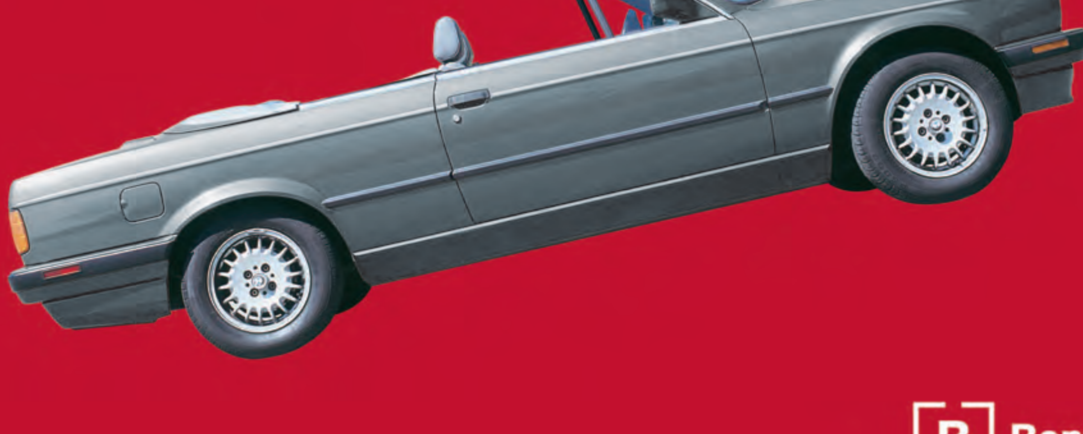
BMW 3 Series

Service Manual

318i, 325, 325e, 325es,
325i, 325is, and 325i Convertible

1984, 1985, 1986, 1987, 1988, 1989, 1990



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WARNING—important safety notice

Do not use this manual unless you are familiar with basic automotive repair procedures and safe workshop practices. This manual illustrates the workshop procedures required for most service work. It is not a substitute for full and up-to-date information from the vehicle manufacturer or for proper training as an automotive technician. Note that it is not possible for us to anticipate all of the ways or conditions under which vehicles may be serviced or to provide cautions as to all of the possible hazards that may result.

The vehicle manufacturer will continue to issue service information updates and parts retrofits after the editorial closing of this manual. Some of these updates and retrofits will apply to procedures and specifications in this manual. We regret that we cannot supply updates to purchasers of this manual.

We have endeavored to ensure the accuracy of the information in this manual. Please note, however, that considering the vast quantity and the complexity of the service information involved, we cannot warrant the accuracy or completeness of the information contained in this manual.

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Your common sense and good judgment are crucial to safe and successful service work. Read procedures through before starting them. Think about whether the condition of your car, your level of mechanical skill, or your level of reading comprehension might result in or contribute in some way to an occurrence which might cause you injury, damage your car, or result in an unsafe repair. If you have doubts for these or other reasons about your ability to perform safe repair work on your car, have the work done at an authorized BMW dealer or other qualified shop.

Part numbers listed in this manual are for identification purposes only, not for ordering. Always check with your authorized BMW dealer to verify part numbers and availability before beginning service work that may require new parts.

Before attempting any work on your BMW, read the **WARNINGS** and **CAUTIONS** on pages **ix and x** and any **WARNING** or **CAUTION** that accompanies a procedure in the service manual. Review the **WARNINGS** and **CAUTIONS** each time you prepare to work on your BMW.

Special tools required to perform certain service operations are identified in the manual and are recommended for use. Use of tools other than those recommended in this manual may be detrimental to the car's safe operation as well as the safety of the person servicing the car.

Copies of this manual may be purchased from most automotive accessories and parts dealers specializing in BMW automobiles, from selected booksellers, or directly from the publisher.

The publisher encourages comments from the reader of this manual. These communications have been and will be carefully considered in the preparation of this and other manuals. Please contact Robert Bentley, Inc., Publishers at the address listed on the top of this page.

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Contents:

Foreword and Disclaimer

For the BMW owner with basic mechanical skills and for independent auto service professionals, this manual includes many of the specifications and procedures that were available in an authorized BMW dealer service department as this manual went to press. The BMW owner with no intention of working on his or her car will find that owning and referring to this manual will make it possible to be better informed and to more knowledgeably discuss repairs with a professional automotive technician.

The BMW owner intending to do maintenance and repair should have screwdrivers, a set of metric wrenches and sockets, and metric Allen and Torx wrenches, since these basic hand tools are needed for most of the work described in this manual. Many procedures will also require a torque wrench to ensure that fasteners are tightened properly and in accordance with specifications. Additional information on basic tools and other tips can be found in **1 Fundamentals**. In some cases, the text refers to special tools that are recommended or required to accomplish adjustments or repairs. These tools are usually identified by their BMW special tool number and illustrated.

Disclaimer

We have endeavored to ensure the accuracy of the information in this manual. When the vast array of data presented in the manual is taken into account, however, no claim to infallibility can be made. We therefore cannot be responsible for the result of any errors that may have crept into the text. Please also read the **Important Safety Notice** on the copyright page at the beginning of this book.

A thorough pre-reading of each procedure, and **WARNINGS and CAUTIONS** at the front of the book and those that accompany the procedure is essential. Reading a procedure before beginning work will help you determine in advance the need for specific skills, identify hazards, prepare for appropriate capture and handling of hazardous materials, and the need for particular tools and replacement parts such as gaskets.

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BMW offers extensive warranties, especially on components of the fuel delivery and emission control systems. Therefore, before deciding to repair a BMW that may be covered wholly or in part by any warranties issued by BMW of North America, LLC, consult your authorized BMW dealer. You may find that the dealer can make the repair either free or at minimum cost. Regardless of its age, or whether it is under warranty, your BMW is both an easy car to service and an easy car to get serviced. So if at any time a repair is needed that you feel is too difficult to do yourself, a trained BMW technician is ready to do the job for you.

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Vehicle Identification and VIN Decoder

Vehicle Identification Number (VIN), decoding

Some of the information in this manual applies only to cars of a particular model year or range of years. For example, 1984 refers to the 1984 model year but does not necessarily match the calendar year in which the car was manufactured or sold. To be sure of the model year of a particular car, check the Vehicle Identification Number (VIN) on the car.

The VIN is a unique sequence of 17 characters assigned by BMW to identify each individual car. When decoded, the VIN tells the country and year of manufacture; make, model and serial number; assembly plant and even some equipment specifications.

The BMW VIN is on a plate mounted on the top of the dashboard, on the driver's side where the number can be seen through the windshield. The 10th character is the model year code. The letters I, O, Q and U are not used for model year designation for US cars. Examples: E for 1984, F for 1985, G for 1986, H for 1987, etc. The table below explains some of the codes in the VIN for E30 cars.

Sample VIN: WBA | AA13 | 1 | 9 | L | A | E58064

position 1 2 3 | 4 5 6 7 | 8 | 9 | 10 | 11 | 12-17

VIN position	Description	Decoding information	
1	Country of Manufacture	W	Germany
2	Manufacturer	B	BMW AG
3	Manufacturing division	A S	BMW BMW Motorsport
4–7	Series, model	AK74 AK84 AJ93 AF93 BA73 AA13 AA23 AD13 AD23 AB54 AB64 AE54 AE64 BB13 BB23 AK03 AB93 AB03 AE93 AE03	318i, 4-cylinder 1.8 liter (M10) 318iA, 4-cylinder 1.8 liter (M10) 318i, 4-cylinder 1.8 liter (M42) 318is, 4-cylinder 1.8 liter (M42) 318i, Convertible, 4-cylinder (M42) 325i, 6-cylinder 2.5 liter (M20) 325iA, 6-cylinder 2.5 liter (M20) 325is, 6-cylinder 2.5 liter (M20) 325isA, 6-cylinder 2.5 liter (M20) 325e/es, 6-cylinder 2.7 liter (M20) 325eA/esA, 6-cylinder 2.7 liter (M20) 325, 6-cylinder 2.7 liter (M20) 325A, 6-cylinder 2.7 liter (M20) 325i Convertible, 6-cylinder 2.5 liter (M20) 325iA Convertible, 6-cylinder 2.5 liter (M20) M3, 4-cylinder 2.3 liter (S14) 325ix, 6-cylinder 2.5 liter (M20) 325ixA, 6-cylinder 2.5 liter (M20) 325ix 4-door, 6-cylinder 2.5 liter (M20) 325ixA 4-door, 6-cylinder 2.5 liter (M20)
8	Restraint system	0 1 2	Manual belts Manual belts with supplemental restraint Manual belts with dual SRS airbags
9	Check digit		0 - 9 or X, calculated by NHTSA
10	Model year	E F G H J K L O	1984 1985 1986 1987 1988 1989 1990 European model
11	Assembly plant	A, F, G, K B, C, D E, J	Munich, Germany Dingolfing, Germany Regensburg, Germany
12-17	Serial number		Sequential production number for specific vehicle

Please read these warnings and cautions before proceeding with maintenance and repair work.

WARNINGS—
*See also **CAUTIONS** on next page.*

- Read the important safety notice on the copyright page at the beginning of the book.

- Some repairs may be beyond your capability.
skills, tools and equipment, or a suitable workplace for any procedure described in this manual, we suggest you leave such repairs to an authorized BMW dealer service department or other qualified shop.

- A thorough pre-reading of each procedure, and the **WARNINGS** and **CAUTIONS** that accompany the procedure is essential. Posted corrections (errata) should also be reviewed before beginning work. Please see `www.BentleyPublishers.com/errata/`

- BMW is constantly improving its cars. Sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, before starting any major jobs or repairs to components on which passenger safety may depend, consult your authorized BMW dealer about Technical Bulletins that may have been issued.

- Do not re-use any fasteners that are worn or deformed in normal use. Many fasteners are designed to be used only once and become unreliable and may fail when used a second time. This includes, but is not limited to, nuts, bolts, washers, self-locking nuts or bolts, circlips and cotter pins. Always replace these fasteners with new parts.

- Never work under a lifted car unless it is solidly supported on stands designed for the purpose. Do not support a car on cinder blocks, hollow tiles or other props that may crumble under continuous load. Never work under a car that is supported solely by a jack. Never work under the car while the engine is running.

- If you are going to work under a car on the ground, make sure that the ground is level. Block the wheels to keep the car from rolling. Disconnect the battery negative (–) terminal (ground strap) to prevent others from starting the car while you are under it.

- Never run the engine unless the work area is well ventilated. Carbon monoxide kills.

- Finger rings, bracelets and other jewelry should be removed so that they cannot cause electrical shorts, get caught in running machinery, or be crushed by heavy parts.

- Tie long hair behind your head. Do not wear a necktie, a scarf, loose clothing, or a necklace when you work near machine tools or running engines. If your hair, clothing, or jewelry were to get caught in the machinery, severe injury could result.

- Do not attempt to work on your car if you do not feel well. You increase the danger of injury to yourself and others if you are tired, upset or have taken medication or any other substance that may keep you from being fully alert.

- Illuminate your work area adequately but safely. Use a portable safety light for working inside or under the car. Make sure the bulb is enclosed by a wire cage. The hot filament of an accidentally broken bulb can ignite spilled fuel, vapors or oil.

- Catch draining fuel, oil, or brake fluid in suitable containers. Do not use food or beverage containers that might mislead someone into drinking from them. Store flammable fluids away from fire hazards. Wipe up spills at once, but do not store the oily rags, which can ignite and burn spontaneously.

- Always observe good workshop practices. Wear goggles when you operate machine tools or work with battery acid. Gloves or other protective clothing should be worn whenever the job requires working with harmful substances.

- Greases, lubricants and other automotive chemicals contain toxic substances, many of which are absorbed directly through the skin. Read the manufacturer's instructions and warnings carefully. Use hand and eye protection. Avoid direct skin contact.

- Disconnect the battery negative (–) terminal (ground strap) whenever you work on the fuel system or the electrical system. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

- Friction materials (such as brake pads or shoes or clutch discs) contain asbestos fibers or other friction materials. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing dust. Breathing any friction material dust can lead to serious diseases and may result in death.

- Batteries give off explosive hydrogen gas during charging. Keep sparks, lighted matches and open flame away from the top of the battery. If hydrogen gas escaping from the cap vents is ignited, it will ignite gas trapped in the cells and cause the battery to explode.

- Battery acid (electrolyte) can cause severe burns. Flush contact area with water, seek medical attention.

- Connect and disconnect battery cables, jumper cables or a battery charger only with the ignition switched off. Do not disconnect the battery while the engine is running.

- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.

- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high rate can cause an explosion.

- The air conditioning system is filled with chemical refrigerant, which is hazardous. The A/C system should be serviced only by trained technicians using approved refrigerant recovery/recycling equipment, trained in related safety precautions, and familiar with regulations governing the discharging and disposal of automotive chemical refrigerants.

continued on next page

Please read these warnings and cautions before proceeding with maintenance and repair work.

WARNINGS— (continued)

- Do not expose any part of the A/C system to high temperatures such as open flame. Excessive heat will increase system pressure and may cause the system to burst.

- Some aerosol tire inflators are highly flammable. Be extremely cautious when repairing a tire that may have been inflated using an aerosol tire inflator. Keep sparks, open flame or other sources of ignition away from the tire repair area. Inflate and deflate the tire at least four times before breaking the bead from the rim. Completely remove the tire from the rim before attempting any repair.

- Connect and disconnect a battery charger only with the battery charger switched off.

- Sealed or “maintenance free” batteries should be slow-charged only, at an amperage rate that is approximately 10% of the battery’s ampere-hour (Ah) rating.

- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.

- The ignition system produces high voltages that can be fatal. Avoid contact with exposed terminals and use extreme care when working on a car with the engine running or the ignition switched on.

- Place jack stands only at locations specified by manufacturer. The vehicle lifting jack supplied with the vehicle is intended for tire changes only. A heavy duty floor jack should be used to lift vehicle before installing jack stands. See **2 Lubrication and Maintenance**.

- Aerosol cleaners and solvents may contain hazardous or deadly vapors and are highly flammable. Use only in a well ventilated area. Do not use on hot surfaces (engines, brakes, etc.).

- Do not remove coolant reservoir or radiator cap with the engine hot. Danger of burns and engine damage.

CAUTIONS—
*See also **WARNINGS** on previous page.*

- If you lack the skills, tools and equipment, or a suitable workshop for any procedure described in this manual, we suggest you leave such repairs to an authorized BMW dealer or other qualified shop.

- BMW is constantly improving its cars and sometimes these changes, both in parts and specifications, are made applicable to earlier models. Therefore, part numbers listed in this manual are for reference only. Always check with your authorized BMW dealer parts department for the latest information.

- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly, and do not attempt shortcuts. Use tools appropriate to the work and use only replacement parts meeting BMW specifications. Makeshift tools, parts and procedures will not make good repairs

- Use pneumatic and electric tools only to loosen threaded parts and fasteners. Never use these tools to tighten fasteners, especially on light alloy parts. Always use a torque wrench to tighten fasteners to the tightening torque specification listed.

- Be mindful of the environment and ecology. Before you drain the crankcase, find out the proper way to dispose of the oil. Do not pour oil onto the ground, down a drain, or into a stream, pond or lake. Dispose of in accordance with Federal, State and Local laws.

- The control module for the anti-lock brake system (ABS) cannot withstand temperatures from a paint-drying booth or a heat lamp in excess of 203°F (95°C) and should not be subjected to temperatures in excess of 185°F (85°C) for more than two hours.

- Before doing any electrical welding on cars equipped with ABS, disconnect the battery negative (–) terminal (ground strap) and the ABS control module connector.

- Always make sure ignition is off before disconnecting battery.

- Label battery cables before disconnecting. On some models, battery cables are not color coded.

- Disconnecting the battery may erase fault code(s) stored in control module memory. Using special BMW diagnostic equipment, check for fault codes prior to disconnecting the battery cables.

- If a normal or rapid charger is used to charge battery, the battery must be disconnected and removed from the vehicle in order to avoid damaging paint and upholstery.

- Do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time.

- Connect and disconnect a battery charger only with the battery charger switched off.

- Sealed or “maintenance free” batteries should be slow-charged only, at an amperage rate that is approximately 10% of the battery’s ampere-hour (Ah) rating.

- Do not allow battery charging voltage to exceed 16.5 volts. If the battery begins producing gas or boiling violently, reduce the charging rate. Boosting a sulfated battery at a high charging rate can cause an explosion.

Section 1

FUNDAMENTALS

Contents

Fundamentals

Introduction

Although BMWs are sophisticated and complex machines, nearly all basic maintenance and most repairs can be accomplished by any interested owner with basic mechanical skills and the right information. While some of the repairs covered in this manual are complicated and require special knowledge and equipment, most of the care that is required in the lifetime of the average BMW is well within the capabilities of the do-it-yourselfer.

This section of the manual is dedicated to helping the beginner get started smartly and safely with BMW maintenance and repair. The section begins with a **General Description** of the car, broken down into its individual systems, and a discussion on **How To Use This Manual**. It is a simple directory of the kind of information you can expect to find, and where to find it.

Safety and **General Advice For The Beginner**, include tips on mechanic's skills and workshop techniques that can help the beginner do a faster, complete, and more thorough job. **Tools** describes the basic tools needed to do 90% of the procedures in this manual, and includes advice on how to buy tools wisely and use them effectively.

Finally, and once again of interest to any owner, this section ends with a quick reference guide to emergencies—what to do when the car won't start or when a warning light comes on, including basic troubleshooting and information on how to gauge the seriousness of a problem.

1. GENERAL DESCRIPTION

BMWs are sophisticated examples of today's automotive engineering, blending advanced design and manufacturing to provide an outstanding combination of performance, roadholding, and reliability.
necessary maintenance and repair can be accomplished by the average owner using this manual. While the complexity of the car may seem to make this a difficult challenge for the novice mechanic, it can be simplified and more easily understood by viewing the car as an assembly of simpler systems, each performing its own independent functions.

1.1 Body

The body is the basic building block. All of the BMW models covered in this manual feature unitized body construction, meaning that they do not have a separate frame.

A complex body shell, shown in Fig. 1-1, is the main structural platform to which all the other systems are attached. Subassemblies attach engine, drivetrain, suspension, and steering systems to the basic body structure.

The doors, the instrument panel, the seats, and other interior trim pieces are also added to the body shell. Other parts of the body shell function as mounting points for the other major and minor subsystems. For more information, see **BODY AND INTERIOR**.

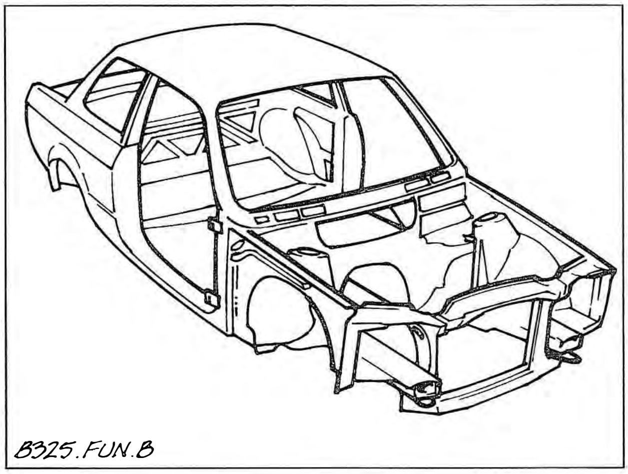


Fig. 1-1. BMW unitized body

1.2 Engine

The engine produces the power to move the car. It burns a precise mixture of fuel and air, converting the fuel's stored energy into mechanical work, and delivering that mechanical work in a useful form.

All of the BMW engines covered in this manual are of reciprocating-piston design and operate on the four-stroke cycle. The combustion of the air/fuel mixture creates tremendous pressure in a closed space above a piston. This pressure forces the piston downward in its cylinder, translating the energy of combustion into mechanical force.

The crankshaft converts each piston's up and down motion into rotating motion, in much the same way that the up-and-down motion of a person's legs rotates the pedals of a bicycle. The power transmitted in this rotary form can then be used to move the car. The four-stroke cycle, the heart of how and why this all happens, is illustrated in Fig. 1-2.

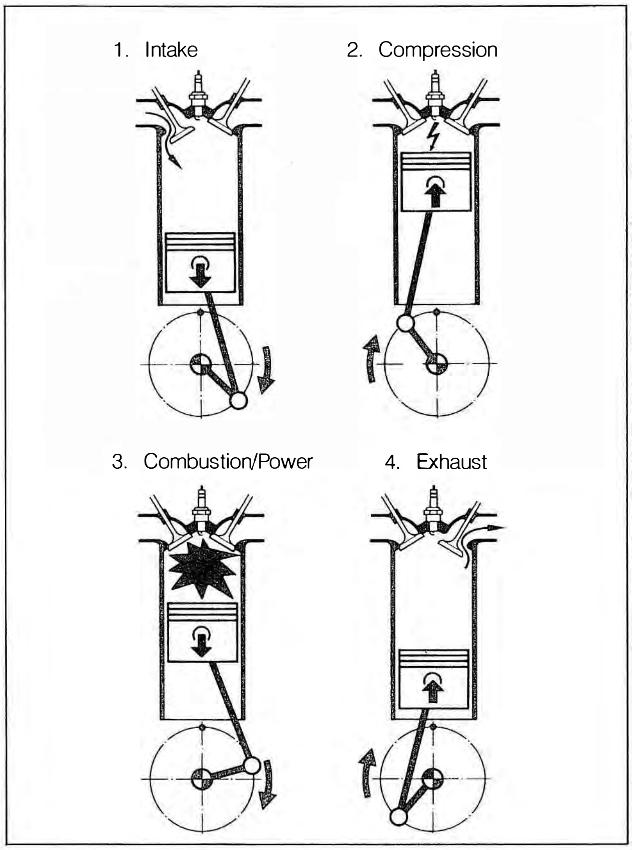


Fig. 1-2. The four-stroke cycle.

Intake Stroke. The piston, traveling downward, creates low pressure inside the cylinder. With the intake valve open, this low pressure causes the fresh air/fuel mixture to rush in. When the piston is near the bottom of its travel, the intake valve closes, sealing the air and vaporized fuel in the cylinder.

Compression Stroke. As the piston begins its upward travel in the sealed cylinder, the air/fuel mixture is compressed to a small percentage of its original volume, creating a very flammable mixture in a very small space. This space is referred to as the combustion chamber. Just before the piston reaches the top of its travel, the air/fuel mixture is ignited by a precisely timed spark, and burns very rapidly.

Combustion or **Power Stroke**. As the confined air/fuel mixture burns, temperature and pressure rise very rapidly, forcing the piston downward, turning combustion energy into work. Generally, the faster an engine runs and the more often this combustion cycle happens, the more power is produced.

Exhaust Stroke. At the end of the power stroke, the piston is near the bottom of its travel and the cylinder is filled with the waste products of combustion. The exhaust valve opens and the piston, now traveling back upward, pushes the burned gasses out into the exhaust system. Near the top of the piston's travel, the exhaust valve closes, the intake valve opens, and the process begins anew with another intake stroke.

Engine Systems

The engine, which seems so complex, is a collection of simpler systems whose sole purpose is to efficiently convert energy into mechanical force and motion. Virtually all automobile engines are multi-cylinder designs, in which a number of individual pistons and cylinders are joined together in a common housing or cylinder block, transmitting their power to a common crankshaft.

A camshaft, driven by the crankshaft, opens and closes the intake and exhaust valves in a precisely timed sequence. Since each valve must cycle open and closed once for every two turns of the crankshaft, camshafts always turn at one-half crankshaft speed.

The rest of the engine assembly is made up of systems that supply the essential fuel, air, ignition, and lubrication to provide continuous operation of the pistons, crankshaft, and valves. For more information, see **ENGINE**.

The ignition system creates the high-voltage spark necessary to ignite the combustible air/fuel mixture in the cylinders. The ignition coil boosts the voltage so that the spark will be hot enough to ignite the air/fuel mixture. The electronic control unit and the distributor control the timing of the spark.

The ignition distributor, synchronized to the rotation of the engine, delivers the spark to the right cylinder at precisely the right time. Since each cylinder has to have a spark once for every two revolutions of the crankshaft, the distributor always turns at one-half crankshaft speed. The basic system is shown schematically in Fig. 1-3. For more information, see **IGNITION**.

Fuel System

To run smoothly and produce power most efficiently, the engine requires the proper mixture of air and fuel. Depending on conditions, the optimum ratio for gasoline-fueled engines is about 14:1, fourteen parts of air for every one part of fuel. The throttle controls the amount of air entering the engine. The fuel system's job is to deliver and disperse fuel in the proper ratio to the incoming air.

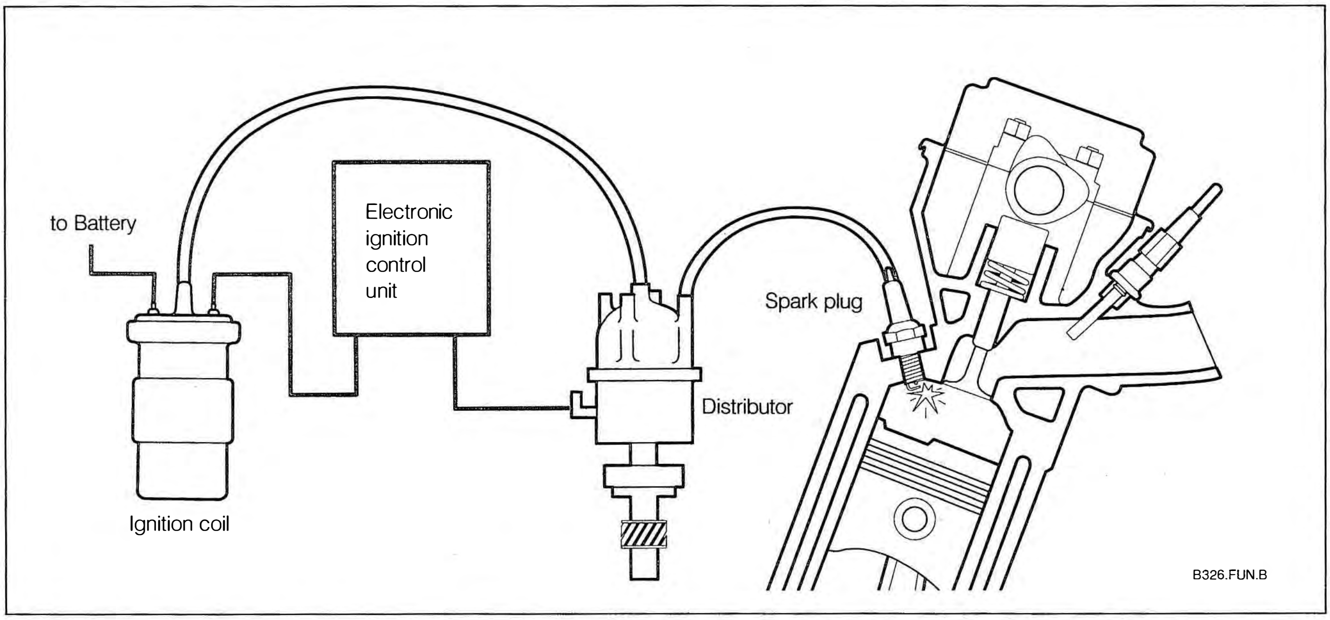


Fig. 1-3. Schematic representation of basic ignition system.

Traditionally, the job of fuel delivery has been handled by a carburetor, a device carefully calibrated to dispense and atomize fuel in proportion to the amount of air passing through it. To meet the increasing demand for performance with economy and reduced exhaust emissions, many modern engines, including the BMW engines covered in this manual, use a more sophisticated fuel injection system.

The fuel injection system measures the incoming air more precisely than a carburetor, and in turn meters fuel more precisely for better control of the air/fuel ratio. This precise control means greater efficiency over a wider variety of operating conditions. In spite of all this sophistication, the fundamental task of the fuel injection system is to control the mixture of air and fuel entering the engine's combustion chambers.

The fuel system also includes a means of fuel storage. The fuel tank and a network of pump and lines transfer the fuel from the tank to the injection system. For more information on the fuel system, see **FUEL SYSTEM**.

Cooling System

Even the most advanced engines lose some of their combustion energy as heat, which must be dissipated to prevent damage to the engine parts. Some heat is carried away in the exhaust, but much of it is absorbed by the valves, the pistons, and the rest of the combustion chamber. Most modern automobile engines are liquid-cooled, using a network of passages around the cylinders and combustion chambers, filled with circulating water-based coolant, to carry away heat.

Coolant is circulated by an engine-driven pump, often called the water pump. The heat which the coolant absorbs from the hot engine is eventually dissipated to the surrounding atmosphere by the radiator at the front of the car.

A smaller radiator-like heater core, located near the interior of the car, radiates heat to warm the passenger compartment. A basic cooling system layout, similar to that used on cars covered by this manual, is shown in Fig. 1-4.

Since some heat is necessary for the engine to run most efficiently, a thermostat in the cooling system restricts the flow of coolant through the radiator until the engine has reached normal operating temperature. For more information on the entire engine cooling system, see **COOLING SYSTEM**.

Lubrication System

The crankshaft and camshaft rotate at speeds up to several thousand revolutions per minute (rpm). Valves and pistons accelerate at tremendous rates, abruptly changing direction between velocities of hundreds of feet per second.

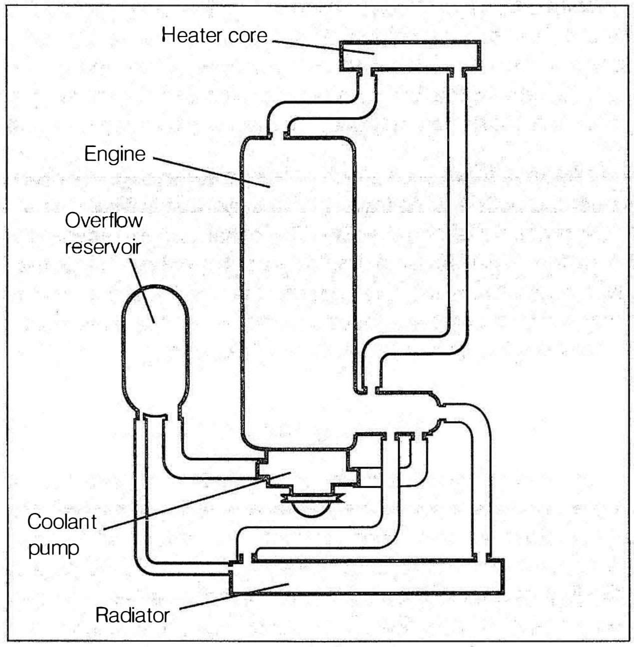


Fig. 1-4. Cooling system. Heat from engine is absorbed by coolant which is circulated by coolant pump and cooled by radiator.

In order to endure these harsh conditions, engine parts are manufactured to exact dimensions, assembled with precision clearances, and lubricated by a pressurized oiling system. The moving parts ride on a cushion of oil instead of each other. An engine-driven oil pump supplies oil under pressure to the engine where it is routed through a network of small passages that deliver it to each critical bearing surface.

The oil system includes a filter to clean the oil and a system to warn the driver of low oil pressure. A secondary function of the lubricating oil is to help carry away excess heat. Some lubrication systems include an oil cooler for reducing oil temperature before it is recirculated to the engine. More information on the lubrication system is found in **ENGINE**. For information on oil and oil filter replacement intervals, see **LUBRICATION AND MAINTENANCE**.

Exhaust System

The exhaust system serves several functions, but the primary one is to carry spent combustion gasses from the engine and route them safely away from the passenger compartment. Modern exhaust systems include mufflers to reduce noise, chemically reactive components (catalytic converters) to reduce harmful emissions, and sensors exposed to the exhaust gasses that provide feedback to the fuel injection system about engine efficiency. Fig. 1-5 shows a typical BMW exhaust system. For more information, see **EXHAUST SYSTEM AND EMISSION CONTROLS**.

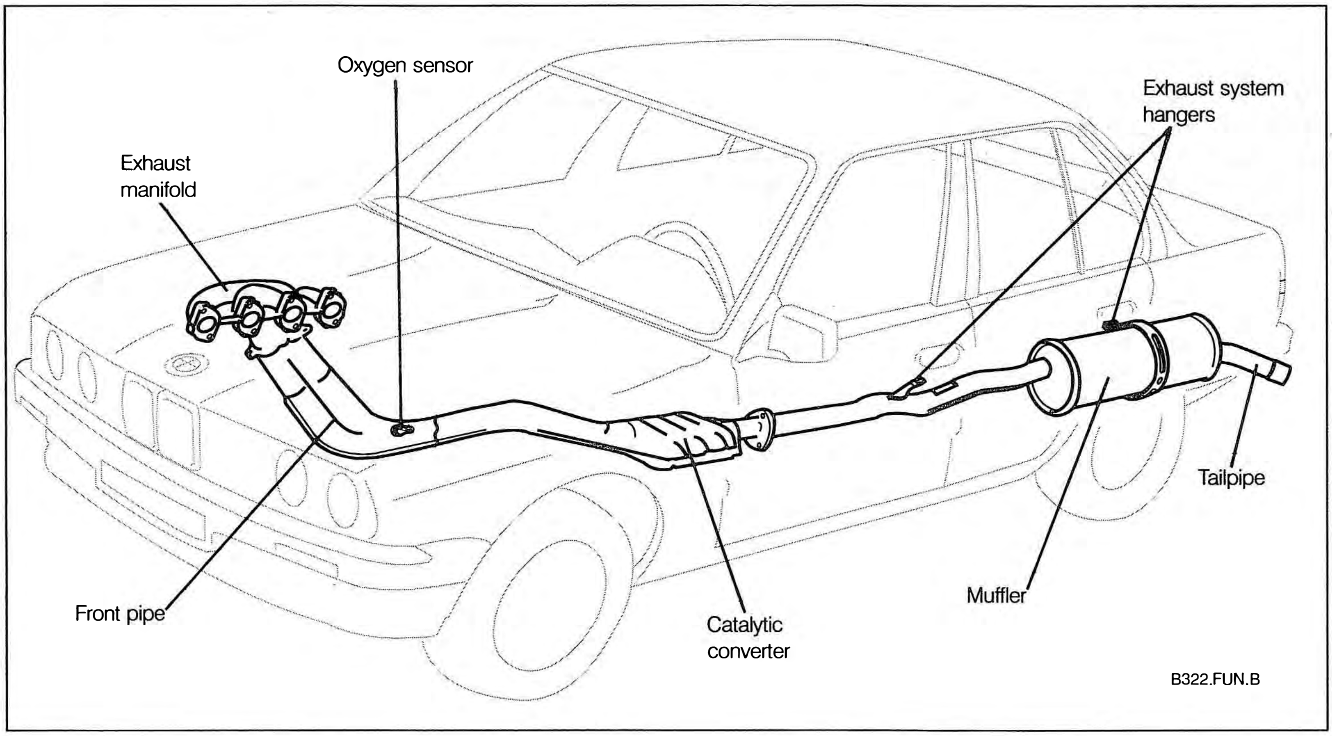


Fig. 1-5. Typical exhaust system.

1.3 Drivetrain

The drivetrain is a series of mechanisms that take the power developed by the engine and deliver it to the wheels in order to move the car. It consists of the clutch or torque converter, the transmission, the final drive, the drive axles, and the wheels and tires.

Clutch or Torque Converter

In a car with manual transmission, the clutch provides a way to connect and disconnect the engine from the drivetrain. The clutch assembly includes the spring-loaded pressure plate, the friction disc or clutch disc, and the engine flywheel.

The clutch disc, attached to the input shaft of the transmission, gets squeezed between the heavily spring-loaded pressure plate and the flywheel, both attached to the engine. The friction between pressure plate, clutch disc and flywheel, boosted by the heavy spring force, makes the transmission input shaft turn at the same speed as the engine.

For stopping, starting, and shifting gears, depressing the clutch pedal works against the spring force, relieving the friction bond and disconnecting the engine from the drivetrain. In normal use the clutch and flywheel wear, much like brakes, and need periodic maintenance or replacement. More information on the clutch is found in **MANUAL TRANSMISSION AND CLUTCH**.

In a car with automatic transmission, the friction clutch is replaced by a sophisticated fluid clutch called a torque converter. One part is attached to the engine and another to the transmission. As one part turns, power is transmitted to the other by a viscous fluid (automatic transmission fluid).

The design of the torque converter allows the engine to turn at idle speeds without transmitting much driving force to the transmission. A slight forward tug may be noticed when the car is in a forward gear, but at idle speed it is barely enough to drive the car. Above idle, the torque converter becomes increasingly resistant to slip, and transmits power through the fluid coupling to the transmission, delivering power through the rest of the drivetrain to the wheels. For more information, see **AUTOMATIC TRANSMISSION**.

Transmission

Although the engine develops a substantial amount of power, it does so best at relatively high revolutions per minute (rpm). To handle all driving conditions, it is necessary to use gearing to change the ratio of engine rpm to vehicle speed. A manual transmission arranges several sets of gears in a common housing.

A set of two gears determines a gear ratio, each suited to a particular range of driving speeds. A shifting mechanism allows the driver to change from one gear ratio to the next to match vehicle speed. For information on manual transmission maintenance and adjustments, see **MANUAL TRANSMISSION AND CLUTCH**.

In an automatic transmission, hydraulic fluid under pressure in a complex network of passages, valves and control mechanisms engage and disengage constantly meshed planetary gear sets. Hydraulic controls responding to vehicle speed, engine load, throttle position and gear shift position select the appropriate gear ratio. For information on automatic transmission maintenance and adjustments, see **AUTOMATIC TRANSMISSION**.

Driveshaft and Final Drive

The driveshaft transmits power from the engine and transmission to the final drive. The final drive is a gearset which transmits power to the drive axles.

When a car turns, the wheels on the outside of the turn have to turn slightly faster than those on the inside, since they have to travel a larger arc in an equal amount of time. The drivetrain must be able to transmit power to the wheels and still allow for these variations in wheel speed when cornering. The final drive includes a device called the differential, which allows wheels on opposite sides of the car to turn at different speeds. For more information see **DRIVESHAFT AND FINAL DRIVE**.

Drive Axles

The final step in the transfer of power from the engine to the wheels is the drive axles, which provide a connection between the differential and the wheel hubs. Information on the drive axles is found in **SUSPENSION AND STEERING**.

1.4 Suspension and Steering

Fig. 1-6 shows a typical front suspension and steering system, and their proximity to other systems in the car.

The suspension and steering systems are what allow the wheels to move and turn for a smooth ride, stability and directional control.

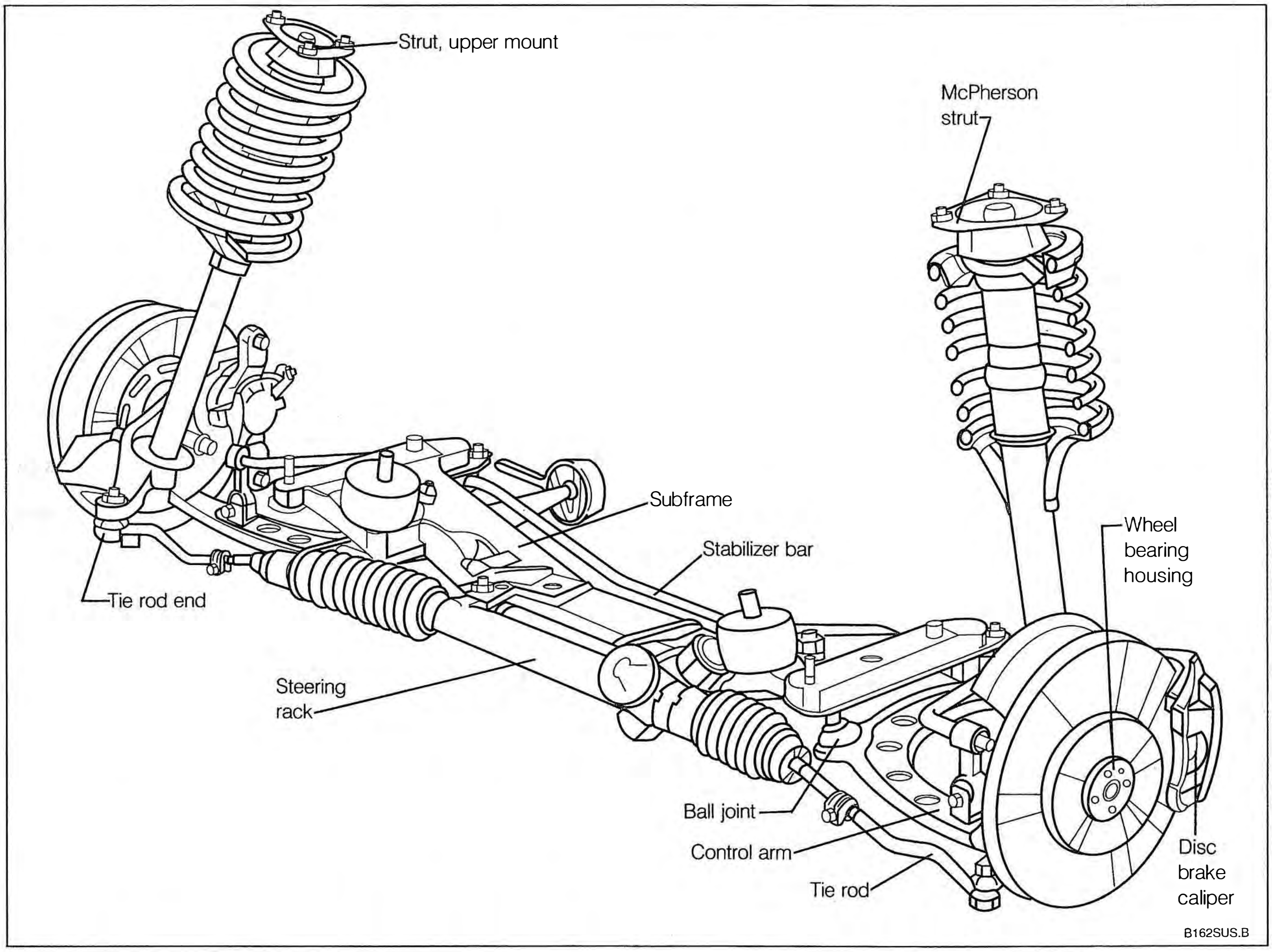


Fig. 1-6. Typical front suspension and steering system.

The suspension system is the combination of springs, shock absorbers, and other stabilizing devices that support the weight of the car and cushion the effects of bumps. For added control, the suspension system also includes dampers, or shock absorbers, which resist excessive movement of the springs. Stabilizer bars aid stability by transferring some of the cornering force acting on the suspension.

BMW's strut-type front suspension, like that of many modern cars, combines the spring and shock absorber into a single unit, performing the same jobs in less space and with fewer individual components.

The remainder of the suspension system are the parts that link it all together, designed with bushings, bearings, and joints which purposely allow or restrict movement.

The steering system is an assembly of gearbox mechanisms and linkages which translate the rotating motion of the steering wheel into the side-to-side motion of the front wheels. Cars covered by this manual use a rack-and-pinion type steering mechanism. A pinion gear, connected to the steering column, moves a toothed rack from side to side. The rack can be thought of as a long, straight gear. The entire assembly is also referred to as the steering rack. Power-assisted steering uses hydraulic fluid under pressure to do some of the work normally done by the driver turning the steering wheel.

For more information, see **SUSPENSION AND STEERING**.

1.5 Brakes

The system for slowing and stopping the car is, not surprisingly, completely independent of the systems which make it go. Although the brakes are located at the wheels where they can act most directly, and they mount to parts of the suspension system, the brakes and suspension are completely separate systems.

The brakes act to slow or stop the car by causing friction. Since cars are relatively heavy, the friction required to stop it safely and effectively is quite high, and generating it requires considerable force. Virtually all modern cars use a system of hydraulics to multiply the force applied to the brake pedal and to distribute it uniformly to the four wheels.

The brake pedal is connected by a mechanical linkage to the first major hydraulic component, the master cylinder, usually mounted on the firewall at the back of the engine compartment. A piston in the master cylinder creates hydraulic pressure in the brake lines going to the wheels. Because the brakes are located at the wheels and move relative to the body, the final length of brake line at each wheel is flexible, so that it follows that movement.

At each wheel, the hydraulic pressure acts on the brake mechanism to cause friction and slow the wheel. The sizes of the hydraulic components are such that the driver's force applied to the brake pedal is multiplied many times by the time it acts on the wheels.

Two types of brake mechanisms are in common use in modern cars. Both create braking friction by forcing a stationary friction material against a larger, rotating member attached to the wheel. A drum brake forces semi-circular shoes, lined with friction material, against the inside of a round brake drum. A disc brake squeezes pads lined with friction material against both sides of a flat, round brake disc, called a rotor. Both types are shown below in Fig. 1-7 and Fig. 1-8.

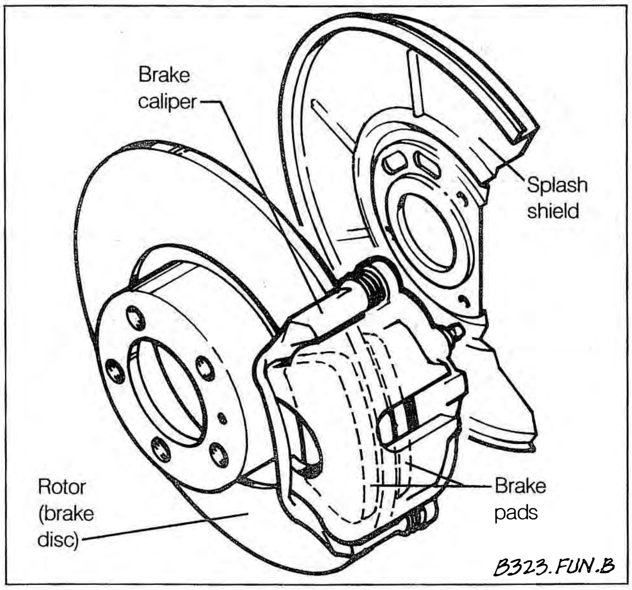


Fig. 1-7. Disc brake assembly showing disc, caliper, and splash shield. Caliper assembly holds pads with friction material.

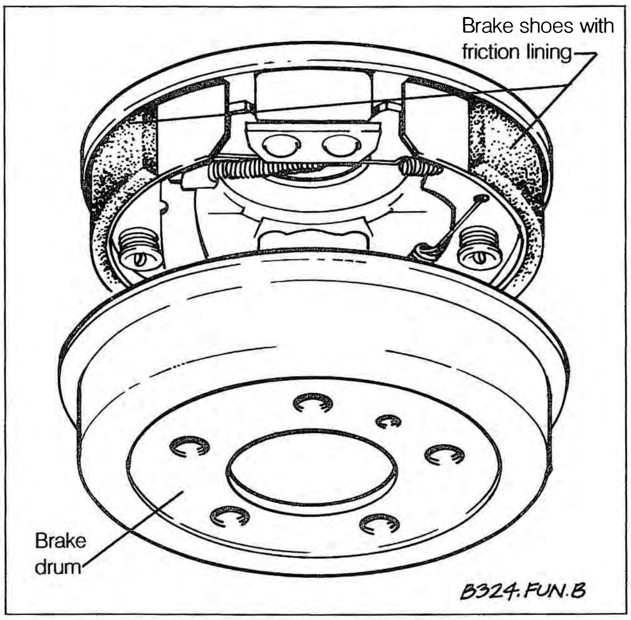


Fig. 1-8. Drum brake assembly with brake drum removed to show brake shoes.

A disc brake is generally capable of generating higher braking forces for a given size, is self-adjusting and self-cleaning, and dissipates heat more easily. Heat is a major enemy of brake efficiency. It affects the friction materials ability to grip, and under extreme conditions, excess heat from repeated heavy braking can cause the brake fluid to boil, resulting in severely diminished braking capability, called brake fade. Disc brakes, because of their greater ability to dissipate heat, are more resistant to brake fade.

Anti-lock Braking System (ABS)

1986 and later models covered in this manual are equipped with an anti-lock braking system, widely referred to as ABS. As the name implies, the purpose of this system is to prevent the wheels from locking during hard braking. Speed sensors at each wheel sense when the wheel is about to lock, and an electronic system modulates the braking force to that wheel.

Contrary to popular belief, research and testing have shown that the tires brake most effectively just before the point of locking up and skidding. Preventing the wheels from locking helps maintain directional control in emergencies, and is especially beneficial on slippery roads.

1.6 Electrical System

Many components, including accessory items, are powered by the car's electrical system. The electrical system uses a battery to store energy, an engine-driven alternator to generate electricity and recharge the battery, and various wiring harnesses and other circuits to distribute electric power to the rest of the car. The electrical system is represented in Fig. 1-9.

Battery

Almost every electrical component in the car operates from 12-volt direct-current (VDC). The battery converts electrical energy into chemical energy for storage, and converts its stored chemical energy back into electrical energy on demand.

Alternator

Left alone to meet all the electrical demands of an automobile, the battery would soon be completely discharged, so the electrical system includes a charging system.

The main component of the charging system is the alternator. Turned by the engine via a V-belt, the alternator takes over from the battery to supply electrical energy to the various electrical components. When the alternator generates more power than is needed, as it usually does at driving speeds, the extra energy recharges the battery.

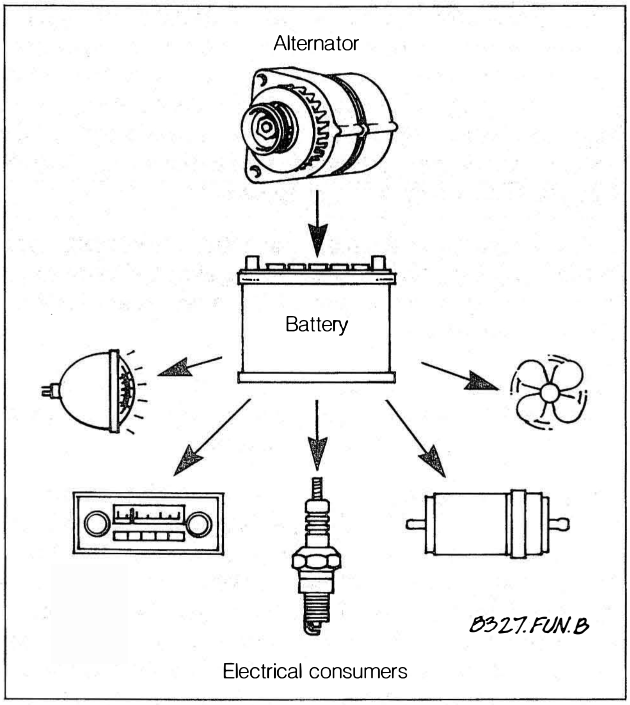


Fig. 1-9. In electrical system, alternator generates electricity to recharge battery and power other electrical consumers.

Wiring Harness and Circuits

The flow of electricity depends upon a closed-loop path—a complete circuit. Electrical current flows through wires to the consumer, a light bulb for example, and back to the battery in a complete circuit. The electrical route back to the source, which completes the circuit, is called a path to ground. Every consumer of electrical power in the car must have a source of power and a path to ground in order to operate.

Commonly, the electrically conductive metal structure of the automobile is used as a ground path. The negative (−) terminal of the battery connects to the car body, and all of the electrical consumers in the car make a ground connection to the car body, thus eliminating the need for many feet of additional wire.

Electrical components near the engine are often grounded directly to the engine, which is then grounded to the body. Some components are grounded through their housings which are bolted to a ground. Electrically, the effect is the same.

2. How To Use This Manual

The manual is divided into 15 sections, **FUNDAMENTALS**, **LUBRICATION AND MAINTENANCE**, **ENGINE MANAGEMENT-DRIVEABILITY**, and 12 repair sections, each covering a particular system or portion of the car. Thumb-tabs on the page margins help locate each section. A page listing section titles and showing their thumb-tab locations is near the front of the manual. An index is located at the back of the manual.

Each section has a Table of Contents listing the major subject headings within the section, and the pages on which they begin. Page numbers in the Table of Contents always refer to pages within that section. References to other numbered headings always refer to headings in the same section. Reference to a procedure in another section is by section title only, which will be in **BOLD TYPE**.

2.1 Fundamentals

This first section is **FUNDAMENTALS**. It contains basic information on equipment and safety which is important to any do-it-yourselfer, regardless of experience, as well as information on getting started and helpful suggestions for the novice. Anyone can use this manual. This section helps show how.

2.2 Lubrication and Maintenance

LUBRICATION AND MAINTENANCE is the section dedicated to taking care of the car and preventing future problems. BMW specifies certain periodic maintenance to prevent trouble and keep the car at its best. This section describes those maintenance tasks, shows how they are done, and tells what is needed to do them.

2.3 Engine Management—Driveability

In today's modern engines, the functions of the ignition system, the fuel delivery system, and the exhaust and emission control systems are closely related. On some of the models covered by this manual, these subsystems are all controlled by one electronic control unit. It manages the related functions together to deliver the best possible combination of performance, fuel economy and clean exhaust, hence the term "engine management".

"Driveability" is a term used to describe the overall performance of the car, its ability to start quickly, run and accelerate smoothly, and deliver fuel economy and low exhaust emissions as well as power. Because engine management functions are so interrelated, it is often difficult to isolate the cause of a driveability problem.

The **ENGINE MANAGEMENT—DRIVEABILITY** section is intended to help the reader diagnose and remedy driveability problems using a logical, systematic approach. In other words, this section is a combined troubleshooting section for the engine and the subsystems responsible for driveability.

2.4 Repair Sections

The repair sections contain the more involved and more detailed information about system function, troubleshooting, and repair. For clarity and ease of use, each repair section begins with **1. General Description**, **2. Maintenance**, and **3. Troubleshooting**.

General Description

The General Description is an overview of the system's technical features. It describes the general layout and function of the system, discusses unique aspects of different versions, and gives information on identifying each version and the repair information which applies to it.

Maintenance

Maintenance is a brief checklist of all routine maintenance specified by BMW for the system(s) being discussed. The listed maintenance items also include references to parts of the manual where particular maintenance procedures are described in detail.

Troubleshooting

A systematic approach to problem solving, based on carefully observing symptoms and isolating their causes, is called troubleshooting. Troubleshooting in each repair section begins with a discussion of the system's basic operating principles. Following that general discussion is a more specific list of symptoms—particular problems which may affect the car—and their probable causes. Suggested corrective actions include references to the numbered heading or section where the repair information can be found.

2.5 Index

A comprehensive index is found at the back of the manual. Each index entry is followed by a page reference giving the section and the section page number. For example, **4:16** refers to section four, **ENGINE**, page 16.

2.6 Notes, Cautions, and Warnings

Throughout this manual are many passages with the headings **NOTE**, **CAUTION**, or **WARNING**. These very important headings have different meanings.

WARNING —

A warning is the most serious of the three. It warns of unsafe practices that are very likely to cause injury, either by direct threat to the person(s) doing the work or by increased risk of accident or mechanical failure while driving.

CAUTION —

A caution calls attention to important precautions to be observed during the repair work that will help prevent accidently damaging the car.

NOTE —

A note contains helpful information, tips which will help in doing a better job and completing it more easily.

Please read every **NOTE**, **CAUTION**, and **WARNING** at the front of the manual and as they appear in repair procedures. They are very important. Read them before you begin any maintenance or repair job.

Some **CAUTION**s and **WARNING**s are repeated wherever they apply. Read them all. Do not skip any. These messages are important, even to the owner who never intends to work on the car.

3. Getting Started

Most of the necessary maintenance and minor repair that a BMW will need can be done with ordinary tools, even by owners with little or no experience in car repair. Below is some important information on how to work safely, a discussion of what tools will be needed and how to use them, and a series of mechanic's tips on methods and workmanship.

3.1 Safety

Although an automobile presents many hazards, common sense and good equipment can ensure safety. Accidents happen because of carelessness. Pay attention and stick to these few important safety rules.

WARNING —

- *Never run the engine in the work area unless it is well-ventilated. The exhaust should be ducted to the outside. Carbon Monoxide (CO) in the exhaust kills.*
- *Remove all neckties, scarfs, loose clothing, or jewelry when working near running engines or power tools. Tuck in shirts. Tie long hair and secure it under a cap. Severe injury can result from these things being caught in rotating parts.*
- *Remove rings, watches, and bracelets. Aside from the dangers of moving parts, metallic jewelry conducts electricity and may cause shorts, sparks, burns, or damage to the electrical system when accidently contacting the battery or other electrical terminals.*
- *Disconnect the battery negative (−) terminal whenever working on the fuel system or anything that is electrically powered. Accidental electrical contact may damage the electrical system or cause fire.*
- *Never work under a lifted car unless it is solidly supported on jack stands which are intended for that purpose. Do not support a car on cinder blocks, bricks, or other objects which may shift or crumble under continuous load. Never work under a car that is supported only by the lifting jack.*
- *The fuel system is designed to retain pressure even when the ignition is off. When working with the fuel system, loosen the fuel lines very slowly to allow the residual pressure to dissipate gradually. Avoid spraying fuel.*
- *Fuel is highly flammable. When working around fuel, do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*
- *Illuminate the work area adequately and safely. Use a portable safety light for working inside or under the car. A fluorescent type is best because it gives off less heat. If using a light with a normal incandescent bulb, use rough service bulbs to avoid breakage. The hot filament of an accidently broken bulb can ignite spilled fuel or oil.*
- *Keep sparks, lighted matches, and open flame away from the top of the battery. Hydrogen gas emitted by the battery is highly flammable. Any nearby source of ignition may cause the battery to explode.*
- *Never lay tools or parts in the engine compartment or on top of the battery. They may fall into confined spaces and be difficult to retrieve, become caught in belts or other rotating parts when the engine is started, or cause electrical shorts and damage to the electrical system.*

Lifting The Car

For those repairs that require raising the car, the proper jacking points should be used to raise the car safely and avoid damage. To use the jack supplied with the car by BMW for changing wheels, there are four jacking points—two on each side of the car—just behind the front wheel or just in front of the rear wheel. See Fig. 3-1. Use the same jacking points to lift the car with a floor jack or hydraulic lift.

CAUTION —

• When raising the car at the rear jacking points using a floor jack or a hydraulic lift, carefully position the jack pad so that it does not contact the fuel tank. A suitable liner (wood, rubber. etc.) should be placed between the jack and the car so that the underbody will not be damaged

• Operating the car in gear while the rear wheels are suspended will cause damage to the axle shafts.

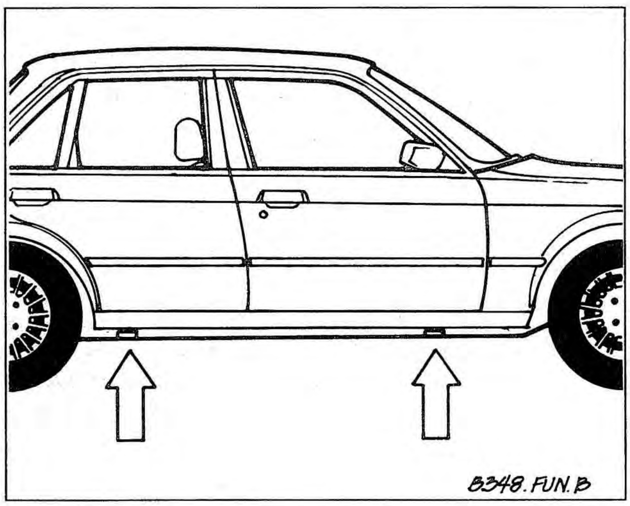


Fig. 3-1. Jacking points for use with BMW-supplied jack.

To raise the car safely:

1. Park the car on a flat, level surface.

2. Place the jack in position. Make sure the jack is resting on flat, solid ground. Use a board or other support to provide a firm surface for the jack, if necessary.

3. Raise the car slowly.

WARNING —

Watch the jack closely. Make sure that it stays stable and does not shift or tip. As the car is raised, the car will want to roll slightly and the jack will want to shift.

4. Once the car is raised, block the wheel that is opposite and farthest from the jack to prevent the car from unexpectedly rolling.

WARNING —

• Do not rely on the transmission or the emergency brake to keep the car from rolling. While they will help, they are not a substitute for positively blocking the opposite wheel.

• Never work under a car that is supported only by a jack. Use jack stands which are properly designed to support the car. See **4. Tools.**

To work safely under a car:

1. Disconnect the battery negative (–) terminal so that no one else can start the car. Let others know what you will be doing.

CAUTION —

BMW anti-theft radios can be rendered useless by disconnecting the battery. If power to the radio is interrupted, a protection circuit engages and disables the radio. For the radio to operate, a code must be entered into the radio after power is restored. Make sure you know the correct code before disconnecting the battery. For more information, see the BMW owner's manual.

2. Use at least two jack stands to support the car. A jack is a temporary lifting device and should not be used alone to support the car while you are under it. Use positively locking jack stands which are designed for the purpose of supporting a car. For more information on jack stands, see **4. Tools.**

WARNING —

Do not use wood, concrete blocks, or bricks to support a car. Wood may split. Blocks or bricks, while strong, are not designed for that kind of load, and may break or collapse.

3. Place jack stands on a firm, solid surface, just like the jack. If necessary, use a flat board or similar solid object to provide a firm footing.

4. After placing the jack stands, lower the car slowly until its weight is fully supported by the jack stands. Watch to make sure that the jack stands do not tip or lean as the car settles on them, and that they are placed solidly and will not move.

5. Observe all jacking precautions again when raising the car to remove the jack stands.

3.2 General Advice For The Beginner

The tips in the paragraphs which follow are general advice to help any do-it-yourself BMW owner perform repairs and maintenance tasks more easily and more professionally.

Planning Ahead

Most of the repairs and maintenance tasks described in this manual can be successfully completed by anyone with basic tools and abilities. Some cannot. To prevent getting in too deep, know what the whole job requires before starting. Read the procedure thoroughly, from beginning to end, in order to know just what to expect and what parts will have to be replaced.

Cleanliness

Keeping things organized, neat, and clean is essential to doing a good job, and a more satisfying way to work. When working under the hood, fender covers will protect the finish from scratches and other damage. Make sure the car is relatively clean so that dirt under the cover does not scratch.

Avoid getting tools or clothing near the battery. Battery electrolyte is a corrosive acid.

Be careful with brake fluid, as it can cause permanent damage to the car's paint.

Finally, keep rubber parts such as hoses and belts free from oil or gasoline, as they will cause the material to soften and fail prematurely.

Tightening Bolts

When tightening the bolts or nuts that attach a component, it is always good practice to tighten the bolts gradually and evenly to avoid misalignment or overstressing any one portion of the component. For components sealed with gaskets, this method helps to ensure that the gasket will seal properly and completely.

Where there are several fasteners, tighten them in a sequence alternating between opposite sides of the component. Fig. 3-2 shows such a sequence for tightening six bolts attaching a typical component. Repeat the sequence until all the bolts are evenly tightened to the proper specification.

For some repairs a specific tightening sequence is necessary, or a particular order of assembly is required. Such special conditions are noted in the text, and the necessary sequence is described or illustrated.

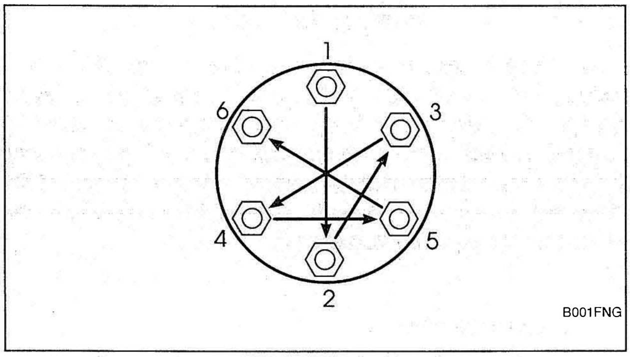


Fig. 3-2. Sequence for alternately tightening multiple fasteners.

Bolt Torque

Tightening fasteners to a specified torque value using a torque wrench is a good way to ensure that bolts are correctly tightened. If a torque wrench is not used there is a danger of going too far and damaging the fastener or the threads in the mating part.

Too little torque on a fastener can also cause problems. Vibration of assembled parts can subject fasteners to stress alternating in opposite directions that will eventually cause them to loosen. To counter this loosening, fasteners are tightened more, and actually stretched, in order to pre-stress them. When tightened this way they are always stressed in one direction and are much less likely to work loose in spite of vibration.

The proper torque for a fastener is related to the amount of stretch necessary to prevent the fastener from working loose in normal use. Always use a torque wrench and follow BMW's torque specifications. See **4. Tools** for more information on torque wrenches.

Gaskets

The smoothest metal mating surfaces still have imperfections that can allow leakage. To prevent leakage at critical joints, gaskets of soft, form-fitting material are used to fill in the imperfections.

To be most effective, gaskets are designed to "crush", to become thinner as they are pressed together between mating parts. Once a gasket has been used and crushed, it is no longer capable of making as good a seal as when new, and is much more likely to leak. For this reason, gaskets should not be reused. Always plan to use new gaskets for any reassembly.

This same logic applies to any part used for sealing, including rubber O-rings and copper sealing washers.

Seals

In places where a shaft must pass through a housing, flexible lip seals are used to keep the lubricating oil or grease from leaking out past the rotating shaft.

Seals are designed to be installed in the housing only once and should never be reused. As long as they are not removed from the housing and not leaking, they need not be replaced. Seals, however, do age and deteriorate, and there is no easier time to replace them than when the car is already apart for some other repair.

When doing repairs that require removing a seal, be very careful not to scratch or otherwise damage the metal surfaces. Even minor damage to sealing surfaces can cause seal damage and leakage.

The key to seal installation is to get the seal in straight without damaging it. Use an object that is the same diameter as the seal housing to gently and evenly drive it into place. If a proper size seal driver is not available, a socket of the right size will do.

Coat the entire seal with a little grease or oil to help it go in more easily. Seals are directional. Make sure that it is being installed with the lip facing the correct way. Normally the lip faces the inside. Notice the installation direction of the old seal before removing it.

Wire Repairs

Repairs to a wiring harness to reconnect broken wires or correct shorts to ground deserve special care to make the repair permanent.

The wire ends must be clean. If frayed or otherwise damaged, cut off the end. If necessary, to maintain proper length, splice in a new piece of wire of the same size and make two connections.

Use connectors which are designed for the purpose. Crimped-on or soldered-on connectors are best. Crimp connectors and special crimping pliers are widely available. If soldering, use a needlenose pliers to hold the wire near the solder joint and create a "heat dam". This keeps the solder from "wicking" up the wire.

Always use a solder made specifically for electrical work, without the usual acid flux which will promote corrosion. Twisting wires together is a temporary repair at best, since corrosion and vibration will eventually spoil the connection.

Insulate the finished connection. Electronics stores can supply heat-shrinkable insulating tubing that can be placed onto the wire before connecting, slid over the finished joint, and shrunk to a tight fit with a heat gun or hair dryer. The next best alternative is electrical tape. Make sure the wire is clean and free of solder flux or other contamination. Wrap the joint tightly and completely to seal out moisture.

WARNING —

If the main ABS wiring harness is damaged in any way, it must be replaced. Do not attempt to repair the wiring harness. The ABS system is sensitive to very small changes in resistance. Repairing the wiring harness could alter resistance values and cause the system to malfunction.

Cleaning

Any repair job will be less troublesome if the parts are clean. For cleaning old parts, there are any number of solvents and parts cleaners available commercially.

For cleaning parts prior to assembly, commercially available aerosol cans of carburetor cleaner or brake cleaner are handy to use, and the cleaner will evaporate completely, leaving no residue.

WARNING —

Virtually all solvents used for cleaning parts are highly flammable, especially in aerosol form. Use with extreme care. Do not smoke. Do not use these products near any source of sparks or flame.

Let any solvent or cleaning product dry completely. Low-pressure, dry compressed air is helpful if available. Also, use only lint-free rags for cleaning and drying.

WARNING —

When drying roller or ball bearings with compressed air, do not allow them to spin. Unlubricated, they may fail and come apart, causing injury.

Electrical Testing

A great many electrical problems can be understood and solved with only a little fundamental knowledge of how electrical circuits function.

Electric current only flows in a complete circuit. To operate, every electrical device in the car requires a complete circuit including a voltage source and a path to ground. The positive (+) side of the battery is the original voltage source, and ground is any return path to the negative (−) side of the battery, whether through the wiring harness or the car body. Except for portions of the charging system, all electrical current in the car is direct current (DC) and flows from positive (+) to negative (−).

Switches are used to turn components on or off by completing or interrupting the circuit. A switch is "open" when the circuit is interrupted, and "closed" when the circuit is completed. Fig. 3-3 shows a complete circuit schematically.

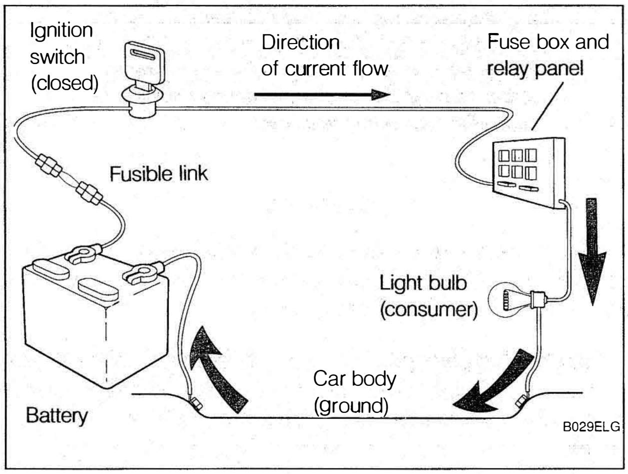


Fig. 3-3. Schematic representation of simple circuit for light bulb. Switch is shown closed, making circuit complete.

The first step in tracing an electrical system problem is to check with a test light, a voltmeter, or a multimeter (DC volts scale) to see that voltage is reaching the component. If so, then the circuit is sound as far as that point.

If voltage is not reaching the component, the circuit is open (interrupted), or shorted to ground, somewhere between the battery positive (+) terminal and the component. Look for a blown fuse, an open switch, a broken wire, or a failed component earlier in the same circuit.

Isolate the location of the problem by doing more voltage measurements at different points in the circuit. Voltage indicated by a test light or voltmeter at any point in the circuit means that the circuit is good at least up to that point. Look for problems after the last point in the circuit where voltage is indicated.

To test for voltage:

1. Start with an electrical connection closest to the component in question. If necessary, remove the terminal cover or disconnect the harness connector.

2. Connect the clip lead of a test light or the black (−) probe of a voltmeter or multimeter to ground (any clean, unpainted metal part of the engine or car).

3. Touch the probe of the test light or the red (+) probe of the meter to the terminal being tested. A meter reading or the test light lighting indicates that voltage is present in the circuit up to that point.

4. If no voltage is indicated, double check it by wiggling the probes and connections to make sure adequate contact is being made.

Once it is confirmed that voltage is reaching the component, check the remainder of the circuit by testing for continuity to ground. If the component is grounded through its mounting, make sure that the contact area is clean, dry, and free of corrosion.

> **NOTE** —
> Always make sure the circuit is turned off before making continuity checks. Voltage to the circuit may damage the ohmmeter.

To test for ground:

1. If the component is grounded through the wiring harness (usually a brown or brown striped wire), disconnect the harness connector or the ground wire. Connect the clip lead of a test light or the black (−) probe of a meter to the removed ground terminal.

2. If the component is grounded by its mounting to the car, connect one end of a test light or the black (−) probe of a meter to the clean metal surface of the component.

3. Briefly touch the remaining probe to a known source of battery voltage.

4. A meter reading or the test light lighting indicates current flow in a complete circuit and, therefore, a good connection to ground.

A continuity test, performed with an ohmmeter, is a universal test of any wire, connection, or component that will tell if current can flow through it. It can be used to check wires for breaks, to find out whether switches are open or closed, to find poor connections, and many other things. Continuity is a measure of resistance. A complete circuit has continuity—resistance is nearly zero. An open circuit due to a broken wire or an open switch has no continuity—there is infinite resistance.

To test the continuity of any conductor between any two points, connect one ohmmeter probe to each test point. If the circuit between points is uninterrupted, the ohmmeter should read nearly zero. If it reads significantly above zero, there may be a component in the circuit which is supposed to have some resistance. If not, there may be a poor connection or a damaged wire somewhere between the test points.

Making An LED Test Light

Many of the electrical tests in this manual require the use of a special LED test light, since the use of a more conventional test light with incandescent bulb can damage sensitive electronic circuits in the ignition, fuel injection, and emission control systems.

A low cost LED test light can be made using parts available from an electronics supply outlet. Assemble the components as shown in Fig. 3-4. Use a needlenose plier to hold the parts and to act as a heat dam while soldering, as described above in **Wire Repairs**. Insulate all connections with heat-shrinkable tubing or electrical tape.

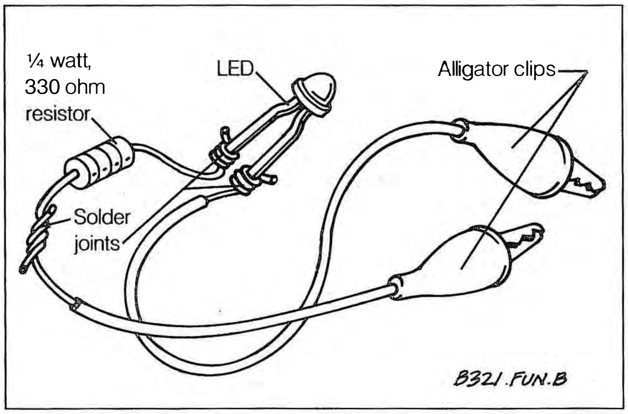


Fig. 3-4. Do-it-yourself LED test light for safe testing of ignition, fuel injection, and emission control circuits.

Parts

1. (1) LED.
2. (1) ¼ watt, 330 ohm resistor.
3. Wire and two alligator clips. (Purchase a jumper wire with an alligator clip on each end, and cut it in half).
4. Solder and soldering iron.
5. Heat-shrinkable tubing or electrical tape.

Disconnecting Wiring Harness Connectors

BMW harness connectors used throughout the car are designed to positively lock into place to prevent them from coming loose. One common type of connector is equipped with an easy disconnect feature. To disconnect this type of connector, press on the wire clip to release the lock and carefully pull the connector loose. The other common type requires that a locking clip be pried from the connector before it can be removed. See Fig. 3-5.

CAUTION —

Always pull only on the connector body to disconnect it. Never pull on the wires themselves.

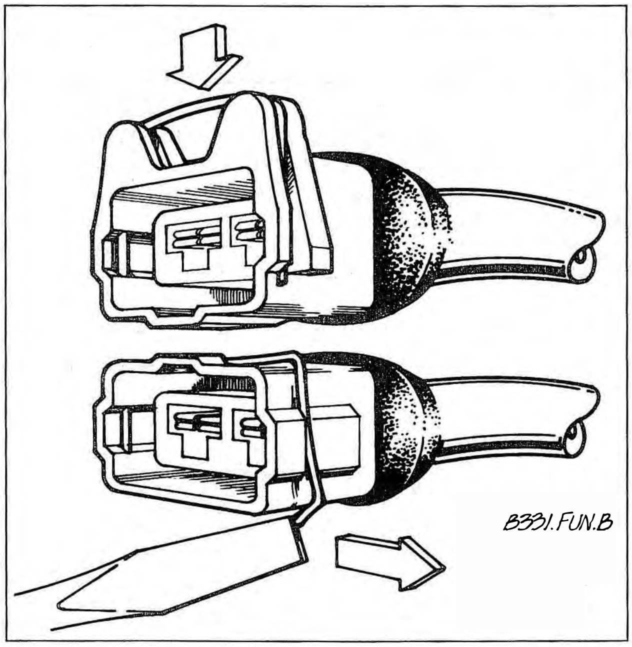


Fig. 3-5. Common versions of harness connectors. Harness connector with quick disconnect feature (top). Harness connector with retaining clip (bottom).

3.3 Buying Parts

Many of the maintenance and repair tasks in this manual call for the installation of new parts, or the use of new gaskets and other materials when reinstalling parts. Most often, the parts that will be needed should be on hand before beginning the job. Read the introductory text and the complete procedure to determine which parts will be needed.

NOTE —

For some bigger jobs, partial disassembly and inspection are required to determine a complete parts list. Read the procedure carefully and, if necessary, make other arrangements to get the necessary parts while your car is disassembled.

Genuine BMW Parts

Genuine BMW replacement parts from an authorized BMW dealer are designed and manufactured to the same high standards as the original parts. They will be the correct material, manufactured to the same specifications, and guaranteed to fit and work as intended by the engineers who designed the car.

Many independent repair shops make a point of using genuine BMW parts, even though they may be more expensive. They know the value of doing the job right with the right parts. Parts from other sources can be as good, particularly if manufactured by one of BMWs original equipment suppliers, but it is often difficult to know.

BMW is constantly updating and improving their cars, often making improvements during a given model year. BMW may recommend a newer, improved part as a replacement, and your authorized dealer's parts department will know about it and provide it. The BMW parts organization is best equipped to deal with any BMW parts needs.

Some caution is appropriate when buying parts. Parts that fit are not necessarily the same as parts that work. If someone else is buying parts for your BMW, make sure they are genuine BMW parts from an authorized BMW dealer or the equivalent from a quality supplier.

Non-returnable Parts

Some parts cannot be returned for credit, even if they are the wrong parts for the car. The best example is electrical parts, which are almost universally considered non-returnable because they are so easily damaged internally.

Buy electrical parts carefully, and be as sure as possible that a replacement is needed, especially for expensive parts such as control units. It may be wise to let an authorized BMW dealer or other qualified shop confirm your diagnosis before replacing an expensive part which cannot be returned.

Information You Need To Know

Model. When ordering parts it is important that you know the correct model designation for your car. Models covered in this manual are 318i, 325, 325e, 325es, 325i, 325is, and 325i Convertible.

Model Year. This is not necessarily the same as date of manufacture or date of sale. A 1986 model may have been manufactured in late 1985, and perhaps not sold until early 1987. It is still a 1986 model.

Date of Manufacture. This information is helpful when ordering replacement parts or determining if any of the warranty recalls are applicable to your car. The label on the drivers door below the door latch will specify the month and year that the car was built.

Vehicle Identification Number (VIN). This is a combination of letters and numbers which identify the particular car. The VIN appears on the state registration document, and on the car itself. One location, shown in Fig. 3-6, is on the dash near the middle of the windshield. It is most easily viewed from outside the car.

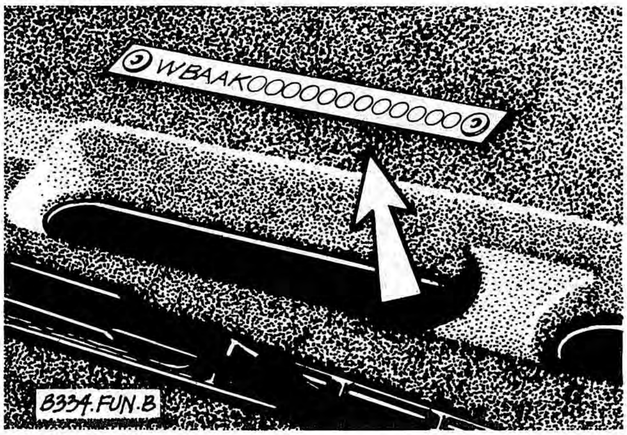


Fig. 3-6. Location (**arrow**) of vehicle identification number (VIN) on 1984-1990 BMW cars.

Copy down the VIN and date of manufacture and have it along whenever buying parts. If there was a mid-year change in specifications which affects replacement parts, the change will often be defined in terms of VIN.

Beginning in 1987, a ruling by the National Highway and Traffic Safety Administration (NHTSA) requires passenger cars with a high theft rate to have the VIN marked on specific parts of the car when manufactured. On BMW cars so affected, these parts are identified by an adhesive label.

Original parts installed during manufacture are identified by a label bearing the VIN and two BMW roundel logos. The replacement parts will have a similar label, bearing one BMW roundel logo and the letters DOT-R. See Fig. 3-7. Parts or assemblies bearing the label are the engine, transmission, front and rear bumpers, front fenders, rear quarter panels, hood, trunk lid and doors. These labels should not be removed as they will tear apart.

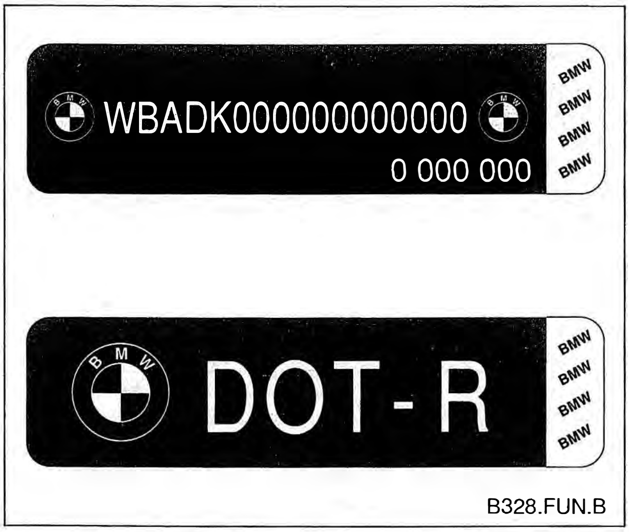


Fig. 3-7. Labels used to identify parts. Original equipment label with VIN number and roundel logos (top) and replacement part label with one roundel logo.

Engine. BMWs covered in this manual are powered by one of three different engines. 1984-1985 318i models have a 4-cylinder, 1.8 liter engine. 325, 325e, and 325es models have a 6-cylinder, 2.7 liter engine. 325i, 325is, and 325i Convertible models have a 6-cylinder, 2.5 liter engine. For more information see **ENGINE**.

Transmission Number. Although most internal repairs to the transmission are beyond the scope of this manual, the transmission number with its identifying code may be important when buying clutch parts, seals, gaskets, and other transmission-related parts for repairs which are covered.

Manual transmissions are identified by a manufacturers stamp and code numbers and letters. The manufacturers stamp is located on the case, just in front of the clutch slave cylinder mounting as shown in Fig. 3-8. The code numbers and letters are located on top of the bellhousing as shown in Fig. 3-9. More information on manual transmission codes and their meanings can be found in **MANUAL TRANSMISSION AND CLUTCH**.

Automatic transmissions are identified by code letters and type numbers, located on a data plate behind the manual valve lever, as shown in Fig. 3-10. More information on automatic transmission codes and their meanings can be found in **AUTOMATIC TRANSMISSION**.

Fig. 3-8. Manufacturers stamp for Getrag manual transmissions. ZF transmissions are similar.

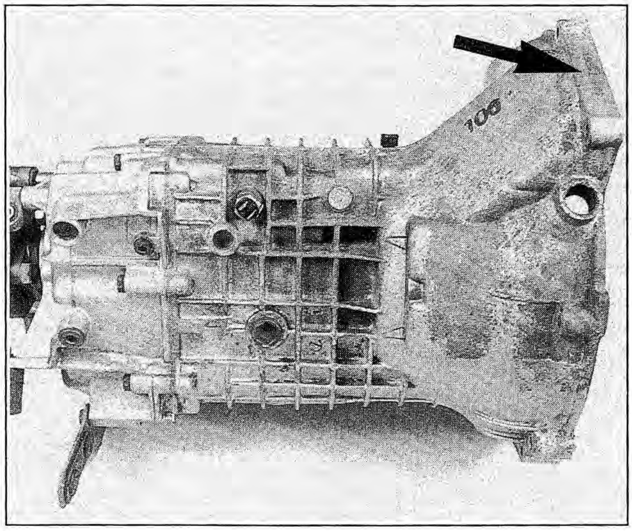


Fig. 3-9. Location (arrow) of transmission identification code for 5-speed manual transmission.

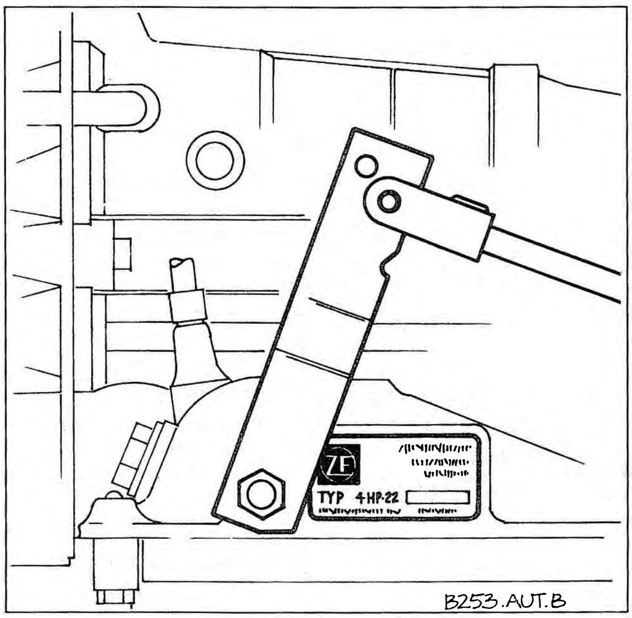


Fig. 3-10. Location of data plate on automatic transmission.

BMW dealers are uniquely qualified to provide service for BMW cars. Their relationship with the large BMW service organization means that they are constantly receiving new tools and equipment, together with the latest and most accurate repair information.

The BMW dealer's service technicians are highly trained and very capable. Unlike most independent repair shops, authorized BMW dealers are intensely committed to supporting the BMW product. They share every owner's interest in BMW value, performance, and reliability.

4. Tools

Most maintenance can be accomplished with a small selection of the right tools. Tools range in quality from inexpensive junk, which may break at first use, to very expensive and well-made tools which, to the professional, are worth every bit of their high cost. The best tools for most do-it-yourself BMW owners lie somewhere in between.

Cheap tools are not a bargain. They often do not hold up to even casual use, and they present a greater risk of personal injury. If they fit poorly, they can actually damage the fasteners they are intended to remove, making it that much harder to use a good tool the next time around.

Many reputable tool manufacturers offer good quality, moderately priced tools with a lifetime guarantee. A broken tool can be exchanged for a new one, for the life of the tool. These are your best buy. They cost a little more, but they are good quality tools which will do what is expected of them. Sears' Craftsman® line is one such source of good quality, reasonably priced, and guaranteed tools.

Basic Tool Requirements

NOTE

BMWs are delivered with a tool kit mounted to the underside of the trunk lid. The kit contains a basic selection of tools that may fulfill some of the requirements listed in this section.

The basic hand tools described below can be used to accomplish most of the simple maintenance and repair tasks.

Screwdrivers. Two types, the common flat-blade type and the Phillips type, will handle 99% of all screws used on BMWs. Two or three different sizes of each type will be best, since a screwdriver of the wrong size will damage the screw head.

Screwdrivers are for screws. Do not use them for anything else, such as prying or chiseling. A complete set of screwdrivers can often be purchased for about the same money as the four or six individual ones that are really necessary. See Fig. 4-1.

For a more complete tool box, include "stubby" screwdrivers or offset screwdrivers for use in tight spots where a normal length screwdriver will not easily fit.

Wrenches. Wrenches come in different styles for different uses. Fig. 4-2 shows several. The basic open-end wrench is the most widely used, but grips on only two sides. It can spread apart and slip off more easily. The box-end wrench has better grip, on all six sides of a nut or bolt, and is much less prone to slip.

A 12-point box-end can loosen a nut or bolt where there is less room for movement, while a 6-point box-end provides better grip. For hex fasteners on fluid lines, like brake lines and fuel lines, a flare-nut wrench offers the advantages of a box-end wrench with a slot that allows it to fit over the line.

The combination wrench, shown in Fig. 4-3, is the most universal. It has one open-end and one 12-point box-end. For BMWs, 10mm and 13mm wrenches are the most common sizes needed. A 17mm wrench is needed to loosen and tighten the engine oil drain plug. A complete set should also include 6mm, 7mm, 8mm, 9mm, 11mm, 12mm, 14mm, and 15mm.

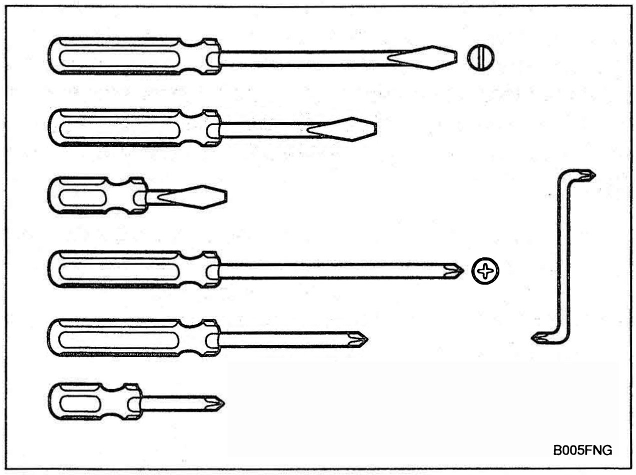


Fig. 4-1. Common flat-blade (top) and Phillips (bottom) screwdrivers. Offset screwdriver (right) is used for screws with limited access.

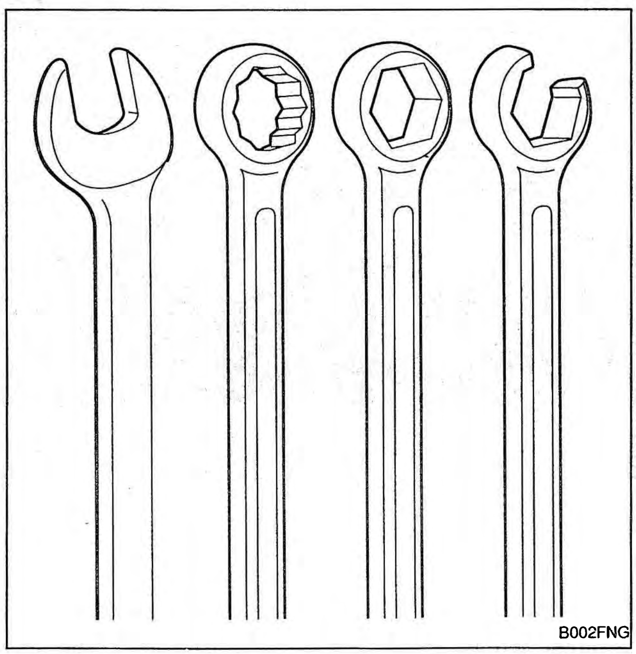


Fig. 4-2. Types of wrench heads. From left, open-end, 12-point box-end, 6-point box-end, flare nut.

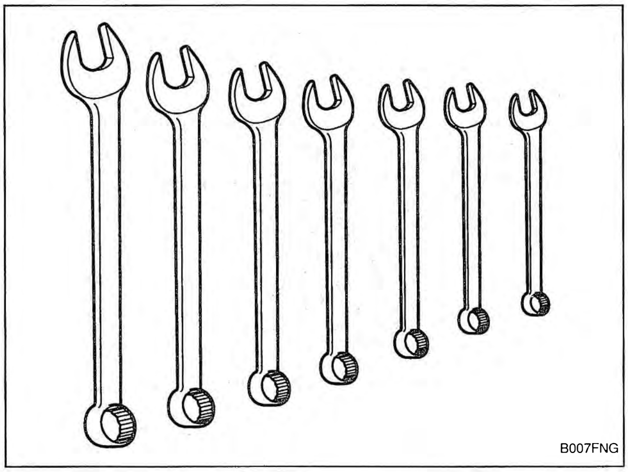


Fig. 4-3. Combination wrenches with one open-end and one 12-point box-end.

Sockets. Sockets perform the same job as box-end wrenches, but offer greater flexibility. They are normally used with a ratchet handle for speed and convenience, and can be combined with extensions to reach fasteners more easily.

Standard sockets come in 6-point and 12-point styles. For use with a ratchet the 6-point offers a better grip on tight nuts and bolts. As with wrenches, 6mm to 15mm, 17mm, and 19mm are the most needed sizes. See Fig. 4-4.

Sockets come with different size connections to drive handles or extensions, called the drive size. The most common drive sizes are ¼ in., ⅜ in. and ½ in.

As a start, 6-point sockets with a ⅜ in. square drive, two or three ⅜ in. extensions of different lengths, and a ⅜ in. drive ratchet handle will be suitable for most jobs.

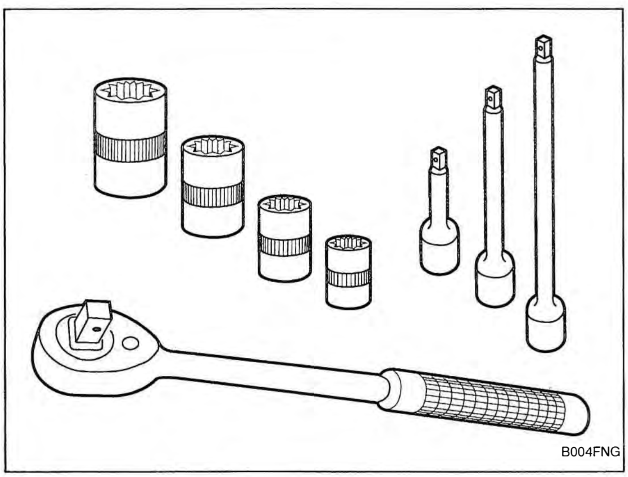


Fig. 4-4. Sockets, extensions, and rachet handle.

For a more complete tool box, add deep sockets and a greater variety of handles and extensions. A universal joint extension can allow access from an angle where a straight extension will not quite fit.

Spark Plug Socket. A special socket for spark plugs is the correct size, is deep enough to accommodate a spark plug's length, and includes a rubber insert to both protect the spark plug from damage and grip it for easier removal. A typical spark plug socket is shown in Fig. 4-5.

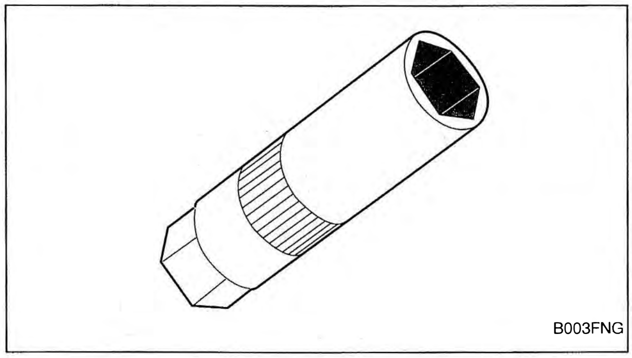


Fig. 4-5. Spark plug socket.

The spark plugs used in all BMW engines require a $^{13}/_{16}$ in. socket. Get one with the drive size to match your ratchet handle and extensions.

Pliers. A few of the many types of pliers are shown in Fig. 4-6. Most are used for holding irregular objects, bending, or crimping. Some have special applications.

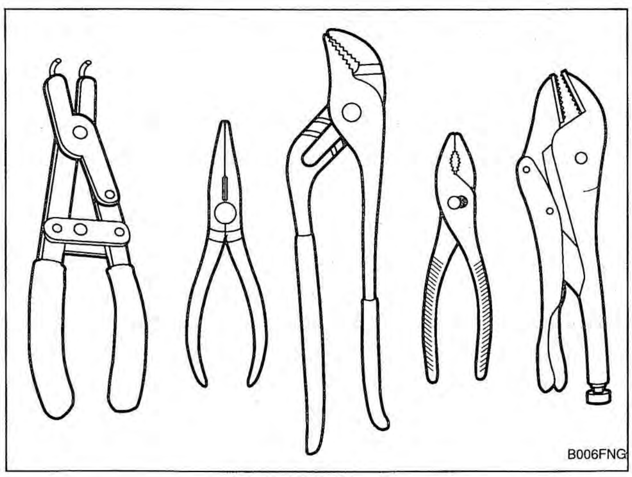


Fig. 4-6. Pliers. From left, snap-ring, needlenose, channel lock, common, locking.

A needlenose plier is used for gripping small and poorly accessible objects, and is useful for wiring and other electrical work. A locking plier such as the well-known Vise-Grip® is useful because of its tight grip.

Snap-ring pliers with special tipped jaws are used to remove and install snap-rings or circlips. A channel lock or water pump plier has adjustable jaws which can be quickly changed to match the size of the object being held to give greater leverage.

There are many different types and sizes of pliers. Start with a small selection of different types of medium size.

Adjustable wrench. An adjustable wrench, shown in Fig. 4-7, can be a useful addition to a small tool kit. It can substitute in a pinch, if two wrenches of the same size are needed to remove a nut and bolt. Use extra care with adjustable wrenches, as they especially tend to loosen, slip, and damage fasteners.

Compared to a wrench of the correct size, an adjustable wrench is always second best. They should only be used when the correct size wrench is not available. Choose one of average size range, about 6 to 8 inches in length.

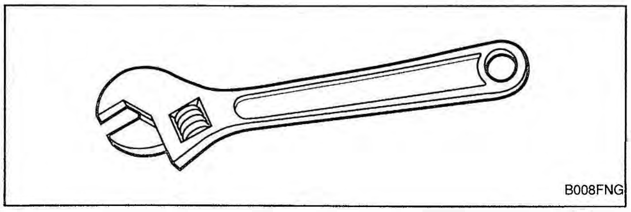


Fig. 4-7. Adjustable wrench.

Jack Stands

Strong jack stands are extremely important for any work that is done under the car. Jacks are designed only for short term use and are not solid enough to support the car for a long period. A jack should never be used alone to support the car while working underneath.

Use only jack stands which are designed for the purpose. Blocks of wood, concrete, bricks, etc. are not safe or suitable substitutes.

Jack stands are available in several styles. A typical jack stand is shown in Fig. 4-8. The best ones are made of heavy material for strength, have a wide base for stability, and are equipped to positively lock in their raised positions. Get the best ones available.

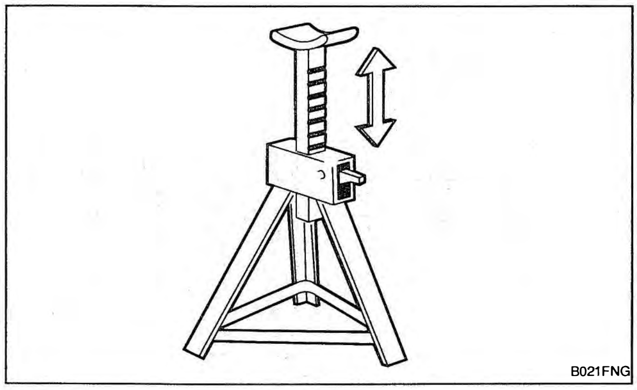


Fig. 4-8. Jack stand for safely supporting car to work underneath.

Oil Change Equipment

Changing oil requires a box-end wrench or socket to loosen and tighten the drain plug (17mm), a drain pan (at least 5 qt. capacity), and an oil filter wrench. These items are shown in Fig. 4-9. A wide, low drain pan will fit more easily under the car. Use a funnel to pour the new oil into the engine.

An oil filter wrench is used to remove the oil filter. Be sure to get a filter wrench which will grip the BMW oil filter tightly.

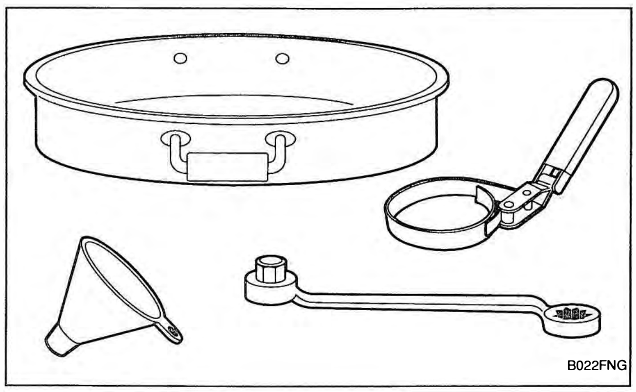


Fig. 4-9. Oil change equipment includes drain plug wrench (17mm), 5 qt. drain pan, oil filter wrench, and funnel.

Torque Wrench

A torque wrench is used to precisely tighten threaded fasteners to a predetermined value. Nearly all of the repair procedures in this manual include BMW-specified torque values in Newton-meters (Nm) and the equivalent values in foot-pounds (ft. lb.).

Several types of torque wrenches are widely available. They all do the same job, but offer different convenience features at different prices. Two typical torque wrenches are shown in Fig.

4-10. The most convenient ones have a built-in ratchet, and can be preset to indicate when a specific torque value has been reached. Follow the wrench manufacturer's directions for use to achieve the greatest accuracy.

A torque wrench with a range up to about 250 Nm (185 ft. lb.) has adequate capacity for most of the repairs covered in this manual. For recommended torque values of 10 Nm or below, the English system equivalent is given in inch-pounds (in. lb.). These small values may be most easily reached using a torque wrench calibrated in inch-pounds. To convert foot-pounds to inch-pounds, multiply by 12. To convert inch-pounds to foot-pounds, divide by 12.

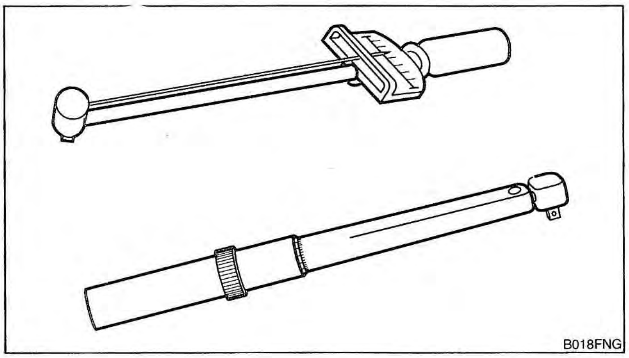


Fig. 4-10. Torque wrenches. Inexpensive beam-type (top) is adequate but must be read visually. Ratchet-type (bottom) can be preset to indicate when torque value has been reached.

Timing Light

A timing light connects to the battery and to the #1 spark plug wire to check ignition timing. A bright strobe light flashes in sequence with the firing of the #1 spark plug. One example is shown in Fig. 4-11. Avoid less expensive models with lights which are too dim to be seen in daylight.

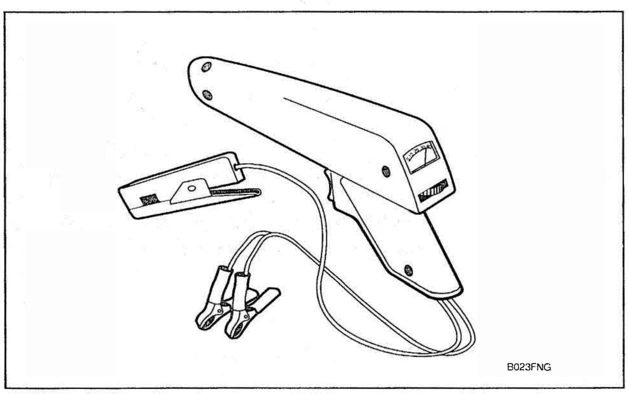


Fig. 4-11. Timing light and electrical connections, including inductive pickup. Dial shown is found on sophisticated adjustable timing lights.

An attractive feature of the more expensive models is an inductive pickup which just clamps on over the spark plug wire to get its signal, rather than needing a more positive connection.

An adjustable timing light is a more sophisticated instrument used to actually measure the timing and the advance and retard characteristics in engine crankshaft degrees. This type is only necessary for detailed analysis of the ignition system's function.

Tachometer

An external tachometer is used to precisely measure engine speed (rpm) for various tests and adjustments. Most tachometers are powered by connection to the battery, and measure engine rpm through a connection to terminal 1 of the ignition coil. To locate terminal 1, see **IGNITION**.

Feeler Gauges

Feeler gauges are thin metal strips of precise thickness, used to measure small clearances. They are normally available as a set, covering a range of sizes. For BMWs, metric feeler gauges (in millimeters) are the best choice. Fig. 4-12 shows a set of feeler gauges.

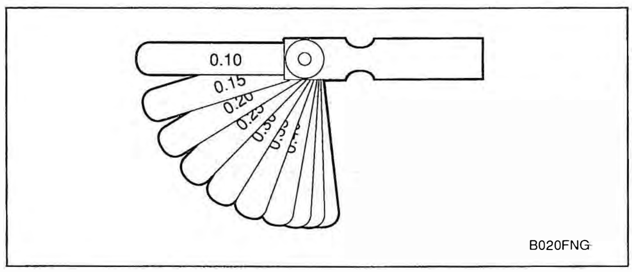


Fig. 4-12. Feeler gauge set, used for precise measurement of clearances between parts.

Micrometers

Precision measurements of internal engine parts and other critical dimensions are made with micrometers, some of which can accurately measure to within thousandths of a millimeter. These are expensive instruments, and are only recommended for those who plan to be repeatedly involved in engine overhauls or other similar work requiring detailed measurement. If such measurements are necessary on a one-time basis, a qualified machine shop can be called upon to make these measurements, particularly if they are also going to be doing the necessary machine work.

Test Light

A test light, shown in Fig. 4-13, is a simple tool used to check electrical circuits for voltage or continuity to ground when actual voltage values are unimportant. A bulb in the handle will light whenever current is flowing through the circuit. The use of a test light is described in **3.2 General Advice For The Beginner**.

CAUTION —
Ignition, fuel injection, emission controls and other electronic systems may be damaged by the high current draw of a test light with a normal incandescent bulb. For these applications, use a low-current LED tester as described in **3.2 General Advice For The Beginner** *under* **Making An LED Test Light**.

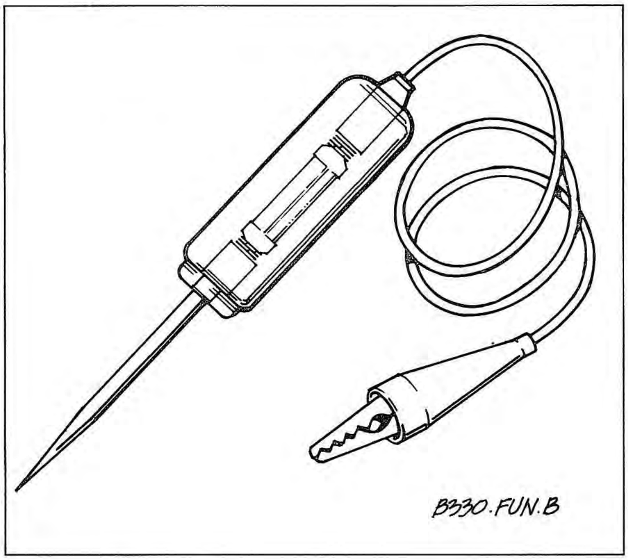


Fig. 4-13. Test light with alligator clip test lead.

Volt-Ohm Meter (VOM) or Multimeter

Many of the electrical tests in this manual call for the measurement of resistance (ohms) or voltage values. For safe and accurate tests of ignition, fuel injection, and emission control systems, the multimeter should be digital, with high (at least 10,000 ohms) input impedance. See Fig. 4-14.

Jumper Wires

Some of the electrical tests in this manual require the use of extra jumper wires to bypass a component or a portion of the wiring harness. For most basic electrical tests, jumper wires with an in-line fuse and alligator clips at each end (made or purchased) are sufficient.

For tests involving harness connectors, hookup of jumper wires may damage the connector and cause inferior connections later on. To avoid this damage, jumper connections to harness connectors should be made using a small, flat-blade (spade) terminal that will mate properly with the connector. See Fig. 4-15.

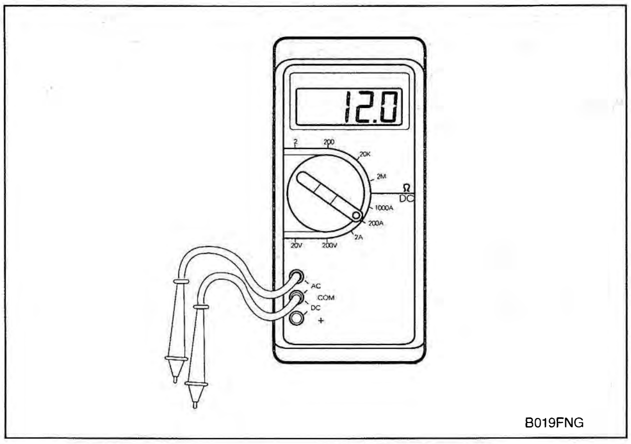


Fig. 4-14. Multimeter with test probes.

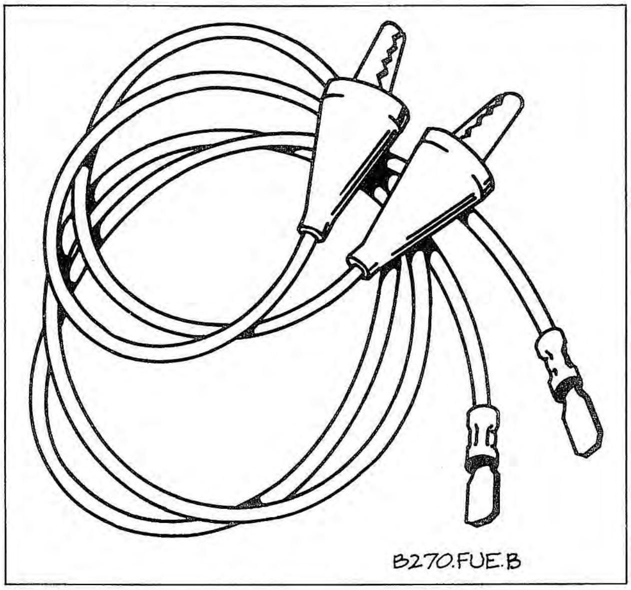


Fig. 4-15. Jumper wires with alligator clips. Flat connectors shown are for electrical testing at harness connectors.

BMW Special Tools

Some of the more challenging repairs covered in this manual call for the use of BMW special tools. This, however, does not automatically mean that the job is too complicated or out of reach of the novice.

Many of the BMW special tools mentioned in this manual are inexpensive and are simply the best thing to use to do the job correctly. In these cases, the tool is identified with a BMW part number. See your authorized BMW dealer parts department for information on how to order special tools.

There are some jobs for which expensive special tools are essential, and not a cost-effective purchase for one-time repair by the do-it-yourself owner. This manual includes such repairs for the benefit of those with the necessary experience and access to tools. For the do-it-yourselfer, the need for special tools is noted in the text, and BMW dealer service is recommended.

5. Troubleshooting Fundamentals

Troubleshooting is a systematic approach to identifying and solving a problem. The exact approach depends on the individual circumstances, but usually relies on carefully observing the symptoms. Paying attention to exactly what is happening, and under what conditions, is the most powerful tool available to get to the cause of a problem.

The basic rule for troubleshooting is to never overlook the obvious. Always start with the basics and work toward the more complex. Lots of time and money can be wasted on exotic testing only to find, eventually, that the problem is a loose wire or an empty fuel tank.

Following are some tips to initial analysis of common problems, and direction to other section or sections of this manual for more detailed troubleshooting information.

5.1 Starting

There are three main requirements for starting the engine:

1. The starting system (battery and starter) must provide adequate engine cranking speed.

2. The ignition system must provide adequate spark at the proper time.

3. The fuel system must deliver the proper amount of fuel at the proper time.

Observing the symptoms of a starting problem will give clues to its cause. Slow cranking speed indicates problems with the electrical system—probably the battery or starter. Further troubleshooting should focus on the electrical system—tests of the ignition or fuel systems at this point would be meaningless. See **ELECTRICAL SYSTEM**.

An engine that cranks normally indicates that the battery and starter are fine, so other starting problems suggest an ignition or fuel system problem. If there is no sign whatsoever of starting, make sure there is adequate fuel in the tank. Check for loose wires around the coil and distributor. Check to see that the distributor cap and spark plug wires are dry.

Unless this basic inspection turns up a cause, the cause could be in either the ignition system or the fuel system. The ignition system is the more likely culprit and is also easier to evaluate. The condition and function of the ignition system should always be confirmed before suspecting the fuel system. See **ENGINE MANAGEMENT—DRIVEABILTY** for more information on troubleshooting starting problems.

5.2 Driveability

Problems with the way the engine runs, also known as driveability, may be caused by faults in either the ignition system or the fuel system. The ignition system should be investigated and its good condition confirmed before beginning any work on the fuel system.

The fuel injection system is far more likely to be influenced by temperature. Symptoms which are present only when the engine is cold, or only when it is warm, tend to suggest fuel system problems.

For an engine with high mileage, the general mechanical condition of the engine may also be a factor. Particularly in cases where driveability problems have developed slowly over time, troubleshooting should include evaluation of the engine's mechanical condition with a compression test. See **ENGINE**.

When attempting to evaluate noise or vibrations which occur when the engine is running, try to eliminate other possible causes. With a manual transmission, symptoms that change depending on whether or not the clutch is engaged suggest that the problem may be in the clutch disc, the clutch release mechanism, or the transmission. See **MANUAL TRANSMISSION AND CLUTCH**. With an automatic transmission, check the symptoms in different shifter positions. If the symptoms differ, the problem may be in the torque converter or the transmission. See **AUTOMATIC TRANSMISSION**.

5.3 Driving

To track down noise and vibrations that occur while driving, first try to learn more about the symptom. Does it occur all the time, or only at certain speeds? Does the symptom change depending on engine speed or vehicle speed?

Compare driving in different gears at the same approximate engine speed (rpm). A symptom which persists at a certain engine speed or speed range regardless of gear selection suggests an engine or exhaust system problem. See **ENGINE** or **EXHAUST SYSTEM AND EMISSION CONTROLS**.

For more analysis try driving the car at the speed where the symptom is most noticeable, then briefly shift into neutral and coast. If the symptom continues unchanged, then it is the car's speed which is a factor, and not engine speed. Symptoms that vary only with the car's speed suggest problems with running gear. See **SUSPENSION AND STEERING** for more detailed troubleshooting information.

6. EMERGENCIES

6.1 Changing a Tire

If the tire goes flat while driving, pull well off the road. Changing a tire on a busy street or highway is very dangerous. If necessary, drive a short distance on the flat tire to get to a safe place. It is much better to ruin a tire or rim than to risk being hit.

Stop the car on as flat a surface as possible, in a place where you can be easily seen by other drivers. Avoid stopping just over the crest of a hill. Turn on the emergency flashers, and set out flares or emergency markers well behind the car. Passengers should get out of the car and stand well away from the road. Take the jack, tools, and spare wheel from the trunk. Chock the wheel diagonally opposite to the one being changed.

Loosen the wheel bolts while the car is on the ground, but leave them a little snug. Place the jack under the lifting point nearest the wheel being changed (lifting points are described in **3.1 Safety**). Use a board to provide a firm footing for the jack if the ground is soft.

Raise the jack until it is just touching the lifting point, and adjust the jack so that its base is slightly under the car. Raise the car only far enough so that the wheel is off the ground, and then remove the wheel bolts and the wheel.

To install the spare wheel and tire, insert the centering pin into one of the holes, put the wheel on the centering pin, install one wheel bolt and remove the pin. Install the remaining wheel bolts and tighten them by hand, then lower the car. With all wheels on the ground, fully tighten the bolts in a cross-wise pattern.

Torque the wheel bolts to 110 Nm (81 ft. lb.), when installing the wheel if possible. If not, tighten them as much as possible, then loosen and retorque the bolts to the proper specification at the earliest opportunity. Check the inflation pressure of the spare tire. Inflation pressures are given in **LUBRICATION AND MAINTENANCE**.

6.2 Car Will Not Start

If the engine turns over slowly or not at all, especially on cold mornings, the battery may not be sufficiently charged. Jump-starting the battery from another car may help. Jump-starting is described below in **6.3 Jump-Starting**.

If the starter seems to be operating but the engine does not turn over (indicated by a high-pitched whine or grinding when the ignition key is turned to START), then there is a problem with the starter. In this case jump starting will not help.

NOTE —

Be sure to read the cautions under **6.3 Jump Starting** prior to jump starting a low battery. Failure to follow the cautions may result in damage to the electronic control units for the On-board computer or the Anti-lock Braking System (ABS).

Push starting (or tow starting) a car with an insufficiently charged battery is another option. To push start the car, turn on the ignition, put the car in third gear and push in the clutch pedal. Push the car. When the car is moving at a fair speed, release the clutch pedal. After the engine has started, push the clutch pedal back in and allow the engine to idle.

WARNING —

Use extreme caution when push starting a car. Be aware of other traffic. Use the emergency flashers.

NOTE —

On cars with automatic transmission, the design of the transmission makes it impossible to push start the engine.

If the engine is turning over at normal speed, the battery and starter are fine. Check to make sure that there is fuel in the tank. Don't rely on the fuel gauge, it may be faulty. Instead, remove the gas filler cap and rock the car. If there is gas in the tank, you should hear a sloshing sound from the filler neck. If so, turn the ignition on and listen for the sound of the fuel pump. It should run for a few seconds, then stop. If it doesn't, fuel may not be reaching the engine.

The engine also may have difficulty starting because it has too much fuel, because the fuel system is vapor-locked on a hot day, or because the ignition system is wet on a very damp day. There will probably be a strong smell of gas if the engine has too much fuel (referred to as "flooded").

The common remedy of repeatedly cranking the engine with the gas pedal floored to clear a flooded engine may damage the catalytic converter. Instead, wait for a few minutes, and then try starting the engine again. If you suspect vapor-lock, raise the hood, let the engine cool, and then try to start the engine.

On damp days, check the distributor cap and spark plug wires for condensation. If they are wet, remove and replace the wires one at a time and dry them off with a clean dry cloth, then remove the distributor cap and wipe it dry inside and out.

6.3 Jump-Starting

Cars with partially discharged or completely dead batteries can be jump-started using the good battery from another car. When jump-starting the engine, always heed the following warnings and cautions.

WARNING —

- *Battery acid (electrolyte) can cause severe burns, and will damage the car and clothing. If electrolyte is spilled, wash the surface with large quantities of water. If it gets into eyes, flush them with water for several minutes and call a doctor.*
- *Batteries produce explosive gasses. Keep sparks and flames away. Do not smoke near batteries.*
- *Do not jump-start the engine if you suspect that the battery is frozen. Trapped gas may explode. Allow the battery to thaw first.*

CAUTION —

- *On models equipped with on-board computers, remove the computer fuses (fuse no. 10, 12, 21, and 27) prior to quick-charging to prevent damaging the computer.*
- *Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time.*

To jump-start the engine, place the cars close together, but do not allow them to touch. Turn off the engine of the car with the good battery. Connect the jumper cables as shown in Fig. 6-1.

On cars with the battery mounted in the engine compartment, connect the end of one cable to the positive post of the good battery, and the other end of the same cable to the positive post of the dead battery. The positive post is the fatter of the two posts and is usually marked with a plus (+) sign. On models with a trunk mounted battery, connect the positive terminal of the jumper cable to the wiring junction on the right side of the heater bulkhead, as shown in Fig. 6-2.

Connect one end of the other cable to the negative (−) post of the good battery, and connect the other end of the same cable to the engine block of the car with the dead battery. Make the connection as far away from the battery as possible, as there may be sparks.

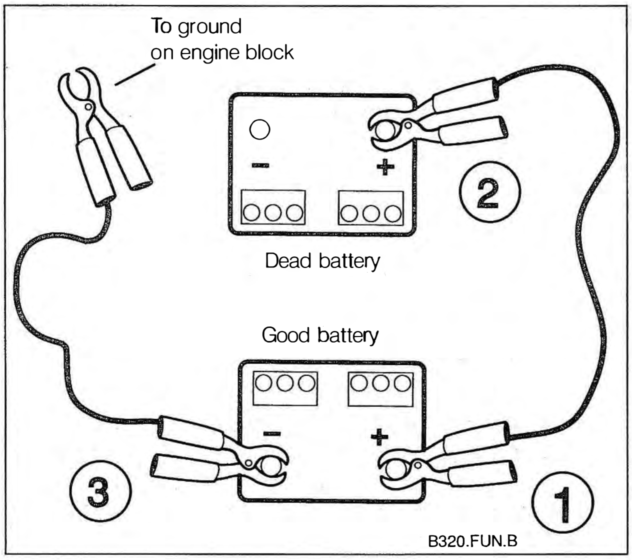


Fig. 6-1. Battery jumper cables connections. Numbers indicate correct sequence for cable attachment.

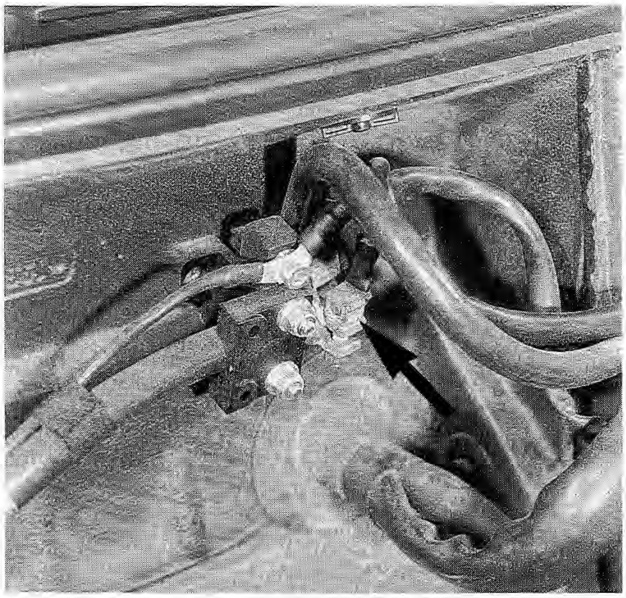


Fig. 6-2. Positive terminal jumper cable connection (**arrow**) for car with trunk mounted battery.

Have a helper start the car with the good battery and race the engine slightly, then start the car with the dead battery. Leave the cars running and disconnect the cables in the reverse order in which they were installed. The car with the dead battery will need to run for at least ½ hour to recharge the battery.

6.4 Overheating

If the coolant temperature is too high, find a safe place to stop and turn the engine off. Open the hood and allow the engine to cool until the temperature gauge needle is at the lower third of the scale. Continuing to drive an overheated car can cause expensive damage.

> ***WARNING —***
> *Do not remove the coolant reservoir or radiator cap with the engine hot. Undoing either could spray hot coolant, and cause burns, or damage the engine.*

> **NOTE —**
> If the engine cannot be safely turned off, make sure the air conditioner is off and turn the heater to high. This will help cool the engine until a safe stopping place can be reached.

Overheating may be caused by the driving conditions, such as operating the air conditioner in slow traffic, or by low coolant level or a damaged V-belt. Turn off the air conditioner. Check the coolant level and V-belts as described in **LUBRICATION AND MAINTENANCE**. If coolant is lost, check the filler cap, hoses, clamps and radiator for signs of leakage.

If no leaks are found, add coolant after the engine has cooled. The car can be driven, but have the cooling system thoroughly checked as soon as possible. If replacement coolant is not available, then plain water can be used, but the coolant should later be drained and refilled with the proper mixture of anti-freeze and water.

> ***CAUTION —***
> *Do not add cold water or coolant to a hot engine. Severe engine damage could result from the sudden temperature change.*

If steam is coming from the engine compartment then there is most likely a burst coolant hose or a large leak in the cooling system. To find the leak, look for signs of coolant leakage on hoses, at hose connections, or on the radiator. Let the engine cool thoroughly, then add coolant or water to fill the system and start the engine. If a great deal of water or coolant flows out of the hole, then the car should not be driven until repairs are made. If there is a slight seepage, then it may be possible to drive a short distance, adding coolant as needed.

6.5 Oil Pressure Warning Light

If the oil pressure warning light does not go out immediately after the engine starts or if it comes on while driving the car, stop the engine immediately to prevent severe engine damage.

Check the oil level as described in **LUBRICATION AND MAINTENANCE**. If the level is low, add oil to the correct level and start the engine. If the light is still on, do not run the car at all. Have it towed.

6.6 Brake Fluid Level Warning Light

The red brake fluid level warning light is an indicator of brake fluid loss. Problems with the brake system should be checked and repaired immediately. See **BRAKES** for more information.

6.7 Anti-Lock Brake System Warning Indicator

If the anti-lock brake system warning indicator comes on at normal driving speeds, the anti-lock braking system is out of service. Under normal conditions, there will be no change in the effectiveness of the brakes. In an emergency situation, however, the normal anti-lock function is lost and the brakes could lock. Check the system as described in **BRAKES**.

6.8 Dim Lights

Headlights that are dim or gradually getting dimmer generally indicate a problem with the battery or charging system. The battery charge indicator light may come on as the lights are dimming. In either case, the engine and accessories are running off of the battery alone, and will soon discharge it altogether.

If possible, do not stop the engine unless you have the capability to jump start it. There may not be enough power in the starting system to restart the engine. Instead, turn off as many electrical consumers as possible. This will reduce the current drain and will allow the car to be driven further before you lose all battery power.

With the engine and ignition off, check to see if the battery cables are firmly attached, or if there are any loose wires leading to the battery or to the alternator. Look for heavily corroded (covered by fluffy white deposits) wires and connectors.

Disconnecting, cleaning, and reinstalling corroded wires and connectors may solve the problem. Also check V-belt tension as described in **LUBRICATION AND MAINTENANCE**.

6.9 Towing

The cars covered by this manual can be towed either flat, on all four wheels, or by a tow truck using wheel lift or flat bed equipment.

NOTE —

Do not tow with sling-type equipment.

If flat-towing the car, use the towing eyes at the front of the car under the bumper. See Fig. 6-3. On some models, the front towing eye is a screw on type, as shown in Fig. 6-4, and is stored in the tool kit. Set the transmission in neutral. BMW recommends using nylon tow ropes.

WARNING —

Never use the screw-on towing eye unless it is fully tightened.

NOTE —

Installation of certain front spoilers may prevent access to the front towing eyes.

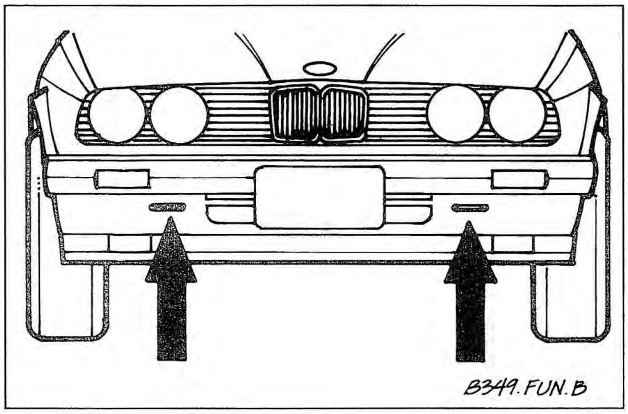


Fig. 6-3. Front towing eyes (**arrows**) used when flat-towing cars.

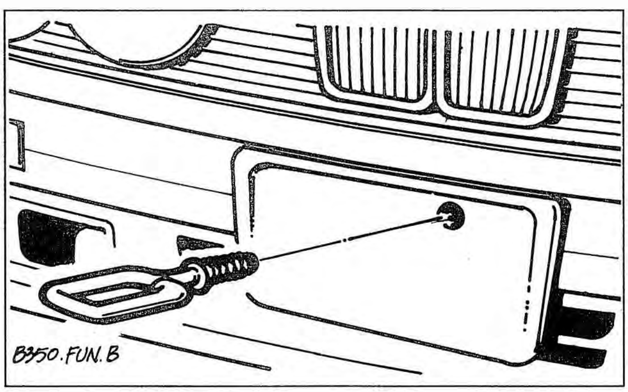


Fig. 6-4. Screw-on type front towing eye.

Towing a BMW with an automatic transmission while the rear wheels are on the ground can cause damage due to lack of lubrication. BMW recommends that cars with automatic transmission be towed with the rear wheels on the ground for no more than 30 miles (50 km), at no more than 30 mph (50 km/h). If the distance will be greater than 30 miles (50 km), either remove the driveshaft (**See DRIVESHAFT AND FINAL DRIVE**) or add 1.05 quarts (1 liter) of ATF to the transmission. Reduce the fluid level to normal before driving the car.

NOTE —

There are no speed or distance restrictions when towing a car with a manual transmission, provided the transmission lubricant is filled to the correct level.

6.10 Spare Parts Kit

Carrying a basic set of spare parts can prevent a minor breakdown from turning into a major annoyance. Many of the following items won't allow you to do major repair work on the car, but they will help in the event of the failure of something which can disable the car or compromise its safety.

Spare Parts Kit - Basic Contents:

1. V-belt for the alternator and water pump.
2. one or two quarts of engine oil
3. a gallon container of engine coolant (pre-mixed anti-freeze and water)
4. spare fuel pump relay, (for 6-cylinder engine, also spare main relay)
5. a new, unopened bottle of brake fluid
6. 10 amp, 15 amp, and 20 amp fuses
7. upper and lower radiator hoses

Spare Parts Kit - Additional Contents:

1. replacement headlight (sealed beam or bulb)
2. brake light, turn signal light, and taillight bulbs
3. other relays such as headlight, turn signal, or load reduction
4. wiper blades
5. distributor cap and rotor

Section 2

2

LUBRICATION AND MAINTENANCE

Contents

TABLES

Lubrication and Maintenance

Introduction

The useful life of any car depends on the kind of maintenance it receives. The procedures described in this section of the manual include all of the routine checks and maintenance steps that are both required by BMW under the terms of their warranty protection and recommended by BMW to ensure long and reliable operation of your car. Also included are some instructions and recommendations for more basic car care.

BMW has taken a unique approach to establishing maintenance intervals for the cars covered by this manual. Most other manufacturers specify maintenance intervals strictly according to the number of miles driven or the number of months that have elapsed since the car's last service. It is well known, however, that mileage and time are not the only relevant factors that determine maintenance intervals. Aggressive driving, short trips, and frequent stops and starts are all harder on a car, and ideally call for more frequent maintenance. On the other hand, a more relaxed driving style, longer trips with the car fully warmed up, and mostly highway driving are easier on the car and can justify less frequent maintenance.

BMW's Service Indicator System computes maintenance intervals based not only on elapsed mileage, but also on such inputs as engine speed, engine temperature, number of starts, and lengths of trips. At the appropriate time, the system indicates that the next routine maintenance is due, based on the type of use experienced by that particular car.

BMW is constantly updating their recommended maintenance procedures and requirements. The information contained here is as accurate as possible at the time of publication. If there is any doubt about what procedures apply to a specific model or model year, or what intervals should be followed, remember that an authorized BMW dealer always has the latest information on factory-recommended maintenance.

Some maintenance procedures, such as oil change service, require no special tools and can be carried out by almost any interested BMW owner, regardless of his or her previous mechanical experience. Certain other diagnostic and maintenance tasks require special tools and equipment. Cylinder compression tests, idle speed and idle mixture (% CO) checks, wheel alignment, and ignition timing are some examples. If you lack the tools or a suitable workplace for doing any of the maintenance described in this section, we suggest you leave this work to an authorized BMW dealer or other qualified shop. We especially urge you to consult an authorized BMW dealer before beginning any repairs on a car still covered by the manufacturer's warranty.

All of the maintenance work described here is important and should be carried out promptly and correctly. Your BMW should not be thought of as a maintenance-free machine. Correct care will protect your investment and help you to get many years of driving reliability and enjoyment from your BMW.

1. General Description

Lubrication and maintenance refers to those routine procedures that are necessary to keep a car operating at its peak and to maintain the service requirements for full warranty coverage.

This section of the manual contains information about all of the routine maintenance that is specified by BMW for the cars covered by this manual.

Maintenance Tables

These tables list all of the routine maintenance tasks for a particular model or model year that should be done at particular maintenance intervals. All of the applicable tables can be found under **2. Maintenance Tables.**

Fluid and Lubricant Specifications

The fluids and lubricants recommended for use in BMWs have been carefully chosen for their ability to perform under a wide range of conditions and to adequately protect your car. To maintain these high standards of performance, and to ensure that full warranty coverage remains in effect, use only the fluids and lubricants that meet the standards set forth by BMW and listed under **3. Fluid and Lubricant Specifications.**

Engine Oil Change

Regular changing of the engine lubricating oil and the engine oil filter is perhaps the single most important maintenance that a car can receive. It is also simple and easy.

The heading **4. Engine Oil Change** covers the basic details of checking and adding oil, as well as changing the oil and filter.

Tune-up

Much of what has traditionally been considered part of a tune-up has been rendered obsolete by sophisticated engine management technology. Therefore, tune-ups have become a less frequent and simpler part of maintenance.

The heading **5. Tune-up** covers those tasks that have traditionally been thought of as tune-up tasks, and that are still included by BMW as periodic routine maintenance.

Routine Maintenance — Engine Compartment

Many of the most important routine maintenance tasks are done under the hood within easy reach. They are grouped together so that more thorough maintenance can be planned and carried out most efficiently. See **6. Engine Compartment Maintenance** for more information.

Routine Maintenance — Chassis and Drivetrain

Thorough maintenance requires periodic inspection and servicing of parts that are only accessible by raising the car. Since this requires a suitable level workspace and the proper equipment to raise the car, a little more planning is required. As a convenient alternative, you may wish to leave these items to an authorized BMW dealer or other qualified and suitably equipped repair shop. See **7. Under-Car Maintenance** for more information.

Routine Maintenance — Body and Interior

Periodic service and inspection of certain safety-related body and interior equipment is specified by BMW and covered under **8. Body and Interior Maintenance.**

Cleaning and Preserving

Aside from improving the car's appearance, cleaning and preserving can reduce the harmful effects of dirt and other contaminants which attack the finish. Information on recommended cleaning materials and methods can be found under **9. Cleaning and Preserving.**

2. Maintenance Tables

The tables that follow list the routine maintenance tasks specified by BMW. As described in the introduction, the intervals for most of these tasks are determined by the BMW Service Indicator System. The intervals vary from car to car, depending on the way the car is used.

The maintenance intervals for a few additional items are based only on elapsed mileage or time only, and these intervals are clearly indicated in separate tables.

2.1 BMW Service Indicator

The BMW Service Indicator notifies the driver when maintenance is required. The indicator, shown in Fig. 2-1, consists of nine light emitting diodes (LEDs)—five green, one yellow, and three red—as well as "Oil Service" and "Inspection" indicators.

When the ignition is turned on, the green LEDs come on. They go out when the engine is started. Immediately after a maintenance service, all five LEDs will be illuminated. As the car is driven in normal use, fewer and fewer green LEDs will be illuminated before start-up, indicating that the next maintenance interval is approaching.

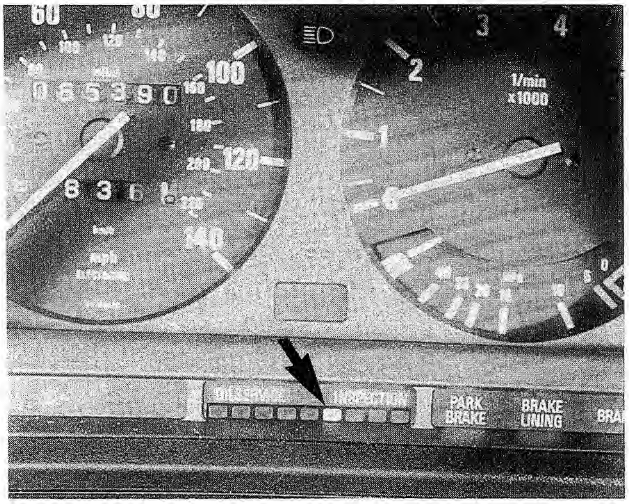


Fig. 2-1. Service indicator display in instrument panel (arrow).

When the car has accumulated sufficient use to require the next maintenance interval, the yellow LED will come on along with either the "Oil Service" indicator or the "Inspection" indicator. These will stay on after the engine is started. If maintenance service is delayed, the red LEDs will also illuminate, one by one, as a reminder that maintenance service is overdue.

An oil service interval will always be followed by an inspection interval, which will then be followed by an oil service interval, and so on. Further explanations of these intervals are given below in **2.2 Oil Service** and **2.3 Inspection**.

Resetting Service Indicator

When the specified maintenance has been carried out, the service indicator memory needs to be reset. Resetting the service indicator turns out the lights.

The service indicator is reset using a special electronic tool. The tool is plugged into the diagnostic connector in the engine compartment, which is electrically connected to the service indicator circuit. See Fig. 2-2.

BMW specifies two individual tools, one for resetting the oil service memory (BMW tool no. 62 1 120) and one for resetting the inspection memory (BMW tool no. 62 1 100). On some 1987 models and on all 1988 through 1990 models, an additional adapter (BMW tool no. 62 1 140) is required. These tools are available from an authorized BMW dealer.

CAUTION —

Follow the manufacturer's directions when resetting the service indicator. If the reset procedures are done incorrectly, the reset tool or the electronic control unit may be damaged.

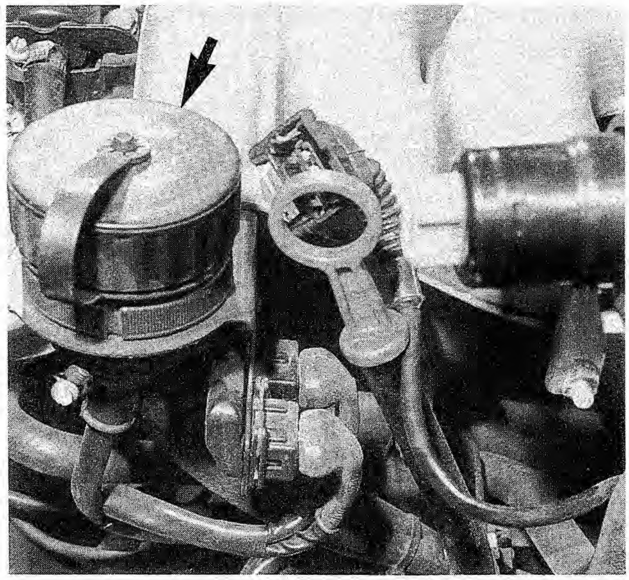


Fig. 2-2. Diagnostic connector in engine compartment (arrow).

NOTE —

1984 through 1987 models (except 1987 325i models) are equipped with a 15-pin connector. 1987 325i and all 1988 through 1990 models are equipped with a 20-pin connector. Check with the tool manufacturer for the correct reset tool application.

As an alternative, a single tool that resets both the inspection and oil service memory can be purchased from one of the following manufacturers:

Assenmacher Specialty Tools
6440 Odell Place
Boulder, CO 80301
(303) 530-2424

or

Peake Research, Automotive Products Division
P.O. Box 28776
San Jose, CA 95159-8776
1-800-231-6861

Table a lists the maintenance tasks that need to be done at the intervals indicated by the BMW Service Indicator. The additional maintenance tasks that are specified at particular time or mileage intervals are listed in **Table b.**

Table a. Routine Maintenance — Service Indicator Intervals

Maintenance item	Oil service	Inspection I	Inspection II	Tools required	New parts required	Warm engine required	Dealer service recommended
Oil change service							
Change oil and oil filter **4.1**	*	*	*	*	*	*	
Tune-up							
Check and adjust valve clearance **5.6**		*	*	*			
Replace spark plugs **5.2**			*	*	*		
Replace air filter **5.1**			*		*		
Replace main fuel filter **5.4**			*	*	*		
Inspect ignition distributor cap, rotor and spark plug wires, and replace as necessary** **5.3**			*				
Check idle mixture and adjust, if applicable (recommended for California models) ***		*	*			*	*
Engine compartment maintenance							
Check brake fluid level **7.2**		*	*				
Check clutch fluid level **7.4**		*	*				
Check automatic transmission fluid level and correct as necessary **7.5**			*				
Check battery acid level and correct as necessary **6.1**		*	*				
Check engine coolant level and anti-freeze protection and add as necessary. Inspect for cooling system leaks **6.4**		*	*				
Lubricate accelerator linkage and throttle linkage with oil. Lubricate bearing of throttle plate with grease **6.2**		*	*				
Inspect V-belt tension and condition, and adjust or replace as necessary **6.3**			*	*			
Under car maintenance							
Check manual transmission oil level and add as necessary **7.4**		*	*	*			
Replace manual transmission oil **7.4**			*	*			
Replace automatic transmission fluid **7.5**		*			*	*	
Check final drive fluid level **7.7**		*	*				
Replace final drive oil **7.7**			*	*		*	
Check fuel tank, fuel lines, and all connections for leaks **7.8**		*	*				
Inspect exhaust system **7.3**		*	*				
Check power steering system for leaks. Check fluid level **7.6**		*	*				
Check brake calipers and dust boots for leaks **7.2**		*	*				
Inspect brake system for damaged hoses and lines, leaks or damage **7.2**		*	*				
Check brake pad and shoe wear **7.2**		*	*				

** Maintenance recommended by the publisher that meets or exceeds BMW's requirements

*** Some California models covered by this manual have non-adjustable idle mixture. See **FUEL SYSTEM** for more information

continued on next page

Table a. Routine Maintenance — Service Indicator Intervals (continued)

Maintenance item	Oil service	Inspection I	Inspection II	Tools required	New parts required	Warm engine required	Dealer service recommended
Under Car Maintenance (cont'd)							
Inspect parking brake cable, adjust as necessary **7.2**		*	*				
Inspect front suspension and steering for play **7.6**		*	*				
Inspect rear drive axle joint boots **7.7**		*	*				
Check front wheel bearing play **7.6**			*				
Inspect wheels and tires, check tire pressure and condition **7.1**		*	*				
Inspect clutch for wear **7.4**			*	*			
Body and Interior Maintenance							
Lubricate door hinges **8.3**		*	*				
Check headlight and driving light aiming and adjust as necessary. See **BODY AND INTERIOR**		*	*				*
Check operation of headlights, parking lights, back-up lights, license plate lights, interior lights, glove box light, engine compartment light, trunk light, instrument panel lights, turn signals, emergency flashers, stop lights, horns, headlight flasher and dimmer switch		*	*				
Check active check control panel. See **ELECTRICAL SYSTEM**		*	*				
Sliding sunroof, clean and lubricate slide rail. See **BODY AND INTERIOR**			*				
Check function of air conditioning and refrigerant charge. See **BODY AND INTERIOR**		*	*				*
Check function of seat belts **8.3**		*	*				
Check windshield washer fluid level and add as necessary. Check operation of washer system. Check condition of wiper blades **8.1**		*	*				
Road Test							
Check braking performance, steering, heating and ventilation, automatic transmission, and mirrors		*	*				

** Maintenance recommended by the publisher that meets or exceeds BMW's requirements

*** Some California models covered by this manual have non-adjustable idle mixture. See **FUEL SYSTEM** for more information

Except where noted, the maintenance items listed apply to all models covered by this manual. The boldface numbers after each listing are the headings in this section where the maintenance procedure is discussed. The columns on the right side of each table give quick-reference information about the job—whether tools are needed, whether the procedure requires new parts, whether the car should be warmed-up to normal operating temperature and, in some cases, a recommendation that the job be turned over to an authorized BMW dealer because of the need for special equipment or expertise.

NOTE —

For reference, BMW's inspection requirements are approximately equivalent to the maintenance requirements that other European manufacturers specify. Inspection I is normally due at intervals with a maximum of 15,000 miles or 12 months. Inspection II is normally due at intervals with a maximum of 30,000 miles or 24 month intervals.

Table b. Routine Maintenance — Time and Mileage Intervals

Maintenance item	every 12 months	every 24 months	every 30,000 miles (48,000 km)	every 50,000 miles (80,000 km)	every 60,000 miles (96,000 km)	Tools required	New parts required	Dealer service recommended
Replace oxygen sensor								
1984 models with 4-cylinder engine			*		*	*	*	
1985 models with 4-cylinder engine and all models with 6-cylinder engine				*	*	*	*	
Replace brake fluid	*	*				*		
Drain and flush cooling system and replace coolant		*				*		

Note: The camshaft timing belt should be replaced every 60,000 miles (100,000 km), every 4 years (48 months), or every second inspection II, whichever comes first

2.2 Oil Service

The "Oil Service" indicator signals the need for the most basic level of routine maintenance. BMW's required oil service specifies changing the engine lubricating oil and the engine oil filter after the engine has been warmed up. BMW-recommended additional maintenance for this same interval is also listed under oil service in **Table a** above.

NOTE

For reference, BMW's "Oil Service" requirements are approximately equivalent to the maintenance that other European manufacturers specify at intervals with a maximum of every 7,500 miles or 6 months.

2.3 Inspection

The "Inspection" indicator signals the need for more comprehensive maintenance and inspection. There are two sets of inspection requirements—Inspection I and Inspection II. These inspections alternate throughout a car's maintenance history. If the last inspection interval was Inspection I, the next inspection interval (following an oil service interval) will be Inspection II, the next after that will be Inspection I, and so on.

Inspection II includes most of the tasks from Inspection I with additional Inspection II tasks. All are highlighted under the "Inspection II" heading in **Table a** above.

NOTE

- Aside from keeping your car in the best possible condition, proper maintenance plays a role in maintaining full protection under BMW's new-car warranty coverage. If in doubt about the terms and conditions of your car's warranty, an authorized BMW dealer should be able to explain them.

- BMW specifies a one-time 1,200 mile inspection for all the cars covered by this manual. For more information on this inspection and on the BMW maintenance system, see your glove box information or an authorized BMW dealer.

3. Fluid and Lubricant Specifications

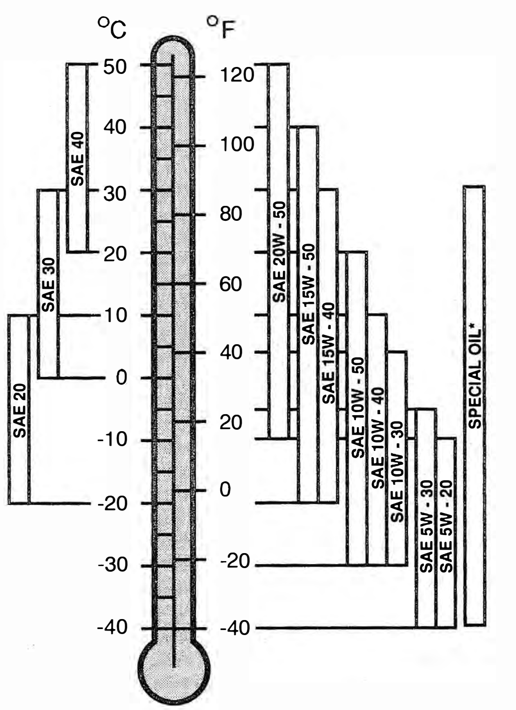
The fluids and lubricants specified by BMW for use in the cars covered by this manual are listed below. **Table c** gives engine oil viscosity (SAE grade) vs. operating temperature range for the all BMW engine types covered in this manual. **Table d** lists fluid and lubricant specifications.

CAUTION —

- *The use of fluids that do not meet BMW's specifications may impair performance and reliability, and may void warranty coverage.*

- *Avoid high-speed long distance driving when using SAE 5W-20 or SAE 10W oil, especially if the outside temperature rises above the indicated limits. If maximum loads on the engine or continuous speeds above 60 mph (100 km/h) are expected, use an oil with the next higher viscosity rating.*

Table c. Oil Viscosity Requirement vs. Temperature



*Engine oils specially formulated and approved by BMW. See an authorized BMW dealer for more information.

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Table d. Fluids and Lubricants

Fluid	Approximate capacity	Specification
Engine oil		
318i	3.75 L (4.0 US qt.)	API service SE or SF
with filter change	add .25 L (.26 US qt.)	
325, 325e, 325i	4.0 L (4.2 US qt.)	API service SE or SF
with filter change	add .25 L (.26 US qt.)	
Manual transmission oil		
318i	1.15 L (1.2 US qt.)	SAE 80, API GL-4, MIL-L-2105 (non-hypoid type) For alternate oils see text
325, 325e, 325i	1.25 L (1.32 US qt.)	SAE 80, API GL-4, MIL-L-2105 (non-hypoid type) For alternate oils see text
Automatic transmission fluid (ATF)(drain and fill)		
318i	2.0 L (2.1 US qt.)	Dexron® or Dexron II® ATF
325, 325e, 325i	3.0 L (3.2 US qt.)	Dexron® or Dexron II® ATF
Final drive (drain and fill)		
318i	.9 (1.3**) L (.95 (1.4)** US qt.)	SAE 90, GL-5 (see text)
325, 325e, 325i	1.7 L (1.9 US qt.)	SAE 90, GL-5 (see text)
Power steering fluid	permanently sealed, no drain plug	Dexron or Dexron II® ATF
Brake fluid	as necessary	Dot 4
Engine coolant		50% phosphate-free ethylene glycol anti-freeze
318i	7.0 L (7.4 US qt.)	
325, 325e	12.0 L (12.7 US qt.)	
325i	10.5 L (11.0 US qt.)	

** Additional fluid required when installing a rebuilt final drive. See **7.7 Final Drive and Rear Drive Axles**

Engine Oil

Engine oil provides a lubricating film between all moving parts, and also helps cool the engine. Maintaining an adequate supply of clean oil is one of the best ways of making an engine last. Some engine oil is consumed during normal operation, making it necessary to regularly check and "top up" the oil supply. Since oil becomes contaminated and breaks down over time, regular oil changes are necessary.

Engine oil requirements are defined by the oil's American Petroleum Institute (API) service rating and by the Society of Automotive Engineers (SAE) viscosity rating. This information can be found on the oil can or bottle, often on a standard label.

The API service rating designates the type of use suited for the oil. The rating is based on the additives that are used to resist break-down and carbon formation, inhibit corrosion, resist foaming, neutralize acids, and help remove deposits and keep contaminants suspended in the oil. Although SE rated oil can be used in the engines covered by this manual, BMW recommends using SF rated oils.

The SAE viscosity rating indicates resistance to flow. An oil designated SAE 40 has a higher viscosity (greater resistance to flow) than an oil designated SAE30. While higher viscosity oils will generally offer greater engine protection, they may be too thick and resistant to flow and may inhibit starting in cold weather.

The correct engine oil viscosity depends on the operating temperature range. See the viscosity vs. temperature table above. Select a viscosity rating for the lowest anticipated temperature at which the engine must start.

Multi-viscosity oils have additives that make them suitable for use over a wider range of temperatures. For example, an oil rated SAE 10W-30 offers the flow characteristics of SAE 10 at low temperatures, but the protection capability of SAE 30 at engine operating temperature. The "W" in the SAE rating indicates that the oil is suitable for winter use.

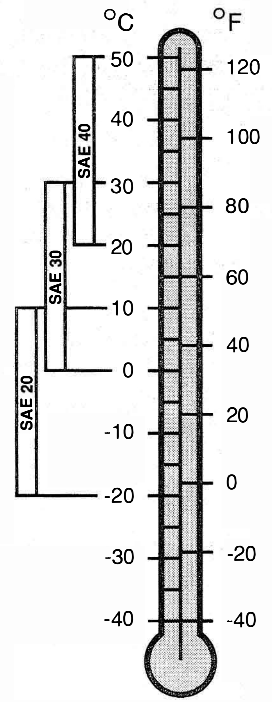
Oils of different viscosity ratings can be mixed, but mixing oils of different API service ratings or brands is not recommended.

Manual Transmission Gear Oil

Gear oil requirements are also defined by API service rating and SAE viscosity rating, as described in **Engine Oil** above. For most driving conditions, a SAE 80, GL-4 rated non-hypoid gear oil is recommended by BMW for use in the manual transmission. In areas where cold temperatures are encountered, a BMW-approved straight weight engine oil or ATF can be used to help reduce the amount of effort required to shift the transmission.

Table e lists manual transmission oil viscosity (SAE grade) vs. operating temperature range. Using engine oil or ATF in the manual transmission will not affect the service life of the transmission, although BMW recommends that the heavier gear oil should be used during warmer temperatures.

Table e. Manual Transmission Oil vs. Temperature



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CAUTION
Multi-viscosity engine oils should not be used in the manual transmission. Use of such an oil could shorten the service life of the transmission.

NOTE
- Changing the manual transmission gear oil to a less viscous engine oil (lower SAE viscosity rating) or ATF may increase the level of gear noise in the passenger compartment.

- On some 1984 325e models, the manual transmission was delivered from the factory filled with Mobil SHC 630 synthetic gear lubricant. These transmissions are identified with a green sticker on the case. These transmissions can be refilled using the guidelines above. However, if refilling the transmission with synthetic lubricant, use only Mobil SHC 630.

- Some other transmissions may be compatible with the use of synthetic lubricants. For information on BMW-approved synthetic lubricants, contact an authorized BMW service department.

Final Drive Gear Oil

Owing to the demanding requirements of the final drive lubricant, BMW recommends using only a specially formulated gear oil that is available through an authorized BMW dealer parts department. For additional information on this lubricant and any other lubricant that may be compatible, contact an authorized BMW dealer service department.

Brake Fluid

Brake fluid deserves special consideration. It absorbs moisture easily, and moisture in the fluid affects brake performance and reliability. When replacing or adding brake fluid, use only new fluid from previously unopened containers. Do not use brake fluid that has been bled from the system, even if it is brand new.

Engine Coolant
(Anti-freeze)

BMW recommends coolant that is a mixture of water and phosphate-free anti-freeze containing ethylene glycol. Anti-freeze raises the boiling point and lowers the freezing point of the coolant. It also contains additives that help prevent cooling system corrosion.

Power Steering Fluid

The power steering fluid is Dexron® or Dexron II® ATF. The system is permanently filled and does not have a drain. Routinely adding ATF is not required unless the system is leaking.

Gasoline Additive

Many gasolines do not contain the necessary additives to help prevent deposits on the fuel injectors and intake valves. For this reason, BMW recommends the periodic use of BMW Gasoline Additive (BMW Part No. 88 88 6 900 314). The additive is available from an authorized BMW dealer.

CAUTION —

Follow all label directions. Do not use a gasoline additive more than the manufacturer recommends. Fuel additives should not be used in conjunction with high-detergency fuel. Exceeding the recommended amount of fuel additive can lead to oil dilution and possible engine damage.

In extreme cases where clogged injectors and carbon deposits are severe, more comprehensive work may be required to completely solve the problem. For complete information on approved methods on injector cleaning and intake valve decarbonizing, consult an authorized BMW dealer.

Greases

Two different types of grease are used for lubrication of drive train and brake components. Multipurpose grease (lithium grease) has a wider temperature tolerance range than ordinary grease and should be used for most general lubrication purposes, including roller bearings.

Molybdenum grease is lithium grease with a friction-reducing molybdenum disulfide additive. This grease is recommended for certain applications including lubrication of the drive axle joints.

4. Engine Oil Change

The engine oil level is checked with a dipstick located in the engine block behind the alternator. Check the level by pulling out the dipstick and wiping it clean. Reinsert it all the way and withdraw it again. The oil level is correct if it is between the two marks near the end of the stick. The location of the dipstick and the level marks are shown in Fig. 4-1. The upper (**MAX**) mark indicates full, the highest acceptable oil level. The lower mark (**MIN**) indicates the minimum acceptable level.

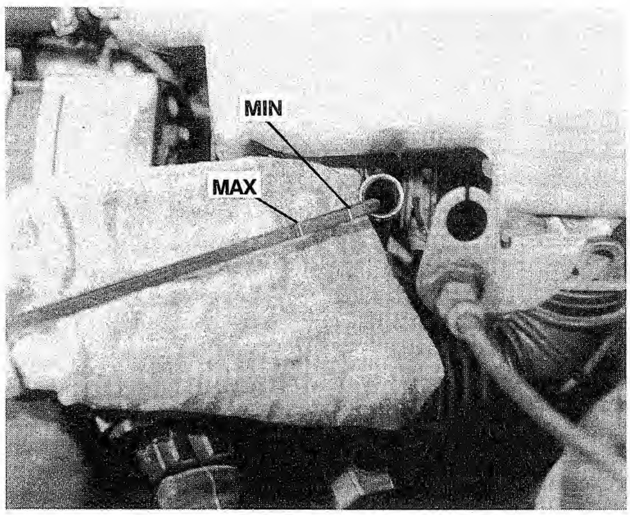


Fig. 4-1. Maximum (**MAX**) and minimum (**MIN**) oil level marks on dipstick.

Always check the oil with the car on a level surface, after the engine has been stopped for at least a few minutes. For the most accurate check, wait a few hours.

Add oil through the filler cap on the top of the cylinder head cover shown in Fig. 4-2. Add only the amount needed to bring the oil level to the **MAX** mark on the dipstick, using an oil of the correct viscosity and grade as described above in **3. Fluid and Lubricant Specifications**. Too much oil can be just as harmful as too little.

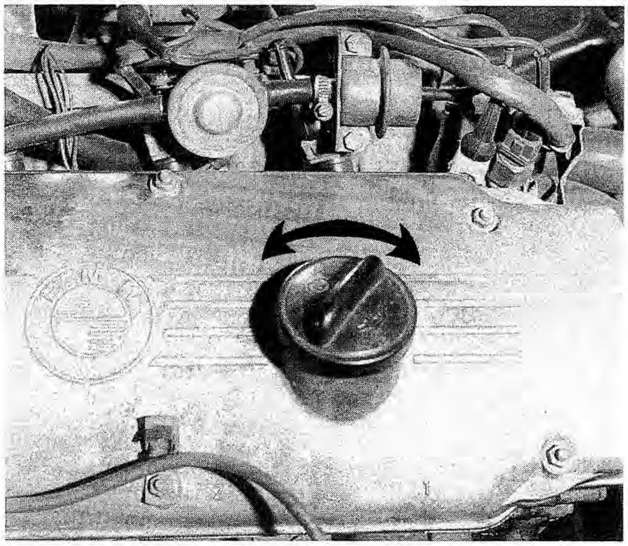


Fig. 4-2. Location of oil filler cap. Remove and install by turning (arrows).

The amount of oil that needs to be added between oil changes varies from one engine to another. Generally, a new engine or an engine operated routinely at high speeds will consume more oil. It is helpful to become familiar with the rate at which a particular engine requires oil. A sudden increase may be an early warning of engine mechanical problems.

4.1 Changing Engine Oil and Filter

The oil service light in the service interval indicator should be the basic guide to scheduling oil changes. Do not rely on the color of the oil on the dipstick to indicate when a change is needed. Because of the detergent additives in the oil, fresh oil can look dark after only a few hundred miles.

The oil service light should come on at or before 7,500 miles. If the car is used primarily for short trips in slow moving traffic, or routinely operated aggressively, the oil service light should come on earlier. In general, changing the oil at more frequent intervals will help better protect the engine and promote longer engine life.

A complete oil change requires approximately 5 qt. of new oil (see **3. Fluid and Lubricant Specifications**), a new oil filter, and a new drain plug sealing washer. Oil filter and sealing washer part numbers are listed in **Table f**. The tools needed—a drain plug socket or box wrench (17 mm), a drain pan of at least 6 US qt. (5.6 L) capacity, and an oil filter wrench—are described in **FUNDAMENTALS**.

Table f. Engine Oil Change Parts

Engine oil filter	
318i	BMW Part No.11 42 1 278 059
325, 325e, 325i	BMW Part No.11 42 1 266 773
Oil pan drain plug sealing washer (all engines)	BMW Part No.01 11 9 963 130

To change oil and filter:

1. Run the car for a few minutes to slightly warm the engine and the oil, then shut the engine off.

2. With the car on level ground, place a drain pan under the oil drain plug shown in Fig. 4-3.

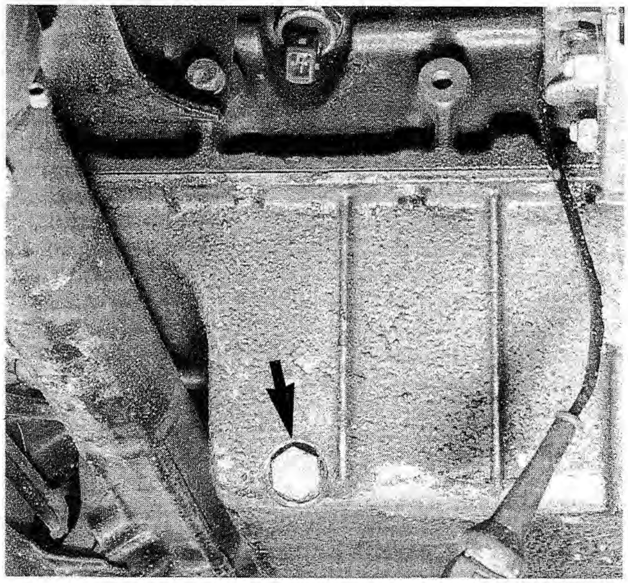


Fig. 4-3. Engine oil drain plug (arrow) in oil pan underneath engine (6-cylinder engine shown). Drain plug on 4-cylinder engine is similar.

NOTE —

The car will not need to be raised if a shallow drain pan is used.

3. Using a socket or box wrench, loosen the drain plug. By hand, remove the plug and let the oil drain into the pan.

CAUTION —

Pull the loose plug away from the hole quickly to avoid being burned by the hot oil. It will run out quickly when the plug is removed.

4. When the oil flow has diminished to an occasional drip, reinstall the drain plug with a new metal sealing washer and torque the plug to 33 + 3 Nm (24 + 2 ft. lb.).

5. Position the drain pan directly under the oil filter. See Fig. 4-4. Using an oil filter wrench, loosen the filter by turning it counterclockwise, then remove it by hand.

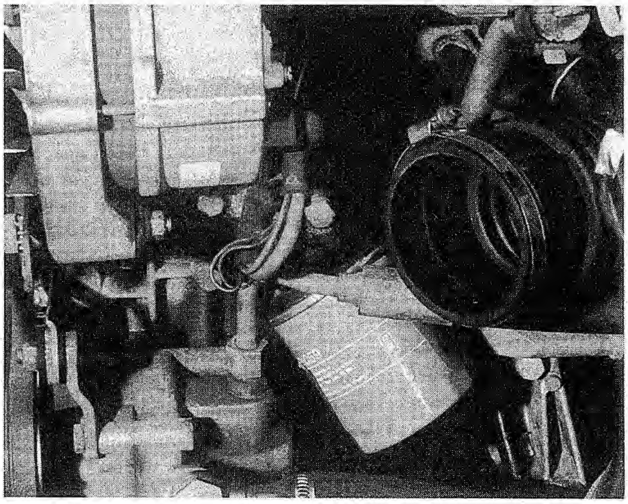


Fig. 4-4. Engine oil filter located in left-hand (driver's) side of engine. Air Filter housing shown removed from car.

6. After the oil stops dripping, wipe clean the oil filter gasket surface on the filter mounting flange. Lubricate the rubber gasket of the new oil filter with a light coating of clean engine oil.

7. Install the filter by hand until the gasket contacts the mounting flange, then turn the filter another 1/2 turn to tighten it.

CAUTION —

Overtightening the oil filter will make the next change much more difficult, and may deform the gasket, causing leaks.

8. Refill the crankcase with oil. Approximate oil capacity is listed in **Table d.** above. Use the dipstick to check for the correct oil level. Oil specifications are found in **3. Fluid and Lubricant Specifications**.

9. Start the engine and check that the oil pressure warning light immediately goes out. Allow the engine to run for a few minutes to circulate the new oil, then check for leaks at the drain plug and around the oil filter. Stop the engine and recheck the oil level.

CAUTION —

If the oil pressure warning light does not immediately go out after the engine is started, quickly turn the engine off. Loosen the oil filter approximately 1/4 turn (90°) and restart the engine. As soon as oil begins to run out of the filter, turn the engine off and tighten the filter. This will release any trapped air that is blocking oil flow.

NOTE —

Dispose of the used oil properly. Use tight-sealing containers and mark them clearly. Check with the place of purchase about disposal.

5. TUNE-UP

A tune-up is regular maintenance of the ignition and fuel systems to compensate for normal wear. Modern BMW electronic ignition and fuel injection systems have eliminated much of the work involved in a tune-up. For the BMWs covered by this manual, only limited tune-up maintenance is necessary to maintain peak performance and economy.

5.1 Air Filter

The specified maintenance intervals for the air filter are based on normal use. If the car is operated primarily in dusty conditions, the air filter should be serviced more frequently. A dirty air filter starves the engine for air, reducing power output and increasing fuel consumption. Fig. 5-1 shows the location of the air filter housing for the engines covered by this manual.

Fig. 5-1. Air filter housing in front left (driver's) side of engine compartment. Loosen nuts and unclip spring clips (arrows) to remove air filter.

2

The upper and lower parts of the air filter housing are fastened together with spring clips around the outside edge. To replace the air filter element, loosen the upper air filter housing mounting nuts and unfasten the clips. See Fig. 5-1 above. Separate the upper air filter housing from the lower housing just enough to remove the filter element. See Fig. 5-2. Take note of the filter's installed position. Wipe the inside of the air filter housing using a lint-free cloth and install the new filter. Reinstall the upper air filter housing, making sure that the two halves are mated correctly. Refasten the spring-clips and tighten the mounting nuts.

CAUTION —

If a used air filter element is to be reinstalled, it is important to reinstall the filter in the same position that it was in before removal. Reversed installation will allow accumulated dirt to be drawn into the engine.

NOTE —

4-cylinder engines and most 6-cylinder engines have 4 spring clips. Some early 6-cylinder engines only have two spring clips.

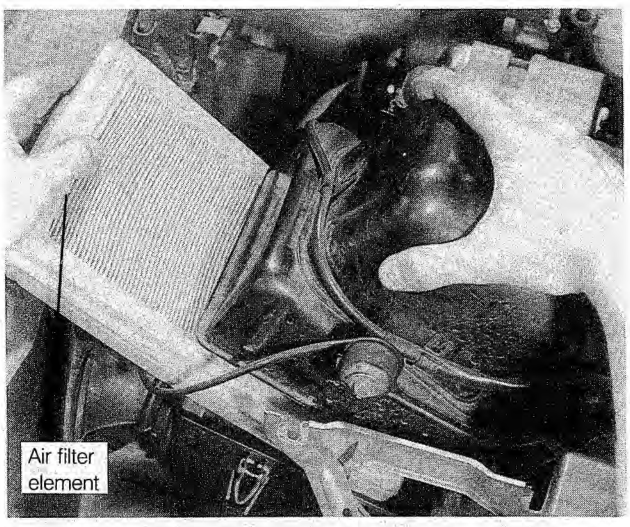


Fig. 5-2. Air filter being removed from air filter housing. Air filter housing will vary slightly between models.

5.2 Spark Plugs

High temperature and high-voltage sparks eventually wear out the spark plug electrodes, and the spark plugs must be replaced. To replace a spark plug, gently remove the spark plug wire by pulling on the protective boot, and blow or brush away any dirt from around the base of the plug to prevent it from entering the engine when the plug is removed.

CAUTION —

Spark plugs should be replaced one at a time so that the spark plug wires do not get mixed up. If all of the wires need to be removed together, label each wire so that they can be reinstalled on the correct spark plug.

Use a 13/16 in. spark plug socket to remove spark plugs. The correct spark plugs for the different engines covered by this manual are listed in **Table g**. Use a spark plug gap gauge to check the gap. If necessary, bend the outer electrode slightly to adjust the gap to meet the specification. Do not bend or file the center electrode.

Table g. Spark Plug Specifications

Model	Spark plug Bosch	Beru	Electrode gap
318i	WR9DS	RS 33	0.8 ± 0.1 mm (.032 ± .004 in.)
1984–1987 325, 325e, 325es	WR9LS	14 R/9 LS	0.7 ± 0.1 mm (.027 ± .004 in.)
325i, 325is, 1988–1990 325	W8LCR	—	0.7 ± 0.1 mm (.027 ± .004 in.)

Lightly lubricate the new spark plug threads with a little oil or grease. Thread the plugs into the cylinder head by hand to prevent cross-threading. Torque the spark plugs to 20 to 30 Nm (15 to 22 ft. lb.). Inspect the old plugs, as the condition of the spark plug is a good indicator of combustion quality that can help diagnose engine faults. Fig. 5-3 shows some examples of spark plug condition and what they mean.

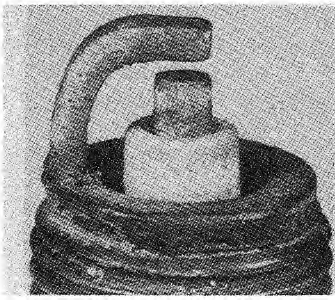
NOTE —

Any of the abnormal spark plug conditions described below could also result from spark plugs of the wrong specification being installed. Check replacement plugs carefully and follow the spark plug manufacturer's recommendations.

Lightly-fouled spark plugs can be cleaned with a light wire brush. Remove all debris from around the electrode. Do not chip the ceramic insulator. Badly fouled spark plugs should be replaced and the cause of the fouling should be investigated and corrected.

5.3 Distributor Cap, Rotor, and Spark Plug Wires

The distributor cap, the rotor, and the spark plug wires deliver a high-voltage spark to the spark plugs. They are subject to insulation breakdown, corrosion fouling, and electrode wear and damage. The components should be check and replaced as necessary at the intervals listed under **2. Maintenance Tables** to ensure maximum ignition system efficiency. Guidelines for visual inspection and testing, and instructions for replacement are found in **IGNITION**.

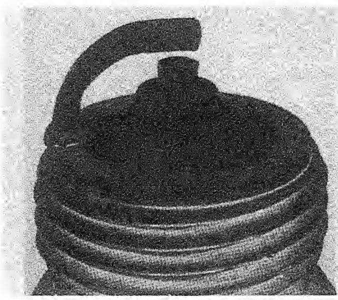


Normal

Normal spark plug has gray or light tan color that indicates proper combustion

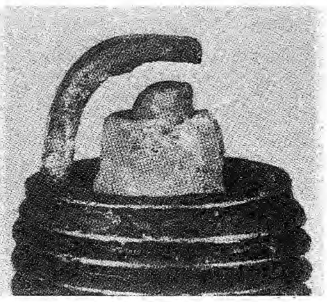
Oil-fouled

Oil-fouled spark plug has wet, oily black deposits caused by excess engine oil getting into combustion chamber, probably due to worn piston rings or valve guide oil seals.



Carbon-fouled

Carbon-fouled spark plug has dry, sooty black deposits caused by too much fuel that may indicate fuel injection or ignition problems.



Worn out

Worn out spark plug may have correct gray or light tan color, but shows physical deterioration (enlarged gasp. eroded electrodes).

Fig. 5-3. Spark plug appearance that may indicate engine condition. For more information on interpreting spark plug condition, see **ENGINE**. Photos courtesy of Champion Spark Plug Co.

Firing Order

Each spark plug wire leads from a specific terminal on the distributor cap to a specific spark plug. This order is known as the ignition firing order. When removing the wires, label their positions so that they can be reinstalled in the proper places. If the wires get mixed up, see **IGNITION SYSTEM** for more information.

5.4 Main Fuel Filter

Because of varying quality of available gasoline, the fuel filter may become clogged enough to restrict fuel flow. To prevent any such problems, and to guarantee continued good performance, the filter should be replaced at the specified interval. The main fuel filter is located beneath the left rear of the car, just in front of the gas tank.

When replacing the fuel filter, disconnect the battery negative (–) cable and clamp the filter inlet and outlet hoses to lessen fuel spillage. Loosen the center mounting bracket and the two hose clamps on either end of the filter. See Fig. 5-4. Note the arrow indicating direction of flow on the new filter. Install the filter and use new hose clamps.

WARNING —

Fuel will be expelled when the filter is removed. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.

CAUTION —

Clean thoroughly around the filter connections before removing them, and make sure that no dirt gets into the fuel lines.

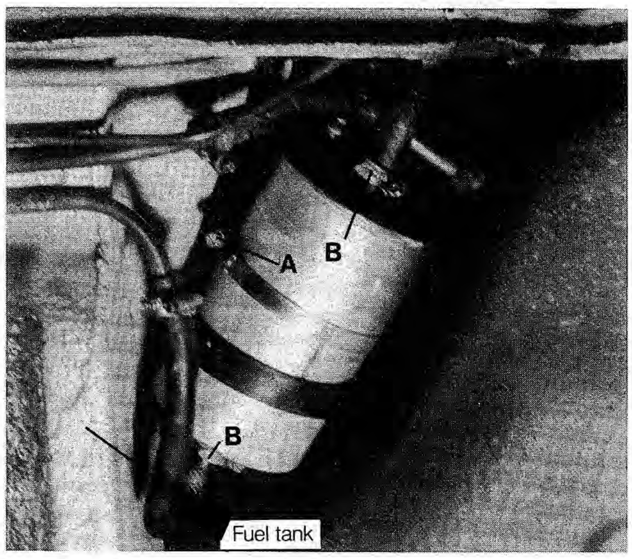


Fig. 5-4. Main fuel filter beneath car near left rear wheel. Direction of flow is indicated by arrow on filter housing. Loosen clamping bracket at filter center (**A**) and two hose clamps (**B**).

5.5 Idle Speed

Engine idle speed can change due to a number of factors, including normal wear of engine and fuel injection components. On most of the models covered in this manual, a check of idle speed simply confirms that the electronic idle speed stabilization system is functioning correctly. See **FUEL SYSTEM** for detailed information on checking engine idle speed.

5.6 Valve Adjustment

All of the engines covered by this manual may require periodic valve clearance adjustment. The complete valve adjustment procedure is covered in **ENGINE**.

6. Engine Compartment Maintenance

The information under this heading describes the routine maintenance—other than oil change and tune-up—that is done in the engine compartment. It is not necessary that the car be raised and supported off the ground. For information on oil change and tune-up, see **4. Engine Oil Change** and **5. Tune-up**.

6.1 Battery

Simple maintenance of the battery and its terminal connections will ensure maximum starting performance, especially in winter when colder temperatures reduce battery power. For a more detailed discussion of the battery and charging system, see **ELECTRICAL SYSTEM**.

Checking and Cleaning Battery

Battery cable clamps should be tight. The terminals, the cable clamps, and the battery case should be clean and free of the white deposits that indicate corrosion and acid salts. Even a thin layer of dust containing conductive acid salts can cause the battery to discharge.

To remove battery corrosion, begin by disconnecting the cables. Disconnect the negative (−) cable first. On 6-cylinder models with the battery mounted in the trunk, remove the battery from the car. Clean the terminal posts and the cable clamps with a wire brush. Corrosion can be washed away with a baking soda and water solution that will neutralize the acid. Apply the solution carefully, though, since it will also neutralize the acid inside the battery. Avoid getting the solution into the battery cells through vent holes. Reconnect the cable clamps, positive (+) cable first. Lightly coat the outsides of the terminals and clamps with petroleum jelly, grease, or a commercial battery terminal corrosion inhibitor.

> ***WARNING —***
> *Battery acid is extremely dangerous. Take care to keep it from contacting eyes, skin, or clothing. Wear eye protection. Extinguish all smoking materials and do not work near any open flames.*

> ***CAUTION —***
> - *Disconnecting the battery cables with the engine running, or reconnecting the cables to the incorrect posts will damage the electrical system.*
> - *BMW Anti-theft radios can be rendered useless by disconnecting battery cables. See your owner's manual for more information.*

Battery electrolyte should be maintained at the correct level just above the battery plates and their separators. The correct level is approximately 5 mm (1/4 in.) above the top of battery plates or to the top of the indicator marks (if applicable). The battery plates and the indicator marks can be seen once the filler caps are removed. If the electrolyte level is low, replenish it by adding distilled water only.

The filler caps are removed by screwing them off. For additional information on batteries, see **ELECTRICAL SYSTEM**.

Replacing Battery

Batteries are rated by ampere hours (Ah), the number of hours they can sustain a specific current drain before complete discharge, or by cold cranking amps (CCA), the number of amps they produce to crank the engine in cold weather conditions. They may be rated according to European (DIN) standards, by Society of Automotive Engineers (SAE) standards, or both. In general, replacement batteries should always be rated equal or higher than the original battery.

The battery is held in place by a single hold-down bolt and plate. A secure battery hold-down is important in order to prevent vibrations and road shock from damaging the plates.

> **NOTE —**
> - Always disconnect the negative (−) cable first, and connect it last. While changing batteries, clean away any corrosion in or around the battery tray using a baking soda and water solution.
> - On trunk-mounted batteries, a degassing tank for collecting overflowing battery acid is located beneath the battery tray. The tank does not require any maintenance. If the tank is damaged, it should be replaced immediately, as battery acid is highly corrosive.

Charging Battery

A discharged battery is not necessarily faulty. It may be restored by recharging, using a battery charger. There are some limitations on the rate at which low-maintenance batteries may be charged. Frozen batteries should be recharged only after they have thawed. For complete information on battery charging and applicable cautions and warnings, see **ELECTRICAL SYSTEM**.

> ***CAUTION —***
> *Do not jump start the car without first removing the fuses for the on-board computer. If the fuses are not removed, the internal fuse in the on-board computer module may blow due to excessive voltage. See* **ELECTRICAL SYSTEM** *or* **FUNDAMENTALS** *for more information.*

6.2 Accelerator and Throttle Linkage

The accelerator and throttle linkage should be lubricated at the intervals described under **2. Maintenance Tables.** Use a general purpose oil on the joints and bearings of the linkage. Use a multipurpose grease on the bearing points of the throttle plate.

6.3 V-Belts

V-belts and pulleys transfer power from the engine crankshaft to various accessories. Cars covered by this manual have at least one V-belt, and may have as many as three, depending on the accessories installed.

Inspecting and Adjusting V-Belts

Incorrect V-belt tension can decrease the life of the belt and the component it drives. Inspect belts with the engine off. Twist the belt to inspect its sidewalls and bottom. Belt structural damage, glazed or shiny sidewalls caused by a loose belt, or separation caused by oil contamination are all reasons to replace a belt. Some of these faults are illustrated in Fig. 6-1.

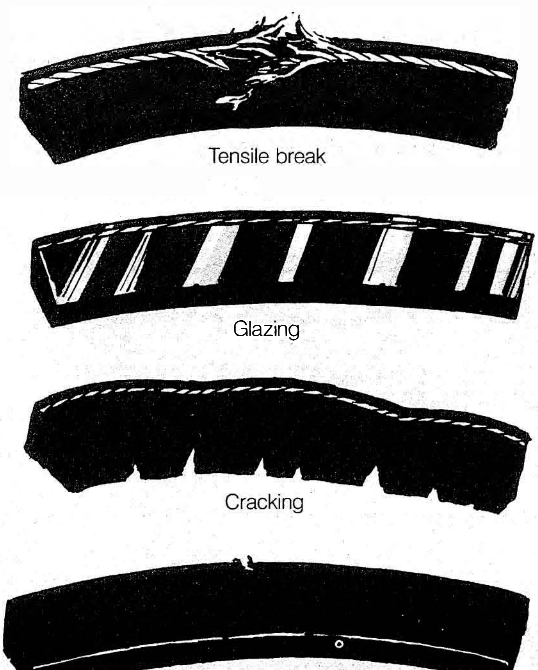


Fig. 6-1. Examples of belt failure.

V-belt squealing is normally caused by incorrect belt tension (too loose) or by contamination between the belt and pulley. Extremely loud squealing may only be corrected by replacing the belt. Belt dressings should not be used to correct the problem. Many dressings contain oil-based compounds that can soften the rubber and reduce belt life.

The drive belt tension for the alternator and the power steering pump is adjusted through a toothed-rack mechanism. To accurately tension the drive belt for the air conditioning compressor, a special drive belt tensioning tool should be used.

Adjust the alternator or the power steering belt by first loosening all of the mounting nuts until the unit is able to move freely. Using a torque wrench and a crowfoot wrench, turn the tensioning gear bolt until the torque wrench reads 7 Nm (62 in. lb.) for the alternator or 8 to 8.5 Nm (71 to 76 in. lb.) for the power steering pump. See Fig. 6-2. Hold the wrench steady and tighten the nut on the rear of the tensioning gear bolt. Tighten all other mounting nuts.

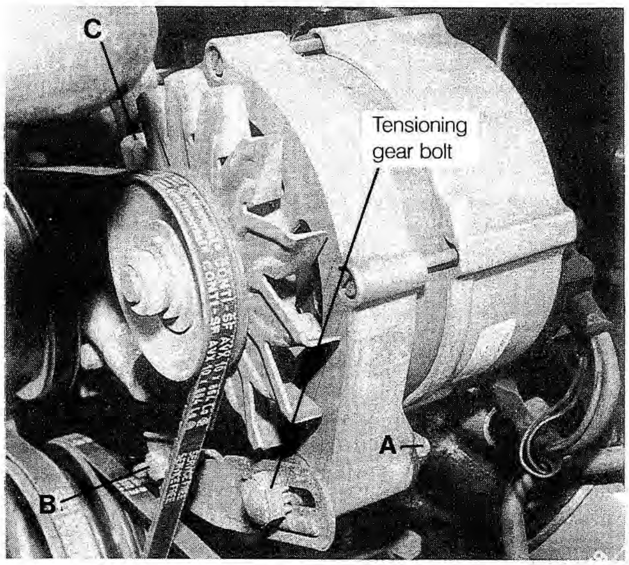


Fig. 6-2. Alternator mounting bolts (**A** and **B**), and pivot bolt (**C**). Four-cylinder engine shown. Six-cylinder engine similar.

The air conditioning compressor V-belt is adjusted one of two ways. On 4-cylinder engines, four bolts on the top of the compressor mounting bracket adjust the position of the compressor. On 6-cylinder engines, a toothed-rack adjusting mechanism similar to that for the power steering pump and alternator is used. In general, the air conditioning compressor drive belt can be adjusted by loosening the compressor's mounting bolts and pivoting the compressor. Check the belt tension using a V-belt tension gauge.

NOTE

When using a belt tension gauge on V-rib type belts, make sure the gauge's pulling hook is on the tip of a V-rib and not between ribs. Otherwise, inaccurate readings may result.

2

Replacing V-Belts

To reduce the chance of V-belt failure while driving, replacement of the belts every four years is recommended. Loosen the mounting bolts and adjust until the belt tension is very loose, then remove the belt by slipping it over the pulleys. In some cases it may be necessary to remove one V-belt to replace another. Cross section and length determine belt size. Use the old belt for comparison, or make sure that the new belt fits into the pulley groove as shown in Fig. 6-3.

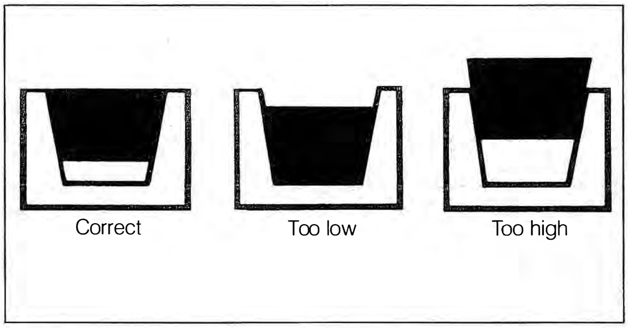


Fig. 6-3. Cross-section of correct V-belt position in pulley.

With the belt off, clean the pulleys using a suitable solvent. Inspect the pulleys for wear or damage that may cause early failure of the new belt. A straight edge on either side of pulley is good way to check for wear. See Fig. 6-4. This is also a good opportunity to inspect the belt-driven accessory, checking for bearing wear and excess play, for example. When installing the new belt, gently pry it over the pulleys. Too much force may damage the belt or the accessory. Tension the belt(s), run the engine for a few minutes (at least 1500 rpm), then recheck the belt tension.

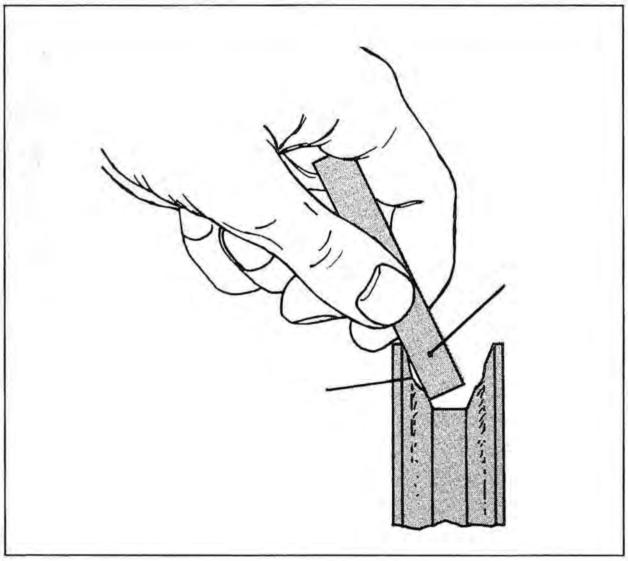


Fig. 6-4. V-belt pulley being checked for wear using a straight edge. A worn pulley may be the cause of a noisy belt, especially if the belt is new.

6.4 Cooling System

Cooling system maintenance consists of maintaining the coolant level and inspecting the hoses. Because the coolant's anti-corrosion and anti-freeze additives gradually lose their effectiveness, replacement of the coolant every 2 years is recommended. As a preventive measure, replacement of the cooling system hoses every 4 years is also recommended.

> ***CAUTION —***
> *Use only BMW-approved phosphate-free anti-freeze when filling the cooling system. Use of anti-freeze containing phosphates is considered to be harmful to the cooling system and may void warranty coverage.*

Checking Coolant Level

On 4-cylinder engines, the coolant level is checked by removing the radiator cap. On 6-cylinder engines, a translucent expansion tank, or overflow reservoir, provides easy monitoring of coolant level. Because the expansion tank is translucent, the coolant level can be checked visually without opening the system.

Always check the coolant level with the engine cold. On 4-cylinder engines, the coolant level should be approximately 20 mm (¾ in.) below the top of the radiator. On 6-cylinder engines, the coolant level should be at the maximum mark on the expansion tank, as shown in Fig. 6-5.

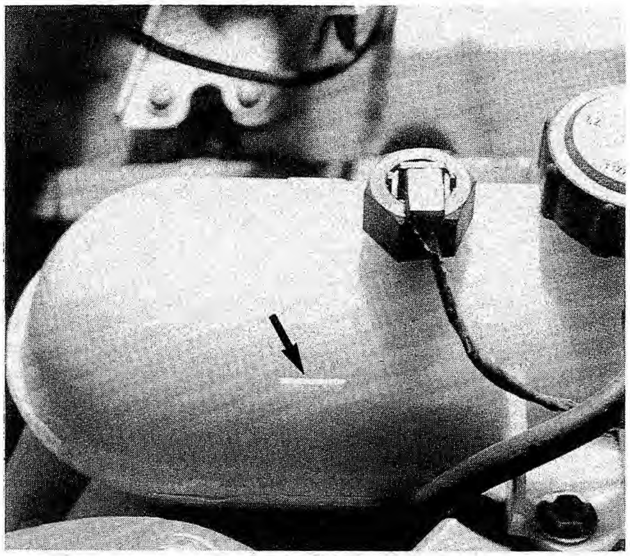


Fig. 6-5. Fill mark on coolant expansion tank on 1984 through 1987 6-cylinder engine (arrow). Expansion tank on 1988 and later models is slightly different. Coolant level should be at mark when engine is cold.

Inspecting Hoses

Connections should be tight and dry. Coolant seepage indicates either that the hose clamp is loose, that the hose is damaged, or that the connection is dirty or corroded. Hoses should be firm and springy. Replace any hose that is cracked, that has become soft and limp, or has been contaminated by oil. See Fig. 6-6.

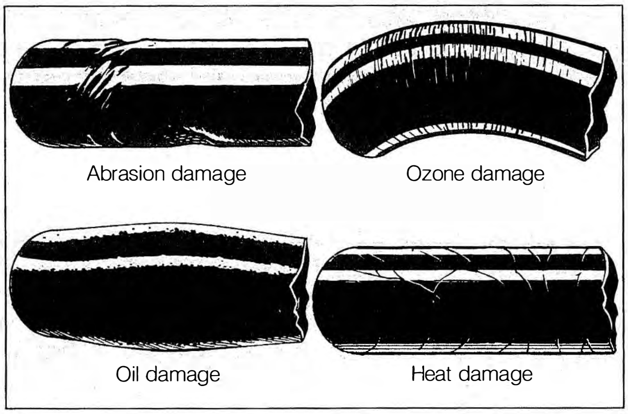


Fig. 6-6. Examples of damage to coolant hoses. Any of conditions shown is cause for replacement.

6.5 Power Steering

Check the power steering fluid level in the fluid reservoir, just to the right of the battery. See Fig. 6-7. Park the car on level ground and start the engine. The fluid level is correct if it is between the **MAX** and **MIN** marks on the reservoir. If the level is below the **MIN** mark, start the engine and add fluid to the reservoir to bring the level up. Hand-tighten the reservoir cap.

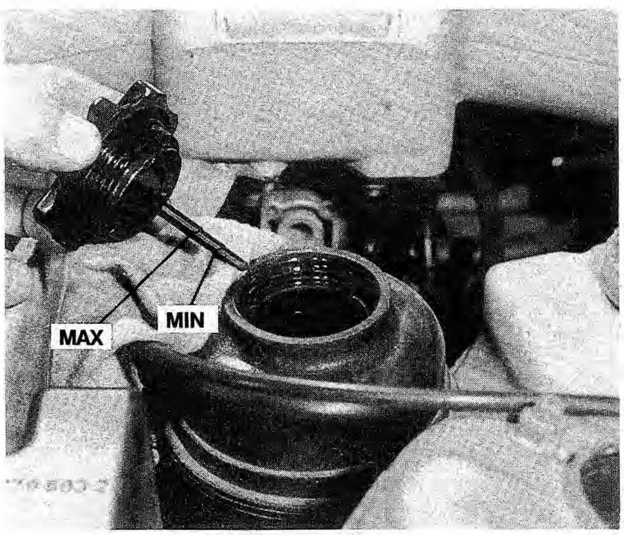


Fig. 6-7. Power steering fluid dipstick showing **MIN** and **MAX** marks.

NOTE —

If fluid is added to the correct level with the engine running and then rechecked after the engine is stopped, the level may be slightly above the **MAX** mark. This condition is normal.

6.6 Oxygen Sensor

The oxygen sensor monitors engine combustion efficiency by measuring the oxygen content of the exhaust gasses. That information in turn is used to control the fuel injection system and reduce exhaust emissions. Any problems with the oxygen sensor will directly affect exhaust emissions and the way the engine runs.

Replacement of the oxygen sensor at the specified interval ensures that the engine and emission control system will continue to operate as designed. Extending the replacement interval may void the emission control warranty coverage.

On 1984 318i models, the sensor is mounted in the exhaust manifold and is accessible from inside the engine compartment. See Fig. 6-8. On 1984 though 1987 325, 325e, and 325es models the sensor is mounted beneath the car at the inlet to the catalytic converter. On 1985 318i models, 1988 325, and all 325i models, the sensor is mounted in the front exhaust pipe. See **EXHAUST SYSTEM AND EMISSION CONTROLS** for more information on the oxygen sensor system.

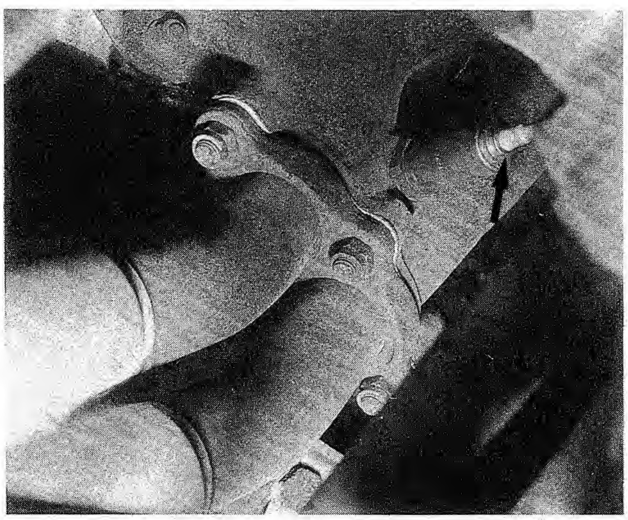


Fig. 6-8. Oxygen sensor mounted in exhaust manifold (arrow) on 1984 318i model as viewed from beneath car. Location of sensor varies between models.

2

Replacing Oxygen Sensor

The sensor is threaded into place. Trace the sensor wiring back from the sensor and disconnect the electrical connector. When installing a new sensor, apply a light coat of anti-seize compound to the sensor threads. Torque the sensor to 55 ± 5 Nm (41 ± 3 ft. lb.) and reconnect the wiring.

CAUTION —

Do not get any anti-seize compound on the sensor tip or in the sensor slits. The anti-seize compound will quickly foul the sensor element and render the sensor inoperative.

NOTE —

Special sockets for replacing the oxygen sensor are available from most automotive parts stores. The socket has a groove cut down one side to allow the sensor to be installed without damaging the wire harness.

Removing OXS Warning Light

(1984 318i models only)

On 1984 318i models with a 30,000 mile (48,000 km) oxygen sensor, a warning light on the instrument panel will illuminate once this mileage is reached to indicate that the sensor needs replacing. The light is designed to come on only once. After that time, the bulb terminals should be disconnected or the bulb itself should be removed.

To disconnect the bulb, remove the mounting screw on the right side of the warning light housing and remove the housing. Bend the bulb back and forth until the bulb is separated from the housing. Reinstall the housing. See Fig. 6-9.

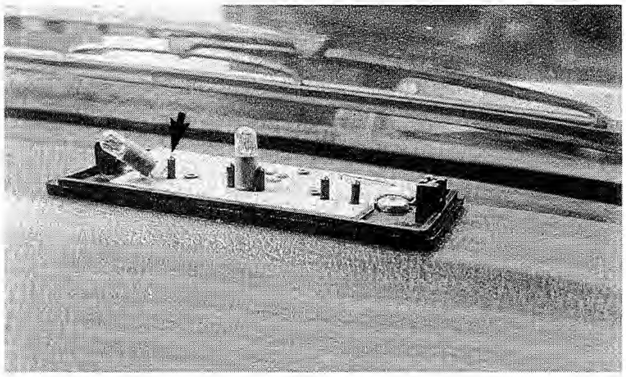


Fig. 6-9. Disconnected bulb terminal (arrow) of oxygen sensor warning light.

7. UNDER-CAR MAINTENANCE

7.1 Tires and Wheels

For stability and car control, the wheels and tires must be of the correct size and in good condition. Tires must be inflated to the recommended air pressures and the wheels must be in proper alignment. For maximum safety and best all-around handling, always install replacement radial tires having the same specifications. When possible, all four tires should be replaced at once, or at least in pairs on the front or rear. New tires do not provide maximum traction, and should be broken in gently for the first 100 miles (160 kilometers) or so.

Tire Inflation Pressure

Correct tire inflation pressures are important to handling and stability, fuel economy, and tire wear. Tire pressures change with temperature. Pressures should be checked often during seasonal temperature changes. The correct inflation pressures for cars covered by this manual are listed in **Table h**. Notice that the pressures should be higher when the car is more heavily loaded.

All inflation pressures are for cold inflation. That is, when the car has not been driven for at least three hours, or for more than one mile after sitting for at least three hours.

WARNING —

Do not inflate any tire to a higher pressure than the tire's maximum inflation pressure listed on the sidewall. Use care when adding air to warm tires. Warm tire pressures can increase as much as 4 psi (0.3 bar) over their cold pressures.

Tire Rotation

BMW does not recommend tire rotation. Owing to the car's suspension design, the front tires begin to wear first at the outer shoulder and the rear tires begin to wear first at the middle of the tread or inner shoulder. Rotating the tires may adversely affect road handling and tire grip.

NOTE —

The main purpose of tire rotation is to promote even wear and maximum tire life. Tire life may be decreased slightly if the tires are not rotated.

Wheel Alignment

BMW recommends checking the front and rear alignment once a year and whenever new tires are installed. See **SUSPENSION AND STEERING** for a more detailed discussion of alignment requirements and specifications.

Table h. Recommended Wheel and Tire Specifications

Model	Wheels	Tires	Tires pressures psi, cold			
			Max. 4 persons (2 persons for convertible)		Heavier load (4 persons max. for convertible)	
			front	rear	front	rear
318i	5 ½J x 14 H2	175/70 HR 14 82H	26	29	29	35
		175/70 SR 14 82Q M+S				
		195/60 HR 14 85H				
		195/60 SR 14 85Q M+S				
	6J x 14 H2	195/60 HR 14 85H	26	29	29	35
		195/60 SR 14 85Q M+S				
325, 325e(es) (1984–1988)	5 ½J x 14 H2 6J x 14 H2	195/60 HR 14 85H	31	32	32	36
		195/60 SR 14 85Q M+S	31	31	31	36
		195/65 HR 14 89H				
		195/65 SR 14 89Q M+S				
		195/65 R 89Q M+S	29	32	31	36
		195/65 R 14 89H				
	6 ½J x H2	195/65 R 14 89Q M+S	29	32	31	36
		195/65 R 14 89H				
	150 TD 365	200/60 SR 365 88Q M+S TD	31	31	31	36
		200/60 HR 365 88H TD				
325i(is, iC) 1987–1988	5 ½J x 14 H2 6J x 14 H2 6 ½J x 14 H2	195/65 VR 14	32	32	33	41
		195/65 R 14 89Q M+S	32	32	33	36
325i(is, iC) 1989–1990	5 ½J x 14 H2 6J x 14 H2 6 ½J x 14 H2	195/65 VR 14 195/65 R 14 89Q M+S	29	32	32	41

7.2 Brakes

Routine maintenance of the brake system includes maintaining an adequate level of brake fluid in the reservoir, checking brake pads and brake shoes for wear, and inspecting the system for fluid leaks or other damage.

WARNING —

- *Friction materials such as brake linings may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing asbestos fibers and asbestos dust, as it may result in serious diseases such as asbestosis and cancer, or in death.*

- *Brake fluid is poisonous. Do not siphon brake fluid by mouth. Wear gloves when working with brake fluid to prevent contamination of cuts.*

Checking Brake Fluid Level

The level of the brake fluid will drop slightly as the brakes wear. Check the fluid level at the brake fluid reservoir, located to the left of the coolant reservoir. See Fig. 7-1. When filling the reservoir, use only new brake fluid from previously unopened containers. See **3. Fluid and Lubricant Specifications** for brake fluid specifications.

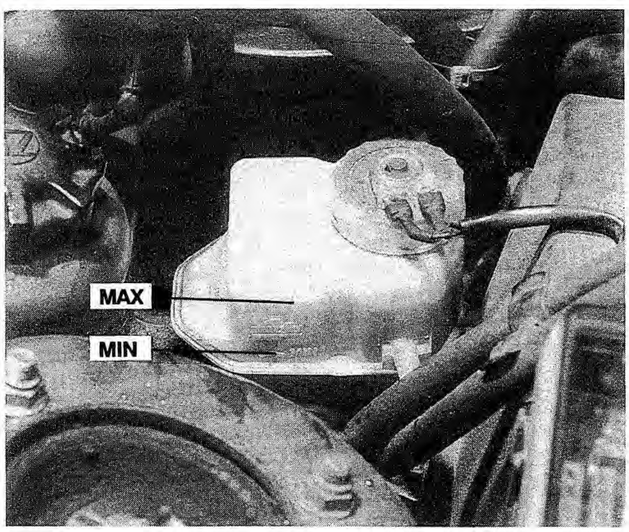


Fig. 7-1. Level indicators on brake fluid reservoir. Correct level is between **MIN** and **MAX** marks.

Inspecting Brake Hoses and Lines

Gently bend the hoses to check for cracks. Check that all hoses are correctly routed to avoid chafing or kinking. Inspect the unions and the brake calipers for signs of fluid leaks. Inspect the lines for corrosion, dents, or other damage. Replace faulty hoses or lines as described in **BRAKES**.

WARNING —

Incorrect installation or overtightening hoses, lines, and unions may cause chafing or leakage. This can lead to partial or complete brake system failure.

Checking Disc Brake Pad Wear

Although the cars covered by this manual are equipped with a brake pad warning system, the system only monitors one wheel per axle. There can be slight variations in brake pad wear at each wheel, so brake pad thickness should be checked whenever the wheels are off or brake work is being done.

Brake pad thickness can be inspected by looking through a hole in the caliper after removing the wheel. See Fig. 7-2. **Table i** lists minimum brake pad thickness.

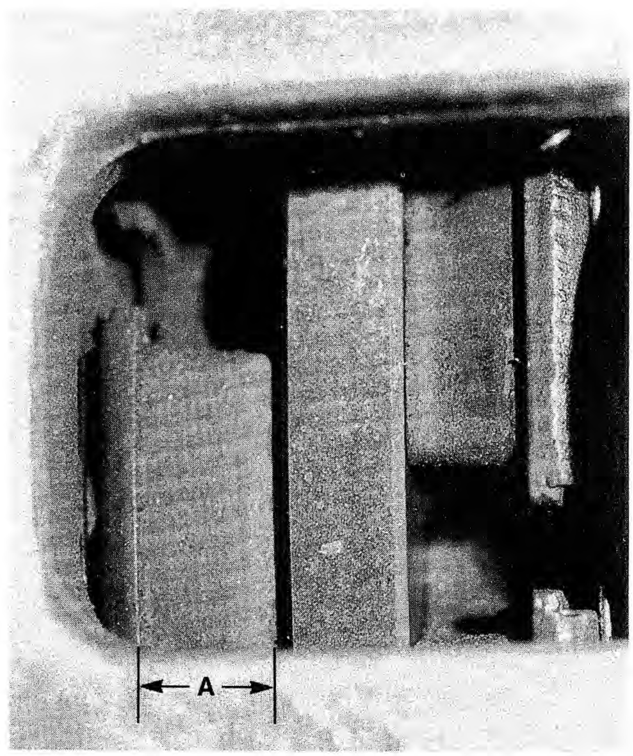


Fig. 7-2. Disc brake pad wear being checked through opening in caliper. Minimum brake pad thickness shown by dimension **A**.

Table i. Brake Pad and Lining Minimum Thickness (not including brake pad backing plate or brake shoe)

Front disc brake pads	2.0 mm (0.08 in.)
Rear disc brake pads	2.0 mm (0.08 in.)
Rear drum brake linings	1.5 mm (0.06 in.)

Checking Rear Drum Brake Lining Wear
(318i models)

On 318i models, the brake pad warning system does not monitor the rear drum brake linings. Rear brake linings can be inspected after the wheel and brake drum are removed as described in **BRAKES.** See Fig. 7-3. Minimum thickness specifications are listed in **Table i** above.

NOTE —
For parking brake lining wear, see **Parking Brake** below.

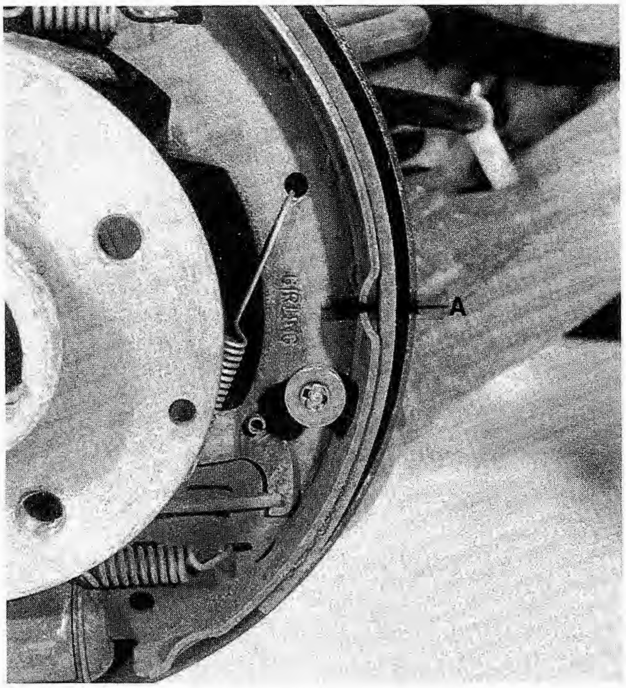


Fig. 7-3. Rear brake lining thickness being checked after brake drum is removed. Dimension **A** shows minimum brake lining thickness.

Replacing Brake Fluid

BMW strictly recommends replacing the brake fluid every year. Doing this will help protect against corrosion and the effects of moisture in the fluid. The procedure is described in detail in **BRAKES**.

2

Parking Brake

On models with 4-cylinder engine, adjusting the parking brake is normally not necessary owing to the self-adjusting rear brakes. On models with 6-cylinder engine, the parking brake system is independent of the main braking system and may require periodic adjustment depending on use. Adjust the parking brake if the brake lever can be pulled up more than 8 clicks on the ratchet mechanism. Check that the cable moves freely in its housing. A complete description of the parking brake and parking brake adjustment are described in **BRAKES.**

NOTE —
On models with 6-cylinder engine, the parking brake may loose some of its effectiveness over time if it is not used frequently. This is due to corrosion build-up on the brake drum. To remove corrosion and restore the brake to normal, apply the brake just until it begins to grip, then pull the lever up one more stop (click). Drive the car approximately 400 meters (1,300 ft.) and release the brake. Recheck the adjustment of the parking brake as described **BRAKES.**

7.3 Exhaust System

Exhaust system life varies widely according to driving habits and environmental conditions. If short-distance driving predominates, the moisture and condensation in the system will not fully dry out. This will lead to early corrosion damage and more frequent replacement.

Scheduled maintenance of the exhaust system is limited to inspection. Check for restrictions due to dents or kinks. Check for weakness or perforation due to rust. Check to see that all the hangers are in place and properly supporting the system and that the system does not strike the body. Alignment of the system and the location of the hangers are described in **EXHAUST SYSTEM AND EMISSION CONTROLS**.

7.4 Manual Transmission Service

Manual transmission service consists of inspecting for leaks, checking and changing the gear oil, and checking the clutch disc for wear.

Evidence of transmission leaks is most likely to be seen around the drive shaft mounting flange and at the bottom of the bellhousing, between the transmission and the engine. For more information on identifying oil leaks and their causes, see **MANUAL TRANSMISSION**.

Checking and Filling Manual Transmission Oil

BMW recommends checking the manual transmission oil level at every first inspection interval and changing the oil at every second inspection interval. Check and fill the transmission with the car on a level surface.

To check the oil level, remove the filler plug on the side of the transmission and carefully insert a finger into the hole. See Fig. 7-4. The oil level should be just flush with the bottom edge of the filler plug threads. In other words, if more oil is added, it would run out of the filler hole.

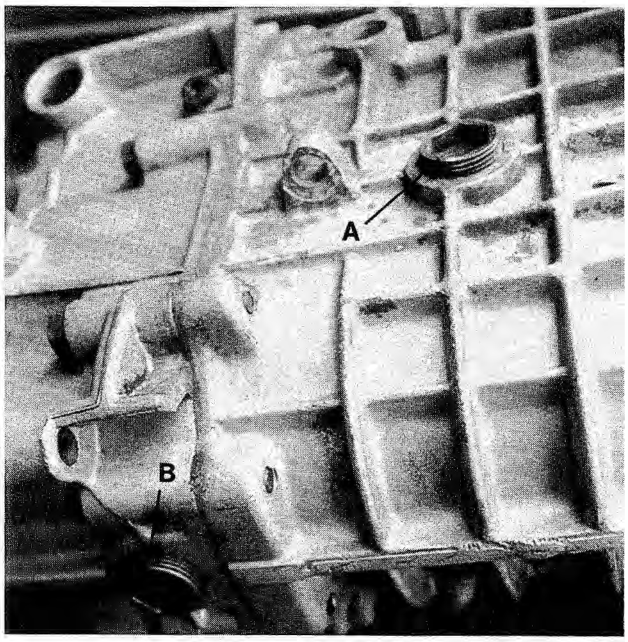


Fig. 7-4. Remove oil filler plug (**A**) to check transmission lubricant level. Remove oil drain plug (**B**) to replace lubricant. Use 17 mm hex wrench to remove plugs.

When changing the oil, drive the car for few miles to warm up transmission oil. Place a drain pan under the oil drain plug on the bottom of the transmission. Remove both the filler plug and the drain plug. Reinstall and torque the drain plug to 40 to 60 Nm (29 to 43 ft. lb.) when the oil is completely drained. Add oil through the filler until it begins to run out of the hole. When no more oil can be added, reinstall and torque the oil filler plug to 40 to 60 Nm (29 to 43 ft. lb.).

NOTE —

On 1984 318i models with ZF transmissions, the fill and drain plugs may be seized due to electrolytic corrosion. The affected plugs are coated with a yellow chromate sealer. If these yellow-colored plugs are installed, they should be replaced with black phosphated plugs (BMW Part No. 23 11 9 057). This procedure should be covered under special warranty. Check with an authorized BMW dealer for more information.

Checking Clutch Disc Wear

The clutch disc can be checked for wear using a special tool (BMW tool no. 21 2 060). Insert the tool in the opening between the transmission bellhousing and the clutch slave cylinder so that the tool touches the slave-cylinder pushrod. See Fig. 7-5. The slave cylinder is mounted to the driver's side of the transmission. If the tool stop (stepped portion) is more than 5 mm (0.2 in.) away from the slave cylinder, the clutch disc is worn and should be replaced. See **MANUAL TRANSMISSION.**

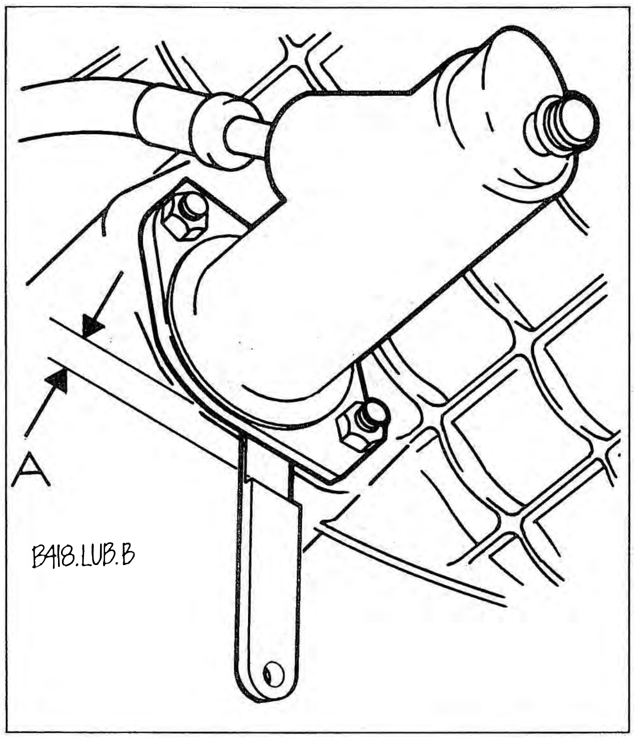


Fig. 7-5. Clutch disc being checked for wear using special tool. If gap of more than 5 mm (0.2 in.) exists (dimension **A**), the clutch disc is excessively worn and should be replaced.

7.5 Automatic Transmission Service

Smooth and efficient operation of the automatic transmission relies on the automatic transmission fluid (ATF). Many automatic transmission problems can be traced to an incorrect fluid level, a clogged ATF strainer, or contaminated fluid. With regular preventative maintenance, expensive and unnecessary automatic transmission repair may be avoided.

Before checking the ATF level, inspect for leaks. ATF leaks are most likely to be seen around the ATF oil sump gasket and at the bottom of the bellhousing, where the transmission joins the engine. All leaks should be corrected to avoid costly repairs. If necessary, replace a leaky ATF oil sump gasket as described below. For more information, see **AUTOMATIC TRANSMISSION**.

CAUTION —
Extreme cleanliness is important when working on the automatic transmission. Use lint-free rags to check the level, and use a clean funnel when adding fluid.

Checking and Filling ATF

The location of the dipstick for checking the ATF is shown in Fig. 7-6. Two dipsticks are installed on cars covered by this manual, a short and a long version. See Fig. 7-7. Models produced before February 1985 are equipped with the short dipstick. All models produced after this date are equipped with the longer dipstick. The longer dipstick (BMW Part No. 24 11 1 207 767) can be fitted retroactively to all earlier models to ensure more accurate fluid checks.

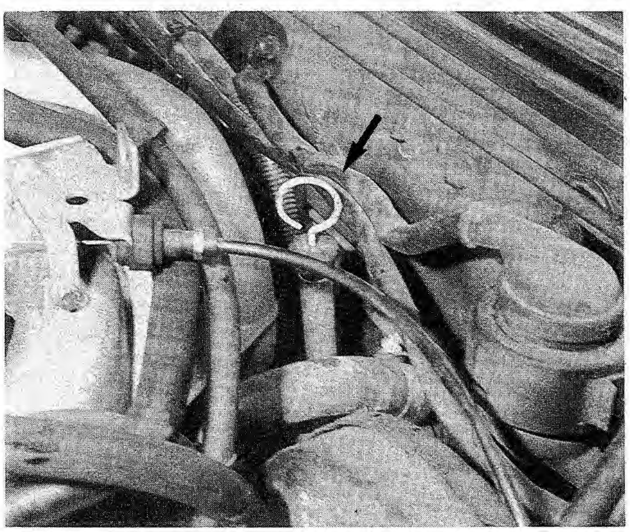


Fig. 7-6. ATF dipstick location (arrow).

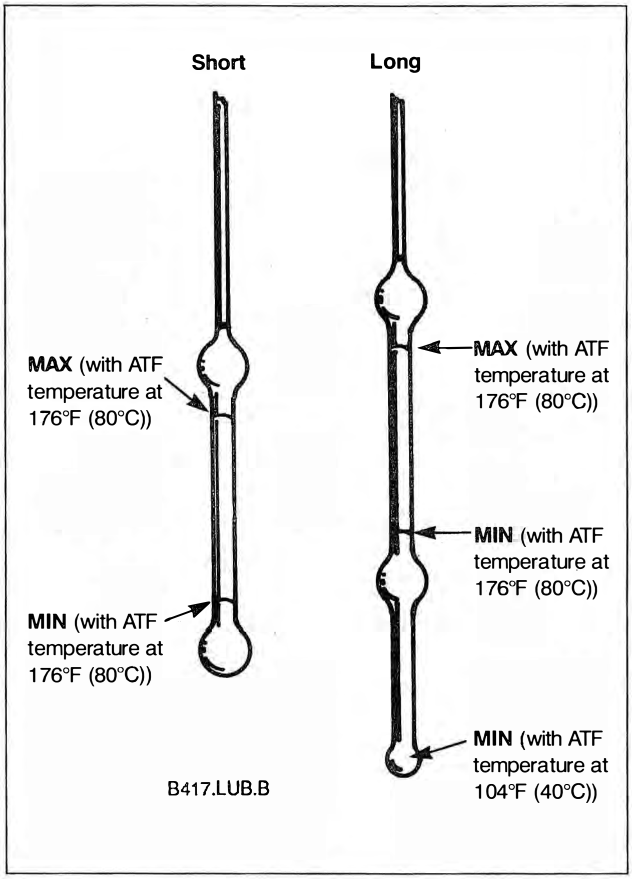


Fig. 7-7. Two versions of automatic transmission dipsticks installed on cars covered by this manual.

CAUTION —
Use care when adding fluid to models equipped with the short dipstick. Unless the transmission fluid is fully warmed (ATF temperature above 175°F (80°C)), the ATF level may appear to be too low when checked. If too much ATF is added, it will escape from the transmission filler tube or the transmission vent under heavy engine load or cruising.

NOTE —
The area between the **MIN** mark and the **MAX** mark on the dipstick is represents approximately 0.6 pints (0.3 liter) of ATF on models with 4-speed automatic transmissions, and approximately 0.8 pints (0.4 liters) of ATF on models with 3-speed automatic transmissions. See **AUTOMATIC TRANSMISSION** for information on transmission applications.

The ATF level should be checked with the car on a level surface with the engine idling and the transmission fully warmed. Firmly set the parking brake and place the transmission selector lever in park or neutral and remove the ATF dipstick. The ATF level is correct if it is between the **MIN** and **MAX** marks on the dipstick.

NOTE —
Driving the car for five to ten minutes around town, or approximately 12 mi. (20 km) on the highway will ensure a fully warmed transmission.

If the level is too low, use a clean funnel to add ATF through the dipstick/filler tube as specified in **3. Fluid and Lubricant Specifications** until the fluid level is between the two marks on the dipstick.

Check the condition of the ATF by rubbing some between your fingers and sniffing it. The ATF should not be foamy, gritty, or have a burnt odor. Contaminated ATF should be drained and replaced to prevent further damage, but doing so will not repair any internal transmission damage that has already occurred.

NOTE —
Because Dexron II® ATF is a red/brown color that discolors to black/brown during normal use, ATF color may not be a good indicator of its condition.

Draining and Replacing ATF, and Cleaning ATF Strainer

With the car raised and supported securely on jack stands, place a drain pan of at least 5.6 L (6 US qt.) capacity under the transmission and remove the transmission drain bolt. See Fig. 7-8. Remove the dipstick/filler tube mounting nut from the front of the sump and remove the tube. See Fig. 7-9. Remove the sump mounting bolts and clamping brackets. See Fig. 7-10. Remove the oil sump and the gasket. Pour out any fluid remaining from the sump.

CAUTION —
Towing the car or running the engine without ATF in the transmission will ruin the transmission bearings.

NOTE —
Two types of sump mounting brackets are used on the 4-speed automatic transmission (4 HP 22). Four rounded brackets are installed at each corner of the sump and two flat brackets are installed at the sump's side. Be sure the brackets are positioned correctly during installation.

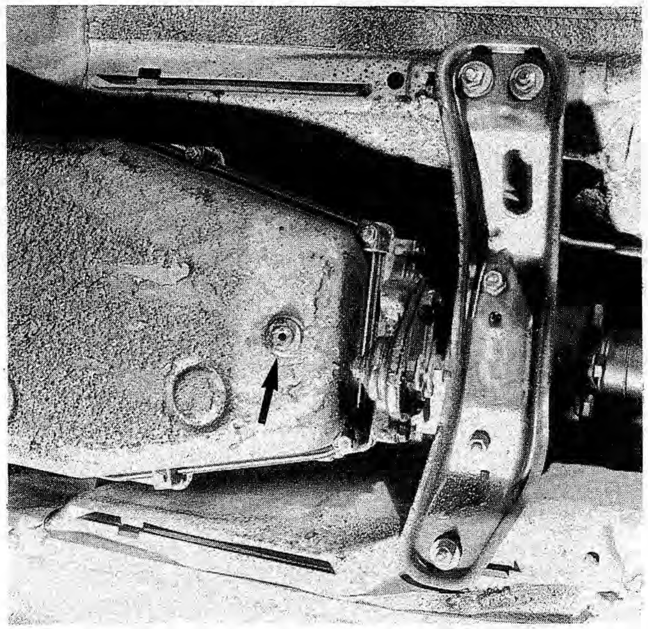


Fig. 7-8. Automatic transmission fluid drain bolt (arrow).

Fig. 7-9. Automatic transmission fluid filler dipstick/tube mounting nut (arrow).

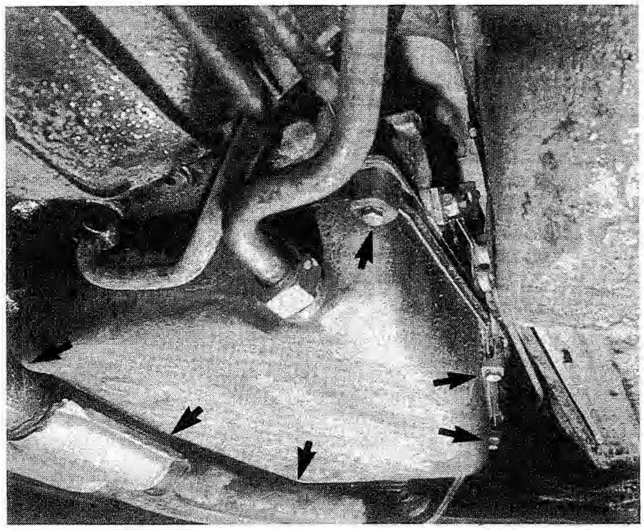


Fig. 7-10. Automatic transmission sump mounting bolts and clamping brackets (arrows).

Remove and clean the magnets in the oil sump. Note the position of the magnets. Remove and clean the transmission strainer. On models with 3-speed transmission, the strainer is held in place with twelve Torx® bolts of unequal length. On models with 4-speed transmission, the strainer is held in place with three Torx® bolts. See Fig. 7-11. On models with 4-speed transmission, remove the strainer O-ring.

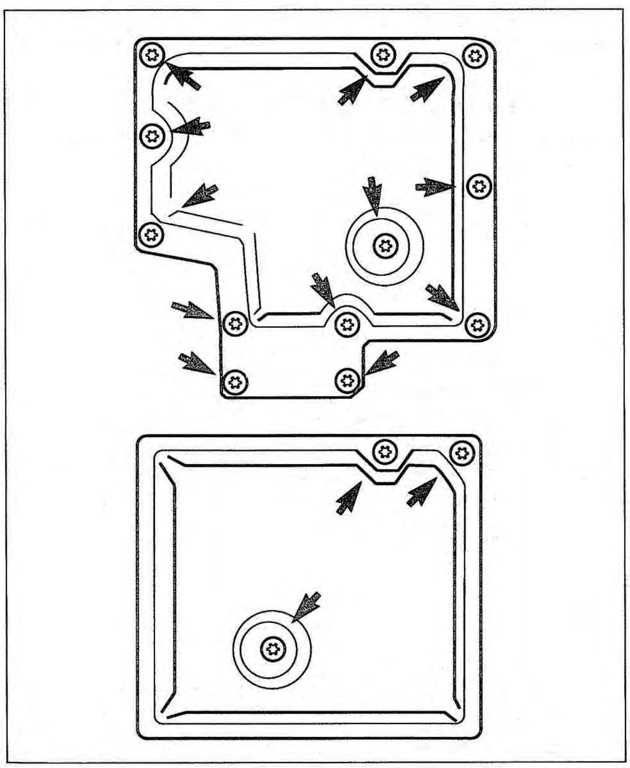


Fig. 7-11. Transmission fluid strainer mounting bolts (arrows) for 3-speed transmission (3 HP 22) (top), and 4-speed transmission (4 HP 22) (bottom).

CAUTION —

The strainer can be cleaned if it is dirty or clogged. The strainer should be replaced if a brown gummy residue has accumulated on the screen, if it cannot be thoroughly cleaned, or if it is in any way damaged. Using a damaged or partially plugged strainer may cause serious transmission damage.

NOTE —

See **AUTOMATIC TRANSMISSION** for more information on how to identify a particular transmission.

Clean the sump and install the sump magnets. Make sure the sump is completely dry. Remount the strainer using a new O-ring (if applicable) and tighten the mounting bolts to the torque listed in **Table j**. Using a new sump gasket without any sealer, install the ATF sump. Install the clamping brackets so that the short leg of the bracket is contacting the sump. Tighten the bolts to the torque listed below. Install and tighten the oil filler tube. Refill the transmission with fluid according to the type and amount specified in **3. Fluid and Lubricant Specifications** and check the fluid level as described earlier.

Table j. Automatic Transmission Tightening Torques

ATF strainer to transmission	10–11 Nm (7–8 ft. lb.)
ATF sump to transmission 3 HP 22 4 HP 22	 8–9 Nm (6–7 ft. lb.) 6–7 Nm (4–5 ft. lb.)
ATF sump drain plug	15–17 Nm (11–13 ft. lb.)
ATF filler tube to oil sump 3 HP 22 4 HP 22	 100–115 Nm (73–84 ft. lb.) 98 Nm (72 ft. lb.)

7.6 Front Suspension and Steering

Inspection of the front suspension and steering includes a check of all moving parts for wear and excessive play. Also inspect the rubber seals and boots for cracks or tears that could allow the entry of dirt, water, and other contaminants. Complete front suspension inspection and troubleshooting information can be found in **SUSPENSION AND STEERING.**

7.7 Final Drive and Rear Drive Axles

Final drive and drive axle service consists of checking and changing the gear oil, inspecting for leaks, and checking the rear drive axle protective boots for damage.

The areas where leaks are most likely to occur are around the drive shaft and drive axle mounting flanges. For more information on identifying oil leaks and their causes, see **DRIVESHAFT AND FINAL DRIVE.**

Checking and Filling Final Drive Lubricant

Check the lubricant level with the car level. Remove the oil filler plug, shown in Fig. 7-12. The level is correct when the fluid just reaches the edge of the filler hole. See **3. Fluid and Lubricant Specifications**. Torque the oil filler plug to 55 Nm (41 ft. lb.).

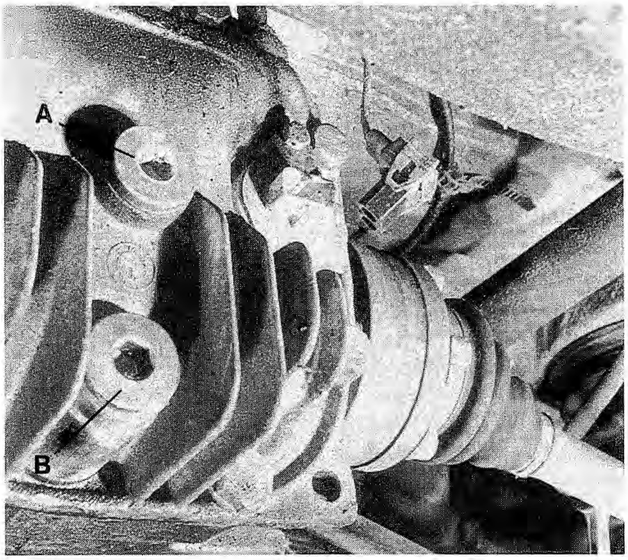


Fig. 7-12. Final drive oil filler plug (**A**) and oil drain plug (**B**).

NOTE —

When installing a BMW remanufactured final drive unit, an additional amount of "running-in" oil is required for the first 1,200 mi. (2,000 km). After this period, the final drive is drained and filled as described below. The additional oil should be added prior to installing the unit because the oil level rises above the oil filler hole when the unit is installed.

To replace the final drive gear oil, drive the car for a few miles to warm up the lubricant. With the car on a level surface, Remove the filler and drain plug as shown above. When the oil is fully drained, install and torque the drain plug to 55 Nm (41 ft. lb.). Add oil though the filler plug until it begins to run out of the filler hole. Install and torque the filler plug to 55 Nm (41 ft. lb.).

Drive Axle Joint Boots

The protective boots must be closely inspected for cracks and any other damage that will allow contaminants to get into the joint. If the rubber boots fail, the water and dirt that enter the joint will quickly damage it. Replacement of the drive axle joint boots and inspection of the joints are described in **SUSPENSION AND STEERING**.

7.8 Fuel Tank and Fuel Lines

Inspect the fuel tank, fuel lines, and fuel system for damage or leaks. If fuel odors are detected in the passenger compartment, the fuel-pump cover O-ring (beneath the rear seat bottom) may be faulty. See **FUEL SYSTEM** for replacement of the O-ring.

Check for fuel leaks in the engine compartment. Check for faulty fuel lines by bending them. If any leaks are present, fuel should be expelled. Check for a damaged fuel tank. Incorrectly raising the car can damage the tank. Check for any evaporative emissions hoses that may have become disconnected, checking carefully at the charcoal canister and evaporative emissions purge valve. See **FUEL SYSTEM** for component locations.

WARNING —

When checking for fuel leaks, the engine must be cold. A hot exhaust manifold or exhaust system could cause the fuel to ignite or explode causing serious personal injury. Clean up spilled fuel immediately.

8. Body and Interior Maintenance

8.1 Windshield Wiper Blades

Common problems with the windshield wipers include streaking or sheeting, water drops after wiping, and blade chatter. Streaking is usually caused when wiper blades are coated with road film or car wash wax. Clean the blades using soapy water. If cleaning the blades does not cure the problem then they should be replaced. BMW recommends replacing the wipers blades twice a year, before and after the cold season.

Drops that remain behind after wiping are caused by oil, road film, or diesel exhaust coating the windshield. Use an alcohol or ammonia solution, or a non-abrasive cleanser to clean the windshield.

Wiper blade chatter may be caused by dirty or worn blades, by a dirty windshield, or by bent or twisted wiper arms. Clean the blades and windshield as described above. Adjust the wiper arm so that there is even pressure along the blade, and so that the blade is perpendicular to the windshield at rest. If the problem persists, the blades are excessively aged or worn and should be replaced.

8.2 Body Lubrication

The door locks and lock cylinders can be lubricated with an oil that contains graphite. The body and door hinges, the hood latch, and the door check rods should be lubricated with SAE 30 or SAE 40 engine oil. Lubricate the seat runners with multipurpose grease. Do not apply any oil to rubber parts. Lubricate the sunroof guide rails with silicone spray. If door weatherstrips are sticking, lubricate them with silicone spray or talcum powder.

8.3 Seat Belts

Dirt and other abrasive particles will damage seat belt webbing. If it is necessary to clean seat belts, use a mild soap solution. Bleach and other strong cleaning agents may weaken the belt webbing.

WARNING —
Do not clean the seat belt webbing using dry cleaning or other chemicals. Allow wet belts to dry before allowing them to retract.

The condition of the belt webbing and the function of the retractor mechanisms should be inspected. See **BODY AND INTERIOR** for seat belt inspection information.

9. Cleaning and Preserving

9.1 Care of Exterior Finish

The longer dirt is left on the paint, the greater the risk of damaging the glossy finish, either by scratching or by the chemical effect dirt particles may have on the painted surface.

Washing

Do not wash the car in direct sunlight. If the engine hood is warm, allow it to cool. Beads of water not only leave spots when dried rapidly by the sun or heat from the engine, but also act as tiny magnifying glasses that can burn spots into the finish. Wash the car with a mixture of lukewarm water and a mild soap made expressly for washing cars. Using general detergents, even ones that claim to be gentle, can cause damage to the paint over time. Rinse using plenty of clear water under as little pressure as possible. Wipe the body dry with a soft terry-cloth towel or chamois to prevent water-spotting. BMW recommends washing the car once a week.

On convertible models, spraying water over the top is normally all that is needed to clean the top. If it is heavily soiled, use a weak concentration of a mild, non-alkaline soap. Gently rub the top with a sponge or soft bristle brush and rinse liberally with clean water.

Waxing

For a long-lasting, protective, and glossy finish, apply a hard wax after the car has been washed and dried. Use carnauba or synthetic based products. Waxing is not needed after every washing. You can tell when waxing is required by looking at the finish when it is wet. If the water coats the paint in smooth sheets instead of forming beads that roll off, a new coat of wax is needed.

Polishing

Use paint polish only if the finish assumes a dull look after long service. Polish can be used to remove tar spots and tarnish, but afterwards a coat of wax should be applied to protect the clean finish. Do not use abrasive polish or cleaners on aluminum trim or accessories.

Washing Chassis

Periodic washing of the underside of the car, especially in winter, will help prevent accumulation of road salt and rust. The best time to wash the underside is just after the car has been driven in wet conditions. Spray the chassis with a powerful jet of water. Commercial or self-service car washes may not be best for this, as they may recycle the salt-contaminated water.

Special Cleaning

Tar spots can be removed with a bug and tar remover. Never use gasoline, kerosene, nail polish remover, or other unsuitable solvents. Insect spots also respond to tar remover. A bit of baking soda dissolved in the wash water will facilitate their removal. This method can also be used to remove spotting from tree sap.

9.2 Care of Interior

Dirt spots can usually be removed with lukewarm soapy water. Use spot remover for grease and oil spots. Do not pour the liquid directly on the carpet, but dampen a clean cloth and rub carefully, starting at the edge of the spot and working inward. Do not use gasoline, naptha, or other flammable substances to clean the carpeting.

Vinyl and Cloth Upholstery and Trim

Use a dry foam cleaner. Grease or paint spots can be removed by wiping with a cloth soaked with this cleaner. Use the same cleaner, applied with a soft cloth or brush, on the headliner and side trim panels. For cloth-covered seat areas, use the techniques described previously for cleaning the carpeting.

Leather Upholstery and Trim

Leather upholstery and trim should be periodically cleaned using a slightly damp cotton or wool cloth. The idea is to get rid of the dirt in the creases and pores that can cause brittleness and premature aging. On heavily soiled areas, use a mild detergent (such as Woolite®). Use two tablespoons to one quart of cold water. Dry the trim and upholstery completely using a soft cloth. Regular use of a good quality leather conditioner will reduce drying and cracking of the leather.

Section 3

ENGINE MANAGEMENT—DRIVEABILITY

3

Contents

Engine Management—Driveability

Introduction

Driveability—the overall performance of the car, its ability to start quickly, run and accelerate smoothly, and deliver fuel economy as well as power—can only be achieved when all of the engine's major systems are working properly. This is even more true for today's cars with strict exhaust emission control.

One problem in troubleshooting an engine that performs poorly is knowing where to begin looking for the problem. There may be an ignition fault, a fuel delivery problem, a faulty emission control system, or a mechanical problem with the engine itself. A fault in any of these systems might cause poor driveability symptoms. Because top engine performance depends on the integrated functions of several systems, effective troubleshooting must include checking all these systems together.

This section offers advice for simple maintenance that can help prevent driveability problems. It also includes basic troubleshooting information that addresses symptoms of poor driveability and can help isolate problems to a specific system. It is a guide to problem solving, intended to be used in conjunction with the other sections in this manual.

1. GENERAL DESCRIPTION

Engine management is a term widely used to describe the control of all the functions that affect how the engine runs. While this obviously includes the fuel system and the ignition system, it may also include emission control systems and auxiliary functions such as idle speed control.

On the 318i model, engine management is a function shared by the L-Jetronic fuel injection system, the ignition system, and various auxiliary controls. For all 3-Series models with 6-cylinder engines, these functions are combined in the single Bosch Motronic engine management system.

Whether the systems are separate or combined, it is important to consider all of the engine management functions when troubleshooting. This section describes some likely causes of general driveability problems, and suggests ways of isolating other problems to faults in a particular system. Specific tests and repairs are covered in **FUEL SYSTEM**, **IGNITION**, **EXHAUST SYSTEM AND EMISSION CONTROLS**, and **ENGINE**.

1.1 L-Jetronic Fuel Injection System

The 4-cylinder engines covered in this manual are equipped with the Bosch L-Jetronic fuel injection system and a transistorized ignition system. The two systems are completely independent, each controlled by its own electronic control unit (ECU).

Basic ignition timing is determined by the mechanical adjustment or position of the distributor. During engine operation, ignition timing is advanced and retarded by a combination of mechanisms. A centrifugal advance mechanism adjusts ignition timing according to engine rpm. A vacuum advance mechanism adjusts ignition timing according to manifold pressure.

The L-Jetronic fuel injection system is an electronic system using electrical signals from an air flow sensor, air and coolant temperature sensors, the ignition system, and an exhaust-mounted oxygen sensor to calculate and deliver the precise amount of fuel required by the engine. Fuel under pressure is injected via electronically controlled solenoid-type fuel injectors. The ECU electrically controls the opening and closing of the injectors by switching the ground side of each injector circuit. The exact amount of fuel injected is determined by the amount of time the injectors are open. Fig. 1-1 shows a schematic of the L-Jetronic fuel injection system.

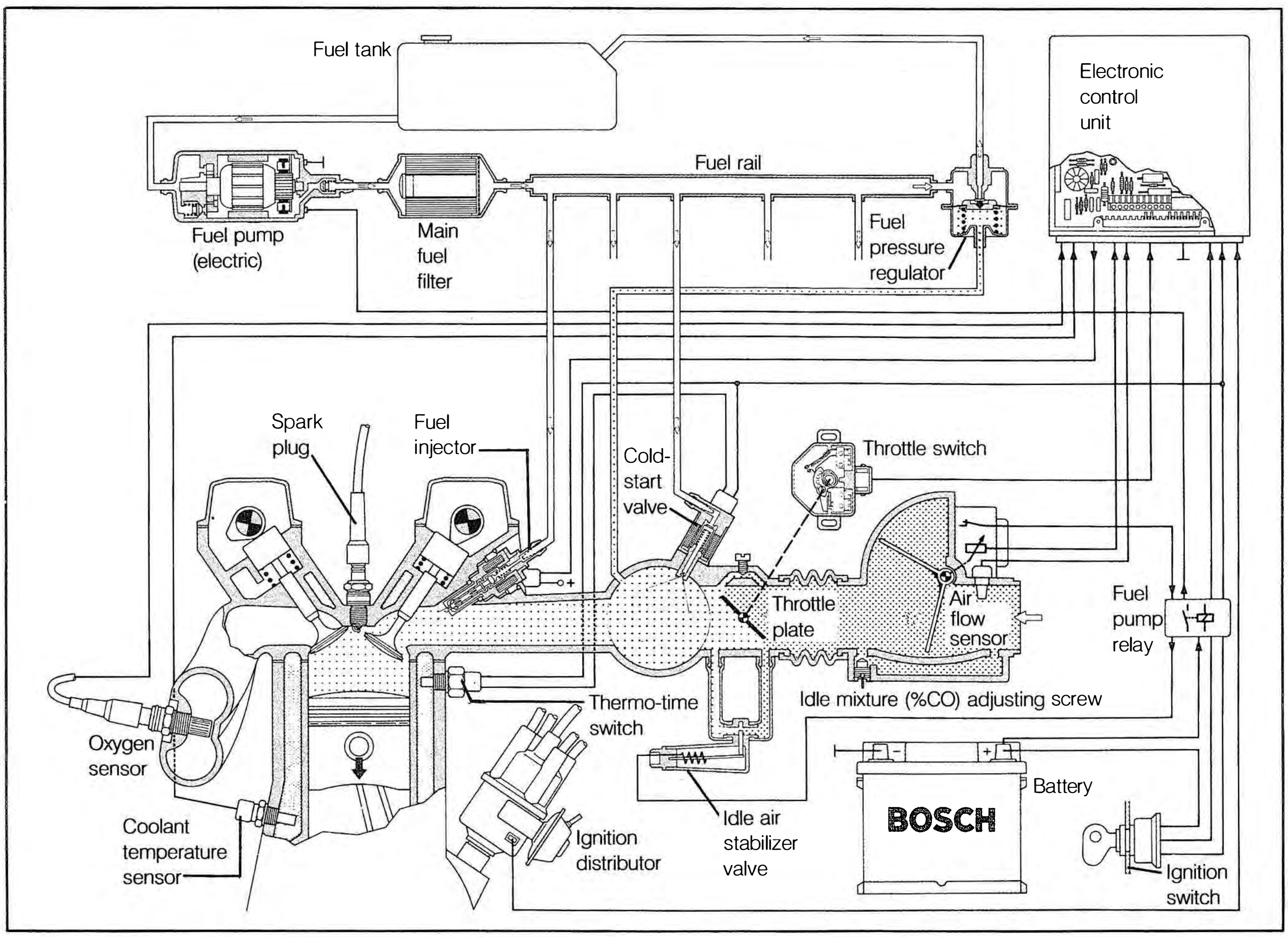


Fig. 1-1. Schematic of L-Jetronic System used on the 4-cylinder (318i) engines. Courtesy Robert Bosch Corp.

1.2 Motronic Engine Management System

All 6-cylinder engines covered by this manual are equipped with a Bosch Motronic engine management system. Fuel injection, ignition, and other functions are combined under the control of one ECU. See Fig. 1-2.

The ignition distributor is an integral part of the cylinder head, driven directly by the camshaft. It contains no mechanical timing-advance components, and basic ignition timing is non-adjustable. All ignition timing is determined by the Motronic ECU, interpreting signals from sensors that indicate engine crankshaft position. Ignition timing is advanced and retarded electronically.

The fuel injection functions of the Motronic system are very similar to those of the L-Jetronic fuel injection system described above. The amount of fuel injected is determined by the ECU. It responds to various sensor inputs, and controls the opening and closing of the solenoid-type fuel injectors.

1.3 Motronic 1.1 Engine Management System

A second generation Motronic system, Motronic 1.1, was introduced in 1987 on the 325i and later in 1988 on the 325 models. It is a more sophisticated version of the "basic" Motronic system. The differences between the two systems are mainly in the electronic circuitry.

Both systems have adaptive abilities that actually adjust the system to compensate for things such as engine wear and vacuum leaks. On Motronic 1.1, the system has additional adaptive features that enable the system to change the system's base settings in the control unit's memory over time. For a more detailed explanation of the Motronic 1.1 engine management system, see **FUEL SYSTEM.**

NOTE

All of the information in this section labeled "Motronic" applies to both Motronic systems, unless Motronic 1.1 is specifically mentioned as an exception.

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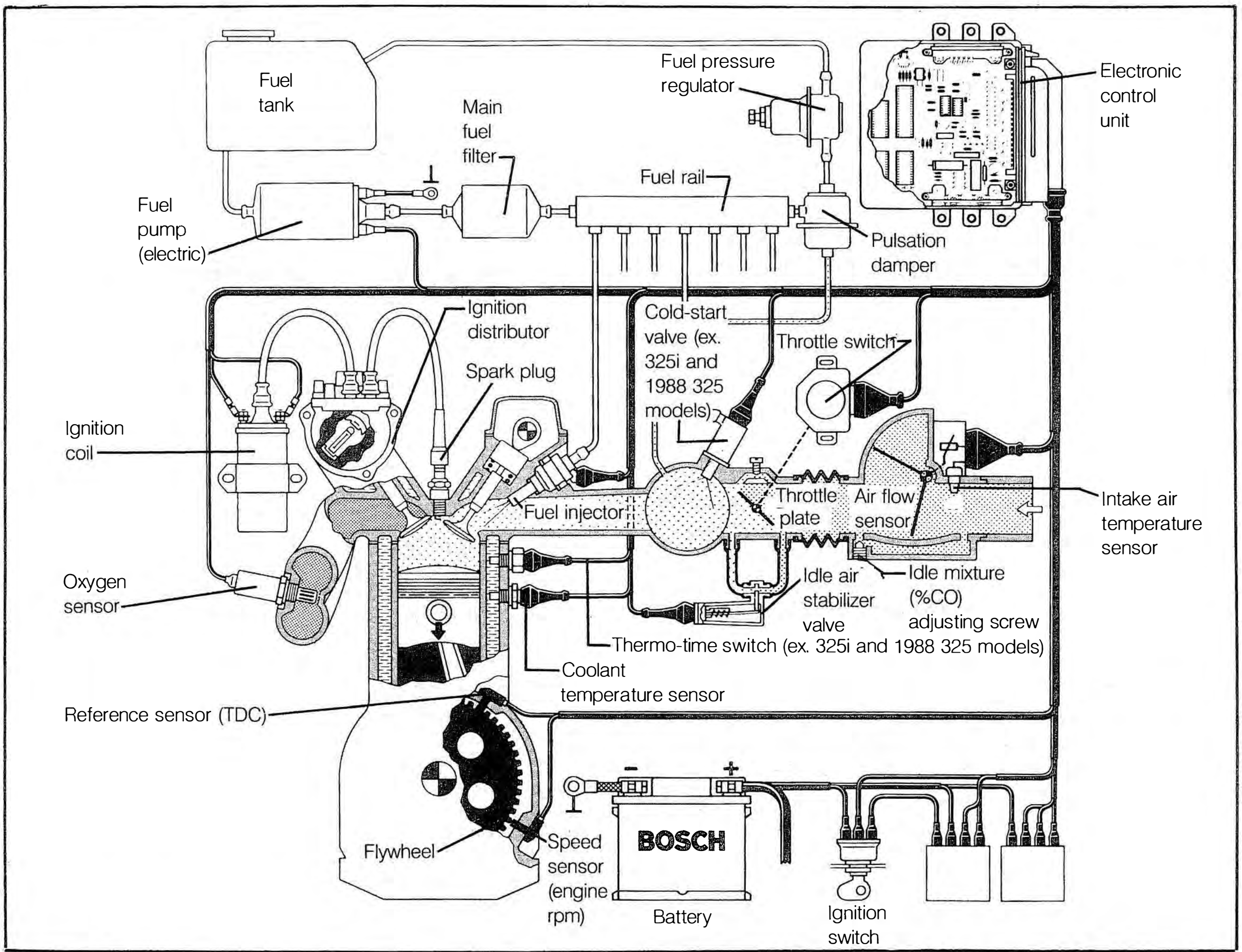

Fig. 1-2. Schematic of Motronic engine management system used on all 6-cylinder engines covered in this manual. Courtesy Robert Bosch Corp.

2. MAINTENANCE

Carrying out maintenance at the specified interval is the key to preventing engine performance and driveability problems. The BMW service interval system has been precisely designed to provide optimum maintenance requirements based on personal driving habits.

Extending the specified service intervals will only lead to driveability problems later on. As an example, extending the replacement of the tune-up components can cause clogged fuel injectors, a damaged oxygen sensor, or even a damaged catalytic converter. A worn out oxygen sensor will cause poor idle characteristics and higher than normal fuel consumption. Diluted engine oil or oil that has reached its "break down" point can lead to engine wear on the cylinder walls and other friction surfaces, such as bearings and bushings. Therefore, it is good insurance to service the car promptly when the maintenance reminder lights come.

For information on BMW's recommended maintenance pertaining to engine management and driveability, see **FUEL SYSTEM**, **IGNITION**, and **EXHAUST SYSTEM AND EMISSION CONTROLS**.

3. TROUBLESHOOTING—BASIC REQUIREMENTS

This heading covers general engine management principles and the basic requirements that allow an engine to run smoothly. Therefore, effective troubleshooting of specific running conditions can only take place after all of the common problem areas listed below have been eliminated as a source of trouble.

Most driveabilty problems are complex in nature. A logical method needs to be used to isolate the trouble area. Always begin with the simplest and most fundamental engine management basics. Jumping to conclusions or searching aimlessly for the problem can be time consuming and frustrating.

As with any troubleshooting, careful observation of symptoms is the key to identifying and isolating driveability problems. A test drive can help by demonstrating when the problem is most pronounced, such as a hesitation which occurs only when accelerating, or a steady miss at high speed.

How has the symptom developed? A symptom that develops quickly is probably caused by a problem that can be corrected by simple maintenance or repair. A symptom that has developed gradually over time, especially after sixty or seventy thousand miles is more likely an indication of general wear and the need for more comprehensive work.

Warnings and Cautions

For general safety, and to protect the sensitive electronic components, the following warnings and cautions should be adhered to during any troubleshooting, maintenance, or repair work. Always follow the proper repair and working procedures in the sections that are referenced.

WARNING —

- *The ignition systems used on the cars covered by this manual are high-energy systems operating in a dangerous voltage range that could prove to be fatal if exposed terminals or live parts are contacted. Use extreme caution when working on a car with the ignition on or the engine running.*

- *Do not touch or disconnect any of the high tension cables from the coil, distributor, or spark plugs while the engine is running or being cranked by the starter.*

- *Connect and disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is switched off.*

- *Before operating the starter without starting the engine (as when making a compression test), disable the ignition. See* **IGNITION** *for more information.*

- *Do not disconnect terminal 4 (center terminal) from the coil or remove the distributor cap to disable the ignition.*

- *During any test where fuel is discharged, do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.*

CAUTION —

- *Do not connect test instruments with a 12-volt power supply to terminal 15 (+) of the ignition coil. The current flow will damage the ignition control unit. In general, make test connections only as specified by BMW, as described in this manual, or as described by the test instrument's manufacturer.*

- *Do not disconnect the battery while the engine is running.*

- *Do not exceed 16.5 volts at the battery with boosting cables attached, and do not quick-charge the battery (for boost starting) for longer than one minute. Wait at least one minute before boosting the battery a second time. On models equipped with on-board computers, the computer fuses (no. 10, no. 12, no. 21, no. 23, no. 27) should be removed prior to quick-charging to prevent damaging the computer.*

- *Do not connect terminal 1 (−) of the ignition coil to ground as a means of preventing the engine from starting.*

- *Running the engine with a spark plug wire disconnected may damage the catalytic converter.*

- *Cleanliness is essential when working with fuel circuit components. Before disconnecting any fuel lines, thoroughly clean the unions. Use clean tools.*

3.1 Engine

Before troubleshooting a poorly running engine or an engine that will not start, determine the general condition of the engine, especially if it has high mileage. If the engine is severely worn or has mechanical problems, the only remedy is overhaul or repair. If a tune-up or scheduled maintenance is due, it should be done before proceeding to other areas of this section.

Mechanical Condition

Only a few basic functions are required of the engine. The parts must fit together properly, operate smoothly, and seal well enough to create and maintain compression, and keep pistons, valve train, and ignition properly timed.

General engine condition can be easily assessed by performing a few simple diagnostic tests. Make sure that the valves are correctly adjusted before making these tests. If the engine cannot be started, perform a compression test. If the engine runs and can idle, perform a vacuum gauge test. These tests are covered in **ENGINE**.

NOTE —

Compression and vacuum gauge tests require special test equipment. If the equipment is not available, most automotive repair shops can do these tests quickly and at a reasonable cost.

Carbon Deposits

Carbon deposits on the fuel injectors and the intake valves will affect the way the engine idles and runs. See Fig. 3-1. Even a ten percent decrease in the amount of fuel that the injectors deliver will cause driveability problems. These deposits normally form during the "hot soak" period immediately after the engine is turned off, at which point the engine temperature rises slightly for a short period.

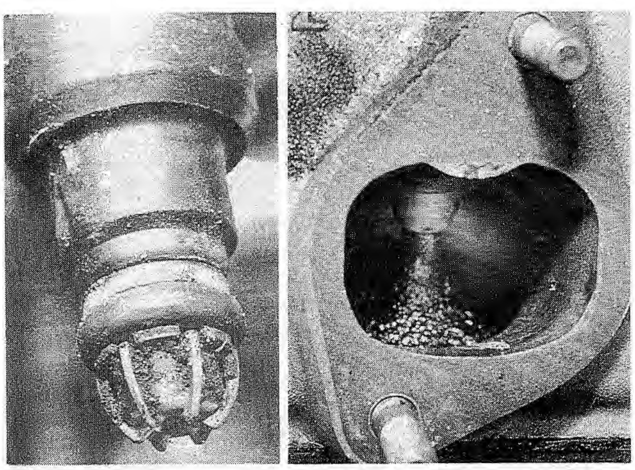

Fig. 3-1. Examples of carbon deposits on fuel injector (left) and intake valve (right). Carbon deposits can cause a rough idle, hard cold starting, and overall poor performance.

Driving style is thought to be the main contributor to the problem. A car that is predominantly driven on short trips around town or in city traffic seems to increase the likelihood of deposits forming.

Carbon deposits on the intake valves and injectors should be removed prior to troubleshooting driveability problems. Special fuel injector test equipment is required to accurately check for clogged injectors. If the injectors are severely clogged, they can be removed and visually inspected. Inspecting the intake valves is more difficult because the intake manifold needs to first be removed. Check with an authorized BMW dealer for the latest information on carbon deposits and the best methods used to remove them.

CAUTION —

Always follow the manufacturer's directions when using fuel tank additives designed to remove carbon deposits and clean injectors. It is recommended that high detergency fuels should not be used together with fuel tank additives. The excess amount of cleaner in the fuel can dilute engine oil and accelerate engine wear. Always check with an authorized BMW dealer before using fuel additives with high detergency fuel.

Tune-up and Preventive Maintenance

The condition of the tune-up and emission control components can affect engine performance and driveability. Extending tune-up and maintenance schedules beyond those recommended by the manufacturer can adversely affect the way the engine runs. When experiencing driveability problems, a good starting point is to do a tune-up, especially if scheduled maintenance is overdue. Many driveability problems are eliminated by simply replacing these components.

A tune-up is regular maintenance of the ignition and fuel system components for normal wear and contamination. The ignition components all carry high voltage to deliver a precisely timed spark to ignite the air/fuel mixture. If any of these components are faulty or worn, the intensity and timing of the spark will be affected. Extending the replacement intervals of fuel system and emission control components can adversely affect fuel delivery and air/fuel mixture.

Replacement schedules and procedures for the spark plugs, spark plug wires, distributor cap, ignition rotor, fuel filter, air filter, oxygen sensor, and oil and oil filter are given in **LUBRICATION AND MAINTENANCE**.

NOTE —

For information on inspecting ignition components, see **IGNITION**. For information on testing the oxygen sensor, see **EXHAUST SYSTEM AND EMISSION CONTROLS**.

Valve Adjustment

Correctly adjusted valves are necessary for efficient engine operation. If the valve clearances are too small, the valves may not close all the way, resulting in low compression and a loss in power. If the valve clearances are too large, the valves may not fully open, causing a reduction in engine efficiency. Procedures for checking and adjusting valve clearances are described in **ENGINE**.

3.2 Basic Adjustments

In addition to tune-up component replacement, it is important that all of the basic adjustments that can be made are correctly set. Check ignition timing, idle speed, and idle mixture (%CO) to be sure they are all within the specified limits. All of the models covered by this manual are equipped with a non-adjustable or self-correcting, electronically controlled idle speed. In addition, some other models have non-adjustable ignition timing and idle mixture. See **Table a.**

NOTE —

All of the basic adjustments require the use of specialized test equipment. In addition, setting idle mixture on the 318i model is done through the use of a special BMW electronic idle mixture test unit (BMW tool no. 12 6 400). If any of the test equipment is not available, it is recommended that the adjustments be done by an authorized BMW dealer or other qualified repair shop. These adjustments can be made quickly and at a reasonable cost.

The systems that adapt idle mixture, idle speed, and ignition timing can only correct engine operation within a limited range. Once these limits are exceeded, driveability problems will become noticeable. For example, the oxygen sensor can adapt idle mixture for things such as a small vacuum leak or minor engine wear. A large vacuum leak or a severely worn engine may exceed the operating range of the sensor, causing the engine to run lean. The same conditions are true for the electronic idle stabilization system. Keep in mind that if large adjustments are necessary, the faults that are causing these incorrect settings should be corrected prior to making any adjustments.

Table a. Basic Adjustment Information

Model	Ignition timing	Idle speed	Idle mixture(©O)
1984–1985 318i	adjustable	non-adjustable	adjustable
1984–1987 325, 325e, 325es	non-adjustable	non-adjustable	adjustable
1987–1990 325i, 1988 325	non-adjustable	non-adjustable	non-adjustable

Oxygen Sensor

The oxygen sensor adapts the air/fuel mixture by sending a varying voltage signal to the fuel injection control unit. The sensor is positioned in the exhaust stream and actually measures the amount of oxygen in the exhaust gas so that the fuel injection system can correctly adjust the air/fuel mixture. A high concentration of oxygen in the exhaust gas indicates a lean mixture and a low content indicates a rich mixture. Thus, the signal from the oxygen sensor plays a major role in engine performance and driveability.

NOTE —

The signal from the oxygen sensor is ignored by the fuel injection control unit until the engine reaches a specified temperature. Therefore, when troubleshooting cold engine driveability problems, the oxygen sensor can be ruled out as a possible cause.

As the sensor grows old, it loses its ability to react quickly to changing conditions and it may eventually cease to produce any signal at all. When this happens, fluctuations in idle speed and increased fuel consumption may be noticed. The oxygen sensor should be replaced at the specified mileage interval as described in **LUBRICATION AND MAINTENANCE**

3.3 Air Flow Measurement and Vacuum Leaks

The fuel injection system or engine management system uses an air flow sensor to precisely measure incoming air. The sensor sends an electrical signal proportional to the measured air flow to the control unit, which uses this signal to determine the amount of fuel the engine needs.

Because proper fuel metering depends on accurately sensing or measuring the intake air, any unmeasured air entering the system will cause a lean fuel mixture and poor running. To see how air leaks can affect engine running, remove the oil filler cap while the engine is running.

There are many possible places for unmeasured air to enter the engine. Carefully inspect all hoses, fittings, duct work, and seals and gaskets. Fig. 3-2 through Fig. 3-5 show some of the common areas where leaks develop. For a thorough inspection, it may be necessary to remove hoses and ducts that cannot be completely checked in their installed positions.

