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## Timing case and drive assembly

15

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## General description

The timing case is made of cast aluminium or cast iron. The helical timing gears are made of steel, except for the camshaft gear of some low rated engines which is made of cast iron. A power take-off is available on the left side of the aluminium timing case or from both sides of the timing case made of cast iron.

The drive from the crankshaft gear passes through an idler gear to the camshaft gear and to the gear of the fuel injection pump. The drive from the crankshaft gear also passes through a lower idler gear to the gear of the lubricating oil pump or, on some four cylinder engines, to the gear of the balancer unit. The gear of the water pump is driven by the gear of the fuel injection pump. The camshaft and the fuel injection pump run at half the speed of the crankshaft.

The aluminium cover of the timing case contains the front oil seal; this is made of viton and has a dust lip in front of the main lip. The cover has a noise shield fitted to its front face.

The camshaft is made of cast iron. The cam lobes and the eccentric for the fuel lift pump are chill hardened.

## Timing case cover

To remove and to fit

15A-01

### To remove

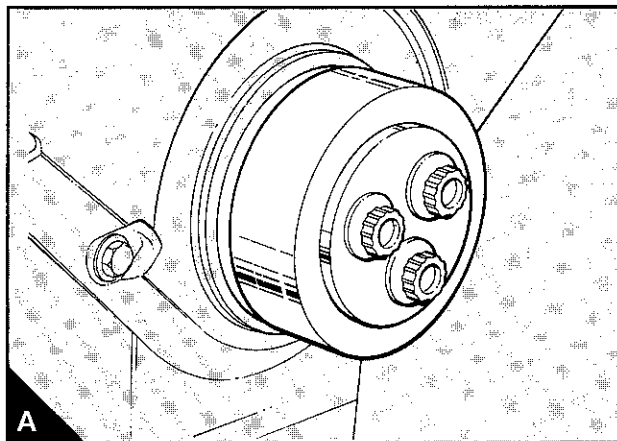
- 1 Remove the fan, operation 21A-04.
- 2 Remove the drive belts 23A-03.
- 3 Remove the crankshaft pulley, operation 14A-01.
- 4 If necessary, remove the fan drive pulley, operation 21A-05.
- 5 Drain the coolant and remove the water pump, operation 21A-02.
- 6 Release the setscrews and nuts of the cover and remove the cover. There is no need to remove the noise shield from the cover.

### To fit

Special tools:

Centralising tool, PD.163A

- 1 Clean the faces of the timing case cover.
- 2 Put the cover and a new joint in position on the timing case. Loosely fit two opposite setscrews to hold the cover in place. Fit the centralising tool in the oil seal housing (A) and use the special washer and the crankshaft pulley setscrews to put the cover in its correct position. Do not overtighten the setscrews. Fit the remainder of the setscrews and nuts and tighten all of the cover fasteners to 22 Nm (16 lbf ft) 2,2 kgf m. Remove the centralising tool.
- 3 Fit the water pump, operation 21A-02.
- 4 Fit the crankshaft pulley, operation 14A-01.
- 5 Where necessary, fit the fan drive pulley, operation 21A-05.
- 6 Fit the drive belts, operation 23A-03 and adjust the belt tension, operation 23A-02.
- 7 Fit the fan, operation 21A-04.
- 8 Fill the cooling system.



## Front oil seal

To remove and to fit

15A-02

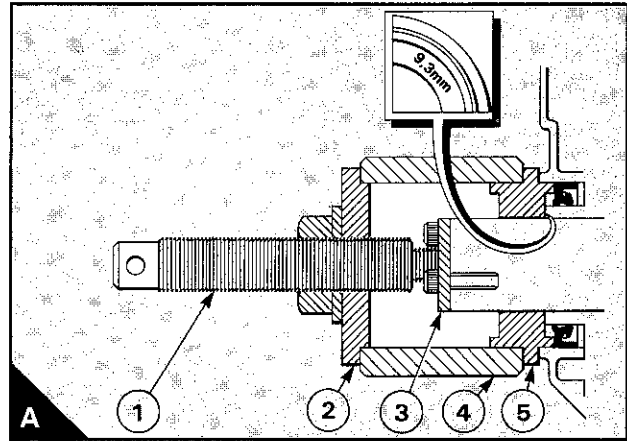
### To remove

- 1 Remove the fan operation 21A-04 and the drive belts operation 23A-03.
- 2 Remove the crankshaft pulley, operation 14A-01.
- 3 Remove the oil seal with a suitable lever behind the main lip of the oil seal. Do not damage the edge of the oil seal housing.

