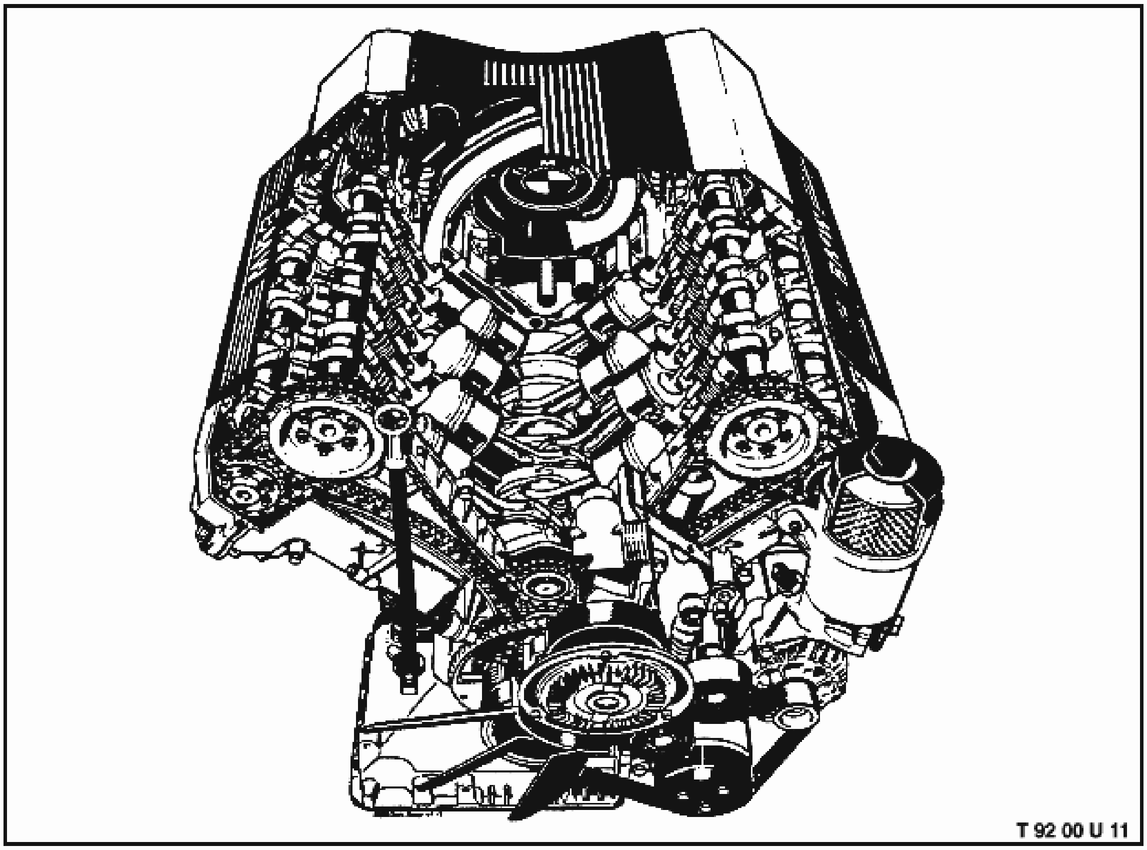

SUBJECT: 4.0 Liter V8 Engine (M60)

MODELS: 740i E32

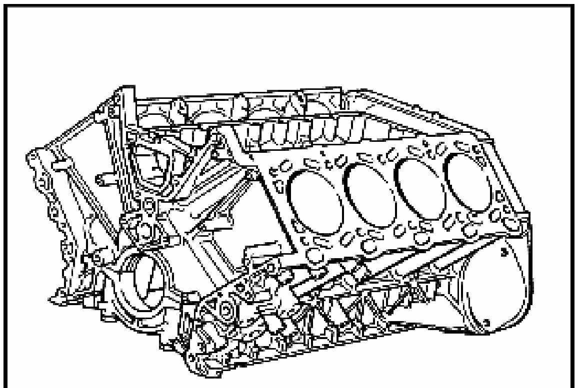
Situation: BMW has developed a new eight cylinder (V8) four valve engine, known internally as the M60, which will be found in the E32 740i and 740iL models.



The introduction of the M60 engine continues the tradition of the other BMW multi-valve engines providing a high specific power output - 21 OKW/282HP @ 5800 rpm, a generous torque curve - 400Nm @ 4500 rpm (= maximum torque) and low emission and fuel consumption levels.

Additional design features incorporated on the new M60 V8 engine include: 90° cylinder arrangement with two four-valve cylinder heads, two overhead camshafts per cylinder bank, driven by the crankshaft via a double chain (primary drive) and 2 double chains (secondary drive), valve actuation via self-adjusting hydraulic valve tappets, and light alloy engine construction. The coolant pump/fan, alternator and air-conditioning compressor are driven by two poly-ribbed V-type drive belts. Direct solid state ignition with separate coils mounted above the spark plugs, and a new generation of Digital Motor Electronics - DME 3.3 are also incorporated.

The key advantages of the M60 engine include: the enhancement of BMWs image in the luxury car class, outstanding performance, low fuel consumption, high quality and reliability, optimum acoustics and great comfort, low engine weight, and easy servicing.



