170 Radiator and Cooling System

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

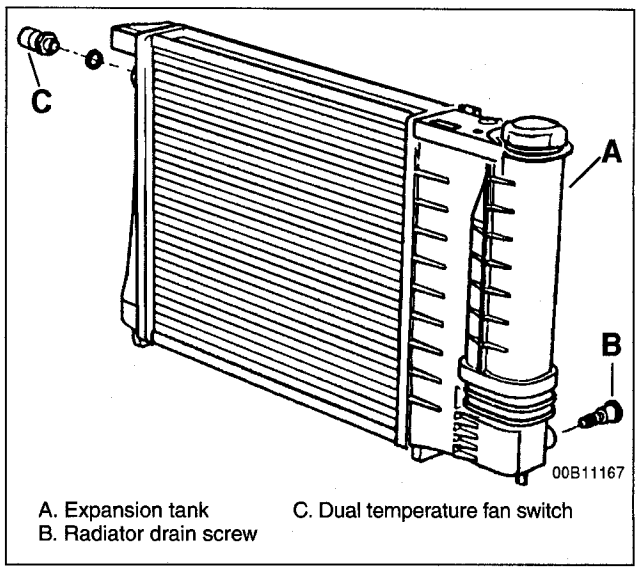
A centrifugal-type coolant pump is mounted to the front of the engine. The belt-driven pump circulates coolant through the system whenever the engine is running. A thermostat controls the flow of coolant into the radiator.

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 and Expansion Tank

The radiator is a crossflow design. A translucent expansion tank provides for coolant expansion at higher temperatures and easy monitoring of the coolant level.

On 4-cylinder models, the radiator expansion tank is integral with the radiator. See Fig. 1.



A. Expansion tank
B. Radiator drain screw
C. Dual temperature fan switch

Fig. 1. Radiator assembly with integral expansion tank (4-cylinder engine).

On 6-cylinder models, a stand alone expansion tank is used.

On cars with automatic transmission, ATF is circulated through an additional heat exchanger (ATF cooler).

Cooling Fans

Belt-driven cooling fan. The primary cooling fan is belt-driven. It 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.

Electric cooling fan. Models with M44 engine and standard transmission substitute an electric fan for the belt-driven viscous fan. This is attached to the rear of the radiator and controlled via the DME 5.2 engine management system.

NOTE —
The electric cooling fan in these models is activated by the engine control module (ECM).

Auxiliary cooling fan. In all models a two-speed electric auxiliary cooling fan is mounted behind the front grill and 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.

Warnings and Cautions

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's 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. Be sure to check the condition and tension of the coolant pump drive belt. Check hoses for cracks or softness. Check clamps for looseness. Check the coolant level and check for evidence of coolant leaks from the engine.

Check that the radiator fins are not blocked with dirt or debris. Clean the radiator using low-pressure water or compressed air. Blow outward, from the engine side out.

Inspect the coolant pump by first removing the drive belt from the pump. Firmly grasp opposite sides of the pulley and check for play in all directions. Spin the pulley and check that the shaft runs smoothly.

NOTE —
The coolant provides 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 can 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 are:

- Faulty radiator fan
- Loose or worn drive belt
- Failed thermostat or coolant pump
- Clogged/plugged radiator or coolant passages.

NOTE —
- *Some early style coolant pumps were fitted with fiber/plastic type impellers. Over time, this impeller can wear away and result in overheating. The plastic impeller can also slip or free-wheel on the pump shaft. If the engine overheats and no other faults can be found, the old style impeller may be the cause of the problem.*
- *Only pumps with the updated metal impeller should be used for replacement.*

Cooling System Pressure Test

A cooling system pressure test is used to check for internal leaks. Some of the common sources of internal leaks are a faulty cylinder head gasket, a cracked cylinder head, or a cracked cylinder block.

To do a cooling system pressure test, a special pressure tester is needed.

> ***WARNING —***
> *At normal operating temperature the cooling system is pressurized. Allow the system to cool before opening. Release the cap slowly to allow safe release of pressure.*

With the engine cold, install a pressure tester to the expansion tank. Pressurize the system to the specification listed below. Pressure should not drop more than 0.1 bar (1.45 psi) for at least two 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 test as described in **100 Engine—General.**

The screw-on type expansion tank cap should also be tested using a pressure tester and the correct adapter.

Cooling System Test Pressure

- Radiator test pressure . . . . . 1.5 bar (21.75 psi)
- Radiator cap test pressure. . . . . 2 bar (29 psi)

> ***CAUTION —***
> *Exceeding the specified test pressure could damage the radiator or other system components.*

Carefully inspect the radiator cap for damage. Replace a faulty cap or a damaged cap gasket.

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). Shut off engine. Feel the top radiator hose. If the hose is hot to the touch, the coolant is probably circulating correctly. If there are any cool areas in the 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 the engine overheats and no other cooling system tests indicate trouble, the radiator may have some plugged passages that are restricting coolant flow.

Temperature Gauge Quick Check

The coolant temperature sensor is located on the intake manifold (left) side of the cylinder head, under the intake manifold runners. See Fig. 2.

