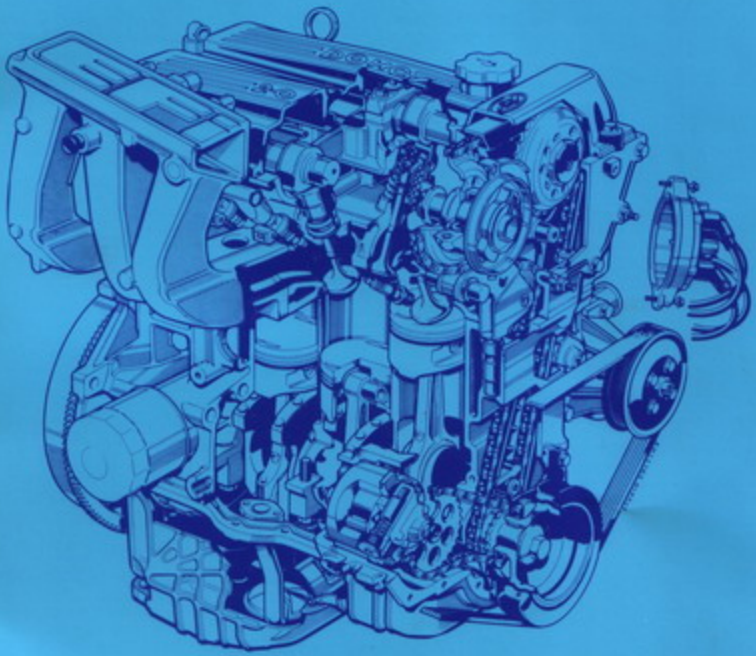
2.0 LITRE DOHC ENGINE



Technicians Product Training

Service Training

CG 7308 GB 4/89

The development of modern power units in automobile construction remains a central aspect of customer interest. Performance and durability were in the past the major image-building characteristics of these units. However, more recently, stringent legislation on exhaust emissions has considerably affected the design and development of modern combustion engines.

With the new 2.0 litre 4 cylinder double overhead cam engine with aluminum cylinder head - in short called DOHC - FORD Engineers have developed an engine which meets not only todays but also tomorrows emission requirements.

Performance, economy, smooth running, durability, low emission levels and ease of repair were some of the major design objectives and these have been fully met.

The DOHC engine is either fitted with carburettor or with electronic fuel injection. With its power range from 77 to 92 kW and its low levels of emission this engine fully meets all requirements.

This Technician Product Training booklet introduces the DOHC engine to you, the Service Technician. It includes all you need to know about its design features, the operation of its systems and its service requirements.

The final sections provide a line-up of the special service tools required for repair operations and useful technical data including torque specifications.

Please note that this booklet has been prepared solely for training purposes and that an updating service is not provided.
It is therefore essential that the appropriate workshop literature is referred to when carrying out service or repair work.

Service Training Programmes

D-P/GK-T-1

February 1989

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Chapter Page

1. General Information

The DOHC engine is a completely newly-developed 4-cylinder in-line engine with twin overhead camshafts and aluminium cylinder head. Four variants are available.

N8A/N8B: carburettor versions, without exhaust emission control (EURONORM 15.04)

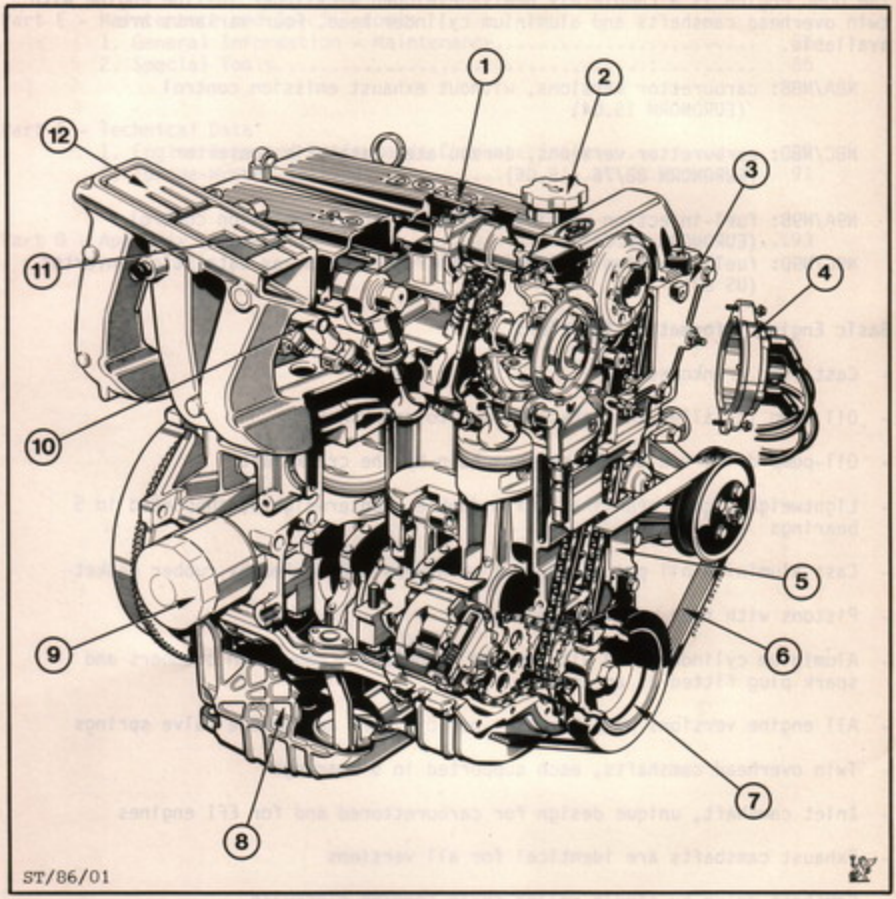
N8C/N8D: carburettor versions, unregulated catalytic converter (EURONORM 88/76 (15.05)

N9A/N9B: fuel-injection versions, without exhaust emission control (EURONORM 15.04)
N9C/N9D: fuel-injection versions, with regulated 3-way catalytic converter (US 83)

Basic Engine Information in Brief:

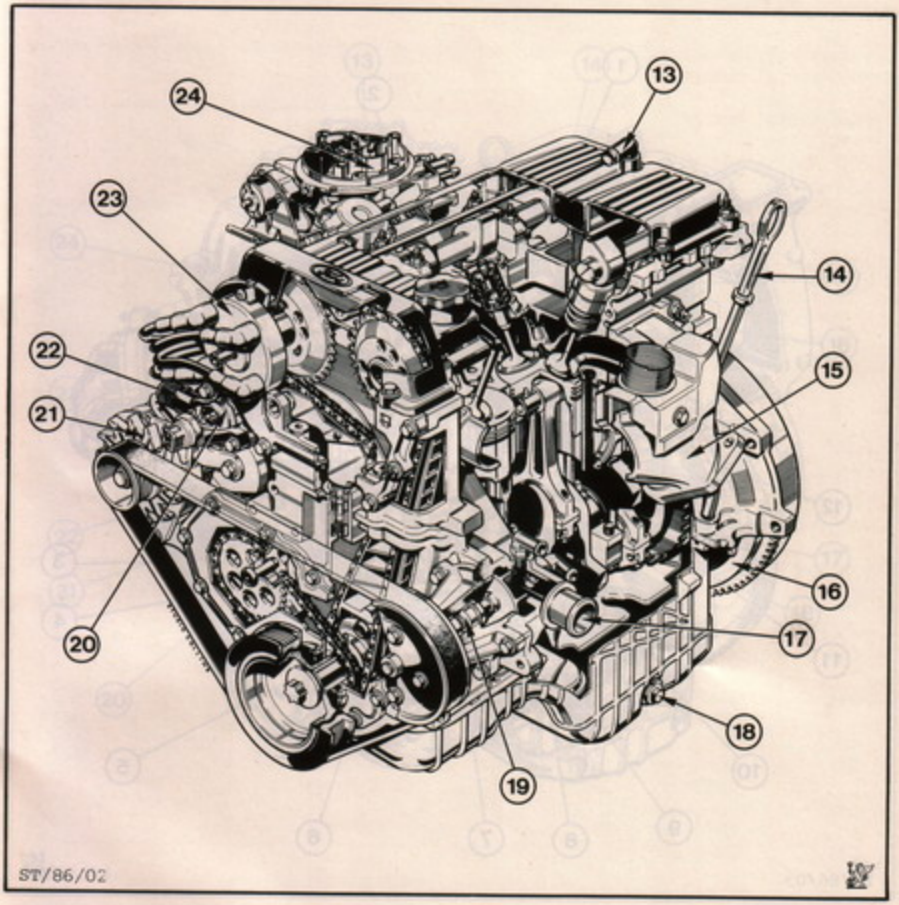
- Cast-iron crankcase
- Oil pump installed in crankcase next to crankshaft
- Oil-pump drive via single roller-chain by the crankshaft
- Lightweight, cast crankshaft with double counterweights; supported in 5 bearings
- Cast aluminium oil pan, stiffened with webs and sealed by rubber gasket
- Pistons with four machined recesses
- Aluminium cylinder head with forced turbulence combustion chambers and spark plug fitted at an angle.
- All engine versions have 2 valves per cylinder and double valve springs
- Twin overhead camshafts, each supported in 5 bearings
- Inlet camshaft, unique design for carburettored and for EFI engines
- Exhaust camshafts are identical for all versions
- Camshaft drive by single roller-chain turning clockwise
- HT-ignition distributor driven directly by inlet camshaft
- Plastic valve cover with special rubber gasket for improved sound deadening.
- Auxiliary equipment driven by belt (water pump, alternator, air-conditioning, power steering pump)
- Plastic timing chain cover sealed by rubber gasket

2. Exterior Features of the Engine



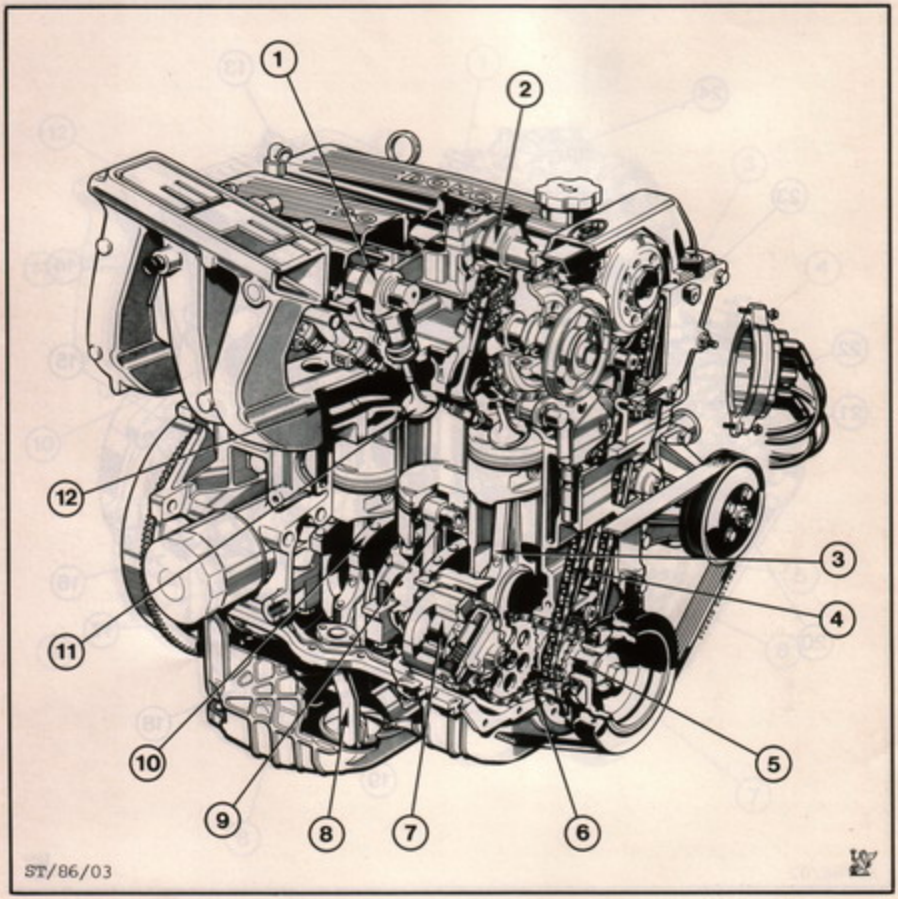
DOHC Engine (EFI versions)
1 = Valve cover, plastic
2 = Oil filler cap
3 = Timing-chain housing cover, upper part, plastic
4 = Distributor cap
5 = Timing-chain housing cover, lower part, plastic
6 = Poly - V - belt
7 = Crankshaft pulley with rubber type damper
8 = Aluminium oil pan, reinforced with ribs
9 = Oil filter
10 = Fuel rail
11 = Connection, crankcase ventilation
12 = Intake manifold

2. Exterior Features of the Engine (cont'd)



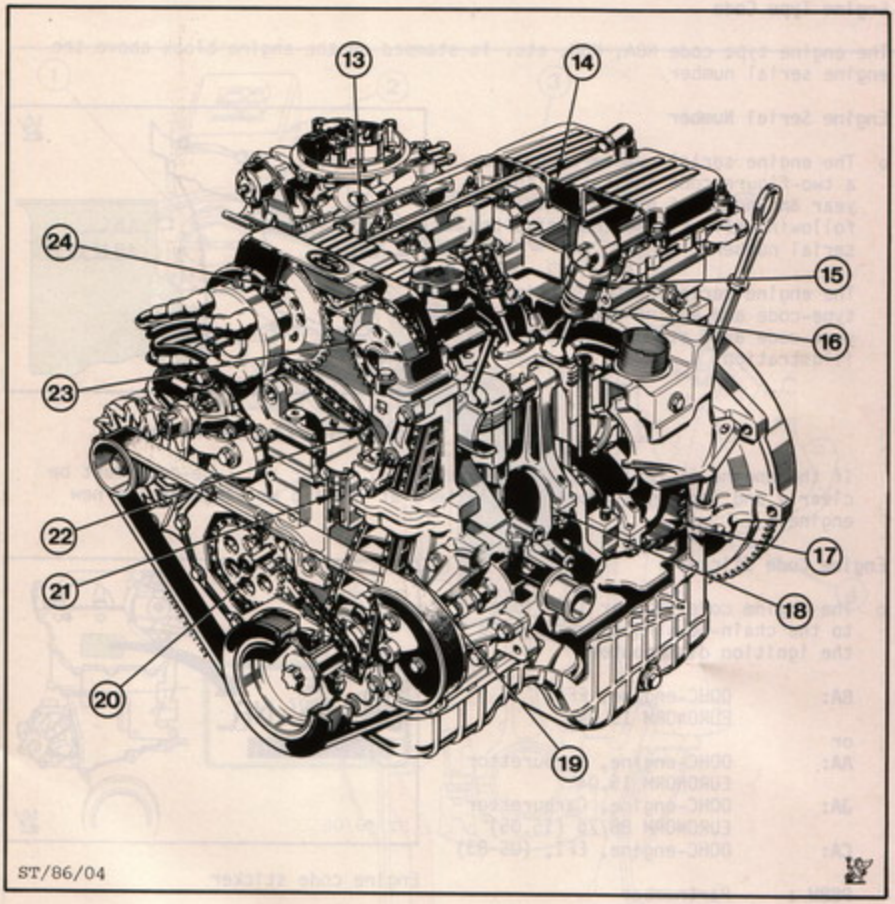
DOHC engine (carburettor versions)
13 = Connection, valve cover ventilation
14 = Oil dipstick
15 = Exhaust manifold
16 = Flywheel
17 = Coolant hose connecion
18 = Oil drain-plug
19 = Water pump
20 = Coolant temperature sensor
21 = Alternator
22 = Coolant hose connection
23 = HT-Ignition distributor
24 = Carburettor

3. Interior Features of the Engine



DOHC Engine (EFI versions)
1 = Inlet camshaft, unique design for carburettored and for EFI-engines
2 = Exhaust camshaft, identical for all engine versions
3 = Oil spray bores in connecting rods
4 = Timing chain for inlet and exhaust camshaft
5 = Double drive-sprocket, inner sprocket for timing chain, outer for oil pump
6 = Drive chain for oil pump, mechanical chain tensioner
7 = Oil pump with integral oil press. relief valve (360-450 kPa)(3.6-4.5 bar)
8 = Oil suction pipe with strainer
9 = Piston pins, interference fit in connecting rods
10 = Crankshaft with double counterweights
11 = Valve-seat, sintered steel
12 = Inlet channel

3. Interior Features of the Engine (cont'd)



DOHC Engine (carburettor versions)
13 = Oil spraytube for lubrication of inlet and exhaust camshaft
14 = Oil separation channel
15 = Hydraulic tappets
16 = Double valve springs
17 = Toothed wheel for crank position sensor. CPS-sensor located at right rear side of crankcase
18 = Connecting rod bolts, Torx-type
19 = Chain guide slipper; polyamide
20 = Drive sprocket for oil pump
21 = Hydraulic plunger for chain tensioner
22 = Timing-chain tensioner with polyamide sprocket
23 = Camshaft drive sprocket, exhaust side
24 = Camshaft drive sprocket, inlet side

4. Engine Identification

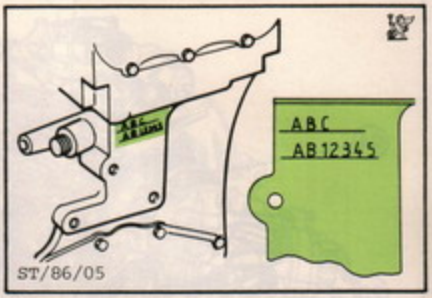
Engine Type Code

The engine type code N8A, N8B, etc. is stamped on the engine block above the engine serial number.

Engine Serial Number

o The engine serial number comprises a two-figure code indicating the year and month of production. The following five figures comprise the serial number.

The engine serial number, engine type-code and engine production-year-code are, stamped numbers (see illustration)



Engine type code/serial number

If the engine is replaced, the engine serial number and type-code must be clearly and legibly stamped with letters at least 6 mm large on the new engine.

Engine Code Sticker

o The engine code sticker is affixed to the chain-housing cover next to the ignition distributor.

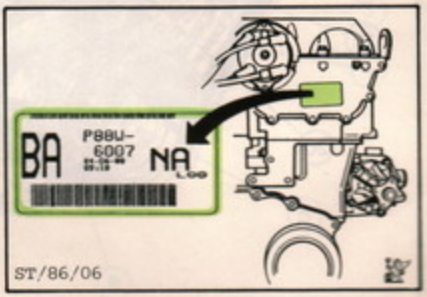
BA: DOHC-engine, EFI, EURONORM 15.04.

or

AA: DOHC-engine, Carburettor EURONORM 15.04

JA: DOHC-engine, Carburettor EURONORM 88/76 (15.05)

CA: DOHC-engine, EFI, (US 83)



Engine code sticker

P88W-: Partnumber
6007: Basic number

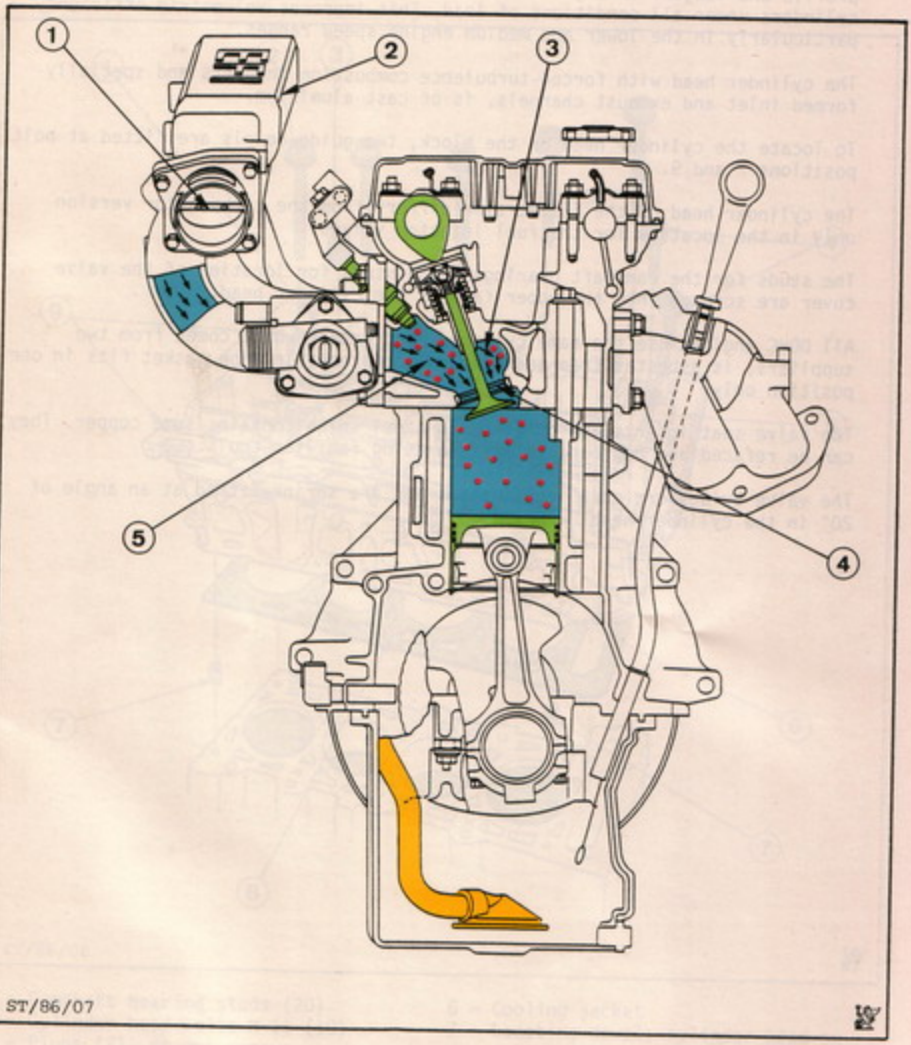
NA: Oil pan type
00: Spacer shim size (1 to 4) to adjust oil pan to different transmissions.

L: left-hand drive installation
or
R: right-hand drive installation

24-06-88: Date of engine production
09:19: Time of engine production

1. Cylinder Head and Valve Train

Air Inlet System



1 = Throttle plate
2 = Intake manifold (EFI version)
3 = Narrowed section between injector and inlet valve to produce swirl
4 = Valve seat insert
5 = Inlet channel

1. Cylinder Head and Valve Train (cont'd)

o On the cylinder head for EFI engines the four inlet channels differ in profile and length. This guarantees a steady and uniform supply to all cylinders under all conditions of load. This improves volumetric efficiency particularly in the lower and medium engine speed ranges.

The cylinder head with forced-turbulence combustion chambers and specially-formed inlet and exhaust channels, is of cast aluminium.

To locate the cylinder head on the block, two guide dowels are fitted at bolt positions 7 and 9.

The cylinder head of the EFI version differs from the carburettor version only in the location for the fuel injector valves.

The studs for the camshaft bearings and 4 studs for location of the valve cover are screwed into the upper face of the cylinder head.

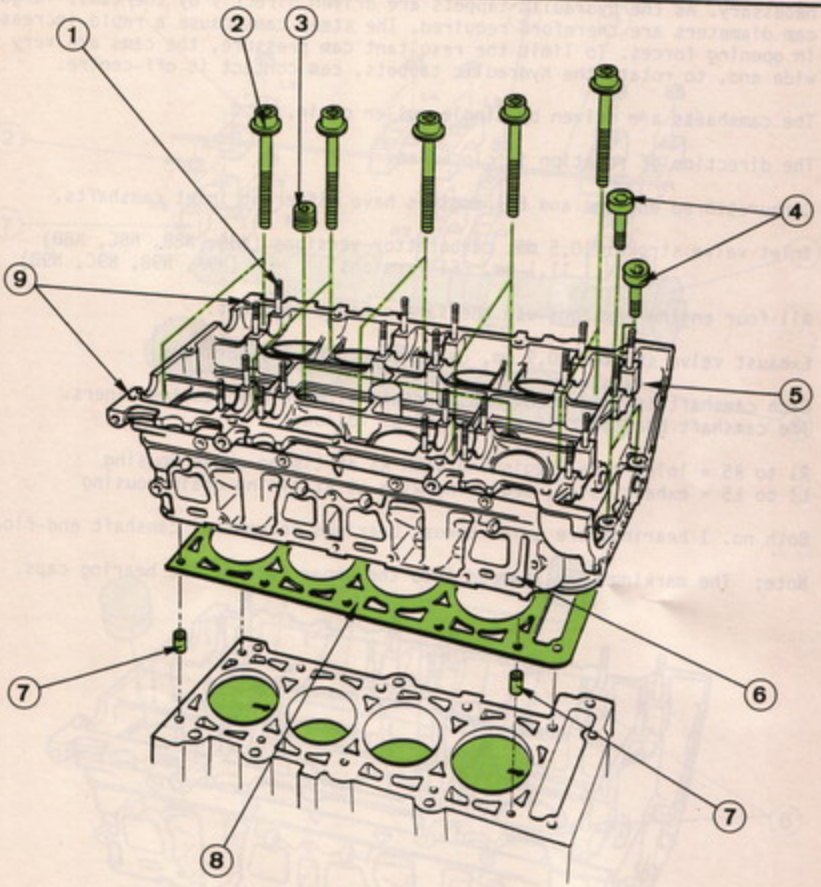
All DOHC engines use the same cylinder head gasket which comes from two suppliers, is asbestos-free and nearly incompressible. The gasket fits in one position only.

