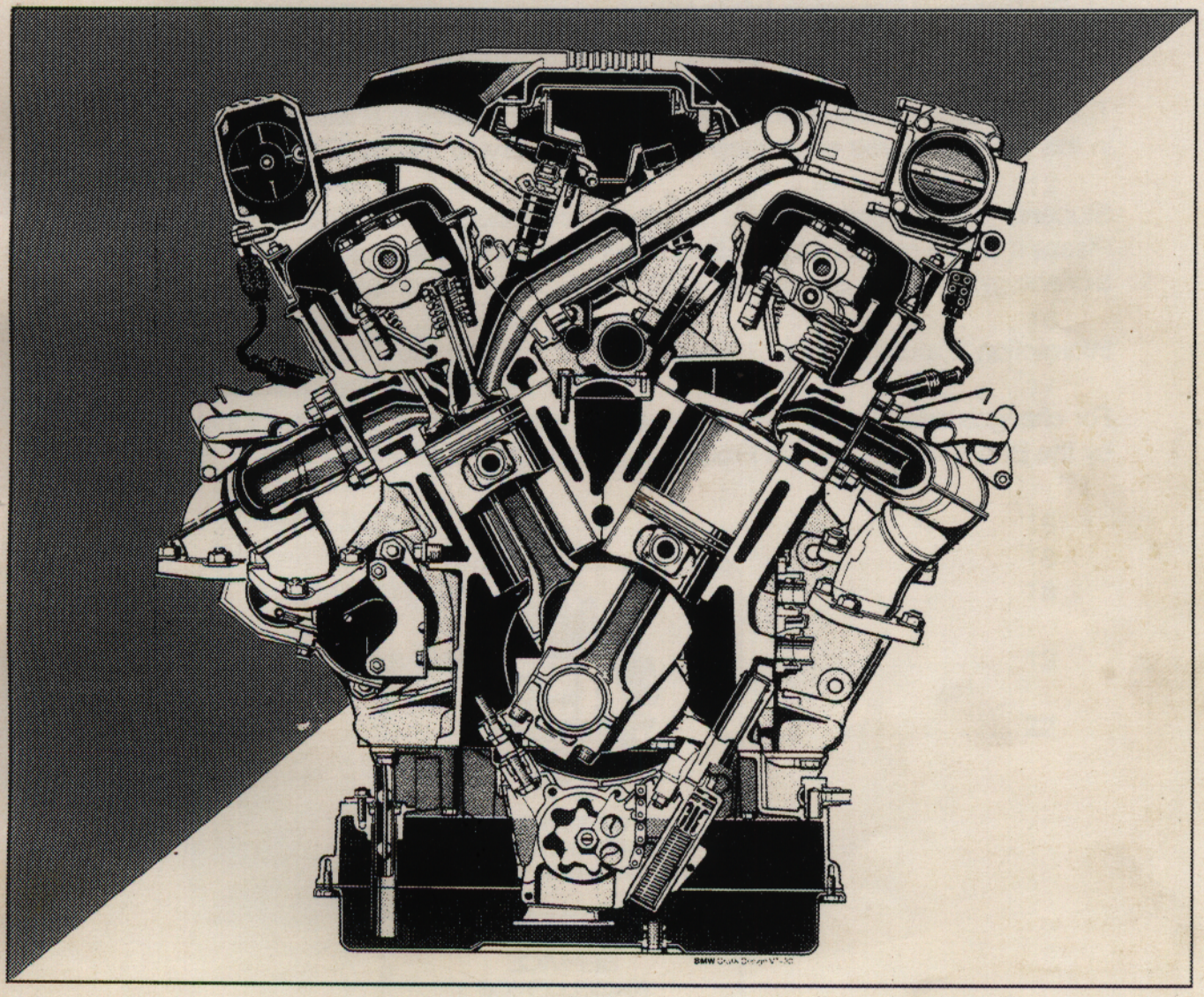
M73 Engine

Training Reference Manual



BMW of North America, Inc.
Service Training Department

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INTRODUCTION

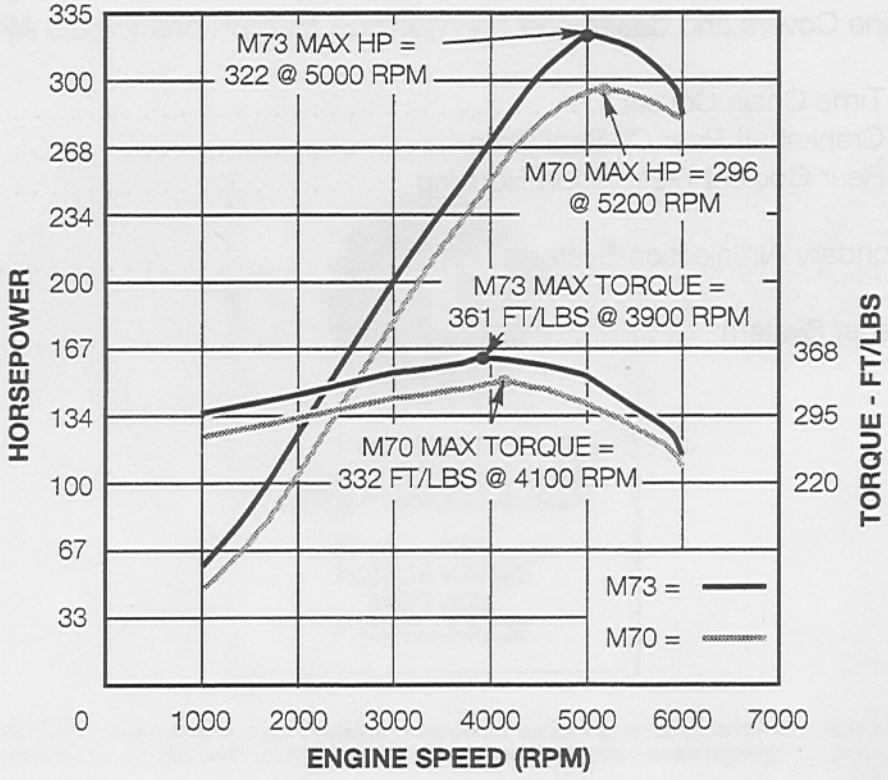
BMW is proud to present the new 5.4 liter, 12 cylinder engine. Designated M73, it's design is based on the proven 5.0 liter M70 engine from the previous E32 and E31 models.

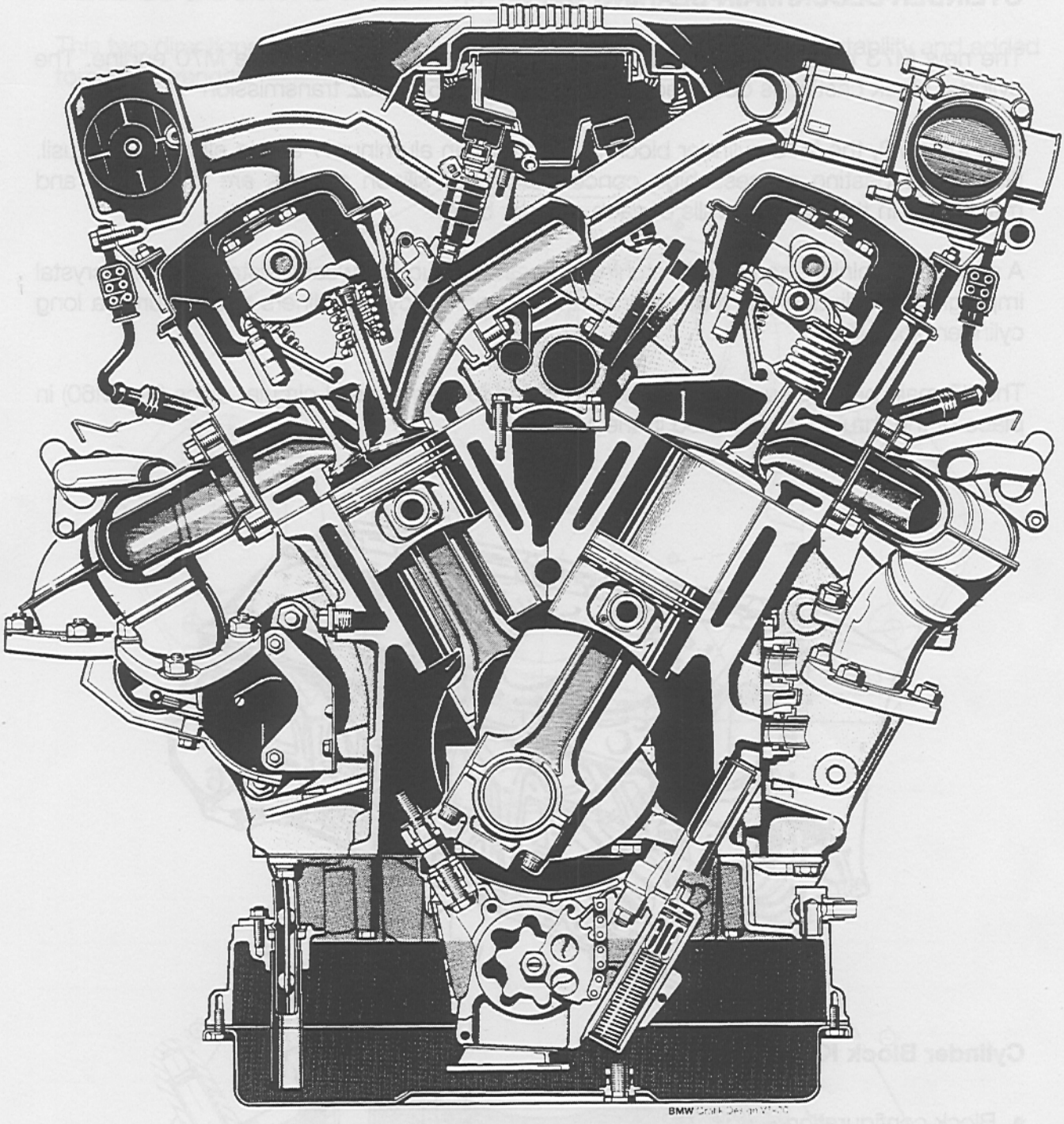
The M73 will replace the M70 and be installed in the E38 750iL and the E31 850Ci. In both of these vehicles the 12 cylinder will only be available mated to the A5S 560Z 5 speed automatic transmission currently found in the 8, 7 and 5 series vehicles with the 4.0 liter M60 engine.

The M73 incorporates many technical advancements which allow it to produce more power and torque output while providing improved fuel economy.

