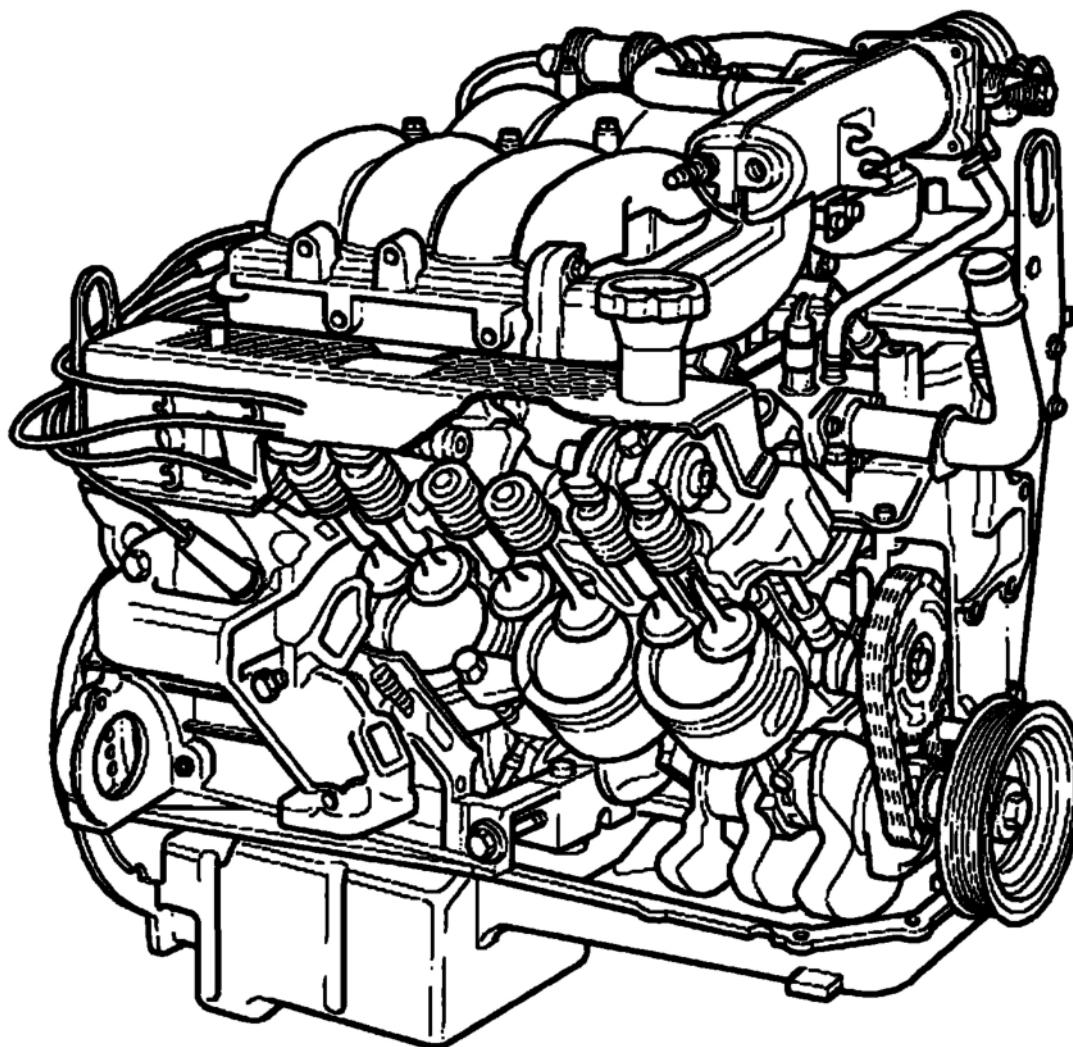


1999-2004 ENGINES**4.0L & 4.6L - Discovery****DESCRIPTION & OPERATION****GENERAL**

The V8 petrol engine is an eight cylinder, water cooled unit having two banks of four cylinders positioned at 90 degrees to each other. The engine comprises five main castings: two cylinder heads, cylinder block, timing cover and the oil sump, all of which are manufactured from aluminum alloy. See **Fig. 1**.

North American Specification (NAS) market vehicles from 2003 model year receive a 4.6L version of the V8 engine to replace the previous 4.0L version.

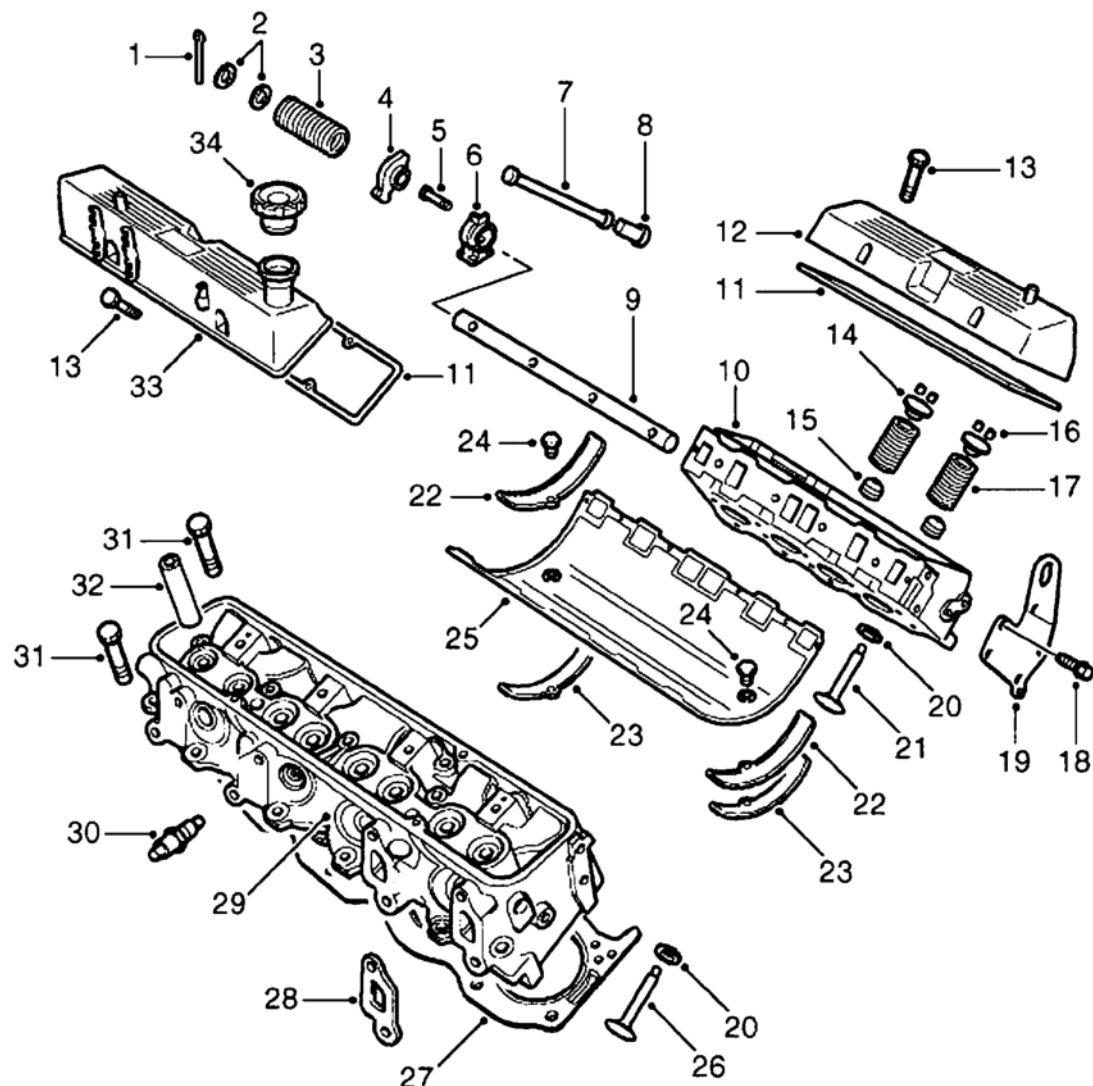


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Fig. 1: Cutaway View Of 4.0L & 4.6L Engine**Courtesy of LAND ROVER NORTH AMERICA, INC.****CYLINDER HEADS**

The cylinder heads are fitted with replaceable valve guides and valve seat inserts with the combustion chambers formed in the head. Each cylinder head is sealed to the cylinder block with a gasket. The exhaust manifolds are bolted to the outside of each cylinder head while the inlet manifolds are located in the center of the VEE and are bolted to the inside face of each head. Inlet and exhaust manifolds are sealed to the cylinder heads by means of gaskets. See **Fig. 2**.

Cylinder head components



- | | | |
|------------------------------|----------------------------------|---------------------------------------|
| 1 Split pin | 12 Rocker cover - left hand | 23 Seal - inlet manifold gasket |
| 2 Washers | 13 Bolt - rocker cover | 24 Bolt - inlet manifold gasket clamp |
| 3 Spring | 14 Valve spring cap | 25 Gasket - inlet manifold |
| 4 Rocker arm | 15 Valve stem oil seals | 26 Inlet valve |
| 5 Pedestal bolt | 16 Collets | 27 Gasket - cylinder head |
| 6 Pedestal | 17 Valve spring | 28 Gasket - exhaust manifold |
| 7 Push rod | 18 Bolt - engine lifting bracket | 29 Cylinder head - right hand |
| 8 Hydraulic tappet | 19 Engine lifting bracket | 30 Spark plug |
| 9 Rocker shaft | 20 Valve seat insert | 31 Bolt - cylinder head |
| 10 Cylinder head - left hand | 21 Exhaust valve | 32 Valve guide |
| 11 Gasket - rocker cover | 22 Clamp - inlet manifold gasket | 33 Rocker cover - right hand |
| | | 34 Engine oil filler cap |

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Fig. 2: Exploded View Of Cylinder Head Components
 Courtesy of LAND ROVER NORTH AMERICA, INC.

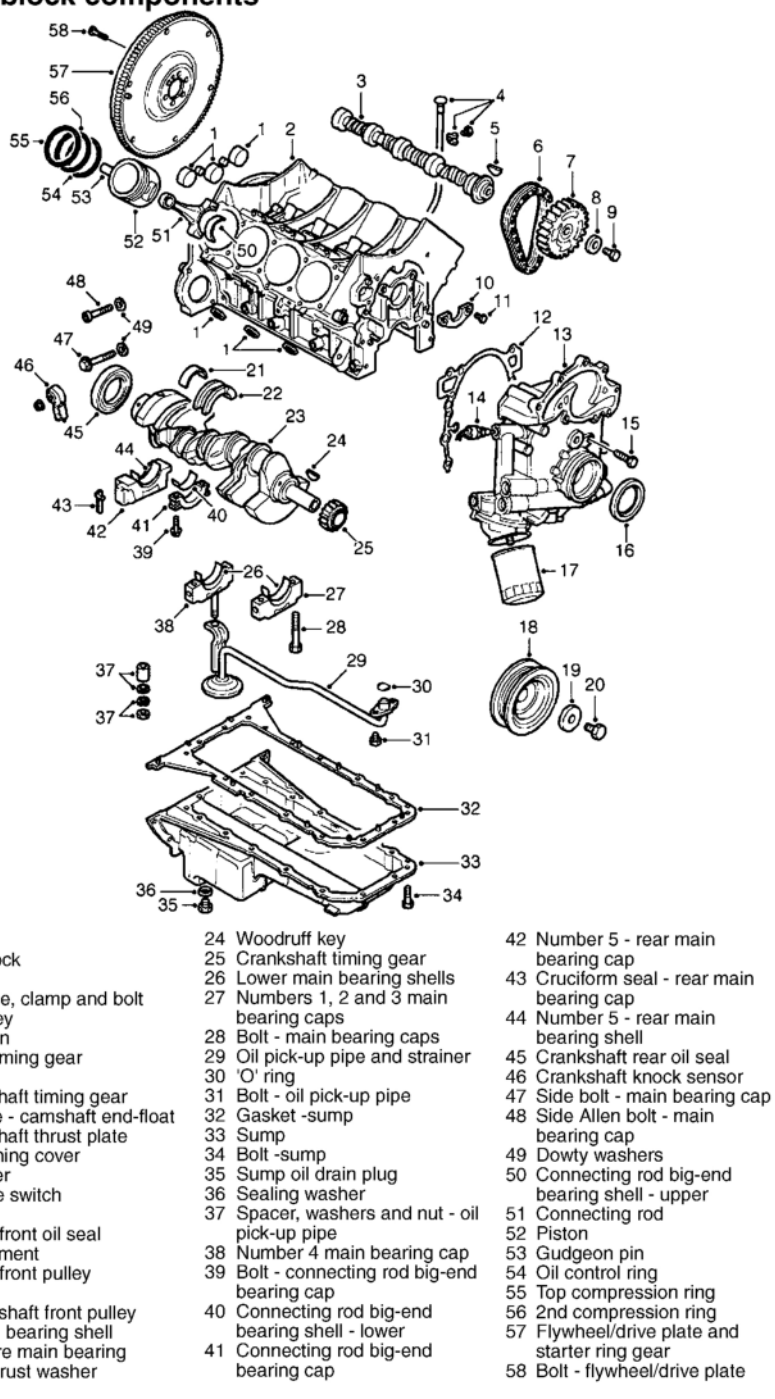
Each cylinder has a single inlet and exhaust valve. The exhaust valves are of the CARBON BREAK type, a recess on the valve stem prevents a build-up of carbon in the valve guide by dislodging particles of carbon as the valve stem moves up and down the guide. Inlet and exhaust valve stem oil seals are fitted at the top of each valve guide. Valve operation is by means of rocker arms, push rods and hydraulic tappets. Each of the rocker arms is located on a rocker shaft which is supported by means of pedestals bolted to the cylinder heads. A spring, positioned on either side of each rocker arm, maintains the correct relative position of the arm to its valve stem. The rocker arms are operated directly by the push rods which pass through drillings in the cylinder heads and cylinder block. The bottom end of each push rod locates in a hydraulic tappet operated by the single, chain driven camshaft.

The rocker covers are bolted to the cylinder heads and are sealed to the heads by a rubber gasket. Stub pipes for crankcase ventilation hose connections are fitted to each rocker cover, the pipe in the right hand cover incorporates an oil separator. The engine oil filler cap is situated in the right hand cover. See **Fig. 2**.

CYLINDER BLOCK & CAMSHAFT

The cylinder block is fitted with cast iron cylinder liners which are shrink fitted and locate on stops in the block. The camshaft is positioned in the center of the cylinder block and runs in one piece bearing shells which are line bored after fitting. Camshaft end-float is controlled by a thrust plate bolted to the front of the cylinder block. A timing gear, chain driven by the crankshaft timing gear is bolted to the front of the camshaft. See **Fig. 3**.

Cylinder block components



- | | | |
|--|---|---|
| 1 Core plugs | 24 Woodruff key | 42 Number 5 - rear main bearing cap |
| 2 Cylinder block | 25 Crankshaft timing gear | 43 Cruciform seal - rear main bearing cap |
| 3 Camshaft | 26 Lower main bearing shells | 44 Number 5 - rear main bearing shell |
| 4 Dipstick tube, clamp and bolt | 27 Numbers 1, 2 and 3 main bearing caps | 45 Crankshaft rear oil seal |
| 5 Woodruff key | 28 Bolt - main bearing caps | 46 Crankshaft knock sensor |
| 6 Timing chain | 29 Oil pick-up pipe and strainer | 47 Side bolt - main bearing cap |
| 7 Camshaft timing gear | 30 'O' ring | 48 Side Allen bolt - main bearing cap |
| 8 Washer | 31 Bolt - oil pick-up pipe | 49 Dowty washers |
| 9 Bolt - camshaft timing gear | 32 Gasket - sump | 50 Connecting rod big-end bearing shell - upper |
| 10 Thrust plate - camshaft end-float | 33 Sump | 51 Connecting rod |
| 11 Bolt - camshaft thrust plate | 34 Bolt - sump | 52 Piston |
| 12 Gasket - timing cover | 35 Sump oil drain plug | 53 Gudgeon pin |
| 13 Timing cover | 36 Sealing washer | 54 Oil control ring |
| 14 Oil pressure switch | 37 Spacer, washers and nut - oil pick-up pipe | 55 Top compression ring |
| 15 Bolt | 38 Number 4 main bearing cap | 56 2nd compression ring |
| 16 Crankshaft front oil seal | 39 Bolt - connecting rod big-end bearing cap | 57 Flywheel/drive plate and starter ring gear |
| 17 Oil filter element | 40 Connecting rod big-end bearing shell - lower | 58 Bolt - flywheel/drive plate |
| 18 Crankshaft front pulley | 41 Connecting rod big-end bearing cap | |
| 19 Washer | | |
| 20 Bolt - crankshaft front pulley | | |
| 21 Upper main bearing shell | | |
| 22 Upper centre main bearing shell and thrust washer | | |
| 23 Crankshaft | | |

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Fig. 3: Exploded View Of Cylinder Block Components
 Courtesy of LAND ROVER NORTH AMERICA, INC.

CRANKSHAFT & MAIN BEARINGS

The crankshaft is carried in five main bearings. The upper main bearing shell locations are an integral part of the cylinder block casting. The lower main bearing caps are bolted to the cylinder block on either side of the upper bearing shell locations with an additional bolt being inserted into each cap from either side of the cylinder block. The rear main bearing cap carries the crankshaft rear oil seal and is sealed to the cylinder block by means of cruciform shaped seals in each side of the cap. Number four main bearing cap carries the stud fixing for the oil pick-up pipe. Lower main bearing shells are plain while the upper shells have an oil feed hole and are grooved. Crankshaft end-float is controlled by the thrust faces of the upper center shell. The crankshaft timing gear is located on the front of the crankshaft by means of a Woodruff key which is also used to drive the gear type oil pump. The flywheel/drive plate carries the crankshaft position sensor reluctor ring and is dowel located and bolted to the flywheel.

TIMING COVER

NOTE: Oil coolers are only fitted to vehicles up to VIN 756821.

The timing cover is bolted to the front of the cylinder block and is sealed to the block with a gasket. The disposable, full flow oil filter canister is screwed on to the timing cover which also carries the oil pressure switch, oil pressure relief valve and crankshaft front oil seal. The gear type oil pump is integral with the cover which also has an internal oilway to direct oil from the oil cooler to the filter.

OIL SUMP

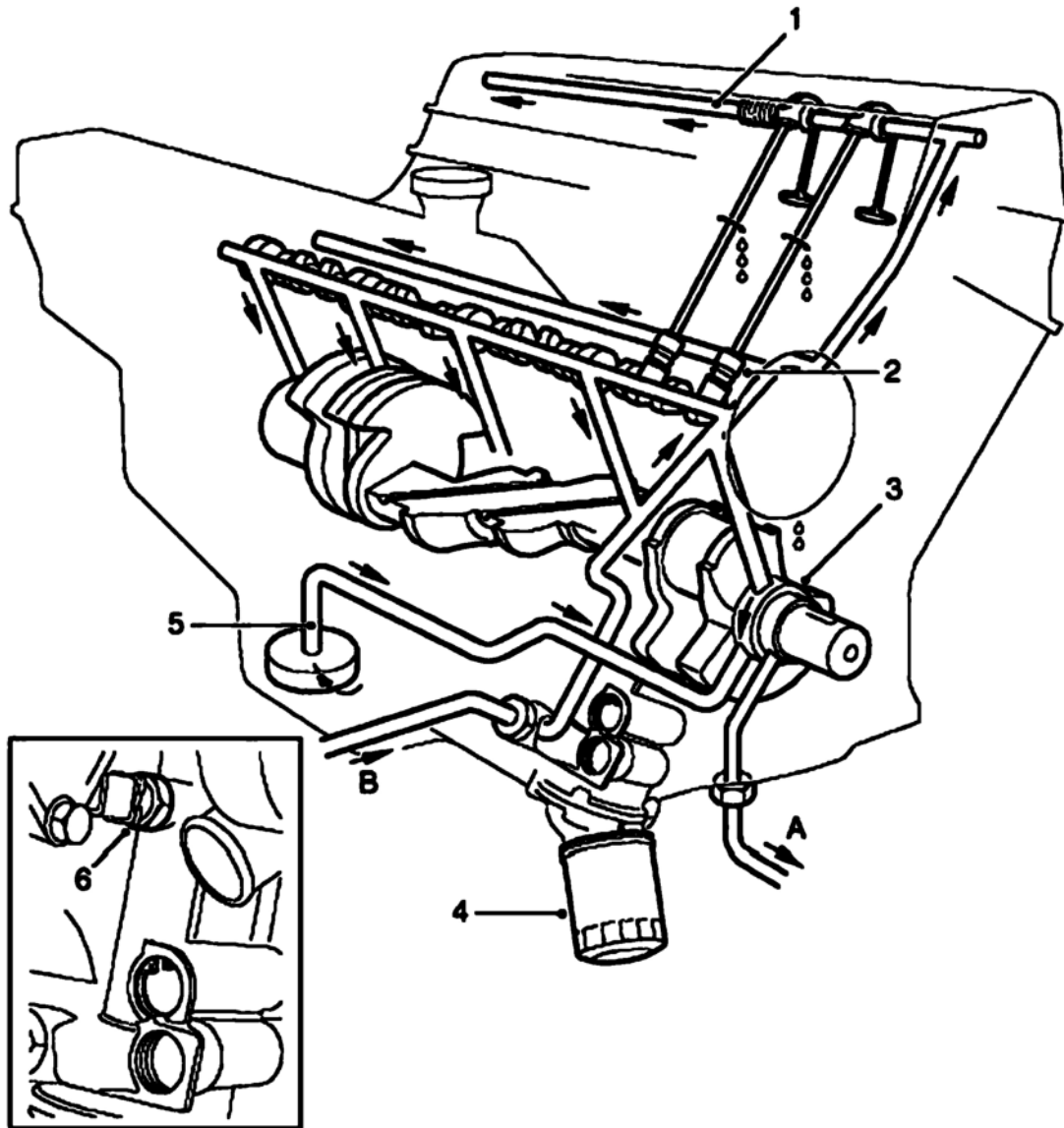
The oil sump is bolted to the bottom of the cylinder block and the timing cover and is sealed to both components with a one piece gasket. A removable baffle to prevent oil surge is fitted in the sump. The oil pick-up pipe and strainer assembly is positioned within the sump and is attached at the pick-up end to a stud screwed into number four main bearing cap and at the delivery end to the oil pump. The oil drain plug is located in the bottom of the sump and is sealed with a washer.

PISTONS & CONNECTING RODS

Each of the aluminum alloy pistons has two compression rings and an oil control ring. The pistons are secured to the connecting rods by semi-floating gudgeon pins. Each gudgeon pin is offset by 0.5 mm (0.02 in). The top of each piston is recessed, the depth of recess determining the compression ratio of the engine. Plain, big-end bearing shells are fitted to each connecting rod and cap.

LUBRICATION

Oil is drawn from the sump through a strainer and into the oil pump via the oil pick-up pipe. Pressurized oil from the pump passes through the oil cooler (if fitted) mounted in front of the radiator and returns to the full flow oil filter element. Oil from the filter passes into the main oil gallery and through internal drillings to the crankshaft where it is directed to each main bearing and to the big-end bearings via numbers 1, 3 and 5 main bearings. An internal drilling in the cylinder block directs oil to the camshaft where it passes through further internal drillings to the hydraulic tappets, camshaft bearing journals and rocker shafts. Lubrication to the pistons, small ends and cylinder bores is by oil grooves machined in the connecting rods and by splash. See **Fig. 4**.



A - To oil cooler, **B** - From oil cooler

NOTE: The oil cooler is only fitted to vehicles up to VIN 756821.

- | | |
|-------------------------|---------------------------------|
| 1 Rocker shaft assembly | 4 Oil filter element |
| 2 Hydraulic tappet | 5 Oil pick-up pipe and strainer |
| 3 Oil pump | 6 Oil pressure switch |

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Fig. 4: Identifying Engine Lubrication Circuit
Courtesy of LAND ROVER NORTH AMERICA, INC.

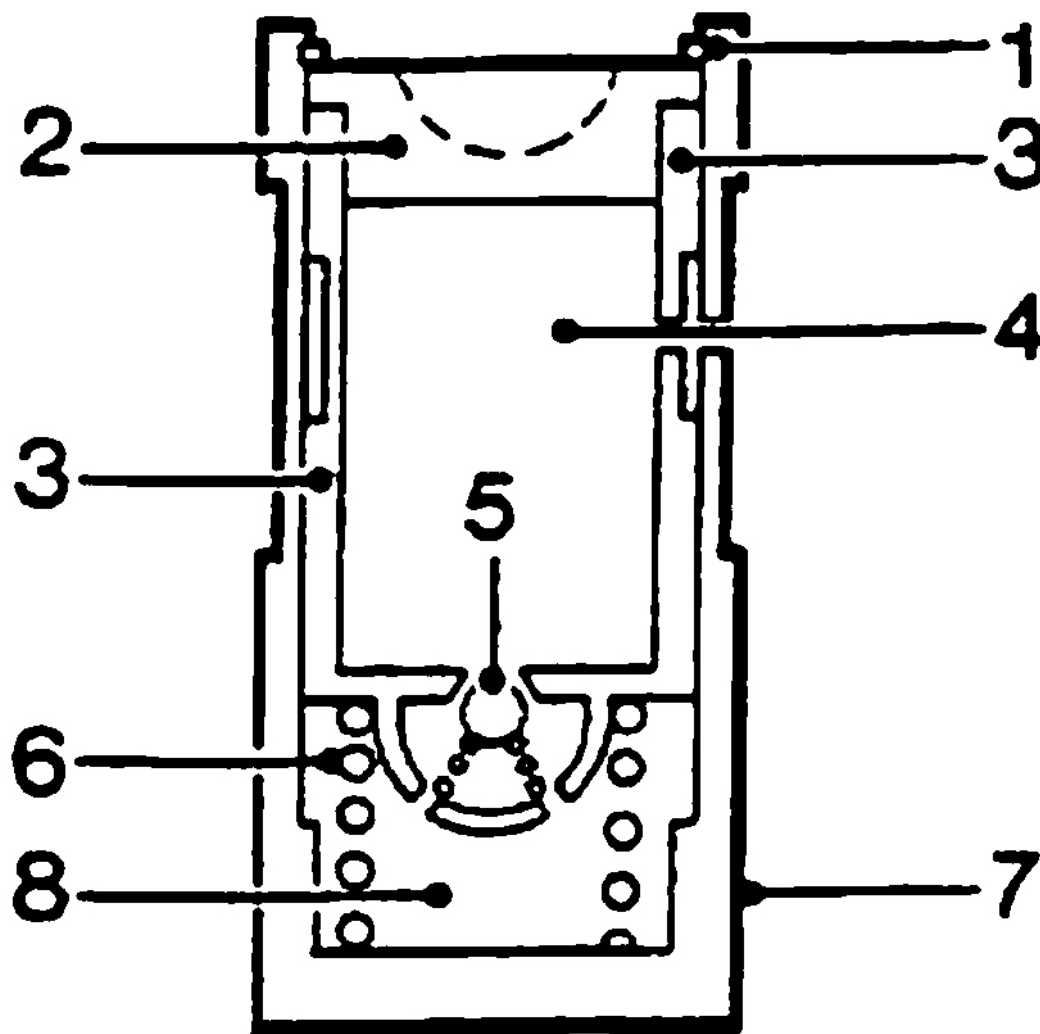
OIL PRESSURE SWITCH

The oil pressure warning light switch registers low oil pressure in the main oil gallery on the outflow side of the filter. While the engine is running and oil pressure is correct, the switch is open. When the ignition is switched on or if oil pressure drops below the pressure setting of the switch, the switch closes and the low oil pressure

warning lamp located in the instrument pack will illuminate.

HYDRAULIC TAPPETS

The hydraulic tappet provides maintenance free, quiet operation of the valves. This is achieved by utilizing engine oil pressure to eliminate the clearance between the rocker arms and valve stems. When the valve is closed, engine oil pressure present in the upper chamber, passes through the non-return ball valve and into the lower chamber. When the cam begins to lift the outer sleeve, the resistance of the valve spring, felt through the push rod and seat, causes the tappet inner sleeve to move downwards inside the outer sleeve. This downwards movement closes the non-return ball valve and increases the pressure in the lower chamber sufficiently to ensure that the valve is fully opened by the push rod. As the tappet moves off the peak of the cam, the non-return ball valve opens thereby allowing the pressure in both chambers to equalize. This ensures that the valve will be fully closed when the tappet is on the back of the cam. See **Fig. 5**.



- | | |
|-----------------|-------------------------|
| 1 Clip | 5 Non-return ball valve |
| 2 Pushrod seat | 6 Spring |
| 3 Inner sleeve | 7 Outer sleeve |
| 4 Upper chamber | 8 Lower chamber |

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Fig. 5: Section View Of Hydraulic Tappet
Courtesy of LAND ROVER NORTH AMERICA, INC.

CRANKCASE VENTILATION

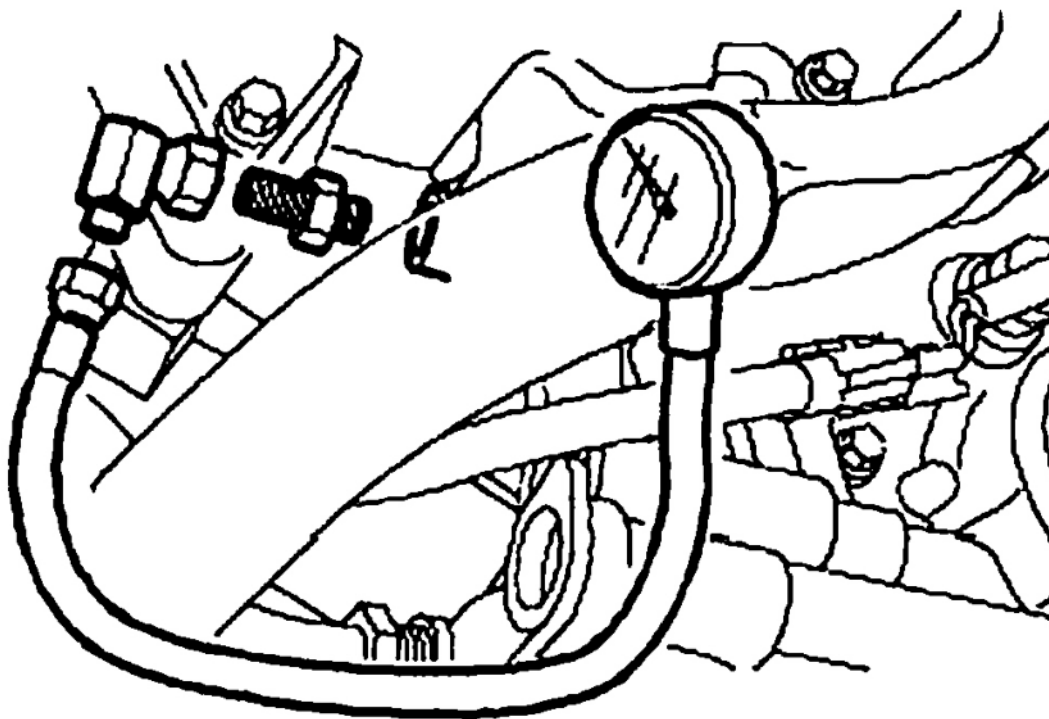
A positive crankcase ventilation system is used to vent crankcase gases to the air induction system. Gases are drawn from the left hand rocker cover to a tapping in the throttle body. An oil separator is incorporated in the hose connection stub pipe in the right hand rocker cover, gases from this connection are drawn to a tapping in the inlet manifold. See **POSITIVE CRANKCASE VENTILATION (PCV)** .

ADJUSTMENTS

ENGINE OIL PRESSURE CHECK

Check

1. Remove oil pressure switch. See **SWITCH - OIL PRESSURE**.
2. Connect pressure check kit LRT-12-052C adaptor and gauge to oil pressure switch position on timing gear cover. See **Fig. 6**.



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Fig. 6: Checking Engine Oil Pressure

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Check and if necessary top up engine oil.
4. Run engine at idle speed and check that oil pressure is within limits given. See **OIL PRESSURE SPECIFICATIONS**.

5. Switch off ignition.
6. Remove pressure check kit LRT-12-052C.
7. Clean oil spillage.
8. Fit oil pressure switch. See **SWITCH - OIL PRESSURE**.

OIL PRESSURE SPECIFICATIONS

Component	Specification
Pressure at idle - minimum	0.7 bar (10 lbf.in2)
Pressure at 2000 rev/min (hot)	3.4 bar (50 lbf.in2)
Relief valve opening pressure	3.4 bar (50 lbf.in2)
Low oil pressure switch opening pressure	0.24-0.41 bar (3.5-6.0 lbf.in2)

Adjust

1. If engine oil pressure is below figures given, check condition of oil pump and/or main and big end bearings.

REPAIRS**SEAL - CRANKSHAFT REAR****Removal**

1. On automatic gearbox models, remove converter drive plate. See **PLATE - DRIVE - AUTOMATIC**.
2. On manual gearbox models, remove flywheel. See **FLYWHEEL**.
3. Carefully remove oil seal from cylinder block to avoid damage to seal location or running surface on crankshaft. Discard seal. See **Fig. 7**.

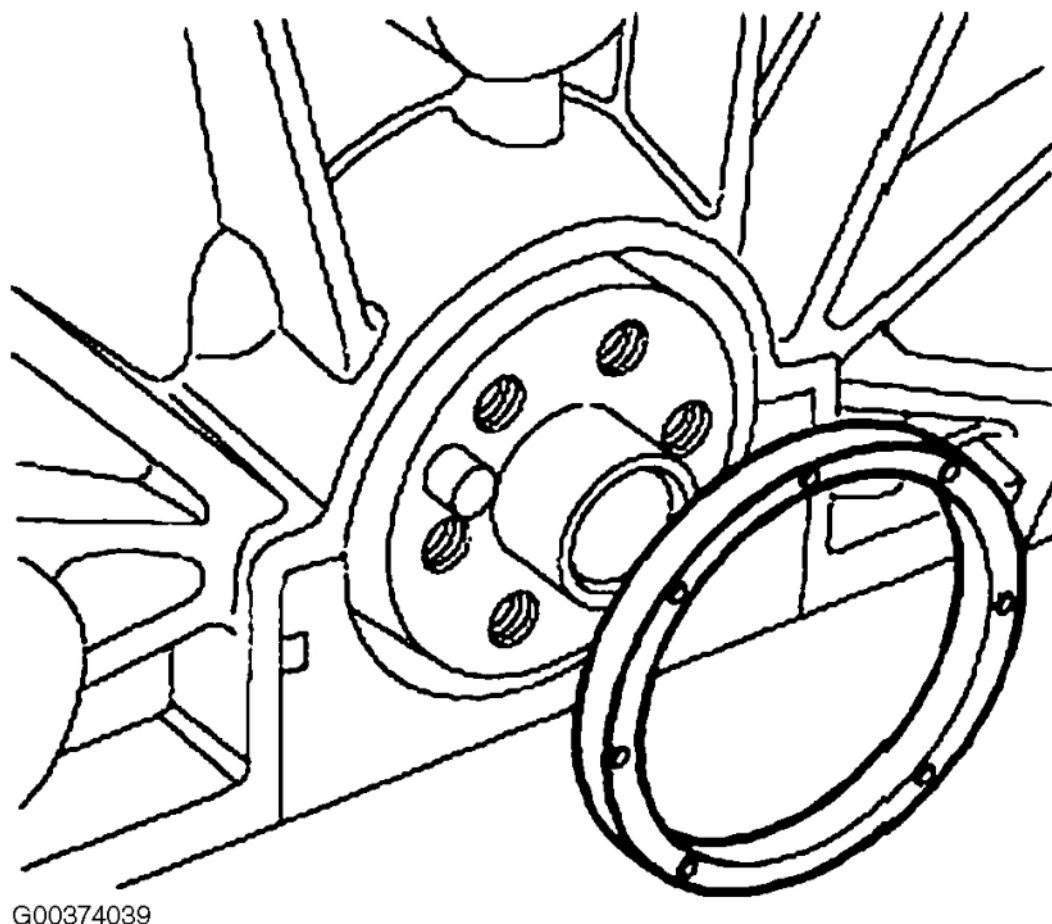
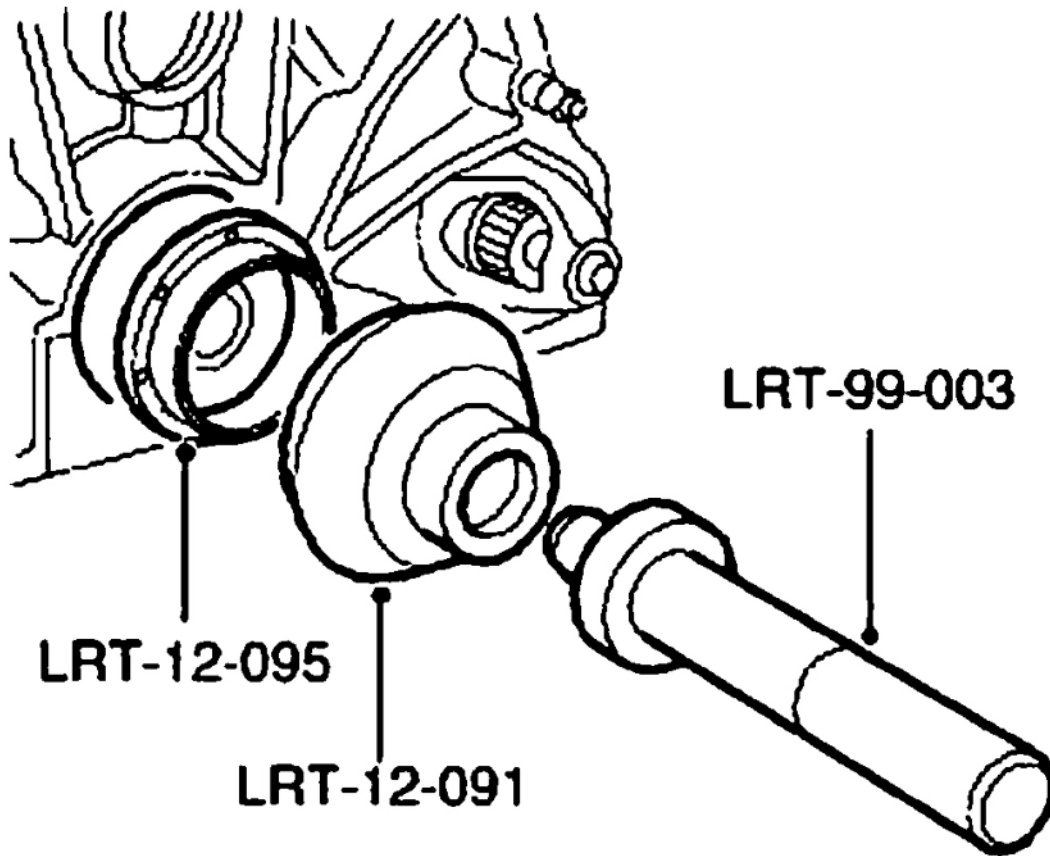


Fig. 7: Removing Rear Crankshaft Seal

Courtesy of LAND ROVER NORTH AMERICA, INC.

Installation

1. Ensure both seal location and running surface on crankshaft are clean.
2. Lubricate replacement oil seal with engine oil.
3. Lubricate seal guide LRT-12-095 with engine oil, fit seal guide to crankshaft.
4. Fit oil seal squarely onto crankshaft and remove seal guide LRT-12-095.
5. Fit seal into location using tools LRT-12-091 and LRT-99-003. See **Fig. 8**.



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Fig. 8: Installing Rear Crankshaft Seal

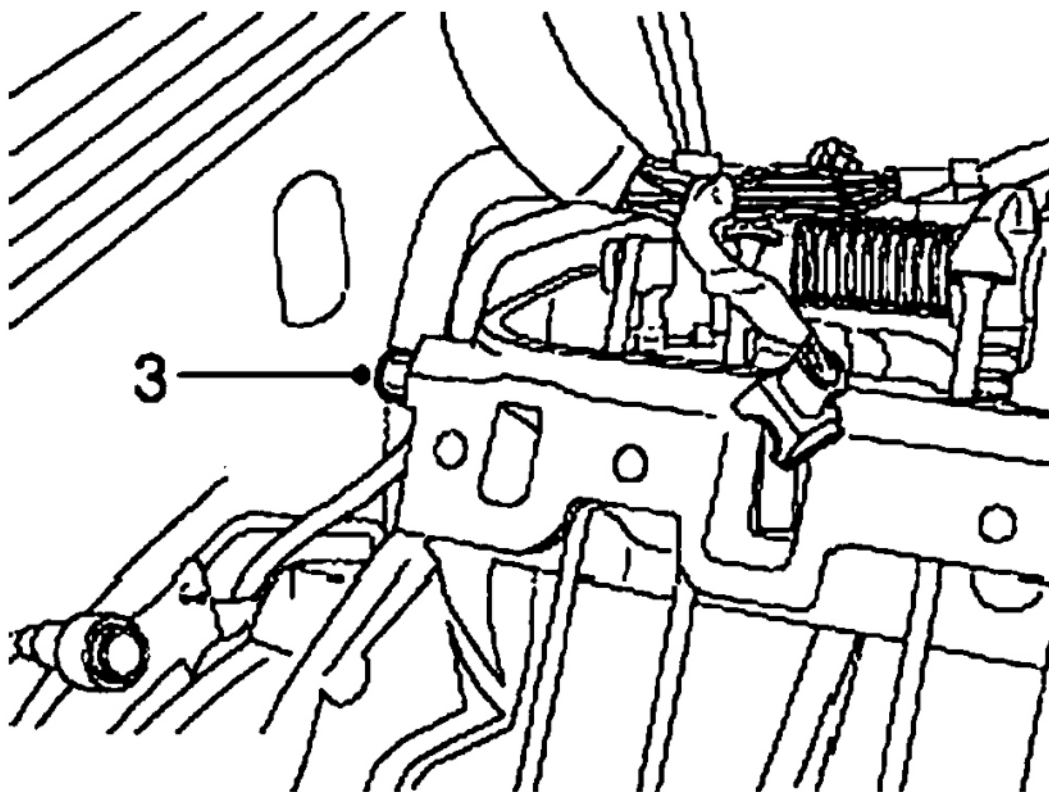
Courtesy of LAND ROVER NORTH AMERICA, INC.

6. On automatic gearbox models, fit converter drive plate. See PLATE - DRIVE - AUTOMATIC.
7. On manual gearbox models, fit flywheel. See FLYWHEEL.

GASKET - CYLINDER HEAD - LEFT

Removal

1. Remove inlet manifold gasket. See GASKET - INLET MANIFOLD.
2. Noting their fitted order, disconnect hot leads from spark plugs.
3. Remove bolt securing engine harness to rear of cylinder head. See Fig. 9.

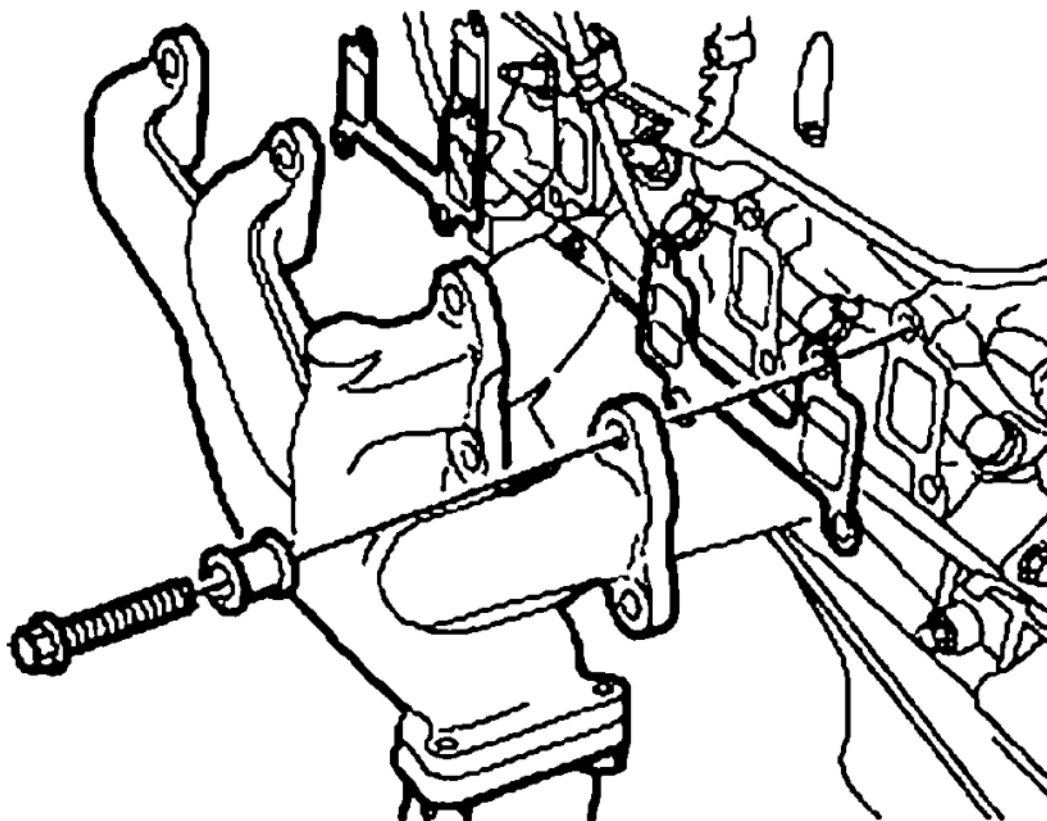


G00374041

Fig. 9: Engine Harness Bolt

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. On left drive models: Remove brake servo heat shield.
5. Remove 8 bolts securing exhaust manifold to cylinder head, release manifold and collect 2 gaskets. See **Fig. 10**.

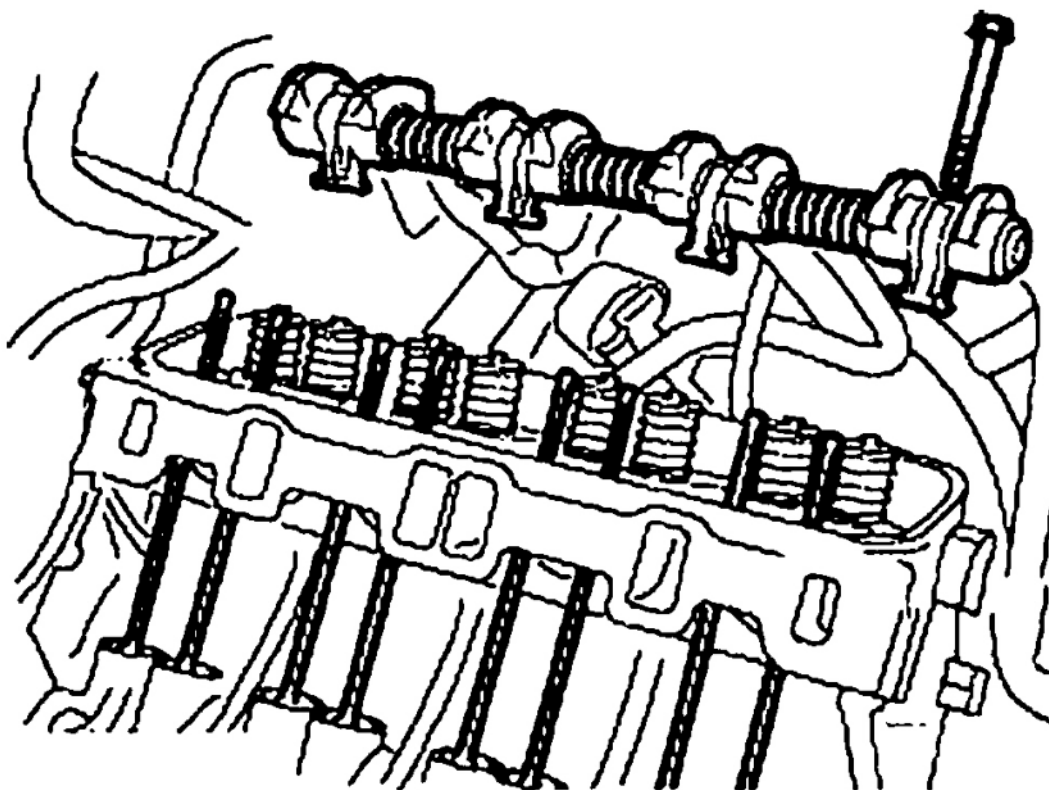


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Fig. 10: Left Exhaust Manifold

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Progressively remove 4 bolts securing the rocker shaft and remove rocker shaft. See **Fig. 11**.



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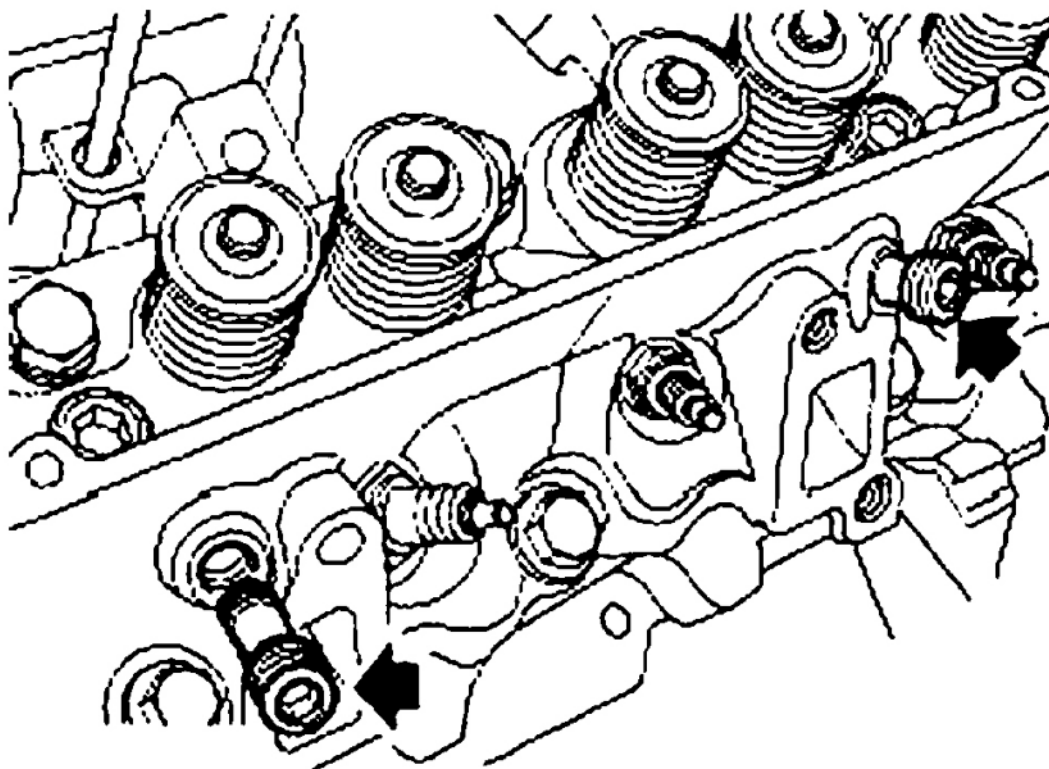
Fig. 11: Left Rocker Shaft Bolts

Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Remove push rods. Store push rods in their fitted order.

CAUTION: DO NOT use air tools to remove adapters.

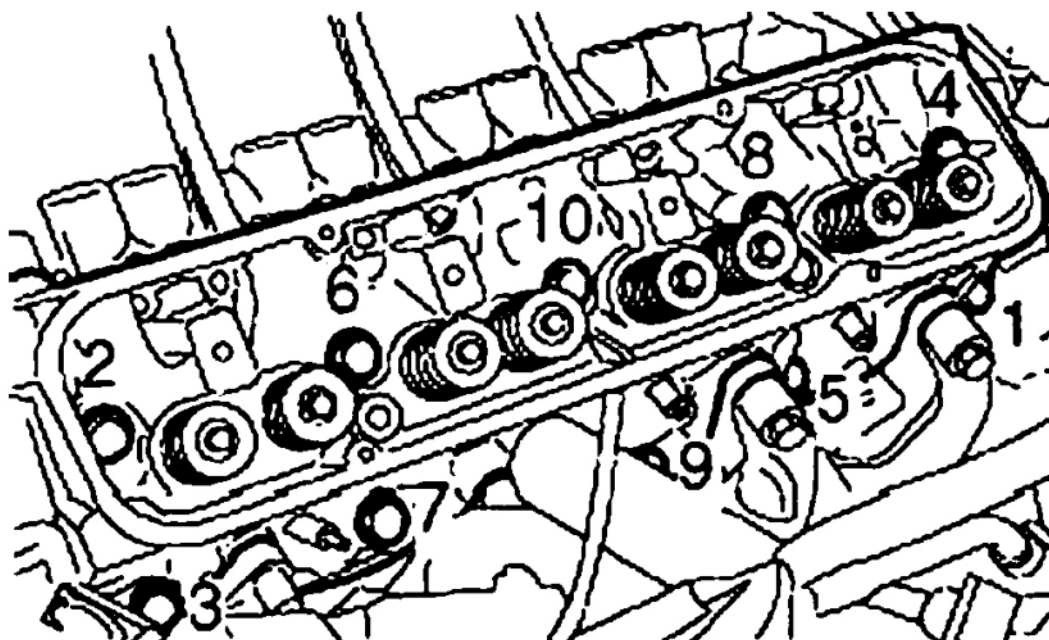
NOTE: To release the adapter thread locking agent and prevent damage to the cylinder head, remove the adapters by alternately loosening then tightening slightly.



G00374044

Fig. 12: Air Injection Adapters At left Cylinder Head (With SAI)**Courtesy of LAND ROVER NORTH AMERICA, INC.**

8. On models with Secondary Air Injection (SAI): Using a 9-mm hexagonal drive bit, remove 2 air injection adapters from cylinder head; discard adapters. Repeat this procedure until adapters are removed. See **Fig. 12**.
9. In the sequence shown, remove 10 bolts securing the cylinder head to block. See **Fig. 13**. Discard the bolts.

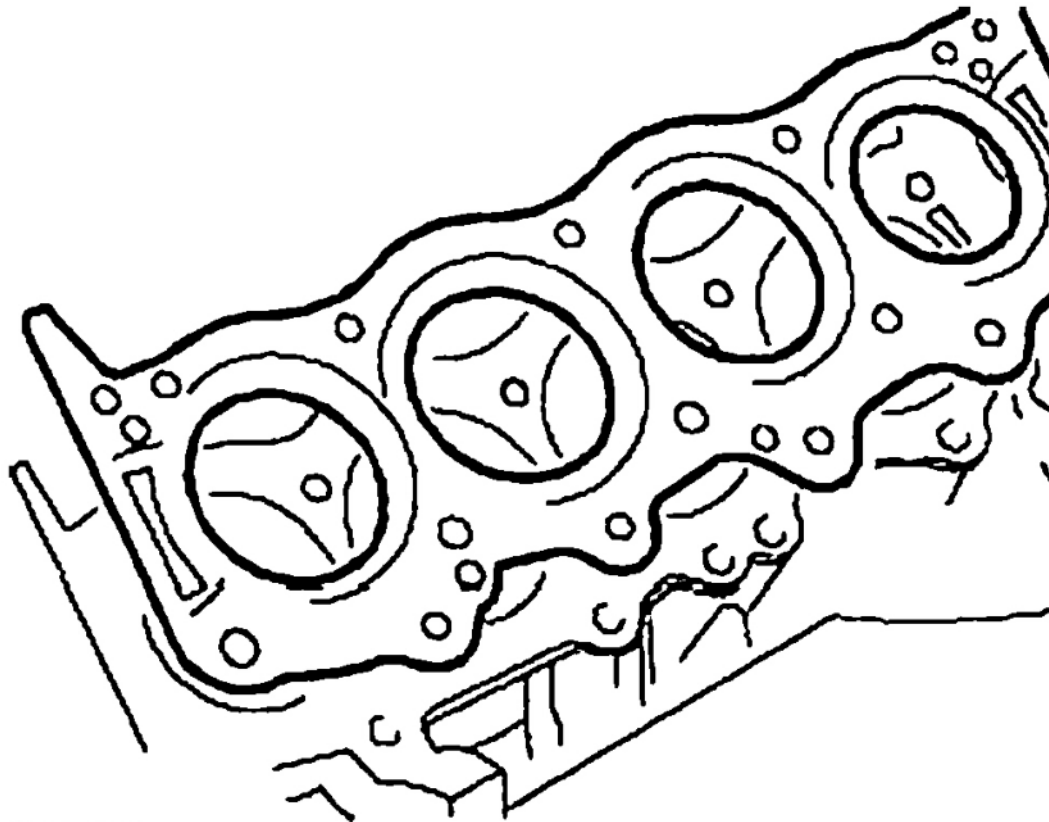


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Fig. 13: Left Cylinder Head Bolt Loosening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Support both ends of cylinder head on blocks of wood.

10. Remove cylinder head.
11. Remove cylinder head gasket. See **Fig. 14**.



G00374046

Fig. 14: Left Cylinder Head Gasket

Courtesy of LAND ROVER NORTH AMERICA, INC.

Installation

CAUTION: DO NOT use a metal scraper or machined surfaces may be damaged.

1. Clean mating faces of cylinder block and head using suitable gasket removal spray and a plastic scraper, ensure that bolt holes in block are clean and dry. Clean mating faces of cylinder head and exhaust manifold.
2. Check head and block faces for warping and pitting. If out of specification, renew head.

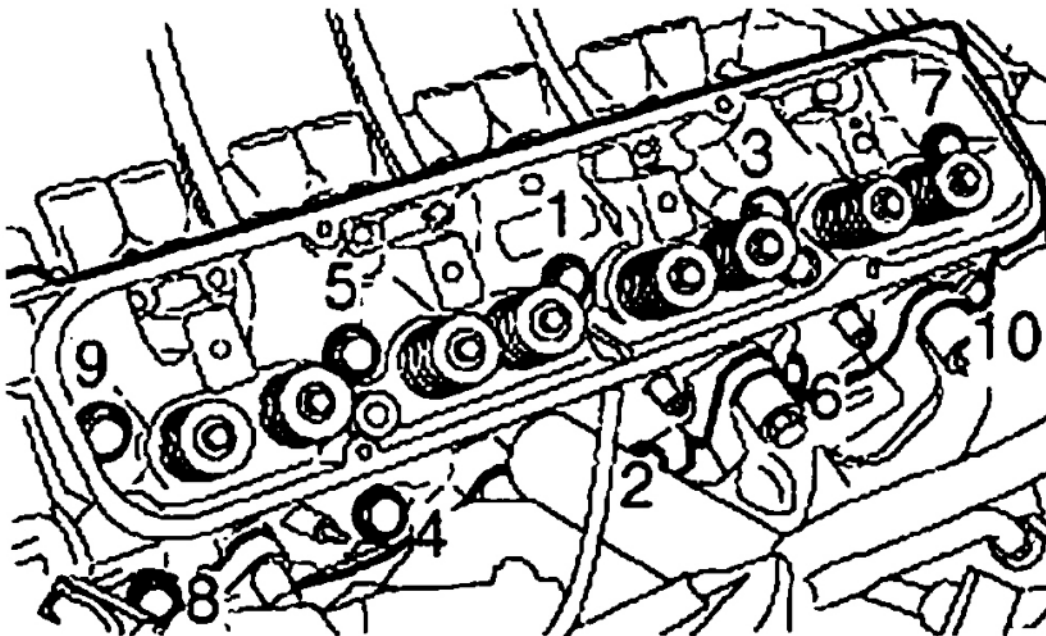
CAUTION: Ensure that tap used has 20 TPI (threads per inch).

3. Models with Secondary Air Injection (SAI): Using a 5/8 in x 20 TPI (threads per inch) UNF tap having a class 2A thread, remove deposits from SAI adapter tappings in cylinder head.

CAUTION: Gaskets must be fitted dry.

4. Fit cylinder head gasket with the word TOP uppermost.
5. Carefully fit cylinder head and locate on dowels.
6. Lightly lubricate NEW cylinder head bolt threads with clean engine oil.

CAUTION: DO NOT tighten bolts 180° in one operation.



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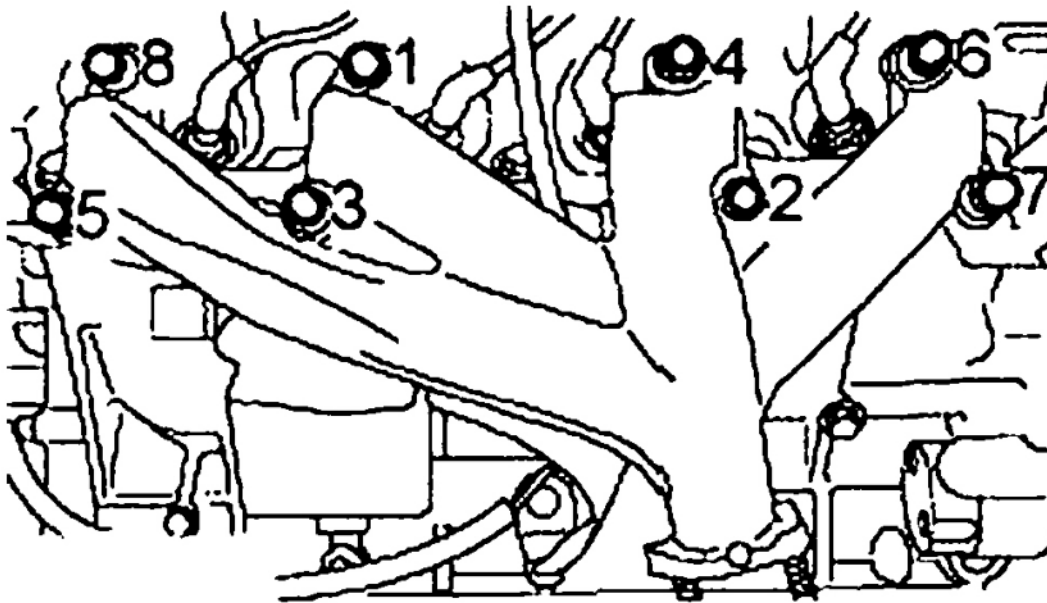
Fig. 15: Cylinder Head Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Noting that bolts 1, 3 and 5 are longer than the remainder, fit cylinder head bolts and tighten in the sequence shown to 20 N.m (15 ft. lbs) then turn through 90°, and finally a further 90°. See **Fig. 15**.

CAUTION: DO NOT use an air tool to tighten adapters.

8. Models with Secondary Air Injection (SAI): Fit NEW air injection adapters and using a 9-mm hexagonal drive bit, tighten to 33 N.m (24 ft. lbs).

9. Clean push rods.
10. Lubricate ends of push rods with clean engine oil.
11. Fit push rods in their removed order.
12. Clean bases of rocker pillars and mating faces on cylinder head.
13. Clean contact surfaces on rockers, valves and push rods.
14. Lubricate contact surfaces and rocker shaft with clean engine oil.
15. Fit rocker shaft assembly and engage push rods.
16. Fit rocker shaft bolts and progressively tighten to 40 N.m (30 ft. lbs).
17. Using NEW gaskets, position exhaust manifold to cylinder head, fit bolts and using sequence shown, tighten initially to 15 N.m (11 ft. lbs), then finally to 36 N.m (28 ft. lbs). See **Fig. 16**.



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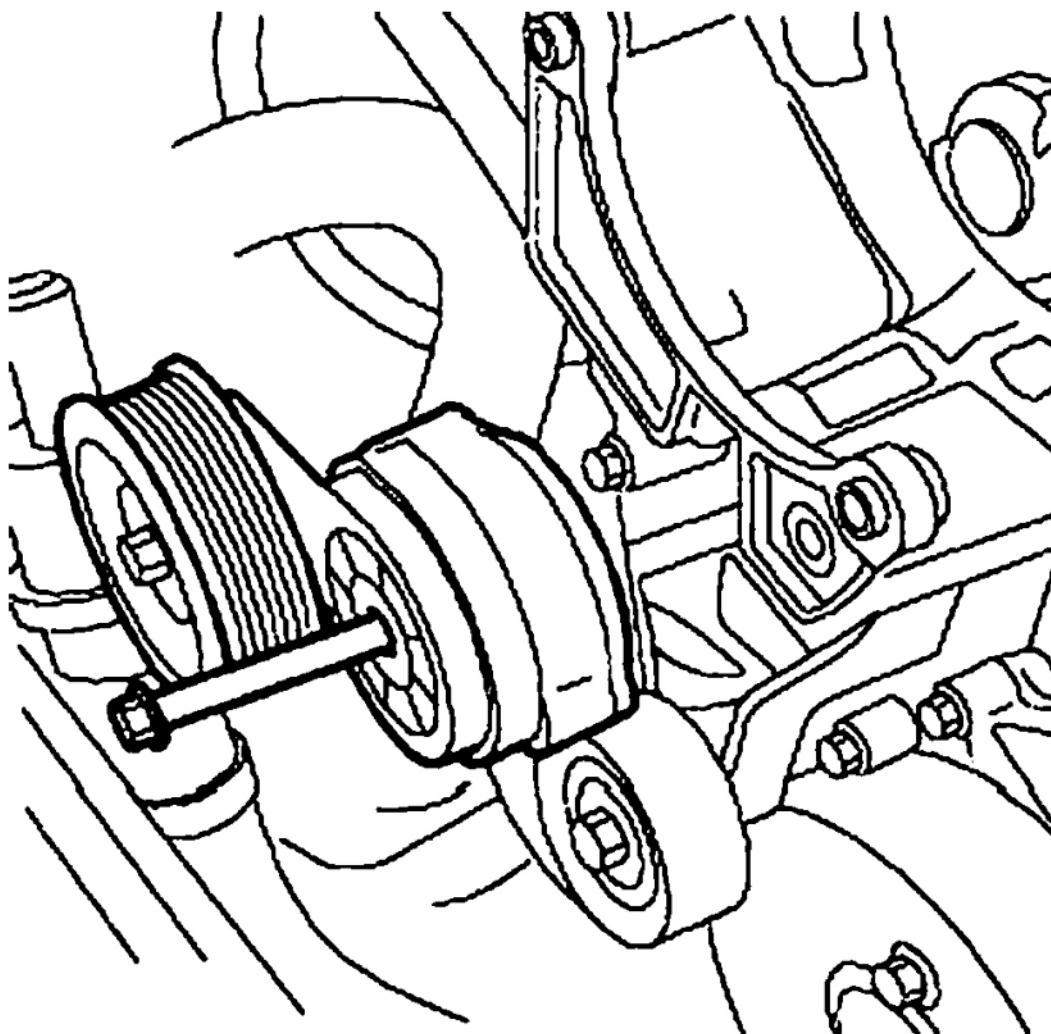
Fig. 16: Exhaust Manifold Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

18. On left drive models: Fit brake servo heat shield.
19. Fit engine harness bolt and tighten to 22 N.m (16 ft. lbs).
20. Connect hot leads to spark plugs in their correct fitted order.
21. Fit inlet manifold gasket. See **GASKET - INLET MANIFOLD** under OVERHAUL.

GASKET - CYLINDER HEAD - RIGHT

Removal

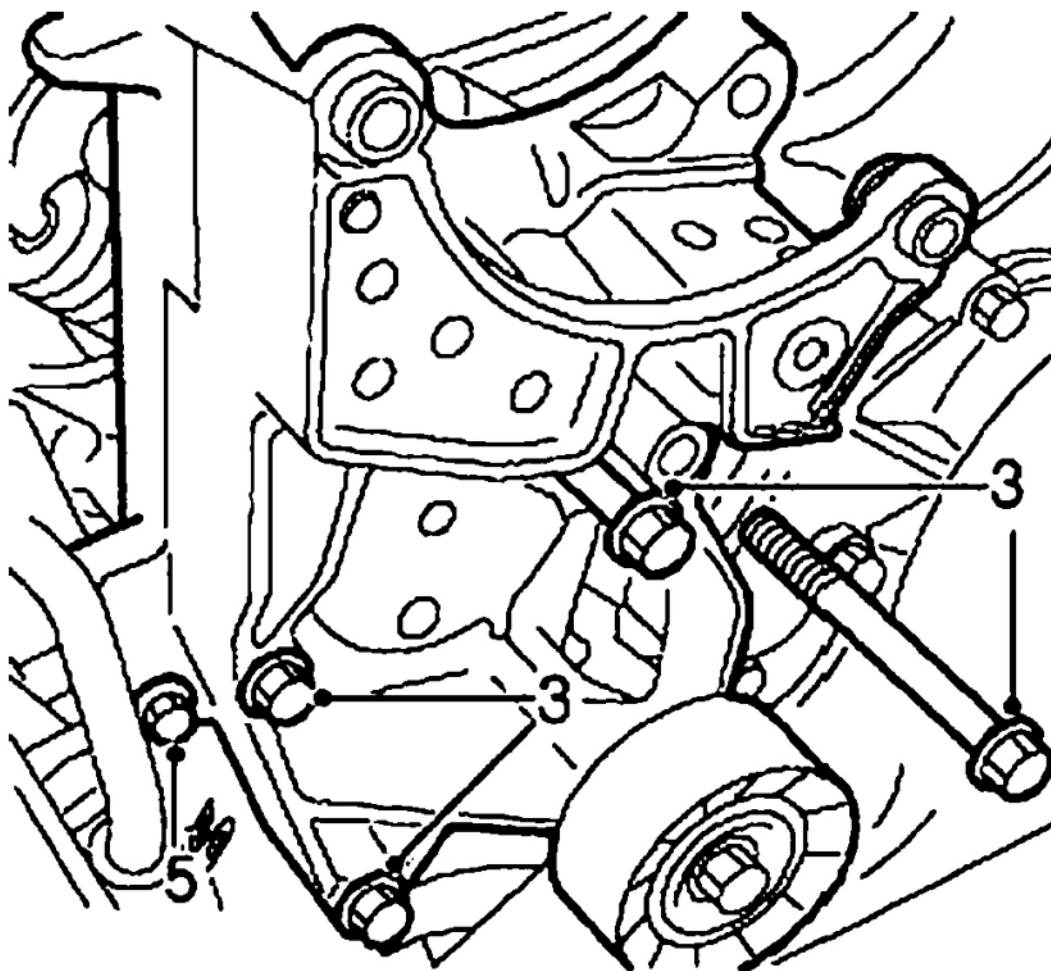
1. Remove inlet manifold gasket. See **GASKET - INLET MANIFOLD** under OVERHAUL.
2. Remove bolt securing auxiliary drive belt tensioner and remove tensioner. See **Fig. 17**.



G00374049

Fig. 17: Auxiliary Drive Belt Tensioner
Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove 4 bolts securing alternator mounting bracket and remove bracket. See **Fig. 18**.

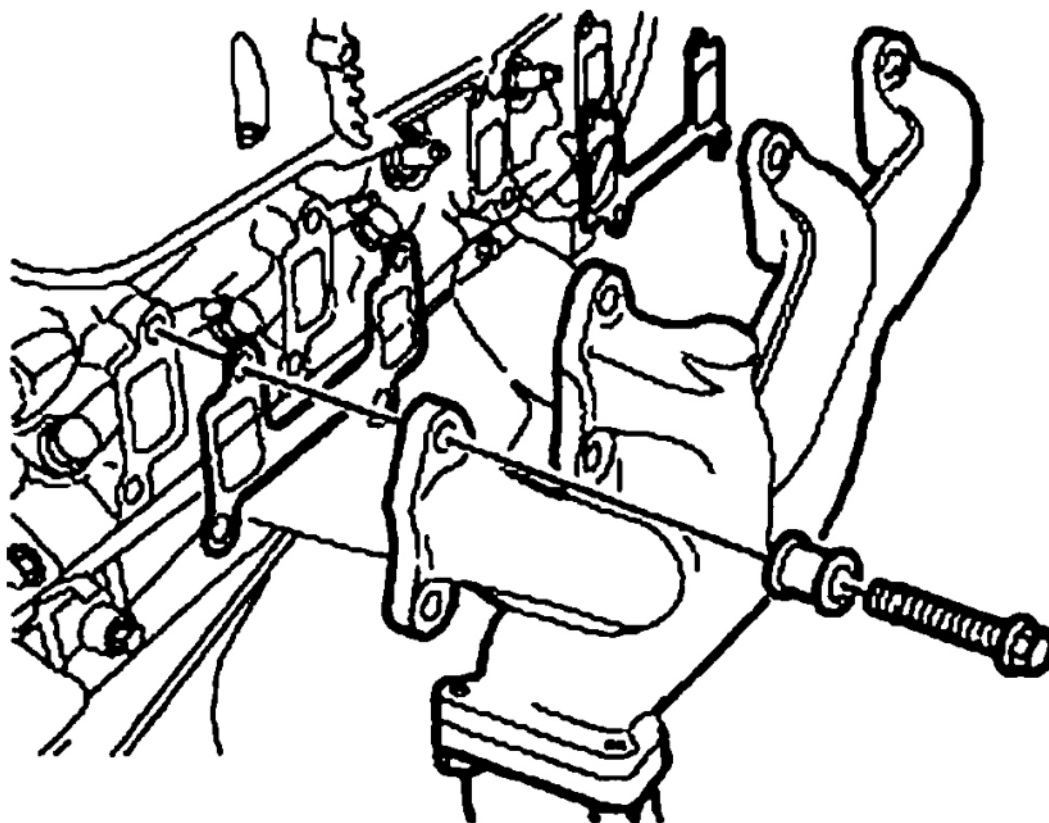


G00374050

Fig. 18: Alternator Mounting Bracket

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Noting their fitted order, disconnect hot leads from spark plugs.
5. Remove bolt securing engine earth lead.
6. On right drive models: Remove brake servo heat shield.
7. Remove 8 bolts securing exhaust manifold to cylinder head, release manifold and collect 2 gaskets. See **Fig. 19**.

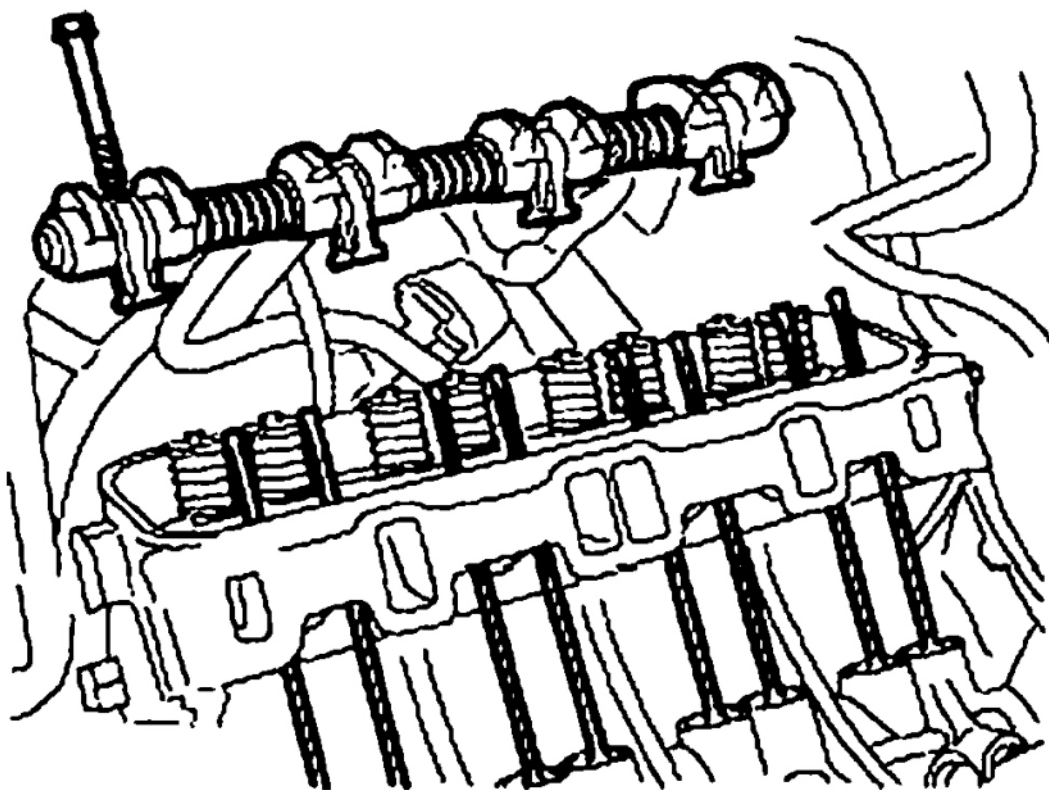


G00374051

Fig. 19: Right Exhaust Manifold

Courtesy of LAND ROVER NORTH AMERICA, INC.

8. Progressively remove 4 bolts securing the rocker shaft and remove rocker shaft. See **Fig. 20**.



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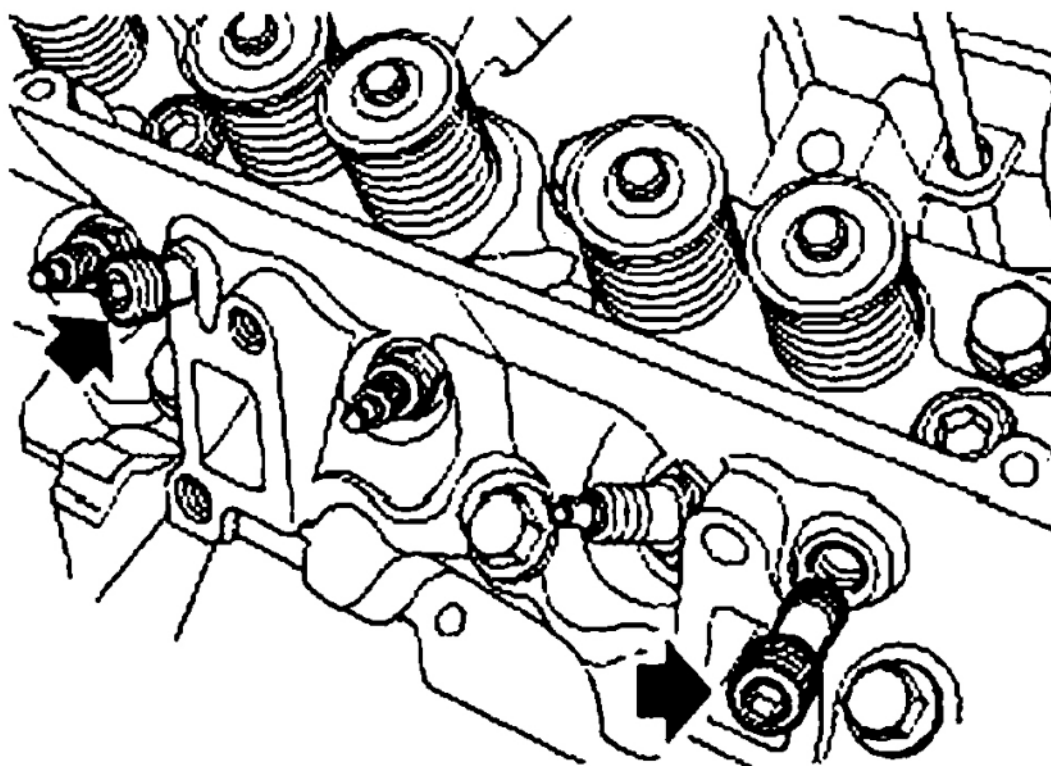
Fig. 20: Right Rocker Shaft Bolts

Courtesy of LAND ROVER NORTH AMERICA, INC.

9. Remove push rods. Store push rods in their fitted order.

CAUTION: DO NOT use air tools to remove adapters.