The valve seat inserts are of sintered steel which contains some copper. They can be refaced and reground in Service using familiar tools.

The valve guides are cast iron inserts and are shrink-fitted at an angle of 20° in the cylinder head.

1. Cylinder Head and Valve Train (cont'd)

Cylinder Head



1 = Camshaft bearing studs (20)
2 = Cylinder head bolts M 11 (10)
3 = Plugs (2)- do not remove
4 = Cylinder head bolts M 8 (3)
5 = Timing chain housing
6 = Cooling jacket
7 = Locating dowel, cylinder head on cylinder block
8 = Cylinder head gasket
9 = Locating studs for valve cover

1. Cylinder Head and Valve Train (cont'd)

Camshafts

o Because of the shape of the combustion chambers long valve strokes are necessary. As the hydraulic tappets are driven directly by the cams, large cam diameters are therefore required. The steep cams cause a rapid increase in opening forces. To limit the resultant cam pressure, the cams are very wide and, to rotate the hydraulic tappets, cam contact is off-centre.

The camshafts are driven by single roller chain.

The direction of rotation is clockwise.

Carburettored engines and EFI engines have different inlet camshafts.

Inlet valve stroke: 10,5 mm, carburettor versions (N8A, N8B, N8C, N8D)
11,1 mm, EFI versions (N9A, N9B, N9C, N9D)

All four engine versions use the same exhaust camshaft.

Exhaust valve stroke: 10,9 mm, carburettor and EFI versions

Each camshaft is supported in 5 bearings without any bearing liners.
The camshaft bearing caps are marked as follows:

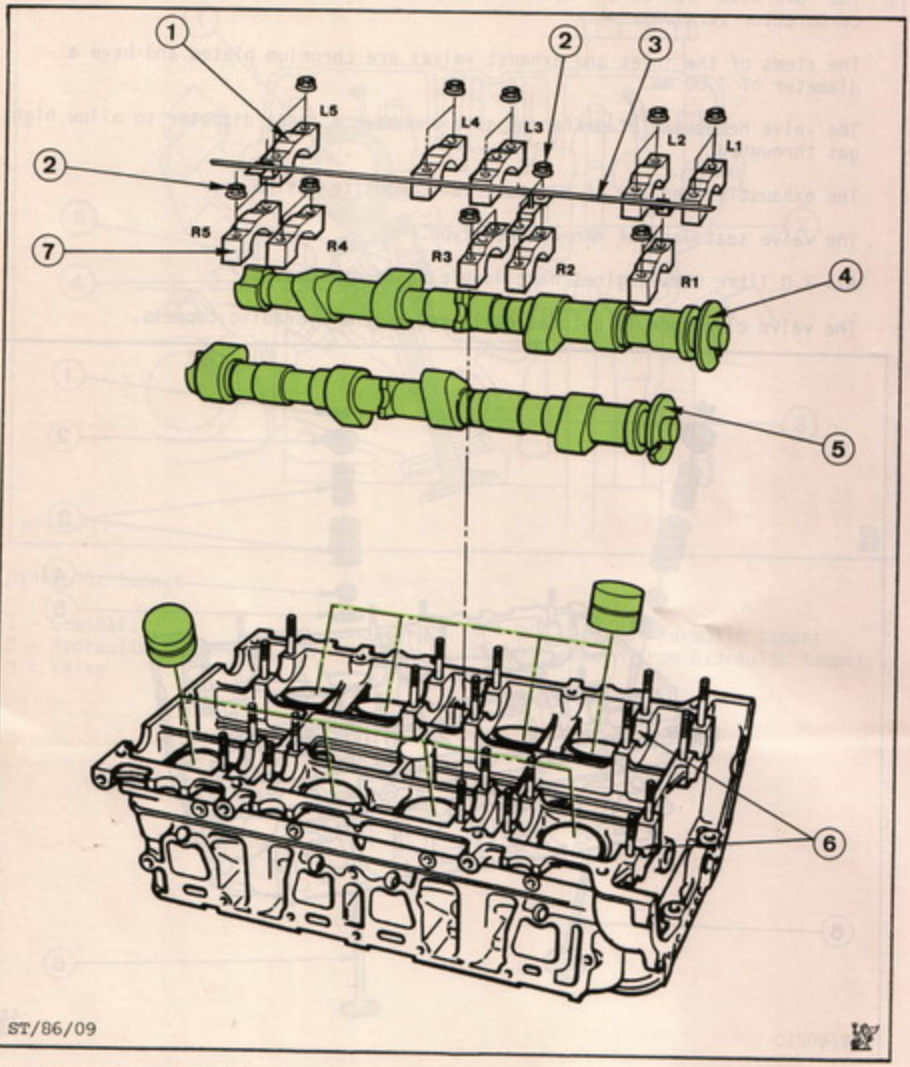
R1 to R5 = inlet side, beginning with R1 at timing-chain housing
L1 to L5 = exhaust side, beginning with L1 at timing-chain housing

Both no. 1 bearings are axial thrust bearings to control camshaft end-float.

Note: The markings are stamped into the upper face of the bearing caps.

1. Cylinder Head and Valve Train (cont'd)

Camshafts



1 = Bearing cap/exhaust side
2 = Fastening nut M 8 (20)
3 = Oil spray tube
4 = Exhaust camshaft
5 = Inlet camshaft
6 = Camshaft bearing/cylinder head
7 = Bearing cap/inlet side

1. Cylinder Head and Valve Train (cont'd)

Valves and Hydraulic Tappets

o The "overhead" valves are symmetrically arranged at an angle of 20° (EFI and carburettor version).

The stems of the inlet and exhaust valves are chromium plated and have a diameter of 7,00 mm.

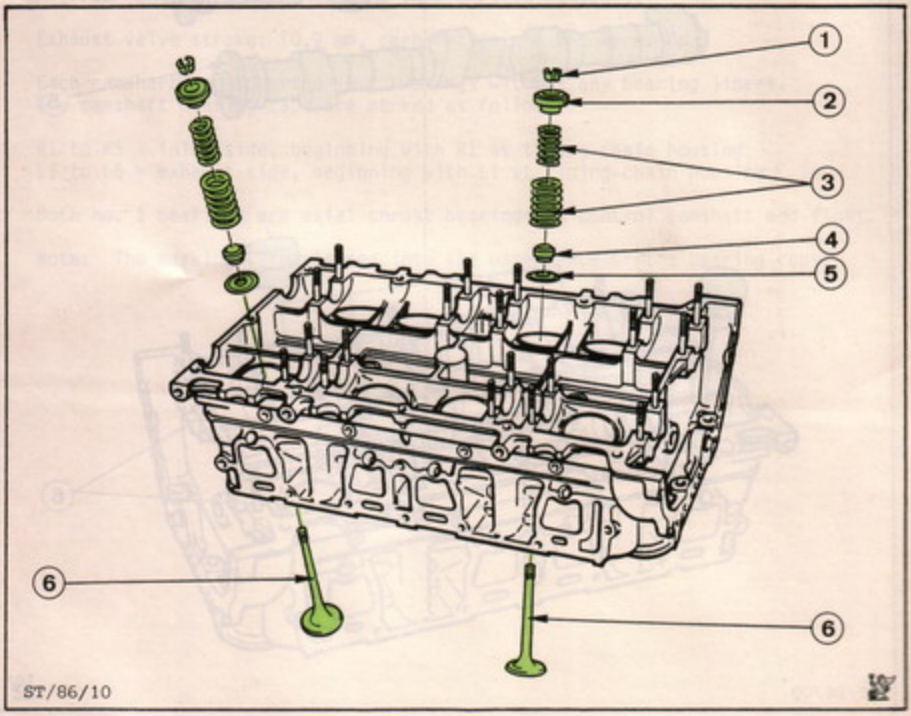
The valve heads are of different size and have a large diameter to allow high gas throughput.

The exhaust valves are of two-material composite design.

The valve seats are of non-armored type.

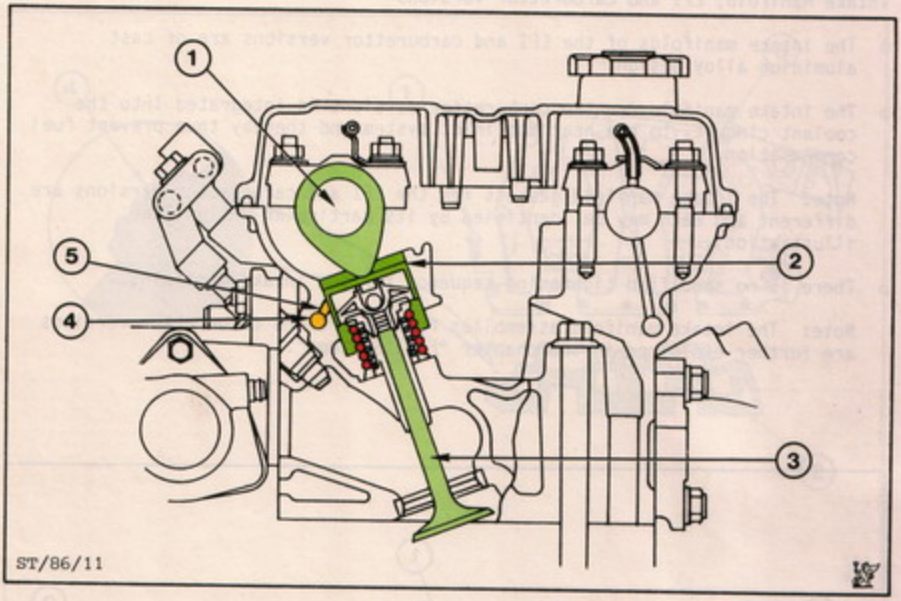
All 2.0 litre DOHC engines have double valve springs.

The valve clearance is automatically set by the hydraulic tappets.



1 = Valve collects secured and rotating in three ring grooves
2 = Valve spring retainer
3 = Double valve spring
4 = Valve stem seal
5 = Washer
6 = Valve

1. Cylinder Head and Valve Train (cont'd)



Hydraulic tappet

1 = Camshaft
2 = Hydraulic tappet
3 = Valve
4 = Oil feed to hydraulic tappet
5 = Oil return from hydraulic tappet

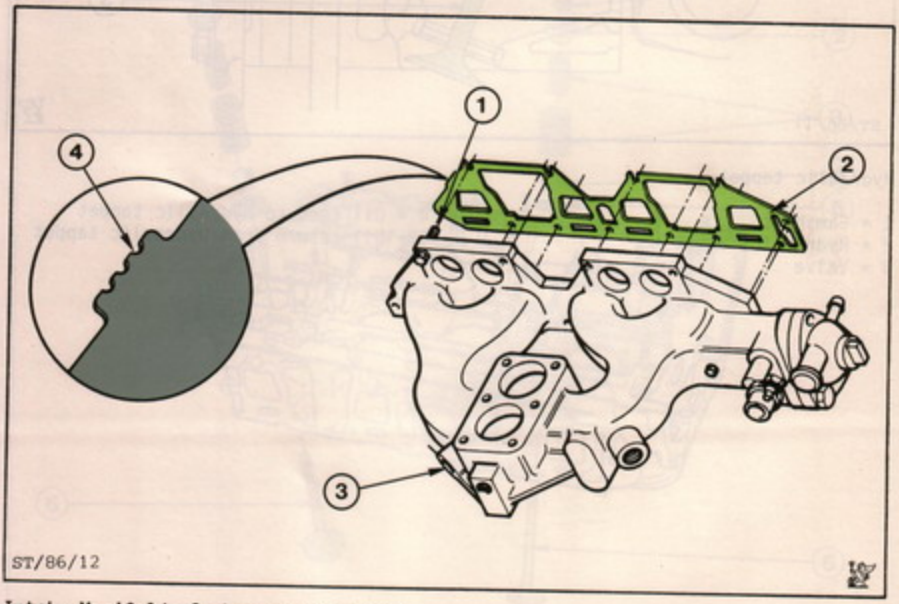
2. Cylinder Head Assemblies and Components

Intake Manifold; EFI and Carburettor Versions

- The intake manifolds of the EFI and carburettor versions are of cast aluminium alloy design.
- The intake manifold for the carburettor versions is integrated into the coolant circuit, to pre-heat the inlet system and thereby thus prevent fuel condensation.

  Note: The intake manifold gaskets for the EFI and carburettor versions are different and each may be identified by its particular design (see illustration).
- There is no specified tightening sequence for the intake manifolds.

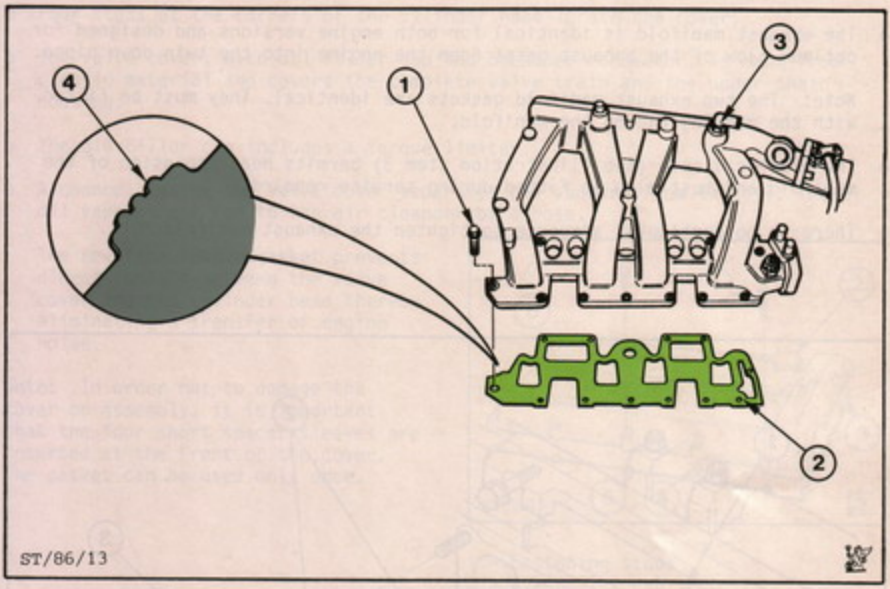
  Note: The intake manifold assemblies for the EFI and carburettor versions are further explained in the chapter "Fuel Systems".



Intake Manifold, Carburettor Versions

1 = Studs
2 = Gasket
3 = Crankcase ventilation connection
4 = Gasket identification marks for carburettor version

2. Cylinder Head and Components (cont'd)



Intake manifold EFI

1 = Studs
2 = Gasket
3 = Crankcase ventilation connection
4 = Gasket identification marks - EFI version

2. Cylinder Head and Components (cont'd)

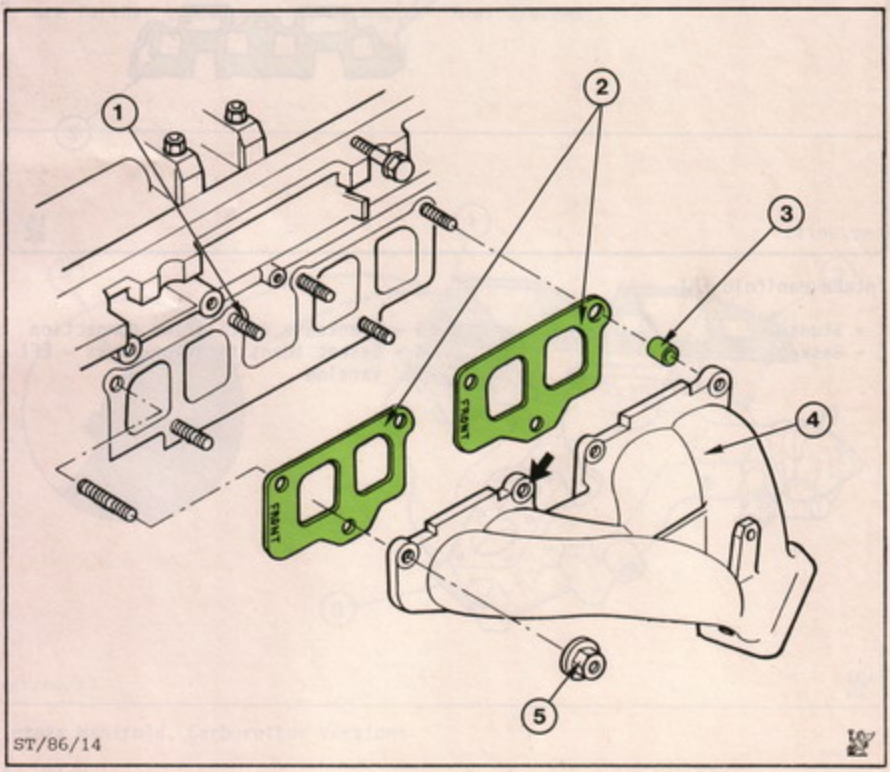
Exhaust Manifold

- The exhaust manifold is identical for both engine versions and designed for optimum flow of the exhaust gases from the engine into the twin down pipes.

  Note: The two exhaust manifold gaskets are identical. They must be fitted with the marking facing the manifold.

- The plastic sleeve (see illustration item 3) permits heat expansion of the manifold and must also be fitted during service repairs.

- There is no particular sequence to tighten the exhaust manifold nuts.



1 = Fastening studs
2 = Gasket
3 = Plastic sleeve
4 = Exhaust manifold
5 = Flange nut

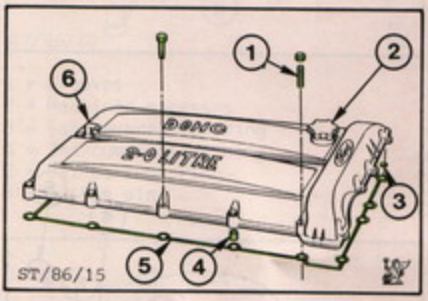
2. Cylinder Head and Components (cont'd)

Valve Cover

- Four studs at the corners of the cylinder head locate the cover.
- The valve cover, with oil filler cap and breather connector, is made from plastic material and covers the complete valve train and the upper chain housing.
- The oil filler cap includes a torque limiter.
- A channel inside the valve cover separates oil vapours from the oil. These oil vapours are fed to the air cleander by a hose.

The new type rubber gasket prevents direct contact between the valve cover and the cylinder head thereby eliminating a transfer of engine noise.

Note: In order not to damage the cover on assembly, it is important that the four short spacer sleeves are inserted at the front of the cover. The gasket can be used only once.



1 = Fastening studs
2 = Oil-filler cap
3 = Spacer sleeves, short (4)
4 = Spacer sleeves, long (11)
5 = Rubber gasket
6 = Connection, breather pipe

Chain Housing Cover, Upper Part

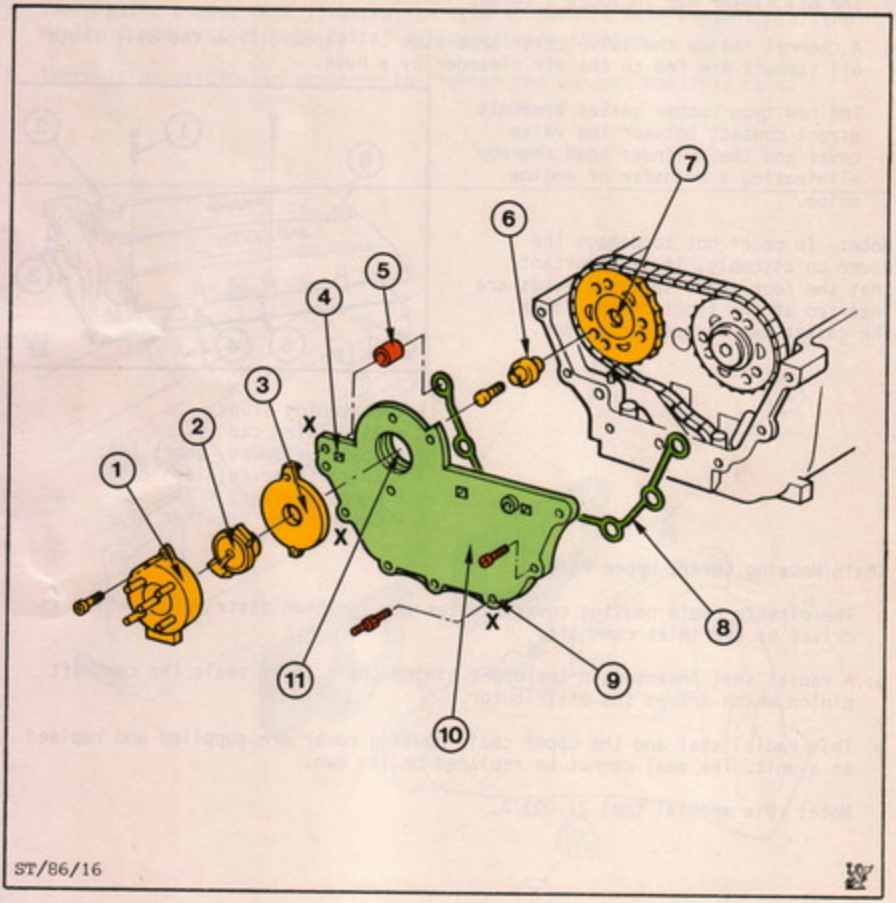
- The plastic chain housing cover carries the ignition distributor, which is driven by the inlet camshaft.
- A radial seal inserted in the upper timing chain cover seals the camshaft pinion which drives the distributor.
- This radial seal and the upper chain housing cover are supplied and replaed as a unit. The seal cannot be replaced on its own.

Note: Use special tool 21-093 A.

2. Cylinder Head and Components (cont'd)

o The lower part of the distributor is attached and centered on the chain housing cover.

Note: When installing the chain housing cover, take care that the top edge of the cover is level with the upper face of the cylinder head (max. tol. ± 0.13 mm).



1 = Distributor cap
2 = Distributor rotor
3 = Distributor lower part
4 = Insert, valve cover fastening
5 = Spacer sleeve
6 = Drive pinion
7 = Inlet camshaft
8 = Gasket
9 = Installation position "X", for the stud
10 = Chain housing cover
11 = Radial seal

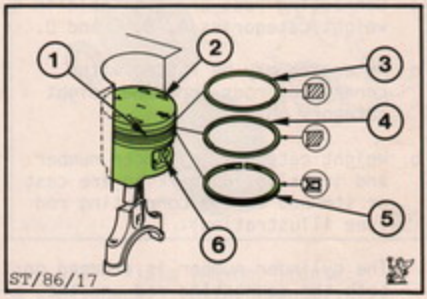
3. Crankcase Components

Pistons

o The pistons are manufactured from a light-metal alloy and have a standart diameter of 86.00 mm. They are cooled and lubricated from below with oil from spray jets in the connecting rods. Pistons are supplied from two sources (KS and HG).

The pistons crown has four machined recesses.
Three piston rings are fitted
- 1st compression ring (cambered)
- 2nd compression ring (tapered)
- Oil scraper ring (in 3 parts with expander spring)

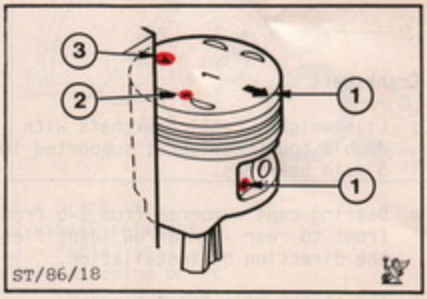
KS-pistons have 6 oil drain holes
HG-pistons have oil drain slots



1 = Grooves
2 = Machined recesses
3 = 1st compression ring
4 = 2nd compression ring
5 = Oil control ring
6 = Piston pin

Note: Extreme care must be taken in particular with the 1st compression ring.

o The arrow on the piston crown must point to the front of the engine. An additional marking is located to the left of the piston pin bore (see illustration).



