

170 Radiator and Cooling System

GENERAL	170-1	Coolant pump, replacing (M70 engine)	170-12
Coolant Pump and Thermostat	170-1	THERMOSTAT	170-13
Radiator, Coolant Expansion Tank and Cooling Fans	170-1	Thermostat, replacing	170-13
TROUBLESHOOTING	170-2	RADIATOR	170-14
Pressure Test	170-3	Radiator, removing and installing	170-14
Thermostat Quick Check	170-4	Engine Oil Cooler	170-16
Temperature Gauge Quick Check	170-4	COOLING FANS	170-16
Cooling Fans Quick Check	170-6	Belt-driven cooling fan, replacing	170-16
COOLANT	170-8	Auxiliary cooling fan, replacing	170-17
Coolant, draining and filling	170-8		
Cooling system, bleeding	170-9	TABLE	
COOLANT PUMP	170-10	a. Temperature Gauge Sender Locations	170-4
Coolant pump, replacing (M30 engine)	170-10	b. Coolant Temperature Sensor Wire Colors	170-5
Coolant pump, replacing (M60 engine)	170-11	c. Auxiliary Fan Temperature Switch Tests	170-7
		d. Cooling System Capacities	170-9

GENERAL

This section covers repair and troubleshooting information for the engine cooling system. For heater core and related heating and air conditioning components, see **640 Heating and Air Conditioning**.

Coolant Pump and Thermostat

A centrifugal-type coolant pump is mounted at the front of the cylinder block. The pump is crankshaft-driven by a drive belt and circulates coolant through the system whenever the engine is running. A thermostat controls the flow of coolant into the radiator.

When the engine is cold the thermostat is closed so coolant bypasses the radiator, recirculating from the engine directly back to the pump. When the engine reaches operating temperature, the thermostat opens and coolant circulates through the whole system including the radiator.

Radiator, Coolant Expansion Tank and Cooling Fans

The radiator is a crossflow design. ATF is circulated through an additional heat exchanger (ATF cooler).

GENERAL

170-2 RADIATOR AND COOLING SYSTEM



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◀ Coolant expansion tank hoses and connectors (arrows) and mounting bolts (A).

- A translucent expansion tank mounted on the engine compartment rear bulkhead, provides for coolant expansion at higher temperatures and easy monitoring of the coolant level.

The primary (belt-driven) cooling fan is mounted to the front of the coolant pump through a fan clutch. The fan clutch is a viscous fluid coupling that controls the speed of the fan based on engine compartment temperature.

A two-speed electric auxiliary cooling fan is mounted behind the front grill, in front of the radiator. This fan is primarily used for the A/C system, but also operates when the coolant temperature exceeds a predetermined level.

The following warnings and cautions should be observed when working on the cooling system.

WARNING—

- At normal operating temperature the cooling system is pressurized. Allow the system to cool as long as possible before opening—a minimum of an hour—then release the cap slowly to allow safe release of pressure.
- Releasing the cooling system pressure lowers the coolant boiling point and the coolant may boil suddenly. Use heavy gloves and wear eye and face protection to guard against scalding.
- Use extreme care when draining and disposing of engine coolant. Coolant is poisonous and lethal to humans and pets. Pets are attracted to coolant because of its sweet smell and taste. Consult a veterinarian immediately if coolant is ingested by an animal.

CAUTION—

- Avoid adding cold water to the coolant while the engine is hot or overheated. If it is necessary to add coolant to a hot system, do so only with the engine running and coolant pump turning.
- Prior to disconnecting the battery, read the battery disconnection cautions given at the front of this manual on page viii.

TROUBLESHOOTING

Most cooling system faults can be grouped into one of three categories:

- Cooling system leaks
- Poor coolant circulation
- Radiator cooling fan faults.

When investigating the cause of overheating or coolant loss, begin with a visual inspection.

RADIATOR AND COOLING SYSTEM 170-3

- Check condition and tightness of coolant pump drive belt.
- Check hoses for cracks or softness.
- Check clamps for looseness.
- Check coolant level and check for evidence of coolant leaks from engine.
- Check that radiator fins are not blocked with dirt or debris. Clean radiator using low-pressure water or compressed air. Blow outward, from engine side out.
- Inspect coolant pump by first removing drive belt from the pump. Firmly grasp opposite sides of pulley and check for play in all directions. Rotate pulley and check that shaft spins smoothly.

NOTE —

The coolant provides some lubrication for the pump shaft, so an occasional drop of coolant leaking from the pump is acceptable. If coolant drips steadily from the vent hole, the pump should be replaced.

The cooling system becomes pressurized at normal operating temperature, which raises the boiling point of the coolant. Leaks may prevent the system from becoming pressurized, allowing the coolant to boil at a lower temperature. If visual evidence is inconclusive, a cooling system pressure test may help to pinpoint hard-to-find leaks.

If the cooling system is full of coolant and holds pressure, the next most probable cause of overheating is the result of poor coolant circulation due to a loose or worn drive belt, a failed thermostat or coolant pump, a pinched or restricted hose, or a partially clogged radiator.

Pressure Test

A cooling system pressure test is used to check for internal leaks. Some of the common sources of internal leaks:

- Faulty cylinder head gasket
- Cracked cylinder head
- Cracked cylinder block.

To do a cooling system pressure test, a special pressure tester is needed. The engine should be fully warm when making the test.

WARNING —

At normal operating temperature the cooling system is pressurized. Allow the system to cool before opening. Then release the cap slowly to allow safe release of pressure.