### To fit

#### Special tools:

- Replacer tool for front oil seal (main tool), PD170
- Pressure plate for use with PD.170, PD170-1
- Fastener plate for use with PD.170, PD170-2
- Sleeve for use with PD.170, PD170-3
- Seal adaptor for use with PD.170, PD170-4



The oil seal is fitted to a depth of 6,75/7,25 mm (0.266/0.285 in) from the front face of the oil seal housing to the flat front face of the oil seal. If, in service, there is wear in the seal location area of the crankshaft pulley, the oil seal can be fitted to a depth of 9,3 mm (0.366 in).

- 1 Clean the oil seal housing. Inspect the new seal for damage. If a scratch can be seen across the lip of the seal, do not fit the seal.
- 2 Lubricate the outer circumference of the oil seal with clean engine lubricating oil and enter the seal into the housing. Ensure that the spring loaded lip of the oil seal is towards the inside of the timing case cover and that the oil seal is square to the bore of the seal housing.
- 3 Assemble the oil seal replacing tool (A). Fasten PD.170-2 (A3) to the front of the crankshaft. Hold PD.170-4 (A5) against the seal with the side stamped 9,3 mm towards the seal, put PD.170-3 (A4) and PD170-1 (A2) in position and fasten PD.170 (A1) to the stud of PD.170-2. Fit a rod through the hole in the end of the tool so that the tool will not turn. Turn the nut with a suitable spanner and the oil seal will be pushed into the housing. Push the seal in to the correct depth. If the seal is to be pushed in to the service position, turn the nut until the face of PD170-4 is against the face of the oil seal housing.
- 4 Remove the replacing tool and lightly lubricate the seal location area of the crankshaft pulley with clean engine lubricating oil. Fit the crankshaft pulley, operation 14A-01.
- 5 Fit the drive belts, operation 23A-03 and adjust the belt tension, operation 23A-02.
- 6 Fit the fan, operation 21A-04.

## Idler gear and hub

To remove and to fit

15A-03

### To remove

- 1 Remove the fan, operation 21A-04.
- 2 Remove the drive belts, operation 23A-03.
- 3 Remove the crankshaft pulley, operation 14A-01.
- 4 If necessary, remove the fan drive pulley, operation 21A-05.
- 5 Drain the coolant and remove the water pump, operation 21A-02.
- 6 Remove the timing case cover, operation 15A-01.
- 7 Turn the crankshaft until the marked teeth of the crankshaft gear, the camshaft gear and the fuel pump gear are all in mesh with the idler gear. The marked teeth of the idler gear will not necessarily be in mesh with the marked teeth of the other gears because of the different speed of rotation of the idler gear.
- 8 Release the three setscrews, remove the plate of the idler gear and remove the gear. The drive gear of the fuel injection pump may turn counter-clockwise when the idler gear is removed.
- 9 Remove the idler hub.