1 = Installation markings
2 = Piston weight identification
3 = Piston size identification

Connecting Rods

o The connecting rod bolts are Torx-bolts with integrated washer. The letter "F" on the face of the connecting rod (see above illustration) should face to the front of the engine.

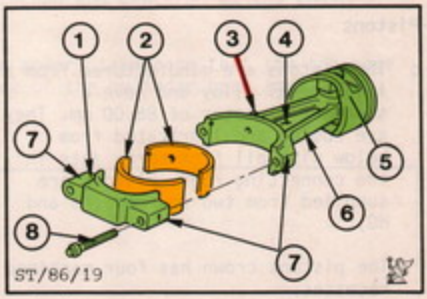
Note: Connecting rod bolts must not be re-used.

o An oil spray bore in the connecting rd sprays oil into the piston. This lubricates the piston and at the same time affects cooling of the piston crown.

3. Crankcase Components (cont'd)

- Connecting rods are available in 4 weight categories A, B, C and D.
- An engine may be fitted with connecting rods from **one** weight category only.
- Weight category, cylinder number and installation marking are cast or stamped on the connecting rod (see illustration).

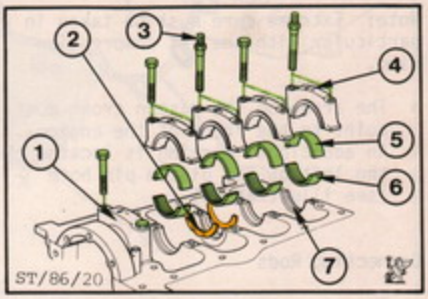
  The cylinder number is stamped on both the connecting rod and the connecting rod cap.



1 = Connecting rod cap
2 = Bearing liner, with oil bore
3 = Spray-bore
4 = "F" must point to front of engine
5 = Piston pin
6 = Connecting rod
7 = Connecting rod identification
  a) Cylinder number
  b) Weight grade
8 = Torx-bolt

Crankshaft

- Lightweight, cast crankshaft with double counterweights; supported in 5 main bearings.
- Bearing caps numbered from 1-5 from front to rear - an arrow identifies the direction of installation.
- The sensor ring for the crank position sensor CPS is rivitted to the counter weight next to bearing 5.
- Main bearings liners
  - with oil grooves in the engine block
  - without oil grooves in the bearing cap.
- Crankshaft endfloat controlled by two half thrust washers at the centre main bearing.

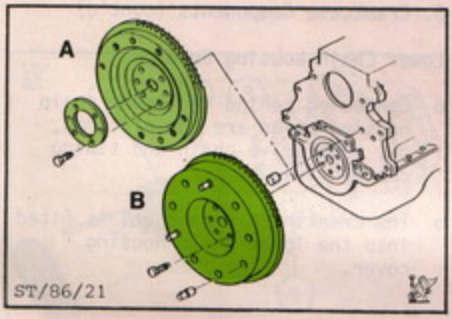


1 = Bearing cap
2 = Thrust washer
3 = Oil baffle attachment
4 = Installation markings
5 = Bearing liner without oil groove
6 = Bearing liner with oil groove
7 = Bearing seat, crankcase

3. Crankcase Components (cont'd)

Flywheel/Torque Converter Mounting Plate

- The flywheel can only be mounted in one position as the six bolts are arranged in unequal radial intervals.

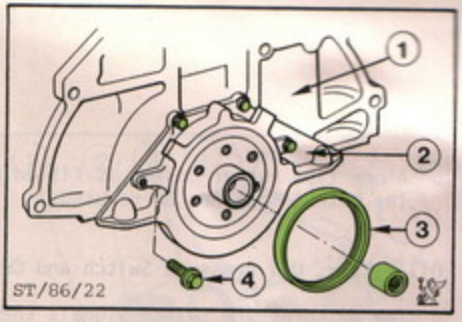


A = Drive Plate (Autom. Transm.)
B = Flywheel (Man. Transm.)

Crankshaft, Radial Oil-Seal, Rear

- The crankshaft rear seal is installed in a retainer which is bolted to the crankcase.

Note: Use special tool 21-096 to remove, 21-141 to install.

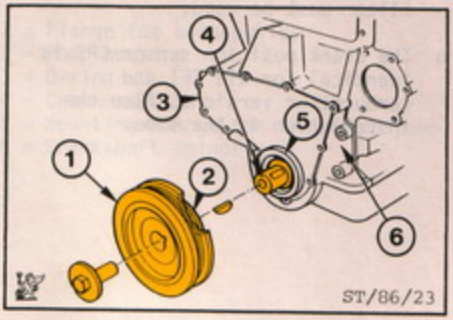


1 = Crankcase
2 = Seal retainer
3 = Radial seal
4 = Fastening bolts

Crankshaft, Radial Oil-Seal, Front

- The crankshaft front seal and the lower timing chain cover are supplied as a unit. The seal cannot be replaced individually.

Note: Use the crankshaft damper/pulley to center the seal and align the cover.

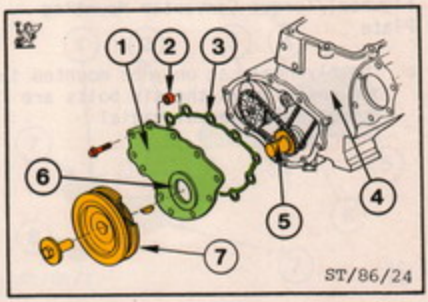


1 = Crankshaft damper/pulley
2 = Baffle
3 = Lower chain housing
4 = Crankshaft spigot
5 = Radial seal
6 = Crankcase

3. Crankcase Components (cont'd)

Lower Chain-housing Cover

- Concealed behind the lower chain housing cover are the oil pump, oil pump drive-chain and timing chain drive.
- The crankshaft front seal is fited into the lower chain housing cover.

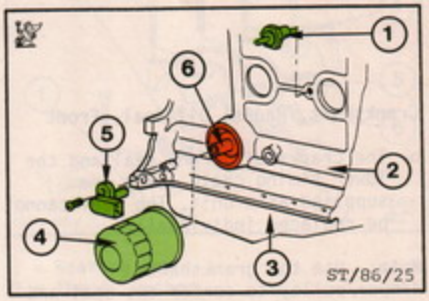


1 = Chain-housing cover
2 = Spacer sleeves
3 = Rubber gasket
4 = Crankcase
5 = Crankshaft spigot
6 = Radial seal location
7 = Crankshaft damper

- A new type rubber gasket is fitted between the lower cover and the crankcase. The gasket must not be re-used.

Oil Filter, Oil Pressure Switch and Crank Position-Sensor CPS

- The oil-pressure switch signals the warning light when the oil pressure drops below 30 to 50 kPa (0.3 to 0.5 bar).
- The "Motorcraft Super EFL 90" oil filter must be used.
- The crank position sensor CPS is identical for all EFI and carburettor versions. Also the installation is the same.



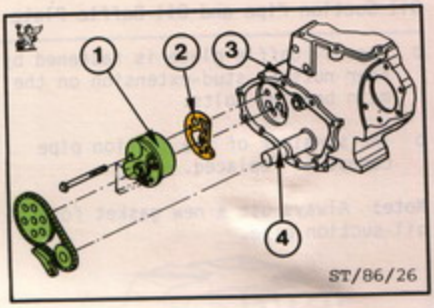
1 = Oil pressure switch
2 = Crankcase
3 = Oil pan
4 = Oil filter with gasket
5 = Crank position sensor CPS
6 = Adapter for oil filter

3. Crankcase Components (cont'd)

Oil Pump

- The rotor type oil pump is fitted from the front into the crankcase. An integral relief valve opens to a by-pass at 360 to 450 kPa (3,6 - 4,5 bar).
- The oil pump is chain driven by the crankshaft.
- The single roller-chain is tensioned by a mechanical chain tensioner.

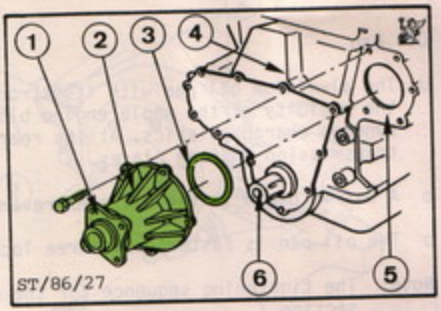
Note: Always use a new oil pump flange gasket.



1 = Oil pump
2 = Paper gasket
3 = Crankcase
4 = Crankshaft spigot

Water Pump

- The impeller type water pump is flanged to the front of the crankcase.
- The coolant pump is belt-driven from the crankshaft belt-pulley.



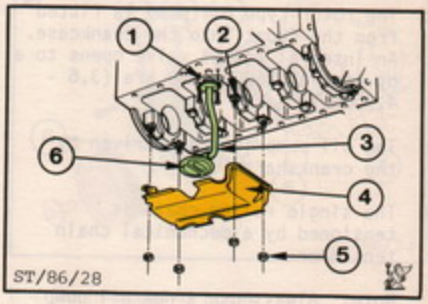
1 = Flange for belt-pulley
2 = Pump housing
3 = O-ring
4 = Crankcase
5 = Mounting flange for the water pump
6 = Crankshaft spigot

3. Crankcase Components (cont'd)

Oil Suction Pipe and Oil Baffle Plate

- The oil baffle plate is fastened by four nuts to stud-extension on the main bearing bolts.
- The strainer of the suction pipe cannot be replaced.

Note: Always use a new gasket for the oil suction pipe.



1 = Paper gasket
2 = Main bearing bolts
3 = Oil suction pipe
4 = Oil baffle plate
5 = Fastening nut
6 = Strainer

Oil Pan

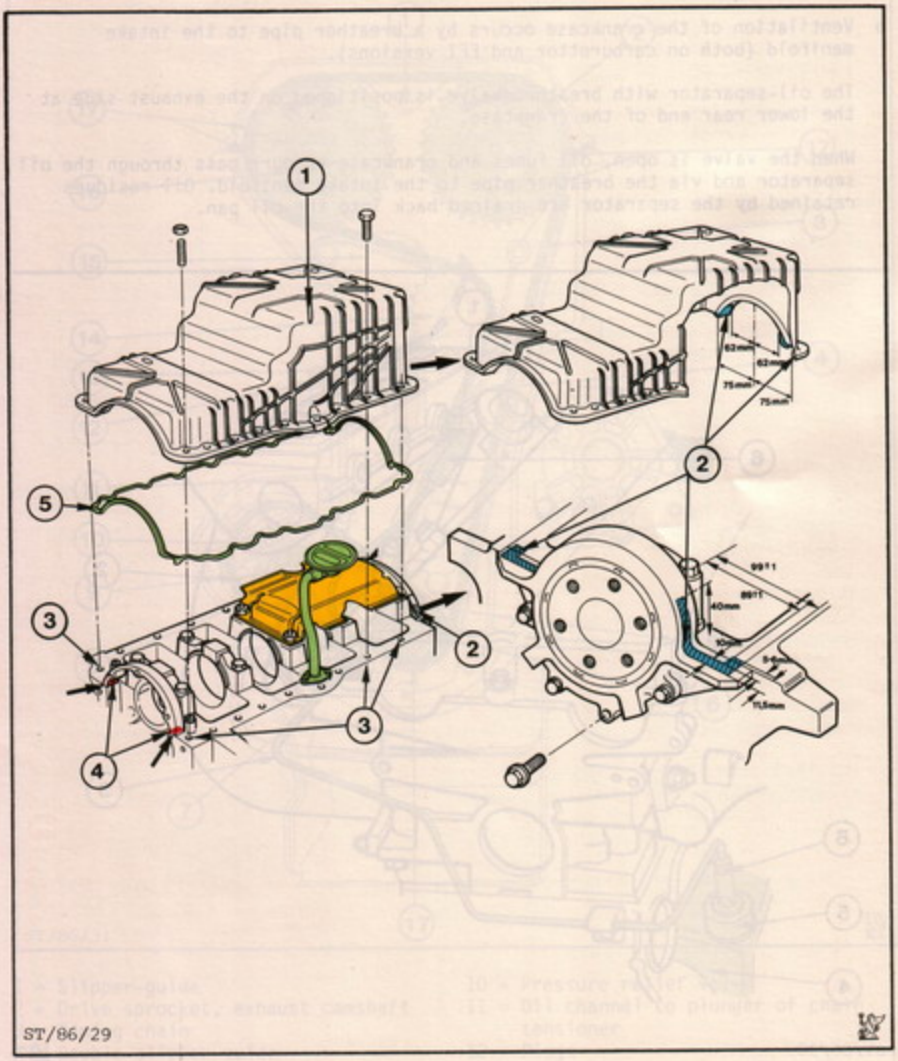
- The aluminium oil pan with its strong reinforcing ribs adds considerably to the rigidity of the whole engine block and increases the engine's smooth-running characteristics. At its rear end the oil pan is bolted to the transmission in four places.
- A baffle plate in the oil pan prevents oil surge when driving.
- The oil pan is fastened by three locating studs with nuts and 15 bolts.

Note: The tightening sequence for the nut and bolts is detailed in Part B, section 7.

- The rubber type oil pan gasket must not be re-used.

Note: In addition, Hylosil 102 sealing compound should be applied evenly to the oil pan and to the oil seal carrier in the areas shown in the following diagram. This sealer also acts as a slip-agent and eases correct assembling.

3. Crankcase Components (cont'd)



1 = Oil pan (aluminium)
2 = Additional sealer - flywheel end
3 = Position of locating studs
4 = Additional sealer - front end
5 = Gasket-preshaped

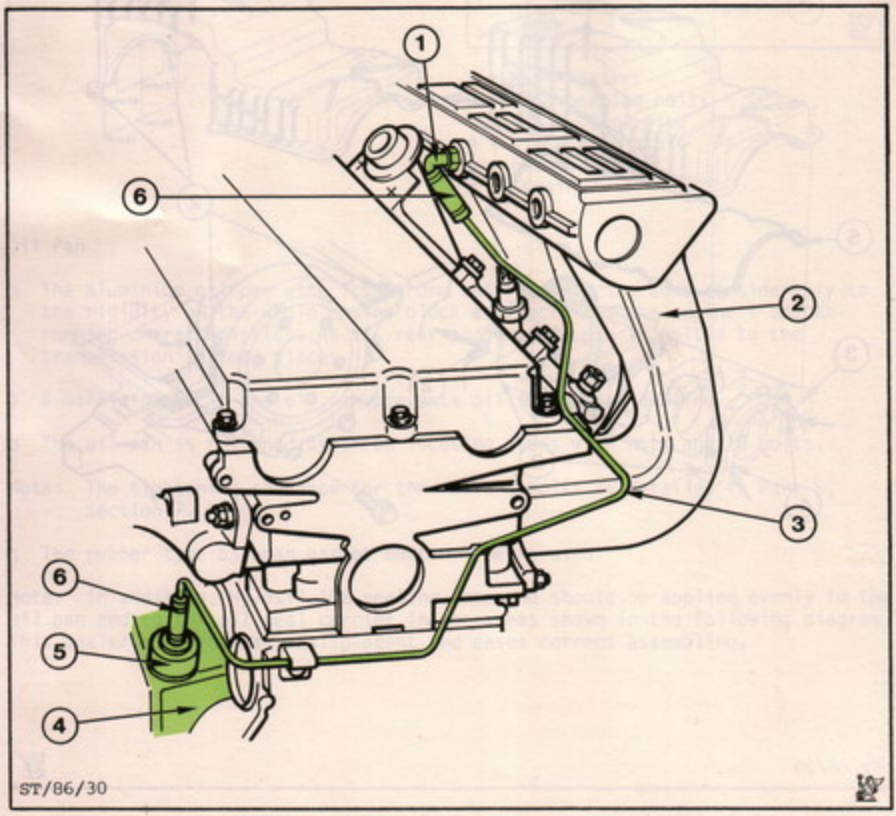
3. Crankcase Components (cont'd)

Crankcase Ventilation

o Ventilation of the crankcase occurs by a breather pipe to the intake manifold (both on carburettor and EFI versions).

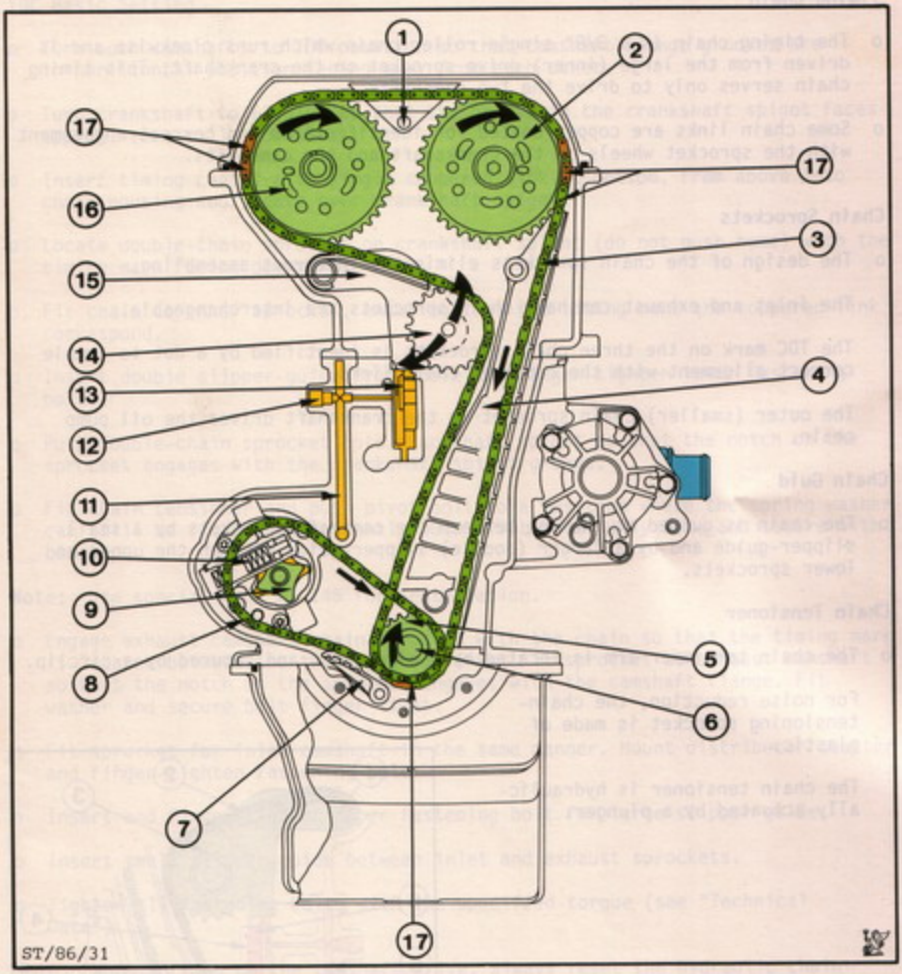
The oil-separator with breather valve is positioned on the exhaust side at the lower rear end of the crankcase.

When the valve is open, oil fumes and crankcase vapours pass through the oil separator and via the breather pipe to the intake manifold. Oil residues retained by the separator are drained back into the oil pan.



1 = Elbow connection
2 = Intake manifold (EFI version)
3 = Breather pipe
4 = Oil separator
5 = Breather valve
6 = Connecting hose

4. Camshaft and Oil-Pump Drive



1 = Slipper-guide
2 = Drive sprocket, exhaust camshaft
3 = Timing chain
4 = Double slipper-guide
5 = Double drive sprocket, crankshaft
6 = Crankshaft spigot
7 = Chain tensioner, oil pump drive
8 = Drive chain, oil pump
9 = Oil pump
10 = Pressure relief valve
11 = Oil channel to plunger of chain tensioner
12 = Plugs
13 = Actuating plunger-chain tensioner
14 = Chain tensioner sprocket, plastic
15 = Chain tensioner, timing chain
16 = Drive sprocket, inlet camshaft
17 = Copper coated chain link

4. Camshaft and Oil-Pump Drive (cont'd)

Timing Chain

- The timing chain is a 3/8" single roller chain which runs clockwise and is driven from the large (inner) drive sprocket on the crankshaft. This timing chain serves only to drive the two camshafts.

- Some chain links are copper coated for identification and correct engagement with the sprocket wheels on the crankshaft and the camshafts.

Chain Sprockets

- The design of the chain sprockets eliminates incorrect assembling.

  The inlet and exhaust camshaft chain sprockets are interchangeable.

  The TDC mark on the three chain sprockets is identified by a dot to enable correct alignment with the coppered chain links.

  The outer (smaller) chain sprocket on the crankshaft drives the oil pump chain.

Chain Guid

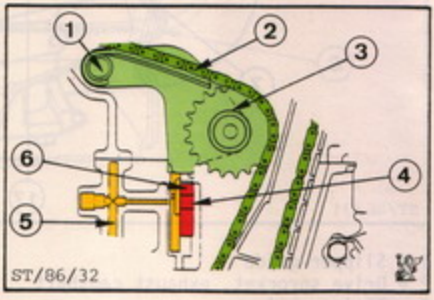
- The chain is guided at the top between the camshaft sprockets by a small slipper-guide and by a larger (double) slipper-guide between the upper and lower sprockets.

Chain Tensioner

- The chain tensioner arm is located by a pivot bolt and secured by a circlip.

  For noise reduction, the chain-tensioning sprocket is made of plastic.

  The chain tensioner is hydraulically actuated by a plunger.



1 = Pivot bolt, chain tensioner
2 = Timing chain
3 = Tensioner arm with sprocket
4 = Plunger guide
5 = Oil pressure fed to actuating plunger
6 = Actuating plunger-chain tensioner

4. Camshaft and Oil-Pump Drive (cont'd)

TDC Basic Setting

- Turn both camshafts to TDC position so that camshaft flange grooves are in horiizontal position facing away from each other.
- Turn crankshaft to 6° BTDC so that the groove in the crankshaft spigot faces approx. vertically downwards.
- Insert timing chain, with single coppered link at bottom, from above into chain housing and locate over crankshaft spigot.
- Locate double-chain sprocket on crankshaft spigot (do not push home) with the timing mark facing downwards.
- Fit chain to inner sprocket, ensuring that the timing mark and coppered link correspond.
- Insert double slipper-guide from above and finger-tighten lower fastening bolt.
- Push double-chain sprocket onto crankshaft spigot so that the notch on the sprocket engages with the crankshaft spigot groove.
- Fit chain tensioner and push pivot bolt to a position where the spring washer can still be fitted. Subsequently push pivot bolt fully home and secure with circlip.

Note: Use special tool 21-145 for installation.

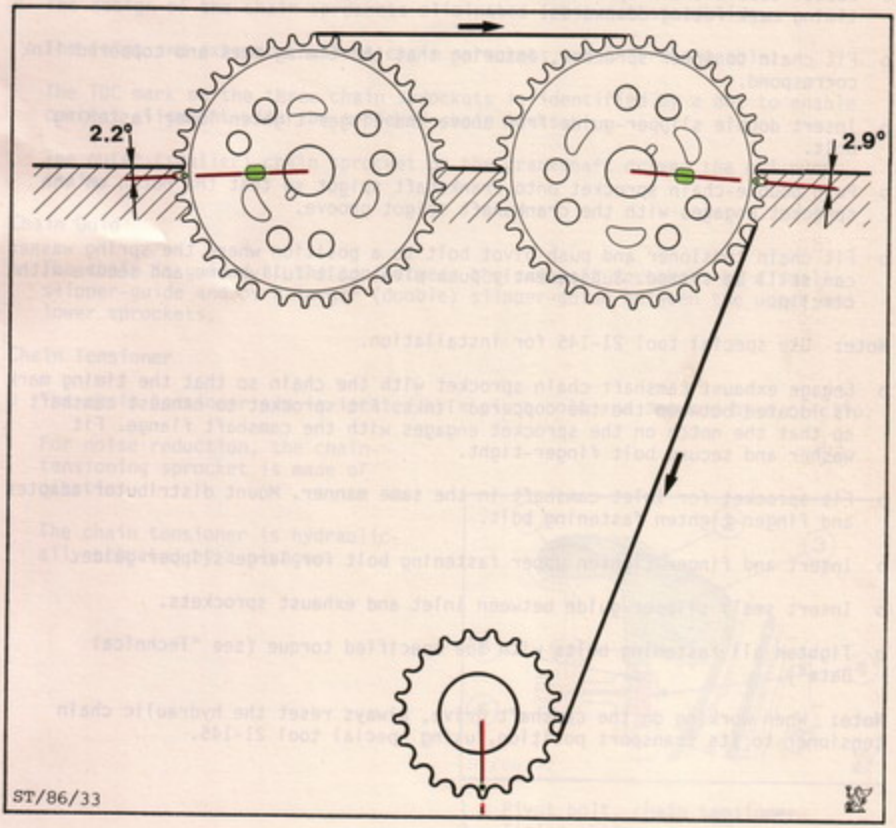
- Engage exhaust camshaft chain sprocket with the chain so that the timing mark is located between the two coppered links. Fit sprocket to exhaust camshaft so that the notch on the sprocket engages with the camshaft flange. Fit washer and secure bolt finger-tight.
- Fit sprocket for inlet camshaft in the same manner. Mount distributor adapter and finger-tighten fastening bolt.
- Insert and finger-tighten upper fastening bolt for large slipper-guide.
- Insert small slipper-guide between inlet and exhaust sprockets.
- Tighten all fastening bolts with the specified torque (see "Technical Data").

