pulleys which should be 7 to 9 mm at the mid-point.
5. When the tension is correct fully tighten the clamp bolts and the pivot nuts and bolts.



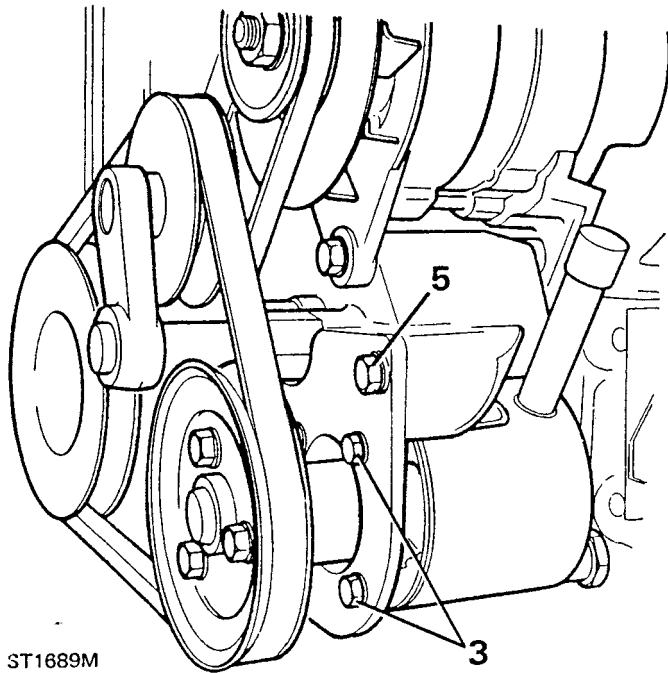
ST1694M

**FIT POWER STEERING PUMP**

1. If removed, fit the jockey pulley to the spindle.
2. Fit the bracket and jockey pulley assembly to the engine with the three bolts.
3. Fit the power steering pump to the bracket and secure the plate to the pump with four bolts.
4. Secure the plate to the bracket with the three bolts.
5. Fit the drive pulley to the pump with the three bolts.
6. Fit the drive belt.

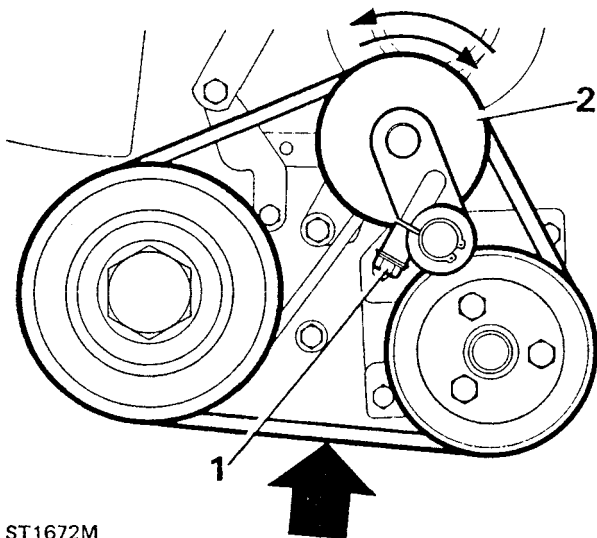


ST1687M



#### ADJUST POWER STEERING DRIVE BELT

1. Slacken the jockey pulley pinch bolt.
2. Move the jockey pulley to the left or right as necessary to achieve a deflection, by thumb pressure, of 12 mm at the mid-point of the belt run between the crankshaft and power steering pump pulley.
3. Tighten the pinch bolt.





## DIESEL ENGINE MECHANICAL FAULTS

SYMPTOM	POSSIBLE CAUSE	CURE
MAIN BEARING RATTLE	34. Low oil level in sump 35. Low oil pressure 36. Excessive bearing clearance 37. Burnt-out bearings 38. Loose bearing caps	Replenish as necessary to high mark on dipstick Worn bearings. Faulty skew, gear assembly. 4-cylinder engine Renew bearings; and or crankshaft Renew and investigate reason for failure Tighten to correct torque
ENGINE OVERHEATING	39. Low coolant level 40. Faulty cooling system 41. Faulty thermostat 42. Cracked cylinder head 43. Defective lubrication system	Check for leaks, check expansion tank level Check fan and belt, pump, radiator fins not blocked rest and renew, if necessary Renew Renew Filter, Check pump, Clean strainer. Check oil circulation. Renew oil temperature thermostat.
LOW OIL PRESSURE WARNING LIGHT REMAINS ON, ENGINE RUNNING	44. Thin or diluted oil 45. Low oil level 46. Choked pump strainer 47. Faulty release valve 48. Excessive bearing clearance 49. Oil pressure switch unservicable 50. Electrical fault 51. Relief valve plunger sticking 52. Weak relief valve spring 53. Pump rotors excessively worn 54. Excessively worn bearings; main. connecting rod. big end, camshaft, etc. 55. Faulty skew gear assembly. 4-cylinder engines	Drain and refill with correct oil and renew filter Replenish to high mark on dipstick Clean Rectify Rectify Renew Check circuit Remove and ascertain cause Renew Overhaul oil pump  Ascertain which bearings and rectify Check skew gear bearing. Check plug not leaking or seals in 2.5 diesel engine. See engine overhaul
RATTLE IN LUBRICATION SYSTEM	56. Oil pressure relief valve plunger sticking	Remove and clean
NOISY VALVE MECHANISM	57. Sticking valves 58. Weak valve springs 59. Tappet clearance too wide 60. Deterioration of timing belt	} Overhaul cylinder head
MECHANICAL NOISES: Low pitch knock Low pitch thud Intermittent thuds High pitch tap Light tapping Clapping	Big-end bearing slack or run Main bearing slack or run Loose flywheel or excessive crankshaft end-float Worn gudgeon pins Excessive valve clearance Excessive piston clearance — more apparent when <b>cold</b>	

## DISMANTLE AND OVERHAUL

Remove the engine from the vehicle and clean the exterior. In the interests of safety and efficient working secure the engine to a recognised engine stand. Drain and discard the sump oil.

Special tools:—

Guide bolts —605351

Torque wrench —18G537

Clutch centralising tool —18G79

Gudgeon pin remover/replacer —Basic tool —18G1150

Adaptor remover/replacer-gudgeon pin. —18G1150E or 605350

Spring compressor —18G106A or RO276102

Valve guide drift exhaust —600959

Valve cutter handle set —MS76

8.5 Adjustable pilot —MS150

Valve seat cutter —MS621

Distance piece for valve guide —RO605774

Drift for guide removal —inlet and exhaust —RO274401

Crankshaft rear seal sleeve —RO1014

## REMOVE ANCILLARY EQUIPMENT

Before commencing, and whilst dismantling, make a careful note of the position of brackets, clips harnesses, pipes, hoses filters and other miscellaneous and non-standard items to facilitate reassembly.

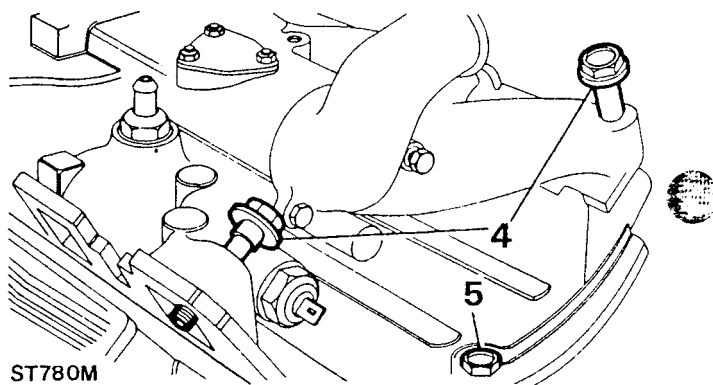
1. Remove the following items of equipment:
  - Starter motor.
  - Alternator and mounting bracket.
  - Power steering pump —where fitted.
  - Disconnect spark plug H.T. leads and remove the distributor.
  - Clutch.
  - Fan blades, pulley and drive belt.
  - Remove pulse air rails from cylinder heads.
  - Dipstick and engine mounting brackets.

## Remove exhaust manifolds

2. Bend back the lock tabs, and remove the eight bolts securing each manifold, and withdraw the manifolds.

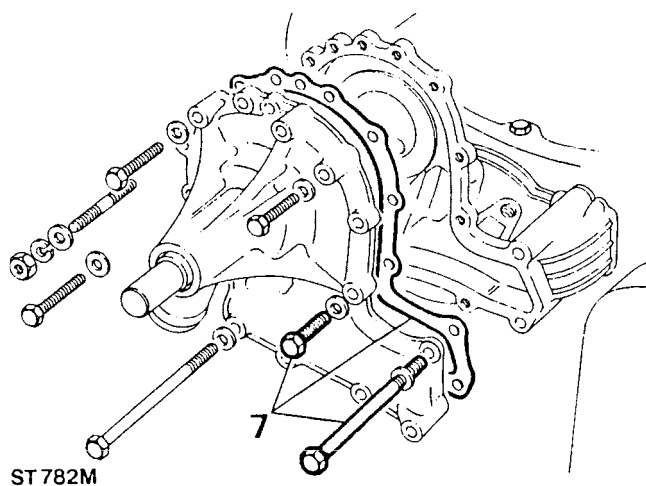
## Remove induction manifold

3. Disconnect miscellaneous pipes and hoses from the induction manifold and the carburetters.
4. Evenly slacken and remove the twelve bolts and lift off the induction manifold complete with carburetters.
5. Wipe away any surplus coolant lying on the manifold gasket and remove the gasket clamp bolts and remove the clamps.
6. Lift off the manifold gasket and seals.



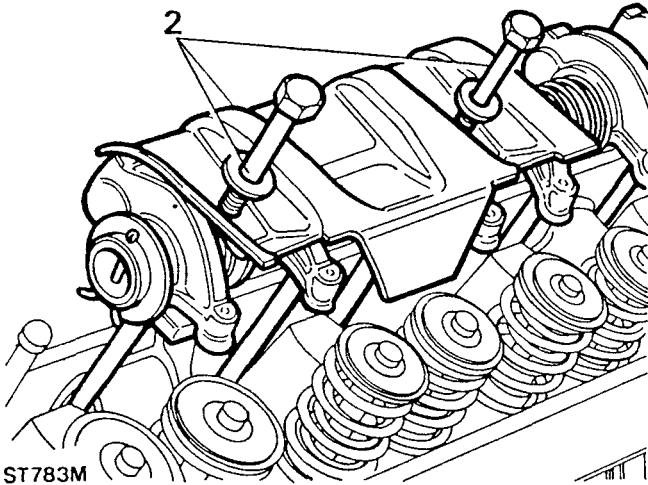
## Remove water pump

7. Remove the fifteen bolts and withdraw the water pump and joint washer.

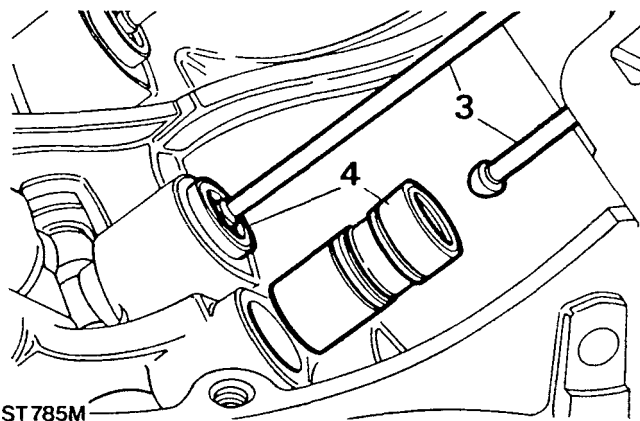


## REMOVE AND OVERHAUL ROCKER SHAFTS AND VALVE GEAR

1. Remove the four screws and lift off the rocker covers
2. Remove the four rocker shaft retaining bolts and lift off the assembly complete with baffle plate.

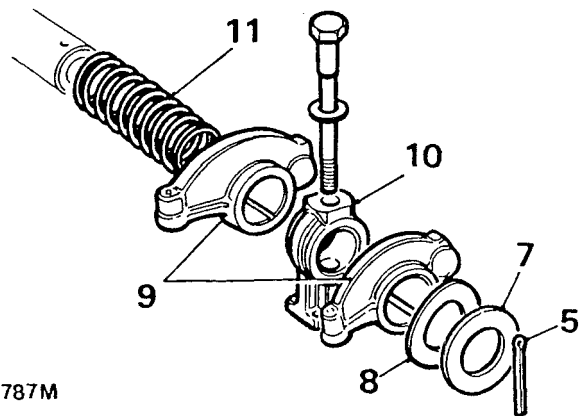


3. Withdraw the pushrods and retain in the sequence removed.
4. Remove the hydraulic tappets and place to one side with their respective pushrods. If a tappet cannot be removed leave in position until the camshaft is removed.



## Dismantle rocker shafts

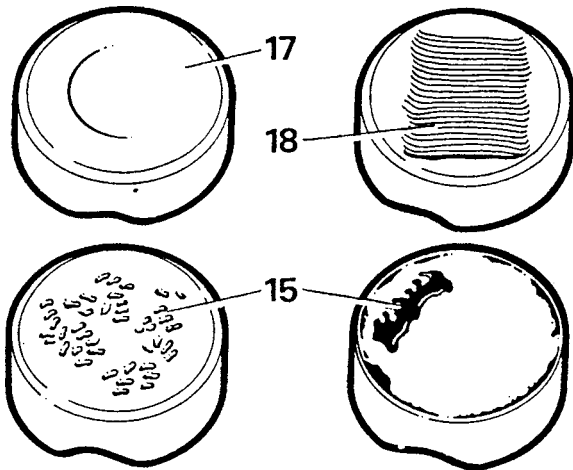
5. Remove the split pin from one end of the rocker shaft.
4. Withdraw the following components and retain them in the correct sequence for reassembly:
  7. A plain washer.
  8. A wave washer.
  9. Rocker arms.
  10. Brackets.
  11. Springs.
12. Examine each component for wear, in particular the rockers and shafts. Discard weak or broken springs.



## Inspect tappets and pushrods

13. Hydraulic tappet; inspect inner and outer surfaces of body for blow holes and scoring. Replace hydraulic tappet if body is roughly scored or grooved, or has a blow hole extending through the wall in a position to permit oil leakage from lower chamber.
14. The prominent wear pattern just above lower end of body should not be considered a defect unless it is definitely grooved or scored. It is caused by side thrust of the cam against the body while the tappet is moving vertically in its guide.
15. Inspect the cam contact surface of the tappets. Fit new tappets if the surface is excessively worn or damaged.
16. A hydraulic tappet body that has been rotating will have a round wear pattern and a non-rotating tappet body will have a square wear pattern with a very slight depression near the centre.
17. Tappets **MUST** rotate and a circular wear condition is normal. Tappets with this wear pattern can be refitted provided there are no other defects.
18. In the case of a non-rotating tappet, fit a new replacement and check camshaft lobes for wear; also ensure the new tappet rotates freely in the cylinder block.

continued



RR750M

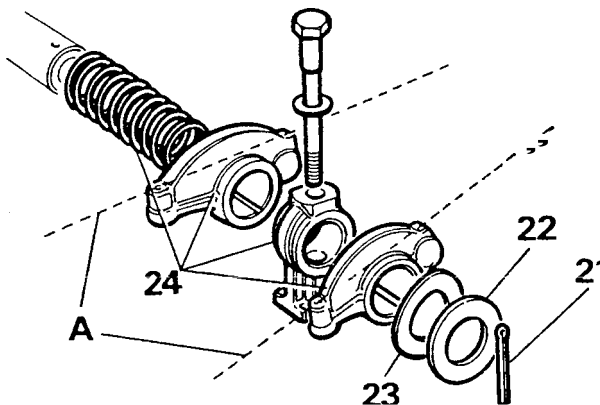
19. Fit a new hydraulic tappet if the area where the pushrod contacts is rough or otherwise damaged.
20. Renew any pushrod having a rough or damaged ball end or seat. **Also** bent rods must be renewed.

#### Assemble rocker shafts

21. Fit a split pin to one end of the rocker shaft.
22. Slide a plain washer over the long end of the shaft to abut the split pin.
23. Fit a wave washer to abut the plain washer.

**NOTE:** Two different rocker arms are used and must be fitted so that the valve ends of the arms slope away from the brackets, as indicated by the dotted lines 'A' on the illustration.

24. Assemble the rocker arms, brackets and springs to the rocker shaft.

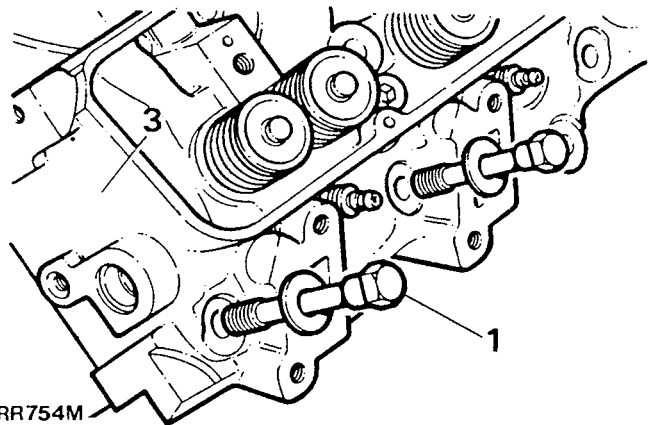


ST788M

25. Compress the springs, brackets and rockers, and fit a wave washer, plain washer and split pin to the end of the rocker shaft.
26. Locate the oil baffle plate in place over the rockers furthest from the notched end of the rocker shaft and fit the bolts through the brackets and place the assemblies to one side.

#### REMOVE AND OVERHAUL THE CYLINDER HEADS

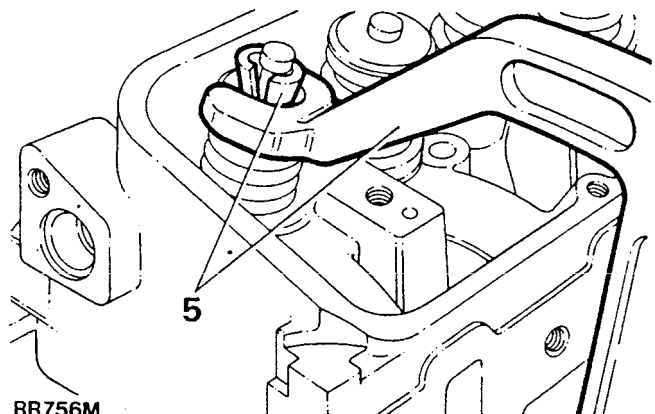
1. Evenly slacken the fourteen cylinder head bolts reversing the tightening order.
2. Before removing the heads mark them relative to the L.H. and R.H. side of the engine.
3. Lift off the cylinder heads and discard the gasket.



RR754M

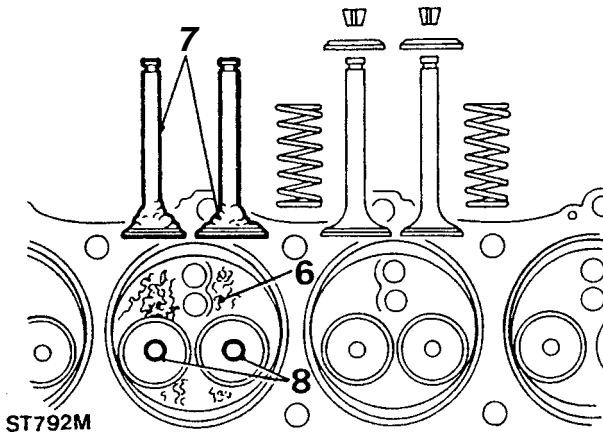
#### Dismantle cylinder heads

4. Remove the spark plugs.
5. Using the valve spring compressor 276102, or a suitable alternative, remove the valves and springs and retain in sequence for refitting.

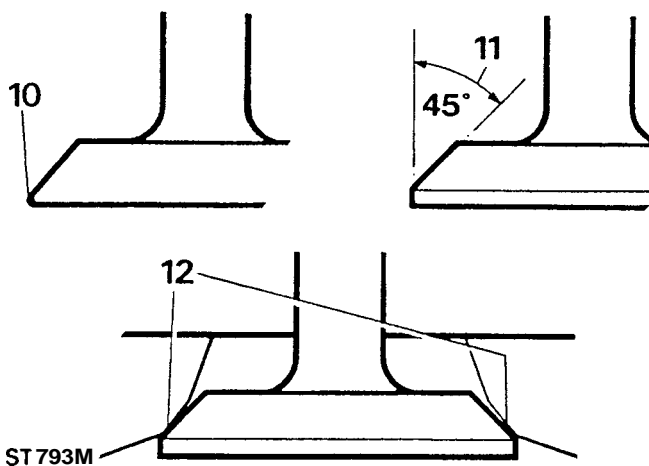


RR756M

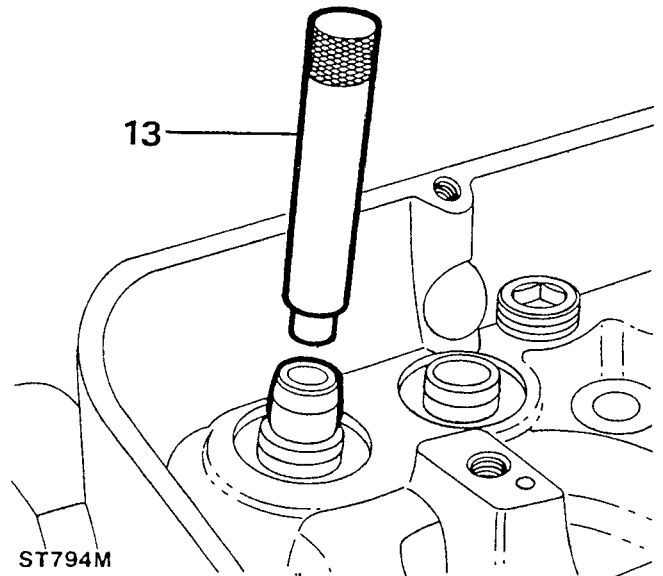
6. Clean the combustion chambers with a soft wire brush.
7. Clean the valves.
8. Clean the valve guide bores.



9. Re grind or fit new valves as necessary.
10. If a valve must be ground to a knife-edge to obtain a true seat, fit a new valve.
11. The correct angle for the valve face is 45 degrees.
12. The correct angle for the seat is  $46 + \frac{1}{4}$  degrees, and the seat witness should be towards the outer edge.



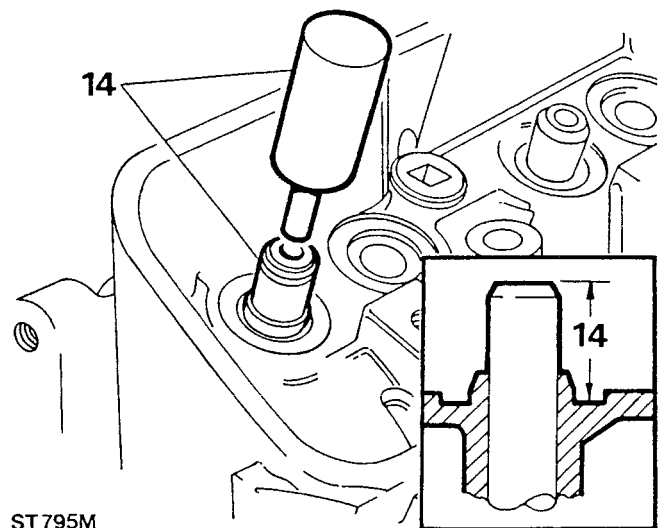
13. Check the valve guides and fit replacements as necessary. Using the valve guide remover 274401, drive out the old guides from the rocker shaft side of the cylinder head.



#### Fit new valve guides

14. Lubricate the new valve guide and place in position. Using guide drift 600959 drive the guide into the cylinder head until it protrudes 19 mm ( $\frac{3}{4}$  in) above the valve spring recess in the head.

**NOTE: Service valve guides are 0,02 mm (0.001 in) larger on the outside diameter than the original equipment to ensure interference fit.**



#### Examine and fit new valve seats

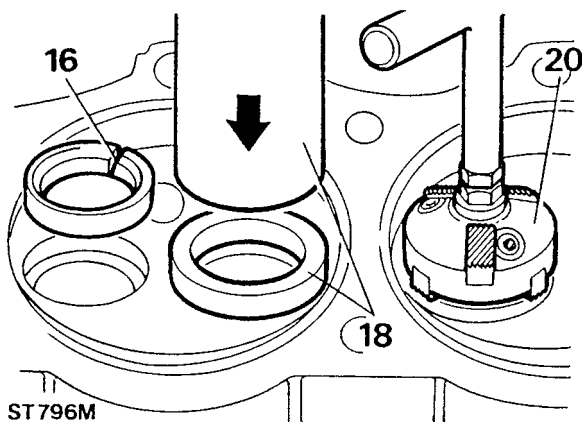
15. Check the valve seats for wear, pits and burning and renew the inserts if necessary.

continued

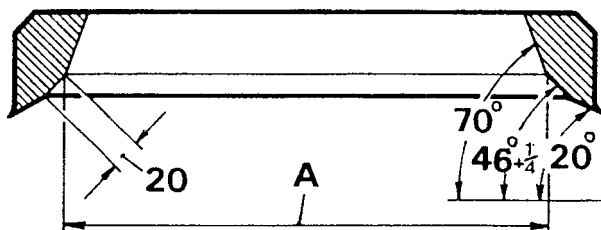
16. Remove the old seat inserts by grinding them away until they are thin enough to be cracked and prised out.
17. Heat the cylinder head evenly to approximately 65 degrees C (150 degrees F).
18. Press the new insert into the recess in the cylinder head.

**NOTE: Service valve seat inserts are available in two over-sizes: 0,25 and 0,50 mm (0.010 and 0.020 in) larger on the outside diameter to ensure interference fit.**

19. If necessary, cut the valve seats to  $46 + \frac{1}{4}$  degrees.
20. The nominal seat width is 1,5 mm (0.031 in). If the seat exceeds 2,0 mm (0.078 in) it should be reduced to the specified width by the use of 20 and 70 degree cutters.
21. The inlet valve seat diameter, A is 37,03 mm (1.458 ins) and the exhaust valve seat is 31,50 mm (1.240 ins) diameter.

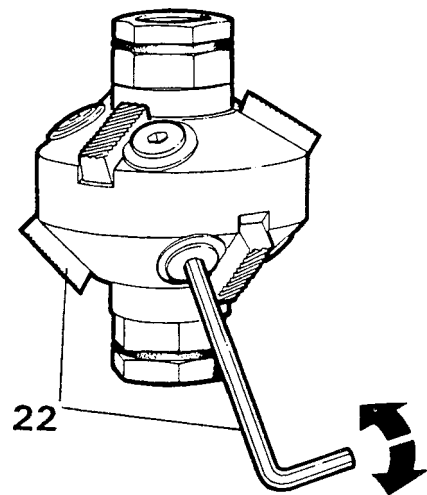


ST796M



ST797M

22. Ensure that the cutter blades are correctly fitted to the cutter head with the angled end of the blade downwards facing the work, as illustrated. Check that the cutter blades are adjusted so that the middle of the blade contacts the area of material to be cut. Use the key provided in the hand set MS 76. Use light pressure, and remove only the minimum material necessary.



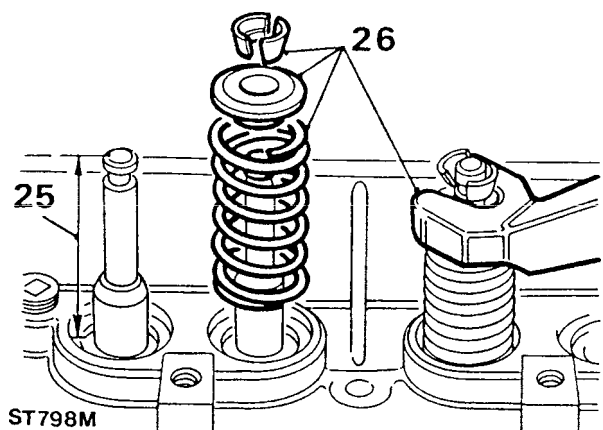
ST1024M

23. Smear a small quantity of engineers' blue round the valve seat and revolve a properly ground valve against the seat. A continuous fine line should appear round the valve. If there is a gap of not more than 12 mm it can be corrected by lapping.
24. Alternatively, insert a strip of cellophane between the valve and seat, hold the valve down by the stem and slowly pull out the cellophane. If there is a drag the seal is satisfactory in that spot. Repeat this in at least eight places. Lapping-in will correct a small open spot.

#### Assemble valves to cylinder head

25. Before fitting the valves and springs the height of each valve above the head must be checked. Insert each valve in turn in its guide and whilst holding the head firmly against the seat, measure the height of the stem above the valve spring seat surface. This dimension must not exceed 47,63 mm (1.875 ins). If necessary renew the valve or grind the end of the valve stem.
26. Lubricate the valve stems and assemble the valves, springs and caps and secure with the collets using valve spring compressor 276102.

**NOTE: Seals are fitted to the inlet valves on later engines, but these can also be fitted to early engines if required.**



ST798M

### Reclaiming cylinder head threads

Damaged or stripped threads in the cylinder head can be salvaged by fitting Helicoils as follows:

**Holes A** — These three holes may be drilled 0.3906 in. dia. x 0.937 + 0.040 in. deep. Tapped with Helicoil Tap No. 6 CPB or 6CS x 0.875 in. (min.) deep ( $\frac{3}{8}$  UNC 1½D insert).

**Holes B** — These eight holes may be drilled 0.3906 in. dia. x 0.812 + 0.040 in. deep. Tapped with Helicoil Tap No. 6 CBB 0.749 in. (min.) deep ( $\frac{3}{8}$  UNC 1½D insert).

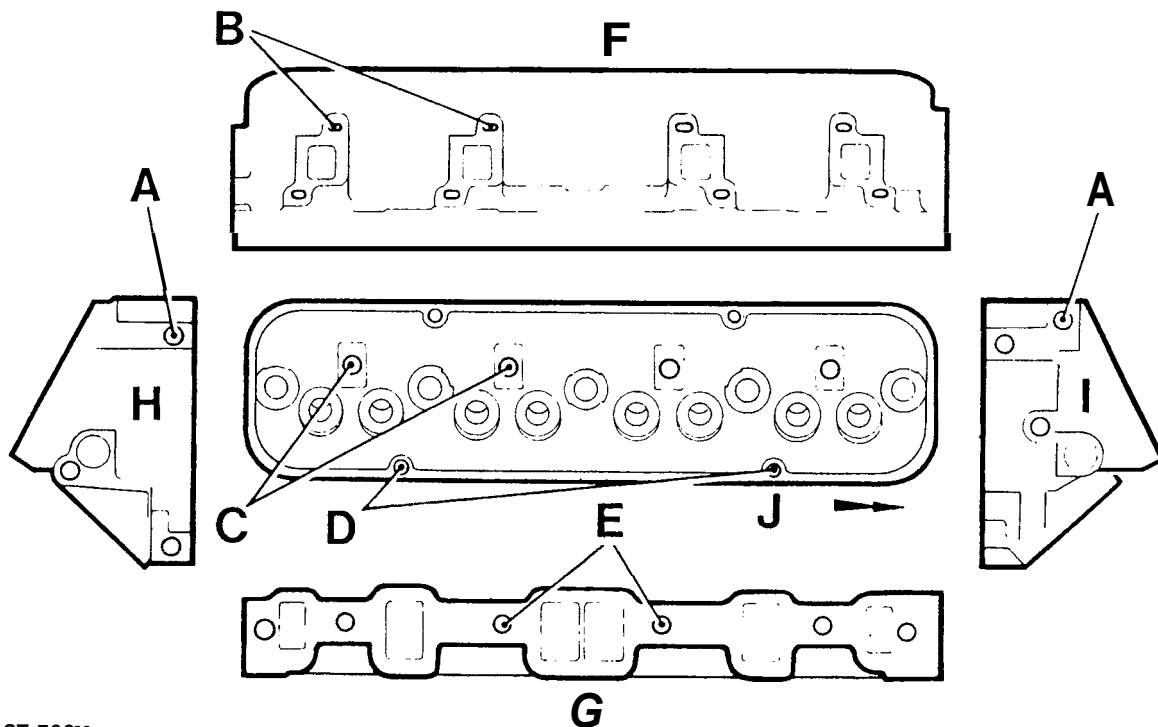
**Holes C** — These four holes may be drilled 0.3906 in. dia. x 0.937 + 0.040 in. deep. Tapped with Helicoil Tap No. 6 CPB or 6CS x 0.875 in. (min.) deep ( $\frac{3}{8}$  UNC 1½D insert).

**Holes D** — These four holes may be drilled 0.261 in. dia. x 0.675 + 0.040 in. deep. Tapped with Helicoil Tap No. 4CPB or 4CS x 0.625 in. (min.) deep ( $\frac{1}{2}$  UNC 1½D insert).

**Holes E** — These six holes may be drilled 0.3906 in. dia. x 0.937 + 0.040 in. deep. Tapped with Helicoil Tap No. 6 CPR or 6CS x 0.875 in. (min.) deep ( $\frac{3}{8}$  UNC 1½D insert).

**NOTE: Right-hand cylinder head illustrated. American projection.**

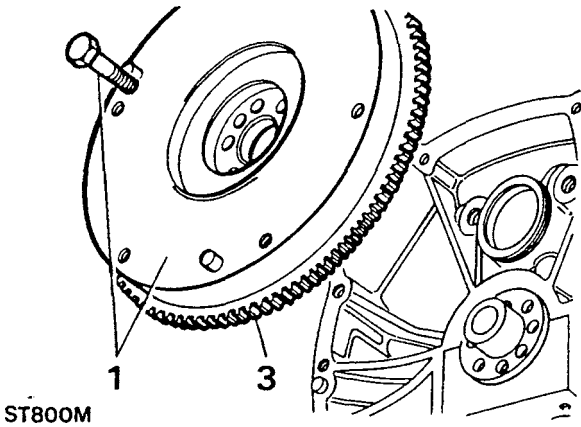
- F Exhaust manifold face
- G Inlet manifold face
- H Front face
- I Rear face
- J Front of engine



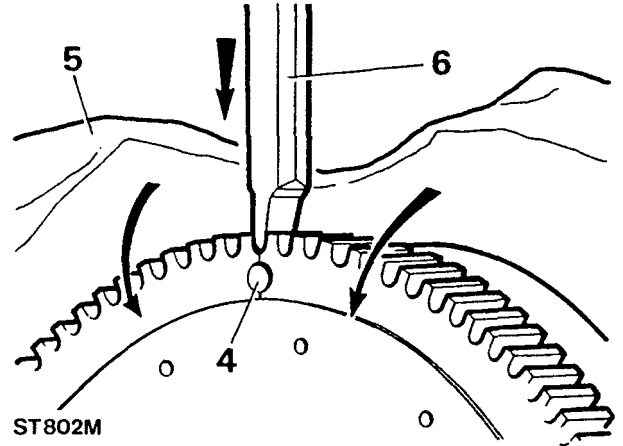
ST 799M

**REMOVE AND OVERHAUL FLYWHEEL**

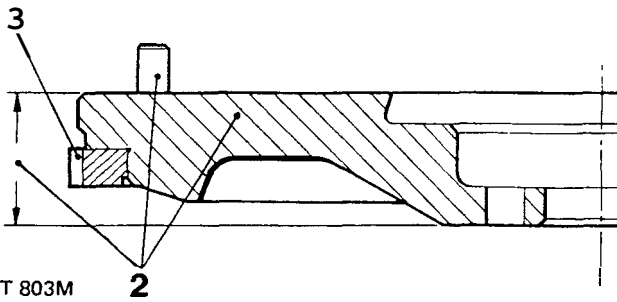
1. Remove the retaining bolts and withdraw the flywheel from the crankshaft.



6. Place a chisel immediately above the drilled hole and strike it sharply to split the starter ring gear.



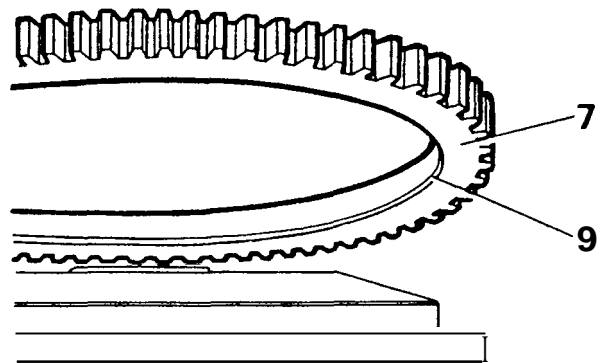
2. Examine the flywheel clutch face for cracks, scores and overheating. If the overall thickness of the flywheel is in excess of the minimum thickness i.e. 39,93 mm (1.572 in) it can be refaced provided that after machining it will not be below the minimum thickness. Remove the three dowels before machining.
3. Examine the ring gear and if worn or the teeth are chipped and broken it can be renewed as follows:



7. Heat the new ring gear uniformly to between 170 degrees and 175 degrees C (338 degrees to 347 degrees F) but do not exceed the higher temperature.
8. Place the flywheel, clutch side down, on a flat surface.
9. Locate the heated starter ring gear in position on the flywheel, with the chamfered inner diameter towards the flywheel flange. If the starter ring gear is chamfered both sides, it can be fitted either way round.
10. Press the starter ring gear firmly against the flange until the ring contracts sufficiently to grip the flywheel.
11. Allow the flywheel to cool gradually. Do NOT hasten cooling in any way or distorting may occur.
12. Fit new clutch assembly location dowels to the flywheel.

4. Drill a 10mm (.375 in) diameter hole axially between the root of any tooth and the inner diameter of the starter ring sufficiently deep to weaken the ring. Do NOT allow the drill to enter the flywheel.
5. Secure the flywheel in a vice fitted with soft jaws and place a cloth over the flywheel to protect the operator from flying fragments.

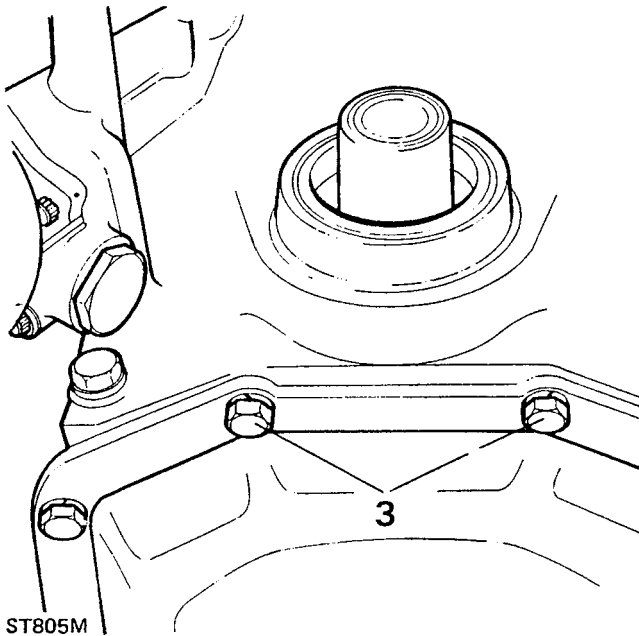
**WARNING:** Take adequate precautions against flying fragments when splitting the ring gear.





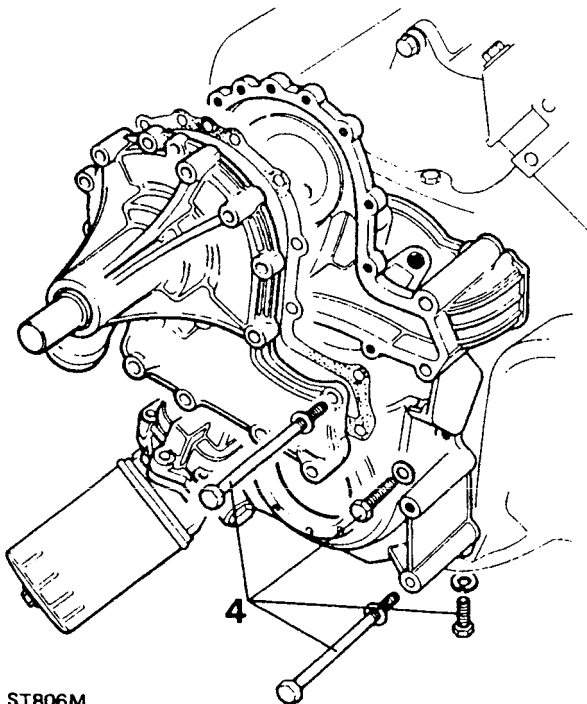
### REMOVE TIMING GEAR COVER AND WATER PUMP

1. Place an oil drip-tray beneath the timing cover and remove the oil filter element.
2. Remove the crankshaft pulley bolt and special washer and withdraw the pulley.
3. Remove the two bolts securing the sump to the bottom of the timing cover.



ST805M

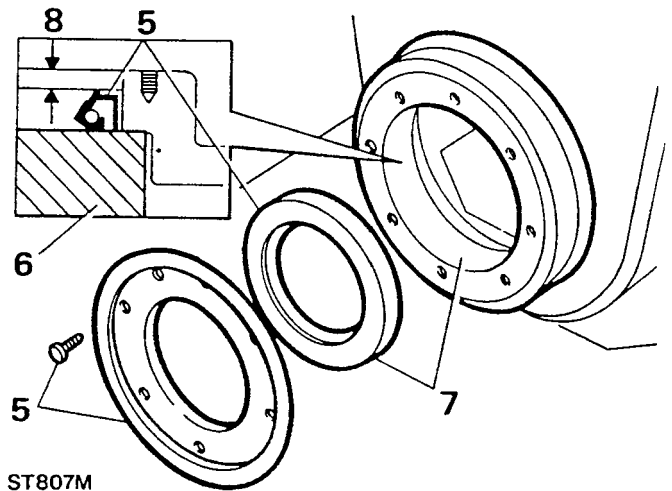
4. Remove the remaining timing cover retaining bolts and withdraw the cover complete with oil pump.



ST806M

### Renewing timing cover oil seal

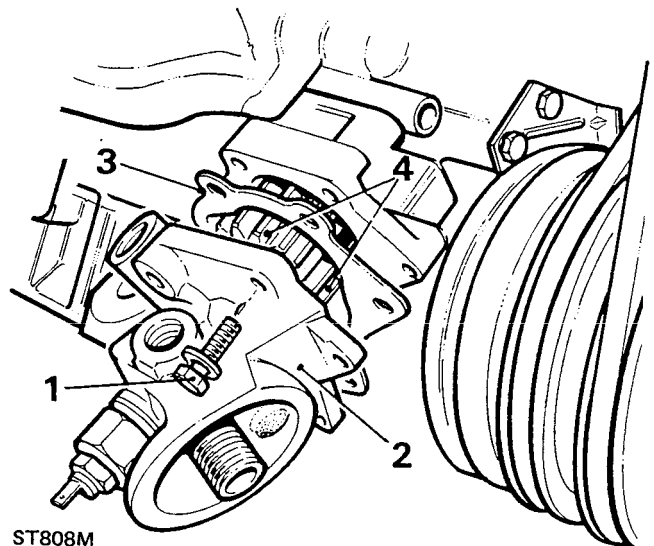
5. Remove the seven drive screws and withdraw the mud shield and the oil seal.
6. Position the gear cover with the front face uppermost and the underside supported across the oil seal housing bore on a suitable wooden block.
7. Enter the oil seal, lip side leading, into the housing bore.
8. Press in the oil seal until the plain face is 1,5 mm (0.062 in) approximately below the gear cover face.
9. Fit the mud shield and secure with the screws.



ST807M

### REMOVE AND OVERHAUL THE OIL PUMP

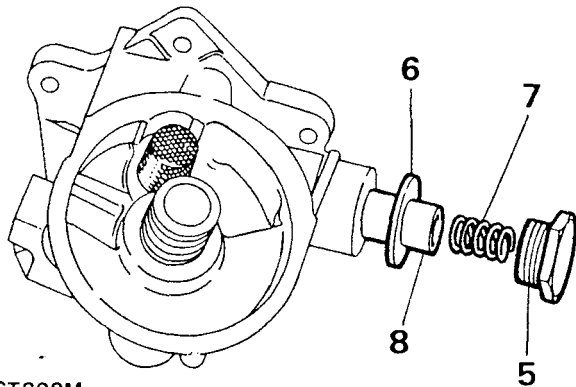
1. Remove the bolts from the oil pump cover.
2. Withdraw the oil pump cover.
3. Lift off the cover gasket.
4. Withdraw the oil pump gears.



ST808M

**Dismantle pump**

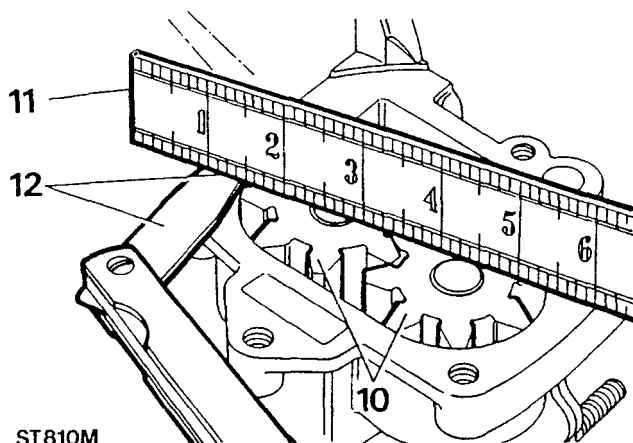
5. Unscrew the plug from the pressure relief valve.
6. Lift off the joint washer for the plug.
7. Withdraw the spring from the relief valve.
8. Withdraw the pressure relief valve.



ST809M

**Examine pump**

9. Check the oil pump gears for wear or scores.
10. Fit the oil pump gears and shaft into the Front cover.
11. Place a straight-edge across the gears.
12. Check the clearance between the straight-edge and the front cover. If less than 0,05 mm (0.0018 in), check the front cover gear pocket for wear.



ST810M

13. Check the oil pressure relief valve for wear or scores.
14. Check the relief valve spring for wear at the sides or signs of collapse.
15. Clean the gauze filter for the relief valve.
16. Check the fit of the relief valve in its bore. The valve must be an easy slide fit with no perceptible side movement.

**Assemble pump**

17. Insert the relief valve spring.
18. Locate the sealing washer on to the relief valve plug.
19. Fit the relief valve plug and tighten to 4,0 to 4,9 kgf m (30 to 35 lbf ft).
20. Fully pack the oil pump gear housing with petroleum jelly. Use only petroleum jelly; no other grease is suitable.
21. Fit the oil pump gears so that the petroleum jelly is forced into every cavity between the teeth of the gears.

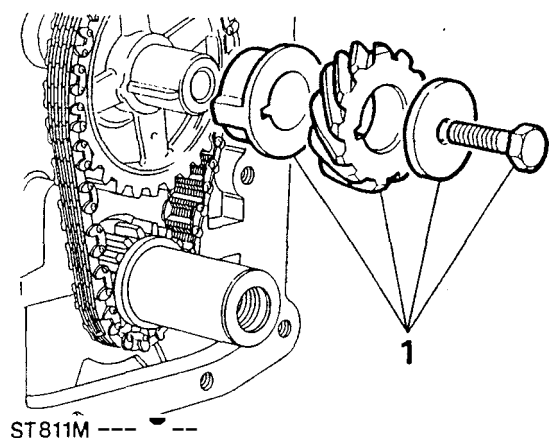
**IMPORTANT:** Unless the pump is fully packed with petroleum jelly it may not prime itself when the engine is started.

22. Place a new gasket on the oil pump cover.
23. Locate the oil pump cover in position.
24. Fit the special fixing bolts and tighten alternately and evenly to the correct torque.

**REMOVE TIMING CHAIN GEARS AND CAMSHAFT**

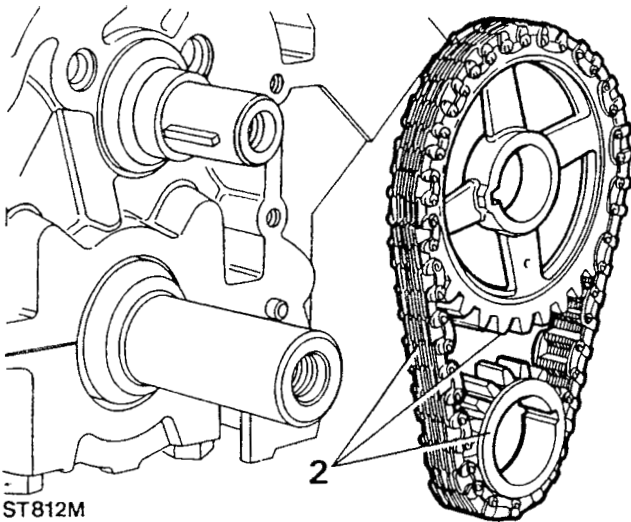
1. Remove the retaining bolt and washer and withdraw the distributor drive gear and spacer.

continued

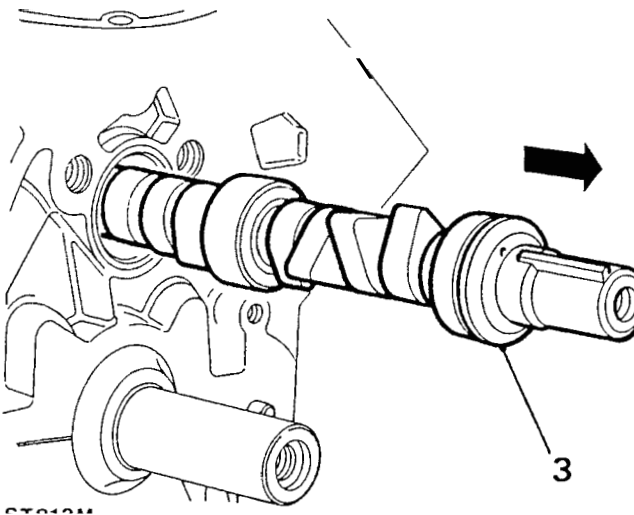


ST811M

2. Withdraw the chain wheels complete with timing chain.



3. Withdraw the camshaft whilst taking particular care not to damage the bearings in the cylinder block.



#### Examine components

4. Visually examine all parts for wear. Check the camshaft bearing journals and cams for wear, pits, scores and overheating. Should any of these conditions be present the shaft should be renewed.
5. Examine the **links** and pins of the timing chain for wear and compare its condition with that of a new chain. Similarly the teeth of the chain wheels should be inspected and if necessary the wheels should be renewed.

6. Measure the camshaft journals for overall wear, ovality and taper. The diameters of the five journals are as follows commencing from the front of the shaft.