With the engine cold, install a pressure tester to the expansion tank. Allow the engine to reach operating temperature, then pressurize the system to the specification listed below. Pressure should not drop noticeably for at least 2 minutes. If the pressure drops rapidly and there is no sign of an external leak, the cylinder head gasket may be faulty. Consider a compression or leak down test, as described in **100 Engine-General**.

170-4 RADIATOR AND COOLING SYSTEM

Cooling System Test Pressure

- M30 engine (max.) 1.0 bar (14.5 psi)
- M60 or M70 engine (max.) 1.5 bar (21.75 psi)

CAUTION—

Exceeding the specified test pressure could damage the radiator or other cooling system components.

NOTE—

The screw-on type expansion tank cap should also be tested using a pressure tester and the correct adapter. Carefully inspect the cap for damage. A faulty cap or a damaged cap gasket should be replaced.

Thermostat Quick Check

To check if the thermostat is opening and coolant is circulating through the radiator, allow a cold engine to reach operating temperature (temperature gauge needle approximately centered).

- Feel top radiator hose. If hose is hot to touch, coolant is probably circulating correctly.
- If there are any cool areas in hose or radiator, coolant flow to the radiator is probably restricted. Check for a faulty thermostat or a plugged radiator.

NOTE—

A thermostat that is stuck open will cause the engine to warm up slowly and run below normal temperature at highway speed. A thermostat that is stuck closed will restrict coolant flow to the radiator and cause overheating.

- If engine overheats and no other cooling system tests indicate trouble, radiator may have some plugged passages that are restricting coolant flow.
- Also, air flow may be restricted. Check for debris or restrictions in radiator cooling fins or front grille.

Temperature Gauge Quick Check

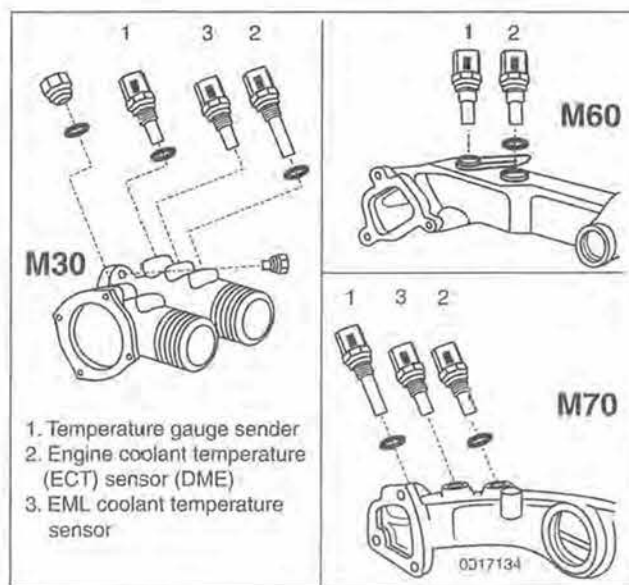
- Use the information in **Table a** and the diagrams to locate the temperature gauge sender.

Table a. Temperature Gauge Sender Locations

Engine	Sender location
M30	In thermostat housing
M60	In coolant crosspipe at rear of engine
M70	In coolant crosspipe at rear of engine

NOTE—

Relative locations of senders and sensors can vary. Use wiring colors, shown in **Table b**, to confirm sensor location during the following tests.



TROUBLESHOOTING

RADIATOR AND COOLING SYSTEM 170-5

Table b. Coolant Temperature Sensor Wire Colors

Engine & year	Gauge sender	ECT sensor (DME)	EML temperature sensor
M30			
1988 - 1992 (DME 1.3)	Brown/violet - brown/yellow	Brown/red - brown/orange	Brown/red - blue/violet
M60			
1993 - 1994 (DME 3.3)	Brown/violet - brown/yellow	Yellow/green - brown/orange	-
M70			
1988 - 1990 (DME 1.2)	Brown/white - brown/yellow	Brown/red/ yellow - brown/red - brown	Brown/red - blue/violet
1991 - 1992 (DME 1.7)	Brown/violet - brown/yellow	Brown/red/ yellow - brown/red - brown	Brown/red - blue/violet
1993 - 1994 (DME 1.7)	Brown/violet - brown/yellow	Brown/red/ yellow - brown/red - brown	Brown/red - white/brown

A quick test at the coolant temperature gauge sender can determine if the gauge is functioning correctly.



On M60 or M70 engine, remove coolant expansion tank to access coolant crosspipe at back of cylinder heads.

- Detach hoses and harness connectors (**arrows**).
- Remove reservoir mounting screws (**A**).

- If gauge needle remains at rest position with engine warm, detach connector from sending unit and jumper two terminals in connector to simulate a high engine temperature.
 - Turn ignition on. If gauge needle moves upward, sending unit is faulty.
 - If gauge does not respond, wiring to gauge is broken (open circuit) or gauge itself is faulty.
- If gauge needle reads too high when engine is cold, detach connector from sender.
 - Turn ignition on. If gauge needle position does not change, wiring or gauge is shorted to ground.
 - If gauge needle drops, sender is faulty and should be replaced.

NOTE—

When replacing a faulty coolant temperature sender, gasket ring on sender should also be replaced.

Tightening Torque

- Temperature gauge sender. 20 Nm (15 ft-lb)

170-6 RADIATOR AND COOLING SYSTEM

Cooling Fans Quick Check

An otherwise sound cooling system may still overheat, particularly with prolonged idling, due to a failure of the primary cooling fan.

The cooling fan is controlled by a temperature dependent viscous fan clutch. A failed fan clutch may affect air flow through the radiator resulting in overheating or possibly over cooling.

- Inspect fan clutch by spinning fan with engine off and cold. The viscous fan should spin on clutch with slight resistance.
- Check for signs of leaking fluid from clutch. If fan free-wheels with little resistance, cannot be turned by hand or there are signs of oil leakage, clutch should be replaced.