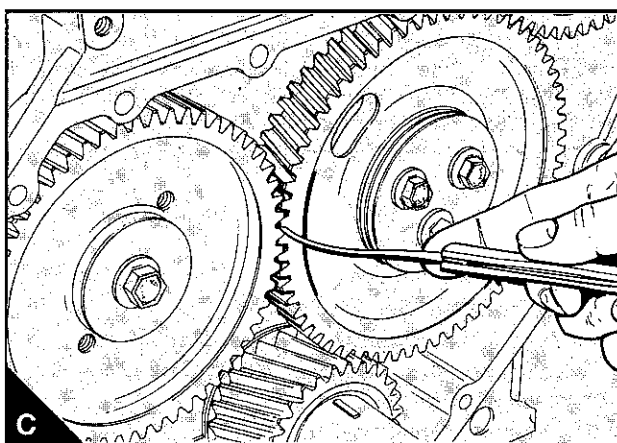
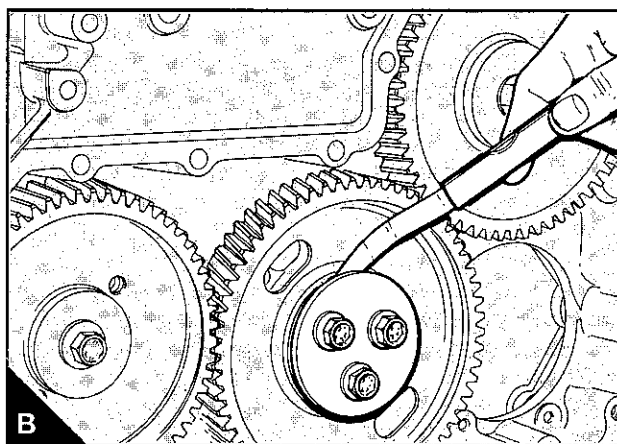
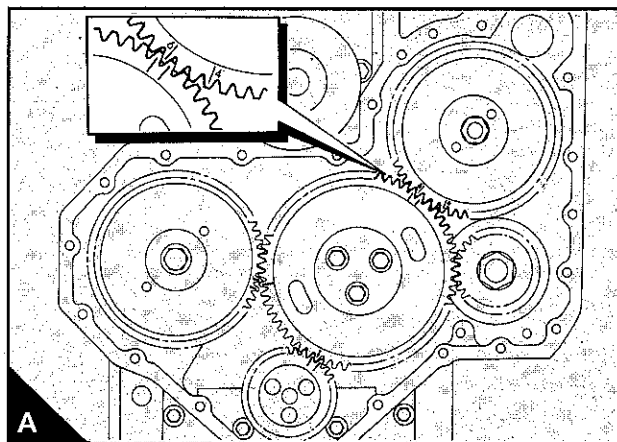
**Attention:** Do not turn the crankshaft with the idler gear removed.

10 Inspect the gear and the bushes for wear and other damage and renew as necessary. The gear and bushes are available as an assembly or separate bushes are available.

11 If the bushes are to be changed, remove them with a suitable puller. If a puller is not available, machine off the face of one of the bushes and press them out. Press in new bushes, machine the bores to get the correct clearance on the hub and machine the faces to get the correct end clearance, see section 11C.

### To fit

- 1 Use the three idler gear setscrews to ensure the correct position of the idler gear hub with the lubrication hole at the top. Push the hub into position and remove the setscrews.
- 2 Lubricate the idler gear bushes with clean engine lubricating oil. Align the timing marks on the idler gear with the marks on the crankshaft and camshaft gears. If necessary, turn the gear of the fuel injection pump clockwise to align the relevant timing mark with the marks on the idler gear and slide the idler gear into position. Check that all the timing marks are in correct mesh (A). Fit the plate and the setscrews to the idler gear hub and tighten the setscrews to 44 Nm (33 lbf ft) 4,5 kgf m.
- 3 Check the idler gear end-float (B) and the timing gear backlash (C).
- 4 Fit the timing case cover, operation 15A-01.
- 5 Fit the water pump, operation 21A-02.
- 6 Fit the crankshaft pulley, operation 14A-01.
- 7 Where necessary, fit the fan drive pulley, operation 21A-05.
- 8 Fit the drive belts, operation 23A-03 and adjust the belt tension, operation 23A-02.
- 9 Fit the fan, operation 21A-04.
- 10 Fill the cooling system.