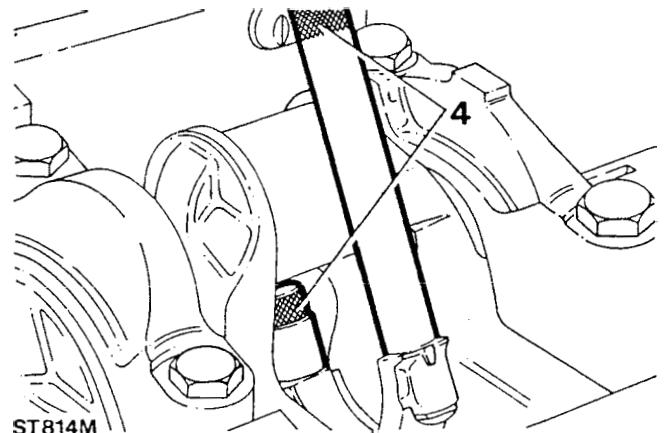
Number 1 journal 1.786 to 1.785 ins  
 Number 2 journal 1.750 to 1.755 ins  
 Number 3 journal 1.726 to 1.725 ins  
 Number 4 journal 1.696 to 1.695 ins  
 Number 5 journal 1.666 to 1.665 ins

7. To check the camshaft for bow, rest the two end journals i.e. numbers 1 and 5 on 'V' blocks and mount a dial gauge on the centre journal. Rotate the shaft and note the reading. If the run out is more than 0,05 mm (0.002 in) it should be renewed.

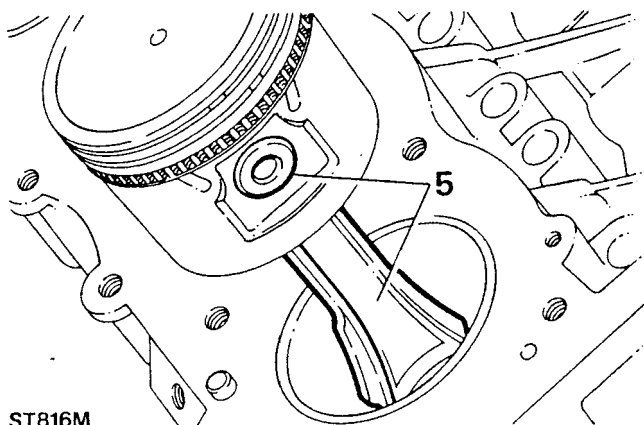
#### REMOVE AND OVERHAUL CONNECTING-RODS AND PISTONS

1. Withdraw the remaining bolts and remove the sump.
2. Remove the sump oil strainer.
3. Remove the connecting-rod caps and retain them in sequence for reassembly.
4. Screw the guide bolts 605351 onto the connecting-rods.

continued



5. Push the connecting-rod and piston assembly up the cylinder bore and withdraw it from the top. Retain the connecting-rod and piston assemblies in sequence with their respective caps.
6. Remove the guide bolts 605351 from the connecting-rod.



ST816M

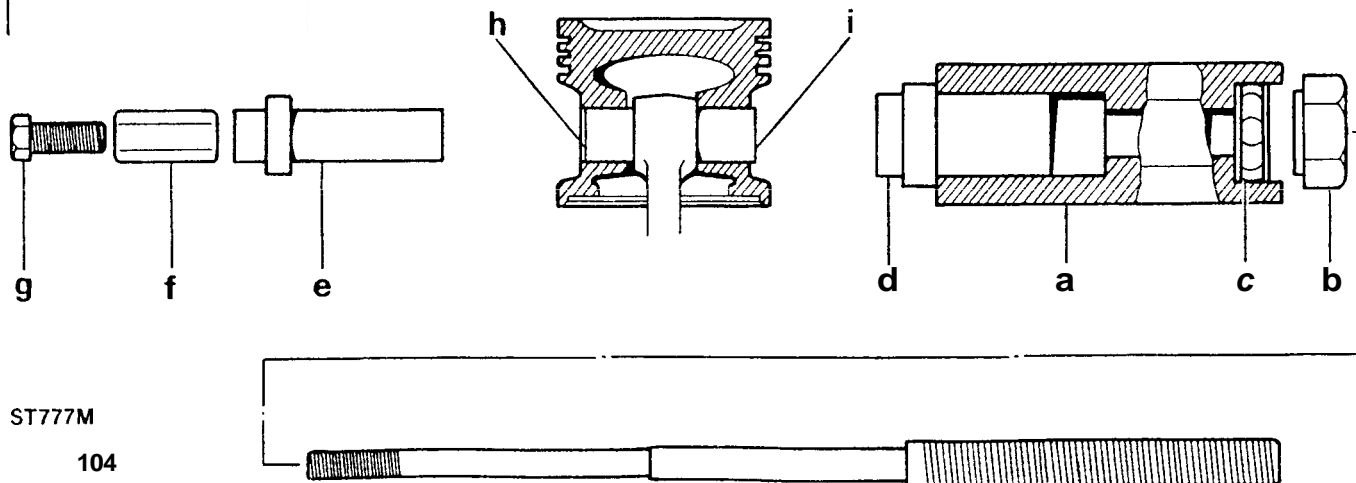
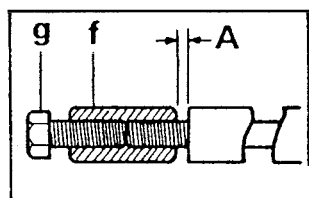
- d. Locate the piston adaptor 18G 1150 E with its long spigot inside the bore of the hexagon body.
- e. Fit the remover/replacer bush of 18G 1150 on the centre screw with the flanged end away from the gudgeon pin.
- f. Screw the stop-nut about half-way onto the smaller threaded end of the centre screw, leaving a gap 'A' of 3 mm ( $\frac{1}{8}$  in) between this nut and the remover/replacer bush.
- g. Lock the stop-nut securely with the lock screw.
- h. Check that the remover-replacer bush is correctly positioned in the bore of the piston.
- i. Push the connecting-rod to the right to expose the end of the gudgeon pin, which must be located in the end of the adaptor 'd'.
- j. Screw the large nut **up** to the thrust race.
- k. Hold the lock screw and turn the large nut until the gudgeon pin has been withdrawn from the piston. Dismantle the tool.

continued

### Overhaul

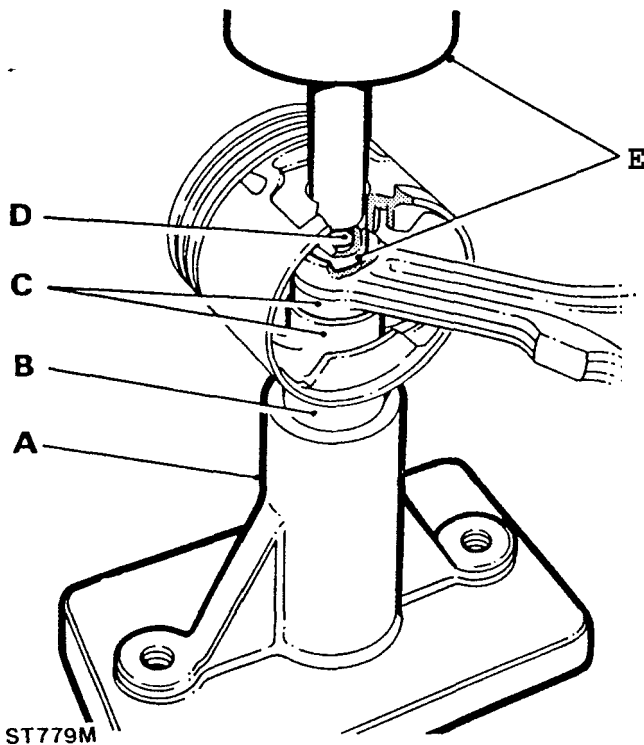
**NOTE:** The connecting-rods, caps and bearing shells must be retained in sets, and in the correct sequence. Remove the piston rings over the crown of the piston. If the same piston is to be refitted, mark it relative to its connecting-rod to ensure that the original assembly is maintained.

7. Withdraw the gudgeon pin, using tool 18G 1150 as follows:
  - a. Clamp the hexagon body of 18G 1150 in a vice.
  - b. Position the large nut flush with the end of the centre screw.
  - c. Push the screw forward until the nut contacts the thrust race.



ST777M

8. As an alternative to tool 18G 1150, press the gudgeon pin from the piston using an hydraulic press and the components which comprise tool 605350 as follows:
- Place the base of tool 605350 on the bed of an hydraulic press which has a capacity of 8 tons (8 tonnes).
  - Fit the guide tube into the bore of the base with its countersunk face uppermost.
  - Push the piston to one side so as to expose one end of the gudgeon pin and locate this end in the guide tube.
  - Fit the spigot end of the small diameter mandrel into the gudgeon pin.
  - Press out the gudgeon pin, using the hydraulic press.



### Original pistons

Remove the carbon deposits, particularly from the ring grooves.

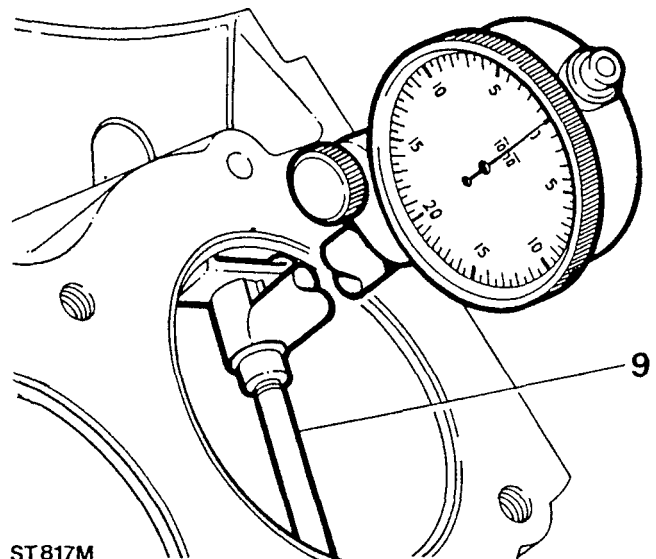
Examine the pistons for signs of damage or excessive wear; refer to 'new pistons' for the method of checking the running clearance. Fit new pistons if necessary.

### New pistons

Pistons are available in service standard size and in oversizes of 0,25 mm (0.010 in) and 0,50 mm (0.020 in). Service standard size pistons are supplied 0,0254 mm (0.001 in) oversize. When fitting new service standard size pistons to a cylinder block, check for correct piston to bore clearance, honing the bore if necessary. Bottom of piston skirt-bore clearance should be 0,018 to 0,033 mm (0.0007 to 0.0013 in).

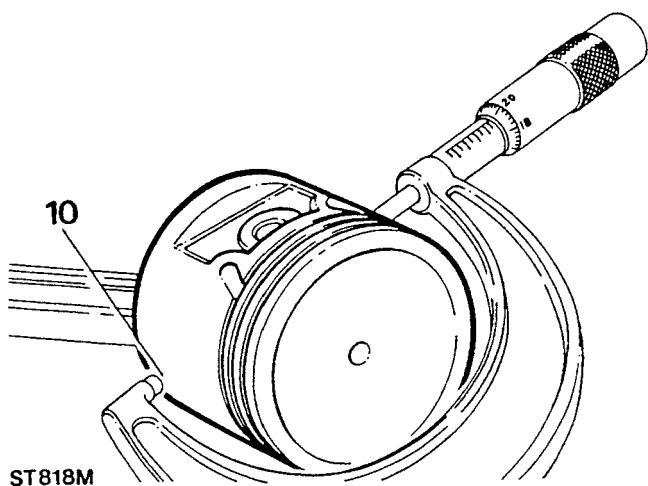
**NOTE: The temperature of the piston and cylinder block must be the same to ensure accurate measurement. When reboring the cylinder block, the crankshaft main bearing caps must be fitted and tightened to the correct torque.**

9. Check the cylinder bore dimension at right angles to the gudgeon pin, 40 to 50 mm (1½ to 2 in) from the top.



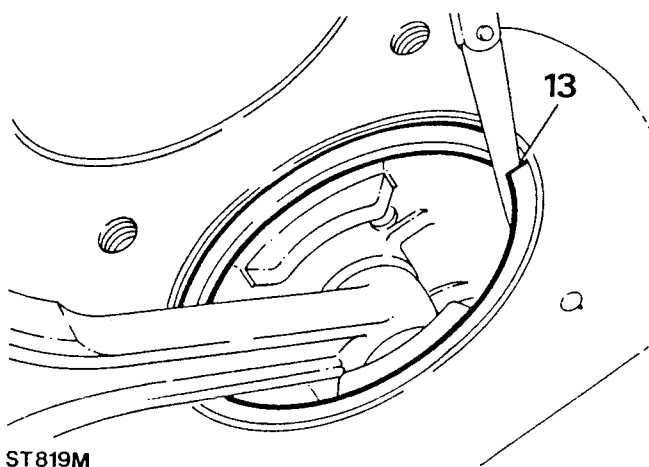
- Check the piston dimension at right angles to the gudgeon pin, at the bottom of the skirt.
- The piston dimension must be 0,018 to 0,033 mm (0.0007 to 0.0013 in) smaller than the cylinder.
- If new piston rings are to be fitted without reboring, deglaze the cylinder walls with a hone, without increasing the bore diameter to provide a cross-hatch finish.

continued

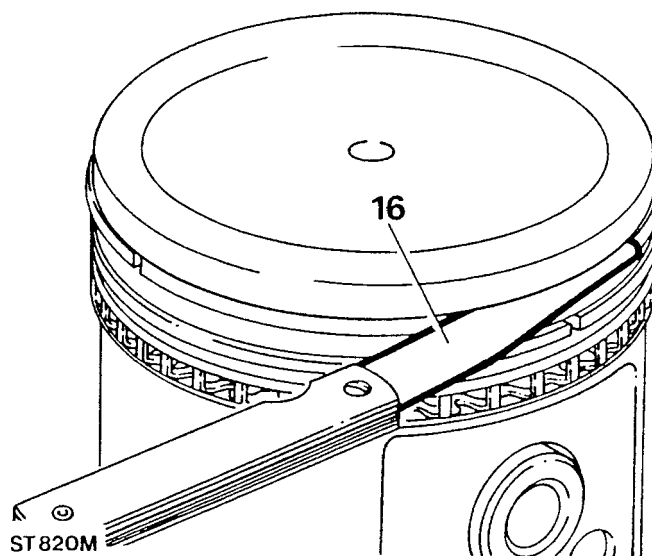


13. Check the compression ring gaps in the applicable cylinder, held square to the bore with the piston. Gap limits: 0,44 to 0,56 mm (0.017 to 0.022 in). Use a fine-cut flat file to increase the gap if required. Select a new piston ring if the gap exceeds the limit.

**NOTE: Gapping does not apply to oil control rings.**

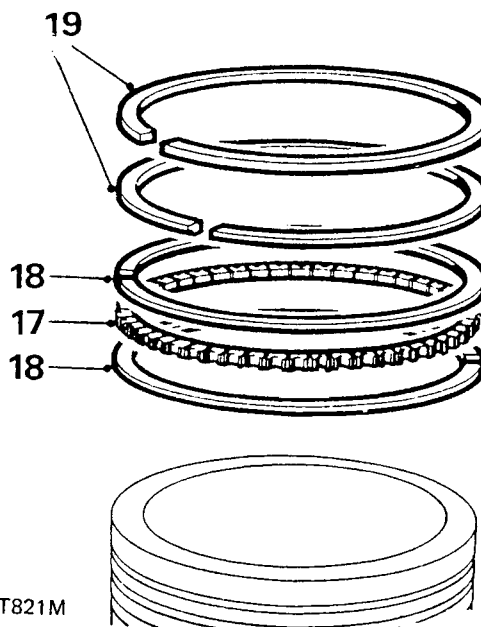


14. Temporarily fit the compression rings to the piston.  
 15. The ring marked 'TOP' must be fitted with the marking uppermost and into the second groove. The chrome ring is for the top groove and can be fitted either way round.  
 16. Check the compression ring clearance in the piston groove. Clearance limits: 0,05 to 0,10 mm (0.002 to 0.004 in).



**Fit piston rings**

17. Fit the expander ring into the bottom groove making sure that the ends butt and do not overlap.  
 18. Fit two ring rails to the bottom groove, one above and one below the expander ring.  
 19. Fit the second compression ring with the marking 'TOP' uppermost and the chrome compression ring in the top groove, either way round.



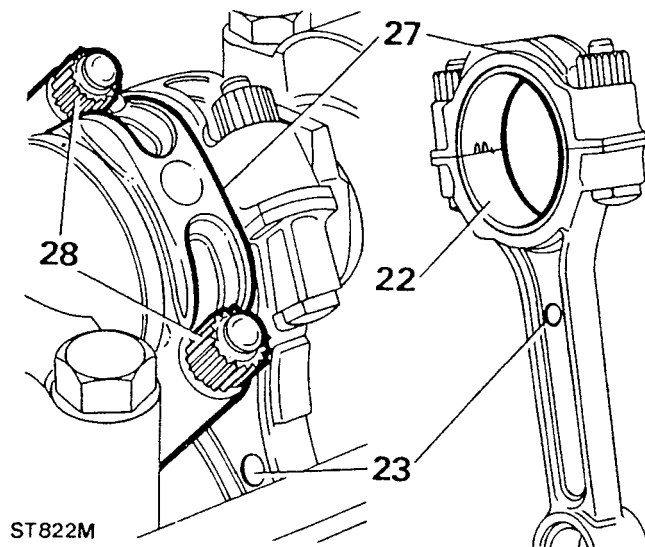
**Examine connecting-rods**

20. Check the alignment of the connecting-rod.  
 21. Check the connecting-rod small end, the gudgeon pin must be a press fit.

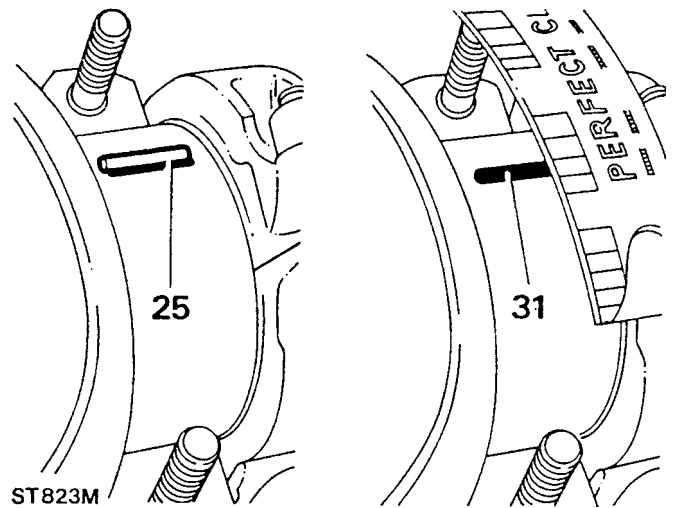
continued

### Check crankshaft bearings

22. Locate the bearing upper shell into the connecting-rod.
23. Locate the connecting-rod and bearing on to the applicable crankshaft journal, noting that the domed shape boss on the connecting-rod must face towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank.
24. When both connecting-rods are fitted, the bosses will face inwards towards each other.
25. Place a piece of Plastigauge across the centre of the lower half of the crankshaft journal.
26. Locate the bearing lower shell into the connecting-rod cap.
27. Locate the cap and shell on to the connecting-rod. Note that the rib on the edge of the cap must be the same side as the domed shape boss on the connecting-rod.
28. Secure the connecting-rod cap, and tighten to the correct torque.



29. Do not rotate the crankshaft or connecting-rod while the Plastigauge is in use.
30. Remove the connecting-rod cap and shell.
31. Using the scale printed on the Plastigauge packet, measure the flattened Plastigauge at its widest point.
32. The graduation that most closely corresponds to the width of the Plastigauge indicates the bearing clearance.
33. The correct bearing clearance with new or overhauled components is 0,013 to 0,06 mm (0.0006 to 0.0022 in).
34. If a bearing has been in service, it is advisable to fit a new bearing if the clearance exceeds 0,08 mm (0.003 in).
35. If a new bearing is being fitted, use selective assembly to obtain the correct clearance.
36. Wipe off the Plastigauge with an oily rag. **DO NOT** scrape it off.

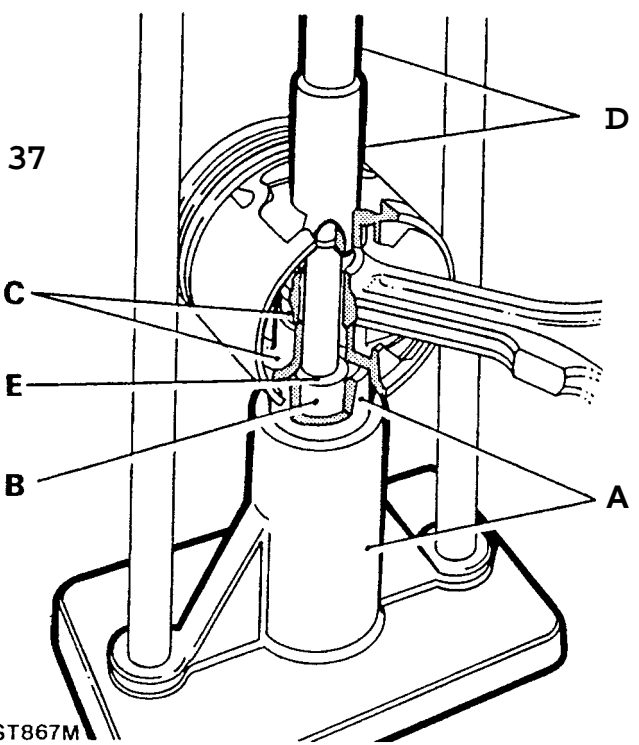


**IMPORTANT:** The connecting-rods, caps and bearing shells must be retained in sets, and in the correct sequence.

### Assembling pistons to connecting-rods

37. If an hydraulic press and tool 605350 was used for dismantling, refit each piston to its connecting-rod as follows:
  - a. Check that the base of tool 605350 and the guide tube are fitted as follows:—  
Place the base of tool 605350 on the bed of an hydraulic press which has a capacity of 8 tons (8 tonnes).  
Fit the guide tube into the bore of the base with its countersunk face uppermost.
  - b. Fit the long mandrel inside the guide tube.
  - c. Fit the connecting-rod into the piston with the markings together if the original pair arc being used, then place the piston and connecting-rod assembly over the long mandrel until the gudgeon pin boss rests on the guide tube.
  - d. Fit the gudgeon pin into the piston up to the connecting-rod, and the spigot end of the small diameter mandrel into the gudgeon pin.
  - e. Press in the gudgeon pin until it abuts the shoulder of the long mandrel.

continued



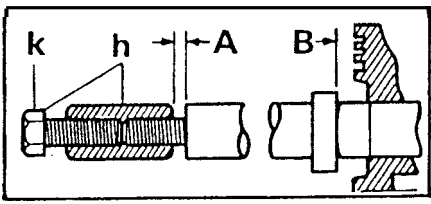
ST867M

38. If tool 18G 1150 was used for dismantling, refit each piston to its connecting-rod as follows:
- Clamp the hexagon body of 18G 1150 in a vice, with the adaptor 18G 1150 E positioned as in 4d.
  - Remove the large nut of 18G 1150 and push the centre screw approximately 50 mm (2 in) into the body until the shoulder is exposed.
  - Slide the parallel guide sleeve, grooved end last, onto the centre screw and up to the shoulder.

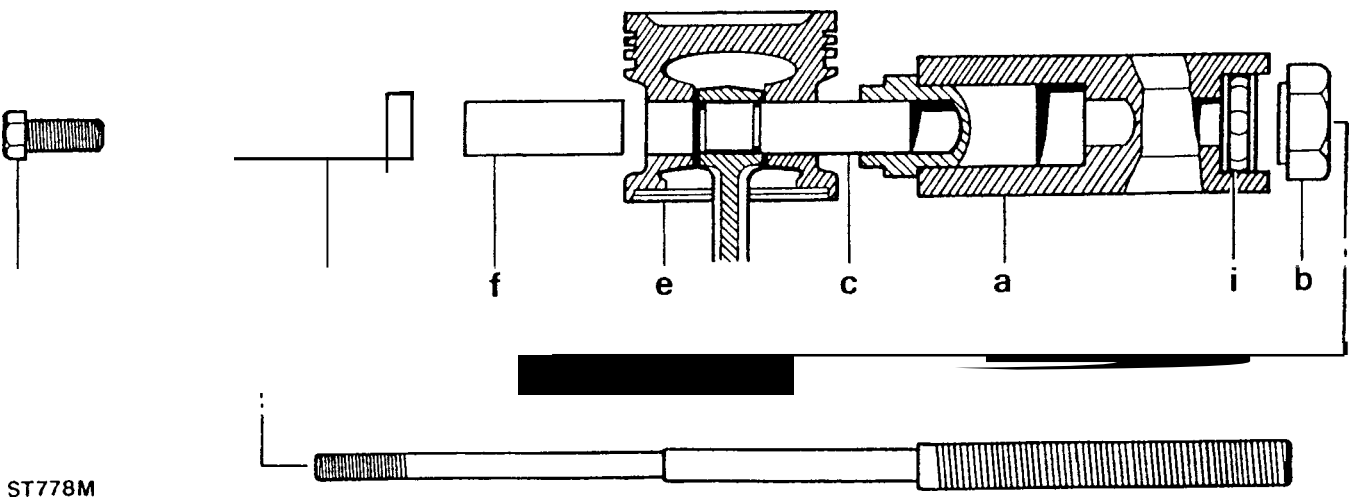
- Lubricate the gudgeon pin and bores of the connecting-rod and piston with graphited oil (Acheson's Colloids 'Oildag'). Also lubricate the ball race and centre screw of 18G 1150.
- Fit the connecting-rod and the piston together onto the tool with the markings together if the original pair are being used and with the connecting-rod around the sleeve up to the groove.
- Fit the gudgeon pin into the piston bore up to the connecting-rod.
- Fit the remover/replacer bush 18G 1150/3 with its flanged end towards the gudgeon pin.
- Screw the stop-nut onto the centre screw and adjust this nut to obtain a 1 mm ( $\frac{1}{32}$  in) end-float 'A' on the whole assembly, and lock the nut securely with the screw.
- Slide the assembly back into the hexagon body and screw on the large nut up to the thrust race.
- Set the torque wrench 18G 537 to 12 lbf ft. This

- represents the minimum load for an acceptable interference fit of the gudgeon pin in the connecting-rod.
- Using the torque wrench and socket 18G 587 on the large nut, and holding the lock screw, pull the gudgeon pin in until the flange of the remover-replacer bush is 4 mm (0.160 in) 'B' from the face of the piston. Under no circumstances must this flange be allowed to contact the piston.

**CAUTION: If the torque wrench has not broken throughout the pull, the fit of the gudgeon pin to the connecting-rod is not acceptable and necessitates the renewal of components. The large nut and centre screw of the tool must be kept well-oiled.**



39. Remove the tool and check that the piston moves freely on the gudgeon pin and that no damage has occurred during pressing.

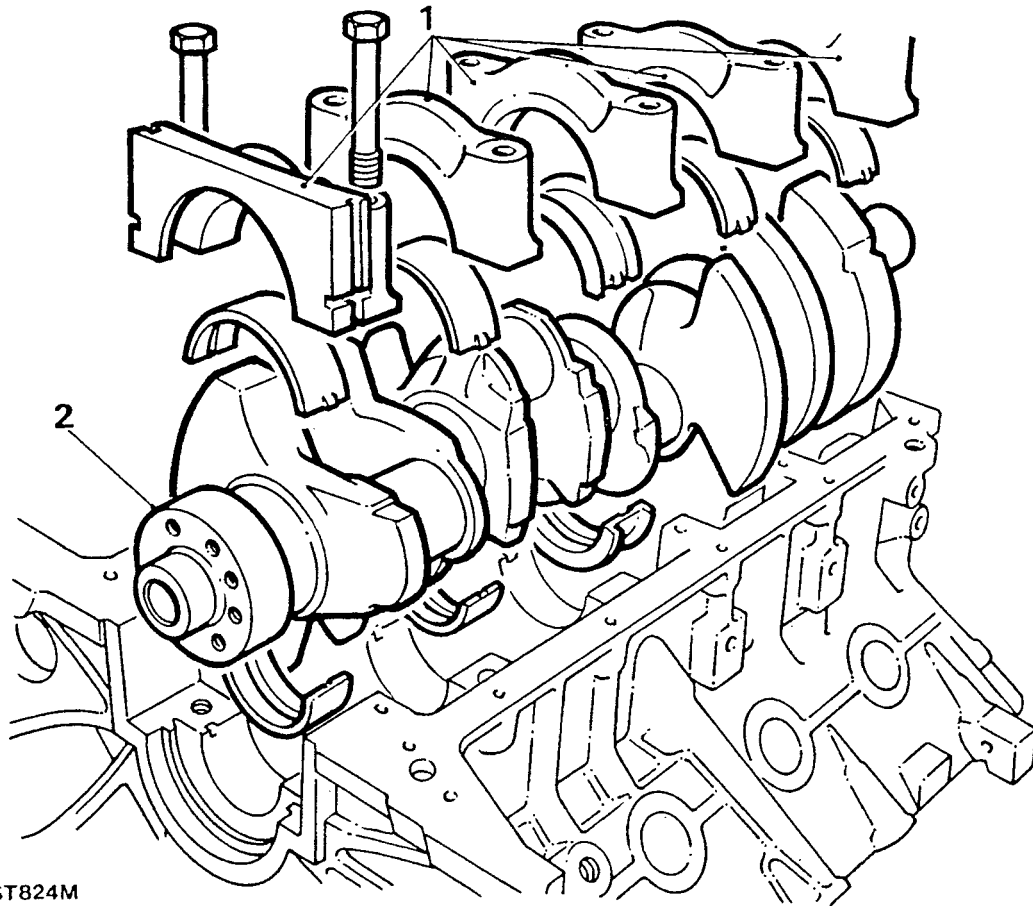


ST778M



## REMOVE AND OVERHAUL CRANKSHAFT

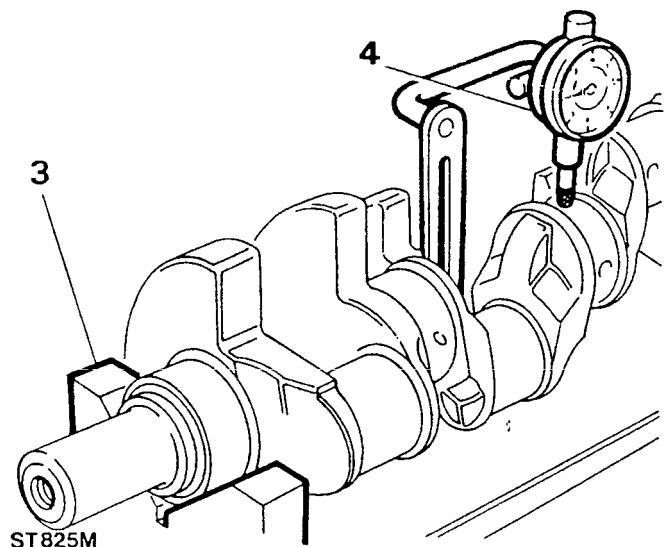
1. Remove the main bearing caps and lower bearing shells and retain in sequence. It is important to keep them in pairs and mark them with the number of the respective journal until it is decided if the bearing shells are to be refitted.
2. Lift out the crankshaft and rear oil seal.



ST824M

### Inspect and overhaul crankshaft

3. Rest the crankshaft on vee-blocks at numbers one and five main bearing journals.
4. Using a dial test indicator, check the run-out at numbers two, three and four main bearing journals. The total indicator readings at each journal should not exceed 0,08 mm (0.003 in).
5. While checking the run-out at each journal, note the relation of maximum eccentricity on each journal to the others. The maximum on all journals should come at very near the same angular location.
6. If the crankshaft fails to meet the foregoing checks it is bent and is unsatisfactory for service.
7. Check each crankshaft journal for ovality. If ovality exceeds 0,040 mm (0.0015 in), a reground or new crankshaft should be fitted.



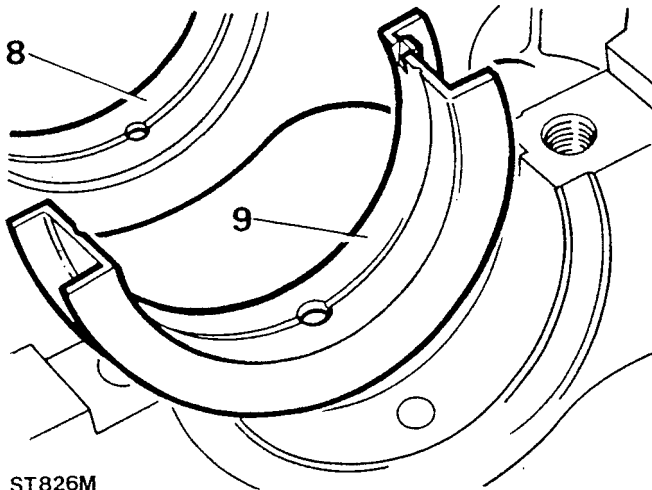
ST825M

continued

8. Bearings for the crankshaft main journals and the connecting-rod journals are available in the following undersizes:

- 0,25 mm (0.010 in)
- 0,50 mm (0.020 in)

9. The centre main bearing shell, which controls crankshaft thrust, has the thrust faces increased in thickness when more than 0,25 mm (0.010 in) undersize, as shown on the following chart.



ST826M

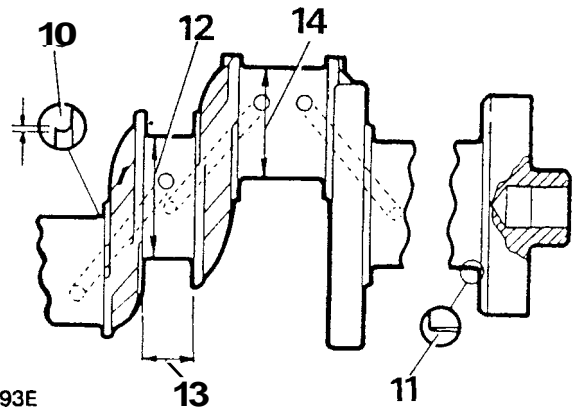
10. When a crankshaft is to be reground, the thrust faces on either side of the centre main journal must be machined in accordance with the dimensions on the following charts.

Main bearing journal size	Thrust face width
Standard	Standard
0,25 mm (0.010 in) undersize	Standard
0,50 mm (0.020 in) undersize	0,25 mm (0.010 in) oversize

11. For example: If a 0,50 mm (0.020 in) undersize bearing is to be fitted, then 0,12 mm (0.005 in) must be machined off each thrust face of the centre journal, maintaining the correct radius.

**Crankshaft dimensions**

- 12. The radius for all journals except the rear main bearing is 1,90 to 2,28 mm (0.075 to 0.090 in).
- 13. The radius for the rear main bearing journal is 3,04 mm (0.120 in).
- 14. Main bearing journal diameter, see the following charts.
- 15. Thrust face width, and connecting-rod journal diameter, see the following charts.



**Crankshaft dimensions — millimetres**

Crankshaft Grade	Diameter '12'	Width '13'	Diameter '14'
Standard	58,400-58,413	26,975-27,026	50,800-50,812
0,254 U/S	58,146-58,158	26,975-27,026	50,546-50,559
0,508 U/S	57,892-57,904	27,229-27,280	50,292-50,305

**Crankshaft dimensions — inches**

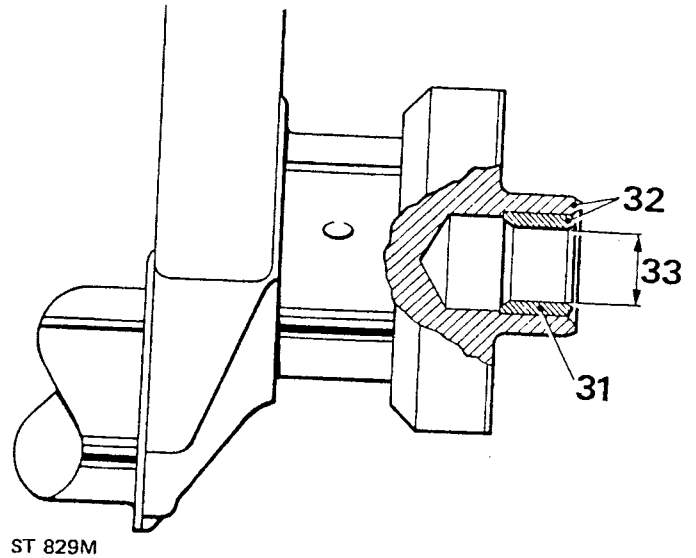
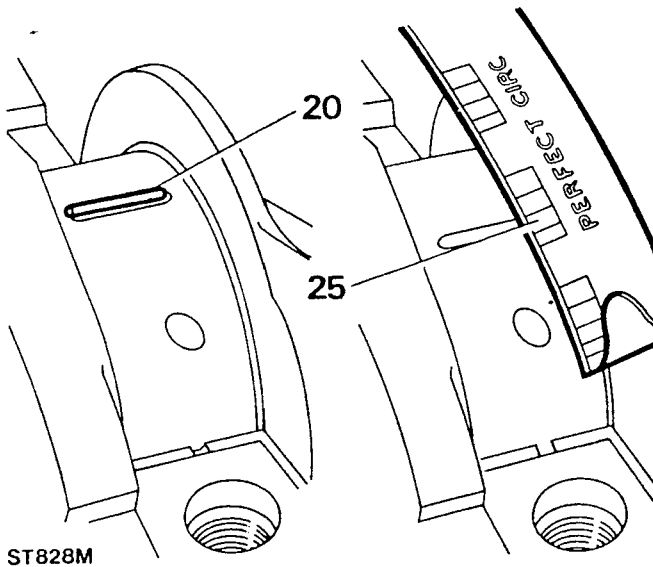
Crankshaft Grade	Diameter '12'	Width '13'	Diameter '14'
Standard	2.2992-2.2997	1.062-1.064	2.0000-2.0005
0.010 U/S	2.2892-2.2897	1.062-1.064	1.9900-1.9905
0.020 U/S	2.2792-2.2797	1.072-1.074	1.9800-1.9805

**Check main bearing clearance**

- 16. Remove the oil seals from the cylinder block and the rear main bearing cap.
- 17. Locate the upper main bearing shells into the cylinder block. These must be the shells with the oil drilling and oil grooves.
- 18. Locate the flanged upper main bearing shell in the centre position.
- 19. Place the crankshaft in position on the bearings.

continued

20. Place a piece of Plastigauge across the centre of the crankshaft main bearing journals.
21. Locate the bearing lower shell into the main bearing cap.
22. Fit numbers one to four main bearing caps and shells. Torque: 7,0 to 7,6 kgf m (50 to 55 lbf ft).
23. Fit the rear main bearing cap and shell. Torque: 9,0 to 9,6 kgf m (65 to 70 lbf ft). Do not allow the crankshaft to be rotated while the Plastigauge is in use.
24. Remove the main bearing caps and shells.
25. Using the scale printed on the Plastigauge packet, measure the flattened Plastigauge at its widest point.
26. The graduation that most closely corresponds to the width of the Plastigauge indicates the bearing clearance.



## ASSEMBLING ENGINE

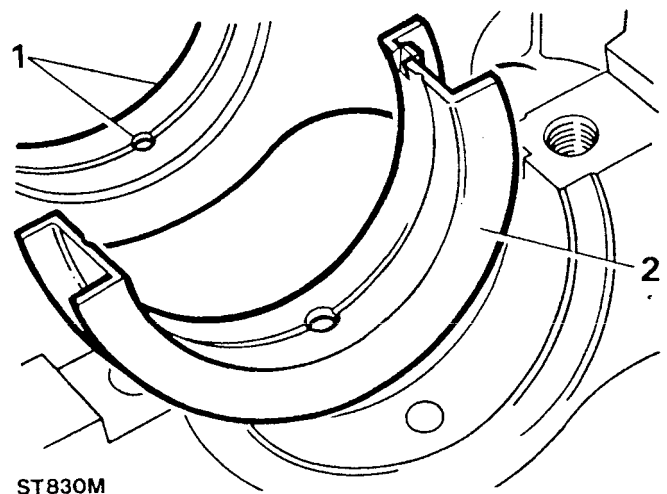
### FIT CRANKSHAFT AND MAIN BEARINGS

27. The correct bearing clearance with new or overhauled components is 0,023 to 0,065 mm (0.0009 to 0.0025 in).
28. If the correct clearance is not obtained initially, use selective bearing assembly.
29. Wipe off the Plastigauge with an oily rag. Do NOT scrape it off.
30. Maintain the bearing shells and caps in sets and in the correct sequence.

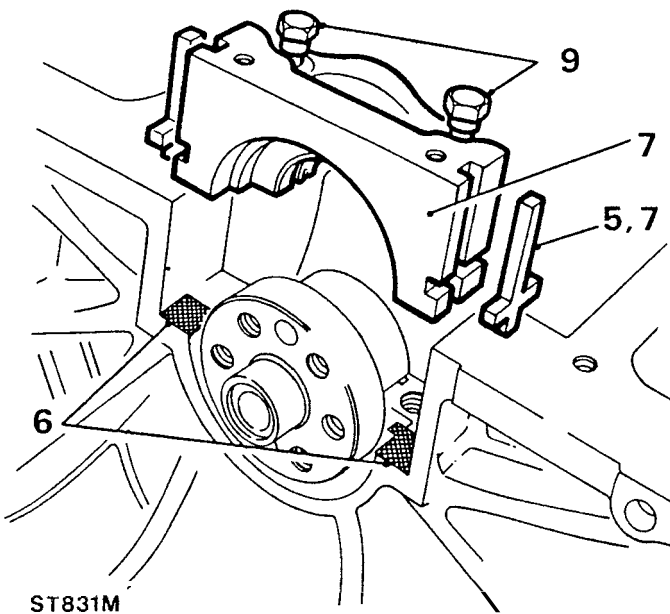
### Renew spigot bearing

31. Carefully remove the old bearing.
32. Fit the spigot bearing flush with, or to a maximum of 1,6mm (0.063 in) below the end face of the crankshaft.
33. Ream the spigot bearing to  $19,177 \pm 0,025$  mm (0.7504 + 0.001 in) inside diameter. Ensure all swarf is removed.

1. Locate the upper main bearing shells into the cylinder block; these must be the shells with the oil drilling and oil grooves.
2. Locate the flanged upper main bearing shell in the centre position.
3. Lubricate the crankshaft main bearing journals and bearing shells with clean engine oil and lower the crankshaft into position.



4. Lubricate the lower main bearing shells and fit numbers one to four main bearing caps and shells only, leaving the fixing bolts finger tight at this stage.
5. Fit the cruciform side seals to the grooves each side of the rear main bearing cap. Do not cut the side seals to length, they must protrude 1,5 mm (0.062 in) approximately above the bearing cap parting face.
6. Apply Hylomar PL32M jointing compound to the rearmost half of the rear main bearing cap parting face or, if preferred, to the equivalent area on the cylinder block as illustrated.
7. Lubricate the bearing half and bearing cap side seals with clean engine oil.
8. Fit the bearing cap assembly to the engine. Do not tighten the fixings at this stage but ensure that the cap is fully home and squarely seated on the cylinder block.
9. Tension the cap bolts equally by one-quarter turn approximately, then back off one complete turn on each fixing bolt.



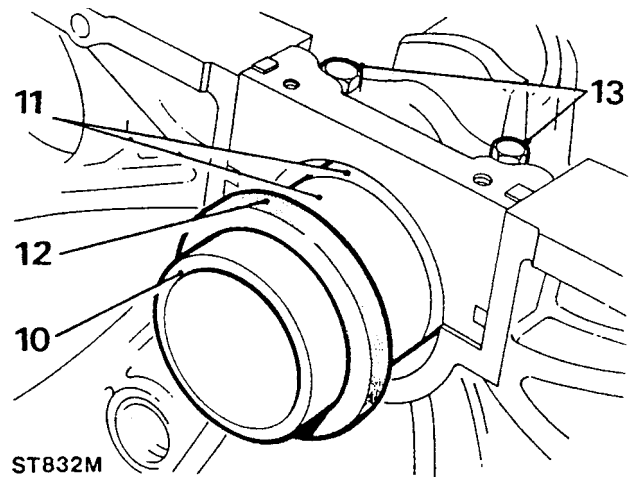
**CAUTION:** Do not handle the seal lip, visually check that it is not damaged and ensure that the outside diameter remains clean and dry.

10. Position the seal guide RO 1014 on the crankshaft flange.
11. Ensure that the oil seal guide and the crankshaft journal are scrupulously clean, then coat the seal guide and oil seal journal with clean engine oil.

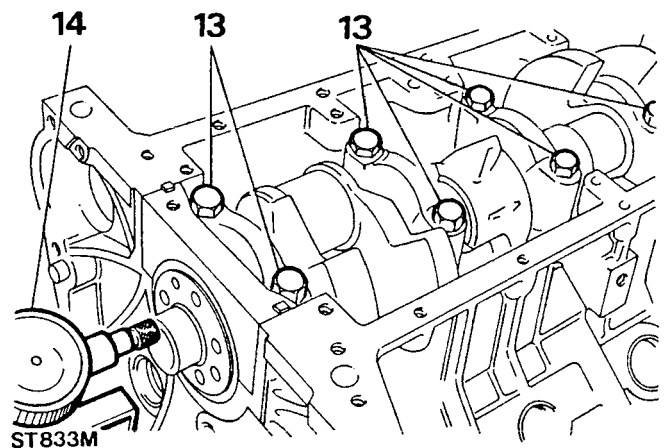
**NOTE:** The lubricant coating must cover the seal guide outer surface completely to ensure that the oil seal lip is not turned back during assembly.

Position the oil seal, lipped side towards the engine, onto the seal guide. The seal outside diameter must be clean and dry.

12. Push home the oil seal fully and squarely by hand into the recess formed in the cap and block until it abuts against the machined step in the recess. Withdraw the seal guide.



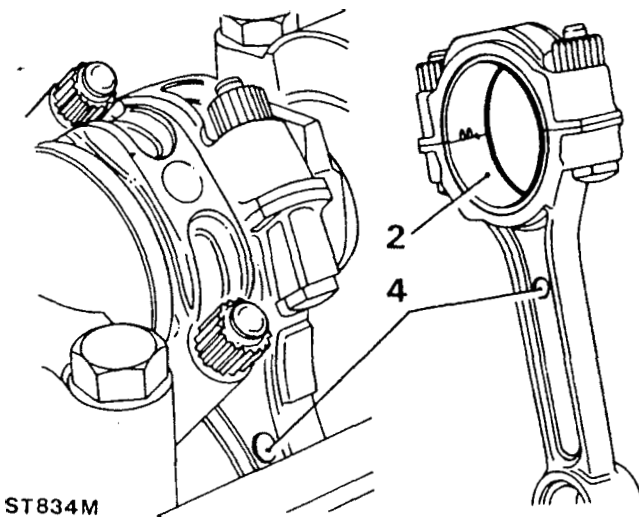
13. Tighten the main bearing cap bolts to the correct torque noting that the bolts for numbers one to four bearings have a different torque to number five bearing cap bolts.
14. Using a feeler gauge or a dial indicator check the crankshaft end-float, 0,10 to 0,20 mm (0.004 to 0.008 in).



**CAUTION:** Do not exceed 1,000 engine rev/min when first starting the engine, otherwise the crankshaft rear oil seal will be damaged.

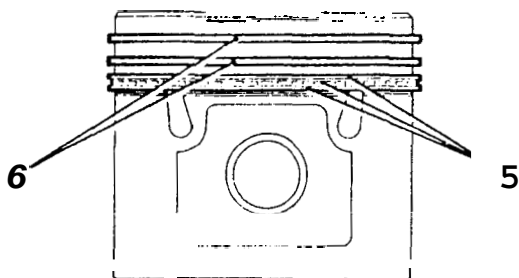
### FIT CONNECTING-RODS AND PISTONS

1. Locate the applicable crankshaft journal at B.D.C.
2. Place the bearing upper shell in the connecting-rod.
3. Retain the upper shell by screwing the guide bolts 605351 onto the connecting-rods.
4. Insert the connecting-rod and piston assembly into its respective bore, noting that the domed shape boss on the connecting-rod must face towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank. When both connecting-rods are fitted, the bosses will face inwards towards each other.



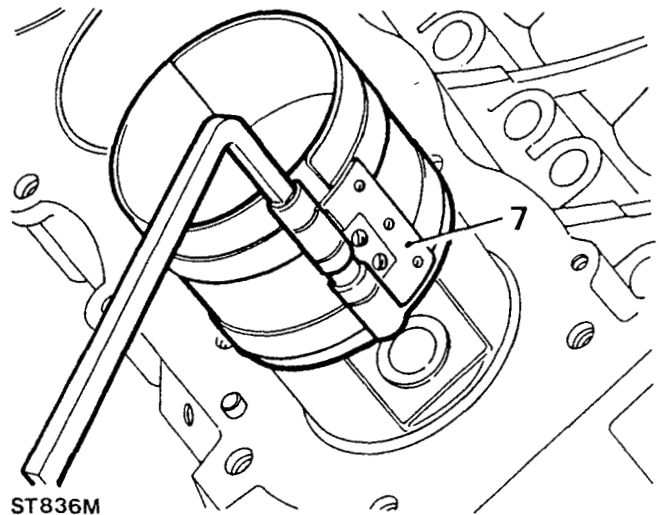
ST834M

5. Position the oil control piston rings so that the ring gaps are all at one side, between the gudgeon pin and piston thrust face. Space the gaps in the ring rails approximately 25 mm (1 in) each side of the expander ring joint.
6. Position the compression rings so that their gaps are on opposite sides of the piston between the gudgeon pin and piston thrust face.



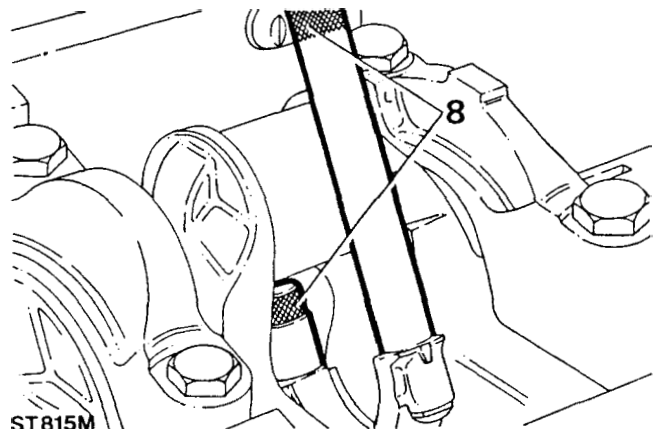
ST835M

7. Using a piston ring compressor, locate the piston into the cylinder bore, until the piston crown is just below the cylinder block top face.