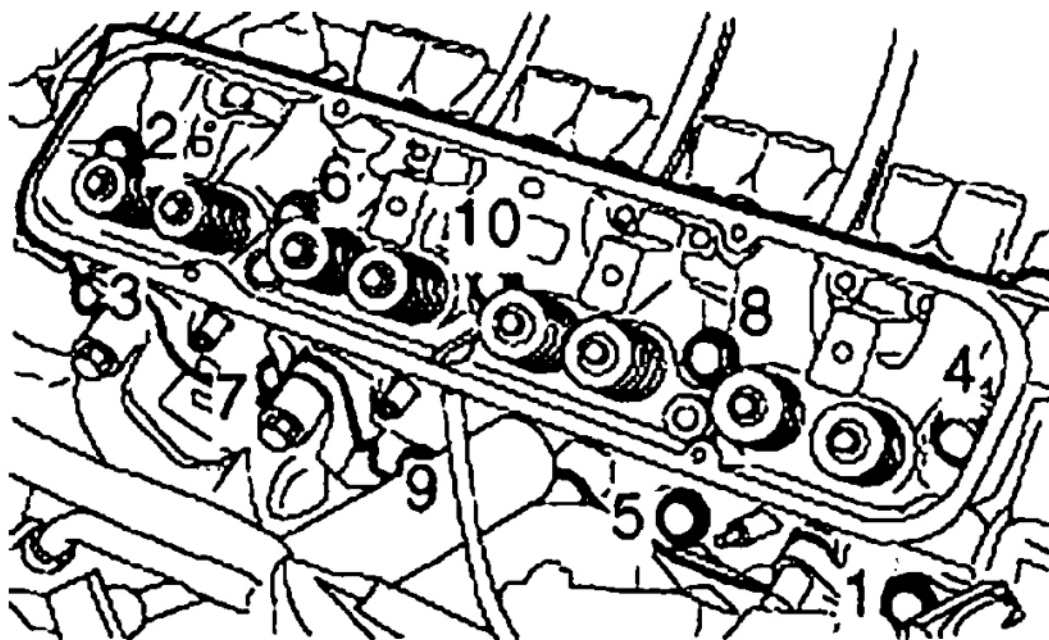
NOTE: To release the adapter thread locking agent and prevent damage to the cylinder head, remove the adapters by alternately loosening then tightening slightly. Repeat this procedure until adapters are removed.



G00374053

Fig. 21: Air Injector Adapters At right Cylinder Head (With SAI)
Courtesy of LAND ROVER NORTH AMERICA, INC.

10. Models with Secondary Air Injection (SAI): Using a 9-mm hexagonal drive bit, remove 2 air injection adapters from cylinder head; discard adapters. See **Fig. 21**.
11. In the sequence shown, remove 10 bolts securing the cylinder head to block. Discard the bolts. See **Fig. 22**.

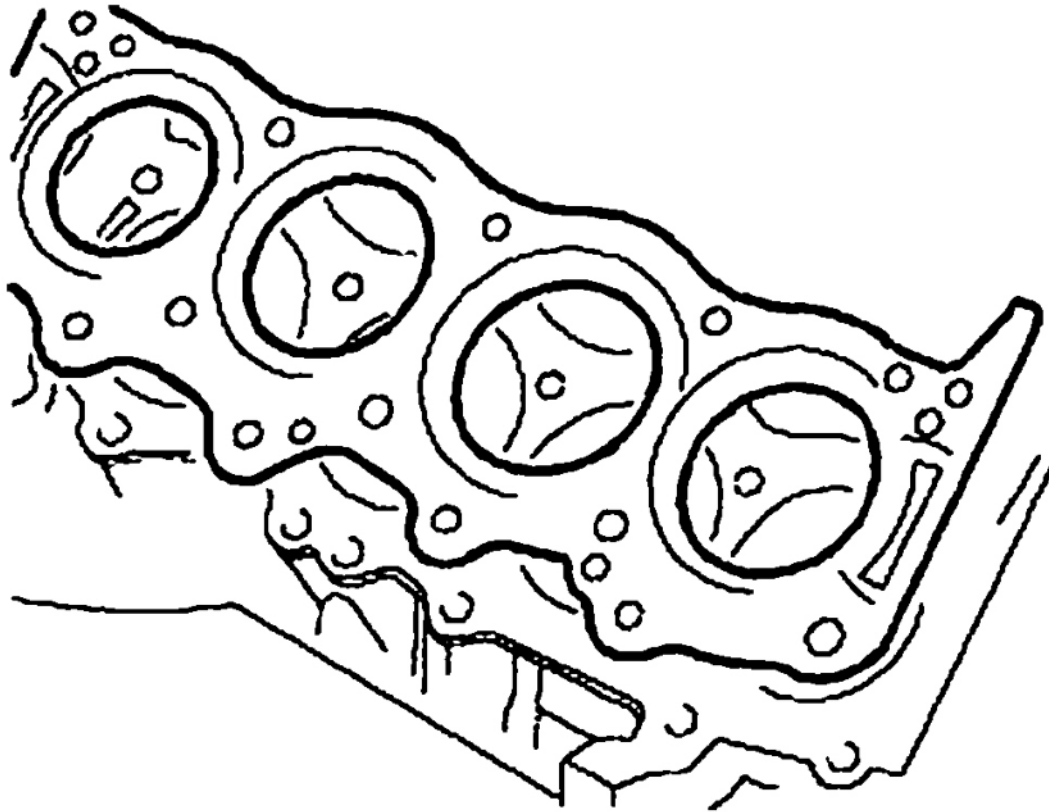


G00374054

Fig. 22: Right Cylinder Head Bolt Removal Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Support both ends of cylinder head on blocks of wood.

12. Remove cylinder head.
13. Remove cylinder head gasket. See **Fig. 23**.



G00374055

Fig. 23: Right Cylinder Head Gasket
Courtesy of LAND ROVER NORTH AMERICA, INC.

Installation

CAUTION: DO NOT use a metal scraper or machined surfaces may be damaged.

1. Clean mating faces of cylinder block and head using suitable gasket removal spray and a plastic scraper, ensure that bolt holes in block are clean and dry. Clean mating faces of cylinder head and exhaust manifold.
2. Check head and block faces for warping and pitting. If out of specification, renew head.

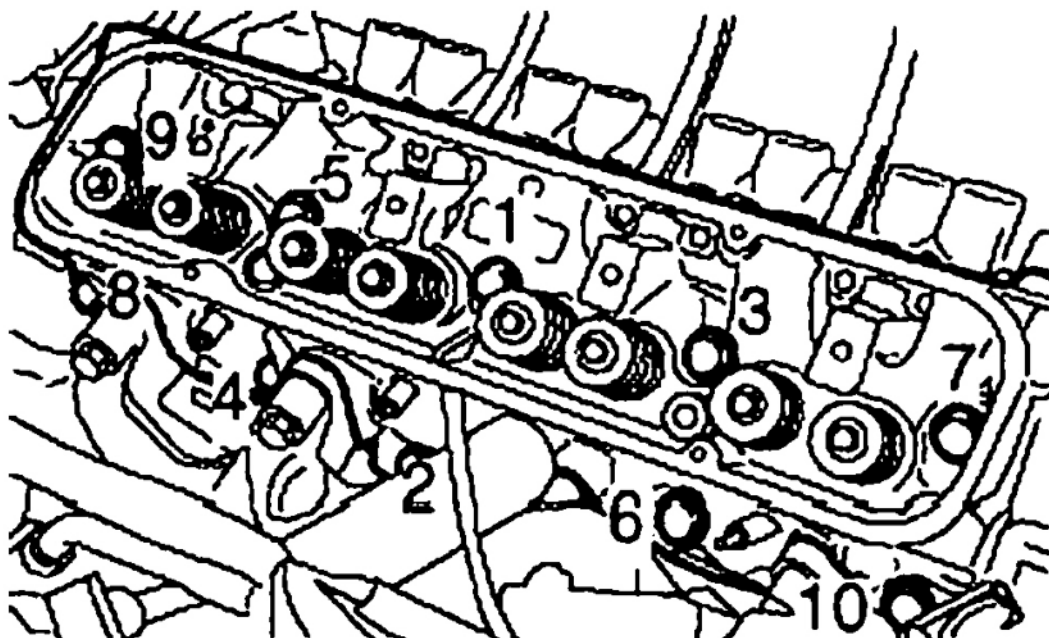
CAUTION: Ensure that tap used has 20 TPI (threads per inch).

3. On models with Secondary Air Injection (SAI): Using a 5/8 in x 20 TPI (threads per inch) UNF tap having a class 2A thread, remove deposits from SAI adapter tappings in cylinder head.

CAUTION: Gasket must be fitted dry.

4. Fit cylinder head gasket with the word TOP uppermost.
5. Carefully fit cylinder head and locate on dowels.
6. Lightly lubricate NEW cylinder head bolt threads with clean engine oil.

CAUTION: DO NOT tighten bolts 180° in one operation.



G00374056

Fig. 24: Cylinder Head Bolt Tightening Sequence

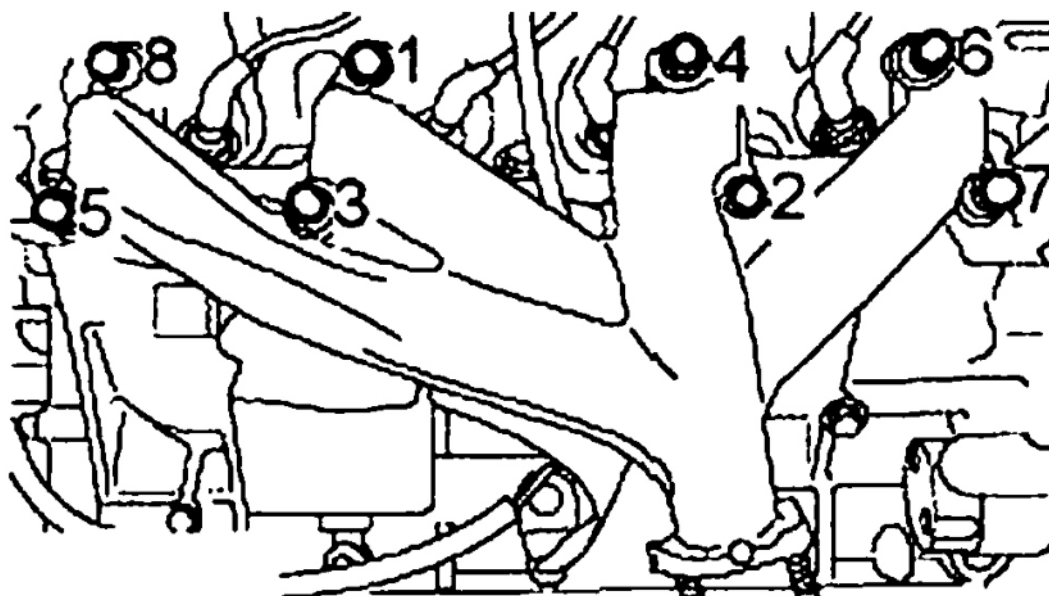
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Noting that bolts 1, 3 and 5 are longer than the remainder, fit bolts and tighten in the sequence shown to 20 N.m (15 ft. lbs) then turn through 90°, and finally a further 90°. See **Fig. 24**.

CAUTION: DO NOT use an air tool to tighten adapters.

8. On models with SAI: Fit NEW air injection adapters and using a 9-mm hexagonal drive bit, tighten to 33 N.m (24 ft. lbs).

9. Clean push rods.
10. Lubricate ends of push rods with clean engine oil.
11. Fit push rods in their removed order.
12. Clean bases of rocker pillars and mating faces on cylinder head.
13. Clean contact surfaces on rockers, valves and push rods.
14. Lubricate contact surfaces and rocker shaft with clean engine oil.
15. Fit rocker shaft assembly and engage push rods.
16. Fit rocker shaft bolts and progressively tighten to 40 N.m (30 ft. lbs).
17. Position alternator mounting bracket, fit bolts and tighten to 40 N.m (30 ft. lbs).
18. Position auxiliary drive belt tensioner, fit bolt and tighten to 45 N.m (33 ft. lbs).
19. Connect hot leads to spark plugs in their fitted order.
20. Using NEW gaskets, fit exhaust manifold to cylinder head. Fit bolts and using sequence shown, tighten initially to 15 N.m (11 ft. lbs), then finally tighten to 36 N.m (28 ft. lbs). See **Fig. 25**.



G00374057

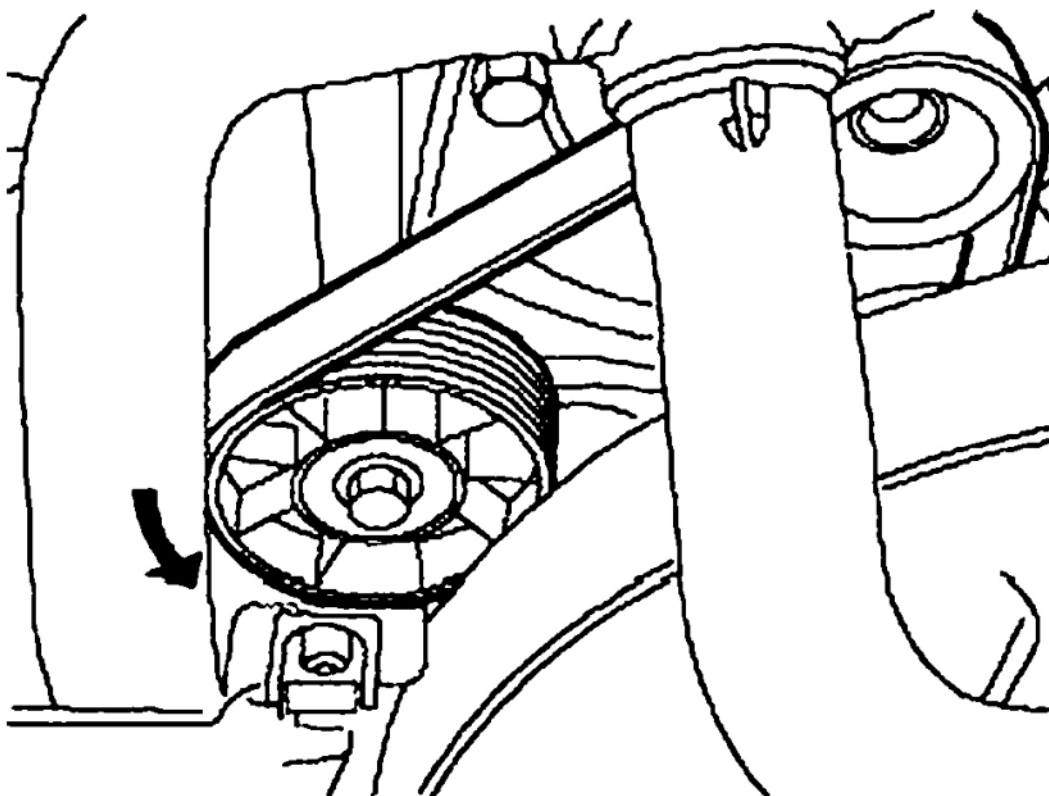
Fig. 25: Exhaust Manifold Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

21. On right drive models: Fit brake servo heat shield.
22. Position engine earth lead, fit bolt and tighten to 22 N.m (16 ft. lbs).
23. Fit inlet manifold gasket. See **GASKET - INLET MANIFOLD** under OVERHAUL.

GASKET - ROCKER COVER - LEFT

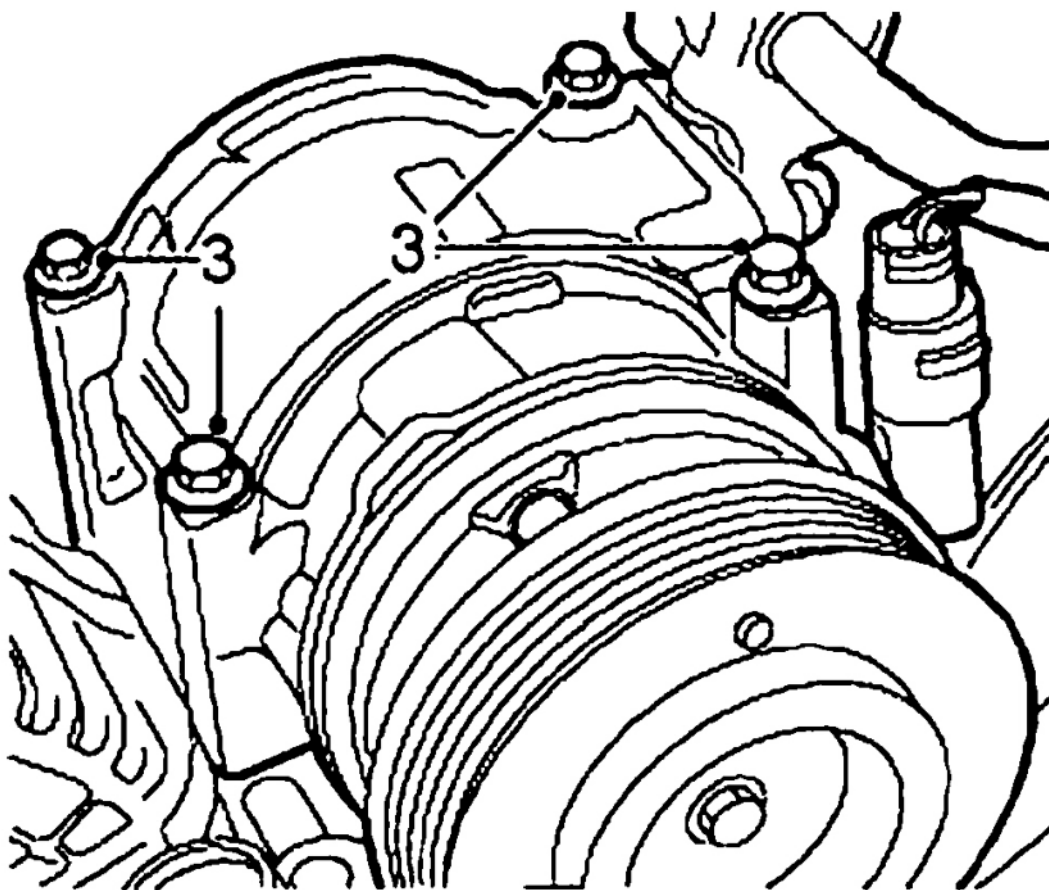
Removal

1. Remove upper inlet manifold gasket. See **GASKET - INLET MANIFOLD**.
2. On models with air conditioning: Release 4 clips and remove fan cowl.
3. On models with air conditioning: Release tension on auxiliary drive belt and remove belt from air conditioning compressor. See **Fig. 26**. Disconnect compressor multiplug. Remove 4 bolts securing compressor and position compressor aside. See **Fig. 27**.



G00374058

Fig. 26: Releasing Auxiliary Drive Belt Tension
Courtesy of LAND ROVER NORTH AMERICA, INC.

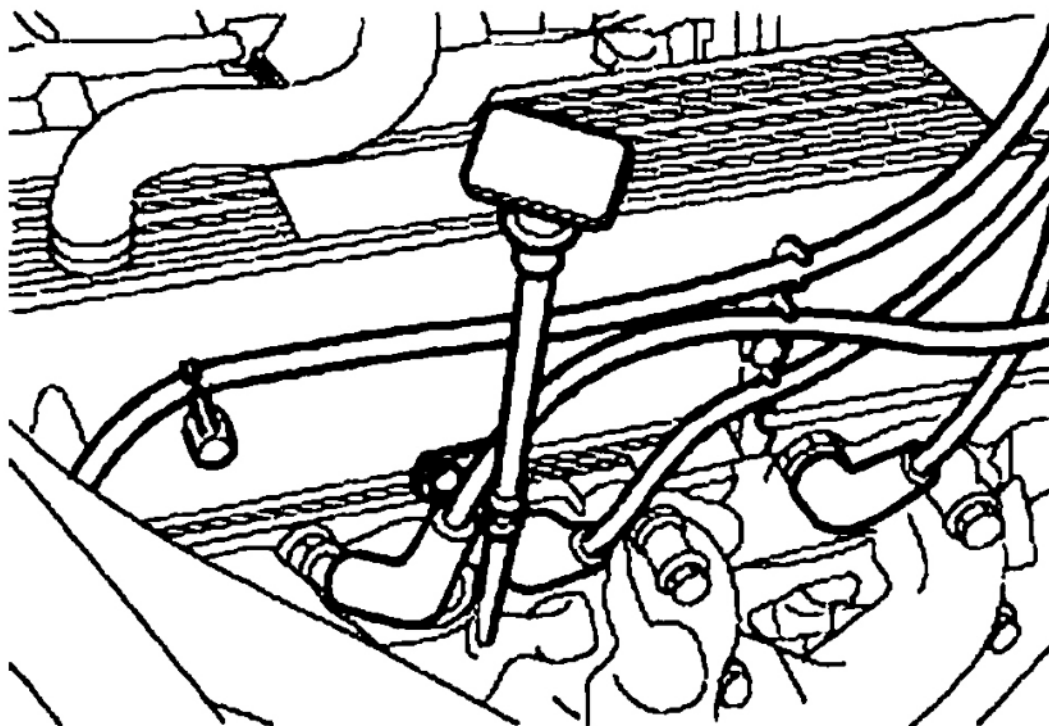


G00374059

Fig. 27: A/C Compressor Mounting Bolts

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Release hot leads (spark plug wires) from rocker cover clips. See **Fig. 28**.

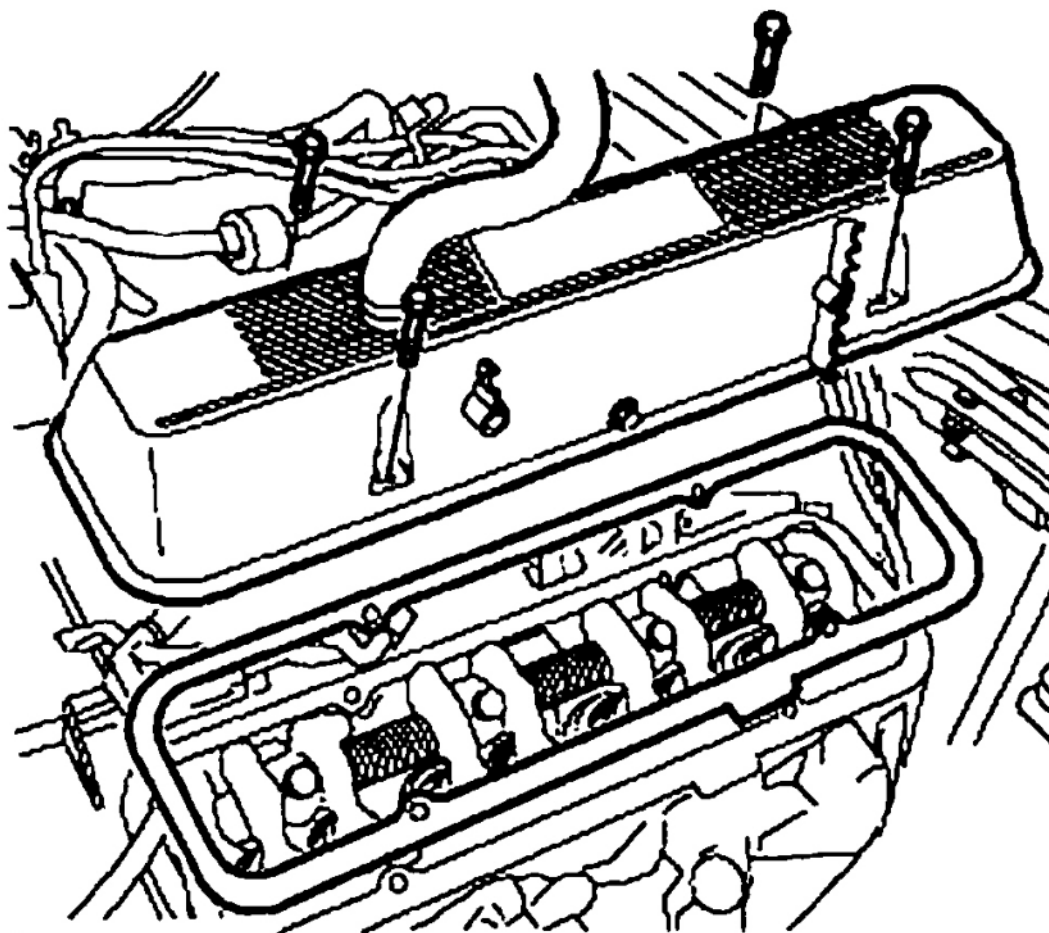


G00374060

Fig. 28: Releasing Hot Leads From Rocker Cover Clips
Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Remove screw securing dip stick tube.

CAUTION: Screws/bolts must be replaced with NEW "patched" multi-hex bolts.



G00374061

Fig. 29: Removing Rocker Cover

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Noting fitted position of 2 long screws or multi-hex bolts, remove and discard screws/bolts securing rocker cover; remove rocker cover. See **Fig. 29**.
7. Remove and discard rocker cover gasket.

Installation

1. Clean mating faces of rocker cover and cylinder head, ensure bolt holes are clean and dry.
2. Fit a NEW gasket dry, position rocker cover ensuring gasket is correctly located.
3. Fit NEW "patched" multi-hex rocker cover bolts ensuring that 2 short bolts are on side of rocker cover nearest center of engine.
4. Tighten bolts by diagonal selection to:

- **Stage 1**

3 N.m (2.5 ft. lbs)

- **Stage 2**

8 N.m (6.0 ft. lbs)

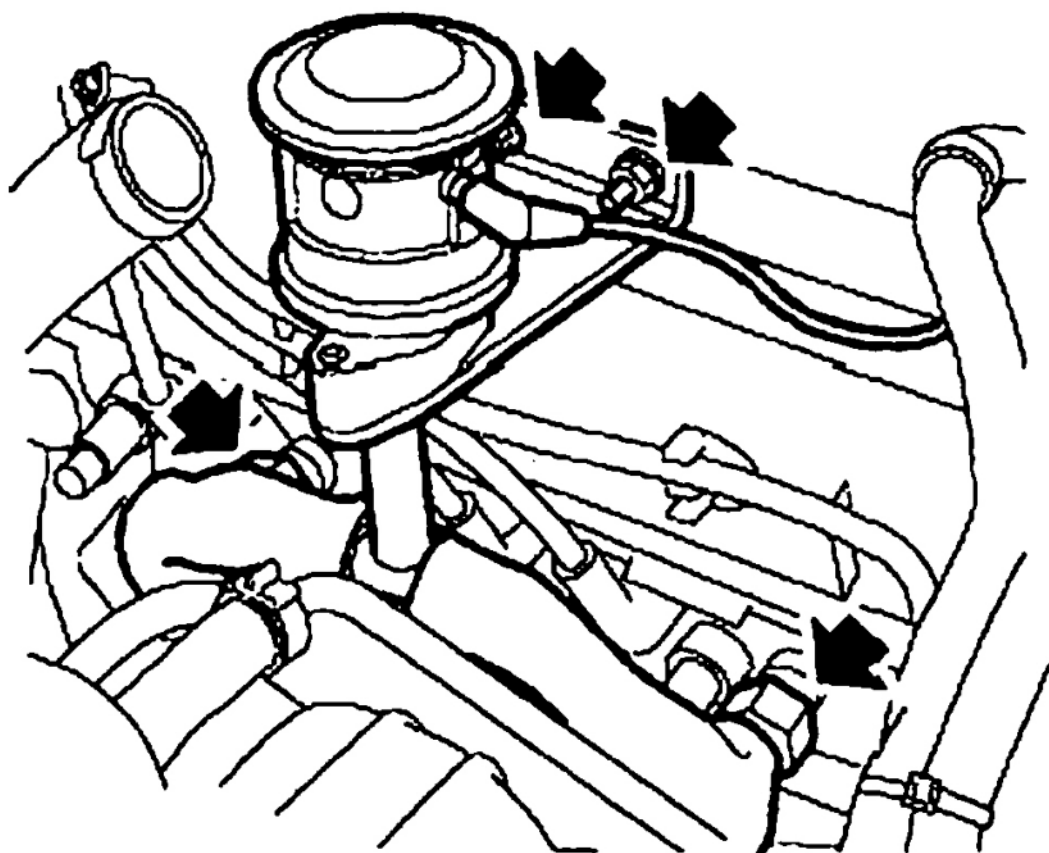
5. Ensure that outer rim of gasket is correctly positioned around periphery of rocker cover.
6. Fit and tighten screw securing dip stick tube.
7. Secure hot leads in rocker cover clips.
8. On models with air conditioning: Clean compressor dowels and dowel holes. Position compressor, fit bolts and tighten to 22 N.m (16 ft. lbs). Release auxiliary drive belt tensioner and fit belt to compressor.
9. On models with air conditioning: Position fan cowl and secure clips.
10. Fit upper inlet manifold. See **GASKET - INLET MANIFOLD** under OVERHAUL.

GASKET - ROCKER COVER - RIGHT

Removal

1. Drain cooling system. See **DRAINING & REFILLING COOLING SYSTEM** .
2. Remove upper inlet manifold gasket. See **GASKET - INLET MANIFOLD**.

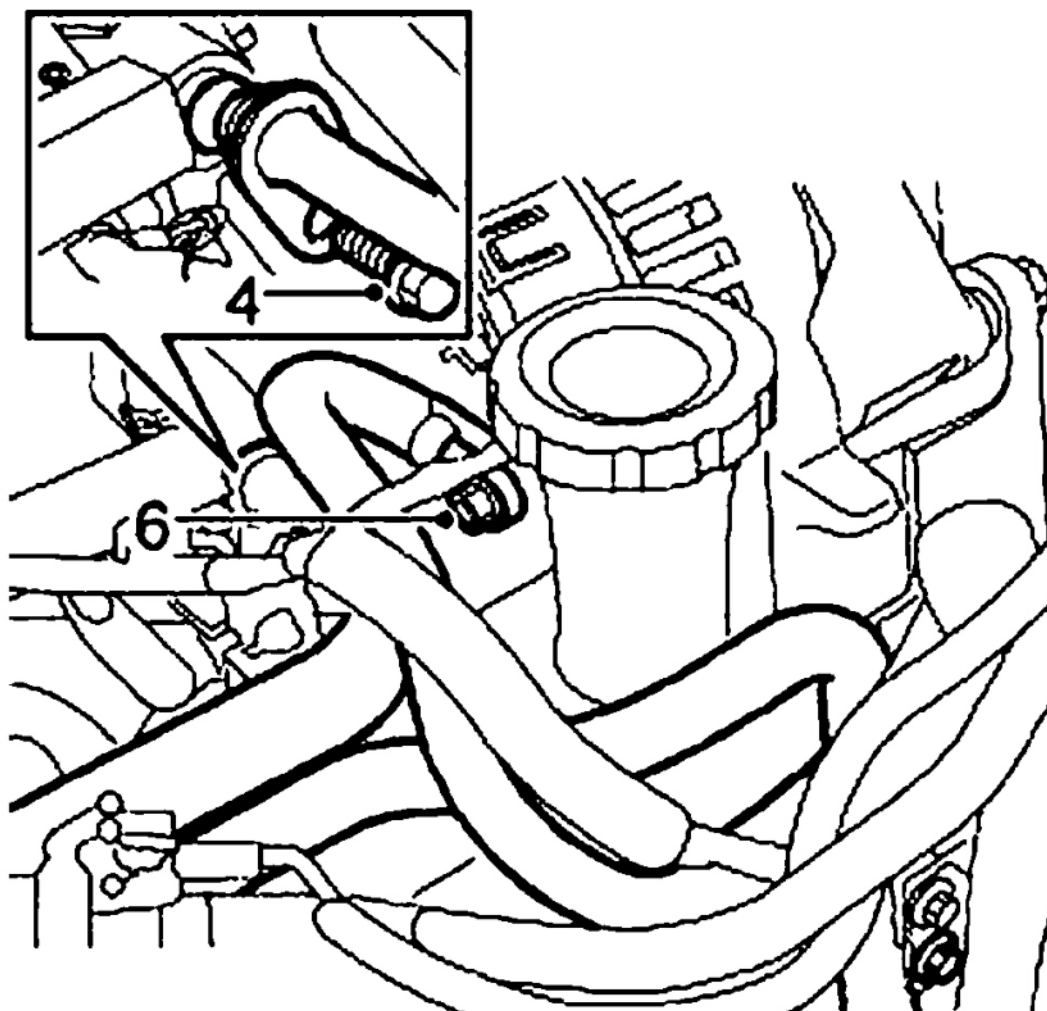
CAUTION: Take care that air manifold pipes are not damaged during removal of union nuts.



G00374062

Fig. 30: Air Manifold Unions At Cylinder Head
 Courtesy of LAND ROVER NORTH AMERICA, INC.

3. On models with Secondary Air Injection (SAI): Disconnect 2 air manifold unions from adapters in cylinder head and remove manifold. See **Fig. 30**.
4. Remove 2 bolts securing coolant rails to inlet manifold.
5. Release coolant rail from inlet manifold and discard "O" ring. See **Fig. 31**.

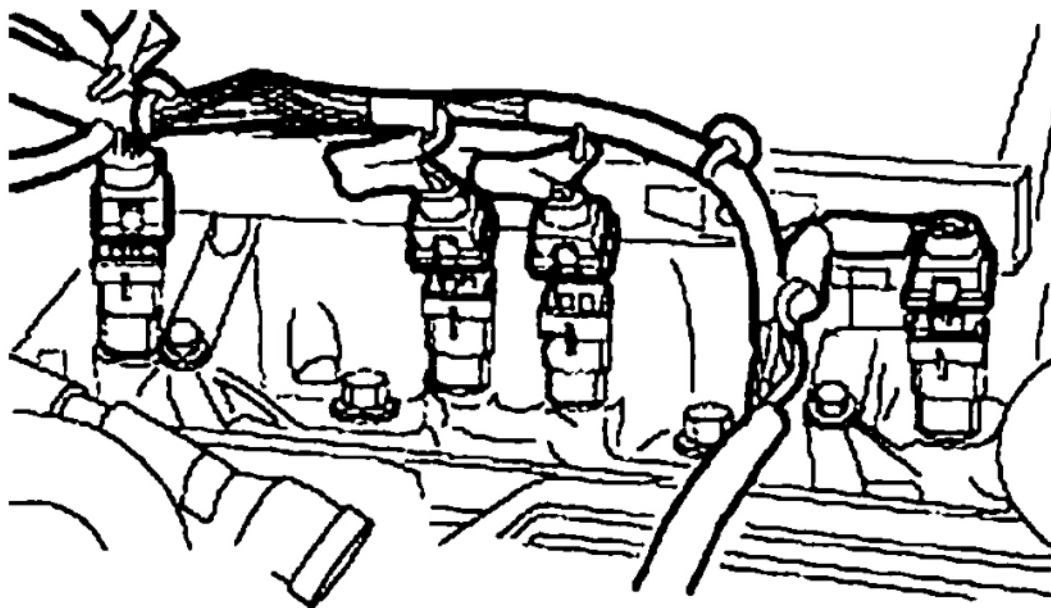


G00374063

Fig. 31: Coolant Rail At Inlet Manifold

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Remove nuts securing alternator cables and release cables from alternator.
7. Disconnect multiplugs from right bank of injectors and release harness from fuel rail. See **Fig. 32**.

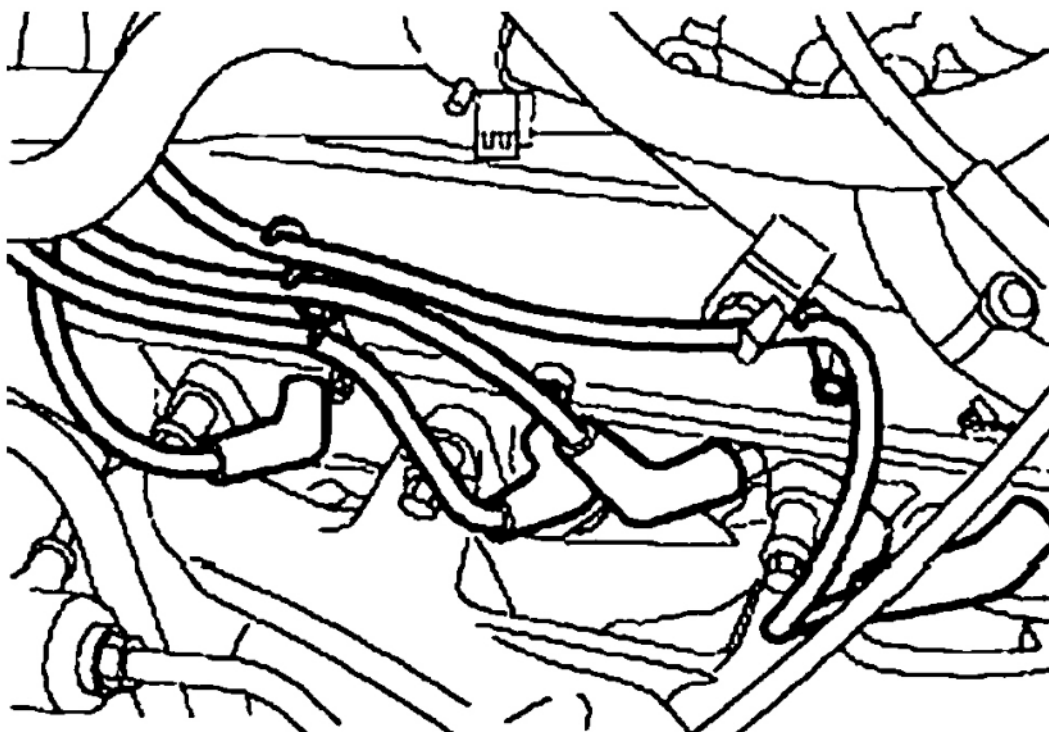


G00374064

Fig. 32: Right Bank Injector Connectors

Courtesy of LAND ROVER NORTH AMERICA, INC.

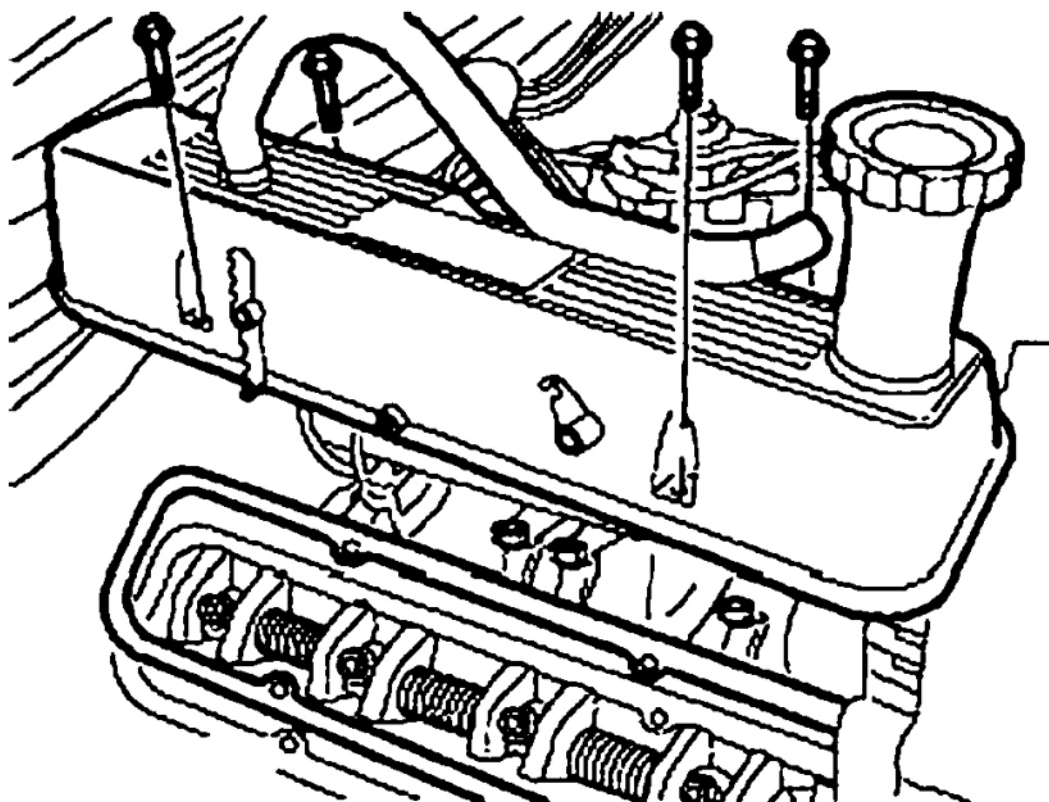
8. Release hot leads from clips on rocker cover. See **Fig. 33**.



G00374065

Fig. 33: Releasing Hot Leads From Rocker Cover
Courtesy of LAND ROVER NORTH AMERICA, INC.

9. Noting fitted position of 2 long screws or multi-hex bolts, remove and discard screws/bolts securing rocker cover; remove rocker cover.
10. Remove and discard rocker cover gasket. See **Fig. 34**.



G00374066

Fig. 34: Rocker Cover

Courtesy of LAND ROVER NORTH AMERICA, INC.

Installation

1. Clean mating faces of rocker cover and cylinder head, ensure bolt holes are clean and dry.
2. Fit a NEW gasket dry, position rocker cover ensuring gasket is correctly located.
3. Fit NEW "patched" multi-hex rocker cover bolts ensuring that 2 short bolts are on side of rocker cover nearest center of engine.
4. Tighten bolts by diagonal selection to:

Stage 1

3 N.m (2.5 ft. lbs)

Stage 2

8 N.m (6.0 ft. lbs)

5. Ensure that outer rim of gasket is correctly positioned around periphery of rocker cover.

6. Secure hot leads in rocker cover clips.
7. Secure injector harness to fuel rail and connect multiplugs to injectors.
8. Position alternator cables and tighten terminals to specification:

B+ Nut

Tighten to 18 N.m (13 ft. lbs)

D+ Nut

Tighten to 5 N.m (3 ft. lbs)

9. Clean coolant rail "O" ring recess.
10. Lubricate and fit NEW "O" ring to coolant rail, position coolant rails, fit bolts and tighten to 22 N.m (16 ft. lbs).
11. On models with SAI: Apply a small amount of engine oil to top of air manifold union nuts and around air manifold pipes.

CAUTION: Finger tighten union nuts as far as possible, damage to air manifold pipes or adapters may result if this is not done.

12. On models with SAI: Position air manifold and finger tighten both air manifold union nuts.

CAUTION: Ensure that air manifold pipes are not distorted during tightening operation.

13. On models with SAI: Tighten both union nuts to 25 N.m (18 ft. lbs).
14. Fit upper inlet manifold.
15. Refill cooling system. See **DRAINING & REFILLING COOLING SYSTEM** .

MOUNTING (ENGINE) - FRONT - LEFT**Removal**

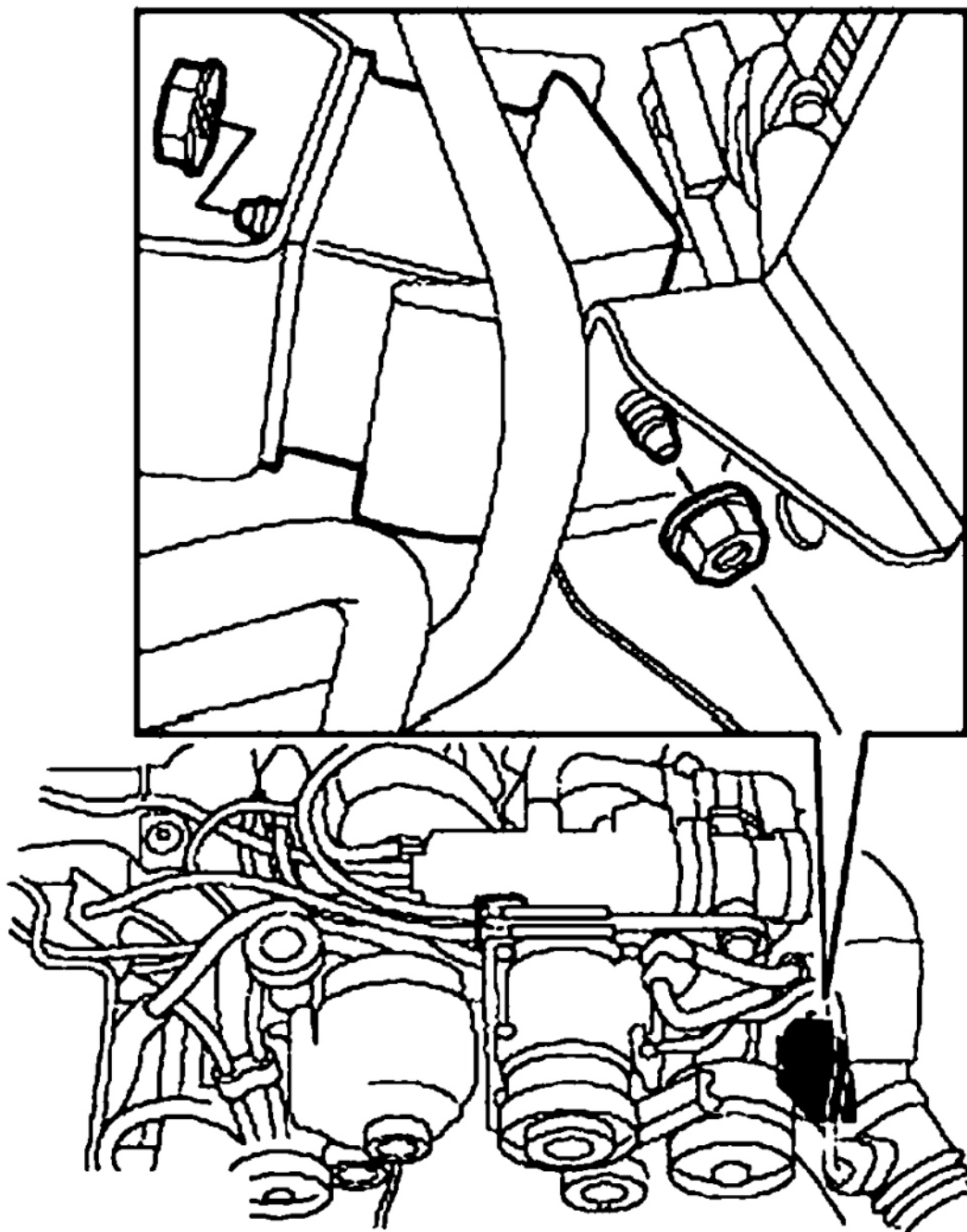
1. Release turnbuckles and remove battery cover.
2. Disconnect battery earth lead.

WARNING: DO NOT work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

3. Raise front of vehicle.
4. Remove underbelly panel. See **REMOVE** .

CAUTION: To prevent damage to components, cushion the jack pad with a block of wood or hard rubber.

5. Position a jack beneath the sump, and support the engine on the jack.
6. Remove 2 nuts securing engine mountings to chassis. See **Fig. 35**.



G00374067

Fig. 35: Left Front Engine Mounting Nuts

Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Remove nut securing left mounting to cylinder block.
8. Raise engine sufficiently to allow engine mounting to be removed, take care not to trap any cables, pipes

or harness.

9. Remove engine mounting. Collect heat shield, if fitted.

Installation

1. Fit heat shield to engine mounting, if fitted.
2. Fit engine mounting ensuring dowel is located.
3. Lower the jack and engage engine mounting studs in chassis.
4. Fit nuts securing left engine mounting and tighten to 85 N.m (63 ft. lbs).
5. Fit underbelly panel. See **REFIT** .
6. Remove stand(s) and lower vehicle.
7. Connect battery earth lead.
8. Fit battery cover and secure turnbuckles.

MOUNTING (ENGINE) - FRONT - RIGHT

Removal

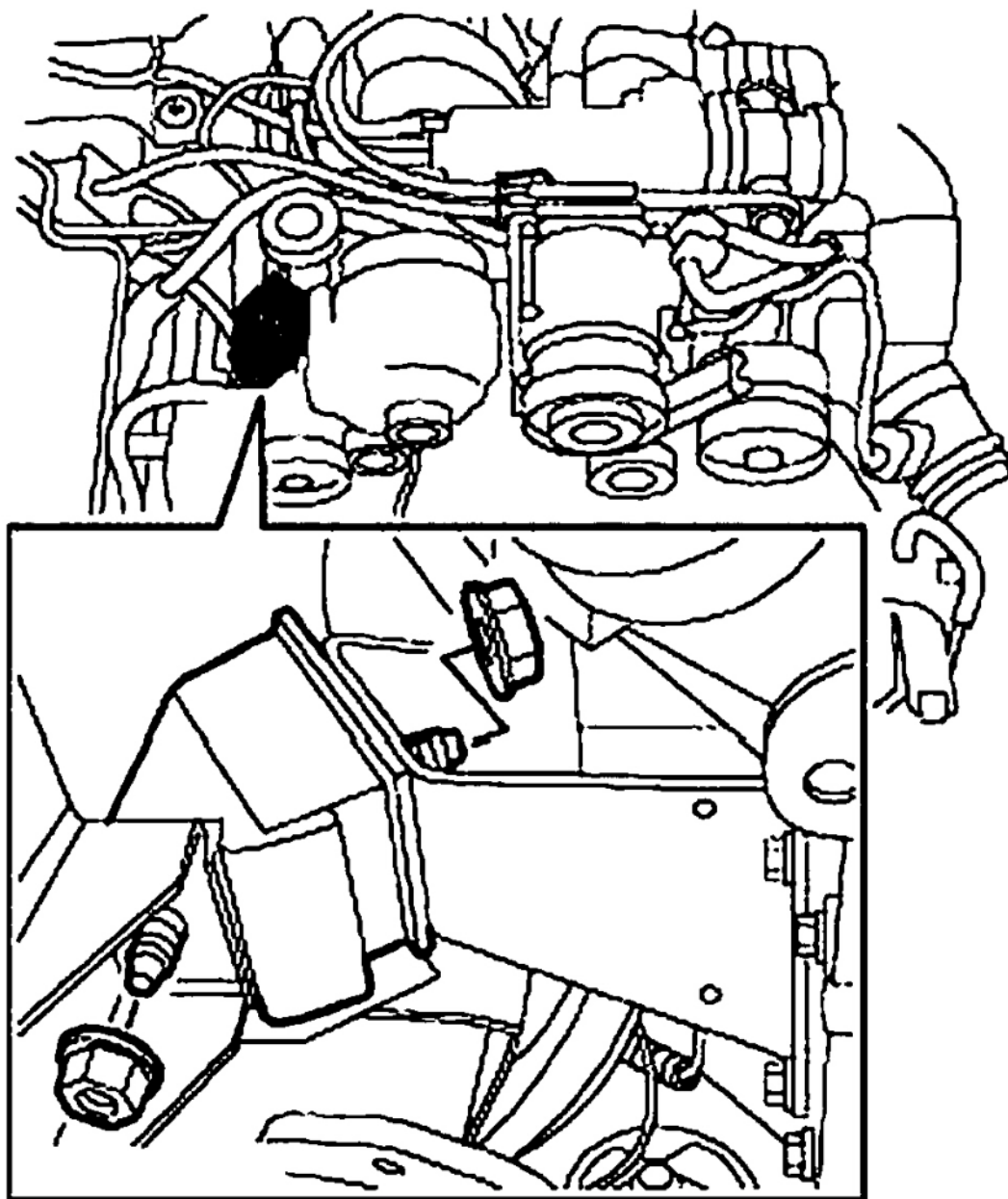
1. Release turnbuckles and remove battery cover.
2. Disconnect battery earth lead.

WARNING: DO NOT work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

3. Raise front of vehicle.
4. Remove underbelly panel. See **REMOVE** .

CAUTION: To prevent damage to components, cushion the jack pad with a block of wood or hard rubber.

5. Position a jack beneath the sump, and support the engine on the jack.
6. Remove 2 nuts securing engine mountings to chassis. See **Fig. 36**.



G00374068

Fig. 36: Right Front Engine Mounting Nuts
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Remove nut securing right mounting to cylinder block.
8. Raise engine sufficiently to allow engine mounting to be removed. Take care not to trap any cables, pipes or harness.
9. Remove engine mounting.

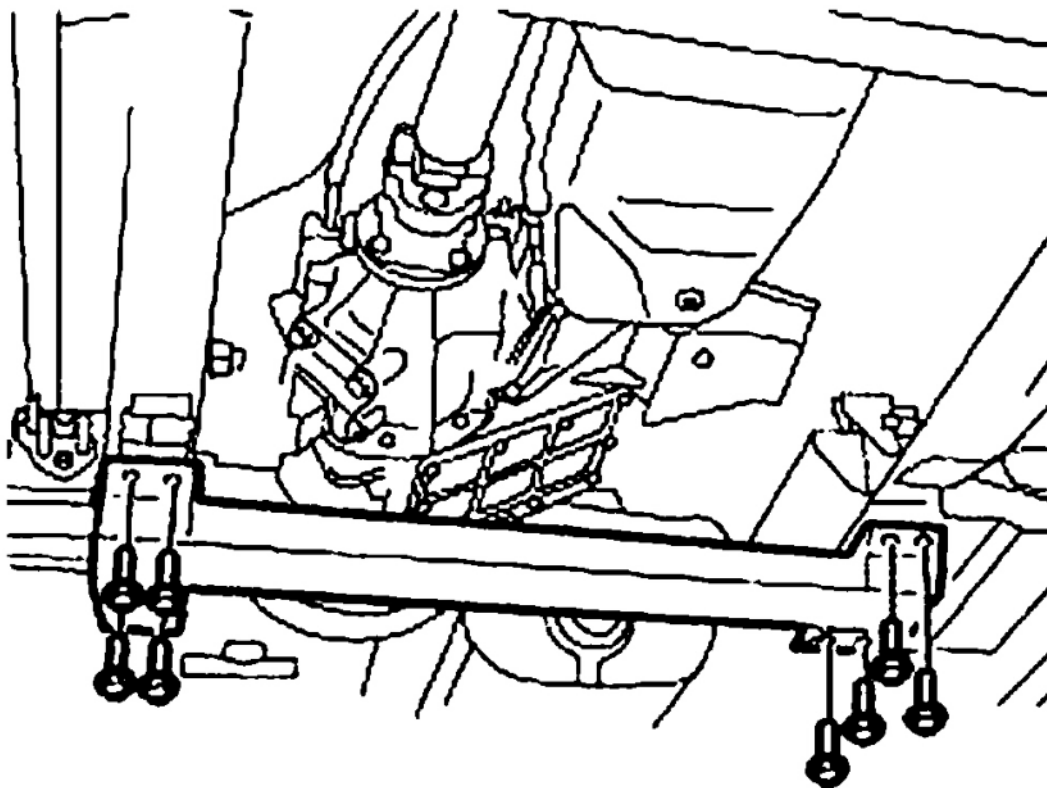
10. Collect heat shield.

Installation

1. Position heat shield.
2. Fit engine mounting ensuring dowel is located.
3. Lower the jack and engage engine mounting studs in chassis.
4. Fit engine mounting nuts and tighten to 85 N.m (63 ft. lbs).
5. Fit underbelly panel. See **REFIT** .
6. Remove stand(s) and lower vehicle.
7. Connect battery earth lead.
8. Fit battery cover and secure turnbuckles.

MOUNTING (ENGINE) - REAR - LEFT**Removal**

1. Raise vehicle on lift.
2. Remove 8 bolts securing rear cross member and remove cross member. See **Fig. 37**.



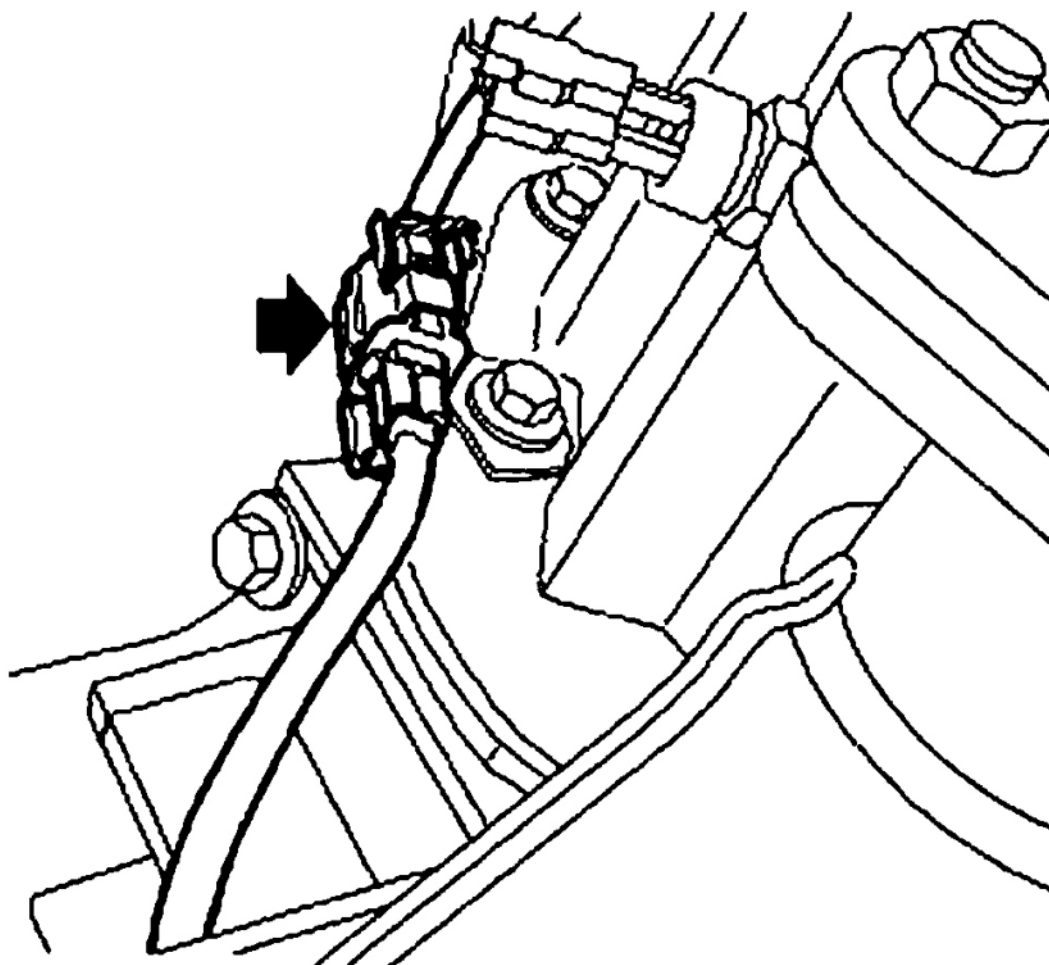
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Fig. 37: Rear Cross Member

Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: To prevent damage to components, cushion the jack pad with a block of wood or hard rubber.

3. Support transfer gearbox on jack.
4. Release and disconnect HO2S multiplug. See **Fig. 38**.

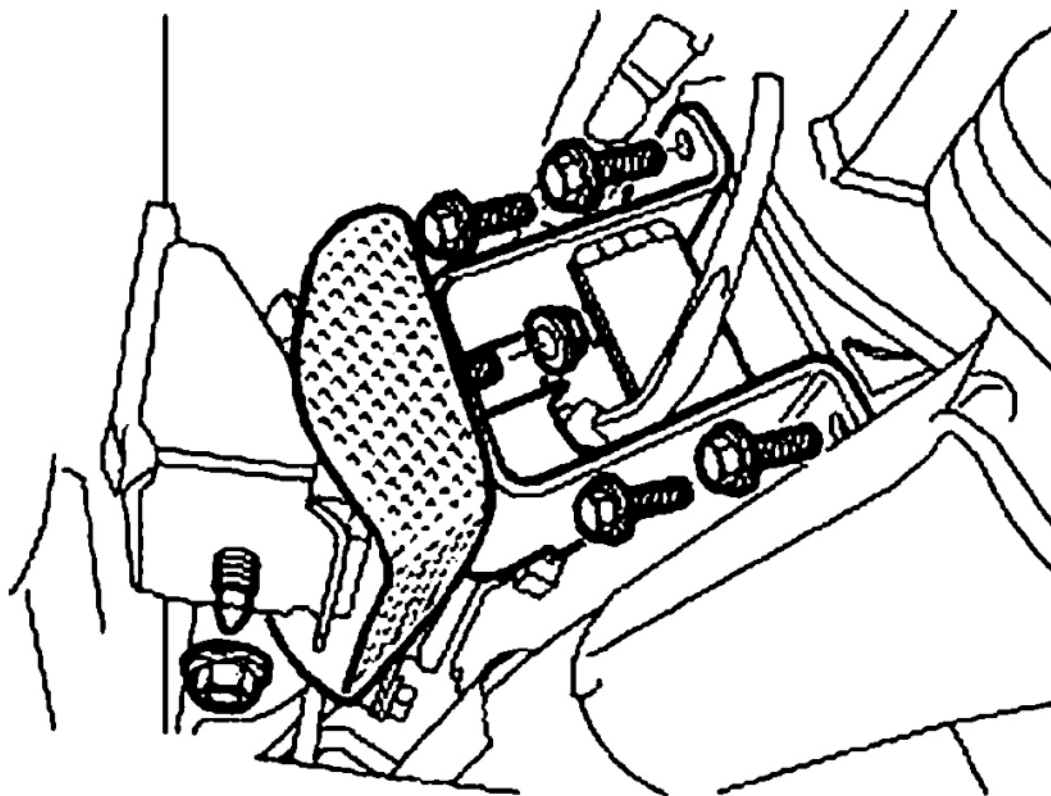


G00374070

Fig. 38: HO2S Connector

Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Remove nut securing mounting to body bracket. See **Fig. 39**.



G00374071

Fig. 39: Left Rear Engine Mounting

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Remove nut securing mounting to mounting bracket.
7. Remove 4 bolts securing mounting bracket to gearbox.
8. Remove mounting and mounting bracket assembly.
9. Remove mounting rubber.
10. Remove heat shield, if fitted.

Installation

1. If fitted position heatshield, fit mounting rubber to mounting bracket, fit nut but do not tighten.
2. Position mounting bracket assembly, fit bolts securing mounting bracket to gearbox and tighten to 85 N.m (63 ft. lbs).
3. Fit nut securing mounting to body bracket and tighten to 48 N.m (35 ft. lbs).
4. Tighten nut securing mounting to gearbox bracket to 48 N.m (35 ft. lbs).
5. Connect HO2S multiplug and secure to support bracket.
6. Position rear cross member, fit bolts and tighten to 26 N.m (19 ft. lbs).

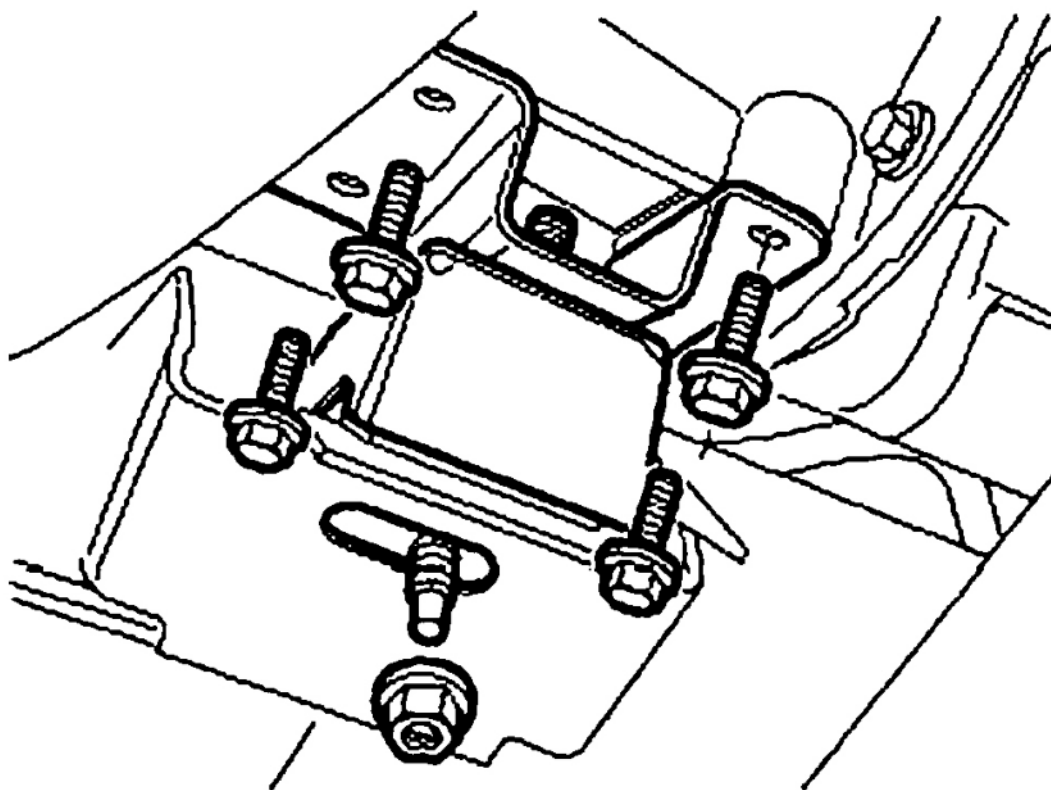
7. Lower vehicle.

MOUNTING (ENGINE) - REAR - RIGHT**Removal**

1. Raise vehicle on lift.
2. Remove 8 bolts securing rear cross member and remove cross member. See **Fig. 37**.

CAUTION: To prevent damage to components, cushion the jack pad with a block of wood or hard rubber.

3. Support transfer gearbox on jack.
4. Remove nut securing mounting to body bracket. See **Fig. 40**.



G00374072

Fig. 40: Right Rear Engine Mounting
Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Remove nut securing mounting to mounting bracket.

6. Remove 4 bolts securing mounting bracket to gearbox.
7. Remove mounting and mounting bracket assembly.
8. Remove mounting rubber.
9. Remove heat shield, if fitted.

Installation

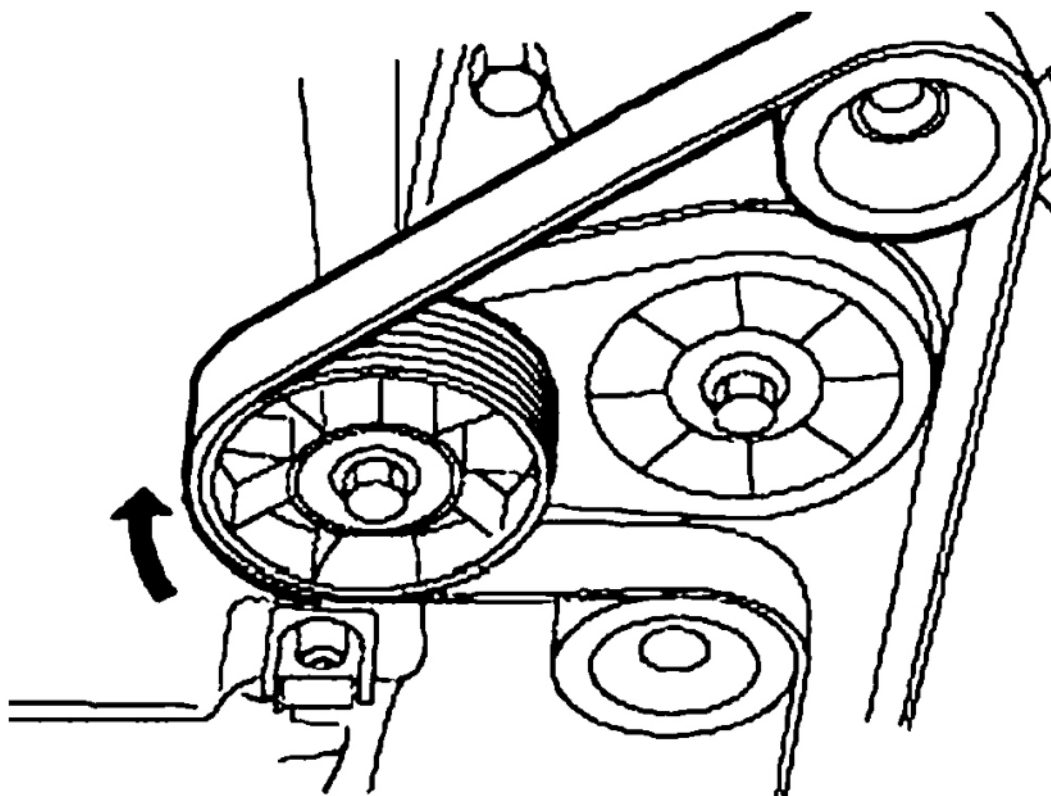
1. If fitted, position heatshield, fit mounting rubber to mounting bracket, fit nut but do not tighten.
2. Position mounting bracket assembly, fit bolts securing mounting bracket to gearbox and tighten to 85 N.m (63 ft. lbs).
3. Fit nut securing mounting to body bracket and tighten to 48 N.m (35 ft. lbs).
4. Tighten nut securing mounting to gearbox bracket to 48 N.m (35 ft. lbs).
5. Position rear cross member, fit bolts and tighten to 26 N.m (19 ft. lbs).
6. Lower vehicle.

ENGINE ASSEMBLY**Removal**

1. Drain engine oil and remove oil filter. See **REPLACE** .
2. Remove radiator.
3. Remove upper inlet manifold. See **GASKET - INLET MANIFOLD**.
4. Remove ignition coil assemblies.

CAUTION: Always fit plugs to open connections to prevent contamination.

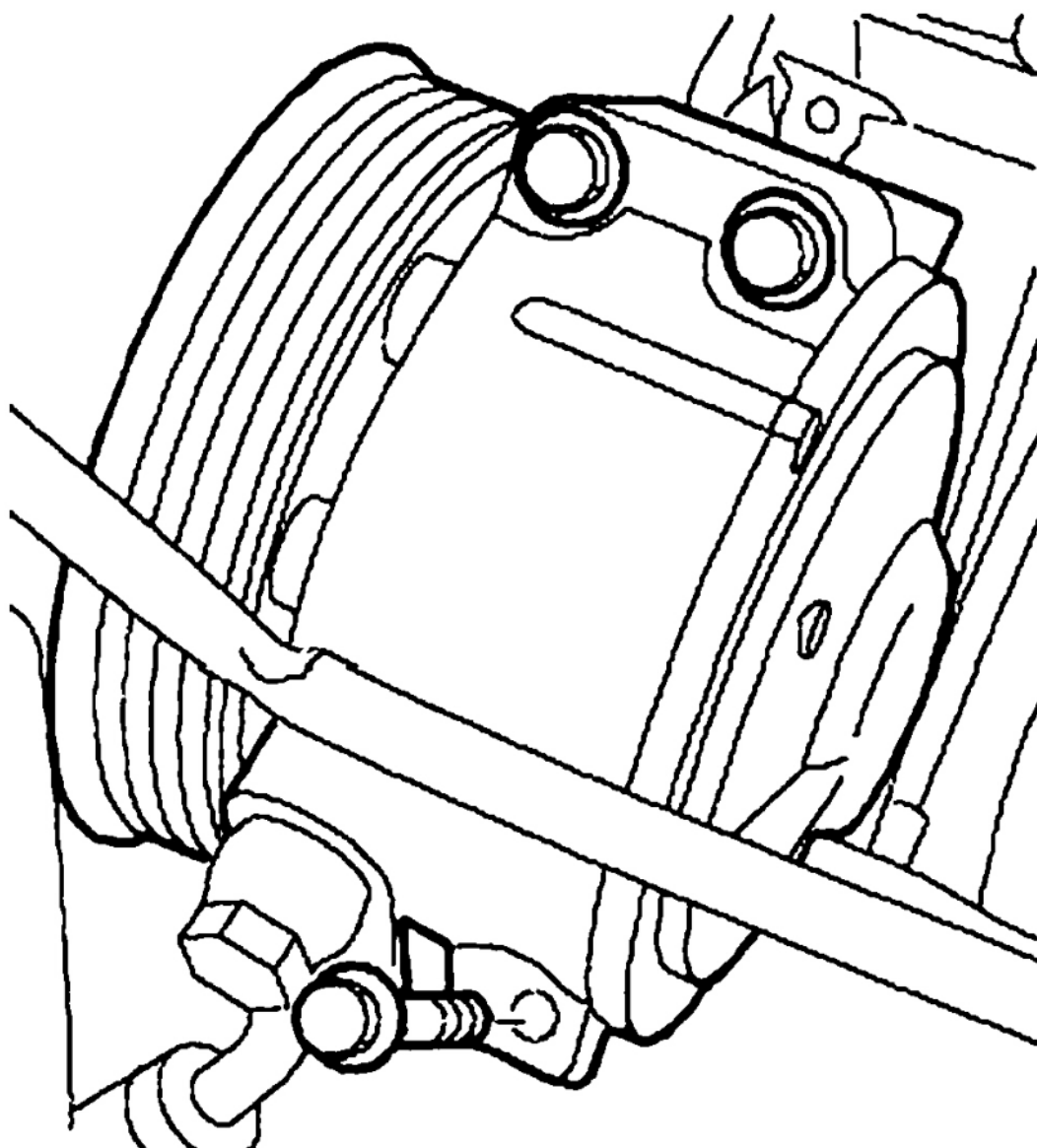
5. Position absorbent material to catch spillage and disconnect fuel pipe from fuel rail.
6. Release 2 hose clips and remove top hose.
7. Using a 15-mm spanner, release auxiliary drive belt tension and remove drive belt. See **Fig. 41**.



G00374073

Fig. 41: Releasing Auxiliary Drive Belt Tension
Courtesy of LAND ROVER NORTH AMERICA, INC.

8. Remove 3 bolts securing ACE pump, release pump and tie aside. See **Fig. 42**.

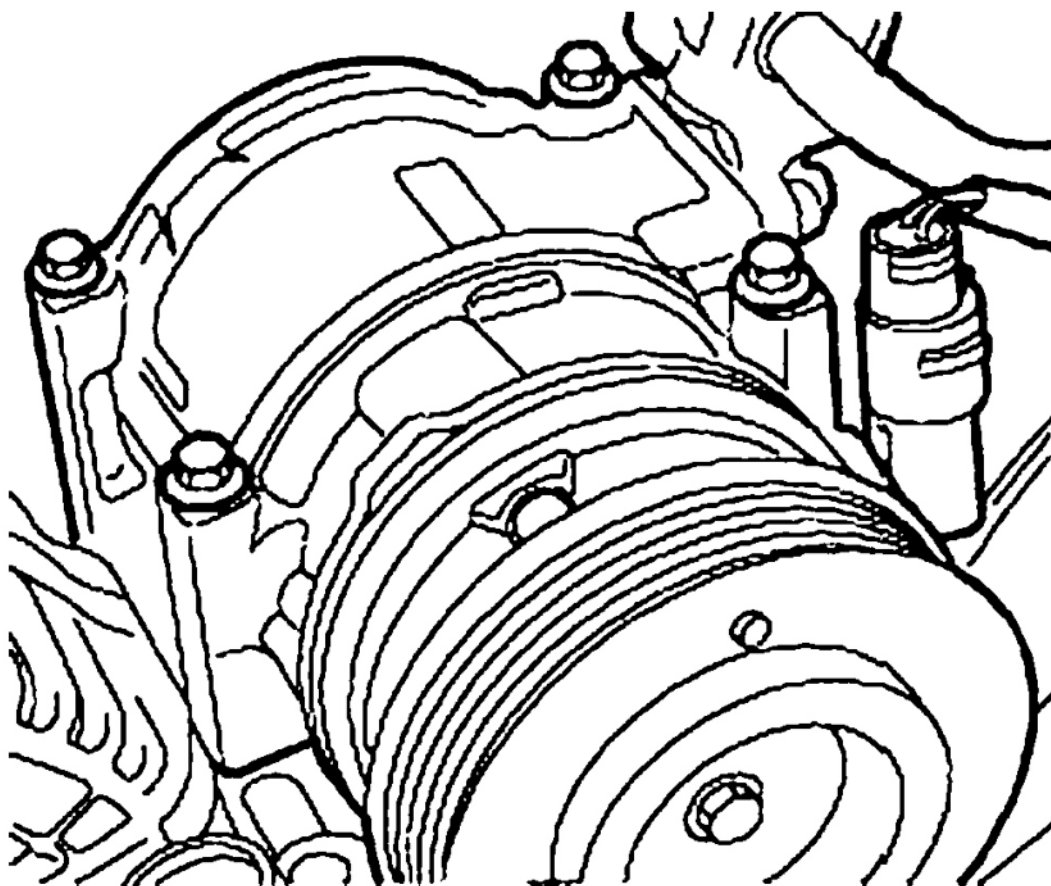


G00374074

Fig. 42: ACE Pump Mounting Bolts

Courtesy of LAND ROVER NORTH AMERICA, INC.

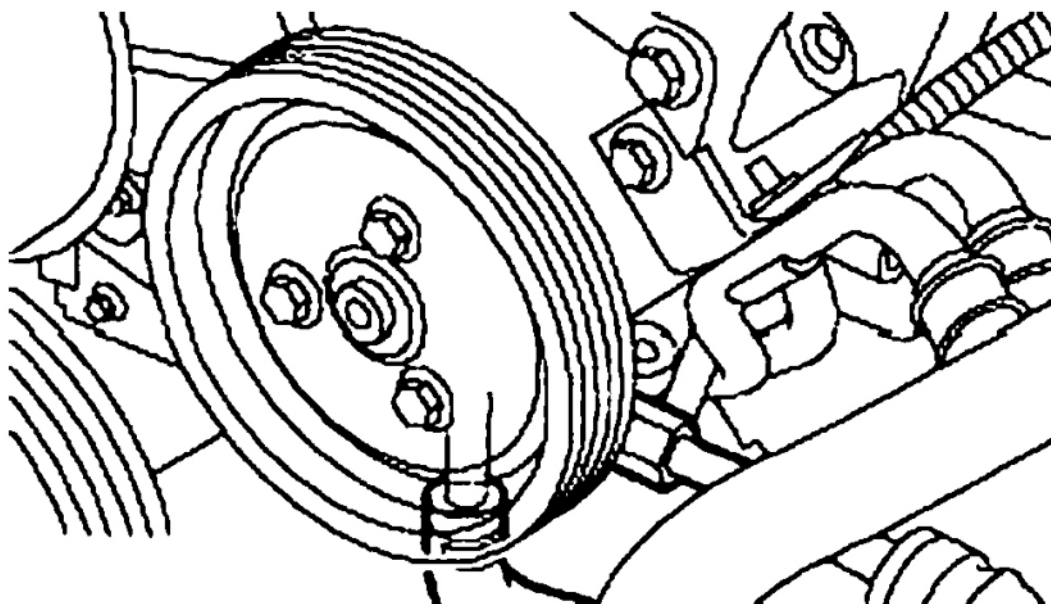
9. Disconnect multiplug from A/C compressor.
10. Remove 4 bolts securing A/C compressor, release compressor and tie aside. See [Fig. 43](#).



G00374075

Fig. 43: A/C Compressor Mounting Bolts
Courtesy of LAND ROVER NORTH AMERICA, INC.

11. Remove bolt securing oil cooling pipes to PAS pump housing and remove saddle clamp. See **Fig. 44**.

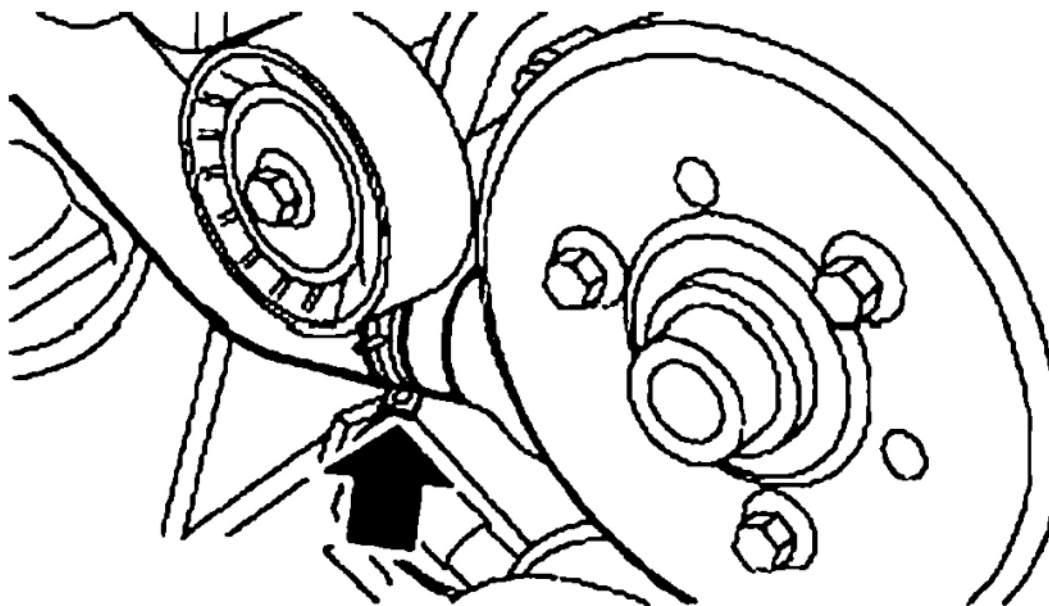


G00374076

Fig. 44: PAS Oil Cooling Pipes Saddle Clamp
Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Always fit plugs to open connections to prevent contamination.