Like the M70, the M73 is managed by two separate Motronic Control Systems (one per cylinder bank). Manufactured by Bosch, the M 5.2 Motronic system is the next generation of engine control. It incorporates features that allow it to comply with the OBD II requirements for the EPA. M5.2 will be covered in its segment of this training course.

Additionally, the EML throttle control system of the M73 engine is new for BMW and is designated EML IIIs. Manufactured by Siemens, EML IIIs is completely redesigned and functions differently as compared to previous EML systems. EML IIIs will also be covered in its segment of this training course.





BMW Crank Design V8-32

MECHANICAL ENGINE COMPONENTS

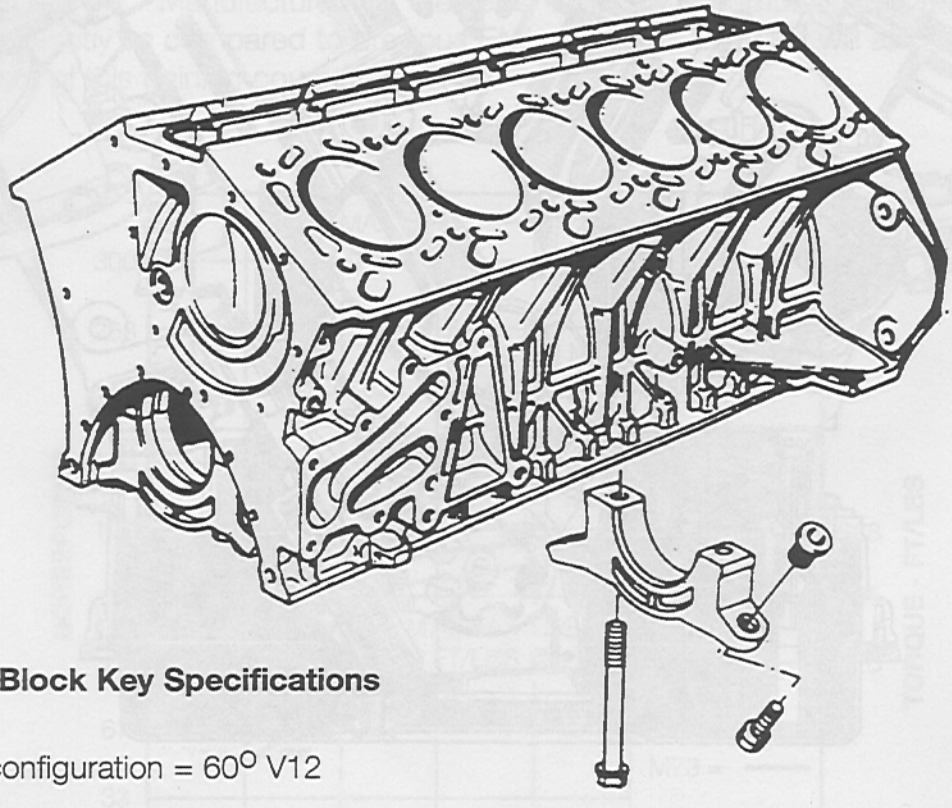
CYLINDER BLOCK/MAIN BEARING CAPS

The new M73 cylinder block and main bearing caps are similar to the M70 engine. The cylinder block casting is designed to mate with the A5S 560Z transmission

Like the M70, the M73 cylinder block is cast from an aluminum / silicon alloy called Alusil. During the casting process high concentrations of silicon crystals are introduced and maintained in the cylinder walls of each cylinder bore.

A special machining, honing and etching process produces a wear resistant, silicone crystal impregnated cylinder wall that eliminates the need for cylinder liners and assures a long cylinder block life.

The #7 main bearing support has been modified for use of semi-circular discs (like M60) in place of the thrust bearing used in the M70.

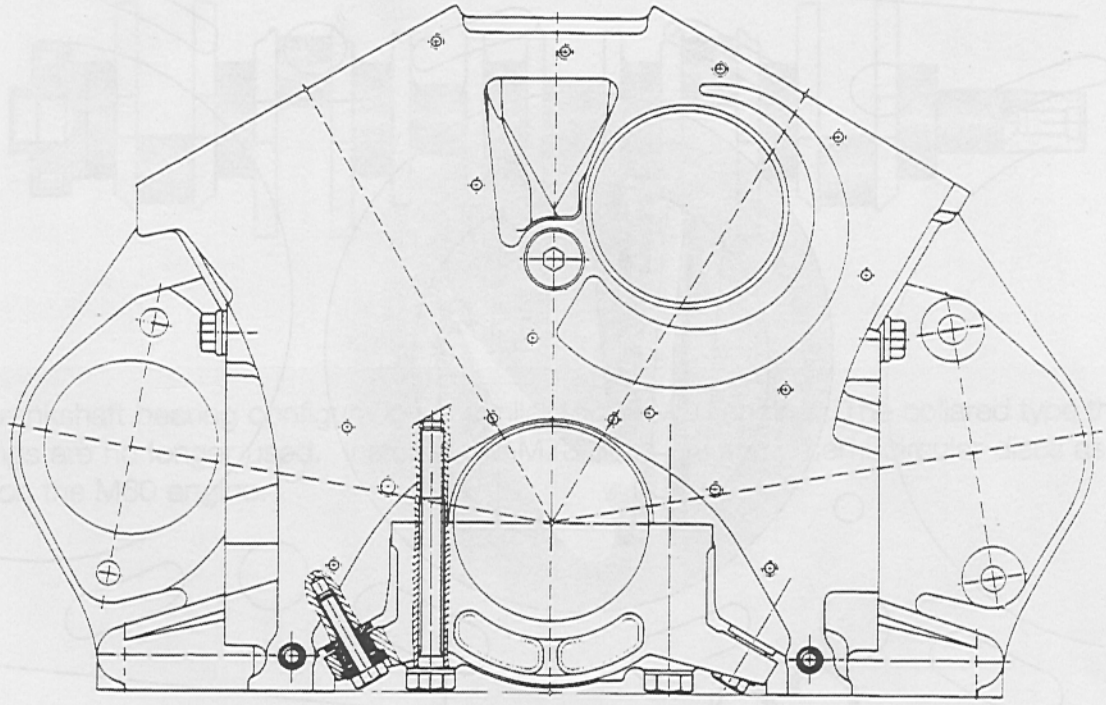


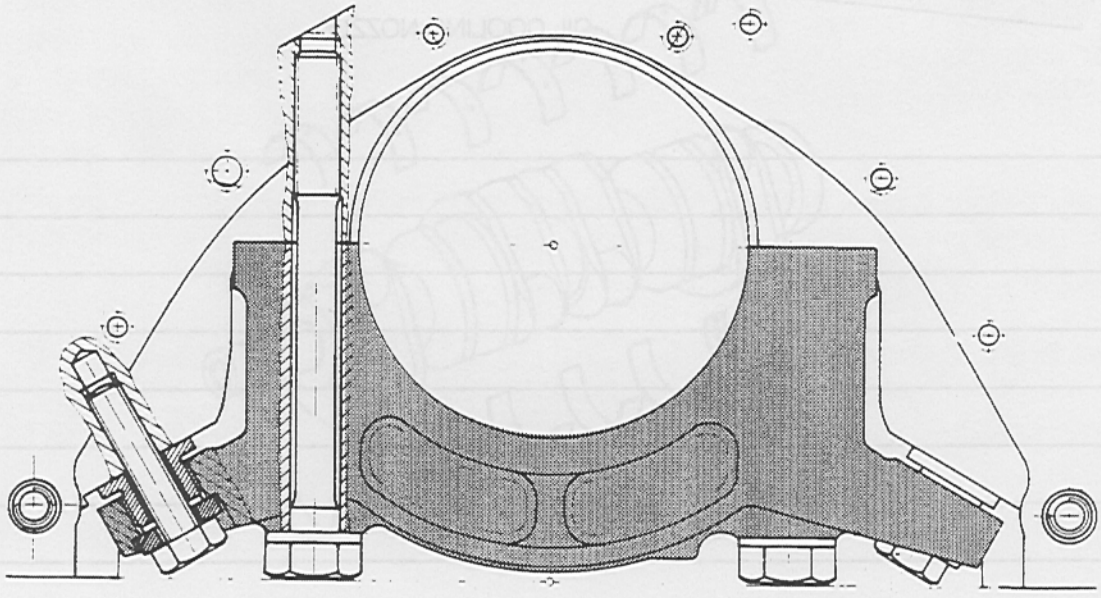
Cylinder Block Key Specifications

- Block configuration = 60° V12
- Bore = 85mm
- 91mm Bore to Bore (center) measurement

The main bearing cap design is identical to the M70 configuration. Each main bearing cap is torqued to the block with four bolts. Two are tightened to the vertical axis of the crankshaft and the other two at an opposed 60° angle (parallel to piston travel).

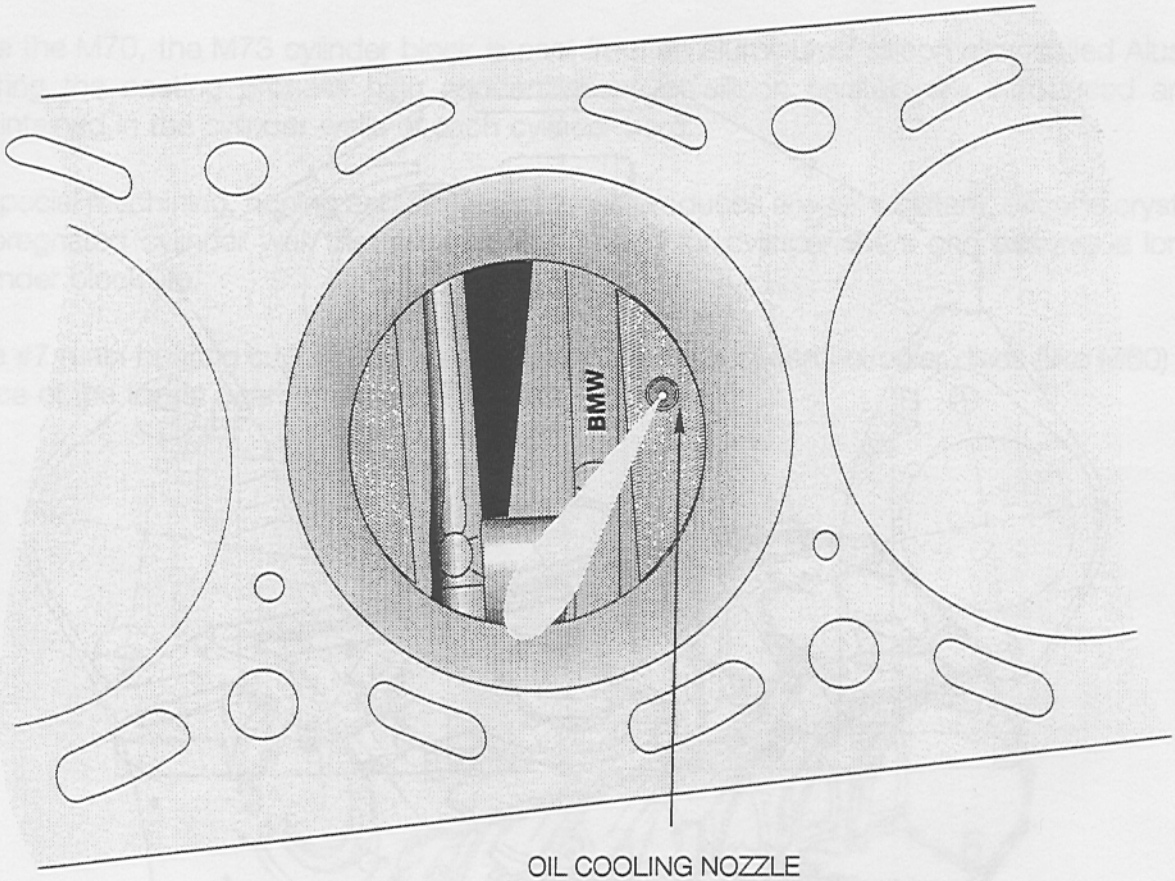
This two directional mounting of the bearing cap promotes bottom end stability and added torsional strength.