ST836M

8. Pull the connecting rods on to the crankpins using the guide rods.



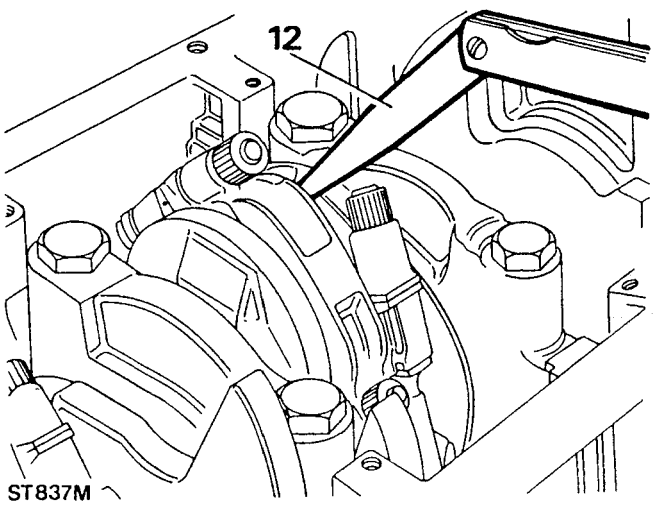
ST815M

9. Place the bearing lower shell in the connecting-rod cap.
10. Locate the cap and shell onto the connecting-rod, noting that the rib on the edge of the cap must be towards the front of the engine on the right-hand bank of cylinders and towards the rear on the left-hand bank.
11. Check that the connecting-rods move freely sideways on the crankshaft. Tightness indicates insufficient bearing clearance or a misaligned connecting-rod.

continued

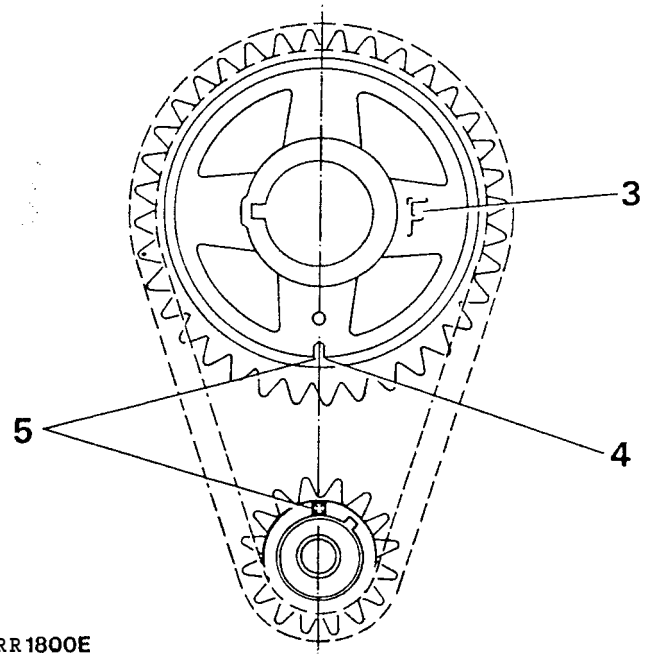
**12** V8 CYLINDER ENGINE

12. Check the end-float between the connecting-rods on each crankshaft journal. Clearance limits: 0,15 to 0,37 mm (0.006 to 0.014 in).
13. Tighten the connecting-rod nuts to the correct torque. Fit the oil strainer and joint washer.



ST837M

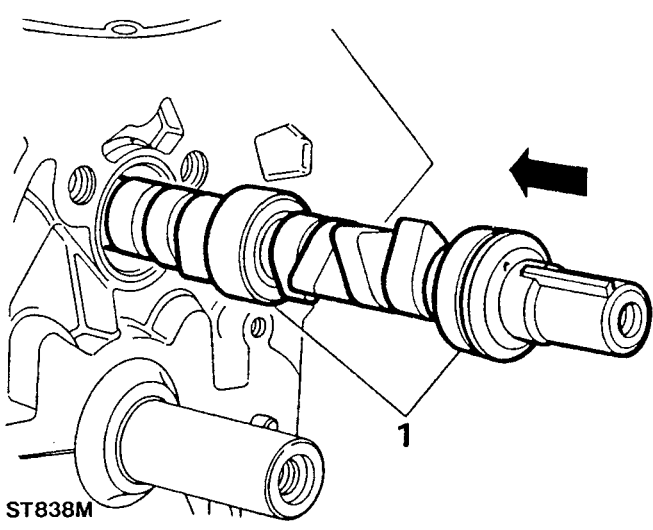
3. Temporarily fit the camshaft chain wheel with the marking 'FRONT' or 'F' outwards.
4. Turn the camshaft until the mark on the camshaft chain wheel is at the six o'clock position, then remove the chain wheel without disturbing the camshaft.
5. Encircle the chain wheels with the chain keeping the timing marks aligned.



RR 1800E

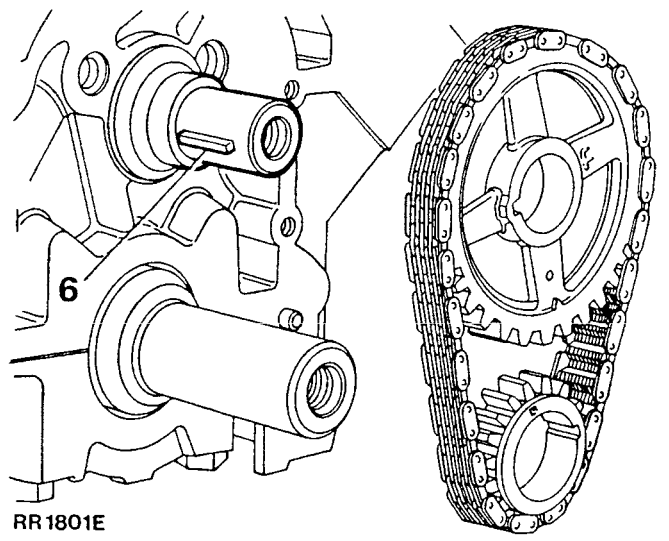
**FIT CAMSHAFT TIMING GEARS AND CHAIN**

1. Lubricate the camshaft journals and carefully insert the camshaft into the cylinder block.



ST838M

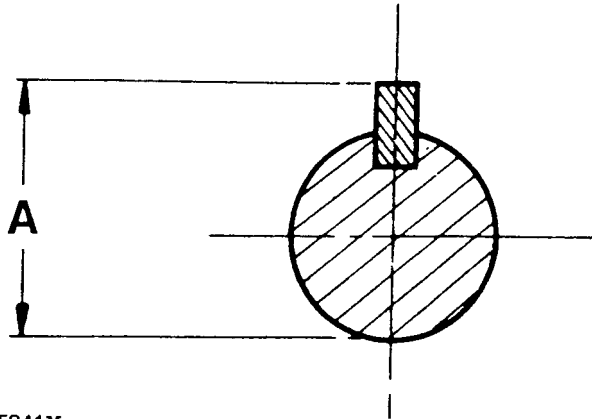
6. Engage the chain wheel assembly on the camshaft and crankshaft key locations and check that the camshaft key is parallel to the shaft axis to ensure adequate lubrication of the distributor drive gear.



RR 1801E

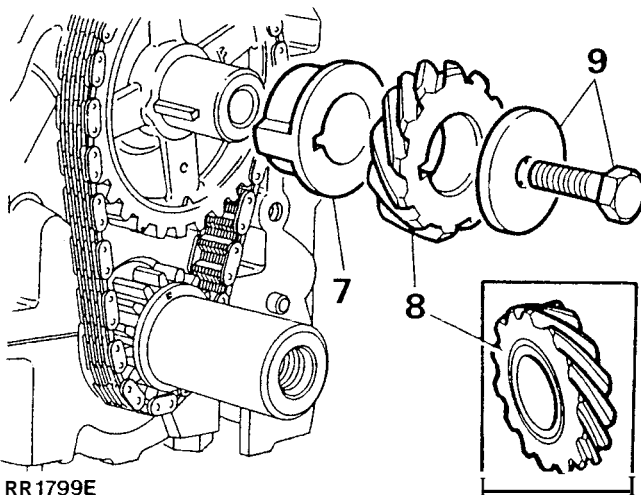
2. Turn the crankshaft to bring number one piston to T.D.C.

**CAUTION:** The space between the key and keyway acts as an oilway for lubrication of the drive gear. Ensure that the key is seated to the full depth of the keyway. The overall dimension of shaft and key must not exceed 30,15 mm (1.187 in). Dimension A below.



-ST841M

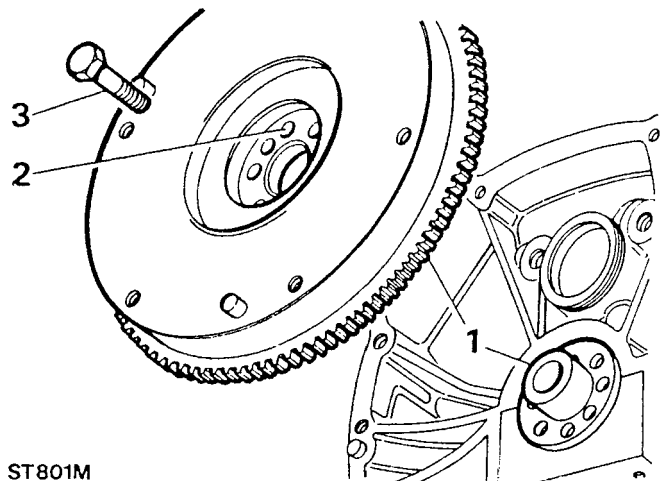
7. Check that the timing marks line-up and fit the spacer with the flange to the front.
8. Fit the distributor drive gear ensuring that the annular grooved side is fitted to the rear, that is towards the spacer.
9. Secure the drive gear and camshaft chain wheel assembly with the bolt and washer and tighten to the correct torque.



RR1799E

### FIT THE FLYWHEEL

1. Locate the flywheel in position on the crankshaft spigot, with the ring gear towards the engine.
2. Align the flywheel fixing bolt holes which are off-set to prevent incorrect assembly.
3. Fit the flywheel fixing bolts and before finally tightening, take up any clearance by rotating the flywheel against the direction of engine rotation. Tighten the bolts evenly to the correct torque.

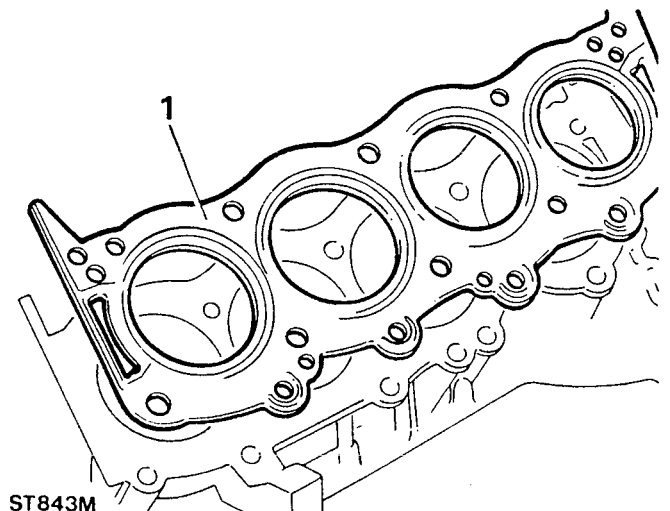


ST801M

### FIT CYLINDER HEADS

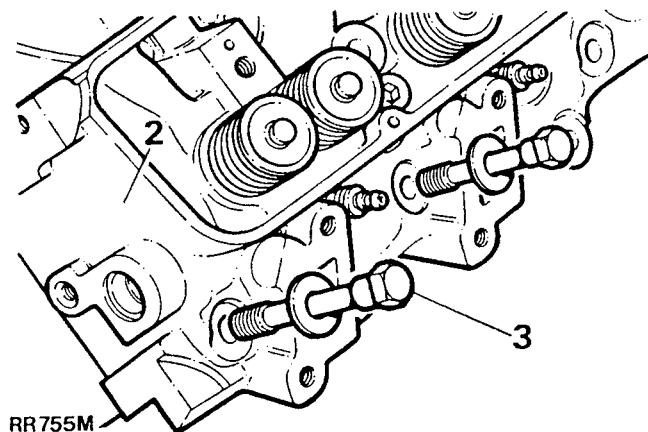
1. Fit new cylinder head gaskets with the word 'TOP' uppermost. Do NOT use sealant.

continued



ST843M

2. Locate the cylinder heads on the block dowel pins.
3. Clean the threads of the cylinder head bolts then coat them with Thread Lubricant-Sealant Loctite 572.



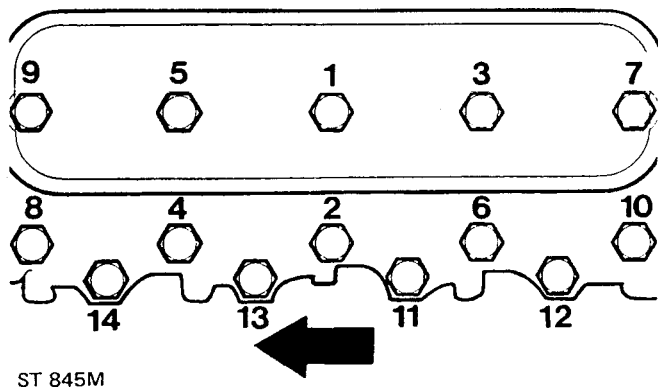
4. Locate the cylinder head bolts in position as illustrated and fit dipstick tube.

Long bolts — 1, 3 and 5.  
 Medium bolts — 2, 4, 6, 7, 8, 9 and 10  
 Short bolts — 11, 12, 13 and 14.

5. Tighten the cylinder head bolts a little at a time in the sequence shown to the following figures:

Bolts 1 to 1065 to 70 lbf ft (88 to 95 Nm).  
 Bolts 11 to 1440 to 45 lbf ft (54 to 61 Nm).

6. When all bolts have been tightened, re-check the torque settings.

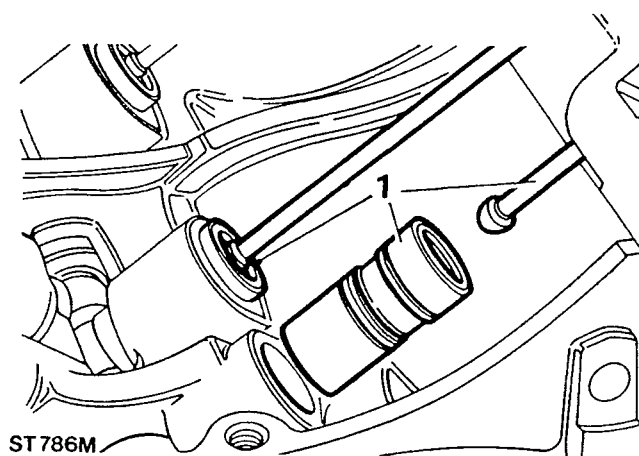


**Note:** Left-hand cylinder head illustrated.  
 Arrow points to front of vehicle.

**FIT TAPPETS, PUSH RODS AND ROCKER ASSEMBLIES**

**Fit tappets and push rods**

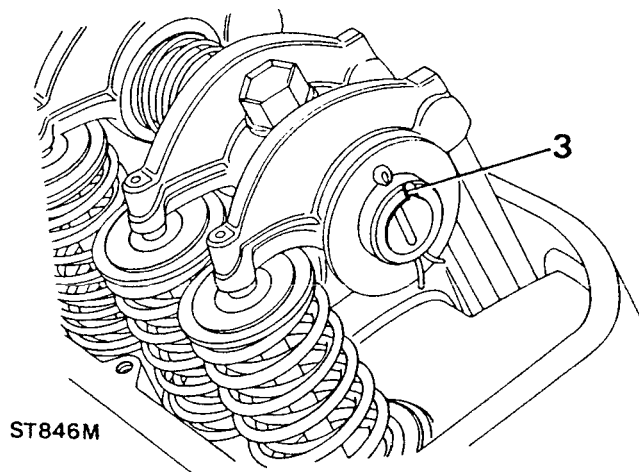
1. Fit the tappets and push rods to their original locations. Ensure that the tappets move freely in their respective bores. Before fitting the tappets immerse them in clean engine oil to reduce tappet noise when the engine is first started after the overhaul.



**Fit the rocker assemblies**

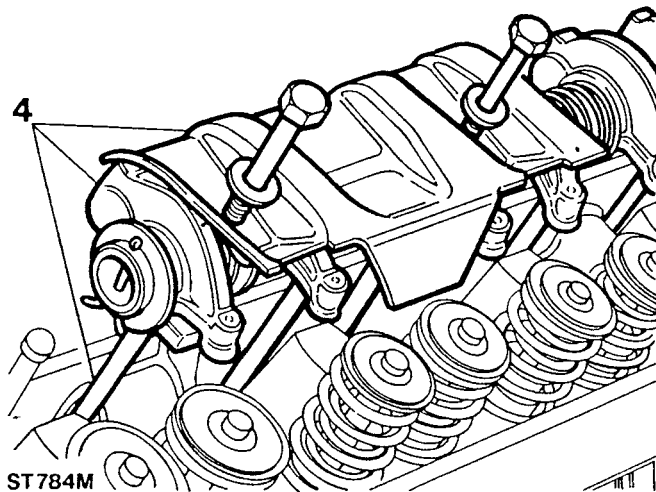
2. The rocker shafts are handed and must be fitted correctly to align the oilways.
3. Each rocker shaft is notched at one end and on one side only. The notch must be uppermost and towards the front of the engine on the right-hand side, and towards the rear on the left-hand side.

continued





4. Fit the rocker shaft assemblies. Ensure that the push-rods engage the rocker cups and that the baffle plates are fitted to the front on the left-hand side, and to the rear on the right-hand side. Tighten the bolts.

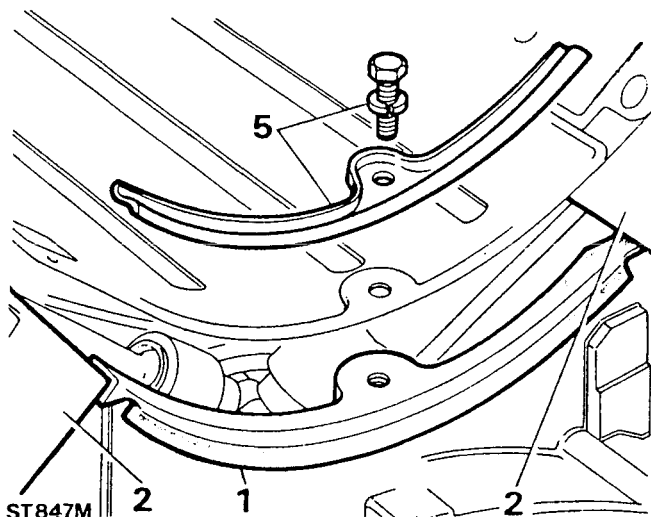


It should be noted that tappet noise can be expected on initial starting-up after an overhaul due to oil drainage from the tappet assemblies or indeed if the vehicle has been standing over a very long period. If excessive noise should be apparent after an overhaul, the engine should be run at approximately 2,500 rev/min for a few minutes (subject to the following caution), when the noise should be eliminated.

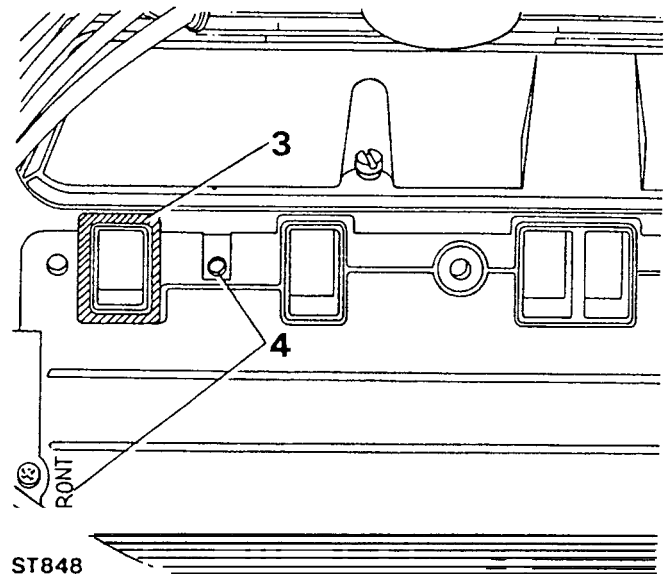
**CAUTION: Do not exceed 1,000 engine rev/min when first starting the engine, otherwise the crankshaft rear oil seal will be damaged.**

#### FIT THE INDUCTION MANIFOLD

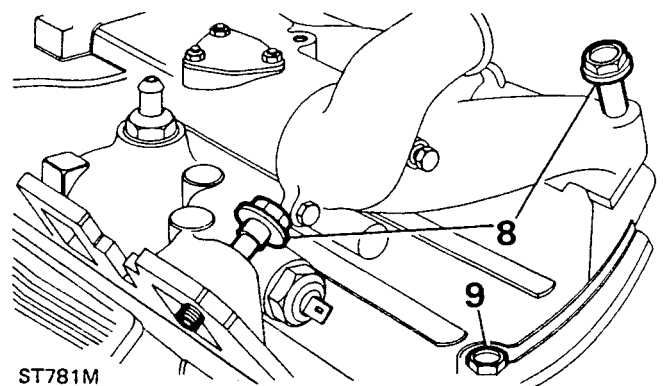
1. Coat both sides of new manifold gasket seals with silicon grease.
2. Locate the seals in position with their ends engaged in the notches formed between the cylinder head and block.



3. Apply 'Hylomar' sealing compound SQ32M on the corners of the cylinder head, manifold gasket and manifold, around the water passage joints.
4. Fit the manifold gasket with the word 'FRONT' to the front and the open bolt hole at the front R.H. side.
5. Fit the gasket clamps but do not fully tighten the bolts at this stage.

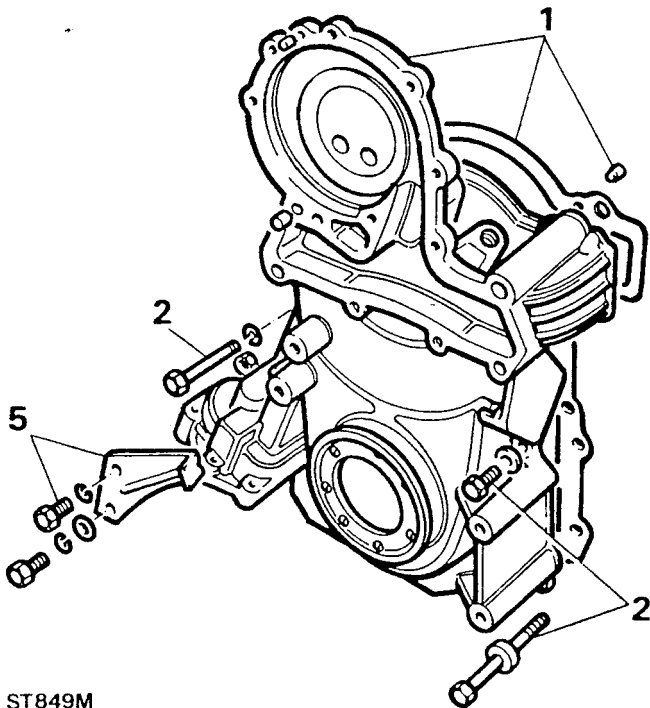


6. Locate the manifold onto the cylinder head.
7. Clean the threads of the manifold securing bolts and apply Loctite 572 to the threads.
8. Fit all the manifold bolts and tighten them a little at a time, evenly, alternate sides working from the centre to each end and finally tighten to the correct torque.
9. Tighten the gasket clamp bolts to the correct torque.



### FIT THE TIMING COVER AND CRANKSHAFT PULLEY

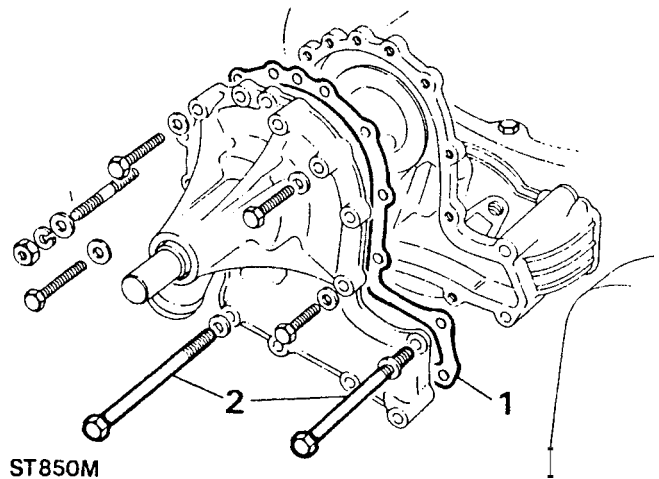
1. Place a new timing cover joint washer in position and fit the timing cover locating it on the two dowels.
2. Clean the threads of the timing cover securing bolts, then coat them with Thread Lubricant-Sealant Loctite 572.
3. Fit and evenly tighten the timing cover bolts to the correct torque figure.
4. Fit the crankshaft pulley and tighten the retaining bolt to the correct torque.
5. Fit timing pointer.



ST849M

### FIT THE WATER PUMP

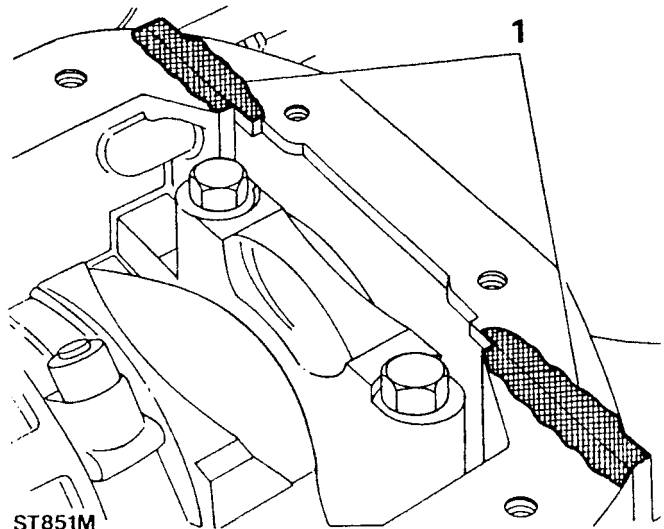
1. Lightly grease a new joint washer and place it in position on the the timing cover.
2. Clean the threads of the four long bolts and smear them with Loctite 572 thread lubricant-sealant. Locate the water pump in position.
3. Locate the alternator adjusting link on the water pump.
4. Leave the alternator adjusting link loose and tighten the remaining water pump housing bolts evenly and to the correct torque.



ST850M

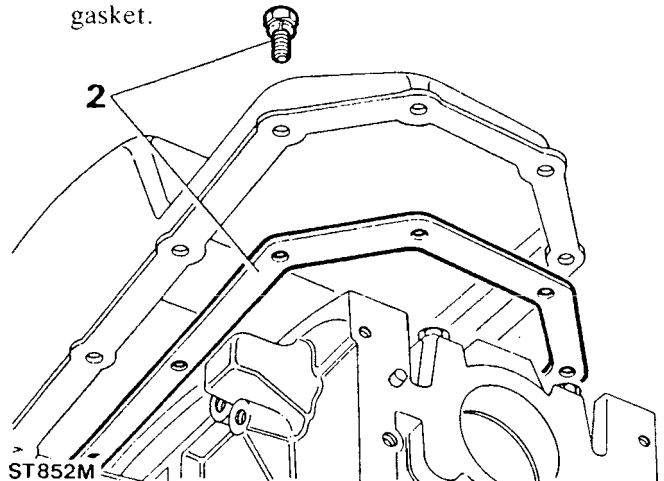
### FIT THE SUMP

1. Clean the sump mating faces and at the joint between the timing cover and crankcase apply a coating of a universal jointing compound about 13 to 19 mm ( $\frac{1}{2}$  to  $\frac{3}{4}$  in) wide in the area illustrated.



ST851M

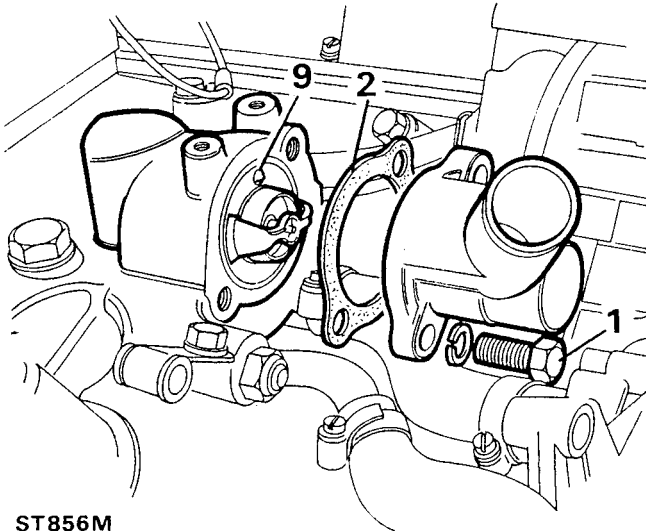
2. Place the sump gasket in position, fit the sump and evenly tighten the retaining bolts to the correct torque. Hylosil is used on later engines instead of a gasket.



ST852M

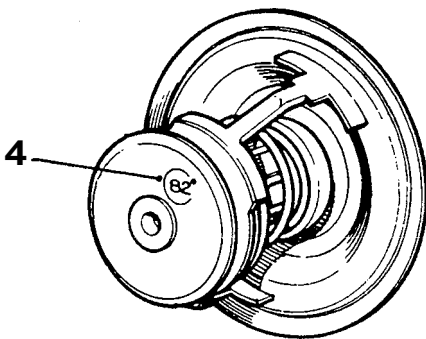
**TEST AND FIT THERMOSTAT**

1. Remove the two bolts securing the thermostat housing to the induction manifold.
2. Remove the housing gasket.
3. Withdraw the thermostat.



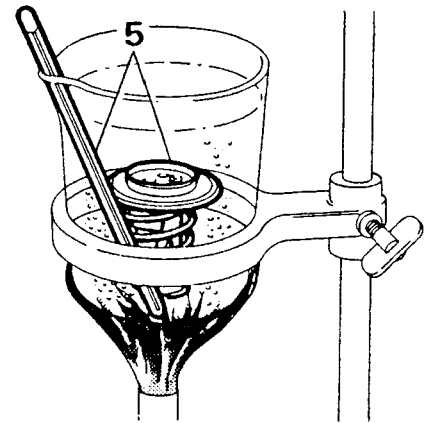
ST856M

4. Note the temperature stamped on the thermostat at which it should be fully open.



ST857M

5. Place the thermostat and a Centigrade thermometer in a laboratory beaker, or a suitable alternative, half full of water.
6. Heat the water and observe the temperature at which the thermostat opens.
7. If faulty discard the thermostat.



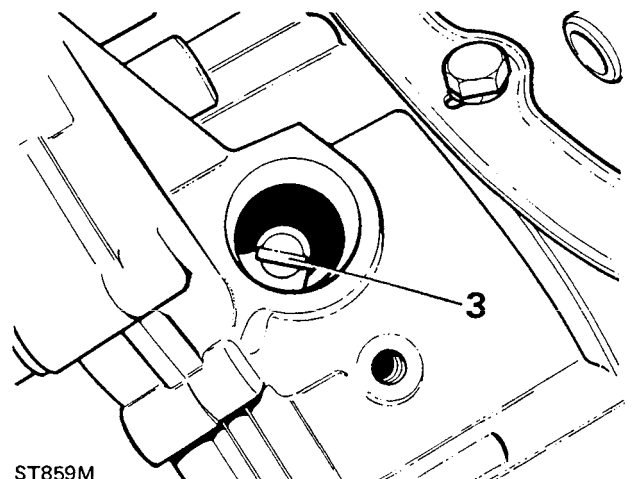
ST858M

8. Clean the induction manifold and thermostat housing mating faces.
9. Fit the thermostat with the jiggle pin uppermost at 12 o'clock.
10. Fit the housing using a new gasket, and evenly tighten the two bolts.

**FIT THE DISTRIBUTOR — including electronic distributor**

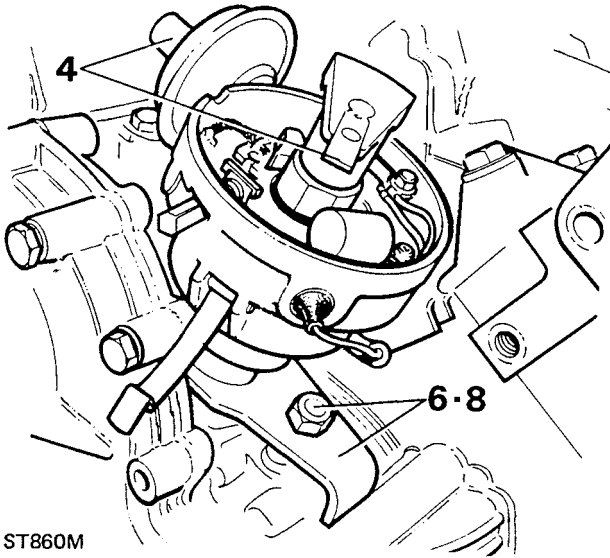
1. Turn the crankshaft to bring number one piston to T.D.C. on the compression stroke (both valves closed number one cylinder).
2. Turn distributor drive until rotor arm is approximately 30° anti-clockwise from number one sparking plug lead position on cap.
3. Turn the oil pump and distributor common drive shaft so that the tongue is in the approximate position as illustrated.

continued



ST859M

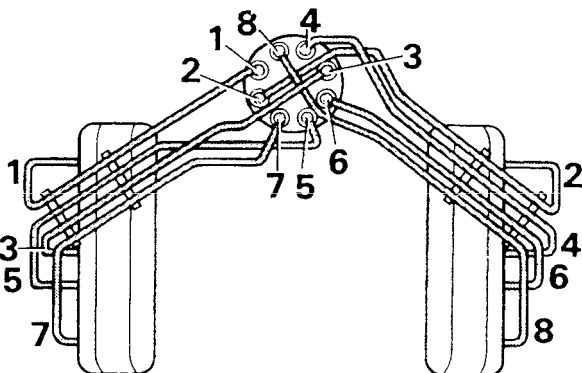
4. Fit distributor to engine and check that centre line of rotor arm is now in line with number one sparking plug lead in cap. Reposition distributor if necessary. The vacuum capsule should be at 90° to the camshaft.
5. If distributor does not seat correctly in front cover, oil pump drive is not engaged. Engage by lightly pressing down distributor while turning engine.
6. Fit clamp and bolt leaving both loose at this stage.



ST860M

7. Rotate distributor anti-clockwise until contact points just start to open.
8. Secure distributor in this position by tightening clamp bolt.
9. Fit the distributor cap and spark plugs and connect the H.T. leads in accordance with the illustration below.

**NOTE:** The above distributor setting is to enable the engine to be run so that the correct setting given in 'Engine Tuning data' can be achieved once the engine is refitted to the vehicle.



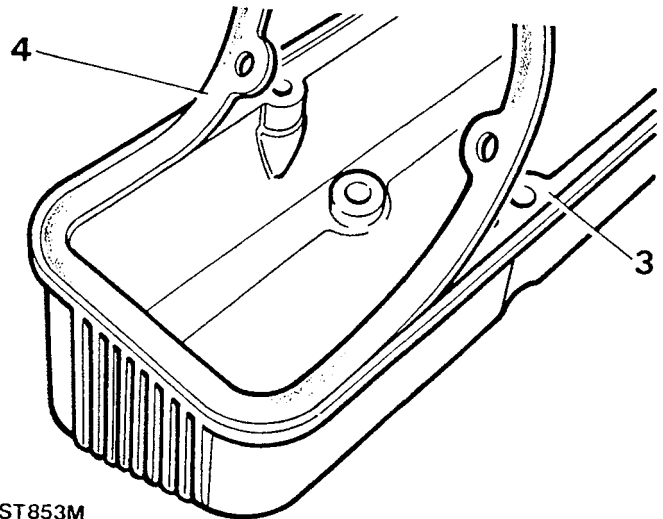
ST098

### FIT ROCKER COVERS

1. Remove all traces of old gasket on the covers and cylinder heads.
2. Clean and dry the gasket mounting surface, using Bostik cleaner 6001.
3. Apply Bostik 1775 impact adhesive to the seal face and the gasket, using a brush to ensure an even film. Allow the adhesive to become touch-dry, approximately fifteen minutes.

**NOTE:** The gasket fits one way round only and must be fitted accurately first time; any subsequent movement would destroy the bond.

4. Place one end of the gasket into the cover recess with the edge firmly against the recess wall; at the same time hold the remainder of the gasket clear; then work around the cover, pressing the gasket into place ensuring that the outer edge firmly abuts the recess wall.

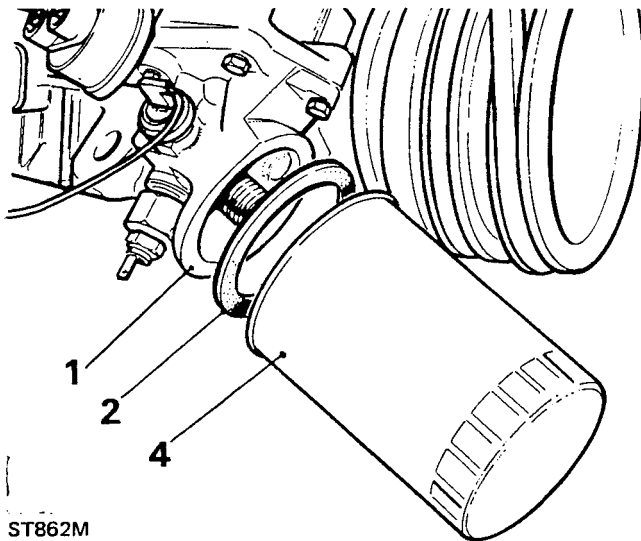


ST853M

5. Allow the cover to stand for thirty minutes before fitting it to the engine.
6. Secure the rocker covers to the engine with the four screws. Short screws — in board, long screws — outboard.

**FIT ENGINE OIL FILTER**

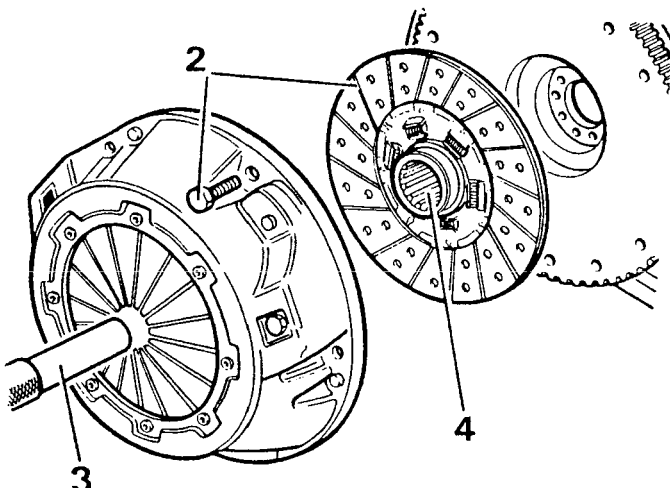
1. Clean oil pump mating face with filter.
2. Smear clean engine oil on the rubber washer of the new filter.
3. Fill the filter with new oil as far as possible, noting the angle at which the filter is to be fitted.
4. Screw on the filter until the sealing ring touches the oil pump cover face, then tighten it a further half turn by hand only. **Do not overtighten.**



ST862M

**FIT THE CLUTCH**

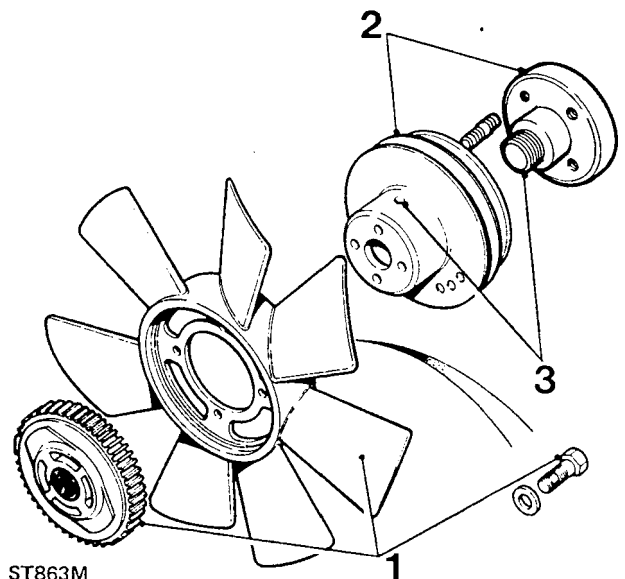
1. Clean the flywheel and clutch assembly pressure plate.
2. Fit the centre plate and the clutch assembly and loosely secure to the flywheel with the retaining bolts.
3. Insert centralising tool 18G 79 or a slave primary shaft and finally tighten the clutch assembly retaining bolts in a diagonal sequence, to the correct torque.
4. Smear the centre plate splines with Rocol MV3 or Rocol MTS 1000 grease.



ST854M

**FIT THE FAN PULLEY, VISCOUS COUPLING AND FAN**

1. Secure the fan to the viscous coupling with the four bolts and tighten evenly.
2. If removed, fit the pulley to hub assembly adaptor and secure with the four nuts.
3. Screw the viscous coupling onto the adaptor thread by inserting a tommy bar in the hole in the pulley to restrain it while tightening the coupling.
4. Fit the fan and any other drive belts.

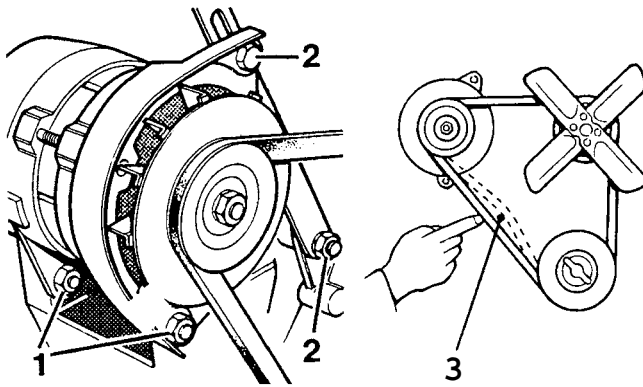


ST863M

**FIT THE ALTERNATOR**

1. Offer up the alternator to the mounting bracket and locate the pivot nuts and bolts noting that the fan guard is attached to the front nut and bolts.
2. Slacken the alternator adjustment bracket and attach alternator bracket. Note that the fan guard is attached to the adjustment bracket bolt.
3. Fit and tension the fan belt as follows:  
Pivot the alternator away from the engine but in doing so, do not apply any pressure to the slip-ring end bracket. Tighten the pivot nuts and bolts and adjustment bolt. The tension is correct when, with thumb pressure, the belt deflection is approximately 8 mm ( $\frac{5}{16}$  in) for non-air condition engines, 4 mm ( $\frac{3}{32}$  in) for air condition engines, between alternator and the crankshaft pulley. Finally, tighten the fixings and connect the wiring plug to the alternator.

continued



ST855M

### FIT THE CARBURETTERS

If removed, fit the carburetters to the induction manifold, using new joint washers in the correct sequence as illustrated according to the engine serial number. See Section 19 for S.U. Carburetters.

Illustration **A** from serial number 1400001A Non-detoxed.

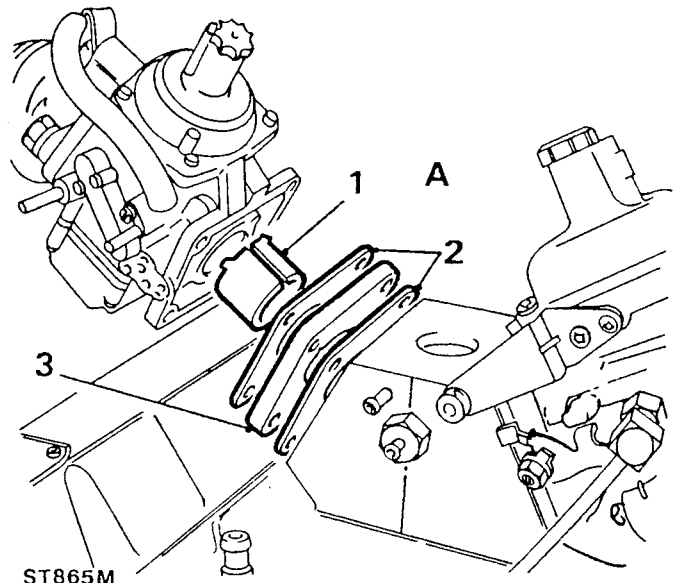
1. Fit the liner.
2. Fit the two joint washers.
3. In between the washers fit the insulator.

Illustration **B** from serial number 15G00001A detoxed.

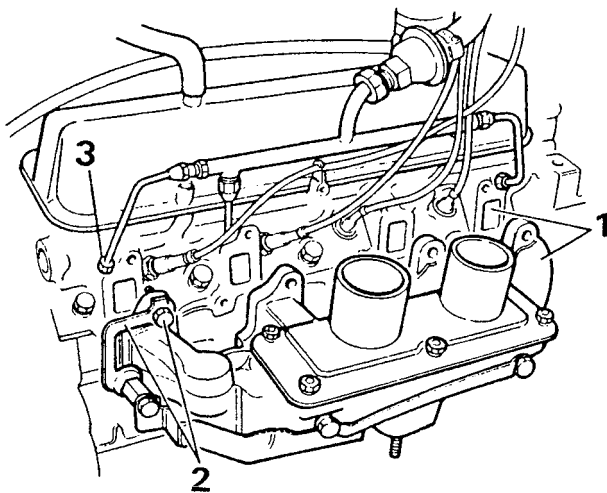
4. Fit the three joint washers.
5. Fit the saw toothed deflector.
6. Fit the insulator.

### FIT EXHAUST MANIFOLD AND AIR RAILS

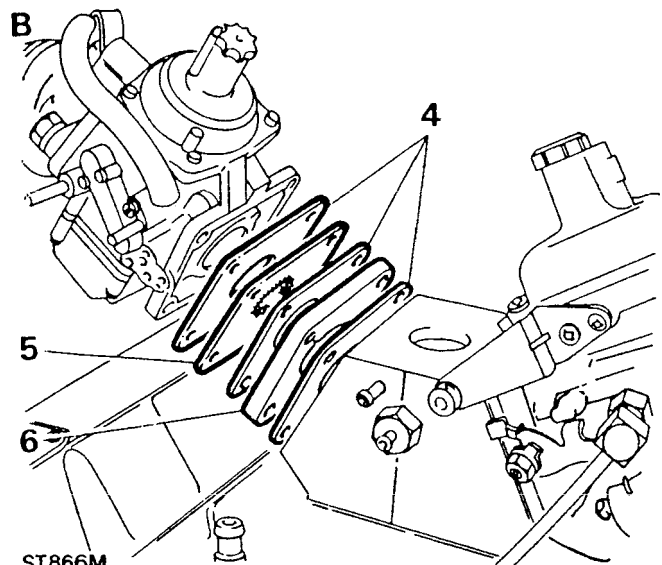
1. Ensure that the mating surfaces of the cylinder head and exhaust manifold are clean and smooth and coat the faces with 'Foliac J 166' or 'Moly Paul' anti-seize compound. 'Foliac J 166' is manufactured by Rocol Ltd., Rocol House, Swillington, Leeds, England. 'Moly Paul' is manufactured by K.S. Paul Products Ltd., Nobel Road, London N18.
2. Place the manifold in position on the cylinder head and fit the securing bolts, lockplates and plain washers. The plain washers are fitted between the manifold and lockplates. Evenly tighten the manifold bolts to the correct torque figure and bend over the lock tabs.
3. Fit pulse-air rails to cylinder heads.



ST865M



ST864M



ST866M

### MISCELLANEOUS AND NON-STANDARD ITEMS

Fit any other items of equipment and miscellaneous hoses, pipes, filters, clips and brackets to the positions noted during dismantling.