The auxiliary (electric) cooling fan provides additional air flow through the radiator when coolant temperature exceeds a predetermined level or whenever the air conditioning is on. The fan assembly is mounted in front of the radiator. A dual-range temperature switch is mounted on the right side of the radiator.

WARNING—

- Use caution when testing the cooling fan and coolant temperature switches. Keep hands and wires clear of the fan blades. The auxiliary cooling fan can run any time the ignition is ON.
- For greatest safety, cooling fan and coolant temperature switch tests should be performed on a cold engine with the air conditioning off.

Auxiliary Cooling Fan Switching Temperatures

- Low speed 196°F (91°C)
- High speed 210°F (99°C)

If a faulty thermostat, trapped air or a restriction in the system is not allowing the coolant to circulate through the radiator, the switch will not close and the fan will not run. Before making the tests described below, make sure the thermostat is operating correctly as described earlier.

If the coolant is circulating at normal operating temperature, and the auxiliary cooling fan does not run, disconnect the connector from the radiator temperature switch and make the tests listed in **Table c**.

If the fan runs only when powered directly by the jumpered connector and hot coolant is circulating through the radiator, the radiator temperature switch is faulty. Use a new gasket ring when replacing the switch.

Table c. Auxiliary Fan Temperature Switch Tests

Wires jumpered	Test condition	Test result
Blue/white/yellow and black/brown	Ignition ON	Fan runs at low speed
Black/grey/yellow and black/brown	Ignition ON	Fan runs at high speed

Tightening Torque

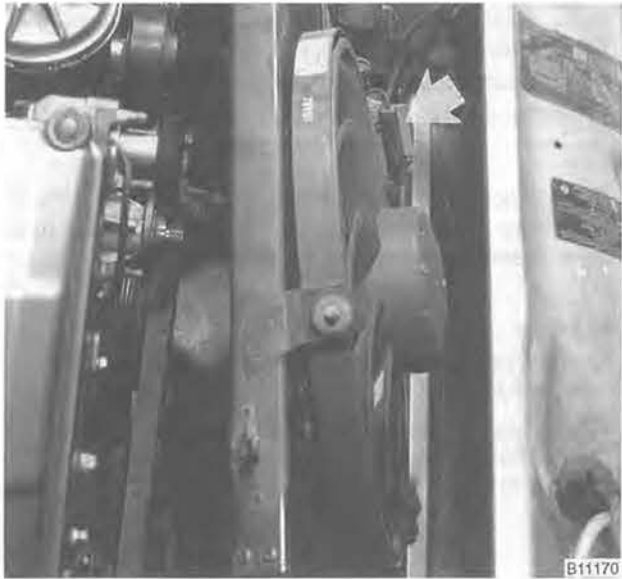
- Temperature switch to radiator 15 Nm (11 ft-lb)



- If the fan does not run when powered directly, check for battery voltage at switch connector with ignition on.
 - If battery voltage is not present, check fuse no. 29 (low-speed) and fuse no. 25 (high-speed).
- If no faults are found, remove auxiliary radiator cooling fan normal speed relay (1) and high speed relay (2) in auxiliary relay panel I (ahead of left front strut tower) and turn ignition on.
 - Check for power at terminals 30 and 86 of relay block with ignition ON.
 - Fix any wiring faults found.

NOTE—

Complete wiring diagrams for the auxiliary radiator cooling fan can be found under **Electrical Wiring Diagrams**.



- If fan operates only at high speed and no electrical faults have been found up to this point, use an ohmmeter to check that fan resistor is not electrically open.
 - Resistor (**arrow**) is mounted on auxiliary fan housing behind front grille.

COOLANT

Coolant, draining and filling

- Remove coolant expansion tank cap. Set temperature controls in passenger compartment to full warm.

WARNING—

Allow the cooling system to cool before opening or draining the cooling system.



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- ◀ Place 3-gallon pail beneath radiator drain plug (arrow). Remove drain plug.

WARNING—

Coolant is poisonous and lethal, especially to pets. Clean up spills immediately and rinse the area with water.

- Place 3-gallon pail beneath rear of engine block. Loosen and remove engine block coolant drain plug(s).

NOTE—

- On the M30 engine the block drain plug is located on the exhaust side of the engine, below cylinder no. 6.
- On the M60 engine the block drains are located below nos. 2 and 3 cylinder exhaust ports, and below nos. 5 and 6 cylinder exhaust ports.
- On the M70 engine the block drains are located below the nos. 4 and 10 cylinder exhaust ports.

- Reinstall radiator and engine block drain plugs using new sealing washers. Be sure heater controls are set to full warm.

Tightening Torques

- Engine block drain plug to block 25 Nm (18 ft-lb)
- Radiator drain plug to radiator . . . 2-3 Nm (18-27 in-lb)

- Using a coolant mixture of 50% anti-freeze and 50% distilled water, fill system slowly so that air is allowed to escape. Bleed cooling system as described later.

NOTE—

- Coolant can often be reused provided it is clean and less than two years old.
- Do not reuse the coolant when replacing damaged engine parts. Contaminated coolant may damage the engine or cooling system.

Table d. Cooling System Capacities

Engine	Capacity
M30	12.5 liters (13.2 qts.)
M60	12.5 liters (13.2 qts.)
M70	
1988 - 1991	15.0 liters (15.8 qts.)
1992 - 1994	13.0 liters (13.6 qts.)