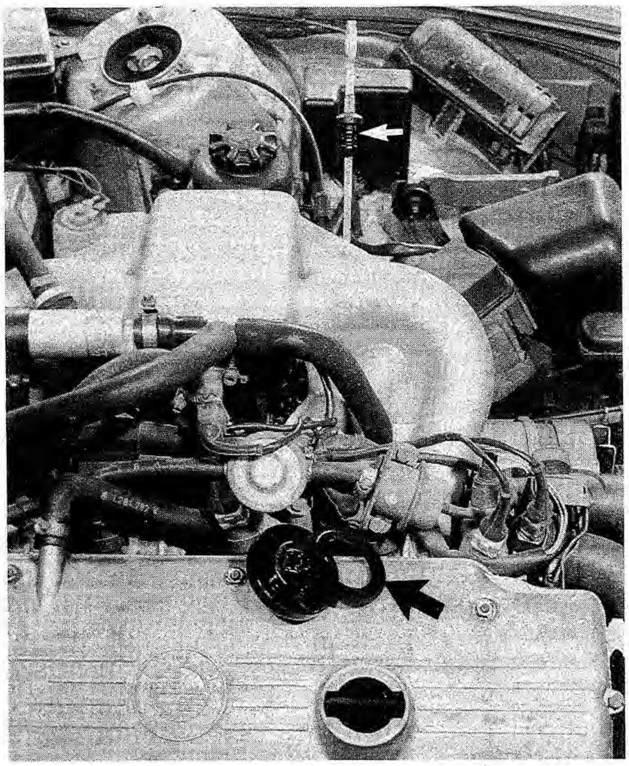

Fig. 3-2. Oil dipstick seal and oil filler cap seal (arrows) should be inspected and replaced if found to be faulty. 4-cylinder engine shown, 6-cylinder engine is similar.

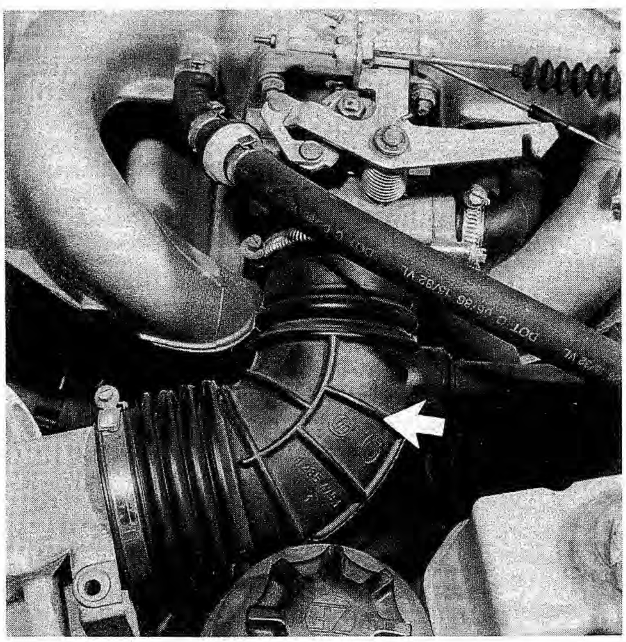

Fig. 3-3. Intake air duct (arrow) can crack or become loose. Be sure to check bottom side of duct. Air bypass hoses and hose fittings are also suspect. Bend air duct and hoses to detect cracks. 6-cylinder engine shown, 4-cylinder is similar.

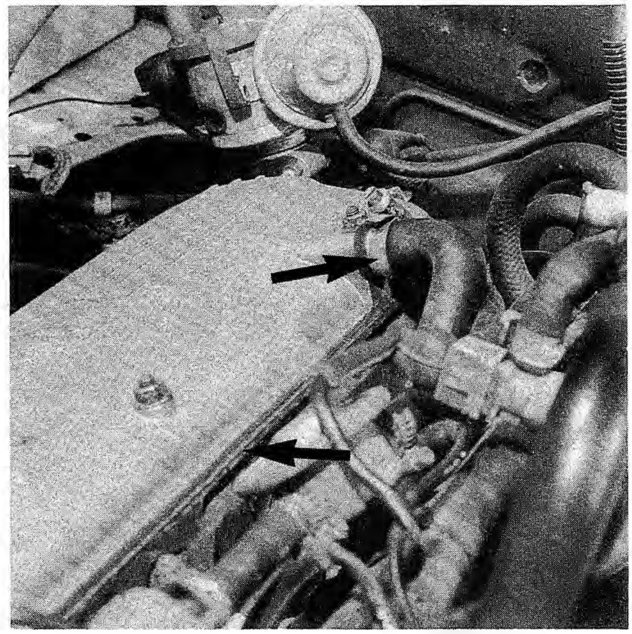

Fig. 3-4. A leaking cylinder head cover gasket or cracked or brittle PCV hose (arrows) should be replaced. Also check the small vacuum hose to distributor on models with 4-cylinder engine.

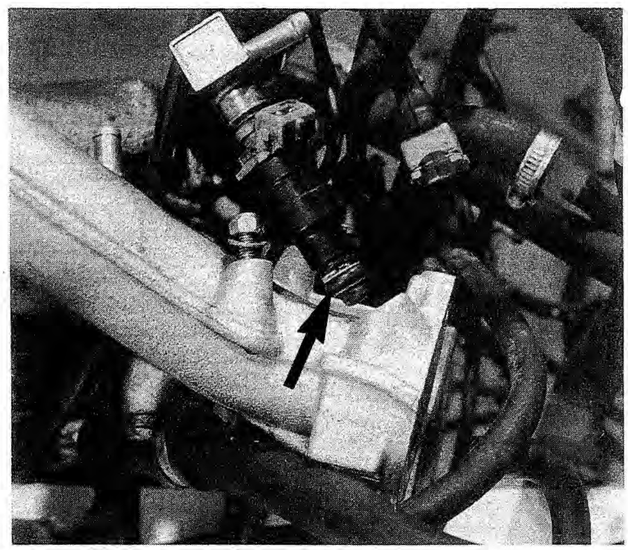

Fig. 3-5. Injector seals or O-rings (arrow) are a common source of air leaks, especially on high mileage engines. Injectors must first be removed to replace seals.

3.4 Electrical System

All the cars covered by this manual use engine management systems that rely on precise electrical signals for proper operation. If any of these signals are distorted, incorrect, or missing, the car can develop major driveability problems.

Battery Voltage

One of the most fundamental requirements in troubleshooting engine performance problems is to make sure the battery is fully charged and in good condition. Many of the sophisticated electronics used on the cars covered by this manual require a specified operating voltage to function correctly.

Battery voltage can be measured across its terminals with all cables attached. Do not eliminate the battery as a possible source of trouble until a load test has been performed, especially if starting problems are encountered. See **ELECTRICAL SYSTEM** for battery testing information.

NOTE —

A digital voltmeter should be used to measure battery voltage. A fully charged battery will measure 12.6 volts as compared to a battery only 25% charged that measures 12.15 volts. Using an analog meter may result in inaccurate results.

For the battery to maintain its proper voltage level, the charging system must be functioning correctly. If in doubt about the condition of the charging system, have the system checked. Most automotive repair shops can test the system quickly and at a reasonable cost.

Wiring and Harness Connectors

The cars covered by this manual are equipped with electronic fuel injection and ignition systems that are controlled by central electronic control units. Many of the circuits operate on very low current and are very sensitive to increased resistance due to faulty wiring or connectors.

NOTE —

In most cases, faulty electronic control units are not the cause of driveability problems. These units are extremely durable and reliable and actual failures are very rare. Driveability problems are more often caused by missing or incorrect signals to the control unit, or other faulty components.

The electrical system is subject to corrosion, vibration, roadway elements and general wear. Because of this, the integrity and freedom from corrosion in the connections, wires, and switches, including all ground connections, is one of the most important conditions for trouble-free operation of the engine management systems.

Always make a thorough visual inspection of all wires and connectors, switches and fuses. Loose or damaged connectors can be the cause of intermittent problems, especially at the small terminals in each control unit connector. In most cases, a visual inspection will detect any faults. If a connector shows no visible faults, but is still suspect, perform a voltage drop test at the connector. Even a small amount of corrosion in a connector can cause a large voltage drop to the circuit's load. See **ELECTRICAL SYSTEM** for more troubleshooting information.

Ground Connections

For any electrical circuit to work, it must make a complete path, beginning at the negative (–) battery terminal and ending at the positive (+) terminal. The negative (–) battery cable runs directly to the car's chassis. Therefore, connecting a wire to the chassis or any metal part bolted to the chassis provides a good ground source or path back to the negative (–) side of the battery.

Poor ground connections are one of the major sources of driveability problems. There are only a few major ground connections or points for the engine management systems. These ground points are a grouping of many wires crimped or welded into an eyelet that is then bolted to the car's chassis or metal parts. If any of these ground points are faulty, the voltage to the affected circuit will be reduced or even eliminated.

When checking ground wires, ground points, or ground straps, begin with a thorough visual inspection. Ground connections and wires can corrode, become loose, or break in areas that are not visible. To thoroughly check a circuit ground, check the voltage drop between the connector and a good ground source. Large voltage drops indicate too much resistance—that the connection is corroded, dirty or otherwise damaged. Clean or repair the connection and retest. Also check both battery terminals and all ground straps between the engine and the body for voltage drops.

NOTE —

For voltage drop tests and other general electrical troubleshooting information, see **ELECTRICAL SYSTEM**.

Fig. 3-6 through Fig. 3-13 show the main ground points for the engine management systems used on the cars covered by this manual.

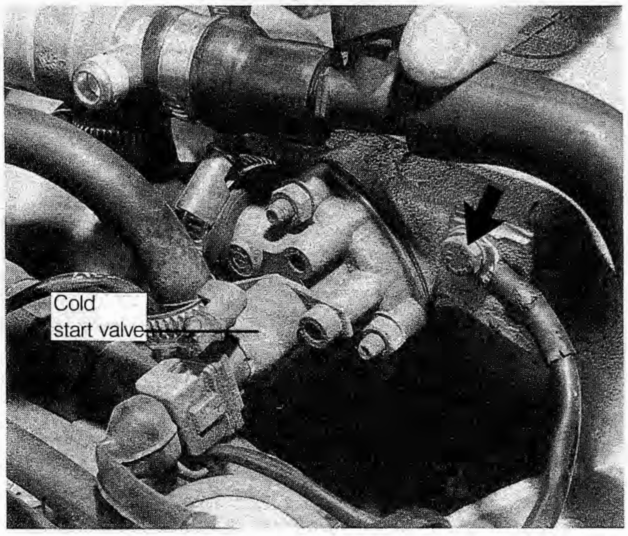

Fig. 3-6. Ground G101 (arrow) for fuel injection system on 1984 and most early 1985 318i models (next to cold start valve).

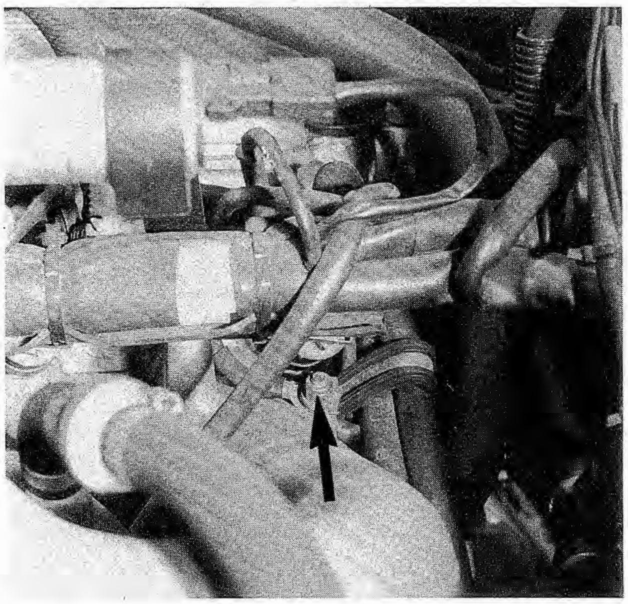

Fig. 3-7. Ground point G102 (arrow) for fuel injection system on all 318i models (rear of engine, below no. 4 fuel injector).

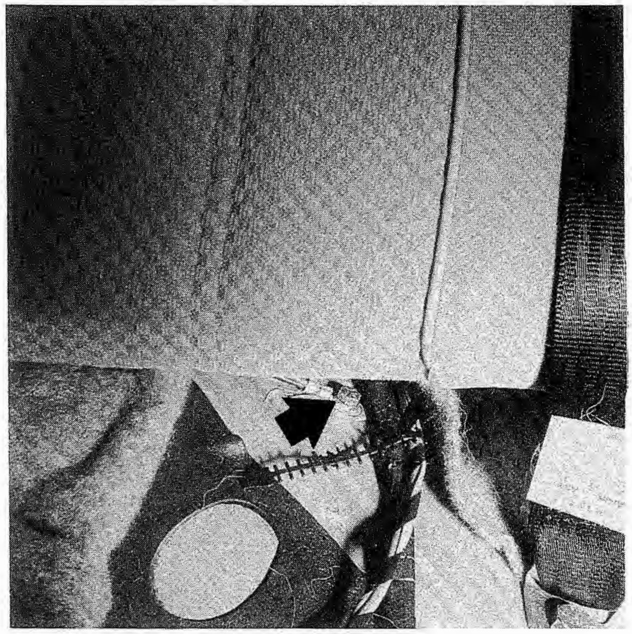

Fig. 3-8. Ground point G300 (arrow) for fuel pumps beneath rear seat bottom on driver's side. Ground point G202 (not shown), used on convertible model only, is also beneath rear seat on passenger's side.

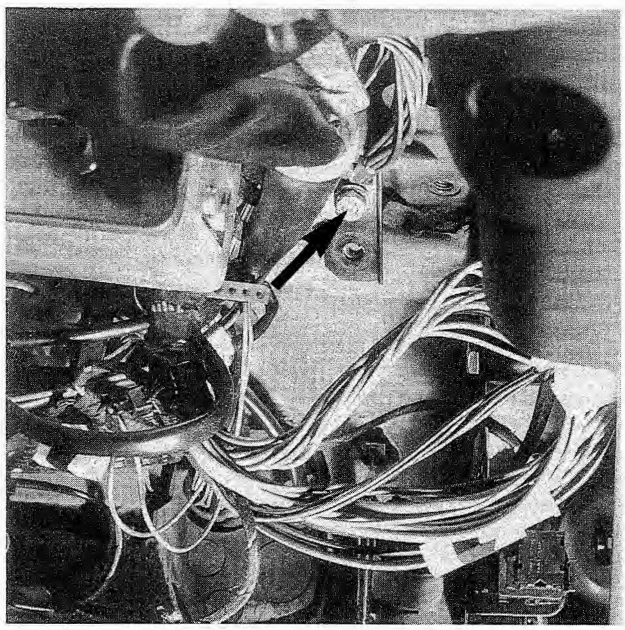

Fig. 3-9. Ground point G200 (above brake pedal) for ignition switch, on-board computer, and start relay (arrow).

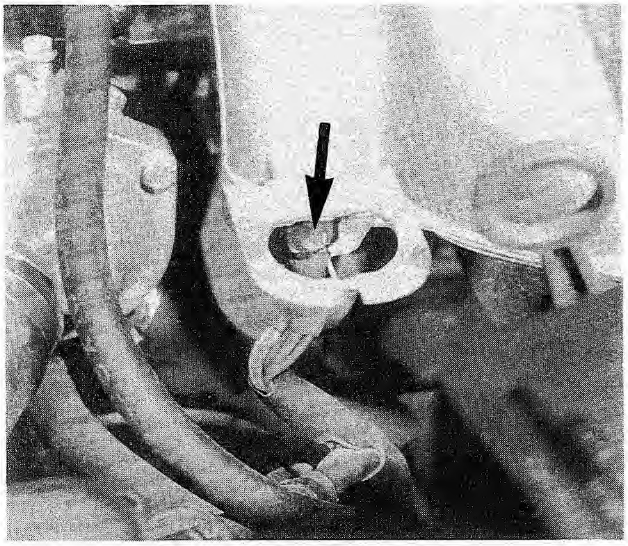

Fig. 3-10. Ground point G103 (arrow) on 325, 325e, and 325es models with 2.7 eta engine (left side of engine, beneath diagnostic connector).

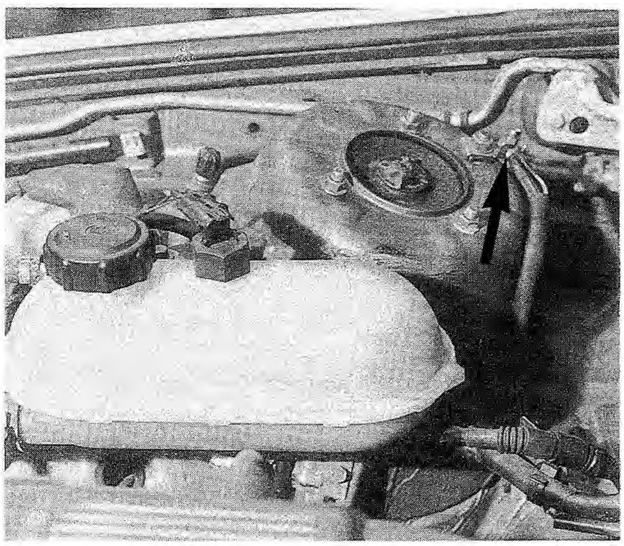

Fig. 3-11. Ground point G103 (arrow) on 325i models with 2.5i engine (on right shock tower).

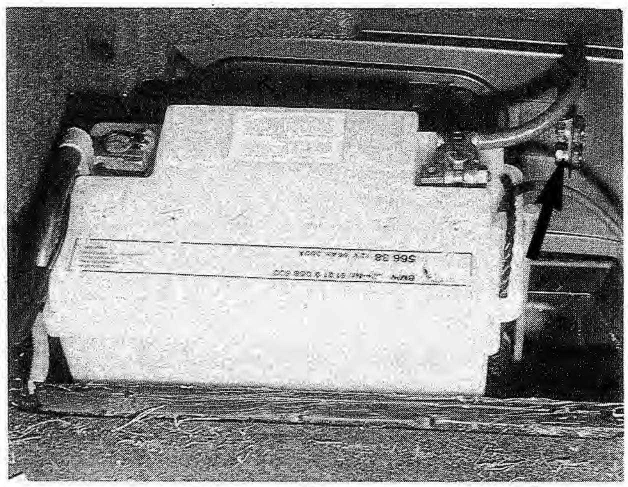

Fig. 3-12. Ground point G100 (arrow) from battery to chassis on all 325 models with battery in left side of trunk.

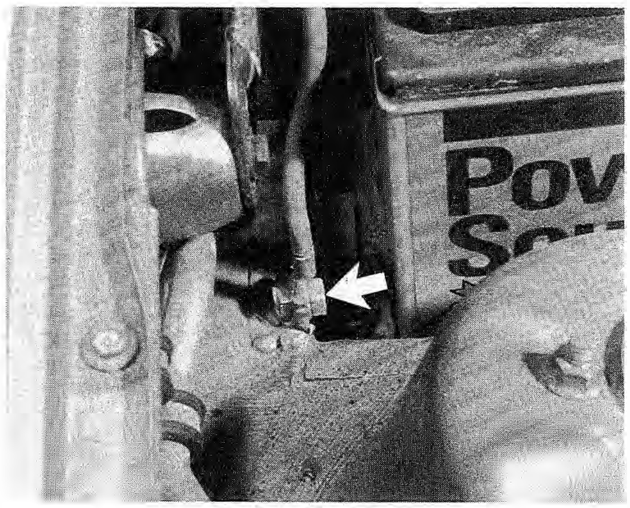

Fig. 3-13. Ground point G100 (arrow) from battery to chassis on all models with battery in engine compartment.

3.5 Fuel System

For the engine to start quickly when cold or hot, run correctly throughout all operating conditions, and accelerate smoothly without hesitation, the fuel system must deliver a precise amount of fuel in relation to the amount of air that is drawn in by the engine.

Fuel Supply

To start and run, the engine needs an adequate supply of fuel. Fuel from the tank is supplied to the engine via an electric fuel pump, a fuel filter, and the connecting fuel lines. If either the filter or a fuel line is restricted, the engine may not run properly. If the restriction is severe, or the main fuel pump is faulty, the engine may not start at all.

Power to run the fuel pump is controlled by a fuel pump relay mounted in the engine compartment. In order for the pump to run, the relay must be functioning correctly.

To check for a clogged fuel filter or a restricted fuel line, perform a fuel delivery rate test to check that the fuel pump is delivering enough fuel to the fuel injection system. For fuel pump, fuel pump relay, and fuel pump delivery rate tests, see **FUEL SYSTEM**.

Fuel Delivery Rate

The fuel injection system has the main function of delivering an optimum fuel/air mixture for all engine operating conditions. Basic fuel delivery is dependent on fuel pressure and the correctly functioning injectors. Fuel pressure is often overlooked when diagnosing driveability problems.

The fuel pressure from the fuel pump is controlled by a pressure regulator by allowing surplus fuel to return back to the fuel tank. The amount of fuel delivered to the engine is varied by changing the amount of time the electric pulsed-type fuel injectors remain open. A change in fuel pressure results in a change in the amount of fuel (or fuel mixture) that is delivered to the engine. Fuel pressure and fuel pressure regulator tests are described under **FUEL SYSTEM**.

> **NOTE —**
> Fuel pressure tests require the use of a pressure gauge. If this equipment is not available, fuel pressure tests can be performed by an authorized BMW dealer or other qualified shop.

Correctly operating fuel injectors play a major role in fuel delivery. The injectors are switched on and off at the ground side of the connector. Positive (+) battery voltage is always present at the connector when the car is running. An injector can become clogged, it can completely fail or lose power and refuse to open, or it can short to ground and remain open whenever the engine is running. Checking if an injector is fundamentally working can be accomplished easily; checking an injector's spray pattern is more difficult. See **FUEL SYSTEM** for additional information.

> **NOTE —**
> High or low fuel pressure or a faulty injector will result in an incorrect fuel mixture and overall poor driveability. A lean mixture (too little fuel) can cause the engine to run poorly when cold or stumble upon acceleration. A rich mixture (too much fuel) can dilute the engine oil, foul the spark plugs, and cause a rough idle.

4. STARTING TROUBLESHOOTING

Starting difficulties can usually be grouped into one of two categories based on engine operating temperature. A cold engine that is difficult to start has different causes and remedies than an engine that is hard to start when warm. A third category, an engine starts but will not keep running, also has its own causes and remedies. Careful observation of the symptoms is the key to isolating and identifying starting problems.

4.1 No start

Only a few requirements are necessary for an engine to start. An engine should start if it has fuel, a properly timed spark and sufficient compression. Make sure the battery is fully charged before troubleshooting an engine that will not start.

When an engine refuses to start, the first thing to check is the ignition system. See **IGNITION** for procedures on making an ignition system quick-test. If the ignition system is producing a spark, then the most likely causes are fuel related.

Check that the fuel pump is operating. Turn the key on or actuate the starter while listening for the fuel pump to come on. If the fuel pump is operating, check that the fuel injectors are getting fuel by making a fuel delivery test. Fuel pump checks and fuel rate delivery tests are described in detail in **FUEL SYSTEM**. If no problems have been found up to this point, go to **4.2 Hard to Start (cold)** below for further troubleshooting.

4.2 Hard to Start (cold)

Starting a cold engine has different fuel and air requirements than those of a warm engine. When the engine is cold, additional fuel and air are needed to maintain a steady idle and to overcome cold engine friction. On most models, ignition timing is also adapted for cold starting. Late 1985 318i models and all 6-cylinder models retard ignition timing to aid in starting. If these systems used to adapt the fuel and ignition systems for cold starting are not operating, excessively long cranking times will result or the engine may not start at all.

Table b lists probable causes and corrective actions for cold starting problems. The boldface type indicates the section of the manual where the applicable test and repair procedures are found.

Table b. Cold Starting Troubleshooting

Symptom	Probable cause	Corrective action
1. Engine hard to start when cold	a. Cold start system not operating	a. Test cold start system. See **FUEL SYSTEM**
	b. Fuel injectors clogged or not opening	b. Test fuel injectors and fuel injector wiring. See **FUEL SYSTEM**
	c. Fuel pressure too low	c. Test fuel pressure. See **FUEL SYSTEM**
	d. Air flow sensor flap binding or stuck in open position	d. Inspect air flow sensor flap for free movement. See **FUEL SYSTEM**
	e. Coolant temperature sensor faulty or faulty sensor wiring	e. Test coolant temperature sensor. See **FUEL SYSTEM**
	f. Reference signal missing (6-cylinder engines only)	f. Faulty reference sensor or reference wheel or flywheel damaged. Reference pin missing (2.7 eta engine only)
	g. Throttle switch incorrectly adjusted or faulty	g. Check throttle switch. See **FUEL SYSTEM**
	h. Large intake air leaks	h. Make thorough inspection of hoses, connections, duct work, and oil filler cap seal and oil dipstick seal.
	i. Wiring installed incorrectly at junction block (models with battery in trunk)	i. Check wire routing at junction block. See **ELECTRICAL SYSTEM**
	j. Wiring incorrectly routed at ignition coil	j. Check wire routing at coil. See **IGNITION**
	k. Idle speed control system faulty	k. Test idle speed control system components. See **FUEL SYSTEM**
	l. Incorrect ignition timing	l. Check ignition timing. Check vacuum advance system (4-cylinder engines only). See **IGNITION**
	m. Poor fuel quality. Water in fuel.	m. Replace fuel in tank. See **FUEL SYSTEM**
	n. Faulty L-Jetronic or Motronic control unit	n. Test control unit inputs. See **FUEL SYSTEM**

4.3 Hard To Start (warm)

If the engine starts and idles well when cold, but is difficult or refuses to start when warm, the most probable cause is fuel related. Although the basic ignition system function can be eliminated as a source of trouble, the components that adapt ignition timing for varying operating conditions should not be overlooked.

Check the systems that adapt the engine to its cold running settings. If additional cold-start fuel is supplied to a warm engine, it will become flooded. When the engine reaches operating temperature, these systems should no longer be adapting the fuel system. **Table c** lists probable causes and corrective actions for warm starting problems. The boldface type indicates the section of the manual where the applicable test and repair procedures are found.

4.4 Starts But Will Not Keep Running

An engine that starts but then immediately stops is most likely due to one of three reasons.

The most common of these is a fuel pump that quits after the key is removed from the start position. In order for the fuel pump to continue to run after the key is removed from the start position, the fuel system needs an engine speed signal. On models with 4-cylinder engines, this signal is supplied to the fuel pump relay from the ignition system. On models with 6-cylinder engines, this signal is supplied to the Motronic control unit from the speed sensor. Check the fuel pump relay electrical circuit as described in **FUEL SYSTEM**

The second most common fault is caused by vacuum or air leaks. This unmeasured air can cause the air/fuel mixture to lean out to the point where the engine cannot maintain a steady idle. See **3.3 Air Flow Measurement and Vacuum Leaks** above for common sources of air leaks.

The last common fault is that the engine is relying on the additional fuel from the cold start system to keep running. Once this fuel is burned, the engine quits. Check for clogged fuel injectors that are not opening or low fuel pressure. On 4-cylinder engines, the injectors are controlled together as a set. On 6-cylinder engines, the injectors are controlled in two sets of three. Check the wiring to the injectors. Special LED testers are available from foreign automobile supply outlets to check for the presence of injector signals from the control unit.

NOTE —

- See **LUBRICATION AND MAINTENANCE** for information on fuel additives and clogged injectors.
- On models with the Motronic 1.1 engine management system, air leaks are not usually a cause of hard starting. The Motronic 1.1 engine management system is adaptive to the point where any air leaks would have to be very large (and easily visible) for the system not to adapt.

As a last resort, review the probable causes shown in **Table b** and **Table c**. If present in a lesser degree, many of these listed causes could also cause an engine to stop running immediately after starting.

Table c. Warm Starting Troubleshooting

Symptom	Probable cause	Corrective action
1. Engine hard to start when warm or hot	a. Fuel pump not operating when warm	a. Check for worn fuel pump by making fuel delivery test with pump at operating temperature. See **FUEL SYSTEM**
	b. Fuel injector(s) leaking or stuck open	b. Test fuel injectors. See **FUEL SYSTEM**
	c. Cold start system operating when warm	c. Test cold start system. See **FUEL SYSTEM**
	d. Fuel pressure incorrect	d. Test fuel pressure. Inspect for leaks. See **FUEL SYSTEM**
	e. Coolant temperature sensor faulty	e. Test coolant temperature sensor. See **FUEL SYSTEM**
	f. Vapor lock (usually on hot days only)	f. Check fuel pressure. See **FUEL SYSTEM**
	g. Evaporative emission system faulty.	g. Test evaporative emission system. See **FUEL SYSTEM**
	h. Idle speed control system faulty	h. Test idle speed control system components. See **FUEL SYSTEM**
	i. Air flow sensor flap binding or stuck in open position	i. Inspect air flow sensor flap for free movement. See **FUEL SYSTEM**
	j. Incorrect ignition timing	j. Check ignition timing. Check vacuum advance system (4-cylinder engines only). See **IGNITION**
	k. Faulty L-Jetronic or Motronic control unit	k. Test electronic control unit inputs. See **FUEL SYSTEM**

3

5. Cold Running and Warm-up Troubleshooting

During engine warm-up, the engine requires a slightly richer mixture and a higher idle speed. This helps to overcome cold engine friction and also gives the engine extra torque to prevent stalling during take off or when selecting a drive position on models with automatic transmission.

A cold engine that accelerates poorly, hesitates or has poor off-idle characteristics can be fuel, ignition, or even emission controls related. Some of the most common causes are due to a lean air/fuel mixture such as intake air leaks or clogged fuel injectors. Although these are some of most probable causes, poor driveability during warm-up can have many other causes, including those that lead to an overly rich air/fuel mixture.

NOTE

For an engine that idles poorly when cold, see **6. Idle Speed Troubleshooting**.

To ensure smooth running, good off-idle and acceleration characteristics, and overall driveability while the engine warms up, both fuel mixture and basic ignition timing need to be modified for cold engine operation.

Additional fuel is supplied to the engine by increasing the opening or pulse time of the injectors based on inputs from the coolant temperature sensor. See Fig. 5-1. To improve driveability, ignition timing is adapted for cold running based on inputs from the intake-air temperature sensor and the coolant temperature sensor.

NOTE

For 4-cylinder engines, ignition timing adjustments for cold running conditions are controlled by the vacuum advance relay. For 6-cylinder engines, the Motronic control unit adjusts ignition timing.

Table d lists probable causes and corrective actions for cold-running and warm-up problems. The boldface type indicates the section of the manual where the applicable test and repair procedures are found.

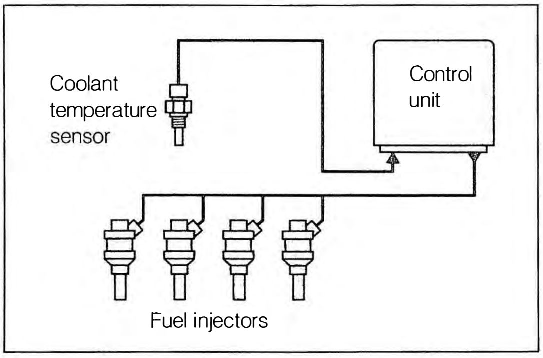

Fig. 5-1. Schematic of coolant temperature sensor used to adapt fuel system for warm-up enrichment. Injectors stay open longer when engine is cold based on cold engine signal from sensor.

Table d. Cold-Running and Warm-up Driveability Troubleshooting

Symptom	Probable cause	Corrective action
1. Engine runs poorly during warm-up, has poor acceleration, off-idle hesitation, and backfires	a. Intake air leaks	a. Make thorough inspection of hoses, connections, duct work, and oil filler cap seal and oil dipstick seal.
	b. Fuel injector(s) clogged or not opening	b. Test fuel injectors and fuel injector wiring. See **FUEL SYSTEM**
	c. Fuel pressure too low.	c. Test fuel pressure. See **FUEL SYSTEM**
	d. Air flow sensor flap binding.	d. Inspect air flow sensor flap for free movement. See **FUEL SYSTEM**
	e. Coolant temperature sensor faulty or faulty sensor wiring	e. Test coolant temperature sensor. See **IGNITION**
	f. Throttle switch incorrectly adjusted or faulty	f. Check throttle switch. See **FUEL SYSTEM**
	g. Idle mixture incorrectly adjusted	g. Adjust idle mixture (except 325i and 1988 325 models). See **FUEL SYSTEM**
	h. Idle speed control system faulty	h. Test idle speed control system components. See **FUEL SYSTEM**
	i. Incorrect ignition timing	i. Check ignition timing. Check vacuum advance system (4-cylinder engines only). See **IGNITION**
	j. Poor fuel quality. Water in fuel.	j. Replace fuel in tank. See **FUEL SYSTEM**
	k. Cold start system operating all the time.	k. Test cold start system. See **FUEL SYSTEM**
	l. Faulty L-Jetronic or Motronic control unit	l. Test control unit inputs. See **FUEL SYSTEM**

6. IDLE SPEED TROUBLESHOOTING

Erratic idle speed is one of the most common driveability problems encountered on the cars covered by this manual. An electronic idle speed system controls the idle speed for all engine operating conditions. The idle air stabilizer valve constantly adjusts the amount of air allowed to bypass the throttle plate to either increase or decrease engine speed. Idle speed is adapted based on various inputs from engine sensors and components. See Fig. 6-1.

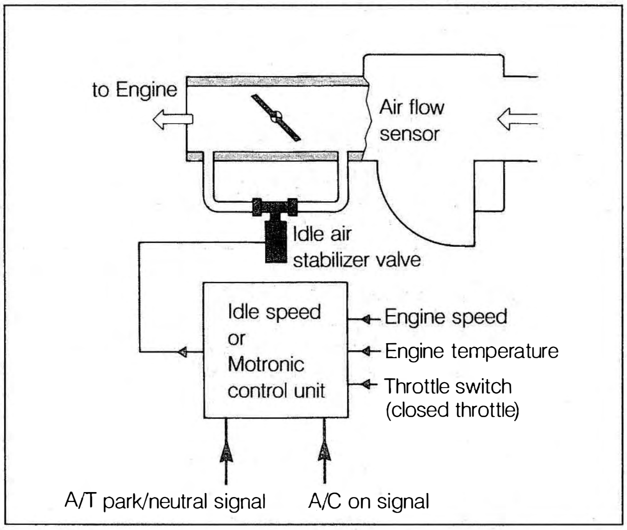

Fig. 6-1. Schematic of idle speed control system.

NOTE —

On all 318i models and on 1984 through 1987 325 and 325e models, idle speed is controlled by a separate idle speed control unit. On all 325i models and 1988 325 models, idle speed is controlled by the Motronic 1.1 control unit.

In addition to the idle speed control system, 318i models are equipped with an electronic vacuum advance relay and, on late 1985 models, an idle speed stabilization relay. These relays modify ignition timing and the fuel delivery rate, which affect idle speed. See **IGNITION** for more information on the vacuum advance relay. See **FUEL SYSTEM** for more information on the idle speed stabilization relay.

6.1 Idle Speed Basics

Begin troubleshooting idle problems by visually inspecting for faulty wiring, especially checking the connectors at the idle air stabilizer valve, the coolant temperature switch (except 1988 325 and all 325i models), the injectors, the throttle switch, and the oxygen sensor. On models with 6-cylinder engine, also check the connector at the coolant temperature sensor.

Carefully inspect for any air leaks, especially checking for cracks in the hoses at the idle air stabilizer valve, the large intake air duct, and the small hose between the intake manifold and the pressure regulator. Make sure the oil filler cap and the dipstick are installed correctly. Check that the throttle switch and the throttle valve are correctly adjusted as described in **FUEL SYSTEM**.

The engine management systems that control idle speed rely on two key inputs—a closed-throttle signal and an engine temperature signal. See Fig. 6-1 above. In addition to these signals, idle speed is further adapted based on engine loads, intake air temperature, and on models with automatic transmission, outside air temperature.

NOTE —

If the test equipment is available, check that idle mixture (% CO) and ignition timing are within specifications. In addition, troubleshoot warm idle problems prior to working on cold idle problems. Cold idle is adjusted based on warm engine settings. Therefore, it is important to troubleshoot idle problems in this order.

Analysis of the observed symptoms is the key to isolating and identifying idle problems. Pay close attention to engine conditions whenever idle problems occur. For example, if the idle speed steadily increases as the engine warms up, check the sensors that give the idle speed control system its temperature information.

6.2 Cold Idle

If the engine idles poorly when cold but maintains a steady idle when warm, the most probable cause is that the air/fuel mixture is too lean for a cold engine. A lean mixture is caused by one of two conditions; either too much air or too little fuel. Excess air is mainly caused by intake air leaks. Insufficient fuel has many causes, such as clogged fuel injectors or incorrect fuel pressure.

NOTE —

The oxygen sensor can be ruled out as a source of cold idle problems. Until the engine reaches a specified temperature, the signal from the oxygen sensor is ignored.

As opposed to a lean mixture, an excessively rich mixture can also be the cause cold idle problems. If too much fuel is delivered to the engine, the spark plugs will not be able to burn the excess fuel. If the condition is severe enough, the engine will eventually stall as it warms up and refuse to start until it cools down. **Table e** lists some of the more common causes of cold idle problems.

NOTE —

Be sure the idle switch is correctly functioning as described in **FUEL SYSTEM** before performing any idle speed troubleshooting.

To help determine if the idle mixture is lean or rich, observe the engine's idling characteristics. An engine that runs lean is normally hard to start or stalls immediately after starting, is unresponsive with off-idle hesitation, and has poor acceleration characteristics. An engine that is running rich will have a steady stumbling or gallop when idling and may possibly stall after running for a minute or so due to fouled spark plugs. Another sure sign of a rich mixture is black exhaust smoke and strong fuel odors. As a quick check, blip the accelerator pedal to quickly raise the idle speed. If the idle speed falls below specifications when the pedal is released and then returns to normal, the engine is running too rich. If the engine hesitates or stalls as it tries to speed up, the mixture is too lean.

NOTE —

The condition of the spark plugs is a good indicator of combustion quality that can help to diagnose idle faults. See **LUBRICATION AND MAINTENANCE** for more specifics on spark plug appearance.

Table e. Cold Idle Troubleshooting

Symptom	Probable cause	Corrective action
1. Engine idles poorly when cold (lean air/fuel mixture)	**a.** Faulty fuel injector seals (O-rings)	**a.** Replace injector seals. See **FUEL SYSTEM**
	b. Faulty or cracked air hoses, vacuum hoses, air duct, and connections	**b.** Replace any faulty hoses or duct work. Tighten any loose connections.
	c. Clogged or faulty fuel injectors	**c.** Test injectors. See **FUEL SYSTEM**
	d. Fuel pressure too low	**d.** Check fuel pressure and fuel delivery rate. See **FUEL SYSTEM**
	e. Coolant temperature sensor or switch faulty	**e.** Test coolant temperature sensor. See **FUEL SYSTEM.** Test coolant temperature switch. See **IGNITION**
	f. Idle air stabilizer valve faulty or out of adjustment	**f.** Test idle air stabilizer valve. See **FUEL SYSTEM**
	g. Valve cover gasket, front or rear crankshaft oil seal leaking or damaged.	**g.** Check for leaking or damaged gaskets or oil seals. See **ENGINE**

continued on next page

3

Table e. Cold Idle Troubleshooting (continued)

Symptom	Probable cause	Corrective action
2. Engine idles poorly when cold (rich air/fuel mixture)	**a.** Injectors leaking or sticking open	**a.** Test injectors. See **FUEL SYSTEM**
	b. Cold start system operating continuously.	**b.** Test cold start system. See **FUEL SYSTEM**
	c. Coolant temperature sensor or switch faulty	**c.** Test coolant temperature sensor. See **FUEL SYSTEM** Test coolant temperature switch. See **IGNITION**
	d. Fuel pressure too high	**d.** Check fuel pressure. See **FUEL SYSTEM**
	e. Intake air flow restricted	**e.** Check air flow path for obstructions. Replace dirty air filter. See **LUBRICATION AND MAINTENANCE**
	f. Ignition timing incorrect or weak spark	**f.** Check ignition timing and spark intensity. See **IGNITION**

6.3 Warm-up Idle

When the engine is cold, the fuel system supplies the engine with additional fuel. As the engine warms up, this fuel is slowly cut back until the engine is at operating temperature. Engine temperature is the primary information that handles this warm-up enrichment. Engine temperature information is supplied by a coolant temperature sensor, and on most models, a coolant temperature switch. Test these components first when experiencing warm-up driveabilty problems. The coolant temperature sensor is covered in **FUEL SYSTEM**. The coolant temperature switch is covered in **IGNITION**

If no faults are found with the coolant temperature sensor or switch, check to see when the oxygen sensor was last replaced. If the sensor is old, the sensor's signal may be incorrect during warm-up. See **3.2 Basic Adjustments** for more information on the oxygen sensor. Checking the accuracy of the oxygen sensor requires special test equipment. As a general rule, replace the sensor if replacement is due. See **LUBRICATION AND MAINTENANCE** for BMW's recommended maintenance schedules.

Other possible causes of poor idle during engine warm-up are clogged injectors and intake valve carbon deposits, although these problems will usually show up first during cold starting and cold idle. See **3.1 Engine** for more on clogged injectors and carbon deposits.

Lastly, 318i models use an electronic vacuum advance system to adapt ignition timing based on intake air temperature and coolant temperature. Check this system as a possible cause of poor warm-up idle as described in **IGNITION.**

6.4 Idle at Operating Temperature

Warm idle speed problems can have numerous causes. The problems can range from a faulty coolant temperature sensor to a faulty fuel injection control unit. **Table f** lists probable causes and corrective actions for warm idle problems. Troubleshoot warm idle problems in the order listed in table. The boldface type indicates the section of the manual where the applicable test and repair procedures are found.

Table f. Warm Idle Troubleshooting

Symptom	Probable cause	Corrective action
1. Engine idles poorly when warm	**a.** Coolant temperature switch faulty	**a.** Test coolant temperature switch/sender (4-cylinder engine) or coolant temperature switch (6-cylinder 2.7 eta engine). See **IGNITION**
	b. Throttle switch incorrectly adjusted or faulty	**b.** Check throttle switch adjustment. See **FUEL SYSTEM**
	c. Throttle plate incorrectly adjusted	**c.** Check throttle plate basic adjustment. See **FUEL SYSTEM**
	d. Coolant temperature sensor faulty	**d.** Test coolant temperature sensor. See **FUEL SYSTEM**
	e. Coolant level incorrect	**e.** Check coolant level. See **COOLING SYSTEM**

continued on next page

Table f. Warm Idle Troubleshooting (continued)

Symptom	Probable cause	Corrective action
1. Engine idles poorly when warm (cont'd)	**f.** Fuel injector(s) clogged, leaking or faulty	**f.** Test fuel injectors and fuel injector wiring. See **FUEL SYSTEM**
	g. Idle air stabilizer valve out of adjustment or idle speed control system faulty	**g.** Test idle speed control system components. See **FUEL SYSTEM**
	h. Vacuum advance system faulty (318i models only)	**h.** Test inputs to vacuum advance relay. See **IGNITION**
	i. Oxygen sensor faulty	**i.** Test oxygen sensor output. See **EXHAUST SYSTEM AND EMISSION CONTROLS**
	j. Cold start system operating continuously	**j.** Test cold start system. See **FUEL SYSTEM**
	k. Idle speed stabilization relay faulty (late 1985 318i models only)	**k.** Test inputs to idle speed stabilization relay. See **FUEL SYSTEM**
	l. Charcoal canister purge valve faulty	**l.** Test evaporative emission system. See **FUEL SYSTEM**
	m. Intake air leaks	**m.** Make thorough inspection of hoses, connections, duct work, and oil filler cap seal and oil dipstick seal.
	n. Incorrect ignition timing	**n.** Check ignition timing. Check vacuum advance system (4-cylinder engines only). See **IGNITION**
	o. Fuel pressure regulator faulty or hose to regulator leaking or faulty	**o.** Test fuel pressure. See **FUEL SYSTEM**
	p. Motronic 1.1 control unit or L-Jetronic control unit faulty	**p.** Test control unit inputs. See **FUEL SYSTEM**

7. Normal Warm Running Troubleshooting

The problems of normal warm running are very similar to those of warm idle. In most cases, warm engine driveability problems also affect warm engine idle. Additional causes of normal warm running that do not manifest themselves at idle are those of the more demanding operating conditions. Be sure the engine idles properly before troubleshooting the engine management systems for warm running conditions.

7.1 Rough Running/Misfiring

Begin troubleshooting an engine that runs poorly or misfires under all operating conditions and speeds by checking the main grounds and the electrical connections for the control units as described above under **3.4 Electrical System**. Make sure the throttle switch is correctly adjusted and properly functioning. Check that the air flow sensor flap is not binding and that there are no faults in the air flow sensor's potentiometer.

Remove the distributor cap and look for any oil-fouled or moisture-laden components. On models with 6-cylinder engine, a faulty dust shield O-ring will allow engine oil to seep into the distributor. On high mileage 4-cylinder engines, check for worn distributor shaft bushings. Worn bushings could cause the air gap for the impulse generator to vary, resulting in intermittent ignition misfires and rough running. See **IGNITION** for more troubleshooting information.

If no faults can be found and all of the causes listed in **Table f** above have been eliminated, carbon deposits on the intake valves or injectors may be the cause of the problem. See **3.1 Engine** for more information on carbon deposits.

7.2 Poor Acceleration

During acceleration, the fuel mixture needs to be quickly enriched and the ignition timing needs to be adapted to prevent detonation and engine damage.

Three fuel system components handle fuel enrichment; the air flow sensor, the fuel pressure regulator, and the throttle switch. When the throttle is quickly opened, the sudden rush of air past the air flow sensor causes the sensor flap to open quickly and over swing, sending a proportional electrical signal to the control unit. As the throttle plate is opened, the vacuum supplied to the top of the fuel pressure regulator is reduced and fuel pressure rises. If the pedal is fully depressed, the full throttle switch closes and the fuel system sends additional signals to the injectors to increase fuel flow. Check these three fuel system components carefully when experiencing acceleration problems.

NOTE —

If no fuel system components are found to be faulty, the injectors may be clogged. Although clogged injectors are most pronounced during cold acceleration, slightly clogged injectors can cause flat spots and poor acceleration. See **LUBRICATION AND MAINTENANCE** for advice on clogged injectors.

If any ignition system components are faulty or worn, their ability to deliver a strong, precisely timed spark will be reduced. The engine may idle fine but miss and skip during acceleration due to a weak spark. Poor spark intensity at the plugs can be caused by worn or fouled plugs, old or faulty plug wires, or a faulty ignition coil, rotor, or distributor cap. Inspect the ignition components carefully and replace any that are worn.

NOTE —

On 318i models, ignition timing is adapted for acceleration via the vacuum advance system and the electronic ignition control unit. On all 325 models, ignition timing is fully controlled by the Motronic control unit and gets its engine load signal from the air flow sensor.

7.3 Poor Fuel Economy

High fuel consumption results when the air/fuel mixture is too rich. As a first step in diagnosing high fuel consumption, check the idle mixture and ignition timing. If the idle mixture cannot be adjusted to within specifications, check the components that adapt the air/fuel mixture for varying operating conditions.

The one component that constantly adjusts fuel mixture is the oxygen sensor. See Fig. 7-1. As an oxygen sensor ages, it loses its ability to accurately and quickly adjust fuel mixture. An oxygen sensor that fails will usually cause the engine to run rich. In addition, check the coolant temperature sensor and the coolant temperature switch as described in **FUEL SYSTEM**. Check for a restricted air filter element.

NOTE —

Oxygen sensor testing procedures are covered in **EXHAUST SYSTEM AND EMISSION CONTROLS**.

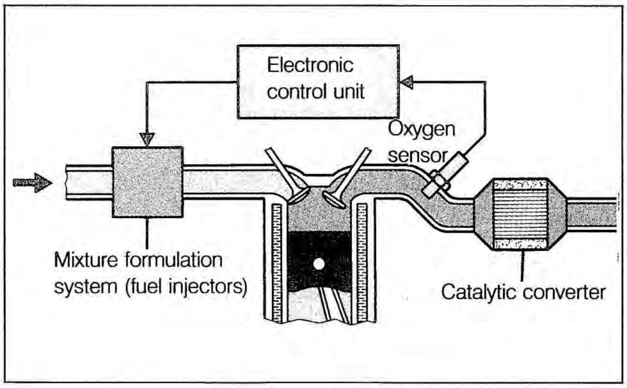

Fig. 7-1. Schematic of oxygen sensor circuit.

7.4 High Exhaust Emissions

Exhaust emission levels that are out of specification usually indicate an engine that is running poorly or is out of tune. For example, an engine that runs lean (low %CO) will usually exhibit cold starting and running problems. An engine that runs rich (high %CO) will usually show up as an increase in fuel consumption. A rich fuel mixture can also cause starting and running problems when the ambient air temperatures are high. Therefore, correcting engine driveability problems will usually return the exhaust emissions to within specifications.

Low exhaust emissions or a low %CO reading results when the basic air/fuel mixture is too lean. A lean fuel mixture will normally cause poor driveability and engine performance. Some of the side effects of a lean mixture are increased operating temperature and reduced spark plug life. The most common causes of low exhaust emissions are intake air leaks and clogged injectors. Review the information under the above headings to troubleshooting lean air/fuel mixtures.

High exhaust emissions or a high %CO reading results when the basic air/fuel mixture is too rich. Unless the ambient air temperatures are high, rich mixtures usually do not cause major engine driveability problems unless the mixture is excessively rich. In severe cases, the engine will run and then die once the spark plugs become fouled, and the engine will refuse to restart.

A rich mixture can cause serious engine damage if allowed to continue. A rich mixture will dilute the engine oil and wash the oil from the cylinder walls and friction surfaces, causing rapid engine wear. The catalytic converter could also be damaged due to the excess fuel. High exhaust emission should be corrected as soon as possible. The most common cause of high exhaust emissions are failed fuel delivery components, such as a stuck-open cold start valve or injector or a faulty coolant temperature sensor. Review the troubleshooting information under the above headings when troubleshooting rich air/fuel mixtures.

Section 4

ENGINE

Contents

4

TABLES

Engine

Introduction

This section of the manual covers the 4-cylinder engine used in the 318i model and the two 6-cylinder engines used in the 325.models. All of the 3-series engines covered by this manual are front-mounted and water-cooled. The valves are operated by an overhead camshaft.

The 4-cylinder engine in the 1984-1985 318i has a displacement of 1766 cc (107.8 cu. in.), commonly referred to as 1.8 liters. It is rated at 101 horsepower (SAE net).

The 6-cylinder engine in the 325, 325e and 325es has a displacement of 2693 cc (164 cu. in.), commonly referred to as 2.7 liters. The 1984 through 1987 325, 325e, and 325es models are rated at 121 horsepower (SAE net). The 1988 325 model is rated at 127 horsepower (SAE net).

The 6-cylinder engine in the 325i, 325is and 325i Convertible has a displacement of 2492 cc (152 cu. in.), commonly referred to as 2.5 liters. It is rated at 168 horsepower (SAE net).

The in-line engine is bolted to a bellhousing on the transmission and is inclined toward the left side of the engine compartment. This permits a lower hood line and lower center of gravity. The engine and the transmission are supported as a single unit by bonded rubber mounts that reduce the transfer of noise and vibration to the rest of the car.

The information in this section of the manual is a guide both to car owners and to professional mechanics. Some of the operations may require special equipment and experience. If you lack the skills, tools, or a suitable workplace for servicing or repairing the engine, we suggest you leave these repairs to an authorized BMW dealer or other qualified shop. We especially urge you to consult an authorized BMW dealer before beginning any work on a car that may be eligible for repair under the manufacturer's warranty.

1. GENERAL DESCRIPTION

The in-line overhead cam engine is water-cooled and transmits power through a piston-driven crankshaft. The cylinder block is made of cast iron with integral cylinders completely exposed on all sides to the coolant that circulates through the water jacket. A separate cast aluminum alloy cylinder head contains the camshaft and the entire valve train.

1.1 Engine Components

Crankshaft and Bearings

The fully counterweighted crankshaft rotates in replaceable split-shell main bearings. A 2-piece center main bearing controls crankshaft end thrust. Flexible lip seals, pressed into light alloy seal carriers, are installed at both ends of the crankshaft to prevent oil leakage.

Connecting Rods and Pistons

The connecting rods are steel forgings. Replaceable split-shell bearings are installed at the crankshaft end and solid bushings at the piston pin end. The pistons are of the three-ring type with two upper compression rings and a lower one-piece oil scraper ring. Full-floating piston pins are retained at each end by circlips.

Cylinder Head

The cylinder head is an aluminum alloy casting. Replaceable valve guides are press-fit, while the bearing surfaces for the overhead camshaft and the rocker arm shafts are machined directly into the cylinder head casting. See Fig. 1-1.

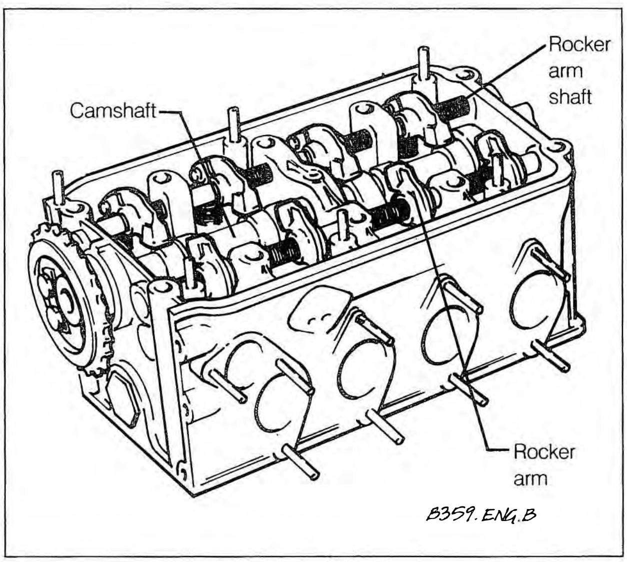

Fig. 1-1. Cylinder head and valve train for models with 4-cylinder engine. Cylinder head for models with 6-cylinder engine is similar.

Valve Train

An overhead camshaft, chain-driven on 4-cylinder engines and belt driven on 6-cylinder engines, operates the valves through rocker arms. One end of each rocker serves as a cam follower and the other end contains the valve adjusting eccentric and its locknut.

Intermediate Shaft (6-cylinder engines only)

The intermediate shaft, turning in the cylinder block, is located above and parallel to the crankshaft. It is gear-driven by the crankshaft and its only purpose is to drive the oil pump.

Lubrication System

The oil pump draws oil through a strainer in the bottom of the oil pan and forces it through a spin-on replaceable filter and into the engine's oil passages. A pressure relief valve limits the pressure in the system, and a filter bypass valve assures lubrication even if the filter is plugged. 4-cylinder engines have a rotor-type pump that is chain-driven off the crankshaft and 6-cylinder engines have a gear-type pump that is shaft-driven off the intermediate shaft.

All models covered by this manual have a low oil pressure warning system. Models with 6-cylinder engines have an additional oil level warning system. This system warns the driver when the oil level falls below a safe level, whether the engine is stopped or running. 325i(is) and 325i Convertible models feature an oil cooler attached to the front of the car through which engine oil circulates to help moderate oil temperature.

1.2 Engine Specifications

Table a lists the major specifications for the engines covered by this manual. Some of this information may be useful when buying parts or making repairs.

2. MAINTENANCE

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of the engine. A number in bold type indicates that the procedure is covered in this section, under that numbered heading. Information on other engine maintenance and on the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Checking engine oil level
2. Changing engine oil and filter
3. Replacing spark plugs
4. Checking compression pressure **3.2**

Table a. Engine Specifications

Model	1984–1985 318i	1984–1987 325 325e 325es	1988 325	1987–1990 325i 325is 325i Convertible
No. of cylinders	4	6	6	6
Bore mm (in.)	89.0 (3.504)	84.0 (3.307)	84.0 (3.307)	84.0 (3.307)
Stroke mm (in.)	71.0 (2.795)	81.0 (3.189)	81.0 (3.189)	75.0 (2.953)
Displacement cc (cu. in.)	1766 (107.8)	2693 (164)	2693 (164)	2492 (152)
Compression ratio	9.0:1	9.0:1	8.5:1	8.8:1
Horsepower SAE net @rpm	101@5800	121@4250	127@4800	168@5800
Torque lbs.-ft. @rpm SAE net	103@4500	170@3250	170@3200	164@4300
Fuel injection system	Bosch L-Jetronic	Bosch Motronic	Bosch Motronic 1.1	Bosch Motronic 1.1
Fuel required	unleaded 91 RON (87 AKI)	unleaded 91 RON (87 AKI)	unleaded 91 RON (87 AKI)	unleaded 91 RON (87 AKI)

5. Adjusting valve clearance **4.4**
6. Replacing cylinder head cover gasket (with valve adjustment above) **4.1**

3. TROUBLESHOOTING

This troubleshooting section applies to problems affecting the basic engine assembly—the cylinder block, cylinder head, and their internal moving parts.

Only a few basic functions are required of the engine. The block, cylinder head, and their moving parts must fit together properly, operate smoothly, seal well enough to create and maintain compression, and keep pistons, valve train, and ignition properly timed. The problems discussed in this troubleshooting section are those that affect one or more of these functions.

Troubleshooting specifically for the lubrication system can be found in this section under **7. Lubrication System**. To troubleshoot overheating and other cooling system problems, see **COOLING SYSTEM**. Troubleshooting for other general starting and running problems can be found in **ENGINE MANAGEMENT-DRIVEABILITY**.

3.1 Basic Troubleshooting Principles

As with any troubleshooting, analysis of the observed symptoms is the key to isolating and identifying engine problems. Begin with careful observation, keeping in mind the following questions:

How has the symptom developed? A symptom that develops quickly is probably caused by a problem that can be corrected by simple maintenance or repair. A symptom that has developed gradually over time, especially after fifty or sixty thousand miles, is more likely an indication of general wear and the need for more comprehensive overhaul work.

Is the symptom engine speed-dependent? A noise that is caused by an engine mechanical problem will be dependent mainly on engine speed, with similar symptoms regardless of changes in car speed. Noises that repeatedly occur only in a certain rpm range suggest a vibration problem. Noises that change with car speed are more likely due to drivetrain or running gear problems.

Is the symptom load dependent? Forces at work inside a running engine vary as the demand for power varies. Symptoms that are more severe during hard acceleration indicate certain kinds of problems. Symptoms that are more apparent at no load or high vacuum (example: coasting at high rpm) point to other problems. Note that higher engine loads also affect the fuel and ignition systems, which may be responsible for high-load performance problems.

Is the symptom temperature dependent? Does it only occur when the engine is cold? Does it change as the engine warms up? How? Metal parts expand and contract with changes in temperature. Clearances change. Oil viscosity and cooling system pressure change. In troubleshooting symptoms that change as the engine gets warm, look for an engine characteristic that changes with temperature.

Noise

In order to run reliably and smoothly under harsh conditions, the internal engine parts are manufactured to precise dimensions, assembled with precision clearances between moving parts, and lubricated by a pressurized oiling system.

Most unidentified engine noises result from clearances that have become too large due to worn or failed parts, lack of adequate lubrication, or both. The importance of lubrication cannot be over-emphasized. For best results, troubleshooting engine noises should only be done when the oil and filter have been recently changed and the oil level is correct.

High-pitched metallic tapping noises are caused by relatively small, lightweight parts and are most likely an indication of excessive clearances in the valve train. Valve train noise accompanied by burning oil (blue-gray smoke in the exhaust), particularly at startup or when decelerating from high rpm, is an indication of worn valve guides that can only be remedied by overhaul or replacement of the cylinder head.

In a high-mileage engine, a light metallic rattle or chatter under acceleration, accompanied by increased oil consumption and smoking, may indicate severely worn or broken piston rings. Since this diagnosis means overhaul or replacement of the engine, the problem should be further investigated with a compression or cylinder leakage test. A vacuum gauge is also helpful when diagnosing engine mechanical faults. See **3.2 Diagnostic Testing**.

Deep, metallic knocking sounds are caused by excessive clearances between heavier components. Closer analysis of the noise will often help identify the problem. Piston slap, caused by excessive piston skirt to cylinder wall clearance, is worse when the engine is cold and may be accompanied by increased oil consumption and reduced compression due to accelerated piston ring wear. A double knock, most pronounced at idle or low load, is due to excessive clearance at the piston pin and upper connecting rod bushing.

Crankshaft bearing problems produce a deep, hollow knock that is worst when the engine is warm. A noise that is very pronounced under load, perhaps louder during the transition from acceleration to coasting, is most likely caused by a damaged connecting rod bearing. Crankshaft main bearings produce a lower, dull knock. An intermittent knock, which may be most apparent when depressing or releasing the clutch, indicates excessive crankshaft end play. These problems seldom occur as isolated failures. They are almost always an indication of the overall engine condition that can only be properly corrected by complete engine overhaul or replacement.

Rumbling or groaning from the engine compartment may not indicate engine problems at all, but rather a worn bearing or bushing in an engine-driven accessory. They include the coolant pump, alternator, and may include a power steering pump and air conditioning compressor. The air conditioning compressor is equipped with an electrically-switched clutch-type pulley, so a bad compressor will only be noisy when the air conditioning is on. To check other accessories, run the engine briefly with the drive belt disconnected and see if the noise has stopped. Once the drive belt is removed, turning the pulley and shaft by hand may also reveal a bad bearing or bushing. A properly functioning accessory should turn smoothly.

Fluid Leaks

Fluid leaking from and around the engine is most likely either oil, coolant, or brake fluid. Look for wet spots on the engine to help pinpoint the source. It may be helpful to start by cleaning the suspected area.

The most likely sources of engine oil leaks are the oil filter gasket, the crankcase oil seals, the cylinder head cover gaskets, or the oil pan gaskets. See **6. Cylinder Block and Pistons** for more information on the gaskets and seals. Because the crankcase is under slight vacuum when the engine is running, some oil leaks may not be apparent until the engine is turned off.

The power steering system is another possible source of oil leaks near the engine. For repairs to the power steering system, see **SUSPENSION AND STEERING**.

Coolant is a mixture of water and anti-freeze, yellow-green in color or perhaps brown if the coolant is old. A pressure test of the cooling system is the best way to discover and pinpoint leaks. See **COOLING SYSTEM**.

Brake fluid is clear, perhaps slightly purple, and a little slippery. Look for wet spots around the master cylinder or brake lines. Especially check the flexible hoses near the wheels. See **BRAKES** for repair information.

Smoking

Smoke that is visible under the hood is usually either blue-gray smoke from burning oil, or white steam from the cooling system. Both symptoms indicate a leak. See **Fluid Leaks** above.

Smoke in the exhaust indicates something getting into the combustion chamber and being burned that does not belong there. The color of the smoke identifies the contaminant.

Blue-gray smoke is from oil. Oil smoke, probably accompanied by increased oil consumption and oil residue on spark plugs, indicates that engine oil is getting past piston rings, valve guides, the cylinder head gasket, or some combination of the three. Use a compression test for diagnosis. See **3.2 Diagnostic Testing**.

In an older engine, compression pressures that are even but below specifications suggest worn piston rings and cylinder walls, and the need to overhaul or replace the engine. If smoking is most obvious under high engine vacuum, such as while coasting at high rpm, and compression pressures are within specifications, leaking valve guide oil seals or worn valve guides are a probable cause. See **4. Cylinder Head** for repair information.

Oil smoke or steam appearing suddenly in the exhaust, along with low compression pressure in one cylinder or two adjoining cylinders, is very probably due to a failed cylinder head gasket. Look also for coolant loss, oil in the radiator, or water in the oil (that turns the oil an opaque, creamy brown). See **4.8 Removing and Installing Cylinder Head** for repair procedures.

Black smoke is caused by the engine getting too much fuel. See **ENGINE MANAGEMENT—DRIVEABILITY** for more troubleshooting information.

Excessive Oil Consumption

Some oil consumption is normal and indicates healthy flow and distribution of the vital lubricant in the engine. BMW states that the maximum allowable oil consumption for the engines covered by this manual is 1 quart per 390 miles. This is why the oil level must be checked, and occasionally corrected, between oil changes. Aside from leaks, increased oil consumption will usually be accompanied by some smoking, however slight, and the causes of excessive oil consumption are the same as those for oil smoke in the exhaust. As with smoking symptoms, gradual increases are caused by worn piston rings and/or valve guides. Sudden high oil consumption suggests broken rings or a failed cylinder head gasket. See **Smoking** above for more troubleshooting information.

Poor Fuel Consumption and Low Power

Poor fuel consumption and low power can suggest problems with the fuel or ignition systems, particularly on a low-mileage engine. On an engine with high mileage, suffering the effects of wear, low compression may be the cause.

Normal wear of the valves, piston rings, and cylinder walls decreases their ability to seal. The intake and compression of the air/fuel mixture becomes less efficient, and the engine has to work harder, using more fuel, to produce the same amount of power. Engine condition can be evaluated with a compression test. See **3.2 Diagnostic Testing**.

Engine Not Running

An engine problem that affects timing may prevent the engine from starting or running. The camshaft drive belt (6-cylinder engines) or timing chain (4-cylinder engines) and sprockets are responsible for timing the actions of the valves and the ignition system relative to the pistons and crankshaft. A worn camshaft drive belt or timing chain may jump teeth, throwing off all the engine's timing functions, and still appear to be perfectly normal.

To check camshaft timing, see **4.2 Camshaft Drive Belt (6-cylinder engines)** or **4.3 Camshaft Timing Chain (4-cylinder engines)**. Other troubleshooting information for an engine that fails to start can be found in **ENGINE MANAGEMENT—DRIVEABILITY**.

Table b lists symptoms of engine problems, their probable causes, and suggested corrective actions. The boldface numbers in the corrective action column indicate the heading in this section of the manual where the applicable test and repair procedures can be found.

4

Table b. Engine Troubleshooting

Symptom	Probable cause	Corrective action
1. Pinging or rattling noise under load, uphill or accelerating, especially from low speeds. Indicates detonation or pre-ignition	**a.** Ignition timing incorrect (too advanced) **b.** Fuel does not meet manufacturer's octane requirements **c.** Overheating **d.** Spark plugs damaged or wrong heat range **e.** Air/fuel mixture too lean	**a.** Check ignition timing. See **IGNITION** **b.** Switch to higher octane fuel. See **FUEL SYSTEM** for fuel octane requirements **c.** See **COOLING SYSTEM** **d.** Replace spark plugs. See **IGNITION** **e.** See **FUEL SYSTEM**
2. Screeching or squealing noise under load. Goes away when coasting. Indicates slipping V-belt	**a.** Loose, worn, or damaged V-belt(s) **b.** Excessive belt loads due to failed engine-driven component	**a.** Inspect, replace, or tighten belt(s). See **LUBRICATION AND MAINTENANCE** **b.** Locate and replace failed component. **3.2**

continued on next page

Table b. Engine Troubleshooting (continued)

Symptom	Probable cause	Corrective action
3. Growling or rumbling, varies with engine rpm. Bad bearing or bushing in an engine-driven accessory	**a.** Coolant pump **b.** Alternator **c.** Power steering pump **d.** Camshaft drive belt tensioner bearing **e.** Air conditioning compressor	**a.** See **COOLING SYSTEM** **b.** See **ELECTRICAL SYSTEM** **c.** See **SUSPENSION AND STEERING** **d.** Replace belt tensioner and drive belt. **4.2** **e.** Replace compressor
4. Light metallic tapping noise, varies directly with engine speed. Oil warning light **not** illuminated	**a.** Low oil pressure and defective warning light circuit **b.** Valve clearance out of adjustment **c.** Defective rocker arm(s) or rocker arm shaft(s)	**a.** Check oil pressure. **7** **b.** Adjust valve clearance. **4.4** **c.** Check rocker arms/shafts and replace as required. **4.6**
5. Light metallic knock, varies directly with engine speed. Oil warning light blinking or fully illuminated (may be most noticeable after hard stops or during hard cornering) Indicates lack of sufficient oil supply	**a.** Low oil level **b.** Restricted (dirty) oil filter **c.** Insufficient oil pressure	**a.** Check and correct oil level. See **LUBRICATION AND MAINTENANCE** **b.** Change engine oil and filter. See **LUBRICATION AND MAINTENANCE** **c.** Check oil pressure. **7**
6. Blue-gray exhaust smoke, oily spark plugs. Indicates oil burning in combustion chamber	**a.** Leaking valve stem oil seals **b.** Worn valve guides **c.** Worn, broken, or incorrectly installed pistons or piston rings	**a.** Replace valve stem oil seals. **4.7** **b.** Overhaul or replace cylinder head. **4.** **c.** Overhaul or replace engine
7. Blue-gray smoke and/or white steam in exhaust	**a.** Failed cylinder head gasket (probably accompanied by low compression readings) See **3.2 Diagnostic Testing** **b.** Warped or cracked cylinder head (probably accompanied by low compression readings) See **3.2 Diagnostic Testing** **c.** Cracked cylinder block	**a.** Replace cylinder head gasket. **4.8** **b.** Resurface cylinder head or replace gasket. **4.8** **c.** Replace engine or short block. To remove engine see **5**
8. Black exhaust smoke	**a.** Rich air/fuel mixture	**a.** See **FUEL SYSTEM**
9. Engine runs badly, pops and backfires	**a.** Spark plug wires installed incorrectly **b.** Incorrect valve timing	**a.** Install wires correctly. See **IGNITION** **b.** Check camshaft drive belt or camshaft timing chain and camshaft timing. **4.2** or **4.3**
10. Engine will not start or run. Starter operates, engine turns over at normal speed	**a.** Failed ignition system **b.** Broken camshaft drive belt or timing chain **c.** Incorrect camshaft timing due to jumped or incorrectly installed belt or chain	**a.** See **IGNITION** **b.** Check camshaft rotation as engine turns over. Install new camshaft drive belt or timing chain as necessary. **4.2** or **4.3** **c.** Check camshaft timing. Replace belt or chain and sprockets as necessary. **4.2** or **4.3**

3.2 Diagnostic Testing

The tests that follow can be used to help isolate engine problems, to better understand a problem before starting expensive repairs, or just to periodically check engine condition.

Compression Test

A test of compression pressures in the individual cylinders will tell a lot about the condition of the engine without the need for taking it apart. The test is relatively simple. It requires a compression tester, a spark plug wrench, and a screwdriver.

To obtain accurate results, the battery and starter must be capable of turning the engine at normal cranking speed. The area around the spark plugs or injectors should be clean, to avoid getting debris inside the engine when they are removed. Because engine temperature may affect compression, the most accurate results are obtained when the engine is at normal operating temperature.

To test compression:

1. Make sure the ignition is turned off.

2. On 4-cylinder engines, remove the fuel pump relay from the auxiliary relay panel. See Fig. 3-1. Disconnect the harness connector(s) from the ignition control unit on the firewall.

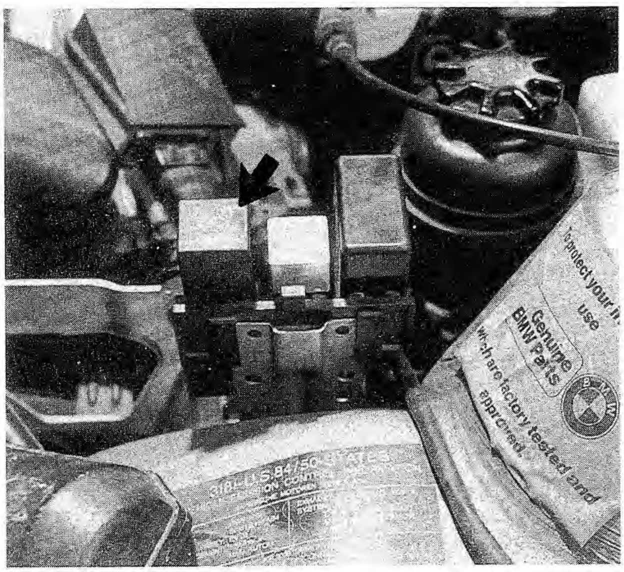

Fig. 3-1. Auxiliary relay panel near left shock tower on 4-cylinder engine. Remove cover from panel and remove fuel pump relay (arrow).

3. On 6-cylinder engines, remove the main relay from the auxiliary relay panel near the left (driver's) side shock tower. See Fig. 3-2.

> ***CAUTION —***
> *The main relay may be located in an adjacent position. To check if the main relay has been correctly identified, inspect the wires leading to the relay socket. There should be two large (4 mm) wires leading to the main relay socket.*

4. Remove and label the spark plug wires from the spark plugs. Use care to pull only on the boot to avoid damage to the connectors.

5. Remove the spark plugs and set them aside, in order corresponding to the cylinders from which they were removed.

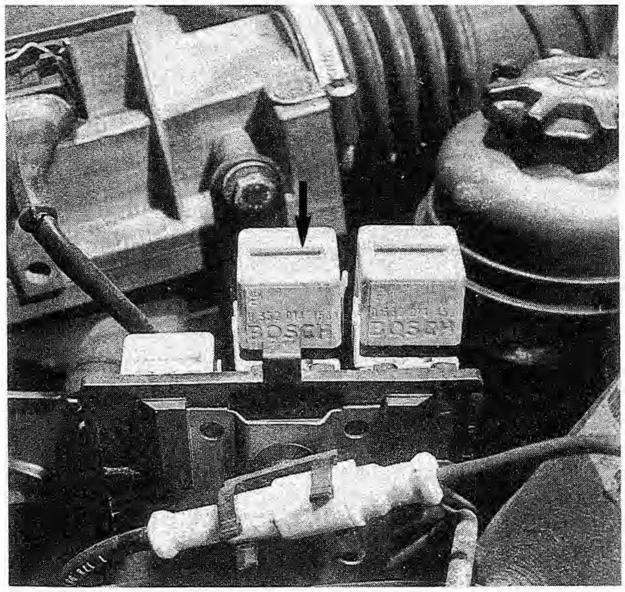

Fig. 3-2. Auxiliary relay panel near left shock tower on 6-cylinder engine. Remove cover from panel and remove main relay (arrow).

6. Thread the compression tester into the first cylinder's spark plug hole, just tight enough to seal around the spark plug hole. Use care not to damage the seal on the gauge line.

7. With the transmission in neutral and the throttle held wide open, crank the engine with the starter. The gauge reading should increase with each engine revolution. Crank the engine about 4 to 5 revolutions. Record the value shown on the gauge.

> **NOTE —**
> The engine should be cranked an equal number of revolutions at each cylinder to obtain the most accurate readings.

8. Release the pressure, either with the gauge valve or by slowly removing the gauge, allowing the pressure to bleed off while threading it out of the spark plug hole.

9. Repeat the test for each of the other cylinders. Record the data and compare with **Table c**.

Table c. Compression Pressure Specifications

Engine	Compression pressure
All	10–11 bar (142–156 psi)

10. Reinstall the spark plugs and the spark plug wires in their original locations. Reconnect all electrical harness connectors and reinstall the relay.

Low compression is evidence of poorly sealed combustion chambers. The characteristics of the test results help isolate the cause or causes. Generally, compression pressures that are relatively even but below acceptable specifications indicate worn piston rings and/or cylinder walls. Low but erratic values tend to indicate valve leakage. Dramatic differences, such as acceptable values in some cylinders and very low values in one or two cylinders are the sign of a localized failure, probably of a head gasket. There are three more tests that can further isolate the problem.

Wet Compression Test

To analyze poor compression and further identify the source of the leakage, repeat the compression test, this time with about a teaspoon of oil squirted into each cylinder. The oil will temporarily help seal between the piston rings and the cylinder wall, practically eliminating leakage past the rings for a short time. If this test yields higher compression readings than the "dry" compression test, the difference can be attributed to leakage between the piston rings and cylinder walls, due either to wear or to broken piston rings. Little or no change in compression readings indicates other leakage, probably from the valves or a failed cylinder head gasket.

Leak-down Test

The most conclusive diagnosis of low compression symptoms requires a leak-down test. Using a special tester and a supply of compressed air, each cylinder is pressurized. The rate at which the air leaks out of the cylinder, as well as where the air leaks out, can more accurately pinpoint the magnitude and source of the leakage. Any engine compression diagnosis that will require major disassembly should first be confirmed by the more accurate leak-down test. Because the test requires special equipment and experience, it may be desirable to have it done by a BMW dealer or other qualified repair shop.

Vacuum Gauge Test

A vacuum gauge can be a useful tool when diagnosing engine problems. Care must be taken in interpreting the readings and the movements of the gauge needle. In many instances, the readings may indicate several problems and further testing may be required to isolate the exact problem. The vacuum gauge should be connected to a vacuum source on the intake manifold and the engine should be at operating temperature.

The engine vacuum gauge measures manifold vacuum. Manifold vacuum varies with different engine operating conditions and also with different engine problems. The manner in which the vacuum reading varies from the normal reading can indicate the type of engine problem. **Table d** lists vacuum gauge readings, their probable causes, and corrective actions.

Table d. Vacuum Gauge Readings

Vacuum gauge reading	Probable cause	Corrective action
1. High and steady reading (15-22 in./Hg.)	a. Normal performance. Engine in good condition	a. No corrective action required
2. Low and steady reading(10-15 in./Hg.)	a. Incorrect ignition timing (retarded) b. Incorrect valve timing c. Low compression d. Throttle valve sticking e. Leaking intake manifold gasket or fuel injector seals	a. Check ignition timing. See **IGNITION** b. Inspect camshaft timing. **4.2** or **4.3** c. Test compression as described above d. Remove intake air boot and check throttle movement. See **FUEL SYSTEM** e. Inspect intake manifold gasket. Remove injectors and check O-rings. See **FUEL SYSTEM**
3. Very low but steady reading at idle (below 10 in./Hg.) Engine idles very rough and stalls	a. Large intake air leak b. Ignition timing severely retarded or advanced	a. Visually inspect for faulty gaskets, hoses, or connections. Check the oil dipstick seal, the oil filler cap and the cylinder head cover gasket carefully b. Check ignition timing. See **IGNITION**

continued on next page

Table d. Vacuum Gauge Readings (continued)

Vacuum gauge reading	Probable cause	Corrective action
4. Gauge reading drifts or floats at idle	**a.** Minor intake air leak **b.** Air/fuel mixture incorrect (rich)	**a.** Visually inspect for intake air leaks **b.** Check air/fuel mixture. See **FUEL SYSTEM**
5. Gauge reading fairly steady at idle but vibrates rapidly when engine speed is increased	**a.** Worn (weak) valve springs **b.** Ignition miss **c.** Faulty cylinder head gasket	**a.** Replace valve springs **4.9** **b.** Test ignition system. See **IGNITION** **c.** Test compression as described above
6. Gauge reading steady at idle but drops regularly	**a.** Sticking or faulty valve or incorrect valve clearance. (Needle drops when faulty valve operates) **b.** One or more spark plugs not firing **c.** Faulty head gasket	**a.** Adjust valve clearance **4.4** If valve clearance is correct, inspect valves **4.9** **b.** Replace faulty spark plugs or spark plug wires. See **IGNITION** **c.** Test compression as described above
7. Gauge reading vibrates rapidly at idle but steadies when engine speed is increased	**a.** Worn valve guides	**a.** Check valve guides and repair or replace as necessary. **4.9**
8. Gauge reading gradually drops to 0 in./Hg at idle	**a.** Plugged or restricted exhaust system	**a.** Check exhaust system for restrictions, especially check for a plugged catalytic converter

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4. Cylinder Head

The cylinder head can be removed from the cylinder block for repairs with the engine in the car. Since the camshaft bearing bores are integral with the head and are not split with removable caps, it is necessary to remove the cylinder head for most cylinder head repairs.

Reconditioning the cylinder head is not overly complicated, but requires time and an extensive tool selection. If good machine shop services are not available in your area, or time is a factor, installation of a remanufactured cylinder head is a good alternative. Remanufactured cylinder heads are available from an authorized BMW dealer.

4.1 Cylinder Head Cover and Gasket

Because the cylinder head cover gasket is deformed during installation, it is not reusable. It should be replaced anytime the cylinder head cover is removed and anytime there is evidence of leaks. A faulty gasket can also be the source of vacuum leaks and erratic idle caused by a lean mixture.

To remove and install cylinder head cover gasket:

1. On 4-cylinder engines, remove the six nuts, one bolt and the breather hose as shown in Fig. 4-1. Disconnect the breather hose from the cover.

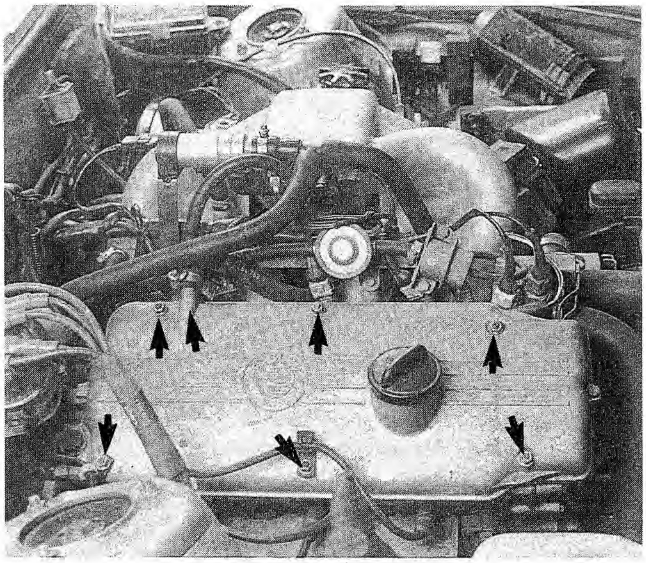


Fig. 4-1. Cylinder head cover mounting nuts, bolt, and breather hose (arrows).

2. On 6-cylinder engines, remove the intake manifold support bracket and the idle air stabilizer valve support bracket as shown in Fig. 4-2. Remove the electrical connectors from the idle air stabilizer valve and, if applicable, the cold-start valve.

NOTE —

The 325i(is), 325i Convertible and 1988 325 models are not equipped with cold-start valves.

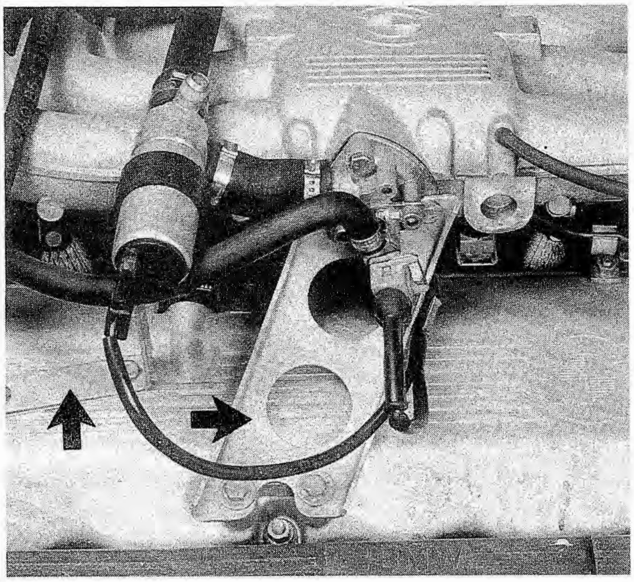


Fig. 4-2. Intake manifold and idle air stabilizer valve support brackets (arrows) on 325e engine. Brackets on other engines are similar.

3. On 1984 and 1985 6-cylinder engines, remove the reference point sensor and the speed sensor connectors from the mounting bracket on the cylinder head cover. See Fig. 4-3.

NOTE —

Mark the wires so they can be reinstalled in the correct location. The engine will not start if they are incorrectly installed.

4. On 6-cylinder engines, disconnect the breather hose from the cover. Remove the eight mounting nuts and the ground strap. See Fig. 4-4. Lift off the large ignition wire cover and place it out of the way.

5. Carefully lift off the cylinder head cover and its gasket. If the gasket is stuck to the cylinder head, use a gasket removing tool or a dull knife to separate the gasket from the head.

CAUTION —

Use care when removing a stuck gasket. Damage to either surface can cause vacuum and oil leaks.

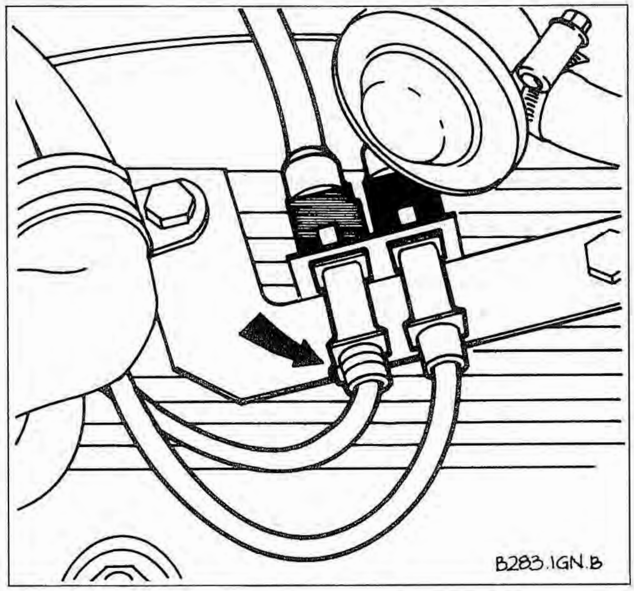


Fig. 4-3. Reference point sensor and speed sensor connector on 1984 and 1985 6-cylinder head cover.

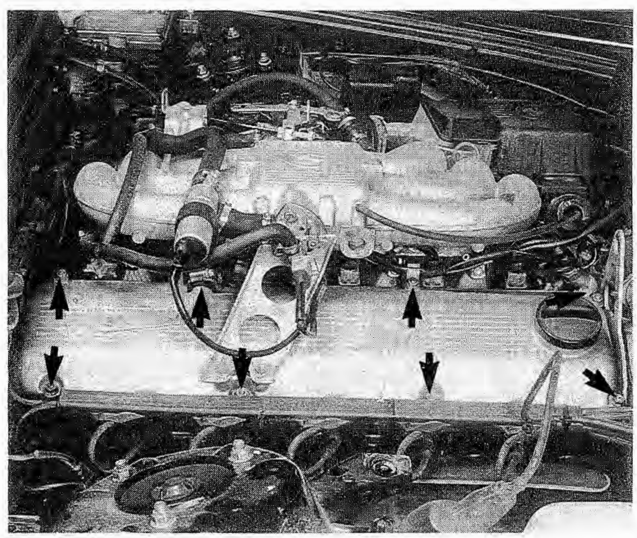


Fig. 4-4. Breather hose and cylinder head cover mounting nuts on 325e engine (arrows).

6. Install a new gasket and the cylinder head cover.

7. On 4-cylinder engines, install the spark plug wire bracket.

8. On 6-cylinder engines, install the support bracket(s). Reconnect the harness connectors. Attach the ground strap under the no. 6 mounting nut.

9. Install and tighten the mounting nuts to 15 ± 1.5 Nm (11 ± 1 ft. lb.) in the sequence shown in Fig. 4-5. Reconnect the breather hose.

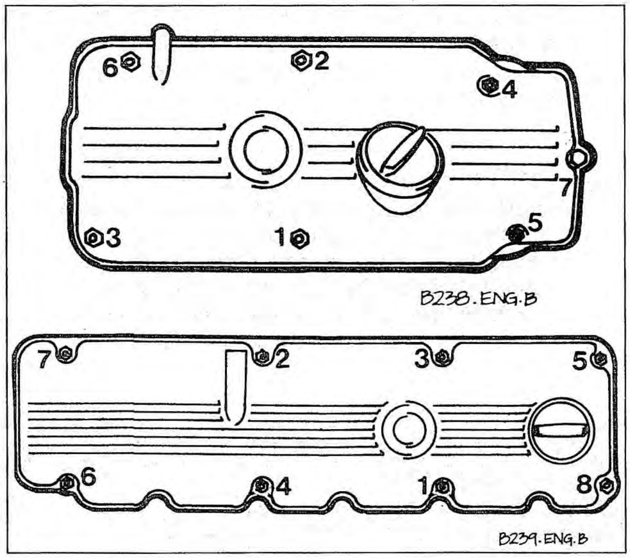


Fig. 4-5. Cylinder head cover mounting nut tightening sequence on 4-cylinder engines (top) and 6-cylinder engines (bottom).

4.2 Camshaft Drive Belt (6-cylinder engines)

The camshaft on the 6-cylinder engines covered by this manual are actuated by a toothed Gilmer-type rubber belt. See Fig. 4-6. Due to belt composition and high under-hood temperatures, the belt is subject to wear. BMW recommends that the belt be replaced at least every 60,000 miles, every four years, or anytime belt tension is relieved.

CAUTION —
Reusing a camshaft drive belt could result in overstretching of the belt, which can cause decreased belt life and possible engine damage.

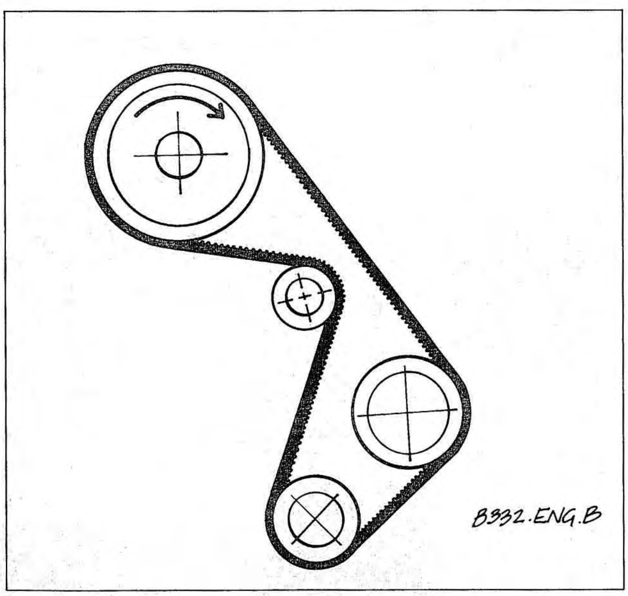


Fig. 4-6. Camshaft drive belt configuration with tensioner and sprockets. Arrow shows engine rotation direction.

Various versions of drive belt tensioner pulleys, belts and sprockets were installed on the 6-cylinder engines covered by this manual. Some of the earlier versions of tensioner pulleys and belts are no longer available. During drive belt replacement only parts containing the Z 127 markings should be installed. See Fig. 4-7. If an earlier version belt is being replaced, the tensioner pulley must also be replaced. Consult your authorized BMW dealer parts department for latest parts information.

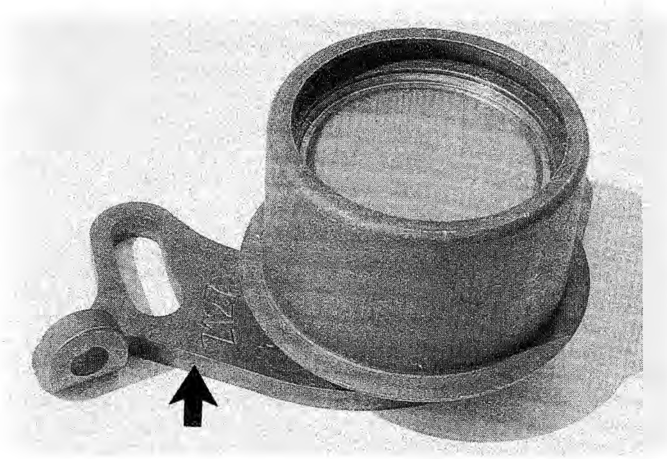


Fig. 4-7. Camshaft drive belt tensioner with stamp "Z 127" (arrow).

NOTE —
Models with 6-cylinder engines built between July 1986 and September 1986 have a camshaft drive belt sprocket that may break. See the build date on the driver's door pillar. Sprockets that have been replaced under warranty will be so noted by a blue paint dot on the thermostat housing and a round label affixed to the driver's door pillar with the number "14" punched out. If this repair has not been done, the sprocket should be inspected by an authorized BMW dealer. All sprockets with stamped markings "W+P 2 86" must be replaced.

To remove:

1. With the engine cold, drain the coolant as described in **COOLING SYSTEM**.

2. Remove the radiator cooling fan and the radiator as described in **COOLING SYSTEM**.

   NOTE —
   Although it is possible to replace the camshaft drive belt without removing the radiator, the removal of the radiator greatly simplifies the task.

3. Remove the distributor cap and ignition rotor as described in **IGNITION**. Place the cap and wires out of the way.

   NOTE —
   Label the spark plug wires so that they can be reinstalled in their original locations.

4. Remove the alternator V-belt, the air conditioning compressor V-belt, and the power steering pump V-belt as described in **LUBRICATION AND MAINTENANCE**.

5. Remove the two mounting bolts from the upper camshaft drive belt cover. Remove the cover and the engine hoisting bracket. See Fig. 4-8.

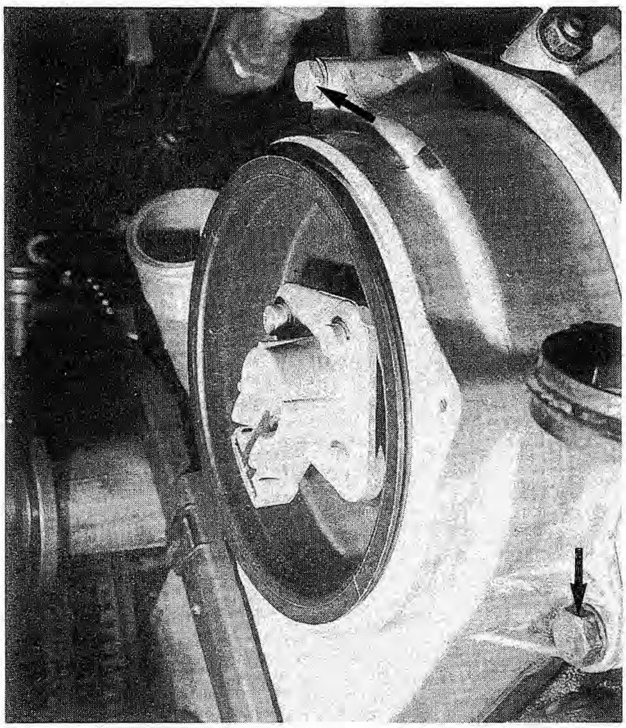


Fig. 4-8. Upper camshaft drive belt cover mounting bolts (arrows).

6. Remove the upper alternator bracket by removing the mounting nut and bolt. See Fig. 4-9.

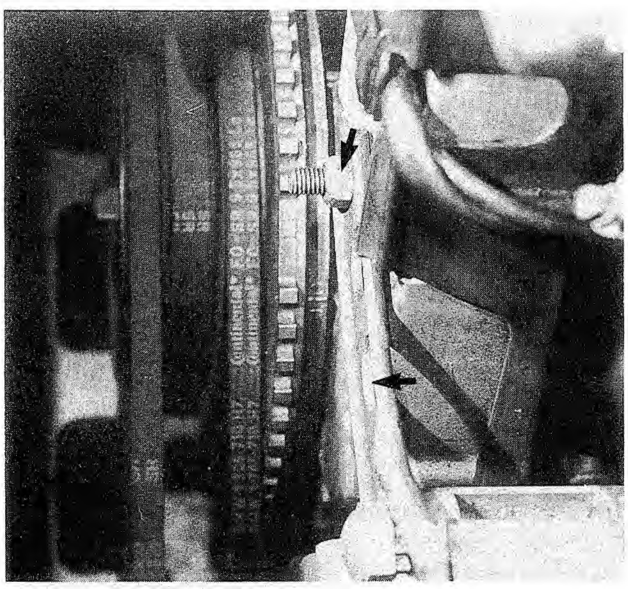


Fig. 4-9. Upper alternator bracket and mounting nut and bolt (arrows).

7. Using a socket wrench on the center vibration damper (crankshaft pulley) bolt, rotate the crankshaft clockwise until the engine is at Top Dead Center (TDC or 0/T) of the No. 1 cylinder.

NOTE —

At TDC on the compression stroke of the No. 1 cylinder, the "0/T" mark on the vibration damper will align with the notch on the lower camshaft drive belt cover. The arrow and notch on the camshaft drive belt sprocket will align with the mark stamped on the cylinder head. See Fig. 4-10.

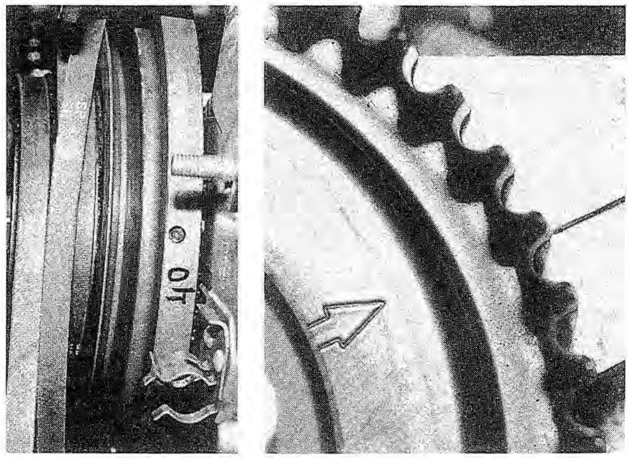


Fig. 4-10. Top Dead Center (TDC) mark on vibration damper aligned with mark on lower drive belt cover (left) and camshaft sprocket aligned with mark on cylinder head (right).

8. On 325e(es) models, remove the Top Dead Center (TDC) sensor from its clip as shown in Fig. 4-11.

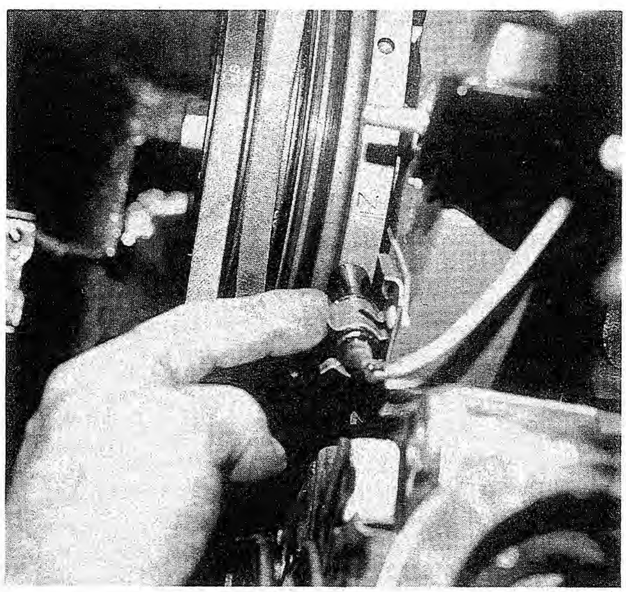


Fig. 4-11. Top Dead Center (TDC) sensor and clip.

9. On 325i(is) and 325i Convertible models, remove the reference sensor mounting bolt. Remove the sensor with the wiring from the mounting clips on the camshaft drive belt cover. See Fig. 4-12.

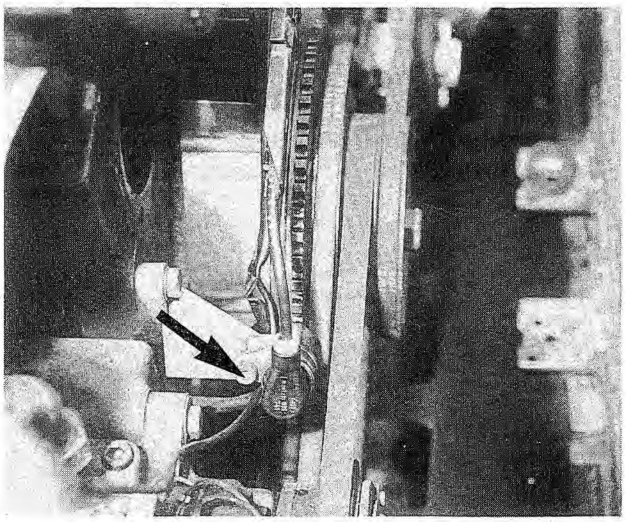


Fig. 4-12. Reference sensor mounting bolt on 325i model (arrow).

10. Remove the lower camshaft drive belt cover mounting bolt together with the cover.

11. Remove the six bolts that hold the lower drive belt pulley and the vibration damper to the front of the crankshaft.

NOTE

It may be necessary to immobilize the crankshaft with a combination wrench.

12. Remove the pulley and the damper. It may be necessary to pry gently with a screwdriver to free the pulley and the damper from the crankshaft.

13. On early models with a two-piece crankshaft hub, hold the hub stationary and remove the hub's center mounting bolt. Then using a suitable puller remove the hub from the crankshaft.

NOTE

- On models with a two-piece crankshaft hub, removal of the hub is necessary to remove the belt from the crankshaft sprocket. On models with a one-piece hub, there is enough clearance to slide the belt over the hub—therefore removal of the hub is not necessary.

- The crankshaft sprocket and hub mounting bolt is tightened to a torque of approximately 410 Nm (302 ft. lb.). A heavy-duty holding device, such as BMW Tool No. 11 2 150, should be used to hold the sprocket. Use a heavy-duty ¾-inch drive socket and breaker bar to break the bolt free.

14. Loosen the upper bolt that secures the belt tensioner pulley. See Fig. 4-13. Loosen the lower nut that is at the base of the long stud that also secures the lower camshaft drive belt cover and the alternator bracket.

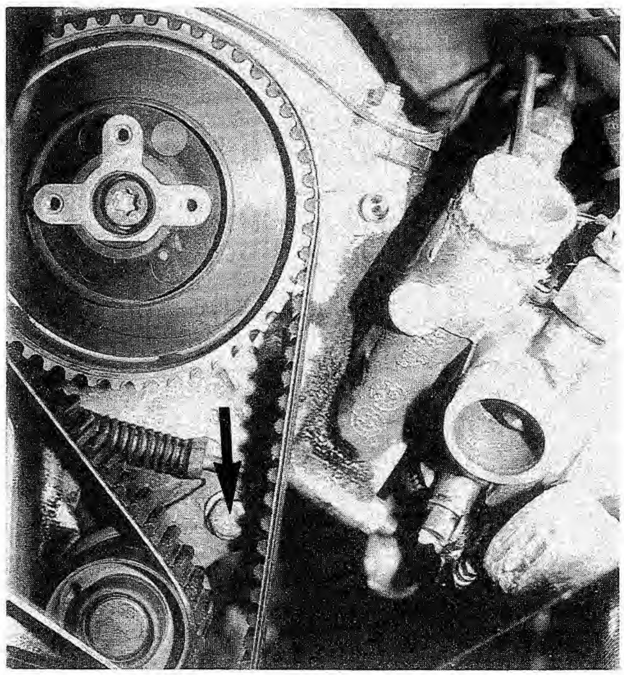


Fig. 4-13. Upper mounting bolt for camshaft drive belt tensioner (arrow).

15. Using a long screwdriver, relieve the belt tension by rotating the belt tensioner pulley counterclockwise (toward the passenger side of the car) as far as it will go, then tighten the upper bolt. Peel the belt from the camshaft, the intermediate shaft and the crankshaft sprockets, and the belt tensioner pulley.

CAUTION

Tools should not be used to assist in removing the belt. Once the belt is removed, do not disturb the camshaft or crankshaft position. Rotation of either shaft could result in engine damage.

16. Inspect the camshaft belt tensioner pulley. If the pulley catches, is noisy, or has radial (side-to-side) or axial (in-and-out) play, or does not spin freely, it is faulty and must be replaced as described below in **Replacing Camshaft Drive Belt Tensioner Pulley**.

NOTE

1986 and later cars have belt tensioner pulleys that are marked with "Z 127." 1985 and earlier cars may be equipped with an earlier version pulley. If there is no "Z 127" stamp on the base of the belt tensioner pulley, it must be replaced with one so marked.

4

To install:

1. Check that both the crankshaft and camshaft timing marks are correctly aligned as shown above in Fig. 4-10. Check the crankshaft position by loosely installing the lower camshaft drive belt cover and the vibration damper so that the alignment of the crankshaft 0/T mark can be inspected.

2. Install the belt beginning at the crankshaft sprocket. Install the camshaft drive belt in a counterclockwise direction, slipping the belt over the intermediate shaft and the camshaft sprockets, and the camshaft belt tensioner pulley.

> ***CAUTION —***
>
> *Do not use any tools to force the camshaft drive belt onto the pulleys.*

3. With the belt correctly positioned on the sprockets, slowly loosen the camshaft belt tensioner pulley upper retaining bolt so that the belt is tensioned.

4. Using a socket wrench on the center crankshaft bolt, slowly rotate the engine clockwise through two complete revolutions (720°) until the timing marks are aligned again.

> ***CAUTION —***
>
> *If either the crankshaft or the camshaft are not perfectly aligned, it is necessary to release tension on the camshaft drive belt, carefully peel the belt from the camshaft drive gear, and repeat the above steps. It is permissible to rotate the camshaft drive gear by hand by one or two teeth in either direction to ensure proper alignment.*

5. Once the alignment of crankshaft and camshaft timing marks are correct, torque first the upper and then the lower tensioner mounting bolts to 22±2 Nm (16±1 ft. lb.).

The remainder of the installation is the reverse of removal. On models with a two-piece crankshaft hub, install the hub aligning the keyway with the key. Hold the crankshaft still using a holding device while tightening the mounting bolt to 410±20 Nm (297±14 ft. lb.). Tighten the bolts on the vibration damper to 22±2 Nm (16±1 ft. lb.). Tighten the smaller M6 nuts and bolts on the upper and lower aluminum camshaft covers to 9 to 11 Nm (7 to 8 ft. lb.). Tighten the larger M8 nuts and bolts on the upper and lower aluminum camshaft drive belt covers to 22±2 Nm (16±1 ft. lb.). Tighten the reference sensor mounting bolt to 7±1 Nm (5±0.5 ft. lb.).

Install the V-belts removed earlier. Adjust V-belt tensions as described in **LUBRICATION AND MAINTENANCE**. Place a label in the engine compartment noting camshaft drive belt replacement date and odometer reading. Refill the cooling system as described in **COOLING SYSTEM**.

Replacing Camshaft Drive Belt Tensioner Pulley

The camshaft drive belt tensioner pulley should be carefully inspected whenever the drive belt is replaced. Prior to inspecting the tensioner, the drive belt should be removed as described above in **4.2 Camshaft Drive Belt (6-cylinder engines)**.

> **NOTE —**
>
> 1986 and later cars have belt tensioner pulleys that are marked with "Z 127." 1985 and earlier cars may be equipped with an earlier version pulley. If there is no "Z 127" stamp on the base of the belt tensioner pulley, it must be replaced with one so marked.

With the drive belt tension relieved, loosen the upper tensioner pulley bolt. Carefully remove the bolt while applying light sideways pressure on the pulley to prevent the guide pin and the spring from flying out. Remove the spring and the pin. Remove the lower bolt with the pulley. Place the new pulley into position and hand start the lower bolt. Install the guide pin with the spring into the notch of the coolant pump. See Fig. 4-14. Rotate the pulley counterclockwise until the pin engages the hole in the tensioner arm. Apply a slight sideways pressure until the upper tensioner pulley retaining bolt can be installed. With a long screwdriver apply pressure to compress the spring fully, then tighten the retaining bolt.

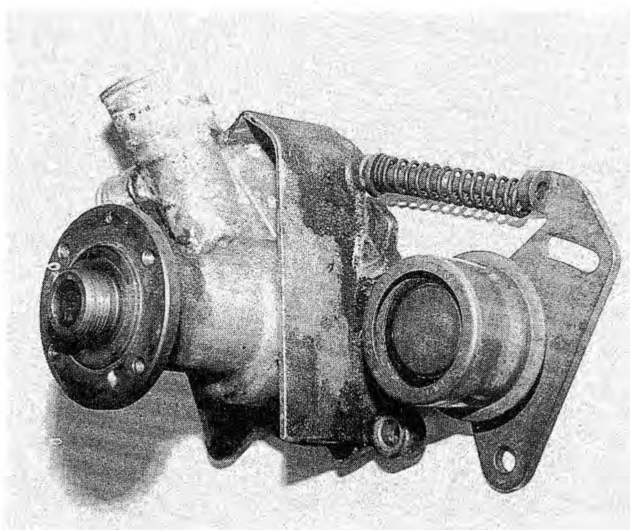


Fig. 4-14. Relationship of camshaft belt tensioner pulley, tensioner spring and pin, and coolant pump.

4.3 Camshaft Timing Chain (4-cylinder engines)

A single-row camshaft timing chain actuates the camshaft. The chain is driven by a sprocket on the front of the crankshaft. The timing chain is lubricated by engine oil and does not require maintenance. On high mileage engines, a timing chain can wear, causing it to stretch until the tensioner system no longer provides proper valve timing. A worn timing chain can be noisy and can cause erratic valve timing, leading to loss of performance. A noisy timing chain can also be caused by a faulty timing chain tensioner piston.

To remove:

1. Disconnect the negative (−) battery cable.

CAUTION —

BMW Anti-theft radios can be rendered useless by disconnecting battery cables. See your owner's manual for more information.

2. Remove the cylinder head cover as described in **4.1 Cylinder Head Cover and Gasket**.

3. Using a 30 mm socket on the center vibration damper (crankshaft pulley) bolt, rotate the crankshaft clockwise until the engine is at Top Dead Center (TDC or 0/T) on the compression stroke of the No.1 cylinder. At TDC, the notch in the vibration damper will align with the cast boss on the camshaft timing chain cover. See Fig. 4-15.

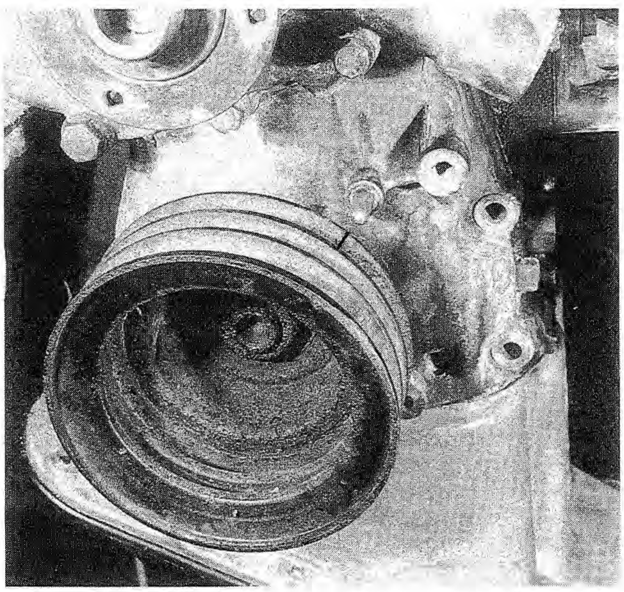


Fig. 4-15. Top Dead Center (TDC) mark on vibration damper aligned with mark on timing chain cover.

4. Drain and remove the radiator, the radiator hoses and the fan shroud as described in **COOLING SYSTEM**.

5. Remove all V-belts as described in **LUBRICATION AND MAINTENANCE**.

6. Remove the bracket for the diagnostic connector.

7. Remove the alternator and its bracket as described in **ELECTRICAL SYSTEM**.

8. Remove the power steering pump and its brackets as described in **SUSPENSION AND STEERING**. Using a stiff wire, support the power steering pump.

CAUTION —

Do not allow the power steering pump to hang from its hoses, as damage to the hoses, the fittings, or the pump may occur.

9. Remove the air conditioning compressor from its brackets by removing the mounting bolts.

WARNING —

Under no circumstances should you attempt to remove the hoses from the air conditioner compressor. Doing so can lead to the expulsion of refrigerant under high pressure, leading to possible eye damage or frostbite.

CAUTION —

Be careful not to damage the compressor body while prying it free from the bracket. Be ready to catch the compressor as it separates from the bracket. Support the compressor using stiff wire.

10. Remove the bolts that hold the air conditioning compressor bracket to the cylinder block and remove the bracket.

11. Remove the coolant pump as described in **COOLING SYSTEM**.

12. Remove the eight bolts that secure the upper camshaft timing chain cover to the cylinder head and to the lower camshaft timing chain cover. Gently pry the upper timing chain cover from the cylinder head, taking care not to tear the cylinder head gasket.

13. Secure the damper or the flywheel to prevent the crankshaft from turning. Using a 30 mm socket, loosen the nut that holds the vibration damper to the crankshaft. See Fig. 4-16.

NOTE —

- The vibration damper nut is tightened to a torque of approximately 190 Nm (140 ft. lb.). Use a large breaker bar to break the bolt free.

- A special BMW service tool (BMW Tool No. 11 2 100) is available to hold the flywheel stationary while the vibration damper mounting nut is removed. As an alternative, a large wrench can be used to hold the rear part of the damper stationary. If the alternate method is used, a thick strip of leather or other material should be used to prevent slippage and damage to the vibration damper.

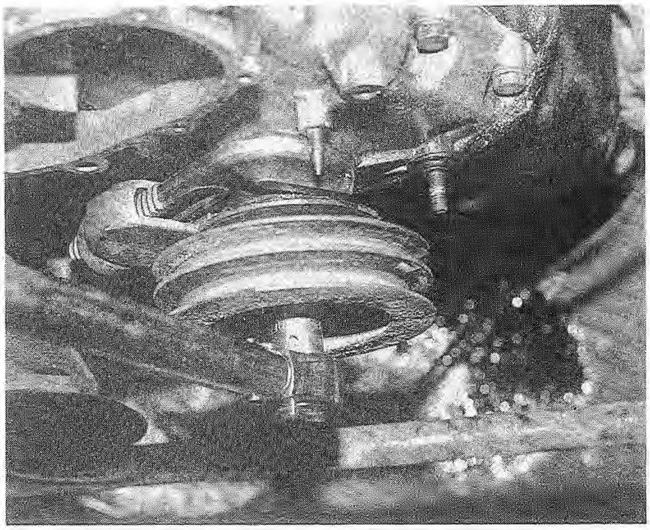


Fig. 4-16. Vibration damper secured with wrench while mounting nut is loosened.

14. Using a 2-jaw or 3-jaw gear puller, remove the vibration damper as shown in Fig. 4-17.

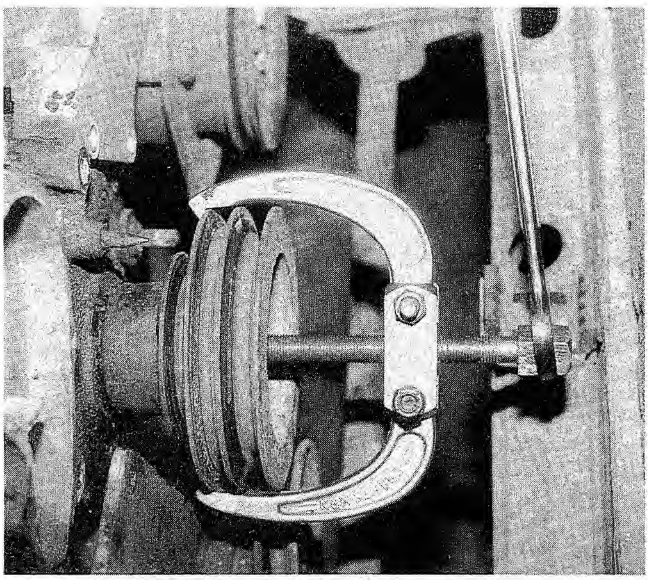


Fig. 4-17. Vibration damper being removed from crankshaft with puller and wrench.

15. Slowly loosen the nut that secures the timing chain tensioner piston and its spring. See Fig. 4-18. Be ready to catch the spring as the nut is removed. Pull the piston from its bore.

16. Check the piston for free movement of the check ball by shaking the piston. If the ball cannot be heard to rattle freely in the piston, the unit should be disassembled and cleaned.

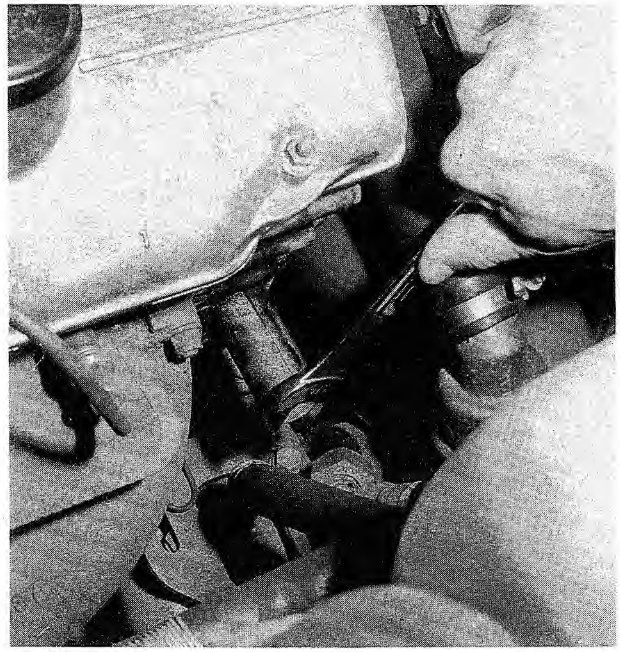


Fig. 4-18. Camshaft timing chain tensioner piston being removed.

17. Check the function of the piston check ball by blowing air into the closed end of the piston. No air should pass. Blow air into the slotted guide end of the piston. Air should pass freely. If either of the test conditions are not met, disassemble and clean the piston. See Fig. 4-19. If the piston cannot be made to operate correctly, it should be replaced.

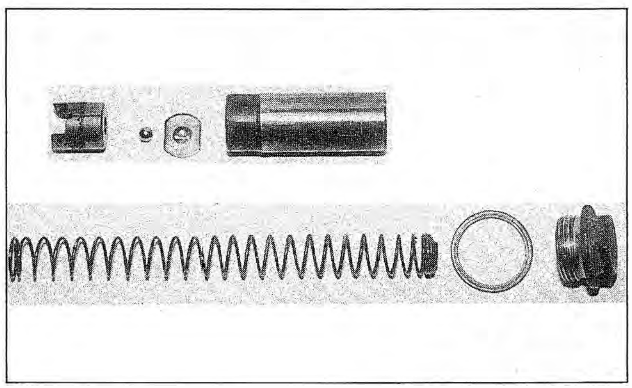


Fig. 4-19. Timing chain tensioner piston assembly shown disassembled.

18. Remove the five bolts from the lower timing chain cover. See Fig. 4-20.

19. Working beneath the car, remove the three bolts that attach the oil pan to the bottom of the timing chain cover. Loosen the three forward oil pan bolts on either side of the engine. Using a sharp knife, separate the cover from the oil pan gasket and remove the cover.

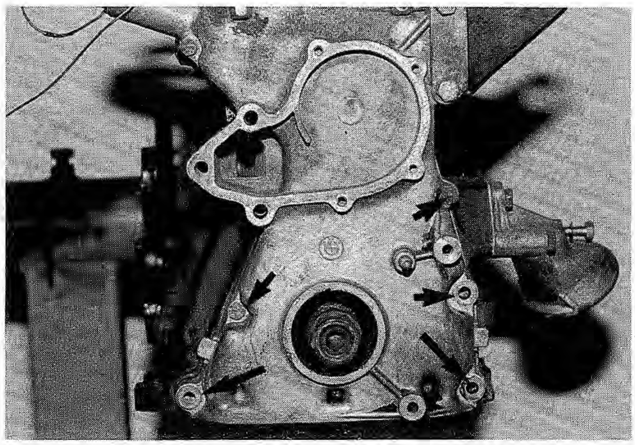


Fig. 4-20. Lower timing chain cover mounting bolts (arrows).

20. Remove the bolts from the camshaft sprocket and pry the sprocket from the camshaft. See Fig. 4-21.

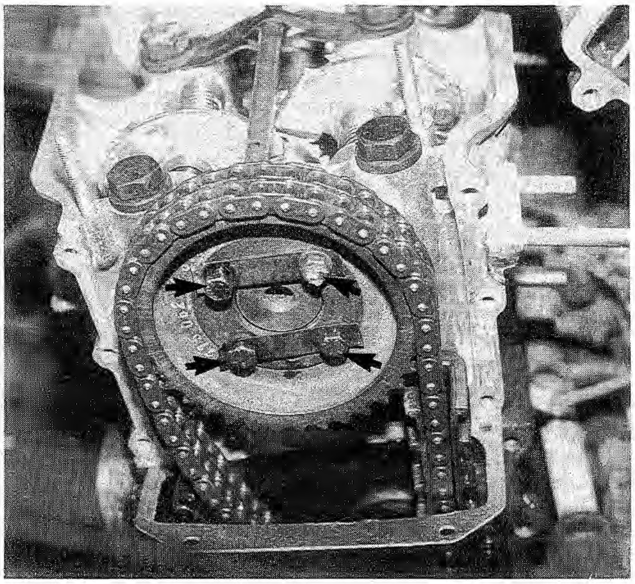


Fig. 4-21. Camshaft drive sprocket mounting bolts (arrows). Sprocket shown with locking tabs.

CAUTION —

Do not rotate the crankshaft or the camshaft while the timing chain is removed, as bent valves may result.

NOTE —

Some models may be equipped with camshaft sprocket bolt locking tabs. The locking tabs are no longer available from BMW and do not have to be reinstalled.

21. Inspect the timing chain sprockets. Sprockets that have worn or missing teeth should be replaced. The chain should also be replaced if the sprockets are excessively worn.

NOTE —

If the crankshaft sprocket requires replacement, the oil pan and the oil pump drive sprocket must be removed as described under **7. Lubrication System**. The crankshaft sprocket can be removed from the crankshaft using a puller. Prior to installing the replacement sprocket, it must first be heated in an oil bath to a maximum temperature of 390°F (200°C). At this temperature, the sprocket can be driven onto the crankshaft while aligning the woodruff keyway. Due to the high temperatures required, we recommend that this be done by an authorized BMW dealer or other qualified shop.

22. Inspect the guide rail and tensioner rail for deep grooves caused by chain contact. The rails can be replaced after removing the circlips from the mounting pins. See Fig. 4-22. Always use new circlips.

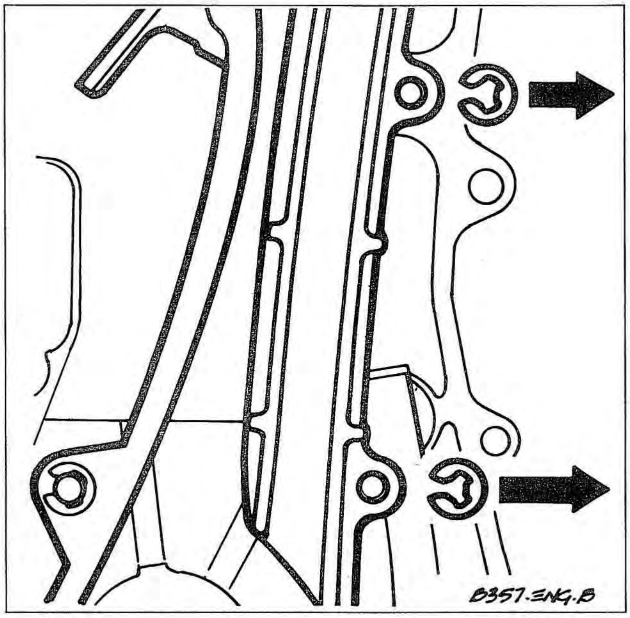


Fig. 4-22. Camshaft timing chain guide rail mounting circlips. Remove circlips in direction of arrows.

23. Inspect the crankshaft oil seal in the front of the lower timing chain cover. If the oil seal is hard, cracked, or otherwise damaged, it should be replaced as described in **6.1 Cylinder Block Oil Seals**.

To install:

1. Check that both the camshaft and the crankshaft are set at Top Dead Center (TDC). At Top Dead Center (TDC or 0/T), the notch in the camshaft flange should be aligned with the cast mark on the cylinder head as shown in Fig. 4-23 and the woodruff key on the crankshaft should point straight up. Also see Fig. 4-15 above.

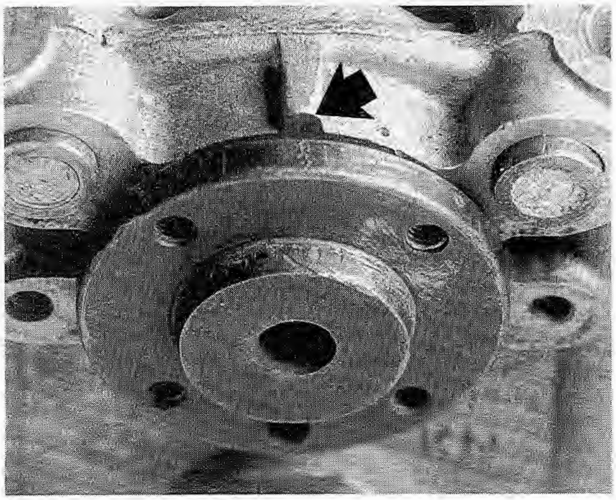


Fig. 4-23. Notch in camshaft flange aligned with mark on cylinder head (arrow).

2. Make sure the chain is properly engaged on the crankshaft sprocket. Install the camshaft sprocket to the chain so that the guide pin on the camshaft flange and its hole on the rear of the sprocket point straight down.

3. Install the sprocket onto the camshaft and torque the mounting bolts to 7 Nm (5 ft. lb.). Check that the TDC marks are still aligned.

4. Install the timing chain guide rail and tensioner rail.

5. Apply a light coat of gasket sealer to the lower camshaft timing chain cover gaskets. Install the gaskets on the cylinder block. Apply a light coating of sealant to the exposed portion of the oil pan gasket, using extra sealer at the rear corners. See Fig. 4-24.

6. Apply a light coat of engine oil to the lip of the crankshaft oil seal in the lower timing chain cover and place the cover into position. Loosely install the cover mounting bolts and the oil pan mounting bolts.

7. Loosely install the power steering bracket and the air conditioning bracket with their mounting bolts.

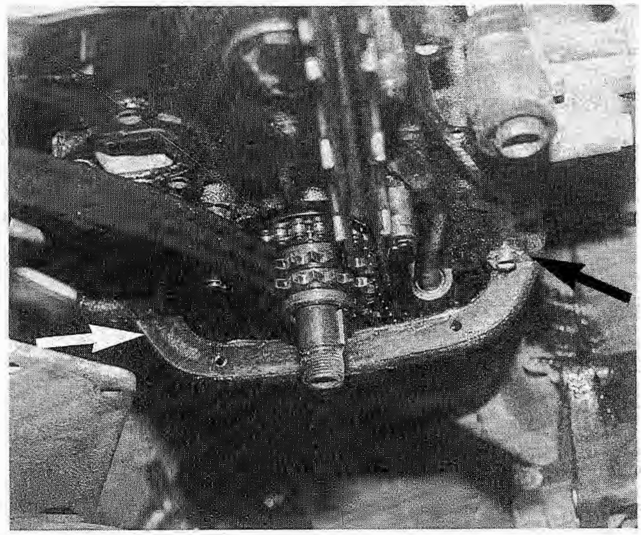


Fig. 4-24. Area of oil pan gasket requiring extra gasket sealer (arrows).

8. When all brackets and bolts are installed, tighten all the smaller M6 bolts to 9 to 11 Nm (7 to 8 ft. lb.) and all the larger M8 bolts to 22 ± 2 Nm (16 ± 1 ft. lb.). Tighten the bolts in an alternating pattern. Tighten the oil pan bolts to 9 to 11 Nm (7 to 8 ft. lb.).

9. Install the camshaft chain tensioner piston, the spring, a new seal, and the chain tensioner securing nut. Be sure that the tapered end of the spring faces the nut when reinstalling the piston.

10. Bleed the camshaft chain tensioner piston by moving the tensioner rail back and forth slowly until oil runs out past the securing nut and resistance can be felt. Tighten the securing nut to 35 ± 5 Nm (26 ± 4 ft. lb.).

11. Install the vibration damper to the crankshaft. While holding either the damper or the flywheel stationary, tighten the nut to a torque of 190 ± 10 Nm (140 ± 7 ft. lb.). See Fig. 4-25.

12. Apply a light coat of sealer to the two upper camshaft timing chain cover gaskets. Set the gaskets into position on the cover. Apply a brush-on gasket sealer using enough around the small bores to fill them. See Fig. 4-26.

NOTE —

The gaskets are not identical and will only fit in one position.

13. Install the bracket for the diagnostic connector onto the upper timing chain cover.

14. Install the upper timing chain cover and hand-tighten the mounting bolts. First tighten the six bolts on the front of the cover then the two lower bolts, torqueing the smaller M6 bolts to 9 to 11 Nm (7 to 8 ft. lb.) and the larger M8 bolts to 22 ± 2 Nm (16 ± 1 ft. lb.).

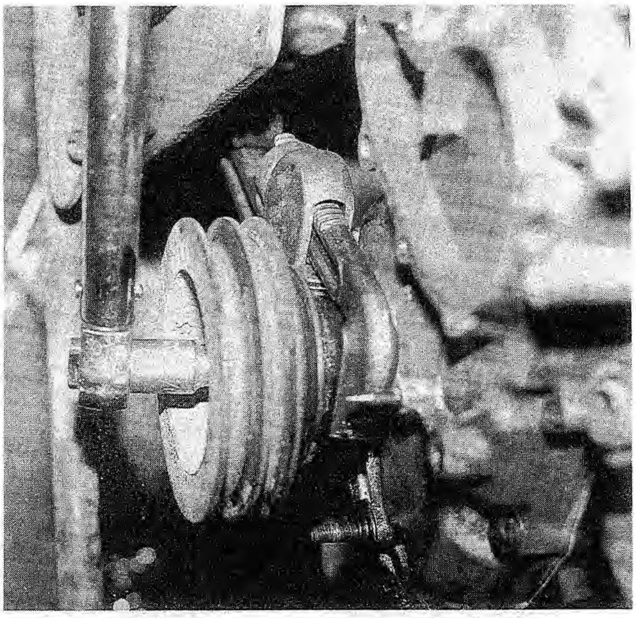


Fig. 4-25. Vibration damper secured with wrench while mounting nut is tightened.

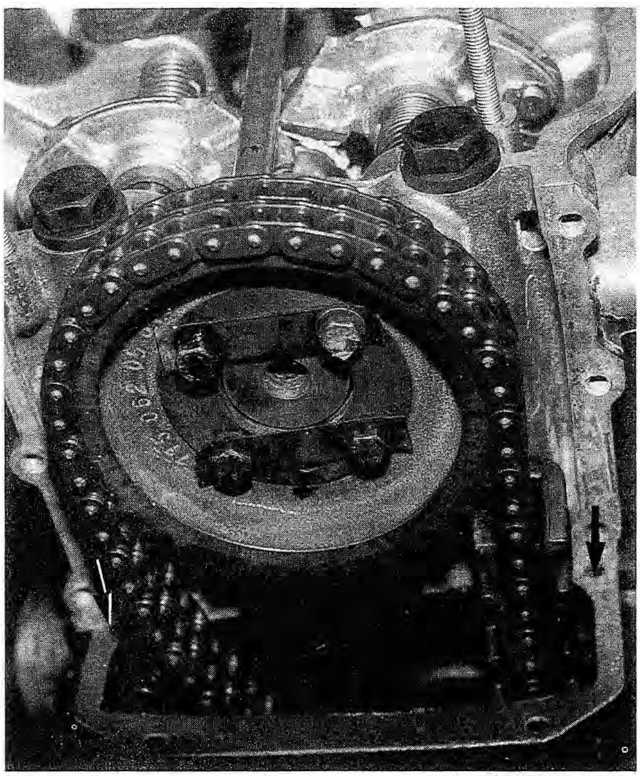


Fig. 4-26. Apply enough sealer to fill bores (arrows).

15. Install the cylinder head cover as described in **4.1 Cylinder Head Cover and Gasket**.

16. Install the coolant pump as described in **COOLING SYSTEM**.

17. Install the air conditioning compressor.

18. Install the power steering pump as described in **SUSPENSION AND STEERING**.

19. Install the alternator as described in **ELECTRICAL SYSTEM**.

20. Install all belts as described in **LUBRICATION AND MAINTENANCE**.

21. Install the radiator, fan shroud, coolant hoses and refill the cooling system as described in **COOLING SYSTEM**.

22. Reconnect the battery.

4.4 Valve Adjustment

Valve adjustment should be done as part of scheduled maintenance. For a listing of recommended adjustment intervals, see **LUBRICATION AND MAINTENANCE**.

A special tool (BMW Tool No. 11 3 070) is available to aid in the adjustment of the eccentric that is used to set the valve clearance. As an alternative, a tool can be easily fabricated from stiff wire (approximate diameter of 3/32 in.). The valves can be adjusted with the engine hot or cold.

To adjust valve clearance:

1. Remove the cylinder head cover as described in **4.1 Cylinder Head Cover and Gasket**.

2. Using a socket wrench on the vibration damper bolt, hand-turn the crankshaft clockwise until the No. 1 cylinder's camshaft lobes are pointing approximately downward (valves fully closed).

NOTE —
- The No. 1 cylinder is the one closest to the radiator end of the engine.
- Crankshaft rotation can be done more easily if the sparks plugs are first removed as described in **LUBRICATION AND MAINTENANCE**.

3. Measure the valve clearances of the intake and exhaust valves using a feeler gauge. See Fig. 4-27. Compare the measured clearance values with the specifications listed in **Table e**.

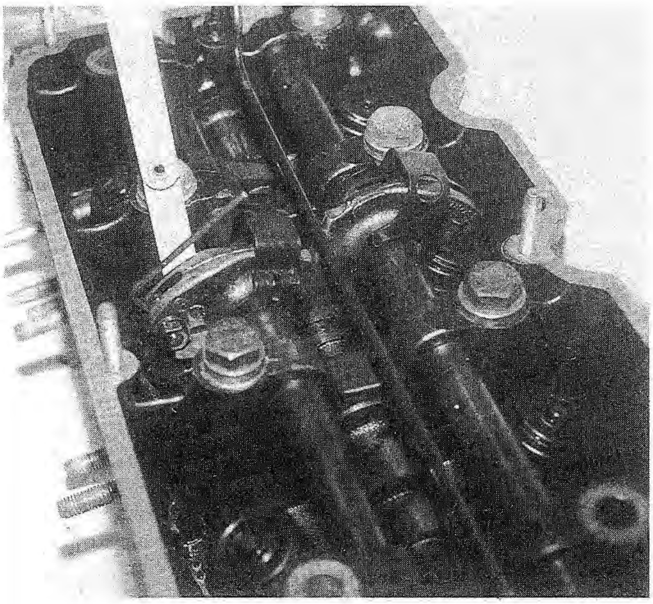


Fig. 4-27. Valve clearance being measured. Feeler gauge is inserted between rocker arm eccentric and valve.

Table e. Valve Clearance Specifications

Engine warm (coolant temperature above 176°F (80°C))	
4-cylinder	0.25 mm (0.010 in.)
6-cylinder	0.30 mm (0.012 in.)
Engine cold (coolant temperature below 95°F (35°C))	
4-cylinder	0.20 mm (0.008 in.)
6-cylinder	0.25 mm (0.010 in.)

NOTE —

Valve clearance specifications for both the intake valves and the exhaust valves are the same.

4. If the valve clearance is not within specifications, adjust the eccentric by loosening the setscrew nut (locknut) with a 10 mm box-end wrench. Rotate the eccentric with a stiff wire hook until the specified clearance is obtained. See Fig. 4-28. Tighten the nut to 10±1 Nm (89±9 in. lb.).

CAUTION —

Avoid using an open-end wrench to loosen the adjusting nut, as a slip of the wrench can round off the nut's edges.

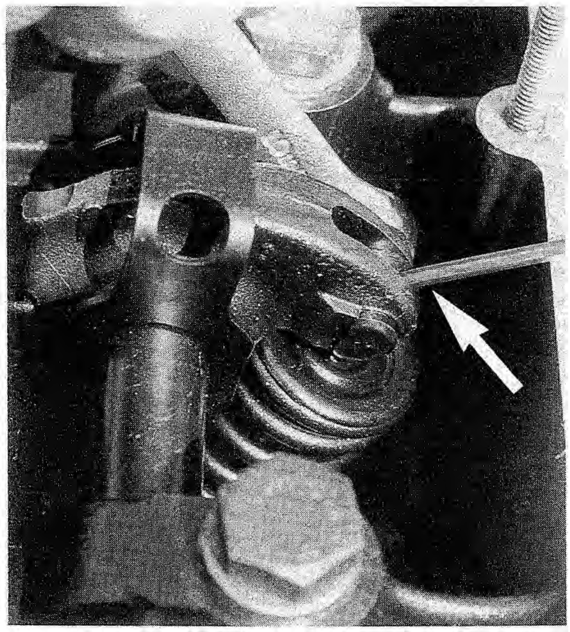


Fig. 4-28. Valve clearance being adjusted. Stiff wire hook inserted into hole in eccentric (arrow).

5. Repeat the adjusting procedure for each pair of valves. Follow the sequence listed in **Table f**. Rotate the crankshaft until the camshaft lobes for the next cylinder are pointing approximately downward (valves fully closed).

NOTE —

On 4-cy
turn (approximately 180°) between adjustments.
On 6-cylinder engines, rotate th
turn (approximately 120°) between adjustments.

Table f. Valve Adjustment Sequence

Engine	Crankshaft rotation between adjustments	Adjustment sequence
4-cylinder	½ turn (approx. 180°)	1—3—4—2
6-cylinder	⅓ turn (approx. 120°)	1—5—3—6—2—4

6. Recheck all clearances before installing the cylinder head cover as described in **4.1 Cylinder Head Cover and Gasket**.

4.5 Removing and Installing Camshaft

The cylinder head must be removed before the camshaft can be removed. Special BMW tools are available to compress the valve springs so that the camshaft can be withdrawn from the head. If the special tools are not available, an alternative is to remove the cylinder head and have the camshaft removed by an authorized BMW dealer or other qualified shop.

To remove and install (4-cylinder engines):

1. Remove the cylinder head as described below in **4.8 Removing and Installing Cylinder Head**.

2. Remove the oil supply tube from the top of the cylinder head. Note the orientation of the spacer washers on the retaining bolt.

3. Adjust all valve clearances so that the hole in the eccentric cam points inward (maximum clearance) as described in **4.4 Valve Adjustment**.

4. Remove the mounting bolts for the camshaft thrust plate. Slide the plate down to remove. See Fig. 4-29.

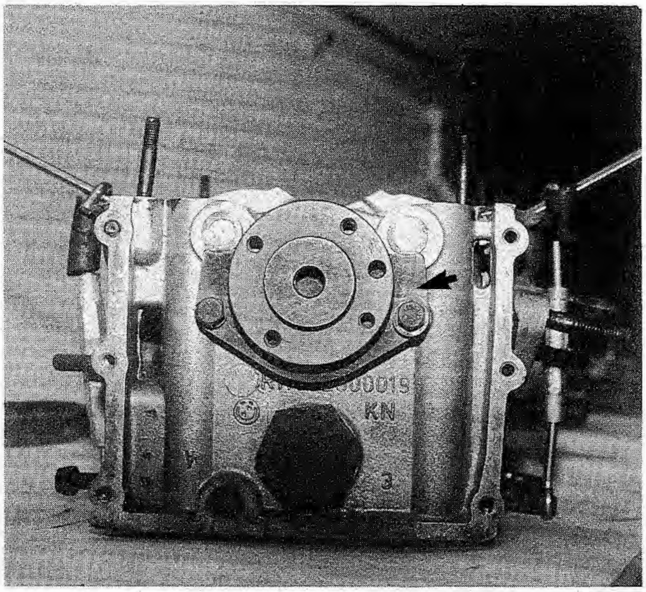


Fig. 4-29. Camshaft thrust plate (arrow).

5. Rotate the camshaft until only three of the eight rocker arms are exerting pressure on the camshaft lobes. Depress the three rocker arms and remove the camshaft. Rotating the camshaft as it is withdrawn will facilitate passage of camshaft lobes through the journal bores.

WARNING

The valves are under considerable pressure from the valve springs. Use extreme care when depressing the valve springs. Wear hand and eye protection.

NOTE

The rocker arms and valve springs can be depressed using standard screwdrivers or a forked tool fabricated from steel. See Fig. 4-30.

Installation is the reverse of removal. The camshaft lobes and journals should be lubricated prior to installation. Rotate the camshaft until the mark in the camshaft flange is aligned with the cast mark in the cylinder head as shown in Fig. 4-31.

Be sure the spacers on the oil supply tube bolt are correctly positioned on either side of the tube. Tighten the supply tube mounting bolt to 11 to 13 Nm (8 to 10 ft. lb.). Install the cylinder head as described under **4.8 Removing and Installing Cylinder Head**. Adjust the valve clearance as described in **4.4 Valve Adjustment**.

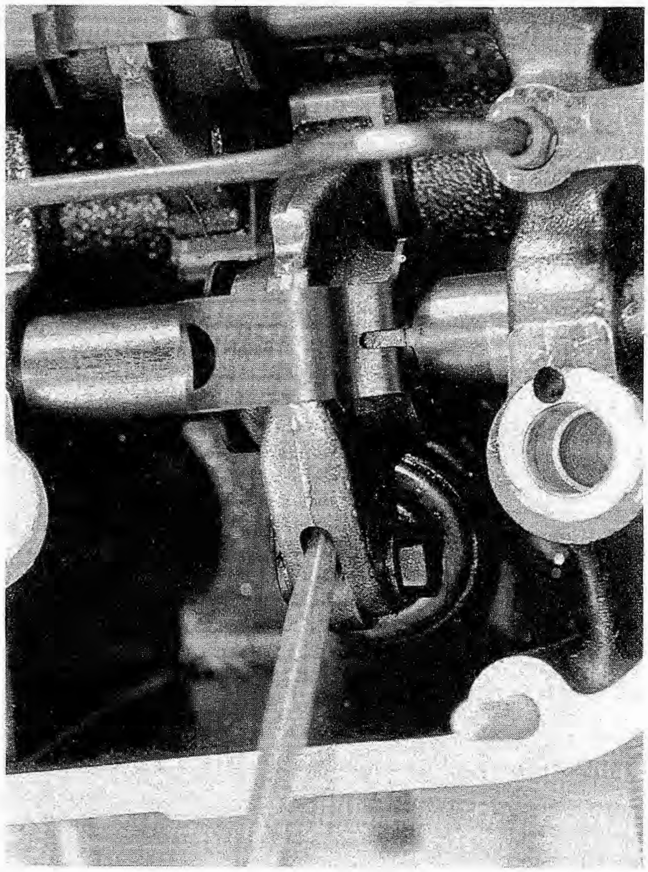


Fig. 4-30. No. 1 intake valve rocker arm being depressed with screwdriver.

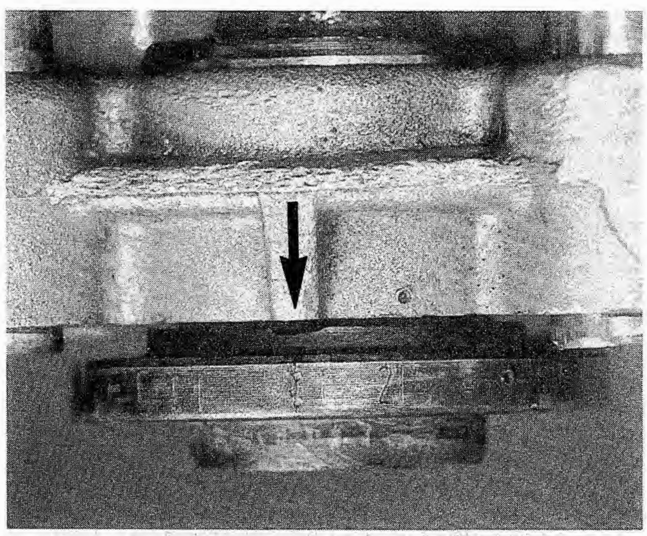


Fig. 4-31. Camshaft flange mark aligned with cast mark on cylinder head (arrow).

To remove and install (6-cylinder engines):

1. Remove the cylinder head as described in **4.8 Removing and Installing Cylinder Head**.

2. Remove the rocker arm shafts as described in **4.6 Removing and Installing Rocker Arm Shafts and Rocker Arms**.

3. Remove the socket head bolt from the camshaft sprocket using a 7 mm hex wrench. See Fig. 4-32. Remove the camshaft drive belt sprocket from the camshaft along with the distributor rotor adaptor.

NOTE —
It
drive belt sprocket while breaking the bolt loose. The old camshaft drive belt, which must be replaced, may be wrapped around the camshaft drive belt sprocket, then clamped with a pair of locking pliers.

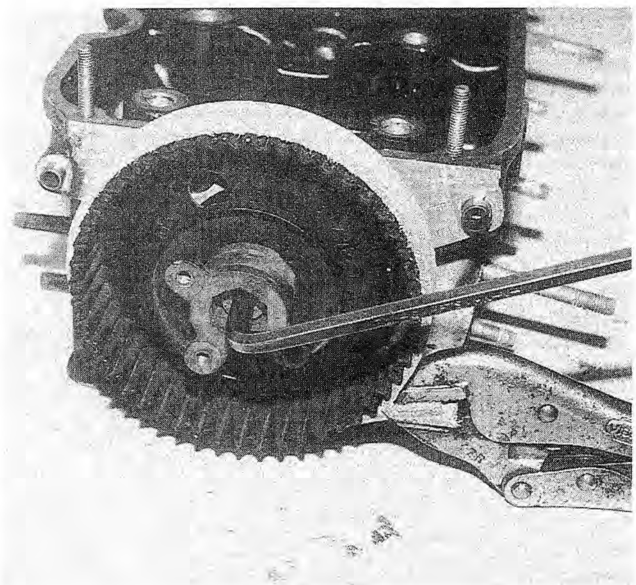


Fig. 4-32. Distributor rotor adaptor and camshaft sprocket mounting bolt being removed. Sprocket is being held stationary with a strip of leather and locking pliers.

4. Remove the two camshaft oil seal housing mounting bolts. Remove the housing by rotating it off the camshaft. See Fig. 4-33.

NOTE —
Inspec
the seal housing for signs of leakage. Check for oil leaks around the housing. A faulty seal or O-ring should be replaced. The camshaft oil seal is pressed into the oil seal housing. If
requires replacement, a service press or its equivalent should be used to re
install the new seal.

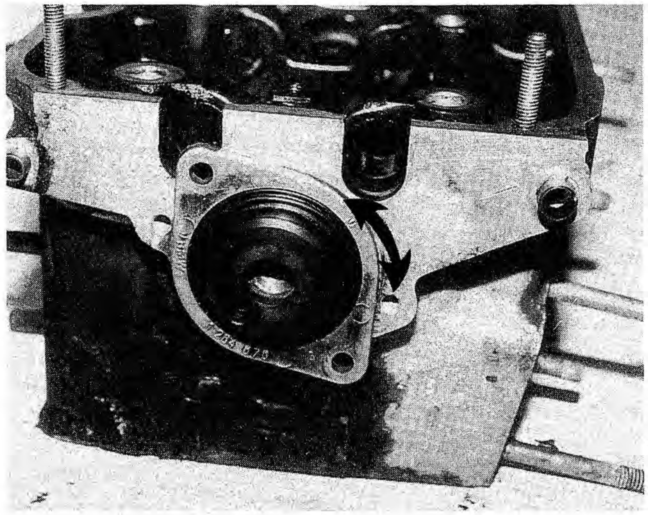


Fig. 4-33. Camshaft oil seal housing being removed from cylinder head. Rotate housing back and forth as it is removed (arrow).

5. Pull the camshaft out of the cylinder head, supporting both ends in order to prevent damage to the camshaft bearing bores in the cylinder head.

Installation is the reverse of removal. Before installing the camshaft, it should be thoroughly lubricated. Coat the camshaft oil seal lip and the housing O-ring with motor oil before installation. To prevent damaging the oil seal, wrap the front of the camshaft with tape. If the oil supply tube was removed, tighten the fittings to 6 to 8 Nm (4.5 to 5.5 ft. lb.). Install the camshaft sprocket and the distributor rotor adaptor so the guide pin correctly aligns with the guide hole in the sprocket and adaptor. Tighten the mounting bolt to 65 to 70 Nm (48 to 52 ft. lb.).

Install the cylinder head rocker arms and rocker arm shaft as described under **4.6 Removing and Installing Rocker Arm Shafts and Rocker Arms**. Install the cylinder head as described in **4.8 Removing and Installing Cylinder Head**.

4.6 Removing and Installing Rocker Arm Shafts and Rocker Arms

Removing and installing the rockers arms and rocker arm shafts requires that the cylinder head be removed from the cylinder block.

Inspecting Rocker Arms and Rocker Arm Shafts

Rocker arms and rocker arm shafts are components that wear and may become noisy due to excessive clearances. Although valve train noise may indicate worn rocker arms or rocker arm shafts, valve train noise may also be caused by incorrect valve clearances or other engine wear. Valve clearance adjustment is described in **4.4 Valve Adjustment**. Additional cylinder head inspection is described in **4.9 Disassembly, Assembly, and Reconditioning Cylinder Head**.

Checking the rocker arm assemblies for wear requires using a dial indicator setup to measure the radial (side-to-side) play of the rocker arm on the shaft. See Fig. 4-34. Play should be between 0.016 mm and 0.052 mm (0.0006 and 0.0020 in.). If the radial play is excessive, the rocker arm or shaft should be replaced as described below.

NOTE —
On models with 6-cylinder engines, remove the rocker arm retaining clips (shown below in Fig. 4-38) from the rocker arm shaft before checking rocker arm radial play.

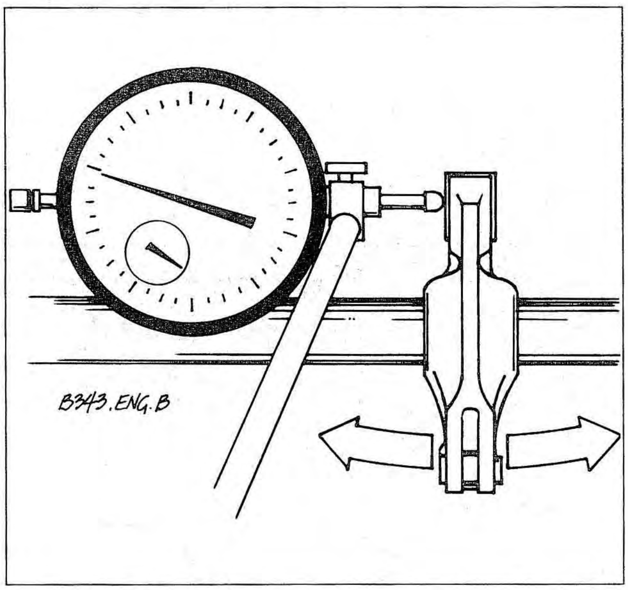


Fig. 4-34. Dial indicator being used to check rocker arm wear.

To remove and install (4-cylinder engines):

1. Remove the cylinder head as described under **4.8 Removing and Installing Cylinder Head**.

2. Remove the camshaft as described under **4.5 Removing and Installing Camshaft**.

3. Remove the distributor housing by removing the five mounting bolts from the rear of the cylinder head.

CAUTION —
The distributor housing is sealed in place. Tap the distributor housing lightly to break the housing free. Do not pry on the mating surfaces.

4. Remove the rocker arm retainers by sliding the rocker arm and the thrust ring to the side and removing the snap ring. See Fig. 4-35.

NOTE —
In case of excessive buildup of material on the rocker arm shaft it may be necessary to clean the shaft before removing it.

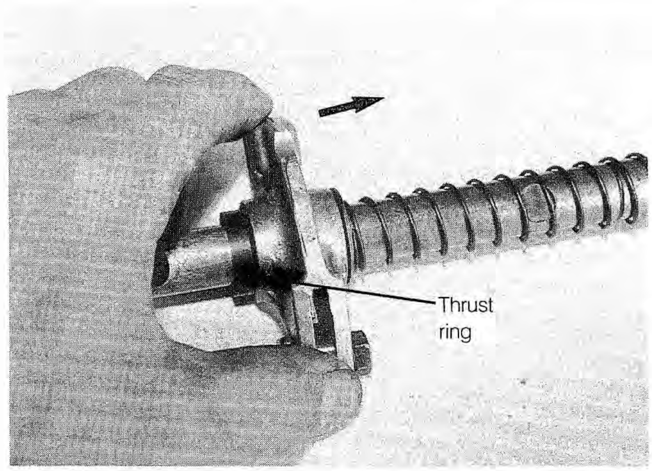


Fig. 4-35. Remove rocker arm retainer (snap ring) by sliding rocker arm and thrust ring in (arrow) and prying off snap ring.

5. Using a long drift, carefully drive the rocker arm shafts out working from the rear of the cylinder head. Remove each spring, washer, rocker arm, and thrust ring from the shaft as it is removed. Label each assembly so they can be in reinstalled in their original positions.

CAUTION —
Care must be taken not to damage the sealing plug on the end of the exhaust-side rocker arm shaft. Do not hammer directly on the end of the shaft.

NOTE —
A BMW special tool (BMW Tool No. 11 3 040) is available to drive the rocker arm shafts from the cylinder head. As an alternative, a ½ inch diameter by 2 feet long bar can be used. The shafts are tightly fitted to the cylinder head and must be tapped out.

4

Installation is the reverse of removal. Prior to installation, visually check all components for wear. Check the rocker arm adjusting eccentrics and the camshaft contact area of the rocker arm. If any flat spots are found, the rocker arm should be replaced. Inspect the rocker arm shafts for any wear or scoring and replace any that are worn.

NOTE —

If replacing damaged or worn rocker arm springs, BMW supplies only short springs that replace the older, longer springs. All springs may be used interchangeably.

Be sure all parts are installed in their original positions. The rear end of the intake rocker arm shaft is hollow to allow oil to reach the distributor and the oil-pressure switch. The rear end of the exhaust rocker arm shaft is plugged. If the plug is loose or missing, the plug must be replaced and sealed with Loctite® No. 270 or an equivalent sealant. Make sure the notches for the thrust plate are facing down and the cutouts for the head bolts are correctly positioned before starting the shafts into the cylinder head. See Fig. 4-36.

Install the camshaft as described under **4.5 Removing and Installing Camshaft**. Install the cylinder head as described under **4.8 Removing and Installing Cylinder Head**.

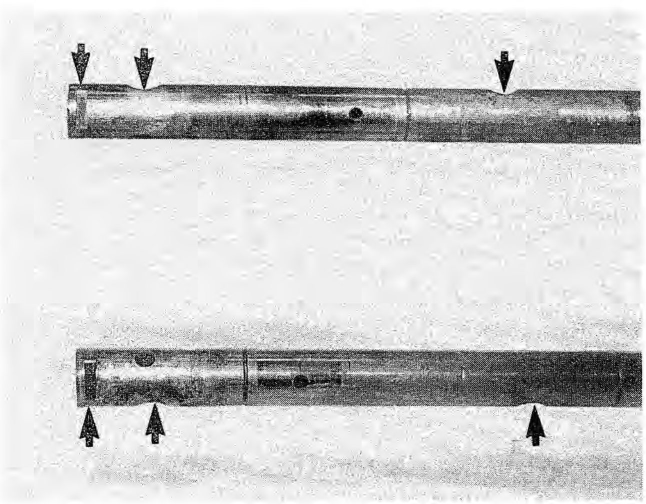


Fig. 4-36. Removed rocker arm shafts showing notches for front guide plate and cylinder head bolts (arrows).

To remove and install (6-cylinder engines):

1. Remove the cylinder head as described under **4.8 Removing and Installing Cylinder Head**.

2. Adjust the valves to maximum clearance by loosening the adjusting eccentric locknut. Rotate the eccentric until the adjusting hole is facing inward. See Fig. 4-37.

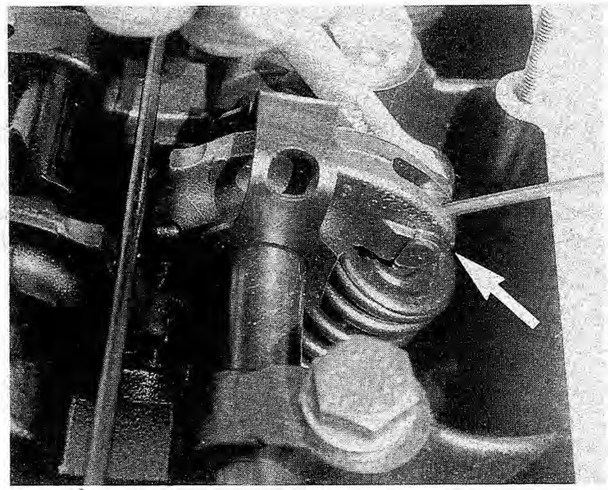


Fig. 4-37. Valves being adjusted to maximum clearance. Adjusting hole in eccentric should face inward (arrow).

3. Remove the rocker arm retainers. Lift the retainers straight off, noting that the straight leg of the clamp fits into the slot in the rocker arm shaft. Lift off the rocker arm shaft guide plate. See Fig. 4-38.

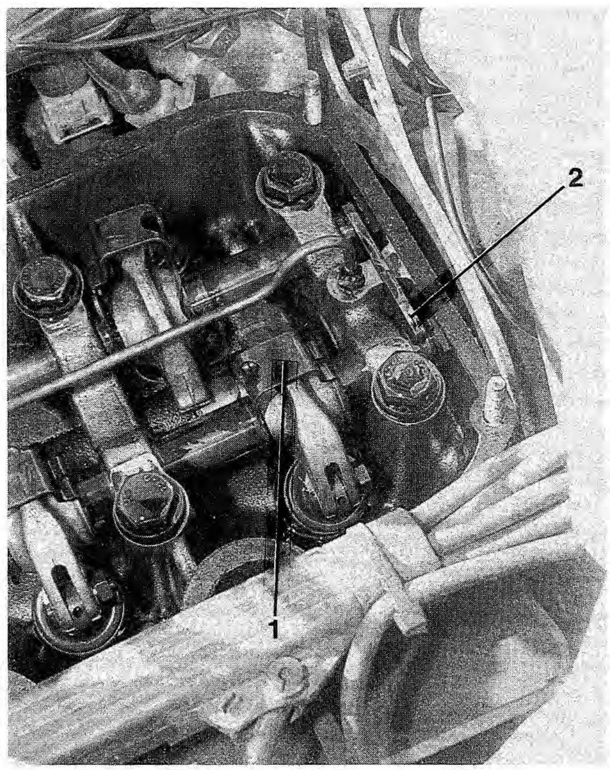


Fig. 4-38. Rocker arm retainer (**1**) and rocker arm shaft guide plate (**2**) on 6-cylinder engine. Note orientation of retainer.

4. Remove the four rubber plugs from the front and rear of the cylinder head. See Fig. 4-39.

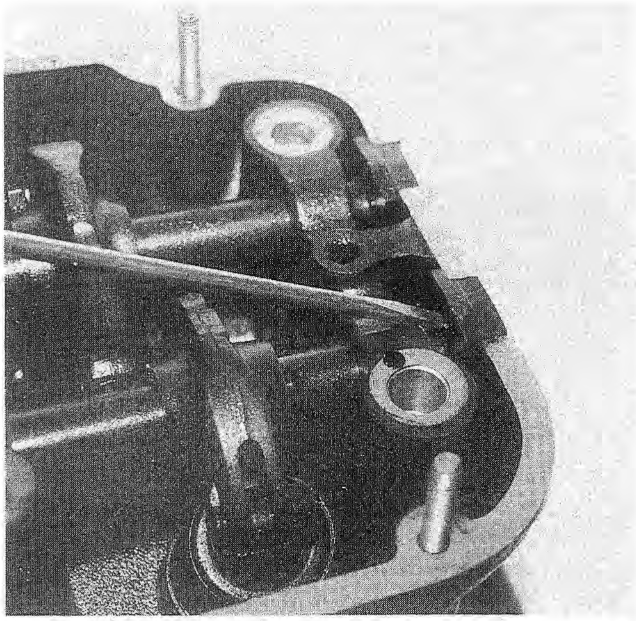


Fig. 4-39. Rubber retaining plug being removed from cylinder head.

5. Temporarily mount the distributor rotor adaptor to the front of the camshaft.

6. Using the rotor adaptor mounting bolt, rotate the camshaft clockwise until the no. 6 intake and exhaust valves are both open. Slide the no. 1 exhaust-side rocker arm off the top of the valve. See Fig. 4-40.

NOTE —

Label each rocker arm assembly as it is removed. Rocker arm assemblies should always be reinstalled in their original locations.

7. Slowly rotate the camshaft relieving the valve spring tension on the exhaust-side rocker arms and sliding the rocker arms off the top of their valves. Remove the exhaust-side rocker arm shaft from the front of the cylinder head. Label all rocker arm assembly parts as they are removed.

8. Remove the intake-side rocker arm shaft using the above procedure.

Installation is the reverse of removal. Prior to installation, visually check all components for wear. Check the rocker arm adjusting eccentrics and the camshaft contact area of the rocker arm. If any flat spots are found, the rocker arm should be replaced. Inspect the rocker arm shafts for any wear or scoring and replace any that are worn.

NOTE —

If replacing damaged or worn rocker arm springs, BMW supplies only short springs that replace the older, longer springs. All springs may be used interchangeably.

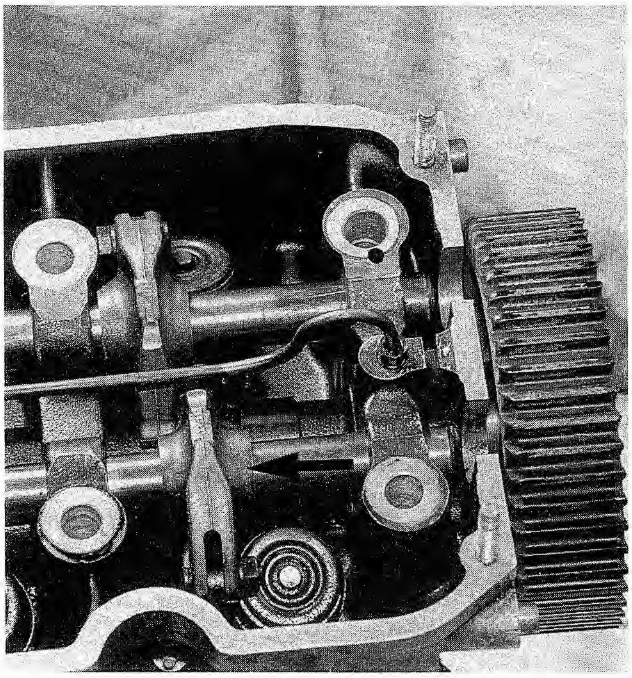


Fig. 4-40. Rocker arm positioned (arrow) for removal of exhaust-side rocker arm shaft.

Be sure all parts are installed in their original positions. The notches for the guide plate and the small oil bores must face in and the large oil bores must face down towards the valve guides. See Fig. 4-41. Install the cylinder head as described under **4.8 Removing and Installing Cylinder Head**.

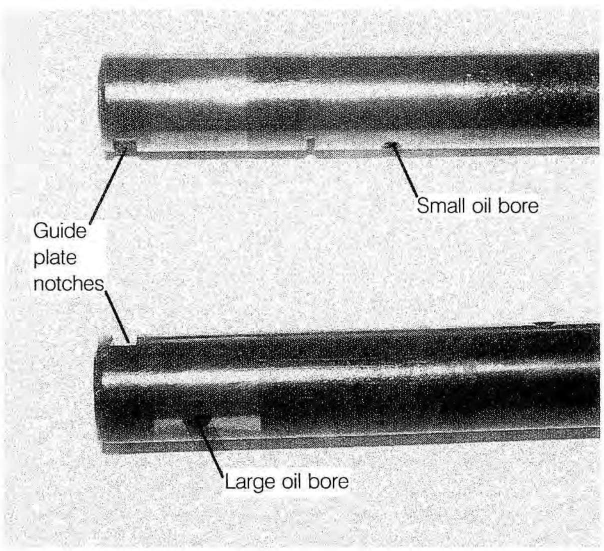


Fig. 4-41. Rocker arm shafts showing notches for front guide plate and oil bores.

4.7 Valve Stem Oil Seals

The valve stem oil seals are fitted over the top of each valve guide. The purpose of the oil seal is to prevent excess oil from entering the combustion chamber. The sign of faulty valve stem oil seals are excessive oil consumption and blue-gray smoke from the exhaust after starting and during sudden deceleration. For more information on excessive oil consumption and smoking, see **3. Troubleshooting**.

Valve stem oil seal replacement requires that the cylinder head be removed and disassembled. This work requires using special tools such as a valve spring compressor. Using an additional BMW special tool, as described below, is highly recommended to install the new oil seals. If the tools are not available, an alternative is to remove the cylinder head and have the valve removal and oil seal replacement done by an authorized BMW dealer or other qualified shop.

To replace valve stem oil seals:

1. Remove the cylinder head as described in **4.8 Removing and Installing Cylinder Head**.

2. Remove the camshaft as described in **Removing and Installing Camshaft**.

3. Remove the rocker arm shafts as described under **4.6 Removing and Installing Rocker Arms and Rocker Arm Shafts**.

4. Use a valve spring compressor to remove the valves.

   NOTE —
   Label all valves as they are removed. Valves must be reinstalled in their original positions.

5. Using a valve stem oil seal removal tool such as the one shown in Fig. 4-42, remove the valve stem oil seals.

   CAUTION —
   Be careful not to scratch the machined cylinder head. A wooden board or a cloth cover on a metal work bench will prevent damage to the cylinder head.

   NOTE —
   A BMW special tool (BMW Tool No. 11 1 250) is available to remove the valve stem oil seals. As the seals will not be reused, it is also possible to carefully remove the valve stem seals with locking pliers. Do not over tighten locking pliers, as damage to valve guide may occur.

6. Install the valve spring seat. Install the new oil seals onto the valve guides using the special installation tool (BMW Tool No. 11 1 200). Press the valve stem seal onto the valve guide using hand pressure only.

   NOTE —
   As an alternative to the special oil seal installation tool, an 11 mm deepwell socket will properly fit the valve stem oil seals for installation.

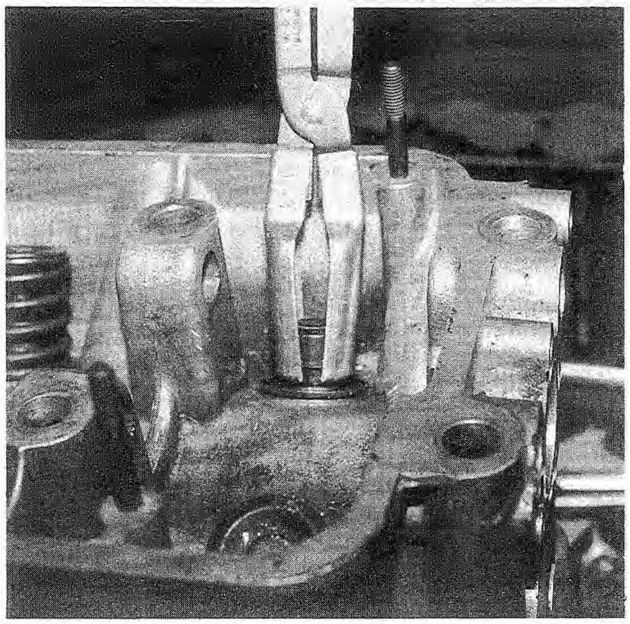


Fig. 4-42. Valve stem oil seal being removed from valve guide using special removal tool.

7. Lubricate the new oil seals with engine oil. Place the valve stem oil seal protector (BMW Tool No. 11 1 340) over the valve stem notches to prevent tearing of the valve stem oil seal.

   NOTE —
   If the special protector is not available, smooth plastic tape may be wrapped around the valve stem notches. A damaged oil seal can lead to excessive oil consumption.

8. Referring to the numbers marked on the valves during removal, insert the valves into their original valve guides. Remove the oil seal protector from the valve stem. The remainder of the procedure is the reverse of removal.

   NOTE —
   A shop rag in the combustion chamber or tape over the valves can be used to hold the valves in.

4.8 Removing and Installing Cylinder Head

The cylinder head can be removed with the engine installed. Special tools are necessary to torque the cylinder head bolts to a specified torque angle during installation. On models with 6-cylinder engines, BMW recommends replacing all hex-head type cylinder head bolts with the new Torx-head "ASA 14" bolts. The Torx-head bolts should be retrofitted whenever the cylinder head is removed or if a bolt is found to be damaged. The Torx-head bolt has been used in production of 6-cylinder engines starting in April 1989.

If a failed cylinder head gasket or warped head is suspected, a compression test, as described in **3. Troubleshooting** should be done before removing the cylinder head. A failed head gasket may be caused by a warped cylinder head. Overheating due to insufficient cooling is a major cause of cylinder head warpage. When replacing the cylinder head gasket, always check the cylinder head for straightness. The procedure for checking for warpage can be found in **4.9 Disassembly, Assembly, and Reconditioning Cylinder Head**.

CAUTION —

To prevent the cylinder head from warping, the car should be allowed to cool down for at least six hours, and preferably overnight before removing the cylinder head.

To remove (4-cylinder engines):

1. Disconnect the negative (−) terminal of the battery.

CAUTION —

BMW anti-theft radios can be rendered useless by disconnecting the battery. See your owner's manual for more information.

2. Drain the engine coolant as described under **COOLING SYSTEM**. Remove the coolant hoses from the front of the cylinder head.

3. Remove the front exhaust pipe from the manifold. See Fig. 4-43. Discard the mounting nuts. Disconnect the oxygen sensor connector, which is located near the battery tray (green wire).

CAUTION —

Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

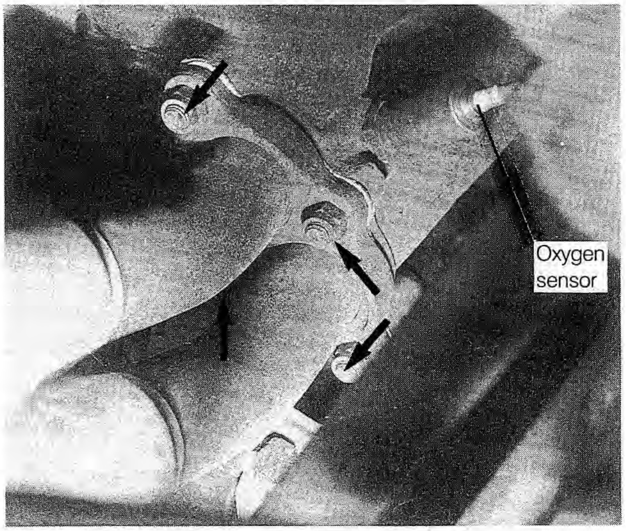


Fig. 4-43. Front pipe to exhaust manifold mounting nuts (arrows) and oxygen sensor.

4. Disconnect the harness connectors from the idle air stabilizer valve, the thermo-time switch, the coolant temperature sender, the engine temperature sensor, and the cold-start valve. See Fig. 4-44.

NOTE —

Label all wires and hoses before removing them to aid in reinstalling them in the correct place.

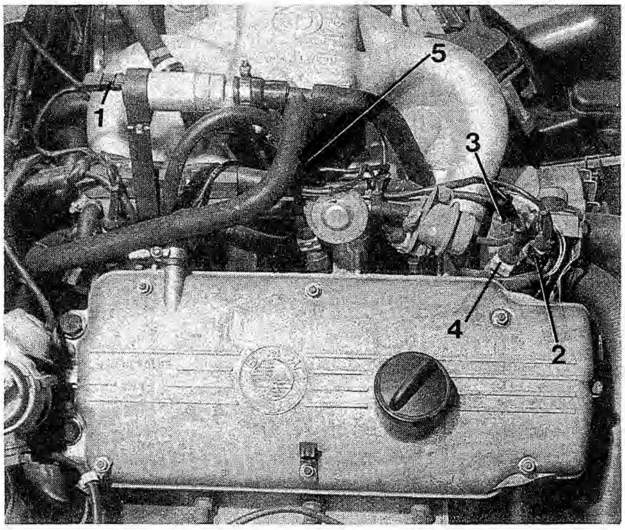


Fig. 4-44. Harness connectors that need to be disconnected. Idle air stabilizer valve connector (**1**), thermo-time switch (**2**), coolant temperature sender (**3**), engine temperature sensor (**4**), and cold-start valve (**5**).

4

5. Disconnect the connector from the air temperature sensor. Loosen the large hose clamps from the rubber boot connecting the air flow sensor to the throttle housing and remove the boot.

NOTE —
The air temperature sensor is in the intake air duct behind the driver's side headlight assembly.

6. Disconnect the harness connector from the air flow sensor. Remove the two bolts from the side of the air filter housing and remove the housing. See Fig. 4-45.

NOTE —
Some hoses may be secured with one-time hose clamps that are crimped with special pliers. The clamps may be pried loose with a small screwdriver. Replace the clamps with standard screw-type clamps.

7. Remove the brake booster vacuum hose from the intake manifold. Remove the air bypass hose from the idle air stabilizer valve. Pry off the diagnostic plug retaining clip and remove the plug from the bracket. See Fig. 4-45.

8. Disconnect the accelerator cable from the throttle lever. If applicable, disconnect the cruise control cable and the automatic transmission throttle cable from the lever.

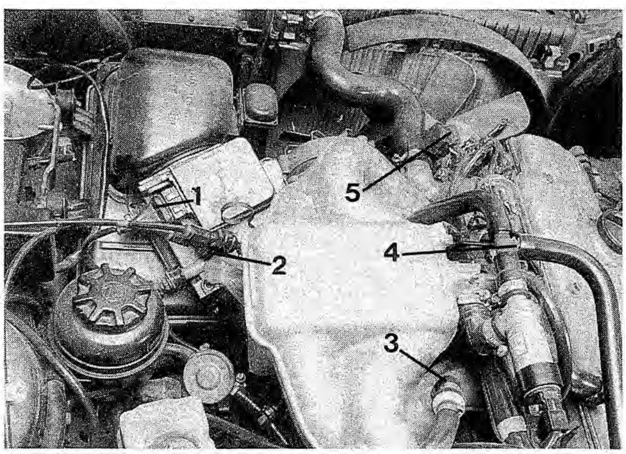


Fig. 4-45. Air flow sensor connector (**1**), air filter housing mounting bolts (**2**), brake vacuum booster hose (**3**), idle air bypass hose (**4**), and diagnostic plug (**5**).

9. Remove the distributor cap, spark plugs, and the distributor as described in **IGNITION**.

NOTE —
Label the spark plug wires so that they can be reinstalled in their original locations.

10. Disconnect the two heater hoses from the heater core. The hoses are located on the driver's side firewall in the rear of the engine compartment.

11. Disconnect the wires from the alternator and from the starter motor as described in **ELECTRICAL SYSTEM**.

12. Disconnect the two coolant hoses and the vacuum hose from the throttle housing. Disconnect the throttle switch harness connector from the throttle switch.

13. Disconnect the vacuum hoses from the vacuum advance solenoid on the firewall.

14. Disconnect the harness connectors from the four fuel injectors. Cut the wire ties so the wiring harness can be placed aside. Remove the ground wire from the intake manifold near the cold-start valve.

15. Remove the fuel supply line from the fuel rail. Remove the fuel return line from the pressure regulator. See Fig. 4-46.

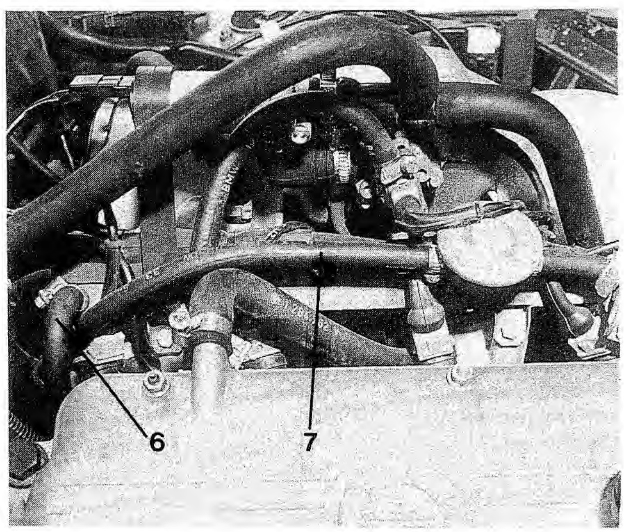


Fig. 4-46. Fuel supply line (**6**) and fuel return line (**7**).

16. Remove the three bolts that attach the intake manifold to the rear support bracket. Remove the two nuts that secure the transmission accelerator cable bracket to the intake manifold. Remove the bolt that secures the oil dipstick to the intake manifold.

17. Using a socket wrench on the center vibration damper (crankshaft pulley) bolt, rotate the crankshaft clockwise until the engine is at Top Dead Center (TDC or 0/T) of the No. 1 cylinder. See Fig. 4-47.

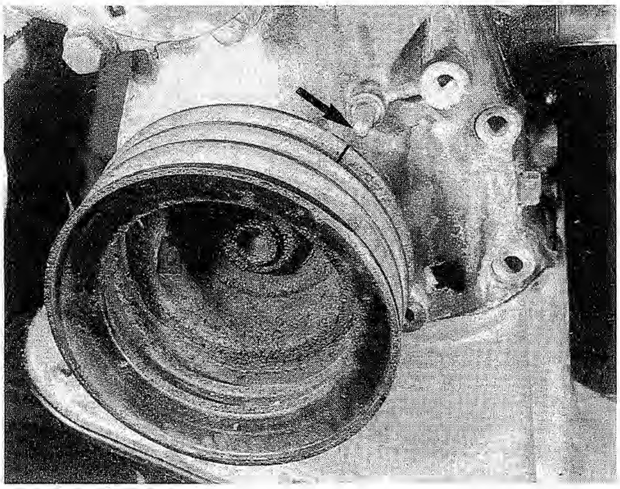


Fig. 4-47. Top Dead Center (TDC) mark on vibration damper aligned with boss on lower timing chain cover (arrow).

18. Remove the cylinder head cover as described in **4.1 Cylinder Head Cover and Gasket**.

19. Remove the upper camshaft timing chain cover, the camshaft timing chain tensioner piston, and the camshaft sprocket as described in **4.3 Camshaft Timing Chain (4-cylinder engine)**.

CAUTION —

Use care when removing the upper timing chain cover. The upper cover may be stuck to the cylinder head gasket.

20. Gradually and evenly loosen the cylinder head bolts using the sequence shown in Fig. 4-48. Carefully remove the cylinder head, making sure all wires, hoses, and fittings are free and clear of the cylinder head. If the head is stuck, use a soft-faced mallet or pry gently with a wooden stick.

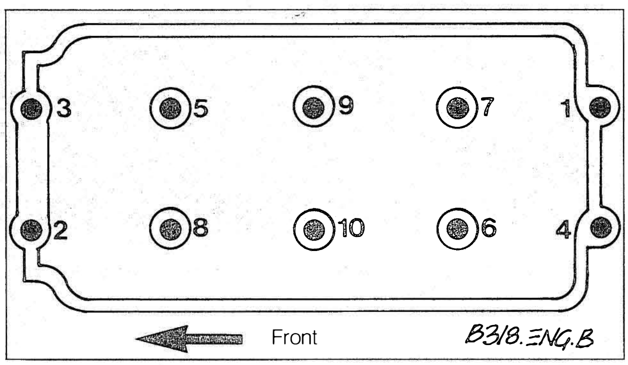


Fig. 4-48. Cylinder head bolt loosening sequence for 4-cylinder engine.

To install (4-cylinder engines):

1. Clean the cylinder head and the gasket surface of the cylinder block. Clean the threads of the head bolts and bolt holes with a thread chaser and remove all foreign matter and oil from the bolt holes. Avoid letting debris into the cylinders or oil passages in the cylinder block.

CAUTION —

Do not use a metal scraper or wire brush to clean the aluminum cylinder head or pistons. These tools may damage the cylinder head and pistons. Instead, use a solvent to soften carbon deposits and old sealing materials. If necessary, use a hard wooden or plastic scraper.

2. Check the gasket surface of the cylinder head and the cylinder block for warpage as described under **4.9 Disassembly, Assembly, and Reconditioning Cylinder Head**.

3. Place a new cylinder head gasket on the surface of the cylinder block. The cylinder head gasket will fit correctly in only one orientation. The word "OBEN" found printed on the gasket, should face up.

CAUTION —

Cylinder head gaskets will make a reliable seal only once. Always use a new cylinder head gasket that has not been previously compressed by tightening the cylinder head bolts.

4. Place the cylinder head in position on the cylinder block. Loosely install the head bolts and their washers, then thread them in until they are finger tight.

NOTE —

To help install the cylinder head, insert two 8 in. long by ⅜ in. round wooden dowels into two of the outermost head bolt holes. The dowels will hold the gasket in position as the cylinder head is installed. Thread in several bolts, then remove the dowels and install the remaining bolts.

5. Tighten the cylinder head bolts in the sequence shown in Fig. 4-49. The bolts should be tightened in three stages as listed in **Table g**. The final stages require using a special tool (BMW Tool No. 11 2 110) or a suitable protractor to tighten the bolts to a specified torque angle.

CAUTION —

The cylinder head bolt torque is critical to proper engine operation. Tighten the bolts in the stages listed in Table g.

4

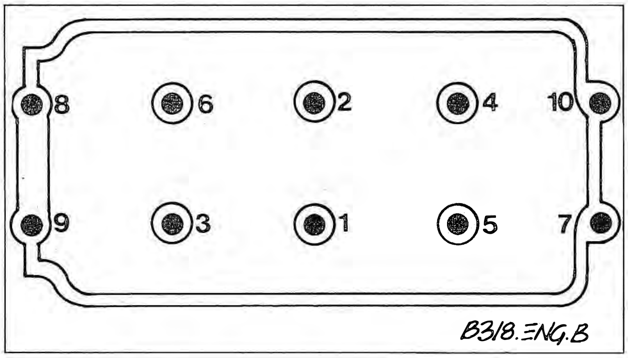


Fig. 4-49. Cylinder head bolt tightening sequence for 4-cylinder engine.

Table g. Cylinder Head Tightening Torques (4-cylinder engines)

Hex-head bolts		
Stage 1 60 ± 2 Nm (44 ± 1 ft. lb.)	**Stage 2** 33 ± 3° after waiting 15 minutes	**Stage 3** 25 ± 5° after running engine for 25 minutes

Installation of the remaining parts is the reverse of removal. Adjust the valve clearances as described under **4.4 Valve Adjustment**. Install the front pipe to the exhaust manifold with CRC® copper paste or equivalent on the mounting studs. Replace the gasket if necessary. Refill the cooling system as described in **COOLING SYSTEM**. Change the engine oil and filter as described in **LUBRICATION AND MAINTENANCE**. Check and adjust ignition timing as described in **IGNITION**. Adjust idle speed and idle mixture as described under **FUEL SYSTEM**. Adjust the accelerator cable as described in **FUEL SYSTEM**. Adjust the transmission throttle cable as described in **AUTOMATIC TRANSMISSION**.

To remove (6-cylinder engines):

1. Disconnect the negative (–) terminal of the battery.

> ***CAUTION —***
>
> *BMW anti-theft radios can be rendered useless by disconnecting the battery. Make sure you know the correct code before disconnecting the battery. See your owner's manual for more information.*

2. Drain the engine coolant as described under **COOLING SYSTEM**. Remove the coolant hoses from the front of the cylinder head as shown in Fig. 4-50.

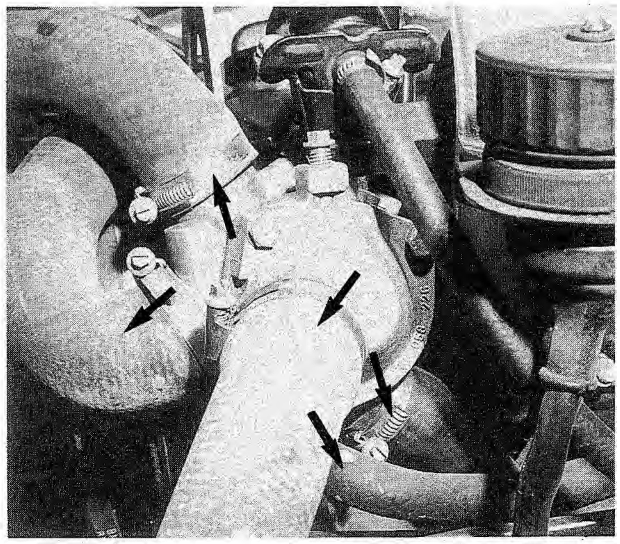


Fig. 4-50. Coolant hoses to be removed from cylinder head (arrows).

3. Remove the front exhaust pipe from the manifold. See Fig. 4-51. Discard the mounting nuts. Disconnect the oxygen sensor on cars equipped with one.

> ***CAUTION —***
>
> *Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.*

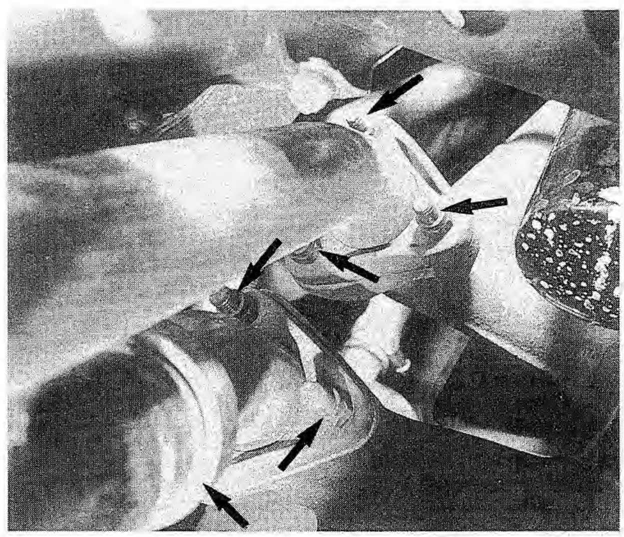


Fig. 4-51. Front pipe to exhaust manifold mounting nuts (arrows).

4. Disconnect the accelerator cable from the throttle lever. If applicable, disconnect the automatic transmission throttle cable and the cruise control cable. See Fig. 4-52.

NOTE —

Label cables, wires and hoses before removing them to aid in reinstalling them in the correct place.

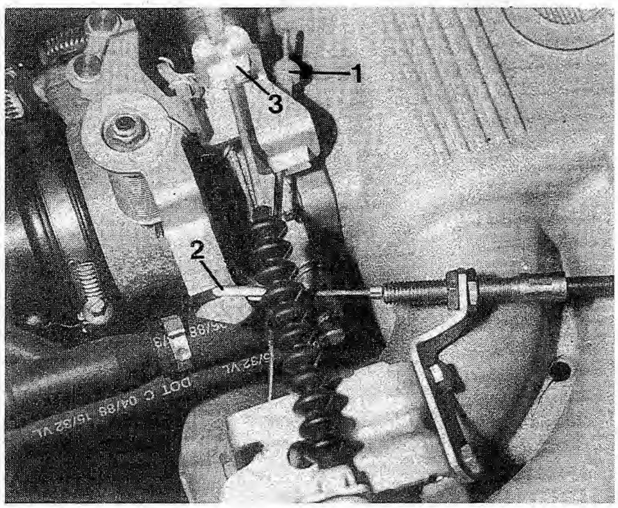


Fig. 4-52. Accelerator cable (**1**), automatic transmission throttle cable (**2**), and cruise control cable (**3**).

5. On 1984-1987 325 and 325e(es) models, disconnect the harness connectors from the cold-start valve and the thermo-time switch.

6. Remove the idle air stabilizer valve from its mounting bracket. Remove the connectors from the coolant temperature sensor and the engine temperature sensor near the thermostat housing.

7. Disconnect the harness connector from the air flow sensor. Remove the small hose from the side of the large rubber air duct and remove the air duct.

NOTE —

Some hoses may be secured with one-time hose clamps that are crimped with special pliers. The clamps may be pried loose using a small screwdriver. Replace the clamps with standard screw-type clamps.

8. Loosen the mounting bolts for the air filter assembly and remove the assembly from the car. On 325 and 325e(es) models, disconnect the connector from the altitude compensator.

9. Remove the harness connector from the throttle switch on the bottom of the throttle housing. On models with Motronic 1.1, disconnect the harness connector from the charcoal canister purge valve that is also mounted beneath the throttle housing. Remove the brake booster vacuum hose from the intake manifold. See Fig. 4-53.

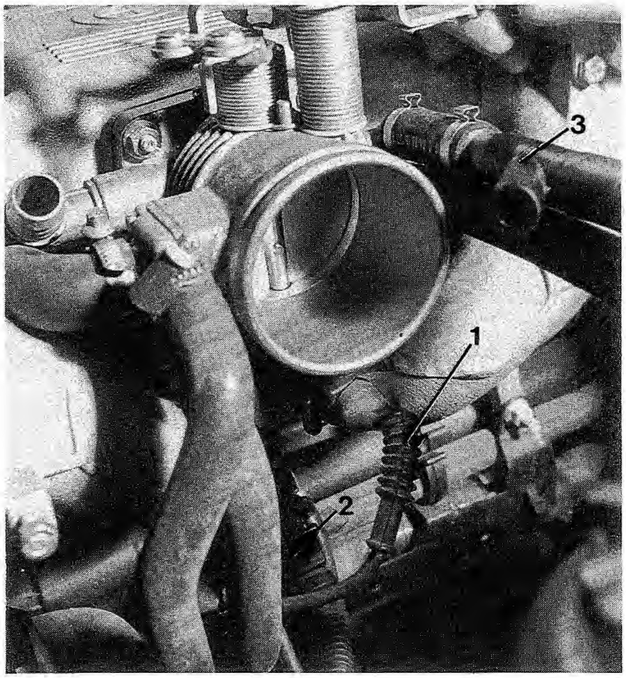


Fig. 4-53. Throttle switch connector (**1**), purge valve connector (**2**), and brake booster vacuum hose (**3**) on 325i models. Other models are similar.

10. Remove the two coolant hoses from the throttle housing.

11. Remove the two nuts from the wire harness retaining bracket beneath the intake manifold. Pull the bracket from the mounting studs. Remove the oil dipstick bracket retaining nut. Separate the harness connector for the fuel injectors' wiring harness. See Fig. 4-54.

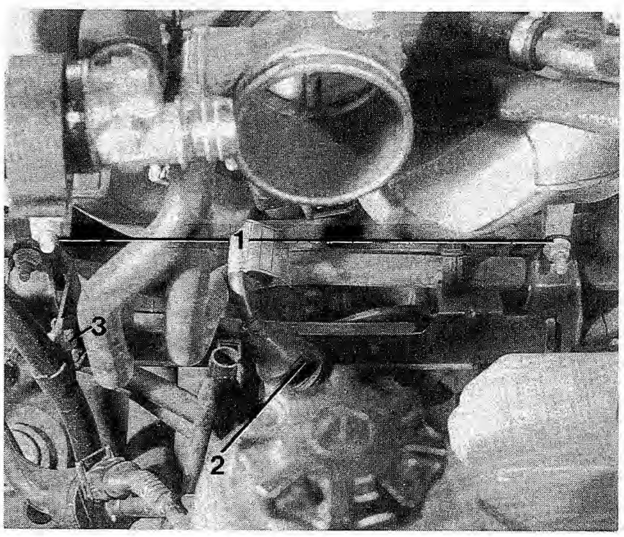


Fig. 4-54. Mounting nuts for wire harness retaining bracket (**1**), fuel injector harness connector (**2**), and oil dipstick mounting bracket (**3**).

12. Disconnect the two heater hoses from the heater core. Hoses are located at rear firewall. See Fig. 4-55.

4

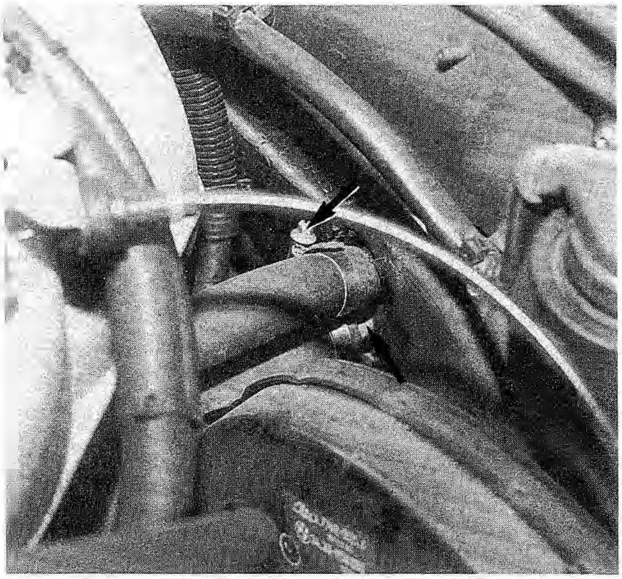


Fig. 4-55. Heater hoses for heater core (arrows).

13. Remove the cover from the auxiliary relay panel. Slide the relay panel assembly from its bracket and set aside. See Fig. 4-56.

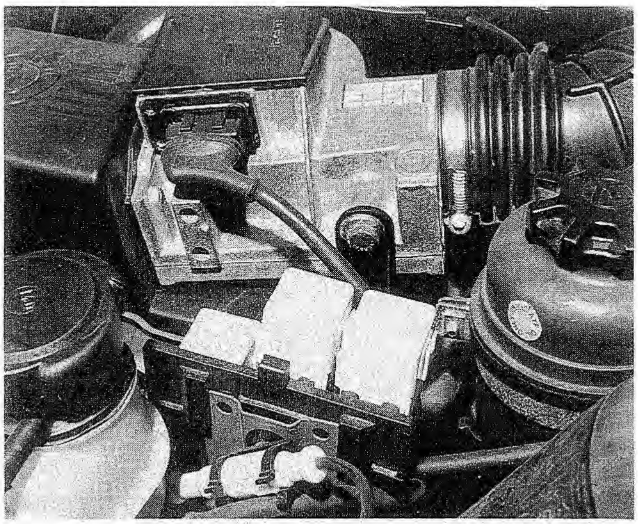


Fig. 4-56. Auxiliary relay panel (arrow) near left (driver's side) shock tower.

14. Remove the diagnostic connector from its mounting bracket. On 325e(es) models, pry off the retaining clip to remove. On 325i(is) and 325i Convertible models, unscrew the locking ring to remove. See Fig. 4-57.

15. Remove the distributor cap and remove the spark plug wires from the plugs. See **IGNITION**.

NOTE —

Label the spark plug wires so that they can be reinstalled in their original locations.

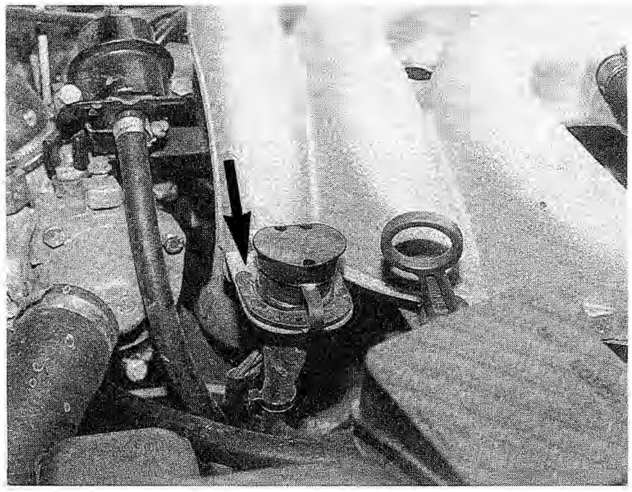


Fig. 4-57. Diagnostic connector installed on 325e model. Pry off clip (arrow) to remove connector from bracket. Connector on late models have locking ring.

16. Disconnect the harness connectors from the six fuel injectors. Cut any wire ties so that the wiring harness can be removed from the engine.

17. On 325i(is), 325i Convertible and 1988 325 models, disconnect the reference point and speed sensor connectors and remove them from the bracket. See Fig. 4-58.

NOTE —

Mark the wires so they can be reinstalled in the correct location. The engine will not start if they are incorrectly installed.

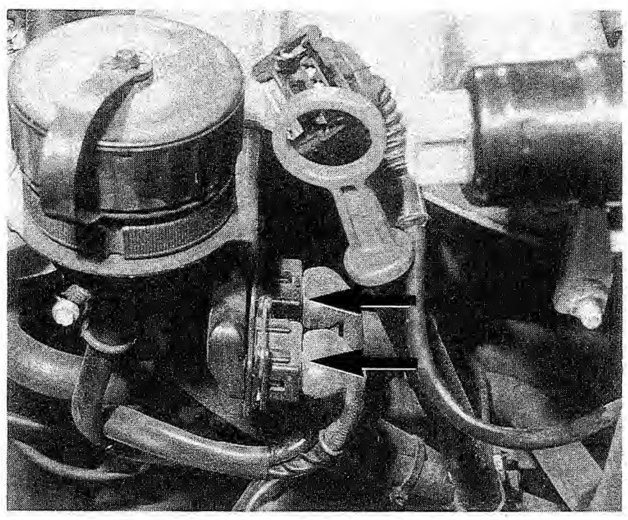


Fig. 4-58. Reference point sensor and speed sensor connectors (arrows).

18. Remove the coolant reservoir from its mountings without disconnecting any of the hoses. On 1984 through 1987 models, remove the two mounting bolts. See Fig. 4-59. On 1988 and later models, carefully pull the reservoir from its mountings. Set the reservoir out of the way.

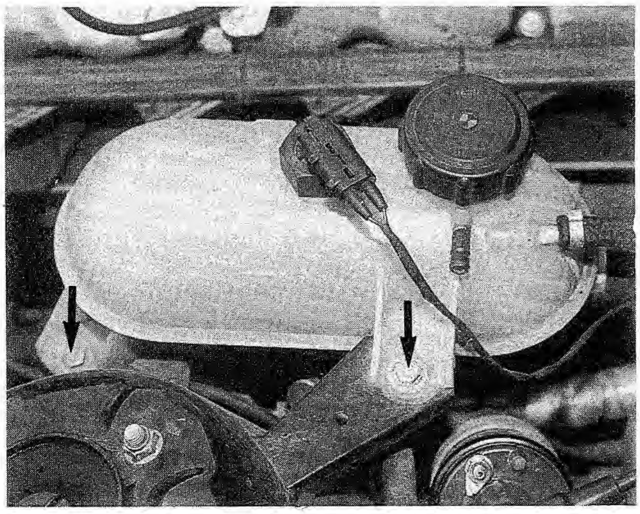


Fig. 4-59. Mounting bolts on coolant reservoir installed on 1984 through 1987 models (arrows).

19. On 1988 and later models, remove the two mounting bolts from the plastic coolant pipe that passes in front of the engine. Disconnect the hoses from each end of the pipe and remove the pipe.

20. Disconnect the fuel return line from the fuel pressure regulator. See Fig. 4-60. Disconnect the fuel supply line at the union beneath the intake manifold.

WARNING —

Fuel will be expelled when the fuel lines are removed. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.

21. Using a socket wrench on the center vibration damper (crankshaft pulley) bolt, rotate the crankshaft clockwise until the engine is at Top Dead Center (TDC or O/T) of the No. 1 cylinder. See Fig. 4-61.

22. Remove the cylinder head cover as described under **4.1 Cylinder Head Cover and Gasket**.

23. Remove the camshaft drive belt as described under **4.2 Camshaft Drive Belt (6-cylinder engine)**.

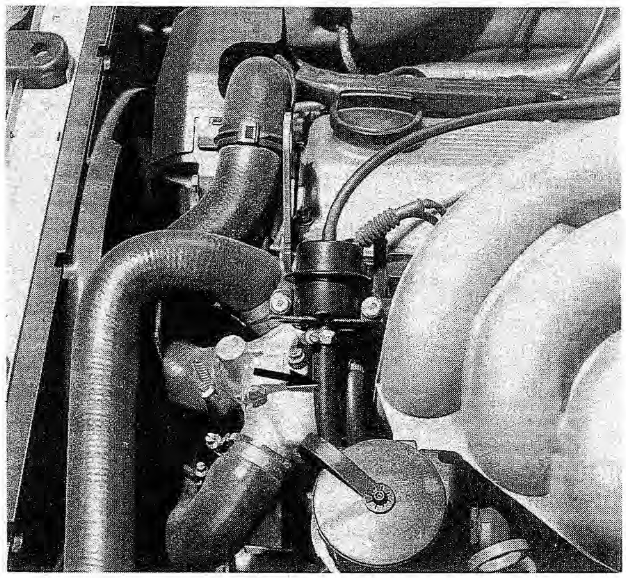


Fig. 4-60. Fuel return hose at fuel pressure regulator (arrow).

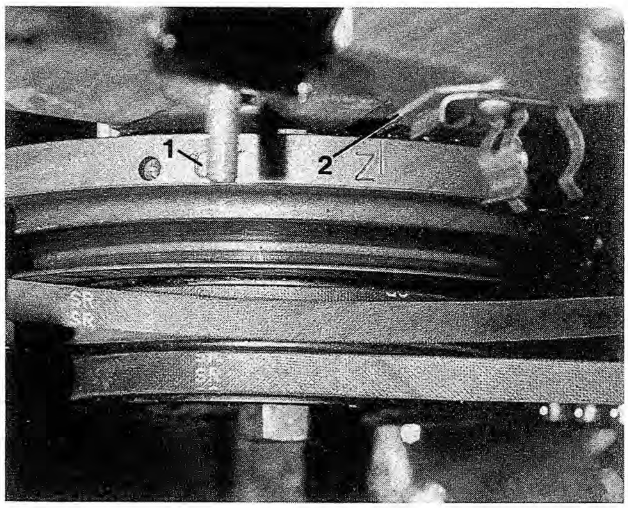


Fig. 4-61. Top Dead Center (TDC or O/T) mark (**1**) on vibration damper should be aligned with mark on drive belt cover (**2**).

24. Gradually and evenly loosen and remove the cylinder head bolts using the sequence shown in Fig. 4-62. Carefully remove the cylinder head, making sure all wires, hoses, and fittings are free and clear of the cylinder head. If the head is stuck, use a soft-faced mallet or pry gently with a wooden stick.

NOTE —

A crankcase ventilation tube is connected between the intake manifold and the crankcase breather assembly. The vent tube is spring loaded. A special tool is available from BMW (BMW Tool No. 11 1 290) to compress the spring and hold the tube in position while the cylinder head is removed.

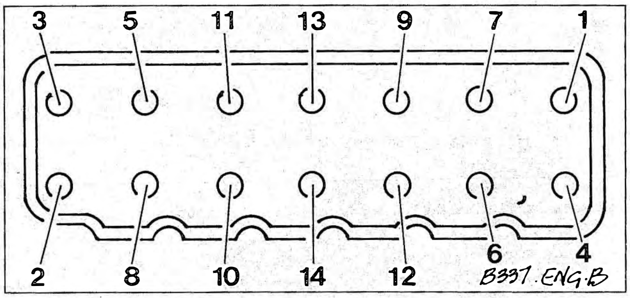


Fig. 4-62. Cylinder head bolt loosening sequence.

To install (6-cylinder engines):

1. Clean the cylinder head and the gasket surface of the cylinder block. Clean the threads of the head bolts and bolt holes with a thread chaser and remove all oil and foreign matter from the bolt holes. Avoid letting debris into the cylinders or oil passages in the cylinder block.

CAUTION —

Do not use a metal scraper or wire brush to clean the aluminum cylinder head or pistons. These tools may damage the cylinder head. Instead, use a solvent to soften carbon deposits and old sealing materials. If necessary, use a hard wooden or plastic scraper.

2. Check the gasket surface of the cylinder head and the cylinder block for warpage as described under **4.9 Disassembly, Assembly, and Reconditioning Cylinder Head**.

3. Place a new cylinder head gasket on the surface of the cylinder block. The cylinder head gasket will fit correctly in only one orientation. The word "OBEN", found printed on the gasket, should face up.

CAUTION —

Cylinder head gaskets will make a reliable seal only once. Always use a new cylinder head gasket that has not been previously compressed by tightening the cylinder head bolts.

NOTE —

Head gaskets on some early 6-cylinder engines may have the engine displacement code stamped on the gasket flange as shown in Fig. 4-63. On 325, 325e, and 325es models, the code number is 2.7. On 325i, 325is and 325i Convertible models, the code number is 2.5. Replacement gaskets supplied by BMW no longer have the code number.

4. Place the cylinder head in position on the cylinder block. Check that the vent tube is correctly positioned. Loosely install the head bolts and their washers, then thread them in until they are finger tight. Guide the vent tube into its opening as the cylinder head bolts are tightened.

CAUTION —

BMW recommends replacing hex-head cylinder head bolts with the Torx-head bolts whenever the cylinder head is removed or if any bolts are found to be faulty (such as a broken off bolt head). When replacing bolts with the head installed, remove and install one bolt at a time until all 14 are replaced. The hex-head bolt was originally installed in all 6-cylinder 3-series engines up to April 1989. All 3-series engines produced after this date use the new Torx-head bolt.

NOTE —

To help install the cylinder head, insert two 8 in. long by 3/8 in. round wooden dowels into two of the outermost head bolt holes. The dowels will hold the gasket in position as the cylinder head is installed. Thread in several bolts, then remove the dowels and install the remaining bolts.

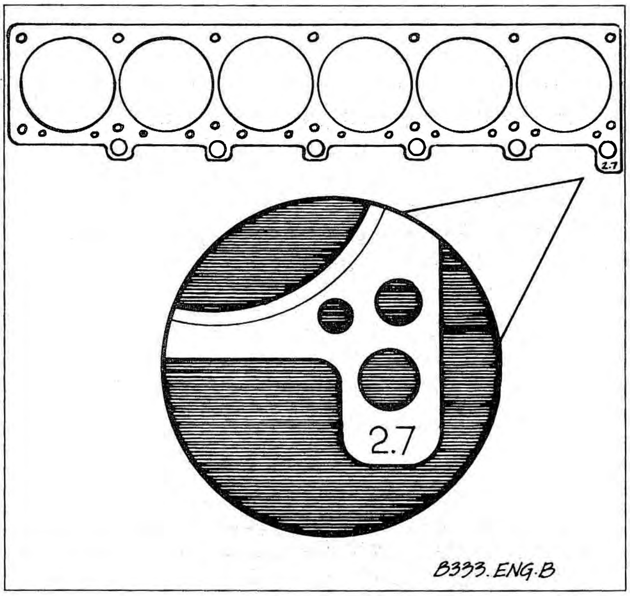


Fig. 4-63. Engine displacement code stamp on cylinder head gasket flange.

5. Tighten the cylinder head bolts in the sequence shown in Fig. 4-64. The bolts should be tightened in three stages as listed in **Table h**. The final stage(s) requires using a special tool (BMW Tool No. 11 2 110) or a suitable protractor to tighten the bolts to a specified torque angle.

CAUTION —

The cylinder head bolt torque is critical to proper engine operation. Tighten the bolts in the stages listed in the Table h.

NOTE —

On engines with Torx®head bolts, the torque angles can be done with engine cold. There is no specified waiting time or engine temperature.

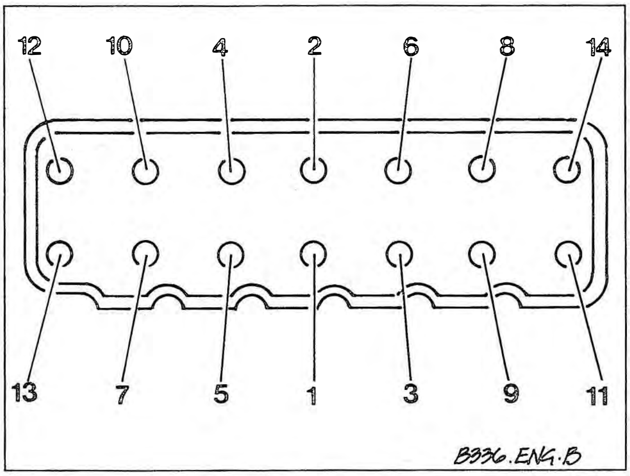


Fig. 4-64. Cylinder head bolt tightening sequence for 6-cylinder engine.

Table h. Cylinder Head Tightening Torques (6-cylinder engines)

	Stage 1	Stage 2	Stage 3
Torx®head bolts	30 Nm (22 ft. lb.)	90°	90°
Hex-head bolts	40 $^{+5}_{-0}$ Nm (30 $^{+4}_{-0}$ ft. lb.)	60 $^{+5}_{-0}$ Nm (44 $^{+4}_{-0}$ ft. lb.) after waiting 15 minutes	25 $^{+5°}_{-0}$ after running engine for 25 minutes

Installation of the remaining parts is the reverse of removal. Adjust the valve clearances as described under **4.4 Valve Adjustment**. Install the camshaft drive belt as described under **4.2 Camshaft Drive Belt (6-cylinder engines)**. Install the front pipe to the exhaust manifold with CRC® copper paste or equivalent on the mounting studs. Replace the gasket if necessary. Refill and bleed the cooling system as described in **COOLING SYSTEM**. Change the engine oil and filter as described in **LUBRICATION AND MAINTENANCE.** Adjust idle speed and idle mixture as described in **FUEL SYSTEM.** Adjust the accelerator cable as described in **FUEL SYSTEM.** Adjust the transmission throttle cable as described in **AUTOMATIC TRANSMISSION.**

4.9 Disassembly, Assembly, and Reconditioning Cylinder Head

Disassembly, assembly, and reconditioning procedures for the BMW cylinder heads covered in this manual are similar to those for most other modern water-cooled engines. For anyone with the proper tools and equipment and basic experience in cylinder head reconditioning, this section provides the specifications and special reconditioning information necessary to repair the cylinder heads covered by this manual.

If machine shop services are not readily available, one alternative is to install a remanufactured cylinder head. Remanufactured cylinder heads are available from an authorized BMW dealer parts department.

Cylinder Head Assembly

The cylinder head should be carefully inspected for warpage and cracks. Always decarbonize and clean the head before inspecting it. A high quality straight edge can be used to check for warpage. See Fig. 4-65. Visually inspect the cylinder head for cracks. If a cracked cylinder head is suspected and no cracks are detected through the visual inspection, have the head further tested for cracks by an authorized BMW dealer. A cracked cylinder head should be replaced.

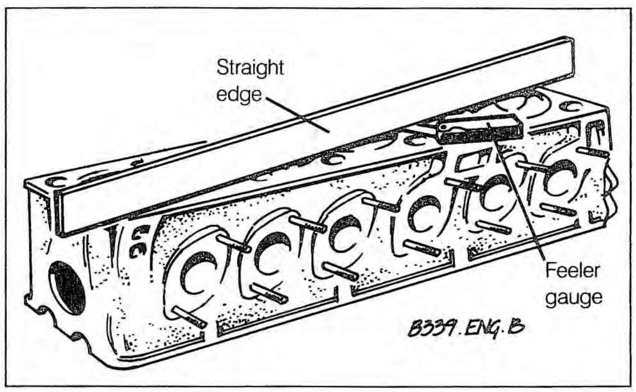


Fig. 4-65. Straight edge and feeler gauge being used to check straightness of cylinder head gasket surface.

A warped cylinder head can be machined provided no more than 0.3 mm (0.012 in.) of material is removed. If further machining is required, the head should be replaced. Removing more than this amount will reduce the size of the combustion chamber and adversely affect engine performance.

NOTE —

A special gasket is available from an authorized BMW parts department for machined heads. The special gasket is 0.3 mm thicker than the original standard gasket.

Before machining the head to correct for warpage, measure the total height of the cylinder head as shown in Fig. 4-66. **Table i** lists the minimum resurfacing height specifications. If the cylinder head height will not meet the minimum height dimension after machining, the cylinder head should be replaced.

NOTE —

When machining cylinder heads on 4-cylinder engines, the upper camshaft chain cover must be bolted to the cylinder head so that an identical amount of material is removed from each. Otherwise the upper camshaft chain cover would protrude below the cylinder head, preventing the cylinder head gasket from sealing properly.

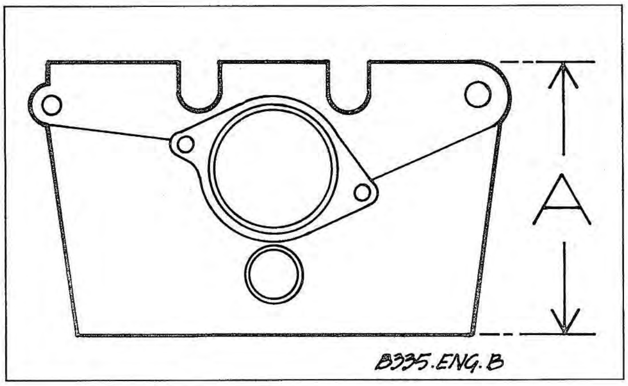


Fig. 4-66. Front view of cylinder head showing minimum resurfacing dimension (**A**). 6-cylinder engine shown.

Table i. Cylinder Head Resurfacing Specifications

Engine	Minimum permissible height (dimension a)	
	new	**after machining**
6-cylinder	125.1 ± 0.1 mm (4.925 ± .004 in.)	124.7 mm (4.909 in.)
4-cylinder	129.0 ± 0.1 mm (5.079 ± .004 in.)	128.6 mm (5.063 in.)

Valve Guides

Special tools and a press are required to replace valve guides. It is also necessary to heat the cylinder head and to chill the valve guides. Check valve guide wear with a new valve as shown in Fig. 4-67. Inspect the valve seats to ensure that the cylinder head can be reconditioned before installing new valve guides.

NOTE —

- If valve guide wear is greater than 0.8 mm (0.031 in.), but less than 1.0 mm (0.039 in.), the valve guide may be reamed out to accept valves with oversized stems as listed in **Table j**.
- If the radial clearance exceeds 1.0 mm (0.039 in.), the valve guide should be replaced.
- If valves with oversized stems are installed, the valve seat must also be machined to accept the new valve.

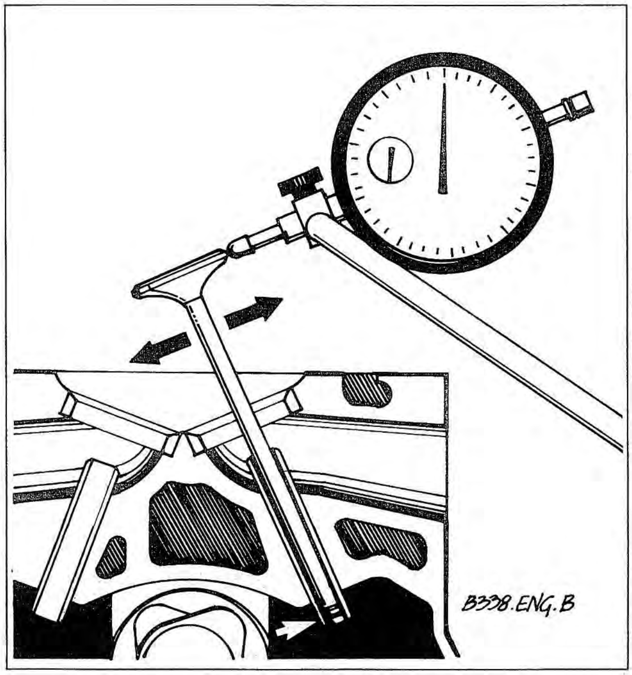


Fig. 4-67. Valve guide wear being checked with dial indicator. Insert new valve until stem end is flush with end of guide (white arrow). Play should not exceed 0.8 mm (0.031 in.).

Worn valve guides are driven out from the camshaft side of the cylinder head. The valve guides should be removed at room temperature. Install new valve guides from the camshaft side of the cylinder head with the stepped end of the valve guide facing the camshaft. Valve guide specifications, including correct installation temperatures, are listed in **Table j**.

Table j. Valve Guide Specifications

Specifications	4-cylinder engine	6-cylinder engine
Valve guide wear, maximum (measured with new valve)	0.8 mm (0.031 in.)	0.8 mm (0.031 in.)
Valve stem diameter standard oversize 1 oversize 2	 8.0 mm (0.315 in.) 8.1 mm (0.319 in.) 8.2 mm (0.323 in.)	 7.0 mm (0.275 in.) 7.1 mm (0.279 in.) 7.2 mm (0.283 in.)
Valve guide inside diameter (tolerance per ISO allowance H7) standard oversize 1 oversize 2	 8.0 mm (0.315 in.) 8.1 mm (0.319 in.) 8.2 mm (0.323 in.)	 7.0 mm (0.275 in.) 7.1 mm (0.279 in.) 7.2 mm (0.283 in.)
Valve guide outside diameter (tolerance per ISO allowance u6) standard old version new version oversize 1 old version new version oversize 2 old version new version oversize 3	 14.0 mm (.5512 in.) NA 14.1 mm (.5551 in.) NA 14.2 mm (.5590 in.) NA 14.3 mm (.5630 in.)	 13.0 mm (.5118 in.) 13.2 mm (.5197 in.) 13.1 mm (.5157 in.) 13.3 mm (.5236 in.) 13.2 mm (.5197 in.) 13.4 mm (.5276 in.) 13.3 mm (.5236 in.)

continued

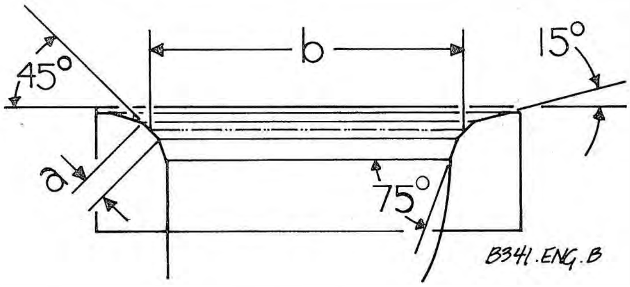
Table j. Valve Guide Specifications (continued)

Specifications	4-cylinder engine	6-cylinder engine
Valve guide bore diameter in cylinder head (tolerance per ISO allowance M7) standard old version new version oversize 1 old version new version oversize 2 old version new version oversize 3	 14.0 mm (.5512 in.) NA 14.1 mm (.5551 in.) NA 14.2 mm (.5590 in.) NA 14.3 mm (.5630 in.)	 13.0 mm (.5118 in.) 13.2 mm (.5197 in.) 13.1 mm (.5157 in.) 13.3 mm (.5236 in.) 13.2 mm (.5197 in.) 13.4 mm (.5276 in.) 13.3 mm (.5236 in.)
Special tools removal installation	 BMW Tool No. 11 1 100 BMW Tool No. 11 1 160	 BMW Tool No. 11 1 330 BMW Tool No. 11 1 320
Valve guide installation temperature cylinder head valve guide Installed depth (height above cylinder head surface)	 122°F (50°C) −238°F (−150°C) 15.0 mm (0.5910 in.)	 122°F (50°C) −238°F (−150°C) 14.5 mm (0.5709 in.)

Valve Seats

The valve seats should be resurfaced whenever new valves or valve guides are installed. Cutters or stones of 15°, 45°, and 75° are required to resurface the seats. **Table k** lists valve seat dimensions. **Table l** lists valve seat replacement specifications, including correct installation temperatures. As with valve guides, replacing the valve seats requires heating the cylinder head, and chilling the valve seat.

Table k. Valve Seat Dimensions



	1984–1987 325, 325e, 325es	1988 325 and all 325i	1984 and 1985 318i
Valve seat width (a)			
intake	1.65 ± 0.35 mm (0.065 ± 0.014 in.)	1.65 ± 0.35 mm (0.065 ± 0.014 in.)	1.3–2.0 mm (0.051–0.079 in.)
exhaust	1.65 ± 0.35 mm (0.065 ± 0.014 in.)	1.65 ± 0.35 mm (0.065 ± 0.014 in.)	1.3–2.0 mm (0.051–0.079 in.)
Valve seat diameter (b)			
intake	38.6 mm (1.520 in.)	40.6 mm (1.598 in.)	44.6 mm (1.756 in.)
exhaust	32.6 mm (1.283 in.)	34.6 mm (1.362 in.)	36.6 mm (1.441 in.)

Table l. Valve Seat Replacement Specifications.

	1984–1987 325, 325e, 325es models	1988 325 and all 325i models	1984 and 1985 318i models
Valve seat insert outside diameter (tolerance as per ISO allowance g6)			
intake			
standard	42.15 mm (1.6594 in.)	43.15 mm (1.6988 in.)	47.15 mm (1.8563 in.)
oversize 0.2 mm	42.35 mm (1.6673 in.)	43.35 mm (1.7067 in.)	47.35 mm (1.8642 in.)
oversize 0.4 mm	42.55 mm (1.6752 in.)	43.55 mm (1.7146 in.)	47.55 mm (1.8720 in.)
exhaust			
standard	37.65 mm (1.4823 in.)	37.65 mm (1.4823 in.)	40.15 mm (1.5807 in.)
oversize 0.2 mm	37.85 mm (1.4902 in.)	37.85 mm (1.4902 in.)	40.35 mm (1.5886 in.)
oversize 0.4 mm	38.05 mm (1.4980 in.)	38.05 mm (1.4980 in.)	40.55 mm (1.5964 in.)
Valve seat bore diameter in cylinder head (tolerance as per ISO allowance H7)			
intake			
standard	42.00 mm (1.6535 in.)	43.00 mm (1.6929 in.)	47.00 mm (1.8504 in.)
oversize 0.2 mm	42.20 mm (1.6614 in.)	43.20 mm (1.7008 in.)	47.20 mm (1.8583 in.)
oversize 0.4 mm	42.40 mm (1.6693 in.)	43.40 mm (1.7086 in.)	47.40 mm (1.8661 in.)
exhaust			
standard	37.50 mm (1.4764 in.)	37.50 mm (1.4764 in.)	40.00 mm (1.5748 in.)
oversize 0.2 mm	37.70 mm (1.4842 in.)	37.70 mm (1.4842 in.)	40.20 mm (1.5827 in.)
oversize 0.4 mm	37.90 mm (1.4921 in.)	37.90 mm (1.4921 in.)	40.40 mm (1.5905 in.)
Installation temperature			
cylinder head	122°F (50°C)	122°F (50°C)	122°F (50°C)
valve seat insert	−238°F (−150°C)	−238°F (−150°C)	−238°F (−150°C)

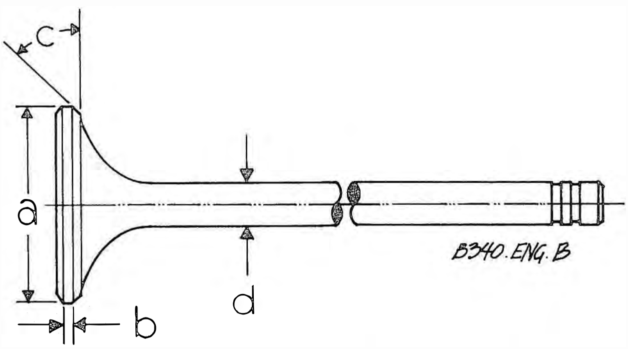
Valves

Valves should be machined using standard valve-grinding techniques. **Table m** lists valve specifications. Remove carbon from the valves using a wire brush or wire wheel.

Testing Valves for Leakage (cylinder head removed)

The valves and their seats can be easily tested for leakage. With the camshaft and the rocker arm assemblies removed, install the valve assemblies and the spark plugs in each cylinder. Place the cylinder head on a workbench with the combustion chamber facing upward. Fill each combustion chamber with water. After fifteen minutes, check the level of the water. If the level of the water in any cylinder drops, that cylinder is not sealing properly.

Table m. Valve Specifications



Specification	1984–1987 325, 325e, 325es	1988 325 and all 325i	1984 and 1985 318i
Valve head diameter (**a**)			
intake	40 mm (1.575 in.)	42 mm (1.654 in.)	46 mm (1.811 in.)
exhaust	34 mm (1.339 in.)	36 mm (1.417 in.)	38 mm (1.496 in.)
Minimum valve head thickness (**b**)			
intake	1.3 mm (0.051 in.)	1.3 mm (0.051 in.)	1.3 mm (0.051 in.)
exhaust	2.0 mm (0.079 in.)	2.0 mm (0.079 in.)	2.0 mm (0.079 in.)
Valve face angle (**c**)	45°	45°	45°
Valve stem diameter (**d**)			
standard	7.0 mm (0.275 in.)	7.0 mm (0.275 in.)	8.0 mm (0.315 in.)
oversize 1	7.1 mm (0.279 in.)	7.1 mm (0.279 in.)	8.1 mm (0.319 in.)
oversize 2	7.2 mm (0.283 in.)	7.2 mm (0.283 in.)	8.2 mm (0.323 in.)

5. Removing and Installing Engine

Before removing the engine it is first necessary to remove the transmission as described in **MANUAL TRANSMISSION AND CLUTCH** or **AUTOMATIC TRANSMISSION**. Remanufactured engines are available from an authorized BMW dealer.

Removing (4-cylinder engines)

The air conditioning compressor and the power steering pump should be unbolted and set aside without disconnecting any of the refrigerant lines or the power steering fluid lines. The hood should be either removed from the car or supported in its fully open position.

To remove:

1. Disconnect the cables at the battery, removing the negative (−) battery cable first. Remove the small bolt holding the wire to the positive (+) battery cable clamp. Cut the wire ties that secure the battery cable harness to the firewall. Disconnect the ground strap from the rear of the cylinder head cover.

> ***CAUTION —***
> *BMW anti-theft radios can be damaged by disconnecting the battery cables. See your owner's manual for more information.*

2. Disconnect the hood support from the fitting on the hood. Securely support the hood in its fully open position, use care not to damage the front grille assembly. As an alternative, the hood can be removed from the car.

> **NOTE —**
> A special tool (BMW Tool No. 51 2 120) to hold the hood in the fully open position is available from an authorized BMW dealer parts department.

3. Drain the engine coolant and remove the radiator as described in **COOLING SYSTEM**. Disconnect the coolant hoses from the front of the engine. Disconnect the heater hoses from the heater core.

4. Peel back the protective cover from the ignition coil. Remove the high tension wire from the center of the ignition coil. Disconnect and label the two wires from the coil. See Fig. 5-1. Unclip the ignition coil wiring harness from the mounting on the side of the shock tower. Separate the harness connector from the wire leading out of the coil wiring harness.

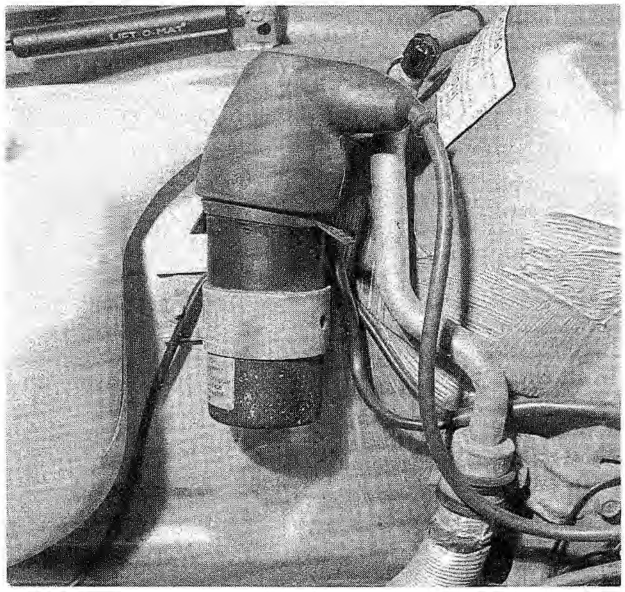


Fig. 5-1. Ignition coil with protective cover.

5. Disconnect the oxygen sensor wire. The connector is clipped to the side of the battery tray.

6. Remove the trim panel from above the glove compartment. Carefully disconnect the harness connectors from the idle speed control unit and the L-Jetronic control unit. Disconnect the white (3-point) harness connector leading out of the L-Jetronic wiring harness. See Fig. 5-2. Working from the engine compartment, pull the idle speed and L-Jetronic control unit wiring harness into the engine compartment.

7. On models with automatic transmission, disconnect the connectors from the temperature switch located in the firewall behind the distributor.

8. Disconnect the harness connector(s) from the ignition control unit. Disconnect the harness connector and the two vacuum hoses from the vacuum advance solenoid. See Fig. 5-3. Cut the wire ties that secure the harness to the firewall.

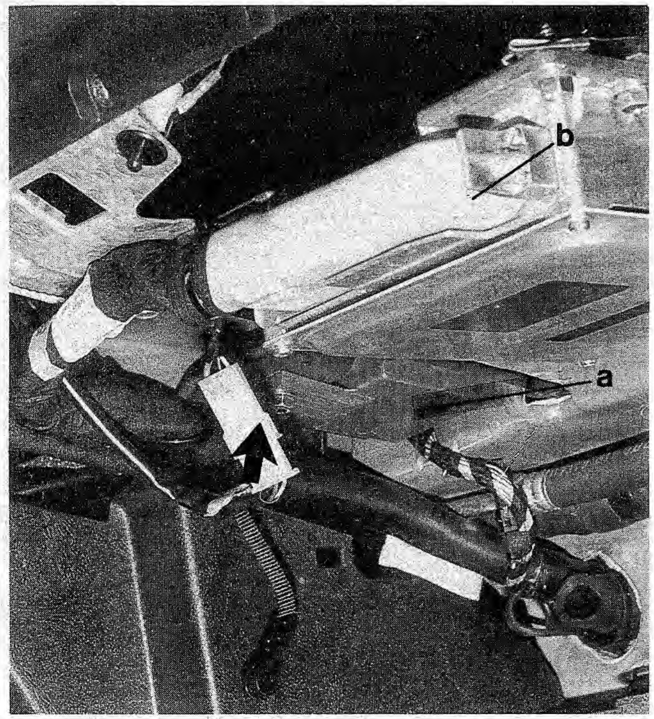


Fig. 5-2. Idle speed control unit (**a**) L-Jetronic control unit (**b**) harness connectors. White 3-point harness connector at arrow.

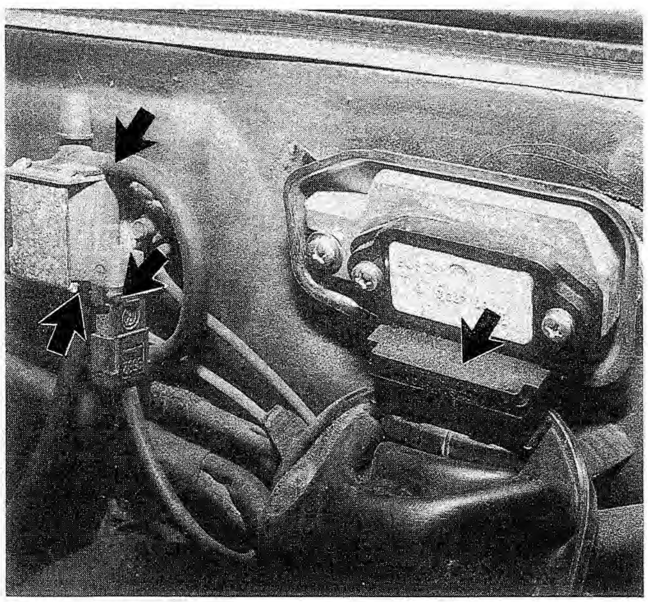


Fig. 5-3. Ignition control unit (Bosch type) connector and vacuum advance solenoid connector and hoses (arrows). Top hose goes to distributor, bottom hose goes to intake manifold.

9. Disconnect the connector from intake air temperature sensor. Sensor is located in the intake air duct behind the headlight. See Fig. 5-4.

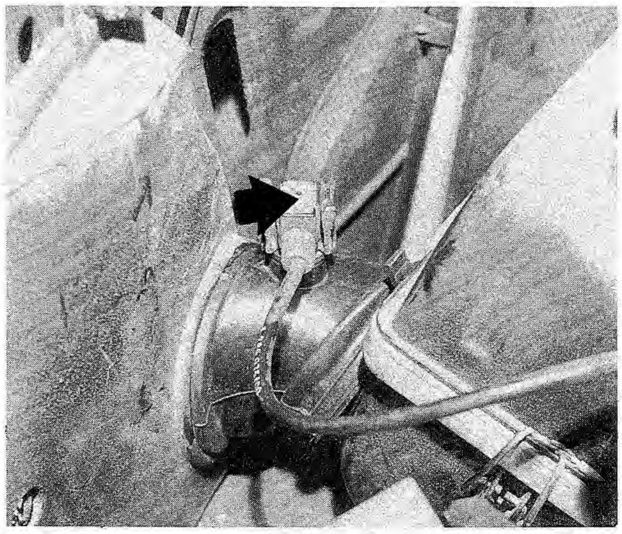


Fig. 5-4. Intake air temperature sensor (arrow).

10. Remove the cover and slide the auxiliary relay panel from its bracket. Disconnect the white harness connector near the relay panel bracket. Disconnect the harness connector from the air flow sensor. See Fig. 5-5.

11. Remove the intake air boot between the throttle housing and the air flow sensor. Remove the two air filter housing mounting nuts and remove the air filter assembly. See Fig. 5-5.

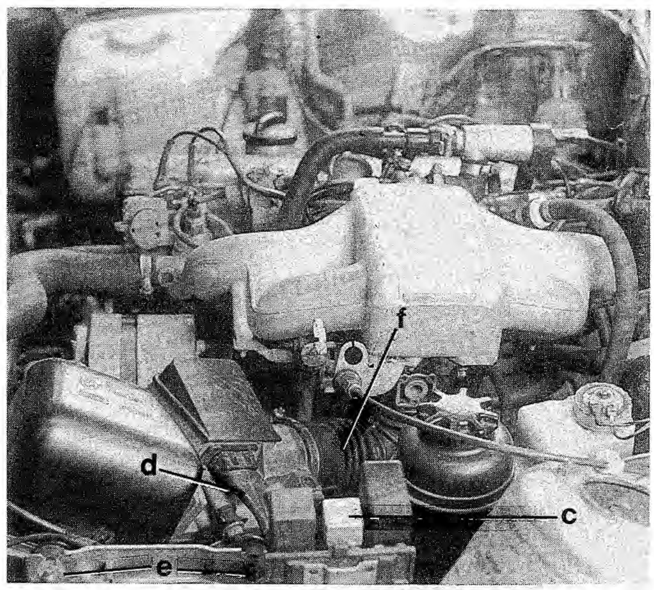


Fig. 5-5. Auxiliary relay panel (**c**), air flow sensor connector (**d**), air filter housing mounting nuts (**e**), and intake air boot (**f**).

12. Disconnect the accelerator cable from its fitting. If applicable, disconnect the automatic transmission throttle cable and the cruise control cable. Disconnect the large brake booster vacuum hose at the intake manifold.

13. Remove the coolant hose clamp from the intake manifold support bracket. Disconnect the vacuum hose from the charcoal canister. See Fig. 5-6.

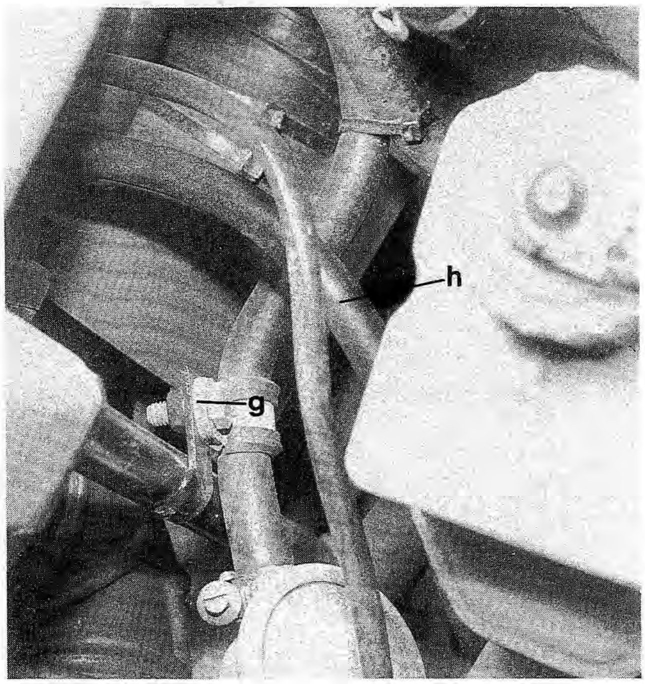


Fig. 5-6. Coolant hose clamp on intake manifold bracket (**g**) and charcoal canister vacuum hose (**h**).

14. Lift off the fuse/relay panel cover. Disconnect the large harness connector and free the harness from the relay panel. See Fig. 5-7.

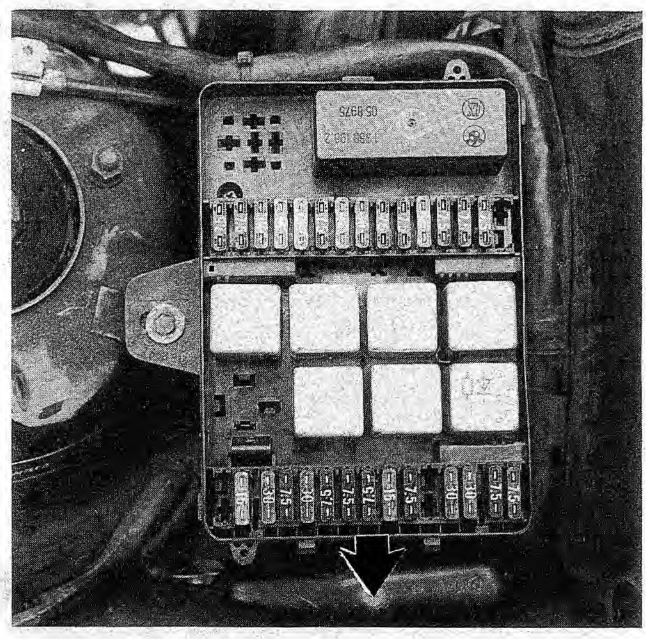


Fig. 5-7. Fuse/relay panel cover removed. Disconnect harness connector (arrow).

15. Disconnect the fuel supply line and fuel return line. Remove the bracket that secures the supply line to the fuel rail. See Fig. 5-8.

WARNING —

Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.

NOTE —

Wrap a cloth around the hose to absorb leaking fuel.

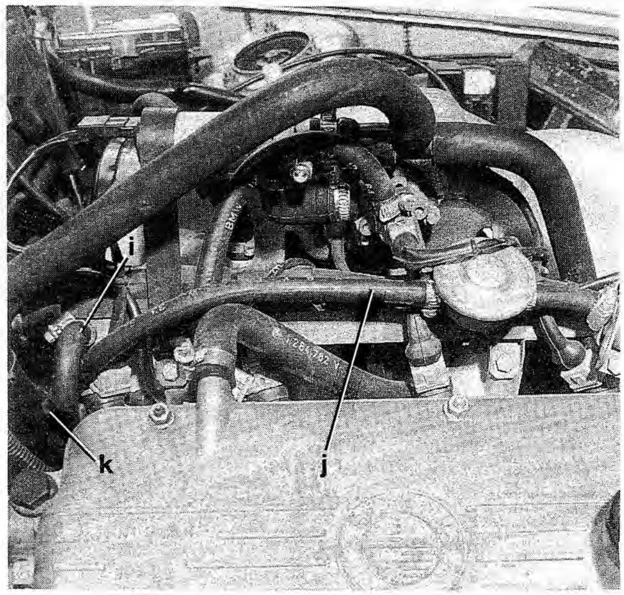


Fig. 5-8. Fuel supply line (**i**), fuel return line (**j**), and supply line bracket (**k**).

16. Loosen the two outer bolts on top of the air conditioning compressor. Remove the two inner bolts. See Fig. 5-9. Remove the lower pivot bolt. Without removing or loosening any refrigerant lines, carefully remove the compressor from the engine and secure it to the body using stiff wire.

WARNING —

Refrigerant hoses should not be removed from the air conditioner compressor. Doing so can lead to the expulsion of refrigerant under high pressure, leading to possible eye damage or frostbite.

NOTE —

Be ready to catch the compressor as it separates from the bracket. Support the compressor using stiff wire.

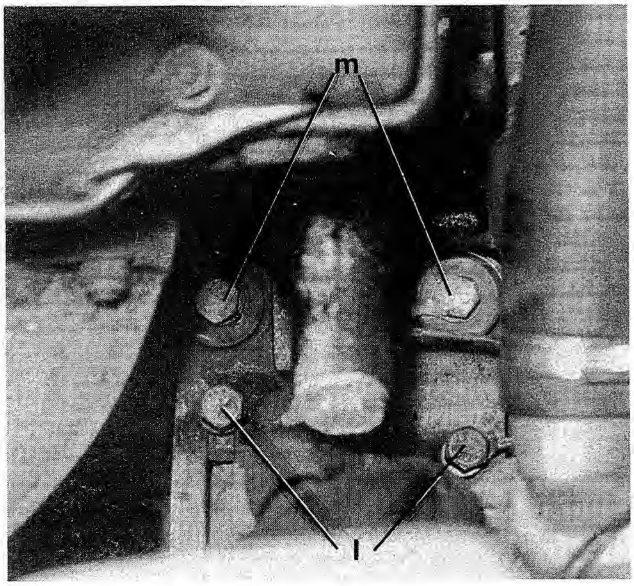


Fig. 5-9. Air conditioning compressor mounting bolts. Loosen outer bolts (**l**) and remove inner bolts (**m**).

17. Without disconnecting any hydraulic lines, remove the power steering pump from the engine as described in **SUSPENSION AND STEERING**.

18. Working under the car, remove the through-bolt from the engine damper. See Fig. 5-10. Remove the braided ground strap that is mounted to the oil pan.

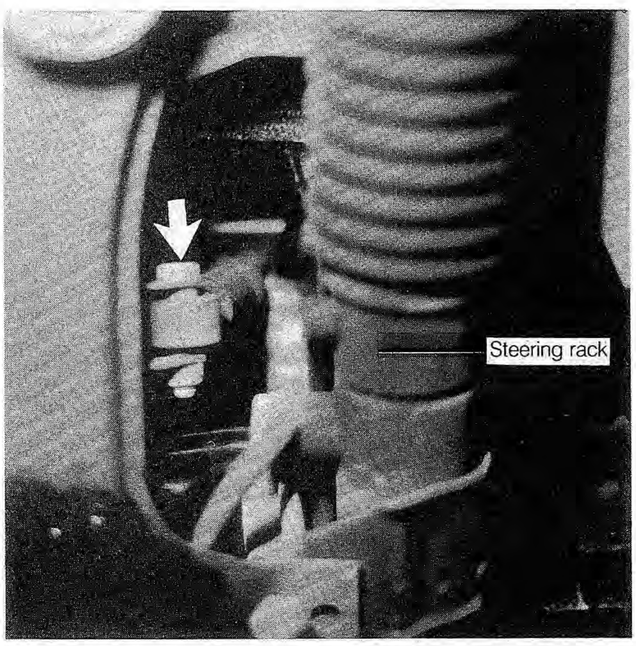


Fig. 5-10. Location of engine damper. Remove damper through-bolt (arrow).

19. Install an engine lifting device, using the front and rear lifting points shown in Fig. 5-11.

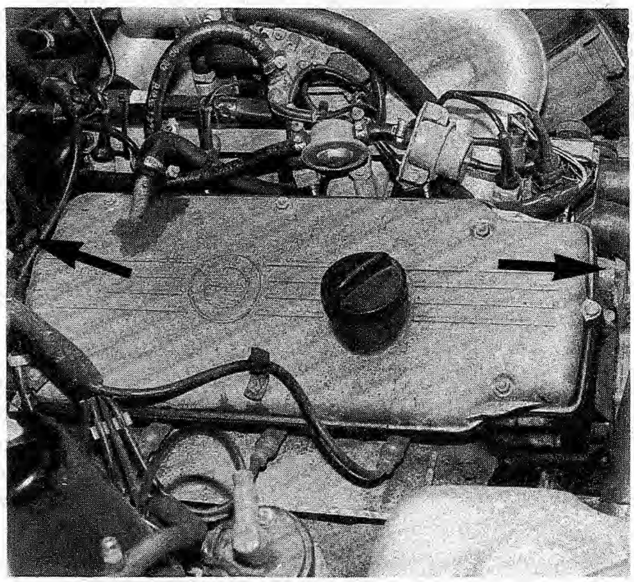


Fig. 5-11. Location of rear engine lifting point in transmission bellhousing (left arrow) and front lifting bracket on cylinder head (right arrow).

20. Remove the nuts that secure the left and the right motor mounts. See Fig. 5-12. Carefully raise the engine out of the car, checking for any wiring, fuel lines, or mechanical parts that might become snagged as the engine is removed.

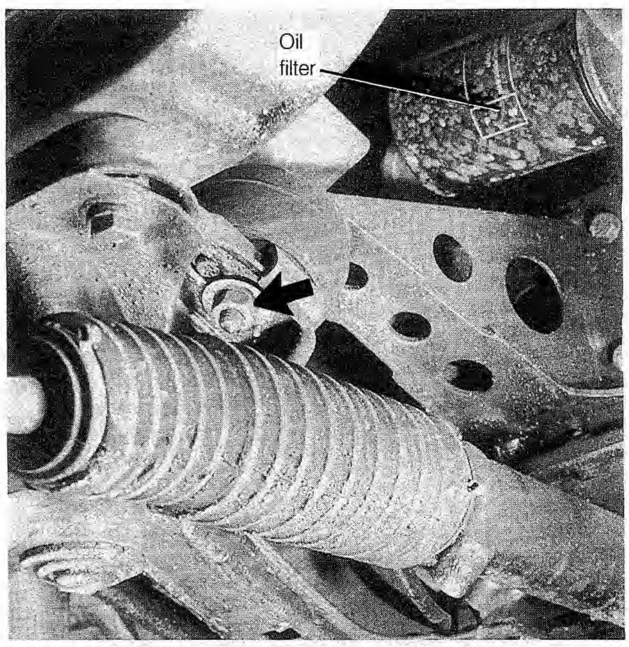


Fig. 5-12. Mounting nut for right engine mount (arrow) as viewed from beneath car. Left engine mount is similar.

Installation is the reverse of removal. When installing the engine into the engine compartment, make sure the guide pins in the left and right engine mounts engage the bores in the front subframe (axle carrier). Engine mount tightening torques are listed in **Table n**.

Table n. Engine Mount Tightening Torques

Rubber mount to mount bracket	43–48 Nm (32–35 ft. lb.)
Rubber mount to subframe	
M10	43–48 Nm (32–35 ft. lb.)
M8	25–28 Nm (18–21 ft. lb.)
Mount bracket to engine	
M10	43–48 Nm (32–35 ft. lb.)
M8	22–24 Nm (16–18 ft.lb.)

Adjust the tension of all V-belts as described in **LUBRICATION AND MAINTENANCE**. Refill the cooling system as described in **COOLING SYSTEM**. Change the engine oil and filter as described in **LUBRICATION AND MAINTENANCE**. Adjust ignition timing as described in **IGNITION SYSTEM**. Adjust the accelerator cable, check the idle speed and adjust idle mixture as described in **FUEL SYSTEM**. Adjust the transmission throttle cable as described in **AUTOMATIC TRANSMISSION**.

Removing (6-cylinder engines)

The air conditioning compressor and the power steering pump should be unbolted and set aside without disconnecting any of the refrigerant lines or the power steering fluid lines. The hood should be either removed from the car or supported in its fully open position.

To remove:

1. Disconnect the hood support from the fitting on the hood. Securely support the hood in its fully open position, use care not to damage the front grille assembly. As an alternative, the hood can be removed from the car.

NOTE —

A special tool (BMW Tool No. 51 2 120) to hold the hood in the fully open position is available from an authorized BMW dealer parts department.

2. Disconnect the cables at the battery. Except on convertible models, disconnect and label the wires at the battery junction block. Disconnect the connectors for the temperature sensor. See Fig. 5-13.

CAUTION —

BMW anti-theft radios can be rendered useless by disconnecting the battery. Make sure you know the correct code before disconnecting the battery. See your owner's manual for more information.

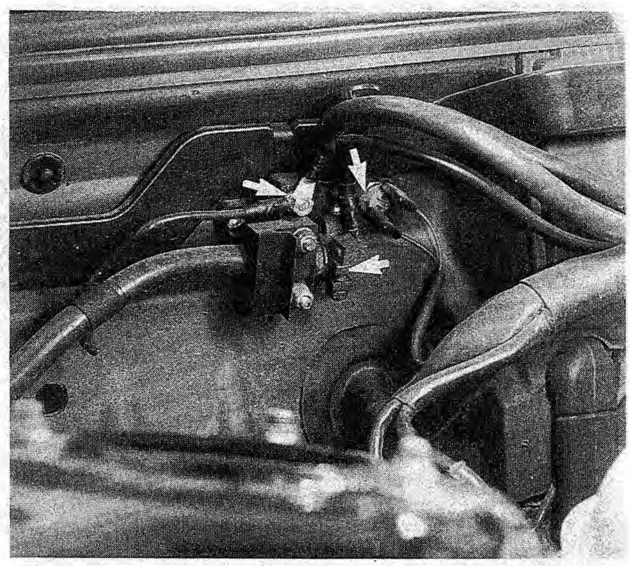


Fig. 5-13. Battery junction block wires and temperature sensor connectors needed to be removed (arrow). Some later models may not have temperature sensor.

3. Disconnect the oxygen sensor connector. See Fig. 5-14.

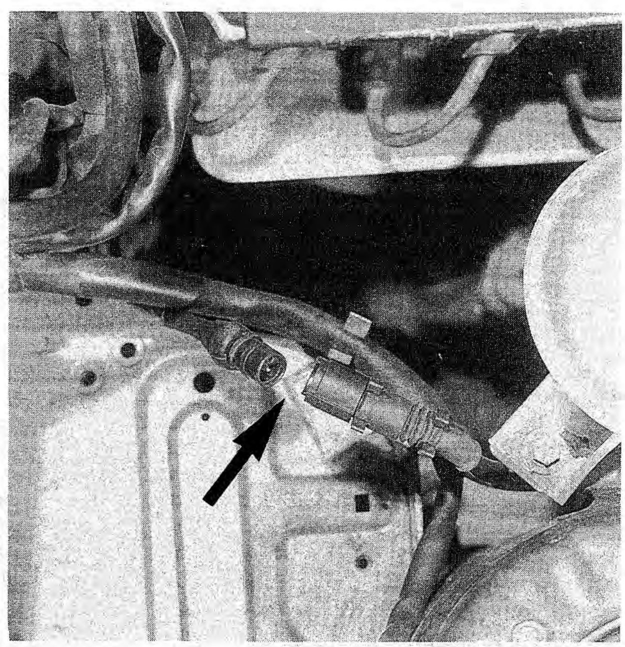


Fig. 5-14. Oxygen sensor connector disconnected (arrow). Types of connectors may vary between models.

4. Remove the trim panel from above the glove compartment. Carefully disconnect the harness connectors from the Motronic control unit. Disconnect the white (3-pin) harness connector leading out of the Motronic harness.

5. On 1984 through 1987 325 and 325e(es) models, remove the mounting bolt for the idle speed control unit and disconnect the harness connector. See Fig. 5-15.

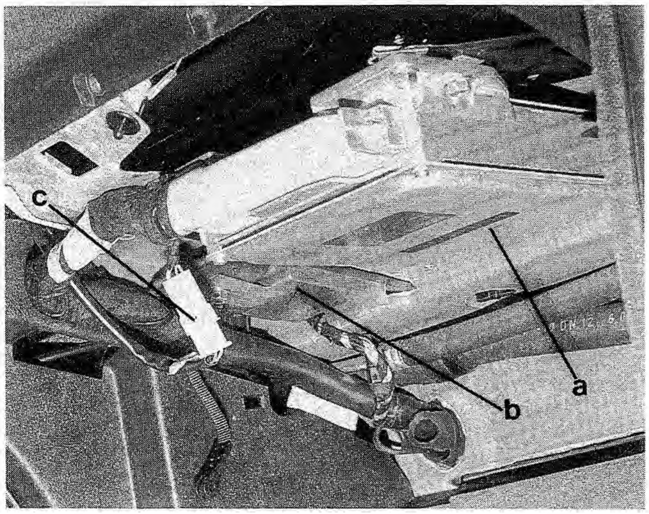


Fig. 5-15. Motronic control unit (**a**), idle speed control unit (**b**), and 3-point harness connector (**c**) as viewed from above glove compartment.

6. Working from the engine compartment, pull the idle speed and Motronic control unit wiring harness into the engine compartment. Cut any wire ties securing the harness to the body.

7. Drain the engine coolant and remove the radiator as described in **COOLING SYSTEM**. Disconnect the coolant hoses from the front of the engine. Disconnect the heater hoses from the heater core fittings at the rear firewall.

8. Remove the high tension wire from the center of the ignition coil. Disconnect and label the two small wires from the coil.

9. On 1988 and later models, disconnect the wire from the oil pressure switch that is mounted in the block near the oil filter. Fig. 7-1 shows the location. Pull the wiring harness from its clips on the front of the engine.

10. On 1984 through 1987 models, remove the two mounting bolts from the coolant expansion tank.

11. On 1988 and later models, disconnect the coolant hose from the bottom of the coolant expansion tank. See Fig. 5-16.

12. Remove the sensor wires and the overflow hose from the expansion tank.

NOTE —

The overflow hose is attached to the coolant expansion tank with a one-time clamp that may be pried open with a small screwdriver. Replace the clamp with a screw-type clamp.

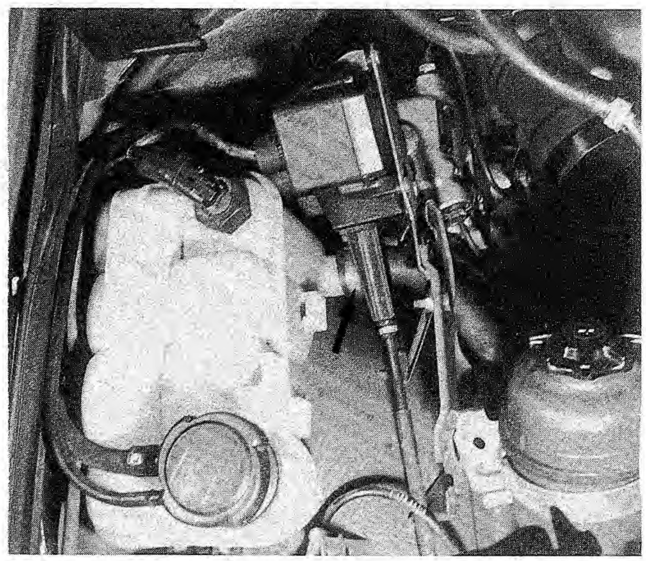


Fig. 5-16. Coolant expansion tank hose (arrow) on 1988 and later models.

13. On 1984 and 1985 models, remove the protective cover from the fuse/relay panel harness connector and separate the connector. Cut the wire ties until the harness is free. See Fig. 5-17.

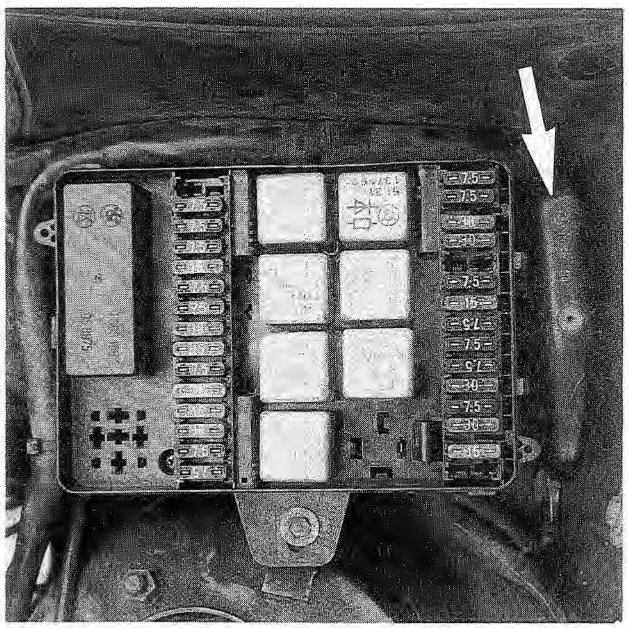


Fig. 5-17. Fuse/relay panel harness connector cover (arrow) on 1984 and 1985 models.