PETROL ENGINE

FAULT DIAGNOSIS

SYMPTOM	POSSIBLE CAUSE	CURE
ENGINE FAILS TO START	<ol style="list-style-type: none"> <li>1. Incorrect starting procedure</li> <li>2. Starter motor speed too slow</li> <li>3. Faulty ignition system</li> <li>4. Water or dirt in fuel system</li> <li>5. Carburetter(s) flooding</li> <li>6. Defective fuel pump</li> <li>7. Defective starter motor</li> <li>8. Starter pinion not engaging</li> </ol>	See owners handbook Check battery and connections Check each component in system Flush out system with clean fuel Check float chamber needle valve Remove, overhaul or renew Overhaul or renew Remove starter motor and overhaul
ENGINE STALLS	<ol style="list-style-type: none"> <li>1. Low idling speed</li> <li>2. Faulty sparking plugs</li> <li>3. Faulty coil or condenser</li> <li>4. Faulty distributor points</li> <li>5. Incorrect mixture</li> <li>6. Foreign matter in fuel system</li> </ol>	Adjust carburetter(s) Clean and test; renew if necessary Renew Rectify or renew Adjust carburetter(s) Investigate source of foreign matter and clean as necessary
LACK OF POWER	<ol style="list-style-type: none"> <li>1. Poor compression</li> <li>2. Badly seating valves</li> <li>3. Faulty exhaust silencer</li> <li>4. Incorrect ignition timing</li> <li>5. Leaks or restriction in fuel system</li> <li>6. Faulty sparking plugs</li> <li>7. Excessive carbon deposit</li> <li>8. Brakes binding</li> <li>9. Faulty coil, condenser or battery</li> </ol>	If the compression is appreciably less than the correct figure, the piston rings or valves are faulty. Low pressure in adjoining cylinders indicates a faulty cylinder head gasket Overhaul cylinder head(s) Renew Check and adjust using electronic equipment Check through system Clean, test and renew, if necessary Decarbonise Adjust brakes or overhaul Determine which component and renew
ENGINE RUNS ERRATICALLY	<ol style="list-style-type: none"> <li>1. Faulty electrical connections</li> <li>2. Defective sparking plugs</li> <li>3. Low battery charge</li> <li>4. Defective distributor</li> <li>5. Foreign matter in fuel system</li> <li>6. Faulty fuel pump</li> <li>7. Sticking valves</li> <li>8. Defective valve springs</li> <li>9. Incorrect ignition timing</li> <li>10. Worn valve guides or valves</li> <li>11. Faulty cylinder head gaskets</li> <li>12. Damaged exhaust system</li> <li>13. Vacuum pipes, disconnected at inlet manifold, distributor or gearbox</li> </ol>	Check security of all ignition connections Clean, test and renew if necessary Recharge battery and test for condition Remove and overhaul Determine source of dirt, and clean system Remove and overhaul or renew Overhaul cylinder head(s) Overhaul cylinder head(s) Check timing with electronic equipment, if possible Overhaul cylinder head(s) Renew gaskets Rectify or renew Refit pipes
ENGINE STARTS, BUT STOPS IMMEDIATELY	<ol style="list-style-type: none"> <li>1. Faulty electrical connections</li> <li>2. Foreign matter in fuel system</li> <li>3. Faulty fuel pump</li> <li>4. Low fuel level in tank</li> </ol>	Check HT leads for cracked insulation; check low tension circuit Determine source of matter and clean system Remove, overhaul or renew Replenish
ENGINE FAILS TO IDLE	<ol style="list-style-type: none"> <li>1. Incorrect carburetter setting</li> <li>2. Faulty fuel pump</li> <li>3. Sticking valves</li> <li>4. Faulty cylinder head gasket(s)</li> </ol>	Adjust as necessary Remove, overhaul or renew Overhaul cylinder head(s) Renew
ENGINE MISFIRES ON ACCELERATION	<ol style="list-style-type: none"> <li>1. Distributor points incorrectly set</li> <li>2. Faulty coil or condenser</li> <li>3. Faulty sparking plugs</li> <li>4. Faulty carburetter(s)</li> <li>5. Vacuum pipes disconnected at inlet manifold</li> </ol>	Set to correct dwell angle Renew Clean, test or renew Overhaul Check all vacuum connections. Renew faulty pipes
ENGINE KNOCKS	<ol style="list-style-type: none"> <li>1. Ignition timing advanced</li> <li>2. Excessive carbon deposit</li> <li>3. Incorrect carburetter setting</li> <li>4. Unsuitable fuel</li> <li>5. Worn pistons or bearings</li> <li>6. Distributor advance mechanism faulty</li> <li>7. Defective sparking plugs</li> </ol>	Adjust using electronic equipment Decarbonise Adjust Adjust ignition timing to suit octane rating Overhaul engine Renew capsule and re-check Clean, test and renew if necessary
ENGINE BACKFIRES	<ol style="list-style-type: none"> <li>1. Ignition defect</li> <li>2. Carburetter defect</li> <li>3. Sticking valve</li> <li>4. Weak valve springs</li> <li>5. Badly seating valves</li> <li>6. Excessively worn valve stems and guides</li> <li>7. Excessive carbon deposit</li> <li>8. Incorrect sparking plug gap</li> <li>9. Air leak in induction or exhaust systems</li> </ol>	Check all ignition components and timing Overhaul carburetter(s) Overhaul cylinder head Clean and reset Renew faulty gaskets or components

SYMPTOM	POSSIBLE CAUSE	CURE
BURNED VALVES	<ol style="list-style-type: none"> <li>1. Sticking valves</li> <li>2. Weak valve springs</li> <li>3. Excessive deposit on valve seats</li> <li>4. Distorted valves</li> <li>5. Excessive mileage between overhauls</li> </ol>	<p>} Overhaul cylinder head</p>
NOISY VALVE MECHANISM	<ol style="list-style-type: none"> <li>1. Excessive oil in sump, causing air bubbles in hydraulic tappets — V8 engine</li> <li>2. Worn or scored parts in valve operating mechanism</li> <li>3. Valves and seats cut down excessively, raising end of valve stem, 1,27 mm (0.050 in) above normal position</li> <li>4. Sticking valves</li> <li>5. Weak valve springs</li> <li>6. Worn timing chain or chain wheels</li> </ol>	<p>Drain and refill to correct level on dipstick</p> <p>Replace faulty parts</p> <p>Grind off end of valve stem or replace parts V8 engine only</p> <p>} Overhaul cylinder head</p> <p>Renew worn parts</p>
NOISE FROM HYDRAULIC TAPPETS — V8 ENGINE ONLY <ol style="list-style-type: none"> <li>1. Rapping noise only when engine is started</li> <li>2. Intermittent rapping noise</li> <li>3. Noise on idle and low speed</li> <li>4. General noise at all speeds</li> <li>5. Loud noise at normal operating temperature only</li> </ol>	<ol style="list-style-type: none"> <li>1. Oil too heavy for prevailing temperature</li> <li>2. Leakage at check ball</li> <li>3. Excessive leakdown</li> <li>4. High oil level in sump</li> <li>5. Excessive leak-down rate or scored lifter plunger</li> </ol>	<p>Drain and refill with correct grade</p> <p>Replace tappet</p> <p>Replace tappet</p> <p>Replace tappet</p> <p>Drain and refill to correct level on dipstick</p> <p>Replace tappet</p> <p>Replace tappet</p> <p>Replace camshaft</p> <p>Replace tappet</p>
MAIN BEARING RATTLE	<ol style="list-style-type: none"> <li>1. Low oil level in sump</li> <li>2. Low oil pressure</li> <li>3. Excessive bearing clearance</li> <li>4. Burnt-out bearings</li> <li>5. Loose bearing caps</li> </ol>	<p>Replenish as necessary to high mark on dipstick</p> <p>Worn bearings. Faulty skew gear assembly. 4-cylinder engine</p> <p>Renew bearings; grind crankshaft — NOT diesel</p> <p>Renew and investigate reason for failure</p> <p>Tighten to correct torque</p>
LOW OIL PRESSURE WARNING LIGHT REMAINS ON, ENGINE RUNNING	<ol style="list-style-type: none"> <li>1. Thin or diluted oil</li> <li>2. Low oil level</li> <li>3. Choked pump strainer</li> <li>4. Faulty release valve</li> <li>5. Excessive bearing clearance</li> <li>6. Oil pressure switch unserviceable</li> <li>7. Electrical fault</li> <li>8. Relief valve plunger sticking</li> <li>9. Weak relief valve spring</li> <li>10. Pump rotors excessively worn</li> <li>11. Excessively worn bearings: main, connecting rod, big end, camshaft, etc</li> <li>12. Faulty skew gear assembly, 4-cylinder engines</li> </ol>	<p>Drain and refill with correct oil and renew filter</p> <p>Replenish to high mark on dipstick</p> <p>Clean</p> <p>Rectify</p> <p>Rectify</p> <p>Rectify</p> <p>Renew</p> <p>Check circuit</p> <p>Remove and ascertain cause</p> <p>Renew</p> <p>Overhaul oil pump</p> <p>Ascertain which bearings and rectify</p> <p>Check skew gear bearing. Check plug not leaking or seals in 2.5 diesel engine. See engine overhaul</p>
RATTLE IN LUBRICATION SYSTEM	<ol style="list-style-type: none"> <li>1. Oil pressure relief valve plunger sticking</li> </ol>	<p>Remove and clean</p>
ENGINE OVERHEATING	<ol style="list-style-type: none"> <li>1. Low coolant level</li> <li>2. Faulty cooling system</li> <li>3. Faulty thermostat</li> <li>4. Incorrect timing</li> <li>5. Defective lubrication system</li> </ol>	<p>Check for leaks. Check expansion tank level</p> <p>Check fan and belt, pump, radiator fins not blocked</p> <p>Test and renew, if necessary</p> <p>Check and adjust using electronic equipment</p> <p>Renew filter. Check pump. Clean strainer.</p> <p>Check oil circulation</p>
MECHANICAL NOISES Medium low pitch knock Low pitch thud High pitch tap Intermittent thuds Continual tapping Continual slapping	<p>Big-end bearing slack or run</p> <p>Main bearing slack or run</p> <p>Worn gudgeon pins</p> <p>Loose fly wheel or excessive crankshaft end-float</p> <p>Excessive valve clearance — NOT V8</p> <p>Piston clearance excessive. — more apparent when engine cold may disappear when engine hot</p>	



**DIESEL ENGINE MECHANICAL FAULTS**

SYMPTOM	POSSIBLE CAUSE	CURE
MAIN BEARING RATTLE	34. Low oil level in sump 35. Low oil pressure 36. Excessive bearing clearance 37. Burnt-out bearings 38. Loose bearing caps	Replenish as necessary to high mark on dipstick Worn bearings. Faulty skew, gear assembly. 4-cylinder engine Renew hearings; and or crankshaft Renew and investigate reason for failure Tighten to correct torque
ENGINE OVERHEATING	39. Low coolant level 40. Faulty cooling system  41. Faulty thermostat 42. Cracked cylinder head 43. Defective lubrication system	Check for leaks, check expansion tank level Check fan and belt, pump, radiator fins not blocked Test and renew, if necessary Renew Renew Filter, Check pump. Clean strainer. Check oil circulation
LOW OIL PRESSURE WARNING LIGHT REMAINS ON, ENGINE RUNNING	44. Thin or diluted oil 45. Low oil level 46. Choked pump strainer 47. Faulty release valve 48. Excessive bearing clearance 49. Oil pressure switch unserviceable 50. Electrical fault 51. Relief valve plunger sticking 52. Weak relief valve spring 53. Pump rotors excessively worn 54. Excessively worn bearings) main, connecting rod, big end, camshaft, etc 55. Faulty skew gear assembly, 4-cylinder engines	Drain and refill with correct oil and renew filter Replenish to high mark on dipstick Clean Rectify Rectify Renew Check circuit Remove and ascertain cause Renew Overhaul oil pump  Ascertain which bearings and rectify Check skew gear bearing. Check plug not leaking or seals in 2.5 diesel engine. See engine overhaul
RATTLE IN LUBRICATION SYSTEM	56. Oil pressure relief valve plunger sticking	Remove and clean
NOISY VALVE MECHANISM	57. Sticking valves 58. Weak valve springs 59. Tappet clearance too wide 60. Worn timing chain or chain wheels	} Overhaul cylinder head
MECHANICAL NOISES: Low pitch knock Low pitch thud intermittent thuds  High pitch tap Light tapping Clapping	Big-end bearing slack or run Main bearing slack or run Loose flywheel or excessive crankshaft end-float Worn gudgeon pins Excessive valve clearance Excessive piston clearance — more apparent when cold	

**DIESEL ENGINE**

**FAULT DIAGNOSIS DPA AND DPS PUMPS — 2.25 and 2.5 litre diesel engines**

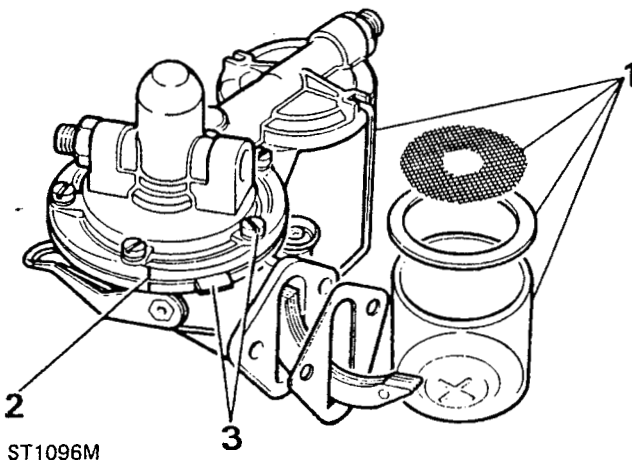
SYMPTOM	POSSIBLE CAUSE	CHECK
DIFFICULT STARTING	1. Lack of fuel 2. Stop solenoid faulty  3. Wrong starting procedure  4. Air in fuel system 5. Fuel inlet restriction 6. Fuel contamination  7. Low cranking speed  8. Starting aid ineffective 9. Injection timing incorrect 10. Timing belt slipped  11. Back leakage restricted  12. Fuel circuit incorrect  13. Engine condition  14. Fuel atomisation  15. Fuel tank blockage 16. HP pipe leaking 17. Injection pump defective internally	Fuel level in tank Audible operation when switched — Check electrical supply, replace solenoid Starting procedure correct — Throttle closed and heater plugs in operation All joints and unions are tight Filter not choked and feed pipes clear Diesel fuel being used. not petrol, free of water, dirt, ice. <b>wax.</b> Battery, starter, cable connections. Correct engine lubricating oil Correct functioning of heater plugs Pump to engine timing using timing tool Belt condition and tension. Pump rotor not seized Tank return clear, flow from cam box valve when cranking. Replace <b>pump</b> if blocked Inlet and back leak pipes correct way round. Banjo bolts of correct type for pump injector seating Cylinder compression, valve timing and clearances. Air filter not choked Injectors; correct type, opening pressure. spray condition Tank vent and outlet unrestricted HP pipe joint tightness If all other relevant checks satisfactory, replace pump

SYMPTOM	POSSIBLE CAUSE	CHECK
IRREGULAR IDLE	Any of the following items: 4, 5, 6, 9, 11, 12, 13, 14, 16, 17. Plus: 18. HP pipe restriction 19. Idling speed incorrect 20. Anti-stall setting incorrect  21. Manual idle advance faulty 22. Accelerator linkage faulty  23. Engine vibration 24. Injection pump loose	HP pipes not kinked or bore reduced at nipples Idling speed given in 'engine tuning data' Recovery from acceleration, engine warm (Reset idling and anti-stall) Cable and lever operation satisfactory Lever tight on pump reaches stop screws, linkage wear, adjustment Engine mountings tight and effective Tightness of pump drive mounting bolts and rear support bracket nut and bolt
INSUFFICIENT MAXIMUM SPEED	Any of items 4, 5, 17, 22. Plus the following: 25. Max. speed setting incorrect  26. Vehicle brakes binding	Seal intact. Engine maximum speed in 'Engine tuning data' — adjust Brake freedom, all wheels in turn and transmission brake
ERRATIC RUNNING OR SURGING	Any of items 1, 2, 4, 5, 9, 12, 13, 14, 15, 16, 17, 18, 22, 23, 24.	
EXCESSIVE SMOKE	Any of items 6, 9, 13, 14 and 17	
EXCESSIVE NOISE	Any of items 9, 14, 24, 23. Plus the following: 27. Cambox pressure low	Pressure with gauge at control cover vent screw. Replace pump if pressure too low
LACK OF POWER	Any of items 4, 5, 6, 9, 11, 12, 13, 14, 15, 16, 18, 22, 24, 25, 26. Plus the following: 28. Exhaust system defective 29. L.P. leakage	System is unrestricted Feed and return pipes, filter and tank for leak
EXCESSIVE FUEL CONSUMPTION	Any of items 9, 13, 14, 16, 17, 19, 26.	
STALLING	Any of the following items; 4, 5, 6, 9, 11, 13, 17, 19, 20, 21.	
SLOW ENGINE DIE DOWN	Any of the following items; 17, 20, 22	
ENGINE WILL NOT SHUT OFF	Either of the following two items: 2 and 17. Plus: 30. Stop solenoid valve leaking	Engine stops when supply lead removed. Replace solenoid if faulty
EXCESSIVE KNOCKING (DETONATION)	Items 8, 9, 13 or any of the following: 31. Injectors sticking  32. Lack coolant in radiator  33. Lack of oil in engine	Injectors individually — see 'Injector overhaul' Cooling system and expansion tank level. Radiator fins not blocked Oil level on dipstick

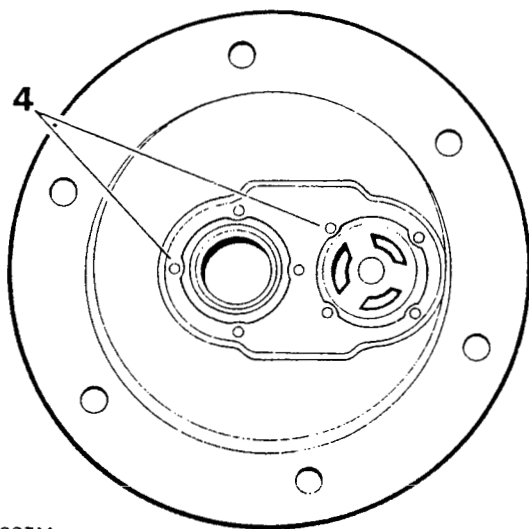
**OVERHAUL FUEL LIFT PUMP**

**DISMANTLE**

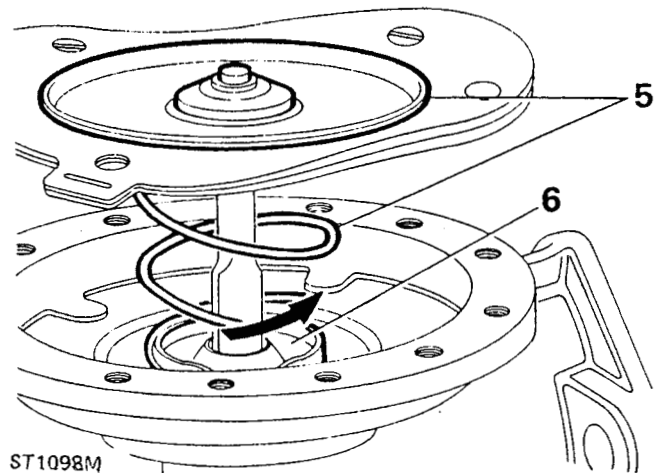
1. Remove the sediment bowl, where fitted, and collect the filter gauze and sealing washer.
2. Mark the upper and lower halves of pump casing to ensure correct alignment on reassembly.
3. Remove top cover fixing screws, and while pressing diaphragm tab against pump body, lift top cover clear.



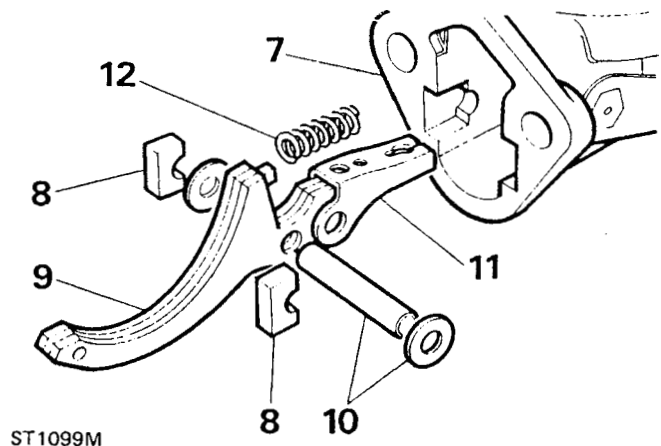
4. If necessary remove the valves by cutting away the retaining stakes with a scraper. Warm the top cover, note the position of the valves and withdraw them from the cover.



5. Turn, whilst pressing down the metal part of the diaphragm through 90° in either direction and withdraw the diaphragm and spring.
6. Unstake the oil seal housing and lever-out the oil seal and retainer.



7. Using a small chisel, remove the staking from the rocker arm retainers.
8. Withdraw the retainers.
9. Withdraw the rocker arm.
10. Withdraw the rocker arm pin and washers.
11. Detach the operating link.
12. Withdraw the rocker arm spring.



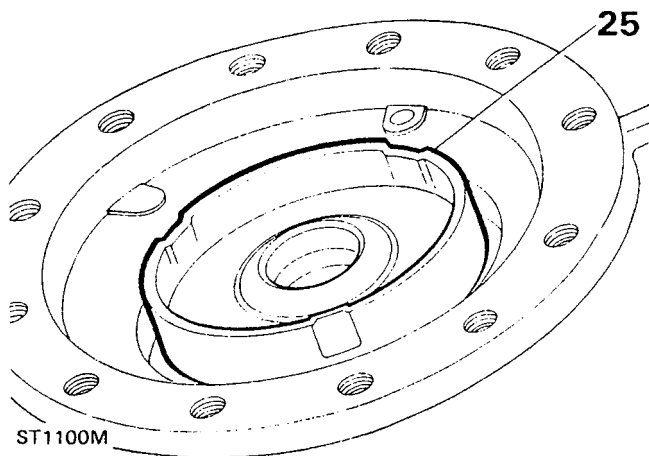
13. It is unlikely that the hand priming mechanism will ever require replacement, but it can be removed by filing the hexagon each side of the operating lever and springing the hand lever clear, withdraw the cork washers and hand rocker.

**Inspect**

14. Clean all parts in paraffin (Kerosene) and examine for wear and renew as necessary including all gaskets.
15. Sediment bowl filter disc must be free of damage and fit tightly around inlet neck of upper casing.
16. Renew diaphragm assembly if any sign of hardening, cracking or porosity is present.
17. Only very slight wear should be tolerated at the rocker arm contact face, pivot pin, operating link and diaphragm pull rod slots.
18. Springs should be renewed ensuring that the correct type are used.
19. Test valves for air tightness, by suction.
20. Check upper and lower casing flanges for distortion, using a straight edge.

**Assemble**

21. Fit the rocker arm spring.
22. Fit the operating link.
23. Fit the rocker arm pin and washers.
24. Fit the rocker arm assembly to the pump body and secure with the retainers and stake.
25. Fit the oil seal and retainer and secure by staking.



26. To refit the diaphragm assembly, hold the pump body with the diaphragm return spring in position, and the rocker arm held outwards. Position the diaphragm over the spring with the flattened end of the pull rod in line with the slot in the operating link. Push the diaphragm inwards and turn to lock.
27. Fit the inlet and outlet valves and secure by staking.
28. Place top cover assembly in position, aligning the marks made before dismantling. Fit securing screws, but do not tighten at this stage; using hand priming lever, fully depress diaphragm and fully tighten securing screws.  
The diaphragm outer edges should be approximately flush with the outer edge of the pump joint faces when fitted.

29. Fit the filter gauze and sealing ring on pumps with a sediment bowl and fit the bowl and secure with the retaining clip. Ensure that the bowl and seal are located squarely. Do not overtighten securing nut to prevent cracking the bowl.

**Test fuel pump**

30. Immerse pump in a bath of paraffin and operate rocker arm several times to flush.
31. Hold the pump clear of the bath and continue to operate the rocker arm until the pump is empty, then place a finger over the inlet port and operate rocker arm several times. A distinct suction should be heard when the finger is removed from the inlet port, denoting that a reasonable degree of suction has been developed.
32. Place a finger over the outlet port and again operate the rocker arm. Air pressure should be felt for two to three seconds after rocker movement has ceased. Build up the air pressure in the pump again, and with the finger held firmly over the outlet, submerge the pump completely in the paraffin bath, then observe the joint face edges for signs of air leakage.

**OVERHAUL ELECTRICAL FUEL PUMP**

**NOTE: The electrical components of the pump are sealed and cannot be repaired.**

**DISMANTLE**

1. Remove pump from the vehicle, and clean outside of pump before dismantling.
2. Release the end-cover from the bayonet fixing.
3. Remove the following items:
  - a) filter and seal
  - b) magnet
  - c) gasket

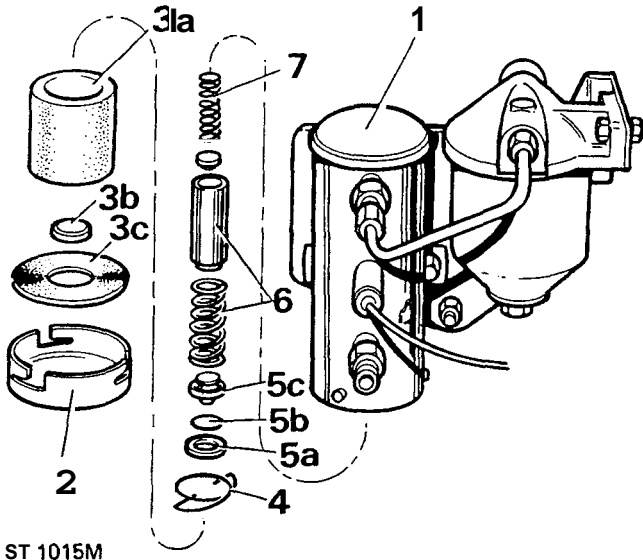
**Pump piston assembly**

4. Carefully prise out the retaining clip.
5. The following parts will then be released:
  - a) plain washer
  - b) rubber seal
  - c) one-way valve
6. Withdraw the piston return spring with the piston. If the piston remains in the pump tube, hold the pump body vertically (in the fitted position) and tap the closed end until the piston is released from its magnetic hold and drops out.

**NOTE: The piston is fitted with a one-way valve which should not be disturbed.**

continued

7. Remove the short rebound spring.
8. Clean all components in paraffin.
9. Immerse pump body in petrol and use air-line inside pump tube.



**NOTE:** The fuel filter assembly, instructions 2 and 3, can be carried out with the pump on the vehicle.

**ASSEMBLE**

**Pump piston assembly**

10. Fit the short rebound spring.
11. Fit the return spring over the opposite end of the piston.
12. Slide the piston assembly into the pump body.
13. Fit the following items:
  - a) plain washer
  - b) rubber seal
  - c) one-way valve
14. Secure the assembly with the spring clip.

**Fuel filter assembly**

15. Fit the filter and seal.
16. Fit the magnet.
17. Fit the end cover with a new gasket.
18. Fit pump to vehicle and ensure that the earth connection lead and its mounting point is clean.

**CARBURETTER FOUR CYLINDER ENGINE OVERHAUL**

**DESCRIPTION**

The twin bored 32 - 34 DMTL Weber carburetter is a fixed choke instrument with a staggered throttle opening. The carburetter is divided, operationally, into two sections namely the primary and secondary carburetters with 32 mm and 34 mm bores respectively. The delayed throttle opening occurs in the secondary carburetter.

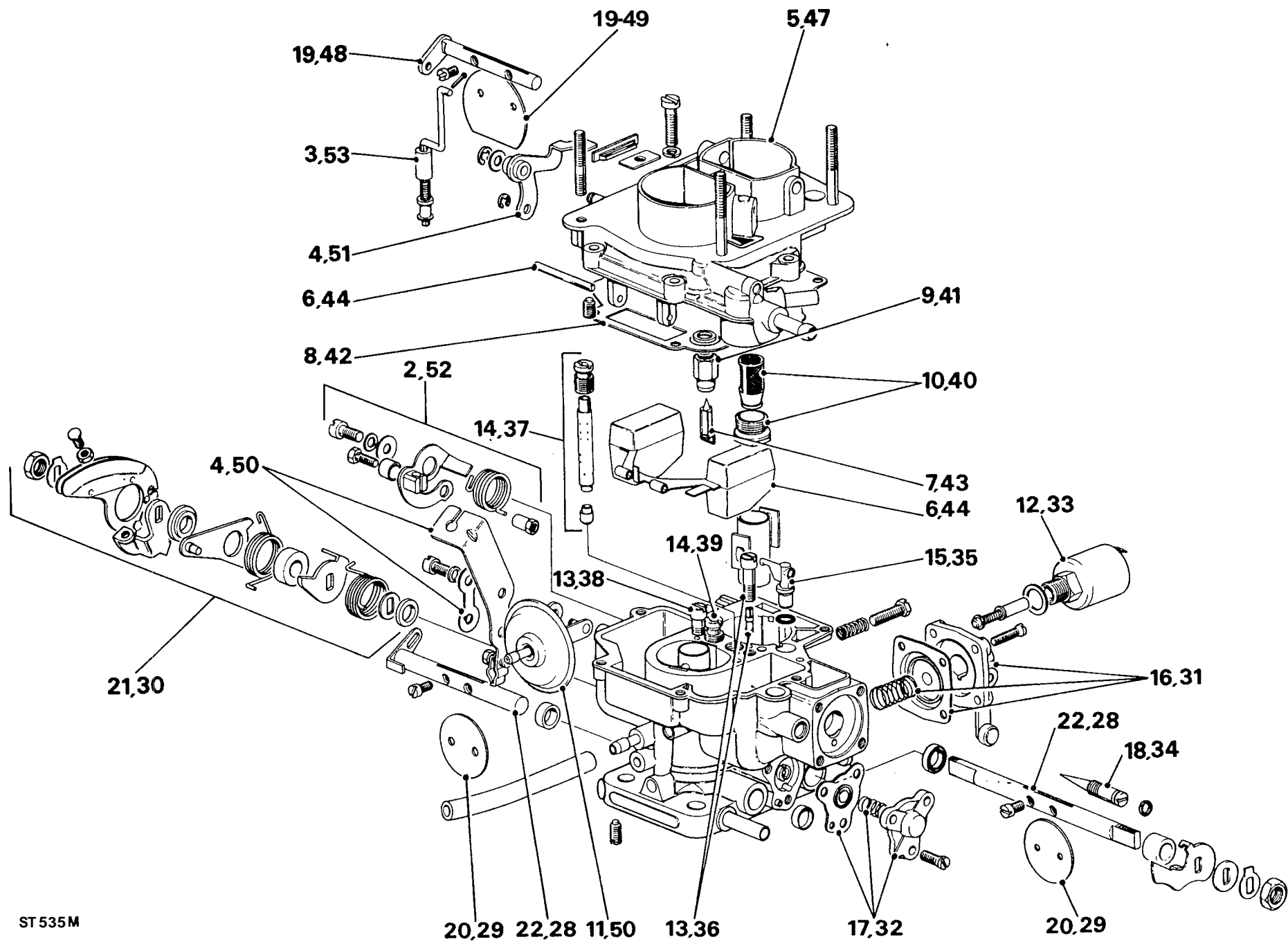
The primary carburetter, which incorporates fuel and air jets for idling, is used for starting, and normal running, up to approximately two thirds throttle opening. Shortly before this stage the secondary carburetter butterfly will begin to open and become increasingly more involved as the throttle is opened further. To ensure a smooth transition during the various stages of throttle opening both sections of the carburetter contain progression fuel and air jets and ports.

To prevent fuel vaporisation and air locks in the system fuel is continuously pumped back to the fuel tank from the carburetter float chamber. The top of the float chamber is so designed that fuel is drawn off from the main stream via the needle valve as dictated by the fuel level in the chamber.

**DISMANTLE**

1. Remove the carburetter.
2. Disconnect the fast idle cam assembly.
3. Disconnect the choke link.
4. Disconnect the pull-down lever and linkage.
5. Remove the top cover from the carburetter body.
6. Withdraw the float pivot and detach the float.
7. Remove the needle valve attached to the float tag.
8. Remove and discard the gasket from the top cover.
9. Withdraw the needle valve housing.
10. Remove the fuel filter plug and filter.
11. Remove the pull-down capsule.
12. Remove the fuel cut-off solenoid and valve.
13. Withdraw both 'primary' and 'secondary' idle jet holders noting their positions for ease of reassembly.
14. Withdraw both 'primary' and 'secondary' main jet assemblies, comprising main jet, emulsion tube and air correction jets.
15. Lift out the pump jet.
16. Remove the accelerator pump cover, diaphragm, gasket and spring.
17. Detach the economy pump assembly, comprising cover, spring and diaphragm.
18. Remove the idle mixture control screw. When the adjustment is tamper-proofed, the tamper-proofing cap must be removed to expose the screw.

continued



ST 535M



19. Mark-up for reassembly purposes and remove the choke butterfly followed by the choke spindle and linkage.
20. Prior to removal, mark each throttle butterfly.
21. Remove the throttle linkage, springs and washers, noting their sequential positions to aid reassembly.
22. If required remove the primary and secondary throttle butterflies (after marking-up) followed by the respective spindles.

**Inspection and cleaning**

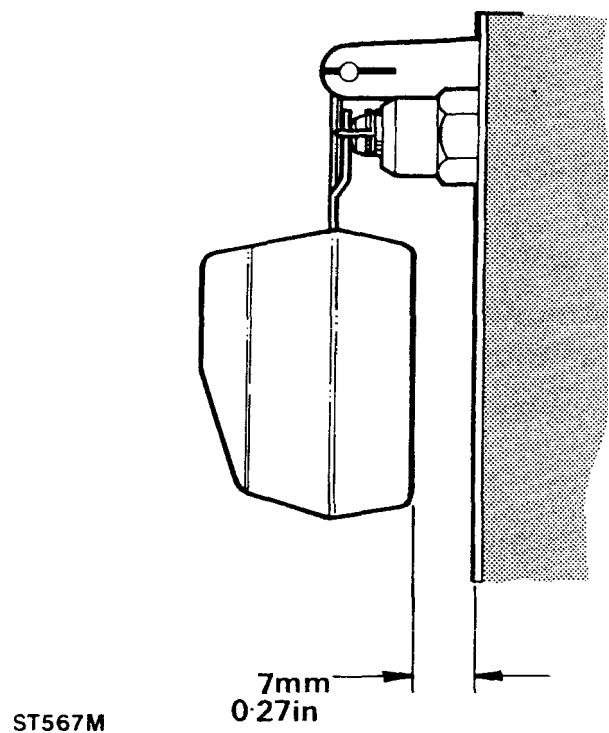
23. When cleaning fuel passages, DO NOT use metal tools which could cause dimensional changes in the drillings or jets. Cleaning should be effected using clean fuel, and, where necessary, a moisture free air blast.
24. If the joint faces on the emulsion block, top cover or carburettor body show any signs of distortion or the edges are burred, these faces may be reclaimed by flattening, using fine grade abrasive cloth and a surface plate. Examine the faces for deep scores which would lead to leakage taking place when assembled.
25. New gaskets and seals should be used throughout the carburettor rebuild. A complete set of gaskets is available for replacement purposes.
26. Examine the throttle spindle bushes for wear, if oval or badly worn, replace the carburettor body.
27. Examine the idle mixture volume screw for wear or damage, replace as required.

**Reassembly**

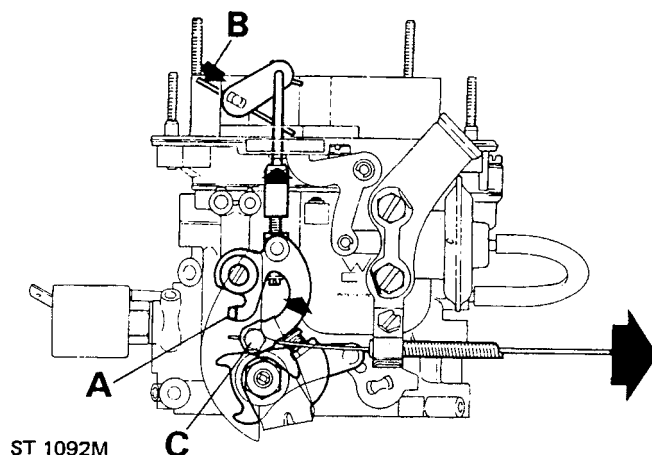
28. If previously dismantled, insert the primary and secondary throttle spindles into their respective positions.
29. Locate the primary and secondary throttle butterflies on to their respective spindles and loosely retain with the special screws. Operate each butterfly to centralise it on each spindle and secure the screws and lock them by peening.
30. Refit the throttle spindle assembly to the carburettor ensuring the pin on the free lever locates in the slot on the primary shaft plate, ensuring that the first spring is located on the spacer, whilst the second spring is engaged on the free lever.
31. Fit the accelerator pump assembly comprising spring, gasket, diaphragm, spring and pump cover.
32. Refit the economy pump assembly comprising diaphragm, spring and pump cover.
33. Replace the fuel cut-off valve and solenoid.
34. Fit the idle mixture control screw and carefully turn until fully home, then turn the screw 1½ to 2 turns in the reverse direction to serve as an initial setting.

35. Fit the pump jet with a new 'O' ring into the carburettor body.
36. Reassemble the primary jet to the jet holder and fit to the carburettor body.
37. Fit the secondary main and air correction jets to the secondary emulsion tube, locate and secure assembly to the carburettor body.
38. Assemble the secondary jet to the jet holder and fit assembly to the carburettor body.
39. Reassemble the primary main and air correction jets to the emulsion tube; and fit assembly to the carburettor body.
40. Fit the fuel filter and filter plug to the top cover.
41. Fit the needle valve seating and washer.
42. Place a new gasket into position.
43. Fit the needle valve into the needle valve seating.
44. Position the float tag in the needle valve wire loop. Align the float carrier with the pin holes and float carrier flange lugs. Secure the float carrier with the hinge pin.
45. With the needle valve on its seating and the float carrier tag resting against the needle valve (ensuring that neither the valve plunger nor the valve ball are depressed) measure the distance between the casing and the front edge of the float.
46. The dimension required is 7 mm (0.27 in). Any adjustment must be made by bending the float carrier tag. Adjustments must NOT be made by bending the float carrier arms.

continued

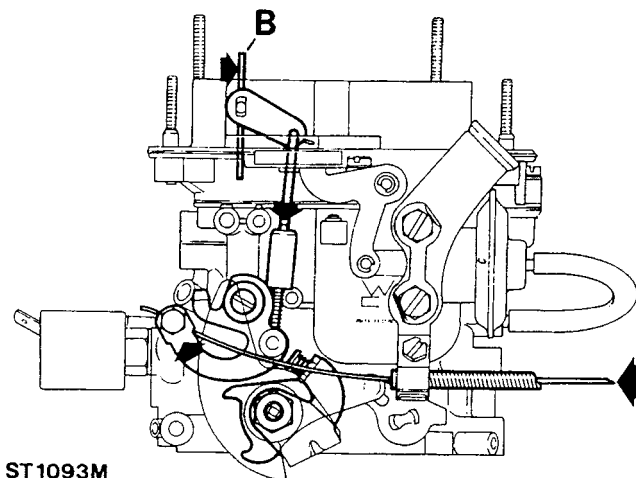


47. Fit and secure the top cover assembly evenly, to the carburettor body.
48. Fit the choke spindle into its housing.
49. Locate the choke butterfly on the spindle and loosely retain with the two special screws. Operate the butterfly to centralise it on the spindle, then secure the screws and lock them by preening.
50. Refit the pull-down capsule, cable retaining bracket, spacer and fixings.
51. Fit the pull-down lever engaging the pivot with the pull-down capsule arm. Secure lever assembly with washer and circlip.
52. Fit the float idle cam ensuring the spring is engaged correctly to the cam.
53. Refit the choke link to the choke spindle, securing with a new split pin. Engage the opposite end of the choke link to the idle cam.



ST 1092M

7. Push the mixture control fully in and confirm that flap 'B' is open, that is in the vertical position.



ST 1093M

**FOUR CYLINDER ENGINE CARBURETTER**

**TUNE AND ADJUST**

1. Before attempting any carburettor adjustments ensure that cylinder compressions, valve clearances, spark plug gaps and ignition timing are satisfactory.  
Check also that there is no air leakage into the inlet system through the inlet manifold and carburettor gaskets and brake servo hose connections.

**Throttle cable**

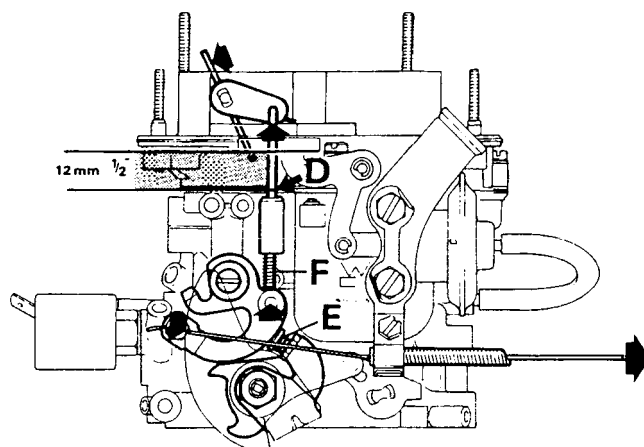
2. Check that the throttle pedal, cable and linkage operate smoothly.
3. Remove the elbow from the top of the carburettor.
4. If necessary adjust the pedal stop bolt so that no strain is exerted on the throttle cable. Depress the throttle pedal and check that both the butterflies are fully open, then adjust the pedal stop bolt so that it touches the floor, without strain on the cable and tighten the locknut
5. Ensure that when the throttle pedal is released both butterflies are closed completely.

**Mixture control (cold start)**

6. Pull the mixture control cable fully out and check that lever 'A' is against its stop and the choke flap 'B' is fully closed. If necessary adjust the inner cable clamp 'C' to achieve this condition.

**Fast idle adjustment**

8. Pull the mixture control out until the dimension between the crank in the vertical rod 'D' and the underside of the carburettor top cover, without compressing the spring 'F' is 12,5 mm (0.5 in). Adjust the fast idle screw 'E' so that it just makes contact with the fast idle cam.



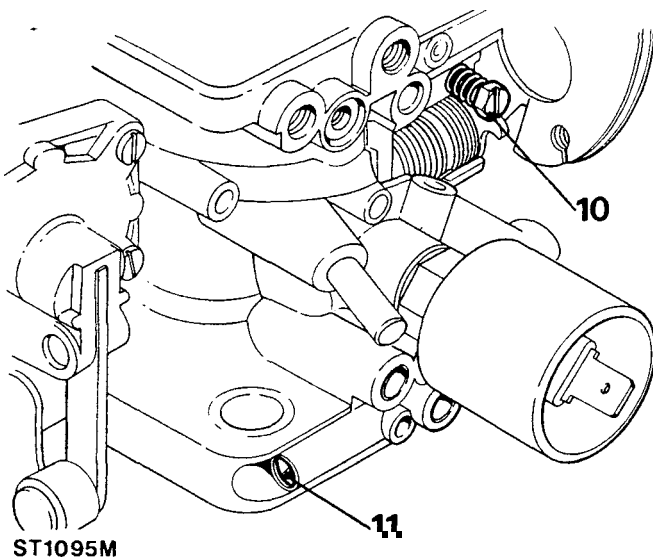
ST 1094M



**Idle adjustment**

**NOTE:** The idle mixture adjustment screw provides mixture variation at idle speed only. Above idle speed the mixture is determined by fixed size jets.

9. Start the engine and run until the normal operating temperature is attained.
10. Turn the throttle butterfly adjustment screw to obtain an idle speed of 600 to 700 r.p.m.
11. Turn the idle mixture adjustment screw clockwise or anti-clockwise by one-quarter turn increments to obtain the highest engine r.p.m. When this has been achieved, re-adjust, if necessary, the butterfly adjustment screw to maintain the 600 to 700 r.p.m. idle speed.
12. Fit the air intake elbow to the carburetter top.



**V8 ENGINE ZENITH — CARBURETTER OVERHAUL**

**DISMANTLE**

**Remove the piston assembly**

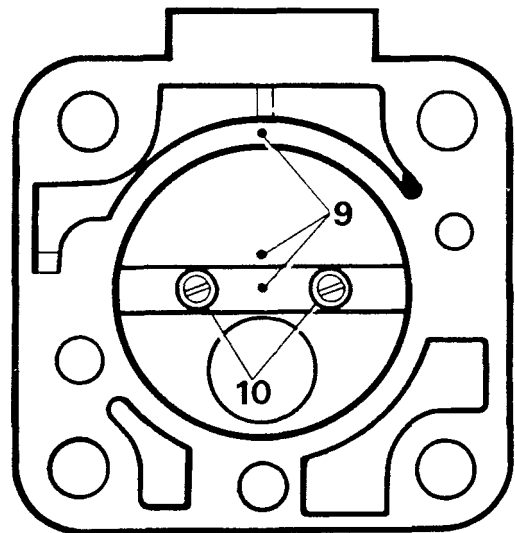
1. Remove the carburetters from the engine.
2. Release the four screws and withdraw the top cover and spring.
3. Withdraw the air valve, shaft and diaphragm assembly.
4. Remove the metering needle retained by a locking screw.
5. Release the four screws and separate the diaphragm from the air valve.

**Remove the float chamber**

6. Release the six screws and remove the float chamber and joint washer.
7. Release the float assembly and spindle from the two clips.
8. Unscrew the needle valve and washer from carburetter body.

**Dismantle carburetter body**

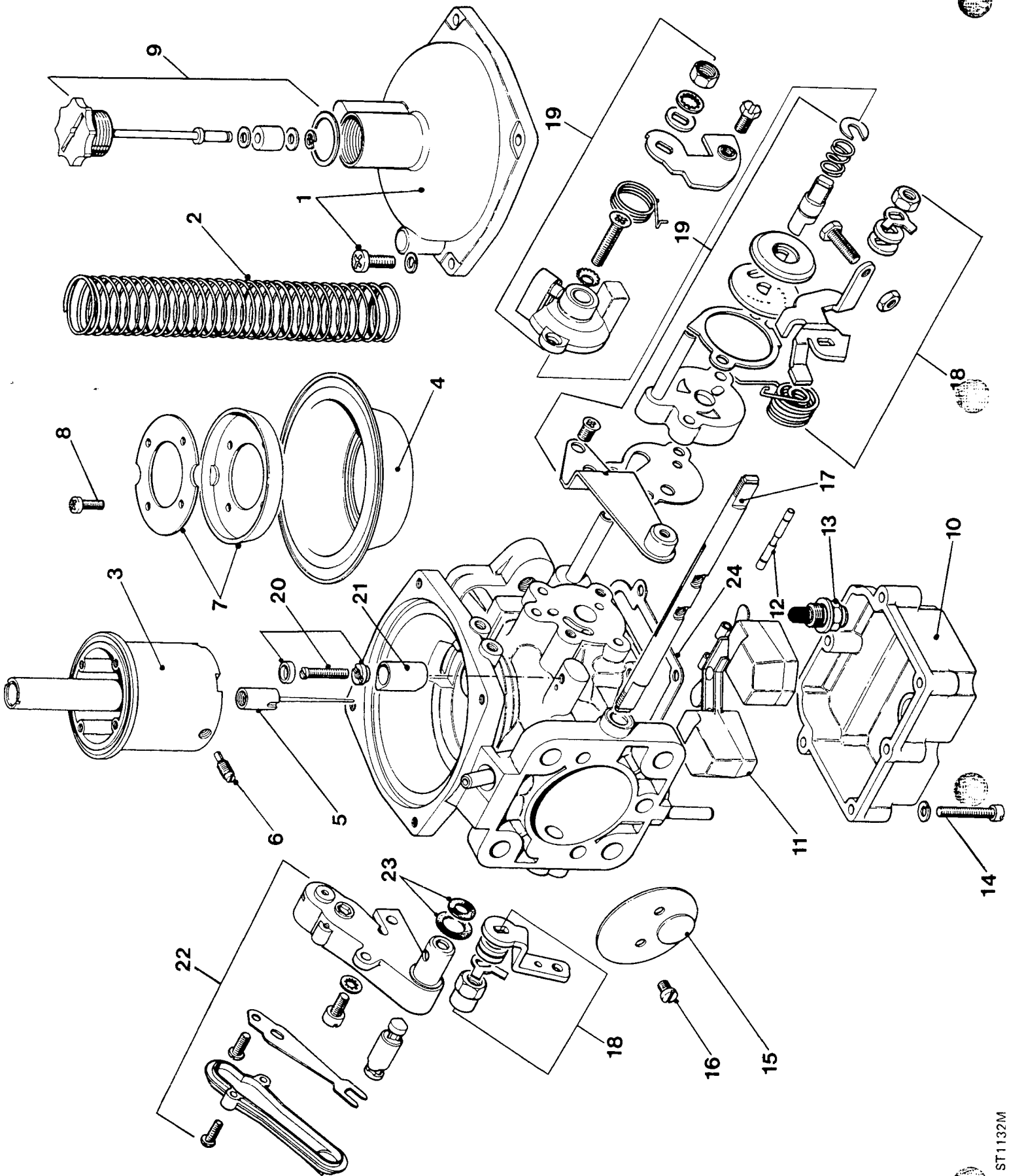
9. **Make location marks**, as illustrated, to assist correct assembly, on the throttle butterfly, spindle and carburetter body.
10. **Right-hand carburetter** Release the two screws and remove the butterfly and withdraw the spindle.



11. **Left-hand carburetter** Remove the left-hand lever assembly. Release the two screws, remove the butterfly and withdraw the spindle.
12. **Left-hand carburetter** Release the two retaining screws and shake-proof washers and remove the cold start assembly and joint washers.

continued

**19** PETROL FUEL SYSTEM



**KEY TO L.H. CARBURETTER**

1. Top cover and retaining screws
2. Air valve return spring
3. Air valve
4. Diaphragm
5. Metering needle
6. Metering needle retaining screw
7. Diaphragm retaining ring and plate
8. Screw (4 off) retaining diaphragm to air valve
9. Damper assembly

10. Float chamber
11. Float assembly
12. Float assembly spindle
13. Needle valve
14. Float chamber retaining screw (2 off)
15. Butterfly
16. Butterfly retaining screws (2 off)
17. Butterfly (throttle) spindle
18. Throttle spindle lever assembly

19. Cold start assembly (left-hand carburettor only)
20. Slow running screw assembly
21. Tamper-proof sleeve
22. Temperature compensator assembly
23. Temperature compensator rubber seals (large and small)
24. Float chamber joint washer

13. Dismantle the cold start assembly but DO NOT remove the discs from the spindle.
14. If necessary, dismantle the throttle spindle lever assemblies from both carburetters.

**Slow-running adjustment screws**

Do not attempt to remove these screws or break the tamper-proof seals. See Cautionary note under 'Tune and Adjust'.

**Remove temperature compensator**

15. Release the two screws and withdraw the temperature compensator unit complete.
16. Remove the large and small rubber washers.

**CLEANING AND INSPECTION**

**Cleaning**

17. When cleaning fuel passages do not use metal tools (files, scrapers, drills etc.) which could cause dimensional changes in the drillings or jets. Cleaning of all components should be effected using clean fuel and, where necessary, a moisture-free air blast.

**Joint washers and seals**

18. New gaskets and seals should be used throughout carburetter rebuild. A complete set of gaskets is available for replacement purposes. Inspect metering needle; it is machined to very close limits and should be handled with care. Examine for wear, bend and twist; renew if necessary.
19. Examine the faces for deep scores which would lead to leakage taking place when assembled.

**Diaphragm**

20. Examine the diaphragm for deterioration, damage and punctures. Do not use any cleaning chemicals on the diaphragm only clean lint free rag.

**Float assembly**

21. Examine the two plastic floats and check for punctures and damage.
22. Check the spindle and retaining clips for wear.
23. Inspect the needle valve assembly for wear. Renew the valve if there is any tendency for the needle to stick.

**Cold start assembly**

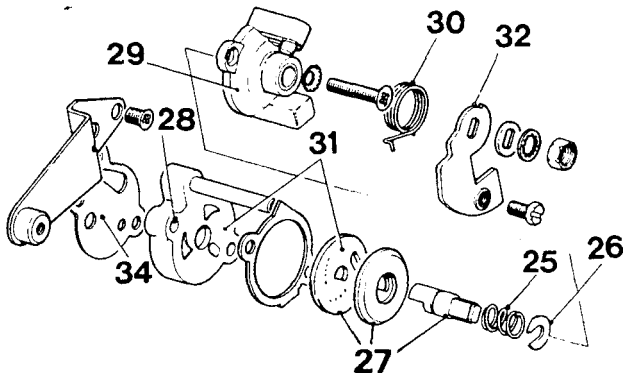
24. Examine all the cold start components for wear and corrosion and the machined faces for scores.

continued

## ASSEMBLE CARBURETTERS

## Cold start — L.H. carburettor

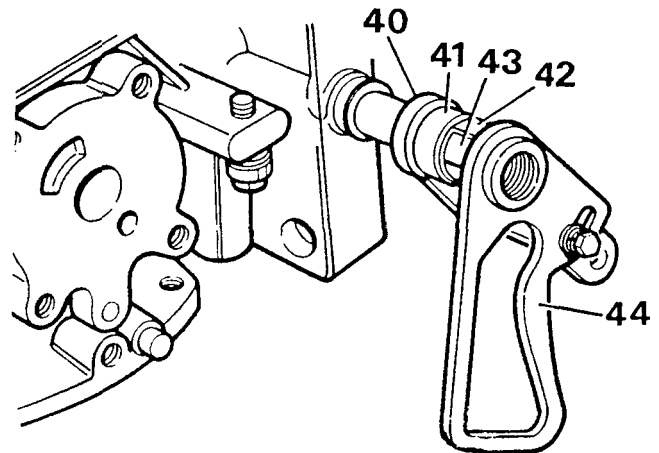
25. Place the spring on the cold start spindle.
26. Fit the spring retaining clip.
27. Check that the discs slide easily on the spindle.
28. Place the cold start spindle on the starter face.
29. Place the starter cover in position.
30. Fit the return spring over the spindle.
31. Rotate the spindle until the oval port in the end disc is aligned with the oval port in the starter face.
32. Fit the cold start lever.
33. Engage the return spring over the lug on the starter cover and the back of the cold start lever.
34. Place the cold start gasket onto the carburettor body.
35. Fit the cold start assembly to the carburettor body, and check for ease of operation.



ST1116M

## Throttle spindle, L.H. carburettor

36. Place the return spring over either end of the spindle.
  37. Fit the throttle stop and fast idle lever and secure with spacers, tab washer and nut.
  38. Insert the throttle spindle from the cold start side of the carburettor body and fit the throttle return spring on the fast idle adjustment lug. Tension the spring half a turn.
- NOTE: Slacken the idle adjustment screw clear of lever to facilitate centralisation of the butterfly.**
39. Fit the throttle butterfly, maintaining the previously marked alignment. Leave the retaining screws loose. Actuate the throttle several times to centralize the butterfly, then tighten the retaining screws and lock by peening ends.
  40. Fit the throttle lever to the spindle at the opposite end.
  41. Place the spacer on the spindle.
  42. Place the tab washer on the spindle.
  43. Fit the sleeve nut, sleeve end last, and engage the tab washer.
  44. Fit the throttle adjusting lever.