## Fuel pump gear

To remove and to fit

15A-04

### To remove

Special tools:

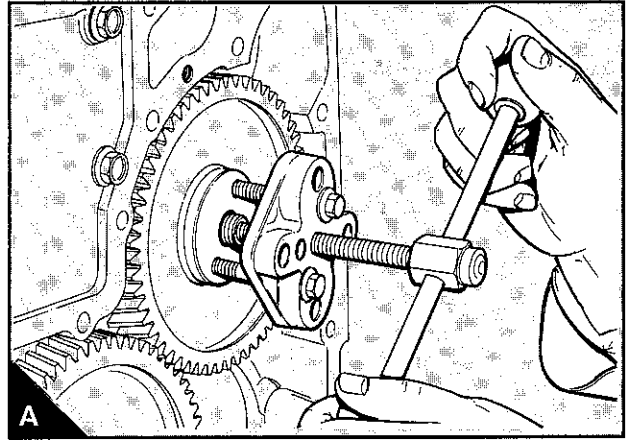
Gear puller, PD.155B

Adaptors for use with PD.155B, PD.155B-5

- 1 Remove the fan, operation 21A-04.
- 2 Remove the drive belts, operation 23A-03.
- 3 Remove the crankshaft pulley, operation 14A-01.
- 4 If necessary, remove the fan drive pulley, operation 21A-05.
- 5 Drain the coolant and remove the water pump, operation 21A-02.
- 6 Remove the timing case cover, operation 15A-01.
- 7 Turn the crankshaft until the marked teeth of the crankshaft gear, the camshaft gear and the fuel pump gear are all in mesh with the idler gear. The marked teeth of the idler gear will not necessarily be in mesh with the marked teeth of the other gears because of the different speed of rotation of the idler gear.
- 8 Remove the nut and the spring washer from the fuel pump gear.
- 9 Remove the idler gear, operation 15A-03.
- 10 Remove the fuel pump gear with the puller and the adaptors (A). Ensure that the key in the fuel pump shaft is not lost.
- 11 Inspect the gear for wear and other damage and renew it, if necessary.

### To fit

- 1 Ensure that the key is fitted correctly in the fuel pump shaft. Fit the gear and the spring washer and loosely fit the nut.
- 2 Turn the fuel pump gear to ensure that the relevant marked tooth of the fuel pump gear ("4" for four cylinder engines or "6" for six cylinder engines) will align with the marked teeth of the idler gear (15A.05/A). Fit the idler gear, operation 15A-03.
- 3 Tighten the nut of the fuel pump gear to 80 Nm (59 lbf ft) 8,2 kgf m.
- 4 If a new gear has been fitted, check the backlash.
- 5 Fit the timing case cover, operation 15A-01.
- 6 Fit the water pump, operation 21A-02.
- 7 Fit the crankshaft pulley, operation 14A-01.
- 8 If necessary, fit the fan drive pulley, operation 21A-05.
- 9 Fit the drive belts, operation 23A-03 and adjust the belt tension, operation 23A-02.
- 10 Fit the fan, operation 21A-04.
- 11 Fill the cooling system.



## Camshaft gear

To remove and to fit

15A-05

### To remove

Special tools:

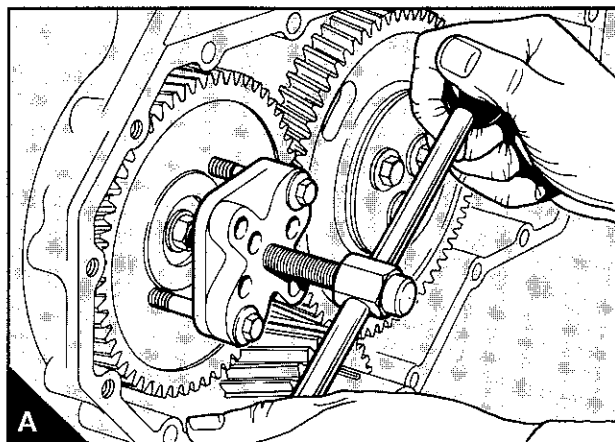
Gear puller, PD.155B

Adaptors for use with PD.155B, PD.155B-5

- 1 Remove the fan, operation 21A-04.
- 2 Remove the drive belts 23A-03.
- 3 Remove the crankshaft pulley, operation 14A-01.
- 4 If necessary, remove the fan drive pulley, operation 21A-05.
- 5 Drain the coolant and remove the water pump, operation 21A-02.
- 6 Remove the timing case cover, operation 15A-01.
- 7 Turn the crankshaft until the marked teeth of the crankshaft gear, the camshaft gear and the fuel pump gear are all in mesh with the idler gear. The marked teeth of the idler gear will not necessarily be in mesh with the marked teeth of the other gears because of the different speed of rotation of the idler gear.
- 8 Remove the setscrew and washer of the camshaft gear and remove the gear with the puller and adaptor (A). Ensure that the key in the camshaft is not lost.
- 9 Inspect the gear for wear and any other damage and renew it, if necessary.