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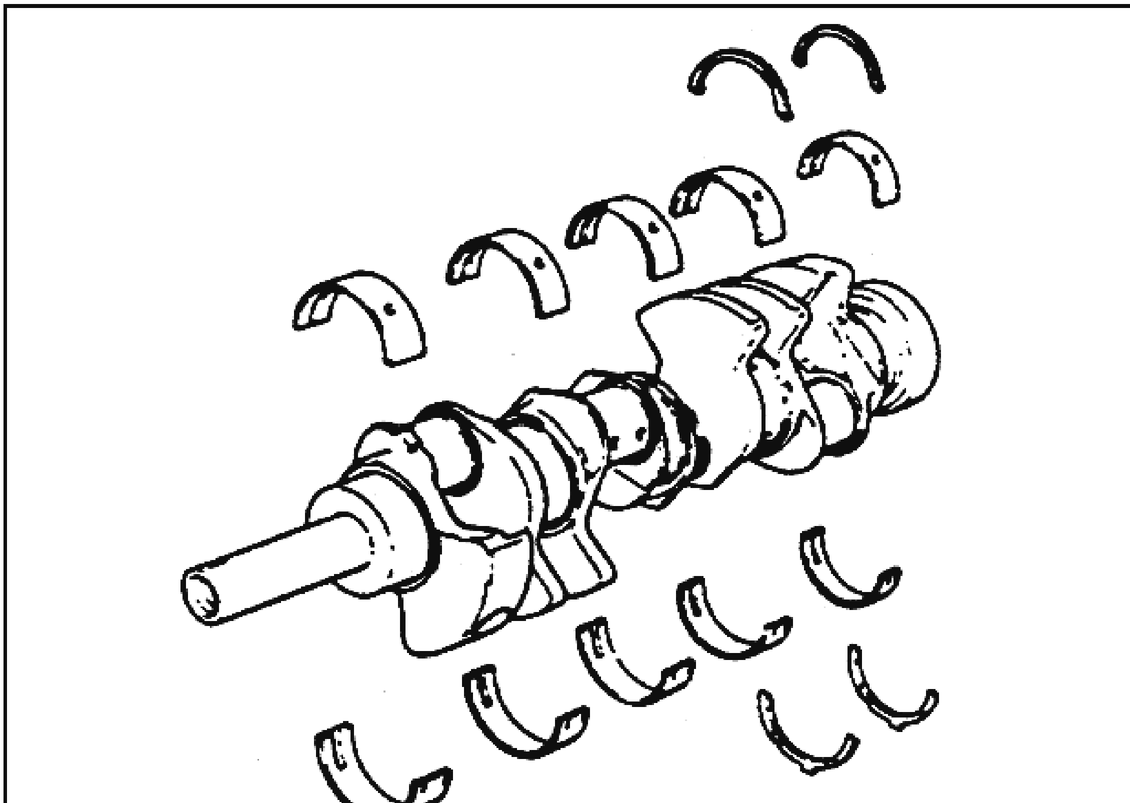
The crankcase is cast from aluminum alloy and has nickel dispersion-coated cylinder bores. The bore size of the M60 B40 engine is 89mm.

The main bearing caps are secured by two M10 and two M8 bolts with threaded support bushings similar to the M70.



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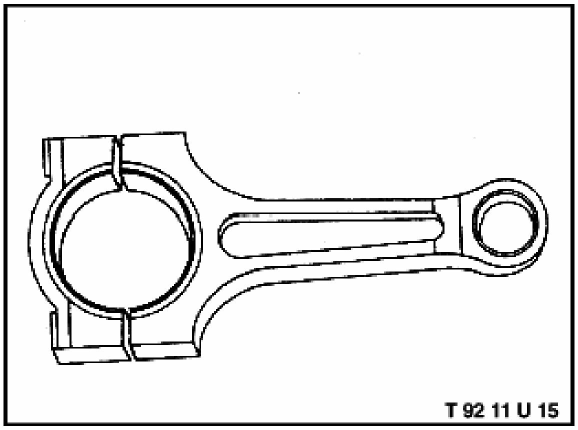
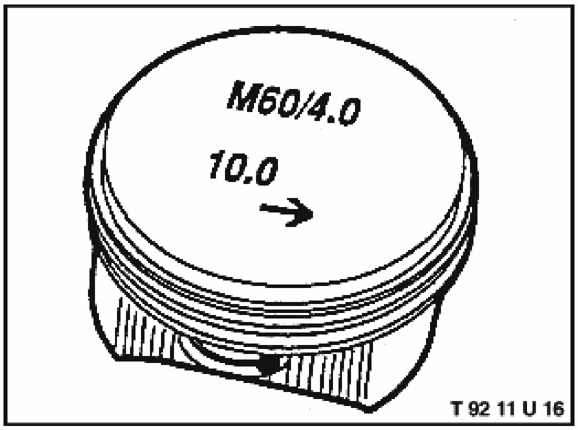
The forged crankshaft is supported in 5 main bearings and has two large and four small balance weights to ensure extremely smooth running. Main bearing 5 is the thrust bearing which uses 4 semi-circular thrust washers for the axial play adjustment. The 3-layer main bearing shells conform to the BMW tri-color classification.



Connecting rods made of sintered metal are being used for the first time in a series production BMW engine. Lower weight and great tensile strength promotes a smooth running engine and ensure reliable operation even at higher speeds. The sintered connecting rod is forged in one piece. The cap is then split off from the main part of the rod leaving rough surfaces on both the cap and rod. Centering of the cap on the rod is carried out through the structure of the split thus eliminating the need for alignment sleeves. The accuracy of the sintering process guarantees that all connecting rods fall into a single weight category which eliminates weight calibration.



The pistons have a flat piston crown and are nickel-plated for improved noise transfer to the knock sensors. The compression ratio of the M60 B40 engine is 10.0:1.

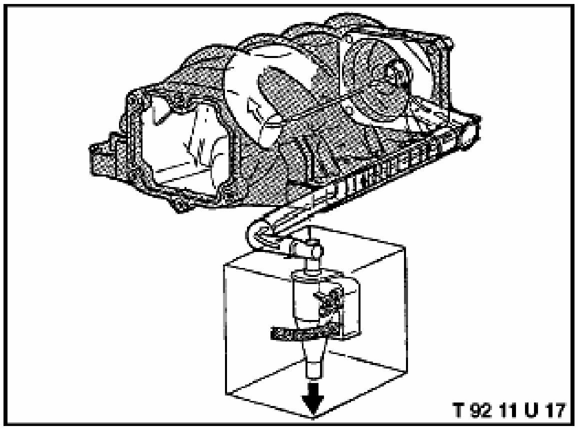
The piston rings have the following configuration:

Top	- Plain compression ring (with-out chamfer)
Middle	- Scraper ring (with micro-chamfer)
Bottom	- Slotted oil control ring with spring (3 piece)

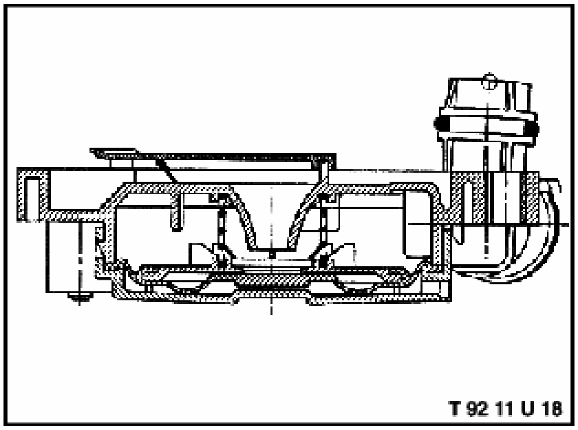
The oil filter housing is mounted vertically and has a plastic cover which is torqued to 23-27 Nm (17-20 ft. lbs.). The oil in the housing is drained into the oil pan through a valve in the bottom of the housing which opens when the oil filter is removed.