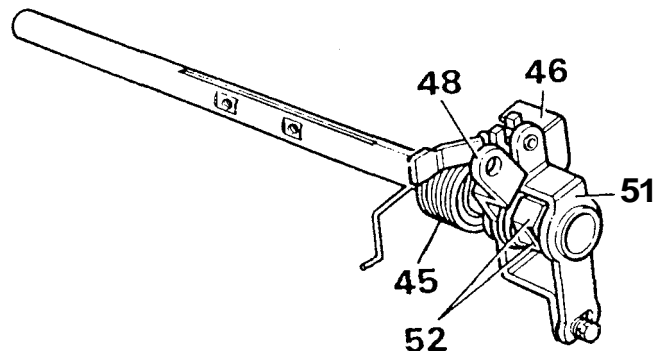


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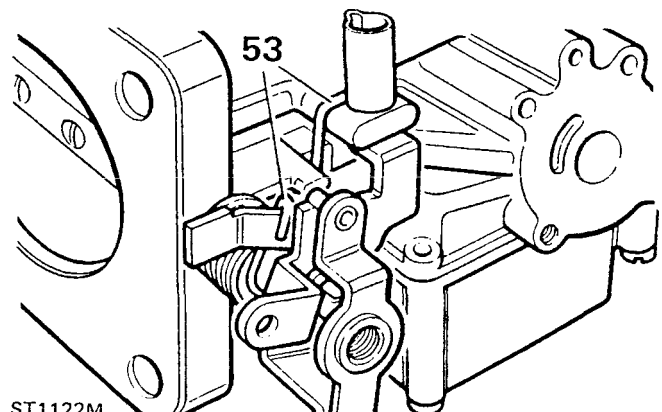
## Throttle spindle, R.H. carburettor

45. Place return spring over threaded end of the spindle.
46. Fit the throttle stop and fast idle lever.
47. Fit the bushed washer, bush outwards.
48. Fit the throttle lever on the bushed washer.
49. Fit the plain washer.
50. Fit the tab washer.
51. Fit the throttle adjustment lever.
52. Secure the assembly with the nut and lock with a tab.
53. Fit the throttle butterfly as described in instruction 39 and anchor the return spring as illustrated. See note before instruction 39.

continued



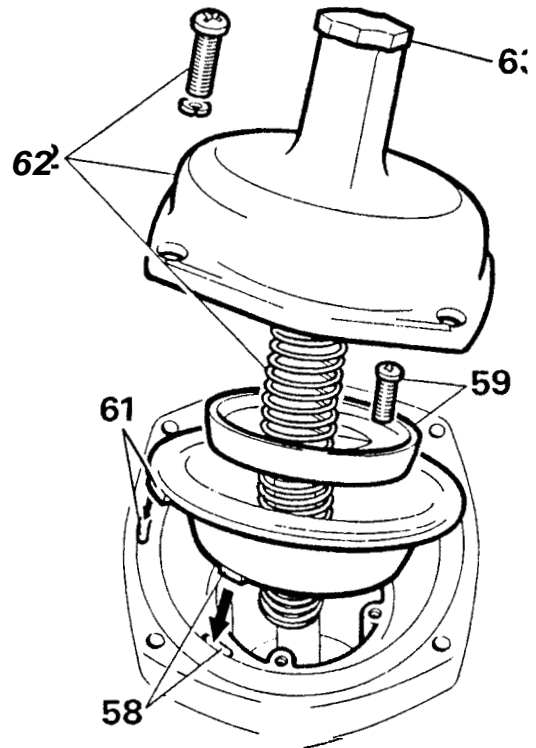
ST1121M



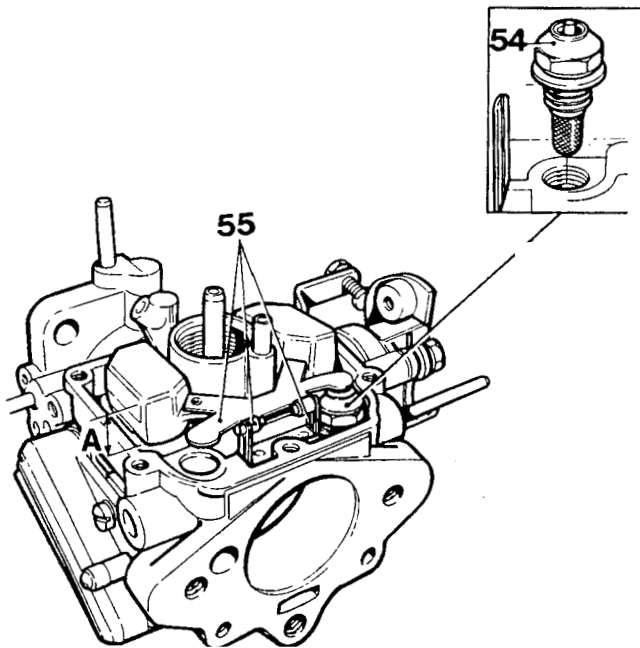
ST1122M

**Float chamber assembly**

54. Fit the needle valve and new washer.
55. Locate the spindle in the float arm and fit the assembly into the retaining clips.
56. Invert the carburettor so that the needle is on its seating and the float tab is contacting the needle. Measure the dimension **A** between the carburettor gasket face and the highest point on the floats. The correct measurement should be 17 to 18 mm (0.67 to 0.71 in). Adjust by bending the float tab. This dimension must be the same for both floats. The float carrier tab must be maintained at right angles to the needle in the closed position.
57. Fit the float chamber and new gasket and evenly tighten the retaining screws.



ST1117M



ST1123M

**Air valve and diaphragm**

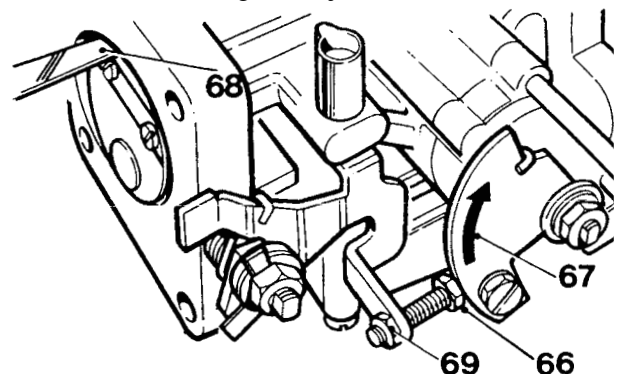
58. Fit the diaphragm to the air valve with the inner tag locating in the air valve recess.
59. Fit the diaphragm retaining ring and secure with the four screws.
60. Fit the metering needle into the air valve and secure with the locking screw.
61. Insert the air valve and needle into the carburettor and locate the diaphragm outer tag into the recess in the carburettor body.
62. Fit the spring and top cover and secure with the four screws.
63. Fit the damper.

**Temperature compensator**

64. Clean the carburettor and compensator mating faces.
65. Fit a new inner and outer rubber washer and secure the temperature compensator with the two screws and shake-proof washers.

**Fast idle adjustment — L.H. carburettor only**

66. Slacken the fast idle adjusting screw.
67. Hold the cold start cam lever in the maximum position.
68. Adjust the fast idle adjusting screw against the cam lever until there is 0,61 to 0,66 mm (0.024 to 0.026 in) gap between the top edge of the throttle butterfly and the carburettor barrel wall. Use feeler gauges or a 0,65 mm diameter (No. 72) drill to measure the gap.
69. Secure the locknut on the fast idle adjusting screw without disturbing the adjustment.



ST1124M

## V8 ENGINE ZENITH CARBURETTERS

### TUNE AND ADJUST

#### Tamper-proofing

These carburetters may be externally identified by a tamper-proof sealing tube fitted around the slow running adjustment screw.

The purpose of these carburetters is to more stringently control the air fuel mixture entering the engine combustion chambers and, in consequence, the exhaust gas emissions leaving the engine.

For this reason the only readily accessible external adjustment is to the throttle settings for idle and fast idle speed and, for the former setting will require the use of a special tool to prevent breaking the tamper-proof seals.

**CAUTION:** Unauthorised breaking of tamper-proofing devices, adjustment of carburettor settings or the fitting of incorrectly related parts may render the vehicle user liable to legal penalties according to local territory legislation.

Whenever adjustments are made to the settings of tamper-proof or emission specification carburetters an approved type CO meter must be used to ensure that the final exhaust gas analysis meets with local territory requirements.

#### Emission Specifications

All carburetters fitted to the Land-Rover conform at the time of manufacture to particular territory requirements in respect of exhaust and evaporative emissions control. However, in some cases changes to the basic carburetters may have been necessary to achieve this.

#### Service tools:

605330 — Carburettor balancer

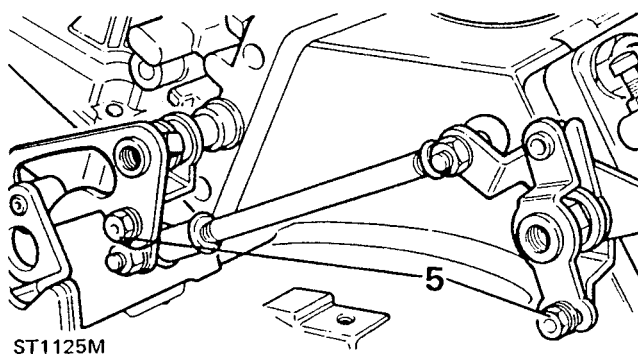
MS80 — Mixture adjusting tool

MS86 or B25243 — Tamper-proofed throttle adjustment tool

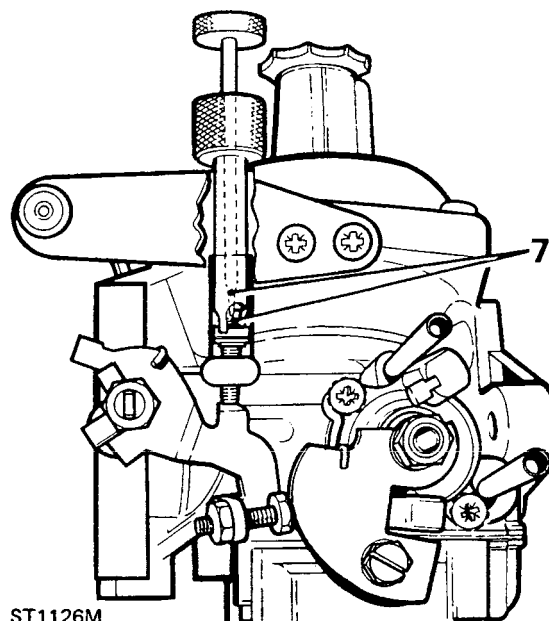
The service tool 605330 carburettor balancer must be used to adjust the carburetters. Primarily, this instrument is for balancing the air-flow through the carburetters, but it also gives a good indication of the mixture setting. Investigation has shown that incorrect mixture setting causes either stalling of the engine or a considerable drop in engine rev/min if the balancer is fitted when the mixture is too rich or a considerable increase in rev/min when used with the mixture setting too weak. Before balancing the carburetters it is most important therefore that the following procedure be carried out:

#### Slow running (idle) adjustment

1. Check that the throttle control between the pedal and the carburetters is free and has no tendency to stick.
2. Check the throttle cable setting with the throttle pedal in the released position. The throttle linkage must not have commenced movement, but commences with the minimum depression of the pedal.
3. Run the engine until it attains normal operating temperature; that is, thermostat open.
4. Remove the air cleaner elbows.
5. Slacken the screws securing the throttle adjusting levers on both carburetters to allow independent adjustment.

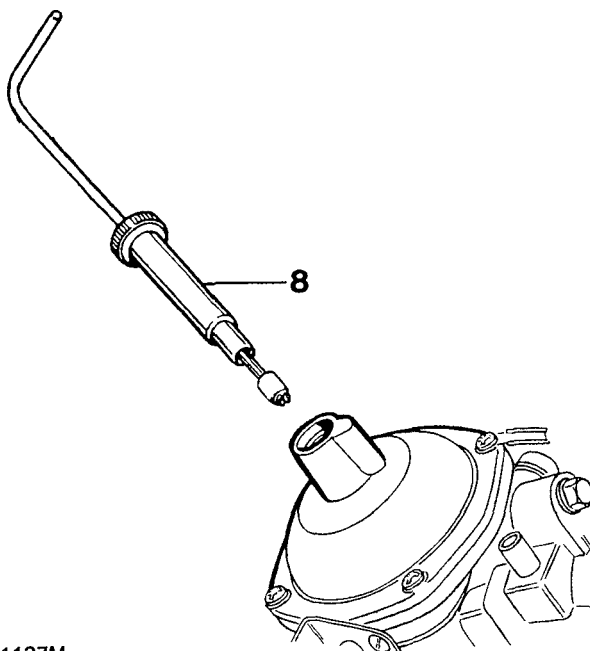


6. Start the engine and check the idle speed using a reliable proprietary tachometer.
7. If necessary, adjust the slow running screw to give the correct idle speed, see 'Engine tuning data'. If a tamper-proof sleeve is fitted over this screw the slow running speed can only be adjusted using special tool MS86 or B25243.



**Mixture setting and balance carburetters**

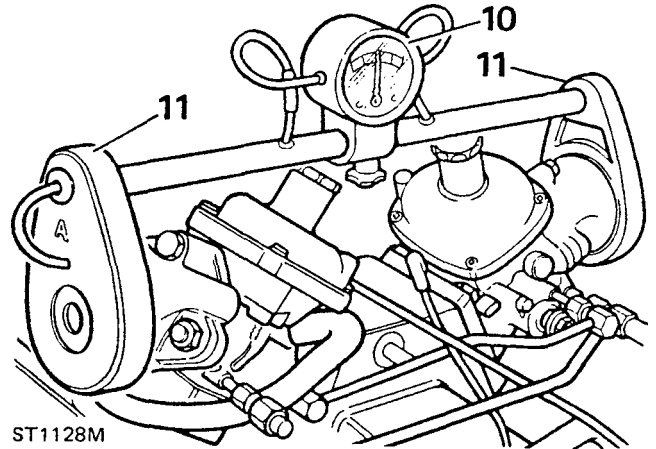
8. Remove the piston damper plug, and using special tool MS80 adjust the mixture. Locate the outer sleeve of the tool to engage a machined slot to prevent the air valve twisting. Turn the inner tool clockwise to enrich the mixture and anti-clockwise to weaken it. After every adjustment the tool should be removed from the carburetter to allow engine to stabilise. Run engine at 2000 rev/min to aid stabilisation.
9. When the mixture is correctly adjusted, the engine speed will remain constant or may fall slowly a small amount as the air valve is lifted.



ST1127M

10. Check, and if necessary, zero the gauge on balancing tool 605330.
11. Place balancer on the carburetter adaptors, ensuring that there are no air leaks. If the engine stalls or decreases considerably in speed, the mixture is too rich. If the engine speed increases, the mixture is too weak.
12. If necessary, remove balancer and re-adjust the mixture, then refit the tool.
13. Check balancer gauge reading.
14. If the gauge pointer is in the 'zero' sector, no adjustment is required.
15. If the gauge pointer moves to the right, decrease the air-flow through the left-hand carburetter by unscrewing the slow running screw or increase the air-flow through the right-hand carburetter by turning clockwise the slow running screw. Reverse the procedure if the pointer moves to the left.
16. If the engine idle speed (slow running) rises too high or drops too low during balancing adjust to the correct idle speed, whilst maintaining the gauge pointer in the zero sector.

17. Remove balancer. With the mixture setting and carburetter balance correctly adjusted the difference in engine rev/min with the tool 605330 on or off will be negligible, approximately plus or minus 25 rev/min.

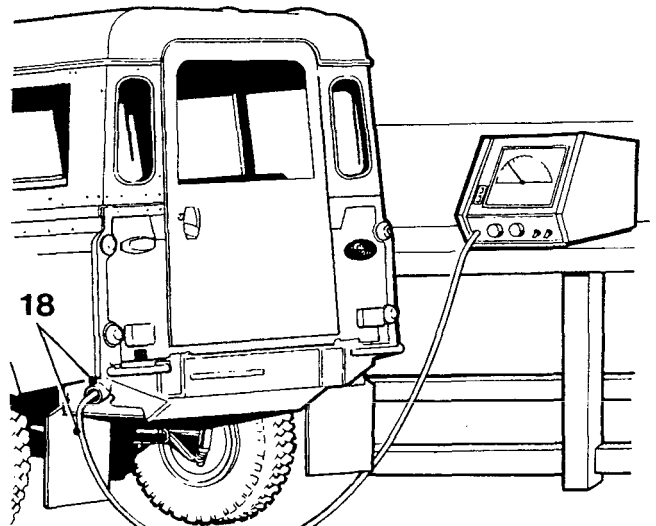


ST1128M

**Check CO level**

Use a proprietary non-dispersive infra-red exhaust gas analyser.

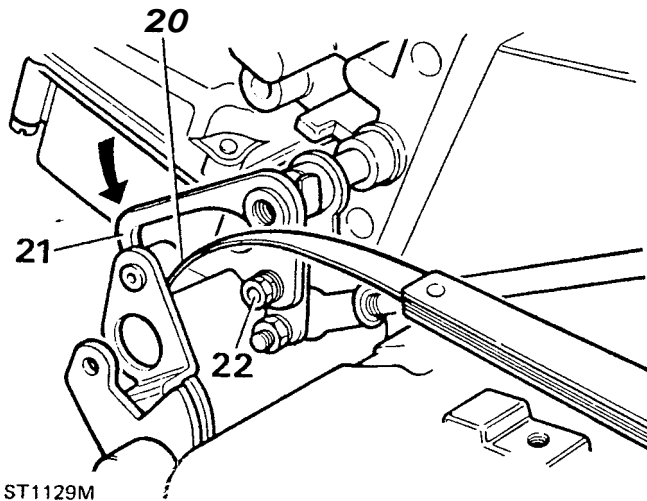
18. Insert the probe of the analyser as far as possible into the exhaust tail pipe, start the engine and allow a one to one and a half minute stabilisation period.
19. Check that the correct idle speed (slow running) is maintained and observe the CO reading against that given in the data section. If necessary re-adjust the mixture setting to achieve the correct CO level.



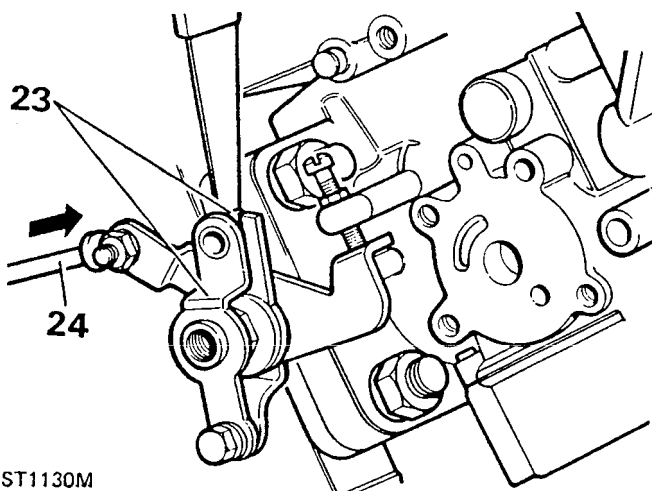
ST 1102M

**Adjust throttle linkage**

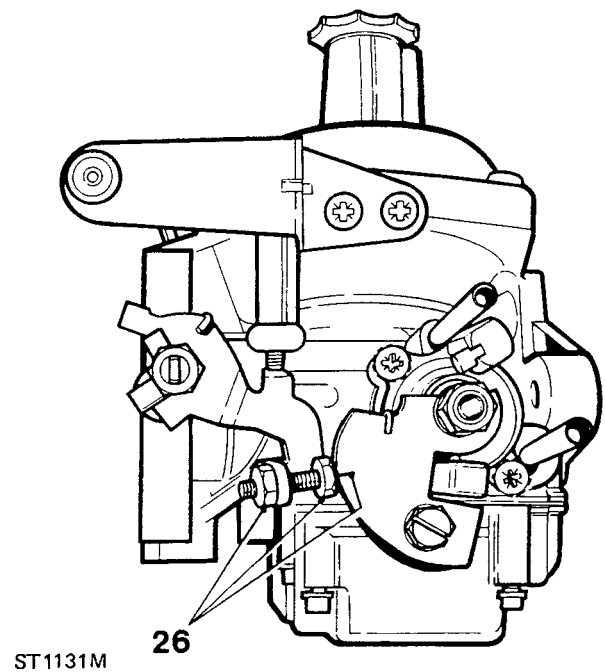
20. On the left-hand carburettor, place a 0,15 mm (0.006 in) feeler between the underside of the roller on the countershaft lever and the throttle lever.
21. Apply pressure to the throttle lever to hold the feeler.
22. Tighten the screw to secure the throttle adjusting lever, then withdraw the feeler.



23. On the right hand carburettor, place a 0,15 mm (0.006 in) feeler between the left leg of the fork on the adjusting lever and the pin on the throttle lever.
24. Apply light pressure to the linkage to hold the feeler.
25. Tighten the screw to secure the throttle adjusting lever, then withdraw the feeler.

**Fast idle adjustment**

26. The fast idle adjustment is pre-set on the left-hand carburettor and should not normally require adjustment. If adjustment is required, the correct procedure is to remove the left-hand carburettor and carry out instructions 66 - 69 under carburettor overhaul. Alternatively the fast idle can be approximately set by pulling the choke cable until the mark on the cam is in-line with the head of the adjusting screw. Slacken the locknut and adjust the screw against the cam until the correct idle speed is achieved see 'Engine tuning data'. Tighten the locknut.



27. Fit the air cleaner elbows.
28. Remove the piston damper plug on both carburettors and replenish the damper reservoir with S.A.E.20 oil to within 12 mm (0.5 in) from the top of the tube and refit damper plug.



**CARBURETTER OVERHAUL — S.U. HIF 44 —  
Right hand**

**DISMANTLE**

1. Remove the carburetters from the engine and clean the exteriors with a suitable solvent.
2. Remove the two nuts and spring washers and withdraw the air intake adaptor and joint washer.
3. Unscrew and remove the piston damper assembly and drain the oil.
4. Remove the three screws and lift-off the suction chamber complete with piston and spring.
5. Remove the spring clip from the top of the piston rod and withdraw the piston and spring.
6. Unscrew the fuel metering needle guide locking screw. If the needle cannot be removed from the piston with the fingers, hold the needle as close to the piston as possible, in a soft jawed vice and with a sharp pull withdraw the needle, guide and spring assembly.
7. Remove the four screws and withdraw the float chamber cover plate and scaling ring.
8. Remove the jet adjusting lever retaining screw and spring.
9. Withdraw the jet complete with the bi-metal lever and separate the lever from the jet.
10. Unscrew and remove the float pivot spindle and plain washer, and remove the float.
11. Lift-out the needle valve.
12. Unscrew and remove the needle valve and filter.
13. Unscrew and remove the jet bearing nut.
14. Invert the carburetter body to allow the jet bearing to fall out. If the bearing sticks, carefully tap it out from the bridge side.
15. Remove the piston guide peg.
16. Remove the suction chamber-to-body sealing ring.
17. Unscrew and remove the mixture adjusting screw and seal. Use thin nosed pliers to finally withdraw the screw.
18. Bend-back the cam lever nut lock tabs and remove the nut and lock washer.
19. Remove the cam lever and spring.
20. Remove the end seal cover and seal.
21. Remove the two screws and withdraw the cold start valve body and seal together with the valve spindle. Also collect the paper joint washer.
22. Note the position of the throttle levers and return spring.
23. Bend-back the lock washer tabs and remove the throttle lever nut.
24. Remove the lock washer, bush washer and throttle actuating lever.
25. Release the throttle return spring and remove the throttle adjusting lever from the throttle butterfly spindle and remove the return spring.
26. Hold the butterfly closed and mark the relationship of the butterfly to the carburetter flange.
27. Remove the butterfly two retaining screws and withdraw the butterfly from the spindle.

28. Withdraw the throttle butterfly spindle from the carburetter body together with the two seals.
29. Clean all components with petrol or de-natured alcohol ready for inspection. Do not use abrasives for the removal of stains or deposits.

**INSPECTION**

30. Examine the throttle spindle and bearings for excessive axial clearance.
31. Check the float needle and seating for wear and the float for punctures and renew if necessary.
32. Check the condition of all rubber seals, 'O' rings and joint washers and renew if necessary. The float cover plate seal must be renewed.
33. Examine the carburetter body for cracks and damage.
34. Ensure that the inside of the suction chamber is clean and fit the piston into the chamber without the spring. Hold the assembly horizontally and spin the piston. The piston should spin freely in the suction chamber without any tendency to stick.
35. Inspect the metering needle for wear, scores and distortion. Check also that it has the correct designation number — see Engine Tuning Data, Section 05.
36. Examine the bi-metal jet lever for cracks.
37. Check all springs for cracks and distortion.

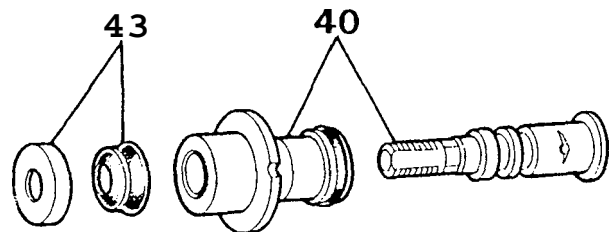
**ASSEMBLE**

**Fit throttle butterfly**

38. Fit the throttle spindle to the carburetter body and insert the throttle disc into the spindle in its original position. Secure the disc with new screws and ensure that before tightening the throttle disc is correctly positioned and closes properly. Splay the split ends of the screws to prevent turning.
39. Fit new seals to both ends of the throttle spindle ensuring that they are fitted the correct way round.

**Fit cold start assembly**

40. Fit a new 'O' ring to the valve body and assemble the valve spindle to the valve body.

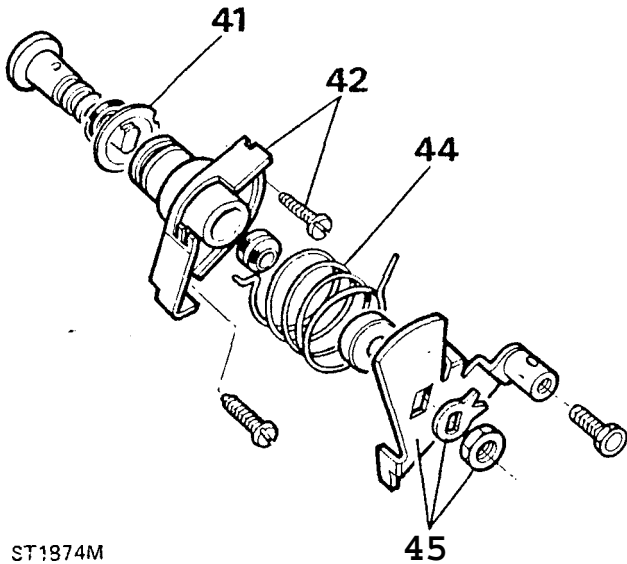


ST1873M

41. Fit a new paper joint washer to the valve noting that the half-moon cut-out in the washer is clearance for the top retaining screw.

continued

42. Fit the starter assembly to the carburettor body and secure with the two screws.
43. Fit the end seal and cover.
44. Fit the return spring.
45. Fit the cam lever and tension the spring. Fit a new lock washer and secure with the nut and bend the tabs over a convenient flat.
46. Adjust the coils of the spring, if necessary, to prevent coil binding.

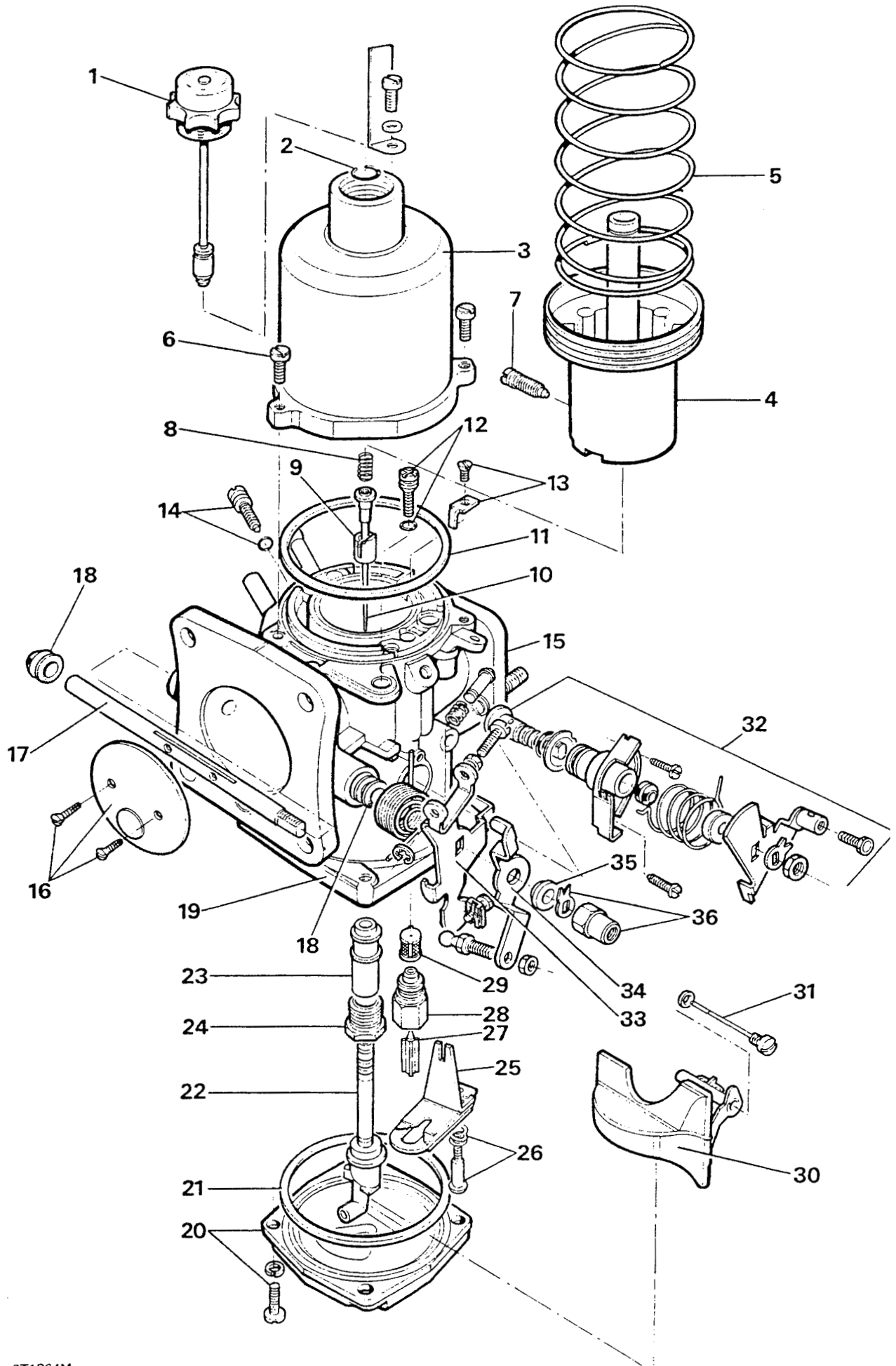


ST1974M

#### KEY TO S.U. CARBURETTER COMPONENTS

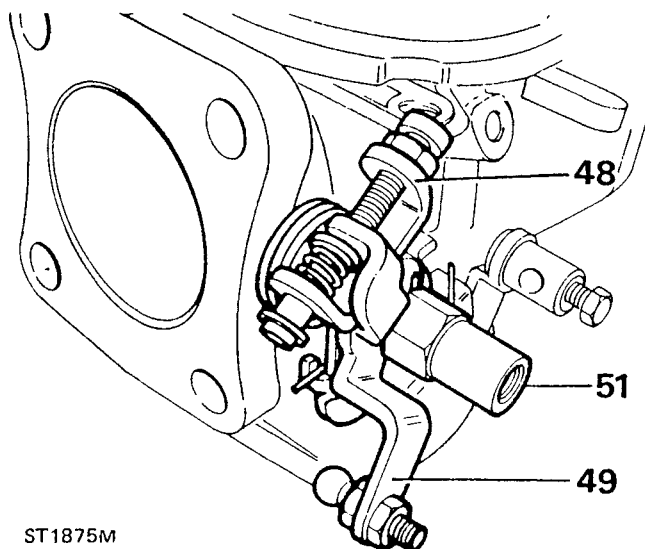
- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Piston damper.</li> <li>2. Spring clip.</li> <li>3. Suction chamber.</li> <li>4. Piston.</li> <li>5. Piston spring.</li> <li>6. Suction chamber retaining screws — 3off.</li> <li>7. Needle retaining screw.</li> <li>8. Needle bias spring.</li> <li>9. Needle guide.</li> <li>10. Needle.</li> <li>11. Suction chamber sealing ring.</li> <li>12. Throttle adjusting screw and scal.</li> <li>13. Piston key and retaining screw.</li> <li>14. Mixture adjusting screw and seal.</li> <li>15. Carburettor body.</li> <li>16. Throttle butterfly and retaining screws.</li> <li>17. Throttle spindle.</li> <li>18. Throttle spindle seals — 2 off.</li> <li>19. Float chamber.</li> <li>20. Float chamber cover and retaining screws.</li> <li>21. Float chamber cover seal.</li> <li>22. Jet assembly.</li> <li>23. Jet bearing.</li> <li>24. Jet bearing nut</li> <li>25. Bi-metal jet lever.</li> <li>26. Jet retaining and adjusting screw and spring.</li> <li>27. Float needle.</li> <li>28. Float needle seat.</li> <li>29. Float needle seat filter.</li> <li>30. Float</li> <li>31. Float pivot spindle.</li> </ol> | <ol style="list-style-type: none"> <li>32. Cold start and cam lever assembly.</li> <li>33. Throttle adjusting lever and lost motion assembly.</li> <li>34. Throttle actuating lever.</li> <li>35. Bush washer.</li> <li>36. Throttle lever assembly retaining nut and lock washer.</li> </ol> |
|---|---|

continued



**Fit throttle lever assembly**

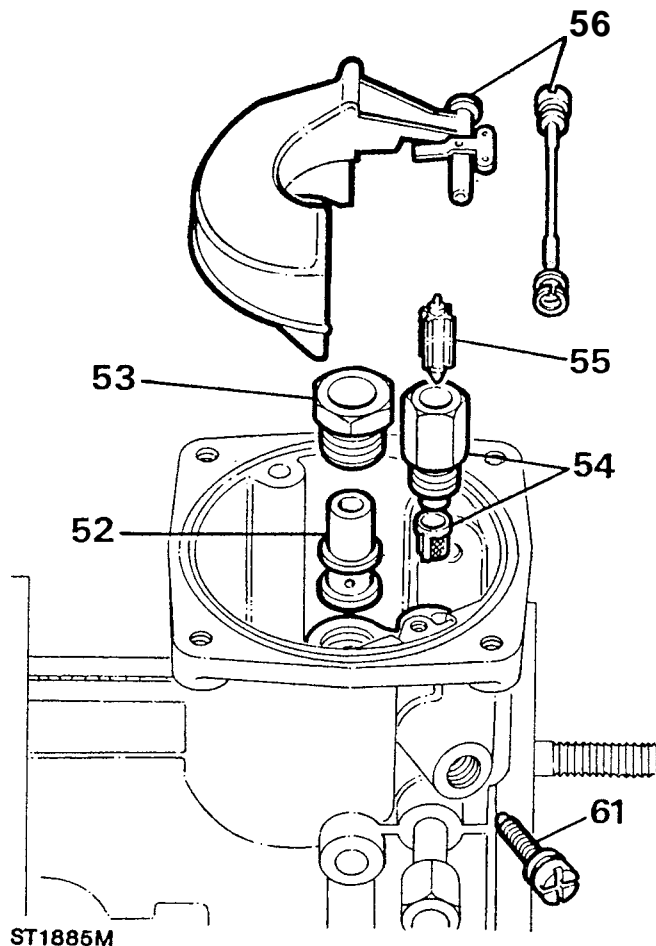
47. Fit the return spring so that the longest leg rests against the throttle adjusting screw housing.
48. Fit the throttle adjusting lever and lost motion assembly and tension the return spring.
49. Fit the throttle actuating lever.
50. Fit the bush washer and lock washer.
51. Fit and tighten the special nut and bend the lock tabs over a convenient flat.



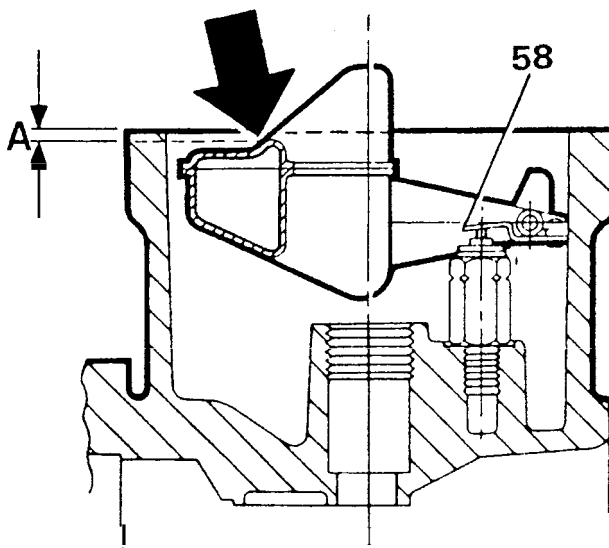
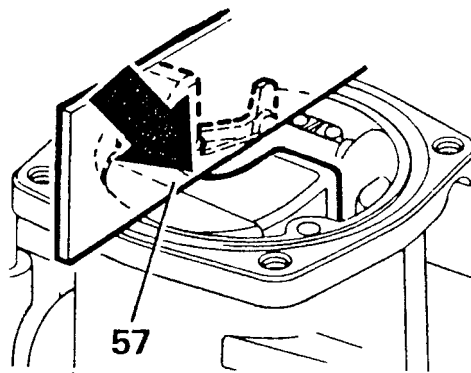
ST1875M

**Fit jet and float assembly**

52. Fit the jet bearing, long end towards the float.
53. Fit the jet bearing nut.
54. Clean or renew the filter and fit the float needle seat.
55. Fit the needle valve, spring loaded pin uppermost.
56. Fit the float and secure with the pivot pin.
57. Hold the carburettor in the inverted position so that the needle valve is closed by the weight of the float only. Check using a straight edge that the point on the float, arrowed on the illustration, is 1.0 to 1.5 mm (0.04 to 0.062 in) below the level of the float chamber face?dimension 'A'.
58. Adjust the float position by carefully bending the brass pad until the correct dimension is achieved. After adjustment, check that the float pivots freely about the spindle.



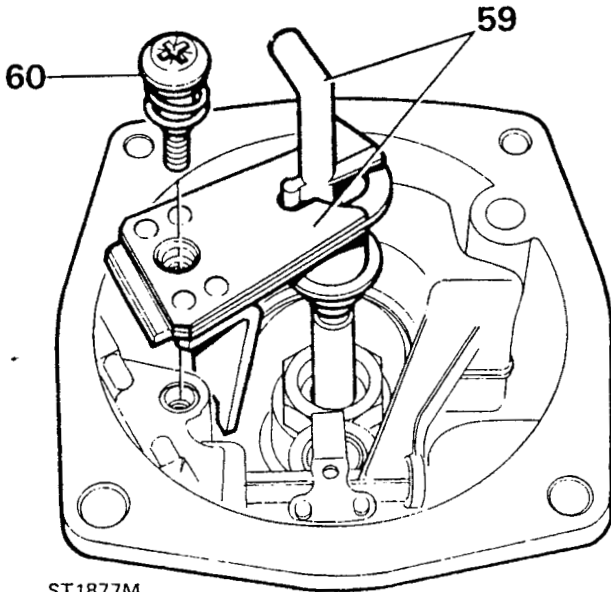
ST1885M



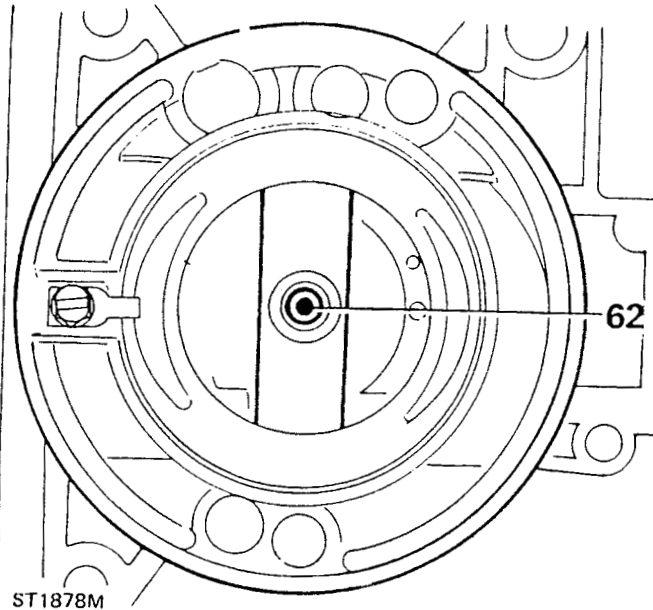
ST1876M

continued

59. Assemble the jet to the bi-metal jet lever and ensure that the jet head moves freely in the cut-out.
60. Fit the jet and bi-metal jet lever to the carburettor and secure with the spring loaded jet retaining screw.
61. Fit the mixture adjusting screw.



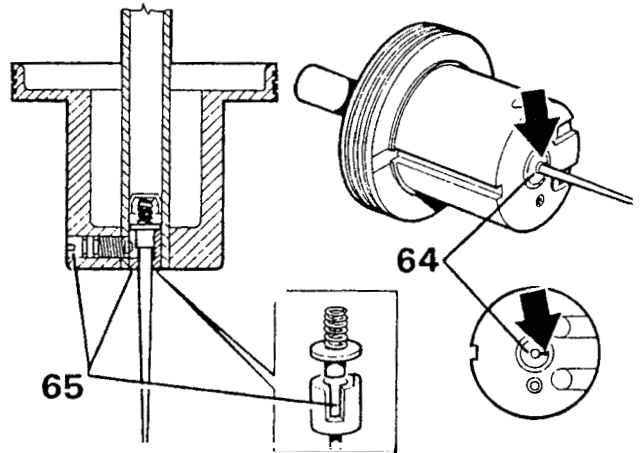
62. Adjust the mixture screw until the jet is flush with the carburettor bridge, then turn the screw a further three and one half turns clockwise.



63. Using a new sealing ring, fit the float chamber cover, noting that it can only be fitted one way. Secure with the four screws and spring washers and evenly tighten.

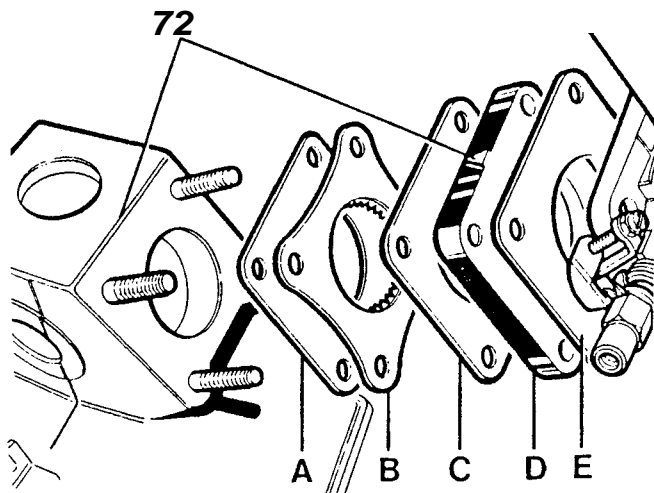
**Fit piston and suction chamber**

64. Fit the needle, spring and guide assembly to the piston ensuring that the etched arrow head on the needle locating guide is aligned between the piston transfer holes, as illustrated.
65. Secure and ensure that when the screw is tightened the guide is flush with the piston and that the screw locates in the guide slot.



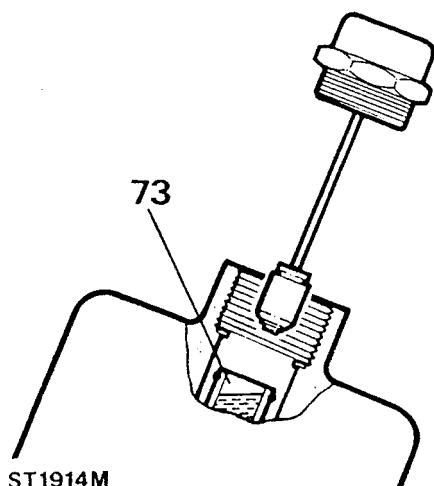
66. Fit the piston key to the carburettor body using a new screw. Tighten the screw and splay the end.
67. Fit a new suction chamber sealing ring to the groove in the carburettor body.
68. To prevent the piston spring being 'wound-up' during assembly, temporarily fit the piston and suction chamber less the spring to the body, and pencil mark the relationship of the chamber to the body. Remove the suction chamber and fit the spring to the piston. Hold the suction chamber above the spring and piston, align the pencil marks and lower the chamber over the spring and piston, taking care not to rotate the suction chamber. Secure the chamber to the body with the three screws, tightening evenly and check that the piston moves freely.
69. Hold the piston at the top of its stroke and fit the spring clip.
70. Fit the piston damper.
71. Using a new joint washer, fit the air intake adaptor and secure with the two nuts and spring washers.
72. Fit the carburettors to the inlet manifold ensuring that the joint washers, deflector and insulator are fitted in the sequence illustrated. The insulator must be fitted with the arrow head uppermost and pointing inwards towards the manifold. Secure with the four nuts and spring washers and tighten evenly to the correct torque.
  - A. Joint washer.
  - B. Deflector-teeth pointing inwards.
  - C. Joint washer.
  - D. Insulator.
  - E. Joint washer.

continued



ST1880M

- 73. Connect the linkages and top-up the carburetter dampers with a recommended oil to the top of the hollow piston rod.
- 74. Tune and adjust the carburetters.



ST1914M

**TUNE AND ADJUST — SU HIF 44 CARBURETTERS**

**Special tools:**

- Carburetter balancer 605330 or B89
- Non-dispersive infra-red exhaust gas analyser

**General Requirements Prior to Tuning Carburetters.**

Accurate engine speed is essential during carburetter tuning, therefore the distributor pick up air gap and ignition timing must be checked together with the vacuum advance system.

Whenever possible the ambient air temperature of the tuning environment should be between 15° to 26°C (60° to 80°F). When checking engine speed, use an independent and accurate tachometer.

Idling adjustments should be carried out on a fully warmed up engine, that is, at least 5 minutes after the thermostat has opened. This should be followed by a run of one minute duration at an engine speed of approximately 2,500 rev/min before further adjustments or checks are carried out. This cycle may

be repeated as often as required. It is important that the above cycle is adhered to, otherwise overheating may result and settings may be incorrect. The piston dampers must always be kept topped-up with the correct grade of oil.

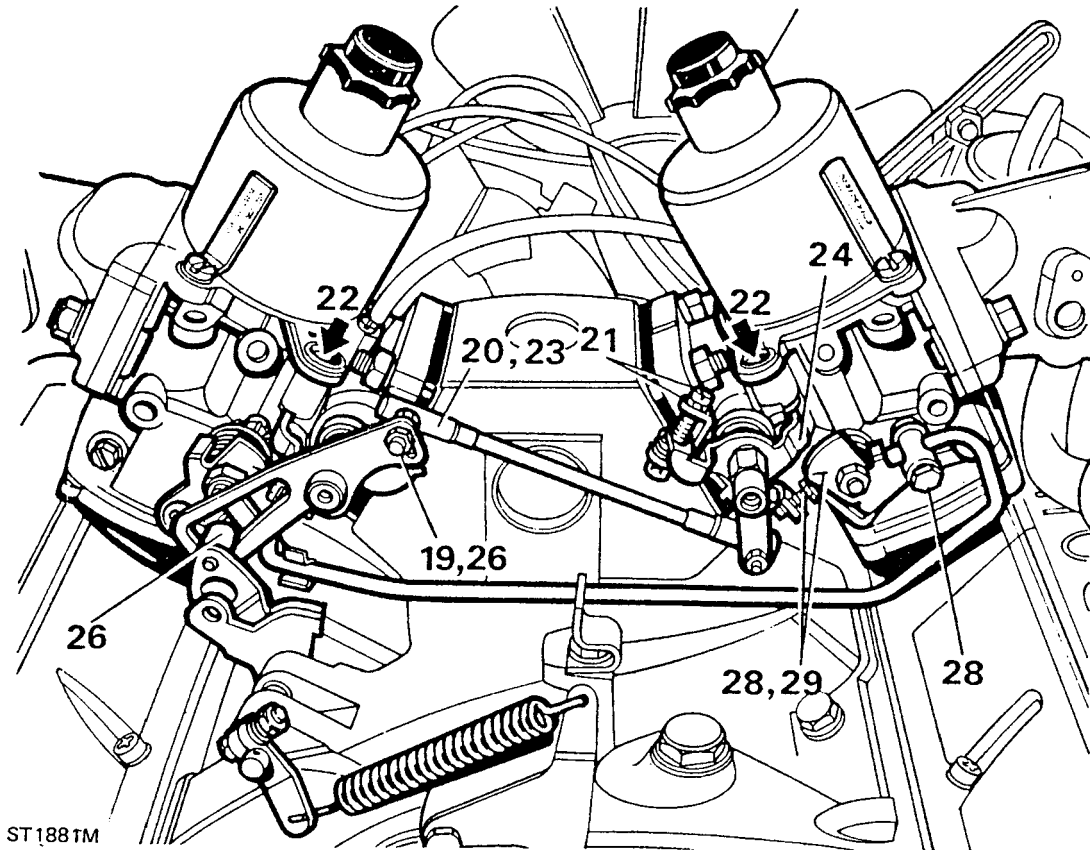
Before any attempt is made to check settings a thorough check should be carried out to ensure that the throttle linkage between the pedal and carburetters is free and has no tendency to stick. Ensure that the choke control lever is pushed fully down.

**NOTE:** References to left and right hand are as from the drivers seat.

**TAMPER — PROOFING**

To comply with E.C.E. regulations the idle speed and mixture adjusting screws must be tamper — proofed following any adjustments. A red blanking plug; **Part number — JZX 1258** must be fitted into the mixture screw recess and a red cap; **Part number JZX 1197** fitted over the idle adjustment screw (throttle adjustment screw).

continued



**TUNE AND ADJUST**

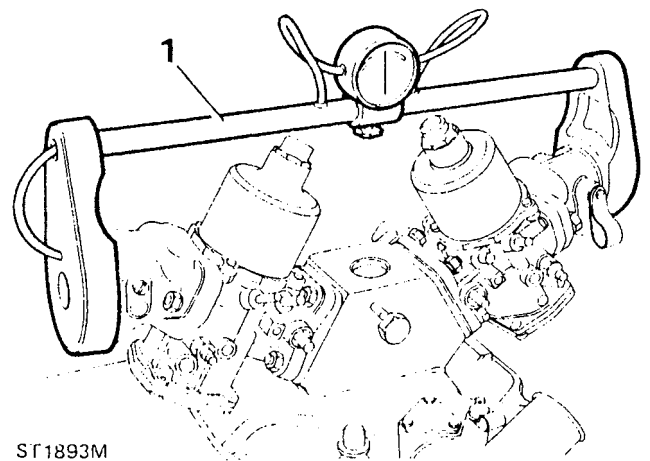
The following instructions apply to both carburetters unless otherwise stated.