14. On 1986 and later models, unclip the main harness connector from the bracket and unscrew the connector to separate it at the firewall. See Fig. 5-18.

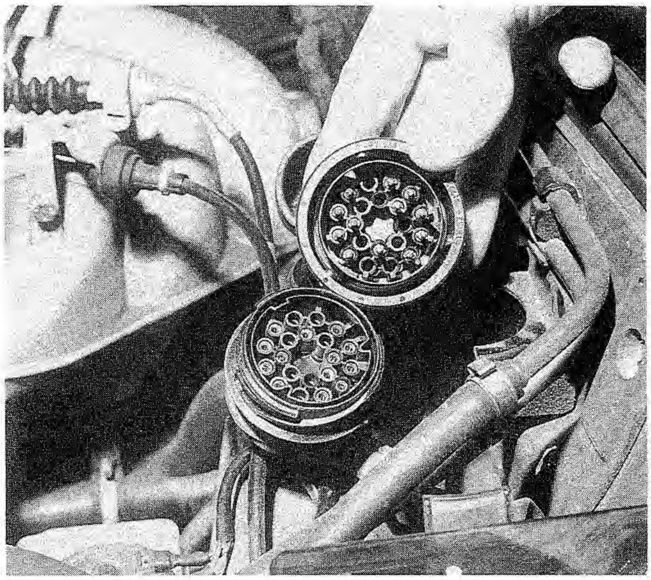


Fig. 5-18. Main harness connector separated on 1986 and later models.

15. Slide the auxiliary relay panel from its bracket and free the harness from its mounting points. Disconnect the harness connector from the air flow sensor. Remove the intake air boot between the throttle housing and the air flow sensor. Remove the two air filter housing mounting nuts and remove the air filter assembly. See Fig. 5-19.

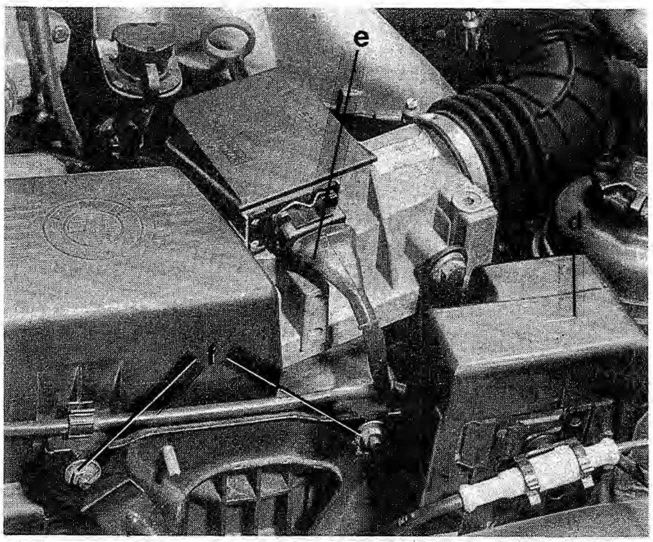


Fig. 5-19. Auxiliary relay panel (**d**), air flow sensor connector (**e**), air filter mounting nuts (**f**).

16. Disconnect the accelerator cable. If applicable, disconnect the automatic transmission throttle cable and the cruise control cable. Disconnect the large brake booster vacuum hose at the intake manifold. See Fig. 5-20.

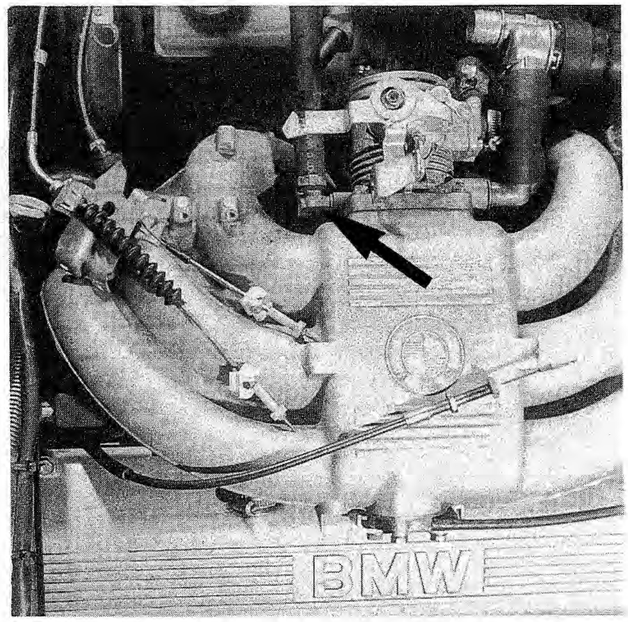


Fig. 5-20. Accelerator cable, automatic transmission throttle cable, and cruise control cable disconnected from throttle housing. Brake booster vacuum hose shown at arrow.

17. Disconnect the vacuum hoses from the charcoal canister. Disconnect the harness connector from the throttle switch. On later models with Motronic 1.1, disconnect the harness connector for the purge valve. See Fig. 5-21.

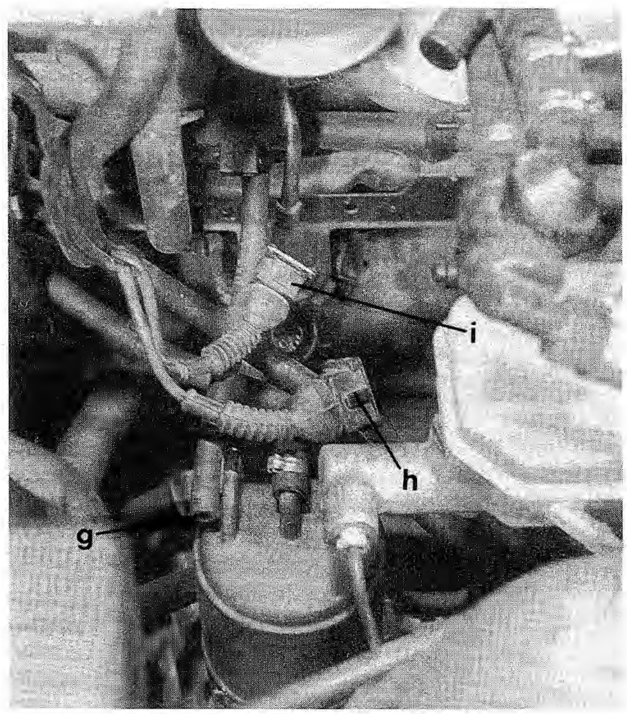


Fig. 5-21. Charcoal canister vacuum hose (**g**), and throttle switch harness connector (**h**) disconnected. Purge valve harness connector installed on models with Motronic 1.1 shown at (**i**).

18. On 1988 and later models, remove the starter as described in **ELECTRICAL SYSTEM**.

Disconnect the harness connector for the fuel injectors' wiring harness and remove the harness bracket mounting nuts as shown in Fig. 5-22.

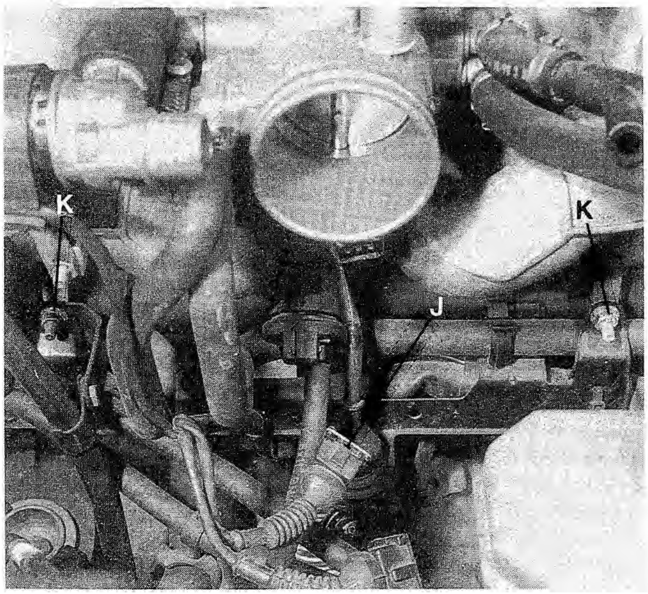


Fig. 5-22. Fuel injector wiring harness connector (**j**) and bracket mounting nuts (**k**).

19. On 1988 and later models, disconnect the wiring connectors on the rear of the alternator. Disconnect the electrical connector adjacent to the alternator.

20. On 1988 and later models, remove the two nuts that hold the wiring harnesses to the rear firewall. Remove the mounting bolts from the plastic coolant pipe that passes along the front of the engine. Disconnect the hoses from each end of the pipe, and remove the pipe.

21. On 1988 and later models, disconnect the reference and speed sensor connectors from their bracket.

22. Remove the diagnostic connector from its bracket. See Fig. 5-23. Remove the oil dipstick bracket retaining nut.

23. On 325i(is) and 325i Convertible models, remove the two oil cooler lines from the oil filter housing. See Fig. 5-24.

24. On models with automatic transmission, remove the bracket that holds the ATF cooler lines to the side of the oil pan.

25. Disconnect the fuel return line from the fuel pressure regulator. See Fig. 4-60. Disconnect the fuel supply line at the union beneath the intake manifold.

WARNING —
Fuel may be expelled under pressure. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.

NOTE —
Wrap a cloth around the hose to absorb leaking fuel.

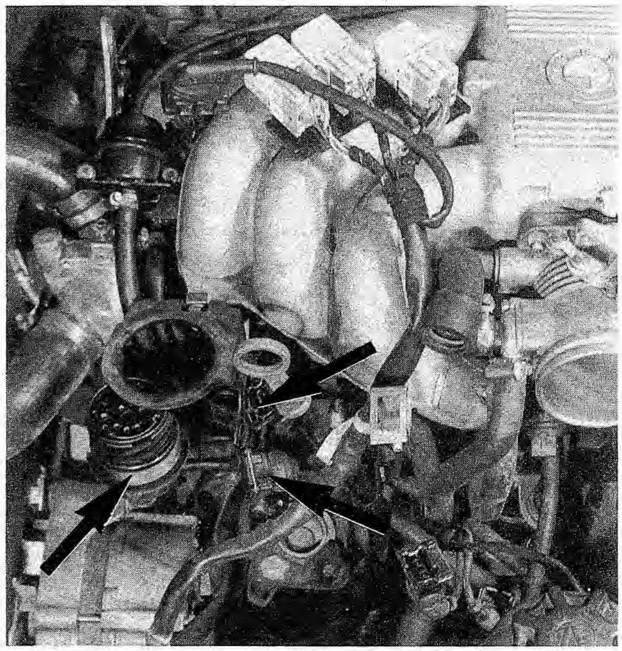


Fig. 5-23. Reference and speed sensor connectors and diagnostic connector removed from bracket (arrows).

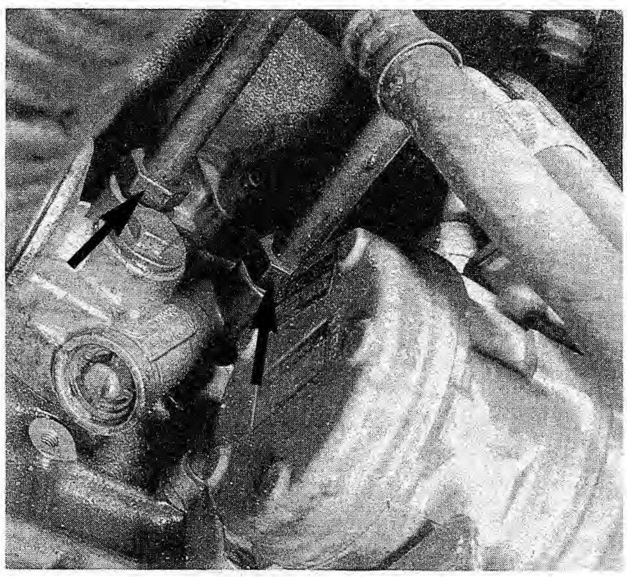


Fig. 5-24. Oil cooler lines at oil filter housing (arrows).

4

26. Without removing or loosening any refrigerant lines, carefully remove the air conditioning compressor from its bracket.

> ***WARNING —***
> *Refrigerant hose should not be removed from the air conditioner compressor. Doing so can lead to the expulsion of refrigerant under high pressure, leading to possible eye damage or frostbite.*

> **NOTE —**
> Be ready to catch the compressor as it separates from the bracket. Support the compressor using stiff wire.

27. Without disconnecting any hydraulic lines, remove the power steering pump from the engine as described in **SUSPENSION AND STEERING**.

28. Working under the car, remove the ground strap running from the engine to the body. Remove the nuts from the left and right engine mount. See Fig. 5-25.

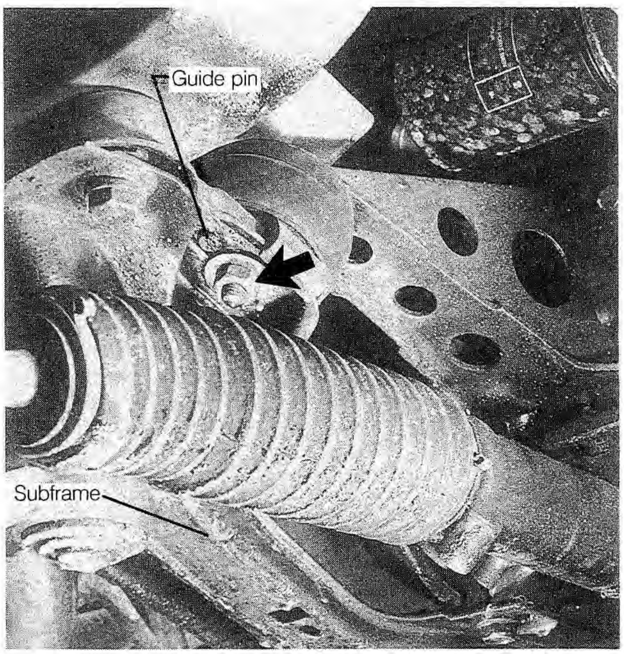


Fig. 5-25. Left engine mount nut (arrow) as viewed from under the car.

29. Install an engine lifting device on the front and rear lifting points. The front lifting point is a bracket on the front of the cylinder head. The rear lifting point is a hole in the left (driver's) side of the transmission flange. Carefully raise the engine out of the car, checking for any wiring, fuel lines, or mechanical parts that might become snagged as the engine is removed.

Installation is the reverse of removal. When installing the engine into the engine compartment, make sure the guide pins in the left and right engine mounts engage the bores in the front subframe (axle carrier). Engine mount tightening torques listed above in **Table n** can be used for all 6-cylinder engines.

Adjust the tension of all V-belts as described in **LUBRICATION AND MAINTENANCE**. Refill the cooling system as described in **COOLING SYSTEM**. Change the engine oil and filter as described in **LUBRICATION AND MAINTENANCE**. Adjust ignition timing as described in **IGNITION SYSTEM**. Adjust the accelerator cable, check the idle speed and adjust idle mixture as described in **FUEL SYSTEM**. Adjust the transmission accelerator cable as described in **AUTOMATIC TRANSMISSION**.

6. Cylinder Block and Pistons

The cylinder block for the engines covered by this manual are made of cast iron. For extra strength, the sides of the crankcase extend well below the centerline of the main bearings. The cylinders are integral with the block and are completely exposed on all sides to the coolant that circulates through the water jackets.

Cylinder block problems normally result from wear due to high mileage. Low compression pressures and noise due to excessive clearances are signs of a seriously worn engine. See **ENGINE MANAGEMENT—DRIVEABILITY** for more information.

6.1 Cylinder Block Oil Seals

On all engines covered by this manual, the front cylinder block oil seal(s) can be replaced with the engine installed. Replacement of the rear oil seal requires that the engine and transmission be separated.

Replacing Front Cylinder Block Oil Seals

On models with 4-cylinder engines, the front crankshaft oil seal can be replaced without removing the timing chain cover or the timing chain. On models with 6-cylinder engines, it is necessary to remove the camshaft drive belt and the lower drive belt sprocket before replacing the crankshaft oil seal or the intermediate shaft oil seal.

To replace crankshaft oil seal (4-cylinder engines):

1. Remove all V-belts from the front of the engine as described in **LUBRICATION AND MAINTENANCE**.

2. Using a 30 mm socket on the bolt in the center of the crankshaft, loosen the nut that secures the vibration damper (crankshaft pulley). Do not remove the nut.

> **NOTE —**
> A special BMW service tool (BMW Tool No. 11 2 100) is available to hold the flywheel stationary while the vibration damper mounting nut is loosened. As an alternative, a large wrench can be used to hold the rear part of the damper stationary. If the alternate method is used, a thick strip of leather or other material can be used to prevent slippage and damage to the vibration damper.

3. Carefully pry the vibration damper loose. It may be necessary to use two screwdrivers on either side of the damper to aid in its removal. Once the damper is loose, remove the nut, the damper, and the woodruff key.

> ***CAUTION —***
> *Excessive force should not be necessary to remove the vibration damper. Be careful not to damage the lower timing chain cover. Use two small blocks of wood under the tips of the screwdrivers to protect the housing.*

4. Using an appropriate seal remover, pry the seal from the housing. See Fig. 6-1. As an alternative, use a screwdriver to carefully pry the seal from its housing.

> ***CAUTION —***
> *Be careful not to mar the surface of the housing when removing the seal.*

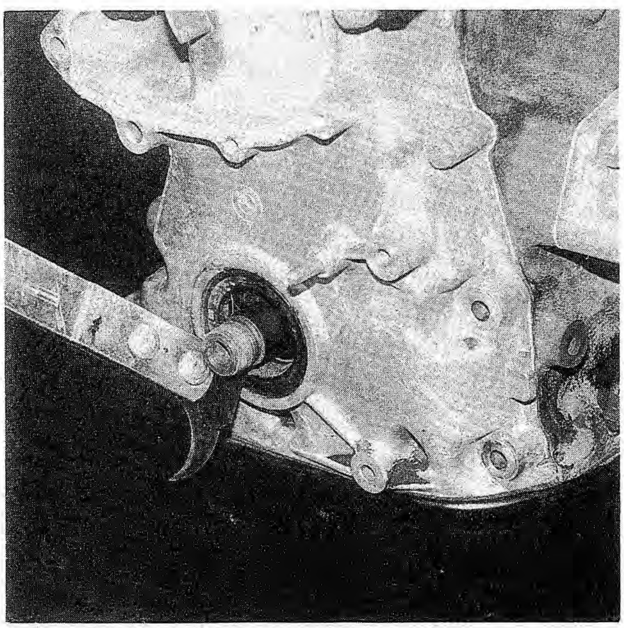


Fig. 6-1. Crankshaft oil seal being removed.

5. Lubricate the nose of the crankshaft and the inside of the oil seal with engine oil. Install the seal, driving it in until the seal is flush with the timing chain cover.

> ***CAUTION —***
> - *The oil seal can be torn as it is placed over the crankshaft. Use tape around the threads on the front of the crankshaft.*
> - *Do not attempt to hammer directly on the surface of the seal, as its rubber cover might be torn or the metal housing may be bent. A damaged oil seal should be replaced. Do not drive the seal in beyond its correct position. There is no shoulder in the housing.*

6. Installation of the remainder of the components is the reverse of removal. Make sure the woodruff key is correctly positioned in the crankshaft. Tighten the vibration damper retaining nut to 190 ± 10 Nm (140 ± 7 ft. lb.). Install all the V-belts as described in **LUBRICATION AND MAINTENANCE**.

To replace crankshaft and intermediate shaft oil seals (6-cylinder engines):

1. Drain the coolant and remove the radiator as described in **COOLING SYSTEM**.

2. Remove the camshaft drive belt as described in **4.2 Camshaft Drive Belt (6-cylinder engines)**.

3. While holding the crankshaft sprocket stationary with a holding device, loosen the sprocket mounting bolt. Remove the sprocket from the front of the crankshaft using a puller. Remove the woodruff key from the crankshaft.

> **NOTE —**
> The crankshaft sprocket mounting bolt is tightened to a torque of approximately 410 Nm (302 ft. lb.). A heavy duty holding device, such as BMW Tool No. 11 2 150, should be used to hold the sprocket. Use a heavy duty ¾-inch drive socket and breaker bar to break the bolt free.

4

4. While holding the intermediate shaft sprocket stationary with a holding device, loosen the bolt that secures the sprocket to the shaft. Remove the sprocket from the shaft using a suitable puller. Remove the centering pin from the intermediate shaft.

> ***CAUTION —***
> *Before removing the intermediate shaft sprocket mounting bolt, inspect for oil leakage at the bolt and on the sprocket. If signs of oil leakage are present, the internal sealing plug in the intermediate shaft may be faulty or missing. A leaking intermediate shaft should be replaced.*

> **NOTE —**
> A special device for holding the intermediate shaft sprocket stationary (BMW Tool No. 11 2 190) is available from an authorized BMW dealer parts department.

5. Working beneath the car, remove the three oil pan bolts that thread into the front end cover. Loosen but do not remove the remaining oil pan bolts. Remove the six bolts that secure the front end cover to the cylinder block. Pry the cover from the engine, being careful not to tear the oil pan gasket.

> **NOTE —**
> If the front end cover is stuck to the oil pan gasket, use a sharp knife to cut it free.

6. Press the oil seals out of the front end cover. Press the new seals into the cover until they are approximately 1 to 2 mm (0.04 to 0.08 in.) below the surface of the cover.

> **NOTE —**
> The old seals were originally installed flush to the cover surface. The new seals should be installed slightly deeper so that they do not ride on the same area of the shafts. This will allow for a good seal despite any wear.

7. Apply a light coating of silicone sealer to the portion of the oil pan gasket that mates to the front end cover. Apply a light coat of engine oil to the seals. Using a new front end cover gasket, install the cover. Torque the smaller M6 mounting bolts to 9 ± 1 Nm (80 ± 9 in. lb.) and the larger M8 bolts to 22 ± 2 Nm (16 ± 1 ft. lb.). Tighten all oil pan mounting bolts to 9 to 11 Nm (7 to 8 ft. lb.).

> ***CAUTION —***
> *Do not use too much sealer as it can leak into the oil pan and plug small oil passages when circulated with the engine oil. This can lead to oil starvation and engine damage.*

> **NOTE —**
> - Permatex® 77B or Wurth® DP-300 sealers can be used to seal the cover to the gasket.
> - To protect the oil seals during installation of the front end cover, BMW recommends using special tools (BMW Tool No. 24 1 040 and 24 1 050) to cover the shafts. As an alternative, the shafts may be wrapped with plastic tape and coated with a small amount of engine oil.

The remainder of the installation is reverse of removal. Be sure the centering pin is installed in the intermediate shaft. Torque the intermediate shaft sprocket mounting bolt to 60 ± 5 Nm (44 ± 4 ft. lb.). Be sure the woodruff key is properly aligned in the crankshaft and install the crankshaft sprocket. Tighten the crankshaft sprocket mounting bolt to 410 ± 20 Nm (302 ± 15 ft. lb.). Install a new camshaft drive belt as described under **4.2 Camshaft Drive Belt (6-cylinder engines)**. Install the radiator, add coolant and bleed the cooling system as described in **COOLING SYSTEM**.

> **NOTE —**
> Most torque wrenches cannot handle the torque setting of the crankshaft sprocket mounting bolt. Special arrangements should be made to tighten the bolt to the proper torque using a heavy-duty torque wrench.

Replacing Rear Crankshaft Oil Seal

Replacing the rear crankshaft oil seal requires that the engine be separated from the transmission and that the flywheel or drive plate be removed. These removal and installation procedures are described in **MANUAL TRANSMISSION AND CLUTCH** or **AUTOMATIC TRANSMISSION**. On 4-cylinder engines, drain the engine oil as described in **LUBRICATION AND MAINTENANCE**.

Once the seal is exposed, remove the mounting bolts for the oil seal carrier as shown in Fig. 6-2. Loosen, but do not remove, the oil pan mounting bolts and remove the oil seal carrier. With the carrier removed, the old seal can be pressed out. Press the new seal in until it is 1 to 2 mm (0.04 to 0.08 in.) below the surface of the carrier surface.

> **NOTE —**
> If the oil seal carrier is stuck to the oil pan gasket, free the cover from the gasket using a sharp knife.

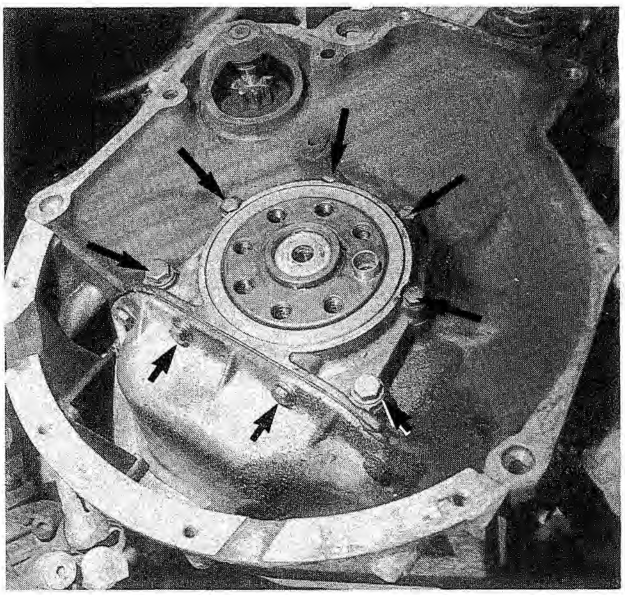


Fig. 6-2. Rear crankshaft oil seal carrier mounting bolts (arrows). Transmission, clutch assembly, and flywheel removed from engine.

When installing the oil seal carrier, apply a light coating of silicone sealer to the portion of the oil pan gasket that mates to the carrier. Apply a light coat of engine oil to the lip of the seal. Install a new gasket and the carrier. Torque the smaller M6 mounting bolts to 9 ± 1 Nm (80 ± 9 in. lb.) and the larger M8 bolts to 22 ± 2 Nm (16 ± 1 ft. lb.). Tighten all oil pan mounting bolts to 9 to 11 Nm (7 to 8 ft. lb.). On 4-cylinder engines, fill the engine with oil as described in **LUBRICATION AND MAINTENANCE**.

CAUTION

Do not use too much sealer as it can leak into the oil pan and plug small oil passages when circulated with the engine oil. This can lead to oil starvation and engine damage.

6.2 Disassembly, Assembly, and Reconditioning Cylinder Block

Disassembly, assembly, and reconditioning procedures for the cylinder blocks covered in this manual are similar to those for most other water-cooled, in-line engines. For anyone with the proper tools and equipment and basic experience in engine reconditioning, this section provides the specifications and special reconditioning information necessary to repair these BMW engines.

If machine shop services are not readily available, one alternative is to install a BMW remanufactured cylinder block (engine cylinder block complete with crankshaft, pistons and connecting rods installed, but without cylinder head or external components). A remanufactured cylinder block is available from an authorized BMW dealer parts department.

Connecting Rods and Pistons

It is necessary to remove the engine, the cylinder head, and the oil pan before removing the pistons. See **4. Cylinder Head** and **5. Removing and Installing Engine**. If pistons, piston pins, piston rings, connecting rods, and bearings are to be reused, they should always be reinstalled in their exact positions. Parts should never be interchanged between cylinders.

Before removing the pistons, mark the cylinder numbers on connecting rods and connecting rod caps. Mark each connecting rod's position on the crankshaft so that they are not reversed during installation. The matching numbers on the side of the connecting rod and rod cap should all be facing the same side of the engine. Mark the piston tops as shown in Fig. 6-3. (avoid scratching the piston).

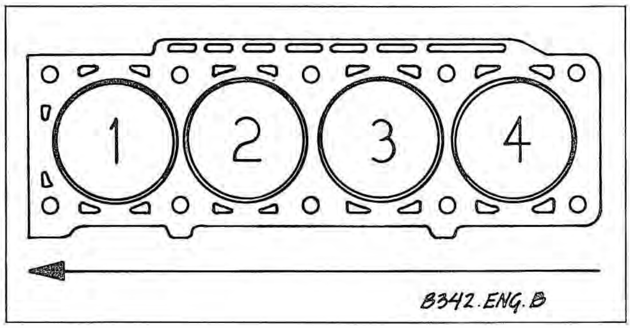


Fig. 6-3. Piston numbering sequence. Arrow points to front (radiator end) of engine.

The piston pin should fit without any play. No specifications for the pin-to-rod fit are provided by BMW. The fit can be checked by pushing the pin through the rod by hand. There should be slight resistance as the pin moves through the rod. If the piston pin-to-connecting rod bushing clearance is excessive, replace the connecting rod bushing and piston pin or the connecting rod. The piston pin circlips should be replaced with new circlips anytime they are removed. When reassembling the piston/rod assembly, make sure the oil hole in the rod's small end is on the same side as the arrow on the piston top.

When replacing the connecting rods, use only ones having the same weight class. The weight class can be found on the bottom of the connecting rod cap. The weight classification is made up of an alphanumeric code, A1 for example.

Each connecting rod is matched with its cap using a stamped number code. The numbers are found on the side of the connecting rod and rod cap. When reinstalling the rods, be sure all matched numbers face the same side of the engine. When installing the connecting rod to the crankshaft, install the piston so that the arrow on the piston crown faces the front of the engine.

Table o lists connecting rod specifications. Connecting rods should be carefully checked for bend, twist and bearing bore out-of-roundness using connecting rod alignment tools.

Table o. Connecting Rod Specifications

Specification	4-cylinder	6-cylinder
Big end diameter (Bearing shells removed) standard no classification double classification (paint dot on rod) red blue	 52.000–52.010 mm (2.0472–2.0476 in.) 52.000–52.008 mm (2.0472–2.0475 in.) 52.009–52.016 mm (2.0476–2.0479 in.)	 NA 48.000–48.008 mm (1.8898–1.8901 in.) 48.009–48.016 mm (1.8901–1.8904 in.)
Connecting rod bushing outside diameter inside diameter (nominal diameter 22.0 mm)	 24.060–24.100 mm (0.9472–0.9488 in.) 22.003–22.008 mm (0.8662–0.8664 in.)	 24.060–24.100 mm (0.9472–0.9488 in.) 22.003–22.008 mm (0.8662–0.8664 in.)
Maximum parallel deviation of connecting rod bores (bearing shells installed) at distance of 150 mm (5.905 in.)	0.04 mm (0.0016 in.)	0.04 mm (0.0016 in.)
Maximum deviation of weight between connecting rods (bearing shells removed) total small end only big end only	 ±4.0 grams (.14 oz.) ±2.0 grams (.07 oz.) ±2.0 grams (.07 oz.)	 ±4.0 grams (.14 oz.) ±2.0 grams (.07 oz.) ±2.0 grams (.07 oz.)
Connecting rod bolt torque	52–57 Nm (38–42 ft. lb.)	20 Nm (14.5 ft. lb.) plus an additional 70°

Piston specifications are listed in **Table p**. When replacing pistons, use only pistons having the same weight class. The piston weight class is stamped with a "+" or "–" on the piston top. The total weight difference between the pistons should not vary more than 10 grams (.35 oz.). The nominal piston diameter is also stamped on the crown. See Fig. 6-4. When installing the pistons, make sure the arrow on the piston top faces the front of the engine.

Table p. Piston Specifications

	4-cylinder engine	6-cylinder engine
Piston diameter standard special oversize 1 oversize 2	 88.97 mm (3.5027 in.) 89.05 mm (3.5059 in.) 89.22 mm (3.5126 in.) 89.47 mm (3.5224 in.)	 83.98 mm (3.3063 in.) 84.06 mm (3.3094 in.) 84.23 mm (3.3161 in.) 84.48 mm (3.3260 in.)
Piston to cylinder clearance new wear limit	 0.02–0.05 mm (.0008–.0020 in.) 0.15 mm (0.0060 in.)	 0.01–0.04 mm (.0004–.0016 in.) 0.12 mm (0.0047 in.)
Weight difference between pistons (maximum permissible)	10 grams (.35 oz.)	10 grams (.35 oz.)

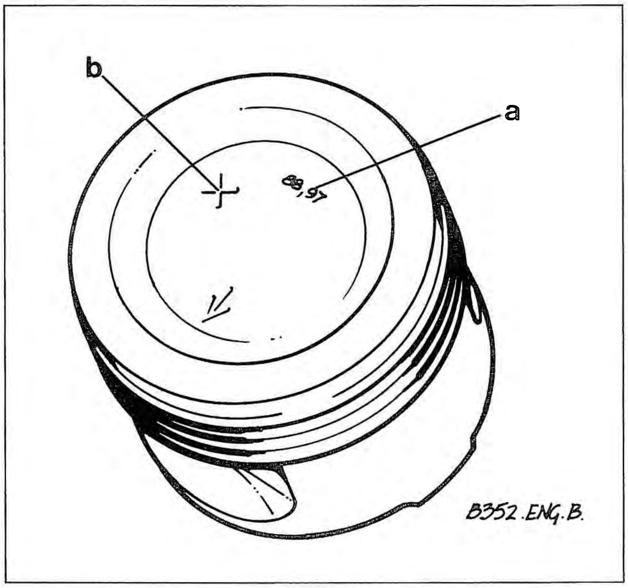


Fig. 6-4. Piston crown identification markings. Arrow should face front. Nominal piston diameter shown at **a**, and weight classification at **b**.

If the piston pin-to-piston clearance is excessive, the piston and the pin should be replaced as a set, as they are machined as matched pairs.

When measuring the piston diameter, make measurements at three places around the piston at the height indicated in Fig. 6-5, using the information listed in **Table q** or **Table r**.

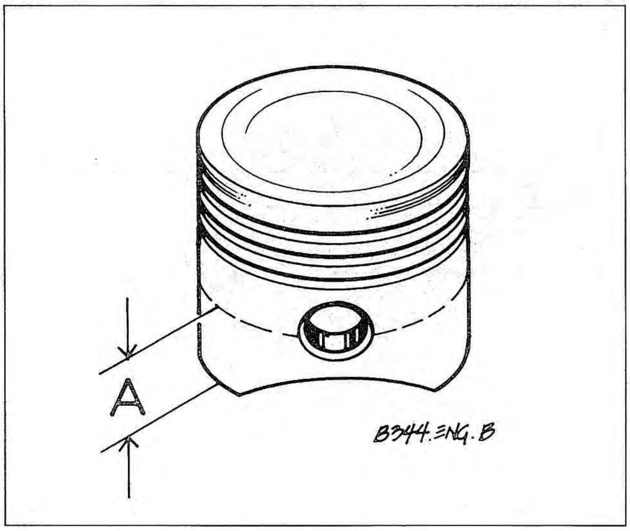


Fig. 6-5. Distance from bottom of piston skirt to measuring point (**A**) for determining piston diameter. Distance varies between engines depending on piston manufacturer.

Table q. Piston Skirt Measuring Points (4-cylinder engine)

Manufacturer	Distance A
Mahle	14.00 mm (0.551 in.)
KS	30.85 mm (1.215 in.)
Alcan	15.50 mm (0.610 in.)

Table r. Piston Skirt Measuring Points (6-cylinder engine)

Manufacturer	Total piston height	Distance A
325,325e models		
Mahle	68.7 mm (2.705 in.)	8 mm (0.315 in.)
KS	68.7 mm (2.705 in.)	14 mm (0.551 in.)
Mahle or KS	77.7 mm (3.059 in.)	23 mm (0.905 in.)
325i models		
Mahle	73.6 mm (2.898 in.)	9 mm (0.354 in.)

Cylinders

Measure cylinder bores at approximately the top, the middle, and the bottom of piston travel. Make all measurements at right angles (90°). Cylinder bore measuring points are shown in Fig. 6-6. Cylinder bore diameters are listed in **Table s**.

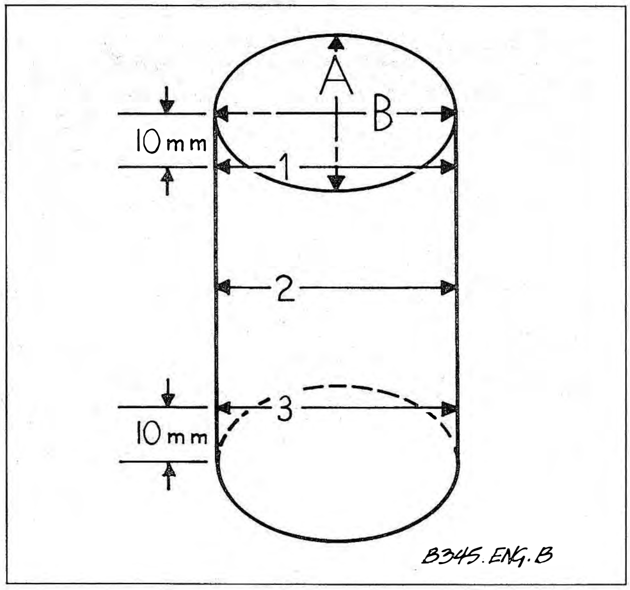


Fig. 6-6. Cylinder bore measuring points. Top (**1**) and bottom (**3**) measurements should be made at least 10 mm (3/8 in.) from ends of cylinder, first in direction **A** and then in direction **B**.

Table s. Cylinder Bore Specifications

Specification	4-cylinder engine	6-cylinder engine
Cylinder bore diameter		
standard	$89.00^{+0.01}_{-0}$ mm ($3.5039^{+0.0004}_{-0}$ in.)	$84.00^{+0.01}_{-0}$ mm ($3.3071^{+0.0004}_{-0}$ in.)
special	$89.08^{+0.01}_{-0}$ mm ($3.5071^{+0.0004}_{-0}$ in.)	$84.08^{+0.01}_{-0}$ mm ($3.3102^{+0.0004}_{-0}$ in.)
oversize 1	$89.25^{+0.01}_{-0}$ mm ($3.5138^{+0.0004}_{-0}$ in.)	$84.25^{+0.01}_{-0}$ mm ($3.3169^{+0.0004}_{-0}$ in.)
oversize 2	$89.50^{+0.01}_{-0}$ mm ($3.5236^{+0.0004}_{-0}$ in.)	$84.50^{+0.01}_{-0}$ mm ($3.3268^{+0.0004}_{-0}$ in.)
Maximum out-of-round	0.01 mm (0.0004 in.)	0.03 mm (0.0012 in.)
Maximum conicity	0.01 mm (0.0004 in.)	0.02 mm (0.0008 in.)

Piston Rings

Piston ring end gaps are checked with the piston rings inserted approximately 15 mm (⅝ in.) from the top of the cylinder. See Fig. 6-7. The piston ring end gap specifications are listed in **Table t**. The gap should be checked after the final cylinder hone.

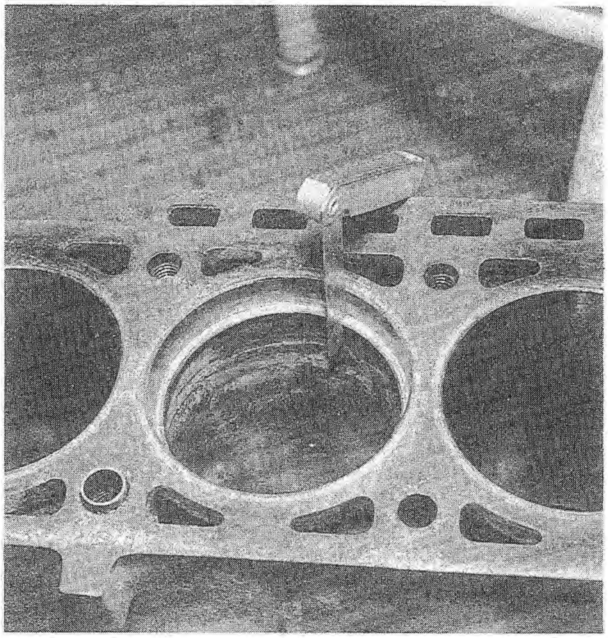


Fig. 6-7. Piston ring end gap being checked in cylinder block using feeler gauge.

Table t. Piston Ring End Gap

Piston ring	4-cylinder engine	6-cylinder engine
Upper compression ring (top ring)	0.30–0.70 mm (0.012–0.028 in.)	0.30–0.50 mm (0.012–0.020 in.)
Lower compression ring (middle ring)	0.20–0.40 mm (0.008–0.016 in.)	0.30–0.50 mm (0.012–0.020 in.)
Oil ring (bottom ring)	0.25–0.50 mm (0.010–0.020 in.)	0.25–0.50 mm (0.010–0.020 in.)

Piston ring side clearance is checked using feeler gauges. Measure each ring in its original groove as shown in Fig. 6-8. Piston ring side clearance specifications are listed in **Table u**.

Install the rings with the gaps offset from each other by 120°. Each ring should be installed so that the word "TOP" found on each ring faces up. Lightly coat the cylinders and the rings with engine oil before installation.

Fig. 6-8. Measuring piston ring side clearance with feeler gauge.

Table u. Piston Ring Side Clearance

Piston ring	4-cylinder engine	6-cylinder engine
Upper compression ring (top ring)	0.06–0.09 mm (0.0024–0.0035 in.)	0.040–0.072 mm (0.0016–0.0028 in.)
Lower compression ring (middle ring)	0.03–0.072 mm (0.0012–0.0028 in.)	0.030–0.062 mm (0.0012–0.0024 in.)
Oil ring (bottom ring)	0.02–0.06 mm (0.0008–0.0024 in.)	0.020–0.042 mm (0.0008–0.0017 in.)

Crankshaft

To remove the crankshaft, both the rear crankshaft oil seal carrier and the front end cover must be removed from the ends of the engine cylinder block. Crankshaft main bearing caps must not be interchanged. Crankshaft main bearing shells, if they are to be used, should only be installed in their original positions.

Crankshaft journal diameters are listed in **Table v**. Crankshaft clearance specifications are listed in **Table w**. Crankshaft bearings are available in standard sizes and undersizes according to a color coding system. A paint dot on the edge of the bearings, on the crankshaft, or on the base of the main bearing web of the cylinder block indicates the sizing classification of the crankshaft and bearings. The sizing colors available are red, blue, yellow, green, or white, with red being the most commonly used.

Crankshaft axial play (also called end play, float, or thrust) is controlled by a two-piece thrust bearing, which has raised edges to control the fore-and-aft movement of the crankshaft. The thrust bearing is the no. 3 main bearing in 4-cylinder engines and the no. 6 main bearing in 6-cylinder engines. Axial play should be measured at center main bearing journal with the crankshaft supported on rollers on the outer main bearing journals.

Table v. Crankshaft Journal Diameters

Specification	4-cylinder engine	6-cylinder engine
Main bearing journal diameter standard	(nominal dia. 55.00 mm)	(nominal dia. 60.00 mm)
red	54.980–54.990 mm (2.1646–2.1650 in.)	59.980–59.990 mm (2.3614–2.3618 in.)
blue	54.971–54.980 mm (2.1642–2.1646 in.)	59.971–59.980 mm (2.3611–2.3614 in.)
yellow	54.984–54.990 mm (2.1647–2.1650 in.)	59.984–59.990 mm (2.3616–2.3618 in.)
green	54.977–54.983 mm (2.1644–2.1647 in.)	59.977–59.983 mm (2.3613–2.3615 in.)
white	54.971–54.976 mm (2.1642–2.1644 in.)	59.971–59.976 mm (2.3611–2.3613 in.)
undersize 1	(nominal dia. 54.75 mm)	(nominal dia. 59.75 mm)
red	54.730–54.740 mm (2.1547–2.1551 in.)	59.730–59.740 mm (2.3516–2.3520 in.)
blue	54.721–54.730 mm (2.1544–2.1547 in.)	59.721–59.730 mm (2.3512–2.3516 in.)
yellow	54.734–54.740 mm (2.1549–2.1551 in.)	59.734–59.740 mm (2.3517–2.3520 in.)
green	54.727–54.733 mm (2.1546–2.1548 in.)	59.727–59.733 mm (2.3515–2.3517 in.)
white	54.721–54.726 mm (2.1544–2.1546 in.)	59.721–59.726 mm (2.3512–2.3514 in.)
undersize 2	(nominal dia. 54.50 mm)	(nominal dia. 59.50 mm)
red	54.480–54.490 mm (2.1449–2.1453 in.)	59.480–59.490 mm (2.3417–2.3421 in.)
blue	54.471–54.480 mm (2.1445–2.1449 in.)	59.471–59.480 mm (2.3414–2.3417 in.)
yellow	54.484–54.490 mm (2.1450–2.1453 in.)	59.484–59.490 mm (2.3419–2.3421 in.)
green	54.477–54.483 mm (2.1448–2.1450 in.)	59.477–59.483 mm (2.3416–2.3418 in.)
white	54.471–54.476 mm (2.1445–2.1447 in.)	59.471–59.476 mm (2.3414–2.3416 in.)

continued

Table v. Crankshaft Journal Diameters (continued)

Specification	4-cylinder engine	6-cylinder engine
Main bearing journal diameter undersize 3	(nominal dia. 54.25 mm)	NA
red	54.230–54.240 mm (2.1350–2.1354 in.)	NA
blue	54.221–54.230 mm (2.1347–2.1350 in.)	NA
yellow	54.234–54.240 mm (2.1352–2.1354 in.)	NA
green	54.227–54.233 mm (2.1349–2.1352 in.)	NA
white	54.221–54.226 mm (2.1347–2.1349 in.)	NA
Connecting rod journal diameter standard	(nominal dia. 48.00 mm) 47.975–47.991 mm (1.8888–1.8894 in.)	(nominal dia. 45.00 mm) 44.975–44.991 mm (1.7707–1.7713 in.)
undersize 1	(nominal dia. 47.75 mm) 47.725–47.741 mm (1.8789–1.8796 in.)	(nominal dia. 44.75 mm) 44.725–44.741 mm (1.7608–1.7615 in.)
undersize 2	(nominal dia. 47.50 mm) 47.475–47.491 mm (1.8691–1.8697 in.)	(nominal dia. 44.50 mm) 44.475–44.491 mm (1.7510–1.7516 in.)
Double classification standard	47.975–47.991 mm (1.8888–1.8894 in.)	44.975–44.991 mm (1.7707–1.7713 in.)
undersize 1	47.725–47.741 mm (1.8789–1.8796 in.)	44.725–44.741 mm (1.7608–1.7615 in.)
undersize 2	47.475–47.491 mm (1.8691–1.8697 in.)	44.475–44.491 mm (1.7510–1.7516 in.)
undersize 3	47.225–47.241 mm (1.8592–1.8599 in.)	NA
Crankshaft thrust bearing width standard	30.020–30.053 mm (1.1819–1.1832 in.)	25.020–25.053 mm (0.9850–0.9863 in.)
oversize 1	30.224–30.264 mm (1.1899–1.1915 in.)	25.220–25.253 mm (0.9929–0.9942 in.)
oversize 2	30.425–30.464 mm (1.1978–1.1994 in.)	25.420–25.453 mm (1.0008–1.0021 in.)
oversize 3	30.625–30.664 mm (1.2057–1.2072 in.)	NA

4

Table w. Crankshaft Clearances

Crankshaft main bearing radial clearance (Plastigage®) red or blue classification yellow, green, or white classification	 0.030–0.070 mm (0.0012–0.0028 in.) 0.020–0.046 mm (0.0008–0.0018 in.)
Connecting rod bearing radial clearance (Plastigage®) no classification double classification	 0.030–0.070 mm (0.0012–0.0028 in.) 0.020–0.055 mm (0.0008–0.0022 in.)
Crankshaft axial clearance 4-cylinder engine 6-cylinder engine	 0.085–0.174 mm (0.0033–0.0069 in.) 0.080–0.163 mm (0.0031–0.0064 in.)
Maximum permissible crankshaft runout 4-cylinder engine 6-cylinder engine	 0.10 mm (0.004 in.) 0.15 mm (0.006 in.)

A crankshaft that requires reconditioning should only be replaced with a new or reconditioned BMW crankshaft. Although many machine shops are capable of regrinding crankshafts, BMW crankshafts are specially heat treated at the factory. BMW recommends that crankshafts only be reconditioned at the factory. See your authorized dealer parts department for the most up-to-date information regarding crankshafts. **Table x** lists crankshaft and cylinder block tightening torques.

Table x. Crankshaft and Cylinder Block Tightening Torques

Rear crankshaft oil seal carrier bolts	
M6	9 ± 1 Nm (6.5 ± 0.5 ft. lb.)
M8	22 ± 2 Nm (16 ± 1 ft. lb.)
Front end cover mounting bolts	
M6	9 ± 1 Nm (6.5 ± 0.5 ft. lb.)
M8	22 ± 2 Nm (16 ± 1 ft. lb.)
Main bearing cap nuts	58-63 Nm (43-46 ft. lb.)
Oil pan bolts	9-11 Nm (7-8 ft. lb.)
(Loctite® 270 used on upper pan inside bolts on 4-cylinder engine)	

Flywheel and Drive Plate

Replacement of the flywheel and the drive plate are similar operations. When removing the mounting bolts, hold the ring gear stationary using a holding fixture. Flywheels and drive-plates should be inspected for excessive runout using a dial indicator. The maximum allowable runout is listed below in **Table y**. If the runout exceeds the maximum, the flywheel or drive plate can be machined, provided it remains within the specifications listed in the table below. Inspect the flange height after machining the flywheel. If the flange height has been reduced to zero clearance during machining, the flange surface of the flywheel must be machined until some clearance exists. See Fig. 6-9. BMW does not list specifications for this flange height.

NOTE —

- A special tool (BMW Tool No. 11 2 160) is available to hold the drive plate or flywheel ring gear stationary.

- Two different types of flywheel are installed on the models covered by this manual. Early models have a conventional plate-type flywheel. Later models have a dual mass flywheel. The dual mass flywheel incorporates a spring damper system. This spring damper system replaces the spring system in the clutch disc. The dual mass flywheel is designed to reduce body and transmission noise. Dual mass flywheels can be serviced as described above. Separate replacement parts for the dual mass flywheel are not available.

Table y. Flywheel Specifications

Maximum axial runout (measured at outer diameter)	0.10 mm (0.004 in.)
Minimum flywheel thickness	
4-cylinder engine	
1984–1985	23.5 mm (.925 in.)
6-cylinder engine	
1984	25.0 mm (.984 in.)
1985–1990	32.0 mm (1.260 in.)
Starter ring gear replacement temperature (manual transmission only)	395°–445°F (200°–230°C)
Mounting bolt tightening torque (installed with Loctite®270)	105 ± 7 Nm (77 ± 5 ft. lb.)

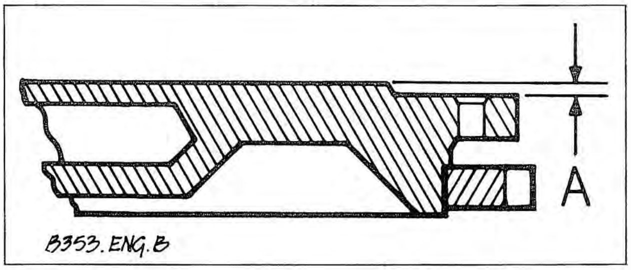


Fig. 6-9. Schematic front view of removed flywheel. Inspect flange height **A** after machining flywheel.

Installation of the flywheel and the drive plate is the reverse of removal. Be sure all bolt holes are clean. Using new bolts, coat the threads with Loctite® 270 and tighten the bolts to 105 ± 7 Nm (77 ± 5 ft. lb.) using the sequence shown in Fig. 6-10.

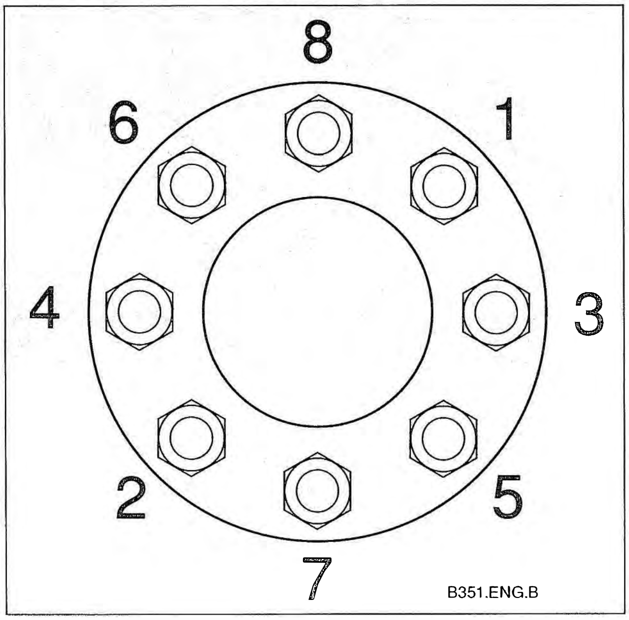


Fig. 6-10. Flywheel or drive plate mounting bolt tightening sequence.

If the starter ring gear (models with manual transmission only) is damaged, it may be replaced. To remove the old gear, drill a 6 mm (0.23 in.) hole about 8 mm deep (0.315 in.) at a tooth gap in the gear. Using a chisel, break the ring gear at the drilled point. To install the new gear, heat the ring gear to 395° to 445°F (200° to 230°C). Using a brass mandrel, drive the ring gear into place on the flywheel, with the beveled edge of the gear facing the engine.

7. LUBRICATION SYSTEM

The primary function of the lubrication system is to lubricate the internal moving parts of the engine. The circulation of oil also aids engine cooling. Proper lubrication requires a constant supply of oil, fed to the moving parts under pressure.

Lubricating oil is drawn from the oil pan into the oil pump. Pressure is supplied by either a rotary-type (4-cylinder engine) or a gear-type (6-cylinder engine) pump, located inside the oil pan. Oil is pumped to the crankshaft main bearings, the connecting rod bearings, and to the camshaft. On 6-cylinder engines the intermediate shaft is lubricated as well. Engine oil returns to the oil pan where it is stored for pickup by the pump. It is cleaned by circulating through a replaceable filter. On 325i(is) and 325i Convertible models, additional oil cooling is provided by an oil cooler mounted beneath the radiator.

This section covers inspection, repair, and assembly of the parts of the lubrication system. Oil change, oil filter change, and engine oil specifications are covered in greater detail in **LUBRICATION AND MAINTENANCE**.

Lubrication system problems result from the system's inability to create oil pressure, the engine's inability to maintain it, or faults with oil pressure warning systems. Because proper lubrication is directly related to engine longevity, its importance cannot be overemphasized. Change the engine oil and oil filter regularly, at least as often as specified by BMW's recommended maintenance intervals, and preferably more frequently. Periodically check engine oil level between oil changes. See **LUBRICATION AND MAINTENANCE**.

4

7.1 Oil Pressure and Oil Level Warning Systems

To prevent serious engine damage, an oil pressure warning system warns the driver of insufficient oil pressure. Other safety features include a filter bypass, to guard against bursting the filter due to overpressure, and an oil pump pressure relief valve to prevent excessive system pressure. On 6-cylinder models, an oil level warning system warns the driver when the oil level drops below a safe level.

CAUTION —
If the engine oil pressure or oil level warning indicator stays on after the engine is started, or flashes on while driving, always assume that there is insufficient oil pressure or the oil level is too low. Check the oil level and test the oil pressure before proceeding with tests of the warning system.

Testing Oil Pressure

Test the oil pressure by removing the pressure switch (See Fig. 7-1 or Fig. 7-2.) and installing a pressure gauge. **Table z** lists oil pressure specifications. If testing shows low oil pressure, one or more of the following conditions is indicated: 1) worn or faulty oil pump 2) worn or faulty bearings or 3) severe engine wear. All of these conditions are serious and indicate the need for major repairs.

Table z. Lubrication System Specifications

Oil pressure at idle	
4-cylinder engine	0.5–2.0 bar (7–28 psi)
6-cylinder engine	0.5–2.0 bar (7–28 psi)
at maximum engine speed	
4-cylinder engine	4.0–5.0 bar (57–71 psi)
6-cylinder engine	4.0–6.0 bar (57–85 psi)

Testing Oil Pressure Warning System

The oil pressure warning system consists of an oil pressure switch mounted in the oil circuit and an instrument panel warning light. When the ignition is turned on, a warning light comes on. When the engine is started and the oil pressure rises above a predetermined pressure, the oil pressure switch opens and the warning light goes out. If this doesn't happen, check to make sure the oil level is correct before doing the tests listed below.

To test:

1. Turn the ignition switch on. The warning light on the instrument panel should light up. Remove the wire from the oil pressure switch. See Fig. 7-1 for 6-cylinder engines or Fig. 7-2 for 4-cylinder engines. The light should go out. If the light does not go out, the wiring to the switch is most likely grounded between the terminal and the warning light. See **ELECTRICAL SYSTEM** for electrical wiring troubleshooting information.

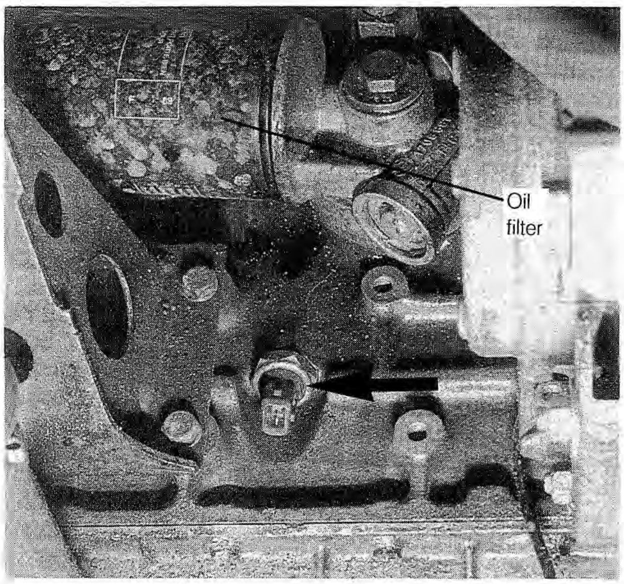


Fig. 7-1. Oil pressure switch on 6-cylinder engine (arrow).

2. If the warning light does not light when the ignition is on, remove the terminal from the oil pressure switch and ground the wire against a clean, unpainted metal part of the engine. If the warning light comes on, check the switch as described in the next step. If the warning light does not come on, the wiring circuit to the dash light or the light itself is faulty.

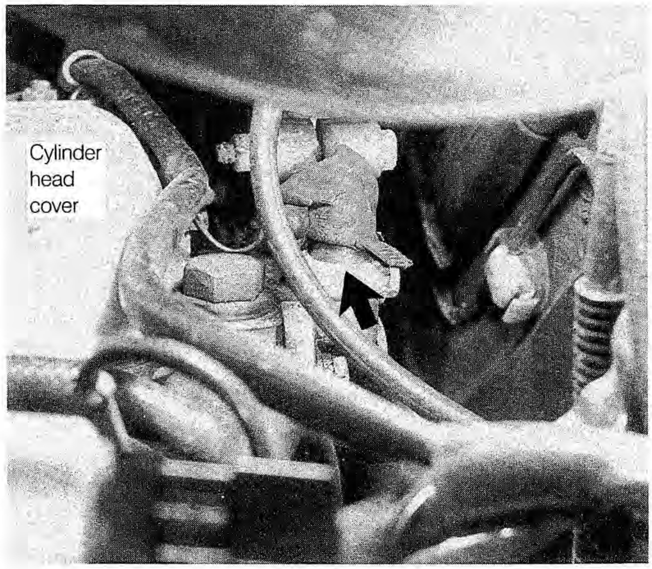


Fig. 7-2. Oil pressure switch on 4-cylinder engine (arrow).

3. To test the switch, remove the terminal from the switch. Connect an ohmmeter between the switch terminal and ground. See Fig. 7-3. With the engine off, there should be continuity. With the engine running there should be no continuity. If any faults are found, the switch is faulty and should be replaced.

CAUTION —

If the oil pressure switch is not faulty and the light remains on while the engine is running, the oil pressure is too low. Do not operate the engine until the problem is corrected. The engine may be severely damaged.

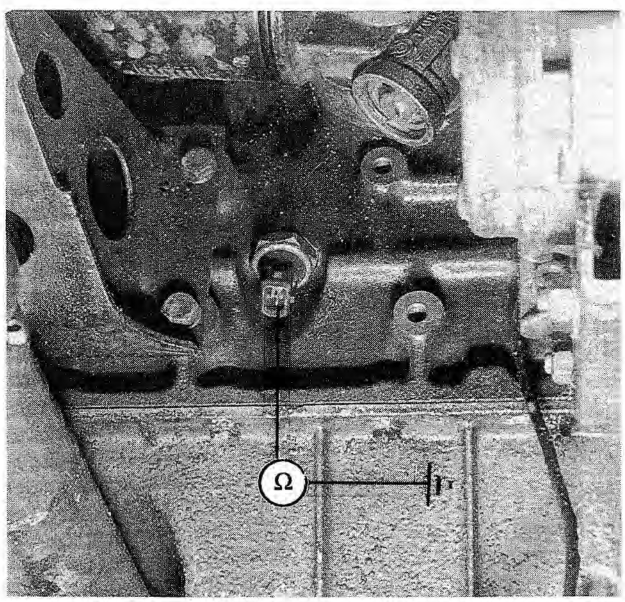


Fig. 7-3. Oil pressure switch being tested using an ohmmeter (shown schematically). Switch on 6-cylinder model shown. Switch on 4-cylinder model is similar.

Testing Oil Level Sensor (6-cylinder engines only)

The oil level sensor is a device similar to the fuel gauge sender in the fuel tank. When the oil level falls below a safe level, the float assembly in the sensor unit completes the electrical circuit to the warning light on the instrument panel. Check that the oil level is correct before testing the sensor.

The oil level sensor incorporates two switches. The static switch senses the oil level when the engine is off and the ignition is on, and the dynamic switch senses the level when the engine is running. The oil level sensor can be tested using an ohmmeter. Disconnect the sensor electrical connector at the base of the alternator. See Fig. 7-4. With the engine off, there should be continuity through the static switch, between terminals 2 and 3 of the sensor connector. With the engine off or running, there should be no continuity through the dynamic switch, between terminals 1 and 2. There should not be continuity between terminals 1 and 2 unless the oil level is low and the engine is running. Replace the sensor if it is faulty.

WARNING —

Use jumper wires when testing the oil level sensor while the engine is running. It is dangerous to make electrical connections at the harness connector while the engine is running. Three lengths of jumper wires with insulated alligator clips on each end can be used to make the connections at the sensor connector near the alternator.

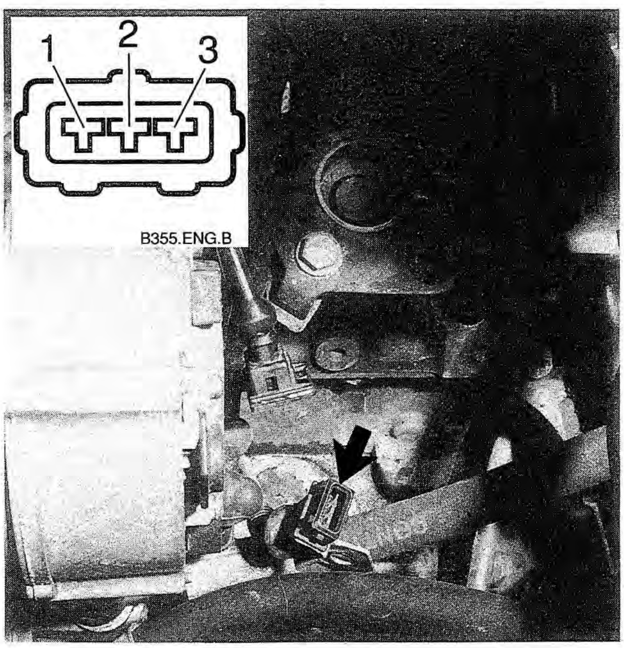


Fig. 7-4. Oil level sensor harness connector shown disconnected on 6-cylinder engine (arrow). Inset shows terminal identification for oil level sensor connector.

The sensor is mounted into the top of the oil pan on the driver's (left) side of the car. The sensor wiring can be disconnected at a connector near the base of the alternator. To remove the sensor, separate the harness connector and remove the two mounting nuts from the sensor. See Fig. 7-5. Withdraw the sensor from the oil pan slowly so that the oil is allowed to drain off. Installation is the reverse of removal. Inspect the sensor O-ring, replacing it if it is crushed or damaged.

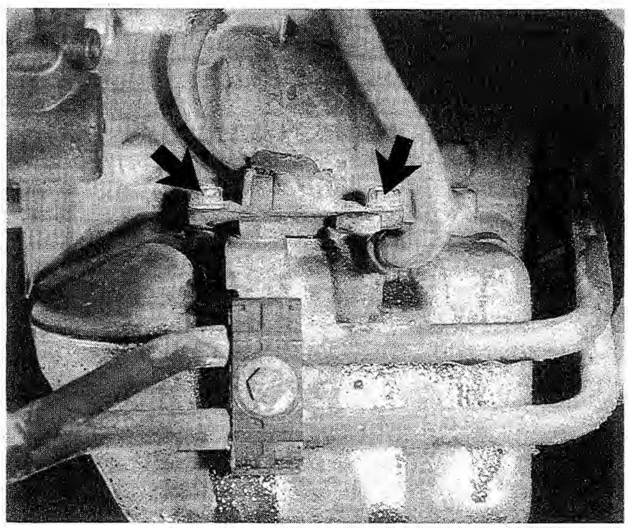


Fig. 7-5. Oil level sensor mounting nuts (arrows). Oil level sensor wiring harness can be separated at connector near bottom of alternator.

7.2 Oil Pan

The oil pan stores the oil used in lubrication and seals the bottom of the engine. The oil pump is located within the oil pan. A one-piece oil pan is installed on models with 6-cylinder engines. On models with 4-four-cylinder engines, a two-piece oil pan is installed.

4

To remove and install (4-cylinder engine):

1. Drain the engine oil as described in **LUBRICATION AND MAINTENANCE**.

2. Remove the lower oil pan retaining bolts and remove the oil pan. See Fig. 7-6.

> ***CAUTION —***
> *If the lower oil pan does not separate easily from the upper pan, a few taps with a rubber mallet should break it free. Never pry between the upper and lower pan sections with a sharp instrument, as oil leaks can occur if either unit is scratched or scored.*

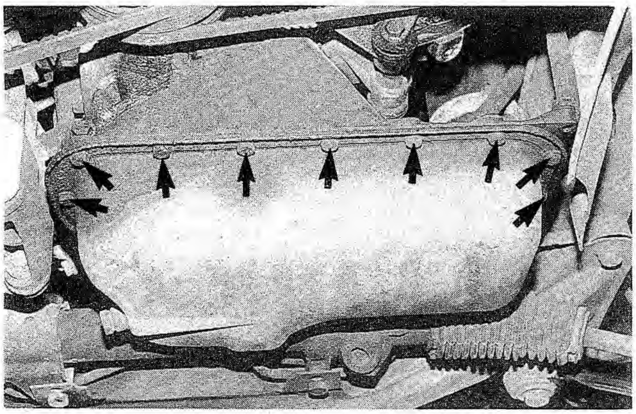


Fig. 7-6. Lower oil pan retaining bolts (arrows).

3. Remove the oil dipstick. Remove the oil pump as described in **7.3 Oil Pump**.

4. Working from the rear of the engine, remove the reinforcement plate mounting bolts that are located between the engine and the transmission.

5. Remove the ground strap from the oil pan. Remove the oil pan retaining bolts from the inside of the upper oil pan. Remove the remaining bolts from the external flange of the upper oil pan and remove the pan.

Installation is the reverse of removal. Thoroughly clean all old gasket material from the mating surfaces. Coat the mating surfaces on the timing case cover and the end cover with a sealing compound. Install the upper gasket and install the upper oil pan. Torque all bolts to 9 to 11 Nm (7 to 8 ft. lb.). Use Loctite® 270 on the six inside bolts for the upper cover. Install a new gasket, install the lower cover. Tighten the lower bolts to 9 to 11 Nm (7 to 8 ft. lb.). Install the dipstick and fill the engine with oil as described in **LUBRICATION AND MAINTENANCE**.

To remove and install (6-cylinder engine):

1. Drain the engine oil as described in **LUBRICATION AND MAINTENANCE**.

2. Disconnect the oil level sensor harness connector. The connector is located at the base of the alternator. Fig. 7-4 shows the location.

3. Remove the two bolts that secure the steering rack to the subframe.

4. Remove the four hex-head bolts and four Torx® head bolts that secure the bellhousing reinforcement plate. See Fig. 7-7. Remove the plate.

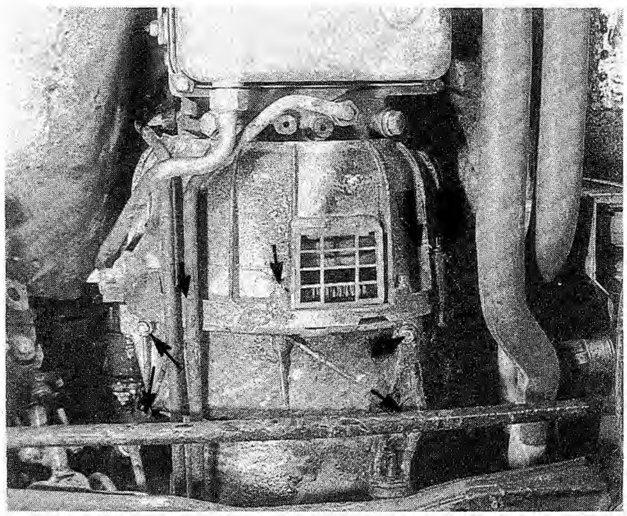


Fig. 7-7. Bellhousing reinforcement plate mounting bolts (arrows) on 6-cylinder engine. One Torx® head bolt is not visible.

5. Remove the oil pan retaining bolts and lower the oil pan. Remove the three oil pump mounting bolts and lower the oil pump into the pan. Withdraw the oil pan with the oil pump.

> ***CAUTION —***
> *If the oil pan does not separate easily from the engine cylinder block, a few taps with a rubber mallet should break it free. Never pry between the oil pan and the engine cylinder block with a sharp instrument, as oil leaks can occur if either is scratched or scored.*

Installation is the reverse of removal. Thoroughly clean all the old gasket material from the mating surfaces. Install the oil pump as described in **7.3 Oil Pump**. Coat the mating surfaces on the timing case cover and the end cover with a sealing compound. Install a new gasket, and the oil pan and torque all bolts to 9 to 11 Nm (7 to 8 ft. lb.). Torque the steering rack bolts to 42 Nm (31 ft. lb.). Reconnect the oil level sensor harness connector. Fill the engine with oil as described in **LUBRICATION AND MAINTENANCE**.

7.3 Oil Pump

The oil pump is mounted to the bottom of the cylinder block inside the engine oil pan. When the engine is running, oil is drawn from the oil pan by the oil pump's pickup tube and circulated through the engine. On models with 4-cylinder engines, the oil pump is driven by a chain actuated by a gear on the front of the crankshaft. On models with 6-cylinder engines, the oil pump is driven by a gear on the intermediate shaft.

There is normally no need to remove the oil pump unless oil pressure is inadequate. Check the oil pressure as described above under **7.1 Oil Pressure and Oil Level Warning Systems**.

Removing and Installing Oil Pump
(4-cylinder engines)

Drain the engine oil and remove the lower oil pan section as described in **7.2 Oil Pan**. Remove the large nut that secures the sprocket to the pump. Pry the sprocket from the pump. Remove the two bolts that secure the pump to the engine cylinder block and remove the pump. See Fig. 7-8.

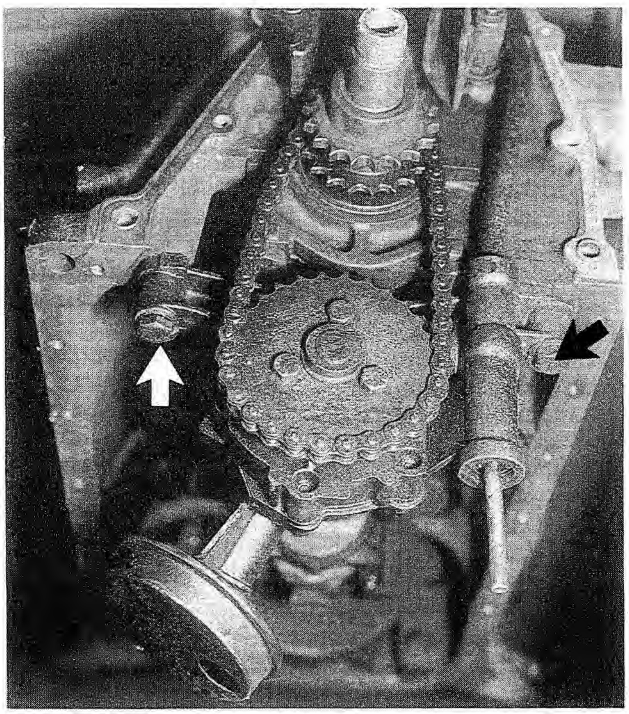


Fig. 7-8. Oil pump mounting bolts (arrows). Type of oil pump varies between models.

Temporarily install the pump to check chain tension. A correctly tensioned chain will deflect slightly at the midpoint under light finger pressure. If the chain tension is incorrect, a shim can be installed between the pump and the cylinder block to obtain the correct tension. Shims are available from an authorized BMW dealer parts department in two sizes. Be sure the shim is correctly installed so that the oil bore in the block is not covered. Check that the suction line O-ring is correctly positioned in the oil pump housing. Torque the pump mounting bolts to 22 ± 2 Nm (16 ± 1 ft. lb.). Install the spacer washer on the pump shaft. Install the sprocket, tightening the nut to 25 to 30 Nm (18 to 22 ft. lb.). Install the oil pan as described in **7.2 Oil Pan**.

Removing and Installing Oil Pump
(6-cylinder engines)

Drain the engine oil and remove the oil pan as described in **7.2 Oil Pan**. Remove the three oil pump mounting bolts and withdraw both the pump and the oil pump drive shaft. Unscrew the cover from the oil pickup and clean the filter screen. Install the cover so that the notch in the cover aligns with the notch in the pump body. When installing the pump, tighten the mounting bolts to 22 ± 2 Nm (16 ± 1 ft. lb.). Install a new gasket and the oil pan as described in **7.2 Oil Pan**.

4

Replacing Oil Cooler
(325i(is) and 325i Convertible models only)

On 325i(is) and 325i Convertible models, an oil cooler is fitted below the radiator to help reduce oil temperature during periods of high operating temperatures. Hot oil is circulated through the oil cooler before being returned to the engine at a lower temperature.

To Replace Oil Cooler

1. Loosen the fittings that attach the oil cooler lines to the oil filter housing. See Fig. 7-9.

CAUTION —
Oil will spill from the hoses and the cooler. Catch the oil in a suitable container.

NOTE —
Label each hose to ensure that it is reattached to its proper fitting.

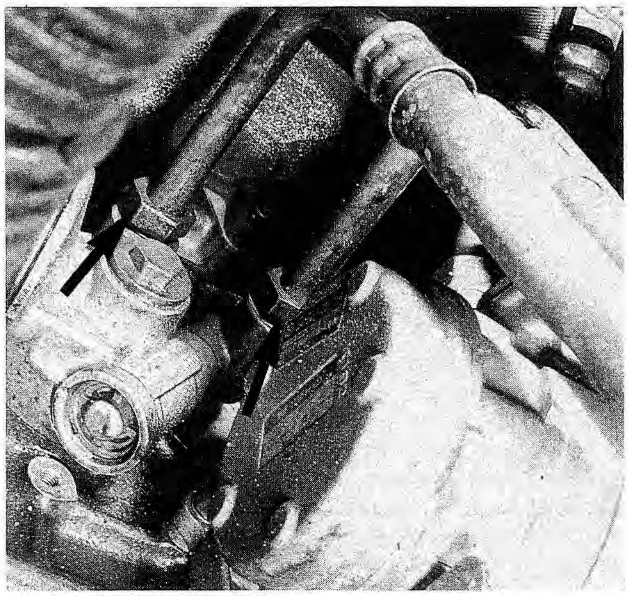


Fig. 7-9. Oil cooler fitting on oil filter housing (arrows).

2. Remove the bolts from the mounting bracket and withdraw the cooler. See Fig. 7-10.

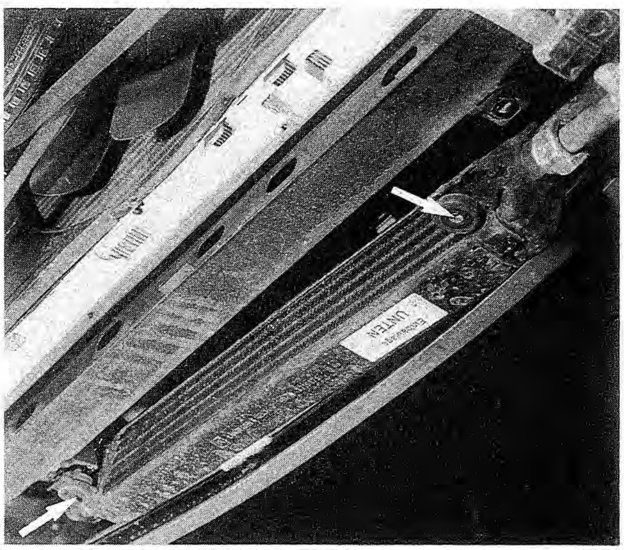


Fig. 7-10. Oil cooler mounting points (arrows).

Installation is the reverse of removal. Torque the fittings on the oil cooler lines to 30 to 40 Nm (22 to 30 ft. lb.)

8. Technical Data

I. Tightening Torques

Camshaft chain tensioner rail securing nut	35 ± 5 Nm (26 ± 4 ft. lb.)
Camshaft drive belt tensioner to engine (bolts)	22 ± 2 Nm (16 ± 1 ft. lb.).
Camshaft oil carrier to cylinder head	
M6 bolts	9 ± 1 Nm (80 ± 9 in. lb.)
M8 bolts	22 ± 2 Nm (16 ± 1 ft. lb.)
Camshaft sprocket to camshaft (bolt)	
4-cylinder engine	7 Nm (5 ft. lb.)
6-cylinder engine	65–70 Nm (48-52 ft. lb.)
Connecting rod cap to connecting rod	
4-cylinder engine	52–57 Nm (38–42 ft. lb.)
6-cylinder engine	20 Nm (15 ft. lb.) plus an additional 70°
Cylinder head cover to cylinder head (nut)	15 ± 1.5 Nm (11 ± 1 ft. lb.)
Cylinder head to cylinder block (bolt)	
4-cylinder engine (Hex-head)	
stage 1	60 ± 2 Nm (44 ± 1 ft. lb.)
stage 2 (after waiting 15 minutes)	33 ± 3°
stage 3 (with engine at operating temperature)	25 ± 5°
6-cylinder engine (Torx® head)	
stage 1	30 Nm (22 ft. lb.)
stage 2	90° (torque angle)
stage 3	90° (torque angle)
6-cylinder engine (Hex-head)	
stage 1	40^{+5}_{-0} Nm (30^{+4}_{-0} ft. lb.)
stage 2 (after waiting 15 minutes)	60^{+5}_{-0} Nm (44^{+4}_{-0} ft. lb.)
stage 3 (with engine at operating temperature)	$25^{+5°}_{-0}$ (torque angle)
Engine mount bracket to engine (bolt)	
M8	22–24 Nm (16–18 ft. lb.)
M10	43–48 Nm (32–35 ft. lb.)
Engine mount to mount bracket (nut)	43–48 Nm (32–35 ft. lb.)
Engine mount to subframe (nut)	
M8	25–28 Nm (18–21 ft. lb.)
M10	43–48 Nm (32–35 ft. lb.)
Engine to transmission bellhousing	
Manual transmission	
Torx® head bolts	
M8	20–24 Nm (14–18 ft. lb.)
M10	38–47 Nm (29–35 ft. lb.)
M12	64–80 Nm (47–59 ft. lb.)
Hex-head bolts	
M8	22–27 Nm (16–20 ft. lb.)
M10	47–51 Nm (35–38 ft. lb.)
M12	66–82 Nm (49–60 ft. lb.)
Automatic transmission	
Torx® head bolts	
M8	21 Nm (15 ft. lb.)
M12	72 Nm (53 ft. lb.)
Hex-head bolts	
M8	24 Nm (18 ft. lb.)
M10	45 Nm (33 ft. lb.)
M12	78–86 Nm (58–63 ft. lb.)
Exhaust manifold to cylinder head (nut)	22–25 Nm (16–18 ft. lb.)
Flywheel or drive plate to crankshaft	105 ± 7 Nm (77 ± 5 ft. lb.)
Front end cover to engine (bolt)	
M6	9 ± 1 Nm (6.5 ± 0.5 ft. lb.)
M8	22 ± 2 Nm (16 ± 1 ft. lb.)
Intake manifold to cylinder head (nut)	30–33 Nm (22–24 ft. lb.)
Intermediate shaft sprocket to intermediate shaft (bolt)	60 ± 5 Nm (44 ± 4 ft. lb.)
Main bearing caps (nuts)	58–63 Nm (43–46 ft. lb.)

continued on next page

I. Tightening Torques (continued)

Oil cooler pipes to oil filter housing	
325i(is), 325i Convertible	30–40 Nm (22–30 ft. lb.)
Oil filter to filter flange	hand tighten
Oil filter housing to engine (bolt)	
except 325i(is), 325i Convertible	24–26 Nm (18–19 ft. lb.)
325i(is), 325i Convertible	40±5 Nm (30±4 ft. lb.)
Oil pan to cylinder block	9–11 Nm (7–8 ft. lb.)
Oil pressure switch to cylinder head or cylinder block	30–40 Nm (22–30 ft. lb.)
Oil pump to engine (bolt)	22±2 Nm (16±1 ft. lb.)
Oil pump sprocket to oil pump (bolt)	
4-cylinder engine	25–30 Nm (18–22 ft. lb.)
Oil supply tube to cylinder (shoulder bolt)	
4-cylinder engine	11–13 Nm (8–10 ft. lb.)
6-cylinder engine	6–8 Nm (4.5–5.5 ft. lb.)
Rear crankshaft oil seal carrier to engine	
M6	9±1 Nm (6.5±0.5 ft. lb.)
M8	22±2 Nm (16±1 ft. lb.)
Rear reinforcement plate to transmission	22–24 Nm (16–18 ft. lb.)
Reference sensor mounting bolt	7±1 Nm (5±0.5 ft. lb.)
Rocker arm eccentric to rocker arm	10±1 Nm (89±9 in. lb.)
Spark plugs to cylinder head	20–30 Nm (15–22 ft. lb.)
Starter to bellhousing	47–50 Nm (35–37 ft. lb.)
Steering rack to subframe bolts	42 Nm (31 ft. lb.)
Torque converter to converter drive plate	
M8	23–26 Nm (17–19 ft. lb.)
M10	46 Nm (34 ft. lb.)
Upper and lower timing chain covers and drive belt covers to engine (bolt)	
M6	9–11 Nm (7–8 ft. lb.)
M8	22±2 Nm (16±1 ft. lb.)
Vibration damper to crankshaft (nut)	
4-cylinder engine	190±10 Nm (140±7 ft. lb.)
6-cylinder engine	22±2 Nm (16±1 ft. lb.)
Vibration damper pulley to vibration damper (bolt)	22±2 Nm (16±1 ft. lb.)

II. Crankshaft and Bearing Specifications

Crankshaft main bearing journal diameter	
4-cylinder engine	
standard (nominal dia. 55.00 mm)	
red	54.980–54.990 mm (2.1646–2.1650 in.)
blue	54.971–54.980 mm (2.1642–2.1646 in.)
yellow	54.984–54.990 mm (2.1647–2.1650 in.)
green	54.977–54.983 mm (2.1644–2.1647 in.)
white	54.971–54.976 mm (2.1642–2.1644 in.)
undersize 1 (nominal dia. 54.75 mm)	
red	54.730–54.740 mm (2.1547–2.1551 in.)
blue	54.721–54.730 mm (2.1544–2.1547 in.)
yellow	54.734–54.740 mm (2.1549–2.1551 in.)
green	54.727–54.733 mm (2.1546–2.1548 in.)
white	54.721–54.726 mm (2.1544–2.1546 in.)
undersize 2 (nominal dia. 54.50 mm)	
red	54.480–54.490 mm (2.1449–2.1453 in.)
blue	54.471–54.480 mm (2.1445–2.1449 in.)
yellow	54.484–54.490 mm (2.1450–2.1453 in.)
green	54.477–54.483 mm (2.1448–2.1450 in.)
white	54.471–54.476 mm (2.1445–2.1447 in.)
undersize 3 (nominal dia. 54.25 mm)	
red	54.230–54.240 mm (2.1350–2.1354 in.)
blue	54.221–54.230 mm (2.1347–2.1350 in.)
yellow	54.234–54.240 mm (2.1352–2.1354 in.)
green	54.227–54.233 mm (2.1349–2.1352 in.)
white	54.221–54:226 mm (2.1347–2.1349 in.)

continued

II. Crankshaft and Bearing Specifications (continued)

6-cylinder engine	
standard (nominal dia. 60.00 mm)	
red	59.980–59.990 mm (2.3614–2.3618 in.)
blue	59.971–59.980 mm (2.3611–2.3614 in.)
yellow	59.984–59.990 mm (2.3616–2.3618 in.)
green	59.977–59.983 mm (2.3613–2.3615 in.)
white	59.971–59.976 mm (2.3611–2.3613 in.)
undersize 1 (nominal dia. 59.75)	
red	59.730–59.740 mm (2.3516–2.3520 in.)
blue	59.721–59.730 mm (2.3512–2.3516 in.)
yellow	59.734–59.740 mm (2.3517–2.3520 in.)
green	59.727–59.733 mm (2.3515–2.3517 in.)
white	59.721–59.726 mm (2.3512–2.3514 in.)
undersize 2 (nominal dia. 59.50 mm)	
red	59.480–59.490 mm (2.3417–2.3421 in.)
blue	59.471–59.480 mm (2.3414–2.3417 in.)
yellow	59.484–59.490 mm (2.3419–2.3421 in.)
green	59.477–59.483 mm (2.3416–2.3418 in.)
white	59.471–59.476 mm (2.3414–2.3416 in.)
Crankshaft connecting rod journals	
Connecting rod journal diameter	
4-cylinder engine	
standard (nominal dia. 48.00 mm)	47.975–47.991 mm (1.8888–1.8894 in.)
undersize 1 (nominal dia. 47.75 mm)	47.725–47.741 mm (1.8789–1.8796 in.)
undersize 2 (nominal dia. 47.50 mm)	47.475–47.491 mm (1.8691–1.8697 in.)
Double classification	
standard	47.975–47.991 mm (1.8888–1.8894 in.)
undersize 1	47.725–47.741 mm (1.8789–1.8796 in.)
undersize 2	47.475–47.491 mm (1.8691–1.8697 in.)
undersize 3	47.225–47.241 mm (1.8592–1.8599 in.)
6-cylinder engine	
standard (nominal dia. 45.00 mm)	44.975–44.991 mm (1.7707–1.7713 in.)
undersize 1 (nominal dia. 44.75 mm)	44.725–44.741 mm (1.7608–1.7615 in.)
undersize 2 (nominal dia. 44.50 mm)	44.475–44.491 mm (1.7510–1.7516 in.)
Double classification	
standard	44.975–44.991 mm (1.7707–1.7713 in.)
undersize 1	44.725–44.741 mm (1.7608–1.7607 in.)
undersize 2	44.475–44.491 mm (1.7510–1.7516 in.)
Crankshaft thrust bearing width	
4-cylinder engine	
standard	30.020–30.053 mm (1.1819–1.1832 in.)
oversize 1	30.224–30.264 mm (1.1899–1.1915 in.)
oversize 2	30.425–30.464 mm (1.1978–1.1994 in.)
oversize 3	30.625–30.664 mm (1.2057–1.2072 in.)
6-cylinder engine	
standard	25.020–25.053 mm (0.9850–0.9863 in.)
oversize 1	25.220–25.253 mm (0.9929–0.9942 in.)
oversize 2	25.420–25.453 mm (1.0008–1.0021 in.)
Crankshaft main bearing radial clearance (Plastigage®)	
red or blue classification	0.030–0.070 mm (0.0012–0.0028 in.)
yellow, green, or white classification	0.020–0.046 mm (0.0008–0.0018 in.)
Crankshaft rod bearing radial clearance (Plastigage®)	
no classification	0.030–0.070 mm (0.0012–0.0028 in.)
double classification	0.020–0.055 mm (0.0008–0.0022 in.)
Crankshaft axial clearance	
4-cylinder engine	0.085–0.174 mm (0.0033–0.0069 in.)
6-cylinder engine	0.080–0.163 mm (0.0031–0.0064 in.)
Maximum permissible crankshaft runout	
4-cylinder engine	0.10 mm (0.004 in.)
6-cylinder engine	0.15 mm (0.006 in.)

4

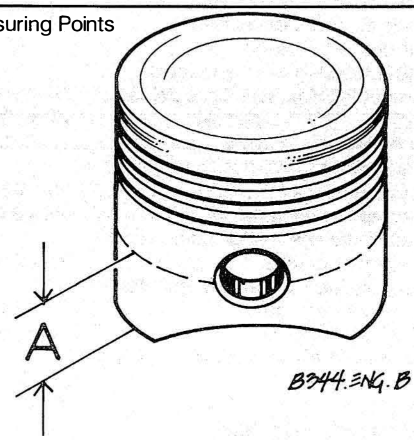
III. Piston, Piston Ring, and Cylinder Specifications

- Cylinder bore diameter
  - 4-cylinder engine
    - standard . . . . $89.00^{+0.01}_{-0}$ mm ($3.5039^{+0.0004}_{-0}$ in.)
    - special . . . . $89.08^{+0.01}_{-0}$ mm ($3.5071^{+0.0004}_{-0}$ in.)
    - oversize 1 . . . . $89.25^{+0.01}_{-0}$ mm ($3.5138^{+0.0004}_{-0}$ in.)
    - oversize 2 . . . . $89.50^{+0.01}_{-0}$ mm ($3.5236^{+0.0004}_{-0}$ in.)
  - 6-cylinder engine
    - standard . . . . $84.00^{+0.01}_{-0}$ mm ($3.3071^{+0.0004}_{-0}$ in.)
    - special . . . . $84.08^{+0.01}_{-0}$ mm ($3.3102^{+0.0004}_{-0}$ in.)
    - oversize 1 . . . . $84.25^{+0.01}_{-0}$ mm ($3.3169^{+0.0004}_{-0}$ in.)
    - oversize 2 . . . . $84.50^{+0.01}_{-0}$ mm ($3.3268^{+0.0004}_{-0}$ in.)
- Maximum out-of-round
  - 4-cylinder engine . . . . 0.01 mm (0.0004 in.)
  - 6-cylinder engine . . . . 0.03 mm (0.0012 in.)
- Maximum conicity
  - 4-cylinder engine . . . . 0.01 mm (0.0004 in.)
  - 6-cylinder engine . . . . 0.02 mm (0.0008 in.)
- Piston diameter
  - 4-cylinder engine
    - standard . . . . 88.97 mm (3.5027 in.)
    - special . . . . 89.05 mm (3.5059 in.)
    - oversize 1 . . . . 89.22 mm (3.5126 in.)
    - oversize 2 . . . . 89.47 mm (3.5224 in.)
  - 6-cylinder engine
    - standard . . . . 83.98 mm (3.3063 in.)
    - special . . . . 84.06 mm (3.3094 in.)
    - oversize 1 . . . . 84.23 mm (3.3161 in.)
    - oversize 2 . . . . 84.48 mm (3.3260 in.)
- Piston to cylinder clearance
  - 4-cylinder engine
    - new . . . . 0.02–0.05 mm (.0008–.0020 in.)
    - wear limit . . . . 0.15 mm (0.006 in.)
  - 6-cylinder engine
    - new . . . . 0.01–0.04 mm (.0004–.0016 in.)
    - wear limit . . . . 0.12 mm (0.0047 in.)
- Piston ring end gap
  - 4-cylinder engine
    - upper compression ring (top ring) . . . . 0.30–0.70 mm (0.012–0.028 in.)
    - lower compression ring (middle ring) . . . . . 0.20–0.40 mm (0.008–0.016 in.)
    - oil ring (bottom ring) . . . . 0.25–0.50 mm (0.010–0.020 in.)
  - 6-cylinder engine
    - upper compression ring (top ring) . . . . 0.30–0.50 mm (0.012–0.020 in.)
    - lower compression ring (middle ring) . . . . . 0.30–0.50 mm (0.012–0.020 in.)
    - oil ring (bottom ring) . . . . 0.25–0.50 mm (0.010–0.020 in.)

continued

III. Piston, Piston Ring, and Cylinder Specifications (continued)

Piston Skirt Measuring Points



Distance A

- 4-cylinder engine
  - Mahle . . . . 14.00 mm (0.551 in.)
  - KS . . . . 30.85 mm (1.215 in.)
  - Alcan . . . . 15.50 mm (0.610 in.)
- 6-cylinder engine
- 325,325e models
  - Mahle
    - piston height, 68.7 mm (2.705 in.) . . . . . 8 mm (0.315 in.)
  - KS
    - piston height, 68.7 mm (2.705 in.) . . . . . 14 mm (0.551 in.)
  - Mahle and KS
    - piston height, 77.7 mm (3.059 in.) . . . . . 23 mm (0.905 in.)
- 325i models
  - Mahle
    - piston height, 73.6 mm (2.898 in.) . . . . . 9 mm (0.354 in.)
- Piston ring side clearance
  - 4-cylinder engine
    - upper compression ring (top ring) . . . . 0.06–0.09 mm (0.0024–0.0035 in.)
    - lower compression ring (middle ring) . . . . 0.03–0.072 mm (0.0012–0.0028 in.)
    - oil ring (bottom ring) . . . . 0.02–0.06 mm (0.0008–0.0024 in.)
  - 6-cylinder engine
    - upper compression ring (top ring) . . . . . 0.040–0.072 mm (0.0016–0.0028 in.)
    - lower compression ring (middle ring) . . . . 0.030–0.062 mm (0.0012–0.0024 in.)
    - oil ring (bottom ring) . . . . 0.020–0.042 mm (0.0008–0.0017 in.)

IV. Connecting Rod Specifications

- Big end diameter
  - 4-cylinder engine
    - standard (no classification) . . . . 52.000–52.010 mm (2.0472–2.0476 in.)
    - double classification
      - red . . . . 52.000–52.008 mm (2.0472–2.0475 in.)
      - blue . . . . 52.009–52.016 mm (2.0476–2.0479 in.)
  - 6-cylinder engine
    - red . . . . 48.000–48.008 mm (1.8898–1.8901 in.)
    - blue . . . . 48.009–48.016 mm (1.8901–1.8904 in.)
- Connecting rod bushing
  - outside diameter . . . 24.060–24.100 mm (0.9472–0.9488 in.)
  - inside diameter (nominal diameter 22.0 mm) . . . . 22.003–22.008mm (0.8662–0.8664 in.)
- Maximum parallel deviation of connecting rod bores (bearing shells installed) at distance of 150 mm (5.905 in.) . . . . . 0.04 mm (0.0016 in.)
- Maximum deviation of weight between connecting rods (bearing shells removed)
  - total . . . . ±4.0 grams (.14 oz.)
  - small end only . . . . ±2.0 grams (.07 oz.)
  - big end only . . . . ±2.0 grams (.07 oz.)
- Connecting rod bolt torque
  - 4-cylinder engine . . . . 52–57 Nm (38–42 ft. lb.)
  - 6-cylinder engine . . . . 20 Nm (14.5 ft. lb.) plus an additional 70°

V. Valve and Cylinder Head Specifications

- Cylinder head thickness
  - 4-cylinder
    - new . . . . 129.0±0.1 mm (5.079±.004 in.)
    - after machining . . . . 128.6 mm (5.063 in.)
  - 6-cylinder
    - new . . . . 125.1±0.1 mm (4.925±.004 in.)
    - after machining . . . . 124.7 mm (4.909 in.)
- Valve guide wear, maximum (measured with new valve) . . . . 0.8 mm (0.031 in.)
- Valve guide inside diameter (tolerance per ISO allowance H7)
  - 4-cylinder engine
    - standard . . . . 8.0 mm (0.315 in.)
    - oversize 1 . . . . 8.1 mm (0.319 in.)
    - oversize 2 . . . . 8.2 mm (0.323 in.)
- Valve guide inside diameter (tolerance per ISO allowance H7)
  - 6-cylinder engine
    - standard . . . . 7.0 mm (0.275 in.)
    - oversize 1 . . . . 7.1 mm (0.279 in.)
    - oversize 2. . . . . 7.2 mm (0.283 in.)
- Valve guide outside diameter (tolerance per ISO allowance u6)
  - 4-cylinder engine
    - standard . . . . 14.0 mm (.5512 in.)
    - oversize 1 . . . . 14.1 mm (.5551 in.)
    - oversize 2 . . . . 14.2 mm (.5590 in.)
    - oversize 3 . . . . 14.3 mm (.5630 in.)
  - 6-cylinder engine
    - standard
      - old version . . . . 13.0 mm (.5118 in.)
      - new version . . . . 13.2 mm (.5197 in.)
    - oversize 1
      - old version . . . . 13.1 mm (.5157 in.)
      - new version . . . . 13.3 mm (.5236 in.)
    - oversize 2
      - old version . . . . 13.2 mm (.5197 in.)
      - new version . . . . 13.4 mm (.5276 in.)
    - oversize 3 . . . . 13.3 mm (.5236 in.)

continued

V. Valve and Cylinder Head Specifications (continued)

- Valve guide bore diameter in cylinder head (tolerance per ISO allowance M7)
  - 4-cylinder engine
    - standard . . . . 14.0 mm (.5512 in.)
    - oversize 1 . . . . 14.1 mm (.5551 in.)
    - oversize 2 . . . . 14.2 mm (.5590 in.)
    - oversize 3 . . . . 14.3 mm (.5630 in.)
  - 6-cylinder engine
    - standard
      - old version . . . . 13.0 mm (.5118 in.)
      - new version . . . . 13.2 mm (.5197 in.)
    - oversize 1
      - old version . . . . 13.1 mm (.5157 in.)
      - new version . . . . 13.3 mm (.5236 in.)
    - oversize 2
      - old version . . . . 13.2 mm (.5197 in.)
      - new version . . . . 13.4 mm (.5276 in.)
    - oversize 3 . . . . 13.3 mm (.5236 in.)
- Valve guide installation temperature
  - cylinder head . . . . 122°F (50°C)
  - valve guide . . . . −238°F (−150°C)
- Valve guide installed depth (height above cylinder head surface)
  - 4-cylinder engine . . . . 15.0 mm (.5906 in.)
  - 6-cylinder engine . . . . 14.5 mm (.5709 in.)
- Valve seat dimensions
  - seat angle . . . . 45°
  - seat correction angles . . . . 15°/75°
- seat width (intake and exhaust)
  - 4-cylinder engines . . . . 1.3–2.0 mm (0.051–0.079 in.)
  - 6-cylinder engines . . . . . . 1.65±0.35 mm (0.065±0.014 in.)
- seat diameter
  - 1984 and 1985 318i models
    - intake . . . . 44.6 mm (1.756 in.)
    - exhaust . . . . 36.6 mm (1.441 in.)
  - 1984–1987 325, 325e, 325es
    - intake . . . . 38.6 mm (1.520 in.)
    - exhaust . . . . 32.6 mm (1.283 in.)
  - 325i(is), 325i Convertible, 1988 325
    - intake . . . . 40.6 mm (1.598 in.)
    - exhaust . . . . 34.6 mm (1.362 in.)
- Valve seat insert outside diameter (tolerance as per ISO allowance g6)
  - 1984 and 1985 318i models
    - intake
      - standard . . . . 47.15 mm (1.8562 in.)
      - oversize 0.2 mm . . . . 47.35 mm (1.8642 in.)
      - oversize 0.4 mm . . . . 47.55 mm (1.8720 in.)
    - exhaust
      - standard . . . . 40.15 mm (1.5807 in.)
      - oversize 0.2 mm . . . . 40.35 mm (1.5886 in.)
      - oversize 0.4 mm . . . . 40.55 mm (1.5964 in.)
  - 1984–1987 325, 325e, 325es
    - intake
      - standard . . . . 42.15 mm (1.6594 in.)
      - oversize 0.2 mm . . . . 42.35 mm (1.6673 in.)
      - oversize 0.4 mm . . . . 42.55 mm (1.6752 in.)
    - exhaust
      - standard . . . . 37.65 mm (1.4823 in.)
      - oversize 0.2 mm . . . . 37.85 mm (1.4902 in.)
      - oversize 0.4 mm . . . . 38.05 mm (1.4980 in.)
  - 1988 325 and all 325i models
    - intake
      - standard . . . . 43.15 mm (1.6988 in.)
      - oversize 0.2 mm . . . . 43.35 mm (1.7067 in.)
      - oversize 0.4 mm . . . . 43.55 mm (1.7146 in.)
    - exhaust
      - standard . . . . 37.65 mm (1.4823 in.)
      - oversize 0.2 mm . . . . 37.85 mm (1.4902 in.)
      - oversize 0.4 mm . . . . 38.05 mm (1.4980 in.)

continued on next page

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V. Valve and Cylinder Head Specifications (continued)

Valve seat bore diameter in cylinder head (tolerance as per ISO allowance H7)	
1984 and 1985 318i models	
intake	
standard	47.00 mm (1.8504 in.)
oversize 0.2 mm	47.20 mm (1.8583 in.)
oversize 0.4 mm	47.40 mm (1.8661 in.)
exhaust	
standard	40.00 mm (1.5748 in.)
oversize 0.2 mm	40.20 mm (1.5827 in.)
oversize 0.4 mm	40.40 mm (1.5905 in.)
1984–1987 325, 325e, 325es	
intake	
standard	42.00 mm (1.6535 in.)
oversize 0.2 mm	42.20 mm (1.6614 in.)
oversize 0.4 mm	42.40 mm (1.6693 in.)
exhaust	
standard	37.50 mm (1.4764 in.)
oversize 0.2 mm	37.70 mm (1.4842 in.)
oversize 0.4 mm	37.90 mm (1.4921 in.)
1988 325 and all 325i models	
intake	
standard	43.00 mm (1.6929 in.)
oversize 0.2 mm	43.20 mm (1.7008 in.)
oversize 0.4 mm	43.40 mm (1.7086 in.)
exhaust	
standard	37.50 mm (1.4764 in.)
oversize 0.2 mm	37.70 mm (1.4842 in.)
oversize 0.4 mm	37.90 mm (1.4921 in.)
Cylinder head installation temperature	
All models	122°F (50°C)
Valve seat insert installation temperature	
All models	-238°F(-150°C)
Valve head diameter	
1984 and 1985 318i	
intake	46 mm (1.811 in.)
exhaust	38 mm (1.496 in.)
1984–1987 325, 325e, 325es	
intake	40 mm (1.575 in.)
exhaust	34 mm (1.339 in.)
325i(is), 325i Convertible, 1988 325	
intake	42 mm (1.654 in.)
exhaust	36 mm (1.417 in.)
Valve head thickness (minimum)	
intake	1.3 mm (0.051 in.)
exhaust	2.0 mm (0.079 in.)
Valve face angle	45°
Valve stem diameter	
4-cylinder engine	
standard	8.0 mm (0.315 in.)
oversize 1	8.1 mm (0.319 in.)
oversize 2	8.2 mm (0.323 in.)
6-cylinder engine	
standard	7.0 mm (0.275 in.)
oversize 1	7.1 mm (0.279 in.)
oversize 2	7.2 mm (0.283 in.)
Valve clearance	
engine warm (coolant temperature above 176°F (80°C))	
intake and exhaust	
4-cylinder	0.25 mm (0.010 in.)
6-cylinder	0.30 mm (0.012 in.)
engine cold (coolant temperature below 95°F (35°C))	
intake and exhaust	
4-cylinder	0.20 mm (0.008 in.)
6-cylinder	0.25 mm (0.010 in.)
Rocker arm radial play	between 0.016 mm and 0.052 mm (0.0006 and 0.0020 in.)

VI. Flywheel or Drive Plate Specifications

Maximum axial runout (measured at outer diameter)	0.10 mm (0.004 in.)
Minimum flywheel thickness	
4-cylinder engine	23.5 mm (.925 in.)
1984 6-cylinder engines	25.0 mm (.984 in.)
1985–1990 6-cylinder engine	32.0 mm (1.260 in.)
Mounting bolt tightening torque (installed with Loctite®270)	105 ± 7 Nm (77 ± 5 ft. lb.)
Starter ring gear replacement temperature (manual transmission only)	395°–445°F (200°–230°C)

VII. Lubrication System Specifications

Oil pressure at idle	
4-cylinder engine	0.5–2.0 bar (7–28 psi)
6-cylinder engine	0.5–2.0 bar (7–28 psi)
Oil pressure at maximum engine speed	
4-cylinder engine	4.0–5.0 bar (57–71 psi)
6-cylinder engine	4.0–6.0 bar (57–85 psi)

Section 5

IGNITION

Contents

5

Ignition

Introduction

The ignition systems installed on the cars covered by this manual incorporate many technologically advanced components. These components maximize engine performance and reliability in the face of increasing restrictions on engine exhaust emissions. The ignition system, in cooperation with the fuel system, precisely controls engine operation. This ensures maximum power and efficiency from the engine under all operating conditions.

The sophisticated electronics used in these modern ignition systems reduce the need for routine maintenance, but can make troubleshooting more difficult. Any service or repair work must be carried out carefully, with special attention to the cautions and warnings and proper working procedures.

This section contains information needed to perform routine maintenance and service for the ignition system, although some of the specifications and procedures may only be useful to professional mechanics. If you lack the skills, the special tools, or a clean workplace for servicing the ignition system, we suggest you leave these repairs to an authorized BMW dealer or other qualified repair shop. We especially urge you to consult an authorized dealer before beginning repairs on a car that may be eligible for repair under the manufacturer's warranty.

1. General Description

The ignition system provides each spark plug with a precisely timed high-voltage charge to ignite the air/fuel mixture in the combustion chamber. The system also makes adjustments to the ignition timing in response to changes in engine speed and load.

The high-voltage charge is created by the primary circuit of the ignition system. In the primary circuit, battery voltage is applied to the ignition coil to charge it. When the primary circuit is broken, the coil discharges its high voltage. The secondary ignition circuit—the rotor, the distributor cap, the spark plug wires, and the spark plugs—distributes the high voltage to the cylinders to ignite the air/fuel mixture. Ignition timing refers to the position of the piston in the cylinder when the coil discharges.

Two types of ignition systems are installed on the cars covered by this manual.

1.1 Transistorized Coil Ignition (TCI-i) System

Cars with a 4-cylinder engine have a Transistorized Coil Ignition system with impulse generator (TCI-i), as shown in Fig. 1-1. The impulse generator provides a timing signal for the ignition system. The impulse generator has no moving parts and does not require any maintenance. The ignition control unit, based on the signal from the impulse generator, switches the primary circuit to discharge the high-voltage spark. Vacuum and centrifugal advance mechanisms in the distributor adjust the ignition timing in response to engine load and speed.

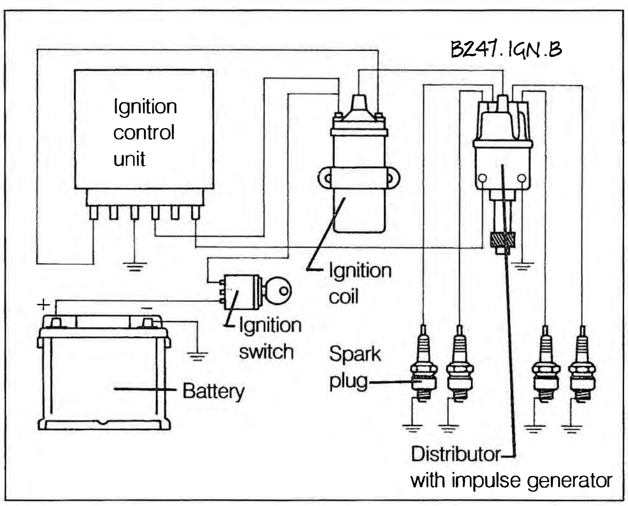

Fig. 1-1. Schematic representation of Transistorized Coil Ignition with impulse generator (TCI-i) installed on 4-cylinder engines.

1.2 Motronic (DME) Ignition System

Cars with a 6-cylinder engine have a Motronic ignition system. See Fig. 1-2. In Motronic systems, also known as Digital Motor Electronics (DME), all ignition functions and fuel injection control functions are controlled by a single electronic control unit. Ignition timing is based on inputs the control unit receives for engine load, engine speed, ignition quality, coolant temperature, and intake-air temperature. The only function that the distributor serves is to distribute the high voltage to the individual spark plugs. The distributor is an integral part of the cylinder head and there is no mechanical spark advance system.

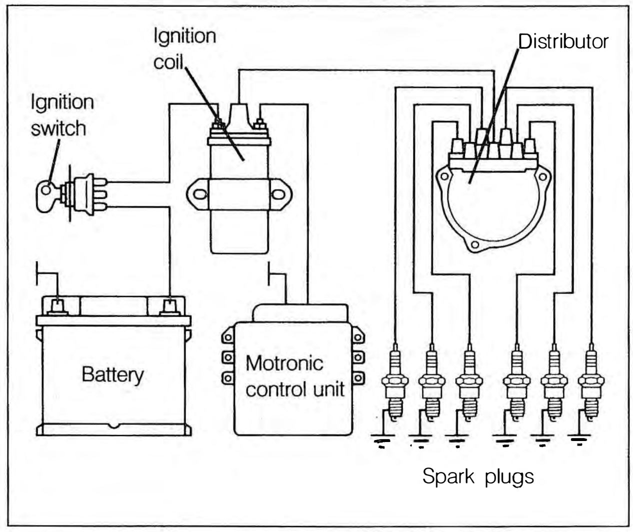

Fig. 1-2. Schematic view of ignition system on Motronic engine-management system for 6-cylinder engines.

2. Maintenance

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of the ignition system. A number in bold type indicates that the procedure is covered in this section, under that numbered heading. Information on other ignition system maintenance and on the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Replacing spark plugs
2. Inspecting and replacing distributor cap and rotor **3.2**
3. Inspecting and replacing spark plug wires **3.3**

3. Troubleshooting

Poor driveability may have a variety of causes. The fault may lie with the ignition system, the fuel system, parts of the emission control system, or a combination of the three. Because of the interrelated functions of these systems and their effects on each other, it is often difficult to know where to begin looking for problems. For this reason, effective troubleshooting should always consider these systems in unison, as one major system.

This troubleshooting section applies to starting and running problems caused specifically by faults in the ignition system, including the coil, the distributor cap and rotor, and the spark plug wires. A complete failure of the ignition system to produce spark at the spark plugs is self-evident as an ignition system problem. For other problems such as rough idle, misfiring, or poor starting, however, the cause is not so clear. For troubleshooting addressing engine management and the way the car runs, see **ENGINE MANAGEMENT—DRIVEABILITY**. There, you will be referred back to the appropriate part of this section for further tests and repairs.

3.1 Basic Troubleshooting Principles

The ignition system's primary function is to provide a properly timed high-voltage spark. On TCI-i ignition systems, the distributor's basic timing adjustment gives the impulse generator and the electronic system its baseline ignition timing. The impulse generator signals the ignition control unit which in turn switches the coil primary circuit, causing the coil to discharge high voltage to the spark plugs through the distributor cap and spark plug wires.

On Motronic ignition systems, the reference sensor determines the crankshaft position and gives the electronic system its baseline ignition timing. Ignition timing is then controlled by the Motronic control unit based on engine load, engine speed, engine temperature, and throttle position.

An engine that starts and runs indicates that the ignition system is fundamentally working—delivering voltage to the spark plugs. A hard-starting or poor-running engine, however, may indicate a problem with how well the spark is delivered. A faulty coil, cracked spark plug wires, a worn or cracked distributor cap or rotor, and worn or fouled spark plugs are all causes of reduced spark intensity and inefficient combustion.

NOTE —

For cars with catalytic converters, inefficient combustion is a serious problem. The poorly burned mixture can overload the catalytic converter with raw fuel. This may lead to converter overheating, causing plugging or presenting a fire hazard.

An engine that has good cranking speed but will not even begin to start may indicate a complete failure of the system to produce spark. Give the ignition system a complete visual inspection. Make sure the spark plug wires have not been interchanged. Ignition firing order is described under **4.2 Distributor** for 4-cylinder engines or **5.3 Distributor** for 6-cylinder engines.

If no faults are located, make a basic check to see if spark is being produced as described below under **Quick-Check of Ignition System**. This will be the most important first troubleshooting step. If a strong spark is observed, then the failure to start is due to another cause, perhaps incorrect timing.

Both the TCI-i ignition system and the Motronic ignition system contain very sensitive electronic components. To protect the system, and for general safety, the following cautions should be observed during any ignition system troubleshooting, maintenance, or repair work.

CAUTION —

- *Do not touch or disconnect any of the high tension cables from the coil, distributor, or spark plugs while the engine is running or being cranked by the starter.*
- *Connect or disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is off.*
- *Switch multimeter functions or measurement ranges only with the test probes disconnected.*
- *Before operating the starter without starting the engine (as when making a compression test), disable the ignition. On models with TCI-i ignition, disconnect the connector(s) from the ignition control unit. On models with Motronic ignition, remove the main relay. See either* **4. TCI-i Ignition (TCI-i) System** *or* **5. Motronic (DME) Ignition System** *for component locations.*
- *Do not disconnect terminal 4 (center terminal) from the coil or remove the distributor cap to disable the ignition.*
- *Do not connect test instruments with a 12-volt current supply to terminal 15 (+) of the ignition coil. The voltage backflow will damage the ignition control unit. In general, make test connections only as specified by BMW, as described in this manual, or as described by the instrument's manufacturer.*
- *Do not disconnect the battery while the engine is running.*
- *The ignition systems covered by this manual use a special shielded rotor with 1000 ohms resistance. Take care to install the correct part. Do not substitute any other BMW or Bosch part.*
- *Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time. On models equipped with on-board computers, remove the computer fuses (no. 10, no. 12, no. 21, no. 23, no. 27.) prior to quick-charging to prevent damaging the computer.*
- *Do not wash the engine while it is running, or any time the ignition is switched on.*

CAUTION —

• Disconnect the battery when doing any electric welding on the vehicle or charging the battery.

• Do not try to start the engine of a car which has been heated above 176°F (80°C), for example, in a paint drying booth, until allowing it to cool to normal temperature.

• Do not conduct ignition system tests with a test lamp that uses a normal incandescent bulb. The high electrical consumption of these test lamps may damage the electronic components.

• Do not connect terminal 1 of the coil to ground as a means of preventing the engine from starting (for example, when installing or servicing anti-theft devices).

Test Equipment

Many of the tests of ignition system components require the use of high-impedance test equipment to prevent damage to the electrical components. An LED test light should be used in place of an incandescent-type test lamp. A high impedance digital multimeter should be used for all voltage and resistance tests.

Many tests require checking for voltage, continuity, or resistance at the terminals of the components' harness connectors. The blunt tips of a multimeter's probes can damage the terminals and cause poor connections. To prevent damage, use flat male connectors to probe the harness connector terminals.

Quick-Check of Ignition System

If the engine does not start, the most fundamental step in troubleshooting the ignition system is to determine whether or not the system is making a spark at the spark plug. If no spark is present, then more detailed testing of the ignition system is necessary.

To check for spark, turn the ignition off and remove a connector from one of the spark plugs. Connect it to a known good spark plug, preferably a new plug. Do not hold the spark plug or its connector, even if using insulated pliers. Position the plug so that the outer electrode is grounded on the engine.

WARNING —

The ignition systems installed on the cars covered by this manual are high-energy systems operating in a dangerous voltage range which could prove to be fatal if exposed terminals or live parts are contacted. Use extreme caution when working on a vehicle with the ignition on or the engine running.

CAUTION —

Any test set-up other than the one described above may cause damage or inconclusive tests.

While a helper actuates the starter, look for spark in the spark plug gap. A bright blue spark indicates a healthy ignition system. A yellow-orange spark is weaker and indicates that, while spark is present and the system is functioning, it is not operating at peak efficiency. Check the condition of the ignition system components as described in **3.2 Ignition System Visual Inspection** and replace any faulty components.

WARNING —

If ignition system failure is not the problem, the engine may start during this test. Be prepared to turn off the ignition immediately. Also, running the engine with a spark plug wire disconnected may damage the catalytic converter.

NOTE —

Before checking the ignition system when there is no spark or a weak spark, make sure that the battery is fully charged. See **ELECTRICAL SYSTEM**.

If there is no spark, test for primary voltage at the ignition coil. Connect a voltmeter between terminal 15 (+) of the ignition coil and ground (a clean, bare metal part of the engine or chassis). See Fig. 3-1. When the ignition is turned on, there should be battery voltage at the terminal. If battery voltage is not present, there is either a fault in the wire between terminal 15 and the ignition switch, in the ignition switch itself, or in the wiring from the battery to the ignition switch.

If no faults have been detected up to this point but there is still no spark or a weak spark, refer to **Table a** for more troubleshooting information. Bold numbers in the corrective action column refer to numbered headings in this section where repair information is located. If the coil is receiving voltage, or if a strong spark is observed but the engine still will not start, refer to **ENGINE MANAGEMENT—DRIVEABILITY** for more troubleshooting information.

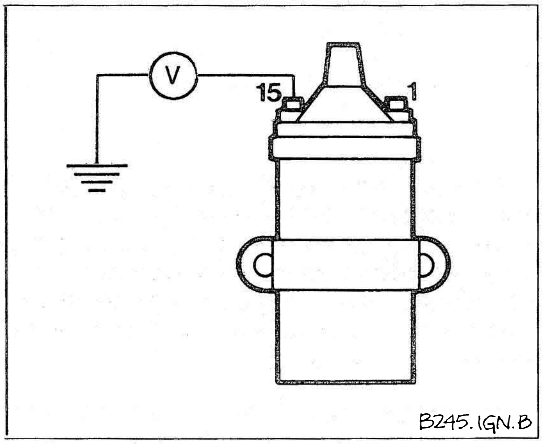

Fig. 3-1. Primary voltage to coil being checked with a voltmeter (shown schematically) between terminal 15 and ground. Coil terminal numbers are found on coil.

Table a. Ignition System Troubleshooting

Symptom	Probable cause	Corrective action
1. No spark or weak spark observed during spark test	a. Wet or damp distributor cap and/or spark plug wires	a. Remove cap and wires. Dry and reinstall. **4.2** or **5.3**
	b. Faulty wires or connectors (primary circuit).	b. Inspect and repair as needed.
	c. Weak or faulty coil	c. Test and replace as needed. **3.3**
	d. Defective spark plug wires	d. Test and replace as needed. **3.3**
	e. Worn or fouled spark plugs	e. Replace spark plugs. See **LUBRICATION AND MAINTENANCE**
	f. Faulty impulse generator (TCI-i ignition only).	f. Test and replace as needed. **4.1**
	g. Faulty ignition control unit (TCI-i ignition only)	g. Test and replace as needed. **4.1**
	h. Faulty reference or pulse sensor (Motronic only)	h. Test and replace as needed. **5.2**
	i. Faulty Motronic control unit (Motronic ignition only)	i. Test and replace as needed. See **FUEL SYSTEM**
	j. Incorrect ignition timing (TCI-i ignition only)	j. Check and adjust timing. **4.3**

3.2 Ignition System Visual Inspection

The spark plug wires, the distributor cap, and the distributor rotor are subject to wear and electrical breakdown which will impair their ability to deliver a crisply timed and powerful spark. Many of these conditions are most easily detected by a thorough visual inspection. Dirt and moisture on any of these components are also potential causes of poor spark at the spark plugs.

To inspect the distributor cap and rotor, first remove the cap as described in **4.2 Distributor** or **5.3 Distributor**. Inspect the contacts inside the distributor cap and at the tip of the rotor for corrosion, wear, or pitting. See Fig. 3-2. Parts with corroded contacts can be cleaned and reused, but if there is wear, pitting, or heavy corrosion, replacement is highly recommended. The center black carbon brush inside the cap should spring back when compressed.

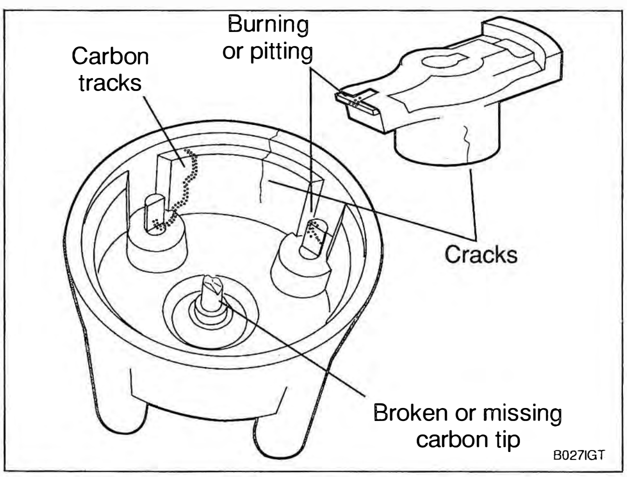

Fig. 3-2. Distributor cap and rotor. Inspect cap and rotor at contact points.

Cracks or carbon tracks in the distributor cap may cause shorts to ground. The cracks may be fine and difficult to see. Check carefully, especially around the contacts. Carbon tracks are the faint black lines, usually running between two contacts or to ground, left over from high-voltage arcing. A distributor cap that shows any sign of cracks or carbon tracking should be replaced.

On models with 6-cylinder engines, inspect the black dust shield mounted behind the rotor. See Fig. 3-3. Excessive oil residue on the shield can lead to engine misfire and poor running under load. If any signs of oil residue are found on the shield, the front camshaft oil seal should be carefully inspected and replaced if necessary. See **ENGINE**.

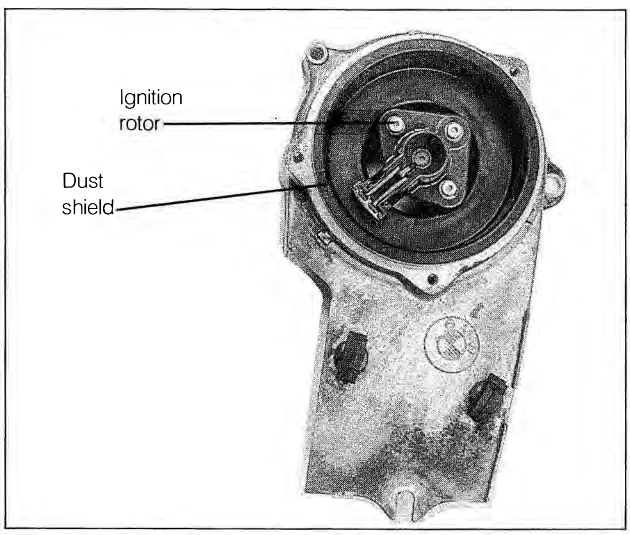

Fig. 3-3. Ignition rotor and dust shield. Front camshaft oil seal is behind dust shield.

To visually check the spark plug wires, gently bend them in several places. This will expose cracks in the insulation which may cause spark "leaks". Peel back the rubber boots and check them for pliancy and the ability to seal out dirt and moisture. Wires that are cracked, oil-soaked or dry and brittle should be replaced.

For a quick-check of distributor cap and spark plug wire condition, listen for the sound of voltage arcing or watch while the engine runs at night. In darkness, the arc of high voltage to ground because of a crack in the cap or a poorly insulated wire may be visible as a blue spark.

The coil should be closely examined for cracks, burns, carbon tracks, or any leaking fluid. The coil tower, terminal 4, should be clean and dry. If necessary, remove the coil for cleaning and closer examination. Check that the wiring at the coil top is routed as shown in Fig. 3-4. Loosen the nuts and reposition the wires as necessary.

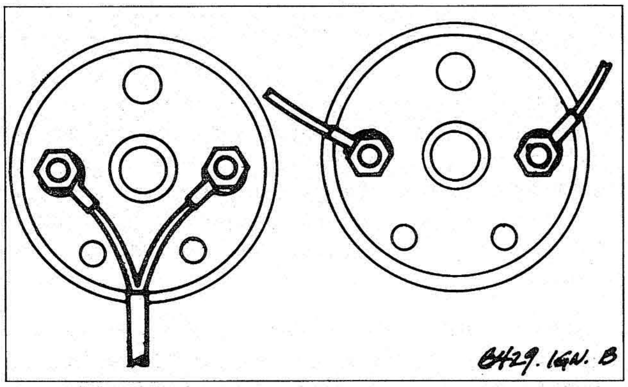

Fig. 3-4. Coil wiring correctly positioned (left) and incorrectly positioned (right). Wires terminals should not touch or come close to metal coil housing.

Inspect all primary wires and connections for any corrosion or damage. Clean or repair any faults found. In these sensitive electronic ignition systems, corroded or loose connections may interfere with the ignition function.

On 6-cylinder engines, inspect the reference and speed sensor(s), their connectors, and wiring. Check for dents or cracks in the sensors, or chafed spots in the wiring. For more information on the sensors and their locations, including testing procedures, see **5.2 Reference Sensor and Speed Sensor**.

3.3 Testing Coil and Spark Plug Wires

Use an ohmmeter to test the ignition coil primary and secondary resistance as shown in Fig. 3-5. Resistance values are listed in **Table b**. Replace any coil which has higher primary or secondary resistance.

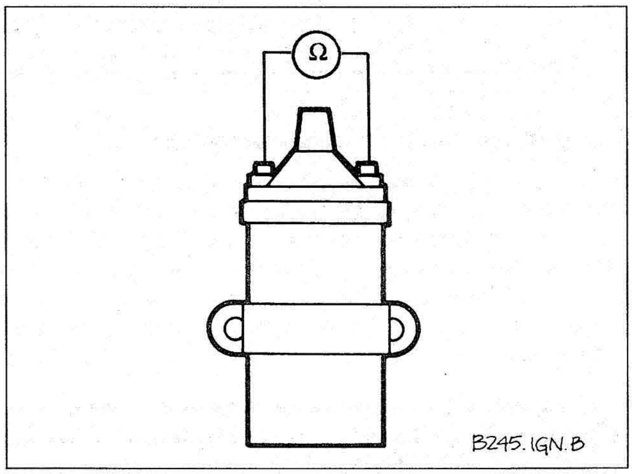

Fig. 3-5. Primary coil resistance being measured .th an ohmmeter (shown schematically) betweer. ərminals 1 and 15. Measurement of secondary resistance is similar.

Table b. Ignition Coil Resistance

TEST	Engine	Terminals	Resistance
Primary resistance	4-cylinder	1 (−) and 15 (+)	.82 ohms
	6-cylinder	1 (−) and 15 (+)	.50 ohms
Secondary resistance	4-cylinder	1 (−) and 4 (center tower)	8250 ohms
	6-cylinder	4 (center tower) and 15 (+)	5000 ohms

To check each spark plug wire, check the resistance of the spark plug end connector by carefully probing either side of the spark plug end. See Fig. 3-6. Check the resistance of the shielded connectors at the distributor cap end of the wire and the coil wire ends using the same method. Spark plug end connectors should have 5000 ± 1000 ohms resistance. Distributor cap suppression connectors, including coil wire ends, should have 1000 ± 200 ohms resistance. The resistance of the wire alone should be nearly zero ohms.

CAUTION —

To avoid damaging the distributor cap, do not wiggle the connectors when removing them. If necessary, twist to loosen. Then, pull straight out from the cap.

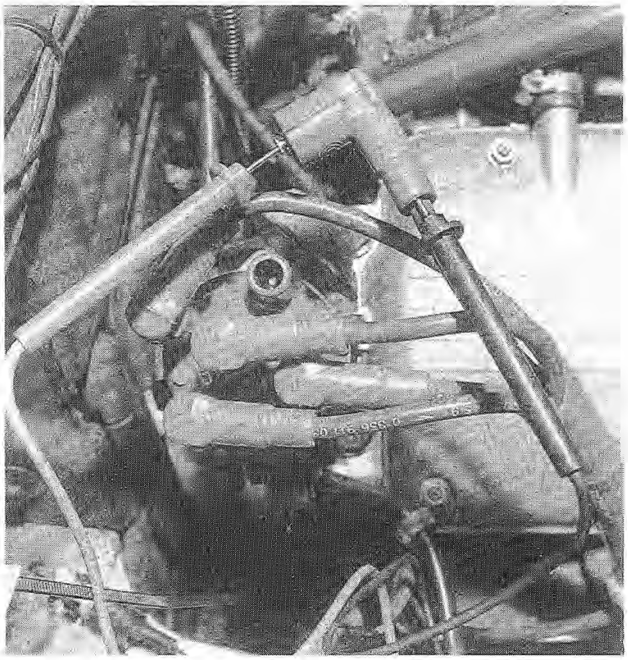

Fig. 3-6. Resistance of spark plug end of wire being measured with an ohmmeter.

If the measured resistance is too high, the wire assembly should be replaced. Also check for corrosion at the connections. Wires or connectors with too much resistance should be replaced.

NOTE —

Individual connectors are available as replacement parts from an authorized BMW dealer. Special tools are required to correctly install the replacement ends to the wires, therefore it may be economical to replace the complete wire assembly.

3.4 Testing Distributor Cap and Rotor

To check the distributor cap, first remove the cap and the rotor as described in **4.2 Distributor** or **5.3 Distributor**. Be sure to label the spark plug wires when disconnecting them from the cap. Check the resistance of the cap between the tower and its matching contact inside of the cap. The resistance should be nearly zero ohms. If the measured resistance is too high the distributor cap should be replaced.

To check the ignition rotor, check its resistance as shown in Fig. 3-7. The rotor should have a resistance of 1000 ± 200 ohms. If the resistance is too high, it should be replaced.

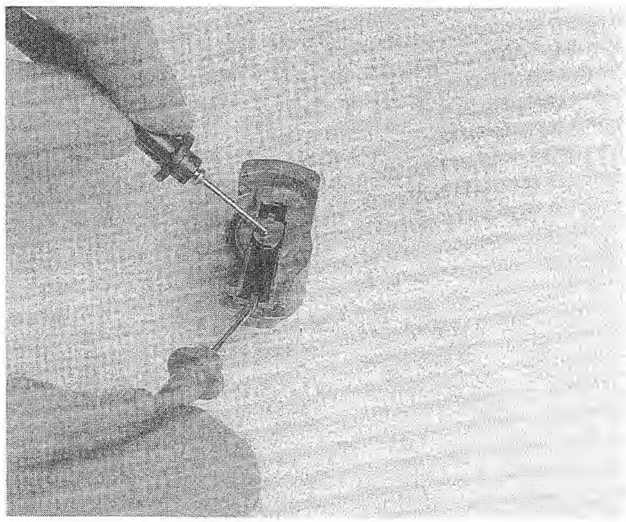

Fig. 3-7. Resistance of rotor being checked with ohmmeter. Rotor from 4-cylinder engine shown.

To remove the rotor from 4-cylinder engines, pull it straight off the distributor shaft. On 6-cylinder engines, use a 3 mm hex wrench to remove the three mounting screws. Installation is the reverse of removal. On models with 4-cylinder engines, apply a small amount of motor oil to the felt piece on the top of the distributor shaft. This helps to lubricate the shaft and distributor assembly. On 6-cylinder engines, be careful not to over tighten the rotor mounting screws. The screws should be tightened to 3 Nm (27 in. lb.).

4. Transistorized Coil Ignition (TCI-i) System

The TCI-i system has four major components: the distributor with impulse generator, the ignition control unit, the coil, and the spark plugs. See Fig. 4-1. The impulse generator (sometimes referred to as a pulse transmitter) is the electronic equivalent of cam-actuated breaker points. Every time the trigger-wheel tabs pass the impulse-generator tabs they create an AC voltage signal. When the ignition control unit (sometimes referred to as a trigger box) receives this voltage signal, it triggers the spark discharge from the coil by interrupting the primary coil circuit. Ignition dwell (coil charging time) is automatically adjusted by the ignition control unit for the most intense spark.

The ignition control unit is mounted on the engine compartment firewall. Two types of control units are installed on the 4-cylinder models covered by this manual. On 1984 and some early 1985 models, a Bosch control unit is installed. On most 1985 models, a Siemens/Telefunken control unit is installed. The control units can be identified by their electrical connectors. A Bosch control unit has a single, flat connector at the bottom of the unit. The Siemens/Telefunken control unit has two round connectors on the front of the unit.

Ignition timing is mechanically adjusted to compensate for changes in engine speed and load. The centrifugal advance system of spring-loaded rotating weights advances ignition timing as engine rpm increases. The vacuum advance mechanism adjusts ignition timing to adapt to changes in engine load, as intake manifold vacuum is routed to the vacuum diaphragm on the distributor. For more information on the vacuum advance mechanism, see **4.4 Centrifugal and Vacuum Spark Advance**.

This section covers testing the system's electronic components, checking and adjusting the ignition timing, checking the basic TCI-i system's mechanical and vacuum timing advance functions, and distributor disassembly. Testing of the basic ignition system components—the coil, the spark plug wires, and the distributor cap and rotor—are covered above under **3. Troubleshooting**.

WARNING —

The ignition systems installed on the cars covered by this manual operate in a dangerous voltage range which could prove to be fatal if exposed terminals or live parts are contacted. Use extreme caution when working on a vehicle with the ignition on, the starter activated, or the engine running.

Specifications for the transistorized coil ignition systems are listed in **Table c** or **Table d**, depending on the type of ignition control unit installed. See **4.1 Testing Ignition Control Unit and Impulse Generator** for more information on identifying ignition control units.

Table c. TCI-i Ignition System Specifications (Bosch control unit)

Ignition control unit code number	0 227 100 111
Ignition coil code number	0 221 122 319 (gray label)
Distributor code number	
1984 (early)	0 237 002 080
1984 and 1985	0 237 002 096
Ignition timing (vacuum hose disconnected at distributor)	
0 237 002 080 distributor	15° BTDC @2000 ± 50 rpm
0 237 002 096 distributor	26° BTDC @4000 ± 50 rpm
Engine idle speed	
0 237 002 080 distributor	750 ± 50 rpm
0 237 002 096 distributor	
manual transmission	850 ± 50 rpm
automatic transmission	750 ± 50 rpm
Vacuum advance	
start (approx.)	70 mbar
end (approx.)	240 mbar
Firing order	1 - 3 - 4 - 2
Spark plugs	
Bosch	WR9DS
Beru	RS 33
Spark plug gap	0.8 + 0.1 mm (.032 + .004 in.)
Spark plug tightening torque	20–30 Nm (15–22 ft. lb.)

Table d. TCI-i Ignition System Specifications (Siemens/Telefunken control unit)

Ignition control unit code number	1 705 607/608
Ignition coil code number	0 221 122 319 (gray label)
Distributor code number	0 237 002 096
Ignition timing (vacuum hose disconnected at distributor)	
all	26°BTDC @4000 ± 50 rpm
Engine idle speed	
manual transmission	750 ± 50 rpm
automatic transmission	850 ± 50 rpm
Vacuum advance	
start (approx.)	70 mbar
end (approx.)	240 mbar
Spark plugs	
Bosch	WR9DS
Beru	RS 33
Spark plug gap	0.8 mm + 0.1 (.032 + .004 in.)
Spark plug tightening torque	20-30 Nm (15-22 ft. lb.)

NOTE —

On 318i models built between 10/28/83 and 12/05/84 with distributor code number 0 237 002 096, the original factory ignition timing specifications have been revised by the factory. On affected models, a special Field Fix Revised Timing decal should have been placed in the engine compartment on the driver's side fender just above the emissions control decal. The specifications above reflect this revision. Build dates are located on a decal on the driver's door jamb.

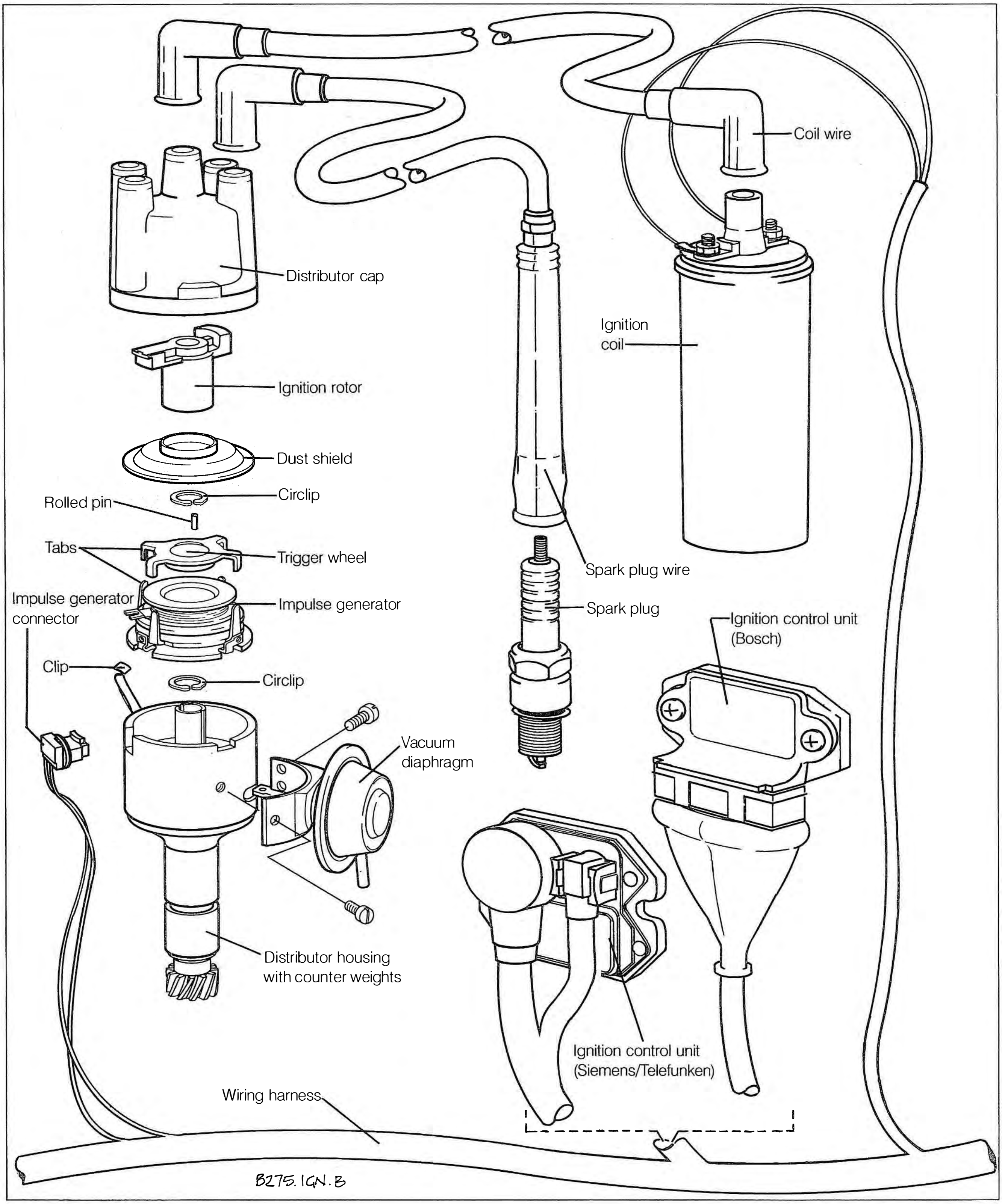

Fig. 4-1. Transistorized coil ignition with impulse generator installed on 4-cylinder engines.

4.1 Testing Ignition Control Unit and Impulse Generator

The impulse generator and ignition control unit only need to be tested if there is no spark at the spark plugs when tested. For these tests, the spark plug wires and ignition coil should be in good condition as described in **3.3 Testing Coil and Spark Plug Wires** and **3.4 Testing Distributor Cap and Rotor.**

These tests require the use of a high-impedance voltmeter or low-current LED test light. For more information, see **3.1 Basic Troubleshooting Principles.** Follow the test sequence as it is presented in order to logically isolate the faulty component.

NOTE —

Two types of ignition control units are installed on the 4-cylinder models covered by this manual. See Fig. 4-1 above for identification.

Voltage Supply and Ground to Ignition Control Unit

With the ignition off, remove the harness connector(s) from the ignition control unit. On Bosch units, connect a voltmeter between connector terminals 2(−) and 4(+). On Siemens/Telefunken connect a voltmeter between terminals 6 (−) and 3 (+). See Fig. 4-2.

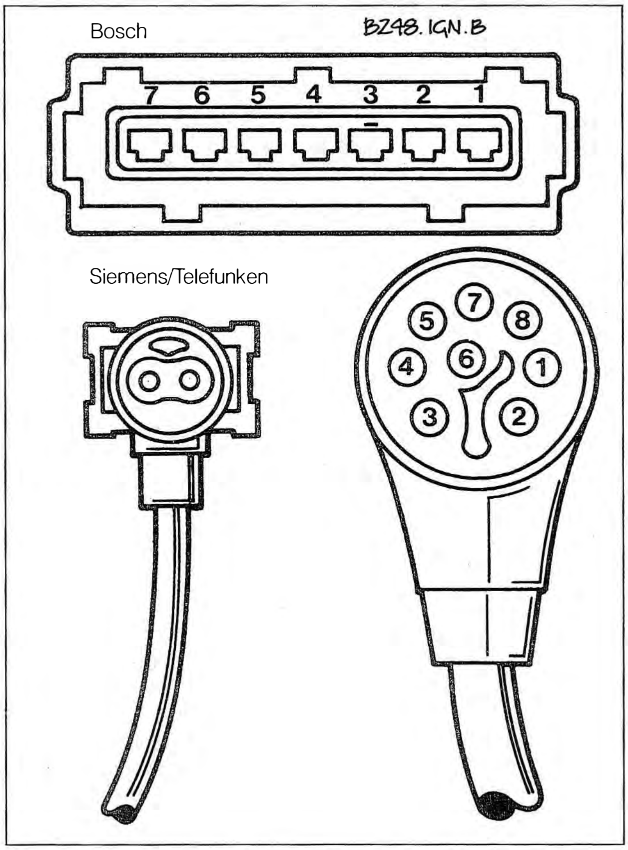

Fig. 4-2. Control unit connectors and terminal identification.

There should be battery voltage when the ignition is turned on. If there is no voltage, check for wiring faults. Check the continuity of the wire from the ground terminal of the connector (2 or 6) to body ground, and from the positive (+) terminal of the connector (4 or 3) to terminal 15 of the coil. Repair wiring as necessary. For more information on wiring repairs, see **ELECTRICAL SYSTEM.**

Impulse Generator Signal

If the control unit is receiving battery voltage, the next logical step is to check the AC voltage signal from the impulse generator to the ignition control unit.

To check the voltage signal, measure the voltage at the control unit connector using a digital voltmeter (10 VAC scale). On Bosch control units, connect the positive (+) probe to terminal 5 and the negative (−) probe to terminal 6. On Siemens/Telefunken control units, connect the positive (+) probe to terminal + and the negative (−) probe to terminal −.

With the starter cranking, there should be approximately 1.0 to 2.0 volts AC. If there is no voltage or the reading is low, check the continuity in the wires between the control unit connector and the distributor. Also check the impulse generator resistance and air gap as described below. If there is voltage, but there still is no spark, the ignition control unit is most likely faulty and should be replaced as described below.

WARNING —

Operate the starter just long enough to get a voltmeter reading. If the starter needs to be operated for a longer period, disconnect the harness connector at the cold start valve of the fuel injection system. See **FUEL SYSTEM** *for cold start valve location.*

To check impulse generator resistance on Bosch control units, measure between terminals 5 and 6. On Siemens/Telefunken control units, measure between the terminal + and terminal − of the small connector. See Fig. 4-3. If the resistance is not 1100 ± 10% ohms and no faults are found in the wires between the control unit connector and the connector at the distributor, the impulse generator should be replaced as described in **4.2 Distributor.**

To check the air gap, use a brass thickness gauge and measure between the trigger-wheel tab and the impulse-generator tab as shown in Fig. 4-4. If the gap is not between 0.3 and 0.7 mm (.012 and .028 in.), center the impulse generator carrier plate as described under **4.2 Distributor.**

If no faults are detected up to this point, but there is still no voltage, the impulse generator is most likely faulty and should be replaced as described in **4.2 Distributor.** Any further testing of low output voltage requires sophisticated test equipment, such as an oscilloscope.

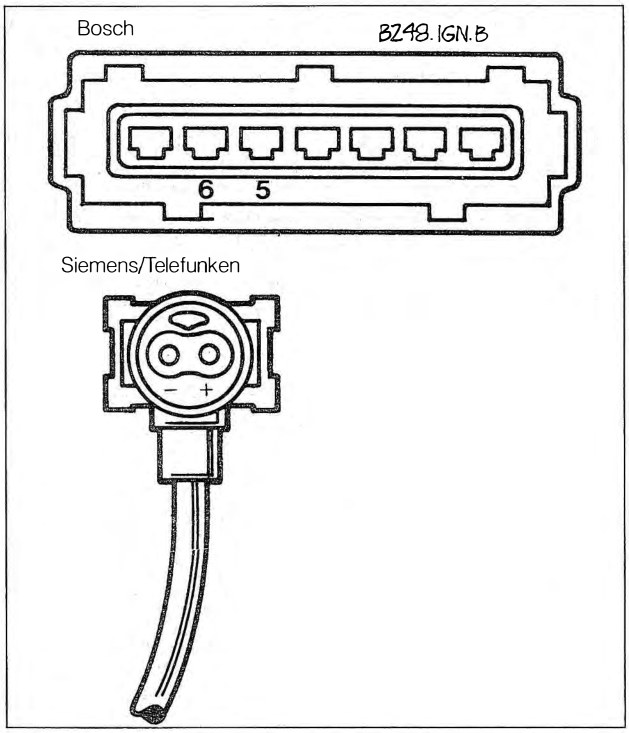

Fig. 4-3. Ignition control unit connectors and terminals used to check impulse generator resistance.

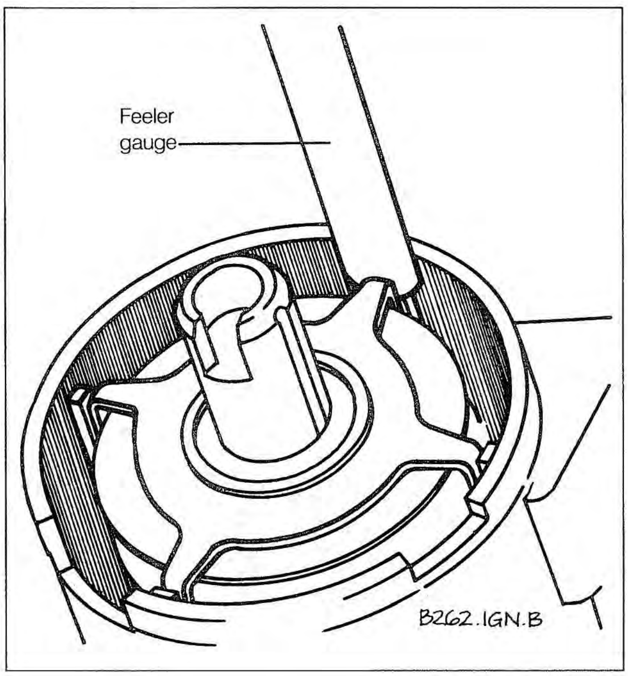

Fig. 4-4. Impulse generator air gap being checked with feeler gauge. Align trigger-wheel tab with impulse-generator tab as shown.

Replacing Ignition Control Unit

When replacing the ignition control unit, make sure the ignition is off. Disconnect the electrical connector(s) and remove the mounting screws. See Fig. 4-5. Installation is the reverse of removal.

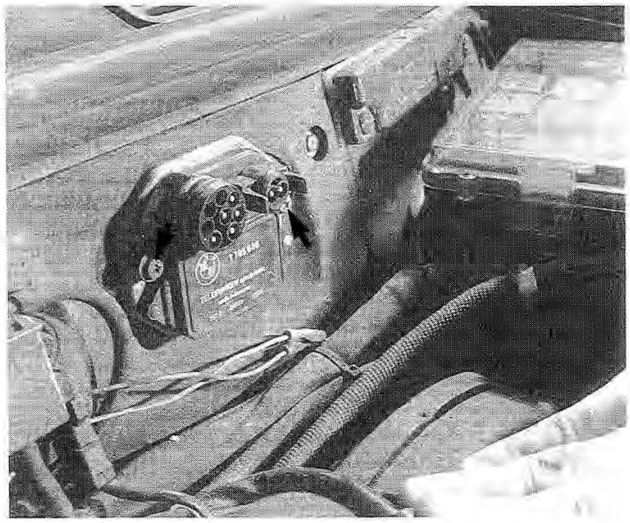

Fig. 4-5. Ignition control unit mounting screws (arrows) on Siemens/Telefunken control unit. Bosch control unit mounting points are similar.

On Bosch control units, a special dielectric corrosion-resistant sealer is used between the heat sink and the control unit. If the control unit is separated from the heat sink for any reason, the old sealer should be completely removed and the heat sink cleaned using 180 grit sandpaper. Apply a generous amount of Curil K2® between the control unit and the heat sink. When the control unit is mounted, excess sealer should squeeze from the sides (approximately 2 mm (5/64 in.)).

CAUTION

Curil K2® (BMW Part No. 81 22 9 400 243) must be applied between the heat sink and the control unit to dissipate heat and prevent corrosion. A silicon dielectric compound can be substituted if Curil K2® is not available. Failure to use the compound as described above can shorten the service life of the control unit.

4.2 Distributor

This heading covers the removal and installation of the distributor, the distributor cap and rotor, the spark plug wires, and the impulse generator. Inspection and testing procedures for these components are covered in **3. Troubleshooting** and **4.1 Testing Ignition Control Unit and Impulse Generator**.

The TCI-i system uses a distributor with mechanical advance mechanisms, as shown in Fig. 4-6. The distributor cap and rotor are generally replaced as a part of normal maintenance. See **LUBRICATION AND MAINTENANCE** for recommended replacement intervals.

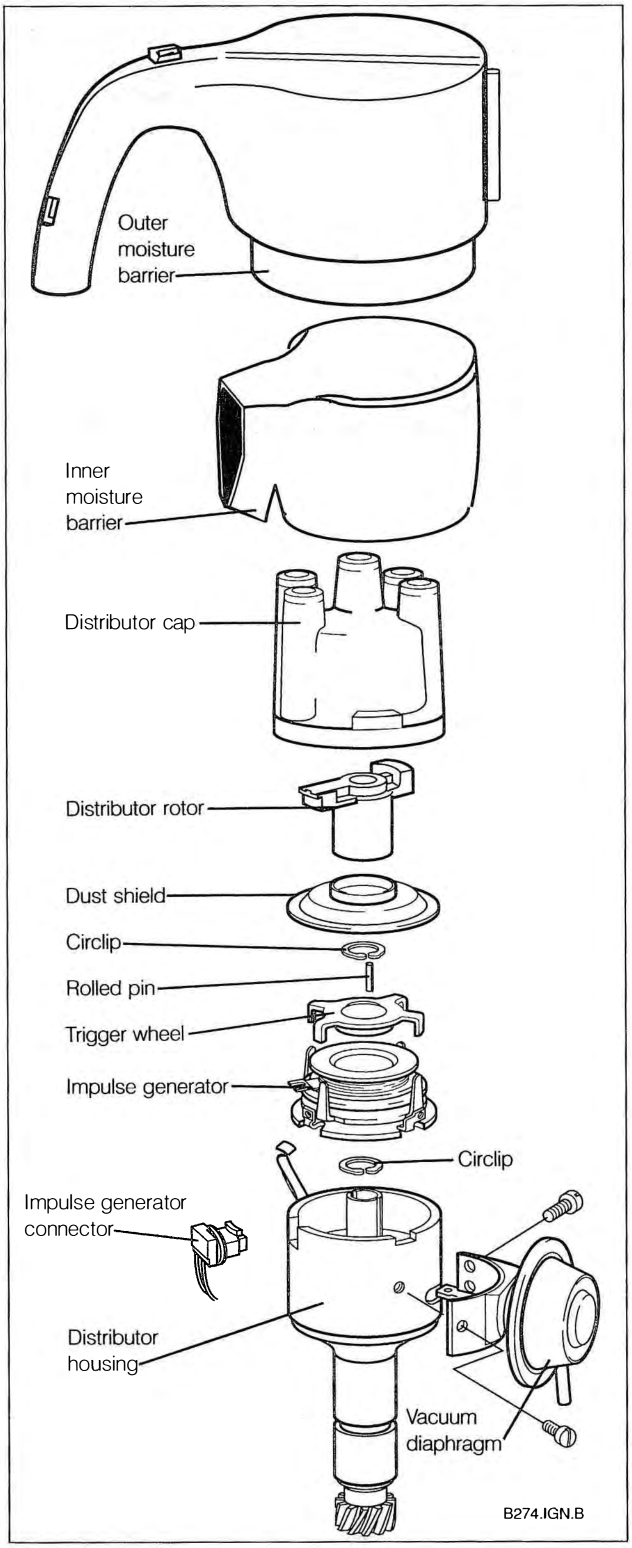

Fig. 4-6. Exploded view of distributor assembly installed on cars with 4-cylinder engines.

The impulse generator, the trigger wheel, the vacuum diaphragm and the dust shield are all available as replacement parts, but replacement is not routinely necessary. The distributor housing parts, including the centrifugal advance mechanism and shaft bushings, are not available. The distributor housing must be replaced as a unit.

Whenever the distributor is disassembled, all of the shims, circlips, gaskets, and O-rings should be replaced. Any disassembly or removal of the distributor will require checking and adjusting the ignition timing, as described in **4.3 Ignition Timing**.

Removing and Installing Distributor Cap, Rotor, and Spark Plug Wires

These components all carry high voltage to the spark plugs and proper engine performance depends on getting the best possible spark at the spark plug. Worn and corroded contacts or poor insulation which allows the spark to short to ground are the primary reasons for replacement of these components.

Each spark plug wire leads from a specific terminal on the distributor cap to a specific spark plug. This order is known as the ignition firing order. When removing the wires, label their positions so that they can be reinstalled in the proper places. If the wires get mixed up, see **Firing Order** below.

The distributor cap is protected from moisture with two black plastic covers. The outer cover can be removed by prying it apart at the points indicated in Fig. 4-7. Spread apart the inner cover to remove it from the cap and wires.

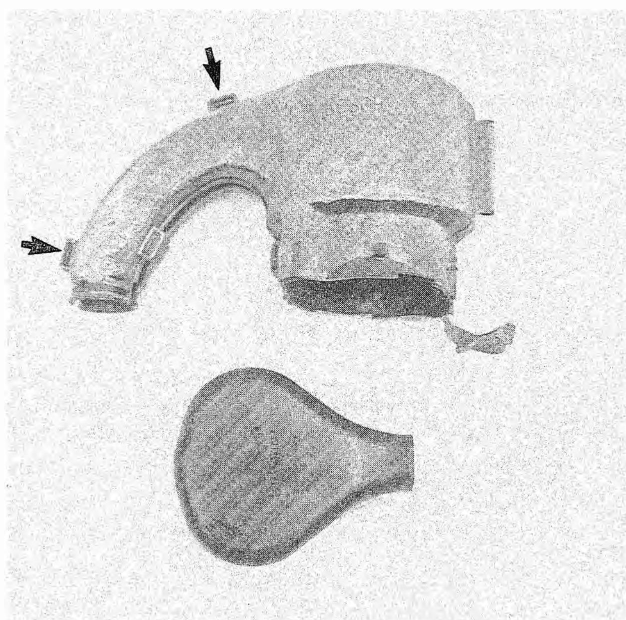

Fig. 4-7. Distributor cap protective covers installed on 4-cylinder engines. Pry cap apart at points indicated by arrows.

The spark plug wires are removed from the distributor cap and spark plugs by pulling straight up. Pull only on the connector, not on the wire itself. On stuck wires, twisting the connector slightly or peeling back the rubber boot from the distributor cap tower may ease removal.

CAUTION —
Wiggling the connectors from side to side when removing the spark plug wires from the distributor cap may damage the cap.

The distributor cap is held in place with two spring clips which can be pried loose using the blade of a screwdriver. Avoid bending the clips. To replace the cap remove the spark plug wires, then remove the suppression shield by releasing the spring clips and sliding it off the cap. Note that there is a tab on the rim of the cap that fits into a notch on the edge of the distributor. Place the new cap on the distributor and fasten the clips. Change over one wire at a time from the old cap to the new one.

CAUTION —
If the engine needs to be turned over with the cap removed, check that the hold down clips are not lying on top of the trigger wheel. If the starter is operated with the clips in this position, the trigger wheel will be damaged.

Simply pull straight up on the rotor to remove it. When installing a new rotor, make sure that the key inside the rotor fits into the notch in the distributor shaft.

Firing Order

Spark plug wires must be installed so that the spark plugs fire in the proper order. For all 4-cylinder engines covered by this manual, the firing order is 1-3-4-2, that is, looking at the top of the distributor cap, the spark plug wires go to cylinders no. 1, no. 3, no. 4, and no. 2, in the direction of the rotor's rotation. To determine the direction in which the rotor rotates, place the transmission in a high gear and move the car forward, just until the rotor begins to move. The direction in which the rotor moves is the firing order direction.

NOTE —
- To determine the location of cylinder no. 1 on the distributor cap, remove the cap and look for a small mark on the rim of the distributor housing. (See Fig. 4-8 below.) The tower on the cap which aligns with this notch is for cylinder no. 1, followed by wire no. 3, wire no. 4, and wire no. 2.
- Cylinder no. 1 is at the front of the engine (closest to the radiator).

Removing and Installing Distributor

Ignition timing must be checked and adjusted any time the distributor is disassembled or removed. See **4.3 Ignition Timing**.

To remove:

1. Remove the distributor cap as described above in **Removing and Installing Distributor Cap, Rotor, and Spark Plug Wires.**

2. Using a wrench on the crankshaft sprocket bolt, rotate the engine by hand until the distributor rotor tip is aligned with the No. 1 cylinder Top Dead Center (TDC) mark on the distributor housing. See Fig. 4-8.

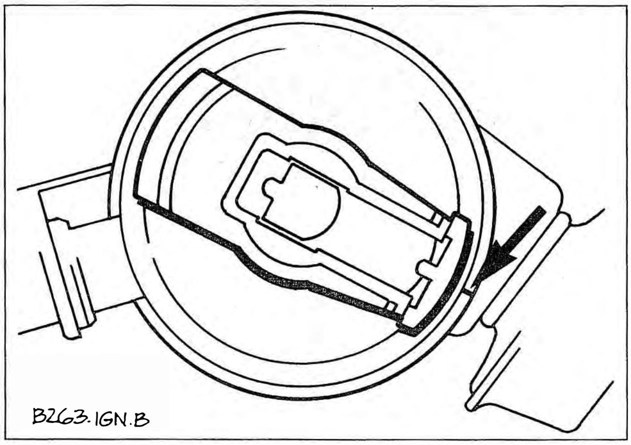

Fig. 4-8. Distributor rotor aligned with No. 1 cylinder TDC mark (arrow) on distributor housing.

3. Remove the retaining screw and disconnect the impulse generator connector from the distributor. Disconnect the vacuum lines from the vacuum diaphragm.

4. Using a 10 mm open end wrench, loosen the distributor clamping nut as shown in Fig. 4-9. Make matching marks to note the position of the distributor relative to the block, and then remove the distributor by pulling it straight out. Cover the opening in the cylinder head.

NOTE —
The distributor shaft will want to rotate approximately 30° as the beveled drive gears disengage. Notice the position of the rotor after removal, in order to position it approximately the same way prior to reinstallation.

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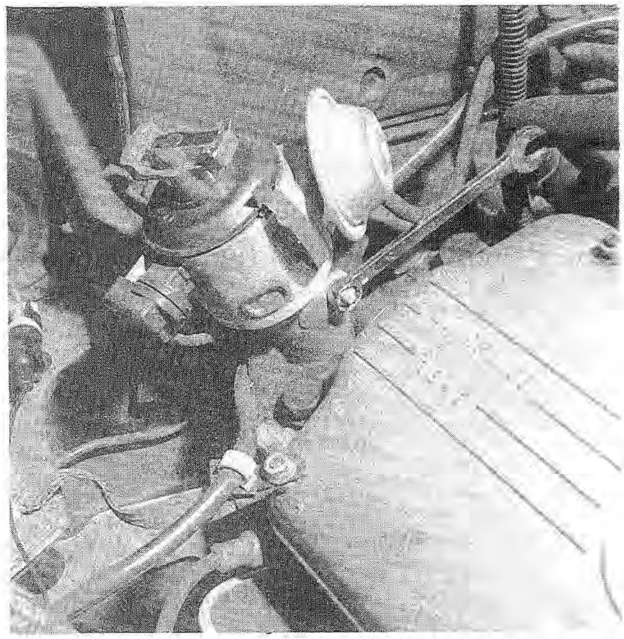

Fig. 4-9. Distributor clamping nut being loosened.

To install:

1. If the crankshaft has been turned since the distributor was removed, rotate the crankshaft so that cylinder no. 1 is at TDC with the valves closed. If necessary, see **ENGINE**.

2. Inspect the distributor shaft O-ring and replace it if it is worn or damaged. Install the distributor, making sure the rotor aligns with the distributor housing as shown in Fig. 4-8 above when the distributor housing is seated firmly.

NOTE —
The rotor will rotate approximately 30° as the beveled drive gears engage, so check for proper alignment after installation.

3. Tighten the distributor clamping nut and install the distributor cap. Reconnect the electrical connections and the vacuum line.

4. Adjust the ignition timing as described in **4.3 Ignition Timing**.

Disassembling and Assembling Distributor

Some disassembly of the distributor is required to replace the impulse generator coil. It will require a snap-ring plier and a thin drift or punch. It is possible to disassemble the distributor shaft and the centrifugal advance mechanism for cleaning and inspection, but these are not available as replacement parts. Fig. 4-6 above illustrates the distributor assembly. The distributor should be removed as described above under **Removing and Installing Distributor** before disassembly.

Use a snap-ring plier to remove the snap ring retaining the trigger wheel. Next, use two screwdrivers positioned at opposite sides of the trigger wheel to pry it up as shown in Fig. 4-10. Do not lose the rolled pin that fits between the trigger wheel and the distributor shaft.

CAUTION —
Push the screwdrivers in as far as possible, and pry up only under the strongest, center portion of the trigger wheel.

NOTE —
A bent trigger wheel must be replaced. Trigger wheels are available as replacement parts from an authorized BMW dealer parts department.

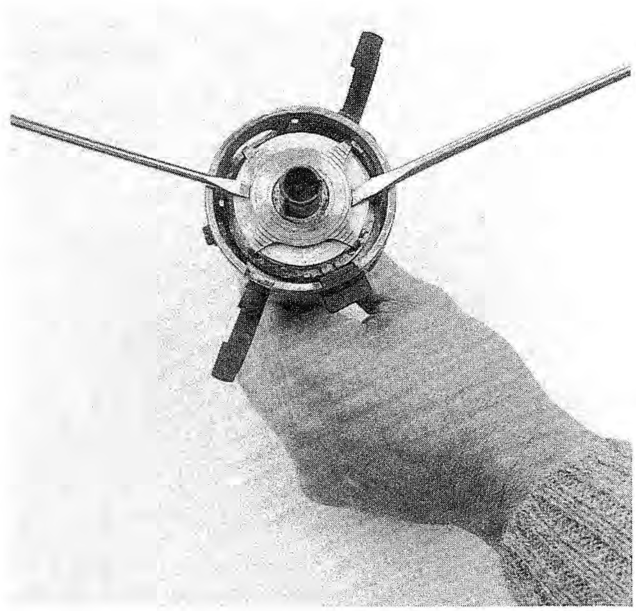

Fig. 4-10. Trigger wheel being removed from distributor shaft. Pry evenly under center of trigger wheel, from both sides using flat-blade screwdrivers.

Remove the mounting screws for the impulse generator electrical connecting socket, the vacuum diaphragm, and the base plate. Pull off the connecting socket from the distributor housing. Remove the vacuum diaphragm by moving the diaphragm assembly down while unhooking it from the base plate pin. Use a snap-ring plier to remove the snap ring retaining the impulse generator coil and base plate assembly. Carefully pry out the impulse generator coil together with the base plate.

The impulse generator coil can be removed from the base plate by removing the three mounting screws shown in Fig. 4-11. Note the insulating ring between the coil and the base plate. Installation is the reverse of removal. Be sure the insulating ring is positioned between the coil and the base plate. Make sure the coil is centered on the base plate before tightening the mounting screws. When installing the trigger wheel, make sure the rolled pin is located between the notch in the distributor shaft and the notch in the trigger wheel.

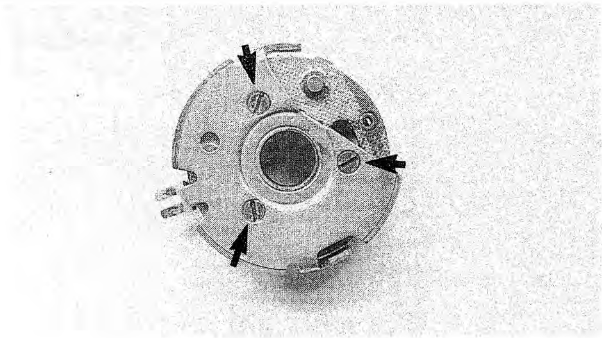

Fig. 4-11. Impulse coil mounting screws on underside of distributor base plate (arrows).

4.3 Ignition Timing

Correct ignition timing is essential to proper engine performance. Checking and adjusting ignition timing is an important part of any engine tune-up. Ignition timing also needs to be adjusted whenever the distributor has been removed or taken apart. On early models with distributors having code number 0 237 002 080, an adjustable timing light is necessary to accurately check and adjust ignition timing.

> **NOTE —**
> Prior to setting ignition timing, identify the distributor code number. Its location is shown in Fig. 4-12. Two different distributors are installed on the 4-cylinder models covered by this manual.

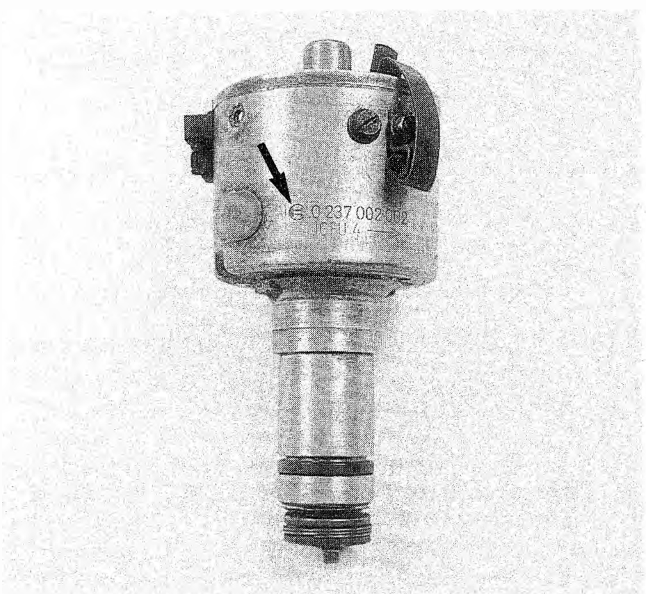

Fig. 4-12. Distributor code number location (arrow). Distributor shown is not one of those covered by this manual.

Ignition timing has a significant effect on engine exhaust emissions. Ignition timing should be adjusted in conjunction with idle speed and idle mixture (exhaust carbon monoxide or CO level) as described in **FUEL SYSTEM**.

> **NOTE —**
> CO measurement and adjustment requires special skills and equipment. Most do-it-yourselfers are advised to leave these adjustments to an authorized BMW dealer service department or other qualified repair shop, to ensure compliance with emissions regulations as well as maximum performance.

To check basic ignition timing:

1. With the ignition off, connect a tachometer and timing light according to the instrument manufacturer's instructions.

2. Disconnect the vacuum hose from the distributor's vacuum diaphragm. It is not necessary to plug the hose.

3. Start the engine and allow it to fully warm up. Oil temperature should be at least 140°F (60°C) or the temperature gauge should be in its normal temperature range.

4. With the engine at the speed indicated in **Table c** or **Table d** given earlier, aim the timing light at the timing check hole in the bellhousing. See Fig. 4-13.

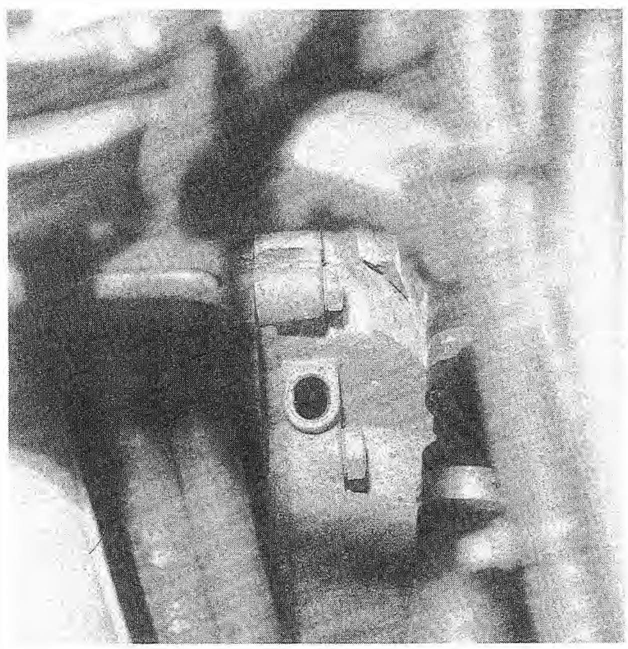

Fig. 4-13. Timing check hole in left (driver's side) of transmission bellhousing. Aim timing light in hole when timing engine.

NOTE —
The basic timing indications are only valid when engine speed is within specifications.

5. On early models with 0 237 002 080 distributors, the 0T (0° Top Dead Center) mark on the flywheel should appear in the center of the timing check hole when the timing light is adjusted to the specifications shown in the above tables. See Fig. 4-14.

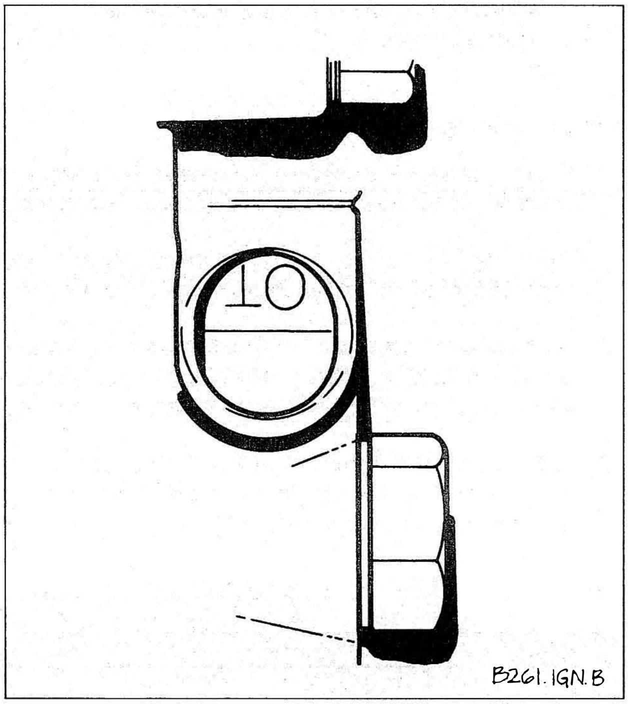

Fig. 4-14. Timing mark used to time models with 0 237 002 080 distributors.

6. On later models with 0 237 002 096 distributors, the timing ball on the flywheel should appear in the center of the inspection hole. See Fig. 4-15.

7. If ignition timing is within specifications, switch off the ignition and disconnect the test equipment. Reconnect the vacuum hose.

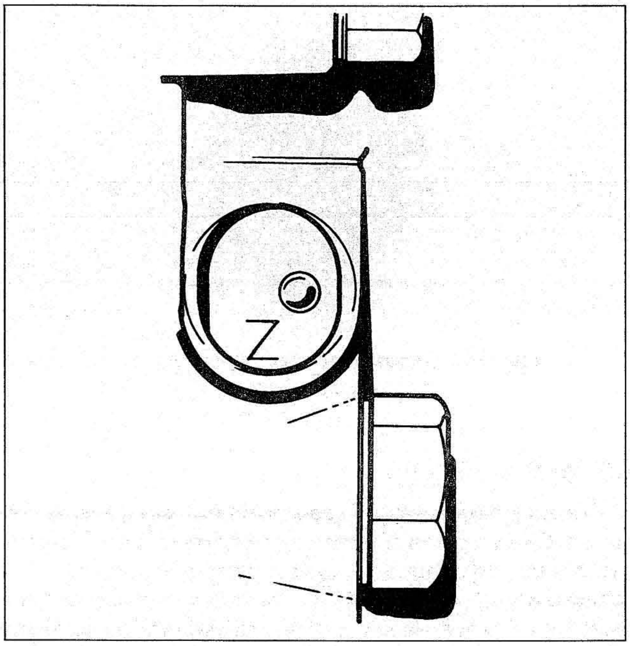

Fig. 4-15. Timing ball used to time models with 0 237 002 096 distributors.

To adjust basic ignition timing:

1. With the ignition off, loosen the distributor clamping nut. Remove the vacuum advance hose from the vacuum diaphragm.

CAUTION —
The distributor should be just loose enough to be moved by hand, but tight enough that it can only be moved by deliberate effort. The distributor must not move by itself while the engine is running.

2. Start the engine and raise the speed to the specifications listed above in **Table c** or **Table d**.

3. Gradually turn the distributor housing until the correct timing mark, viewed with the timing light, lines up in the bellhousing hole. See Fig. 4-14 or 4-15 above.

4. Stop the engine and tighten the distributor hold-down bolt without moving the distributor. Tighten the nut to 8 to 10 Nm (6 to 7 ft. lb.).

5. Start the engine and recheck the ignition timing. Repeat the adjustment if necessary.

6. Turn the ignition off and remove the test equipment. Reconnect the vacuum hose.

4.4 Centrifugal and Vacuum Spark Advance

The centrifugal advance mechanism advances ignition timing as rpm increases. A set of weights in the distributor is connected to the distributor shaft. The distributor base plate is connected to the weights. As engine rpm increases, the weights are forced outward by centrifugal force. This moves the position of the base plate and the impulse generator, changing the point at which the signal is sent to the ignition control unit.

The vacuum advance mechanism advances ignition timing as engine vacuum increases. A schematic view of the vacuum advance system is shown in Fig. 4-16. Engine vacuum is routed from the intake manifold to the vacuum diaphragm on the side of the distributor. The vacuum diaphragm changes the position of the base plate and impulse generator to alter timing.

The routing of vacuum is controlled by a solenoid valve, which is operated by the vacuum advance relay. Using inputs from the injection control unit (for engine load), intake air temperature, and coolant temperature, the vacuum advance relay switches the solenoid valve so that engine vacuum can affect the vacuum diaphragm.

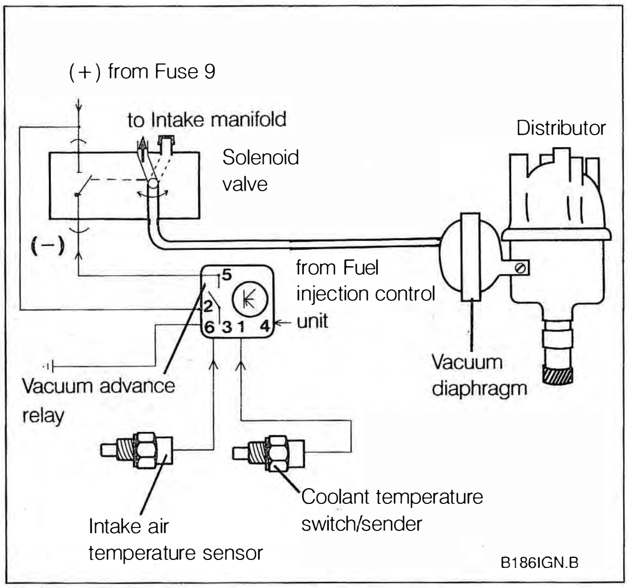

Fig. 4-16. Schematic view of vacuum advance system. Vacuum is switched on and off at solenoid valve by the electronic relay.

The timing advance functions are most accurately checked using specialized equipment. An adjustable timing light or an engine analyzer can be used to accurately read rpm-dependent timing advance. A BMW special tool should be used to accurately check vacuum-dependent timing advance.

Checking Centrifugal Ignition Timing Advance

Check centrifugal advance with the vacuum advance hose disconnected at the distributor and plugged. A basic check can be made by observing the change in ignition timing at speeds above idle. Using a timing light, watch the timing mark on the flywheel as engine rpm is increased. A movement of the timing mark is a rough indication that the centrifugal advance is working.

Precise measurement requires an adjustable timing light which can accurately indicate how much timing changes from the basic timing value. Raise the engine rpm and compare the timing advance with the values listed in **Table e**.

If the distributor's centrifugal advance mechanism is not performing properly, the base plate may be binding. Further check the centrifugal advance mechanism, by removing the distributor cap and twisting the distributor rotor. The movement of the rotor should be smooth and it should spring back to its original position when released. If it doesn't, disassemble the distributor as described above, checking carefully for signs of binding. If there are no other faults, then there is a problem with the weight assembly or distributor shaft, and the distributor housing assembly should be replaced.

Table e. RPM-Dependent Ignition Timing Advance

Engine rpm (approx.)	Total advance
Distributor No. 0 237 002 080	
1000	−2-6°
1500	6-15°
2000	12-19°
2500	17-24°
3000	22-29°
3500	24-31°
4000	23-30°
4500	22-29°
5000	22-28°
Distributor No. 0 237 002 096	
1000	2-9°
1500	6-14°
2000	11-18°
2500	16-24°
3000	22-28°
3500	23-30°
4000	22-29°
4500	21-28°
5000	21-27°

5

Checking Vacuum Ignition Timing Advance

Check the vacuum advance function only after determining that the rpm dependent timing advance is correct. To make a basic check of the vacuum advance system, the engine should be fully warmed up. The timing should change as the vacuum hose is disconnected and connected. If the timing does not change, then either a vacuum hose is faulty, the vacuum diaphragm is faulty, or the advance system is not switching the vacuum.

To check the operation of the vacuum diaphragm, remove the distributor cap. Using a vacuum pump and gauge, apply vacuum to the diaphragm. The base plate and impulse generator should move. In addition, the diaphragm should hold vacuum of approximately 500 mbar, losing no more than 50 mbar in one minute. If the diaphragm fails either of these tests it should be replaced.

To check the advance system, first check the solenoid valve. Remove the vacuum advance relay as shown in Fig. 4-17. Use a jumper wire to connect terminal 5 (green/yellow wire) of the relay socket to terminal 6 (brown wire) to power the solenoid directly as the engine runs. The timing should change. If the timing does not change, either the solenoid is not getting voltage (green/yellow wire) or the solenoid itself is faulty.

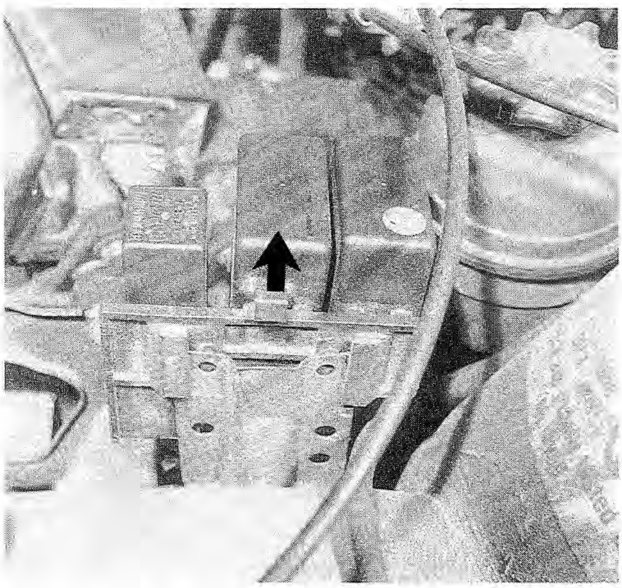

Fig. 4-17. Vacuum advance control relay (arrow). Similar relay in adjacent position with yellow dot on top is for idle speed stabilization (late 1985 models only). Small relay on 1984 and early 1985 models (not shown) is for deceleration fuel shut-off.

If the timing does change, then there is a problem with the relay or its inputs. Check the inputs to the relay with the relay removed. At engine coolant temperatures above 113°F (45°C), the coolant temperature switch/sender should be closed (continuity between terminal 1 (white wire) and terminal 6 (brown wire) of the relay socket). At intake air temperatures between 50 and 100°F (10 and 38°C), check the resistance of the intake air temperature sensor between terminal 3 (black wire) and terminal 6 (brown wire). The resistance should be approximately 950 ohms. Check the engine load signal using a LED test light between socket terminal 5 (red/green wire) and terminal 6 (brown wire). The LED should flash with the engine running.

Replace faulty sensors and repair wires as necessary. If there are no sensor or wire faults, then the vacuum advance relay is most likely faulty and should be replaced.

NOTE —

The coolant temperature switch/sender also functions as the coolant temperature gauge sender. The switch/sender is located in the coolant flange outlet on the cylinder head. The coolant temperature switch/sender is the one with two single push-on connectors. The intake air temperature sensor is mounted in the intake air duct in the front left corner of the engine compartment. See Fig. 4-18.

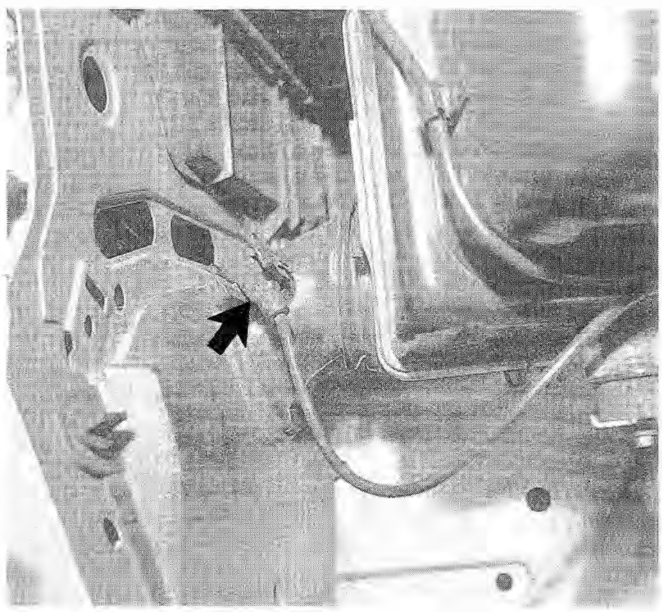

Fig. 4-18. Intake air temperature sensor mounted in air duct (arrow).

5. Motronic (DME) Ignition System

All ignition functions of the Motronic ignition system are controlled electronically by the Motronic control unit. This system combines both the ignition and fuel injection systems together. Specialized test equipment is necessary to check the timing, as well other ignition system signals to the control unit such as spark advance and retard, and spark quality.

Testing of the spark plug wires, ignition coil, and the distributor cap and rotor should be performed prior to making any tests of the Motronic system. See **3. Troubleshooting** for complete testing of these components.

5.1 Ignition Timing

The ignition point is controlled according various inputs to the control unit. Inputs such as engine load, engine speed, temperature, and throttle position are used to determine the optimum ignition point.

Ignition timing is electronically controlled and is not adjustable on Motronic systems. The initial baseline ignition point is determined based on the crankshaft position during starting. This is signalled by a reference sensor. Once the engine is running, the ignition point is continually changed based on the various inputs to the control unit. Engine speed is signalled by a speed sensor. A Motronic ignition characteristic map illustrating all the possible ignition points is shown in Fig. 5-1. A map similar to the one shown is digitally stored in the Motronic control unit.

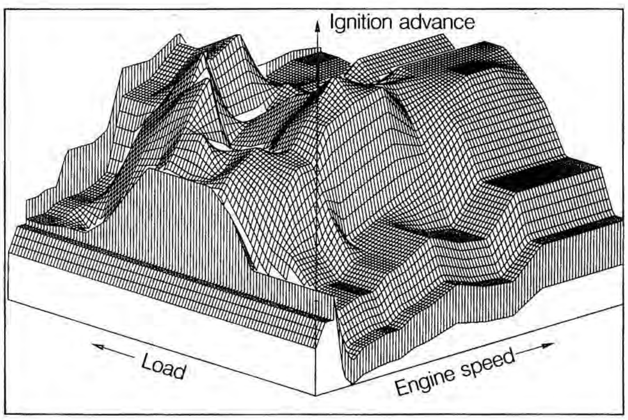

Fig. 5-1. Motronic ignition characteristic map. Courtesy Robert Bosch Corp.

5.2 Reference Sensor and Speed Sensor

On 1984 through 1987 325e(es) models, two separate sensors supply the control unit with engine speed and crankshaft position. The sensors are mounted on the driver's side of the transmission bellhousing. The speed sensor uses the flywheel teeth to determine engine speed. The reference sensor determines the crankshaft's position, or angle, when a raised pin on the flywheel or a missing tooth on a front pulse wheel passes the sensor. See Fig. 5-2.

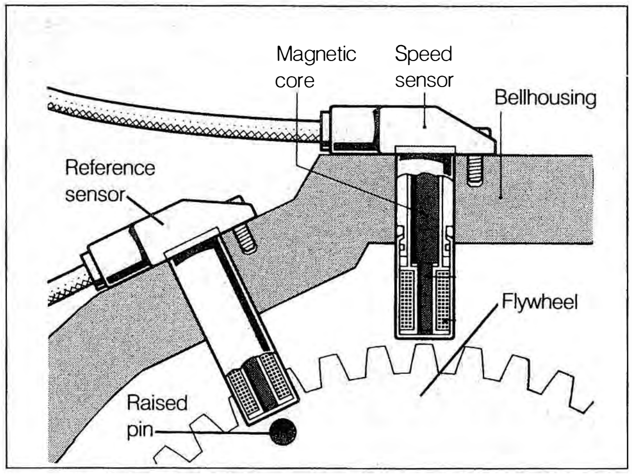

Fig. 5-2. Schematic of reference sensor and speed sensor on 1984 through 1987 325e(es) models. Courtesy Robert Bosch Corp.

NOTE —

A Top Dead Center (TDC) position sensor mounted on the front of the engine on 1984 through 1987 325 and 325e(es) models is for use with the BMW Service-test unit. This sensor is not linked to the Motronic system or the engine in any way and does not affect ignition timing or the way the engine runs.

On 325i(is) and 1988 through 1990 325 models, a single pulse sensor senses engine speed and crankshaft position. The pulse sensor is mounted on the front of the engine and reads a pulse wheel mounted on the front of the crankshaft. Engine speed is determined by the rate at which the wheel's teeth pass the sensor. Crankshaft position is determined by the missing-teeth area on the pulse wheel. See Fig. 5-3.

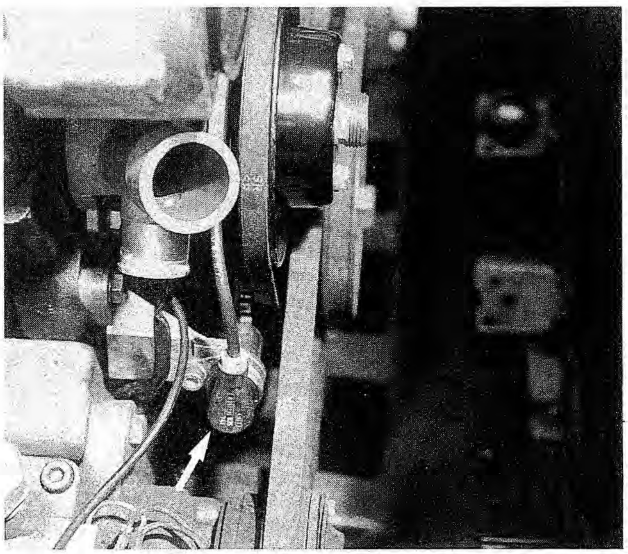

Fig. 5-3. Pulse sensor on 325i(is) and 1988 through 1990 325 engine (arrow).

If the control unit does not receive a crankshaft position signal from the sensor, the engine will not start. If the engine consistently misses at constant speeds, test the speed sensor. Motronic electrical tests other than those described below can be found in **FUEL SYSTEM**. When testing the sensors, the temperature should be approximately 77°F (25°C) to obtain the most accurate results.

Testing Reference and Speed Sensors
(1984 through 1987 325e(es) models only)

Disconnect the two electrical connectors shown in Fig. 5-4 or 5-5. The gray connector is for the reference mark sensor and the white connector is for the speed sensor. Using an ohmmeter, check the resistance between terminal 1 (yellow wire) and terminal 2 (black wire) on the sensor side end of each connector. If the resistance is not approximately 960 $\pm$ 96 ohms, the sensor is faulty and should be replaced.

When replacing a sensor, be sure the connectors are not interchanged, and that the sensor is placed in the correct position in the bellhousing. The bellhousing is marked with a **B** for the reference sensor, and a **D** for the speed sensor. See Fig. 5-6. Tighten the sensor mounting screw to 7 $\pm$ 1 Nm (62 $\pm$ 9 in. lb.). Be careful not to overtighten the mounting screw.

If no faults are found with the reference sensor, inspect the raised pin on the flywheel. Using a socket wrench on the front of the crankshaft vibration damper (pulley), hand-turn the engine until the pin is visible through the bellhousing timing check hole. If the pin is missing or damaged, it should be replaced with an original pin available from BMW.

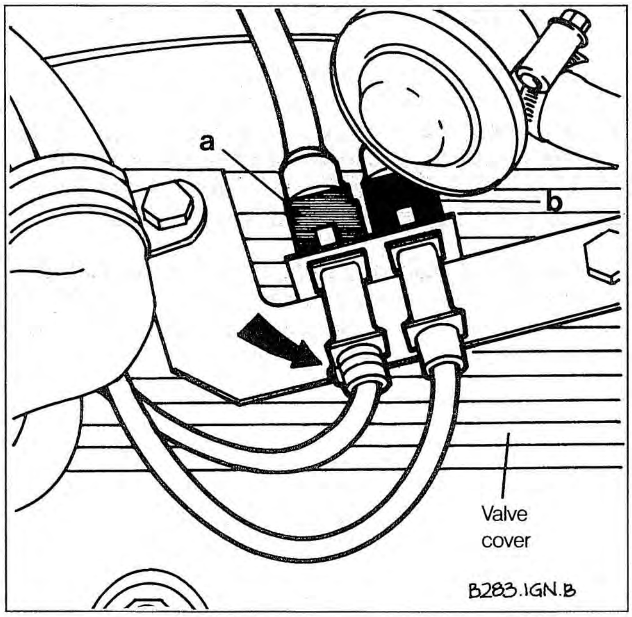

Fig. 5-4. Gray reference sensor connector (**a**) and black speed sensor connector (**b**) for 1984 and 1985 325e(es) engine. Reference sensor also marked with a ring (arrow).

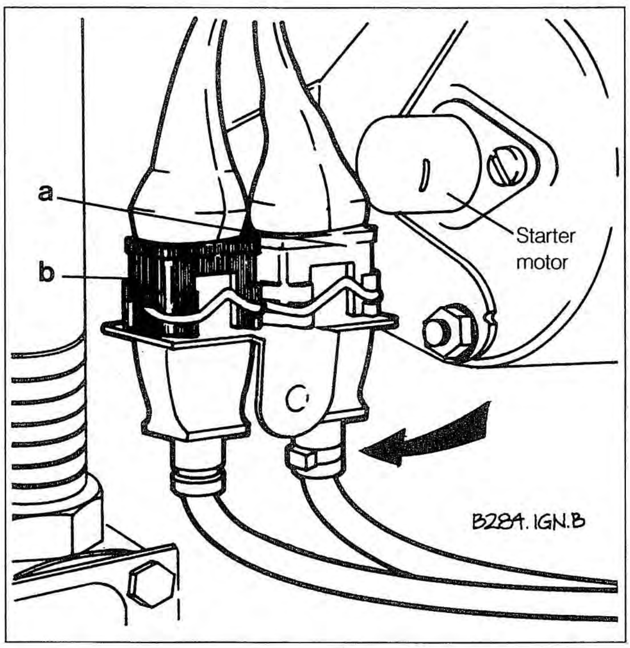

Fig. 5-5. Gray reference sensor connector (**a**) and black speed sensor connector (**b**) for 1986 and 1987 325e(es) engine. Reference sensor also marked with a ring (arrow).

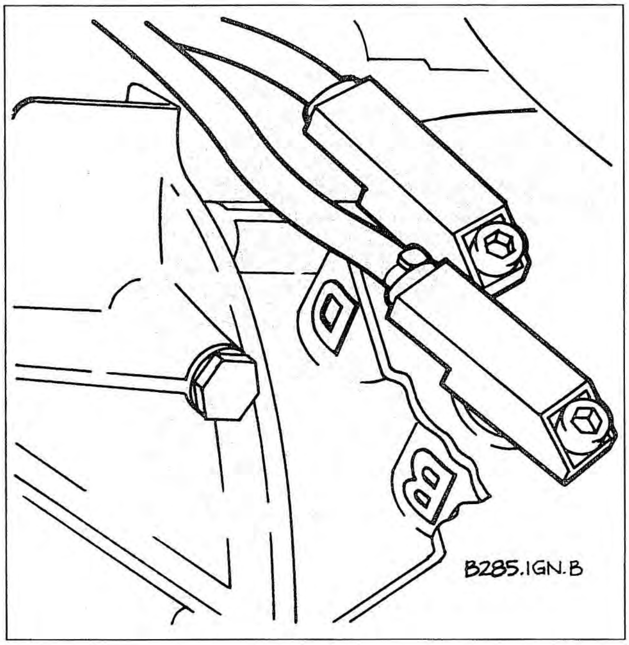

Fig. 5-6. Bellhousing reference sensor position (**B**) and speed sensor position (**D**).

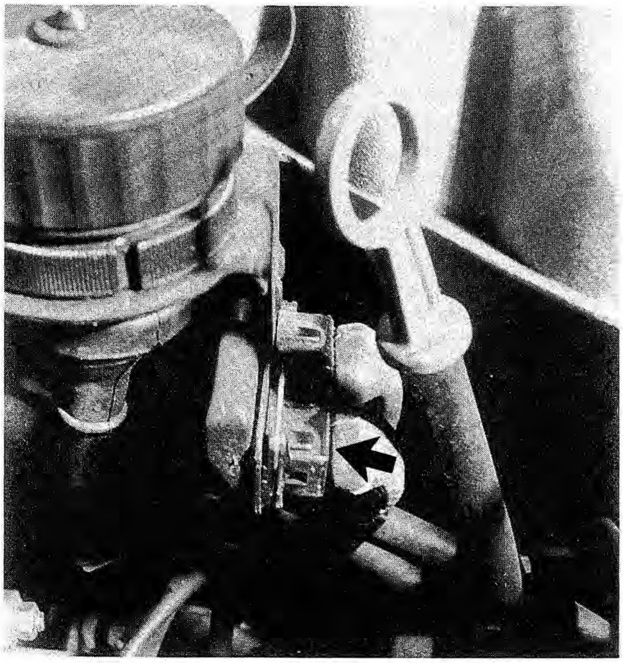

Fig. 5-7. Pulse sensor connector for 325i(is) engine (arrow).

Testing Pulse Sensor
(325i, 325is and 1988 through 1990 325 models)

Disconnect the electrical connector shown in Fig. 5-7. Using an ohmmeter, check the resistance between terminal 1 (yellow wire) and terminal 2 (black wire) on the sensor side end of the connector. If the resistance is not approximately 540 ± 54 ohms, the sensor is faulty and should be replaced. Remove the sensor mounting bolt using a 5 mm hex wrench. When the sensor is installed, the distance between the sensor tip and the toothed wheel should be 1.0 ± 0.3 mm (.04 ± .01 in.) Tighten the sensor mounting screw to 7 ± 1 Nm (62 ± 9 in. lb.). Be careful not to overtighten the mounting screw. Be sure the wiring is correctly routed through the protective covering. See Fig. 5-8.

Fig. 5-8. Pulse sensor wiring routed through protective covering (arrow).

These components all carry high voltage to the spark plugs and proper engine performance depends on getting the best possible spark at the spark plug. Worn and corroded contacts or poor insulation which allows the spark to short to ground are the primary reasons for replacement of these components.

The distributor cap and rotor do not require replacement as part of normal maintenance unless found to be worn or corroded. See **3.4 Testing Distributor Cap and Rotor** for information on inspecting these components.

5.3 Distributor

The only function of the Motronic distributor is to distribute high voltage to the spark plugs. There are no advance mechanisms or electronics in the distributor. The rotor is driven directly off the front of the camshaft.

Removing and Installing Distributor Cap, Rotor, and Spark Plug Wires

Each spark plug wire leads from a specific terminal on the distributor cap to a specific spark plug. This order is known as the ignition firing order. When removing the wires from the harness assembly, label their positions so that they can be reinstalled in the proper places. If the wires get mixed up, see **Firing Order** below.

NOTE —
On 325i(is) and 1988 through 1990 325 models, there is an inductive pickup on the no. 6 spark plug wire. This sensor signal is used to sequence the fuel injectors. See **FUEL SYSTEM** for more information.

The spark plug wires are removed from the distributor cap and spark plugs by pulling the boots straight up. Pull only on the connector, not on the wire itself. On particularly old wires, twisting the connector or peeling back the rubber boot from the distributor cap tower may ease removal.

CAUTION —
Wiggling the connectors from side to side when removing the spark plug wires from the distributor cap may damage the cap.

Before the distributor cap can be removed, the radiator cooling fan and the fan shroud should be removed. This is easily accomplished as described in **COOLING SYSTEM**. If the fan and shroud are not removed, it may be difficult to remove the distributor cap and rotor mounting screws.

The distributor cap is protected with a black plastic cover. The cover can be removed by releasing the two retainers on either side of the cover. See Fig. 5-9. The distributor cap can be removed after the three internal-hex head mounting screws are removed.

Remove the rotor by removing the three 3-mm mounting screws. Remove the dust shield and inspect the large O-ring on the rear of the dust shield. See Fig. 5-10. If it is crushed or damaged, it should be replaced. Inspect the distributor cap and rotor as described under **3.4 Testing Distributor Cap and Rotor**. Installation is the reverse of removal. Tighten the rotor mounting screws to 3 Nm (27 in. lb.). Be careful not to overtighten the screws.

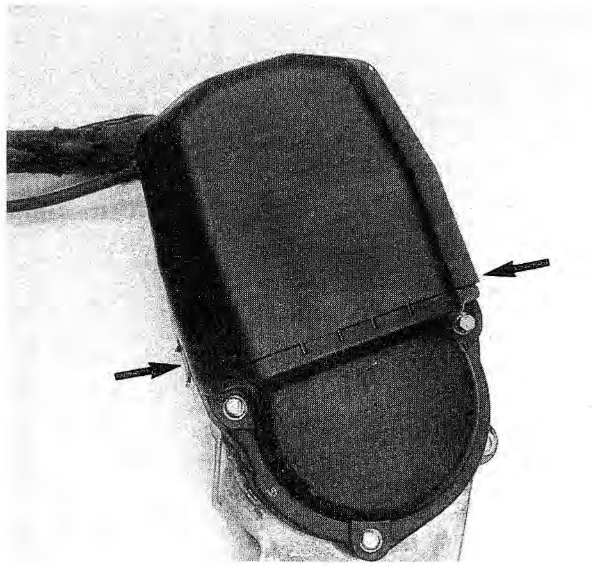

Fig. 5-9. Distributor cap protective cover installed on 6-cylinder engines. Unclip cap at points indicated by arrows.

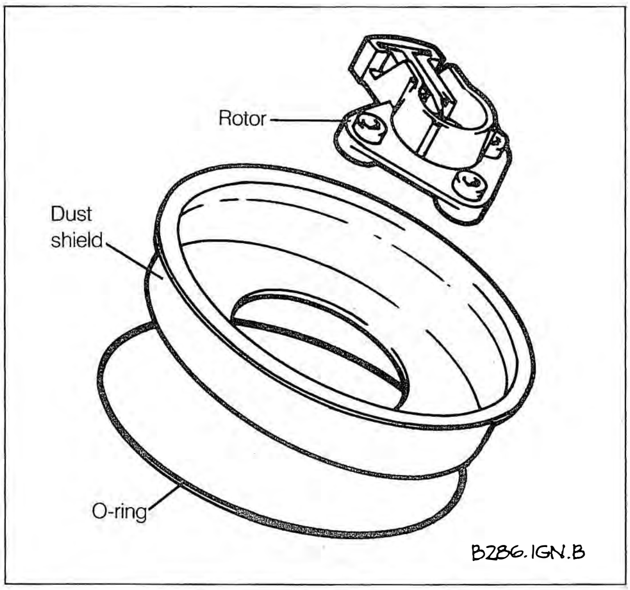

Fig. 5-10. Ignition rotor, distributor cap dust shield and O-ring.

Firing Order

Spark plug wires must be installed so that the spark plugs fire in the proper order. For all 6-cylinder engines covered by this manual, the firing order is 1-5-3-6-2-4. That is, looking at the top of the distributor cap, the spark plug wires go to cylinders no. 1, no. 5, no. 3, no. 6, no. 2, and no. 4 in the direction of the rotor's rotation. Fig. 5-11 shows the correct routing of the spark plugs wires in the distributor cap.

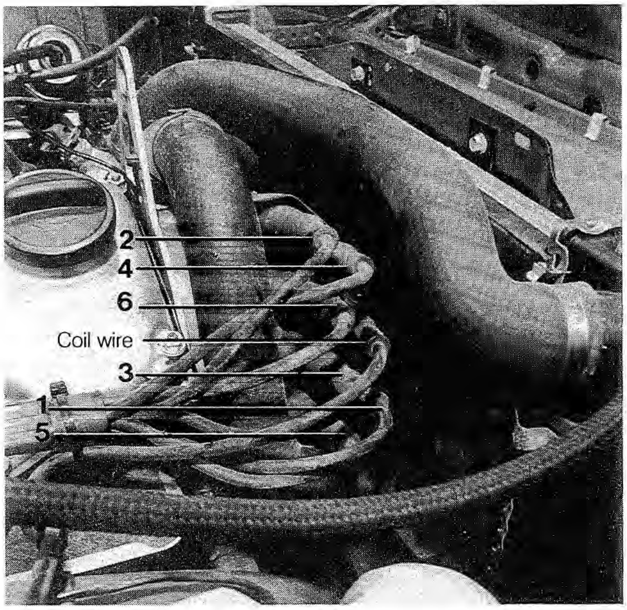

Fig. 5-11. Spark plugs wires correctly installed in distributor cap of 6-cylinder engine.

NOTE —

Cylinder no. 1 is at the front of the engine (radiator end).

6. Technical Data

I. TCI-i Ignition System Specifications (Bosch control unit)

Ignition control unit code number	0 227 100 111
Ignition coil code number	0 221 122 319 (gray label)
Distributor code number	
1984 (early)	0 237 002 080
1984 and 1985	0 237 002 096
Ignition timing (vacuum hose disconnected at distributor)	
0 237 002 080 distributor	15° BTDC @2000±50 rpm
0 237 002 096 distributor	26° BTDC @4000±50 rpm
Engine idle speed	
0 237 002 080 distributor	750±50 rpm
0 237 002 096 distributor	
manual transmission	850±50 rpm
automatic transmission	750±50 rpm

continued

I. TCI-i Ignition System Specifications (Bosch control unit) (continued)

Vacuum advance	
start (approx.)	70 mbar
end (approx.)	240 mbar
Firing order	1 - 3 - 4 - 2
Spark plugs	
Bosch	WR9DS
Beru	RS 33
Spark plug gap	0.8+0.1 mm (.032+.004 in.)
Spark plug tightening torque	20-30 Nm (15-22 ft. lb.)
Impulse generator	
impulse generator coil resistance	1100±10 ohms
trigger wheel air gap	between 0.3 and 0.7 mm (.012 and .028 in.)

II. TCI-i Ignition System Specifications (Siemens/Telefunken control unit)

Ignition control unit code number	1 705 607/608
Ignition coil code number	0 221 122 319 (gray label)
Distributor code number	0 237 002 096
Ignition timing (vacuum hose disconnected)	
all	26° BTDC @4000±50 rpm
Engine idle speed	
manual transmission	750±50 rpm
automatic transmission	850±50 rpm
Vacuum advance	
start (approx.)	70 mbar
end (approx.)	240 mbar
Firing order	1 - 3 - 4 - 2
Spark plugs	
Bosch	WR9DS
Beru	RS 33
Spark plug gap	0.8 mm+0.1 (.032+.004 in.)
Spark plug tightening torque	20-30 Nm (15-22 ft. lb.)
Impulse generator	
impulse generator coil resistance	1100±10 ohms
trigger wheel air gap	between 0.3 and 0.7 mm (.012 and .028 in.)

III. Motronic (DME) Ignition System Specifications

Ignition coil code number	0 221 118 335 (yellow label)
Firing order	1 - 5 - 3 - 6 - 2 - 4
Spark plugs	
1984-1987 325 and 325e(es)	
Bosch	WR9LS
Beru	14 R/9 LS
325i(is), 1988-1990 325	
Bosch	W8LCR
Spark plug gap	0.7+0.1 mm (.027+.004 in.)
Spark plug tightening torque	20-30 Nm (15-22 ft. lb.)
Reference or speed sensor coil resistance (325e, 325es engine)	960±96 ohms
Pulse sensor coil resistance (Motronic 1.1)	540±54 ohms
Ignition rotor tightening torque (6-cylinder engines)	3 Nm (27 in. lb.)
Reference, speed, or pulse sensor tightening torque	7±1 Nm (62±9 in. lb.)

Section 6

FUEL SYSTEM

Contents

6

TABLES

Fuel System

Introduction

The fuel system has four main functions: (1) it provides storage space for the fuel; (2) it delivers fuel to the engine; (3) it admits filtered air to the engine to be mixed with fuel; (4) it mixes fuel and air in precise proportions and delivers the mixture to the cylinders as a combustible vapor. The fourth function is performed by one of two similar types of fuel injection systems.

Unlike a carburetor, which depends on the velocity of the incoming air to vaporize the fuel and draw it into the engine, a fuel injection system injects atomized fuel into the intake air stream under pressure. This method of active fuel metering means that the fuel mixture entering the engine can be controlled more precisely and used more efficiently, yielding improved driveability, fuel economy, and performance.

Two types of fuel injection systems are installed on the cars covered by this manual. Each has its own unique features and methods, but all achieve the same result. Although these systems appear complicated at first, they operate on simple principles and can be easily understood. This section provides separate and thorough descriptions of each system, making it simple to identify and understand the system installed on a particular car.

This section covers repair information specifically for the fuel system. General troubleshooting information to be used as an aid in diagnosing problems can be found in **ENGINE MANAGEMENT—DRIVEABILITY**. Test procedures in this section for individual components also explain their function, so that the purpose of each test can be understood. Information on the oxygen sensor system is found in **EXHAUST SYSTEM AND EMISSION CONTROLS**.

Special equipment is necessary for some servicing of the fuel injection system. Please read the information carefully before beginning any test or repair. If you lack the skills and tools or a suitable workplace, we suggest you leave service and repair of the fuel injection system to an authorized BMW dealer or other qualified repair shop. We especially urge you to consult an authorized BMW dealer before beginning any work on a car that may be subject to the manufacturer's new car warranty coverage.

1. General Description

Each of the cars covered by this manual is equipped with an electronic fuel injection system. Fuel is delivered to the engine under pressure, then metered by precise electronic control in proportion to measured air flow. Though there are some differences between the systems installed on the various models, all are supplied by Bosch—a highly respected name in automotive technology. The main components of the fuel system, the different fuel injection systems, and their identifying features are described below.

Fuel Storage

The fuel tank is located beneath the car under the rear seat. Most 1984 through 1987 models have a fuel tank capacity of 55 liters (14.5 gallons). On a few early 1984 318i models, the tank was slightly larger. For 1988 through 1990 models, the fuel tank was enlarged to 63 liters (16.6 gallons). Mounted with the fuel tank are the fuel gauge sending unit, a fuel pump, connecting lines for the evaporative emission control system, and a fuel supply and return line.

Fuel Pump and Fuel Supply

On 1984 through 1987 models, an electric transfer pump supplies fuel at low pressure to the main fuel pump. The transfer pump is mounted in the fuel tank along with the fuel gauge sending unit. The main fuel pump delivers fuel at high pressure to the fuel injection system. It is mounted beneath the car near the driver's side rear tire.

On 1988 through 1990 models there is only a main fuel pump. It is mounted in the fuel tank together with the fuel gauge sending unit.

A pressure regulator mounted in the engine compartment maintains constant fuel pressure to the fuel injection system and allows surplus fuel to flow back to the fuel tank.

Air Filter

A rectangular, dry-type pleated paper air filter element is installed on the cars covered by this manual. The filter element is mounted in a silencer housing that quiets the air entering the fuel injection system's air flow sensor.

1.1 L-Jetronic Fuel Injection

The Bosch L-Jetronic fuel injection system is electronically controlled. Sensors supply information about air flow, engine temperature, and other operating conditions to the central electronic control unit. This information is used to electrically operate the solenoid-type fuel injectors. Fuel is metered to the engine, according to demand, by controlling the amount of time that the injectors are open. All functions and adjustments for varying operating conditions are controlled electronically by the control unit based on inputs from the engine's sensors.

For more detailed information on the L-Jetronic fuel injection system, see **5. L-Jetronic Fuel Injection**.

1.2 Motronic Engine Management System

The Bosch Motronic system combines the basic L-Jetronic fuel injection system with the additional electronic control of ignition timing and idle speed. This system, which monitors and adjusts these three factors, is much more than a fuel injection system, hence the term Engine Management System.

A second generation Motronic system, Motronic 1.1, was introduced in 1987. It is a more sophisticated version of the "basic" Motronic system, using a control unit that features adaptive control circuitry. Where the basic Motronic system compares data from its sensors to baseline values in memory and makes adjustments, Motronic 1.1 actually changes its baseline values based on how that particular car is operating. Over time, the system adapts to the conditions that are "normal" for that car. In this way, the system compensates for small changes in engine operating parameters caused, for example, by wear or by small intake air leaks.

1.3 Applications – Identifying Features

Table a lists the models covered by this manual and their corresponding fuel injection systems.

Table a. Fuel Injection System Applications

Year and model	Engine	No. of cylinders	Fuel injection system
1984–1985 318i	1.8 liter	4	L-Jetronic
1984–1987 325, 325e, 325es	2.7 liter	6	Motronic
1988 325	2.7 liter	6	Motronic 1.1
1987–1990 325i, 325is, 325iC	2.5 liter	6	Motronic 1.1

All of the 4-cylinder, 318i models are equipped with the Bosch L-Jetronic fuel injection system. The fuel injection and ignition systems are separate. Repair information for these fuel injection systems is covered under **5. L-Jetronic Fuel Injection**.

All of the 6-cylinder, 325 models are equipped with one of two versions of the Bosch Motronic engine management system: the "basic" Motronic system or the newer Motronic 1.1 system. To quickly tell the Motronic systems apart, look for a "fifth injector" or cold-start valve, mounted on the intake manifold. The Motronic 1.1 system has no such valve. See Fig. 1-1. Repair information for these models is covered under **6. Motronic Engine Management System**.

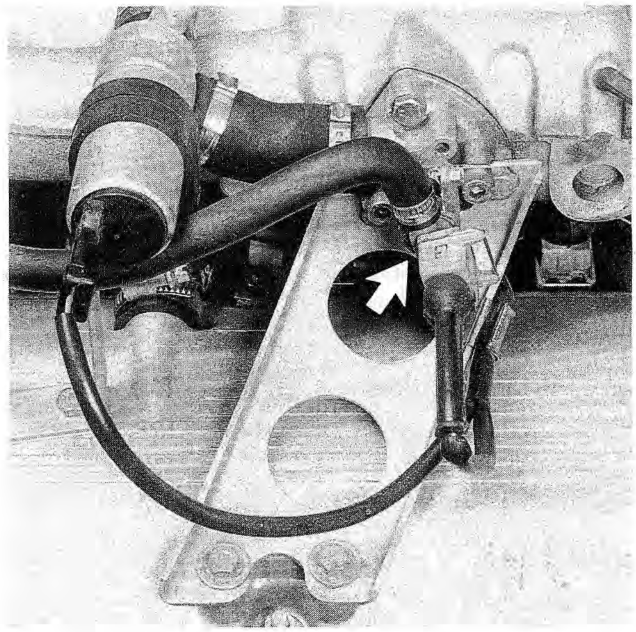

Fig. 1-1. Cold-start valve or "fifth injector" (arrow) on intake manifold distinguishes earlier Motronic system (with valve) from later Motronic 1.1 system (without valve).

Many of the testing and adjusting procedures are the same for L-Jetronic and Motronic systems. The addition of the other engine management functions to the Motronic systems, however, means that there are some differences. Unless the text clearly states otherwise, the procedures in this section apply to all systems. Read each procedure carefully to see the differences that may apply only to certain models. Similarly, all of the information in this section labeled "Motronic" applies to both Motronic systems, unless Motronic 1.1 is specifically mentioned as an exception.

2. Maintenance

BMW specifies the procedures below to be carried out at particular time or mileage intervals for proper maintenance of the fuel system. Information on these steps and the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Servicing the air filter
2. Replacing the fuel filter
3. Lubricating throttle linkage and throttle bearings.
4. Inspecting fuel hoses.

3. Troubleshooting

Poor driveability or faulty running may have a variety of causes. The fault may lie with the fuel system, the ignition system, parts of the emission control system, or a combination of the three. Because of the interrelated functions of these systems it is often difficult to know where to begin looking for problems.

For this reason, effective troubleshooting must always consider these systems as one major system. While this may seem obvious when dealing with the integrated Motronic engine management systems of the 6-cylinder engine, the same engine management principle applies to troubleshooting the L-Jetronic fuel injection and separate ignition systems of the 4-cylinder engine.

This section of the manual covers those tests, adjustments, and repairs that apply specifically to the fuel system. For troubleshooting information addressing engine management and car-running problems and their likely causes, see **ENGINE MANAGEMENT—DRIVEABILITY**.

Please observe the following cautions and warnings when performing any service or repair on the fuel system.

WARNING —

- *The fuel system is designed to retain pressure even when the ignition is off. When working with the fuel system, loosen the fuel lines very slowly to allow residual fuel pressure to dissipate gradually. Avoid spraying fuel.*
- *Fuel is highly flammable. When working around fuel, do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

CAUTION —

- *Before making any electrical tests with the ignition turned on, disable the ignition system as described in* **IGNITION SYSTEM**.
- *To prevent damage to the ignition system or the electronic fuel system components, including the control unit, always connect and disconnect wires and test equipment with the ignition off.*
- *Absolute cleanliness is essential when working with the fuel system. Even a minute particle of dirt can cause trouble if it reaches an injector. Thoroughly clean the fuel line unions before disconnecting any of the lines.*

6

- *Use only clean tools. Keep removed components clean, and sealed or covered with a clean, lint-free cloth, especially if completion of the repair is delayed.*

- *When replacing parts, install only new, clean components.*

- *Avoid nearby use of compressed air, and do not move the car while the fuel system is open.*

- *Always replace seals and O-rings.*

4. FUEL SUPPLY

While the fuel injection system controls the amount of fuel metered to the engine, the remainder of the fuel system is dedicated to storing fuel and supplying it to the injection system. See Fig. 4-1.

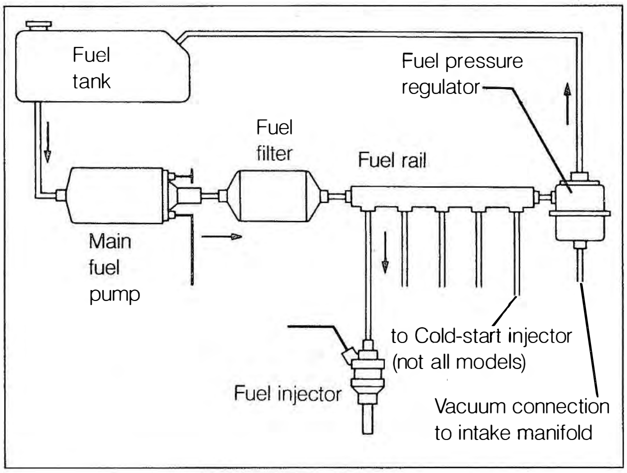

Fig. 4-1. Schematic view of L-Jetronic fuel supply system.

The main fuel pump supplies fuel to the fuel injection system and creates fuel pressure. The pressure regulator maintains system pressure. The quantity of fuel supplied exceeds demand, so excess fuel returns to the fuel tank via a return line. This constant recirculation of fuel in the system keeps the fuel cooler and helps prevent fuel starvation due to vapor lock—air bubbles created by fuel vaporizing in the lines.

The pulsation damper reduces the pressure surge when the fuel pump starts. The damper is mounted under the car in-line after the fuel filter. On some models, additional dampers are installed in the fuel lines leading to and from the fuel rail. The fuel rail distributes pressurized fuel to the injectors. In addition, the volume of fuel in the fuel rail reduces the effect of pressure surges when the injectors open and close.

On 1984 through 1987 models, the main fuel pump is mounted under the car, near the fuel tank. The main pump is supplied by a small electric transfer pump located in the fuel tank. This ensures a constant supply of fuel to the main electric fuel pump.

On 1988 and later models, the main fuel pump is mounted directly in the tank. A transfer pump is not used.

A failure of the transfer pump will not necessarily prevent the engine from running, but may cause starting problems or fuel starvation at the main pump, particularly in summer weather. If an electrical system fault interrupts power to the main fuel pump, however, the engine will not run at all.

4.1 Fuses and Relays

Both the transfer pump and the main fuel pump are electric, and operated by a fuel pump relay. On 6-cylinder engines only, an additional main relay supplies power to the Motronic control unit and the fuel pump relay. If both pumps are not running, the cause may be a faulty fuse or a faulty relay. In cold weather, water in the fuel may freeze in the pump, causing the circuit to overload and the fuse to fail. Troubleshooting of any fuel pump fault should begin with checking the fuel pump fuse (no. 11) and the fuel pump relay. On 6-cylinder models, the main relay should also be checked.

To quickly check if the fuel pump is coming on, actuate the starter while listening for the running pump.

Operating Fuel Pump For Tests

Unless the fuel pump relay receives a signal indicating that the engine is running, the fuel pumps only operate for a few seconds when the ignition is first turned on. On cars with 4-cylinder engine, the signal is the rpm signal from the ignition system. On cars with 6-cylinder engine, the signal comes from the Motronic control unit, through the main relay. In either case, to operate the pumps longer for fuel system tests without the engine running, the relay must be bypassed to power the pumps directly.

One method is to remove the relay and connect two sockets on the fuse/relay panel with a fused jumper wire. The sockets used are those corresponding to relay terminals 30 and 87 (6-cylinder models) or 30 and 87b (4-cylinder models). Fig. 4-2 shows the location of the fuel pump relay.

CAUTION
Fuse and relay locations are subject to change and may vary due to production line changes. Use care when troubleshooting the electrical system at the fuse/relay panel. To resolve problems in identifying a relay, see an authorized BMW dealer.

NOTE —

The jumper wire should be 1.5 mm (16 ga.) and include an in-line fuse holder with a 15 amp fuse. To avoid fuse/relay panel damage from repeated connecting and disconnecting, also include a toggle switch. A commercially available jumper, BMW Tool No. 61 3 050, is also available from an authorized BMW dealer.

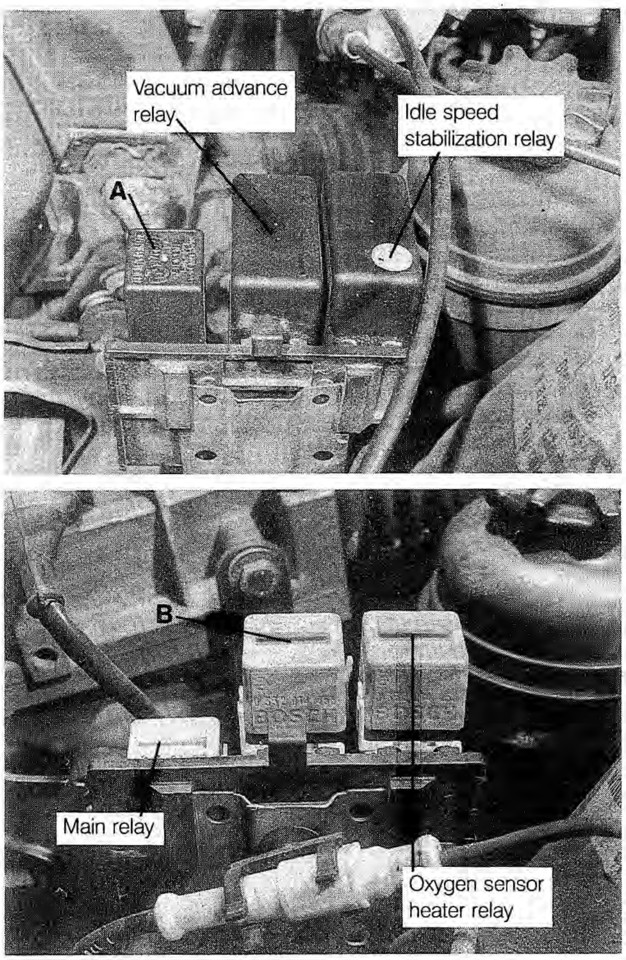

Fig. 4-2. Fuel pump relay location on 4-cylinder engine (**A**) and 6-cylinder engine (**B**).

With the ignition off and the fuel pump relay removed, use the jumper (be sure toggle switch is off) to bridge the sockets in the auxiliary relay panel. Turn on the toggle switch to operate the fuel pumps. If the pump does not run with the jumper in place of the relay, the fault could be in the fuel pump or the electrical wiring to the fuel pump. For more fuel pump electrical testing, see **4.2 Transfer Pump** or **4.3 Fuel Pump**.

4.2 Transfer Pump

(1984 through 1987 models only)

The transfer pump is mounted in the fuel tank together with the fuel gauge sender. The pump is cooled and lubricated by fuel and may therefore be damaged if allowed to run dry or if the fuel pickup strainer becomes blocked. Access to the transfer pump is from the top of the fuel tank, reached by removing the rear seat bottom.

WARNING —

When removing the transfer pump and fuel gauge sending unit, the fuel tank level must be below 3/4 full. If higher, fuel will be spilled when the transfer pump is removed.

To test:

1. Remove the three mounting screws to remove the transfer pump and fuel sender gauge access cover.

2. Operate the fuel pump relay using a jumper wire as described in **4.1 Fuses and Relays**. You should hear the transfer pump running. Disconnect the jumper when finished.

NOTE —

If the transfer pump does not run, disconnect the transfer pump harness connector, as shown in Fig. 4-3. Operate the pump and check for voltage across the connector terminals. If there is voltage, the transfer pump is probably faulty and should be replaced. If there is no voltage, trace the wiring and check for breaks or shorts to ground.

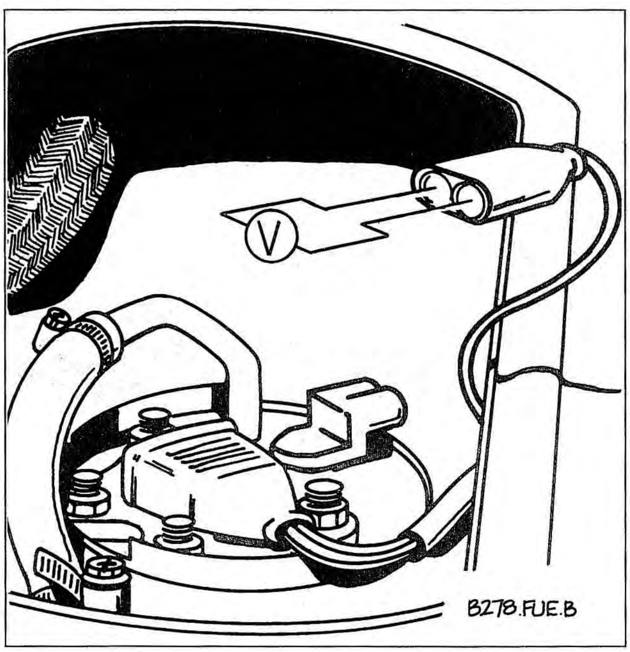

Fig. 4-3. Schematic view of voltage supply to transfer pump being checked at harness connector.

3. Next, check transfer pump fuel delivery pressure. Remove the fuel filler cap. Remove and plug the transfer pump output hose. See Fig. 4-4.

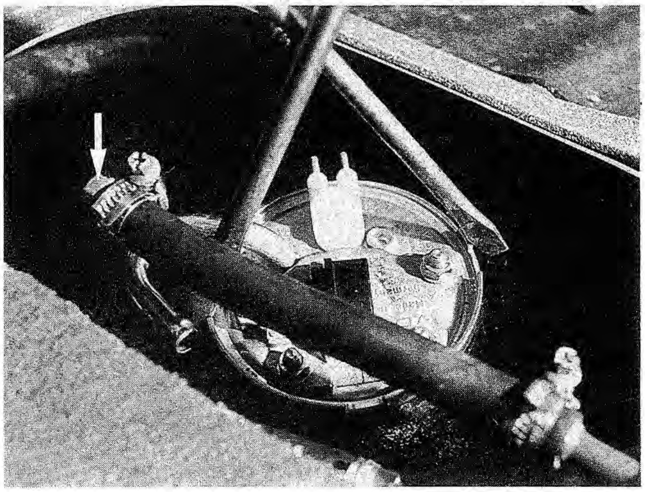

Fig. 4-4. Transfer pump output hose disconnected and plugged (arrow).

4. Connect a fuel pressure gauge to the output fitting of the transfer pump. See Fig. 4-5. Make sure all electrical connectors are connected.

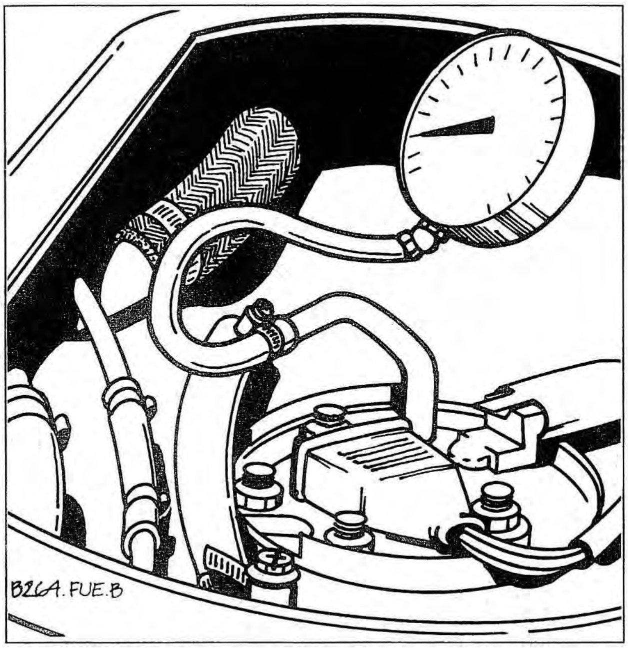

Fig. 4-5. Transfer pump fuel pressure being measured with fuel pressure gauge.

5. Operate the fuel pumps using the jumper wire. At approximately 68°F (20°C), the pump should produce a pressure of at least 0.3 bar (4.3 psi).

6. If the pressure is low, check the pump's power consumption using an ammeter. See Fig. 4-6. Operate the fuel pump as described above. With the pump running, the current draw should be no more than 1.4 amps.

NOTE —
To achieve accurate test results, the battery voltage at the connector must be between 12 and 13 volts. Charge the battery if necessary. If the battery voltage is too high, turn on the headlights until the correct voltage is obtained.

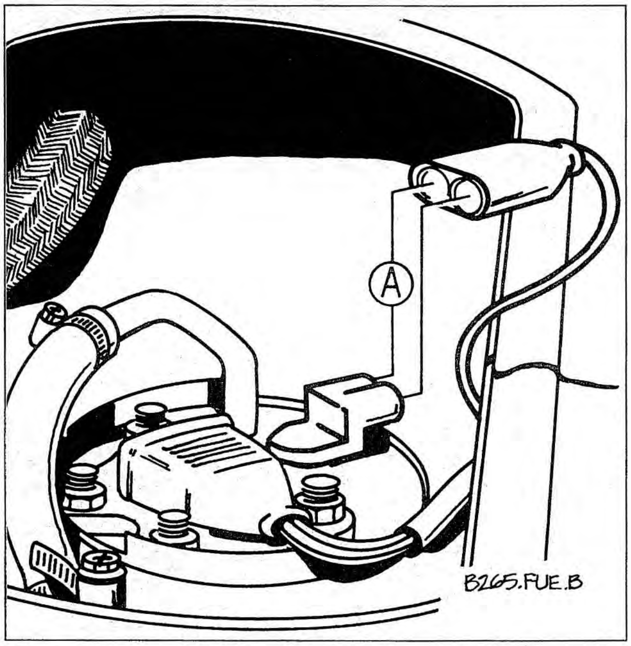

Fig. 4-6. Transfer pump power consumption being tested. Connect ammeter between one connector terminal and its corresponding terminal on pump. Jumper other terminal using a length of wire.

7. If the current is too high, remove the transfer pump as described below and inspect the pickup strainer/filter for blockage. Retest the fuel pressure. If still too low, the transfer pump is faulty and should be replaced.

To remove and install:

1. Disconnect the negative (–) battery cable.

> *CAUTION —*
> *BMW anti-theft radios can be rendered useless by disconnecting the battery. See your owner's manual for more information.*

2. Remove the access cover and the harness connectors as described above.

3. Remove the fuel hoses and discard the hose clamps.

> *WARNING —*
> *Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

4. Remove the four mounting nuts from the top of the fuel gauge sending unit. Slowly remove the sending unit from the tank, allowing fuel to drain off.

5. Loosen the transfer pump and fuel gauge sending unit assembly by turning it counterclockwise. See Fig. 4-7. Remove the assembly from the fuel tank. Discard the O-ring.

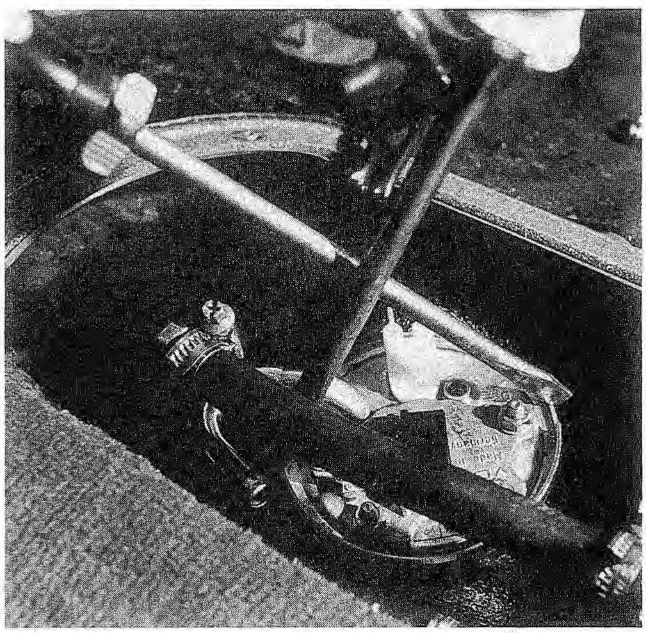

Fig. 4-7. Transfer pump and fuel gauge sending unit being removed from fuel tank. Use two screwdrivers to engage lugs on housing.

6. Inspect and, if necessary, clean the strainer/filter. See Fig. 4-8.

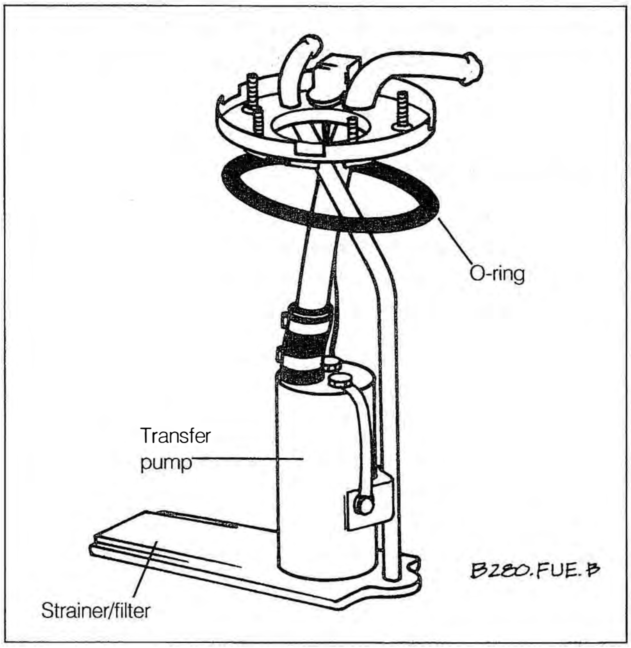

Fig. 4-8. Transfer pump, shown with fuel gauge sending unit removed from assembly.

7. Lubricate the new O-ring with a small amount of fuel, then place the assembly with the O-ring into the tank and tighten in a clockwise direction until snug. Install the fuel gauge sending unit and tighten the mounting nuts.

8. Using new hose clamps, connect the fuel hoses. Reconnect the harness connectors. Run the fuel pump as described under **4.1 Fuses and Relays** and check for leaks. Install the access cover and its mounting screws. Install the rear seat bottom and reconnect the negative (–) battery cable.

4.3 Fuel pump

The main fuel pump is mounted in different locations, depending on model year. On 1984 through 1987 models, the fuel pump is mounted beneath the car near the driver's side rear wheel. On all 1988 and later models, the fuel pump is mounted directly in the tank. The pump is cooled and lubricated by fuel and therefore may be damaged if allowed to run dry. During starting, the pump runs as long as the ignition switch is in the start position and continues to run once the engine starts. Fuel pressure and rate of fuel delivery are the important fuel-pump performance measurements.

The procedure for checking fuel pump delivery rate appears below. To test fuel pump pressure, see the heading covering pressure tests under **5. L-Jetronic Fuel Injection** or **6. Motronic Engine Management System**. On 1984 through 1987 models, the transfer pump must be operating correctly as described above in **4.2 Transfer Pump** before testing the main fuel pump.

To test fuel delivery rate:

1. Disconnect the fuel return hose from the pressure regulator. Connect a length of fuel hose to the fuel pressure regulator and place its open end into a container of at least 2000 ml (1.89 qt.). See Fig. 4-9.

WARNING —
Fuel will be discharged. Do not disconnect wires that could cause sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

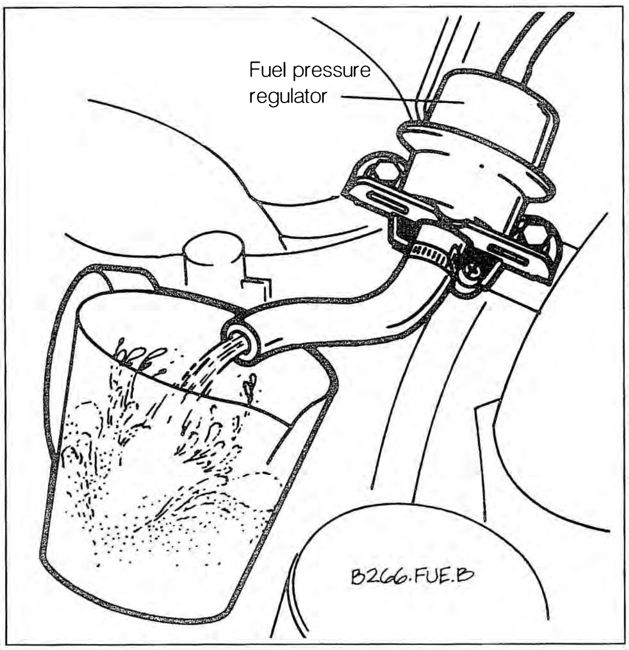

Fig. 4-9. Container being used to measure fuel delivery rate at output side of pressure regulator. Pressure regulator is mounted at end of fuel rail in engine compartment.

2. Run the fuel pump as described in **4.1 Fuses and Relays** for exactly 30 seconds. The pump should deliver the quantity of fuel shown in **Table b.**

Table b. Fuel Pump Delivery Specifications

Model year	Minimum delivery rate in 30 seconds
All	875 ml (30 oz.)

If the fuel pump does not run, make the fuel pump electrical tests as described below. If fuel delivery is below specification, check the power consumption of the fuel pump as described below. If the pump's current draw is within limits, check for leaks, blocked or kinked fuel lines, a blocked filter, or a blocked transfer pump strainer/filter. If no such faults are found, the fuel pump is probably faulty. For more information on the fuel filter, see **LUBRICATION AND MAINTENANCE**.

Fuel Pump Electrical Tests

These tests are for use in finding out why the main fuel pump does not run or why the fuel delivery rate is below specifications. The tests check the fuel pump relay, power to the fuel pump, and fuel pump current draw.

The relay is actually a part of two separate circuits. One circuit powers the fuel pump—the relay acts as a switch to turn the pump on and off. The other circuit is the one that energizes the relay with power. Fig. 4-10 and Fig. 4-11 are schematic representations of the fuel pump relays and circuits installed on the 4-cylinder and 6-cylinder engines covered by this manual.

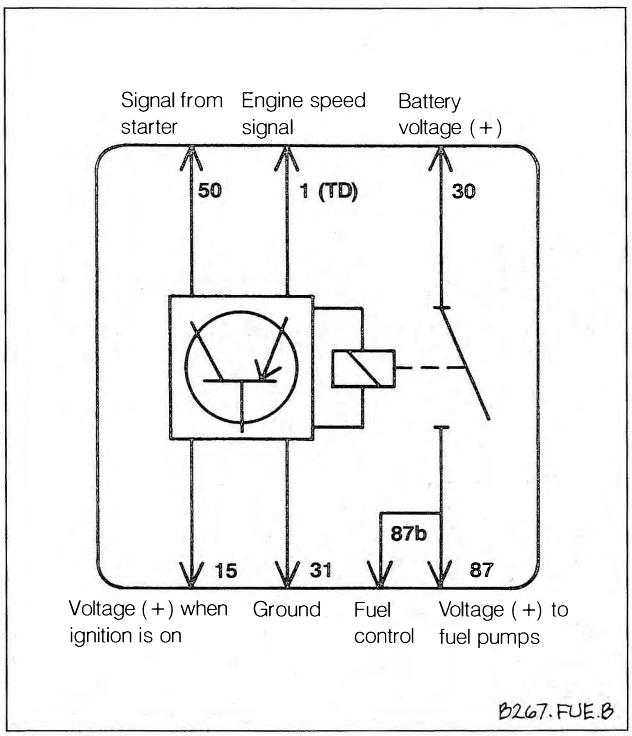

Fig. 4-10. Schematic view of fuel pump relay and circuits on models with 4-cylinder engine.

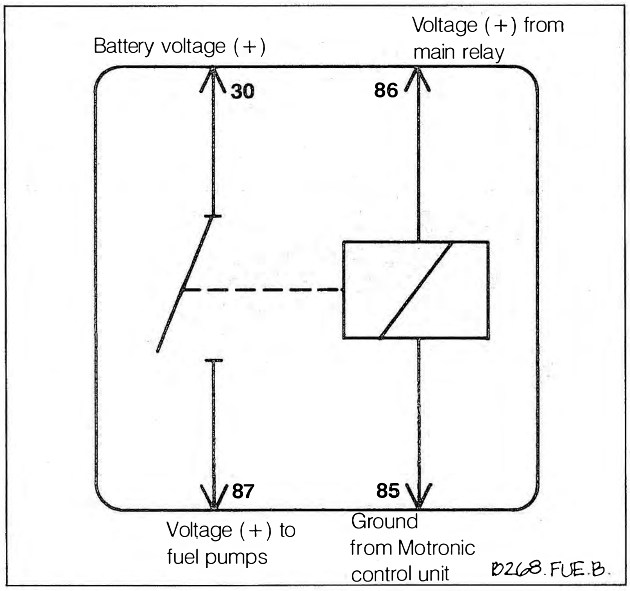

Fig. 4-11. Schematic view of fuel pump relay and circuits installed on models with 6-cylinder engine.

The first step in troubleshooting the fuel pump circuit is to check the fuel pump fuse (no. 11). Replace a failed fuse and test the fuel pump again. If the fuel pump fuse is good, test the fuel pump circuit as described below.

CAUTION —

Fuse and relay locations are subject to change and may vary due to production line changes. Use care when troubleshooting the electrical system at the fuse/relay panel. To resolve problems in identifying a relay, see an authorized BMW dealer.

To test fuel pump circuit:

1. Remove the fuel pump relay. See Fig. 4-12. Identify the relay terminal numbers on the bottom of the relay.

CAUTION —

The fuel pump relay may be located in an adjacent position. To check if the fuel pump relay has been correctly identified, inspect the wires leading to the fuel pump relay socket. On 4-cylinder engines, there should be a large (4 mm) wire at the relay socket. On 6-cylinder engines, the fuel pump relay socket should contain four wires having the following colors; red, red/white, green/violet, and brown/green.

NOTE —

If voltage is not present between socket 30 and ground, power is not reaching the fuel pump relay from the battery. Check the red wire between the battery or battery junction block and the relay socket.

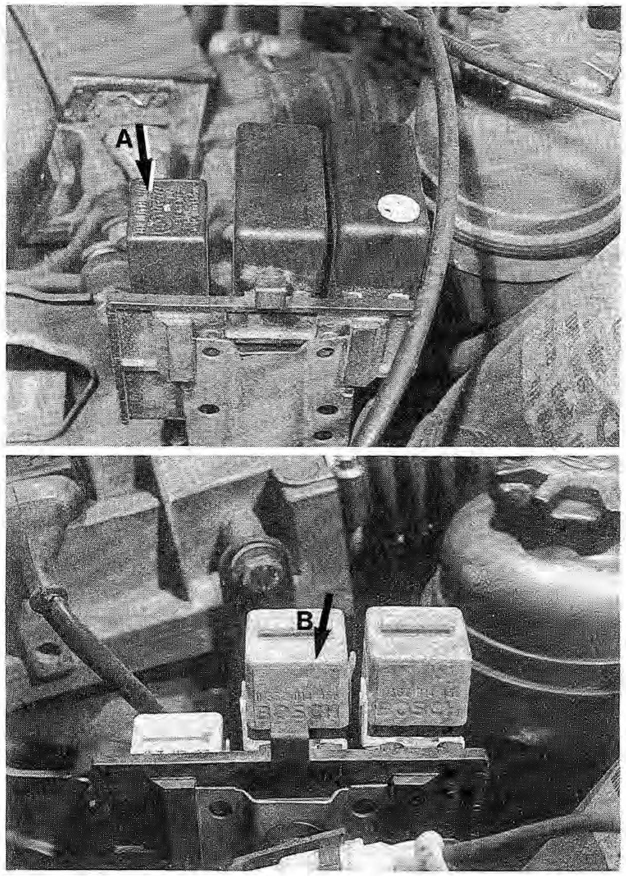

Fig. 4-12. Fuel pump relay location on 4-cylinder engines (**A**) and 6-cylinder engines (**B**).

2. Use a test light or voltmeter to check for voltage between the socket corresponding to relay terminal 30(+) and ground. There should be approximately battery voltage.

NOTE —

On 6-cylinder models with trunk-mounted batteries, check for a faulty fusible link. If no voltage is present at the red 1.5 mm or the 4.0 mm wires on the junction block, inspect the fusible link. The 50-amp link is approximately 6 inches from the battery in the 6 mm black wire. Disconnect negative battery terminal. Carefully slice the harness covering open to check the link. A faulty link must be replaced with BMW Part No. 12 41 1 706 111.

3. On models with 4-cylinder engine, turn the ignition on and check for voltage between the socket corresponding to relay terminal 15 and ground. There should be approximately battery voltage. Turn the ignition off. Check for continuity between the socket corresponding to relay terminal 31 and ground (a clean, unpainted metal part of the car).

NOTE —
If voltage is not present at socket 15, power is not reaching the relay from the ignition switch. If there is no continuity to ground at socket 31, check the brown wire leading to the ground point at the rear of the engine. See **ELECTRICAL SYSTEM** for more information on locating electrical faults.

4. On models with 6-cylinder engine, with the ignition off, connect an LED test light or a digital voltmeter between the sockets corresponding to relay terminals 85 (−) and 86 (+). Briefly operate the starter and check for voltage. There should be approximately battery voltage.

NOTE —
If voltage is not present between sockets 85 and 86, power is not reaching the fuel pump relay from the main relay or the ground signal from the Motronic control unit is not present. Test the main relay and the Motronic control unit as described under **6. Motronic Engine Management System**.

5. On models with 4-cylinder engine, connect an LED test light or a voltmeter and between relay terminal 50 and ground. While briefly operating the starter, check that there is approximately battery voltage.

NOTE —
If voltage is not present, check the black/yellow wire coming from the starter and repair any faults found.

If no faults are found after these tests, and the fuel pump will run only with the jumper connected, as described in **4.1 Fuses and Relays**, then the relay itself is faulty.

If the pump still will not run with the jumper connected, check to see whether voltage is reaching the fuel pump. On externally mounted pumps, pull back the two rubber boots that protect the fuel pump electrical connectors. On in-tank mounted fuel pumps, remove the rear seat bottom and disconnect the oval two-pin connector from the pump.

With the relay removed and the jumper wire connected, check for voltage between the fuel pump connectors as shown in Fig. 4-13. If there is voltage and the connectors are not loose or corroded, then the fuel pump is faulty. Replace a faulty fuel pump. If there is no voltage, look for a faulty wire or connection between the fuel pump relay and the fuel pump connector.

WARNING —
The ignition must be off when disconnecting or connecting electrical connections. Sparks may ignite spilled fuel. Keep an approved fire extinguisher handy.

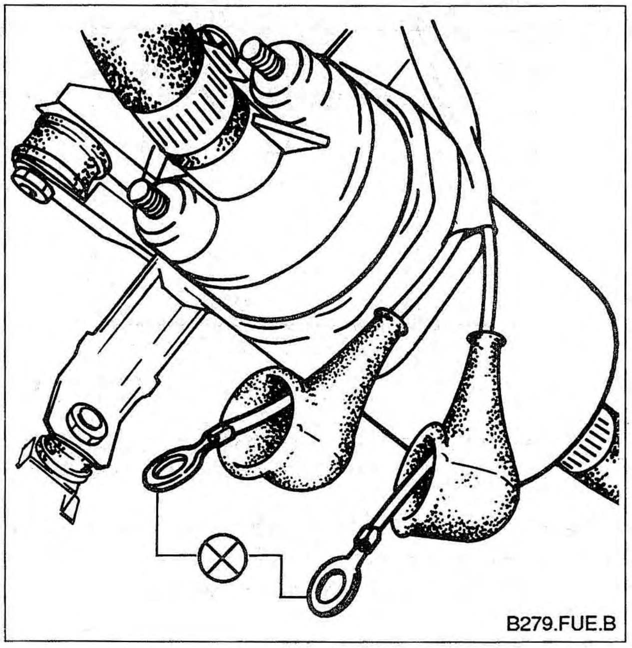

Fig. 4-13. Voltage supply to fuel pump being checked with test light (shown schematically). Externally mounted fuel pump shown.

To test fuel pump current draw:

1. On models with external fuel pumps, pull back the two protective rubber boots from the pump's connectors. Remove the nut and disconnect the green/violet wire from the fuel pump.

2. On 1988 and later models with in-tank fuel pumps, disconnect the two-pin connector from the fuel pump.

NOTE —
On 1988 and later models, remove the rear seat bottom and remove the larger (right side) inspection cover to gain access to the main fuel pump.

3. Connect an ammeter between one of the disconnected wires or connector sockets and one of the fuel pump's terminals. Connect the other socket and terminal using a jumper wire. See Fig. 4-14.

4. Use a jumper wire to bypass the fuel pump relay as described in **4.1 Fuses and Relays**.

5. Compare the ammeter reading with the specification listed in **Table c**.

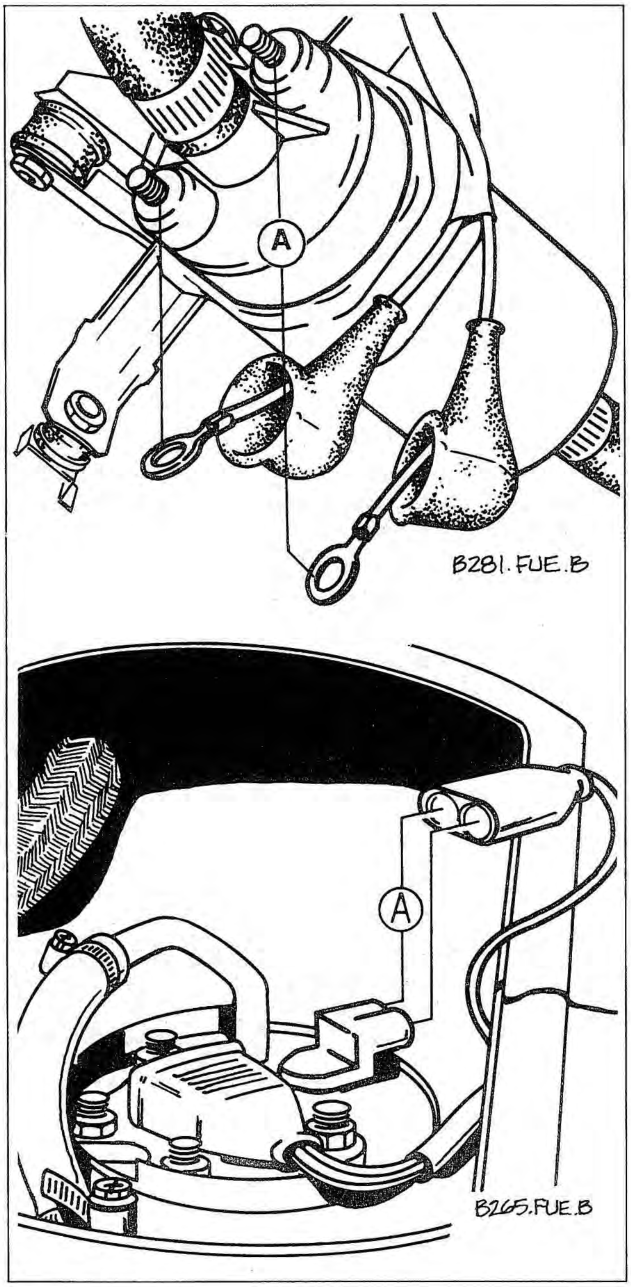

Fig. 4-14. Schematic view of ammeter connected between fuel pump connector and fuel pump on externally mounted fuel pump (top) and in-tank mounted fuel pump (bottom).

Table c. Fuel Pump Current Specifications

Model year	Fuel pump code number	Maximum current consumption
1984–1985	0 580 464 013	6.5 amps
1986–1987	0 580 464 032	5.0 amps
1988–1990	644 29 20	7.0 amps

A higher than normal power consumption usually indicates a worn fuel pump, which may cause intermittent fuel starvation due to pump overheating and seizure. The only remedy is pump replacement.

Replacing Fuel Pump

On models with under-car mounted fuel pumps, a large container for catching fuel and a clamping device to pinch off the hose from the fuel tank are the only special tools needed to replace the fuel pump. On models with in-tank fuel pumps, no special tools are necessary.

NOTE —
Make sure that the Bosch code number on the replacement pump matches the code number on the old pump. See **Table c** for more information.

To replace fuel pump:
(1984 through 1987 models)

1. Disconnect the negative (–) battery cable.

2. Working beneath the car, pull back the two rubber boots that protect the pump's electrical connectors. Remove the two nuts and disconnect the wires from the pump. Thoroughly clean the fuel line unions.

3. Temporarily pinch shut the inlet hose that comes from the transfer pump. See Fig. 4-15. Place a large container beneath the fuel pump for catching fuel.

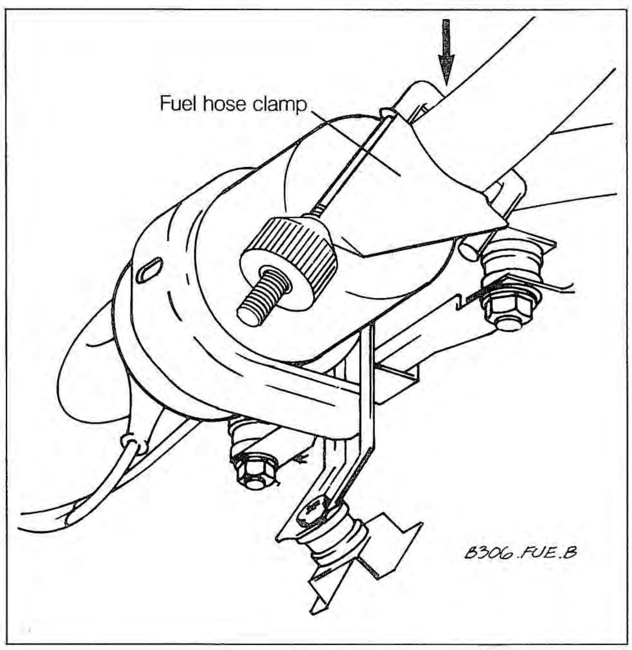

Fig. 4-15. Fuel pump inlet hose being pinched shut (arrow) with special clamp.

4. Loosen the supply line and output line hose clamps. Remove the fuel lines from the pump.

WARNING —

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

5. Remove the bracket clamping nut and bolts and remove the pump and bracket from the car. See Fig. 4-16. Unbolt the pump from the bracket.

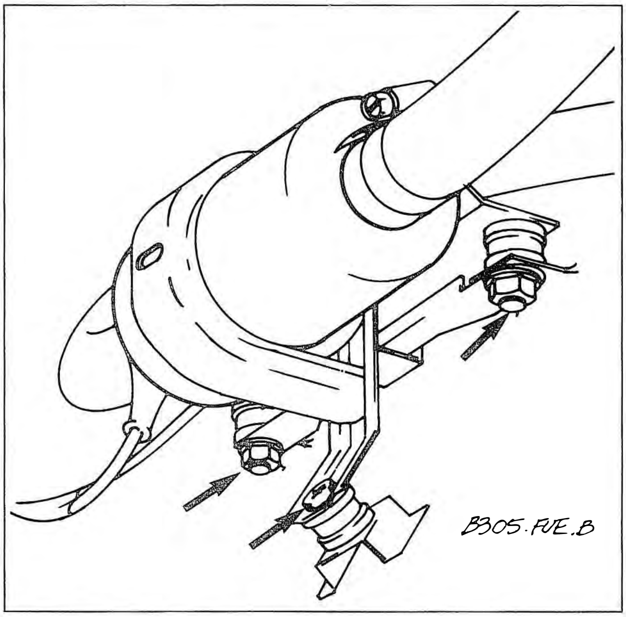

Fig. 4-16. Fuel pump bracket mounting points (arrows).

6. Place the new pump in the mounting bracket and install and tighten the mounting bolt.

7. Reconnect the fuel lines and tighten the hose clamps. Reconnect the electrical wires and tighten the nuts. Reposition the rubber boots over the connectors.