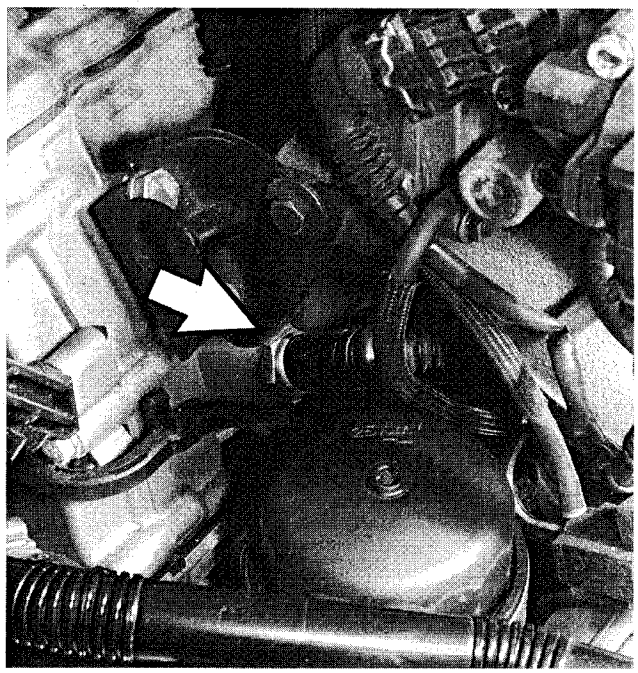


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Fig. 2. Temperature gauge sender on M44 engine. Temperature gauge sender location is similar on all engines.

In early models, the engine coolant temperature (ECT) sensor for the fuel injection and the coolant temperature gauge sender are located side by side.

In later models, the ECT sensor and the gauge sender are combined into one sender unit. For wire colors refer to **Table a.**

Table a. Coolant Temperature Sensor Wire Colors

Function	Sensor location	Terminal number	Wire colors
Two sensors:			
Temperature gauge sender	Rear	1	Brown/violet
		2	Brown/yellow
ECT sensor	Front	1	Brown/red
		2	Brown or Brown/black
One sensor:			
Temperature gauge sender	Dual sensor	1	Brown/yellow
		2	Brown/violet
ECT sensor		3	Brown/red
		4	Brown/black or Grey/black

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

If the gauge needle remains at the rest position with the engine warm, remove the harness connector from the sender and jumper the correct terminals in the connector to simulate a high engine temperature. See **Table a**. Turn the ignition on. If the gauge needle moves upward, the sender is faulty. If the gauge does not respond, the wiring to the gauge is broken (open circuit) or the gauge itself is faulty.

> ***WARNING —***
> *1996 and later models are OBD II compliant. Disconnecting electrical connectors with the ignition turned on may set fault codes in the ECM. It is recommended that you leave the diagnosis of faults in the coolant temperature sensor system to the BMW dealer service department which has specialized OBD II scan tool equipment.*

If the gauge needle reads too high when the engine is cold, remove the harness connector from the sender. Turn the ignition on. If the gauge needle position does not change, the wiring or the gauge is shorted to ground. If the gauge needle drops, the sender is faulty and should be replaced. When replacing a faulty coolant temperature sender, the gasket ring on the sender should also be replaced.

Tightening Torque

- Temperature gauge sender to engine 18 Nm (13 ft-lb)

Cooling fan, testing

> ***NOTE —***
> *On M44 engines with manual transmission, the primary electric cooling fan is mounted on the engine side of the radiator and is controlled by the engine control module (ECM). Troubleshooting this circuit should be left to an authorized BMW dealer with the proper diagnostic equipment.*

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

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

With the engine off, check the fan clutch by spinning the fan. The fan should spin on the clutch with some resistance. Check for signs of leaking fluid from the clutch. If the fan freewheels with no resistance, cannot be turned by hand, or there are signs of oil leakage, the clutch should be replaced.

The auxiliary cooling fan comes on when coolant temperature exceeds a predetermined level or whenever the air conditioning is on. A dual-range temperature switch for cooling fan control is mounted on the right side of the radiator. See Fig. 3.

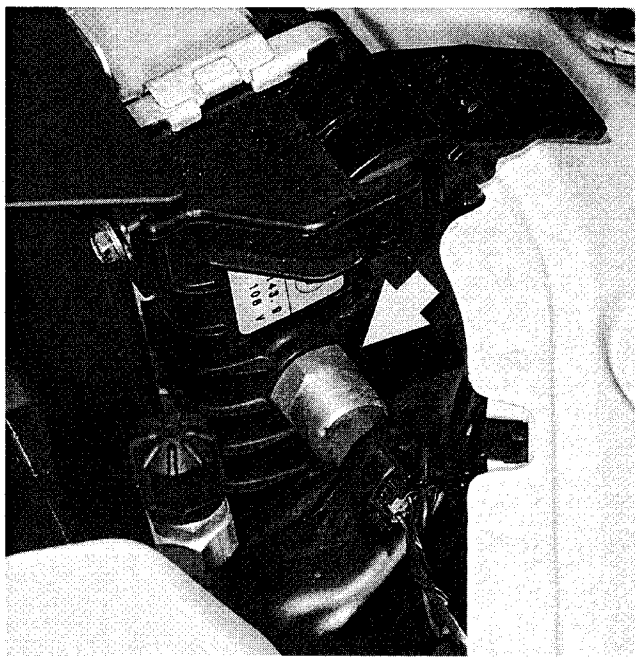

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Fig. 3. Radiator cooling fan temperature switch (**arrow**).

> ***WARNING —***
> - *Use caution when testing the electric cooling fan(s) and coolant temperature switch. Keep hands and wires clear of the fan blades. The cooling fan(s) 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.*

If a faulty thermostat, trapped air, or a restriction in the system is not allowing the coolant to circulate through the radiator, the temperature switch will not close and the auxiliary cooling fan will not run. Before making the tests described below, make sure the thermostat is operating correctly as described earlier. The normal switching temperatures for the dual -speed switch are listed in **Table b**.