12. Release PAS pump high and low pressure pipes and position aside.
13. Release clips securing hose to coolant pump and coolant rail, release hose and position aside. See **Fig. 45**.

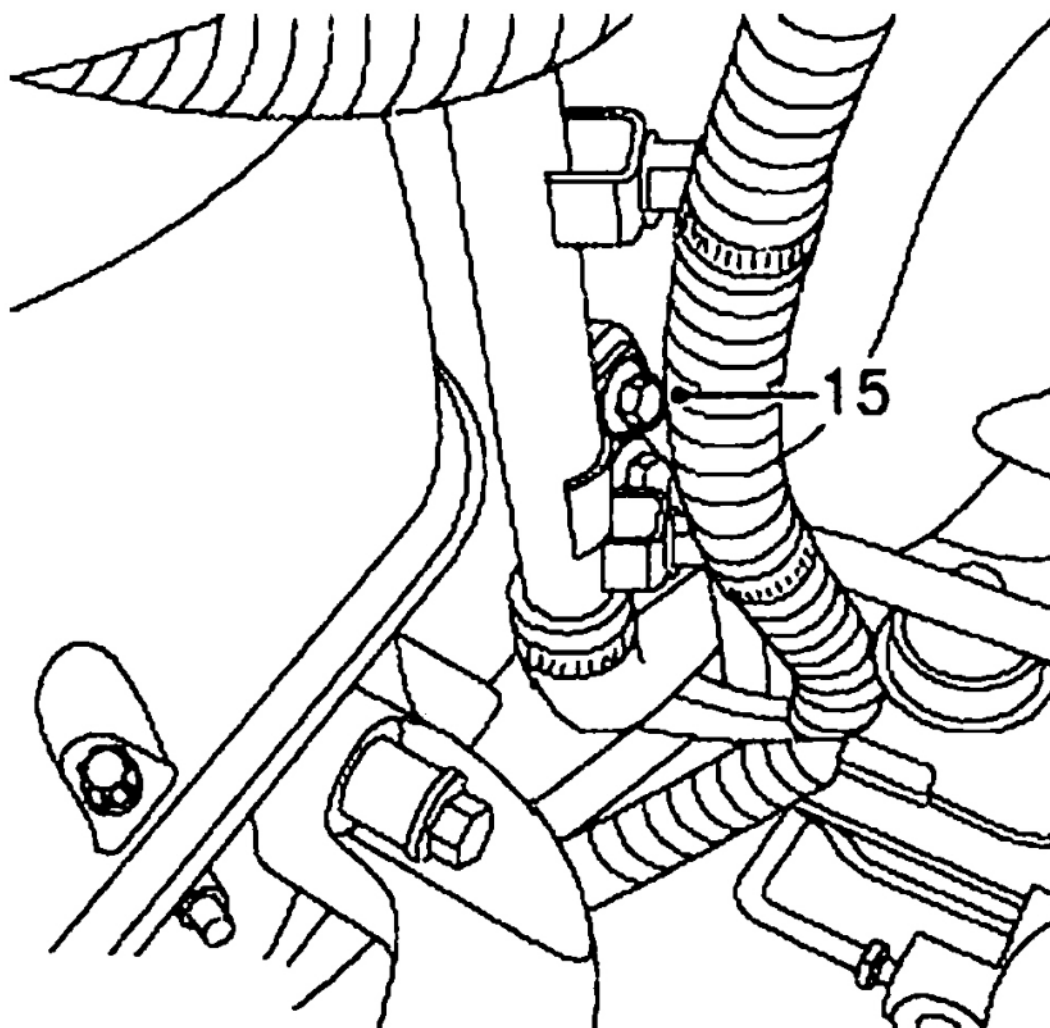


G00374077

Fig. 45: Coolant Pump Hose

Courtesy of LAND ROVER NORTH AMERICA, INC.

14. Release 2 harness clips from coolant rail.
15. Remove bolt securing coolant rail and position rail aside. See **Fig. 46**.

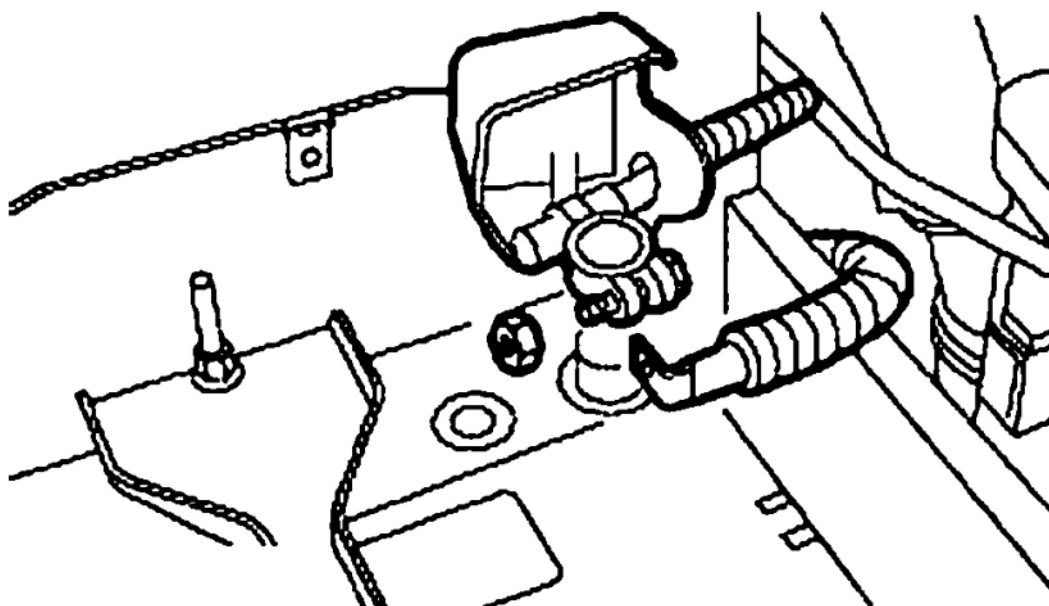


G00374078

Fig. 46: Bolt Securing Coolant Rail

Courtesy of LAND ROVER NORTH AMERICA, INC.

16. Remove bolt securing engine earth lead and position earth lead aside.
17. Remove nut securing engine harness positive lead to battery, release lead and position aside. See **Fig. 47**.

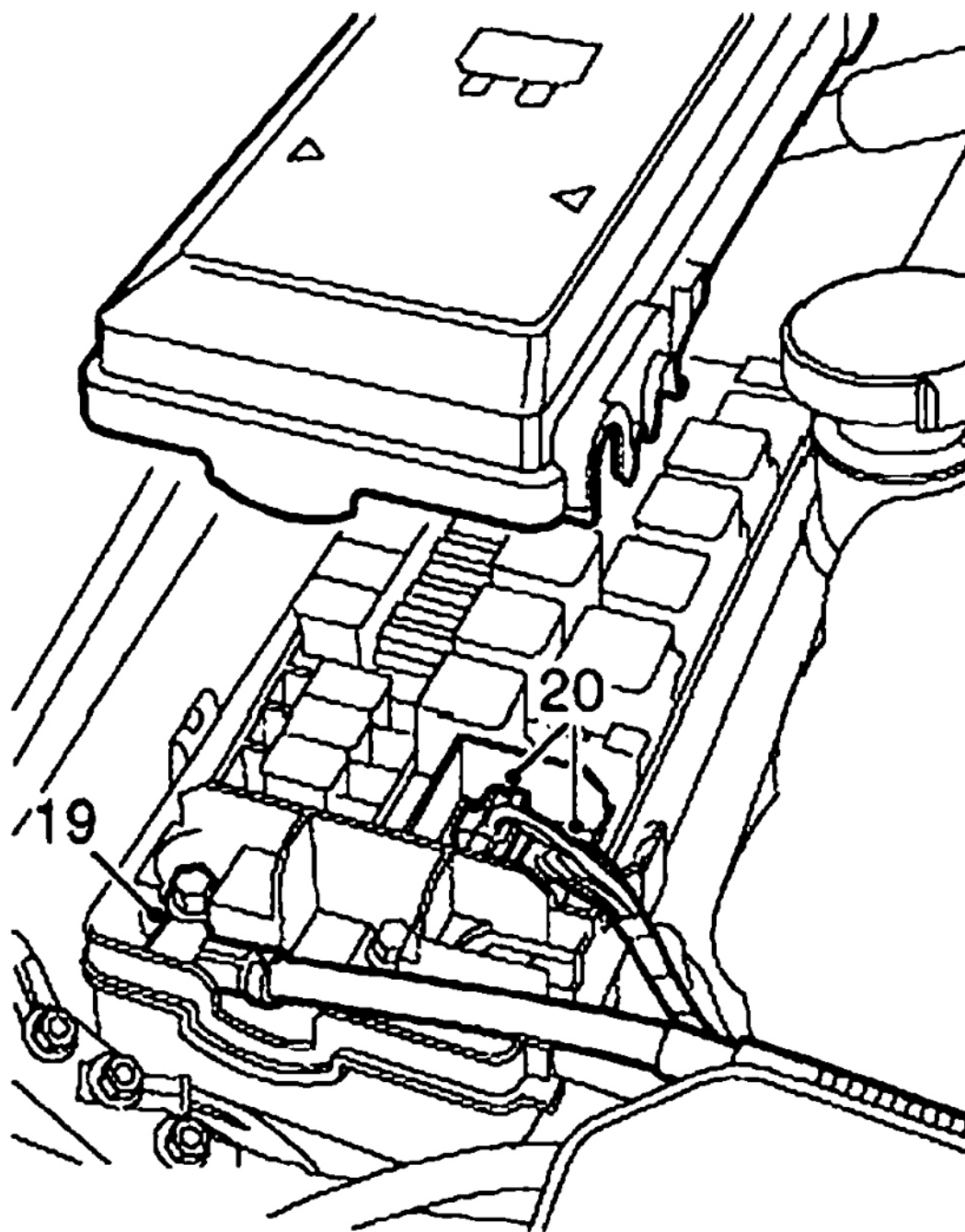


G00374079

Fig. 47: Battery Positive Lead

Courtesy of LAND ROVER NORTH AMERICA, INC.

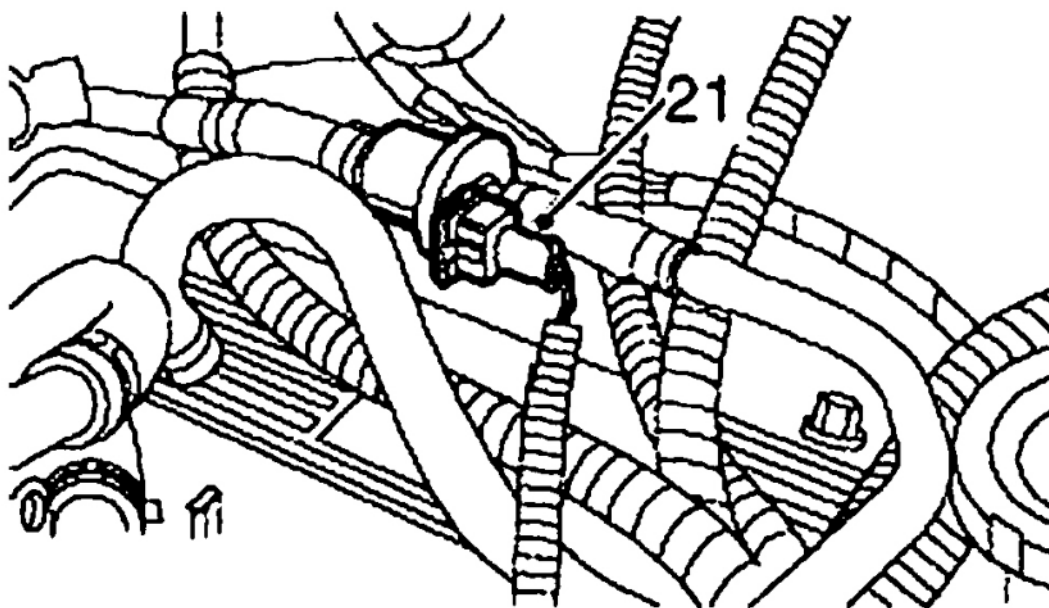
18. Release clips and remove fuse box cover.
19. Remove bolt securing starter lead to fuse box, release lead and position aside. See **Fig. 48**.



G00374080

Fig. 48: Engine Harness Multiplugs At Fuse Box
Courtesy of LAND ROVER NORTH AMERICA, INC.

20. Disconnect 2 engine harness multiplugs from fuse box.
21. Disconnect multiplug from EVAP purge valve. See [Fig. 49](#).

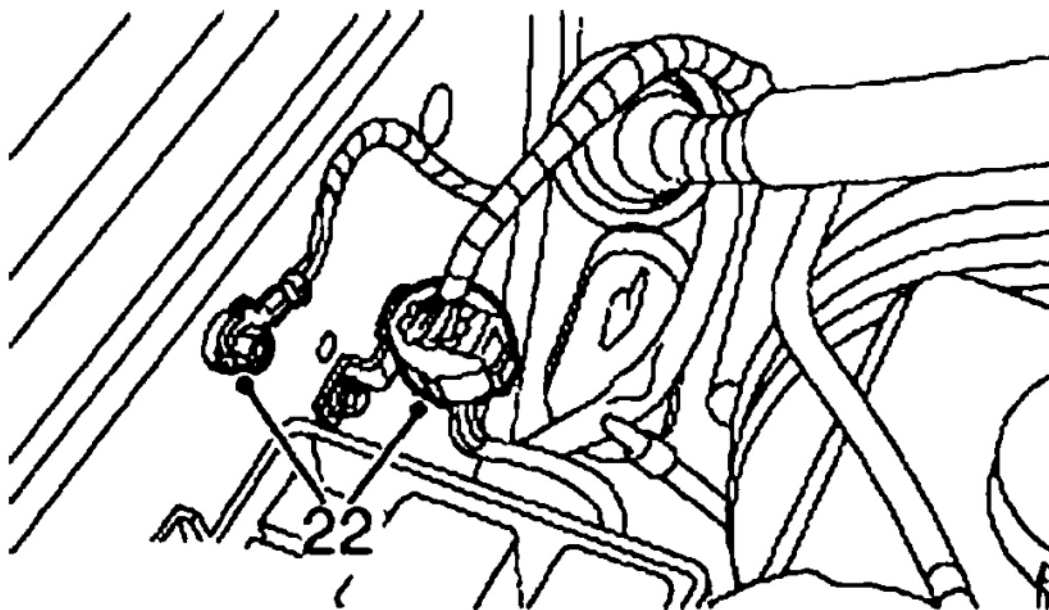


G00374081

Fig. 49: EVAP Purge Valve Multiplug

Courtesy of LAND ROVER NORTH AMERICA, INC.

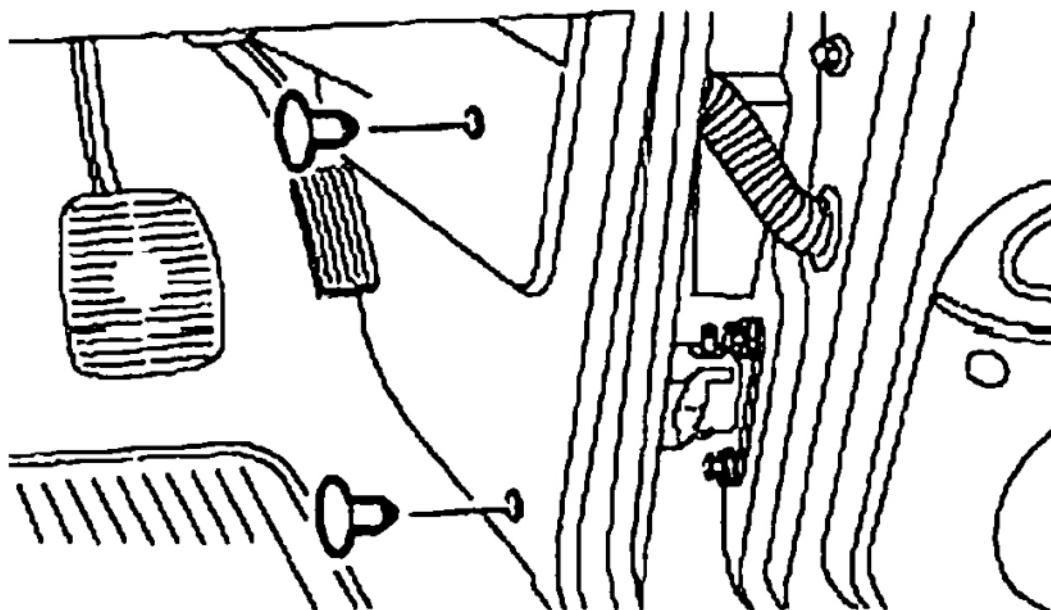
22. Remove nut securing engine harness earth to body and disconnect engine harness to main harness multiplug. See **Fig. 50**.



G00374082

Fig. 50: Engine Harness Ground & Main Harness Multiplug
Courtesy of LAND ROVER NORTH AMERICA, INC.

23. Remove trim fixings securing toe board and remove toe board. See **Fig. 51**.

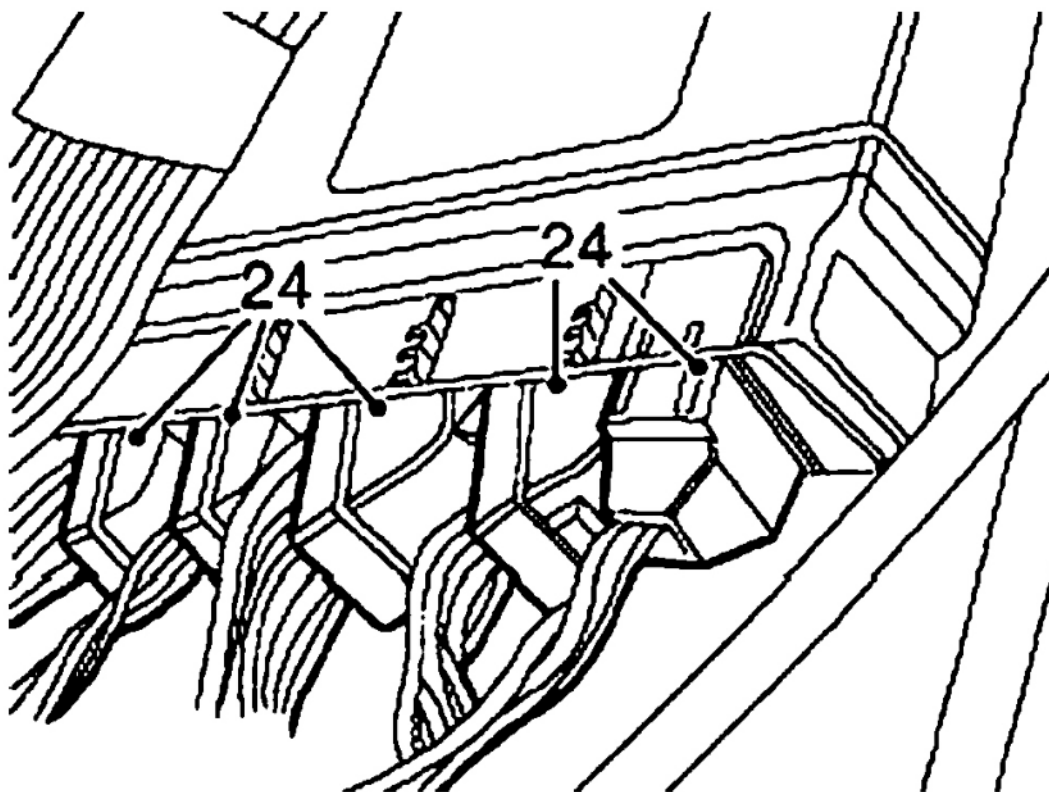


G00374083

Fig. 51: Toe Board

Courtesy of LAND ROVER NORTH AMERICA, INC.

24. Disconnect 5 multiplugs connecting engine harness to ECM. See **Fig. 52**.

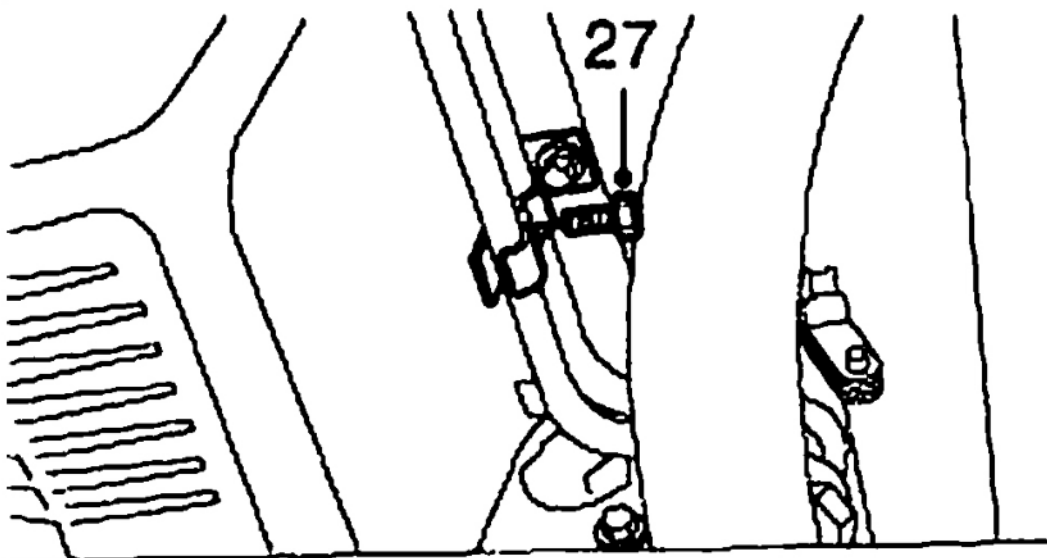
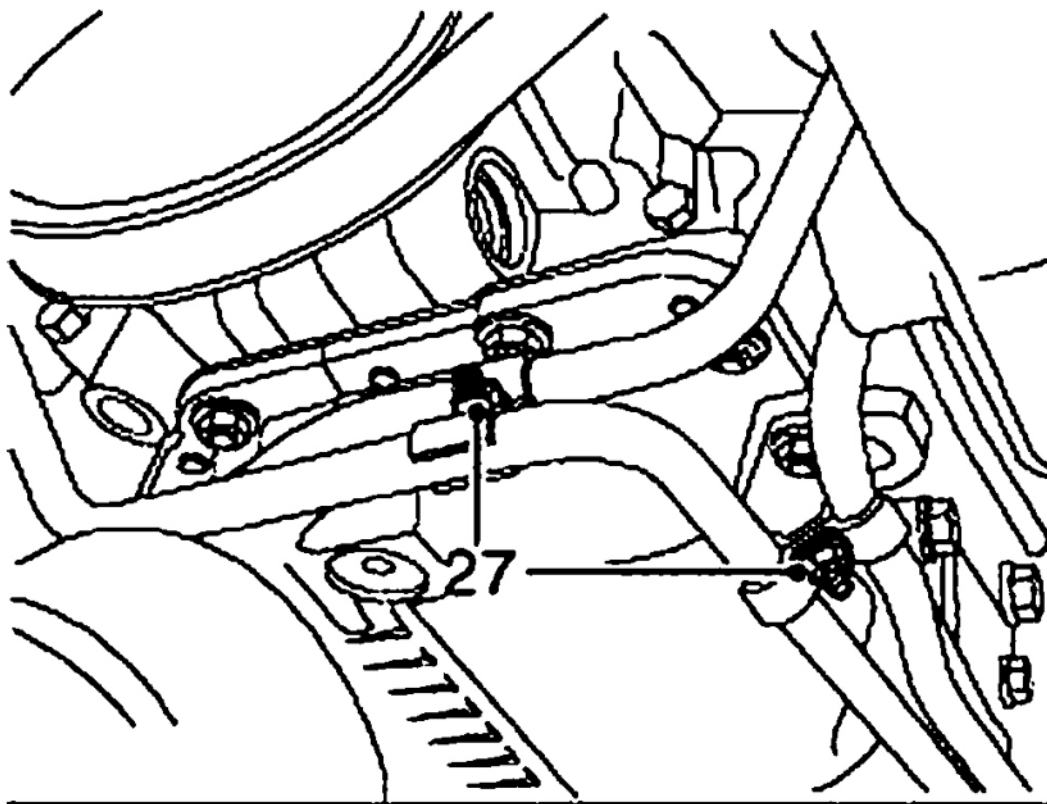


G00374084

Fig. 52: 5 ECM Engine Harness Multiplugs

Courtesy of LAND ROVER NORTH AMERICA, INC.

25. Release engine harness, pull into engine bay and coil on top of engine.
26. Raise vehicle on ramp.
27. Remove 3 bolts securing oil cooling pipes to sump and remove saddle clamps. See **Fig. 53**.

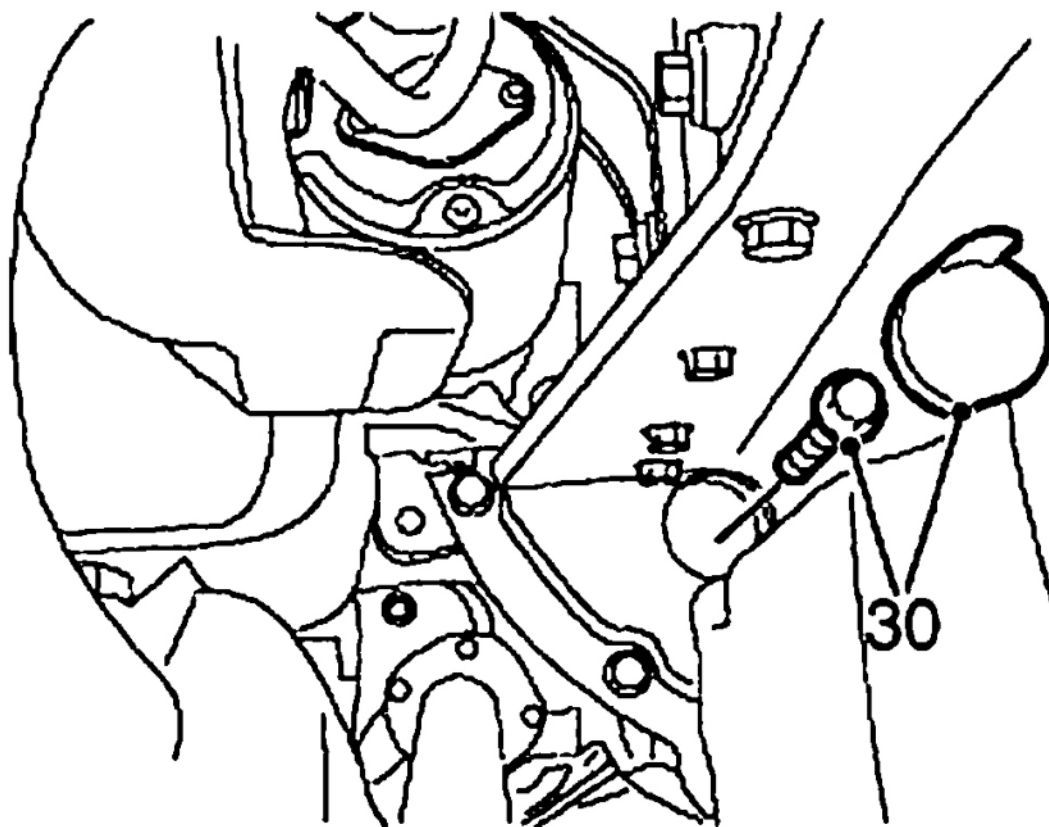


G00374085

Fig. 53: Bolts Securing Oil Cooling Pipes

Courtesy of LAND ROVER NORTH AMERICA, INC.

28. Tie oil cooling pipes aside.
29. Remove exhaust front pipe.
30. On models with automatic gearbox: Remove access plug and remove 4 bolts securing torque converter to drive plate. See **Fig. 54**.

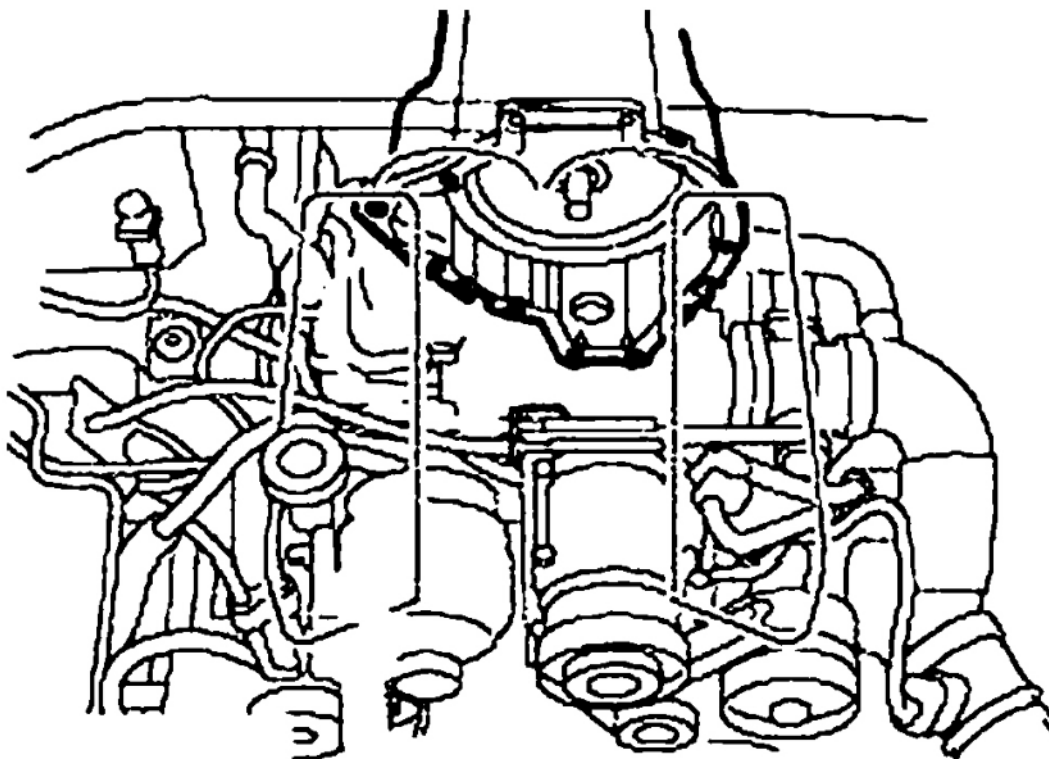


G00374086

Fig. 54: Access Plug & 4 Bolts Securing Torque Converter To Drive Plate

Courtesy of LAND ROVER NORTH AMERICA, INC.

31. Rotate engine to access bolts.
32. Remove 12 bolts securing engine to gearbox. DO NOT remove the top 2 bolts at this stage. See **Fig. 55**.

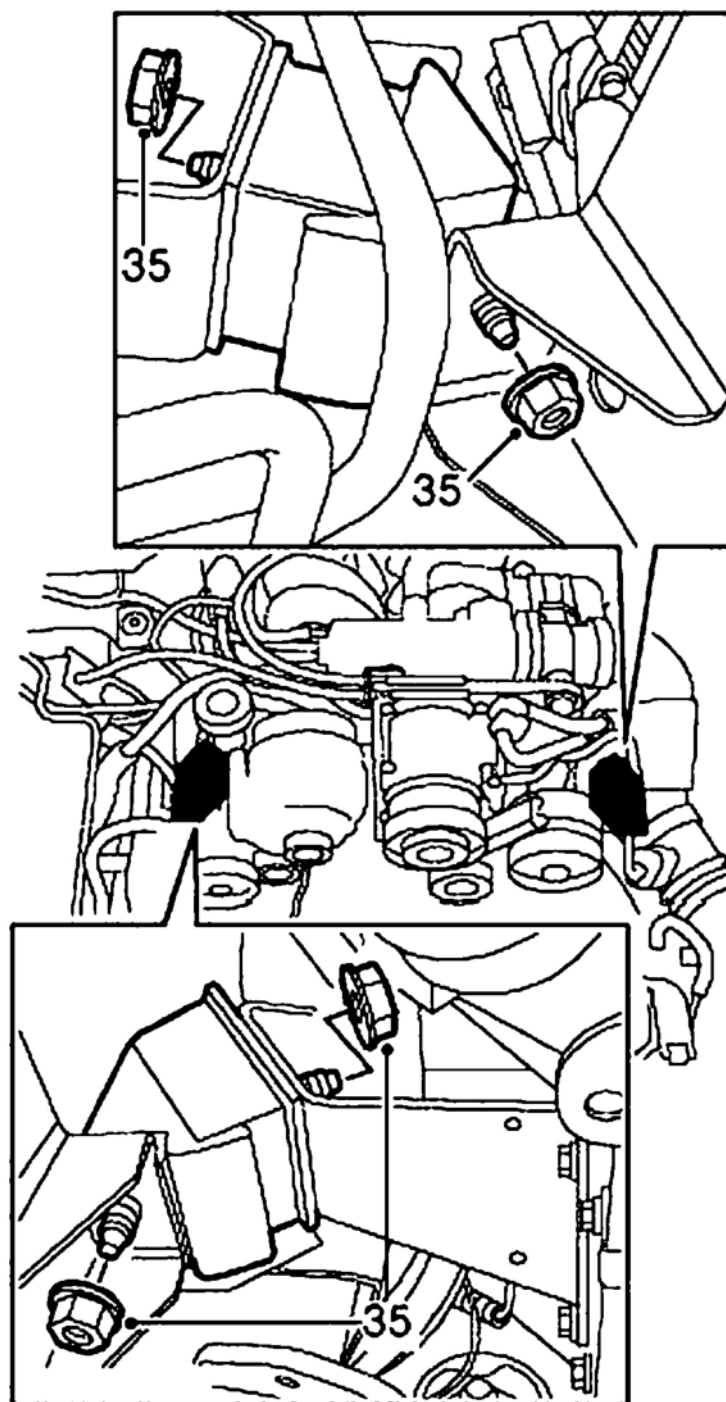


G00374087

Fig. 55: Gearbox Mounting Bolts

Courtesy of LAND ROVER NORTH AMERICA, INC.

33. Collect support brackets from bell housing bolts.
34. Attach suitable lifting equipment to engine.
35. Remove 4 nuts securing engine mountings, raise engine and remove engine mountings. See **Fig. 56**.

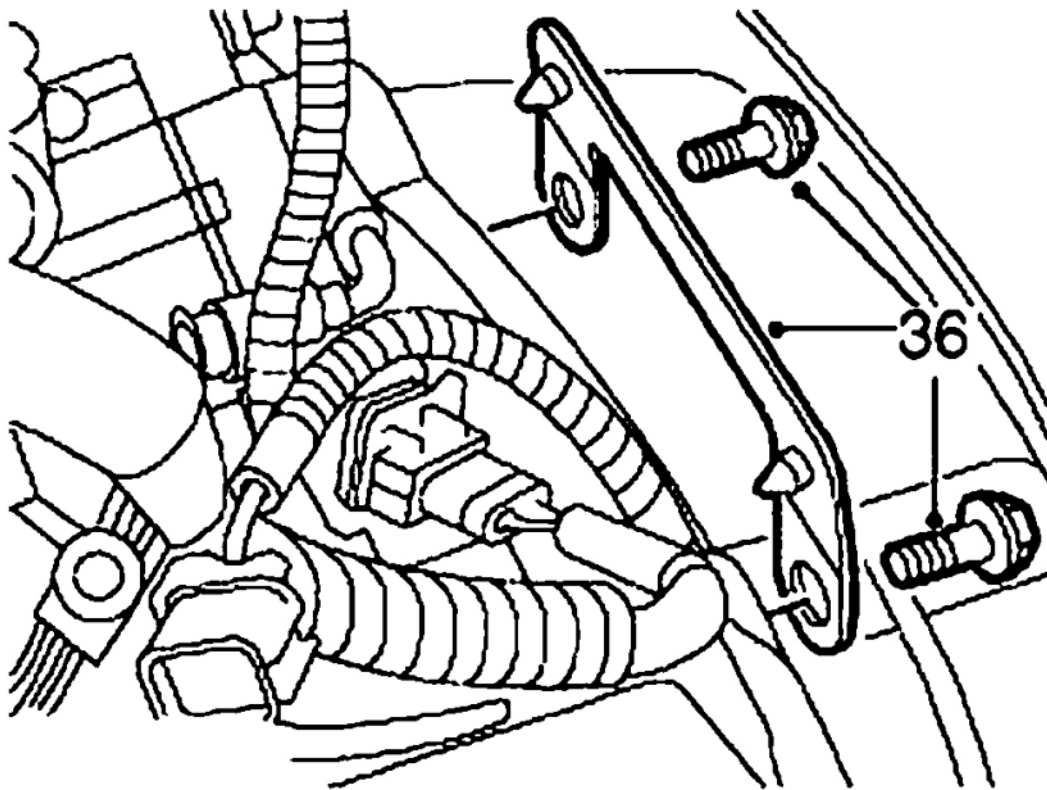


G00374088

Fig. 56: Engine Mounting Nuts

Courtesy of LAND ROVER NORTH AMERICA, INC.

36. Lower engine, remove top bolts securing engine to gearbox and collect bracket. See **Fig. 57**.



G00374089

Fig. 57: Gearbox Top Mounting Bolts

Courtesy of LAND ROVER NORTH AMERICA, INC.

37. Support gearbox on a jack.
38. Release engine from gearbox dowels.
39. With assistance remove engine from engine bay.

Installation

1. Clean mating faces of engine and gearbox, dowel and dowel holes.
2. Lubricate splines and bearing surface on first motion shaft with grease.
3. With assistance position engine in engine bay, align to gearbox and locate on dowels.
4. Position support brackets, fit bell housing bolts and tighten to 50 N.m (37 ft. lbs).
5. Position engine mountings, fit nuts and tighten to 85 N.m (63 ft. lbs).
6. Lower lifting equipment and remove from engine.
7. Models with automatic gearbox: Align torque converter to drive plate, fit bolts and tighten to 50 N.m (37 ft. lbs). Fit access plug.
8. Fit exhaust front pipe.

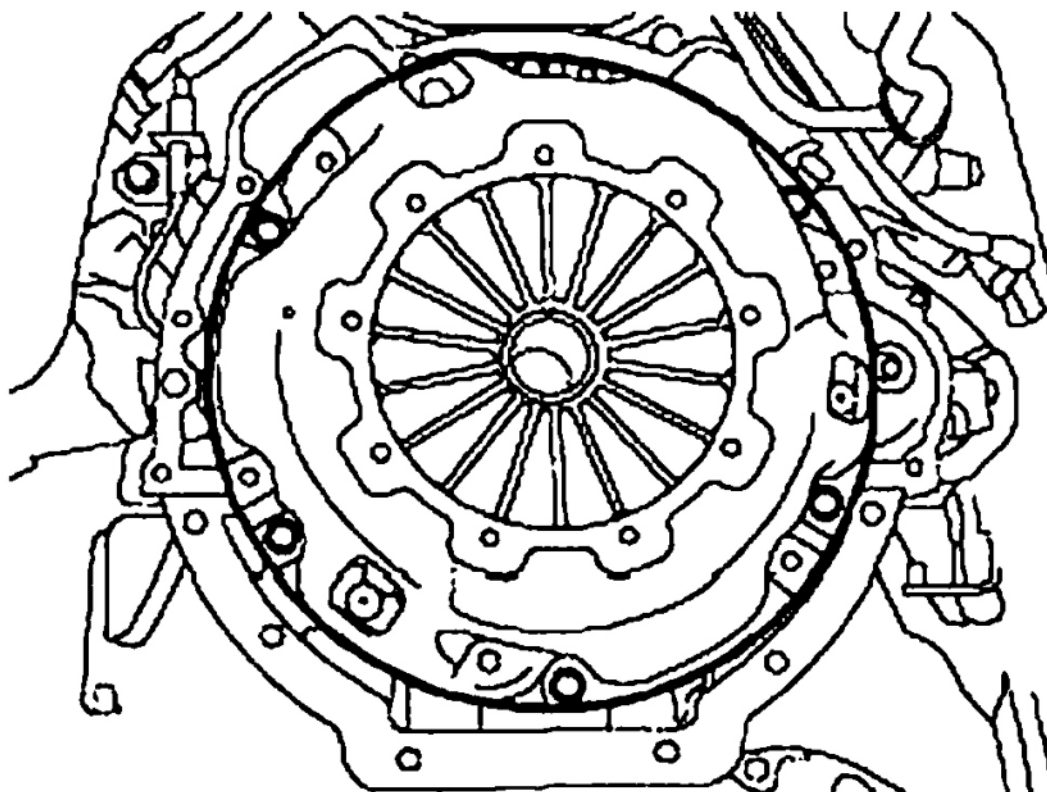
9. Position oil cooling pipe saddle clamps and tighten bolts.
10. Position engine harness into foot well.
11. Connect 5 multiplugs to ECM.
12. Fit toe board and secure with trim fixings.
13. Connect engine harness earth to body and secure with nut.
14. Connect engine harness to main harness multiplug.
15. Connect multiplug to EVAP purge valve.
16. Connect engine harness multiplugs to fuse box.
17. Connect starter lead to fuse box and secure with nut.
18. Connect engine harness positive lead to battery and tighten nut.
19. Fit fuse box cover.
20. Position engine earth lead and secure with bolt.
21. Position coolant rail and secure with bolt.
22. Connect harness clips to coolant rail.
23. Connect hose to coolant rail and coolant pump and secure with clips.
24. Connect PAS pump high and low pressure pipes and secure with clips.
25. Position oil cooling pipe saddle clamp to PAS pump housing and secure with bolt.
26. Clean A/C compressor and housing mating faces, dowels and dowel holes.
27. Position A/C compressor, fit bolts and tighten to 22 N.m (16 ft. lbs).
28. Connect multiplug to A/C compressor.
29. Clean ACE pump and housing mating faces, dowels and dowel holes.
30. Position ACE pump, fit bolts and tighten to 22 N.m (16 ft. lbs).
31. Clean all pulley VEE, fit auxiliary drive belt, using a 15-mm spanner, release belt tensioner secure belt and re-tension drive belt.
32. Ensure auxiliary drive belt is correctly located on all pulleys.
33. Fit radiator.
34. Fit top hose and secure with clips.
35. Connect fuel pipe to fuel rail.
36. Position ignition coils and connect hot leads.
37. Fit upper inlet manifold. See **GASKET - INLET MANIFOLD**.
38. Fit NEW oil filter and refill engine with oil. See **REPLACE** .
39. Top up gearbox oil. See **LUBRICATION** .

FLYWHEEL

Removal

1. Remove manual gearbox.
2. Restrain flywheel.

3. Working in sequence, progressively slacken 6 bolts securing clutch cover to flywheel. Remove bolts. See **Fig. 58**.

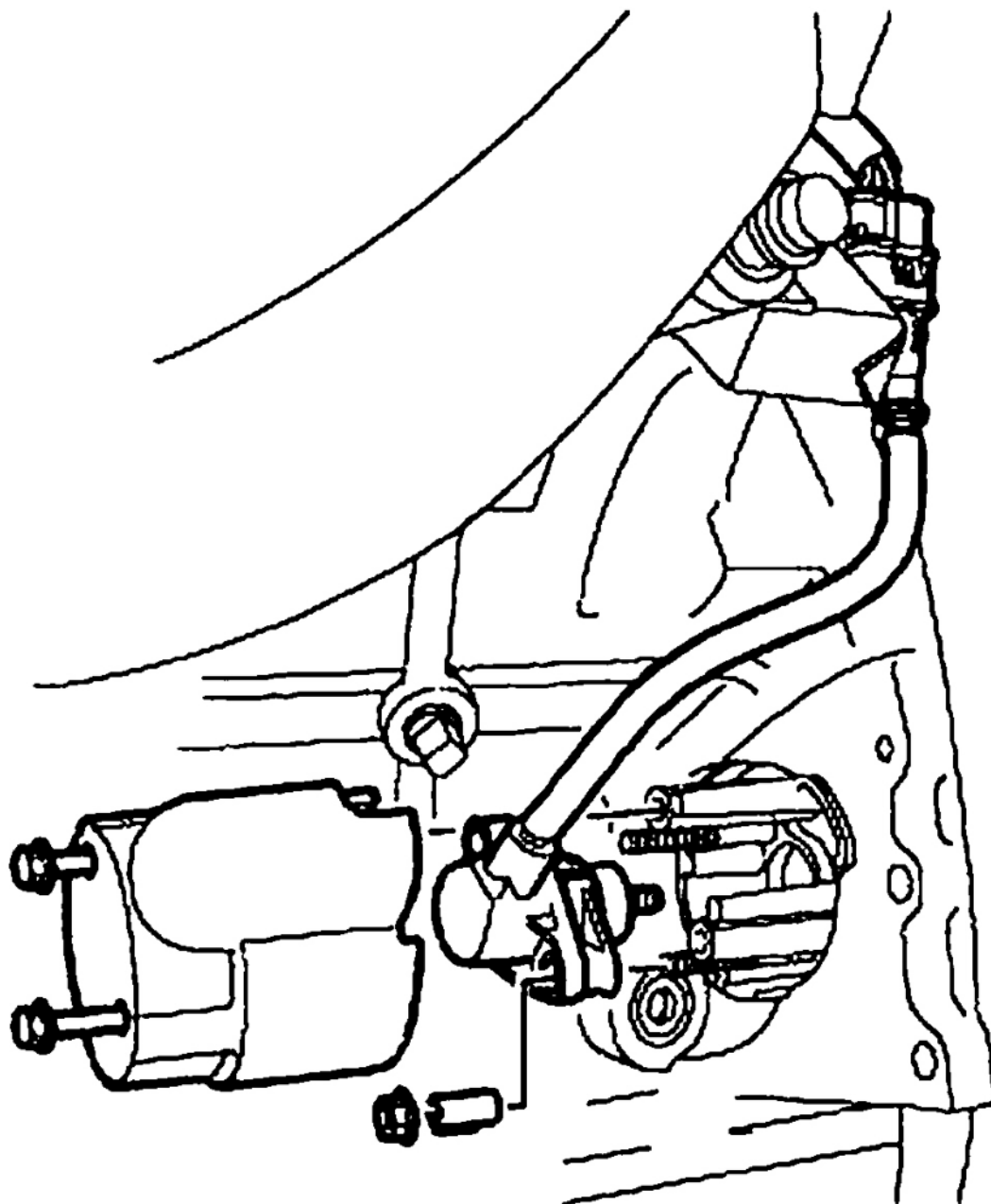


G00374090

Fig. 58: Clutch Cover From Flywheel

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Remove clutch cover.
5. Remove clutch plate.
6. Release Crankshaft Position (CKP) sensor multiplug from bracket. See **Fig. 59**.

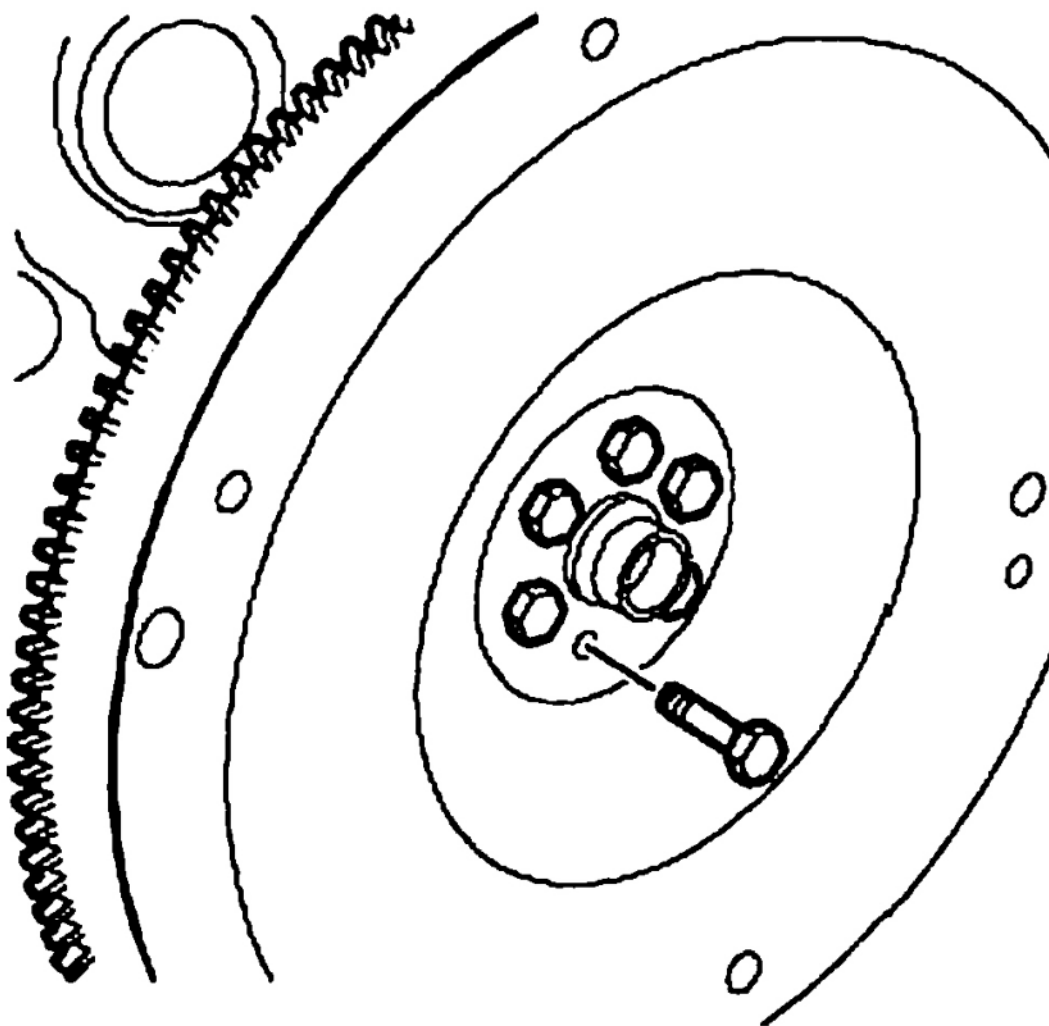


G00374091

Fig. 59: Crankshaft Position (CKP) Sensor Multiplug
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Remove 2 bolts securing crankshaft sensor cover.
8. Remove crankshaft sensor cover.
9. Remove 2 nuts securing crankshaft sensor.

10. Remove crankshaft sensor.
11. Remove 6 bolts securing flywheel. See **Fig. 60**.



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Fig. 60: Flywheel

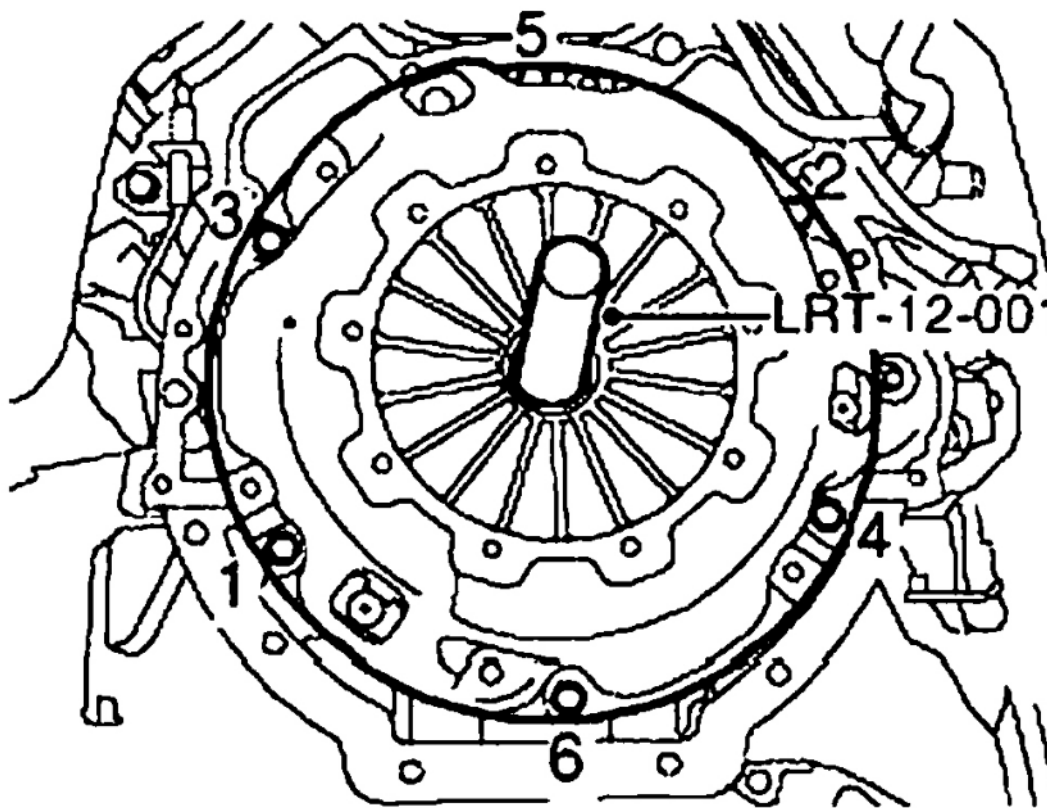
Courtesy of LAND ROVER NORTH AMERICA, INC.

NOTE: On early engines, balance weights are on engine side of flywheel; replacement flywheels will have balance weights on clutch side of flywheel.

12. Remove flywheel.

Installation

1. Clean mating faces of flywheel and crankshaft, dowel and dowel hole. Ensure bolt holes in crankshaft are clean and dry.
2. Fit flywheel to crankshaft and tighten bolts to 78 N.m (58 ft. lbs).
3. Clean crankshaft sensor and mating face.
4. Fit crankshaft sensor and tighten nuts to 6 N.m (4.4 ft. lbs).
5. Fit crankshaft sensor cover and tighten bolts to 6 N.m (5 ft. lbs).
6. Fit crankshaft sensor multiplug to bracket.
7. Clean clutch cover, drive plate and spigot bush in end of crankshaft. Renew worn components as necessary.
8. If refitting existing drive plate, apply Molycote FB 180 to splines.
9. Fit alignment tool LRT-12-001 to spigot bearing in crankshaft. See **Fig. 61**.



G00374093

Fig. 61: Clutch Cover Bolt Tightening Sequence

Courtesy of LAND ROVER NORTH AMERICA, INC.

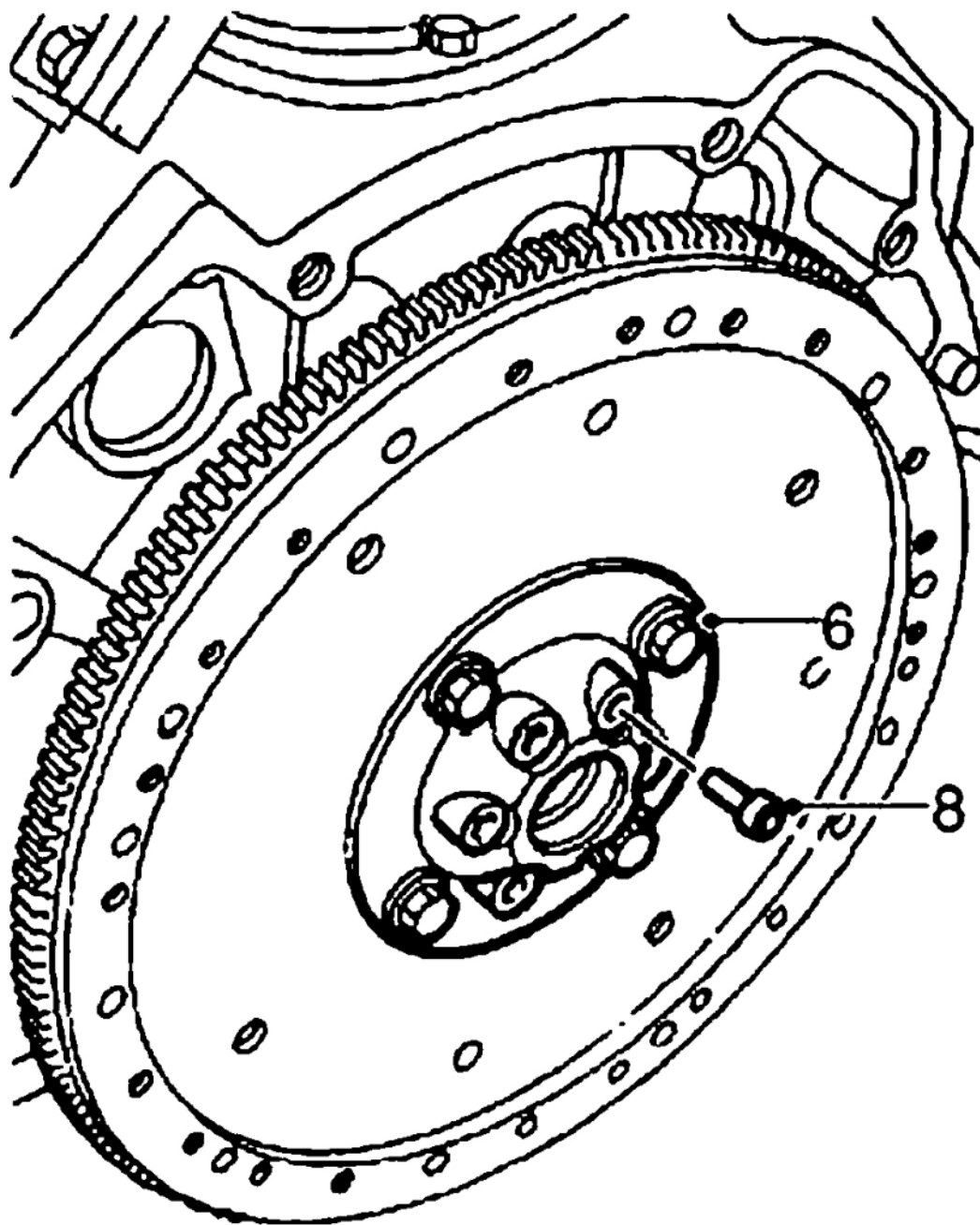
10. Fit drive plate onto tool LRT-12-001 ensure side marked FLYWHEEL SIDE is towards flywheel.
11. Fit clutch cover and locate on dowels.

12. Fit clutch cover bolts and tighten in diagonal sequence to 40 N.m (30 ft. lbs).
13. Fit gearbox assembly.

PLATE - DRIVE - AUTOMATIC**Removal**

NOTE: Later engines are fitted with a modified starter ring gear which incorporates the reluctor plate, spacer and hub. The modified ring gear may be fitted as a replacement to early engines.

1. Remove automatic gearbox. See **REMOVAL & INSTALLATION - AUTOMATIC TRANSMISSION**.
2. Remove 2 bolts securing CKP sensor cover.
3. Remove Crankshaft Position (CKP) sensor cover. See **Fig. 59**.
4. Remove 2 nuts securing CKP sensor.
5. Remove CKP sensor.
6. Early engines: Remove 4 bolts securing drive plate clamp ring and remove ring. See **Fig. 62**.



G00374095

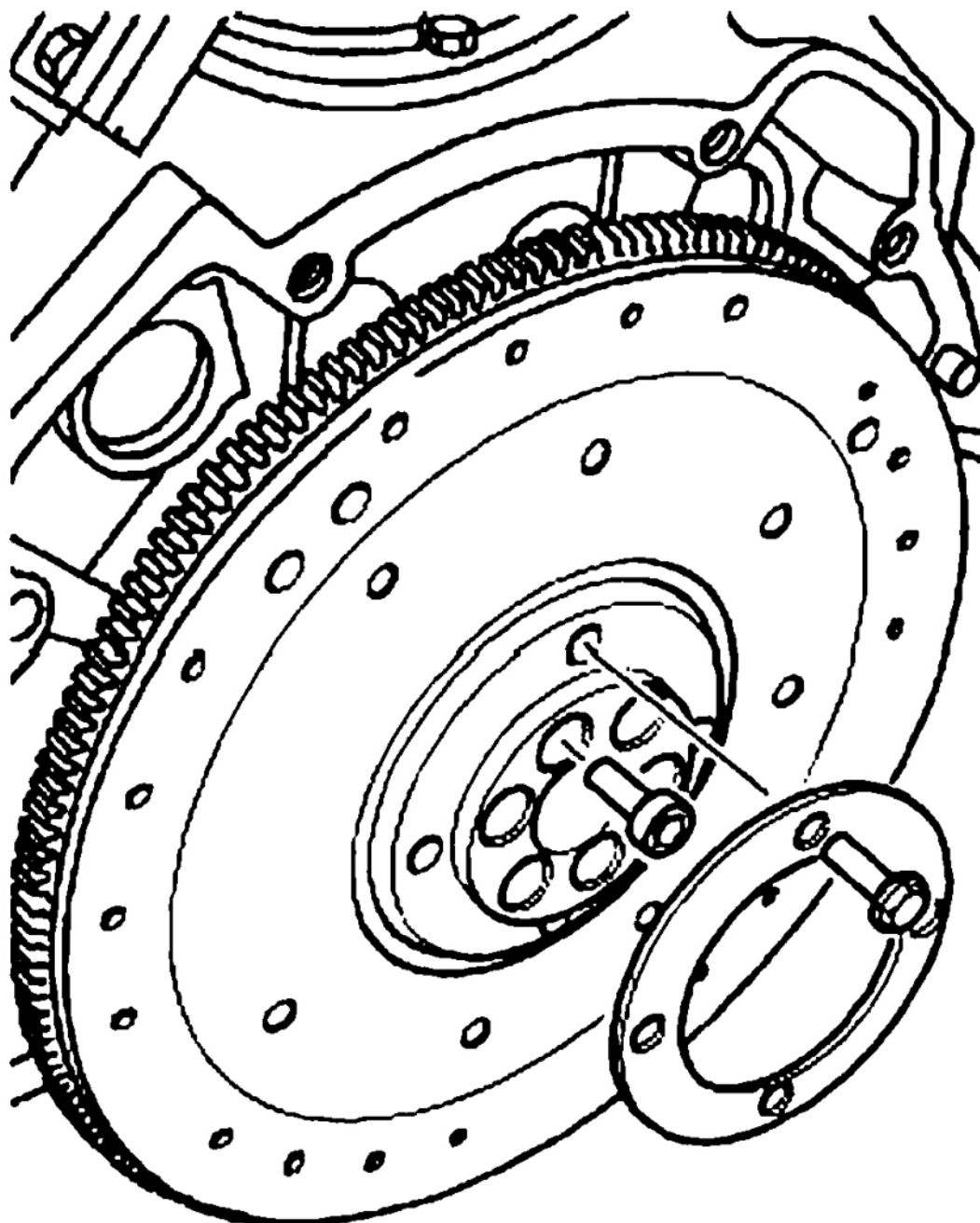
Fig. 62: A/T Drive Plate (Early Engine)

Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Early engines: Remove drive plate from hub.
8. Early engines: Remove 6 Allen bolts securing hub and starter ring gear, remove hub, starter ring gear and collect spacer. On early engines, balance weights are on engine side of drive plate; replacement drive

plates will have balance weights on torque converter side of drive plate.

9. Later engines: Remove 4 bolts securing drive plate clamp ring and remove ring. See **Fig. 63**.



G00374096

Fig. 63: A/T Drive Plate (Later Engine)

Courtesy of LAND ROVER NORTH AMERICA, INC.

10. Later engines: Remove drive plate.
11. Later engines: Remove 6 Allen bolts securing starter ring gear to crankshaft; remove starter ring gear.

Installation

1. All engines: Ensure bolt holes in crankshaft are clean and dry.
2. All engines: Clean all component.
3. All engines: Check that drive plate is free from cracks and distortion.
4. Early engines: Fit hub, starter ring gear and spacer to crankshaft, fit Allen bolts and tighten to 78 N.m (58 ft. lbs).
5. Early engines: Fit drive plate and clamp ring, fit bolts and tighten to 45 N.m (33 ft. lbs).
6. Later engines: Fit starter ring gear, fit Allen bolts and tighten to 85 N.m (63 ft. lbs).
7. Later engines: Fit drive plate and clamp ring, fit bolts and tighten to 45 N.m (33 ft. lbs).
8. Clean CKP sensor and mating face.
9. Fit crankshaft sensor and tighten nuts to 6 N.m (5 ft. lbs).
10. Fit CKP sensor cover and tighten bolts to 6 N.m (5 ft. lbs).
11. Fit CKP sensor multiplug to bracket.
12. Fit automatic gearbox. See **REMOVAL & INSTALLATION - AUTOMATIC TRANSMISSION** .

RING GEAR - STARTER**Removal**

1. Remove flywheel. See **FLYWHEEL**.
2. Drill a 3 mm (0.12 in) diameter hole at root of 2 teeth. See **Fig. 64**.

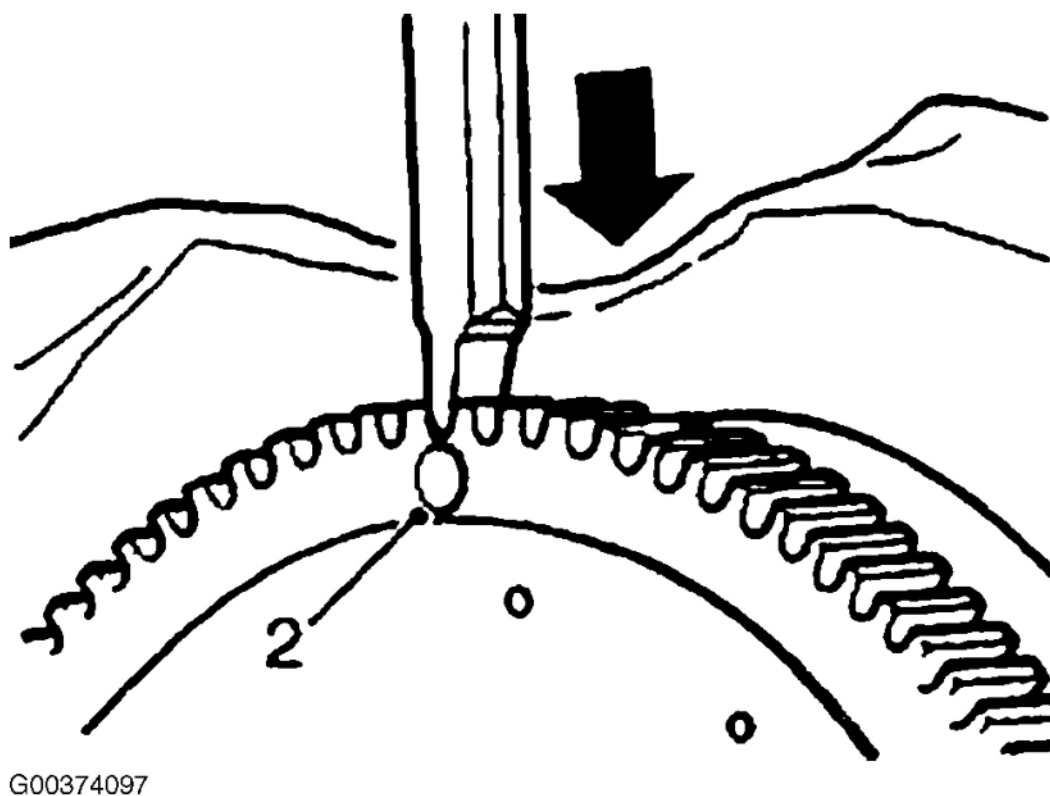


Fig. 64: Drilling Ring Gear

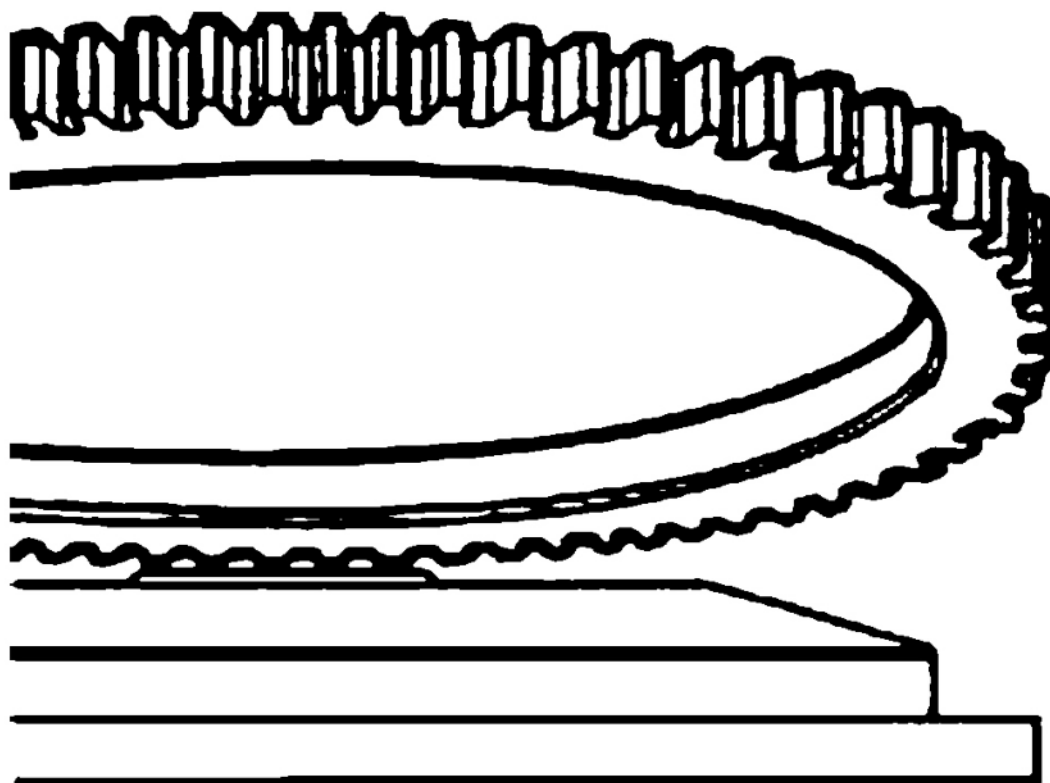
Courtesy of LAND ROVER NORTH AMERICA, INC.

WARNING: SUITABLE EYE PROTECTION MUST BE WORN.

3. Apply a cold chisel in root of one of ring gear teeth, strike chisel with hammer to break ring gear.
4. Remove starter ring gear.

Installation

1. Clean flywheel and starter ring gear.
2. Heat NEW starter ring gear evenly to 350°C (660°F), indicated when the ring is a Light Blue color. See **Fig. 65**.



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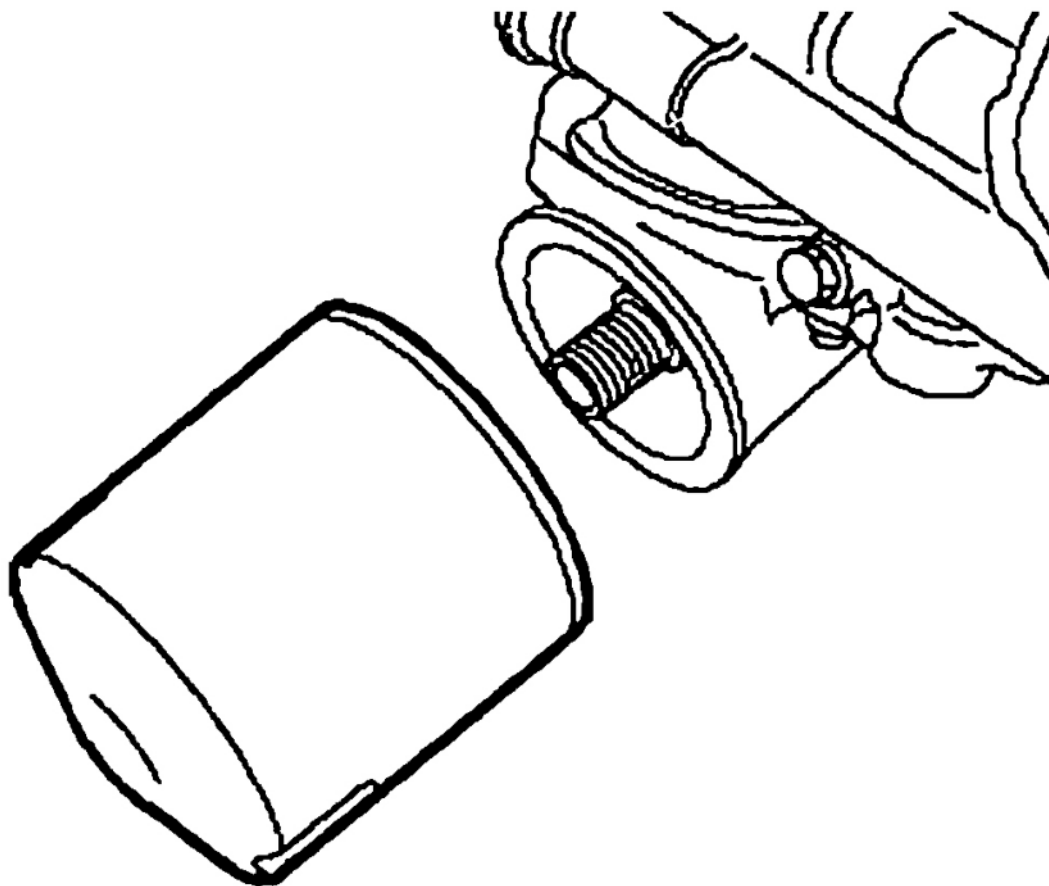
Fig. 65: Ring Gear

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Locate ring gear on flywheel and press ring gear hard against flange on flywheel.
4. Ensure ring gear is correctly seated around the complete circumference of flywheel and allow to cool.
5. Fit flywheel. See **FLYWHEEL**.

FILTER - OIL**Removal**

1. Clean area around filter head and place a container beneath engine.
2. Using a strap wrench, unscrew and discard filter. See **Fig. 66**.



G00374094

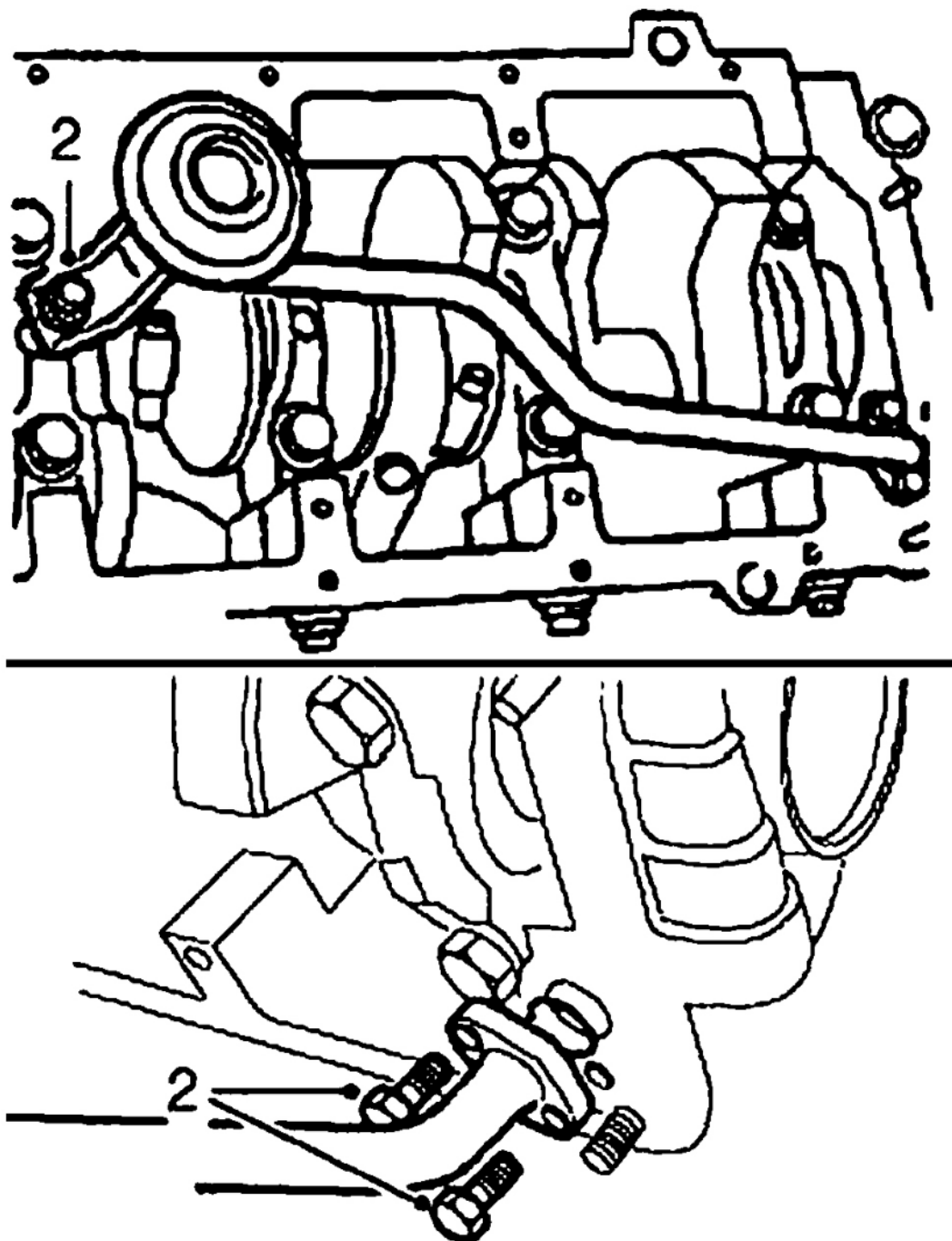
Fig. 66: Oil Filter**Courtesy of LAND ROVER NORTH AMERICA, INC.****Installation**

1. Clean mating face of filter head.
2. Lubricate sealing ring of NEW filter with clean engine oil.
3. Fit filter and tighten by hand until it seats then tighten a further half turn.
4. Start and run engine to check for leaks.
5. Stop engine, wait a few minutes, then check oil level.
6. Top up engine oil.

STRAINER - OIL PICK-UP**Removal**

1. Remove sump gasket. See **GASKET - SUMP**.

2. Remove 2 bolts and one nut securing oil pick-up strainer. See **Fig. 67**.



G00374099

Fig. 67: Oil Pick-Up Strainer

Courtesy of LAND ROVER NORTH AMERICA, INC.

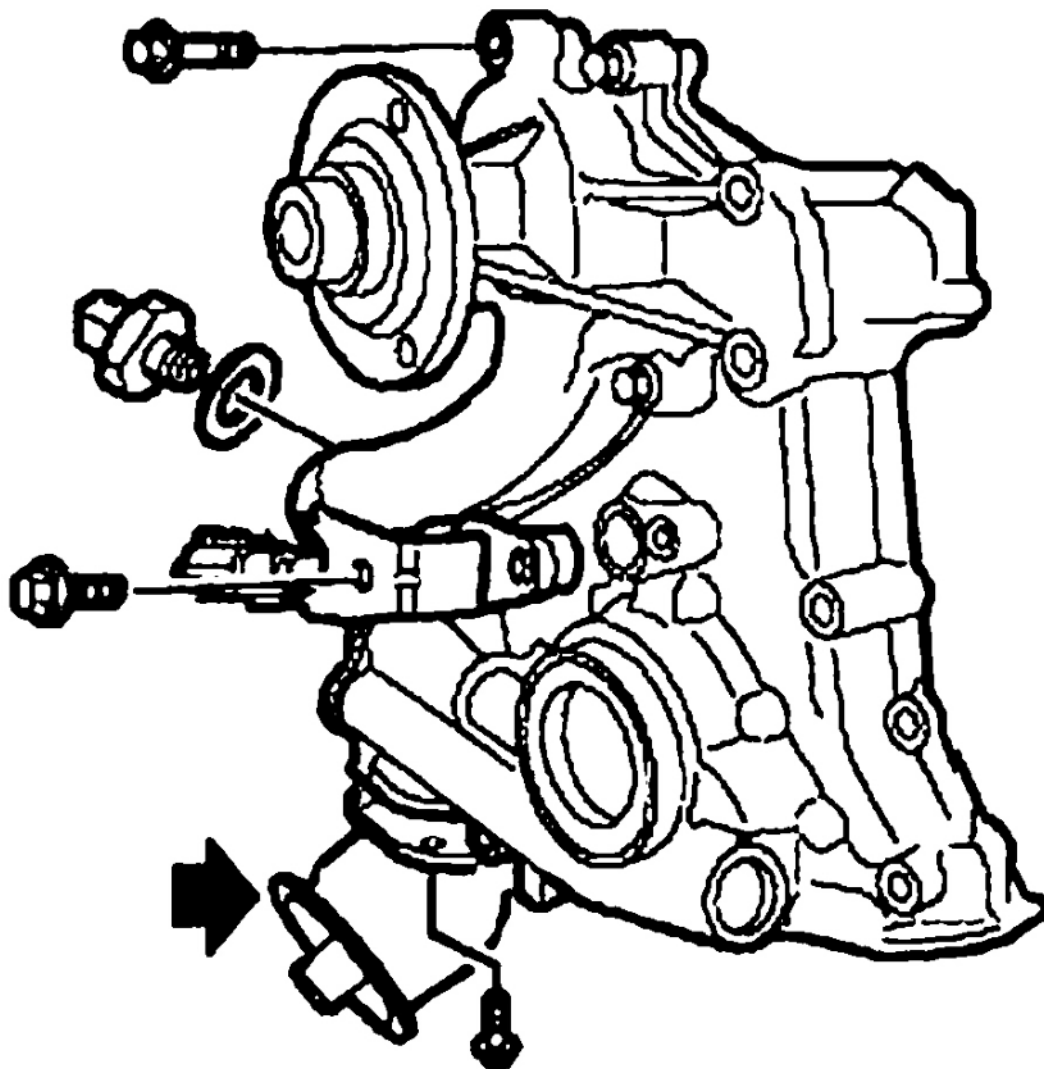
3. Remove oil pick-up strainer.
4. Collect spacer from stud.
5. Remove and discard "O" ring.