An oil filter bypass valve is mounted in the filter element which opens at a pressure of 2.5 + 0.5 bar. To prevent the oil passageways from bleeding down after the engine has been switched off, a check valve is installed in the oil feed side of the filter housing.

The engine oil capacity including oil filter housing volume is 8.0 U.S. quarts (7.5 liters).

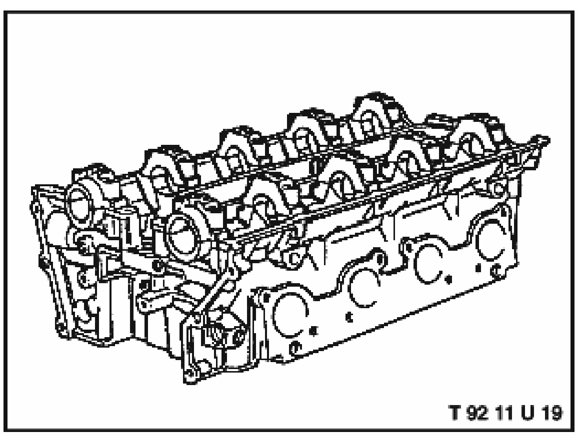


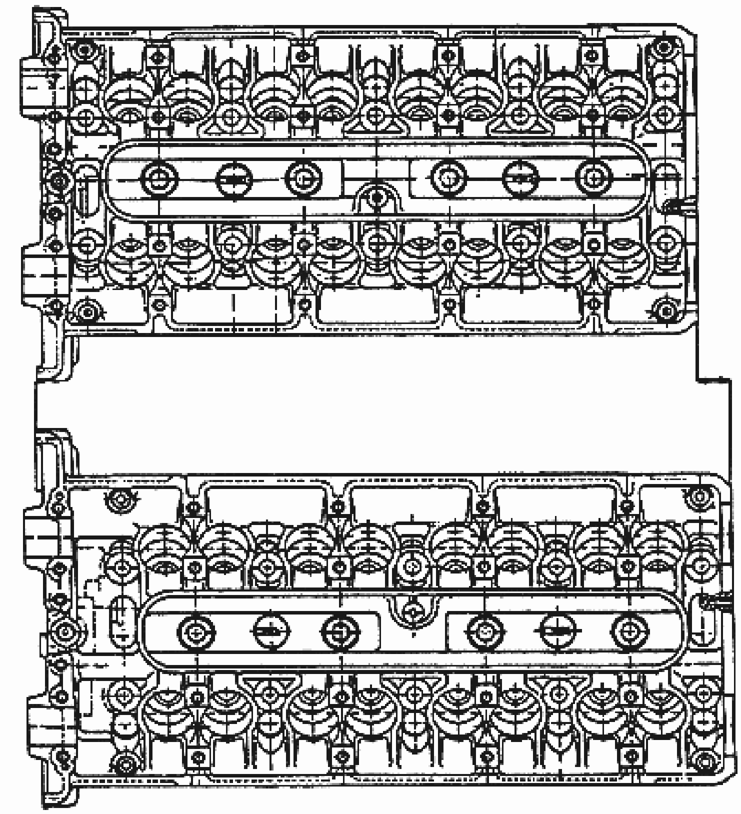
The crankcase is ventilated by a pressure-controlled system. The oil vapors in the crankcase enter a cyclone-type liquid/vapor separator which allows the liquid oil to return to the oil pan and the oil vapors to be drawn into the intake manifold via a pressure control valve.



The pressure control valve is centrally located in the rear end cover of the intake manifold and is connected directly to the cyclone-type separator via an aluminum pipe. It varies the pressure in the crankcase continuously depending on engine load and speed conditions. This prevents blue exhaust smoke and excessive oil consumption on deceleration due to peaking manifold vacuum, and assures reliable crankcase venting during all other engine operating conditions.

The M60 four valve cross flow cylinder heads are constructed without separate camshaft housings which reduces production costs and simplifies the production process. They are made of die cast aluminum and incorporate the timing chain housing.

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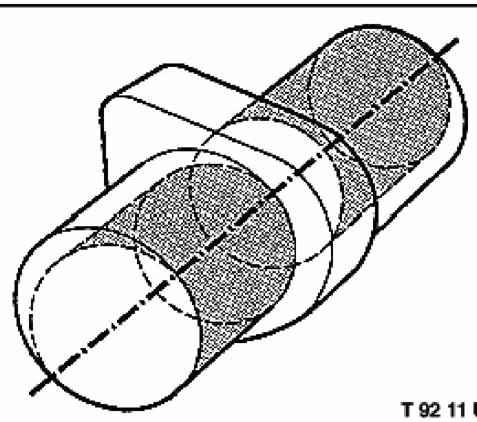
The cylinder heads and the two camshafts for each bank of cylinders are of different lengths.