Note: When working on the camshaft drive, always reset the hydraulic chain tensioner to its transport position, using special tool 21-145.

5. Checking Valve-timing (cont'd)

o Checking or adjusting the valve-timing with reference to the position of coppered links on the marked teeth of the sprockets, as explained before is difficult on engines which have already been in operation. The following method does not require the coppered links to be observed.

- Turn the crankshaft **clockwise** to TDC for cylinder 1 (marking on belt-pulley)
- The grooves in the camshaft flanges and the corresponding notches in both sprockets should then point outwards and be in a position approximately level with the top edge of the cylinder head.

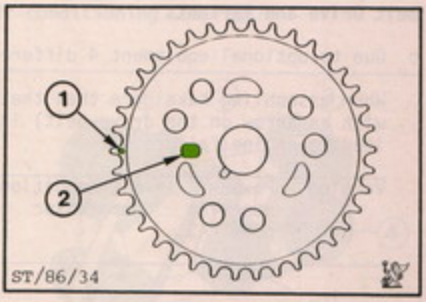


- Take care that the chain sectiones opposite the chain tensioner and between the camshaft sprockets are taut.
  If necessary hold the camshafts from rotation during the check.

5. Checking Valve-timing (cont'd)

o To be quite sure, observe which chain link is positioned approximately centrally over the top edge of cylinder head and check whether this link is on the marked tooth.

As the mark on this tooth is not visible when engaged in the chain, refer to the notch which is in line with the mark.

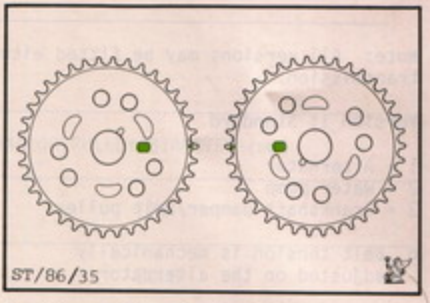


Markings on the Camshaft Sprockets

1 = Sprocket mark
2 = Sprocket notch

- Crank engine several times and repeat the check.

- As an additional check, the top dead centre of the exhaust stroke of cylinder 1 can be used. In this case the tooth markings should be exactly facing each other and be approximate by level with the cylinder head top edge.



Position of the Camshaft Sprockets

Note: Always secure and empty the chain tensioner when removing the camshaft sprockets. Reassemble tensioner using special tool 21-145.

6. Auxiliary Drives

Belt Drive and Variants

o Due to optional equipment 4 different length Poly-V-belts required.

When assembling take care that the indicated direction of rotation (marked with an arrow on the drive belt) is achieved. Incorrect installation can lead to engine failure.

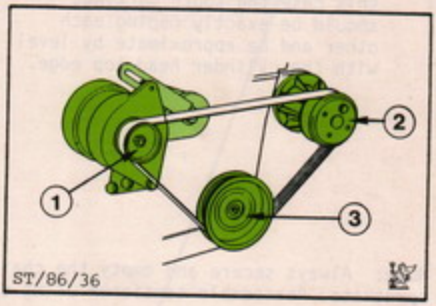
Version	Power-steering pump PAS	Air-conditioning compressor	Belt-tensioning	Number of pulleys
1			fixed with alternator	3
2	x		automatic	5
3	x	x	automatic	6

Note: All versions may be fitted either with manual or with automatic transmission.

Version 1: Standard

1 = Alternator
2 = Water pump
3 = Crankshaft damper/belt pulley

o Belt tension is mechanically adjusted on the alternator.

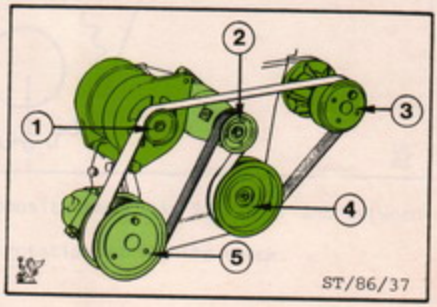


Version 1

Version 2: With Power Steering Pump, without Air-conditioning Compressor

1 = Alternator
2 = Automatic belt tensioner
3 = Water pump
4 = Crankshaft damper/belt pulley
5 = Power steering pump PAS

o Belt tension is automatically adjusted.



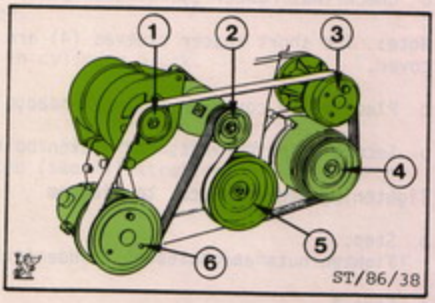
Version 2

6. Auxiliary Drives (cont'd)

Version 3: With Power Steering Pump and Air-conditioning Compressor

1 = Alternator
2 = Automatic belt tensioner
3 = Water pump
4 = Air-conditioning compressor
5 = Crankshaft damper/belt-pulley
6 = Power steering pump

o Belt tension is automatically adjusted.



Version 3

VERSION	ALTERNATOR PULLEY DIAMETER (mm)	
	Carburettor	EFI
Manual Steering	80 Ø	60 Ø
Power Steering	80 Ø	60 Ø
Air Conditioning	- . -	60 Ø

7. Tightening Procedures

Valve Cover

o Check that rubber gasket and spacer sleeves are correctly installed.

Note: The short spacer sleeves (4) are inserted at the front of the valve cover.

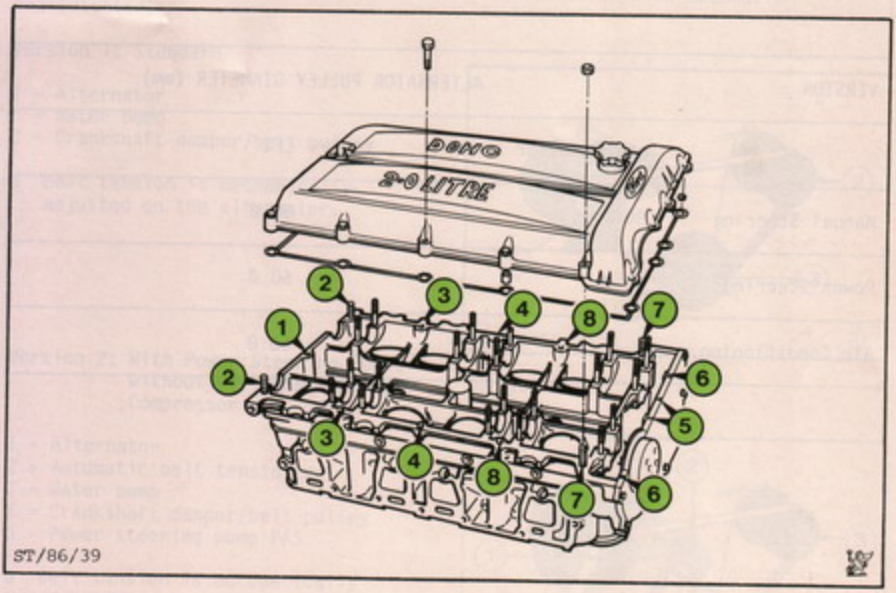
o Place valve cover on cylinder head, locating over studs.

o Secure with four nuts and eleven bolts.

Tightening Sequence acc. to Diagram

o Step. 1
Tighten nuts and bolts to torque of 1.0 - 3.0 Nm.

o Step 2
Tighten nuts and bolts to a torque of 6.0 - 8.0 Nm.



Tightening Sequence, Valve Cover

7. Tightening Procedures (cont'd)

Cylinder Head; Torque and Angle-of-Rotation Method

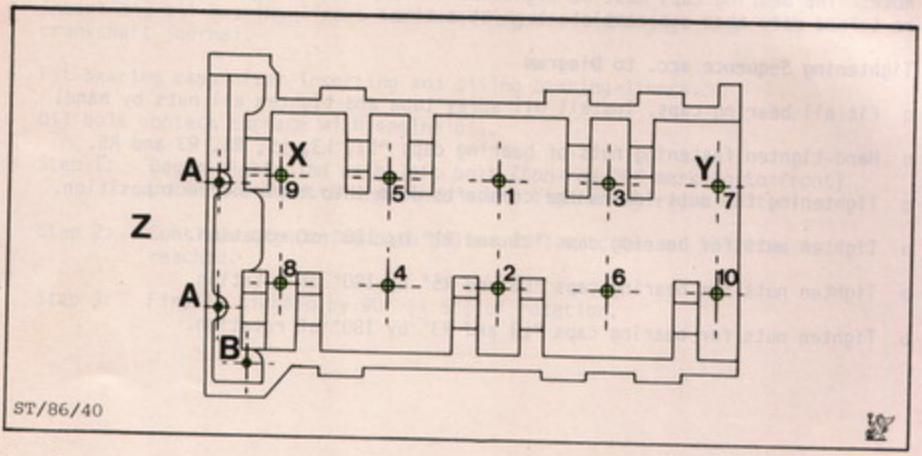
Note: Because of this procedure, cylinder head bolts must be replaced after each disassembly. They must not be re-used.

- o Insert dowels at position "X" and "Y" in cylinder block.
- o Fit cylinder head gasket and cylinder head.
- o Loosely insert ten M 11 bolts at positions "1-10" and three M 8 bolts at positions "A" and "B" and finger-tighten (see illustration).

Tightening Sequence acc. to Diagram

- o Stage 1: The M 11-bolts are tightened in three groups to a max. torque of 20 - 30 Nm.
  Step 1: Bolts 1 and 2
  Step 2: Bolts 3, 6 and 5, 4
  Step 3: Bolts 7, 10 and 8, 9
- o Stage 2: Tighten all M 11-bolts in numeric sequence (1-10) with a torque of 65 ± 5 Nm.
- o Stage 3: Tighten all M 11-bolts in numeric sequence (1-10) by 130° ± 5° of rotation.
  - Tighten the two M 8-bolts in position "A" to 24.0 - 27.0 Nm.
  - Tighten the single M 8-bolt at position "B" to 31.0 - 34.0 Nm.

Note: None of the M 8/M 11 bolts must be retightened!

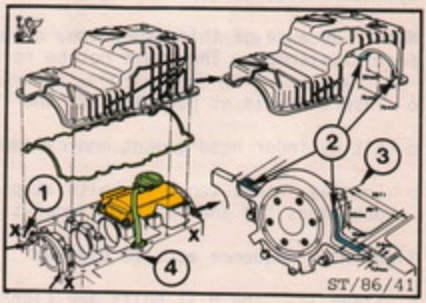


Z = Front of engine
Tightening sequence for cylinder head bolts

7. Tightening Procedures (cont'd)

Oil Pan

- o Insert the three studs at position "X" in the crankcase and tighten to a torque of 6.0 - 8.0 Nm.
- o Apply Hydrosil 102 (dimensions and location as illustrated) to crankcase at flywheel end, left and right, and on the corresponding part of the oil pan.
- o Check that rubber gasket is correctly installed.
- o Place oil pan on crankcase, locating it on the studs.



1 = Installation position "X", studs
2 = Sealer application area
3 = Axis, crankshaft
4 = Crankcase

- o Fit three nuts and 15 bolts and tighten evenly to a torque of 8.0 - 10.0 Nm.

Camshafts

Note: Turn crankshaft so that a clearance of at least 15 mm between pistons and valves is ensured.

- o The bearing caps can only be fitted if they and the camshafts are installed in their correct position.

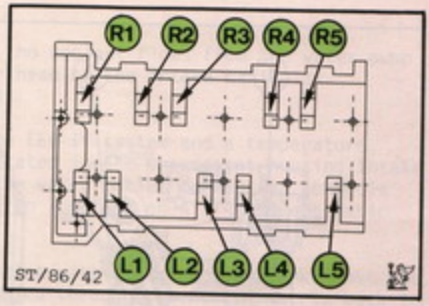
Note: The bearing caps must be tightened in very small steps. The nuts may not be turned more than one complete turn at a time.

Tightening Sequence acc. to Diagram

- o Fit all bearing caps. Install oil spray tube and tighten all nuts by hand.
- o Hand-tighten fastening nuts of bearing caps "L1, L3, L5, R1, R3 and R5.
- o Tightening the nuts lowers the camshafts down into their correct position.
- o Tighten nuts for bearing caps "L1 and R1" by 180° of rotation.
- o Tighten nuts for bearing caps "L5 and R5" by 180° of rotation.
- o Tighten nuts for bearing caps "L3 and R3" by 180° of rotation.

7. Tightening Procedures (cont'd)

- Continue tightening the bearing caps in small stages as described above until the caps come to rest on the cylinder head.
- Fit bearing caps "L2, L4" and "R2, R4" and drive them down on the cylinder head by light taps from a plastic mallet. Hand-tighten their nuts evenly.
- Following the above sequence, tighten all nuts to a torque of 22.0 - 26.0 Nm.



Tightening Sequence, Camshafts

Crankshaft

- Insert and oil bearing-liners
- Insert crankshaft
- Attach bearing caps
- Hand-tighten all bolts.
- Tighten bearings in pairs with 90 - 109 Nm.

Con-Rod Bolts

Note: Use new con-rod bolts!

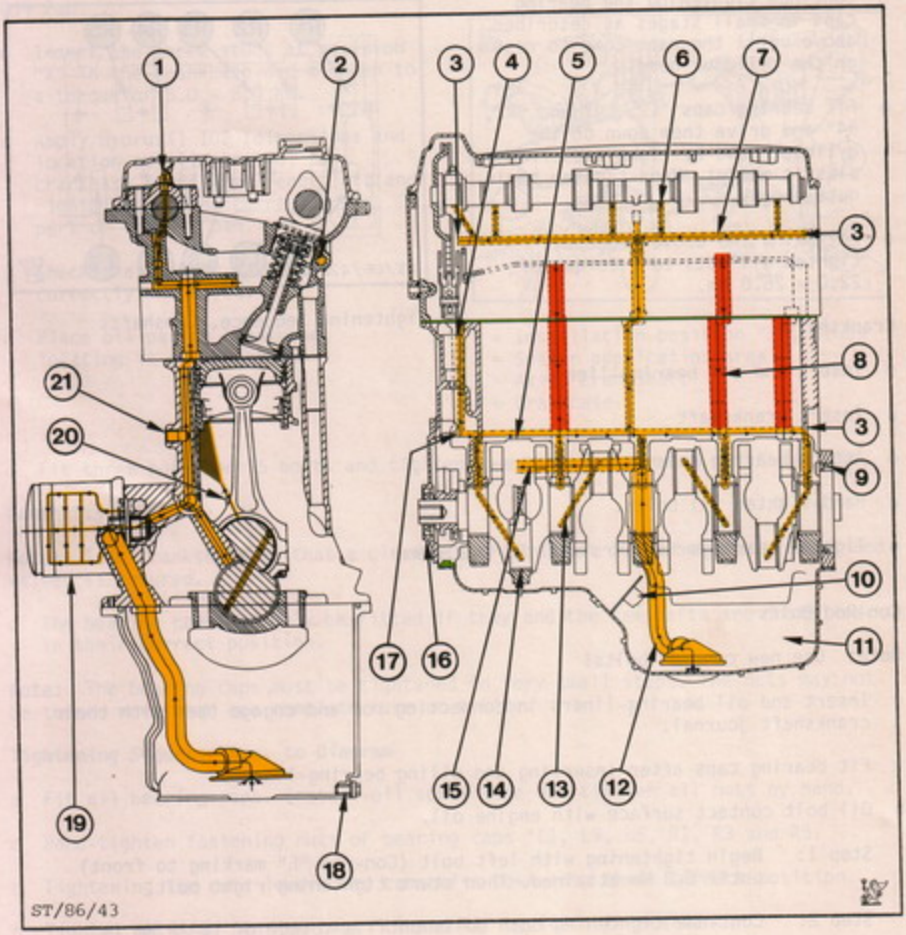
- Insert and oil bearing-liners in connecting rod and engage them with their crankshaft journal.
- Fit bearing caps after inserting and oiling bearing-liners.
- Oil bolt contact surface with engine oil.

Step 1: Begin tightening with left bolt (Con-rod "F" marking to front) until 6-8 Nm attained. Then start tightening right bolt.

Step 2: Continue tightening both bolts until a torque of 15-20 Nm is reached.

Step 3: Finally tighten by 90° (± 5°) of rotation.

8. Engine Lubrication Oil Circuit



1 = To oil spray tube, valve train
2 = Oil supply to hydraulic tappets
3 = Plugs
4 = To chain tensioner
5 = Main oil gallery, crankcase
6 = To camshaft bearings
7 = Main oil gallery, cylinder head
8 = Return passage
9 = Radial seal, crankshaft rear
10 = Oil baffle plate
11 = Oil pan
12 = Oil suction pipe
13 = Main bearing
14 = Connection rod bearing
15 = Oil feed to oil pump
16 = Radial seal, crankshaft front
17 = Oil pump to oil filter
18 = Oil drain plug
19 = Oil filter
20 = Oil spray bore, connecting rod
21 = Oil-pressure switch

9. Cooling System EFI and Carburettor Versions

Coolant Circuit Thermostat closed

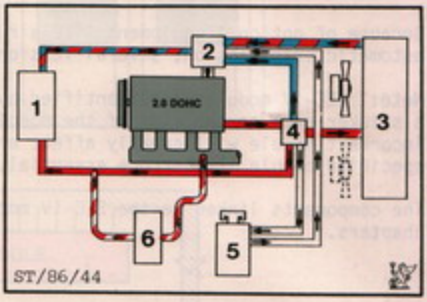
- Below a temperature of 88° Centigrade, the coolant flows from the water pump through the cylinder block and cylinder head to the intake manifold/-thermostat housing and the heater matrix.

  A coolant temperature sensor ECT for the EEC-IV system and a temperature sensor for the temperature gauge are located in the thermostat housing/intake manifold. A thermal switch located in the water outlet connection controls the operation of the electric radiator fan (or fans on 4 x 4 and automatic transmission vehicles).

  A breather pipe connects the coolant outlet with the expansion tank. When the thermostat is closed, the coolant is passed through the heater matrix back to the water pump.

Coolant Circuit Thermostat open

- The thermostat opens at a temperature of 88°C. The coolant then flows from the pump through the cylinder block and cylinder head, exits at the intake manifold/ thermostat housing, flows further through the radiator and returns to the water pump.



1 = Heater matrix
2 = Water pump
3 = Radiator and fan
4 = Thermostat housing with coolant temperature sensor and thermal switch for radiator fan (S)
5 = Expansion tank
6 = Carburettor preheating (carburettor versions only)

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.1 General Information

Fuel injected DOHC engines are fitted with EFI fuel injection and EEC-IV engine management. Fuel is injected into each intake port.
The EEC IV system controls fuel mixture, ignition timing and idle speed of the engine.

Differences exist between those with exhaust emission control and those without.

This part "C-1" covers all components of the fuel, air, ignition and engine management system of DOHC EEC-IV/EFI engines without exhaust emission control, meeting emission regulation EURONORM 15.04.

The chart below shows the availability of engines with and without exhaust emission control for the various markets. In each case the level of exhaust emission control depends on local legislation.

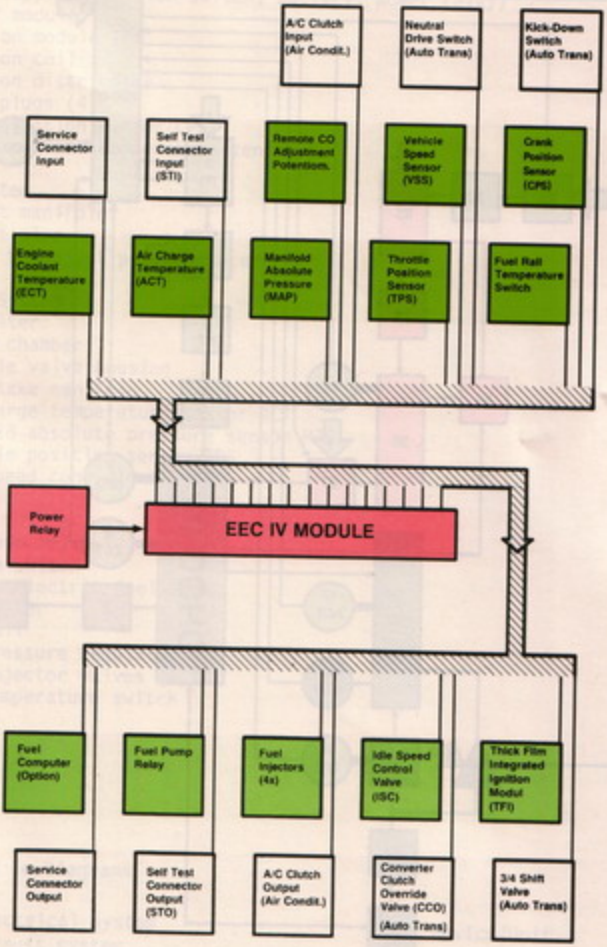
Because of optional equipment like air conditioner, power steering and automatic transmission, several versions of the EEC-IV module are necessary.

Note: EEC-IV modules are identified by a code in the recess for the plug and by a sticker each on the side of the module and inside the drivers door. An incorrect module will greatly affect engine and vehicle performance. The specified module is therfore essential.

The components linked to the EEC-IV module are explained in the following chapters.