A new piston oil cooling nozzle is fitted directly into the main bearing support area of the block which accesses the main oil pressure supply. The steady oil stream from the nozzle continuously cools the underside of the piston.

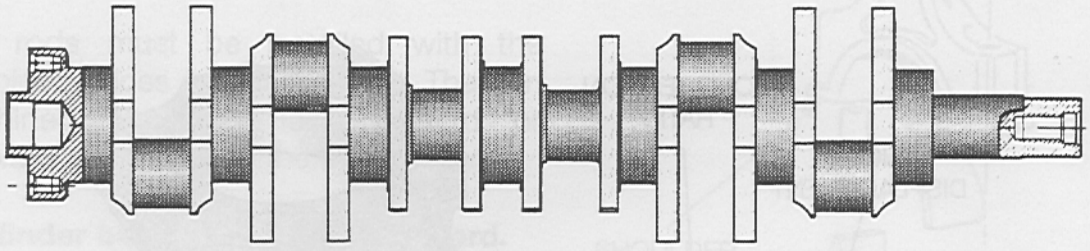
The nozzle is threaded and screws into the cylinder block with a 4mm allen wrench.



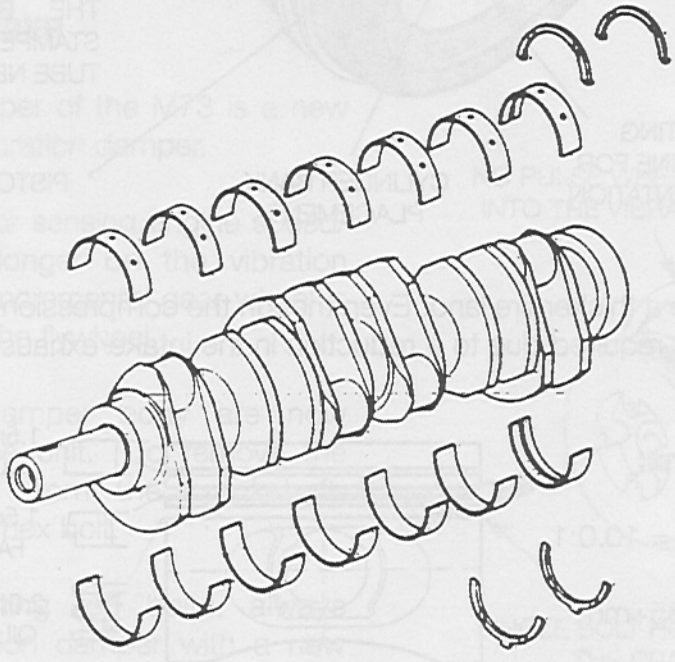
OIL COOLING NOZZLE

CRANKSHAFT

The M73 forged steel crankshaft has a stroke of 79 mm which is increased by 4mm compared to the M70. The front journal pin is also shortened to accommodate a new type of vibration damper mounting.



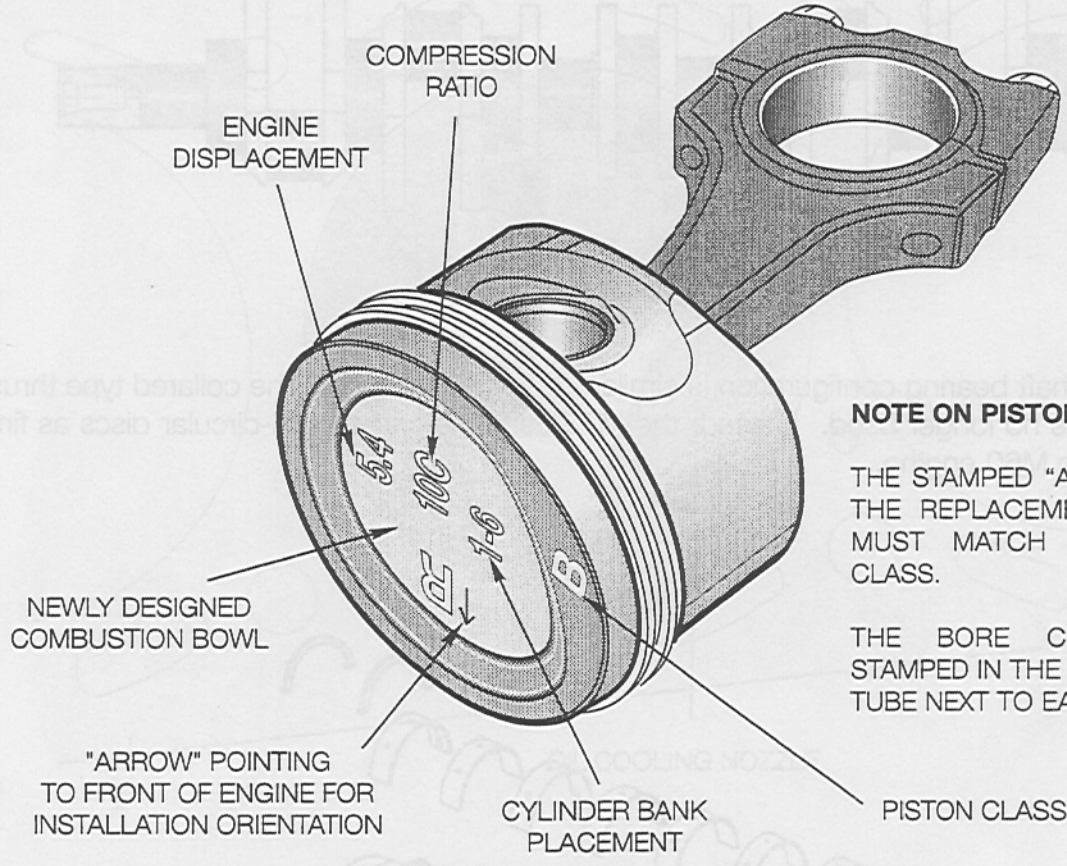
The crankshaft bearing configuration is similar to the M60 engine. The collared type thrust bearings are no longer used. Instead, the M73 uses the same semi-circular discs as first seen on the M60 engine.



PISTONS

The aluminum alloy pistons of the M73 are coated with a very thin (0.1mm) metal film. Like the M70, the pistons are different for the left and right cylinder banks to compensate for the wrist pin offset and the asymmetrical combustion chamber.

The combustion bowl on the top of the piston has been redesigned to spread the initial combustion forces evenly across the top of the piston.



NOTE ON PISTON CLASS:

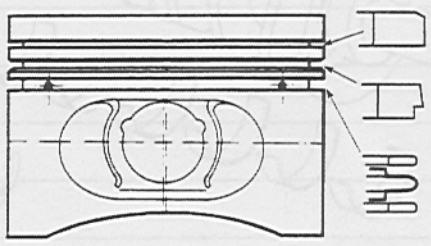
THE STAMPED "A" OR "B" OF THE REPLACEMENT PISTON MUST MATCH THE BORE CLASS.

THE BORE CLASS IS STAMPED IN THE OIL RETURN TUBE NEXT TO EACH BORE.

The new pistons have a thicker fire land. Even though the compression ratio has increased, valve notches are not required due to a reduction in the intake/exhaust valve overlap.

Piston Specifications:

- Compression Ratio = 10.0:1
- Piston Diameter = 85+mm



CONNECTING RODS

The conrods are identical to the M70 engine.

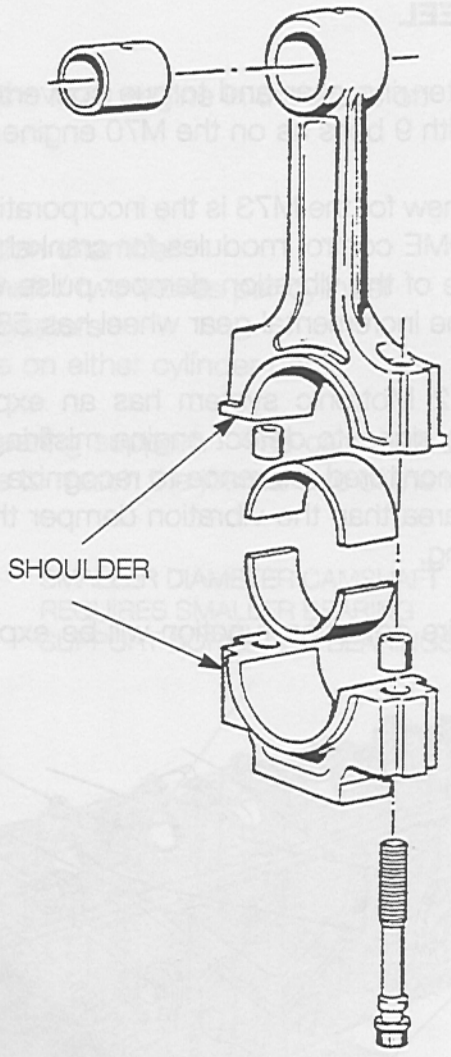
Each connecting rod big end has a machined shoulder on one side to allow for the positioning of two rods on one crankshaft journal.

The rods must be installed with the machined edges facing together. The non machined shoulders face forward or rearward depending on the cylinder bank.