8. Reconnect the negative (–) battery cable. Be sure to run the engine and check for leaks.

To replace fuel pump: (1988 through 1990 models)

1. Disconnect the negative (–) battery cable.

2. Remove the rear seat bottom. Remove the mounting bolts from the access cover and remove the cover. Disconnect the harness connectors.

3. Loosen the hose clamp and remove the fuel hose.

WARNING —

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

4. Remove the four mounting nuts from the top of the fuel gauge sending unit. Slowly pull out the sending unit from the tank, allowing fuel to drain off.

5. Loosen the fuel pump assembly by turning it counterclockwise. See Fig. 4-17. Remove the assembly from the fuel tank. Discard the O-ring.

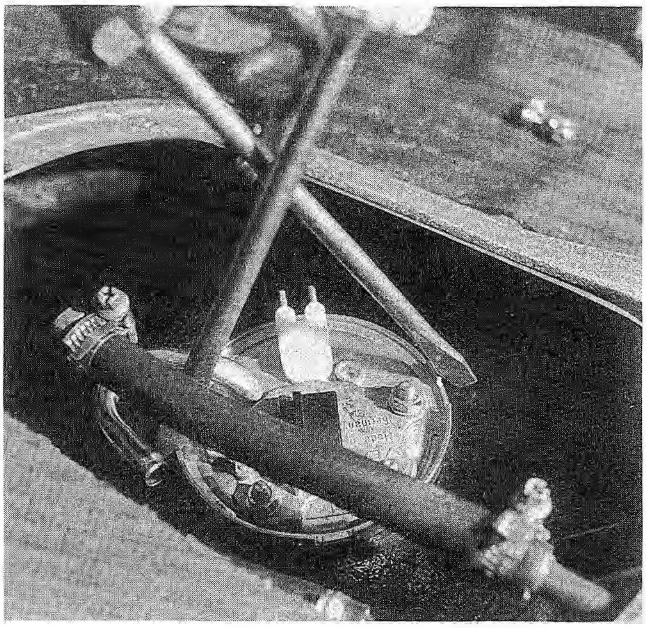

Fig. 4-17. Main fuel pump and fuel gauge sending unit being removed from fuel tank. Use two screwdrivers to engage lugs on housing.

6. Inspect and, if necessary, clean the strainer/filter. See Fig. 4-18.

7. Lightly lubricate a new O-ring with fuel, then place the assembly with the O-ring into the tank and tighten the assembly in a clockwise direction until snug. Install the fuel gauge sending unit and tighten the mounting nuts.

8. Connect the fuel hose and tighten the clamp. Reconnect the harness connectors. Operate the fuel pump as described under **4.1 Fuses and Relays** and check for leaks.

9. Install the access cover and its mounting screws. Install the rear seat bottom and reconnect the negative (–) battery cable.

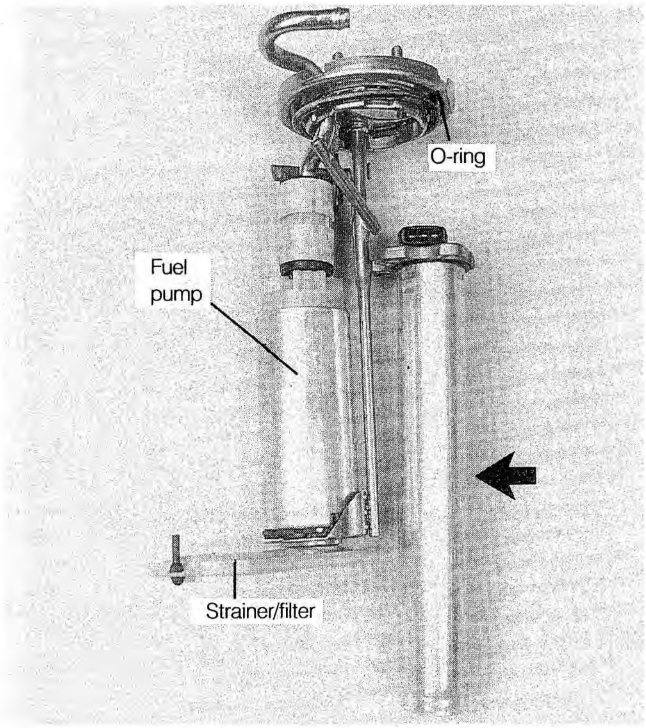

Fig. 4-18. Fuel pump assembly. Fuel gauge sending unit shown removed from assembly (arrow).

4.4 Fuel Pressure Regulator

The pressure regulator regulates fuel pressure in the fuel system. It is a diaphragm-type regulator, which means that when fuel pressure reaches a certain point a diaphragm deflects to open a valve. See Fig. 4-19. This recirculates excess fuel back to the fuel tank and maintains the desired pressure.

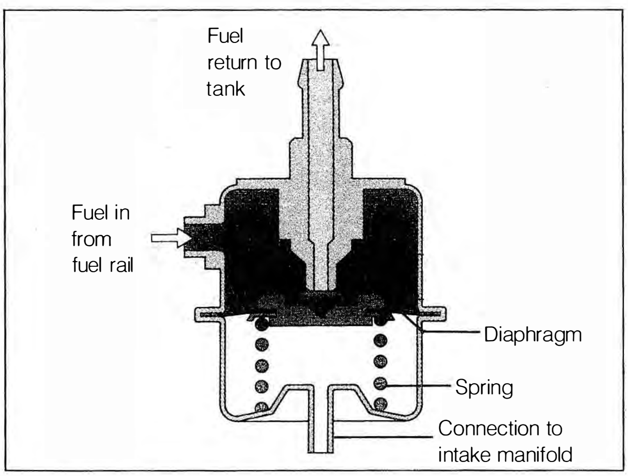

Fig. 4-19. Schematic view of fuel pressure regulator. Fuel pressure deflects diaphragm to return fuel to tank. Amount of fuel return determines pressure.

A vacuum connection to the intake manifold ensures that the difference between fuel pressure and manifold pressure is constant. Manifold pressure changes act on the regulator diaphragm to increase or decrease fuel pressure. As a result, fuel pressure does not affect fuel metering as engine load changes. The amount of injector opening time is the only factor that regulates fuel metering.

NOTE —

A cracked or leaking vacuum hose may cause an erratic idle. For more information see **5.5 Fuel Pressure Tests and Specifications** (L-Jetronic) or **6.5 Fuel Pressure Tests and Specifications** (Motronic).

The pressure regulator is mounted on the end of the fuel rail. See Fig. 4-20. Fuel flows into the fuel rail first, and then into the pressure regulator. In addition to controlling system pressure, it acts as a one-way check valve to maintain slight residual pressure in the system after the engine is turned off. The diaphragm pressure regulator is not adjustable and should be replaced if system pressure is not within the specifications listed in **5. L-Jetronic Fuel Injection** or **6. Motronic Engine Management System.**

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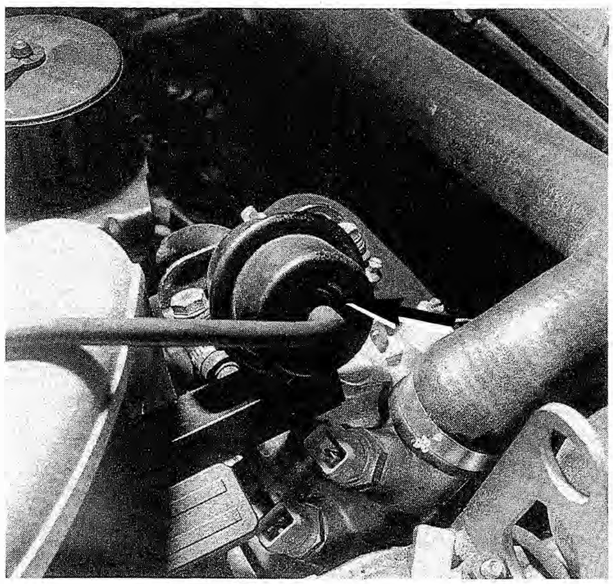

Fig. 4-20. Fuel pressure regulator (arrow). Vacuum hose connection to engine intake manifold adjusts fuel pressure based on engine load to keep difference between fuel pressure and manifold pressure constant.

4.5 Evaporative Emission Controls

The evaporative emission system provides venting for the fuel tank while at the same time preventing trapping the fuel vapors that would otherwise be vented into the atmosphere. The system collects fuel vapors from the fuel tank in a charcoal canister. During certain engine operating conditions, the vapors are then vented to the engine air intake to be burned.

The main components of the system are the charcoal canister (located in engine compartment), the bypass valve (near the charcoal canister), and an expansion tank (near the fuel tank filler neck).

The charcoal canister collects fuel vapors from the tank when the engine is idling or stopped. During normal driving, the fuel vapors are drawn into the engine. The bypass valve prevents fuel vapors from being drawn into the engine at the wrong time, such as during starting and idle. A faulty charcoal canister or bypass valve can cause hard warm engine starting or erratic idle if the fuel vapors are drawn into the engine at the wrong time.

NOTE —

Some 325i models produced in December 1986 are equipped with faulty charcoal canisters that can cause hard starting and rough idle during high ambient temperatures. Check for a white dot on top of the canister, adjacent to the production stamp. If a white dot is not present, check with an authorized BMW dealer for the VIN numbers of the affected cars. These faulty canisters have loose charcoal particles that can be drawn into the purge valve causing the valve to jam in the open position.

Testing Charcoal Canister Bypass Valve

The bypass valve is tested by trying to pass air through it to determine when it is open or closed. On all models except those with Motronic 1.1, the valve is mechanically actuated with engine vacuum. On models with Motronic 1.1, the valve is electrically operated by the Motronic control unit.

NOTE —

On 4-cylinder models, the bypass valve is mounted beneath the intake manifold and the charcoal canister is mounted below and ahead of the air flow sensor. On 6-cylinder models, the bypass valve is mounted underneath the throttle housing and the charcoal canister is mounted below the brake master cylinder.

To test the vacuum-actuated bypass valve, remove the vent lines from the valve and blow into the larger port of the valve. It should be closed and not pass any air. Apply vacuum to the small vacuum hose connection on the bypass valve. When vacuum is applied, the valve should be open and air should be able to pass through. Replace a bypass valve that fails either of these tests.

On models with Motronic 1.1, the bypass valve hose routing is slightly different. See Fig. 4-21. With the ignition off, remove the valve. Do not disconnect the harness connector. Turn the ignition on and check that the valve makes an audible click. If the valve does not click, remove the harness connector. Using a voltmeter, check for voltage between the connector terminals. With the ignition on, there should be approximately battery voltage. If there is voltage, the valve is faulty and should be replaced. If there is no voltage, then there is a either a fault in the wiring to the Motronic control unit or the control unit is faulty.

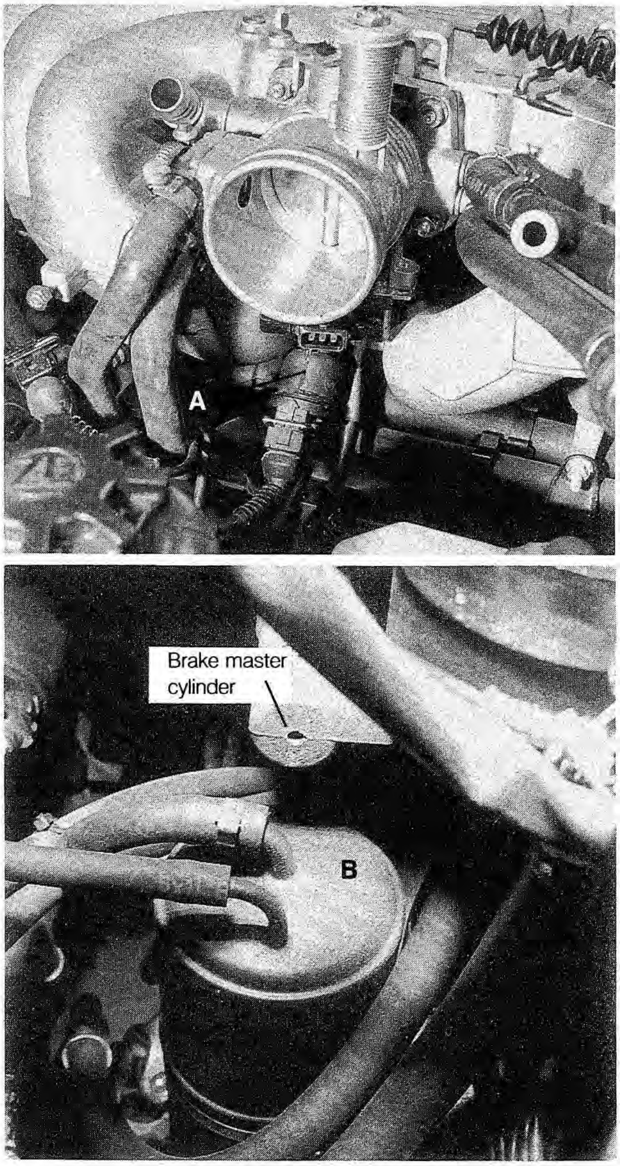

Fig. 4-21. Charcoal canister bypass valve (**A**) and charcoal canister (**B**) used with Motronic 1.1 engine management System.

4.6 Accelerator Cable

The accelerator cable links the accelerator pedal to the throttle lever on the throttle housing. Cars with automatic transmission have an additional accelerator cable, called the transmission accelerator cable. It connects the throttle lever to the transmission to make the transmission responsive to throttle position.

> ***CAUTION —***
> *The throttle plate adjusting screw is factory-set and should not be used to correct idle speed. For more information on idle speed adjustments, see the appropriate heading under* **5. L-Jetronic Fuel Injection** or **6. Motronic Engine Management System**.

> **NOTE —**
> Because the adjustment of the transmission accelerator cable affects the operation of the automatic transmission, adjustment of this cable is covered in **AUTOMATIC TRANSMISSION**.

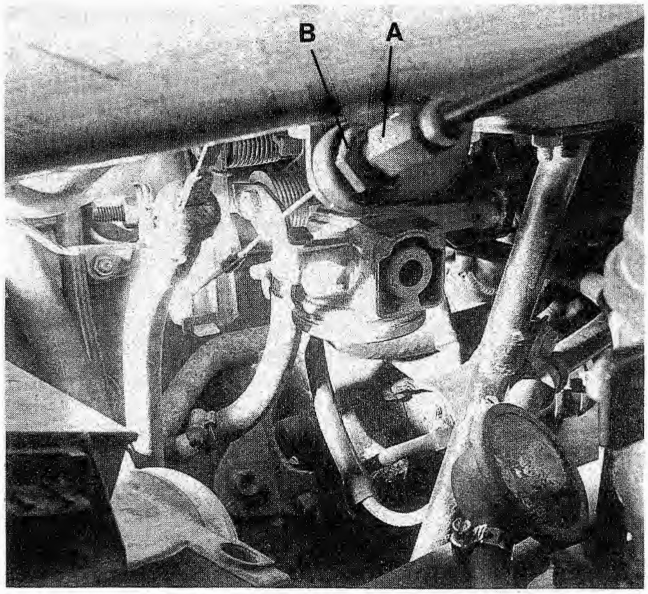

Fig. 4-23. Accelerator cable adjusting nut (**A**) on 4-cylinder engines. To adjust, hold guide nut (**B**) and turn adjusting nut.

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To adjust:

1. With the accelerator pedal in the idle or rest position, there should be approximately 1-2 mm (.04-.08 in.) of clearance between the throttle lever and the cable's adjusting sleeve. Make sure that the cable is slack by pulling lightly on the cable end. If necessary, turn the adjusting nut to obtain the correct clearance. See Fig. 4-22 or Fig. 4-23.

2. Have a helper push the accelerator pedal down until it just reaches its full-throttle position. There should be approximately 0.5 mm (.02 in.) of clearance between the full-throttle stop and the throttle lever. See Fig. 4-24. If the clearance is incorrect, adjust the accelerator pedal stop or the automatic transmission kickdown switch as described below in step 3.

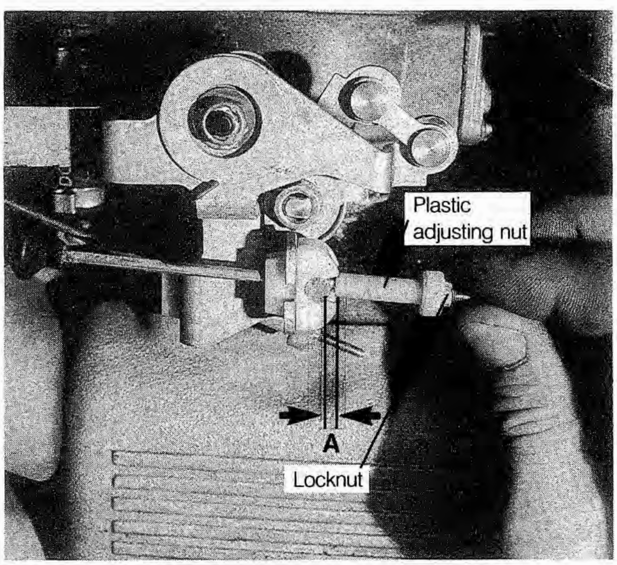

Fig. 4-22. Correct amount of slack in accelerator cable (**A**) on 6-cylinder engines. Adjust cable by turning plastic adjusting nut. On some models, it is necessary to first loosen a small locknut.

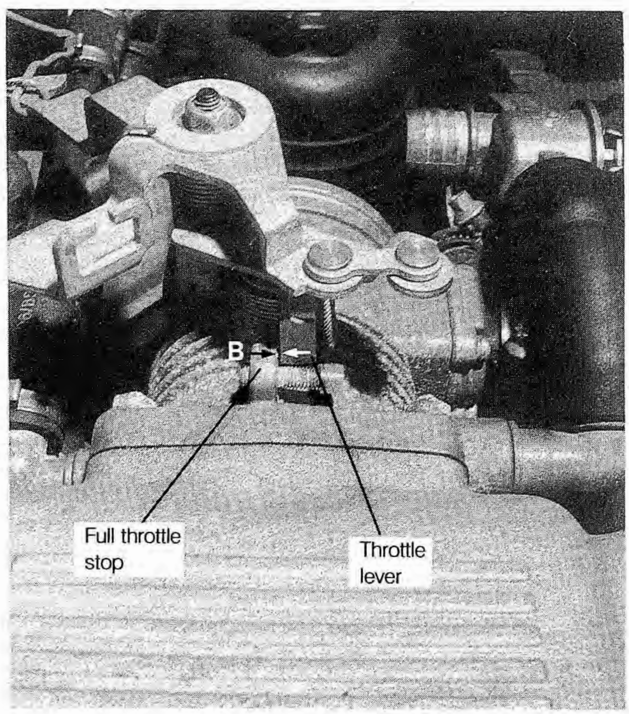

Fig. 4-24. Correct amount of clearance at full-throttle stop (dimension **B**). 6-cylinder engine shown, 4-cylinder engine similar.

3. Check the total height of the pedal stop or kickdown switch by measuring from the car floor under the carpet to the top of the stop/switch. The total height should be approximately 55 mm (2 in.) on models with manual transmission, or 60 mm (2.5 in.) on models with automatic transmission. If the height is incorrect, loosen the locknut and turn the stop/switch to correct it. See Fig. 4-25. Tighten the locknut to 9 Nm (80 in. lb.)

NOTE —
Rotating the pedal stop or kickdown switch 1 ½ turns results in a 0.5 mm (.02 in.) change at the full-throttle stop.

NOTE —
On models with electronically controlled transmissions (code letters EH), disconnect the electrical connector from the kickdown switch before rotating it. See **AUTOMATIC TRANSMISSION** for more information.

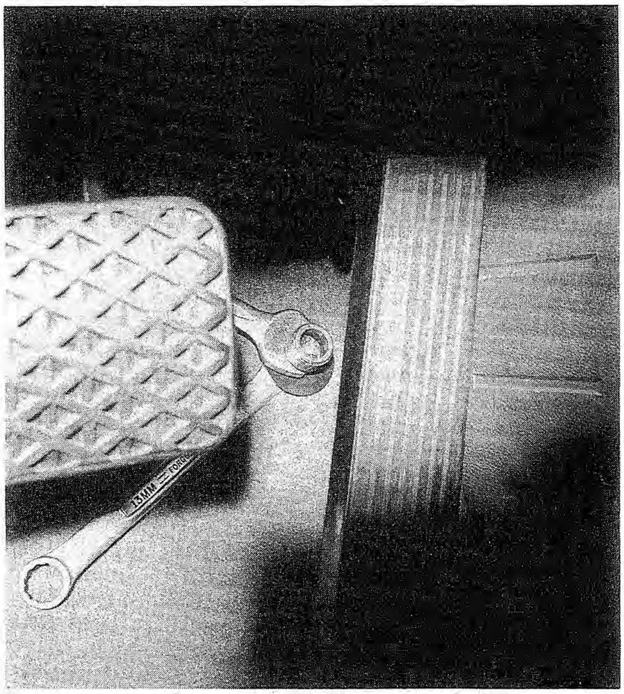

Fig. 4-25. Accelerator pedal stop locknut being loosened using two open end wrenches. Total height (measured from floor beneath carpet) should be 55 mm (2.165 in.) on automatic transmission or 60 mm (2.362 in.) on manual transmission.

4. Recheck all adjustments after adjusting the accelerator pedal stop or kickdown switch. On models with automatic transmission, check the adjustment of the transmission accelerator cable as described in **AUTOMATIC TRANSMISSION**.

To remove and install:

1. On 6-cylinder engines, pry off the plastic retaining clip from the throttle lever and remove the cable end from the lever.
2. On 4-cylinder engines, loosen the two locknuts on either side of the adjusting nut on the mounting bracket.
3. Working from inside the car, pull the cable end from its ball socket in the accelerator pedal assembly.
4. Pull the cable through the firewall from the engine compartment by compressing the two locking tabs on either side of the firewall grommet.
5. Installation is the reverse of removal. Adjust the new cable as described above. Depress the accelerator pedal several times to check for binding before driving.

4.7 Fuel Injectors

The fuel injectors installed on the models covered by this manual are electrically operated solenoid valves. They are turned on and off by signals from the control unit. Fig. 4-26 shows a typical fuel injector. The injectors are connected to a common fuel supply, called the fuel rail. See Fig. 4-27.

Fig. 4-26. Electric fuel injector. O-rings seal injector to intake manifold and fuel rail.

In each injector, the solenoid opens a needle valve to spray fuel into the intake port. The frequency at which the injectors open is synchronized to the engine's speed. The quantity of fuel delivered to the engine is determined by the amount of time the injectors remain open. The injectors are not repairable, and must be replaced if found to be faulty.

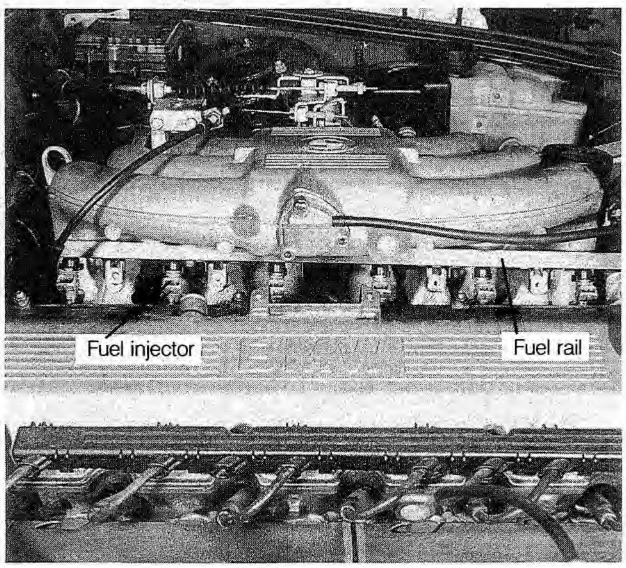

Fig. 4-27. Fuel rail is common fuel supply to injectors. Fuel rail from 325i model shown.

Faulty injectors or clogged injectors may cause rough running. Carbon deposits that form at the tips of the injectors reduce fuel flow. Clogged injectors cause erratic idle and poor performance, especially when accelerating a cold engine.

If the O-rings that seal the injectors are cracked or seated poorly, rough running may also result. Air leaking past the O-rings is not measured by the fuel injection system, and it will lean the mixture. The injectors must be removed as described below to replace the O-rings.

Testing Injectors

Injector tests include electrical checks to make sure the injectors are receiving a signal from the control unit and are opening, and flow tests to make sure that the injectors are not clogged.

Most electrical tests can be performed using a volt/ohmmeter. In addition, inexpensive LED testers that plug into the injector harness connector to check for a signal are available from many parts sources.

Flow tests require specialized equipment that opens each injector for a precise amount of time to measure the amount of fuel delivery. Most authorized BMW dealers can perform an injector balance test to locate clogged injectors. For more information on cleaning and preventing clogged injectors, see **LUBRICATION AND MAINTENANCE**.

To quickly check if an injector is electrically functioning, start the engine and place a screwdriver or a finger on the injector. A slight vibration or buzzing sound indicates that the injector is functioning.

If the injector does not vibrate, turn the engine off and disconnect the electrical connector from the suspected injector. Using an ohmmeter, check the injector's resistance. The resistance should be within the specifications listed in **Table d**. If the resistance is greater, the injector is faulty and should be replaced.

If the injector's resistance is within specifications, but the injector does not operate as described above, check for positive (+) battery voltage at the connector.

On models with 4-cylinder engine, there should be voltage between the red/white wire and ground when the starter is actuated.

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Table d. Fuel Injector Specifications

Model and date of manufacture*	Injector code no. (BMW Part No.)	Color of plug connection	Color of injector shield	Coil resistance in ohms at 68°F (20°C)
318i models built up to Dec. 1984	0 280 150 704 (1 706 058.9)	black	yellow	14.5–17.5
318i models built from Dec. 1984	0 280 150 211 (1 279 665.9)	blue	yellow	14.5–17.5
325e, 325es models built up to Sept. 1984	0 280 150 716 (1 706 414.9)	white	yellow	14.5–17.5
325, 325e, 325es models built from Sept. 1984	0 280 150 126 (1 273 271.9)	light gray	orange	2.0–3.0
325i, 325is, 325i Convertible	0 280 150 715 (1 706 162.9)	yellow/blue	yellow/yellow	14.5–17.5

*See **FUNDAMENTALS** on using Vehicle Identification Numbers (VIN) to determine date of manufacture

On models with 6-cylinder engine, there should battery voltage between the red/white wire and ground when the ignition is on. If no faults are found, check for continuity between the connector's ground wire (brown wire with colored stripe) and the control unit. If no wiring faults can be found, the control unit may be faulty. See **5.4 Electrical Tests** (L-Jetronic) or **6.4 Electrical Tests** (Motronic) for control unit terminal identification and additional electrical tests.

> ***WARNING —***
> *To prevent the engine from starting, disable the ignition system before operating the starter. On models with 4-cylinder engine, disconnect the electrical connector(s) at the ignition control unit mounted on the firewall near the fuse/relay panel.* See **IGNITION** for more information.

Removing and Installing Injectors

The fuel injectors are removed by first partially removing the complete injector/fuel rail assembly and then unclipping the injectors from the fuel rail.

To remove:

1. Disconnect the negative (–) battery cable.
2. Disconnect the electrical connectors from the injectors.
3. Remove the fuel rail mounting bolts. On models with 4-cylinder engine there are two bolts. See Fig. 4-28. On models with 6-cylinder engine, there are four fuel rail mounting bolts. See Fig. 4-29.

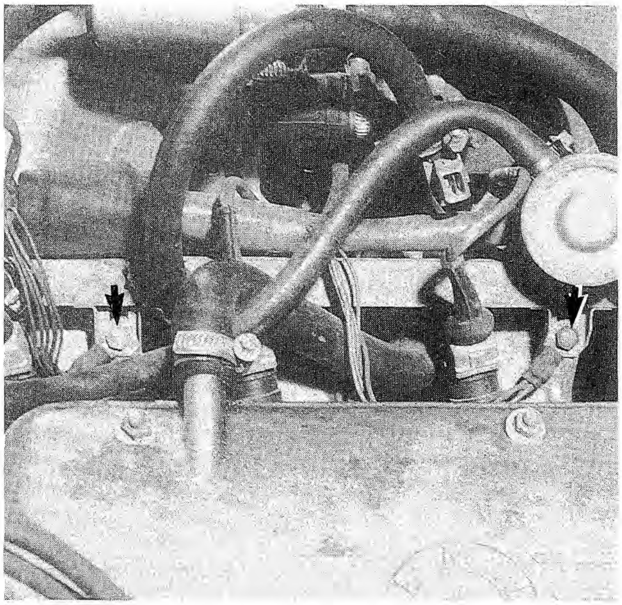

Fig. 4-28. Fuel rail mounting bolts on 4-cylinder engines (arrows).

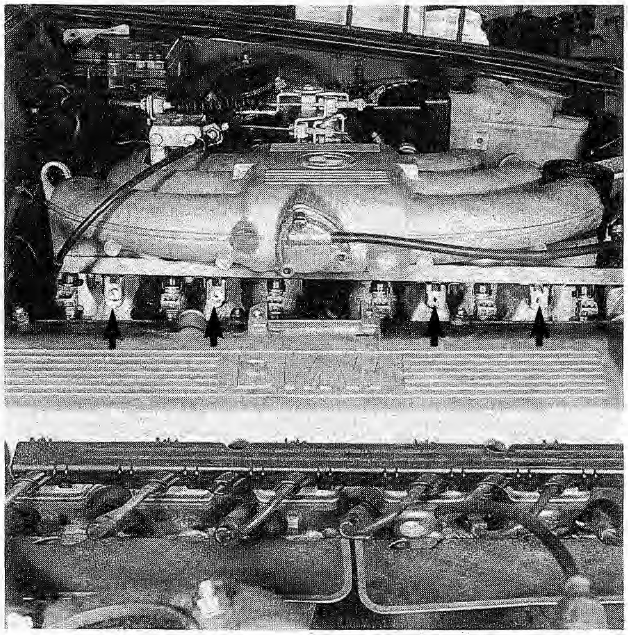

Fig. 4-29. Fuel rail mounting bolts on 6-cylinder engines (arrows).

4. Carefully pull the fuel rail assembly up and away from the cylinder head until the injectors are completely removed from the intake ports.
5. Use a small screwdriver to pry off the injector's retaining clip. See Fig. 4-30. Remove the injector from the fuel rail.

> ***WARNING —***
> *Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

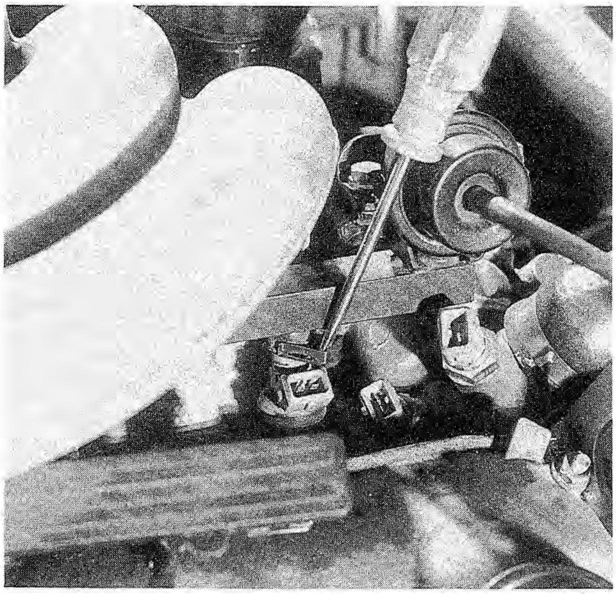

Fig. 4-30. Fuel injector mounting clip being removed.

Installation is the reverse of removal. Replace injector O-rings that are hard, cracked, or otherwise damaged. Apply a light coat of gear oil (SAE 90 weight) to the injector O-rings before installation. Be sure the injector's electrical connections are correctly fitted and that the injectors are fully seated prior to installing the fuel rail mounting bolts. Tighten the mounting bolts to 9 to 11 Nm (80 to 97 in. lb.) Reconnect the negative (–) battery cable.

5. L-JETRONIC FUEL INJECTION

Fig. 5-1 shows the main components of the L-Jetronic fuel engine injection system. The L-Jetronic system is an electronic pulsed-type fuel injection system. Fuel is metered to the engine via the fuel injectors, which are electrically pulsed on and off by the control unit.

The basic fuel metering is determined by engine rpm and by the volume and temperature of the air entering the engine. The control unit receives air flow volume and temperature data from the air flow sensor and engine rpm data from the ignition system.

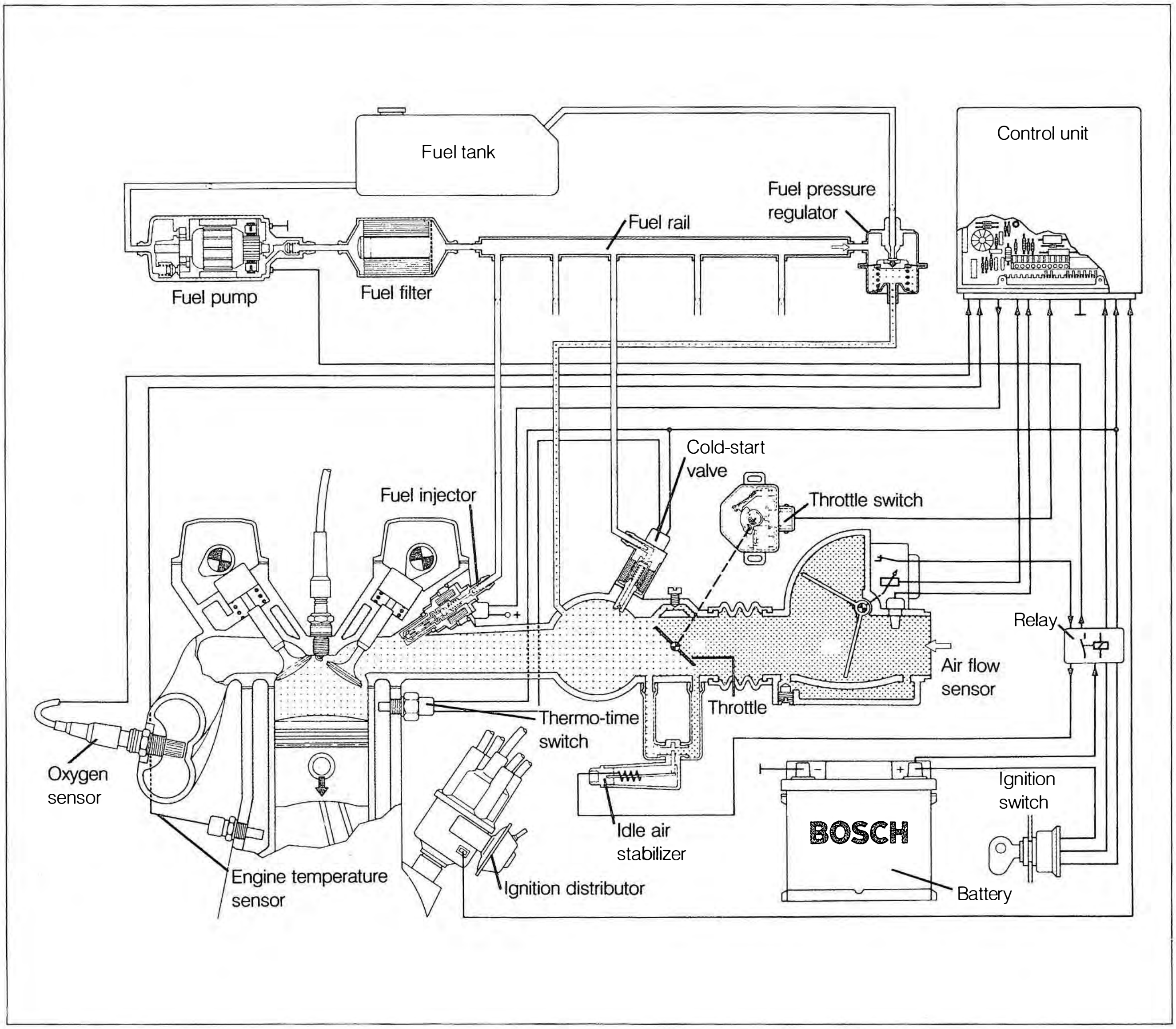

Fig. 5-1. Schematic view of L-Jetronic fuel injection system.
Art courtesy of Robert Bosch Corporation

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Four injectors, one for each cylinder, are triggered simultaneously, twice per working cycle, at a rate that is governed by engine rpm. Fuel mixture is controlled by the length of the electrical impulse from the control unit—the length of time that the injectors are open. The injectors are mounted to a common fuel supply, called the fuel rail. Fuel pressure is regulated by a fuel pressure regulator on the end of the fuel rail.

Information on fuel injectors can be found under **4.7 Fuel Injectors**. Additional information on fuel pressure regulator operation is under **4.4 Fuel Pressure Regulator**.

The control unit makes adjustments to fuel delivery by the injectors based on input from various engine sensors. The oxygen sensor system provides the control unit with information on engine combustion efficiency by measuring the amount of oxygen in the exhaust stream. Switches on the throttle housing inform the control unit when the throttle is fully open or fully closed. A coolant temperature sensor provides the control unit with engine temperature information for adjustments during starting and warmup. For information on the oxygen sensor system, see **EXHAUST SYSTEM AND EMISSION CONTROLS**.

In order for the system to operate properly, the basic adjustments to the ignition timing, idle mixture (% CO), and throttle switch must be correct. Idle speed should be checked, although it is electronically controlled and not adjustable. If these basic settings are incorrect, all other test results will be misleading. These basic settings are all related and all adjustments should be made together. See **5.3 Idle Speed** and **5.6 Idle Specifications (rpm and % CO)**.

The L-Jetronic system has been designed so that almost all electrical components can be tested using a low-current LED test light and a digital multimeter. Most of these tests can be performed right at the control-unit harness connector using a special test-harness adapter. The other major piece of test equipment required is a fuel pressure gauge. Incorrect system fuel pressure can directly affect engine performance.

CAUTION —

The ignition must be off before disconnecting or connecting any electrical connections.

5.1 Air Flow Measurement

The amount of air entering the engine is measured by the air flow sensor. As intake air is drawn past the air flow sensor flap, the spring-tensioned flap opens and in turn actuates a potentiometer inside the sensor. See Fig. 5-2. The varying resistance of the potentiometer provides a signal to the control unit that is proportional to air flow. The air flow sensor also contains an intake air temperature sensor that measures the temperature of the incoming air.

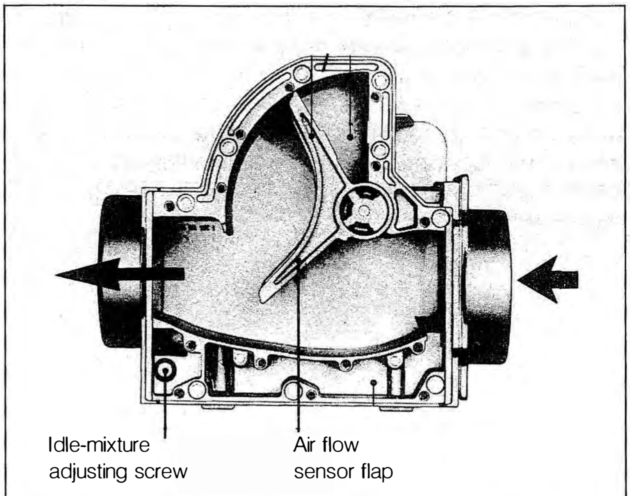

Fig. 5-2. Cutaway view of air flow sensor. Arrows indicate direction of air flow. Courtesy Robert Bosch Corp.

The throttle is operated by the accelerator pedal via the accelerator cable, and controls the amount of air drawn in by the engine. The throttle is adjusted during manufacture and does not require any routine adjustment. The throttle can be readjusted if the factory settings have been tampered with.

Air Flow Sensor

The sensor's mechanical operation depends upon the free movement of the flap inside the main air passage. To check the flap movement, loosen the clamps, remove the rubber intake air duct, and move the flap through its range of travel. See Fig. 5-3.

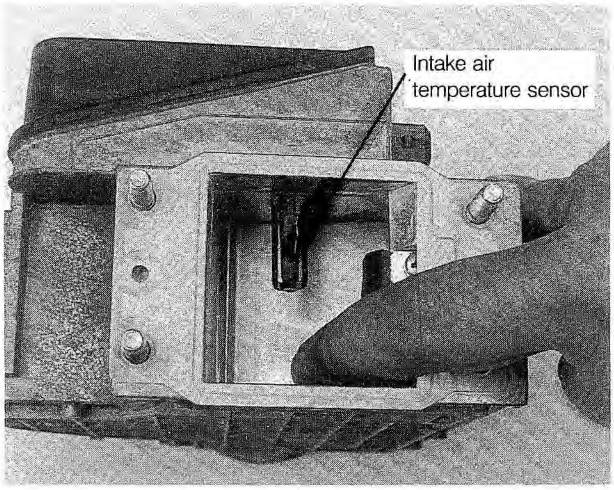

Fig. 5-3. Air flow sensor flap being checked. Move flap through entire range of travel to check for binding and smooth operation.

If the flap binds at any point, remove the intake air flow sensor, as described later under this heading, and check for any foreign material that may be interfering with the flap's movement. Check that the flap returns to the closed position smoothly. If the flap cannot be made to move freely or the flap's spring tension is uneven, the air flow sensor is faulty and should be replaced.

The sensor's electrical operation is checked by measuring resistance across the potentiometer's electrical terminals. Disconnect the harness connector from the sensor and connect an ohmmeter between terminals 7 and 8 of the sensor. See Fig. 5-4 for terminal identification. The resistance between the terminals should increase steadily without any flat spots as the sensor flap is moved to the full open position. If any faults are found, the air flow sensor is faulty and should be replaced.

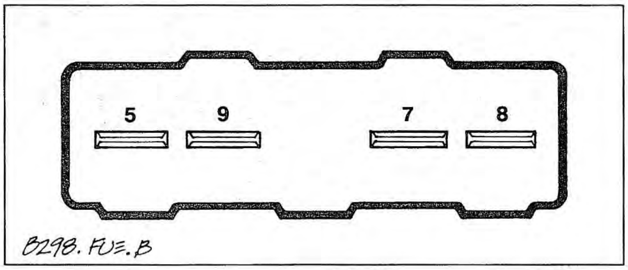

Fig. 5-4. Air flow sensor terminal identification used for testing potentiometer.

Check the intake air temperature sensor by connecting an ohmmeter between terminals 8 and 9. At approximately 68°F (20°C), the resistance should be between 2200 and 2700 ohms.

Throttle Basic Adjustment

The factory-set throttle adjusting screw is not used to adjust idle speed. Its only function is to provide a mechanical stop for the linkage to prevent damage to the throttle plate and housing. It should be adjusted only if the factory setting has been tampered with. Check for a slight clearance between the throttle housing and the throttle plate. If the clearance is incorrect, the throttle should be adjusted.

Correct a faulty throttle adjustment by removing the tamper proof cap from the adjusting screw. See Fig. 5-5. Rotate the screw counterclockwise until there is clearance between its tip and the throttle lever. There should be no clearance between the throttle plate and the inside of the housing. Rotate the screw slightly clockwise until the throttle plate is no longer contacting the housing. For a more accurate setting, use a .0015 in. feeler gauge between the throttle plate and the throttle housing. Apply paint or lacquer to the screw's threads to lock it in place and install the tamper-proof cap.

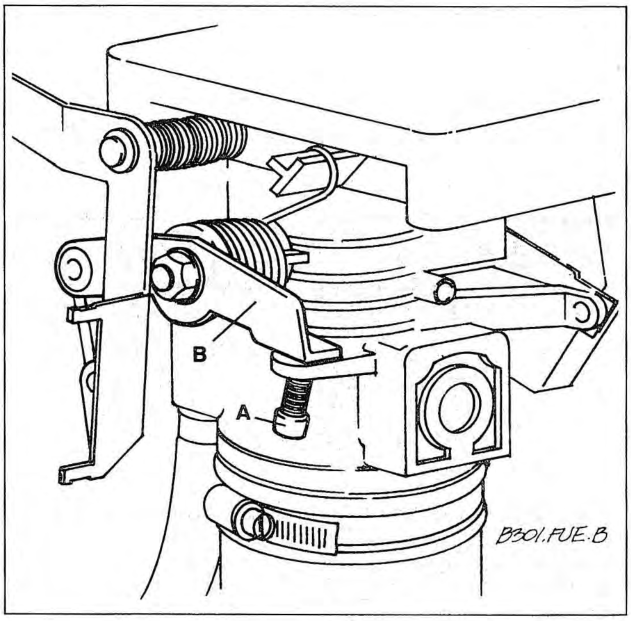

Fig. 5-5. Throttle adjusting screw with tamper-proof cap (**A**) and throttle lever (**B**).

Removing and Installing Throttle Housing

Removing the throttle housing requires that some of the engine coolant first be drained as described in **COOLING SYSTEM**.

To remove and install:

1. Remove the two air hoses from the throttle housing and the large intake air boot. Loosen the hose clamp and disconnect the air boot from the throttle housing.

2. Disconnect the cables from the throttle levers. If applicable, pry out the cruise control and accelerator cable's plastic retainers and remove the cables from the levers together with the retainers. On models with automatic transmission, disconnect the automatic transmission accelerator cable from the lever.

3. Drain approximately 2 quarts of coolant from the cooling system.

4. Loosen the hose clamps and remove the two coolant hoses from the housing.

5. Disconnect the idle air bypass hose from the rear of the throttle housing.

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6. Disconnect the harness connector from the throttle switch.

7. Remove the four mounting nuts from the housing and withdraw the housing from the intake manifold. See Fig. 5-6.

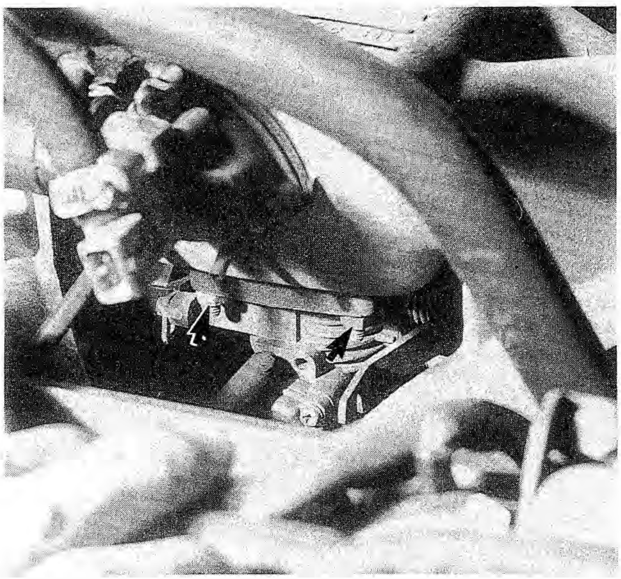

Fig. 5-6. Front throttle housing mounting nuts (arrows). Rear mounting nuts not visible.

Installation is the reverse of removal. Replace the gasket between the housing and the intake manifold. Adjust the accelerator cable as described earlier under **4.6 Accelerator Cable**. Adjust the automatic transmission accelerator cable as described in **AUTOMATIC TRANSMISSION**. Adjust the cruise control cable as described in **ELECTRICAL SYSTEM**. Refill the cooling system as described in **COOLING SYSTEM**.

5.2 Cold Start and Cold Running Enrichment

To aid in starting a cold engine, an electrically operated cold-start valve sprays extra fuel into the intake manifold for several seconds when the starter is actuated. The valve is controlled by the thermo-time switch, located in the cylinder head coolant outlet.

To ensure smooth running when the engine is cold, the L-Jetronic system provides extra fuel during warm-up. The coolant temperature sensor and the coolant temperature switch give the control unit information on engine temperature. The control unit, in turn, makes an adjustment to injector opening time to provide the necessary richer mixture.

For additional cold running driveability and fuel economy, the throttle housing is heated by engine coolant. This system helps to warm the air entering the engine in cold weather to reduce fuel condensation and improve mixture formation.

Cold-Start Valve

Below a certain engine coolant temperature, the thermo-time switch is closed, allowing power to reach the cold-start valve and open it when the starter is actuated. When the engine is warm enough, the switch is open and the valve does not operate during starting. To further limit valve operation and prevent flooding, an electric current also warms the switch and opens the circuit after a few seconds. The cold-start valve and the thermo-time switch are shown in Fig. 5-7.

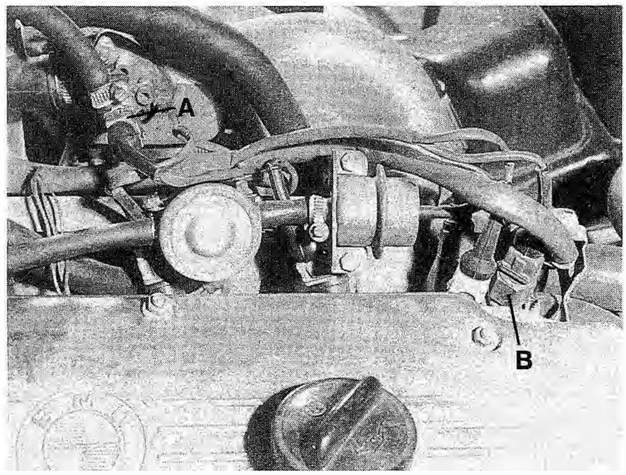

Fig. 5-7. Cold-start valve (**A**) and thermo-time switch (**B**) used to provide extra fuel for cold starting. Thermo-time switch has brown connector.

If a cold-start valve fails to inject fuel during starting, it will be difficult or impossible to start the engine. If the cold-start valve leaks or stays open too long, the engine may receive extra fuel at the wrong time and become flooded, especially if the engine is hot.

To test cold-start valve:

1. Make sure engine coolant temperature is below 86°F (30°C). Preferably the engine should sit for several hours.

2. Remove the two internal-hex head screws holding the cold-start valve to the intake manifold. See Fig. 5-8. Without disconnecting the fuel line or the harness connector, remove the cold-start valve from the intake manifold.

3. Disable the ignition system by disconnecting the electrical connector(s) from the ignition control unit on the firewall near the fuse/relay panel. See **IGNITION SYSTEM** for more information.

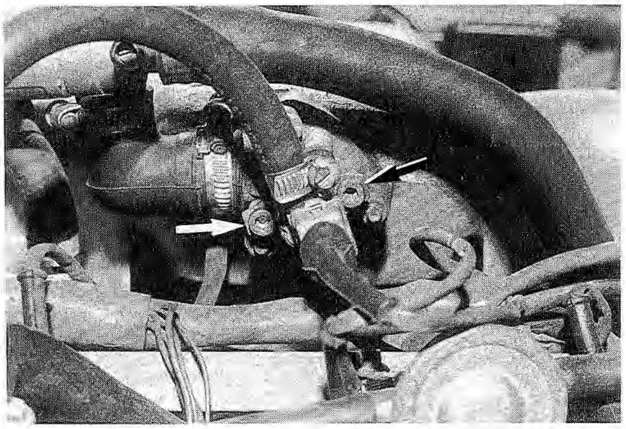

Fig. 5-8. Cold-start valve mounting screws (arrows).

4. Wipe the cold-start valve nozzle dry. Point the valve into a transparent container, and have a helper actuate the starter. See Fig. 5-9. The valve should spray in an even, cone-shaped pattern until the thermo-time switch interrupts the circuit, up to a maximum of eight seconds. An irregular spray pattern indicates a dirty or faulty cold-start valve. If the valve does not spray, test the thermo-time switch as described below.

WARNING —

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

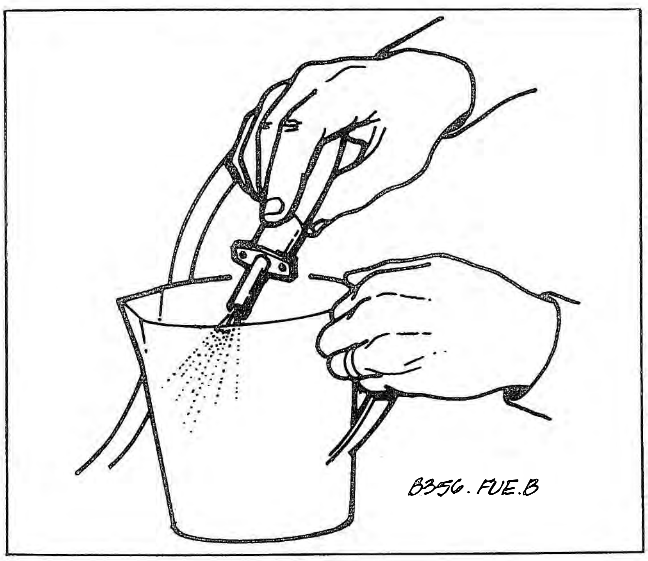

Fig. 5-9. Cold-start valve operation being checked.

5. Wipe the nozzle dry. The valve should not drip for at least a minute. If it does, it is faulty and should be replaced.

To test thermo-time switch:

1. Make sure engine coolant temperature is below 86°F (30°C). Preferably the engine should sit for several hours.

2. Disable the ignition system by disconnecting the electrical connector from the ignition control unit on the firewall near the fuse/relay panel. See **IGNITION SYSTEM** for more information.

3. Disconnect the cold-start valve harness connector and connect a test light across the connector terminals, as shown in Fig. 5-10.

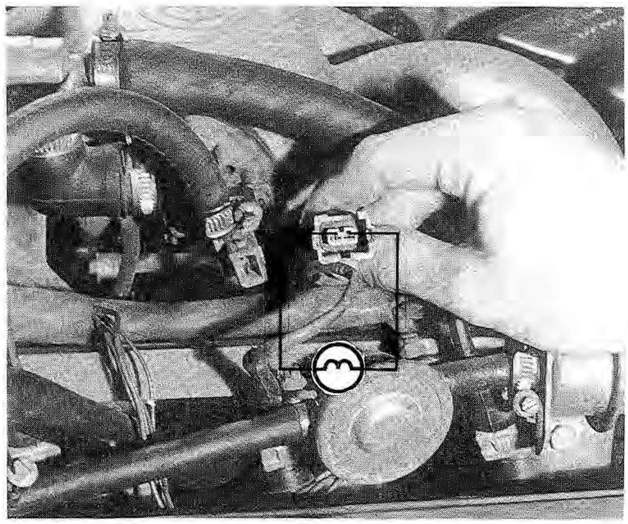

Fig. 5-10. Schematic view of test light connected across cold-start valve harness connector.

4. Actuate the starter while observing the test light. The test light should light for a maximum of 8 seconds, then go out. The amount of time that the light should stay on depends on coolant temperature and cranking time.

If the test light does not light, it is either because voltage is not reaching the connector due to faulty wiring, or because the path to ground (directly through the thermo-time switch housing) is interrupted by a faulty switch.

Check for voltage at the removed thermo-time switch harness connector. There should be battery voltage between terminal G (black/yellow wire) and ground when the starter is actuated.

Check for a faulty switch by checking for continuity between terminal W (terminal corresponding to black/red wire) and ground. At coolant temperatures below 86°F (30°C), there should be continuity to ground (switch closed). At coolant temperatures above 105°F (40°C), there should be no continuity to ground (switch open). Repair any electrical faults found or replace the thermo-time switch.

6

Replacing the thermo-time switch will require draining and replacing some of the engine coolant. See **COOLING SYSTEM**. Use a thread sealant when installing the new switch, and torque it to 20 to 25 Nm (15 to 18 ft. lb.).

Coolant Temperature Sensor

The coolant temperature sensor is located in the cylinder head coolant outlet, next to the thermo-time switch. See Fig. 5-11. To test the sensor, disconnect the white harness connector from the sensor and measure resistance across the sensor's terminals. The proper resistance value depends on engine coolant temperature as listed in **Table e**.

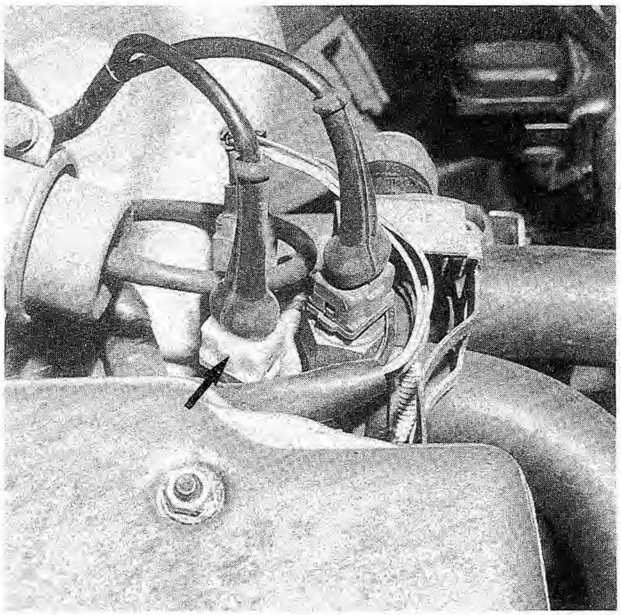

Fig. 5-11. Coolant temperature sensor (arrow). Remove connector and connect ohmmeter across sensor terminals to test.

Table e. Coolant Temperature Sensor Test Values

Sensor temperature	Resistance
14 ± 2°F (−10 ± 1°C)	7000–11600 ohms
68 ± 2°F (20 ± 1°C)	2100–2900 ohms
176 ± 2°F (80 ± 1°C)	270–400 ohms

If the resistance of the coolant temperature sensor is incorrect, the sensor is faulty and should be replaced. Replacing the sensor will require draining and replacing some of the engine coolant. See **COOLING SYSTEM**.

Coolant Temperature Switch

The coolant temperature switch/sender is located in the cylinder head coolant outlet, next to the coolant temperature sensor. The switch/sender switches a ground circuit for timing and idle control, depending on coolant temperature. The coolant temperature switch/sender also functions as the coolant temperature gauge sender. The switch/sender can be identified by its two single push-on connectors.

To test the switching function, disconnect the white wire from the switch. Using an ohmmeter, check for continuity between the switch terminal corresponding to the white wire and ground. At coolant temperatures below 86°F (30°C), there should be no continuity (switch open). At coolant temperatures above 118°F (45°C), there should be continuity (switch closed).

If any faults are found, the switch should be replaced. Replacing the switch will require draining and replacing some of the engine coolant. See **COOLING SYSTEM**. Use a thread sealant when installing the new switch/sender, and torque it to 25 to 30 Nm (18 to 22 ft. lb.).

5.3 Idle Speed

Engine idle speed is controlled not by a fine adjustment of the throttle, but by an electronic idle stabilization system that regulates a small amount of air that is allowed to bypass the throttle. Bypass air flow is regulated by an idle air stabilizer valve. The amount that the valve is open is controlled by an electronic control unit. By this method, idle speed is more accurate and reliable since it compensates for varying engine loads and operating conditions. The idle air stabilization system is shown schematically in Fig. 5-12.

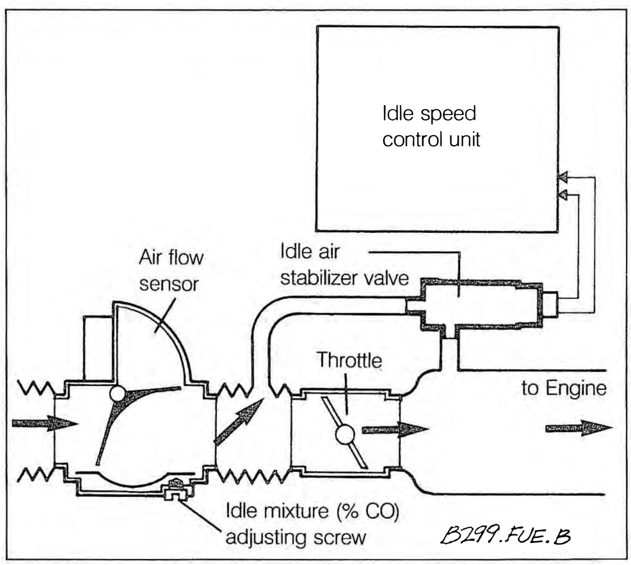

Fig. 5-12. Schematic view of idle air stabilization system showing idle air stabilizer valve and idle speed control unit

NOTE —

Early 4-cylinder models were originally fitted with a plastic housed idle stabilizer valve. All other models were equipped with an externally adjustable metal valve. Plastic idle stabilizer valves are no longer available as replacement parts. The plastic valve part number is superseded by the metal valve part number. When replacing a plastic valve with a metal valve, the idle speed control unit must also be replaced. See your authorized BMW dealer parts department for the most accurate and up-to-date parts information.

The need for additional inlet air during cold running is handled much the same way, by allowing additional air to bypass the throttle.

There are no means provided for idle speed adjustment, as it is electronically regulated by the idle stabilization system. The idle air stabilizer valve's base setting can be adjusted, although adjustment is somewhat complicated due to the effects on exhaust emissions and the sensitivity of the electronic controls. An incorrect or erratic idle speed is usually caused by a faulty idle speed stabilization system. See **ENGINE MANAGEMENT—DRIVEABILITY** for more information on troubleshooting idle speed problems.

Before troubleshooting the idle stabilization system, check and, if necessary, adjust ignition timing first. See **IGNITION**. Then, check and adjust CO to within specifications. For idle speed and mixture (% CO) specifications, see **5.6 Idle Specifications (rpm and % CO)**.

Making these checks and adjustments together is very important to both driveability and emissions control. If the equipment necessary to accurately perform this work is not available, we suggest turning the job over to an authorized BMW dealer or other qualified repair shop. In a properly equipped shop, these checks and adjustments can be made quickly, accurately, and at reasonable cost.

When checking the idle stabilization system, the following requirements apply:

1. The engine must be at normal operating temperatures (oil temperature at approximately 140°F (60°C)).
2. All electrical accessories should be off (including the auxiliary radiator cooling fan—make adjustments only when the fan is not on).
3. The throttle switch must be operating correctly.
4. The exhaust system must be free of leaks.
5. There must be no engine vacuum leaks.
6. The oxygen sensor must be operating correctly.

Connect a tachometer according to the instrument manufacturer's instructions in order to accurately measure rpm. The ignition signal lead from the tachometer should be connected to terminal 1 of the coil.

CAUTION —

The ignition must be off before disconnecting or connecting any electrical connections.

Idle Air Stabilizer Valve

The idle air stabilizer valve operates continuously when the ignition is on. To quickly check that the valve is functioning, start the engine. The valve should vibrate and hum slightly. If the valve is not operating, make sure the throttle switch is functioning correctly as described below. If the valve is functioning as described but idle is still erratic, perform the test below.

6

To test:

1. With the engine running, remove the harness connector from the valve. The idle speed should increase to approximately 2000 rpm.
2. If the idle speed does not increase, turn the engine off and check the valve's resistance between its terminals. There should be 9–10 ohms at approximately 73°F (23°C).
3. Remove the air hoses and the harness connector from the valve. Using jumper wires (positive (+) jumper wire should be fused), apply battery voltage to the valve's terminals. When voltage is applied, the valve should close tightly. When voltage is removed, the valve should spring open.

If the resistance of the valve is not as specified or if the valve does not open and close as specified, the valve is faulty and should be replaced. If no faults can be found with the valve, test the control current to the valve as described below.

Idle Speed Control

If no faults are detected with the idle air stabilizer valve, but the idle speed is incorrect, check the signal from the control unit by measuring the current to the valve. Fig. 5-13 shows an ammeter (0–1000 mA range) correctly connected to the idle air stabilizer valve. With the engine idling at operating temperature, the current reading should fluctuate between 400 and 500 mA.

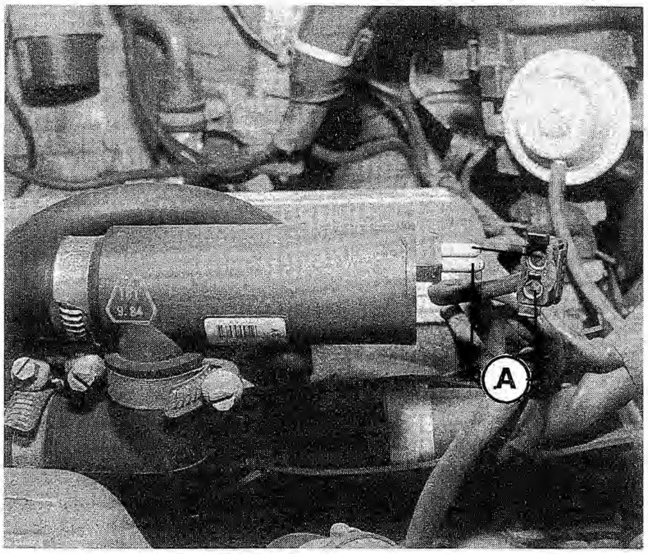

Fig. 5-13. Ammeter connected to plastic idle air stabilizer valve (shown schematically) to measure current from the idle speed control unit.

If there is no current reading, check the wires between the control unit and the valve. If the control current is not within specifications, check, and if necessary, adjust the base setting of the idle air stabilizer valve as described below.

If the valve cannot be correctly adjusted, disconnect the harness connector from the idle speed control unit. Working at the harness connector, test the inputs to the control unit using the information listed in **Table f.** The idle speed control unit is located above the glove compartment behind a trim panel. See Fig. 5-14. If no electrical faults can be found, the control unit is probably faulty and should be replaced.

NOTE
Idle air stabilizer current will fluctuate significantly if the engine is cold, if the coolant temperature sensor or coolant temperature switch is faulty, if there is an engine vacuum leak, or if any electrical accessories are on.

Table f. Idle Speed Control Unit Electrical Tests

Component or circuit	Test terminals on Harness Connector	Test conditions	Correct test value
Voltage supply to control unit	2 and ground	ignition ON	battery voltage (approximately 12 VDC)
Main ground	14 and ground		continuity
Coolant temperature switch	2 and 6	ignition ON, coolant temp. below 86°F (30°C) ignition ON, coolant temp above 118°F (48°C)	no voltage battery voltage (approximately 12 VDC)
Speed signal from ignition system	3 and 4	ignition ON	battery voltage for 1–2 seconds (approximately 12 VDC)
Air temp. switch (auto. trans. only)	4 and 10	ignition ON air temp. below 18°F (−8°C). ignition ON air temp above 39°F (4°C)	battery voltage (approximately 12 VDC). no voltage
Auto. trans. range switch	4 and 7	ignition ON, selector lever in N or P position	battery voltage (approximately 12 VDC)
Throttle switch	4 and 12	ignition ON, accelerator pedal in rest position. ignition on accelerator pedal depressed midway	battery voltage for 1–2 seconds (approximately 12 VDC). no voltage
Air cond. ON signal	4 and 9	ignition ON, air conditioning switch turned on	battery voltage (approximately 12 VDC)
Air cond. compressor ON signal	4 and 11	engine running, A/C clutch cycled	battery voltage (approximately 12 VDC)
Idle air stabilizer valve	1 and 5	ignition OFF	9–10 ohms at 73±9°F (23±5°C)

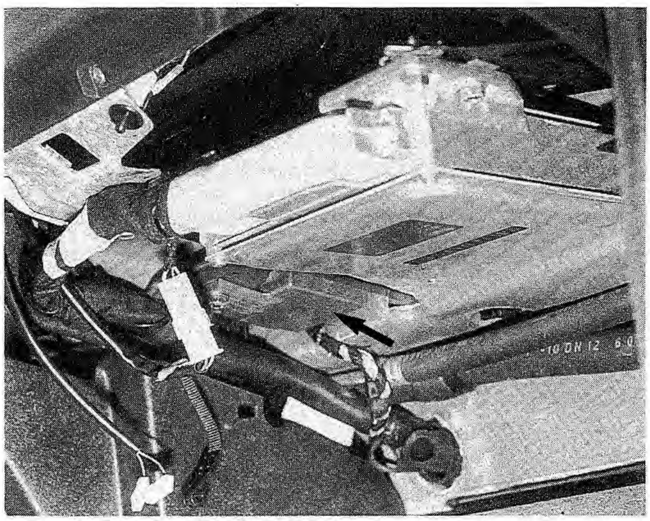

Fig. 5-14. Idle speed control unit location (arrow) as viewed from above glove compartment. Terminal numbers are identified on connector. Remove trim panel to access control unit.

To adjust idle air stabilizer valve:

1. Allow the engine to reach operating temperature. Connect a tachometer according to the instrument manufacturer's instructions in order to accurately measure rpm.

   NOTE —
   Ignition timing should be adjusted to specifications (as described in **IGNITION**) before adjusting idle speed control unit current.

2. Connect an ammeter to the valve as shown above in Fig. 5-13.

3. With the engine running, the current reading should be 460 ± 10 mA at 850 ± 50 rpm on cars with manual transmissions and 470 ± 10 mA at 850 ± 50 rpm on cars with automatic transmissions.

4. If the control current is not as specified, turn the valve's adjusting screw until the current reading is as specified. On models with metal idle air stabilizer valves, the adjusting screw is external, and is most likely marked with a yellow paint dot. On models with plastic idle air stabilizer valves, the adjustment screw is internal and can be reached after removing the hose on the end of the valve. See Fig. 5-15.

   NOTE —
   Turning the idle air bypass adjusting screw clockwise will increase control current; turning screw counterclockwise will decrease control current.

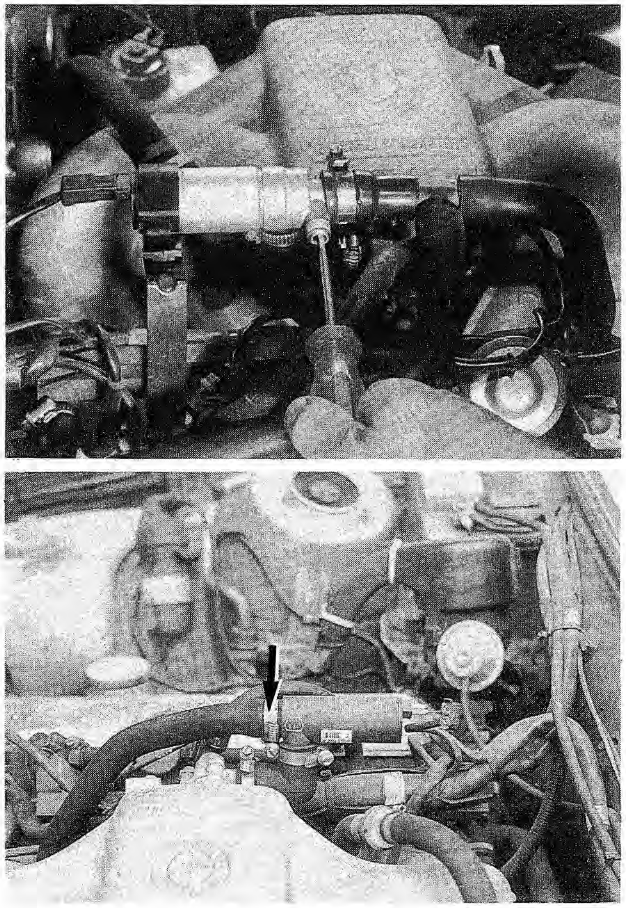

Fig. 5-15. Adjusting idle air stabilizer valve. **Top** On metal valve, adjusting screw is external. **Bottom** On plastic valve, adjusting screw is visible after removing hose (arrow).

5. Disconnect the test equipment and reconnect the idle air stabilizer valve harness connector.

Idle and Full Throttle Switch

The idle and full throttle switch is mounted as a single unit to the side of the throttle housing. Through this switch the control unit receives a signal whenever the throttle is fully closed (idle) or fully open (full throttle). An incorrectly adjusted throttle switch can cause an erratic idle speed. The switch can be easily checked with the throttle housing installed. On some models it is necessary to remove the throttle housing as described in **5.1 Air Flow Measurement** to adjust or replace the switch.

NOTE —
A digital ohmmeter should be used to check and adjust the idle and full throttle switch. Some analog ohmmeters may not be sensitive enough to detect small amounts of resistance.

Before testing the switch, check that the switch is receiving voltage. With the ignition on, there should be at least 5 volts (VDC) between the center terminal and either of the outer terminals of the switch harness connector. If voltage is not present, test the electronic control unit as described under **5.4 Electrical Tests.**

Test the switch by checking for continuity at the connector terminals on the switch. Connect an ohmmeter between terminals 2 and 18. See Fig. 5-16. Open the throttle part way by hand. Slowly let the throttle return to its idle stop. There should be continuity (0 ohms) at the terminals when the throttle lever is approximately 0.20 to 0.60 mm (.008 to .024 in.) from its stop. Connect an ohmmeter between terminals 3 and 18. Open the throttle slowly. There should be continuity when the throttle switch is within 10±2° of the full-throttle position.

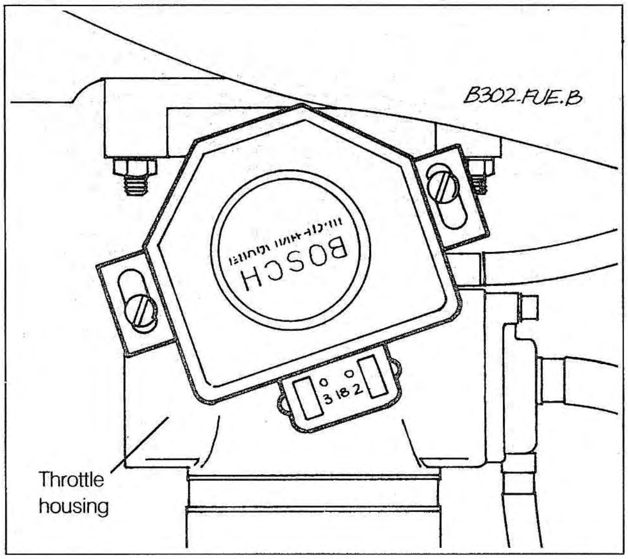

Fig. 5-16. Throttle switch showing terminal identification. Throttle switch is mounted on the right-hand side of throttle housing.

Adjust the switch by first loosening the two mounting screws. With an ohmmeter connected across the switch's terminals and the throttle in the rest position, rotate the switch just until there is continuity (0 ohms). Tighten the mounting screws. Check the adjustment of the switch as described above.

5.4 Electrical Tests

These voltage and continuity tests can help determine whether there are faults in the wiring or components that provide information to the L-Jetronic control unit. If all control unit inputs are found to be correct and the system still does not perform as specified, the control unit itself may be faulty.

As a general rule, a complete absence of the voltage or continuity specified in the tests suggests an open circuit in the wiring harness. Test results that differ from the values specified in the table does not necessarily mean that a component is faulty. Check carefully for connections that are loose or that are inadequate due to contamination or corrosion.

Before carrying out the test indicated in **Table g**, disconnect the harness connector(s) from the ignition control unit on the firewall. With the ignition turned off, remove the 25-point L-Jetronic connector retaining screw and then disconnect the connector. The connector terminals are identified in Fig. 5-17. The control unit is mounted beneath the right-hand (passenger's) side of the dashboard, above the glove compartment. See Fig. 5-18.

NOTE —

To achieve accurate test results, the battery voltage at the connector must be between 12 and 13 volts. Charge the battery if necessary. If the battery voltage is too high, turn on the headlights until the correct voltage is obtained.

Use care to avoid damaging the delicate connector terminals with meter probes during testing. For best and safest results, fabricate a set of test leads as shown in Fig. 5-19.

CAUTION —

- *Use only a digital voltmeter, ohmmeter, or multimeter with high input impedance. The electrical characteristics of other types of test equipment may cause inaccurate results or damage to the electronic components. For more information, see* **FUNDAMENTALS.**

- *Always connect or disconnect the control unit connector and the meter probes with the ignition off to avoid damage to the electronic components.*

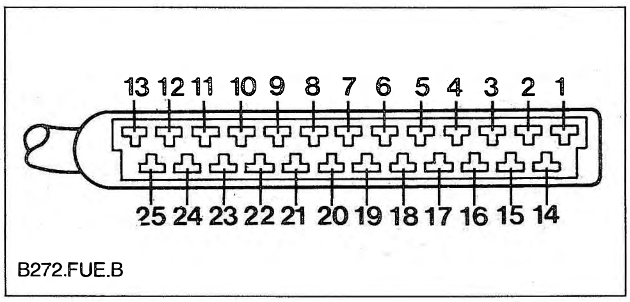

Fig. 5-17. Terminal identification for 25-point L-Jetronic control unit connector.

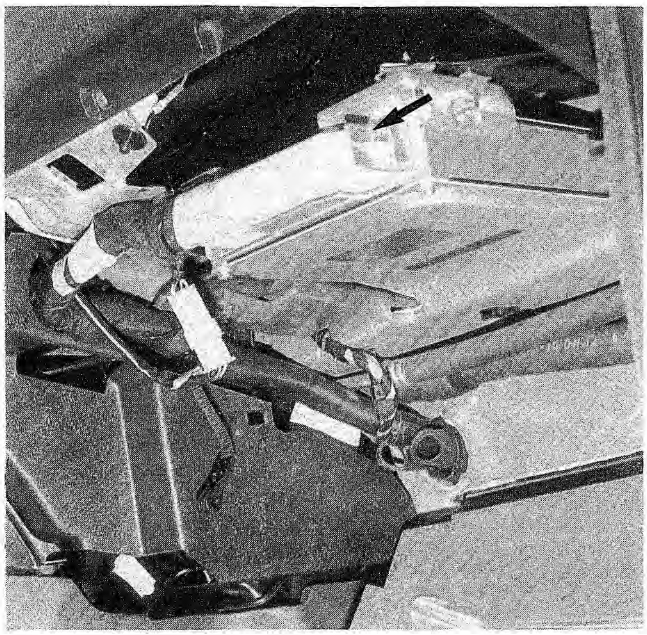

Fig. 5-18. L-Jetronic control unit connector and retaining screw (arrow).

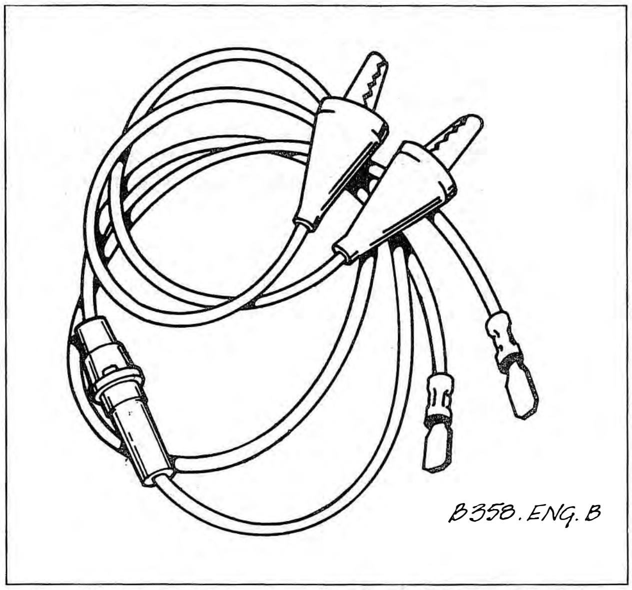

Fig. 5-19. Test leads made with flat connectors, alligator clips, and in-line fuse. Test leads used to make contact without spreading or damaging terminals in control unit connector.

Table g. L-Jetronic Electrical Tests

Component or circuit	Test terminals (at 25-point connector unless otherwise specified)	Test conditions	Correct test value
Voltage supply to control unit	9 and 13	actuate starter	battery voltage (approximately 12 VDC)
Wire from starter solenoid (terminal 50)	4 and 13	actuate starter	8 VDC (minimum)
Fuel injectors (all except late 1985 models*)	12 (L-Jetronic control unit) and brown/yellow wire of each injector connector		continuity
Coolant temperature sensor	10 and 13		resistance varies with temperature. See **5.2**
Throttle switch	2 and 13	actuate starter, throttle closed	battery voltage (approximately 12 VDC)
		actuate starter, open throttle slowly to half-open position	no voltage
	3 and 13	actuate starter, throttle fully open	battery voltage (approximately 12 VDC)
Air flow sensor	7 and 8	move sensor flap or actuate starter	resistance must fluctuate
Oxygen sensor	20 and 5	separate oxygen sensor connector and connect green wire to ground	continuity
		green wire reconnected	no continuity
Main grounds	5 and 13		continuity

*On late 1985 318i models, the fuel injectors are controlled by the L-Jetronic control unit via the idle speed stabilization relay

Idle Speed Stabilization Relay
(late 1985 318i models)

The idle speed stabilization relay alters the ground pulses from the control unit to the injectors based on various engine sensor inputs to the relay when the engine is idling. Fig. 5-20 is schematic representation of the idle speed stabilization relay.

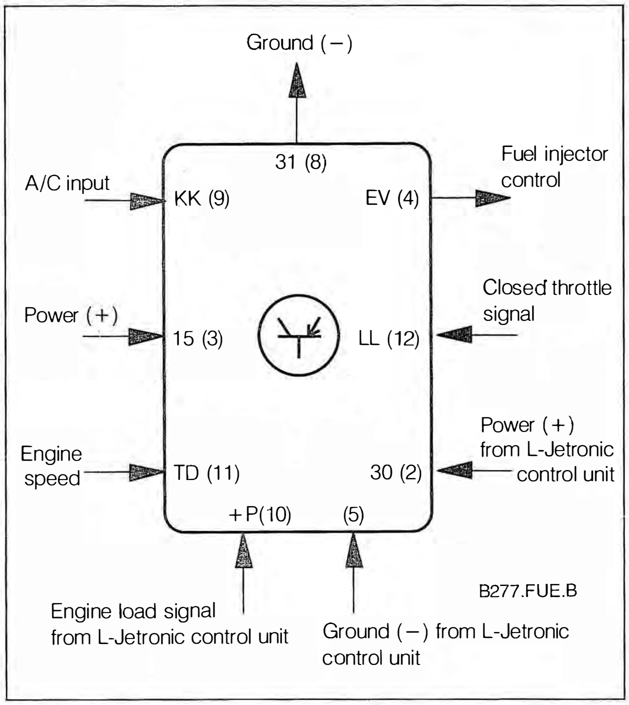

Fig. 5-20. Schematic of the idle speed stabilization relay. Symbol in relay center designates electronic control.

Test the relay by making the electrical tests listed in **Table h**. Make the tests at the relay socket after the relay has been removed. The idle speed stabilization relay is mounted next to the fuel pump relay. See Fig. 5-21. Before carrying out the tests, disable the ignition by disconnecting the harness connector(s) from the ignition control unit on the firewall. If all of the tests are as specified, the relay is probably faulty and should be replaced. A Light Emitting Diode (LED) test light is necessary to check that an engine speed signal is reaching the relay. See **FUNDAMENTALS** for more information on LED test lights.

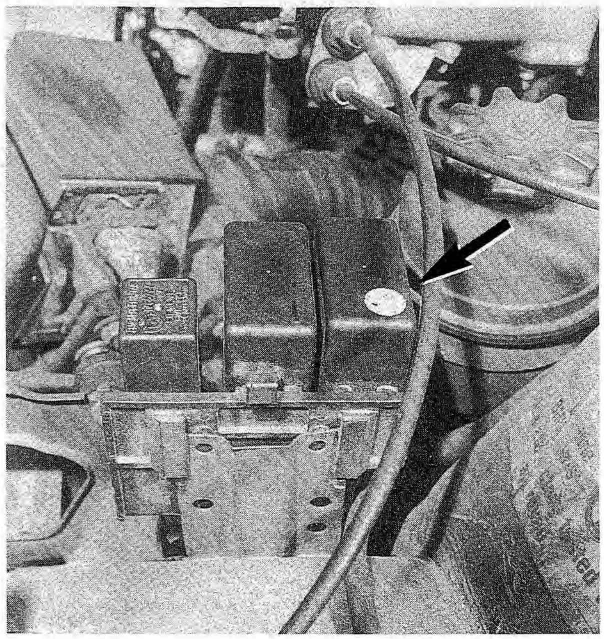

Fig. 5-21. Idle speed stabilization relay (arrow) identified by yellow dot on relay top.

Table h. Idle Speed Stabilization Relay Electrical Tests

Component or circuit	Relay panel socket	Test conditions	Correct test value
Voltage supply to relay	3 (+) and 8 (−)	ignition ON	battery voltage (approximately 12 VDC)
Engine speed input (use LED test light)	11 (+) and 8 (−)	actuate starter briefly	LED should flash
Fuel injectors	4 and 8 (−)	bridge terminal 4 to 8 (−) and turn ignition ON	fuel injectors should click on briefly
Throttle switch	12 (+) and 8 (−)	ignition ON, throttle fully closed	battery voltage for 1–2 seconds (approximately 12 VDC)
Air cond. compressor ON signal (from idle speed control unit)	9 (+) and 8 (−)	ignition ON, A/C switched ON	battery voltage (approximately 12 VDC)

5.5 Fuel Pressure Tests and Specifications

Although the amount of fuel delivered to the engine is controlled primarily by how long the injectors are open, fuel pressure can also influence fuel delivery. To eliminate the influence of fuel-pressure variations, the fuel pressure created by the fuel pump is regulated by a diaphragm-type pressure regulator mounted to the end of the fuel rail.

A vacuum hose connected to the top of the regulator helps to control the fuel pressure as a function of engine vacuum (manifold pressure). For more information on the pressure regulator, see **4.4 Fuel Pressure Regulator**.

> ***CAUTION —***
> *Cleanliness is essential when working with fuel circuit components. Before disconnecting any fuel lines, thoroughly clean the unions. Use clean tools.*

System Pressure and Residual Pressure

System pressure is the pressure value that is maintained in the system by the pressure regulator. When fuel pressure from the pump reaches the desired system pressure, the regulator opens and routes fuel back to the fuel tank. System pressure is not adjustable and the pressure regulator should be replaced if it is faulty.

To avoid fuel vaporization and hard starting (vapor lock) when the engine is hot, the system is designed so that slight fuel pressure is retained for a time after the engine has been turned off. This residual pressure is maintained by a check valve in the regulator and also at the main fuel pump outlet. The fuel pump check valve is not serviceable as an individual part.

To test system pressure:

1. Loosen the hose clamp and remove the hose from the cold-start valve. Using a small length of fuel hose, two hose clamps, and a T-fitting, connect a fuel gauge between the cold-start valve and its supply line. See Fig. 5-22.

> ***WARNING —***
> *Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

> **NOTE —**
> The fuel pressure guage must have a range of at least 0-5 bar (0-75 psi) and must be securely connected to prevent it from coming loose under pressure.

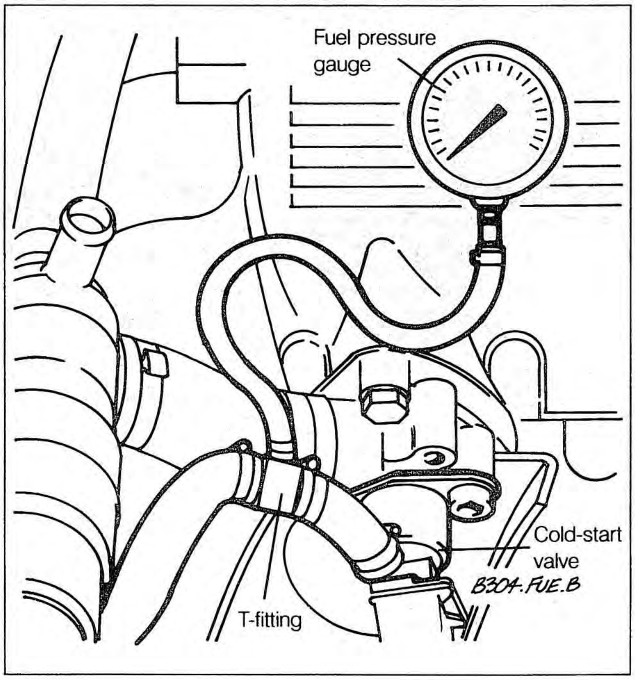

Fig. 5-22. Fuel pressure gauge connected between cold-start valve and supply line.

2. Operate the fuel pump as described in **4.1 Fuses and Relays.**

3. Check that the fuel pressure is 3.0 ± 0.06 bar (43.5 ± 0.9 psi).

If the system pressure is too high, check that the return from the pressure regulator to the tank is not pinched or restricted. Blow compressed air through it to check for blockages. If no faults can be found, the regulator is faulty and should be replaced. If the system pressure is too low, repeat the above pressure test while gradually clamping off the return hose at the fuel pressure regulator as shown in Fig. 5-23. The pressure should rise to at least 3 bar (44 psi) or possibly higher. If it does, then the pressure regulator is faulty and should be replaced.

If the pressure is still low, check visually for leaks in the fuel system. Leaks can also be due to a faulty cold-start valve or an injector. If no leaks can be found, test the fuel pump as described in **4.3 Fuel Pump.**

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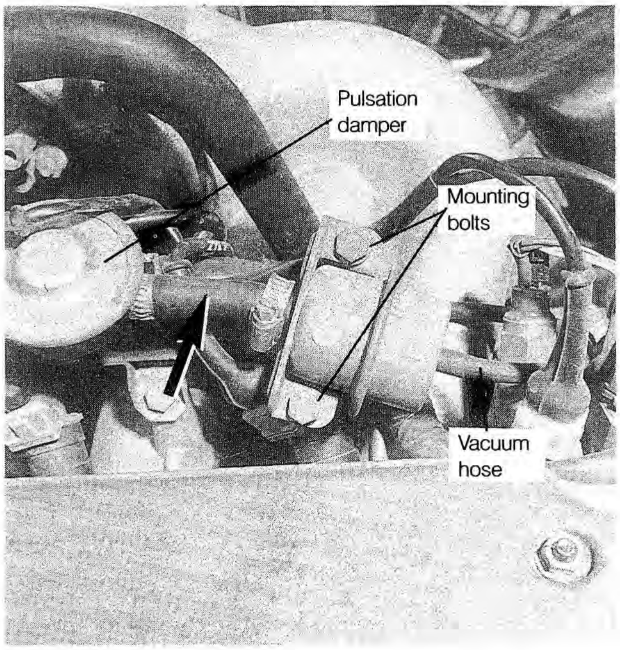


Fig. 5-23. Clamp shut fuel pressure regulator return hose at point indicated by arrow.

To test fuel pressure regulator response to engine load:

1. Reinstall the fuel pump relay. Start the engine and allow it to idle. Fuel pressure should be between 2.8 and 3.2 bar (40.6 and 46.4 psi).

2. Remove the vacuum hose from the regulator. The pressure should increase.

3. Reconnect the hose and check that the pressure returns to the above specifications.

If any faults are found, the fuel pressure regulator is faulty and should be replaced. Disconnect the gauge and reconnect the fuel line to the cold-start valve. Tighten the hose clamp. Clean up any spilled fuel.

Replacing Pressure Regulator

The fuel pressure regulator attaches to the fuel rail with two bolts. Disconnect the vacuum hose and the fuel return hose. See Fig. 5-23 above. Remove the bolts and pull the regulator from the fuel rail. Inspect the O-ring for damage and replace it if necessary. Installation is the reverse of removal. Be sure the code number (0 280 160 226) of the old pressure regulator matches that of the new regulator.

WARNING —

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

5.6 Idle Specifications (rpm and % CO)

Idle speed, ignition timing, and idle mixture (% CO) should be checked together. See **5.3 Idle Speed**. Making these checks and adjustments together is important to both driveability and emissions control. On BMW 318i models, the idle mixture is checked and adjusted using special electronic test equipment (BMW Special Tool No. 12 6 400). Because of the need for this test equipment, we suggest turning the job over to an authorized BMW dealer or other qualified repair shop. In a properly equipped shop, these checks and adjustments can be made quickly, accurately, and at reasonable cost.

The idle mixture screw can only be reached and adjusted after removing the anti-tampering plug in the top of the air flow sensor housing. See Fig. 5-24. This small plug is removed by drilling with a 2.5 mm (3/32 in.) drill bit and threading a screw into the plug so that it can be extracted with pliers.

With the plug removed, adjust the idle mixture screw using a 5-mm hex head wrench. In general, with the oxygen sensor system disconnected, turning the screw counterclockwise makes the mixture leaner (lower % CO). Turning it clockwise makes the mixture richer (higher % CO).

NOTE —

CO readings may be affected by the presence of unburned gasoline and combustion by-products in the engine oil. For the most accurate CO setting, always change the engine oil and filter before making any adjustments.

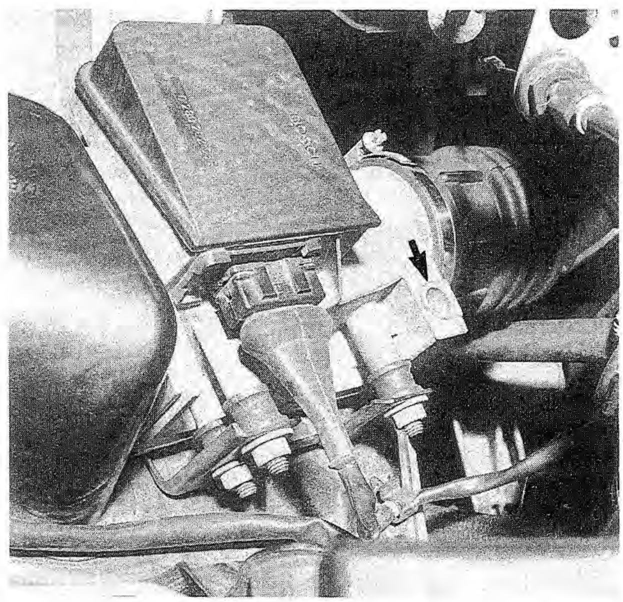


Fig. 5-24. Idle mixture adjusting screw in corner of air flow sensor (arrow).

6. MOTRONIC ENGINE MANAGEMENT SYSTEM

Fig. 6-1 shows the main components of the Motronic engine management system (also known as Digital Motor Electronics (DME)). The Motronic system is similar to the widely installed L-Jetronic fuel injection system. The major difference is that the single Motronic control unit also controls the ignition and idle speed functions. The Motronic control unit continuously collects various engine sensor signals to determine the optimum ignition timing point and injection quantity.

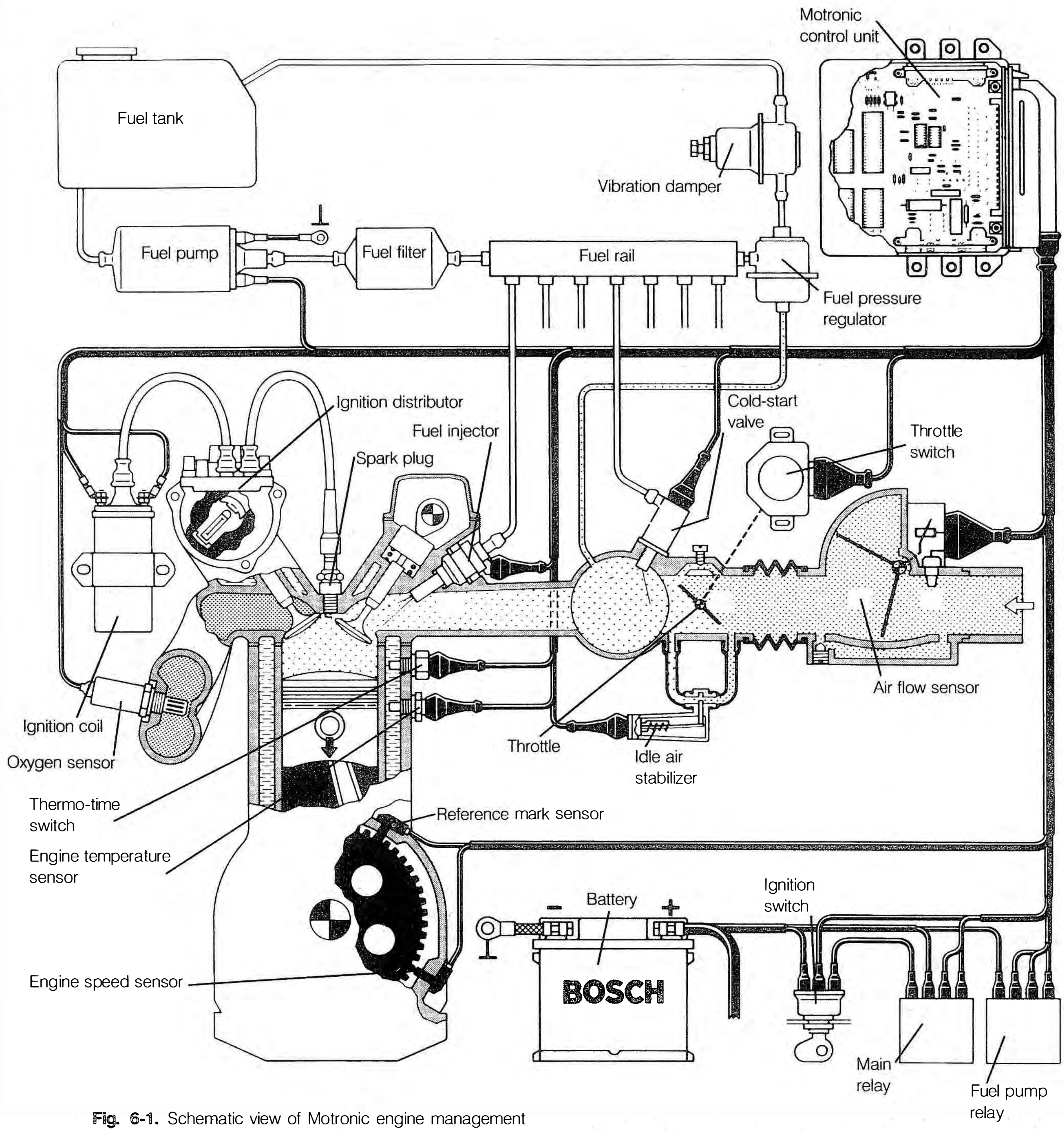


Fig. 6-1. Schematic view of Motronic engine management system. Motronic 1.1 system is similar.
Art courtesy of Robert Bosch Corporation

In the Motronic system, basic fuel metering is determined by engine rpm and by the volume and temperature of the air entering the engine. Fuel is metered to the engine via the fuel injectors, which are electrically pulsed on and off by the control unit. The control unit receives air flow volume and temperature data from the air flow sensor and engine rpm from the reference or speed sensor.

Six injectors, one for each cylinder, are triggered on and off at a rate governed by engine rpm. Fuel mixture is controlled by the length of the electrical impulse from the control unit—the length of time that the injectors are open. The injectors are mounted to a common fuel supply, called the fuel rail. Fuel pressure is regulated by a fuel pressure regulator mounted to the end of the fuel rail.

Information on fuel injectors can be found in **4.7 Fuel Injectors**. Additional information on the fuel pressure regulator is covered separately in **4.4 Fuel Pressure Regulator**.

The control unit makes additional adjustments to the amount of fuel metered by the injectors based on input from various engine sensors. The oxygen sensor system provides the control unit with information on engine combustion efficiency by measuring the amount of oxygen in the exhaust stream. Switches on the throttle housing inform the control unit when the throttle is fully open or fully closed. A coolant temperature sensor provides the control unit with engine temperature information for adjustments during starting and warmup. On early models, a barometric pressure sensor adjusts the fuel mixture based on changes in altitude. For testing and repair information on the oxygen sensor system, see **EXHAUST SYSTEM AND EMISSION CONTROLS**.

Two versions of the Motronic engine management system are installed on the 6-cylinder, 325 models covered by this manual. The first is the basic Motronic system just described. The second is Motronic 1.1, a newer version of the "basic" Motronic. The differences between the two systems are mainly incorporated in the circuitry. Both systems have adaptive abilities that adjust the system to compensate for things such as engine wear and vacuum leaks.

On Motronic 1.1, the system has additional adaptive features that change the system's base settings in the control unit's memory. In addition, the Motronic 1.1 injectors are controlled in two sets of three cylinders each (on the basic Motronic, all injectors are controlled at the same time). This allows for a more precise, better atomized fuel mixture. An induction sensor is connected to the no. 6 cylinder spark plug wire as a timing reference signal for the control unit. Other Motronic 1.1 differences include an electrically operated purge valve for the charcoal canister, a single, front-mounted reference sensor (earlier system uses two sensors), and on-board diagnostics.

The "basic" Motronic system is installed on 1984 through 1987 325, 325e, and 325es models. The 325i, 325is, and the 1988 325 models are equipped with the newer Motronic 1.1 system. The information in this repair section applies to both Motronic systems unless the text specifically mentions an exception.

In order for the system to operate properly, basic idle speed, ignition timing, and idle mixture (% CO) must be correct. The throttle switch must be functioning correctly. Idle speed and ignition timing are electronically controlled and are therefore not adjustable. In addition, on models with Motronic 1.1, idle mixture is not adjustable. If these basic settings are incorrect, all other test results will be misleading. See **6.3 Idle Speed** and **6.6 Idle Specifications (rpm and % CO)** for more information.

The Motronic system has been designed so that most electrical components can be tested using a low-current LED test light and a digital multimeter. Most of these tests can be performed right at the control unit harness connector using a special test harness adapter. The other major piece of test equipment required is a fuel pressure gauge. Incorrect system fuel pressure can directly affect engine performance and driveability.

On-board Diagnostics
(325i models only)

An On-Board Diagnostic system is incorporated into the Motronic 1.1 control unit. This system is able to detect certain emissions-related engine management malfunctions. When a malfunction is detected, the Check Engine warning light in the instrument cluster will come on and flash in coded intervals representing the faults(s).

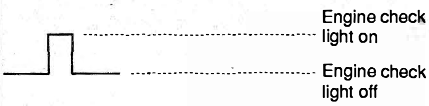
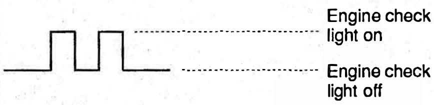
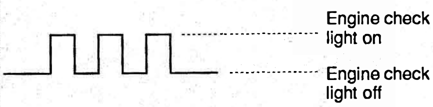
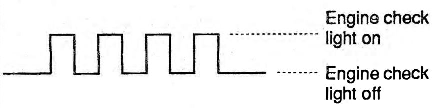
These fault codes can be read when the key is in the on position. The code(s) begin after three seconds and each flash is approximately one second apart. If more than one fault has been detected, each code will be separated by a 3 second pause. When all fault codes have been displayed, there will be another 3 second pause and then the check engine light will come on and stay on. To read the codes again, simply turn the key off and then on again. After 3 seconds, the codes will be repeated.

Table i lists the fault codes, their probable causes and corrective actions. The boldface numbers in the corrective action column indicate the headings in this section or the sections in the manual where the applicable test and repair procedures can be found. After the faults have been corrected, the fault memory can be erased by starting the engine at least five times.

NOTE

Fault codes that are not emissions-related are stored in the internal memory of the control unit and can only be read using the special BMW Service Tester. The check engine light does not come on for these malfunctions.

Table i. 325i Motronic 1.1 On-Board Diagnostics Fault Codes

Code number, meaning, and number of light flashes	Possible reason for malfunction	Corrective actions
 Code 1: Air flow sensor malfunction	Air flow sensor flap binding or air flow sensor potentiometer faulty	Test air flow sensor. **6.1 Air Flow Measurement**
 Code 2: Oxygen sensor malfunction or oxygen sensor parameters exceeded	Oxygen sensor faulty or fuel mixture too lean or too rich, due to faulty fuel or ignition system components causing oxygen sensor to exceed its operating parameters.	Test oxygen sensor. **EXHAUST SYSTEM AND EMISSION CONTROLS**. Check for intake air leaks or reasons for rich mixture. **ENGINE MANAGEMENT—DRIVEABILITY**
 Code 3: Coolant temperature sensor malfunction	Coolant temperature sensor faulty, or engine running too hot or too cold due to faulty cooling system component.	Test coolant temperature sensor. **6.2 Cold Start and Cold Running Enrichment**. Test cooling system components. **COOLING SYSTEM**
 Code 4: Throttle switch malfunction	Throttle switch incorrectly adjusted or faulty	Test throttle switch. **6.3 Idle Speed**

NOTE —

The flashing of the check engine light is shown graphically in the table. Each peak in the graph indicates one flash.

6.1 Air Flow Measurement

The amount of air entering the engine is measured by the air flow sensor. See Fig. 6-2. As intake air is drawn past the air flow sensor flap, the spring-tensioned flap opens and in turn actuates a potentiometer inside the sensor. The varying resistance of the potentiometer provides a varying voltage signal (approximately 0–5 volts) to the control unit that is proportional to air flow. The air flow sensor also contains an intake air temperature sensor that measures the temperature of the incoming air.

The throttle is operated by the accelerator pedal via the accelerator cable, and controls the amount of air drawn in by the engine. The throttle is adjusted during manufacture and does not require any routine adjustment. The throttle can be readjusted if the factory settings have been tampered with. A throttle switch is mounted to the underside of the throttle housing. The throttle switch sends a voltage signal to the control unit whenever the throttle is fully closed or fully open.

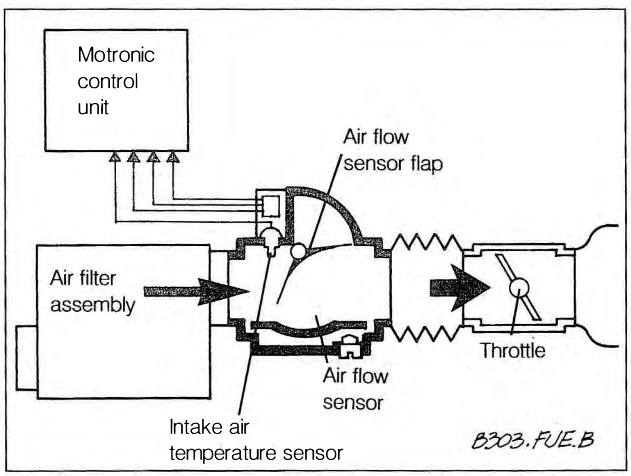


Fig. 6-2. Schematic of air flow sensor and related components. Arrows indicate direction of air flow.

6

Air Flow Sensor

The sensor's mechanical operation depends upon the free movement of the flap inside the main air passage. To check the flap movement, loosen the clamps, remove the rubber intake air duct, and move the flap through its range of travel. See Fig. 6-3.

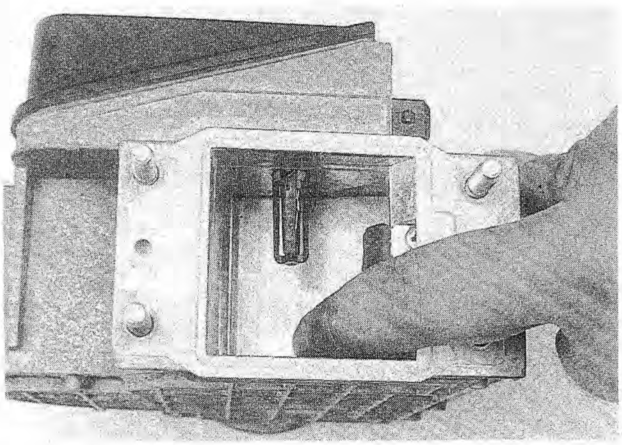


Fig. 6-3. Air flow sensor flap being checked. Move flap through entire range of travel to check for binding and smooth operation.

If the flap binds at any point, remove the intake air flow sensor, as described later under this heading, and check for any foreign material that may be interfering with the flap's movement. Check that the flap returns to the closed position smoothly. If the flap cannot be made to move freely, or if the flap's spring tension is uneven, the air flow sensor is faulty and should be replaced.

NOTE

No electrical test specifications are available for the air flow sensor installed on the 6-cylinder models covered by this manual. Check the air flow sensor's input signals from the control unit as described under **6.4 Electrical Tests**.

Throttle Basic Adjustment

The factory-set throttle adjusting screw is not used to adjust idle speed. Its only function is to provide a mechanical stop for the linkage to prevent damage to the throttle plate and housing. It should be adjusted only if the factory setting has been tampered with. Check for a slight clearance between the throttle housing and the throttle plate as shown in Fig. 6-4. If the clearance is incorrect, the throttle should be adjusted.

Correct a faulty throttle adjustment by removing the tamper proof cap from the adjusting screw. See Fig. 6-5. Rotate the screw counterclockwise until there is clearance between its tip and the throttle lever. There should be no clearance between the throttle plate and the inside of the housing. Rotate the screw slightly clockwise until the throttle plate is no longer contacting the housing. For a more accurate setting, use a .0015 in. feeler gauge between the throttle plate and the throttle housing. Apply paint or lacquer to the screw's threads to lock it in place and install the tamper-proof cap. The throttle switch adjustment should be checked anytime the throttle is adjusted. See **6.3 Idle Speed** for throttle switch adjustment procedures.

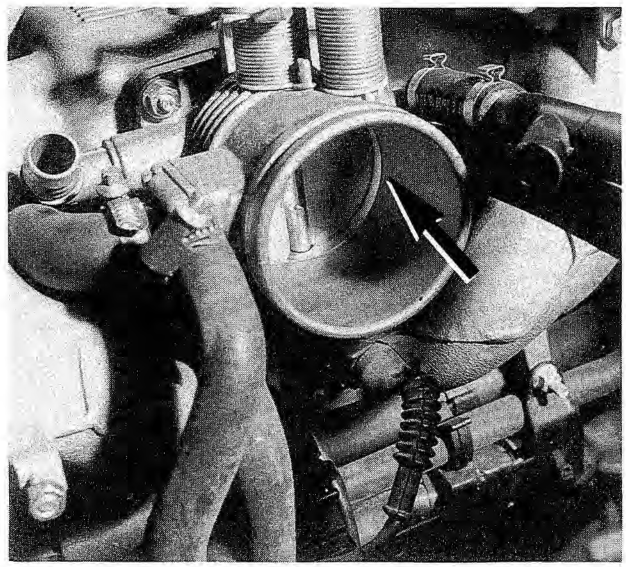


Fig. 6-4. Throttle plate clearance between housing and plate (arrow) on 325i model. 325e model is similar. Throttle plate should not contact housing.

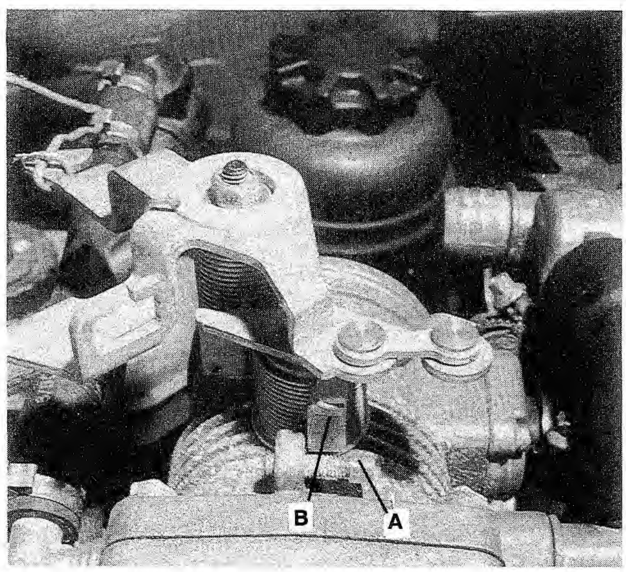


Fig. 6-5. Throttle adjusting screw with tamper-proof cap (**A**) and throttle lever (**B**).

Removing and Installing Throttle Housing

Removing the throttle housing requires that some of the engine coolant be drained as described in **COOLING SYSTEM**. If the throttle housing is being removed for the purpose of adjusting the throttle switch, check that the throttle basic adjustment is correct before removing the housing. See **Throttle Basic Adjustment**.

To remove and install:

1. Disconnect the cables from the throttle levers. Where applicable, disconnect the automatic transmission accelerator cable from the lever. Pry out the cruise control and accelerator cable's plastic retainers and remove the cables from the levers together with the retainers. See Fig. 6-6.

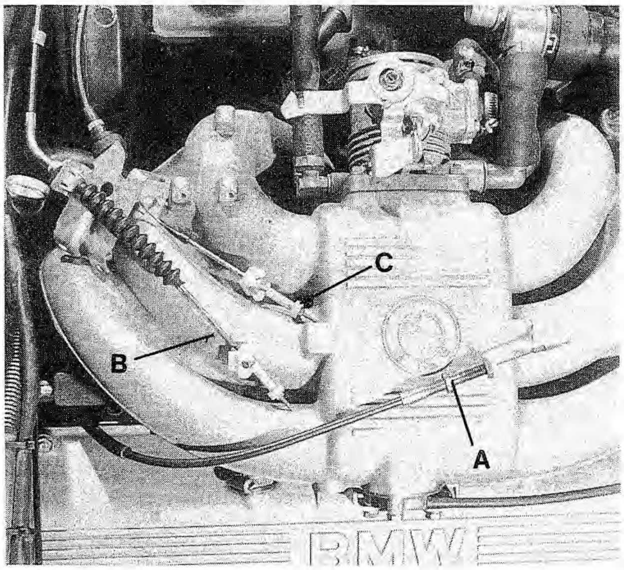


Fig. 6-6. Automatic transmission accelerator cable (**A**), cruise control cable (**B**), and accelerator cable (**C**).

2. Drain approximately 2 quarts of coolant from the cooling system.

3. Loosen the two large hose clamps and remove the rubber intake-air duct. See Fig. 6-7. Separate the rubber hose from the idle air stabilizer valve.

4. Disconnect the harness connector from the throttle switch.

5. Loosen the hose clamps and remove the coolant hoses from the housing. See Fig. 6-8.

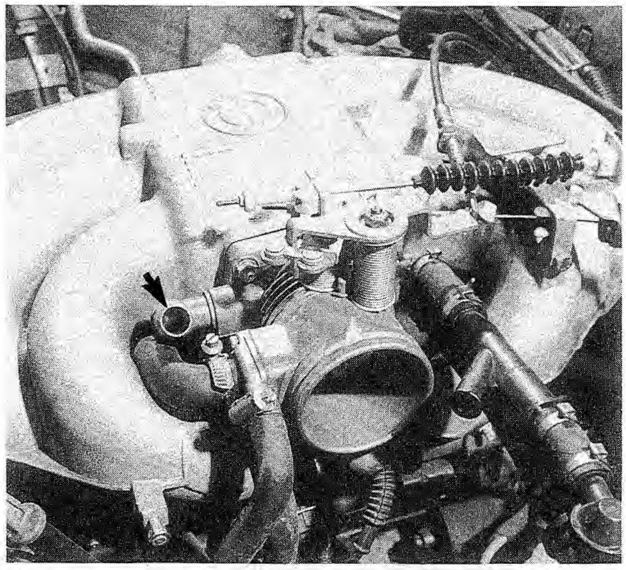


Fig. 6-7. Throttle housing, showing intake duct removed, and hose removed from idle air stabilizer valve (arrow).

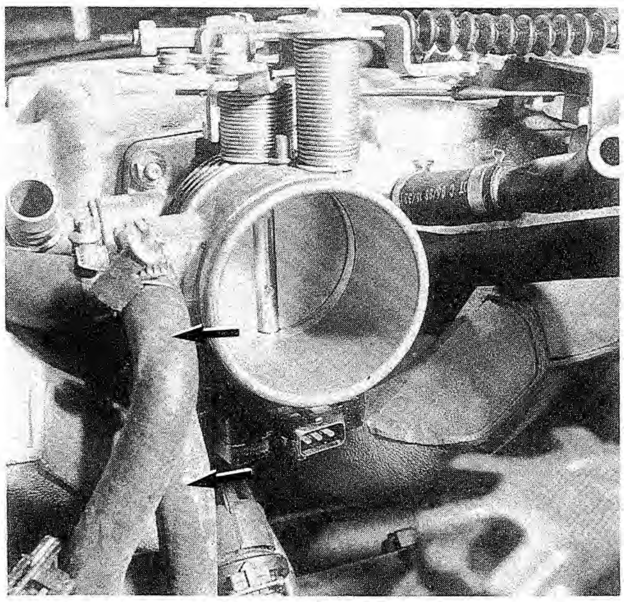


Fig. 6-8. Coolant hoses to be removed from throttle housing (arrows).

6. Remove the four mounting bolts from the housing and withdraw the housing from the intake manifold. See Fig. 6-9.

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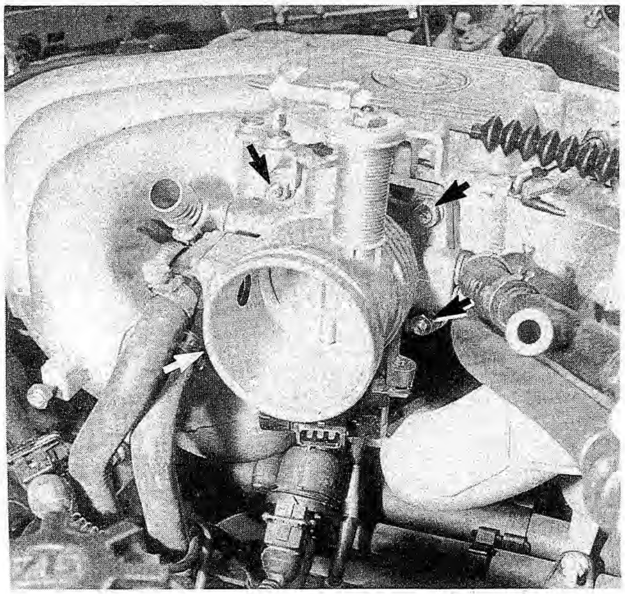

Fig. 6-9. Throttle housing mounting bolts (arrows).

Installation is the reverse of removal. Replace the gasket between the housing and the intake manifold. Adjust the accelerator cable as described earlier under **4.6 Accelerator Cable**. Adjust the automatic transmission accelerator cable as described in **AUTOMATIC TRANSMISSION**. Reconnect the cruise control cable. Refill and bleed the cooling system as described under **COOLING SYSTEM**.

6.2 Cold Start and Cold Running Enrichment

When an engine is cold, additional fuel is needed for starting and during warmup. Two methods are used on models with Motronic fuel injection.

On 1984 though 1987 325 and 325e models, an electrically operated cold-start valve sprays extra fuel into the intake manifold for several seconds during starting. The valve is controlled by the thermo-time switch.

On all 325i and 1988 325 models, an auxiliary cold-start system is not used. Instead, cold-start enrichment is handled in the same away as cold running enrichment. Based on the signal from the coolant temperature sensor, additional fuel is supplied to the engine during starting by increasing injector opening time.

On all Motronic models, to ensure smooth running during warmup, the coolant temperature sensor, and on some models, the coolant temperature switch, give the control unit information on engine temperature. The control unit, in turn, makes an adjustment to injector opening time. For additional cold running driveability and fuel economy, the throttle housing is heated by engine coolant. This system warms the air entering the engine in cold weather to reduce fuel condensation and improve mixture formation.

Cold-Start Valve
(1984 through 1987 325 and 325e models only)

Below a certain engine coolant temperature, the thermo-time switch is closed, allowing power to reach the cold-start valve and open it when the starter is actuated. When the engine is warm enough, the switch is open and the valve does not operate during starting. To further limit valve operation and prevent flooding, an electric current also warms the switch and opens the circuit after a few seconds. The cold-start valve and the thermo-time switch are shown in Fig. 6-10.

If a cold-start valve fails to inject fuel during starting, it will be difficult or impossible to start the engine. If the cold-start valve leaks or stays open too long, the engine may receive extra fuel at the wrong time and become flooded, especially if the engine is hot.

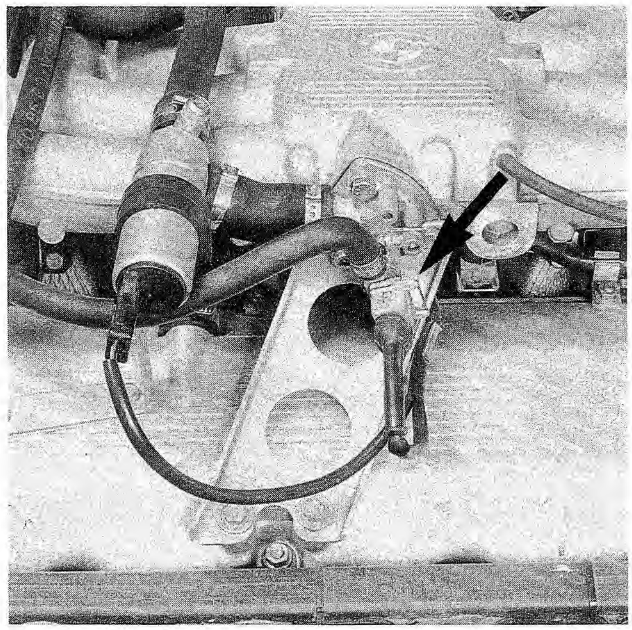

Fig. 6-10. Cold-start valve (arrow) controlled by thermo-time switch is used to provide extra fuel for cold starting.

To test cold-start valve:

1. Make sure engine coolant temperature is below 86°F (30°C). Preferably the engine should sit for several hours.

2. Remove the two internal-hex head screws holding the cold-start valve to the intake manifold. Without disconnecting the fuel line or the harness connector, remove the cold-start valve from the intake manifold.

3. Disable the ignition system by removing the main relay. See **6.4 Electrical Tests** for relay location.

4. Wipe the cold-start valve nozzle dry. Point the valve into a transparent container, and have a helper actuate the starter. See Fig. 6-11. The valve should spray in an even, cone-shaped pattern until the thermo-time switch interrupts the circuit, up to a maximum of eight seconds. An irregular spray pattern indicates a dirty or faulty cold-start valve. If the valve does not spray, test the thermo-time switch as described below.

WARNING —

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

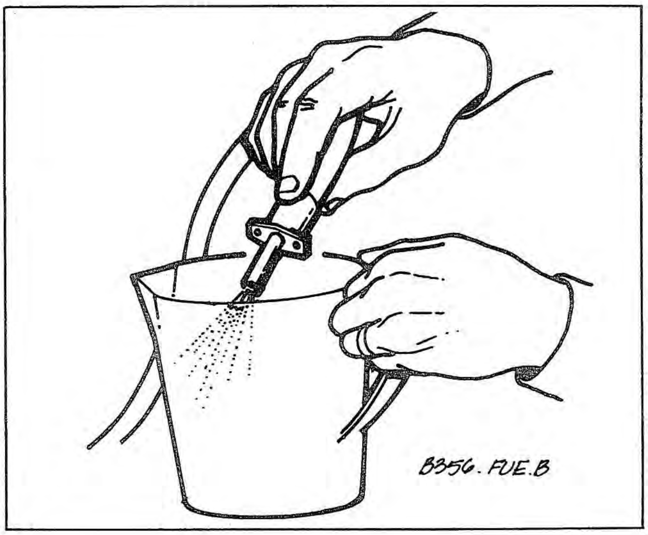

Fig. 6-11. Cold-start valve operation being checked.

5. Wipe the nozzle dry. The valve should not drip for at least a minute. If it does, it is faulty and should be replaced.

To test thermo-time switch:

1. Make sure engine coolant temperature is below 86°F (30°C). Preferably the engine should sit for several hours.

2. Disable the ignition system by removing the main relay from the auxiliary relay panel. See **6.4 Electrical Tests** for relay location.

3. Disconnect the cold-start valve harness connector and connect a test light or voltmeter across the connector terminals, as shown in Fig. 6-12.

4. Actuate the starter while observing the test light. The test light should light for a maximum of 8 seconds, then go out. The amount of time that the light should stay on depends on coolant temperature and cranking time.

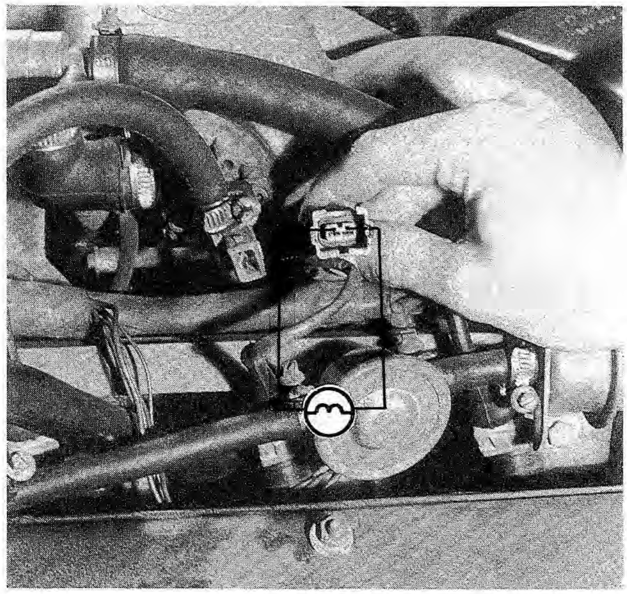

Fig. 6-12. Schematic view of test light connected across cold-start valve harness connector.

If the test light does not light, it is either because voltage is not reaching the connector due to faulty wiring, or because the path to ground (through the thermo-time switch) is interrupted by a faulty switch.

Check for voltage at the removed thermo-time switch harness connector. There should be battery voltage between terminal G (black/yellow wire) and ground when the starter is actuated.

Check for a faulty switch by checking for continuity between terminal W (terminal corresponding to black/red wire) and ground. At coolant temperatures below 86°F (30°C), there should be continuity to ground (switch closed). At coolant temperatures above 105°F (40°C), there should be no continuity to ground (switch open). Repair any electrical faults found or replace the thermo-time switch.

Replacing the thermo-time switch will require draining and replacing some of the engine coolant. See **COOLING SYSTEM**. Use a thread sealant when installing the new switch, and torque it to 20 to 25 Nm (15 to 18 ft. lb.).

6

Coolant Temperature Sensor

The coolant temperature sensor is located in the cylinder head coolant outlet, next to the thermo-time switch. To test the sensor, disconnect the harness connector from the sensor. See Fig. 6-13. Measure the resistance across the sensor's terminals. The proper resistance value depends on engine coolant temperature as listed in **Table j**.

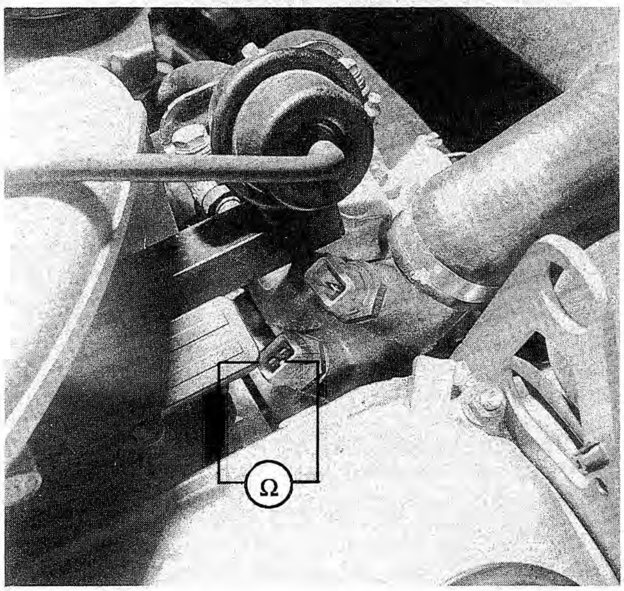

Fig. 6-13. Schematic view of ohmmeter test leads connected across coolant temperature sensor terminals.

Table j. Coolant Temperature Sensor Test Values

Model	325, 325e, 325es	325i, 325is
Connector color	white	blue
Test temperature	Resistance (ohms)	Resistance (ohms)
14 ± 2°F (−10 ± 1°C)	7000–11600	8200–10500
68 ± 2°F (20 ± 1°C)	2100–2900	2200–2700
176 ± 2°F (80 ± 1°C)	270–400	300–360

If the resistance of the coolant temperature sensor is incorrect, the sensor is faulty and should be replaced. Replacing the sensor will require draining and replacing some of the engine coolant. See **COOLING SYSTEM**.

Coolant Temperature Switch
(1984 through 1987 325, 325e, 325es models only)

The coolant temperature switch is located in the cylinder head coolant outlet, next to the thermo-time switch. The switch turns a ground circuit for timing and idle control on and off, depending on coolant temperature. The coolant temperature switch can be identified by its two single push-on connectors.

To test the switch, disconnect both wires from the switch. Using an ohmmeter, check for continuity across the switch terminals. At coolant temperatures below 86°F (30°C), there should be no continuity (switch open). At coolant temperatures above 118°F (48°C), there should be continuity (switch closed).

If any faults are found, the switch should be replaced. Replacing the switch will require draining and replacing some of the engine coolant. See **COOLING SYSTEM**.

6.3 Idle Speed

Engine idle speed is controlled not by a fine adjustment of the throttle, but by an electronic idle stabilization system that regulates a small amount of air that is allowed to bypass the throttle plate. Bypass air flow is regulated by an idle air stabilizer valve. The amount that the valve is open is controlled by an electronic control unit. By this method, idle speed is more accurate and reliable since it compensates for varying engine loads and operating conditions.

On 1984 through 1987 325 and 325e models, an idle air stabilizer valve is controlled by a separate idle speed control unit. The idle air stabilization system for these models is shown schematically in Fig. 6-14. On 1988 325 and all 325i models, the idle air stabilizer valve is controlled by the Motronic 1.1 control unit. Both systems are designed to maintain idle speed within a prescribed range.

The need for additional inlet air during cold running is handled much the same way, by allowing additional air to bypass the throttle.

There are no means provided for idle speed adjustment, as it is electronically regulated by the idle stabilization system. On 1984 through 1987 325 and 325e models, an adjustment screw in the idle air stabilizer valve can be used to adjust the base setting of the valve, but altering the position of this screw will not change the idle speed. The valve normally does not require adjustment unless the factory setting has been tampered with.

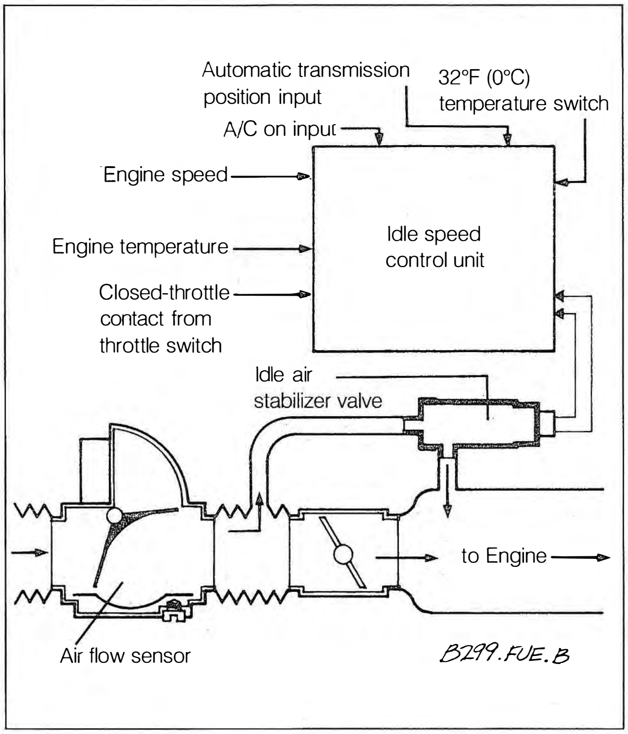

Fig. 6-14. Schematic view of idle air stabilization system installed on 1984 through 1887 325 and 325e models. System on 1988 325 and all 325i models similar, except that Motronic control unit replaces idle speed control unit, and there are additional inputs.

An incorrect or erratic idle speed is usually caused by a faulty idle speed stabilization system. See **ENGINE MANAGEMENT—DRIVEABILITY** for more information on troubleshooting idle speed problems. Idle mixture should be checked before troubleshooting the idle stabilization system. See **6.6 Idle Specifications (rpm and % CO)**. If the equipment necessary to accurately perform this work is not available, we suggest turning the job over to an authorized BMW dealer or other qualified repair shop. In a properly equipped shop, these checks and any applicable adjustments can be made quickly, accurately, and at reasonable cost.

When checking the idle stabilization system, the following requirements apply:

1. The engine must be at normal operating temperature (oil temperature at approximately 140°F (60°C)).

2. All electrical accessories should be off (including the auxiliary radiator cooling fan—make adjustments only when the fan is not on).

3. The throttle switch must be operating correctly.

4. The accelerator cable and the basic throttle must be correctly adjusted.

5. The exhaust system must be free of leaks.

6. There must be no engine vacuum leaks.

7. The oxygen sensor must be operating correctly.

Connect a tachometer according to the instrument manufacturer's instructions in order to accurately measure rpm. The ignition signal lead from the tachometer should be connected to terminal 1 of the coil. See **7. Fuel System Technical Data** for idle speed checking specifications.

CAUTION —

The ignition must be off before disconnecting or connecting any electrical connections.

Idle Air Stabilizer Valve

The electronic idle stabilizer valve controls the amount of air allowed to bypass the throttle and increase engine idle speed. Whenever the throttle switch is closed, the valve receives voltage from the electronic control unit. The idle air stabilizer valve operates continuously when the ignition is on.

To quickly check that the valve is functioning, turn the ignition on or start the engine. The valve should vibrate and hum slightly. If the valve is not operating, check that the idle switch is operating correctly as described below. If the valve is functioning but idle speed is still erratic, test the valve as described below.

NOTE —

Two versions of the idle stabilizer valves are installed on the 6-cylinder cars covered by this manual. On 1988 325 and all 325i models, a three-wire stabilizer valve is installed. On 1984 through 1987 325 and 325e models, a two-wire stabilizer valve is installed. Testing procedures vary depending on the type of valve installed.

On two-wire valves, remove the hoses and the electrical connector from the valve. Using jumper wires, apply battery voltage to the valve's terminals as shown in Fig. 6-15. The valve's piston should close when voltage is applied and open when voltage is removed. If any faults are found, the valve is faulty and should be replaced. If no faults are found, check the control signal to the valve as described below.

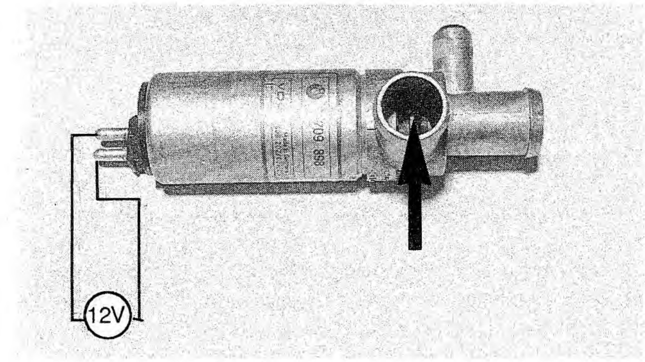

Fig. 6-15. Schematic view of battery voltage being applied to idle air stabilizer valve. Valve piston (arrow) should close when voltage is applied.

On three-wire valves, remove the two hoses and the electrical connector from the valve. Withdraw the valve from the rubber mount. With the valve removed, check that the valve's piston moves freely by quickly rotating the valve back and forth. The piston should visibly move. There should be approximately 40 ohms of resistance between the valve's two outer terminals, and approximately 20 ohms of resistance between the center terminal and each of the outer terminals.

If no faults are found, reinstall the valve and reconnect the wiring. Start the engine and allow it to reach operating temperature, then turn the engine off. Turn off all electrical accessories. Remove the hose so that the piston can be seen and turn the ignition on. The valve's piston should move to approximately halfway across the valve's opening. See Fig. 6-16.

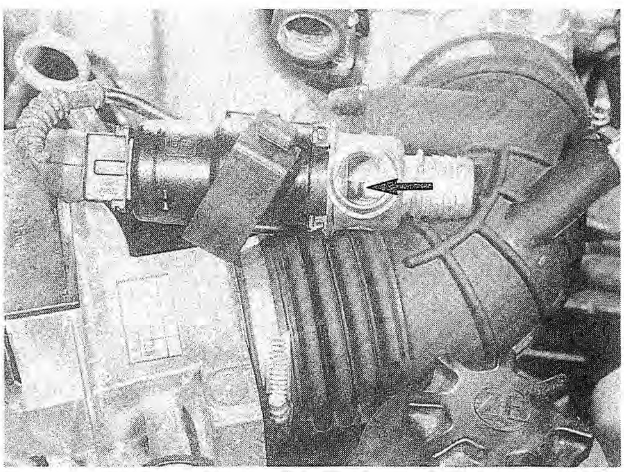

Fig. 6-16. Idle air stabilizer valve piston (arrow) in center position with harness connector connected and ignition on.

NOTE —

The position of the piston can vary significantly if the engine is cold, if the coolant temperature sensor is faulty, if the throttle switch is open, or if any electrical accessories are on.

Idle Speed Control

If no faults are detected with the idle air stabilizer valve, but the idle speed is not within specifications, check the idle stabilization function of the control unit.

On models with three-wire valves, check for voltage at the harness connector. See Fig. 6-17. With the ignition on, there should be battery voltage (approximately 12 VDC) between the center terminal and ground on some unpainted part of the chassis. There should also be approximately 10 VDC between the center terminal and each of the two outer terminals. If no voltage is present, check the wires between the Motronic control unit (terminal 4 and 22 of the control unit connector) and the two outer terminals of the valve for continuity. If no wiring faults are found, see **6.4 Electrical Tests**.

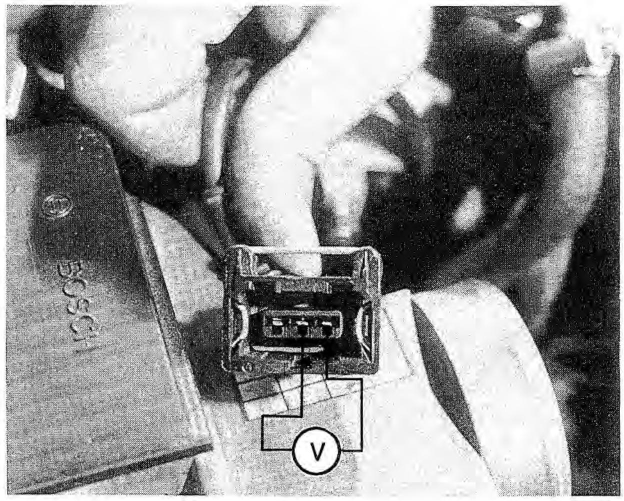

Fig. 6-17. Schematic view of voltmeter being used to test idle stabilizer valve voltage signal from the control unit, on models with 3-wire valves (Motronic 1.1).

NOTE —

Idle air stabilizer voltage between the center terminal and each of the two outer terminals can vary significantly if the engine is cold, if the coolant temperature sensor is faulty, if the throttle switch is not closed, or if any electrical accessories are on.

On models with two wire idle stabilizer valves, check the signal from the idle speed control unit by measuring the current to the valve. Fig. 6-18 shows an ammeter (0–1000 mA range) correctly connected to the idle air stabilizer valve. With the engine idling at operating temperature, the current reading should fluctuate between 400 and 500 mA.

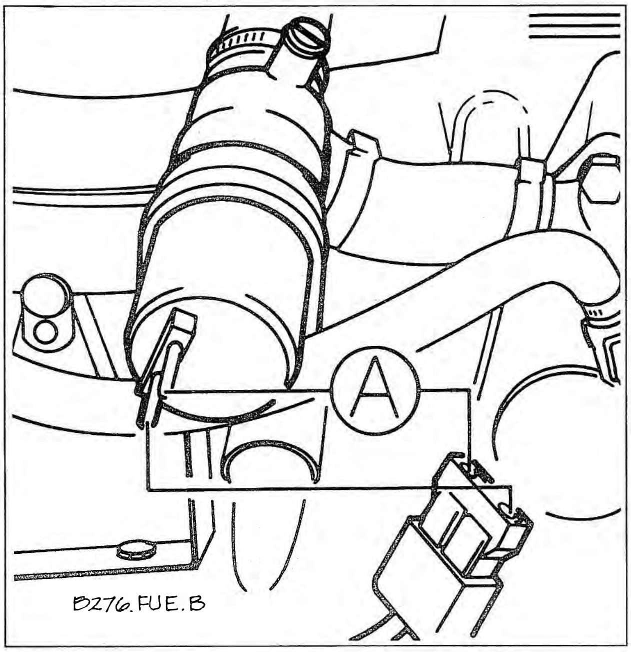

Fig. 6-18. Schematic view of ammeter connected to idle air stabilizer valve to measure current from control unit, on models with 2-wire valves (325e).

NOTE —

Idle air stabilizer current will fluctuate significantly if the engine is cold, if the coolant temperature switch or coolant temperature sensor is faulty, if there is an engine vacuum leak, or if any electrical accessories are on.

If there is no current reading, check the wires between the idle speed control unit and the valve. If the current is not as specified, adjust the base setting of the idle air stabilizer valve as described below.

To adjust idle air stabilizer valve (idle air stabilizer valve with external adjusting screw):

1. Allow the engine to reach operating temperature. Connect a tachometer according to the instrument manufacturer's instructions in order to accurately measure rpm.

2. Connect an ammeter to the valve as shown above in Fig. 6-18.

3. The current reading should be 460 ± 10 mA at 700 ± 50 rpm.

4. If the current is not as specified, slowly turn the valve's bypass screw until the current reading is correct.

NOTE —

Turning the idle air bypass adjusting screw clockwise will increase control current; turning the screw counterclockwise will decrease control current.

5. Disconnect the test equipment and reconnect the idle air stabilizer valve harness connector.

If the valve cannot be correctly adjusted, disconnect the harness connector from the idle speed control unit. Working at the harness connector, test the inputs to the control unit. Fig. 6-19 shows the connector terminals. **Table k.** lists the electrical tests. The idle speed control unit is located above the glove compartment to the left of the Motronic control unit. If no electrical faults can be found, the control unit is probably faulty and should be replaced.

6

NOTE —

325e models built before January 1985 may experience poor warm engine driveability when the air conditioning is on and when outside temperatures are above 68°F. If these symptoms are present, disconnect the harness connector at the idle speed control unit and peel back the rubber boot from the connector. Remove the brown/red wire from the connector. Insulate the wire end and tape it back to the harness. Reposition the boot and reconnect the harness connector.

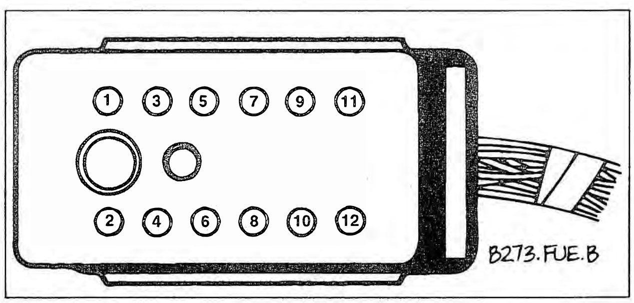

Fig. 6-19. Idle speed control unit harness connector terminal identification. Terminal numbers are also printed on connector. Remove trim panel above glove compartment to access control unit.

Table k. Idle Speed Control Unit Electrical Tests (1984 through 1987 325 and 325e models)

Component or circuit being tested	Test terminals on harness connector	Test conditions	Correct test value
Voltage supply to control unit	2 and ground	ignition ON	battery voltage (approximately 12 VDC)
Main ground	4 and ground		continuity
Coolant temp. switch	2 (+) and 6 (−)	ignition ON, coolant temp. below 86°F (30°C) ignition ON, coolant temp. above 118°F (48°C)	no voltage battery voltage (approximately 12 VDC)
Air temp. switch	10 (+) and 4 (−)	ignition ON, air temp. below 18°F (−8°C) ignition ON, air temp. above 39°F (4°C)	battery voltage (approximately 12 VDC) no voltage
Aut. trans. range switch	7 (+) and 4 (−)	ignition ON, selector lever in N or P position	battery voltage (approximately 12 VDC)
Throttle switch	12 (+) and 4(−)	ignition OFF, accelerator pedal in rest position ignition OFF, accelerator pedal slightly depressed	continuity no continuity
Air cond. ON signal	9 (+) and 4 (−)	ignition ON, air cond. ON	battery voltage (approximately 12 VDC)
Engine temp.	11 (+) and 4 (−)		resistance varies with temperature. Test coolant temperature sensor. See **6.2 Cold Start and Cold Running Enrichment**
Idle air stabilizer valve	1 and 5	ignition OFF	9–10 ohms at 73 ± 9°F (23 ± 5°C)
Engine speed (rpm)	3 and ground	LED test light connected between terminal 3 and ground. starter actuated	LED must flicker

Idle and Full Throttle Switch

The idle and full throttle switch is mounted as a single unit to the bottom of the throttle housing. Through this switch the control unit receives a signal whenever the throttle is fully closed (idle) or fully open (full throttle). An incorrectly adjusted switch can cause an erratic idle speed. The switch can be easily checked with the throttle housing installed. If the switch requires adjustment, the throttle housing should be removed as described in **6.1 Air Flow Measurement** to gain access to the switch's mounting screws.

NOTE —

A digital ohmmeter should be used to check and adjust the throttle switch. Some analog ohmmeters may not be sensitive enough to detect small amounts of resistance.

Before testing the switch, check that the switch is receiving voltage. With the ignition on, there should be at least 5 volts (VDC) between the center terminal and either of the outer terminals of the switch harness connector. If voltage is not present, test the electronic control unit inputs as described under **6.4 Electrical Tests**.

Test the switch by checking for continuity at the switch terminals. Connect an ohmmeter between terminals 2 and 18. See Fig. 6-20. Open the throttle part way by hand. Slowly let the throttle return to its idle stop. There should be continuity at the terminals when the throttle lever is approximately 0.20–0.60 mm (.008–.024 in.) from its stop. Connect an ohmmeter between terminals 3 and 18. Open the throttle slowly. There should be continuity when the throttle switch is within 10 ± 2° of the full-throttle position.

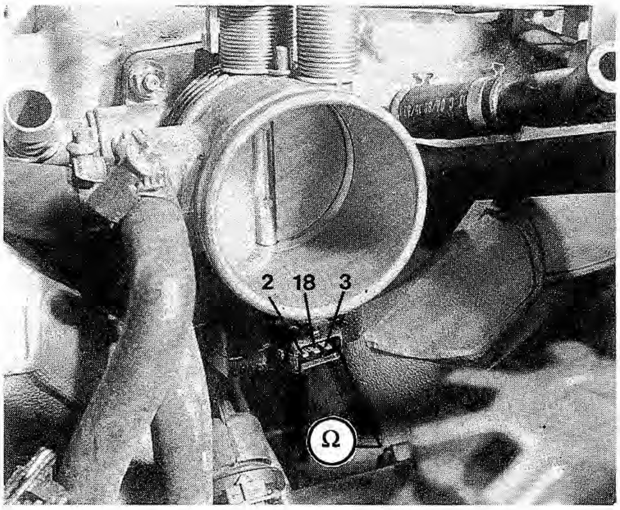

Fig. 6-20. Idle and Full throttle switch showing terminal identification.

If the switch does not operate as specified, remove the throttle housing and adjust switch position by loosening the mounting screws. With an ohmmeter connected across the switch's terminals and the throttle in the rest position, rotate the switch just until there is continuity. Tighten the mounting screws. Check the adjustment of the switch as described above.

6.4 Electrical Tests

These voltage and continuity tests can be used to help determine whether there are faults in the wiring or components that provide information to the Motronic control unit. If all inputs are found to be correct and the system still does not perform as specified, the control unit itself may be faulty.

As a general rule, a complete absence of the voltage or continuity specified in the tests suggests an open circuit in the wiring harness. Test results that differ from the specified values do not necessarily mean that components are faulty. Check carefully for connections that are loose or that are inadequate due to contamination or corrosion. Before testing, disable the ignition system by removing the main relay from the auxiliary relay panel. See **6.4 Electrical Tests** for relay location.

To make the tests, with the ignition turned off remove the Motronic control unit connector retaining screw and disconnect the connector. Then use a multimeter to check for voltage or continuity at the connector terminals. Use care to avoid damaging the delicate terminals with the meter probes. For best and safest results, fabricate a set of test leads as shown in Fig. 6-21. The Motronic control unit is located above the glove compartment. See Fig. 6-22. The test terminals are identified in Fig. 6-23. The tests are listed in **Table l** and **Table m**.

NOTE —

To achieve accurate test results, the battery voltage at the connector must be between 12 and 13 volts. Charge the battery if necessary. If the battery voltage is too high, turn on the headlights until the correct voltage is obtained.

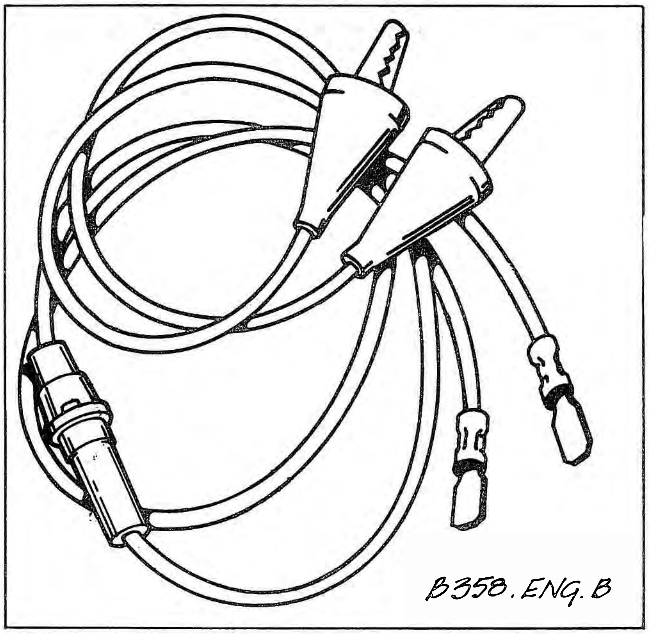

Fig. 6-21. Test leads made with flat connectors, alligator clips, and in-line fuse. Test leads are used to make contact without damaging control unit connector terminals.

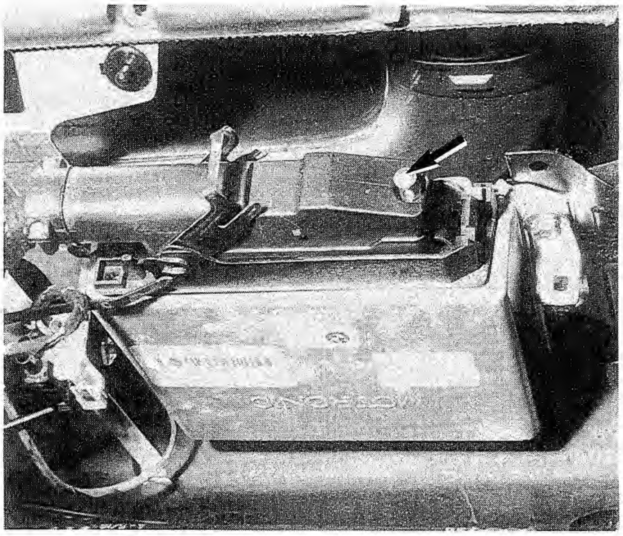

Fig. 6-22. 325i Motronic 1.1 control unit and connector. Retaining screw is shown at arrow. Other Motronic control unit connector is similar.

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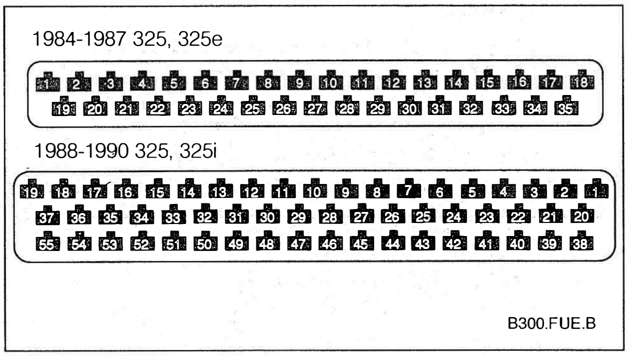

Fig. 6-23. Terminal identification for 35-point Motronic control unit connector (top) and 55-point Motronic 1.1 control unit connector (bottom).

CAUTION —

- *Use only a digital voltmeter, ohmmeter, or multimeter with high input impedance. The electrical characteristics of other types of test equipment may cause inaccurate results or damage to the electronic components. For more information, see* **FUNDAMENTALS**.

- *The ignition must be off before disconnecting or connecting any electrical connections.*

Table I. Motronic Control Unit Electrical Tests (1984 through 1987 325 and 325e models)

Component or circuit	Test terminals (at 35-point connector unless otherwise specified)	Test conditions	Correct test value
Voltage supply to control unit	18 and ground 35 and ground	ignition ON	battery voltage (approximately 12 VDC)
Main grounds	5 and ground 10 and ground 16 and ground 17 and ground 19 and ground	ignition OFF	continuity
Throttle switches	2 and ground 3 and ground	throttle closed open throttle slowly to half-open position, throttle fully open	continuity no continuity continuity
Fuel pump relay control	20 and ground	ignition ON	fuel pumps run (audibly) when terminal 20 is touched to ground
Starter input (terminal 50)	4 and ground	actuate starter	8 VDC (minimum)
Engine speed sensor	8 and 27	ignition OFF	960±96 ohms resistance
Reference sensor	25 and 26	ignition OFF	960±96 ohms resistance
Coolant temperature sensor	13 and ground	ignition OFF	resistance varies with temperature. See **6.2**
Fuel injector control (injectors 1, 2, and 3)	14 and ground	ignition ON	fuel injectors (1, 2, and 3) click when terminal 14 is touched to ground
Fuel injector control (injectors 4, 5, and 6)	15 and ground	ignition ON	fuel injectors (4, 5, and 6) click when terminal 15 is touched to ground
Air flow sensor	7 and 9	move sensor flap or actuate starter	resistance must fluctuate
Oxygen sensor	24 and ground	separate oxygen sensor connector and connect green wire to ground	continuity

Table m. Motronic 1.1 Control Unit Electrical Tests (1988 325 and all 325i models)

Component or circuit	Test terminals (at 55-point connector unless otherwise specified)	Test conditions	Correct test value
Main relay control	36 and ground		Main relay must click on when terminal 36 is touched to ground
Voltage supply to control unit	18 and ground 37 and ground	 bridge terminal 36 and 2 with fused jumper wire	battery voltage (approximately 12 VDC) battery voltage (approximately 12 VDC)
Main grounds	2 and ground 14 and ground 19 and ground 24 and ground		continuity
Throttle switches	52 and ground 53 and ground	throttle closed open throttle slowly to half-open position throttle fully open	continuity no continuity continuity
Fuel pump relay control	3 and ground	bridge terminal 36 and 2 with fused jumper wire	Fuel pumps run (audibly) when terminal 3 is touched to ground
Fuel injector control (injectors 1, 3, and 5)	16 and ground	bridge terminal 36 and 2 with fused jumper wire	fuel injectors (1, 3, and 5) click when terminal 16 is touched to ground
Fuel injector control (injectors 2, 4, and 6)	17 and ground	bridge terminal 36 and 2 with fused jumper wire	fuel injectors (2, 4, and 6) click when terminal 17 is touched to ground
Starter input (terminal 50)	27 and ground	ignition ON	battery voltage (approximately 12 VDC)
Reference sensor	48 and 47		540 ± 54 ohms resistance
Coolant temperature sensor	45 and ground		resistance varies with temperature. See **6.2**
Idle air stabilizer valve	4 and 22		40 ohms resistance
Air flow sensor	7 and 12	move sensor flap or actuate starter	Resistance must fluctuate
Evaporative emissions purge valve	5 and ground	bridge terminal 36 and 2 with fused jumper wire	purge valve clicks on when terminal 5 is touched to ground
Cylinder identification sensor	8 and 31		less that 1.0 ohm resistance
Air conditioning on signal	40 and ground 41 and ground	air conditioning switch ON ignition ON; ambient ternperature above 60°F (16°C)	battery voltage (approximately 12 VDC)
Automatic transmission park/neutral signal	42 and ground	selector lever in park or neutral position, ignition ON	battery voltage (approximately 12 VDC)

6

Testing Main Relay

The Motronic control unit, the fuel injectors, and the fuel pump relay all receive battery voltage from the main relay. On models with Motronic 1.1, the idle air stabilizer valve and the evaporative emission purge valve also receive battery voltage from the main relay. If the relay fails, the car will not start. Below is a quick test to help determine if the relay is faulty.

On 1984 through 1987 325 and 325e models, disconnect a harness connector from one of the fuel injectors. On 1988 325 models and all 325i models, disconnect the harness connector from the idle air stabilizer valve. Check for voltage between the red/white wire of the connector and ground with the ignition on. If battery voltage is present, the relay is probably working.

If voltage is not present, check the voltage supply and wiring to the control unit connector first before eliminating the main relay as a source of trouble. Next, remove the protective cover from the auxiliary relay panel on the left-hand (driver's side) fender. Remove the main relay from the relay panel. See Fig. 6-24. Check for voltage between terminal 30 and ground and also between terminal 86 and ground. If battery voltage is not present, check the large red wire between the relay socket and the battery junction block on the firewall. If battery voltage is present and no faults are found in the wires or the connectors, the relay is faulty and should be replaced.

CAUTION —

The main relay may be located in an adjacent position. To check if the main relay has been correctly identified, inspect the wires leading to the relay socket. There should be two large (4 mm) wires leading to the main relay socket.

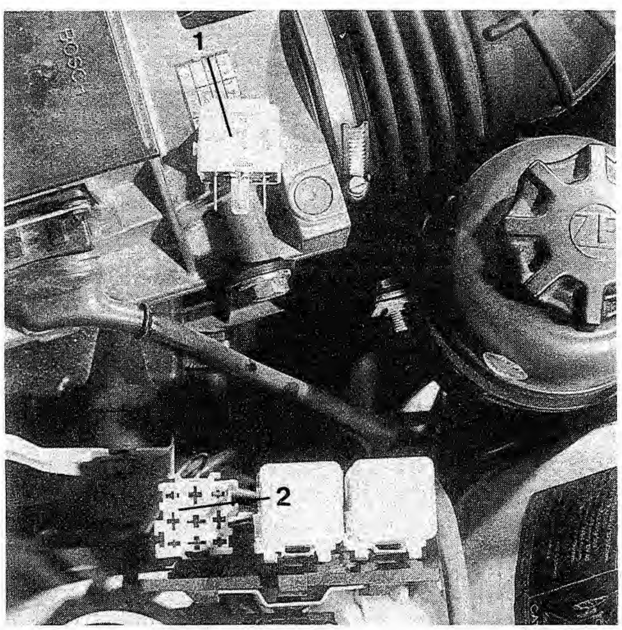

Fig. 6-24. Main relay (**1**) removed from relay socket (**2**).

6.5 Fuel Pressure Tests and Specifications

Although the quantity of fuel delivered to the engine is controlled primarily by how long the injectors are open, fuel pressure also influences fuel delivery. To eliminate the influence of fuel pressure variations, the fuel pressure is regulated by a diaphragm-type pressure regulator mounted to the end of the fuel rail. Pulsation dampeners are installed to reduce noise and pressure pulsations caused by the opening and closing injectors and by the fuel pump.

A vacuum hose connected to the top of the regulator helps to control the fuel pressure as a function of engine vacuum (manifold pressure). For more information on the pressure regulator, see **4.4 Fuel Pressure Regulator**.

CAUTION —

Cleanliness is essential when working with fuel system components. Before disconnecting any fuel lines, thoroughly clean the unions. Use clean tools.

System Pressure and Residual Pressure

System pressure is the pressure value that is maintained in the system by the pressure regulator. When fuel pressure from the pump reaches the desired system pressure, the regulator opens and routes fuel back to the fuel tank. System pressure is not adjustable.

To avoid fuel vaporization and hard starting (vapor lock) when the engine is hot, the system is designed to retain slight fuel pressure for after the engine has been turned off. This residual pressure is maintained by a check valve in the regulator and at the main fuel pump outlet. The fuel pump check valve is not serviceable as an individual part.

WARNING —

Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.

NOTE —

The fuel pressure gauge must have a range of at least 0–5 bar (0–75 psi) and must be securely connected to prevent it from coming loose under pressure.

To test system pressure:

1. On 1984 through 1987 325 and 325e models, loosen the hose clamp and remove the hose from the cold-start valve. Using a small length of fuel hose, two hose clamps, and a T-fitting, connect a fuel gauge between the cold-start valve and the supply line. See Fig. 6-25.

2. On 1988 325 models and all 325i models, disconnect the fuel supply line at the firewall end of the fuel rail. Using a small length of fuel hose, two hose clamps, and a T-fitting, connect a fuel gauge between the fuel rail and the supply line. See Fig. 6-25.

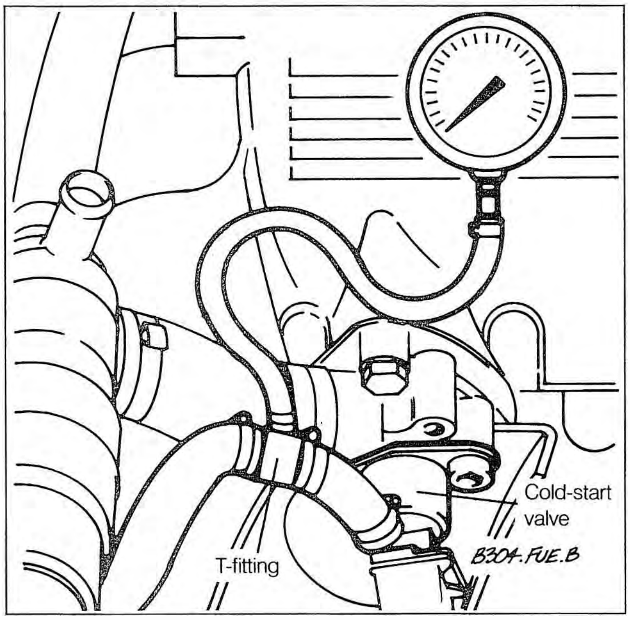

Fig. 6-25. Fuel pressure gauge connected between the cold-start valve and cold-start valve supply line. Connection at fuel rail supply line is similar.

3. Operate the fuel pump as described in **4.1 Fuses and Relays**.

4. Check that the fuel pressure corresponds to the specifications listed in **Table n**.

Table n. 325 Fuel Pressure Specifications

Model	Fuel pressure
325, 325e, 325es	2.5 ± .05 bar (36.3 ± 0.7 psi)
325i	3.0 ± .06 bar (43.5 ± 0.9 psi)

If the system pressure is too high, check the return line from the pressure regulator to the tank. Check for kinks in the hose. Blow compressed air through the line to check for blockages. If no faults can be found, the pressure regulator is faulty and should be replaced.

If the system pressure is too low, repeat the above pressure test while gradually clamping off the return hose at the fuel pressure regulator as shown in Fig. 6-26. The pressure should rise to at least 3.2 bar (46.4 psi) or possible higher. If it does, then the pressure regulator is faulty and should be replaced.

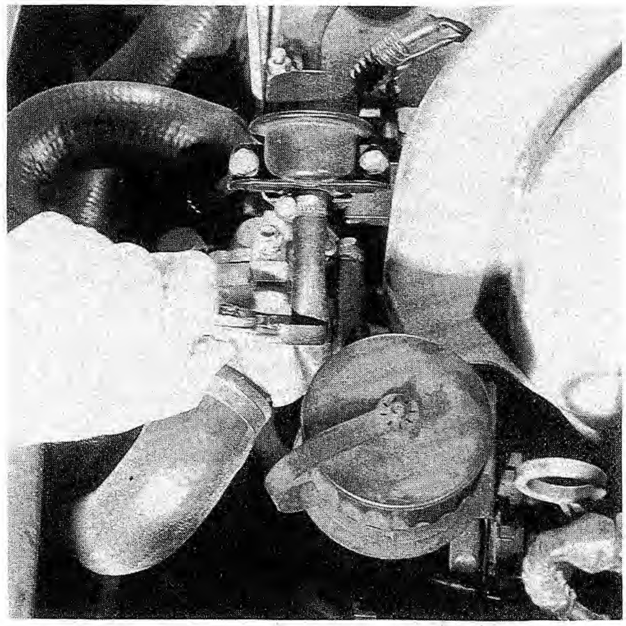

Fig. 6-26. Fuel pressure regulator return hose being clamped shut to check fuel pump delivery pressure.

If the pressure still drops, check visually for leaks. Leaks can also be due to a leaking cold-start valve or injector. If no leaks can be found, test the fuel pump as described in **4.3 Fuel Pump**.

To test fuel pressure regulator response to engine load:

1. Reinstall the fuel pump relay. Start the engine and allow it to idle. Check that the regulating pressure is as specified in **Table o**.

Table o. 325 Fuel Regulating Pressure

Model	Regulating pressure
325, 325e, 325es	2.3–2.7 bar (33.4–39 psi)
325i	2.8–3.2 bar (40.6–46.4 psi)

2. With the engine idling, remove the vacuum hose from the regulator. The pressure should increase.

3. Reconnect the hose and check that the pressure returns to the lower regulating pressure.

If any faults are found, the fuel pressure regulator is faulty and should be replaced. Disconnect the gauge and reconnect the fuel line to the cold-start valve or the fuel rail. Tighten the hose clamp.

6

Replacing Pressure Regulator

The fuel pressure regulator attaches to the fuel rail with two bolts. Disconnect the vacuum hose and the fuel return hose as shown in Fig. 6-27. Remove the bolts and pull the regulator from the fuel rail. Inspect the O-ring for damage and replace it if necessary. Installation is the reverse of removal. Be sure the code number on the side of the old pressure regulator matches that of the new regulator.

> ***WARNING —***
> *Fuel will be discharged. Do not disconnect any wires that could cause electrical sparks. Do not smoke or work near heaters or other fire hazards. Keep an approved fire extinguisher handy.*

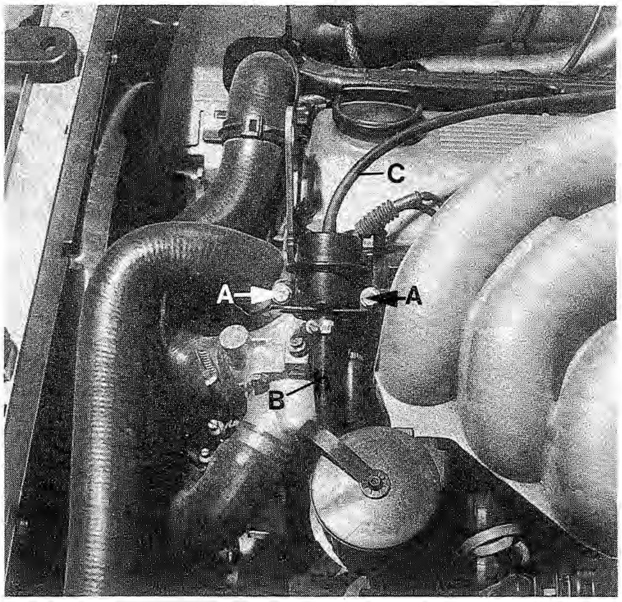

Fig. 6-27. Fuel pressure regulator mounting bolts (**A**), return fuel line (**B**), and vacuum line (**C**).

6.6 Idle Specifications (rpm and % CO)

Idle speed and ignition timing are electronically controlled and are therefore not adjustable. In addition, idle mixture is not adjustable on models with Motronic 1.1. However, checking idle speed and idle mixture (% CO) together is a good way to determine the general condition of the Motronic system.

The Motronic fuel management systems installed on the cars covered by this manual are adaptive. In other words, if any of the above operating parameters are not within specified limits, the system will electronically self-correct, within limits, until the correct settings are obtained.

Making these checks requires special test equipment. If the equipment necessary to accurately perform this work is not available, we suggest turning the job over to an authorized BMW dealer or other qualified repair shop. In a properly equipped shop, these checks can be made quickly, accurately, and at reasonable cost. Idle specifications can be found under **7. Fuel System Technical Data**.

When checking idle mixture, the following requirements apply:

1. The engine must be at normal operating temperature (oil temperature at approximately 140°F (60°C)).
2. All electrical accessories should be off (including the auxiliary radiator cooling fan—make adjustments only when the fan is not on).
3. The throttle switch must be operating correctly.
4. The exhaust system must be free of leaks.
5. There must be no engine vacuum leaks.
6. The valves must be correctly adjusted.
7. The oxygen sensor must be operating correctly.

> **NOTE —**
> CO readings may be affected by the presence of unburned gasoline and combustion by-products in the engine oil. For the most accurate CO settings, always change the engine oil and filter before making any adjustments.

To check and adjust idle mixture (%CO):
(1984 through 1987 325, 325e, 325es only)

1. Disconnect from the throttle housing the small hose that runs from the housing to the charcoal canister. See Fig. 6-28. Do not plug the hose or the hose fitting.
2. Remove the CO tap bolt from the exhaust manifold. The bolt is directly below the no. 5 cylinder plug wire. Install a threaded adapter with a pipe fitting and connect the hose of the exhaust gas analyzer to the adapter.

> **NOTE —**
> • Exhaust gas content should only be measured at the exhaust manifold. Checking the exhaust gas content at the tailpipe is checking the gas after it has been cleaned by the catalytic converter.
>
> • The special exhaust manifold adapter (BMW Tool No. 13 0 100) is available from an authorized BMW dealer parts department.

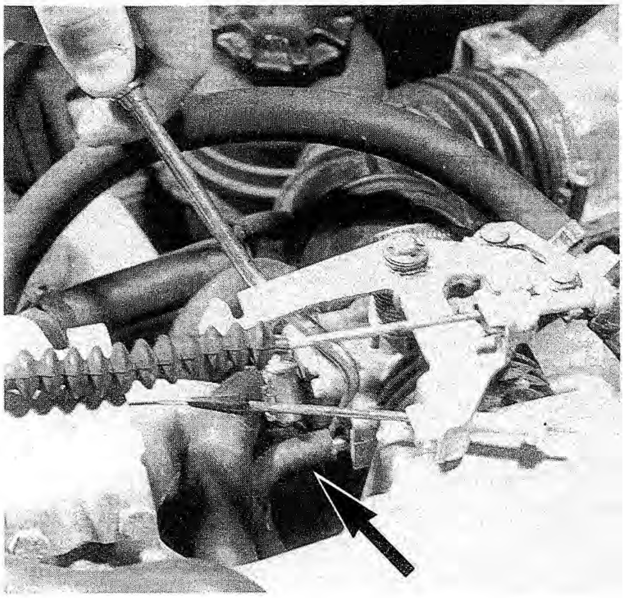

Fig. 6-28. Small vacuum hose from charcoal canister (arrow) being removed and vented to atmosphere.

3. Disconnect the oxygen sensor harness connector. See Fig. 6-29.

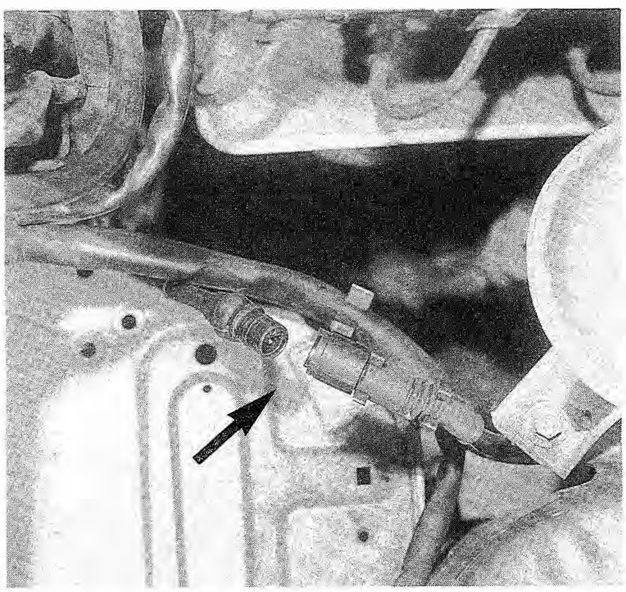

Fig. 6-29. Oxygen sensor harness connector (arrow).

4. With the anti-tampering plug removed, adjust the idle mixture using a 5 mm hex wrench. **Table p** lists idle specifications.

Table p. Idle Specifications (1984–1987 325, 325e, 325es)

Specification	Value
Idle speed	700 rpm ± 50
% CO	0.2–1.2%

NOTE —

- Check the idle mixture with and without the oxygen sensor connected before making any adjustments. The idle mixture should be almost the same in both cases. If there is a big difference, the CO screw may be misadjusted, or there may be other faults such as a vacuum leak or a faulty injector. See ENGINE MANAGEMENT—DRIVEABILITY for more troubleshooting information.

- The idle mixture screw can only be adjusted after removing the anti-tampering plug in the air flow sensor housing. See Fig. 6-30. This small plug is removed by drilling with a 2.5 mm (3/32 in.) drill bit and threading a screw into the plug so that it can be extracted with pliers. Turning the screw counterclockwise makes the mixture leaner (lower % CO). Turning it clockwise makes the mixture richer (higher % CO).

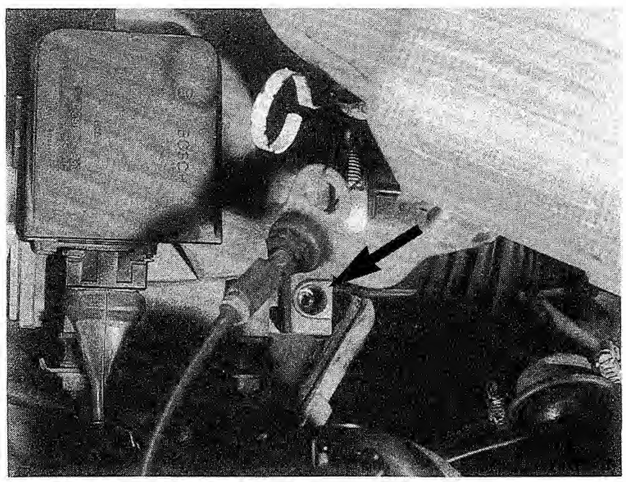

Fig. 6-30. Air flow sensor idle mixture screw (arrow), beneath anti-tampering plug.

5. Turn the engine off and disconnect all test equipment. Install the exhaust manifold tap bolt. Reconnect the oxygen sensor harness connector. Replace the anti-tampering plug.

6

7. Technical Data

I. L-Jetronic Fuel Injection Specifications (1984 and 1985 318i models)

Fuel pump delivery rate	
with fuel pump operated for 30 seconds	875 ml (30 oz.)
Transfer pump delivery pressure	0.3 bar (4.3 psi)
System fuel pressure	3.0 ± 0.06 bar (43.5 ± 0.9 psi)
System regulating pressure	2.8–3.2 bar (40.6–46.4 psi)
Fuel injector coil resistance	
code no. 0 280 150 704	14.5–17.5 ohms
code no. 0 280 150 211	14.5–17.5 ohms
Idle speed (non-adjustable)	750/850 ± 50 rpm
Idle mixture (electronically adjusted)	See **5.6 Idle Specifications (rpm and % CO)**

NOTE —

Most 318i models have an idle speed of 750 ± 50 rpm. Models with an idle speed of 850 ± 50 rpm have been modified according to an authorized BMW dealer field fix (No. 84-1.8V5-2). To determine if the car has been modified, look for a sticker attached to the driver's side fender, near the shock tower. The sticker will contain the new idle speed specification.

II. Motronic Fuel Injection Specifications (1984-1987 325, 325e models)

Fuel pump delivery rate	
with fuel pump operated for 30 seconds	875 ml (30 oz.)
Transfer pump delivery pressure	0.3 bar (4.3 psi)
System fuel pressure	2.5 ± 0.05 bar (36.3 ± 0.7 psi)
System regulating pressure	2.3–2.7 bar (33.4–39 psi)
Fuel injector coil resistance	
code no. 0 280 150 716	14.5–17.5 ohms
code no. 0 280 150 126	2.0–3.0 ohms
Idle speed (non-adjustable)	700 ± 50 rpm
Idle mixture	0.2–1.2% CO

III. Motronic 1.1 Fuel Injection Specifications (1988 325 and all 325i models)

Fuel pump delivery rate	
with fuel pump operated for 30 seconds	875 ml (30 oz.)
System fuel pressure	
1988 325	2.5 ± 0.05 bar (36.3 ± 0.7 psi)
325i, 325is, 325iC	3.0 ± 0.06 bar (43.5 ± 0.9 psi)
System regulating pressure	
1988 325	2.3–2.7 bar (33.4–39 psi)
325i, 325is, 325iC	2.8–3.2 bar (40.6–46.4 psi)
Fuel injector coil resistance	
code no. 0 280 150 715	14.5–17.5 ohms
code no. 0 280 150 126	2.0–3.0 ohms
Idle speed (non-adjustable)	
1988 325	720 ± 40 rpm
325i, 325is, 325iC	760 ± 40 rpm
Idle mixture (non-adjustable)	
1988 325	0.2–1.2% CO
325i, 325is, 325iC	0.4–0.8% CO

Section 7

COOLING SYSTEM

Contents

7

Cooling System

Introduction

The engines covered by this manual are liquid-cooled, and rely on a closed system of circulating coolant to maintain an even engine temperature and help transfer heat away from the engine. To provide adequate cooling system performance over a range of temperature conditions, lubricate the system's moving parts, and prevent the buildup of mineral deposits and other contaminants, the coolant recommended for use year-round is a mixture of phosphate-free anti-freeze and clean water. The closed system becomes pressurized at normal engine operating temperature. Under pressure the boiling point of the coolant is increased, allowing the engine and cooling system to operate at higher temperatures without boiling the coolant.

The coolant pump is driven mechanically by the engine, and operates continuously whenever the engine is running. Coolant circulates through the engine to the radiator, the heat exchanger or heater core in the passenger compartment heating system, and back to the pump. Before the engine is up to normal operating temperature, the flow of coolant is controlled by a thermostat. When closed, the thermostat forces coolant to bypass the radiator and return directly to the coolant pump, retaining as much heat as possible until the engine is warm.

A primary radiator cooling fan driven by the engine draws air through the radiator any time the engine is running. The fan is mounted on a viscous drive unit that, depending on engine compartment temperature, limits the amount of engine power that is absorbed in driving the fan. On most models, an auxiliary cooling fan is located in front of the radiator. This fan is electrically operated and thermostatically controlled so that it runs only when the extra air flow is required to maintain proper coolant temperature.

Proper care of the cooling system is easy. Simple preventive maintenance can keep the system operating at its best and help prevent temperature-related problems from shortening engine life. If you lack the tools or a suitable workspace for servicing the cooling system, we suggest you leave this work to an authorized BMW dealer or other qualified shop. We especially urge you to consult your authorized BMW dealer before beginning any repairs on a car still covered by the manufacturer's warranty.

1. GENERAL DESCRIPTION

Fig. 1-1 and Fig. 1-2 are schematic views of the cooling systems installed on 4-cylinder and 6-cylinder engines. Arrows indicate the direction of coolant flow.

Coolant Pump and Thermostat

A centrifugal-type coolant pump is mounted to the front of the cylinder block. The pump is crankshaft-driven by a V-belt and circulates coolant through the system whenever the engine is running.

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

Radiator

The radiator is constructed of an aluminum core and plastic side tanks. On 6-cylinder engines, a translucent expansion tank, or overflow reservoir, provides for the expansion of the coolant at higher temperatures and easy monitoring of coolant level.

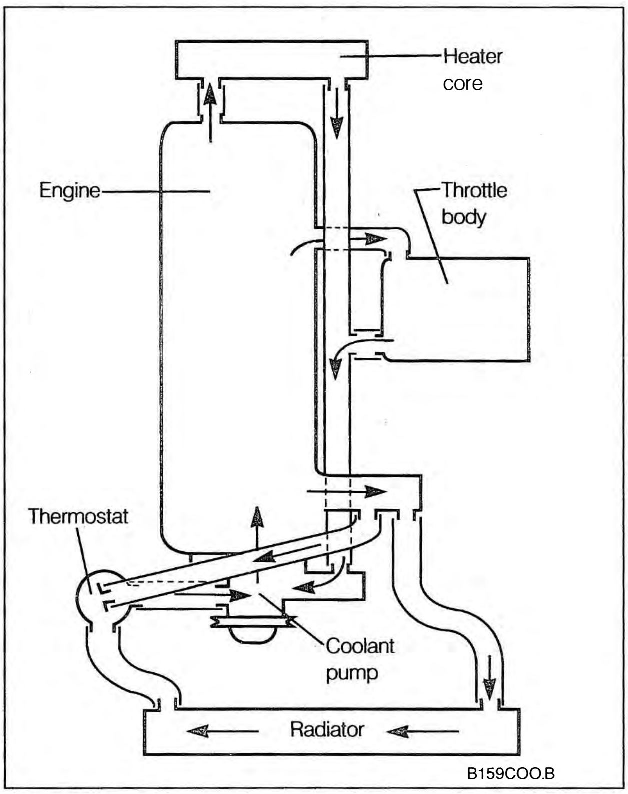

Fig. 1-1. Schematic view of cooling system components and hose routing showing coolant flow (**arrows**) for 4-cylinder engine.

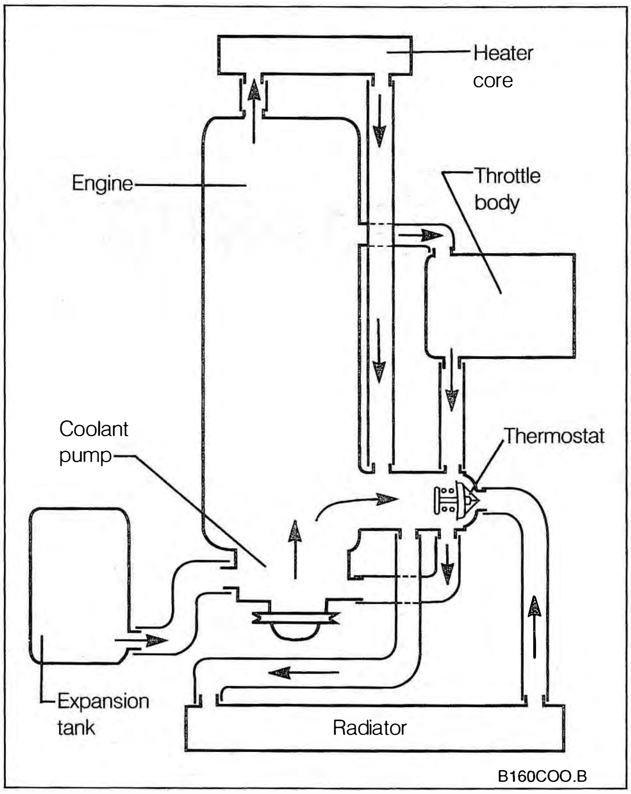

Fig. 1-2. Schematic view of cooling system components and hose routing showing coolant flow (**arrows**) for 6-cylinder engine.

Radiator Cooling Fan

The primary cooling fan is mounted to the coolant pump through a fan clutch. The fan clutch is a viscous coupling which controls the speed of the fan based on engine compartment temperature. The electric auxiliary cooling fan is mounted in front of the radiator and operates independent of the engine. Power to the auxiliary fan is controlled by thermo-switches mounted on the radiator. High coolant temperature closes a switch to start the cooling fan. When the coolant temperature is in the correct range, the switch opens. An additional circuit powers the auxiliary cooling fan whenever the air conditioning is on.

2. MAINTENANCE

BMW specifies the following steps for proper maintenance of the cooling system, to be carried out at particular time or mileage intervals. For information on the prescribed maintenance intervals and these maintenance steps, see **LUBRICATION AND MAINTENANCE**.

1. Checking coolant level and anti-freeze protection (concentration)
2. Inspecting coolant pump V-belt tension and condition
3. Inspecting coolant hoses for leaks; checking tightness of hose clamps
4. Replacing engine coolant

3. TROUBLESHOOTING

This troubleshooting section applies to problems affecting the cooling system, which includes the components that store, pump, and regulate circulation of the engine coolant.

Problems associated with the operation and repair of the heating system are covered in **BODY AND INTERIOR**. Removal and replacement of the coolant temperature gauge is covered in **ELECTRICAL SYSTEM**.

Overheating problems may also be caused by an engine fault that allows hot combustion gases to leak into the cooling system, or by incorrect ignition timing. See **ENGINE** or **IGNITION** for more information.

3.1 Basic Troubleshooting Principles

When investigating the cause of overheating or coolant loss, begin with a visual inspection of the system. Check coolant level and check for evidence of coolant leaks. Leaks can occur at any place in the cooling system where there is a bolted housing or other connection.

The closed cooling system becomes pressurized at normal operating temperature, and maintaining this pressure is an important system function. Leaks may prevent the system from becoming pressurized and allow the coolant to boil at a lower temperature. If visual evidence is inconclusive, a cooling system pressure test will determine whether the system leaks, and may help to indicate the source. See **3.2 Diagnostic Tests**.

If the cooling system is full of coolant and holds pressure, the next most probable cause of overheating is poor coolant circulation caused by a broken V-belt, a failed thermostat, a pinched or restricted hose, or a clogged system. In warm weather, virtually all clogs are caused by neglect of the coolant, or by the addition of substances to the coolant that are not recommended. In cold weather, the cooling system may also be clogged by frozen coolant resulting from an inadequate amount of anti-freeze.

The engine-driven coolant pump is subject to wear, just as any other rotating engine part. Complete failure of the pump to circulate coolant is unusual, but excessive wear may cause noisy operation or coolant leaks at the pump shaft.

An otherwise sound cooling system may still overheat, particularly with prolonged idling, due to a failure of either the primary cooling fan or the auxiliary cooling fan. The primary cooling fan is controlled by a temperature-dependent fan clutch, shown in Fig. 3-1. A failed fan clutch may affect air flow through the radiator, resulting in overheating or possibly overcooling. See **4.3 Coolant Pump** for more information on the fan clutch. The electrically operated auxiliary cooling fan should be switched on and off according to engine coolant temperature. If the auxiliary fan does not operate, see **4.4 Auxiliary Cooling Fan** for testing information.

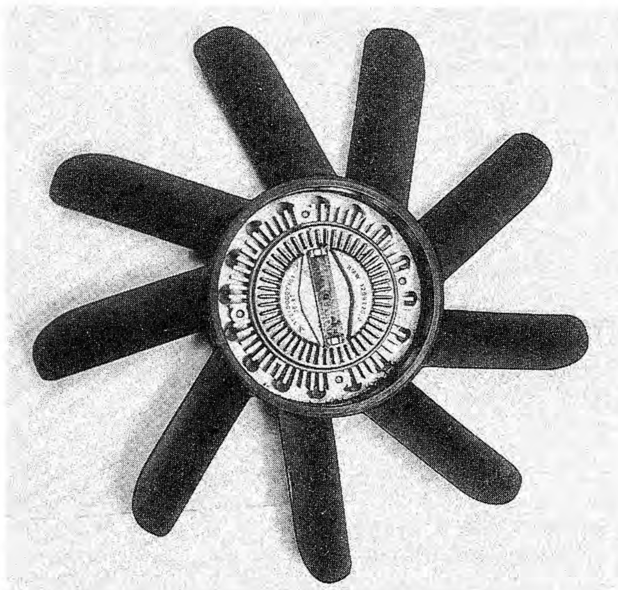

Fig. 3-1. Primary cooling fan and clutch assembly.

Table a lists overheating and underheating symptoms, their probable causes, and suggested corrective actions. The bold numbers in the corrective action column refer to headings in this section where the suggested repairs are described.

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Table a. Cooling System Troubleshooting

Symptom	Probable cause	Corrective action
1. Engine overheats	a. Low coolant level	a. Fill cooling system; Pressure-test system to check for leaks **3.2**
	b. Burst hose	b. Replace hose. Refill cooling system **4.1, 3.2**
	c. Radiator hose restricted (faulty lower hose may collapse only at high engine speeds)	c. Replace hose. **4.1**
	d. V-belt loose or broken	d. Inspect V-belt; adjust or replace as necessary. **4.3**
	e. Faulty thermostat	e. Remove and test thermostat. Replace if necessary. **4.2**
	f. Auxiliary fan not switching on	f. Test thermo-switch and fan. Replace faulty part. **4.4**
	g. Faulty cap on radiator or expansion tank	g. Pressure-test cap and replace if faulty. **3.2**
	h. Clogged radiator	h. Clean or replace radiator **4.5**
	i. Incorrect ignition timing or valve timing	i. Check ignition timing; See **IGNITION**; Check camshaft drive chain (4-cylinder) or drive belt (6-cylinder). See **ENGINE**
	j. Coolant pump faulty	j. Inspect coolant pump. Repair or replace if necessary. **4.3**
2. Temperature gauge reads low (heater output inadequate)	a. Faulty thermostat	a. Remove and test thermostat. **4.2.**
	b. Auxiliary cooling fan not switching off	b. Replace thermo-switch for fan. **4.4.**
	c. Cooling fan clutch hub seized.	c. Inspect clutch and replace if faulty. **4.3.**
3. Temperature gauge reads low (heater output normal)	a. Faulty temperature gauge or sending unit	a. Test temperature gauge and sending unit. Replace faulty part. **3.2**
4. Heater output inadequate (temperature gauge reading normal)	a. Heater hose restricted	a. Replace hose. **4.1.**
	b. Heat exchanger (heater core) clogged or heating valve clogged or faulty	b. Replace heater exchanger or heating valve or have core cleaned. See **BODY AND INTERIOR**
	c. Heater controls broken or out of adjustment	c. Adjust or replace controls. See **BODY AND INTERIOR**

3.2 Diagnostic Tests

These system tests are used to help diagnose cooling system problems and isolate their causes.

Pressure Testing

A pressure test will help find any leaks and show whether the cooling system can maintain pressure. If the system cannot maintain pressure, the boiling point of the coolant will be reduced and the engine will overheat more easily. Various kinds of cooling system pressure testers are available, such as Snap-on® tool no. SVT 262. Follow the instructions supplied by the tester's manufacturer. If such a tool is not available, an authorized BMW dealer or other qualified repair shop can perform this test inexpensively.

With the engine at normal operating temperature, pressurize the system to 1 bar (14 psi) using a pressure tester. See Fig. 3-2. Inability to maintain this pressure indicates leaks which may also be detected by the seepage of coolant. If the pressure drops rapidly and there is no sign of coolant leakage, the cylinder head gasket may be faulty. Inability to build pressure or an especially rapid pressure drop indicates a more serious leak, possibly due to a cracked cylinder head. See **ENGINE** for more information.

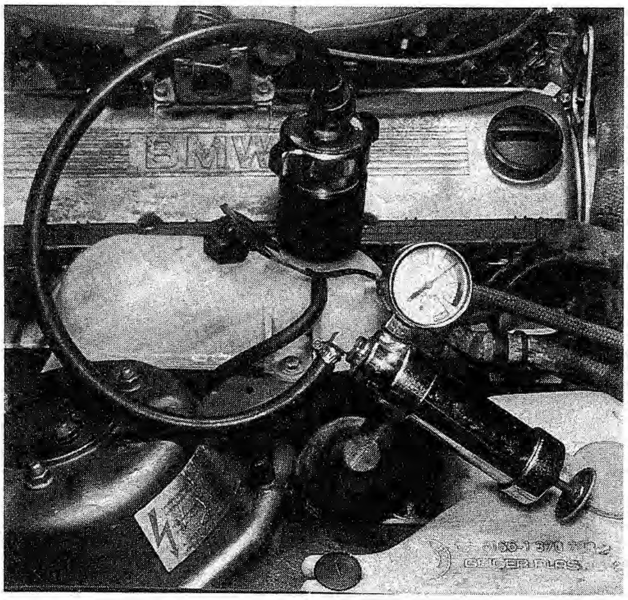

Fig. 3-2. Pressure tester shown installed on expansion tank of 6-cylinder engine. On 4-cylinder engine, install pressure tester in place of radiator cap.

CAUTION

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

To test the cap, install the cap on the pressure tester and increase the pressure to the cap's opening pressure. The correct specification—1 bar (14 psi) or 1.2 bar (17 psi)—is molded into the top of the cap. See Fig. 3-3. The pressure relief valve should open at the specified pressure, but not below. Relieve the pressure, remove the cap from the tester and lift up on the vacuum valve on the inside of the cap. See Fig. 3-4. The vacuum valve should spring back into position on its seat. Inspect the cap's gasket. A faulty cap or a damaged cap gasket should be replaced.

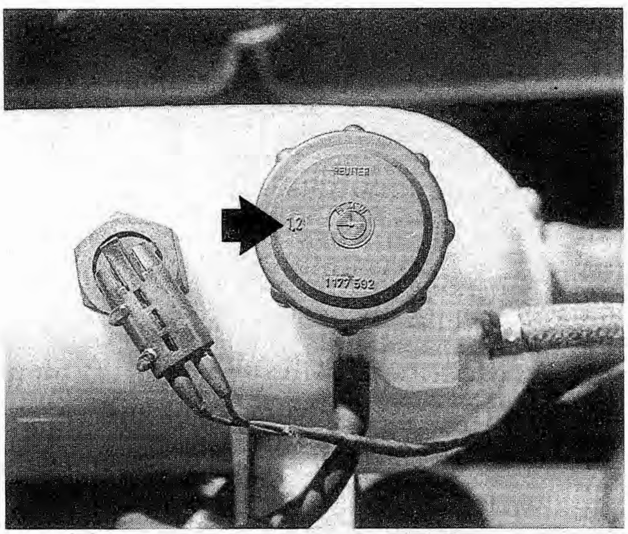

Fig. 3-3. Expansion tank cap (6-cylinder engine) showing opening pressure specification (**arrow**).

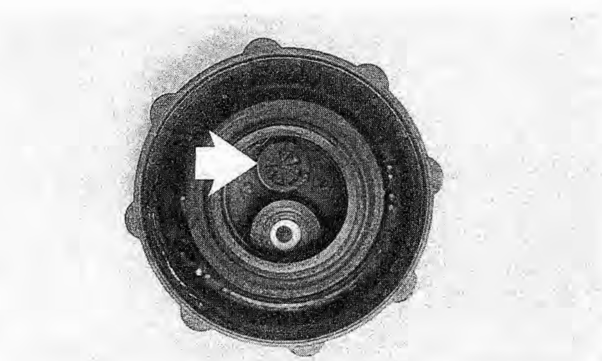

Fig. 3-4. Inside of radiator cap showing location of vacuum valve (**arrow**).

Temperature Gauge and Sending Unit Quick-Check

A quick, easy test will determine whether the coolant temperature gauge is functioning correctly.

If the temperature gauge needle remains at its rest position even though the engine is fully warmed, test the gauge as follows. With the engine not running, disconnect the electrical connector from the temperature sending unit. See Fig. 3-5. With the ignition on, use a jumper wire to briefly touch the connector terminal to ground, simulating a high engine temperature signal to the gauge. If the gauge needle moves upward, the sending unit is faulty and should be replaced. If the needle still does not move, either the wire to the gauge is broken (open circuit) or the gauge is faulty.

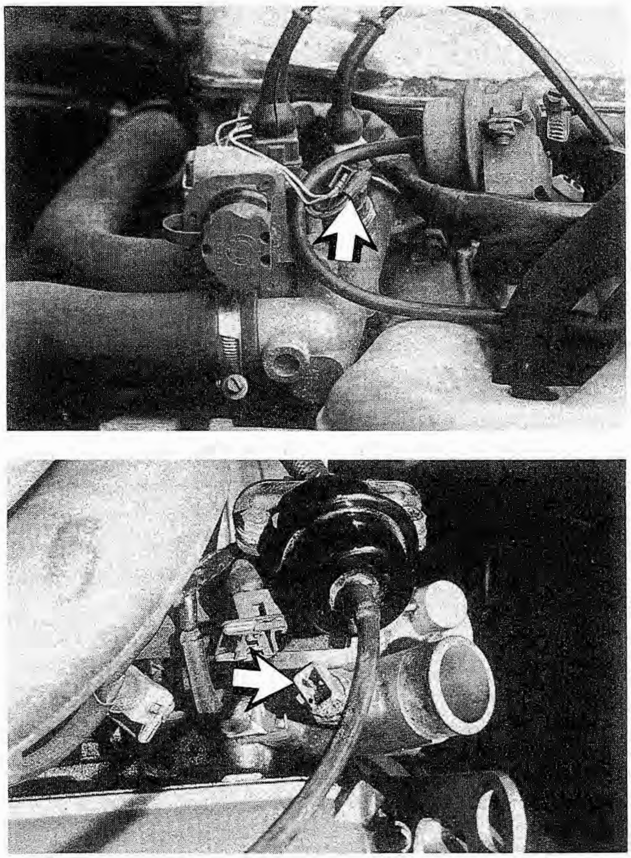

Fig. 3-5. Coolant temperature sender (brown/violet wire) on 4-cylinder engine (**top arrow**) and 6-cylinder engine (**bottom arrow**).

If the gauge reads too high when the engine is cold, test by disconnecting the electrical connector from the sending unit. If the needle drops to a lower reading, the sending unit is faulty. If the needle position does not change, the wire or the gauge is shorted to ground. See **ELECTRICAL SYSTEM**.

4. Cooling System Service

Most cooling system repairs are easy and require relatively little time. Always plan to replace gaskets and seals and have those on hand before beginning.

WARNING —

• At normal operating temperature the cooling system is pressurized. Allow the system to cool as long as possible before opening—a minimum of several minutes—then release the cap very slowly to allow safe release of pressure.

• Releasing cooling system pressure lowers the coolant's boiling point, and the coolant may boil suddenly. Use heavy gloves and wear eye or face protection to guard against scalding.

• Use extreme care when draining and disposing of engine coolant. Coolant is poisonous and lethal to pets. Pets are attracted to coolant because of its sweet smell and taste. See a veterinarian immediately if any amount of coolant is ingested by the animal.

CAUTION —

Avoid adding cold water to the coolant while the engine is hot or overheated. If it is absolutely necessary to add coolant to a hot system, do so only with the engine running and coolant pump turning.

4.1 Coolant and Cooling System Hoses

To guard against cooling system trouble the coolant level and the hoses should be inspected periodically, as described in **LUBRICATION AND MAINTENANCE**. Hoses deteriorate with time, and periodic inspection will help prevent unexpected failure.

CAUTION —

BMW recommends the use of phosphate-free anti-freeze to avoid the formation of harmful, clogging deposits in the cooling system. Use of anti-freeze containing phosphates is considered by BMW to be harmful to the cooling system.

Always mix anti-freeze with clean water. Distilled water is best because of its reduced mineral content. Oil in the coolant will encourage the formation of sludge which can clog the system and damage rubber parts. Oil should never be added as a lubricant. If using leak sealer as a precaution against leaks, the system should never contain more than one can. The additives that plug leaks can also plug radiators and heater cores.

Draining the coolant is a first step in almost all cooling system repairs. Coolant can be reused provided it is drained into a clean pan. New coolant is recommended every 2 years. Replacing hoses or draining and filling the coolant requires only a large-sized Phillips head screwdriver or a medium-sized flat blade screwdriver and a 3-gallon drain pan.

CAUTION —

Do not reuse the coolant when replacing damaged engine parts. Contaminated coolant may damage the engine or cooling system.

Draining and Filling Coolant

Set the temperature control lever in the passenger compartment to the warm position. Loosen the cap on the radiator or the coolant expansion tank. To drain the coolant from the radiator only, loosen and remove the drain plug at the bottom of the radiator. See Fig. 4-1. Alternatively, drain the radiator by removing the lower radiator hose. Hose removal is described below. To drain the coolant from the engine block, loosen and remove the block drain plug on the right side of the engine block. See Fig. 4-2.

Before refilling the system, reinstall the radiator drain plug or the lower radiator hose. Torque the radiator drain plug to 1.5 to 3.0 Nm (1.2 to 2.2 ft. lb.). Replace the metal gasket on the block drain plug if it is crushed or otherwise damaged. Torque the block drain plug to 50^{+6}_{-0} Nm (36^{+4}_{-0} ft. lb.).

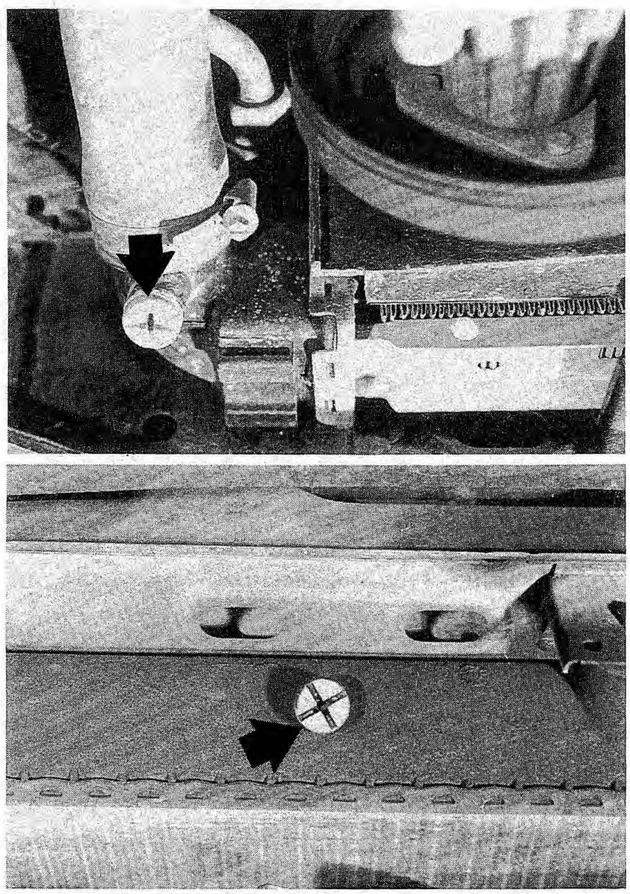

Fig. 4-1. Location of radiator drain plug on 6-cylinder engine (**top arrow**) and 4-cylinder engine (**bottom arrow**).

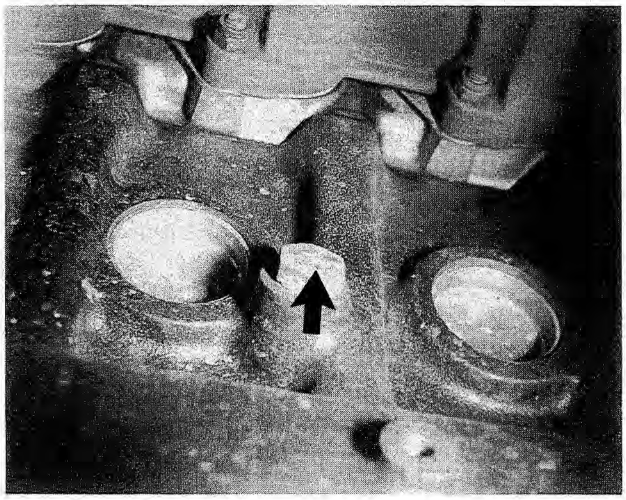

Fig. 4-2. Typical location of coolant drain plug (**arrow**) on right side of engine (6-cylinder engine shown).

Using a coolant mixture of 50% anti-freeze and 50% water, fill the system slowly so that air is allowed to escape. Cooling system capacities are given in **Table b.**

Table b. Cooling System Capacities

Model	Approximate capacity liters (quarts)
318i	7.0 (7.4)
325e(es), 325	11.0 (11.6)
325i(is), 325i Convertible	10.5 (11.1)

On 4-cylinder engines, add coolant until the level is approximately 20 mm (¾ in.) below the top of the cap. Start the engine and let it idle, rechecking the coolant level after it has had a chance to circulate.

On 6-cylinder engines, air may become trapped in the system during filling due to the design of the cooling system. This trapped air can prevent good coolant circulation. First, add coolant until the level reaches the mark on the coolant reservoir shown in Fig. 4-3, then bleed trapped air from the system as described below.

To bleed air from the system on 6-cylinder models, loosen the 8 mm bleeder screw and add coolant until it spills from the screw. See Fig. 4-4. Tighten the screw and start the engine. With the engine idling at normal operating temperature, loosen the bleeder screw until the coolant spilling out is free from air bubbles, then tighten the screw. After the engine has cooled, recheck the coolant level and add coolant as necessary.

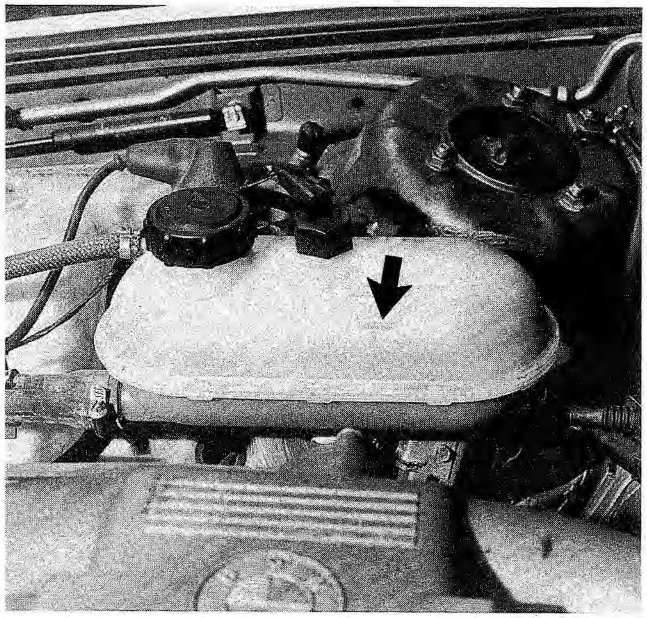

Fig. 4-3. Fill mark on coolant expansion tank on 6-cylinder engine (**arrow**). Coolant level should be at mark when engine is cold.

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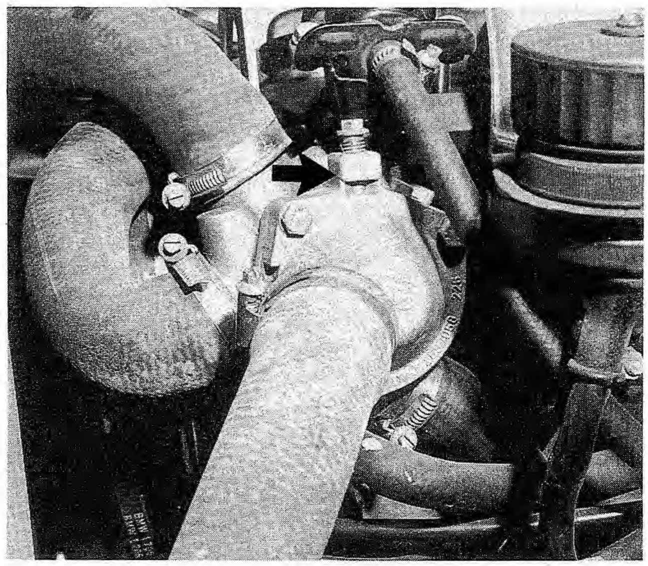

Fig. 4-4. Location of bleeder screw on thermostat housing of 6-cylinder engine (**arrow**).

To replace a hose:

1. Drain the coolant as described above.

2. Remove the hose. Using a screwdriver, loosen each hose clamp and slide the clamps away from the hose ends.

NOTE —

If a radiator hose is stuck to the radiator connection, cut the old hose off the connection as shown in Fig. 4-5. Prying the hose loose may damage the connection or the radiator.

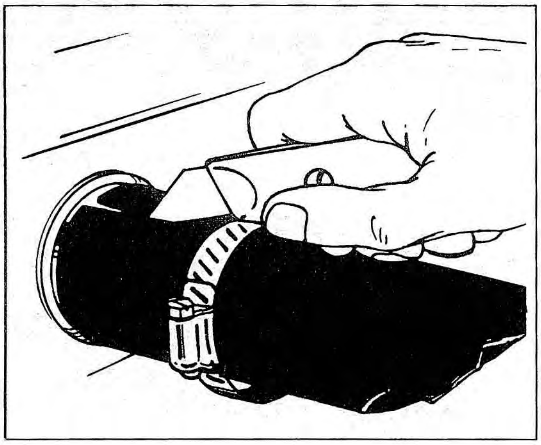

Fig. 4-5. Stuck hose being removed by cutting.

3. Clean the hose connections and remove any bits of old hose and sealer, using a wire brush if necessary.

4. Install the new hose. Slide the loose clamps over the hose and slide the hose ends over the connections.

5. Position and tighten the clamps. Place the clamp as near the bead as possible and at least 4 mm (5⁄32 in.) from the hose end, as shown in Fig. 4-6. Tighten the clamps enough to compress the hose firmly around the connections.

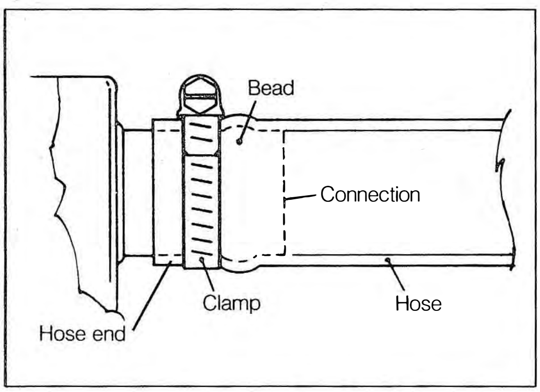

Fig. 4-6. Hose clamp correctly installed on hose end.

CAUTION —

Do not overtighten clamps. Tighten just enough to seal. Overtightening may damage the hose and cause premature failure.

6. Refill the radiator as described in **Draining and Filling Coolant**. Run the engine until warm. Check and if necessary retighten the hose clamps, and check for leaks. Check once more after the engine has cooled.

4.2 Thermostat

The thermostat controls coolant temperature by regulating coolant flow to the radiator. 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.

Replacement is only necessary if the thermostat is faulty. On 6-cylinder engines, in addition to the tools required to drain the coolant, a socket wrench is required to remove the thermostat housing. On 4-cylinder engines, no additional tools are required.

Removing and Installing Thermostat

Before removing the thermostat, drain the coolant as described in **Draining and Filling Coolant**.

On 6-cylinder engines, remove the three thermostat housing mounting bolts and separate the housing from the cylinder head. Pull the thermostat with its O-ring from the coolant outlet on the cylinder head. See Fig. 4-7. To install, position the thermostat in the cylinder head as shown in Fig. 4-8. Using a new O-ring, install the thermostat housing, and torque the bolts to 9 ± 1 Nm (80 ± 5 in. lb.). Reinstall the disconnected hoses. Fill and bleed the cooling system as described in **Draining and Filling Coolant**. Warm the engine and check for leaks. Check again after the engine has cooled.

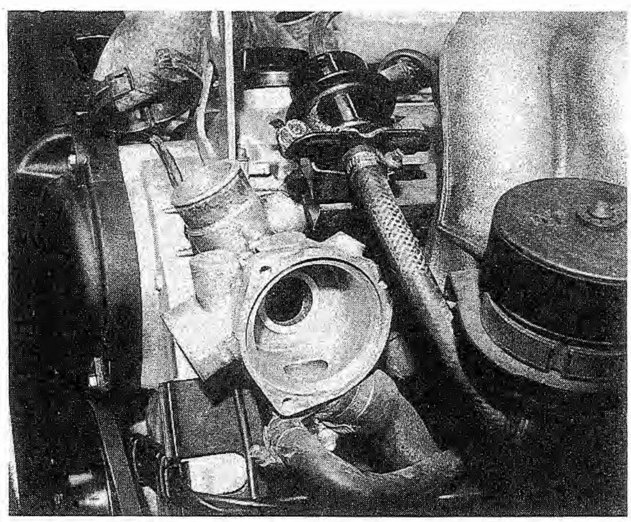

Fig. 4-7. 6-cylinder coolant outlet (on cylinder head) with thermostat housing, thermostat, and O-ring removed.

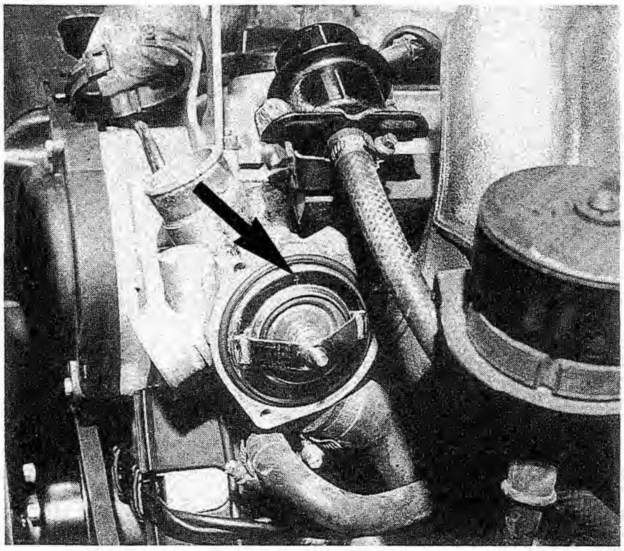

Fig. 4-8. Thermostat correctly positioned in coolant outlet. Arrow shaped mark (**arrow**) must point up.

On 4-cylinder engines, loosen the three hose clamps on the thermostat housing and separate the upper and lower hoses from the housing. See Fig. 4-9. Pull the housing from the remaining hose. Installation is the reverse of removal.

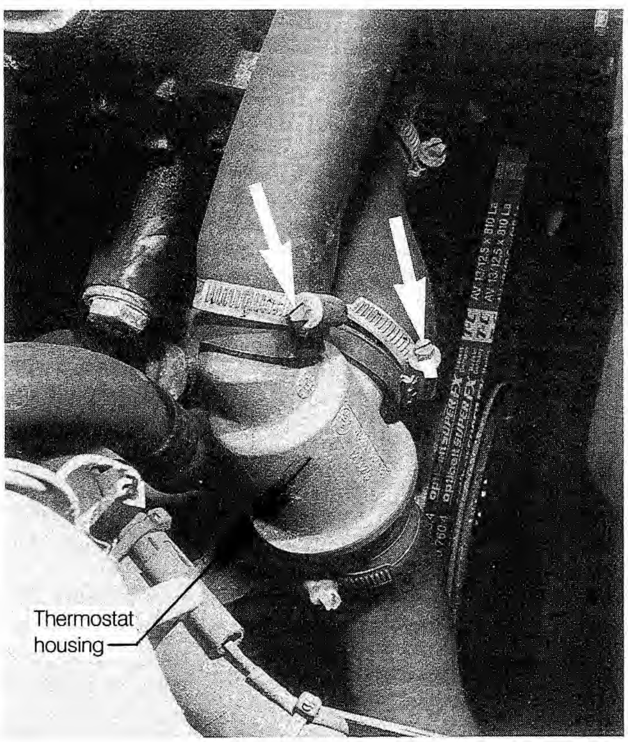

Fig. 4-9. Location of hose clamps (**arrows**) and thermostat housing on 4-cylinder engine.

Testing Thermostat

Test the thermostat when it is removed from the engine. It is also wise to perform this simple test to a new thermostat before installation. If any faults are found, the thermostat should be replaced.

For 6-cylinder engines, heat the thermostat in a pan of water while monitoring the temperature with a thermometer. The thermostat should open at approximately 176°F (80°C).

For 4-cylinder engines, measure inside the thermostat housing and determine the change in length between cold and hot conditions. Heat the thermostat housing in a pan of water and measure as shown in Fig. 4-10 while monitoring temperature with a thermometer. The thermostat should begin to open at approximately 176°F (80°C). At boiling temperature, approximately 212°F (100°C), the measurement should be 8 ± 1 mm ($\frac{5}{16} \pm \frac{3}{64}$ in.) greater than when cold. A thermostat that does not open the full amount is faulty and should not be installed.

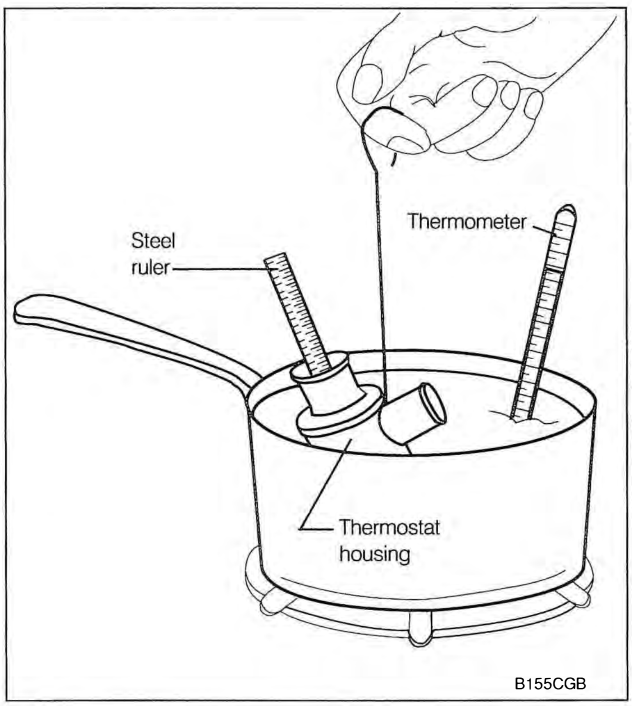

Fig. 4-10. Testing thermostat of 4-cylinder engine in hot water. Change in length is being measured using steel ruler.

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4.3 Coolant Pump

The coolant pump is replaced as a unit. Although individual parts are available, special tools and press equipment are necessary for rebuilding. Always use a new gasket between the pump and cylinder block.

Inspecting and Replacing Coolant Pump

To inspect the coolant pump, first loosen the V-belt so that the pulley and pump shaft can be turned freely. Firmly grasp opposite sides of the fan and check for play in all directions. Rotate the pulley and check that the shaft runs smoothly. Inspect the pump for signs of coolant leakage.

The coolant provides some lubrication for the pump shaft, so an occasional drop of coolant leaking from the pump is acceptable. A larger leak, a loose pump shaft, or a shaft that is noisy and turns roughly indicates a worn shaft bushing—the pump is faulty and should be replaced. Also, plan to replace the V-belt if it is worn or damaged. For information on checking, replacing and adjusting the V-belt, see **LUBRICATION AND MAINTENANCE**.

To remove coolant pump (4-cylinder):

1. Drain the cooling system as described in **4.1 Coolant and Cooling System Hoses**.

2. Remove the fan clutch assembly as described later in this section under **Inspecting and Replacing Primary Fan Clutch**.

3. Placing light pressure on the V-belt to hold the pulley, loosen the four pulley mounting bolts, then remove the V-belt and remove the pulley.

4. Loosen the hose clamps and remove the two hoses from the pump.

5. Remove the seven coolant pump mounting bolts and remove the pump. See Fig. 4-11.

Installation is the reverse of removal. Use a new gasket between the coolant pump and engine block. Tighten the three larger M8 bolts to 22±2 Nm (16±1 ft. lb.) and the four smaller M6 bolts to 9±1 Nm (80±5 in. lb.). Install the pulley, torquing the bolts to 9±1 Nm (80±5 in. lb.). Install the fan assembly as described below. Fill the system with coolant as described in **4.1 Coolant and Cooling System Hoses**. Tension the V-belt as described in **LUBRICATION AND MAINTENANCE**.

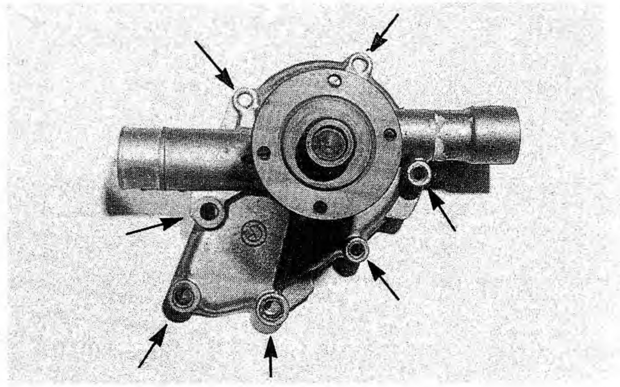

Fig. 4-11. Coolant pump mounting points (**arrows**) on 4-cylinder engine.

To remove coolant pump (6-cylinder):

1. Drain the cooling system as described in **4.1 Coolant and Cooling System Hoses**.

2. Remove the fan clutch assembly as described later in this section under **Inspecting and Replacing Primary Fan Clutch**.

3. Place light pressure on the V-belt to hold the pulley, then loosen the four pulley mounting bolts and remove the V-belt and the pulley.

4. Loosen the hose clamps and remove the two hoses from the pump.

5. Remove the distributor cap with wire assembly, the ignition rotor, and the dust shield as described in **IGNITION**.

6. On 325i models, remove the reference sensor from its mounting bracket. See Fig. 4-12.

7. Loosen the upper alternator mounting bracket nut. On 325i models, remove the plastic wire holder from its mounting clips on the camshaft drive belt cover. See Fig. 4-13.

8. Remove the two camshaft drive belt cover mounting bolts. Remove the cover together with the side rubber piece. See Fig. 4-14.

9. Loosen all three coolant pump mounting bolts. Then remove the two bolts from the holes indicated in Fig. 4-15. Pivot the pump down as far as it will go and remove the camshaft drive belt tensioner spring and pin. Remove the remaining lower bolt together with the pump.

CAUTION —

Do not loosen the camshaft drive belt tensioner bolts. The valves can be damaged if the pistons are accidentally moved while belt tension is relieved.

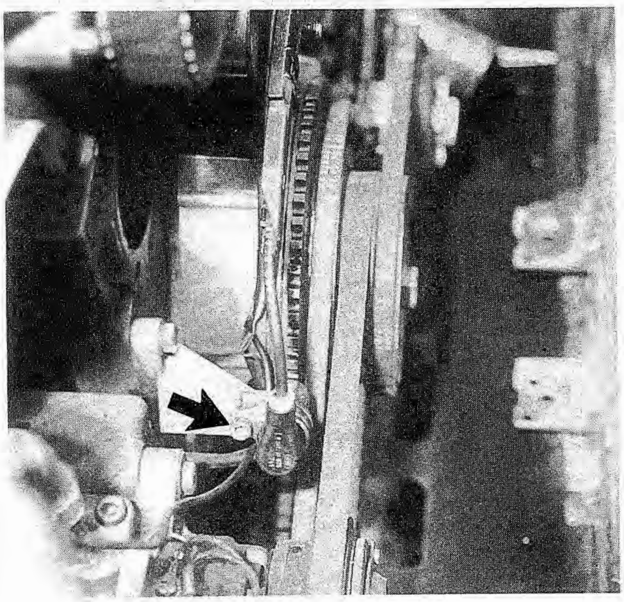

Fig. 4-12. Reference sensor and internal-hex head screw (**arrow**). Use 5 mm hex wrench to remove screw.

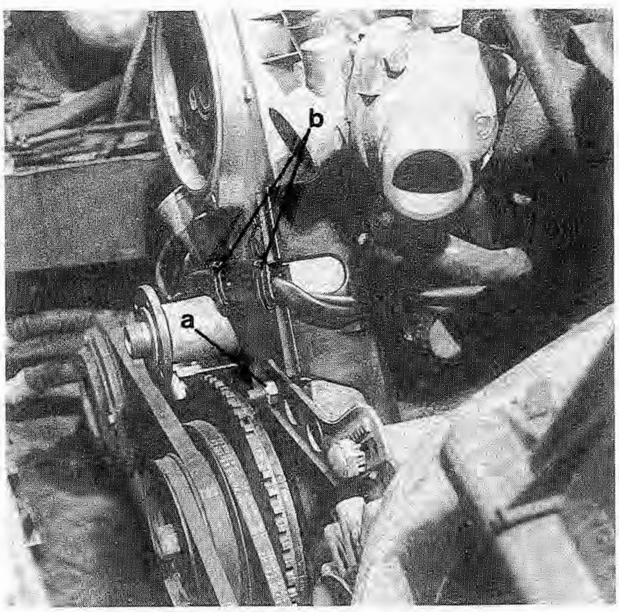

Fig. 4-13. Upper alternator mounting bracket nut (**a**) and wire holder retaining clips (**b**) on camshaft drive belt cover.

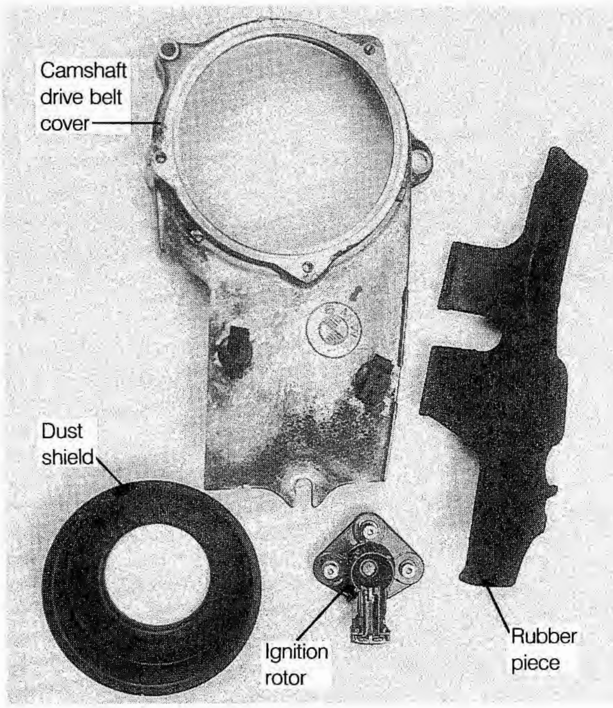

Fig. 4-14. Camshaft drive belt cover and rubber piece shown removed. Dust shield and ignition rotor also shown.

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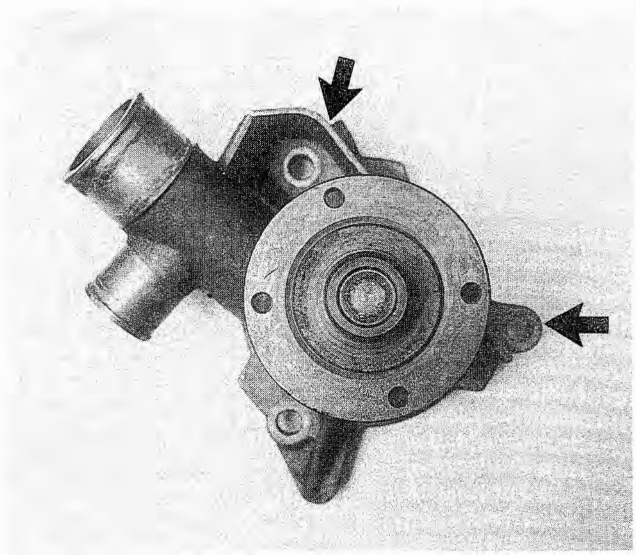

Fig. 4-15. Locations of coolant pump mounting bolts (**arrows**) which must be removed first.

Installation is the reverse of removal. Use a new gasket between the coolant pump and engine block. When installing the pump, check that the camshaft drive belt tensioner spring and pin correctly engage the detent in the pump. See Fig. 4-16. Tighten the three M8 bolts to 22 ± 2 Nm (16 ± 1 ft. lb.). Install the pulley, torquing the bolts to 9 ± 1 Nm (80 ± 5 in. lb.). Install the fan assembly as described below. Fill the system with coolant and bleed air from the system as described in **4.1 Coolant and Cooling System Hoses**. Tension the V-belt as described in **LUBRICATION AND MAINTENANCE**.

NOTE —
It may be a good time to inspect the camshaft drive belt tension while it is exposed. See **ENGINE** for more information.

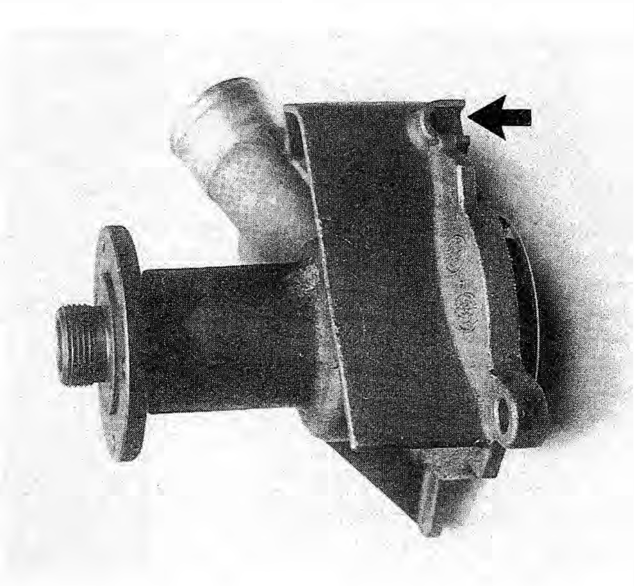

Fig. 4-16. Coolant pump detent (**arrow**) for camshaft drive belt tensioner spring.

Inspecting and Replacing Primary Fan Clutch

Inspect the fan clutch by spinning the fan with engine off and cold. See Fig. 4-17. The fan should spin on the clutch with slight resistance. Check for signs of oil leaking from the clutch. If the fan cannot be turned by hand or if there are signs of oil leakage, the clutch is faulty and should be replaced.

NOTE —
In cold weather, this test should be performed inside a suitable heated work area. Low ambient temperatures cause the clutch fluid to thicken, making a perfectly good fan appear bad by being hard to turn.

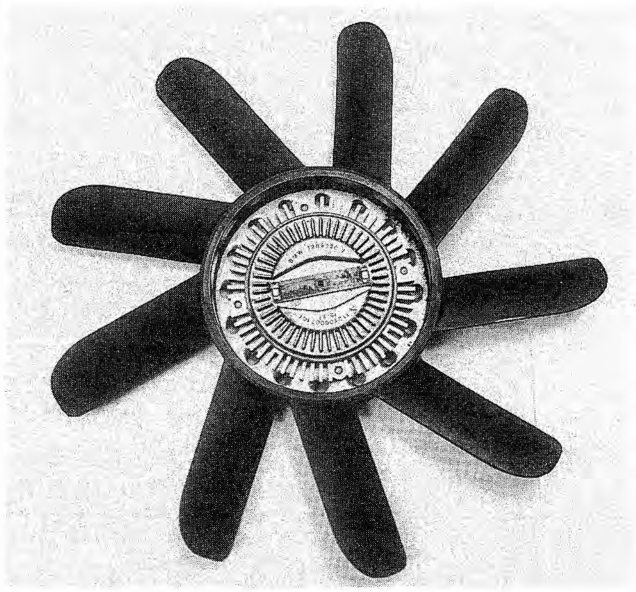

Fig. 4-17. Radiator cooling fan and clutch assembly.

To remove the clutch from the coolant pump, place a 32 mm open-end wrench on the fan clutch nut. See Fig. 4-18. Using the palm of your hand quickly hit the end of the wrench, turning the left-hand threaded nut in a clockwise direction (as viewed from the front of the car) to loosen it.

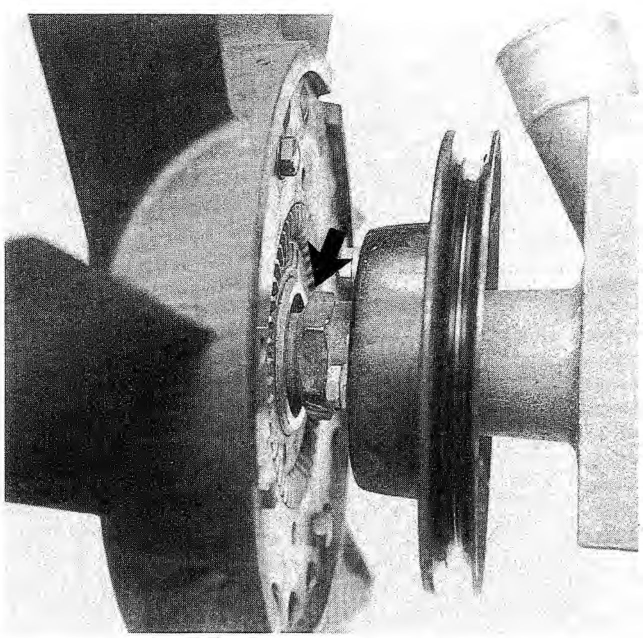

Fig. 4-18. Nut (left-hand thread) on fan clutch (**arrow**).

NOTE —

Always store the removed fan clutch assembly in an upright position. Failure to store the clutch assembly upright may result in a loss of clutch fluid.

When replacing the clutch, transfer the plastic fan from the old clutch to the new clutch. Torque the four M6 mounting bolts to 9 ± 1 Nm (80 ± 5 in. lb.). Install the clutch assembly to the coolant pump until the nut is hand tight. Tighten the nut in a counterclockwise direction, using the same sudden impact with the wrench as was used to loosen it. The correct torque of the nut is 40 Nm (29 ft. lb.). When tightening the fan clutch, be sure the coolant pump V-belt is correctly tensioned as described in **LUBRICATION AND MAINTENANCE**.

NOTE —

BMW special tool no. 11 5 040 is used in conjunction with a ⅜ in. drive torque wrench to accurately torque the fan clutch to the coolant pump. See Fig. 4-19. Because the tool provides increased leverage, it multiplies the torque. Using this tool, the correct torque is 30 Nm (22 ft. lb.).

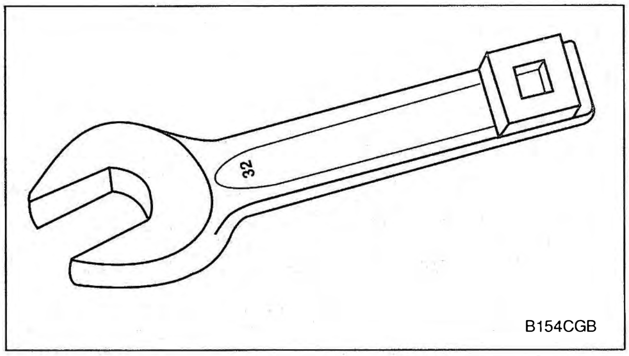

Fig. 4-19. Special 32 mm open end wrench (BMW Part No. 11 5 040).

4.4 Auxiliary Cooling Fan

The auxiliary cooling fan provides additional air flow through the radiator. It operates when high coolant temperature closes the radiator-mounted thermo-switch, or whenever the air conditioning is on. See Fig. 4-20. If the fan does not operate properly, the lack of air flow through the radiator may result in overheating.

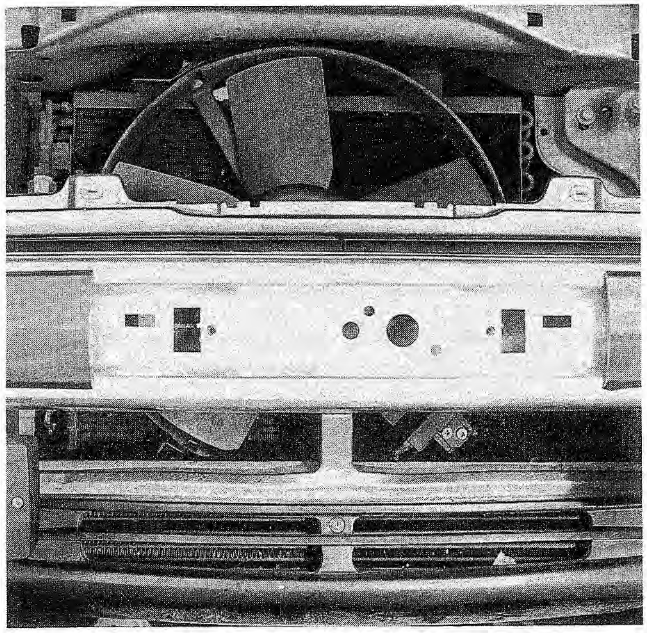

Fig. 4-20. Auxiliary cooling fan assembly viewed from front. Shown with grille removed for clarity.

Testing Cooling Fan and Radiator Thermo-switch

WARNING —

Use extreme caution when testing the cooling fan and thermo-switch. The cooling fan can run any time the ignition is on.

For greatest safety, cooling fan and thermo-switch tests should be performed with the air conditioner off, and preferably with the engine cold. The tests below simulate a warm engine by electrically bypassing the thermo-switch with a jumper wire. Switching temperatures are given in **Table c**.

Table c. Auxiliary Cooling Fan Switching Temperatures

Fan speed	Thermo-switch closes
Low	196°F (91°C)
High	210°F (99°C)

Remember that the radiator thermo-switch will only turn on the electric cooling fan when the coolant temperature is high enough to close the switch. If a faulty thermostat is not allowing the coolant to bypass the radiator and warm up to the switching temperature, the thermo-switch will not close and the cooling fan will not run.

NOTE —

A temperature gauge which is not indicating normal operating temperature may be an indication of a faulty (stuck open) thermostat.

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In addition, the fan will not run and the engine will overheat if a faulty thermostat or a plugged radiator will not allow hot coolant to reach the switch. To quickly check that the thermostat is opening and that coolant is circulating through the radiator, allow a cold engine to reach operating temperature (temperature gauge needle approximately centered) and then feel the upper radiator hose. If the hose is hot to the touch, the coolant is circulating. If the hose is not hot, either the radiator is plugged or the thermostat is not opening. See **4.2 Thermostat** or **4.5 Radiator**

If the coolant is circulating at normal operating temperature and the auxiliary cooling fan does not run, test the fan as described below. Disconnect the radiator thermo-switch connectors and use a jumper wire with an in-line switch to bypass the thermo-switch and simulate a switch closed by warm coolant temperature. Test the fan with the ignition on.

CAUTION —

Connect and disconnect all test leads with the ignition off.

Table d. Auxiliary Cooling Fan Thermo-switch Tests

Model	Connections to test low speed	Connections to test high speed
318i, 325, 325e(es)	white terminals jumpered	red terminals jumpered
325i(is), 325i Convertible	black wire jumpered to green/black wire	black/brown wire jumpered to green/black wire

WARNING —

Always keep hands and wires clear of the fan blades. The cooling fan may run at any time the ignition is on.

NOTE —

On 318i models, the thermo-switches are located on the lower left-hand (driver's side) corner of the radiator as shown in Fig. 4-21. On 325 and 325e(es) models, the thermo-switches are located on the upper left-hand side of the radiator. 325i(is) models use a single thermo-switch combining both switch functions in one housing, also located on the upper left-hand side of the radiator. See Fig. 4-22.

If the fan runs only when powered directly by the jumpered connector, the radiator thermo-switch should be replaced. Torque a new thermo-switch to a maximum torque of 15 Nm (11 ft. lb.). Inspect the thermo-switch gasket ring whenever the switch is removed. The gasket should be replaced if it is crushed or otherwise damaged.

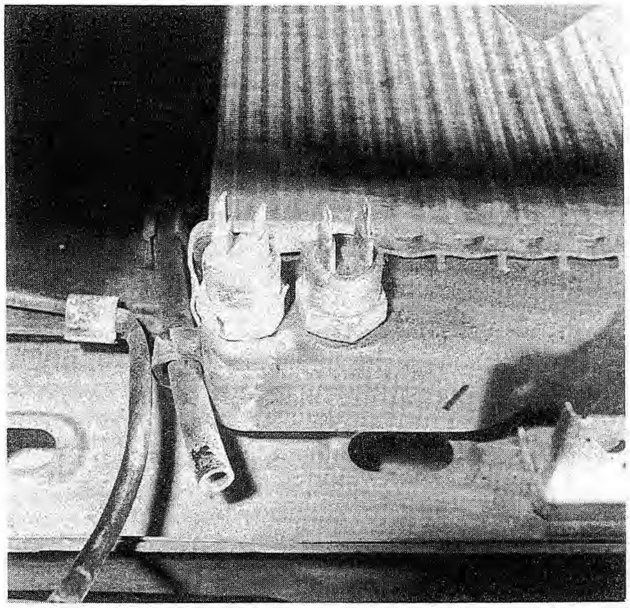

Fig. 4-21. Thermo-switches for radiator cooling fan low-speed (left) and high-speed (right) on 4-cylinder engine (viewed from beneath).

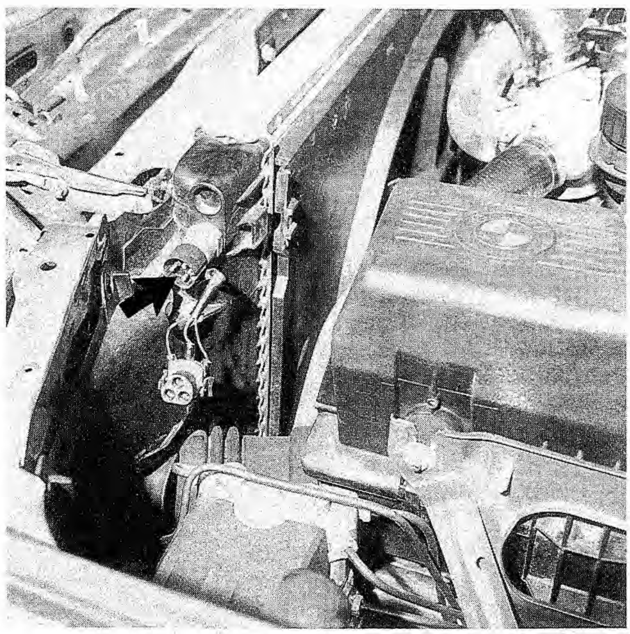

Fig. 4-22. Single thermo-switch (**arrow**) on 325i(is) models. Connector shown disconnected from switch.

If the fan does not run when powered by the jumpered connector, check for voltage at the connectors. Measuring between the green/black wire and ground, there should be battery voltage (approx. 12 VDC) whenever the ignition is on. If not, check fuse no. 19 (7.5 amp) in the fuse/relay panel. If battery voltage is reaching the connector, check the high speed relay fuse no. 18 (30 amp), and the low speed relay fuse no. 3 (15 amp).

If the fan runs only at low speed, check the high-speed fan relay (position K6). If the fan runs only at high speed, check the low speed fan relay (position K1) and the low speed resistor. The resistor is mounted to the auxiliary fan housing, behind the center of the front bumper. See Fig. 4-23. Test the resistor by removing its electrical connectors and measuring its resistance. If the resistance is not approximately 6 ohms, the resistor is faulty and should be replaced.

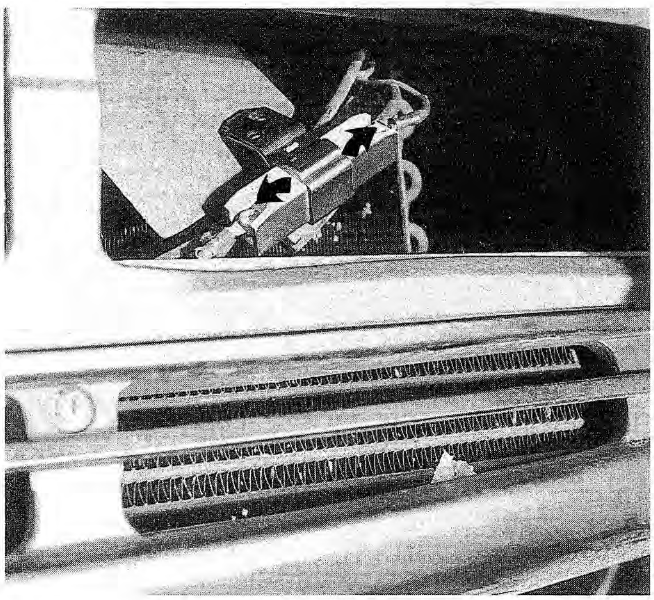

Fig. 4-23. Auxiliary cooling fan low speed resistor and electrical connectors (**arrows**). Resistor shown removed from fan housing for clarity.

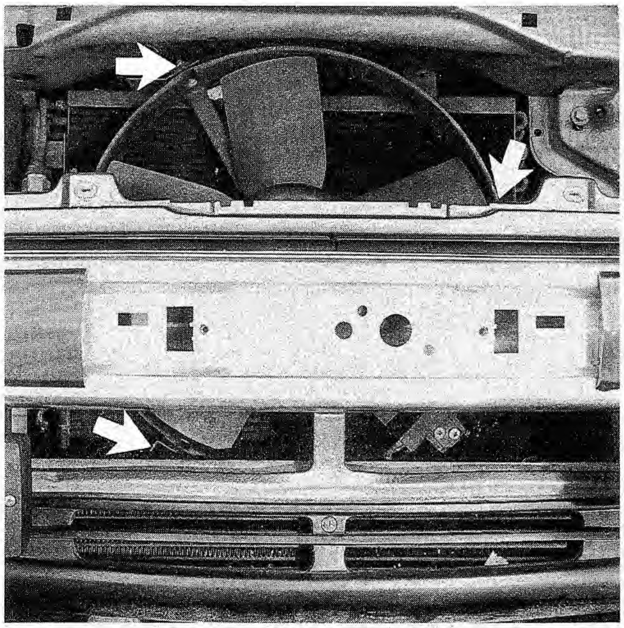

Fig. 4-24. Auxiliary cooling fan mounting nuts (**arrows**).

Removing and Installing Auxiliary Fan Assembly

To remove the auxiliary fan assembly, remove the radiator as described in **4.5 Radiator** and remove the front grille assembly as described in **BODY AND INTERIOR**. Remove the three nuts from the fan assembly as shown in Fig. 4-24. Remove the two air conditioning condenser mounting bolts as shown in Fig. 4-25. Remove the trim panel from the rear of each headlight. Disconnect the fan's electrical connectors and remove the fan resistor from the fan housing.

Carefully, without disturbing any of the refrigerant lines, lift the condenser up while swinging it away from the body. See Fig. 4-26. Remove the auxiliary fan from the car.

Installation is the reverse of removal. Be sure the air conditioning condenser fits correctly into the lower channels before tightening the mounting bolts.

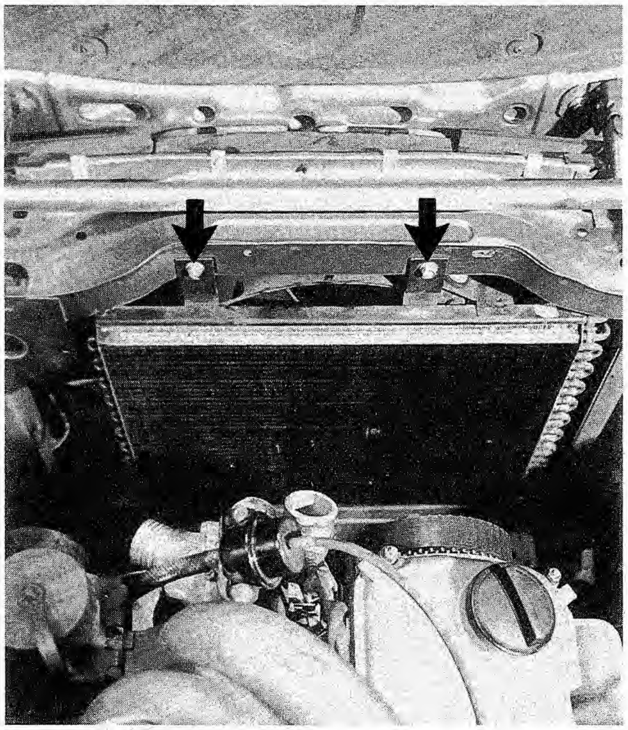

Fig. 4-25. Air conditioning condenser mounting bolts (**arrows**).

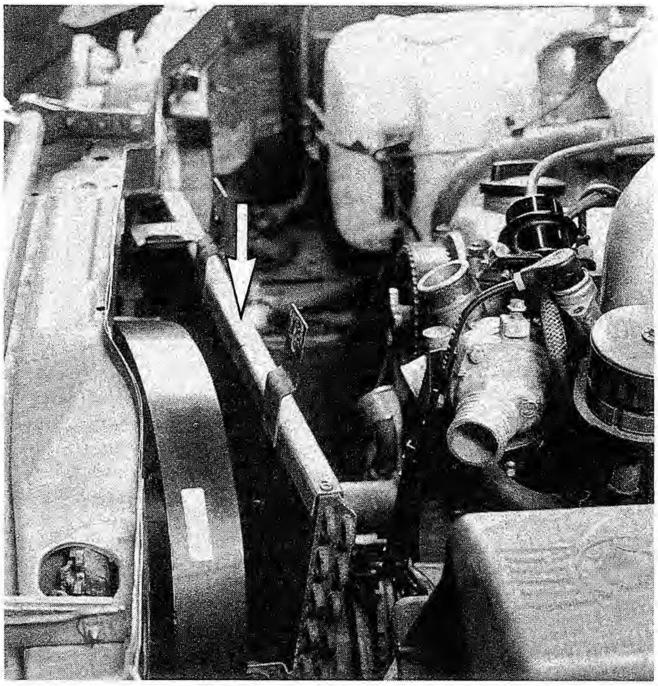

Fig. 4-26. Air conditioning condenser correctly positioned for removal of auxiliary cooling fan.

4.5 Radiator

To perform efficiently, the radiator must not be blocked with dirt or debris, and it must be firmly mounted. Excess vibration due to loose, broken, or missing fasteners may damage the radiator. Clean the radiator fins using low pressure compressed air.

If the engine overheats and no other cooling system tests indicate trouble, the radiator may have some plugged passages which are restricting coolant flow. This does not necessarily mean that the radiator must be replaced. In many cases the radiator can be chemically cleaned by a qualified radiator repair shop to relieve the plugging.

NOTE —

Repairing radiators of aluminum and plastic construction used on some BMW models requires some specialized knowledge. Choose a shop with the necessary experience.

Removing and Installing Radiator

To remove the radiator, first drain the cooling system and disconnect the upper and lower radiator hoses, as described in **4.1 Coolant and Cooling System Hoses**. Remove the auxiliary cooling fan and clutch assembly as described above. On 6-cylinder engines, disconnect the hose from the coolant expansion tank.

Disconnect the electrical connectors from the radiator thermo-switches and from the auxiliary cooling fan. If an engine splash guard is installed, remove it from beneath the car as described in **ENGINE**. Pry off the clips from the plastic fan shroud. See Fig. 4-27. Pull the fan shroud up and off the radiator and position the shroud over the cooling fan, towards the engine.

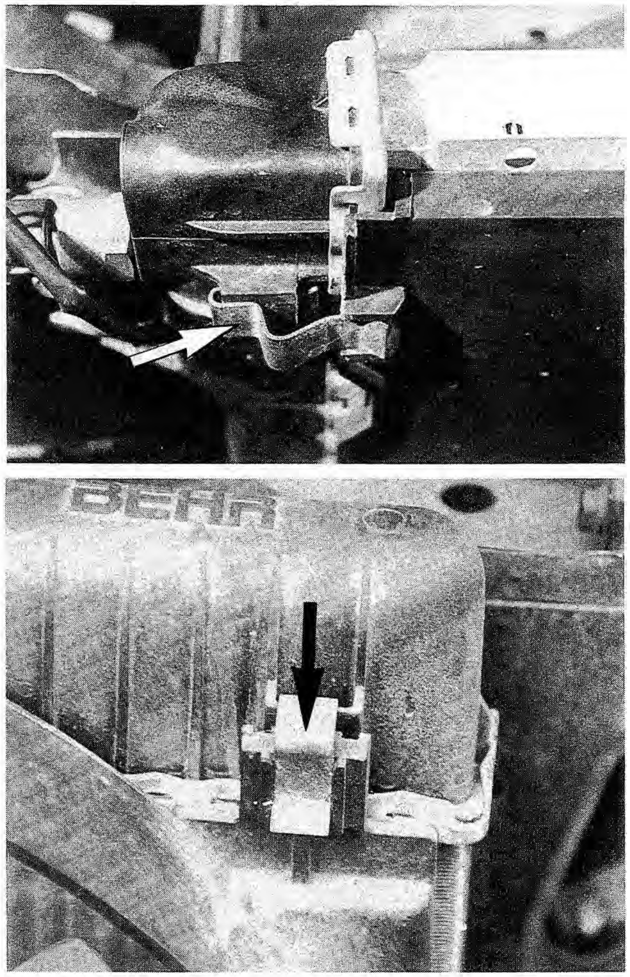

Fig. 4-27. Radiator shroud mounting clips used on 1984-1987 6-cylinder models (top) and all 4-cylinder models (bottom). Clips on 1988-1990 models are similar.

On models with automatic transmission, thoroughly clean around the two transmission cooler line unions at the radiator, then loosen the nuts and disconnect the lines. See Fig. 4-28. Plug the cooler lines and the radiator openings to keep them clean. On cars with 4-cylinder engines, remove the radiator mounting nut as shown in Fig. 4-29. On cars with 6-cylinder engines, remove the radiator mounting bolts from either side of the radiator. See Fig. 4-30. Lift the radiator out from the top.

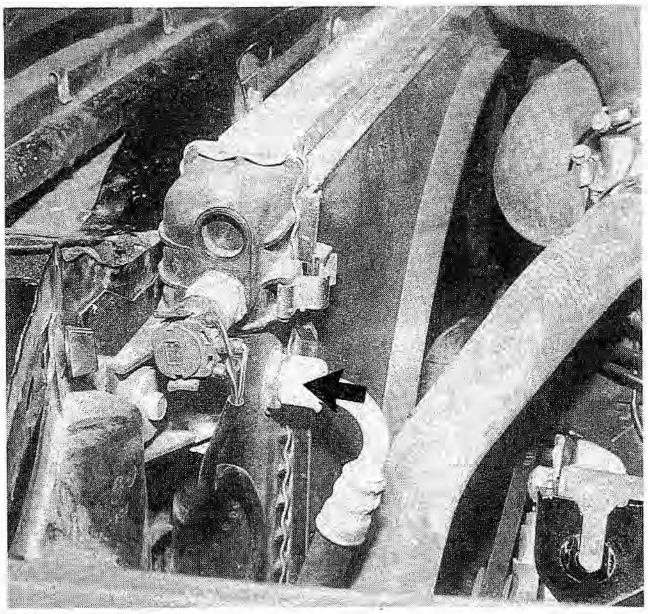

Fig. 4-28. Automatic transmission cooler line on radiator of 6-cylinder engine (**arrow**). Transmission cooler lines on 4-cylinder engine are at radiator bottom.

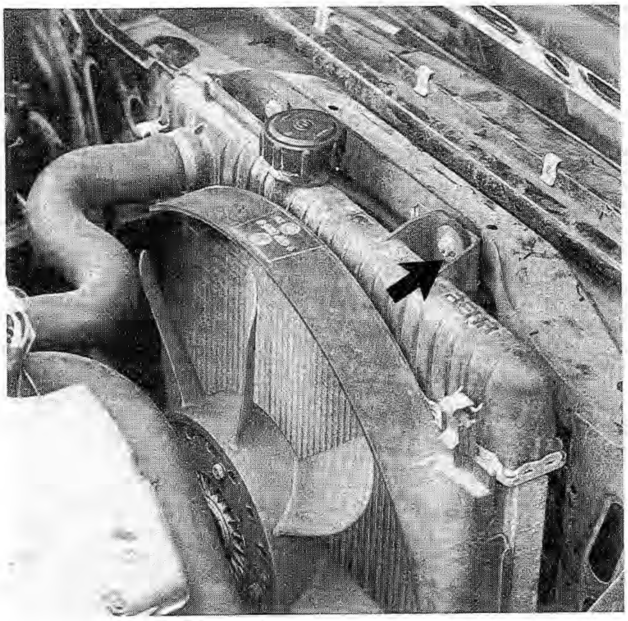

Fig. 4-29. Radiator mounting nut on cars with 4-cylinder engine (**arrow**).

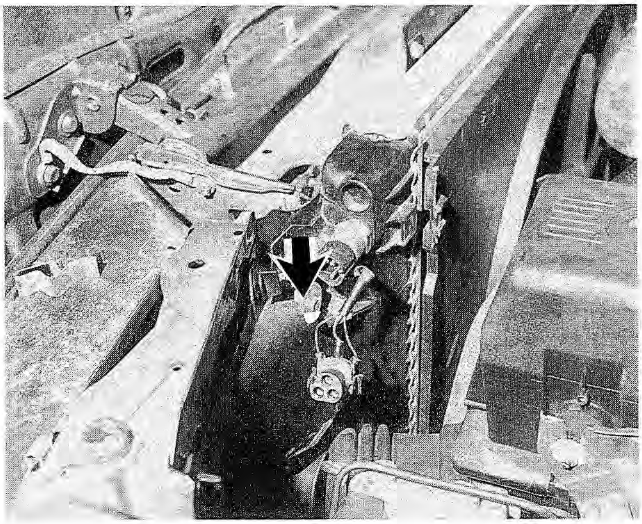

Fig. 4-30. Left radiator mounting bolt on cars with 6-cylinder engine (**arrow**). Right mounting bolt (not shown) must also be removed.