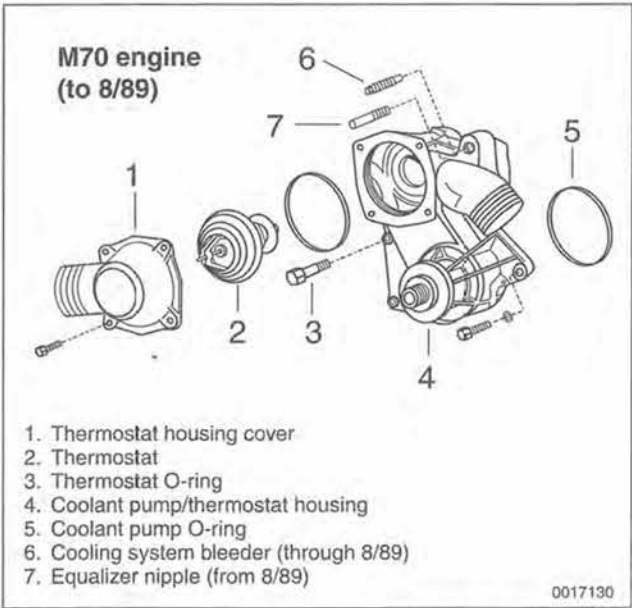
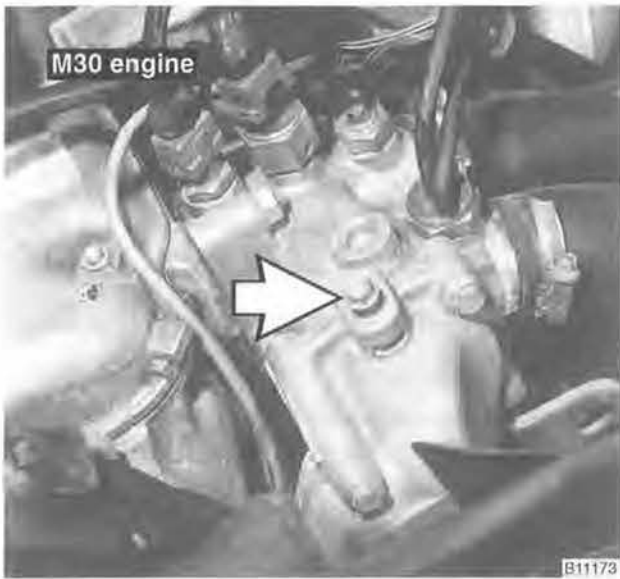
Cooling system, bleeding

Air may become trapped in the cooling system during filling. Trapped air can prevent proper coolant circulation. Whenever the coolant is drained and filled, the system should be bled of trapped air.

NOTE—

All M60 engines and M70 engines from 8/89 (1990 model year) are equipped with a coolant equalizer hose from thermostat housing to radiator. These models lack a coolant bleeder screw.

- Add coolant to expansion tank until level reaches COLD mark on tank.
- On M30 engine: Loosen bleeder screw (arrow) on thermostat housing.
- Add coolant to expansion tank until it spills from screw. Tighten screw.



- On early M70 engine: Loosen bleeder screw on thermostat housing.
- Add coolant to expansion tank until it spills from screw.
- Tighten screw.
- Set temperature controls in passenger compartment to full warm and start engine.
- With engine idling at normal operating temperature, loosen bleeder screw.
- Tighten screw when coolant spilling from bleeder is free from air bubbles.
- After engine has cooled, recheck coolant level and add coolant as necessary.

CAUTION—

Always use genuine BMW coolant or its equivalent to avoid the formation of harmful, clogging deposits in the cooling system. Use of other anti-freeze solutions may be harmful to the cooling system.

Tightening Torque

- Coolant bleeder screw 8 Nm (71 in-lb)

COOLANT PUMP

E32 cars are equipped with a belt-driven coolant pump at the front of the engine which circulates coolant through the engine and the radiator.

In addition to the conventional coolant pump, an electric pump is used to circulate coolant to the heater core. This unit is located below the coolant control valves at the left side of the engine compartment rear bulkhead. For more information on the electric coolant pump and the coolant control valves, see **640 Heating and Air Conditioning**.

Belt-driven coolant pump replacement procedures are organized according to engine codes. For engine code application information, see **100 Engine-General**.

Coolant pump, replacing (M30 engine)

- Drain cooling system as described earlier.

WARNING—

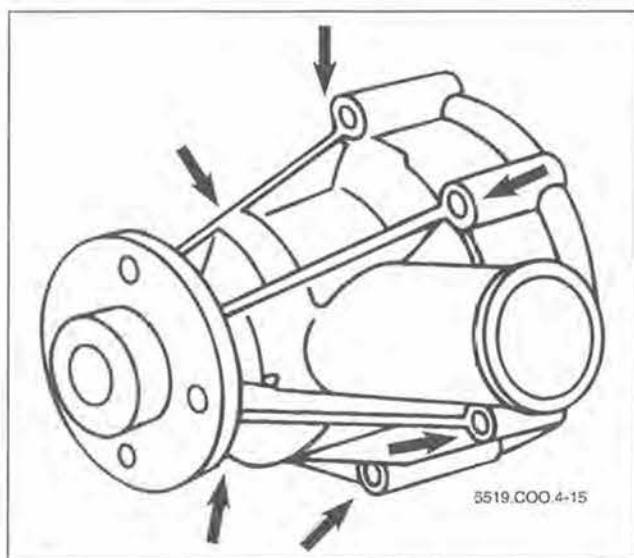
Allow cooling system to cool before opening or draining cooling system.

- Remove fan clutch assembly and fan shroud as described below under **Cooling fan, removing and installing**.

NOTE—

The radiator cooling fan nut (32 mm wrench) has left-hand threads.