- **Cylinder bank I -** Shoulders **forward.**

- **Cylinder bank II -** Shoulders **rearward**.

Note: When engine disassembly requires removal of the connecting rod bolts, always replace them when reassembling the engine.



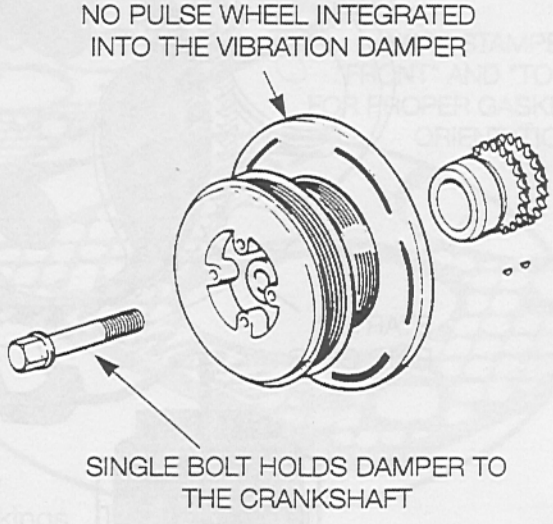
VIBRATION DAMPER

The vibration damper of the M73 is a new axially designed vibration damper.

The pulse wheel for sensing engine speed/ reference is no longer on the vibration damper. A new incremental gear wheel is now mounted on the flywheel.

The hub and damper body are now integrated into one unit. To remove the vibration damper from the crankshaft, remove the center hex bolt.

Like the connecting rod bolts, always reinstall the vibration damper with a new bolt.



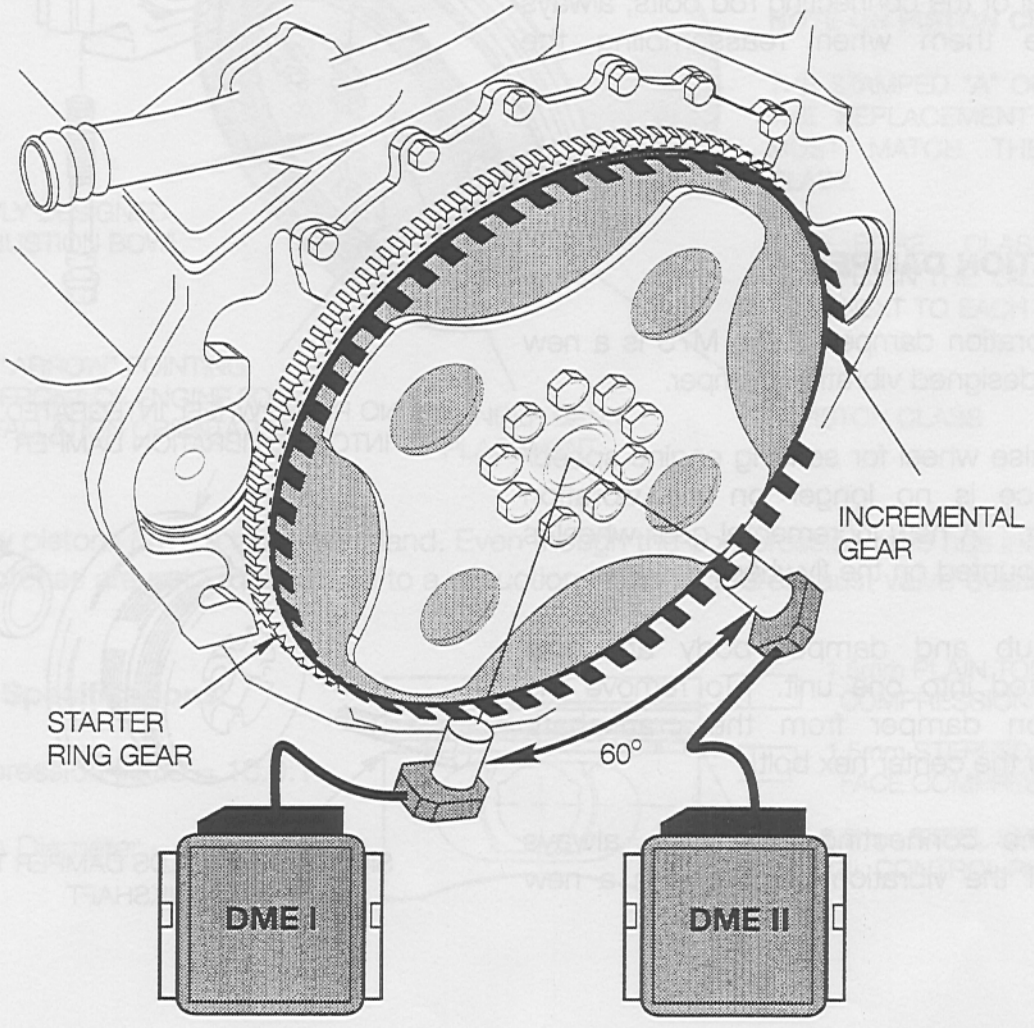
FLYWHEEL

The starter ring gear and torque converter flexplate are bolted together to the crankshaft flange with 9 bolts as on the M70 engine.

What is new for the M73 is the incorporation of an incremental gear wheel that is monitored by the DME control modules for crankshaft speed and reference. This gear wheel takes the place of the vibration damper pulse wheel. Like the previous vibration damper pulse wheel, the incremental gear wheel has 58 teeth with a gap of two missing teeth.

The M5.2 Motronic system has an expanded function that will utilize the speed and reference signal to detect engine misfiring. The misfire detection feature requires a more precise monitored reference to recognize a misfire. Since the flywheel ring gear has more surface area than the vibration damper the flywheel is now used for all crankshaft related monitoring.

The misfire detection function will be explained in the DME M5.2 segment of this training course.

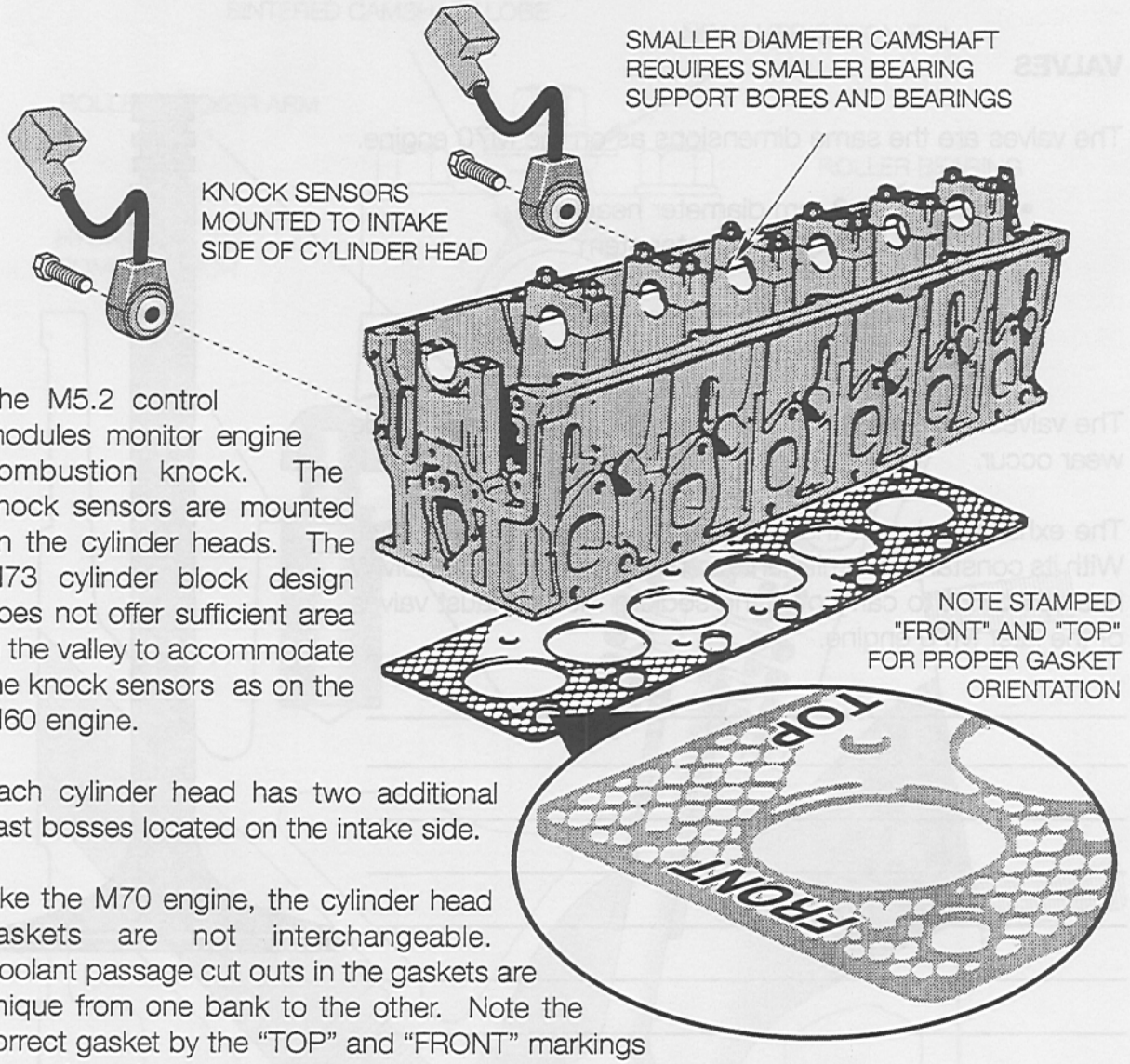


CYLINDER HEAD AND GASKET

The cylinder heads of the M73 are identical to the M70 engine in the areas of:

- Cross flow design
- Die cast aluminum
- Asymmetrical combustion chamber
- Single overhead camshaft / two valves per cylinder
- Hydraulic valve compensators
- Interchangeable for use on either cylinder bank.

One difference is in the area of the camshaft bearing support. The camshaft diameter is reduced and requires reduced diameter supports to match the journal size of the new cams.



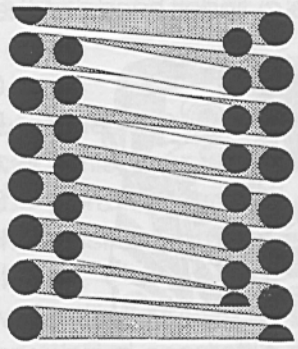
The M5.2 control modules monitor engine combustion knock. The knock sensors are mounted on the cylinder heads. The M73 cylinder block design does not offer sufficient area in the valley to accommodate the knock sensors as on the M60 engine.