Before commencing the following instructions, remove the air cleaner, air intake elbows, mixture adjustment screw plug and mixture screw cap.

**CARBURETTOR BALANCE**

Using balancer 605330

1. Disconnect the interconnecting link between the two carburetters. Fit the balancer to the carburettor intakes and ensure that there are no air leaks, if necessary, zero the gauge with the adjustment screw.
2. Start the engine, and if necessary allow it to reach normal operating temperature. If the needle moves to the right, decrease the air flow through the left hand carburettor by unscrewing the idle screw. Alternatively, increase the air flow through the right hand carburettor by screwing down the idle screw. Reverse the procedure if the pointer moves to the left. Reconnect the carburettor interconnecting link.

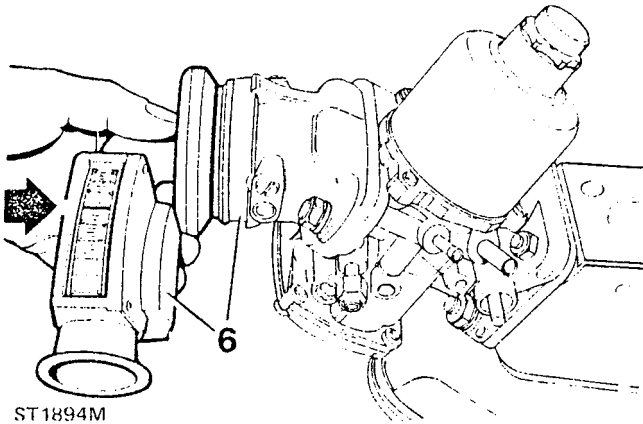


Using balancer B89

3. Disconnect the inter-connecting throttle link between the two carburetters.
4. Back-off the idle adjusting screw on each carburettor, clear of the throttle lever.
5. Turn each throttle adjusting screw so that it touches the throttle lever. then turn the screws by equal amounts to achieve an approximate idle speed of 700 to 800 rev/min.
6. Press the balancer firmly over the carburettor intake. Press or withdraw the control on the side of the balancer to adjust the meter needle reading to approximately half scale, and note the reading.

continued

7. Without altering the position of the balancer control, place the balancer on the second carburetter intake and adjust the idle screw as necessary to achieve the same reading.

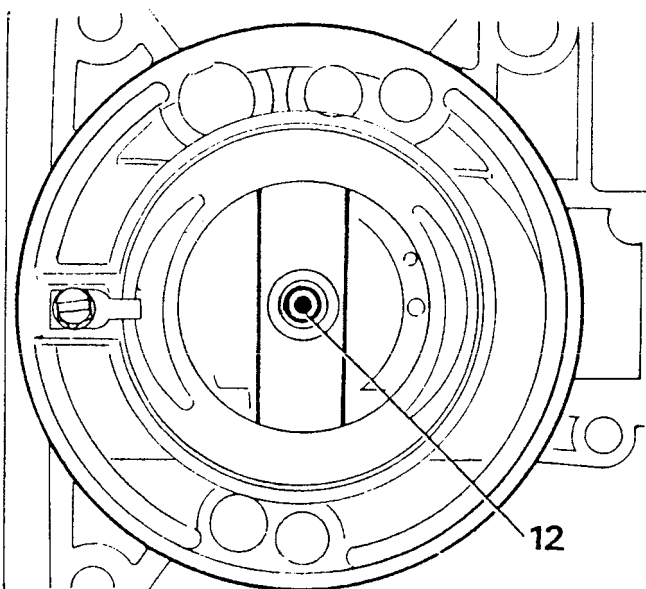


ST1894M

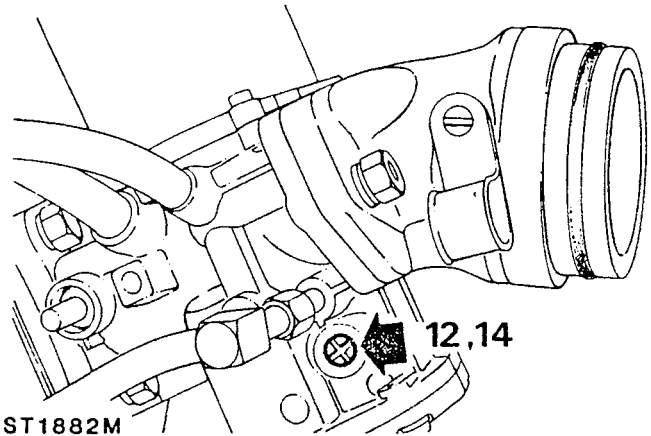
8. Alternatively, adjust and check the balance of both carburetters until an idle speed of 700 to 800 rev/min is obtained.  
9. Reconnect the throttle inter-connecting link, and again check the idle speed and balance.

#### Mixture setting

10. Ensure that the engine is still at normal operating temperature.  
11. Mark the relationship of the suction chamber to the carburetter body, remove the retaining screws and lift off the suction chamber complete with pistons.  
12. To achieve a datum setting for the mixture screw, turn it anti-clockwise until the jet is level with the carburetter bridge. Check by placing a straight edge across the bridge and adjust as necessary so that the jet just touches the straight edge.  
13. Refit the suction chamber and piston, evenly tighten the retaining screws. Check that the piston moves freely without sticking. Top-up the piston damper.

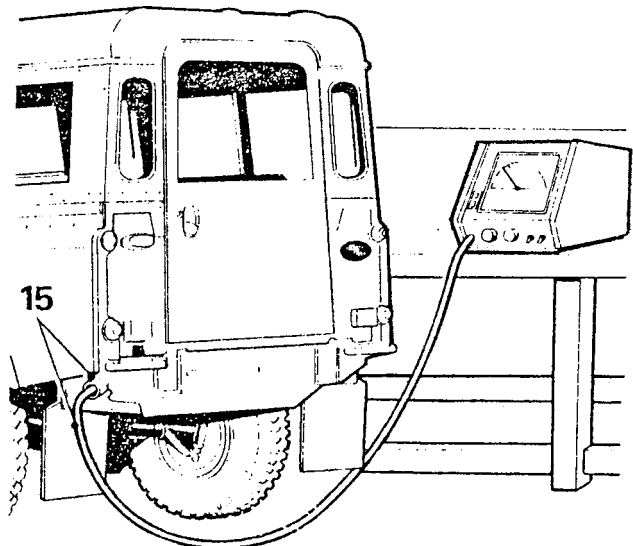


ST1883M



ST1882M

14. Turn the mixture adjustment screw three and one half turns clockwise.  
15. Insert the probe of an infra-red exhaust gas analyser as far as possible **up** the exhaust pipe, start the engine and allow a one and one half minute stabilisation period.  
16. Adjust the mixture screw on both carburetters by equal amounts, rich or weak to achieve a CO reading of 0.5 to 2.5%.  
17. If after approximately two minutes the CO level is not satisfactory run the engine at 2000 rev/min for one minute to stabilise the equipment, continue the setting procedure until a stable CO reading of 0.5 to 2.5% at an idle speed of 700-800 rev/min is obtained.



ST1915M

#### Idle speed and linkage adjustment

18. Check that the engine is at normal operating temperature.  
19. Slacken the nut, at the left hand carburetter securing the inter-connecting link ball to the throttle cam lever.

continued



20. Disconnect the inter-connecting link between the carburetters at the left hand carburetter.
21. At the right hand carburetter, release the lock nut and slacken off the lost motion adjustment screw, until it is well clear of the spring loaded pad.
22. If necessary adjust the idle screw to maintain the correct idle speed. Check the CO level and carburetter balance, adjust if required.
23. Re-connect the inter-connecting link to the left hand carburetter.
24. Hold the right hand throttle lever against the idle screw stop and adjust the lost motion screw until contact is made with the spring loaded pad, tighten the lock nut.
25. Check the idle speed and balance. Adjust the lost motion screw to restore balance if necessary.
26. Ensuring that the roller is firmly seated in the lower corner of the cam lever, tighten the nut which secures the inter-connecting link ball to the cam lever.

#### Fast idle adjustment

27. Pull out the cold start control (choke) until the scribed line on the left hand fast idle cam is in-line with the centre of the fast idle screw head.
  28. Check that the scribed line on the right hand fast idle cam is similarly in-line with the fast idle screw head. If there is mis-alignment, slacken the fast idle cam link rod screw at the right hand carburetter and move the cam until the scribed line coincides with the centre of the screw head. Tighten the cam rod screw.
  29. Turn the fast idle screw clockwise, on each carburetter, until just clear of the cam.
  30. Turn the fast idle screw of the leading (left-hand) carburetter down (clockwise) until a slight change in engine speed is noted.
  31. Similarly turn the fast idle screw of the second carburetter (right-hand) down until a further slight change of engine speed is noted.
  32. Adjust the fast idle screws of both carburetters by equal amounts to achieve a fast idle speed of 1100 to 1150rev/min.
  33. Tighten the fast idle screw lock-nut on both carburetters. Push the cold start (choke) fully home then **pull** it out again to its full extent and recheck the fast idle speed.
  34. Fit the appropriate blanking plug and cap to the mixture screw recess and idle adjusting screw.
  35. Fit the carburetter air intake elbows and air cleaner.
-

### V8 ENGINE CARBURETTER FAULT DIAGNOSIS

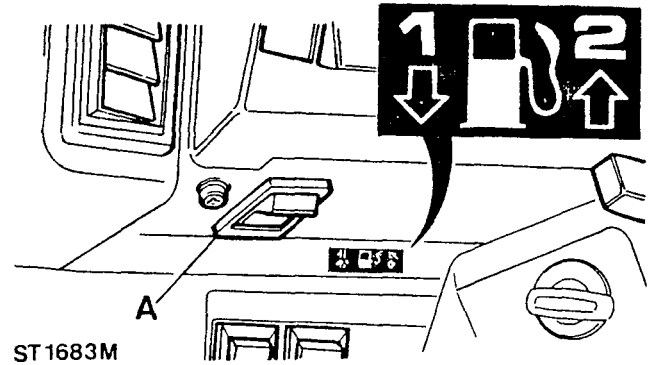
SYMPTOM	POSSIBLE CAUSE	CURE
DIFFICULT STARTING WHEN COLD	<p>Insufficient choke action</p> <p>Fast idle adjustment incorrect</p> <p>Float chamber level too low</p> <p>Carburetter flooding</p> <p>No fuel supply to carburetter</p>	<p>Check action of cold start unit to ensure that the choke is being applied fully — adjust choke cable. Check position of cold start adjuster — move outward</p> <p>Check and adjust fast idle setting. Check linkage between choke and throttle for distortion</p> <p>Check needle valve for sticking — (closed). Check float level setting. Check inlet connection filter for blockage. Check external fuel system in accordance with fuel system fault diagnosis</p> <p>Check needle valve for sticking — (open) Float punctured Fuel pump pressure too high Float level too high</p> <p>Check filters and pump for blockage Check fuel tank breather and fuel lines for blockage Remove fuel pump and check operation Overhaul or fit new pump</p>
DIFFICULT STARTING WHEN HOT	<p>Choke sticking 'on'</p> <p>Blocked air cleaner</p> <p>Float chamber level too high</p>	<p>Check to ensure choke is returning to fully 'off' position; reset as necessary</p> <p>Fit new air cleaner elements</p> <p>Check float level setting. Check float arms for distortion. Check needle valve for sticking. Punctured float. fuel pump pressure too high</p>
LACK OF ENGINE POWER	<p>No oil in damper or oil too thin</p> <p>Air valve sticking</p> <p>Water in fuel</p>	<p>Check level of oil in damper, and fill to correct level with oil of a viscosity of <b>S.A.E.20</b></p> <p>Check air valve assembly moves freely and returns under spring load — centre jet assembly</p> <p>Check diaphragm for cracks or porosity — Zenith</p> <p>If water is present in float chamber, the complete fuel system should be drained, fuel components should be dismantled, inspected for contamination, paying particular attention to filters.</p>
ERRATIC SLOW-RUNNING OR STALLING ON DECELERATION	<p>Float level too low</p> <p>Incorrect jet setting</p> <p>Carburetter air leaks</p> <p>Manifold air leaks</p> <p>Damper oil too thick. No oil in damper</p> <p>Air valve sticking</p>	<p>Check float chamber level Check for needle valve sticking</p> <p>Check and reset jet settings in accordance with carburetter overhaul instructions</p> <p>Check throttle spindle and bearings for wear</p> <p>Check inlet manifold gasket for leakage. Check inlet manifold for cracks and distortion at mating faces. Check gasket between carburetter and manifold. Check condition of vacuum advance pipe and connections. Check vacuum servo pipes and connections</p> <p>Check and refill to correct level with oil specified</p> <p>Clean and check freedom</p>
EXCESSIVE FUEL CONSUMPTION	<p>Blocked air cleaner</p> <p>Damper oil too thick</p> <p>Incorrectly adjusted carburetter</p> <p>Float level too high</p> <p>Worn jets and needle</p> <p>Incorrect needle</p> <p>Choke sticking 'on'</p> <p>Engine fault</p>	<p>Fit new air cleaner elements</p> <p>Replace with correct grade</p> <p>Check and reset slow running in accordance with carburetter tune and adjust instructions</p> <p>Check and reset float level</p> <p>Check and replace as necessary</p> <p>Check needle type</p> <p>Check to ensure choke is returning to fully 'off' position. reset as necessary</p> <p>See Engine Fault diagnosis</p>

**LAND ROVER 110 TWIN TANK INSTALLATION**

**Description**

The fuel system includes two fuel tanks, one at the rear of the vehicle and an additional fifteen gallon (68,20 litres) capacity tank on the right-hand side of the vehicle. Both tanks contain an electrically operated submerged fuel pump in addition to a fuel level indicator unit in each tank. An ignition controlled switch on the control panel enables the driver to select the tank to be used. The switch also energises the fuel level indicator unit of the tank selected and records the fuel level on the single indicator dial. When the ignition is switched 'on' the pump in the selected tank will draw fuel into the carburetter float chamber via a paper element type filter and a vapour separator. To prevent fuel vapourisation and air locks a spill return system is incorporated in the fuel pipe layout to pass back vapour and excess fuel from the vapour separator to the tank in use through a restrictor and a solenoid operated valve. The valve, which is energised by the tank selection switch, closes the port to the tank not in use and simultaneously opens the port to the selected tank. The restrictor is necessary to prevent fuel by-passing the carburetter and flowing back to the selected tank through the spill return system.

In addition, a non-return valve is enclosed inside the hose connection of the supply pipe from the rear and side tanks to prevent the possibility of a back-flow of fuel along the supply lines to the fuel tanks.



ST1683M

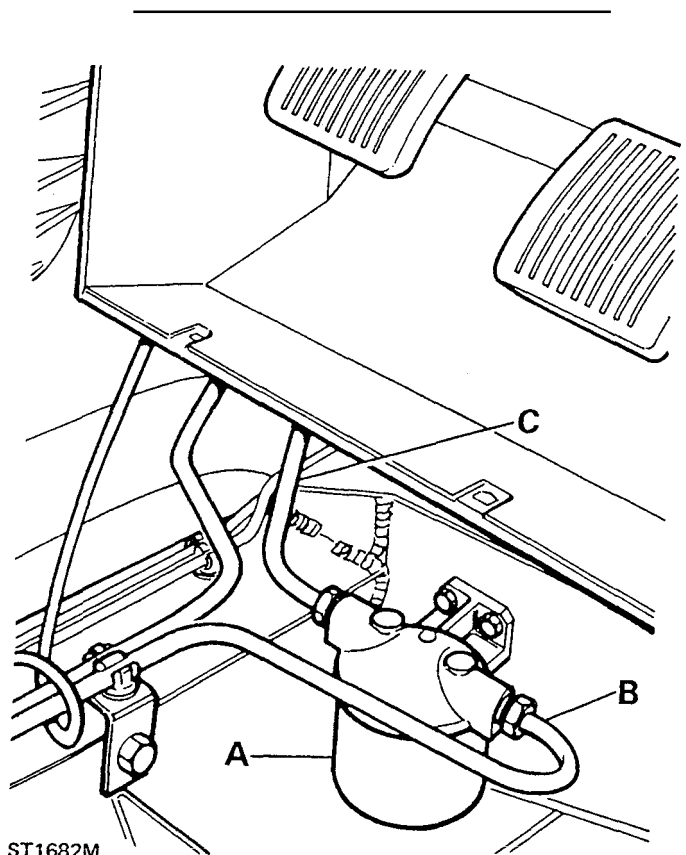
**FUEL TANK SELECTION SWITCH**

A. Fuel tankswitch

**LAND ROVER 110 REAR TANK AND 90 SIDE TANK INSTALLATION**

**Description**

Fuel drawn by the electrically operated in-tank pump, is delivered to a paper element type filter. Situated beneath the right-hand front footwell attached to a chassis outrigger from the filter, fuel enters a vapour separator located on the left-hand side of the bulkhead in the engine compartment. Fuel finally enters the carburetter float chamber from the port at the base of the vapour separator. The vapour separator comprises part of the spill return system and its purpose is to prevent fuel vapour causing air locks in the supply to the carburetter. Vapour and excess fuel flows back into the fuel tank through a restrictor fitted to the spill return port on the vapour separator. The restrictor is designed to assist in maintaining a constant fuel level in the vapour separator bowl and to prevent fuel flowing back to the tank at the same rate as the delivery.

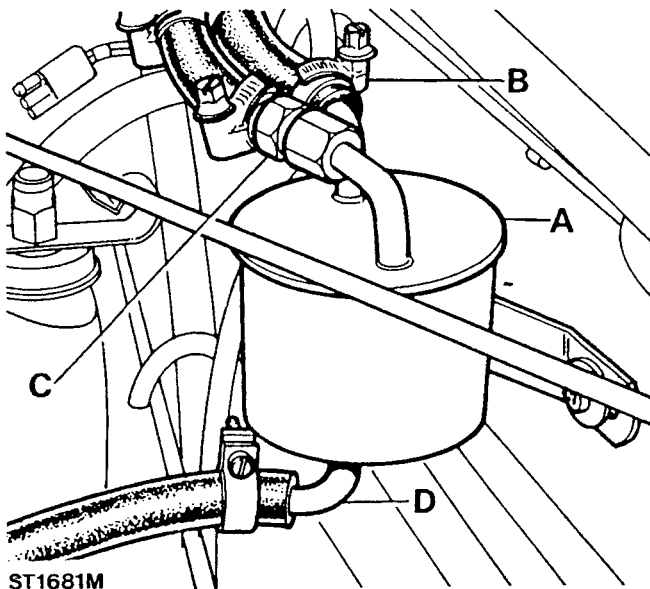


ST1682M

**FUEL FILTER**

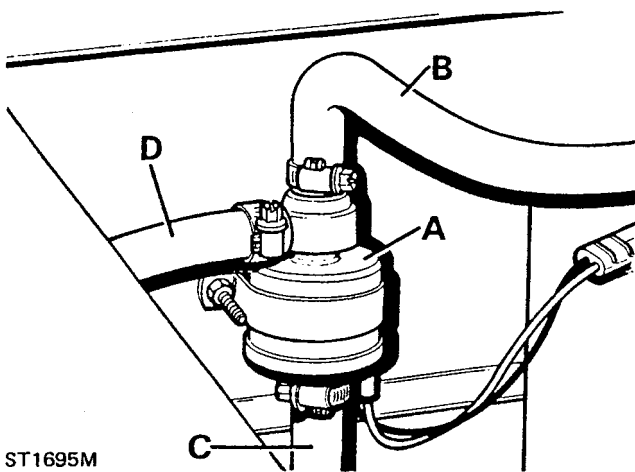
- A. Fuel filter
- B. From fuel pump to filter pipe
- C. From fuel filter to carburetter via vapour separator





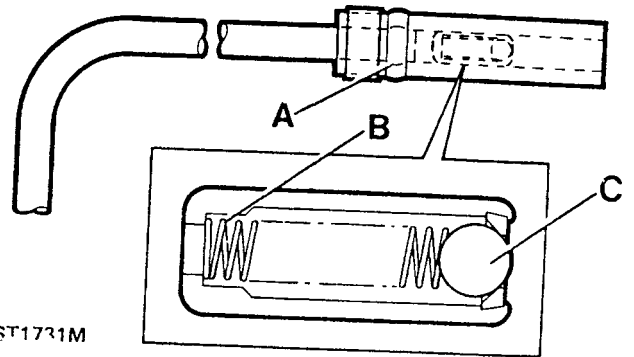
ST1681M  
VAPOUR SEPARATOR

- A. Vapour separator
- B. Spill return to side tank
- C. Restrictor and spill return to solenoid valve
- D. Outlet from separator to carburettor



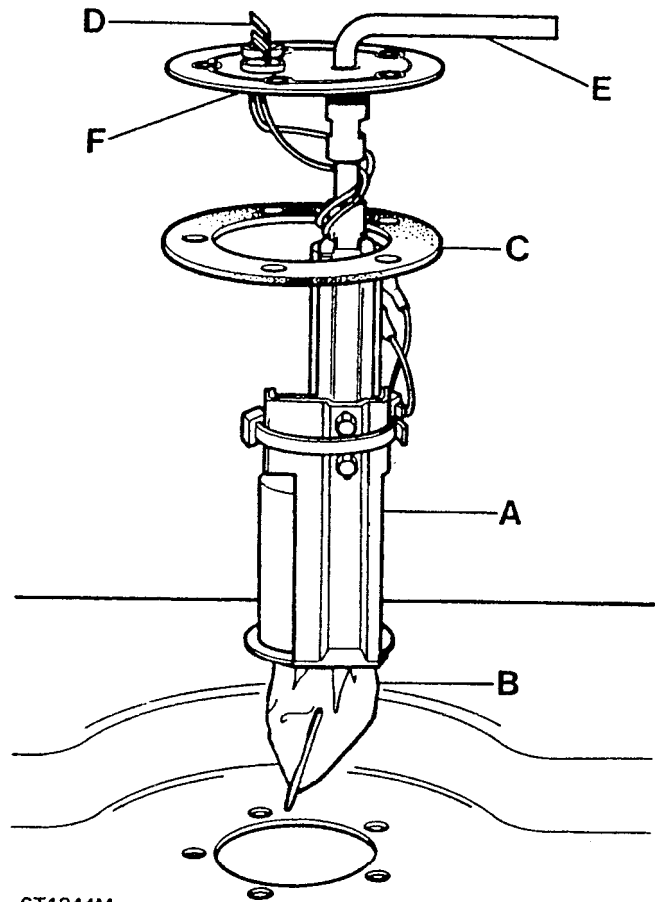
ST1695M  
SPILL RETURN SOLENOID VALVE

- A. Solenoid valve
- B. Spill return to side tank
- C. Spill return to rear tank
- D. To carburettor via filter and vapour separator



ST1731M  
NON-RETURN VALVE

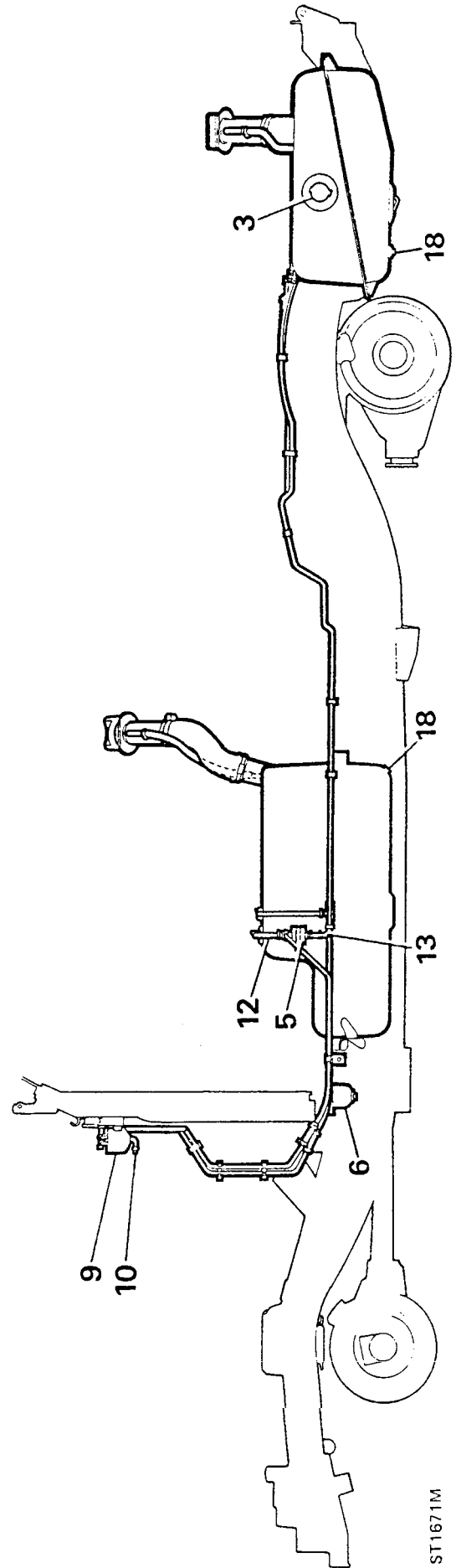
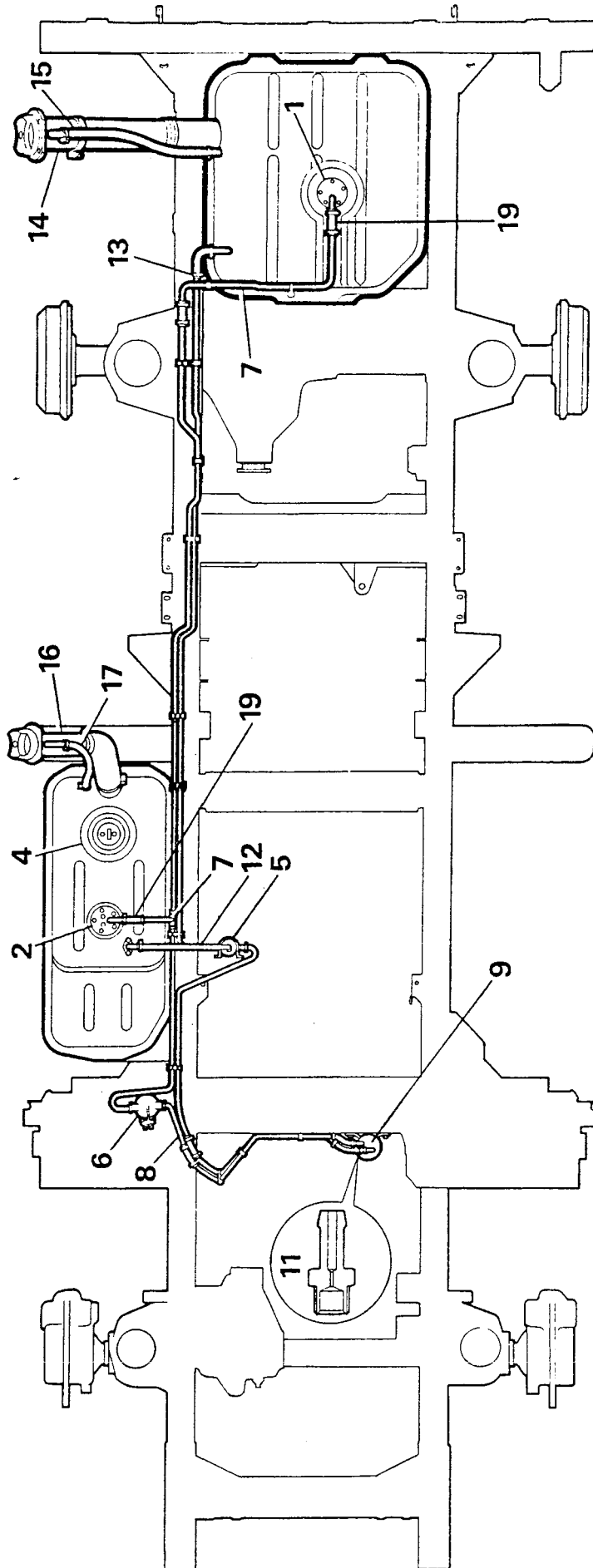
- A. Non-return valve
- B. Spring
- C. Ball



ST1844M  
FUEL PUMP

- A. Pump and motor
- B. Filter
- C. Gasket
- D. Electrical terminals
- E. Outlet pipe
- F. Fixing plate to tank
- G. Plastic tie clip — See CAUTION — remove and refit pump

LAND ROVER 110 TWIN TANK FUEL SYSTEM



ST1671M

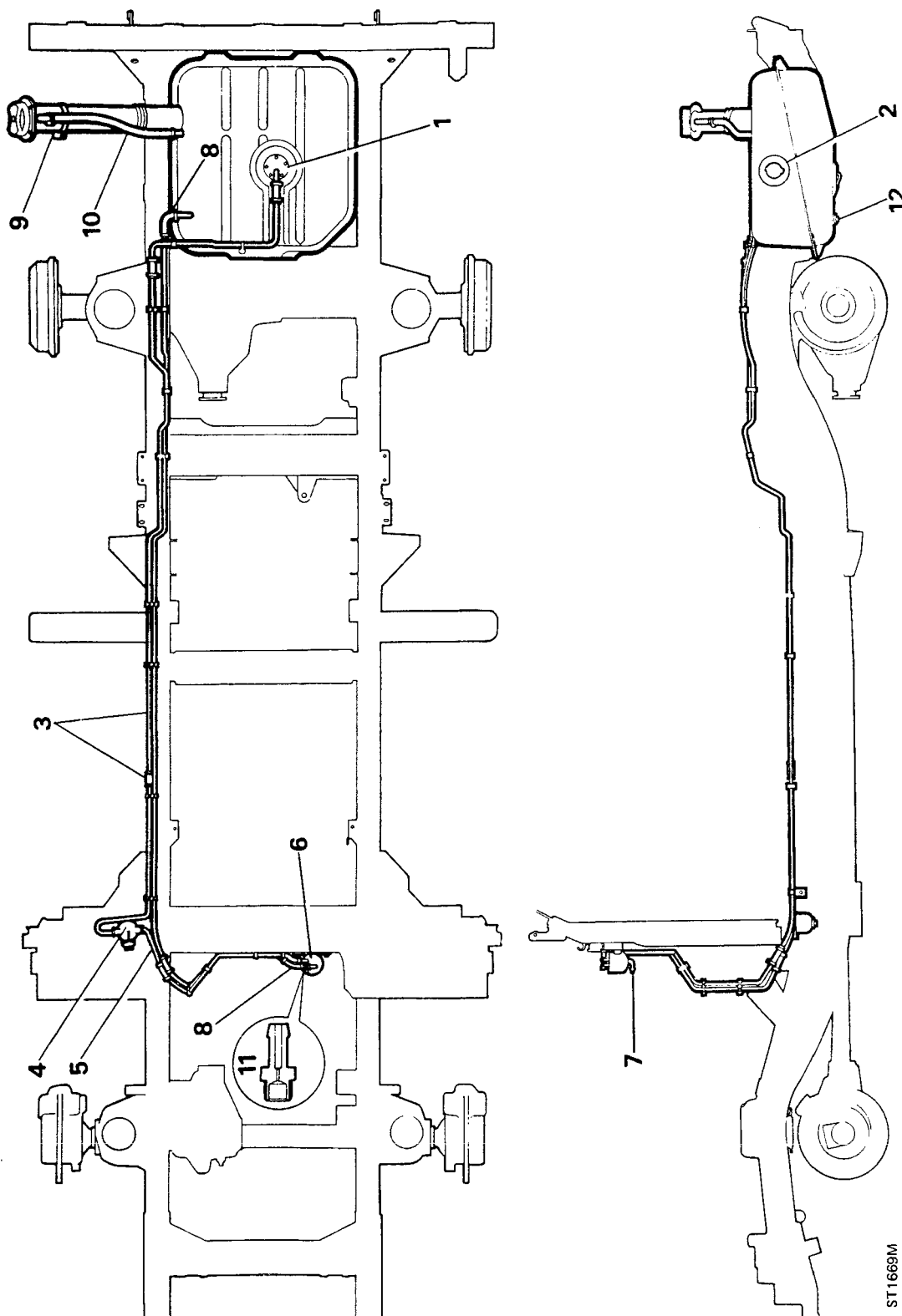
## LAND ROVER 110 TWIN TANK FUEL SYSTEM

### KEY TO FUEL LINE INSTALLATION

1. In-tank fuel pump — rear tank.
2. In-tank fuel pump — side tank.
3. Fuel gauge tank unit — reartank.
4. Fuel gauge tank unit — sidetank.
5. Spill return solenoid.
6. Fuel filter.
7. Fuel supply pipe — rear tank to filter via T-piccc.
8. Pipe, filter to vapour separator.
9. Vapour separator.
10. Vapour separator outlet to carburetter.
11. Spill return pipe to fuel tank via restrictor and solenoid valve.
12. Spill return pipe to side tank from solenoid.
13. Spill return pipe to rear tank from solenoid.
14. Fuel filler — rear tank.
15. Breather pipe — rear tank.
16. Fuel filler — side tank.
17. Breather pipe — side tank.
18. Drain plugs side and rear tanks.
19. Non return valve incorporated in hose.

LAND ROVER 110 BASIC FUEL SYSTEM

- 1. In-tank fuel pump.
- 2. Fuel gauge tank unit.
- 3. Fuel supply pipe to filter via connector.
- 4. Fuel filter.
- 5. Fuel supply pipe filter to vapour separator
- 6. Vapour separator.
- 7. Vapour separator, outlet to carburetter.
- 8. Spill return pipe to fuel tank via restrictor.
- 9. Fuel filler.
- 10. Breather hose.
- 11. Restrictor.
- 12. Fuel tank drain plug.

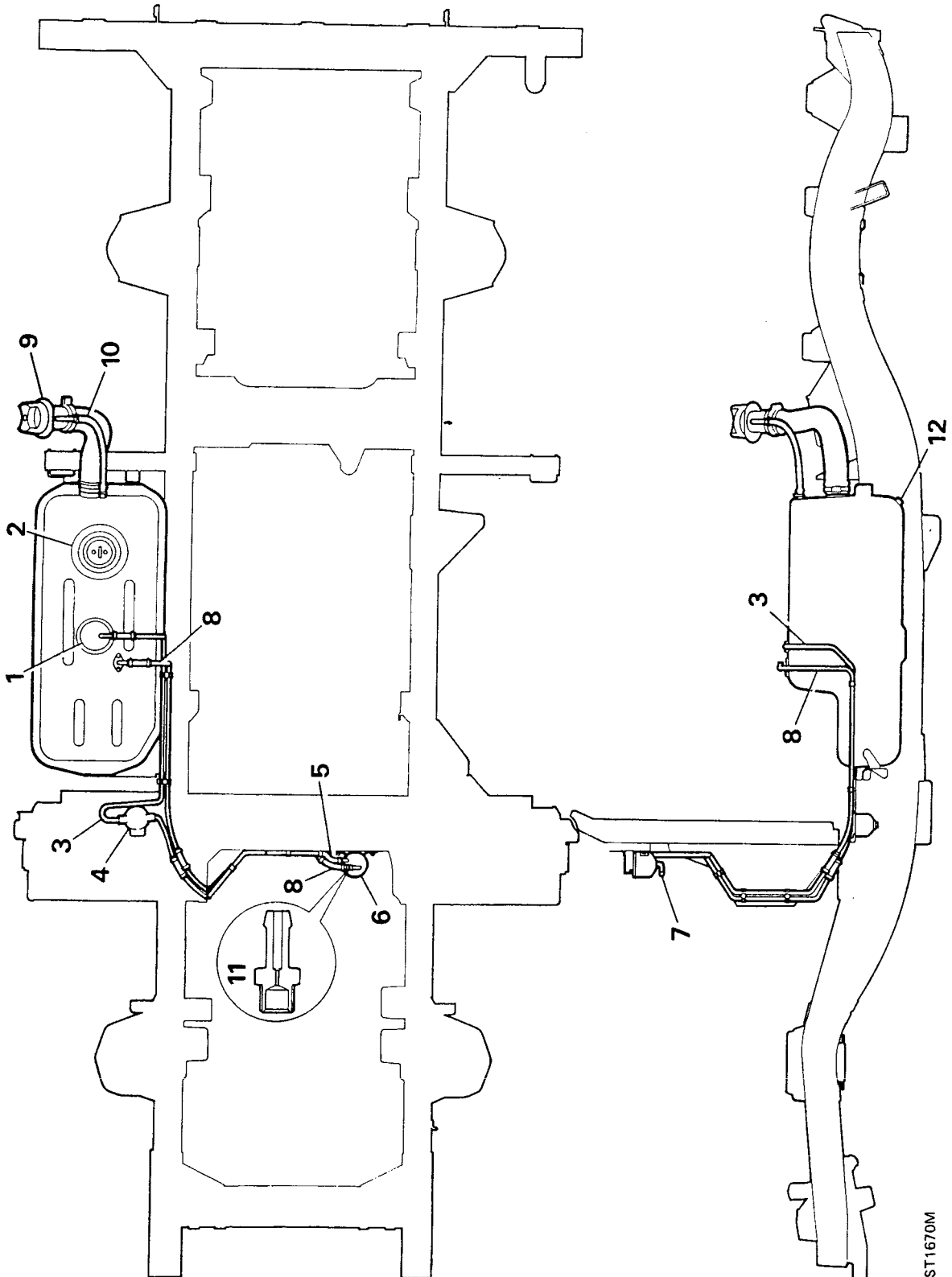


ST1669M



LAND ROVER 90 BASIC FUEL SYSTEM

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>1. In-tank fuel pump.</li> <li>2. Fuel tank gauge unit.</li> <li>3. Fuel supply pipe to filter.</li> <li>4. Fuel filter.</li> <li>5. Fuel supply pipe filter to vapour separator</li> <li>6. Vapour separator.</li> </ul> | <ul style="list-style-type: none"> <li>7. Vapour separator, outlet to carburettor.</li> <li>8. Spill return pipe to fuel tank via restrictor.</li> <li>9. Fuel filler.</li> <li>10. Breather hose.</li> <li>11. Restrictor.</li> <li>12. Fuel tank drain plug.</li> </ul> |
|--|---|



ST1670M

**REMOVE REAR TANK FUEL PUMP**

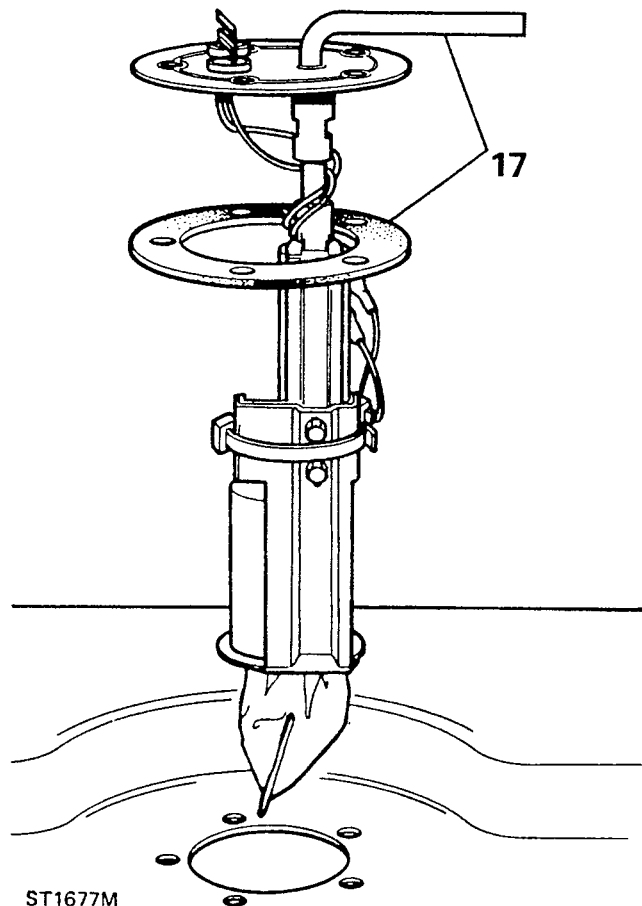
To renew the pump it is first necessary to remove the fuel tank from the vehicle. Before commencing the following instructions it is essential that the **WARNINGS** and safety precautions concerning fuel tank draining and removal are studied and observed. These precautions are included in the introduction to this and each of the five books comprising the workshop manual for the Ninety and One-Ten vehicles.

1. Move vehicle to well ventilated area and disconnect the battery.
2. Remove the fuel tank drain plug and allow the fuel to drain into a suitable receptacle and refit the plug.
3. Working from the right-hand side of the vehicle disconnect the fuel feed pipe and the spill return at the rubber connections.
4. Disconnect the fuel filter hose and breather hose from the tank.
5. Whilst, noting the cable colours, disconnect the electrical leads from the fuel gauge unit at the left-hand side of the vehicle.
6. If the vehicle is fitted with a towing ball drop-plate with support bars the bars must be removed.
7. Remove the eight nuts and bolts securing the anti-roll bar to the chassis and push the roll bar down to provide access to the tank.
8. Remove the left-hand lashing eye to facilitate removal of the tank.
9. Place a support under the tank, preferably one which will enable the tank to be progressively lowered.
10. Remove the two nuts retaining the forward end of the tank.
11. Remove the two nuts securing the rear of the tank.
12. Carefully lower the tank sufficiently to enable the electrical leads to the fuel pump to be disconnected.
13. Finally remove the tank from the vehicle together with the pump and rear section of the fuel feed pipe.
14. Disconnect the rear section of the feed pipe from the pump.
15. Remove the five retaining screws and withdraw the fuel pump and sealing ring from the tank.
16. Cover the pump aperture in the tank to prevent the ingress of foreign matter.

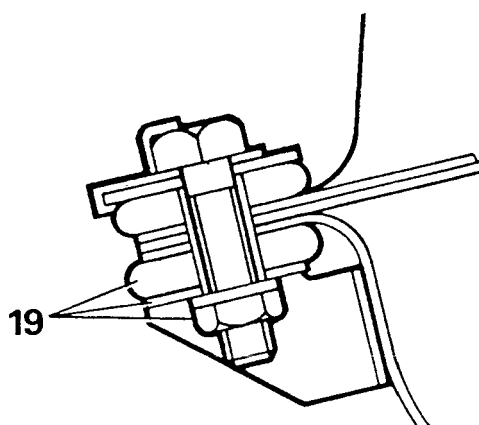
**Fitting fuel pump**

**CAUTION:** On some early models a modification was carried out to the fuel pump to prevent the possibility of the contacts earthing. These pumps can be recognised by a black plastic tie clip as illustrated. See Fuel System description. If the fuel tank only is being renewed and the original pump is being re-fitted, ensure that the tie clip is correctly positioned.

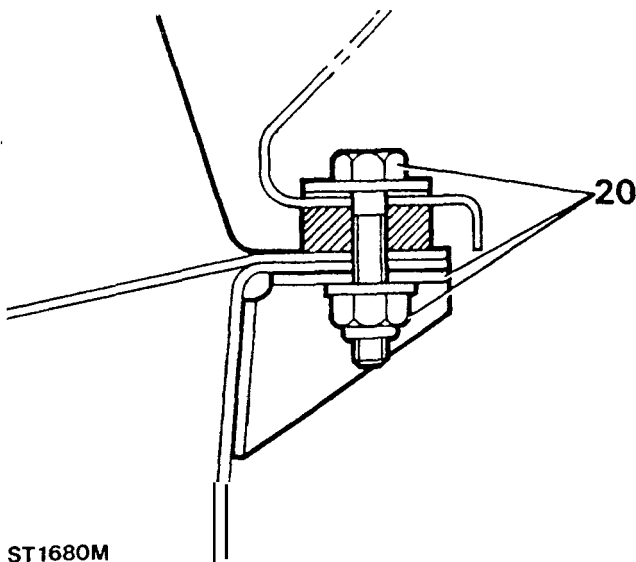
17. Fit the pump into the tank with a new Sealing ring so that the outlet pipe is directed towards the front of the vehicle and the electrical connections to the rear.



18. Offer-up tank to the chassis and connect the electrical leads black to negative (-) white to positive (+).
19. Locate front of the tank on the two captive bolts and secure with the mounting rubber, flat and spring washer and nut.

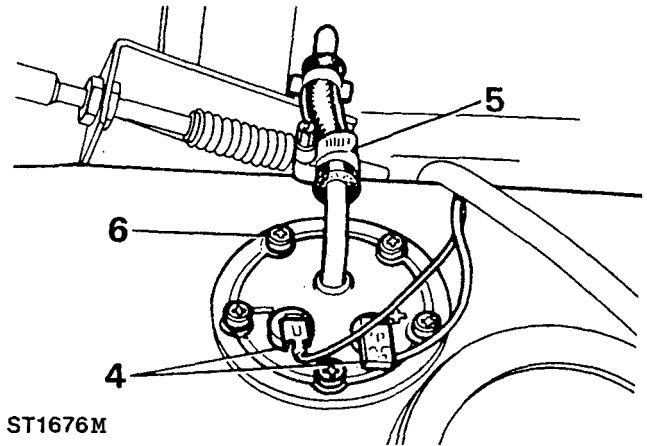


20. Secure the rear of the tank with the two captive bolts, plain washer and nyloc nut.



ST1680M

21. Connect the fuel feed pipe.
22. Connect the spill return pipe.
23. Connect the fuel filter hose and breather pipe to the tank.
24. Fit the left-hand lashing eye.
25. Fit the anti-roll bar.
26. Fit the drop plate support bars — if fitted.
27. Connect the fuel gauge unit leads.
28. Reconnect battery, and check operation of pump and change-over solenoid — if fitted.



ST1676M

7. Cover the pump aperture in the tank to prevent the ingress of foreign matter.

**CAUTION:** On some early models a modification was carried out to the fuel pump to prevent the possibility of the contacts earthing. These pumps can be recognised by a black plastic tie clip as illustrated. See fuel system description. If the fuel tank only is being renewed and the original pump is being re-fitted, ensure that the tie clip is correctly positioned.

#### Refitting

8. Insert the pump and new sealing washer into the tank so that the outlet pipe is directed towards the left-hand side of the vehicle and the electrical connections to the right.
9. Secure the pump with the five screws tightening evenly.
10. Fit the supply pipe to the pump outlet and tighten the hose clip.
11. Connect the white/green wire to the positive (+) terminal and the black wire to the negative (-) terminal.
12. Connect the batteries, switch on ignition and operate the tank selection switch, if it is a twin tank installation and check that the pump operates.
13. Switch off ignition, fit the seal base cover and carpet and refit the seat cushion.

#### REMOVE SIDE TANK FUEL PUMP

1. Move the vehicle to a well ventilated area, extinguish all naked lights and disconnect the vehicle batteries.
2. Remove the right-hand side front seat cushion.
3. Move the carpet aside, where fitted and unclip and remove the seat base cover.
4. Disconnect the two Lucars from the fuel pump.
5. Disconnect the fuel outlet pipe from the pump.
6. Remove the five retaining screws and withdraw the pump and sealing ring.

## FUEL INJECTORS

### CHECKING NOZZLE ASSEMBLIES

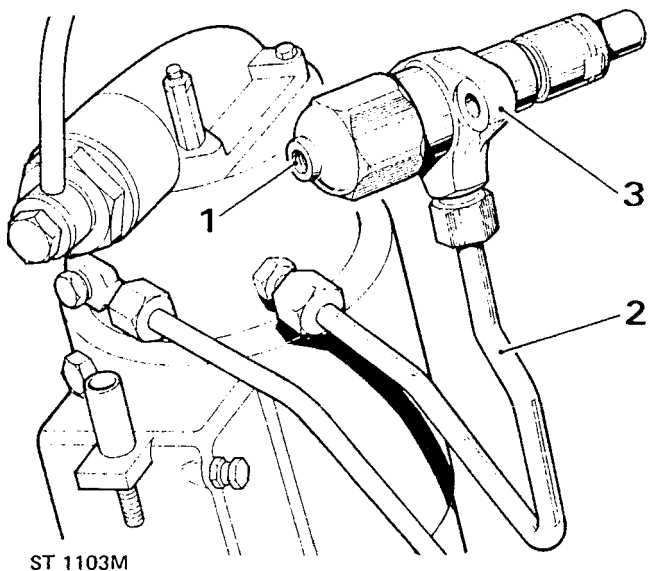
**WARNING:** Do not allow the fuel spray to contact the person otherwise injury may result from skin penetration.

When an injection nozzle is considered to be the cause of irregular running and loss of power, a quick check may be made by loosening the fuel feed pipe union nut on each nozzle in turn, whilst the engine is idling at approximately 1,000rev/min.

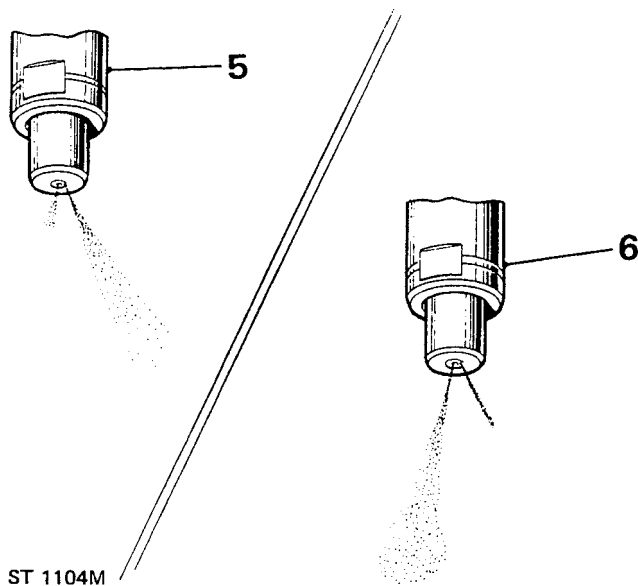
If the injection nozzle assembly being checked has been operating properly, there will be a distinct reduction in engine speed accompanied by obvious roughness, but a faulty injection nozzle may make little or no difference to the engine note when its fuel feed pipe is loosened.

### Spray check

1. Remove the fuel spill gallery pipe complete from the injection nozzles.
2. Disconnect the fuel feed pipe (injection pump to nozzle) from the nozzle to be tested and from the injection pump.
3. Release the fixings and withdraw the suspected injection nozzle assembly; reconnect the pipe and nozzle assembly to the injection pump in a position whereby fuel ejection may be observed.



4. Loosen the union nuts securing the remaining fuel pipes to injection nozzles.
5. Whilst the starter turns the engine over, observe the manner in which fuel issues from the nozzle and compare the spray form with the correct form as illustrated.  
Very little fuel should issue from the main spray hole with the engine turning over at starter speed but a fine spray comparable to that illustrated should be ejected from the auxiliary spray hole.
6. If the ejected fuel is more in the form of a liquid jet or issues from the main pintle hole, then the nozzle and holder assembly should be removed for overhaul and a replacement unit fitted.
7. Refit the injectors and tighten the union nuts.
8. Connect the spill gallery pipe with the bolt and two washers.