The combustion chambers are machined into the cylinder heads using endface and spherical milling cutters, to minimize volume tolerances thereby achieving higher idle quality as compared to the cast combustion chambers.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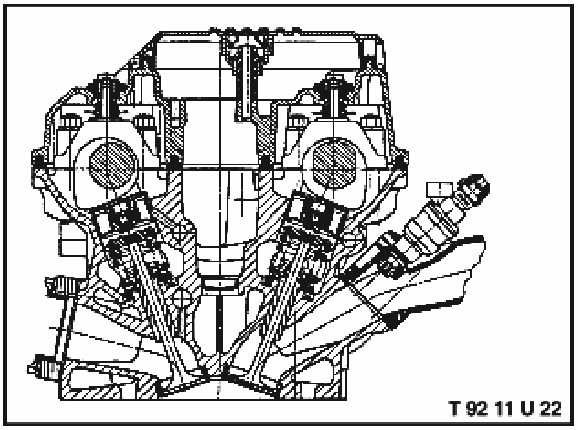
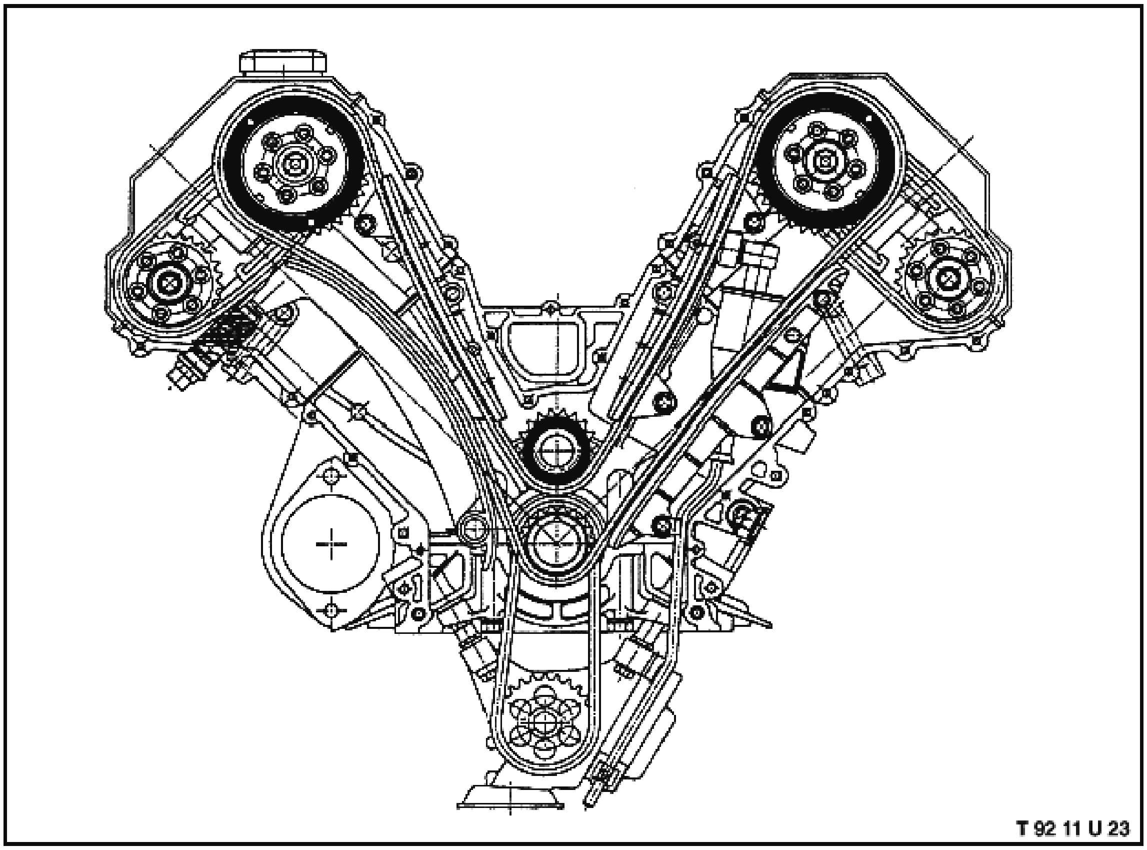
The double overhead camshafts are solid castings and rotate in five bearing journals. To compensate for the camshaft lobe imbalance, counter weights in a crank shape have been incorporated in the camshaft design.

The intake and exhaust camshafts have different valve opening periods: intake valves 246°, exhaust valves 242°.

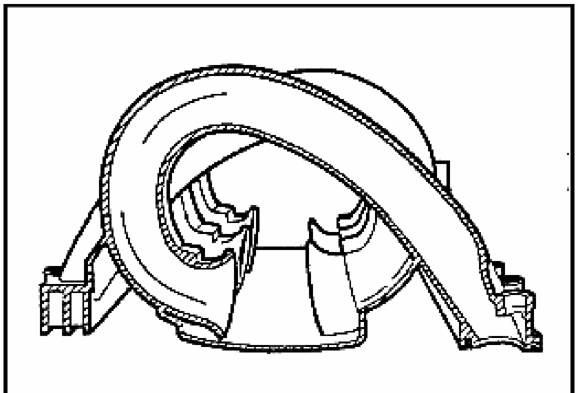
The valve angles are identical to the M50 engine with the intake valves at 20°15' and the exhaust valves at 19°15'.



Bucket-type tappets with hydraulic lash adjusters are used for maintenance-free valve operation. Valve stem diameters are reduced to 6mm and valve diameters are 35mm on the intake and 30.5mm on the exhaust valves. The reduced valve mass allows for lower valve spring forces and reduced internal friction on the engine thus decreasing fuel consumption.



The intake camshafts are driven via a double roller chain (primary chain) off the crankshaft. Tensioner rails with plastic coating and rubberized sprockets ensure low friction and low noise levels in the valve train drive. The exhaust camshafts are driven off the intake camshafts also via double roller chains (secondary chains).



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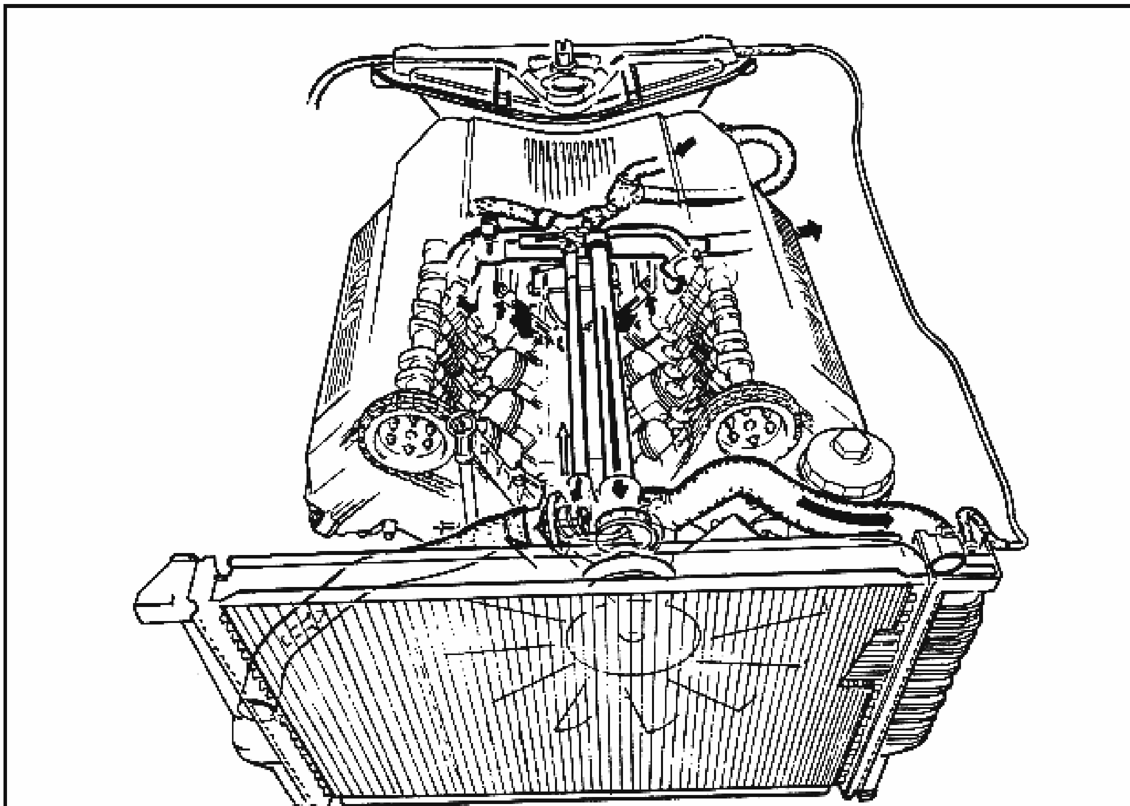
The one-piece injection-molded plastic intake manifold has extremely smooth internal surfaces which reduce uncontrolled air swirling and therefore do not require separate machining during production.