Each cylinder head has two additional cast bosses located on the intake side.

Like the M70 engine, the cylinder head gaskets are not interchangeable. Coolant passage cut outs in the gaskets are unique from one bank to the other. Note the correct gasket by the "TOP" and "FRONT" markings on each gasket.

VALVE TRAIN

VALVE SPRINGS



The dual valve springs have a reduced spring rate

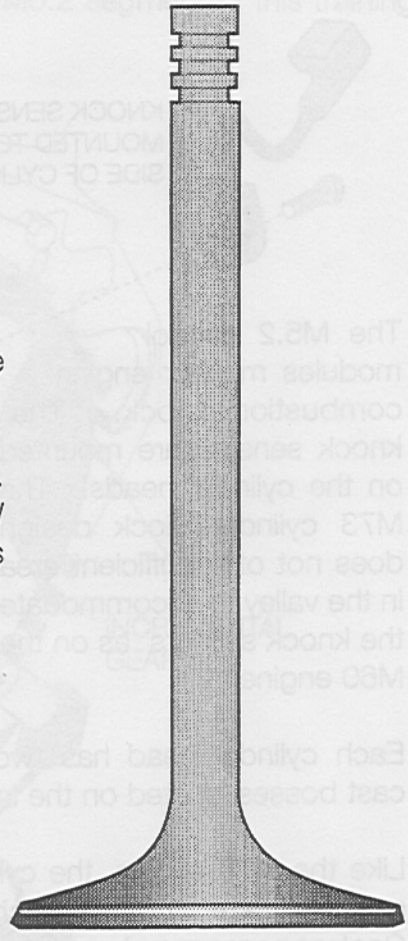
- Outer Spring = 190 Nm (260 Nm - M70)
- Inner Spring = 100 Nm (105 Nm - M70)

The reduction was necessary to match the calibration of the roller rocker valve train. This change also reduces the friction in the valve/rocker contact.

VALVES

The valves are the same dimensions as on the M70 engine.

- Intake = 42.0 mm diameter head
  6.94 mm diameter stem
- Exhaust= 36.0 mm diameter head
  6.94 mm diameter stem



The valves are available in two oversizes should valve guide wear occur.

The exhaust valve of the M73 engine is a solid steel valve. With its constant commitment to environmental issues, BMW has opted not to carry over the sodium filled exhaust valves of the later M70 engine.

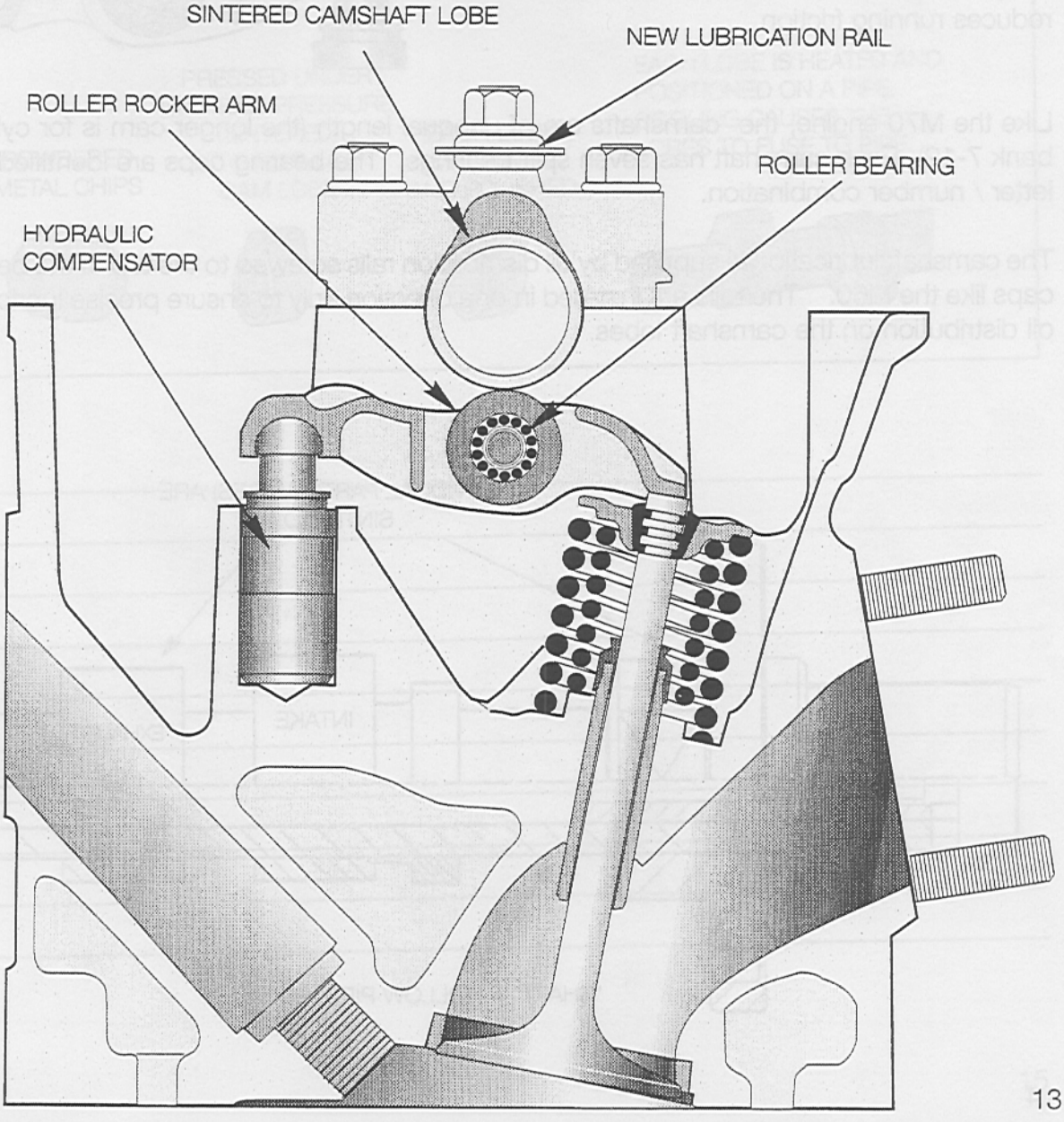
"ROLLER" ROCKER ARMS

The M73 uses Roller Rocker Arms to actuate the valves. Use of roller rockers in place of solid rocker arms allows for a more aggressive camshaft profile and reduces the overall rotating friction in the valve train.

The reduction of friction:

- improves fuel efficiency
- reduces heat
- increases camshaft life

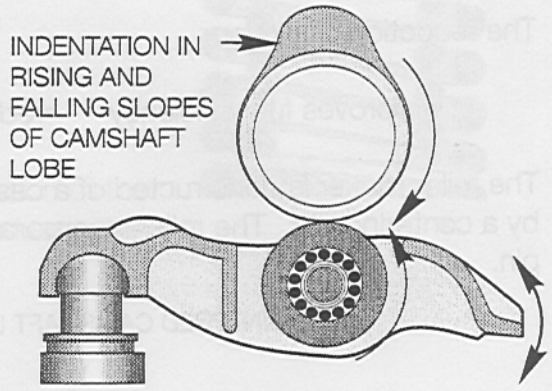
The roller rocker is constructed of a cast metal arm. The roller is attached to the metal arm by a centering pin. The roller incorporates a needle bearing that rotates on the centering pin.



CAMSHAFTS

The camshafts of the M73 engine are fabricated via a combination of manufacturing processes. Sintered metal camshaft lobes are fused to the hollow metal shaft creating the camshaft. *See inset about manufacturing process.*

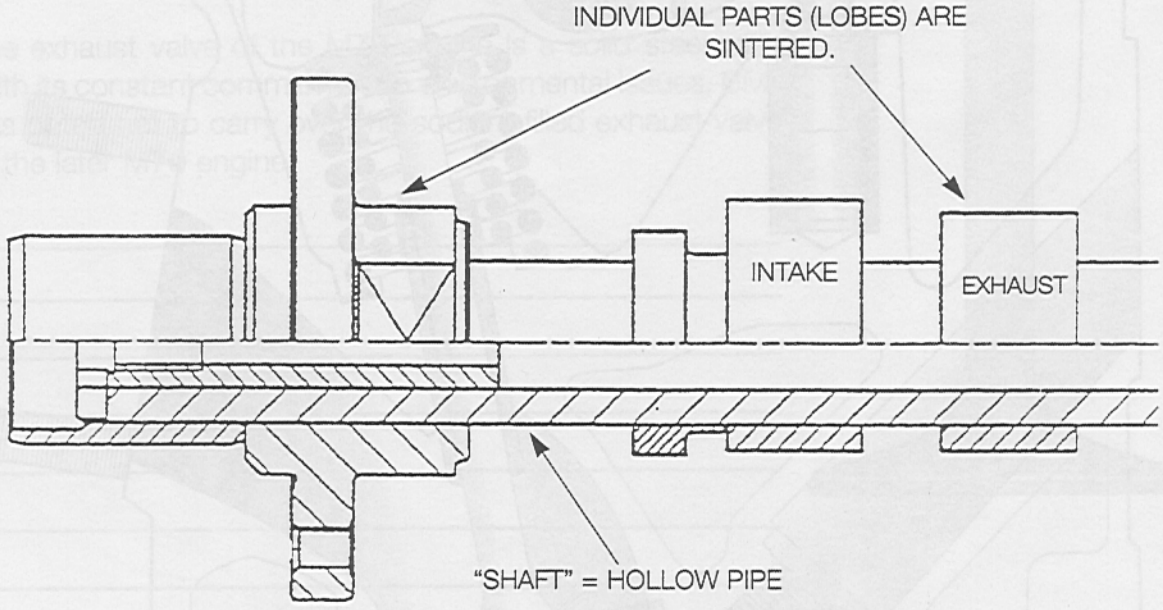
The utilization of the roller rockers required an indentation on the leading slope of the camshaft lobes to achieve the correct valve lift and duration.



The combination of the roller rockers and the sintered camshaft lobes provide a valvetrain that is lighter, less expensive to manufacture and reduces running friction.

Like the M70 engine, the camshafts are of unequal length (the longer cam is for cylinder bank 7-12) Each camshaft has seven split bearings. The bearing caps are identified by a letter / number combination.

The camshaft lubrication is supplied by oil distribution rails screwed to the top of the bearing caps like the M60. The rails are installed in one direction only to ensure precise lubrication oil distribution on the camshaft lobes.



HOW THE CAMSHAFTS ARE MANUFACTURED

Like the M60 connecting rods, each lobe of the M73 camshaft is individually formed via the sintered metal process. The lobes start out as powdered metal in a form. Extreme pressure and heat are applied to the form and casts the powder into a solid metal lobe. Each lobe is then individually machined to an exact specification.