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

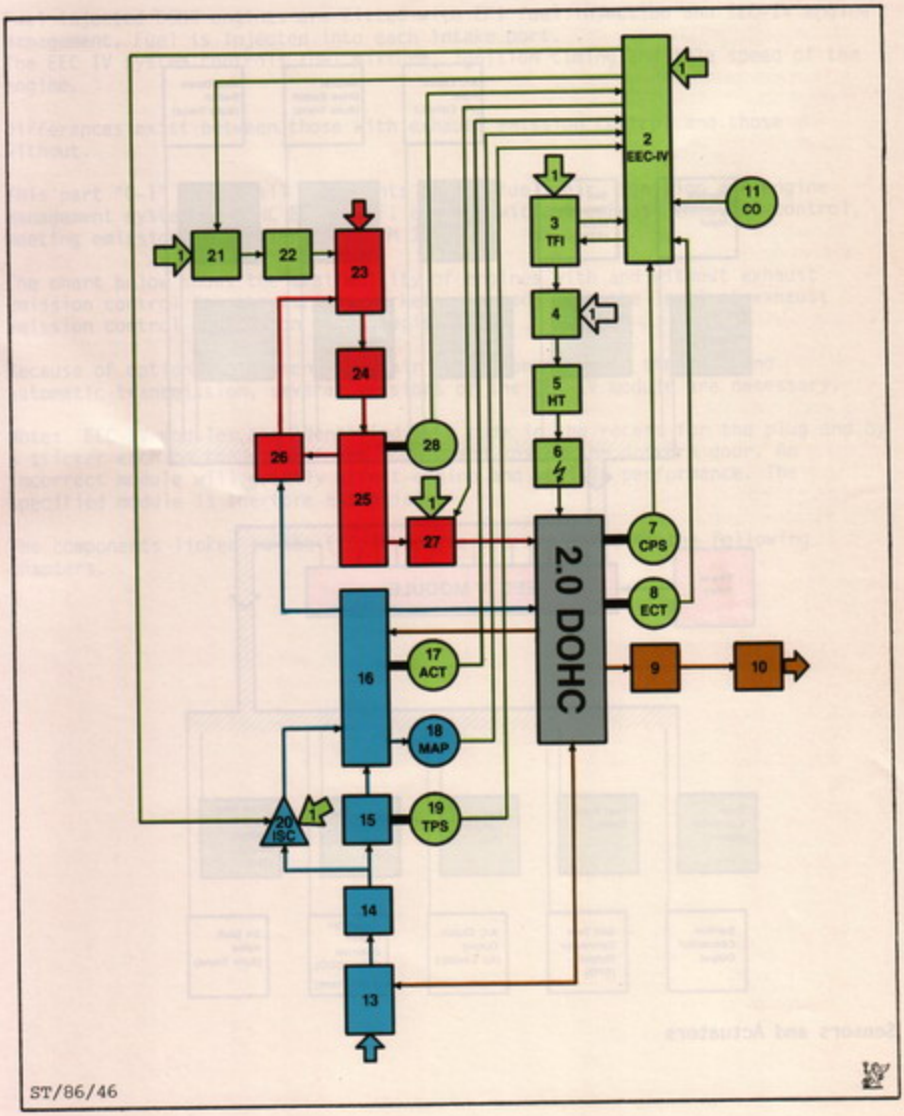
1.2 System Diagrams



Sensors and Actuators

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.2 System Diagrams (cont'd)



Component Diagram

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.2 Diagrams (cont'd)

Electric and Ignition System
1 = Power supply (Ignition switch, battery, power relay)
2 = EEC-IV module
3 = Ignition module TFI
4 = Ignition coil
5 = Ignition distributor
6 = Spark plugs (4)
7 = Crank position sensor CPS
8 = Engine coolant temperature sensor ECT

Exhaust System
9 = Exhaust manifold
10 = Exhaust pipe
11 = Remote CO adjust potentiometer

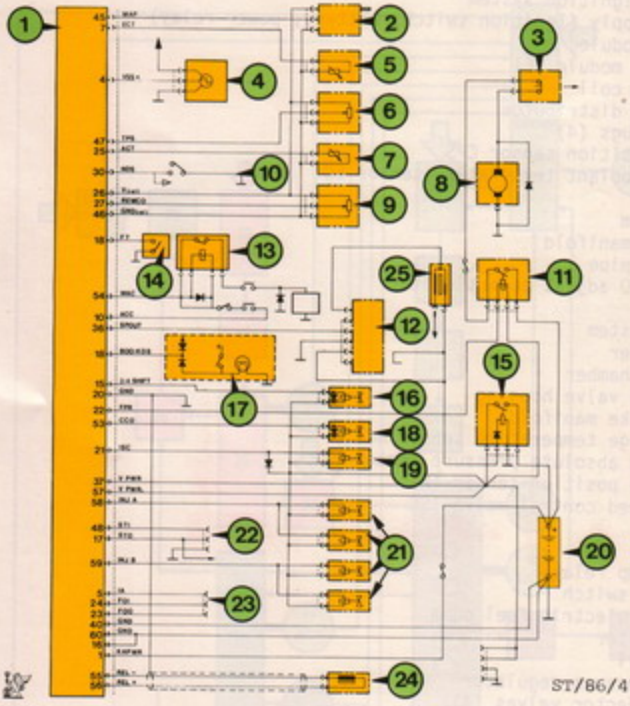
Air Intake System
13 = Air filter
14 = Plenum chamber
15 = Throttle valve housing
16 = Air intake manifold
17 = Air charge temperature sensor ACT
18 = Manifold absolute pressure sensor MAP
19 = Throttle position sensor TPS
20 = Idle speed control valve ISC

Fuel System
21 = Fuel pump relay
22 = Inertia switch
23 = In-tank electric fuel pump
24 = Fuel filter
25 = Fuel rail
26 = Fuel pressure regulator
27 = Fuel injector valves (4)
28 = Fuel temperature switch

Symbols used in Diagrams

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.3 Wiring Diagram Emission Regulation EURONORM 15.04



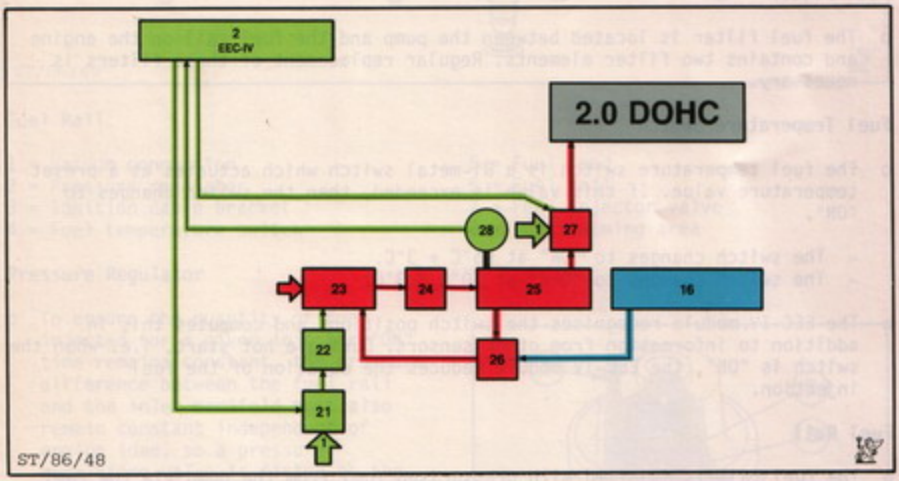
1 = EEC IV-module
2 = Manifold absolute pressure sensor MAP
3 = Inertia switch
4 = Vehicle speed sensor VSS
5 = Engine coolant temperature sensor ECT
6 = Throttle position sensor TPS
7 = Air charge temperature sensor ACT
8 = Fuel pump
9 = CO Remote adjust potentiometer
10 = Auto trans neutral drive switch
11 = Fuel pump relay
12 = TFI-Ignition module
13 = Air conditioning switches
14 = Fuel rail temperature switch
15 = Main power relay
16 = 3/4 shift solenoid ATS
17 = Kick down switch
18 = Converter clutch override solenoid CCO
19 = Idle speed control valve ISC
20 = Battery
21 = Fuel injectors (4)
22 = Self-test connector
23 = Service connector
24 = Crank position sensor CPS
25 = Ignition coil

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.4 Fuel System

The fuel system consists of the following sub-assemblies:

2 = EEC-IV module
16 = Air intake manifold
21 = Fuel pump relay
22 = Inertia switch
23 = Fuel tank with in-tank pump
24 = Fuel filter
25 = Fuel rail
26 = Fuel pressure regulator
27 = Fuel injection valves (4)
28 = Fuel temperature switch



Fuel System

- The fuel suction (feed) pipe, the fuel tank sender unit and the fuel return are combined in one unit which is inserted into the fuel tank.

Fuel Pump

- The electrically operated pump is mounted inside the fuel tank.

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.4 Fuel System (cont'd)

- The EEC-IV module controls the fuel pump relay. The module ensures that the pump is given a lead time of approx. one second, to build up the necessary operating pressure in the fuel system.

- The electric fuel pump includes a non-return valve which maintains pressure in the feed system after engine switch off, thereby easing restarts.

Inertia Switch

- On impact-as may be the case in the event of an accident this switch cuts the power supply to the electric fuel pump.

Fuel Filter

- The fuel filter is located between the pump and the fuel rail on the engine and contains two filter elements. Regular replacement of these filters is necessary.

Fuel Temperature Switch

- The fuel temperature switch is a Bi-metal switch which actuates at a preset temperature value. If this value is exceeded, then the switch changes to "ON".

  - The switch changes to "ON" at 85°C ± 3°C.
  - The switch changes to "OFF" at 70°C ± 3°C.

- The EEC-IV module recognises the switch positions and computes this in addition to information from other sensors. During a hot start, i.e. when the switch is "ON", the EEC-IV module reduces the duration of the fuel injection.

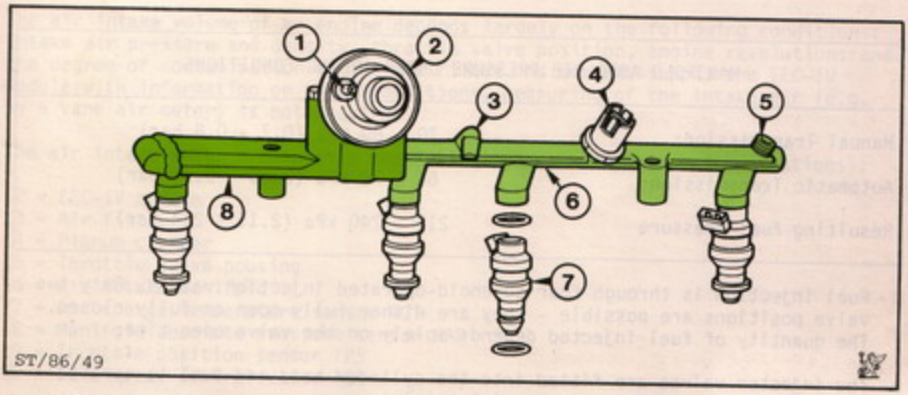
Fuel Rail

- The fuel rail is supplied with pressurised fuel from the pump via the fuel filter.

  The fuel rail fulfills the following functions:
  - Includes the fuel temperature switch and pressure regulator.
  - Secures the injector valves in the cylinder head.
  - Smoothes the fuel supply and ensures even distribution of the fuel to the injector valves.

1. Electronic Fuel Injection EFI without Exhaust Emission Control EURONORM 15.04)

1.4 Fuel System (cont'd)

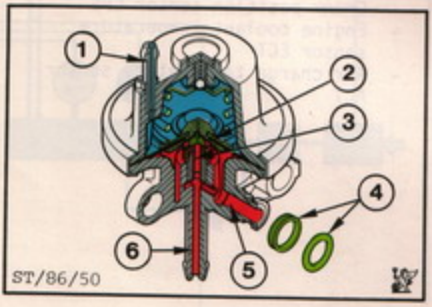


Fuel Rail

1 = Vacuum connection
2 = Pressure regulator
3 = Ignition cable bracket
4 = Fuel temperature switch
5 = Fuel feed
6 = Fuel rail
7 = Fuel injector valve
8 = Fuel calming area

Pressure Regulator

- To ensure the quantity of fuel injected for a given injector "ON" time remains constant, the pressure difference between the fuel rail and the inlet manifold must also remain constant independent of engine load, so a pressure regulating valve is fitted to the end of the fuel rail. This valve senses inlet manifold pressure and, by releasing fuel from the fuel rail back to the tank, maintains a constant pressure difference between the manifold and the rail.



Schematic Pressure Regulator

1 = Vacuum connection
2 = Diaphragm
3 = Valve
4 = Seal
5 = Fuel feed
6 = Fuel return

- The control pressure in the fuel rail is under all load conditions: 300 kPa ± 15 kPa (3.0 ± 0.15 bar)

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.4 Fuel System (cont'd)

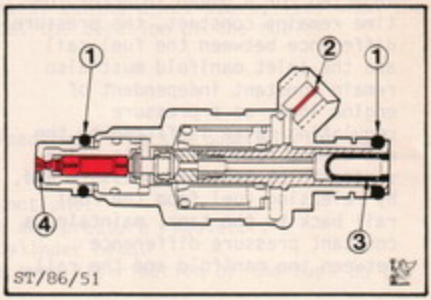
MANIFOLD ABSOLUTE PRESSURE UNDER IDLING CONDITIONS	
Manual Transmission:	70 - 80 kPa (0.7 - 0.8 bar)
Automatic Transmission:	65 - 75 kPa (0.65 - 0.75 bar)
Resulting Fuel Pressure	215 - 240 kPa (2.15 - 2.4 bar)

- o Fuel injection is through four solenoid-operated injection valves. Only two valve positions are possible - they are either fully open or fully closed. The quantity of fuel injected depends solely on the valve open time:

- o The injector valves are fitted into the cylinder head and fuel is sprayed into each inlet channel near the inlet valve.

- o The injection takes place after each 180° crankshaft rotation simultaneously at two inlet valves.
  The required "injector valve open time" is calculated by the EEC-IV module based on information received from the following sensors:

  - Throttle position sensor TPS
  - Manifold absolute pressure sensor MAP
  - Crank position sensor CPS
  - Engine coolant temperature sensor ECT
  - Air charge temperature sensor ACT



Fuel Injector Valve

1 = Sealing ring
2 = Electrical plug connection
3 = Filter
4 = Nozzle valve

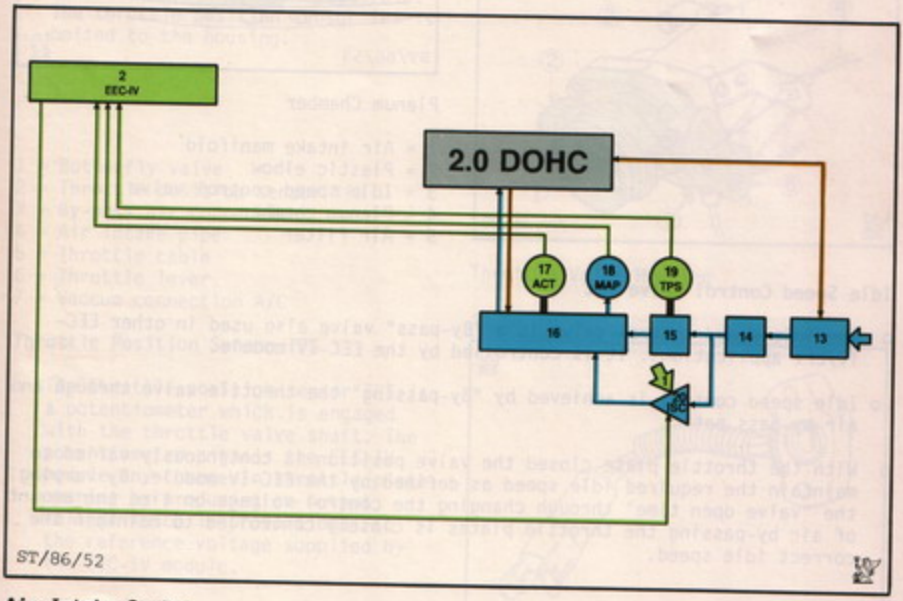
1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.5 Air Intake Section

The air intake volume of an engine depends largely on the following conditions: Intake air pressure and density, throttle valve position, engine revolutions and the degree of contamination of the air filter. As sensors supply the EEC-IV module with information on these conditions, measuring of the intake air (e.g. by a vane air meter) is not required.

The air intake section comprises the following assemblies (see illustrations):

2 = EEC-IV module
13 = Air filter
14 = Plenum chamber
15 = Throttle valve housing
16 = Air intake manifold
17 = Air charge temperature sensor ACT
18 = Manifold absolute pressure sensor MAP
19 = Throttle position sensor TPS
20 = Idle speed control valve ISC



Air Intake System

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURNORM 15.04)

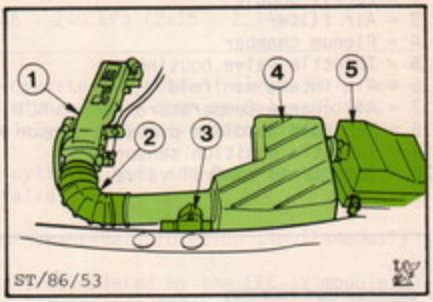
1.5 Air Intake Section (cont'd)

Air Filter

- The air filter is mounted before the plenum chamber and a breather pipe to the valve cover provides for engine ventilation.
- The air filter is a new development and can be replaced without tools.

Plenum Chamber

- The plenum chamber is an "L" shaped plastic housing.



Plenum Chamber

1 = Air intake manifold
2 = Plastic elbow
3 = Idle speed control valve
4 = Plenum chamber
5 = Air filter

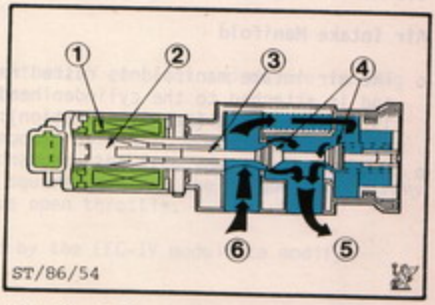
Idle Speed Control Valve ISC

- The idle speed control valve is a "By-pass" valve also used in other EEC-IV/EFI applications. It is controlled by the EEC-IV module.
- Idle speed control is achieved by "By-passing" the throttle valve through an air by-pass path.
- With the throttle plate closed the valve position is continuously varied to maintain the required idle speed as defined by the EEC-IV module. By varying the "valve open time" through changing the control voltage on time the amount of air by-passing the throttle plates is closely controlled to maintain the correct idle speed.

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.5 Air Intake Section (cont'd)

- The idle speed control valve and the idling speed are not adjustable in service.

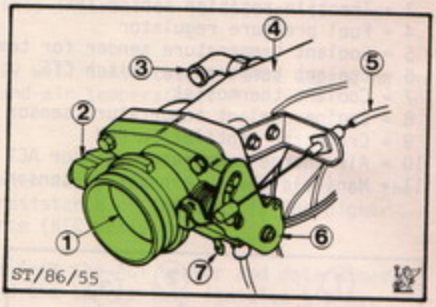


Idle Speed Control Valve ISC

1 = Coil
2 = Armature
3 = Valve stem
4 = Valve seats
5 = Air flow in
6 = Air flow out

Throttle Plate Housing

- The throttle plate housing is bolted to the air intake manifold. The throttle position sensor TPS is bolted to the housing.

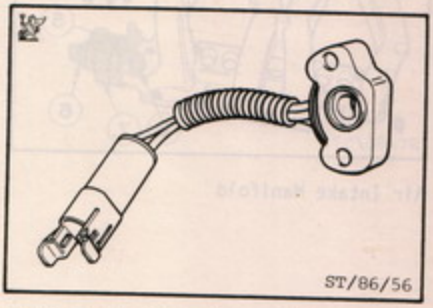


Throttle Valve Housing

1 = Butterfly valve
2 = Throttle position sensor TPS
3 = By-pass air connection
4 = Air intake pipe
5 = Throttle cable
6 = Throttle lever
7 = Vaccum connection A/C

Throttle Position Sensor TPS

- The throttle position sensor TPS is a potentiometer which is engaged with the throttle valve shaft. The potentiometer signals the EEC-IV module any change in throttle plate opening by producing an output voltage which is proportional to the reference voltage supplied by the EEC-IV module.



Throttle Position Sensor TPS

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

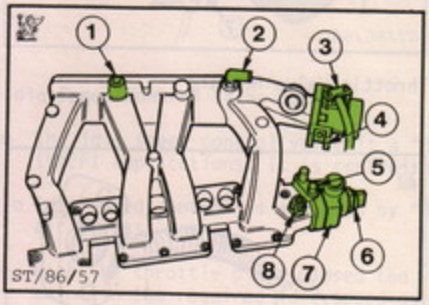
1.5 Air Intake Section (cont'd)

Air Intake Manifold

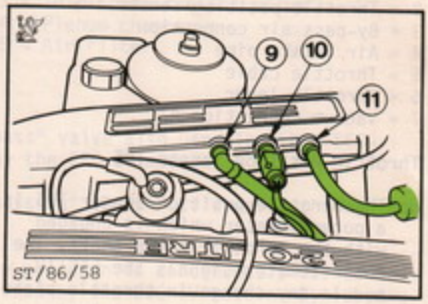
- The air intake manifold is casted from aluminium. It has four intake ducts and is attached to the cylinder head with "TORX" bolts. The intake manifold is equipped with (see illustration):

- Brake booster (not with ABS)

1 = Fuel tank evaporation EVAP (only with US 83)
2 = Idle speed control valve ISC
3 = Throttle position sensor TPS
4 = Fuel pressure regulator
5 = Coolant temperature sender for temperature gauge
6 = Coolant temperature switch CTS
7 = Coolant thermostat
8 = Engine coolant temperature sensor ECT
9 = Crankcase ventilation PCV
10 = Air charge temperature sensor ACT
11 = Manifold absolute pressure sensor MAP



Air Intake Manifold



Air Intake Manifold - installed

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.5 Air Intake Section (cont'd)

Manifold Absolute Pressure Sensor MAP

- The MAP sensor is an electronic component which contains a pressure sensing element and a signal conditioning electronics.
- The sensor is powered from the EEC-IV module by a 5 V reference supply. As pressure varies within the air plenum chamber, the frequency of the output signal changes. The output signal is a square wave and the frequency can vary from 88.9 Hz at idle to 162.4 Hz at wide open throttle.
- The information from the sensor is used by the EEC-IV module to modify fuelling and spark advance.
- With the ignition on and engine not running, the MAP sensor senses atmospheric pressure. Once the engine is running it senses intake manifold vacuum.
- The engine management module will use this information to update its memory for engine fuelling.
- On failure of the MAP sensor, the EEC IV will substitute a value depending on throttle position angle, engine speed and air temperature.

Air Charge Temperature Sensor ACT

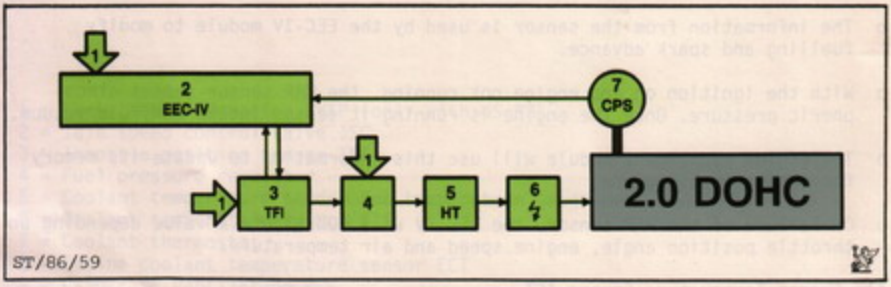
- The ACT sensor is a resistive device which determines the temperature of the inlet air. This inlet air changes the resistance of the sensor. The higher the temperature, the lower the resistance (NTC resistor).
- The EEC-IV module processes the signals from the ACT sensor and determines the opening period for the injectors and the appropriate ignition timing.
- The ACT sensor is bolted to the air intake manifold.

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.6 Ignition System

The ignition system consists of the following components:

1 = Current supply (Ignition switch, Battery, main relay)
2 = EEC-IV module
3 = Ignition module TFI
4 = Ignition coil
5 = HT-Distributor
6 = Spark plugs
7 = Crank position sensor CPS

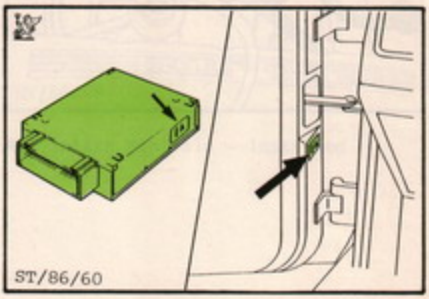


Ignition System

EEC-IV Module

- The module is a microprocessor based system containing the necessary strategy and calibration data within its memory. It provides control signals to the output actuators dependent upon input signals from various engine condition sensors, which are used in calculations from data stored or programmed in its memory. The result of these calculations is then passed as a series of signals to the actuators. This enables very close control over engine requirements.

- The ignition system is breakerless. The EEC-IV module processes signals from the crank position sensor CPS with information from other sources and determines the optimum ignition advance.

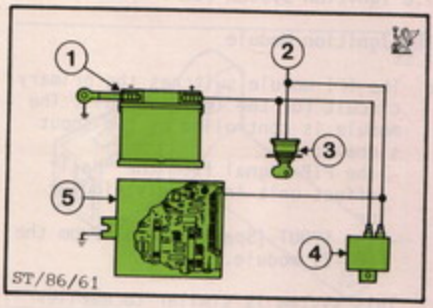


EEC-IV Module Specification

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.6 Ignition System (cont'd)

- In the event of component malfunction the EEC-IV module uses a pre-determined value which is programmed in its memory. This may give rise to poor performance or economy but enables the vehicle to be driven.



EEC-IV Module

1 = Battery
2 = Ignition coil power supply
3 = Ignition switch
4 = Supply relay
5 = EEC-IV Module

- If a fault occurs in the EEC-IV module itself, the module will switch to fixed, pre-determined values for spark advance and fuelling.

  This function is known as the "Limited Operation Strategy" LOS, and enables the vehicle to be driven.

- The EEC-IV module contains a Self Test Capability STC and Keep Alive Memory KAM.

Adaptive Strategy

- This feature continually adjusts the module calibration to compensate for wear and aging of calibrated components. This information is then stored in the
- "keep alive" memory so they will not be erased when the ignition is switched "OFF".

- If the battery has to be disconnected during routine servicing, the Keep Alive Memory will be erased. The module then requires a learning period to reprogrammme the memory. During this learning period the vehicle could exhibit abnormal drive symptons (surge, hesitation, incorrect idle speeds).

Self Test

- The self test capability includes approx. 99 defect codes which are stored in the Memory.

- Codes of intermittent faults are **not** erased when the ignition is switched off. They are stored in the KAM for some time.

- Disconnecting the battery erases all codes on intermittent faults recorded.