Installation is the reverse of removal. Inspect the rubber lower radiator mountings as shown in Fig. 4-31. Replace any mounting that is damaged. When installing the radiator, be sure the radiator fits into the lower mountings correctly. On models with automatic transmission, torque the cooler line fittings to 18^{+3}_{-0} Nm (13^{+2}_{-0} ft. lb.). Torque the radiator mounting nuts to 9^{+1}_{-0} Nm (80^{+5}_{-0} in. lb.). Fill the cooling system as described in **4.1 Coolant and Cooling System Hoses**. On models with automatic transmission, check the level of the automatic transmission fluid (ATF). See **AUTOMATIC TRANSMISSION**.

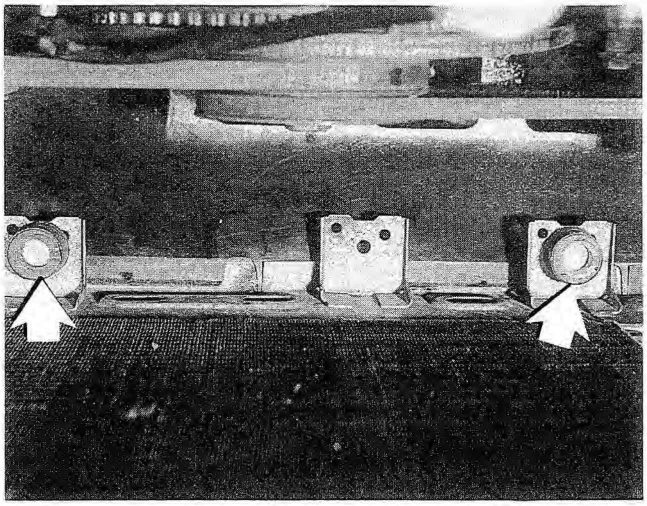

Fig. 4-31. Typical rubber lower radiator mountings (**arrows**).

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Flushing Radiator

If the radiator has been contaminated with engine oil, BMW recommends that the radiator and expansion tank be flushed with Solvethane®, available from an authorized BMW dealer.

NOTE —
Although the radiator and cooling system should be periodically flushed as part of scheduled maintenance, the procedure below applies only to oil-contaminated radiators. For information on flushing the cooling system as a part of routine maintenance, see **LUBRICATION AND MAINTENANCE**.

WARNING —
Solvethane® is poisonous. Wear safety glasses and gloves. Always follow the manufacturer's safety precautions listed on the container. Dispose of Solvethane® properly when flushing is complete.

CAUTION —
Solvethane® is damaging to rubber seals, gaskets and hoses. Do not allow it to enter the cooling system or to contact rubber parts.

To flush the system, remove the radiator as described above. Pour 4 to 6 pints (2 to 3 liters) of Solvethane® into the radiator. Cover any openings and vigorously shake the radiator. After approximately 2 to 3 minutes, drain the Solvethane® and reinstall the radiator. Flush using hot water until there are no signs of oil in the water. For cars with 6-cylinder engines, repeat the process for the expansion tank. Finally, fill the system with coolant as described in **4.1 Coolant and Cooling System Hoses**.

5. TECHNICAL DATA

I. Cooling System Specifications

Cooling system leakage test	
maximum test pressure	1 bar (14 psi)
Expansion tank cap	
opening pressure	see specification on cap top
Thermostat opening temperature	
4-cylinder engines	
begins to open	176°F (80°C)
fully open	212°F (100°C)
thermostat stroke	8 ± 1 mm (5/16 ± 3/64 in.)
6-cylinder engines	
begins to open	176°F (80°C)
fully open	N/A
thermostat stroke	N/A
Cooling fan thermo-switch switching temperature	
Low-speed	
ON (switch closed)	196°F (91°C)
High-speed	
ON (switch closed)	210°F (99°C)
Cooling system capacity	
318i	7.0 ltrs. (7.4 qts)
325e(es), 325	11.0 ltrs. (11.6 qts)
325i(is), 325i convertible	10.5 ltrs (11.1 qts)
V-belt tension	See **LUBRICATION and MAINTENANCE**.
Coolant type	Phosphate-free, containing ethylene glycol

II. Tightening Torques

Automatic transmission cooler lines to	
radiator	18^{+3}_{-0} Nm ($13\ ^{+2}_{-0}$ ft. lb.)
Coolant pump pulley to	
coolant pump (bolt)	9 ± 1 Nm (80 ± 5 in. lb.)
Coolant pump to cylinder block	
M6 bolt	9 ± 1 Nm (80 ± 5 in. lb.)
M8 bolt	22 ± 2 Nm(16 ± 1 ft. lb.)
Coolant primary fan to:	
coolant fan clutch	9 ± 1 Nm (80 ± 5 in. lb.)
Coolant fan clutch to coolant pump	
with special tool (BMW Part No. 11 5 040)	30 Nm (22 ft. lb.)
without special tool	40 Nm (29 ft. lb.)
Coolant temperature sending unit to	
cylinder head water outlet	18 ± 1 Nm (13 ± 1 ft. lb.)
Thermo-switch to radiator	
(maximum permissible)	15 Nm (11 ft. lb.)
Upper radiator mounting	
to body (nut)	9 ± 1 Nm (80 ± 5 in. lb.)

Section 8

EXHAUST SYSTEM AND EMISSION CONTROLS

Contents

Exhaust System and Emission Controls

Introduction

The exhaust system has two main functions: first, to guide the rapidly expanding gasses of combustion out of the engine and away from the passenger compartment, and second, to quiet and cool the exhaust. On U.S. cars equipped with a catalytic converter, the exhaust system and the emission controls remove most of the pollutants which are the normal by-products of combustion.

Proper exhaust system function depends on each component being free from holes, with airtight seals at all joints. Emission control system function depends on proper adjustment of the fuel injection system and the ignition system, as well as chemical treatment of the exhaust gasses by the catalytic converter. Misadjustment of the fuel injection or ignition systems, or failure of the catalytic converter can damage the emission control system and increase harmful exhaust emissions.

Exhaust system components are subjected to vibration and extreme temperature and pressure, and exposed to all manner of road hazards. The exhaust system is designed for relatively maintenance-free operation, but regular inspection is warranted due to these harsh operating conditions. The only scheduled emission control maintenance is replacement of the oxygen sensor at specified mileage intervals.

This section covers maintenance, troubleshooting, and repair of the exhaust system and the emission controls. Only basic hand tools are required for most service. Testing the emission control systems requires some specialized knowledge and equipment. If you lack the necessary skills or equipment, we suggest that you leave these tests or repairs to an authorized BMW dealer or other qualified and properly equipped repair shop. We especially urge you to see an authorized BMW dealer before beginning any work on a car that may be eligible for repair under the manufacturer's warranty.

1. GENERAL DESCRIPTION

1.1 Exhaust System

The basic exhaust system components, shown in Fig. 1-1, are the exhaust manifold, the front pipe with integral catalytic converter, and the rear pipe with rear muffler. On 325 and 325e(es) models, the rear pipe includes an additional middle muffler.

The exhaust manifold is mounted to the cylinder head and channels exhaust from the individual exhaust ports into the front pipe. The manifold is made of cast iron to withstand the extreme heat, vibration, and pressures of combustion.

The front end of the system is supported by attachment to the exhaust manifold, and by a mounting bracket on the transmission. The rear part of the system is suspended by rubber retaining rings or hangers from the underbody of the car. The retaining rings provide positive but non-rigid mounting, allowing some expansion and contraction of the system due to changes in temperature and helping to isolate noise and vibration from the body.

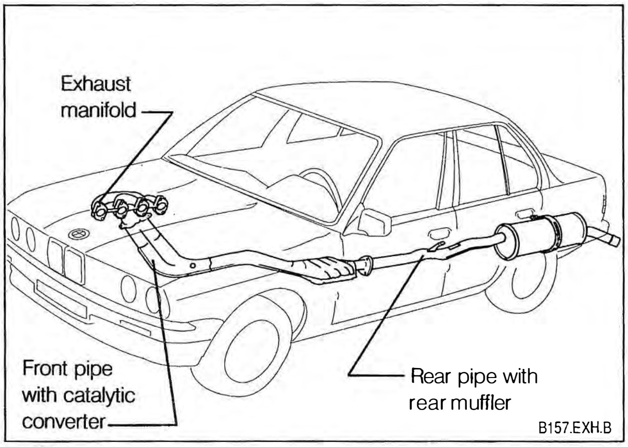

Fig. 1-1. Typical two-piece BMW 3-series exhaust system. Exact configuration varies from model to model.

1.2 Emission Controls

Emission controls are used to reduce harmful emissions. Emission controls used on the cars covered by this manual include an evaporative emission system, an oxygen sensor system, and a catalytic converter.

Because the evaporative emission system is related to the fuel supply, this system is covered in **FUEL SYSTEM**. The oxygen sensor system and the catalytic converter are covered in this section.

Catalytic Converter

The catalytic converter is similar in appearance to a small muffler. Its honeycombed ceramic core contains hundreds of tiny passages whose surfaces are coated with precious metal catalysts. The catalysts promote chemical reactions in the exhaust gasses which reduce the quantity of harmful pollutants in the exhaust.

Oxygen Sensor System

The catalytic converter reduces emissions most efficiently when the percentage of oxygen in the exhaust falls within a certain narrow range. The oxygen sensor system is part of a closed-loop system which regulates fuel mixture to maintain peak combustion efficiency and proper oxygen content in the exhaust.

The oxygen sensor, shown in Fig. 1-2, continuously reacts to the amount of oxygen in the exhaust stream and generates a proportional low-voltage signal. This low-voltage serves as an input to the fuel injection system which in turn adjusts the fuel mixture. The oxygen sensor system consists of an oxygen sensor mounted in the exhaust system which is wired to an electronic control unit and, in turn, to the fuel injection system.

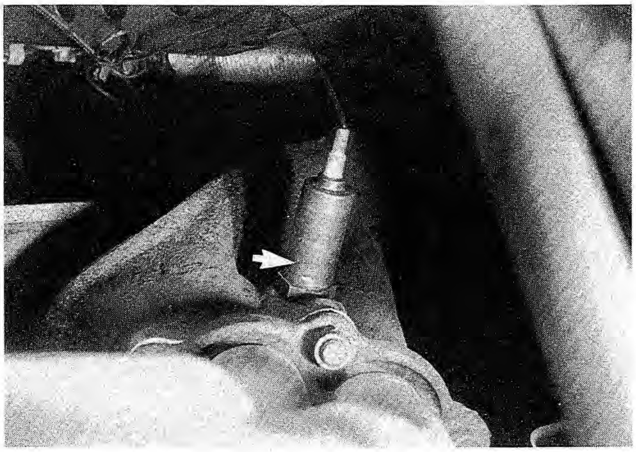

Fig. 1-2. Oxygen sensor (**arrow**) installed in 4-cylinder exhaust manifold.

2. MAINTENANCE

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of the exhaust system and emission controls. A number in bold type indicates that the procedure is covered in this section, under that numbered heading. Information on other exhaust system and emission control maintenance and on the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Inspecting exhaust system.

2. Replacing oxygen sensor. **5.1**

BMW recommends inspection of the exhaust system during each scheduled maintenance, but it is also a good idea to inspect it whenever other repair work allows access to the underside of the car. The system should always be inspected immediately if it becomes unusually noisy or if exhaust odor is detected inside the car.

3. TROUBLESHOOTING

This troubleshooting section covers the exhaust and emission control systems, including the exhaust manifold and pipes, the muffler, the catalytic converter and the oxygen sensor system.

Problems such as exhaust leakage or excessive noise almost certainly indicate faults in the exhaust system. Other problems such as poor performance, rough running, or increased emissions may have more complex causes. For help in troubleshooting running and performance problems, see **ENGINE MANAGEMENT-DRIVEABILITY**.

3.1 Basic Troubleshooting Principles

As with any troubleshooting, analysis of the observed symptoms is the key to isolating and identifying exhaust and emission systems problems. Begin with careful observation, keeping in mind the following questions:

How has the problem developed? A symptom which develops quickly usually indicates recent damage, or failure of an isolated part. In the case of the exhaust system, such damage may be due to striking a road hazard. Noise is, of course, the main indicator of exhaust system problems. A gradual increase in noise level is most likely an indication of the general deterioration of the whole system, due to corrosion for example. More extensive repair, and perhaps complete replacement, may be necessary.

Is the symptom related to engine rpm? The correct amount of backpressure helps the engine produce power smoothly over a wide range of engine speeds. Excessive backpressure due to a failed or damaged component may cause poor driveability, rough idling, or stalling. The catalytic converter with its small passages is especially susceptible to plugging if it gets overheated, if the fuel injection or ignition systems are misadjusted, or if the car is run on leaded fuel.

Is the symptom related to temperature? Cold running problems are almost certainly not caused by the oxygen sensor system, since the fuel injection system operates without it until the sensor is fully warmed.

Table a lists common exhaust and emission control system problems, their probable causes, and suggested corrective actions. The numbers in bold type in the corrective action column refer to the numbered headings in this section of the manual where the suggested repairs are described.

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Table a. Exhaust and Emission Control Troubleshooting

Symptom	Probable cause	Corrective action
1. Hissing, rumbling, loud noise during acceleration	**a.** Exhaust system leaks **b.** Internally damaged muffler or catalytic converter **c.** Exhaust system out of alignment.	**a.** Examine all system joints (see **LUBRICATION AND MAINTENANCE**). Replace faulty components. **4.1** **b.** Replace faulty components. **4.1** **c.** Re-align exhaust system.**4.1**
2. Exhaust system rattles	**a.** Exhaust system out of alignment **b.** Missing or broken exhaust system rubber retaining ring	**a.** Re-align exhaust system. **4.1** **b.** Replace retaining ring(s). **4.1**
3. Reduced power, poor mileage, hesitation on initial acceleration, rough idle	**a.** Excessive backpressure (damaged muffler or pipes) **b.** Oxygen sensor system faulty **c.** Excessive backpressure (plugged catalytic converter)	**a.** Inspect components and replace as required. **4.1** **b.** Test oxygen sensor system function, replace faulty components. **5.1** **c.** Replace catalytic converter. **4.2**
4. Failed emissions test	**a.** Oxygen sensor system faulty **b.** Catalytic converter failed	**a.** Test oxygen sensor system function and replace faulty components. **5.1** **b.** Replace catalytic converter. **4.2**

4. EXHAUST SYSTEM

The main exhaust system components are bolted together at welded flanges. Gaskets are used at each flange and between the exhaust manifold(s) and the cylinder head. Brackets welded to the pipes and clamps mounted to the muffler are used to support the system by rubber retaining rings, hanging from brackets welded to the underbody. Fig. 4-1, Fig. 4-2, and Fig. 4-3 show the exhaust systems used on the various models covered by this manual. These figures also illustrate the fasteners used in each system and list their correct torque specifications.

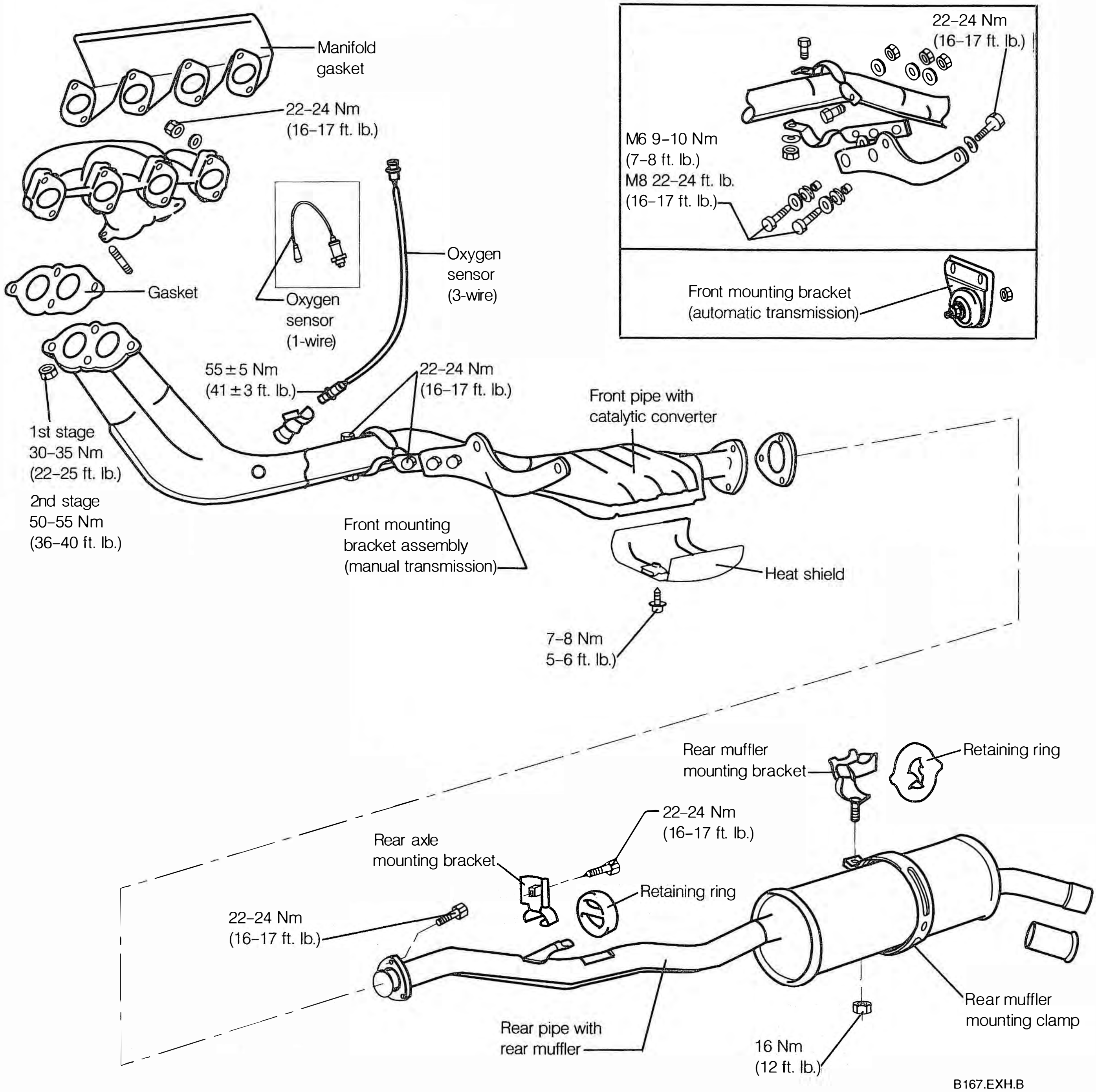

Fig. 4-1. Exploded view of 318i exhaust system.

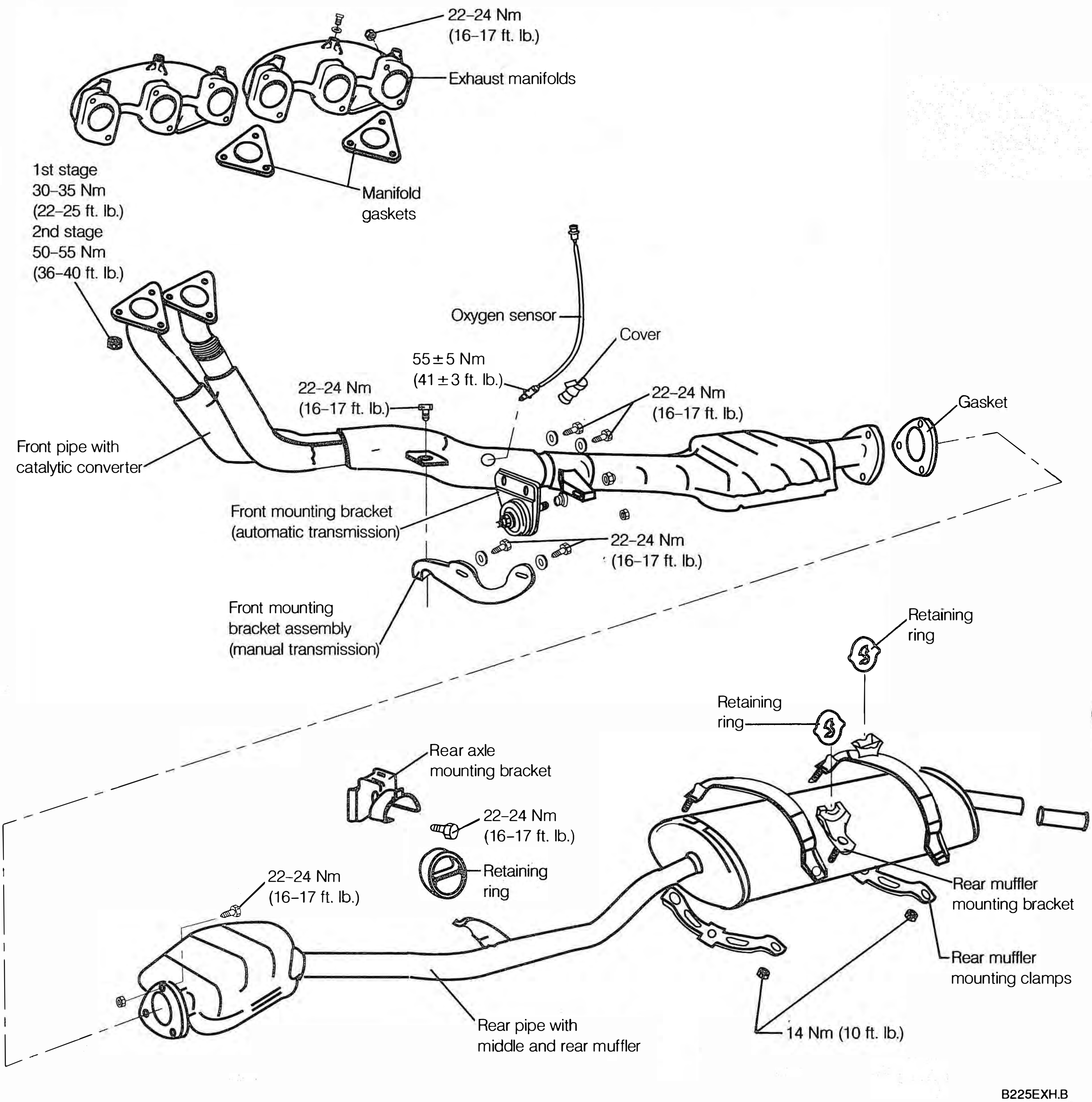

Fig. 4-2. Exploded view of 325 and 325e(es) exhaust system.

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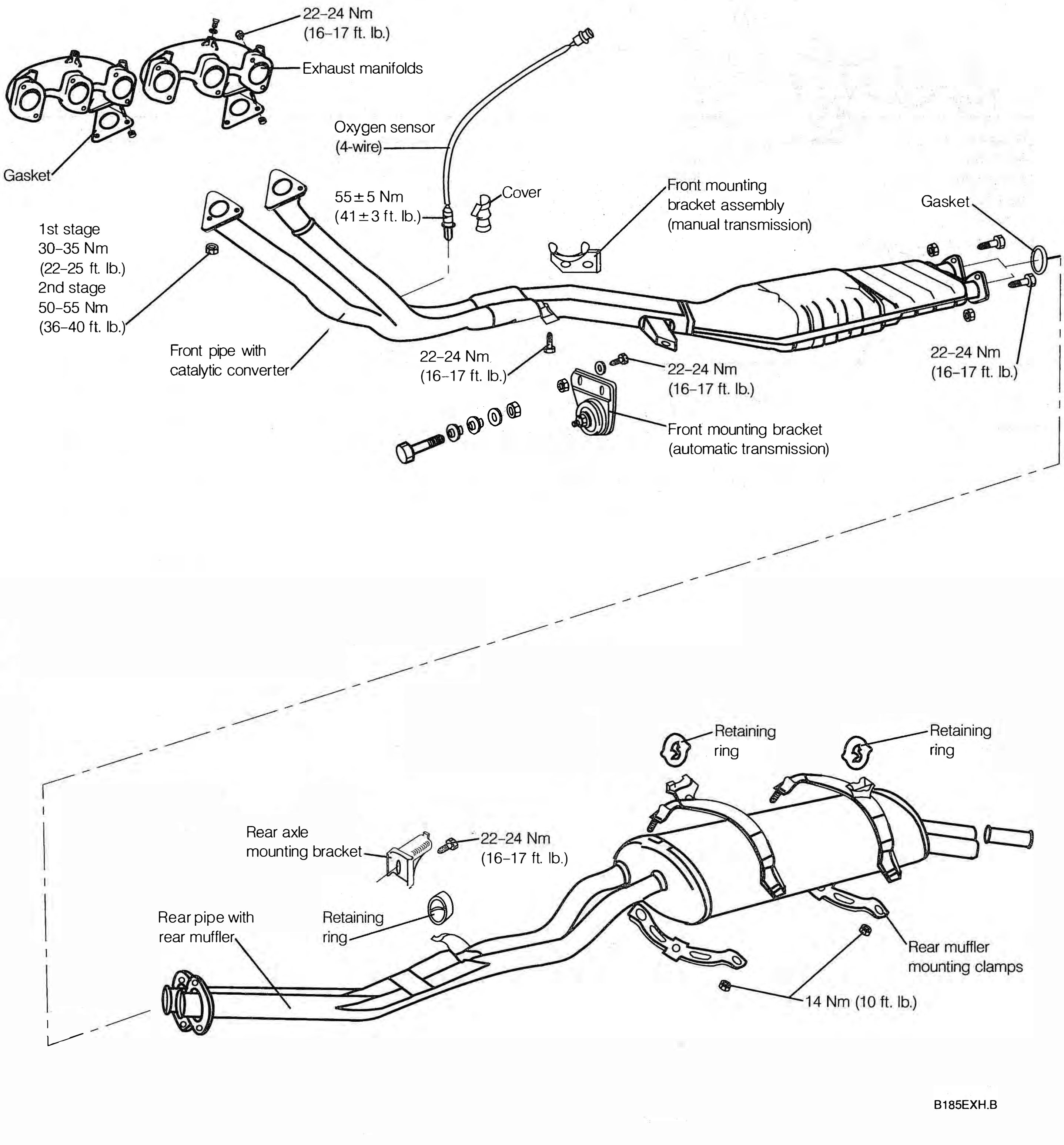

Fig. 4-3. Exploded view of 325i(is) and 325i Convertible exhaust system.

4.1 Removing and Installing Exhaust System

The pipes, mufflers, and catalytic converter are made to resist corrosion, but they are still prone to deterioration and this deterioration tends to affect the system as a whole. If any one part of the system is perforated by rust, it is very likely that other parts are similarly affected, or soon will be.

When replacing only part of the system, make sure that the new parts will fit properly with the old before removal. Parts from different sources may not mate properly. Genuine BMW replacement parts will probably mate best with the original parts.

NOTE —

Use of non-original exhaust system components can change system backpressure and may affect fuel mixture. It may be necessary to check and adjust the fuel injection system after installing any non-original exhaust pipes or mufflers. See **FUEL SYSTEM**.

New fasteners and clamps are always recommended. The chance of getting the old ones off undamaged and in reusable condition is slim. Gaskets should always be replaced whenever the flanged joints are disconnected.

WARNING —

To avoid injury, wear eye protection and heavy gloves when working on the rusty parts of the old exhaust system.

Removing Exhaust System

Individual components can be removed without completely dismantling the system. The rubber retaining rings allow some movement—enough to remove front components without removing the rear also. A penetrating oil applied to all bolts several hours in advance of beginning the work will make removal easier.

When removing the front exhaust pipe from the car, be sure the oxygen sensor's electrical connector is disconnected. If the front pipe is to be replaced, the oxygen sensor can be transferred from one pipe to the other. For more information on removing and installing the oxygen sensor, see **5. Oxygen Sensor System**.

Installing Exhaust System

Loosely install and assemble the complete system, then evenly tighten the clamps and mounting bolts to their final torque values. Make sure that no part of the exhaust system contacts any part of the car body. Anti-seize compound used on all threaded fasteners will extend service life and make any future replacement easier.

CAUTION —

Do not let anti-seize compound come in contact with the slit portion of the oxygen sensor body. The oxygen sensor is very sensitive and will be destroyed if contaminated with anti-seize compound.

To allow for thermal expansion of the exhaust system, position rear muffler clamp(s) so that the retaining ring(s) are preloaded approximately 6 mm (1/4 in.). See Fig. 4-4. On 4-cylinder models, tighten the clamping bolt to a maximum torque of 16 Nm (12 ft. lb.). On 6-cylinder models, tighten the clamping bolt to a maximum torque of 14 Nm (10 ft. lb.).

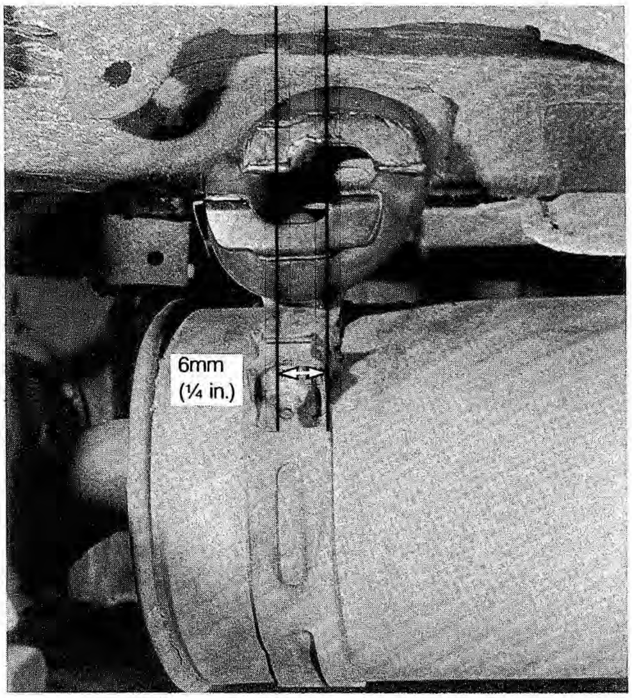

Fig. 4-4. Rear muffler retaining ring preload. Preload shown has been exaggerated for clarity.

Adjust the clearance between the tailpipe and the body using the rear axle clamping bracket. When the clearance is correct, as shown in Fig. 4-5, tighten the clamping bolt to 22 to 24 Nm (16 to 17 ft. lb.). See Fig. 4-6.

After the system is aligned as described above, tighten the remaining bolts and clamps. Fastener torque values for the various systems are shown in Fig. 4-1, Fig. 4-2 and Fig. 4-3 above. After completing the installation, start the engine and check for any exhaust leakage. Some slight smoking and odor as the new parts become hot for the first time is normal. System alignment can be checked by driving the car over a rough road and listening for sounds of the exhaust system striking the underbody.

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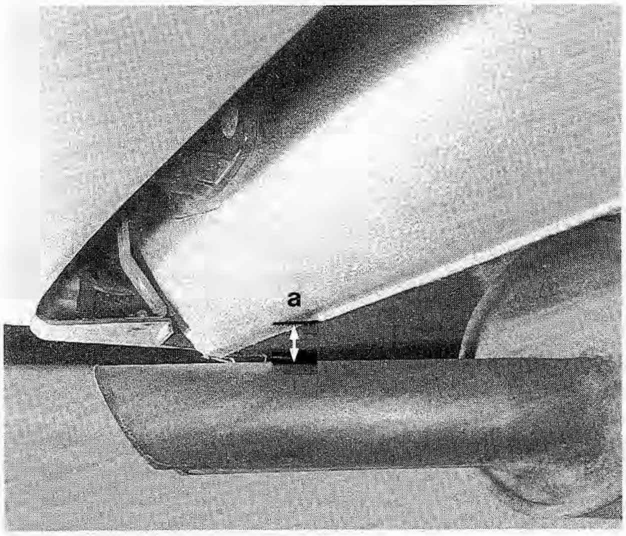

Fig. 4-5. Clearance (**a**) between tailpipe and body.

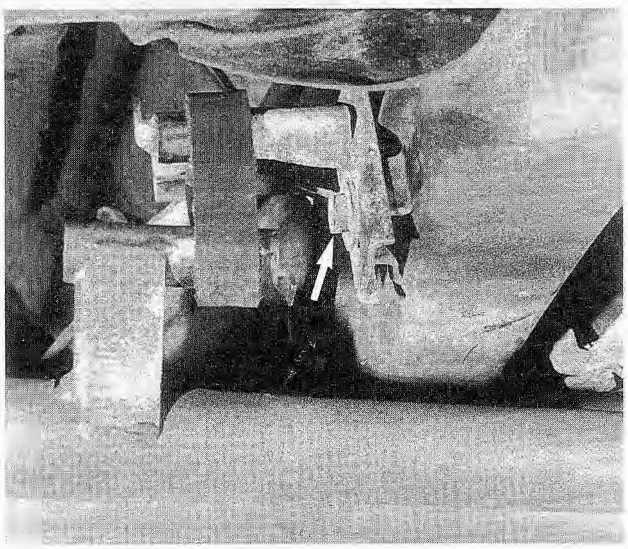

Fig. 4-6. Rear axle clamping bracket. Loosen bolt (**arrow**) to adjust clearance between tailpipe and body.

4.2 Catalytic Converter

All models covered by this manual are equipped with a three-way catalytic converter in the exhaust system. Fig. 4-7 shows the internal construction of the catalytic converter, designed to maximize surface area for the catalysts and promote the chemical reactions that convert harmful compounds into nitrogen, carbon dioxide, and water.

The catalytic converter is designed to be maintenance free, and under normal operating conditions it should last at least 60,000 miles (96,000 km). Certain improper operating conditions can, however, cause thermal breakdown of the catalytic material and leave the converter partially plugged or otherwise inoperative. Some of these conditions are: incorrect ignition timing, incorrect fuel injection CO adjustment, engine misfiring, prolonged idling, prolonged high load such as towing, and, the use of leaded gasoline.

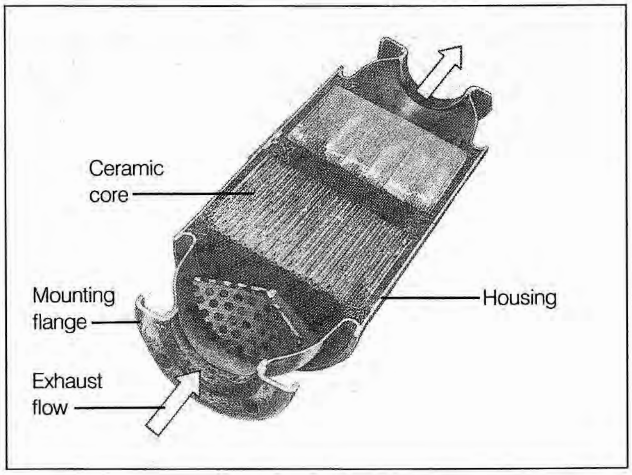

Fig. 4-7. Cutaway view of catalytic converter.

WARNING —

Do not operate the starter for more than 1 to 3 minutes if the engine fails to start. Excessive cranking may allow raw fuel to enter the converter, creating a fire hazard and potentially damaging the catalytic converter.

Reduced power, stalling at idle, rattles in the exhaust system, and high exhaust emissions measured at the tailpipe are all possible indications of a faulty catalytic converter. The converter can be removed and visually inspected if converter failure is suspected. See **Checking Catalytic Converter** below.

Removing and Installing Catalytic Converter

The catalytic converter is one of the main components of the exhaust system and can be removed and installed as part of it as described in **4.1 Removing and Installing Exhaust System**.

Checking Catalytic Converter

Since the catalytic converter is an integral part of the front exhaust pipe, opportunity for visual inspection is limited. The only realistic test is to remove the front exhaust pipe and check for evidence of physical damage. Remove the pipe and hold it vertically with the outlet end down. Firmly tap the end on a block of wood, then turn the pipe over and tap the other end in the same manner. A knocking sound from inside the converter housing probably indicates that the ceramic core has become dislodged, and that the converter should be replaced.

5. Oxygen Sensor System

The oxygen sensor system provides the fuel injection system with feedback information about combustion efficiency by reacting to the oxygen content in the exhaust. The exhaust-mounted oxygen sensor is constructed of ceramic material coated with platinum. One surface is exposed to the exhaust gas, while the other is exposed to the atmosphere. The difference in oxygen content between the two surfaces causes a chemical reaction which generates a low-voltage electrical signal (100–1000mv). This signal is monitored by the fuel system's electronic control unit which, in turn, signals for changes in fuel delivery to optimize combustion efficiency and minimize emissions.

Since the oxygen sensor system relies on low-voltage signals, it is very sensitive to contamination or poor connections. Making sure that the electrical contacts are clean and dry may cure system problems easily and preclude the need for time-consuming testing.

Oxygen sensor replacement is a maintenance procedure scheduled at a specified time or mileage interval which varies depending on model year. See **LUBRICATION AND MAINTENANCE** for more information on recommended service intervals and servicing the oxygen sensor.

> **NOTE**
>
> Emission controls, including the oxygen sensor system, are covered by an extended warranty. See **LUBRICATION AND MAINTENANCE** for maintenance requirements. Consult an authorized BMW dealer about warranty coverage before beginning any repairs.

5.1 Testing Oxygen Sensor System

The signal from the oxygen sensor is monitored by the fuel system's electronic control unit. The signal from the oxygen sensor is just one of many inputs the control unit receives and processes in order to properly control the air/fuel mixture. For more information on the operation of the control unit and the rest of the fuel system, see **FUEL SYSTEM**.

Because of the closed-loop interaction between the fuel injection system and the oxygen sensor, accurate testing of the oxygen sensor requires special equipment. There are, however, a few simple tests which can help determine whether the sensor is functioning correctly. These tests require an accurate voltmeter and, on models with four-wire oxygen sensors, an ohmmeter.

This is a sensitive measurement. In the interest of accuracy, the engine must be fully warmed up, the exhaust system must be free of leaks, and all electrical consumers (cooling fan, air conditioning, lights, etc.) must be off.

To test:

1. With the ignition off, remove the oxygen sensor connector from the mounting clip and disconnect the connector. See Fig. 5-1 or Fig. 5-2.

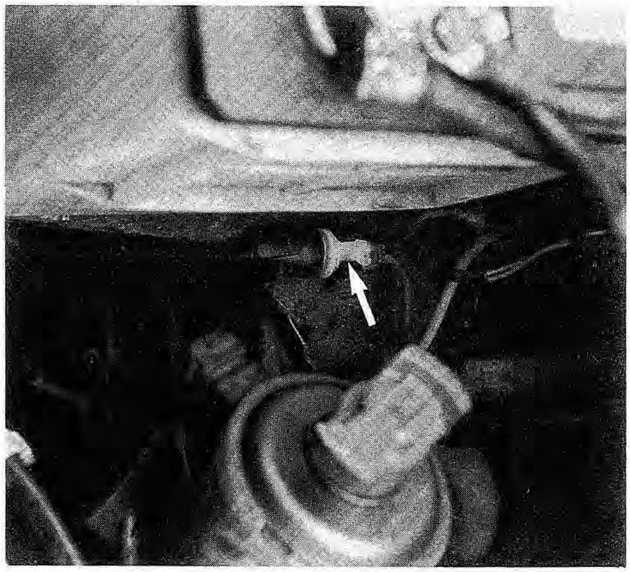

Fig. 5-1. Oxygen sensor connector (**arrow**) on early 1984 318i model (near left-hand side of battery). Connector on late 1984 and all 1985 318i models is similar.

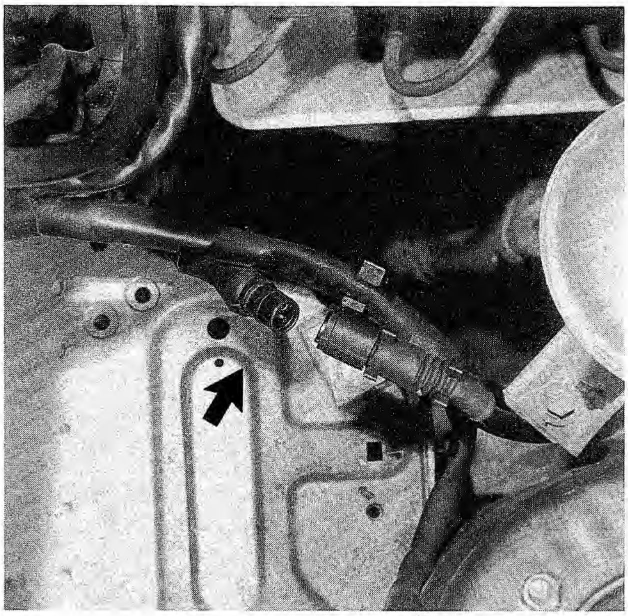

Fig. 5-2. Oxygen sensor connector (**arrow**) on 1986–1988 325i(is) models. Connectors on 325e(es) models and all 1989–1990 models are similar.

2. Connect a voltmeter (approximately 0 to 1 VDC scale) to measure the oxygen sensor output signal at the sensor side of the harness connector. **Table b** lists the correct terminal connections for the various models and sensor types. The connectors and terminals are shown in Fig. 5-3.

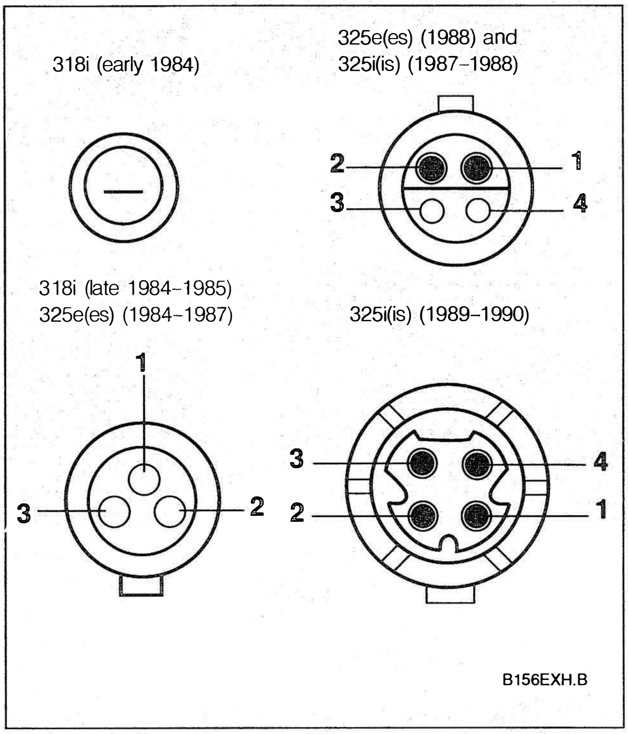

Fig. 5-3. Identification of terminals at oxygen sensor harness connectors. Wiring harness side shown. Terminals are also identified on connector.

3. Start the engine and let it idle. After about two minutes the oxygen sensor's output voltage should be fluctuating, indicating correct oxygen sensor function.

WARNING —

Exhaust manifolds and pipes can be hot enough to cause serious burns. When working near hot pipes or mufflers, use heavy gloves and other appropriate protection.

CAUTION —

Connect and disconnect test leads only with the ignition off.

4. With the engine running, loosen the oil filler cap or pull up on the oil level dipstick to admit unmeasured intake air and simulate a lean running condition. The oxygen sensor's output voltage should drop.

Lack of a fluctuating voltage signal from the sensor indicates a problem, perhaps only that the sensor is not hot enough. This problem occurs mainly at idle, and is more likely to occur on cars with unheated oxygen sensors. Accelerate the engine several times or run it at fast idle for a few minutes to increase sensor temperature, then check the output signal again. If there is still no fluctuating voltage signal, check for a faulty wire between the connector and the sensor. If the wire is undamaged, the sensor is probably faulty and should be replaced.

On cars with heated oxygen sensors, too little sensor temperature may be caused by a faulty heater circuit. Check the heater circuit as described below before replacing the oxygen sensor.

Table b. Oxygen Sensor System Test Connections

Model (model year)	Sensor type	Sensor output signal (VDC)	Heater power supply (approx. 12 VDC)	Heater resistance (ohms)
318i (early 1984)	Unheated (single wire)	black wire (+) and ground (−)	N/A	N/A
318i (late 1984–1985) 325e(es) (1984–1987)	Heated (three-wire)	terminal 1 (+) and ground (−)	terminals 3 (+) and 2 (−)	N/A
325e(es) (1988) 325i(is) (1987–1990)	Heated (four-wire)	terminal 2 (+) and ground (−)	terminals 4 (+) and 3 (−)	terminals 4 and 3

Checking Oxygen Sensor Heater Circuit

If oxygen sensor function is in doubt, particularly at idle speeds, check the oxygen sensor heater circuit at the harness side of the oxygen sensor connector. See **Table b** and Fig. 5-3. With the ignition on, there should be battery voltage (approximately 12 VDC) to the heater. If not, check the oxygen sensor heater relay or the voltage source to the relay. The oxygen sensor heater relay is shown in Fig. 5-4.

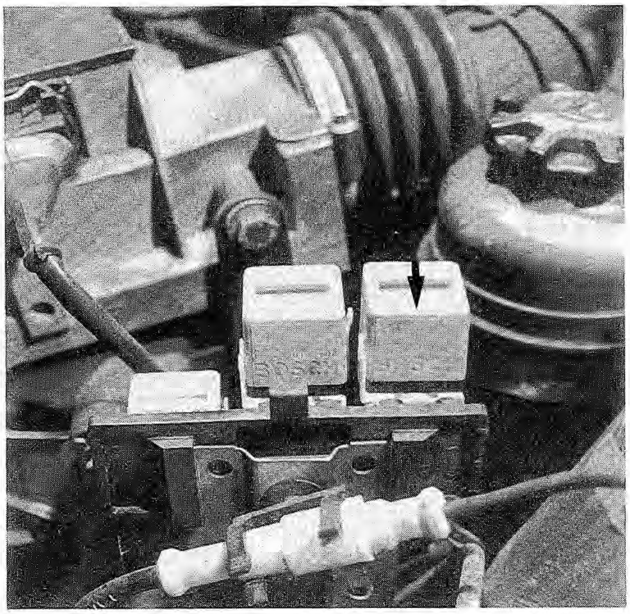

Fig. 5-4. Oxygen sensor heater relay (**arrow**). Relays shown with protective cover.

CAUTION —
Connect and disconnect test leads only with the ignition off.

On systems with four-wire oxygen sensors, also check resistance of the heater circuit at the sensor side of the connector. Resistance greater than 5 ohms indicates that the oxygen sensor is faulty and should be replaced.

NOTE —
On 1984 and 1985 325e(es) models with heated oxygen sensors (three-wire sensors), check for heater voltage at the connector located beneath the right-hand side of the car, near the oxygen sensor.

NOTE —
On 1985 318i models with heated oxygen sensors, an oxygen sensor heater relay is not used. The oxygen sensor receives battery voltage from the fuel pump relay (terminal 87b). See **FUEL SYSTEM** for fuel pump relay location.

NOTE —
The oxygen sensor heater relay may be located in the adjacent position. To determine the position of the relay, check the wire colors leading to the relay. The relay which has a green/blue wire leading to it is the oxygen sensor heater relay.

Replacing Oxygen Sensor

To replace an oxygen sensor, disconnect the wiring to the sensor and use a wrench on the hex portion of the sensor housing. Apply an anti-seize compound to the threads of the new sensor. Install the sensor, torquing it to 55 ± 5 Nm (41 ± 3 ft. lb.). Reconnect the wiring.

CAUTION —
Do not let anti-seize compound come in contact with the slit portion of the oxygen sensor body or the sensor will be damaged.

6. TECHNICAL DATA

I. Tightening Torques

Front exhaust pipe to rear exhaust pipe (nut or bolt)	22–24 Nm (16–17 ft. lb.)
Exhaust manifold to cylinder head (nut)	22–24 Nm (16–17 ft. lb.)
Front exhaust pipe to exhaust manifold (nut)	
1st stage	30–35 Nm (22–25 ft. lb.)
2nd stage	50–55 Nm (36–40 ft. lb.)
Front exhaust pipe clamp to exhaust pipe (nut or bolt)	22–24 Nm (16–17 ft. lb.)
Front exhaust pipe bracket to transmission bracket (nut or bolt)	22–24 Nm (16–17 ft. lb.)
Heat shield to exhaust system (self-tapping screw)	7–8 Nm (5–6 ft. lb.)
Oxygen sensor to exhaust manifold or exhaust pipe	55 ± 5 Nm (41 ± 3 ft. lb.)
Rear muffler clamp to rear muffler maximum permissible (clamping bolt)	
4-cylinder engine	16 Nm (12 ft. lb.)
6-cylinder engine	14 Nm (10 ft. lb.)
Rear muffler clamping bracket to rear axle (bolt)	22–24 Nm (16–17 ft. lb.)
Front pipe clamping bracket to transmission bracket (rubber mounts)	
M6 bolts	9–10 Nm (7–8 ft. lb.)
M8 bolts	22–24 Nm (16–17 ft. lb.)

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Section 9

MANUAL TRANSMISSION AND CLUTCH

Contents

TABLES

9

Manual Transmission and Clutch

Introduction

The cars covered by this manual are equipped with one of three different five-speed manual transmissions. Most 318i models are equipped with the Getrag 240 transmission. Some early 1984 318i models are equipped with a ZF S5-16 transmission. All 6-cylinder (325) models are equipped with a Getrag 260 transmission.

All three transmissions are fully synchronized in all gears and are housed in lightweight alloy cases. From the transmission, power is transmitted to the drive wheels by the driveshaft and final drive. The transmission can be removed and installed without removing the engine. Service and repair of the driveshaft and final drive are covered in **DRIVESHAFT AND FINAL DRIVE**.

Repairs to the internal parts of the transmission require special tools and knowledge. If you lack the skills and tools, or a suitable workplace for servicing the transmission, we suggest you leave these repairs to an authorized BMW dealer or other qualified shop.

Though you may not have the skills and knowledge for doing actual internal repairs, it may be possible to save some of the expense of professional repair by removing and installing the transmission yourself, using the procedures described in this section. It is important to realize, however, that a partially disassembled transmission may be a problem for a mechanic. We strongly advise against taking the transmission apart to begin any repair that cannot be properly finished.

1. GENERAL DESCRIPTION

This section covers both the clutch and the manual transmission. Fig. 1-1 shows a typical BMW five-speed manual transmission.

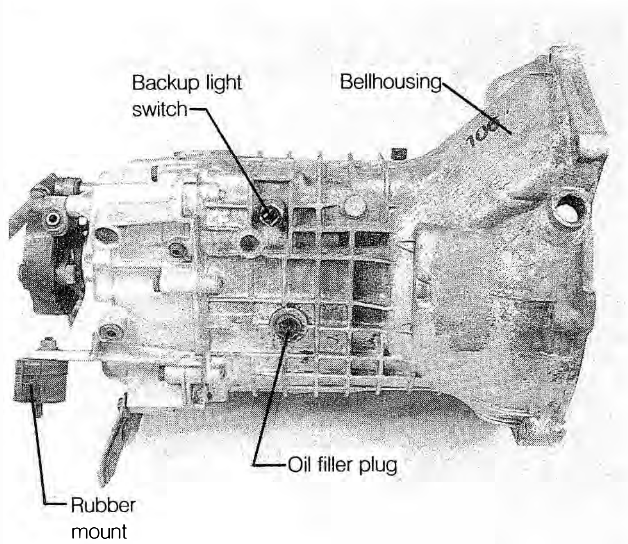

Fig. 1-1. Transmission case of five-speed Getrag 240 manual transmission.

1.1 Transmission

The transmission case, which contains the transmission gear train, is a lightweight alloy die casting with an integral bellhousing. The transmission gears are of the constant-mesh type with balk ring synchronizers. Each gear (1st through 5th) is actually a mating pair of gears, and constant-mesh simply means the mating gears are always meshing, as shown in Fig. 1-2.

The 4th gear is mounted on the input shaft and rotates the layshaft at engine speed. The 1st through 3rd and 5th gears are mounted in bearings with their mating gears on the layshaft, and the gears freewheel until engaged. The synchronizers are splined and mounted on the output shaft and always rotate at rear wheel speed.

Gear selection is made using the gearshift lever in the passenger compartment, which is linked to the transmission by the gearshift linkage. When shifting, the synchronizers match the speed of the selected gear to the speed of the output shaft, then lock the selected gear into rotation with the output shaft. This eases shifting, minimizes wear, and helps prevent damage to the gears.

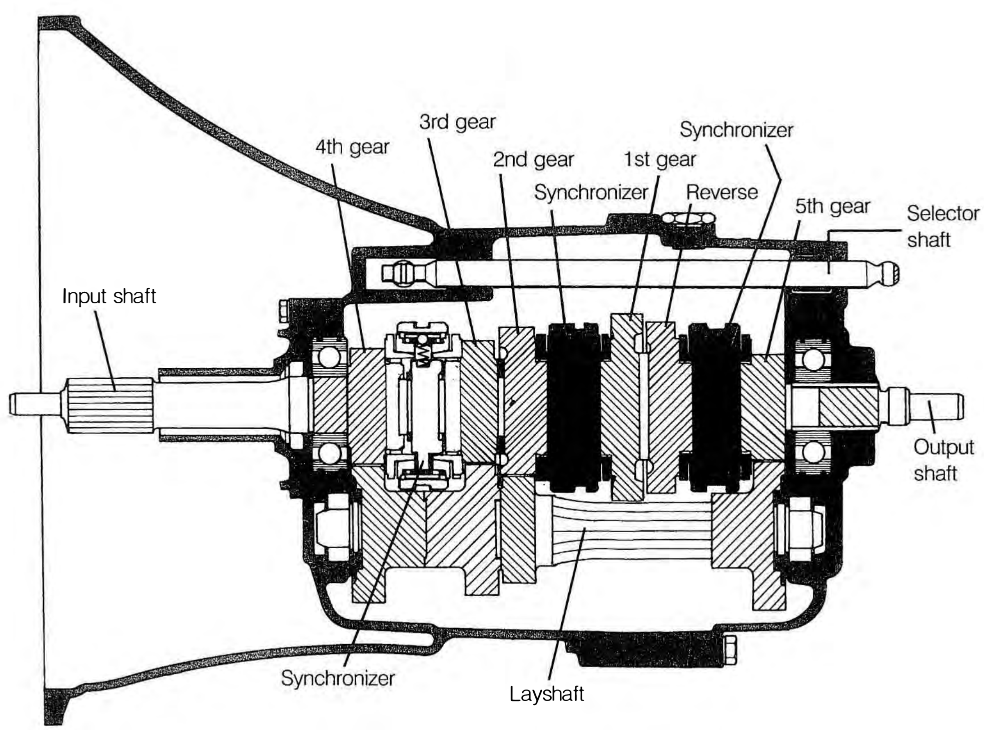

Fig. 1-2. Cross section of manual transmission showing position of gear train.

1.2 Clutch

The transmission bellhousing houses the clutch components. The clutch is hydraulically operated. When the clutch pedal is depressed, the clutch master cylinder generates hydraulic pressure to activate the slave cylinder on the transmission. The slave cylinder moves the clutch release lever and release bearing, which are inside the bellhousing, to engage or disengage the clutch.

1.3 Identification Codes and Specifications.

Transmissions are identified by manufacturer's stamp and by code numbers and letters. The manufacturer's stamp is on the case, just in front of the mounting for the clutch slave cylinder as shown in Fig. 1-3. The code number and letters are located on the top of the Bellhousing as shown in Fig. 1-4. **Table a** lists manual transmission gear ratios.

Fig. 1-3. Manufacturer's stamp for Getrag transmissions. ZF transmissions are similar.

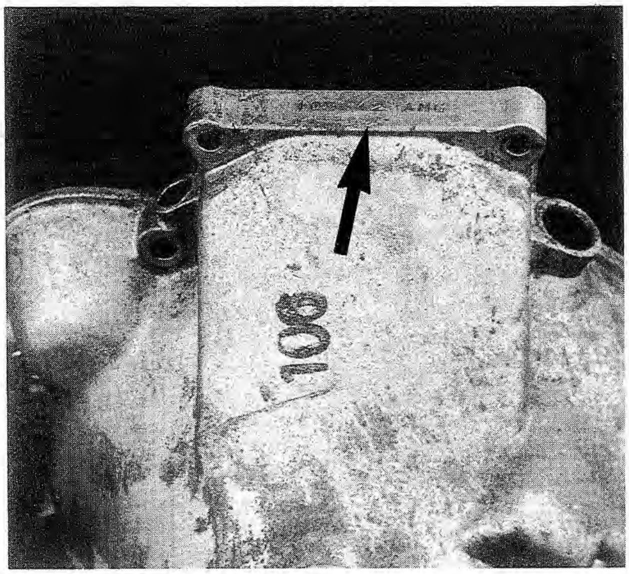

Fig. 1-4. Location of transmission identification code (arrow) on five-speed manual transmissions.

Table a. Manual Transmission Gear Ratios

Transmission type	Getrag 240	ZF S5-16	Getrag 260
Gear ratios			
1st gear	3.72	3.72	3.83
2nd gear	2.02	2.04	2.20
3rd gear	1.32	1.34	1.40
4th gear	1.00	1.00	1.00
5th gear	0.81	0.80	0.81
Reverse gear	3.45	3.54	3.46

2. MAINTENANCE

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of the clutch and transmission. Information on clutch and transmission maintenance and on the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Checking clutch master cylinder fluid level
2. Checking transmission oil level
3. Checking clutch disc for wear
4. Changing transmission oil

NOTE —
Checking clutch freeplay is not necessary for the BMW cars covered by this manual. The clutch system is hydraulic and is self-adjusting.

3. TROUBLESHOOTING

This troubleshooting section applies to problems affecting the transmission—including the gearshift mechanism and the gear train—as well as the clutch.

The source of most problems is apparent from the symptoms. For example, difficulty in engaging a gear or imprecise shifting are transmission problems. Other symptoms, such as loss of performance, vibration or shuddering when releasing the clutch, or noises from the area of the transmission, are less specific.

Poor performance may be evidence of a slipping clutch, but it may also be caused by an engine problem. Vibration suggests a faulty clutch, but might also indicate a driveline problem.

Noises may be the result of a failure in the gear train, or of the driveshaft and final drive. What appears to be a transmission oil leak may be engine oil leaking from a faulty rear crankshaft oil seal, especially if the leak is near the bottom of the transmission bellhousing. See **ENGINE** for information on crankshaft oil seals. See **DRIVESHAFT AND FINAL DRIVE** for information on the driveshaft.

3.1 Basic Troubleshooting Principles

Transmission problems fall into two categories: those that can be fixed by external adjustments, and those that require disassembly of the transmission. Problems that at first appear to be caused by internal faults, such as gear shifting difficulty or noisy operation, can often be corrected by external adjustments.

Begin any transmission troubleshooting with a thorough visual inspection, both in the engine compartment and from beneath. Check all parts of the gearshift mechanism for wear that might cause misalignment and shifting difficulty. Look for wet spots that may indicate oil leaks. Low oil level may be the cause of hard shifting or noise. Accurate pinpointing of leaks may require that the suspected area be cleaned and reinspected.

To avoid removing the transmission unnecessarily, check the gearshift mechanism for wear and correct leaks and oil level before acting on suspected internal problems. The gearshift mechanism is covered in **4. Shift Mechanism**. Replacement of oil seals is covered in **7.3 Transmission Oil Seals**. Checking and correcting oil level is covered in **LUBRICATION AND MAINTENANCE**.

As with most other troubleshooting, careful observation of the symptoms is the key to isolating and identifying transmission problems. A road test is an important step. Determining whether the problem is present in all gears, only during acceleration, when the clutch is engaged, or in some other special conditions may help isolate the source of the problem.

Table b lists manual transmission and clutch symptoms, their probable causes, and recommended corrective actions. The numbers in bold type in the corrective action column refer to the numbered headings in this section where the suggested repairs are described.

3.2 Diagnostic Tests

Most internal transmission problems cannot be accurately diagnosed unless the unit is removed and disassembled. However, a quick test can be used to determine whether the clutch is performing satisfactorily or slipping.

To quick-check clutch performance, start the engine and set the parking brake. Depress the clutch pedal and place the gearshift lever in 3rd or 4th gear, then slightly accelerate the engine and slowly release the clutch pedal. The engine should immediately stall, indicating that the clutch is engaging properly and will not slip enough to allow the engine to continue to run. If the engine stalls slowly, or does not stall at all, the clutch is most likely slipping. See **5. Clutch** for more information.

Table b. Manual Transmission Troubleshooting

Symptom	Probable cause	Corrective action
1. Difficult or noisy shifting	a. Clutch not fully releasing	a. Air in clutch hydraulic system. Bleed system. **5.1** Incorrect pedal adjustment. Check and correct pedal adjustment. **5.2**
	b. Clutch disc binding on transmission input shaft	b. Remove transmission and inspect splines of clutch disc and input shaft. If necessary, replace clutch disc. **5.3**
	c. Worn gearshift linkage, or loose shift console	c. Check shift mechanism and tighten shift console. If necessary, replace worn parts. **4.1**
	d. Low gear oil level	d. Check for transmission oil leaks. Check and correct oil level if needed. See **LUBRICATION AND MAINTENANCE**
	e. Incorrect gear oil for ambient temperature	e. Drain oil and replace with oil of correct viscosity. See **LUBRICATION AND MAINTENANCE**
	f. Worn or damaged internal gear train components	f. Inspect internal transmission components and replace faulty parts. **7**
	g. Not waiting long enough before shifting (Reverse)	g. Wait at least 3-4 seconds after depressing clutch pedal before shifting into reverse
2. Transmission noisy	a. Insufficient gear oil	a. Check for transmission oil leaks. Check and correct oil level if needed. See **LUBRICATION AND MAINTENANCE**
	b. Worn or damaged internal gear train components	b. Inspect internal transmission components and replace faulty parts. **7**
	c. Clutch dampening springs broken	c. Inspect clutch components and replace faulty parts. **5.3**
3. Grinding noise when shifting (1st or Reverse gears)	a. Idle speed too high	a. Adjust idle speed. See **FUEL SYSTEM**
	b. Not waiting long enough before shifting (Reverse)	b. Wait at least 3-4 seconds after depressing clutch pedal before shifting into reverse
	c. Worn or damaged internal gear train components	c. Inspect internal transmission components and replace faulty parts. **7**
4. Transmission fails to engage a gear or jumps out of gear	a. Worn gearshift linkage or loose shift console	a. Check shift mechanism and tighten shift console. If necessary, replace worn parts. **4.1**
	b. Transmission output flange loose	b. Check output flange. See **DRIVESHAFT AND FINAL DRIVE**
	c. Worn or damaged internal gear train components	c. Inspect internal transmission components and replace faulty parts. **7**
5. Poor acceleration, clutch slipping on hills when accelerating	a. Clutch friction surfaces worn or burnt	a. Inspect clutch components and replace faulty parts. **5.3**
	b. Clutch not fully engaging	b. Inspect clutch disc for binding on input shaft. Check condition of bearing on input shaft. Check condition of release bearing and release lever. Replace faulty parts. **5.3**. Check for binding in clutch hydraulic system at slave cylinder and master cylinder pushrods. **5.2**
	c. Clutch disc, pressure plate, or flywheel oil soaked	c. Inspect clutch components and engine and transmission oil seals. If necessary, clean pressure plate and flywheel. Replace clutch disc and faulty oil seals. **5.3, 7.3**
6. Clutch grabs or chatters when the pedal is released	a. Faulty clutch release system	a. Check condition of release bearing and release lever. Replace faulty parts. **5.3**. Check for binding in clutch hydraulic system. **5.2**
	b. Clutch disc binding on transmission input shaft	b. Remove transmission and inspect splines of clutch disc and input shaft. If necessary, replace clutch disc. **5.3**
	c. Contaminated or glazed (overheated) clutch disc	c. Inspect clutch disc and replace faulty parts. **5.3**
	d. Faulty engine/transmission mounting	d. Check engine and transmission mounts for oil contamination. Replace if necessary. See **ENGINE**

4. SHIFT MECHANISM

The basic shift mechanism on the cars covered by this manual is a shift lever and shift rod connected to the transmission selector shaft. See Fig. 4-1. The shift lever swivels in a ball-and-socket mounted in the shift console. The shift rod is carried in bushings at either end to dampen transmission vibration.

There are two versions of the shift mechanism. One has a sheet metal shift console and one has an aluminum shift console. The version with sheet-metal shift console is installed

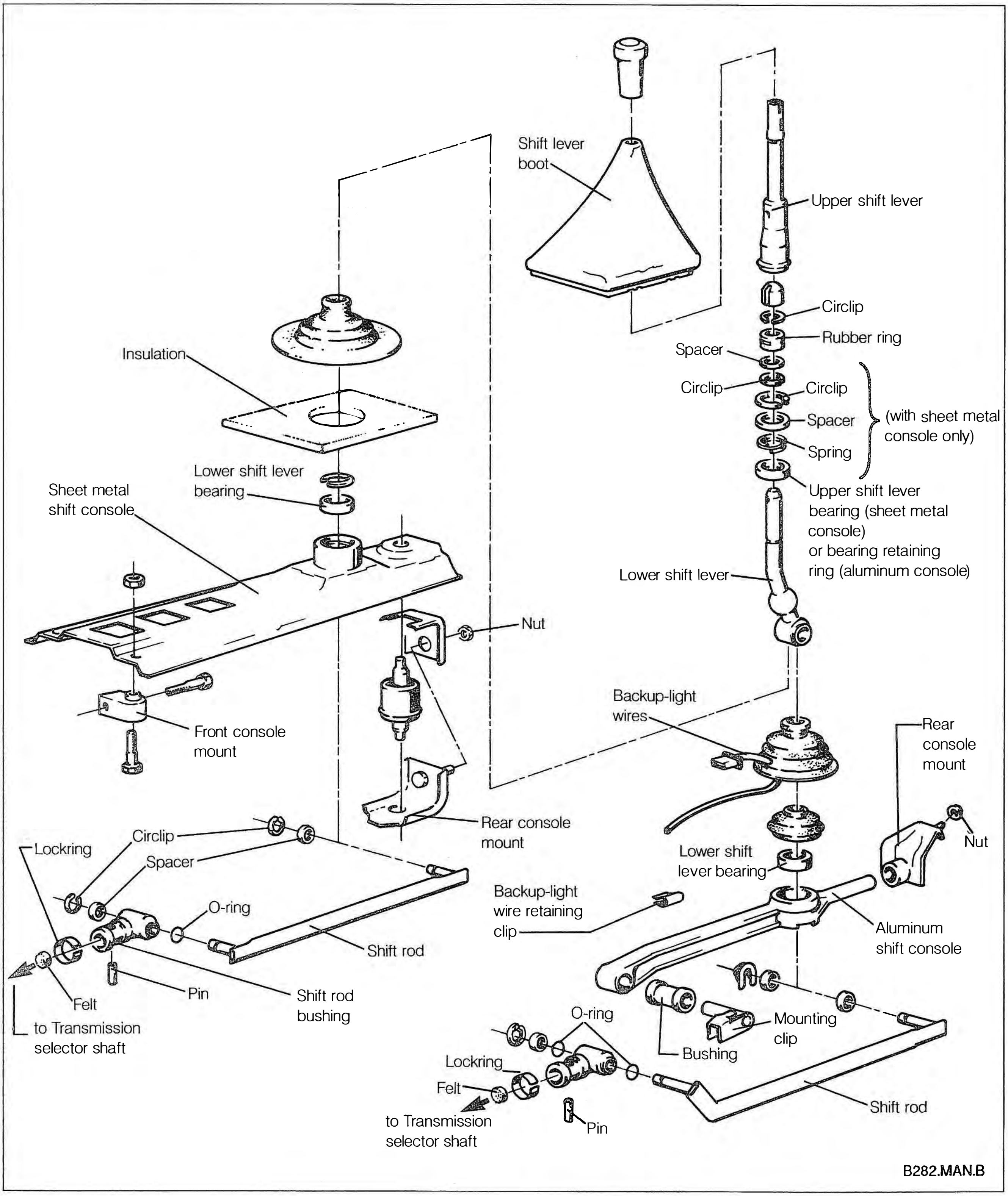

Fig. 4-1. Exploded view of shift mechanism.

on most models through 1986. On sheet-metal consoles, the shift lever is mounted in a two-piece plastic bearing secured by a circlip. At the front, the console is bolted to the transmission case.

The version with aluminum shift console is installed on most models from 1987 on. On aluminum consoles, the shift lever and its bearing are held in the frame by a plastic retaining ring that snaps into place. The front of the console is mounted to the transmission case by a clip.

The shift mechanism is not adjustable. For any shifting problems, the gearshift bearing and shift-rod bushings should be inspected for wear or for a lack of lubrication that might affect smooth or accurate shifting. The shift console should also be checked for secure mounting and bushing wear. All bearings and bushings are available as replacement parts.

4.1 Disassembling and Assembling Shift Mechanism

The shift mechanism itself is easily removed and installed, but in most models complete access to the mechanism requires removing the exhaust system, the exhaust heat shield, and the driveshaft. See **EXHAUST SYSTEM AND EMISSION CONTROLS** and **DRIVESHAFT AND FINAL DRIVE** for more information.

On models with the aluminum shift console, removal of the shift lever may require the use of a special tabbed tool to unlock the plastic retaining ring.

On models with the sheet-metal console, special bolts coated with a locking compound are used to hold the console to the transmission. This prevents the bolts from loosening and being stripped by the shifting action.

When assembling the shift rod or shift lever bearing, lubricate all joints and pivot points with molybdenum disulfide grease (Molykote Longterm 2 or equivalent).

To remove and install shift lever and shift rod:

1. Put the transmission in reverse.
2. Pull the shift knob up and off of the shift lever. Remove the shift boot and the sound insulating felt underneath it.
3. Remove the rubber dust cover. On models with aluminum shift console, it is necessary to first disconnect the plug for the backup light switch.
4. Working underneath the car, disconnect the shift lever from the shift rod by removing the circlip as shown in Fig. 4-2.

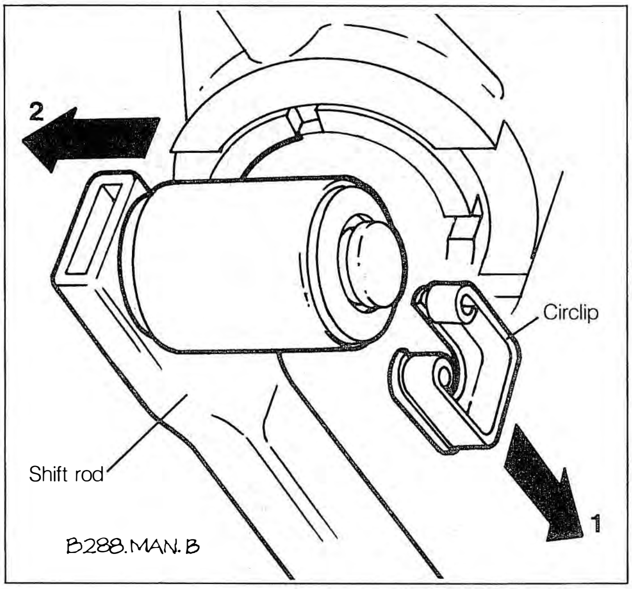

Fig. 4-2. Lower shift lever being disconnected from shift rod. Pull off circlip in direction of arrow (**1**) and then disengage shift rod from bushing (**2**).

5. On models with sheet-metal shift console, remove the circlip from the top of shift lever bearing shown in Fig. 4-3 and lift out the shift lever.

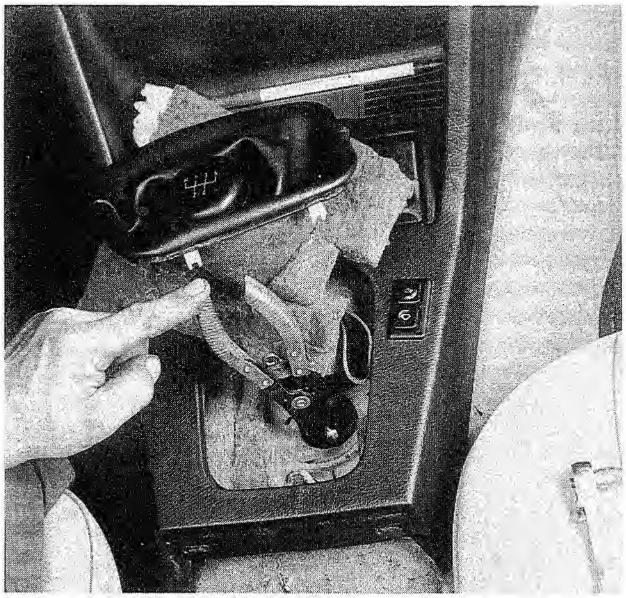

Fig. 4-3. Circlip being removed on models with sheet-metal shift console.

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6. On models with aluminum shift console, work underneath the car and use the special tool (BMW Part No. 25 1 100) or a screwdriver to engage the locking tabs of the bearing retaining ring from below the lower shift lever bearing. Turn the ring 90° (¼ turn) counterclockwise, as shown in Fig. 4-4 to unlock it, and lift out the shift lever.

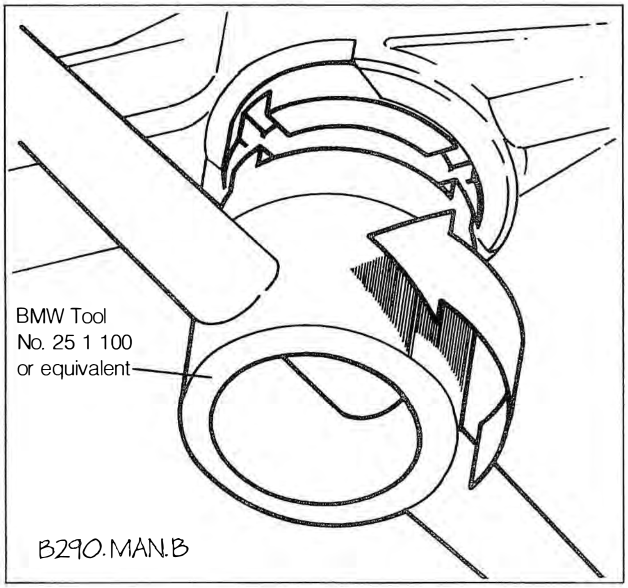

Fig. 4-4. Removing shift lever retaining ring on models with aluminum shift console.

7. Remove the shift rod from the transmission selector shaft. This is done by pulling off the bushing lockring, then using a suitable drift to drive out the pin. See Fig. 4-5.

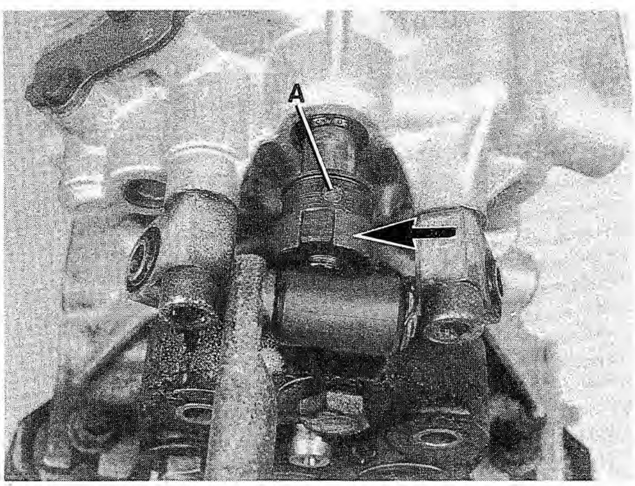

Fig. 4-5. Shift rod bushing lockring (arrow), and pin (**A**). Transmission shown removed. With transmission installed, drive pin out from below.

NOTE

- Note the installed orientation of the shift rod so that it can be reinstalled the same way. Depending on the transmission, the shift rod may be on the right or left side of the bushing.

- On models with sheet-metal shift console, it may be easier to drive the pin out with the selector shaft in 3rd or 5th gear.

Installation is the reverse of removal. Check the condition of the felt in the shift rod bushing, and replace it if it is torn or damaged. Drive the bushing pin in from the bottom. Remove any old grease from the shift lever bearing and lubricate it with molybdenum disulfide grease (Molykote Longterm 2 or equivalent).

On models with sheet-metal shift console, the shift lever bearing should be lubricated with the same grease. On models with aluminum shift console, align the tabs on the plastic retaining ring with the openings in the shift console, as shown in Fig. 4-6, and press in the retaining ring until it clicks twice.

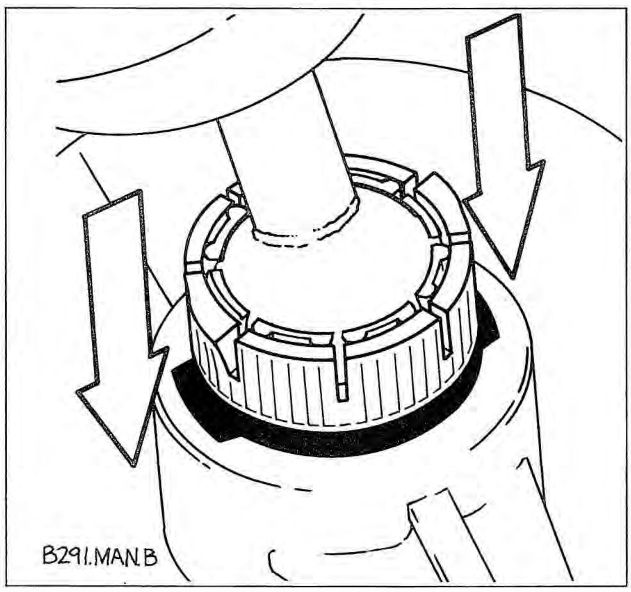

Fig. 4-6. Shift lever being installed.

To remove and install shift console:

1. Remove the shift lever and shift rod as described above.

2. Disconnect the wires for the backup lights from the transmission. On models with sheet-metal console also disconnect the plug on the top of the console. On models with aluminum console, remove the wiring clips on the console and remove the wires.

3. Working under the car, remove the shift console rear mounting nut, shown in Fig. 4-7.

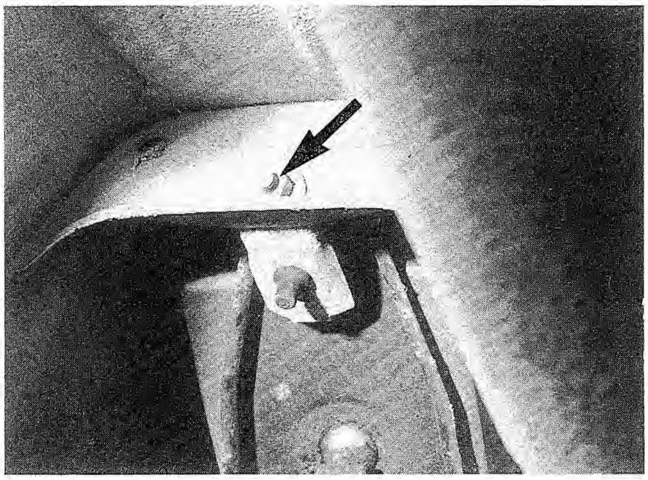

Fig. 4-7. Shift console rear mounting nut to be removed (arrow). Model with sheet-metal console shown. Aluminum console is similar.

4. On models with sheet-metal console, remove the front console-to-transmission mounting bolts shown in Fig. 4-8 and remove the console.

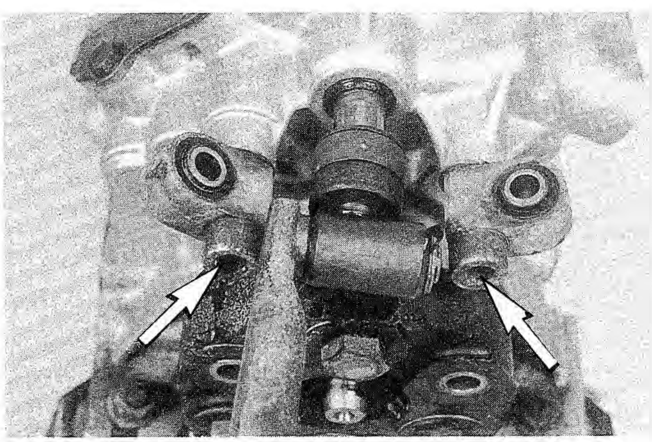

Fig. 4-8. Shift console-to-transmission mounting bolts (arrows) to be removed. Transmission shown removed.

NOTE —

The bolts may be difficult to remove since they are installed with a locking adhesive.

5. On models with aluminum shift console, support the transmission with a jack and unbolt the rear transmission support from the body. Then lower the transmission so that it rests on the front cross member. Remove the front mounting clip for the console as shown in Fig. 4-9 and remove the console.

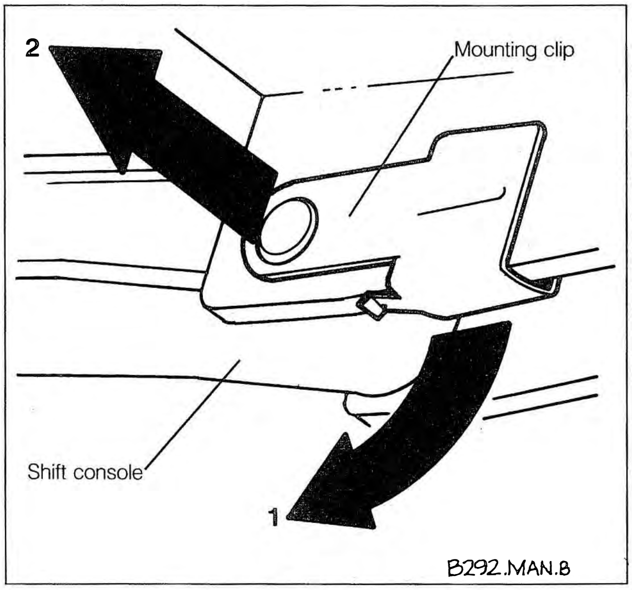

Fig. 4-9. Front mounting clip for aluminum shift console. Remove by first unclipping (**1**), and then sliding pin and clip out (**2**).

Installation is the reverse of removal. Torque the rear mounting nut to 11 Nm (8 ft. lb.).

On models with sheet-metal console, use new front console mounting bolts (Part No. B 25 11 1 205 659) with locking compound, and torque them to 23 Nm (17 ft. lb.).

On models with aluminum shift console, torque the transmission support bolts to 22 to 24 Nm (16 to 18 ft. lb.).

5. CLUTCH

Fig. 5-1 is a schematic view of the hydraulically-operated clutch. The friction clutch disc is clamped by spring pressure between the diaphragm-type pressure plate assembly and the engine flywheel. The splined hub ofthe clutch disc rides on the transmission input shaft, while the pressure plate assembly is bolted to the engine flywheel.

Depressing the clutch pedal operates the master cylinder and generates hydraulic pressure. This pressure forces the slave cylinder pushrod out to move the release lever and release bearing. As the release bearing presses on the pressure-plate release levers, the clamping pressure is eased on the clutch disc, disengaging engine power from the transmission.

Two basic types of clutch discs are installed, depending on the type of flywheel. On models with a conventional plate-type flywheel, the clutch disc has integral cushion springs and dampening springs. The cushion springs—that are between the friction surfaces of the disc—help to reduce the shock when the clutch is engaged. The dampening springs—that are visible in the center hub—help to absorb the rotating power pulses of the engine. On models with dual-mass flywheels, the dampening springs are integrated into the flywheel. For more information on flywheels, see **ENGINE**.

Except for repairs and maintenance to the clutch hydraulic system, inspection or repair of the clutch assembly requires removing the transmission. When the transmission is removed, the flywheel and the clutch assembly remain bolted to the crankshaft, while the release bearing and release lever remain mounted on the transmission. Fig. 5-2 shows the clutch components that are usually replaced when the clutch is overhauled.

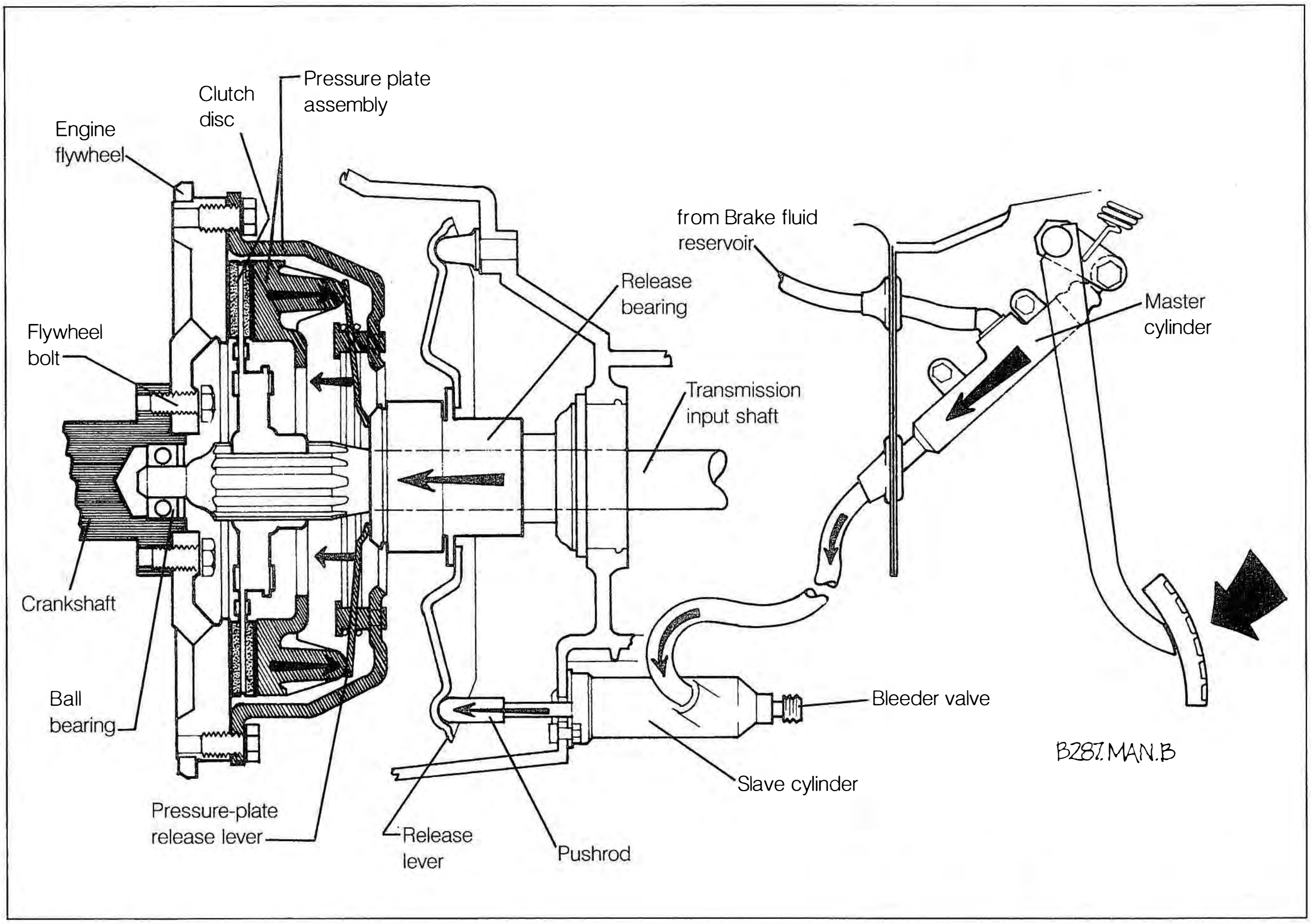

Fig. 5-1. Schematic view of hydraulic clutch components.

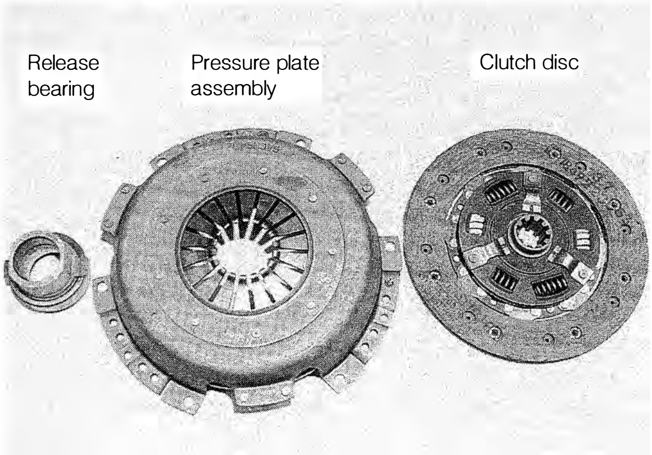

Fig. 5-2. Clutch components that are usually replaced when the clutch is overhauled.

The clutch release system is not adjustable. The clutch slave cylinder automatically compensates for normal wear of the clutch disc. The clutch disc should be replaced when worn beyond acceptable limits. Checking clutch disc wear is a regular maintenance procedure and is covered in **LUBRICATION AND MAINTENANCE**.

Failure of the clutch to fully disengage may be caused by inadequate travel or misalignment of the slave-cylinder pushrod, by a bent master-cylinder pushrod, or by the clutch disc binding on the transmission input shaft. Bleed the clutch as described in **5.1 Bleeding Clutch Hydraulic System**, and then check the slave and master cylinders as described in **5.2 Clutch Master Cylinder and Slave Cylinder**. Inspection of the input shaft and clutch disc splines requires removing the transmission, as described in **6.1 Removing and Installing Transmission**.

The clutch shares a common fluid reservoir with the brake system. The same problems that typically affect brake operation—air in the lines and moisture in the fluid—can also affect clutch operation. BMW does not specify any particular interval for replacement of the clutch hydraulic fluid, but the publisher recommends changing the fluid whenever the brake fluid is changed. This should provide adequate protection against corrosion in the clutch master and slave cylinders.

5.1 Bleeding Clutch Hydraulic System

Bleeding the clutch hydraulic system is necessary to remove any air from the lines that may affect the function of the clutch slave cylinder, and to drain the system when changing the fluid.

Bleeding the clutch is similar to bleeding the brakes. Aerated or contaminated fluid is expelled from the system and replaced with new, clean fluid. The three basic methods—pressure bleeding, vacuum bleeding, and manual bleeding—are used to force fluid through the line and release it at the bleeder valve on the slave cylinder. For more information on bleeding methods and on handling brake fluid, see **BRAKES**.

To bleed the clutch manually, have an assistant pump the clutch pedal a few times and then hold it down. Open the bleeder valve to expel the old fluid, then close the valve and release the pedal. Repeat the procedure until the fluid runs clear and without bubbles.

If you suspect that there is still some air in the lines, remove the slave cylinder from the transmission as described below. Push the pushrod all the way in, then release it slowly. This will force any remaining air in the fluid back into the fluid reservoir. When finished, check the fluid level and top it up if necessary.

> ***CAUTION***
>
> *Do not operate the clutch with the slave cylinder removed from the transmission. The slave cylinder may be damaged if the pushrod is forced out of the cylinder.*

5.2 Clutch Master Cylinder and Slave Cylinder

Although seal rebuild kits are available for both the master and slave cylinders, replacing leaking master or slave cylinders as complete units is usually preferred. In addition, rebuilding these units successfully depends on their internal condition, which can only be determined after the unit is removed and fully disassembled.

Checking Slave Cylinder Pushrod Travel

Inadequate travel of the slave cylinder pushrod may prevent the clutch from fully disengaging when the clutch pedal is depressed, leading to difficult shifting.

To check pushrod travel, use a strip of stiff metal that is thin enough to fit be ween the slave cylinder and the transmission bellhousing. Push the strip through the slot and hold it against the slave cylinder pushrod. See Fig. 5-3. Have an assistant depress the clutch pedal and release it. The metal strip should scribe a mark on the pushrod, indicating its travel. Remove the slave cylinder as described below and check the mark. Pushrod travel specifications are listed in **Table c**.

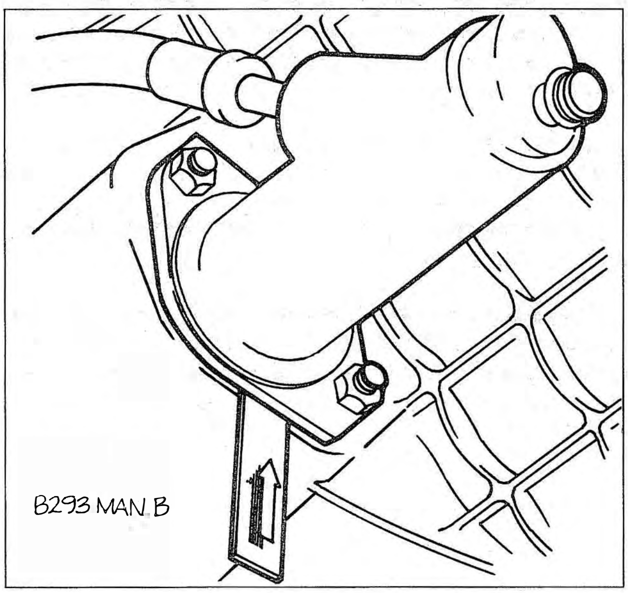

Fig. 5-3. Slave cylinder pushrod travel being checked with metal strip.

Table c. Slave Cylinder Specifications

Pushrod travel	at least 20 mm (¾ in.)

Inadequate pushrod travel may be due to air in the system, a leaky seal, or the clutch disc binding on the transmission input shaft. Reinstall the slave cylinder, bleed the system as described in **5.1 Bleeding Clutch Hydraulic System**, and recheck travel.

If pushrod travel is still inadequate after bleeding, check the adjustment of the clutch pedal as described below, and adjust as necessary. Also check the master and slave cylinder seals and hose connections for leaks, and replace as necessary. Finally, check the clutch disc and input shaft as described in **5.3 Removing and Installing Clutch**.

Removing and Installing Clutch Master Cylinder and Slave Cylinder

Incorrect installation of either the master cylinder pushrod or the slave cylinder pushrod may cause the clutch release mechanism to bind. This will prevent the clutch pedal from returning or cause the release action to feel jerky. It may even prevent the clutch pedal from being depressed.

To remove master cylinder:

1. Remove the brake fluid reservoir cap and, using a clean syringe, remove brake fluid until the level is below the hose connection for the clutch master cylinder.

> ***WARNING —***
> *Brake fluid is poisonous. Do not siphon brake fluid with your mouth. Wear safety glasses when working with brake fluid, and wear rubber gloves to prevent brake fluid from entering the bloodstream through cuts or scratches.*

2. Disconnect the hose from the master cylinder, where it projects through the firewall. See Fig. 5-4. Be prepared to catch any leaking fluid.

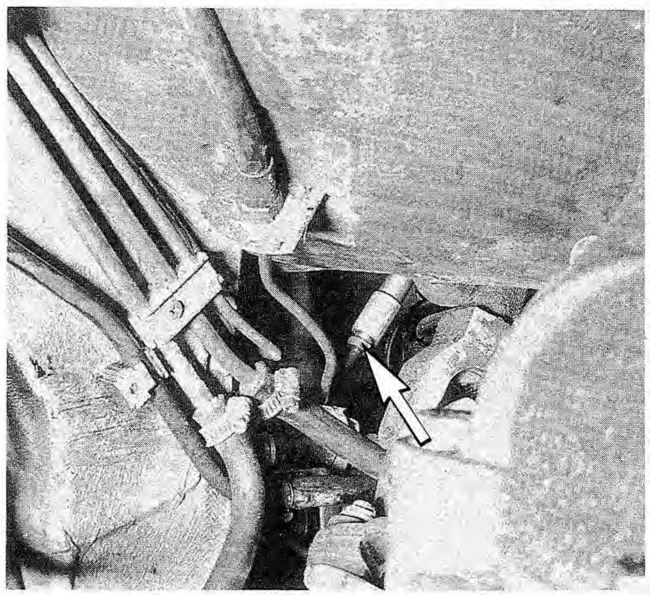

Fig. 5-4. Clutch hydraulic hose connection (arrow) to master cylinder.

3. Remove the lower left instrument panel trim as described in **BODY AND INTERIOR**.

4. Remove the bolt that connects the master cylinder push-rod to the clutch pedal. See Fig. 5-5.

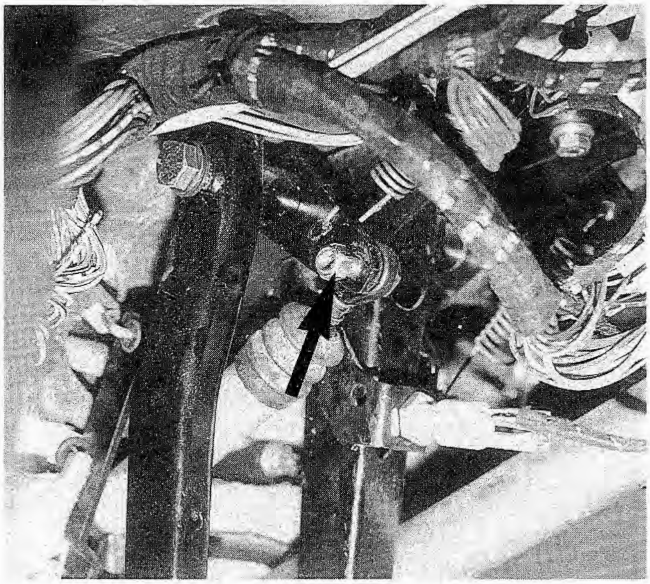

Fig. 5-5. Bolt (arrow) that connects master cylinder pushrod to clutch pedal.

5. Remove the two bolts that hold the master cylinder to the clutch pedal bracket, disconnect the fluid pipe from the top of the master cylinder, and remove the master cyl-inder.

CAUTION —

Brake fluid is damaging to paint. Be prepared to catch any fluid that leaks from the master cylin-der and fill pipe. Any brake fluid that spills on the car should be cleaned off immediately.

To install master cylinder:

1. Position the master cylinder against the pedal bracket and install the mounting bolts. Tighten them to 9 Nm (7 ft. lb.). Reattach the filler pipe.

2. Install the bolt that holds the pushrod to the clutch pedal and tighten it to 21 Nm (15 ft. lb.). On models with an over-center pedal helper spring, shown in Fig. 5-6, make sure the spring is engaged in its bracket before installing the pushrod bolt.

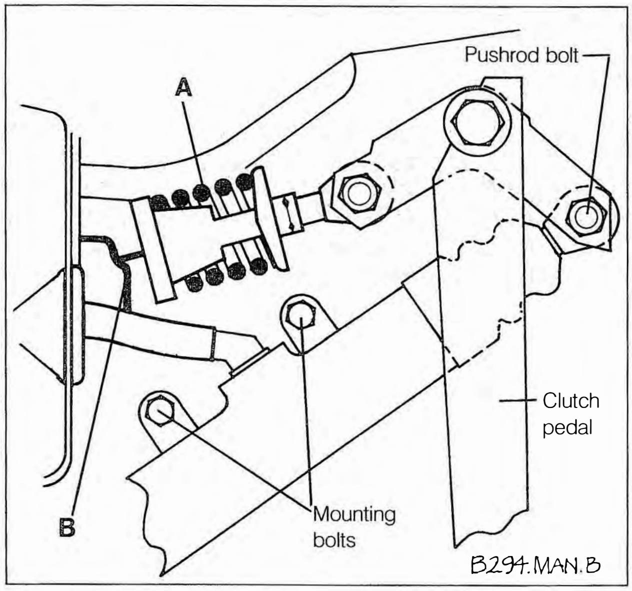

Fig. 5-6. Clutch pedal over-center helper spring (**A**) and spring guide (**B**).

3. Reconnect the fluid pipe and torque the fitting to 13 to 16 Nm (10 to 12 ft. lb.).

4. Check the adjustment of the clutch pedal as shown in Fig. 5-7. The specification is found in **Table d**.

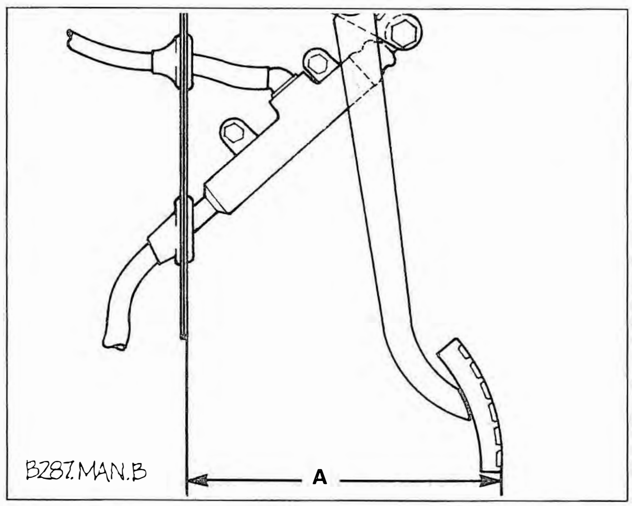

Fig. 5-7. Clutch pedal adjustment is checked at dimension **A**, from firewall to clutch pedal face.

Table d. Clutch Pedal Adjustment Specifications

Distance of pedal face from firewall	253 mm $^{+11}_{-0}$ (10 in. $^{+.4}_{-0}$)

5. If the adjustment is incorrect, loosen the pushrod nut and bolt. The bolt is eccentric and rotating it should change the adjustment.

6. Some models also have an adjustable pushrod. If the correct adjustment cannot be achieved by turning the eccentric bolt, loosen the pushrod locknut, shown in Fig. 5-8, and turn the pushrod until the correct adjustment is achieved. Torque the locknut to 4.5 to 6 Nm (3 to 4 ft. lb.) when the adjustment is correct.

CAUTION —

• Do not screw the pushrod all the way in. This may cause the locknut to jam against the clutch pedal during operation, breaking the master cylinder pushrod. If the pushrod length is changed, check the locknut clearance before fully depressing the clutch pedal.

• Do not over torque the pushrod locknut. If the threads are stripped, the master cylinder may jam, causing clutch failure.

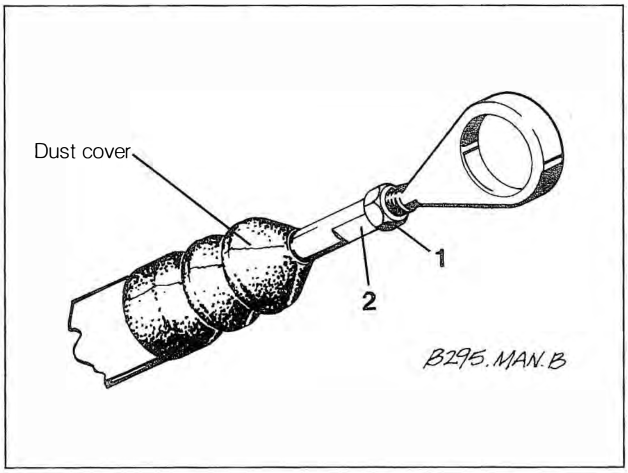

Fig. 5-8. Master cylinder pushrod locknut (**1**). Pull dust cover back, loosen locknut, and use wrench on **2** to adjust length of pushrod.

7. Reinstall the lower left instrument panel trim.

8. Refill the brake fluid reservoir and then bleed the clutch hydraulic system as described in **5.1 Bleeding Clutch Hydraulic System**.

To remove, inspect, and install slave cylinder:

1. Remove the brake fluid reservoir cap. Using a clean syringe, remove brake fluid until the level is below the hose connection for the master cylinder.

WARNING —

Brake fluid is poisonous. Do not siphon brake fluid with your mouth. Wear safety glasses when working with brake fluid, and wear rubber gloves to prevent brake fluid from entering the bloodstream through cuts or scratches.

2. Unbolt the slave cylinder from the transmission, then disconnect the fluid pipe and catch any excess fluid in a container.

3. Inspect the plastic tip of the pushrod and the release lever for wear. The pushrod should be worn only on the tip.

NOTE —

The release lever should show wear only in the pushrod recess. Wear on the side of the pushrod tip, or wear on the release lever other than in the pushrod recess indicates that the pushrod was misaligned.

4. Check the slave cylinder seal for leaks. If the pushrod seal is leaking, the slave cylinder should be replaced.

NOTE —

If the slave cylinder is replaced, make sure it is the correct type. Models with dual-mass flywheel require a slave cylinder with a diameter of 22.2 mm (.874 in.). All other models are equipped with a cylinder with a diameter of 20.64 mm (.813 in.). See **ENGINE** for more information on the flywheel.

5. Lightly coat the plastic pushrod tip with molybdenum disulfide grease (Molykote Longterm 2 or equivalent) and make sure the tip engages the recess in the clutch release lever.

NOTE —

When installing the slave cylinder, the bleeder valve faces down.

6. Torque the mounting nuts to 24 Nm (18 ft. lb.), and torque the fluid pipe connection to 13 to 16 Nm (10 to 12 ft. lb.).

7. Refill the brake fluid reservoir and then bleed the clutch hydraulic system as described in **5.1 Bleeding Clutch Hydraulic System**.

5.3 Removing and Installing Clutch

The transmission must be removed from the engine to reach the clutch. See **6.1 Removing and Installing Transmission**. It is normally recommended that the pressure plate be replaced when a new clutch disc is installed. If the clutch pressure plate is removed from the crankshaft, new mounting bolts should be used to reinstall it.

The flywheel should be carefully inspected when replacing the clutch. Replacing the clutch disc without replacing other worn components may accelerate clutch disc wear.

An inexpensive alignment tool—commonly called a clutch pilot tool or clutch arbor—is used to center the clutch disc during installation. Use of this tool or its equivalent will greatly aid the installation of the transmission. Clutch pilot tools are available from many aftermarket suppliers or from BMW.

BMW recommends lubrication of some parts when reassembling the clutch. The BMW-recommended lubricants are noted in the procedures below. If there are signs of oil at the bottom of the transmission, carefully inspect the rear crankshaft oil seal while the clutch is removed. A faulty oil seal should be replaced. See **ENGINE** for information on crankshaft oil seals.

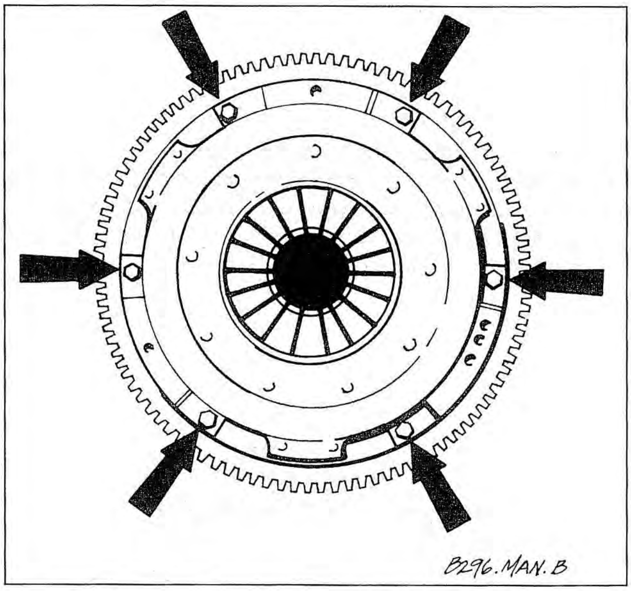

Fig. 5-9. Pressure plate bolts (arrows) to be removed for clutch removal.

To remove clutch:

1. Remove the transmission from the engine as described in **6.1 Removing and Installing Transmission**.

2. Remove the pressure plate and clutch disc. The bolts are shown in Fig. 5-9. Loosen the bolts evenly, one turn at a time, until the clutch pressure is relieved, then remove the pressure plate and clutch disc.

> ***WARNING —***
> *Clutch discs may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning the disc with compressed air. Avoid breathing any asbestos fibers or dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.*

> **NOTE —**
> A holding fixture—the BMW special tool or an equivalent—is needed to hold the flywheel while the six pressure-plate bolts are removed. For 4-cylinder models, the BMW Special Tool No. is 11 2 160; for 6-cylinder models, the BMW Special Tool No. is 11 2 170.

3. Pull the release bearing off of the transmission input shaft. Remove the release lever by unclipping the retaining spring as shown in Fig. 5-10.

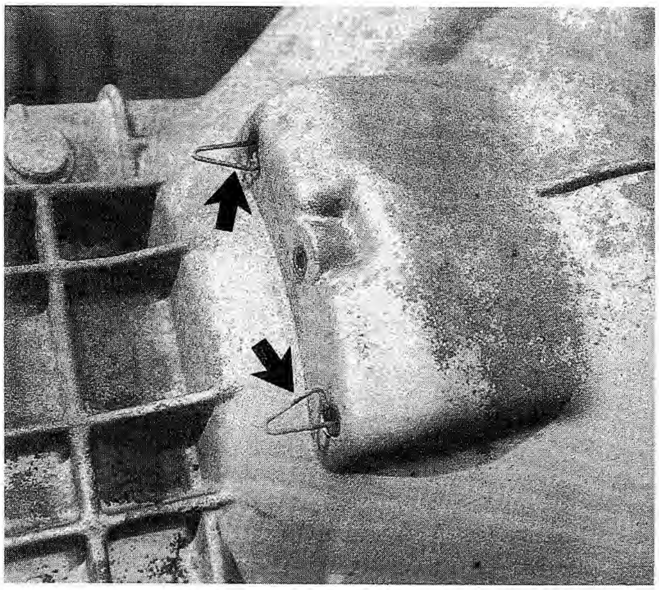

Fig. 5-10. Release lever retaining spring tabs (arrows). Squeeze tabs to remove spring.

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To inspect and install:

1. Inspect the clutch pressure plate. Check for loose rivets and for bent or misaligned release levers. See Fig. 5-11. The levers should be almost parallel with each other. **Table e** lists the correct specification. Lay a straightedge across the friction surface of the pressure plate to check that the surface is flat. See Fig. 5-12. Inspect the surface for cracks, scoring, discoloration due to heat or oil contamination, or other damage.

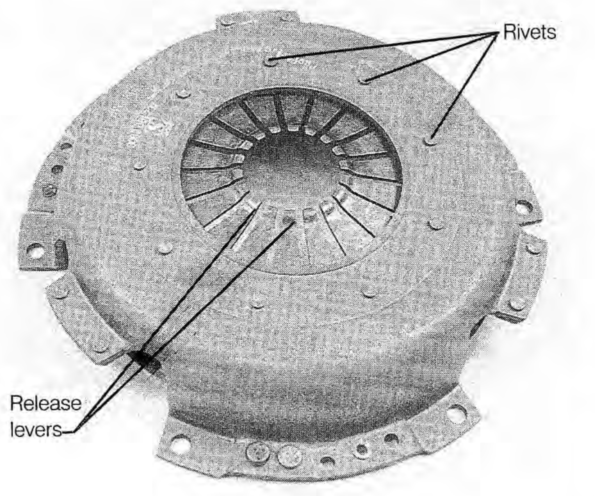

Fig. 5-11. Clutch pressure plate rivets and release lever tips to be checked.

Table e. Clutch Specifications

Release lever tips, maximum deviation from parallel	0.60 mm (.024 in.)
Clutch disc runout, maximum allowable	0.50 mm (.020 in.)
Clutch disc thickness, minimum allowable	7.5 mm (.295 in.)

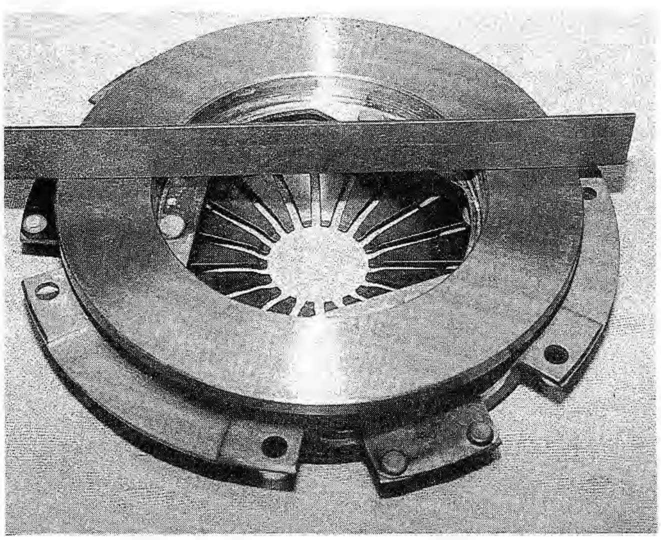

Fig. 5-12. Clutch pressure plate friction surface being checked for flatness using straightedge.

NOTE —

- A clutch pressure plate that shows any of the signs of damage described above or is not flat should be replaced.
- New pressure plates are coated with a corrosion inhibitor. Use a grease-free solvent to clean the friction surface of new pressure plates before installation.

2. Clean the flywheel friction surface and inspect it for wear, cracks, and grooves. Check for loose or worn guide pins. Replace a flywheel with any of these faults. See **ENGINE**.

3. Check the thickness, runout, and general condition of the clutch disc. If runout or thickness are not as specified above in **Table e**, or if there is any evidence of contamination by oil, the disc should be replaced.

NOTE —

The clutch disc is a relatively low-cost part that commonly wears out and requires replacement. Many experienced mechanics routinely install a new clutch disc anytime the transmission is removed.

4. Inspect the splines of the clutch disc and the transmission input shaft. Check that the clutch disc is free to slide on the shaft. If the clutch disc is in any way unserviceable, it should be replaced. Clean all traces of grease from the shaft and clutch splines.

5. Inspect the release bearing for smooth operation, and check the wear of the bearing face. See Fig. 5-13 and **Table f**. Replace the bearing if it feels rough or is worn beyond specification.

Fig. 5-13. Clutch release bearing should be checked for wear at dimension **A** and dimension **B**.

Table f. Release Bearing Specifications

Dimension A	
Fichtel & Sachs	49 ± 0.40 mm (1.929 ± .016 in.)
SKF	51.5 ± 1.0 mm (2.028 ± .039 in.)
Dimension B (both)	25 ± 0.25 mm (.984 ± .010 in.)

6. Check the grooved ball bearing in the center of the crankshaft. Replace it if it does not rotate smoothly.

7. Position the clutch disc and pressure plate assembly against the engine flywheel and start the mounting bolts in their holes. Leave the bolts loose enough so that the clutch disc can still move. Make sure the pressure plate is aligned on the guide pins. See Fig. 5-14.

CAUTION —
Always use new pressure plate mounting bolts. Once torqued, they are deformed and should not be reused.

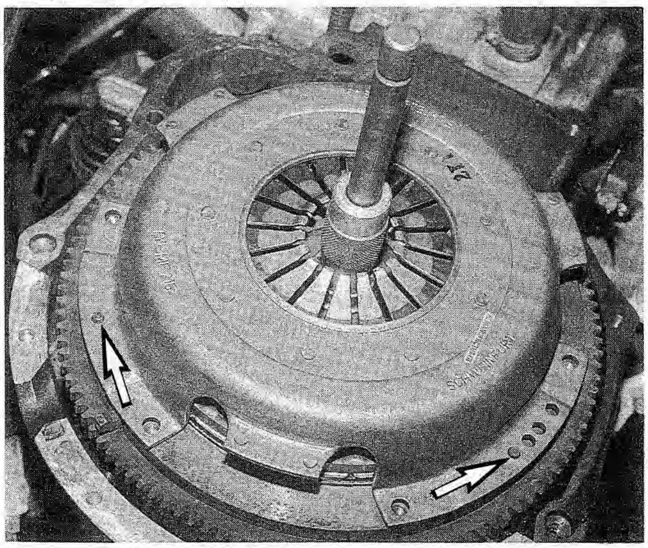

Fig. 5-14. Pressure plate guide pins (arrows). Note use of pilot tool to align clutch disc.

8. Using the clutch pilot tool, center the clutch disc. Tighten the pressure plate mounting bolts evenly until the clutch disc is firmly held in place.

9. Remove the centering tool and finish torquing the bolts. Torque 8.8 grade bolts to 22 to 24 Nm (16 to 18 ft. lb.). Torque 10.9 grade bolts to 30 to 35 Nm (22 to 26 ft. lb.).

NOTE —
The bolt grade should be marked on the bolt head.

10. Using Microlube GL 261, lightly lubricate the clutch disc splines and the transmission input shaft splines.

CAUTION —
BMW recommends using only Microlube GL 261 on the clutch disc and transmission input shaft splines. Otherwise the clutch disc may bind on the input shaft and cause hard shifting. This lubricant is available under the BMW Part No. 81 22 9 407 436.

11. Use molybdenum disulfide grease (Molykote Longterm 2 or equivalent) to pack the release bearing lubricating groove and to coat the guides. See Fig. 5-15. Grease the release lever pivot points, and install the release lever as shown in Fig. 5-16, and then the release bearing, making sure the guides are flush against the release lever.

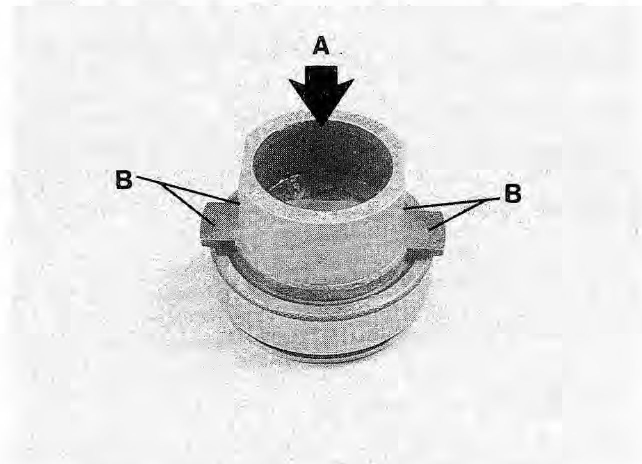

Fig. 5-15. Release bearing lubricating groove (**A**) and guides (**B**) to be greased.

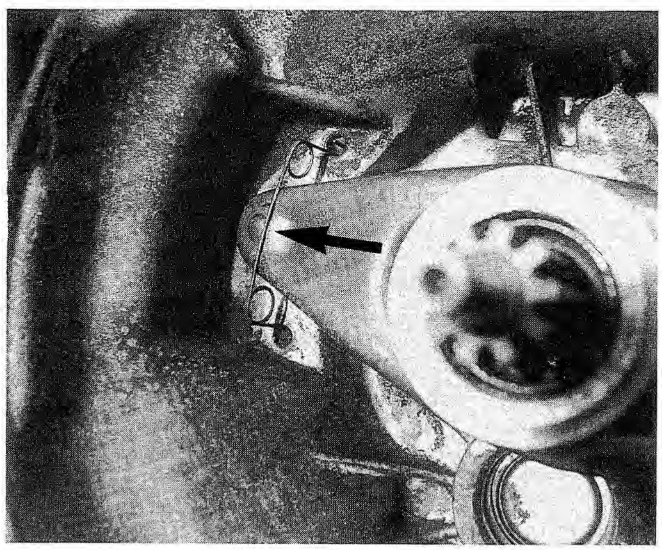

Fig. 5-16. Installed position of release lever. Note location of retaining clip (arrow).

12. Reinstall the transmission as described in **6.1 Removing and Installing Transmission.**

9

6. Transmission Removal and Installation

This section covers the removal and installation of the transmission only. Internal transmission repairs and replacement of oil seals are covered below under **7. Transmission Service.**

Testing of the reverse light switch, located on the side of the transmission case, is covered in **ELECTRICAL SYSTEM**. It is not adjustable. Replacement is the only remedy for a faulty switch.

6.1 Removing and Installing Transmission

The transmission must be removed from the car for most internal repairs or for replacement. In the procedure below, the transmission is separated from the engine, supported on a jack, and removed from below.

Removal of the transmission requires a transmission jack or a floor jack with transmission adaptor, and jack stands to support the car. Use extreme caution when working beneath the car and lowering the transmission.

To remove:

1. Disconnect the battery negative (–) terminal. Disconnect the electrical connectors from the reverse light switch on the side of the transmission.

2. Remove the exhaust system as described in **EXHAUST SYSTEM AND EMISSION CONTROLS**.

   NOTE —
   It is possible to disconnect only the exhaust downpipe from the exhaust manifold, and the exhaust hanger from the transmission support, and to then push the exhaust system to the side and out of the way. The transmission removal procedure is somewhat easier, though, if the exhaust system is removed completely.

3. Remove the driveshaft as described in **DRIVESHAFT AND FINAL DRIVE**.

4. Disconnect the shift rod and shift console from the transmission as described in **4.1 Disassembling and Assembling Shift Mechanism**.

5. Remove the TDC and reference sensors from the bellhousing, where applicable, as described in **IGNITION**.

6. Remove the clutch slave cylinder from the transmission as described in **5.2 Clutch Master Cylinder and Slave Cylinder**. Do not disconnect the fluid hose. Instead, suspend the slave cylinder from the body with a short piece of wire.

7. Support the transmission from below with the jack and remove the transmission support mounting nuts shown in Fig. 6-1. Then lower the transmission/engine assembly so that it rests on the front crossmember.

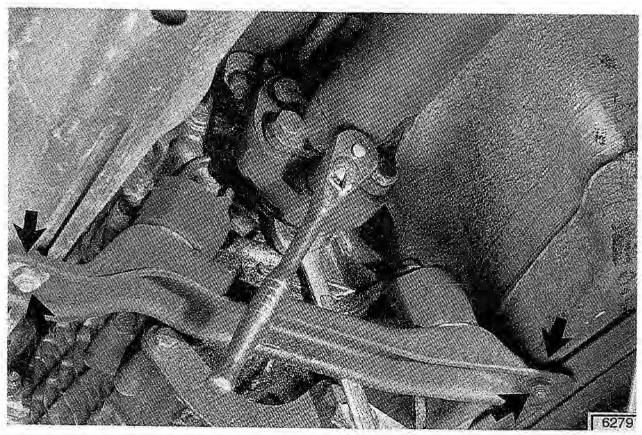

Fig. 6-1. Transmission support **(arrows)** to be removed.

8. Remove the bolts that hold the transmission to the engine. Some bolts may have a Torx® head and require the use of a special Torx® socket.

   CAUTION —
   At no time should the weight of the transmission be supported by the transmission input shaft. Such a load will damage the clutch and transmission components.

9. Separate the transmission from the engine, taking care not to place any strain on the transmission input shaft, and either lower the jack or raise the car until there is enough clearance to remove the transmission. Pull the transmission out from under the car.

   WARNING —
   Make sure the car is stable and well supported at all times during the removal procedure. Use jack stands that are designed for the purpose. A floor jack alone is not adequate support.

Installation is the reverse of removal. Lightly lubricate the input shaft splines with Microlube GL 261, then carefully position the transmission on the engine. The splines of the input shaft and the splines of the clutch disc may not align exactly. If not, use a wrench on the crankshaft pulley to rotate the crankshaft. Refer to **Table g** for torque values.

If the transmission was drained, refill it with the appropriate lubricant before starting or towing the car. See **LUBRICATION AND MAINTENANCE** for more information.

CAUTION —

BMW recommends using only Microlube GL 261 on the clutch disc and transmission input shaft splines. Otherwise the clutch disc may bind on the input shaft and cause hard shifting. This lubricant is available under the BMW Part No. 81 22 9 407 436.

NOTE —

Washers should always be used with Torx®-head bolts. Installing bolts without washers may cause the bolts to seal tightly against the transmission case, making them difficult to loosen.

Table g. Transmission Installation Tightening Torques

Bolt	Torque
Transmission to engine (hex-head)	M8: 22–27 Nm (16–20 ft. lb.) M10: 47–51 Nm (35–38 ft. lb.) M12: 66–82 Nm (49–60 ft. lb.)
Transmission to engine (Torx®-head)	M8: 20–24 Nm (15–18 ft. lb.) M10: 38–47 Nm (28–35 ft. lb.) M12: 64–80 Nm (47–59 ft. lb.)
Rear transmission support, nut (to body)	22–24 Nm (16–18 ft. lb.)
Rubber mount, nut (to transmission or support)	43–48 Nm (32–35 ft. lb.)
Transmission drain plug/fill plug	40–60 Nm (30–44 ft. lb.)

7. TRANSMISSION SERVICE

This section covers internal transmission repairs, including replacement of the transmission case oil seals, bushings, and bearings. Read the procedures completely before starting any repair job under this heading. Thoroughly clean the outside of the transmission before beginning any disassembly work. This will help keep abrasive dirt from getting into the working components as they are disassembled. If the transmission is to be disassembled, drain the gear oil before removing it from the car as described in **LUBRICATION AND MAINTENANCE.**

7.1 Removing and Installing Gear Train

This section covers the Getrag 240 and Getrag 260 transmissions. The procedures below do not cover the ZF transmission.

Removal of the gear train requires special tools to press the gear assembly out of the transmission case. Also covered under this heading is the removal of the shift forks, shafts and shift rods. Installation of the gear train requires new circlips, rolled pins, and spacers. The circlips and spacers set axial play of the input shaft. The rolled pins retain the shift forks to the shift rods.

To remove gear train:

1. Remove the transmission as described under **6. Transmission Removal and Installation.**

2. Mount the transmission on a stand or place it on a work bench. Drain the transmission oil into a 4-quart pan by removing the fill plug and the drain plug shown in Fig. 7-1. Reinstall the plugs loosely.

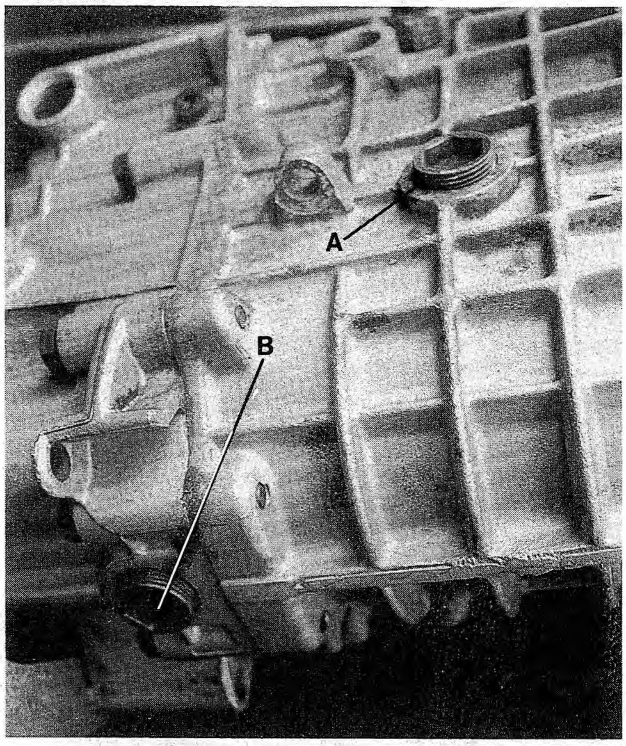

Fig. 7-1. Transmission fill plug (**A**) and transmission drain plug (**B**)

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3. If not already removed, remove the clutch release lever and release bearing. Remove the clutch release bearing guide sleeve mounting bolts and pull the sleeve from the transmission. Remove and label any spacers from behind the sleeve. Remove and label the input shaft circlip and the spacer from the front of the input shaft. See Fig. 7-2.

NOTE —
On Getrag 260 transmissions with two-piece guide sleeves, remove only the outer flange mounting bolts.

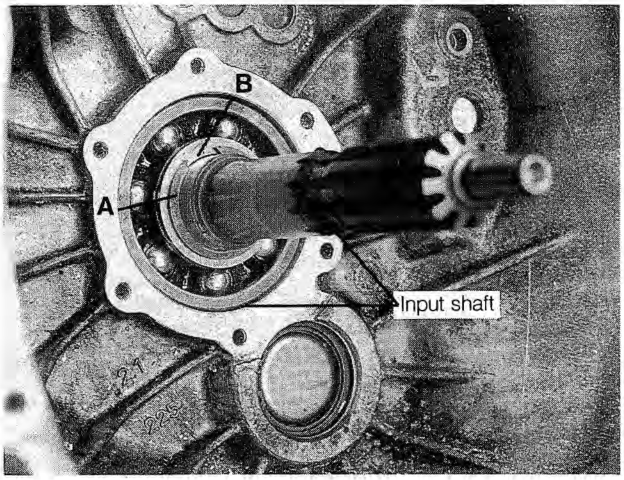

Fig. 7-2. Input shaft circlip (**A**) and spacer (**B**) on Getrag 260 transmission.

4. Unscrew the back-up light switch and pry out the plug for the selector shaft lock pin. Remove the spring and the lock pin from the transmission. See Fig. 7-3.

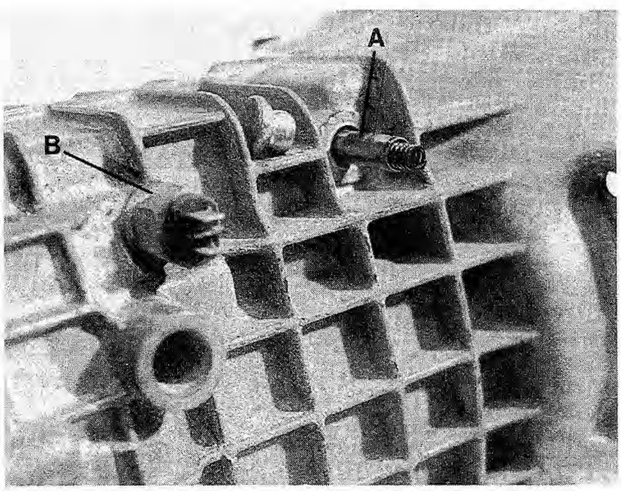

Fig. 7-3. Selector shaft lock pin and spring (**A**) and back-up light switch (**B**).

5. Working from the rear of the transmission, drive out the top guide pin and remove the case mounting bolts. See Fig. 7-4.

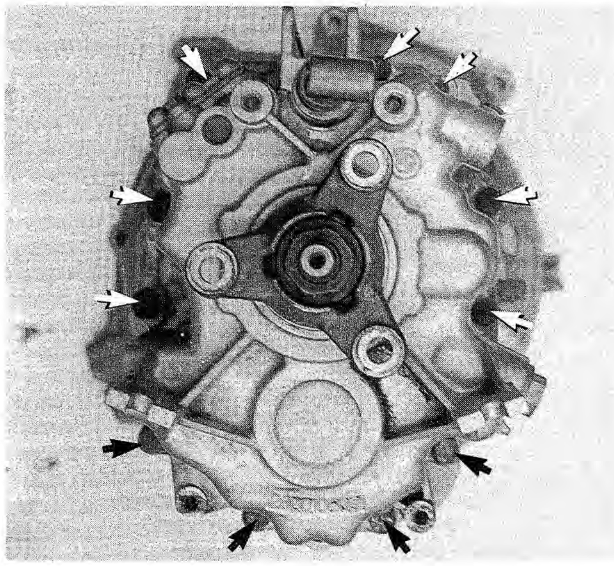

Fig. 7-4. Transmission case mounting bolts and guide pins (arrows).

6. Remove the reverse gear shaft retaining bolt from the front transmission case. See Fig. 7-5.

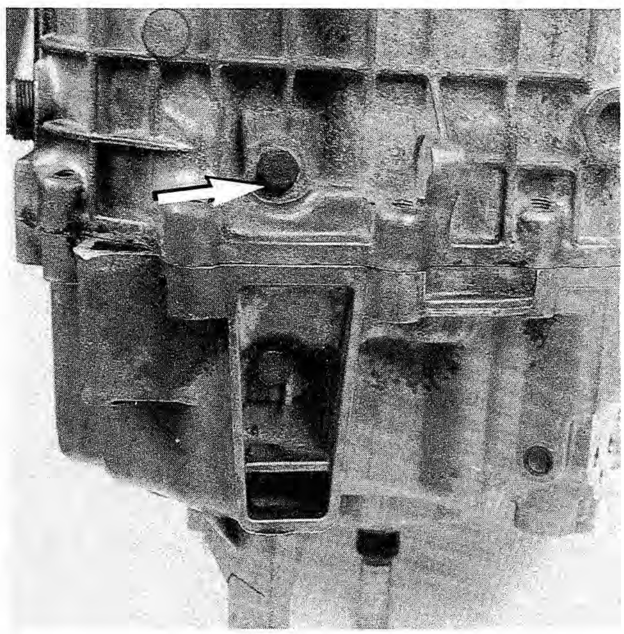

Fig. 7-5. Reverse gear shaft retaining bolt (arrow) in front transmission case.

7. Separate the front transmission case from the rear case by pressing the input shaft out of the front case using BMW special tools. Remove the roller bearing from the top of the layshaft.

CAUTION —
Do not attempt to separate the case by driving on the front of the input shaft or the front case casting. The front case casting is not designed to take this type of a load. The housing may crack and break.

NOTE —
BMW special tools ((BMW Tool No. 23 1 460 and BMW Tool No. 33 1 301) or an equivalent must be used. The special tool is bolted to the guide sleeve surface of the front case. The sleeve part of the tool extends above the tip of the input shaft. A bolt is then threaded through the top of the tool to bear on the input shaft, and the input shaft bearing is pulled off together with the front case.

8. At the rear of the transmission, pry out the drive flange lock plate from the mounting nut. Using a thin-walled 30 mm socket (BMW Tool No. 23 1 210), remove the drive flange nut while holding the flange stationary. Remove the flange from the transmission output shaft.

NOTE —
If the drive flange cannot be easily removed, it may be necessary to use a puller.

9. Remove the reverse-gear shaft retaining bolt from the side of the transmission case. Remove the reverse-gear retaining bracket and its mounting bolt. See Fig. 7-6.

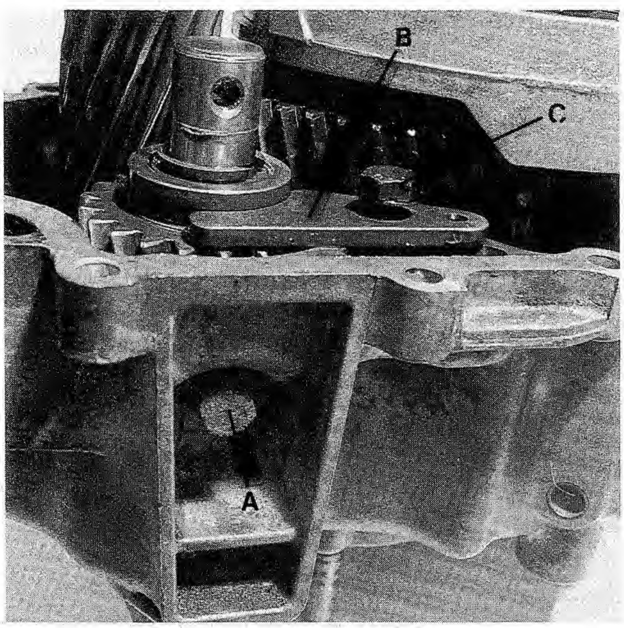

Fig. 7-6. Reverse gear shaft retaining bolt (**A**), retaining bracket (**B**), and bracket mounting bolt (**C**).

10. Pull the shaft out of reverse gear and then remove the gear from the case. See Fig. 7-7.

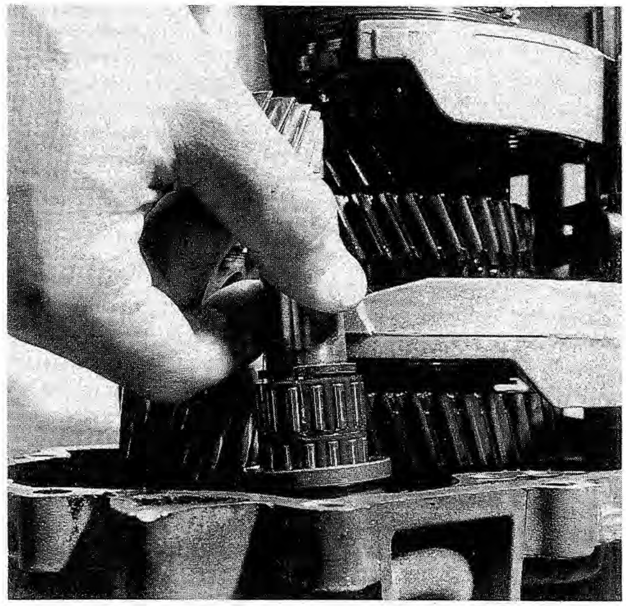

Fig. 7-7. Reverse gear shaft being withdrawn from transmission case.

11. Pull out the locking pin for the shift operating lever and slide the lever off the shift operating shaft. Pull the shift operating shaft out of the transmission. See Fig. 7-8.

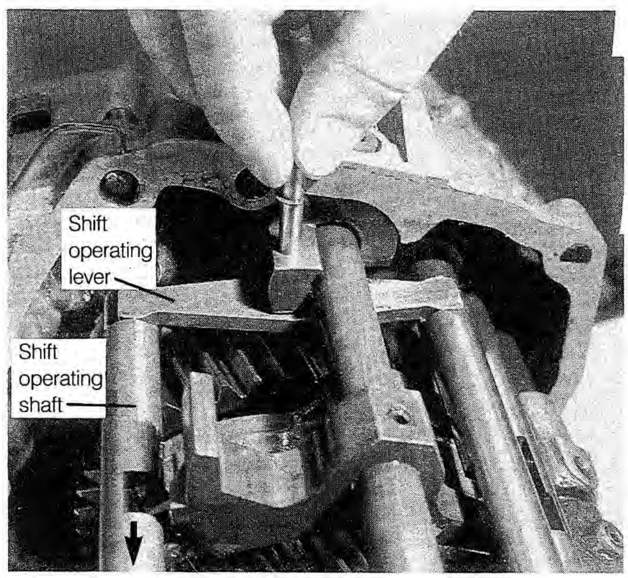

Fig. 7-8. Shift operating lever locking pin being removed. Slide out shaft in direction of arrow.

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12. Hand-turn the input shaft while engaging 4th gear. Support the underside of the selector shaft and drive the selector shaft operating lever rolled pin in just until the shaft can be pulled from the operating lever. See Fig. 7-9.

CAUTION —

Do not drive the rolled pin all the way out. Pull on the selector shaft so that the rolled pin is between 2nd and 3rd gears. Otherwise the selector shaft cannot be removed.

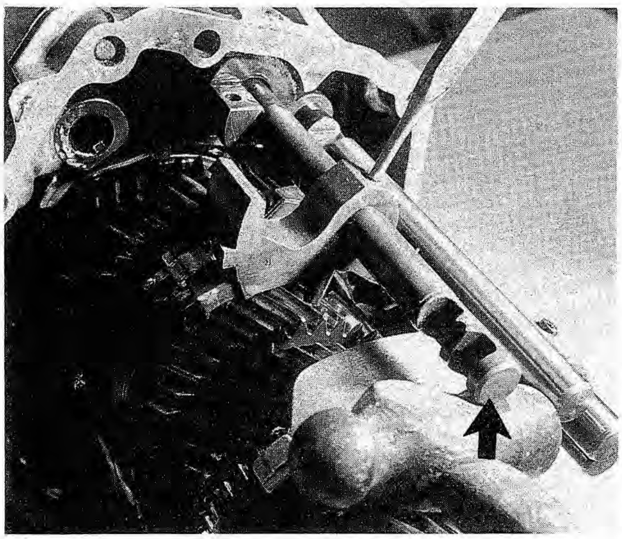

Fig. 7-9. Selector shaft operating lever rolled pin being driven in. Support end of shaft (arrow) while driving pin.

13. Pull the selector shaft from the rear of the transmission. Be ready to catch the four roller bearings on the end of the shaft. Remove the selector shaft oil seal from the shaft. Remove the selector shaft operating lever.

NOTE —

It may be necessary to tap on the end of the shaft to release the oil seal from the transmission case. Use only a soft-faced hammer when driving the shaft.

14. Remove the shift rod detent ball end plate and remove the three springs and balls. Carefully pry out the shift rod detent ball end plug. See Fig. 7-10.

NOTE —

The end plug can be easily removed by first pivoting the plug in its bore. Use a small drift to tap on one side of the plug until it is on its side, then use small needle-nose pliers to remove the plug.

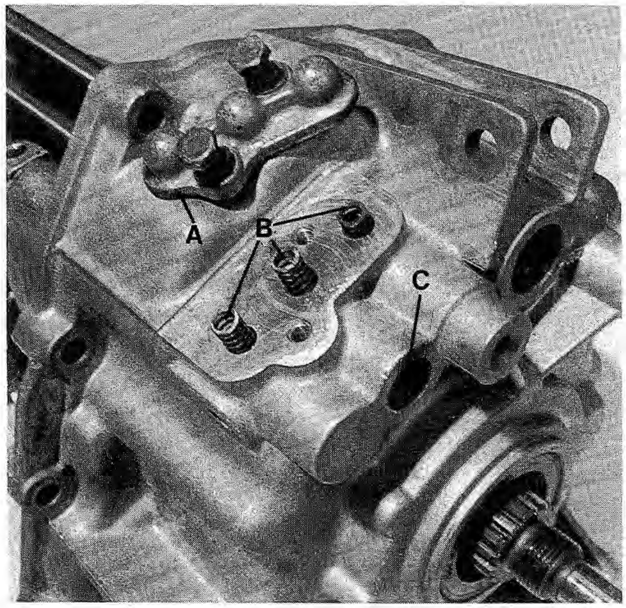

Fig. 7-10. Shift rod detent ball end plate (**A**), springs (**B**), and end plug (**C**). Detent balls are under springs.

15. Carefully drive out the rolled pin from the 3rd/4th gear shift fork. Pull the 3rd/4th gear selector rod out of the shift fork. Be sure the small pin in the end of the rod does not fall out as the rod is being removed. See Fig. 7-11. Remove the two detent balls from either side of the end plug bore.

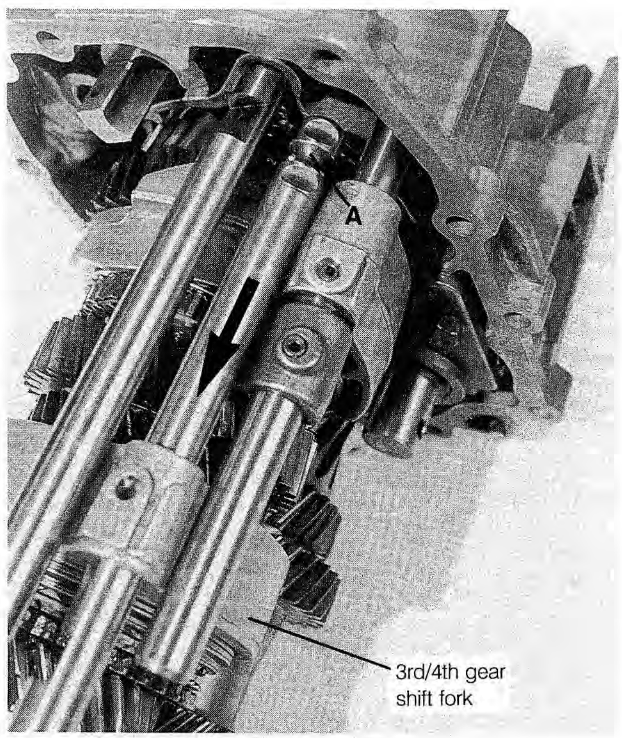

Fig. 7-11. 3rd/4th gear shift rod being removed. Arrow shows direction of removal. Note small pin (**A**) in end of rod.

16. Pull on the 1st/2nd gear shift rod to engage 2nd gear. Pull on the 5th/reverse gear shift rod to engage reverse gear.

17. Using a large puller, press the input shaft, the output shaft, and the layshaft assembly out of the transmission case. See Fig. 7-12.

> ***CAUTION —***
> *Place small blocks of wood under the jaws of the puller to prevent damaging the case sealing surface. Check to make sure that the selector rods, forks, and the layshaft clear the jaws of the puller as the gear assembly is being removed.*

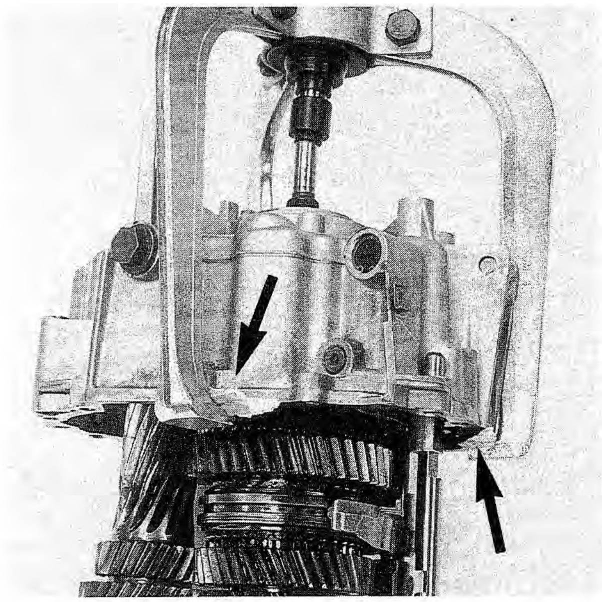

Fig. 7-12. Transmission gear assembly being removed from transmission rear case using puller. Place small blocks of wood beneath the jaws of the puller (arrows).

18. Remove the layshaft roller bearing from the rear case.

To install gear train:

1. Inspect all bearings and bushings in the transmission case. Replace any that are damaged as described below under **7.4 Inspecting Transmission Components.** Inspect the thrust washer on the end of the output shaft and replace it if scored or damaged.

2. Drive out the input shaft roller bearing from the front case.

3. Position the 3rd/4th gear shift fork, the 1st/2nd gear shift fork and rod, and the 5th/reverse shift fork and rod onto the gear train assembly. See Fig. 7-13. Engage 2nd gear and reverse gear.

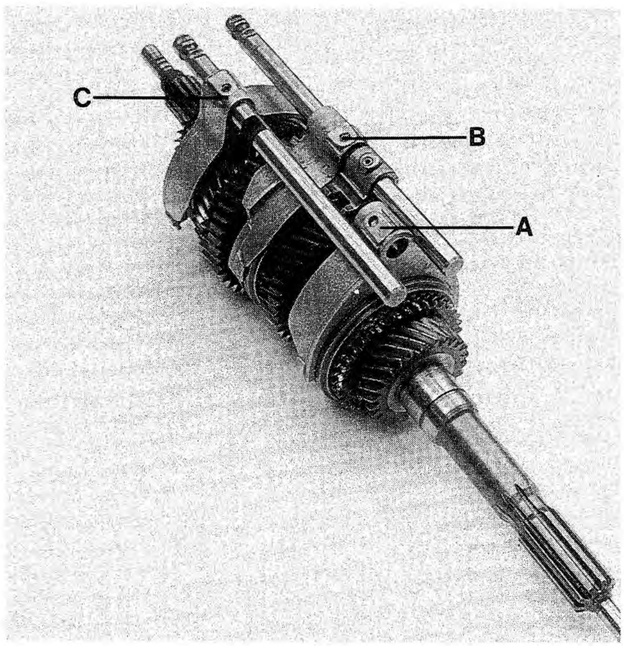

Fig. 7-13. 3rd/4th gear shift fork (**A**), 1st/2nd gear shift fork and rod (**B**), and 5th/reverse gear shift fork and rod (**C**) correctly positioned on gear train.

4. Apply grease to the layshaft roller bearing and then install it into the rear case so that the side with the larger diameter cage is facing up. See Fig. 7-14.

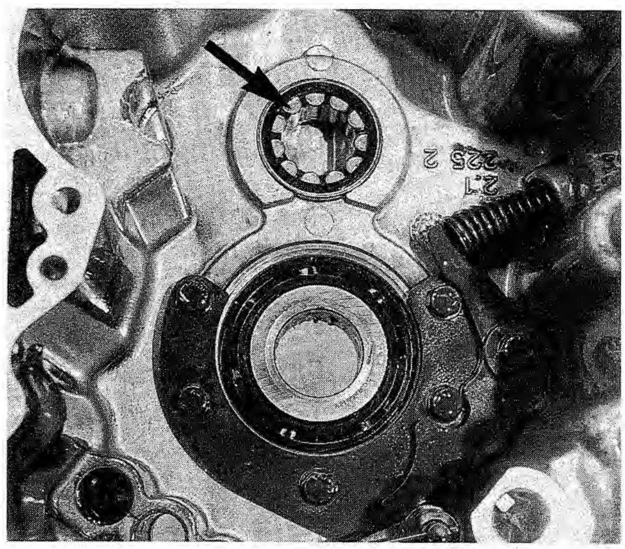

Fig. 7-14. Layshaft roller bearing position in rear transmission housing with large side of cage facing up (arrow).

5. Using a hot air blower, heat the output shaft bearing's inner race to approximately 176°F (80°C). Place the layshaft in position against the gear train, then install the gear train assembly into the rear transmission case while aligning the shift rods and layshaft. Using an appropriate puller, draw the output shaft into the rear case until it is firmly seated.

NOTE —

- The BMW special tools used to pull the output shaft onto the output shaft bearing are BMW Tool No. 23 2 150 and BMW Tool No. 23 1 300.

- It may be necessary to have a helper support the shift fork assembly and the layshaft against the gear train until the assembly is seated in the rear case.

6. Apply a small amount of grease to the two end plug detent balls. Install the two balls through the plug opening and drive in a new end plug. See Fig. 7-15.

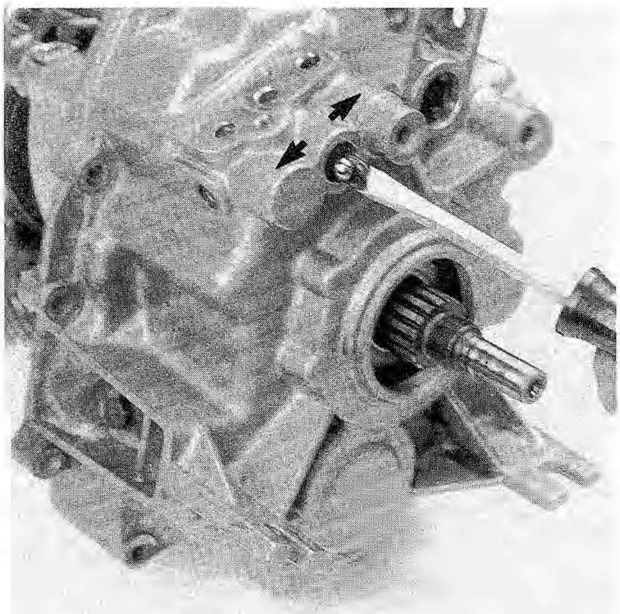

Fig. 7-15. Shift rod detent balls being installed into transmission rear case. Arrows indicate position of balls.

7. Position the shift rods in their neutral positions. Apply a small amount of grease to the 3rd/4th gear shift rod pin and install it into the hole in the end of the rod. Install the rod through the shift fork so that the cutouts in the rod are facing up. See Fig. 7-16. Push the shift rod in until it is fully seated.

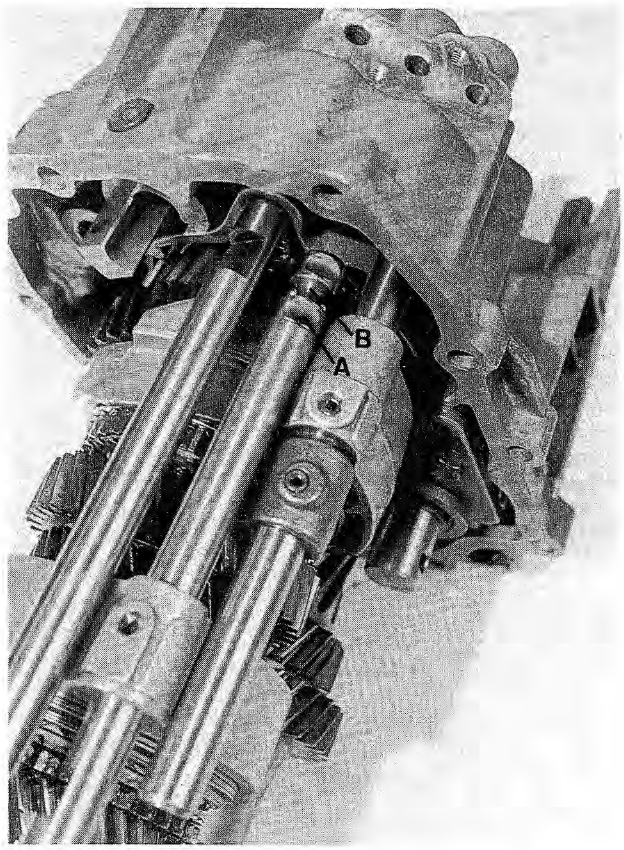

Fig. 7-16. 3rd/4th gear shift rod cutouts (**A**) and pin (**B**) correctly positioned.

8. While supporting the end of the 3rd/4th gear shift rod, drive in a new 3rd/4th gear shift-fork rolled pin.

9. Install the three detent balls and the springs into the shift rod bores shown in Fig. 7-17. Apply gasket sealer (Loctite No. 573® or equivalent) to the sealing surface of the detent ball end plate and install the plate. Tighten the mounting bolts to 10 Nm (89 in. lb.).

CAUTION —

Some transmissions may be equipped with one short spring and two longer, equal length springs. On these transmissions, install the short spring (free length of 15.9 mm (0.626 in.) into the bore for the 5th/reverse gear shift rod (bore closest to the selector shaft). The other two springs can be installed in either bore.

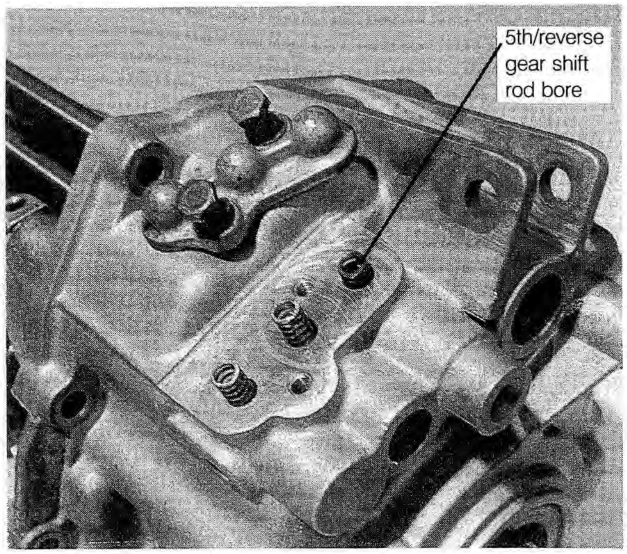

Fig. 7-17. Shift rod detent balls and springs installed into transmission case. Detent balls are under springs.

10. Insert the rolled pin into the selector shaft operating lever. Install the small roller bearings on the selector shaft using a small amount of grease to hold them in place. Slide the selector shaft through the bore in the rear case while aligning the roller bearings in the case and operating lever. See Fig. 7-18.

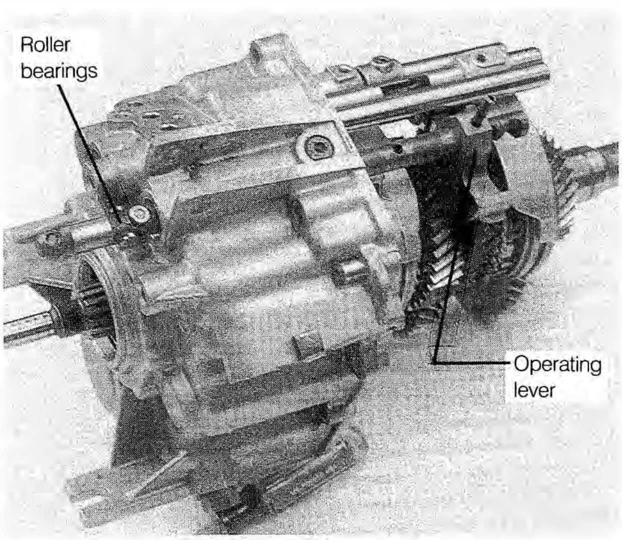

Fig. 7-18. Selector shaft with roller bearings being installed.

11. While supporting the end of the selector shaft, drive in the operating lever rolled pin. Lubricate the new selector shaft oil seal sealing lips with oil and install it onto the shaft, driving it into position until it is firmly seated.

12. Install the shift operating shaft and shift operating lever. Position the shift operating lever so that groove in the top of the lever is facing up and towards the shift operating shaft, then install the locking pin. See Fig. 7-19.

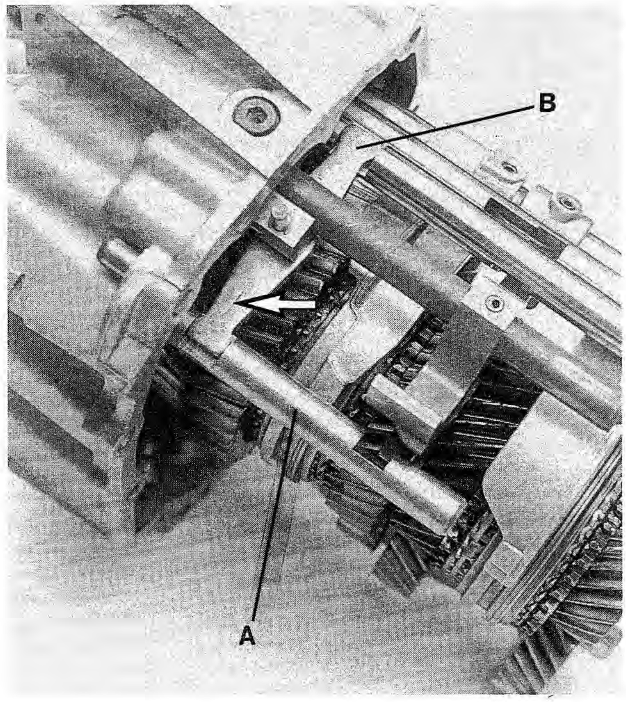

Fig. 7-19. Shift operating shaft (**A**) and shift operating lever (**B**) correctly installed in transmission. Groove in lever should be up and facing left (arrow).

13. Thoroughly clean the reverse gear shaft sealing surface in the rear transmission case, then apply a gasket sealer (Loctite 573® or equivalent) to the area. See Fig. 7-20.

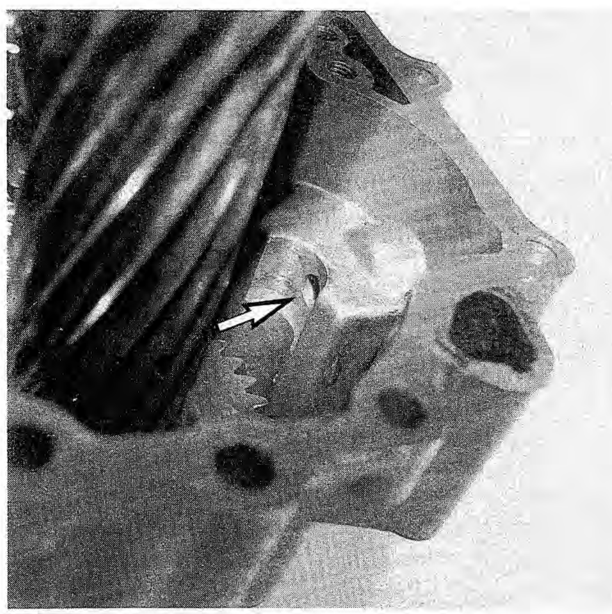

Fig. 7-20. Area of rear transmission case (arrow) requiring gasket sealer.

14. Install the reverse gear in the case and then install the shaft with the needle bearing. Using a bolt locking compound, install and torque the shaft retaining bolt to 25 Nm (18 ft. lb.)

15. Install the reverse gear shaft retaining bracket and bolt. While applying outward pressure on the bracket, torque the bolt to 25 Nm (18 ft. lb.). See Fig. 7-21.

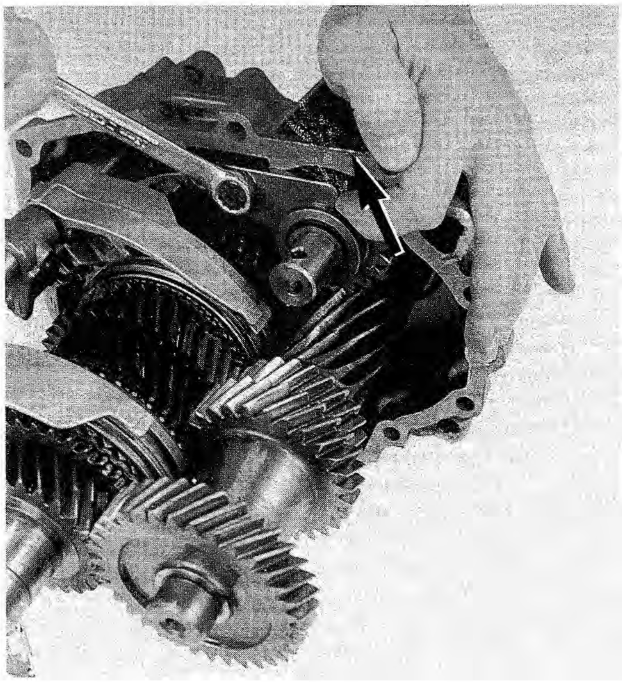

Fig. 7-21. Reverse gear shaft retaining bracket correctly positioned. Apply outward pressure (arrow) and then tighten bolt.

16. Install the output flange onto the output shaft. Apply a sealer (Loctite 270® or Hylogrip) to the bearing surface of the nut and torque the nut.

NOTE —

Tighten the bolt in two stages; first tighten the bolt to 170 Nm (123 ft. lb.) to fully seat the flange. Loosen the bolt and retighten it to 120 Nm (87 ft. lb.). Install the lock plate over the nut and bend the tab into the groove.

17. Install the layshaft roller bearing onto the layshaft so that the larger diameter part of the bearing's cage is facing the layshaft. Apply grease to the bearing's rollers and press them tight to the layshaft.

18. Thoroughly clean the reverse gear sealing surface in the front transmission case and apply gasket sealer (Loctite 573® or equivalent) to the area. See Fig. 7-22.

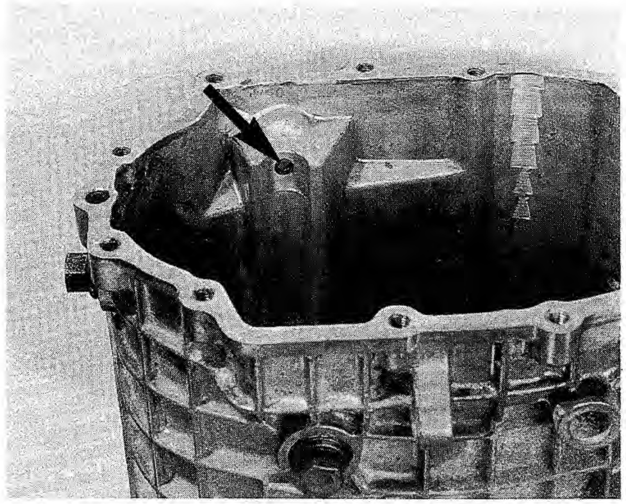

Fig. 7-22. Area of front transmission case (arrow) requiring gasket sealer.

19. Apply a gasket sealer (Loctite 573® or equivalent) to the rear case sealing surface and install the front transmission case into position. Using a screwdriver through the oil filler plug hole, align the layshaft as the case is lowered into position. See Fig. 7-23. Install the guide pin and the mounting bolts, torquing them to 25 Nm (18 ft. lb.).

NOTE —

The input shaft roller bearing should be removed from the case prior to installing the case.

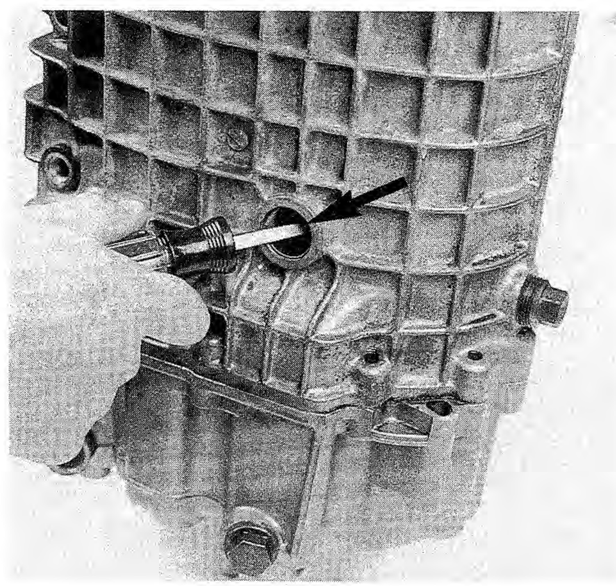

Fig. 7-23. Screwdriver being used to guide layshaft into bearing shell (arrow) as front case is installed.

20. Using a bolt locking compound, install the reverse gear shaft mounting bolt into the side of the transmission and torque the bolt to 25 Nm (18 ft. lb.).

21. Insert the selector shaft lock pin and spring into the transmission side and install the plug. See Fig. 7-3 above.

22. Install the backup light switch, torquing it to 6 to 10 Nm (53 to 89 in. lb.)

23. Heat the input shaft bearing area of the front case and the bearing's inner race to approximately 176°F (80°C). Position the input shaft bearing into the case so that the protruding side of the bearing's inner race faces the gear train. See Fig. 7-24. Carefully drive the bearing into the case and onto the input shaft until it is firmly seated.

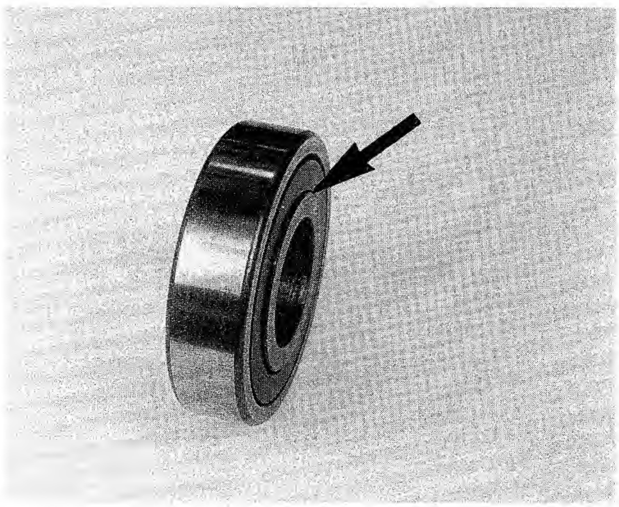

Fig. 7-24. Input shaft bearing showing protruding part of inner race (arrow). Protruding side of inner race faces gear train.

24. Install the spacer and the new circlip onto the input shaft. See Fig. 7-25. While pulling on the input shaft, check the shaft's axial play between the spacer and the circlip using a feeler gauge. If the clearance is not between 0 to 0.09 mm (0 to 0.0035 in.), install a new spacer (Getrag 240) or circlip (Getrag 260) of a different thickness to achieve the proper clearance. **Table h** lists the available spacers and circlips.

NOTE —

Spacers and circlips can be ordered from an authorized BMW dealer parts department.

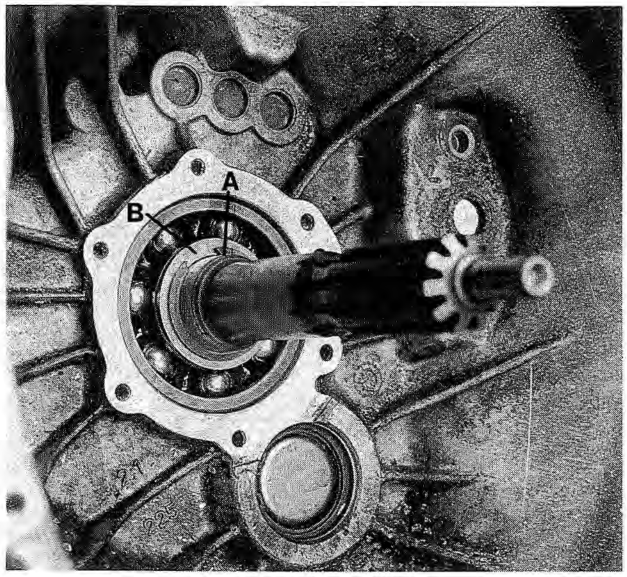

Fig. 7-25. Input shaft circlip (**A**) and spacer (**B**).

Table h. Selective Spacers and Circlips for Input Shaft and Clutch Guide Sleeve

Location	Dimension and thickness in mm	
	Getrag 240	Getrag 260
Input shaft bearing	30x42x2.3 (spacer) 30x42x2.4 (spacer) 30x42x2.5 (spacer) 30x42x2.6 (spacer)	35x2.0 (circlip) 35x2.1 (circlip) 35x2.2 (circlip) 35x2.3 (circlip)
Clutch guide sleeve	52x65x1.3 (spacer) 52x65x1.4 (spacer) 52x65x1.5 (spacer)	80x66x0.3 (spacer) 80x66x0.4 (spacer) 80x66x0.5 (spacer)

25. Using a vernier caliper, measure and record the input shaft bearing depth in the case. See Fig. 7-26. Then measure and record the height of the protrusion on the back of the guide sleeve. See Fig. 7-27. Subtract the protrusion height from the depth, then select the correct spacer(s) from **Table h** to bring the clearance to within 0 to 0.09 mm (0 to 0.0035 in.).

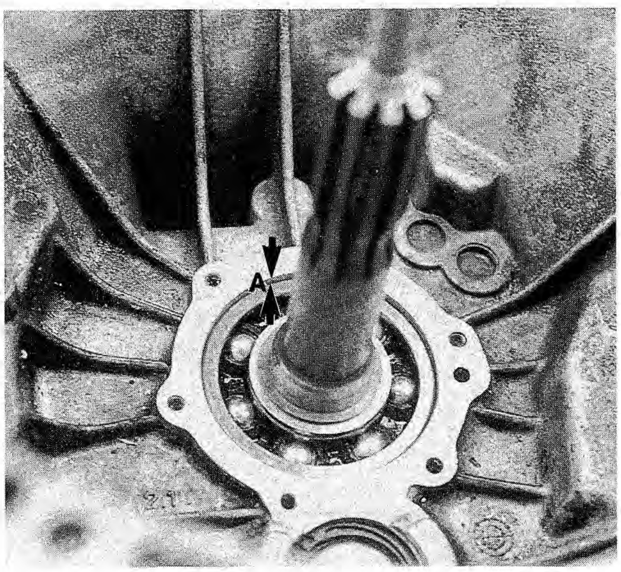

Fig. 7-26. Input shaft bearing depth in case (dimension **A**).

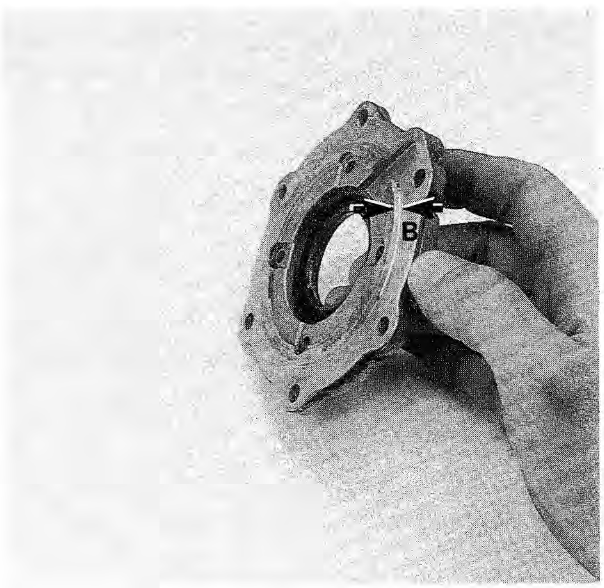

Fig. 7-27. Clutch guide sleeve protrusion height (dimension **B**).

26. Lubricate the input shaft oil seal lip with oil. Apply a gasket sealer (Loctite 573® or equivalent) to the sealing surface of the guide sleeve and install the sleeve with the correct spacer(s). See Fig. 7-28. Tighten the mounting bolts to 10 Nm (89 in. lb.). Install the clutch release lever and bearing.

NOTE —

Some transmissions have an arrow on the guide sleeve, to align the oil bore in the case with the oil groove in the sleeve. Align the arrow so that it is pointing towards middle of layshaft bearing cover.

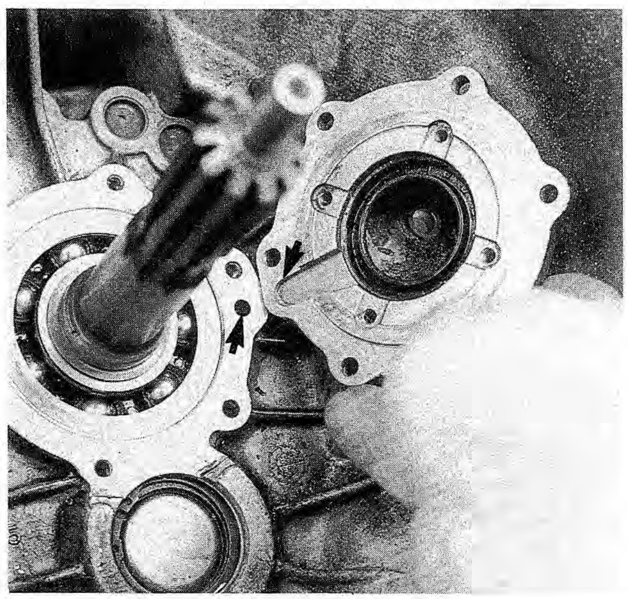

Fig. 7-28. Clutch guide seal oil groove and transmission case oil bore (arrows).

Table i. Gear Train Installation Tightening Torques

Front transmission case to rear case (bolt)	25 Nm (18 ft. lb.)
Drive Flange to output shaft (nut)	
initial torque	170 Nm (123 ft. lb.)
final torque (after loosening nut)	120 Nm (87 ft. lb.)
Reverse gear shaft to transmission case (bolt)	25 Nm (18 ft. lb.)
Reverse gear shaft retaining bracket to transmission case (bolt)	25 Nm (18 ft. lb.)
Detent ball and spring locking plate to transmission case (bolt)	10 Nm (89 in. lb.)
Clutch guide sleeve to front transmission case	10 Nm (89 in. lb.)
Back-up light switch to transmission case	6–10 Nm (53–89 in. lb.)

7.2 Disassembling and Assembling Gear Train

Disassembly of the gear train requires a hydraulic press or other suitable pullers. Special press bed adaptors are available from an authorized BMW dealer to adapt the press bed to the Getrag gear train. Each of the three synchronizer guide sleeves are tightly fitted to the output shaft and need to be pressed off.

Assembly of the gear train requires new circlips and possibly new selective spacers. The circlips and the spacers correctly set axial play of the three synchronizer guide sleeves. Inspect the synchronizer rings before removing the gear clusters as described under **7.4 Inspecting Transmission Components.** Label all parts as they are removed from the shafts. Many parts are similar in appearance but can only be reinstalled in one position. Fig. 7-29 is an assembly view of the gear train components.

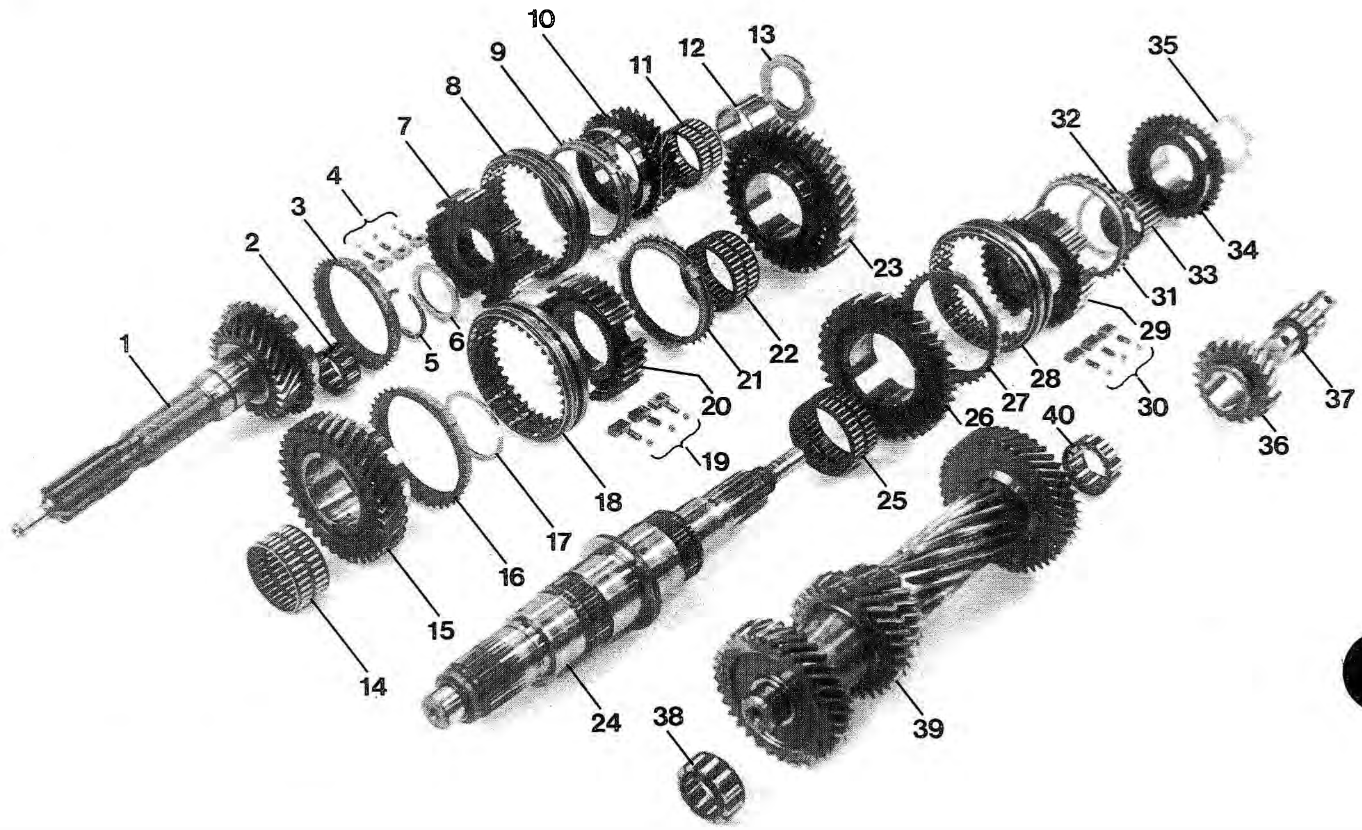

Fig. 7-29. Getrag 240 and 260 gear train components.

1. Input shaft with integral 4th gear
2. Roller bearing
3. 4th gear synchronizer ring
4. Pressure pieces (dogs), springs, and balls
5. Circlip
6. Spacer
7. 3rd/4th gear guide sleeve
8. 3rd/4th gear operating sleeve
9. 3rd gear synchronizer ring
10. 3rd gear
11. 3rd gear needle bearing
12. Spacer sleeve*
13. Thrust washer and ball*
14. 2nd gear needle bearing
15. 2nd gear
16. 2nd gear synchronizer ring
17. Circlip
18. 1st/2nd gear operating sleeve
19. Pressure pieces (dogs), springs, and balls
20. 1st/2nd gear guide sleeve
21. 1st gear synchronizer ring
22. 1st gear needle bearing
23. 1st gear
24. Output shaft
25. Reverse gear needle bearing
26. Reverse gear
27. Reverse gear synchronizer ring
28. 5th/reverse gear operating sleeve
29. 5th/reverse gear guide sleeve
30. Pressure pieces (dogs), springs, and balls
31. 5th gear synchronizer ring
32. Circlip
33. 5th gear needle bearing
34. 5th gear
35. Thrust washer
36. Reverse idler gear
37. Reverse idler gear shaft
38. Layshaft roller bearing
39. Layshaft
40. Layshaft roller bearing

* Some transmissions may be equipped with a one-piece spacer sleeve and thrust washer

To disassemble gear train:

1. Remove the gear train from the transmission case as described in the above heading.

2. Pull the input shaft from the front of the output shaft. Remove the 4th gear brass synchronizer ring and the roller bearing. See Fig. 7-30.

NOTE —

If the synchronizer rings are going to be reinstalled, be sure to mark their gear positions as they are removed. Used synchronizer rings must be reinstalled in their exact position.

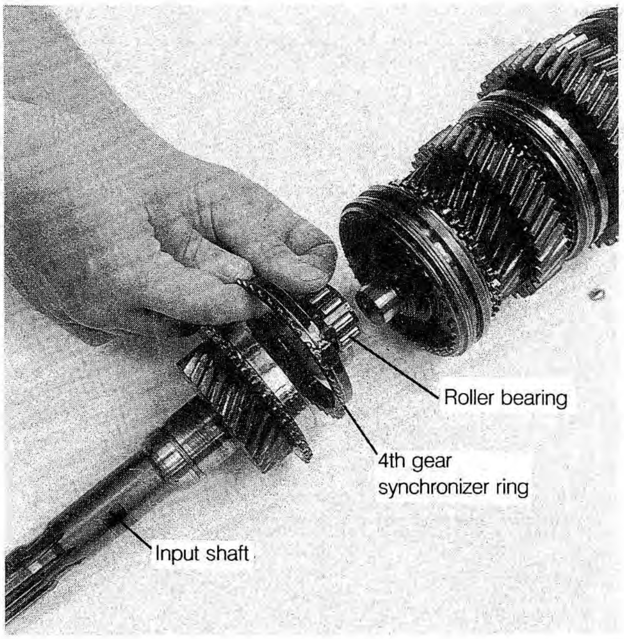

Fig. 7-30. Input shaft with 4th gear, 4th gear synchronizer ring, and roller bearing being removed.

3. Working from the rear of the output shaft, pull off 5th gear, the 5th gear synchronizer ring and its thrust washer (Getrag 260 transmission only). Remove the 5th gear needle bearing. See Fig. 7-31.

4. Remove the circlip and the spacer from in front of the 3rd/4th gear synchronizer guide sleeve on the output shaft.

CAUTION —

Circlips should not be reused.

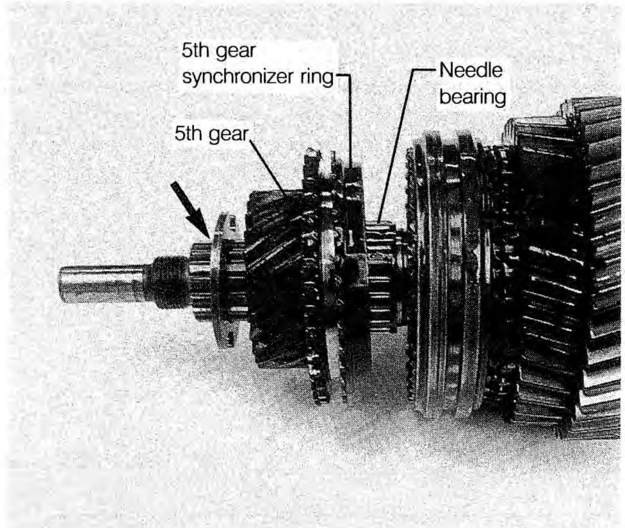

Fig. 7-31. 5th gear, 5th gear synchronizer ring, and needle bearing being removed from rear of output shaft. Thrust washer (arrow) on Getrag 260 transmission.

5. On Getrag 240 transmissions, rotate and slide the 3rd/4th gear synchronizer operating sleeve towards 3rd gear until it engages the gear. Press off 3rd gear together with its operating sleeve, guide sleeve, and synchronizer ring. Pull off the needle bearing.

NOTE —

Use an appropriate bearing separator (BMW Tool No. 23 1 490) to support the back side of 3rd gear when pressing it off the output shaft. Pressing off force should not exceed 2.7 tons.

6. On Getrag 240 transmissions, press off the 2nd gear bearing sleeve together with 2nd gear. Remove and label the 2nd gear synchronizer ring, the needle bearing, and the thrust washer and ball (if applicable).

NOTE —

Use an appropriate bearing separator (BMW Tool No. 23 1 490) to support the back side of 2nd gear when pressing off the gear and spacer. No pressing-off force specifications are given by BMW for this operation.

7. On Getrag 260 transmissions, press off in a single operation the 3rd/4th gear guide sleeve with operating sleeve, the 3rd gear synchronizer ring, 3rd gear, the bearing sleeve and needle bearing, and 2nd gear. See Fig. 7-32. If applicable, remove the thrust washer and small ball from in front of 2nd gear. Pull the needle bearing from the shaft.

NOTE —

- Use an appropriate press bed adaptor (BMW Tool No. 23 2 080) or gear puller on the back side of 2nd gear when pressing the gear cluster off the shaft. Pressing off force should not exceed 3.0 tons.

- Two types of bearing sleeves are installed between 2nd and 3rd gear. On early transmissions, a one piece spacer/thrust washer is installed. On later transmissions, the thrust washer and sleeve are separate parts. On two piece models, the thrust washer is located on the shaft with a small ball. See Fig. 7-33.

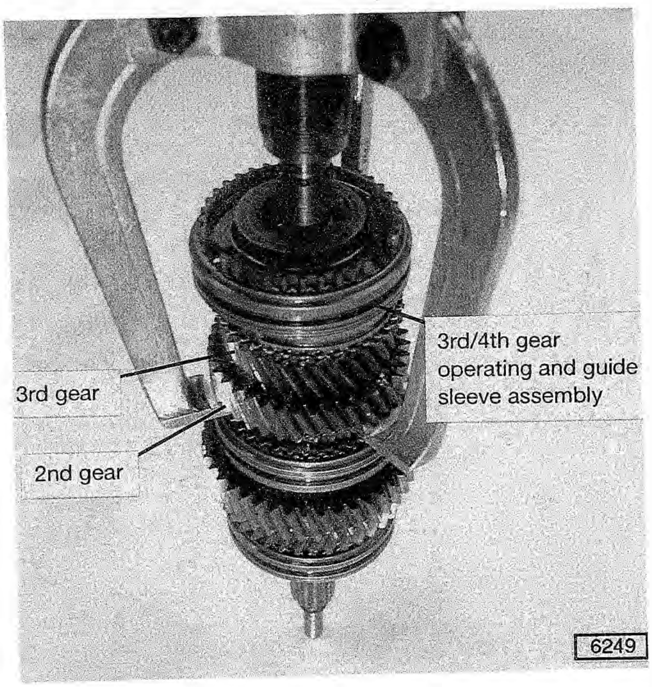

Fig. 7-32. 3rd gear cluster and 2nd gear being removed from output shaft of Getrag 260 transmission.

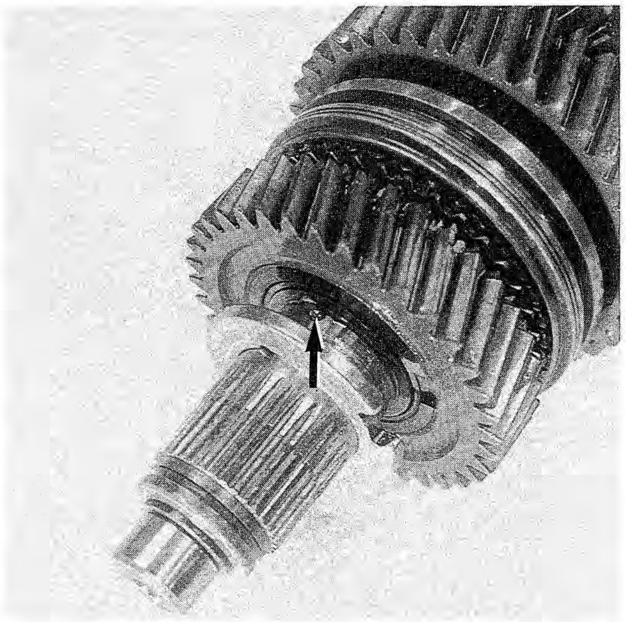

Fig. 7-33. Thrust washer and ball between 2nd and 3rd gear. Ball in shaft (arrow) prevents washer from rotating.

8. Remove the circlip from the front of the 1st/2nd gear guide sleeve. Press off the 1st/2nd gear guide sleeve with operating sleeve and 1st gear. Remove the needle bearing.

NOTE —

Use an appropriate press bed adaptor (BMW Tool No. 23 1 490) or gear puller on the back side of 1st gear when pressing the gear cluster off the shaft. Pressing off force should not exceed 3.7 tons on the Getrag 260 transmission or 3.0 tons on the Getrag 240 transmission.

9. Remove the circlip from the front of the 5th/reverse gear guide sleeve. Press off 5th/reverse gear guide sleeve with the operating sleeve and reverse gear. Remove the needle bearing. See Fig. 7-34.

NOTE —

Use an appropriate press bed adaptor (BMW Tool No. 23 2 080) or gear puller on the back side of reverse gear when pressing the guide sleeve off the shaft. Pressing off force should not exceed 3.7 tons on the Getrag 260 transmission or 3.0 tons on the Getrag 240 transmission.

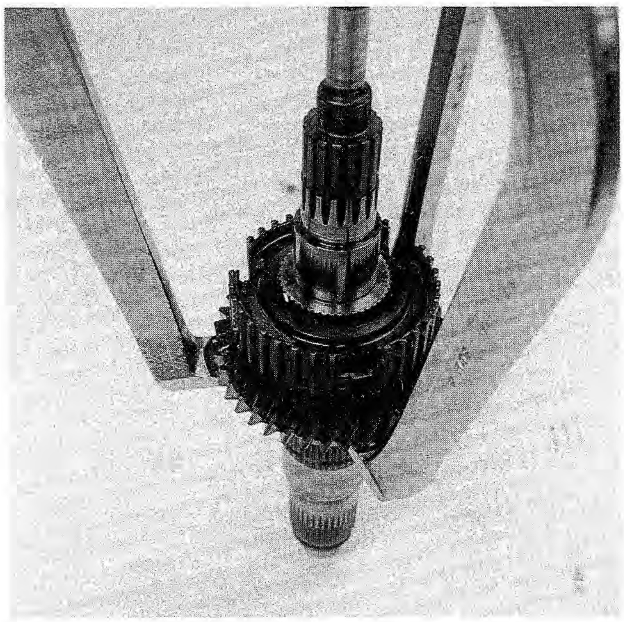

Fig. 7-34. 5th/reverse gear guide sleeve assembly being removed from output shaft.

To assemble gear train:

1. Assemble the synchronizer guide sleeves to the operating sleeves. Position the dogs so that the beveled edge or stepped side is facing the operating sleeve. See Fig. 7-35.

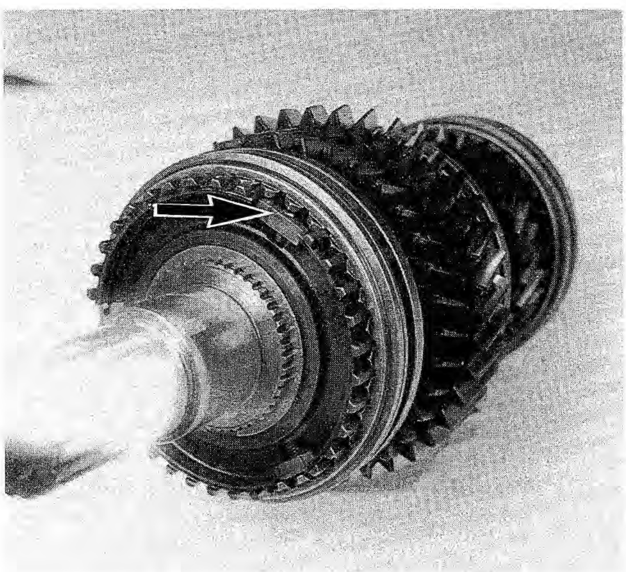

Fig. 7-35. Guide sleeve operating dog correctly installed with beveled edge facing operating sleeve (arrow). On early transmissions, dog with stepped side faces operating sleeve.

NOTE —

- Two types of guide sleeve dogs are installed in the Getrag transmissions covered by this manual. On early transmissions, a stepped dog is installed. On later transmissions, a dog with beveled edges is installed. On early transmissions with the stepped dog, make sure that the balls align with the hole in the operating s

- When installing the 3rd/4th gear operating sleeve to the guide sleeve, position the operating sleeve so that the grooves in the operating sleeve are on the opposite side from the longer collar on the guide sleeve hub. See Fig. 7-36.

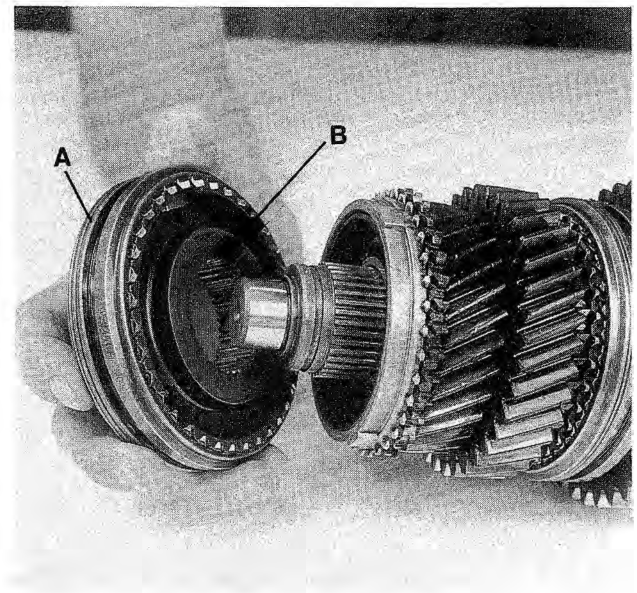

Fig. 7-36. Operating sleeve grooves (**A**) and longer collar on guide sleeve hub (**B**).

2. Install the reverse gear needle bearing, reverse gear, the reverse gear synchronizer ring, and the operating and guide sleeve assembly onto the output shaft. Align the splines in the guide sleeve with the splines on the shaft. Align the tabs (blocks) on the synchronizer ring with the openings in the guide sleeve and press the sleeve onto the shaft. See Fig. 7-37.

CAUTION —

There are two types of synchronizer rings in the Getrag 240 and 260 transmissions. One type of ring is for 1st and reverse gears and another type is for 2nd through 5th gears. The two types of rings should not be interchanged. See Fig. 7-38.

NOTE —

- On transmissions built from May 1985 and later, install the reverse/5th gear operating sleeve so that the side of the sleeve with the groove is facing 5th gear.

- Pressing on force should not exceed 2.5 tons on the Getrag 260 transmission or 2.1 tons on the Getrag 240 transmission.

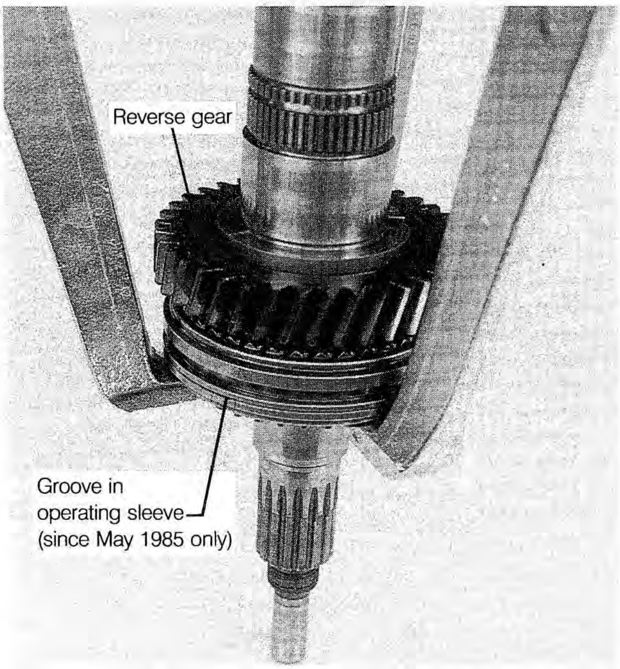

Fig. 7-37. Reverse gear assembly being installed on output shaft.

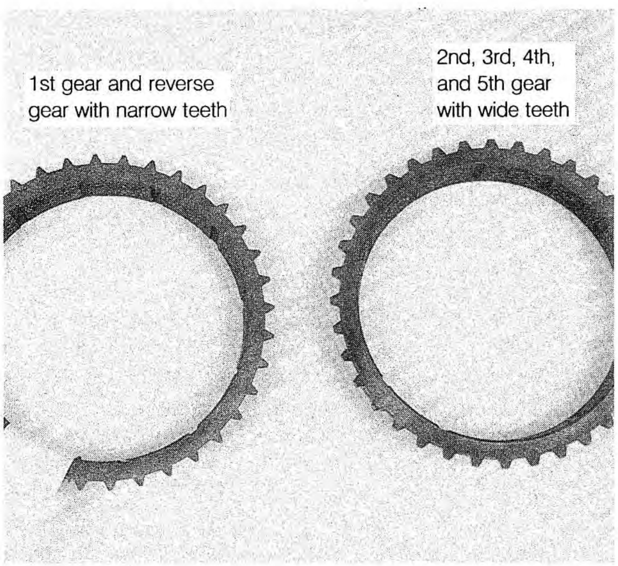

Fig. 7-38. Two types of synchronizer rings.

3. Check the 5th/reverse gear guide sleeve axial play by inserting the old circlip and a feeler gauge into the groove in the shaft. See Fig. 7-39. Select a new circlip based on the information listed in **Table j** below so that there is no play.

CAUTION —
Old circlips should not be reused.

NOTE —

- To determine the thickness of the circlip to install, add the thickness of the old circlip and the thickness of the feeler gauge that just fits in the groove. Select the circlip which is closest to this value but not over.

- Circlips can be ordered from an authorized BMW dealer parts department.

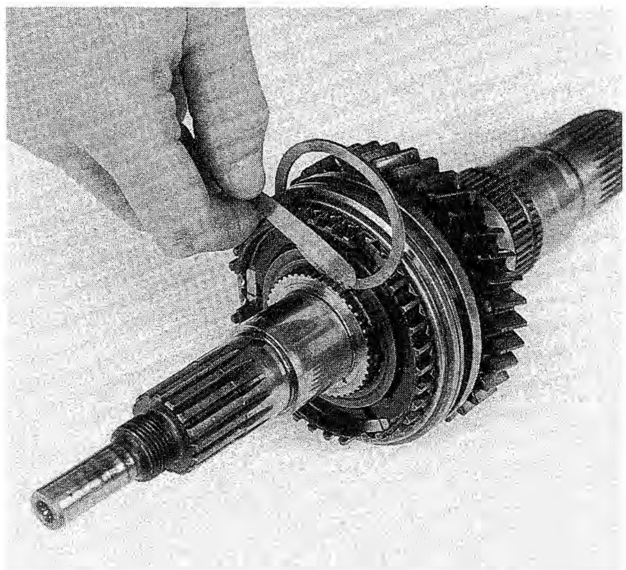

Fig. 7-39. 5th/reverse gear guide sleeve axial play being measured.

Table j. 5th/Reverse Gear and 1st/2nd Gear Guide Sleeve Selective Circlips

Dimension and thickness in mm	
Getrag 240	**Getrag 260**
36.5x1.7	52x44x1.80
36.5x1.8	52x44x1.85
36.5x1.9	52x44x1.90
36.5x2.0	52x44x1.95
	52x44x2.00

9

4. Install the 1st gear needle bearing, 1st gear, the 1st gear synchronizer ring, and the operating and guide sleeve assembly onto the output shaft. Align the splines in the guide sleeve with the splines on the shaft. Align the tabs on the synchronizer ring with the openings in the guide sleeve and press the sleeve onto the shaft.

NOTE —

On transmissions built from May 1985 and later, install the 1st/2nd gear operating sleeve so that the side of the sleeve with the grooves is facing 2nd gear. See Fig. 7-40.

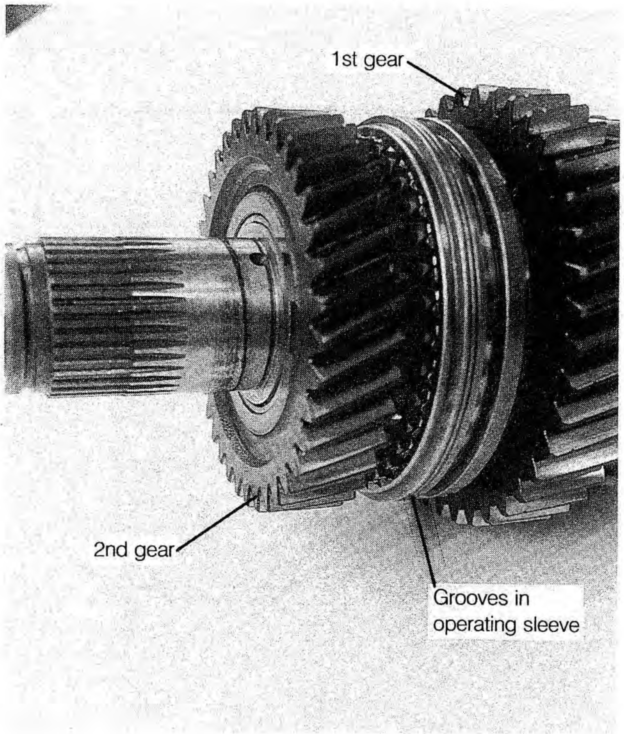

Fig. 7-40. 1st/2nd gear guide sleeve assembly correctly installed on late model (from May 1985 and later) transmissions. Grooves in operating sleeve should face 2nd gear.

5. Check the 1st/2nd gear guide sleeve axial play. See Fig. 7-39 above. Select a new circlip based on the information listed in **Table j** above.

CAUTION —

Old circlips should not be reused.

6. Install the 2nd gear needle bearing, the 2nd gear synchronizer ring, and 2nd gear.

CAUTION —

Check that the bearing surface on the output shaft is slightly above the 2nd gear shoulder on the guide sleeve. See Fig. 7-41. If there is no protrusion, check that the circlip for the 1st/2nd gear guide sleeve below 2nd gear is fully seated.

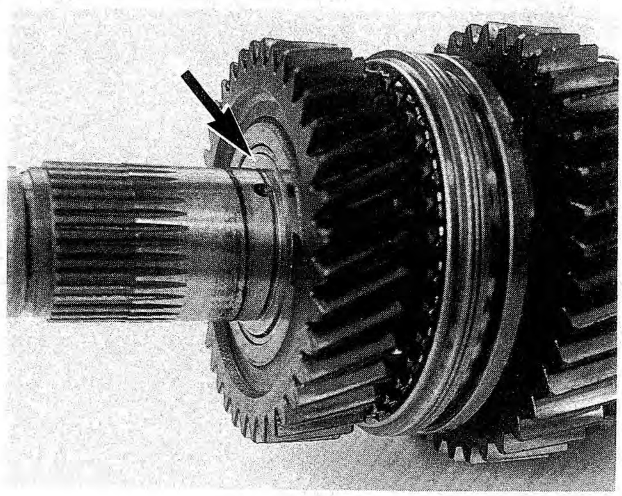

Fig. 7-41. Output shaft bearing surface protruding above second gear shoulder (arrow).

7. On models with a two-piece bearing sleeve install the thrust washer and ball to the shaft while aligning the notch in the washer with the ball in the shaft. See Fig. 7-33 above.

8. Heat the bearing sleeve for 3rd gear to approximately 176°F (80°C) using a hot air blower and drive it onto the shaft.

9. Install the 3rd gear needle bearing, 3rd gear, and the 3rd gear synchronizer ring.

10. Install the 3rd/4th gear operating and guide sleeve assembly so that the longer collar on the guide sleeve hub is facing 3rd gear. See Fig. 7-42. Align the splines in the guide sleeve with the splines on the shaft. Align the tabs on the synchronizer ring with the openings in the guide sleeve and press the sleeve onto the shaft.

NOTE —

- Pressing on force should not exceed 2.1 tons on the Getrag 260 transmission or 1.9 tons on the Getrag 240 transmission.
- On transmissions built from May 1985 and later, install the 3rd/4th gear operating sleeve so that the side of the sleeve with the grooves is facing 4th gear.

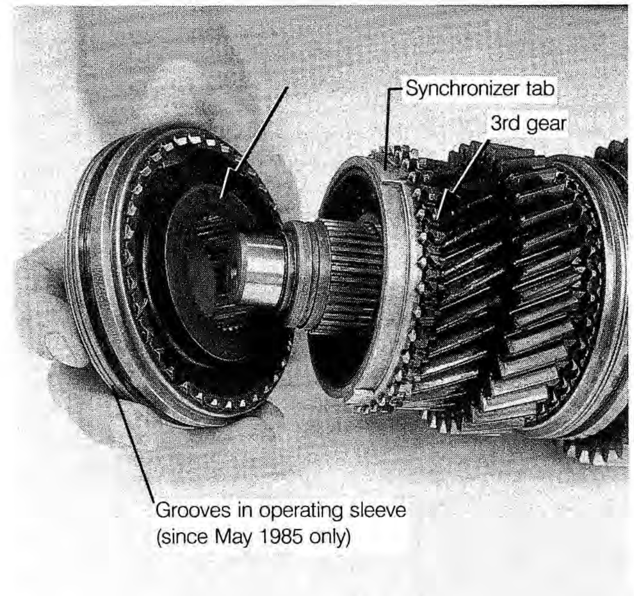

Fig. 7-42. 3rd/4th gear operating sleeve assembly being installed on output shaft with long collar (arrow) facing 3rd gear.

11. Check the 3rd/4th gear guide sleeve axial play. See Fig. 7-42 above. Select a new spacer (Getrag 240) or circlip (Getrag 260) using the information listed in **Table k** below.
12. Install the input shaft roller bearing onto the output shaft and install the output shaft.

Table k. 3rd/4th Gear Guide Sleeve Selective Spacers and Circlips

Dimension and thickness in mm	
Getrag 240 (spacers)	**Getrag 260** (circlips)
30x42x2.3	35x2.0
30x42x2.4	35x2.1
30x42x2.5	35x2.2
30x42x2.6	35x2.3
	35x2.4

7.3 Transmission Oil Seals

Replacing the transmission oil seals can be done without any major disassembly of the transmission, and two of the three seals can be replaced with the unit installed in the car.

Low gear oil level due to a faulty oil seal may cause problems such as hard shifting, jumping out of gear, and transmission noise. Oil at the bottom of the bellhousing may also be due to a leaking rear crankshaft seal.

Before assuming that the seals are at fault, check the transmission vent on the top of the case. A clogged or damaged vent can cause the pressure inside the case to increase to a point where the lubricant is forced passed the seals. The vent is shown in Fig. 7-43.

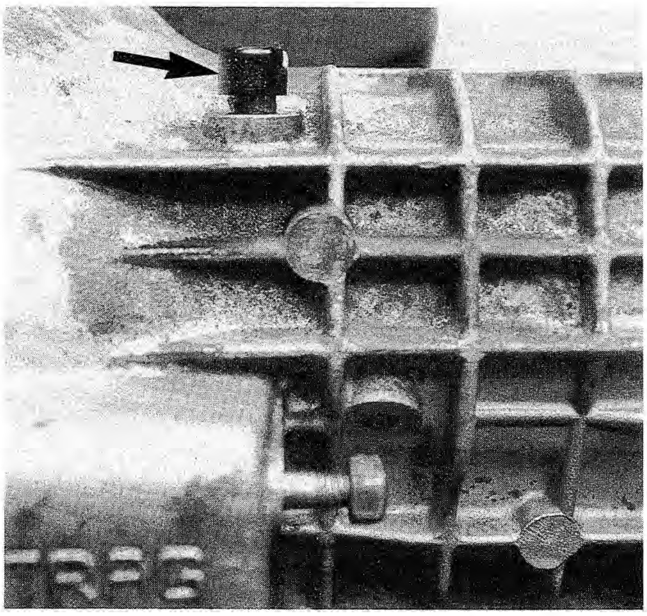

Fig. 7-43. Manual transmission vent (arrow). Check vent for free movement up and down.

To replace output shaft oil seal:

1. Remove the exhaust system as described in **EXHAUST SYSTEM AND EMISSION CONTROLS.**
2. Disconnect the driveshaft and, where applicable, the vibration damper from the transmission. See **DRIVESHAFT AND FINAL DRIVE.**

3. Bend back the lockplate tabs shown in Fig. 7-44, and remove the lockplate. Hold the flange steady and remove the collar nut using a 30 mm thin-walled wrench.

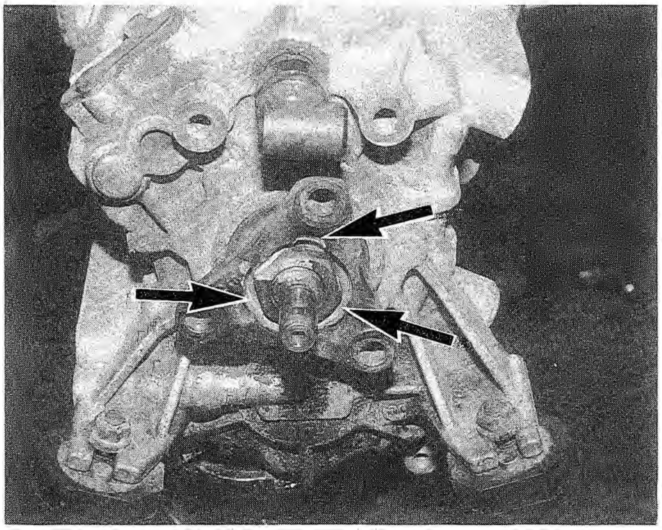

Fig. 7-44. Lockplate tabs (arrows). Bend tabs out of groove to remove lockplate and collar nut.

4. Remove the output flange from the output shaft. If necessary use a puller to remove the flange.

5. Using a seal remover or a small screwdriver, pry out the old seal. Lubricate the new seal with oil and carefully drive it into place.

> ***CAUTION —***
> *Be careful not to damage the transmission case housing when prying*
> *aged case can result in oil leaks.*

6. Install the output flange. Coat the bearing surface of the collar nut with sealer and install the nut, torquing it to the specifications listed below.

> **NOTE —**
> • BMW recommends the use of a sealer such as Loctite 270, Hylogrip, or Curil K2 when installing the collar nut to prevent transmission oil leaks. Such a sealant is available from your BMW dealer.
>
> • On Getrag 240 and 260 transmissions, the drive flange nut must be tightened in two stages. Initially torque the collar nut to 170 Nm (125 ft. lb.), loosen the nut, and retorque it to 120 Nm (89 ft. lb.).
>
> • On ZF transmissions, torque the collar nut to 100 to 120 Nm (74 to 89 ft. lb.).

7. Reinstall the lockplate and bend the tabs into the grooves as shown above in Fig. 7-44.

8. Reinstall the driveshaft and exhaust system.

To replace selector shaft oil seal:

1. Remove the exhaust system as described in **EXHAUST SYSTEM AND EMISSION CONTROLS**.

2. Remove the driveshaft or disconnect the flexible coupling as described in **DRIVESHAFT AND FINAL DRIVE**.

3. Bend back the lockplate tabs shown above in Fig. 7-44, and remove the lockplate. Hold the flange steady and remove the collar nut.

4. Remove the output flange from the output shaft. If necessary use a puller to remove the flange.

5. Disconnect the selector rod from the selector shaft as described in **4.1 Disassembling and Assembling Shift Mechanism**.

6. Using a pick or small screwdriver, pry out the seal as shown in Fig. 7-45. Lubricate the new seal with oil and drive it into place.

> ***CAUTION —***
> *Be careful not to mar the housing when removing the seal.*

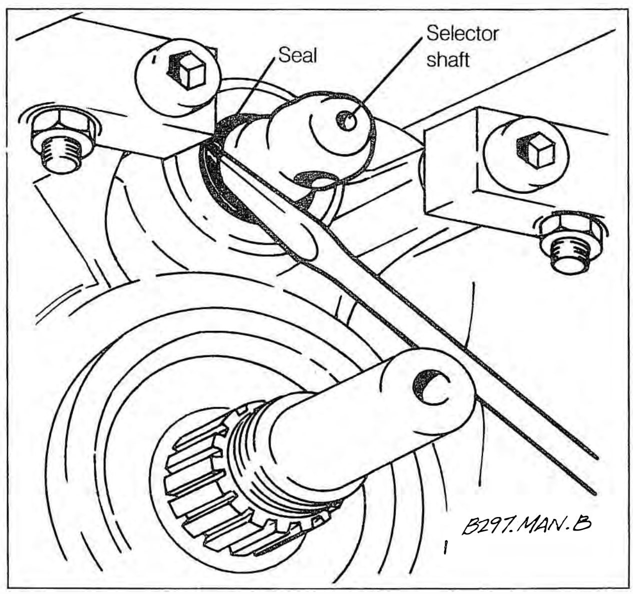

Fig. 7-45. Selector shaft oil seal being pried out with screwdriver. Take care not to scratch selector shaft.

7. Reinstall the selector rod, the driveshaft flange and driveshaft, and the exhaust system.

CAUTION —

The tightening torque on the drive flange nut is critical. Tighten the collar nut as described above under the procedure for replacing the output shaft oil seal.

To replace input shaft oil seal:

1. Remove the transmission as described in **6.1 Removing and Installing Transmission**.

2. Remove the clutch release bearing and release lever as described in **5.3 Removing and Installing Clutch**.

3. Remove the bolts for the clutch release guide sleeve, shown in Fig. 7-46, and remove the sleeve.

NOTE —

On ZF transmissions a gasket is installed behind the guide sleeve. On Getrag transmissions, the sleeve is sealed in place. On Getrag 260 transmissions with two-piece guide sleeves, remove only the outer bolts when removing the sleeve.

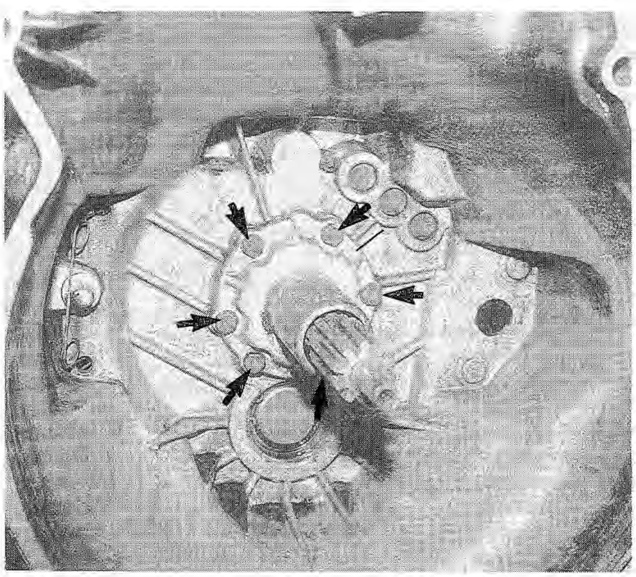

Fig. 7-46. Guide sleeve bolts (arrows) to be removed. Getrag 240 transmission shown.

4. Pry out the old seal, lubricate the new seal with oil, and drive it into place.

CAUTION —

Be careful not to mar the housing when removing the seal.

5. Clean the mounting bolts and sealing surface of the guide sleeve. On ZF transmissions, use a new gasket without sealer. On Getrag transmissions, apply sealer (Loctite 573® or equivalent) to the guide sleeve sealing surface. Reinstall the guide sleeve and spacer(s).

CAUTION —

On Getrag 260 transmissions, make sure that the groove in the sleeve is aligned with the oil bore in the transmission case.

NOTE —

A diferent spacer may be required if either the bearing or guide sleeve are replaced. See **7.1 Removing and Installing Gear Train** for more information.

6. Coat the bolt shoulders with sealing compound and install the bolts. Torque M8 x 22 bolts to 18 Nm (13 ft. lb.); torque M8 x 30 bolts to 25 Nm (18 ft. lb.); and torque M6 bolts to 10 Nm (7 ft. lb.).

7. Reinstall the clutch release lever and release bearing and reinstall the transmission.

7.4 Inspecting Transmission Components

The inspection information listed under this heading covers the transmission components that are most likely to wear. Some of the inspection procedures require precision measuring equipment such as a dial indicator setup and a vernier caliper. If this equipment is not available, a local machine shop should be able to do the work quickly and at a reasonable cost. In addition, some of the steps below can be done prior to complete disassembly of the transmission. For example, checking for worn synchronizer rings and checking the axial play of the guide sleeves on the output shaft.

Gears and Synchronizer Rings

Gears should be inspected for wear and broken or missing teeth. Because the gears are constantly meshing with the gears on the layshaft, they are not normally a cause of transmission trouble. Check the gear's surface that the needle bearing rides on, the needle bearing itself, and the gear's journal on the output shaft. Replace any components that are found to be faulty.

The contact surface of each synchronizer ring is coated with a rough friction material that can wear away over time. Visually inspect the rings for damaged or missing teeth. Check that the ring's friction surface is not shiny and smooth. If no visible faults are found, check each ring with its matching gear as shown in Fig. 7-47. **Table I** lists synchronizer ring wear specifications.

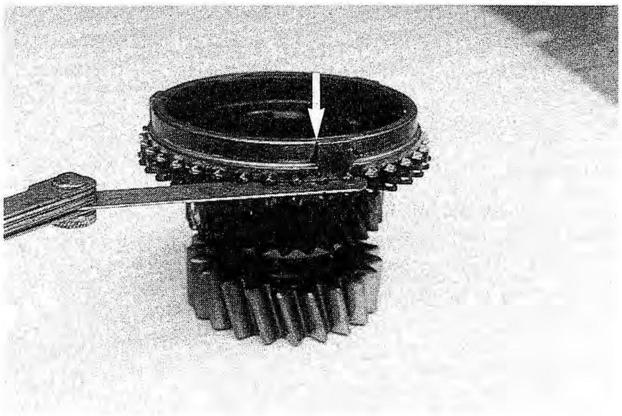

Fig. 7-47. Synchronizer ring being checked for wear using feeler gauge. Measure in the area of the tabs (arrow).

Table l. Synchronizer Ring Wear Specifications

Gear	New	Wear Limit
Forward gears (1st–5th)	1.0–1.3 mm (0.039–0.051 in.)	0.8 mm (0.031 in.)
Reverse	0.5–0.6 mm (0.020–0.024 in.)	0.4 mm (0.016 in.)

Shift Forks and Shift Rods

Inspect the aluminum shift fork guides that ride in the grooves of the steel synchronizer operating sleeves. Measure each shift fork at the area shown in Fig. 7-48. **Table m** lists shift fork wear specifications. Replace any shift fork that exceeds the wear limits.

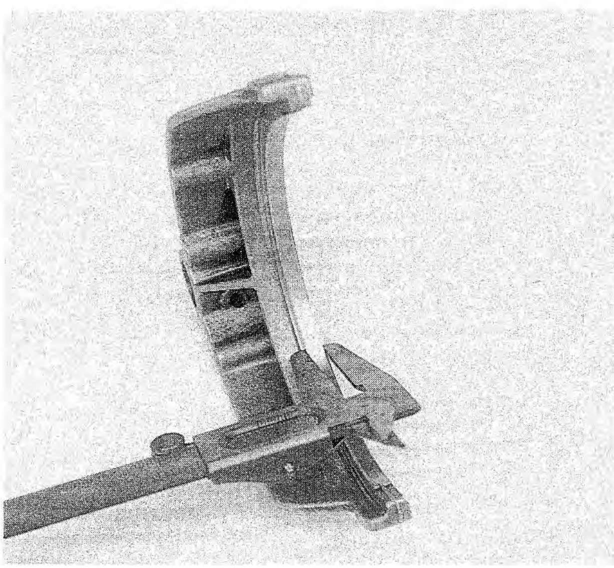

Fig. 7-48. Shift fork being checked for wear.

Table m. Shift Fork Guide Wear Specifications

Shift fork	Wear limit
1st/2nd, 3rd/4th	4.8 mm (0.189 in.)

NOTE —

Wear specifications for the 5th/reverse gear shift fork are not given by BMW.

The shift rods should not be bent or otherwise damaged. Make sure that the shift rods slide smoothly in their bores and that they are not worn.

Transmission Shafts

Visually inspect the output shaft and the input shaft for wear. Check for distorted or damaged splines or journals. The output shaft can be inspected for radial runout (bending) using a dial indicator setup. **Table n** lists the output shaft radial runout specifications.

Table n. Output Shaft Radial Runout Specifications

Wear limit (measured at journals)	. . . . . .0.07 mm (0.0027 in.)

Transmission Case Bushings and Bearings

Ball bearing races should turn smoothly, without roughness or tight spots. There should be no visible damage or heat discoloration. Look for galled or flattened areas on the roller bearings and the inner races. Inspect the needle bearings to see that none are flattened or heat damaged. Check that the bearing cage is not damaged. Replace any bearing that is damaged or worn.

When installing a new output shaft bearing, first measure the height of the new bearing. Then measure the bearing depth in the case (measuring from the top of the raised bolt lands on the case). Subtract the first measurement from the later. The difference in the two measurements is the thickness of the shim needed to be installed between the bearing and the rear case. **Table o** lists available shims. Install the shim, then heat the rear case to 176°F (80°C) and drive the bearing into the case. Install the bearing so that the protruding side of the bearing faces the gears. See Fig. 7-24 above.

Table o. Output Shaft Bearing Selective Shims

Dimension and thickness in mm	
Getrag 240	**Getrag 260**
72x60x0.3	80x66x0.3
72x60x0.4	80x66x0.4
72x60x0.5	80x66x0.5

NOTE —

Replacing the input shaft bearing and checking input shaft axial play is described above under **7.1 Removing and Installing Gear Train.**

The layshaft bearing shells can be checked by temporarily installing only the layshaft with its bearings into the transmission case and bolting the case together. Insert a screwdriver through the oil fill plug and lever the shaft up and down in its bearings. Measure the shaft's axial play at the top of the shaft (through the input shaft's bearing hole in case) using a dial indicator setup. Layshaft axial play specifications are listed in **Table p.**

Table p. Layshaft Axial Play Specifications

Maximum play (measured at top of shaft with shaft installed in case)	0.13–0.23 mm (0.005–0.009 in.)

If the layshaft axial play exceeds the allowable limits, the bearing shells in the front and rear case should be replaced and a new shim(s) should be installed behind the front bearing shell. When installing the front bearing shell, be sure the oil passage in the shell aligns with the bore in the case. See Fig. 7-49. Selective shims for the layshaft bearing are listed in **Table q.**

Table q. Layshaft Bearing Shell Selective Shims

Dimension and thickness in mm	
Getrag 240	**Getrag 260**
44x36.5x1.7	44x36.5x1.7
44x36.5x1.8	44x36.5x1.8
44x36.5x2.0	44x36.5x2.0
44x36.5x2.2	44x36.5x2.2
44x36.5x2.3	44x36.5x2.3
44x36.5x2.4	44x36.5x2.4

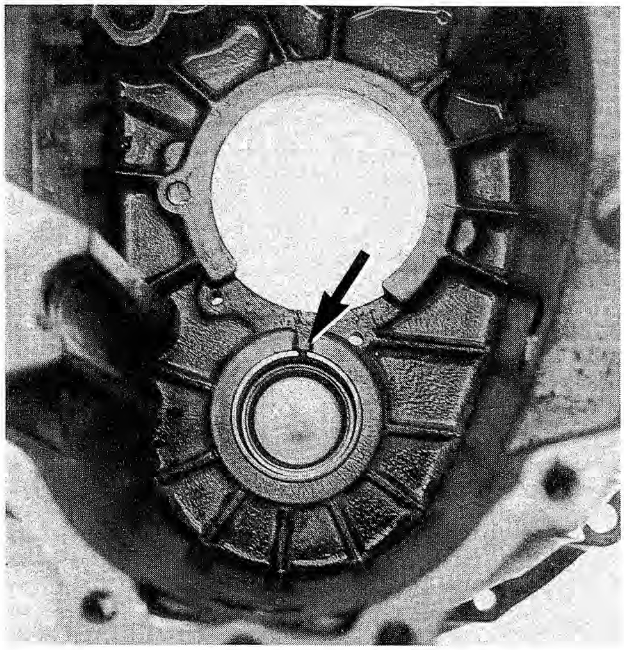

Fig. 7-49. Layshaft bearing shell correctly installed in front case, with oil passage aligned with hole in case (arrow).

NOTE —

Special tools (BMW Tool No. 23 1 280, No. 23 1 300, and No. 33 4 020) are used to remove the layshaft bearing shells from the case.

8. TECHNICAL DATA

I. Tightening Torques

Shift console rear mounting nut	11 Nm (8 ft. lb.)
Sheet-metal console to transmission (bolts, with locking compound)	23 Nm (17 ft. lb.)
Transmission support bolts	22–24 Nm (16–18 ft. lb.)
Clutch master cylinder mounting bolts	9 Nm (7 ft. lb.)
Clutch master cylinder pushrod to clutch pedal (bolt)	21 Nm (15 ft. lb.)
Clutch master cylinder pushrod locknut	4
Clutch hydraulic hose connections	13–16 Nm (10–12 ft. lb.)
Clutch slave cylinder mounting nuts	24 Nm (18 ft. lb.)
Clutch pressure plate mounting bolts	
Grade 8.8	22–24 Nm (16–18 ft. lb.)
Grade 10.9	30–35 Nm (22–26 ft. lb.)

continued on next page

9

I. Tightening Torques (continued)

Transmission to engine (hex-head)
- M8 .22–27 Nm (16–20 ft. lb.)
- M10 . . . . .47–51 Nm (35–38 ft. lb.)
- M12 . . . . .66–82 Nm (49–60 ft. lb.)

Transmission to engine (Torx®-head)
- M8 .20–24 Nm (15–18 ft. lb.)
- M10 . . . . .38–47 Nm (28–35 ft. lb.)
- M12 . . . . .64–80 Nm (47–59 ft. lb.)

Rear transmission support
- to body (nut) . . . . .22–24 Nm (16–18 ft. lb.)

Transmission rubber mount
- (nut, to transmission or support) . . .43–48 Nm (32–35 ft. lb.)

Transmission drain plug/fill plug . . . . .40–60 Nm (30–44 ft. lb.)

Transmission output flange collar nut
- Getrag 240/260
  - initial .170 Nm (125 ft.lb.)
  - final . . . . .120 Nm (89 ft. lb.)
- ZF . . . . .100–120 Nm (74–89 ft. lb.)

Release bearing guide sleeve (bolt)
- M8 x 22 .18 Nm (13 ft. lb.)
- M8 x 30 .25 Nm (18 ft. lb.)
- M6 . . . . .10 Nm (89 in. lb.)

Getrag Transmission Assembly Tightening Torques
- Front transmission case
  - to rear case (bolt) . . . . .25 Nm (18 ft. lb.)
- Drive flange to output shaft (nut)
  - Initial torque . . . . .170 Nm (127 ft. lb.)
- Reverse gear shaft to
  - transmission case (bolt) . . . . .25 Nm (18 ft. lb.)
- Reverse gear shaft retaining bracket
  - to transmission case (bolt) . . . . .25 Nm (18 ft. lb.)
- Detent ball and spring locking plate
  - to transmission case (bolt) . . . . .10 Nm (89 in. lb.)
- Clutch guide sleefe to
  - front transmission case . . . . .10 Nm (89 in. lb.)
- Back-up light switch to
  - transmission case . . . . .6–10 Nm (53–89 in. lb.)

II. Transmission Tolerances, Wear Limits and Settings

Shift fork guide wear limit . . . . .4.8 mm (0.189 in.)
Layshaft axial play, maximum . .0.13–0.23 mm (0.005–0.009 in.)
Output shaft axial play, maximum . . .0–0.09 mm (0–0.0035 in.)
Input shaft axial play, maximum . . . .0–0.09 mm (0–0.0035 in.)
Output shaft radial runout, maximum . . . .0.07 mm (0.0027 in.)

Guide sleeve pressing-off force (maximum permissible)
- 1st/2nd gear
  - Getrag 240 . . . . .3.0 tons
  - Getrag 260 . . . . .3.7 tons
- 3rd/4th gear
  - Getrag 240 . . . . .2.7 tons
  - Getrag 260 . . . . .3.0 tons
- 5th/Reverse gear
  - Getrag 240 . . . . .3.0 tons
  - Getrag 260 . . . . .3.7 tons

continued

II. Transmission Tolerances, Wear Limits and Settings (continued)

Guide sleeve pressing-on force (maximum permissible)
- 1st/2nd gear
  - Getrag 240 . . . . .2.1 tons
  - Getrag 260 . . . . .2.5 tons
- 3rd/4th gear
  - Getrag 240 . . . . .1.9 tons
  - Getrag 260 . . . . .2.1 tons
- 5th/Reverse
  - Getrag 240 . . . . .2.1 tons
  - Getrag 260 . . . . .2.5 tons

Synchronizer ring specifications
(measured between ring and gear)
- Forward gears
  - new . . . . .1.0–1.3 mm (0.039–0.051 in.)
  - wear limit . . . . .0.8 mm (0.031 in.)
- Reverse
  - new . . . . .0.5–0.6 mm (0.020–0.024 in.)
  - wear limit . . . . .0.4 mm (0.016 in.)

Transmission case bearing
- installation temperature . . . . .176°F (80°C)

III. Clutch Tolerances, Wear Limits and Settings

Slave cylinder pushrod travel (measured with
- slave cylinder installed) . . . . .at least 20 mm (3/4 in.)

Clutch pedal adjustment
- (measured from firewall) . . . . .253 mm $^{+11}_{-0}$ (10 in. $^{+.4}_{-0}$)

Release lever tips deviation
- from parallel, maximum . . . . .0.6 mm (.024 in.)

Clutch disc runout, maximum . . . . .0.5 mm (.020 in.)
Clutch disc thickness, minimum . . . . .7.5 mm (.295 in.)

IV. Manual Transmission Gear Ratios

Transmission type	Getrag 240	ZF S5-16	Getrag 260
Gear ratios			
1st gear	3.72	3.72	3.83
2nd gear	2.02	2.04	2.20
3rd gear	1.32	1.34	1.40
4th gear	1.00	1.00	1.00
5th gear	0.81	0.80	0.81
Reverse gear	3.45	3.54	3.46

Section 10

AUTOMATIC TRANSMISSION

Contents

Tables

Automatic Transmission

Introduction

Three different automatic transmissions are used on the various cars covered by this manual, all manufactured by ZF. Early 4-cylinder models are equipped with the 3 HP 22 three-speed. Later 4-cylinder and all 6-cylinder models are equipped with either the 4 HP 22 H four-speed with lockup torque converter or the 4 HP 22 EH, a refined four-speed automatic with electronic control of shifting.

The automatic transmission is housed in a cast alloy case that is bolted to the engine block. Though the automatic transmission is entirely different from the manual transmission used in these cars, the driveshaft and final drive components are virtually identical. See **DRIVESHAFT AND FINAL DRIVE**.

Cleanliness and a careful approach are very important when repairing the transmission. Read the procedure thoroughly before beginning any repair. Some specifications are given in metric units only, requiring that the work be carried out using metric tools and instruments. If you lack the skills, the tools, or a suitable workplace for servicing the automatic transmission, we suggest you leave these repairs to an authorized BMW dealer or other qualified shop.

With normal use and regular maintenance, the automatic transmission is very reliable and does not require internal repairs. Repairs to the internal sections of the transmission require special knowledge and equipment, and as such are beyond the scope of this manual. In the event that internal repairs or overhaul are required, it may be possible to save some of the expense of professional repair by removing and installing the transmission yourself, using the procedures described in this section.

We recommend that the outside of the transmission be thoroughly cleaned and taken to the shop fully assembled. It is important to realize that a partially disassembled transmission is a mechanic's nightmare. We strongly advise against disassembling the transmission to begin any repair you cannot properly finish. We especially urge you to see an authorized BMW dealer before beginning any work on a car that may be eligible for warranty repair.

1. GENERAL DESCRIPTION

The 4 HP 22 automatic transmission is shown in Fig. 1-1 and Fig. 1-2. At the front end of the transmission is the bellhousing, which is bolted to the transmission and houses the torque converter. The bellhousing is bolted to the engine block. At the rear end of the transmission is the extension housing, which is also bolted to the main transmission case and contains the governor and the vent for the automatic transmission.

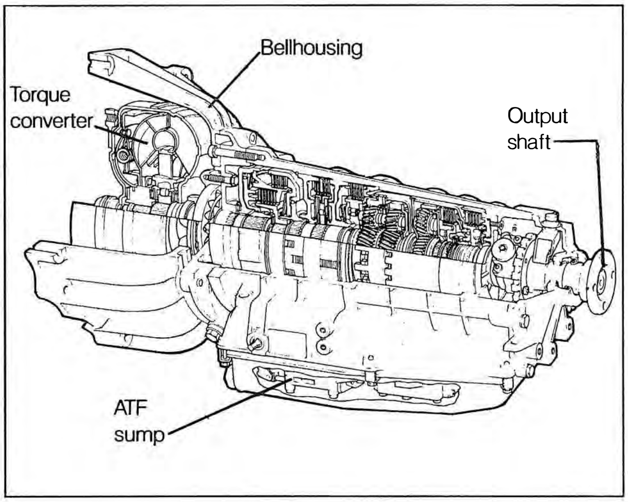

Fig. 1-1. Phantom view of 4-speed ZF 4 HP 22 automatic transmission.

The transmission case contains the ATF pump, the hydraulic controls, the planetary gear system, and a supply of automatic transmission fluid (ATF). The planetary gear system is lubricated solely by ATF, circulated through the transmission by the ATF pump. The ATF does not circulate unless the engine is running, so the transmission parts are only partially lubricated when the engine is turned off.

CAUTION

- *Towing a BMW with an automatic transmission while the rear wheels are on the ground can cause damage due to lack of lubrication.*
- *BMW recommends that cars with automatic transmission be towed with the rear wheels on the ground for no more than 30 miles (50 km), at no more than 30 mph (50 km/h).*
- *If the distance will be greater than 30 miles (50 km), either remove the driveshaft or add 1.05 quarts (1 liter) of ATF to the transmission. Reduce the fluid level to normal before driving the car.*

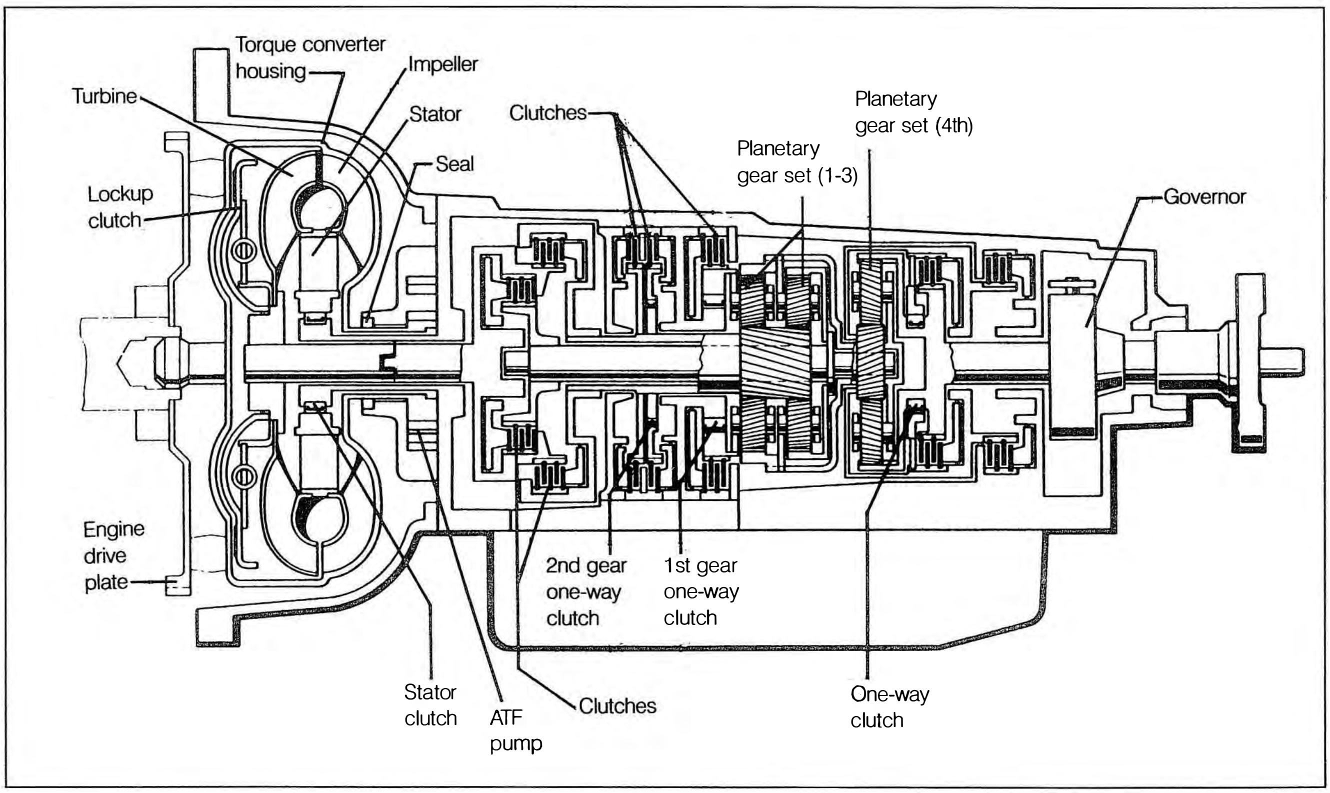

Fig. 1-2. Schematic view of 4-speed ZF 4 HP 22 automatic transmission. 3-speed ZF 3 HP 22 automatic transmission is similar.

1.1 Automatic Transmission

All automatic transmissions used on the BMWs covered by this manual are hydraulically controlled with either three or four forward speeds. The 4 HP 22 EH transmission features additional electronic control of the hydraulic system.

The automatic transmission can best be described and understood by dividing it into subsystems. These are the torque converter, the ATF pump, the planetary gear system, and the hydraulic and electronic controls. All cars with automatic transmission also have an ATF cooler integrated into the radiator for the engine cooling system.

Torque Converter

The torque converter is a doughnut-shaped assembly located between the engine and the transmission inside the bellhousing. The torque converter transmits engine output to the transmission, and also multiplies engine torque at low speeds. The torque converter is a fluid coupling. Power is transmitted as internal vanes driven by the engine create a flow of ATF to drive other vanes.

The first set of vanes are called the impeller. The impeller is part of the converter housing. Since the housing is bolted to the engine drive plate, the impeller vanes are always driven at engine speed. As the converter spins, the curved impeller vanes set up a flow of ATF that drives the second set of vanes opposite it, called the turbine. The turbine is directly connected to the transmission gear system.

A third set of vanes, called the stator, is between the impeller and turbine. At low speeds, a one-way clutch keeps the stator stationary so that its curved vanes will redirect the flow of ATF so that torque is multiplied. At higher speeds, when there is no longer a speed differential between the impeller vanes and the turbine, the stator freewheels and torque multiplication ceases.

Lockup Torque Converter

Because a normal torque converter is only a fluid coupling between the engine and transmission, there is always some loss of efficiency due to slippage. To ensure maximum efficiency and power transmission, the 4 HP 22 H and EH transmissions are equipped with a lockup torque converter. Above an ATF temperature of 68°F (20°C) and a road speed of 53 mph (85 km/h), and depending on throttle position, an additional clutch in the torque converter locks the turbine to the impeller. This provides a direct mechanical link between the transmission and the engine.

ATF Pump

Automatic transmission fluid (ATF) is circulated through the transmission under pressure. The pump that creates this pressure and pumps the fluid is located at the front of the transmission case, between the torque converter and the transmission. The torque converter shaft engages the ATF pump and drives the pump when the engine is running. ATF is drawn from the ATF sump (also referred to as the transmission oil pan) through a filter screen, and fills the valve body before circulating to fill the torque converter and transmission.

Planetary Gear System

A torque converter alone cannot provide the torque multiplication needed for all driving conditions. The transmission therefore contains a planetary gear system which can operate at different drive ratios. The gears are driven directly by the torque converter turbine.

The planetary gear system contains a number of one-way and hydraulically-operated clutches along with the planetary gearsets. The gearsets—one gearset for the three-speed transmission, and two gearsets for the four-speed transmission—drive the transmission output shaft.

A planetary gearset consists of one large gear called a sun gear, and a number of smaller gears called planet gears inside the sun gear. The rotational speed of the transmission output shaft depends on which gears are rotating and which are stationary.

The rotation of the gears are controlled by the clutches. By varying the application of hydraulic pressure to the clutches, one or more of the sun and planet gears can be held stationary. This changes the gear ratio, and also controls reverse.

The clutches also affect the freewheeling of the transmission during coasting. For example, when the selector lever is at 1, the normally freewheeling 1st gear is locked in order to provide additional engine braking.

Hydraulic Controls

The hydraulic control system directs and regulates hydraulic pressure from the ATF pump to control shifting of the planetary gear system. Shifts are produced by ring-shaped clutch pistons or brake bands, based on the flow of ATF from the pump through the valve body. Three primary control devices regulate the movement of the control valves in the valve body.

The first primary control device is the manual valve, which is connected to the selector lever by a rod and linkage. Moving the lever changes the setting of the valve and produces the necessary application of hydraulic pressure for the drive range selected.

The second primary control device, the throttle valve, is linked by cable to the position of the accelerator pedal and makes the transmission responsive to engine speed and load.

The third primary control device, the governor, controls ATF pressure relative to the output shaft rotational speed, making the transmission responsive to rear wheel speed.

Electronic Controls

The 4 HP 22 EH transmission is a further refinement of the 4 HP 22 H transmission, with electronic shift control. The transmission range is still selected by the selector lever and the planetary-gear clutches are actuated hydraulically, but the control valves in the valve body are operated by electric solenoids. The solenoids are controlled by an electronic control unit based on various inputs. See Fig. 1-3.

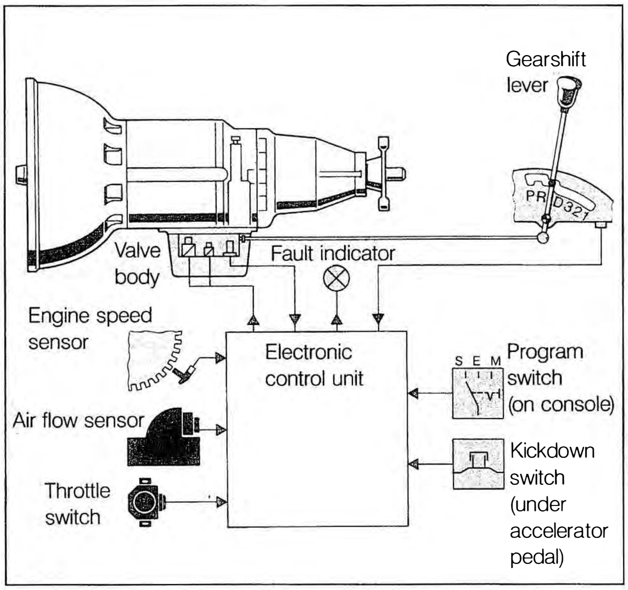

Fig. 1-3. Schematic of 4 HP 22 EH automatic transmission showing electronic control system.

ATF Cooler

Transmission performance and reliability life depend almost entirely on the condition of the transmission fluid. To ensure that the transmission fluid does not overheat, reducing its effectiveness, an ATF cooler is integrated with the engine cooling system radiator.

The ATF cooler is in the side of the radiator and is linked to the transmission by metal pipes. The ATF is circulated through the cooler by the ATF pump, and heat is removed by the engine coolant.

1.2 Identification Codes and Specifications

Due to different power characteristics and performance requirements of various engine/model combinations, there are minor variations of the basic automatic transmission, including the torque converter. The different versions are identified by code letters.

The transmission code letters and type number are located on a data plate on the left side of the transmission housing, just behind the manual valve lever. See Fig. 1-4.

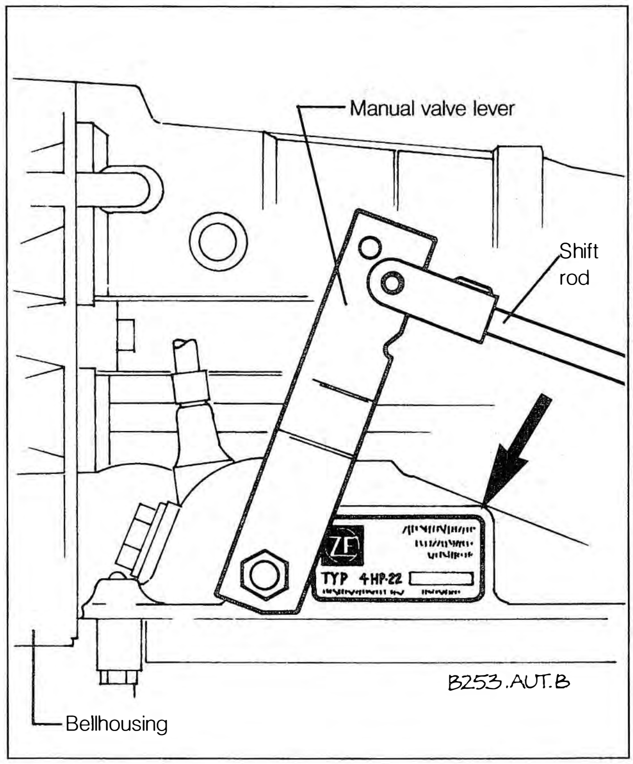

Fig. 1-4. Location (**arrow**) of automatic transmission data plate.

Table a lists automatic transmission and torque converter combinations for all cars covered by this manual. When replacing the transmission or the torque converter, the replacement part's code letters should correspond to those of the original part.

Table a. Automatic Transmission Specifications.

Model	318i	318i	325 325e(es)	325	325i, Convertible	325i, Convertible
Type	3 HP 22	4 HP 22 H	4 HP 22 H	4 HP 22 EH	4 HP 22 EH	4 HP 22 H
Code letters	RX	UC, XX VM,XS	AB, TY, XG,AB,AT	AR	AP	AC,GA
Torque converter code	P	U4	C7, R2	R2	R2	W2
Gear ratios						
1st gear	2.73	2.73	2.48	2.48	2.48	2.48
2nd gear	1.56	1.56	1.48	1.48	1.48	1.48
3rd gear	1.0	1.0	1.0	1.0	1.0	1.0
4th gear	N/A	0.73	0.73	0.73	0.73	0.73
Reverse	2.09	2.09	2.09	2.09	2.09	2.09

2. MAINTENANCE

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of the automatic transmission. Information on automatic transmission maintenance and on the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Checking ATF level and adding ATF
2. Changing ATF
3. Checking all transmission mating surfaces and ATF cooler lines for leaks
4. Cleaning or replacing the ATF filter screen

3. TROUBLESHOOTING

This troubleshooting section applies to problems affecting the transmission, including the torque converter. The basic functions of the automatic transmission are to circulate clean ATF under pressure, to provide the correct drive ratio in response to both the hydraulic and mechanical or electronic controls, and to transfer engine power to the rear wheels.

Most external adjustments to the transmission, as well as removal and installation, are covered in this manual, but some of the troubleshooting information in this section describes problems which can only be remedied by disassembly and internal repair. Internal transmission repairs require specialized knowledge and equipment and are, therefore, beyond the scope of this manual. The publisher recommends that such repairs be left to an authorized BMW dealer or other qualified automatic transmission repair shop.

NOTE

On transmissions manufactured before February 1985, transmission fluid leaks at the ATF filler tube or breather under heavy engine loads or during cruising may be caused by the transmission being overfilled. This mistake is common due to the design of the dipstick used on these earlier models. See **LUBRICATION AND MAINTENANCE** for more information on correctly filling the transmission and on retrofitting the later dipstick.

3.1 Basic Principles

In order for automatic transmission troubleshooting to provide meaningful results, the engine must be in good mechanical condition and properly tuned. See **ENGINE** for troubleshooting engine problems.

Inspect the transmission for external damage, loose or missing fasteners, and for any obvious leaks. Many automatic transmission problems can be traced to an incorrect ATF level, to contaminated ATF, or to misadjusted transmission controls.

Check for leaks, check the ATF level, and check to see if the fluid is dirty or has a burned odor. A burned odor indicates overheated fluid, which may be accompanied by burned clutches, as well as friction material which may be clogging the valve body passages.

Minor automatic transmission problems can often be corrected merely by correcting the ATF level, by draining and refilling the transmission as described in **LUBRICATION AND MAINTENANCE**, or by inspecting the adjustment and operation of the controls as described in **4.2 External Transmission Adjustments**.

Table b lists symptoms of automatic transmission problems, their probable causes, and recommended corrective actions. Numbers in bold type in the corrective action column indicate the heading in this section where the appropriate test and repair procedures can be found. Probable causes and corrective actions that refer to specific internal transmission faults are also provided for reference.

NOTE —

On 4 HP 22 EH transmissions with electronic control, a misaligned valve body may cause shorting out of the lockup clutch solenoid. This will cause the Transmission Fault Indicator to stay on after the car is started, and will allow the car only to be driven in the Emergency program. This fault may also cause engine rpm to drop below normal when braking to a stop.

Table b. Automatic Transmission Troubleshooting

Symptom	Probable cause	Corrective action
1. Park does not hold	a. Selector lever linkage misadjusted b. Parking pawl broken	a. Adjust selector linkage. **4.2** b. Overhaul or replace transmission. To remove and install, see **5.1**
2. No Drive (car will not move)	a. ATF level low b. Drive plate or torque converter incorrectly installed c. Selector lever linkage misadjusted d. Sticking pressure valves, faulty ATF pump, or broken gear or shaft—no pressure	a. Check and if necessary correct ATF level. See **LUBRICATION AND MAINTENANCE** b. Check and correct drive plate installation. See **ENGINE** Check and correct torque converter installation. **5.1, 5.2** c. Adjust linkage. **4.2** d. Test ATF pressure. **3.2** Overhaul or replace transmission. To remove and install, see **5.1**
3. Irregular drive in all forward gears and reverse	a. ATF level low b. ATF pump filter screen partially clogged c. Damaged clutch pistons or brake bands.	a. Check and if necessary correct ATF level. See **LUBRICATION AND MAINTENANCE** b. Remove ATF sump. Clean or replace filter screen. See **LUBRICATION AND MAINTENANCE** c. Overhaul or replace transmission. To remove and install transmission, see **5.1**
4. Kickdown fails to operate	a. Accelerator cable misadjusted b. Kickdown switch misadjusted or faulty c. Kickdown function faulty	a. Adjust cable. **4.2** b. Adjust or replace switch. To adjust, see **FUEL SYSTEM** c. Overhaul or replace transmission. To remove and install transmission, see **5.1**
5. Poor acceleration, poor high-speed performance	a. Engine out of tune b. Transmission accelerator cable misadjusted	a. Tune engine. See **LUBRICATION AND MAINTENANCE** b. Adjust cable. **4.2**
6. Transmission slips during hard cornering	a. ATF level low b. Clogged ATF filter screen	a. Check and if necessary correct ATF level. See **LUBRICATION AND MAINTENANCE** b. Remove ATF sump. Clean or replace filter screen. See **LUBRICATION AND MAINTENANCE**
7. ATF appears dirty, smells burnt	a. Contaminated ATF b. Damaged clutch friction linings	a. Drain and replace ATF. Remove and clean ATF filter screen. See **LUBRICATION AND MAINTENANCE** b. Overhaul or replace transmission. To remove and install transmission, see **5.1**

continued on next page

Table b. Automatic Transmission Troubleshooting (continued)

Symptom	Probable cause	Corrective action
8. Selector lever will not move	**a.** Selector lever linkage binding **b.** Internal transmission failure	**a.** Check and adjust linkage. **4.2** **b.** Overhaul or replace transmission. To remove and install transmission, see **5.1**
9. Hard jolt when moving selector lever from **N** to **D** or **R**	**a.** Idle speed too high **b.** ATF level low **c.** Transmission accelerator cable misadjusted **d.** Transmission electronics faulty (4 HP 22 EH only) **e.** Internal transmission fault	**a.** Adjust idle. See **FUEL SYSTEM** **b.** Check and correct ATF level. See **LUBRICATION AND MAINTENANCE** **c.** Adjust cable. **4.2** **d.** Check transmission electronics. **e.** Overhaul or replace transmission. To remove and install transmission, see **5.1**
10. Hard jolt on upshift or downshift	**a.** Transmission accelerator cable misadjusted **b.** Faulty clutch **c.** Valve body faulty **d.** Transmission electronics faulty (4 HP 22 EH only)	**a.** Adjust cable. **4.2** **b.** Overhaul or replace transmission. To remove and install transmission, see **5.1** **c.** Replace valve body. **d.** Check transmission electronics.
11. Vibration when accelerating quickly from a stop	**a.** Driveshaft vibration **b.** Faulty clutch	**a.** See **DRIVESHAFT AND FINAL DRIVE** **b.** Overhaul or replace transmission. To remove and install transmission, see **5.1**
12. Vibration or slipping when accelerating in **R**	**a.** Internal transmission fault	**a.** Overhaul or replace transmission. To remove and install transmission, see **5.1**
13. Car cannot be started in **N** or **P**	**a.** Faulty transmission switch	**a.** Replace transmission switch. See **ELECTRICAL SYSTEM**
14. No upshift into 2nd, 3rd or 4th gear	**a.** Governor bushing seized **b.** Valve body faulty **c.** Transmission electronics faulty (4 HP 22 EH only) **d.** Valve body solenoids faulty (4 HP 22 EH only)	**a.** Replace governor. **b.** Replace valve body. **c.** Check transmission electronics. **d.** Repair or replace valve body.
15. Upshift delayed in all gears	**a.** ATF level low **b.** Transmission accelerator cable misadjusted **c.** Valve body contaminated or plugged **d.** Internal pressure valves sticking or faulty **e.** Transmission electronics faulty (4 HP 22 EH only)	**a.** Check and correct ATF level. See **LUBRICATION AND MAINTENANCE** **b.** Adjust cable. **4.2** **c.** Remove valve body and clean or replace. **d.** Overhaul or replace transmission. To remove and install transmission, see **5.1** **e.** Check transmission electronics.
16. Downshift delayed or no downshift	**a.** Transmission accelerator cable misadjusted **b.** Governor dirty **c.** Shift valves sticking **d.** Clutches slipping **e.** Transmission electronics faulty (4 HP 22 EH only) **f.** Valve body solenoids faulty (4 HP 22 EH only)	**a.** Adjust cable. **4.2** **b.** Remove governor and clean or replace. **c.** Remove valve body and clean or replace. **d.** Overhaul or replace transmission. To remove and install transmission, see **5.1** **e.** Check transmission electronics. **f.** Repair or replace valve body.

3.2 Diagnostic Tests

Although most internal transmission problems cannot be fully diagnosed unless the unit is removed and disassembled, these tests may help further diagnose transmission trouble prior to its removal. To obtain accurate test results, the ATF must be clean, in good condition (not previously overheated or burnt), and at the proper level.

Stall Speed Test

This test is used to check for faults in the torque converter and planetary gear system when there is no other apparent cause for poor performance and acceleration. The test results are meaningless if the engine is not running properly. A precise tachometer must be used for the rpm measurements, as dashboard instruments are not sufficiently accurate.

CAUTION —

The stall speed test should be as short as possible, and should never extend beyond 10 seconds maximum. Prolonging the test may overheat the transmission and damage the seals or internal components.

To test:

1. Drive the car to warm the engine and transmission to normal operating temperature.

2. Connect a tachometer according to the instrument manufacturer's instructions, so that it can be read from the driver's seat, then start the engine.

3. Set the parking brake and depress the foot brake firmly to hold the car stationary.

4. Select the transmission drive range. On 3 HP 22 transmissions, place the selector lever in R or 1. On 4 HP 22 H/EH transmissions, place the selector lever in D.

5. While holding the car stationary with the brakes, floor the accelerator for no more than 10 seconds. Note the tachometer readings.

NOTE —

- Engine rpm should increase, and then hold steady. Maximum rpm achieved during this test is the stall speed. See **Table c** for stall speed specifications.

- It is normal for the stall speed to be 125 rpm lower than specified for each 1000 meters (3200 ft.) above sea level. High ambient air temperature will also cause a slight drop in stall speed.