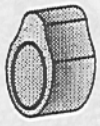
The "shaft" of the camshaft starts out as a hollow pipe machined and polished to specification.

The finished lobes are then heated. With the use of a special jig, the lobes are slid onto the pipe and held at their exact positions. As the lobes cool they contract and fuse themselves directly to the pipe.

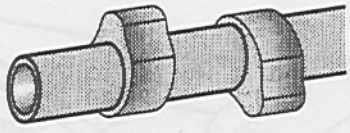
POWDERED METAL CHIPS

PRESSED UNDER EXTREME PRESSURE (SINTERED) TO FORM A CAM LOBE

EACH LOBE MACHINED AND POLISHED

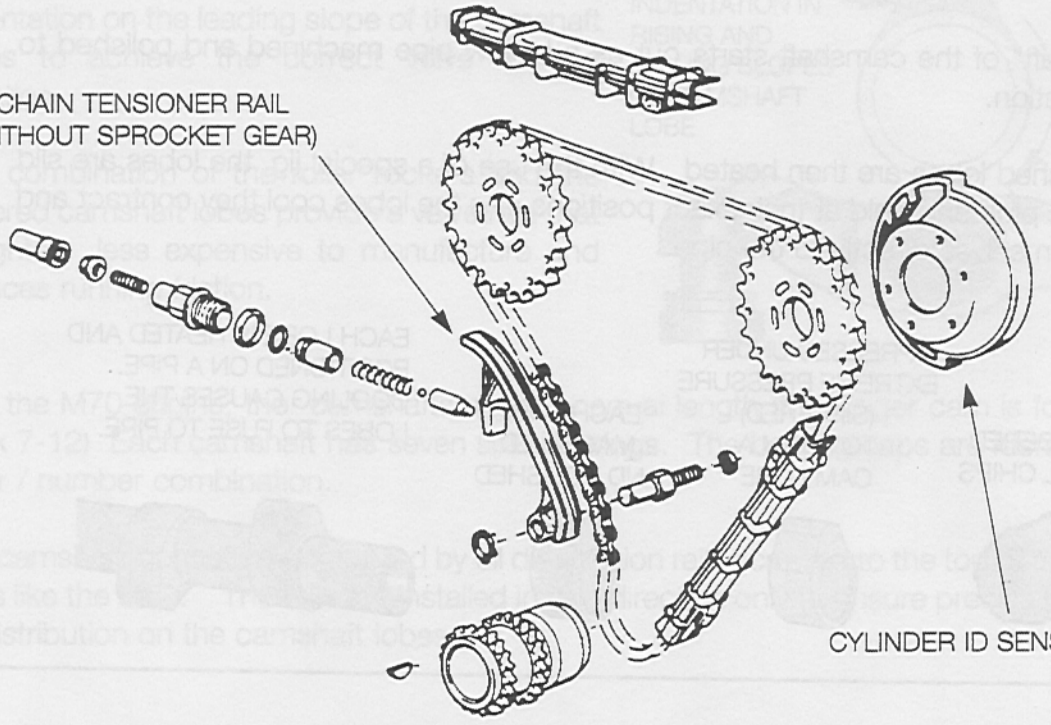


EACH LOBE IS HEATED AND POSITIONED ON A PIPE. COOLING CAUSES THE LOBES TO FUSE TO PIPE.



CAMSHAFT DRIVE

The chain tensioner layout of the M73 engine is changed. It is the design first seen in the M70 prior to the production change of a chain tensioner rail with a sprocket incorporated into it. This design reduces valve train noise.



CAMSHAFT METAL POSITION SENSOR DISC

A camshaft reference disc is mounted to the camshaft of cylinder bank 7-12. The disc references cylinder #12 TDC compression stroke for the Cylinder ID Hall Sensor mounted in the timing chain housing.

Further information on the DME function will be covered in the M5.2 segment of this training course.

CRANKCASE VENTILATION VALVE

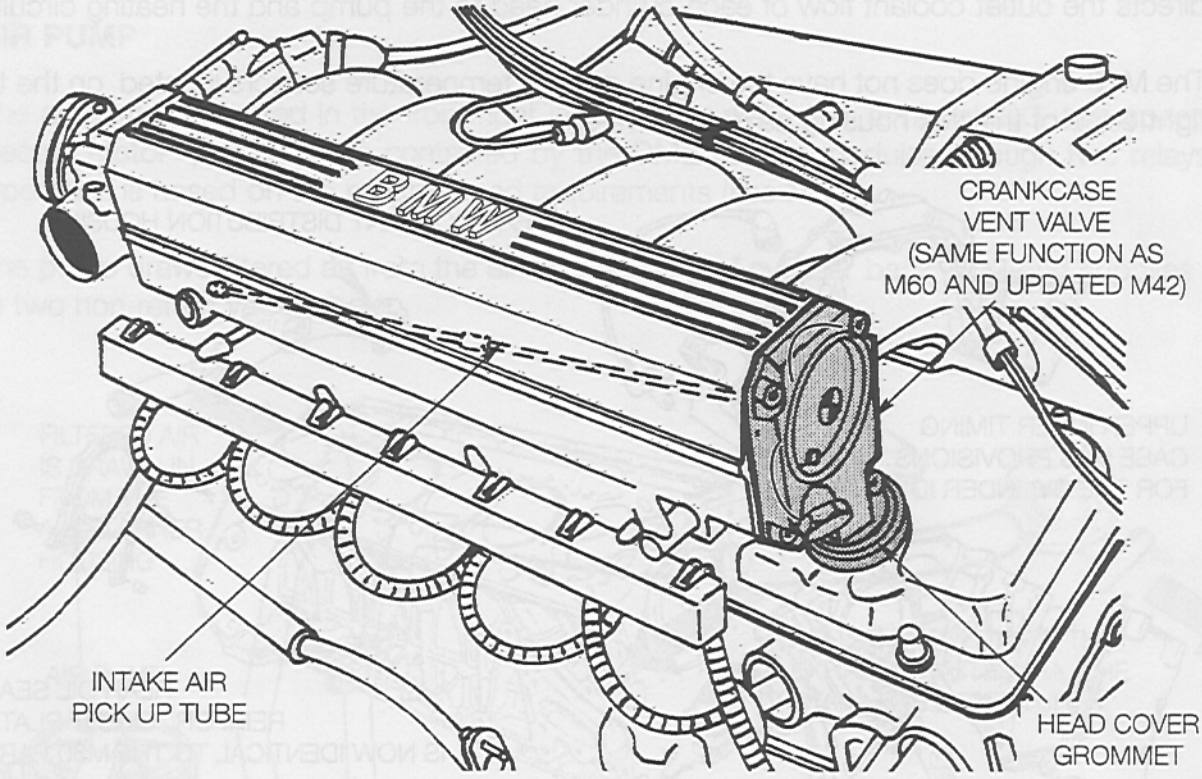
The M73 utilizes a new type of crankcase ventilation valves. This single valve per bank replaces the dual TSV and MBV crankcase ventilation valves per bank of the M70.

The new valve functions the same as the M60 and late M42 crankcase ventilation valves. The valve is influenced by engine vacuum.

- Low vacuum = Fully open by spring pressure.
- High vacuum = Fully closed by influence of vacuum.

The amount of valve opening is varied continually through all engine operating conditions.

The new valves are mounted directly to the rear of each intake manifold. The crankcase gas inlet of the valve is connected to the cylinder head cover by a rubber grommet. The cylinder head cover is modified to accommodate the valve and includes an integrated oil/vapor separator.



ENGINE COVERS AND CASES

TIMING CHAIN COVERS

The mounting boss for the crankshaft speed and reference sensor has been removed from the lower outer timing chain cover.

The upper inner timing chain cover is modified to house the new camshaft position hall sensor. A bore in the left side of the case aligns the tip of the camshaft position sensor with the metal position disc.

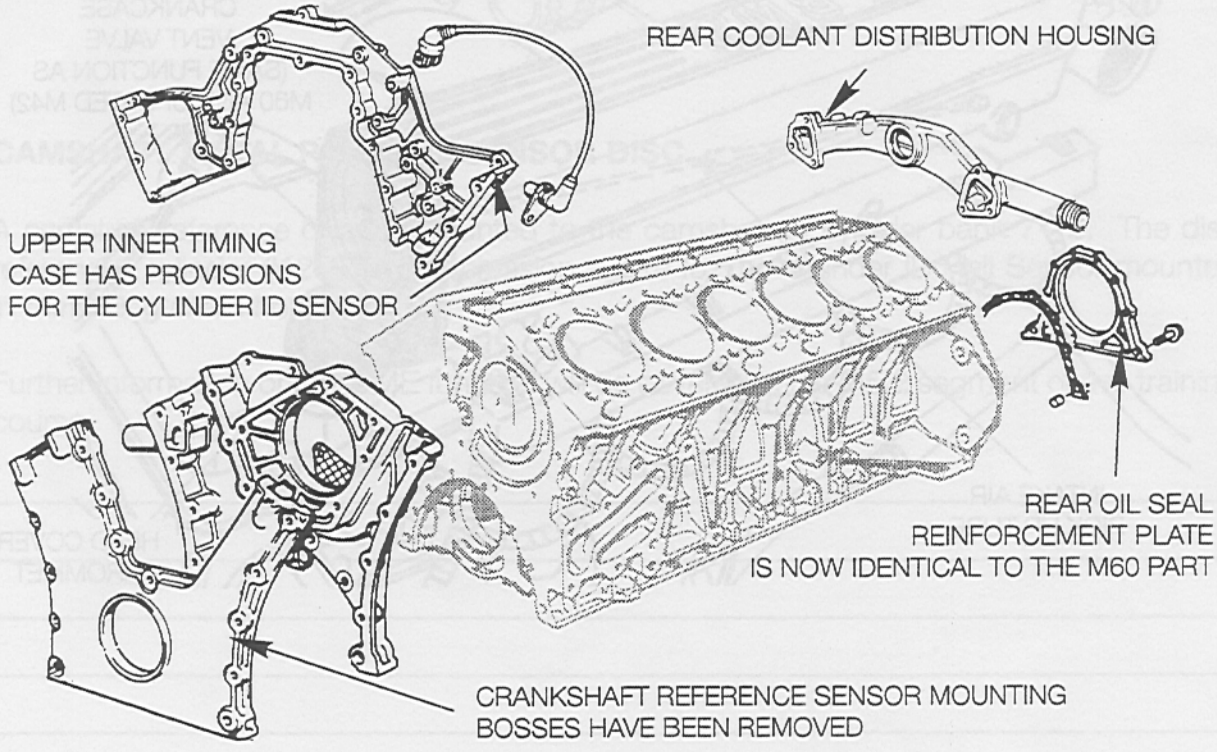
CRANKSHAFT REAR OIL SEAL PLATE

The crankshaft rear oil seal housing plate and gasket of the M73 engine are now identical to the cover (and gasket) of the M60 engine.