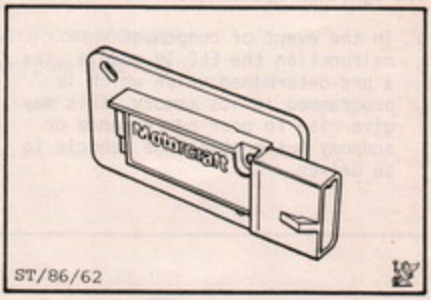
1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.6 Ignition System (cont'd)

TFI Ignition Module

- The TFI module switches the primary circuit for the ignition coil. The module is controlled by two input signals:
  - The **PIP** signal from the "Hall" effect unit in the distributor or
  - the **SPOUT** (Spark) signal from the EEC-IV module.

  This system is similar to earlier applications.



Thick Film Ignition TFI

Ignition Coil

- The ignition coil produces the HT voltage and releases it to the distributor.

Distributor

- The distributor is fitted to the front end of the cylinder head and is directly driven by the inlet camshaft.
- The high tension voltage is distributed to the spark plugs in the usual way.
- The firing order is 1-3-4-2.

Spark Plugs

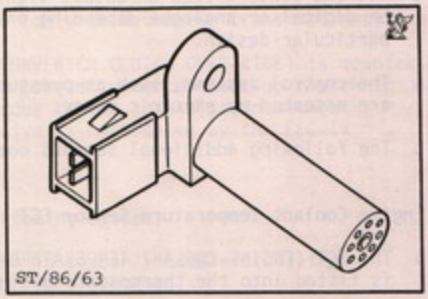
- For specified type of spark plug see "Technical Data".

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.6 Ignition System (cont'd)

Crank Position Sensor CPS

- The crank position sensor CPS is a Variable Reluctance Sensor, which is activated by the toothed wheel on the crankshaft. The toothed wheel causes an interruption in the magnetic flux in the sensor, thereby producing alternating electrical pulses.
- The EEC-IV module computes these alternating current signals which provide information on the crank position.



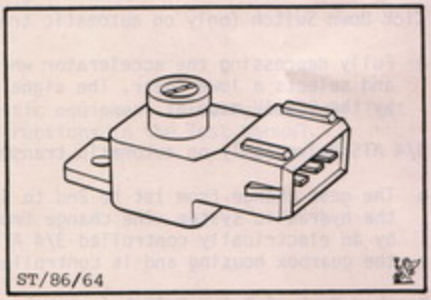
Crank Position Sensor CPS

- The toothed wheel has 35 teeth spaced every 10° with a gap in the 36th position. This missing tooth is positioned 90° Before Top Dead Centre of number 1 piston and is used as a reference by the module to define the engines crankshaft position.

Remote CO Adjust Potentiometer

- This 5 KOhm potentiometer is a constant value device which feeds the EEC-IV module with a constant resistance value when the system operates in "open loop" mode.

  The potentiometer is factory adjusted and sealed.



Remote CO Adjust Potentiometer

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.7 Additional Sensors and Control Units

- All the sensors feed an output signal to the EEC-IV module. This signal may be digital or analogue depending on the application of the sensor and its particular design.

- The control systems, such as pressure regulators, work either mechanically or are actuated by electric power.

- The following additional sensors complete the EEC-IV system.

Engine Coolant Temperature Sensor ECT

- The ECT (ENGINE COOLANT TEMPERATURE) is an electrical resistance element and is fitted into the thermostat housing.

Vehicle Speed Sensor

- The vehicle speed sensor is a "HALL-Effect" sensor and is mounted on the gearbox. Its output signal is supplied to the EEC-IV module

Kick-Down Switch (only on automatic transmissions)

- Fully depressing the accelerator while driving actuates the kick-down switch and selects a lower gear. The signal from the kick-down switch is evaluated by the EEC-IV module.

3/4 ATS Valve (only on automatic transmissions)

- The gear change from 1st to 2nd to 3rd and back is achieved automatically by the hydraulic system. The change from 3rd to 4th gear, and back is initiated by an electrically controlled 3/4 ATS shift solenoid. The ATS is mounted on the gearbox housing and is controlled by the EEC-IV module.

Gearbox Neutral Drive Switch (only on automatic transmissions)

The neutral drive switch informs the EEC-IV module that the transmission is in neutral.

1. Electronic Fuel Injection EFI without Exhaust Emission Control (EURONORM 15.04)

1.7 Additional Sensors and Control Units (cont'd)

Torque Converter Clutch Over-ride Valve CCO (only on automatic transmissions)

The converter clutch over-ride valve CCO (CONVERTER CLUTCH OVER-RIDE) is mounted on the transmission housing. It engages the torque converter lock-up clutch in 3rd and 4th gear. This transfers engine torque to the transmission without slipping. The converter clutch over-ride valve is controlled by the EEC-IV module.

Air Conditioning Switch (only on air conditioning system)

When starting the engine, or when the engine is suddenly accelerated, the electromagnetic clutch of the A/C compressor is disengaged.
This is controlled by the EEC-IV module.

Fuel Tank Sender Unit

The unit is located in the fuel tank. Its signal is fed to the fuel gauge in the instrument panel but not to the EEC-IV module.

Diagnostic Plug

This plug allows to connect special diagnostic equipment to carry out Self Test Diagnostic procedures in line with the instructions in the Test Manual.

2. Electronic Fuel Injection EFI with Exhaust and Evaporative Emission Control (Emission Regulation 83 US)

2.1 General Information

This system covers the additional components required to comply with the emission regulation "83 US".

To reduce the emission of Carbon Monoxide (CO), Hydrocarbons (HC) and Oxides of Nitrogen (NO_x), the following systems are used:

- The 3-way catalytic converter with HEGO-sensor to reduce exhaust emission of Carbon Monoxide, Hydrocarbons and Oxides of Nitrogen.

- The evaporative emission control system EVAP to control the emission of Hydrocarbons from the fuel tank and the crankcase ventilation system.

Additional service literature:

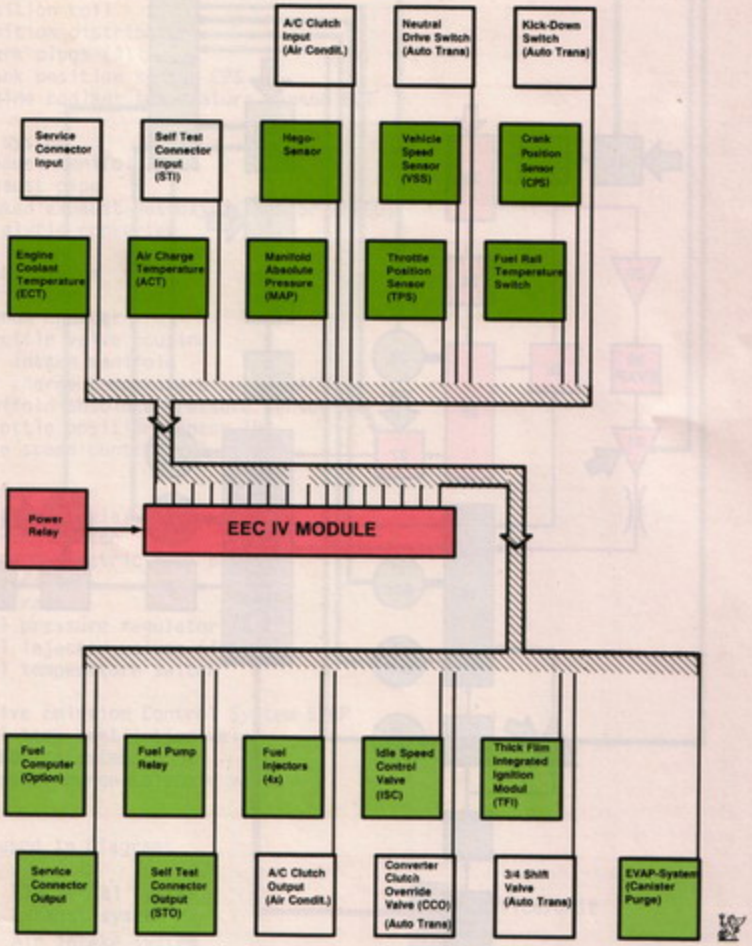
- CG 7267-06/87 EVAP-System
- CG 7227-11/84 Fuel injection system EEC IV

2. Electronic Fuel Injection EFI with Exh. and Evap. Emission Control (83 US)

2.2 System Diagrams

Sensors and Actuators

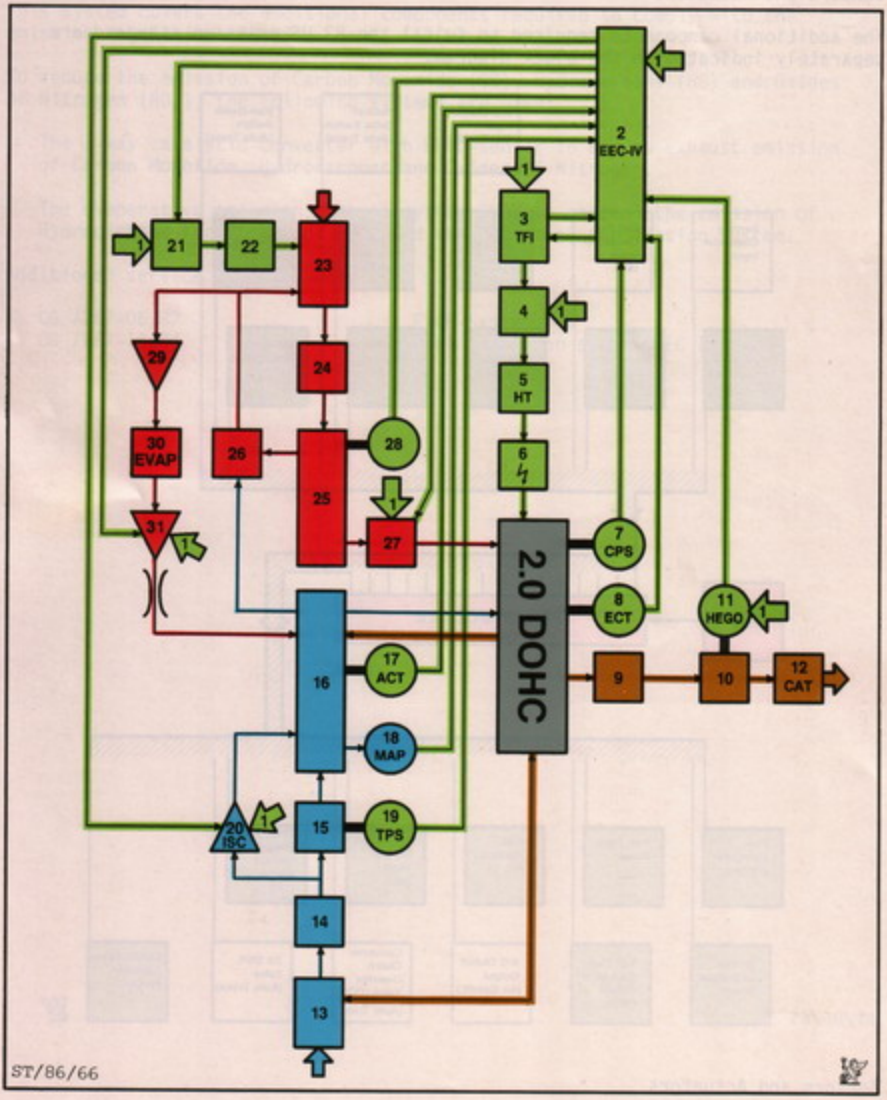
The additional components required to fulfil the 83 US emission standard are separately indicated in the block diagram.



Sensors and Actuators

2. Electronic Fuel Injection EFI with Exh. and Evap. Emission Control (83 US)

2.2 System Diagrams (cont'd)



Component Diagram (Emission Regulation 83 US)

2. Electronic Fuel Injection EFI with Exh. and Evap. Emission Control (83 US)

2.2 System Diagrams (cont'd)

Electric and Ignition System
1 = Power supply (ignition switch, battery, power relay)
2 = EEC-IV module
3 = Ignition module TFI
4 = Ignition coil
5 = Ignition distributor
6 = Spark plugs (4)
7 = Crank position sensor CPS
8 = Engine coolant temperature sensor ECT

Exhaust system
9 = Exhaust manifold
10 = Exhaust pipe
11 = Heated exhaust gas oxyden sensor (HEGO)
12 = Catalytic converter

Air Intake System
13 = Air filter
14 = Plenum chamber
15 = Throttle valve housing
16 = Air intake manifold
17 = Air charge temperature sensor ACT
18 = Manifold absolute pressure sensor MAP
19 = Throttle position sensor TPS
20 = Idle speed control valve ISC

Fuel System
21 = Fuel pump relay
22 = Inertia switch
23 = In-tank electric fuel pump
24 = Fuel filter
25 = Fuel rail
26 = Fuel pressure regulator
27 = Fuel injector valves (4)
28 = Fuel temperature switch

Evaporative Emission Control System EVAP
29 = Fuel tank ventilation valve
30 = Carbon canister
31 = Canister purge solenoid valve

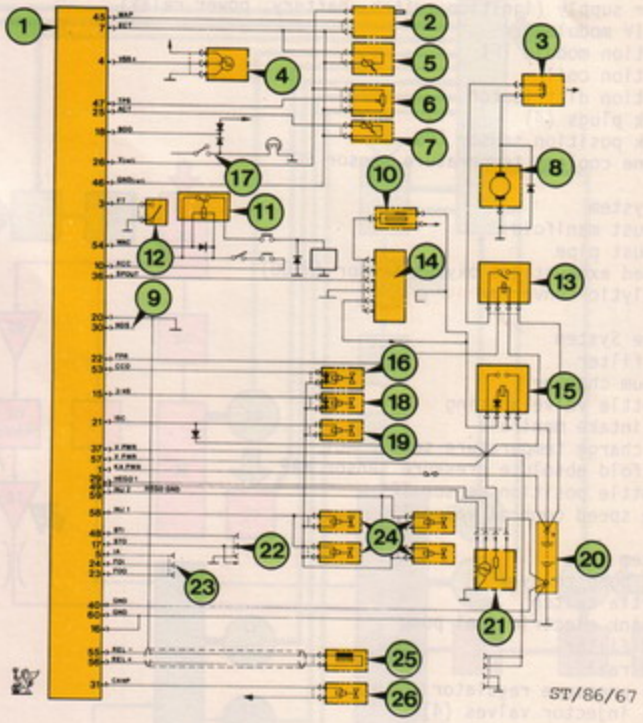
Symbols used in Diagrams

Electrical system
Exhaust system
Air intake system
Fuel system

Device/Unit
Sensor
Valve

2. Electronic Fuel Injection EFI with Exh. and Evap. Emission Control (83 US)

2.3 Wiring Diagram - Emission Regulation 83 US



1 = EEC IV-module
2 = Manifold absolute pressure sensor MAP
3 = Inertia switch
4 = Vehicle speed sensor (VSS)
5 = Engine coolant temperature sensor (ECT)
6 = Throttle position sensor (TPS)
7 = Air charge temperature sensor (ACT)
8 = Fuel pump
9 = Kick-down switch
10 = Ignition coil
11 = Air conditioning switches
12 = Fuel rail temperature switch
13 = Fuel pump relay
14 = TFI-ignition module
15 = Main power relay
16 = 3/4 shift solenoid ATS
17 = Neutral switch (autom. transm.)
18 = Converter clutch override solenoid CCO
19 = Idle speed control valve (ISC)
20 = Battery
21 = Heated exhaust gas oxygen sensor (HEGO)
22 = Self-test connector
23 = Service connector
24 = Fuel injector valves (4)
25 = Crank position sensor (CPS)
26 = Cannister purge solenoid (EVAP-system)

2. Electronic Fuel Injection EFI with Exh. and Evap. Emission Control (83 US)

2.4 Fuel System

Evaporation Emission Control System EVAP

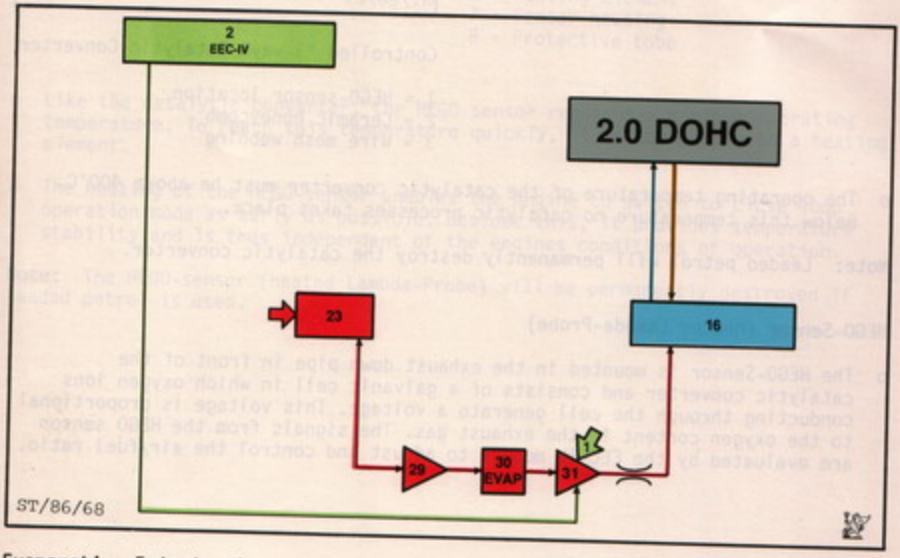
- To prevent the release into the atmosphere of vapourised fuel containing harmful hydrocarbons (HC) from the fuel tank, an evaporation emission control system is used.

- With the ignition switched off, vapours from the tank are fed to a carbon canister where they are absorbed by active carbon.

- When the engine is started, the EEC-IV module opens a purge solenoid valve and the fuel vapours are fed into the intake manifold and mixed with inlet air. This cleans the carbon filter. A blow-back valve prevents inlet air from being forced back to the fuel tank.

The EVAP system to comply with emission regulation 83 US contains the following main components:

2 = EEC-IV module
16 = Intake air manifold
23 = Fuel tank with in-tank fuel pump
29 = Fuel tank ventilation valve
30 = Carbon canister
31 = Canister purge solenoid valve



Evaporative Emission Control System (Emission Regulation 83 US)

2. Electronic Fuel Injection EFI with Exh. and Evap. Emission Control (83 US)

2.5 Exhaust System

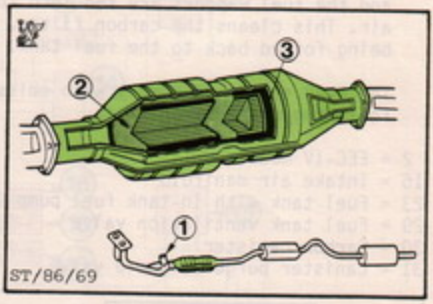
Controlled "3-way" Catalytic Converter

- The catalytic converter is, similar to an exhaust silencer, directly flanged to the exhaust down pipe.

- The function of the catalytic converter is to control and reduce harmful exhaust emissions without affecting engine performance and economy. For optimum operation the air/fuel ratio must be kept as close as possible to the ideal ratio of 14.7:1.

- The FORD catalytic converter is of the "3-way" type. Three-way means, a reduction of all three pollutants.

  - Carbon Monoxide (CO)
  - Hydrocarbons (HC)
  - Oxides of Nitrogen (NO_x)



Controlled "3-way" Catalytic Converter

1 = HEGO-sensor location
2 = Ceramic honeycomb
3 = Wire mesh webbing

- The operating temperature of the catalytic converter must be above 400°C. Below this temperature no catalytic processes takes place.

Note: Leaded petrol will permanently destroy the catalytic converter.

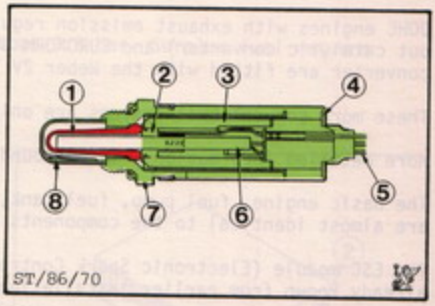
HEGO-Sensor (heated Lambda-Probe)

- The HEGO-Sensor is mounted in the exhaust down pipe in front of the catalytic converter and consists of a galvanic cell in which oxygen ions conducting through the cell generate a voltage. This voltage is proportional to the oxygen content in the exhaust gas. The signals from the HEGO sensor are evaluated by the EEC-IV module to adjust and control the air/fuel ratio.

2. Electronic Fuel Injection EFI with Exh. and Evap. Emission Control (83 US)

2.5 Exhaust System (cont'd)

- With the HEGO-sensor it is possible to maintain the air/fuel ratio very close to the ideal of: 14,7 parts air to one part fuel.



HEGO-Sensor

1 = Sensor ceramic
2 = Bonding
3 = Ceramic support
4 = Disc spring
5 = Connecting leads
6 = Heating element
7 = Sensor housing
8 = Protective tube

- Like the catalytic converter, the HEGO sensor requires a minimum operating temperature. To reach this temperature quickly, it is equipped with a heating element.

- The heating of the HEGO-sensor enables the engine to switch to close loop operation mode as early as possible. Besides this, it provides temperature stability and is thus independent of the engines conditions of operation.

Note: The HEGO-sensor (heated Lambda-Probe) will be permanently destroyed if leaded petrol is used.

1 Carburettors without and with Emission Control

1.1 General Information

DOHC engines with exhaust emission regulation EURONORM 15.04 (N8A, N8B without catalytic converter) and EURONORM 88/76 (15.05) with unregulated catalytic converter are fitted with the Weber 2V TLD carburettor.

These more conventional systems are only briefly covered.

More detailed information will be found in other Service Publications.

The basic engine, fuel pump, fuel tank, exhaust and catalytic converter etc. are almost identical to the components used for EFI engines.

The ESC module (Electronic Spark Control) controls engine operations and is already known from earlier installations on carburettored engines.

3.2 Main Features - Carburettor and Fuelling System

- Twin progressive venturi design with vacuum operated secondary barrel.
- Three piece design (i. e. top cover, main body, throttle body) for improved HOT FUEL HANDLING.
- Through bolt fixing for easy assembly to intake manifold.
- Main metering plus fuel inlet and return in top cover.
- Electrically controlled AUTOMATIC CHOKE system with water assist and modulated pull-down facility.
- Manually operated accelerator pump.
- Vaccum operated power valve.
- Fixed size main jet system.
- Anti-dieseling solenoid.
- Secondary bowl enrichment.
- Weight saving all aluminium construction (circa 2,2 kg).

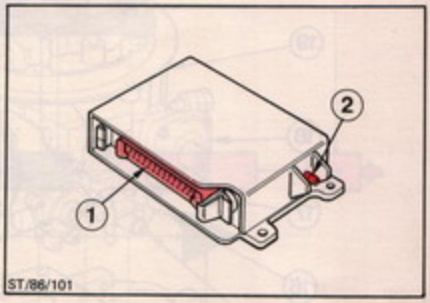
1.2 Main Features - Carburettor and Fuelling System

Fuel Pump

o The Fuel pump works at a pressure of about 0.8 bar. Surplus fuel returns to the fuel tank via a returnline.

The ESC II module

The ESC II (Electronic Spark Control) engine management system provides a very fine control of the iginition timing, giving optimum spark advance at any given engine condition. The module computes inputs from various sensors and transmits command signals to the actuators. If the microprocessor fails, the system switches automatically to LOS (Limited Operation Strategy) which enables limited vehicle operation.