All eight fuel injection valves, the fuel pressure regulator and the U-shaped fuel rail are mounted on the intake manifold. The throttle body is located on the front with the pressure control valve for the crankcase ventilation system integrated into the rear cover of the intake manifold.

The complete air intake manifold system is concealed beneath a plastic cover which is lined with noise-absorbent material for very effective noise reduction and improved engine appearance.



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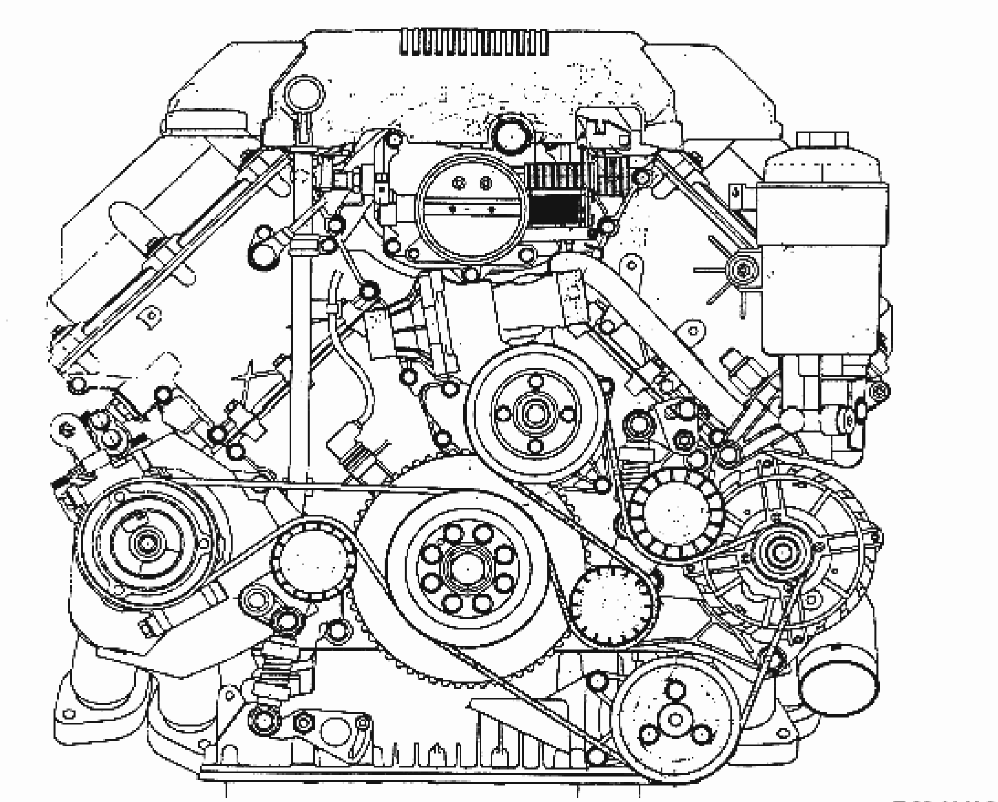
The coolant system incorporates an aluminum pressure cast water pump, with integrated thermostat housing, which is bolted to the timing chain case and sealed by a flat gasket with a polyurethane bead. The thermostat is calibrated to open at 85℃

(185°F) and is secured into the water pump housing by a plastic cover.

The coolant system has been designed as a continuous bleeding system, which eliminates the need for bleed screws or hoses.