### To fit

- 1 Ensure that the key in the camshaft is fitted correctly.
- 2 Remove the idler gear, operation 15A-03.
- 3 Fit the camshaft gear to the camshaft with the marked teeth towards the front and the keyway correctly aligned with the key. If necessary, lightly hit the gear with a soft face hammer to engage the key into the keyway.
- 4 Fit the idler gear with the marked teeth in correct mesh, operation 15A-03. If the camshaft has to be turned and a valve hits a piston, disengage the rocker assembly.
- 5 Fit the washer and the setscrew for the camshaft gear and tighten the setscrew to press the camshaft gear into position. Tighten the setscrew to 78 Nm (58 lbf ft) 8,0 kgf m. If a new camshaft gear has been fitted, check the backlash.
- 6 Fit the timing case cover, operation 15A-01.
- 7 Fit the water pump, operation 21A-02.
- 8 Fit the crankshaft pulley, operation 14A-01.
- 9 Where necessary, fit the fan drive pulley, operation 21A-05.
- 10 Fit the drive belts, operation 23A-03 and adjust the belt tension, operation 23A-02.
- 11 Fit the fan, operation 21A-04.
- 12 Fill the cooling system.



## Crankshaft gear

To remove and to fit

15A-06

### To remove

- 1 Remove the fan, operation 21A-04.
- 2 Remove the drive belts, operation 23A-03.
- 3 Remove the crankshaft pulley, operation 14-01.
- 4 If necessary, remove the fan drive pulley, operation 21A-05.
- 5 Drain the coolant and remove the water pump, operation 21A-02.
- 6 Remove the timing case cover, operation 15A-01.
- 7 Turn the crankshaft until the marked teeth of the crankshaft gear, the camshaft gear and the fuel pump gear are all in mesh with the idler gear. The marked teeth of the idler gear will not necessarily be in mesh with the marked teeth of the other gears because of the different speed of rotation of the idler gear.
- 8 Remove the idler gear, operation 15A-03.
- 9 The crankshaft gear is a transition fit on the crankshaft. It may slide off easily or, if it is a tight fit and the gear is to be renewed, it may be necessary to remove the crankshaft, operation 14A-08, to remove the gear safely.

### To fit

- 1 The gear can fit easily, or it may be necessary to heat the gear before it will fit onto the crankshaft. If the gear is to be heated, heat it in an oven to not more than 180°C (226°F). If an oven is not available, heat it in water which is at its boiling point. Do not use a flame as this can cause local damage. Fit the gear with the timing marks to the front.
- 2 Fit the idler gear, operation 15A-03 and ensure that all the timing marks are correctly aligned.
- 3 Fit the timing case cover, operation 15A-01
- 4 Fit the water pump, operation 21A-02.
- 5 Fit the crankshaft pulley, operation 14A-01.
- 6 Where necessary, fit the fan drive pulley, operation 21A-05.
- 7 Fit the drive belts, operation 23A-03 and adjust the belt tension, operation 23A-02.
- 8 Fit the fan, operation 21A-04.
- 9 Fill the cooling system.