Installation

1. Clean oil pick up strainer and "O" ring recess.
2. Lubricate and fit NEW "O" ring.
3. Locate spacer on stud.
4. Position oil pick-up strainer, fit bolts and tighten to 10 N.m (8 ft. lbs). Fit nut and tighten to 22 N.m (16 ft. lbs).
5. Fit NEW sump gasket. See **GASKET - SUMP**.

PUMP - OIL**Removal**

1. Remove timing gear cover gasket. See **GASKET - TIMING GEAR COVER**.
2. Remove bolt securing CMP sensor, remove clamp and sensor. See **Fig. 68**.



G00374100

Fig. 68: CMP Sensor & Coolant Pump

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove 6 bolts securing coolant pump, remove pump and discard gasket.
4. Remove oil pressure switch and discard sealing washer.
5. Remove 4 bolts securing oil filter head, remove filter head and discard 2 "O" rings.
6. Remove filter head adaptor.

Installation

1. Ensure filter head adaptor is clean.

2. Fit filter head adaptor and tighten bolts to 13 N.m (9 ft. lbs).
3. Clean filter head and mating face.
4. Fit NEW "O" rings to filter head and filter head adaptor.
5. Fit filter head and tighten bolts to 8 N.m (6 ft. lbs).
6. Ensure oil pressure switch and mating face is clean.
7. Fit NEW sealing washer and tighten switch to 15 N.m (11 ft. lbs).
8. Clean coolant pump and mating face.
9. Use a NEW gasket and fit coolant pump. Tighten bolts securing coolant pump to 25 N.m (19 ft. lbs).
10. Ensure CMP sensor is clean and fit sensor to cover.
11. Fit clamp to CMP sensor and tighten bolt to 8 N.m (6 ft. lbs).
12. Fit timing gear cover gasket. See **GASKET - TIMING GEAR COVER**.

GASKET - SUMP

Removal

1. Release fixings and remove battery cover.
2. Disconnect battery earth lead.
3. Remove dipstick.
4. Raise the vehicle on a ramp.
5. Drain engine oil. See **REPLACE** .
6. Remove 8 bolts securing cross member and remove cross member. See **Fig. 69**.

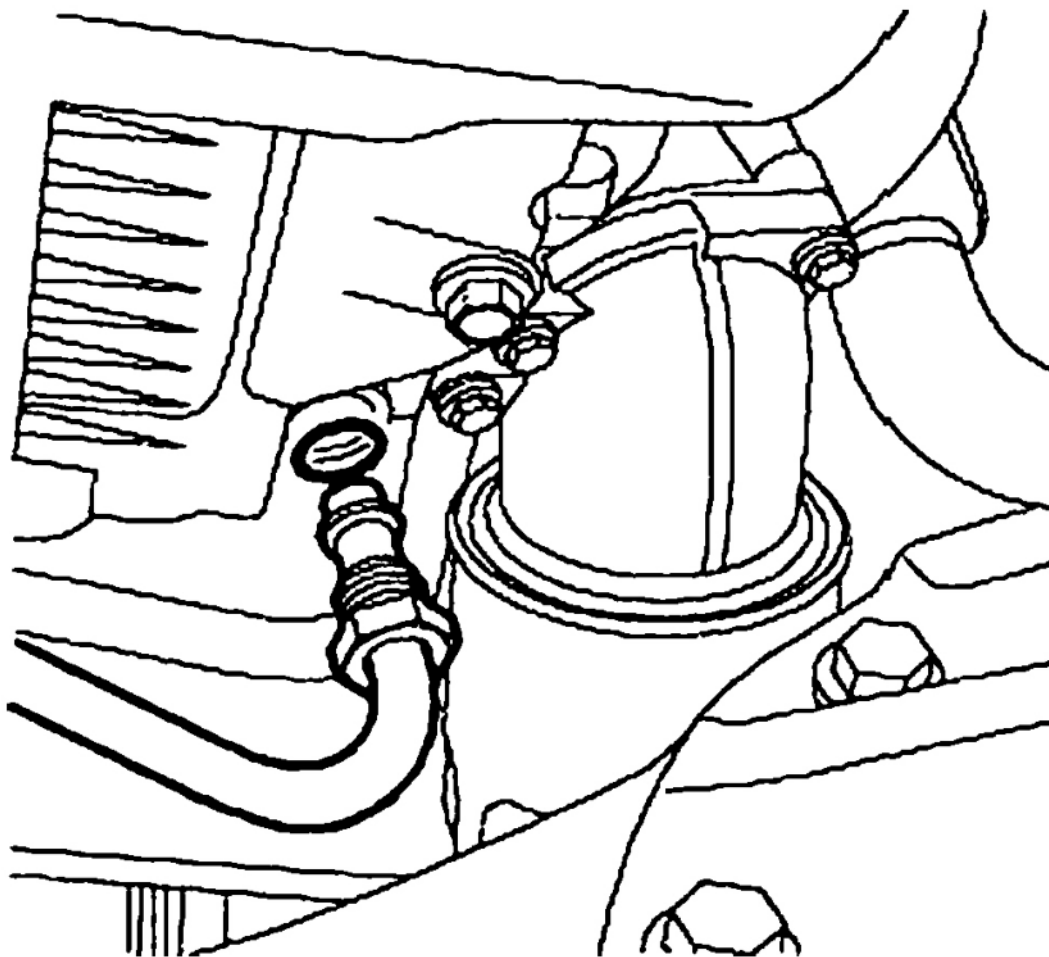


G00374101

Fig. 69: Cross Member

Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Raise front of vehicle under body to increase clearance between engine and front axle.
8. Disconnect and release gearbox oil cooler pipe and discard "O" ring. See **Fig. 70**.

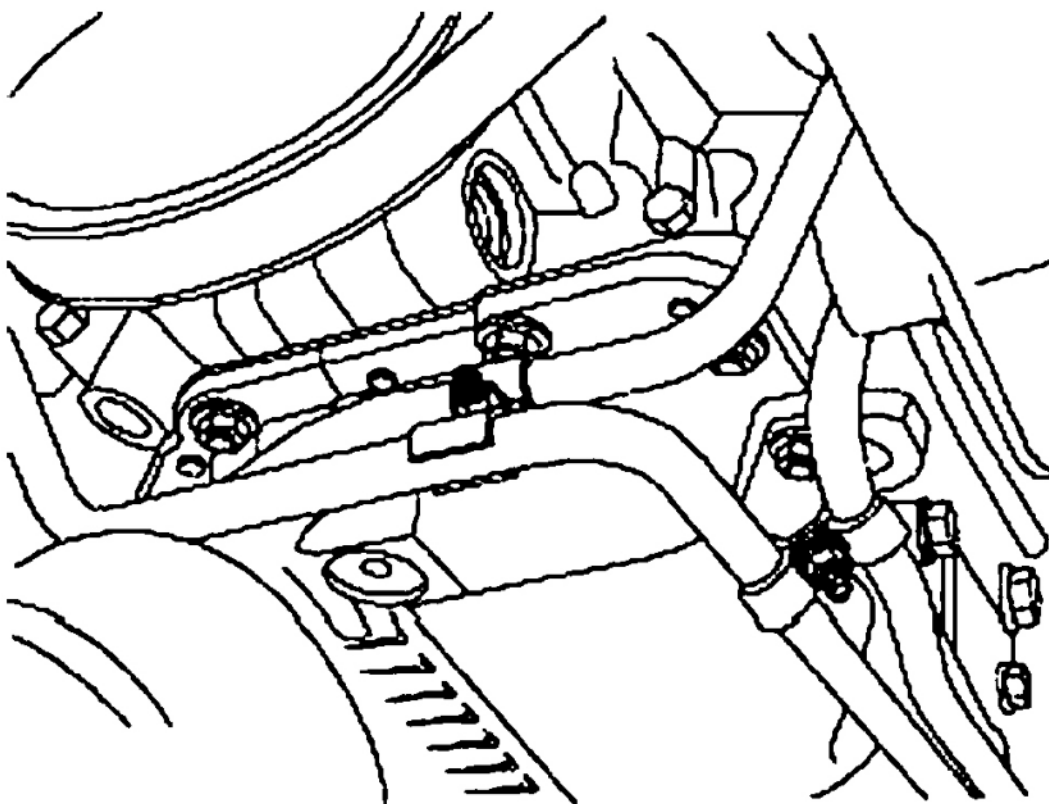


G00374102

Fig. 70: Gearbox Oil Cooler Pipe

Courtesy of LAND ROVER NORTH AMERICA, INC.

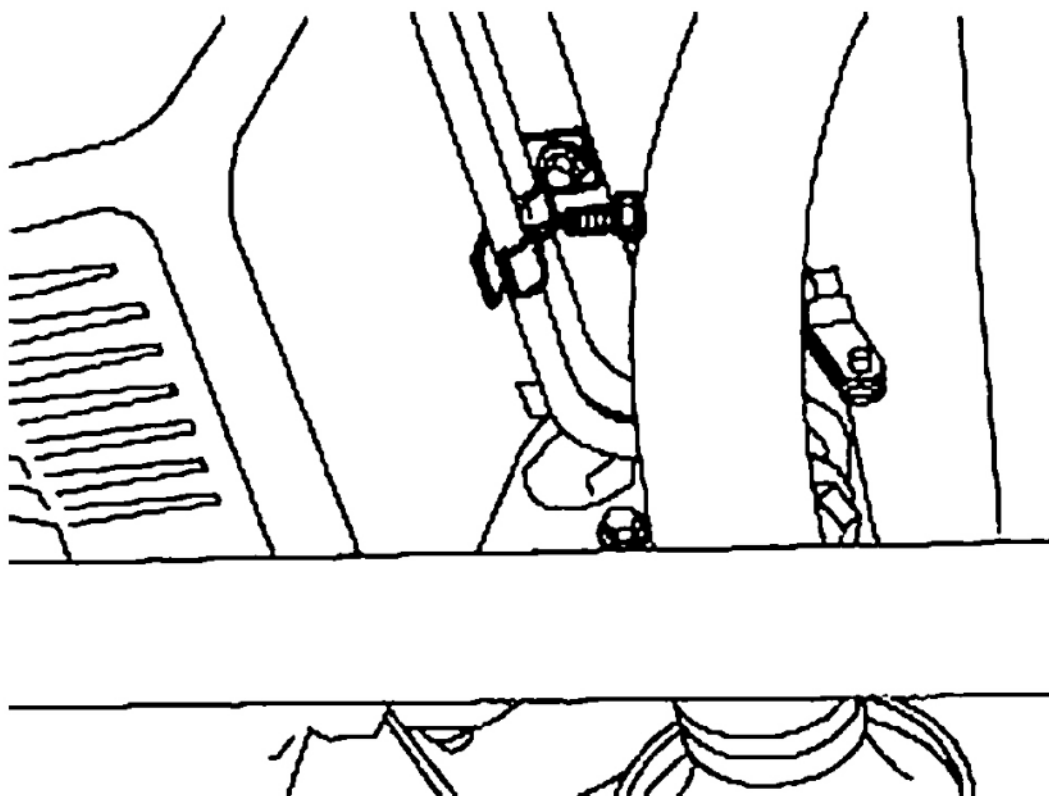
9. Remove 2 clips securing oil cooler pipes at front of sump. See **Fig. 71**.



G00374103

Fig. 71: Gearbox Oil Cooler Pipe Clips At Front Of Sump
Courtesy of LAND ROVER NORTH AMERICA, INC.

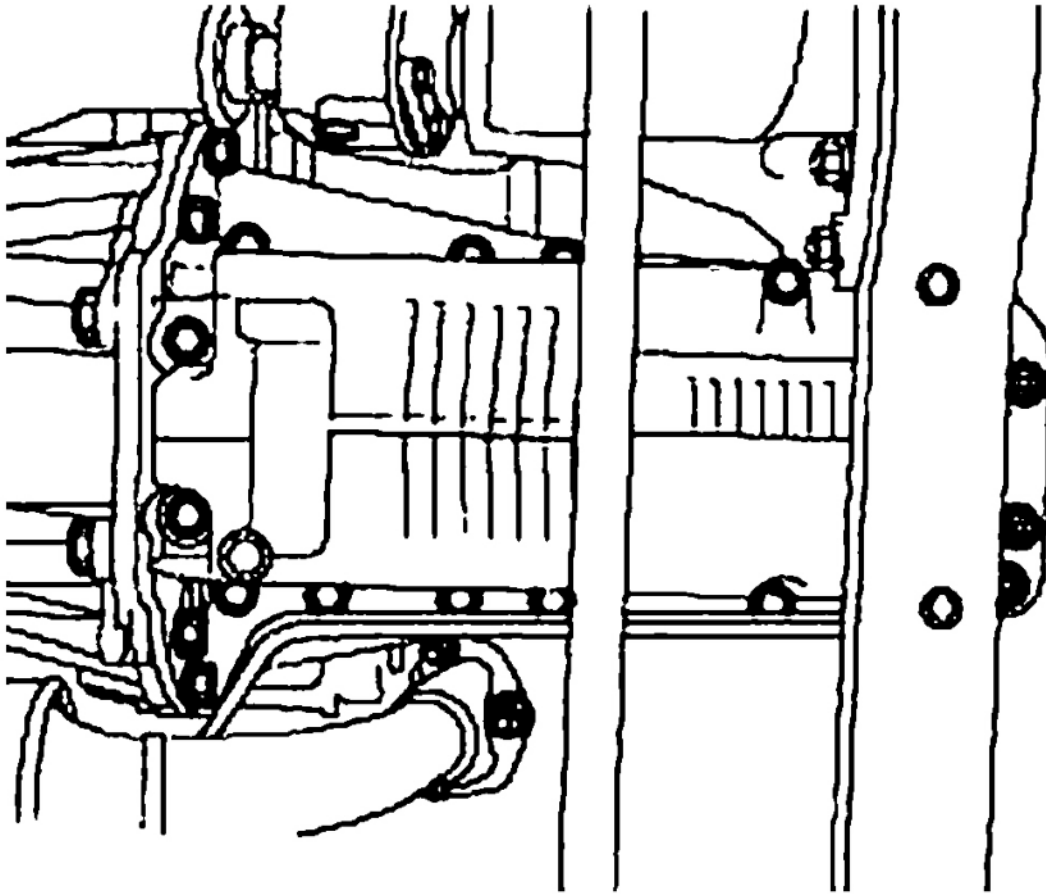
10. Remove clip securing oil cooler pipes to side of sump. See **Fig. 72**.



G00374104

Fig. 72: Gearbox Oil Cooler Pipe Clip At Side Of Sump
Courtesy of LAND ROVER NORTH AMERICA, INC.

11. Remove clip bracket.
12. Remove 2 forward facing bolts securing sump to bell housing. See **Fig. 73**.



G00374105

Fig. 73: Sump Bolts

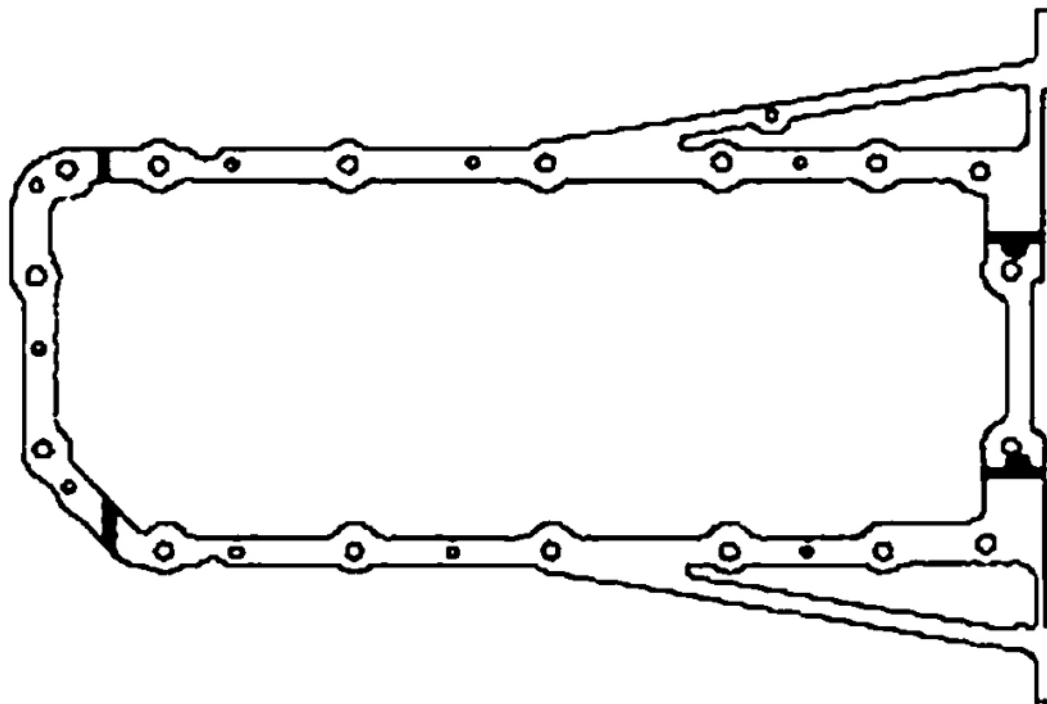
Courtesy of LAND ROVER NORTH AMERICA, INC.

13. Remove 4 rear facing bolts securing sump to bell housing.
14. Remove 2 bolts in sump recess.
15. Remove 3 nuts securing front of sump.
16. Remove 12 bolts securing sump flange to engine.
17. Maneuver sump over front axle and remove sump.
18. Discard sump gasket.

Installation

1. Clean all traces of sealant from the sump and sump mating faces using a plastic scraper or solvent.
2. Ensure bolt holes in cylinder block are clean and dry.
3. Apply a 5 mm (0.2 in) wide bead of sealant, Part No. STC 50550, across the cylinder block to front cover joint and across the cylinder block to rear main bearing joint. Apply a globule of sealant to cover the ends

of the cruciform seals. See **Fig. 74**.

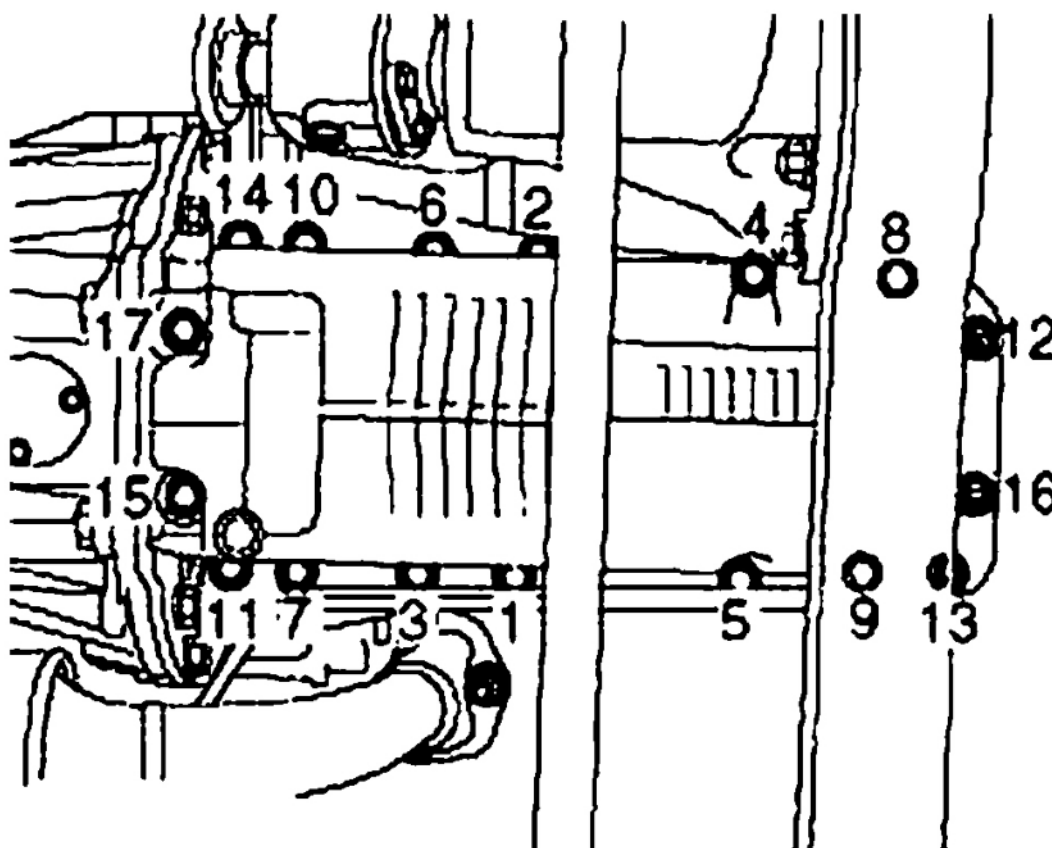


G00374106

Fig. 74: Identifying Sump Sealant Locations

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Fit NEW gasket, dry, to sump, ensuring that locating tags are correctly positioned.
5. Maneuver sump into position, fit and lightly tighten 2 bolts to retain sump in place, then fit and lightly tighten remainder of bolts.
6. Working in the sequence illustrated, tighten the sump bolts to 22 N.m (16 ft. lbs). See **Fig. 75**.



G00374107

Fig. 75: Sump Bolts Tightening Sequence

Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Position side clip bracket, fit and tighten bolt.
8. Position oil cooler pipe clips, fit and tighten nuts.
9. Clean gearbox oil cooler pipe "O" ring recess and mating face.
10. Lubricate and fit NEW "O" ring to gearbox oil cooler pipe.
11. Position pipe and tighten nut.
12. Lower front of vehicle.
13. Position cross member to chassis, fit bolts and tighten to 25 N.m (18 ft. lbs).
14. Refill engine oil and fit dipstick.
15. Connect battery earth lead.
16. Fit battery cover and retain with fixings.

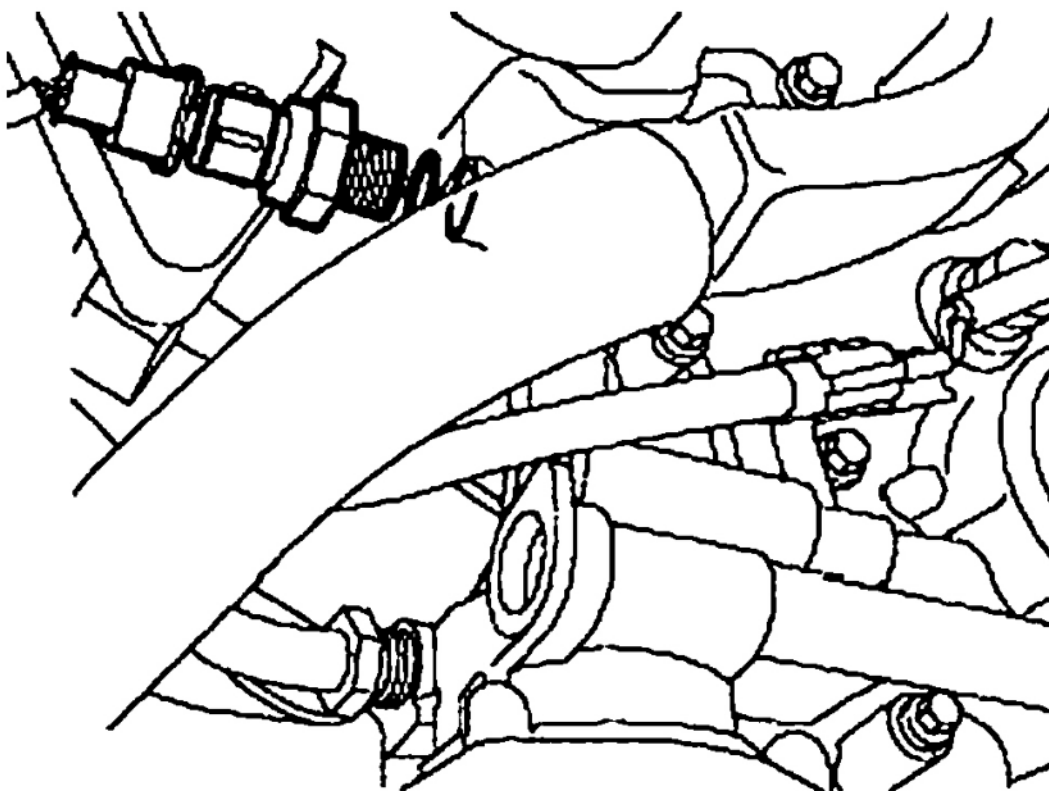
SWITCH - OIL PRESSURE

Removal

1. Release fixings and remove battery cover.
2. Disconnect battery earth lead.

WARNING: DO NOT work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

3. Raise front of vehicle.
4. Remove fixings and remove underbelly panel.
5. Disconnect multiplug from oil pressure switch. See **Fig. 76**.



G00374108

Fig. 76: Oil Pressure Switch Multiplug
Courtesy of LAND ROVER NORTH AMERICA, INC.

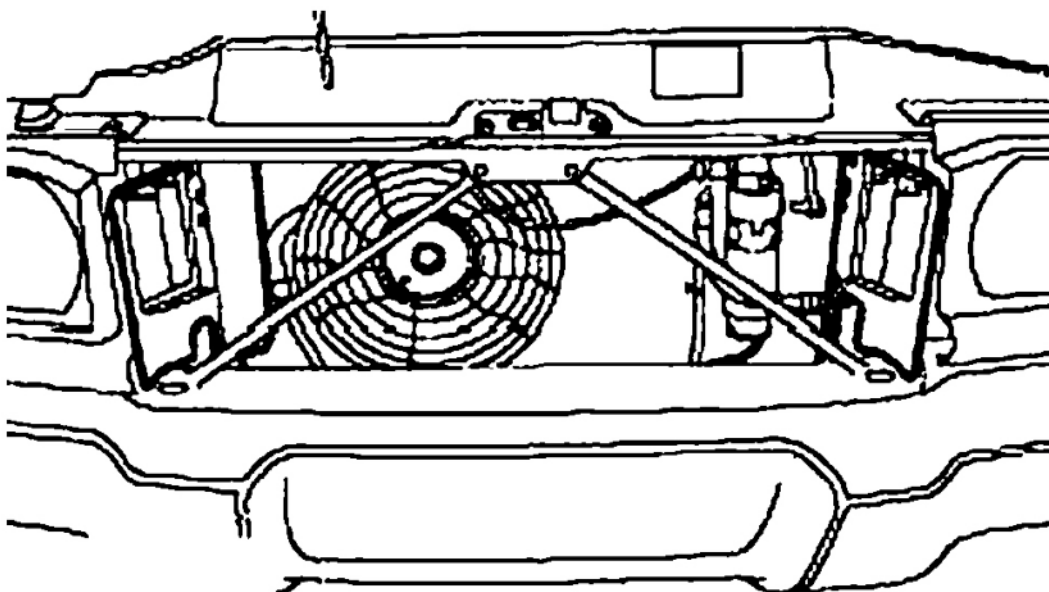
6. Position container below switch to catch oil spillage.
7. Remove oil pressure switch and discard sealing washer.

Installation

1. Clean oil pressure switch threads.
2. Fit NEW sealing washer to switch.
3. Fit oil pressure switch and tighten to 15 N.m (11 ft. lbs).
4. Connect multiplug to oil pressure switch.
5. Fit underbelly panel and secure with fixings.
6. Remove stand(s) and lower vehicle.
7. Connect battery earth lead.
8. Fit battery cover and retain with fixings.
9. Top up engine oil.

COOLER - ENGINE OIL**Removal**

1. Release fixings and remove battery cover.
2. Release fixings and remove cooling fan cowl.
3. Remove front grille. See **REMOVE**.
4. Remove 6 scrivenets and remove left and right air deflectors from front panel. See **Fig. 77**.

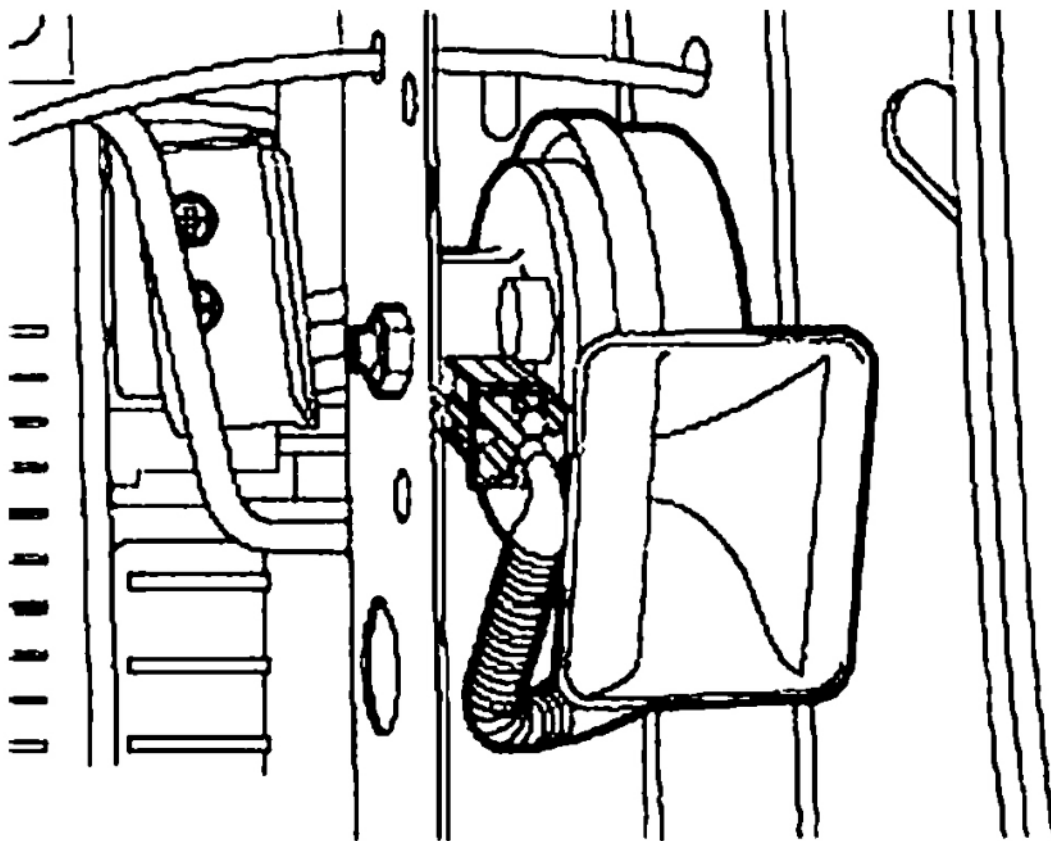


G00374109

Fig. 77: Front Panel Air Deflectors

Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Remove nut and move left horn aside. See **Fig. 78**.

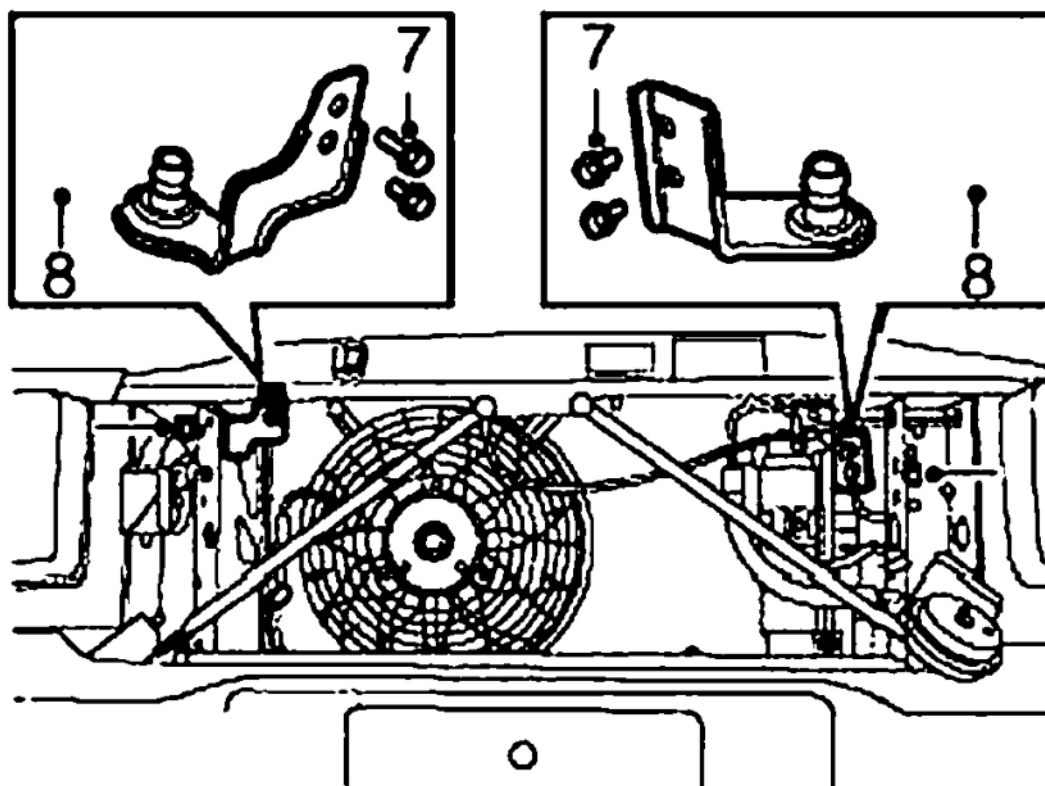


G00374110

Fig. 78: Left Horn

Courtesy of LAND ROVER NORTH AMERICA, INC.

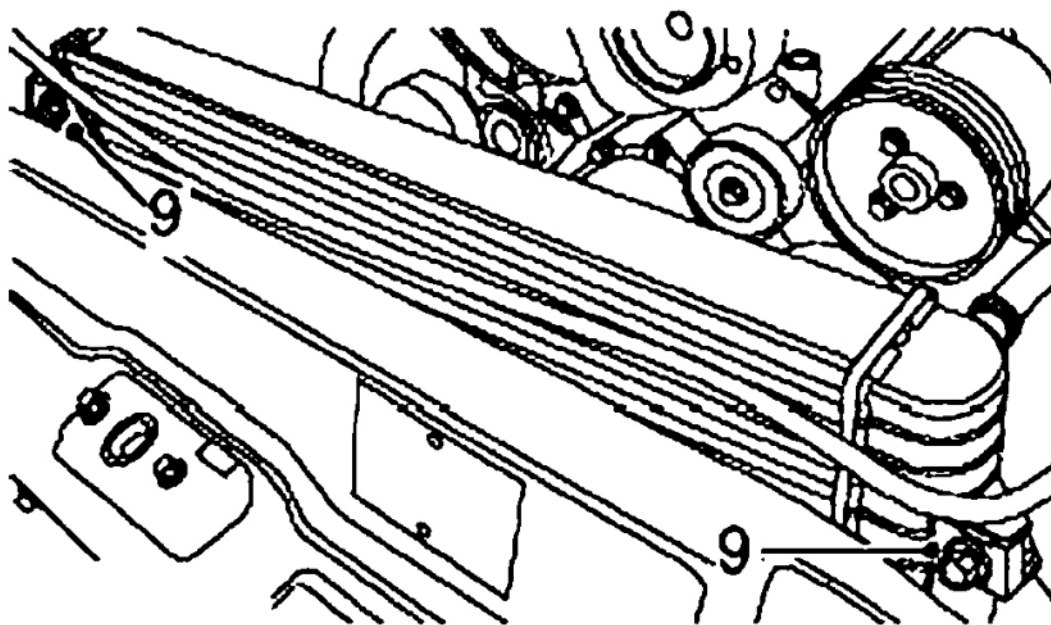
6. Remove 2 bolts securing radiator left and right upper mounting brackets to body panel and remove brackets. See **Fig. 79**.



G00374111

Fig. 79: Radiator Left & Right Upper Mounting Brackets
 Courtesy of LAND ROVER NORTH AMERICA, INC.

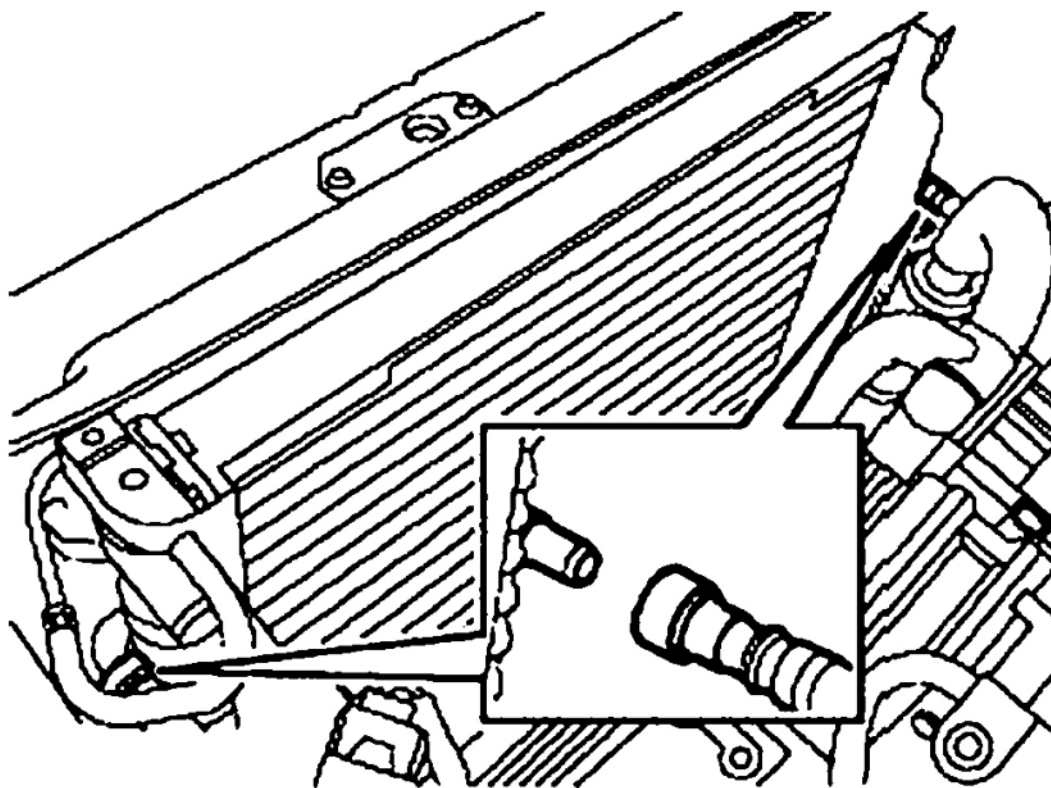
7. Remove 4 screws securing air conditioning condenser left and right upper mounting brackets to condenser.
8. Remove condenser upper mounting brackets with rubber mounts from radiator extension brackets.
9. Remove 2 bolts securing left and right extension brackets to radiator and remove brackets. See **Fig. 80**.



G00374112

Fig. 80: Left & Right Radiator Extension Brackets
Courtesy of LAND ROVER NORTH AMERICA, INC.

10. Position absorbent cloth under each oil cooler hose connection to collect oil spillage. See **Fig. 81**.



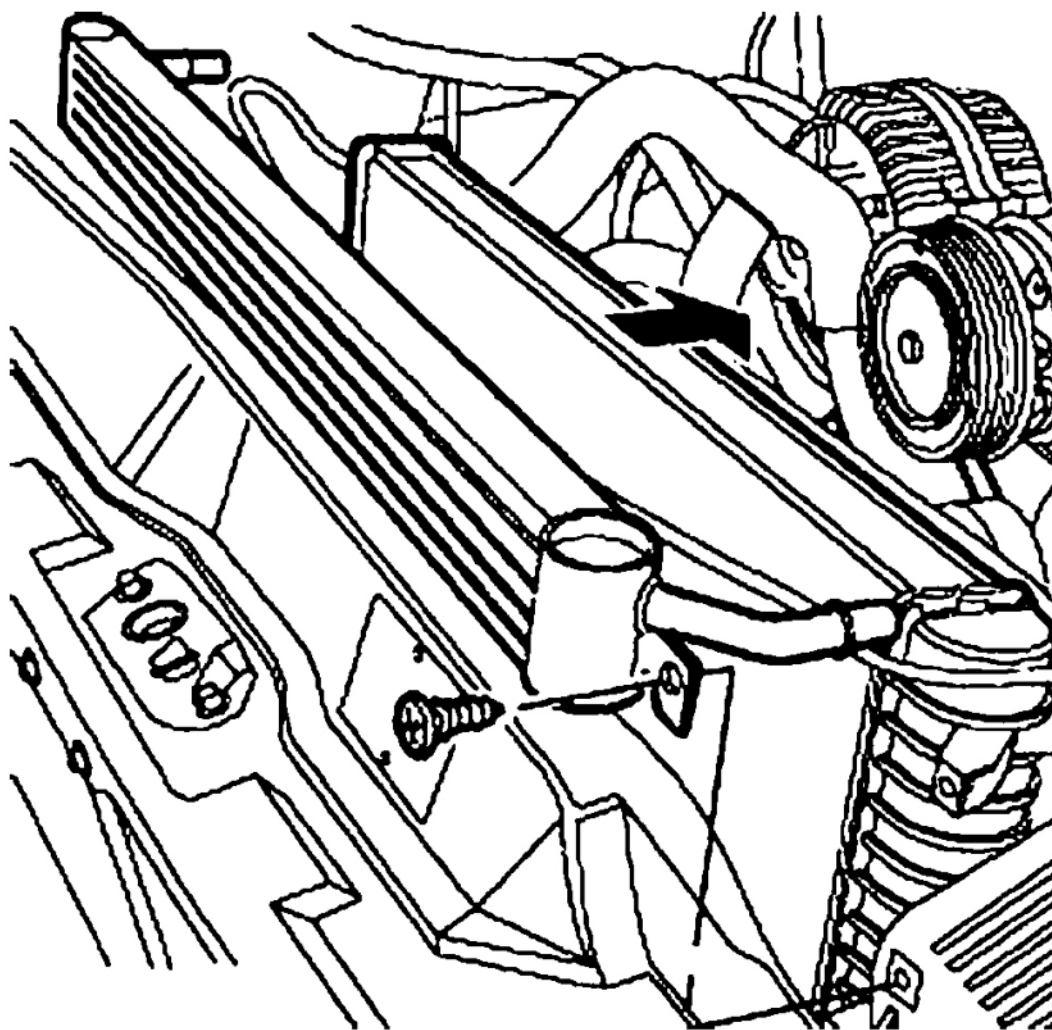
G00374113

Fig. 81: Engine Oil Cooler Hoses

Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Always fit plugs to open connections to prevent contamination.

11. Push against coupling release rings and disconnect both hoses from oil cooler.
12. Remove screw securing oil cooler to radiator.
13. Release cooler from its location on radiator.
14. Release radiator lower mountings from location in chassis and carefully move radiator towards engine sufficiently only to release engine oil cooler from radiator. See **Fig. 82**.



G00374114

Fig. 82: Engine Oil Cooler

Courtesy of LAND ROVER NORTH AMERICA, INC.

15. Remove engine oil cooler.

Installation

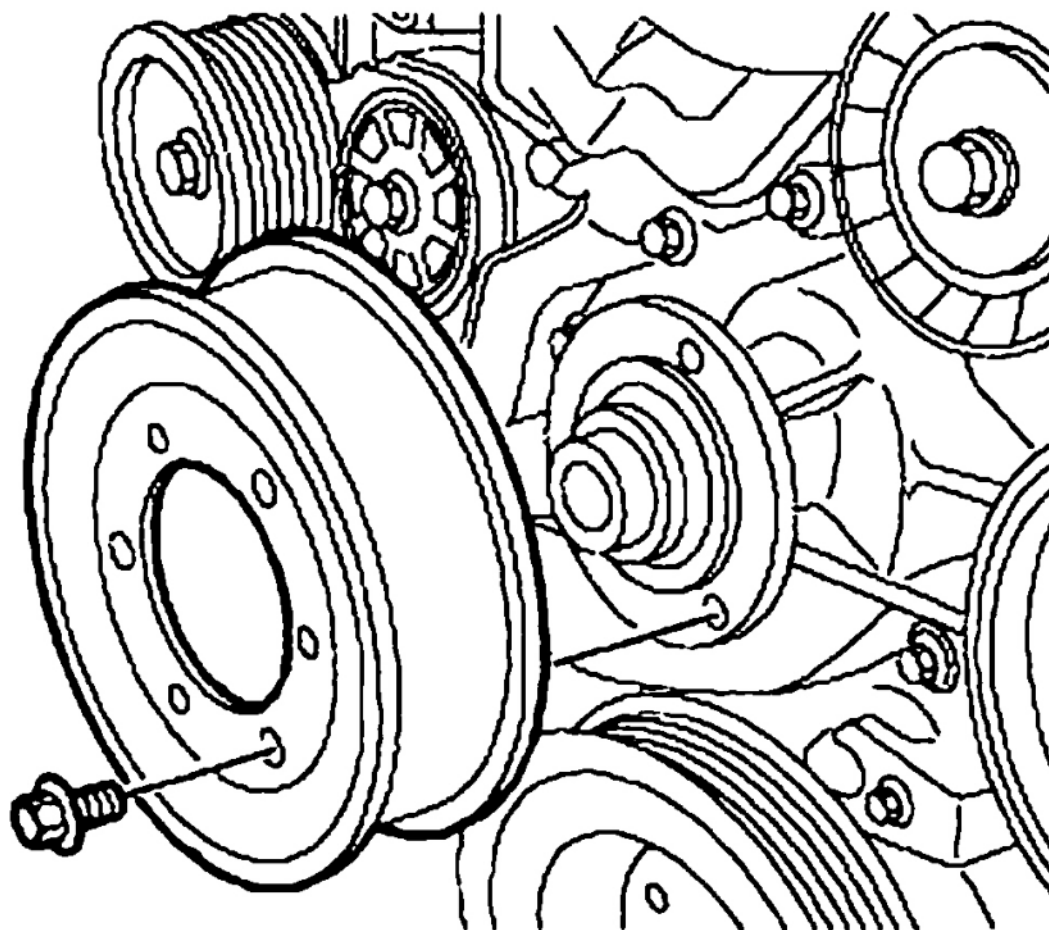
1. Fit engine oil cooler to radiator, engage in location and secure with screw.
2. Fit radiator to location in chassis.
3. Ensure connections are clean, then secure hoses to oil cooler.
4. Fit extension brackets to radiator and secure with bolts.
5. Fit brackets with rubber mounts to extension brackets and secure to air conditioning condenser with screws.

6. Fit radiator upper mounting brackets and secure to body with bolts.
7. Fit left horn and secure with nut.
8. Fit left and right air deflectors to front panel and secure with scrivenets.
9. Fit front grille. See **REFIT** .
10. Fit cooling fan cowl and secure with fixings.
11. Fit battery cover and secure with fixings.
12. Top up engine oil.

GASKET - TIMING GEAR COVER

Removal

1. Remove oil pick-up strainer. See **STRAINER - OIL PICK-UP**.
2. Remove timing gear cover oil seal. See **SEAL - COVER - TIMING GEARS**.
3. Remove engine oil filter. See **FILTER - OIL**.
4. Remove and discard 3 bolts securing coolant pump pulley and remove pulley. See **Fig. 83**.

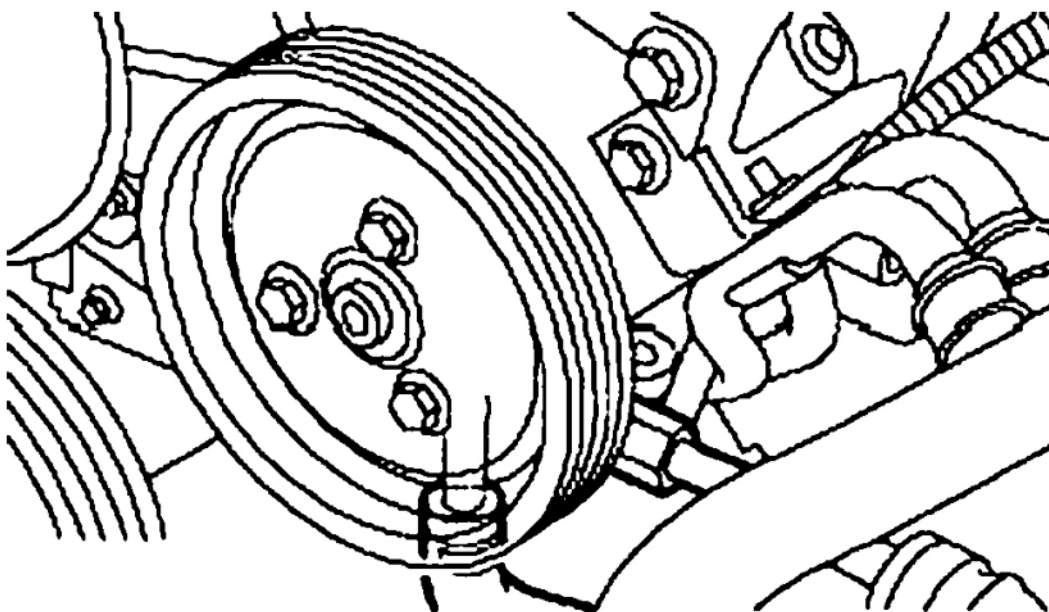


G00374115

Fig. 83: Coolant Pump Pulley

Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Remove 3 bolts securing PAS pump pulley and remove pulley. See **Fig. 84**.

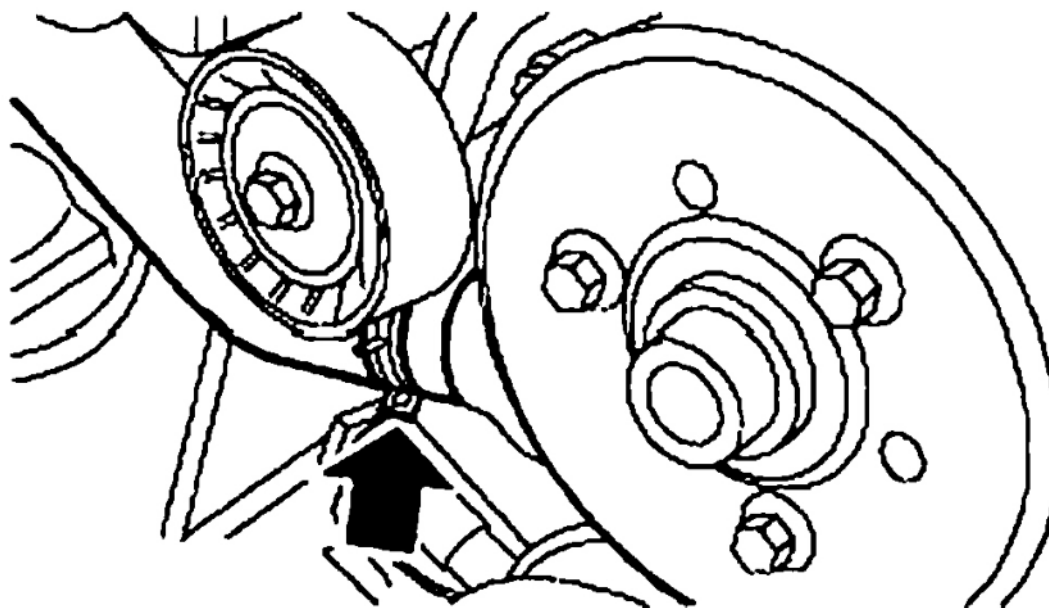


G00374116

Fig. 84: PAS Pump Pulley

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Drain cooling system. See **DRAINING & REFILLING COOLING SYSTEM** .
7. Release clip and disconnect coolant hose from coolant pump. See **Fig. 85**.

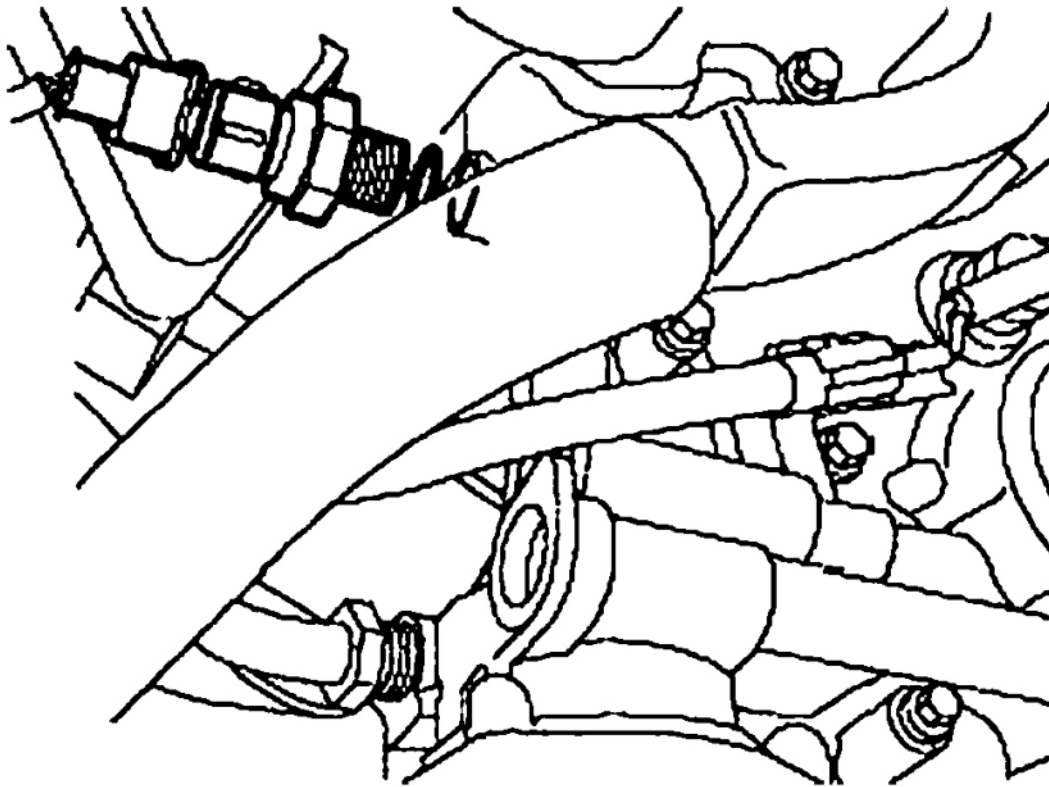


G00374117

Fig. 85: Coolant Pump Hose

Courtesy of LAND ROVER NORTH AMERICA, INC.

8. Disconnect multiplug from oil pressure switch. See **Fig. 86**.



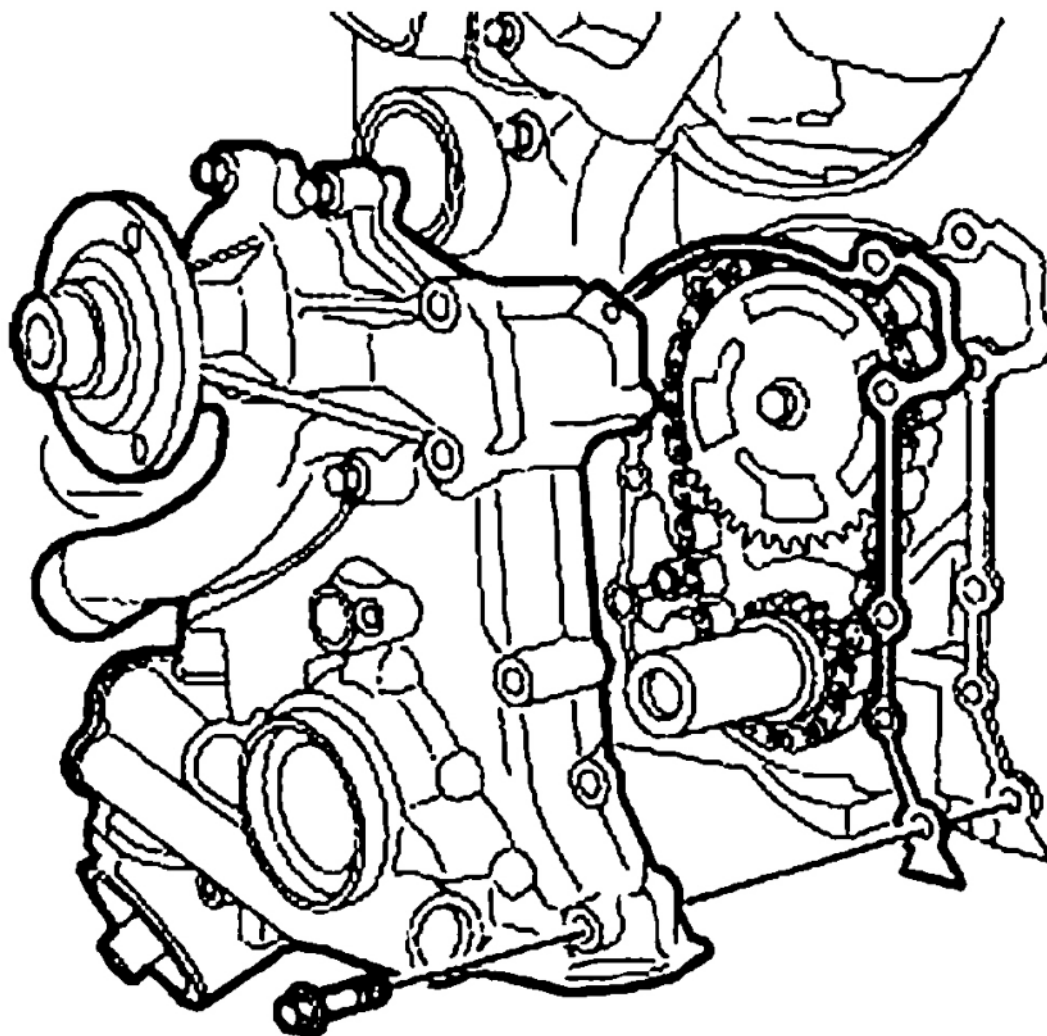
G00374118

Fig. 86: Oil Pressure Switch Multiplug
Courtesy of LAND ROVER NORTH AMERICA, INC.

9. Disconnect multiplug from CMP sensor.

CAUTION: Always fit plugs to open connections to prevent contamination.

10. If fitted: Loosen union and disconnect oil cooler pipe from timing gear cover. Remove and discard "O" ring.
11. Remove 9 bolts securing timing gear cover and remove cover. Remove and discard gasket. See **Fig. 87**.



G00374119

Fig. 87: Timing Gear Cover

Courtesy of LAND ROVER NORTH AMERICA, INC.

Installation

1. Clean mating faces of timing gear cover and cylinder block. Clean dowels and dowel holes. Ensure bolt holes are clean and dry, remove all traces of sealant from bolt threads.
2. Fit NEW gasket, dry, to dowels in cylinder block.
3. Locate tool LRT-12-090 on timing cover and oil pump drive gear. See **Fig. 88**.

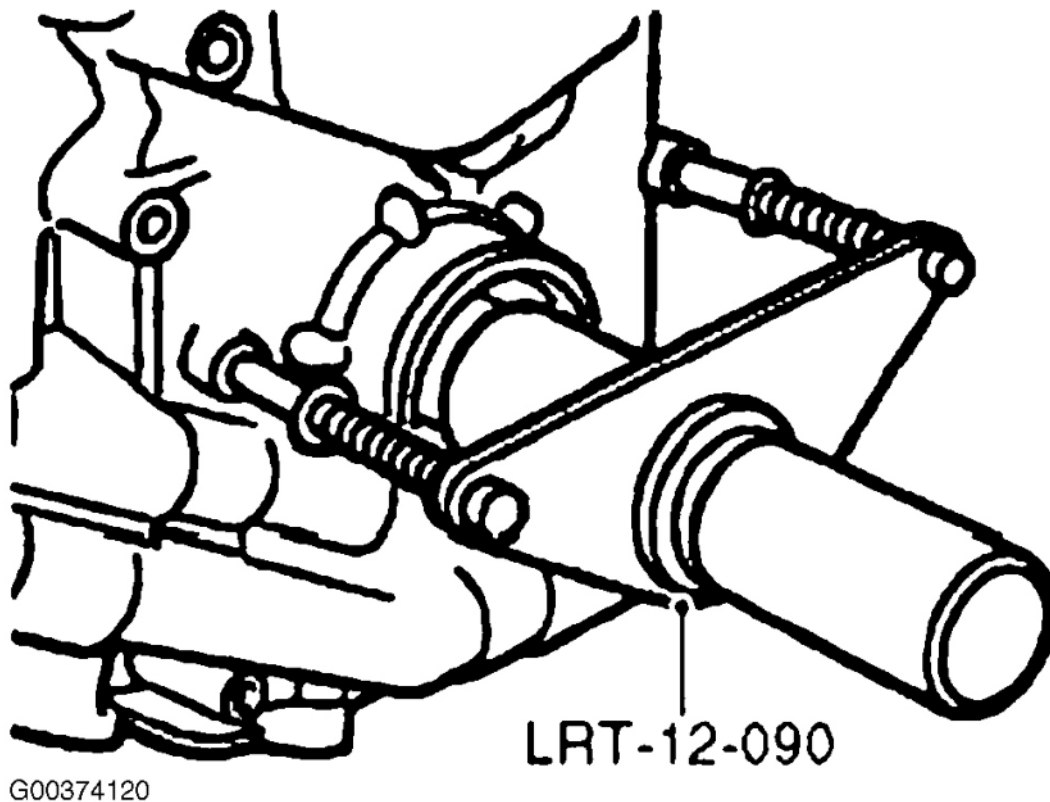
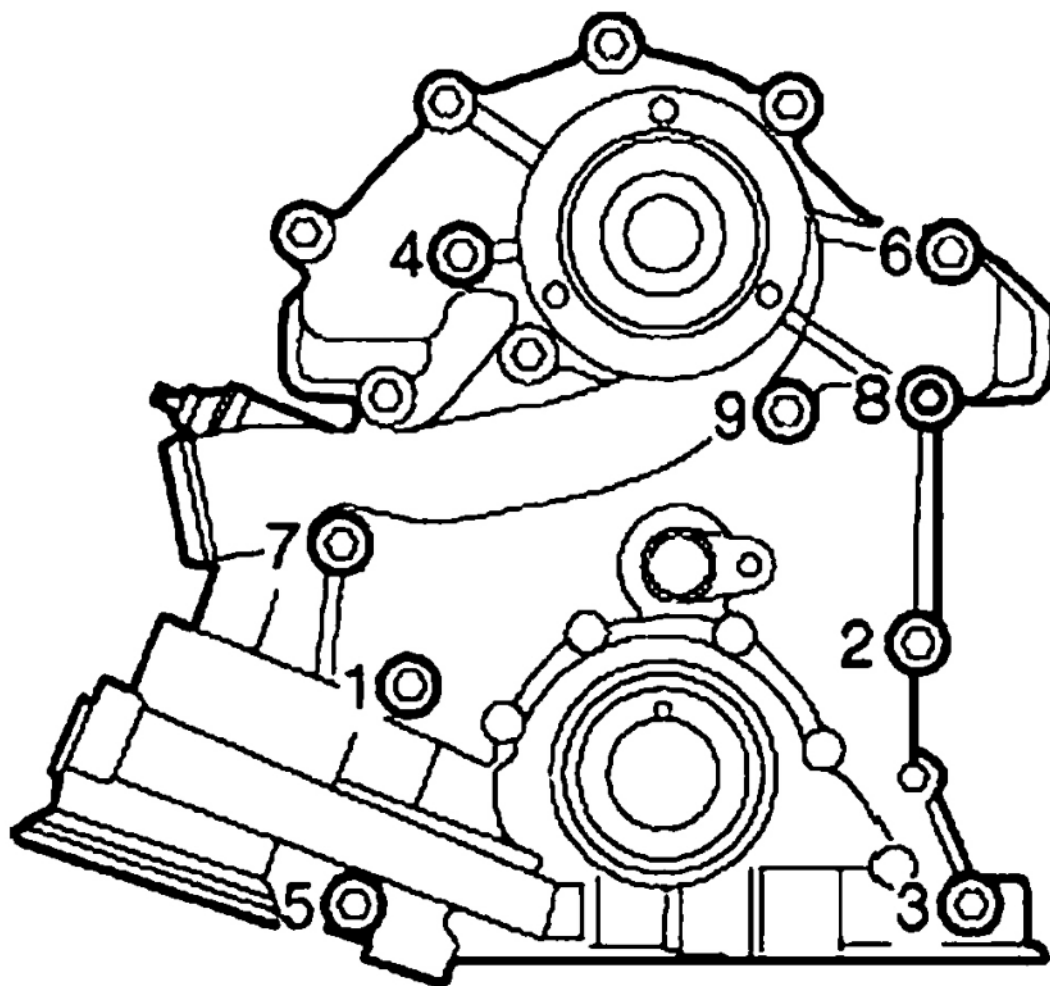


Fig. 88: Positioning LRT-12-090 To Timing Cover & Oil Pump Drive Gear
Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Position timing cover to cylinder block and at the same time, rotate tool LRT-12-090 until drive gear keyway is aligned with Woodruff key.
5. Remove tool LRT-12-090.
6. Apply sealant, Part Number STC 50552 to threads of timing cover bolts, fit bolts and working in the sequence illustrated, tighten to 22 N.m (17 ft. lbs). Ensure CMP sensor multiplug bracket is secured by bolt. See **Fig. 89**.



G00374121

Fig. 89: Timing Cover Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. If fitted: Fit NEW "O" ring to oil cooler pipe, connect pipe to timing gear cover and tighten union to 15 N.m (11 ft. lbs).
8. Connect multiplug to oil pressure switch.
9. Connect multiplug to CMP sensor.
10. Connect coolant hose to coolant pump and secure with clip.
11. Ensure mating faces of PAS pump pulley and drive flange are clean, fit pulley and tighten bolts to 22 N.m (16 ft. lbs).
12. Remove all traces of thread locking material from coolant pump pulley drive flange bolt holes using an M8 tap.
13. Ensure mating faces of coolant pump pulley and drive flange are clean, fit pulley and tighten NEW

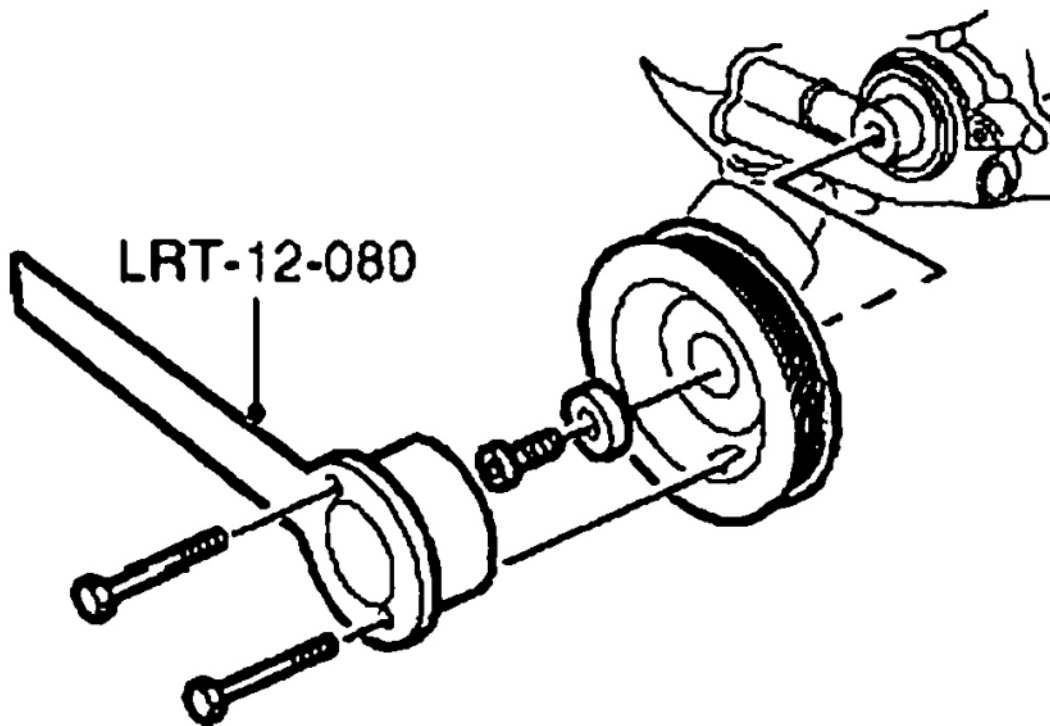
Patchlok bolts to 22 N.m (16 ft. lbs).

14. Ensure mating faces of oil filter and adaptor are clean, smear clean engine oil onto seal and fit filter. See **FILTER - OIL**.
15. Fit timing gear cover oil seal. See **SEAL - COVER - TIMING GEARS**.
16. Fit oil pick-up strainer. See **STRAINER - OIL PICK-UP**.
17. Refill cooling system. See **DRAINING & REFILLING COOLING SYSTEM**

SEAL - COVER - TIMING GEARS

Removal

1. Remove auxiliary drive belt. See **GENERATORS & REGULATORS**.
2. Secure tool LRT-12-080 to crankshaft pulley with 2 bolts. See **Fig. 90**.

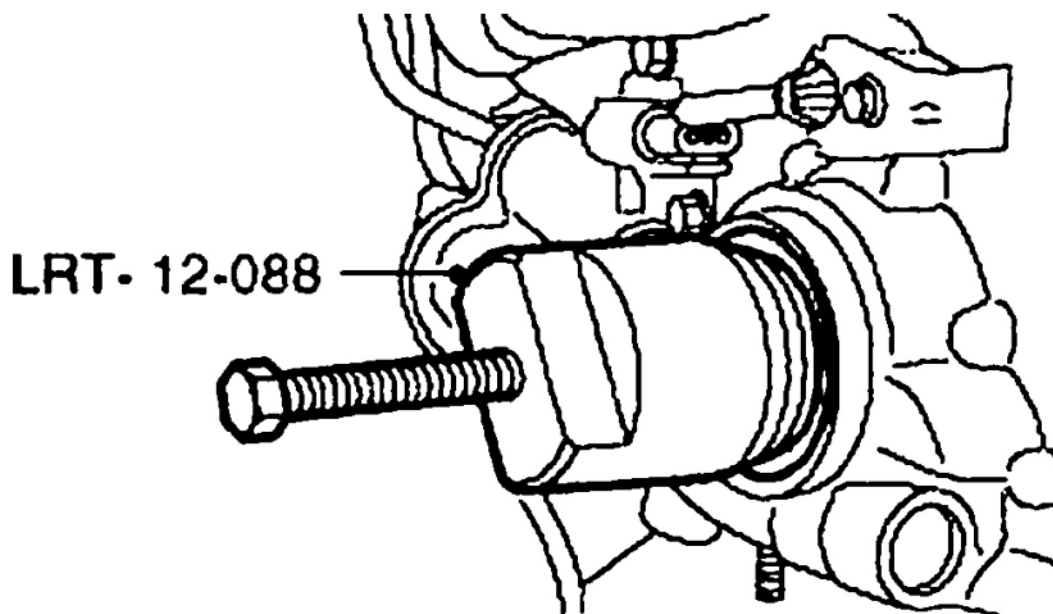


G00374122

Fig. 90: Crankshaft Pulley Bolt

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove crankshaft pulley bolt.
4. Remove crankshaft pulley.
5. Use tool LRT-12-088, to remove oil seal from timing gear cover. See **Fig. 91**.



G00374123

Fig. 91: Removing Timing Gear Cover Seal
Courtesy of LAND ROVER NORTH AMERICA, INC.

Installation

CAUTION: Seal is pre-greased, DO NOT apply additional lubricant.

1. Clean seal register in timing gear cover and crankshaft pulley.
2. Apply smear of Retinax LX grease to seal running surface on crankshaft.
3. Fit seal to timing gear cover using tool LRT-12- 089. See **Fig. 92**.

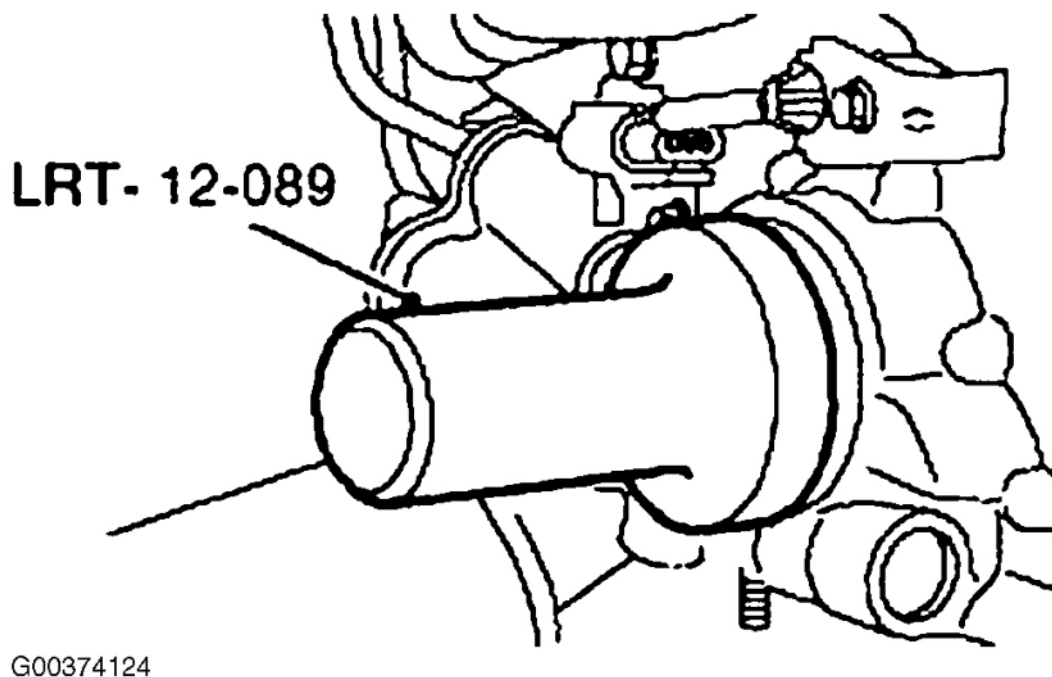


Fig. 92: Installing Timing Gear Cover Seal

Courtesy of LAND ROVER NORTH AMERICA, INC.

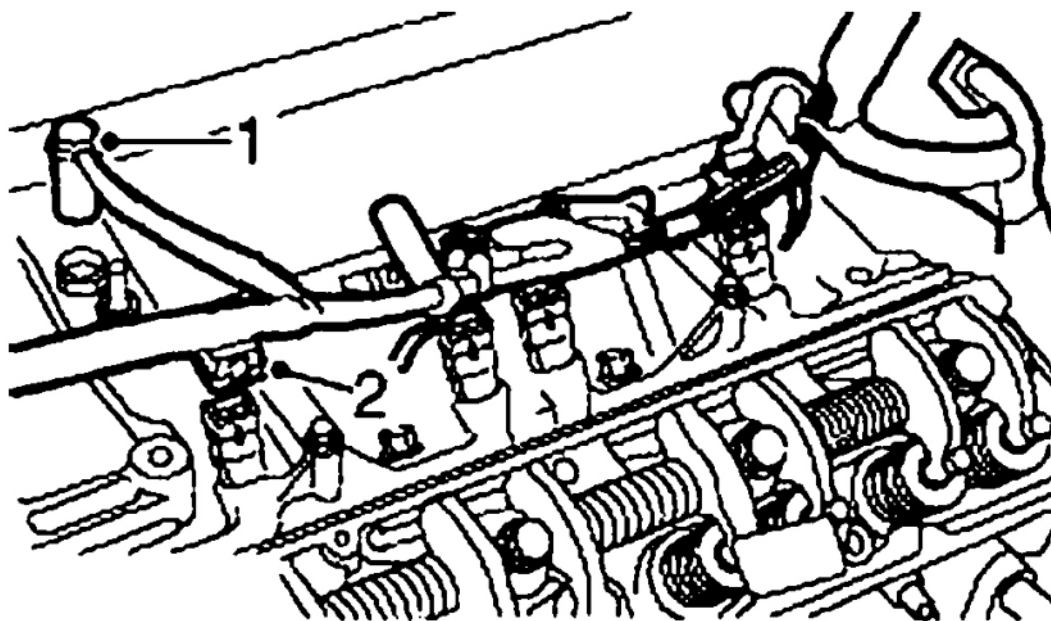
4. Fit crankshaft pulley bolt and tighten to 270 N.m (200 ft. lbs).
5. Remove tool LRT-12-080 from crankshaft pulley.
6. Fit auxiliary drive belt. See **GENERATORS & REGULATORS** .

OVERHAUL

GASKET - INLET MANIFOLD

Disassembly

1. Disconnect multiplug from coolant thermistor. See **Fig. 93**.

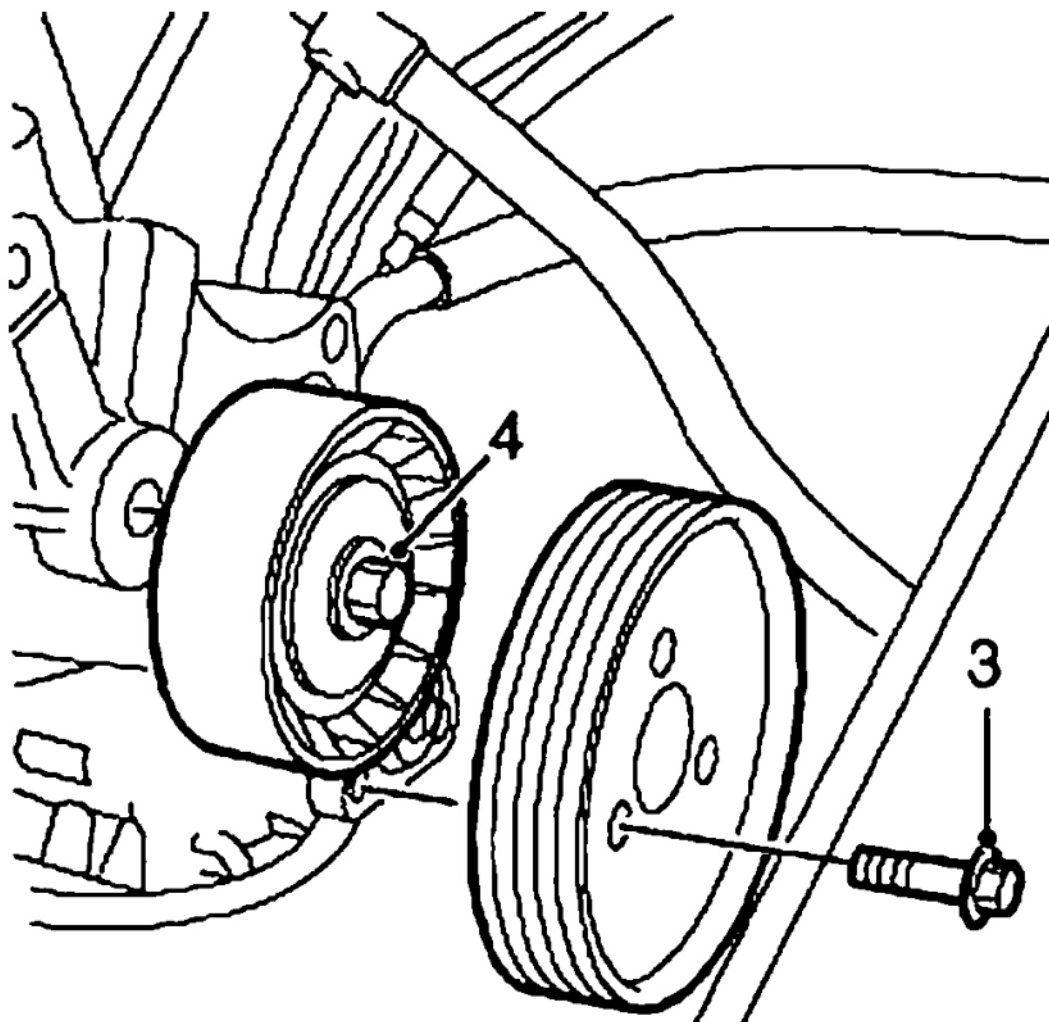


G00386274

Fig. 93: Coolant Thermistor Multiplug

Courtesy of LAND ROVER NORTH AMERICA, INC.