Table c. Automatic Transmission Stall Speed Specifications

Transmission	Model	Converter code	Stall speed (rpm)
3 HP 22 H	All	P	1970–2070
4 HP 22 H	318i	U4	1980–2220
	325, 325e(es) (through 1987)	R2	1900–2050
	325i, 325i Convertible (through 1987)	W2	2210–2420
	325e (1988-1990)	C7	1900–2100
	325i, 325i Convertible (1988-1990)	W2	2200–2400
4 HP 22 EH	325, 325i, 325i Convertible	R2	2210–2420

Stall speed that is below the specified range by a few hundred rpm is probably due to reduced engine performance. Stall speed that is below the specified range by 400 rpm or more indicates a faulty torque converter stator or ATF pump. Check the pump pressure as described below.

Stall speed above the specified range is caused either by low ATF level, or by slippage in the hydraulic or one-way clutches.

Pressure Tests

A main pressure test will reveal internal leaks, sticking control valves, or other troubles in the hydraulic controls. The pressure gauge should have a range of at least 0 to 20 bar (0 to 300 psi), and a hose long enough to allow it to be read from the passenger compartment. Engine idle speed must be correctly adjusted.

The main pressure tap is shown in Fig. 3-1. Because the location of the tap makes it difficult to fit a thick tester hose, an additional thin extension pipe, bent at a right angle and with pressure fittings on either end, may be needed between the tap and the pressure tester hose. The test procedures are slightly different for the 3 HP 22 and 4 HP 22 transmissions.

To test (3 HP 22 transmissions only):

1. Remove the main pressure tap plug and connect the pressure gauge to the transmission. Route the hose so that the gauge can be read from inside the car.

2. Drive the car to warm the engine and transmission to normal operating temperature. Stop the car and firmly set the parking brake and block the wheels.

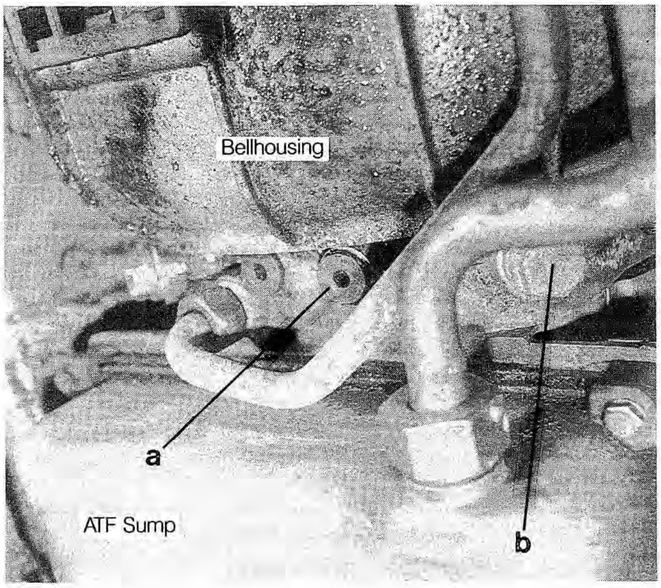

Fig. 3-1. Main pressure tap on transmission case for 3 HP 22 transmissions (**a**), and 4 HP 22 transmissions (**b**). Tap is located below torque converter bellhousing.

3. Disconnect the transmission accelerator cable from the throttle lever. See Fig. 3-2. Set engine idle speed at 1500 rpm.

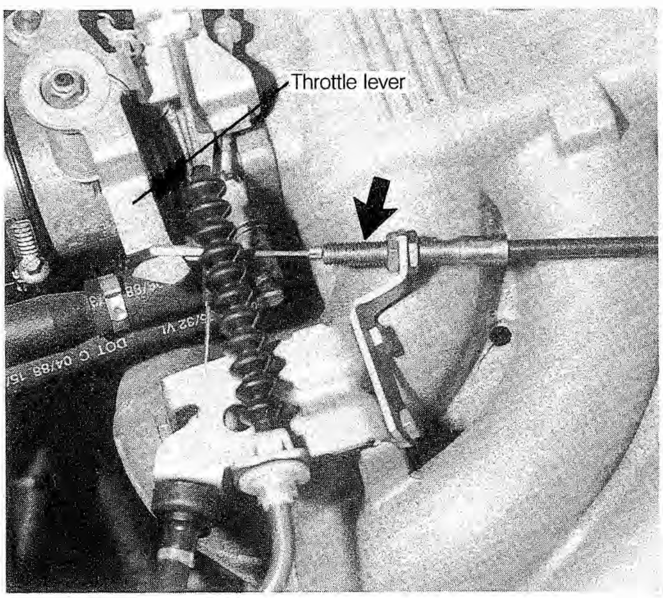

Fig. 3-2. Transmission accelerator cable (**arrow**).

4. With the selector lever in **R**, the pressure should be 12.5 to 14.5 bar (180 to 210 psi). When the transmission accelerator cable is pulled fully out to the kickdown position, the pressure should increase to 16.5 to 18.3 bar (240 to 265 psi). Release the transmission accelerator cable when done.

5. Move the selector lever to any of the other drive ranges, including **P**. The pressure should now be 5.5 to 6.4 bar (80 to 93 psi). When the transmission accelerator cable is pulled fully out to the kickdown position, the pressure should increase to 7.2 to 8.0 bar (104 to 116 psi).

6. Stop the engine.

7. Reconnect the transmission cable to the throttle lever, and adjust it as described in **4.2 External Transmission Adjustments**. Torque the plug for the pressure tap to 40 to 46 Nm (30 to 34 ft. lb.).

To test (4 HP 22 transmissions only):

1. Remove the main pressure tap plug and connect the pressure gauge to the transmission. Route the hose so that the gauge can be read from inside the car.

2. Drive the car to warm the engine and transmission to normal operating temperature. Stop the car and firmly set the parking brake.

3. With the selector lever in **D**, let the engine idle. Pressure should be 6.0 to 7.5 bar (87 to 109 psi). Shift the transmission into **R**. Pressure should increase to 11 to 13 bar (160 to 189 psi).

4. Shift back to **D** and road test the car. At approximately 4000 rpm and in any gear range from **2** to **4**, pressure should be 4.6 to 5.8 bar (67 to 84 psi).

5. When finished, stop the engine, remove the gauge and torque the pressure tap plug to 40 to 46 Nm (30 to 34 ft. lb.).

Pressure that is higher or lower than specification usually indicates a malfunctioning valve body and valves, probably due to contamination. The valve body can be removed, cleaned, and reinstalled with the transmission in place by removing the ATF sump and filter screen.

CAUTION —

The valve body contains many precision parts which must be reassembled in their exact locations. Because of the complexity of the valve body assembly, we recommend that these repairs be left to an authorized BMW dealer or other qualified repair shop.

Low pressure may also indicate a worn ATF pump or internal ATF pump leaks past seals, gaskets, and metal mating surfaces. These repairs require that the transmission be removed and disassembled.

4. CONTROLS

The automatic transmission controls include the selector lever, the selector lever linkage, and the transmission accelerator cable. The selector lever and linkage allows the transmission to be manually shifted from inside the passenger compartment. The transmission accelerator cable makes the transmission responsive to throttle position.

The selector lever linkage activates the manual valve on the transmission. When the lever is moved out of park, the parking pawl is released and the manual valve is correctly positioned according to the gear selected.

The transmission accelerator cable is shown in Fig. 4-1. It modifies transmission shift points based on engine load. The cable connects the throttle operating lever to the transmission. Inside the transmission, the cable is connected to a cam on the valve body. Movement of the accelerator pedal and throttle lever also moves the transmission accelerator cable. This changes pressures in the valve body to adjust shift points.

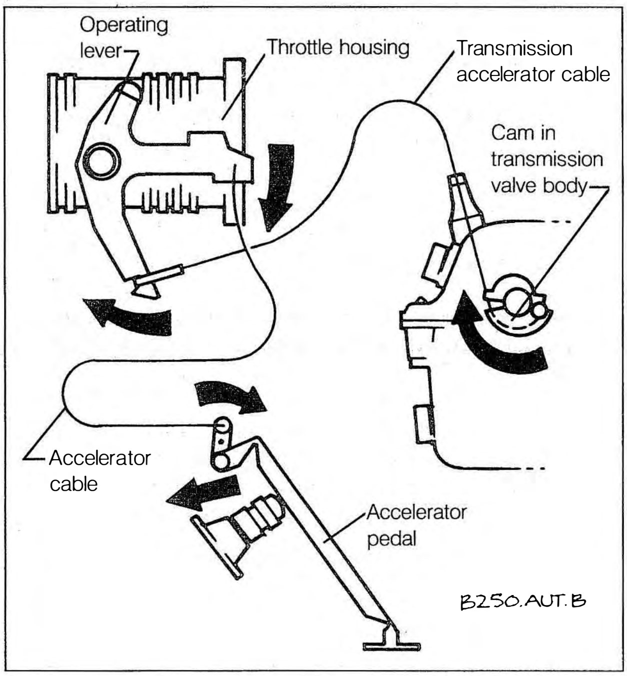

Fig. 4-1. Accelerator cable and transmission accelerator cable layout. Arrows show movement of operating lever and transmission cable when accelerator pedal is depressed.

On all except 4 HP 22 EH transmissions, the transmission accelerator cable also activates the transmission kickdown feature when the accelerator pedal is depressed to the kickdown position.

On 4 HP 22 EH transmissions, kickdown is activated by a switch underneath the accelerator pedal. Adjustment of the kickdown switch is covered in **FUEL SYSTEM**.

The transmission accelerator cable is easily adjusted. Repacement, however, requires removal of the valve body. Because of the complexity of the valve body assembly, we recommend that replacement of the cable be left to an authorized BMW dealer or other qualified repair shop.

4.1 Removing and Installing Selector Lever and Linkage

The selector lever linkage and related parts are shown in Fig. 4-2. The neutral/park/reverse light switch prevents the car from starting when the selector lever is in gear. The switch also actuates the reverse lights when the selector lever is in reverse. For information on testing the switch, see **ELECTRICAL SYSTEM**.

To remove selector lever:

1. Disconnect the selector rod from the bottom of the lower selector lever. See Fig. 4-3. On some models, it may be necessary to remove the exhaust system and heat shield to reach the linkage.

2. At the shift console inside the car, remove the console trim. Pry out the console plate, and then remove the screws that hold the trim to the console. See Fig. 4-4.

3. Remove the shift lever assembly by disconnecting the electrical switch and removing the hex-head screws holding the lever assembly to the frame. See Fig. 4-5.

4. When reassembling the selector lever assembly, make sure that the sound insulator is between the assembly and the transmission tunnel, and adjust the linkage as described in **4.2 External Transmission Adjustments**.

If the lever is removed from the manual valve on the transmission, torque the nut to 8 to 10 Nm (6 to 7 ft. lb.) when reinstalling the lever. On 3 HP 22 transmissions, make sure the selector rod is installed in the correct hole as shown in Fig. 4-6.

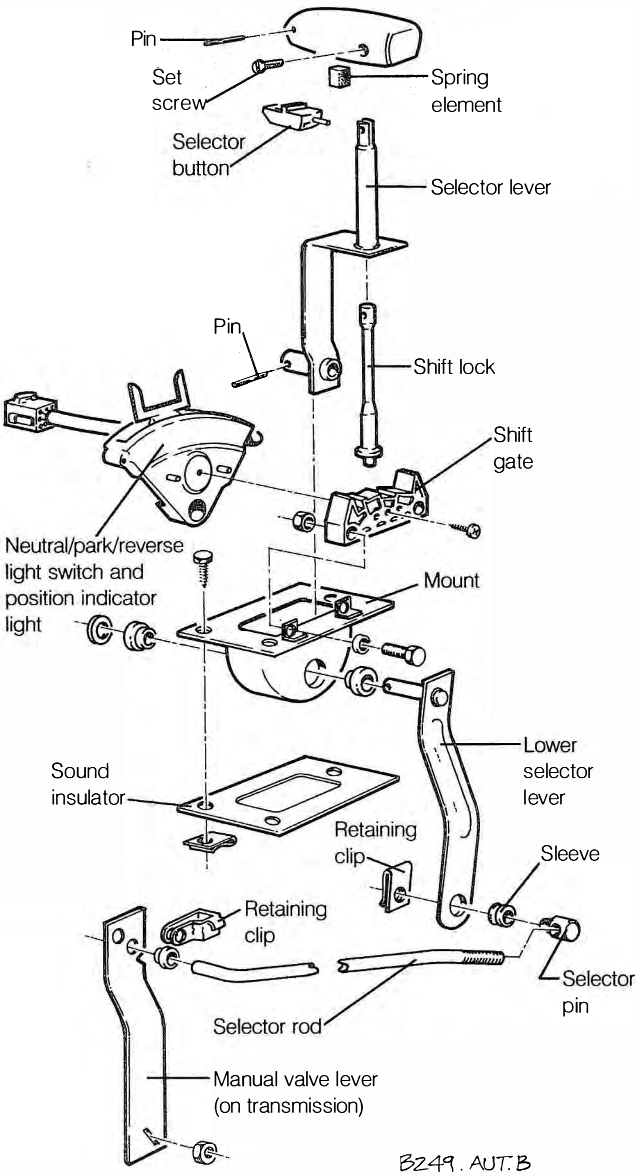

Fig. 4-2. Exploded view of automatic transmission selector lever and linkage.

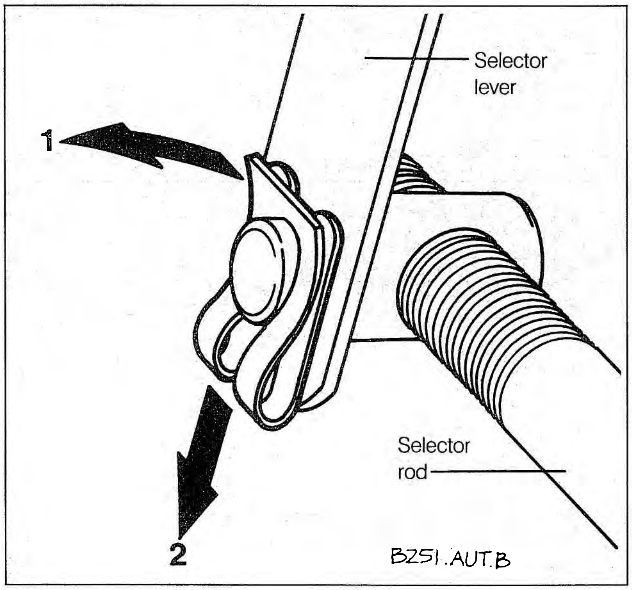

Fig. 4-3. Selector rod being disconnected from bottom of lower selector lever. Lift tab of retaining clip (direction **1**) and slide clip off (direction **2**).

Fig. 4-4. Console trim mounting screws (**arrows**).

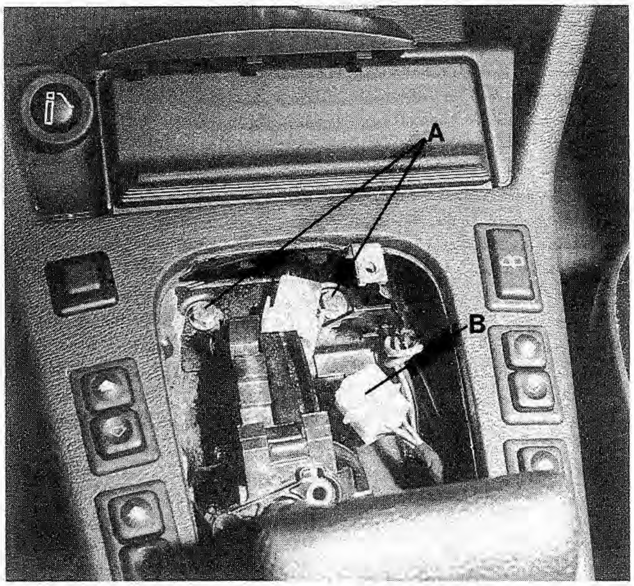

Fig. 4-5. Selector lever assembly showing screws (**A**) and wiring harness (**B**).

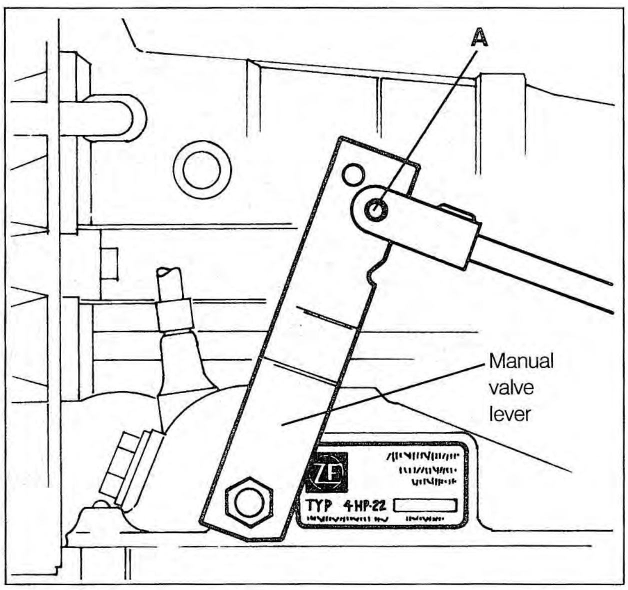

Fig. 4-6. Manual lever for 3 HP 22 transmissions. Selector rod should be installed in hole **A**.

4.2 External Transmission Adjustments

External adjustments to the automatic transmission include adjustments of the selector linkage and the transmission accelerator cable. A helper will be required to hold the accelerator pedal at full throttle while the cable adjustment is made.

Adjusting Selector Lever Linkage

This external adjustment may correct imprecise shifting without the need for removal of the transmission or costly overhaul work. On some models, it may be necessary to remove the exhaust assembly and heat shield to reach the bottom of the selector lever.

To adjust:

1. Remove the selector rod from the bottom of the selector lever by removing the retaining clip shown in Fig. 4-3 above and pulling out the selector pin.

2. Pull the manual valve lever on the transmission all the way to the rear, then push it forward two clicks. The transmission should now be in **N**.

3. In the passenger compartment, move the selector lever to **N**, and then push it forward against the Neutral position stop in the shift gate.

4. While holding the selector lever against the gate, turn the selector pin on the selector rod until the pin lines up with the hole on the lower selector lever. Then shorten the linkage by turning the pin an additional one to two turns clockwise.

> ***CAUTION —***
> *Because of a new shift gate beginning with the 1985 models, the pin should be turned only one turn to shorten the linkage.*

5. Reinstall the selector pin and check that the linkage is correctly adjusted by starting the engine and moving the selector lever through all shift positions.

Adjusting Transmission Accelerator Cable and Kickdown

Proper throttle control and transmission operation depend on accurate adjustment of the accelerator cable. Before performing the adjustment, make sure the full-throttle adjustment for the accelerator cable and throttle linkage is correct, as described in **FUEL SYSTEM**.

To adjust:

1. With the throttle at idle position, use a feeler gauge to check the distance between the lead seal and the end of the cable sleeve, as shown in Fig. 4-7. **Table d** gives the correct specification. If the distance is incorrect, loosen the locknuts and adjust the position of the cable sleeve, then tighten the nuts.

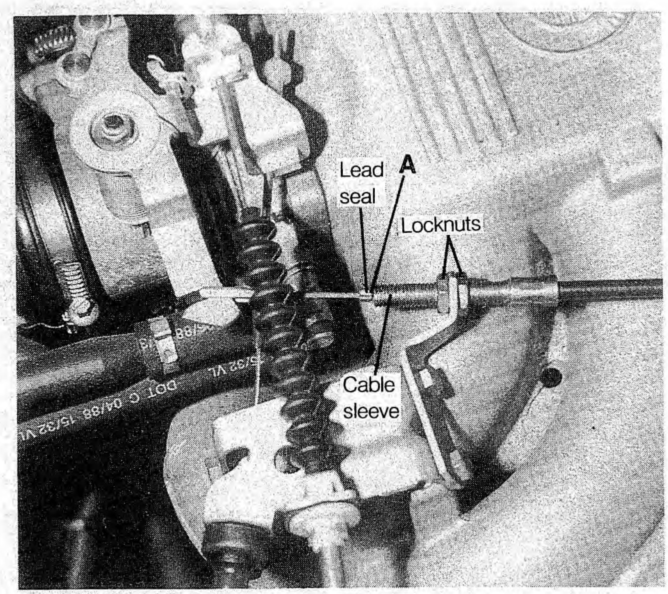

Fig. 4-7. Transmission accelerator cable adjustment point. Check distance **A** at idle and at kickdown position. Six-cylinder shown. Four-cylinder models are similar.

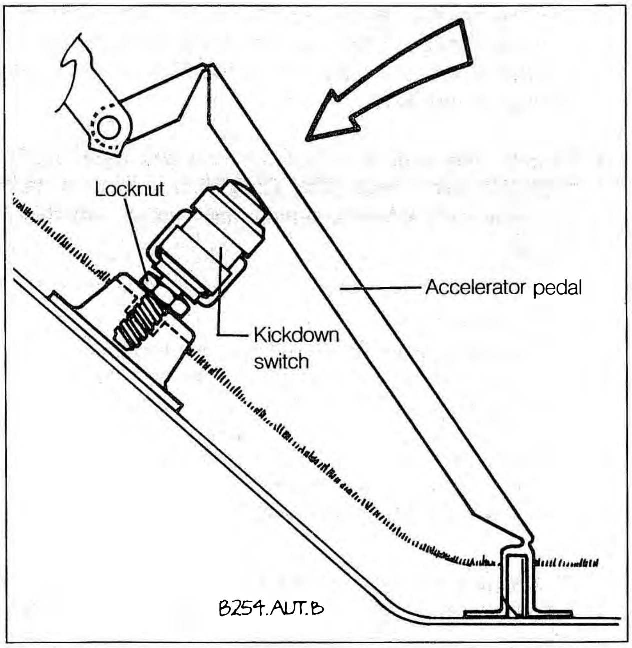

Fig. 4-8. Kickdown switch and accelerator pedal.

Table d. Transmission Accelerator Cable Adjustment Specifications

Measured between lead seal on cable and end of cable housing	
at idle	0.50±0.25 mm (.020±.010 in.)
with accelerator pedal at kickdown position	at least 44 mm (1.5 in.)

2. Working under the accelerator pedal, loosen the kickdown switch locknut, shown in Fig. 4-8 and screw the kickdown switch in.

3. Depress the accelerator just until the point where transmission resistance is felt. Hold the pedal in this position and screw out the kickdown switch so that it just contacts the pedal. Then tighten the locknut.

4. Check the adjustment by depressing the accelerator pedal to the kickdown position and noting the position of the lead seal. The correct specification is listed in **Table d** above.

> **NOTE**
> If the transmission accelerator cable cannot be adjusted to the correct specification, check the full-throttle adjustment of the throttle. Adjust it if necessary, then recheck the transmission accelerator cable adjustment.

5. TRANSMISSION ASSEMBLY

Repair of internal transmission components requires that the transmission be removed for disassembly. Remanufactured transmissions are available through authorized BMW dealers, and these offer some savings over the purchase of a new unit.

To correct fluid leaks, the output shaft seal and the manual valve seal are replaceable with the transmission installed in the car. The transmission must be removed to replace the torque converter seal.

5.1 Removing and Installing Automatic Transmission

Using this procedure, the transmission assembly is separated from the engine, supported on a floor jack, and taken out from below. Removal of the transmission requires a transmission jack or a floor jack with transmission adaptor, and jack stands to support the car. Use extreme caution when working beneath the car and lowering the transmission.

To remove:

1. Disconnect the negative (−) and positive (+) battery cables from the battery, in that order.

2. Disconnect the transmission accelerator cable from its bracket on the intake manifold and then remove it from the throttle operating lever. Refer to Fig. 4-7 above.

3. On 318i models, remove the protective cap and distributor cap from the distributor. This will prevent damage to the distributor when the engine tilts back as the transmission is removed.

4. Remove the exhaust system as described in **EXHAUST SYSTEM AND EMISSION CONTROLS**. Also remove the heat shield from the transmission tunnel, where applicable.

NOTE

It is possible to disconnect only the exhaust downpipe from the exhaust manifold, and the exhaust hanger from the transmission support, and to then push the exhaust assembly to the side and out of the way. The transmission removal procedure is somewhat easier, though, if the exhaust is removed completely.

5. Disconnect the selector rod from the bottom of the lower selector lever as described in **4.1 Removing and Installing Selector Lever and Linkage**.

6. Remove the driveshaft as described in **DRIVESHAFT AND FINAL DRIVE**. Leave the flexible coupling attached to the driveshaft.

7. Drain the transmission by removing the ATF sump drain plug, then remove the ATF filler tube and ATF cooler lines shown in Fig. 5-1. Plug the holes to prevent dirt from entering the transmission.

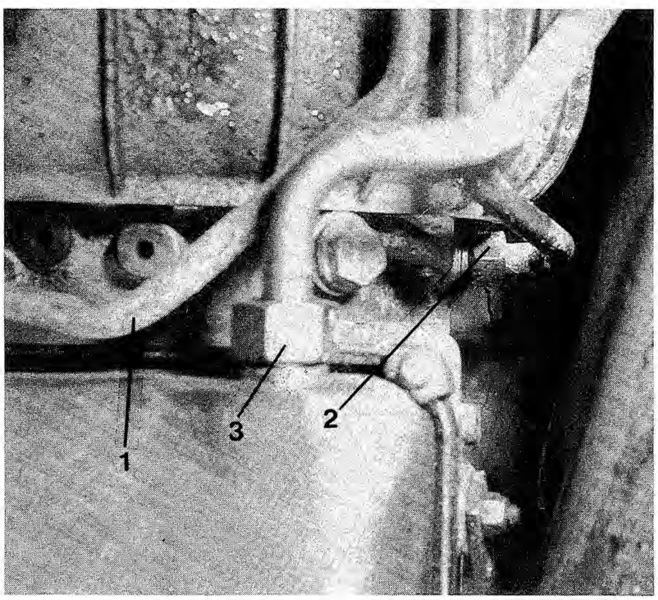

Fig. 5-1. ATF cooler lines for 4 HP 22 transmissions are at **1** and **2**. ATF filler tube is at **3**. Cooler lines on 3HP22 transmission are similar.

8. Remove the reinforcement plate and transmission bump stop at the bottom of the bellhousing as shown in Fig. 5-2.

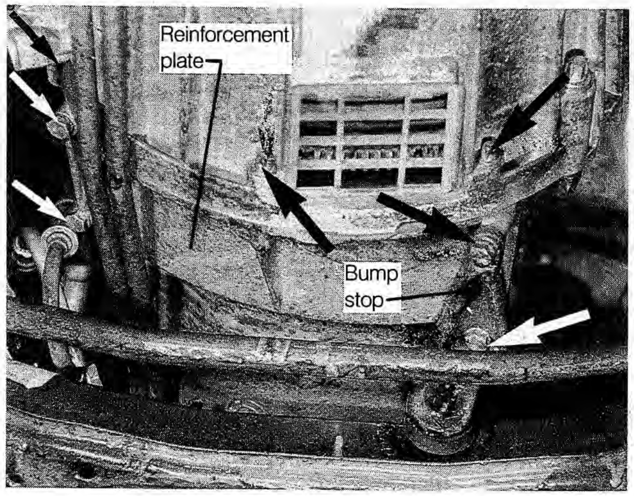

Fig. 5-2. Transmission reinforcement plate and bump stop, showing bolts to be removed (**arrows**).

9. Working through the opening in the bellhousing, remove the bolts that hold the torque converter to the drive plate. See Fig. 5-3.

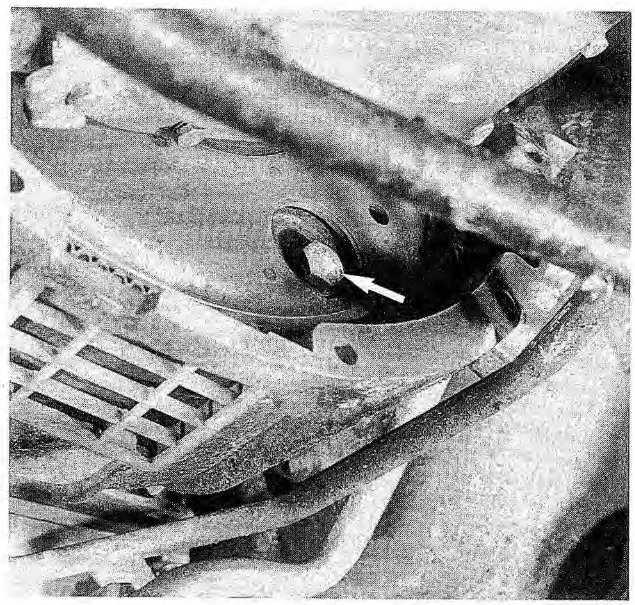

Fig. 5-3. Torque converter mounting bolt (**arrow**). Rotate torque converter for access to all bolts.

NOTE —

- Use a socket wrench on the crankshaft vibration damper and turn the crankshaft clockwise to move the bolts into position for removal.
- On 3 HP 22 transmissions there are four bolts. On 4 HP 22 transmissions there are three bolts.

10. On cars with the Motronic engine rpm sensor and the reference sensor mounted in the bellhousing, remove the sensors as described in **IGNITION**.

11. On cars with 4 HP 22 EH transmission, disconnect the control unit plug from the left side of the transmission, just above the ATF sump.

12. Support the transmission from below. Remove the rear transmission support and, where applicable, the reinforcement bar, by removing the bolts that hold them to the body. See Fig. 5-4. Lower the engine and transmission onto the front axle carrier.

CAUTION —

At no time should the weight of the transmission be supported by the torque converter shaft. Such a load will damage the torque converter or transmission.

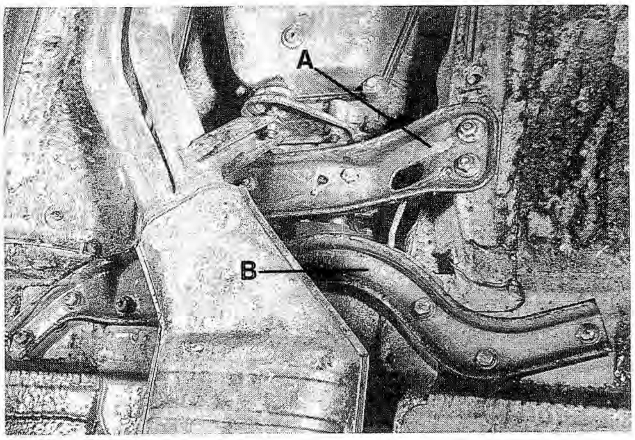

Fig. 5-4. Rear transmission support (**A**) and reinforcement bar (**B**) to be removed.

13. Remove the bolts that hold the transmission bellhousing to the engine.

14. Remove the inspection grill from the side of the bellhousing for access to the torque converter. While using a lever to make sure that the torque converter stays firmly mounted to the transmission, pull the transmission off of the engine. See Fig. 5-5.

WARNING —

Make sure the car is stable and well supported at all times during the removal procedure. Use jack stands which are designed for the purpose. A floor jack alone is not adequate support.

NOTE —

If the engine drive plate is cracked, it must be replaced. Use only new stretch bolts when installing the new drive plate, and coat them with thread lock. Torque M 12 bolts to 113 to 130 NM (82-94 ft. lb.).

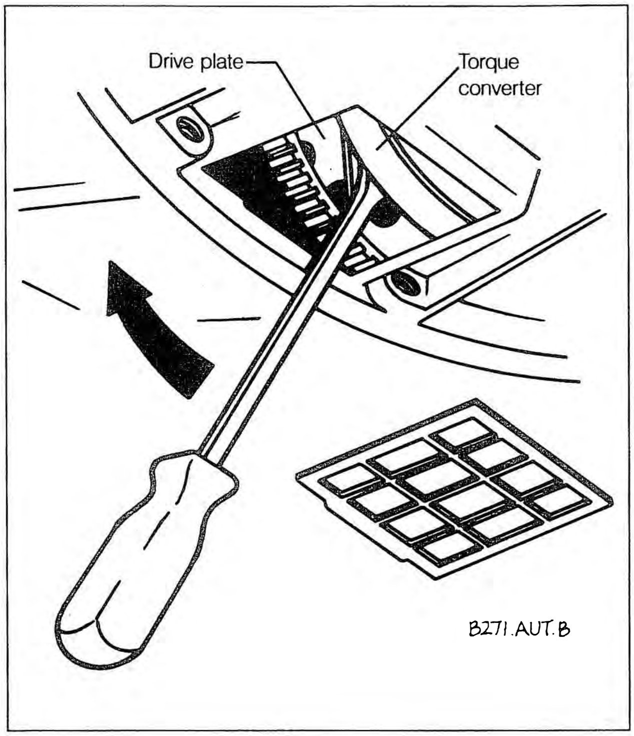

Fig. 5-5. Torque converter being held against transmission. Use screwdriver or lever to apply pressure in direction of arrow as transmission is pulled off of engine.

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Installation is the reverse of removal. To avoid serious damage when installing the transmission, make certain the torque converter has not slipped off of its support. The forward edge of the torque converter should be below the edge of the bellhousing. Turn the converter back and forth to check that it has engaged its splines.

Use a new gasket on the ATF sump drain plug, and a new O-ring on the ATF filler tube connection to the ATF sump. Adjust the transmission accelerator cable and selector lever linkage as described above in **4.2 External Transmission Adjustments**. Fastener torque specifications are listed in **Table e**.

CAUTION —

- *When installing a new or rebuilt transmission, the ATF cooler and lines must be blown clean with compressed air and then thoroughly flushed twice with clean ATF. This will clean out any dirt or friction lining particles that could clog the passages of the new transmission.*
- *Refill the transmission with ATF as described in* **LUBRICATION AND MAINTENANCE** *before starting the engine or moving the car.*
- *Do not reuse drained ATF.*

NOTE —

- Torx® bolts must be used with washers. Bolts without washers may increase the effort needed to remove them.
- When reconnecting the control unit plug on 4 HP 22 EH transmissions, make sure that the marking lines are aligned.

Table e. Transmission Installation Torque Specifications

Bolt	Torque
Transmission to engine (hex-head)	M 8: 24 Nm (18 ft. lb.)
	M 10: 45 Nm (33 ft. lb.)
	M 12: 78–86 Nm (58–63 ft. lb.)
Transmission to engine (Torx®-head) . . .	M 8: 21 Nm (15 ft. lb.)
	M 12: 72 Nm (53 ft. lb.)
Rear transmission support (to body) . . .	22–24 Nm (16–18 ft. lb.)
Torque converter to drive plate . . .	M 8: 25–27 Nm (18–20 ft. lb.)
	M 10: 47–51 Nm (35–38 ft. lb.)
Transmission reinforcement plate	22–24 Nm (16–18 ft. lb.)
ATF cooler lines to transmission case. . .	$35\ ^{+3}_{-0}$ Nm ($26\ ^{+2}_{-0}$ ft. lb.)
ATF filler tube to ATF sump	
3 HP 22	100–115 Nm (74–85 ft. lb.)
4 HP 22 H/EH	98 Nm (72 ft. lb.)
ATF sump drain plug.	M 10: 15–17 Nm (11–13 ft. lb.)

5.2 Seals

Three seals in the transmission are potential areas for ATF leaks. The first is the torque converter seal around the torque converter shaft. ATF leaking from this seal will usually be seen at the bottom of the bellhousing. The second seal is for the manual valve. ATF leaks here will be seen at the side of the transmission case and on the side of the ATF sump. The third seal is for the transmission output shaft, and ATF leaking here will drip down onto the extension housing.

All of the seals can be replaced without extensive disassembly of the transmission. However, it is necessary to remove the transmission to replace the torque converter seal. See **5.1 Removing and Installing Automatic Transmission**. It is also necessary to disconnect the driveshaft from the transmission to replace the output shaft seal. See **DRIVESHAFT AND FINAL DRIVE**.

Torque Converter Seal

A leaking torque converter seal is often caused by a worn bushing in the torque converter hub. The bushing should always be checked when the seal is replaced. A worn bushing will promote rapid wear of the new seal.

Fig. 5-6 shows the bearing surface that should be checked. Remove sharp edges and burrs with fine emery cloth. If the hub is deeply scored, the torque converter should be replaced.

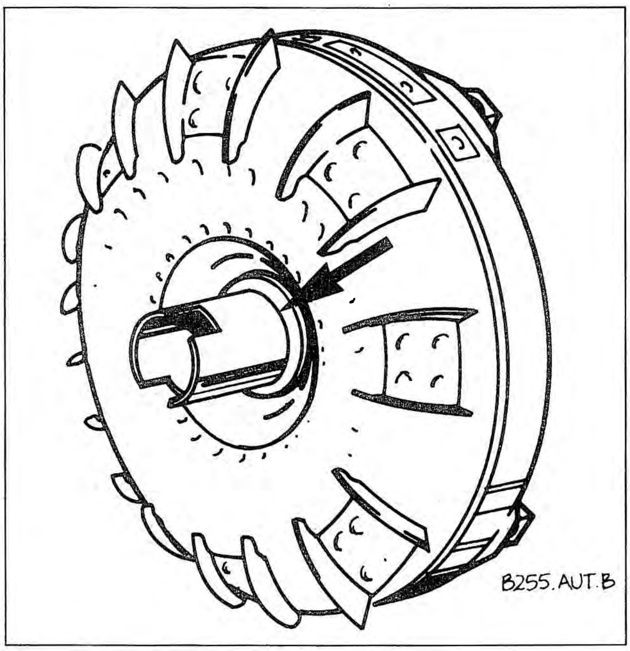

Fig. 5-6. Torque converter removed from engine showing bearing surface (**arrow**) that should be checked for scoring or wear.

To replace the seal, pull the converter off of its mounting on the transmission. To facilitate removal, install two long bolts halfway into the converter mounting holes and pull evenly on both of the bolts. Using a hooked seal tool or screwdriver, pry the old seal out of the transmission case. Lubricate the new seal with ATF and drive it into position.

CAUTION —
Be careful not to mar the surface of the housing when removing the seal.

Output Shaft Seal

The output shaft seal can be replaced without removing the transmission from the car, but a thin-walled 30 mm deep-well socket will be needed to remove the output flange collar nut. Also, installation of the collar nut requires a new lockplate, and application of a sealant to prevent transmission fluid leakage. BMW specifies Curil K2, which should be available from your BMW dealer. If Curil K2 is not available, a silicone dielectric compound can be used instead.

To replace the output shaft seal, bend back the locking tab on the lockplate, shown in Fig. 5-7. Hold the output flange stationary and remove the collar nut, then use a puller to pull off the flange. Pry the old seal out of the transmission, lubricate the new seal with ATF, and drive it into place.

When installing the collar nut, coat the side that presses against the output flange with the sealer and torque the nut to 100 Nm (74 ft. lb.). Install the new lockplate and bend the tab into the slot.

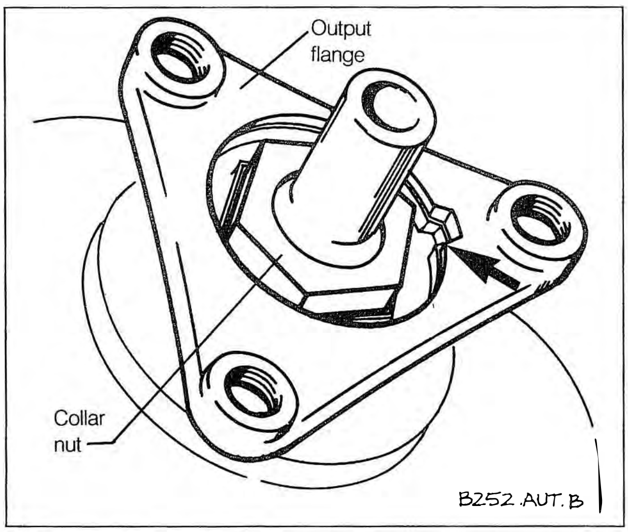

Fig. 5-7. Locking tab for output flange collar nut (**arrow**). Bend tab out of groove to remove nut.

CAUTION —
Be careful not to mar the surface of the housing when removing the seal.

Manual Valve Seal

To replace the manual valve seal, remove the manual valve lever from the transmission, shown in Fig. 5-8. Pry out the old seal using a small screwdriver or hooked tool. Lubricate the new seal with ATF, and drive it into place.

When installing the manual lever, torque the nut to 8 to 10 Nm (6 to 7 ft. lb.). If the linkage was not disconnected from the manual valve lever, it should not be necessary to adjust the shift linkage.

CAUTION —
Be careful not to mar the surface of the housing when removing the seal.

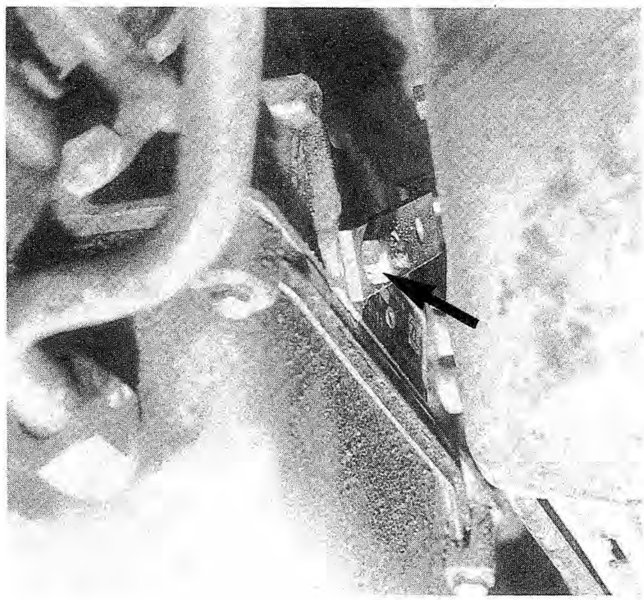

Fig. 5-8. Manual valve lever and nut on transmission to be removed for replacement of seal.

6. TECHNICAL DATA

I. Automatic Transmission Test Data

Stall speed specifications			
Transmission	Model	Converter code	Stall speed (rpm)
3 HP 22	All	P	1970–2070
4 HP 22 H	318i 325, 325e(es) (through 1987) 325i, 325i Convertible (through 1987) 325e (1988-1990) 325i, 325i Convertible (1988-1990)	U4 R2 W2 C7 W2	1980–2220 1900–2050 2210–2420 1900–2100 2200–2400
4 HP 22 EH	325, 325i, 325i Convertible	R2	2210–2420

Main pressures		
3 HP 22	Transmission accelerator cable pulled out to kickdown position in **R**	16.5 to 18.3 bar (240 to 265 psi)
	At 1500 rpm, all other drive ranges except in **R**	5.5 to 6.4 bar (80 to 93 psi)
	Transmission accelerator cable pulled fully out to kickdown position in all other drive ranges except **R**	7.2 to 8.0 bar (104 to 116 psi)
4 HP 22	At idle, in **D**	6.0 to 7.5 bar (87 to 109 psi)
	At idle, in **R**	11 to 13 bar (160 to 189 psi)
	At 4000 rpm, on road, in any gear from **2** to **4**	4.6 to 5.8 bar (67 to 84 psi)

II. Torque Specifications

Bolt	Torque
Transmission to engine (hex-head)	M 8: 24 Nm (18 ft. lb.) M 10: 45 Nm (33 ft. lb.) : 78–86 Nm (58–63 ft. lb.)
Transmission to engine (Torx®-head)	M 8: 21 Nm (15 ft. lb.) M 12: 72 Nm (53 ft. lb.)
Rear transmission support (to body)	22–24 Nm (16–18 ft. lb.)
Rear transmission support (to transmission)	43–48 Nm (32–35 ft. lb.)
Torque converter to drive plate	M 8: 25–27 Nm (18–20 ft. lb.) M 10: 47–51 Nm (35–38 ft. lb.)
Transmission reinforcement plate	22–24 Nm (16–18 ft. lb.)
ATF cooler lines to transmission case	35^{+3}_{-0} Nm (26^{+2}_{-0} ft. lb.)
ATF filler tube to ATF sump 3 HP 22 4 HP 22 H/EH	 100–115 Nm (74–85 ft. lb.) 98 Nm (72 ft. lb.)
ATF sump drain plug	M 10: 15–17 Nm (11–13 ft. lb.)
Output flange collar nut	100 Nm (74 ft. lb.)
Pressure tap plug	40–46 Nm (30–34 ft. lb.).
Manual valve lever to transmission	8–10 Nm (6–7 ft. lb.)
Drive plate to flywheel M 12	 113–130 Nm (82–94 ft. lb.)

III. Automatic Transmission Specifications.

Model	318i	318i	325 325e(es)	325	325i, Convertible	325i, Convertible
Type	3 HP 22	4 HP 22 H	4 HP 22 H	4 HP 22 EH	4 HP 22 EH	4 HP 22 H
Code letters	RX	UC, XX VM,XS	AB, TY, XG,AB,AT	AR	AP	AC,GA
Torque converter code	P	U4	C7, R2	R2	R2	W2
Gear ratios						
1st gear	2.73	2.73	2.48	2.48	2.48	2.48
2nd gear	1.56	1.56	1.48	1.48	1.48	1.48
3rd gear	1.0	1.0	1.0	1.0	1.0	1.0
4th gear	N/A	0.73	0.73	0.73	0.73	0.73
Reverse	2.09	2.09	2.09	2.09	2.09	2.09

Section 11

DRIVESHAFT AND FINAL DRIVE

Contents

11

Driveshaft and Final Drive

Introduction

The driveshaft transmits power from the engine and transmission to the final drive. From the final drive, power is transmitted through the drive axles and constant velocity joints to the drive wheels.

While the driveshaft and final drive are very durable, the driveshaft flexible coupling will eventually wear and require replacement. Service and repair of drive axles is covered in **SUSPENSION AND STEERING**. Repairs to the rear wheel bearings are also covered in **SUSPENSION AND STEERING**. Repairs to the rear brakes are covered in **BRAKES**.

Repairs to the internal parts of the final drive require special tools and knowledge, and are beyond the scope of this manual. If you lack the skills, the tools, or a suitable workplace for servicing the final drive, we suggest you leave these repairs to an authorized BMW dealer or other qualified shop.

If internal final drive repairs are necessary, it may be possible to save some of the expense of professional repair by removing and installing the unit yourself, using the procedures described in this section. It is important to realize, however, that a partially disassembled final drive unit may be a problem for a mechanic. We strongly advise against taking the unit apart to perform any repair you cannot properly finish.

1. GENERAL DESCRIPTION

Fig. 1-1 shows the driveshaft and final drive removed from the car. Together, the two are often referred to as the driveline. The installed position of the driveshaft and final drive in relation to the rear axle carrier and rear suspension is shown in **SUSPENSION AND STEERING**.

1.1 Driveshaft

The driveshaft is made of two sections that are joined by a sliding, splined coupling. This coupling compensates for the slight front-and-back movement of the engine and transmission. A clamping sleeve at the coupling compresses a bushing on the splined shaft of the driveshaft to seal out moisture and dirt.

The rear of the driveshaft is solidly bolted to the final drive. The front is connected to the transmission by a flexible rubber coupling. The coupling—sometimes known as the guibo or flex-disc—isolates the driveshaft and final drive from the sudden torque forces of the engine. On some models, a vibration damper is mounted between the flexible coupling and the transmission output flange.

The middle of the driveshaft is supported by the center bearing. The bearing is rubber mounted to isolate driveshaft vibrations. The bearing housing is bolted to the car body.

The front of the driveshaft is aligned with the transmission by a centering guide. The guide is recessed into the front of the driveshaft. It engages a centering pin on the transmission output flange when the driveshaft is installed. Universal joints on the front and rear sections compensate for differences in the installed angle of the driveshaft as it rotates.

1.2 Final Drive

The final drive consists of the drive pinion, the ring gear, the differential, and the output flanges. The drive pinion is also known as the final drive input shaft. It is connected to the driveshaft by the input flange, and drives the ring gear. Together, the drive pinion and ring gear are known as the crown wheel set.

The differential is bolted to the ring gear and drives the rear wheels through the output flanges and drive axles. The differential also allows the rear wheels to turn at different speeds, as is necessary when making turns (the outside wheel must travel farther than the inside wheel in the same amount of time). The final drive assembly is bolted to the rear axle carrier, and is connected to the car body by flexible rubber bushings.

Limited-Slip Differential

Some models are equipped with a limited-slip differential in the final drive. In a limited-slip differential the two output flanges are connected by a number of clutch plates. The plates create

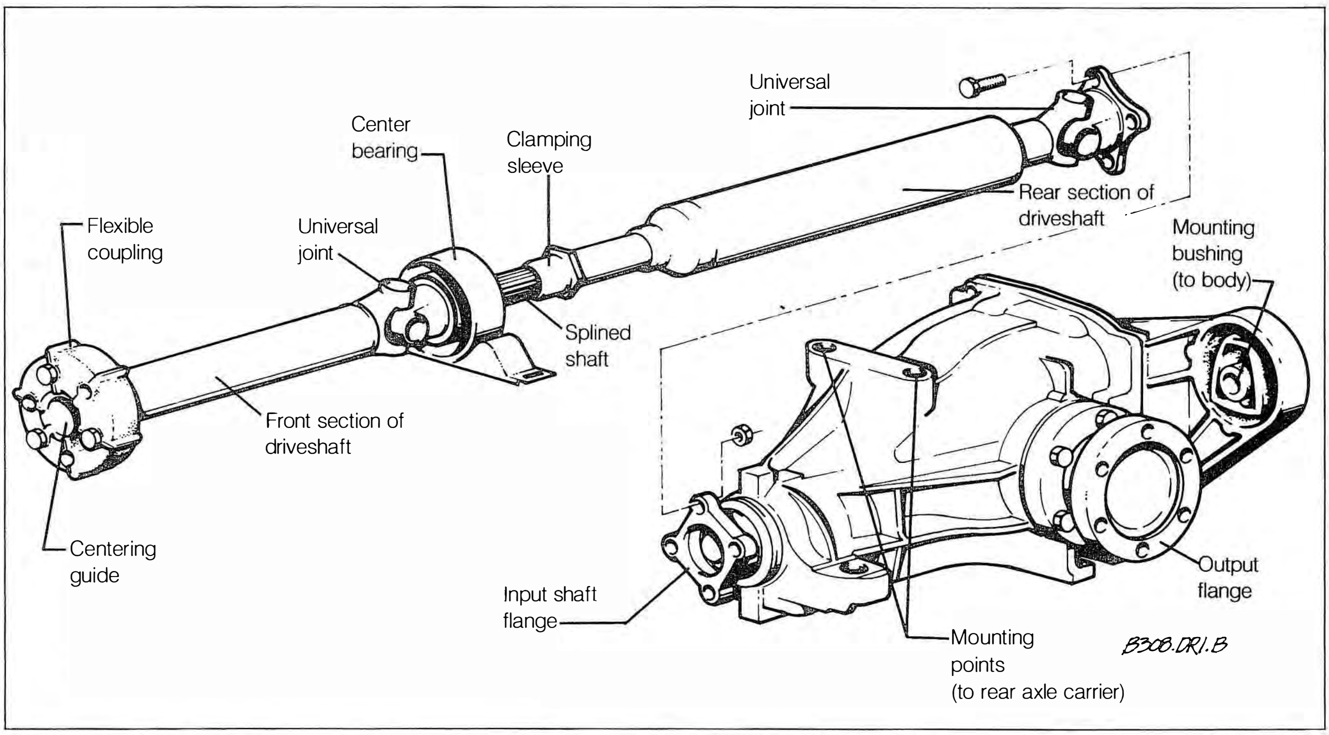

Fig. 1-1. Driveshaft and final drive assemblies.

a solid connection so that both wheels are always driven, even if one is slipping. In cornering, when the rear wheels move at different speeds, the clutch plates allow a limited amount of slip between the rotational speed of the two axles.

> **NOTE** —
> Limited-slip differentials and non-slip differentials may require different lubricating oils. For more information on differential lubrication requirements, see **LUBRICATION AND MAINTENANCE**.

1.3 Applications—Identifying Features

Final drives are identified by a code that gives drive ratio and manufacturing number. The code is stamped on a metal tag attached to the final drive. See Fig. 1-2. The code on the tag depends on whether the final drive is the original one installed in the car or whether it is a replacement final drive.

For original final drives, the code gives the drive ratio first and then the manufacturing number. So code **3.45 4002** identifies an original equipment final drive with a ratio of 3.45:1. Limited-slip new final drives are identified with the prefix **S** (S 3.45 4002).

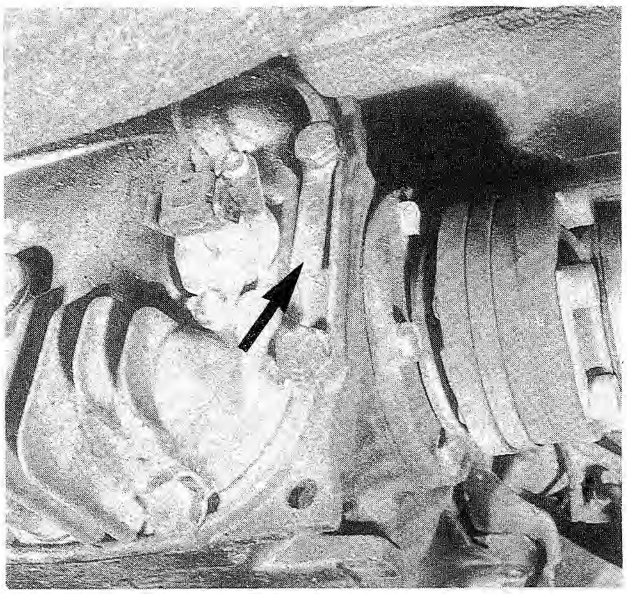

Fig. 1-2. Final drive showing location of identification tag (arrow).

For replacement final drives, the code also has the drive ratio and manufacturing number. However, the ratio is given indirectly, by the number of teeth on the ring and pinion. For example, **11 38 A 405** is an exchange final drive with a ratio of 3.45:1 (38 ring teeth divided by 11 pinion teeth). The **A** is an additional indicator that it is a replacement final drive. Limited-slip replacement final drives are identified by the suffix **S** (11 38 A 405 S).

2. MAINTENANCE

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of the final drive. Information on performing these maintenance steps, and on the prescribed maintenance intervals, can be found in **LUBRICATION AND MAINTENANCE**.

1. Checking final drive oil level

2. Changing final drive oil

3. TROUBLESHOOTING

This troubleshooting section applies to problems affecting the driveshaft and final drive. The basic function of these components is to smoothly transmit engine power to the drive axles and rear wheels.

The source of driveline vibrations and noise can be difficult to pinpoint. Engine, transmission, rear axle, or wheel vibrations can be transmitted through the driveshaft to the car body. Noises from the rear of the car may be caused by final drive problems, or by faulty wheel bearings or constant velocity (CV) joints. Also check that the tires are correctly inflated and are not excessively worn.

To isolate a vibration or noise problem, speed up the engine in the stopped car to the rpm range where the problem occurs. This eliminates the influence of the rotating driveshaft and will help indicate if the problem is caused by an engine condition.

Drive the car at the speed where the problem occurs, then shift to different gear ranges to see if the problem changes with road-speed or engine-speed. Road-speed dependent problems indicate trouble in the driveline.

Detach the axle shafts at the final drive and then operate the engine at the speed and gear/selector-lever position where the problem occurs. If the problem disappears, then it may be in the CV joints or wheel bearings.

> **NOTE** —
> No-load tests with the car stopped or the drive axles disconnected will only give a general idea of the car's performance under the load of normal operation.

For more information on troubleshooting engine or transmission problems, see **ENGINE, MANUAL TRANSMISSION** or **AUTOMATIC TRANSMISSION.** For information on troubleshooting rear axle, wheel bearing or constant velocity joint problems, see **SUSPENSION AND STEERING**.

3.1 Basic Troubleshooting Principles

Smooth operation of the driveshaft and final drive depends on the condition of the rubber isolation components and center bearing, the lubricant level in the final drive, and properly tightened fasteners. Any symptom of vibration or noise may be caused by worn or damaged driveline components.

Aside from inspection for worn or broken parts, troubleshooting should also consider the installed angle of the driveshaft. Also check the splined coupling for free movement. See **4.1 Driveshaft Noise and Vibration** for more information.

Table a lists symptoms of driveshaft and final drive problems and their probable causes, and suggests corrective actions. The numbers in bold type in the corrective action column refer to headings in this section where the repairs are described.

Table a. Driveshaft and Final Drive Troubleshooting

Symptom	Probable cause	Corrective action
1. Vibration when moving off (forward or reverse)	**a.** Center bearing rubber deteriorated or torn	**a.** Inspect center bearing. Replace if necessary. **4.4**
	b. Flexible coupling damaged or worn	**b.** Inspect flexible coupling. Replace if necessary. **4.3**
	c. Engine or transmission mounts faulty	**c.** Inspect engine and transmission mounts. Align or replace, if necessary
	d. Front centering guide worn, or driveshaft mounting flanges out of round	**d.** Check front centering guide and replace if necessary. **4.5** Check runout of driveshaft flanges. **4.1**
	e. Universal joints worn or seized	**e.** Check universal joint play and movement. **4.1**. Replace driveshaft if necessary. **4.2**
	f. Sliding coupling seized	**f.** Remove driveshaft and check movement of sliding coupling. Clean coupling splines or replace parts as necessary. **4.2**
	g. Driveshaft misaligned	**g.** Check driveshaft alignment. **4.1**
2. Vibration at 25 to 30 mph (40 to 50 km/h)	**a.** Front centering guide worn, or driveshaft mounting flanges out of round or damaged	**a.** Check front centering guide and replace if necessary. **4.5** Check runout of driveshaft flanges. **4.1**
	b. Universal joints worn or seized	**b.** Check universal joint play and movement. **4.1**. Replace driveshaft if necessary. **4.2**
	c. Flexible coupling damaged or worn	**c.** Inspect flexible coupling. Replace if necessary. **4.3**
	d. Center bearing rubber deteriorated or torn	**d.** Inspect center bearing. Replace if necessary. **4.4**
	e. Sliding coupling seized	**e.** Remove driveshaft and check movement of sliding coupling. Clean coupling splines or replace parts as necessary. **4.2**
	f. Driveshaft misaligned	**f.** Check driveshaft alignment. **4.1**
3. Vibration, audible rumble over 35 mph (60 km/h)	**a.** Front centering guide worn, or driveshaft mounting flanges out of round or damaged	**a.** Check front centering guide and replace if necessary. **4.5** Check runout of driveshaft mounting flanges. **4.1**
	b. Mounting flange bolts loose or holes worn	**b.** Remove driveshaft and check transmission output flange and final drive input flange. Replace if necessary. **4.1**
	c. Driveshaft unbalanced	**c.** Check driveshaft for loose or missing balance plates. Have driveshaft rebalanced or replace if necessary. **4.1**
	d. Universal joints worn or seized	**d.** Check universal joint play and movement. **4.1**. Replace driveshaft if necessary. **4.2**

continued on next page

Table a. Driveshaft and Final Drive Troubleshooting (continued)

Symptom	Probable cause	Corrective action
3. Vibration, audible rumble over 35 mph (60 km/h) (cont'd)	**e.** Sliding coupling seized	**e.** Remove driveshaft and check movement of sliding coupling. Clean coupling splines or replace parts as necessary. **4.2**
	f. Incorrect preload of center bearing	**f.** Check preload of center bearing. Readjust if necessary. **4.2**
	g. Center bearing faulty	**g.** Replace center bearing. **4.4**
	h. Final drive rubber mount faulty	**h.** Inspect final drive rubber mount and replace if necessary. **5.2**
	i. Driveshaft misaligned	**i.** Check driveshaft alignment. **4.1**
4. Noise during on/off throttle or when engaging clutch	**a.** Internal final drive fault	**a.** Remove final drive and repair. **5.1**
	b. Drive axle or CV joint faulty	**b.** Inspect drive axles and CV joints. Repair or replace as necessary. See **SUSPENSION AND STEERING**
	c. Sliding coupling seized	**c.** Remove driveshaft and check movement of sliding coupling. Clean coupling splines or replace parts as necessary. **4.2**
5. Rattling, clicking or groaning	**a.** Universal joints worn or seized	**a.** Check universal joint play and movement. **4.1**. Replace driveshaft if necessary. **4.2**
	b. Final drive lubricant level low	**b.** Check for final drive leaks. Replace oil seals as necessary. **5.3** Check and correct gear oil level if needed. See **LUBRICATION AND MAINTENANCE**
	c. Faulty CV joint or wheel bearing	**c.** Inspect CV joints and wheel bearings. Replace as necessary. See **SUSPENSION AND STEERING**
	d. Loose flexible coupling mounting bolts	**d.** Inspect flexible coupling and tighten bolts as necessary. **4.3**
6. Grinding noise when turning corner	**a.** Faulty wheel bearing	**a.** Inspect wheel bearings, replace as necessary. See **SUSPENSION AND STEERING**
	b. Limited-slip differential faulty	**b.** Remove final drive and repair. **5.1**
7. Continual drumming or humming noise from rear end (goes away when accelerator pedal is released)	**a.** Final drive components worn or damaged (pinion-to-ring-gear clearance)	**a.** Remove final drive and repair. **5.1**

4. DRIVESHAFT

Most components of the driveshaft are easily replaced once the driveshaft is removed from the car. Repair kits for the universal joints may be available, but it is not common practice to repair the universal joints on BMW driveshafts, and there are no BMW-recommended repair procedures. Worn or damaged universal joints usually require replacement of that section of the driveshaft.

The driveshaft is balanced to very close tolerances. Whenever it is to be removed or disassembled, the mounting flanges and driveshaft sections should be marked with paint or a punch before proceeding with work. This will ensure that the driveshaft can be reassembled or installed in exactly the same orientation.

4.1 Driveshaft Noise and Vibration

The causes of driveshaft noise and vibration can be difficult to pinpoint, and frustrating. When troubleshooting driveshaft problems, begin with a close visual inspection. Check the driveshaft for broken or missing balance weights. The weights are welded to the driveshaft, so broken welds will indicate where a weight may have fallen off.

Check the torque of the fasteners at the flange connections, check the rubber of the flexible coupling and center bearing for deterioration or tearing, and check that the preload for the center bearing is correct. See **4.2 Removing and Installing Driveshaft** for more information.

Check the universal joints for play. With the driveshaft installed, pull and twist the driveshaft while watching the joint. The BMW specification for play as listed in **table b** is very small, so almost any noticeable play could indicate a problem.

Table b. Universal Joint Specification

Maximum allowable play	0.15 mm (.006 in.)

Further inspection requires removal of the driveshaft. Check the front centering guide for correct installation as described in **4.5 Replacing Front Centering Guide**. Also check runout at the transmission output flange and centering pin, and at the final drive input flange. Specifications are listed in **Table c**.

Table c. Driveshaft Flange Runout Specifications

Axial play	
transmission output flange	0.10 mm (.004 in.) maximum
Radial play	
transmission output flange	0.07 mm (.003 in.) maximum
final drive input flange (measured at driveshaft centering lip)	0.07 mm (.003 in.) maximum

Check for smooth operation of the center bearing. There should be slight resistance, but no binding or grittiness. Check that the splines of the sliding coupling are properly lubricated and free from corrosion. Retorque the clamping sleeve to the proper torque as described in **4.2 Removing and Installing Driveshaft** and check that the coupling slides freely. If it doesn't, clean the splines and lubricate them with molybdenum disulfide grease (Molykote Longterm 2 or equivalent). Replace the clamping bushing if necessary, then recheck movement.

Check that the universal joints move freely without binding. If they are difficult to move or feel gritty, the driveshaft may have to be replaced.

NOTE —
With the driveshaft installed, the actual amount that the universal-joints can pivot is limited. Check universal-joints only in their normal range of movement (as with the driveshaft installed).

If inspection reveals nothing wrong with the driveshaft, it may need to be rebalanced. This can be done by any repair shop with the right equipment. Also, check the alignment of the driveshaft as described below.

NOTE —
Minor driveshaft vibrations can often be corrected simply by disconnecting the driveshaft at the final drive, and repositioning the driveshaft 90°, 180° or 270° in relation to the final drive input flange.

Aligning Driveshaft

The alignment of the driveshaft does not normally need to be checked unless the engine/transmission or the final drive have been removed and installed. If, however, all other parts of the driveshaft have been inspected and found to be okay, but there is still noise or vibration, it's probably a good idea to check driveshaft alignment.

There are two important driveshaft alignment checks. The first is to make sure that the driveshaft runs straight from the transmission to the final drive, without any variation from side-to-side. Any unevenness is caused by the engine/transmission being uncentered in its mounts. You can make a basic alignment check by sighting along the driveshaft from back to front. Any misalignment will be apparent from the center bearing forward. To adjust the side-to-side alignment, loosen the transmission or engine mounts as necessary to reposition them, then retighten the mounts. The driveshaft is centered when it is positioned as shown in Fig. 4-1.

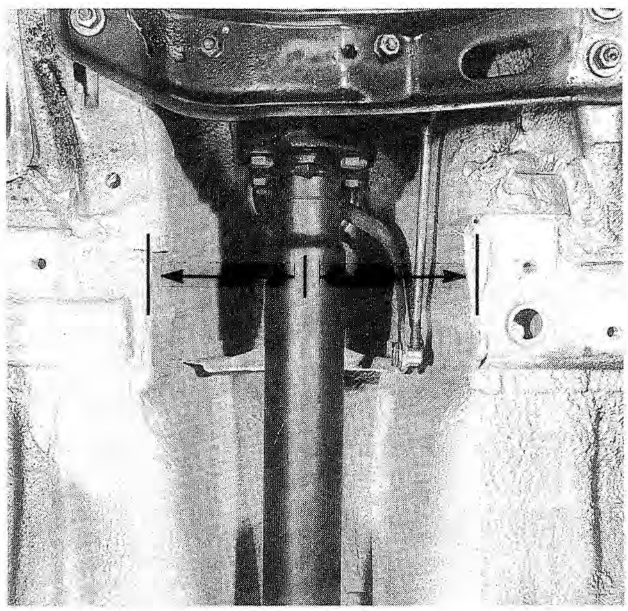

Fig. 4-1. Driveshaft side-to-side alignment. Driveshaft should be centered between the edges of the driveshaft tunnel as shown.

The second important driveshaft alignment check is more complicated. It checks the amount the driveshaft is angled vertically at the joints. This angle is known as driveshaft deflection.

In general, there should be little deflection at the flexible coupling and the universal joints. More precise checks require the use of a large protractor or some other means of measuring the angle. The angle of the front and rear driveshaft sections are compared to the transmission and final drive to compute the amount of driveshaft deflection. To change the angle, shims are placed between the center bearing and the body or between the transmission and its rear support. When using shims to change a deflection angle, keep in mind that the angle of adjacent joints will also change. Deflection angles should be as small as possible. **Table d** lists the correct specifications.

> **CAUTION —**
> *The maximum allowable change in height of the center bearing or transmission support using shims is 3 mm (.118 in.).*

4.2 Removing and Installing Driveshaft

The driveshaft must be removed for complete inspection, for replacement of worn or broken driveshaft components, or when removing other components such as the engine or transmission. On models with an additional vibration damper, the damper is removed along with the driveshaft and flexible coupling.

The procedure below describes the complete removal of the driveshaft from the car. It is possible to disconnect only one end of the driveshaft and leave the other end connected, for instance when removing the transmission, but the center bearing must always be unbolted and the driveshaft securely supported. To prevent damage to the driveshaft and to make working under the car easier, the publisher recommends always removing the complete driveshaft.

> **WARNING —**
> *Removal of the driveshaft will disconnect the transmission from the final drive. Do not rely on engagement of the transmission to prevent the car from rolling. Chock all wheels that are on the ground. Use extreme caution when working beneath the car and lowering the driveshaft.*

> **CAUTION —**
> - *Do not let the driveshaft hang unsupported with only one end connected. Damage to the universal joints requiring driveshaft replacement could result. If only one end of the driveshaft is disconnected, use stiff wire to suspend the driveshaft out of the way, in as close to the installed position as possible.*
> - *Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.*

To remove:

1. Remove the exhaust system as described in **EXHAUST SYSTEM AND EMISSION CONTROLS**.

2. Remove the rear reinforcement bar and, where applicable, the exhaust and gas-tank heat shields. See Fig. 4-2.

> **CAUTION —**
> *On some models, one of the reinforcement-bar bolts also secures the holder for the oxygen sensor plug. Take care not to damage the sensor leads.*

3. At the sliding coupling, loosen the clamping sleeve by several turns, but do not remove it. See Fig. 4-3.

4. Using paint or a punch, make matching marks on the driveshaft at the transmission output flange and flexible coupling, and at the final drive input flange so that the driveshaft can be reinstalled in the same position.

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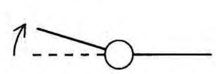
Table d. Driveshaft Deflection Angle Specifications

Deflection angle being checked	4-cylinder		6-cylinder	
	manual transmission	automatic transmission	manual transmission	automatic transmission
Flexible coupling (difference between engine/transmission angle and front driveshaft angle)	−27' to +33'	−25' to +35'	−47' to +13'	−49' to +11'
Center bearing (difference between front driveshaft angle and rear driveshaft angle)	−48' to +12'	−50' to +10'	−1°10' to −10'	−1°8' to −8'
Rear universal joint (difference between rear driveshaft angle and final drive angle)	−10' to +50'	−10' to +50'	−10' to +50'	−10' to +50'



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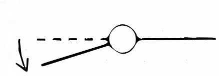

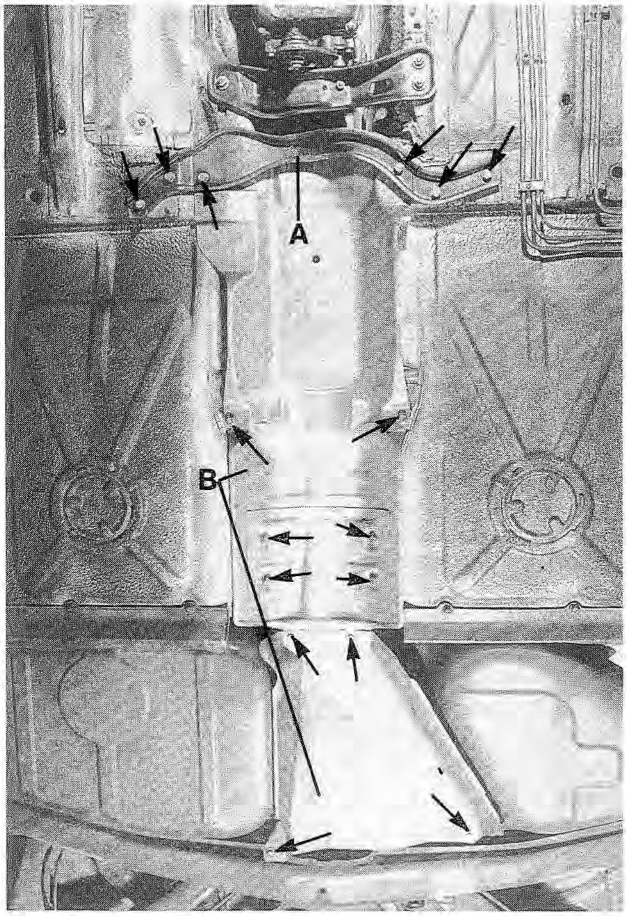

Fig. 4-2. Rear reinforcement bar (**A**) and heat shields (**B**) to be removed after removing bolts (arrows).

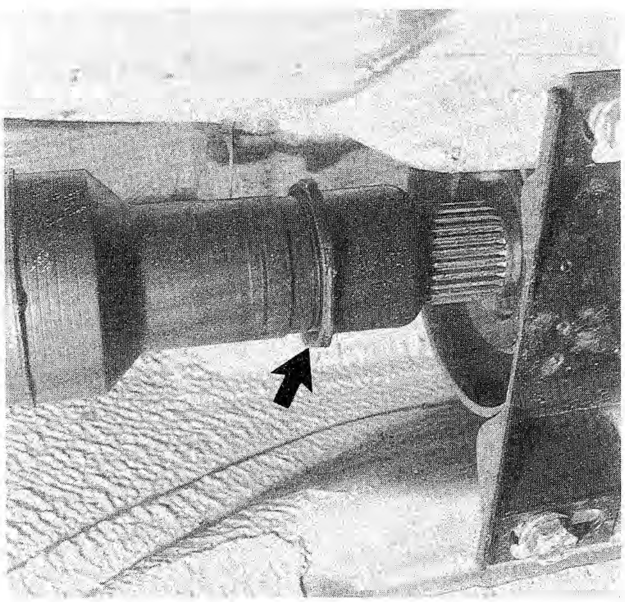

Fig. 4-3. Clamping sleeve for sliding coupling (arrow) to be loosened.

5. Remove the bolts that hold the flexible coupling to the transmission output flange, but do not pull the driveshaft off. See Fig. 4-4.

NOTE —

Removal of the bolts may be made easier by placing a large hose clamp around the flexible coupling, and tightening the clamp slightly to compress the coupling.

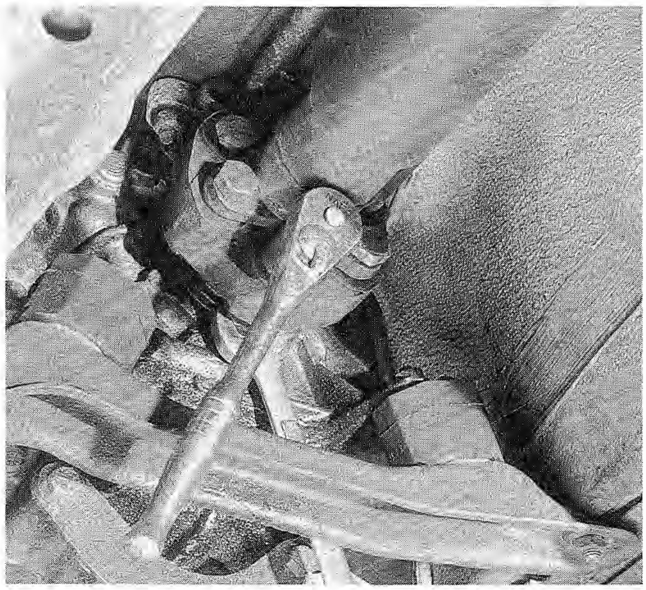

Fig. 4-4. Front driveshaft mounting bolts being removed.

6. Support the driveshaft at the center and remove the center bearing bolts.

7. Remove the bolts that hold the rear driveshaft section to the final drive. See Fig. 4-5.

CAUTION —

Do not let the rear section rest on the fuel tank connection line.

8. Remove the driveshaft. Bend it down at the center bearing, and then pull it off of the centering pin on the transmission output flange. It may be necessary to slide the splined coupling together to make enough room. Do not pull the two sections apart.

NOTE —

On models with a vibration damper, it is necessary to first turn the damper assembly 60° as shown in Fig. 4-6 before pulling it off of the centering pin on the transmission output flange.

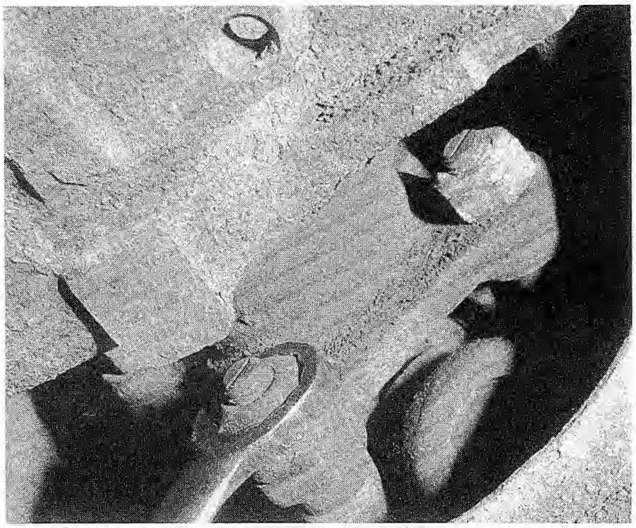

Fig. 4-5. Rear driveshaft mounting bolts being removed.

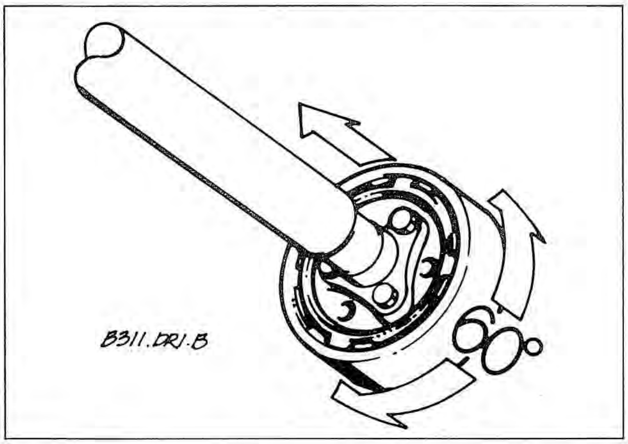

Fig. 4-6. On models with vibration damper, turn damper 60° in either direction before pulling driveshaft off transmission flange.

If the splined coupling is to be cleaned or if the rubber bushing is being replaced, mark the two sections of the driveshaft before pulling the coupling apart. Lubricate the splines with molybdenum disulfide grease (Molykote Longterm 2 or equivalent) before reassembly. If the two sections are pulled apart without the driveshaft being marked, reassemble the splined coupling so that the universal joints are on the same plane as shown in Fig. 4-7. There is still the possibility of the driveshaft being reassembled wrong by 180° and causing vibration. In this case remove the driveshaft, separate the two sections at the splined coupling, turn one section 180°, and reassemble.

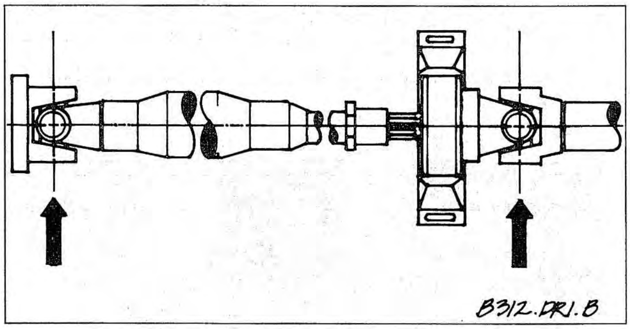

Fig. 4-7. If driveshaft sections are separated, make sure U-joints are on same plane as shown when driveshaft is reassembled.

To install:

1. To protect against corrosion, lightly lubricate the centering pin on the transmission output flange with molybdenum disulfide grease (Molykote Longterm 2 or equivalent).

2. Reinstall the driveshaft by first positioning it against the final drive input flange and then sliding it onto the centering pin. Position the center bearing up against the body and loosely install the mounting bolts but do not tighten them.

3. Using new self-locking nuts, reconnect the rear drive shaft section to the final drive. Align the marks made during removal. Torque the nuts to 72 Nm (53 ft. lb.).

CAUTION

Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

4. Using new self-locking nuts, reconnect the flexible coupling to the transmission. Align the marks made during removal. Torque M 10 8.8-grade bolts and nuts to 46 Nm (34 ft. lb.). Torque M 10 10.9-grade bolts and nuts to 72 Nm (53 ft. lb.). Torque M 12 bolts and nuts to 123 Nm (91 ft. lb.).

CAUTION

Avoid stressing the flexible coupling when torquing the bolts. Do this by holding the bolt steady and turning the nut on the flange side.

NOTE

- Installation of the bolts may be made easier by first placing a large hose clamp around the flexible coupling, and then tightening the clamp slightly to compress the coupling.

- The bolt grade should be marked on the bolt head.

5. Preload the center bearing by moving it forward from its unstressed position 4 to 6 mm (.157 to .236 in.), and then torque the mounting bolts to 22 Nm (16 ft. lb.) See Fig. 4-8.

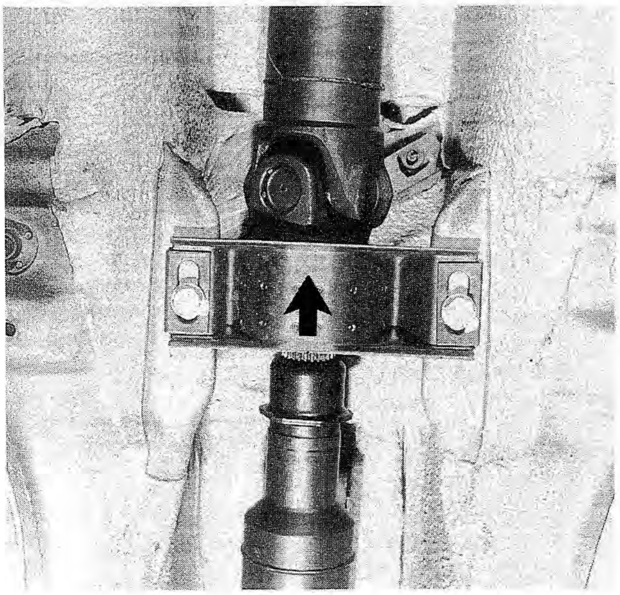

Fig. 4-8. Before tightening bolts, push center bearing towards the front (arrow) to preload it.

6. Tighten the clamping sleeve on the splined coupling and torque it to 17 Nm (13 ft. lb.).

7. Reinstall the heat shields, the reinforcement bar, and the holder for oxygen sensor, where applicable.

8. Reinstall the exhaust system.

4.3 Replacing Flexible Coupling

The flexible coupling between the front section of the driveshaft and the transmission is made of rubber. The coupling is vulnerable to harsh elements and heat under the car, as well as to the twisting torque of the drivetrain. It will eventually deteriorate and should be replaced.

Although BMW specifies no maintenance interval for the flexible coupling it should be inspected regularly, especially whenever the underside of the car is accessible because of other repair or inspection work. Check the coupling for cracks, tears, missing pieces, or distortion. When replacing the flexible coupling, use new self-locking nuts.

To replace:

1. Remove the driveshaft as described above in **4.2 Removing and Installing Driveshaft**.

CAUTION —

It is possible to only partially remove the driveshaft, leaving it connected to the final drive. Use extreme care when using this method. If the driveshaft hangs from the final drive unsupported, the rear universal joint may be damaged. The entire rear driveshaft section will then need to be replaced.

2. Remove the flexible coupling from the driveshaft.

NOTE —

Removal and installation of the bolts may be made easier by placing a large hose clamp around the flexible coupling, and tightening the clamp slightly to compress the coupling.

3. Install the new flexible coupling using new self-locking nuts. If the coupling has arrows on it, they should face the flange arms, as shown in Fig. 4-9. Torque M 10 8.8-grade bolts and nuts to 46 Nm (34 ft. lb.). Torque M 10 10.9-grade bolts and nuts to 72 Nm (53 ft. lb.). Torque M 12 bolts and nuts to 123 Nm (91 ft. lb.).

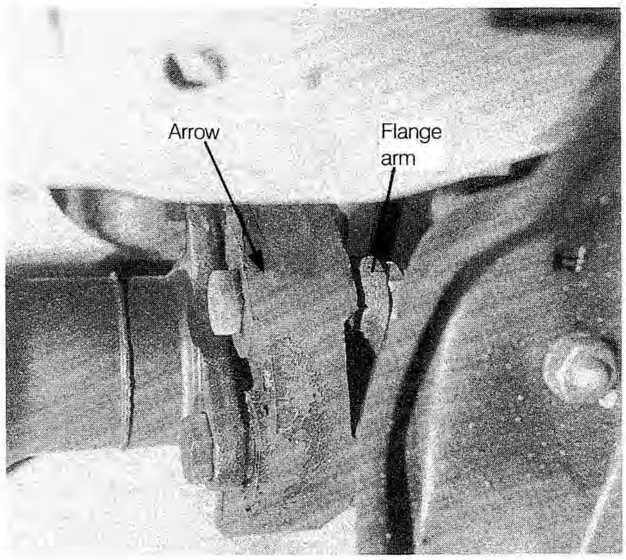

Fig. 4-9. When attaching flexible coupling to driveshaft or to transmission flange, arrows must point toward flange arms as shown.

CAUTION —

- *Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.*

- *Avoid stressing the flexible coupling when torquing the bolts. Do this by holding the bolt steady and turning the nut on the flange side.*

NOTE —

- Remove the hose clamp if one was used during installation or if the flexible coupling came supplied with one.
- The bolt grade should be marked on the bolt head.

4. Reinstall the driveshaft.

4.4 Replacing Center Bearing

The center bearing consists of a grooved ball bearing assembly press-fit in a rubber mount. The bearing assembly is pressed onto the front section of the driveshaft and secured by a circlip. See Fig. 4-10.

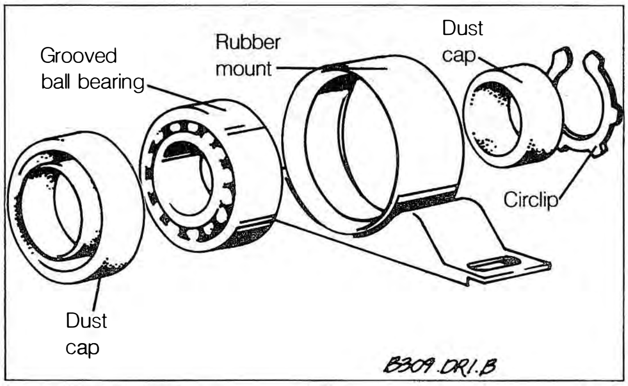

Fig. 4-10. Exploded view of center bearing components.

The center bearing is usually protected by dust caps on either side, but water and dirt may contaminate the bearing and cause it to fail. Driveshaft vibration may also contribute to bearing failure. BMW does not specify any periodic maintenance or lubrication procedures for the center bearing.

To properly inspect the bearing, the driveshaft must be removed from the car. Check the bearing for smooth movement, and check the condition of the mounting rubber. If the bearing is difficult to turn or if there is a gritty feeling, only the bearing needs to be replaced. If the rubber is cracked or deteriorated, the entire assembly should be replaced.

To replace:

1. Remove the driveshaft as described in **4.2 Removing and Installing Driveshaft**.
2. Make matching marks on the front and rear sections of the driveshaft for reassembly as shown in Fig. 4-11.
3. Unscrew the clamping sleeve all the way and then pull the two sections of the driveshaft apart. Remove the rubber bushing, washer, and clamping sleeve from the front section of the driveshaft.

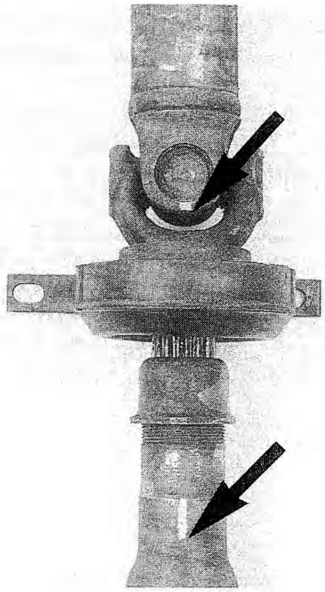

Fig. 4-11. Before pulling apart driveshaft sections, make matching marks as shown.

4. Inspect the condition of the rubber bushing for the splined coupling. It should be replaced if it is cracked or torn.
5. Remove the center bearing circlip, and dust guard if applicable. See Fig. 4-12. Then use a puller to pull the bearing off of the driveshaft.

NOTE —

Install the puller so that it pulls on the inner hub of the bearing. Pulling on the outer ring of the mount may tear the rubber, necessitating replacement of the entire bearing assembly.

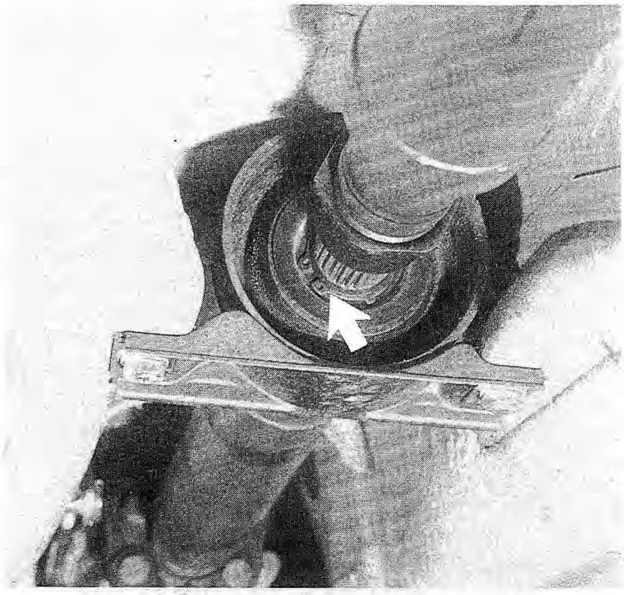

Fig. 4-12. Center bearing circlip (arrow) to be removed. Driveshaft shown installed.

6. If the bearing is being replaced, press it out of the bearing mount and press a new bearing in.

7. Make sure that the dust guard is on the driveshaft, and then press the center mount onto the driveshaft so that it is flush with the dust guard.

8. Place the clamping sleeve, washer, and rubber bushing on the front driveshaft section. Lubricate the splines with molybdenum disulfide grease (Molykote Longterm 2 or equivalent) and then reassemble the driveshaft. Make sure the matching marks align. Do not retighten the clamping sleeve until the driveshaft is installed.

9. Reinstall the driveshaft.

10. Tighten clamping sleeve to 17 Nm (13 ft. lb.).

4.5 Replacing Front Centering Guide

The front centering guide precisely positions the driveshaft in relation to the transmission. The guide is press-fit into a cavity in the front of the driveshaft and slides onto a guide pin on the transmission output flange.

A worn centering guide will allow the front of the driveshaft to wobble and cause vibration. It is necessary to remove the driveshaft to inspect and replace the centering guide. No specifications are given for wear of the guide, but generally the guide should fit snugly on the pin of the transmission output flange.

NOTE —
Some driveshafts have a dust cap installed on the end of the driveshaft, over the centering guide. The dust cap may become bent or distorted when the driveshaft is removed or installed. Damage to the dust cap should not affect the centering guide and should not be mistaken for guide wear.

To replace:

1. Remove the driveshaft as described in **4.2 Removing and Installing Driveshaft**.

2. Pack the cavity behind the centering guide with a heavy grease until the grease is flush with the bottom edge of the guide.

3. Insert a 14 mm (approximately ½ in.) diameter mandrel or metal rod into the guide, then strike it with a hammer. The pressure of the mandrel against the grease should force the centering guide out of the driveshaft.

NOTE —
The mandrel needs to fit snugly in the centering guide so that the grease cannot escape around the sides of the mandrel.

4. Lubricate the new centering guide with molybdenum disulfide grease (Molykote Longterm 2 or equivalent) and then drive it into the driveshaft. The sealing lip of the guide should face outward, and it should protrude from the face of the driveshaft by 4.5 mm (.177 in.) as shown in Fig. 4-13.

5. Reinstall the driveshaft.

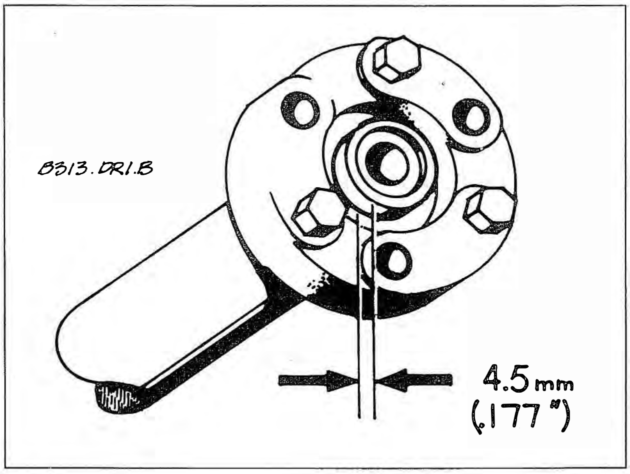

Fig. 4-13. When installing new driveshaft centering guide, check protrusion of guide as shown.

5. FINAL DRIVE

This heading covers removal and installation of the final drive, as well as those repair operations which do not require complicated disassembly of the final drive. Disassembly of the final drive requires special tools and knowledge, and is beyond the scope of this manual.

All final drive work requires some method of raising the car and supporting it securely while the work is performed. Jack stands and a floor jack can easily be used, but use extreme caution when working beneath the car and lowering the final drive. For more information on raising the car see **FUNDAMENTALS**.

5.1 Removing and Installing Final Drive

The final drive is easily removed or installed using ordinary hand tools. New self-locking nuts are required when reattaching the driveshaft and the final drive rubber mounting bushing.

If the final drive is being replaced with a remanufactured unit, the speedometer pulse sender must be removed from the old final drive. The sender is not supplied on replacement final drives. Remanufactured final drives are essentially new, and therefore require break-in. For more information see **LUBRICATION AND MAINTENANCE**.

To remove:

1. Raise the rear of the car and support it securely.

2. Make matching marks on the driveshaft and final drive input flange, and then remove the bolts and nuts that hold the driveshaft to the final drive. Push the driveshaft forward slightly and suspend it from the body with stiff wire.

CAUTION —

- *Do not let the driveshaft hang unsupported from the center bearing. Damage to the center bearing could result. If only one end of the driveshaft is disconnected, use stiff wire to suspend the driveshaft out of the way, in as close to the installed position as possible.*

- *Do not let the driveshaft rest on the fuel tank connection line.*

3. Disconnect the drive axles from the final drive as described in **SUSPENSION AND STEERING**.

CAUTION —

Suspend the detached drive axle from the car body with a stiff wire hook to prevent damage to the outer constant velocity joint.

4. Disconnect the wires for the speedometer pulse sender, as shown in Fig. 5-1.

NOTE —

If the final drive is being replaced, remove the two bolts that hold the speedometer pulse sender, and remove the sender. Using a new O-ring, install the sender on the new final drive. Torque the bolts to 10 Nm (7 ft. lb.).

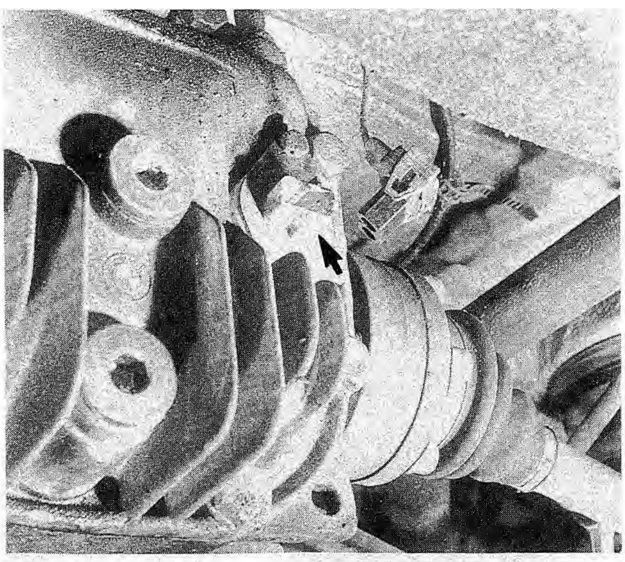

Fig. 5-1. Wires removed from speedometer pulse sender (arrow).

5. Remove the two rearmost final-drive mounting bolts on the top of the rear axle carrier, as shown in Fig. 5-2.

Fig. 5-2. Final drive rear mounting bolt (arrow), on top of rear axle carrier, being removed using box wrench. Also remove rear bolt from other side.

6. Support the final drive with the floor jack, and then remove the two front final drive mounting bolts, as shown in Fig. 5-3.

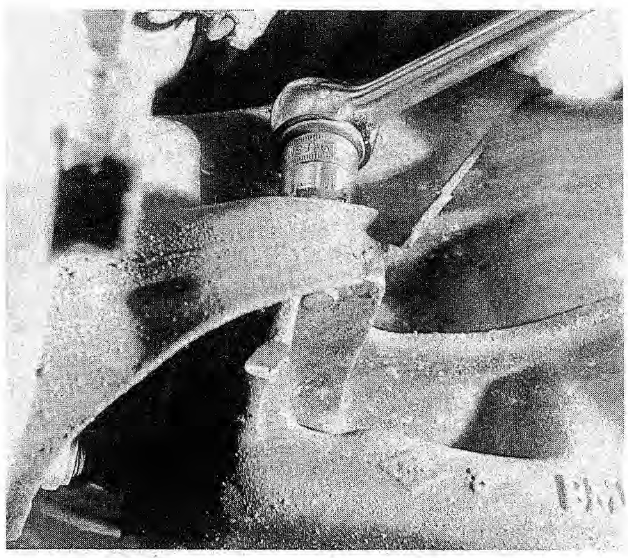

Fig. 5-3. Final drive front mounting bolt being removed. Also remove front bolt from other side.

7. Remove the nut and bolt for the rubber mounting bushing. See Fig. 5-4. Lower the final drive, and remove it from under the car.

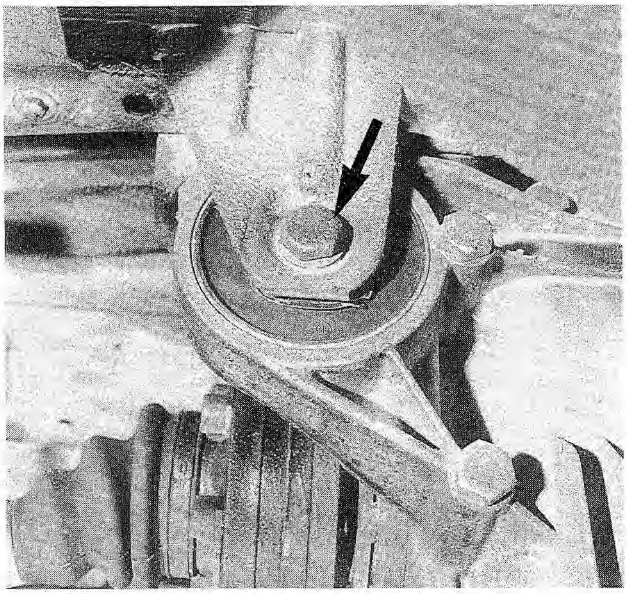

Fig. 5-4. Mounting bolt (arrow) for final drive rubber mounting bushing. Remove nut from other side.

To install:

1. Position the final drive in place against its mounts and loosely install the two rear bolts first. Then install the two front bolts and the bolt for the rubber mounting bushing. Fastener torque specifications are listed in **Table e**.

CAUTION —
Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

2. Reattach the drive axles as described in **SUSPENSION AND STEERING**.

Table e. Final drive mounting bolt torque values

1984–1987	
final drive to rear axle carrier	110–123 Nm (81–91 ft. lb.)
rubber mounting bushing to body (bolt and nut)	80–87 Nm (59–64 ft. lb.)
1988–1990	
final drive to rear axle carrier	80 Nm (59 ft. lb.)
rubber mounting bushing to body (bolt and nut)	87 Nm (64 ft. lb.)

3. Using new self-locking nuts, reconnect the rear driveshaft section to the final drive. Align marks made during removal. Torque the nuts to 72 Nm (53 ft. lb.).

CAUTION —
Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

4. Reconnect the wires for the speedometer pulse sender.

5. Check the final drive oil level and add or fill as necessary. See **LUBRICATION AND MAINTENANCE**.

5.2 Replacing Final Drive Rubber Mounting Bushing

The final drive rubber mounting bushing can be replaced without removing the final drive or the drive axles.

To replace:

1. Remove the wires for the speedometer pulse sender.

2. Support the final drive from below and remove the mounting bolts.

3. Lower the final drive just until the rubber mounting bushing is accessible. Press out the old mounting bushing and press in a new one. Orient the bushing as shown in Fig. 5-5.

NOTE —
- The mounting bushing is eccentric. Make sure the pressing tool works only against the metal sleeve of the bushing.
- Removal of a seized bushing can be made easier by using a hacksaw to cut from the rubber part out through the metal sleeve. Take care not to cut into the final drive cover flange.

4. Raise the final drive up against its mounts and install the two rear bolts first, then install the two front bolts and the bolt for the rubber mounting bushing with new self-locking nut. Fastener torque specifications are listed in **Table e**. See **5.1 Removing and Installing Final Drive**.

CAUTION —
Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

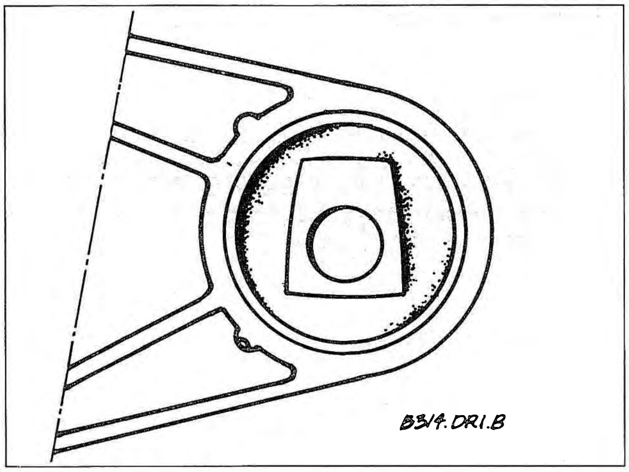

Fig. 5-5. Installed orientation of final drive rubber mounting bushing.

5.3 Replacing Final Drive Oil Seals

Oil leakage due to faulty final drive oil seals may be the cause of problems such as noisy operation or limited-slip chatter. The drive flange oil seals can be replaced while the final drive is installed in the car, but the final drive must be removed as described in **5.1 Removing and Installing Final Drive** to replace the input shaft oil seal. Read the procedure to determine what other new parts are required before beginning repairs.

To replace drive flange oil seals:

1. Detach the drive axle from the final drive as described in **SUSPENSION AND STEERING**.

> ***CAUTION —***
> *Suspend the detached drive axle from the car body with a stiff wire hook to prevent damage to the outer constant velocity joint.*

2. Pry the drive flange from the final drive as shown in Fig. 5-6. Then remove the flange snap ring shown in Fig. 5-7. Inspect the flange and replace it if there is a groove worn where it contacts the oil seal.

3. Pry the faulty seal from its recess using a hooked seal removal tool, or a large screwdriver.

> ***CAUTION —***
> *Be very careful not to mar the housing when removing the seal.*

4. Dip the new seal in final drive lubricant and drive the new seal into place until it is fully seated.

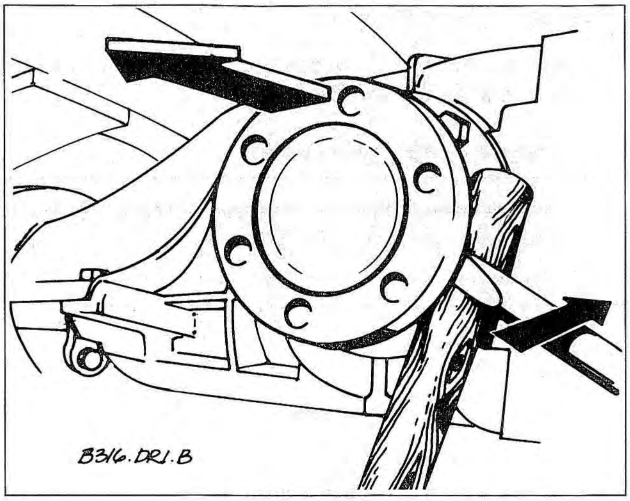

Fig. 5-6. Prying off drive flange. Use extreme care to avoid damaging final drive. For leverage, use wooden dowels as shown.

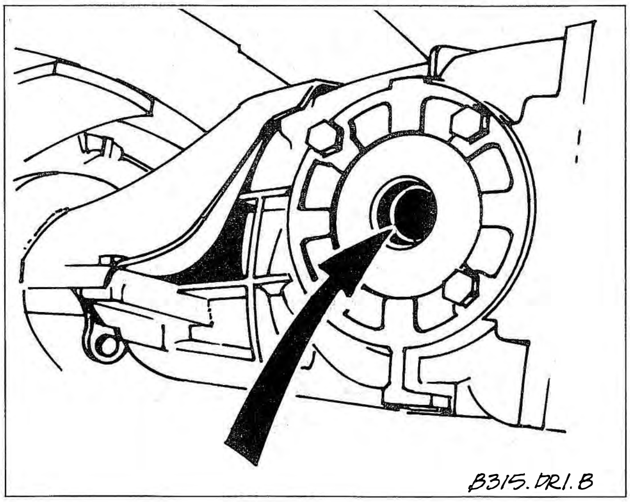

Fig. 5-7. Drive flange snap ring (arrow) to be removed from differential housing.

5. Install a new snap ring in the groove of the differential housing. Make sure both ends of the ring are fully seated in the groove.

6. Install the drive flange by pressing it in by hand until the snap ring engages. It may be necessary to turn the drive flange slightly while pushing.

7. Attach the drive axle as described in **SUSPENSION AND STEERING**.

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To replace input shaft oil seal:

1. Remove the final drive as described in **5.1 Removing and Installing Final Drive**.

2. Drain the oil from the final drive.

3. Make matching marks on the input shaft and input shaft collar nut as shown in Fig. 5-8.

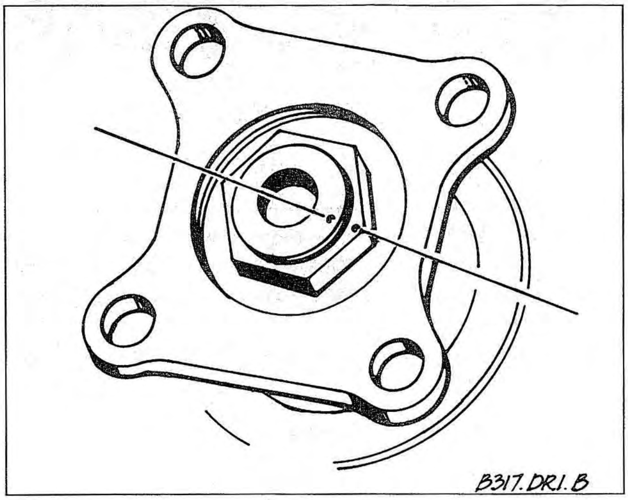

Fig. 5-8. Final drive input shaft, collar nut, and flange, showing matching marks made with punch.

4. Remove the lockplate, then hold the input flange and remove the collar nut. Using a puller, remove the input flange.

5. Pry the faulty seal from its recess using a hooked seal removal tool or a large screwdriver. Dip the new seal in final drive lubricant and drive the new seal into position.

> ***CAUTION —***
> *Be very careful not to mar the housing when removing the seal.*

6. Lightly lubricate the input shaft and press the input flange back on, but do not bottom it out. Install the collar nut and slowly tighten it until the matching marks line up, coming as close as possible to the torque specified in **Table f**.

Table f. Input Shaft Collar Nut Torques

318i	at least 150 Nm (111 ft. lb.) until matching marks line up
Other models	at least 310 Nm (229 ft. lb.) until matching marks line up

7. Install a new lockplate.

> ***CAUTION —***
> *Do not tighten the collar nut past the matching marks to reach the specified torque, and then move the nut back. This may over-compress the pinion shaft bushing and require disassembly of the final drive for replacement.*

6. TECHNICAL DATA

I. Driveshaft Flange Runout Specifications

Axial play	
transmission output flange	0.10 mm (.004 in.) maximum
Radial play	
transmission output flange	0.07 mm (.003 in.) maximum
final drive input flange (measured at driveshaft centering lip)	0.07 mm (.003 in.) maximum

II. Universal Joint Play Specifications

Maximum allowable play	0.15 mm (.006 in.)

III. Driveshaft Installation Specifications

Center bearing preload (towards front of car)	4–6 mm (.157–.236 in.)

IV. Tightening Torques

Driveshaft to final drive, bolt and nut	72 Nm (53 ft. lb.)
Flexible coupling to transmission or driveshaft	
M 10, 8.8 bolt and nut	46 Nm (34 ft. lb.)
M 10, 10.9 bolt and nut	72 Nm (53 ft. lb.)
M 12 bolt and nut	123 Nm (91 ft. lb.)
Center bearing to body, bolt	22 Nm (16 ft. lb.)
Clamping sleeve for splined coupling	17 Nm (13 ft. lb.)
Final drive to rear axle carrier, bolts	
1984–1987	110–123 Nm (81–91 ft. lb.)
1988–1990	80 Nm (59 ft. lb.)
Final drive rubber mounting bushing to body	
1984–1987	80–87 Nm (59–64 ft. lb.)
1988–1990	87 Nm (64 ft. lb.)
Final drive flange to input shaft, collar nut	
318i	at least 150 Nm (111 ft. lb.) until matching marks line up
Other models	at least 310 Nm (229 ft. lb.) until matching marks line up
Speedometer pulse sender to final drive	10 Nm (7 ft. lb.)

Section 12

BRAKES

Contents

Tables

Brakes

Introduction

All cars covered by this manual are equipped either with front disc brakes and rear drum brakes, or with disc brakes on all four wheels. The brakes are a dual-circuit system, meaning there are separate hydraulic circuits for the front and rear brakes.

The brakes are hydraulically actuated by the master cylinder, with a vacuum-operated booster to reduce braking effort. In addition, 1986 and later models are equipped with a Bosch anti-lock braking system (ABS). This electronically-controlled system maintains stability and control during emergency braking by preventing wheel lock-up.

Properly functioning brakes are essential to safe driving. If either the brake warning indicator or the ABS warning indicator comes on while driving, it is imperative that the system be given a thorough check, even if braking action still seems satisfactory. The brakes should be regularly inspected, and all brake work must be done with careful attention to cleanliness, correct specifications and proper working procedures.

This section contains information needed to perform routine maintenance and service of the brakes, although some of the information may only be useful to the professional mechanic. If you lack the skills, the tools, or a clean workplace for servicing the brakes, we suggest you leave these repairs to an authorized BMW dealer or other qualified shop. We especially urge you to consult an authorized dealer before beginning repairs on a car which may be eligible for repair under the manufacturer's warranty.

1. General Description

Fig. 1-1 is a schematic diagram of the dual-circuit hydraulic brake system. The master cylinder, operated by the brake pedal, creates pressure in the hydraulic system. At the wheels, the hydraulic pressure acts on the calipers or wheel cylinders which in turn mechanically apply the brakes. The use of hydraulics makes it possible for the driver to generate high braking forces with a comparatively small amount of effort.

WARNING —

- *Friction materials such as brake linings or brake pads may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing any asbestos fibers or dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.*

- *Brake fluid is poisonous. Wear safety glasses when working with brake fluid, and wear rubber gloves to prevent brake fluid from entering the bloodstream through cuts or scratches. Do not siphon brake fluid with your mouth.*

CAUTION —

Brake fluid is very damaging to paint. Any brake fluid that spills on the car should be cleaned off immediately.

Master Cylinder, Vacuum Booster, and Brake Lines

The master cylinder has separate chambers for the two hydraulic circuits. The front chamber operates the brakes on the front wheels, while the rear chamber operates the brakes on the rear wheels. In the event of a loss of pressure in one circuit, the other will still supply a portion of the normal braking force.

The vacuum booster uses engine vacuum to assist braking effort. The pedal pushrod is directly connected to the master cylinder so that a failure of the vacuum booster, although it will greatly increase braking effort, will not result in total brake failure.

The rigid brake lines transmit hydraulic pressure to the wheels and resist expansion and pressure loss. Flexible hoses joining the rigid lines to the brakes accommodate wheel movement due to steering and suspension action.

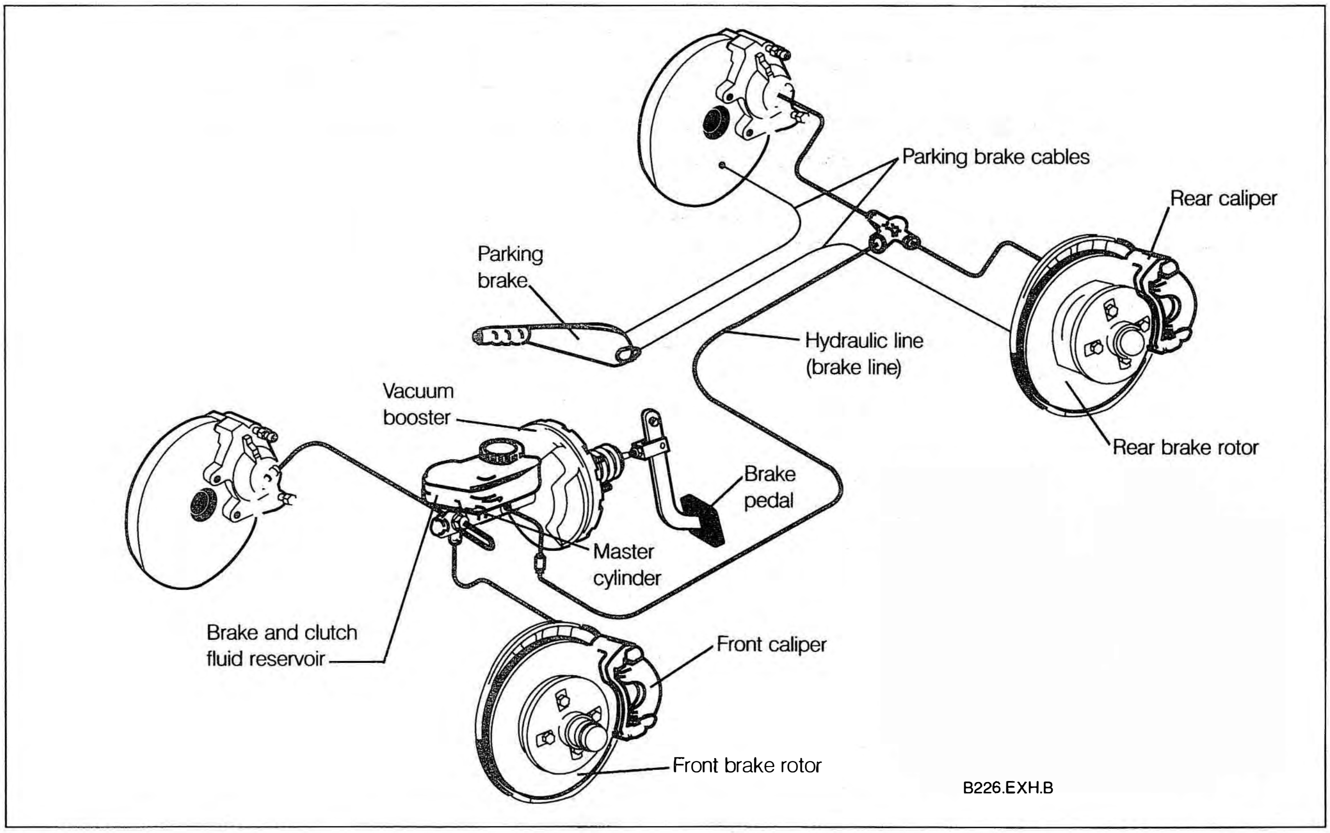

Fig. 1-1. Schematic view of dual-circuit brakes. Four-wheel disc brakes shown. Front disc and rear drum system is similar.

Disc Brakes

Each disc brake uses a cast-iron caliper with a single hydraulic cylinder to clamp the rotor (disc) between two brake pads. Front and rear rotors are mounted to the wheel hubs. Disc brakes automatically adjust for brake pad and rotor wear.

Rear Drum Brakes

The self-adjusting rear drum brakes use a dual-opposed hydraulic wheel cylinder to apply pressure to the brake shoes, forcing the friction linings against the inside of the brake drum.

Anti-Lock Braking System (ABS)

The anti-lock braking system (ABS) is designed to provide optimum deceleration and stability during emergency braking by adjusting the hydraulic pressure at each wheel to prevent wheel lock.

The system's main components are the wheel speed sensors, the electronic control unit, and the hydraulic control unit. See Fig. 1-2. The wheel speed sensors continuously send wheel speed signals to the control unit. The control unit compares these signals to determine, in fractions of a second, whether any of the wheels is about to lock. If any wheel is about to lock, the control unit signals the hydraulic unit to maintain or reduce hydraulic pressure at the appropriate wheel(s). Pressure is modulated by electrically-operated solenoid valves in the hydraulic unit.

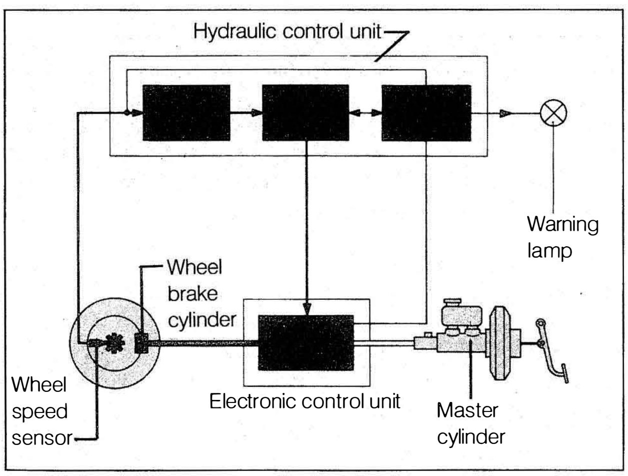

Fig. 1-2. Schematic representation of the ABS system used on cars covered by this manual.

Parking Brakes

The parking brake is mechanically operated. On cars with rear drum brakes, the parking brake operates the rear brake shoes. Cars with rear disc brakes have a separate system with mechanically operated parking brake shoes acting on a small drum inside the brake rotor. The position of the parking brake lever is held by a thumb-release ratchet.

2. Maintenance

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of the brakes. A number in bold type indicates that the procedure is covered in this section, under that numbered heading. Information on other brake system maintenance and on the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Checking brake fluid level
2. Inspecting brake hoses, lines, and wheel calipers or cylinders for leaks
3. Checking brake pad and/or lining wear
4. Replacing brake fluid **4.2**

3. Troubleshooting

This heading describes symptoms of trouble with the brakes, and suggests probable causes and appropriate corrective actions.

The sole function of the brakes is to generate friction to slow or stop the car. Brake problems are usually obvious because they affect the way the car slows and stops. Noise or problems with the car's handling may be caused by the brakes, but they may also be caused by faults in the suspension or steering systems. Information on troubleshooting these systems can be found in **SUSPENSION AND STEERING**. For more help in selecting the appropriate section, see the discussion of troubleshooting in **FUNDAMENTALS** at the front of the manual.

3.1 Basic Troubleshooting Principles

As with any troubleshooting, careful analysis of the symptoms is the key to isolating and identifying braking problems. Reliable braking depends on creating and applying hydraulic pressure, which requires a non-compressible fluid. Brake performance is mainly affected by three things: the level and condition the brake fluid, the system's ability to create and maintain pressure, and the condition of the friction components. On cars so-equipped, a fault in the anti-lock braking system may affect brake performance during emergency stops.

NOTE —

If an ABS system malfunction is detected by the electronic control unit, the ABS warning lamp will light and the ABS system will automatically turn off. Once the ABS system is turned off, the brakes will operate in the normal mode (i.e., the wheels may lock during emergency braking).

Because air is compressible and brake fluid is not, air in the fluid will make the brake pedal feel spongy during braking, or will increase the force required on the brake pedal to stop the car. Fluid contaminated by moisture or dirt will dramatically increase internal corrosion and wear.

Seals are used throughout the system to maintain hydraulic pressure. Faulty seals or wear and corrosion on the sealing surfaces will reduce braking efficiency. A symptom of this condition is the need to pump the pedal to get good braking. Simple leaks at the brake line or hose unions may cause the same problems.

Worn or contaminated brake pads or linings are an obvious cause of poor braking performance. The friction material is slowly consumed by use of the brakes and must be periodically replaced. Also, pads and linings which are oil-contaminated or glazed due to overheating cannot produce as much friction, and stopping distances will increase.

When troubleshooting the brakes, consider how quickly the problem occurred. Sudden brake failure is most likely caused by the failure of one component, such as a damaged hose or a disconnected vacuum booster vacuum line. A gradual decline in braking efficiency probably indicates the general state of wear in the system, and more than one component may need to be repaired or replaced.

For ABS-equipped cars, most of this same troubleshooting information applies. ABS has no effect on normal braking. ABS activates automatically only when the brakes start to lock during hard braking or on a slippery road surface. When the ABS is activated and is modulating brake pressure to one or more wheels to prevent lock-up, there will be some pulsation in the system which may be felt through the brake pedal. This condition is normal.

Table a lists symptoms of problems commonly associated with the brakes, their probable causes, and suggested corrective actions. The numbers in bold type in the corrective action column refer to numbered headings in this section where the suggested repairs are described.

3.2 Diagnostic Checks

Component inspection and some general brake system checks can help isolate problems.

Check the vacuum booster first by pumping the brake pedal approximately 10 times with the engine off, and then holding the pedal down. When the engine is started, the pedal should fall slightly. The booster diaphragm rarely fails, but leaks in the vacuum line, a faulty check valve, or a faulty O-ring between the master cylinder and the vacuum booster will decrease the vacuum assist. Insufficient engine vacuum or a clogged vacuum booster filter could also decrease vacuum assist. Test the check valve by removing it from the booster vacuum line and blowing through it. Air should pass through in the direction of the arrow, but not pass through the opposite way.

Check the master cylinder by holding the pedal down hard with the car stopped and the engine running. The pedal should feel solid and stay solid. If the pedal slowly falls to the floor, either the master cylinder is leaking internally, or fluid is escaping from the system. If no leaks can be found, the master cylinder is faulty and should be replaced.

3.3 Brake Noise

Occasional groaning or squealing sounds from the brakes, especially disc brakes, are usually caused by vibration being transmitted through the brake pads. Brake friction materials that contain little or no asbestos, may contribute to an increase in brake noise. These noises, though discomforting, are normal and rarely indicate a problem in brake function or effectiveness.

Although there is no permanent solution, proper maintenance and repair can help minimize brake noise. Disc brake caliper assemblies include anti-rattle springs, designed to minimize vibration and noise. As much as possible, brake pads and calipers should be kept free of foreign matter and corrosion which may inhibit smooth operation. Always resurface or replace brake rotors when changing brake pads.

Rear drum brake noise may be more easily corrected than rotor noise. Drum brake noise is usually caused by the brake shoes contacting the backing plate. To help eliminate squeaking drum brakes, apply a small amount of multipurpose grease at the point where the brake shoes contact the backing plate (raised or embossed points).

CAUTION —

Apply grease sparingly. Do not allow grease to contaminate the brake linings.

To reach the contact points, the brake shoes must be removed as described in **6.1 Reconditioning Rear Drum Brakes.**

Table a. Brake Troubleshooting

Symptom	Probable cause	Corrective action
1. Brake squeak or squeal	a. Normal condition	a. See **3.3**
	b. Incorrectly installed brake pads or brake shoes	b. Check installation. **5.1, 6.1, 7.1**
	c. Brake pad carriers or backing plates dirty or corroded	c. Clean calipers and/or backing plates. **3.3, 5.1, 6.1, 7.1**
	d. Brake shoe return springs weak	d. Replace return springs. **6.1**
	e. Pad anti-rattle springs faulty or missing	e. Install/replace anti-rattle springs. **5.1, 7.1**
	f. Brake pads or linings heat-glazed or oil-soaked	f. Replace brake pads/linings. Clean rotors/drums. Replace leaking calipers/wheel cylinders as required. **5.1, 5.2, 6.1, 7.1** Replace wheel bearing grease seals as required. See **SUSPENSION AND STEERING**
	g. Wheel bearings misadjusted	g. See **SUSPENSION AND STEERING**
2. Pedal goes to floor when braking	a. Insufficient brake fluid	a. Check fluid level. See **LUBRICATION AND MAINTENANCE** Check for leaks. Fill and bleed system. **4.2**
	b. Master cylinder faulty	b. Replace master cylinder. **4.3**
3. Low pedal even after brake adjustment and bleeding	a. Master cylinder faulty	a. Replace master cylinder. **4.3**
4. Pedal feels spongy or brakes work only after pedal is pumped	a. Insufficient brake fluid	a. Check fluid level. See **LUBRICATION AND MAINTENANCE** Check for leaks. Fill and bleed system. **4.2**
	b. Air in brake fluid	b. Bleed system. **4.2**
	c. Master cylinder spring weak	c. Replace master cylinder. **4.3**
	d. Leaking line and hose unions	d. Repair or replace lines and hoses. Bleed system. **4.2**
5. Excessive braking effort with little effect	a. Brake pads or linings wet	a. Use light pedal pressure to dry brakes while driving.
	b. Brake pads or linings heat-glazed or oil-soaked	b. Replace brake pads/linings. Clean rotors/drums. Replace leaking calipers/wheel cylinders as required. **5.1, 5.2, 6.1, 7.1** Replace wheel bearing grease seals as required. See **SUSPENSION AND STEERING**
	c. Vacuum booster or vacuum connections faulty	c. Inspect vacuum lines. Test booster and replace as required. **4.3**
6. Brakes pulsate, chatter, or grab	a. Warped disc brake rotors	a. Recondition or replace rotors. **5.1, 7.1**
	b. Brake drums worn or out-of-round	b. Recondition or replace brake drums. **6.1**
	c. Brake pads or linings worn	c. Recondition brakes. **5.1, 6.1, 7.1**
	d. Brake pads or linings heat-glazed or oil-soaked	d. Replace brake pads/linings. Clean rotors/drums. Replace leaking calipers/wheel cylinders as required. **5.1, 5.2, 6.1, 7.1** Replace wheel bearing grease seals as required. See **SUSPENSION AND STEERING**
7. Uneven braking, car pulls to one side, rear brakes lock	a. Incorrect tire pressures	a. Check and correct tire pressures. See **LUBRICATION AND MAINTENANCE**
	b. Brake pads or linings heat-glazed or oil-soaked	b. Replace brake pads/linings. Clean rotors/drums. Replace leaking calipers/wheel cylinders as required. **5.1, 5.2, 6.1, 7.1** Replace wheel bearing grease seals as required. See **SUSPENSION AND STEERING**
	c. Pressure regulator valve faulty	c. Replace pressure regulator. **4.5**
	d. Caliper/wheel cylinders or brake pads/shoes binding	d. Clean and recondition brakes. **5.1, 6.1, 7.1**
	e. Drum brake self-adjusters faulty	e. Clean, repair, or replace self-adjusting mechanism. **6.2**
	f. Brake fluid contaminated	f. Drain, flush, refill, and bleed brakes. **4.2**
	g. Worn tires or suspension components	g. See **SUSPENSION AND STEERING**
8. Brakes drag, bind, or overheat	a. Brake shoe return springs weak	a. Replace springs. **6.1**
	b. Brake caliper/wheel cylinder or brake pad/shoe binding	b. Clean and recondition brakes. **5.1, 6.1, 7.1**
	c. Master cylinder faulty	c. Replace master cylinder. **4.3**

4. Brake Service

This section includes important information about brake fluid, methods for bleeding the brakes, and service and repair procedures for the master cylinder, the vacuum booster, and the pressure regulator.

4.1 Brake Fluid

Brake fluid is the heart of the hydraulic system. It transmits the mechanical braking force at the pedal to the brake mechanisms at the wheels. Any contamination of the fluid will have a direct influence on braking performance and reliability. Dirt in the system will clog small passages and increase wear of rubber parts.

Brake fluid is hygroscopic, meaning it absorbs moisture. Moisture in the fluid lowers its boiling point, allowing it to be boiled more easily by the heat generated during braking. Boiling the fluid will create air bubbles in the system and, since air is compressible, will reduce braking effectiveness. Moisture in the system also causes corrosion.

When adding brake fluid, use only new fluid from unopened containers. Do not reuse brake fluid that has been bled from the system, even if it is brand new. Bleeding the brakes aerates the fluid. See **LUBRICATION AND MAINTENANCE** for brake fluid specifications. For best performance and system reliability, use only BMW-approved brake fluid.

Because it readily absorbs moisture, brake fluid should be changed annually, regardless of the number of miles driven. The system should also be bled of air after any repairs in which brake lines are disconnected. See **Replacing Brake Fluid** for more information.

> ***WARNING —***
>
> *Brake fluid is poisonous. Wear safety glasses when working with brake fluid, and wear rubber gloves to prevent brake fluid from entering the bloodstream through cuts or scratches. Do not siphon brake fluid with your mouth.*

> ***CAUTION —***
>
> *Brake fluid is very damaging to paint. Immediately wipe up any brake fluid that spills on painted surfaces.*

4.2 Bleeding Brakes

Bleeding brakes is the process of purging aerated or contaminated brake fluid from the system and replacing it with new, clean fluid. Bleeding brakes periodically is good preventive maintenance, but it is essential if brake lines or components have been disconnected, or any time air is introduced into the system. Spongy or vague-feeling brakes may indicate the need to bleed air from the system.

There are three widely used methods of bleeding brakes. Each employs some means of forcing the fluid through the system to the calipers or wheel cylinders, and releasing contaminated fluid through the bleeder valves. The system can be bled using a pressure bleeder, using a hand-held vacuum bleeder, or manually using the brake pedal and a helper. Each method accomplishes the same result. Pressure bleeding, if available, is fastest. Manual bleeding is simple since it requires no special tools.

For the best possible results, bleeding should start at the wheel farthest from the master cylinder and end at the wheel closest to the master cylinder. This bleeding sequence is as follows:

1. **Right rear** caliper or wheel cylinder
2. **Left rear** caliper or wheel cylinder
3. **Right front** caliper
4. **Left front** caliper

Although it is possible to bleed the brakes with the car on the ground, for best access to the bleeder valves, the car should be raised and firmly supported on jack stands. The wheels should be removed and the engine should not be running.

Use a box wrench to open and close the bleeder valves. Use a clear container to catch the expelled fluid and a piece of clear, flexible tubing (about 4 mm or 5/32 in. inside diameter) connected to the bleeder valve, as shown in Fig. 4-1, so that outgoing air bubbles are visible.

On both disc brake calipers and drum brake wheel cylinders, 7-mm bleeder valves should be tightened to 3.5 to 5.0 Nm (31 to 44 in. lb.). Larger 9-mm bleeder valves should be tightened to 4.0 to 6.0 Nm (35 to 53 in. lb.).

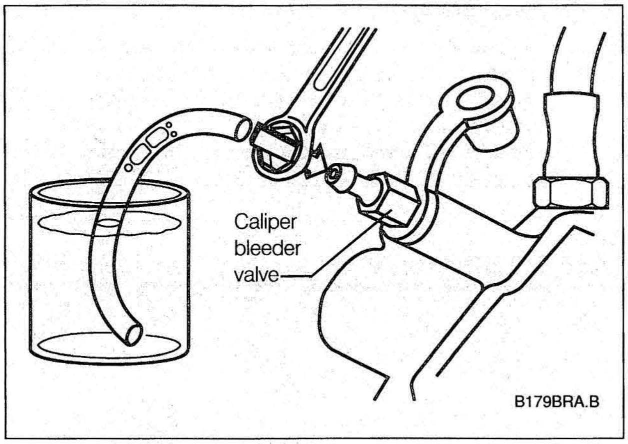

Fig. 4-1. Container (partially filled with brake fluid) connected to caliper bleeder valve with clear tubing for bleeding brakes. Bleeding rear drum brake wheel cylinder is similar.

Pressure Bleeding

Pressure bleeding, using special equipment and compressed air, is the method used by most commercial repair shops. It is the quickest method and the best way to prevent contaminants and air from entering the system. The pressure bleeder is connected to the brake fluid reservoir and fills the system with fluid under pressure. Follow the instructions supplied by the equipment manufacturer. A pressure of 0.8 to 1.0 bar (12 to 15 psi) should be used to bleed the brakes.

CAUTION

Do not exceed a pressure of 2 bar (28 psi) when pressure bleeding the brake system. Excessive pressure will damage the brake fluid reservoir.

Vacuum Bleeding

Vacuum bleeding uses an inexpensive hand pump connected at the bleeder valve to draw the fluid through the system. It is a practical, do-it-yourself alternative to pressure bleeding, is faster than manual bleeding, and can be accomplished by only one person. Pumps of this general type are available from auto parts and supply outlets.

Follow the pump manufacturer's instructions very carefully. Make sure that the hose connection to the brake bleeder valve is secure and air-tight. Check the brake fluid level in the master cylinder often to guard against emptying the reservoir.

Manual Bleeding

Manual bleeding, using pressure created by pumping the brake pedal, is the most economical method. The only disadvantage is that it requires a helper.

When manually bleeding the brakes, first fill the brake fluid reservoir on top of the master cylinder until the level is well above the MAX mark, and replace the cap to prevent contamination of the fluid.

Starting with the right rear caliper or cylinder, clean the area around the bleeder valve and remove the dust cap. Fit the box wrench to the bleeder valve, then slip one end ofthe hose onto the valve and submerge the other end in clean brake fluid in the clear container.

Have a helper slowly pump the brake pedal about three times (12 times or more on cars with ABS). The last time, hold the pedal down. Slowly open the bleeder valve approximately one-half turn. Close the bleeder valve when brake fluid stops flowing from it, then release the brake pedal.

CAUTION

- *Be sure that the bleeder valve is fully closed before releasing the brake pedal to avoid drawing air back into the system.*

- *On a car with high mileage, it is safest to avoid using the full stroke of the pedal while bleeding. This will prevent overrunning the master cylinder's normal stroke, which may damage the master cylinder piston seals if the inside of the master cylinder is worn or corroded beyond the normal piston stroke. This is especially likely on an older car, one that has had water in the fluid or one that has not had the brakes bled for quite some time.*

NOTE

On cars with ABS, pump the brake pedal a minimum of 12 times before opening the bleeder valve. This will help to expel air trapped in the hydraulic unit.

Repeat the bleeding procedure until clear fluid with no air bubbles is coming from the bleeder valve, then fully tighten the valve and replace the dust cap. Using the sequence described above, follow the same procedure at the other three wheels. Check the fluid level in the master cylinder frequently, and add more to keep the level at the MAX mark.

Replacing Brake Fluid

BMW recommends that the brake fluid be replaced at least once per year. This short replacement interval is due to the fact that brake fluid readily absorbs moisture. Moisture in the brake fluid can adversely affect braking performance and may also damage the system, leading to costly repairs.

Replace the brake fluid using the procedure described above in **4.2 Bleeding Brakes** to expel the old fluid. Remove the filter/strainer from the brake fluid reservoir and clean it in new, unused brake fluid. Using new, unused brake fluid, pump at least 1 pint (500 cc) of brake fluid through each caliper or wheel cylinder to completely flush the system and expel the old fluid. Then refill the reservoir and bleed the brakes as described above. See **LUBRICATION AND MAINTENANCE** for brake fluid specifications. Use only BMW-recommended brake fluid.

NOTE —
On cars with hydraulic clutches, the brake fluid reservoir also supplies the clutch master cylinder. It is a good idea to also flush the clutch slave cylinder when replacing the brake fluid.

Flushing the Brake System

Do not rely on flushing alone to clean a system contaminated with dirt or corrosion. The flushing procedure may actually force dirt in the lines into the calipers or wheel cylinders. To do the job thoroughly, the system must be disassembled and the parts individually cleaned. Use only brake fluid to flush the lines. Alcohol must not be used since it will encourage the accumulation of water in the system.

Replacing Brake Lines

Only straight brakes lines are available as replacements. To replace a brake line, first remove the old line from the car and measure its length. Using a straight brake line of the same length, bend the new line to match the pattern of the old line. Each bend radius should be no smaller than about 15 mm (9/16 in.). Check that the protective coating on the brake line is not damaged after bending. Make sure the new brake line has sufficient clearance from the body and suspension when installed, to allow for suspension bottoming and steering travel. Tighten brake line unions 10 to 15 Nm (7 to 11 ft. lb.). Tighten brake hose unions to 13 to 16 Nm (10 to 12 ft. lb.).

CAUTION —
The use of a tube bender is highly recommended for shaping replacement brake lines. Bending brake lines by hand can cause kinks that weaken the line and restrict fluid flow. Inexpensive tube benders are available at most auto parts stores. See Fig. 4-2.

Fig. 4-2. Typical tube bender used to shape replacement brake lines.

4.3 Master Cylinder and Vacuum Booster

The master cylinder and vacuum booster assembly are shown in Fig. 4-3. The vacuum booster and master cylinder are mounted to the firewall in the engine compartment. The brake pedal operates the master cylinder via a pushrod which passes through the firewall. The master cylinder piston acts on the brake fluid to create pressure in the system. The brake fluid reservoir is mounted on the master cylinder.

The vacuum booster, mounted between the pedal mechanism and the master cylinder, uses the difference between engine vacuum and atmospheric pressure to help actuate the master cylinder and reduce pedal effort.

When the engine is running, vacuum is applied equally to both sides of the booster diaphragm. When the brake pedal is pressed, atmospheric pressure reaches the pedal side of the diaphragm and creates the brake-boosting pressure differential. A check valve in the vacuum hose holds vacuum in the booster when the engine is stopped. The pedal pushrod is connected directly to the master cylinder, so failure of the vacuum booster does not normally result in total brake failure.

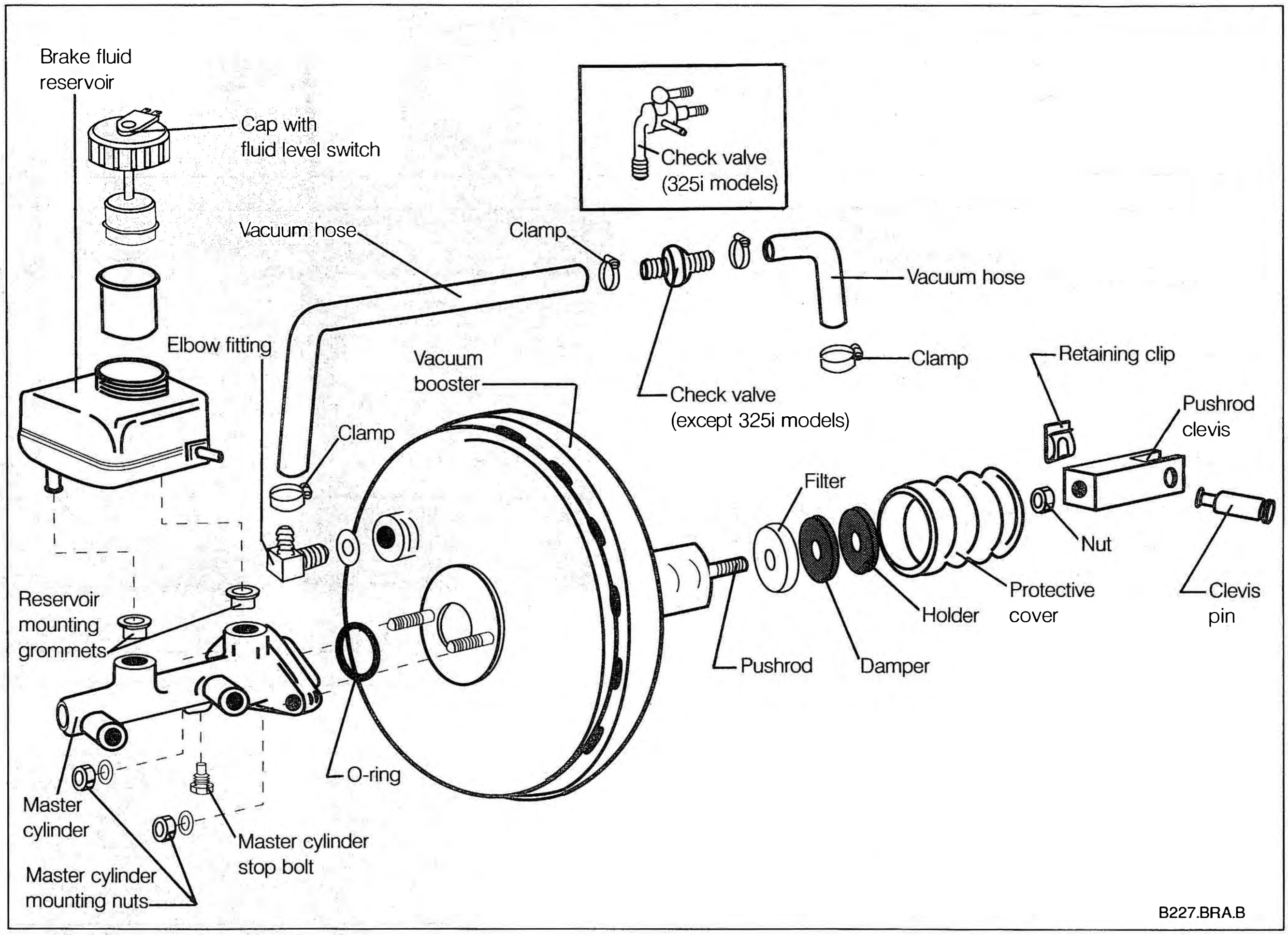

Fig. 4-3. Master cylinder and vacuum booster assembly.

Removing and Installing Master Cylinder

The master cylinder can be removed and installed with ordinary hand tools. The O-ring between the master cylinder and the vacuum booster should always be replaced. A faulty O-ring can be the source of a vacuum leak, causing a reduction in braking performance or an erratic idle speed. Be sure to have an adequate supply of new, unopened brake fluid on hand, as bleeding the brakes will be necessary after installation. See **4.2 Bleeding Brakes**.

Although master cylinder parts and rebuild kits are available for most models, replacing the master cylinder as a complete unit may be preferrable. It will take more time to rebuild the master cylinder than to replace it. Also, whether or not it can be successfully rebuilt depends on its internal condition. This is very difficult to check until after it is disassembled.

To remove:

1. Disconnect the battery negative (–) terminal.

2. Loosen and remove the brake fluid reservoir cap.

3. Using a clean syringe or some equivalent, empty the brake fluid reservoir.

> ***WARNING —***
> *Brake fluid is poisonous. Do not siphon brake fluid with your mouth. Wear safety glasses when working with brake fluid, and wear rubber gloves to prevent brake fluid from entering the bloodstream through cuts or scratches.*

4. Disconnect the brake lines from the master cylinder. On models with manual transmission, disconnect the hydraulic clutch supply hose.

5. If the master cylinder is being replaced, remove the brake fluid reservoir from the top of the master cylinder by gently prying it out of the rubber mounting grommets, and install the reservoir on the new master cylinder.

> ***CAUTION —***
> *Use care when removing the reservoir from the master cylinder to avoid damaging the plastic fittings. Gently rock the reservoir while pulling it from the master cylinder.*

6. Remove the master cylinder by removing the two nuts holding it to the vacuum booster.

To install:

1. Install the new master cylinder, using new self-locking nuts and a new O-ring. Torque the nuts to 22 to 24 Nm (16 to 17 ft. lb.).

> ***CAUTION —***
> *Do not exceed the recommended mounting torque on master cylinder mounting nuts. Over tightening may damage the vacuum booster.*

2. Connect the brake lines and torque the unions to 10 to 15 Nm (7 to 11 ft. lb.). If applicable, connect the hydraulic clutch supply hose using a new hose clamp.
3. Fill the reservoir with new brake fluid, put the cap with the fluid level switch back on and bleed the system as described in **4.2 Bleeding Brakes**.
4. Reconnect the battery negative (–) terminal.
5. Road test the car and, if necessary, bleed the brakes again.

Removing and Installing Vacuum Booster

The vacuum booster is not repairable, and if faulty must be replaced. It can be removed and installed with ordinary hand tools. Replacing the vacuum booster requires removing and installing the master cylinder. See **Removing and Installing Master Cylinder** above.

To remove the vacuum booster, disconnect the vacuum hose from the booster. Working from inside the passenger compartment, remove the lower left trim panels above the brake pedal. Disconnect the pushrod from the brake pedal by disconnecting the brake pedal return spring, prying off the retaining clip, and sliding out the clevis pin. See Fig. 4-4. Remove the four mounting nuts as shown in Fig. 4-5. Working from the engine compartment side, pull the vacuum booster from the pedal base.

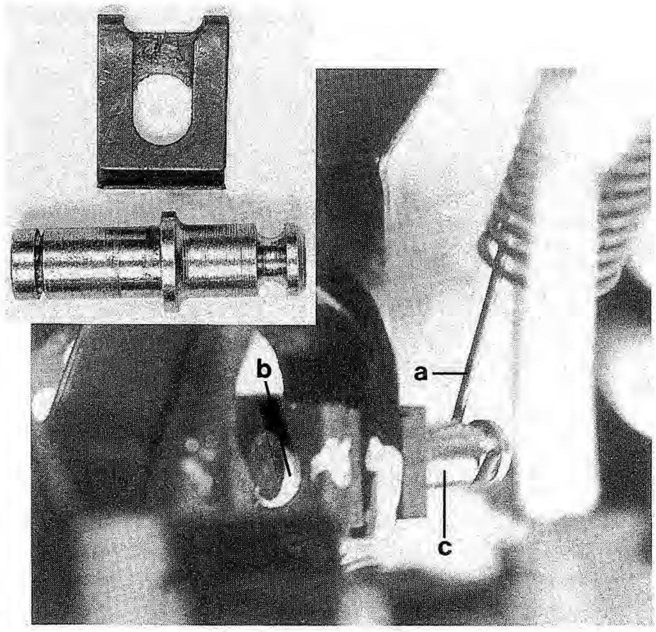

Fig. 4-4. Brake pedal return spring (**a**), retaining clip (**b**) and clevis pin (**c**) as viewed from inside passenger compartment. Inset shows removed clevis pin and clip.

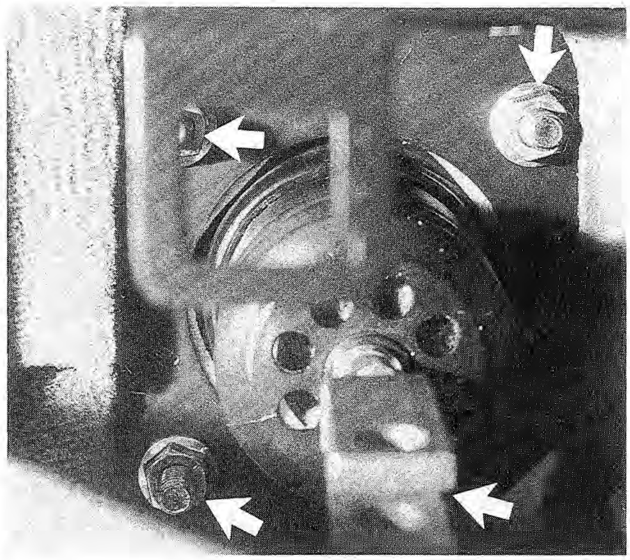

Fig. 4-5. Vacuum booster mounting nuts (**arrows**) as viewed from inside the passenger compartment.

Inspect the small foam filter beneath the rubber boot on the brake pedal pushrod. See Fig. 4-6. If the filter is clogged, it could affect the booster's performance. The filter can be cleaned using a mild soap. If it cannot be sufficiently cleaned it should be replaced.

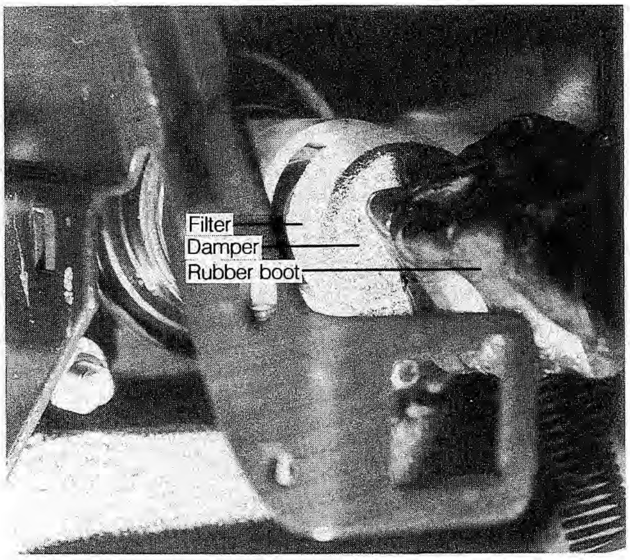

Fig. 4-6. Vacuum booster foam filter and damper as viewed from inside passenger compartment. (Rubber boot turned inside out for clarity.)

Installation of the vacuum booster is the reverse of removal. When reinstalling the filter, be sure the notches in the filter offset the notches in the damper by 180°. Adjust the basic setting of the pushrod's threaded clevis until the dimension is as shown in Fig. 4-7. When the basic setting is correct, tighten the locknut. Tighten the mounting nuts to 22 to 24 Nm (16 to 17 ft. lb.). Adjust the brake pedal travel and the brake light switch as described below.

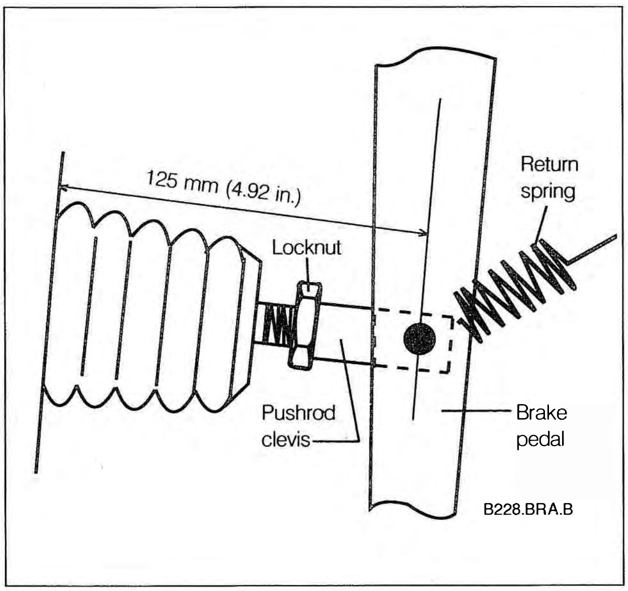

Fig. 4-7. Basic brake pedal pushrod adjustment as viewed from side.

4.4 Brake Pedal Adjustments

Brake pedal freeplay should be adjusted whenever the master cylinder or the vacuum booster are removed or replaced. Also covered under this heading is the adjustment of the brake light switch.

Correct brake pedal freeplay is shown in Fig. 4-8. If not as specified, loosen the locknut on the rear of the pushrod clevis. Rotate the pushrod while holding the clevis stationary. When freeplay is correct, tighten the locknut.

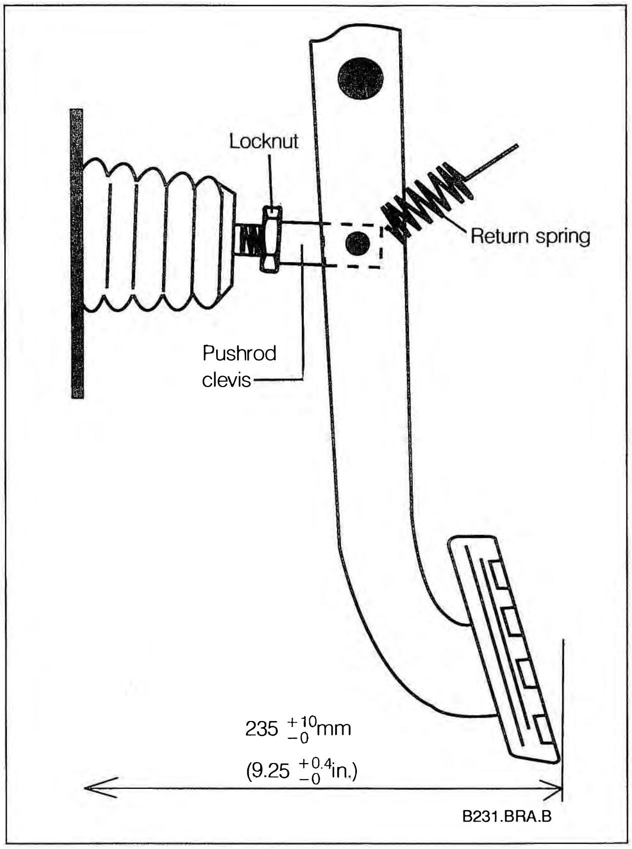

Fig. 4-8. Schematic drawing of brake pedal assembly showing brake pedal freeplay measurement.

On 1984 through 1986 and most 1987 models, the brake light switch adjustment should be checked whenever any brake service is performed. Check the adjustment with the pedal in the rest position. Measure the distance between the switch contact point on the brake pedal and the switch housing as shown in Fig. 4-9. If the measurement is outside the specified range, the switch should be adjusted.

NOTE —

On late 1987 models and all 1988 through 1990 models the brake-light switch, identified by its rectangular housing, is non-adjustable.

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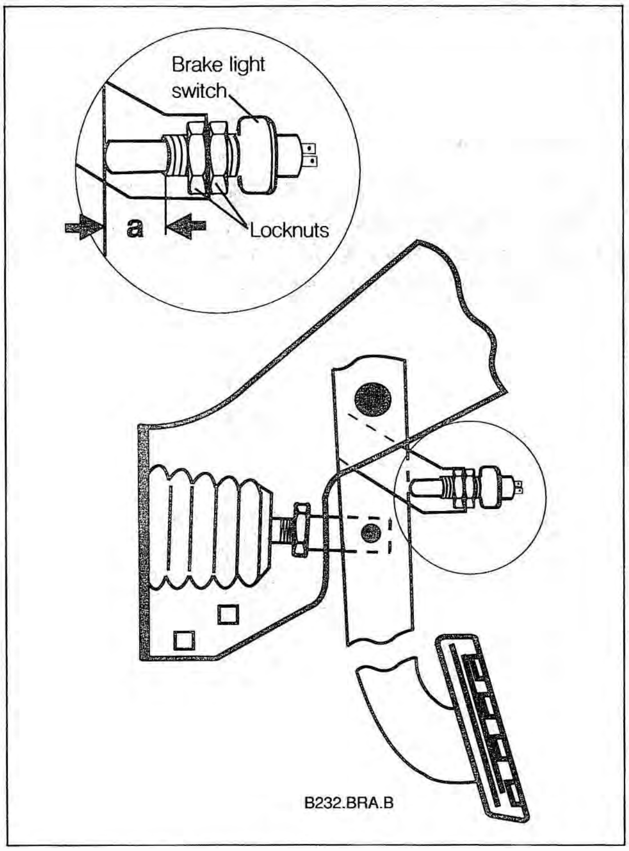

Fig. 4-9. Schematic of brake light switch. Adjust so that dimension **a** is 5^{+1}_{-0}mm ($0.2^{+0.4}_{-0}$in.).

Disconnect the electrical connector(s) and loosen the locknuts. Turn the brake light switch or adjust the locknuts to change the position of the switch. Tighten the locknuts and reconnect the electrical connector(s).

4.5 Brake Pressure Regulator

The brake pressure regulator is shown in Fig. 4-10. It is mounted in-line below the master cylinder. The pressure regulator limits the amount of hydraulic pressure applied to the rear brakes and is non-adjustable.

Testing Pressure Regulator

Testing the pressure regulator requires measuring hydraulic pressure at each wheel, using two pressure gauges with a range of at least 160 bar (2320 psi) connected in place of the brake bleeder valves. Because of this need for specialized equipment, we recommend having this test performed by an authorized BMW dealer or other qualified and suitably equipped shop.

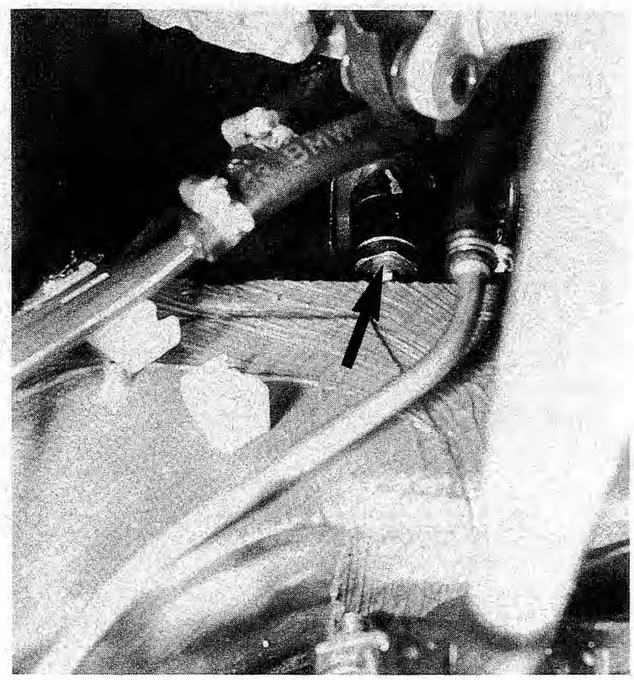

Fig. 4-10. Rear brake pressure regulator (**arrow**) viewed from beneath car.

Replacing Pressure Regulator

The pressure regulator is easily replaced by removing the brakes lines and the retaining clip. When installing the new regulator, torque the line fittings to 10 to 15 Nm (7 to 11 ft. lb.) and then bleed the brakes as described in **4.2 Bleeding Brakes**.

CAUTION —

Compare the markings of the old regulator with those on the new regulator. The switching pressure and reduction pressure specifications must be the same. A regulator with different specifications should not be installed.

4.6 Brake Pad Wear Warning System

The brake pad wear warning system is designed to notify the driver when the brake pads have worn to the point where replacement is necessary. This warning system should not be ignored. Failure to replace the pads soon after the light comes on may cause caliper or rotor damage which will add to the cost of repairs.

On 1984 and most 1985 models, the brake pad wear warning system includes an early warning lamp that lights only when the brake pedal is depressed. This light notifies the driver in advance that the pads will need replacement. On all models, the pads should be replaced when the red instrument panel lamp comes on continuously.

The wear sensor is attached separately to the brake pads. See Fig. 4-11. On 318i models, the sensor is at the front left wheel. All other models have one sensor at the front left wheel and one at the rear right wheel. The sensor is part of a closed circuit. As the brake pads wear, the sensor contacts the rotor. Part of the sensor is then worn away, breaking a wire. This opens the circuit and turns the instrument panel light on. For sensor replacement, see **5.1 Reconditioning Front Disc Brakes** or **7.1 Reconditioning Rear Disc Brakes**.

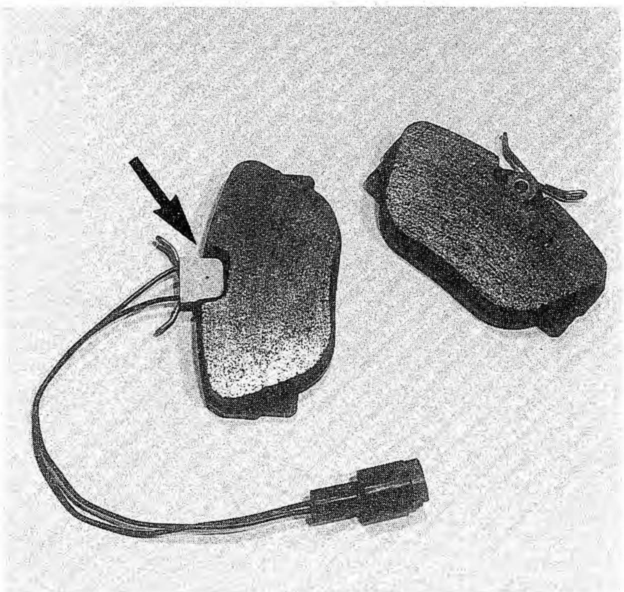

Fig. 4-11. Front left brake pads with brake pad wear sensor (**arrow**).

4.7 Anti-Lock Brake System (ABS)

Fig. 4-12 shows the main components of the ABS. The wheel sensors supply wheel speed information to the electronic control unit in the form of electrical impulse signals. The control unit continuously compares these signals to determine whether any of the wheels is about to lock. The hydraulic unit modulates hydraulic pressure to prevent wheel lock.

CAUTION —

- *Voltage spikes can damage the sensitive ABS control unit. If electrical welding is to be carried out on the car, disconnect the electrical connector from the ABS electronic control unit.*

- *Extreme heat can damage the sensitive ABS control unit. If the car is to be subjected to sustained temperature above 185°F (85°C), the control unit should be removed from the car. The ABS control unit is located beneath the instrument panel to the left of the steering column.*

NOTE —

The ABS warning indicator should come on briefly when the car is started, then go out. If it comes on while the car is running, the ABS system has detected a fault. Once a fault has been detected by the built-in safety circuit, the system is automatically turned off.

The hydraulic unit consists of a three-way electrically operated solenoid valve for each wheel, a brake fluid reservoir for each brake circuit, a return pump, and two relays. During normal braking, the solenoid valves allow brake fluid to pass

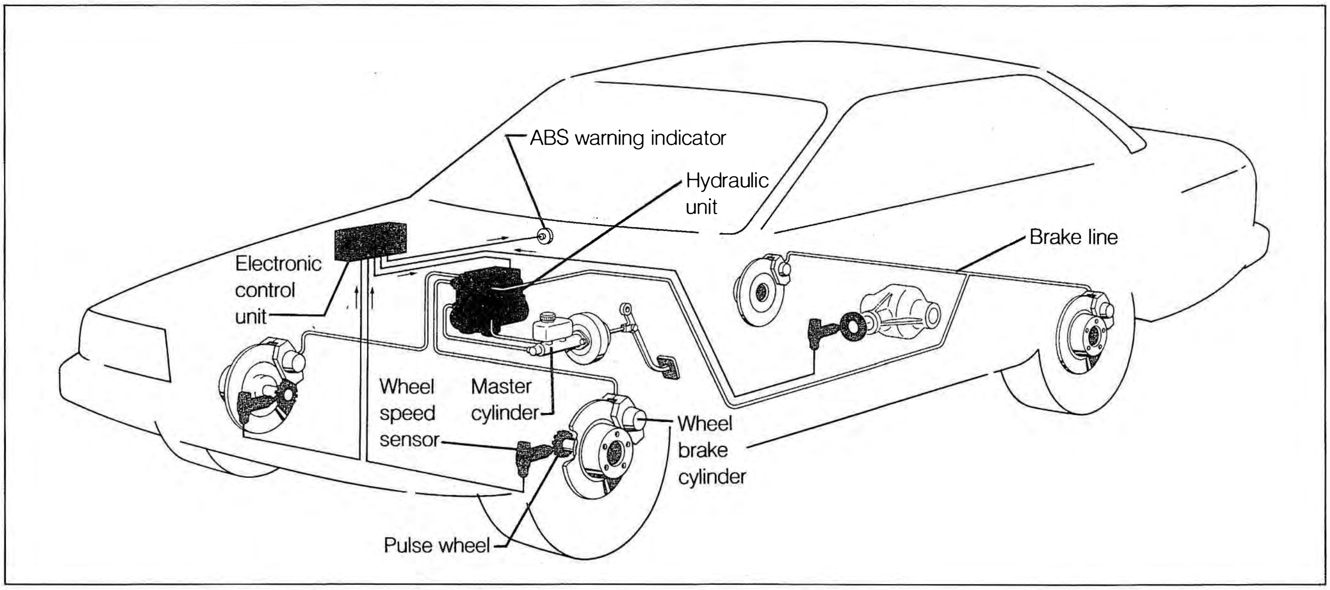

Fig. 4-12. Schematic representation of typical anti-lock braking system (ABS). Exact location and configuration of components may vary.

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freely from the master cylinder to the wheels. If a wheel sensor detects that a wheel is about to lock, the control unit signals the appropriate solenoid valve to hold the brake pressure to that wheel constant.

If holding constant pressure does not prevent the wheel from locking, the valve is repositioned and a small amount of brake fluid is allowed to pass from the brake line into the hydraulic unit reservoir to reduce the hydraulic pressure at that wheel. During this regulating period, the return pump is activated and any brake fluid in the hydraulic unit reservoir is returned to the master cylinder reservoir. The regulating cycle continues as necessary until the car has reached a safe speed (approximately 4 mph, or until the brake pedal is released).

The ABS system is designed to be maintenance free. There are no adjustments that can be made to the system. Repair and troubleshooting of the ABS system requires special test equipment and knowledge, and are therefore outside the scope of this manual.

Inspecting ABS System

If the ABS warning indicator comes on, indicating a problem, a visual inspection of the system may help to locate the fault. Carefully inspect the wiring harness. Check especially the harness and connections near each wheel for chafing or damage due to incorrectly routed wires. If the wheel sensor harness is damaged, the wheel sensor with its integral harness should be replaced.

WARNING —

If the main ABS wiring harness is damaged in any way, it must be replaced. Do not attempt to repair the wiring harness. The ABS system is sensitive to very small changes in resistance. Repairing the wiring harness could alter resistance values and cause the system to malfunction.

CAUTION —

The ignition must be off before connecting or disconnecting any electrical connections.

The pulse wheels themselves may be responsible for faulty speed signals reaching the control unit. Inspect the pulse wheels for damage such as cracks or missing teeth. Check to see that a crack has not made the pulse wheel loose. Spin the tire to check to see if the pulse wheel is out-of-round. Check for dirt or worn wheel bearings which could reduce the clearance between the sensor and the wheel. Even accumulated metallic brake pad dust has been known to cause problems. A faulty pulse wheel should be replaced. See Fig. 4-13.

NOTE —

Front pulse wheels are replaced as part of the front wheel bearing assembly as described in **SUSPENSION AND STEERING**. Rear pulse wheels are replaced together with the rear output shaft as described in **SUSPENSION AND STEERING**.

Fig. 4-13. Front-left ABS pulse wheel (**arrow**).

5. Front Disc Brakes

Fig. 5-1 is an exploded view of a front disc brake. When the brakes are applied, the caliper pushes the inside brake pad against the rotor. This moves the caliper body at the same time, pulling the outside pad against the rotor.

Because the front brakes do more of the work of stopping the car, they are likely to wear faster and may require service more frequently than the rear brakes. The brake pads and rotors are subjected to the greatest wear, and are the components most often needing attention.

The brake pads are designed to be routinely replaced as they wear out. While it is possible to restore the brakes by replacing only the brake pads, the rotors should be resurfaced or replaced at the same time to achieve full braking performance and maximize pad life.

WARNING —

Brake pad friction materials may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing any asbestos fibers or dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

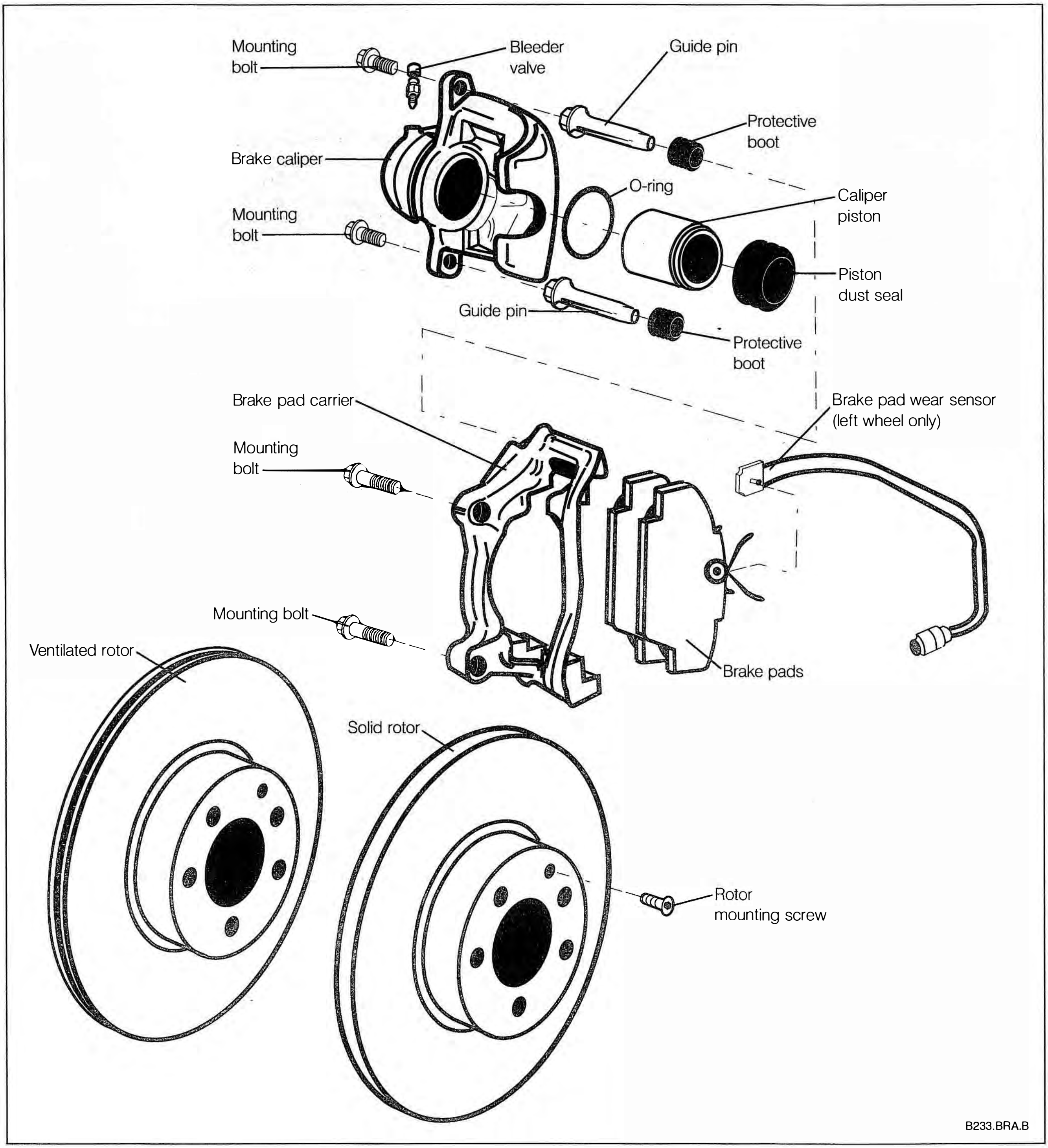

Fig. 5-1. Exploded view of front disc brake assembly.

Checking Brake Pad Wear

The inspection procedure and specifications for checking the brake pads are found in **LUBRICATION AND MAINTENANCE**. For more complete inspection of pad condition, the pads must be removed as described in **5.1 Reconditioning Front Disc Brakes**.

5.1 Reconditioning Front Disc Brakes

Reconditioning the front disc brakes typically includes replacing the brake pads and resurfacing or replacing the brake rotors. Unless the calipers and hoses are damaged, visibly worn, or leaking fluid, more extensive front brake repairs are not normally required.

If the brake pads are soaked with oil, grease, or brake fluid, the cause of the contamination must be found and corrected before new pads are installed. Brake rotors must be replaced when they cannot be resurfaced without exceeding specified limits. See **Removing, Reconditioning, and Installing Brake Rotors** for rotor thickness and runout (out-of-round) specifications.

Changing brake pads or removing and installing calipers calls for replacement of the caliper mounting bolts.

WARNING —

Do not reuse self-locking fasteners. They are designed to be used only once and should be replaced whenever they are removed.

Removing and Installing Front Brake Pads

Although the calipers must be partially removed to change the brake pads, this can be done without disconnecting the flexible brake hose. Keeping the hydraulic system sealed eliminates the need to bleed the brakes afterward.

Brake pads and the surfaces of the rotors wear slightly differently. Always replace brake pads in complete sets. If the old pads are to be reinstalled, such as after inspecting them, always make sure they are refitted in their original locations.

To remove:

1. Raise the front of the car and support it securely on jack stands. Remove the front wheels.

2. When working on the left wheel: Separate the brake pad wear sensor connector and remove the wiring from the brake bleeder dust cap. See Fig. 5-2.

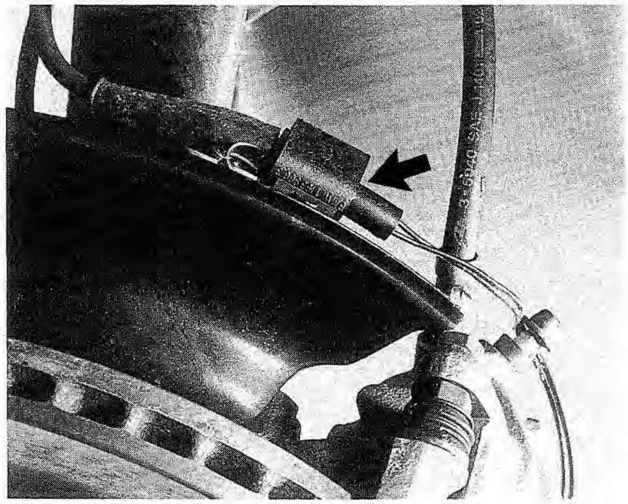

Fig. 5-2. Brake pad wear sensor connector on front left wheel (**arrow**).

3. Using a hex wrench, remove the lower mounting bolt from the guide pin while holding the guide pin stationary, then discard the bolt. See Fig. 5-3.

NOTE —

The mounting bolts that thread into the guide pins are self-locking and should not be reused.

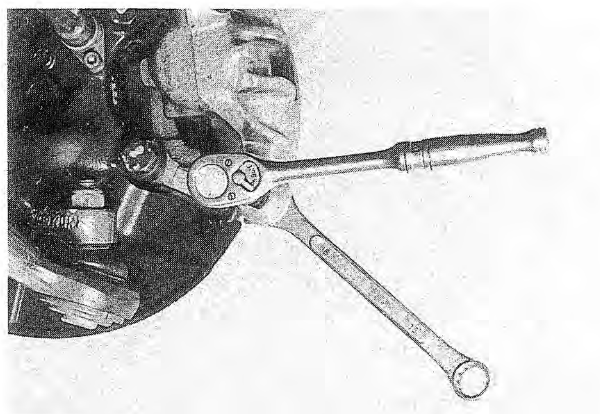

Fig. 5-3. Lower caliper mounting bolt being removed while guide pin is held stationary with open end wrench.

4. Swing the caliper up, and remove the brake pads. See Fig. 5-4. When working on the left wheel: Guide the brake pad wear sensor wiring through the opening in the caliper.

CAUTION —

If the pads are to be reused, mark the pads so that they can be reinstalled in their original position.

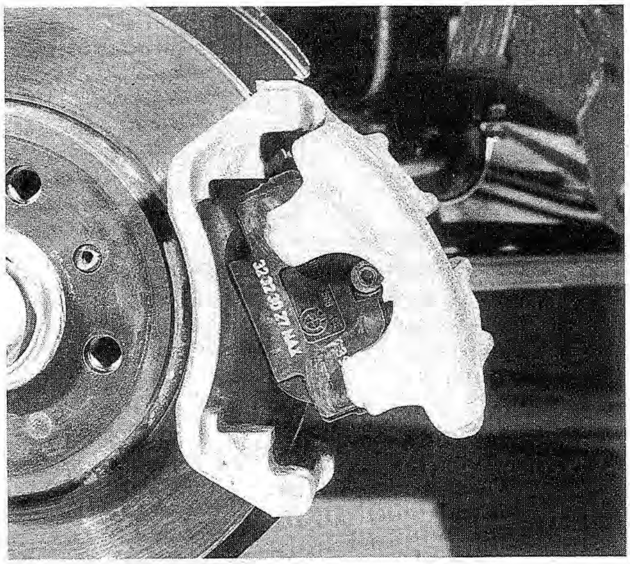

Fig. 5-4. Brake caliper being pivoted up to remove front brake pads.

NOTE —

If the piston creeps out of the caliper due to residual pressure in the brake lines, place a strong rubber band around the piston and caliper to hold the piston.

5. If the pads are being replaced, use a drift to carefully drive the sensor pin out of the left pad assembly. See Fig. 5-5.

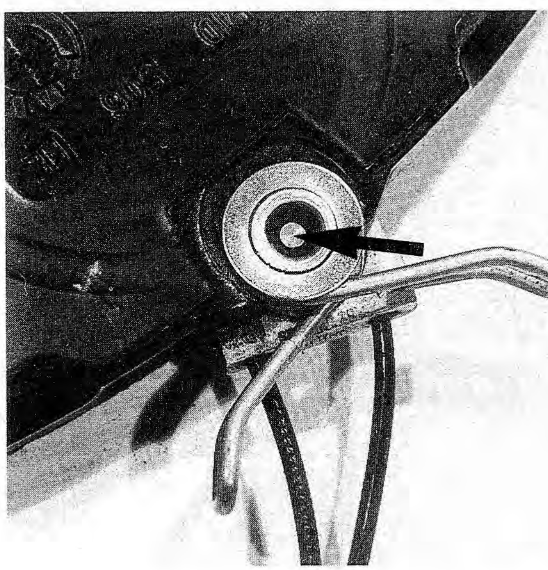

Fig. 5-5. Front brake pad and wear sensor. Remove sensor from pad by driving pin (**arrow**) down.

NOTE —

- Inspect the plastic part of the brake pad wear sensor. If the plastic part of the sensor is worn through to the wires, the sensor should be replaced.
- If the pads are being replaced because the brake pad wear indicator light on the instrument panel came on, the sensor should be replaced, whether or not it appears worn.

To install:

1. When working on the left wheel: Carefully press the brake pad wear sensor pin into the new pad assembly.

CAUTION —

Inspect the retaining clip for the pad wear sensor pin. If either the pin or the retaining clip was damaged during the pin's removal, the sensor should be replaced.

2. Install the brake pads into the brake pad carrier. When working on the left wheel: Route the pad wear indicator wires behind the bleeder and through the retaining loop of the dust cap. See Fig. 5-2 above.

CAUTION —

If the dust cap is broken or missing, it should be replaced (BMW Part No. 34 11 1 153 198). If the sensor wiring is incorrectly routed, it could be damaged by wearing against the tire.

3. Gently push the piston back into the caliper to provide clearance for the thicker new brake pads. Be careful not to push the piston past the outer edge of the piston dust seal. See Fig. 5-6.

NOTE —

Pushing in the caliper pistons to gain clearance for the thicker new brake pads will cause brake fluid to overflow a full master cylinder fluid reservoir. To prevent this, use a clean syringe or some equivalent to first remove some fluid from the reservoir.

4. Pivot the caliper into position over the pads, as shown in Fig. 5-7. Check the position of the dust seal as the caliper is lowered into position.

CAUTION —

When reinstalling the caliper, carefully check that the dust seal is positioned so that it does not catch the edge of the piston when the pedal is depressed. Installing it incorrectly will damage the dust seal.

5. Install a new self-locking lower mounting bolt. Torque the bolt to 31 to 35 Nm (23 to 25 ft. lb.) while holding the guide pin stationary.

6. Mount the wheel and loosely install the lug bolts. Lower the car and then torque the lug bolts to 100 ± 10 Nm (74 ± 7 ft. lb.).

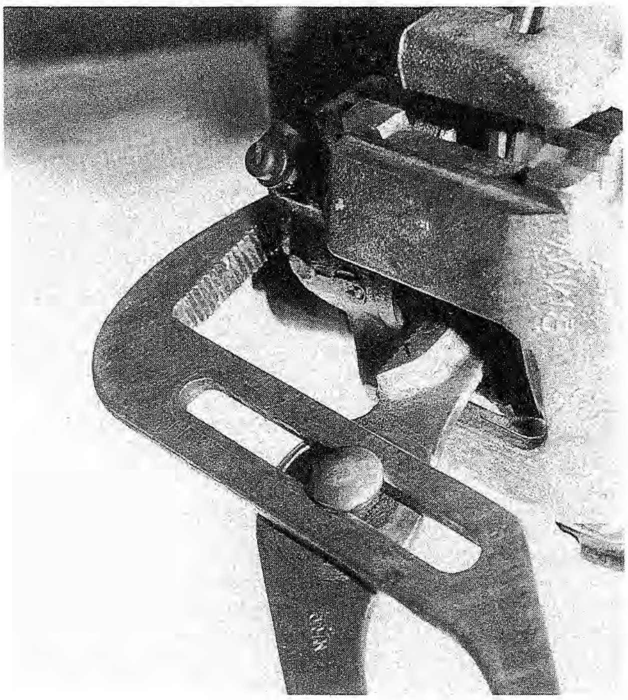

Fig. 5-6. Water pump pliers being used to carefully push piston into caliper.

CAUTION —

Use rags or a scrap of wood to protect the caliper piston from being marred by the jaws of the water pump pliers.

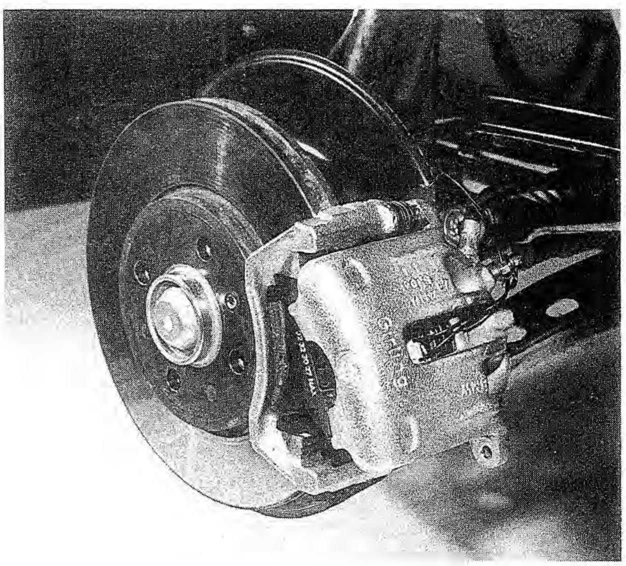

Fig. 5-7. Brake caliper being pivoted into position on pad carrier over brake pads.

NOTE —

Lightly lubricate the wheel hub center with multipurpose grease before installing the wheel.

7. Depress the brake pedal using several short strokes to adjust the caliper and brake pads to the rotor.

8. Check the level of brake fluid in the reservoir. If necessary, add new brake fluid to fill the reservoir to the MAX mark.

WARNING —

New brake pads require some break-in. Allow for slightly longer stopping distances for the first 100 to 150 miles of city driving, and avoid hard stops. See **LUBRICATION AND MAINTENANCE** *for more information.*

Removing, Reconditioning, and Installing Brake Rotors

To remove the brake rotors, first remove the caliper and brake pads as described below in **5.2 Calipers**. Using a hex wrench, remove the mounting screw from between two of the wheel bolt holes, and pull the rotor off the hub. See Fig. 5-8. Use a soft-faced mallet to free a stuck rotor.

CAUTION —

Do not try to remove the rotor without first removing the caliper assembly. Excessive force may damage the rotor or the wheel bearing housing.

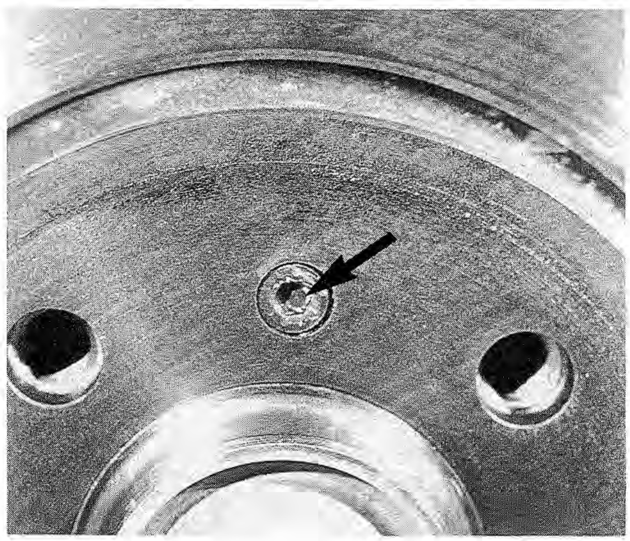

Fig. 5-8. Front rotor mounting screw (**arrow**).

Installation is the reverse of removal. Make sure that the rotor and wheel hub mounting surfaces mate properly and are free of dirt and corrosion.

NOTE —

New replacement brake rotors should be cleaned with a grease-free solvent, such as a commercially available brake cleaner, before installing the caliper and brake pads.

Check the brake rotor for wear anytime the brakes are serviced. Rotors which are scored with sharp ridges, warped, worn irregularly or cracked should be replaced.

Brake rotors should always be resurfaced in pairs, with an equal amount of material removed from both sides of each rotor. **Table b** lists the dimensions for resurfacing solid and ventilated rotors—the minimum thickness of a rotor which can still be resurfaced, the minimum allowable thickness after resurfacing, and the maximum allowable runout. Rotors which fail to meet these requirements should be replaced.

Table b. Front Rotor Reconditioning Specifications

	Solid rotors	Ventilated rotors
Minimum thickness after machining	11.1 mm (0.437 in.)	20.4 mm (0.803 in.)
Wear limit (minimum permissible thickness)	10.7 mm (0.421 in.)	20.0 mm (0.787 in.)
Thickness tolerance (difference between any two measurements)	0.02 mm (0.0008 in.)	0.02 mm (0.0008 in.)
Axial runout (maximum permissible)		
rotor removed	0.05 mm (0.002 in.)	0.05 mm (0.002 in.)
rotor installed	0.20 mm (0.008 in.)	0.20 mm (0.008 in.)

NOTE —
On original equipment rotors, the minimum thickness dimension can be found stamped into the rotor's hub. See Fig. 5-9.

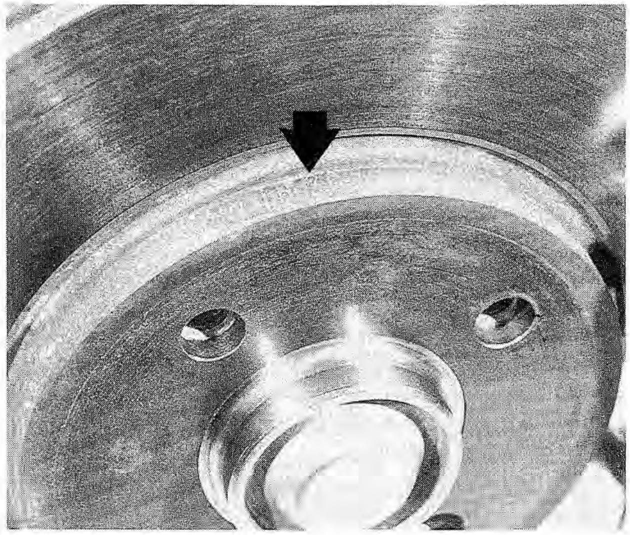

Fig. 5-9. Front rotor minimum dimension stamped on rotor hub (**arrow**).

Use a micrometer to measure the rotor thickness at eight to ten positions along the rotor's braking surface. Rotor runout should be measured using a dial indicator setup. If a low speed shimmy goes away when the brakes are released, excessive rotor runout is probably the cause of the shimmy. If the rotor's runout is within limits, and the shimmy still persists, check the front wheel bearings as described in **SUSPENSION AND STEERING**. Brake rotors can be resurfaced by most local automotive machine shops.

5.2 Calipers

Fig. 5-10 is an exploded view of the front disc brake caliper. The piston seal holds the hydraulic pressure in the system as the piston moves, and also contributes to the caliper's self-adjusting action.

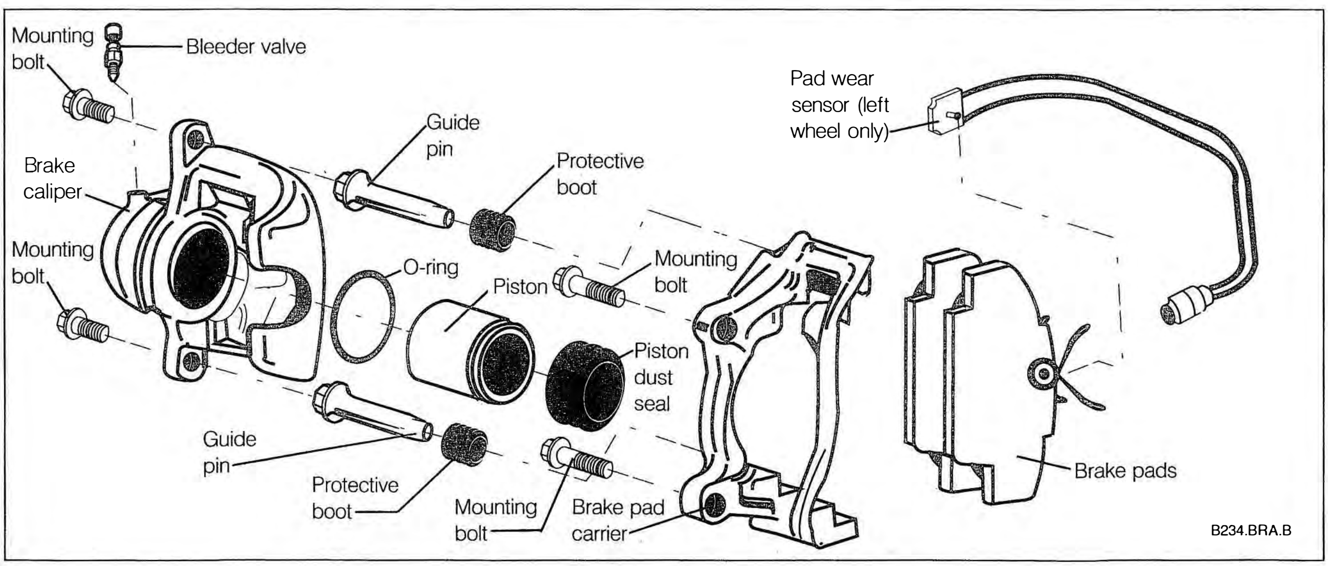

Fig. 5-10. Exploded view of front disc brake caliper.

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The caliper is self-adjusting. When the piston moves and presses on the brake pads, the seal is distorted slightly. When the pressure is removed, the seal returns to its normal shape and pulls the piston back slightly, creating a small gap between pad and rotor to minimize wear. As the pads wear, the seal moves with the piston, so the gap always remains about the same.

Brake fluid leaks around the brake caliper piston are the result of a failed or damaged piston seal, perhaps caused by corrosion, scoring, or pitting of the piston or caliper bore. The seal can be replaced, but a damaged piston will promptly destroy the new seal. To remedy a leaking caliper piston seal and avoid future problems, complete replacement of the caliper is recommended. A damaged caliper dust seal can be replaced separately.

To remove:

1. Raise the front of the car and support it securely on jack stands. Remove the front wheels.

2. When working on the left wheel: Disconnect the pad wear indicator connector as shown above in Fig. 5-2.

3. Loosen the hose fitting on the caliper. Remove the two mounting bolts from the steering knuckle. See Fig. 5-11.

4. Disconnect the brake hose from the caliper by spinning the caliper off the fitting. Drain the brake fluid into a container. Cap the end of the brake line to prevent dirt and moisture from entering the brake system.

CAUTION —

Do not let brake fluid contaminate the brake pads or brake rotor surface.

Installation is the reverse of removal. Start all brake line fittings by hand to avoid cross-threading. Torque the brake hose fitting to 13 to 16 Nm (9 to 12 ft. lb.).

Bleed the brakes as described in **4.2 Bleeding Brakes**. When working on the left wheel: Reconnect the pad wear indicator connector. Torque the caliper mounting bolts to 110 to 123 Nm (80 to 89 ft. lb.).

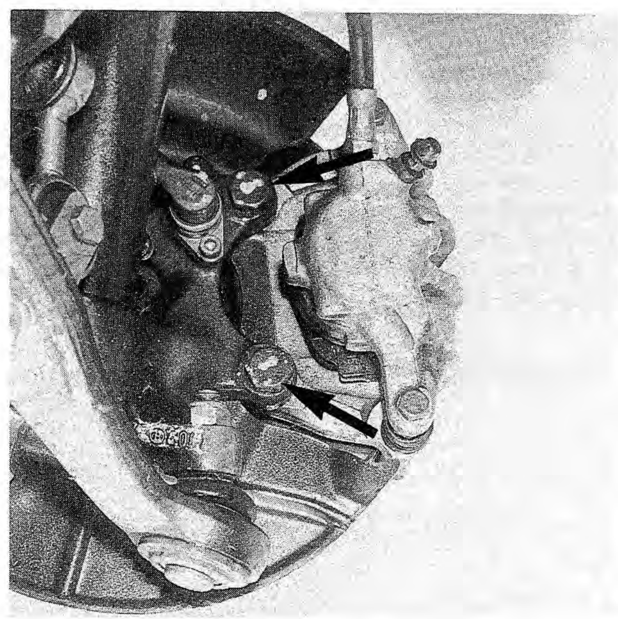

Fig. 5-11. Front brake caliper mounting bolts (arrows).

6. Rear Drum Brakes

Fig. 6-1 is an exploded view of the rear drum brake assembly used on 318i models. Retaining springs hold the brake shoes in place. The shoes rest against a fixed bracket at the top of the backing plate. When the brakes are applied, the wheel cylinder pushes against the bottoms of the shoes to force them against the brake drum. Return springs retract the brake shoes when the brakes are released.

The rear drum brakes are equipped with a self-adjusting mechanism which compensates for wear and thermal expansion. At the bottom of the forward brake shoe, a spring loaded lever rests against an adjusting wheel on the adjusting bar. As the brake lining wears and brake shoe travel increases, the lever automatically advances the adjusting wheel, lengthening the adjusting bar and keeping the brake shoes from retracting too far from the drum.

To prevent the self-adjusting mechanism from making incorrect adjustments when the brake is hot, a thermo-clip is incorporated in the adjusting bar. The thermo-clip changes the length of the adjusting bar based on temperature, to compensate for heat generated by brake friction.

Because the rear brakes do less of the work of stopping the car, they are not likely to wear as quickly or require service as frequently as the front brakes. Unless problems obviously affect only the rear brakes, brake troubleshooting should always include the front brakes. If the rear brakes are worn and require

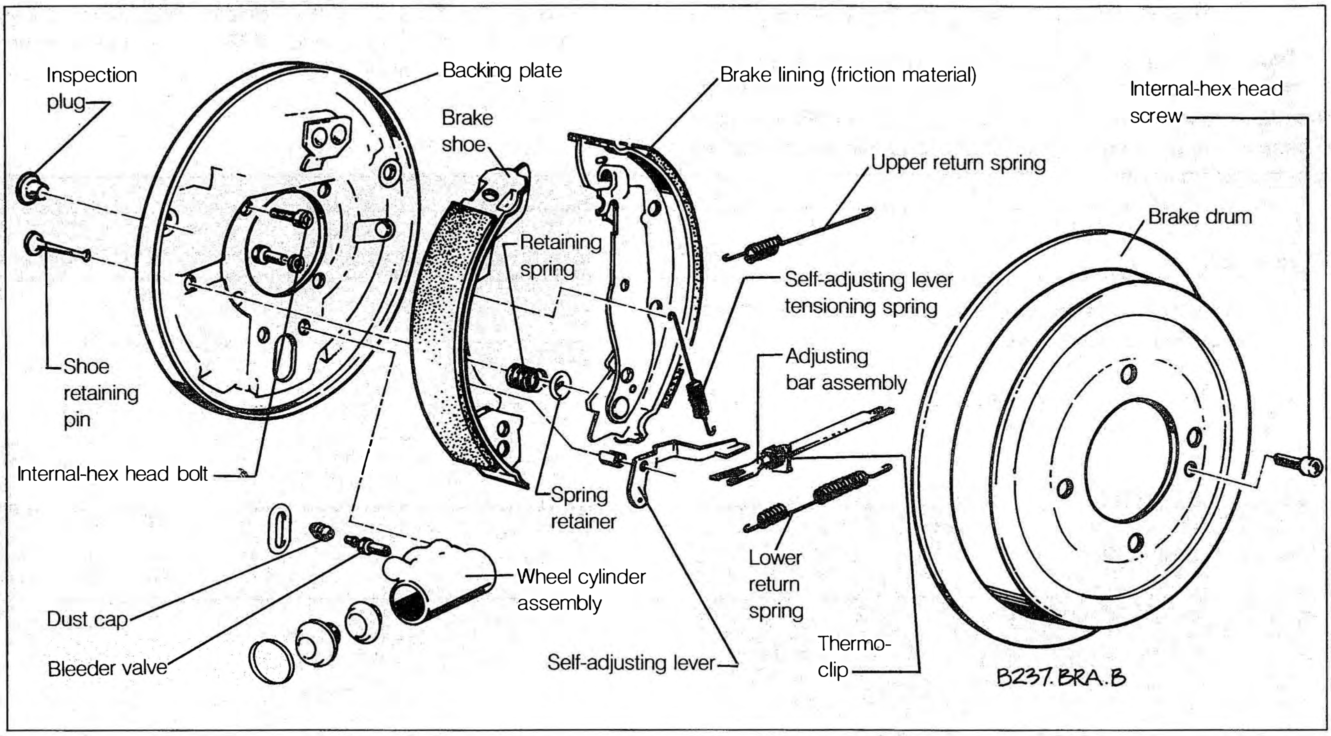

Fig. 6-1. Exploded view of rear drum brake assembly (318i).

service, then at the very least the front brakes should also be thoroughly inspected. The brake shoes, the drums, and the attaching and adjusting parts are subjected to the greatest wear, and are the components most often needing attention.

The brake shoes are designed to be routinely replaced as they wear out. While it is possible to restore the brakes by replacing only the brake shoes, the drums should be resurfaced or replaced at the same time to achieve full braking performance and maximize life of the new linings. The return springs and the adjusting bar thermo-clip should be replaced whenever the brake shoes are replaced.

WARNING —

Brake pad friction materials may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing any asbestos fibers or dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

Checking Brake Lining Wear

The inspection procedure and specifications for checking the brake lining wear are found in **LUBRICATION AND MAINTENANCE**. For more complete inspection of lining condition, the drums must be removed, as described in **6.1 Reconditioning Rear Drum Brakes**.

NOTE —

Although the cars with rear drum brakes covered by this manual incorporate a wear indicator system that illuminates an instrument panel light when the front brake pads need replacement, this system does not notify the driver when the rear brake shoes are worn. It is a good idea to periodically check the brake shoes for wear.

6.1 Reconditioning Rear Drum Brakes

Reconditioning the rear drum brakes typically includes replacing the brake shoes, resurfacing or replacing the brake drums, and replacing the attaching and adjusting hardware. Unless the wheel cylinders or hoses are damaged or leaking fluid, more extensive rear drum brake repairs are not normally required.

If the brake linings are soaked with grease or brake fluid, the cause of the contamination must be found and corrected before new brake shoes are installed. Brake drums must be replaced when they cannot be resurfaced without exceeding specified limits. See **Reconditioning Brake Drums** for specifications.

Removing and Installing Brake Shoes

The brake shoes only need to be removed when they are being replaced. If the backing plate must be removed for other repairs, the brake shoes can remain attached to it. Bleeding the brakes will not be necessary as long as the brake lines or hoses are not disconnected.

To remove:

1. Raise the rear of the car and support it securely on jack stands. Remove the wheels.

2. Remove the internal-hex head mounting screw from the brake drum. See Fig. 6-2.

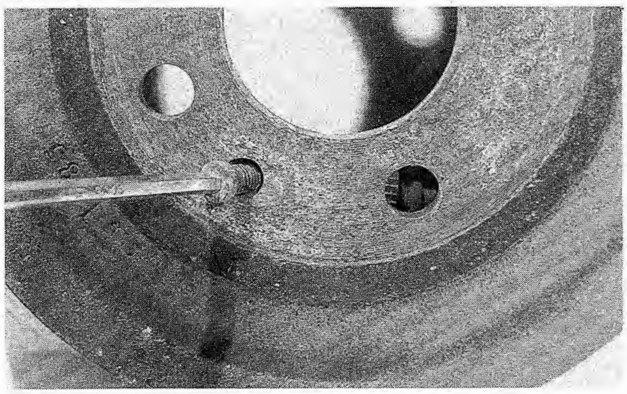

Fig. 6-2. Rear drum brake mounting screw being removed. Brake drum shown removed for clarity.

3. With the parking brake released, rotate the brake drum until the automatic adjusting mechanism can be seen through a wheel bolt hole. Using a screwdriver as shown in Fig. 6-3, rotate the adjusting wheel until the drum can be pulled straight off.

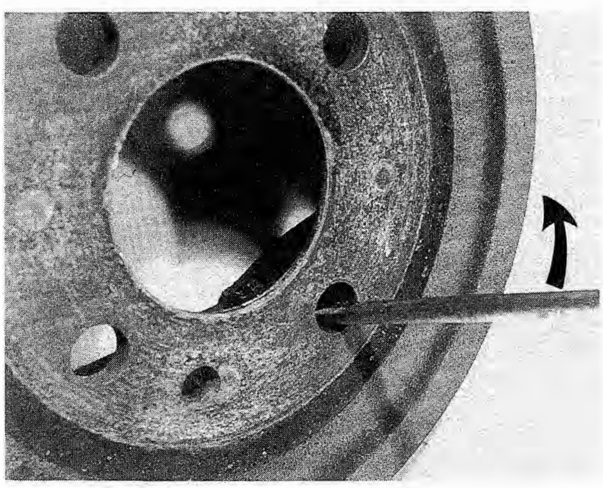

Fig. 6-3. Rear drum brake with screwdriver inserted into wheel bolt hole. Rotate screwdriver in direction of arrow to retract brake shoes.

4. While supporting the head of one shoe retaining pin from behind the backing plate, push the spring retainer in and rotate it 90° to remove it. See Fig. 6-4. Repeat the step for the other retainer.

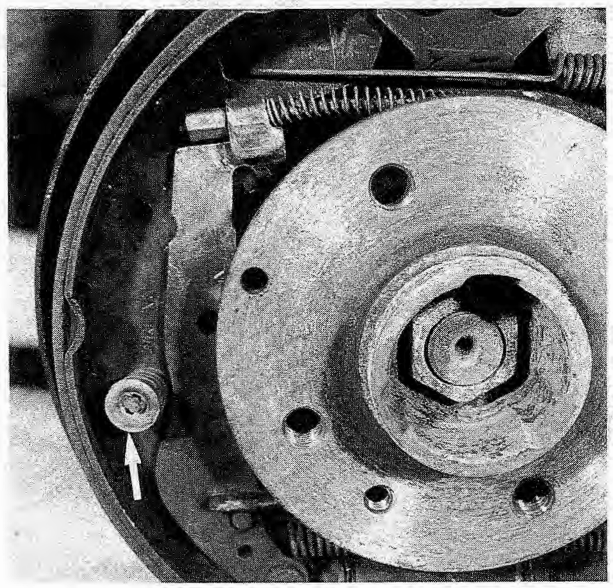

Fig. 6-4. Rear brake assembly brake shoe retaining pin and spring retainer (**arrow**).

5. Unhook the lower return spring from the forward brake shoe. Disengage the lower part of the shoes from the wheel cylinder. See Fig. 6-5.

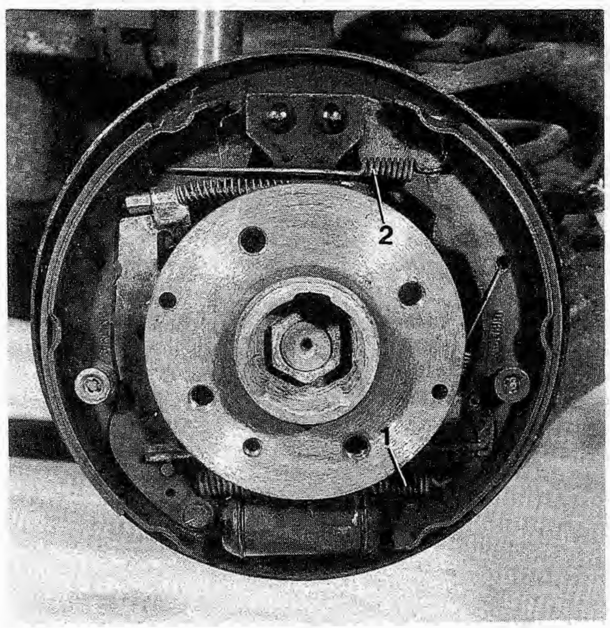

Fig. 6-5. Rear brake lower return spring (**1**) and upper return spring (**2**).

6. Unhook the upper return spring from the forward brake shoe. Pull the shoes away from the backing plate. Unhook the parking brake cable from the top of the rear shoe and remove the shoes. See Fig. 6-6.

CAUTION —

Used brake shoes and brake parts should not be interchanged. If the shoes are to be reused, mark each shoe's position for reinstallation.

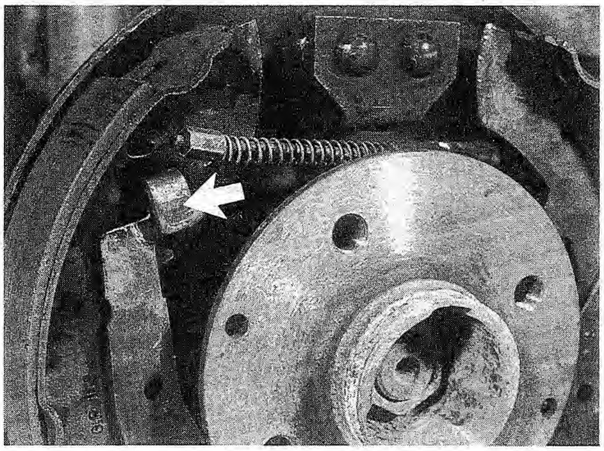

Fig. 6-6. Parking brake cable disconnected from attachment point (arrow) on rear shoe.

To install:

1. Disassemble the automatic adjusting mechanism. See Fig. 6-1, above. Clean the threads of the adjusting pinion and check that the adjusting parts are free of corrosion and that the assembly operates smoothly.

2. Replace the thermo-clip and lightly lubricate the threads before reassembling the mechanism. The thermo-clip compensates for thermal expansion of the brake drum.

CAUTION —

The left and right automatic adjusting mechanisms should not be interchanged. The left-side adjusting rod has a right-hand thread and the right-side adjusting rod has a left-hand thread.

NOTE —

The thermo-clip and both return springs should be replaced.

3. Position the shoes into their installed position. Connect the new upper return spring to the forward shoe. Attach the parking brake cable to the upper part of the rear brake shoe as shown in Fig. 6-7. Connect the upper return spring to the rear shoe.

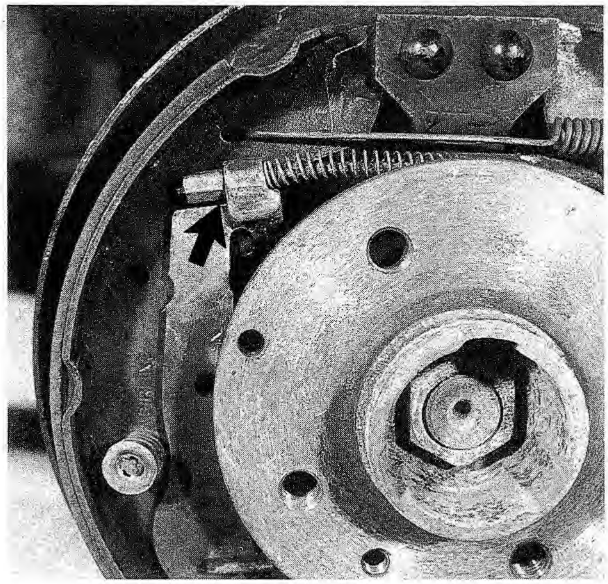

Fig. 6-7. Parking brake cable attached to rear brake shoe (arrow).

4. Install the automatic adjusting mechanism and connect the lever tensioning spring. See Fig. 6-8. Make sure the groove in the thermo-clip engages the self-adjusting lever.

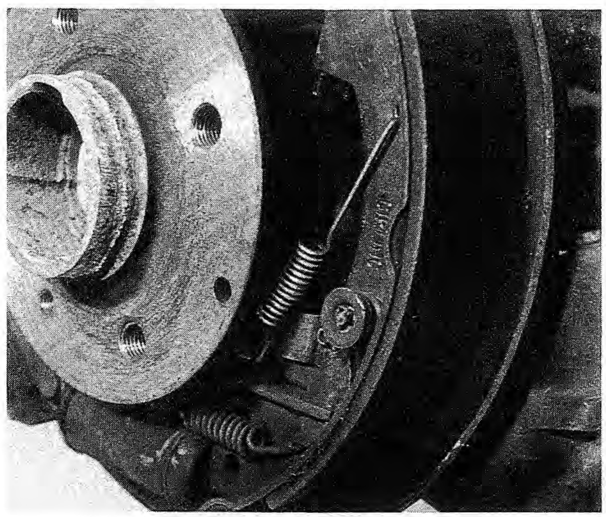

Fig. 6-8. Automatic adjusting lever tensioning spring correctly installed.

5. Install the new lower return spring. See Fig. 6-9.

6. Install the shoe retaining pins, the springs, and the spring retainers. Turn the retainers 90° to lock them in place.

7. Install the brake drum and install and tighten the internal-hex head screw.

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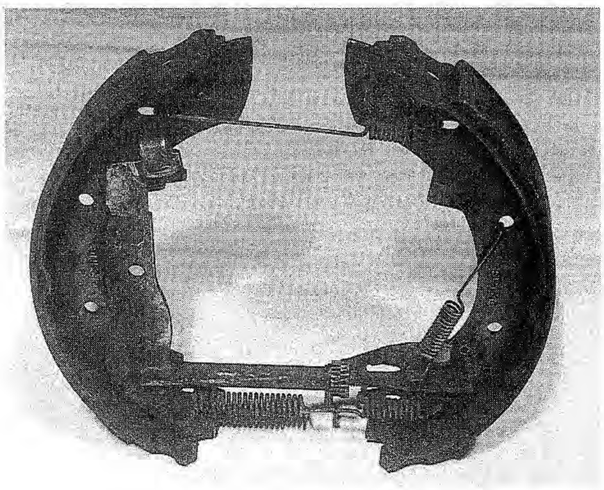

Fig. 6-9. Automatic adjusting mechanism correctly installed to brake shoes. Install lower return spring with bends as shown.

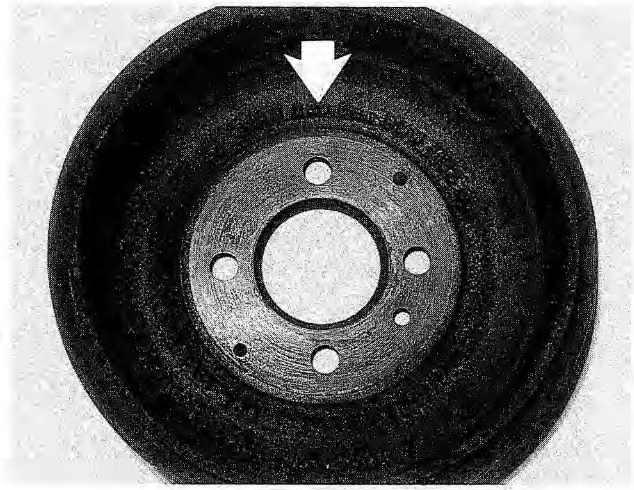

Fig. 6-10. Rear brake drum showing location of stamped drum diameter specifications (**arrow**). Check diameter of drum at several points.

8. Mount the wheels and install the wheel lug bolts. Lower the car and then torque the lug bolts to 100 ± 10 Nm (74 ± 7 ft. lb.).

NOTE —

Lightly lubricate the wheel hub center with multipurpose grease before installing the wheel.

9. After completing the installation on both rear brakes, firmly apply the brake pedal several times to set the self-adjusting mechanism. The mechanism will make a light clicking sound until the brakes are fully adjusted.

WARNING —

New brake linings require some break-in. Allow for slightly longer stopping distances for the first 100 to 150 miles of city driving, and avoid hard stops. See **LUBRICATION AND MAINTENANCE** *for more information.*

10. Check the adjustment of the parking brake cable as described in **6.2 Parking Brake (Drum Brakes)**.

Reconditioning Brake Drums

Both rear brake drums should be resurfaced whenever new brake shoes are installed. The brake drums can be resurfaced to a maximum inside diameter of 229.5 mm (9.035 in.). See Fig. 6-10. Drums which exceed the maximum diameter are too thin to be reliably used and should be replaced. Check the drum's warping or radial runout (out-of-round) using a dial indicator. If runout exceeds 0.05 mm (0.002 in.), the drum should be replaced.

If a warped drum is suspected, the parking brake can be used to quickly check for excessive runout. While driving at approximately 15 mph, apply light pressure to the parking brake. If a thumping or vibration is felt, the drum is probably excessively warped.

Brake drums can be resurfaced by most local automotive machine shops. Torquing a wheel to a brake drum changes its shape slightly. If possible, the drums should be resurfaced with a wheel mounted to the drum and the wheel lug bolts torqued to 100 ± 10 Nm (74 ± 7 ft. lb.).

Inspecting and Replacing Wheel Cylinder

The wheel cylinder is mounted at the bottom of the backing plate between the brake shoes. It is reached by removing the brake drum as described in **Removing and Installing Brake Shoes**. Inspect the wheel cylinder by observing the action of the brake shoes while an assistant slowly depresses the brake pedal a small amount. Replace the cylinder if the pistons stick, or if the brake shoes do not move an equal distance at a uniform rate. Also replace the cylinder if there are signs of brake fluid leakage under the dust boot. To replace a wheel cylinder the brake line must be disconnected, and it will be necessary to bleed the brakes. See **4.2 Bleeding Brakes**.

NOTE —

When the brake drum is removed, insert two screwdrivers behind the backing plate flange and press them against the brake shoes to limit their travel.

To replace the wheel cylinder, first remove the brake shoes as described in **Removing and Installing Brakes Shoes.** Disconnect the brake line from the cylinder behind the backing plate. Cap the brake line to prevent contamination. Remove the two bolts that hold the wheel cylinder to the backing plate, and remove the wheel cylinder.

> ***CAUTION***
> *Do not let brake fluid contaminate the brake shoes or brake drum surface.*

Installation is the reverse of removal. Tighten the wheel cylinder mounting bolts to 9 to 10 Nm (6.5 to 7 ft. lb.). Torque the brake line union to 10 to 15 Nm (7 to 11 ft. lb.). Install the brake shoes as described in **Removing and Installing Brake Shoes**, and bleed the brakes as described in **4.2 Bleeding Brakes.**

6.2 Parking Brake (Drum Brakes)

The parking brake lever and its cable connections are shown in Fig. 6-11. The mechanical parking brake operates only on the rear wheels, and is independent of the hydraulic brake system. Each of the two parking brake cables is connected to a lever on one of the rear brakes shoes. See Fig. 6-7 above. When the parking brake is applied, the brake shoes are forced out against the brake drum. A parking brake switch located under the parking brake lever activates the parking brake indicator light when the parking brake lever is pulled up.

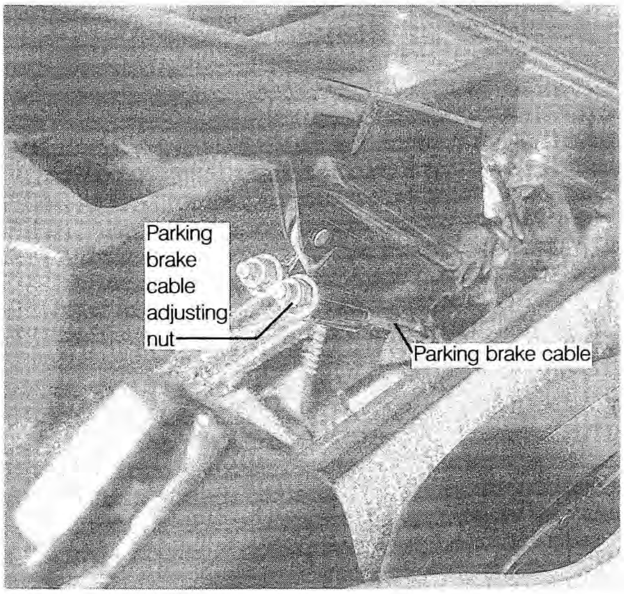

Fig. 6-11. Parking brake lever assembly showing cable connections and adjustment points.

Adjusting Parking Brake

Adjusting the parking brake should only be necessary if a cable is replaced. Failure of the brake to hold the car most likely indicates worn brake shoes or a faulty self-adjusting mechanism. Check to see that the parking brake functions properly whenever the cables have been detached for rear brake service.

To adjust:

1. Raise the rear of the car and support it securely on jack stands.
2. With the parking brake fully released, firmly apply the brakes several times.
3. Move the parking brake lever to the fifth detent (click) from the bottom.
4. Tighten or loosen the adjusting nuts by equal amounts just until the rear brake shoes contact the brake drum. Check that both wheels rotate with the same amount of friction.
5. Release the parking brake and check that both rear wheels rotate freely. Readjust if necessary.

Replacing Parking Brake Cable

The cables can be replaced separately. Remove the adjusting nut that holds the cable to the parking brake lever. Remove the rear brake drum as described in **Removing and Installing Brake Shoes,** and then unhook the parking brake cable from the lever on the rear brake shoe. Pull the cable and conduit out of the backing plate and remove the cable from the guides and hangers which secure it to the underside of the car.

Remove the old cable from the body working from the wheel end of the cable. Lubricate the new cable with multipurpose grease before inserting it. Feed the cable into the backing plate, and hook the end to the brake shoe. Avoid kinking the cable.

Reinstall the rear brake drum as described in **Removing and Installing Brake Shoes.** At the parking brake lever inside the car, install the adjusting nut and the locknut on the cable and adjust the parking brake as described above in **Adjusting Parking Brake.**

7. Rear Disc Brakes

The components of the rear disc brakes are shown in Fig. 7-1. The rear disc brakes operate in much the same way as the front disc brakes described in **5. Front Disc Brakes**, except that the rear rotor doubles as the brake drum for the parking brake. The rotor is easily removed without having to remove the rear axle bearings.

Because the rear brakes do less of the work of stopping the car, they are not likely to wear as quickly or require service as frequently as the front brakes. Unless problems obviously affect only the rear brakes, brake troubleshooting should always include the front brakes. If the rear brakes are worn and require service, then at the very least the front brakes should also be thoroughly inspected. The brake pads and rotors are subjected to the greatest wear, and are the components most often needing attention.

The brake pads are designed to be routinely replaced as they wear out. While it is possible to restore the brakes by replacing only the brake pads, the rotors should be resurfaced or replaced at the same time to achieve full braking performance and maximize life of the new pads.

WARNING —

Brake pad friction materials may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning the pads with compressed air. Avoid breathing any asbestos fibers or dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

Checking Brake Pad Wear

The inspection procedure and specifications for checking the brake pads are found in **LUBRICATION AND MAINTENANCE**. For more complete inspection of pad condition, the pads must be removed, as described in **7.1 Reconditioning Rear Disc Brakes**.

7.1 Reconditioning Rear Disc Brakes

Reconditioning the rear disc brakes typically includes replacing the brake pads and resurfacing or replacing the brake rotors. Unless the calipers and hoses are damaged, visibly worn, or leaking fluid, more extensive rear brake repairs are not normally required.

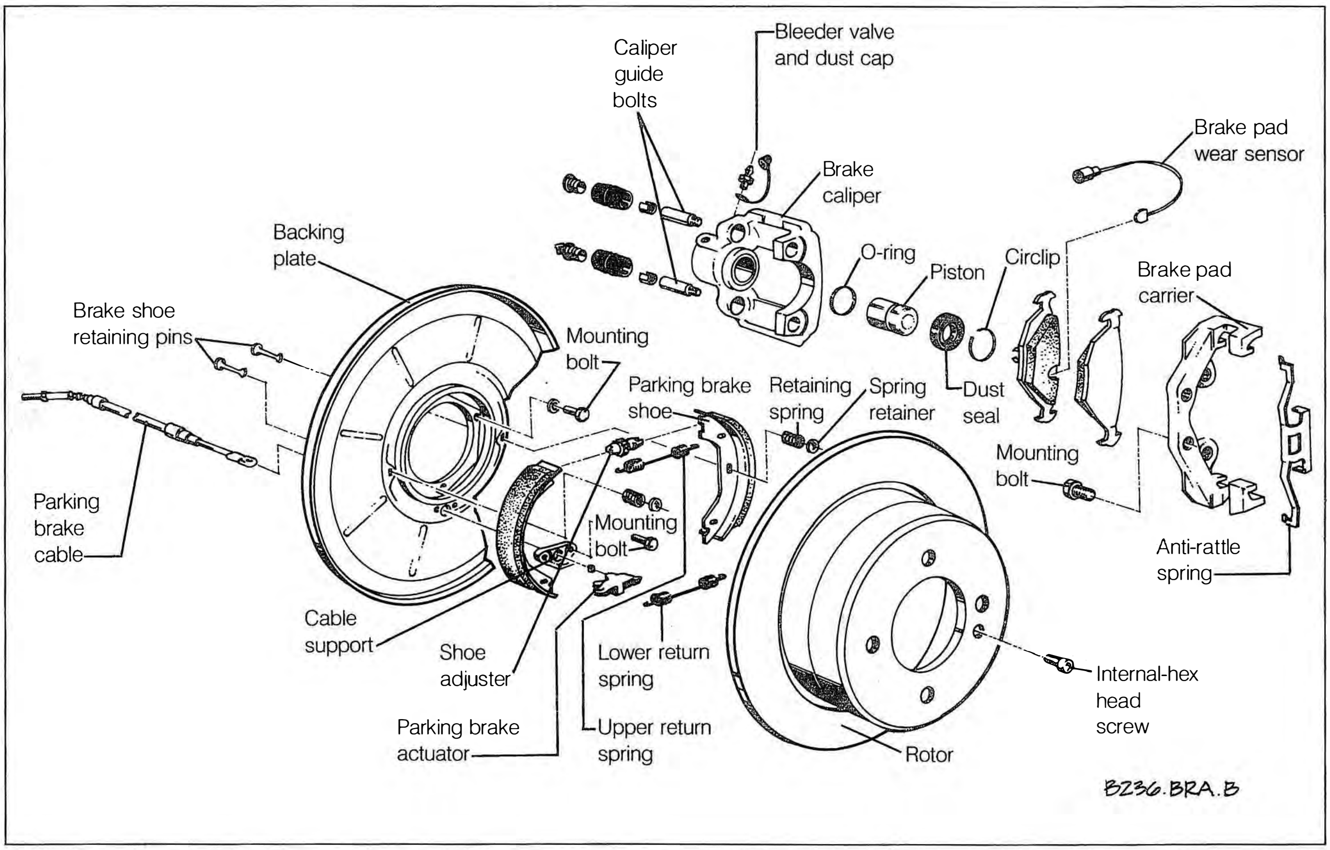

Fig. 7-1. Exploded view of rear disc brake assembly.

If the brake pads are soaked with oil, grease, or brake fluid, the cause of the contamination must be found and corrected before new pads are installed. Brake rotors must be replaced when they cannot be resurfaced without exceeding specified limits. See **Removing, Reconditioning, and Installing Rear Brake Rotors** for rotor thickness specifications.

Removing and Installing Rear Brake Pads

Although the calipers must be removed to change the brake pads, this can be done without disconnecting the flexible brake hose. Keeping the hydraulic system sealed eliminates the need to bleed the brakes afterward.

Brake pads and the surfaces of the rotors wear slightly differently. Always replace brake pads in complete sets. If old pads are to be reinstalled, after inspecting them for example, always make sure they are refitted in their original locations.

To remove:

1. Raise the rear of the car and support it securely on jack stands.

2. Remove the rear wheels. Release the parking brake.

3. Working on the right wheel: Separate the brake pad wear sensor connector and remove the wire from the clip on the guide bolt cap. See Fig. 7-2.

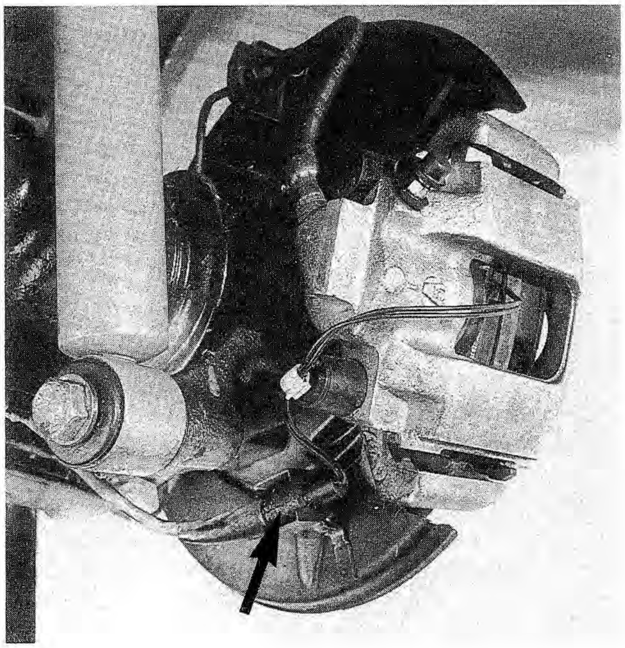

Fig. 7-2. Brake pad wear sensor connector for right-rear wheel (**arrow**).

4. Pry out the two plastic caps which protect the caliper guide bolts. Remove the two internal-hex head guide bolts. See Fig. 7-3.

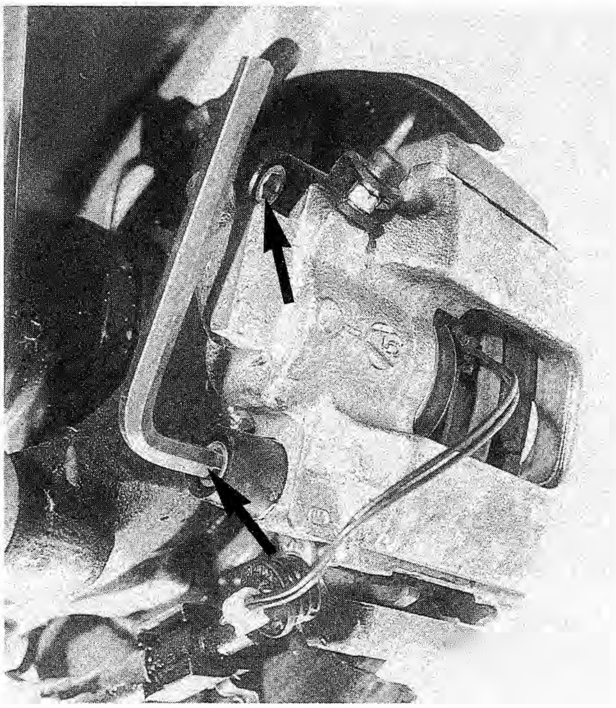

Fig. 7-3. Upper and lower caliper guide bolts (**arrows**) being removed.

5. Remove the anti-rattle spring as shown in Fig. 7-4.

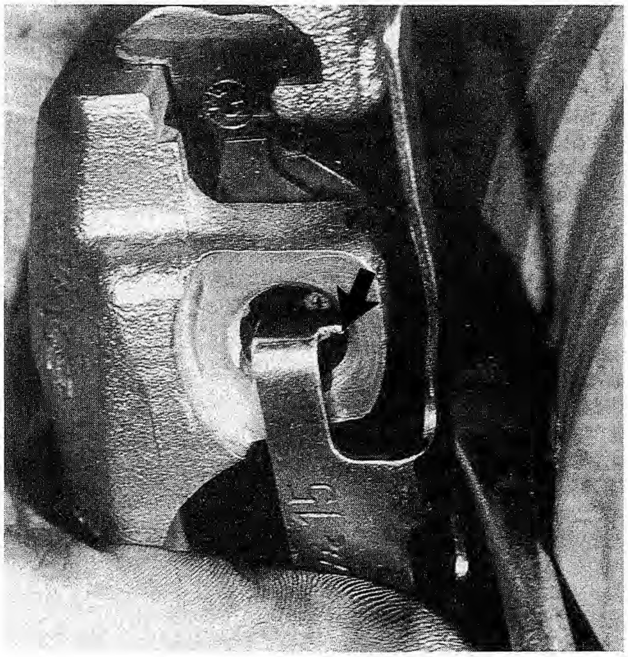

Fig. 7-4. Anti-rattle spring being removed. Unhook spring from caliper housing at arrow.

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6. Pull the caliper straight off the rotor. Lift out the outer brake pad from the pad carrier. Pull out the inner pad from the caliper together with its spring.

CAUTION —

- *Do not let the brake hose support the weight of the caliper. Suspend the caliper and pad carrier assembly from the suspension or body. Avoid stretching or kinking the hose.*
- *Do not interchange used pads. If the pads are to be reused, mark them for reinstallation in their same positions.*

7. When working on the right wheel: Remove and inspect the pad wear sensor. If the plastic housing of the sensor is worn through to the wires by contact with the rotor, the sensor should be replaced. If the brake pad wear indicator light on the instrument panel light came on, the sensor should be replaced.

To install:

1. Place the outer brake pad in position on the brake pad carrier. Place the inner brake pad with its spring into position on the brake caliper.
2. Gently push the piston back into the caliper to provide clearance for the thicker new brake pads. Be careful not to push the piston past the outer edge of the piston dust seal. See Fig. 7-5.

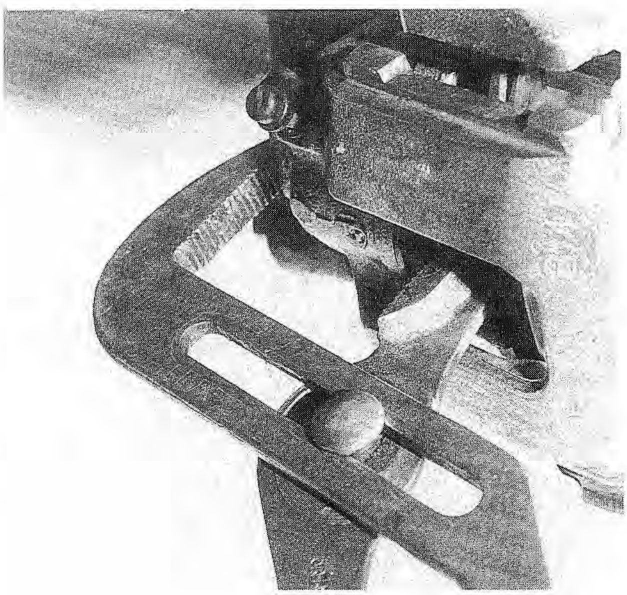

Fig. 7-5. Water pump pliers being used to carefully push piston into caliper.

CAUTION —

Use rags or a scrap of wood to protect the caliper piston from being marred by the jaws of the water pump pliers.

NOTE —

Pushing the caliper piston in to gain clearance for the thicker new brake pads may cause brake fluid to overflow from the master cylinder fluid reservoir. To prevent this, use a clean syringe or some equivalent to first remove some fluid from the reservoir.

3. Carefully inspect the guide bolts. If they are damaged in any way, they should be replaced. Position the caliper onto the brake pad carrier and install the guide bolts. Torque the guide bolts to 30 to 35 Nm (22 to 25 ft. lb.). Install the protective caps.
4. When working on the right wheel: Reconnect the pad wear sensor connector and attach it to the mounting clip. Route the wiring through the clip on the guide bolt cover. See Fig. 7-6.

CAUTION —

If the guide bolt cover is broken or missing, it should be replaced. If the sensor wiring is incorrectly routed, it could be damaged by wearing against the tire.

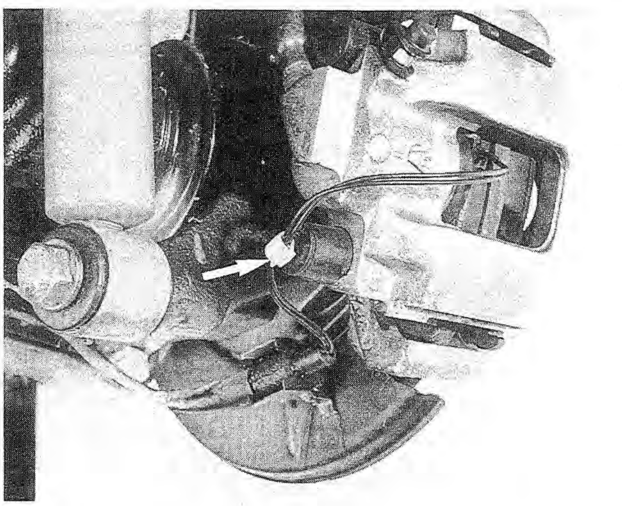

Fig. 7-6. Rear brake pad wear sensor shown correctly routed through clip (arrow).

5. Mount the wheel and loosely install the lug bolts, then lower the car and torque the bolts to 100 ± 10 Nm (74 ± 7 ft. lb.).

NOTE —

Lightly lubricate the wheel hub center with multipurpose grease before installing the wheel.

6. Before running the engine or moving the car, slowly pump the brake pedal using several short strokes to seat the brake pads.

7. Check the level of brake fluid in the reservoir. If necessary, add new brake fluid to fill the reservoir to the MAX mark.

WARNING —
New brake pads require some break-in. Allow for slightly longer stopping distances for the first 100 to 150 miles of city driving, and avoid hard stops.

Removing, Reconditioning, and Installing Rear Brake Rotors

To remove the rear brake rotors, first remove the brake pad carrier mounting bolts from the trailing arm as shown in Fig. 7-7.

CAUTION —
Do not let the brake hose support the weight of the caliper. Suspend the caliper and pad carrier assembly from the suspension or body. Avoid stretching or kinking the hose. If the brake hose remains connected, it will not be necessary to bleed the brakes.

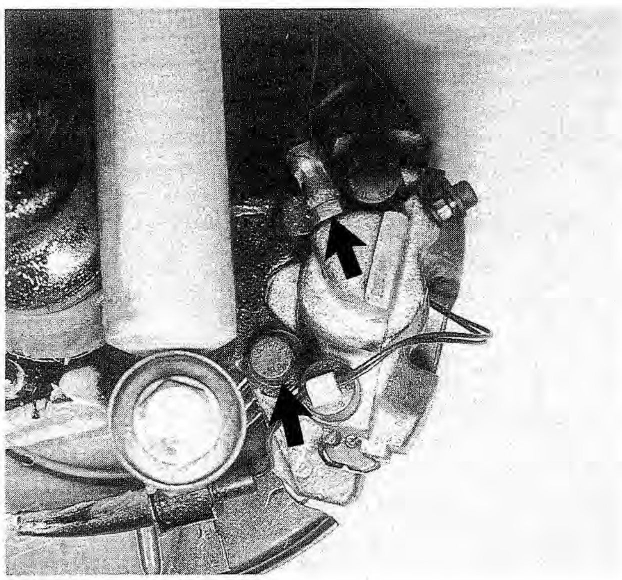

Fig. 7-7. Rear disc brake pad carrier mounting bolts (**arrows**).

Using a hex wrench, remove the mounting screw from the front of the rotor and remove the rotor from the hub. See Fig. 7-8. Use a soft-faced mallet to free a stuck rotor.

Installation is the reverse of removal. Install the rotor and the internal-hex head screw. Install the brake caliper and brake pad carrier assembly to the trailing arm. Torque the pad carrier mounting bolts to 60 to 67 Nm (44 to 49 ft. lb.). After replacing rotors, adjust the parking brake as described in **7.2 Parking Brake (Disc Brakes)**.

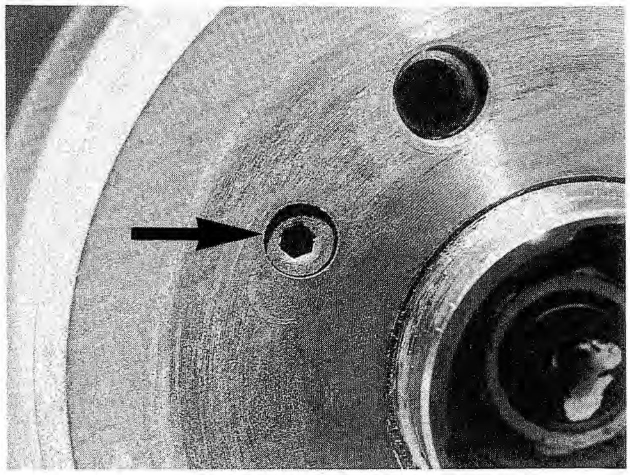

Fig. 7-8. Rear rotor mounting screw (**arrow**).

NOTE —
New replacement brake rotors should be cleaned with a grease-free solvent, such as a commercially available brake cleaner, before installing the caliper and brake pads.

Check the rotors for wear any time the brakes are serviced. Rotors that are scored with sharp ridges, warped, worn irregularly or cracked should be replaced.

Brake rotors should always be resurfaced or replaced in pairs, with an equal amount of material removed from both sides of each rotor. **Table c** lists the dimensions for resurfacing the rear rotors—the minimum thickness of a rotor which can still be resurfaced, the minimum allowable thickness after resurfacing, and the maximum allowable runout. Rotors which fail to meet these requirements should be replaced.

NOTE —
On original equipment rotors, the minimum thickness dimension can be found stamped into the rotor's hub. See Fig. 7-9.

Table c. Rear Rotor Reconditioning Specifications

Minimum thickness	
(after machining)	8.4 mm (0.331 in.)
Wear limit	
(minimum permissible thickness)	8.0 mm (0.315 in.)
Thickness tolerance	
(difference between any two measurements)	0.02 mm (0.0008 in.)
Axial runout	
(maximum permissible)	
rotor removed	0.05 mm (0.002 in.)
rotor installed	0.20 mm (0.008 in.)

Fig. 7-9. Rear rotor minimum dimension stamped on rotor hub.

Use a micrometer to measure the rotor thickness at eight to ten positions along the rotor's braking surface. Rotor runout should be measured using a dial indicator setup. If a low speed shimmy goes away when the brakes are released, excessive rotor runout is probably the cause of the shimmy. If rotor runout is within limits, and the shimmy still persists, check the rear wheel bearings as described in **SUSPENSION AND STEERING**. Brake rotors can be resurfaced by most local automotive machine shops.

7.2 Parking Brake (Disc Brakes)

The parking brake used on models with 4-wheel disc brakes is similar to the system used on the models with the rear drum brakes. A small brake drum is inside the rotor hub and the parking brake shoe assembly is fitted in the drum. See Fig. 7-1 above.

The parking brake lever and its cable connections are shown earlier in Fig. 6-11. The mechanical parking brake operates only on the rear wheels and is independent of the main hydraulic brake system. Each of the two parking brake cables is connected to an actuator lever on one of the rear parking brake shoes. When the parking brake is applied, the brake shoes are forced out against the brake drum.

Adjusting Parking Brake

There is no automatic adjusting mechanism for the parking brake on cars with 4-wheel disc brakes. The parking brake needs periodic adjustment to compensate for wear of the brake linings. The parking brake should also be adjusted if the cable, the brake rotor, or the parking brake shoes are replaced. Check to see that the parking brake functions properly whenever the cables have been detached for rear brake service.

To quickly check the parking brake adjustment, apply the parking brake while counting the number of clicks at the lever. If the brake linings have worn to the point where the parking brake lever can be pulled up further than the eighth detent (click), the parking brake should be adjusted.

To adjust:

1. Raise the rear of the car and support it securely on jack stands. Remove one lug bolt from each rear wheel. Release the parking brake.

2. Position the wheel so that the adjuster (star) wheel is visible through the bolt hole. Insert a screwdriver into the bolt hole and turn the adjuster wheel until the brake shoes just begin to contact the brake drum. See Fig. 7-10. Then back off the brake shoes until they are no longer contacting the drum. (three to four teeth on the adjuster wheel).

NOTE —
When adjusting the left rear wheel, pivot the screwdriver down to retract the brake shoes. When adjusting the right rear wheel, pivot the screwdriver up to retract the brake shoes.

Fig. 7-10. Screwdriver inserted into lug bolt hole on left rear wheel to adjust parking brake shoes. Shown with brake drum removed for clarity.

3. Set and release the parking brake three times to stretch and seat the cables. Then pull the lever up to the fifth detent (click) from the bottom.

4. Working inside the car, tighten or loosen the parking brake cable adjusting nuts by equal amounts just until the rear brake shoes contact the brake drum. See Fig. 6-11 above. Check that both wheels rotate with the same amount of friction.

NOTE —

When adjusting the left rear wheel, pivot the screwdriver up to expand the brake shoes. When adjusting the right rear wheel, pivot the screwdriver down to expand the brake shoes.

5. Release the parking brake and check that both rear wheels rotate freely. Readjust if necessary.

6. Loosely install the lug bolt. Lower the car and torque the lug bolts to 100 ± 10 Nm (74 ± 7 ft. lb.).

Replacing Parking Brake Shoes

Always replace parking brake shoes in complete sets. Make sure the parking brake is released before beginning. Remove the rear rotor as described in **Removing, Reconditioning, and Installing Rear Brake Rotors**.

Using brake spring pliers, disconnect the lower return spring from the forward brake shoe. While supporting the head of one shoe retaining pin from behind the backing plate, push the spring retainer in and rotate it 90° to remove it. See Fig. 7-11. Repeat the step for the other retainer. Spread apart the lower part of the shoes and lift the shoes out from above.

NOTE —

A special tool (BMW Part No. 34 4 000) is available to remove and install the spring retainers. The tool is available from an authorized BMW dealer parts department.

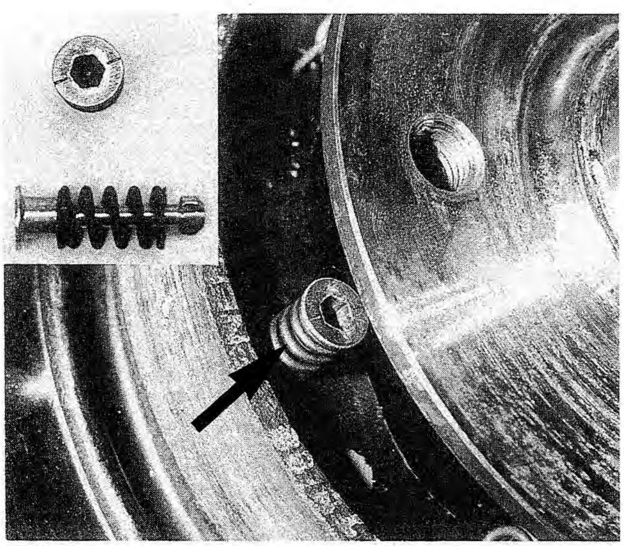

Fig. 7-11. Rear parking brake shoe retaining spring and spring retainer (**arrow**). Inset shows retainer assembly.

Installation is the reverse of removal. Inspect the return springs and replace any that are damaged. Adjust the parking brake as described above in **Adjusting Parking Brake**.

NOTE —

New parking brake linings require a break-in procedure. Begin by making five full stops from a speed of 30 mph. Allow the brakes to cool, then repeat the procedure. This break-in procedure ensures proper seating of the parking brakes.

Replacing Parking Brake Actuator

Remove parking brake shoes as described above. Remove the parking brake actuator by pulling the outer cam from the actuator off towards the rear. See Fig. 7-12. Push out the pivot pin. Disconnect the inner cam from the parking brake cable.

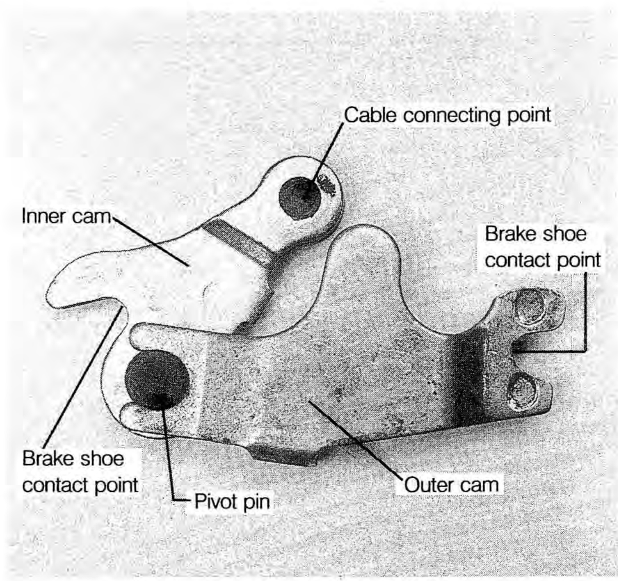

Fig. 7-12. Parking brake actuator components used on cars with rear disc brakes.

Installation is the reverse of removal. Lightly coat the moving parts and the pins with molybdenum disulfide (Molykote G paste or equivalent) grease. Adjust the parking brake as described above, in **Adjusting Parking Brake**.

CAUTION —

Apply grease sparingly. Do not allow grease to contaminate the brake linings.

Replacing Parking Brake Cable

The cables can be replaced separately. Remove the adjusting nut that holds the cable to the parking brake lever. Remove the parking brake shoes and the parking brake actuator as described above in **Replacing Parking Brake Shoes** and **Replacing Parking Brake Actuator**. Unhook the cable from the guides and hangers which secure it to the trailing arm and the body.

Pull the old cable out of the body, working from the wheel end of the cable. See Fig. 7-13. Lubricate the new cable with multipurpose grease before inserting it. Without kinking the cable, feed it through the protective tube and into the passenger compartment. Attach the cable to the guides and hangers which secure it to the trailing arm and the body. Insert the cable end into the brake backing plate. At the parking brake lever inside the car, make sure the cable is correctly routed through the lever. Install the adjusting nut on the cable. Reinstall the wheel actuator and the brake shoes as described below. Adjust the parking brake as described above in **Adjusting Parking Brake**.

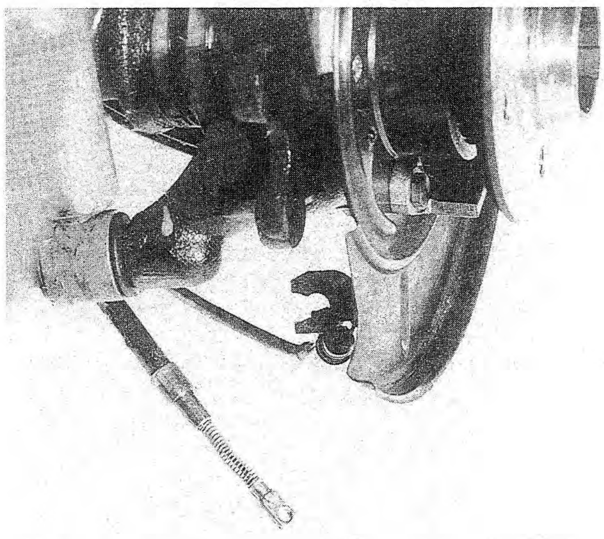

Fig. 7-13. Parking brake cable removed from backing plate.

7.3 Calipers

Fig. 7-14 is an exploded view of the rear disc brake caliper. Brake fluid leaks around the brake caliper piston are the result of a failed or damaged piston seal, perhaps caused by corrosion, scoring, or pitting of the piston or caliper bore. The seal can be replaced, but a damaged piston will promptly destroy the new seal. To remedy a leaking caliper piston seal and void future problems, complete replacement of the caliper is recommended. A damaged caliper dust seal can be replaced separately.

To replace a caliper, loosen the brake hose fitting at the caliper. See Fig. 7-15. Remove the two brake pad carrier mounting bolts from the trailing arm, as shown above in Fig. 7-7. Remove the caliper from the wheel bearing housing and rotate the caliper to remove it from the hose fitting. Drain the brake fluid into a container. Cap the end of the brake line to prevent dirt and moisture from entering the brake system. When working on the right wheel: Disconnect the brake pad wear sensor and remove the wiring from the guide bolt cover and mounting clip.

CAUTION —
Do not let brake fluid contaminate the brake pads or brake rotor surface.

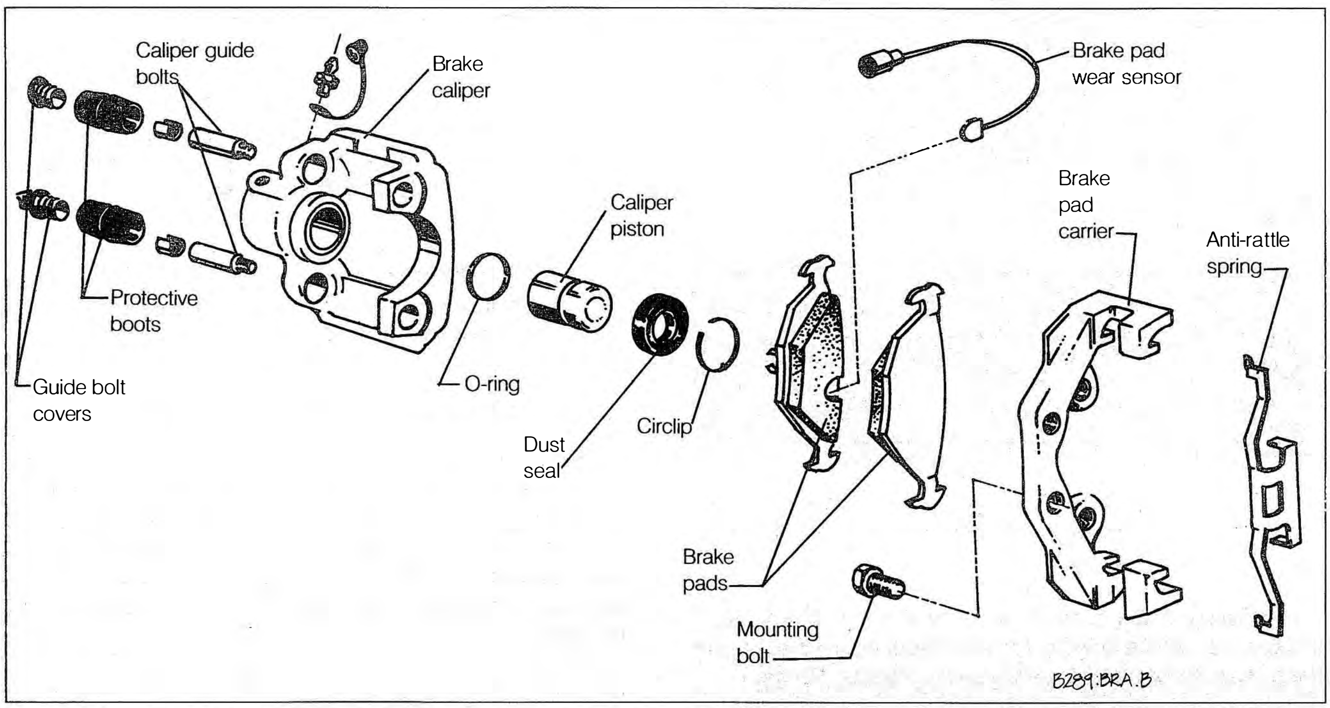

Fig. 7-14. Exploded view of rear brake caliper.

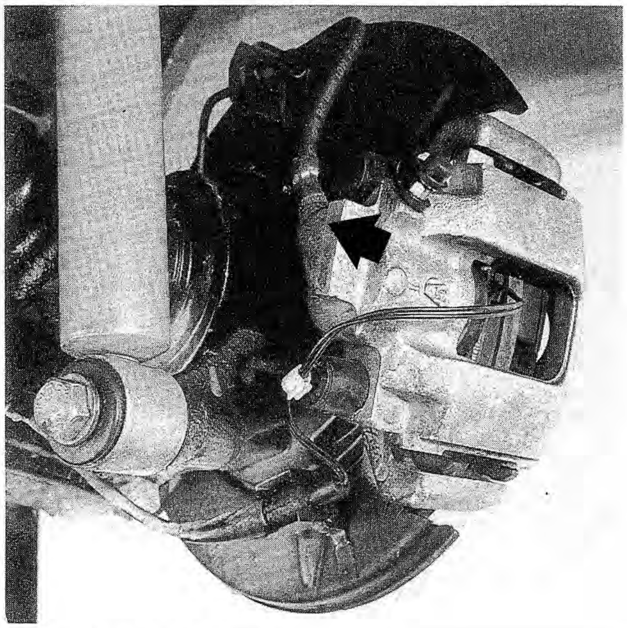

Fig. 7-15. Rear brake caliper brake hose fitting (**arrow**).

Installation is the reverse of removal. Torque the brake hose fitting to 13 to 16 Nm (9 to 12 ft. lb.). Torque the brake pad carrier mounting bolts to 60 to 67 Nm (44 to 49 ft. lb.). Reconnect the brake pad wear sensor and route the wire through the clip on the guide bolt cover. Bleed the brakes as described in **4.2 Bleeding Brakes**.

WARNING —

New brake pads require some break-in. Allow for slightly longer stopping distances for the first 100 to 150 miles of city driving, and avoid hard stops.

CAUTION —

If the guide bolt cover is broken or missing, it should be replaced. If the sensor wiring is incorrectly routed, it could be damaged by wearing against the tire.

8. TECHNICAL DATA

I. Tolerances, Wear Limits, and Settings

Brake rotor, front solid	
thickness after machining (minimum)	11.1 mm (0.437 in.)
wear limit (minimum thickness)	10.7 mm (0.421 in.)
axial runout (maximum permissible)	
rotor installed	0.20 mm (0.008 in.)
rotor removed	0.05 mm (0.002 in.)
thickness tolerance	
(maximum permissible)	0.02 mm (0.0008 in.)
Brake rotor, front ventilated	
thickness after machining (minimum)	23.4 mm (0.921 in.)
wear limit (minimum thickness)	23 mm (0.905 in.)
axial runout (maximum permissible)	
rotor installed	0.20 mm (0.008 in.)
rotor removed	0.05 mm (0.002 in.)
thickness tolerance	
(maximum permissible)	0.02 mm (0.0008 in.)
Brake drum, rear	
inside diameter, maximum	
after resurfacing	229.5 mm (9.035 in.)
radial runout (maximum permissible)	0.05 mm (0.002 in.)
Brake rotor, rear	
thickness after machining (minimum)	8.4 mm (0.331 in.)
wear limit (minimum thickness)	8.0 mm (0.315 in.)
axial runout (maximum permissible)	
rotor installed	0.20 mm (0.008 in.)
rotor removed	0.05 mm (0.002 in.)
thickness tolerance	
(maximum permissible)	0.02 mm (0.0008 in.)

II. Tightening Torques

Front brake caliper to steering knuckle (bolt)	110–123 Nm (80–89 ft. lb.)
Front brake caliper to guide bolt (self-locking bolt)	31–35 Nm (23–25 ft. lb.)
Rear brake caliper to brake pad carrier (guide bolt)	30–35 Nm (22–25 ft. lb.)
Rear brake pad carrier to trailing arm (bolt)	60–67 Nm (44–49 ft. lb.)
Wheel cylinder to backing plate	9–10 Nm (6.5–7 ft. lb.)
Bleeder valve to caliper or wheel cylinder	
7-mm	3.5–5.0 Nm (31–44 in. lb.)
9-mm	4.0–6.0 Nm (35–53 in. lb.)
Brake line unions (union nuts)	10–15 Nm (7–11 ft. lb.)
Brake hose unions (union nuts)	13–16 Nm (10–12 ft. lb.)
Master cylinder to vacuum booster (nut)	22–24 Nm (16–17 ft. lb.)
Vacuum booster to pedal base (nut)	22–24 Nm (16–17 ft. lb.)
Wheel to rotor or brake drum (lug bolt)	100 ± 10 Nm (74 ± 7 ft. lb.)

Section 13

SUSPENSION AND STEERING

Contents

TABLES

Suspension and Steering

Introduction

BMW 3-Series cars are equipped with a strut-type independent front suspension and independent rear suspension with semi-trailing arms. The front suspension struts are integral spring and shock absorber units, while the rear suspension has separate shock absorbers and coil springs.

The power-assisted steering is a rack and pinion steering gear with tie rods connecting to the front suspension steering arms. The rack and pinion design offers superior steering feel and precise control in a compact housing, minimizing weight and space requirements. The steering column is connected to the steering gear by a universal joint shaft.

The front suspension struts and many other parts of the front and rear suspension and the steering can be disassembled for repair, but much of this work requires special tools and experience. If you lack the skills, the tools, or a suitable workplace for suspension and steering work, we suggest you leave such repairs to an authorized BMW dealer or other qualified repair shop. We especially urge you to consult your authorized BMW dealer before beginning any repairs on a car that may be eligible for repairs under BMW's extensive warranty coverage.

1. GENERAL DESCRIPTION

The BMW 3-series suspension and steering systems are engineered to provide a sophisticated compromise between taut, responsive handling and ride comfort. Although the front and rear suspension assemblies are independent sub-systems, and are of completely different designs, they work together to achieve BMW's overall combination of precise handling and comfort. Maintenance, troubleshooting and repair of these systems should always consider the condition of both front and rear suspension, as well as the steering.