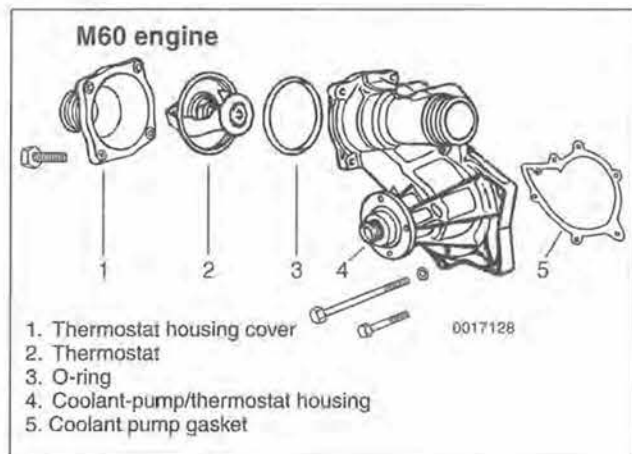
- Apply pressure to pump V-belt and loosen coolant pump pulley mounting bolts. Then remove V-belt and remove pulley from pump.
- Remove engine lifting bracket from front of engine.
- Remove coolant hose from pump.
- Remove six coolant pump mounting bolts (arrows) and remove pump.
- Installation is reverse of removal.
 - Use a new gasket and make sure gasket mating surfaces are clean and dry.
 - Fill system with coolant and bleed system as described under **Coolant, draining and filling**.



COOLANT PUMP

Tightening Torques

- Coolant pump to cylinder block 10 Nm (89 in-lb)
- Coolant pump pulley to coolant pump 10 Nm (89 in-lb)



Coolant pump, replacing (M60 engine)

- M60 engine coolant pump and thermostat housing assembly.

- Drain cooling system as described earlier.

WARNING—

Allow cooling system to cool before opening or draining cooling system.

- Raise car and support in a safe manner.

WARNING—

Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove fan clutch assembly and fan shroud as described under **Cooling fan, removing and installing**.

NOTE—

The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Working from below car, remove engine splash shield and then remove heat shields from front suspension crossmember.

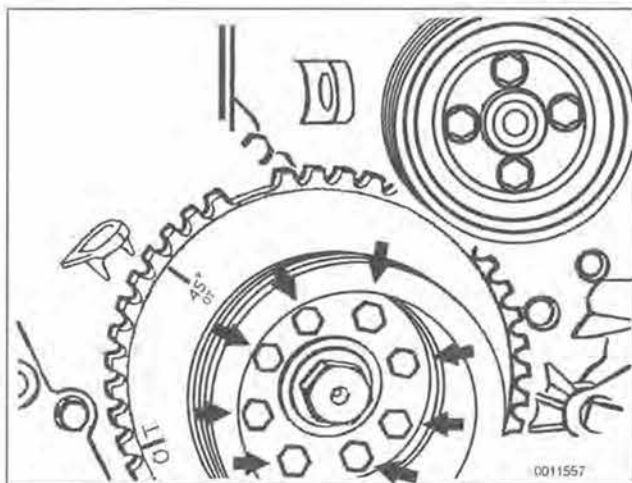
- Loosen coolant pump pulley mounting bolts.

- Remove engine drive belt as described in **020 Maintenance**.

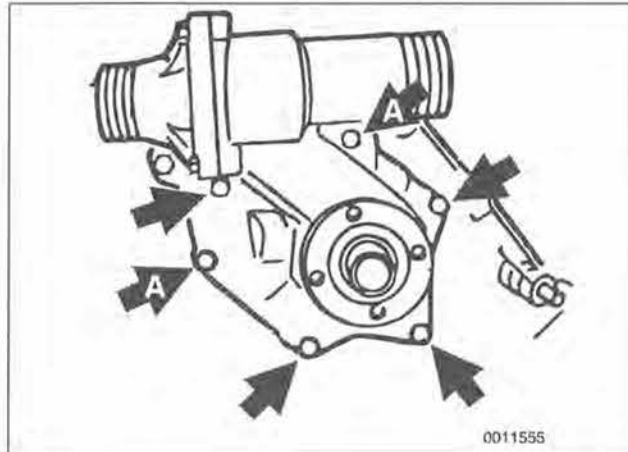
- Remove coolant pump pulley mounting bolts and remove pulley from coolant pump.

- Remove vibration damper mounting bolts (**arrows**) from crankshaft hub on M60 engine.

- Remove coolant hoses from coolant pump/thermostat housing. Remove pump mounting bolts (qty. 6).



170-12 RADIATOR AND COOLING SYSTEM



- ◀ Install coolant pump mounting bolts (**arrows**).
- Be sure pump aligns correctly with dowels (**A**) in timing chain cover during installation.

- Installation is reverse of removal.
- Transfer thermostat from old pump using new O-ring.
- Fill system with coolant and bleed as described under **Coolant, draining and filling**.

CAUTION—

- The vibration damper is located by dowel pins.
- Use new bolts when installing vibration damper.

Tightening Torques

- Coolant drain plug to engine block 25 Nm (18 ft-lb)
- Coolant pump to timing chain cover 10 Nm (89 in-lb)
- Coolant pump pulley to coolant pump 10 Nm (89 in-lb)
- Thermostat housing to coolant pump 10 Nm (89 in-lb)
- Vibration damper to crankshaft hub (M8) 22 Nm (17 ft-lb)

Coolant pump, replacing (M70 engine)

- ◀ M70 engine coolant pump and thermostat housing.

- Drain cooling system as described earlier.

WARNING—

Allow cooling system to cool before opening or draining cooling system.

- Raise car and support in a safe manner.