2. Disconnect multiplugs from injectors; release injector harness from fuel rail and position aside.
3. Remove 3 bolts securing PAS pump pulley and remove pulley. See **Fig. 94**.

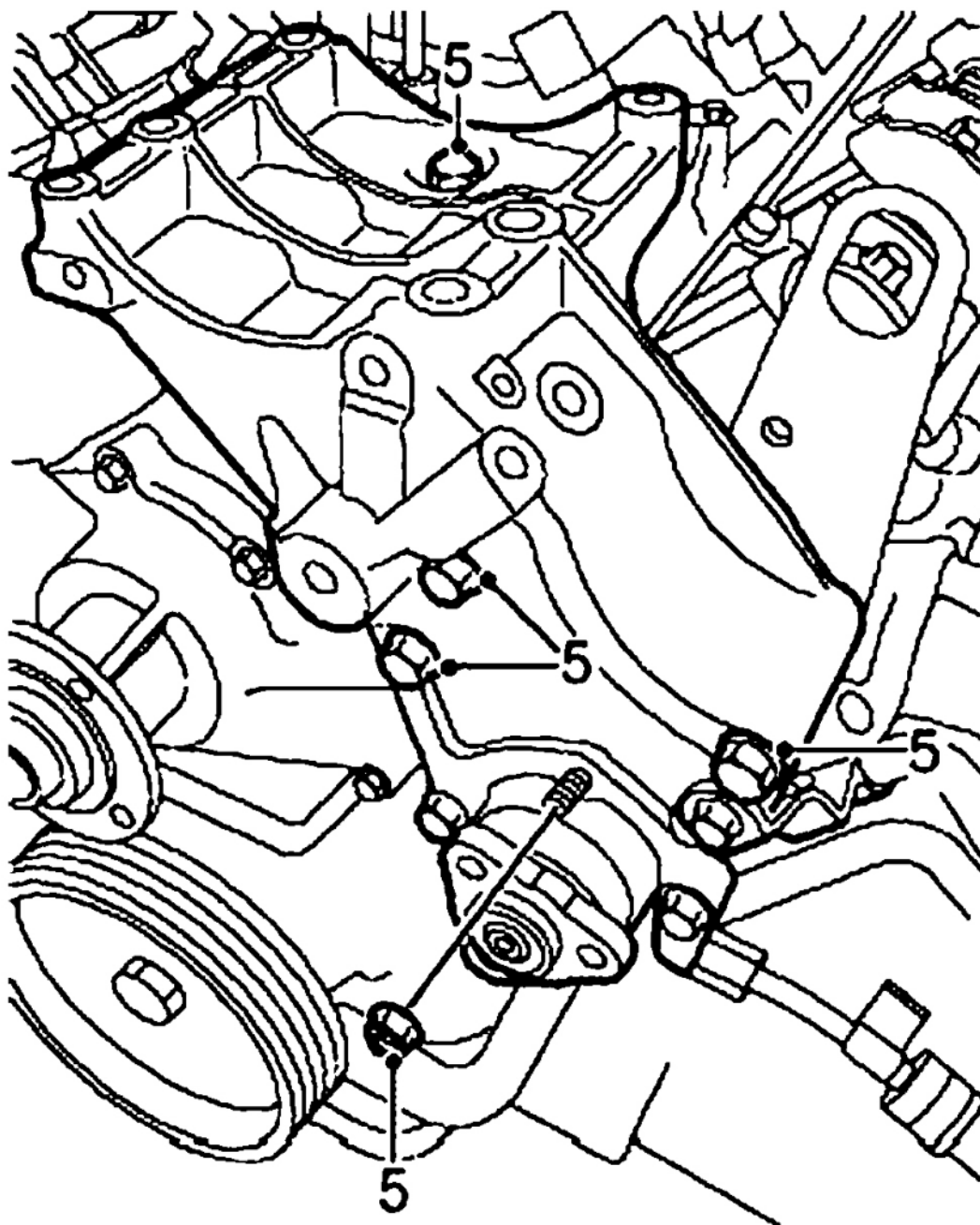


G00386275

Fig. 94: PAS Pump Pulley

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Loosen bolt securing jockey pulley and remove pulley.
5. Remove 4 bolts and one nut securing auxiliary housing and remove housing. See **Fig. 95**.

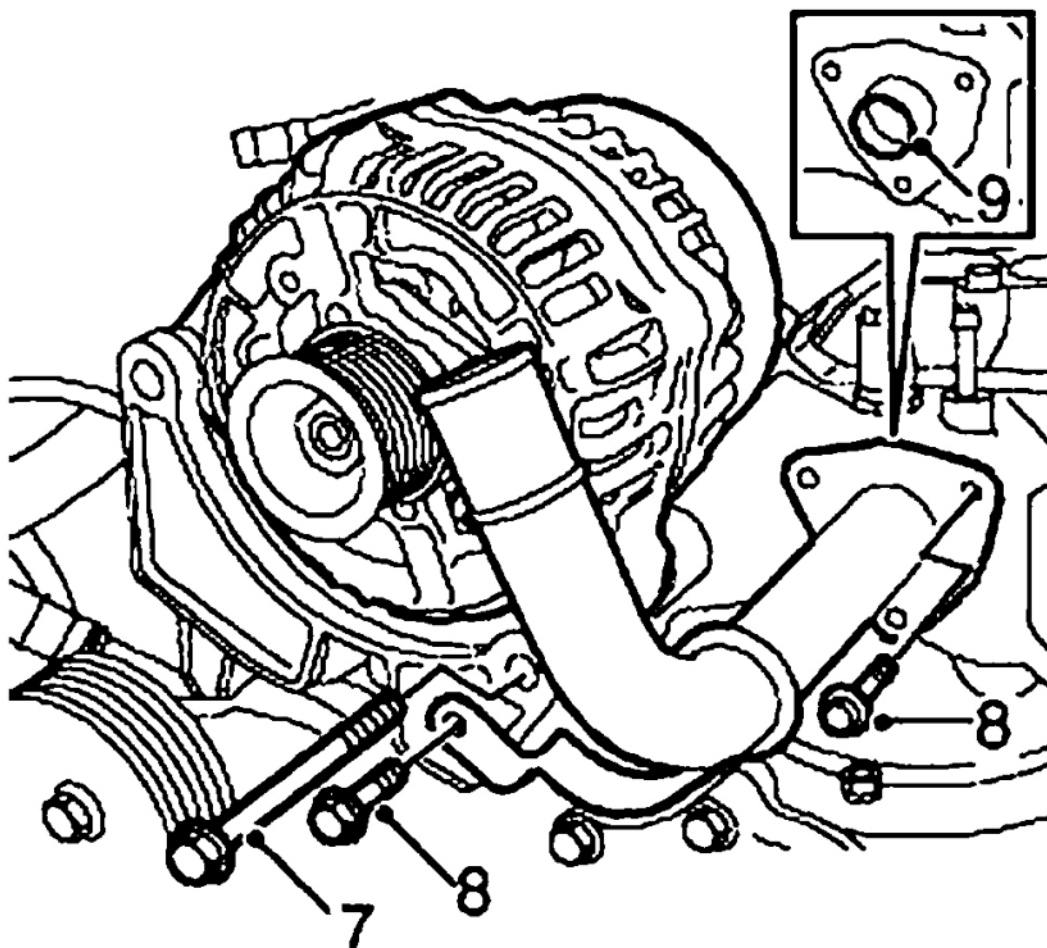


G00386276

Fig. 95: Auxiliary Housing

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Remove 2 nuts securing alternator cables and release the cables.
7. Remove two bolts securing alternator and remove alternator. See **Fig. 96**.



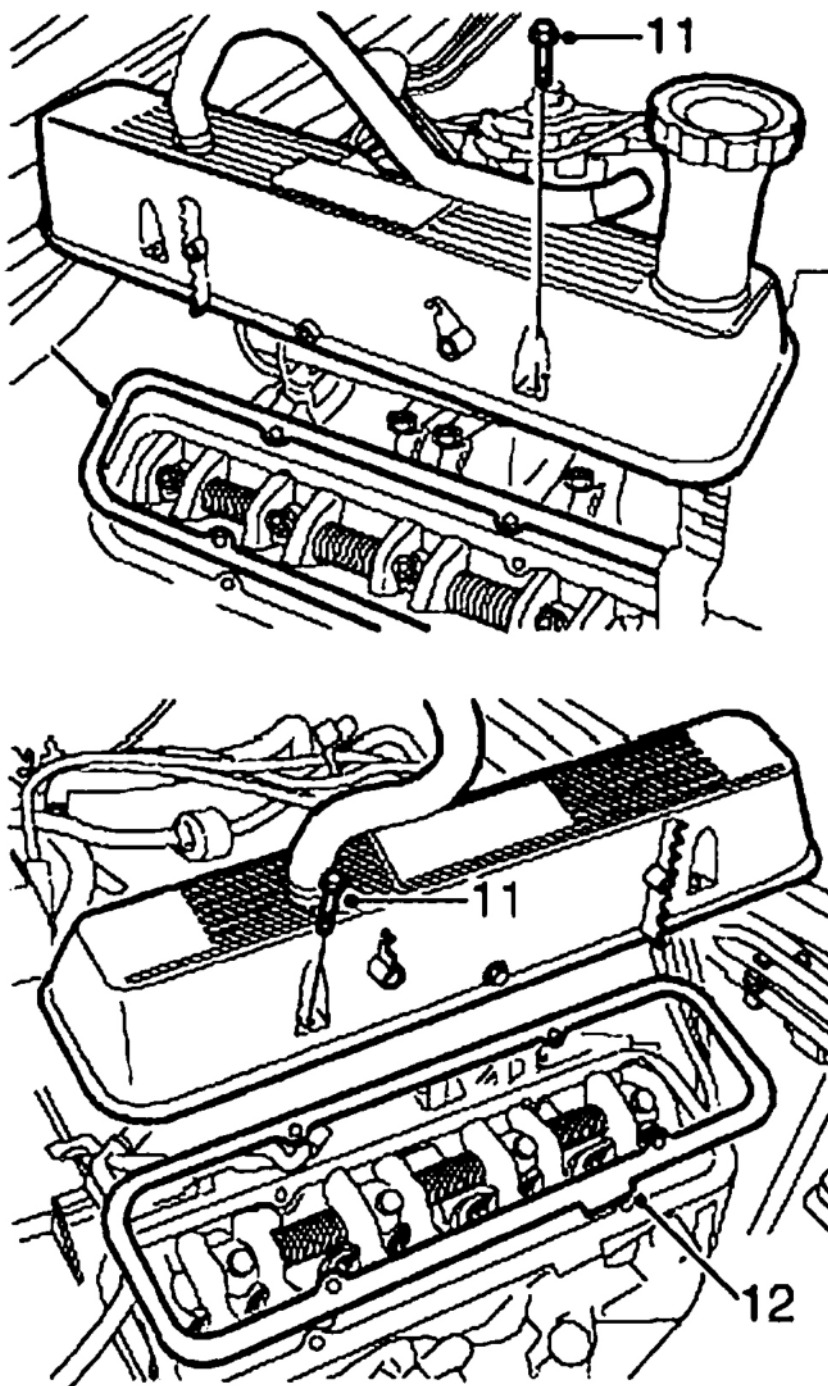
G00386277

Fig. 96: Alternator & Coolant Outlet Elbow

Courtesy of LAND ROVER NORTH AMERICA, INC.

8. Remove 4 bolts securing coolant outlet elbow and remove outlet elbow. See **Fig. 96**.
9. Remove and discard "O" ring.
10. Release hot leads from rocker covers.

CAUTION: Screws/bolts must be replaced with NEW Patched multi-hex bolts.



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Fig. 97: Rocker Covers

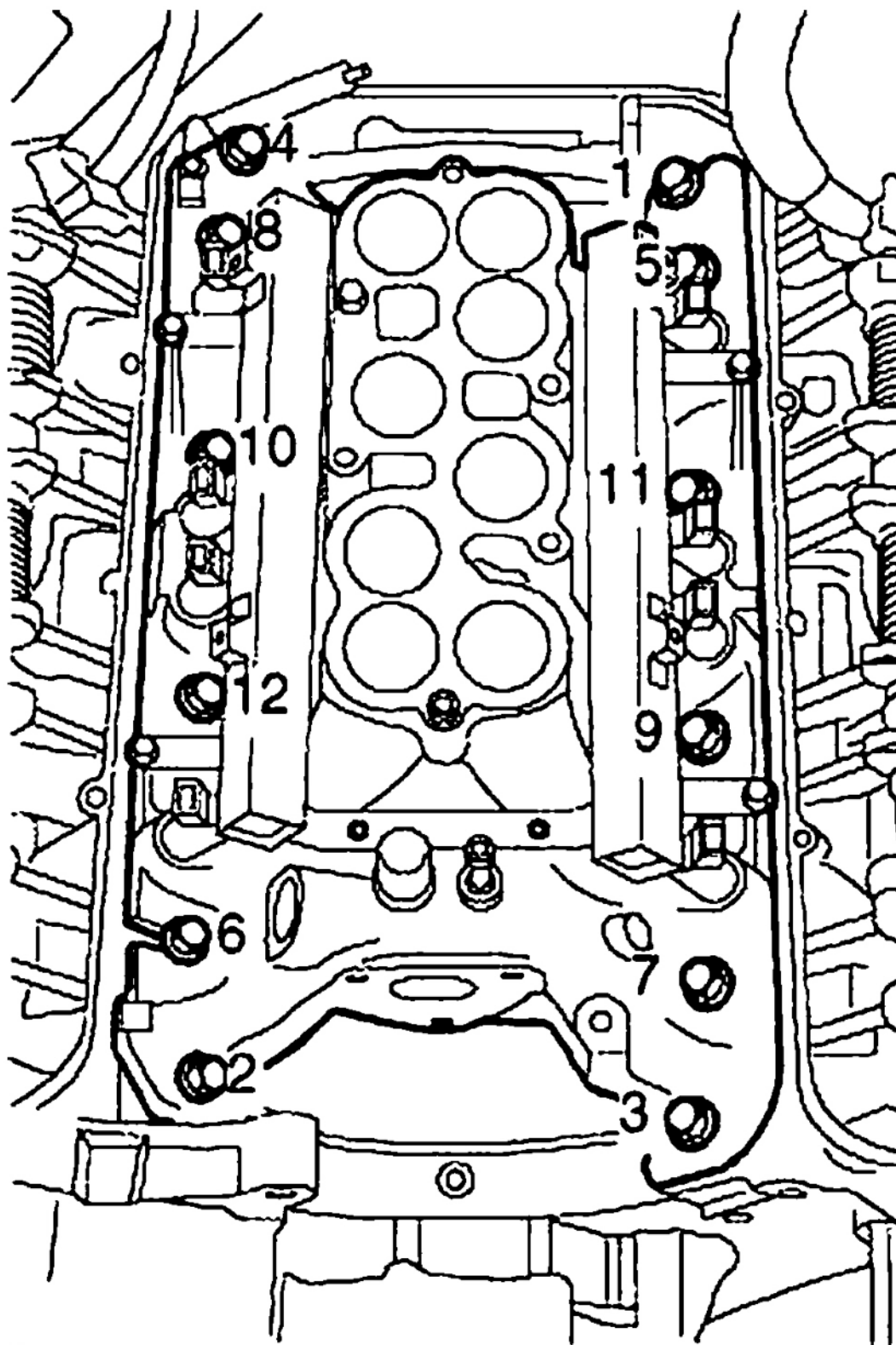
Courtesy of LAND ROVER NORTH AMERICA, INC.

11. Noting fitted position of 4 long screws or multi-hex bolts, remove and discard 8 screws/bolts securing rocker covers; remove rocker covers. See [Fig. 97](#).

12. Remove and discard rocker cover gaskets.
13. Using the sequence shown, remove 12 bolts securing the inlet manifold. See **Fig. 98**.

2003 Land Rover Discovery S

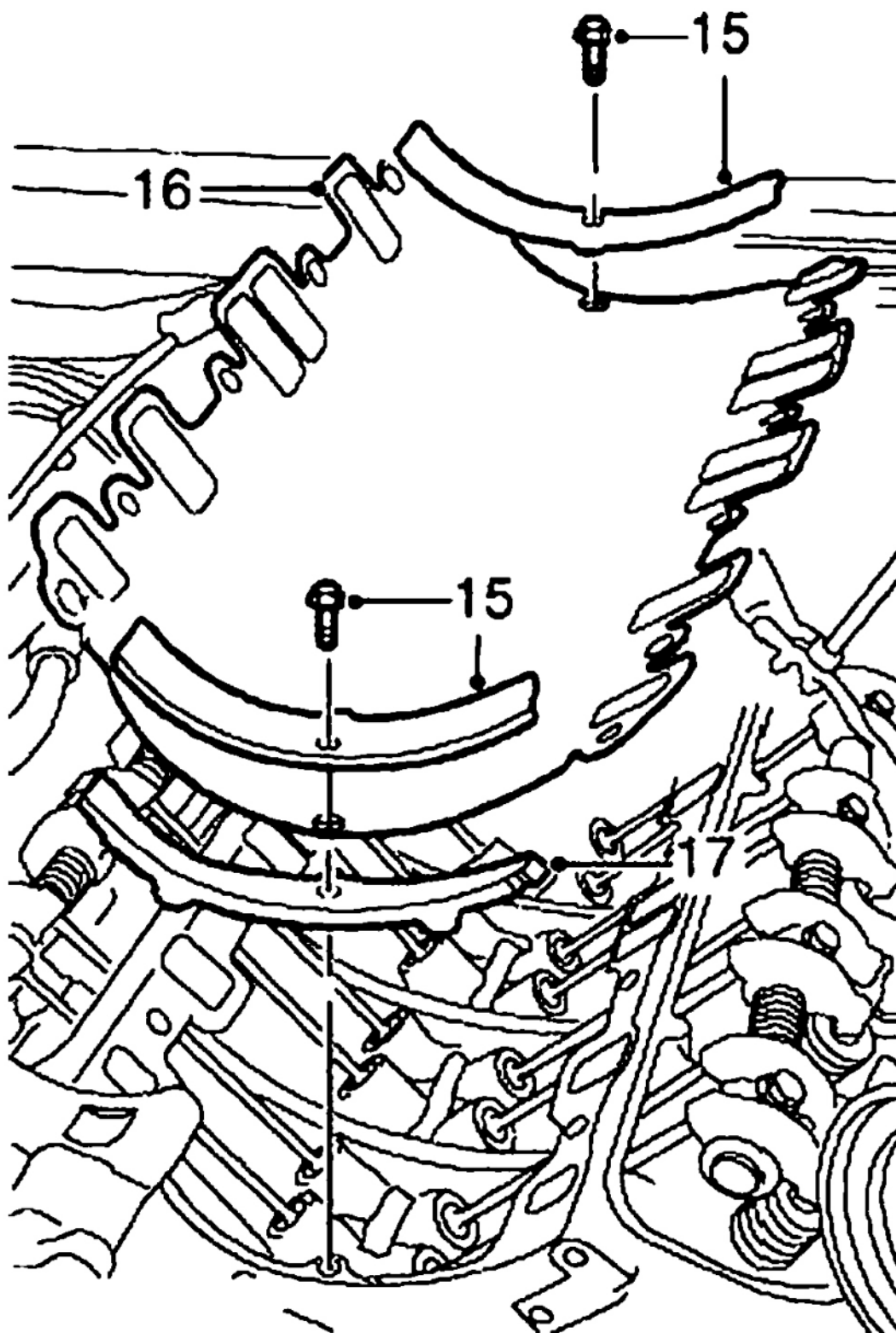
1999-2004 ENGINES 4.0L & 4.6L - Discovery



G00386279

Fig. 98: Inlet Manifold Bolt Removal Sequence**Courtesy of LAND ROVER NORTH AMERICA, INC.**

14. Remove inlet manifold assembly.
15. Remove 2 bolts securing manifold gasket and collect gasket clamps. See **Fig. 99**.



G00386280

Fig. 99: Inlet Manifold Gasket & Gasket Clamps
Courtesy of LAND ROVER NORTH AMERICA, INC.

16. Remove inlet manifold gasket.
17. Remove gasket seals.

Reassembly

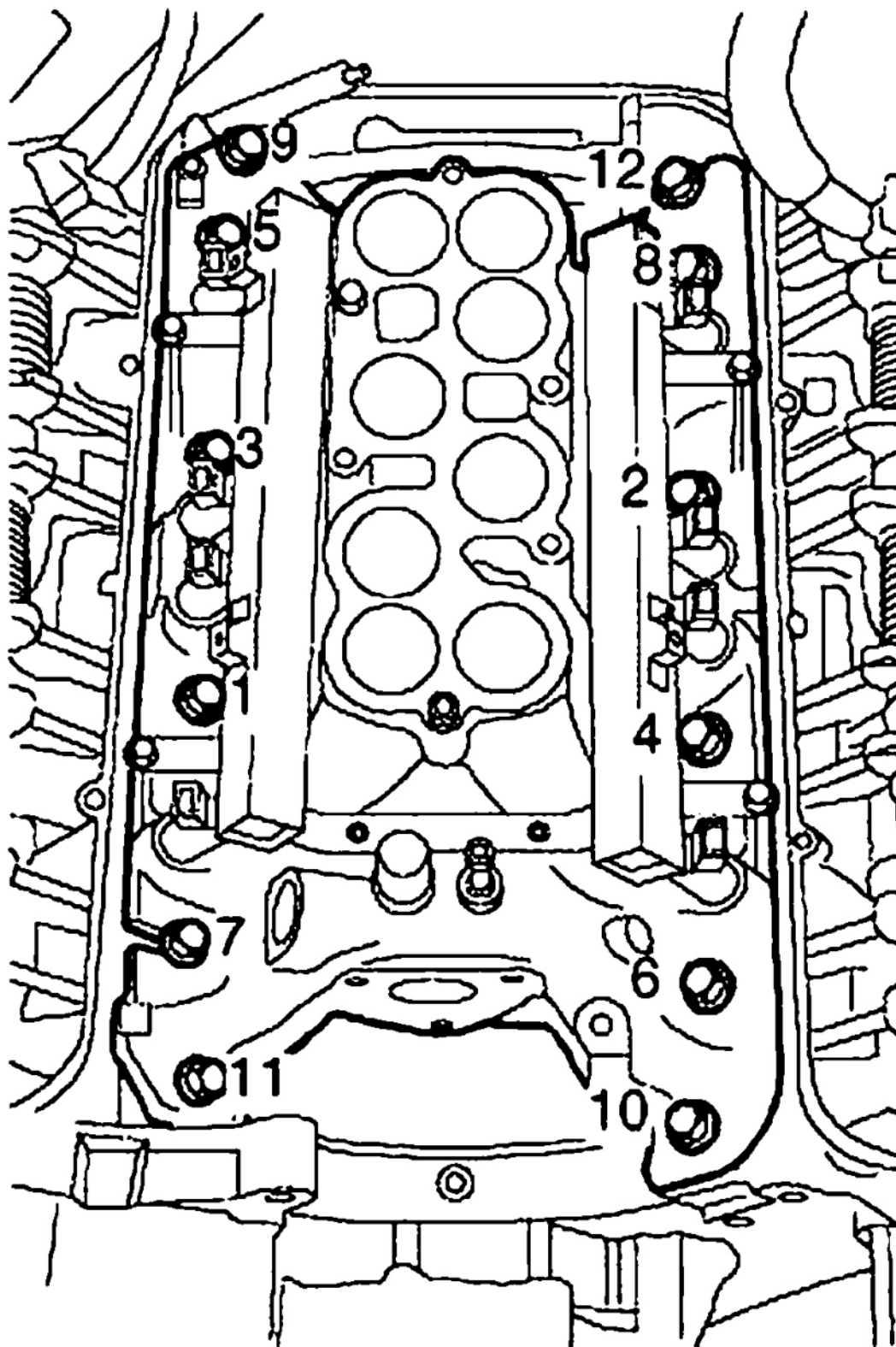
1. Clean sealant from cylinder head and from notches in the cylinder block.

CAUTION: DO NOT use a metal scraper or machined surfaces may be damaged.

2. Clean mating faces of cylinder block, cylinder head and manifold.
3. Ensure bolt holes are clean and dry.
4. Apply sealant, Part No. STC 50550 to cylinder head and notches in cylinder block.
5. Fit NEW gasket seals, ensuring the ends engage correctly in notches.
6. Apply sealant, Part No. STC 50550 to gasket seals above the notches in the cylinder block.
7. Fit NEW manifold gasket, dry.
8. Position gasket clamps, fit and lightly tighten bolts.
9. Position inlet manifold assembly to cylinder head.
10. Fit manifold bolts and, working in the sequence illustrated, tighten as follows:
 - Initially, tighten bolts numbered 1, 4, 9 and 12 in numerical order to 5 N.m (4 ft. lbs). See **Fig. 100**.

2003 Land Rover Discovery S

1999-2004 ENGINES 4.0L & 4.6L - Discovery



G00386281

Fig. 100: Inlet Manifold Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

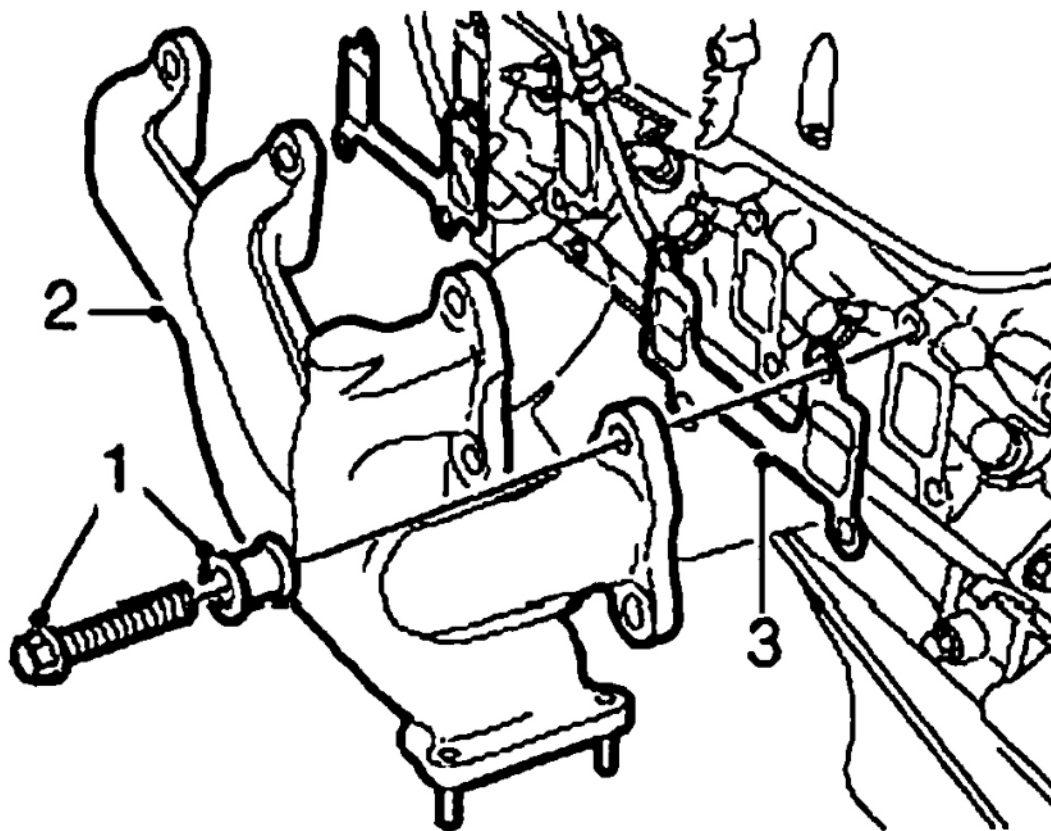
- Inlet manifold bolts - initial tighten = 10 N.m (8 ft. lbs).
 - Inlet manifold bolts - final tighten = 51 N.m (38 ft. lbs).
 - Tighten inlet manifold gasket clamp bolts to = 18 N.m (14 ft. lbs).
 - Tighten inlet manifold bolts to = 51 N.m (38 ft. lbs).
11. Clean mating faces of rocker cover and cylinder head, ensure that bolt holes are clean and dry.
 12. Fit NEW rocker cover gaskets, dry, position rocker covers, ensuring gaskets are correctly located.
 13. Fit NEW Patched multi-hex rocker cover bolts ensuring that short bolts are on sides of rocker covers nearest center of engine.
 14. Tighten bolts by diagonal selection to:
 - **Stage 1**
3 N.m (2.5 ft. lbs).
 - **Stage 2**
8 N.m (6.0 ft. lbs).
 15. Ensure that outer rim of each gasket is correctly positioned around periphery of rocker cover.
 16. Secure hot leads to rocker cover.
 17. Clean coolant outlet elbow mating faces.
 18. Lubricate and fit NEW "O" ring to outlet pipe.
 19. Position coolant outlet elbow, fit bolts and tighten to 22 N.m (17 ft. lbs).
 20. Position alternator, fit mounting bolts and tighten to 45 N.m (34 ft. lbs).
 21. Position alternator cables and tighten terminals:
 - **B+**
Tighten to 18 N.m (13.0 ft. lbs)
 - **D+**
Tighten to 5 N.m (3.5 ft. lbs)
 22. Position auxiliary housing, fit bolts and tighten to 40 N.m (30 ft. lbs). Fit nut and tighten to 22 N.m (17 ft. lbs).
 23. Clean jockey pulley mating faces.
 24. Position jockey pulley and tighten bolt to 50 N.m (37 ft. lbs).
 25. Clean PAS pump pulley mating faces.
 26. Position PAS pump pulley, fit bolts and tighten to 22 N.m (17 ft. lbs).
 27. Secure injector harness and connect injector multiplugs.

28. Connect multiplug to coolant thermistor.

GASKET - EXHAUST MANIFOLD

Disassembly

1. Remove 8 bolts securing exhaust manifold and collect spacers. Discard the bolts.
2. Remove exhaust manifold. See **Fig. 101**.



G00386282

Fig. 101: Exhaust Manifold & Spacers
Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove 2 manifold gaskets and discard.

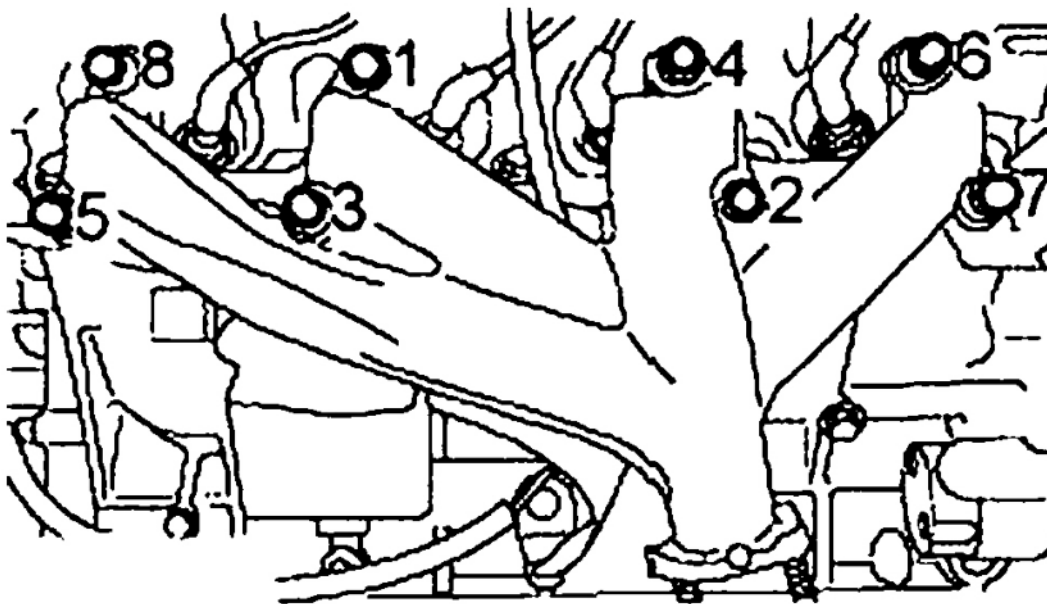
Reassembly

CAUTION: DO NOT use a metal scraper or machined surfaces may be damaged.

1. Clean exhaust manifold and cylinder head mating face.

CAUTION: Ensure that link bar on gasket is positioned below spark plugs.

2. Fit NEW gaskets, dry, fit exhaust manifold.
3. Fit spacers to NEW manifold bolts and, working in the sequence illustrated, initially tighten bolts to 15 N.m (11 ft. lbs), then finally tighten to 38 N.m (28 ft. lbs). See **Fig. 102**.



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Fig. 102: New Exhaust Manifold Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

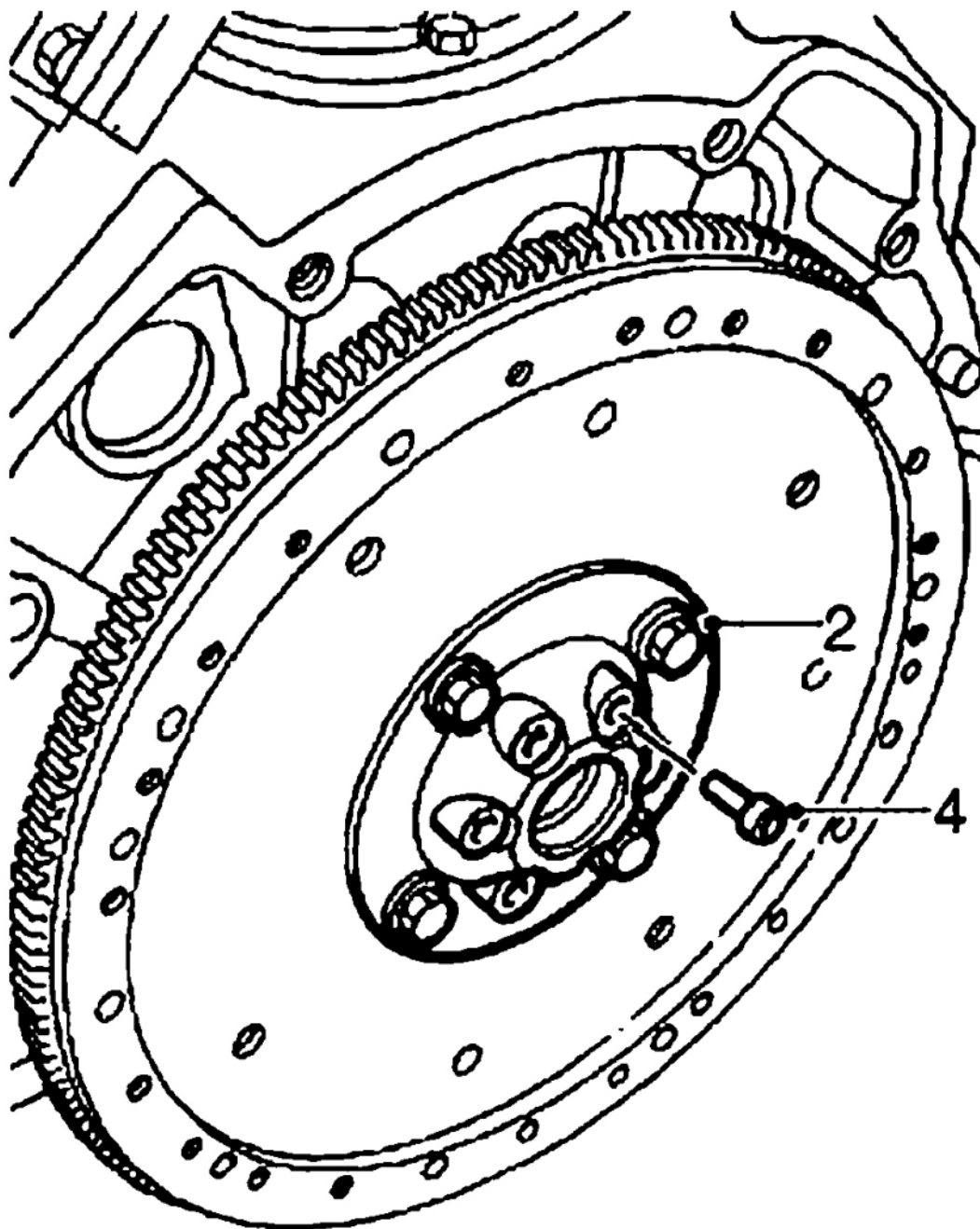
SEAL - CRANKSHAFT - REAR - A/T

Disassembly

NOTE: Later engines are fitted with a modified starter ring gear which incorporates the reluctor plate, spacer and hub. The modified ring gear may be fitted as a replacement to early engines.

1. Remove CKP sensor. See **REMOVAL**.
2. **Early Engines**

Remove 4 bolts securing drive plate clamp ring and remove ring. See **Fig. 103**.



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Fig. 103: Drive Plate (Early Engine With A/T)
Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Early Engines

Remove drive plate from hub.

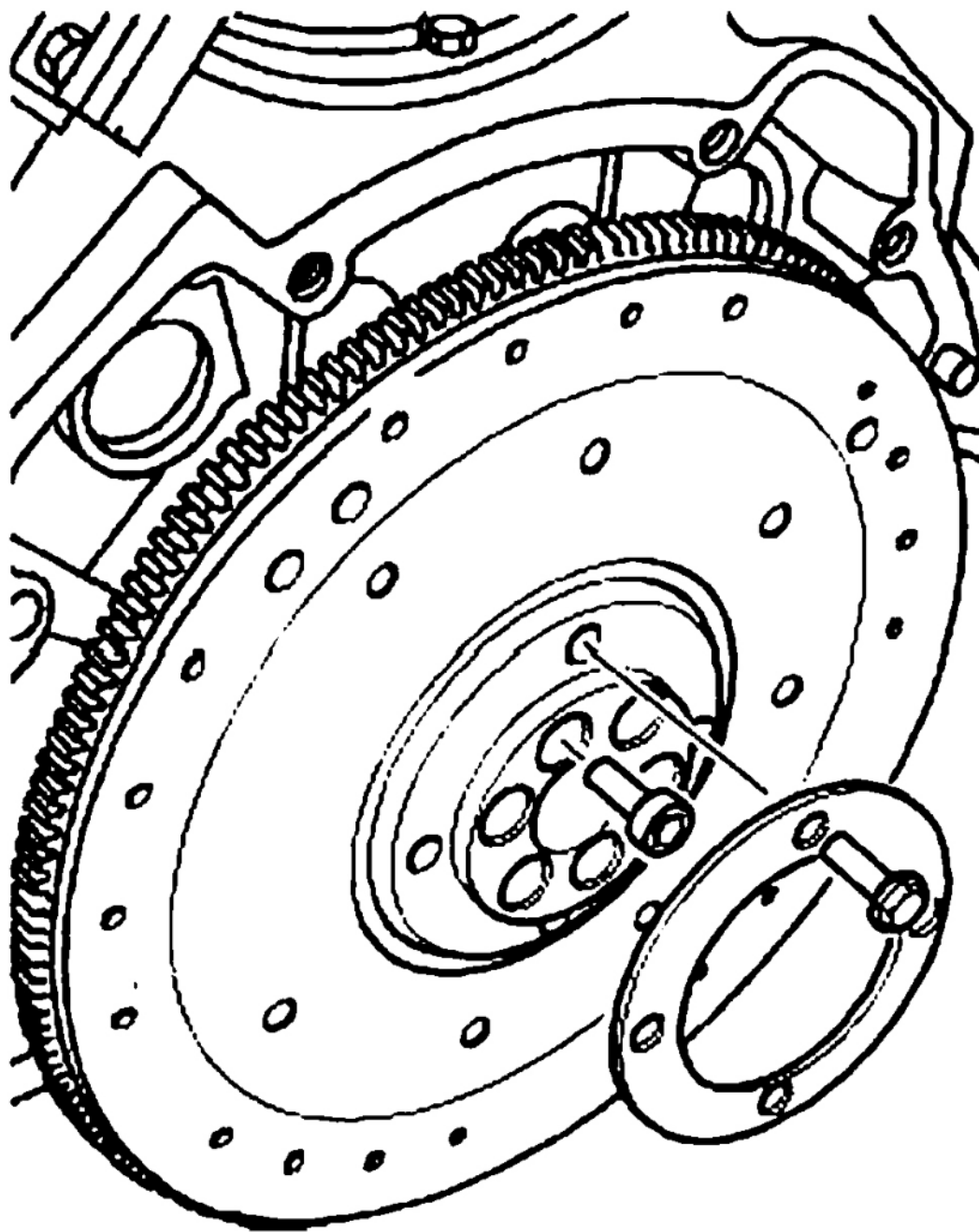
NOTE: On early engines, balance weights are on engine side of drive plate, replacement drive plates will have balance weights on torque converter side of drive plate.

4. Early Engines

Remove 6 Allen bolts securing hub and starter ring gear, remove hub, starter ring gear and collect spacer.

5. Later Engines

Remove 4 bolts securing drive plate clamp ring and remove ring. See **Fig. 104**.



G00386285

Fig. 104: Drive Plate (Later Engine With A/T)
Courtesy of LAND ROVER NORTH AMERICA, INC.

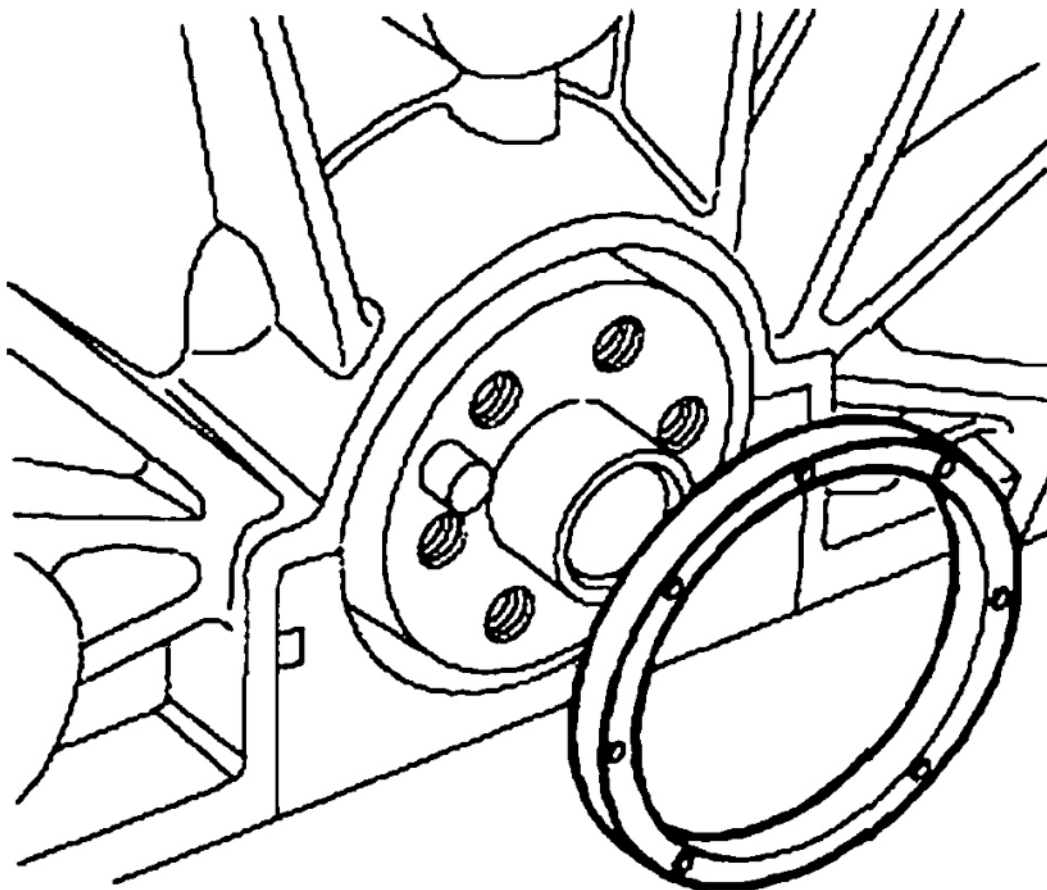
6. Later Engines

Remove drive plate.

7. Later Engines

Remove 6 Allen bolts securing starter ring gear to crankshaft, remove starter ring gear.

8. Carefully remove oil seal from cylinder block to avoid damage to seal location or running surface on crankshaft. See **Fig. 105**.

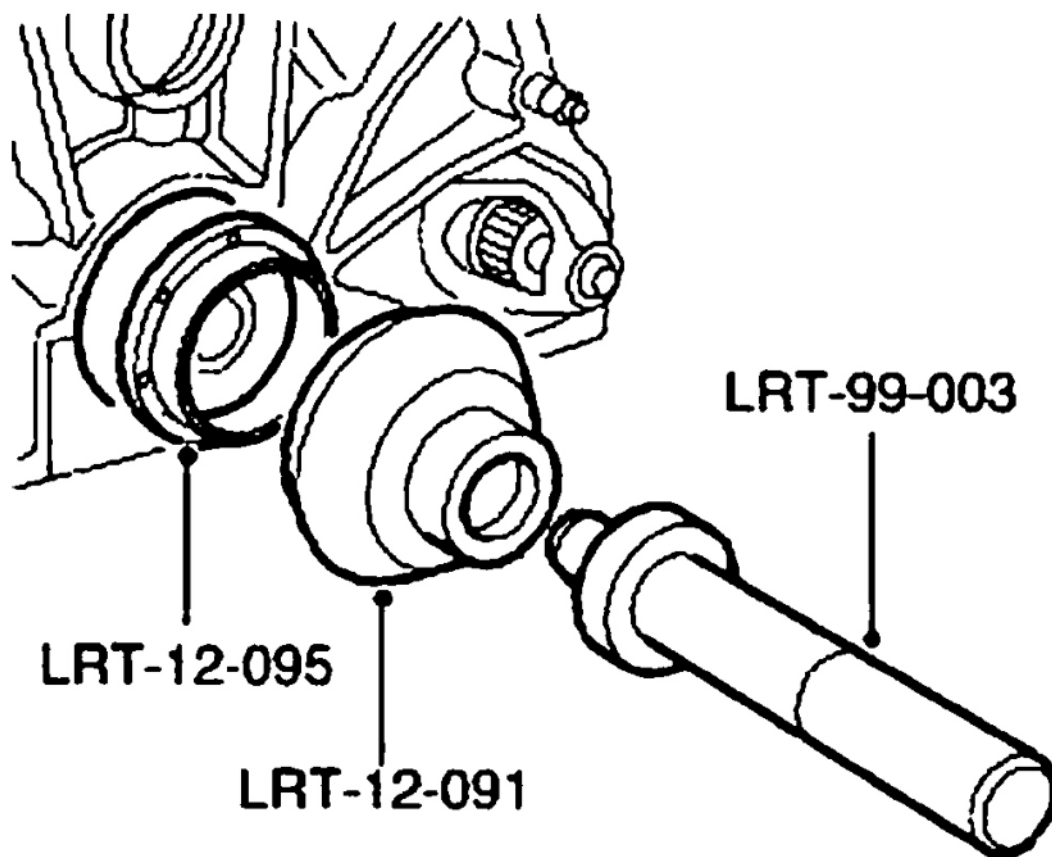


G00386286

Fig. 105: Removing Rear Crankshaft Seal (With A/T)
Courtesy of LAND ROVER NORTH AMERICA, INC.

Reassembly

1. Ensure both seal location and running surface on crankshaft are clean. Ensure that bolt holes in crankshaft are clean and dry.
2. Lubricate replacement oil seal with engine oil.
3. Lubricate seal guide LRT-12-095 with engine oil and position guide to crankshaft. See **Fig. 106**.



G00386287

Fig. 106: Installing Rear Crankshaft Seal (A/T)
Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Fit NEW seal squarely onto crankshaft and remove guide LRT-12-095.
5. Fit seal into location using tools LRT-12-091 and LRT-99-003.

6. **All Engines**

Ensure bolt holes in crankshaft are clean and dry.

7. **All Engines**

Clean all components.

8. **All Engines**

Check that drive plate is free from cracks and distortion.

9. Early Engines

Fit hub, starter ring gear and spacer to crankshaft, tighten Allen bolts to 78 N.m (58 ft. lbs).

10. Early Engines

Fit drive plate and clamp ring, tighten bolts to 45 N.m (35 ft. lbs).

11. Later Engines

Fit starter ring gear, fit Allen bolts and tighten to 85 N.m (63 ft. lbs).

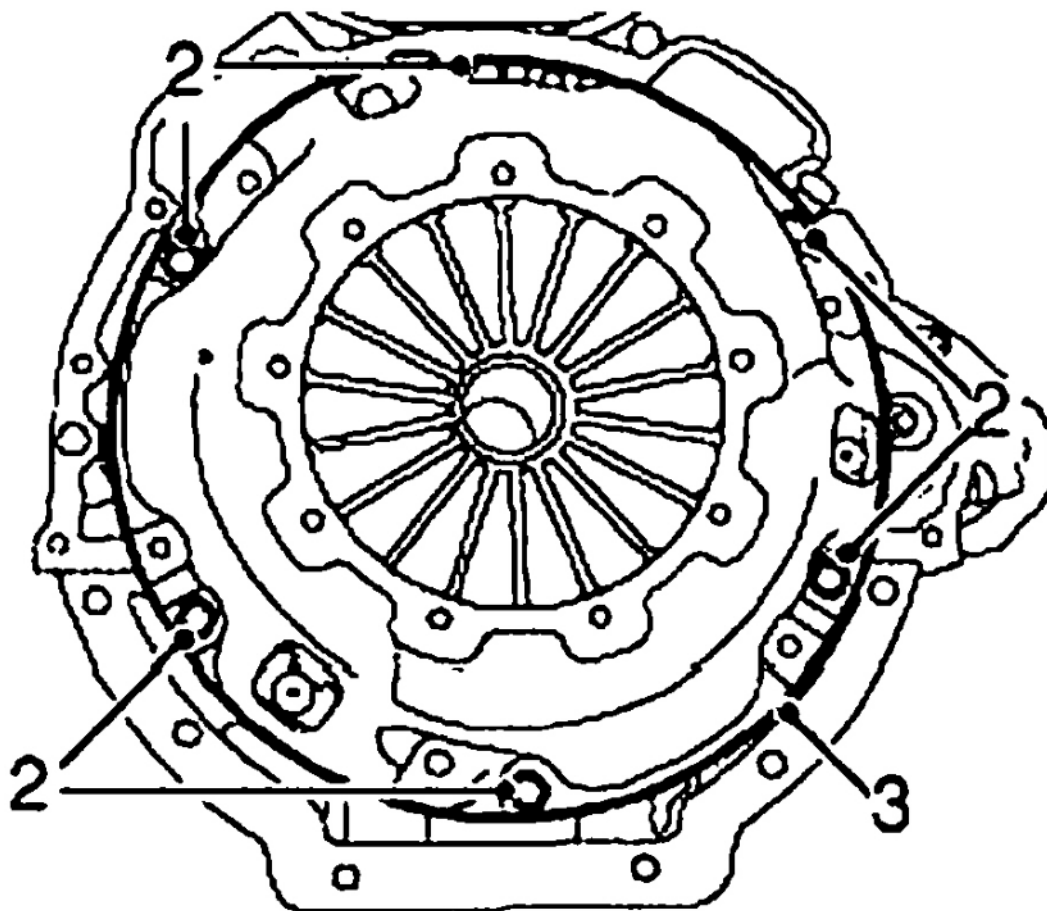
12. Later Engines

Fit drive plate and clamp ring, fit bolts and tighten to 45 N.m (33 ft. lbs).

13. Fit CKP sensor. See **INSTALLATION** .

SEAL - CRANKSHAFT - REAR - M/T**Disassembly**

1. Restrain flywheel.
2. Working in sequence, loosen and remove 6 bolts securing clutch cover to flywheel. See **Fig. 107**.

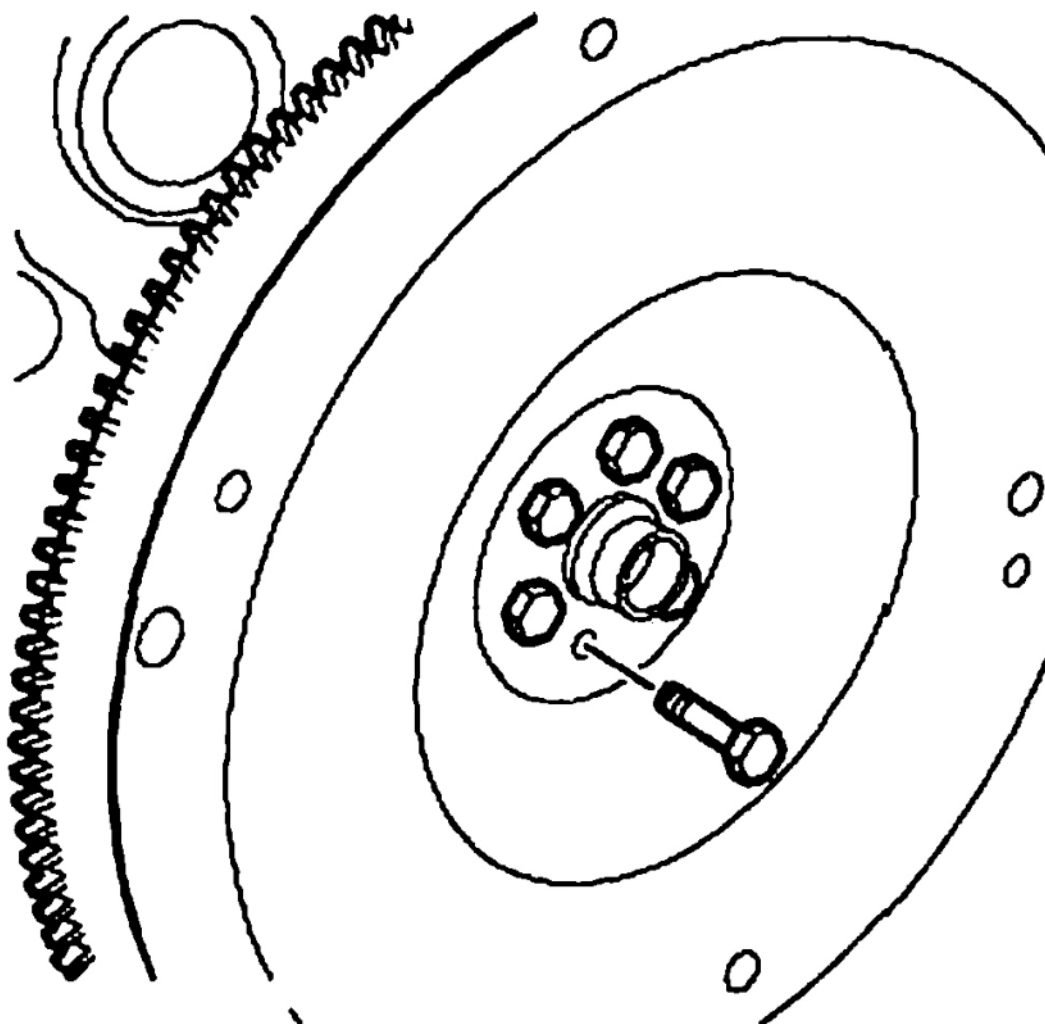


G00386288

Fig. 107: Clutch Cover And Flywheel (M/T)

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove clutch cover.
4. Remove clutch plate.
5. Remove CKP sensor. See **REMOVAL** .
6. Remove 6 bolts securing flywheel. See **Fig. 108**.

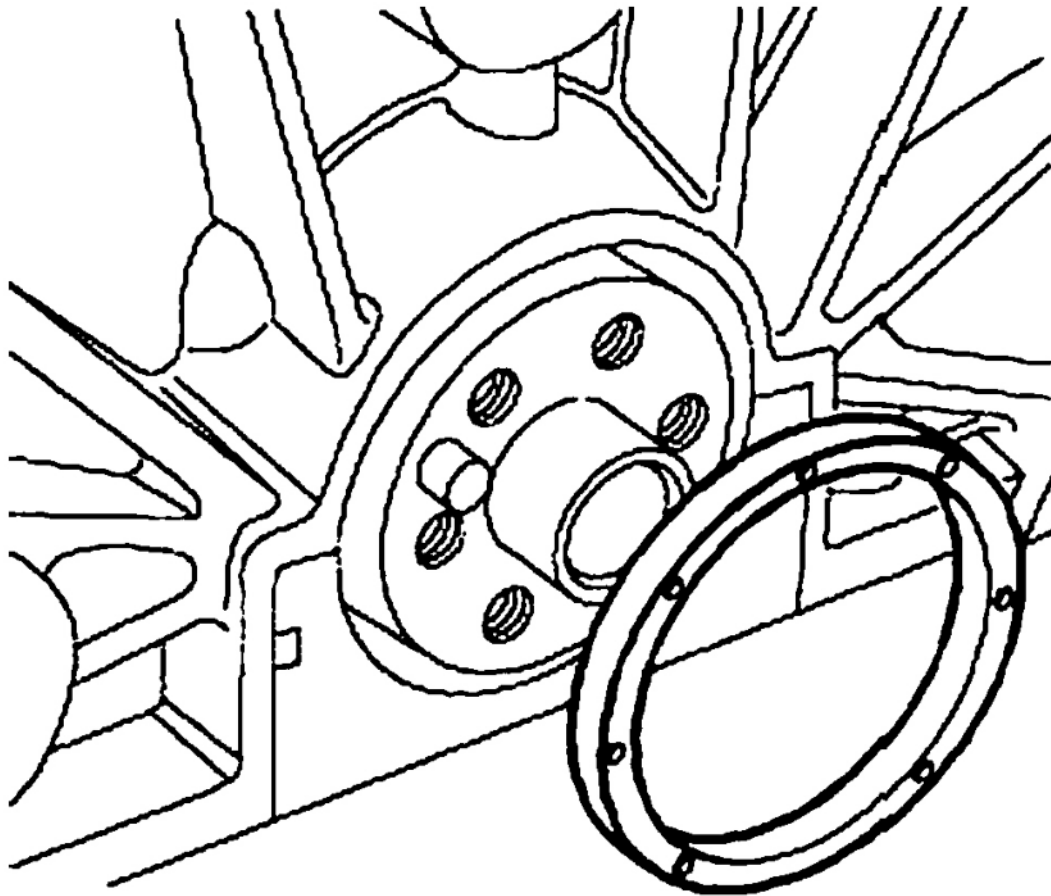


G00386289

Fig. 108: Flywheel (M/T)

Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Remove flywheel.
8. Carefully remove oil seal from cylinder block to avoid damage to seal location or running surface on crankshaft. See **Fig. 109**.

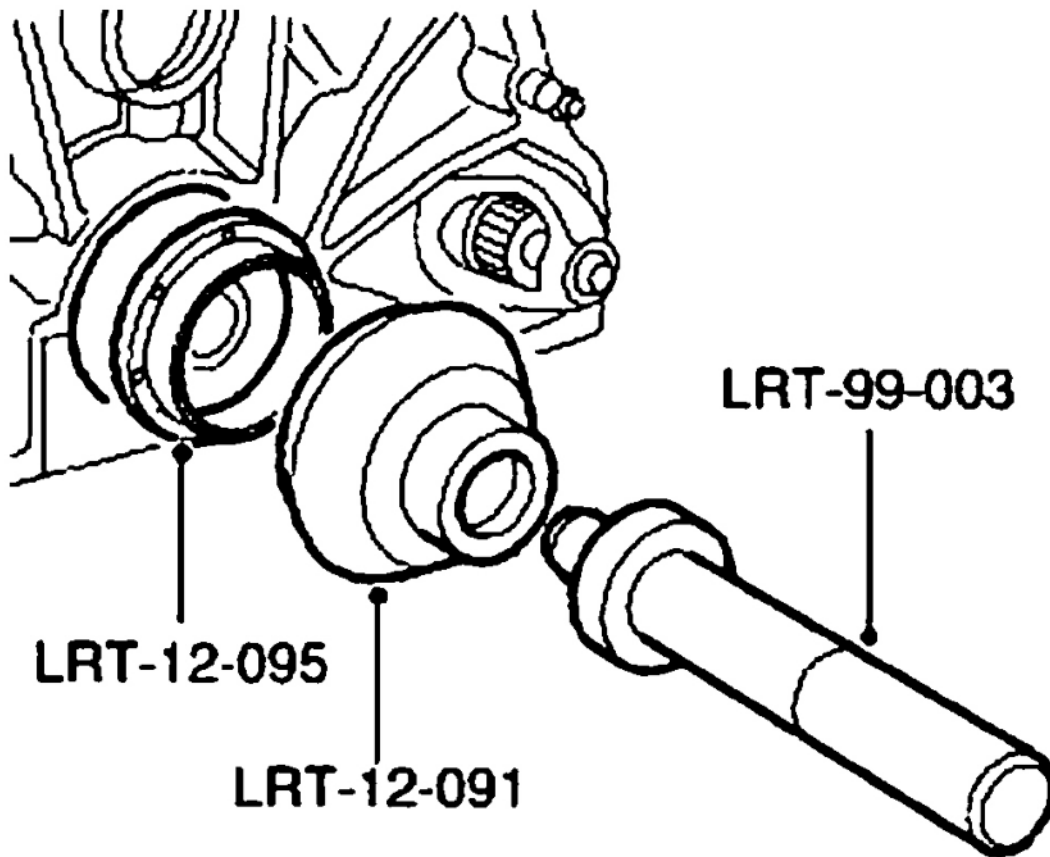


G00386290

Fig. 109: Removing Rear Crankshaft Seal (M/T)
Courtesy of LAND ROVER NORTH AMERICA, INC.

Reassembly

1. Ensure both seal location and running surface on crankshaft are clean. Ensure that bolt holes are clean and dry.
2. Lubricate replacement oil seal with engine oil.
3. Lubricate seal guide LRT-12-095 with engine oil and position to crankshaft.
4. Fit NEW seal squarely onto crankshaft and remove guide LRT-12-095.
5. Fit seal into location using tools LRT-12-091 and LRT-99-003. See **Fig. 110**.



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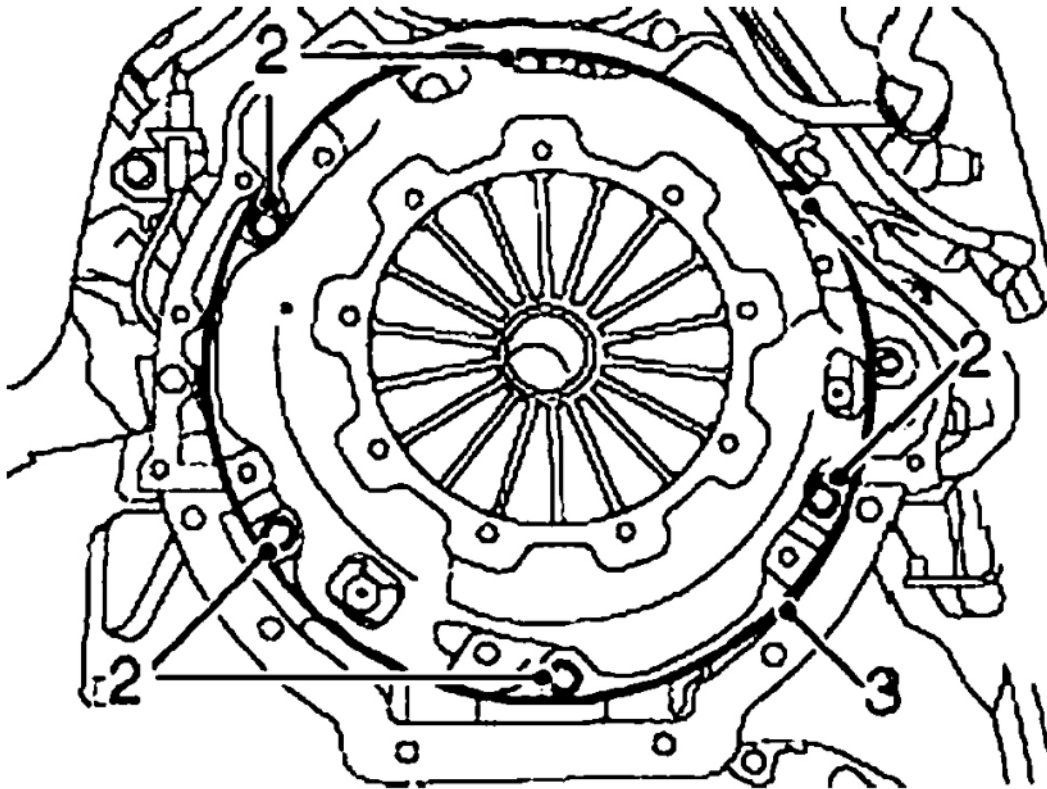
Fig. 110: Installing Crankshaft Rear Seal (M/T)
Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Clean mating faces of flywheel and crankshaft, dowel and dowel hole.
7. Fit flywheel to crankshaft and, working in a diagonal sequence, tighten bolts to 78 N.m (58 ft. lbs).
8. Fit CKP sensor. See **INSTALLATION**.
9. Clean clutch cover, drive plate and spigot bush in end of crankshaft.
10. Renew worn components as necessary.
11. If refitting existing drive plate, apply Molycote FB 108 to splines.
12. Fit LRT-12-001 alignment tool to spigot bearing in crankshaft.
13. Fit drive plate onto alignment tool, ensure side marked FLYWHEEL SIDE is against flywheel.
14. Fit clutch cover and locate on dowels.
15. Fit clutch cover bolts and tighten in diagonal sequence to 40 N.m (30 ft. lbs).

BEARING - SPIGOT (PILOT) - CRANKSHAFT

Disassembly

1. Remove 6 bolts securing clutch cover. See **Fig. 111**.

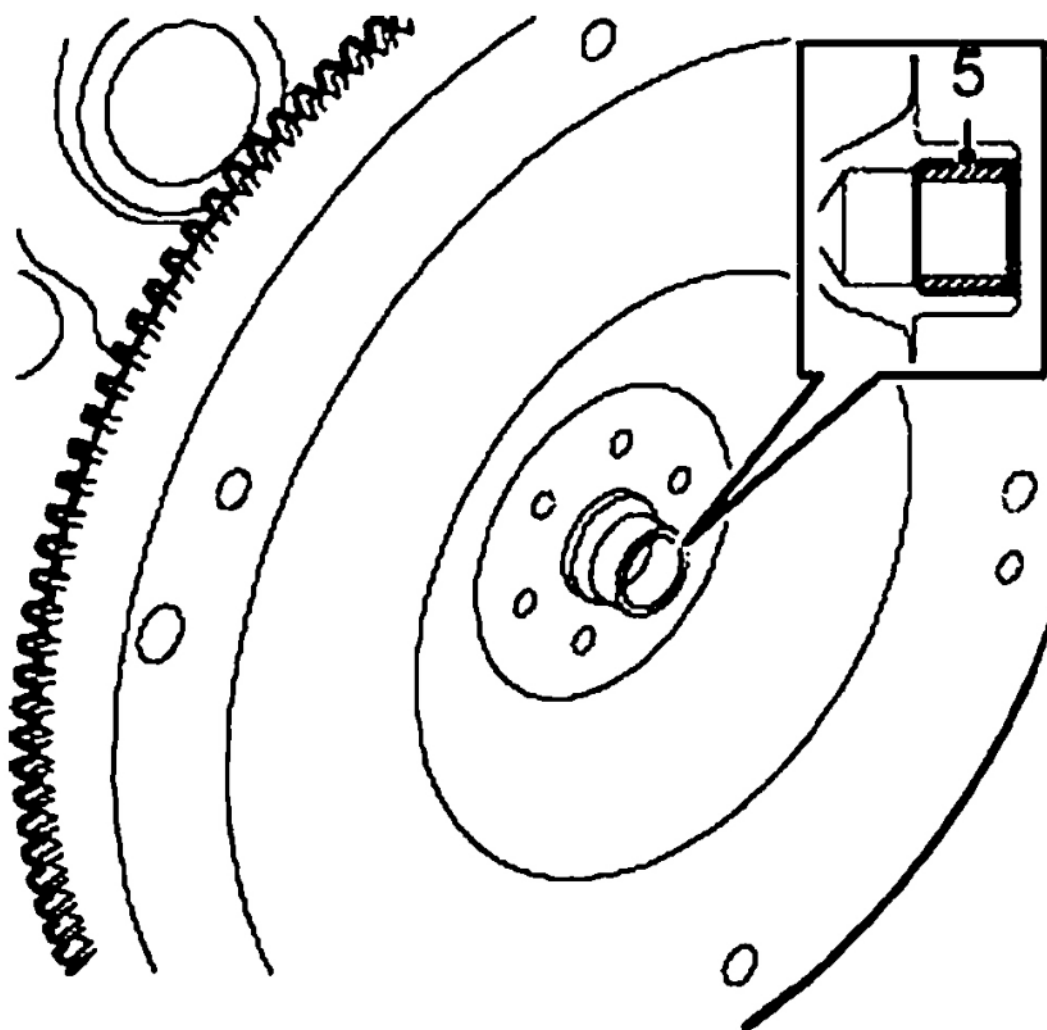


G00386292

Fig. 111: Clutch Cover Bolts

Courtesy of LAND ROVER NORTH AMERICA, INC.

2. Remove clutch cover.
3. Tap a thread in spigot bush to accommodate a suitable impulse extractor.
4. Fit extractor to bush (spigot bearing).
5. Remove pilot bush (spigot bearing) from crankshaft. See **Fig. 112**.



G00386293

Fig. 112: Crankshaft Spigot Bearing

Courtesy of LAND ROVER NORTH AMERICA, INC.

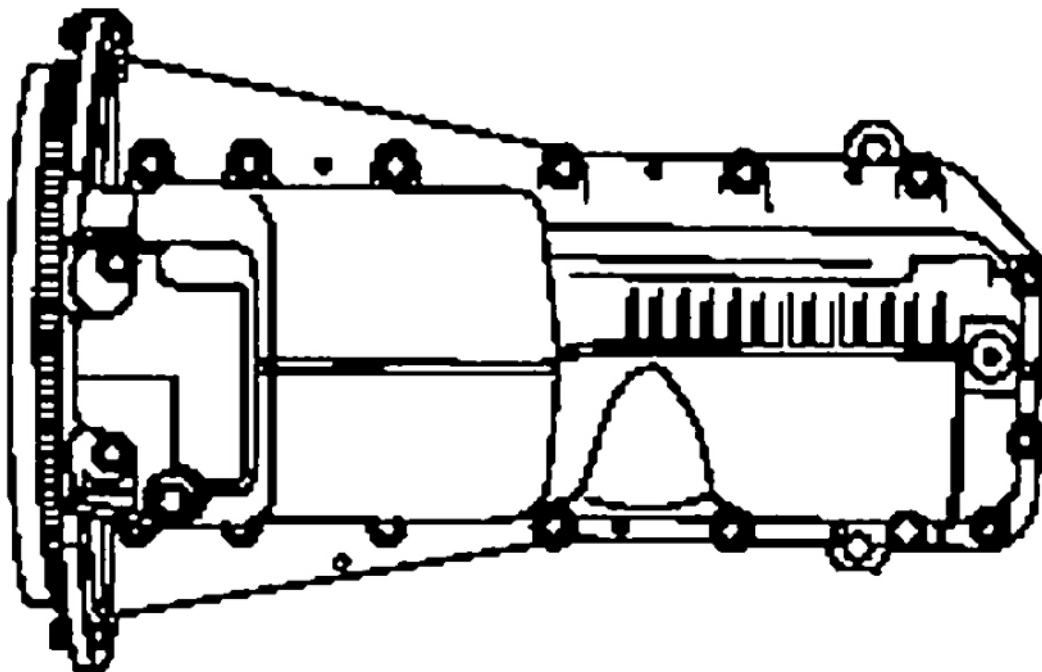
Reassembly

1. Clean pilot bush register in rear of crankshaft.
2. Using a suitable drift, fit NEW bush to crankshaft so that it is flush with or up to a maximum of 1.6 mm (0.06 in) below the end of the crankshaft.
3. Ream spigot bush to $19.117 + 0.025 - 0.00$ mm ($0.75 + 0.001 - 0.00$ in).
4. Remove all traces of swarf on completion.
5. Clean mating faces of flywheel and crankshaft, dowel and dowel hole.
6. Fit clutch cover to flywheel and tighten bolts by diagonal selection to 40 N.m (30 ft. lbs).

GASKET - ENGINE SUMP

Disassembly

1. Remove 3 nuts and 14 bolts securing sump to cylinder block.
2. Remove sump. See **Fig. 113**.



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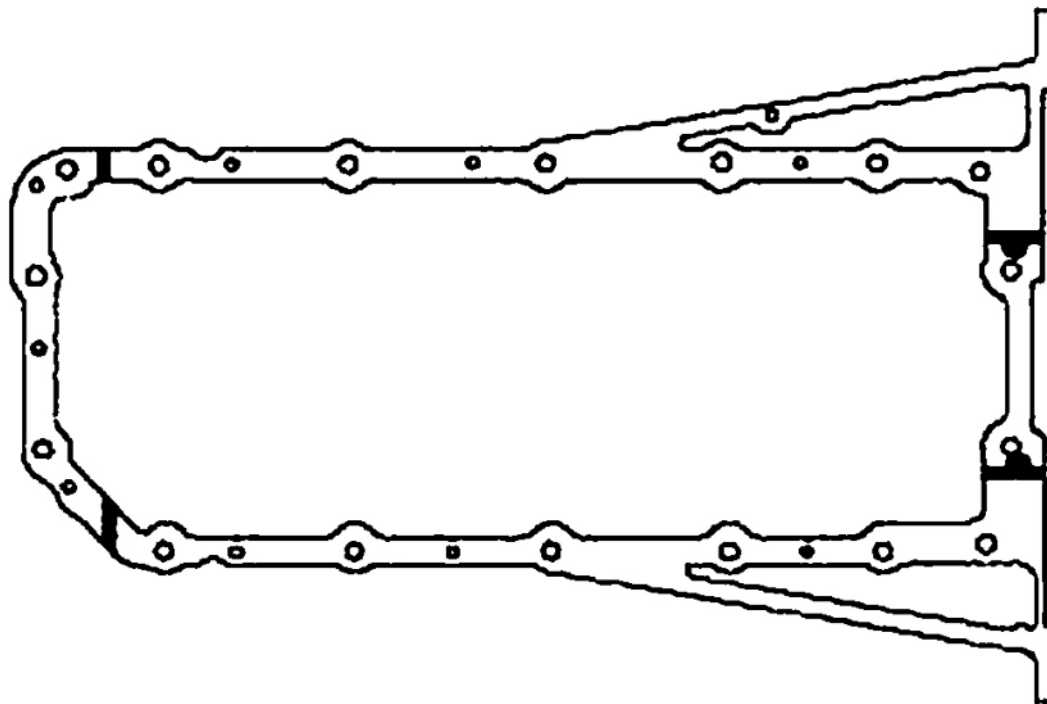
Fig. 113: Engine Sump

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove and discard gasket.

Reassembly

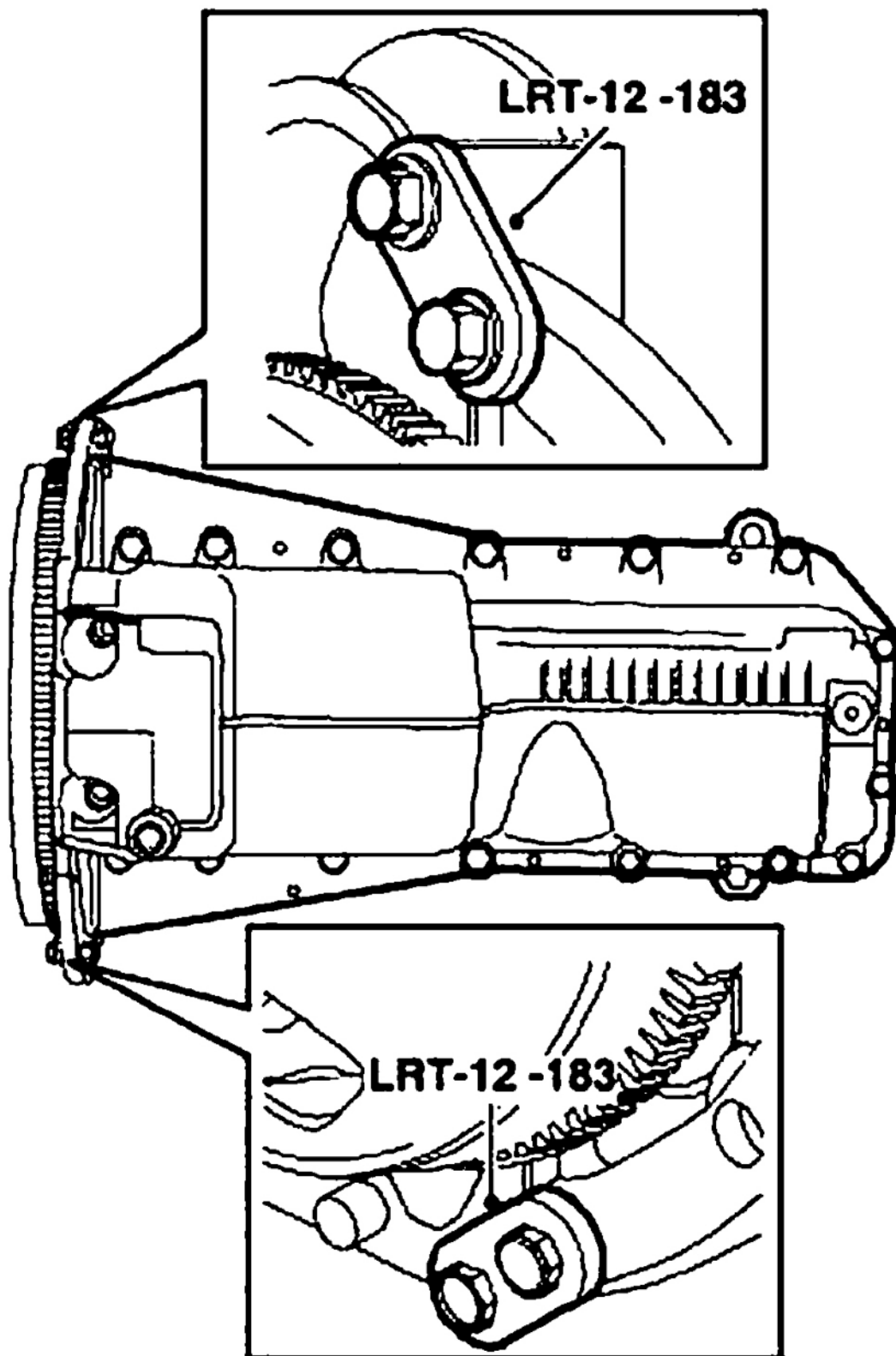
1. Clean all traces of sealant from the sump and sump mating faces, using a solvent cleaner or plastic scraper.
2. Ensure that bolt holes in cylinder block are clean and dry.
3. Apply a 5 mm (0.2 in) wide bead of sealant, Part No. STC 50550 across the cylinder block to front cover joint and across the cylinder block to rear main bearing joint. Apply a globule of sealant to cover the ends of the cruciform seals. See **Fig. 114**.