ESC II Module

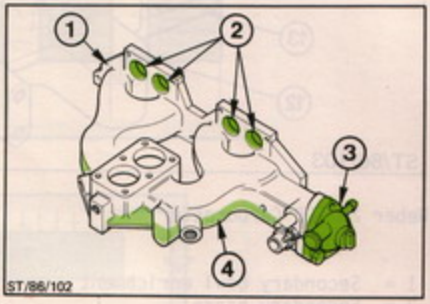
1 = Plug connection
2 = Vacuum intake

Intake Manifold

o The new features of the manifold are:

- openings for the spark plugs
- coolant water jacket (flow chamber)
- aluminium alloy
- improved mixture preheating

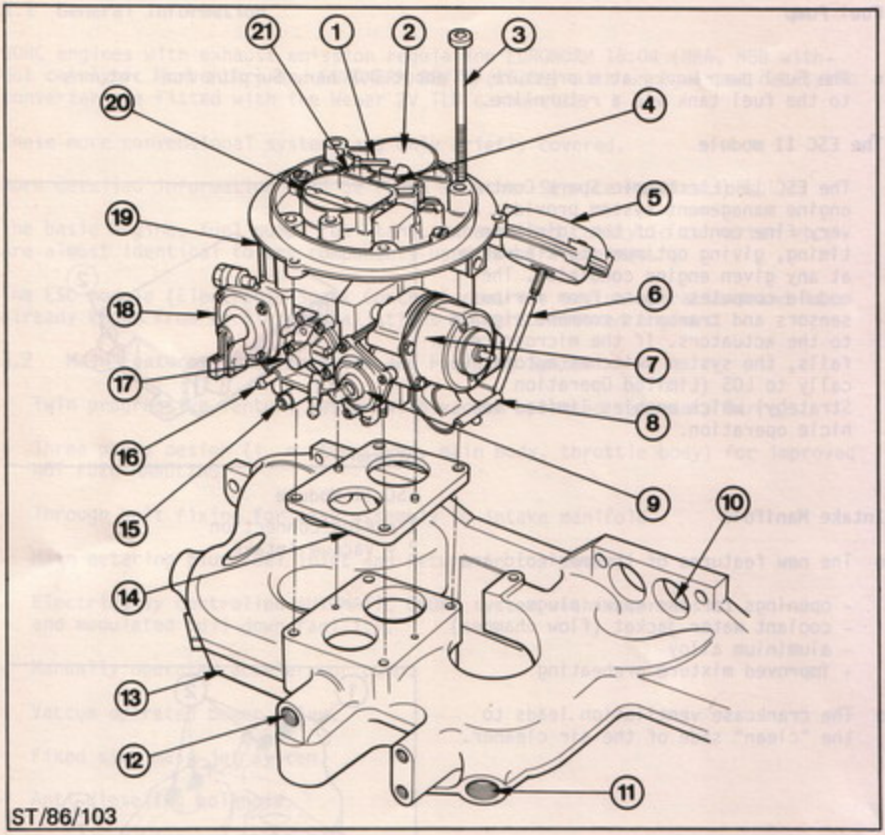
o The crankcase ventilation leads to the "clean" side of the air cleaner.



Coolant Flow

1 = Air intake manifold
2 = Openings for spark plugs
3 = Thermostat
4 = Coolant water jacket (flow chamber)

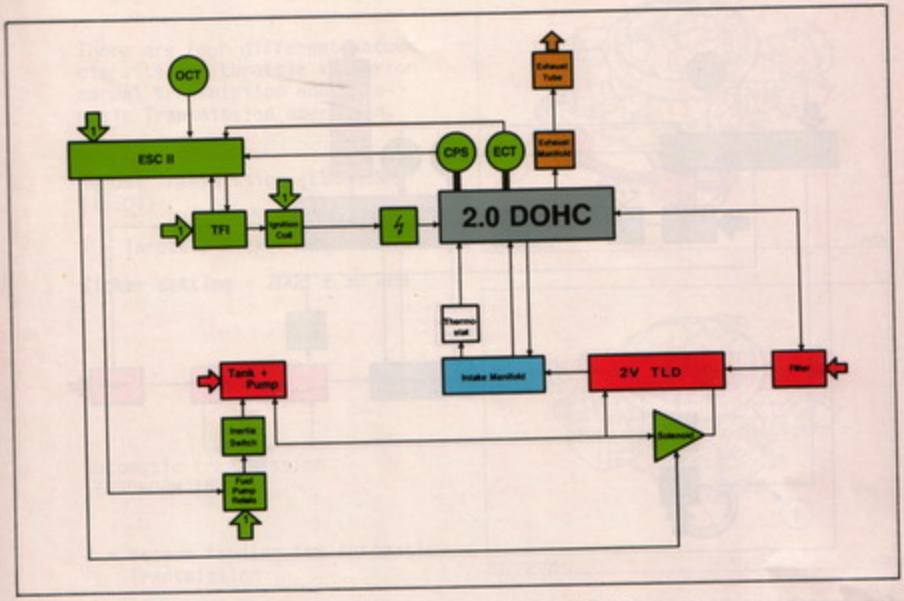
1. 2 Main Features - Carburettor and Fuelling System (cont'd)



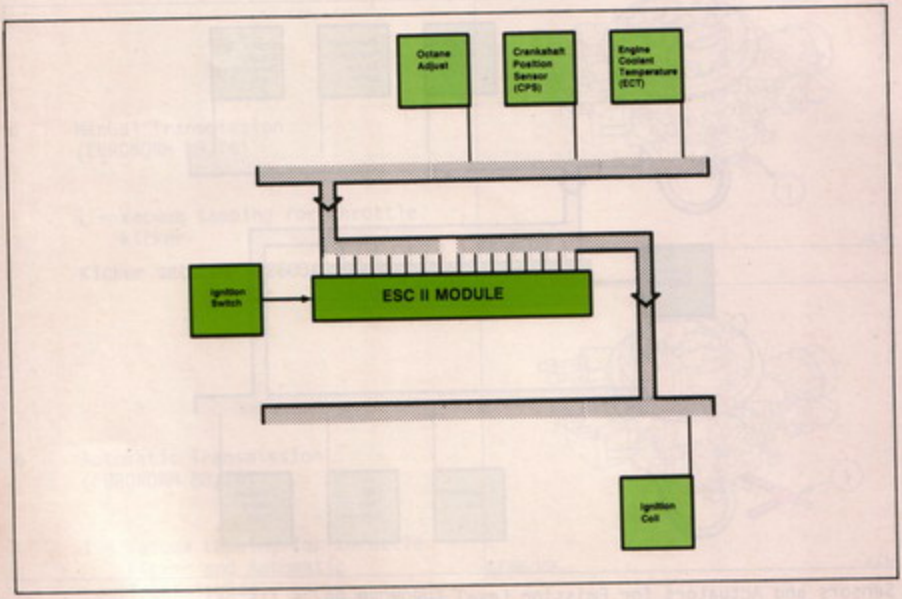
Weber 2V TLD Carburettor

1 = Secondary bowl enrichment
2 = Secondary barrel
3 = Carburettor to manifold bolts(4)
4 = Secondary main metering assembly
5 = Secondary venturi vacuum motor
6 = Telescopic link
7 = Choke assembly
8 = Water assist base bracket
9 = Choke pull down housing
10 = Openings for spark plugs
11 = Bore for coolant temperature sensor CTS
12 = Crankcase ventilation
13 = Intake manifold
14 = Carburettor to manifold gasket
15 = Idle mixture screw
16 = Vacuum port for the trottle kicker
17 = Power valve housing
18 = Accelerator pump
19 = Carburettor main body
20 = Choke plate
21 = Primary main metering assembly

1.3 System Diagram

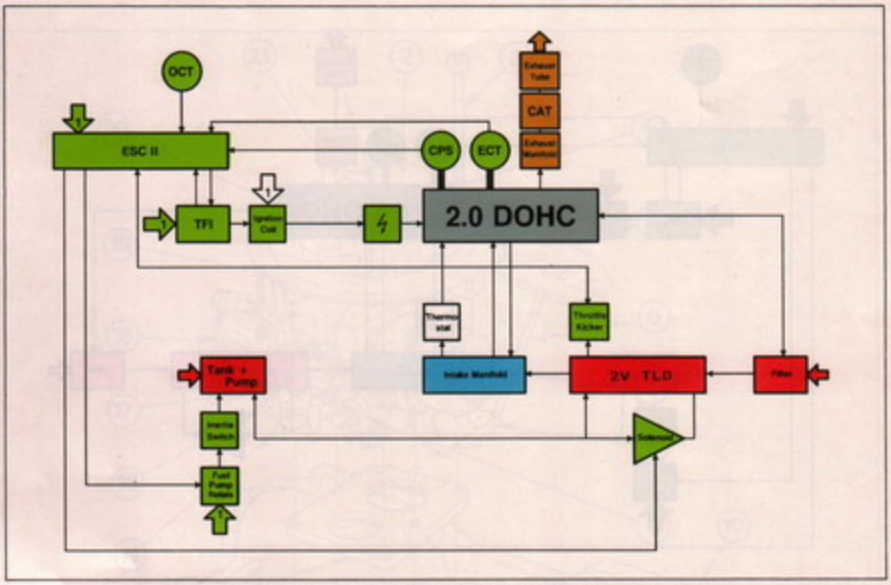


Sub-assemblies Diagram for Emission Level EURONORM 15.04

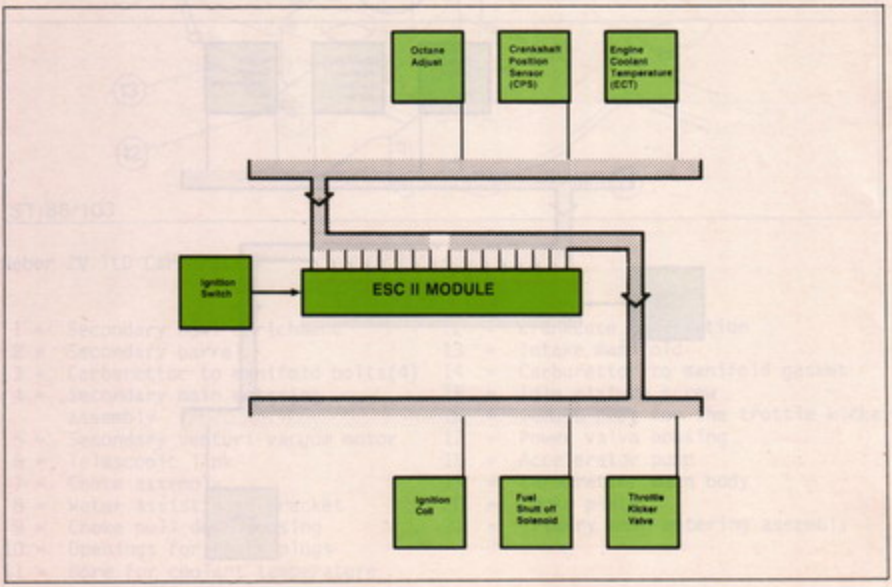


Sensors and Actuators for Emission Level EURONORM 15.04

1.3 System Diagram (cont'd)



Sub-assemblies Diagram for Emission Level EURONORM 88/76 (15.05)



Sensors and Actuators for Emission Level EURONORM 88/76 (15.05)

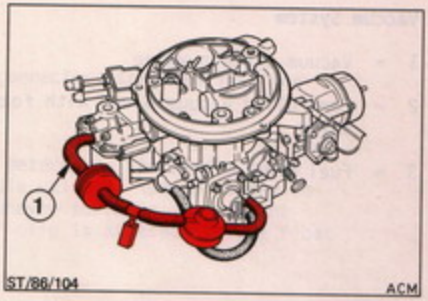
1.4 Carburettor Versions

There are four different vacuum circuits for throttle kicker on manual transmission and Automatic Transmission operation.

o Manual Transmission (EURONORM (15.04)

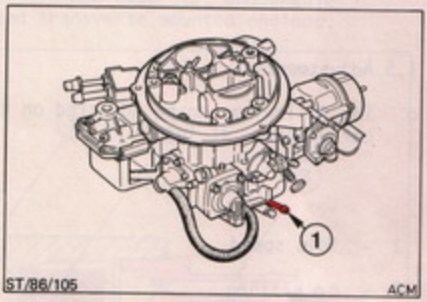
1 = Throttle kicker vacuum loom

Kicker setting = 2000 ± 50 RPM



o Automatic transmission (EURONORM 15.04)

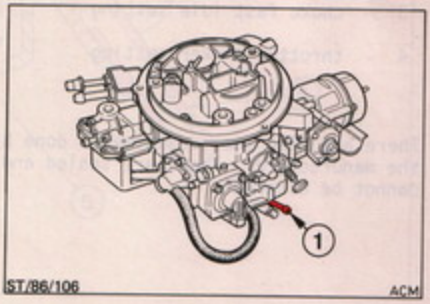
1 = Vacuum tapping for Automatic-Transmission



o Manual Transmission (EURONORM 88/76)

1 = Vacuum tapping for throttle kicker

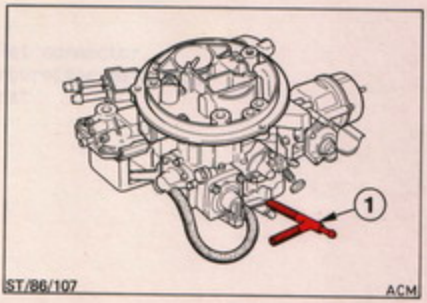
Kicker setting = 2600 ± 50 RPM



o Automatic Transmission (EURONORM 88/76)

1 = Vaccum tapping for throttle kicker and Automatic Transmission

Kicker setting = 2200 ± 50 RPM

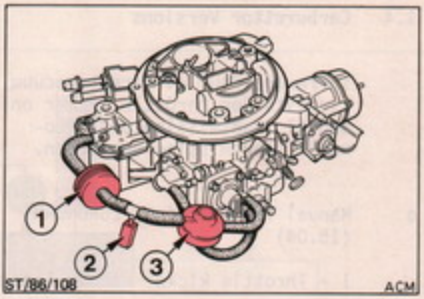


Vaccum System

1 = Vacuum sustain valve

2 = Controlled vacuum bleed with foam cover

3 = Fuel trap



1.5 Adjustments

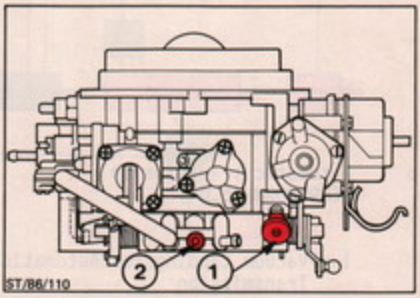
o The following can be adjusted on the carburettor at idle:

1 - idle speed

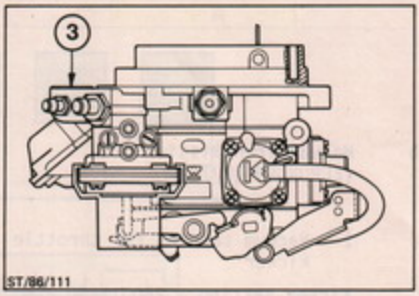
2 - co setting

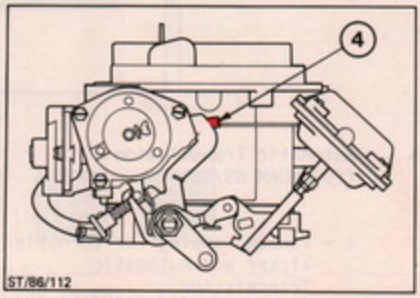
3 - choke fast idle setting

4 - throttle kicker setting



There are also some adjustments done by the manufacturer. These are sealed and cannot be altered.



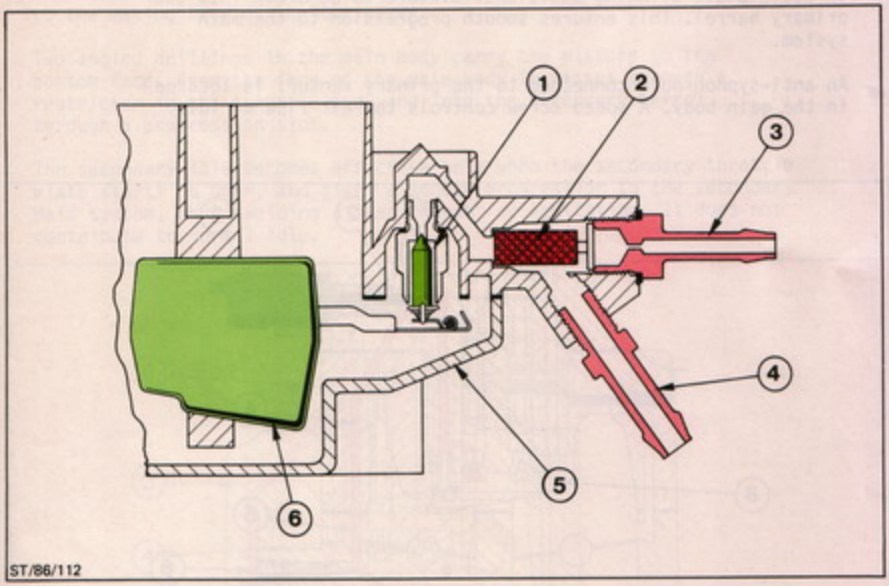


1.6 Fuel System

- The fuel feed is through a fuel inlet connector, threaded into the top cover, and a separate filter.

- Passing through the filter the fuel is metered by the needle valve before entering the fuel bowl. The needle valve is spring loaded to damp out vibrations when driving over uneven surfaces, to prevent uncontrolled fuel ingress. A "pull off" clip is attached to the float via a control lever.

- The fuel bowl and float are designed for minimum capacity, and enable the carburettor to be used on in-line and transverse mounted engines.



Fuel System

1 = Needle valve
2 = Fuel filter
3 = Fuel return connector with 1.1 mm restrictor
4 = Inlet connector
5 = Carburettor main body
6 = Float

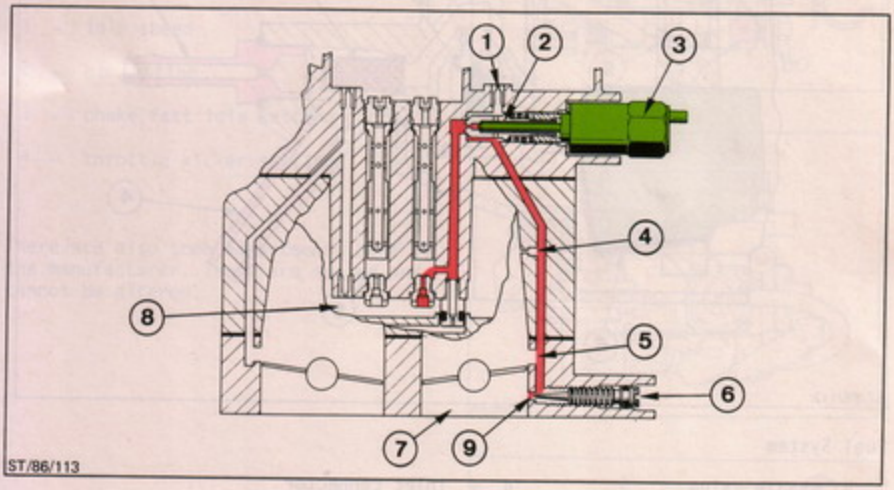
1. 7 IDLE SYSTEM

Primary idle System

o The fuel supply to the Primary Idle System is drawn by idle vaccum from the fuel bowl into the top cover through an idle jet integral with the anti-dieseling solenoid. When the solenoid is energised fuel is mixed with the air drawn through the idle air bleed jet (1). The mixture is carried through the idle channel to the throttle body and is discharged into the primary barrel, below the throttle plate, via the idle discharge orifice. The screw (6) is adjusted to control the discharged mixture.

During "off idle" operation the slot (5) is uncovered by the throttle plate allowing additional mixture to be drawn into the primary barrel. This ensures smooth progression to the main system.

An anti-syphon hole connected to the primary venturi is located in the main body. A speed screw controls the air flow at idle.



Primary Idle System

1 = Primary idle air bleed jet
2 = Primary idle jet assy
3 = Solenoid
4 = Anti-syphon hole
5 = Progressive slot
6 = Idle mixture srew
7 = Primary barrel
8 = Main fuel well
9 = Idle discharge orifice

1.7 Idle System (cont'd)

Solenoid and Idle Jet Assembly

o The spring loaded idle jet is fitted into the solenoid body. Fuel passes through the idle orifice and out to the assembly via three holes and mixes with air from the idle air jet.

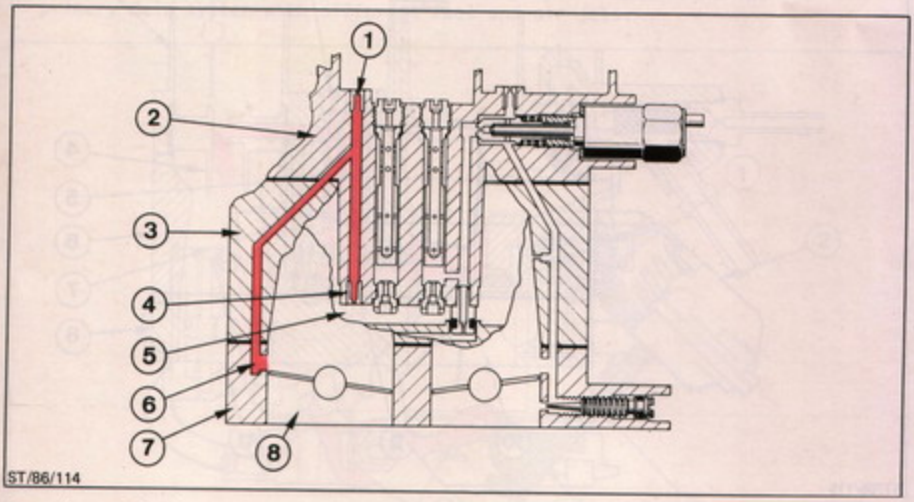
Secondary Idle System

o The secondary idle fuel jet is mounted above the fuel pick up from the main well. The fuel is drawn up through the idle drilling and mixes with air from the secondary idle air bleed mounted on the top of the air horn.

The resulting mixture is then transferred through a short drilling to the mating face of the top cover.

Two angled drillings in the main body carry the mixture to the bottom face. From the face of the main body it passes through a restrictor in the throttle body and into the secondary barrel through a progression slot.

o The secondary idle becomes effective only when the secondary throttle plate starts to open, and gives a smooth progression to the secondary main system, thus avoiding a lean "hunch" or hesitation. It does not contribute to normal idle.



Secondary Idle System

1 = Secondary idle air bleed jet
2 = Top cover
3 = Main body
4 = Secondary idle fuel jet
5 = Main fuel well
6 = Secondary progression slot
7 = Throttle body
8 = Secondary barrel

1. 8 Main System

o There is a primary and a secondary main system. The primary main system is operated by normal throttle operation, the secondary main system is operated by a vacuum controled system.

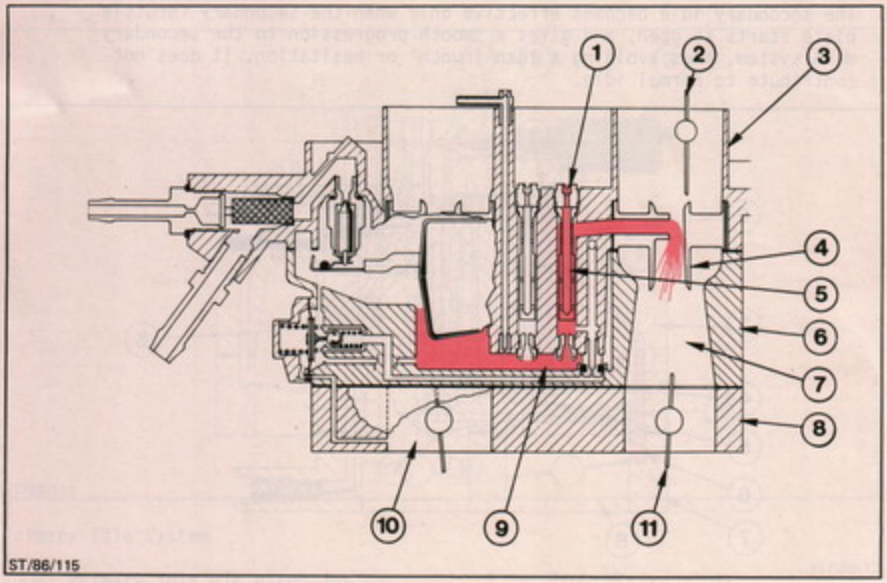
Primary Main System

o The primary barrel, smaller than the secondary, is calibrated to provide an economic mixture strength for part load operation.

When a depression is established in the retriction of the booster venturi it communicates with the primary main well through an emulsion tube. Fuel is drawn up through a main jet and mixes with air drawn through an air correction jet mounted on top of the emulsion tube.

In the emulsion tube air mixes with fuel to give the required mixture for all operating conditions of the engine.

The booster venturi and discharge jet is a separate casting which has a press-fit in the top cover.



Primary Main System

1 = Air correction jet
2 = Choke plate
3 = Top cover
4 = Discharge jet
5 = Emulsion tube
6 = Main body
7 = Primary barrel
8 = Throttle body
9 = Primary main well
10 = Secondary barrel
11 = Throttle plate

1. 8. Main System (Cont'd)

Secondary Main System

o Upon opening the primary throttle the vacuum in the primary venturi is ducted to the vacuum motor via a drilling within the throttle body.

When the primary throttle plate opens to a specific air flow, it lowers the spring loaded lever assembly and frees the lever, connected to the link rod of the vacuum motor.