## PRIME FUEL SYSTEM

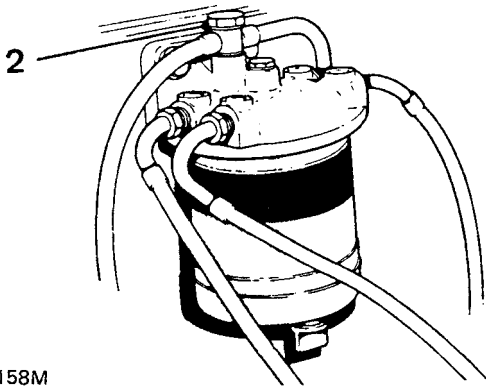
### Procedure following fuel filter or sedimentor service

When models fitted with a sedimentor have had the water drained only from the sedimentor bowl, no priming is necessary as the water is replaced by fuel automatically syphoned from the tank. However, if the sedimentor has been dismantled and air has entered the body, or where the fuel filter element has been replaced and the filter bowl cleaned, then the system must be primed as follows:

continued

**NOTE:** The above illustration shows the D.P.A. pump fitted to the 3.25 litre diesel engine.

1. Do not attempt to start the engine hoping to draw the fuel through in this way, otherwise the full priming procedure will be necessary.
2. Slacken the bleed pipe banjo bolt on the top of the main fuel filter.



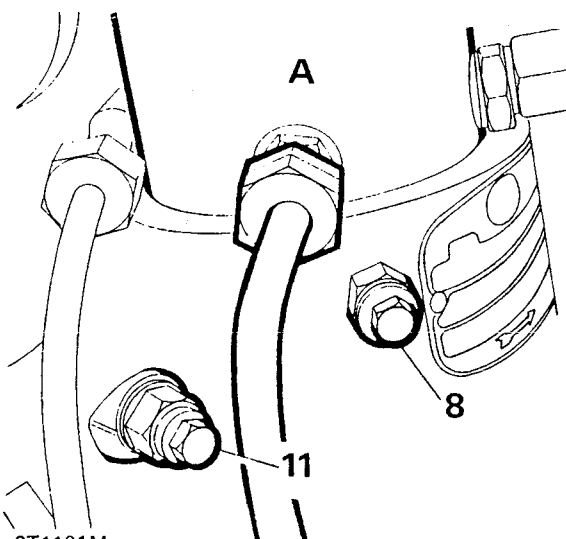
ST 1158M

3. Operate the hand priming lever on the mechanical pump, until fuel free from bubbles emerges. Always ensure that fuel pump lever is on the bottom of the operating cam when priming the fuel system, otherwise maximum movement of the priming lever cannot be achieved.
4. Tighten the bleed pipe banjo bolt whilst the fuel is still emerging.
5. Operate the hand priming lever once or twice to clear the last bubbles of air into the filter bleed pipe.
6. Start engine in normal way and check for leaks.

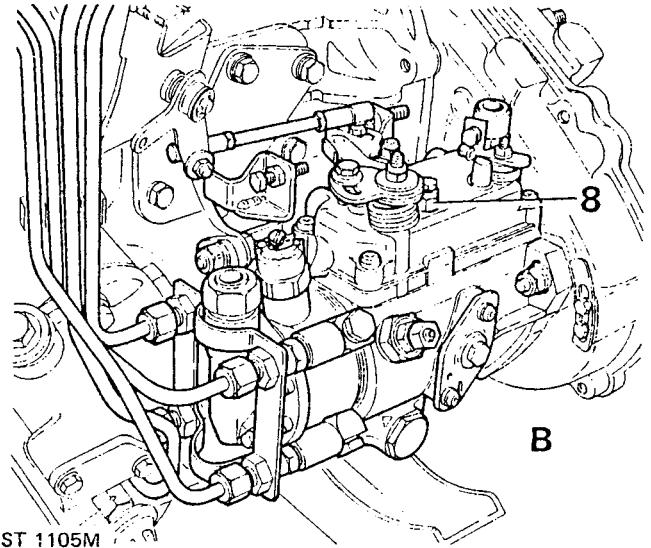
#### Procedure when fuel system has been drained

7. Carry out instructions 1 to 5 inclusive.
8. Release air vent screw on distributor body.

Illustration A — 2.25 litre D.P.A. pump  
 Illustration B — 2.5 litre D.P.S. pump



ST 1101M



ST 1105M

9. Operate the fuel pump hand priming lever until fuel free of air emerges.
10. Retighten the air vent screw.
11. To ensure that all air is exhausted from the pump it may also be necessary to slacken air vent screw in the distributor control cover and repeat instructions 9 and 10. 2.25 litre engine D.P.A. pump only.
12. Start the engine in the normal way and check for leaks.

#### Procedure when distributor pump has been drained

13. Carry out instructions 8 to 12 inclusive.

#### FUEL INJECTION PUMP — Altitude compensation

When Diesel engines are operated at high altitude it is recognised that the reduced air density causes a reduction in the weight of air drawn into the engine cylinders, which results in incomplete combustion of the injected fuel at full throttle, unless this is reduced in proportion to the reduction in air density. To compensate for these variations and to avoid excessive fuel consumption, accompanied by excessive exhaust smoke, the amount of fuel delivered to the cylinders must be reduced to suit the conditions under which the engine is required to operate. For every 330 metres (1000 feet) above 990 metres (3000 feet) the fuel delivery must be reduced by 3%. Adjustments to the D.P.S. pump, however, must only be carried-out by an authorised C.A.V. Dealer.

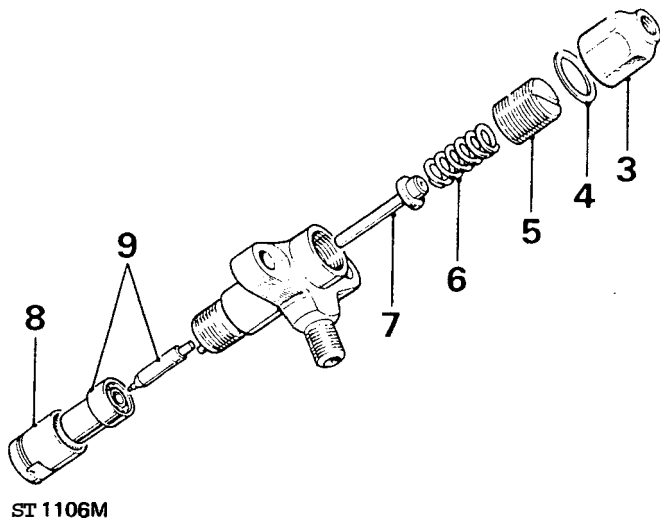
**OVERHAUL FUEL INJECTORS**

**Service tools:**

- 271483 or 18G109 or Diesel tune III } **Injector nozzle testing and setting kit**
- 278182 or 18G109B or Diesel tune 102 } **Adaptor Pintaux Injector**
- 278181 or 18G109E } **Injector nozzle flushing tool**
- 605002 or 18G1487 or FT9101 } **Injector nozzle cleaning kit**

**DISMANTLE**

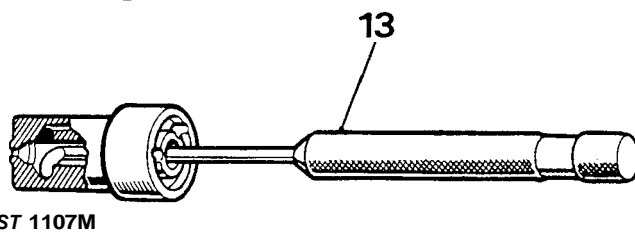
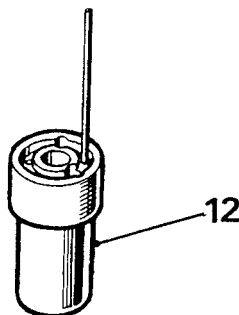
1. Remove the injectors from the engine.
2. Disconnect the injectors from the fuel spill rail.
3. Remove the combined locknut and end cap.
4. Withdraw the sealing washer.
5. Unscrew the pressure adjusting screw.
6. Withdraw the pressure spring.
7. Withdraw the valve spindle.
8. Unscrew the cap nut.
9. Withdraw the nozzle valve and body.



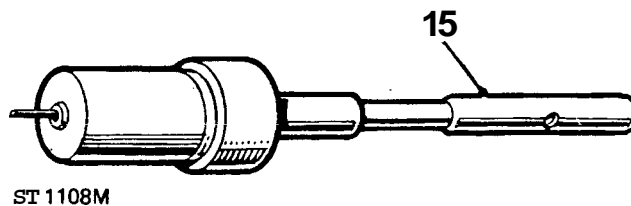
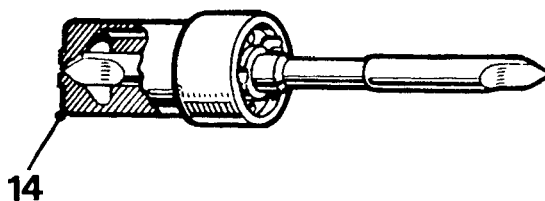
**Cleaning and inspecting**

10. Soak the component parts of the assembly in Shell Calibration Fluid to loosen carbon deposits, but do not allow parts of any one assembly to be interchanged with those of another.
11. Brush away all external carbon deposits from component parts with a brass wire brush and return them to the fluid bath. Particular care must be exercised when cleaning the pintle and seat of nozzle valve to avoid scratching or scoring, which could result in spray distortion.

12. Clean the three oil feed passages in the nozzle body with a wire or drill of 1,5 mm (0.062 in) diameter.
13. Remove the carbon from the annular recess with the tool illustrated.



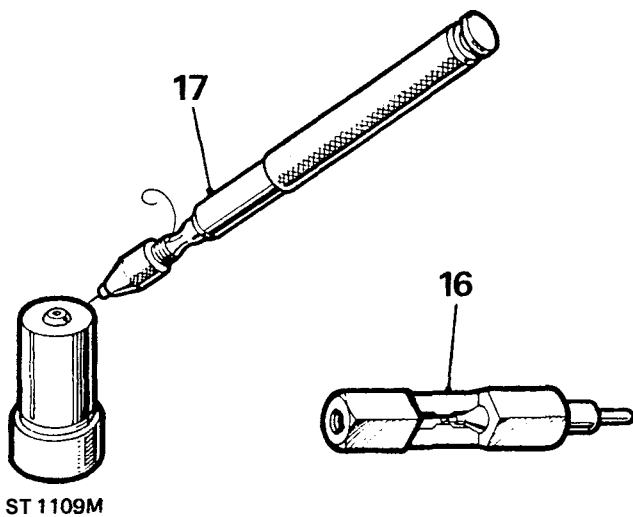
14. Remove the carbon from the valve seat, using the appropriate tool with a rotary motion.
15. Select the appropriate size probe from the pocket of cleaning kit and secure it in the pintle hole cleaner. Insert the probe into the bore of nozzle valve body and allow the end to extend through the main fuel outlet, then turn in a rotary manner to remove carbon.



continued

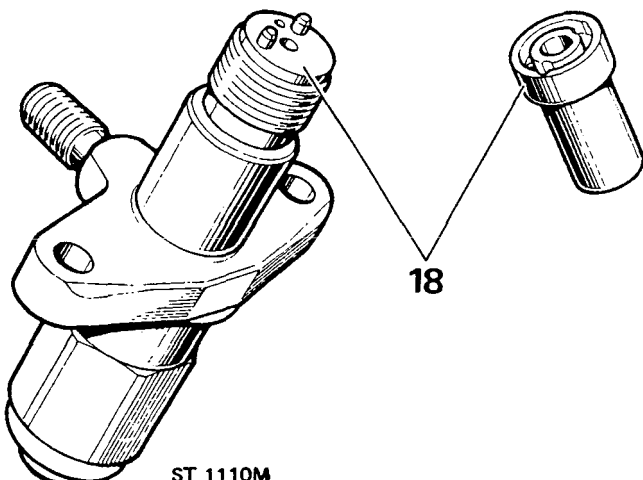
16. Carbon may be removed from the nozzle valve cone by inserting the valve into the tool illustrated and then rotating it alternately in a clockwise then anti-clockwise manner whilst pressing the valve inward. If the nozzle is blued or the seating has a dull circumferential ring indicating pitting or wear, the nozzle body and valve should be returned to a CAV Service Agent and replacement parts fitted. Do not attempt to lap the nozzle valve to body. This process requires special equipment and training.
17. Clean the auxiliary spray hole using the special tool fitted with probing wire 0,20 mm (0.008 in) diameter.

**NOTE:** Allow 1,5 mm (0.062 in) only to extend from the chuck and thus minimise the possibility of the wire bending or breaking while probing. Great care must be taken to prevent breakage of the wire in the hole.



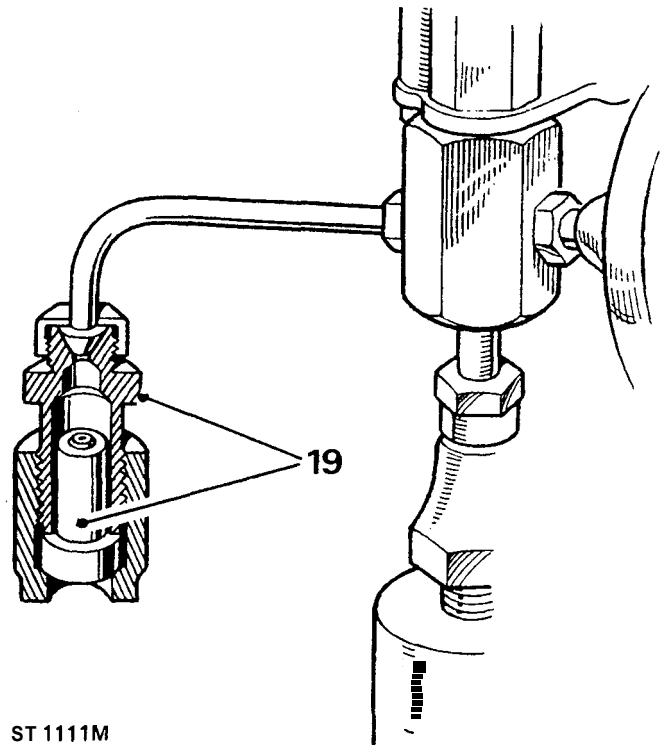
ST 1109M

18. Examine the pressure faces of nozzle body and nozzle holder to ascertain their freedom from scoring and scratches. These surfaces must be perfectly smooth.



ST 1110M

19. With the flushing tool secured to the nozzle testing outfit, fit the nozzle body (spray holes uppermost) to the flushing tool and pump test oil through vigorously. This flushing process is necessary for the removal of any tiny carbon particles which may have become lodged in the body after scraping and probing.



ST 1111M

#### Assemble

20. Fit the nozzle valve to nozzle and check for freedom of movement.
21. Immerse the nozzle body and valve in the fluid bath and assemble whilst submerged.
22. Wash the remaining components and assemble the injector in the sequence illustrated during the dismantling.
23. Set the injection nozzle assembly in accordance with the following test procedure.

#### Bench test injector nozzle and holder assembly

24. To check a nozzle assembly and to ensure that it is functioning correctly, a setting outfit, as illustrated, is essential. A bench covered with linoleum or non-ferrous sheet metal is most suitable for mounting the outfit; such a surface facilitates the cleanliness essential when checking nozzle parts. Between the bench and setting outfit, a tray, also of non-ferrous metal, should be positioned to prevent spilt fuel spreading. Small containers may be attached to the bench to isolate the component parts of each assembly. These parts are carefully mated by the manufacturers and must **not** be interchanged. Lastly, a small bath with a cover, containing Shell Calibration Fluid for washing components, should be kept conveniently near.

25. The efficient operation of the injection nozzle assembly is dependent on four main conditions, as follows:

The nozzle valve must open at 135 Ats.

The rate of back leakage must be within 150 to 100 Ats.

Seat tightness must be sufficient to prevent leakage.

Spray form must compare favourably with the illustrations.

26. Pressure setting, back leakage and seat tightness tests may be made by coupling the injection nozzle and holder assembly direct to the pressure feed pipe on the setting outfit, but an adaptor must be fitted between the pipe and injection nozzle and holder assembly when testing spray form. This adaptor, see instruction 38, increases the pressure of fuel to the injection nozzle and holder assembly sufficiently for the main and auxiliary spray form to be determined.

#### Test procedure

**WARNING: The injection nozzle must not be allowed to point towards the operator when spraying and the hands must never be allowed to contact the spray which has a force that can penetrate the flesh.**

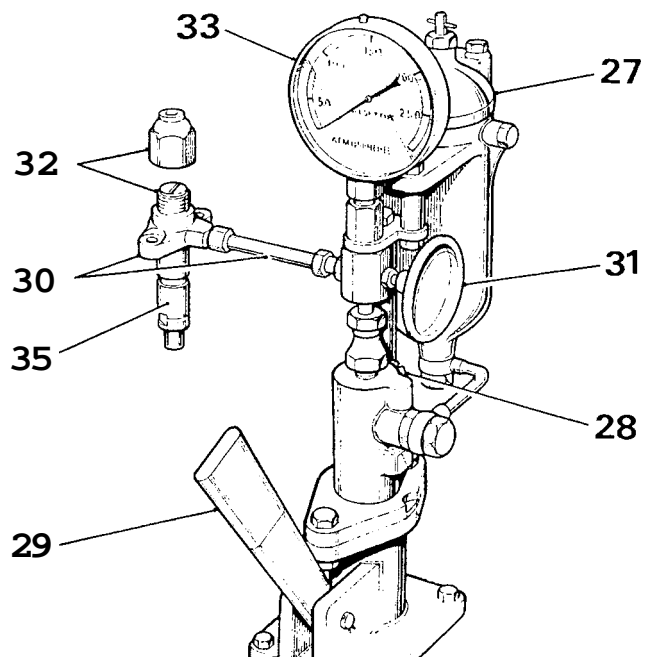
27. Remove the cap from the setting outfit container and fill with 0,8 litre (1.5 pints) of Shell Calibration Fluid.
28. Air vent the system by removing the vent screw, allow oil to flow freely for a few seconds and replace the screw whilst the flow continues.
29. Operate the pump handle until fluid flows from pipe.
30. Connect the injector and holder assembly to the pressure feed pipe with the nozzle pointing downwards. The length and bore of this pipe is important and replacement pipes must be approximately 75 mm (2.8 in) between the union nuts and of 3 mm (0.118 in) bore.
31. Close the check valve to keep the pressure gauge out of circuit and smartly operate the hand lever several times to expel all air from the system.

#### Leak-back test

32. Adjustment is made by removing the combined end cap and locknut from the nozzle holder, and turning the adjusting screw clockwise to increase and anti-clockwise to decrease the opening pressure.
33. Fit assembled injector to nozzle setting outfit and adjust to open at 160 to 170 atmospheres then pump up to just below this figure, release handle to allow the needle of gauge to fall naturally. Time the pressure drop from 150 atmospheres down to 100 atmospheres.
34. This should be not less than 5 seconds for the original nozzle and not less than 7 seconds if a new one is to be fitted, and not more than 36 seconds for either with oil temperature 10° to 21°C (50° to 70°F).

35. Check externally the top and bottom of nozzle cap nut and pressure pipe union nuts for signs of oil leakage. If leakage occurs at the nozzle cap nut, remove the nut and examine the pressure faces of nozzle holders and nozzle body (see item 18) for presence of foreign matter or surface scoring, before tightening further.

A leak-proof nozzle assembly with an excessive rate of pressure drop indicates a worn nozzle valve; the nozzle valve and nozzle body should be renewed.



ST 11127M

#### Pressure setting

36. The selected operational opening pressure of the nozzle valve is 135 atmospheres. Readjust to this setting in the manner described in item 32.

#### Seat tightness

37. Wipe the bottom face of the injection nozzle dry and raise the pressure in the system to 125 atmospheres. A slight dampness on the bottom face is permissible, but blob formation or dripping indicates a badly seating valve in which case the assembly should be dismantled for further examination.

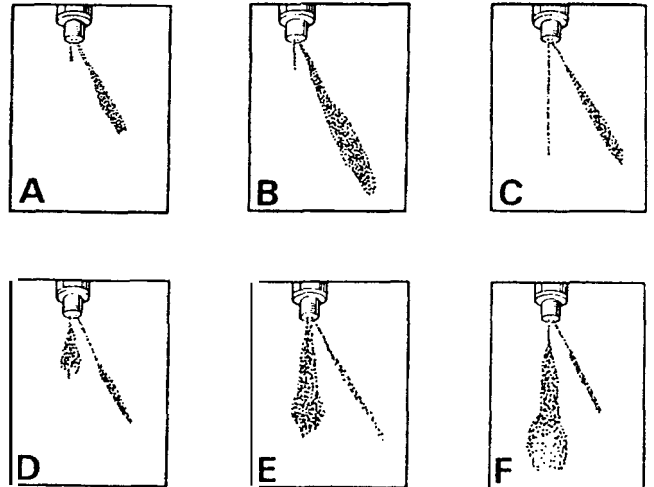
#### Spray form

38. Fuel delivery to the injection nozzle assembly when testing spray form must be characteristically similar to fuel delivery under normal operating conditions and to effect these conditions an adaptor (CAV Y7044872) must be fitted between the injection nozzle assembly and the pressure pipe.

continued

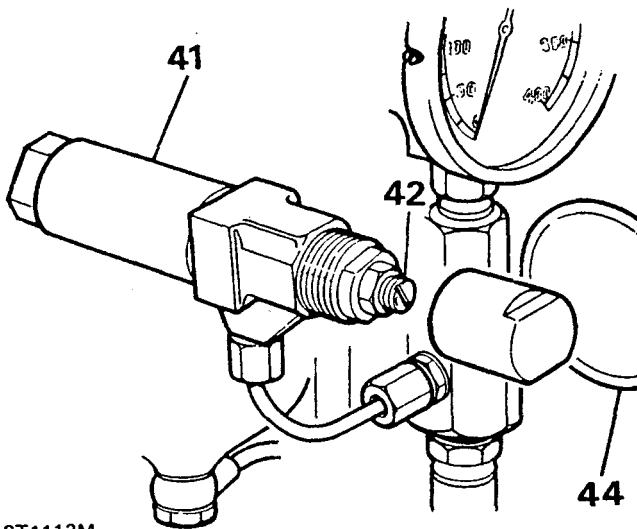


39. The adaptor differs mainly in the cap nut and nozzle valve from the ordinary type of injection nozzle and holder assembly as fitted to the engine; the nozzle valve has no pintle.
40. The cap nut is extended, bored and threaded to receive nozzles for testing.
41. Connect the adaptor assembly to the pressure pipe.
42. Remove the end cap and adjust the opening pressure of the nozzle valve to 220 atmospheres.
43. Screw the injection nozzle and holder assembly to be tested, into the adaptor.
44. With the check valve closed, operate the handle smartly to expel air from the system. The auxiliary spray form may be tested at 60 strokes per minute and the main spray at 140. Spray development from starting to running speeds is illustrated, this illustration should be referred to and compared with the spray form of nozzles under test. Spray formation should be well formed and free from splits or distortion. A slight centre 'core' can be disregarded. Observe the main spray through 360 degrees to ensure a uniform spray.



ST 1115M

45. When satisfactory, fit the combined locknut and end cap, connect the injectors to the fuel spill rail and fit them to the engine.



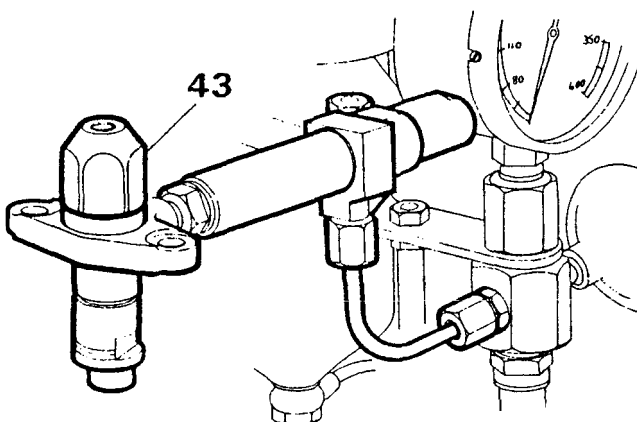
ST1113M

### FITTING FUEL INJECTORS

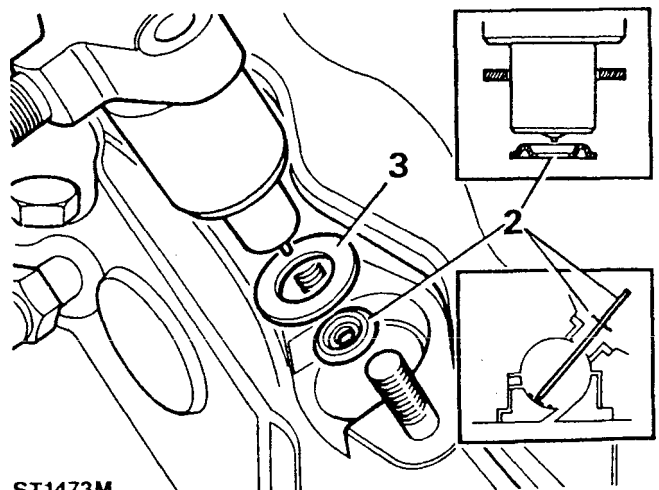
The steel sealing washer fitted below the injector nozzle is to ensure that combustion does not take place around the nozzle body and cause it to overheat. A washer which has been used more than once, or an incorrectly fitted washer may cause the nozzle to overheat and result in that cylinder misfiring.

1. Ensure that the new washers are separated from each other and are clean.
2. Use a length of thin welding wire to guide one washer only into each port with the domed side toward the injector as illustrated. Ensure that only one washer is fitted to each port.

continued



ST1114M



ST1473M

3. Lightly grease the copper washer into position on each injector before fitting to the cylinder head.
4. Fit the injector and evenly tighten the retaining nuts to the correct torque **6 to 8 Nm (4 to 6 lbs ft)**. Uneven or overtightening of the injector nuts could distort the nozzle and cause misfiring when normal running temperature is reached.
5. Reconnect the injector pipes but do not overtighten the union nuts.

**HAND THROTTLE** — where fitted

**Petrol and Diesel four cylinder engines**

Adjust

1. Slacken the lock nut on the cable adjuster and turn the adjuster to remove all slack from the cable and tighten the locknut.

**NOTE: The first illustration petrol engine and second illustration Diesel engine.**

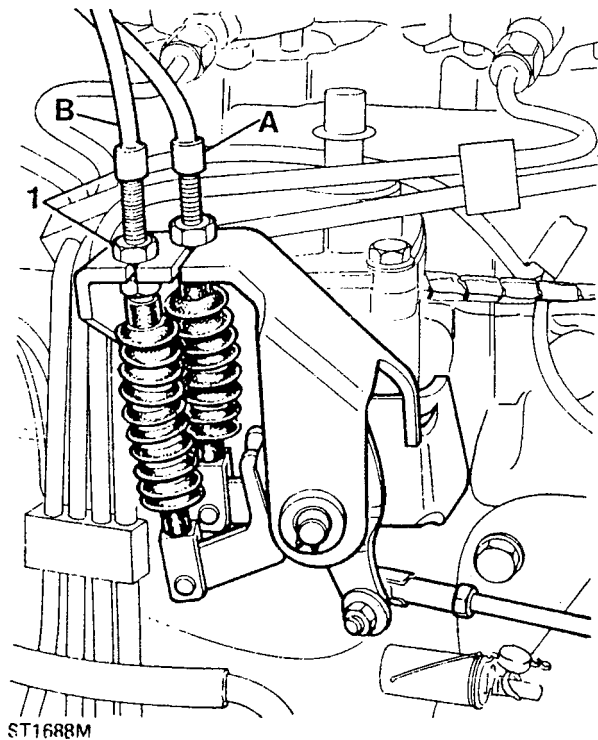
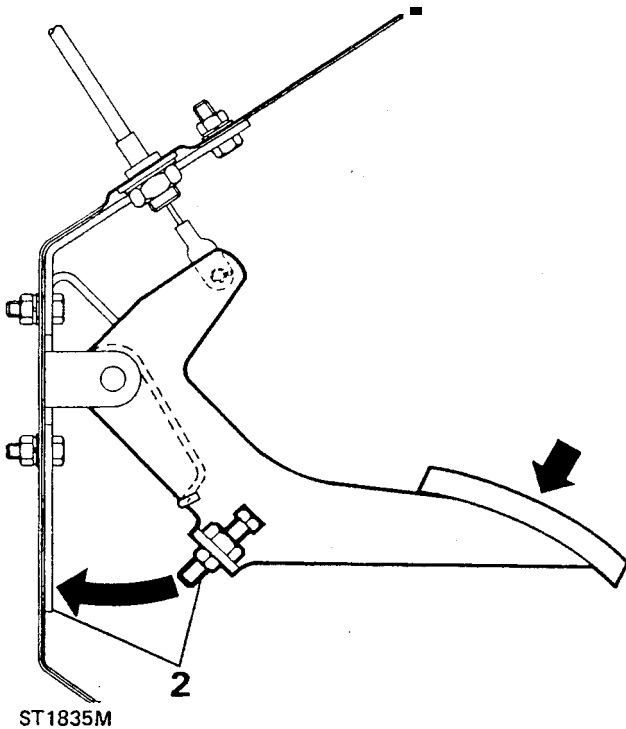
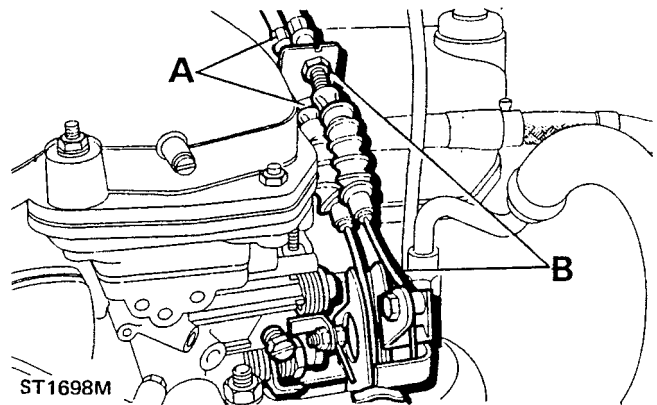
A.) Foot pedal cable adjuster

B.) Hand throttle cable adjuster

**THROTTLE PEDAL ADJUSTMENT** —

**Petrol and Diesel four cylinder engines**

1. After renewing the throttle cable, remove any slack in the cable by adjustment of the cable adjuster at the engine end.
2. Depress the throttle pedal, by hand, to the full extent of the carburetter, DPA or DPS pump linkage, and adjust the pedal stop screw to take up all clearance between the screw and scuttle panel. Make sure that no strain is placed upon the carburetter or pump linkage.



**GENERAL SPECIFICATION DATA**  
**2.5 Litre Turbo Charged Diesel Engine — Supplement**

Number of cylinders .....	4
Bore .....	90,47 mm (3.562 ins)
Stroke .....	97,00 mm (3.822 ins)
Capacity .....	2495 cc
Compression ratio .....	21:1
Valve charger .....	O.h.v. pushrod operated
Turbo charger .....	Garrett T2
<b>Crankshaft</b>	
Main bearing journal diameter .....	63,487-63,500 mm (2.4995-2.500 in)
Regrind dimensions:	
63,246-63,2333 mm (2.490-2.4895 in) .....	Use 0.010 in U/S bearings
Crankpin journal diameter .....	58,725-58,744 mm (2.312-2.31275 in)
Regrind dimensions:	
58,48985-58,4708 mm (2.30275-2.30200 in) .....	Use 0.010 in U/S bearings
Crankshaft end thrust .....	Taken on thrust washers at centre main bearing
Crankshaft end-float .....	0,05-0,15 mm (0.002-0.006 in)
<b>Main bearings</b>	
Number and type .....	5 halved shells without oil grooves
Diametrical clearance .....	0,018-0,061 mm (0.0007-0.0024 in)
<b>Connecting rods</b>	
Length between centres .....	175,38-175,43 mm (6.905-6.907 in)
Diametrical clearance (big-end bearings) .....	0,025-0,075 mm (0.001-0.003 in)
End-float on crankpin .....	0,15-0,356 mm (0.006-0.014 in)
<b>Pistons</b>	
Type .....	Aluminium alloy 'V' shaped valve recess in crown
Skirt diametrical clearance (at right angle to gudgeon pin) .....	0,025-0,05 mm (0.001-0.002 in)
<b>Gudgeon pins</b>	
Type .....	Floating
Fit in piston .....	Hand push fit
Diameter .....	30,1564-30,1625 mm (1.18726-1.18750 in)
Clearance in connecting rod .....	0,0196-0,0036 mm (0.00077-0.00014 in)
<b>Piston rings</b>	
Type:	
Top .....	Chamfered friction edge, chrome plated
Second .....	Taper faced
Oil control .....	Expander and rails
Gap in bore:	
Top .....	0,30 to 0,50 mm (0.011-0.019 in)
Second .....	0,25 to 0,45 mm (0.009-0.017 in)
Oil control .....	0,3 to 0,6 mm (0.011-0.023 in)
Clearance in piston grooves:	
Top .....	0,140 to 0,180 mm (0.002 to 0.007 in)
Second .....	0,040 to 0,080 mm (0.001 to 0.003 in)
Oil control .....	0,04 to 0,080 mm (0.001 to 0.003 in)

continued

**Camshaft**

Drive .....	25,4 mm (0.1 in) wide dry toothed belt
Location .....	Right-hand side (thrust side)
End-float .....	0,1-0,2 mm (0.004-0.008 in)
Number of bearings .....	4
Material .....	Steel shell, white metal lined

**Valves**

Seat angle:	
Inlet .....	45°
Exhaust .....	45°
Head diameter:	
Inlet .....	39,12-39,37 mm (1.540-1.550 in)
Exhaust .....	33,25-33,50 mm (1.309-1.319 in)
Stem diameter:	
Inlet .....	7,912-7,899 mm (0.3114-0.3109 in)
Exhaust .....	8,682-8,694 mm (0.3418-0.3422 in)
Valve lift:	
Inlet .....	9,85 mm (0.388 in)
Exhaust .....	10,26 mm (0.404 in)
Cam lift:	
Inlet .....	6,81 mm (0.268 in)
Exhaust .....	7,06 mm (0.278 in)

**Valve springs**

Type .....	Duplex Interference double coil
Inner:	
Length, free .....	42,67 mm (1.680 in)
Length, under 8.0 kg (17.7 lb) load .....	40,30 mm (1.587 in)
Outer:	
Length, free .....	46,28 mm (1.822 in)
Length, under 21 kg (46 lb) load .....	40,30 mm (1.587 in)

**Lubrication**

System .....	Wet sump, pressure fed
System pressure, engine warm at 2000 rpm .....	2,5-4,57 kgf cm <sup>2</sup> (35-65 lbf in <sup>2</sup> )
Oil pump:	
Type .....	Double gear 10 teeth, sintered iron gears
Drive .....	Splined shaft from camshaft skew gear
End-float of both gears .....	0,026-0,135 mm (0.0009-0.0045 in)
Radial clearance of gears .....	0,025-0,075 mm (0.0008-0.0025 in)
Backlash of gears .....	0,1-0,2 mm (0.0034-0.0067 in)
Oil pressure relief valve:	
Type .....	Non-adjustable
Relief valve spring:	
Full length .....	67,82 mm (2.670 in)
Compressed length at 2.58 kg (5.7 lb) load .....	61,23 mm (2.450 in)
Oil filter:	
Type .....	Screw-on disposable canister

**FUEL SYSTEM**

Inspection pump .....	See 'ENGINE TUNING DATA'
Fuel lift pump type .....	Mechanical with hand primer
Pressure range .....	0,35-0,56 kgf cm <sup>2</sup> (5-8 lbf in <sup>2</sup> )
Fuel filter .....	Paper element
Air cleaner .....	Paper element type

continued

**COOLING SYSTEM**

Type .....	Pressurized spill return system with thermostat control, pump and fan assisted
Thermostat opening temperature .....	82°C
Pressure cap .....	1,0 kgf cm <sup>2</sup> (15 lbf in <sup>2</sup> )
Water pump type .....	Centrifugal
Fan type .....	7 blade with viscous coupling
Radiator .....	Combined engine coolant and oil cooler

**CLUTCH**

Type .....	Verto diaphragm spring
Centre plate diameter (friction plate) .....	235 mm (9.25 in)
Facing material .....	Verto 791
Number of damper springs .....	8
Damper spring colour .....	2 off white/green -Suffix 'C' 2 off pigeon blue - Suffix 'A' 4 off ruby red - Suffix 'B'
Clutch release bearing .....	Ball journal

**TRANSMISSION**

Type .....	LT230T. Two-speed reduction on main gearbox output. Front and rear drive permanently engaged via a lockable differential
Ratios Ninety and One Ten .....	High 1.4109:1 Low 3.3198:1

**Rear axle**

Type-Ninety models .....	Spiral bevel
Type-One Ten models .....	Hypoid; full floating shafts, Salisbury 8HA
Ratio-All models .....	3.54:1

**Front axle**

Type-Ninety models .....	Spiral bevel
Front wheel drive .....	Enclosed constant velocity joint
Ratio .....	3.54:1

Overall ratio (including final drive)		In high transfer	In low transfer
Ninety and One Ten models .....			
	Fifth (Cruising gear)	4.15:1	9.76:1
	Fourth	4.99:1	11.75:1
	Third	7.53:1	17.71:1
	Second	11.49:1	27.03:1
	First	17.90:1	42.11:1
	Reverse	18.48:1	43.47:1

**ELECTRICAL**

Starter motor .....	Paris Rhone type D9R91 12 volt, with reduction gear
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**ENGINE TUNING DATA**

**ENGINE**

Firing order ..... 1-3-4-2  
 Injection timing ..... 13° B.T.D.C.

**Timing marks:**

Valve timing ..... Slot for peg in flywheel and TDC mark on front pulley  
 Injection timing ..... Special tool 18G 1458 inserted in D.P.S. pump  
 Tappet clearances inlet and exhaust ..... 0,25 mm (0.010 in)

**Valve timing**

Inlet opens ..... 16° B.T.D.C.  
 Inlet closes ..... 42° A.B.D.C.  
 Inlet peak ..... 103° A.T.D.C.  
 Exhaust opens ..... 51° B.B.D.C.  
 Exhaust closes ..... 13° A.T.D.C.  
 Exhaust peak ..... 109° R.T.D.C.

**Valve lift**

Inlet ..... 9,85 mm (0,388 ins)  
 Exhaust ..... 10,26 mm (0.404 ins)

**Maximum governed speeds**

Full load ..... 4000 r.p.m.  
 No load (flight speed) ..... 4400 ± 80 r.p.m.  
 Idle speed ..... 670 ± 20 r.p.m.  
 Dic-down time ..... 4 seconds

**DISTRIBUTOR PUMP**

Make/type ..... CAV DPS type with boost control and two speed  
 mechanical governor with auto advance and solenoid  
 electrical shut-off. Tamper proof sealing on flight speed  
 and fuel adjustment screws.  
 Direction of rotation ..... Clockwise, viewed from drive end  
 Advance box (two stage) ..... 7" advance with 3" start retard  
 Back leakage rate 150-100Atm:  
     New nozzle ..... 7 seconds  
     Original nozzle ..... 5 seconds  
     Despatch nozzle ..... 8520A290A

**INJECTORS**

Make/type ..... CAV Pintaux DES5385001  
 Nozzle size ..... BDNO/SPC 6209  
 Opening pressure (working pressure) ..... 135 to 140 Atmospheres  
 Injector pipe type ..... High pressure multi-bundy  
     size ..... 1,94 to 2,06 mm  
     length ..... 457,2 mm (18 ins)

**HEATER PLUGS**

Make/type ..... Probe type, Champion CH63 i i volts 90 watts nominal  
 Time to reach operating temperature of 850°C ..... 8 seconds

**TURBO-CHARGER**

Make/type ..... Garrett T2  
 Maximum boost pressure ..... 48 cm HG (9.3 P.S.I.G.) measured at wastegate actuator  
 "T" piece

## TORQUE WRENCH SETTINGS

TURBO-CHARGER FIXINGS	Nm	lbf.ft
Stud-Turbo charger to exhaust manifold	22-28	16-21
Nut-Turbo charger to exhaust manifold	21-26	15-19
Adaptor-Oil feed to cylinder block	22-28	16-21
Adaptor-Oil drain to cylinder block	22-28	16-21
Pipe-Oil feed to turbo charger	15-22	11-16
Pipe-Oil drain	32-48	23-35
Stud-Outlet elbow to turbo charger	22-28	16-21
Nut-Outlet elbow to turbo charger	21-26	15-19
Heat shield support to inlet manifold	22-28	16-21
Stud-Exhaust manifold to cylinder head	30-40	22-30
Nut-Exhaust manifold to cylinder head	28-36	21-26
Screw-inlet and exhaust manifold to cylinder head	30-40	22-30

## RECOMMENDED ENGINE OILS

The following list of recommended engine oils for temperate climates - ambient temperature range - 10°C to 35°C should be used for oil changes and topping up. They are SHPD (Super High Performance Diesel) oils that allow a maximum of 10,000 km (6,000 miles) between oil and filter changes.

BP	Vanellus C3 Extra 15/40
CASTROL	Deusol Turbomax 15/40
MOBIL	Delvac 1400Super 15/40
SHELL	Myrina 15/40

The following list of oils is for emergency use only if the above oils are not available. They can be used for topping-up without detriment, but if used for engine oil changing, they are limited to a maximum of 5,000 km (3,000 miles) between oil and filter changes.

BP	Vanellus C3 Multigrade 15/40
CASTROL	Deusol RX Super 15/40
DUCKHAMS	Hypergrade 15/50
ESSO	Essolube XD-3 15/40
MOBIL	Delvac Super 15/40
PETROFINA	Fina Dilano HPD 15/40
SHELL	Rimula X 15/40
TEXACO	URSA Super Plus 15/40

Use only oils to MIL-L-2104C/D or API Service levels CD or SE/CD-15W/40 SECTION 10

## MAINTENANCE SCHEDULE

The following additional maintenance is required for the turbo charged engine to that contained in the main schedule for the non-Turbo Charged 2.5 Litre Diesel engine.

Every 500 km (250 miles)

- Check engine oil level

At 1,600 km (1,000 miles), 10,000 km (6,000 miles) and 20,000 km (12,000 miles) then every 20,000 km (12,000 miles)

- Check tappets, and adjust if necessary

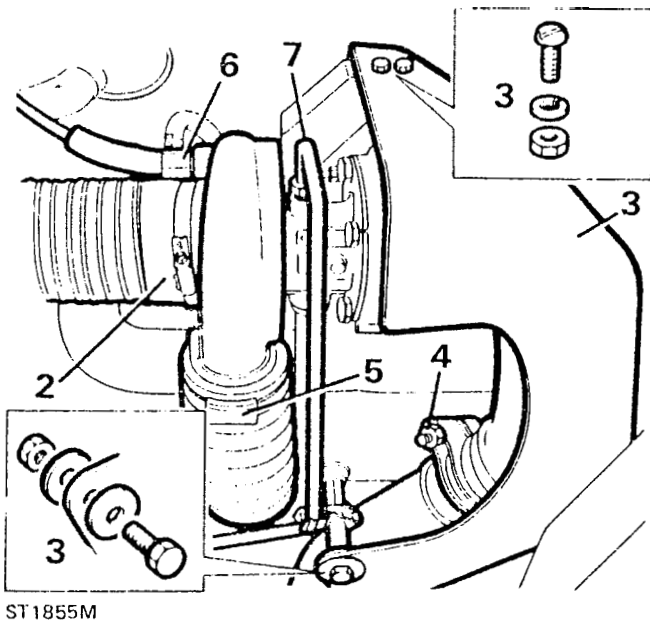
Every 80,000 km (48,000 miles)

- Check maximum turbo-charge boost pressure.

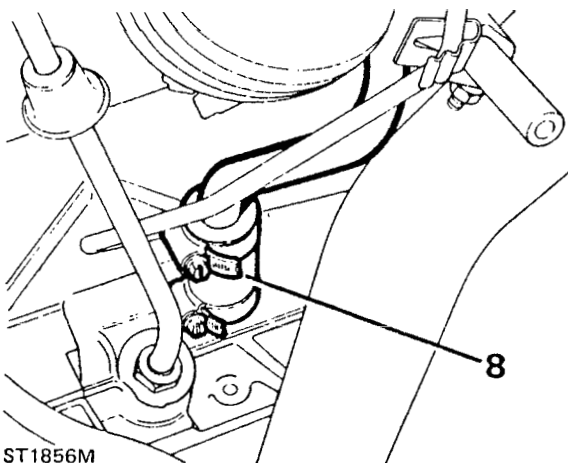
## TURBO-CHARGER

## Removing

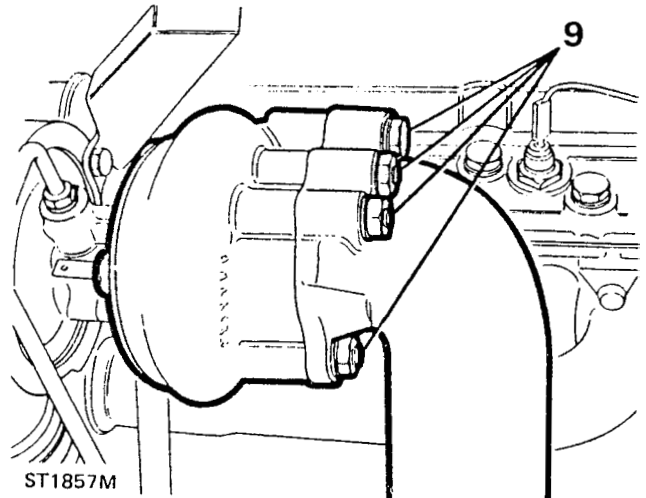
1. Remove the bonnet.
2. Remove the hose connecting the air cleaner to the turbo-charger.
3. Remove the turbo-charger heat shield fixings and remove the heat shield.
4. Release the clamp securing the turbo-charger elbow to the exhaust downpipe.
5. Remove the inlet manifold to the turbo-charger hose.
6. Disconnect the boost control hose from the turbo-charger.
7. Disconnect from the turbo-charger the lubrication inlet pipe.



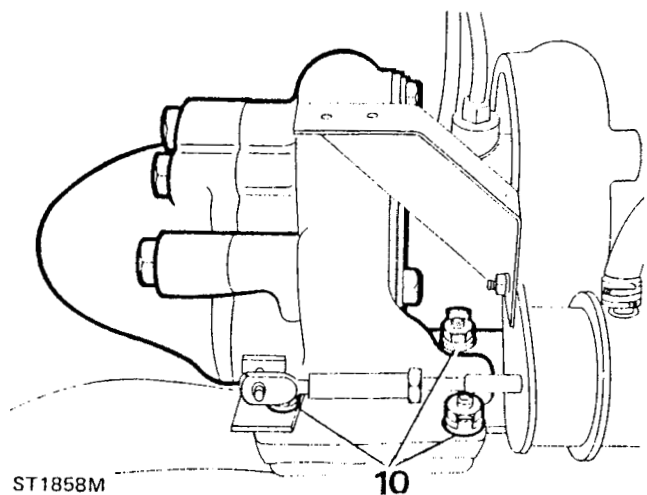
8. Disconnect, at the flexible hose, the lubrication drain pipe from the turbo-charger.



9. Remove the five nuts to release the exhaust elbow and gasket from the turbo-charger.



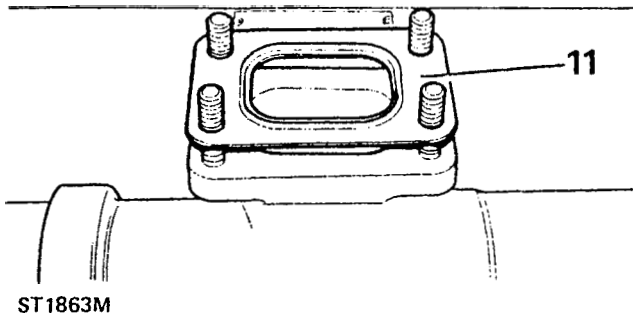
10. Release the lock tabs and remove the four nuts securing the turbo-charger to the exhaust manifold and remove the turbo-charger and gasket.



## Fitting

11. Fit the raised bead side of a new gasket uppermost to the exhaust manifold and fit and secure the turbo-charger with the four nuts, tightening evenly to the correct torque and secure with lock tabs.
12. Fit the exhaust elbow, using a new gasket, to the turbo-charger and retain with the five nuts tightening evenly to the correct torque.

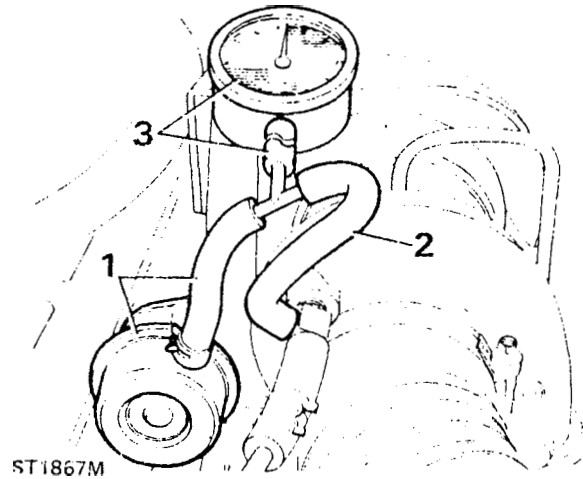




13. Fit the exhaust downpipe to the turbo-charger elbow and tighten the clamp bolt.
14. Connect the lubrication inlet pipe to the turbo-charger.
15. Fit the oil drain pipe to the flexible connection.
16. Connect the boost control pipe to the turbo-charger.
17. Fit the hose connecting the inlet manifold to turbo-charger.
18. Fit the heat shield.
19. Fit the air cleaner to turbo-charger hose.
20. Immediately prior to starting the engine release the oil inlet pipe to the turbo-charger and fill the centre housing with a recommended make and grade of engine oil and re-fit the pipe.

#### CHECKING TURBO-CHARGER BOOST PRESSURE

1. Disconnect, from the turbo-charger, the hose to the actuator and insert, into the free end a suitable 'T' piece.
2. Connect a short length of slave hose to the turbo-charger and connect the other end to the 'T' piece.
3. Connect a further slave hose to the third leg of the 'T' piece and the other end to a pressure gauge capable of reading in excess of 50 cm of Mercury. The pressure gauge hose must be long enough to reach into the cab of the vehicle so that the gauge can be observed by the driver or passenger.
4. Drive the vehicle in the normal manner (2,500-3,000 r.p.m. full load) and observe the maximum pressure obtained and compare with the figure in Data Section 05.



#### RENEW TURBO-CHARGER ACTUATOR

1. Remove the two screws securing actuator bracket to the turbo-charger.
2. Remove the nut and bolt securing actuator to the heat shield bracket and disconnect the hose.
3. Remove clip retaining actuator arm to the wastegate lever pin and withdraw the actuator from the engine.
4. Fit the replacement actuator with the two bolts and single nut and bolt. Tighten bolts to 12.5 to 14.0 Nm (111 to 124 in lbs).
5. Push the wastegate lever as far as possible towards the actuator and apply pressure to keep lever in this position.
6. Pressurize the replacement actuator to 57-62 cm HgG (11-12 p.s.i.g) and hold this pressure.