Table b. Auxiliary Cooling Fan Switching Temperatures

Speed	Switching temperature
Low speed High speed	196°F (91°C) 210°F (99°C)

NOTE —
Some cars covered by this manual may have an alternate cooling fan switch with switching temperatures of 176°/190°F (80°/88°C). When replacing the switch check the switching specifications, which should be stamped on the switch body.

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

Table c. Auxiliary Cooling Fan Temperature Switch Tests

Wires jumpered	Test conditions	Test results
Black/green (terminal 2) and brown (terminal 1)	Ignition ON	Fan runs on low speed
Black/gray (terminal 3) and brown (terminal 1)	Ignition ON	Fan runs on high speed

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

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

3. If auxiliary fan does not run when powered directly, check for battery voltage at temperature switch connector (black/green wire) with ignition on. If battery voltage is not present, check fuses. See **610 Electrical Component Locations.**

Auxiliary Cooling Fan Circuit Fuses
- Fuse 16 ..... 5 amp
- Fuse 41 (ex. M44 w/man. trans) ..... 30 amp
- Fuse 48 (M44 w/man. trans. only) ..... 40 amp

4. If no faults are found, remove low speed relay and turn ignition ON. See Fig. 4.
   - Check for power at terminal 30 and terminal 86 of relay socket.
   - Reinstall low speed relay and repeat test at high speed relay socket. Fix any wiring faults found.

On early production cars (up to 9/92): If fan operates only on 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 is mounted on auxiliary cooling fan housing behind front grille. See Fig. 5. Wiring diagrams for the radiator cooling fan can be found under **Electrical Wiring Diagrams.**

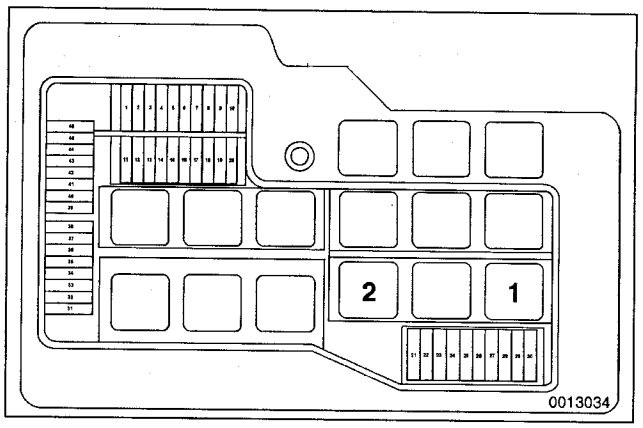

Fig. 4. Auxiliary radiator cooling fan low speed relay (**1**) and high speed relay (**2**) in power distribution box. (Relay locations may vary.)

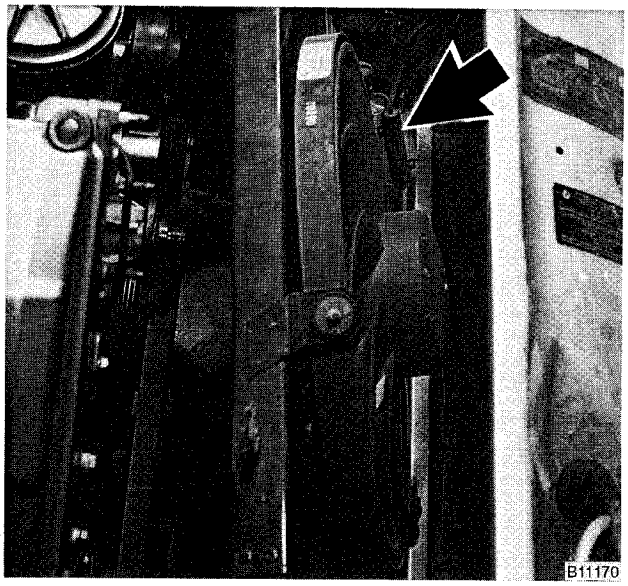

Fig. 5. Auxiliary radiator fan resistor (**arrow**).

COOLING SYSTEM SERVICE

Coolant, draining and filling

1. Remove expansion tank cap. Set temperature controls to full warm.

> ***WARNING —***
> *Allow the cooling system to cool before opening or draining the cooling system.*

2. Place 3-gallon pail beneath radiator drain plug and remove drain plug. See Fig. 6.

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

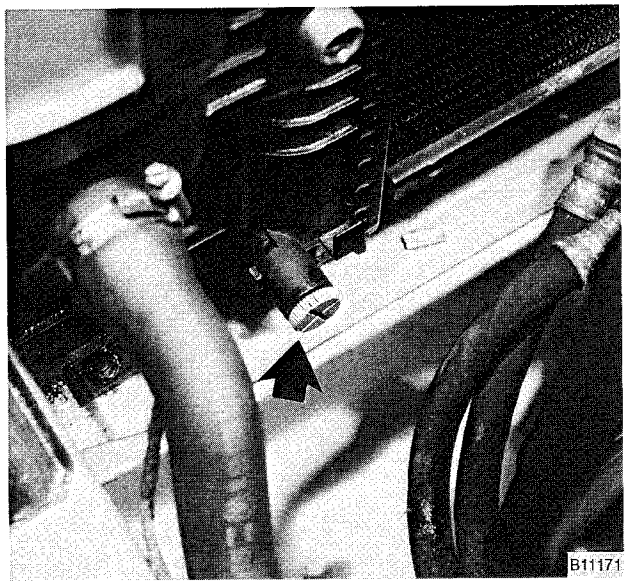

Fig. 6. Radiator drain plug (**arrow**).