WARNING—

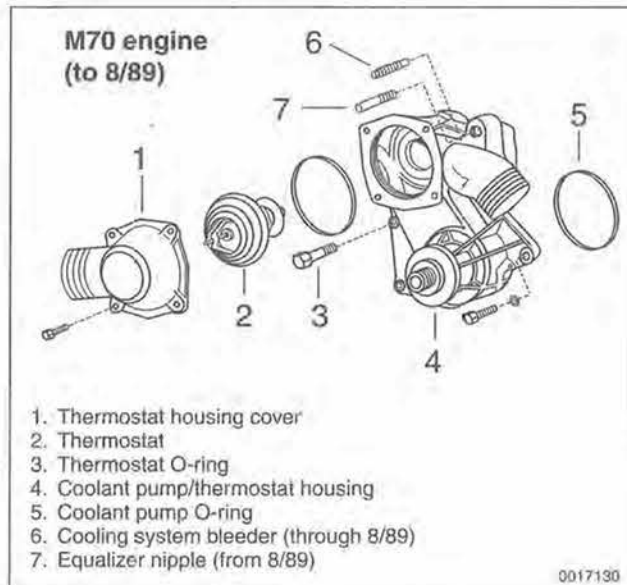
Make sure the car is stable and well supported at all times. Use a professional automotive lift or jack stands designed for the purpose. A floor jack is not adequate support.

- Remove fan clutch assembly and fan shroud as described under **Cooling fan, removing and installing**.

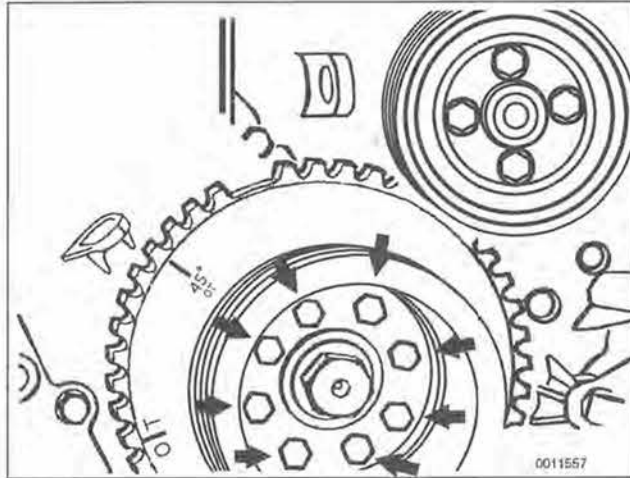
NOTE—

The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Working below car, remove engine splash shield.



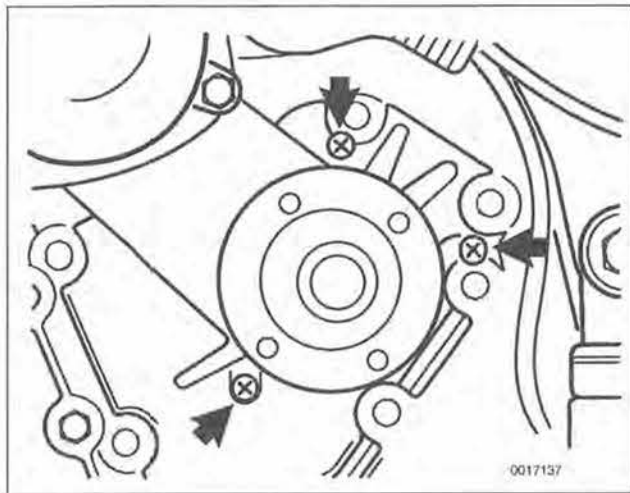
RADIATOR AND COOLING SYSTEM 170-13



➤ Remove crankshaft vibration damper mounting bolts (**arrows**) and remove vibration damper on M70 engine.

— Remove water pump pulley and drive belt.

— Remove coolant hoses from coolant pump/thermostat housing. Remove pump mounting bolts (qty. 6).



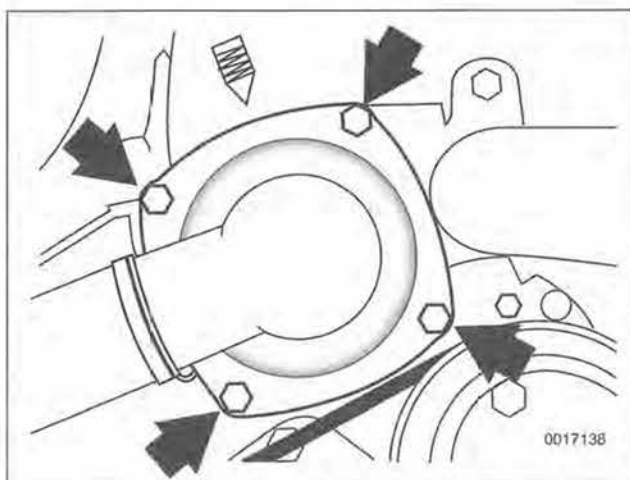
➤ Uniformly screw three M5 bolts (**arrows**) into tapped holes in coolant pump housing to push coolant pump out of mounting block.

— Installation is reverse of removal.

- Transfer thermostat from old pump using a new O-ring. Use HWB[®] lubricant or equivalent to lubricate O-rings.
- Fill system with coolant and bleed as described under **Coolant, draining and filling**.