G00386295

Fig. 114: Identifying Sump Sealant Locations
Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Fit NEW sump gasket, dry, ensure location tags are correctly positioned.
5. Fit the sump to the cylinder block.
6. Noting that the two parts of the tool are handed, fit tool LRT-12-183 to the engine back plate using bell housing nuts and bolts. See **Fig. 115**.

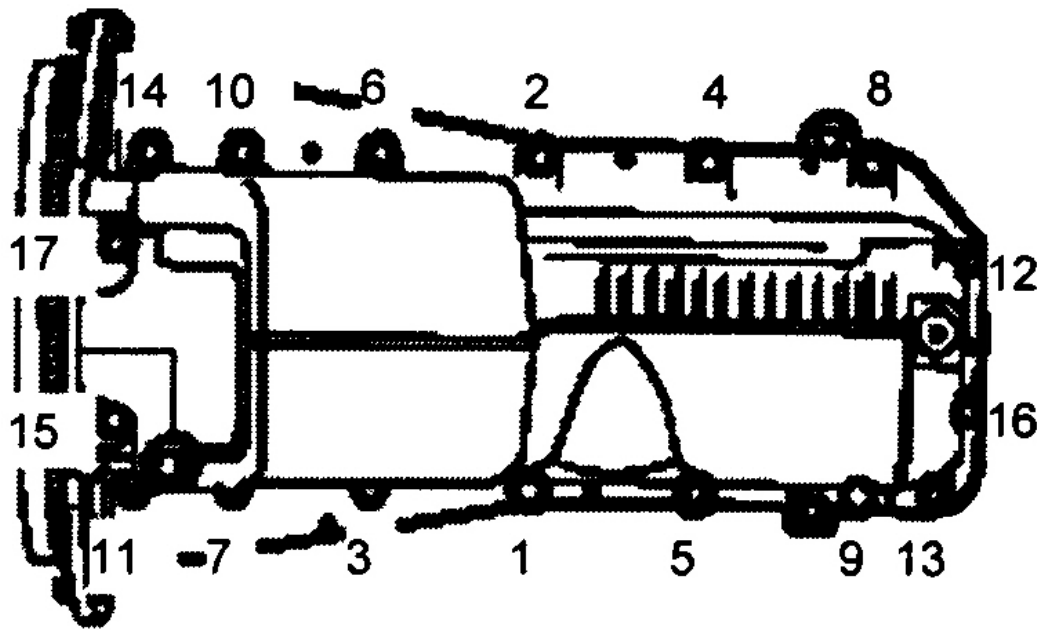


G00386296

Fig. 115: Positioning Sump Support Tool

Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Secure the tool to the sump using the bolts which are part of the tool. The holes in the tool are larger than the diameter of the bolts, allowing the tool and the sump to move as the sump bolts are tightened.
8. Fit the sump nuts and bolts, and working in the sequence shown, tighten to 22 N.m (16 ft. lbs). See **Fig. 116**.



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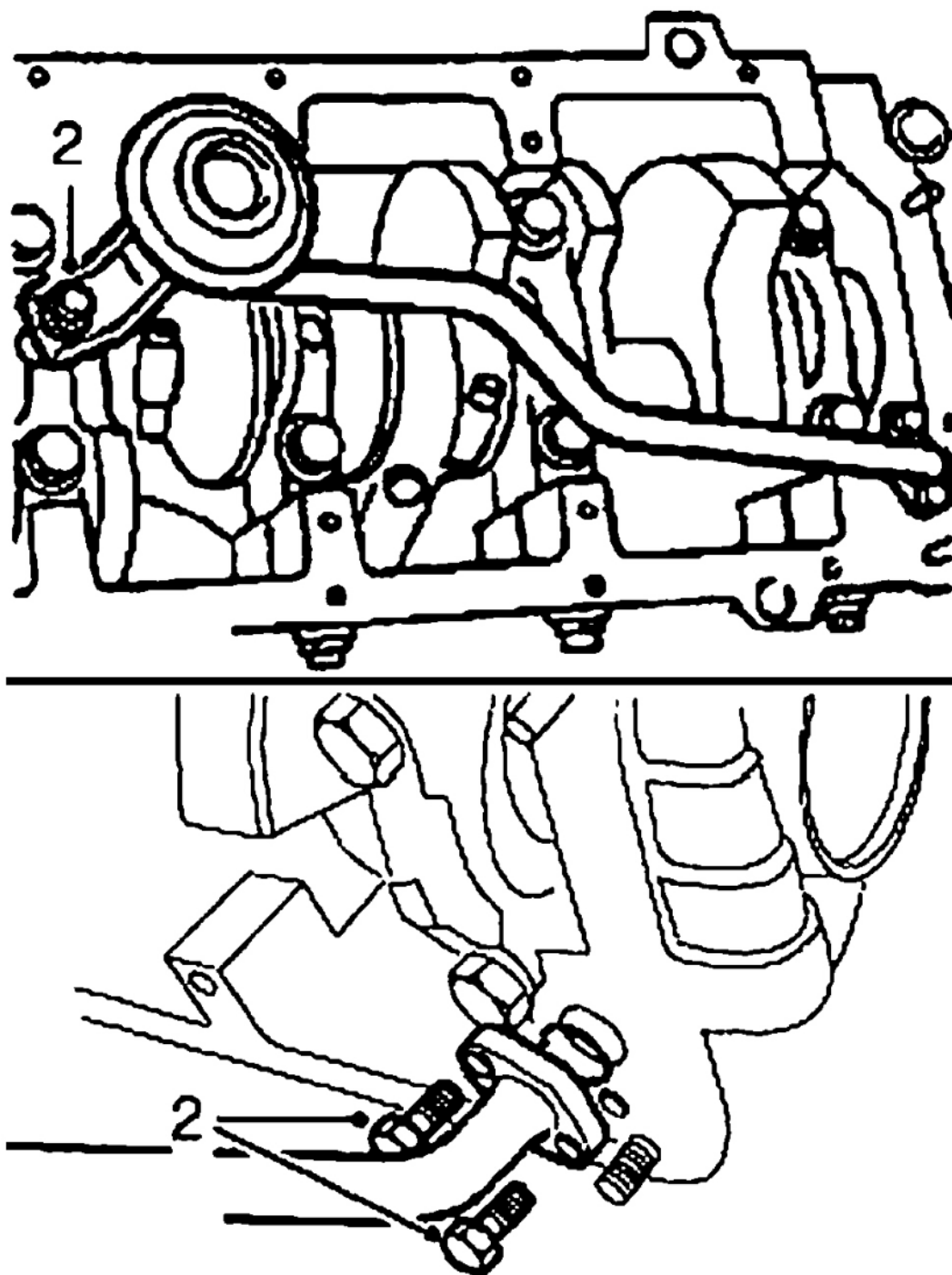
Fig. 116: Sump Bolt Tightening Sequence

Courtesy of LAND ROVER NORTH AMERICA, INC.

9. Remove tool LRT-12-183.

STRAINER - OIL PICK-UP**Disassembly**

1. Remove sump gasket. See **GASKET - SUMP**.
2. Remove 2 bolts and 1 nut securing oil pick up strainer. See **Fig. 117**.



G00386298

Fig. 117: Oil Pick-Up Strainer

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove oil pick up strainer.
4. Collect spacer.
5. Remove and discard "O" ring.

Reassembly

1. Clean oil pick up strainer and "O" ring recess.
2. Lubricate NEW "O" ring with clean engine oil and fit to recess.
3. Locate spacer on stud.
4. Position oil pick up strainer, fit bolts and tighten to 10 N.m (7 ft. lbs). Fit nut and tighten to 22 N.m (16 ft. lbs).
5. Fit NEW sump gasket. See **GASKET - SUMP**.

SEAL - TIMING GEAR COVER**Disassembly**

1. Secure tool LRT-12-080 to crankshaft pulley with 2 bolts.
2. Remove crankshaft pulley bolt. See **Fig. 118**.

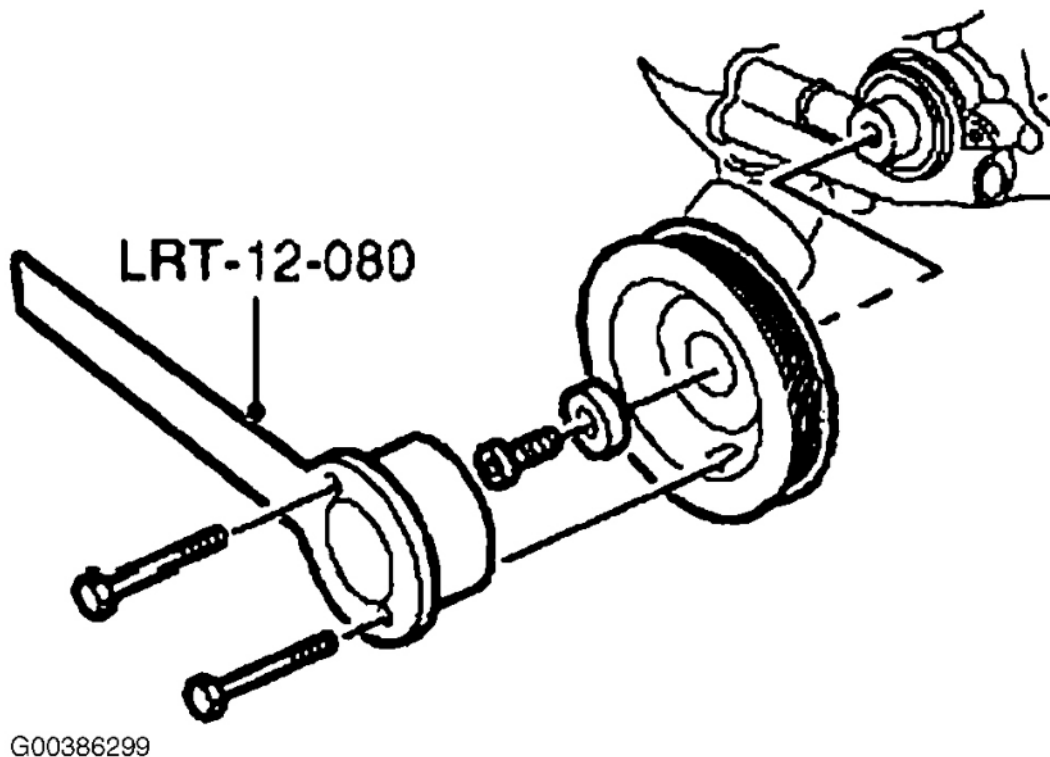
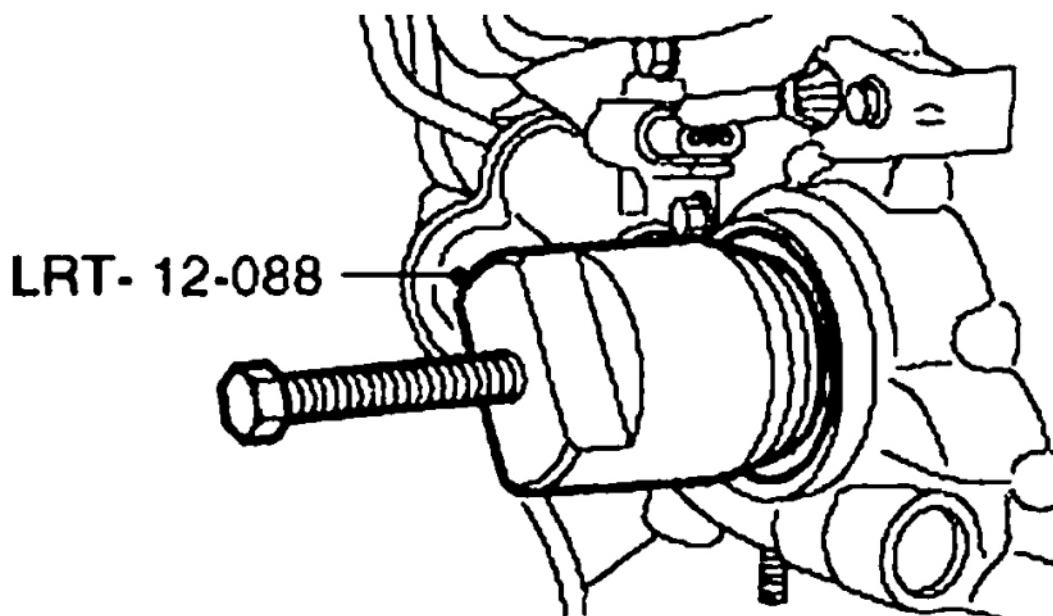


Fig. 118: Removing Crankshaft Pulley

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove crankshaft pulley.
4. Using tool LRT-12-088, remove oil seal from timing gear cover and discard. See **Fig. 119**.



G00386300

Fig. 119: Removing Timing Gear Cover Seal

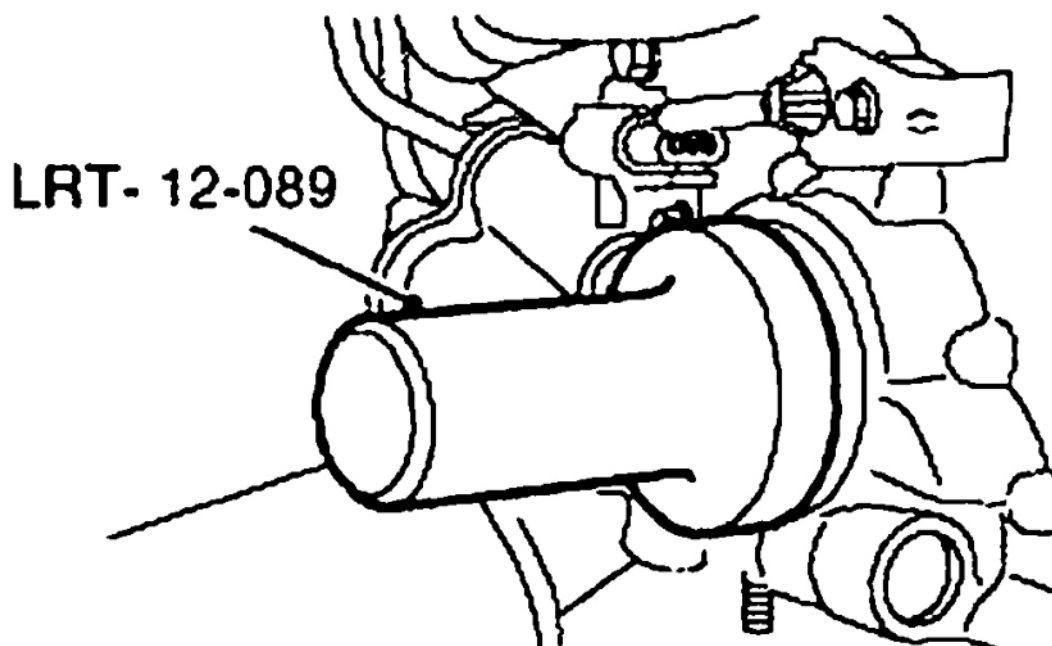
Courtesy of LAND ROVER NORTH AMERICA, INC.

Reassembly

1. Clean seal register in timing gear cover and crankshaft pulley.
2. Ensure that bolt holes are clean and dry.

CAUTION: Replacement oil seal is pre-greased, do not apply additional lubricant.

3. Apply smear of Retinax LX grease to seal running surface on crankshaft.
4. Fit seal to timing gear cover using tool LRT-12-089. See **Fig. 120**.



G00386301

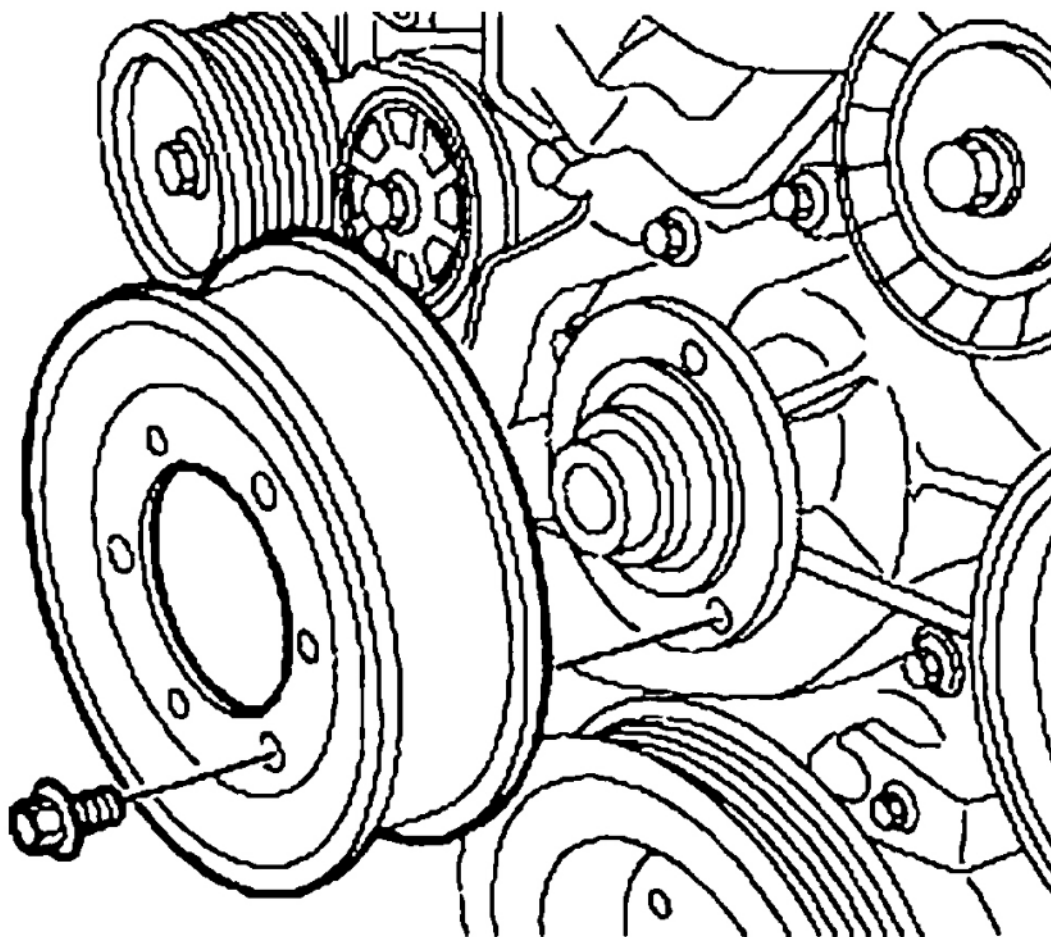
Fig. 120: Installing Timing Gear Cover Seal
Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Secure tool LRT-12-080 to crankshaft pulley with 2 bolts. Fit crankshaft pulley.
6. Fit crankshaft pulley bolt and tighten to 270 N.m (200 ft. lbs).
7. Remove tool LRT-12-080 from crankshaft pulley.

GASKET - TIMING GEAR COVER

Disassembly

1. Remove oil pick up strainer. See **STRAINER - OIL PICK-UP**.
2. Remove and discard 3 bolts securing coolant pump pulley. See **Fig. 121**.



G00386302

Fig. 121: Coolant Pump Pulley

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove coolant pump pulley.
4. Secure tool LRT-12-080 to crankshaft pulley with 2 bolts. See **Fig. 122**.

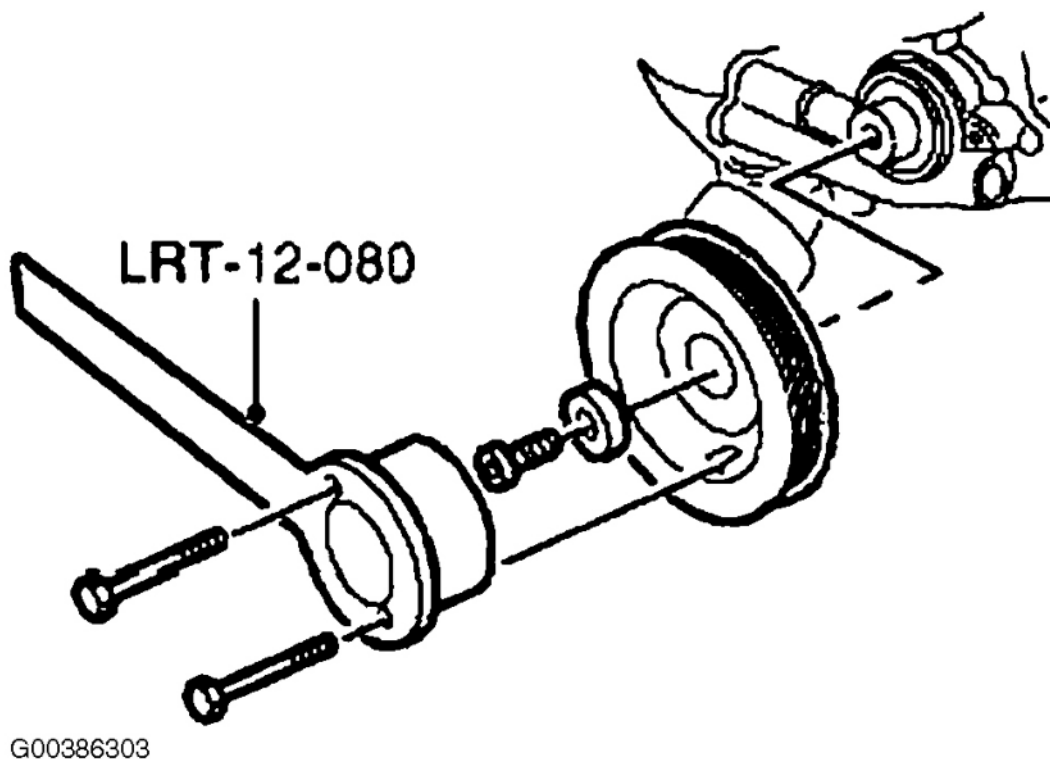
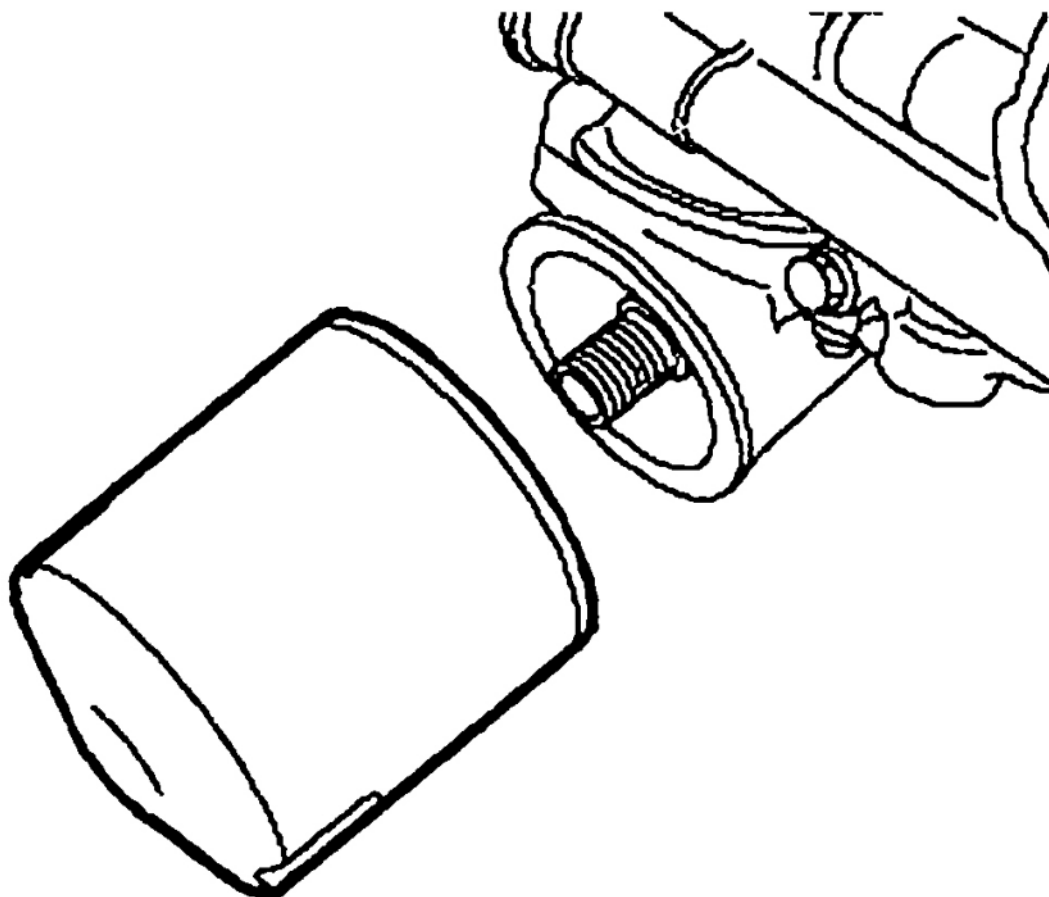


Fig. 122: Crankshaft Pulley

Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Remove crankshaft pulley bolt.
6. Remove crankshaft pulley.
7. Remove oil filter and discard. See **Fig. 123**.

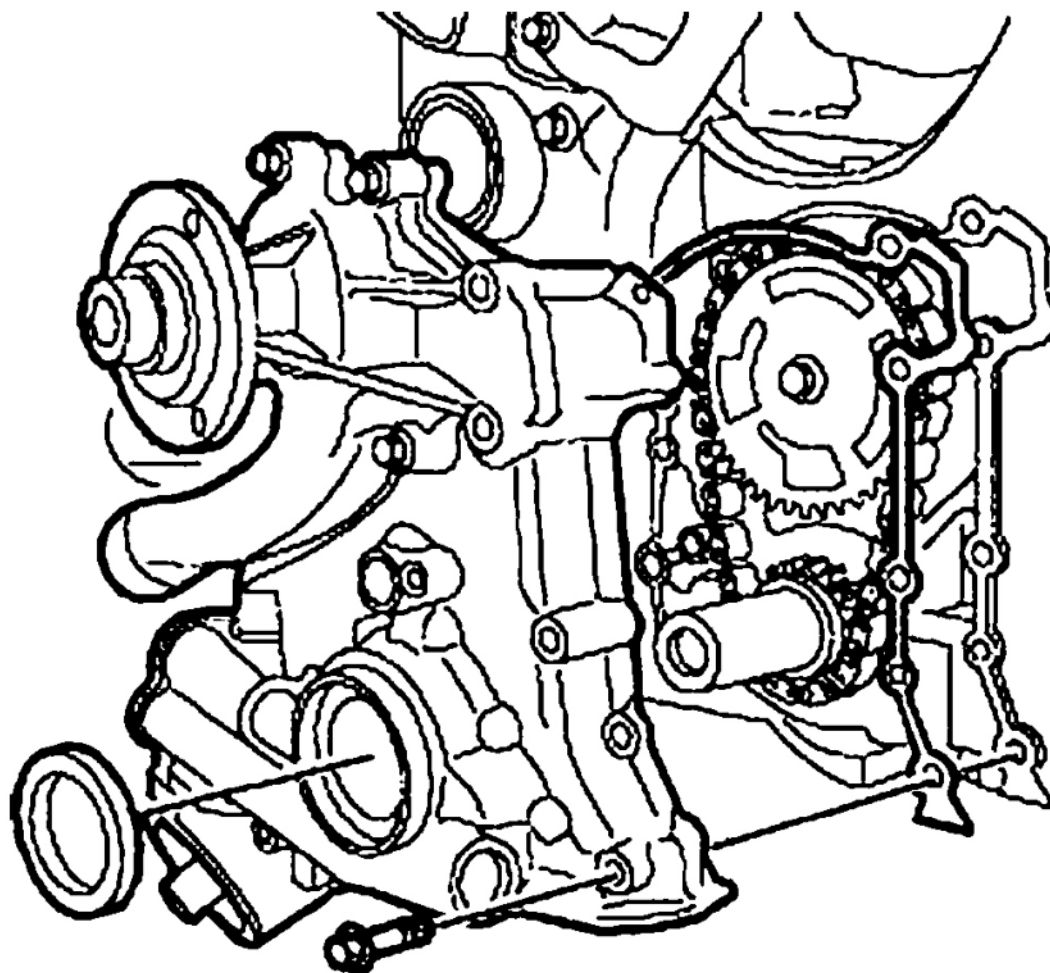


G00386304

Fig. 123: Oil Filter

Courtesy of LAND ROVER NORTH AMERICA, INC.

8. Noting the positions of the longer bolts, remove 9 bolts securing timing gear cover.
9. Remove timing gear cover. See **Fig. 124**.



G00386305

Fig. 124: Timing Gear Cover

Courtesy of LAND ROVER NORTH AMERICA, INC.

10. Remove and discard timing gear cover gasket.
11. Remove seal from timing gear cover and discard.

Reassembly

1. Clean timing gear cover and mating face.
2. Clean oil seal register in timing gear cover.
3. Ensure bolt holes in cylinder block are clean and dry, remove all traces of sealant from threads of timing cover bolts.
4. Fit a NEW timing gear cover gasket, dry, to timing cover locating dowels.
5. Locate tool LRT-12-090 on timing cover and oil pump drive gear. See **Fig. 125**.

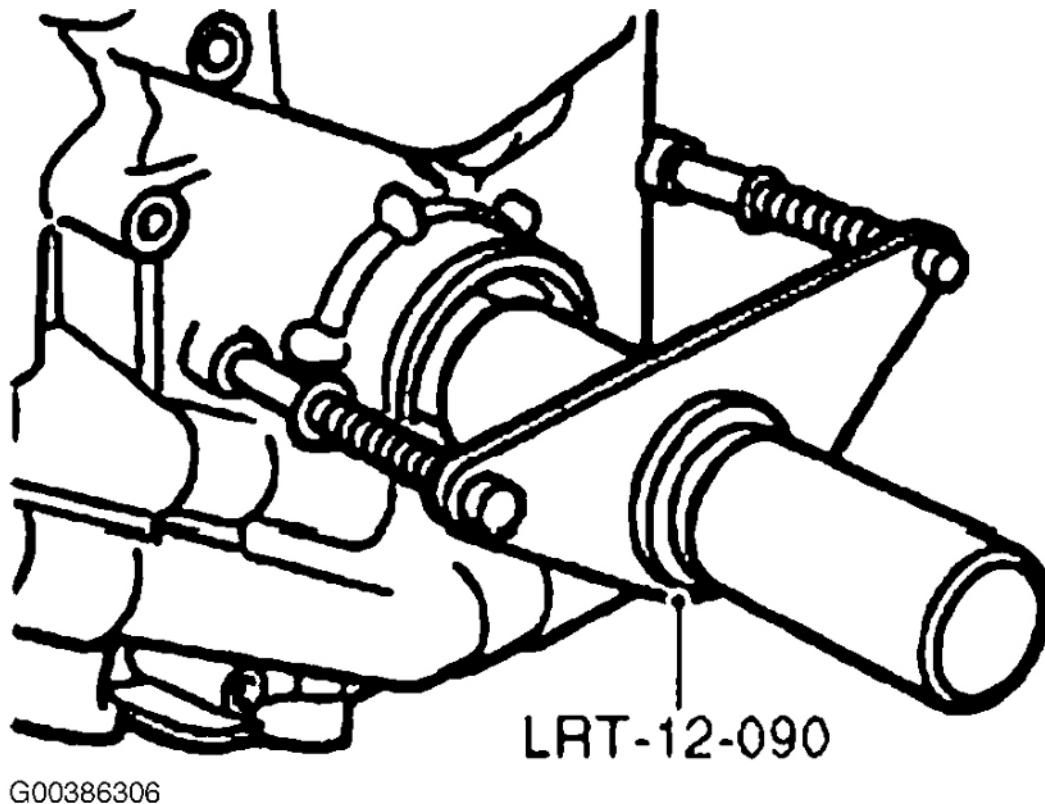
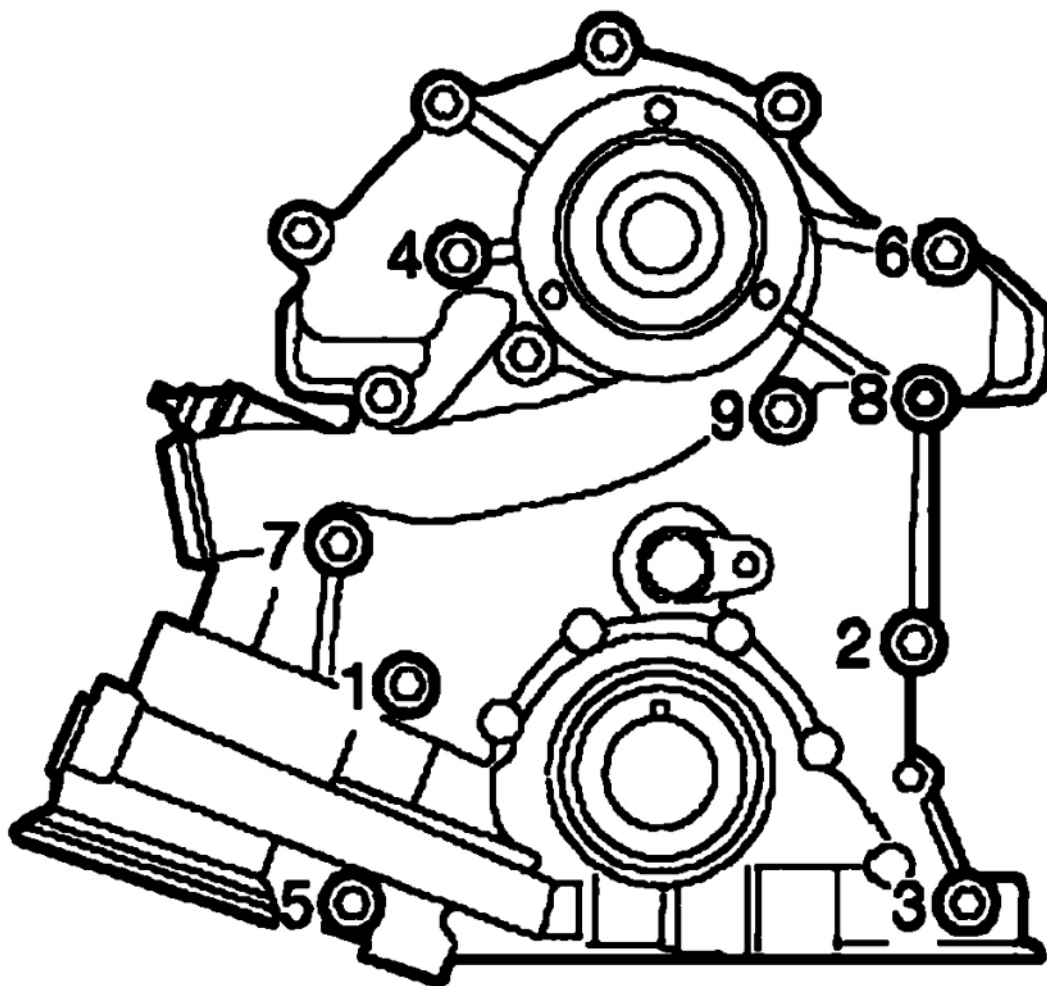


Fig. 125: Locating LRT-12-090 Tool To Timing Cover
Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Position timing cover to cylinder block and at the same time rotate tool LRT-12-090 until drive gear keyway is aligned with Woodruff key.
7. Remove tool LRT-12-090.
8. Apply sealant, Part Number STC 50552 to threads of timing cover bolts.
9. Align 2 camshaft sensor harness clips to timing gear cover bolt holes. Noting positions of the longer bolts and, working in the sequence shown, tighten timing gear cover bolts to 22 N.m (16 ft. lbs). See **Fig. 126**.

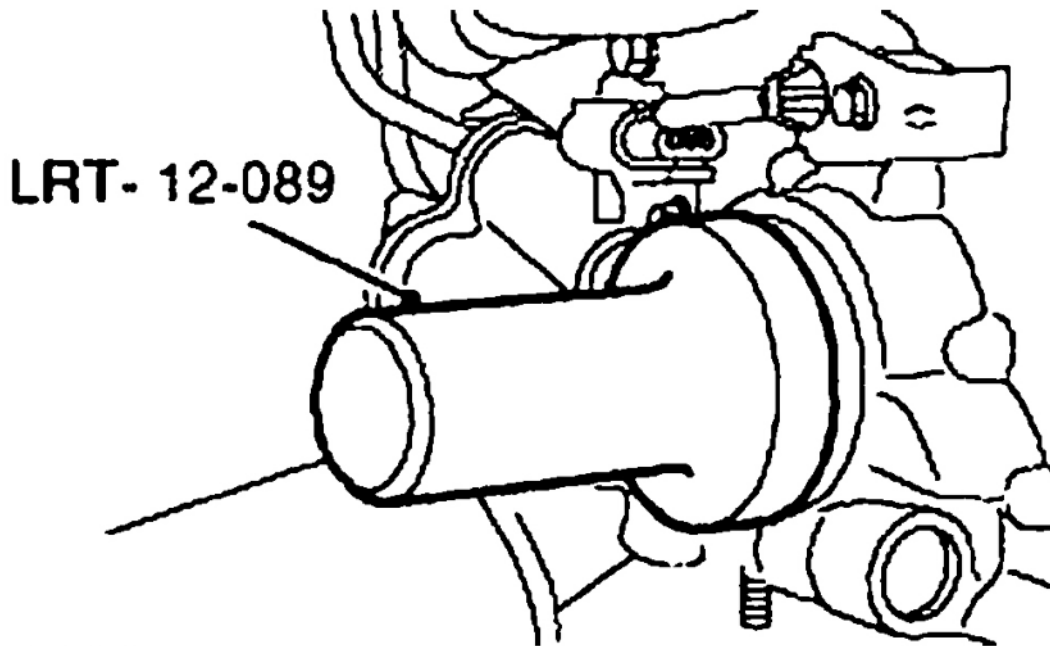


G00386307

Fig. 126: Timing Gear Cover Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Replacement oil seal is pre-greased, DO NOT apply any additional lubricant.

10. Apply smear of Retinax LX grease to oil seal running surface on crankshaft.
11. Fit seal to timing gear cover using tool LRT-12-089. See **Fig. 127**.



G00386308

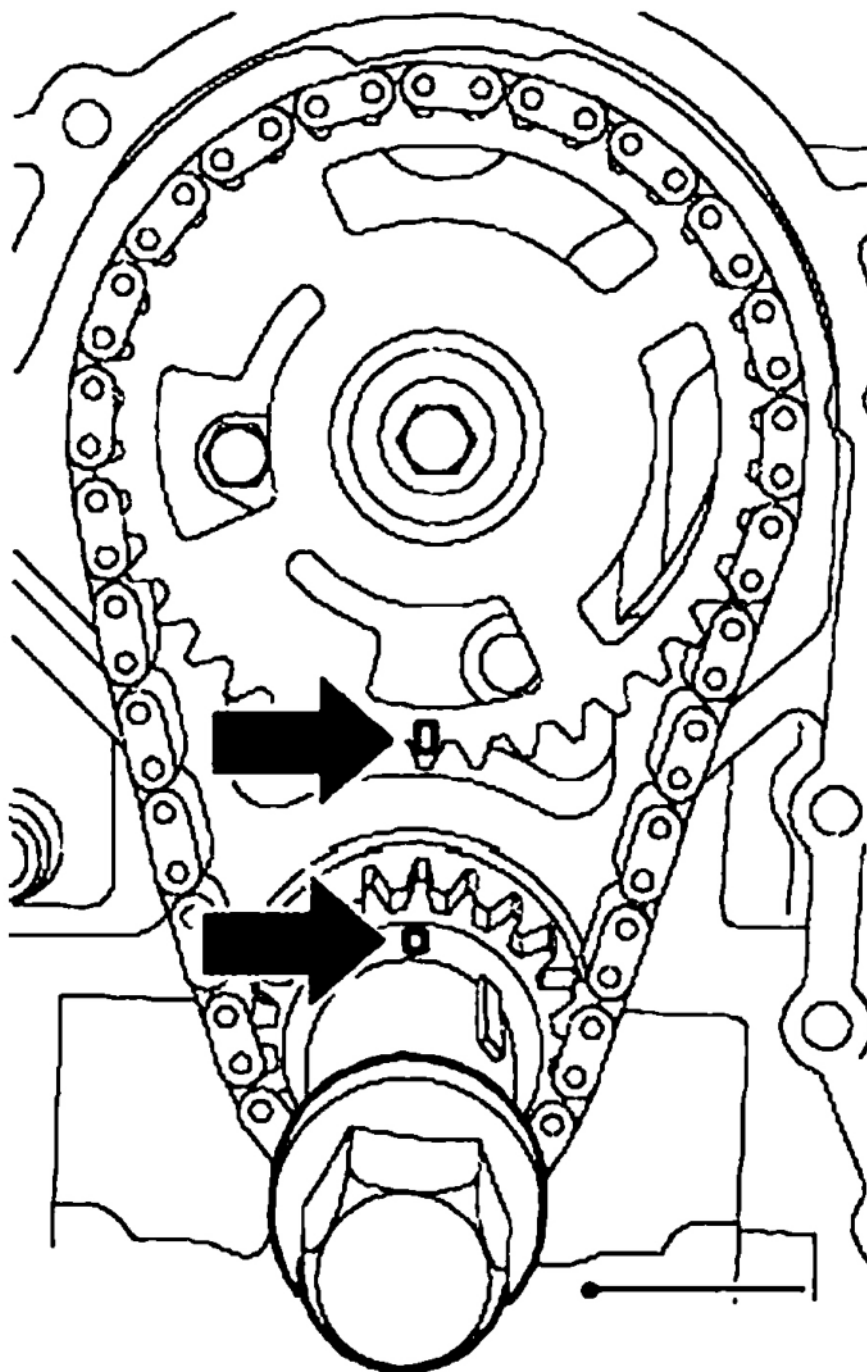
Fig. 127: Installing Timing Gear Cover Seal
Courtesy of LAND ROVER NORTH AMERICA, INC.

12. Clean and fit crankshaft pulley.
13. Fit crankshaft pulley bolt and tighten to 270 N.m (200 ft. lbs).
14. Remove tool LRT-12-080 from crankshaft pulley.
15. Clean oil filter mating face.
16. Lubricate NEW oil filter seal with clean engine oil and fit filter.
17. Ensure coolant pump and pulley mating faces are clean.
18. Remove all traces of thread locking material from coolant pump pulley drive flange bolt holes using an M8 tap.
19. Fit coolant pump pulley and tighten NEW Patchlok bolts to 22 N.m (16 ft. lbs).
20. Fit oil pick up strainer. See **STRAINER - OIL PICK-UP**.

TIMING CHAIN & GEARS

Disassembly

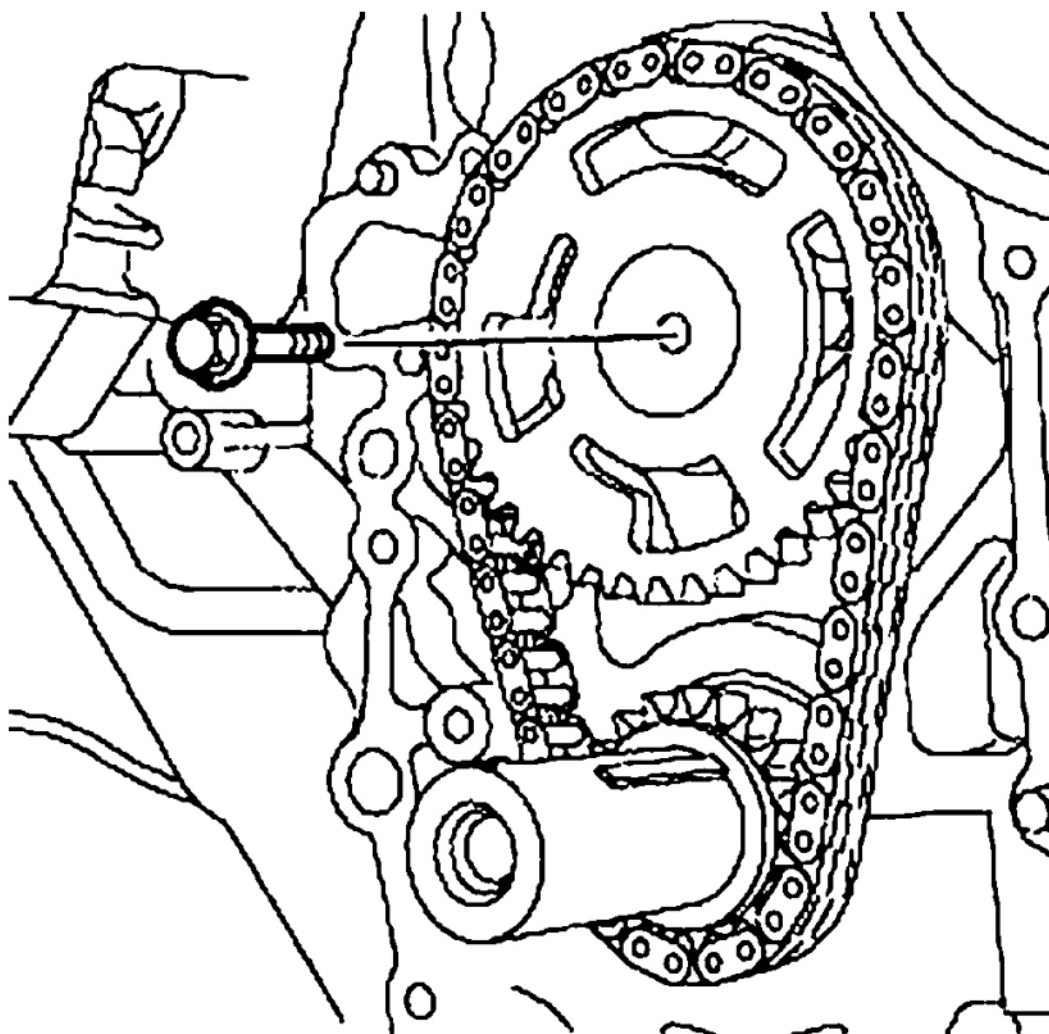
1. Remove timing gear cover gasket. See **SEAL - TIMING GEAR COVER**.
2. Fit crankshaft pulley bolt and rotate engine to align timing marks. Remove crankshaft pulley bolt. See **Fig. 128**.



G00386309

Fig. 128: Aligning Timing Gears & Chain Timing Marks
Courtesy of LAND ROVER NORTH AMERICA, INC.

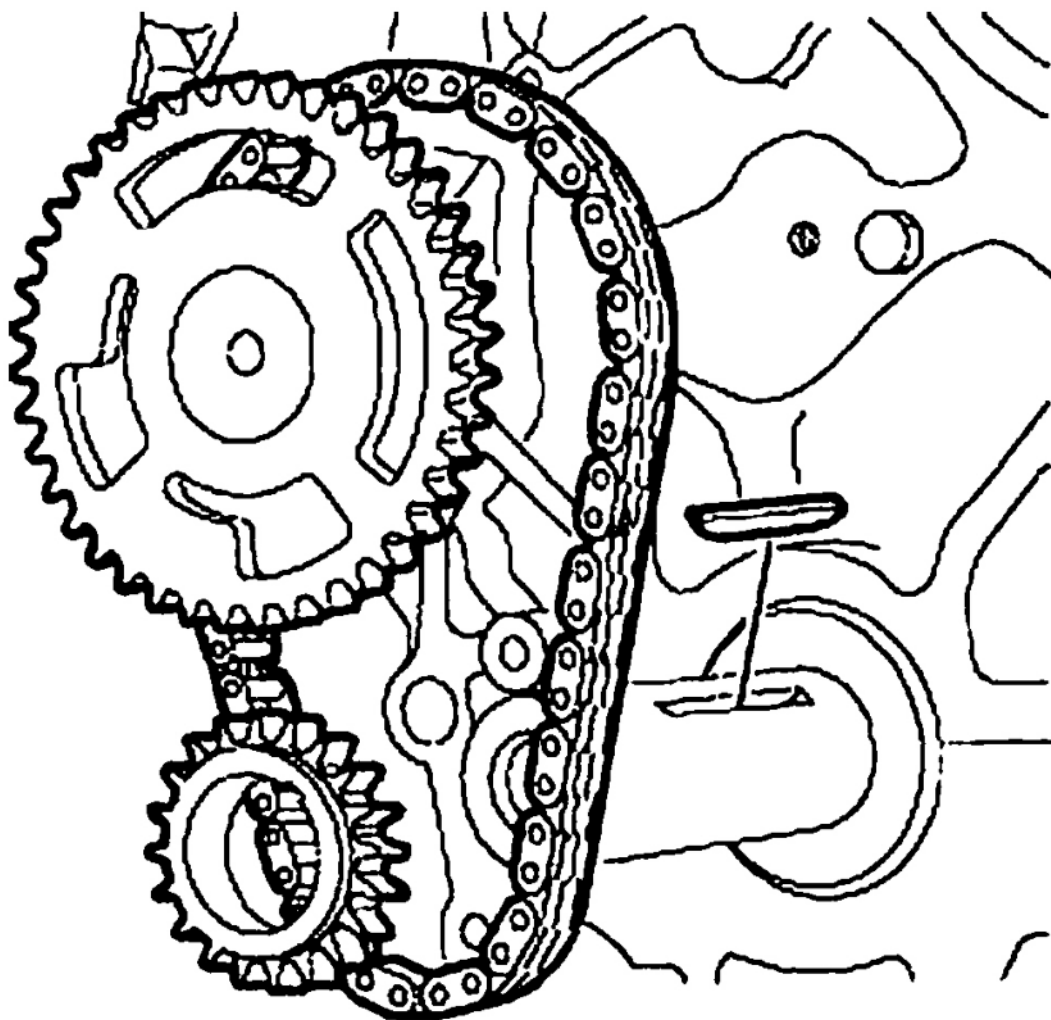
3. Restrain camshaft gear and remove gear retaining bolt. See **Fig. 129**.



G00386310

Fig. 129: Timing Chain Retaining Bolt
Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Remove timing chain and gears as an assembly.
5. Remove gears from timing chain. See **Fig. 130**.



G00386311

Fig. 130: Timing Chain & Gears

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Remove key from crankshaft.

Reassembly

1. Clean timing chain and gears and gear locations.
2. Fit key to crankshaft.
3. Temporarily fit gears to camshaft and crankshaft. If necessary, rotate shafts to align timing marks. When aligned correctly, the timing marks will face each other; crankshaft gear timing mark at twelve o'clock position and camshaft gear timing mark at six o'clock position. See **Fig. 128**.
4. Remove gears from shafts and fit to timing chain.

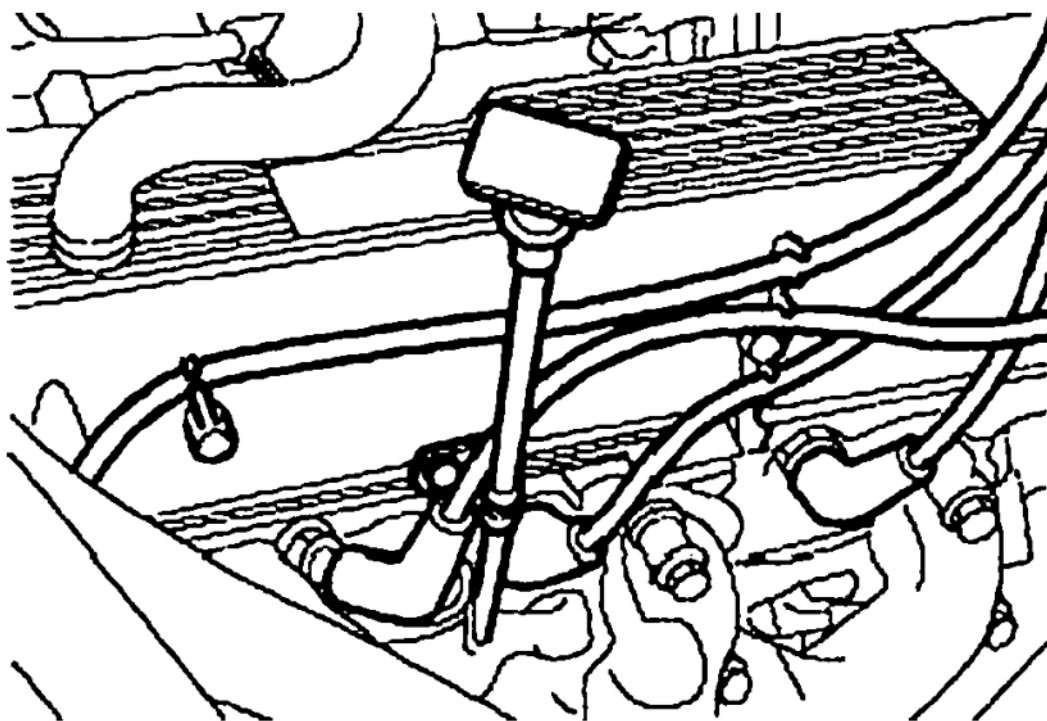
5. With timing marks aligned, fit timing chain and gears as an assembly.
6. Restrain the camshaft gear and tighten retaining bolt to 50 N.m (37 ft. lbs).
7. Fit timing gear cover gasket. See **SEAL - TIMING GEAR COVER**.

ROCKER SHAFT - OVERHAUL

Disassembly

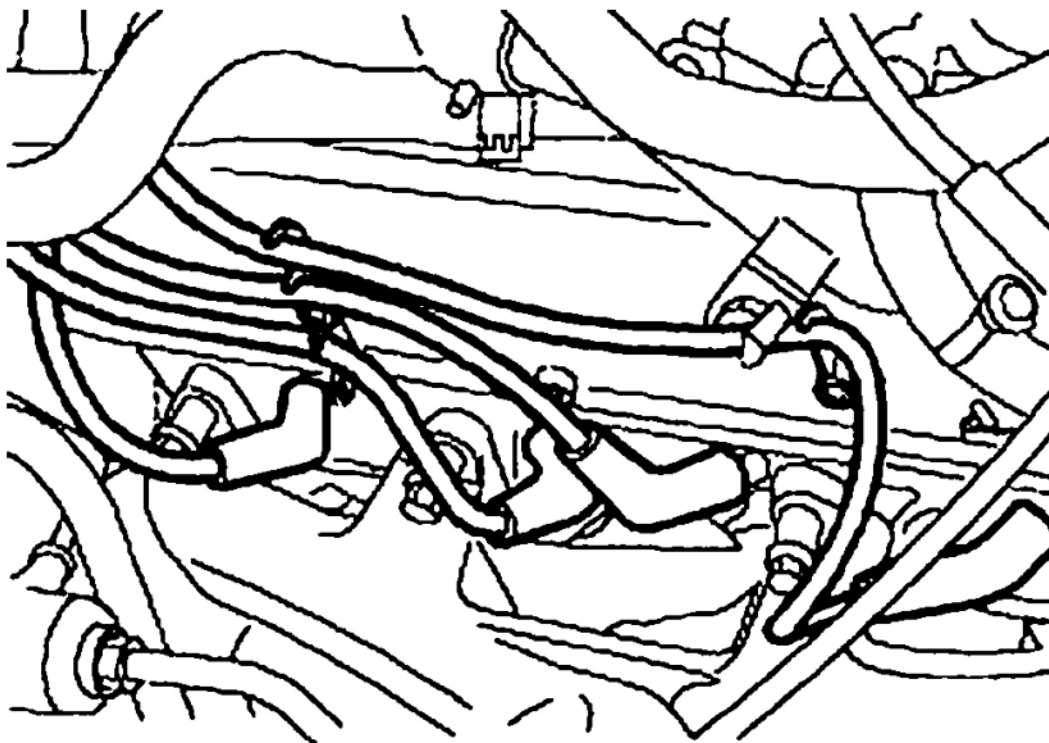
NOTE: If both rocker shafts are to be removed, identify each assembly to ensure refitment to original cylinder head.

1. Release hot leads (spark plug wires) from rocker cover clips. See **Fig. 131** and **Fig. 132**.



G00386313

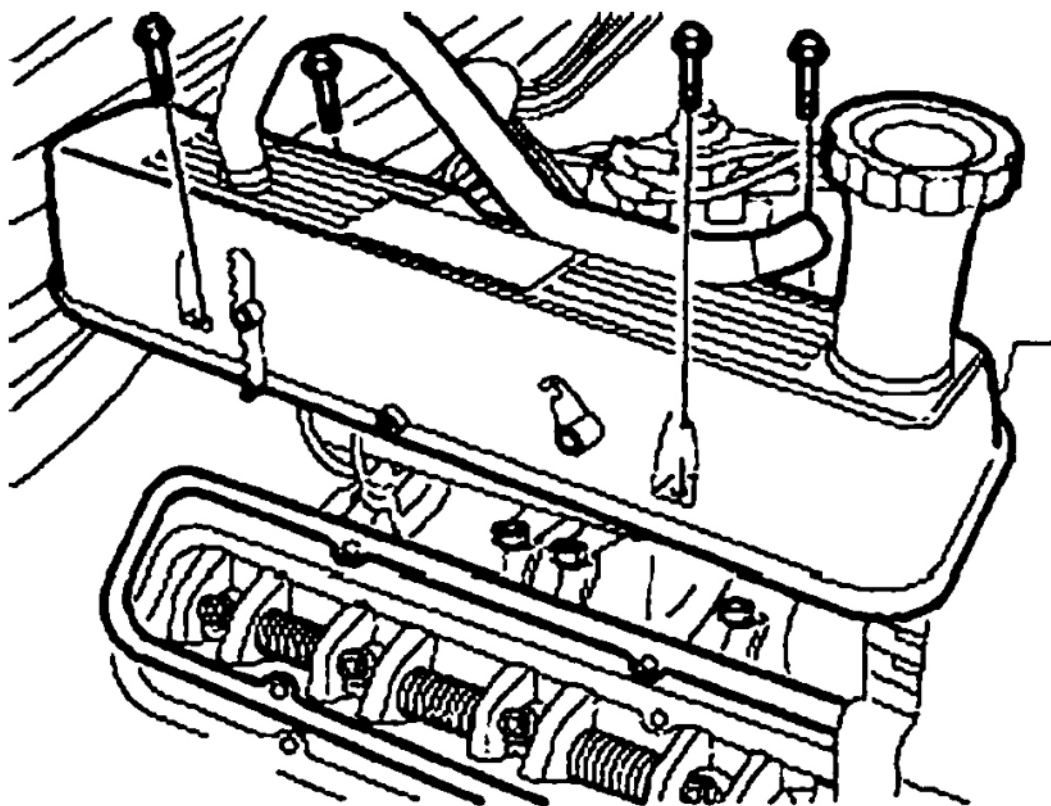
Fig. 131: Hot Leads At Left Rocker Cover Clips
Courtesy of LAND ROVER NORTH AMERICA, INC.



G00386314

Fig. 132: Releasing Hot Leads From Right Rocker Cover
Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Screws/bolts must be replaced with NEW Patched multi-hex bolts.

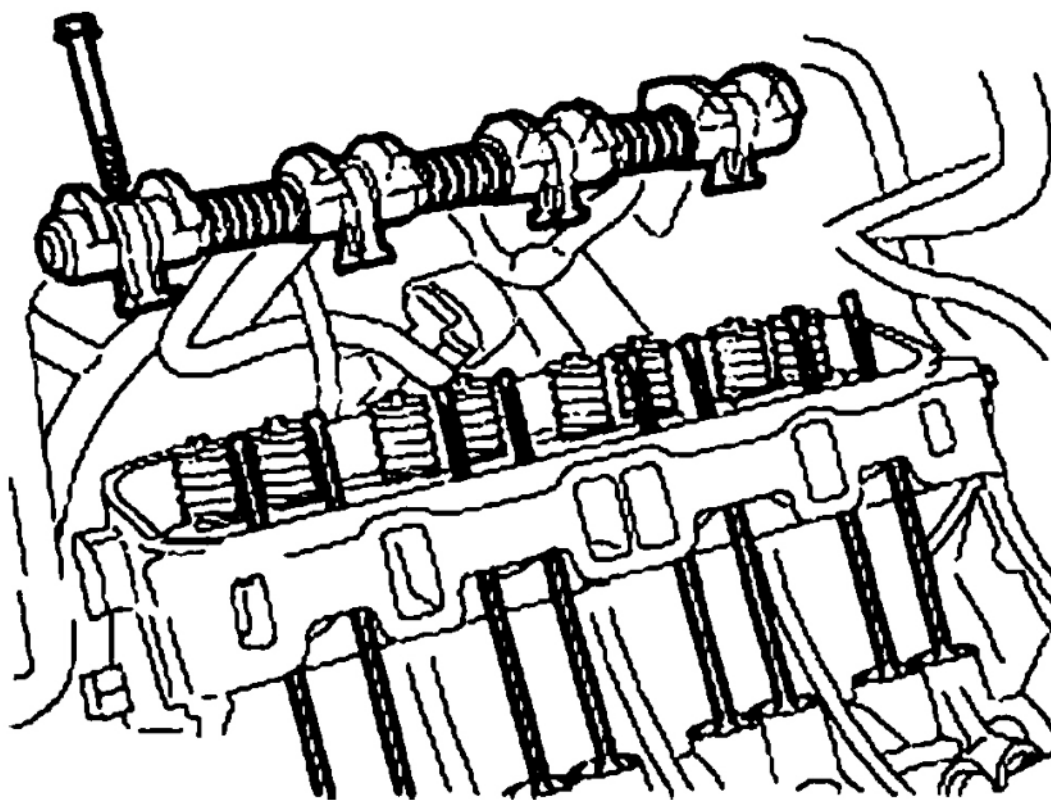


G00386315

Fig. 133: Left & Right Rocker Covers

Courtesy of LAND ROVER NORTH AMERICA, INC.

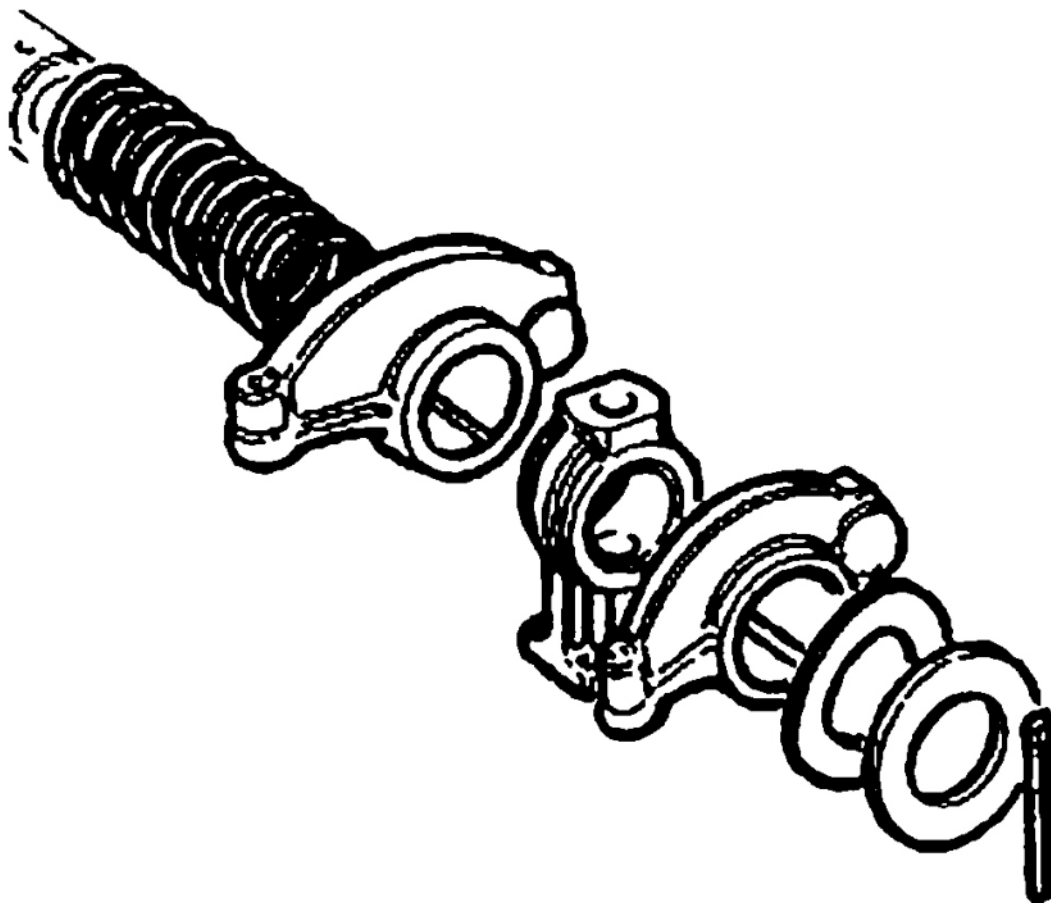
2. Noting fitted position of 4 long screws or multi-hex bolts, remove and discard 8 screws/bolts securing rocker covers; remove rocker covers. See **Fig. 133**.
3. Remove and discard rocker cover gaskets.
4. Progressively remove 4 bolts securing rocker shaft assembly to cylinder head, release rocker shaft from push rods and remove rocker shaft. See **Fig. 134**.



G00386316

Fig. 134: Rocker Shaft Assembly At Cylinder Head
Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Ensure push rods remain located in tappets when rocker shaft is removed. Retain all components in their removed sequence for re-assembly.
6. Remove and discard split pin from one end of rocker shaft. See **Fig. 135**.



G00386317

Fig. 135: Rocker Shaft Assembly Components
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Collect plain and wave washers.
8. Remove the rocker arms, rocker pillars and springs.
9. Remove and discard remaining split pin and collect plain and wave washers.

Inspection

1. Clean all components.
2. Inspect rocker shaft and rocker arms for wear and scoring. Replace as required.
3. Replace weak or broken springs.
4. Lubricate moving parts with clean engine oil.

Reassembly

1. Reassemble rocker shafts, ensuring that components are returned to their original positions, secure plain washers with NEW split pins.
2. Ensure shaft identification groove is positioned at one o'clock, with push rod locations of rocker arms to the right. Oil feed restriction will result if rocker shafts are incorrectly assembled.
3. Ensure that rocker shaft bolt holes are clean and dry.
4. Position rocker shaft assembly to cylinder head ensuring push rods are engaged in rocker arms.
5. Fit rocker shaft bolts and progressively tighten to 40 N.m (30 ft. lbs).
6. Clean mating faces of rocker cover and cylinder head, ensure that bolt holes are clean and dry.
7. Fit NEW rocker cover gasket, dry, position rocker cover, ensuring that gasket is correctly located.
8. Fit NEW, Patched multi-hex bolts ensuring that 2 short bolts are on side of rocker cover nearest center of engine.
9. Tighten bolts by diagonal selection to:

Stage 1

3 N.m (2.5 ft. lbs)

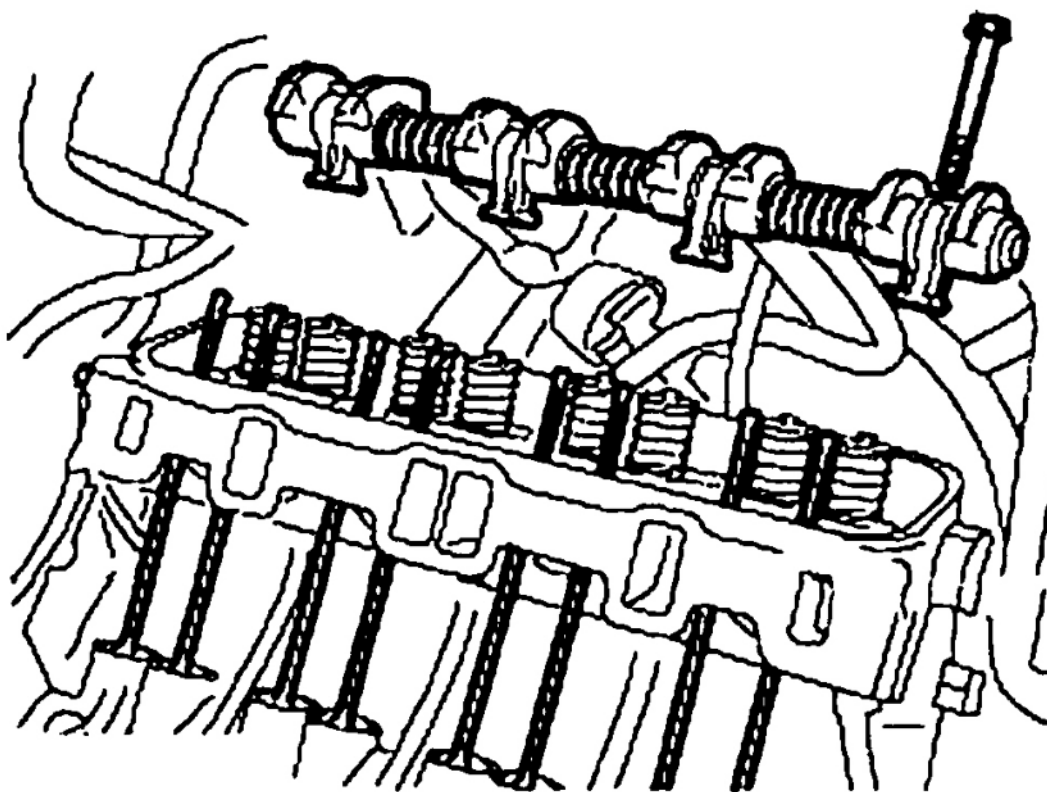
Stage 2

8 N.m (6.0 ft. lbs)

10. Ensure that gasket is correctly positioned around periphery of rocker cover.
11. Secure hot leads to rocker cover.

GASKET - CYLINDER HEAD**Disassembly**

1. Remove inlet manifold gasket. See **GASKET - INLET MANIFOLD**.
2. Right cylinder head: Remove auxiliary drive belt tensioner.
3. Right cylinder head: Remove bolts securing alternator mounting bracket and remove bracket.
4. Noting their fitted order, disconnect hot leads from spark plugs.
5. Progressively remove 4 bolts securing the rocker shaft and remove rocker shaft. See **Fig. 136**.



G00386318

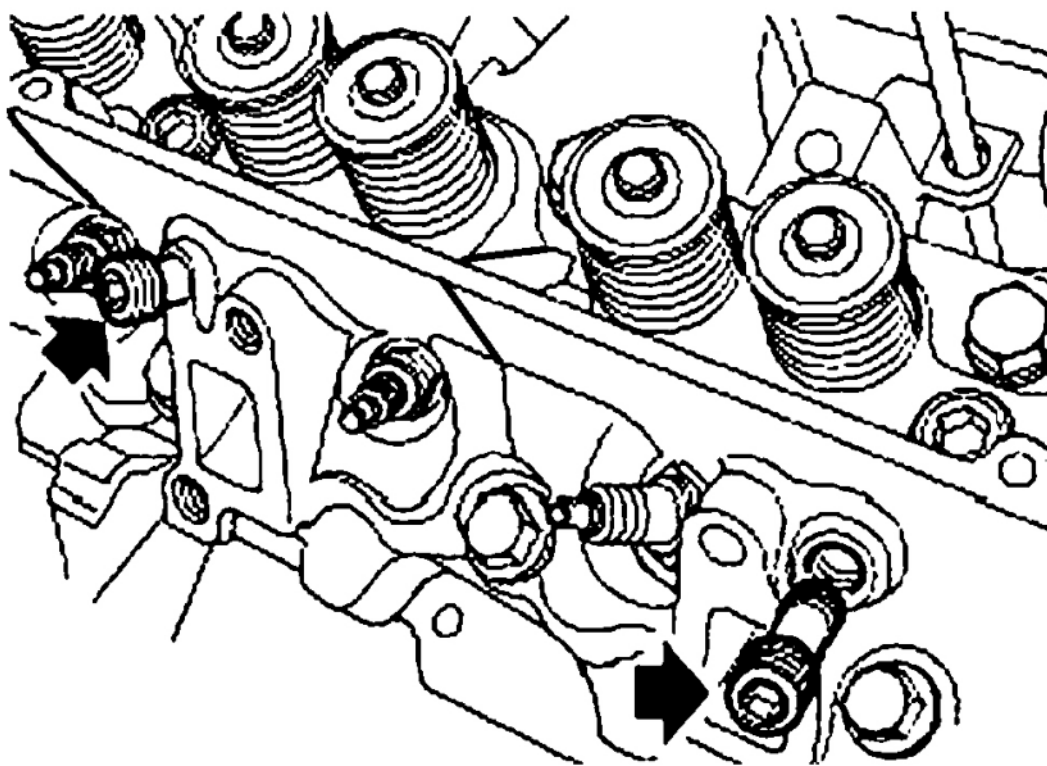
Fig. 136: Rocker Shaft

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Remove push rods and store in their fitted order.

CAUTION: DO NOT use air tools to remove adapters.

NOTE: To release the adapter thread locking agent and prevent damage to the cylinder head, remove the adapters by alternately loosening then tightening slightly. Repeat this procedure until adapters are removed.



G00386319

Fig. 137: Air Injection Adapters At Cylinder
 Courtesy of LAND ROVER NORTH AMERICA, INC.

7. On models with Secondary Air Injection (SAI): Using a 9-mm hexagonal drive bit, remove 2 air injection adapters from cylinder head; discard adapters. See **Fig. 137**.
8. Working in the sequence shown remove 10 bolts securing the cylinder head to block. Discard the bolts. See **Fig. 138**.

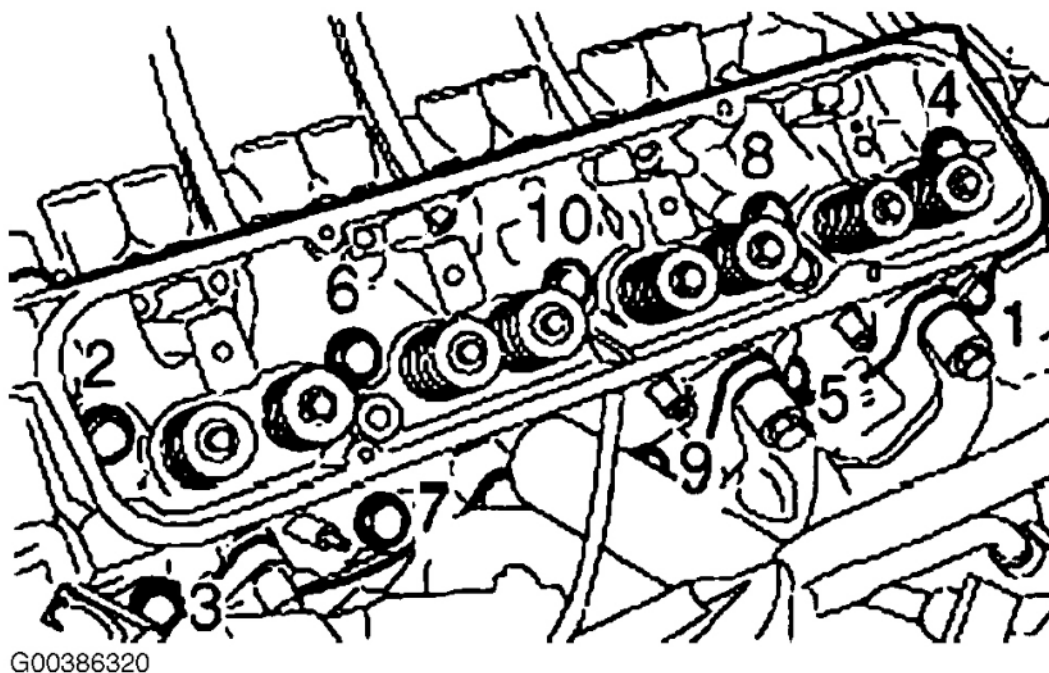
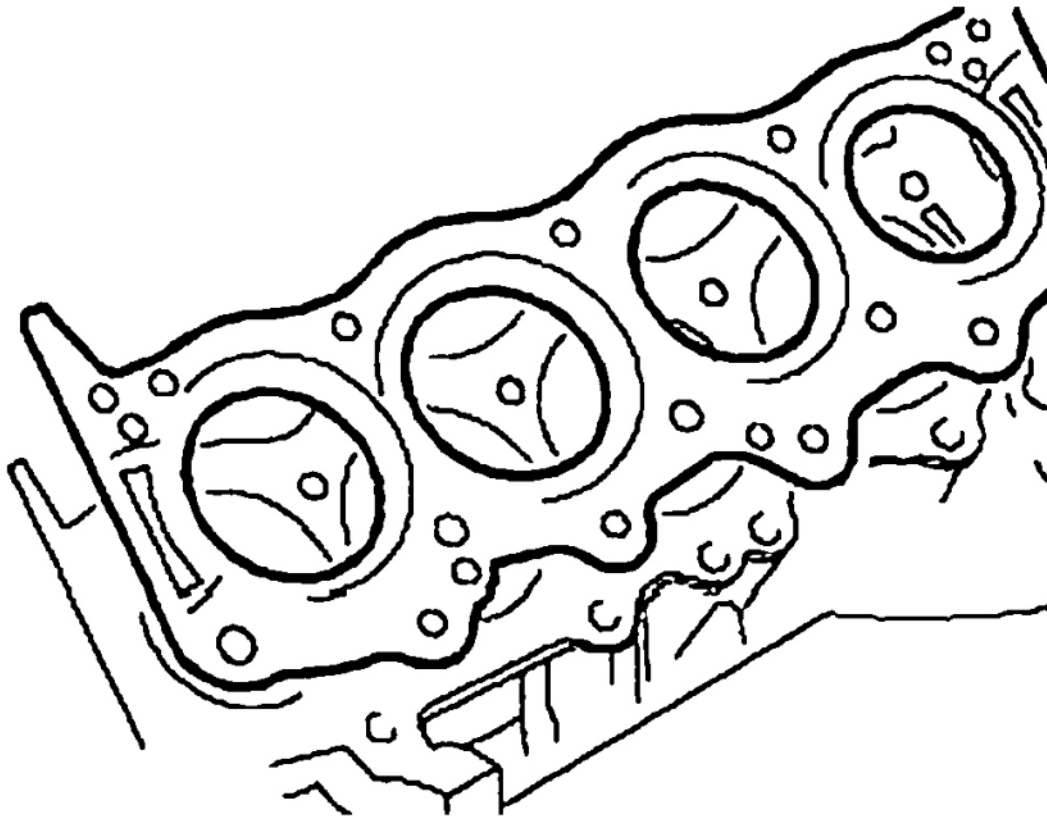


Fig. 138: Cylinder Head Bolts Removal Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

9. Remove cylinder head.

CAUTION: Support both ends of cylinder head on blocks of wood.



G00386321

Fig. 139: Cylinder Head Gasket

Courtesy of LAND ROVER NORTH AMERICA, INC.

10. Remove cylinder head gasket. See **Fig. 139**.

Inspection

CAUTION: DO NOT use a metal scraper or machined surfaces may be damaged.

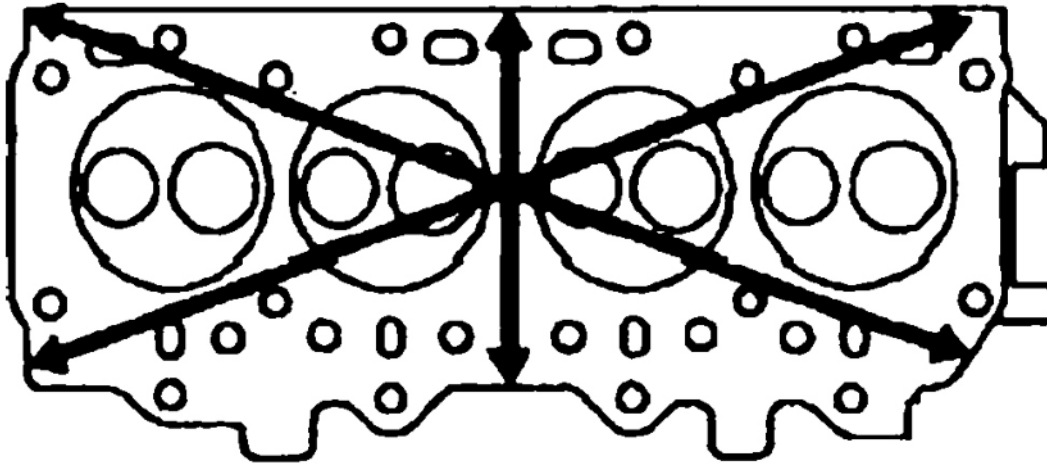
1. Clean mating faces of cylinder block and head using suitable gasket removal spray and a plastic scraper, ensure that bolt holes in block are clean and dry.