> ***WARNING —***
> *Coolant is poisonous. It is especially lethal to pets. Clean up spills immediately and rinse the area with water.*

NOTE —
The block drain plug is located on the exhaust side of the engine, near the rear of the engine.

4. Reinstall radiator and engine block drain plugs using new sealing washers. Leave heater controls on full warm.

5. Using a coolant mixture of 50% antifreeze and 50% distilled water, fill system slowly. On radiator with integral expansion tank, bleed cooling system as described below.

NOTE —
- *Tap water may cause corrosion of radiator, engine and coolant hoses.*
- *Coolant can often be reused provided it is clean and less than two years old. Do not reuse coolant when replacing damaged engine parts. Contaminated coolant may damage the engine or cooling system.*

Table d. Cooling System Capacities

Engine	Capacity
4-cylinder	6.5 liters (6.9 qt)
6-cylinder M50/M52 S50US/S52US	 10 liters (10.6 qt) 10.5 liters (11.1 qt)

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

Cooling system, bleeding (radiator with integral expansion tank)

NOTE —
On radiators with a separate expansion tank, a bleed screw is not provided. The cooling system with separate expansion tank is self bleeding via the vent hose on the expansion tank.

Air may become trapped in the 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.

1. With engine cold, add coolant to expansion tank until level reaches COLD (KALT) mark on tank.

2. Loosen bleed screw on radiator expansion tank. See Fig. 7.

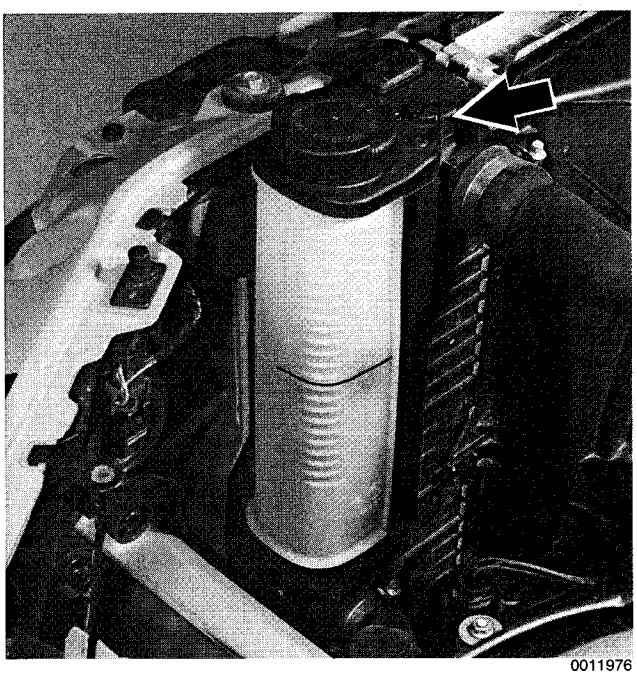

Fig. 7. Cooling system bleed screw on radiator (**arrow**). Note cold level mark on expansion tank.

3. M3 models: Loosen bleed screw on thermostat housing.

4. Set temperature controls in passenger compartment to full warm and turn ignition on position (do *not* start engine).

5. Slowly add coolant until it spills from bleed screws. When coolant spilling from bleed screws is free of air bubbles, tighten screws.

6. Run engine until it reaches operating temperature. After engine has cooled, recheck coolant level and top up 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 antifreeze solutions may be harmful to the cooling system.*

Tightening Torque

- Radiator bleed screw to thermostat housing . . . . . 8 Nm (71 in-lb)

Belt-driven cooling fan, replacing

1. Using a 32 mm wrench on fan clutch nut, turn wrench quickly in a clockwise direction (working from front of car) to loosen. Spin fan off pump. See Fig. 8.

NOTE —

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

2. Remove expansion rivets holding shroud to radiator. See Fig. 9. Remove fan and shroud together.

NOTE —

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

3. To replace fan clutch, remove fan mounting bolts and separate clutch from fan.

4. Installation is reverse of removal.

Tightening Torques

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

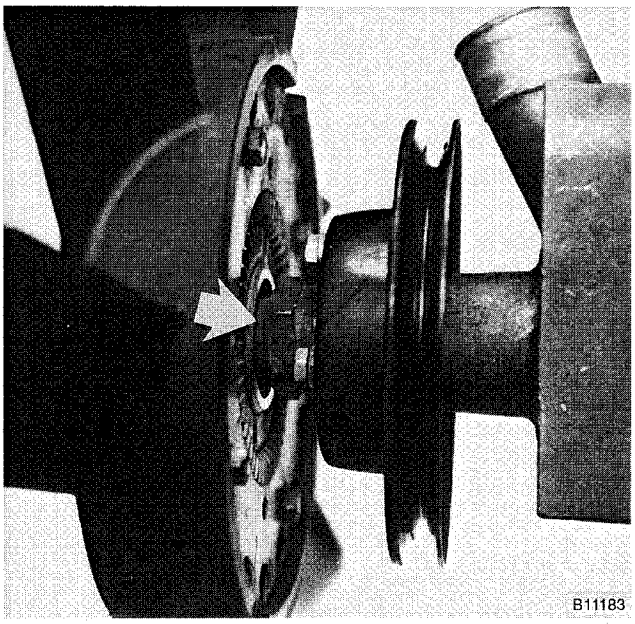

Fig. 8. Radiator cooling fan nut (**arrow**). Nut has left-hand threads.