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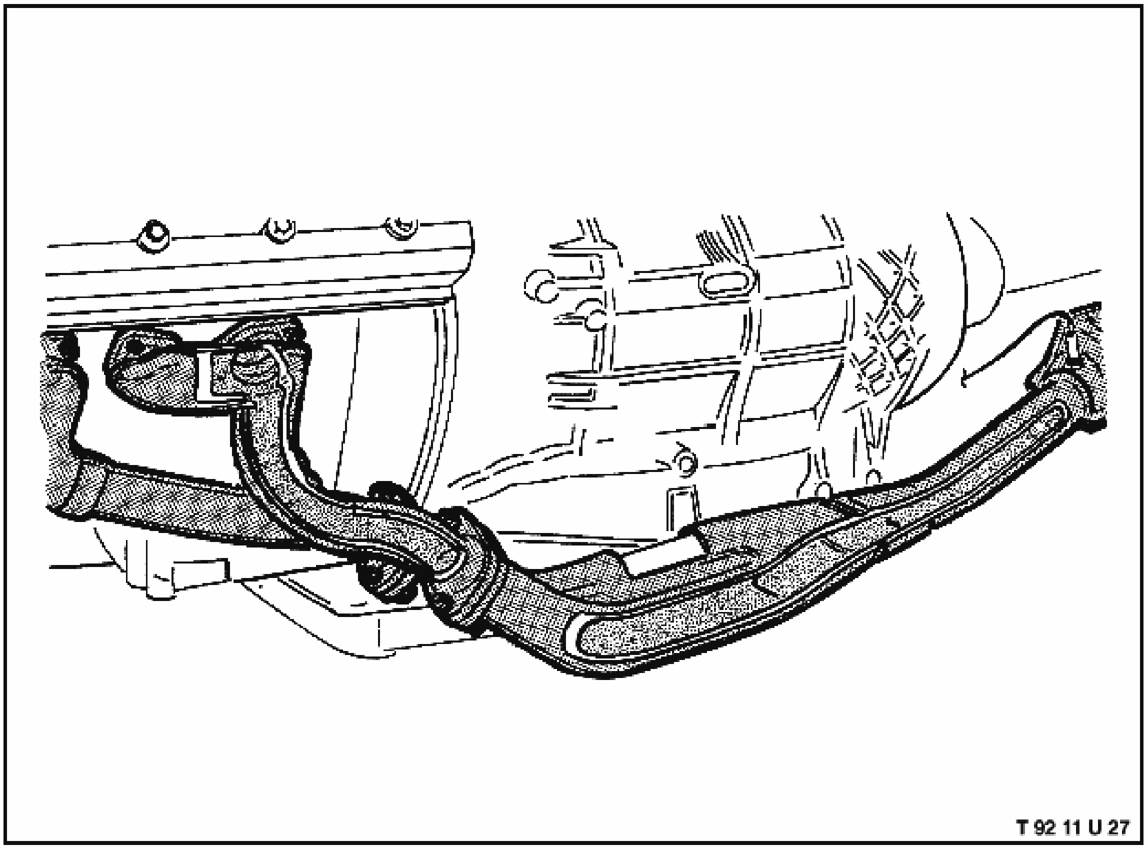
Two poly V-belts drive all accessory component rotary drives. The first belt drives the air conditioning compressor. The second belt drives the power steering pump, alternator and water pump.

The belt tensioners for both drives are mechanically dampened by spring tension.



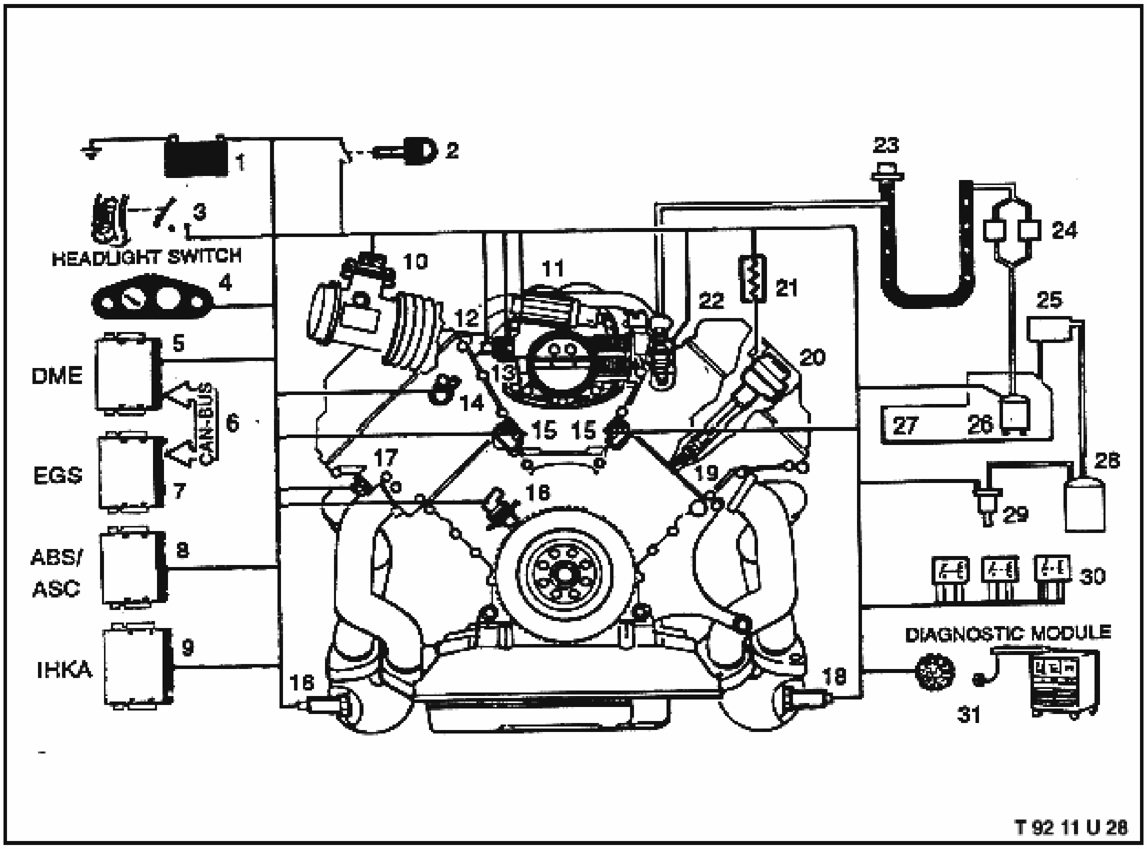
The engine's exhaust gases are fed from the exhaust ports to the catalytic converter in double-jacketed exhaust manifolds and down pipes. The inner and outer pipes have a 3.5mm air gap between them for heat insulation.

The inner pipe is thin-walled (1mm) and therefore does not have the capacity to absorb as much heat from the exhaust gas. The insulating effect of the air gap between the inner and outer pipes allows for a low heat loss thus preventing the exhaust gas from rapidly cooling down. As a result, the catalytic converter is activated earlier and can start to reduce the exhaust emissions shortly after a cold engine is started.

The advantages of the insulation principle are: rapid start of the catalytic action, the oxygen sensors are ready to operate sooner and the surface temperature of the exhaust manifold and down pipes is reduced by approximately 400℃ (750℉) compared to the conventional cast manifold and single wall down pipes, thus reducing under-hood temperatures.

The engine control module used on the M60 engine is the Digital Motor Electronics (DME) M3.3 system manufactured by Bosch. The most notable differences between DME M3.1 and DME M3.3 are the addition of knock control, dual oxygen sensor control, and a high speed data bus between the transmission and engine control modules called CAN (Controller Area Network).