## Timing case

To remove and to fit

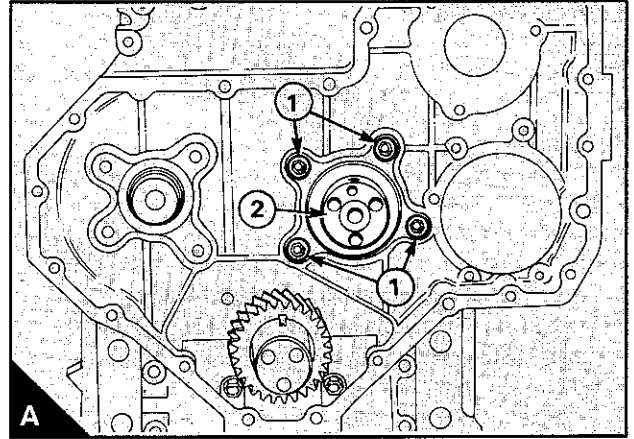
15A-07

### To remove

- 1 Remove the fan, operation 21A-04.
- 2 Remove the drive belts, operation 23A-03.
- 3 Remove the crankshaft pulley, operation 14A-01.
- 4 If necessary, remove the fan drive assembly, operation 21A-05.
- 5 Drain the coolant and remove the water pump, operation 21A-02.
- 6 Remove the alternator together with its mounting bracket and front support plate.
- 7 Remove the compressor and drive assembly, operation 24A-01, if fitted.
- 8 Remove the timing case cover, operation 15A-01.
- 9 Turn the crankshaft until the marked teeth of the crankshaft gear, the camshaft gear and the fuel pump gear are all in mesh with the idler gear. The marked teeth of the idler gear will not necessarily be in mesh with the marked teeth of the other gears because of the different speed of rotation of the idler gear.
- 10 Remove the fuel injection pump, operation 20A-06.
- 11 Remove the idler gear, operation 15A-03 and the camshaft gear, operation 15A-05.
- 12 Remove the setscrews which hold the timing case to the cylinder block and the setscrews which hold the sump to the bottom of the timing case.
- 13 Remove the timing case and the joint, do not allow the idler gear hub to fall. Ensure that the camshaft thrust washer is not lost.

### To fit

- 1 Ensure that the sump joint is not damaged. If the joint is damaged, remove the sump and fit it with a new joint after the timing case has been fitted. The front section of the joint can be cut away and a front section of a new joint fitted, without the removal of the sump, but extreme care must be used to prevent possible leaks.
- 2 If the sump has been removed, fit the idler gear hub to the front of the cylinder block; use the three setscrews of the idler gear to hold the hub in position. Ensure that the oil hole is at the top.
- 3 Ensure that the thrust washer for the camshaft is in position.
- 4 Fit a new joint for the timing case to the cylinder block. Cut the bottom ends of the joint to fit correctly. Apply a suitable jointing compound to the bottom ends of the joint.
- 5 Put the timing case in position. If the sump has not been removed, fit the idler gear hub, see paragraph 2. Fit the four setscrews (A1) around the idler gear hub (A2) and tighten them. Put the fan drive assembly and/or the alternator and its front support plate in position and fit and tighten the remainder of the setscrews of the timing case. If the front support plate has been separated from the alternator bracket, ensure that the right side of the plate is level with the machined face on the cylinder block where the alternator bracket is fitted. If a new timing case is fitted, remove the two studs from the timing case and clean the threads which fit into the timing case. Seal the threads with a suitable sealant and fit the studs into the new timing case. Remove the setscrews from the idler gear hub.
- 6 If necessary, fit the lubricating oil sump, operation 19A-03, and fill it to the correct level with an approved oil.
- 7 Fit the camshaft gear, operation 15A-05 and the idler gear, operation 15A-03. Ensure that all the timing marks are correctly aligned.



- 8 If a new timing case has been fitted, put a timing mark for the fuel injection pump on the rear face of the timing case, operation 17A-05 or 17B-05. Fit the fuel injection pump and the drive gear, operation 20A-06. Eliminate air from the fuel system, operation 20A-08.
- 9 Fit the compressor and its drive assembly, operation 24A-01.
- 10 Fit the timing case cover, operation 15A-01
- 11 Fit the water pump, operation 21A-02.
- 12 Fit the crankshaft pulley, operation 14A-01.
- 13 Where necessary, fit the fan drive pulley, operation 21A-05.
- 14 Fit the alternator, operation 23A-04 and the alternator front bracket.
- 15 Fit the drive belts, operation 23A-03 and adjust the belt tension, operation 23A-02.
- 16 Fit the fan, operation 21A-04.
- 17 Fill the cooling system.