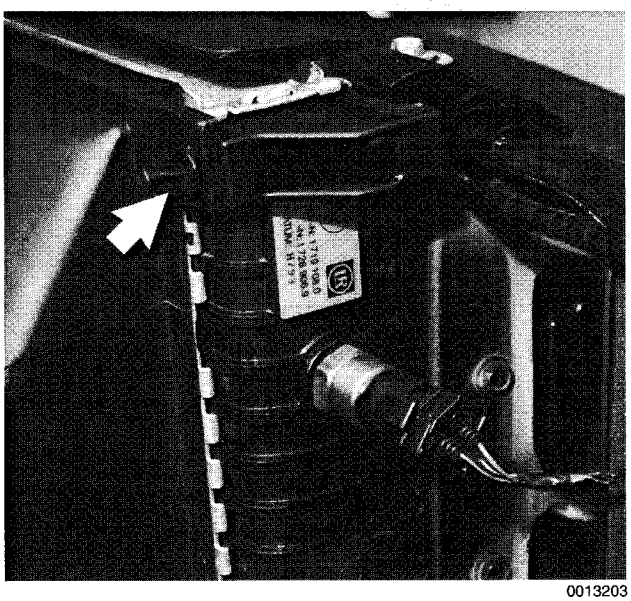

Fig. 9. Fan shroud retaining rivet (**arrow**). Pry out center pin and remove rivet. Rivet design may vary depending on model and model year.

Electric cooling fan, replacing

On late 4-cylinder models (M44 engine) with manual transmission, the primary cooling fan is electrically operated and is mounted on the engine side of the radiator.

1. If necessary, remove cover from top of radiator. See Fig. 10.

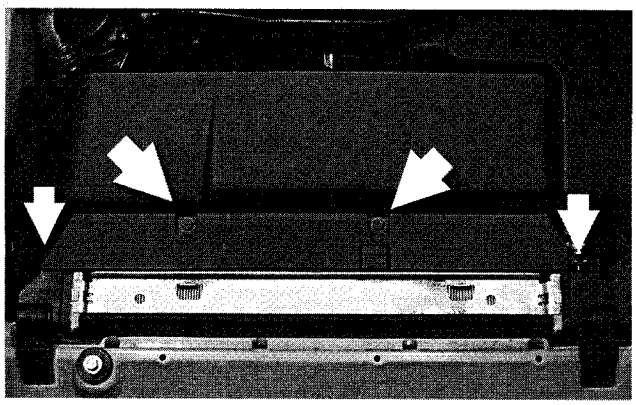

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Fig. 10. Air cover in back of radiator. Unclip cover from fan shroud after removing mounting screws.

2. Disconnect fan harness connector at bottom left of radiator.
3. Remove fan shroud mounting screws at left and right side of radiator. Lift fan assembly straight up and off radiator.
4. Installation is reverse of removal. Be sure to align side tabs on fan housing with retaining tabs on radiator when reinstalling fan.

Auxiliary cooling fan, replacing

The auxiliary electric cooling fan is mounted behind the front bumper, in front of the A/C condenser. There are two versions of auxiliary fans installed, depending on model and engine installed.

◗Type 1 (up to 9/92)

1. Remove front radiator air shroud. See Fig. 11.
2. Remove fan mounting screws. See Fig. 12.
3. Tilt fan forward. Disconnect electrical harness connector before lifting fan up.

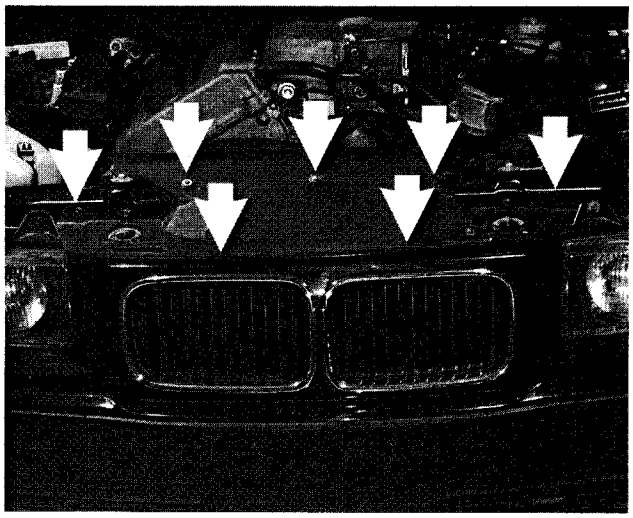

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Fig. 11. Front radiator air shroud fasteners (**arrows**).

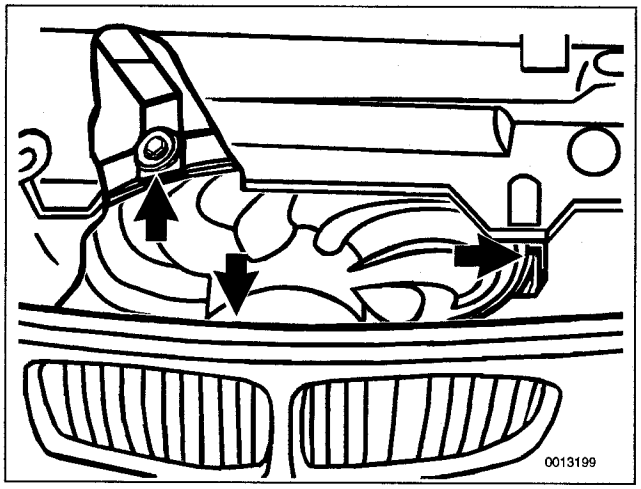

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Fig. 12. Version 1 auxiliary fan mounting screws (**arrows**).

NOTE —
If necessary, remove front bumper or lower engine cover to access electrical harness connector.