OVERVIEW OF DME M3.3 (M60 ENGINE)



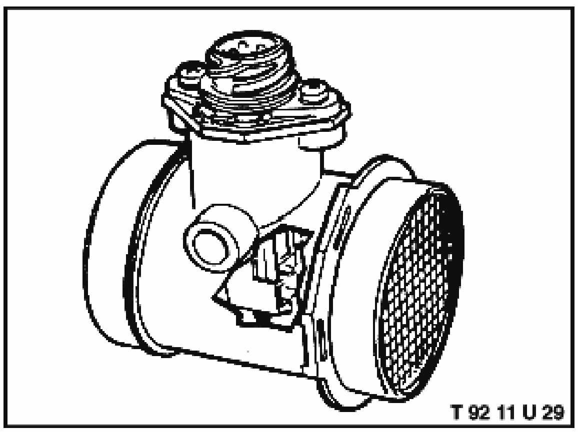
1. Battery
2. Ignition Switch
3. Light Switch
4. Instrument Cluster
5. Engine Control Module (DME)
6. CAN - Bus
7. EGS Control Module
8. IHKA Control Module
9. ABS/ASC Control Module
10. Hot Film Mass Air Flow Sensor
11. Idle Speed Control Valve
12. Intake Air Temperature Sensor
13. Throttle Position Sensor
14. Camshaft Position Sensor
15. Knock Sensors (4)
16. Crankshaft Position Sensor
17. Coolant Temperature Sensor
18. Oxygen Sensors (2)
19. Spark Plugs (8)
20. Ignition Coils (8)
21. Shunt Resistor (Engine Ignition)
22. Fuel Injectors (8)
23. Fuel Pressure Regulator
24. Twin Inline Fuel Filters
25. Fuel System Liquid/Vapor Separator
26. Fuel Pump
27. Fuel Tank
28. Charcoal Canister
29. Fuel Tank Vent Valve (Purge)
30. DME Relays, 1. Main Relay 2. 0_2 Sensors Heating, 3. Fuel Pump
31. Diagnostic Plug (TXD,RXD)

DME 3.3/3.1 Comparison

	METHOD OF CONTROL	
FUNCTION	**DME M3.1**	**DME M3.3**
FUEL INJECTION	Up to 6 cylinders sequentially (SEFI-sequential fuel injection)	Up to 8 cylinders individually (CIFI-cylinder individual

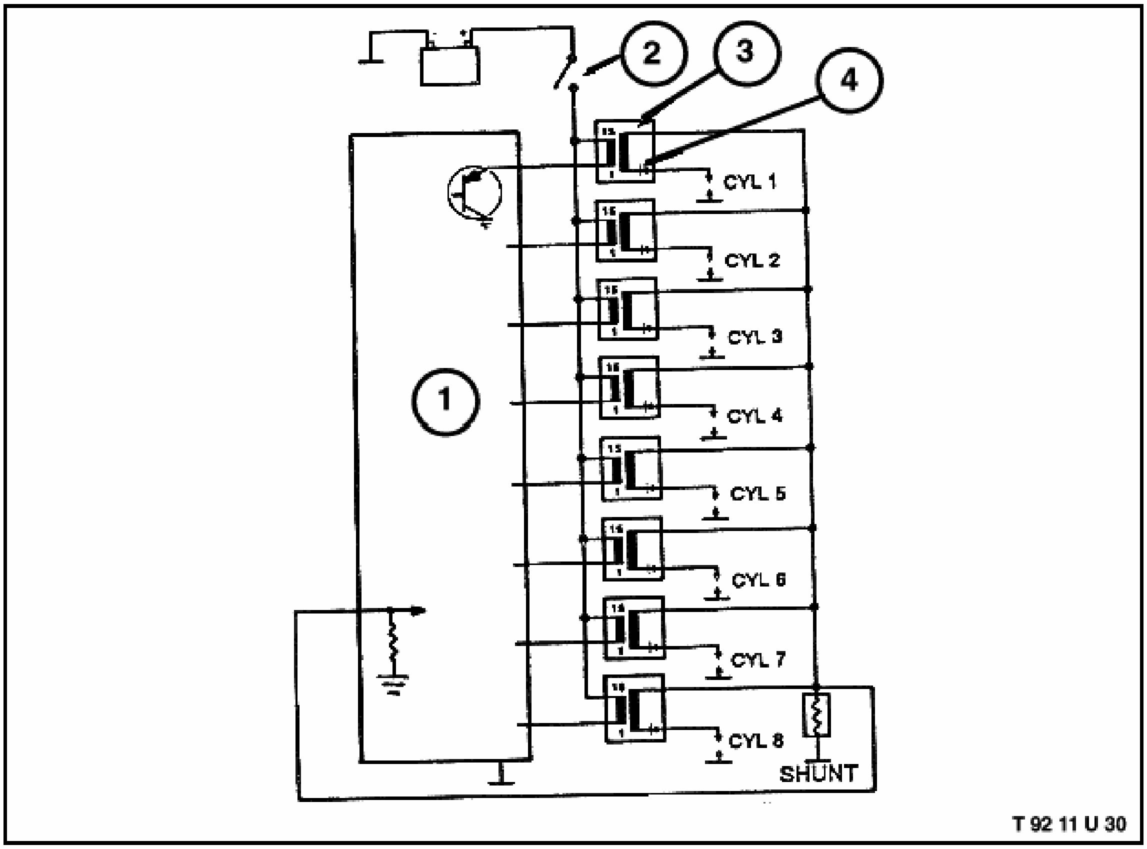
		fuel injection)
	Hot-wire mass air flow meter (HLM)	Hot-file mass air flow meter (HFM)
	Single oxygen sensor control	Dual oxygen sensor control (two sensors)
IGNITION	Individual primary control for up to 6 cylinders	Individual primary control for up to 8 cylinders
	Fault monitoring of primary circuit	Fault monitoring of primary and secondary circuits
KNOCK CONTROL	Not installed	4 knock sensors capable of monitoring all 8 cylinders individually
CAN (CONTROLLER AREA NETWORK)	Not installed	Installed

While not presently used in this manner, the software of the Cylinder Individual Fuel Injection (CIFI) system can be programmed for each cylinder on an individual basis, i.e. the duration of injection can differ for the individual cylinders. Presently, the duration of injection is the same for all cylinders.



A hot film mass air flow sensor is used for the first time on the M60 engine. The hot film air mass metering principle means that the sensor does not have to be burned clean after the engine is switched off. Any dirt deposits on the surface have no direct influence on the sensor signal, due to the protective film which is self-cleaning at the constant high operating temperatures.