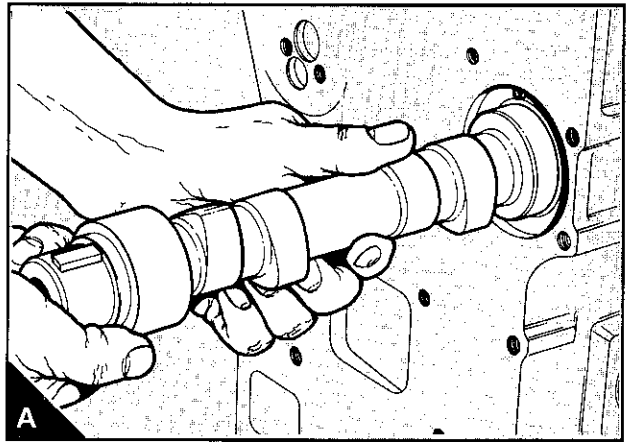
## Camshaft and tappets

To remove and to fit

15A-08

### To remove

- 1 Before the engine is removed from the vehicle or the machine, drain the lubricating oil and the coolant.
- 2 Remove the fan, operation 21A-04.
- 3 Remove the drive belts, operation 23A-03.
- 4 Remove the crankshaft pulley, operation 14A-01.
- 5 If necessary, remove the fan drive assembly, operation 21A-05.
- 6 Drain the coolant and remove the water pump, operation 21A-02.
- 7 Remove the alternator together with its mounting bracket and front support plate.
- 8 Remove the compressor and its drive assembly or remove the exhauster, see section 24.
- 9 Remove the timing case cover, operation 15A-01.
- 10 Remove the timing gears, operations 15A-03, 15A-04 and 15A-05.
- 11 Remove the fuel injection pump, operation 20A-06.
- 12 Remove the timing case, operation 15A-07.
- 13 Remove the rocker cover, the rocker assembly and the push rods, see section 12.
- 14 Remove the fuel lift pump, operation 20A-03.
- 15 Turn the engine upside down and remove the lubricating oil sump, operation 19A-03.
- 16 Remove the camshaft thrust washer (15A.11/A) and carefully remove the camshaft (A).
- 17 Remove the tappets.
- 18 Inspect the camshaft and the tappets for wear and other damage, also inspect the camshaft bush. Renew the components as necessary.



**To fit**

- 1 Ensure that all components are clean and are lubricated with clean engine lubricating oil.
- 2 Fit the tappets in position.
- 3 Carefully fit the camshaft.
- 4 Fit the camshaft thrust washer (A1). Ensure that it is fitted correctly on the hollow dowel (A2).
- 5 Fit the timing case together with a new joint, operation 15A-07.
- 6 Check that the camshaft end-float is within the limits shown in section 11C.
- 7 Turn the camshaft until the cam for the fuel lift pump is at the minimum lift position and fit the fuel lift pump, operation 20A-03.
- 8 Turn the engine to an upright position. Turn the crankshaft until the keyway in the crankshaft is at the top. Fit the timing gears, operations 15A-03, 15A-04 and 15A-05, and ensure that all the timing marks are correctly aligned.
- 9 Fit the fuel injection pump, operation 20A-06.
- 10 Fit the push rods and the rocker assembly, see section 12.
- 11 Set the valve tip clearances, operation 12A-05.
- 12 Fit the timing case cover, operation 15A-01 and the lubricating oil sump, operation 19A-03.
- 13 Fit the water pump, operation 21A-02.
- 14 Fit the crankshaft pulley, operation 14A-01.
- 15 Where necessary, fit the alternator and its mounting brackets and the fan drive pulley, operation 21A-05.
- 16 Fit the drive belts, operation 23A-03, and adjust the belt tension, operation 23A-02.
- 17 Fit the fan, operation 21A-04.
- 18 After the engine has been installed: Fill the cooling system. Fill the lubricating oil sump to the correct level with an approved lubricating oil. Eliminate air from the fuel system, operation 20A-08.