1.1 Front Suspension

Fig. 1-1 shows the components of the front suspension system. The lower control arms, sometimes called wishbones, connect the lower ends of the suspension struts to mounting points on the subframe.

Each front suspension strut is an assembly including a shock absorber cartridge inside the tubular strut housing, and a concentrically-mounted coil spring. The lower end of each strut, which includes the stub axle for the front wheel bearing and hub, connects to a ball-joint on the suspension control arm. The front suspension is designed with minimum positive steering offset. This geometry contributes to stability in braking, particularly when traction is unequal from side to side. Suspension travel is limited by rubber bump stops in the strut assemblies.

The three-point mounting of each L-shaped control arm precisely controls the front-to-rear and side-to-side position of the strut, while the flexibility of the joints and mounts also allows the movement necessary for suspension travel. The control arm mounting points are designed with anti-dive geometry. The suspension reduces the normal tendency for the front of the car to "dive" under braking.

Control arm position is fixed, with no adjustment to the control arms for altering front wheel alignment. See **4.2 Alignment** for more information. A stabilizer bar mounted to both control arms helps to reduce body roll when cornering.

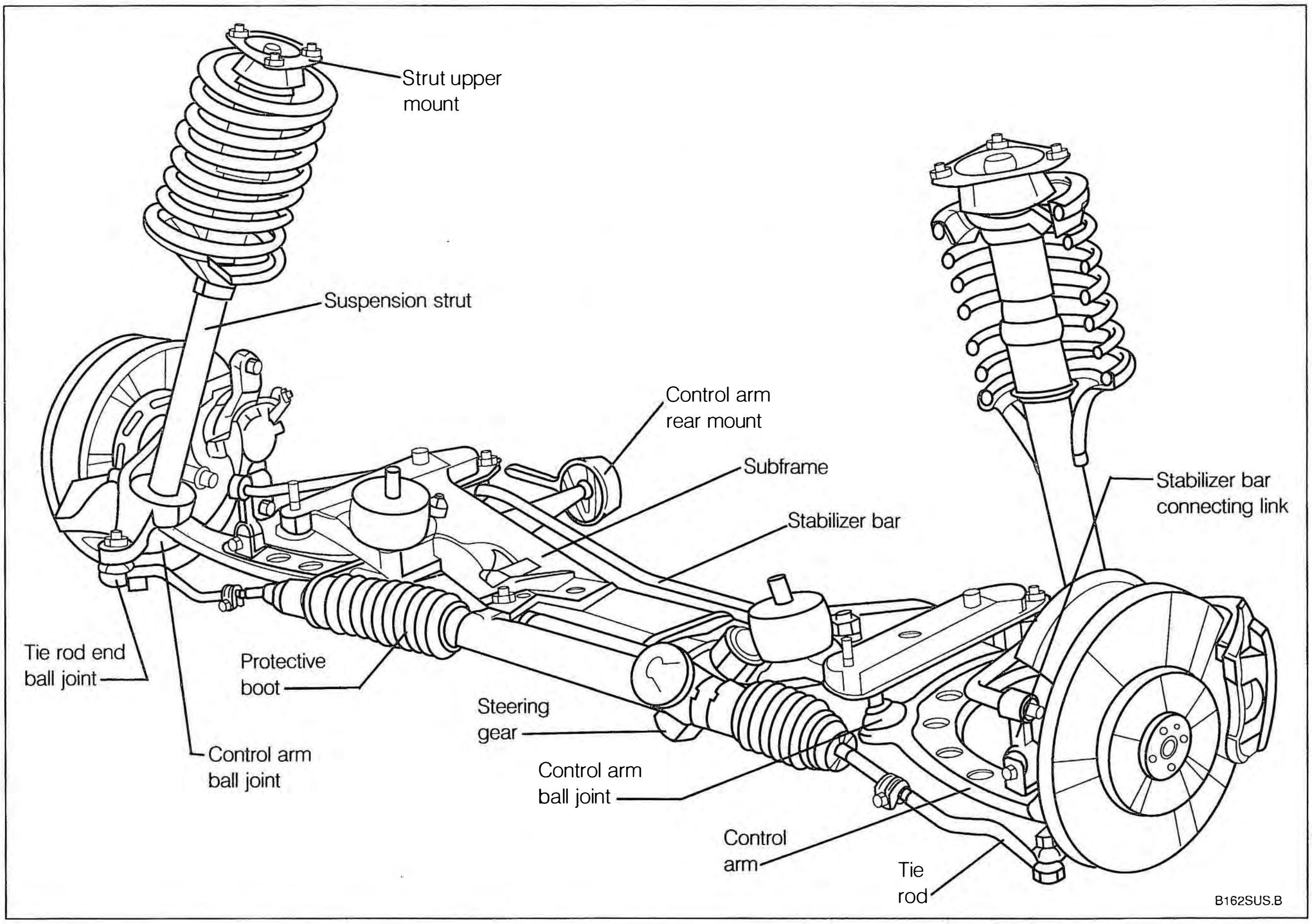

Fig. 1-1. BMW 3-series front suspension.

1.2 Rear Suspension

The BMW 3-series rear suspension is shown in Fig. 1-2. The final drive housing is firmly mounted to the chassis, and the independent suspension allows each rear wheel to react independently to bumps and other suspension loads. The rear suspension is designed with anti-squat geometry. It reduces the normal tendency for the rear of the car to "squat" during acceleration.

The rear axle carrier spans the width of the car and is the main mounting for the final drive housing and the rear suspension. Trailing arms, mounted to pivot points on the rear axle carrier, are the main suspension components. These trailing arms also house the rear wheel bearings. Suspension loads are taken up by separate coil springs and shock absorbers mounted between the trailing arms and the underbody.

1.3 Steering

All models covered by this manual feature a power-assisted steering system, where hydraulic pressure, supplied by an engine-driven pump, reduces steering effort. The two main components of the system are the pressure pump mounted in the engine compartment and driven by a V-belt, and the rack and pinion steering gear, mounted in front of the front suspension subframe. Tie rods connect the steering rack to the steering arms which are an integral part of each front suspension strut.

The power-assisted steering provides varying amounts of assist, depending on engine speed. The fluid flow rate from the pressure pump is highest at low engine speeds, to provide more assist for low speed maneuvers such as parking. It is reduced at higher engine speeds, to prevent over-assist and to maximize road feel at highway speed.

The system also responds to varying amounts of steering effort. When steering effort is high—as when turning the wheels while stopped—the power assist is greater. When steering effort is reduced—when driving on slippery surfaces for example—the amount of power assist is also reduced.

Neither the steering gear nor the tie rod ends require any routine lubrication service during normal service life, and there is no provision for routine adjustment for wear in the mechanical steering gear.

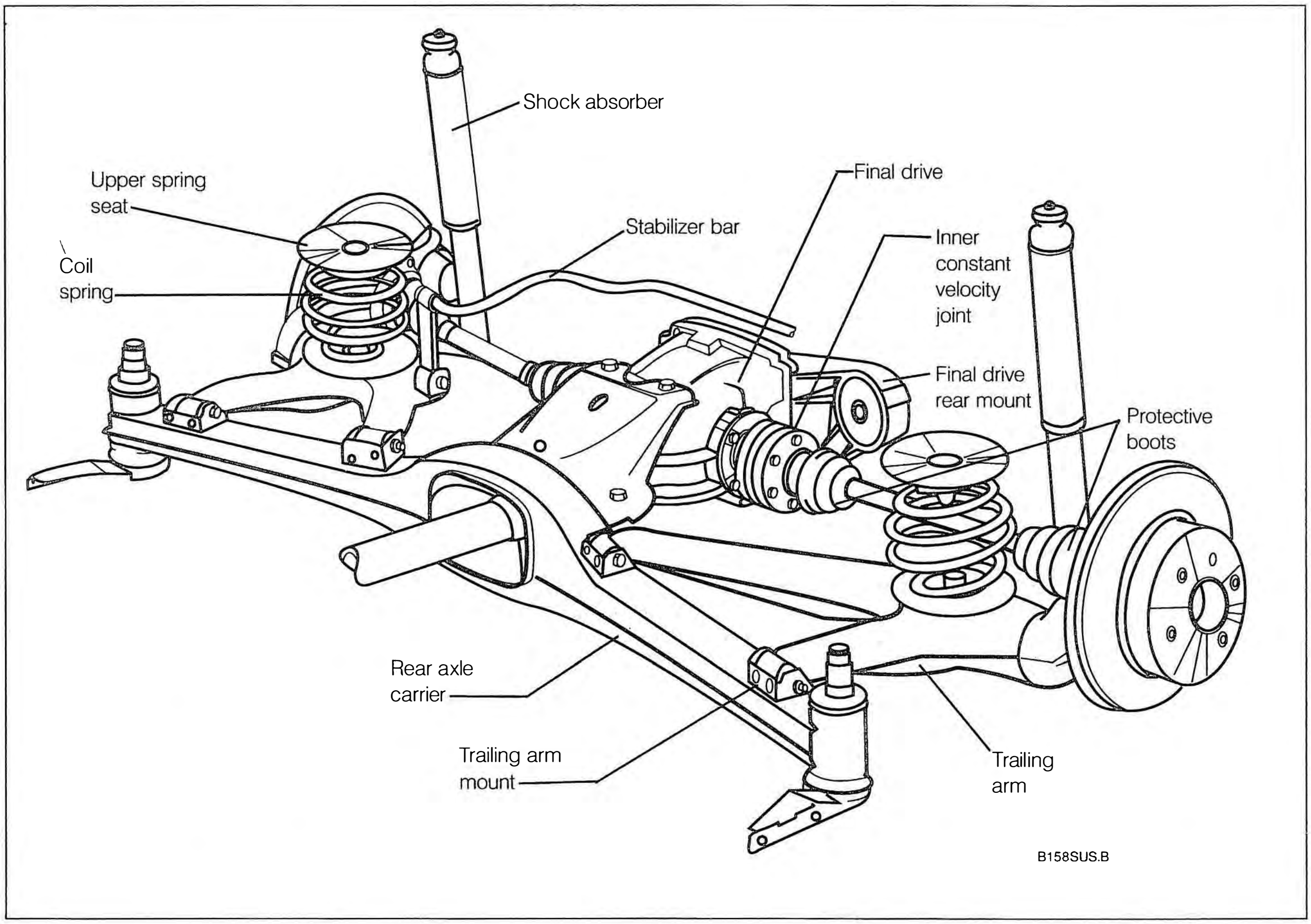

Fig. 1-2. Rear suspension assembly.

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2. MAINTENANCE

Scheduled maintenance includes checking the fluid level for the power-assisted steering, and periodic inspections of the suspension and steering components for wear and damage.

Another periodic requirement is precise adjustment of wheel alignment. This can be done by an authorized BMW dealer service department or other qualified alignment shop. See **4. Wheels, Tires, and Alignment**.

BMW recommends that the following items be routinely checked at periodic intervals as described in **LUBRICATION AND MAINTENANCE**. Detailed descriptions of these maintenance operations can be found either in this section of the manual under the boldface numbered headings shown, or in **LUBRICATION AND MAINTENANCE**.

1. Checking fluid level and checking power steering for leaks

2. Inspecting suspension and control arm joints. **5.2**

3. Inspecting steering gear and steering coupling. **7.2**

4. Inspecting tie rods and tie rod boots. **7.2**

The following additional periodic maintenance is recommended by the publisher of this manual:

5. Inspecting drive axle constant velocity (CV) joint boots. **6.2**

6. Checking tightness of anchor bolts at front suspension subframe. **5.2**

3. TROUBLESHOOTING

This troubleshooting section applies to problems affecting ride comfort, handling and stability, and steering. Such problems are usually caused by faults in the suspension or steering systems, but a problem such as consistently pulling to one side may also be caused by faulty brakes. For brake system troubleshooting, see **BRAKES**. For more basic help in determining the appropriate section for troubleshooting a particular symptom, see **FUNDAMENTALS** at the front of the manual.

3.1 Basic Troubleshooting Principles

Stable handling and ride comfort both depend on the integrity of the suspension and steering. These systems must precisely position the wheels so that the car is stable and controllable, but also allow movement so that the wheels can steer and react to bumps. Any symptom of instability or imprecise road feel may be caused by worn or damaged suspension and steering components.

In addition to inspecting for worn parts, troubleshooting must also consider the condition of tires, wheels, and their alignment. Tire wear and incorrect inflation pressures can dramatically affect handling. Subtle irregularities in wheel alignment angles also affect stability. Mixing different types or sizes of tires, particularly on the same end of the car, can affect alignment and may unbalance a car's handling.

Table a lists symptoms of suspension and steering problems and their probable causes, and suggests corrective actions. The boldface numbers in the corrective action column refer to headings where the repairs are described.

Table a. Suspension and Steering Troubleshooting

Symptom	Probable cause	Corrective action
1. Pull to one side, wandering	a. Incorrect tire pressure	a. Check and correct tire pressures. See **LUBRICATION AND MAINTENANCE**
	b. Defective/unevenly worn tire	b. Inspect tires and replace as needed. **4.1**
	c. Incorrect wheel alignment	c. Check and adjust wheel alignment. **4.2**
	d. Faulty brakes (pull under braking)	d. See **BRAKES**
2. Steering heavy, noisy, poor return-to-center	a. Incorrect tire pressure	a. Check and correct tire pressures. See **LUBRICATION AND MAINTENANCE**
	b. Low power steering fluid	b. Check power steering fluid and add as required. See **LUBRICATION AND MAINTENANCE**
	c. Loose or broken power steering pump V-belt	c. Inspect V-belt. Tighten or replace as necessary. See **LUBRICATION AND MAINTENANCE**
	d. Worn front strut upper mount(s)	d. Remove and disassemble front struts. Replace strut mounts. **5.1**
	e. Worn or damaged steering coupling	e. Replace steering coupling. **7**
	f. Faulty power steering pump	f. Test and, if necessary, replace pump. **7.3**
	g. Air in power steering fluid	g. Repair air leak and, if necessary, add fluid. **7.3**

continued on next page

Table a. Suspension and Steering Troubleshooting (continued)

Symptom	Probable cause	Corrective action
3. Front-end vibration or shimmy	**a.** Incorrect tire pressure	**a.** Check and correct tire pressures. See **LUBRICATION AND MAINTENANCE**
	b. Unbalanced wheels/tires	**b.** Balance tires. Check for uneven wear patterns. **4.1**
	c. Loose wheel lug bolts	**c.** Tighten lug bolts to proper torque. **4**
	d. Bent wheel rim (radial or lateral runout)	**d.** Inspect wheels and replace as necessary. **4**
	e. Tire(s) out-of-round (radial runout)	**e.** Measure tire radial runout and remount or replace as necessary. **4**
	f. Severely worn shock absorbers	**f.** Replace front strut cartridges. **5.1**
	g. Worn or defective control arm rubber mounts	**g.** Replace control arm rubber mounts. **5.4**
4. Steering loose, imprecise	**a.** Incorrect tire pressure	**a.** Check and correct tire pressures. See **LUBRICATION AND MAINTENANCE**
	b. Loose steering rack mounting bolt(s)	**b.** Inspect and tighten bolts. **7.2**
	c. Worn tie rod end(s)	**c.** Replace tie rod(s) and align. **7.2**
	d. Worn control arm joint(s)	**d.** Replace control arm(s) and align. **5.2**
	e. Faulty front wheel bearing	**e.** Replace wheel bearing and hub. **5.3**
	f. Worn or damaged steering coupling	**f.** Replace coupling. **7.1**
	g. Worn or damaged steering gear	**g.** Replace steering gear. **7**
5. Poor stability, repeated bouncing after bumps, suspension bottoms out easily	**a.** Weak shock absorbers	**a.** Replace front strut cartridges and rear shock absorbers. **5.1, 6.1**
6. Suspension noise (especially over bumps)	**a.** Worn front strut upper mount(s)	**a.** Replace strut upper mounts. **5.1**
	b. Loose shock absorber cartridge (in front strut)	**b.** Disassemble strut, check for damage, tighten cartridge. **5.1**
	c. Faulty rubber shock absorber damper	**c.** Replace rubber damper. **5.1**
	d. Worn control arm joints	**d.** Replace control arm(s). **5.2**
	e. Loose or worn stabilizer bar rubber mounts	**e.** Retorque stabilizer bar rubber mounts; replace rubber mounts as necessary. **5.4**
	f. Poorly seated control arm mounts	**f.** Clean front control arm mount tapered seats. See installation procedure at **5.2** for more information
	g. Loose front suspension subframe	**g.** Check for damage; tighten mounting bolts
7. Uneven ride height	**a.** Incorrect coil springs	**a.** Measure ride height and replace springs as required. **5.1, 6.1**
	b. Bent or damaged suspension components	**b.** Inspect and repair/replace as necessary
	c. Sagging coil springs	**c.** Replace front and/or rear springs in pairs. **5.1, 6.1**
8. Front wheel noise, continuous growling, may be more noticeable when turning	**a.** Worn front wheel bearing	**a.** Replace front wheel bearing and hub. **5.3**
9. Rear wheel noise, scraping, dragging	**a.** Worn rear wheel bearing	**a.** Replace bearings. **6.2**
	b. Faulty rear brakes	**b.** See **BRAKES**

3.2 Diagnostic Inspection and Testing

Suspension and steering problems can usually be isolated and at least partially diagnosed by careful observation of the symptoms and inspection of the components which are the most likely cause.

Tire Wear

Tire wear can, over a period of time, be an indicator of suspension and steering problems. Proper tread wear is difficult to notice, so tires are made with wear-indicator bands that indicate when the tire is nearly worn-out. On an evenly worn tire, these wear-indicator bars will eventually appear as evenly spaced bald "stripes" about ½ in. wide running across the tread surface, as shown in Fig. 3-1. The appearance of these tread-wear bands on only one part of the tread indicates uneven wear.

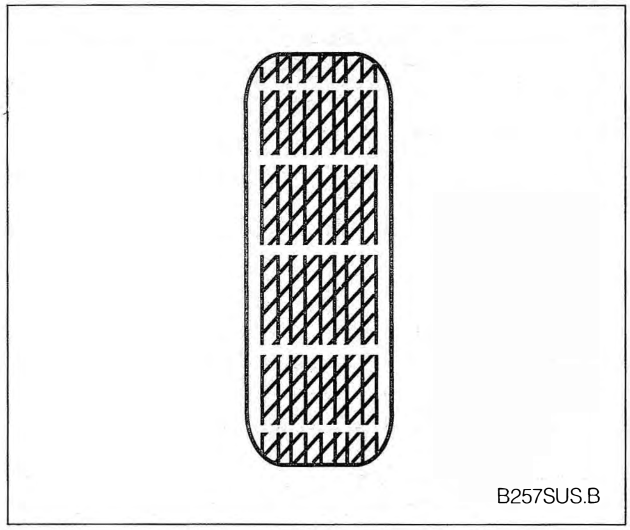

Fig. 3-1. Tire tread wear-indicator bands showing on worn tire indicate that replacement is necessary.

Uneven tire wear is usually caused by improper tire inflation pressures or misalignment. Fig. 3-2 illustrates the influence of inflation pressures on tire wear. Fig. 3-3 illustrates uneven tread wear resulting from prolonged over- or underinflation. For more information on maintaining proper tire inflation pressures, as well as other general tire maintenance, see **LUBRICATION AND MAINTENANCE**.

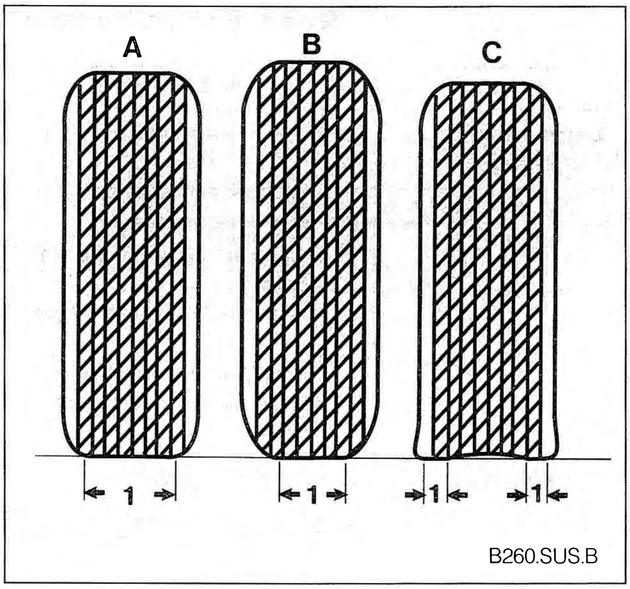

Fig. 3-2. Effect of tire inflation pressure on wear pattern. Condition **A** is normal. Condition **B** is overinflation which causes increased wear in center of tire tread. Condition **C** is underinflation which causes increased wear on outer edges of tire tread. Dimension **1** is tire contact area.

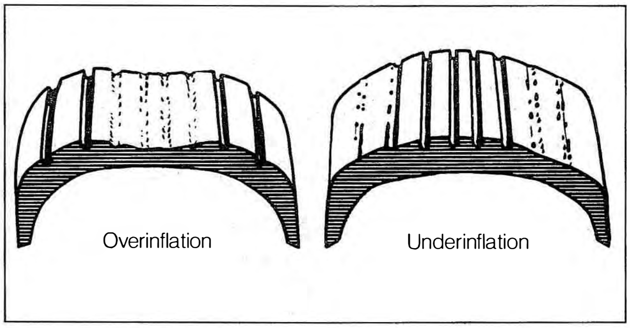

Fig. 3-3. Examples of uneven tread wear caused by overinflated and underinflated tires. Drawings courtesy of Goodyear Tire and Rubber Co.

Other kinds of uneven tread wear may be the result of faulty components or improper alignment. See Fig. 3-4. Tire wear that is uneven across the tread—one side worn more than the other, or unusual wear of individual tread ribs—indicates an alignment problem, and perhaps worn suspension or steering components. Cupping or scalloping—wear that is uneven around the circumference of the tire—is a telltale sign of an unbalanced tire or a worn-out shock absorber.

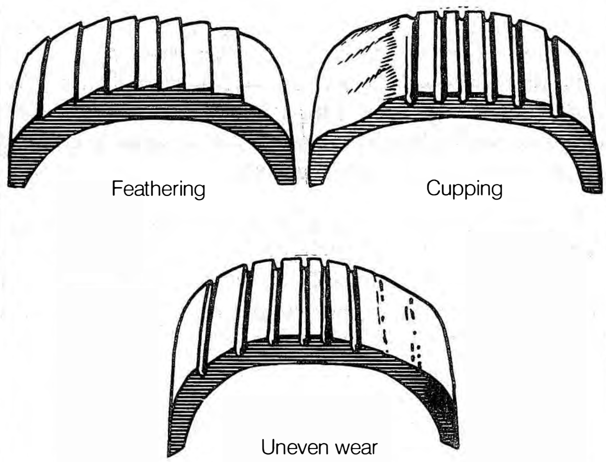

Fig. 3-4. Examples of uneven tread wear caused by misalignment and/or worn or damaged components. Feathering suggests incorrect alignment. Uneven wear on one side suggests incorrect alignment or repeated hard cornering. Cupping results from vibration, often caused by unbalanced tire or faulty shock absorber. Drawings courtesy of Goodyear Tire and Rubber Co.

Isolating Pulling Symptoms

Consistent pulling to one side in a car driven straight ahead on a level road may be caused either by suspension misalignment or by a faulty tire. In more unusual cases, a brake problem may be the cause.

To help decide whether tires or alignment are at fault, temporarily swap the front wheels (and tires), and then road-test the car. If a tire problem is the cause of the pulling symptom, the problem should switch to the other side of the car when the wheels are switched, and it should now pull to the other side. If the symptom persists, then the problem is probably caused by faulty alignment.

Vibration

Abnormal vibration, if not caused by a mechanical problem, will most often be caused by wheels and tires which are out of balance. Another, less likely cause of vibration is a tire which has become distorted and out-of-round. These and other tire conditions can be checked by any reputable tire professional.

Before spending the money for balancing, look for an obvious cause of imbalance. Caked-on mud, ice, or snow can dramatically affect wheel balance. Clean the wheels and tires and road-test the car before investigating more serious causes.

4. Wheels, Tires, and Alignment

For stability and control, wheels and tires must be in good condition and be properly aligned. Tire inflation pressures, tire wear and wheel alignment will all influence how the car feels and responds on the road.

Precise wheel alignment can only be accomplished when the tires, the suspension, and the steering are in good condition. Uneven tire wear, different size tires, or worn suspension and steering parts all affect wheel alignment. Reputable wheel alignment technicians will always inspect the suspension and steering for worn parts before an alignment, and will recommend that any necessary repairs be made first. Alignment of a car with worn suspension and steering parts is a complete waste of time and money.

4.1 Wheels and Tires

Wheels and tires are subject to many stresses. They will perform as intended only if undamaged, properly inflated, and correctly balanced. If properly maintained, tires of the correct size will provide long service with comfort and safety. See **LUBRICATION AND MAINTENANCE** for information on wheel size, tire size, recommended inflation pressures, and other routine tire maintenance.

NOTE —
A thin coating of multi-purpose grease applied to the wheel mounting surface of the brake drum or disc brake rotor will help prevent corrosion.

Wheels

The BMW wheels supplied as original equipment are designed for tubeless, radial-ply tires of a specific size. Replacement tires of non-standard size or construction should be installed only if the tire manufacturer specifies them for your specific make and model. See **LUBRICATION AND MAINTENANCE** for information on the sizes of BMW 3-Series original equipment wheels.

The wheels are sized according to diameter, width, and offset. Offset is the distance between the wheel's mounting surface and the rim's true centerline. When fitting a non-standard wheel with different dimensions, there is danger of wheels or tires interfering with the body or with suspension parts. Even if there is no interference, incorrectly sized wheels may place additional loading on wheel bearings or adversely affect steering geometry. For best results, rely on the advice of your BMW dealer or reputable wheel and tire professionals.

Wheel lug bolts should always be tightened using a torque wrench. Too little torque is obviously dangerous as the wheel may come loose, but excessive torque is also a problem. Over-tight wheel lug bolts can warp the hub, causing vibration and other problems affecting stability and braking. The proper torque value for wheel lug bolts is listed in **Table b**.

Damaged wheels may also be a source of vibration problems. Check for a bent wheel by measuring lateral or radial runout at the part of the wheel where the tire bead meets the rim. Maximum allowable runout values are listed in **Table b**.

Table b. Wheel Bolt-Torque and Runout Specifications

Wheel lug bolt torque	100±10 Nm (74±7 ft. lb.)	
Model	**Lateral Runout (maximum)**	**Radial Runout (maximum)**
1984–1987 (all)	0.5 mm (0.020 in.)	0.5 mm (0.020 in.)
1988–1990 (w/steel wheels)	1.0 mm (0.039 in.)	1.0 mm (0.039 in.)
1988–1990 (w/alloy wheels)	0.6 mm (0.024 in.)	0.6 mm (0.024 in.)

Tires

Radial-ply tires are installed as standard equipment on all cars covered by this manual. To retain the car's excellent handling characteristics, it is recommended that the tires only be replaced with those of the same (radial-ply) construction, size and speed rating.

Winter Tires

Though inferior to regular tires for dry-road wear and handling, winter (mud and snow) tires offer a big improvement on snow-covered winter roads. Studded winter tires improve traction on icy surfaces, but may be more dangerous than non-studded tires on dry roads. They should be used only if icy conditions predominate. Check local laws. Studded tires are restricted or completely prohibited in many states.

WARNING —

If winter tires are to be installed on only two of the four wheels, they should be installed on the rear driving wheels. To avoid creating dangerous handling characteristics, they must be of the same type (radial-ply construction) as those on the front of the car.

4.2 Alignment

Wheel alignment is the precise adjustment of the suspension to ensure that all wheels are oriented correctly, compared to the other wheels, the chassis and the direction of travel. Small changes can have a big effect on how the car drives. Proper alignment provides the best compromise between responsiveness, stability, and tire wear.

Alignment specifications differ from model to model. It is important to use the correct alignment specifications for the specific car. Wheel alignment can also be fine-tuned for specific driving conditions. If, for example, the car normally carries only one person or is often heavily loaded, this information will help the alignment technician. Like tire pressure, wheel alignment also has some influence on fuel economy, because of its potential to affect the tires' rolling resistance. The important alignment angles are camber, caster, and toe.

Camber is the angle at which the wheels tilt away from vertical, as viewed from the front or rear. Camber is illustrated in Fig. 4-1. Wheels tilting in at the top display negative (−) camber. Wheels tilting out at the top display positive (+) camber.

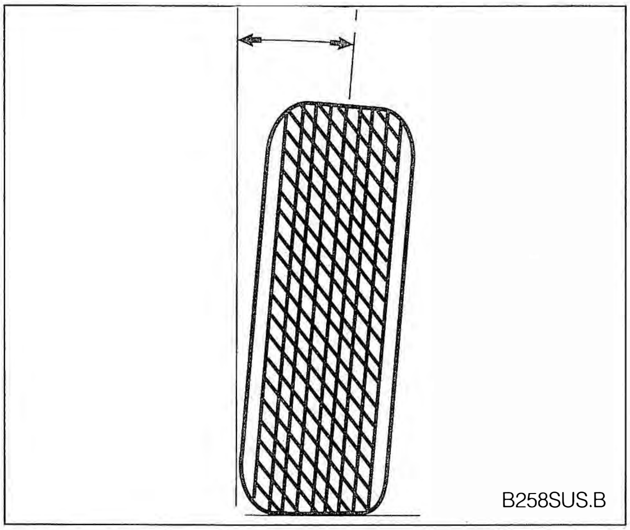

Fig. 4-1. Camber angle viewed from front or rear.

Camber influences cornering and directional stability. A difference in camber between two front or two rear wheels may cause the car to pull to one side. Misadjusted camber will cause uneven tire wear.

On the cars covered by this manual, camber is slightly negative by design and is not normally adjustable. Some camber correction can be achieved on the front wheels with the installation of alternate parts, available from BMW. See **Front Wheel Camber Correction** below.

Caster is the angle at which the steering axis deviates from vertical, illustrated in Fig. 4-2. The steering axis is an imaginary line about which the front wheels turn. Most cars are designed with a steering axis which is inclined toward the rear at the top (positive caster), giving them directional stability and self-centering steering.

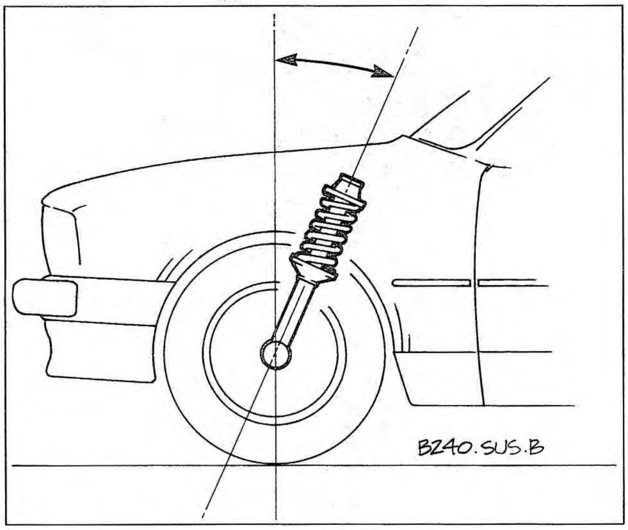

Fig. 4-2. Caster: angle of steering axis inclination from vertical. Caster is non-adjustable on cars covered by this manual.

Caster should be checked as part of any alignment. It is not, however, an adjustable angle on cars covered by this manual. Caster which is out of specification suggests worn or damaged components. Uneven front wheel caster will cause the car to pull to one side. Too little caster reduces directional stability. Too much caster increases turning effort.

Toe is a measurement of the amount that two wheels on the same axle point toward each other (toe-in) or away from each other (toe-out) in their direction of travel. Toe-in is illustrated in Fig. 4-3. Toe is the primary alignment adjustment for cars covered by this manual.

Toe affects directional stability and tire wear, and also has some effect on how the car responds to steering input. Too much toe will cause the tires to "scrub" and to wear unevenly and more quickly. Too little toe—too near zero—may cause the car to be less stable and wander slightly at highway speeds. See **Front Wheel Toe Adjustment** for information on adjusting toe.

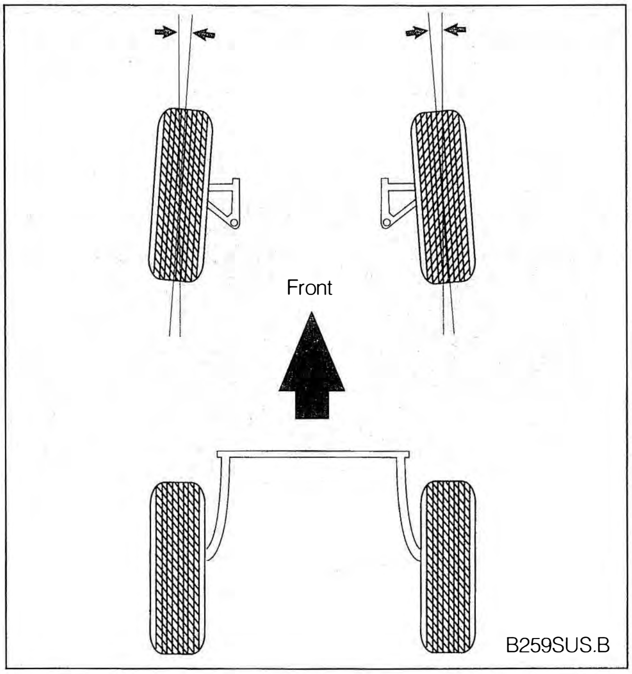

Fig. 4-3. Illustration of toe-in of front wheels. Toe angle is the measurement of how far the wheels point away from the direction of travel. The total toe specification is the sum of the toe angles of both wheels.

Because of the emphasis on precision, wheel alignment has become very sophisticated. Modern computerized equipment, using special optics or laser beams for precise measurement, helps the qualified technician do the job more quickly and more accurately than is possible for the do-it-yourselfer. For this reason, this manual covers only the specific adjustment methods, and not the basic procedures for measuring wheel alignment angles. The reasonable cost of a professional wheel alignment is money well spent.

Four-wheel Alignment

A four-wheel alignment considers not just the individual wheels or pairs of wheels, but also the alignment of the wheels relative to the car's centerline and the relationships between the front and rear wheels. Because of the independent rear suspension design on cars covered by this manual, it is especially important to have all four wheels properly aligned.

Front Wheel Toe Adjustment

Toe at the front wheels is adjusted by changing the length of the steering tie rods. Because camber also affects toe, any camber correction as described in **Front Wheel Camber Correction** below should be made before adjusting toe.

First, center the steering wheel so that the front wheels are pointing straight ahead, as indicated by the alignment of the marks on the steering shaft and steering gear housing. See Fig. 4-4. To adjust toe on each side, loosen the tie rod clamping bolt and thread the two parts closer together or farther apart to shorten or lengthen the tie rod. See Fig. 4-5.

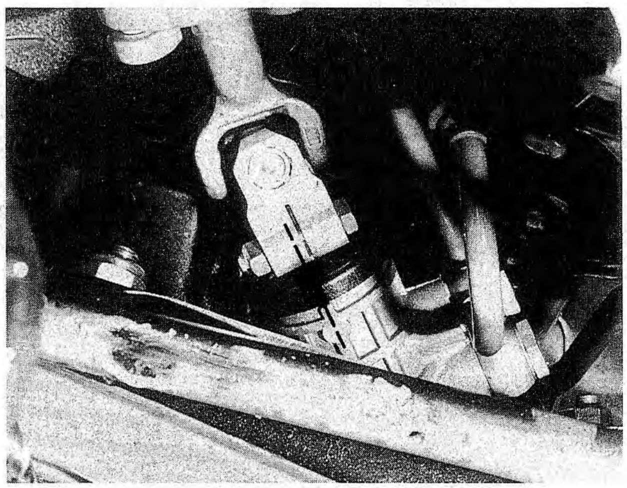

Fig. 4-4. Marks on steering gear housing align as shown when steering gear is centered and front wheels are in straight-ahead position.

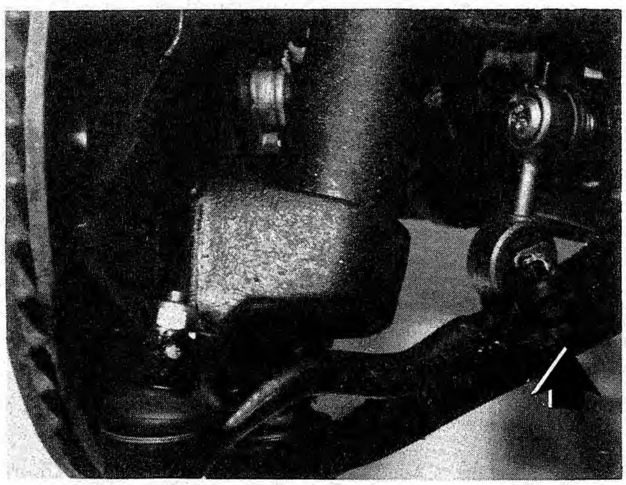

Fig. 4-5. Front wheel toe is adjusted by shortening or lengthening tie rod. Loosen tie rod clamping bolt (arrow) and turn tie rod as shown. (Shown with steering turned off-center for clarity).

NOTE —

Shorten the tie rod to increase toe-in; lengthen it to reduce toe-in.

When the toe on each side is correctly adjusted, tighten and torque the clamping bolts to 14 Nm (10 ft. lb.). Make certain that the rubber boots are not twisted and that the tie rod ends are positioned correctly. See Fig. 4-6.

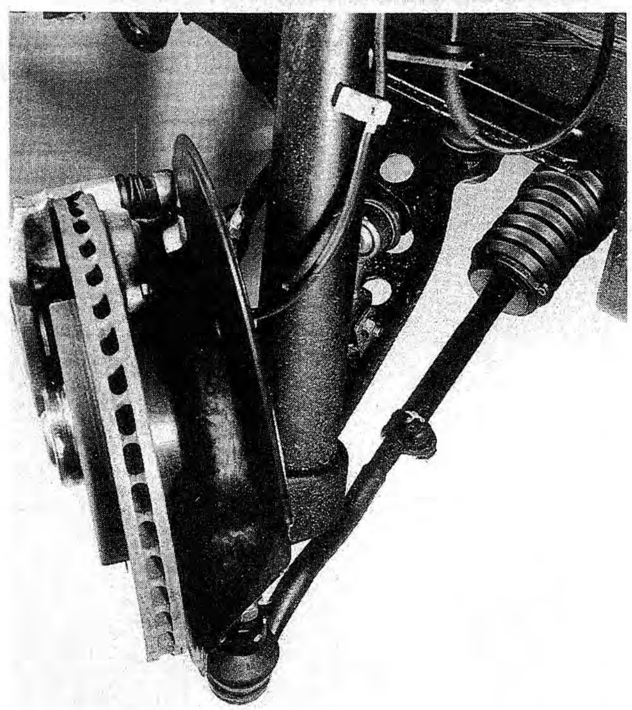

Fig. 4-6. Tie rod end and rubber boot shown in correct position (not twisted).

Front Wheel Camber Correction

Although there is no provision for routine camber adjustment on the BMW 3-series models covered by this manual, some correction is possible for those cases where the measured camber falls outside the specification.

The original three-cornered upper strut mount, shown in Fig. 4-7, can be replaced with an eccentric version which repositions the top of the strut. Depending on the installed position, the new strut mounts add or subtract 30' (½°) of camber.

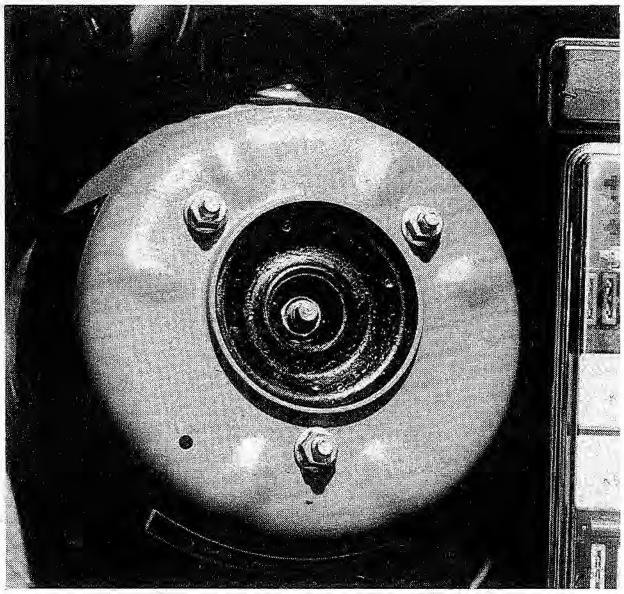

Fig. 4-7. Three mounting points of upper strut mount. Available replacement mount moves strut off-center to alter front wheel camber.

For the cars covered by this manual, the eccentric strut mount is BMW Part No. 31 33 1 127 515. Each mount will also require three new studs, BMW Part No. 31 33 1 124 547. For more information on removing and installing the front suspension struts and replacing the upper mounts, see **5. Front Suspension**.

WARNING —

Eccentric strut mounts should not be installed to try to correct camber measurements which are out of specification due to crash damage.

CAUTION —

BMW part numbers are provided for reference only and are subject to change. Always rely on an authorized BMW dealer parts department for the most up-to-date and accurate parts information.

Rear wheel camber is not adjustable. Rear wheel camber which does not meet specifications suggests damaged components. See **6. Rear Suspension** for more information.

Rear Wheel Toe Correction

Although there is no provision for routine rear wheel toe adjustment on the cars covered by this manual, some correction is possible in those cases where rear wheel toe falls outside the limits of the toe specification.

The correction is made by removing the trailing arm and replacing the outer rubber trailing arm pivot bushing, shown in Fig. 4-8, with an alternate, eccentric version. The eccentric version, BMW Part No. 33 32 9 123 105, repositions the trailing arm slightly, resulting in a toe change.

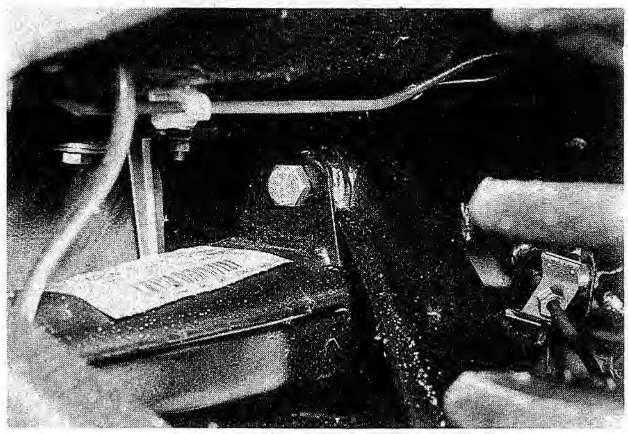

Fig. 4-8. Rear trailing arm pivot bushing (inner). Installation of replacement eccentric bushings can correct rear wheel toe.

The eccentric bushings are marked, indicating increments of change, and can be installed in any position to produce a specific amount of toe correction. In extreme cases, two eccentric bushings can be installed in both pivot points of a single trailing arm for twice as much correction. For information on removing and installing the trailing arms, see **6. Rear Suspension**.

WARNING —

Eccentric bushings should not be installed to try to correct toe measurements which are out of specification due to crash damage.

CAUTION —

BMW part numbers are provided for reference only and are subject to change. Always rely on an authorized BMW dealer parts department for the most up-to-date and accurate parts information.

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4.3 Alignment Specifications

Alignment specifications for all models covered by this manual are listed in **Table c** and **Table d**. These specifications apply only under the following conditions:

1. Correct wheels and tires are installed, in good condition, at the correct inflation pressures.
2. Wheel bearings are in good condition.
3. Ride height is in accordance with specifications.
4. Car is loaded as follows: 68 kg (150 lb.) on each front seat, 68 kg (150 lb.) in the middle of the rear seat, 21 kg (46 lb.) in the trunk, and a full tank of fuel.

NOTE —
Detailed alignment specifications are furnished for reference only. Many of these measurements are beyond the capabilities of anyone but an experienced alignment technician using sophisticated equipment.

Table c. Front Wheel Alignment Specifications*

	1984–1986 (all)	1987–1990 (all except M-Technic sports suspension)	1987–1990 (all with M-Technic sports suspension)
Toe angle (total)	18' ± 05'	18' ± 05'	18' ± 05'
corresponding linear toe measurement	2.0 ± 0.6 mm (0.079 ± 0.024 in.)	2.0 ± 0.6 mm (0.079 ± 0.024 in.)	2.0 ± 0.6 mm (0.079 ± 0.024 in.)
toe difference angle (inside wheel @ 20° lock)	– 1° 40' ± 30'	– 1° 40' ± 30'	– 1° 50' ± 30'
maximum permissible difference between right and left	30'	30'	30'
Camber			
wheels straight ahead	– 40' ± 30'	– 40' ± 30'	– 1° 10' ± 30'
Caster			
@ 10° wheel lock	8° 30' ± 30'	8° 30' ± 30'	8° 46' ± 30'
@ 20° wheel lock	8° 46' ± 30'	8° 46' ± 30'	9° 03' ± 30'
maximum permissible difference between sides	30'	30'	30'
Kingpin Inclination			
@ 10° wheel lock	13° 37' ± 30'	13° 52' ± 30'	14° 22' ± 30'
@ 20° wheel lock	13° 51' ± 30'	14° 15' ± 30'	14° 45' ± 30'
Front Wheel Displacement	± 15'	± 15'	± 15'
Full lock			
inside wheel (approximate)	41.3°	41.3°	41.3°
outside wheel (approximate)	33.9°	33.9°	41.3°

*special measurement conditions apply. See **4.3** above.

Table d. Rear Wheel Alignment Specifications*

	1984–1986 all	1987 318i, 325, 325e	1987 325i	1988–1990 all except Convertible and M-Technic sports suspension	1988–1990 325i Convertible	1988–1990 all with M-Technic sports suspension
Toe angle (total)	18' ± 07'	18' ± 07'	23' ± 07'	20' ± 07'	18' ± 07'	26' ± 07'
corresponding linear toe measurement	2.0 ± 0.8 mm (0.079 ± 0.031 in.)	2.0 ± 0.8 mm (0.079 ± 0.031 in.)	2.6 ± 0.8 mm (0.102 ± 0.031 in.)	2.2 ± 0.8 mm (0.087 ± 0.031 in.)	2.0 ± 0.8 mm (0.079 ± 0.031 in.)	3.0 ± 0.8 mm (0.118 ± 0.031 in.)
maximum permissible deviation from driving direction	15'	15'	15'	15'	15'	15'
Camber						
each side	– 1° 50' ± 30'	– 1° 40' ± 30'	– 2° 15' ± 30'	– 2° ± 30'	– 1° 50' ± 30'	– 2° 30' ± 30'
maximum permissible difference between sides	NA	30'	30'	30'	30'	30'

*special measurement conditions apply. See 4.3 above.

5. FRONT SUSPENSION

The BMW 3-series cars covered by this manual, though renowned for their excellent roadholding and responsive handling, feature a relatively simple front suspension design. The limited number of parts that wear can be easily replaced. Some of these repairs do, however, require special tools and equipment. To avoid starting a job that may be difficult to complete, please read the entire procedure before beginning.

When doing any front suspension maintenance or repair, please observe the following general cautions:

CAUTION

- *Do not install bolts and nuts coated with undercoating wax, as correct tightening torque cannot be assured. Always clean the threads with solvent before installation, or install new parts.*
- *Do not attempt to weld or straighten the suspension struts, the control arms, or the subframe. Replace damaged parts.*
- *Do not reuse self-locking nuts. These nuts are designed to be used only once.*

5.1 Front Suspension Struts

Fig. 5-1 shows the main components of the front strut assembly. These are the strut housing, the shock absorber cartridge, the upper strut mount, and the coil spring. Each of

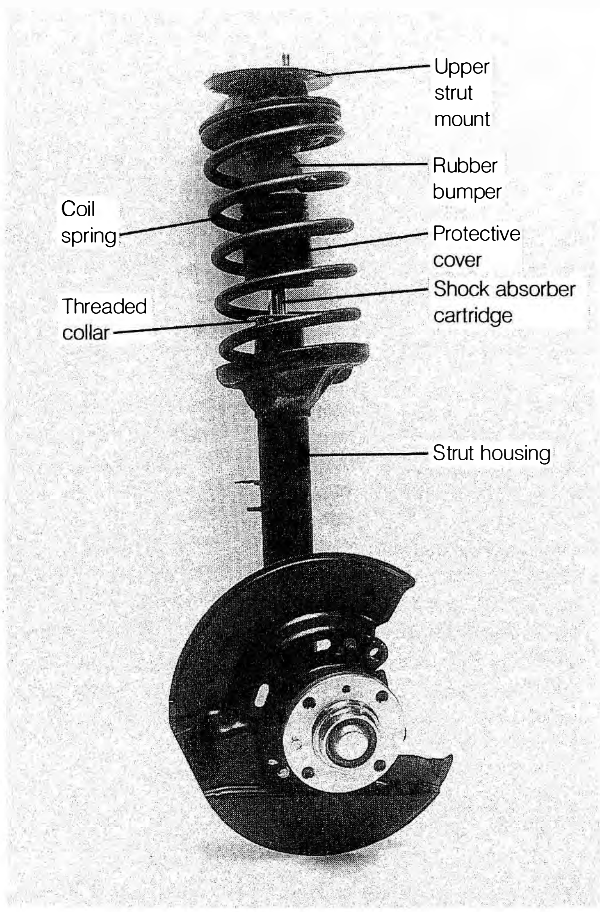

Fig. 5-1. Front suspension strut assembly.

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these main components can be replaced separately as required. The strut housing itself need only be replaced if it is damaged.

The procedures which follow, beginning with **Removing and Installing Front Suspension Struts**, describe in order the steps which should be followed to completely disassemble the strut.

Differences from side to side will affect handling and stability. It is strongly recommended that springs, shock absorber cartridges, or strut mounts be replaced in pairs.

Checking Shock Absorbers

Springs are what support the weight of the car and allow the suspension to travel smoothly over bumps and other road irregularities. A spring, however, absorbs only minor amounts of energy. A spring which is compressed by a bump simply rebounds, springing in the other direction with nearly the same force that compressed it.

The function of a shock absorber, or damper, is to moderate the spring action. It slows the bounce and helps the spring return to its normal position. Shock absorbers require no routine maintenance. An adequate supply of fluid is placed in them during manufacturing to compensate for small leaks. Minor leakage is acceptable if the shock absorber still functions correctly. Shock absorbers cannot be serviced, and need to be replaced when they lose their ability to control the suspension.

The best evidence of failing shock absorbers is their behavior in normal driving. Worn shock absorbers will allow extra skittishness over bumps, and a less-controlled and wallowing feel in corners and after bumps. When seriously worn, the shock absorbers present little resistance to spring oscillations. Because they so easily reach the limits of their travel, they may knock when going over bumps.

The most common—though not entirely accurate—test of shock absorber function involves vigorously bouncing each end or corner of the car, and then releasing and observing how quickly the bouncing stops. More than one bounce usually suggests that the shock absorbers are not properly damping the spring action and need to be replaced.

Some evaluation of a shock absorber's condition can be made by removing and disassembling the strut and checking the shock absorber's resistance to movement. When held vertically, the shock absorber shaft should move firmly and smoothly throughout its entire range of travel. If possible, compare the movement of the shock absorber in question to a new one.

Removing and Installing Front Suspension Struts

The struts can be easily removed for replacement of components. Special tools may be necessary to remove the control arm mount and the tie rod end from the strut. See the procedure below for more information.

> ***CAUTION —***
> *Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.*

The exact mounting of the struts affects wheel alignment. A wheel alignment is highly recommended any time the struts have been removed.

To remove front struts:

1. Loosen the wheel lug bolts, then raise the front of the car and support it securely on jack stands which are designed for the purpose.

2. Remove the wheel.

3. On cars equipped with anti-lock brakes (ABS), disconnect the electrical connections for the ABS sensor. On the left side only, disconnect the electrical connector for the brake pad wear indicator. See Fig. 5-2. Remove these wires from their hold-down on the strut housing.

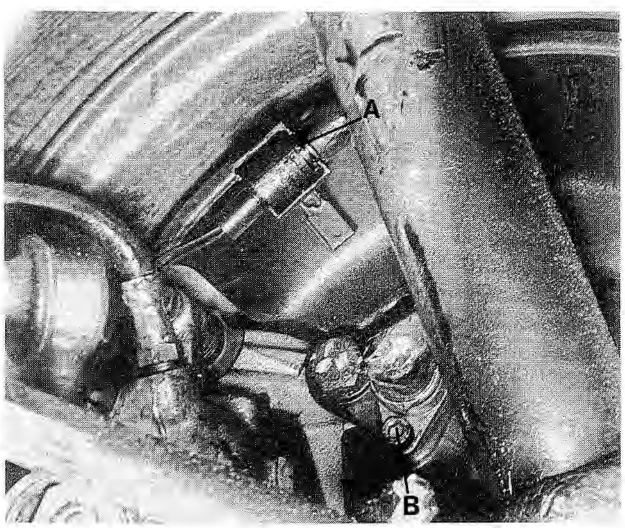

Fig. 5-2. Electrical connection at front strut for brake pad wear indicator (**A**). Internal-hex-head screw (**B**) secures ABS sensor.

4. Using a 5 mm hex wrench, remove the mounting screw and the ABS sensor, shown above in Fig. 5-2.

CAUTION —
Make sure that the ignition is off when removing ABS sensors.

5. Without disconnecting the flexible brake hose, remove the brake caliper mounting bolts shown in Fig. 5-3 and slide the caliper off the brake rotor and strut housing. To avoid kinking or damaging the hose, use stiff wire to suspend the caliper from the underbody.

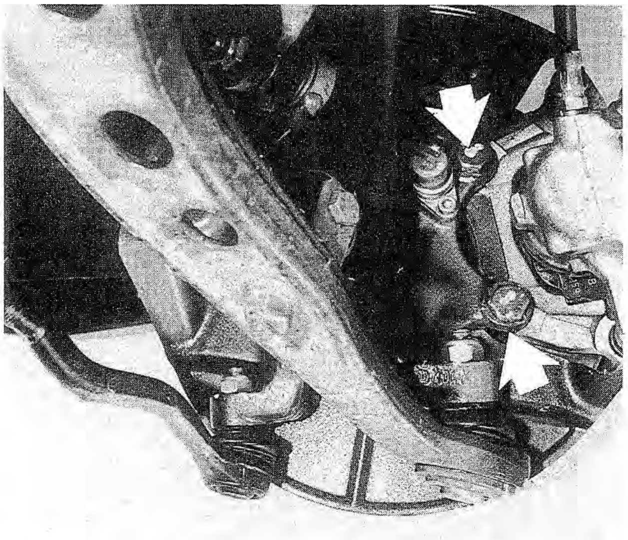

Fig. 5-3. Front brake caliper mounting bolts (arrows). Right (passenger) side shown.

6. Disconnect stabilizer bar from stabilizer bar connecting link. See Fig. 5-4.

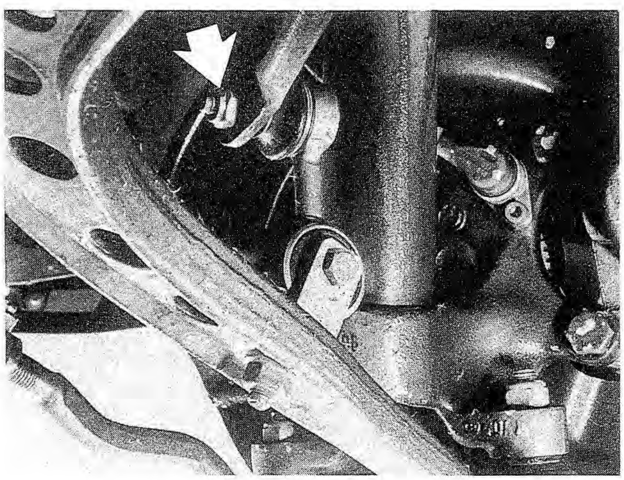

Fig. 5-4. Nut (arrow) fastens stabilizer bar to stabilizer bar connecting link. Right (passenger) side shown.

7. After removing the self-locking nuts, disconnect the control arm joint from the strut housing, and disconnect the tie rod end joint from the steering arm. See Fig. 5-5.

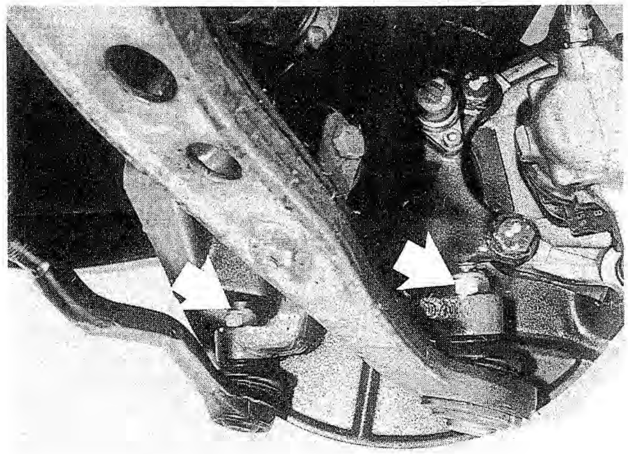

Fig. 5-5. Self-locking nuts (arrows) secure the control arm to the strut housing and the tie rod to the steering arm.

8. Pull the bottom of the strut out away from the car, far enough to clear the end of the control arm.

9. Working in the engine compartment, remove the three mounting nuts at the top of the strut tower. See Fig. 5-6.

10. Remove the strut.

CAUTION —
Support the weight of the strut while removing the bolts.

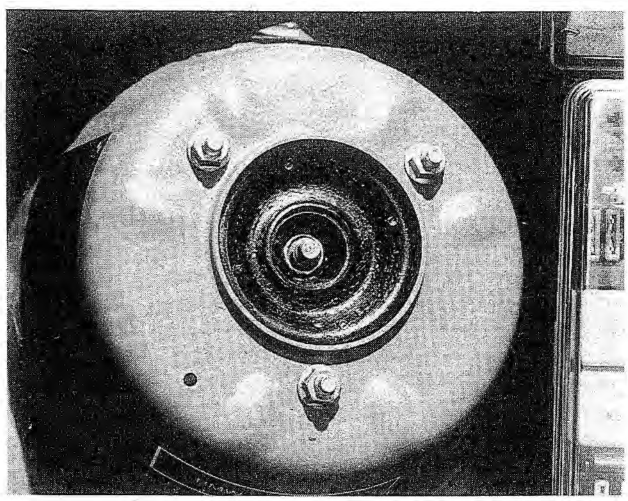

Fig. 5-6. Strut mounting nuts in engine compartment.

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WARNING —
Further disassembly of the strut requires special tools and extreme cauti
sonal injury. Do not proceed without reading the procedure below.

Installation is the reverse of removal. Install new self-locking nuts on the control arm joint, the tie rod end joint, and the upper strut mount. The mating surfaces of the control arm mounts should be kept clean and free of grease. BMW recommends coating the ABS sensor and housing with Molykote Longterm 2 before installing. Fastener torque specifications are listed in **Table e**.

CAUTION —
Shock absorbers should be stored upright, imitating their normal installed position. If they are stored horizontally or upside-down for an extended period, they should be placed upright at room temperature with shock absorber rods fully extended for at least 24 hours prior to installation.

Table e. Front Strut Torque Specifications

Brake caliper mounting bolts	110–123 Nm (80–90 ft. lb.)
Control arm joint locknut	65 Nm (47 ft. lb.)
Stabilizer bar to link	42 Nm (30 ft. lb.)
Tie rod end locknut	36.5±3.5 Nm (26.5±2.5 ft. lb.)
Strut mounting nuts (top)	22 Nm (16 ft. lb.)
Wheel lug bolts	100±10 Nm (74±7 ft. lb.)
Shock absorber top nut	65±6 Nm (47±5 ft. lb.)
Shock absorber cartridge threaded collar	130±13 Nm (96±9 ft. lb.)
Wheel hub collar nut	290±29 Nm (214±21 ft. lb.)

Removing and Installing Strut Bearing (Upper Mount)

Replacement of the strut bearing requires removal of the strut from the car and partial disassembly of the strut. Even when the strut is removed from the car, the spring is preloaded, exerting considerable force on the ends of the strut. Attempting to disassemble the strut without first compressing the spring is extremely dangerous. Read the procedure carefully.

WARNING —
Do not attempt to disassemble the struts without a spring compressor that is designed specifically for this particular job.

CAUTION —
Do not attempt to disassemble a strut by removing the upper mounting nut while the strut is still installed in the car. To avoid damage to other steering and suspension components, the strut must be completely removed from the car before being disassembled.

To remove:

1. Install a proper spring compressor and relieve the preload on the upper spring retainer by compressing the coil spring.

WARNING —
Work slowly. Keep watch to make sure the spring compressor stays securely in place on the spring.

2. Pry the protective cap off the top nut. Holding the shock absorber shaft so that it cannot turn, slowly loosen the top self-locking nut. Remove the nut and the washer.

WARNING —
Do not remove the top nut from the shock absorber rod until the coil spring is compressed and there is no spring force against the upper mount.

NOTE —
BMW Special Tool 31 3 115 is an extension that temporarily threads onto the end of the shock absorber shaft to make disassembly and reassembly easier and safer. Use of this tool is highly recommended.

3. Lift off the strut bearing, the insulator, and the large washer.

4. To remove the coil spring, lift off the upper spring retainer and the rubber ring at the top of the spring.

5. Release the spring compressor carefully, letting the spring slowly expand to its free length.

NOTE —
If the strut is to be disassembled for only a short time, it may be simpler and more convenient to leave the spring compressor attached. If so, make certain the compressor is secure and handle the compressed spring with extreme caution.

Installation is the reverse of removal. Always use a new self-locking top nut. Check the shock absorber protective tube and rubber bumper and replace them if they are worn or damaged.

Align the ends of the coil spring to mate properly with the shoulder of the rubber ring and with the spring retainers, as shown in Fig. 5-7. With the spring compressed so that there is no pressure on the upper mounting, torque the top nut to 65 Nm (4

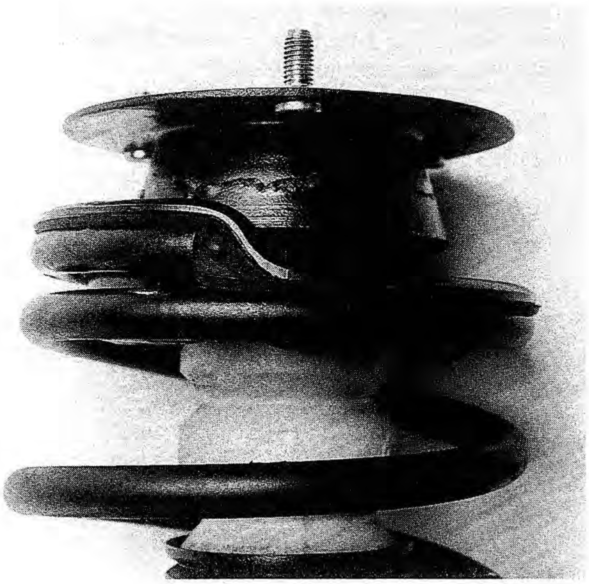

Fig. 5-7. Correct assembly of coil spring, rubber ring, and spring retainer.

Springs of different specifications are identified by a number stamped on the top coil, and may or may not be marked with a red stripe. Springs are matched to one of two different size rubber rings. All of these characteristics should match when installing replacement parts. See **Checking and Correcting Ride Height** for more information.

Replacing Front Strut Shock Absorber Cartridges

To replace the cartridges, the struts must be removed from the car and partially disassembled as described in **Removing and Installing Strut Bearing (Upper Mount)** above. With the strut upper mounting and the coil spring removed, loosen and remove the threaded collar, as shown in Fig. 5-8. The shock absorber cartridge can then be pulled out of the strut housing.

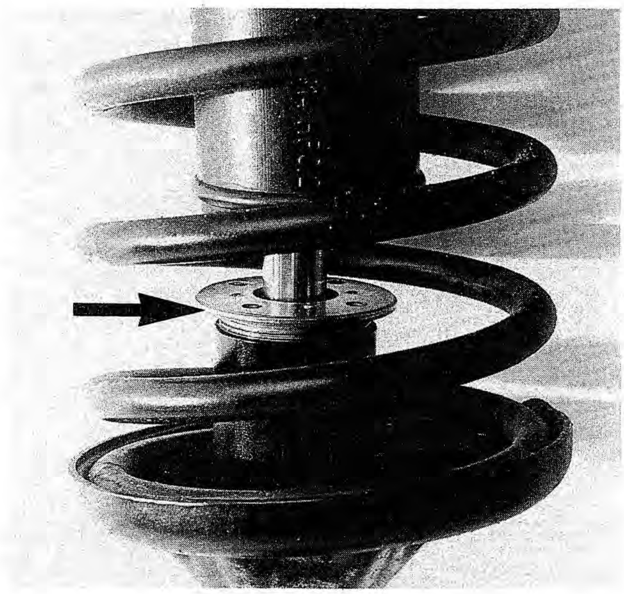

Fig. 5-8. Threaded collar (arrow) on top of strut housing retains shock absorber cartridge.

To install:

1. Pour the old oil from the strut housing.
2. For installation of all except gas pressure shock absorbers, fill the strut housing with 20 to 25 ml (¾ fl. oz.) of ordinary engine oil.

CAUTION —
The strut housing must NOT be filled with oil when installing gas-pressure shock absorber cartridges.

NOTE —
In
absorber cartridges, the oil helps cool the shock absorber by transferring heat to the strut housing. The grade of engine oil is not critical.

3. Slide the shock absorber cartridge into the strut housing and install the threaded collar. The correct tightening torque for the threaded collar is 130 Nm (96 ft. lb.).
4. Reassemble the strut as described above in **Removing and Installing Strut Bearing (Upper`Mount)**.

Checking and Correcting Ride Height

Ride height is measured from the lower edge of the wheel arch to the center of the bottom edge of the wheel rim, as shown in Fig. 5-9.

Fig. 5-9. Ride height measurement is taken from bottom of wheel arch to edge of wheel rim. (Measure with car on ground and loaded. See text.)

Table f lists front suspension ride height specifications for the cars covered by this manual. These specifications apply to a car loaded as follows: 68 kg (150
kg (1
trunk, and a full tank of fuel.

Table f. Front Ride Height Specifications*

Model	Ride Height
1984–1987 318i, 325, 325e	570 ± 10 mm (22.441 ± 0.394 in.)
1984–1987 325i	565 ± 10 mm (22.244 ± 0.394 in.)
1988–1990 all except Convertible and M-Technic sports suspension	565 ± 10 mm (22.244 ± 0.394 in.)
1988–1990 325i Convertible	570 ± 10 mm (22.441 ± 0.394 in.)
1988–1990 M-Technic sports suspension	550 ± 10 mm (21.653 ± 0.394 in.)

*special measurement conditions apply. See above.

BMW offers a wide assortment of springs to accommodate virtually any combination of "extra" weight added by options and accessories. If the ride height is outside the specification, new springs can be selected to correct the ride height, knowing only what springs are installed and how much correction is needed.

The various springs which are available are listed in **Table g**, **Table h**, **Table i**, and **Table j** below. The springs are identified by a number found on the top coil.

To use the tables, find the number of the installed springs in the top row. Moving down in that column, each spring number listed will give the ride height correction shown in that row at the left of the table.

For example, in Table g, if the original springs are number 1 127 282 and the ride height is too low, installing springs marked with number 1 128 349 would increase ride height by 7 mm (9/32 in.). Installing springs marked with number 1 129 880 would increase ride height by 13 mm (½ in.).

The identifying numbers marked on the springs are not BMW part numbers. To get the part number for a spring with a red stripe, add 1 to the spring number. For springs without a red stripe, add 2. For example, if the spring is number 1 131 937 and has a red stripe, it is BMW Part No. 1 131 938. If the spring is number 1 130 043 and does not have a red stripe, it is BMW Part No. 1 130 045.

CAUTION

BMW part numbers are provided for reference only and are subject to change. Always rely on an authorized BMW dealer parts department for the most up-to-date and accurate information.

To change springs, remove the front suspension struts from the car, as described in **Removing and Installing Front Suspension Struts**. Then remove the upper strut mount and the old springs as described in **Removing and Installing Strut Bearing (Upper Mount)**.

All springs are installed with a rubber ring which fits between the top coil and the upper spring retainer. The coil rests on the shoulder of the rubber ring. This ring comes in two thicknesses. The correct size depends on whether or not the spring is marked with a red stripe.

Springs marked **with** a red stripe use a thicker rubber ring: the shoulder on which the spring rests is approximately 9 mm (⅜ in.) thick. Springs **without** a red stripe use the thinner rubber ring: the shoulder is approximately 3 mm (⅛ in.) thick.

NOTE

In some cases, a small ride height adjustment is available by exchanging the rubber rings. Replacing the thinner rings with thick ones will increase ride height by about 5 mm (3⁄16
Replacing the thick rings with thinner ones will reduce ride height by about 5 mm (3⁄16

Table g. Front Coil Spring Applications: 1984–1986

Installed Spring	Height Correction (mm)	Replacement Spring
1 127 935	+6	1 126 397
	+14	1 127 279
	+20	1 126 516
1 126 397	−6	1 127 935
	+8	1 127 279
	+14	1 126 516
	+21	1 127 282
1 127 279	−12	1 127 935
	−7	1 126 397
	+7	1 126 516
	+14	1 127 282
	+20	1 128 349
1 126 516	−12	1 126 397
	−7	1 127 279
	+7	1 127 282
	+14	1 128 349
	+20	1 129 880
1 127 282	−12	1 127 279
	−7	1 126 516
	+7	1 128 349
	+13	1 1
	+19	1 125 341
1 128 349	−12	1 126 516
	−6	1 127 282
	+6	1 129 880
	+11	1 125 341
	+16	1 127 503
1 129 880	−11	1 127 282
	−5	1 128 349
	+4	1 125 341
	+9	1 127 503
	+15	1 125 726

Table g. Front Coil Spring Applications: 1984–1986 (continued)

Installed Spring	Height Correction (mm)	Replacement Spring
1 125 341	−9	1 128 349
	−4	1 129 880
	+4	1 127 503
	+10	1 125 726
1 127 503	−8	1 129 880
	−4	1 125 341
	+6	1 125 726
1 125 726	−10	1 125 341
	−6	1 127 503

Table h. Front Coil Spring Applications: 1987–1990 (except Convertible and models with M-Technic Sport Suspension)

Installed Spring	Height Correction (mm)	Replacement Spring
1 131 324	+8	1 131 327
	+15	1 131 027
	+21	1 131 030
1 131 327	−8	1 131 324
	+7	1 131 027
	+14	1 131 030
	+20	1 131 330
1 131 027	−16	1 131 324
	−8	1 131 327
	+7	1 131 030
	+14	1 131 330
	+20	1 131 333
1 131 030	−15	1 131 327
	−7	1 131 027
	+7	1 131 330
	+13	1 131 333
1 131 330	−15	1 131 027
	−7	1 131 030
	+6	1 131 333
1 131 333	−14	1 131 030
	−7	1 131 333

Table i. Front Coil Spring Applications: 1987–1990 (325i Convertible)

Installed Spring	Height Correction (mm)	Replacement Spring
1 132 073	+8 +15 +22	1 131 937 1 131 940 1 131 943
1 131 937	−9 +8 +15 +21	1 132 073 1 131 940 1 131 942 1 131 946
1 131 940	−17 −8 +7 +14	1 132 073 1 131 937 1 131 943 1 131 946
1 131 943	−17 −8 +7	1 131 937 1 131 940 1 131 946
1 131 946	−16 −8	1 131 940 1 131 943

Table j. Front Coil Spring Applications: 1987–1990 (with M-Technic Sport Suspension)

Installed Spring	Height Correction (mm)	Replacement Spring
1 130 037	+8 +15 +21	1 130 040 1 130 043 1 130 046
1 130 040	−8 +8 +15 +20	1 130 037 1 130 043 1 130 046 1 130 049
1 130 043	−16 −8 +7 +14 +19	1 130 037 1 130 040 1 130 046 1 130 049 1 130 054
1 130 046	−15 −7 +7 +14	1 130 040 1 130 043 1 130 049 1 130 054
1 130 049	−14 −7 +7	1 130 043 1 130 046 1 130 054
1 130 054	−14 −7	1 130 046 1 130 049

5.2 Control Arms

The control arms link the front suspension subframe and the lower part of the front suspension strut. They give precise control of wheel angles yet still allow the suspension to move. There are three mounting points on each control arm. See Fig. 5-10. The two inner mounting points—a ball joint at the front and a rubber bushing at the rear—allow the outer end of the control arm to pivot up and down. The third mounting point—a ball joint at the outer end of the control arm—connects the control arm to the suspension strut.

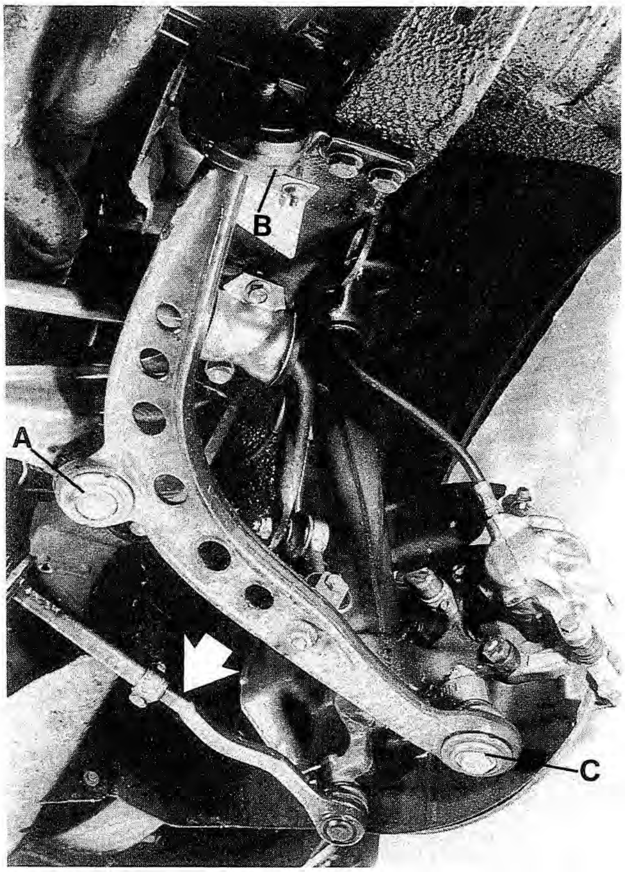

Fig. 5-10. Front suspension control arm viewed from below, showing inner ball joint (**A**) and rubber bushing (**B**) mounts, and outer ball joint (**C**) mount. Arrow points to front.

The ball joints are permanently lubricated and surrounded by a protective rubber boot. The only recommended routine maintenance is a periodic inspection for damage and wear. The rubber bushing at the rear of each arm is replaceable. The ball joints, however, cannot be replaced separately. If the ball joints are worn, the entire control arm must be replaced as a unit.

Inspecting Control Arm Mounts

The ball joints are checked for freeplay. To inspect them, lift the front end of the car and support it securely on jack stands. Check for movement between the control arm and the mounting point (either the subframe or the strut housing). See Fig. 5-11. Even a worn joint may be stiff. Grip the top and bottom of the joint with a large pliers and squeeze to check for play. If play exceeds 1.4 mm (0.055 in.), then the joint is excessively worn and the control arm should be replaced.

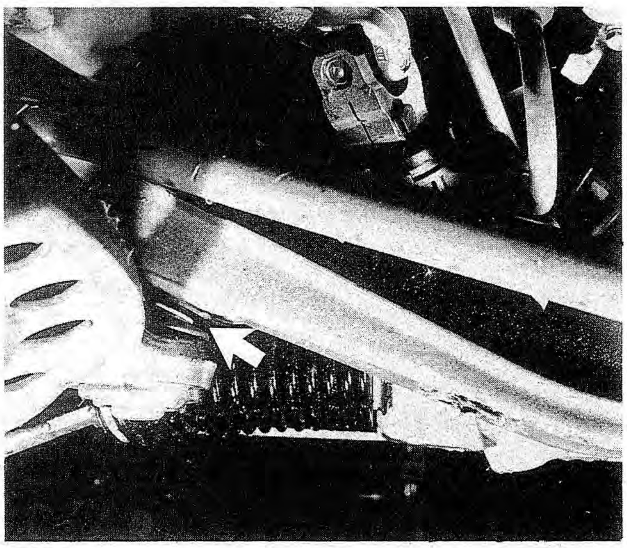

Fig. 5-11. Outer control-arm ball joint. Inner ball joint is similar. Excessive play between control arm and subframe or suspension strut (arrow) is cause for replacement.

To check a rubber bushing, the car must be at rest in its normal position on the ground. BMW defines normal position as loaded with 68 kg (150 lb.) on each front seat, 68 kg (150
in the middle of the rear seat, 21 kg (4
full tank of fuel. Using a feeler gauge, measure the gap in the bushing as shown in Fig. 5-12. The gap should be 0.7 to 1.7 mm (0
replaced as described in **Replacing Control Arm Rubber Bushing**.

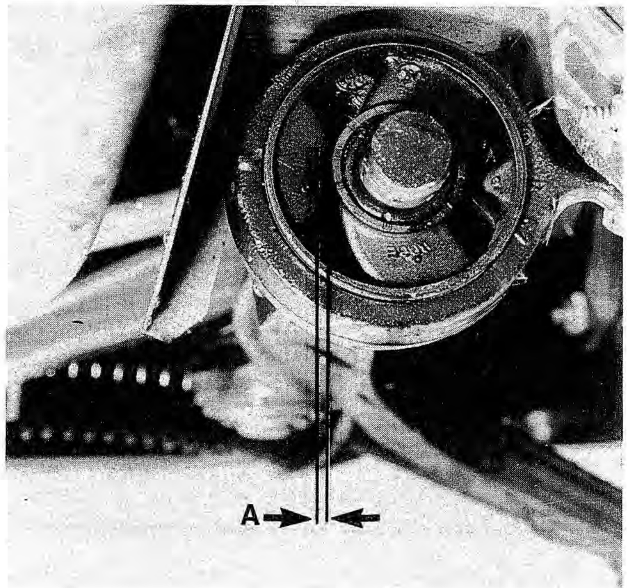

Fig. 5-12. Control arm rubber bushing. Measure gap (**A**) with car at rest on ground and loaded. See text.

Removing and Installing Control Arms

Replacement of the control arm is the only way to correct for worn or damaged ball joints or a damaged control arm. Installation of a new control arm also requires a new rubber bushing, as the old bushing cannot be reused once it is removed. See **Replacing Control Arm Rubber Bushing** below.

The self-locking nuts that secure the ball joints are meant to be used only once. They should be replaced any time they are removed. In the procedure below, the suspension strut remains attached to the body at its top mounting point.

CAUTION —

Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

In the procedure below, the suspension strut remains attached to the body at its top mounting point.

To remove:

1. Loosen the wheel lug bolts, then raise the front of the car and support it on jack stands which are designed for the purpose. The front wheels should be off the ground so that the suspension is not bearing any weight.

2. Remove the wheel.

3. Remove the two bolts holding the rubber bushing bracket to the underbody. See Fig. 5-13.

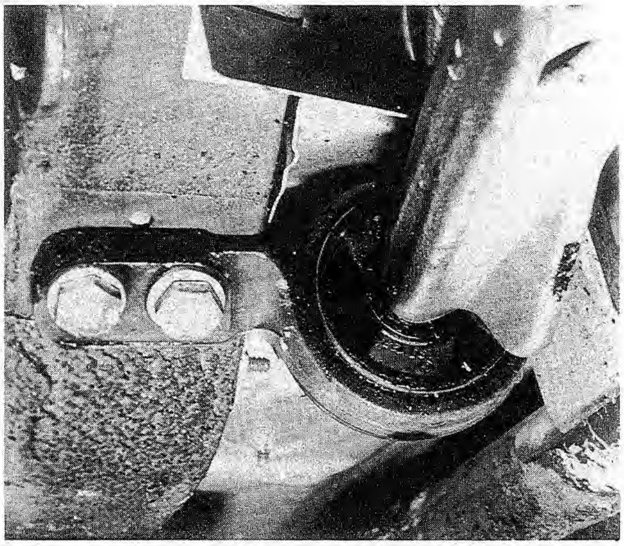

Fig. 5-13. Bracket for rubber bushing mounts to underbody with two bolts.

4. Disconnect the stabilizer bar from the stabilizer-bar connecting link. See Fig. 5-14.

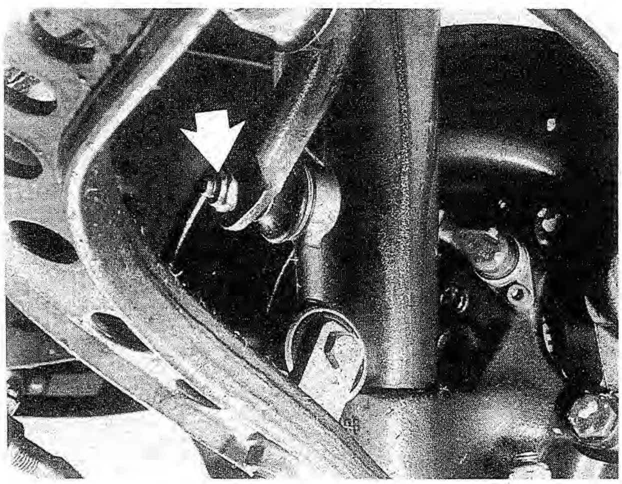

Fig. 5-14. Nut (arrow) fastens stabilizer bar to stabilizer-bar connecting link. Right (passenger) side shown.

5. Remove the self-locking nut which fastens the ball joint to the subframe. See Fig. 5-15. Using a soft-faced hammer, lightly tap the ball joint to free it.

6. After removing the self-locking nut, disconnect the outer ball joint from the strut housing. See Fig. 5-16.

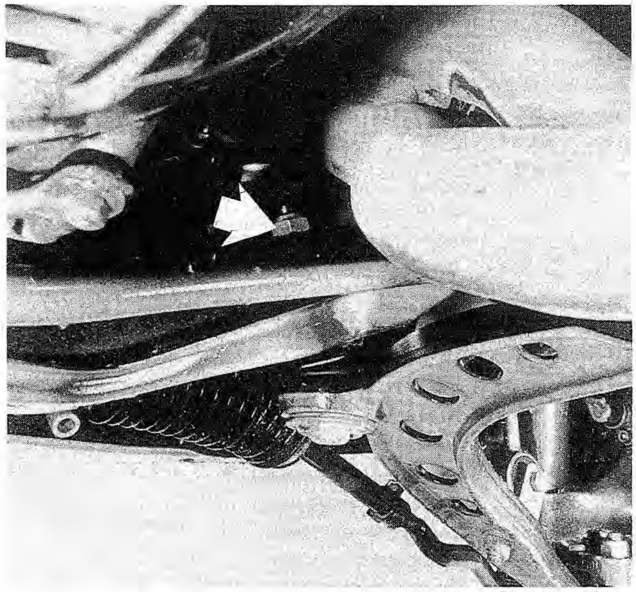

Fig. 5-15. Self-locking nut (arrow) secures ball joint to subframe.

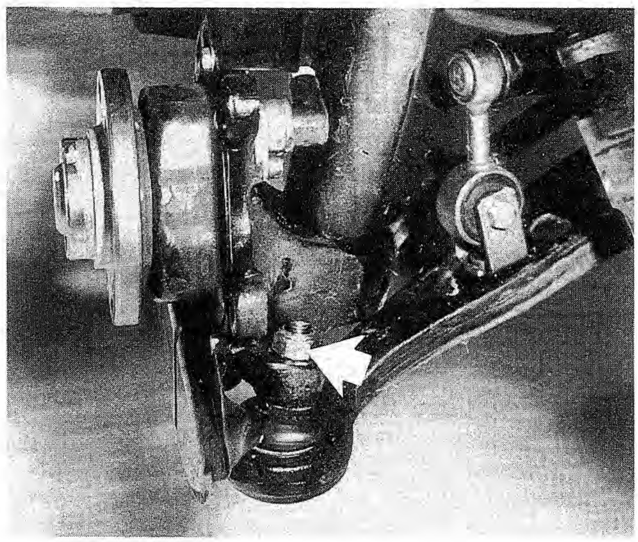

Fig. 5-16. Outer ball joint connection to lower part of strut housing. (Shown with disc brake rotor and caliper removed). Self-locking nut (arrow) should always be replaced.

7. Remove control arm.

Installation is the reverse of removal. Use new self-locking nuts on the ball joints. The mating surfaces should be kept clean and free of grease. Fastener torque specifications are listed in **Table k**.

Table k. Suspension Control Arm Torque Specifications

Control arm ball joint to strut housing	65 Nm (47 ft. lb.)
Control arm ball joint to subframe	85 Nm (61 ft. lb.)
Control-arm rubber-bushing mounting bracket	42 Nm (30 ft. lb.)
Stabilizer bar to link	42 Nm (30 ft. lb.)
Subframe anchor bolts	
M10	42 Nm (30 ft. lb.)
M12	77 Nm (56 ft. lb.)

Replacing Control Arm Rubber Bushing

The rubber bushing with mounting bracket is replaceable separately from the control arm. It is, however, a very snug fit. It is worth noting that BMW's method calls for special tools for both removal and installation.

To remove the bushing and bracket, remove the two bolts holding it to the underbody, as shown above in Fig. 5-13. Then, using a puller, remove the bracket and bushing from the end of the control arm.

NOTE —

When using a puller to remove the bracket and bushing, it may be helpful to first centerpunch the end of the control arm to give the puller a place to seat.

The rubber bushings should always be replaced in pairs, and the two bushings should have the same markings, indicating that they come from the same manufacturer. After the mounting bracket is removed from the control arm as described above, the old rubber bushing is pressed out and the new one is pressed in. Fig. 5-17 shows the correct orientation of the rubber bushing in the bracket.

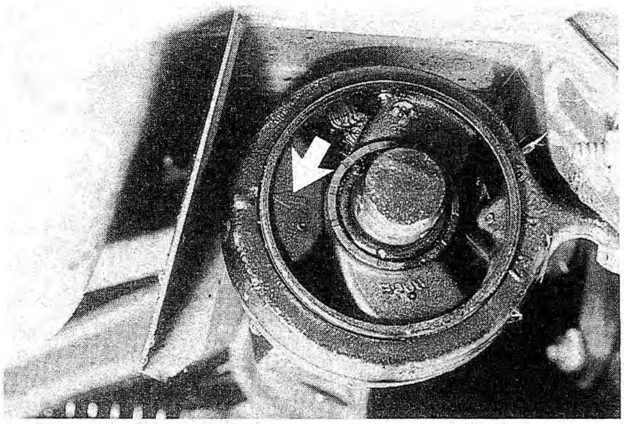

Fig. 5-17. When correctly installed in mounting bracket, arrow on rubber bushing (arrow) is aligned with mark on bracket.

To install:

1. Coat the end of the control arm with BMW's special lubricant.

CAUTION —

BMW part numbers are provided for reference only and are subject to change. Always rely on an authorized BMW dealer parts department for the most up-to-date and accurate information.

2. Press the new bushing and bracket onto the arm, all the way to the stop.

NOTE —

The bracket's mounting holes provide a clue to the proper installation position. When properly oriented, the side of the bracket with the larger counterbored holes faces upward, toward the centering sleeves on the underbody.

3. Immediately bolt the bracket to the underbody, torque the bolts to 42 Nm (30 ft. lb.), and lower the car.

4. Leave the car in its normal position at rest on the ground, loaded as described above, without moving, for at least 30 minutes.

CAUTION —

Failure to follow the above procedure when replacing control arm bushings may impair the car's handling and stability.

NOTE —

After 30 minutes, the lubricant becomes inactive and the rubber bushing is permanently located in its proper position.

5.3 Front Wheel Bearings

The front wheel bearings are permanently sealed and lubricated. They do not require any routine maintenance. The sealed bearing and the front hub are removed and installed as a unit. The bearing cannot be replaced separately. The bearing inner race is press-fit onto the stub axle—an integral part of the front strut housing—and held in place with a large collar nut.

The bearing and hub will normally be damaged as it is removed, and therefore cannot be reinstalled. In addition to a new bearing and hub, a new collar nut and a new grease cap are required when replacing a wheel bearing.

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NOTE —

Install only the later, smaller volume grease cap, BMW Part No. 31 21 1 130 125. This later cap will fit all cars covered by this manual. It is not reusable.

Removing the bearing and hub requires a puller, and installation requires special tools. Read the procedure before starting work. If the necessary tools are not available, this work may be best left to an authorized BMW dealer or other qualified repair shop.

To remove:

1. Loosen the wheel lug bolts, then raise the front of the car and support it securely on jack stands. The front wheels should be off the ground so that the suspension is not bearing any weight.

2. Remove the wheel.

3. Using a thin, flat-blade screwdriver or a brass drift, remove the dust cap in the center of the front wheel hub. Remount the wheel, install the lug bolts hand tight, and lower the car to the ground.

4. Using a chisel, unlock the collar nut by breaking away the portion that engages the slot in the stub axle. See Fig. 5-18. With the car on the ground, loosen the collar nut but do not remove it.

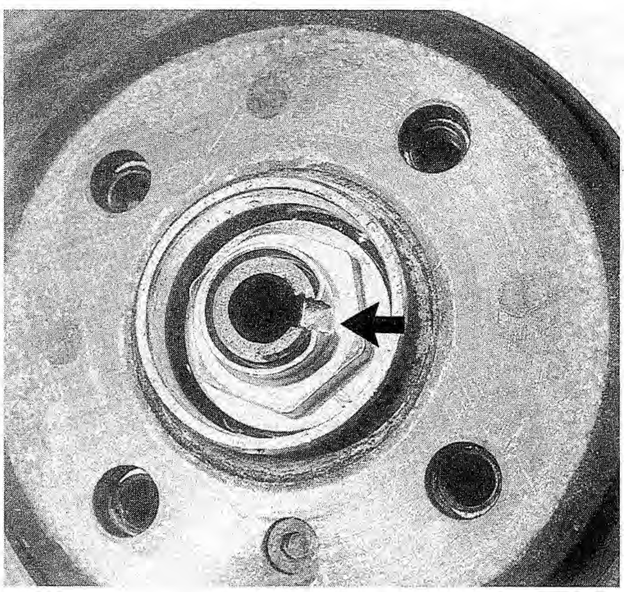

Fig. 5-18. Collar nut locked into front stub axle. Unlock nut by breaking locked portion (arrow) with chisel.

WARNING —

Always loosen and tighten collar (axle) nuts only while the car is on the ground. The leverage required to do this could topple the car off a lift or jack stand.

5. Raise the front end of the car, support it securely on jack stands, and remove the wheel.

6. Without disconnecting the flexible brake hose, dismount the brake caliper as described in **BRAKES**. See Fig. 5-19. To avoid kinking or damaging the hose, use stiff wire to suspend the caliper from the underbody.

CAUTION —

- *Do not allow the caliper to hang by the brake line. Doing this could damage the line and cause later brake failure.*

- *Do not step on the brake pedal or operate the brakes while the caliper is removed.*

NOTE —

By leaving the brake line attached to the caliper there will be no need to bleed the brake system.

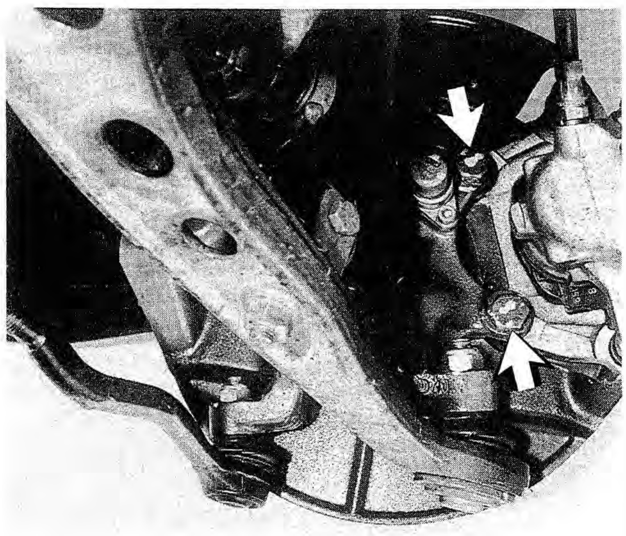

Fig. 5-19. Front brake caliper mounting bolts (arrows). Right (passenger) side shown.

7. Using a 5 mm hex wrench, remove the countersunk screw that holds the brake rotor to the wheel hub, and remove the rotor. Also see **BRAKES** for information on disassembling and assembling brake components.

8. Remove the collar nut and, using a puller, remove the hub and bearing from the stub axle.

9. If the inner race of the bearing remains on the stub axle, as it probably will, remove the rubber boot (dust shield) behind the bearing. Then use a puller to remove the bearing inner race.

To install:

1. Install a new rubber dust shield.

2. Applying force only to the bearing's inner race, press the hub and bearing onto the stub axle.

3. Install a new collar nut and tighten it slightly. Do not try to tighten it to its final torque value.

4. Mount the disc brake rotor with its countersunk screw.

5. Mount the wheel and lower the car to the ground. Torque the collar nut to 290 Nm (210 ft. lb.) and bend the collar to lock it to the stub axle as shown in Fig. 5-18 above.

> ***WARNING —***
> *Always loosen or tighten collar (axle) nuts while the car is on the ground. The leverage required to do this could topple the car from a lift or jack stand.*

6. Raise the front end of the car, support it securely on jack stands, and remove the wheel.

7. Making sure that the flexible brake hose is not twisted or kinked, remount the disc brake caliper. The correct mounting bolt torque is 110 to 123 Nm (80 to 89 ft. lb.).

8. Apply Loctite® 638 sealant to a new grease cap, then install it using a soft-faced mallet to gently drive it into place.

> **NOTE —**
> Install only the later, smaller volume grease cap, BMW Part No. 31 21 1 130 125. This later cap will fit all cars covered by this manual. It is not reusable.

9. Lubricate the wheel and hub contact surface with a thin film of multi-purpose grease and mount the wheel. Lower the car to the ground and torque the wheel lug bolts to 100 ± 10 Nm (7

5.4 Front Stabilizer Bar

The stabilizer bar is essentially a spring that helps to distribute cornering loads and reduce body roll. The stabilizer bar only requires attention if it is broken or bent, or if the mountings are faulty. Deterioration of the rubber mountings may cause some clunking noise in the suspension when going over bumps or starting into turns.

The one-piece stabilizer bar is mounted to the underbody of the car in rubber bushings which allow it to twist. These can be replaced separately if necessary. The ends of the bar are mounted via short connecting links to the control arms. The connecting links and their rubber parts are not available separately. If worn, the entire link must be replaced.

To remove:

1. Remove the single nut on each side that fastens the bar to the connecting links. See Fig. 5-20.

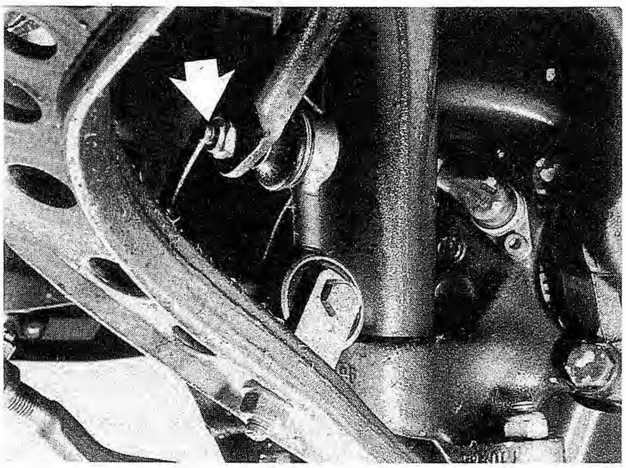

Fig. 5-20. Nut (arrow) fastens stabilizer bar to stabilizer bar connecting link. Right (passenger) side shown.

2. Disconnect the left-side (driver's side) control-arm rubber-bushing mounting bracket from the underbody. See Fig. 5-13 above.

3. Remove the mounting bolts and brackets which fasten the middle part of the bar to the subframe. See Fig. 5-21.

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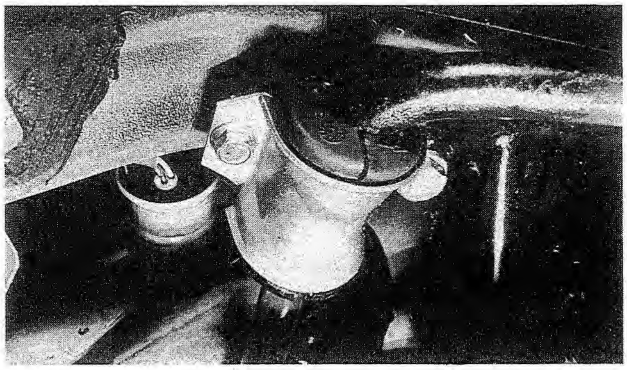

Fig. 5-21. Brackets and rubber bushings mount stabilizer bar to front suspension subframe.

To replace the connecting links, simply remove the nut and through-bolt which fastens each link to its respective control arm bracket. As an alternative, remove each bracket's mounting nut and remove the bracket with the link, disassembling the two afterwards. See Fig. 5-22.

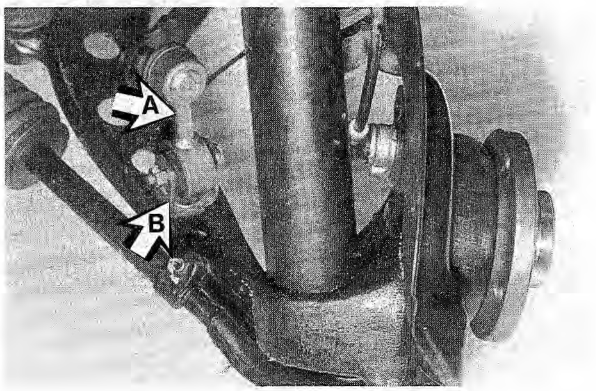

Fig. 5-22. Stabilizer bar connecting link (**A**) and control arm mounting bracket (**B**). Left (driver's) side shown.

Installation is the reverse of removal. Fastener torque specifications are listed in **Table I**.

NOTE —

Installation of the bar and proper tightening of the mountings will be easiest with the car level (front wheels at the same height), and as near normal ride height as possible.

Table I. Front Stabilizer Bar Torque Specifications

Connecting link to bracket	22 Nm (16 ft. lb.)
Connecting link bracket to control arm	42 Nm (30 ft. lb.)
Control-arm rubber-bushing mounting bracket	42 Nm (30 ft. lb.)
Stabilizer bar to connecting link	42 Nm (30 ft. lb.)
Stabilizer bar mounting brackets to subframe	22 Nm (16 ft. lb.)

6. Rear Suspension

The main rear suspension components are the trailing arms. Mounted in rubber bushings at pivot points on the rear axle carrier, they also house the wheel bearings and serve as lower mounting points for both shock absorbers and struts. The limited number of parts that normally wear can be replaced. Some of these repairs require special tools and equipment. To avoid starting a job that may be difficult to complete, please thoroughly read the entire procedure before beginning each repair.

This portion of the manual covers servicing of the rear suspension and the drive axles. Information on the final drive and its mounting is in **DRIVESHAFT AND FINAL DRIVE**.

6.1 Shock Absorbers and Springs

In the rear suspension, unlike the front, the shock absorbers and the springs are separate components. The shock absorbers can be simply and easily replaced as necessary, without touching the springs. The springs, if necessary, can be removed and installed without the need for special tools.

Although their mounting is different, the rear shock absorbers function identically to the front ones. See **Checking Shock Absorbers** in **5.1 Front Suspension Struts** for more information.

Removing and Installing Shock Absorbers

At full extension, the rear shock absorbers also limit rear suspension travel. This helps prevent damage to the drive axle constant velocity (CV) joints.

CAUTION —

To avoid damaging the CV joints when removing the rear shock absorbers, the suspension must remain approximately within its normal range of travel. It should be supported either by a stand under the trailing arm or by the wheel in contact with the ground before removing the shock absorber.

To remove:

1. Disconnect the lower shock absorber from its mounting on the trailing arm by removing the mounting bolt, shown in Fig. 6-1.

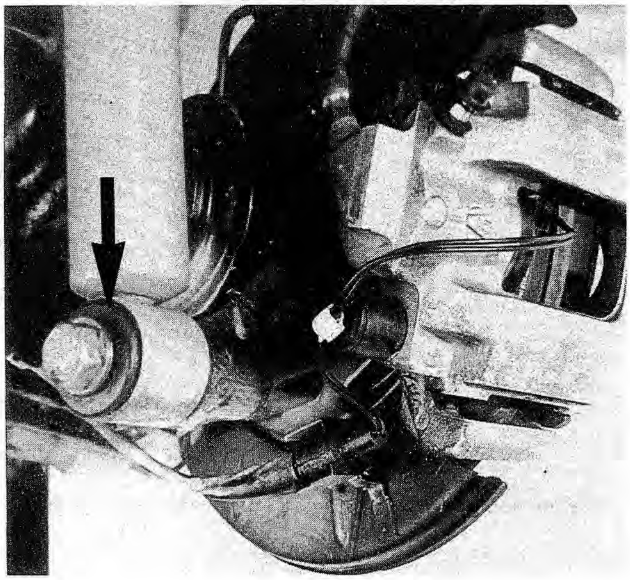

Fig. 6-1. Lower mount for rear shock absorber (arrow).

2. In the trunk, partially remove the trim to expose the upper shock absorber mounts on each side. See Fig. 6-2.

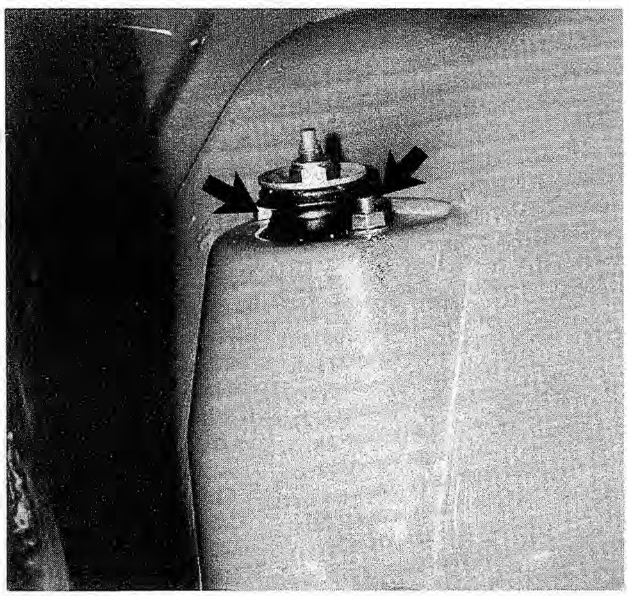

Fig. 6-2. Rear shock absorber upper mounting nuts (arrows) in trunk. Shown with trim partially removed for access.

3. Loosen the two upper shock absorber mounting nuts. While supporting the shock absorber from below, remove the mounting nuts, the shock absorber, and the gasket. See Fig. 6-3.

NOTE —

When replacing shock absorbers, it may be necessary to reuse the mounting hardware from the top of the old shock absorber. If so, remove the hardware by loosening the single nut on the end of the shock absorber shaft.

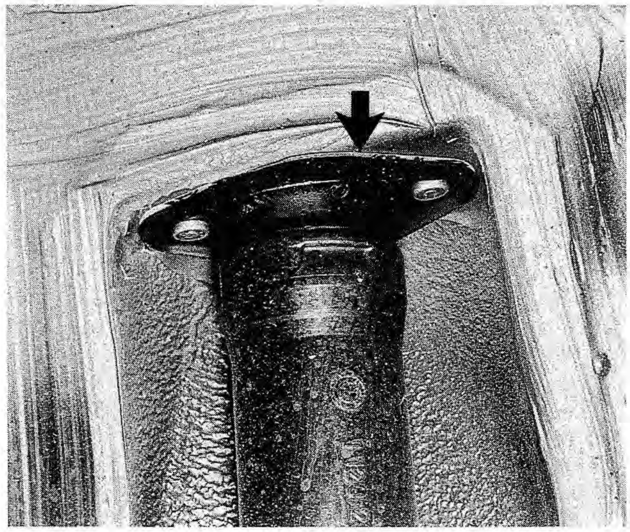

Fig. 6-3. Rear shock absorber upper mounting viewed from below. Notice location of gasket (arrow).

Installation is the reverse of removal. Make sure there is a gasket between the mounting hardware and the body as shown in Fig. 6-3, and use new self-locking nuts on the upper mounts. Fastener torque specifications are listed in **Table m**.

CAUTION —

Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

Table m. Rear Shock Absorber Torque Specifications

Lower mount to trailing arm	72–87 Nm (52–63 ft. lb.)
Shock absorber to upper mounting bracket	13–15 Nm (9–11 ft. lb.)
Upper bracket mounting nuts	22–24 Nm (16–17 ft. lb.)

CAUTION —

Shock absorbers should be stored upright, imitating their normal installed position. If they are stored horizontally or upside-down for an extended period, they should be placed upright at room temperature with shock absorber rods fully extended for at least 24 hours prior to installation.

Removing and Installing Rear Coil Springs

The springs are held in position by the upper spring seats on the underbody and the lower spring seats on the trailing arms. They are removed simply by allowing the trailing arms enough downward travel to release the springs.

All rear springs are installed with rubber pads which fit between the end coils and the spring retainers. This pad is available in three sizes. The correct size depends on the springs' color code. See **Table n**.

Table n. Rear Spring Installation Specifications

Spring Color Code	Rubber Pad	Thickness
None	Thin	3 mm (1/8 in.)
White stripe	Intermediate	6 mm (1/4 in.)
Red stripe	Thick	9 mm (3/8 in.)

The rear springs should only be replaced in pairs, and should always be replaced with springs of the same number and color code as those which were removed. Note that different models are equipped with different springs. They are not necessarily interchangeable.

To remove:

1. Disconnect the hangers and brackets which support the rear of the exhaust system, and temporarily lower the exhaust system.

> ***CAUTION***
> *To avoid damaging the exhaust system, lower it only as far as necessary to lower the suspension and remove the springs, and suspend it from the body using a piece of wire.*

2. Remove the rear final drive mounting bolt from the rubber mount, push the rear of the unit down, and wedge it into this lowered position using a block of wood or other suitable object. See Fig. 6-4.

> **NOTE**
> Disconnecting the mount and pushing the final drive down reduces drive axle angle. This prevents damage to CV joints as trailing arms are lowered to remove springs.

3. On cars equipped with a rear stabilizer bar, disconnect the bar from its connecting links, or disconnect the connecting links from each trailing arm.

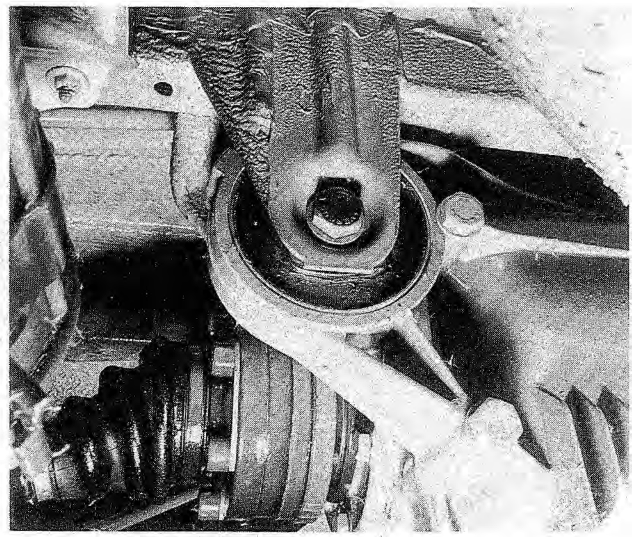

Fig. 6-4. Final drive rear mount.

4. Disconnect the shock absorber from its lower mounting on the trailing arm by removing the mounting bolt, shown in Fig. 6-5.

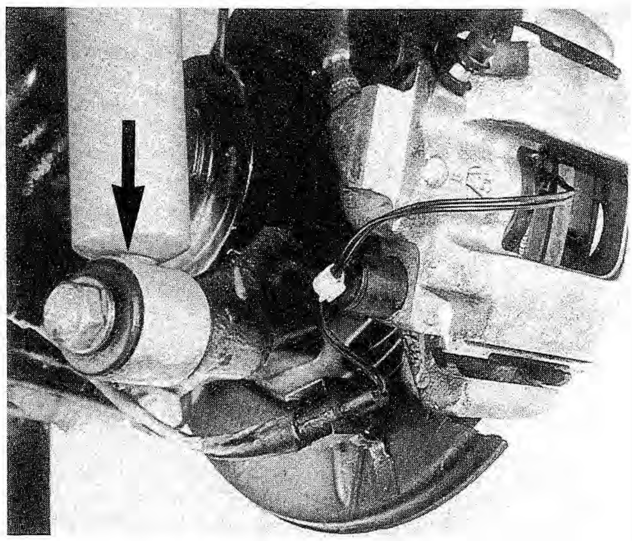

Fig. 6-5. Lower mount for rear shock absorber (arrow).

> ***CAUTION***
> *To avoid damaging the CV joints when removing the rear shock absorber mounting bolt, the suspension must be supported before disconnecting the shock absorber. Lower the trailing arm only far enough to remove the spring.*

CAUTION —

When using a stand or other support under the trailing arm, position it carefully to avoid damaging the brake line.

Installation is the reverse of removal. As the spring and trailing arm are being returned to their normal positions, check to see that the spring is seating properly, as shown in Fig. 6-6. Tighten the fasteners using the torque values provided in **Table o**. Note that the stabilizer bar should be tightened with the car resting at normal ride height. See **4.3 Alignment Specifications** for information on BMW's definition of normal ride height.

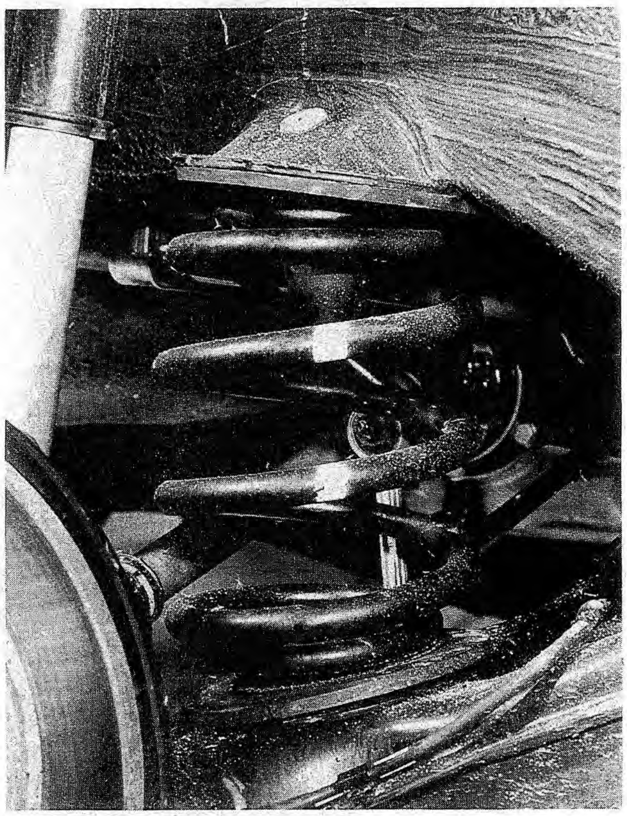

Fig. 6-6. Normal installed position of rear coil spring.

Table o. Rear Suspension Torque Specifications

Final drive rubber mount to body	80–87 Nm (58–63 ft. lb.)
Lower shock absorber mount to trailing arm	72–87 Nm (52–63 ft. lb.)
Brake caliper mounting bolts	60–67 Nm (43–48 ft. lb.)
Stabilizer bar to trailing arm (tighten in normal position)	22–24 Nm (16–17 ft. lb.)

6.2 Drive Axles and Constant Velocity (CV) Joints

Since the 3-series BMW models covered by this manual feature independent rear suspension and a final drive mounted to the underbody, the drive axles must be able to move at an angle, following the movement of the rear suspension. To accomplish this, a constant velocity (CV) joint is located at each end of each drive axle.

A CV joint is similar in function to the more familiar "universal" joint. The CV joint allows for the smooth flow of power to the drive wheels, even though the final drive, axles and wheels are not precisely straight. The advantage of the more complicated CV joint is that it operates more smoothly and can accept more radical drive axle angles than a universal joint. A complete drive axle in its installed position is shown in Fig. 6-7.

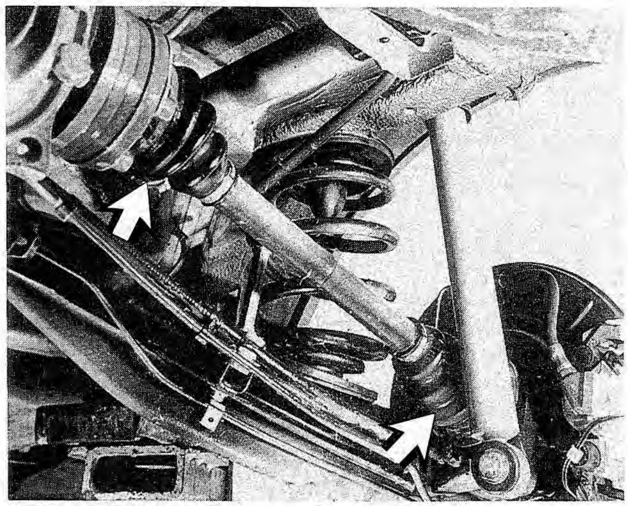

Fig. 6-7. Drive axle and CV joints. Rubber boots (arrows) retain lubricant and protect joints from dirt.

The inner CV joints are bolted to the drive flanges of the final drive. On the outer CV joints, splined stub axles engage the splines of the wheel hubs and are secured by a large nut. Each joint is packed with a special lubricant and sealed by a rubber boot.

The rubber boots retain the CV joint lubricant and protect the joints. The boots should be inspected periodically to see that they are in good condition. A damaged boot will let in dirt which will very quickly destroy the joint. The CV joints are not rebuildable. If necessary, the inner joint can be replaced separately. The outer joint and the drive axle must be replaced as a unit.

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Removing and Installing Drive Axles

The large nut securing the stub axle to the hub is very tight, and the stub axle is press-fit into the hub. Removing the stub axle from the hub, installing it, and torquing the nut properly may require special tools. The inner CV joints are mounted to the drive flanges with internal-hex-head bolts which require a special wrench. Read the procedure carefully before starting work. If you lack the necessary tools and equipment, or a suitable workplace, we suggest leaving these repairs to an authorized BMW dealer or other qualified repair shop.

To remove:

1. With the car on the ground, pry off the dust cap in the center of the wheel hub, lift out the lockplate around the nut, and loosen (do not remove) the nut. See Fig. 6-8.

WARNING ―
Always loosen or tighten axle nuts only while the car is on the ground. The leverage required could topple the car from a lift or jack stands.

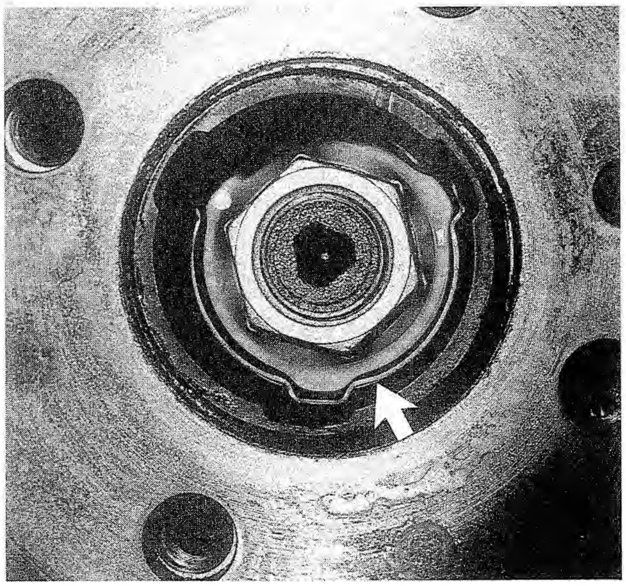

Fig. 6-8. View of rear hub showing axle nut and lockplate (arrow).

2. Raise the rear end of the car and support it securely on jack stands.

3. Clean around the inner CV joint and remove the six internal-hex-head bolts that hold it to the drive flange.

CAUTION ―
To prevent damage to the outer CV joint, do not allow the inner end of the axle to hang free. Use stiff wire to suspend the inner end of the drive axle from a convenient point on the underbody.

4. Remove the axle nut and press the stub axle out of the wheel hub, using a puller as shown in Fig. 6-9.

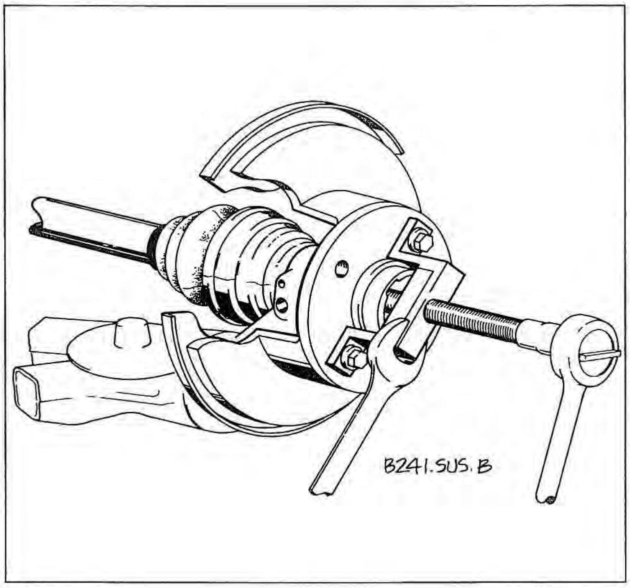

Fig. 6-9. Puller being used to press rear stub axle from wheel hub to remove axle shaft.

Installation is the reverse of removal. Lubricate the inner surface of the axle nut with oil. Torque the inner CV joint internal-hex-head bolts to 58 to 63 Nm (42 to 46 ft. lb.). Torque the axle nut to 195 to 210 Nm (144 to 155 ft. lb.), and install a new lockplate.

WARNING ―
Always loosen or tighten axle nuts only while the car is on the ground. The leverage required could topple the car from a lift or jack stands.

Removing and Installing Inner CV Joint and Replacing CV Joint Protective Boots

The CV joints and boots are serviced by removing the inner joint from the shaft.

Begin either procedure by removing the drive axle as described above. Then, using a small punch and a hammer, carefully drive the covers off the joints, and fold the rubber boot away from the joint, inside out over the axle shaft.

To remove the inner CV joint, remove the circlip holding the inner joint to the axle. See Fig. 6-10. While supporting the inner CV joint hub, press the joint off the axle. See Fig. 6-11. Inspect the shaft and the splines for wear or damage.

CAUTION —
Always install a new circlip on the inner joint.

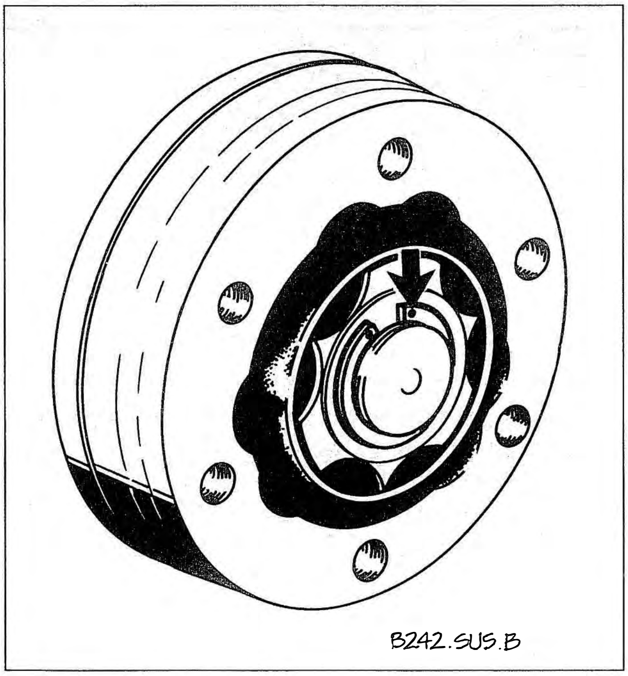

Fig. 6-10. Circlip (arrow) securing inner CV joint to axle shaft. Always replace.

CAUTION —
Do not pivot the ball hub more than 20° in the outer ring of the joint. The balls will fall out if the hub is pivoted too far.

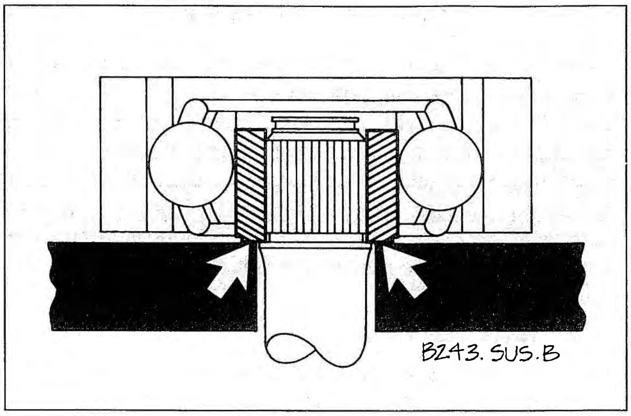

Fig. 6-11. When pressing inner CV joint from axle shaft, support joint on inner hub only (arrows).

To replace a CV joint boot, use a complete CV joint boot repair kit. The kit will include a new boot, clamps, lubricant, and a new inner CV joint circlip. With the inner joint and the old boots removed, carefully slide the new boot(s) and clamps over the shaft.

To reinstall the inner joint, first clean all the old lubricant off the shaft splines and the joint's inner splines, then coat the splines with locking compound. Press the joint into place on the shaft splines and install a new circlip.

NOTE —
BMW recommends Loctite® No. 270 locking compound. Use care to keep it from entering the joint and contacting the joint's balls or ball grooves.

Pack each CV joint and rubber boot with approximately 80 gm (2.8 oz.) of the lubricant supplied in the boot kit. Apply adhesive to the large end of the boot and mount it on the joint. Secure the boot with the clamps. Then apply sealer to the joint cover(s) and install them.

NOTE —
BMW recommends Bostik 1513 or Epple 4851 adhesive, and Epple 39 or Curil K sealer. These materials or suitable equivalents are available from your BMW dealer.

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Inspecting CV Joints

The components of each CV joint are precisely matched during manufacture and cannot be serviced or replaced individually. To inspect a CV joint, clean away the grease and look for galling, pitting and other signs of wear or physical damage. Any of these is cause for replacement. Discoloration due to overheating indicates lack of lubrication. A joint that is otherwise in good condition may be reinstalled if thoroughly cleaned and repacked with the proper amount of new grease.

NOTE —

Polished interior surfaces or visible ball tracks alone are not necessarily cause for replacement.

The balls and grooves allow the hub to move, but the parts should fit snugly and move only with some effort. A joint with obvious freeplay between inner hub, balls and outer cage should be replaced.

Disassembly of the CV joints is not normally recommended. If the joint must be disassembled for cleaning, mark the relative positions of the inner hub, the ball cage, and the outer housing. Remove the balls one at a time, and keep track of them so that each can be reinstalled in its original position in the hub and cage.

CAUTION —

- *The cage, housing, and balls are precisely matched during manufacture. When disassembling more than one joint, do not intermix components.*

- *The CV joint should go together firmly but smoothly. Heavy force should not be required. If in doubt, start over and recheck the alignment. A joint which is forced together incorrectly may lock and not come apart again.*

6.3 Rear Suspension Trailing Arms

Fig. 6-12 shows the installed position of one of the rear trailing arms. The trailing arms and their mounting points control the position and movement of the rear wheels. A damaged trailing arm or worn mounting bushings will change rear wheel alignment, and may adversely affect handling and stability.

CAUTION —

Do not attempt to straighten a damaged trailing arm. Bending or heating may weaken the original part. Replace damaged parts.

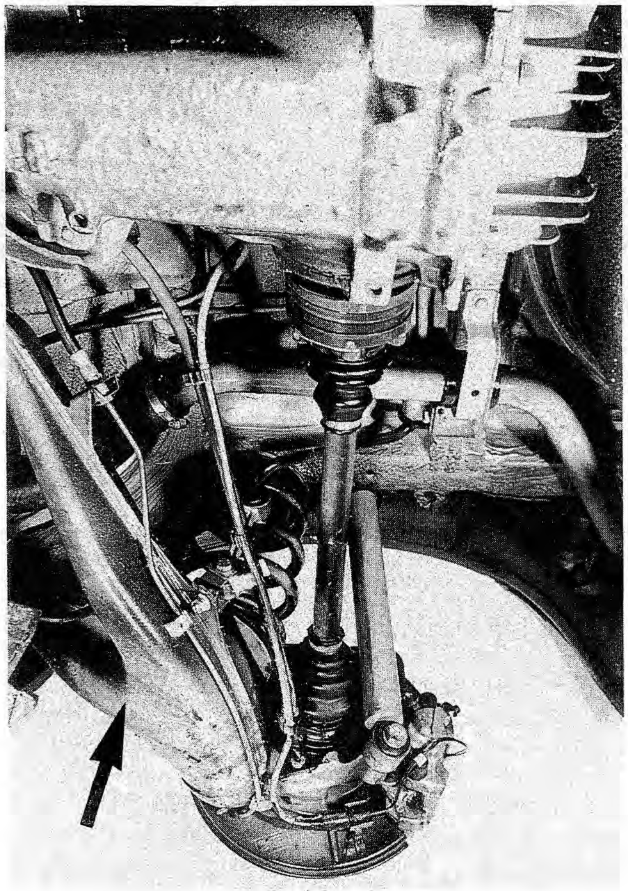

Fig. 6-12. Rear suspension trailing arm (arrow) installed position.

To remove a trailing arm the rear brake lines must be disconnected, thus the brakes will have to be refilled with fluid and bled when the trailing arm is reinstalled. To replace a trailing arm the drive axle must be removed, and this may require special tools. See **6.2 Drive Axles and Constant Velocity (CV) Joints.**

To remove:

1. Remove the drive axle as described in **6.2 Drive Axles and Constant Velocity (CV) Joints.**

2. Disconnect the rear brake lines at the union shown in Fig. 6-13, and drain the brake fluid or plug the line. Disconnect the parking brake cable, as described in **BRAKES.**

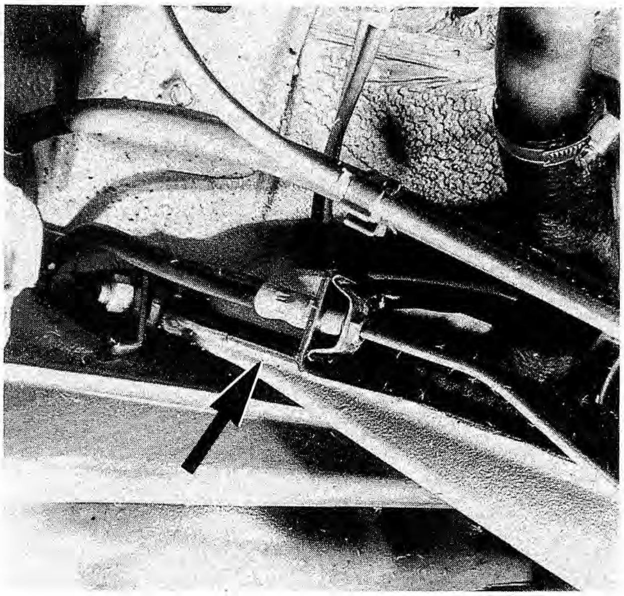

Fig. 6-13. Rear brake line union (arrow) near rear suspension trailing arm inner mount.

3. Disconnect the lower shock absorber mount, lower the trailing arm, and remove the bolts from the trailing arm mounts, shown in Fig. 6-14 and Fig. 6-15.

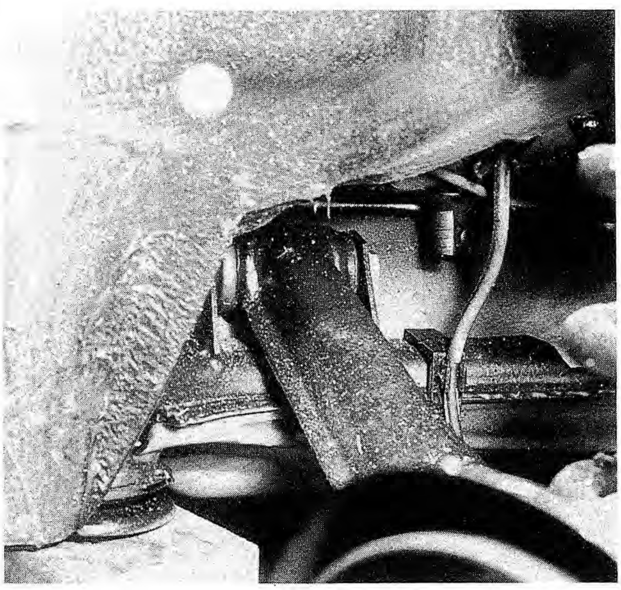

Fig. 6-14. Outer rear suspension trailing arm mount on top of rear axle carrier.

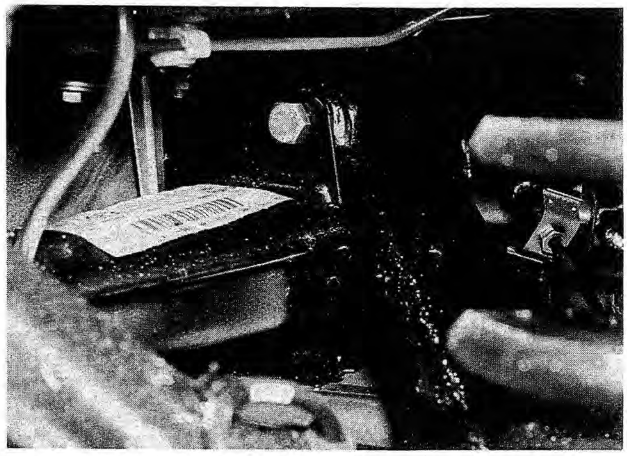

Fig. 6-15. Inner rear suspension trailing arm mount on top of rear axle carrier.

Installation is the reverse of removal. When installing the trailing arm mounting bolts, begin with the inner bolt. Fastener torque specifications are listed in **Table m** and **Table o**, earlier in this section. Refill and bleed the brake system as described in **BRAKES**.

Removing and Installing Trailing Arm Bushings

With the trailing arm removed as described above, the rubber mounts can be removed for replacement due to wear or for installation of eccentric bushings to correct toe (rear wheel alignment).

The rubber bushings are pressed into the trailing arms. BMW specifies special tools to remove them and to install replacements. Each bushing has a larger diameter shoulder on one end. This shoulder always faces away from the trailing arm. In other words, the inner bushing's shoulder faces the center of the car, and the outer bushing's shoulder faces away from the car. See Fig. 6-14 and Fig. 6-15 above.

Standard replacement bushings are concentric. They need not be lined up in any particular way for installation. When installing the eccentric bushings to change toe, however, their installed position is critical. Fig. 6-16 and Fig. 6-17 illustrate the installation of the eccentric bushings according to the markings on the bushings. Fig. 6-18 shows in graph form the nominal toe change resulting from each of the different bushing installation angles.

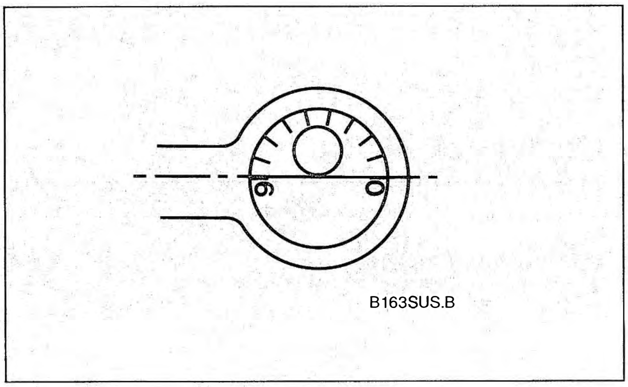

Fig. 6-16. Installed angle of eccentric bushing (which determines amount of toe correction) is measured from imaginary reference line (parallel to trailing arm as shown).

NOTE —

The maximum amount the bushing should be turned either way is 4½ (90°).

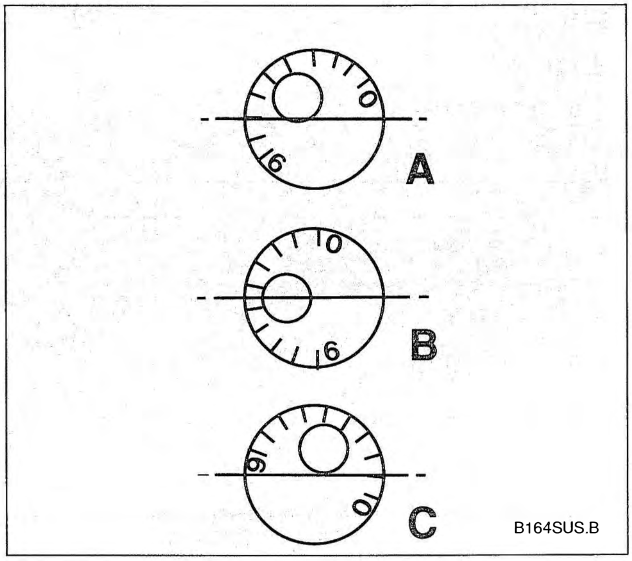

Fig. 6-17. Examples of matching eccentric bushing installation marks to imaginary reference line. **A** is set at "7". **B** is set at "4½" (maximum correction). **C** is set at "1".

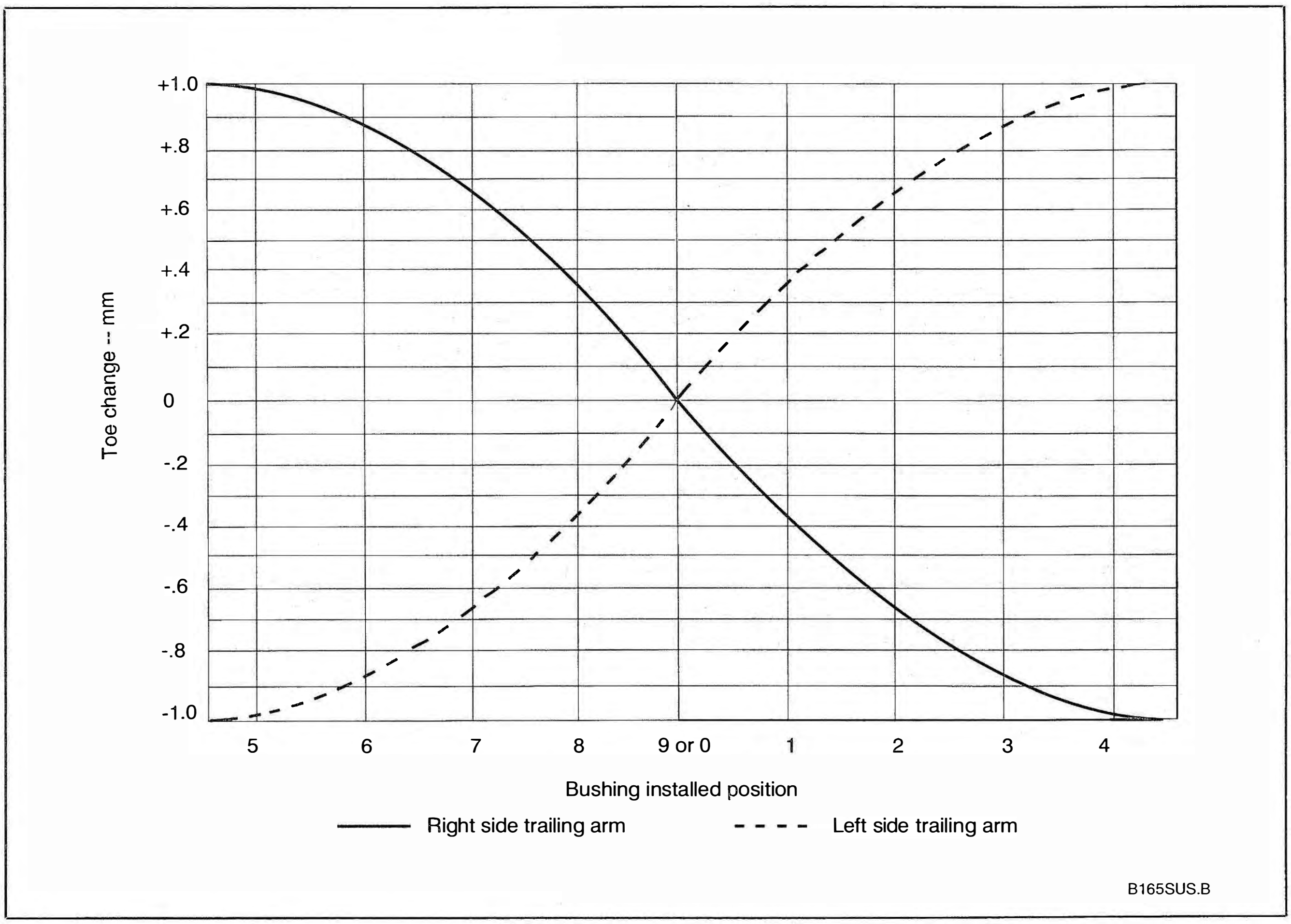

Fig. 6-18. Nominal toe correction (mm) vs. installed position of trailing arm eccentric bushings. Notice that positions for left and right side trailing arms are different.

6.4 Rear Wheel Bearings

The wheel bearings are permanently sealed and lubricated. As such, they do not require any routine maintenance. Bearings are serviced by replacement only, as they are normally damaged when removed.

The bearing is pressed into the trailing arm wheel bearing housing, and the outer race is secured with a large circlip. The wheel hub is in turn pressed into the bearing inner race, and held in place by the installation of the outer CV joint stub axle and its nut.

Removal and installation of the drive axle, the wheel hub, and the wheel bearing requires some special tools. If proper tools are not available, this work may be best left to an authorized BMW dealer or other qualified repair shop.

To remove rear wheel bearings:

1. Remove the drive axle as described in **6.2 Drive Axles and Constant Velocity (CV) Joints**.

2. On models with rear disc brakes, leave the flexible brake hose connected and dismount the brake caliper. See **BRAKES**. To avoid kinking or damaging the brake hose, use stiff wire to suspend the caliper from the underbody.

> ***CAUTION***
> *Do not allow the caliper to hang by the brake line. Doing this could damage the line and cause later brake failure.*

> **NOTE**
> Leaving the brake line attached to the caliper eliminates the need to bleed the brake system after reassembly.

3. Remove the countersunk screw that holds the brake rotor or drum to the wheel hub, and remove the rotor or drum. Also see **BRAKES** for more information on brake components.

4. From behind, drive the wheel hub out of the wheel bearing. See Fig. 6-19.

5. Remove the large circlip which holds the wheel bearing in the wheel bearing housing, then drive the bearing out.

6. If the bearing inner race remains attached to the hub when the hub is removed, as it probably will, it will be necessary to use a puller to remove the bearing inner race from the hub.

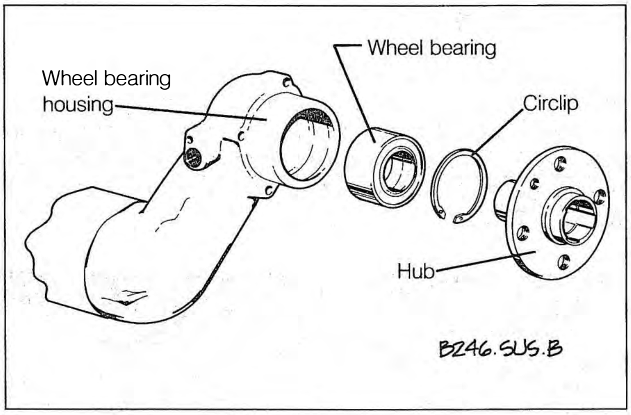

Fig. 6-19. Trailing arm wheel bearing housing, hub, and wheel bearing. Hub is driven out from behind after removing drive axle and outer CV joint. Bearing is pressed out after removing circlip from wheel bearing housing.

While installation is basically the reverse of removal, some care is necessary to avoid damaging the new bearing. Special tools are required to press the bearing into the bearing housing, to press the hub into the bearing, and to pull the splined drive axle into position in the hub.

To install rear wheel bearings:

1. Applying force to the bearing on the outer race only, press the bearing into position in the trailing arm wheel bearing housing and fit a new circlip.

> ***CAUTION***
> *Make sure that the bearing is pressed in far enough to contact the shoulder at the backside of the housing, and that the circlip is fully seated in its groove.*

2. Applying force to the bearing on the inner race only, press the hub into position.

3. Reinstall the drive axle.

4. Reinstall the brake rotor or drum. On cars with rear disc brakes, remount the caliper, making sure that the flexible brake hose is not twisted or kinked. Torque the caliper mounting bolts to 60 to 67 Nm (43 to 48 ft. lb.).

5. Lubricate the wheel and hub contact surface with a thin film of multi-purpose grease, and mount the wheel. Lower the car to the ground, and torque the wheel lug bolts to 100 ± 10 Nm (74 ± 7 ft. lb.).

7. STEERING

The steering wheel and steering column are connected to the mechanical rack and pinion steering gear by a short universal joint shaft. Turning the steering wheel turns the steering gear pinion which in turn moves the rack and tie rods to turn the wheels. The steering gear and tie rods are shown installed on the car in Fig. 7-1.

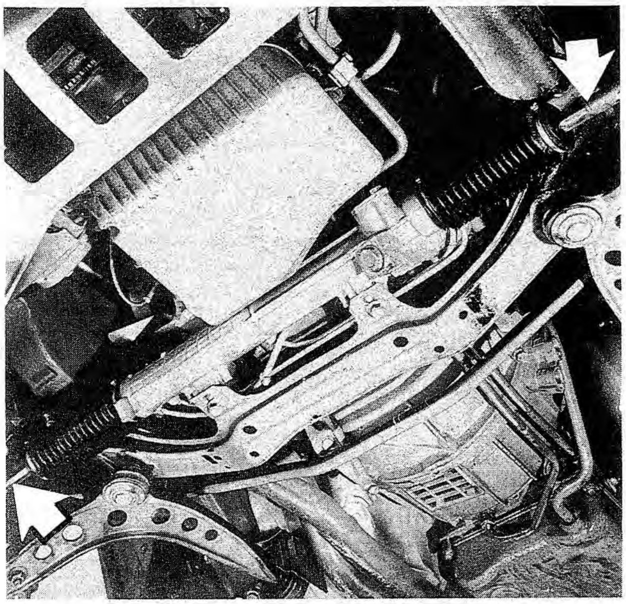

Fig. 7-1. Rack and pinion steering gear, operated by steering wheel, is connected to wheels by tie rods (arrows).

The steering gear is power-assisted. Hydraulic pressure boosts the response of the steering gear and reduces steering effort. An engine-driven pump delivers power steering fluid to the system under pressure.

The steering column and universal joint shaft connect to the steering gear pinion via the power steering control valve, which controls the pressure and flow of the power steering fluid in response to the driver's steering inputs.

A hydraulic operating cylinder, built into the steering gear housing, is operated by the pressurized fluid to help move the steering rack. Fig. 7-2 is a view of the control valve (part of the steering gear) and the universal joint shaft.

Wear and excessive play or clearance anywhere in the system will cause sloppy, loose-feeling, and imprecise steering. On cars with high mileage, the tie rod end joints, the universal joints on each end of the universal joint shaft, and the rubber coupling on the universal joint shaft are particularly prone to wear.

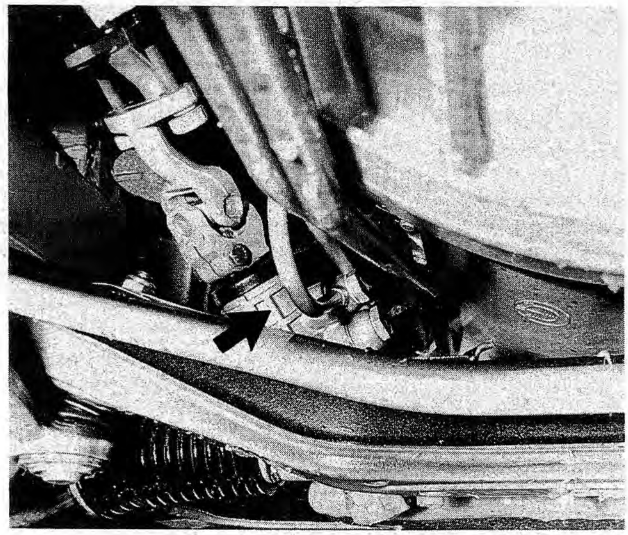

Fig. 7-2. Power steering control valve (arrow) is part of steering gear. Universal joint shaft connects steering column to steering gear pinion at control valve.

There are no provisions for either periodic lubrication or adjustment of the steering gear. The steering system is serviced only by the replacement of worn parts. Checking and filling power steering fluid is covered in **LUBRICATION AND MAINTENANCE**.

If steering requires excessive effort or lacks precise feel, the steering mechanism may not be to blame. Faulty front strut bearings (upper mounts) or other worn front suspension parts may also cause or contribute to the symptoms. Before checking for any suspension or steering problems, check the tires and tire inflation pressures. For more information, see **3. Troubleshooting** and **5. Front Suspension**.

Supplemental Restraint System

Some of the cars covered by this manual are equipped with a Supplemental Restraint System (SRS), which automatically deploys an airbag to protect the driver in the event of a frontal impact. Crash sensors in the front of the car detect frontal impact and electrically ignite a powerful gas generator to inflate the airbag, located in the steering wheel.

The airbag unit is literally a pyrotechnic device. Handled improperly or without adequate safeguards, the system can be very dangerous. Because of this danger, both BMW and the publisher of this manual strongly recommend that the system be serviced only by professional, BMW-trained technicians. Procedures for servicing the SRS are, therefore, not included in this manual.

On cars equipped with the Supplemental Restraint System, the following precautions must be observed, to prevent injury due to unwanted activation of the system:

> ***WARNING —***
>
> - *Tests and installation/removal should only be performed by personnel with qualified training in BMW service.*
>
> - *The supplemental restraint system can only be checked electrically, in the car, and only with the testers specified by BMW.*
>
> - *Always disconnect the battery, cover the negative terminal, disconnect both plugs from the front crash sensors in the engine compartment, and disconnect the orange SRS plug at the steering column to be sure that the power supply to the gas generator is interrupted prior to any work on the SRS, any body straightening, or any electric welding.*
>
> - *Never treat the airbag unit with cleaning solutions or grease.*
>
> - *Never subject an airbag unit to temperatures above 212°F (100°C).*
>
> - *Never install airbag units, crash sensors, or SRS electronic units which have been dropped from a height of 1/2 meter (1 1/2 ft.) or more.*
>
> - *If an airbag has been activated, all components must be replaced. The wiring harness, if it is undamaged, may be reused.*
>
> - *Cars which are to be scrapped must have the gas generator rendered unusable prior to scrapping. Consult an authorized BMW dealer service department for the proper procedure.*

7.1 Steering Column

The steering column connects the steering wheel to the steering gear. The column is supported by the steering column housing which is fastened to the instrument panel (by shear-bolts) and to the firewall. Several accessory switches are also mounted on the steering column housing. The steering column housing and its firewall mounting point are shown in Fig. 7-3.

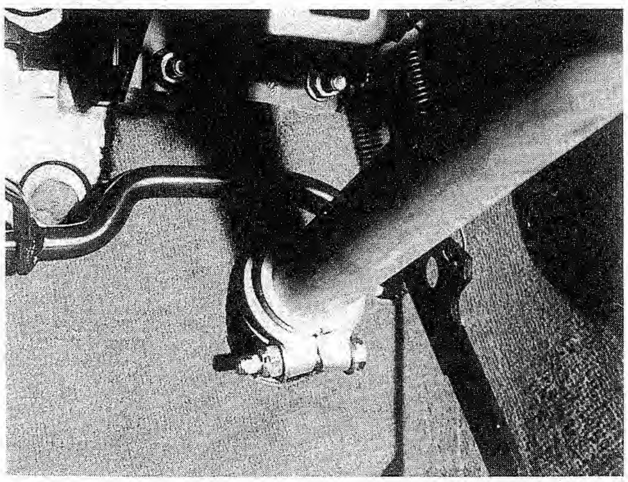

Fig. 7-3. Firewall mounting point for steering column housing. Clamp attaches steering column housing to firewall mount.

Removal and installation of the steering column switches, including the windshield wipers and washers, the turn signals, and the headlight high beam switch, are covered here. For information on the electrical functions and troubleshooting of these switches, see **ELECTRICAL SYSTEM**.

Removing and Installing Steering Wheel

The steering wheel must be removed for access to the steering column switches and the ignition switch. The steering wheel is held in place with a self-locking nut which should always be replaced.

To remove:

1. Disconnect the battery negative (−) terminal.

2. Use a small screwdriver to gently pry up the center cover (the BMW emblem). Center the wheel and mark its position relative to the steering column shaft, so that it can be properly aligned when reinstalled. See Fig. 7-4.

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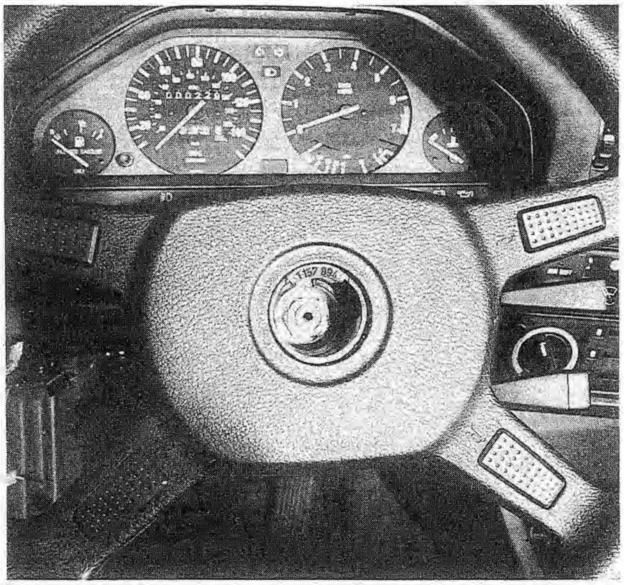

Fig. 7-4. Large nut secures steering wheel to steering column. Mark wheel and steering column shaft prior to removal to ensure proper alignment for reinstallation.

3. Holding the steering wheel, remove the nut and washer that hold it to the steering column.

4. Insert the ignition key into the ignition switch. Turn the key to the first position to unlock the ignition lock. Do not switch on the ignition.

5. Pull the steering wheel straight off the steering column, and disconnect the wiring from the horn pad or pads.

Installation is the reverse of removal. If it is necessary to realign the steering wheel with the steering column splines, or if a new, unmarked steering wheel is being installed, first make sure that the marks on the steering gear shaft and the steering gear housing are aligned, as shown in Fig. 7-5. Then install the steering wheel. Torque the nut to 80 Nm (58 ft. lb.).

NOTE —

In some cases, slight interference between the steering column housing and the installed steering wheel may cause noise. To solve this problem, BMW makes a washer available which can be installed between the steering wheel and the collar on the steering column (under the steering wheel). Install BMW Part No. 07 11 9 932 650. If the problem persists, install the thicker washer, BMW Part No. 32 31 2 682 144.

CAUTION —

BMW part numbers are provided for reference only and are subject to change. Always rely on an authorized BMW dealer parts department for the most up-to-date and accurate parts information.

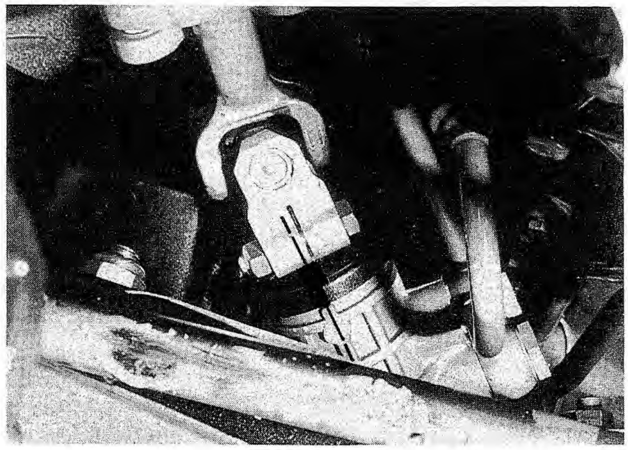

Fig. 7-5. Marks on steering gear housing align as shown when steering gear is centered and front wheels are in straight-ahead position.

Removing and Installing Steering Column Switches

For access to the turn signal/headlight flasher switch, and the windshield wiper/washer switch, remove the lower left-side instrument panel trim, as indicated in Fig. 7-6, and the lower steering column trim panel, shown in Fig. 7-7.

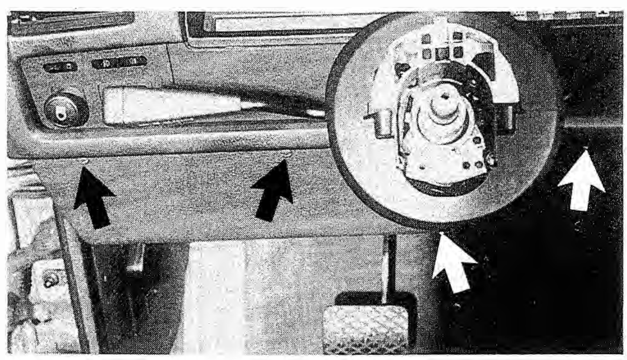

Fig. 7-6. Turn fasteners (arrows) ¼ turn counterclockwise to release lower left-side instrument panel trim for access to instrument column.

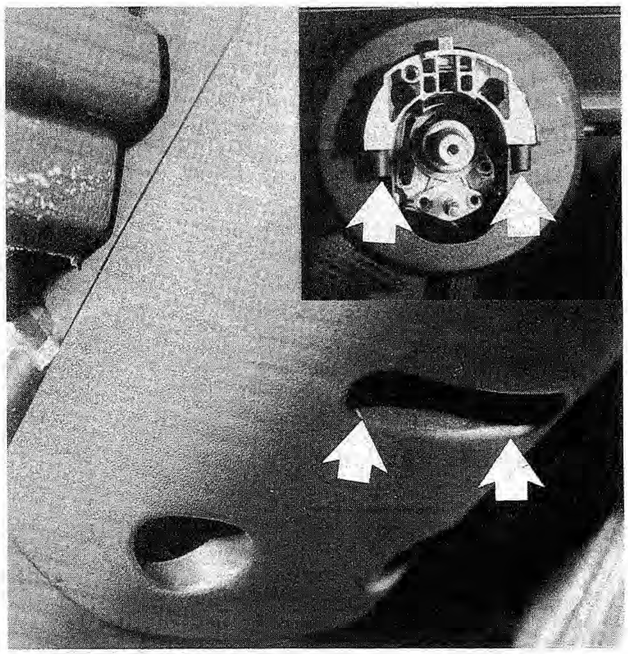

Fig. 7-7. Remove four screws (arrows) to release lower steering column trim panel for access to switches on steering column.

Each switch is fastened to the steering column with screws, as shown in Fig. 7-8. The lower screws are also ground wire connections. To remove a switch, remove the two screws on that side of the steering column and disconnect the appropriate wiring harness connectors. Fig. 7-9 shows the main harness connector cluster for all steering column wiring on 1989 models. Other models are similar. Installation is the reverse of removal.

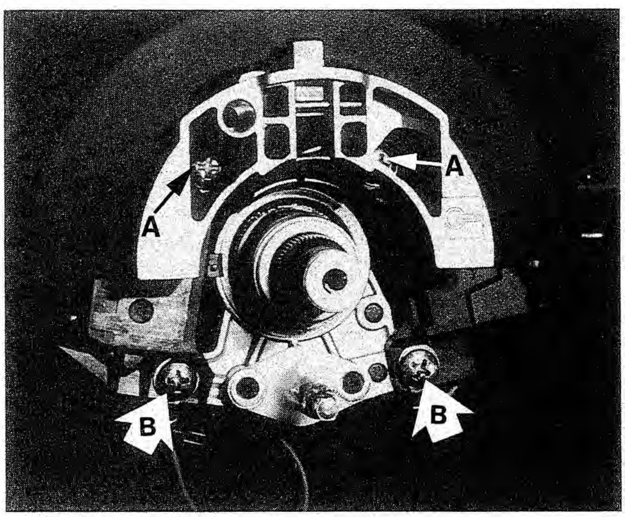

Fig. 7-8. Screws fasten steering column switches (**A**) and ground wires (**B**).

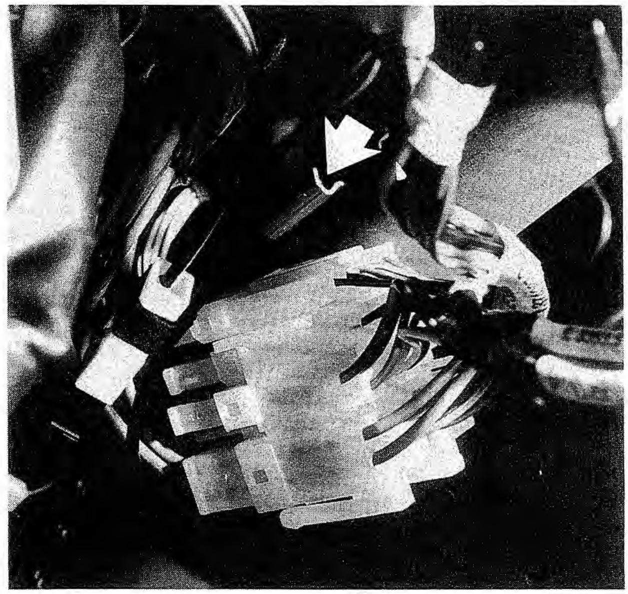

Fig. 7-9. Main harness connector cluster for steering column wiring. Connector snaps into bracket (arrow) on top of column housing. (1989 model shown).

Replacing Ignition Switch/Steering Lock

The ignition switch snaps into place on the steering lock housing, on the end opposite the lock cylinder. The ignition switch and switch harness can be removed from the back of the ignition lock by using a small screwdriver to release the spring catch.

To remove the ignition/steering lock cylinder insert the key and work through the small hole to release the lock. On 1984–1986 models, the lock can be released by pressing in with a small screwdriver as the key is turned, as shown in Fig. 7-10.

On 1987–1990 models, turn the key clockwise 60° and insert a 1.2 mm ($\frac{3}{64}$ in.) diameter wire into the hole in the lock cylinder to release the lock.

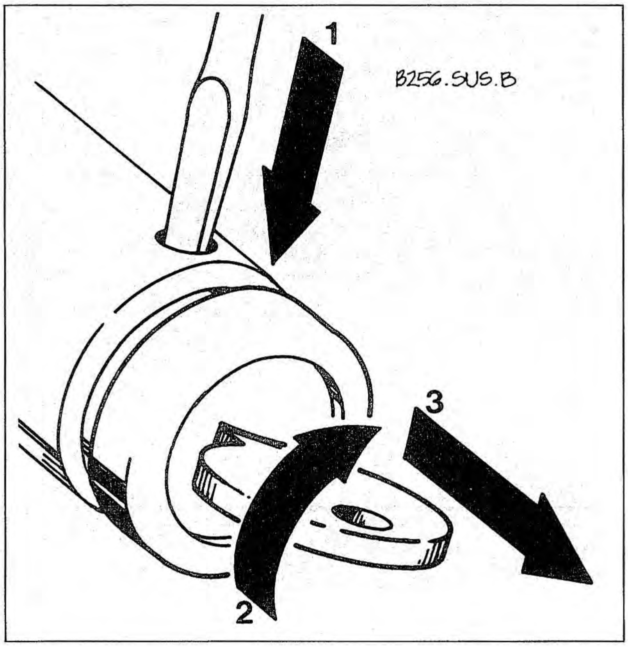

Fig. 7-10. Screwdriver inserted in small hole (arrow) will release ignition/steering lock on older (1984–1986) models. Newer models are similar. See text.

Removal of the steering lock mechanism from the steering column is more involved. With the trim and the steering column switches removed as described above, remove the collar, the snap ring, the washer, the spring, and the plastic sleeve, in that order, from the end of the steering column. Then, use two screwdrivers to pry up the upper steering column bearing. See Fig. 7-11. With the electrical harness connectors disconnected, chisel off the head of the shear bolt. Then remove the steering lock mechanism from the steering column.

Installation is the reverse of removal. The new shear bolt is BMW Part No. 32 31 1 154 176. Tighten it until the head shears off. If the lock mechanism is being replaced, remove the carbon contact, shown in Fig. 7-11, from the old mechanism by drilling out the rivets, and install it on the new mechanism. Screws, washers, and nuts for this purpose are available from your authorized BMW dealer.

CAUTION

BMW part numbers are provided for reference only and are subject to change. Always rely on an authorized BMW dealer parts department for the most up-to-date and accurate parts information.

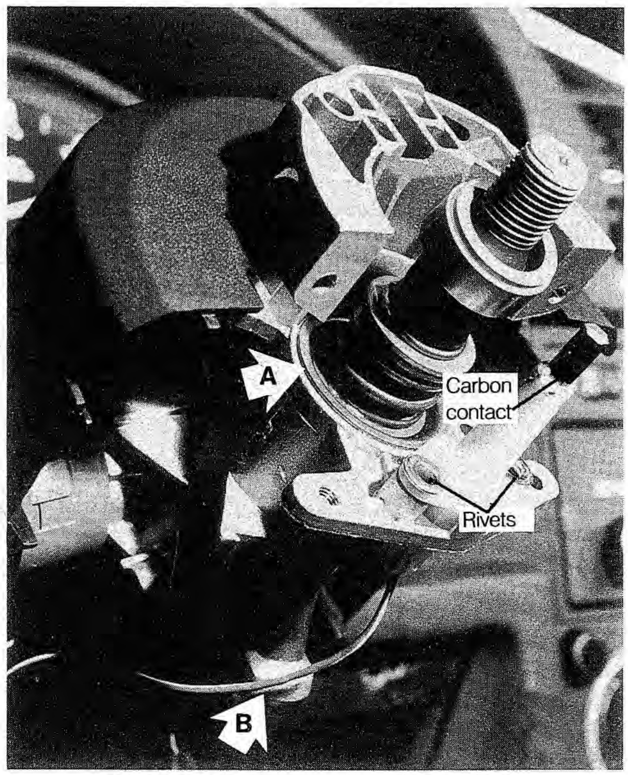

Fig. 7-11. Collar, spring, upper bearing (**A**) and related parts must be removed for access to steering lock mechanism. Shear bolt (**B**) fastens ignition/steering lock mechanism to steering column housing. Carbon contact is for horn.

7.2 Steering Gear and Tie Rods

In the rack and pinion steering gear, the steering pinion translates rotating motion of the steering wheel into the side-to-side motion of the steering rack, which is essentially a long, straight gear. Tie rods connect the ends of the steering rack to the steering arms on the front suspension struts, near the wheels.

The inner and outer tie rod ends are ball-jointed to combine precise steering with the flexibility necessary to accommodate suspension movement. Rubber boots protect the joints and retain lubricant. Other than periodic inspections for wear or damage, the joints require no maintenance or additional lubrication.

Parts of the steering mechanism are fastened with self-locking nuts. To guard against hydraulic leaks when servicing the hydraulic fluid lines, the sealing washers should always be replaced. Note too that adjustment or replacement of tie rods will always affect wheel alignment. A wheel alignment should be included as the final step in any such repair work.

CAUTION —

Do not reuse self-locking nuts. These nuts are designed to be used only once and should be replaced whenever they are removed.

Inspecting Tie Rod Ball Joints

Two areas are most important when inspecting tie rod ends and their protective boots. Look for wear and excess play in the tie rod ball joints, and look for damage to the boots which will allow dirt to get in and cause them to wear faster.

Check the condition of the inner tie rod boots and the small rubber boots that protect the outer tie rod end ball joints. Cracked or ripped inner tie rod boots can be replaced separately, perhaps prolonging the life of the tie rod end. Damage to the outer tie rod boots requires replacing the tie rod or the tie rod end.

Inner tie rod boots can be replaced without removing the tie rod from the steering rack, and re-alignment is not necessary as long as tie rod length is unchanged. Disconnect the outer tie rod end from the steering arm. Use a puller to avoid damaging the threads. Remove the boot clamps and slide the boot off over the outer tie rod end. Installation is the reverse of removal. Torque the tie rod end self-locking nut to 36.5 ± 3.5 Nm (26.5 ± 2.5 ft. lb.).

To inspect the tie rod ends, raise the car and support it securely on jack stands. Grasp the tire firmly and check for play between the steering rack and the tie rods at the inner tie rod ball joints (under the boot), or between the tie rod ends and the steering arms.

At the four tie rod ball joints, inner and outer, there should be little or no lateral play. Any turning motion of the wheel should be translated directly to the steering gear with no freeplay in between. At the outer tie rod ends, there should be no vertical freeplay. Try forcing the mating parts in opposite directions and looking for freeplay. See Fig. 7-12. Replace any worn tie rod, as described in **Replacing and Adjusting Tie Rods**.

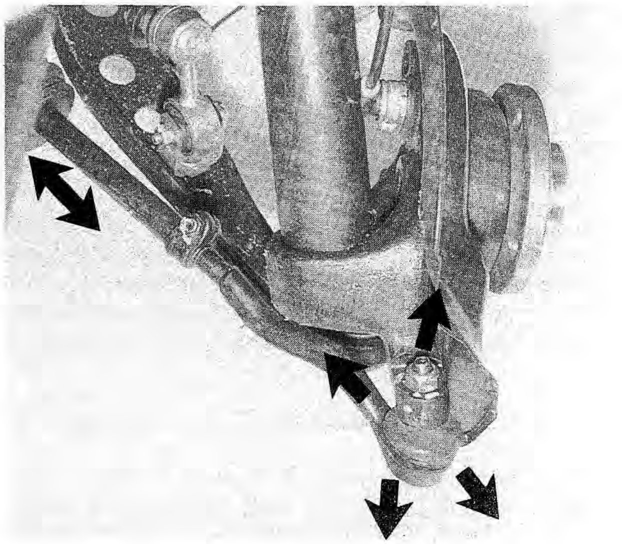

Fig. 7-12. Inspecting tie rods. There should be no noticeable play (arrows) between mating parts.

Replacing and Adjusting Tie Rods

Use a puller to disconnect outer tie rod ends from the steering arms. Remove the clamps that hold the tie rod boots to the steering gear housing, and slide the boots back over the tie rod to expose the inner tie rod end.

To disconnect the inner tie rod end from the steering rack, first bend open the folded tabs of the lockplate. See Fig. 7-13. Then, turn the steering so that the tie rod end is up against the steering gear housing and there is just enough room for a wrench. Loosen and remove the tie rod.

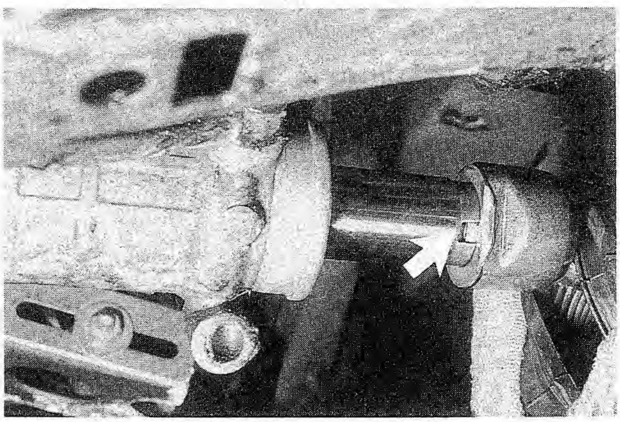

Fig. 7-13. Inner tie rod end ball joint and lockplate. Tab on lockplate (arrow) fits into notch on steering gear housing. (Shown with protective boot pulled back).

Installation is the reverse of removal. When replacing a tie rod, loosen the clamping bolt and adjust the new part to match the old, using a measuring tape to compare their lengths. This way the tie rod adjustment (toe-in) with the new part will be approximately correct. Recheck toe as part of a wheel alignment after the job is complete. See **4.2 Alignment**.

Use a new lockplate to secure the inner tie rod ends to the steering rack, as shown in Fig. 7-13 above. Bend the edges of the lockplate to lock the tie rod end nut in place. Use a new self-locking nut to fasten the outer tie rod end ball joint to the steering arm. Torque it to 36.5 ± 3.5 Nm (26.5 ± 2.5 ft. lb.).

Removing and Installing Steering Gear

If the steering gear requires repair or replacement, it is most easily removed as a unit. As this is written, internal seals and gaskets, available as a set, are the only repair parts available from BMW.

To remove:

1. Remove the nut and bolt which secure the universal joint shaft to the steering gear (pinion shaft), and loosen the upper nut and bolt. See Fig. 7-14.

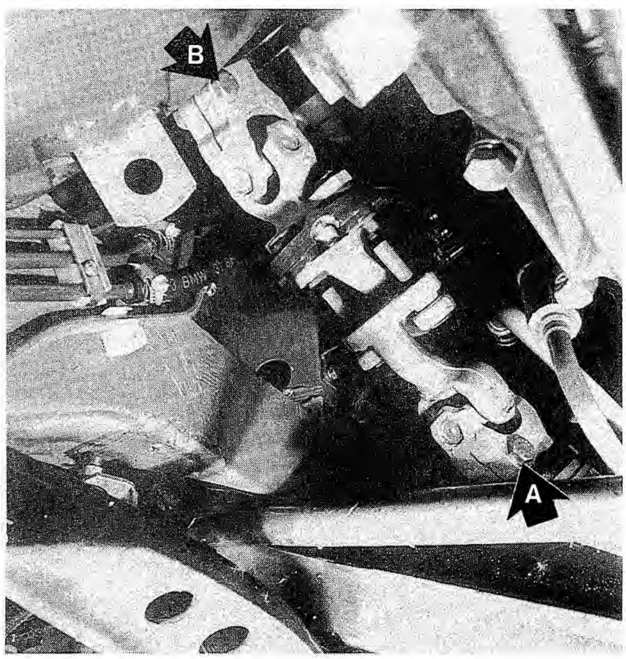

Fig. 7-14. Steering universal joint shaft with universal joints and rubber coupling. Lower bolt (**A**) fits in slot on steering gear pinion shaft and must be completely removed. Loosen upper bolt (**B**) to aid removal of universal joint shaft.

NOTE —
If the rubber coupling or either of the universal joints is worn or defective, the entire universal joint shaft should be replaced.

2. Using a large syringe, a hand pump, or other suitable method, empty the power steering fluid reservoir in the engine compartment.

3. Disconnect the pressure line from its connection at the steering control valve. See Fig. 7-15. Disconnect the fluid return line (to the reservoir) from the steering gear.

NOTE —
It may be helpful at this point to mark the lines for identification during reassembly.

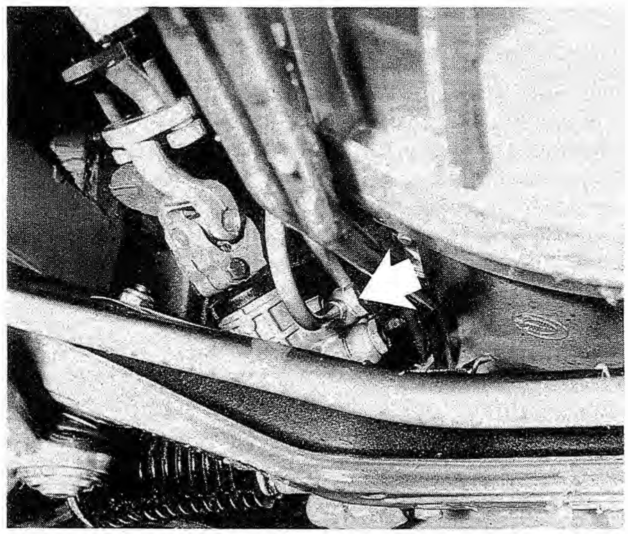

Fig. 7-15. Power steering pressure line connection (arrow) at steering control valve.

4. Disconnect the outer tie rod end joints from the steering arms, as described in **Replacing and Adjusting Tie Rods**.

5. Remove the steering gear mounting bolts and nuts and remove the steering gear. See Fig. 7-16.

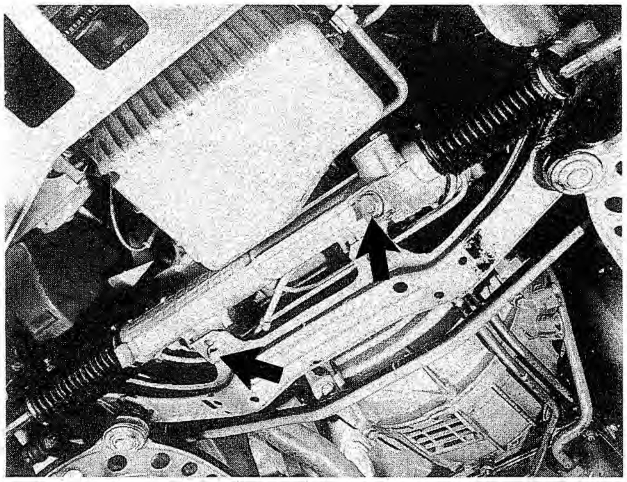

Fig. 7-16. Mounting bolts (arrows) and self-locking nuts mount steering gear to front suspension subframe. Always replace self-locking nuts.

Installation is the reverse of removal. Make sure that the steering gear is centered, as shown in Fig. 7-5 above. Use new self-locking nuts on the universal joint shaft, the tie rod ends, and the steering gear mounting bolts. Use new sealing washers on the power steering pressure line connection to the steering gear. Fastener torque specifications are listed in **Table p**. Refill the power steering system with new fluid and bleed the air from the system as described in **7.3 Power Steering Pressure System**.

Table p. Steering Gear Torque Specifications

Hydraulic line (pressure) connection to steering gear	40 Nm (29 ft. lb.)
Steering gear to front suspension subframe	42 Nm (30 ft. lb.)
Tie rod end self-locking nut	36.5 ± 3.5 Nm (26.5 ± 2.5 ft. lb.)
Universal joint shaft clamping bolts	22 Nm (16 ft. lb.)
Universal joint shaft coupling	22 Nm (16 ft. lb.)

CAUTION —

Do not reuse power steering fluid which has been drained from the system.

If necessary, the steering column (shaft) can also be removed once the universal joint shaft is out of the way. Remove the steering wheel as described in **7.1 Steering Column**. Remove the parts which secure the upper end of the steering column and the upper steering column bearing, as described in **7.1 Steering Column**. Then pull the steering column down slightly out of the lower bearing and remove the similar snap ring, collar, and ring from the lower end of the steering column. Remove the steering column from the top.

7.3 Power Steering Pressure System

This heading covers the hydraulic pressure portion of the power steering system. Information on adjusting or replacing the power steering pump V-belt is found in **LUBRICATION AND MAINTENANCE**.

Filling and Bleeding

Checking and correcting the fluid level in the fluid reservoir is covered in **LUBRICATION AND MAINTENANCE**. The layout of the system ensures that, under normal conditions, any trapped air escapes from the fluid in operation. If, however, the system is being refilled after being drained or to compensate for severe leaks, it may be necessary to deliberately bleed unwanted air from the system. Air in the system may cause noisy and inconsistent operation.

To bleed the system, make sure the fluid level in the reservoir is at the MAX mark, as shown in **LUBRICATION AND MAINTENANCE**, and start the engine. With a helper, turn the steering wheel back and forth from full left to full right, gradually adding fluid to the reservoir as the level drops. When the fluid level remains constant, continue turning the steering wheel until no more air bubbles appear in the reservoir. Add fluid until the fluid level is at the MAX mark. Replace the cap gasket if it is damaged.

NOTE —

Total fluid volume in the power steering hydraulic system is approximately 1200 ml (40 fl. oz.).

Pressure Testing

The power steering pump is tested by measuring its output pressure, using a pressure gauge installed in-line, as illustrated in Fig. 7-17. The pressure gauge requires a range that is adequate to measure the pump's rated pressure of 110–120 bar (1565–1705 psi), and a valve between the gauge and the pressure line to the steering gear. Connect the gauge, with the valve open, between the pump and the pressure hose. Use new sealing washers to avoid leaks and ensure an accurate measurement, and torque the connections to 40 Nm (29 ft. lb.). Center the steering. Start the engine and let it idle.

To test the pump, close the valve for no more than ten seconds, quickly read the pressure, then open the valve. With the valve closed, the pressure should rise to at least 100 bar (1470 psi). If not, the pump should be replaced.

CAUTION

The valve should be closed for no more than 10 seconds. A longer test risks damaging the steering gear, the pump, and/or the V-belt.

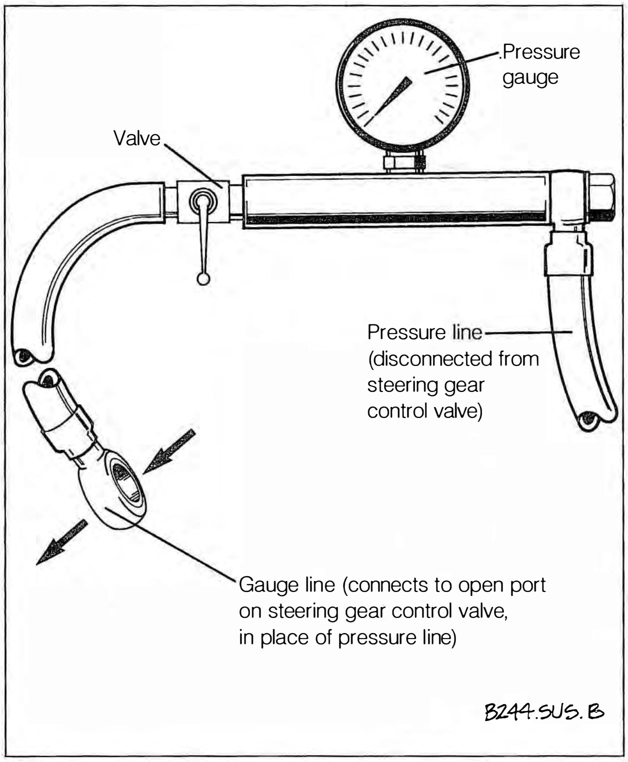

Fig. 7-17. Pressure gauge set-up for measuring power steering pump pressure. Disconnect original pressure line from steering gear and connect to gauge as shown. Connect gauge line to open pressure line connection on steering gear.

To test system pressure, leave the gauge valve open and have a helper turn the steering wheel full right and full left, holding it in each position for about 5 seconds. BMW recommends applying a force of 100 N (22 lb.) to the wheel, measured with a force gauge. At each position, the pressure with the valve open should equal the pump pressure measured above. Lower pressure during this test indicates internal leaks, and the steering gear should be overhauled or replaced.

Power Steering Pump

The power steering pump is mounted on a bracket attached to the engine block. The pump, mounting brackets, and belt-tensioner are shown in Fig. 7-18 and Fig. 7-19. For information on V-belt adjustment or replacement, see **LUBRICATION AND MAINTENANCE**.

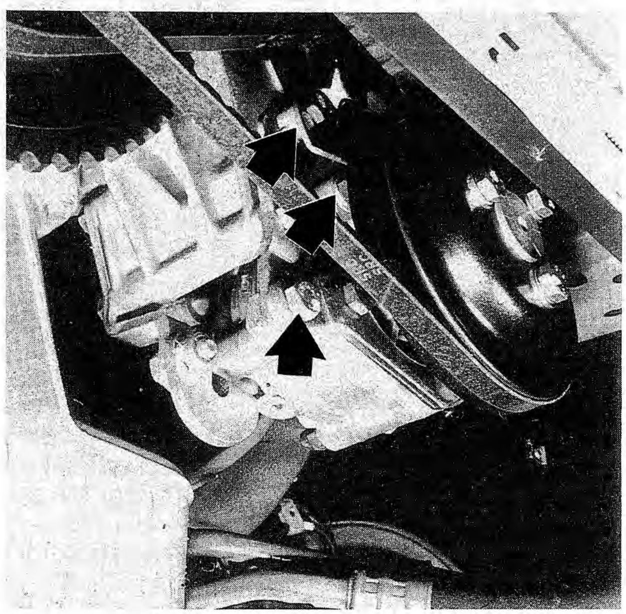

Fig. 7-18. Power steering pump mounting bolts (arrows).

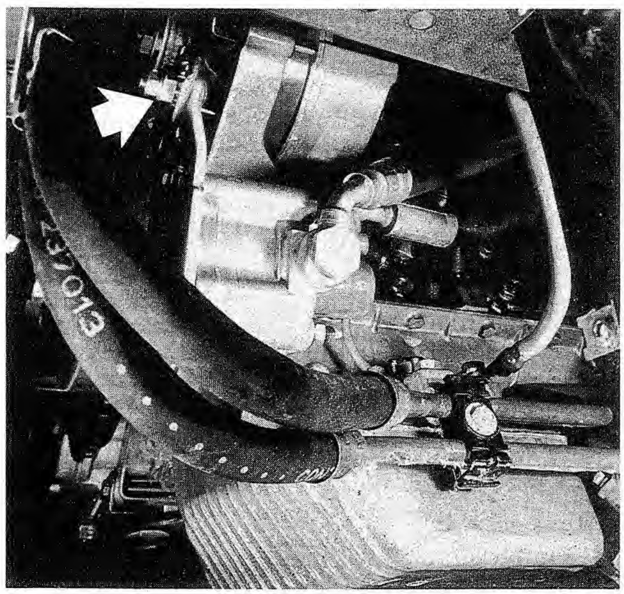

Fig. 7-19. Power steering pump belt tension adjuster (arrow).

When installing the power steering pump, torque the mounting bolts to 22 Nm (16 ft. lb.) and the hose connections (banjo bolts) to 40 Nm (29 ft. lb.).

8. TECHNICAL DATA

I. Tightening Torques

Connecting link to bracket	22 Nm (16 ft. lb.)
Connecting link bracket to control arm	42 Nm (30 ft. lb.)
Control arm ball joint to strut (locknut)	65 Nm (47 ft. lb.)
Control arm ball joint to subframe (locknut)	85 Nm (61 ft. lb.)
Control arm rubber bushing (bracket to underbody, bolts)	42 Nm (30 ft. lb.)
Final drive rubber mount to body	80–87 Nm (58–63 ft. lb.)
Front brake caliper to suspension strut (bolt)	110–123 Nm (80–90 ft. lb.)
Front strut mounting nuts (top)	22 Nm (16 ft. lb.)
Front shock absorber cartridge threaded collar	130 ± 13 Nm (94 ± 9 ft. lb.)
Front shock absorber top nut	65 ± 6 Nm (47 ± 5 ft. lb.)
Front wheel bearing collar (axle) nut	290 ± 29 Nm (210 ± 21 ft. lb.)
Power steering pressure line to steering gear	40 Nm (29 ft. lb.)
Rear brake caliper to wheel bearing housing (bolts)	60–67 Nm (43–48 ft. lb.)
Rear shock absorber to trailing arm	72–87 Nm (52–63 ft. lb.)
Rear shock absorber to upper mounting bracket	13–15 Nm (9–11 ft. lb.)
Rear stabilizer bar to trailing arm (tighten in normal position)	22–24 Nm (16–17 ft. lb.)
Stabilizer bar to connecting link	42 Nm (30 ft. lb.)
Stabilizer bar mounting brackets to subframe	22 Nm (16 ft. lb.)
Steering gear to front suspension subframe	42 Nm (30 ft. lb.)
Subframe anchor bolts	
M10	42 Nm (30 ft. lb.)
M12	77 Nm (56 ft. lb.)
Tie rod end locknut	36.5 ± 3.5 Nm (26.5 ± 2.5 ft. lb.)
Universal joint shaft clamping bolts	22 Nm (16 ft. lb.)
Universal joint shaft coupling	22 Nm (16 ft. lb.)
Upper bracket to body (nuts)	22–24 Nm (16–17 ft. lb.)
Wheel lug bolts	100 ± 10 Nm (74 ± 7 ft. lb.)

Section 14

BODY AND INTERIOR

Contents

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2 BODY AND INTERIOR

TABLES

Body and Interior

Introduction

The BMW 318 and 325 have unit construction steel bodies that are exceptionally strong and light. Their lightness contributes greatly to the outstanding performance and fuel economy of the cars. Because very few screws and bolts are used in assembling the body, fewer rattles are likely to develop. The ride is quieted further by the application of sound-dampening material to the floor plates and the body panels.

During manufacture, the various body panels, subassemblies, and a number of smaller pressed-steel panels and plates are joined by electric welding. Although all body panels are available as replacement parts, most of these replacement panels must be butt-welded to the body after the damaged panels have been cut away. This work should be left to an experienced body repair technician.

The front fenders, however, are bolted to the main body structure and can be easily and economically replaced in the event of damage. The hood, the grille, the doors, and the trunk lid are also removable. These bolt-on components are easily replaced even if you have little or no knowledge of auto body repair.

Also covered in this section is the ventilation and heating system. Electrical repairs to the instrument cluster, including the gauges and lights, are covered in **ELECTRICAL SYSTEM**. Care of the body, trim, upholstery, and windows is described in **LUBRICATION AND MAINTENANCE**.

If you lack the skills, special equipment, or a suitable workshop for extensive body repairs, we suggest that you leave this work to an authorized BMW dealer or other qualified repair shop. We especially urge you to consult a BMW dealer before beginning repairs on a vehicle that may be subject to BMW's warranty coverage.

1. GENERAL DESCRIPTION

1.1 Instrument Panel and Instrument Cluster

The padded instrument panel houses the instrument cluster and the ventilation and heating system. It is fastened to the body and can be removed using ordinary hand tools. The instrument cluster is removable as a unit without removing the instrument panel. All electrical repairs to the instrument cluster are covered in **ELECTRICAL SYSTEM**.

1.2 Seats, Seat Belts, and Interior

The front seats are mounted to the floor. Rear seats are bolted to the body and are easily removed for access to the rear seat belt mountings. The seat belts are typical three-point belts that cross the hips and the shoulder. All interior trim is easily removed using ordinary hand tools.

1.3 Ventilation, Heating, and Air Conditioning

Fresh air continuously enters the car at the air intake, located at the base of the windshield in the body cowl. Interior air exits through vents located in the side panels of the luggage compartment and through slots at the base of the rear window. The incoming air can be either heated or cooled as it flows through the integrated heating and air-conditioning system contained in the heater box located behind the instrument panel. A fresh air blower assists air flow.

The heating system is a blend system with controlled coolant flow through the heater core. In a blend system, temperature is regulated by a blending flap. See Fig. 1-1. The flap controls the amount of fresh air that passes through the heater core before it enters the passenger compartment. Coolant flow through the heater core is regulated by an solenoid valve that is controlled by the dash-mounted temperature control. Air flow to the windshield and to the footwells of the passenger compartment is controlled by two additional flaps in the heater box.

On cars with air conditioning, the fresh air can first be cooled and dehumidified by the evaporator. A portion of the air can then be directed by the blending flap through the heater core to maintain the desired temperature. In very hot conditions the interior air can be recirculated for maximum cooling.

1.4 Body

The body is of welded, unitized construction, meaning it does not have a separate frame. This design forms a very rigid passenger compartment, with large crumple zones in the front and rear for energy absorption in the event of a collision.

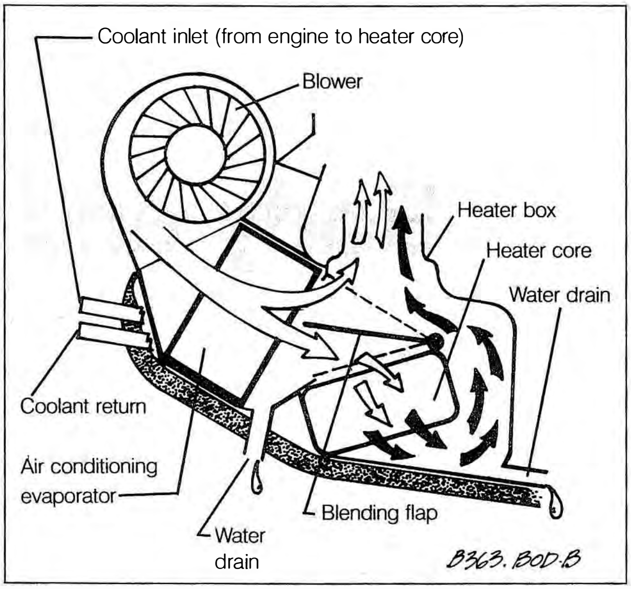

Fig. 1-1. Schematic view of heating and air conditioning system.

For corrosion protection, all steel is treated and has a multilayer finish. The body seams are then sealed using a PVC compound. The front fenders are flanged to allow trapped moisture to evaporate. The body is undercoated and all interior cavities are flooded with a rust preventative sealant.

2. MAINTENANCE

BMW specifies the maintenance steps below to be carried out at particular time or mileage intervals for proper maintenance of body and interior components. A number in bold type indicates that the procedure is covered in this section, under that numbered heading. Information on other body and interior maintenance and on the prescribed maintenance intervals can be found in **LUBRICATION AND MAINTENANCE**.

1. Lubricate door hinges
2. Check headlight and driving light aim. **6.1**
3. Clean and lubricate sunroof slide rails. **7**
4. Check air conditioner function and refrigerant charge. **9**
5. Check seat belts. **4.5**
6. Check windshield wiper/washer system
7. Check wiper blade condition

3. TROUBLESHOOTING

Because the components and assemblies covered in this section vary widely, specific troubleshooting is covered with the repair information in this section. For more help when troubleshooting electrical problems, see **ELECTRICAL SYSTEM**, or see the discussion of troubleshooting in **FUNDAMENTALS** at the beginning of the manual.

4. INTERIOR

This section covers the removal and replacement of interior components. Repairs to interior electrical components are described in **ELECTRICAL SYSTEM**. Information on interior door trim, door locks, window controls, and other mechanical parts of the door are covered in **5. Doors**.

4.1 Instrument Cluster and Instrument Panel

This heading covers the removal and installation of instrument panel components and related trim.

Removing and Installing Instrument Cluster and Instrument Panel Trim

The instrument cluster and other instrument panel trim can be removed using ordinary hand tools and without removing the instrument panel.

To remove instrument cluster:

1. Disconnect the negative (–) cable from the battery.

2. Remove the steering wheel as described in **SUSPENSION AND STEERING**.

> ***WARNING***
> *Some of the 1990 cars covered by this manual are equipped with a Supplemental Restraint System (SRS) that automatically deploys an airbag. The airbag unit uses a pyrotechnical device to electrically ignite a powerful gas. On cars so equipped, any work involving the steering wheel should only be performed by an authorized BMW dealer. Performing repairs without disarming the SRS may cause serious personal injury.*

3. Remove the lower-left instrument panel trim by removing the screws indicated in Fig. 4-1.

4. Remove the instrument trim panel shown in Fig. 4-2 by removing the two knurled nuts from behind the panel.

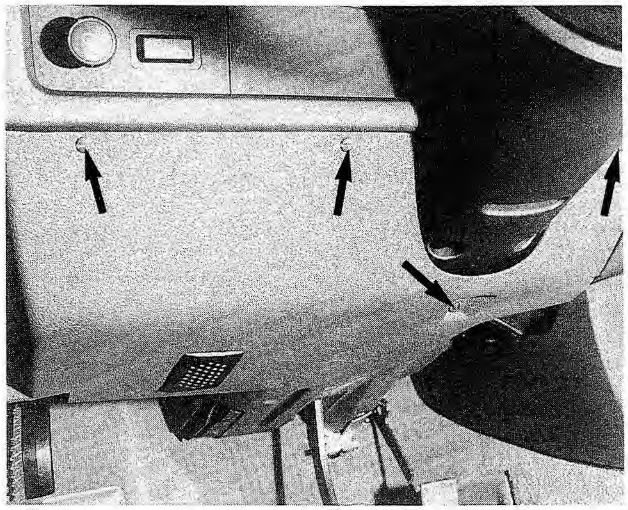

Fig. 4-1. Retaining screws (arrows) to be removed from left-side instrument panel trim.

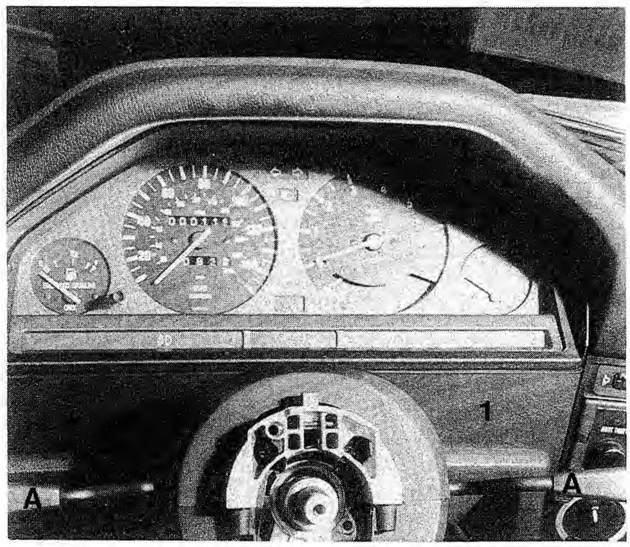

Fig. 4-2. Instrument trim panel (**1**) to be removed by removing two knurled nuts from up behind panel (**A**).

5. Remove the instrument cluster trim plate by removing the retaining screws shown in Fig. 4-3.

6. Remove the two instrument cluster retaining screws indicated in Fig. 4-4, then pull the cluster out slightly. Disconnect the electrical connectors from the back of the cluster and remove the cluster.

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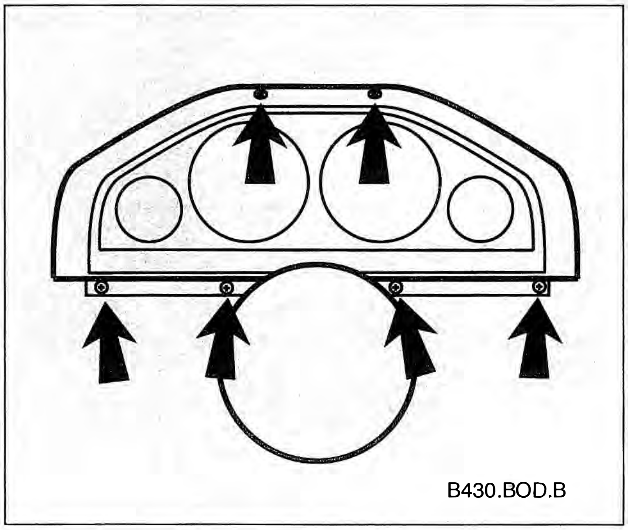

Fig. 4-3. Instrument cluster trim plate retaining screws (arrows) to be removed.

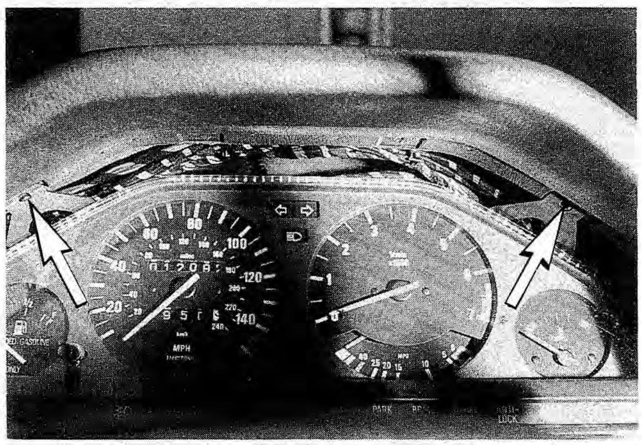

Fig. 4-4. Instrument cluster retaining screws (arrows) to be removed.

To remove shift console:

1. Disconnect the negative (−) cable from the battery.

2. Remove the lower-left instrument panel trim as shown in Fig. 4-1 above.

3. Remove the parking brake handle trim by lifting out the ashtray and removing the screw shown in Fig. 4-5. Pull the trim back slightly to disengage the tab at the front and lift it off the brake handle.

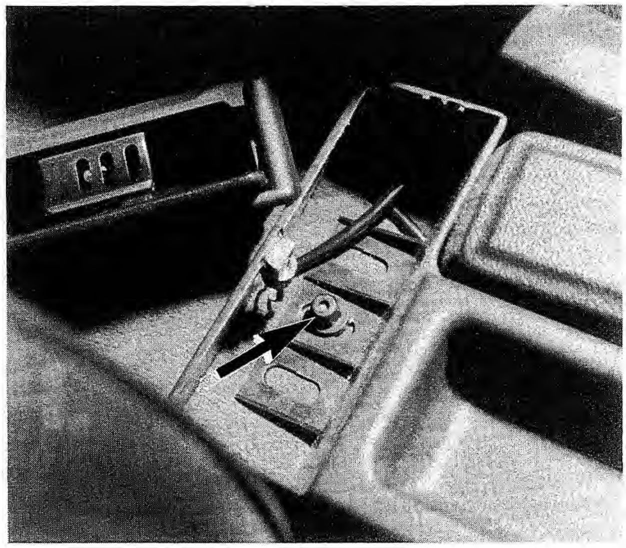

Fig. 4-5. Screw under ashtray (arrow) that secures parking brake handle trim. Remove screw and pull trim back slightly to release at front.

4. On cars with manual transmission, pull the shift knob up and off the shift lever, and then remove the shift boot.

5. On cars with automatic transmission, pry out the selector lever trim plate, remove the two screws shown in Fig. 4-6, and then remove the shift lever trim panel.

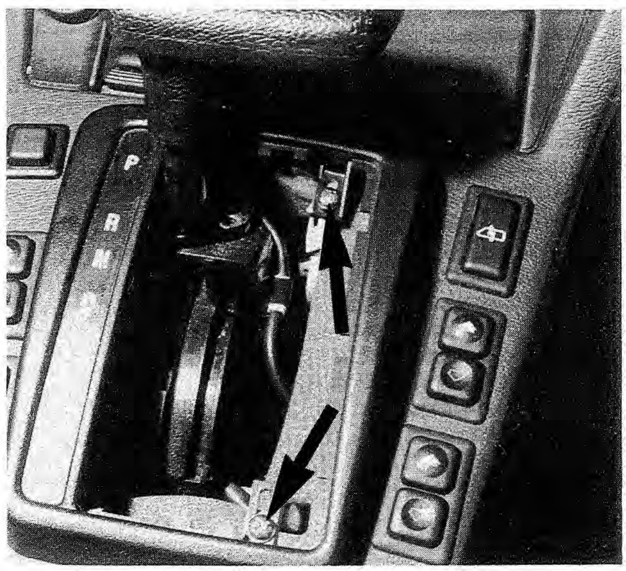

Fig. 4-6. Screws to be removed (arrows) for removal of shift lever trim panel.

6. Remove the insulation material and then remove the console mounting nut, shown in Fig. 4-7.

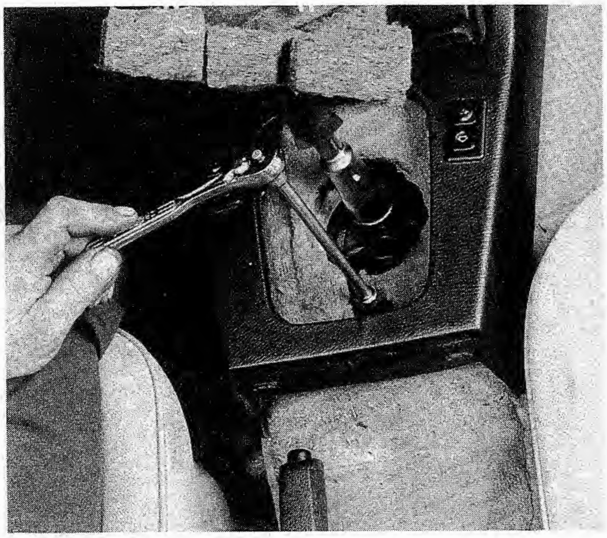

Fig. 4-7. Console mounting nut being removed.

7. Pry out the electric window switches, the heated seat switches, and the automatic transmission switch, where applicable, and disconnect the wiring connectors.

8. Remove the ashtray and cigar lighter console by removing the two screws shown in Fig. 4-8, and then disconnect the wiring.

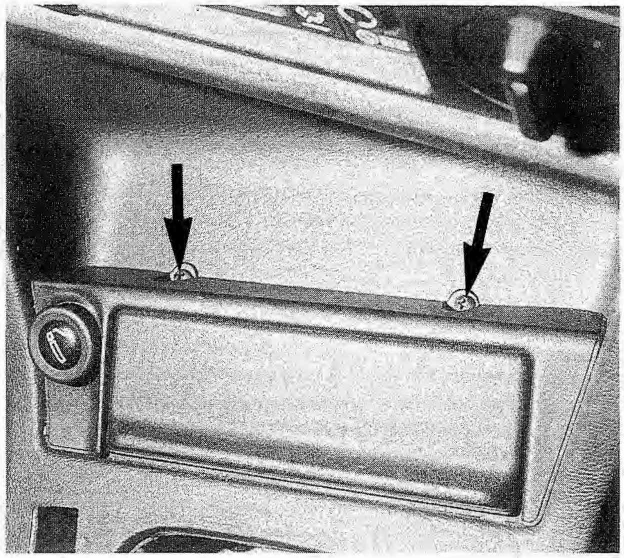

Fig. 4-8. Ashtray console retaining screws (arrows).

9. Remove the screw under the lip of the heater controls, shown in Fig. 4-9, and turn the console retainers on either side as shown in Fig. 4-10. Remove the shift console by pulling it out to the rear.

Installation is the reverse of removal.

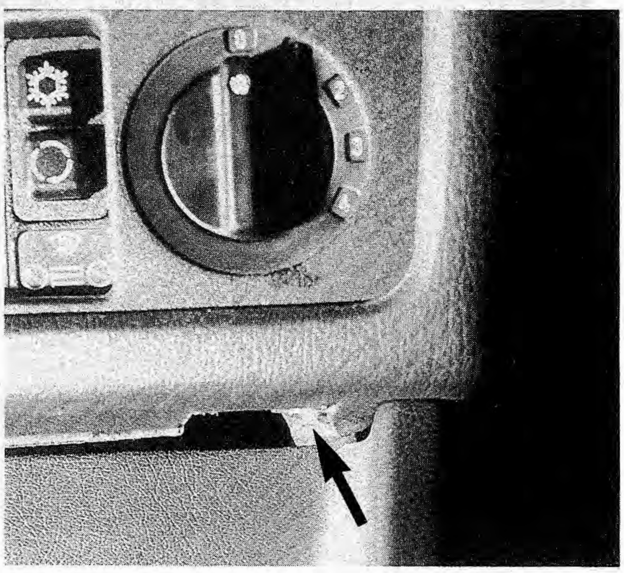

Fig. 4-9. Shift console mounting screw (arrow) under lip of heater controls.

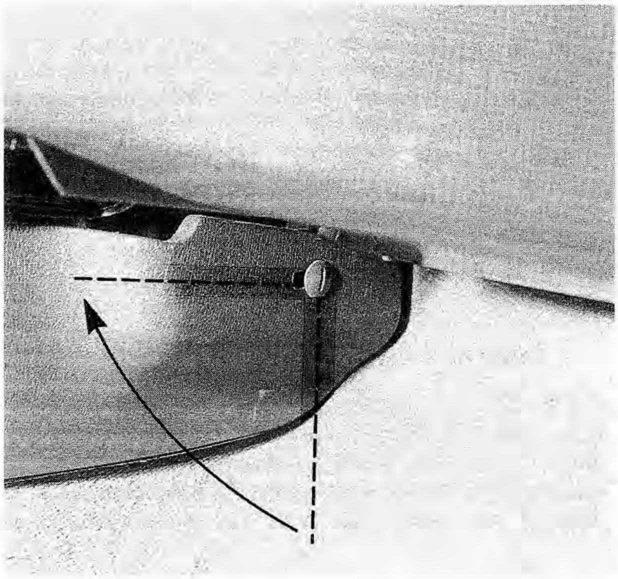

Fig. 4-10. Console retainer. To unlock, turn 90° (¼ turn) counterclockwise. Remove retainers from both sides.

To remove glove box:

1. Open the glove box and disconnect the retaining straps by pushing out the securing pins. See Fig. 4-11.

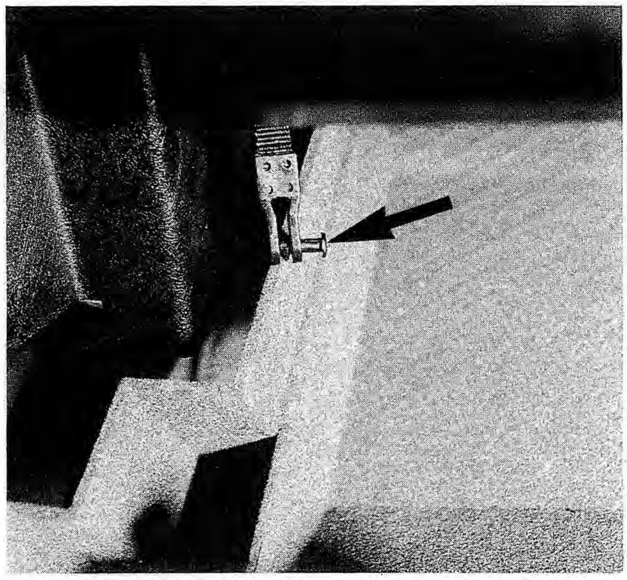

Fig. 4-11. Glove box retaining strap with pin partially removed (arrow). Remove pins from both sides.

2. Close the glove box and remove the screws that hold it to the body. The screws are located beneath the back of the glove box.

3. Lower the glove box slowly while disconnecting the light wiring from the side of the glove box.

NOTE —

When installing the glove box, it may be necessary to loosen the striker plate screws and adjust the plate up or down so that the lock fully engages.

Removing and Installing Instrument Panel

This heading describes the general steps necessary to remove the instrument panel. The instrument panel is held to the body by six bolts, two on each end and two underneath attached to brackets. It will be helpful to label all wires when disconnecting them to ensure correct reinstallation.

To remove and install:

1. Remove the instrument cluster, instrument panel trim, shift console, and glove box as described above. Additional trim at the top and left side of the passenger footwell must also be removed.

2. Disconnect the wiring from the instrument panel switches. In some cases it is necessary to pry out the switch first. Also disconnect and remove the fuel injection control unit as described in **FUEL SYSTEM**. Remove the radio as described in **4.2 Radio and Antenna**.

3. Remove the wiring and cables from the heater controls as described in **4.4 Heater and Controls** and remove the controls.

4. Remove the interior A-pillar trim above the ends of the instrument panel by prying back the edge guard.

5. Remove the steering column trim, switches, and levers as described in **SUSPENSION AND STEERING**.

6. Locate and undo all plastic ties that hold the instrument panel and radio wiring harnesses to the instrument panel.

7. Remove the instrument panel mounting bolts. Make one last check for any installed bolts or wires that may still be connected, then carefully pull out the instrument panel.

Installation is the reverse of removal. Make sure the ventilation air ducts are fully seated in the instrument panel before installation, and that the cruise control lever engages both tabs when installed on the steering column.

4.2 Radio and Antenna

Factory installed radios are held in place by clips on either side of the radio. On early models, the clips can be released by inserting stiff wire hooks into the access holes in the radio's face plate. The special wire tools are available from an authorized BMW dealer or from a specialty car stereo shop. See Fig. 4-12. On later models, the clips are released by backing out the internal-hex head screws. See Fig. 4-13. Whenever removing or installing the radio, always disconnect the battery negative (–) cable.

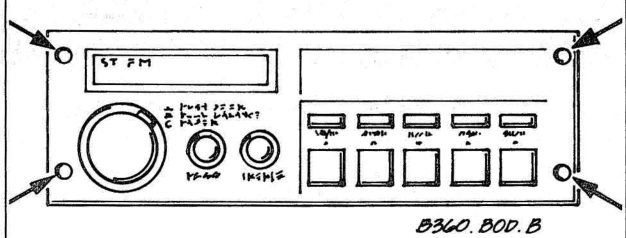

Fig. 4-12. Access holes (arrows) for retaining clips of early BMW radios. Release clips by inserting stiff wire in holes.

Fig. 4-13. Access hole (arrow) for internal-hex head screw used to retract retaining clip on late model BMW radios.

CAUTION —

On BMW cars equipped with anti-theft radios, make sure you know the correct radio activation code before disconnecting the battery. If the wrong code is entered into the radio when power is restored, the radio may lock up and be rendered inoperable, even if the correct code is then entered. For more information, see your owner's manual.

Radios on some 1986 and 1987 models may have a high-frequency background noise when the radio is played with the ignition key in the Accessory position. This interference is most likely due to a fault in the Service Indicator printed circuit board. To check if the noise is caused by a faulty service indicator, remove the instrument cluster as described in **4.1 Instrument Cluster and Instrument Panel**. Disconnect the cluster wiring and then turn on the radio with the key in the Accessory position. If the noise goes away, the circuit board is faulty and should be replaced as described in **ELECTRICAL SYSTEM**.

Power Antenna and Mast

For best power antenna operation, BMW recommends monthly cleaning of the antenna mast. Clean the mast in its up position. Failure of the mast to operate may be due to an electrical fault, to dirt or corrosion in the power assembly, or to a faulty mast. Replacement power antenna masts are available from an authorized BMW dealer parts department. The entire power antenna assembly does not have to be replaced due to a damaged mast.

NOTE —

Two different replacement masts are available, depending on the type of power antenna assembly. Power antennas with a plastic housing use mast Part No. 88 88 0 825 948. Antennas with a metal housing and a plastic cover use mast Part No. 88 88 0 882 090. The power antenna assembly is located in the trunk. See Fig. 4-14.

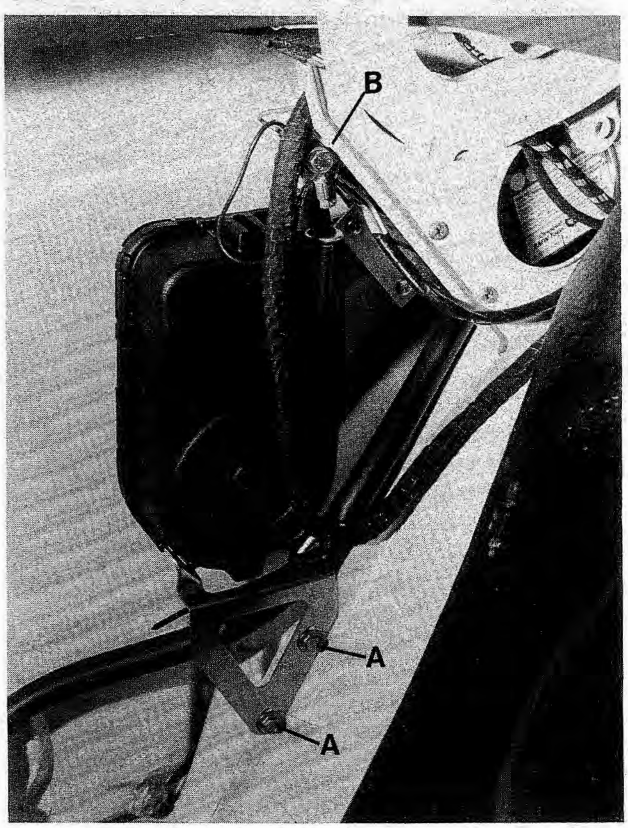

Fig. 4-14. Power antenna with plastic housing in trunk. Antenna with metal housing is similar. Housing mounting bolts are at **A**, ground strap is at **B**.

To replace power antenna mast:

1. Turn on the radio to extend the mast as far as possible, then loosen the mast clamping nut shown in Fig. 4-15.

2. Firmly pull on the antenna mast until the mast and the plastic actuating cable are free of the guide sleeve.

3. Slide the plastic tip of the new antenna mast into the guide sleeve until it is felt to contact the motor guide roller.

4. Turn off the radio so that the plastic cable is retracted by the motor, and guide the mast into the sleeve at the same time. Tighten the clamping nut when finished and recheck antenna operation.

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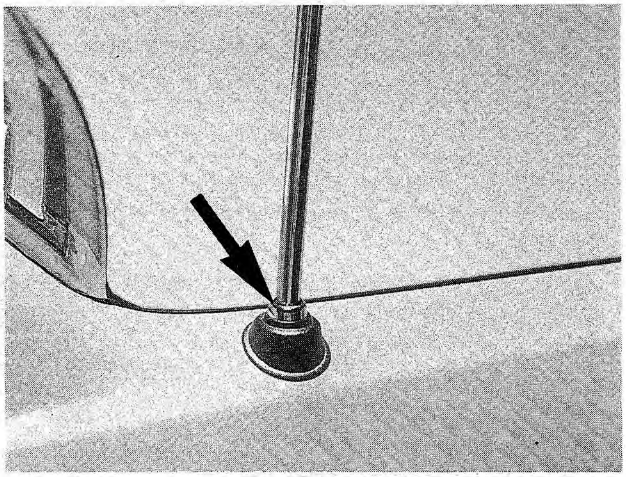

Fig. 4-15. Antenna mast clamping nut (arrow).

4.3 Interior Lights

A light failure may be caused by a blown fuse, especially if more than one bulb is out. Check and, if necessary, replace fuses as described in **ELECTRICAL SYSTEM**. Dashboard light replacement is also covered there.

Replacing Interior Light Bulbs

Always turn off the ignition before replacing a bulb. Avoid leaving fingerprints on the bulb. Fingerprints can cause hot spots or evaporate when the glass gets hot and dim the light or reflector. Wipe off any fingerprints using a soft cloth.

To replace the interior dome light bulb, press against the spring clip indicated in Fig. 4-16 and withdraw the assembly. Press the assembly back into position after installing the new bulb.

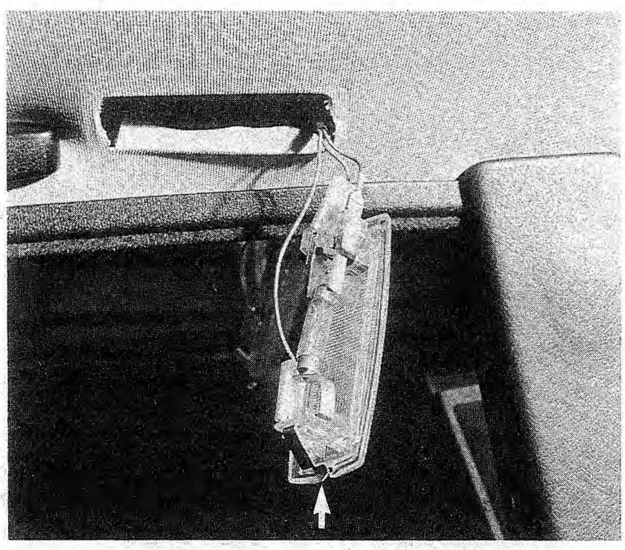

Fig. 4-16. Spring clip (arrow) that holds interior dome light in headliner.

To replace the luggage compartment light bulb, use a small flat-blade screwdriver to pry the light assembly as shown in Fig. 4-17, then withdraw the assembly. Install the wiring connector end first, and press the assembly back into position. Replace the glove compartment bulb the same way.

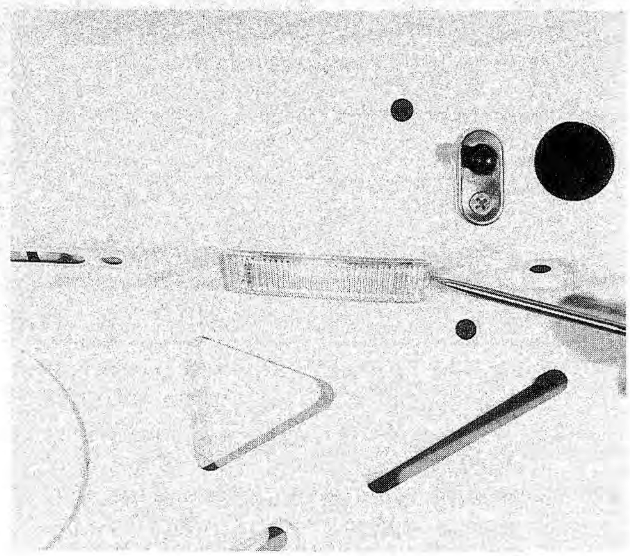

Fig. 4-17. Luggage compartment light assembly being pried out.

For 1987 and earlier cars, the center stop light is reached from inside the car. Pull the assembly cover up at an angle, then compress the tabs on either side of the bulb holder and pull out the holder. Replace the bulb and press the holder back into place until the tabs lock.

For 1988 and later cars, the center stop light is reached from inside the luggage compartment. Remove the bulb and its holder by turning it counterclockwise. See Fig. 4-18. After installing the new bulb, turn the bulb housing clockwise to install.

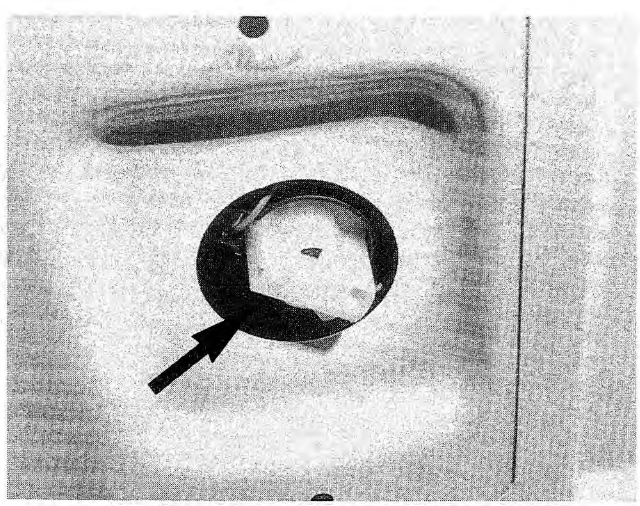

Fig. 4-18. Center stop light housing (arrow) in trunk, for 1988 and later models. Stop light for 1987 and earlier models is reached from inside passenger compartment.

On convertibles, replace the center stop light by first removing the screws that secure the light lens. Remove the lens and then remove the bulb.

4.4 Heater and Controls

The heater box and its components are shown in Fig. 4-19. Temperature and air flow are controlled by instrument panel levers, by a knob that actuates cables connected to flaps in the heater box, and by the electrically-operated heater core valve.

The rotary temperature-regulating knob controls both the opening of the blending flap and the opening of the heater core solenoid valve. The cable connection controls the flap. An electrical contact on the knob controls the power to the valve. Whenever the knob is positioned more than 20° from its coldest setting, power to the valve is interrupted and the valve opens. When the knob is turned back to its cold setting (last 20° on scale), the valve closes and stops coolant flow through the heater core.

On 1987 and earlier cars with air conditioning (A/C), the lever that regulates air flow for the instrument-panel vents also electrically controls the A/C compressor. To prevent condenser freeze-up and A/C system damage, the compressor is switched off if the lever is set below a certain point.

The flaps for air recirculation are opened and closed by small electric motors. The motors are connected to the flaps by adjustable rods. The motors are activated by a relay mounted on the heater box, just behind the control panel. See **ELECTRICAL SYSTEM** for general information on troubleshooting heating and ventilation electrical circuits.

Heater Core and Heater Valve

Insufficient heater output may be caused by a faulty heater valve, by a misadjusted blending flap cable, or by a cooling system fault. Coolant leaking visibly into the passenger compartment is a sign of a faulty core or coolant hose. A sweet, anti-freeze odor in the car's interior, or a constantly fogged windshield may also indicate a faulty core. Inspect the carpet and the area near the footwell vents for any moisture or coolant. A leaking heater core may be caused by over pressurization of the cooling system. See **COOLING SYSTEM** for more information.

When replacing the heater core or heater valve, be prepared to catch any coolant that may spill when the coolant pipe connections are opened. Also have some pre-mixed coolant on hand to top up the cooling system when finished.

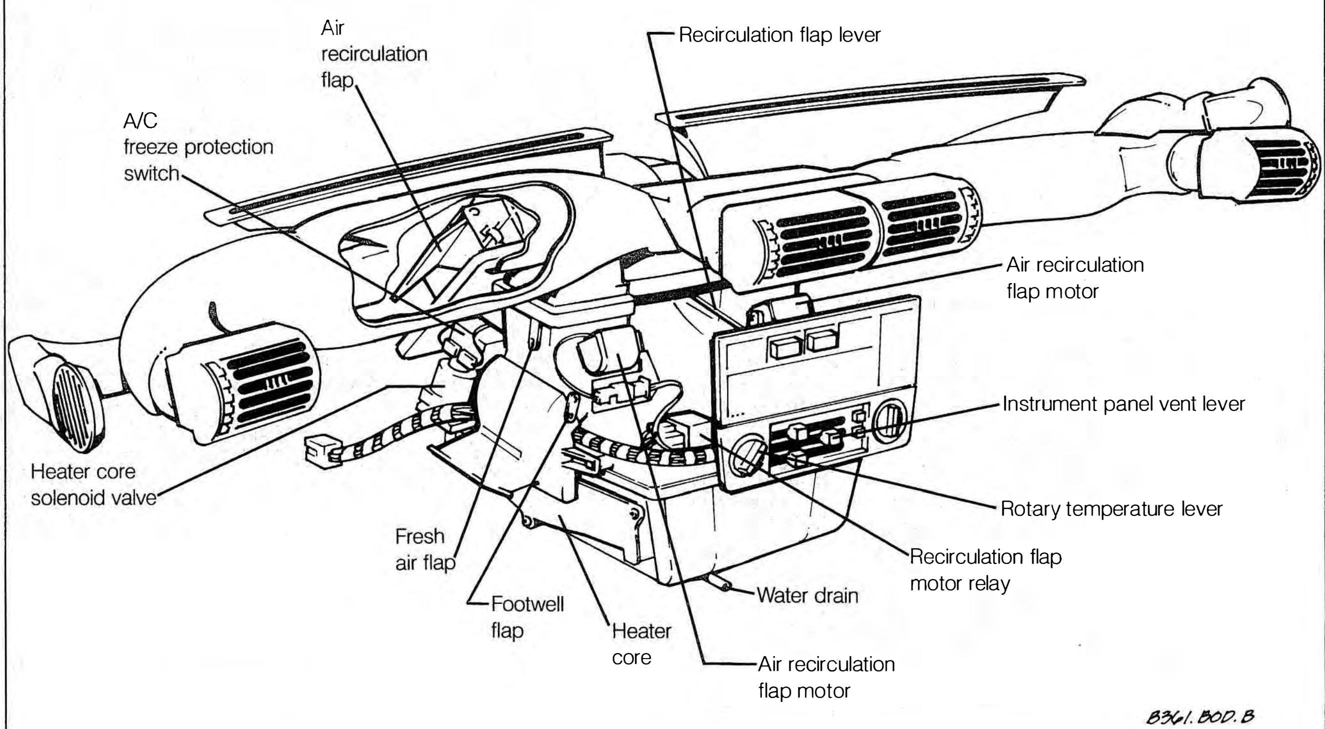

Fig. 4-19. Heater box for heating and ventilation system with air conditioning shown removed from car.

To replace heater valve:

1. Disconnect the negative (–) cable from the battery.
2. Drain the coolant as described in **COOLING SYSTEM**.
3. In the engine compartment, disconnect the coolant hoses from the heater core inlet and outlet pipes. See Fig. 4-20.

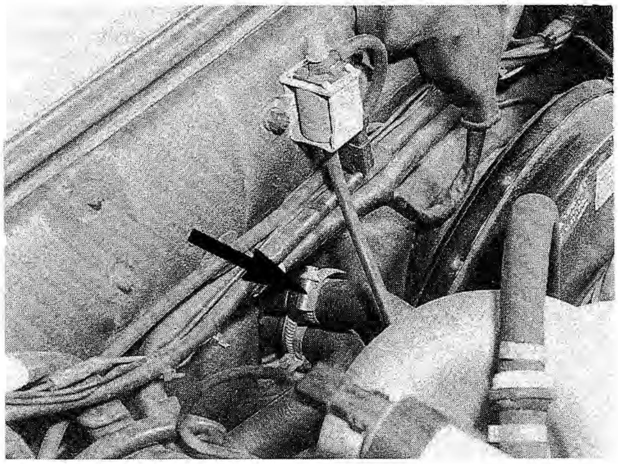

Fig. 4-20. Coolant hoses leading to heater core (arrow).

4. In the passenger compartment, remove the lower left instrument panel trim and the shift console as described in **4.1 Instrument Cluster and Instrument Panel**.
5. Disconnect the wiring connector from the heater valve.
6. Remove the heater ducts shown in Fig. 4-21.

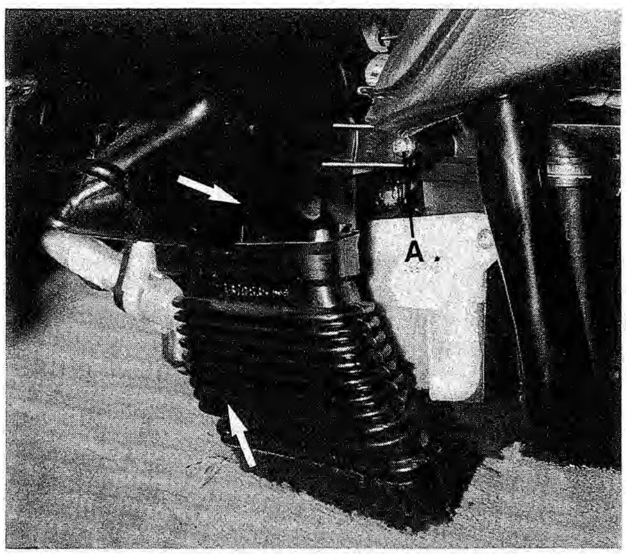

Fig. 4-21. Heater ducts (arrows). Remove screw (**A**) then gently pry out ducts.

7. At the left side of the valve, remove the clamp and the two mounting flange bolts shown in Fig. 4-22.

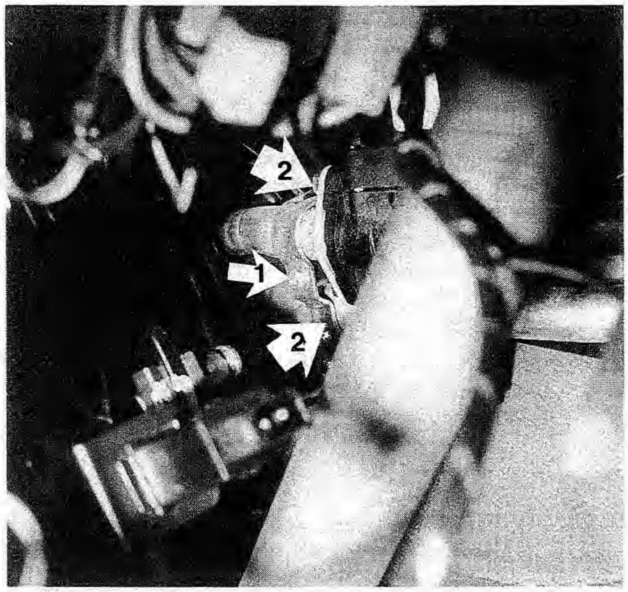

Fig. 4-22. Heater valve clamp (**1**) and flange bolts (**2**).

8. Remove the heater core flange bolts shown in Fig. 4-23 and remove the heater valve along with the coolant pipes.

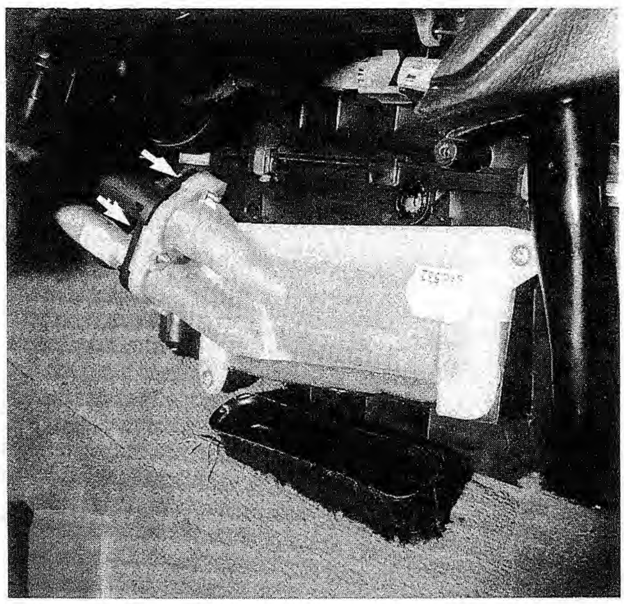

Fig. 4-23. Heater core flange bolts (arrows) between heater valve and heater core.

When installing the heater valve, use new O-rings between the mounting flanges.

To replace heater core:

1. Disconnect the negative (−) cable from the battery.
2. Drain the coolant as described in **COOLING SYSTEM.**
3. In the passenger compartment, remove the lower left instrument panel trim and the shift console. Then remove the instrument panel. See **4.1 Instrument Cluster and Instrument Panel**.
4. Remove the heater connector and duct shown above in Fig. 4-22.
5. Remove the clamp shown above in Fig. 4-22.
6. Remove the mounting flange bolts shown above in Fig. 4-23.
7. Remove the two heater core mounting screws shown in Fig. 4-24 and slide the heater core out of its mounting.

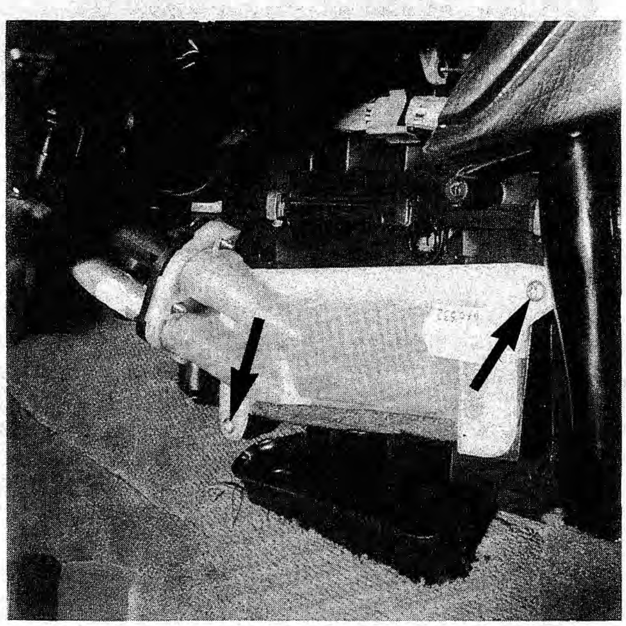

Fig. 4-24. Heater core mounting screws (arrows).

8. When installing the heater core, use new O-rings between the coolant pipe mounting flange.

Replacing and Adjusting Control Cables

The heating and ventilation control cables and the motors and relays that control air recirculation can be reached by removing the footwell trim and shift console as described in **4.1 Instrument Cluster and Instrument Panel**. In addition, the radio must be removed and the heater trim panel pulled out slightly for access to the cable mountings on the heater control levers.

To pull out the heater trim panel, pry out the switches or trim blanks at the top of the panel, then remove the screws shown in Fig. 4-25.

The control cables are held to the operating levers by removable clips. When replacing control cables, make sure that the end of the cable nearest the heater box flap is flush with the stop before reinstalling the clip. See Fig. 4-26.

Fig. 4-25. To release heater trim panel for access to back of operating levers, remove screws from underneath (**A**) and behind switches (**B**).

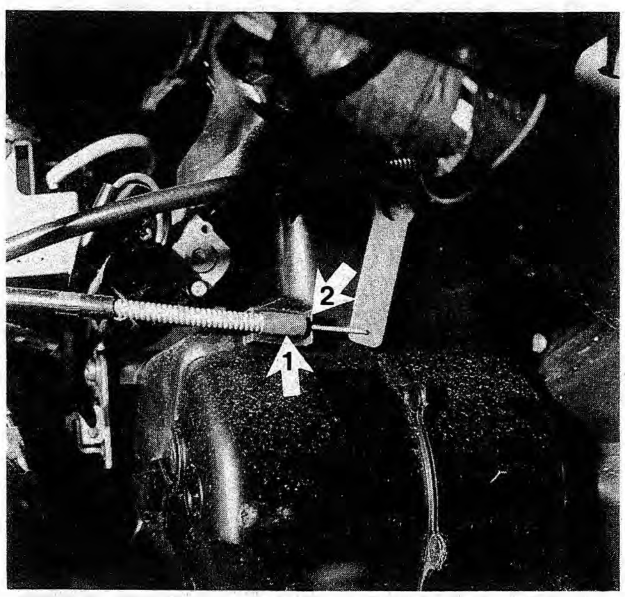

Fig. 4-26. Heater control cables are held to operating levers and flaps by clips (**1**). Make sure cable ends are flush with stop (**2**) before attaching clip.

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Replacing or adjusting the temperature regulating flap control cable requires special attention. The cable is adjusted with a knurled adjusting knob so that when the dash-mounted knob is in the fully cold position, air flow past the heater core is blocked. To adjust the cable, first place the dash-mounted temperature knob in the fully cold position. Place the temperature flap in the fully cold (down) position. Turn the cable adjusting knob until it is correctly aligned with its opening and secure the cable with the clip. See Fig. 4-27.

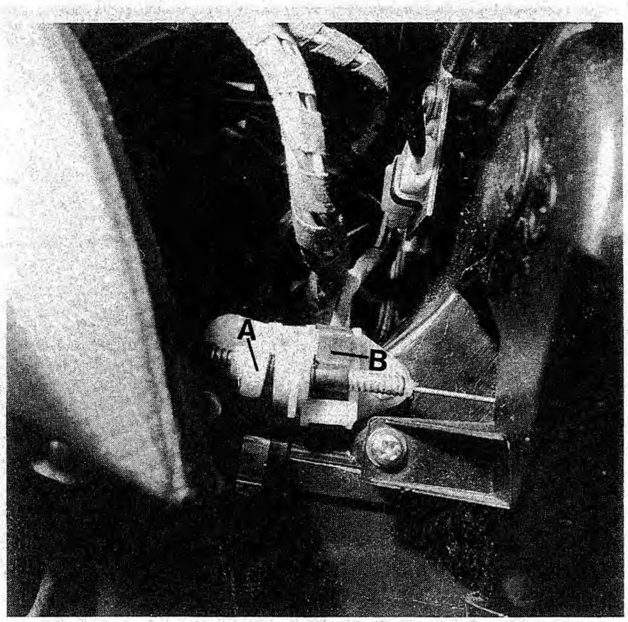

Fig. 4-27. Temperature flap control cable showing adjusting knob (**A**) and cable retaining clip (**B**).

The recirculation flap motors are mounted to the heater box. If a motor is replaced or if a flap does not fully close, the control rods should be adjusted. Adjust the length of the rods by unscrewing and turning the motor with the rod. See Fig. 4-28.

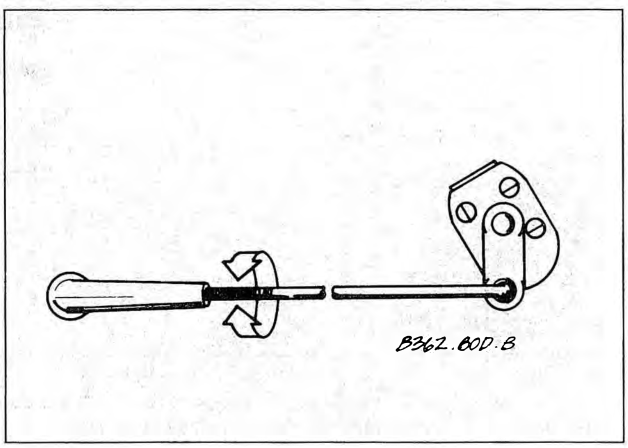

Fig. 4-28. Air recirculation flap control rod and motor. Adjust flap by unscrewing motor and turning to change length of rod.

To remove the air conditioning control switch assembly and operating levers, p y out the trim plate as shown in Fig. 4-29. The switch assembly retaining screws are behind the plate. Partially remove the heater trim panel as shown in Fig. 4-25 above, then remove the switch assembly.

Fig. 4-29. Removing air conditioning control switch assembly trim plate.

Fresh Air Blower

The fresh air blower is located in the front body cowl just behind the firewall. It is reached from the engine compartment after removing a cover. The cover must also be removed for testing of the motor series resistors. If replacing the blower motor, check the blower motor code number on the motor body to identify the correct replacement part. See **ELECTRICAL SYSTEM** for electrical tests of the blower motor.

> ***CAUTION —***
> *Do not remove the fan wheels or reposition them on the motor shaft. Blower motors are balanced in their assembled state. Changing the position of the fans can lead to noisy operation and rapid bearing failure.*

To remove and install:

1. Remove the firewall access cover shown in Fig. 4-30. The cover is held in place by four bolts and two plastic nuts. Disconnect all wiring harnesses from the cover by unclipping the plastic ties.

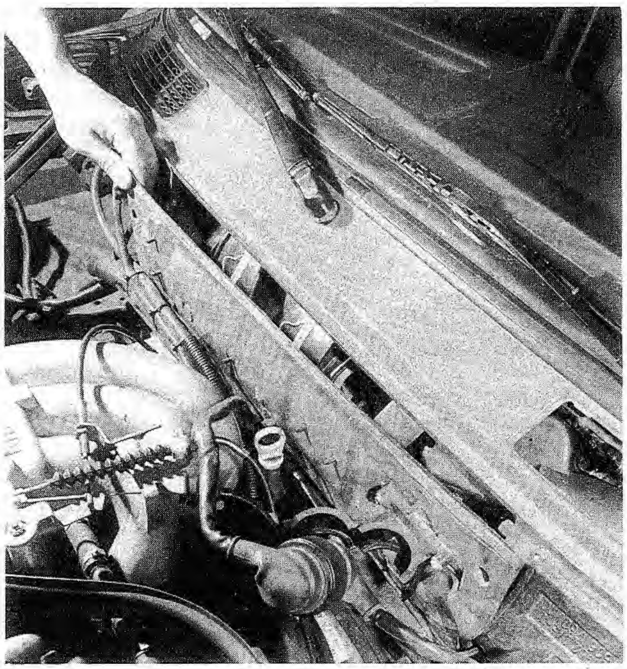

Fig. 4-30. Firewall access cover being removed.

2. Remove the blower housing cover by disconnecting the plastic retaining straps as shown in Fig. 4-31.

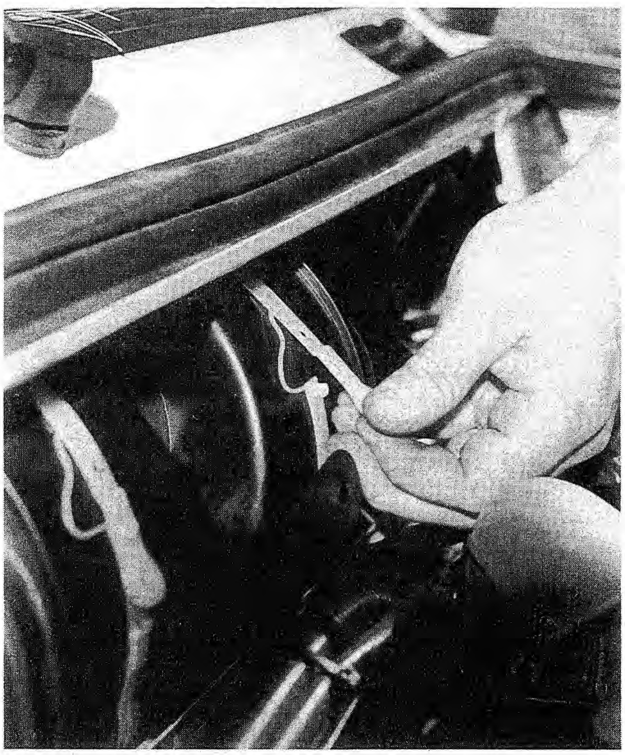

Fig. 4-31. Blower motor housing retaining straps being removed.

3. Disconnect the blower wiring shown in Fig. 4-32, then unclip the blower retaining clip shown in Fig. 4-33 and remove the blower motor.

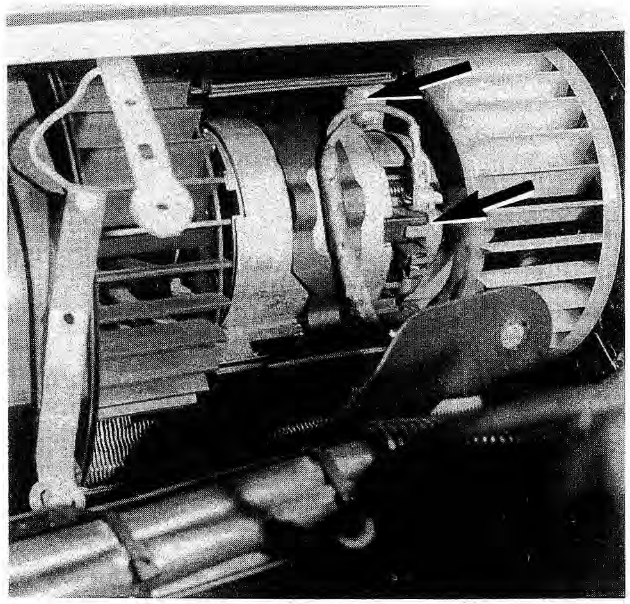

Fig. 4-32. Blower motor wires (arrows) to be removed.

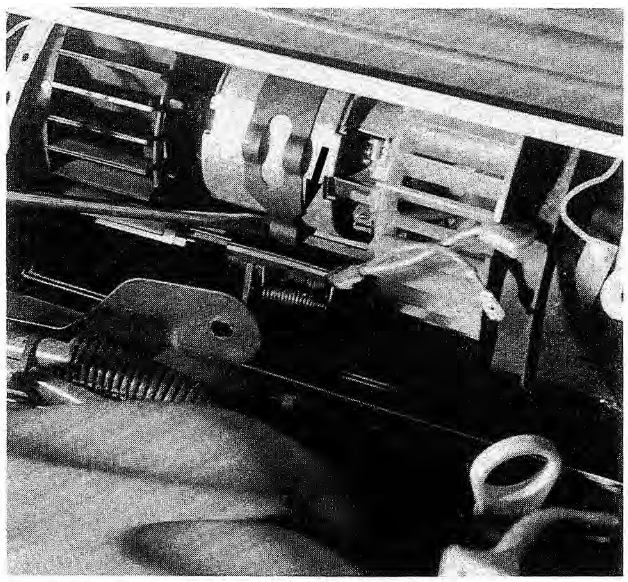

Fig. 4-33. Blower motor retaining clip being removed using screwdriver (arrow).

4. When installing the motor, note that the motor is located by a tab on its mounting. It may be necessary to move the motor around slightly in position until it is felt to engage the tab.

It is necessary to remove the blower motor housing for access to the windshield wiper motor and linkage. With the blower motor removed as described above, disengage the air recirculation flaps from the housing. See Fig. 4-34. Then unclip the four retaining clips that hold the blower motor housing to the heater box and remove the housing.

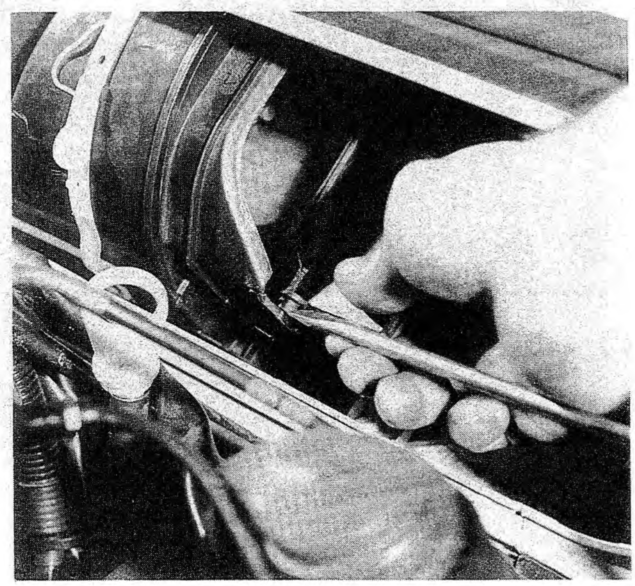

Fig. 4-34. Air recirculation flap being disengaged from blower motor housing. Disengage both sides.

4.5 Seat Belts

The seat belts installed on the cars covered by this manual are combination lap-shoulder belts (three-point). The seat belts should be periodically inspected for webbing defects and proper operation. If the seats belts are removed for any reason, it is of extreme importance to reinstall them correctly.

> ***WARNING —***
>
> - *For maximum protection from injury, seat belts should be replaced as a set if they are subjected to occupant loading in a collision.*
> - *Do not bleach or dye seat belt webbing. Webbing that is severely faded or redyed will not meet the strength requirements and must be replaced.*

Inspecting Seat Belts

When inspecting belt webbing, replace belts with broken or pulled threads, cut loops at the belt edge, bowed, creased, or melted webbing, faded areas, or cuts. Pull the belt out fully and let it retract. If it does not move smoothly in either direction, check for dirt, grease, or gum on the webbing. If the belt cannot be cleaned using only a mild soap solution recommended for cleaning upholstery or carpet, replace the belt.

Replace the belt if the buckle cover is cracked, if the push button is loose, or if the buckle does not lock securely. Check all mounting points. The mounting bolts must be tight, yet allow the hardware to swivel freely. Clean any corrosion away from the anchoring points, and replace any corroded hardware.

The belt mechanism should lock up when the belt is tugged out quickly, or when the car is stopped quickly from a speed approximately twice that of walking speed. Replace any belt that does not lock up.

Installing or Replacing Seat Belts

All seat belt mounting bolts should be installed to a torque of 43 to 48 Nm (32 to 35 ft. lb.). Front seat belt buckles are bolted to the seat frame. On 4-door and convertible models, the lower belt anchor is bolted to the seat. On 2-door models, the lower belt is attached to a rail that is bolted to the body. On all except convertibles, the belt retractor is bolted to the body behind the B-pillar (center pillar) trim. On convertibles, the retractor is behind the interior trim panel for the rear seat.

> ***WARNING —***
>
> *For maximum protection from injury, do not interchange buckle and retractor assemblies with those designated for other seating positions or other models.*

To remove the B-pillar trim panel, first remove the screws shown in Fig. 4-35 and then pull the panel out to disengage two retaining clips. Guide the belt through the trim panel opening.

The rear interior trim panel on convertibles is held in place by two screws and the rubber door seal. First remove the rear seat as described in **4.7 Rear Seats**. Pry out the trim plate in the trim panel by sliding it towards the rear and then lifting it out. See Fig. 4-36. Disconnect any speaker wires and remove the trim panel.

On all models except convertibles, the height of the upper anchor point for front seat belts can be changed. A special kit is available from BMW that permits the anchor point to be moved lower or higher. The B-pillar trim and seat belt is removed, and then additional holes are drilled in the trim to permit anchor bolt reinstallation. A new trim piece covers the holes in the B-pillar trim. The kit is available as BMW Part No. 72 11 9 061 138.

> **NOTE —**
>
> Part numbers are for reference only. Always check with your local BMW parts department for the latest parts information.

Fig. 4-35. B-pillar trim panel showing upper seat-belt anchor bolt (**1**) and panel retaining screws (**2**).

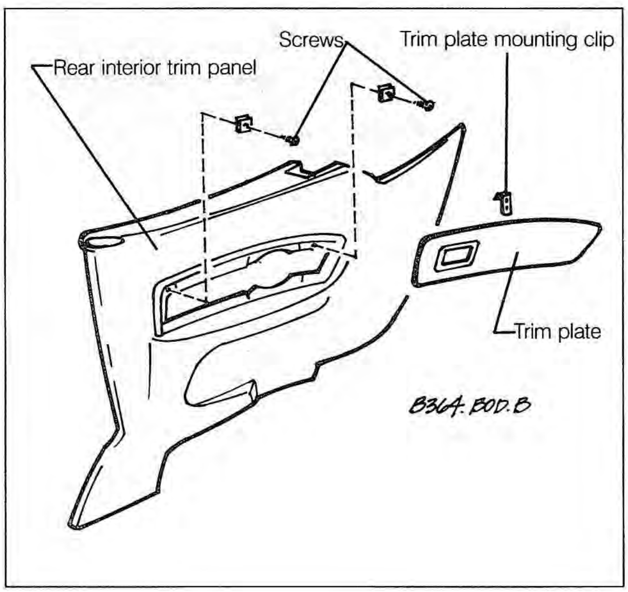

Fig. 4-36. Exploded view of rear interior trim panel on convertible models. Trim panel must be removed for access to upper anchor for front seat belt.

Rear seat belt lower anchor points are underneath the rear seat, as shown in Fig. 4-37. On models up to 1986, the belt retractor is mounted in the trunk as shown in Fig. 4-38. On 1986 and later models, the retractor is mounted under the hatrack trim panel. For access to the retractor on 1986 and later models, first remove the rear seat and backrest as described in **4.7 Rear Seats**. Lift up the belt guide on the hatrack and unclip the hatrack panel at its center. On convertible models, the rear seat backrest must also be removed for access to the retractor.

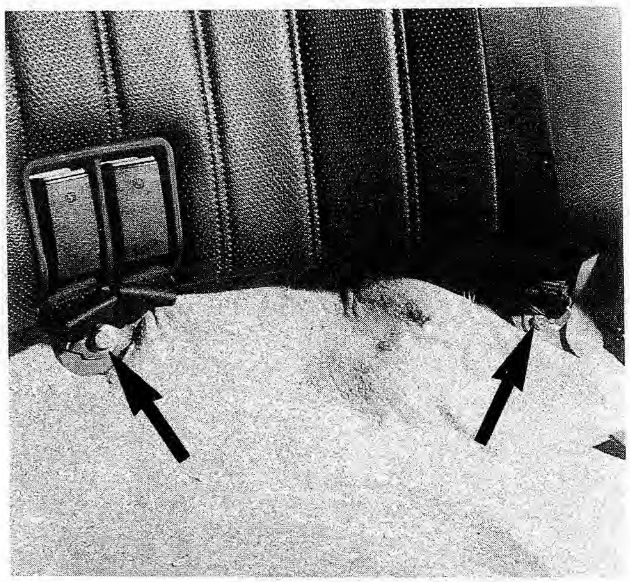

Fig. 4-37. Rear seat belt anchor bolts (arrows).

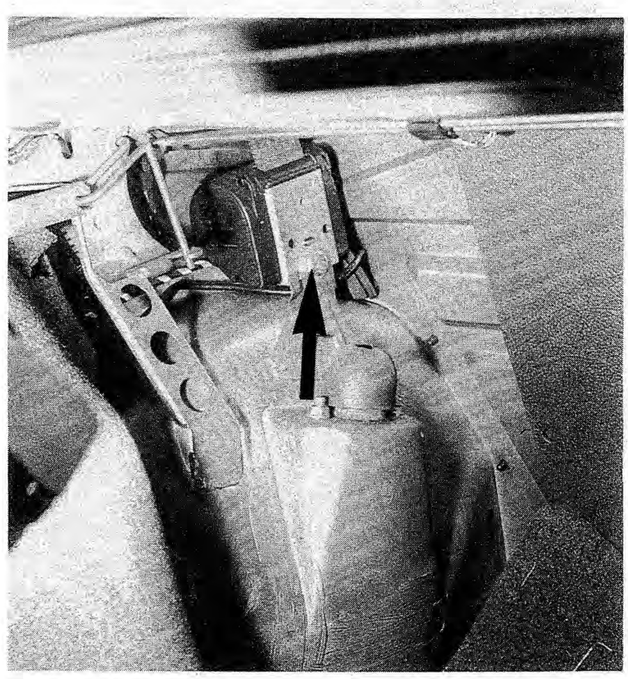

Fig. 4-38. Rear seat belt retractor mounting in trunk (arrow) for models up to 1986.

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4.6 Front Seats

Front seats are held to the floor by four nuts, two at the front and two at the rear. See Fig. 4-39. To remove a seat, first slide the seat all the way to the rear. Remove the nut covers and then remove the nuts. Slide the seat forward and then remove the two rear mounting nuts, then remove the seat. On 4-door models and convertibles, also remove the bolt that holds the seat belt to the seat. When installing the seat, torque the seat belt bolt to 43 to 48 Nm (32 to 35 Nm).

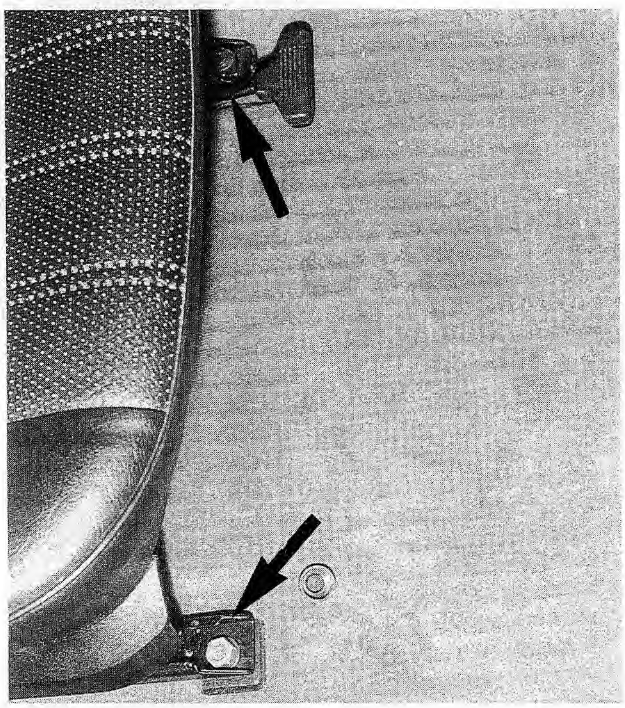

Fig. 4-39. Front-seat mounting nuts at front of seat rails (arrows). One nut cover is shown removed. Also remove two nuts at rear of seat rails.

4.7 Rear Seats

Two types of rear seats are used on the cars covered by this manual. Rear seats with a spring suspension are held in by two bolts below the front edge of the seat. See Fig. 4-40. Remove the bolts and pull the seat forward. Rear seats with a foam suspension are held in place by two clips at the front corners. Lift up firmly at the corners until the seat is disengaged.

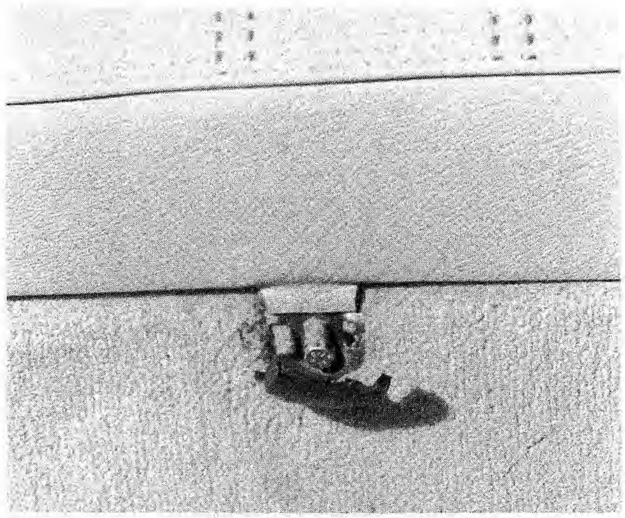

Fig. 4-40. Rear seat mounting bolt on seat with spring suspension. Remove bolts from both sides.