REAR COOLANT DISTRIBUTION HOUSING

The coolant distribution housing mounted on the rear of the cylinder heads merges and directs the outlet coolant flow of each cylinder head to the pump and the heating circuits.

The M73 engine does not have the engine coolant temperature sensors located on the top right edge of the this housing as did the M70.



SECONDARY AIR INJECTION SYSTEM

The M73 is equipped with a secondary air injection system. This system is required to meet 1995 federal emission requirements.

The air injection system helps the catalytic converter to function more efficiently at its most inefficient period of operation. Catalytic converters need heat and oxygen to operate effectively. When first starting and idling a cold engine, heat and oxygen are at their lowest levels in the exhaust stream.

The Air injection system injects fresh air into the exhaust manifolds. The air mixes with the exhaust gas as it leaves the engine. The additional air helps the catalytic converter to function earlier and further reduce the exhaust emissions during the critical higher emission warm up period.

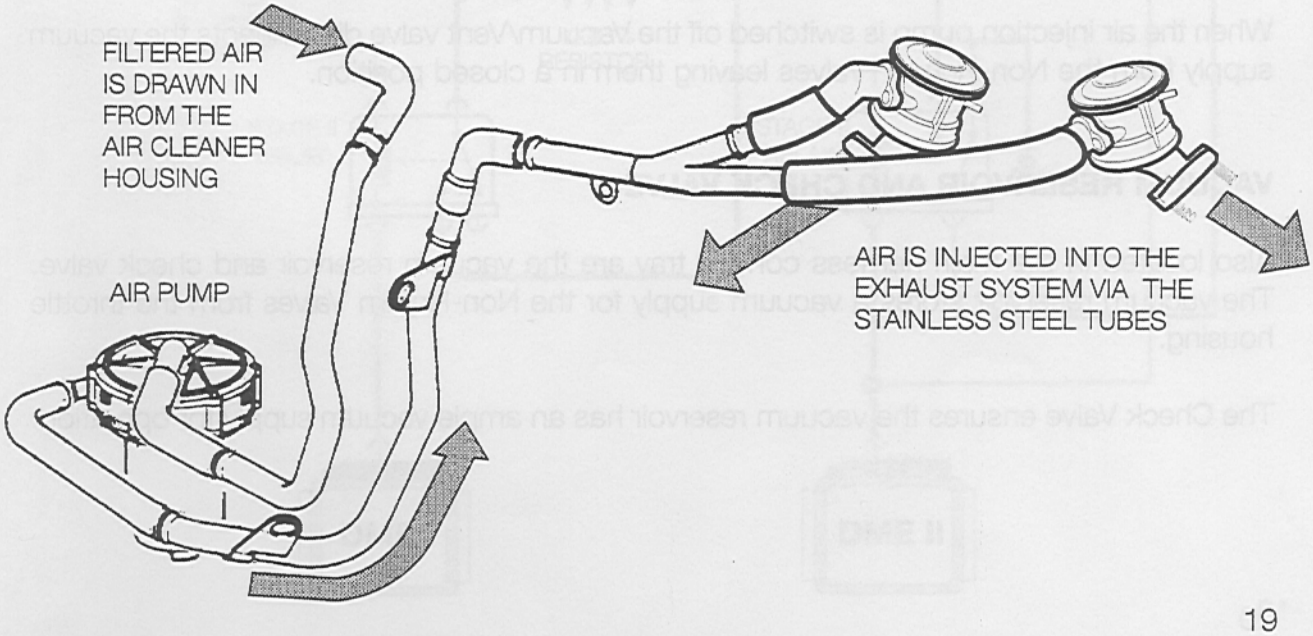
Detail on the operation and control functions of this system will be covered in the DME 5.2 segment of this training course.

The mechanical components of this system on the M73 engine are:

AIR PUMP

The air pump is located in the front right inner fender well. It is a 12 volt DC, two speed, electric motor pump that is controlled by the DME control modules through two relays. Operation is based on the programmed requirements (see M5.2).

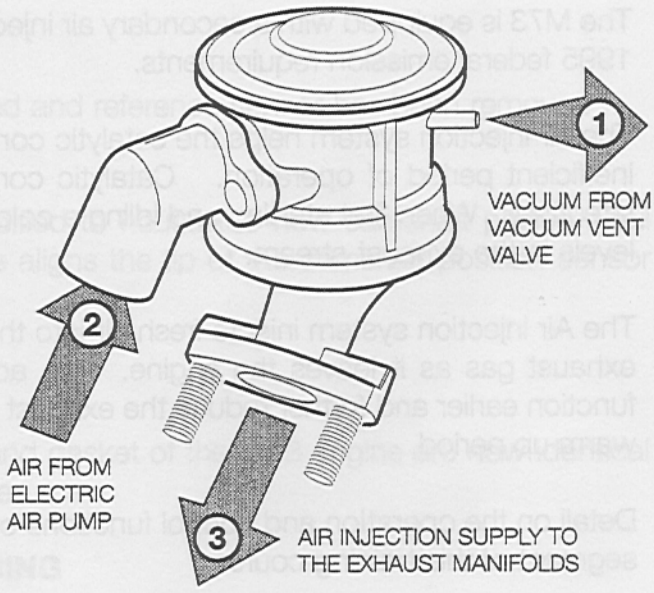
The pump draws filtered air from the air filter housing of cylinder bank 7-12 and supplies it to two non-return valves.



NON-RETURN (ONE WAY) VALVES

Located on the front of the engine are the two Non-Return Valves. The Non-Return valves serve the following functions.

- When activated by a controlled vacuum source the valves open and allow the supplied air from the electric motor pump to inject air into the exhaust manifolds.
- In the event of an engine backfire they will check the back pressure from damaging the pump, hoses or secondary air solenoid vacuum valve.



STAINLESS STEEL INJECTION PIPES

Outlet of each Non-Return Valve is a stainless steel injection pipe. Each pipe forks into two outlets for connection to each of the four exhaust manifolds (two per bank). The pipes are connected to the exhaust system to inject the air directly into the exhaust gas stream.

SECONDARY AIR VACUUM/VENT VALVE

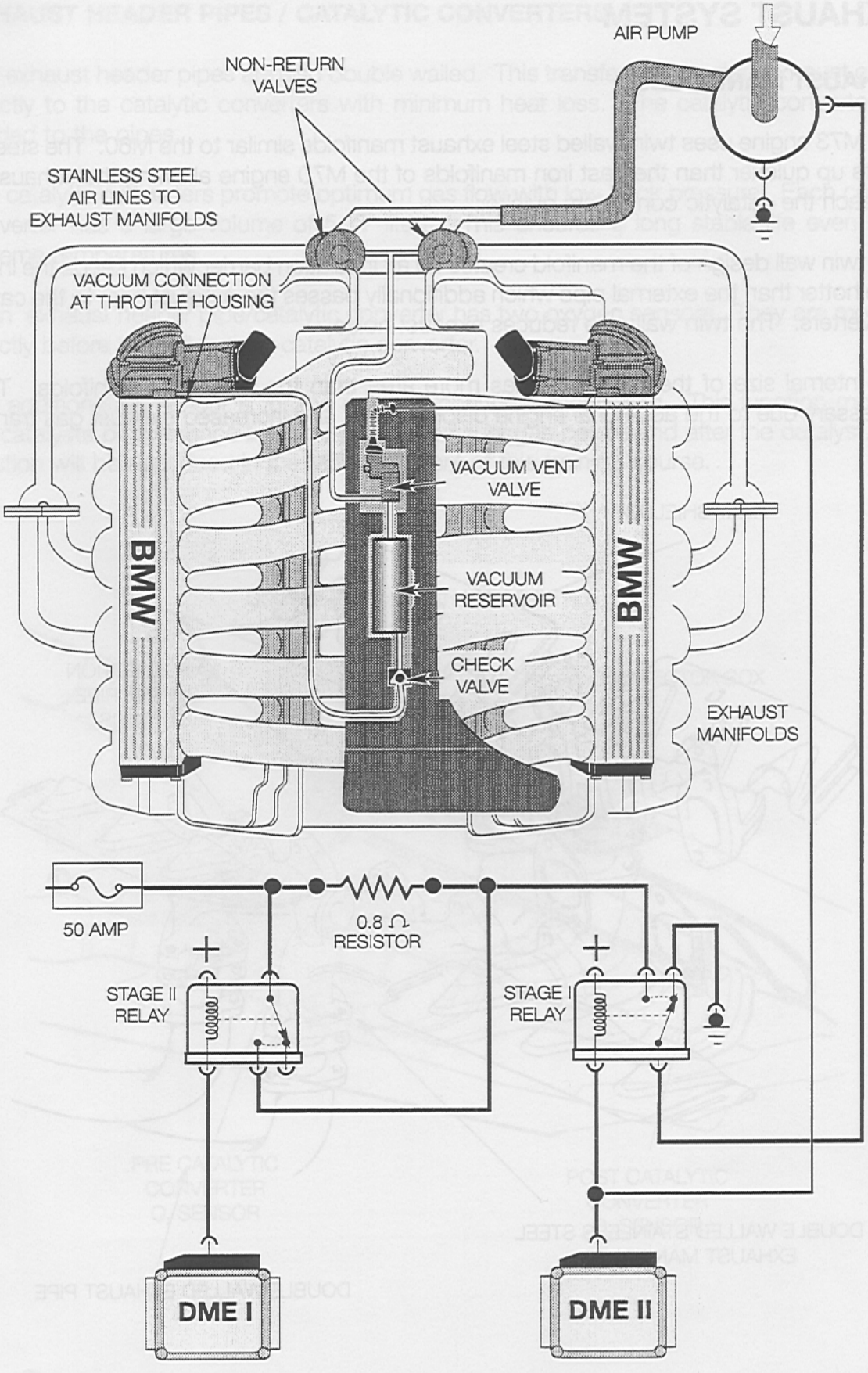
The Vacuum/Vent Valve is located in the main harness conduit tray on top of the engine. It is energized by DME II simultaneously with the Air Injection Pump.

When the air injection pump is switched off the Vacuum/Vent valve disconnects the vacuum supply from the Non-Return Valves leaving them in a closed position.