Tightening Torques

- Coolant drain plug to engine block 25 Nm (18 ft-lb)
- Coolant pump to timing chain cover. 10 Nm (89 in-lb)
- Coolant pump pulley to coolant pump 10 Nm (89 in-lb)
- Thermostat housing to coolant pump 10 Nm (89 in-lb)
- Vibration damper to crankshaft hub (M8) 22 Nm (17 ft-lb)



THERMOSTAT

Thermostat, replacing

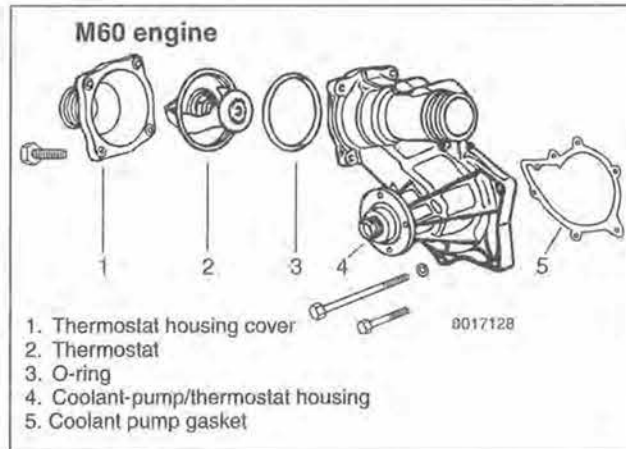
— With engine cold, drain radiator as described above under **Coolant, draining and filling**.

— On M60 engine: Remove upper section of air cleaner complete with mass air flow sensor.

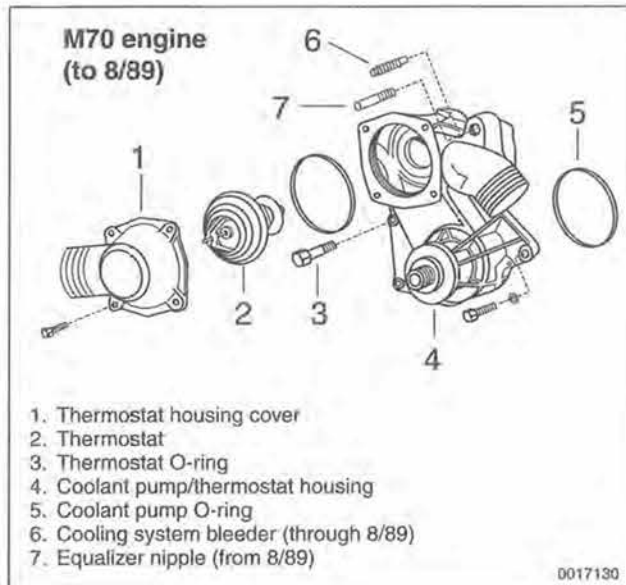
➤ On M30 engine: Remove thermostat cover mounting bolts (**arrows**) from thermostat housing on front of engine.

THERMOSTAT

170-14 RADIATOR AND COOLING SYSTEM



On M60 engine: Remove thermostat from coolant pump and thermostat housing assembly.



On M70 engine: Remove thermostat from coolant pump and thermostat housing assembly.

NOTE —

• On M60 or M70 engine, removal of the cooling fan and fan shroud will provide additional clearance. See **Cooling fan, removing and installing**.

• In all engines, note direction and orientation of thermostat before removing.

— Install new thermostat and thermostat cover using new O-ring and gasket(s) as necessary.

NOTE —

Some thermostats have a direction arrow or vent hole near the edge. Install the thermostat so that either the arrow or hole are at the top.

— Installation is reverse of removal.

• Fill system with coolant and bleed system as described under **Coolant, draining and filling**.

Tightening Torque

• Thermostat housing cover
to housing or coolant pump 10 Nm (89 in-lb)

RADIATOR

Radiator, removing and installing

— Drain radiator as described earlier under **Coolant, draining and filling**.

WARNING —

Allow cooling system to cool before opening or draining system.

RADIATOR AND COOLING SYSTEM 170-15

- Remove fan clutch assembly and fan shroud as described below under **Cooling fan, removing and installing**.

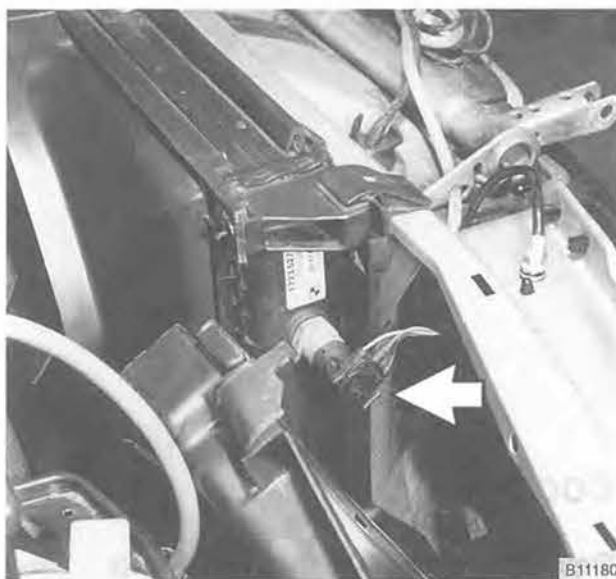
NOTE—

The radiator cooling fan nut (32 mm wrench) has left-hand threads.

- Detach all coolant hoses from radiator.
- Disconnect harness connector from auxiliary fan temperature switch (**arrow**).
- Disconnect automatic transmission fluid (ATF) cooler lines from radiator, where applicable.

NOTE—

Plug the disconnected ATF cooler lines and position them upwards to avoid loss of fluid.



- Push down and pull screwdriver forward to release radiator retaining clip.
- Pull radiator up and out of car.