NOTE: **Cylinder head can be refaced to 0.50 mm (0.02 in) maximum below head height - See cylinder head overhaul.**

2. Check head and block faces for warping and pitting. See **Fig. 140**:

- **Maximum Cylinder Head Warp**

0.05 mm (0.002 in)



G00386322

Fig. 140: Checking Cylinder Head & Block Faces For Warping & Pitting
Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Ensure that tap used has 20 TPI (threads per inch).

3. On models with SAI: Using a 5/8 in x 20 TPI (threads per inch) UNF tap having a class 2A thread, remove deposits from secondary air injection adapter tappings in cylinder head.

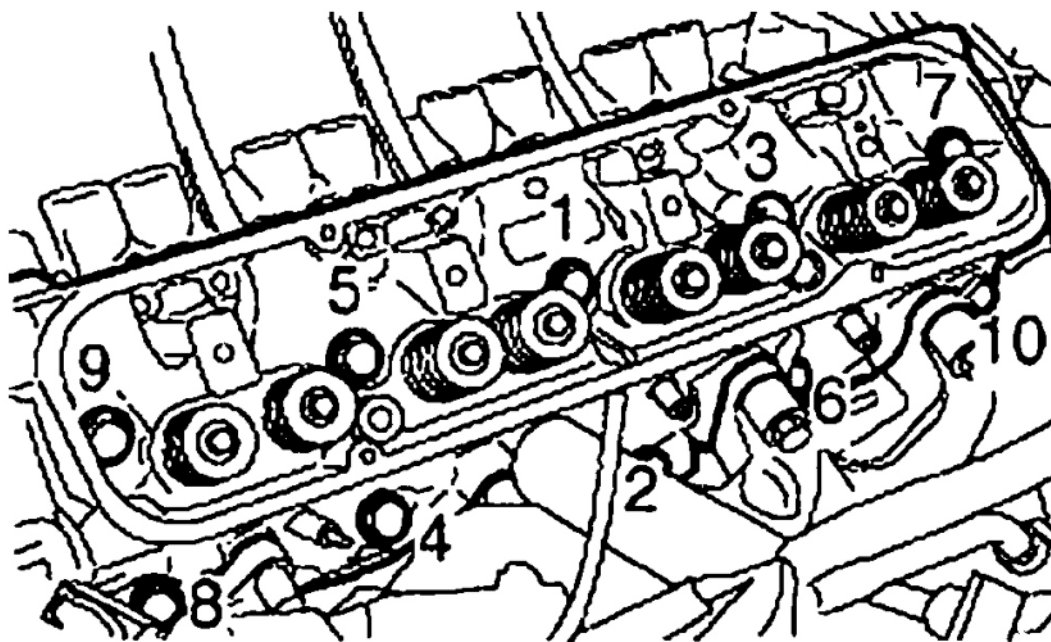
Reassembly

1. Ensure that cylinder head bolt holes are clean and dry.

CAUTION: Gaskets must be fitted dry.

2. Fit cylinder head gasket with the word TOP uppermost.
3. Carefully fit cylinder head and locate on dowels.
4. Lightly lubricate NEW cylinder head bolt threads with clean engine oil.

CAUTION: DO NOT tighten bolts 180° in one operation.



G00386323

Fig. 141: Cylinder Head Bolt Tightening Sequence
 Courtesy of LAND ROVER NORTH AMERICA, INC.

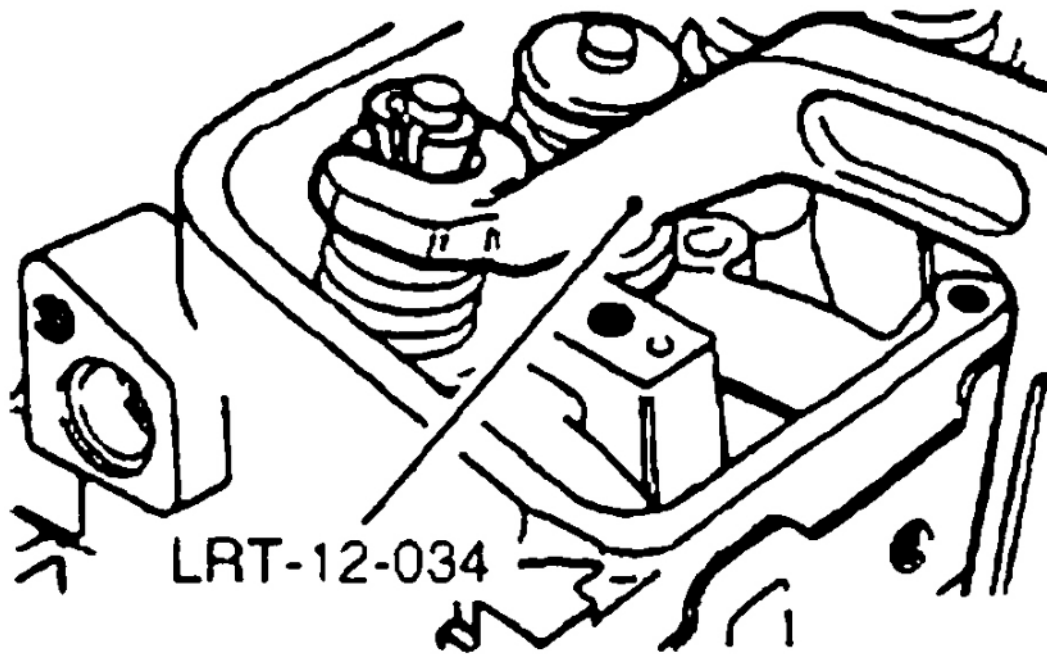
5. Noting that bolts 1, 3 and 5 are longer than the remainder, fit bolts and tighten in the sequence shown to 20 N.m (15 ft. lbs) then turn through 90°, then a further 90°. See **Fig. 141**.

CAUTION: DO NOT use an air tool to tighten adapters.

6. On models with SAI: Fit NEW air injection adapters and using a 9-mm hexagonal drive bit, tighten to 33 N.m (24 ft. lbs).
7. Clean the push rods, Lubricate ends of push rods with clean engine oil, and fit in their removed order.
8. Clean bases of rocker pillars and mating faces on cylinder head.
9. Clean contact surfaces on rockers, valves and push rods.
10. Lubricate contact surfaces and rocker shaft with clean engine oil.
11. Fit rocker shaft assembly and engage push rods.
12. Fit rocker shaft bolts and progressively tighten to 40 N.m (30 ft. lbs).
13. Connect hot leads to spark plugs in their correct fitted order.
14. Right cylinder head: Position alternator mounting bracket, fit bolts and tighten to 40 N.m (30 ft. lbs).
15. Right cylinder head: Fit auxiliary drive belt tensioner.
16. Fit inlet manifold gasket. See **GASKET - INLET MANIFOLD**.

CYLINDER HEAD - OVERHAUL**Disassembly**

1. Remove cylinder head gasket. See **GASKET - CYLINDER HEAD**.
2. Loosen screw on tool LRT-12-034.
3. Fit tool LRT-12-034 to valve and tighten screw to compress valve spring sufficiently to release collets from valve spring cap. See **Fig. 142**.

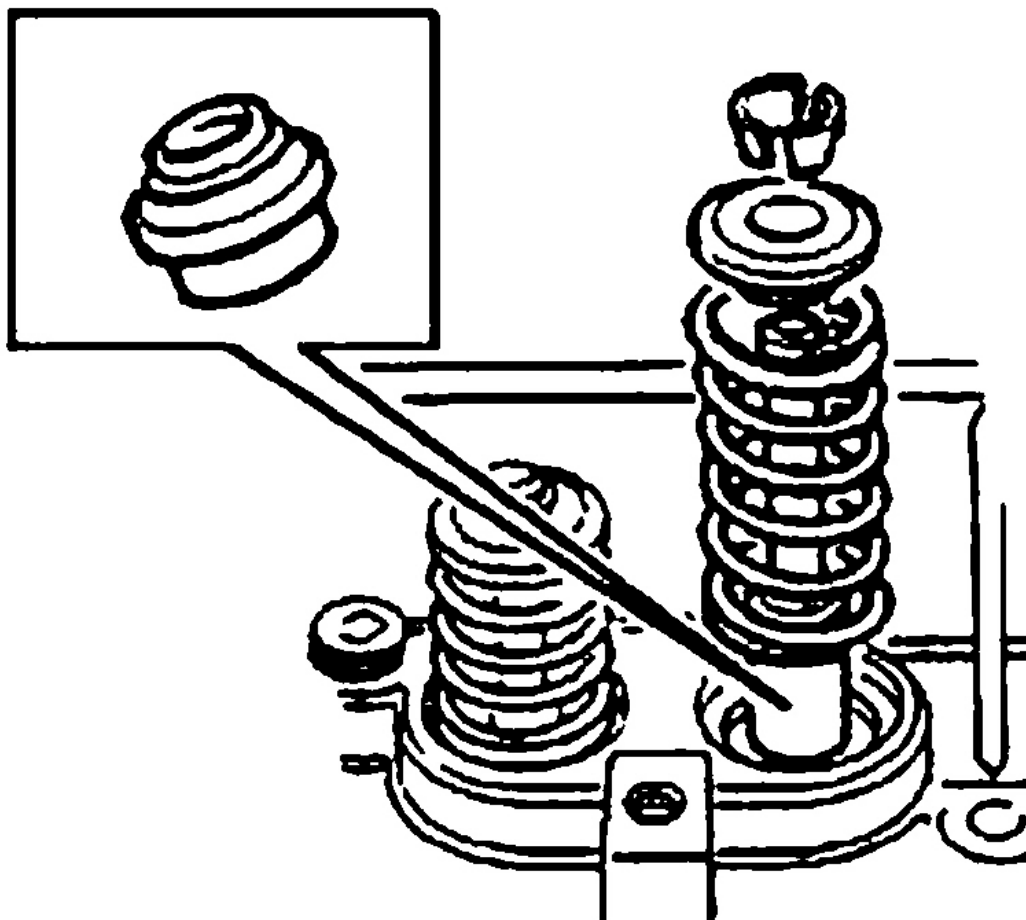


G00386324

Fig. 142: Valve Spring Cap Collets

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Remove 2 collets and release valve spring compressor. See **Fig. 143**.



G00386325

Fig. 143: Valve Spring Cap & Valve Spring
Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Remove valve spring cap and valve spring.
6. Remove valve from cylinder head.
7. Remove and discard valve stem oil seal.
8. Repeat above operations for remaining valves.
9. Keep valves, springs, caps and collets in their fitted order.

Inspection

CAUTION: DO NOT use a metal scraper or machined surfaces may be damaged.

1. Clean mating faces of cylinder block and head using suitable gasket removal spray and a plastic scraper, ensure that bolt holes in block are clean and dry.
2. Clean cylinder head, valve springs, valves and inlet valve guide bores. Ensure all loose particles of carbon are removed on completion.

CAUTION: Ensure that tap used has 20 TPI (threads per inch).

3. On models with SAI: Using a 5/8 in x 20 TPI (threads per inch) UNF tap having a class 2A thread, remove deposits from secondary air injection adapter tappings in cylinder head.
4. Check head and block faces for warping and pitting. See **Fig. 140**. Maximum warp = 0.05 mm (0.002 in).
5. Check cylinder head height at each end of head. See **Fig. 144**. Renew a head which is outside limits:
 - A. 22.94 mm (0.903 in) - New
 - B. 62.56 mm (2.463 in) - New

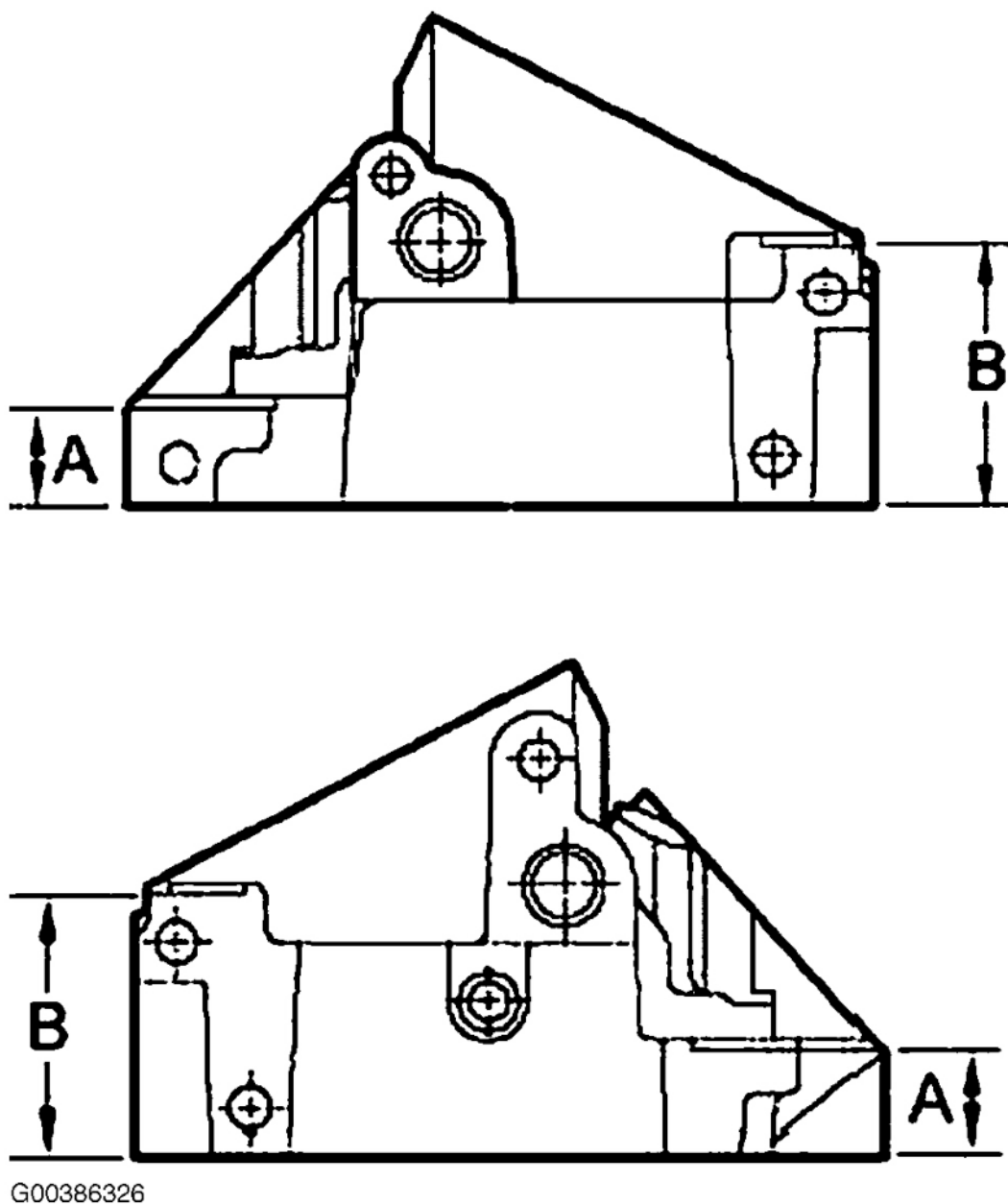
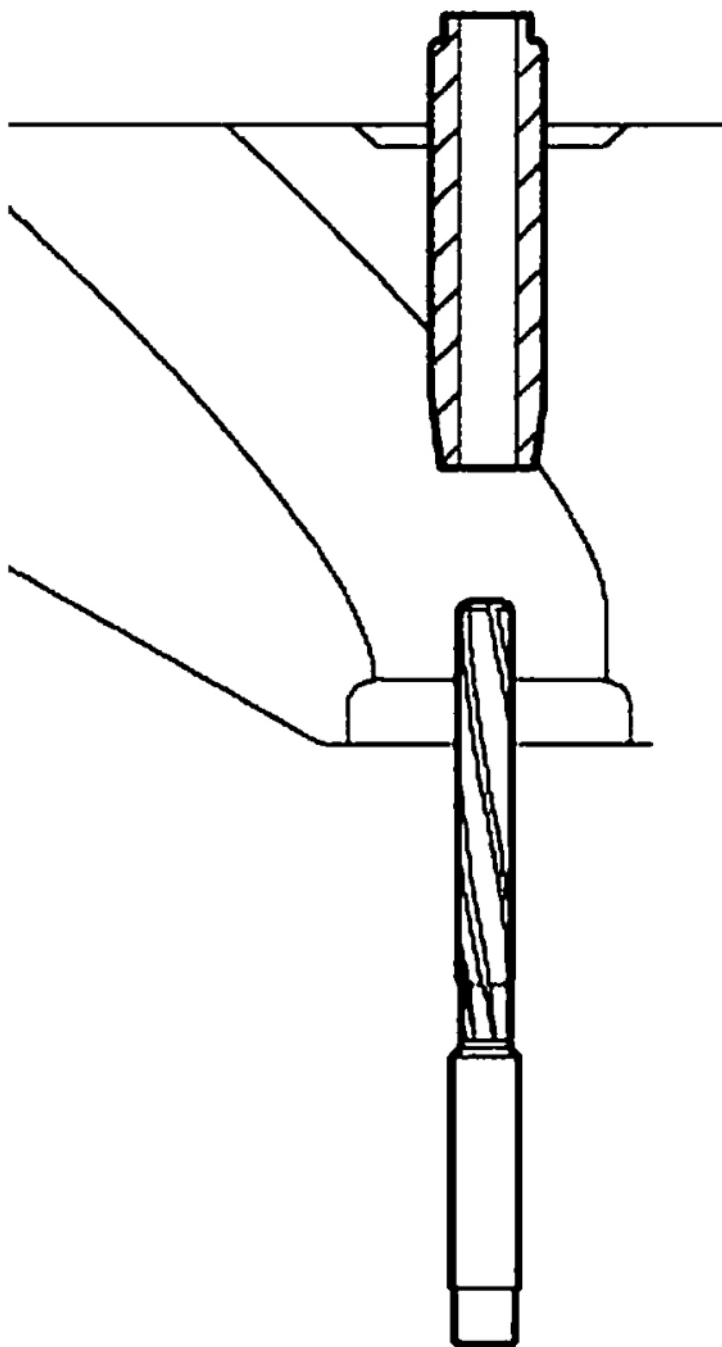


Fig. 144: Checking Cylinder Head Height

Courtesy of LAND ROVER NORTH AMERICA, INC.

6. Cylinder head can be refaced to 0.50 mm (0.02 in) maximum below head height.

NOTE: Modified inlet valves, exhaust valves and valve guides were fitted to 4.0L engines from the following engine numbers: 55D 05678A; 56D 50788A and 97D 05505A and are fitted to all 4.6L engines. See [Fig. 145](#).



G00386327

Fig. 145: Reaming Exhaust Valve Guide Carbon Deposits
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Remove carbon deposits from exhaust valve guide using a 8.70 mm (0.34 in) diameter reamer inserted from combustion face side of cylinder head.

8. Modified inlet valves may be identified by measuring the distance "A" from the valve head face to the top of the undercut on the valve stem:

- **Early Valves**

29.5 to 30.5 mm (1.16 to 1.20 in).

- **Later Valves**

32.5 to 33.5 mm (1.28 to 1.32 in).

See **Fig. 146**.

9. Modified exhaust valves may be identified as follows:

- **Early Valves "A"**

Chrome finish.

- **Later Valves "B"**

Black nitrided finish.

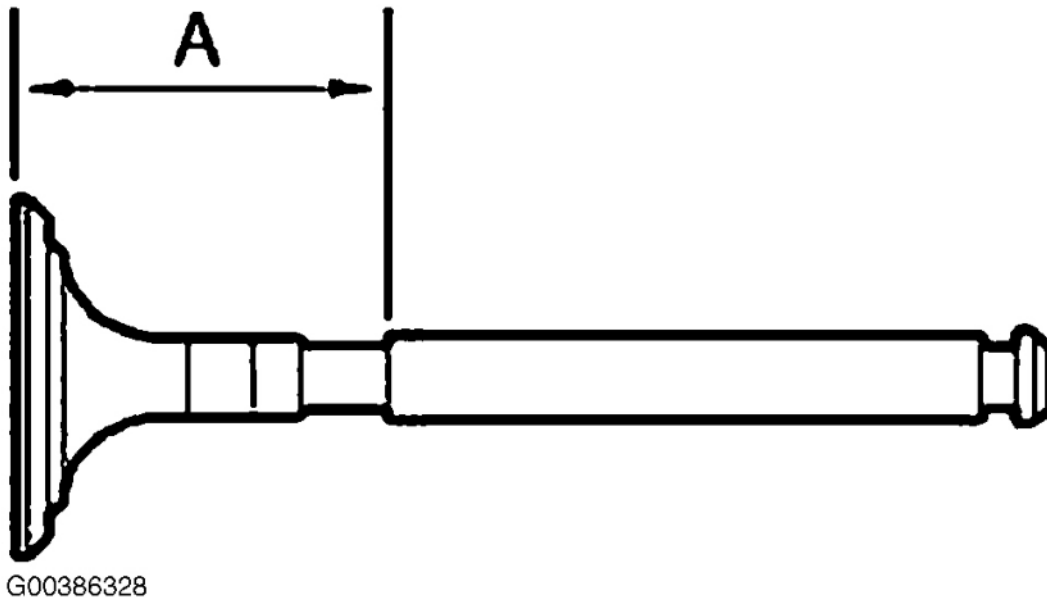
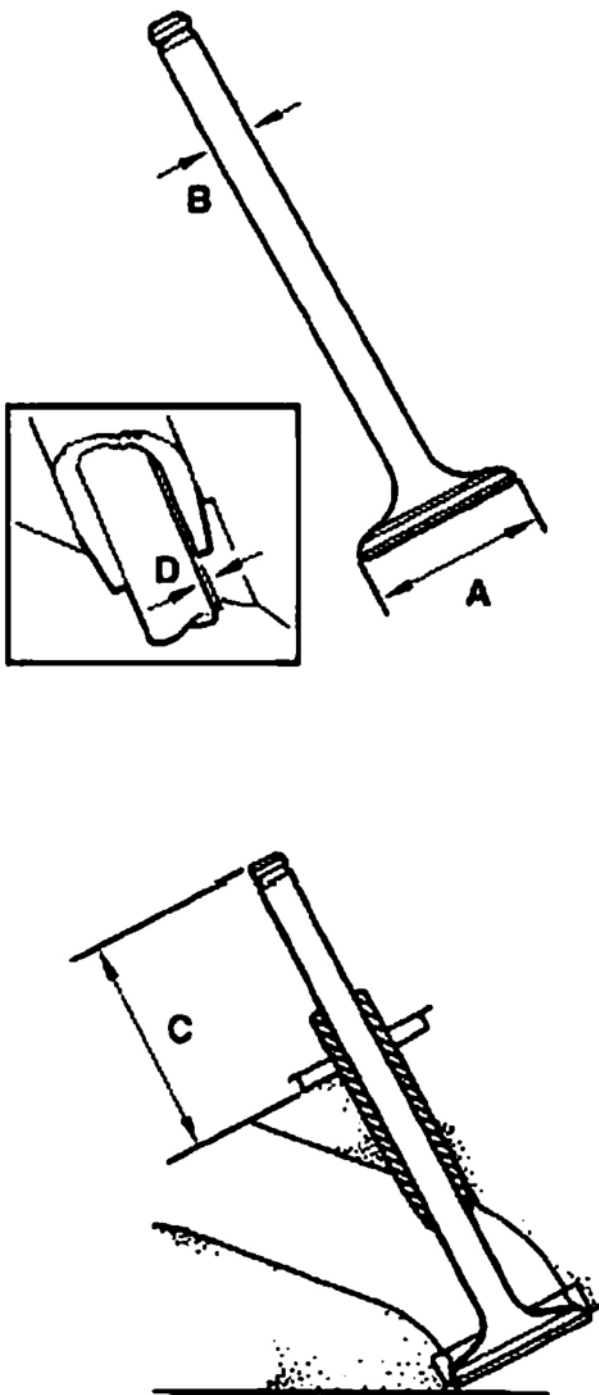


Fig. 146: Identifying Inlet Valves

Courtesy of LAND ROVER NORTH AMERICA, INC.

NOTE: The modified valves and guides may be fitted to 4.0L engines prior to the

above numbers in cylinder sets. Early type valves will continue to be supplied for early 4.0L engines but if valve guides are found to be worn, the later valves and guides must be fitted.



G00386329

Fig. 147: Checking Inlet Valve Dimensions**Courtesy of LAND ROVER NORTH AMERICA, INC.**

10. Modified valve guides are 5 mm (0.211 in) shorter than the early type, the overall length is now 57 mm (2.24 in); the reduction in length being the distance the guide protrudes into the combustion chamber side of the cylinder head. See **Fig. 147**.
11. Check the following valve dimensions. See **Fig. 147**. Renew valves as necessary:

Valve Head Diameter "A"

Inlet = 39.75 to 40.00 mm (1.56 to 1.57 in).

Valve Head Diameter "A"

Exhaust = 34.23 to 34.48 mm (1.35 to 1.36 in).

Valve Stem Diameter "B"

Inlet = 8.664 to 8.679 mm (0.341 to 0.342 in).

Valve Stem Diameter "B"

Exhaust - 4.0L engines up to engine Nos. 55D 05677A; 56D 50787A and 97D 05504A = 8.651 to 8.666 mm (0.340 to 0.341 in).

Valve Stem Diameter "B"

Exhaust - 4.0L engines from engine Nos. 55D 05678A; 56D 50788A and 97D 05505A and all 4.6L engines = 8.641 to 8.656 mm (0.340 to 0.341 in).

12. Check installed height of valve. See **Fig. 147**:
 - Valve installed height, end of valve to base of spring seat, "C" = 44.163 to 45.288 mm (1.741 to 1.802 in).
13. Check condition of valve springs. Valve springs must be replaced as a complete set:
 - Valve spring free length = 48.30 mm (1.90 in).
 - Valve spring fitted length = 40.40 mm (1.59 in).
 - Spring load - valve closed = 339 +/- 10 N (76 +/- 2.25 lbf).
 - Spring load - valve open = 736 +/- 10 N (166 +/- 2.25 lbf).
14. Check valve stem to guide clearance using the following procedures:
15. Insert each valve into its respective guide.
16. Extend valve head approximately 13 mm (0.6 in) out of valve seat and position a DTI gauge to rear of valve head.
17. Move valve towards front of cylinder head and zero DTI gauge ensuring that stylus of gauge remains in contact with valve head.
18. Move valve towards rear of cylinder head and record gauge reading to give valve stem to guide clearance.

See **Fig. 147**:

- Valve stem to guide clearance "D": Inlet = 0.025 to 0.066 mm (0.001 to 0.002 in).
- Valve stem to guide clearance "D": Exhaust - 4.0L engines up to engine Nos. 55D 05677A; 56D 50787A; 97D 05504A = 0.038 to 0.078 mm (0.0015 to 0.003 in).
- Valve stem to guide clearance "D": Exhaust - 4.0L engines from engine Nos. 55D 05678A; 56D 50788A; 97D 05505A and all 4.6L engines = 0.048 to 0.088 mm (0.0019 to 0.0035 in).

19. Renew valve guides as necessary.

20. Using valve guide remover tool LRT-12-037 press valve guide into combustion face side of cylinder head. See **Fig. 148**.

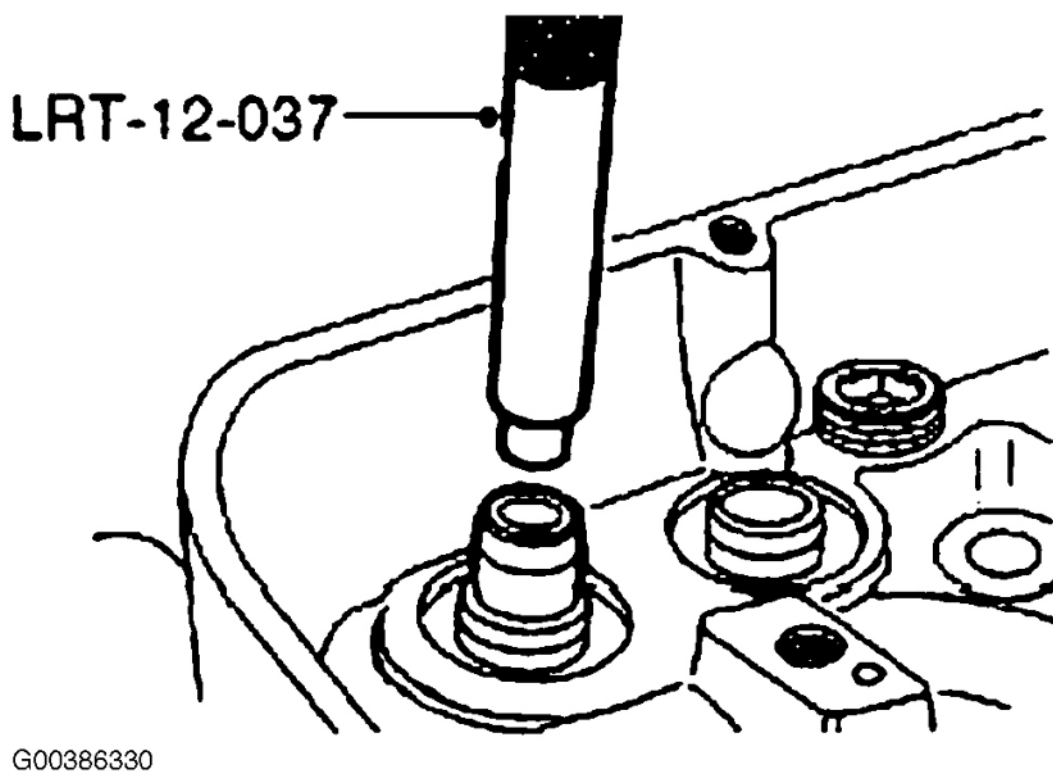
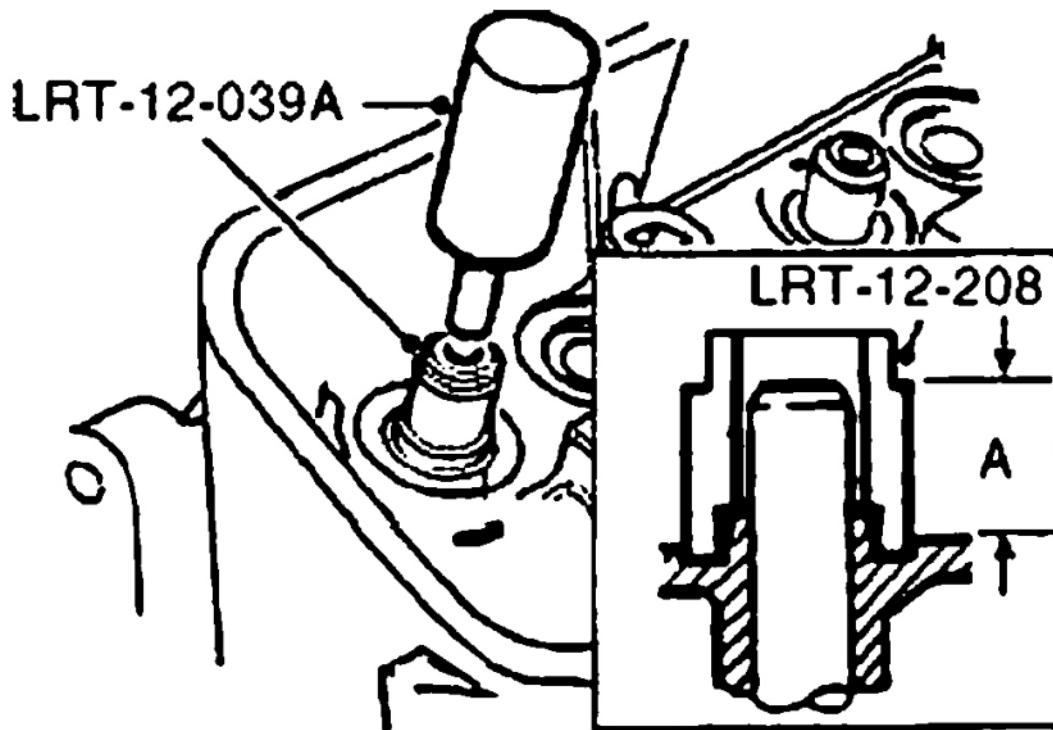


Fig. 148: Pressing Valve Guide Into Cylinder Head
Courtesy of LAND ROVER NORTH AMERICA, INC.

NOTE: Service valve guides are 0.025 mm (0.001 in) oversize on outside diameter to ensure an interference fit.

21. Lubricate NEW valve guide with engine oil and with tapered portion of guide leading, insert guide from valve spring side of head.
22. Fully fit guide using tool LRT-12-039A and distance piece tool LRT-12-208. See **Fig. 149**.
 - Valve guide installed height "A" = 15.00 mm (0.590 in).



G00386331

Fig. 149: Installing Valve Guide

Courtesy of LAND ROVER NORTH AMERICA, INC.

NOTE: Service valve guides are supplied with an internal diameter of 8.1 mm (0.319 in).

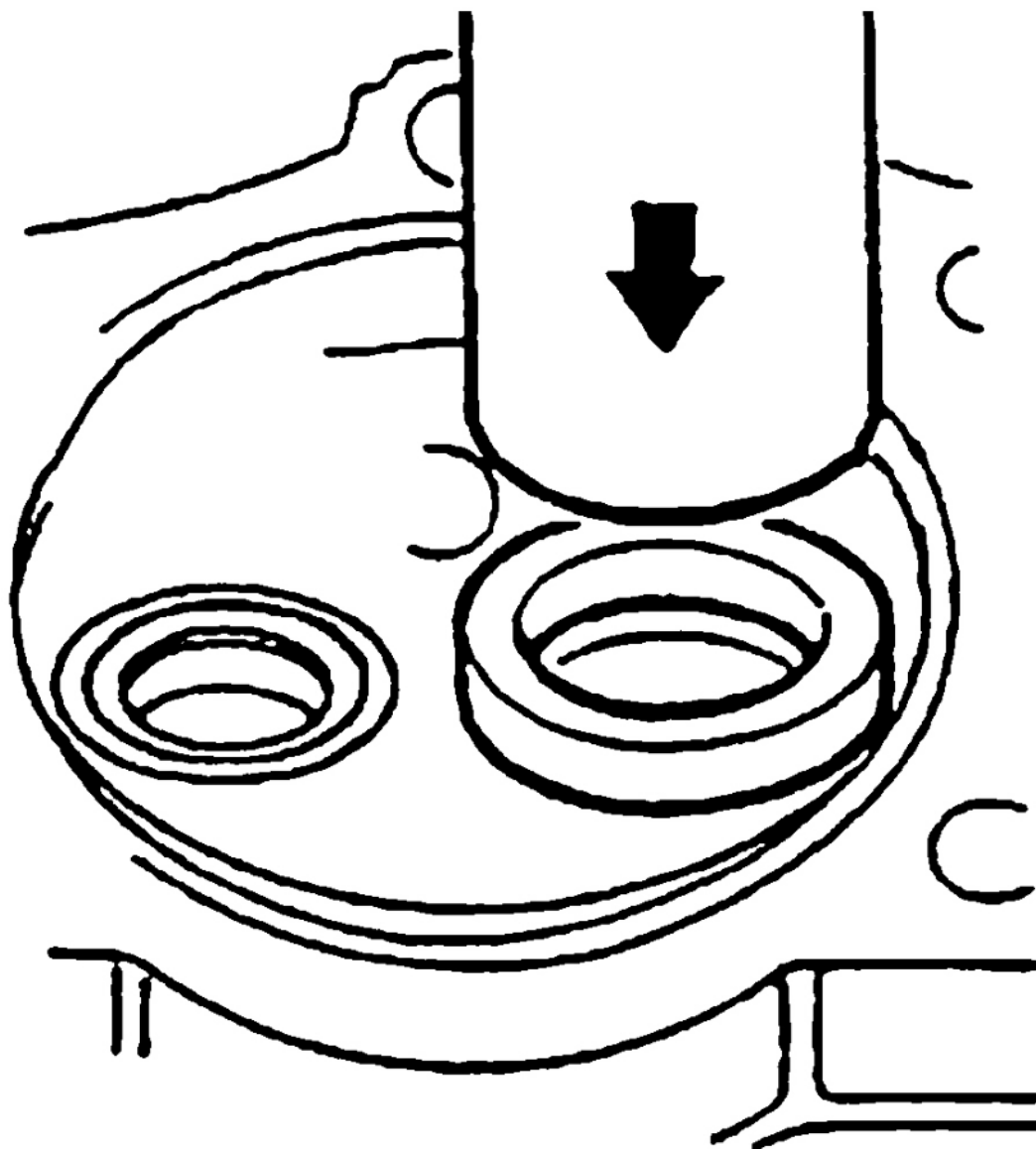
23. Ream valve guide to 8.70 mm (0.342 in).
24. Position cylinder head stands and mount cylinder head on stands.
25. Check valve seat insert for pitting, burning, cracks and wear. Replace as necessary. Service valve seat inserts are available 0.025 mm (0.001 in) oversize on outside diameter to ensure interference fit.

CAUTION: Take care not to damage the counterbore in the cylinder head when removing valve seats.

26. Remove worn valve seat.

WARNING: Handle the hot cylinder head with care.

27. Heat cylinder head evenly to approximately 120°C (250°F).
28. Using a suitable mandrel, press NEW insert fully into counterbore. See **Fig. 150**.

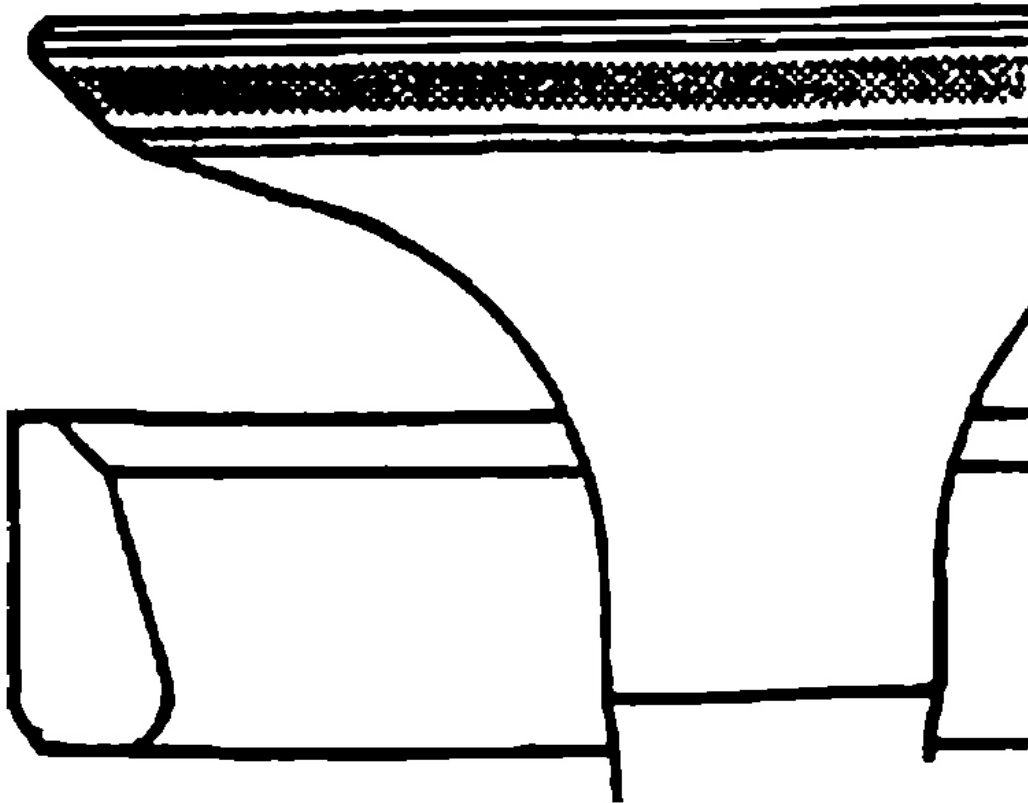


G00386332

Fig. 150: Installing New Insert Into Counterbore
Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Renew worn valve guides and/or valve seats before lapping the valves.

29. Allow cylinder head to air cool.
30. Recut valve seat in head and lap in valves using fine paste.
31. Coat valve with a small quantity of engineer's blue, insert valve and press into position several times without rotating. Seating position should be in center of valve face. See **Fig. 151**.

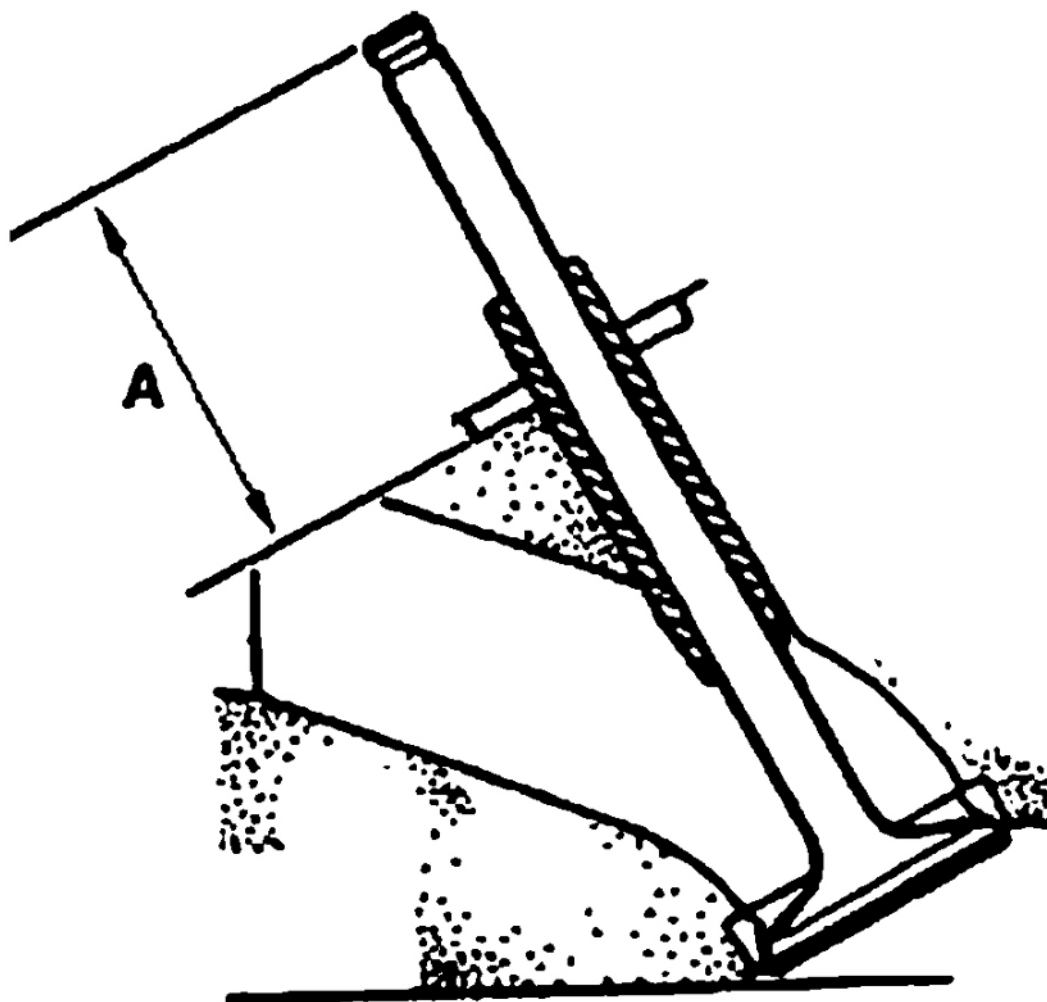


G00386333

Fig. 151: Checking Valve Seated Position

Courtesy of LAND ROVER NORTH AMERICA, INC.

32. Check valve installed height if valve seats have been refaced or renewed. See **Fig. 152**:
 - Valve installed height, end of valve to base of spring seat, "A" = 44.16 to 45.29 mm (1.74 to 1.80 in).



G00386334

Fig. 152: Checking Installed Valve Seat Height
 Courtesy of LAND ROVER NORTH AMERICA, INC.

33. Reface valves as necessary. If a valve has to be ground to a knife-edge to obtain a true seat, renew valve.
34. Cut valve seats using suitable cutters. See **Fig. 153**:
 - Valve seat angle "A" = 45° .
 - Valve seat insert diameter "B" Inlet = 36.83 mm (1.45 in).
 - Valve seat insert diameter "B" Exhaust = 31.50 mm (1.24 in).
 - Seating width "C" - Inlet = 0.89 to 1.4 mm (0.035 to 0.055 in).
 - Seating width "C" - Exhaust = 1.32 to 1.83 mm (0.052 to 0.072 in).
 - Angle "D" = 70° .
 - Angle "E" = 46° to $46^{\circ} 25'$.

- Angle "F" = 20°.

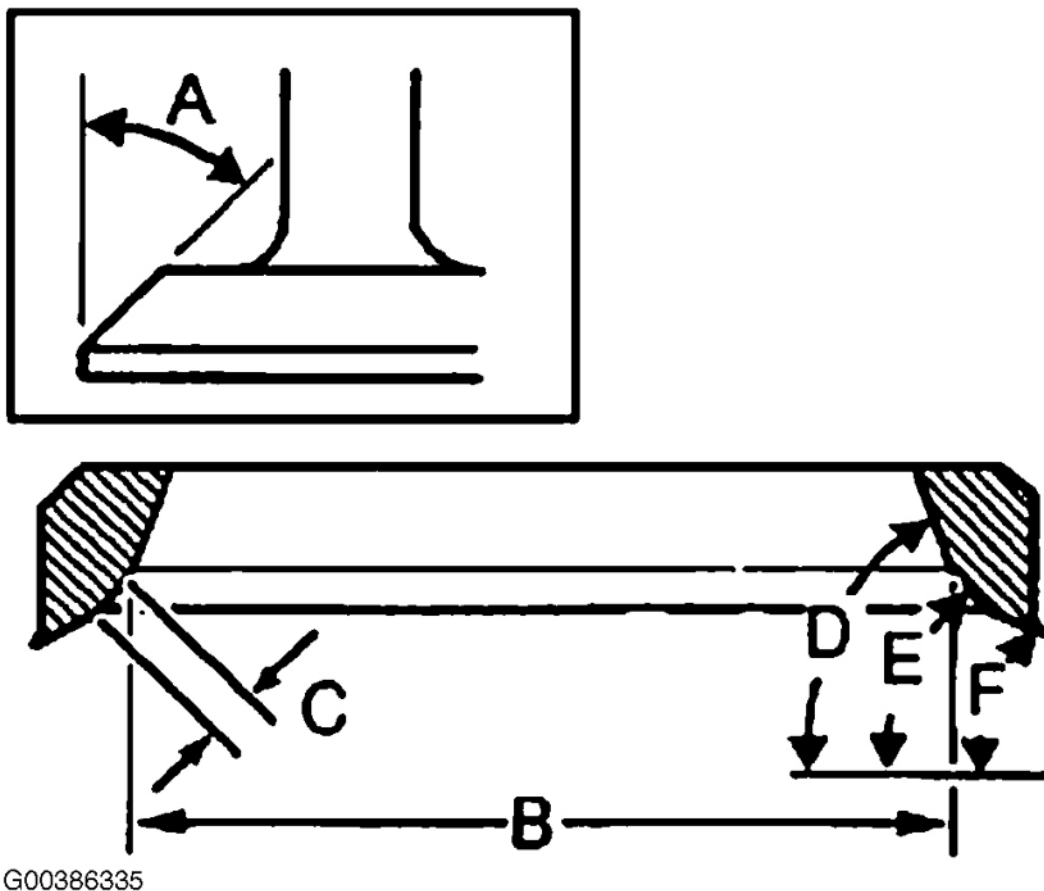


Fig. 153: Measuring Valve Seat Dimensions

Courtesy of LAND ROVER NORTH AMERICA, INC.

35. Check that cutter blades are adjusted so that middle of blade contacts area of material to be cut. Use light pressure and only remove the minimum of material necessary.
36. Clean valve seat and valve.

Reassembly

1. Clean spring caps, collets and valve springs.
2. Lubricate NEW valve stem oil seal with clean engine oil and fit seal.
3. Lubricate valve with clean engine oil and fit valve.
4. Fit spring and cap, compress spring using tool LRT-12-034 and fit collets. See **Fig. 154**.

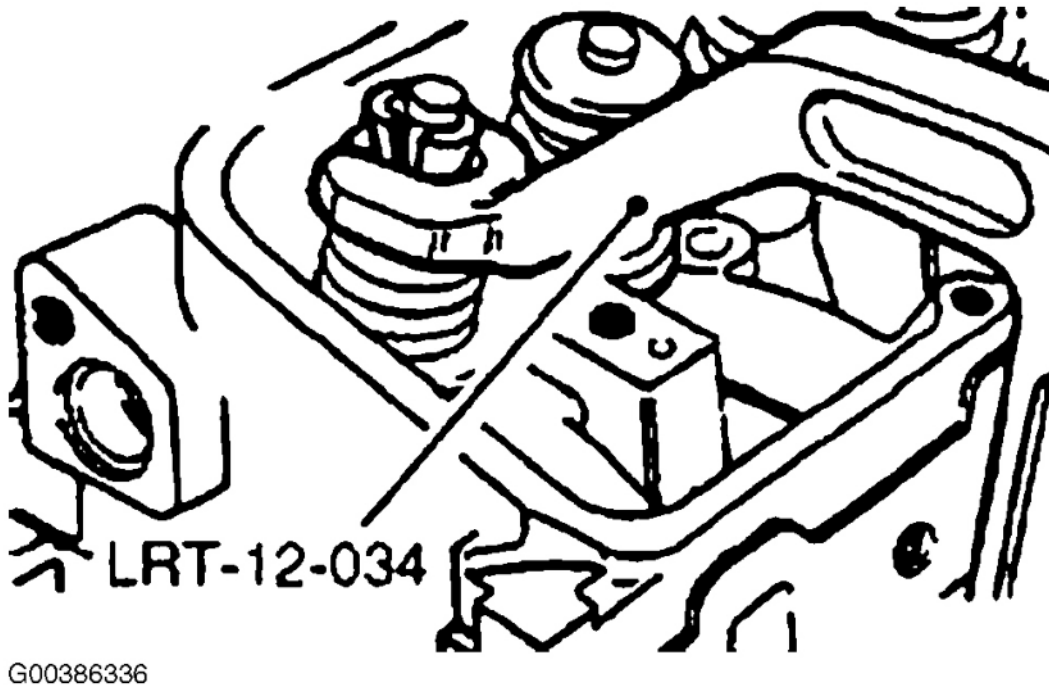


Fig. 154: Valve Assembly

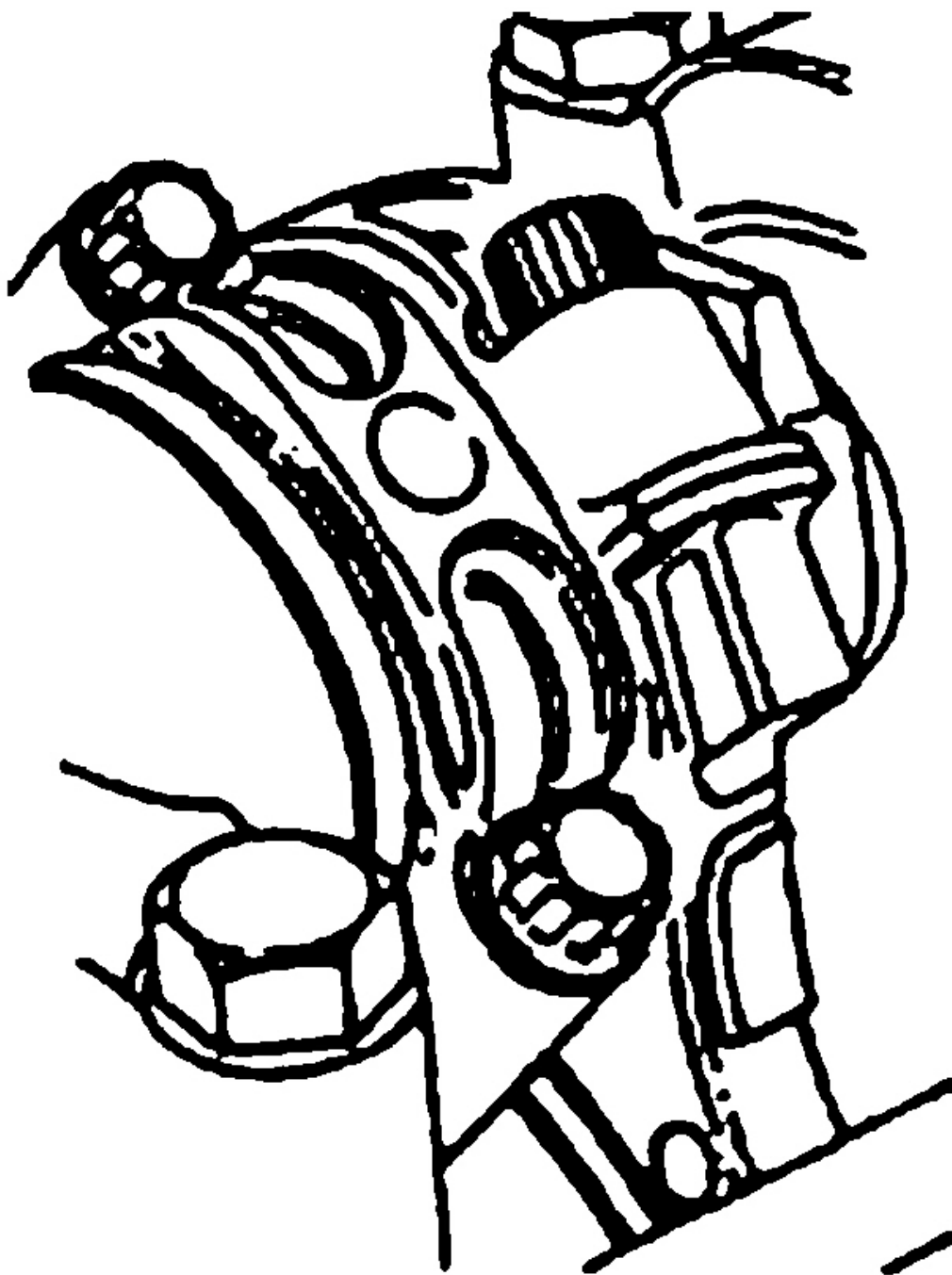
Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Release valve spring and remove tool LRT-12- 034.
6. Fit cylinder head gasket. See **GASKET - CYLINDER HEAD.**

PISTON ASSEMBLIES

Disassembly

1. Remove cylinder head. See **GASKET - CYLINDER HEAD.**
2. Remove oil pick-up strainer. See **STRAINER - OIL PICK-UP.**
3. Suitably identify each connecting rod and piston assembly to its respective cylinder bore. See **Fig. 155.**



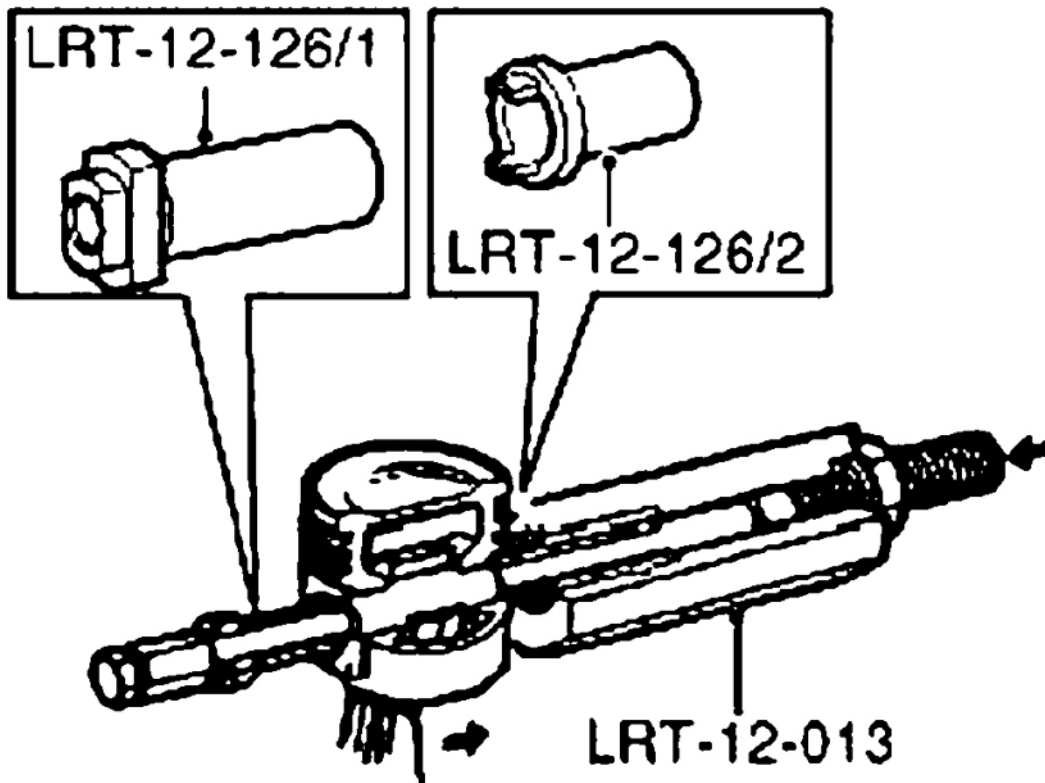
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Fig. 155: Identifying Connecting Rod & Piston Assembly
Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Remove 2 bolts securing each connecting rod bearing cap.
5. Remove connecting rod bearing cap and collect connecting rod bearings.
6. Remove ridge of carbon from top of cylinder bores.

CAUTION: Ensure that connecting rods do not contact cylinder bores.

7. Carefully push each piston assembly from the top of the cylinder.
8. Refit bearing cap onto connecting rod, lightly tighten dowel bolts.
9. Suitably identify each piston to its respective connecting rod.
10. Position body of tool LRT-12-013 in vice. See **Fig. 156**.
11. Screw large nut back until flush with end of center screw.
12. Push center screw forward until nut contacts thrust race.
13. Position remover/replacer LRT-12-126/2 in LRT-12-013 with its long spigot inside bore of hexagon body. See **Fig. 156**.



G00386338

Fig. 156: Removing Piston Gudgeon Pin

Courtesy of LAND ROVER NORTH AMERICA, INC.

CAUTION: Ensure that prongs of remover/replacer adapter LRT-12-162/2 remain in contact with piston and do not contact gudgeon pin.

14. Locate piston and connecting rod assembly on center screw and up to remover/replacer adapter tool LRT-12-126/2. See **Fig. 156**.

CAUTION: Ensure that remover/replacer bush LRT-12-126/1 is correctly located in gudgeon pin bore of piston.

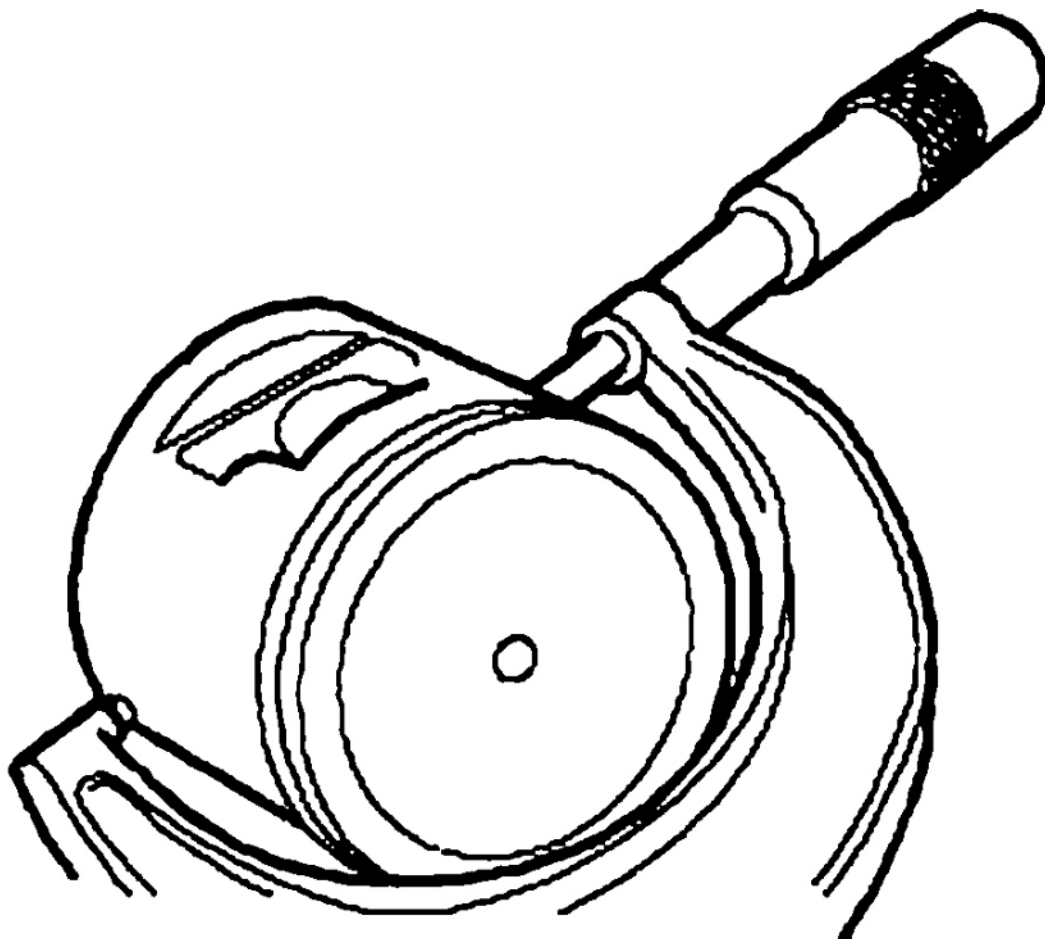
15. Fit remover/replacer bush LRT-12-126/1 on center screw with flanged end facing away from gudgeon pin. See **Fig. 156**.
16. Screw stop nut onto center screw.
17. Lock the stop nut securely with the lock screw.
18. Push connecting rod to locate end of gudgeon pin in remover/replacer adapter LRT-12-126/2.
19. Ensure remover/replacer bush LRT-12-126/1 is located in gudgeon pin bore of piston.
20. Screw large nut up to tool LRT-12-013.

CAUTION: Ensure that prongs of tool LRT-12-126/2 remain in contact with piston and do not contact the gudgeon pin.

21. Hold lock screw and turn large nut until gudgeon pin is withdrawn from piston.
22. Dismantle tool LRT-12-013 and remove piston, connecting rod and gudgeon pin. See **Fig. 156**.

Inspection

1. Clean carbon from piston. Inspect piston for distortion, cracks and burning.
2. Remove piston rings from piston.
3. Measure and record piston diameter at 90° to gudgeon pin axis and 10 mm (0.4 in) from bottom of the skirt. The piston must be 0.015 to 0.045 mm (0.001 to 0.002 in) smaller than the cylinder bore. See **Fig. 157**.



G00386339

Fig. 157: Measuring Piston Diameter

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Check gudgeon pin bore in piston for signs of wear and overheating.
5. Pistons fitted on production are graded "A" or "B", the grade letter is stamped on the piston crown:

- **Grade "A"**

Piston diameter = 93.970 to 93.985 mm (3.6996 to 3.7002 in).

- **Grade "B"**

Piston diameter = 93.986 to 94.00 mm (3.7002 to 3.7007 in).

CAUTION: Ensure replacement pistons are correct for the compression ratio of

the engine. The compression ratio will be found on the cylinder block adjacent to the engine serial number.

6. Worn cylinders fitted with grade "A" pistons may be honed to accept the grade "B" piston provided that specified cylinder bore and roundness limits are maintained. Grade "B" pistons are supplied as service replacements. DO NOT attempt to de-glaze cylinder bores.
7. Check gudgeon pins for signs of wear and overheating.
8. Check clearance of gudgeon pin in piston:
 - Gudgeon pin to piston clearance = 0.006 to 0.015 mm (0.0002 to 0.0006 in).
9. Check overall dimensions of gudgeon pin. Gudgeon pins are only supplied as an assembly with replacement pistons:
 - Gudgeon pin length = 60.00 to 60.50 mm (2.362 to 2.382 in).
 - Gudgeon pin diameter = 23.995 to 24.00 mm (0.9446 to 0.9448 in).
10. Measure cylinder bore wear and roundness in two axis 40 to 50 mm (1.6 to 2 in) from top of bore. See **Fig. 158**. The temperature of piston and cylinder block must be the same to ensure accurate measurement. DO NOT attempt to de-glaze cylinder bores.

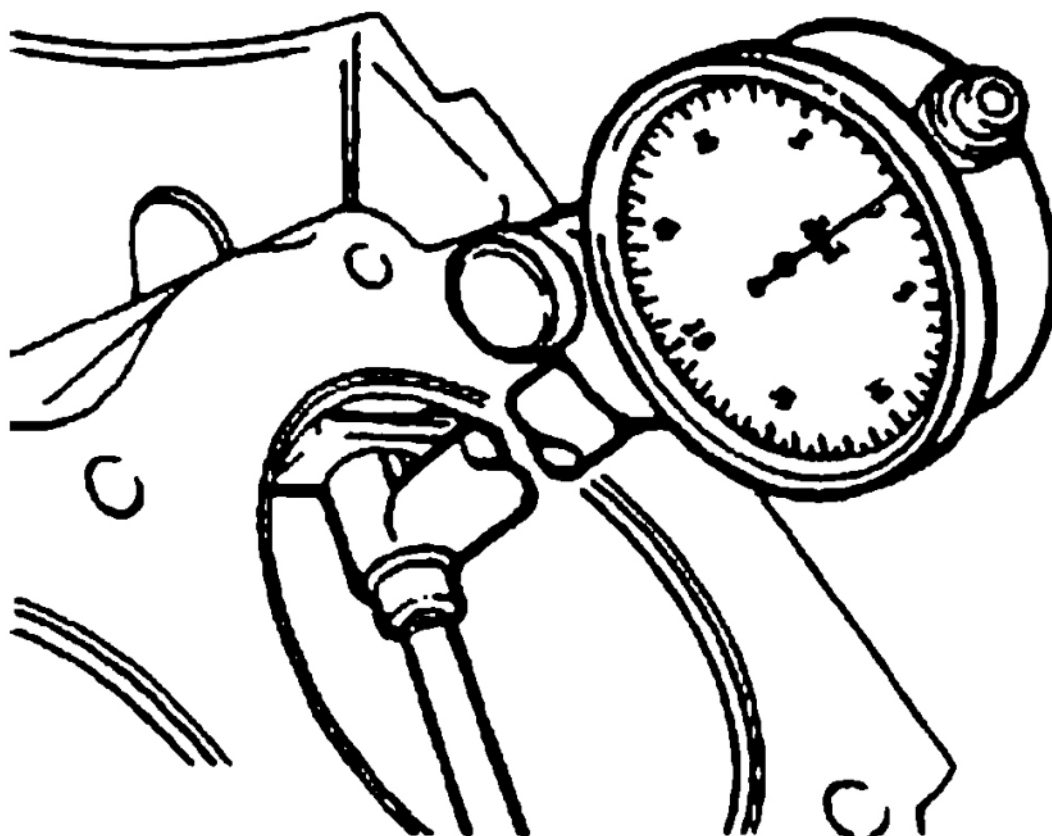
- **Grade "A" Pistons**

Cylinder bore = 94.00 to 94.015 mm (3.7007 to 3.7013 in).

- **Grade "B" Pistons**

Cylinder bore = 94.016 to 94.030 mm (3.7014 to 3.7019 in).

- Maximum roundness = 0.013 mm (0.0005 in).



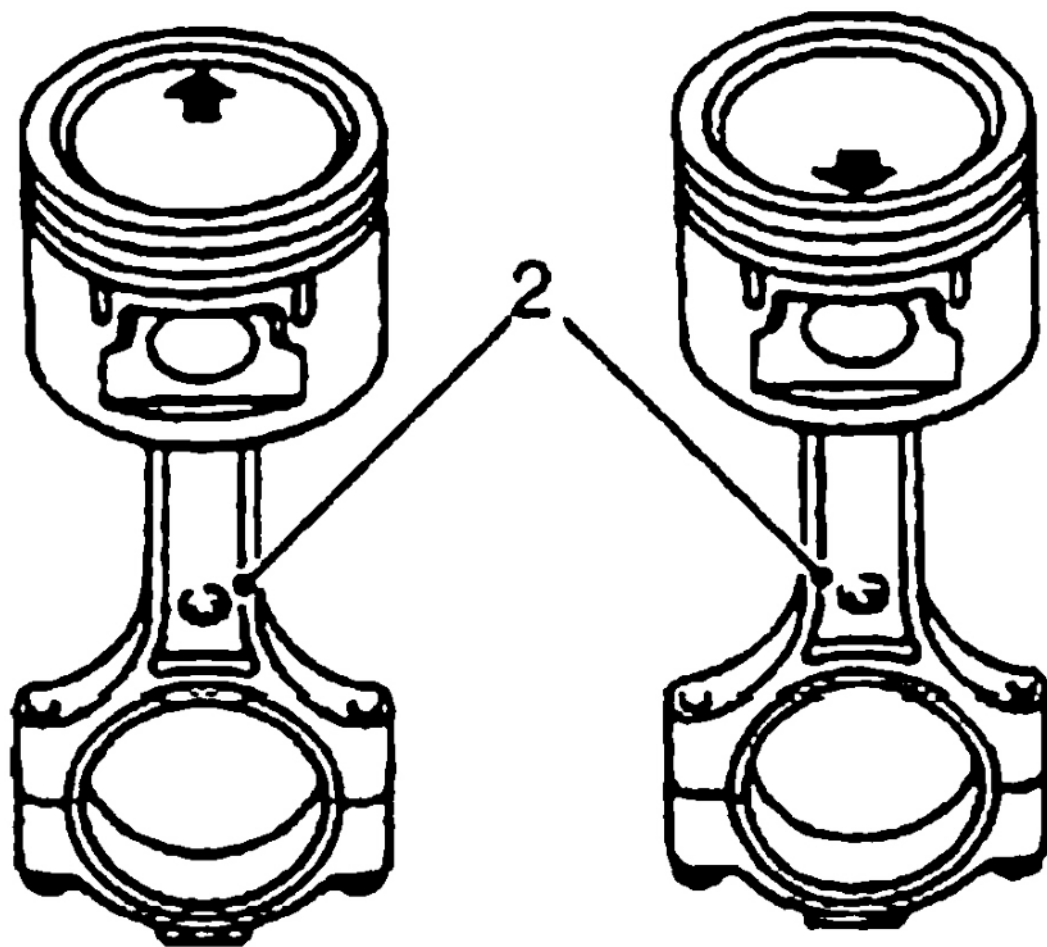
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Fig. 158: Measuring Cylinder Bore Wear & Roundness
Courtesy of LAND ROVER NORTH AMERICA, INC.

11. Check alignment of connecting rods.

Reassembly

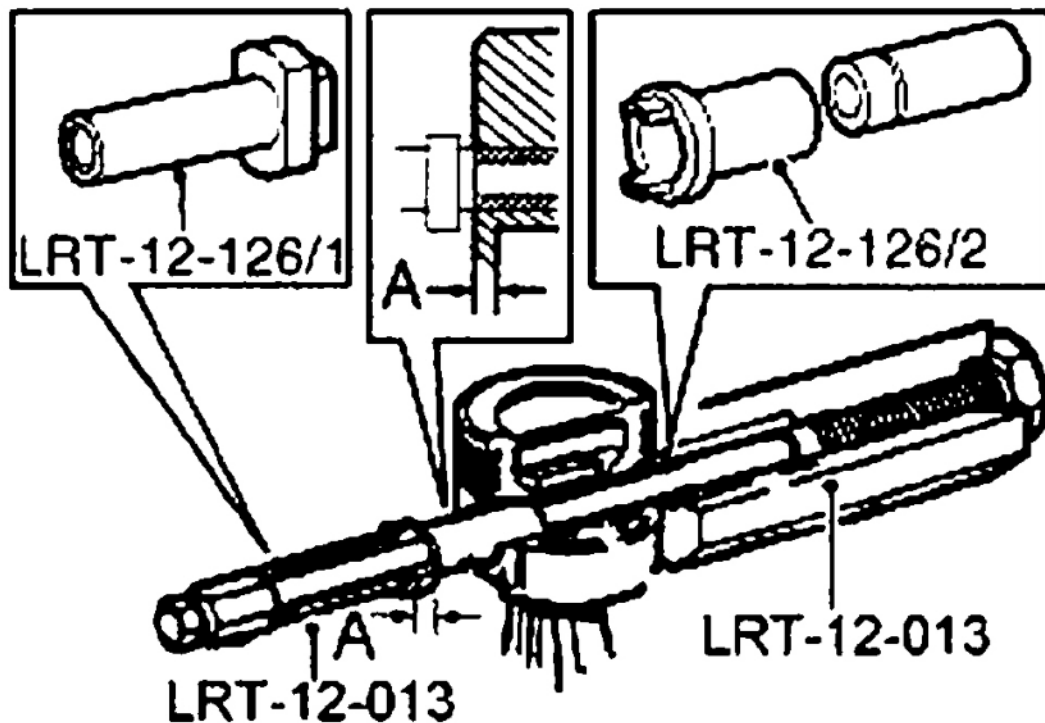
1. Pistons have a 5 mm (0.2 in) offset gudgeon pin which can be identified by an arrow mark on the piston crown. This arrow must always point towards the front of the engine.
2. Assemble pistons to connecting rods with arrow on piston pointing towards domed shaped boss on connecting rod for right bank of cylinders and arrow pointing away from domed shaped boss for left bank of cylinders. See **Fig. 159**.



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Fig. 159: Assembling Pistons To Connecting Rods
Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Clamp hexagon body of tool LRT-12-013 in vice. See **Fig. 160**.



G00386342

Fig. 160: Installing Piston Gudgeon Pin

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Screw large nut back until flush with end of center screw.
5. Locate remover/replacer adapter LRT-12-126/2 with its long spigot inside bore of hexagon body. See **Fig. 160**.
6. Fit parallel sleeve, part of tool LRT-12-013, ensuring that grooved end is towards open end of tool LRT-12-013. Position sleeve up to shoulder of center screw. See **Fig. 160**.
7. Lubricate gudgeon pin and bores of connecting rod and piston with graphite oil.
8. Locate connecting rod and piston to center screw with connecting rod entered on parallel sleeve, part of LRT-12-013 up to the machined groove on the sleeve. See **Fig. 160**.
9. Fit gudgeon pin on to center screw and into piston bore up to connecting rod.
10. Fit remover/replacer bush LRT-12-126/1 with flanged end towards gudgeon pin.

CAUTION: Ensure that prongs of tool LRT-12-126/2 remain in contact with piston and do not contact gudgeon pin.

11. Screw the stop nut on to center screw and position piston against groove of tool LRT-12-126/2.
12. Lock the stop nut securely with the lockscrew.

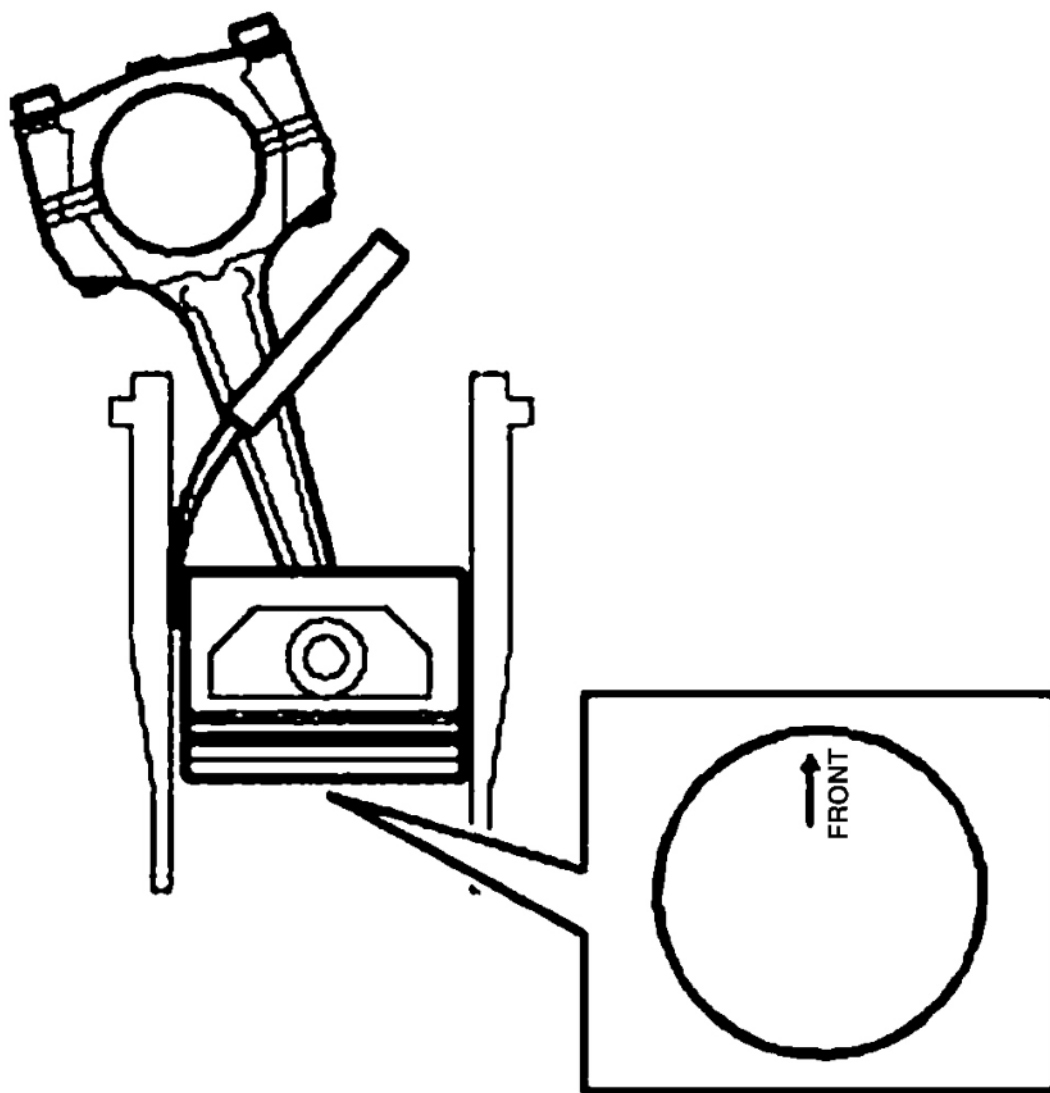
13. Lubricate center screw threads and thrust race with graphite oil, screw large nut up to tool LRT-12-013.

CAUTION: The center screw and thrust race must be kept well lubricated throughout the operation.

14. Set torque wrench to 16 N.m (12 ft. lbs), and using socket on large nut, pull gudgeon pin in until flange of remover/replacer bush LRT-12-126/1 is 0.40 mm (0.016 in), dimension "A" from face of piston. If torque is exceeded during this procedure, fit of gudgeon pin to connecting rod is not acceptable and components must be replaced. See **Fig. 160**.
15. Dismantle tool, remove piston and check no damage has occurred during pressing and that piston moves freely on gudgeon pin.
16. Remove compression rings, oil control rails and expander from NEW piston.
17. Invert piston and with arrow pointing towards rear of cylinder block, insert piston into cylinder liner.
18. Position piston with bottom of skirt 30 mm (1.12 in) from top cylinder liner.
19. Using feeler gauges, measure and record clearance between piston and left hand side of cylinder, viewed from the front of cylinder block. See **Fig. 161**:

- **Piston To Bore Clearance**

0.020 to 0.045 mm (0.001 to 0.002 in)



G00386343

Fig. 161: Measuring Piston-To-Cylinder Liner Bore Clearance
Courtesy of LAND ROVER NORTH AMERICA, INC.