4. Installation is reverse of removal.

◗ Type 2 (from 9/92)

1. Remove front bumper and radiator grilles. See **510 Exterior Trim, Bumpers**.
2. Remove fan mounting screws. See Fig. 13.
3. Angle fan up and forward, disconnecting electrical harness connector behind it. Remove it through bumper opening.

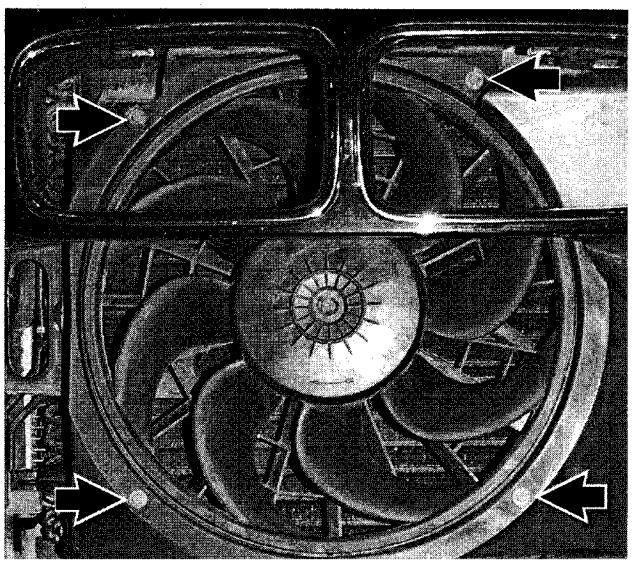

Fig. 13. Version 2 auxiliary fan mounting screws (**arrows**). Front bumper has been removed.

4. Installation is reverse of removal.

Thermostat, replacing

The coolant thermostat is installed in a housing at the front of the cylinder head. See Fig. 14.

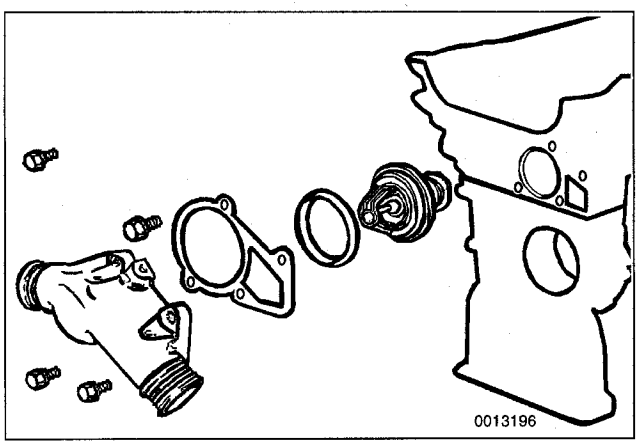

Fig. 14. Coolant thermostat and housing.

NOTE —
On M44 engines, the thermostat is integrated into the thermostat housing. If the thermostat requires replacement, the complete thermostat housing must be replaced.

1. Drain radiator as described above under **Coolant, draining and filling**.

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

2. Remove belt-driven cooling fan and fan shroud as described earlier.

3. On M52/S52US engines: Unclip wiring duct retaining clips and remove duct from above thermostat housing. Also remove engine front lifting bracket.

4. Remove thermostat housing from front of engine. See Fig. 15.

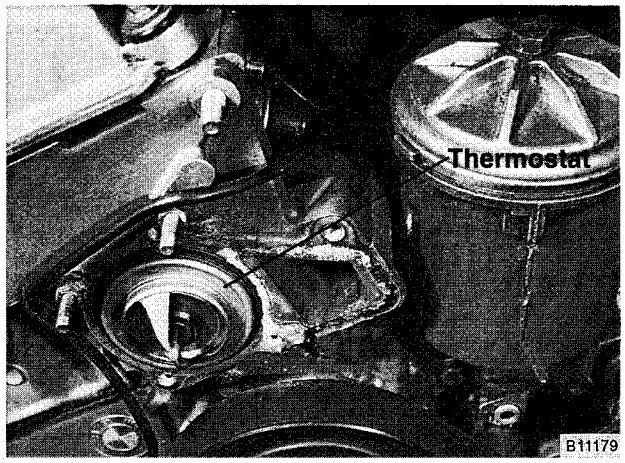

Fig. 15. Thermostat housing shown removed (6-cylinder engine).

5. Remove thermostat. Note thermostat direction and orientation before removing.

6. Install new thermostat and/or thermostat housing 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.

7. Installation is reverse of removal. Fill system with coolant as described under **Coolant, draining and filling.**

CAUTION —
Be sure to reconnect ground wire(s) at thermostat housing mounting bolt, where applicable.

Tightening Torques

- Thermostat housing cover to housing or coolant pump . . . . . 10 Nm (89 in-lb)
- Engine lifting bracket bolt to thermostat housing (M52/S52US engine)(M8) . . . . . 22 Nm (17 ft-lb)

Coolant pump, replacing

The engine coolant pump is mounted in the front of the engine on the timing cover. See Fig. 16.

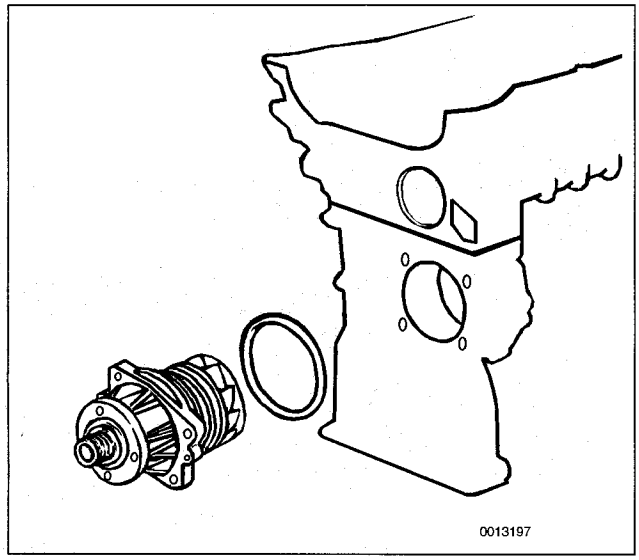

Fig. 16. Coolant pump mounted on timing cover.