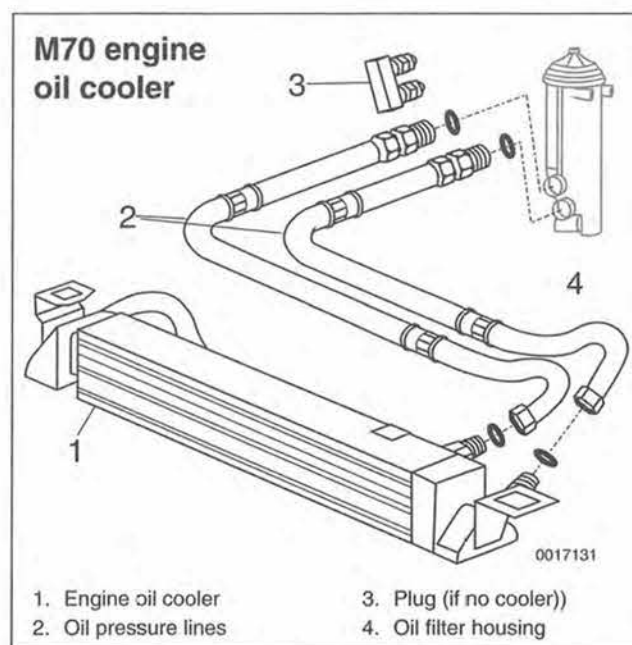
NOTE—

The radiator is mounted on two angled rubber buffers halfway down the sides of the radiator.

- Installation of radiator is reverse of removal, noting following:
 - Use new sealing rings when installing ATF cooler lines. Check ATF level. See **020 Maintenance**.
 - Fill and bleed radiator and cooling system as described under **Coolant, draining and filling**.



RADIATOR



Engine Oil Cooler

- Engine oil cooler on M70 engine. M30 oil cooler is similar.
- The engine oil cooler is mounted below the radiator. The oil pressure lines for the cooler originate at the oil filter housing.

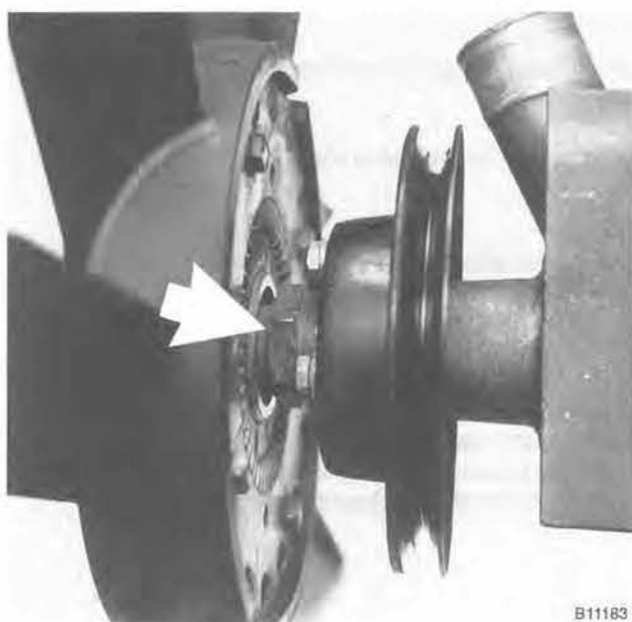
COOLING FANS

Belt-driven cooling fan, replacing

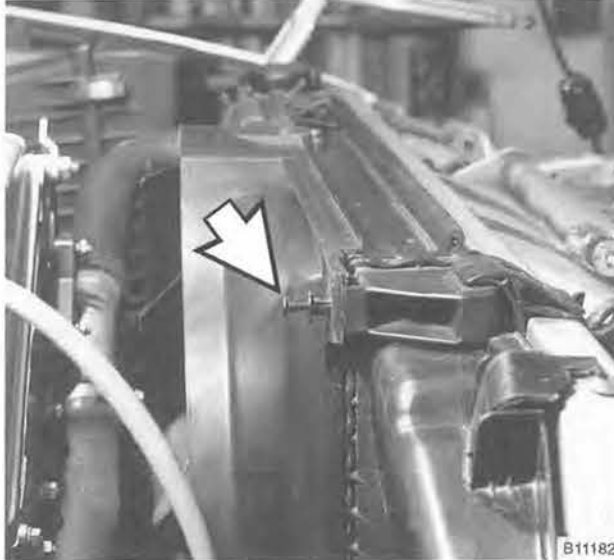
- Place 32 mm wrench on fan clutch nut (**arrow**). Strike wrench sharply in clockwise direction (looking from front of car) to loosen nut. Spin fan off pump.

NOTE—

- If the nut is difficult to loosen, use a tool to hold the coolant pump pulley stationary. BMW has a special tool for this purpose (BMW special tool no. 11 5 030 for M30 engines or 11 5 050 for M60 engines).
- The radiator cooling fan nut (32 mm wrench) has left-hand threads.



RADIATOR AND COOLING SYSTEM 170-17



➤ Remove expansion rivets (**arrow**) holding shroud to radiator.

— Remove fan and shroud together.

NOTE—

Store the removed fan clutch assembly in an upright position to prevent loss of clutch fluid.

— To replace fan clutch, remove fan mounting bolts (qty. 4) and separate fan from clutch.

— Installation is reverse of removal.

Tightening Torques

- Fan to viscous clutch 10 Nm (89 in-lb)
- Clutch nut to coolant pump (left-hand thread)
 - Without BMW tool no. 11 5 040 40 Nm (29 ft-lb)
 - With BMW tool no. 11 5 040 30 Nm (22 ft-lb)

Auxiliary cooling fan, replacing

— Remove front bumper and center radiator grille as described in **510 Exterior Trim, Bumpers**.

— Detach auxiliary fan harness connector.

➤ Auxiliary cooling fan harness connector (**A**) and mounting bolts (**B**).

- Remove fan mounting bolts and lower fan out of car.

— Installation is reverse of removal.