20. Insert piston rings into cylinder bore, use the piston to hold the rings square to bore and check the ring gap:
- **1st Compression Ring**
0.30 to 0.50 mm (0.012 to 0.02 in)
 - **2nd Compression Ring**

0.40 to 0.65 mm (0.016 to 0.026 in)

- **Oil Control Ring Rails**

0.38 to 1.40 mm (0.015 to 0.055 in)

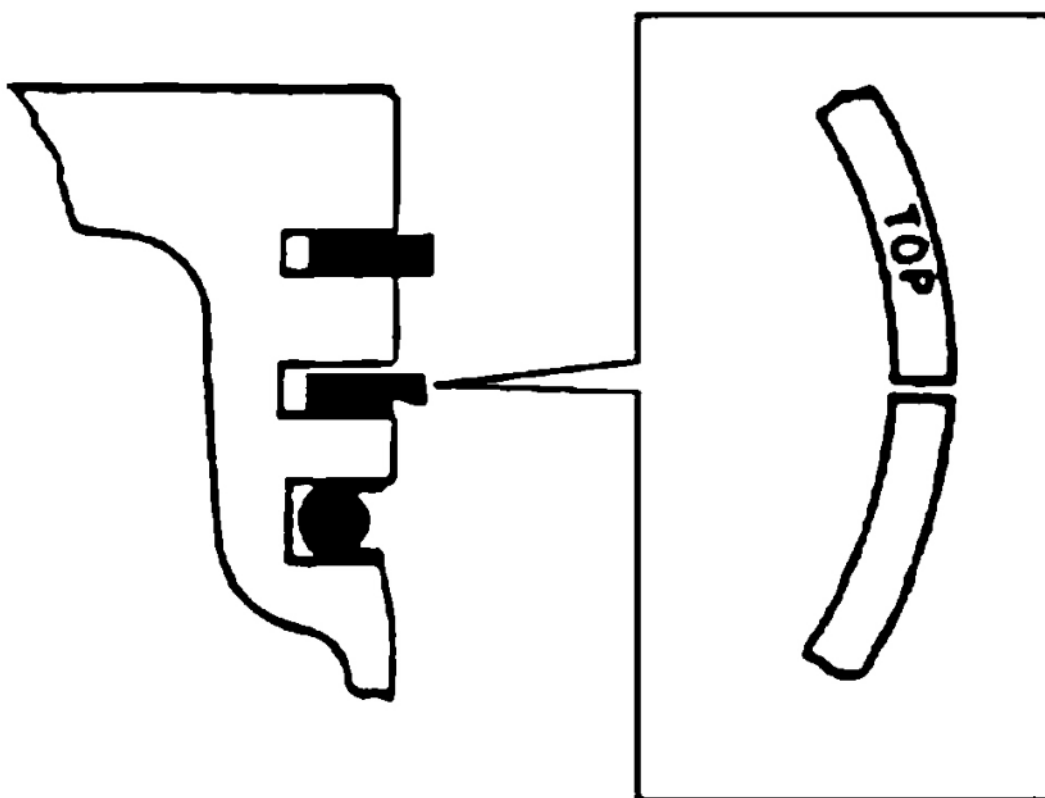
21. Remove piston rings from bore.
22. Fit oil control ring rails and expander, ensuring ends butt and do not overlap.
23. Fit 2nd compression ring marked TOP with marking uppermost in 2nd groove. See **Fig. 162**.
24. Fit 1st compression ring in first groove either way round.
25. Check piston ring to groove clearance:

- **1st Compression Ring**

0.05 to 0.10 mm (0.002 to 0.004 in)

- **2nd Compression Ring**

0.05 to 0.10 mm (0.002 to 0.004 in)

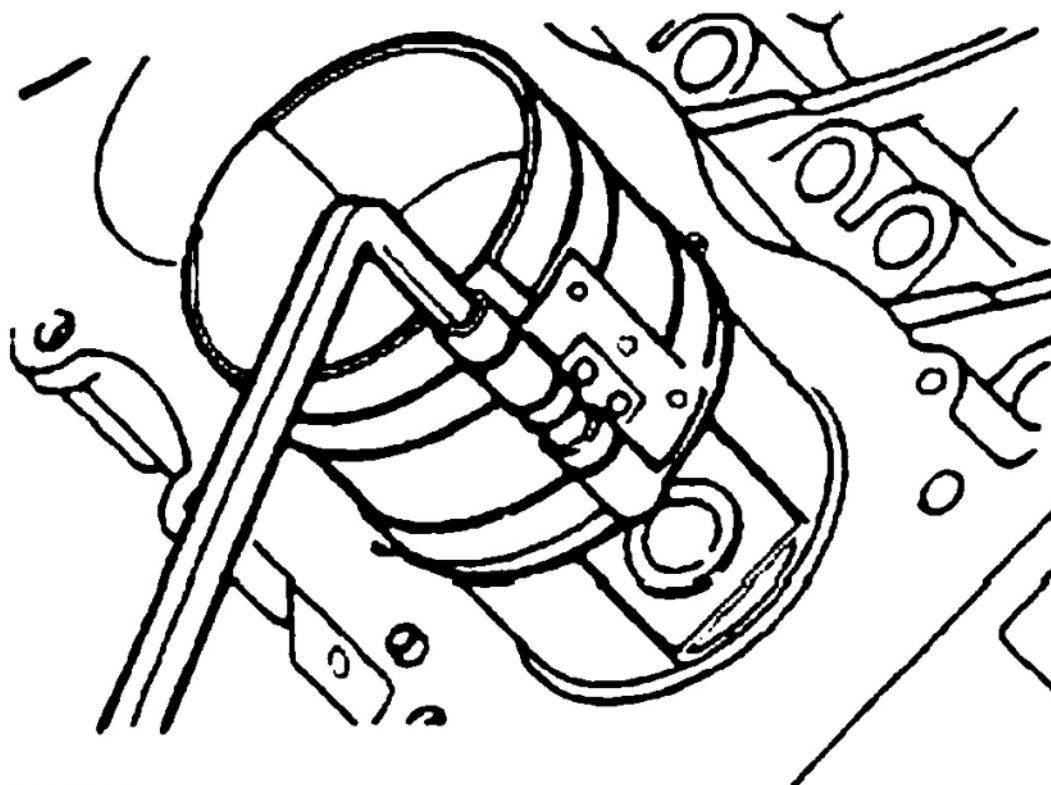


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Fig. 162: Positioning Piston Rings

Courtesy of LAND ROVER NORTH AMERICA, INC.

26. Position oil control expander ring joint and ring rail gaps all at one side, between gudgeon pin and away from left side of piston - viewed from front of piston. Position the gaps in ring rails approximately 25 mm (1.0 in) each side of expander ring joint.
27. Position compression rings with gaps on opposite side of piston between gudgeon pin and right side of piston, viewed from front of piston.
28. Thoroughly clean cylinder bores.
29. Lubricate piston rings and gudgeon pin with clean engine oil.
30. Lubricate cylinder bore with clean engine oil.
31. Using LRT-12-204, compress piston rings. See **Fig. 163**.

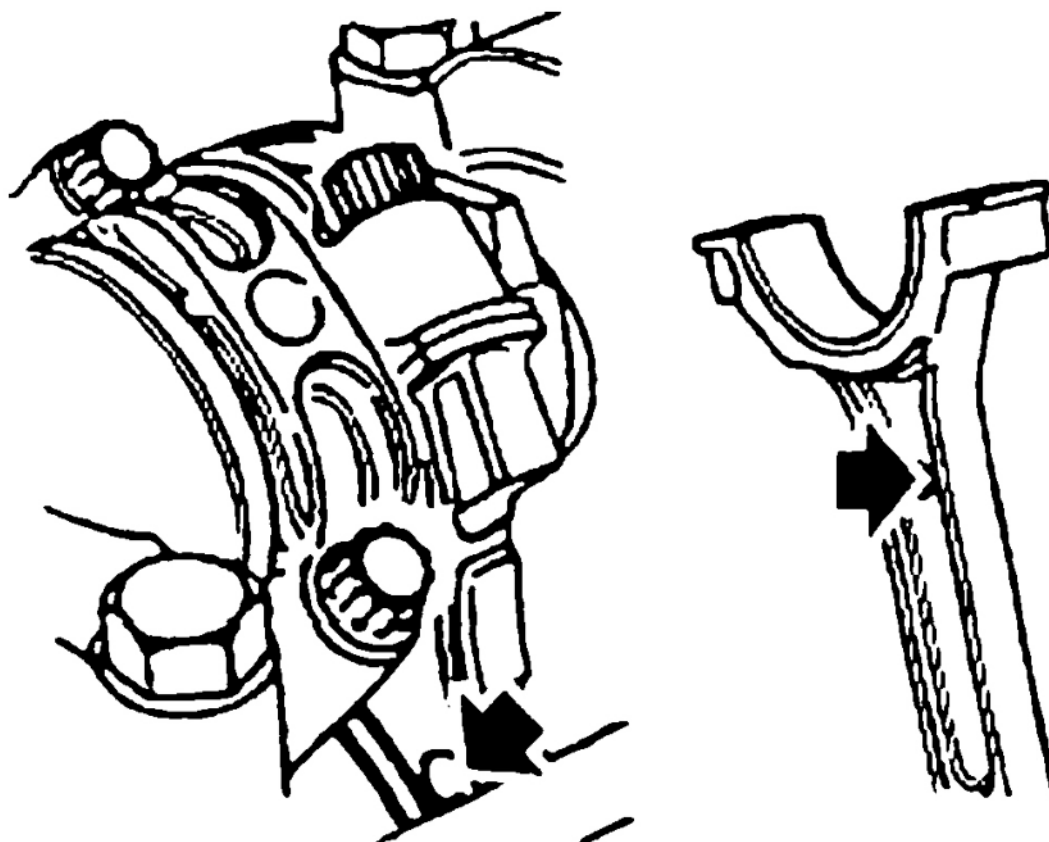


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Fig. 163: Compressing Piston Rings For Piston Installation

Courtesy of LAND ROVER NORTH AMERICA, INC.

32. Insert connecting rod and piston into its respective cylinder bore, ensuring domed shaped boss on connecting rod faces towards front of engine on right bank of cylinders and towards rear on left bank of cylinders. See **Fig. 164**.

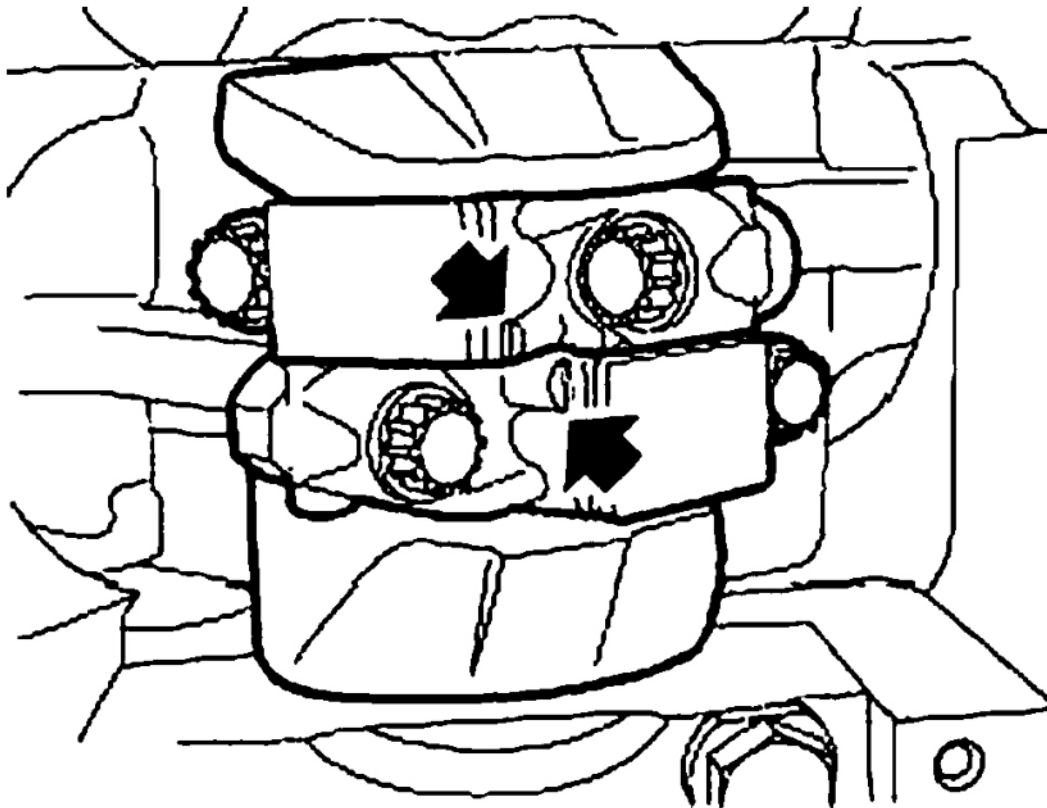


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Fig. 164: Installing Piston & Connecting Rod
Courtesy of LAND ROVER NORTH AMERICA, INC.

33. Clean connecting rod journal and bearing cap.
34. Lubricate connecting rod journal and connecting rod bearings.

NOTE: The rib on the edge of the bearing cap must face towards the front of the engine on the right bank of cylinders and towards the rear on the left bank.



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Fig. 165: Installing Bearing Caps

Courtesy of LAND ROVER NORTH AMERICA, INC.

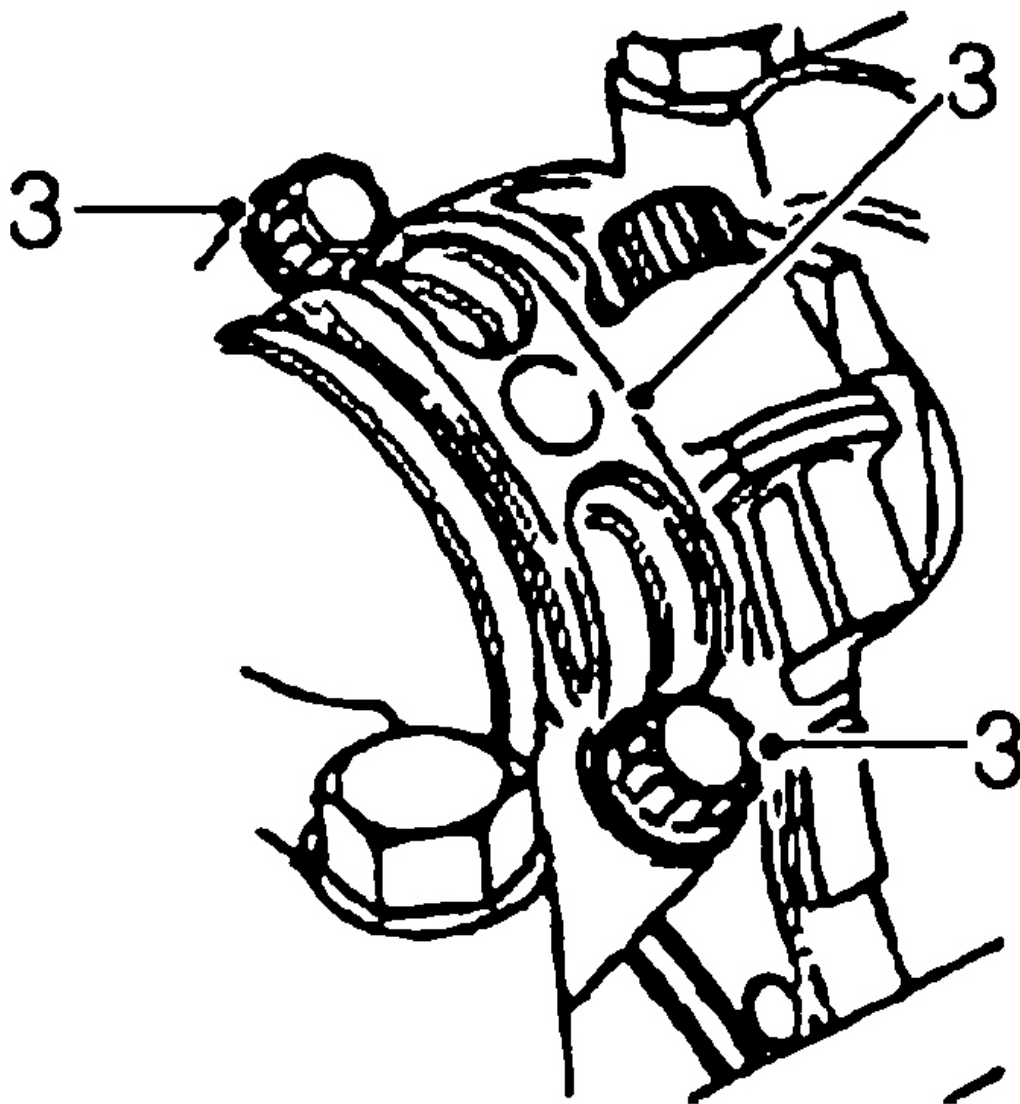
35. Fit connecting rod bearings and connecting rod bearing caps ensuring they are in their correct fitted order. See **Fig. 165**.
36. Fit bolts and tighten to 20 N.m (15 ft. lbs), then turn a further 80°.
37. Fit oil pick-up strainer. See **STRAINER - OIL PICK-UP**.
38. Fit cylinder head gasket. See **GASKET - CYLINDER HEAD**.

BEARINGS - CONNECTING RODS

Disassembly

1. Remove oil pick up strainer. See **STRAINER - OIL PICK-UP**.
2. Suitably mark cylinder reference number on each connecting rod bearing cap.

CAUTION: Keep bearing caps, bearings and bolts in their fitted order.



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Fig. 166: Removing Connecting Rod Bearing Caps
Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Remove 2 bolts securing each connecting rod bearing cap, remove caps and recover connecting rod bearings. See **Fig. 166**.

CAUTION: Ensure that connecting rods do not contact cylinder bores.

4. Push each connecting rod up cylinder bore until connecting rods are clear of crankshaft journals.
5. Remove bearing shells from each connecting rod.

Inspection

1. Clean crankshaft journals and bearing locations in connecting rods.
2. Inspect connecting rod bearings for wear and renew if necessary. Connecting rod bearings are available in two oversizes:

- **Connecting Rod Bearing - 1st Oversize**

0.254 mm (0.01 in)

- **Connecting Rod Bearing - 2nd Oversize**

0.508 mm (0.02 in)

3. Check crankshaft big-end journals for wear and scoring. Measure for roundness; taking 3 measurements at 120° intervals at each end and at center of journals:

- **Standard Journal**

55.500 to 55.513 mm (2.20 to 2.22 in)

- **1st Undersize Journal**

0.254 mm (0.010 in) = 55.246 to 55.259 mm (2.170 to 2.180 in)

- **2nd Undersize Journal**

0.508 mm (0.020 in) = 54.992 to 55.005 mm (2.160 to 2.165 in)

- **Journal - Max. Roundness**

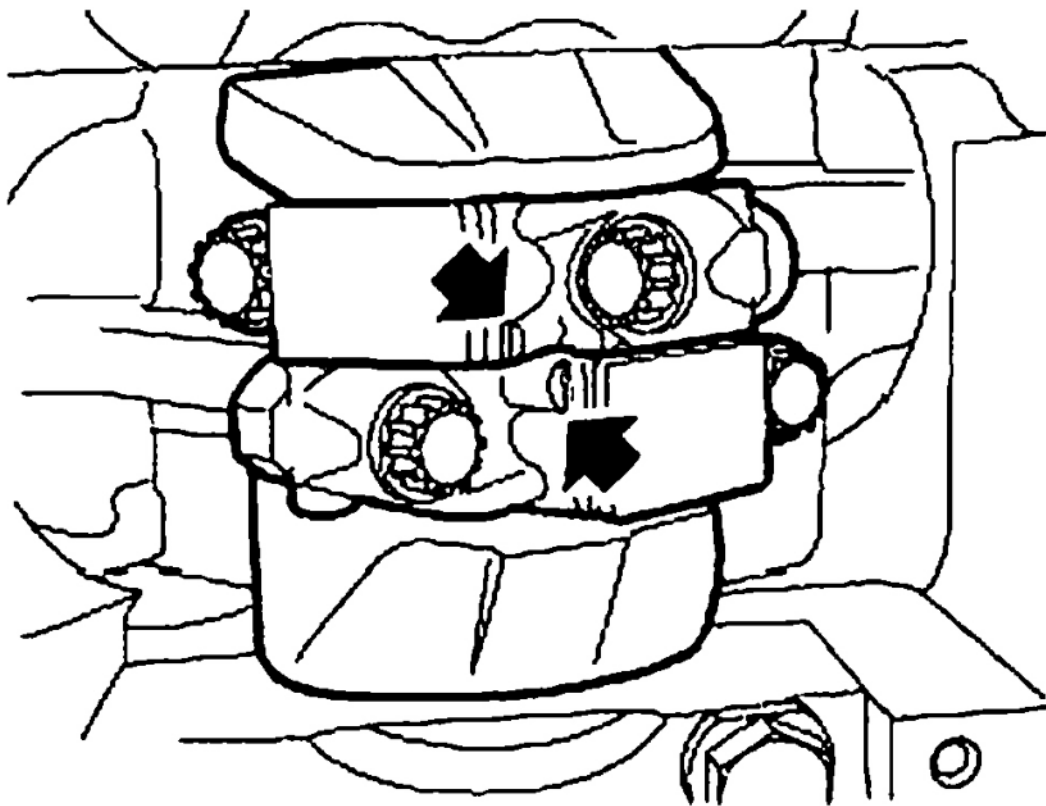
0.040 mm (0.002 in)

Reassembly

1. Clean connecting rod caps.
2. Lubricate connecting rod journals and bearing shells with clean engine oil.
3. Fit bearing shells to connecting rods and caps.
4. Rotate crankshaft until connecting rod journals are correctly positioned.
5. Taking care not to displace bearing shells, pull connecting rods on to crankshaft journals.
6. Check that bearing shells are correctly located in connecting rod bearing caps.

NOTE: **The rib on the edge of the bearing cap must face towards the front of**

engine on the right bank of cylinders and towards the rear on the left bank.



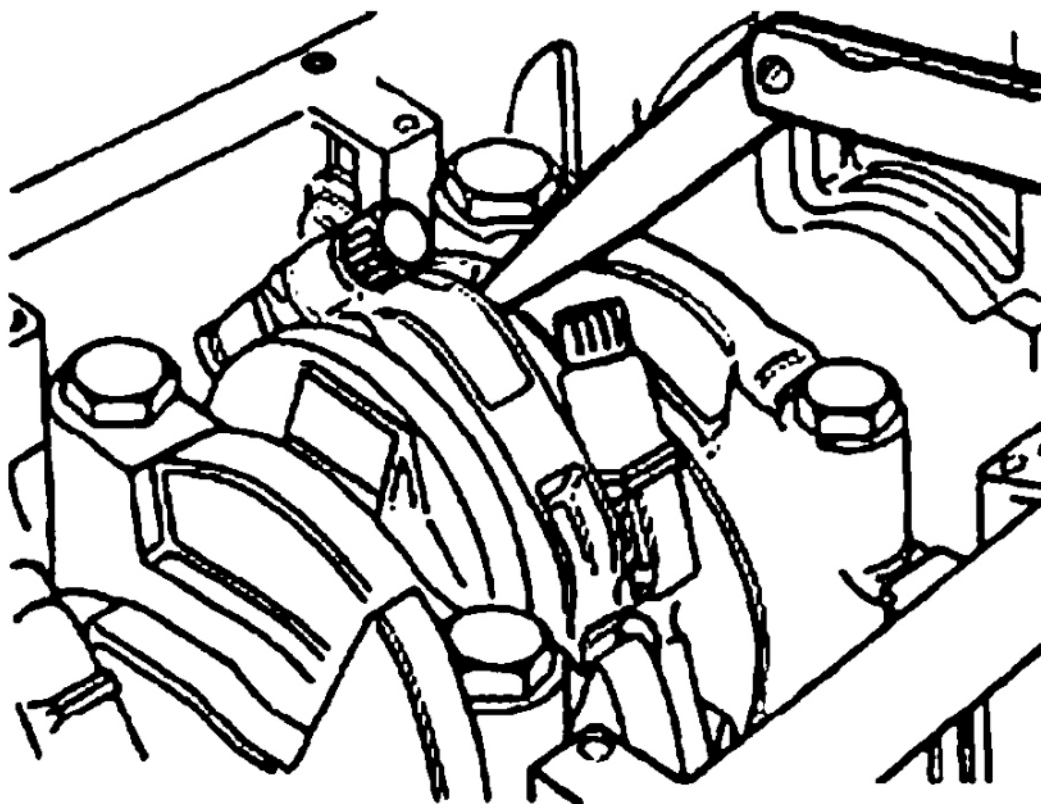
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Fig. 167: Positioning Connecting Rod Bearing Caps
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Fit connecting rod bearing caps, ensuring that they are in their correct fitted order. See **Fig. 167**.
8. Lightly oil threads of connecting rod bolts. Fit connecting rod bolts and tighten to 20 N.m (15 ft. lbs), then turn a further 80°.
9. Check clearance between connecting rods on each crankshaft journal. See **Fig. 168**:

- **Connecting Rod Clearance**

0.15 to 0.36 mm (0.006 to 0.014 in)



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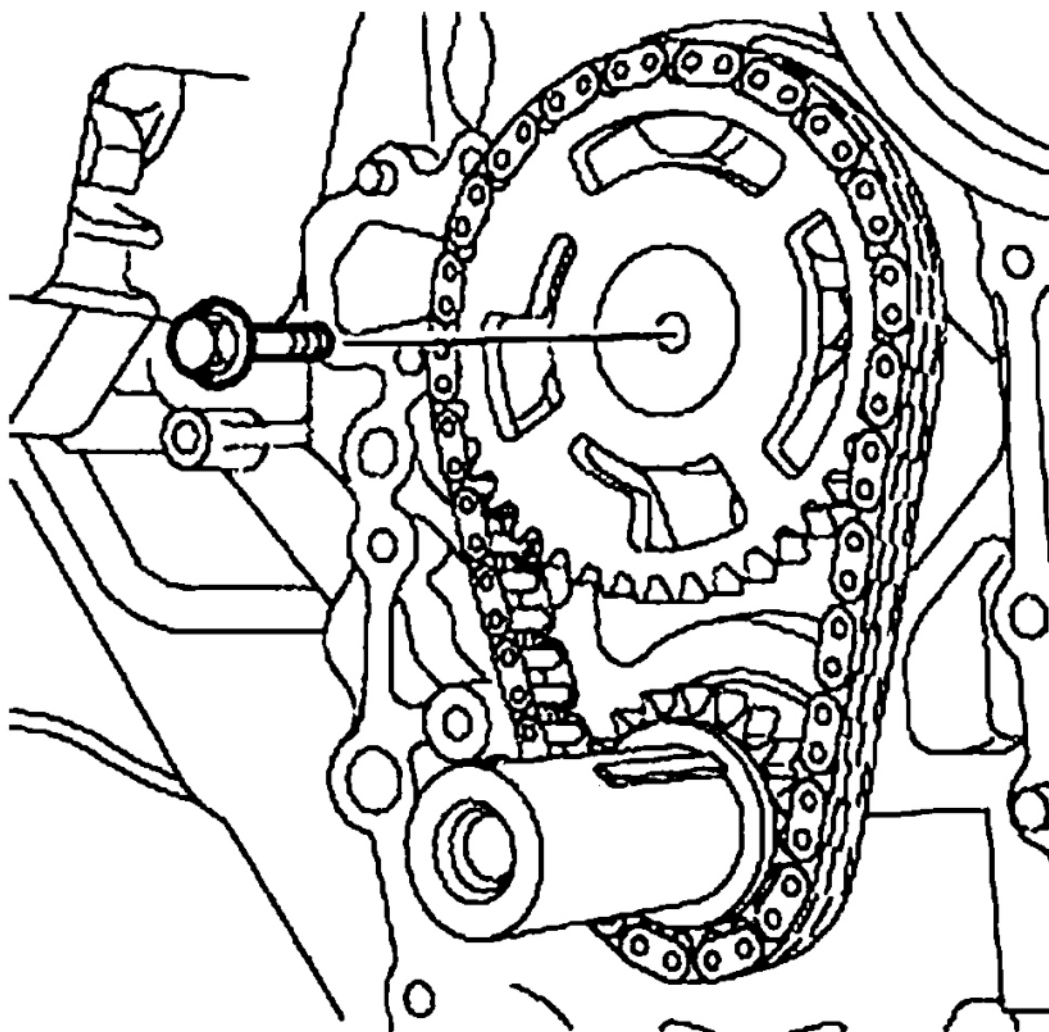
Fig. 168: Checking Connecting Rod-To-Crankshaft Journal
Courtesy of LAND ROVER NORTH AMERICA, INC.

10. Fit oil pick up strainer. See **STRAINER - OIL PICK-UP.**

CRANKSHAFT & MAIN BEARINGS

Disassembly

1. Remove crankshaft rear oil seal. See **SEAL - CRANKSHAFT - REAR - AUTOMATIC MODELS.**
2. Remove timing gear cover gasket. See **GASKET - TIMING GEAR COVER.**
3. Remove bolt securing camshaft gear. See **Fig. 169.**

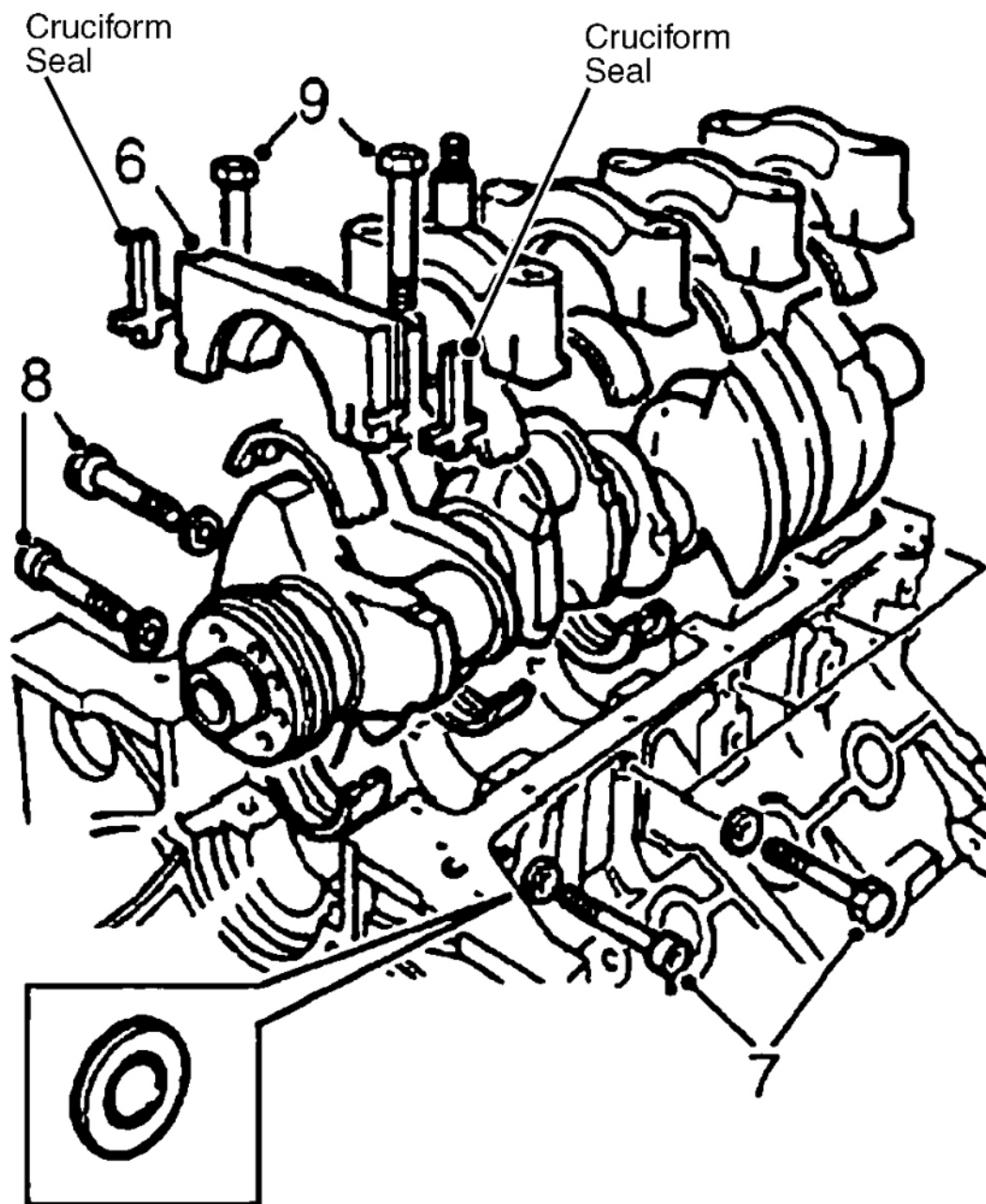


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Fig. 169: Removing Camshaft Gear Bolt

Courtesy of LAND ROVER NORTH AMERICA, INC.

4. Remove timing chain and gears.
5. Remove connecting rod bearings. See **BEARINGS - CONNECTING RODS**.
6. Reference mark main bearing caps to aid assembly. See **Fig. 170**.



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Fig. 170: Removing Crankshaft & Main Bearings
Courtesy of LAND ROVER NORTH AMERICA, INC.

7. Remove 10 side bolts securing main bearing caps to block.
8. Collect DOWTY washers from side bolts. Rear side bolts have Allen heads.
9. Starting at the center main bearing cap, progressively loosen, then remove 2 bolts securing each main

bearing cap.

CAUTION: Keep bearing caps, bearings and bolts in their fitted order.

10. Release and remove main bearing caps.
11. Remove and discard cruciform seals from rear main bearing cap.
12. Remove crankshaft.
13. Remove main bearings from cylinder block and main bearing caps.
14. Remove key from keyway.
15. Remove rear main sealing washers.

Inspection

1. Clean crankshaft journals and bearing locations in cylinder block.
2. Inspect main bearings for wear and renew if necessary. Main bearings are available in two oversizes. If 2nd oversize bearing is being fitted, it may be necessary to grind thrust face of center main bearing to achieve correct end-float:

- **Main Bearing 1st Oversize**

0.254 mm (0.01 in)

- **Main Bearing 2nd Oversize**

0.508 mm (0.02 in)

3. Check main bearing journals for wear and scoring. Measure for roundness; taking 3 measurements at 120° intervals at each end and at center of journals. See **Fig. 171** and **Fig. 172** :

- **Journal Standard Diameter**

63.487 to 63.500 mm (2.499 to 2.520 in)

- **1st Undersize Journal**

63.223 to 63.246 mm (2.511 to 2.512 in)

- **2nd Undersize Journal**

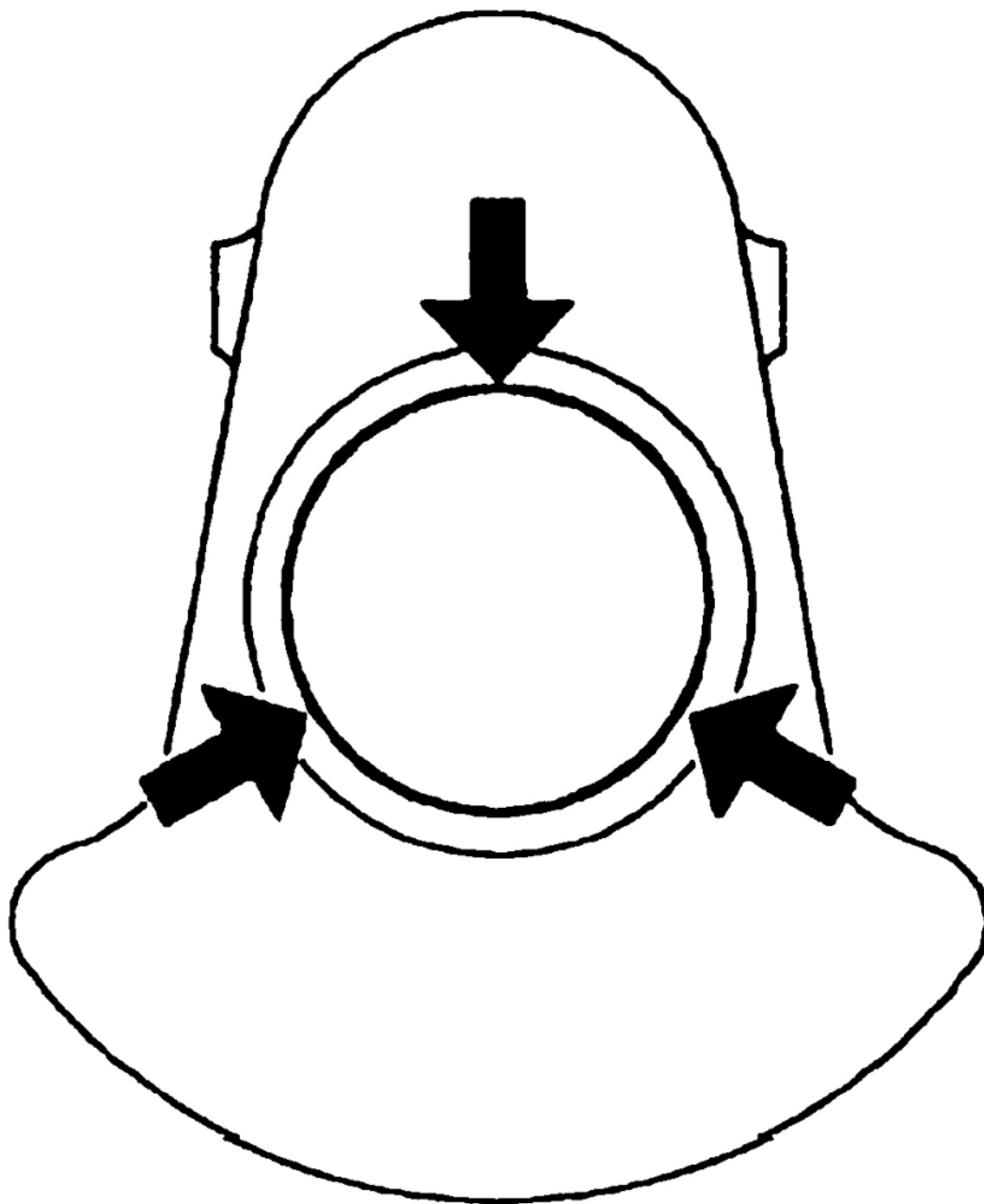
62.979 to 62.992 mm (2.509 to 2.510 in)

- **Journal Standard Width**

26.975 to 27.026 mm (1.061 to 1.064 in)

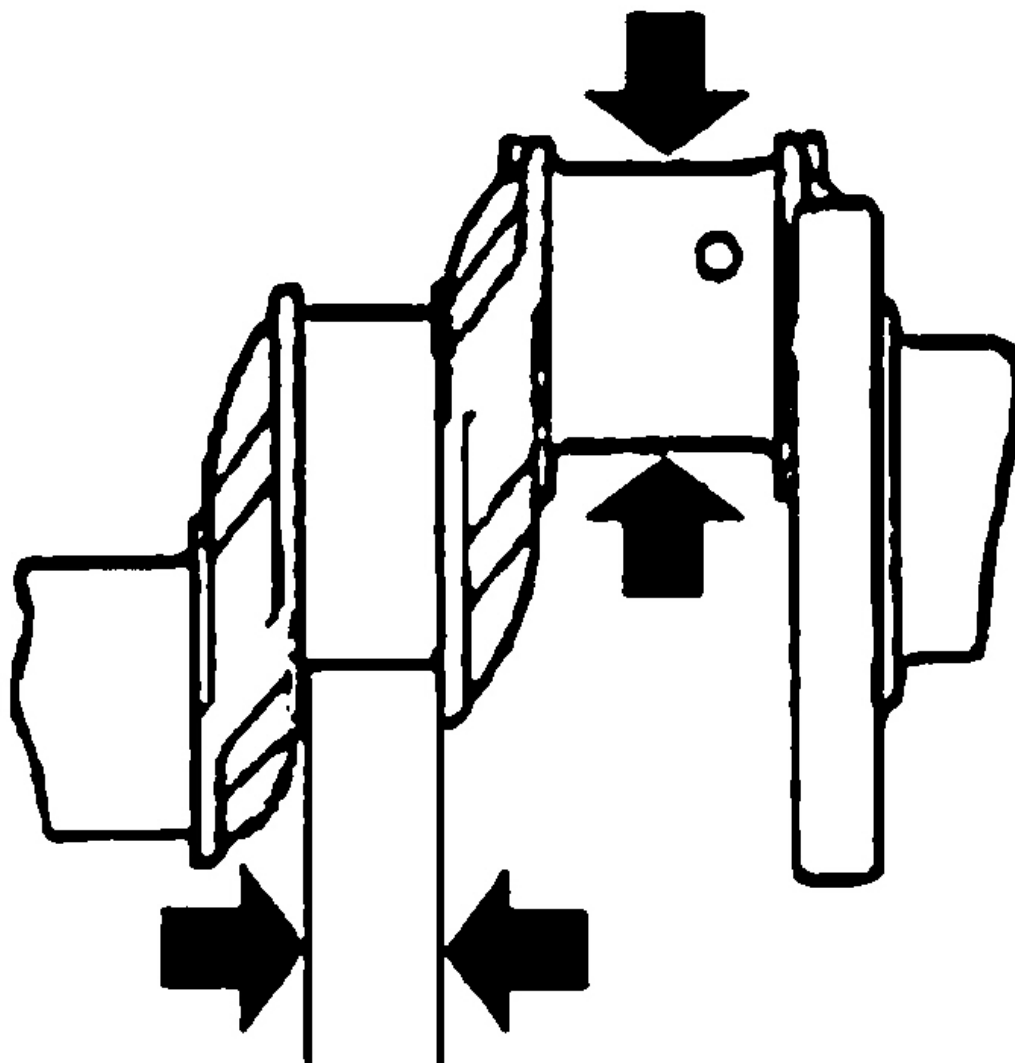
- **Maximum Roundness**

0.040 mm (0.002 in)



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Fig. 171: Main Bearing Journal Measurement Positions (1 Of 2)
Courtesy of LAND ROVER NORTH AMERICA, INC.



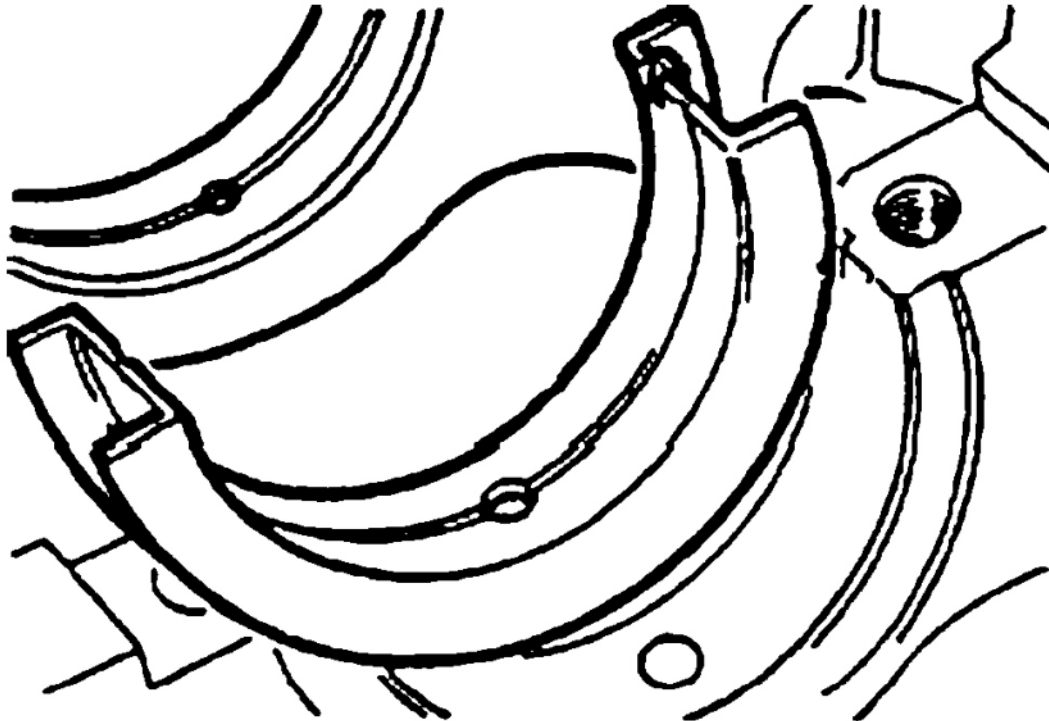
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Fig. 172: Main Bearing Journal Measurement Positions (2 Of 2)
Courtesy of LAND ROVER NORTH AMERICA, INC.

Reassembly

1. Clean main bearing locations in cylinder block and bearing caps; ensure bolt holes are clean and dry.
2. Clean sealant from rear main bearing cap and mating faces.
3. Fit key to keyway.
4. Check threads of main bearing cap bolts for damage, renew bolts in pairs.

NOTE: Ensure that the flanged bearing is fitted to the center position.

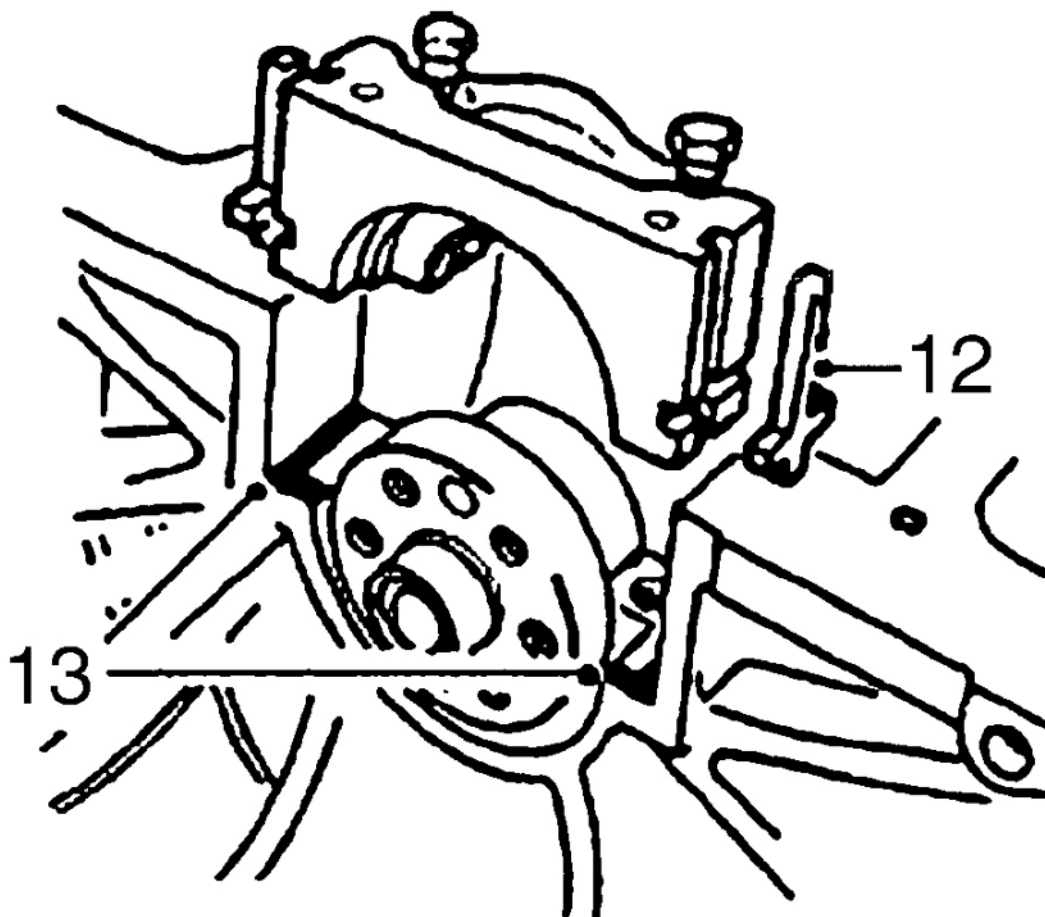


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Fig. 173: Installing Main Bearing Shells To Cylinder Block
Courtesy of LAND ROVER NORTH AMERICA, INC.

5. Lubricate grooved main bearing shells with clean engine oil and fit to their locations in cylinder block. See **Fig. 173**.
6. Lubricate crankshaft journals with clean engine oil.
7. Position crankshaft in cylinder block.
8. Lubricate plain bearing shells with clean engine oil and fit to main bearing caps.
9. Fit main bearing caps 1 to 4 only at this stage, ensuring that they are the correct way round and in their fitted order.
10. Lightly lubricate threads of main bearing cap bolts with clean engine oil.
11. Fit main bearing cap bolts but do not tighten at this stage. DO NOT fit side bolts at this stage.

CAUTION: DO NOT trim off excess from cruciform seals at this stage.



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Fig. 174: Installing Rear Bearing Cap

Courtesy of LAND ROVER NORTH AMERICA, INC.

12. Lubricate NEW cruciform seals with engine oil and fit to rear main bearing cap. See **Fig. 174**.

CAUTION: Ensure sealant does not enter bolt holes.

13. Apply a 3 mm (0.12 in) wide bead of sealant, Part No. STC 50550 to bearing cap rear mating faces on cylinder block. See **Fig. 174**.

CAUTION: Ensure engine oil does not enter the side bolt holes in the bearing cap. Do not trim off excess material from cruciform seals at this stage.

14. Carefully fit rear main bearing cap assembly, fit but do not tighten bolts.
15. Lubricate DOWTY washers with engine oil and fit to side bolts.
16. Fit but do not tighten side bolts. Rear side bolts are Allen headed.
17. Using the sequence shown. See **Fig. 175**. Tighten main bearing cap bolts as follows:

- **All Main Bearing Cap Bolts & Side Bolts**

Initial torque for all bolts to 13.5 N.m (10 ft. lbs).

- **Main Bearing Cap Side Bolts**

Final torque bolts 11-15 to 45 N.m (34 ft. lbs).

- **Main Bearing Cap Bolts**

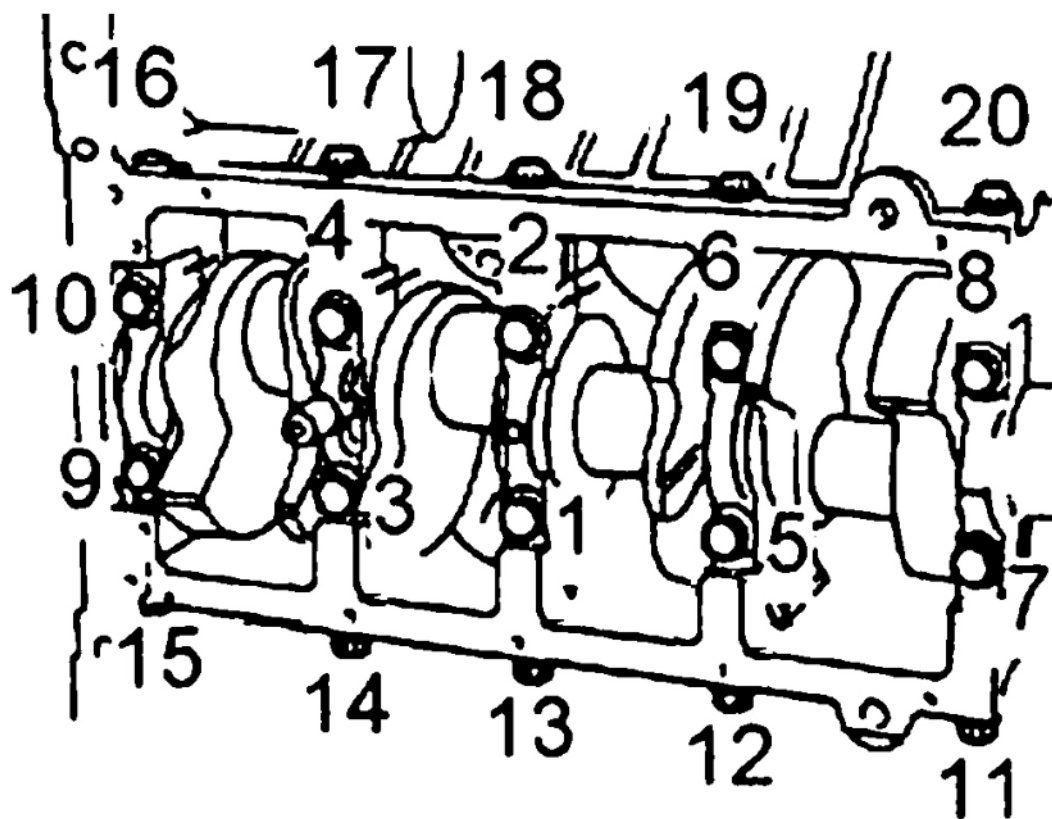
Final torque bolts 1-8 to 72 N.m (54 ft. lbs).

- **Main Bearing Cap Bolts**

Final torque bolts 9-10 to 92 N.m (68 ft. lbs).

- **Main Bearing Cap Side Bolts**

Final torque bolts 16-20 to 45 N.m (34 ft. lbs).



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Fig. 175: Main Bearing Cap Bolt Tightening Sequence
Courtesy of LAND ROVER NORTH AMERICA, INC.

18. Trim off excess material from cruciform seals.
19. Attach a Dial Test Indicator (DTI) to front of cylinder block, move crankshaft rearwards, position stylus of gauge on end of crankshaft and zero gauge. See **Fig. 176**.

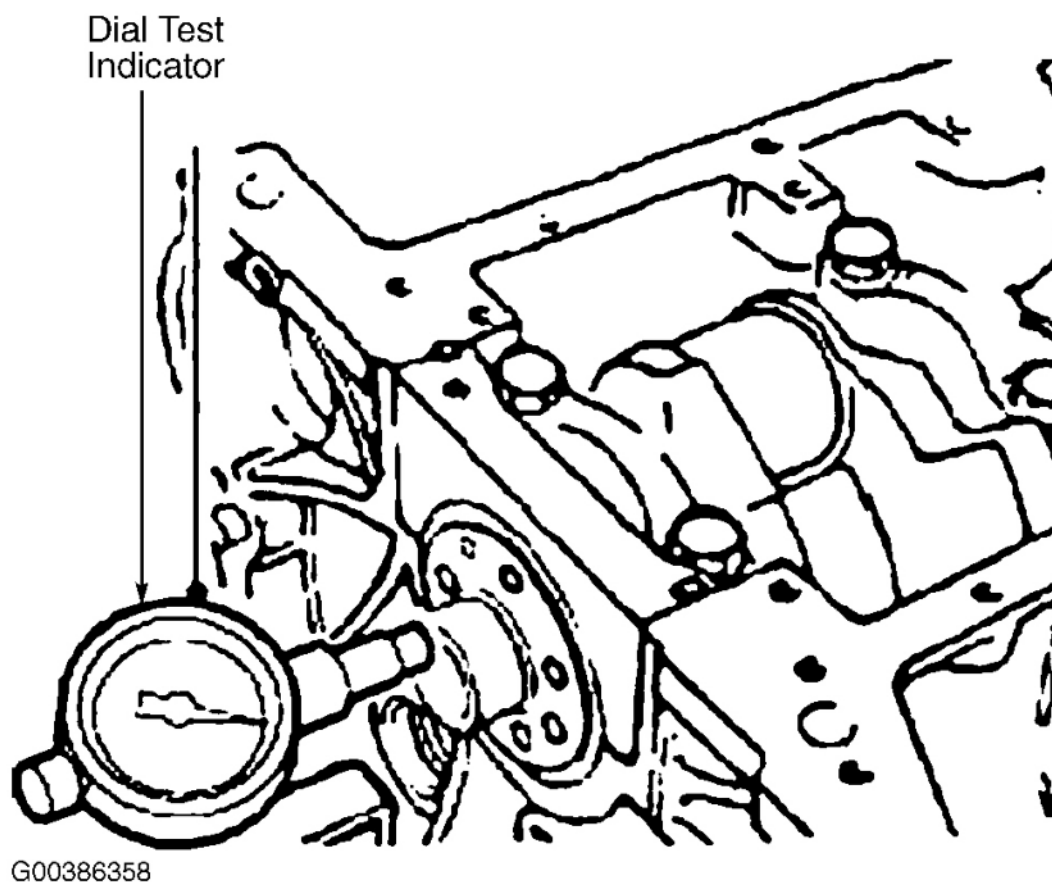


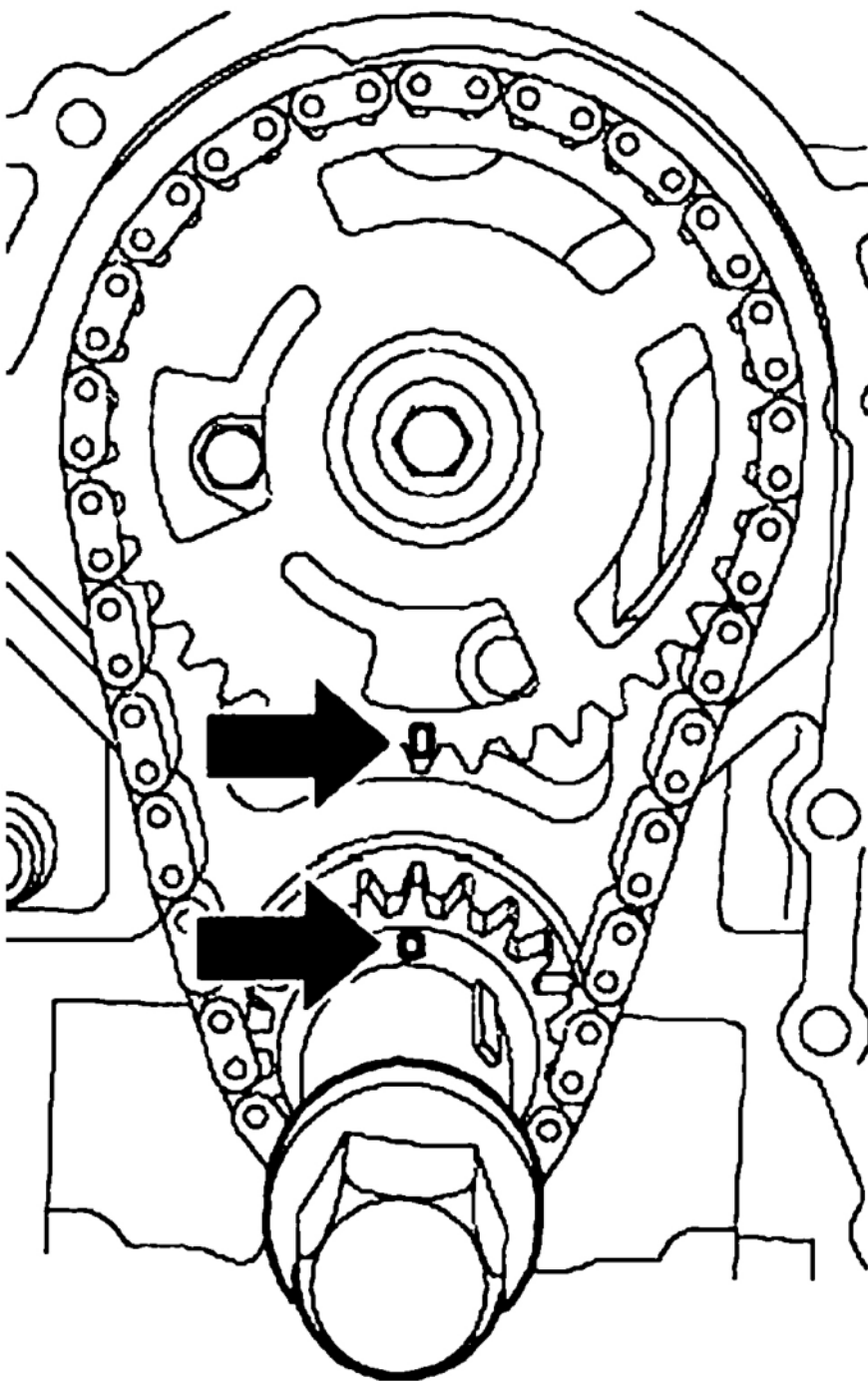
Fig. 176: Measuring Crankshaft End-Float
Courtesy of LAND ROVER NORTH AMERICA, INC.

20. Move crankshaft forwards, measure and record end-float obtained. See **Fig. 176**:

- **Crankshaft End-Float**

0.08 to 0.26 mm (0.003 to 0.01 in)

21. Fit connecting rod bearings. See **BEARINGS - CONNECTING RODS**.
22. Clean timing chain and gears.
23. Clean ends of crankshaft and camshaft.
24. Lubricate timing chain assembly with clean engine oil.
25. Align timing marks and fit timing chain assembly. See **Fig. 177**.



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Fig. 177: Aligning Timing Gears & Chain Timing Marks
Courtesy of LAND ROVER NORTH AMERICA, INC.

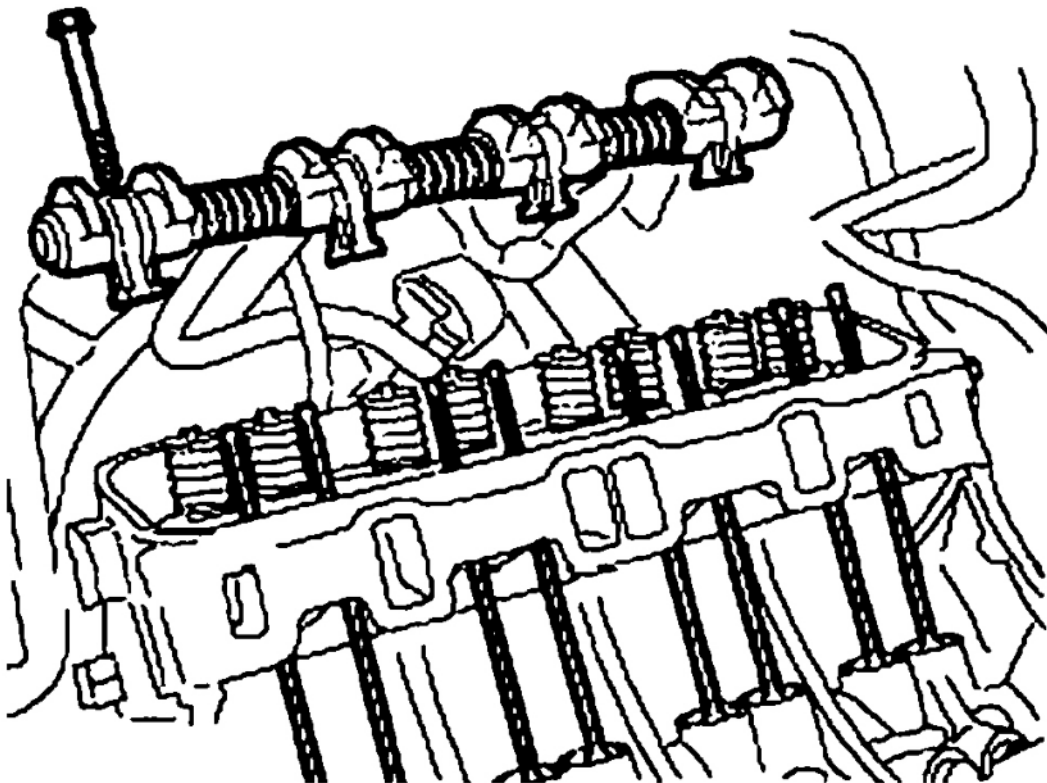
26. Fit camshaft gear bolt and tighten to 50 N.m (37 ft. lbs).

27. Fit timing gear cover gasket. See **GASKET - TIMING GEAR COVER**.
28. Clean crankshaft pulley.
29. Fit crankshaft pulley.
30. Fit crankshaft pulley bolt and tighten to 270 N.m (200 ft. lbs).
31. Remove tool LRT-12-080 from crankshaft pulley.
32. Clean oil filter and mating face.
33. Lubricate oil filter seal and fit filter to oil pump.
34. Ensure drive belt pulleys are clean and damage free.
35. Fit auxiliary drive belt to pulleys.
36. Fit crankshaft rear oil seal. See **SEAL - CRANKSHAFT - REAR - AUTOMATIC MODELS**.

CAMSHAFT

Disassembly

1. Remove inlet manifold gasket. See **GASKET - INLET MANIFOLD**.
2. Progressively loosen and remove 8 bolts securing rocker shaft assemblies. See **Fig. 178**.



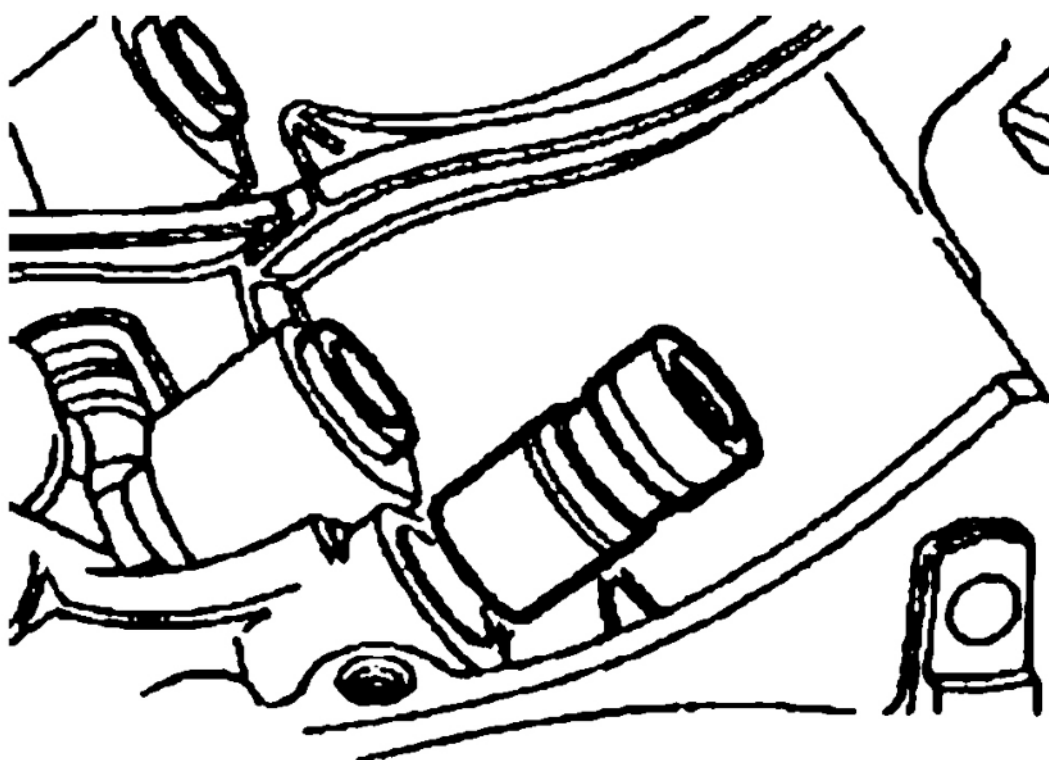
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Fig. 178: Rocker Shaft Assemblies

Courtesy of LAND ROVER NORTH AMERICA, INC.

3. Mark each rocker shaft in relation to original head.
4. Remove rocker shaft assemblies.
5. Remove push rods and store in their fitted order.

CAUTION: Store tappets upright and in their fitted order.

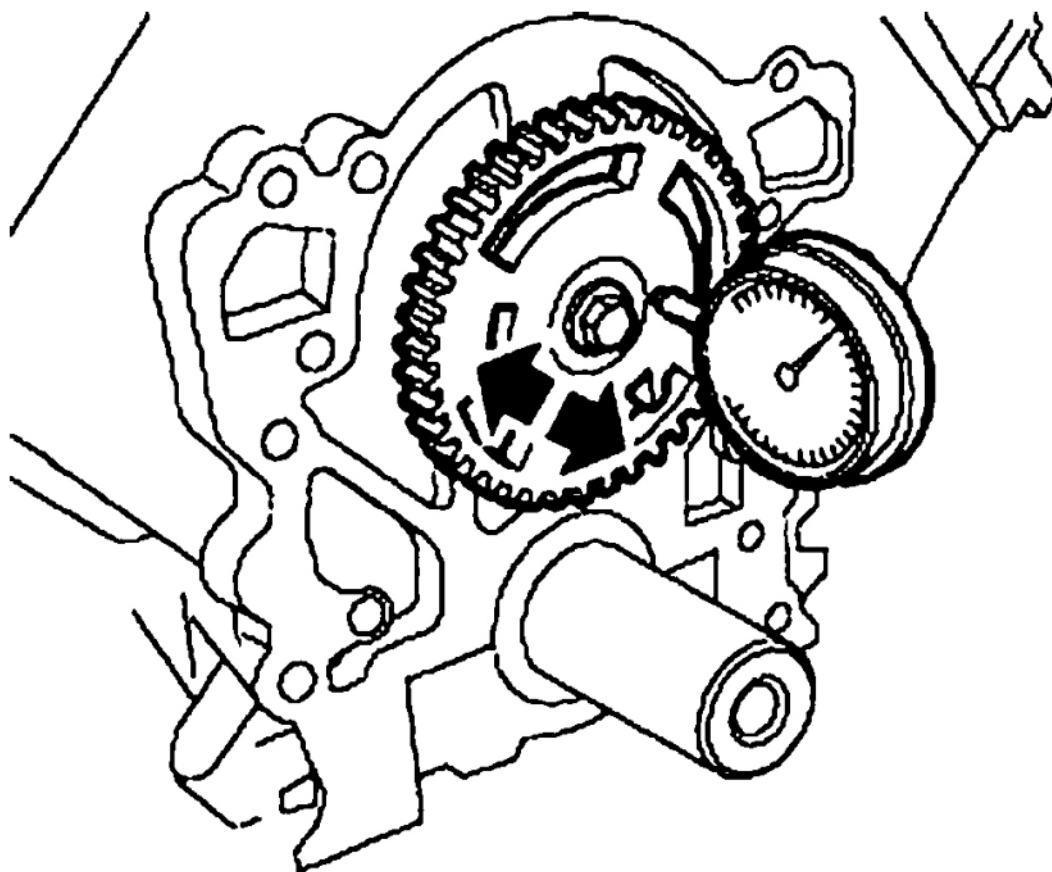


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Fig. 179: Tappets

Courtesy of LAND ROVER NORTH AMERICA, INC.

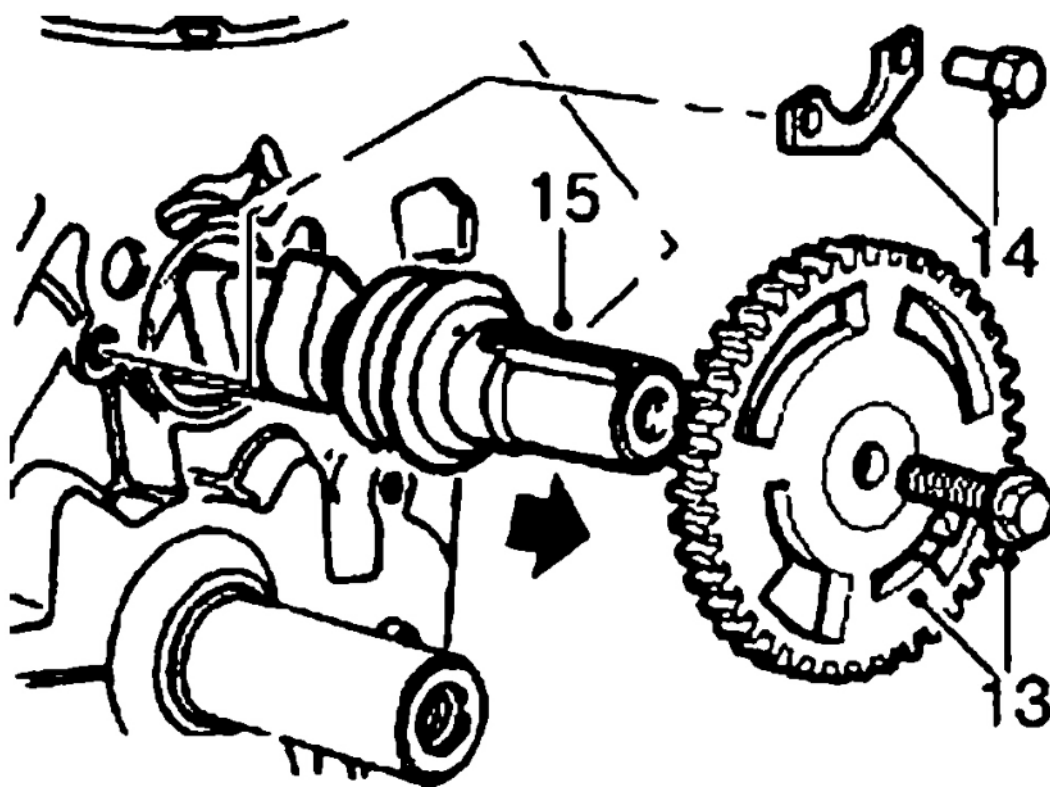
6. Remove tappets. See **Fig. 179**.
7. Remove timing chain and gears. See **TIMING CHAIN & GEARS**.
8. Temporarily fit camshaft gear and lightly tighten bolt.
9. Attach a Dial Test Indicator (DTI) to front of cylinder block with stylus of DTI contacting camshaft gear. See **Fig. 180**.



G00386362

Fig. 180: Measuring Camshaft End-Float**Courtesy of LAND ROVER NORTH AMERICA, INC.**

10. Push camshaft rearwards and zero the DTI.
11. Using the camshaft gear, pull camshaft forwards and note reading on DTI. End-float should be from 0.075 to 0.25 mm (0.003 to 0.010 in). See **Fig. 180**.
12. If end-float is incorrect, fit a NEW thrust plate. If end-float is still incorrect, a NEW camshaft/gear must be fitted.
13. Remove camshaft bolt and gear. See **Fig. 181**.



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Fig. 181: Camshaft, Gear & Thrust Plate
 Courtesy of LAND ROVER NORTH AMERICA, INC.

14. Remove 2 bolts securing camshaft thrust plate and remove thrust plate.
15. Carefully remove the camshaft avoiding damage to the camshaft bearings.

Reassembly

1. Clean camshaft bearings in block.
2. Clean camshaft.
3. Wipe camshaft bearing faces and lobes.
4. Clean thrust plate and mating face.
5. Lubricate camshaft bearings with clean engine oil.
6. Fit camshaft, take care not to damage camshaft bearings.
7. Lubricate thrust plate and mating face with clean engine oil.
8. Position thrust plate, fit and tighten bolts to 22 N.m (17 ft. lbs).
9. Fit timing chain and gears. See **TIMING CHAIN & GEARS**.
10. Immerse tappets in engine oil. Before fitting, pump the inner sleeve of tappet several times using a push

rod to prime the tappets.

11. Clean tappet bores.
12. Lubricate tappets and tappet bores with clean engine oil.
13. Fit tappets.
14. Clean push rods.
15. Lubricate tappet end of push rods with clean engine oil.
16. Fit push rods.
17. Clean bases of rocker pillars and mating faces.
18. Clean contact surfaces on rockers and valves.
19. Lubricate contact surfaces on rockers and valves with clean engine oil.
20. Fit rocker shafts and engage push rods. Ensure rockers shafts are fitted to the correct cylinder head.
21. Fit and progressively tighten rocker shaft bolts to 40 N.m (30 ft. lbs).
22. Fit inlet manifold gasket. See **GASKET - INLET MANIFOLD**.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS ⁽¹⁾

Application	Ft. Lbs. (N.m)
A/C Compressor	16 (22)
ACE Pump	16 (22)
Auxiliary Drive Belt Tensioner	33 (45)
Auxiliary Housing	30 (40)
Block Coolant Drain Plug	22 (30)
Camshaft Gear Bolt	37 (50)
Camshaft Thrust Plate Bolts	16 (22)
Connecting Rod Cap Bolts ⁽²⁾	
Step 1	15 (20)
Step 2	Tighten An Additional 80 Degrees
Coolant Outlet Elbow	16 (22)
Crankshaft Pulley Bolt	200 (270)
Cylinder Head Bolt ^{(2) (3)}	
Step 1	15 (20)
Step 2	Tighten An Additional 90 Degrees
Step 3	Tighten An Additional 90 Degrees
Drive Plate & Clamp Ring Bolt (Early Engine)	33 (45)
Drive Plate Spacer & Hub-To-Crankshaft Bolt (Early Engine)	63 (85)
Drive Plate-To-Crankshaft Allen Bolt (Later Engine)	63 (85)

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Engine Ground Strap	16 (22)
Engine Mount Bolts	63 (85)
Engine Mount Nuts	33 (45)
Engine-To-Transmission Bolt	63 (85)
Exhaust Manifold Bolt ⁽⁴⁾	
Initial Torque	11 (15)
Final Torque	28 (38)
Front Exhaust Pipe Flange Nuts	22 (30)
Flywheel-To-Crankshaft Bolt	58 (78)
Generator Mounting Bracket	30 (40)
Intake Manifold ⁽⁵⁾	
Step 1	(6)
Step 2	38 (51)
Intake Manifold Gasket Clamp Bolt	13 (18)
Jockey (Idler Pulley)	37 (50)
Knock Sensor	16 (22)
Main Bearing Cap Bolts ⁽⁷⁾	
Initial Torque - All Main Bearing Cap & Side Bolts	10 (14)
Final Torque	
Main Bearing Cap Bolts 1-8	53 (72)
Main Bearing Cap Bolts 9-10	68 (92)
Main Bearing Cap Side Bolts 11-15	33 (45)
Main Bearing Cap Side Bolts 16-20	33 (45)
Oil Cooler Pipe-To-Timing Cover	11 (15)
Oil Drain Plug	24 (33)
Oil Pressure Switch	11 (15)
Oxygen Sensor	33 (45)
Plenum Chamber	16 (22)
Rocker Shaft Bolt	30 (40)
Secondary Air Injection Adapters	24 (33)
Spark Plugs	15 (20)
Sump (Oil Pan) Bolts & Nuts ⁽⁸⁾	16 (22)
Tail Pipe	18 (25)
Timing Cover Bolt ⁽⁹⁾ ⁽¹⁰⁾	16 (22)
Torque Converter-To-Flexplate Bolt	37 (50)
Viscous Fan Nut	33 (45)
Water Pump Bolt	18 (24)
Water Pump Pulley	16 (22)
INCH Lbs. (N.m)	
Breather Adapter	53 (6)

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Camshaft Position (CMP) Sensor Bolt	71 (8)
Crankshaft Position (CKP) Sensor Bolt	53 (6)
Crankshaft Position (CKP) Sensor Cover	53 (6)
Engine Coolant Temperature Sensor ⁽¹⁰⁾	89 (10)
Fuel Rail	80 (9)
IACV Sensor	71 (8)
Ignition Coils	71 (8)
Oil Pick-Up Strainer Bolt	89 (10)
Oil Pump Filter Head Adapter ⁽¹⁰⁾	115 (13)
Oil Pump Filter Head Bolt	71 (8)
Rocker Cover Bolts ⁽²⁾	71 (8)
Throttle Body	89 (10)
Throttle Cable Abutment Bracket	89 (10)
Throttle Position Sensor	18 (2)

(1) For torque specifications not specified, refer to **STANDARD TORQUE SPECIFICATIONS** table for bolt size torque specification.

(2) Replace bolts after every use.

(3) Tighten cylinder head bolts in sequence. See **Fig. 15**.

(4) Tighten exhaust manifold bolts in sequence. See **Fig. 25**.

(5) Tighten lower intake manifold bolts in sequence. See **Fig. 100**.

(6) 89 INCH Lbs. (10 N.m)

(7) Tighten main bearing cap bolts in sequence. See **Fig. 175**.

(8) Tighten oil pan bolts in sequence. See **Fig. 75**.

(9) Tighten timing cover bolts in sequence. See **Fig. 89**.

(10) Apply sealant, Part Number STC 50552 to threads prior to assembly.

STANDARD BOLT TORQUE SPECIFICATIONS

Bolt Size	Ft. Lbs. (N.m)
M8	13 (18)
M10	26 (35)
M12	48 (65)
M14	59 (80)
M16	96 (130)
5/16 UNC/UNF	18 (25)
3/8 UNC/UNF	30 (40)
7/16 UNC/UNF	55 (75)
1/2 UNC/UNF	66 (90)
5/8 UNC/UNF	100 (135)

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	INCH Lbs. (N.m)
M5	27 (4)
M6	53 (6)
1/4 UNC/UNF	80 (9)