NOTE —
Only replacement coolant pumps with metal impellers should be installed. Pumps with plastic impellers should not be used.

1. Drain cooling system as described earlier.

> ***WARNING —***
> *Allow cooling system to cool before opening or draining system.*

2. Remove primary cooling fan shroud and cooling fan (belt-driven or electric) as described earlier.
3. Disconnect hoses from thermostat housing. Unbolt thermostat housing from front of cylinder head.
4. Remove coolant pump drive belt. See Fig. 17 or Fig. 18.

NOTE —
- *Mark direction of drive belt rotation if reusing belt.*
- *Several drive belt and tensioner configurations have been used in E36 models. Refer to* **020 Maintenance Program** *and* **640 Heating and Air Conditioning**.

5. Remove coolant pump pulley from pump.
6. Remove mounting fasteners from pump.

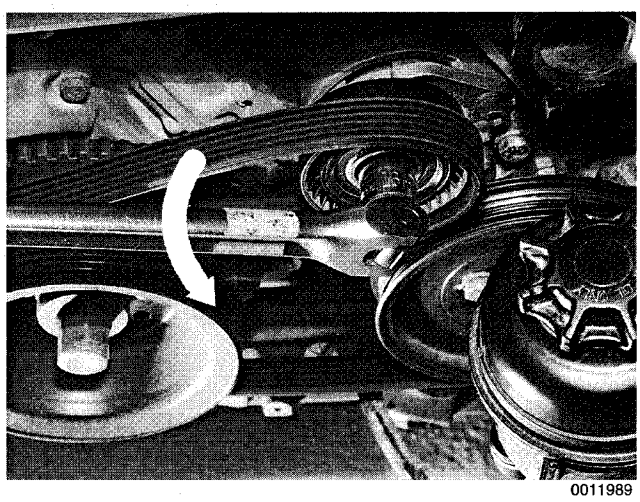

Fig. 17. Engine drive belt tensioner being released on M44 engine. Pry off tensioner cover and then lever tensioner in counterclockwise direction (as facing engine) and slip belt off pulleys.

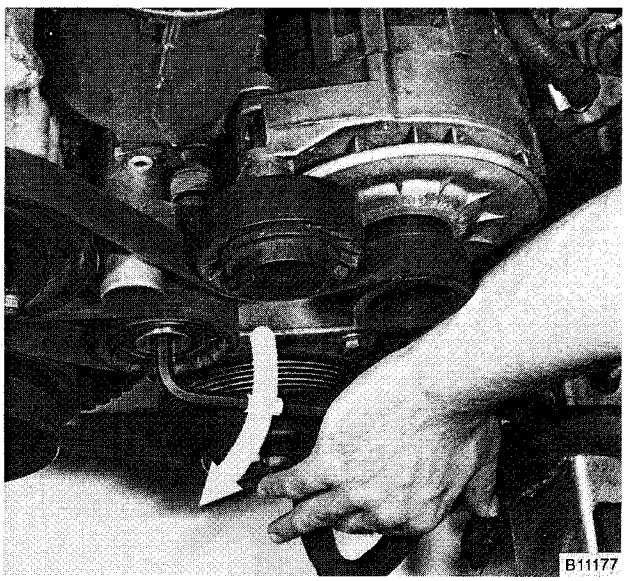

Fig. 18. Drive belt tensioner being released on M52 engine. Pry off tensioner cover and then lever tensioner clockwise (as facing engine) to release belt tension.

NOTE —
- *The 4-cylinder coolant pump is mounted using two different length bolts. Note where the longer bolt fits during disassembly.*
- *The 6-cylinder coolant pump is mounted on studs and retained by nuts.*

7. Insert two screws (M6) in tapped bores and tighten uniformly until pump is free from timing chain cover. See Fig. 19.

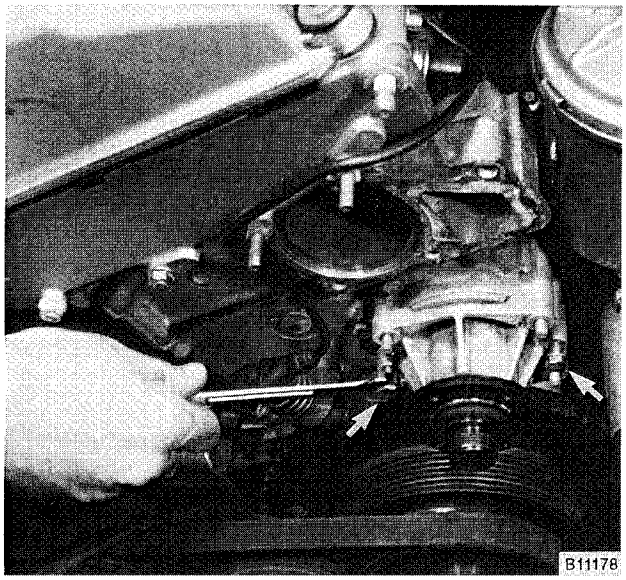

Fig. 19. Coolant pump being removed. Thread two M6 bolts (**arrows**) in evenly to withdraw pump. (Thermostat and hoses have been removed for visual access.)