**CAUTION: Use only the threaded rod-end to make adjustments. Forcing the entire rod in or out will change the calibration with the possibility of damaging engine over-boost.**

7. Screw the rod-end in either direction until the rod end eye will locate easily over the wastegate pin and secure with retaining clip.
8. Release the calibration pressure and tighten the rod end locknut. Reconnect the hose.
9. Check the boost pressure, on the road, as described earlier. The pressure should not fall below 44 or exceed 50 cm HgG (8.5 — 9.7 p.s.i.g.)

### TURBO-CHARGER FAULT TRACING

It is important to be aware that when tracing a suspected fault in a turbo-charger that a turbo-charger cannot compensate for incorrect engine operation deficiencies in the air, or fuel intake systems, exhaust emission components or for damaged and worn engine internal parts such as valves and pistons. Before suspecting the turbo-charger, the engine should be checked against the tuning data in Section 05. Replacing a sound turbo-charger with another will not correct engine deficiencies.

Systematic fault tracing of a suspected turbo-charger failure is important for two reasons. First, it must be found what, if anything, is wrong with the turbo-charger so that it can be exchanged. Second, it must be decided what action is necessary to prevent a repeat failure.

In many cases, evidence pointing to the cause of a failure is destroyed while removing the turbo-charger from the engine. For example, if a turbo-charger failed because of a faulty installation, such as loose connections that allowed dirt to enter the compressor, this would not be evident once the turbo-charger was removed from the engine. Failure to correct the installation, such as reinstalling defective manifold flange connections, could cause an identical failure of the replacement unit. The hose connecting the air cleaner to the compressor, which could contain dirt or harmful particles, should be cleaned or renewed if necessary.

In general, the fault tracing procedures that can be done with the least effort and in the least amount of time should be done first. Do not remove and renew the turbo-charger until the following visual checks and repairs that can be made with the turbo-charger installed, have been done. **DO NOT, UNDER ANY CIRCUMSTANCES, DISMANTLE THE TURBO-CHARGER.**

### VISUAL INSPECTION

1. Inspect all connections within the intake system. Tighten loose connections as required.
2. Replace damaged air intake components.
3. Check the connection between the compressor and the engine intake manifold. Tighten loose bolts as required.
4. Check exhaust system connections at turbine housing inlet and outlet flanges for oil leakage and loose connections. Tighten loose connections as required. If oil leakage exists, check the general condition of the engine.
5. Check the oil line connections at the centre housing oil inlet and outlet ports for leakage. Tighten loose connections as required. Start engine and recheck connections.

## ENGINE PROTECTION

To prevent corrosion of the aluminium alloy engine parts it is imperative that the cooling system is filled with a solution of clean water and the correct type of anti-freeze, winter and summer, or water and inhibitor if frost precautions are not required. Never fill or top-up with water only, always add an inhibitor (Marston's SQ36) if anti-freeze is not used. NEVER use salt water with an inhibitor otherwise corrosion will occur. In certain territories where the only available water supply may have some salt content, use only clean rainwater or distilled water.

### Recommended solutions

**Anti-freeze** Unipart Universal Anti-freeze or permanent type ethylene base, without methanol, with a suitable inhibitor for aluminium engines and engine parts.

Use one part of anti-freeze to one part water.

**Inhibitor** Marston Lubricants SQ36 inhibitor concentrate.

Use 100 cc of inhibitor per litre of water.

Anti-freeze can remain in the cooling system and will provide adequate protection for two years provided that the specific gravity of the coolant is checked before the onset of the second winter and topped-up with new anti-freeze as required.

Land Rovers leaving the factory have the cooling system filled with 50% of anti-freeze mixture. This gives protection against frost down to minus 47°C (minus 53°F). Vehicles so filled can be identified by a label affixed to the windscreen and radiator.

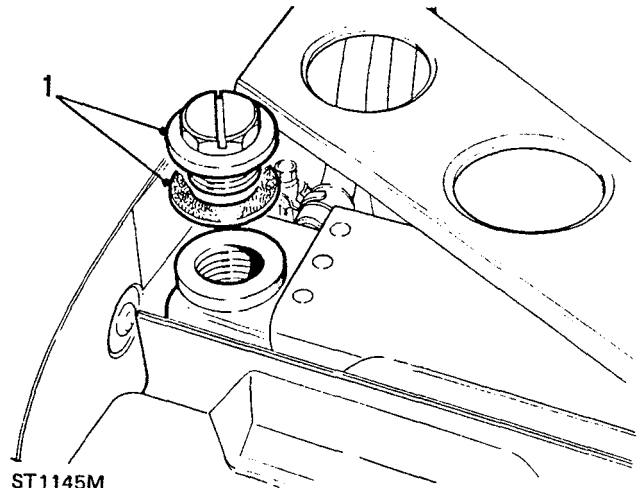
After the second winter the system should be drained and thoroughly flushed. Before adding new anti-freeze examine all joints and renew defective hoses to make sure that the system is leakproof. Inhibitor solution should be drained and flushed out and new inhibitor solution introduced every two years, or sooner where the purity of the water is questionable.

See the 'General specification data' section for protection quantities.

## DRAIN AND FILL V8 ENGINE COOLING SYSTEM

**WARNING: Do not remove the radiator filler cap when the engine is hot because the cooling system is pressurized and personal scalding could result.**

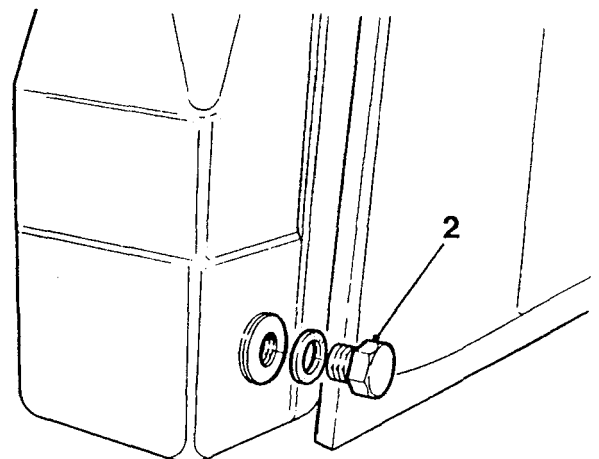
1. Remove the radiator filler plug.



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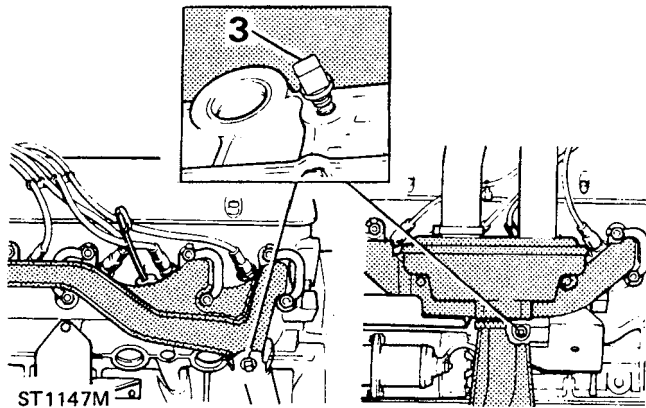
2. Remove the radiator drain plug and allow the coolant to drain, if necessary, into a suitable container. Refit the drain plug and new washer. The drain plug is situated on the left-hand side of the radiator towards the bottom facing the engine compartment.

**NOTE: Disconnect bottom hose to drain on radiators without a drain plug. Connect hose after draining.**

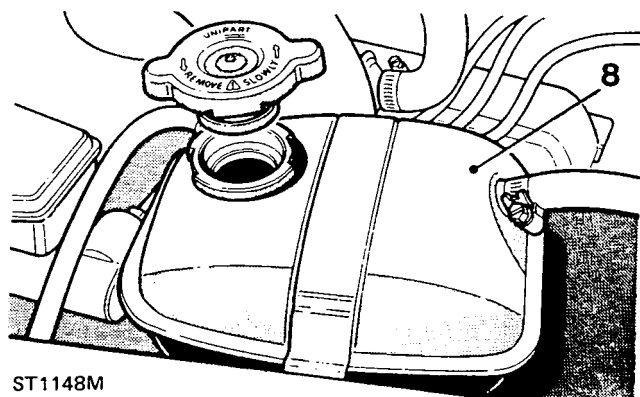


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3. Remove the engine drain plugs, one each side of the cylinder block, beneath the exhaust manifolds. Allow the coolant to drain and refit plugs and washers.



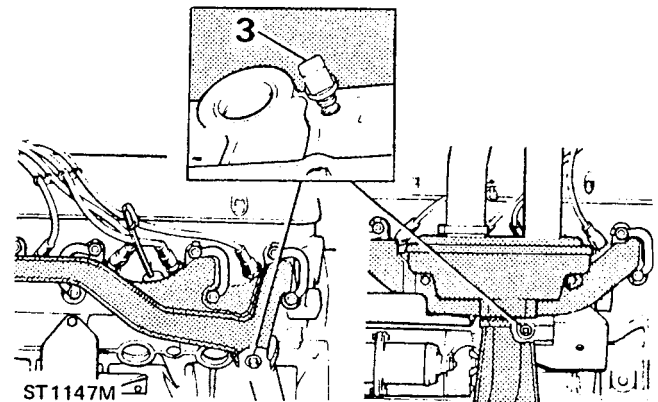
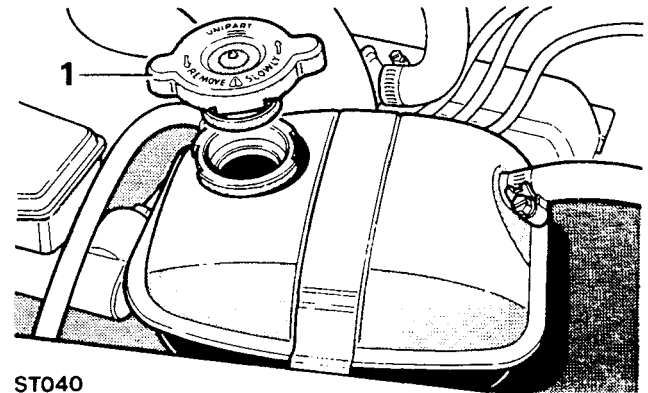
4. To drain the expansion tank remove it from the vehicle, empty, flush-out and refit. If necessary renew the expansion tank hose.
5. Make up a solution of anti-freeze and water in a separate container in the concentration required. The cooling system capacity is quoted in the data section. Therefore to allow for topping up and the expansion tank make up a quantity in excess of this quantity.
6. If anti-freeze is not required use Marstons SQ36 in the concentration recommended as described under 'Engine protection'. Make up a quantity in excess of capacity for topping up and expansion tank.
7. Make sure all drain plugs are tight and fill the system through the radiator filler plug until the coolant is just below the filler neck. Fit the plug but do not over tighten.
8. Half fill the expansion tank with coolant and secure the cap correctly.



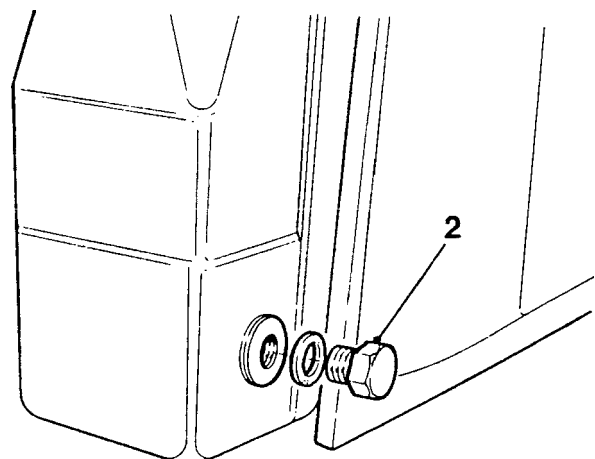
**DRAIN AND FILL 2.25 LITRE PETROL AND DIESEL AND 2.5 DIESEL SYSTEMS**

**WARNING:** Do not remove the radiator or expansion tank filler caps when the engine is hot because the cooling system is pressurized and personal scalding could result.

1. Remove the expansion tanks and radiator filler plug.



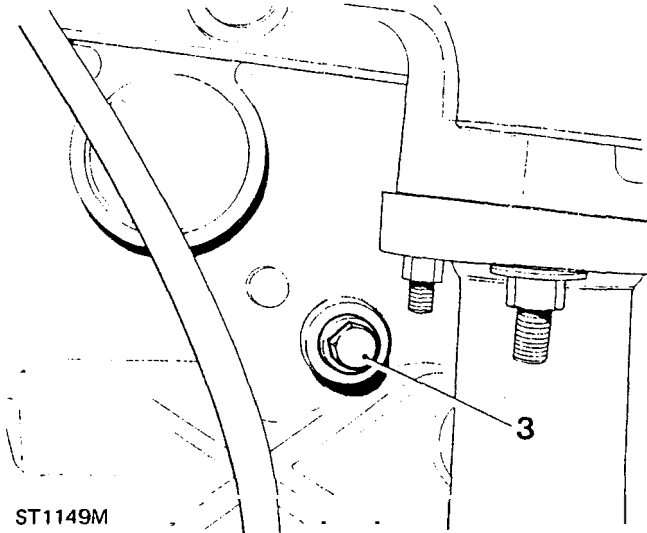
2. Remove the radiator drain plug and allow the coolant to drain, if necessary into a suitable container. Refit the drain plug with a new washer. The plug is located on the left-hand side of the radiator facing the engine compartment.



9. Start and run the engine until normal operating temperature is reached. Allow the engine to cool and check the levels in the radiator and expansion tank and top up if necessary. Finally check all hose connections for leaks.

**NOTE: Radiator without a drain plug, disconnected the bottom hose to drain. Reconnect after draining.**

3. Remove the cylinder block drain plug, on the left-hand side of the engine, and allow coolant to drain completely before refitting the plug.



4. To drain the expansion tank, disconnect the hose from the tank to the water pump. Drain and flush and reconnect the hose.
5. Make up a solution of anti-freeze and water in a separate container in the concentration required. The cooling system capacity can vary so refer to 'Capacities' under 'General specification data'. To allow for topping up and the expansion tank prepare a quantity in excess of the capacity of the system concerned.
6. If anti-freeze is not required, use Marstons inhibitor SQ36 in the recommended concentration, see under 'Engine protection'. Prepare a quantity in excess of the capacity for topping up and the expansion tank.
7. Check all hoses and drain plugs for security and fill the system through the expansion tank until approximately three quarters full.
8. Fit the expansion tank cap and radiator filler plug and run the engine until normal operating temperature is reached. Allow the engine to cool completely. Remove the expansion tank cap and if necessary top up to half full. Remove the radiator filler plug and check that the coolant level is just below the filler neck. Finally examine the cooling system for leaks. Tighten the radiator filler plug to 40—50 lbs. in.

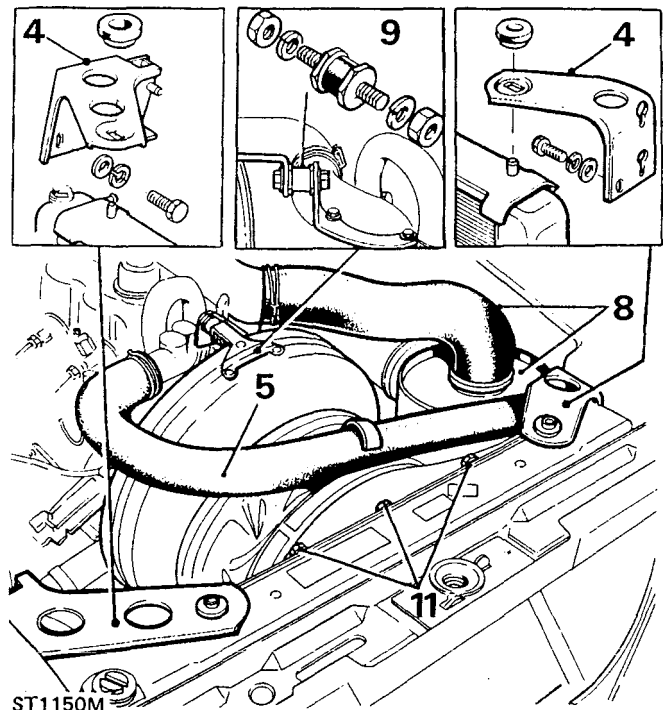
### REMOVING THE RADIATOR (2.25 litre petrol and 2.25 and 2.50 diesel)

1. Disconnect the battery.
2. Drain the radiator by removing the drain plug at the bottom left-hand side of the radiator and releasing the expansion tank filler cap. See drain and fill cooling system.
3. Disconnect the overflow hose from the radiator.
4. The radiator is held in position by two brackets each secured by three screws. Remove the screws and brackets.
5. Disconnect the top and bottom hoses from the radiator.
6. **Diesel engine**
7. Disconnect the vacuum pump hose from the pump and release it from the clips on the radiator cowling.

#### Petrol engine

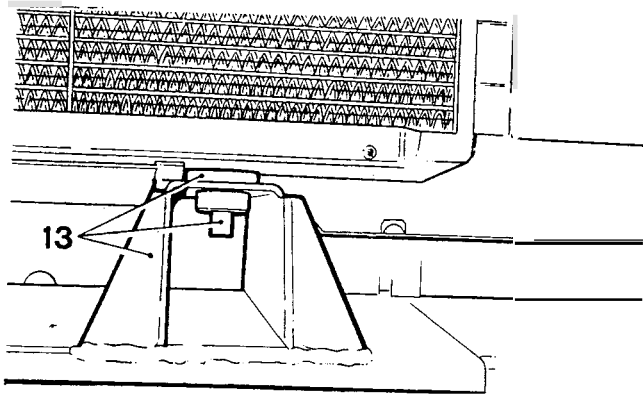
8. Disconnect the air cleaner hose from the carburettor and remove the air cleaner.
9. Release the three fixings securing cowling to the engine.
10. Pull back the cowling towards the radiator and lift radiator and cowl.
11. Remove the five screws securing the cowling to the radiator and separate the two units noting that the cowling is held to the bottom of the radiator by two clips.

continued



**FITTING THE RADIATOR**

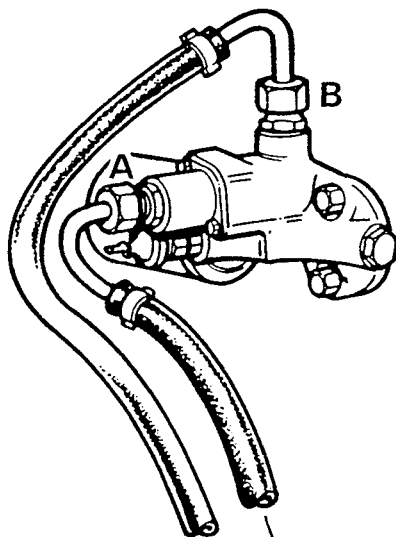
12. Locate the cowl into the clip at the bottom of the radiator and secure it at the top with the five screws.
13. Lower the radiator and cowl assembly into position in the vehicle ensuring that the two pegs at the bottom of the radiator locate in the corresponding rubber pads in the crossmember brackets.



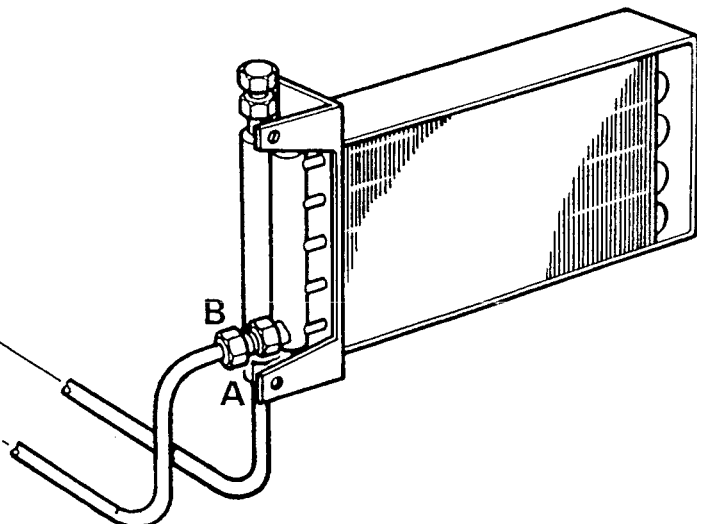
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14. Secure the top of the radiator with the two brackets and bolts.
15. Secure the cowl to the engine.
16. Connect the top, bottom and overflow hoses.
17. **Diesel engine**  
Fit the hose to the vacuum pump and secure it with the clips on the cowl.  
Fit the air cleaner and connect the hose to the air intake manifold.
18. **All engines**

Check that the radiator drain plug (where fitted) is tight and fill the cooling system.



- A. Oil from engine to oil cooler.
  - B. Cooled oil from cooler to engine.
- Start engine and check for oil leaks

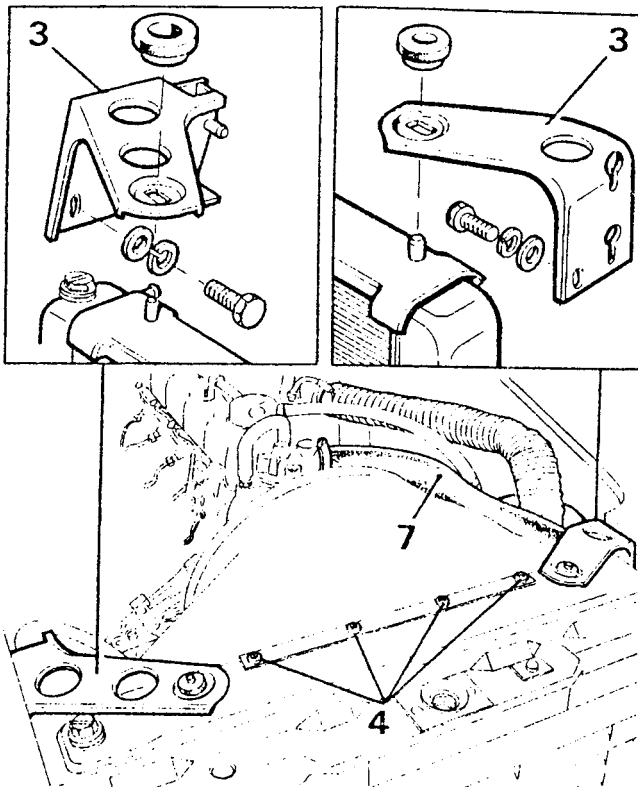


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## RADIATOR ASSEMBLY — TURBO-CHARGED VEHICLES.

### Removing

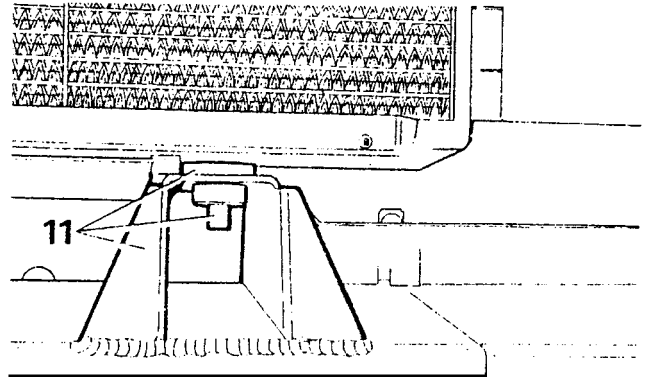
1. Disconnect the battery.
2. Remove the split pin and clevis pin securing the lower end of the bonnet stay and lift-off the bonnet.
3. Remove the three screws each side securing the radiator left-hand and right-hand retaining brackets and remove the brackets.
4. Remove the four screws and withdraw the radiator cooling fan cowl.
5. Disconnect the bottom hose from the radiator and drain the coolant.
6. Disconnect the oil cooler inlet and outlet pipes from the radiator and blank-off the pipes and radiator apertures to prevent ingress of dirt.
7. Disconnect the radiator top hose from the radiator and thermostat housing.
8. Disconnect expansion tank hose from radiator.
9. Lift the radiator from the engine compartment.
10. If the radiator is to be renewed, remove the oil cooler unions from the radiator and fit to the replacement radiator.



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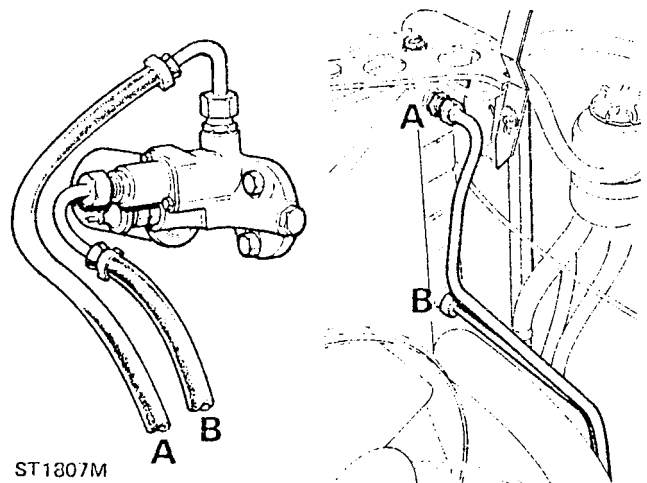
### Fitting

11. Fit the radiator into position ensuring that the two pegs at the bottom of the radiator locate in the corresponding rubber pads in the cross member brackets.



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12. Fit the radiator top hose to the radiator and thermostat housing.
13. Connect the radiator bottom hose.
14. Fit the expansion tank hose to radiator.
15. Fit the fan cowl and secure with the four screws.
16. Fit the radiator left-hand and right-hand retaining brackets.
17. Fit the oil cooler inlet and outlet hoses to the radiator.  
Hose A to top of radiator.  
Hose B to bottom of radiator.

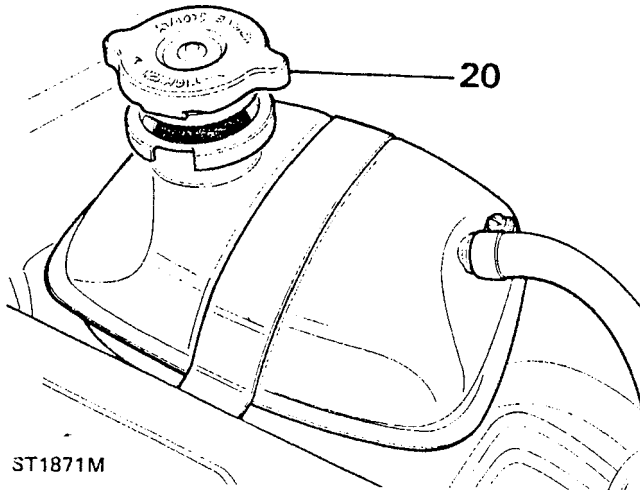


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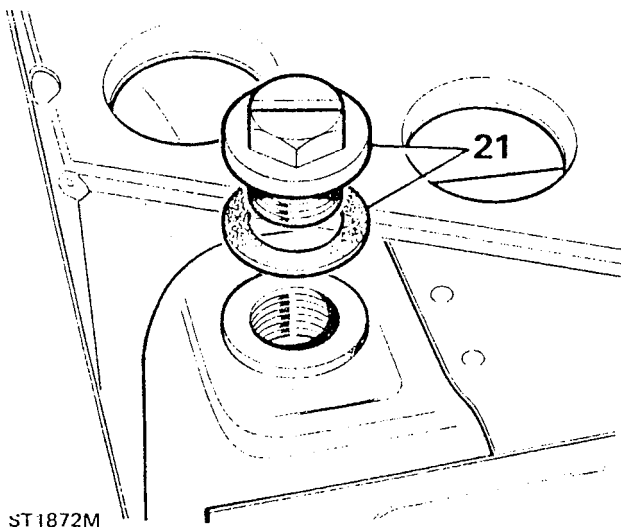
18. Fit the bonnet and stay securing with the clevis pin and new split pin.

**Filling radiator**

19. Check that all hose clips are tight.
20. Remove the expansion tank cap.



21. Remove the radiator plug.



22. Fill the system with coolant using a mixture of water and anti-freeze or anti-corrosion inhibitor, through the expansion tank until the coolant is just below the level of the radiator plug hole. Continue filling until the expansion tank is half-full.
23. Fit the expansion tank cap and radiator plug. Tighten the plug to 40 — 50 lbs. in.
24. Check the engine oil level in sump and top-up.

25. Connect the battery and run the engine until normal running temperature is attained whilst checking for coolant leaks.
26. Stop the engine and allow it to cool completely.
27. Remove the radiator plug and check the level and fit and tighten plug.
28. Top-up level of expansion tank and fit the cap.



## COOLING SYSTEM FAULT DIAGNOSIS

SYMPTOM	POSSIBLE CAUSE	CURE
A — EXTERNAL LEAKAGE	<ol style="list-style-type: none"> <li>1. Loose hose clips</li> <li>2. Defective rubber hose</li> <li>3. Damaged radiator seams</li> <li>4. Excessive wear in the water pump</li> <li>5. Loose core plugs</li> <li>6. Damaged gaskets</li> <li>7. Leaks at the heater connections or plugs</li> <li>8. Leak at the water temperature gauge plug</li> </ol>	<ol style="list-style-type: none"> <li>1. Tighten</li> <li>2. Renew</li> <li>3. Rectify</li> <li>4. Renew</li> <li>5. Renew</li> <li>6. Renew</li> <li>7. Rectify</li> <li>8. Tighten</li> </ol>
B — INTERNAL LEAKAGE	<ol style="list-style-type: none"> <li>1. Defective cylinder head gasket</li> <li>2. Cracked cylinder wall</li> <li>3. Loose cylinder head bolts</li> </ol>	<ol style="list-style-type: none"> <li>1. Renew. Check engine oil for contamination and refill as necessary</li> <li>2. Renew cylinder block</li> <li>3. Tighten. Check engine for oil contamination and refill as necessary</li> </ol>
C — WATER LOSS	<ol style="list-style-type: none"> <li>1. Boiling</li> <li>2. Internal or external leakage</li> <li>3. Restricted radiator or inoperative thermostat</li> </ol>	<ol style="list-style-type: none"> <li>1. Ascertain the cause of engine overheating and correct as necessary</li> <li>2. See items A and B</li> <li>3. Flush radiator or renew the thermostat as necessary</li> </ol>
D — POOR CIRCULATION	<ol style="list-style-type: none"> <li>1. Restriction in system</li> <li>2. Insufficient coolant</li> <li>3. Inoperative water pump</li> <li>4. Loose fan belt</li> <li>5. Inoperative thermostat</li> </ol>	<ol style="list-style-type: none"> <li>1. Check hoses for crimps, reverse-flush the radiator, and clear the system of rust and sludge</li> <li>2. Replenish</li> <li>3. Renew</li> <li>4. Adjust</li> <li>5. Renew</li> </ol>
	<ol style="list-style-type: none"> <li>2. Infrequent flushing and draining of system</li> <li>3. Incorrect anti-freeze mixtures</li> </ol>	<ol style="list-style-type: none"> <li>1. Use only soft, clean water together with correct anti-freeze or inhibitor mixture</li> <li>2. The cooling system should be drained and flushed thoroughly at least once a year</li> <li>3. Certain anti-freeze solutions have a corrosive effect on parts of the cooling system. Only recommended solutions should be used.</li> </ol>
F — OVERHEATING	<ol style="list-style-type: none"> <li>1. Poor circulation</li> <li>2. Dirty oil and sludge in engine</li> <li>3. Radiator fins choked with chaff, mud, etc.</li> <li>4. Incorrect ignition timing</li> <li>5. Insufficient coolant</li> <li>6. Low oil level</li> <li>7. Tight engine</li> <li>8. Choked or damaged exhaust pipe or silencer</li> <li>9. Dragging brakes</li> <li>10. Overloading vehicle</li> <li>11. Driving in heavy sand or mud</li> <li>12. Engine labouring on gradients</li> <li>13. Low gear work</li> <li>14. Excessive engine idling</li> <li>15. Inaccurate temperature gauge</li> <li>16. Defective thermostat</li> </ol>	<ol style="list-style-type: none"> <li>1. See item D</li> <li>2. Refill</li> <li>3. Use air pressure from the engine side of the radiator and clean out passages thoroughly</li> <li>4. Check using electronic equipment</li> <li>5. See item D</li> <li>6. Replenish</li> <li>7. New engines are very tight during the 'running-in' period and moderate speeds should be maintained for the first 1,000 miles (1500 km)</li> <li>8. Rectify or renew</li> <li>9. Adjust brakes</li> <li>10. In the hands of the operator</li> <li>11. In the hands of the operator</li> <li>12. In the hands of the operator</li> <li>13. In the hands of the operator</li> <li>14. In the hands of the operator</li> <li>15. Renew</li> <li>16. Renew</li> </ol>
G — OVERCOOLING	<ol style="list-style-type: none"> <li>1. Defective thermostat</li> <li>2. Inaccurate temperature gauge</li> </ol>	<ol style="list-style-type: none"> <li>1. Renew</li> <li>2. Renew</li> </ol>



**OVERHAUL RELEASE BEARING ASSEMBLY**

1. Remove the clutch slave cylinder from the bell housing.
2. Withdraw the retaining staple, if fitted.
3. Remove the release bearing assembly.
4. Remove spring clip retaining bolt and spring — V8.
5. Remove the slipper pads — 4-cylinder engines only.
6. Withdraw the release lever.
7. Discard worn parts.
8. Smear the pivot with grease and fit the release lever and retain with the spring clip and bolt — V8.
9. Smear the release bearing sleeve inner diameter with Molybdenum disulphide base grease.
10. Fit the slipper pads.
11. Fit the release bearing assembly and retain with the staple. The staple is to aid assembly and has no other purpose. It may become dislodged in service, without detriment.

Illustration A. V8 engine

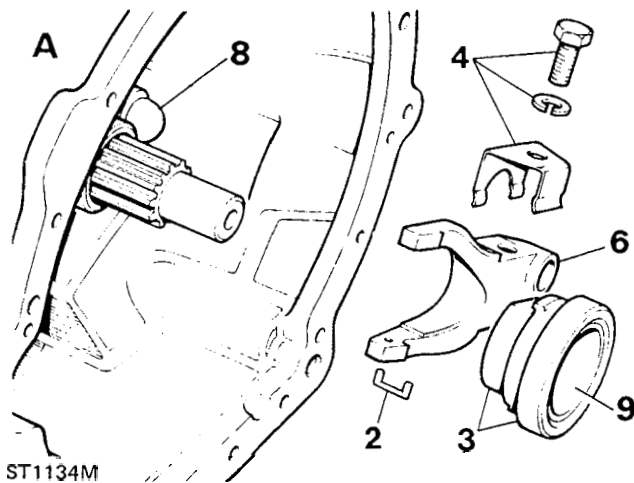
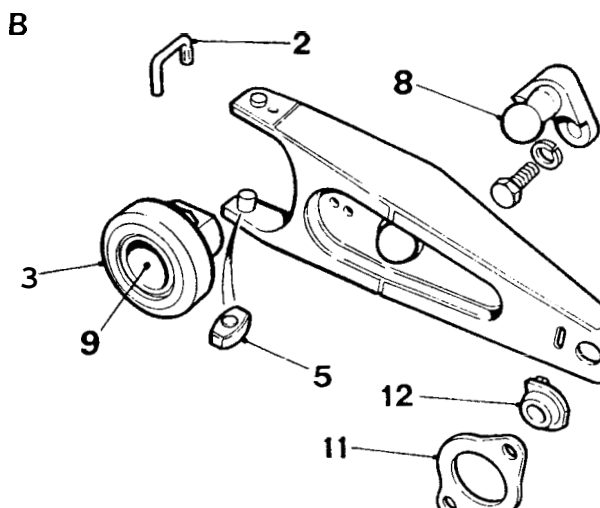


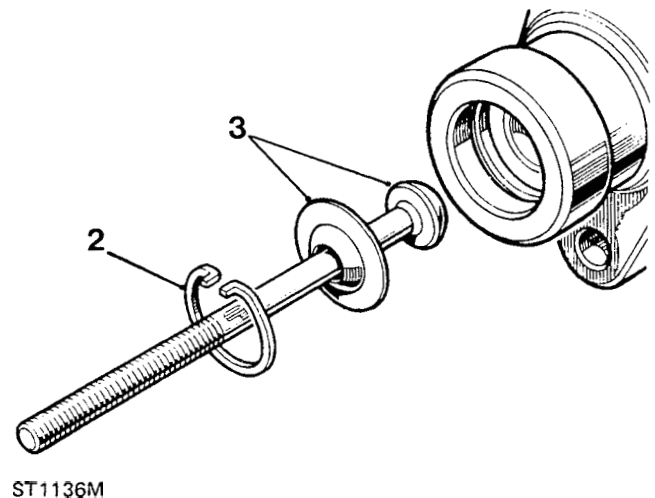
Illustration B. 4-cylinder engines



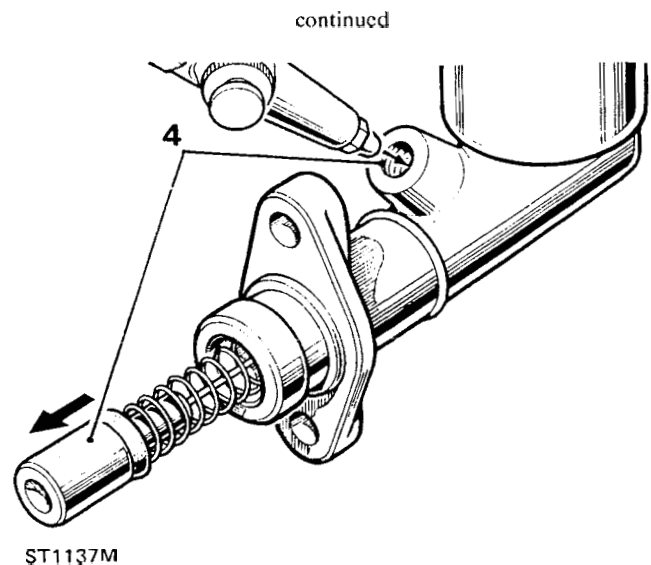
12. Coat both sides of the backing plate with a waterproof joint compound such as Hylomar PL32M and locate the backing plate and dust cover in position on the slave cylinder.
13. Check that the push-rod clip is in position.
14. Fit the slave cylinder, engaging the push-rod through the centre of the dust cover and with the bleed screw uppermost. Secure the cylinder with the two bolts, tightening evenly to the correct torque.

**OVERHAUL MASTER CYLINDER — All models****DISMANTLE**

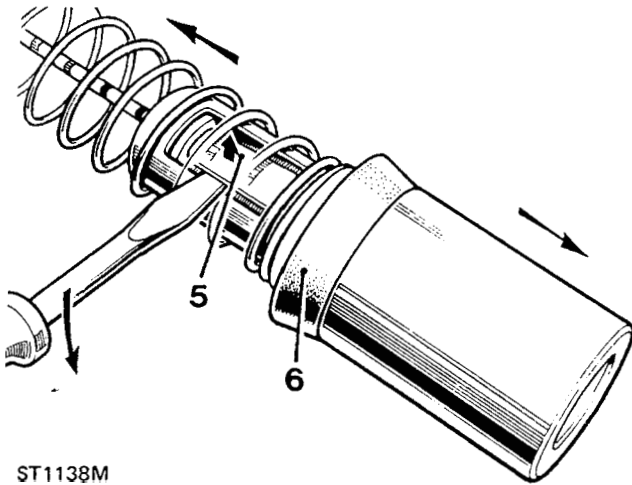
1. Remove the master cylinder from the vehicle.
2. Remove the circlip.
3. Withdraw the push-rod and retaining washer.



4. Withdraw the piston assembly. If necessary, apply a low air pressure to the outlet port to expel the piston.

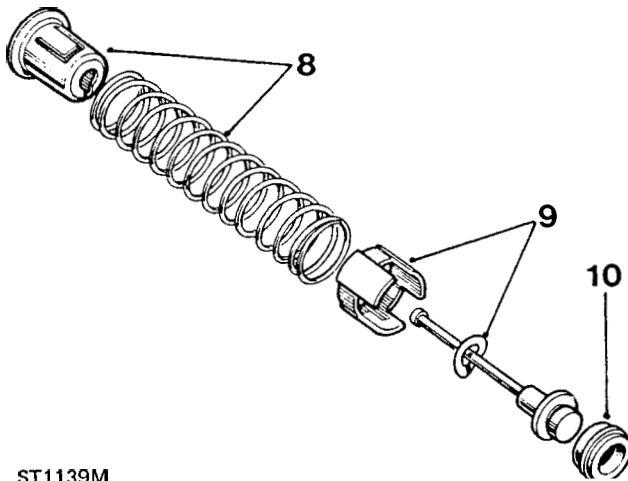


5. Prise the locking prong of the spring retainer clear of the piston shoulder and withdraw the piston.
6. Withdraw the piston seal.
7. Compress the spring and position the valve stem to align with the larger hole in the spring retainer.



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8. Withdraw the spring and retainer.
9. Withdraw the valve spacer and spring washer from the valve stem.
10. Remove the valve seal.



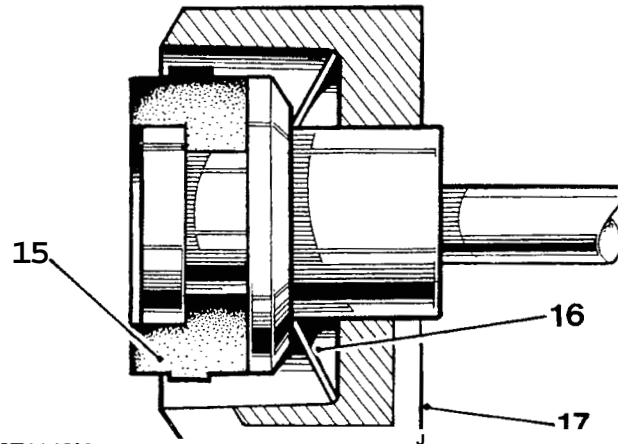
ST1139M

### Inspection

11. Clean all components in Girling cleaning fluid and allow to dry.
12. Examine the cylinder bore and piston, ensure that they are smooth to the touch with no corrosion, score marks or ridges. If there is any doubt, fit new replacements.
13. The seals should be replaced with new components.

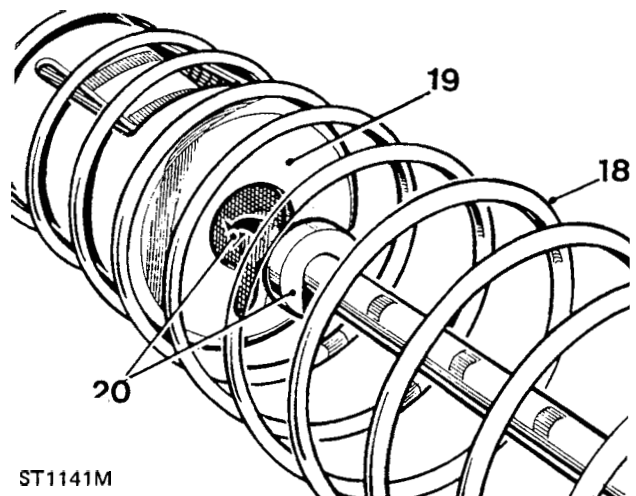
### Assemble

14. Smear the seals with Castrol-Girling rubber grease and the remaining internal items with Castrol-Girling brake and clutch fluid.
15. Fit the valve seal, flat side first, onto the end of the valve stem.
16. Place the spring washer, domed side first, over the small end of the valve stem.
17. Fit the spacer, legs first.



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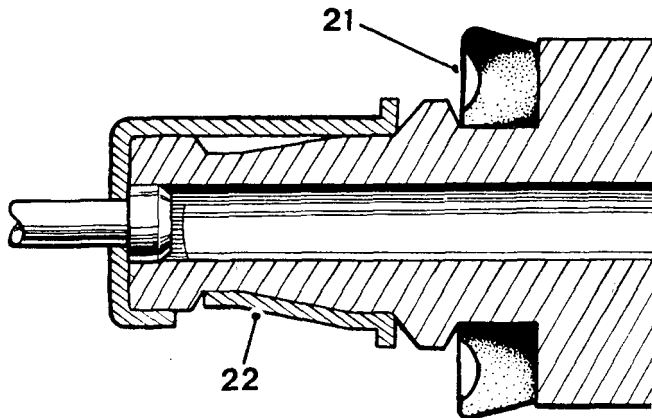
18. Place the coil spring over the valve stem.
19. Insert the retainer into the spring.
20. Compress the spring and engage the valve stem in the keyhole slot in the retainer.



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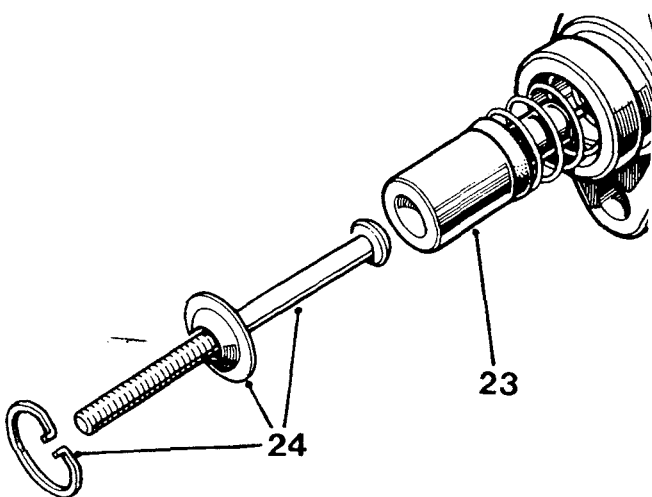
21. Fit the seal, large diameter last, to the piston.
22. Insert the piston into the spring retainer and engage the locking prong.

continued



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23. Smear the piston with Castrol-Girling rubber grease and insert the assembly, valve end first, into the cylinder.
24. Fit the push-rod, retaining washer and circlip.



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### BLEED CLUTCH HYDRAULIC SYSTEM

When the gearbox and bell housing assembly has been fitted to the vehicle the hydraulic clutch release system must be bled to expel air.

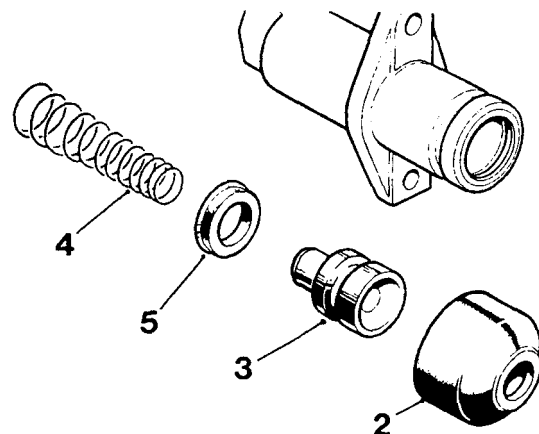
**NOTE:** During the following procedure, keep the fluid reservoir topped-up to avoid introducing air into the system. Use only the fluid recommended in the Lubrication chart. Use only new fluid from a sealed container.

1. Attach a length of suitable tubing to the slave cylinder bleed screw and immerse the free end of the tube in a glass jar containing new clutch fluid.
2. Slacken the bleed screw and depress the clutch pedal, pausing at the end of each stroke, until the fluid issuing from the tubing is free of air with the tube free end below the surface of the fluid in the container. Whilst holding the clutch pedal down and with the free end of the tube below the fluid, tighten the bleed screw.

### OVERHAUL SLAVE CYLINDER

#### DISMANTLE

1. Remove the slave cylinder from the vehicle.
2. Withdraw the dust cover.
3. Expel the piston assembly, applying low pressure air to the fluid inlet.
4. Withdraw the spring.
5. Prise off the seal from the piston.



ST1144M

#### Inspection

6. Clean all components with Girling cleaning fluid and allow to dry.
7. Examine the cylinder bore and piston, ensure that they are smooth to the touch with no corrosion, score marks or ridges. If there is any doubt, fit new replacement.
8. The seal should be replaced with a new component.

#### Assemble

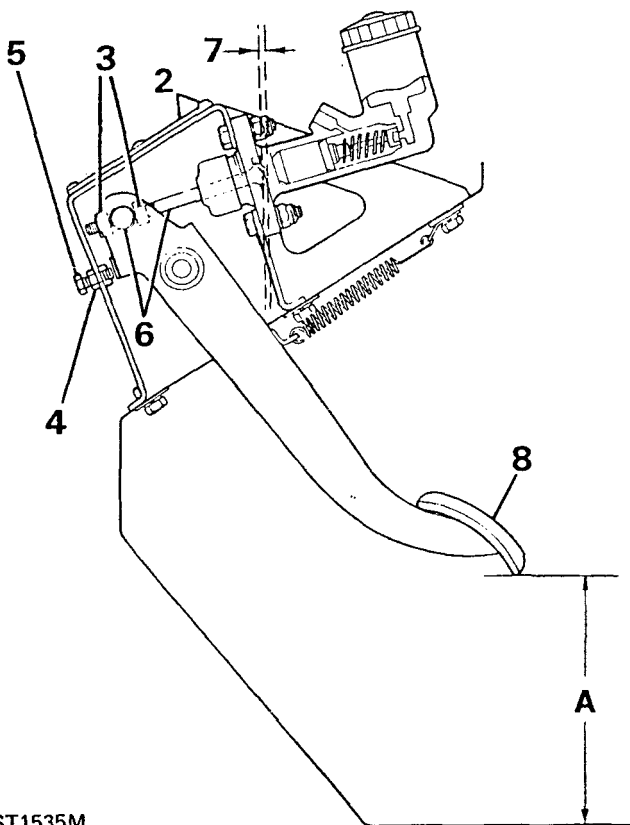
9. Smear the seal with Castrol-Girling rubber grease and the remaining internal items with Castrol-Girling brake and clutch fluid.
10. Fit the seal, large diameter last, to the piston.
11. Locate the conical spring, small diameter first, over the front end of the piston.
12. Smear the piston, with Castrol-Girling rubber grease and insert the assembly, spring end first, into the cylinder.
13. Fill the dust cover with Castrol-Girling rubber grease and fit the cover to the cylinder.

### CLUTCH PEDAL AND MASTER CYLINDER ADJUSTMENT

1. The correct height for the clutch pedal from the floor of the footwell, without a mat, to the lower edge of the pedal is 140 mm (5.5 in), dimension 'A'.

#### Adjust

2. Withdraw the six screws and remove the top plate.
3. Slacken master cylinder push-rod locknuts to provide free movement of the push-rod through the pedal trunnion.
4. Slacken the adjustment screw locknut.
5. To increase the pedal height, turn the adjustment screw anti-clockwise. To reduce turn clockwise. When correct tighten the locknut.
6. To adjust the master cylinder push-rod, check that the push-rod has free-play through the trunnion.
7. Adjust the locknuts until the push-rod has 1,5 mm (0.062 in) free-play between the push-rod and master cylinder. When correct tighten the locknuts.
8. Check that there is 6 mm (0.350 in) free movement of the pedal at the pad. If necessary re-adjust the push-rod.
9. Refit the top plate.



ST1535M