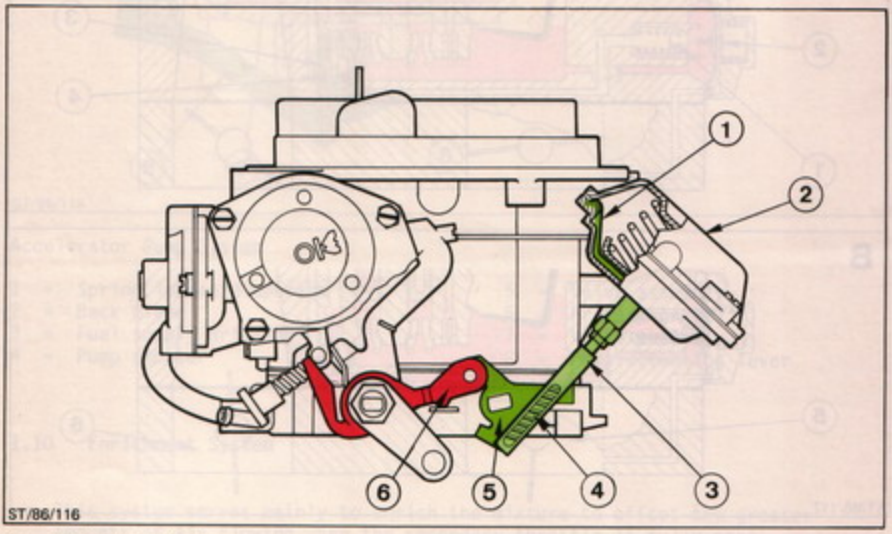
The increased vacuum in the primary vacuum circuit is sufficient to activate the vacuum motor diaphragm against the opposing spring and opens the secondary throttle plate gradually and in accordance with the amount of air required by the engine.

When the secondary throttle plate opens, the vacuum increases the signal at the vacuum motor diaphragm thus continuing opening of the secondary throttle plate.

Upon closing the primary-throttle, the lever (6) retracts and ensures prompt closure of the secondary throttle plate.

The vacuum motor's telescopic link is fitted with a spring, which allows the influence of the vacuum motor to be over-ridden.

The secondary fuel system functions in exactly the same manner as the primary main system with different fuel and air jets.



Secondary Main System

1 = Diaphragm
2 = Vacuum motor
3 = Telescopic link
4 = Telescopic spring
5 = Lever
6 = Spring loaded lever asembly

1. 8 Main System (cont'd)

Power System

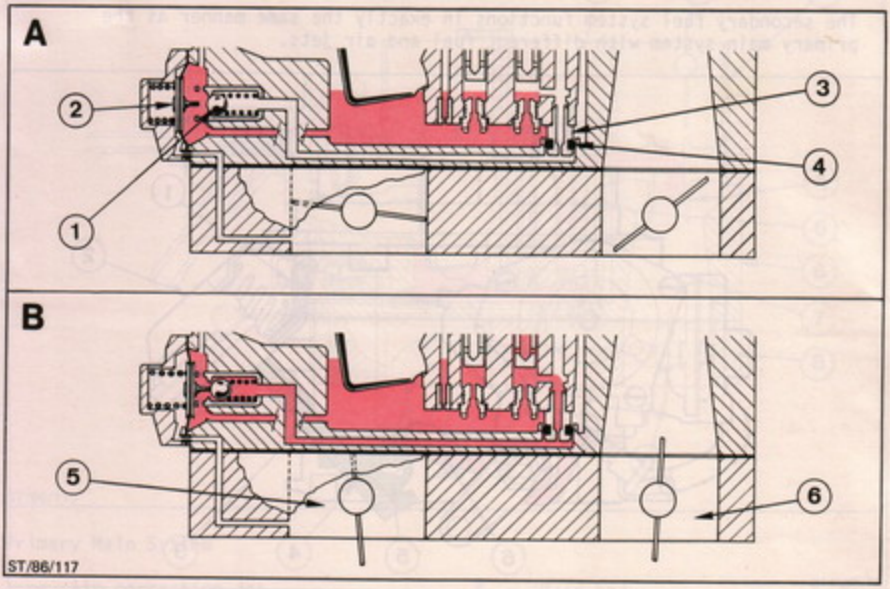
o The power system is used to pass additional fuel upstream of the primary main jet when the engine is operating under a high power demand. The power jet is mounted at the bottom of the primary idle leg on the top cover and and is sealed to the housing by an O-ring.

A valve assembly is pressed into the power valve cavity in the main body. Fuel is supplied by a drilling from the bottom of the fuel bowl.

A = Low power demand: Light throttle, the manifold vacuum is sufficiently high to hold the diaphragm assembly back against the spring thus there is no flow through the power valve assembly.

B = High power demand: Low manifold vacuum, the vacuum is insufficient to hold the diaphragm assembly against the spring and fuel flows through the power valve assembly.

In sunmary, the power valve supplies additional fuel into the mixture tube when a richer mixture is required to meet the demand for extra power.



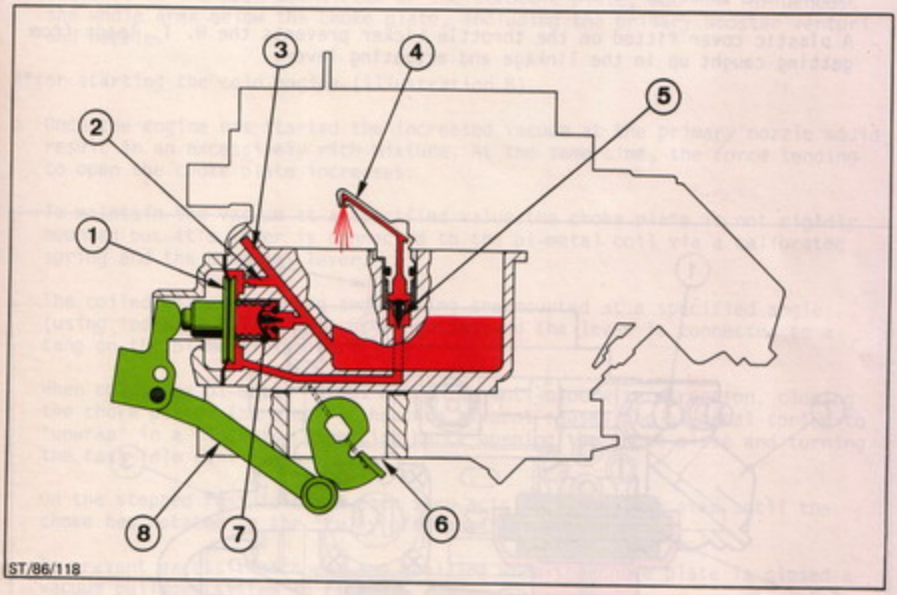
Power System

1 = Spring loaded ball
2 = Spring loaded diaphragm
3 = Power jet
4 = O-ring
5 = Secondary barrel
6 = Primary barrel

1. 9 Accelerator Pump System

o The accelerator pump system is mechanically operated by a two stage cam on the throttle shaft. This cam operates the pump actuating lever. When the throttle is operated, the lever pushes the diaphragm assembly forward, forcing a jet of fuel down into primary air horn and venturi.

When the throttle returns to idle, the diaphragm assembly is moved back by the spring and draws fuel through a one way umbrella valve assembly.



Accelerator Pump System

1 = Spring loaded diaphragm
2 = Back bleed
3 = Fuel supply drilling
4 = Pump shooter
5 = Valve assembly
6 = Primary barrel
7 = Valve assembly
8 = Pump actuating lever

1.10 Enrichment System

o This system serves mainly to enrich the mixture to offset the greater amounts of air flowing when the secondary throttle is fully open.

Installed in the secondary air horn is a separate circuit in parallel with, but independent of the main system.

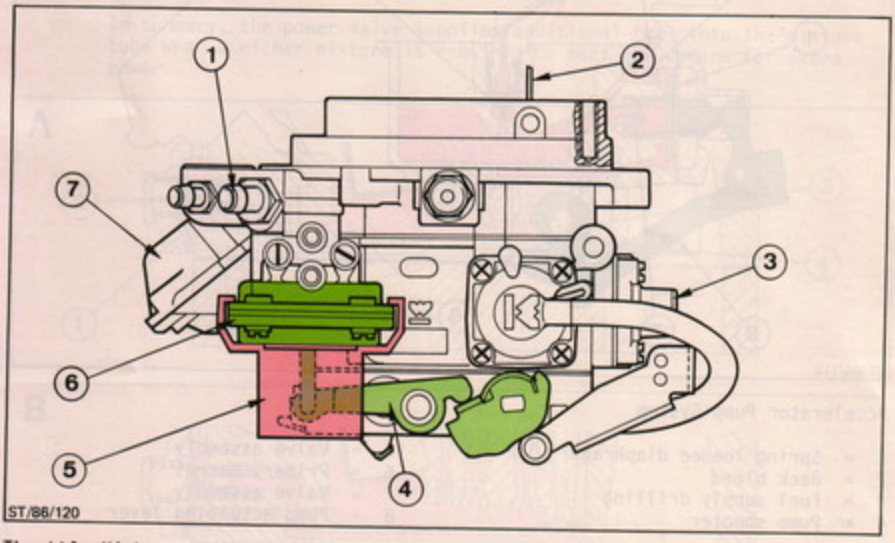
1.11 Throttle Kicker

o The throttle kicker is a vacuum motor operated by a vacuum source from the throttle body or the intake manifold. It can be used either for damping or to reduce the emission of decel hydrocarbons.

When the throttle is opened the vacuum actuates the throttle kicker which lifts the throttle above it's normal idle setting. When the throttle is released the damper slowes the return of the throttle lever.

An externally mounted sustain valve allows the throttle kicker to slowly return the throttle to the idle position as the actuating vacuum decays.

A plastic cover fitted on the throttle kicker prevents the H. T. leads from getting caught up in the linkage and actuating lever.



Throttle Kicker

1 = Fuel Intake
2 = Choke plate
3 = Accelerator pump cover
4 = Throttle kicker pivot lever
5 = Plastic cover
6 = Throttle kicker
7 = Secondary vacuum motor

1.12 Auto Choke System

Before starting the cold engine (illustration A)

- The auto choke consists of a choke plate or strangler, positioned offset with respect to the barrel centre line and upstream of the primary venturi. During the starting stage the choke plate is closed while the throttle plate is partially open - FAST IDLE POSITION - operated by the fast idle cam and fast idle adjusting lever mounted on the throttle shaft.

  As a result, the vacuum produced by the cranked engine is no longer confined to the area downstream of the throttle plate, but now influences the whole area below the choke plate, including the primary booster venturi and nozzle.

After starting the cold engine (illustration B)

- Once the engine has started the increased vacuum at the primary nozzle would result in an excessively rich mixture. At the same time, the force tending to open the choke plate increases.

  To maintain the vacuum at a specified value the choke plate is not rigidly mounted but it's lever is connected to the bi-metal coil via a calibrated spring and the bi-metal lever.

  The coiled bi-metal spring and housing are mounted at a specified angle (using index marks) on the choke housing and the lever is connected to a tang on the bi-metal spring.

  When cold, the bi-metal "wraps up" in an anti-clockwise direction, closing the choke plate. The electric heating element causes the bi-metal spring to "unwrap" in a clockwise direction hence opening the choke plate and turning the fast idle cam.

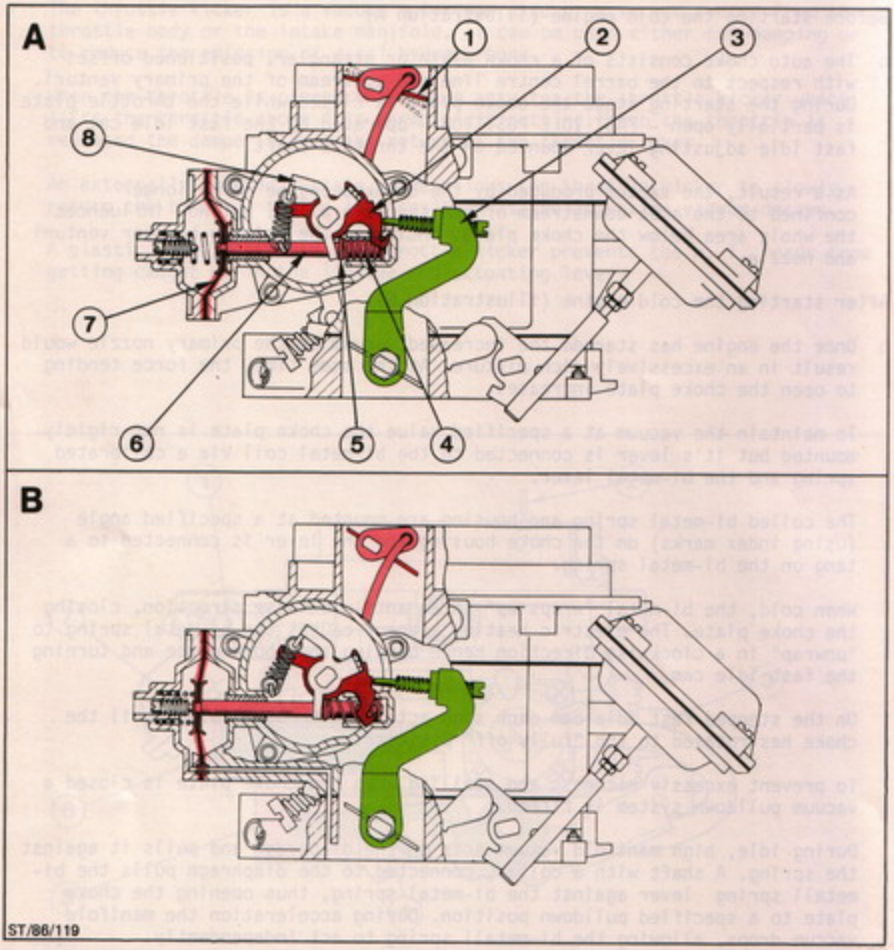
  On the stepped fast idle cam each step acts as a throttle step until the choke has rotated to the "fully off" position.

  To prevent excessiv richness and stalling when the choke plate is closed a vacuum pulldown system is fitted.

  During idle, high manifold vacuum acts on the diaphragm and pulls it against the spring. A shaft with a collar, connected to the diaphragm pulls the bi-metall spring lever against the bi-metal spring, thus opening the choke plate to a specified pulldown position. During acceleration the manifold vaccum drops, allowing the bi-metall spring to act independently.

  When the throttle is opened fully the deload lever acts on the bi-metal lever to open the choke plate and avoid flooding.

1.12 Auto Choke System (cont'd)



Auto Choke System

1 = Choke plate
2 = Fast idle cam
3 = Fast idle adjusting lever
4 = Calibrated pull down spring
5 = Pull down bush
6 = Pull down spindle
7 = Spring loaded diaphragm
8 = Bi-metal lever

1. General Information - Maintenance

- First Serice at 1500
- Interim Service 10.000 km / 30.000 km / 50.000 km etc.
- Standard Service 20.000 km / 40.000 km / 60.000 km etc.
- The work required is listed in the Service Booklet.

Important points

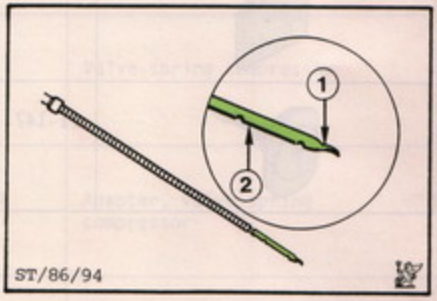
Engine oil change

Only use Ford super motor oil SAE 10W-30 or an equivalent oil according to the Specification SG/CD.

Capacities: Oil change with filter 4,50 Litre
Oil change without filter 4,00 Litre

Markings on Dipstick

- 1 = MIN = 3.5 litres oil in sump
  2 = MAX = 4.5 litres in sump



Dipstick Markings

Coolant

Only use Motorcraft Special Coolant Concentrate according to FORD specifications SSM-9789103-A.

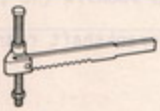
2. Special Tools

Three special tools are new. The remaining special tools are already available from other models.

The following table shows all the special tools necessary for the DOHC engine.

New Special Tools	Number	Description
	21-145	Mounting fixture - Timing chain (two parts)
	21-146	Mounting plate (only use together with 21-031 B)
	21-147	Puller for crankshaft-vibration damper

2. Special Tools (cont'd)

Existing Special Tools	Number	Description
	21-007 A	Replacer, valve stem oil seal
	GV-2124 MS 1500	Pliers, valve stem oil seal
	21-023	Universal spindle
	21-024	Valve-spring compressor
	21-024-04	Adapter, valve spring compressor
	none	Locally-made tool/mounting plate for 21-024 and 21-024-04
	21-031 B	Engine mounting bracket (only use together with 21-146)
	21-036 A	Remover, flywheel bearing

2. Special Tools (cont'd)

Existing Special Tools	Number	Description
	21-044 A	Installer, pilot bearing and clutch
	21-093 A	Installer, camshaft oil seal
	21-096	Remover, oil seals
	21-141	Installer, crankshaft rear oil seal

1. Engine Data and Performance Characteristics (EEC Specification)

Engines with carburettor

Engine Type		N8A (Sierra) N8B (Scorpio)	N8C N8D
Exhaust emission specifications EURONORM		15.04	88/76 (15.05)
Bore	mm	86.00	
Stroke	mm	86.00	
Total swept volume	cm^3	1988	
Nominal performance/engine speed	kW/min^{-1}	79/5600	75/5500
Max. torque/engine speed	Nm/min^{-1}	171/3000	166/3000
Max. engine speed, short periods	min^{-1}	6275	6175
Max. engine speed, continuous	min^{-1}	6050	5950
Specific fuel consumption b_e (min)	g/kWh	265/1950	275/2000
Compression ratio		10.3:1	
Engine type		4-stroke Combustion	
Fuelling system		carburettor	
Carburettor type		Weber 2V-TLD	
Ignition/engine management system		Spark Control ESC II	
Firing order		1-3-4-2	
Fuel required	octane	Super 97/unleaded 95	
Weight, dry without clutch	kg	134	

Engines with Electronic Fuel Injection

Engine Type		N9A (Sierra) N9B (Scorpio)	N9C N9D
Exhaust emission specifications EURONORM		15.04	83 US
Bore	mm	86.00	
Stroke	mm	86.00	
Total swept volume	cm^3	1988	
Nominal performance/engine speed	kW/min^{-1}	90/5500	87/5500
Max. torque/engine speed	Nm/min^{-1}	171/2500	171/2500
Max. engine speed, short periods	min^{-1}	6175	
Max. engine speed, continuous	min^{-1}	5950	
Specific fuel consumption b_e (min)	g/kWh	265/2100	275/2800
Compression ratio		10.3:1	
Engine type		4-stroke-combustion	
Fuelling system		Electronic Fuel Injection EFI	
Ignition/Engine Management system		EEC IV	
Ignition module		TFI	
Firing order		1-3-4-2	
Fuel required	octane	unleaded 95	
Weight, dry without clutch	kg	134	

1. Engine Data and Performance Characteristics (cont'd)

EFI and Carburettor-Versions:

Main bearing clearance	0.011 - 0.048 mm
Crankshaft end-float	0.093 - 0.303 mm
Big-end bearing clearance	0.01 - 0.03 mm
Piston pin end-float	none, interference fit
Camshafts end-float	0.02 - 0.26 mm
Valve clearance	Hydro-tappets
Flywheel run-out	0.13 mm
Crankcase ventilation system	closed
Coolant concentrate FORD spec.	SSM-97 B9103-A
Oil quality specification	SG/CD
Spark plugs	M 14 x 19 mm
Spark plug gap	0,70 - 0,80 mm

Engine Type	Emission Specification	Heat Rating
N8A, B, C, D	EURONORM 15.04 and 88/76 (15.05)	AGPR 32 CD
N9A, B, C, D	EURONORM 15.04 and 83 US	AGPR 22 CD

2. Torque-Wrench Settings

		Nm (Degree)
Cylinder Head Area		
Studs for valve cover location		6 - 8
Valve cover		
1. Step		1 - 3
2. Step		6 - 8
Spark plugs		17 - 33
Cylinder head bolts		
- torque/angle-of-rotation method		
1. Stage/steps 1-3	10 bolts M 11	20 - 30
2. Stage/steps 1-3	tighten degrees of rotation	65° (± 5°)
3. Stage	tighten degrees of rotation	130° (± 5°)
	2 bolts "A" M 8	24 - 27
	1 bolt "B" M 8	31 - 34
Camshaft bearing caps		22 - 26
Studs for exhaust manifold		12 - 16
Exhaust manifold to block		21 - 25
Lifting eye fitting on cylinder head		23 - 28
Crankcase Area		
Crankshaft main bearing		90 - 109
Connecting rod, bearing cap		
1. Step		6 - 8
2. Step		15 - 20
3. Step	tighten degrees of rotation	+ 90° (± 5°)
Bolts for belt-pulley (vibration damper)		
1. Step		15 - 18
2. Step	tighten degrees of rotation	+ 85° (± 5°)
Moulding, oil pan mount, front		23 - 28
Flywheel automatic/manual		82 - 92
Retainer, rear radial seal		8 - 11
Locating studs for oil pan, crankcase		6 - 8
Oil pan, nuts and bolts		8 - 10
Oil induction pipe to block		9 - 13
Oil screen plate to main bearing		17 - 21
Oil drain plug to oil pan		21 - 28
Studs for camshaft bearing caps		18 - 23
Oil plugs, crankcase		19 - 25
Oil-pressure switch to crankcase		18 - 22
Adapter oil filter mount		14 - 21
Oil filter to adapter, crankcase		12 - 15
Water pump to engine block		20 - 25
Water pump inlet, elbow		8.5 - 11.5
Attachment breather pipe, crankcase ventilation		8 - 10

2. Torque-Wrench Settings (cont'd)

	Nm
Timing Chain Area	
Fastening bolts, camshaft drive sprockets	55 - 63
Slipper-guide, timing chain, upper	10 - 13
Slipper-guide, timing chain lower	24 - 28
Chain tensioner for oil pump	10 - 13
Fastening bolts, drive sprocket oil pump	16 - 19
Oil pump to crankcase	8.5 - 11.5
Chain housing cover, upper	6.5 - 9.5
Chain housing cover, lower	6.5 - 9.5
Distributor cap to chain housing cover	3 - 5
Intake Manifold Area; EFI	
Ignition cable holder	3 - 5
Throttle valve, EFI	8.5 - 10.5
Fuel rail, EFI	21 - 26
Intake Manifold Area; Carburettor	
Carburettor to intake manifold	8 - 10

Abbreviations

2V-TLD	- Double Venturi-Carburettor
A/C	- Air Condition
ACT	- Air Charge Temperature Sensor
ATS	- Automatic Transmission Solenoid
CCO	- Converter Clutch Override
CO	- Carbon Monoxide
CPS	- Crank Position Sensor
CTS	- Coolant Temperature Switch
DOHC	- Double Over-Head Camshaft
ECE	- Economic Comission for Europe
ECT	- Engine Coolant Temperature Sensor
EEC	- European Economic Community
EEC IV Module	- Electronic Engine Control IV Module
EFI	- Electronic Fuel Injection

ESC	- Electronic Spark Control
EVAP	- Evaporative Emission Control System
EVR	- Elektronic Vacuum Regulator
HC	- Hydrocarbons
HEGO Sensor	- Heated Exhaust Gas Oxygen Sensor
HT	- High Tension Voltage
ISC	- Idle Speed Control Valve
KAM	- Keep Alive Memory
LOS	- Limited Operation Strategy
MAP	- Manifold Absolute Pressure Sensor
NDS	- Neutral Drive Switch
NO_x	- Oxides of Nitrogen
PCV	- Positive Crankcase Ventilation
PIP	Profile Ignition Pulse
SAW	Spark Advanced Word Signal
SPOUT	- Spark Out signal
STAR Tester	- Self Test Automatic Readout Tester
STI	- Self Test Input
STO	- Self Test Output

TFI Module	- Thick Film Ignition Module
TWC	- Three Way Catalyst
TPS	- Throttle Position Sensor
VSS	- Vehicle Speed Sensor

Emission Level:

EURONORM 15.04	- European Emission Standard for vehicles without Catalytic Converter (old version ECE 15.04 or EEC 15.04)
EURONORM 88/76	- European Emission Standard for vehicles with unregulated Catalytic Converter (old version ECE 15.05, NEW EEC or 5th Amendment
83 US	- US-Emission Standard for vehicles with Regulated Catalytic Converter valid since 1983. (old version FTP 72/49 or 83 US)

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