8. Installation is reverse of removal.
   - Be sure to replace O-ring and gaskets.
   - Coat O-ring with lubricant during installation.

Tightening Torque

- Coolant pump to timing chain cover
  - M6 ..... 10 Nm (89 in-lb)
  - M8 ..... 22 Nm (17 ft-lb)
- Coolant pump pulley to coolant pump ..... 10 Nm (89 in-lb)

RADIATOR SERVICE

Radiator, removing and installing

1. Drain radiator as described earlier.

> ***WARNING —***
> *Allow cooling system to cool before opening or draining system.*

2. Remove primary cooling fan (belt-driven or electric) as described earlier.

3. Disconnect cooling fan and level sensor harness connectors from bottom of radiator, where applicable

4. Disconnect harness connector from auxiliary fan dual temperature switch. See Fig. 20.

5. Disconnect all coolant hoses from radiator.

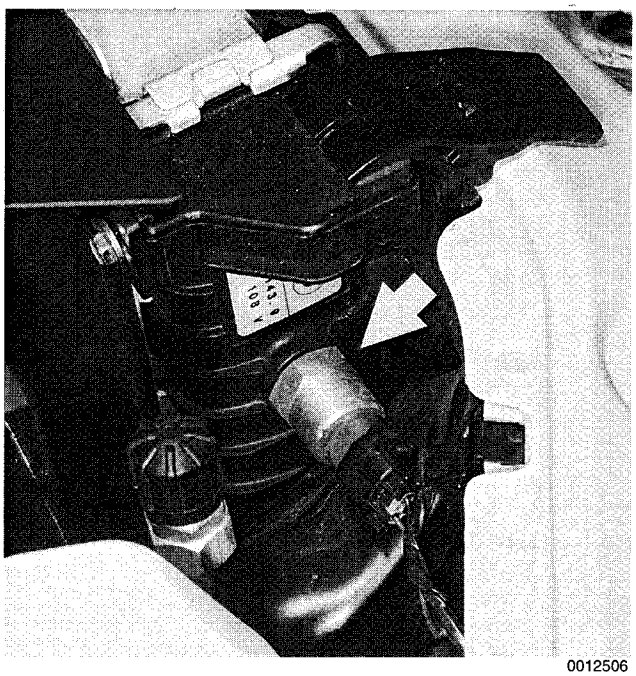

Fig. 20. Cooling fan dual temperature switch (**arrow**) on right side of radiator.

6. Where applicable, disconnect automatic transmission fluid (ATF) cooler lines from radiator. See Fig. 21.

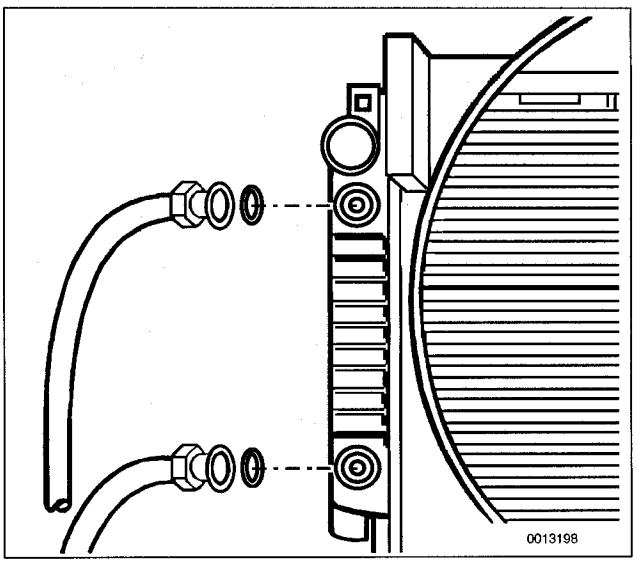

Fig. 21. Automatic transmission fluid (ATF) lines at radiator.

7. Carefully pry out radiator retaining clips from top of radiator. See Fig. 22.

8. Pull radiator up and out of car.

> ***NOTE —***
> *The radiator rests on two rubber mounts. Check that the mounts do not stick to the bottom of the radiator.*

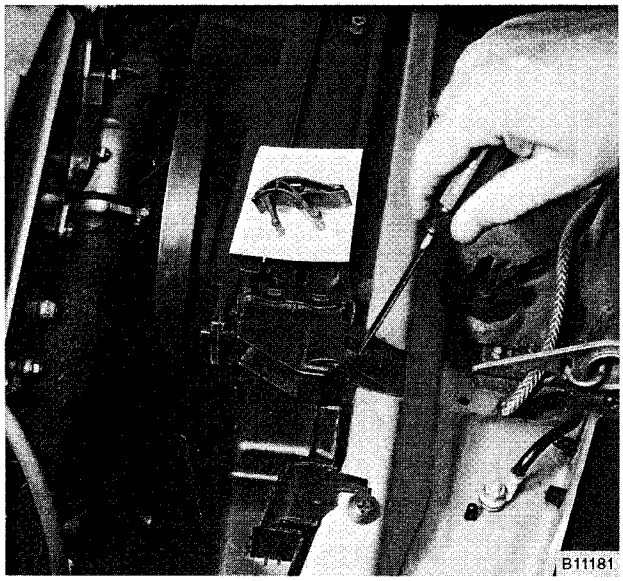

Fig. 22. Radiator retaining clip being removed. Push down and pull screwdriver forward to release clip.

9. Installation is reverse of removal.
   - Fill radiator and cooling system as described under **Coolant, draining and filling.**
   - Check ATF level and, if necessary, top up. See **240 Automatic Transmission.**