VACUUM RESERVOIR AND CHECK VALVE

Also located in the main harness conduit tray are the vacuum reservoir and check valve. The vacuum reservoir stores a vacuum supply for the Non-Return Valves from the throttle housing.

The Check Valve ensures the vacuum reservoir has an ample vacuum supply for operation.


AIR PUMP
NON-RETURN VALVES
STAINLESS STEEL AIR LINES TO EXHAUST MANIFOLDS
VACUUM CONNECTION AT THROTTLE HOUSING
VACUUM VENT VALVE
VACUUM RESERVOIR
CHECK VALVE
BMW
BMW
EXHAUST MANIFOLDS
50 AMP
0.8 Ω RESISTOR
STAGE II RELAY
STAGE I RELAY
DME I
DME II

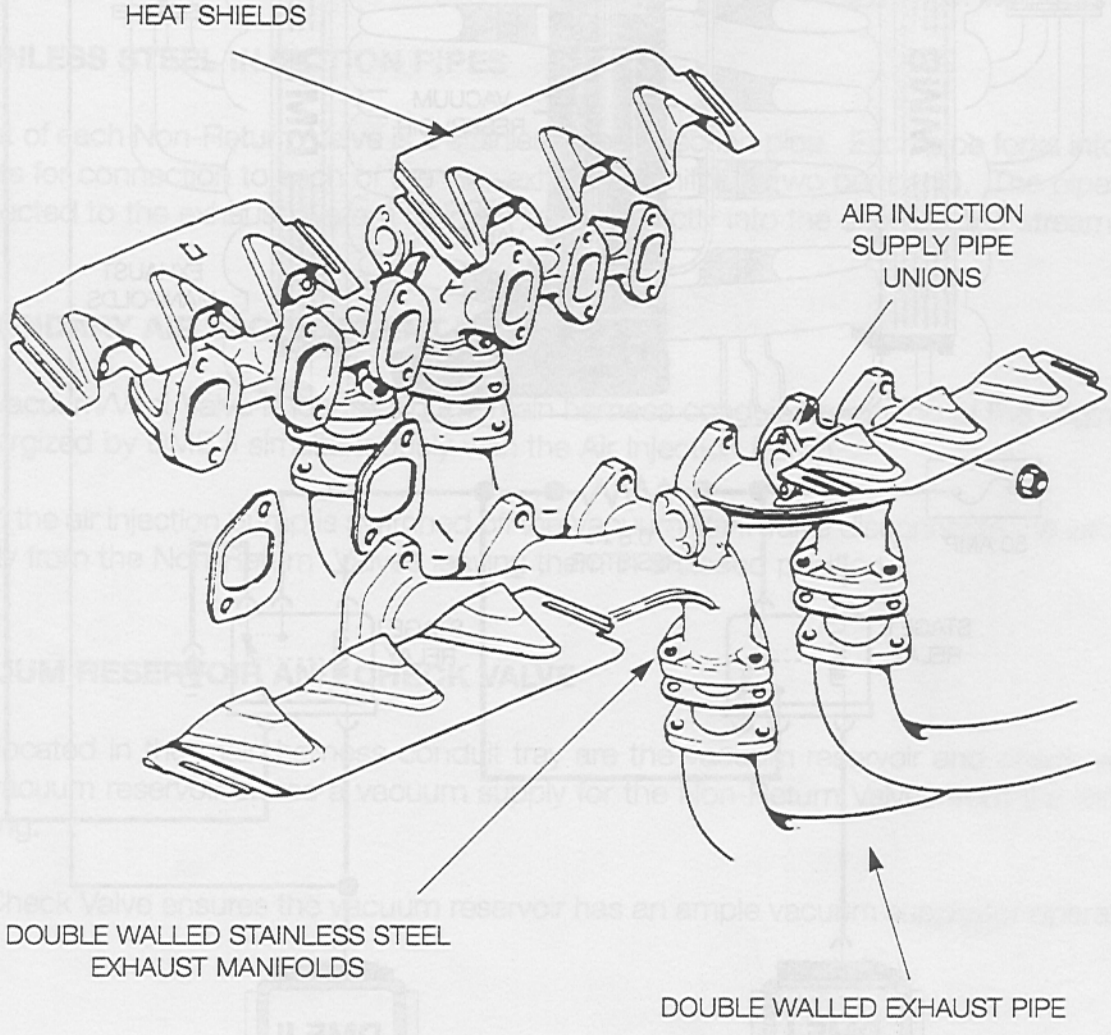
EXHAUST SYSTEM

EXHAUST MANIFOLDS

The M73 engine uses twin walled steel exhaust manifolds similar to the M60. The steel pipe heats up quicker than the cast iron manifolds of the M70 engine allowing the exhaust heat to reach the catalytic converters quicker.

The twin wall design of the manifold creates an air insulation barrier which keeps the internal pipe hotter than the external pipe which additionally passes the exhaust heat to the catalytic converters. The twin wall also reduces exhaust noise.

The internal size of the inner pipe has more area than the M70 cast manifolds. This is necessary due to the additional engine displacement and increased exhaust gas transfer.



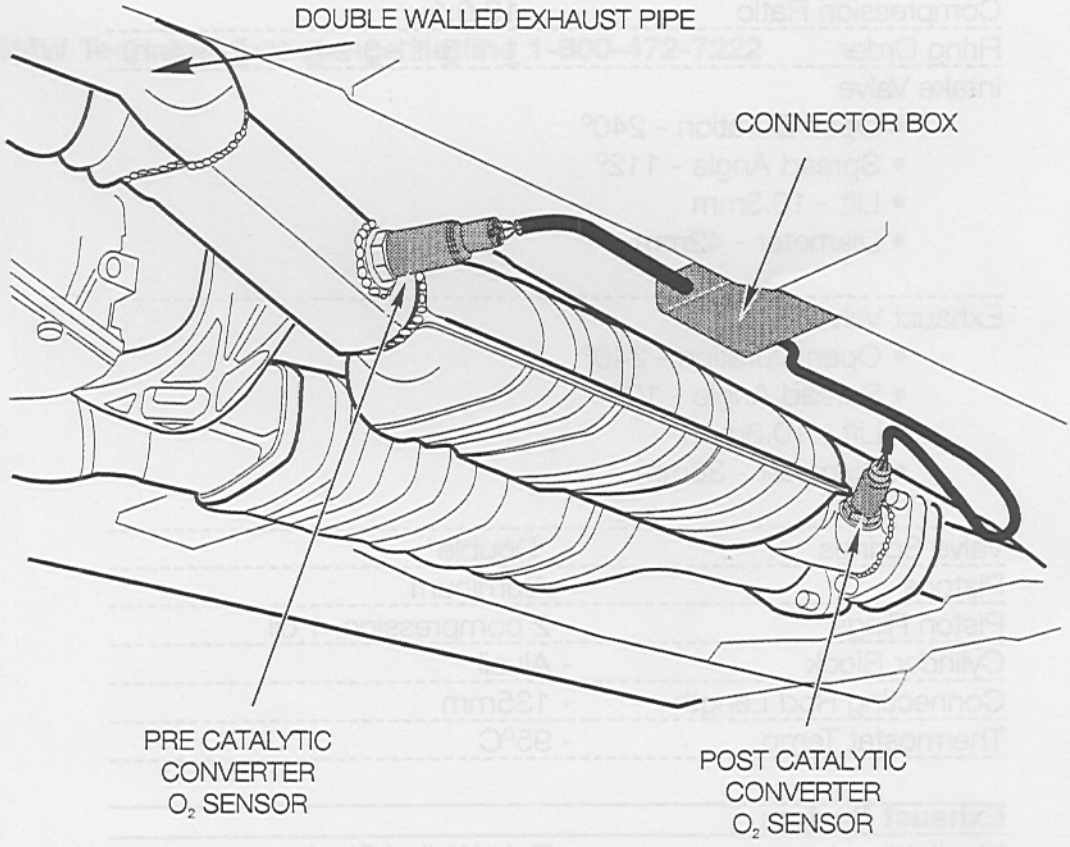
EXHAUST HEADER PIPES / CATALYTIC CONVERTERS

The exhaust header pipes are also double walled. This transfers the heated exhaust gasses directly to the catalytic converters with minimum heat loss. The catalytic converters are welded to the pipes.

The catalytic converters promote optimum gas flow with low back pressure. Each catalytic converter has a large volume of 5.77 liters. This ensures a long stable life even under extreme temperatures.

Each exhaust header pipe/catalytic converter has two oxygen sensors. They are mounted directly before and after each catalytic converter.

The additional O_2 sensor is for the catalytic converter monitoring. This function monitors the catalysts performance by sampling the exhaust gas before and after the catalyst. This function will be described in the M5.2 segment of this training course.



M73 ENGINE SPECIFICATIONS

Engine	
Engine Type	M73 - B54, 60° V12
Vehicle Application	E38 and E31

Engine Data	
Max Power	322 HP @ 5000 RPM
Max Torque	361 Ft/lbs @ 3900 RPM
Engine Idle Speed	600 RPM
Max Engine Speed	6000 RPM
Engine Oil Capacity	8.5 liters w/filter
Required Fuel	Premium Unleaded

Engine Mechanical Data	
Bore	85mm
Stroke	79mm
Displacement	5379cc
Cylinder Bore Center Distance	91mm
Compression Ratio	10.0:1
Firing Order	1-7-5-11-3-9-6-12-2-8-4-10

Intake Valve

- Open Duration - 240°
- Spread Angle - 112°
- Lift - 10.3mm
- Diameter - 42mm

Exhaust Valve

- Open Duration - 240°
- Spread Angle - 109°
- Lift - 10.3mm
- Diameter - 36mm

Valve Springs	- "Double"
Pistons	- Aluminum
Piston Rings	- 2 compression, 1 oil
Cylinder Block	- Alusil
Connecting Rod Length	- 135mm
Thermostat Temp	- 95°C

Exhaust System	
Manifolds	- Twin Walled Steel
Manifold inside diameter	- 34mm
Header Pipe	- Twin Walled Steel

BASIC TROUBLESHOOTING

- Always personally verify the customer complaint.
- Perform a Quick Test to determine if the vehicle systems have logged fault codes.
- Call up the faulted system or appropriate test schedule to verify the correct control module is installed in the car.
- Follow the Diagnostic Information System (DIS) on screen instructions and perform all tests as specified.
- Use the DIS and fault symptom diagnostic procedures as trained.
- Follow the appropriate test module procedures for systems that malfunction but fail to set faults in memory.
- System problems which elude diagnostic procedures must be brought to the attention of BMW of North America, Inc.
- **BMW Technical Assistance Hotline 1-800-472-7222**