Secondary circuit monitoring is accomplished by using a shunt (resistance) in the common secondary ground lead of the individual coils. The engine control module monitors the voltage drop across this resistor to verify that the secondary voltage threshold has been exceeded, indicating that ignition has taken place in the individual cylinder.



1	DME Control Module	2	Ignition Switch
3	Ignition Coils	4	Diode

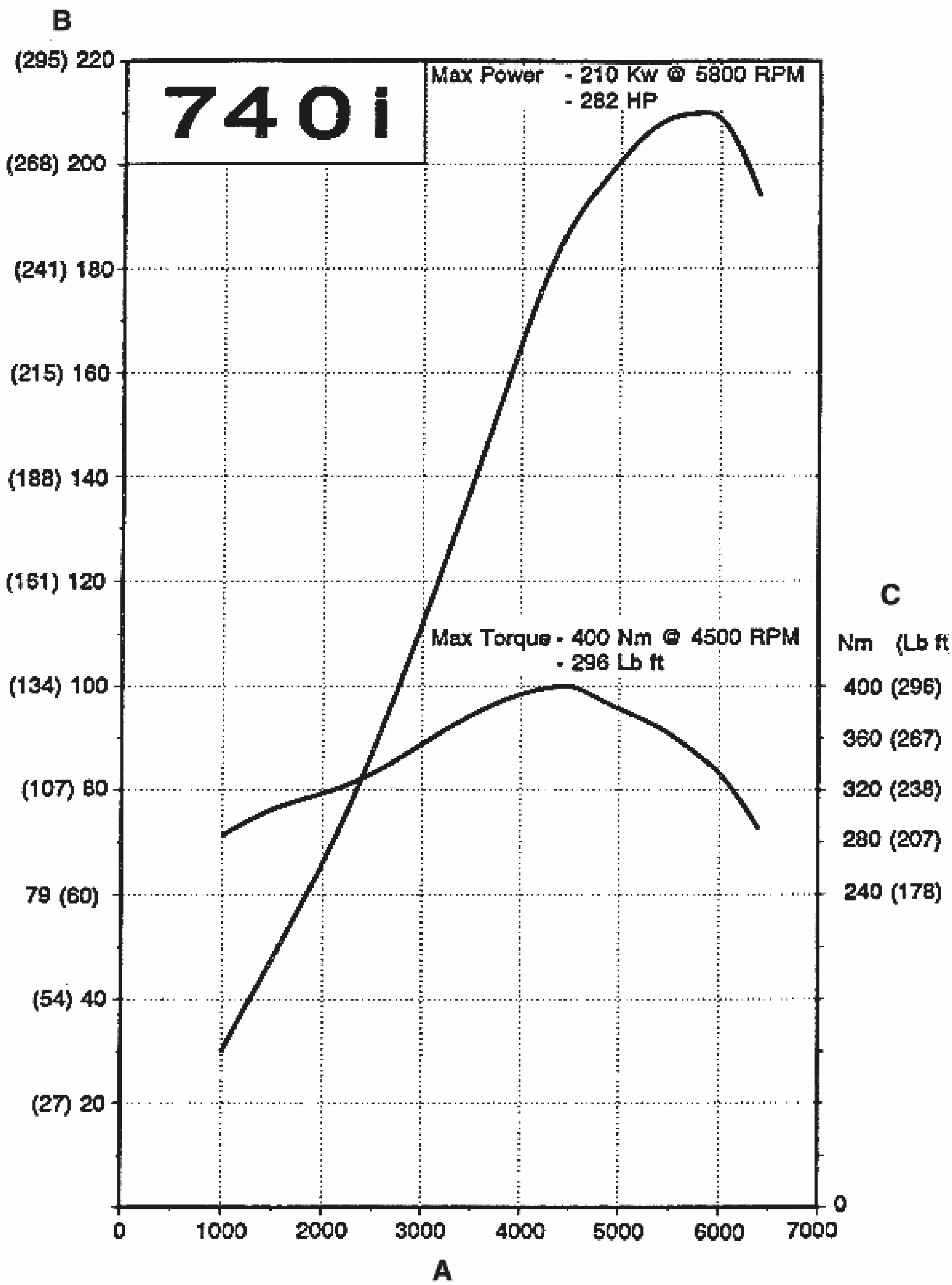
SECONDARY IGNITION MONITOR INPUT

The CAN bus is a high speed data bus between the engine and transmission control module which allows the data to be transmitted in digital form (a "1 " or "O"). Previously, these data were converted into a different form of signal, i.e. a pulse of variable length and constant frequency, then converted back to digital form at the receiving control module. The CAN bus eliminates the need for this conversion of data and results in a more reliable method of data exchange. (See TRI 24 01 92 (2127) for details on CAN bus.)

Technical Data

Engine designation	M60 B40
Engine code	40 8 51
Design	90°V8 cylinder
Displacement	3982cc (243 cu. in.)
Stroke	89mm (3.504 in.)
Bore	80 mm (3.149 in.)
Maximum power	210 KW (282 HP)
At engine speed	5800 RPM
Maximum torque	400 Nm (296 lb. ft.)
At engine speed	4500 RPM
Maximum permitted engine speed	6500 RPM

Compression ratio	10:1
Intake valve diameter	35.0mm (1.378 in.)
Exhaust valve diameter	30.5mm (1.201 in.)
Minimum oil pressure at idle/max speed	0.5 bar (7 psi) / 4.5 bar (66 psi)
Oil capacity with oil filter	7.5 ltr. (8.0 qts.)
Coolant thermostat (opening temp.)	85℃ (185℉)
Engine Control	Digital Motor Electronics (DME) M3.3
Firing order	1-5-4-8-6-3-7-2
Spark plug (dual electrode) electrode gap	0.9mm 0.035 in., non adjustable
CO value at idle	0.7 ± 0.5%, non adjustable
Idle speed	600 ± 50 RPM
Recommended fuel	Unleaded gasoline of at least 89 AKI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(295) 220
(268) 200
(241) 180
(215) 160
(188) 140
(161) 120
(134) 100
(107) 80
79 (60)
(54) 40
(27) 20
740i
Max Power - 210 Kw @ 5800 RPM
- 282 HP
Max Torque - 400 Nm @ 4500 RPM
- 296 Lb ft
C
Nm (Lb ft
400 (296)
360 (267)
320 (238)
280 (207)
240 (178)
0
0
1000
2000
3000
4000
5000
6000
7000
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