The rear seat backrest is held in place by two bolts and clips. Remove the bolts shown in Fig. 4-41, then pull the backrest straight up and off the clips.

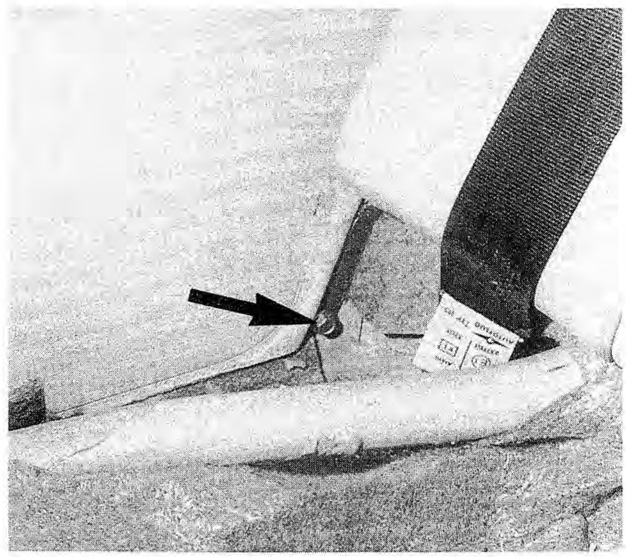

Fig. 4-41. Rear seat backrest mounting bolt (arrow). There is one on each side. On some models, bolts may be at center of backrest.

5. DOORS

This heading covers removal and alignment of the doors, as well as removal and installation of internal door components and door trim.

Removing and Installing Doors

Doors are mounted to the body with two hinges. The front half of each hinge is welded to the car body, while the rear half is bolted to the door. The two hinge halves are held together by a center pin and bolt. The center bolt screws into a replaceable hinge pin and bushing. The hinge pin is held by a circlip. See Fig. 5-1.

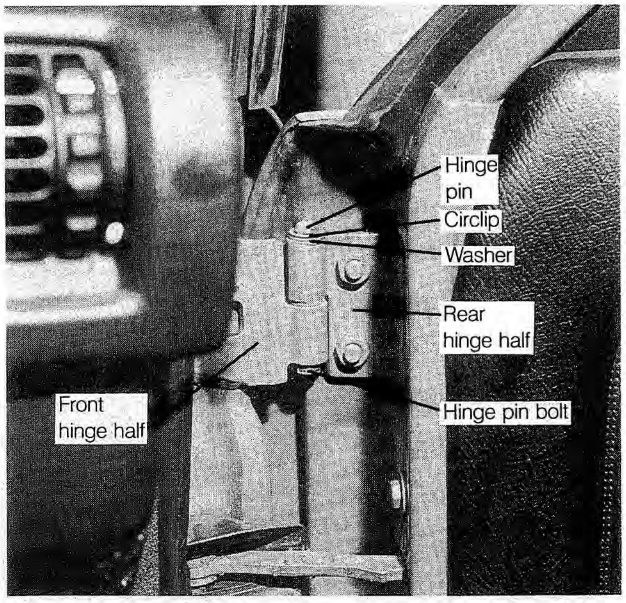

Fig. 5-1. Top hinge on front door, showing mounting hardware. Bottom hinge is similar, except mounting bolt installs from top.

Although a door can be removed by unbolting the rear hinge half from the door, this can change door alignment. In the procedure below, the hinge pin bolts are instead removed so that door alignment is undisturbed. The hinge half only needs to be unbolted from the door if the entire door assembly is being replaced since new doors do not come with hinges. Replacement doors should be aligned after installation.

NOTE —

- If the rear hinge half must be removed from the door, mark the hinge's location on the door so that it can be reinstalled as close to its original position as possible.

- The body is painted at the factory after assembly. Realignment of body panels may expose unpainted metal. To prevent rust, paint all exposed metal as soon as possible.

To remove:

1. Pull back the rubber protector on the door check rod. See Fig. 5-2. Disconnect the check rod by removing the circlip and then pressing out the pin.

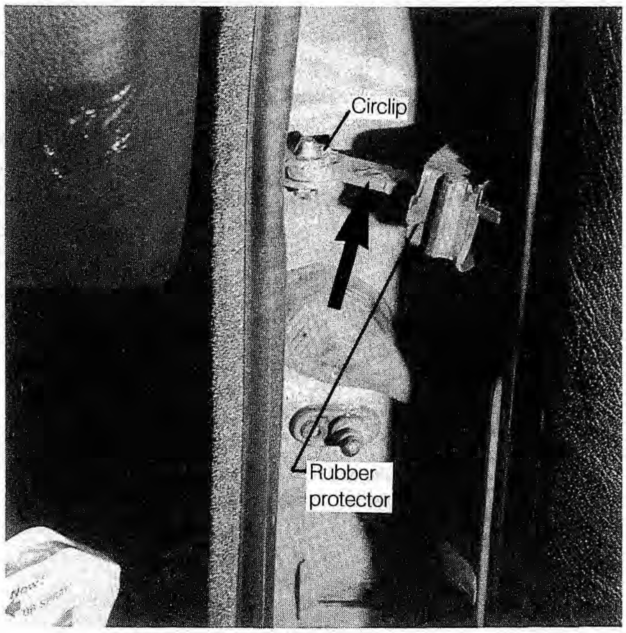

Fig. 5-2. Door check rod (arrow). Remove circlip and press out pin.

2. Disconnect the door wiring. On front doors, pull back the protective boot and disconnect the wiring by squeezing the tabs on the connector and then pulling it out. See Fig. 5-3. On rear doors, the wiring connector is behind the B-pillar (center pillar) trim panel. Remove the panel as described in **4.5 Seat Belts** and then disconnect the wiring.

Fig. 5-3. Door wiring connector (arrow) for front doors.

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3. Unscrew and remove the upper and lower hinge pin bolts. See Fig. 5-1 above.

4. Lift the door up and off the hinges, being careful not to scratch the paint with the door check rod.

Installation is the reverse of removal.

Adjusting Doors

Misaligned doors can cause wind noise or damage to the paint due to abrasion by road debris. Check the door's depth compared to the adjacent body panels, and the door's fore-aft and height position compared to the door opening of the car body. Adjustments can be made at both ends of the door. Some adjustments may require new shims between the hinge and the door.

NOTE —
For adjustment of the rear door on 4-door models, the door's interior trim panel must first be removed to access the hinge bolts. See **5.1 Door Assembly** for removal of the interior trim panel.

Front edge depth as well as small height adjustments can be made by simply loosening the hinge mounting bolts and repositioning the door in the opening. If the door's fore-aft position requires adjustment, or if the door is crooked in its opening, a combination of shims will be needed to correctly align the door. See Fig. 5-4. By varying the number of shims at the top and bottom, door alignment is changed.

NOTE —
Two different types of shims are available from authorized BMW dealer. Large initial adjustments are made with a shim 1.0 mm (.039 in.) thick (BMW Part No. 41 51 1 888 319). The hinge bolts must be removed to install this shim. Fine adjustments are made with a shim 0.5 mm (.020 in.) thick (BMW Part No. 41 51 1 916 686) or a shim 1.0 mm (.039 in.) thick (BMW Part No. 41 51 1 916 719). These shims slide between the hinge and door when the bolts are loosened.

Adjust the door's rear edge position by changing the position of the door striker plate. See Fig. 5-5. Using a Torx® driver, loosen the bolts and move the striker to the right or left to adjust the closed position of the door. Make sure that the striker plate is adjusted vertically so that the door lock engages the striker equally on the top and bottom when the door is closed.

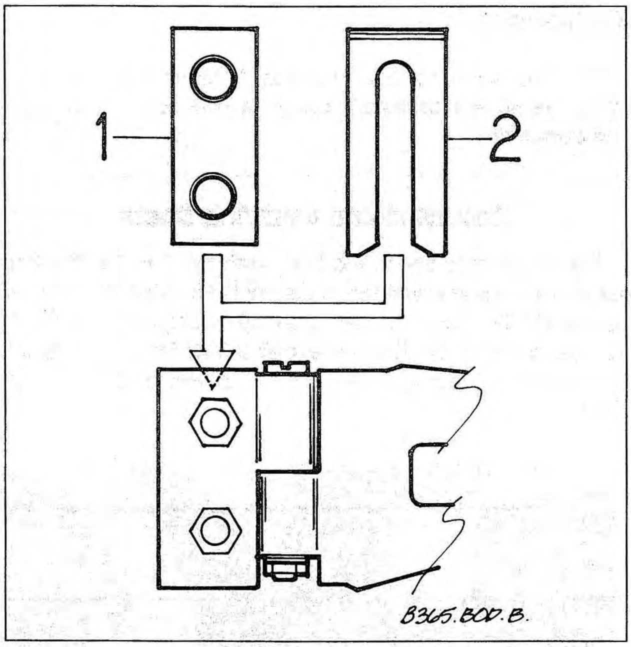

Fig. 5-4. Door hinge showing location of shims between hinge and door. Initial adjustment made with shim style **1.** Fine adjustment made with shim style **2** (available in 1.0 mm or 0.5 mm thickness).

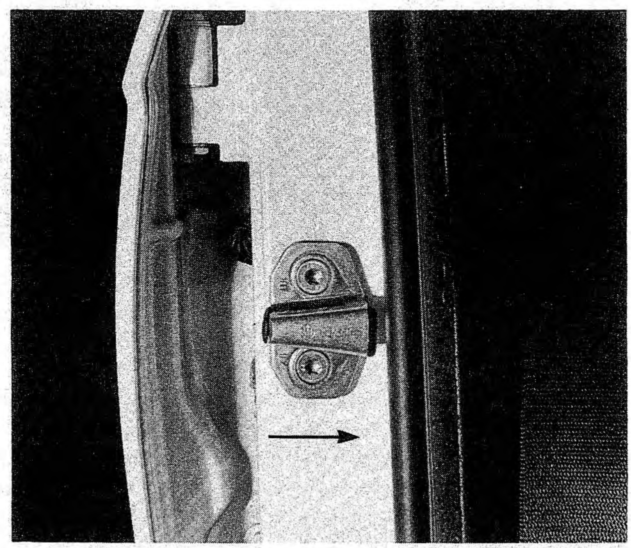

Fig. 5-5. Door striker plate. Loosen bolts and move in or out to adjust closed position of door (arrow).

NOTE —
The fore-aft position of the door is correct when there is an equal amount of space between the door's edges and its adjacent panels. The door height is correct when the stamped creases in the upper and lower part of the door are aligned with the same creases in the adjacent panels.

NOTE
Door depth is correct when the door's front edge is slightly deeper than its adjacent panel or door and its rear edge is slightly higher than its adjacent panel or door.

5.1 Door Assembly

The interior door trim, the glass, door handles and locks, side mirrors, and internal door components are all removable with the door installed on the car. The interior trim must be removed for access to the internal door components.

Interior Trim

Although the procedures below apply to the front doors, they can be used as a general guide when removing the interior trim from the rear doors on 4-door models.

To remove interior trim panel:

1. Unscrew and remove the lock button. Fully lower the window.

2. Remove the door handle trim by sliding it to the rear and then pulling it off. See Fig. 5-7.

Fig. 5-7. Door handle trim being removed. Slide trim to rear then pull off.

3. On models with manual windows, pry the trim off of the window crank, remove the crank mounting screw, and then remove the crank. See Fig. 5-8.

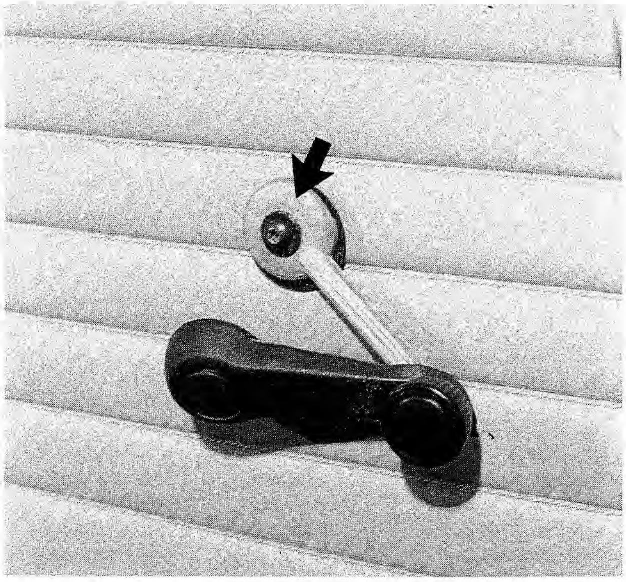

Fig. 5-8. Window crank and mounting screw (arrow). Trim and crank may differ slightly on other models.

4. On front doors, remove the screws that hold the armrest to the door. See Fig. 5-9. Pull the armrest forward and up to disengage the locking tabs from the trim. See Fig. 5-10.

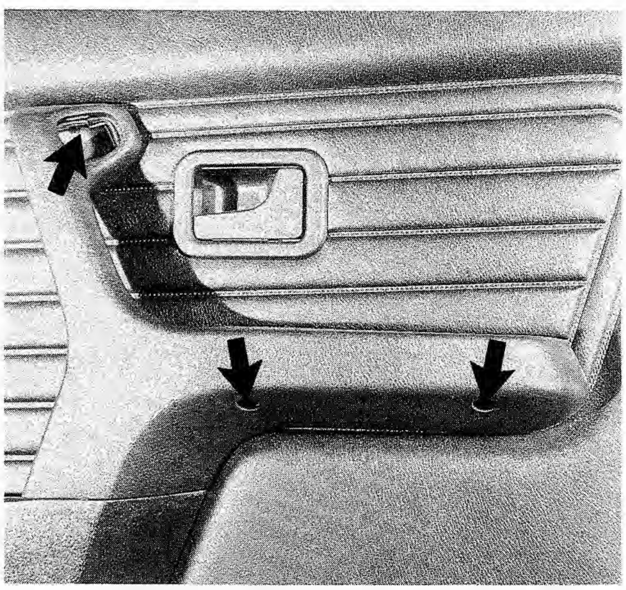

Fig. 5-9. Front armrest screws to be removed (arrows). Upper screw is behind trim piece or power mirror switch, which should be pried out.

Fig. 5-10. Front armrest being disengaged from door trim panel. Note locking tabs (arrows). Pull armrest forward and out.

5. On rear doors, remove the two trim panel securing screws shown in Fig. 5-11, but do not remove the armrest. It is held to the trim panel by an additional screw behind the panel.

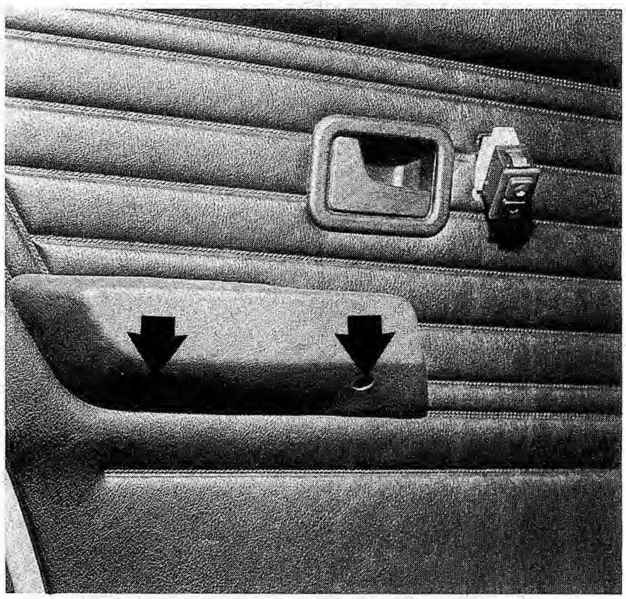

Fig. 5-11. Rear door trim panel securing screws (arrows). Armrest remains secured to panel after screws are removed.

6. On rear doors of 4-door models with power windows, pry out the window switch and disconnect the wiring.

7. Beginning with one of the lower corners of the doors, work around to the top to unclip the trim panel from the door. See Fig. 5-12. Work slowly to ensure that the clips are not broken. When all of the clips are undone, push the trim panel straight up. The window seal may be removed with the trim panel.

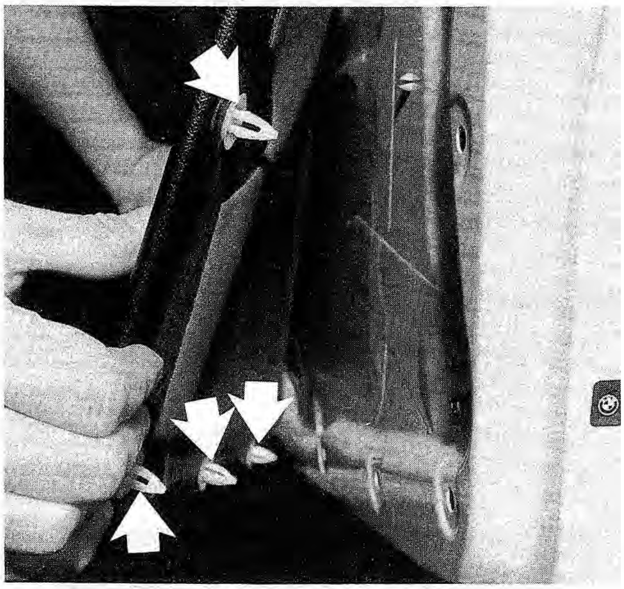

Fig. 5-12. Door interior trim panel being removed, showing securing clips (arrows).

Installation is the reverse of removal. Replace any broken clips. If the window seal was removed with the trim panel, install it at the same time as the panel. On models with manual windows, the crank handle should face forward with the window fully raised.

Window Regulator

The procedure below applies to both manual and power window regulators, for front and rear windows. Rear convertible windows are covered separately in the second procedure. Whenever the regulator is removed and installed, check that the window contacts the top of the window frame squarely as it is raised. If the window does not meet the frame squarely, loosen the regulator or window mounting bolts and reposition the window.

NOTE —
Check the power window electrical circuit and switches as described in **ELECTRICAL SYSTEM** before assuming that the power regulator is faulty.

To remove: (all except convertible rear window regulators)

1. Remove the interior trim panel as described above.

2. Peel back and remove the plastic door moisture seal, taking care not to tear it.

3. Raise the window enough for access to the window securing bolts shown in Fig. 5-13. While supporting the window, remove the bolts.

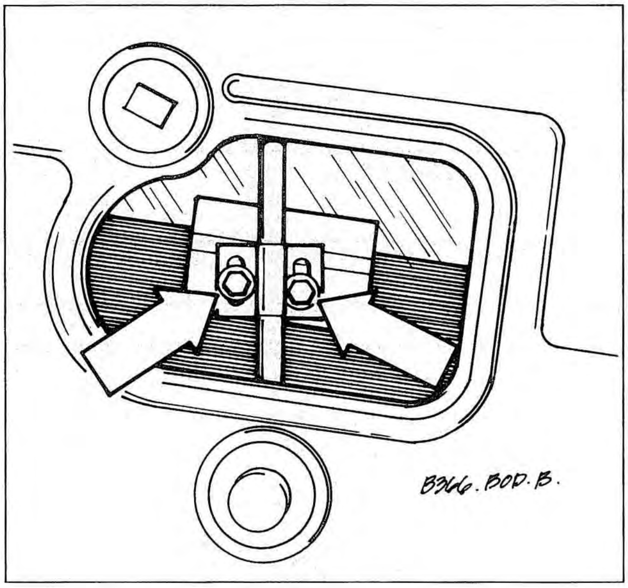

Fig. 5-13. Bolts (arrows) that secure window glass to window regulator.

4. Swing the front of the window out of the regulator guide roller and lower the window into the door.

5. On power window regulators, disconnect the electrical plug.

6. Remove the screws and wire ties shown in Fig. 5-14.

7. On front doors of convertible models, remove the additional screws shown in Fig. 5-15.

8. Tilt the regulator up slightly and remove the regulator.

Installation is the reverse of removal. When installing the regulator on convertible front windows, make sure the regulator rollers are inserted into the guides on the bottom of the glass before installing the regulator bolts.

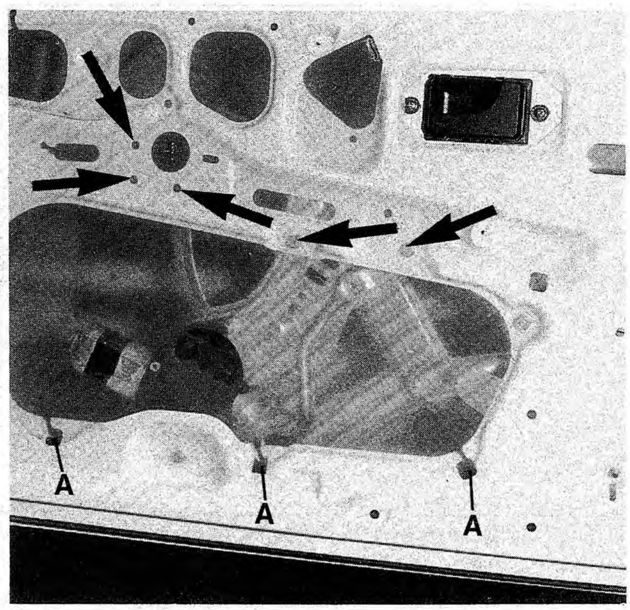

Fig. 5-14. Window regulator retaining screws (arrows) and wire ties (**A**). Plastic moisture barrier must be removed for access.

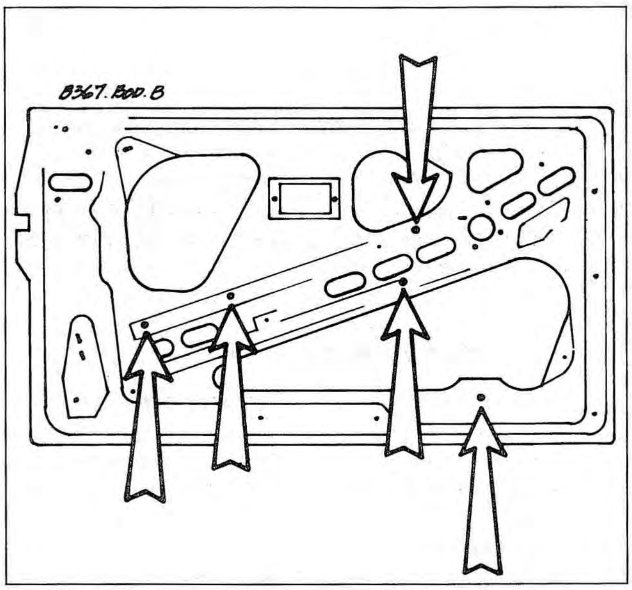

Fig. 5-15. Additional screws (arrows) on convertible front windows to be removed for window regulator removal.

To remove: (convertible rear window regulators only)

1. Remove the rear interior trim panel as described in **4.5 Seat Belts**.

2. Raise the window, then disconnect the regulator electrical harness connector.

3. Remove the screws shown in Fig. 5-16, then remove the window and regulator together.

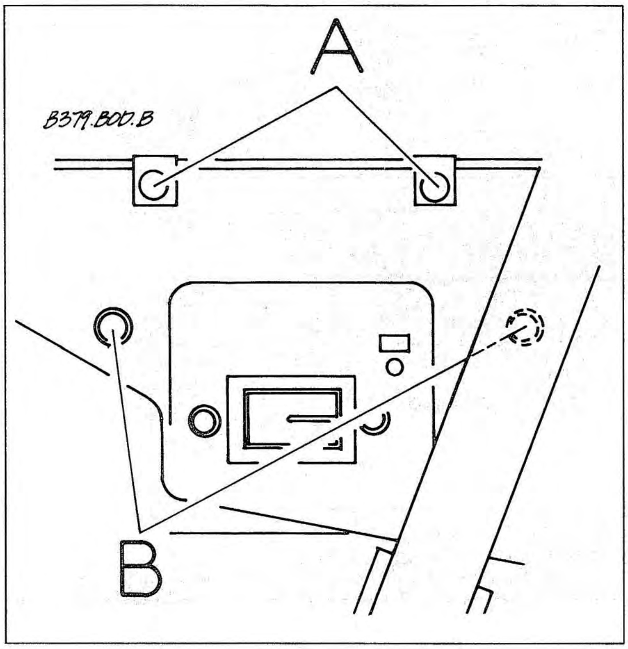

Fig. 5-16. Convertible rear window regulator mounting screws (**B**). Screws at **A** do not apply to this procedure.

Windows

This heading covers removal of front and rear door windows, as well as the fixed rear door window. Convertible rear side window removal is covered as part of the regulator removal procedure above. On convertible models, replacement of the front door window will require new rivets to reinstall a small trim piece on the door.

To remove front door windows:

1. Remove the door interior trim panel as described above.
2. Peel back and remove the plastic door moisture seal, taking care not to tear it.
3. If the inner window channel seal, shown in Fig. 5-17, was not removed with the trim panel, remove it and the panel retaining clips from the door.

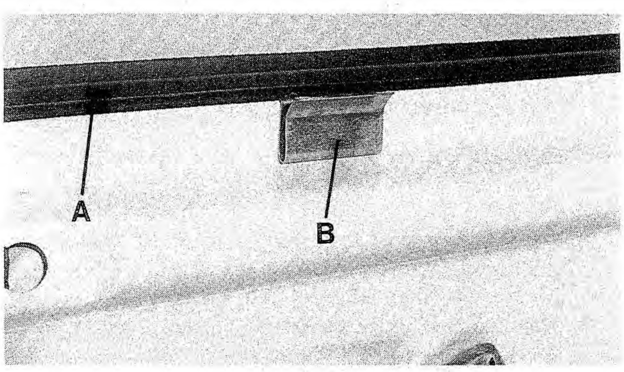

Fig. 5-17. Inner window channel seal (**A**) and interior trim panel retaining clip (**B**).

4. On convertible models, remove the trim at the end of the door by prying out the rivets. See Fig. 5-18. Then remove the outer window-channel seal as shown in Fig. 5-19.

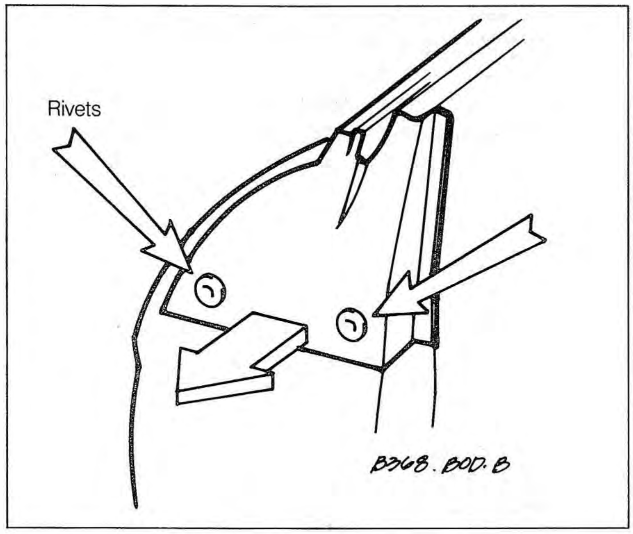

Fig. 5-18. Door trim and securing rivets (arrows) on convertible models.

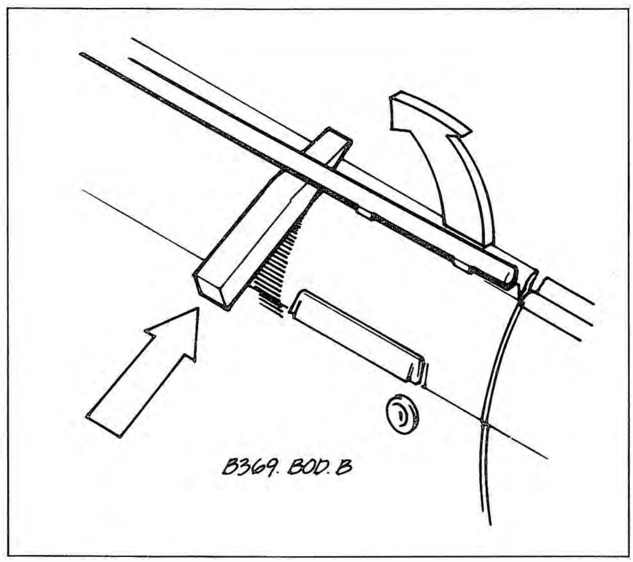

Fig. 5-19. Outer window channel seal being removed using wooden wedge. Be careful not to damage paint.

5. On convertible models, remove the bolts that secure the window regulator as shown in Fig. 5-15 above.
6. On all models, while holding the glass, remove the bolts shown in Fig. 5-13 above.
7. Disengage the forward end of the glass from the regulator guide roller, then tilt the glass on its side as it is removed through the window channel.

Installation is the reverse of removal. When installing the window on convertible models, make sure the window regulator rollers are inserted into the guides on the bottom of the glass before installing the regulator bolts. Use new rivets to install the door trim.

To remove rear door windows:

1. Remove the door interior trim panel as described above.

2. Peel back and remove the plastic door moisture seal, taking care not to tear it.

3. If the inner window channel seal, shown in Fig. 5-17 above, was not removed with the trim panel, remove it and the panel retaining clips from the door.

4. Remove the outer window channel seal as shown in Fig. 5-19 above.

5. Remove the bolts that hold the window glass to the window regulator, as shown in Fig. 5-13 above. Then disengage the window glass from the front guide roller.

6. Remove the front and rear rubber window guides by pulling them out of their channels in the door frame.

7. Remove the bolts that hold the door opening lever to the door and let it hang down.

8. Remove the bolts that hold the rear window frame, shown in Fig. 5-20, and push the frame into the door. Note how the tabs on the rubber part of the frame engage the metal for reinstallation.

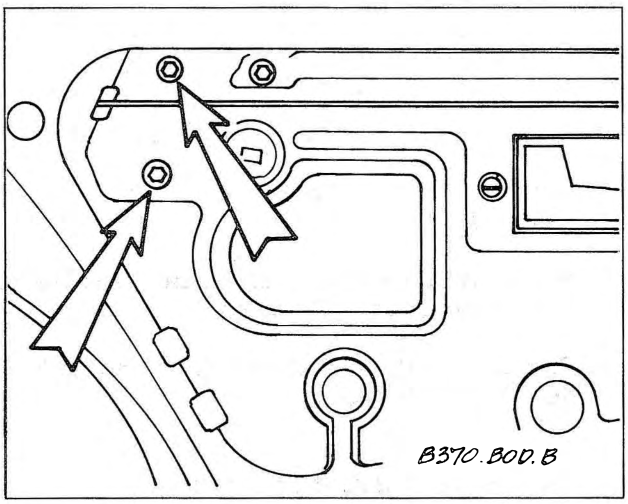

Fig. 5-20. Securing screws (arrows) for rear window frame.

9. If removing the door glass, tilt it slightly and pull it up through the window channel. If removing the fixed quarter window, tilt it forward slightly and pull it out.

Installation is the reverse of removal. The use of a light soap solution will make installation of the fixed window and rubber guides easier. When installing the door opening lever, preload the lever assembly slightly forward the front of the car before tightening the bolts.

Handles and Locks

Fig. 5-21 shows the basic lock linkage used on the cars covered by this manual. The lever on the top of the lock assembly is actuated by the outside door handle to open the door. It is necessary to remove the outside door handle and the lock assembly for access to the door lock cylinder. On some models, lifting the driver's outside door handle actuates a microswitch that turns on the heated locks or the delayed interior light. For information related to troubleshooting these electrical circuits, see **ELECTRICAL SYSTEM**.

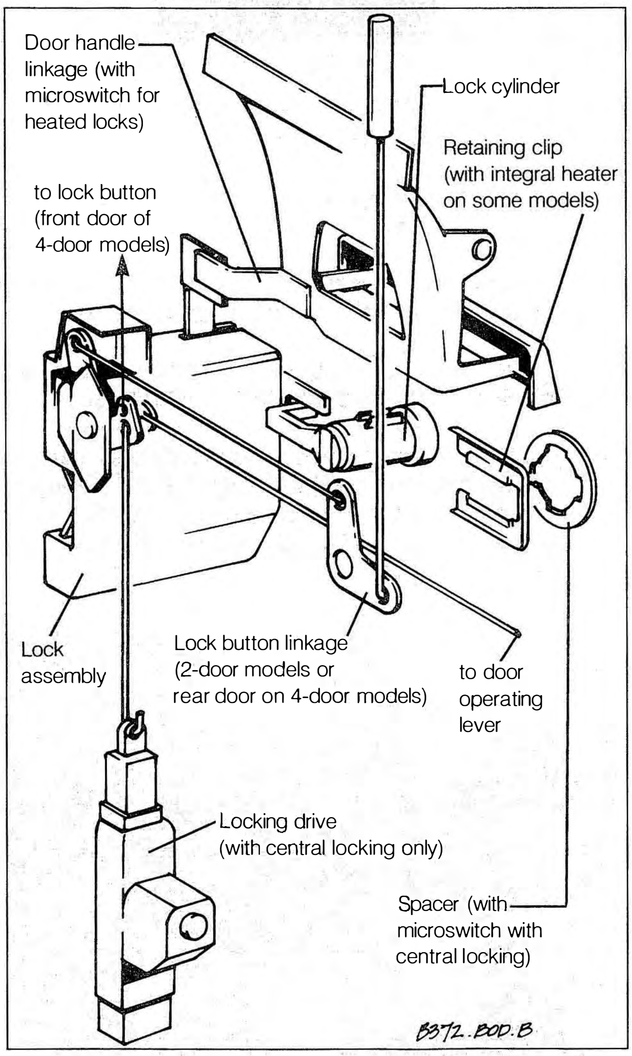

Fig. 5-21. Phantom view of lock linkage used on front doors of 2-door models with central locking. Linkage differs slightly for other door applications.

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To remove lock assembly and linkage:

1. Remove the door interior trim panel as described above.

2. Peel back and remove the plastic door moisture seal, taking care not to tear it.

3. Remove the screws that secure the door operating lever, shown in Fig. 5-22. Unclip operating rod from the lever and let the lever hang down.

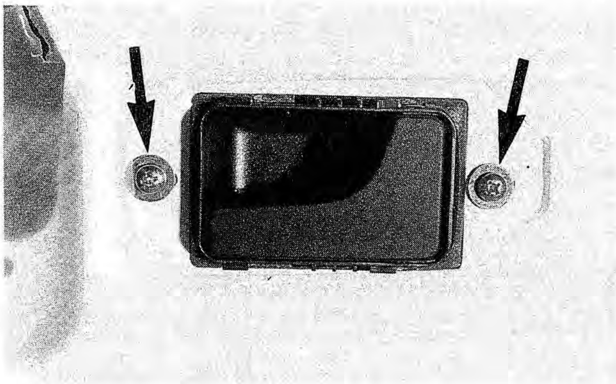

Fig. 5-22. Door operating lever and securing screws (arrows).

4. On 2-door models or on rear doors, unscrew the nut or bolt that holds the lock button linkage to the door.

5. On rear doors, disengage the lock button linkage from the lock assembly and remove it from the door.

6. On cars with central locking, remove the nuts that hold the locking drive to the door. See Fig. 5-23. Disengage the locking linkage from the lock assembly, disconnect the locking drive harness connector, and remove the drive from the door.

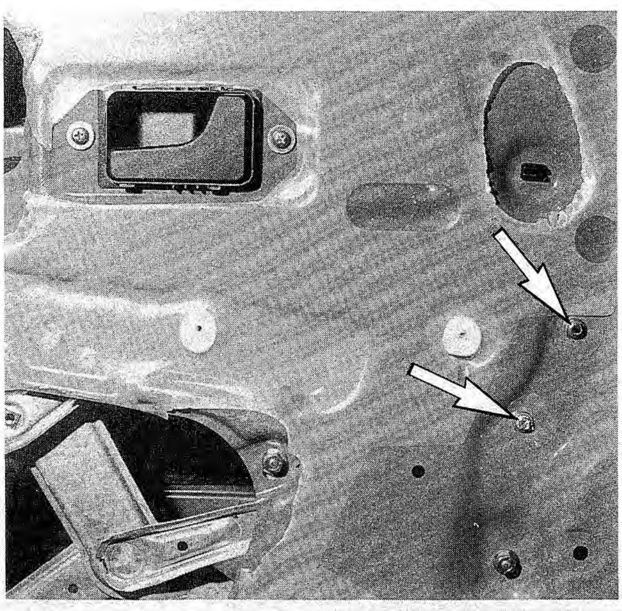

Fig. 5-23. Central locking drive securing nuts (arrows).

7. On convertible models, remove the lock cylinder as described below.

8. Remove the bolts that hold the lock assembly to the door. See Fig. 5-24. Then remove the lock assembly and linkage.

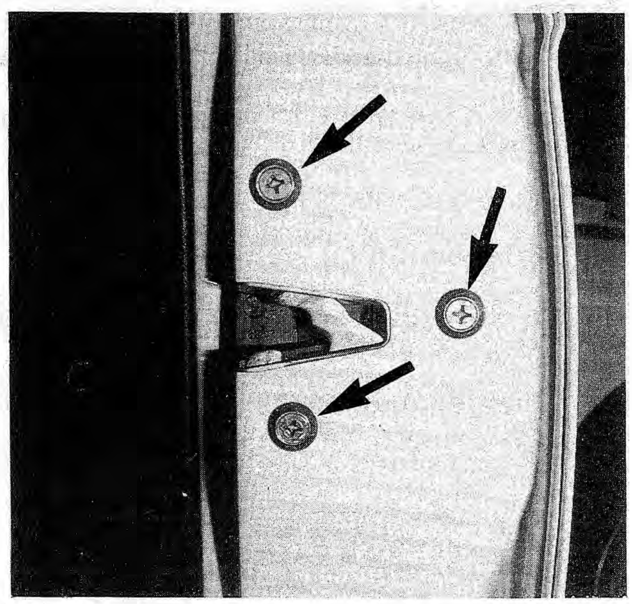

Fig. 5-24. Lock assembly securing bolts (arrows) on edge of door.

Installation is the reverse of removal. When installing the door operating lever, preload it slightly towards the front of the car before tightening the screws. On models with central locking, install and adjust the locking drive as described in **5.2 Central Locking System**.

To remove door lock cylinder:

1. Remove the door interior trim panel as described above.

2. Peel back and remove the plastic door moisture seal, taking care not to tear it.

3. Working inside the door, pull the retaining ring off of the lock cylinder. See Fig. 5-21 above.

4. Remove the spacer and withdraw the lock cylinder from the outside of the door.

To remove outside door handle mechanism:

1. Remove the door interior trim panel as described above.

2. Peel back and remove the plastic door moisture seal, taking care not to tear it.

3. Remove the outside door handle by removing the screws shown in Fig. 5-25.

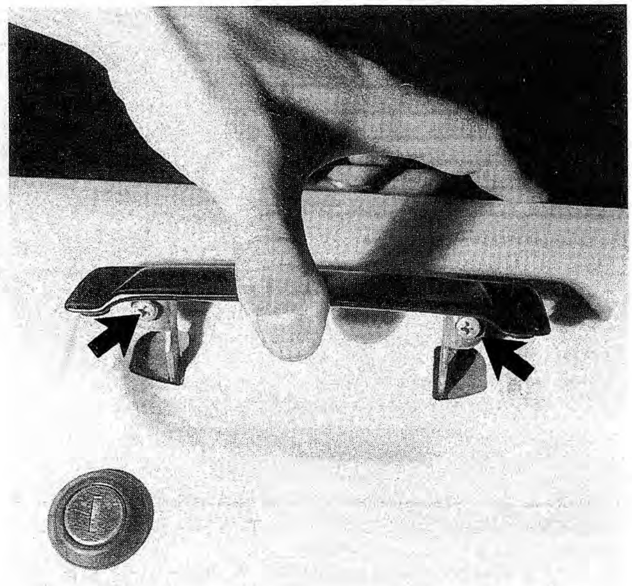

Fig. 5-25. Door handle retaining screws (arrows).

4. On models with heated door locks, disconnect the electrical connector inside the driver's side door that leads to the microswitch and control unit on the door handle mechanism.

5. Working from inside the door, remove the two nuts that secure the handle mechanism and remove the mechanism.

When installing the door handle on models with heated door locks, the tab on the handle linkage should actuate the microswitch when the handle is pulled up. If it does not, bend the actuating tab on the handle linkage.

5.2 Central Locking System

The central locking system consists of solenoid locking drives at each of the doors, at the rear lid, and at the gas tank filler flap. The drives are connected to the lock by a linkage rod. When the key is turned in the driver's door or trunk lock, the central locking control unit activates the drives to open or close the locks. The central locking system control unit and safety switch, which opens the locks in an accident, are located behind the speaker in the driver's footwell.

This heading covers only the removal and installation of the mechanical parts. For general electrical information to aid in troubleshooting the central locking electrical circuit, see **ELECTRICAL SYSTEM.**

Different locking drives are used depending on the application. The drives are identified by the color of the housing. See Fig. 5-26 and **Table a**. On 2-door models, the upper section of door drives faces toward the front of the car. On 4-door models, the upper section faces toward the rear of the car.

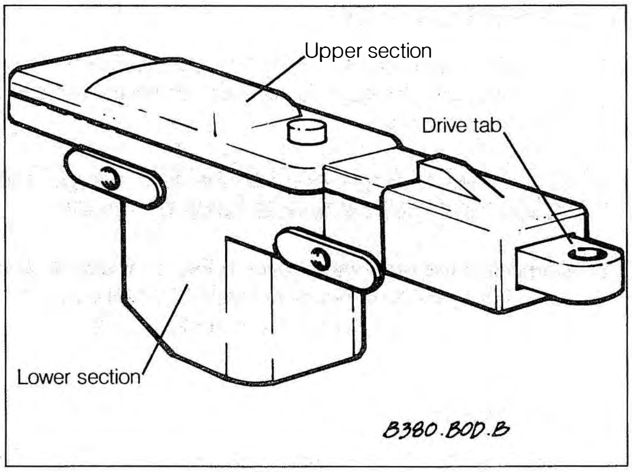

Fig. 5-26. Central locking system locking drive. See **Table a.** for correct identification of drives.

Table a. Central Locking System Locking Drive Identification

Locking drive	Upper section color	Lower section color
Driver's door	White	Red
Passenger door	Red	Red
Rear doors	Red	White
Trunk lid	White	Red

Removing, Installing, and Adjusting Locking Drives

The door locking drives are removed by first removing the interior door trim panel as described in **5.1 Door Assembly**. Remove the drive mounting nuts shown in Fig. 5-23 above, disconnect the lock linkage and harness connector, and remove the drive.

The trunk locking drive is mounted behind the trunk rear trim panel. See Fig. 5-27. The gas tank flap activator is located behind the trunk right side trim panel. Remove the mounting bolts, disconnect the lock linkage and harness connector, and remove the drive.

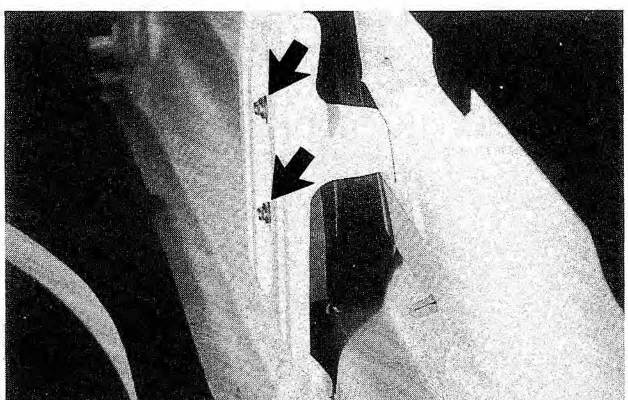

Fig. 5-27. Trunk central locking drive mounting bolts (arrows).

To install and adjust drives:

1. Place the door or trunk lock in the locked position. Make sure that the lock linkage is installed correctly and also in the locked position.

2. Engage the locking drive with the lock linkage and loosely install the bolts to hold the drive in position.

3. Compress the drive tab shown in Fig. 5-26 above, pull down lightly on the entire drive assembly to take up slack in the linkage, then tighten the mounting bolts.

5.3 Side Mirrors

The mirror housing is held to the car door by two mounting bolts. The mirror glass is held in the housing by a locking ring.

To remove the mirror housing, pry out the mirror trim panel or upper speaker on the inside of the door. Unclip the wiring harness connector. Remove the two bolts shown in Fig. 5-28 and remove the mirror housing.

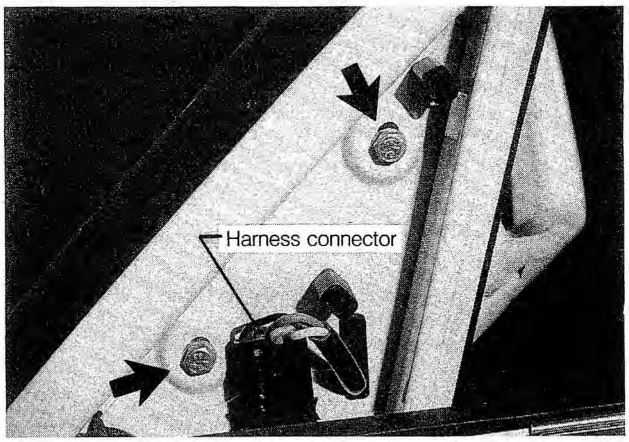

Fig. 5-28. Side mirror housing mounting bolts (arrows), behind small trim panel or radio speaker.

To remove the mirror glass, insert a screwdriver into the housing from below as shown in Fig. 5-29. Engage the tab on the locking ring with the screwdriver and push it to one side or the other to disengage the ring. Fig. 5-30 shows the mounting screws for the mirror motor on electric side mirrors. To install the glass, push the locking ring to its stop on one side, then mount the glass and use the screwdriver to push the tab to one side to lock the glass.

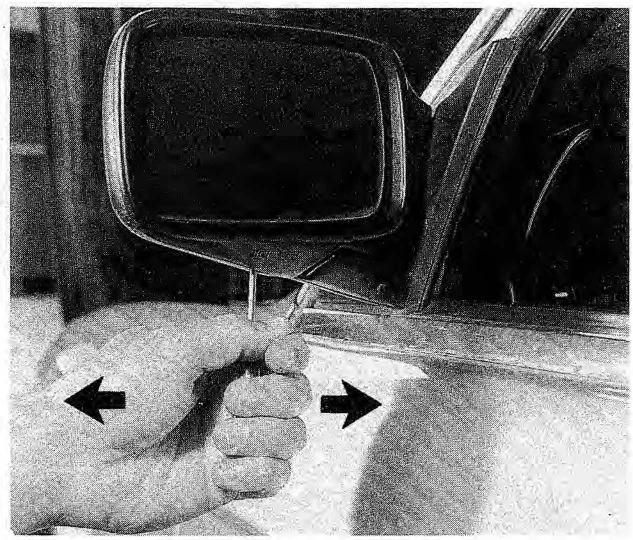

Fig. 5-29. Insert screwdriver as shown to engage tab on mirror-glass locking ring, then push in either direction to unlock glass.

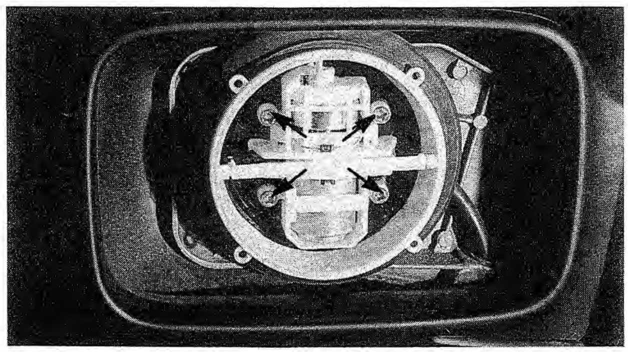

Fig. 5-30. Motor and mounting screws (arrows) for electric side mirrors.

6. EXTERIOR

The exterior body parts and trim discussed under this heading are fastened with conventional fasteners, and are easily removed using ordinary hand tools. A thorough knowledge of automobile body repair is not needed to perform the procedures.

6.1 Headlights

The cars covered by this manual have dual high and low beam headlights. 1984 through 1987 models have sealed-beam halogen headlights that are held in the housing by a retaining ring. Each headlight is aimed with two screws, and the bulb and lens must be replaced as one assembly.

1988 and later models have halogen headlights with a one-piece lens and reflector assembly that is held in place with clips. The halogen bulb locks into the lens assembly and is replaceable. Two screws are used to aim each of the headlights.

It should not be necessary to aim the headlights after replacing a bulb if the adjustment screws have not been touched, however, it is a good idea to check headlight aim as described below.

To replace sealed beam headlights:

1. Remove the front grille as described in **6.4 Trim, Bumpers, and Body**.

2. Remove the retaining ring screws shown in Fig. 6-1, then remove the light and disconnect the wiring.

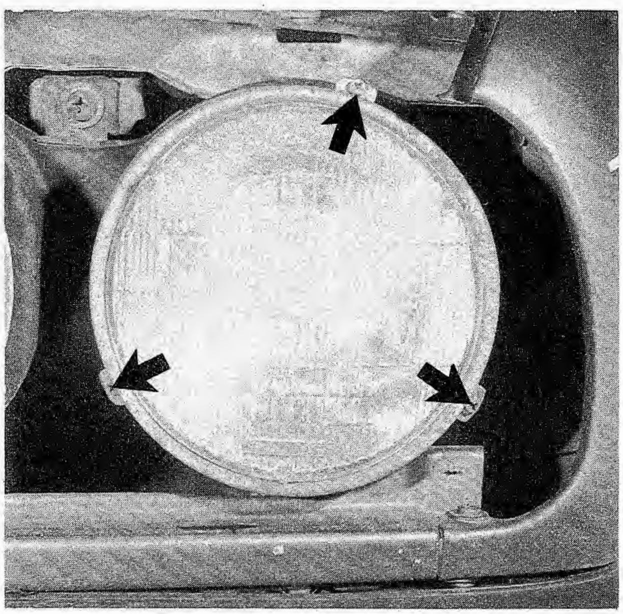

Fig. 6-1. Sealed beam headlight and retaining ring screws (arrows).

3. When installing the new light, make sure the part of the lens marked TOP is uppermost, and that the tabs on the light engage the recesses in the headlight housing.

To replace two-piece headlight lens or bulb:

1. Remove the front grille as described in **6.4 Trim, Bumpers, and Body**.

2. Using a hot air blower, heat the lens-assembly retaining clips shown in Fig. 6-2, then pull out the light assembly. Replace any broken clips.

3. Disconnect the wiring and twist the bulb 90° to remove it.

CAUTION —

Do not touch the bulb glass. Dirt and oil deposits on the glass can cause hot spots and rapid bulb failure. Clean off fingerprints using a soft cloth.

NOTE —

Do not interchange the bulbs for high and low beams. The high beam halogen bulb is identified by the black tip.

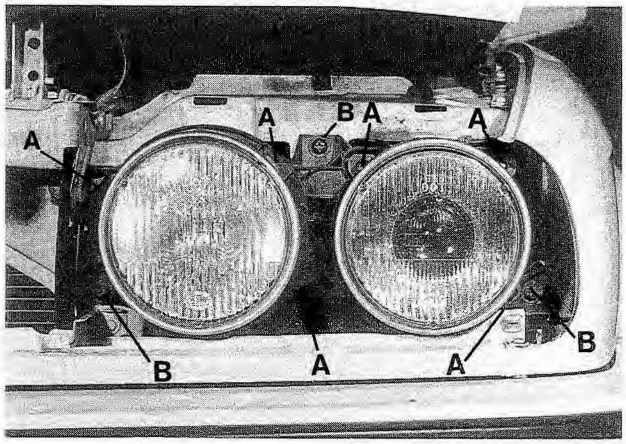

Fig. 6-2. Headlight assembly for models with two-piece halogen lights with replaceable bulb. Lens-assembly retaining clips are at **A**. Headlight housing retaining screws for all models are at **B**.

4. When installing the lens assembly, first install the clips into the headlight housing, then press the lens assembly onto the clips.

To replace the headlight housing on all models, remove the retaining screws shown in Fig. 6-2 above. Pull the housing forward off the car and disconnect the wiring.

Aiming Headlights

Headlights are usually aimed using special adaptors and equipment. Headlight aiming can also be done as described below without any special tools, however, the results will not be as exact.

NOTE —

Check your state laws to see if headlight adjustments must be made by a licensed shop. Some states may also have different aiming specifications from those described here.

To aim headlights without using special tools, position the car on a level surface, 7.65 meters (25 ft.) from a vertical wall. The gas tank should be full, tire pressures should be correct, and there should be a weight of approximately 155 lbs. in the back seat. Turn the headlights to low beam. With a person in the driver's seat, the low beams must be in the areas shown in Fig. 6-3. If re-aiming is necessary, open the hood and remove the cover shown in Fig. 6-4. The headlight adjusters are shown in Fig. 6-5. Use a screwdriver on the vertical and horizontal adjusting screws to move the headlight.

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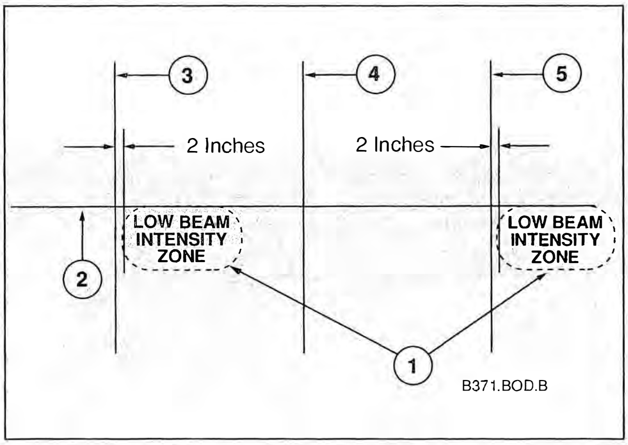

Fig. 6-3. Headlight aiming target on vertical wall. Low beam light intensity areas are at **1**. **Line 2** is at height of headlight centers. Line **4** is car centerline. Lines **3** and **5** are distance from centerline to centers of headlights.

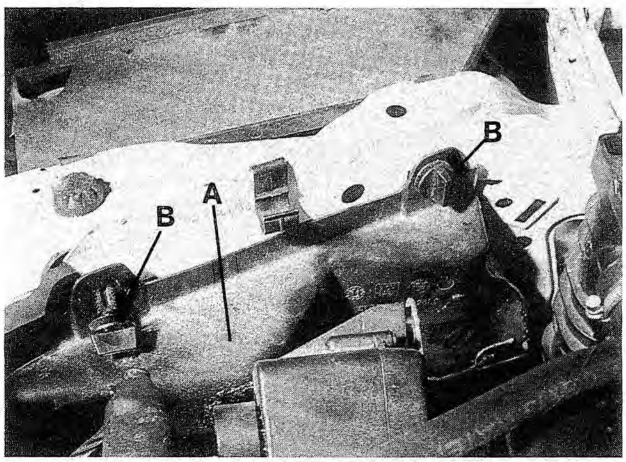

Fig. 6-4. Headlight cover (**A**) in front part of engine compartment. Turn fasteners (**B**) 90° to remove cover.

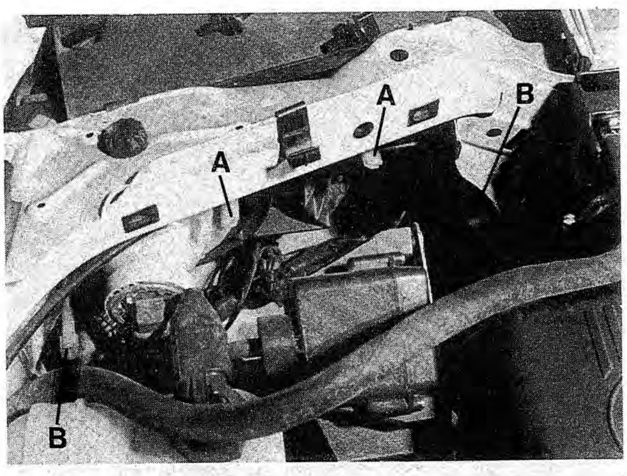

Fig. 6-5. Headlight aiming screws for horizontal adjustment (**A**) and vertical adjustment (**B**)

6.2 Taillight Assembly

All rear bulbs and the taillight lens are replaced from the luggage compartment. Replacement of the center brake light is covered in **4.3 Interior Lights**.

Replace a faulty taillight bulb by first removing the bulb holder. Turn the bulb carrier lock shown in Fig. 6-6 and remove the bulb carrier. Push in on the bulb and twist to remove, push in and twist to install.

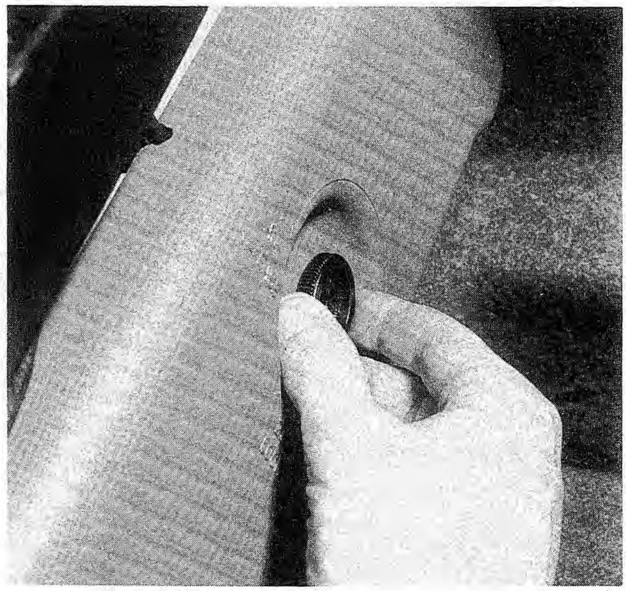

Fig. 6-6. Rear taillight bulb carrier being removed. 1988 and later models shown. On earlier models, there are two locks. Turn counterclockwise to release.

To replace the taillight lens, first remove the bulb carrier. Disconnect the wiring harness connector by compressing the tabs on the connector. Remove the six nuts in the luggage compartment that hold the lens to the body. See Fig. 6-7. From outside, pull the lens off the car with its gasket.

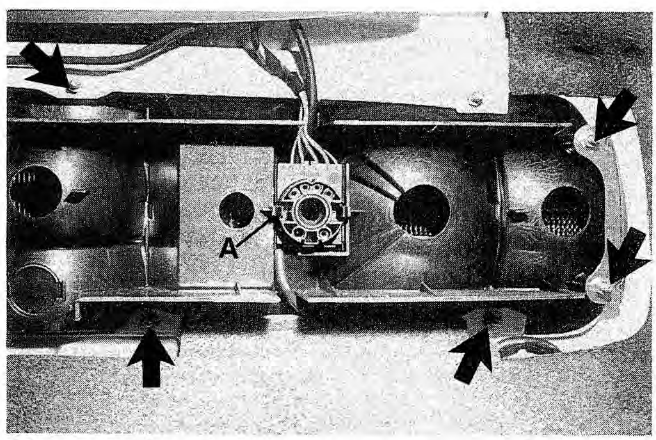

Fig. 6-7. Retaining nuts (arrows) for taillight lens. Remove harness connector (**A**) before removing lens. On some models, connector may be to side of lens.

6.3 Side Marker, Front Turn Signal, and Fog Lights

To replace a front turn signal bulb or lens, remove the Phillips screws and pull the lens away from the fender or bumper. Push and turn the bulb counterclockwise to remove it.

To replace a side marker bulb or lens, pry out the lens and bulb as shown in Fig. 6-8. Disconnect the wiring connector. Turn the bulb holder counterclockwise to remove the bulb.

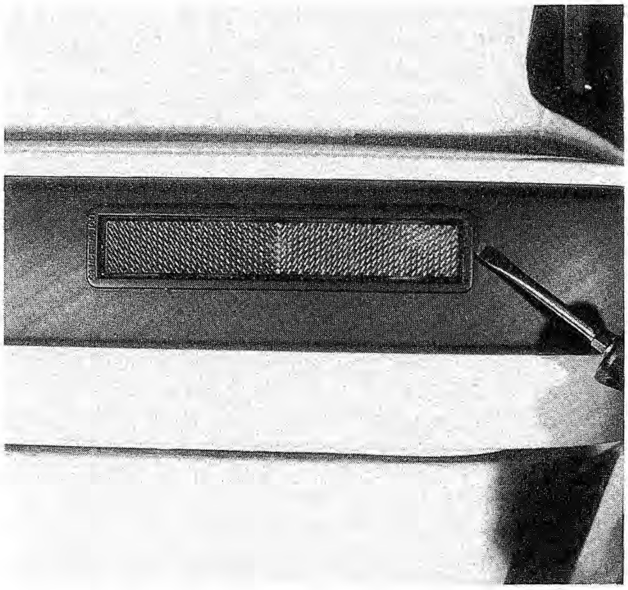

Fig. 6-8. Side marker lens being removed. Use screwdriver to pry at front of housing.

To replace a fog light bulb, first remove the front engine splash shield under the bumper. Remove the access cover shown in Fig. 6-9, then disconnect the wiring and unclip the bulb. When installing the new bulb, make sure the notch in the bulb assembly fits correctly.

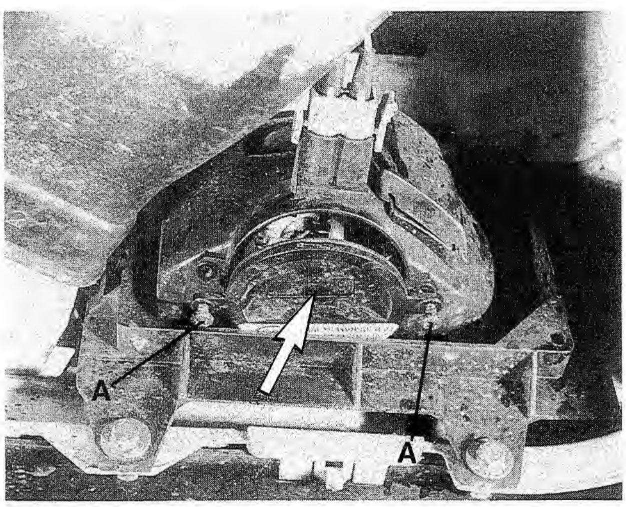

Fig. 6-9. Access cover (arrow) for fog light bulb. Mounting screws are at **A**.

To replace the entire fog light lens and assembly, disconnect the harness connector, and then remove the four mounting bolts shown in Fig. 6-10. Do not lose the gasket between the lens and the spoiler.

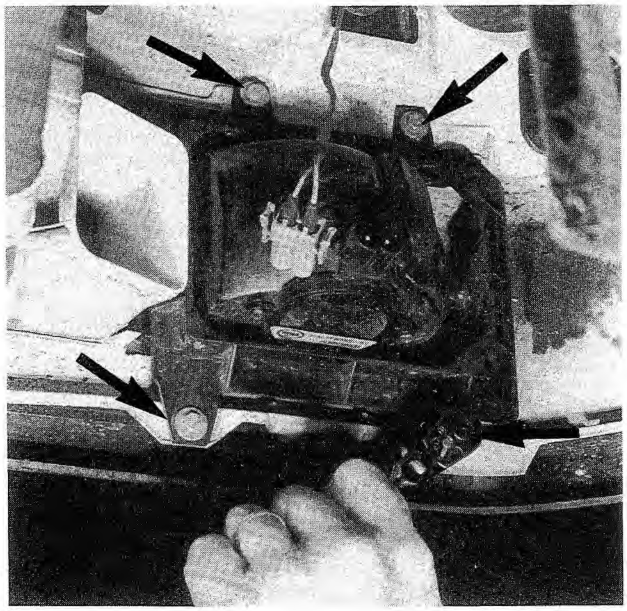

Fig. 6-10. Fog light mounting bolts (arrows).

The fog lights are adjusted from the front, with two screws. See Fig. 6-11. The screws are behind two rubber plugs.

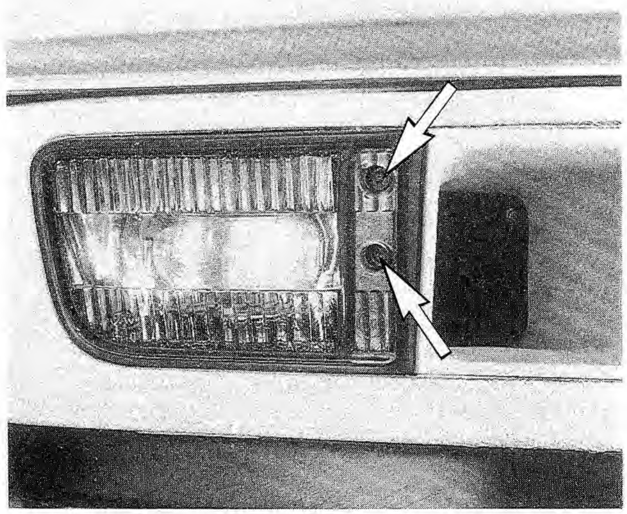

Fig. 6-11. Fog light adjusting screws (arrows).

6.4 Trim, Bumpers, and Body

This heading covers removal of components such as the fenders, hood, and trunk, as well as alignment of those components.

Removing and Installing Fenders

For corrosion protection, the fenders are assembled with a sealant strip between the top mating surfaces to prevent moisture from becoming trapped. This strip should be replaced any time the fenders are removed.

> **NOTE —**
> The sealant strip is installed as part of the corrosion warranty. If in doubt about warranty protection, consult an authorized BMW dealer.

To replace fenders:

1. Remove the front bumper and, where applicable the bumper side pieces, as described below.

2. Remove the wheelhouse liner by removing the bolts shown in Fig. 6-12.

3. Remove the fender mounting bolts. There are six bolts along the top of the fender, four bolts inside the wheelhouse that hold the fender to the body, and two bolts at either end of the fender bottom.

4. Peel back the rubber seal along the top edge of the fender. Carefully use a heat gun and razor knife to cut through the sealant along the edge of the fender, and to cut through the PVC coating along the A-pillar where the fender meets the body.

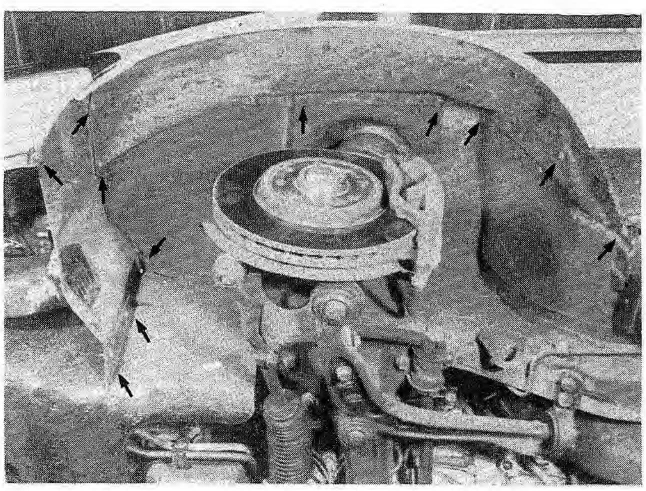

Fig. 6-12. Wheelhouse liner mounting bolts (arrows).

> ***CAUTION —***
> *Use extreme care when applying heat to the body to avoid blistering the paint or discoloring the PVC body coating.*

5. Gently pry the old fender off of the body. Clean the old sealant and coating off of the body mounting surfaces.

When installing the new fender, first install a new sealant strip between the top edge of the fender and the body. The sealant strip is available from an authorized BMW dealer as BMW Part No. 51 71 1 933 209. Loosely install the fender mounting bolts. Position the fender so that it lines up correctly with the door and A-pillar, then tighten the bolts. Reinstall the wheelhouse liner and the bumper.

> **NOTE —**
> Part numbers are for reference only. Always consult with an authorized BMW parts department for the most up-to-date parts information.

Removing and Installing Body Trim and Front Grille

Body trim includes the body side moldings, the rain gutter trim, and the front grille components. The body side moldings are held in place with clips and screws. The grille trim is held by clips.

To remove body side moldings on the front fender, pry the molding straight off the clips. Replace any broken clips, and press the molding onto the clips.

To remove a door or rear side panel body molding, first remove the securing nut. See Fig. 6-13 or Fig. 6-14. Pry the molding straight off the clips, and replace any broken clips. When installing the molding, first slide it onto the beveled clip, as shown in Fig. 6-15, and then press the molding onto the other clips.

Fig. 6-13. Mounting nut (arrow) for front door body side molding. Nut for rear side panel body molding is similar.

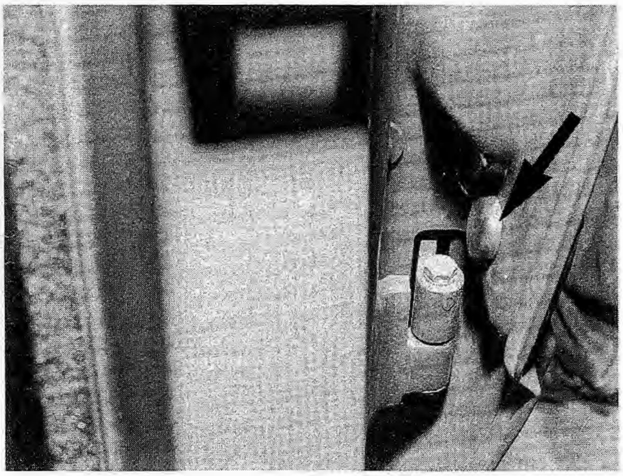

Fig. 6-14. Mounting nut for rear door body side molding is beneath rubber plug (arrow).

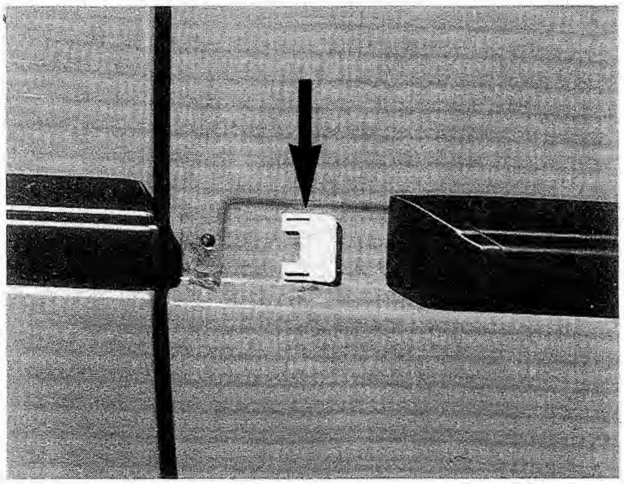

Fig. 6-15. Beveled clip (arrow) for body side moldings. Slide molding onto clip first, then press onto other clips.

To remove a rain gutter molding, first slide the clamp shown in Fig. 6-16 towards the back of the car. Beginning at the front of the car, pry the molding from the rain gutter. Twist and lift the molding as you go along. Before installation, replace any clips at the front of the rain gutter, and lightly lubricate the inside of the molding with silicone. Install the molding from the rear of the car forward.

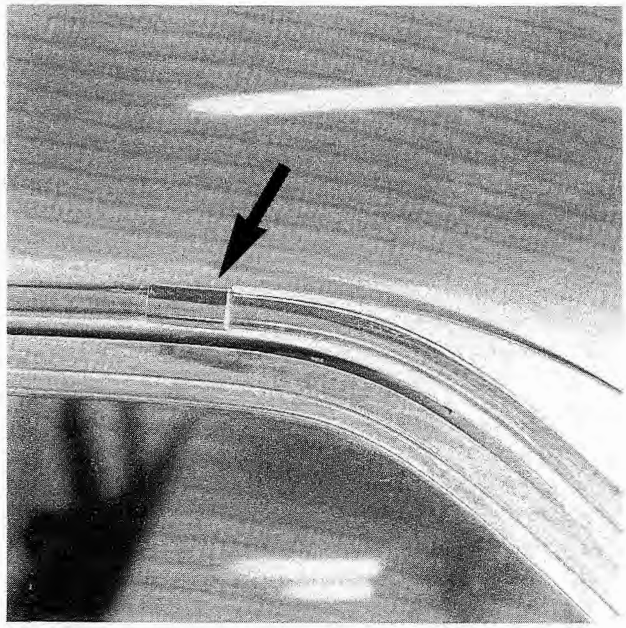

Fig. 6-16. Clip on rain gutter molding (arrow) to be moved back.

The front center grille is held by two clips. The front side grilles are held by two screws and three clips. See Fig. 6-17.

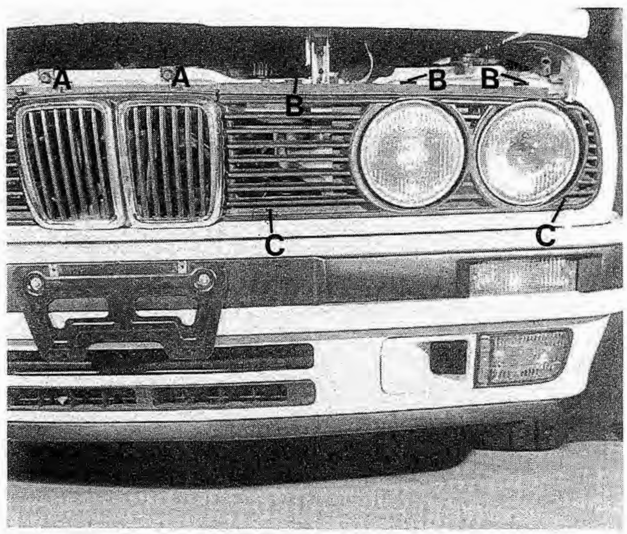

Fig. 6-17. Front center grille retaining clips (**A**), and side grille retaining clips (**B**) and screws (**C**).

Removing and Installing Bumpers

Two types of bumpers are used on the models covered by this manual.

Models up to 1989 and convertibles have three-piece bumpers. The main bumper is bolted to shock absorbers that are bolted to the frame, and two side pieces are bolted to the car body. Upper and lower bumper trim is also bolted to the body.

1989 and later models have a one-piece bumper that is bolted to frame-mounted shock absorbers. All trim is clipped or bolted to the bumper.

To remove three-piece bumpers, work under the car to remove the four bolts that hold the bumper to the shock absorbers (two bolts per absorber). On front bumpers, also disconnect the turn signal harness connectors. Pull the bumper straight off the car. When installing the bumper, torque bumper-to-shock absorber bolts to 22 to 25 Nm (16 to 18 ft. lb.).

Front side pieces on three-piece bumpers are held to the car by two bolts inside the fender, and three bolts below the headlights. Pull the side piece away from the car slightly after removing the bolts and disconnect the side marker light harness connector. Rear bumper side pieces are held by two nuts and one bolt in the trunk as shown in Fig. 6-18, and one bolt and one nut under the car at the rear edge of the wheelhousing. When installing side pieces, torque all bolts and nuts to 6 to 9 Nm (4 to 7 ft. lb.).

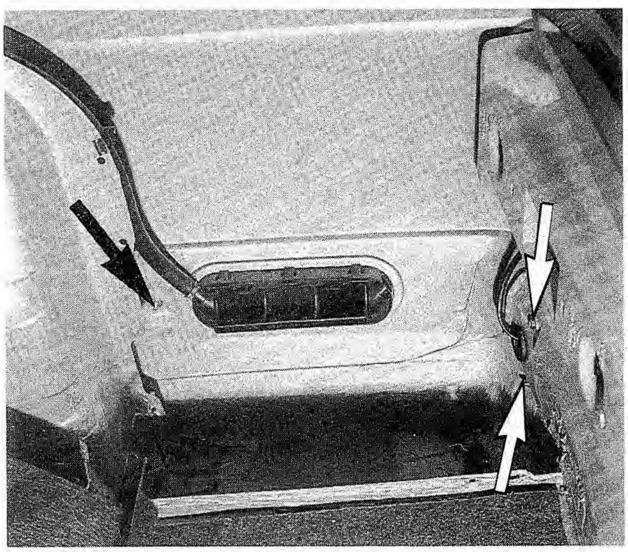

Fig. 6-18. Mounting nuts and bolt inside trunk (arrows) for right rear side piece on three-piece bumpers. Left side is similar. Additional mounting bolt and nut are at rear edge of wheel housing.

To remove one-piece bumpers, use a 10 mm hex wrench and work from below the bumper to remove the two mounting bolts. See Fig. 6-19. Pull the bumper away from the body slightly and disconnect the turn signal and side marker light harness connectors. When installing the bumper, torque the mounting bolts to 87 Nm (64 ft. lb.).

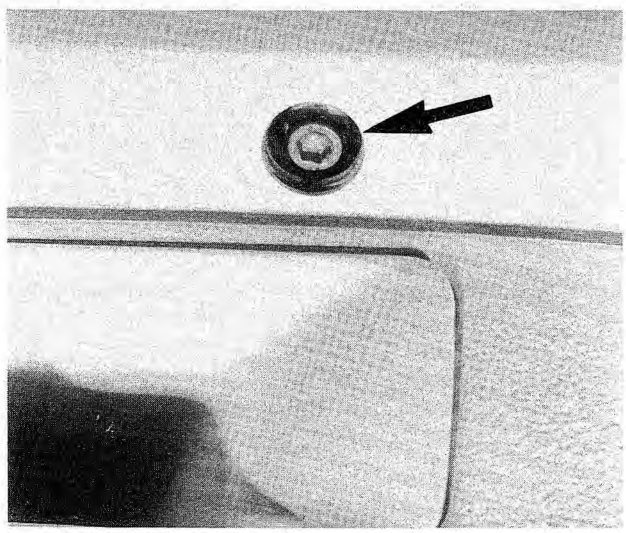

Fig. 6-19. Mounting bolt (arrow) for one-piece bumper. Remove bolts from both sides.

Hood and Hood Lock

When removing the hood, first mark the hinge plate locations on the hood for reinstallation. Raise the hood and unclip the gas strut and support from the right side of the hood. Loosen the mounting bolts shown in Fig. 6-20, then with a helper supporting the opposite side, remove the bolts. Install the original hood by aligning the matching marks made earlier.

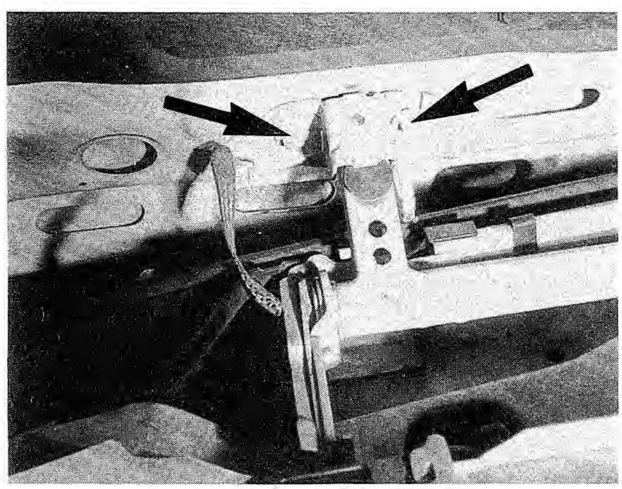

Fig. 6-20. Left-side hood mounting bolts (arrows). Remove bolts from right side also.

NOTE

The body is painted at the factory after assembly. Realignment of body panels may expose unpainted metal. To prevent rust, paint all exposed metal as soon as possible.

Hood alignment considers front-to-back and side-to-side alignment, front height, rear height, and hood guide alignment. Before making any adjustments, first screw the hood stops all the way in. See Fig. 6-21. When finished with any adjustments, screw the stops out until the hood rests on them, unlocked, with slight pressure.

To make front-to-back or side-to-side adjustments, loosen the hood mounting bolts, shown in Fig. 6-20 above, just enough so that the hood can be moved with some effort. Close the hood and then move it as necessary until it is aligned. Open it gently when finished and tighten the bolts.

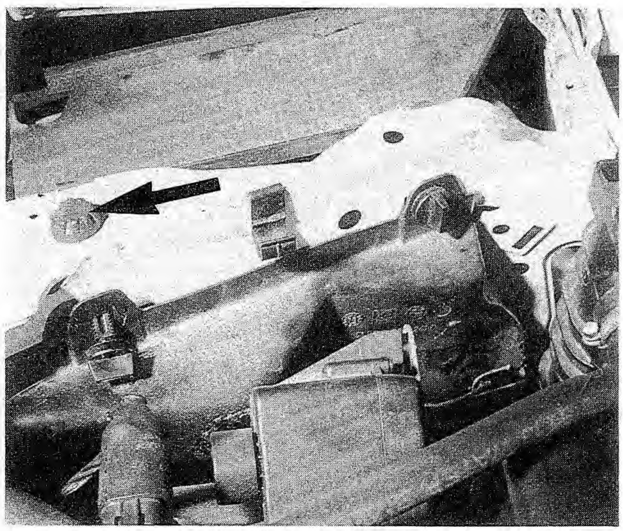

Fig. 6-21. Hood stop (arrow). Screw stops all the way in on both sides before making any hood adjustments.

To make front height adjustments, loosen the two bolts on either side of the hinge assembly. See Fig. 6-22. The correct height of the hood at the front is approximately 1 mm (.04 in.) lower than the tops of the fenders.

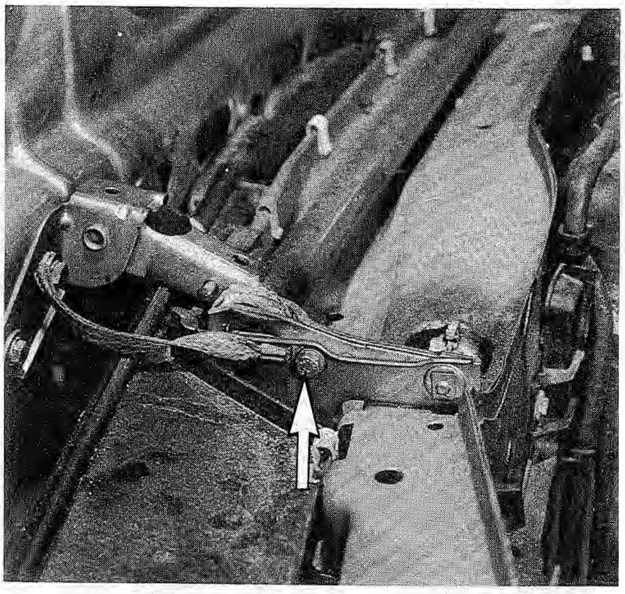

Fig. 6-22. Left-side hood hinge bolt (arrow) to be loosened for front hood height adjustments. Loosen bolts on right side also.

To make rear hood height adjustments, loosen the rear-guide bolts on either side. See Fig. 6-23. The correct height of the hood at the rear is even with the tops of the fenders. To center the rollers that engage the rear catches, loosen the roller mounting bolts.

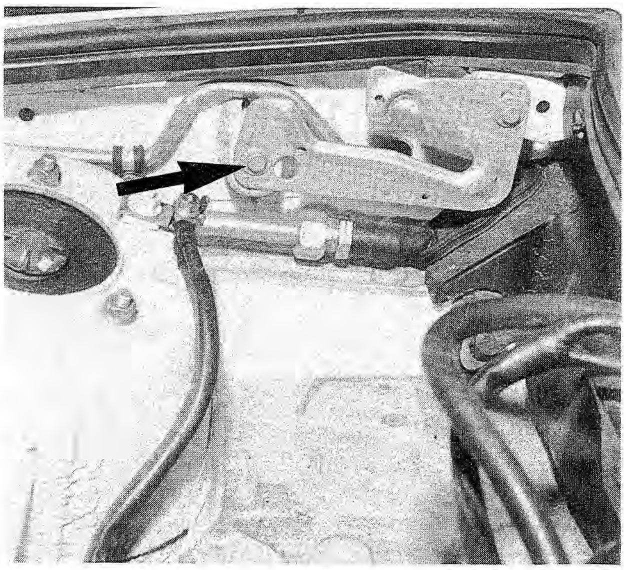

Fig. 6-23. Right-side hood rear-guide bolts (arrows) to be loosened for rear hood height adjustments. Left side is similar.

The hood lock and cable are not adjustable. The only repair is replacement. Fig. 6-24 shows the hood lock mounting bolts, behind the front grille trim.

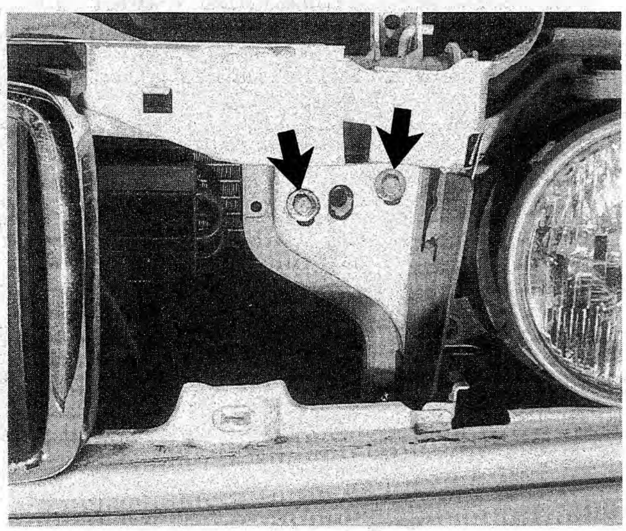

Fig. 6-24. Hood lock mounting bolts (arrows).

To replace hood lock cable:

1. Remove the headlight assembly as described in **6.1 Headlights**.

2. Remove the lock mounting bolts and remove the lock.

3. Unclip the plastic cover on the lock and unclip the cable from the lock.

4. Working in the passenger compartment, remove the screws holding the release handle to the body. Pull the cable through the firewall.

5. When installing the new cable, check that the firewall grommet is correctly seated for an air-tight seal. Install the release handle and cable to the body first before attaching the cable to the lock.

Trunk Lid and Trunk Lock

When removing the trunk lid, first mark the hinge plate locations on the lid for reinstallation. Raise the trunk lid and loosen the mounting bolts, then with a helper supporting the opposite side, remove the bolts. Install the original lid by aligning the matching marks made earlier.

> **NOTE —**
> The body is painted at the factory after assembly. Realignment of body panels may expose unpainted metal. To prevent rust, paint all exposed metal as soon as possible.

Trunk lid alignment considers front-to-back and side-to-side alignment, front height, and rear height alignment. Before making any adjustments, first screw the lid stops all the way in. See Fig. 6-25. When finished with any adjustments, screw the stops out until the trunk lid rests on them, unlocked, with slight pressure.

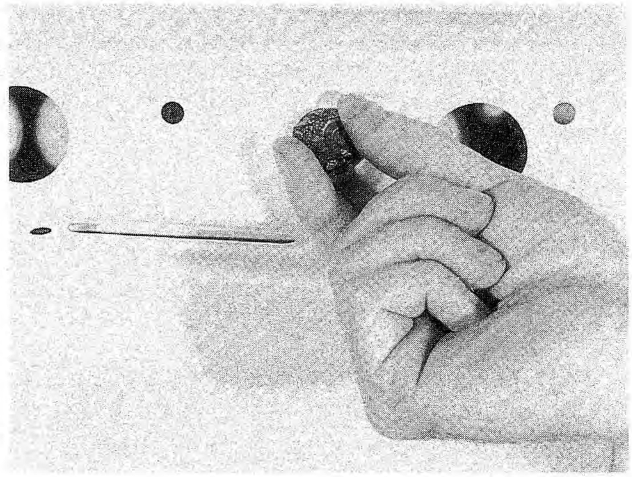

Fig. 6-25. Trunk lid stop being adjusted. Screw stops all the way in on both sides before making any adjustments to trunk lid.

To make front-to-back or side-to-side adjustments, loosen the trunk hinge and latch mounting bolts just enough so that the lid can be moved with some effort. Close the trunk lid and then move it as necessary until it is aligned. Open it gently when finished and tighten the bolts.

To make height adjustments at the hinges, loosen the mounting bolts and insert shims between the trunk lid and the hinge. The correct height of the lid at the hinges is even with the tops of the fenders. The shims are available as BMW Part No. 41 62 1 922 498.

> **NOTE —**
> Part numbers are for reference only. Always check with an authorized BMW parts department for the latest parts availability information.

Adjust the height of the trunk lid at the rear by moving the locking bar on the latch in or out as necessary. See Fig. 6-26. The correct height of the trunk lid at the rear is approximately 1 mm (.04 in.) lower than the tops of the fenders.

The trunk lock is located behind the rear trunk trim panel. See Fig. 6-27. To remove the lock, first pull out the rear trunk trim panel. Remove the lock mounting bolts and slide the lock out from the side. The lock cylinder is held in by a circlip. On models with central locking, see **5.2 Central Locking System** for information on removing the locking drive.

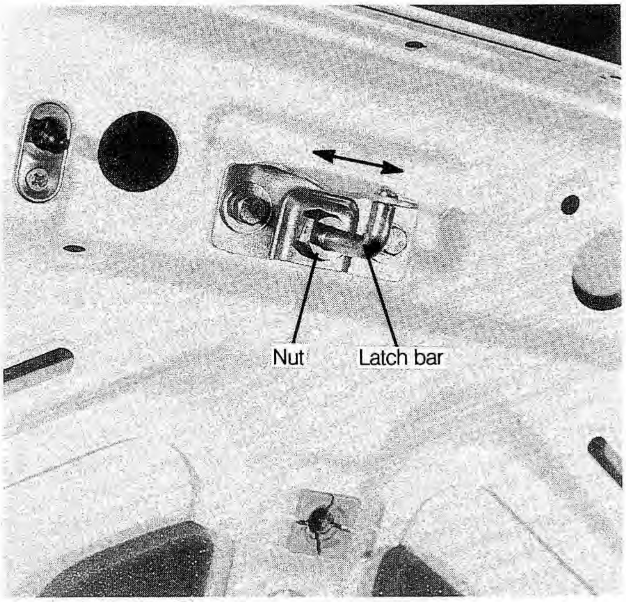

Fig. 6-26. Trunk lid latch. To adjust, turn nut to move latch bar in or out (arrows).

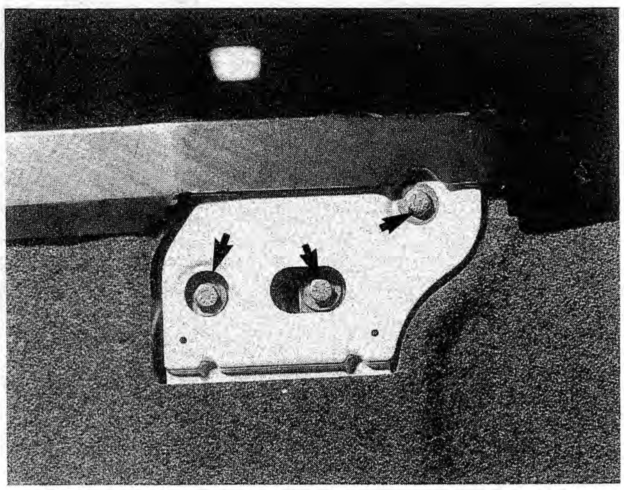

Fig. 6-27. Trunk lock mounting bolts (arrows).

7. SUNROOF

The sunroof is controlled by a set of cables that pull the sunroof panel along guide rails when the crank is turned or the motor is operated. The sunroof can be adjusted without removing it from the car. Replacement of the sunroof liner or components such as the cable assembly require sunroof removal. If the sunroof leaks or sticks, adjust it as described in **7.2 Adjusting Sunroof Fit** before deciding that it needs to be removed from the car.

Leaks may also be caused by clogged drain hoses. The front hoses lead from the top of the A-pillar into the space between the front fender and the door. The rear hoses run into the rear fender wells, to the air extraction vents behind the trunk side trim. See Fig. 7-1. Clean the hoses with a length of flexible cable, such as an old speedometer cable.

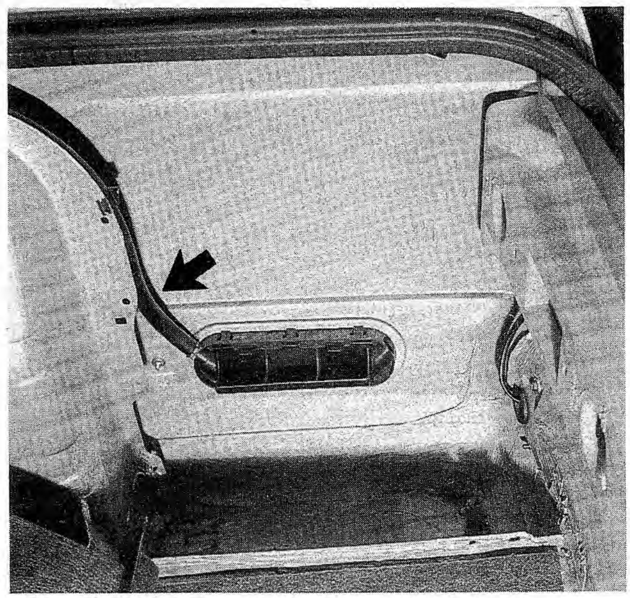

Fig. 7-1. Sunroof rear drain hose (arrow) behind trunk side trim.

Creaking of the sunroof when opened or closed on hot and humid days may be due to grease and dirt build-up on the slide rails. To correct this problem, use a grease-free solvent to clean the slide rails and any other mechanical components that come in contact with the plastic shoes of the sunroof.

7.1 Removing and Installing Sunroof Panel

The sunroof mounting screws are coated with a special adhesive to prevent loosening due to vibration. Whenever the sunroof panel is removed and installed, new self-locking sunroof mounting screws should be used. The screws are available as BMW Part No. 54 12 1 907 282. If the sunroof seal is being replaced, install it as shown in Fig. 7-2.

NOTE —

Part numbers are for reference only. Always check with an authorized BMW parts department for the latest parts availability information.

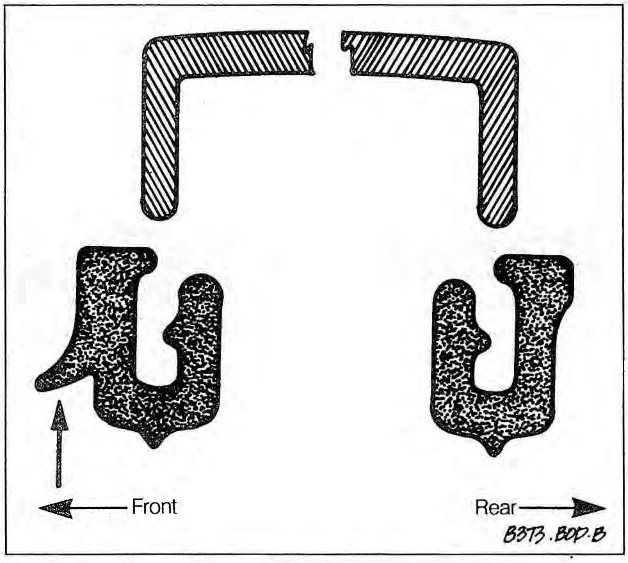

Fig. 7-2. Cross-section of sunroof seal showing correct installation of seal to sunroof panel. Note sealing lip (arrow) on forward portion.

To remove and install:

1. Open the sunroof approximately a quarter of the way. Using a wooden or plastic wedge, unclip the trim panel retaining clips at the front edge of the sunroof. See Fig. 7-3. Pry as close as possible to each of the clips. Close the sunroof and push the trim panel back into the roof.

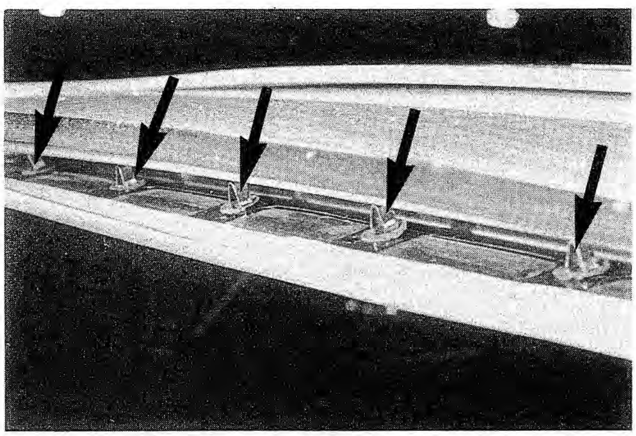

Fig. 7-3. Clips (arrows) that hold trim panel to sunroof.

2. Remove the sunroof mounting screws from the left and right as shown in Fig. 7-4 and lift the sunroof panel out of the car.

3. Install the sunroof panel and new self-locking screws. Loosely tighten the screws, then adjust the sunroof panel as described in **7.2 Adjusting Sunroof Fit**.

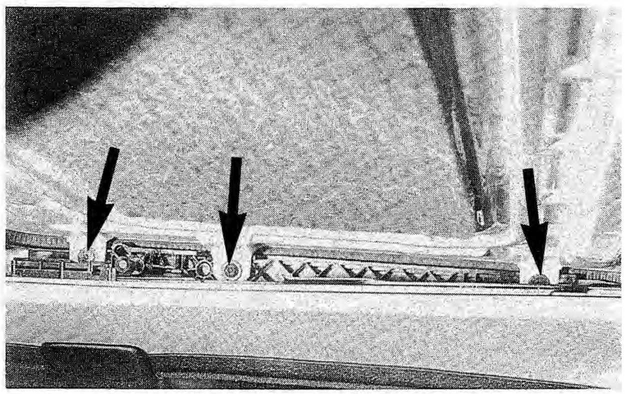

Fig. 7-4. Sunroof left-side mounting screws (arrows). Remove screws from both right and left sides.

4. Pull the sunroof trim panel as far forward as possible. While holding the rear of the trim panel up, open the sunroof slightly to engage the trim panel onto the rear guide pin. See Fig. 7-5. Press in the trim panel mounting clips.

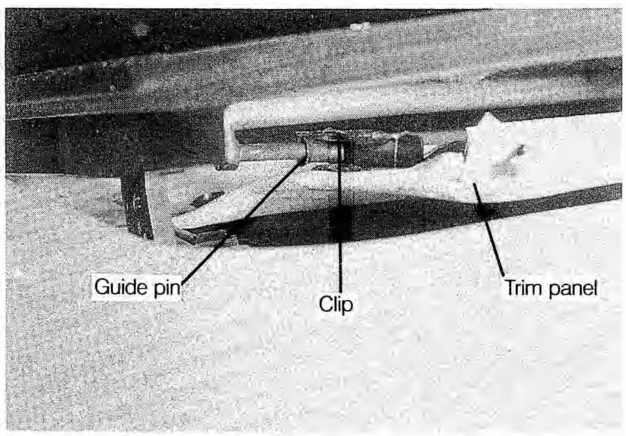

Fig. 7-5. Rear guide pin engaged in sunroof trim panel clip. Sunroof shown raised for clarity.

7.2 Adjusting Sunroof Fit

The sunroof should be adjusted whenever the top of the closed sunroof does not lie flush with the roof of the car, if it does not close squarely, if there are wind noises at high speed, if there are water leaks, or if the sunroof has been removed.

To adjust:

1. Open the sunroof approximately a quarter of the way. Using a wooden or plastic wedge, unclip the trim panel retaining clips at the front edge of the sunroof. See Fig. 7-3 above. Pry as close as possible to each of the clips. Close the sunroof and push the trim panel back into the roof.

2. Loosen the mounting screws on both sides that hold the sunroof to the guides. See Fig. 7-4 above.

3. Lock the sunroof guides in place to ensure parallelism of the guides and cables. Using a 4 mm allen wrench or equivalent on both sides, insert the wrench through the rear guide into the lift channel. See Fig. 7-6.

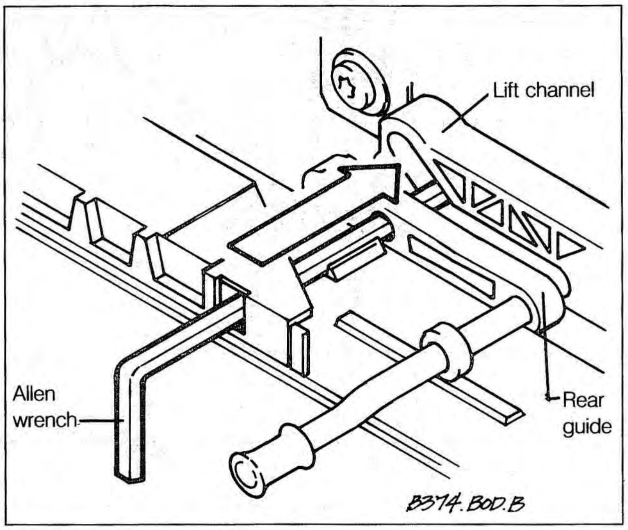

Fig. 7-6. Allen wrench inserted through rear guides to lock guides in place. Lock both sides.

4. Adjust the sunroof by tilting it as necessary until the front edge is lower than the roof by 1 mm (0.04 in.), and the rear edge is higher than the roof by 1 mm (0.04 in.). When the adjustment is correct, torque the sunroof mounting screws to 4 to 5 Nm (3 to 4 ft. lb.) and remove the allen wrenches.

8. Convertible Top

The Convertible model is essentially a two-door BMW with a number of structural additions to compensate for the loss of the rigidity of the hardtop. These modifications include thicker body side member and sill steel, additional reinforcement to the side members and the front of the transmission tunnel, plates installed between the engine mountings and the front bulkhead and also across the width of the car in the rear, a steel exhaust heat shield, stiffer front seat cross members, and a reinforced bulkhead between the passenger compartment and the trunk.

The joints of the top frame do not require lubrication. The only parts that should be lubricated are the guides in the frame assembly near the mounting bolts. If the top is difficult to raise from its stored position, then it is most likely that the gas struts need replacement. The rear window is not available as a separate part. Light scratches in the window or cloudy or smeared areas may be corrected by heating the area to a maximum of 90°C (195°F) with a hot air blower.

Adjustments can be made to the convertible top and to the windows in order to ensure proper weather sealing. In general, if the top is difficult to open or close, or if drafts, water leaks, or fluttering noises come from around the top's front header, the top frame needs to be adjusted. If there are rattles or air leaks around the windows, then either the frame or the windows must be adjusted. Make all adjustments with the car on level ground.

8.1 Frame Adjustments

Frame adjustment should be checked whenever the top is replaced, if there are air or water leaks at the front edge of the top, or if there are air or water leaks where the top contacts the body at the rear. The frame can be adjusted fore-and-aft and side-to-side.

To adjust vertical fit of top against body:

1. Remove the entire top assembly by lowering it and then removing the mounting bolts and nuts. See Fig. 8-1. Lift the top and its frame out of the car.

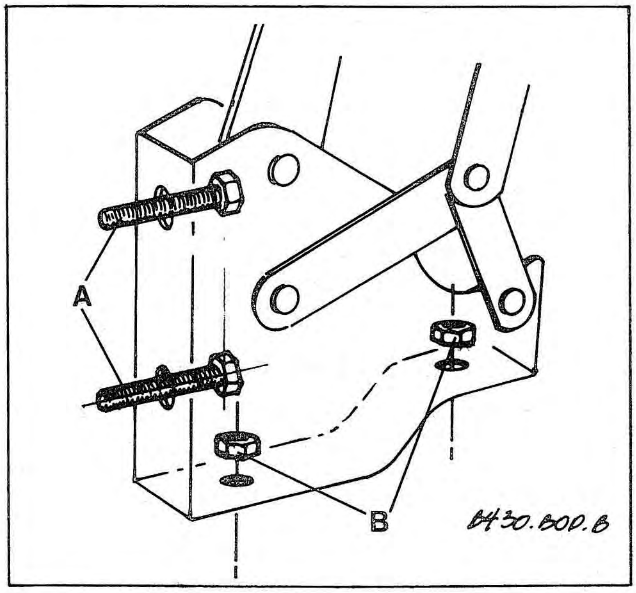

Fig. 8-1. Left-side convertible top mounting bolt (**A**) and mounting nuts (**B**). Remove nuts and bolts from both sides of frame.

2. Measure the distance from the frame mounting studs on the body floorpan to the top edge of the rear quarter panel. To do this, peel up part of the weatherstripping on either side, then lay a straightedge across the width of the car. Measure from the bottom edge of the straightedge down to the base of the frame mounting studs. See Fig. 8-2. Measure both sides.

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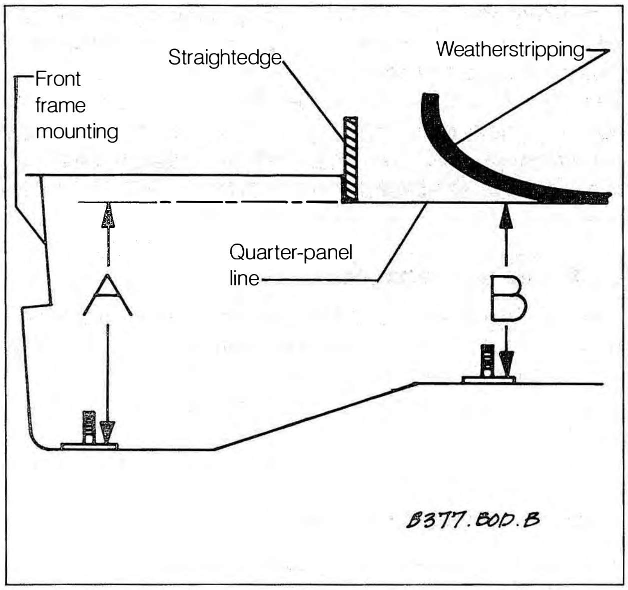

Fig. 8-2. Checking vertical adjustment of convertible frame. Distance from bottom edge of straightedge to stud **A** should be 181 mm (7.13 in.). Distance from stud **B** to bottom edge of straightedge should be 159 mm (6.26 in.).

3. If the measurement is incorrect, shims are placed on the studs until the correct distance is achieved. The shims are available in 1 mm (.04 in.) thickness, BMW Part No. 54 31 1 932 744.

4. Reinstall the convertible top and frame and install the mounting nuts and bolts

To adjust top fit against windshield frame:

1. Remove the top frame mounting bolts and loosen but do note remove the mounting nuts. See Fig. 8-1 above.

2. With the top lowered, check that the frame is centered in the body in relation to the quarter panels.

3. Loosely install the mounting bolts, then raise the top and latch the latches.

4. Take up any space between the convertible frame and the front frame mounting by inserting shims over the bolts, between the frame and the mounting. See Fig. 8-3. The shims are available in 1 mm (.04) thickness, BMW Part No. 54 31 1 932 743.

NOTE —

Part numbers are for reference only. Always check with an authorized BMW parts distributor for the latest parts availability information.

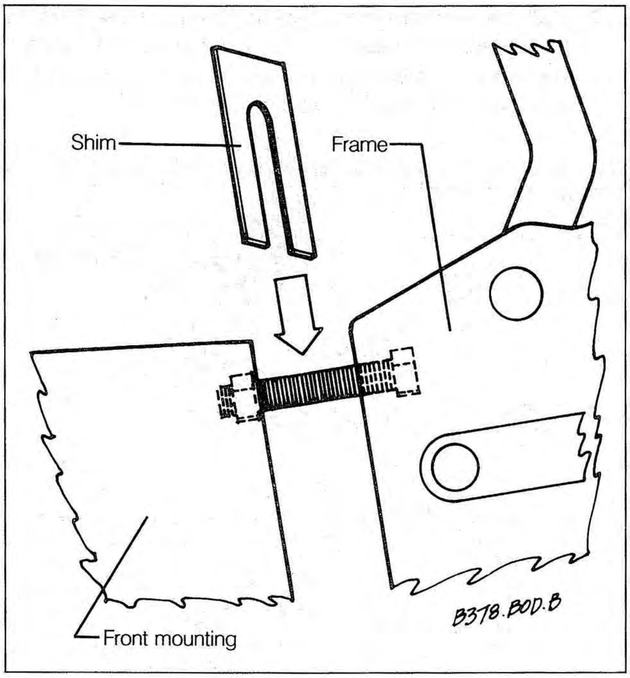

Fig. 8-3. Adjusting front-to-back position of convertible top frame with top raised and latched. Insert only as many shims as necessary to take up space between frame and front mounting.

5. Tighten all mounting nuts and bolts and then raise and lower the top a few times to check operation.

8.2 Window Adjustments

Two adjustments are made to the front and rear side windows to ensure a weather tight fit and smooth operation. The adjustments include the window fit against the convertible top seal, and the parallel fit of the window in its frame. The correct fit of the windows against the convertible top seal is shown in Fig. 8-4.

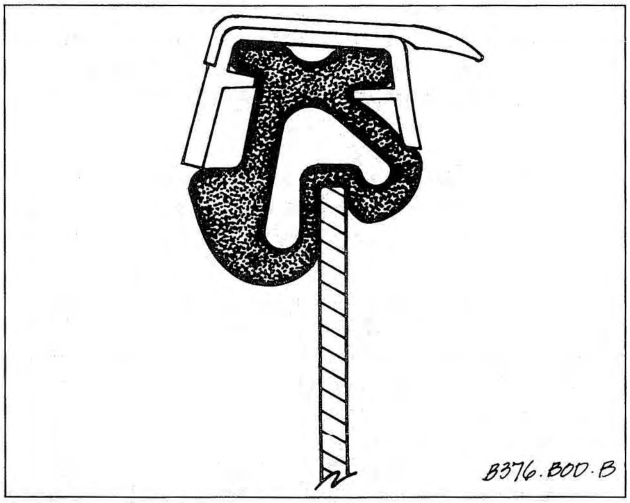

Fig. 8-4. Correct fit of convertible windows against window seals.

Make sure the convertible top is adjusted correctly as described in **8.1 Frame Adjustments** before making any window adjustments. Front window adjustments are made with the door trim panel removed as described in **5.1 Door Assembly**. Also make sure the door is adjusted correctly. Rear window adjustments are made with the rear seat and side trim panel removed as described in **4.7 Rear Seats**.

To adjust the parallel fit of a front windows, lower the window half way and then loosen the two screws shown in Fig. 8-5. While pressing the window against the front window guide rail, shut the window. Tighten the two screws when finished and check window operation.

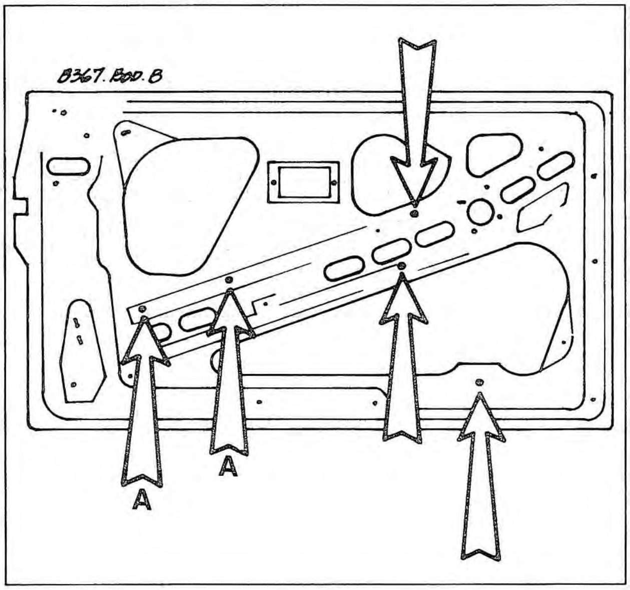

Fig. 8-5. Screws to be loosened (A) to make parallel fit of window glass. Other arrows do not apply to this procedure.

The vertical fit of the window glass against the top seal is adjusted with a screw on the power window regulator frame. See Fig. 8-6. The screw limits the vertical travel of the regulator. To adjust, lower the window slightly and turn the screw, then recheck the window fit.

Rear window parallel fit against the front window, and vertical fit against the top seal are adjusted with the screws shown in Fig. 8-7.

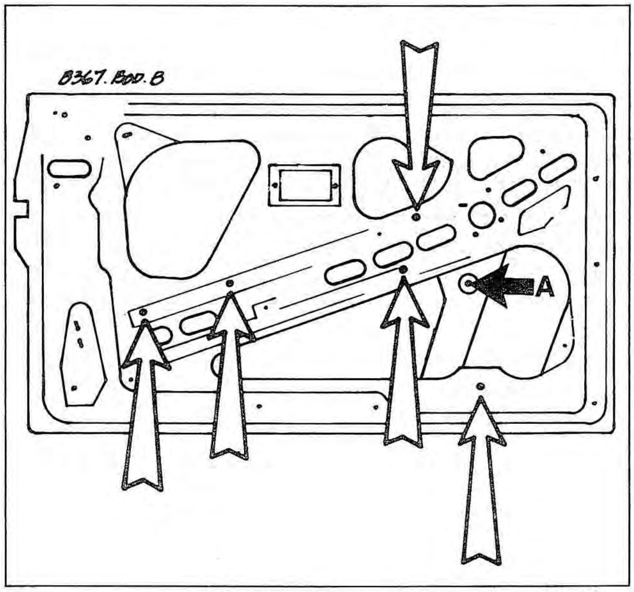

Fig. 8-6. Window stop adjustment point (A). Other arrows do not apply to this procedure.

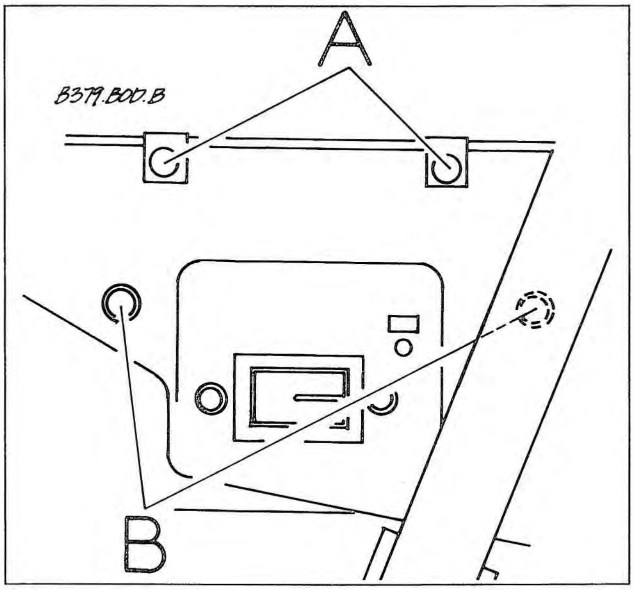

Fig. 8-7. Convertible rear window adjustment screws for parallel fit (A) and vertical fit (B).

9. AIR CONDITIONING

Air conditioning (A/C) service and repair requires special equipment and knowledge. Incorrect procedures not only may damage the system, but also may be hazardous. Pressures in excess of 300 psi are created in the system when it is operating. The refrigerant used (R-12) is not poisonous, but in its vapor form it can accumulate in areas with poor ventilation and cause suffocation. Also, in vapor or liquid form R-12 can immediately freeze anything it contacts, including eyes and skin.

Although tests can determine A/C efficiency, it is recommended that all service to the system be left to an authorized BMW dealer or other qualified repair shop. For information on the interior A/C control switch assembly, see **4.4 Heater and Controls**. Dismounting of the A/C compressor and the condenser, without disconnecting the hoses, is covered as part of the engine removal procedure in **ENGINE**. If any of the hoses or components are disconnected and the system is opened, special equipment will be needed remove moisture from the system before it can be closed back up.

9.1 System Description

Fig. 9-1 is a schematic view of a typical BMW A/C system. The air conditioning system removes heat and moisture from the passenger compartment. It accomplishes this through the application of four principles: materials absorb heat as they change from a liquid to a gas (evaporate); materials give off heat as they change from a gas to a liquid (condense); the boiling point of a liquid varies with its pressure; and, heat always flows from hot to cold. For example, the first principle is demonstrated by wetting your hand and then blowing on it. As the water evaporates, it takes some heat with it and your hand feels cooler.

In the air conditioning system, the heat from the passenger compartment boils (evaporates) the refrigerant (R-12) in the evaporator, causing heat to be absorbed by the R-12. This heat is then released into the atmosphere when the R-12 is cooled and condensed into a liquid at the condenser. Moisture is removed at the evaporator in the same way that water drops form on a cold glass. The moisture drips onto the water tray beneath the evaporator in the heater box and is routed outside. This is the reason a water puddle may often be seen under the car when the A/C is operating.

The compressor forces the R-12 through the system and at the same time pressurizes it, raising the R-12's boiling point to make it more easily condensed. The compressor is engaged by an electro-magnetic clutch that is actuated when the A/C is turned on. The thermostat switch automatically disengages the clutch when the temperature in the passenger compartment reaches the level set on the operating controls.

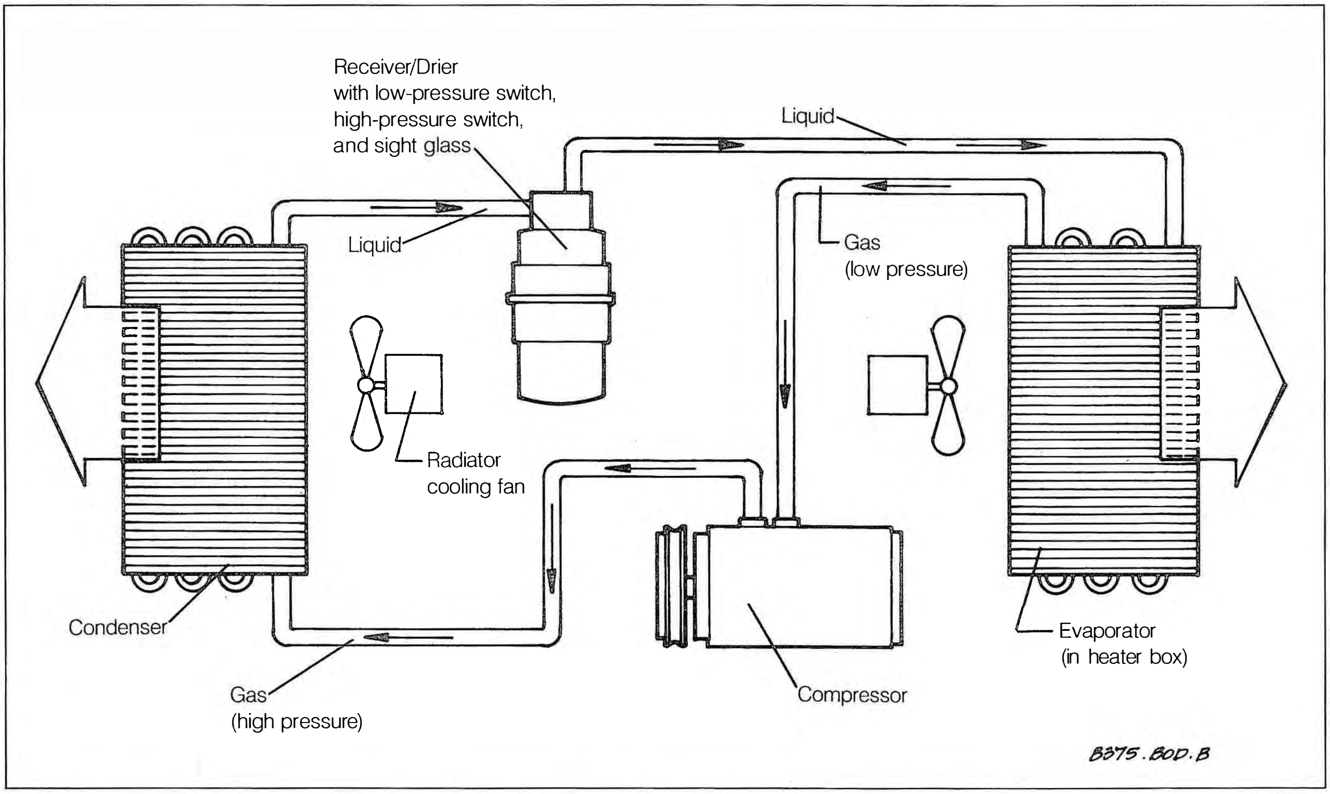

Fig. 9-1. View of typical BMW air conditioning system.

The condenser, which looks like a small radiator, is located in front of the engine radiator. The receiver/drier removes small amounts of moisture and dirt from the system. The freeze protection switch on the evaporator interrupts power to the compressor clutch if the temperature in the system is too cold.

Safety Features

To prevent system freeze-up, the fresh air blower comes on at low speed whenever the A/C is turned on. A low-pressure switch prevents engagement of the compressor clutch if the R-12 charge is too low. A high-pressure switch interrupts power to the compressor clutch if the pressure in the system is excessive. Additional temperature switches on the radiator increase radiator fan speed in steps if the coolant temperature is excessive. Depending on the model, there may be two switches or one combined switch.

9.2 Inspections and Tests

Periodic inspections will help keep the A/C operating at its peak. There are almost always small leaks in the system that will require that it eventually be recharged with R-12. The V-belt that drives the compressor is subject to wear. The condenser fins can become bent or covered with debris, reducing air flow and raising system pressure to damaging levels.

With the engine off, clean any debris or bugs from the front of the condenser. Straighten any bent fins using a fin comb. Check the fresh air intake for obstructions. Inspect the compressor, the hoses, and all visible components for any oil leaks. These leaks are often seen at the bottom side of the fittings and components. Inspect the wiring to the pressure switches and compressor clutch. Check the compressor mountings for tightness, and check the condition and tension of the V-belt as described in **LUBRICATION AND MAINTENANCE**.

WARNING —
Wear eye protection when inspecting the system. R-12 at normal atmospheric pressures can evaporate and freeze anything it contacts.

The following tests will aid in evaluating system performance.

Checking Refrigerant Charge

Inspect the refrigerant charge of R-12 by starting the engine and turning the air conditioner on to MAX A/C. With the compressor running (clutch cycled on) view the sight glass, located in the engine compartment just behind the passenger-side headlights. See Fig. 9-2. There should be few or no bubbles visible in the glass. A constant foaming indicates that the system charge is low. Streaks on the interior of the glass may indicate that the system is totally discharged.

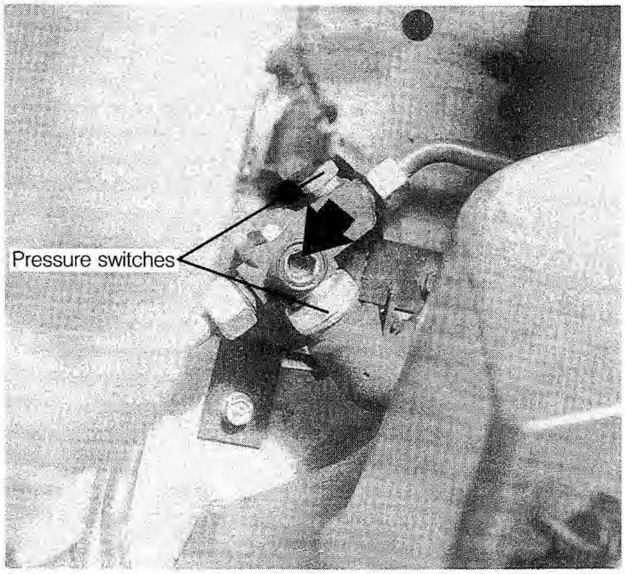

Fig. 9-2. Air conditioning sight glass (arrow) on receiver/drier.

If using an aftermarket refrigerant product to recharge the system, follow the manufacturer's directions closely. To prevent component damage, a totally discharged system must be evacuated (sometimes called pulling a vacuum) using special equipment before recharging. This removes any moisture from the lines and components, which can damage the system.

WARNING —
Adding refrigerant or servicing the system without the proper tools, equipment, or knowledge may cause severe personal injury as well as damage to the A/C components.

9.3 Air Conditioning Specifications

The specifications listed below in **Table b** are intended to be used by those experienced in air conditioning service.

Table b. Air Conditioning Specifications

Refrigerant capacity (R-12)	975 grams (2.1 lbs.)
Refrigerant oil capacity (total)	
Swash plate-type compressor	300 cc
Valve-type compressor	200 cc
Oil to add after replacement of:	
Drier	10 grams (.35 oz.)
Evaporator	40 grams (1.4 oz.)
Condenser	20 grams (.70 oz.)
Any pipe or hose	10 grams (.35 oz.)
High pressure switch	
Opens	25.5–27.5 bar (370–399 psi)
Closes	20–22.5 bar (290–326 psi)
Low pressure switch	
Opens	1.72–2.22 bar (25–32 psi)
Closes	2.0–2.4 bar (29–35 psi)
Temperature switches	
Low fan speed, closes	approx. 91°C (196°F)
High fan speed, closes	approx. 99°C (210°F)

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Section 15

ELECTRICAL SYSTEM

Contents

TABLES

Electrical System

Introduction

The electrical system is an efficient means for distributing power to the electrical components of the car. It does this with the help of the alternator, which converts some of the engine's mechanical energy into electrical energy. The electrical energy is then carried through wires to the various electrical components such as motors, light bulbs, or electronic control units. The battery in the system supplies electrical power when the engine is not running, and also supplies power to start the engine.

The electrical system is based on negative (–) ground. In other words, the negative terminal of the battery is connected to the car body, and any electrical connection to the body is a connection to ground. This greatly reduces the amount of wire used in the system. Voltage from the battery to the various electrical components is carried by the wiring harness. Most components are then grounded through either direct mounting to the car body or by a ground wire leading to the car body. It is very important for trouble-free operation of the electrical system that the ground connections, including the negative battery cable and the body ground straps, remain sound and free of corrosion.

The connecting terminals on components and wiring harness connectors can be either pins, or sockets into which pins fit. Most terminals are identified with a number stamped next to the pins on the components. On relays, the terminals are also identified by numbers on the relay. Throughout this section, sockets on the fuse/relay panel are identified by referring to the pin that fits into them. The terminal numbers and the location of all the major electrical connections can be found in the diagrams included in this section and in the BMW Electrical Troubleshooting Manual (ETM) for your specific vehicle. BMW ETMs are available through an authorized BMW dealer parts department.

All electrical circuits except those required for starting and operating the engine are protected by fuses. To prevent accidental shorts that might blow a fuse or damage wires and electrical components, the negative (–) battery cable should always be disconnected before working on the electrical system. On models equipped with anti-theft radios, the anti-theft circuitry is activated when power to the battery is removed, such as when the battery cables are removed. Be sure to have the anti-theft code on hand before removing the battery terminals or the radio fuse.

If you lack the skills or the equipment needed for testing and repairing the electrical system, we suggest you leave this work to an authorized BMW dealer or other qualified repair shop. We especially urge you to consult an authorized BMW dealer before beginning repairs on a car that may be subject to warranty coverage.

1. GENERAL DESCRIPTION

A brief description of the principal parts of the electrical system is presented here for familiarization with the system. The components are each discussed in greater detail later in this section.

Voltage and Polarity

The cars covered by this manual have a 12-volt, direct current (DC), negative-ground electrical system. The voltage regulator maintains the voltage in the system at approximately the 12-volt rating of the battery, and all circuits are grounded by direct or indirect connection to the negative (−) terminal of the battery.

Battery

On models with 4-cylinder engine and all convertibles, the battery is located in the engine compartment, near the firewall. On sedan models with 6-cylinder engine, the battery is located in the passenger's side of the luggage compartment.

The six-cell, 12-volt lead-acid battery capacity is determined by the amount of current needed to start the car, and by the amount of current consumed by the electrical system. BMW batteries are rated by ampere/hours (Ah) and cold cranking amps (CCA) rating. The Ah rating is determined by the average amount of current the battery can deliver over time without dropping below a specified voltage. The CCA is determined by the battery's ability to deliver starting current at 0°F (−18°C).

Starter

The starter and its attached solenoid are mounted to the left (driver's) side of the engine. To maximize the amount of current available to the starter, load-reduction relays interrupt the voltage to many of the electrical accessories when the ignition key is in the START position.

Charging System

The charging system consists of a belt-driven alternator and a voltage regulator. The voltage regulator, which is mounted on the alternator, also serves as the alternator brush holder. The alternator may be one of four capacities—65 amperes, 80 amperes, 90 amperes, or 95 amperes—depending on the type and number of electrical accessories fitted to the car.

Ignition System

The transistorized ignition system is covered in **IGNITION**. To avoid personal injury, as well as damage to the sensitive electronic components of the ignition system, review the cautions and warnings in that section before troubleshooting or repairing any ignition related part of the electrical system.

Wiring, Fuses, and Relays

Nearly all parts of the wiring harness connect to components of the electrical system with keyed, push-on connectors that lock into place. Notable exceptions are the heavy battery cables and the alternator wiring. The wiring is color-coded for circuit identification.

With the exception of the battery charging system, all electrical power is routed from the ignition switch or the battery through the fuse/relay panel, located in the left rear side of the engine compartment. Fuses prevent excessive current from damaging components and wiring. Fuses are color coded to indicate their different current capacities.

The relays are electromagnetic switches that operate on low current to switch a high-current circuit on and off. Most of the relays are mounted on the fuse/relay panel or the auxiliary relay panel. For information concerning relay and fuse locations, see **14. Fuse/Relay Panel**.

Lights

The lighting system includes the parking lights, the side marker lights, the turn signals, the back-up lights, the interior lighting, the headlights, and the driving or fog lights. The headlight dimmer switch is on the steering column. The headlight circuit contains separate relays for the high beams, the low beams, and the fog lights. High/low beam switching is handled at the contacts in the dimmer control switch. Information on changing bulbs and lenses can be found in **BODY AND INTERIOR**. Information on relay location can be found under **14. Fuse/Relay Panel.**

Heating and Ventilation

The heating and ventilation system includes either a three-speed or a four-speed fresh air blower controlled by a dashboard-mounted switch. The control levers for the air conditioning (A/C) system switch power to the A/C compressor, the fresh air blower, and the radiator cooling fan. Removal and installation of the heating and ventilation components is covered in **BODY AND INTERIOR**.

Windshield Wipers and Washers

The blades of the two-speed windshield wiper system with intermittent operation come to rest in the "park" position automatically when the wiper switch is turned off. The wiper switch includes a windshield washer control. A motor-driven pump supplies the washers with fluid.

Instruments

The dashboard instruments, including the speedometer, are all electrical. All differences in instrumentation among models are covered in the applicable BMW ETM wiring diagrams. Removal and installation of the instrument cluster is described in **BODY AND INTERIOR**.

2. MAINTENANCE

No routine lubrication of the alternator, the starter, or other motors is required. The following electrical system maintenance is described in **LUBRICATION AND MAINTENANCE**.

1. Checking the battery

3. TROUBLESHOOTING

This heading describes general procedures for electrical system circuit and component troubleshooting, and provides specific troubleshooting information for the battery, the starter, and the charging system. For information regarding the fuses and relays mounted in the fuse/relay panel, see **14. Fuse/ Relay Panel.** For information regarding splice, ground, harness connector, relay, and component locations see **13. Harness Connector, Ground, Splice and Component Locations.** Read the following cautions before testing any part of the electrical system.

CAUTION —

- *Connect or disconnect multiple connectors and test equipment leads only while the ignition is off. Switch multimeter functions or measurement ranges only with the test probes disconnected.*
- *Before operating the starter without starting the engine (as when making a compression test), disable the ignition. For more information see* **IGNITION**.
- *Do not connect terminal 1 of the coil to ground as a means of preventing the engine from starting (for example, when installing or servicing anti-theft devices).*

CAUTION —

- *Do not connect test instruments with a 12-volt current supply to terminal 15 (+) of the ignition coil. The voltage backflow will damage the ignition control unit. In general, make test connections only as specified by BMW, as described in this manual, or as described by the instrument's manufacturer.*
- *Do not disconnect the battery while the engine is running.*
- *Do not quick-charge the battery (for boost starting) for longer than one minute, and do not exceed 16.5 volts at the battery with the boosting cables attached. Wait at least one minute before boosting the battery a second time. On models equipped with on-board computers, remove the computer fuses (no. 10, no. 12, no. 21, no. 23, no. 27) prior to quick-charging to prevent damaging the computer.*
- *Do not wash the engine while it is running, or any time the ignition is switched on.*
- *Disconnect the battery when doing any electric welding on the vehicle or charging the battery.*
- *Do not use a test lamp that has a normal incandescent bulb to test circuits containing electronic components. The high electrical consumption of these test lamps may damage the components.*

3.1 Basic Electrical Troubleshooting Principles

Four things are required for current to flow in any electrical circuit: a voltage source, wires or connections to transport the voltage, a consumer or device that uses the electricity, and a connection to ground. Most problems can be found using only a multimeter (volt/ohm/amp meter) to check for voltage supply, for breaks in the wiring (infinite resistance/no continuity), or for a path to ground that completes the circuit.

Electric current is logical in its flow, always moving from the voltage source toward ground. Keeping this in mind, electrical faults can be located through a process of elimination. When troubleshooting a complex circuit, separate the circuit into smaller parts. The general tests outlined below may be helpful in finding electrical problems. The information is most helpful when used with the wiring diagrams found throughout this section and in the applicable BMW ETM.

Testing For Voltage and Ground

The most useful and fundamental electrical troubleshooting technique is checking for voltage and ground. A voltmeter or a simple test light should be used for this test. For example, if a parking light does not work, checking for the presence of voltage at the bulb socket will determine if the circuit is functioning correctly or if the bulb itself is faulty. If voltage and ground are found at the bulb connector, but the bulb does not illuminate, the bulb is most likely faulty.

NOTE —

Test leads with flat male connectors should be used to prevent damaging terminal connections. For basic information on using a multimeter or constructing test leads, see **FUNDAMENTALS** at the front of the manual.

To check for positive (+) battery voltage using a test light, connect the test light wire to a clean, unpainted metal part of the car or a known good ground. Use the pointed end of the light to probe the positive (+) wire. See Fig. 3-1. To check for continuity to ground, connect the test light wire to the positive (+) battery post or a battery source. Use the pointed end of the light to probe the wire leading to ground. In either case, the test light should light up.

NOTE —

- A test light only determines if voltage or ground is present—it does not determine how much voltage or how good the path to ground is. If the actual voltage reading is important, such as when testing a battery, use a digital voltmeter. To check the condition of the ground connection, check voltage drop on the suspected connection as described below.

- The pointed end of the test light can be used to pierce through the wire's insulation. This may help locate areas where wires are broken or connections are faulty.

To check for voltage using a voltmeter, the meter should be set to DCV and the correct scale. Connect the negative (−) test lead to the negative (−) battery terminal or known good ground. Touch the positive (+) test lead to the positive wire or connector. To check for ground, connect the positive (+) test lead to the positive (+) battery terminal or voltage source. Touch the negative (−) test lead to the wire leading to ground. In either case the meter should read battery voltage. See Fig. 3-2.

NOTE —

When using an analog (swing needle) voltmeter, be careful not to reverse the test leads. Reversing the polarity may damage the meter.

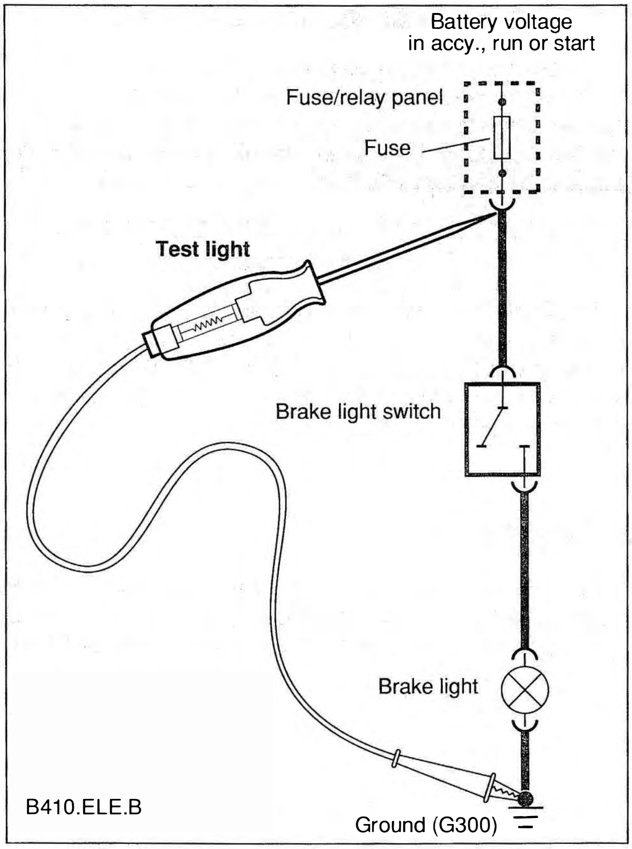


Fig. 3-1. Test light being used to check for voltage. A test light is the best tool to quickly check for voltage or ground.

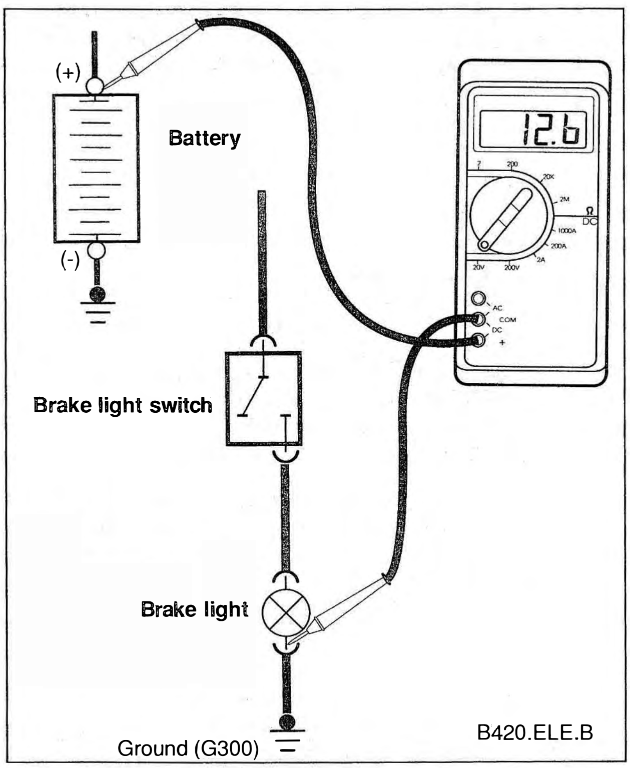


Fig. 3-2. Voltmeter being used to check for ground.

Continuity Test

The continuity test can be used to check the integrity of a circuit or a switch. Because most automotive circuits are designed to have little or no resistance, a circuit or part of a circuit can be easily checked for faults using an ohmmeter or a self-powered test light. An open circuit or a circuit with high resistance will not allow current to flow. A circuit with little or no resistance allows current to flow easily.

When checking continuity, the ignition should be off. On circuits that are hot at all times, the battery should be disconnected. Fig. 3-3 shows a brake light switch being tested for continuity using an ohmmeter. Using the appropriate wiring diagram, a circuit can be easily tested for faulty connections, wires, switches, relays, and engine sensors by checking for continuity.

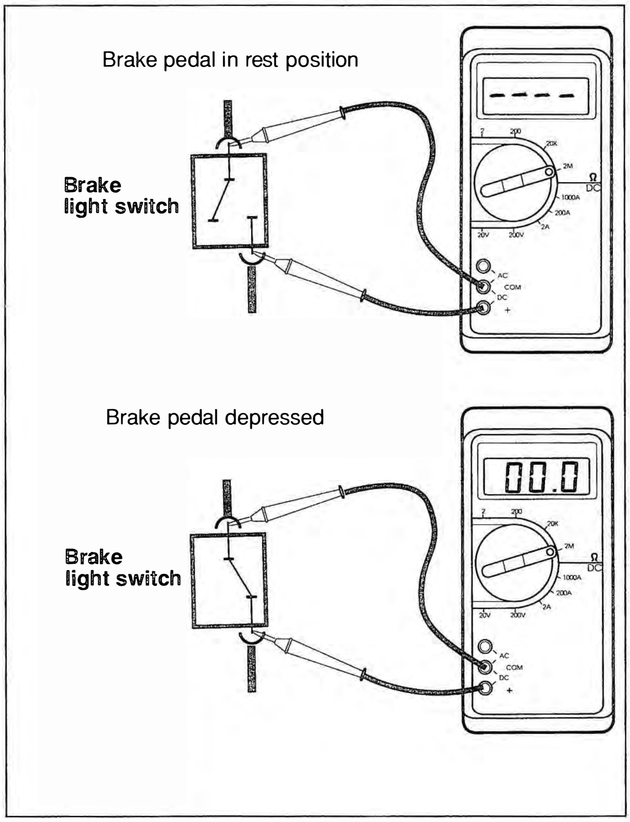


Fig. 3-3. Brake light switch being tested for continuity. With brake pedal in rest position (switch open) there is no continuity (infinite ohms). With the pedal depressed (switch closed) there is continuity (zero ohms)

CAUTION —

Do not use an analog (swing-needle) ohmmeter to check circuit resistance or continuity on any electronic (solid-state) components. The internal power source used in most analog meters can damage solid state components. Use only a high quality digital ohmmeter having high input impedance when checking any electronic component.

Short Circuit Test

A short circuit is exactly what the name implies. The circuit takes a shorter path than it was designed to take. The most common short that causes problems is a short to ground where the insulation on a positive (+) wire wears away and the metal wire is exposed. When the wire rubs against a metal part of the car or other ground source, the circuit is shorted to ground. If the exposed wire is live (positive battery voltage), a fuse will blow and the circuit may possibly be damaged.

CAUTION —

On circuits protected with large fuses (25 amp and greater), the wires or circuit components may be damaged before the fuse blows. Always check for damage before replacing fuses of this rating.

Shorts to ground can be located with a voltmeter, a test light, or an ohmmeter. Short circuits are often difficult to locate and may vary in nature, Therefore, it is important that the correct wiring diagram is available. Short circuits can be found using a logical approach based on the current path.

CAUTION —

When replacing blown fuses, use only fuses having the correct rating. Always confirm the correct fuse rating printed on the fuse/relay panel cover. See ***14. Fuse/Relay Panel*** *at the end of this section.*

To check for a short circuit to ground, remove the blown fuse from the circuit and disconnect the cables from the battery. Disconnect the harness connector from the circuit's load or consumer. Using a self-powered test light or an ohmmeter, connect one test lead to the load side fuse terminal (terminal leading to the circuit) and the other test lead to ground. See Fig. 3-4.

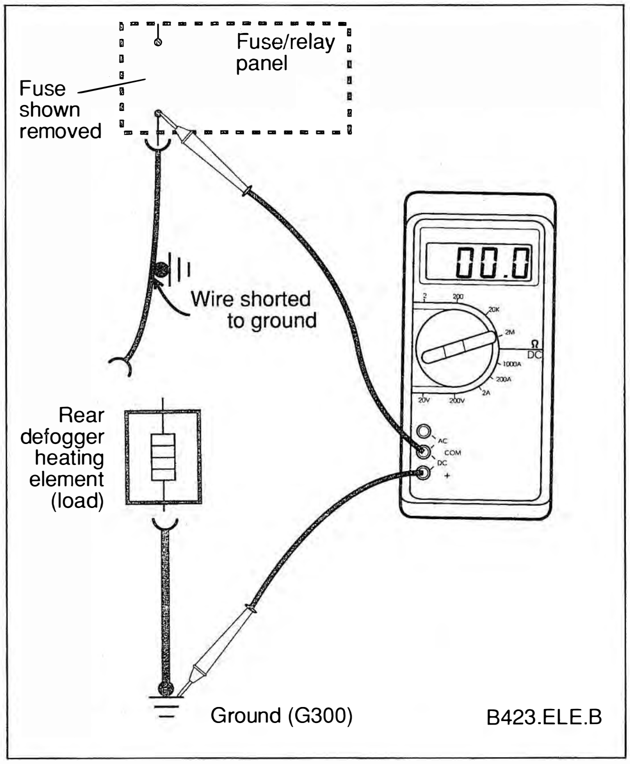


Fig. 3-4. Ohmmeter being used to check for a short circuit to ground.

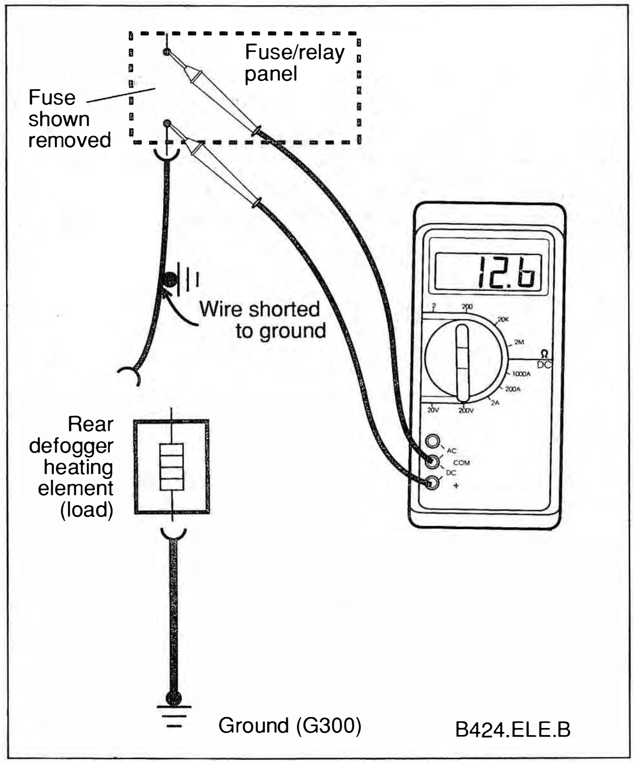


Fig. 3-5. Voltmeter being used to check for a short circuit to ground.

Short circuits can also be located using a test light or a voltmeter. Connect the instrument's test leads across the fuse terminals (fuse removed) and turn the circuit on. See Fig. 3-5. If necessary, check the wiring diagram to determine when the circuit is live.

Working from the wire harness nearest to the fuse/relay panel, move or wiggle the wires while observing the test light or the meter. Continue to move down the harness until the test light blinks or the meter displays a reading. This is the location of the short. Visually inspect the wire harness at this point for any faults. If no faults are visible, carefully slice open the harness cover or the wire insulation for further inspection. Repair any faults found.

Voltage Drop Test

The wires, connectors, and switches that carry current are designed with very low resistance so that current flows with a minimum loss of voltage. A voltage drop is caused by higher than normal resistance in a circuit. This additional resistance actually decreases or stops the flow of current. A voltage drop can be noticed by problems ranging from dim headlights to sluggish wipers. Some common sources of voltage drops are faulty wires or switches, dirty or corroded connections or contacts, and loose or corroded ground wires and ground connections.

Voltage drop can only be checked when current is running through the circuit, such as by operating the starter motor or turning on the headlights. Making a voltage drop test requires measuring the voltage in the circuit and comparing it to what the voltage should be. Since these measurements are usually small, a digital voltmeter should be used to ensure accurate readings. If a voltage drop is suspected, turn the circuit on and measure the voltage at the circuit's load. See Fig. 3-6.

NOTE

- A voltage drop test is generally more accurate than a simple resistance check because the resistances involved are often too small to measure with most ohmmeters. For example, a resistance as small as .02 ohms would results in a 3 volt drop in a typical 150 amp starter circuit. (150 amps $\times$.02 ohms = 3 volts).

- Keep in mind that voltage with the key on and voltage with the engine running are not the same. With the ignition on and the engine off (battery voltage), voltage should be approximately 12.6 volts. With the engine running (charging voltage), voltage should be approximately 14.5 volts. Measure voltage at the battery with the ignition on and then with the engine running to get exact measurements.

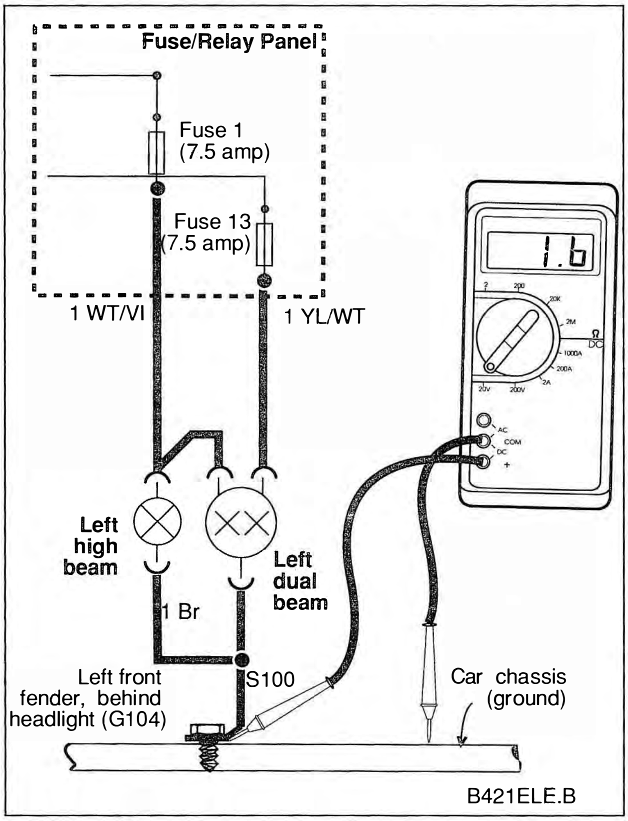


Fig. 3-6. Example of voltage drop test on dim headlights. Voltmeter showed 1.6 volt drop between ground connector and chassis ground. After removing and cleaning headlight ground connector (G104), voltage drop returned to normal (0.2 volts) and headlights were bright.

NOTE —

The maximum voltage drop in an automotive circuit, as recommended by the Society of Automotive Engineers (SAE), is as follows: 0 volt for small wire connections; 0.1 volt for high current connections; 0.2 volt for high current cables; and 0.3 volt for switch or solenoid contacts. On longer wires or cables, the drop may be slightly higher. In any case, a voltage drop of more than 1.0 volt usually indicates a problem.

To troubleshoot a circuit:

1. Check to see that all the connections in the circuit are tight and free of corrosion. Pay special attention to all ground connections.

2. Check the fuse. In the circuit example shown in Fig. 3-7 below, the circuit receives power through a 7.5 amp fuse in position 10 on the fuse/relay panel.

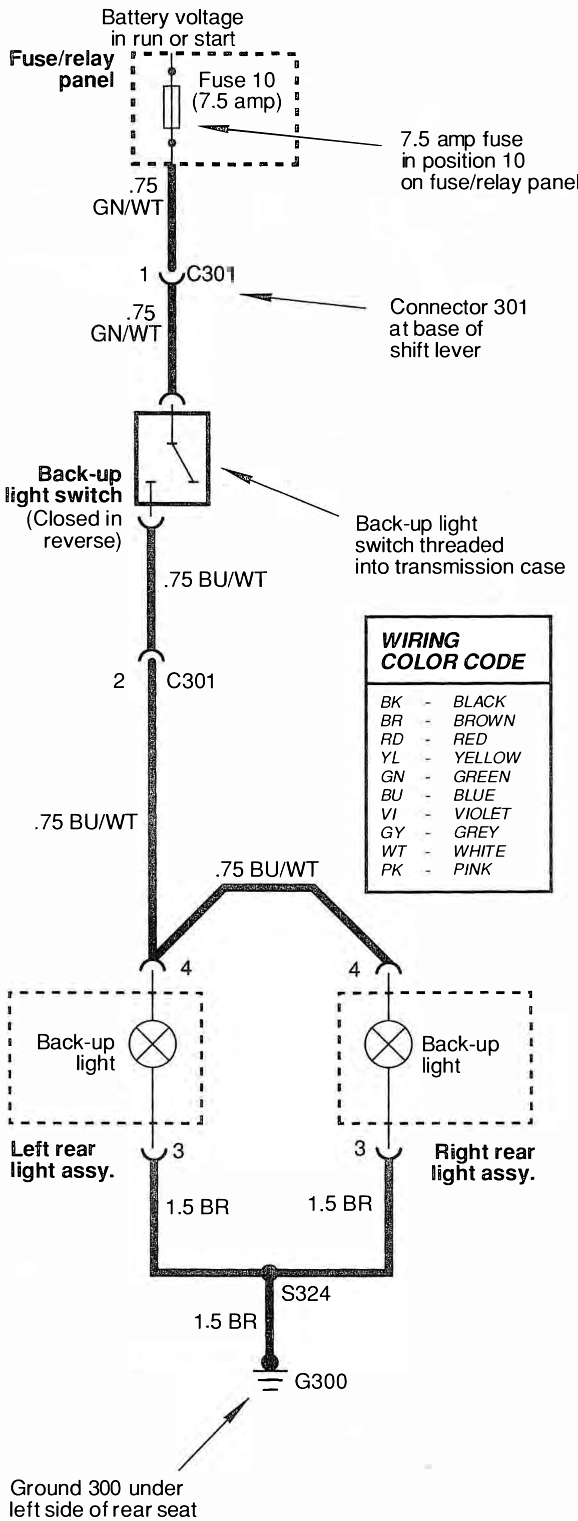


Fig. 3-7. Sample of BMW wiring diagram of back-up lights circuit for cars with manual transmission.

NOTE —

A fuse that repeatedly fails indicates an unusually high current flow, probably caused by a damaged wire, a faulty component, or a short directly to ground.

3. Check for voltage reaching the circuit. Connect a voltmeter or test light between a point in the circuit and ground (a clean, unpainted metal part of the car). In the example, the ignition must be switched on since fuse 10 only receives power when the ignition is on or the engine is running.

4. In the example, the blue/white wire (terminal 4) at the rear light assembly should be getting voltage when the ignition is on and the transmission is in reverse. Voltage indicated by the voltmeter (or by the test light coming on) means that the circuit is doing its job.

5. If there is no indication of voltage, something has interrupted the circuit between the power source and the test point. Pick a new test point farther "upstream" in the current path. In the example, the green/white wire at the back-up light switch would be a good point. If there is voltage at this point, then the fault lies somewhere between the two test points.

6. Check circuit integrity between two points using an ohmmeter. Continuity (little or no resistance) between two points indicates that part of the circuit is complete and is allowing current flow. No continuity (infinite resistance) indicates that part of the circuit is interrupted and would not allow current flow. In the example, operation of the back-up light switch could be checked by disconnecting the connectors from the switch and testing for continuity across its terminals. There should be continuity only when in reverse gear—otherwise the switch is faulty and should be replaced.

7. If the back-up lights work intermittently, check voltage drop at the switch with the transmission in reverse. Connect the digital voltmeter test leads to the rear of each connector at the switch. Turn the ignition on. A voltage reading of more than 1 volt indicates a faulty switch.

3.2 How To Use The Wiring Diagrams

The wiring diagrams presented in this section of the manual are organized to indicate current flow, from positive to negative. The diagrams are also organized to show the actual routing of the wires in the car's wiring harness.

As a general rule, the diagrams show current flow from positive (+) to negative (−). The fuse, or source of voltage, is normally shown at the top of the diagram and the circuit ground is normally at the bottom of the diagram.

Fig. 3-8 is an example of a wiring diagram in this section, showing the meanings of various symbols. These are general examples. They do not show all of the symbols used. For a complete listing of the symbols, see **Wiring Diagram Symbols** below.

Wiring Diagram Symbols

Fig. 3-9 is a full listing of the wiring and component symbols appearing in the diagrams. A complete list of ground, splice, connector, and component locations, can be found under **13. Harness Connector, Ground, Splice, and Component Locations.**

Terminal and Circuit Identification

Most terminals are identified by numbers on the components and harness connectors. The terminal numbers for the major electrical connections are shown in the circuit diagrams throughout this section and in the BMW ETM.

Though many terminal numbers appear only once to identify a particular terminal, several numbers appear in numerous places throughout the electrical system and identify certain types of circuits. A letter suffix is sometimes added to the number to distinguish between two different circuits, or between two parts of the same circuit. **Table a** lists several of the most common circuit numbers, and identifies the circuit type and the wire color normally used.

3.3 Battery, Starter and Charging System Troubleshooting

The causes of a dead battery or an inoperative starter are often interrelated and hard to pinpoint. **Table b** lists symptoms of trouble with the battery, starter, and charging system, their probable causes, and suggested corrective actions. The bold numbers in the corrective action column refer to the numbered headings in this section where the suggested repairs can be found.

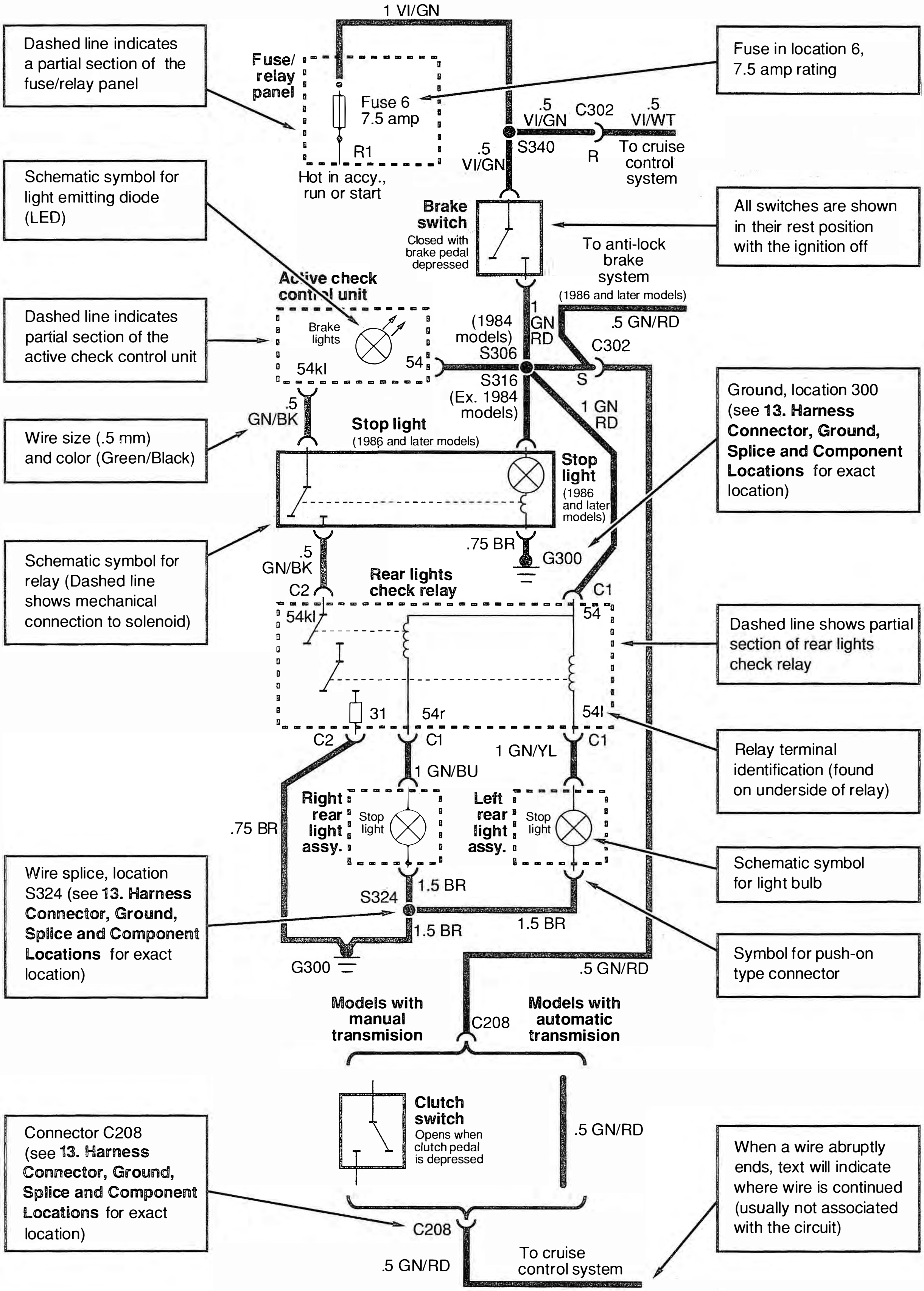
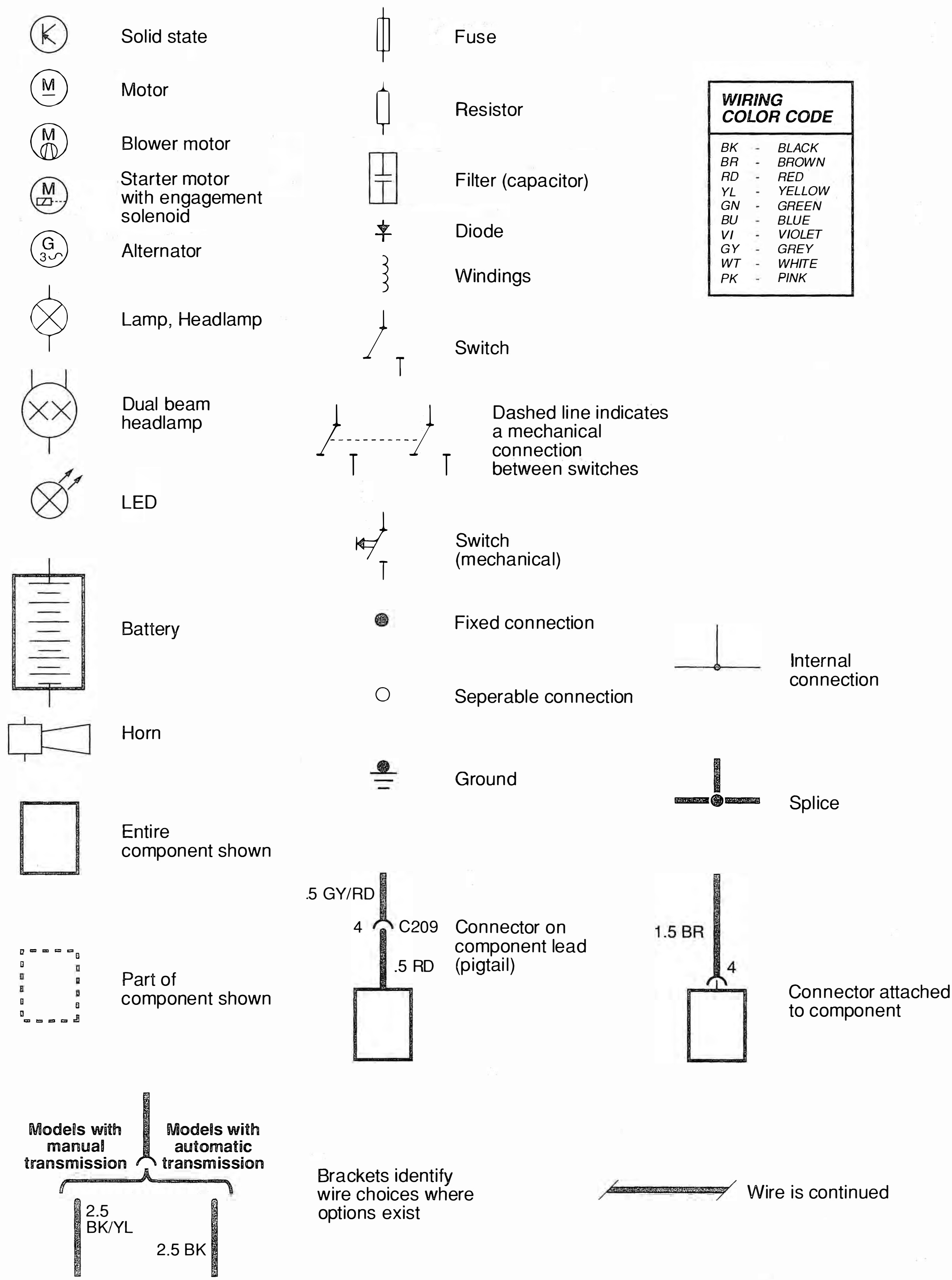


Fig. 3-8. Sample wiring diagram of stop light circuit on models with active check control.



WIRING COLOR CODE

BK	-	BLACK
BR	-	BROWN
RD	-	RED
YL	-	YELLOW
GN	-	GREEN
BU	-	BLUE
VI	-	VIOLET
GY	-	GREY
WT	-	WHITE
PK	-	PINK

Fig. 3-9. Wiring and component symbols in the wiring diagrams in this section of the manual.

Table a. Terminal and Circuit Numbers

Number	Circuit description	Most common wire color
1	Low voltage ground (−) terminal of coil	Black
4	High voltage center terminal of coil	—
15	Originates at ignition switch. Supplies power when ignition switch is in ON or START position	—
30	Battery positive (+) voltage. Supplies power whenever battery is connected. (Not dependent on ignition switch position)	Red
31	Ground battery negative (−)	Brown
50	Supplies power from battery to starter solenoid when ignition switch is in START position	Black/yellow

continued

Table a. Terminal and Circuit Numbers (continued)

Number	Circuit description	Most common wire color
D+	Alternator warning light and field energizing circuit	Blue
85	Ground side (−) of switching relay	Brown
86	Power-in side (+) of switching relay	—
87	Relay change-over contact	—

4. BATTERY

The battery does not actually store electricity—it stores energy chemically. The battery contains a number of negative and positive lead plates, along with a liquid solution of sulfuric acid and water called the electrolyte. When an electrical load is placed across the battery, the sulfuric acid combines with the lead in the plates to produce lead sulfate and water. A great number of electrons are released as electrical current flow by this chemical process. Charging the battery reverses the reaction—lead sulfate is released from the plates and sulfuric acid is formed.

Table b. Battery, Starter and Charging System Troubleshooting

Symptom	Probable cause	Corrective action
1. Engine cranks slowly or not at all, solenoid clicks when starter is operated	a. Battery cables loose, dirty, or corroded b. Battery discharged c. Body ground strap loose, dirty, or corroded d. Poor connection or no voltage at starter motor terminal 30 e. Starter motor or solenoid faulty	a. Clean or replace cables. See **LUBRICATION AND MAINTENANCE** b. Charge battery; test and replace if necessary. **4** c. Inspect ground strap; clean, tighten, and replace as necessary d. Check connection, test for voltage at starter. **6.** Test neutral/park/reverse light switch (auto. trans.). **10.1** e. Test starter. **6.1**
2. Battery will not stay charged (more than a few days)	a. Shorted circuit draining battery b. Alternator V-belt loose or damaged c. Battery faulty d. Battery cables loose, dirty, or corroded e. Alternator or voltage regulator faulty	a. Test for current drain. **5.2** b. Inspect alternator V-belt. **5.3** c. Test battery and replace if necessary. **4.1** d. Clean or replace cables. See **LUBRICATION AND MAINTENANCE** e. Test alternator and regulator. **5.2**
3. Battery losing water	a. Battery being overcharged	a. Test voltage regulator. **5.2**
4. Lights dim, light intensity varies with engine speed	a. Alternator V-belt loose or damaged b. Alternator or voltage regulator faulty c. Body ground straps loose, dirty, or corroded	a. Inspect alternator V-belt. **5.3** b. Test alternator and voltage regulator. **5.2** c. Inspect ground straps; clean, tighten, and replace as required

Charging the battery does not remove all of the sulfate from the plates. The battery will gradually become sulfated and will no longer hold a sufficient charge to start the car. Replacement of the battery is the only remedy. Temperature also affects the efficiency of the battery. The current-producing capacity of a battery at 5°F (– 15°C) is only half its capacity at 68°F (20°C), and partly-discharged batteries can freeze due to the higher proportion of water in the electrolyte. A frozen battery produces no current, but can usually be restored when thawed.

Low-maintenance batteries have been supplied as original equipment in the cars covered by this manual. These batteries have vented filler caps and may require distilled water to be added periodically to maintain the electrolyte level. Under normal operation the battery is maintenance-free, the electrolyte does not need to be periodically checked, and normal charging can be done without removing the caps.

For more information on checking the battery and on battery maintenance, see **LUBRICATION AND MAINTENANCE**. For information on starting with jumper cables, see **FUNDAMENTALS**.

WARNING —

- *Wear goggles, rubber gloves, and a rubber apron when working with battery electrolyte. Battery electrolyte contains sulfuric acid, and can cause severe burns and damage to clothing. If electrolyte is spilled on your skin or clothing, flush the area at once with large quantities of water. If electrolyte gets into your eyes, bathe them with large quantities of clean water for several minutes and call a physician.*

- *Batteries generate explosive gasses. Keep sparks and open flame away. Do not smoke.*

CAUTION —

Replace batteries with cracked or leaking cases. Leaking electrolyte can damage the car. If acid is spilled on the car, clean the area with a solution of baking soda and water.

4.1 Testing Battery

Before testing the battery check that the cables are tight and free of corrosion. On models with trunk-mounted battery, check that the wiring at the junction block is correctly routed, tight and free of corrosion and damage. Fig. 4-1 shows the correct routing of the battery wiring at the junction block.

Battery testing determines the state of battery charge. On conventional or low-maintenance batteries the most common method of testing the battery is that of checking the specific gravity of the electrolyte using a hydrometer.

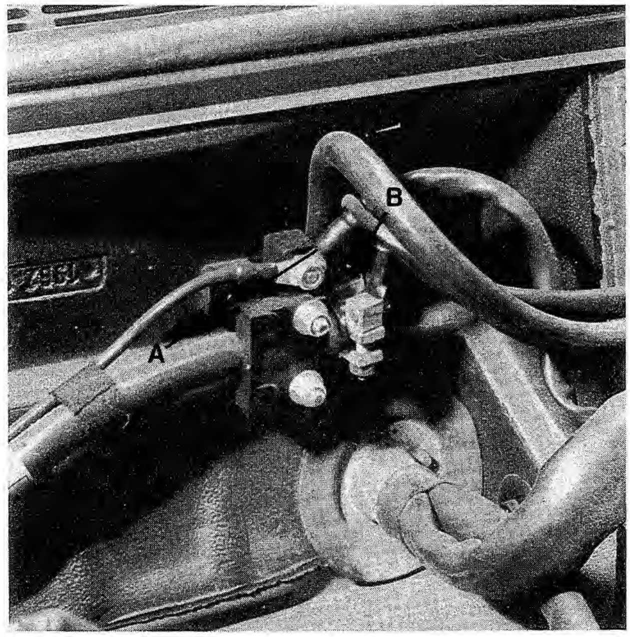


Fig. 4-1. Battery junction block in rear of engine compartment on models with battery in trunk.

NOTE —

On 325e models produced up to October 1985, the wire shown at **A** in Fig. 4-1 may be connected to the wrong post (**B**) on the junction block. This can result in a no start condition (no ignition spark) during low outside temperatures only.

Hydrometer Testing

The hydrometer consists of a glass cylinder with a freely moving float inside. When electrolyte is drawn into the cylinder, the level to which the float sinks indicates the specific gravity of the electrolyte. The more dense the concentration of sulfuric acid in the electrolyte, the less the float will sink, resulting in a higher reading (and state of charge).

Electrolyte temperature affects the reading, so a thermometer should be used to determine electrolyte temperature before making a hydrometer test. Add .004 to the hydrometer reading for every 10°F (6°C) that the electrolyte is above 80°F (27°C). Subtract .004 from the reading for every 10°F (6°C) that the electrolyte is below 80°F (27°C).

Before checking the specific gravity of a battery, load the battery with 15 amps for one minute. This can be done by turning on the headlights without the engine running if the battery is installed in the vehicle. **Table c** lists the percent of charge based on specific gravity values.

Table c. Specific Gravity of Electrolyte at 80°F (27°C)

Specific gravity	State of charge
1.265	Fully charged
1.225	75% charged
1.190	50% charged
1.155	25% charged
1.120	Fully discharged

The battery is in satisfactory condition if the average specific gravity of the six cells is at least 1.225. If the specific gravity is above this level, but the battery lacks power for starting, determine the battery's service condition with a load voltage test, as described below. If the average specific gravity of the six cells is below 1.225, recharge the battery. If, after recharging, the specific gravity varies by more than .050 between any two cells, replace the battery.

Open-Circuit Voltage Test

An open-circuit voltage test checks battery voltage by connecting an accurate digital voltmeter to the battery posts after disconnecting the battery ground cable. Before making an open-circuit voltage test on a battery, first load the battery with 15 amps for one minute. If the battery is installed in a car, this can be done by turning on the headlights without the engine running. Open-circuit voltage levels and their corresponding percentages of charge are in **Table d**.

Table d. Open-Circuit Voltage and Battery Charge

Open-circuit voltage	State of charge
12.6 V or more	Fully charged
12.4 V	75% charged
12.2 V	50% charged
12.0 V	25% charged
11.7 V or less	Fully discharged

The battery is in satisfactory condition if the open-circuit voltage is at least 12.4 volts. If the open-circuit voltage is at this level or above, but the battery lacks power for starting, make a load voltage test to determine the battery's service condition. If the open-circuit voltage is below 12.4 volts, recharge the battery. If the battery cannot be recharged to at least 75%, it should be replaced.

Load Voltage Testing

A load voltage battery test should be performed by an authorized BMW dealer or qualified repair facility if, after the tests described earlier, the battery appears to be in good condition but still can't provide enough current for starting.

4.2 Battery Charging

Discharged batteries can be recharged using a battery charger, but a battery can never be charged to a voltage in excess of that which it is capable of producing electrochemically. During charging, the battery's voltage builds to a peak called the terminal voltage. If charging is continued beyond the terminal voltage, the water in the electrolyte begins to decompose into hydrogen and oxygen. This condition, called gassing, will evaporate the electrolyte to a level that can damage the battery.

Thoroughly read the instructions provided by the battery charger's manufacturer and always follow the instructions carefully. Do not use a charger if the instructions are not available. **Table e** lists charging rates and times that should be followed when charging batteries.

WARNING —

The gasses given off by the battery during charging are explosive. Do not smoke. Keep open flames away from the top of the battery, and prevent electrical sparks by turning off the battery charger before connecting or disconnecting it.

CAUTION —

- *Always allow a frozen battery to thaw before attempting to recharge it.*
- *On models equipped with on-board computers, remove the computer fuses (no. 10, 12, 21, 23, and 27) prior to fast-charging to prevent damaging the on-board computer module.*

Table e. Battery Charging Specifications

Charging rate (low-maintenance batteries only)	Specific gravity	Approximate charging time
Fast charge (at 80% to 90% of battery's capacity, example: 44 to 50 amperes for a 55-ampere hour battery)	1.150 or less 1.150 to 1.175 1.175 to 1.200 1.200 to 1.225	1 hour 3/4 hour 1/2 hour 1/4 hour
Slow charge (at 10% of battery's capacity, example: 5.5 amperes for a 55-ampere hour battery)	Above 1.225	Slow charge only, to a specific gravity of 1.250 to 1.265

5. CHARGING SYSTEM

The charging system provides the current necessary to keep the battery charged. The system includes an alternator driven from the engine crankshaft by a V-belt to generate the charging current, and a voltage regulator to control the rate at which the battery is charged.

The charging capacity of the alternator installed on each car depends on the type and number of electrical accessories. The alternator rating can be found on its housing. The voltage regulator is mounted on the back of the alternator housing. Voltage regulators and alternators are available as replacement parts from an authorized BMW dealer. BMW remanufactured alternators are also available as an alternative to new ones.

To prevent damage to the alternator or regulator when making tests or repairs, make all connections with negative (−) to negative, and positive (+) to positive unless directed otherwise. Even momentary contact with a conductor of the wrong polarity can cause damage to the alternator's diodes. Make certain that the battery ground strap is connected to the battery's negative (−) terminal and that the cable to terminal 30 on the starter is connected to the battery's positive (+) terminal.

CAUTION —

Never operate the engine with the battery disconnected. Never operate the alternator with its output terminal (B+ or 30) disconnected and the other terminals connected. Never short, bridge, or ground any terminals of the charging system except as specifically described in **5.1 Charging System Troubleshooting**.

5.1 Charging System Troubleshooting

Charging system trouble is indicated by an illuminated alternator warning light on the instrument panel, or by an under- or overcharged battery.

The alternator generates electrical current by electrical induction. That is, a magnetic field is placed in motion to induce a current in a stationary coil. When the engine is running and the alternator is spinning, part of the current it produces energizes its electromagnetic field. When starting, some other current must be provided to initially energize the field and begin the current generating process. This current is provided by the battery through the alternator warning light in the instrument cluster.

NOTE —

On models built up to late 1986, a burned out alternator warning light will prevent the alternator from charging. On late 1986 and later models, a resistor is wired in parallel with the alternator warning light. This will allow current to reach the alternator during starting when the warning light is burned out. See Fig. 5-1.

As soon as the alternator's output equals the battery's voltage, the light goes out. Normally, the warning light should be off when the ignition is off and the engine is stopped. The light should only come on when the ignition is turned on (current to the rotor) and go out again when the engine is started and the battery is being charged.

Table f describes symptoms of trouble indicated by the warning light, lists tests and probable causes for the problem, and suggests corrective actions. The bold numbers in the corrective action column refer to the numbered headings in this section where the suggested repairs can be found. Fig. 5-1 is a simplified wiring schematic of the charging system that can be used as a guide during troubleshooting.

WARNING —

Disconnect the battery negative (−) cable before disconnecting any wires from the rear of the alternator. Battery voltage is wired directly to the alternator without fuse protection. Reconnect the battery cable after all wires have been safely disconnected.

An undercharged battery is usually associated with starting trouble. Again, make sure that the battery is in good condition and capable of accepting a full charge before blaming the charging system. Causes of an undercharged battery are: the simultaneous use of many electrical accessories for long periods of time, leaving accessories or lights in operation with the engine stopped, frequent long periods of starter usage, and frequent short-trip driving.

Broken or frayed charging system wiring or corroded connections at the D+ and B+ terminals of the alternator, as well as worn, corroded, or loose battery cable connections will also prevent adequate charging or increase charging time.

5.2 In-Car Testing of Charging System

The tests described here will help determine the cause of charging system trouble. The battery should be fully charged and the alternator V-belt correctly tensioned. If in doubt about either, test the battery as described in **4.1 Testing Battery**, and adjust the V-belt as described in **5.3 Removing and Installing Alternator and Voltage Regulator**. The charging system warning light should be operating correctly. All electrical connections should be clean and tight. Replace wires that are hard or cracked.

Table f. Warning Light Troubleshooting

Symptom	Test and probable cause	Corrective action
1. Ignition off, engine not running, warning light glowing or on	**(TEST)** Disconnect blue wire (D+) from alternator. **a.** Light goes out: Faulty alternator diodes **b.** Light does not go out: Short to ground in wiring harness or wiring connector	 **a.** Repair or replace alternator. **5.3** **b.** Repair or replace faulty wiring
2. Ignition on, engine not running, warning light off	**a.** Battery fully discharged. **b.** Bulb burned out **(TEST)** Disconnect blue wire (D+) from alternator. With battery connected and ignition on, touch blue wire to ground **c.** Light does not come on: Faulty bulb socket, open circuit between socket and terminal 15 of ignition switch, or open circuit between blue wire (D+) on alternator and instrument cluster. **d.** Light comes on: Loose connection between regulator and alternator or loose connection between brushes and regulator **e.** Light comes on, no faults with regulator: Internal alternator faults or faulty regulator	**a.** Charge battery. **4.2** **b.** Remove and test bulb. Replace faulty bulb. **7.1** **c.** Replace printed circuit board. Repair wires or connections **d.** Inspect brushes. Correct loose connections. **5.3** **e.** Repair or replace alternator or voltage regulator. **5.3**
3. Engine running at any speed, warning light stays on	**a.** Loose or broken alternator V-belt **(TEST)** Disconnect red wire (B+) from alternator. Using a voltmeter, test between red wire and ground with battery terminal connected **b.** No voltage to alternator: open circuit between red wire on alternator and starter or between starter and battery positive (+) pole **c.** Exciter diodes burned out **d.** Faulty regulator or faulty alternator windings **e.** High voltage drop between red alternator positive (+) wire and starter due to broken, loose, or corroded wires	**a.** Replace or adjust V-belt. See **LUBRICATION AND MAINTENANCE** **b.** Repair wire or connections between alternator and starter **c.** Repair or replace alternator. **5.3** **d.** Test charging system and replace faulty components as needed. **5.2** **e.** Repair wires or connections

A general test of charging system output can be made with an accurate digital voltmeter. The most accurate testing is done using an alternator and regulator tester that applies a high-current load to the alternator. Conclusive tests using this equipment can be made inexpensively by an authorized BMW dealer or other qualified shop.

CAUTION

An alternator must never be run with the battery disconnected. This will severely damage the alternator, the voltage regulator, or electronic components. The alternator wiring should be secure.

Testing Alternator and Regulator

Start the engine and run it at about 1500 rpm with all electrical accessories turned off. Set the voltmeter to the DCV scale and measure the voltage between the positive and negative terminals of the battery. Make sure that the tester is connected to clean areas of the terminals. A reading between 13.5 to 14.2 volts indicates a correctly operating system. A reading much higher than 14.2 volts most likely indicates a faulty voltage regulator.

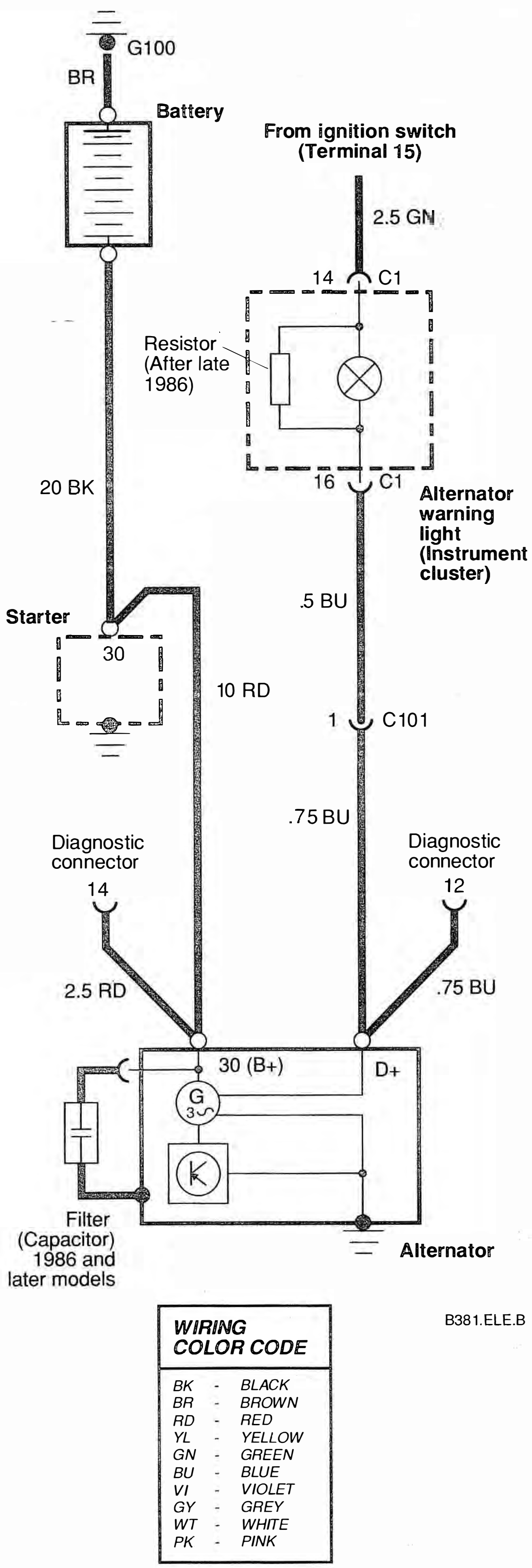


Fig. 5-1. Simplified charging system circuit.

A reading below 13.5 volts means that the battery is not being adequately charged. This may be due to either a faulty regulator or alternator. To determine which, keep the car running at about 1500 rpm and turn on all electrical accessories, then check voltage across the battery. A reading that is the same as the first most likely indicates a faulty regulator. A reading that is lower most likely indicates a faulty alternator.

Testing Current Drain

If tests show that the alternator and regulator are operating correctly, but the battery still continually runs down, there may be a short in the electrical system causing a continuous current drain.

To test for current drain, turn off the ignition switch, the radio, and all lights. Turn on the switches for the blower motor, the air conditioning, and the heated seats. This will determine if the load reduction relays are faulty. Disconnect the negative (–) cable from the battery and connect a test light between the cable and the negative post.

If the test light comes on, some electrical accessory or a short in the electrical system is draining current from the battery. Isolate the faulty circuit by removing and replacing the fuses one at a time. When the test light goes out, the circuit with the short is located. If no fault is found in this way, a fault may exist in the components without fuses, such as the alternator, the starter motor, and the instrument cluster. Disconnect the items one at a time until the test light goes out.

Low level current drain may not be detectable with a test light. If the light does not come on, but a current drain is still suspected, repeat the test using an ammeter set to the 0 to 200 mA range.

Noisy Alternator

Alternator noises are usually mechanical in origin, but a high, soft whistling sound may be produced by an alternator that is overcharging because of a faulty regulator diode. The same sound may be heard if there is a shorted diode placing an abnormal electrical strain on the alternator. Some alternators make this sound when operating normally at maximum output.

Alternator mechanical noises are usually the result of misalignment between the V-belt and the pulley, a loose or broken pulley, worn bearings, or a bent rotor shaft. Check for bad bearings by removing the V-belt as described below and rotating the alternator pulley by hand. If the shaft grinds or grates, the alternator should be replaced.

5.3 Removing and Installing Alternator and Voltage Regulator

The alternator is connected to battery current even when the ignition is turned off. To prevent shorts and electrical damage, always disconnect the battery negative (−) cable before removing the alternator.

To remove:

1. Disconnect the negative (−) battery cable from the battery.

2. Remove the two mounting nuts for the wiring and remove the wiring from the back of the alternator. On models with 4-cylinder engine, remove the ground wire mounting bolt and the ground wire. See Fig. 5-2.

3. Loosen the upper and lower alternator mounting bolts. Loosen the nut that holds the alternator belt adjusting bracket to the front of the engine.

4. Push the alternator as far as possible toward the engine, then take the V-belt off the alternator pulley.

5. Remove the lower alternator mounting bolt, then remove the upper alternator mounting bolt and remove the alternator from the engine.

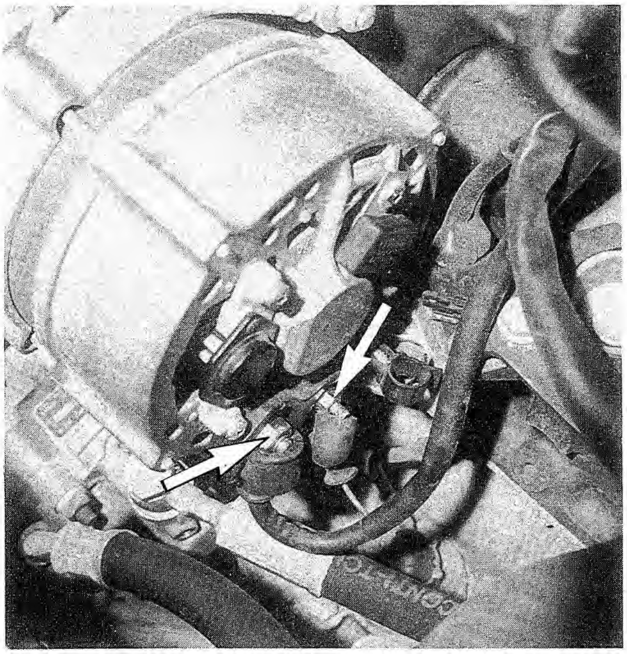


Fig. 5-2. Alternator wiring mounting nuts and wiring on models with 6-cylinder engine (arrows). Models with 4-cylinder engine have additional ground wire.

Installation is the reverse of removal. Torque the larger nut on the B+ terminal (red wire) to 7.5 to 8.0 Nm (66 to 71 in. lb.), and torque the smaller nut on the D+ terminal (blue wire) to 1.6 to 2.3 Nm (14 to 20 in. lb.). Use a torque wrench and a crowfoot wrench to tension the V-belt. Turn the tensioning gear bolt counterclockwise until the torque wrench reads 7 Nm (62 in. lb.). Hold the wrench steady and tighten the nut on the rear of the alternator to 35 Nm (26 ft. lb.). Tighten all other mounting nuts and reconnect the ground wire if applicable.

Brushes and Voltage Regulator

The brushes contact the alternator's slip rings to supply the current that magnetizes the alternator rotor. The voltage regulator maintains a nominal voltage in the electrical system by feeding excess output from the alternator back to ground. In addition, it regulates the amount of current supplied to the alternator rotor, turning it on and off as needed. If either component is faulty, the result will be an over- or undercharged battery. The brushes wear under normal use, and will eventually need to be replaced.

The brushes and regulator are mounted on the rear of the alternator. The brushes and regulator can be replaced with the alternator installed provided the negative (−) battery cable is removed from the battery. The regulator and brush holder is removed by removing two screws. Check the brush length as shown in Fig. 5-3.

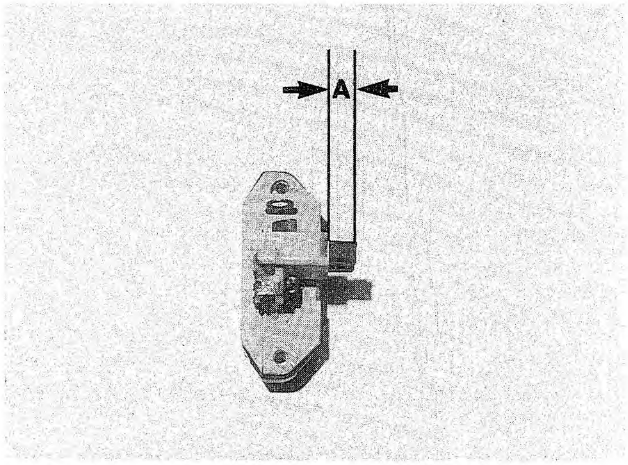


Fig. 5-3. Alternator brush length being checked. Length **A** of new brushes is 12 mm (15/32 in.). Replace brushes worn to 5 mm (7/32 in.) or less.

6. STARTING SYSTEM

When the ignition key is in the START position, a solenoid switch engages the starter's drive pinion with the ring gear on the engine flywheel or drive plate. To minimize wear and stress on the drive pinion and ring gear, the solenoid does not switch current to the starter until the drive pinion is fully engaged. Also, the drive pinion has an overrunning clutch to prevent the starter from being driven by the engine.

Two versions of starters are installed on the cars covered by this manual: a 1.1 kw starter and a 1.4 kw starter. These starters are not interchangeable among the different applications. When replacing the starter, make sure that the replacement part is correct for the application.

6.1 Starting System Troubleshooting

The battery and its cables should be in good condition when troubleshooting the starter. If in doubt about the battery, see **4. Battery**. If the outside temperature is at or below 32°F (0°C), check the viscosity of the engine oil, as described in **LUBRICATION AND MAINTENANCE.** The use of an oil of improper viscosity for cold conditions can increase engine friction and lead to starting difficulties.

Troubleshooting information for the starting system appears in **Table g**. The bold numbers in the corrective action column refer to headings in this section where the repair procedures are described. Fig. 6-1 is a wiring schematic of the starting system that can be used as a guide when troubleshooting.

Table g. Starting System Troubleshooting

Symptom	Probable cause	Corrective action
1. Starter does not operate when ignition switch is turned to START	a. Ignition switch or wire leading from ignition switch to solenoid faulty (less than 8 volts to solenoid switch)	a. Test for voltage at terminal 50 of solenoid switch with ignition switch at START. If not at least 8 volts, test for voltage at terminal 50 of ignition switch with switch at START. Replace ignition switch (See **SUSPENSION AND STEERING**) or eliminate open circuit between ignition switch and solenoid switch
	b. Solenoid switch faulty (less than 8 volts to starter motor)	b. Test for voltage at field-winding connecting strap with ignition at START. (See Fig. 6-3 below). If not at least 8 volts, replace solenoid
	c. Starter motor faulty	c. Test for voltage at field-winding connecting strap with ignition at START. If at least 8 volts, repair or replace starter motor. **6.2**
	d. Neutral/park/reverse switch faulty (automatic transmission only)	d. Test switch. **10.1**
2. Starter turns slowly or fails to turn engine	a. Dirty, loose, or corroded starter connections	a. Remove, clean, and tighten connections. **6.2**
	b. Dirty, loose, or corroded ground strap between engine and body	b. Remove and clean or replace strap
	c. Starter worn or faulty	c. Repair or replace starter. **6.2**
3. Starter makes unusual noise, turns erratically, or fails to turn	a. Drive pinion defective	a. Repair or replace starter. **6.2**
	b. Flywheel or driveplate ring gear damaged	b. Replace flywheel or driveplate. See **MANUAL TRANSMISSION AND CLUTCH** or **AUTOMATIC TRANSMISSION**
4. Starter operates, but does not turn engine	a. Starter drive pinion or armature shaft faulty	a. Repair or replace starter. **6.2**
	b. Solenoid switch mechanism faulty	b. Replace starter solenoid switch. **6.2**

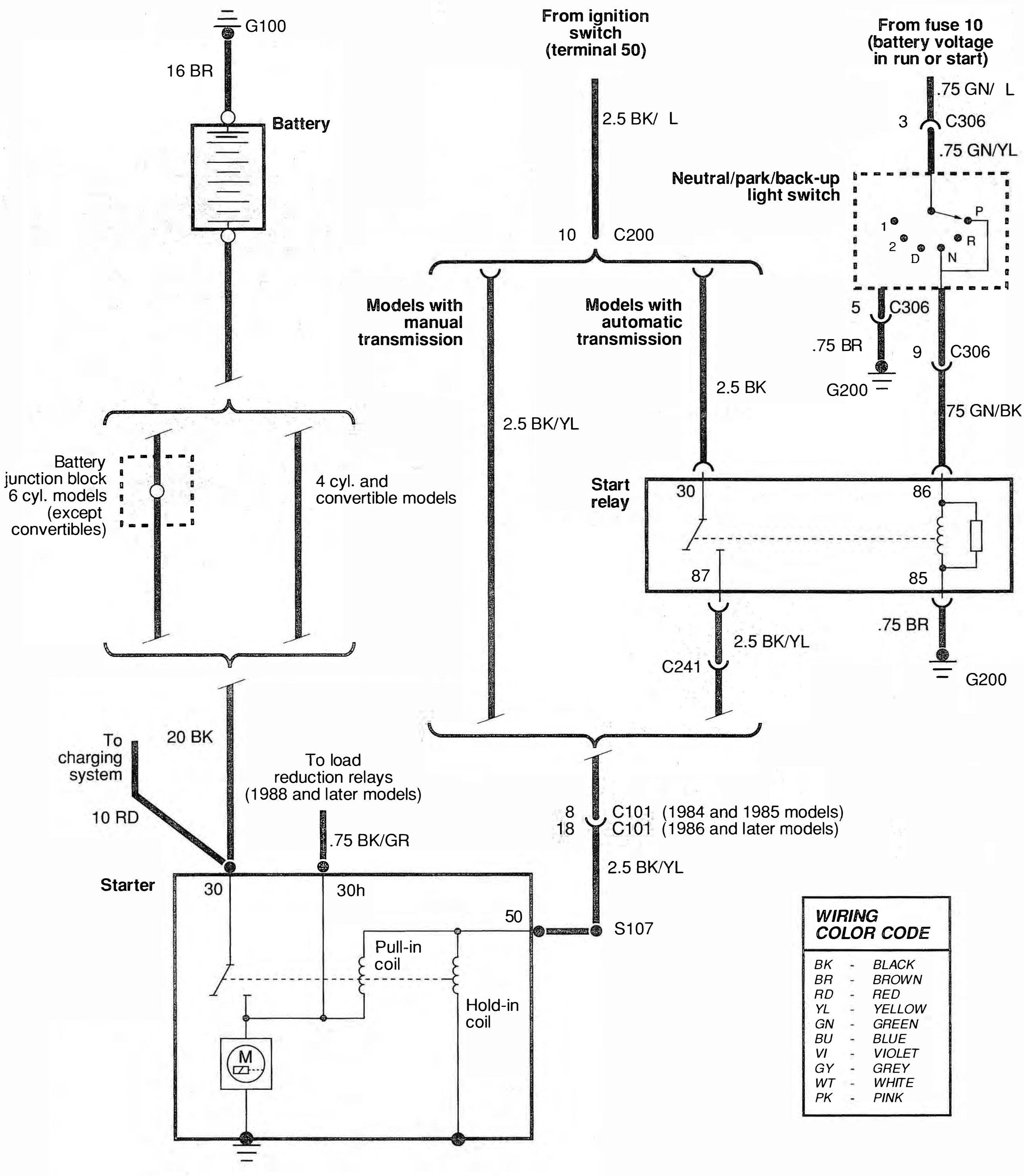


Fig. 6-1. Starting system circuit diagram. Circuit may vary slightly on some models.

6.2 Removing and Installing Starter

The starter is wired directly to the positive (+) battery terminal without fuse protection. To prevent shorts and electrical damage, always disconnect the negative (−) battery cable before removing the starter.

To remove:

1. Disconnect the negative (−) battery cable.

2. Remove the two air cleaner housing mounting nuts. Disconnect the electrical connector from the air flow sensor and the altitude compensator, if applicable. Remove the air cleaner assembly from the car.

3. On models with 4-cylinder engine, remove the upper and lower nuts and bolts from the intake manifold support and remove the support from the car. See Fig. 6-2.

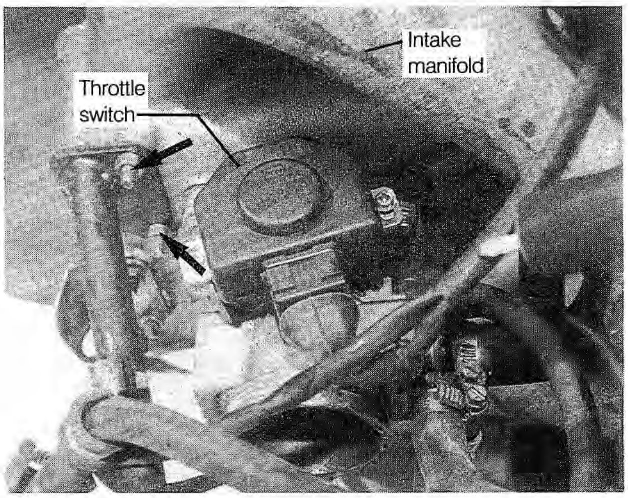


Fig. 6-2. Intake manifold support and upper mounting nuts (arrows) on models with 4-cylinder engine.

4. Drain the engine coolant as described in **COOLING SYSTEM** and remove any heater or coolant hoses that will obstruct the removal of the starter.

5. Disconnect the wires from the starter solenoid. See Fig. 6-3.

6. Remove the bolt that holds the starter bracket to the engine block. See Fig. 6-4.

7. Remove the bolts that hold the starter to the transmission bellhousing and remove the starter.

NOTE —

On models with 6-cylinder engine, the use of a half-moon
the removal of the top mounting bolt.

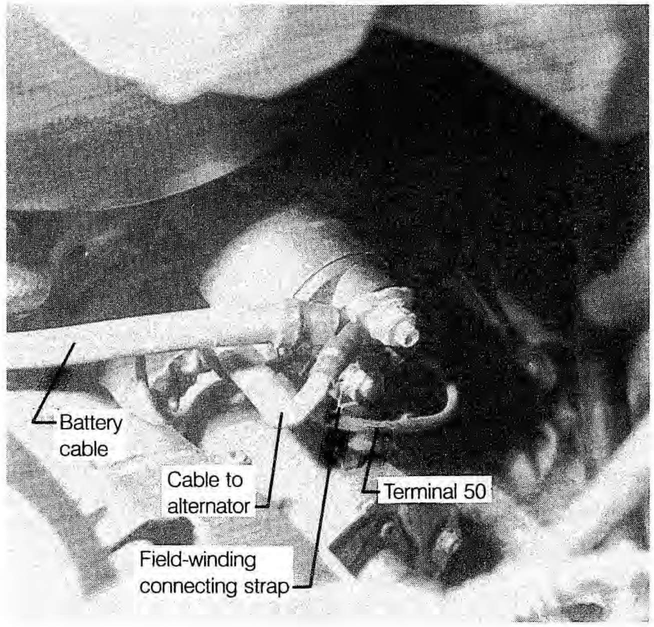


Fig. 6-3. Starter wiring at solenoid. Remove wires shown at arrows. 1988 through 1990 models have an additional wire (not shown).

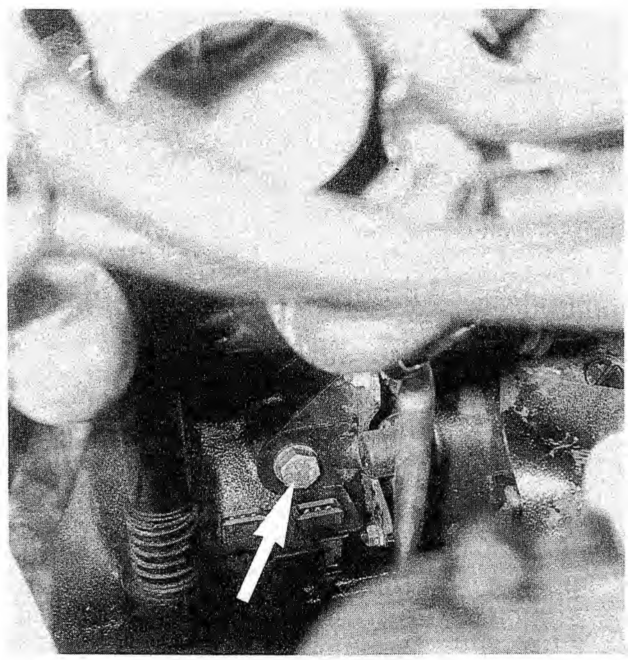


Fig. 6-4. Starter bracket mounting bolt (arrow).

Inspect the starter. Replace or repair the starter if the drive pinion teeth are worn or broken. Inspect the starter bushing that is pressed into the front of the starter casting. A worn or damaged bushing should be replaced.

Installation is the reverse of removal. Lubricate the bearing surface of the drive pinion with multipurpose grease. Torque all starter mounting bolts to 47 to 50 Nm (35 to 37 ft. lb.). Install the starter wires as shown above in Fig. 6-3.

CAUTION —

Connect wires to the proper terminals. Incorrect installation may damage the electrical system.

Removing and Installing Solenoid Switch

A faulty solenoid switch can be replaced separately. First remove the starter as described above. Remove the nut from the field-winding connecting strap and remove the strap from the solenoid. Remove the three screws holding the solenoid to the starter. Remove the solenoid and its spring. Installation is the reverse of removal. Apply a sealer to the screw heads after installing the solenoid.

7. INSTRUMENTS

A printed circuit is used in place of the numerous wires and connectors that would otherwise be required to connect the instruments and switches. Three main wire harness connectors supply the power and electrical signals to the instruments.

In addition to the visible instruments, the instrument cluster houses an electronic control unit for the service indicator. This control unit is not repairable.

Troubleshooting or repair of the instrument cluster is easiest with the cluster removed. See **BODY AND INTERIOR** for the removal procedure. Disassembly and replacement of the separate instruments is covered under **7.2 Removing and Installing Instruments.**

7.1 Troubleshooting Instrument Cluster and Gauges

Begin diagnosing instrument cluster electrical problems by checking the fuses. Make a thorough check in the engine compartment and under the instrument panel for disconnected or damaged wires or connectors. If the fuses, wires, and connectors are intact, then problems are caused by faulty sensors or senders, by the correct signal not reaching the instrument cluster, or by faulty instrument cluster components.

If only one function is affected, the problem is most likely one that affects only that individual circuit. If more than one function of the instrument cluster is affected, it is logical to begin with the instrument cluster's common wiring. Check the main power supply from the ignition switch and battery and the main ground wire.

Testing Instrument Cluster Voltage and Ground

If the warning lamps or gauges do not respond with the ignition on, it may be that either battery voltage is not reaching the instrument cluster or the cluster is not properly grounded.

With the battery negative (–) cable disconnected, remove the instrument cluster as described in **BODY AND INTERIOR**. Make sure that the blue, yellow, and white 26-point connectors at the rear of the cluster are also disconnected. Reconnect the battery negative cable.

CAUTION —

Do not allow any unprotected part of the instrument cluster electrical circuitry to touch any metal part of the car while the cluster is removed and the battery is connected.

With the ignition switched on, use a voltmeter or test light to check for voltage and ground at the harness connector terminals listed in **Table h.** The test terminals for the 26-point connectors are identified in Fig. 7-1.

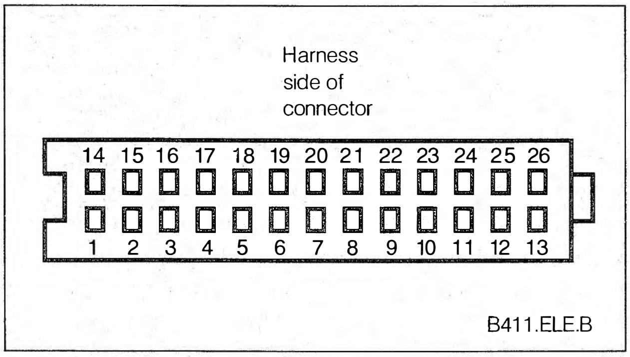


Fig. 7-1. Terminal identification for 26-point instrument cluster connectors. There are three 26-point connectors attached to the rear of the cluster. Use care not to damage connector terminals with test probes.

Table h. Instrument Cluster Electrical Tests

Circuit	26-point connector (color)	Test terminals	Test conditions	Correct test value
Voltage supply to instrument cluster	C1 (blue)	23 and ground	Ignition ON	Battery voltage (approx. 12 VDC)
	C2 (white)	6 and ground	Ignition ON	Battery voltage (approx. 12 VDC)
	C1 (blue)	2 and ground	Ignition OFF/ON	Battery voltage (approx. 12 VDC)
	C2 (white)	13 and ground	Ignition ON	Battery voltage (approx. 12 VDC)
	C1 (blue)	14 and ground	Ignition ON	Battery voltage (approx. 12 VDC)
Main ground to instrument cluster	C2 (white)	16 and ground	—	Continuity
	C1 (blue)	20 and ground	—	Continuity

If voltage is not present in any of the above tests, check fuses 10, 12, and 21. If no faults are found, check the wires between the fuse/relay panel and the instrument cluster connectors and also between the ignition switch and the instrument cluster connector. If there is no continuity to ground, check the main ground connection that is behind the instrument panel directly above the brake pedal. See Fig. 7-2.

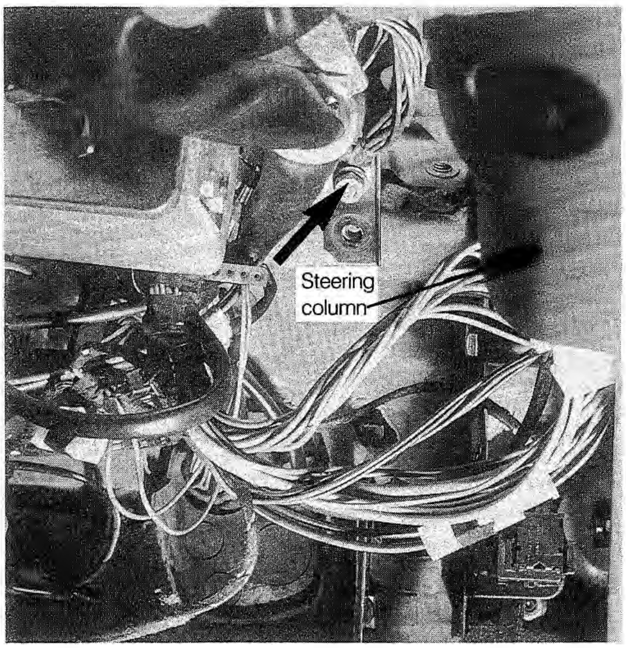


Fig. 7-2. Main ground connection for instrument cluster (arrow). Lower instrument panel trim removed.

Testing and Replacing Indicator Bulbs

Test indicator bulbs by first removing the instrument cluster as described in **BODY AND INTERIOR.** Remove the bulb housings from the rear of the cluster by turning the housing 90° and pulling the housing from the cluster. Using an external 12-volt power source and jumper wires, apply voltage to the terminals of the removed bayonet socket.

7.2 Removing and Installing Instruments

Individual replacement instruments as well as the service interval indicator board are available from an authorized BMW dealer parts department. To remove instruments from the cluster, first remove the instrument cluster as described in **BODY AND INTERIOR.** Remove the nine mounting screws from the rear of the cluster as shown in Fig. 7-3. Carefully separate the instrument cluster from the front housing. Remove individual instruments from the printed circuit board by removing their mounting screws on the rear of the board and pulling the instrument from the front of the board. Installation is the reverse of removal.

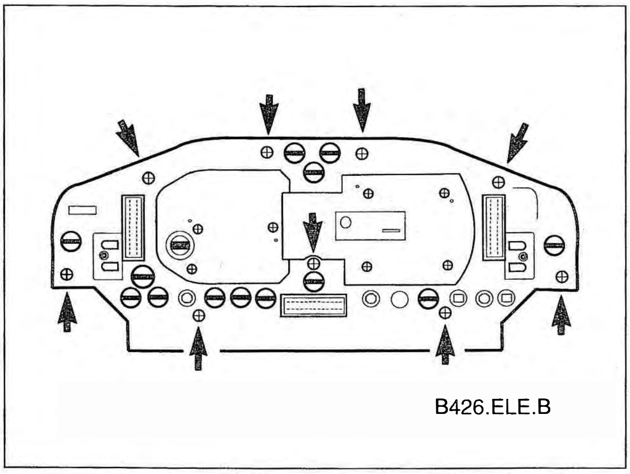


Fig. 7-3. Instrument cluster viewed from rear showing cover mounting screws (arrows).

Service Interval Indicator

The service interval indicator board needs voltage to maintain the board's stored memory and to keep its integral ni-cad batteries charged. This voltage is supplied to the board directly from the battery via fuse no. 21 (7.5 amp). If the car's battery is disconnected or becomes discharged, the ni-cad cells are designed to hold the board's memory for up to four months. Over time, these buffer batterie [illegible] or discharged if the correct voltage supply is not present (i.e., missing or blown fuse, broken or damaged wire to the instrument cluster).

Discharged ni-c d batteries will cause all of the interval lights to come on at the same time. In addition, the lights will not go out after doing a reset. If this happens, check that the board is receiving the voltage and ground at the instrument cluster harness connectors. See Fig. 7-4. **Table i** lists connector and test terminals. If no faults are found, the ni-cad batteries are probably faulty and the complete board will need to be replaced. Ni-cad batteries are not available as replacement parts from BMW.

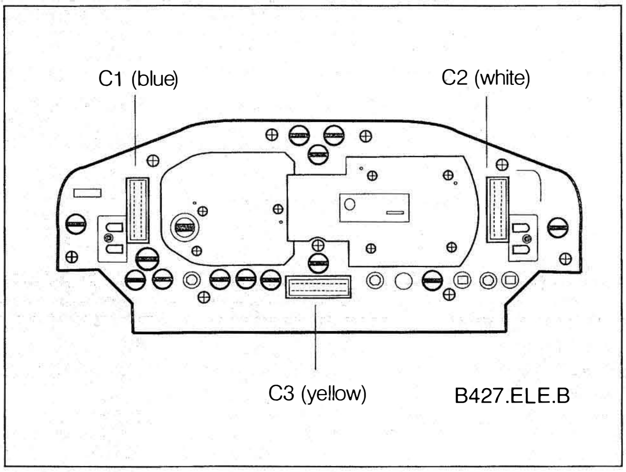


Fig. 7-4. Instrument cluster viewed from the rear.

Table i. Service Interval Indicator Voltage and Ground Tests

	Test terminals	
Build date	**Voltage**	**Ground**
All models built up to January 1988	C1-2	C1-16
All models built after January 1988	C1-2	C1-20

NOTE —

If the green lights go out after approximately 175 to 200 miles (especially after a memory reset), the problem is most likely caused by a faulty fuel economy gauge (gives the service interval indicator its mileage input) and not a faulty service interval indicator board. Replace the fuel economy gauge as described above.

To remove the service interval indicator board from the bottom of the instrument cluster housing, first remove the instruments from the housing as described above. Working from the rear of the instrument cluster housing, remove the instrument panel light duct and pull the board from the housing. Installation is the reverse of removal.

CAUTION —

The solid-state service indicator interval board is static sensitive. Static discharge will permanently damage the board. Always handle the modules using proper static prevention equipment and techniques. See an authorized BMW dealer for the most up-to-date parts and installation information.

NOTE —

When installing a new service interval indicator board, the ni-cad buffer batteries may need to be charged. When 12-volt battery voltage is applied to the board, the ni-cad batteries begin to charge after approximately one minute and the inspection light will come on and all other lights will go out. At this point the service indicator should be reset as described in **LUBRICATION AND MAINTENANCE**. Battery voltage to the board should not be interrupted for at least three hours after the reset. The buffer batteries will be fully charged after approximately 85 hours.

8. Windshield Wipers and Washers

The operation of the two-speed windshield wipers and washers is controlled by a lever on the steering column. The wiper blades park automatically when the lever is turned off. The wiper motor and its linkage are located in the air plenum at the base of the windshield. It is reached from the engine compartment after removing the firewall access panel.

A control unit on the fuse/relay panel controls the operation of the wipers, and runs the wipers for several sweeps if the washer is actuated while the wiper switch is in the OFF position. On 1984 and 1985 325 models, the washer spray nozzles are heated to prevent freezing in cold weather.

If the wiper or washer motor fails to operate when the steering column lever is moved, see **8.1 Windshield Wiper and Washer Troubleshooting**. If the wiper motor runs but the wiper arms do not move, see **8.2 Windshield Wiper Motor and Linkage**.

8.1 Windshield Wiper and Washer System Troubleshooting

For best results, these troubleshooting tests should be done in the sequence outlined below.

Before diagnosing windshield wiper and washer problems, check the fuse in position number 5 (30 amp). If no faults are found, remove the wiper control unit from the fuse relay/panel as shown in Fig. 8-1. With the ignition switched on, use a voltmeter or test light to check for voltage between the socket corresponding to terminal 15 of the control unit and ground. Using an ohmmeter, check for continuity between the socket corresponding to terminal 31 of the control unit and ground. Fig. 8-2 is a schematic of the windshield wiper and washer system circuit. Use the diagram as a guide during troubleshooting.

If voltage is not present, the fault is in the fuse/relay panel or the connections to the panel See **14. Fuse/Relay Panel** for more information. If there is no continuity to ground, check the main ground connection that is behind the instrument panel, directly above the brake pedal. See Fig. 7-2 above. If the voltage and ground signals are as specified, continue the tests as outlined below.

Testing Windshield Wiper/Washer Motors

The wiper and washer motors can be quickly checked at the fuse/relay panel. Using a 1.5 mm (14 AWG) fused jumper wire with flat spade connectors on either end, make the electrical tests in **Table j**. Make all tests at the wiper control unit sockets identified in Fig. 8-1.

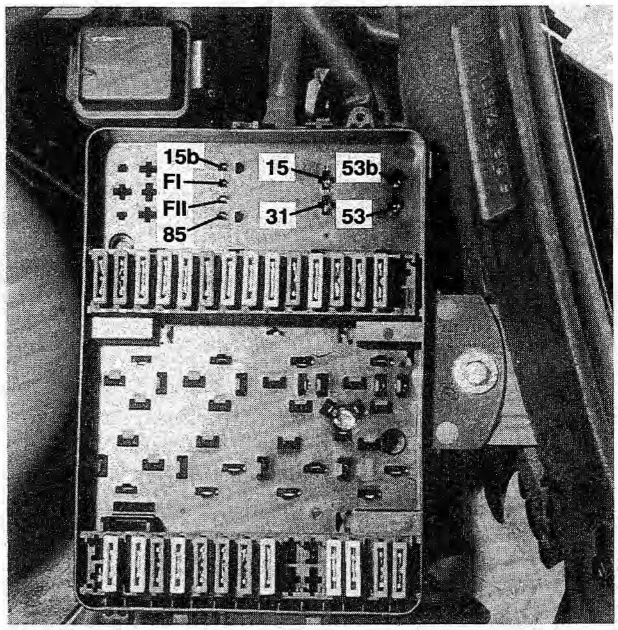


Fig. 8-1. Wiper control unit location (control unit removed) and terminal identification on fuse/relay panel.

CAUTION —
Use only a fused (30 amp) jumper wire of the specified diameter. Make all electrical connections with the ignition off. When connections have been safely made, turn the ignition on.

Table j. Windshield Wiper and Washer Motor Tests

Fuse/relay panel socket(s) (wiper control unit removed)	Test conditions	Correct test results
15 and 53	Ignition ON	Wiper motor runs on low speed
15 and 53b	Ignition ON	Wiper motor runs on high speed
85 and ground	Ignition ON	Washer motor runs

If either motor does not operate as specified, and battery voltage is present at terminal 15 with the ignition on, check the wires between the wiper control unit and the wiper or washer motor. If no wiring faults can be found, the wiper/washer motor is faulty and should be replaced. See **8.2 Windshield Wiper Motor and Linkage.**

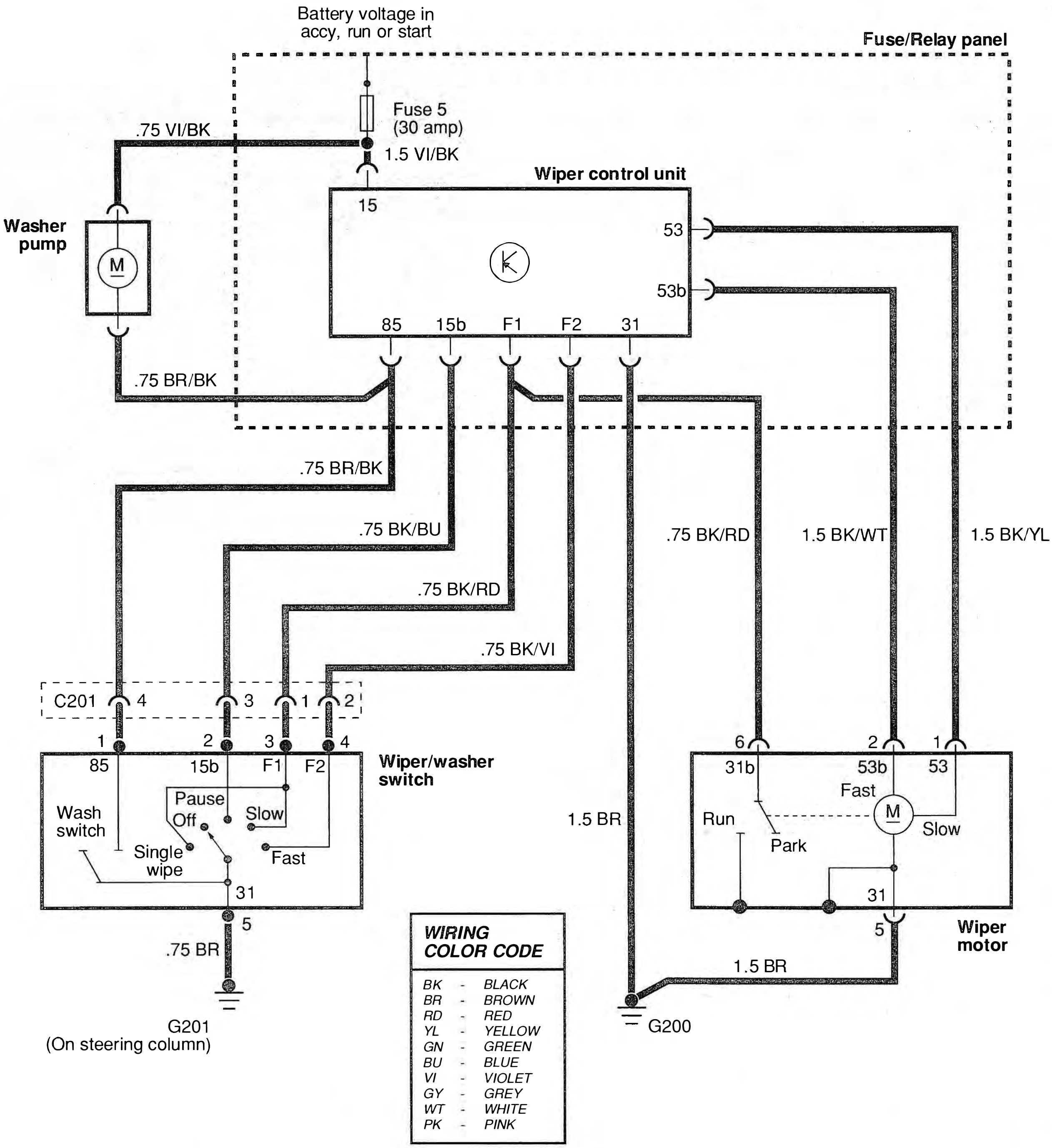


Fig. 8-2. Windshield wiper and washer system circuit.

If the motor operates as specified, the problem lies elsewhere in the system. Continue troubleshooting by testing the wiper/washer switch as described below.

Testing Wiper/Washer Switch

The switch supplies the wiper control unit with ground inputs and routes them depending on the position of the lever. The switch can be easily tested using an ohmmeter. To reach the switch, first remove the steering wheel as described under **SUSPENSION AND STEERING.** Remove the lower steering-column cover by removing the Phillips-head screws. Disconnect the harness connector as shown in Fig. 8-3.

WARNING —

Some of the 1990 cars covered by this manual are equipped with a Supplemental Restraint System (SRS) that automatically deploys an airbag. The airbag unit uses a pyrotechnical device to electrically ignite a powerful gas. On cars so equipped, any work involving the steering wheel should only be performed by an authorized BMW dealer. Performing repairs without disarming the SRS may cause serious personal injury.

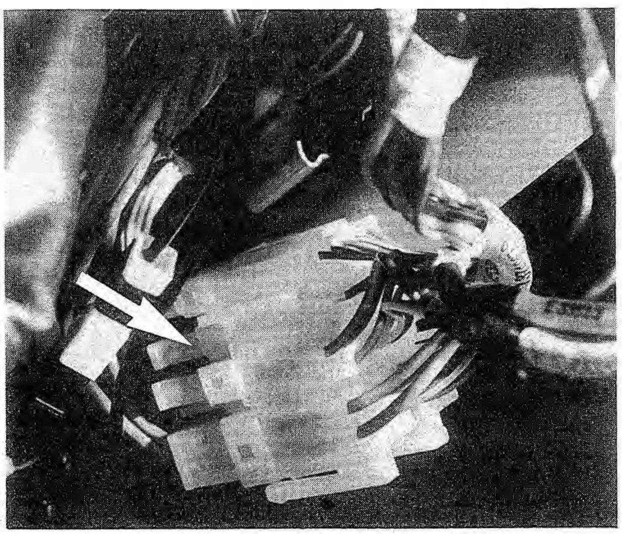


Fig. 8-3. Wiper/washer switch harness connector (arrow).

Before testing the switch, check the ground wire on the front of the steering column. See Fig. 8-4. If this wire is faulty, the wipers will not operate. Use an ohmmeter to test the switch by making continuity checks as indicated in **Table k**. If the switch fails any of these tests, it is faulty and should be replaced as described in **SUSPENSION AND STEERING**.

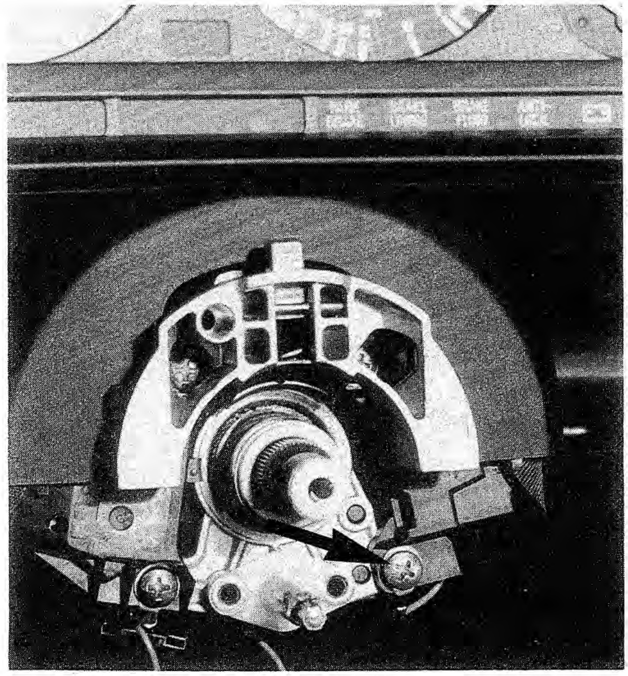


Fig. 8-4. Location of ground wire for wiper/washer switch (arrow).

Table k. Wiper/Washer Switch Continuity Tests

Wiper/Washer Switch Position	Terminals	Test result
Single wipe	1 (black/red) and ground	Continuity
Low Speed	1 (black/red) and ground	Continuity
High Speed	2 (black/violet) and ground	Continuity
Intermittent	3 (black/blue) and ground	Continuity
Washer	4 (brown/black) and ground	Continuity

Wiper Control Unit

Except for the washer motor, all wiper functions are wired through the wiper control unit. If the wiper motor and the wiper switch are functioning correctly, and there are no wiring faults, the wiper control unit is most likely faulty. Because the control unit is an electronic component, it cannot be easily tested. The only remedy for a faulty control unit is replacement.

NOTE —

Inspect the terminals of the control unit. Dirty or corroded terminals can cause erratic and sluggish wiper operation. Control unit terminals can be cleaned using a suitable electrical contact cleaner.

8.2 Windshield Wiper Motor and Linkage

The wiper motor and its linkage are accessible for replacement. For information on windshield wiper blades, see **LUBRICATION AND MAINTENANCE.**

Removing and Installing Windshield Wiper Motor

The wiper linkage assembly should be removed from the body when replacing the wiper motor. The drive crank should not be removed from the motor unless the motor is being replaced.

To remove:

1. Disconnect the battery negative (−) cable.
2. Remove the heater blower motor and blower motor housing as described in **BODY AND INTERIOR.**
3. Remove the wiper arms. Pry up the wiper arm retaining nut cover and mark the position of the wiper arm on the wiper arm shaft. Remove the wiper arm retaining nut and remove the arm from the shaft. See Fig. 8-5

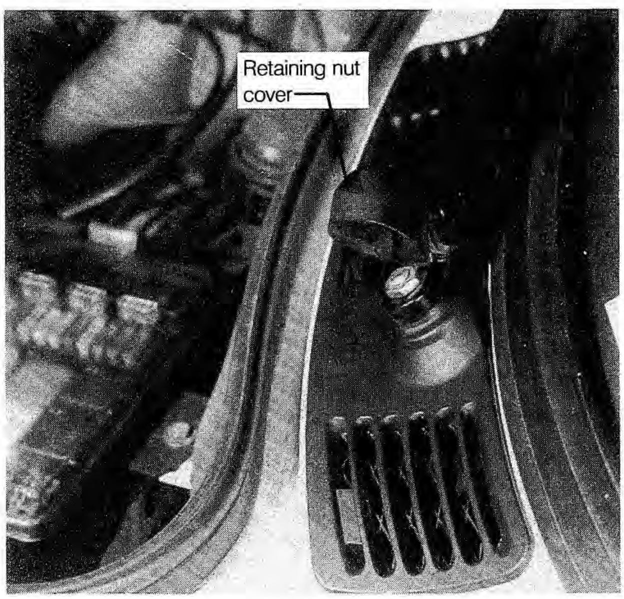


Fig. 8-5. Wiper arm retaining nut (arrow).

4. Using a small screwdriver, carefully pry off the left ventilation grill as shown in Fig. 8-6. Remove the protective cover from the right wiper arm shaft. Remove the shaft mounting nuts and washers from both wiper arm shafts.

Fig. 8-6. Ventilation grill being removed from body. Wrap tip of screwdriver with tape to protect paint.

5. Disconnect the harness connector from the wiper motor. Remove the wiper linkage assembly mounting bracket. Remove the linkage assembly together with the motor from the plenum chamber. See Fig. 8-7.

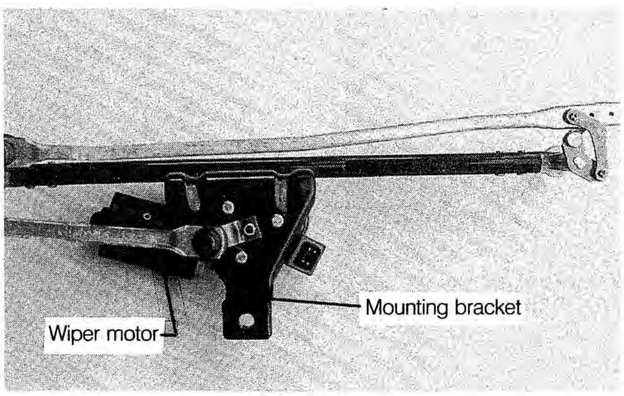


Fig. 8-7. Wiper linkage assembly with wiper motor.

When replacing the wiper motor, mark the position of the drive crank relative to the wiper motor bracket, then remove the crank and the motor. See Fig. 8-8. Install the new motor onto the bracket but leave the drive crank off temporarily. Connect the wiring and operate the wiper motor for about one minute and then turn it off. The motor will stop in its park position. Now install the drive crank, aligning it with the mark on the bracket. Connect the linkage and install the assembly into the car. Install the wiper blades, aligning the matching marks made earlier.

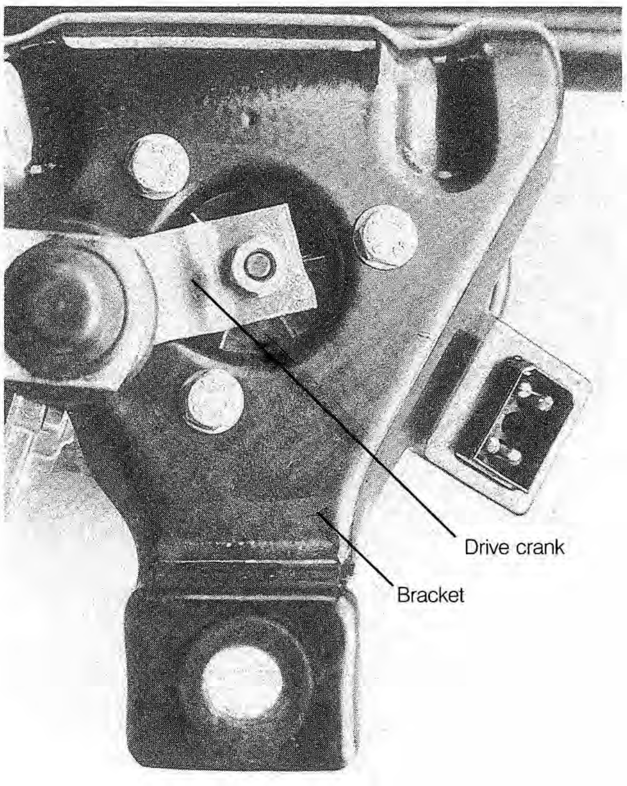


Fig. 8-8. Wiper motor assembly. Mark position of drive crank on bracket before removing motor from bracket.

9. HORNS

The components of the horn system are the dual horns, the horn relay, and the horn buttons on the steering wheel. A brush and slip ring assembly make the electrical contact between the rotating steering wheel and the steering column.

The horns are connected to ground (−). Depressing the horn button with the ignition on activates the horn relay, which in turn supplies the horns with positive (+) battery voltage to complete the circuit and sound the horns. See Fig. 9-1.

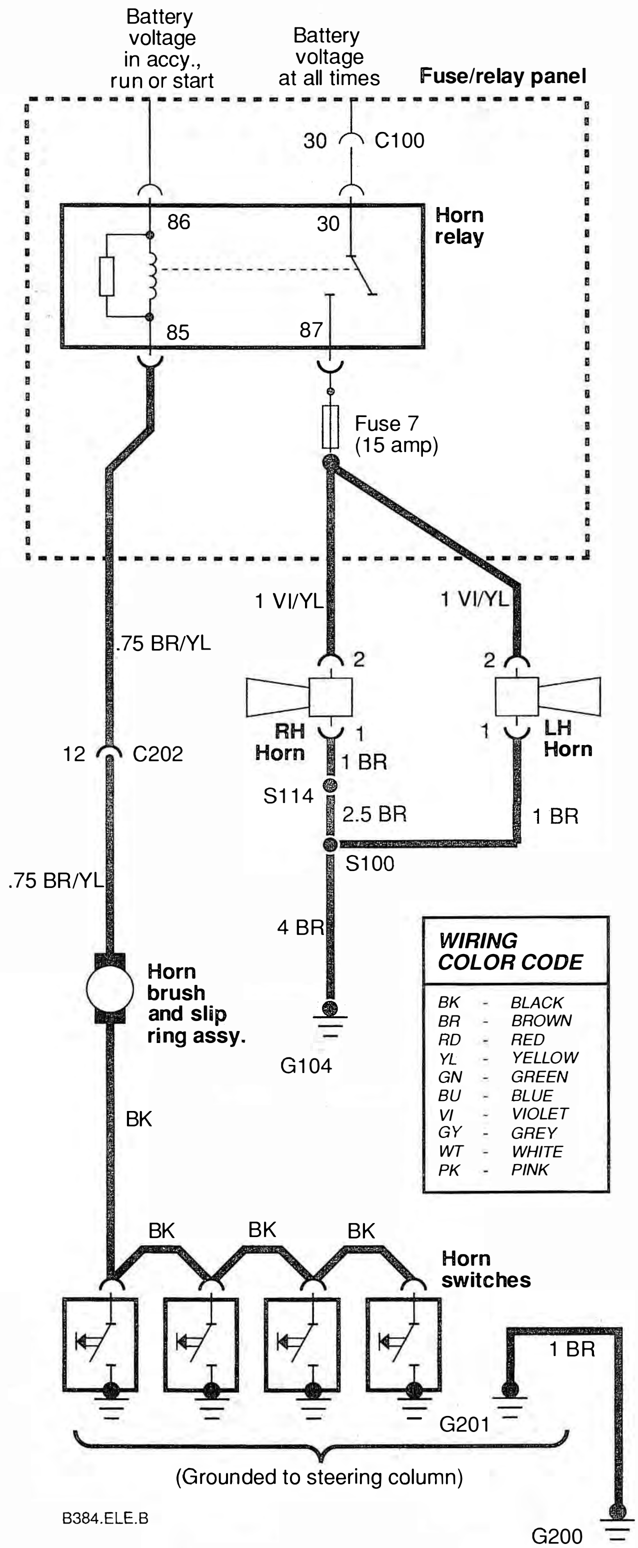


Fig. 9-1. Dual horn system circuit.

9.1 Horns Troubleshooting

Horns that continually sound when the ignition is off usually indicate a faulty horn relay. Horns that continually sound when the ignition is turned on usually indicate a short in the horn circuit—most likely in the switch or steering column.

If the horns do not sound, check the fuse(s) and all the wiring connections. If no faults are found, remove the harness connectors from the horns. Check for battery voltage between the brown wire (−) and the violet/yellow wire (+) of the connectors with the ignition on and the horn button depressed. If voltage is present, the horn(s) are faulty and should be replaced. If voltage is not present at either of the connectors, do the electrical tests outlined below. Check for continuity between the brown wire of the connector and ground. If ground is not present, check the ground connection on the forward portion of the left front fender.

> **NOTE** —
> The horns are mounted beneath the car directly above the fog lights. On some later models, the splash guard will have to be removed before the horns can be reached.

Testing Horn Relay

Remove the horn relay from the fuse/relay panel. See **14. Fuse/Relay Panel** for relay locations. With the ignition off, check for voltage between the fuse/relay panel socket corresponding to relay terminal 30 and ground. Turn the ignition on and check for battery voltage between the socket corresponding to relay terminal 86 and ground. With the horn button depressed, check for continuity between the socket corresponding to relay terminal 85 and ground. If no electrical faults are found, the relay is faulty and should be replaced. If any electrical check is not as specified, check for faulty wiring to the relay socket.

10. EXTERIOR LIGHTS

This heading covers exterior light electrical circuits. Replacement of bulbs and lenses for the driving lights, taillights, side marker lights, turn signals, brake lights, back-up lights, and headlights is covered in **BODY AND INTERIOR**.

10.1 Troubleshooting Exterior Lights

Most of the exterior lighting involves pairs of lights, and this fact is an aid to troubleshooting. If only one of a pair of lights is out—one taillight for example—then the problem is most likely due to a failed bulb or some other problem with that particular light socket or its wiring. A simple test is to exchange the bulb with its counterpart that is known to be good. If the same bulb fails to light in a new location, then the bulb is faulty and should be replaced. If the same light fails to light with the other bulb, then the problem is in the socket or wiring.

Many lighting problems are due to dirty or corroded sockets, or loosely-fitting bulb contacts or connectors. Check that voltage is reaching the bulb and that the socket has a good connection to ground.

If a pair of bulbs are both out—both taillights for example—then the problem is most likely in some part of the system that is common to both lights. Begin by checking for a failed fuse. Test switches using simple continuity checks made with an ohmmeter. Check the switch connectors for voltage and continuity to ground.

Headlights

Fig. 10-1 and Fig. 10-2 are diagrams for the headlight circuit. Power to the headlights comes only with the ignition on (15 circuit). When the headlight switch and the ignition switch are on, the low beam relay closes to supply power to the low beams. If the high beams are selected with the headlight dimmer switch on the steering column switch, the high beam relay also closes.

If either both low beams or both high beams are out and no fuses are faulty, the problem is most likely due to a faulty relay. With the ignition off, remove the low beam and high beam relays. See **14. Fuse/Relay Panel.** Check the headlight circuit using the information in **Table l.** Make all electrical checks at the sockets of the fuse/relay panel corresponding to the relay terminal numbers found on the bottom of the relay.

> **NOTE** —
> On 6-cylinder models, a faulty low beam check relay can only be remedied by replacement of the fuse/relay panel. The low beam check relay, part of the check control system, is integral with the fuse/relay panel circuitry.

If no electrical faults are found, check for voltage at the headlight electrical connector with the lights on and the ignition in the ON position. If no voltage is present, the relay is probably faulty and should be replaced. If voltage is present, the headlight itself is faulty and should be replaced.

Test the headlight switch by first removing it from the instrument panel. Unscrew the knob from the switch. Remove the lower instrument panel trim from the left side of the dash. Disconnect the electrical connector from the light switch and pull the switch from its mounting. Using an ohmmeter, check for continuity between the switch terminals listed in **Table m.** If no faults are found, test the headlight dimmer switch as described under **10.2 Steering Column Switches.**

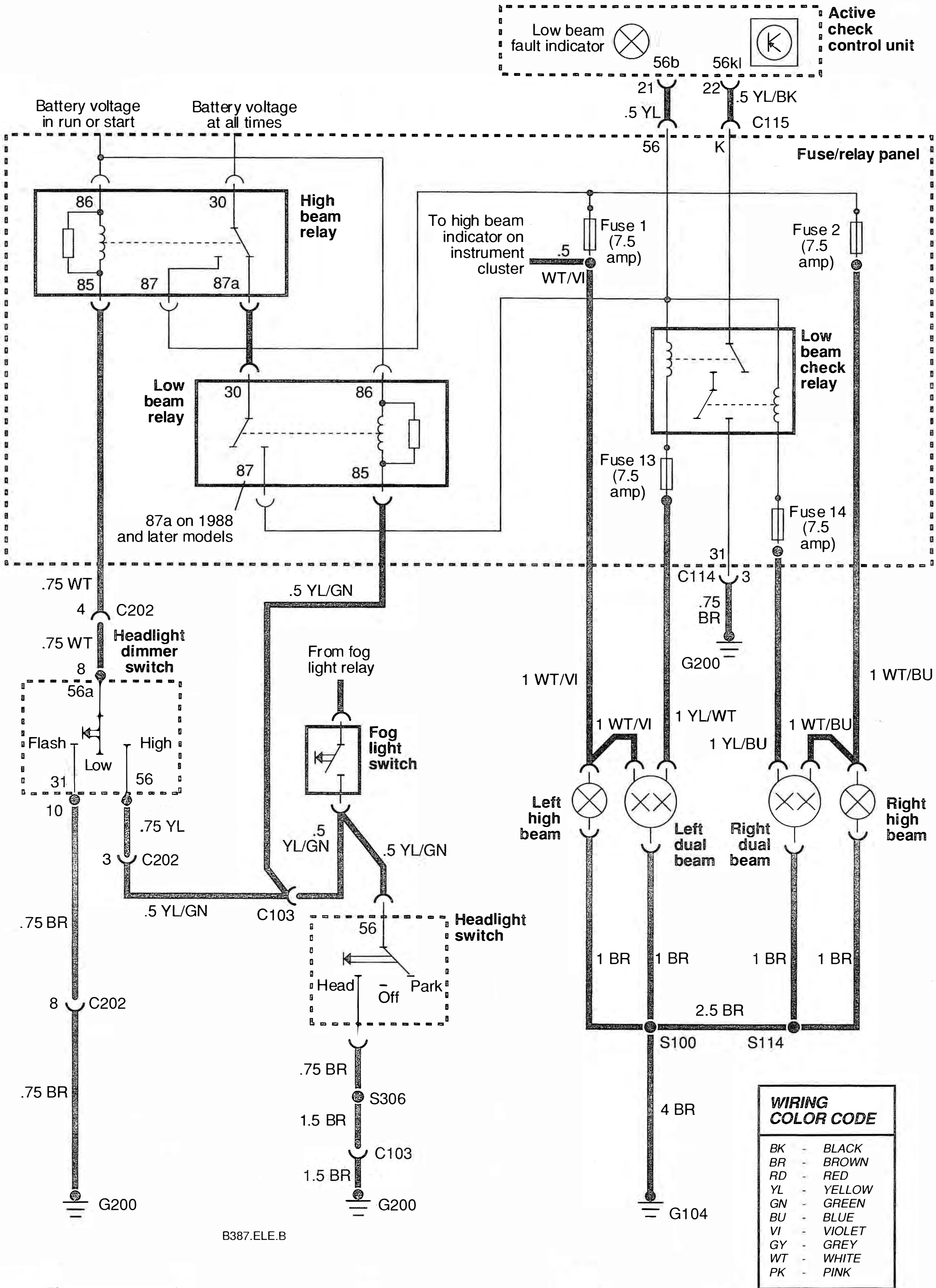
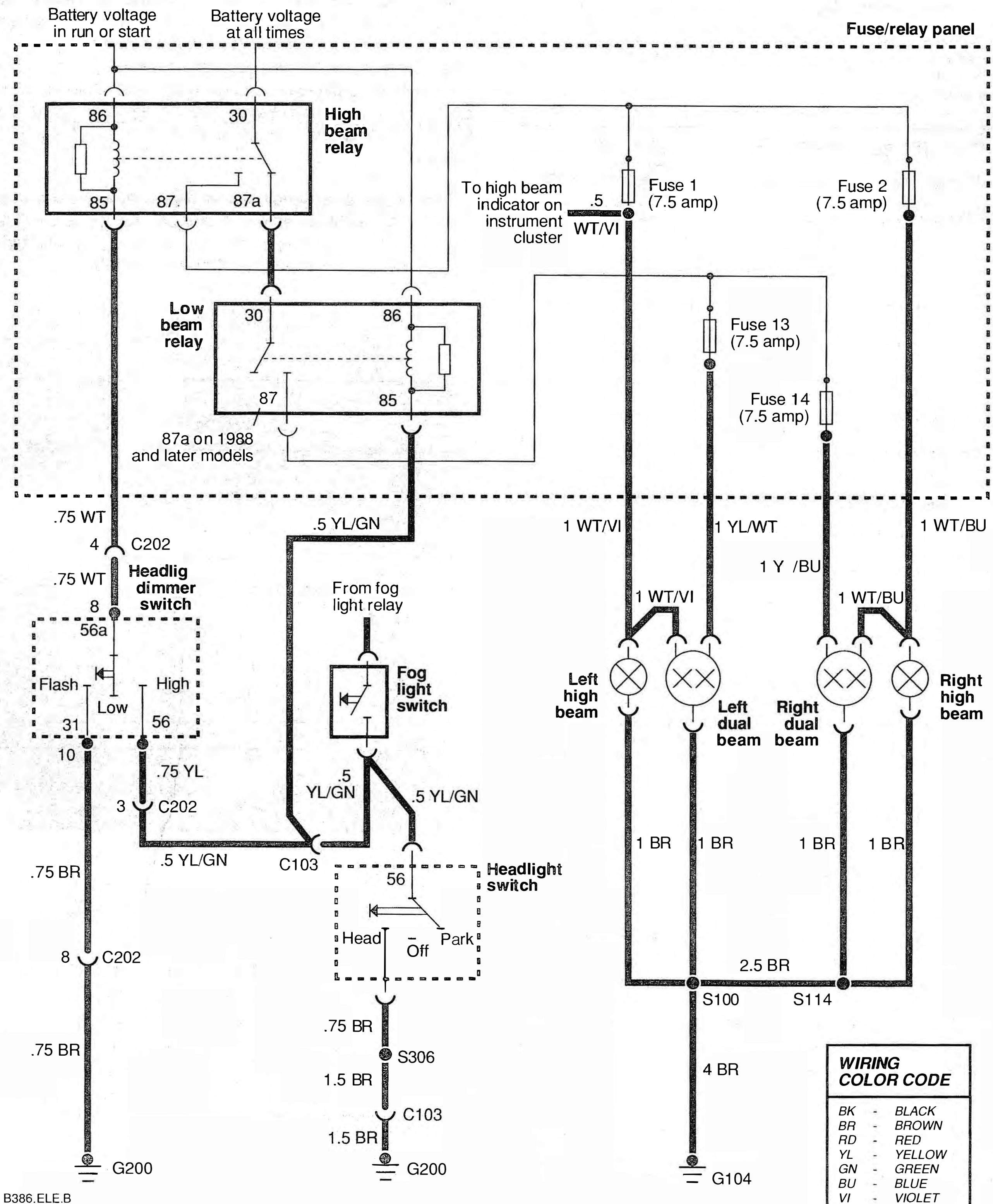


Fig. 10-1. Headlight circuit for models with active check control. Circuit may vary slightly on some models.



WIRING COLOR CODE		
BK	-	BLACK
BR	-	BROWN
RD	-	RED
YL	-	YELLOW
GN	-	GREEN
BU	-	BLUE
VI	-	VIOLET
GY	-	GREY
WT	-	WHITE
PK	-	PINK

Fig. 10-2. Headlight circuit for models without active check control. Circuit may vary slightly on some models.

Table l. Headlight Circuit Electrical Tests

Fuse/Relay panel sockets (low and high beam relays)	Test conditions	Correct test results
High Beam		
86 and ground	Ignition ON	Battery voltage (12 VDC)
30 and ground	Ignition OFF	Battery voltage (12 VDC)
85 and ground	Ignition off , dimmer switch in flash position	Continuity
Low Beam		
86 and ground	Ignition ON	Battery voltage (12 VDC)
30 and ground	Ignition OFF, high beam relay installed temporarily	Battery voltage (12 VDC)
85 and ground	Ignition OFF, headlight switch on	Continuity

Table m. Headlight Switch Continuity Tests

Headlight switch position	Test terminals	Correct test results
Headlights on	56 and 31	Continuity
Parking Lights on	58RE and 58RA 58LE and 58LA 58RE and 58K	Continuity Continuity Continuity
Instrument Illumination (parking lights on or headlights on)	58RE and 58K 31 and 31h	Continuity Resistance changes as knob is rotated

Turn Signals and Emergency Flashers

Power for the turn signal circuit is routed through the emergency flashers switch only when the ignition is on (15 circuit). The emergency flashers circuit receives power from the battery at all times. When the emergency flashers switch is on, the turn signal switch is bypassed. Fig. 10-3 shows the location of the turn signal/flasher relay. Fig. 10-4 is a schematic of the turn signals and emergency flashers electrical circuit.

The turn signals and the emergency flashers share the same flasher relay, but each circuit has its own fuse. One system working indicates that the flasher relay is good. Look for a failed fuse.

If both the flashers and turn signals are inoperative, then it is probably either the flasher relay or the emergency flasher switch that is faulty. Check to see if power is reaching the relay. Remove the lower steering column trim and remove the relay. Check that the emergency flasher switch is in the OFF position. With the ignition on, check for voltage between terminal 49 (green/violet wire) of the harness connector and ground. Check for continuity between the brown wire (terminal 31) in the connector and ground. Repair any wiring faults found. If no faults are found, the relay is probably faulty and should be replaced.

Check the emergency flasher switch by removing it and checking for continuity in the ON and OFF positions. Use **Table n** as a guide. If no faults are found, test the turn signal switch as described in **10.2 Steering Column Switches**.

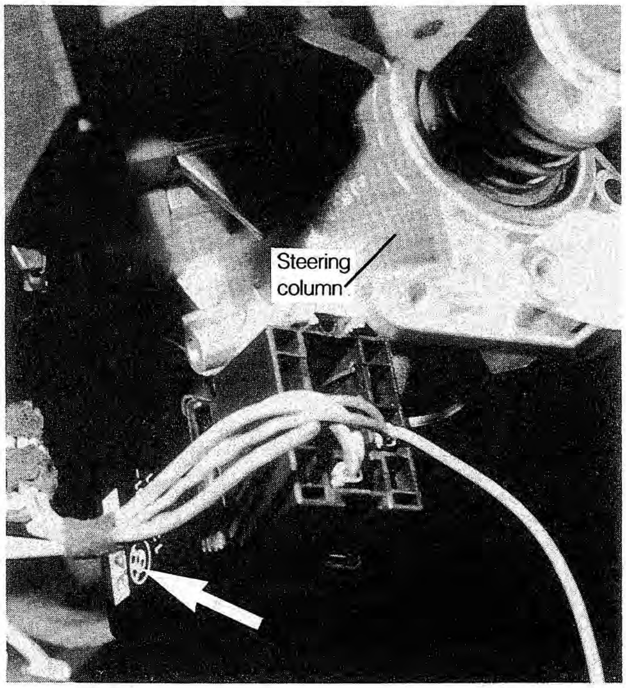


Fig. 10-3. Turn signal/emergency flasher relay (arrow) and harness connector. Flasher is located beneath steering column trim, below steering wheel.

Table n. Emergency Flasher Switch Continuity Tests

Switch Position	Terminals	Test result
Off	R and 49	Continuity
On	49 and 30 49a and BR 49a and BL	Continuity Continuity Continuity

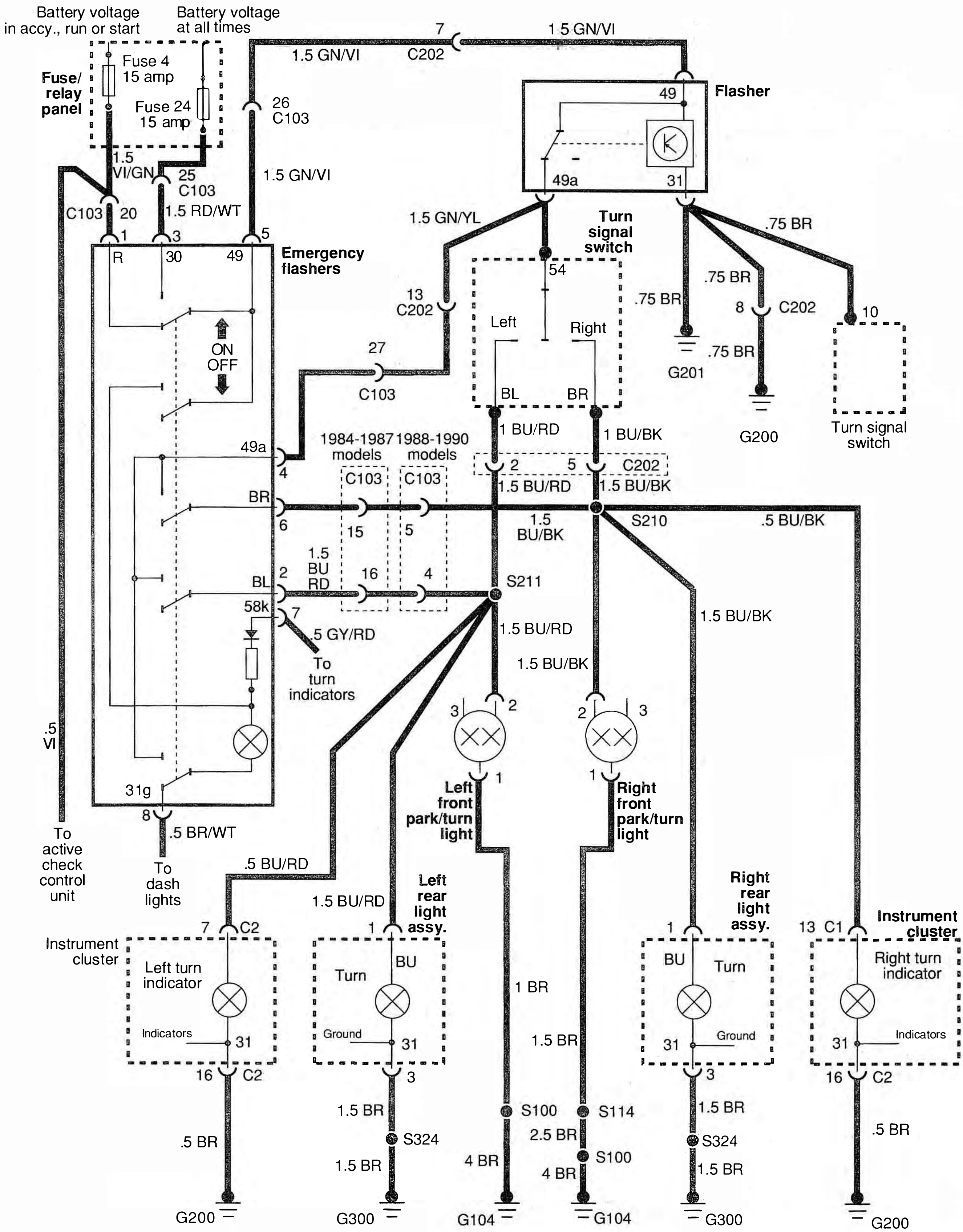


Fig. 10-4. Turn signal and emergency flashers circuit.

Back-up Lights

On cars with manual transmission, the back-up lights receive power through the back-up light switch when the transmission is in reverse gear. The switch is mounted on the transmission as shown in Fig. 10-5 and is accessible from beneath car. Check the switch by removing the electrical connectors from the switch and checking for continuity across the switch terminals with the transmission in reverse. When installing a new switch, torque it to 20 Nm (14 ft. lb.)

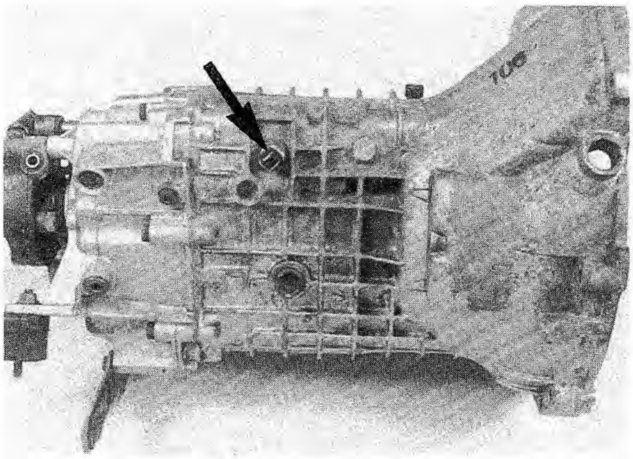


Fig. 10-5. Location of back-up light switch on manual transmission housing (arrow).

On cars with automatic transmission, the back-up lights receive their power through the neutral/park/back-up light switch mounted at the base of the shift lever in the passenger compartment. The switch prevents the car from starting if the shift lever is not in the neutral or park position. To test the switch, pry out the trim from around the base of the shift lever. Disconnect the connector shown in Fig. 10-6. Make the continuity checks listed in **Table o.** at the switch side of the connector.

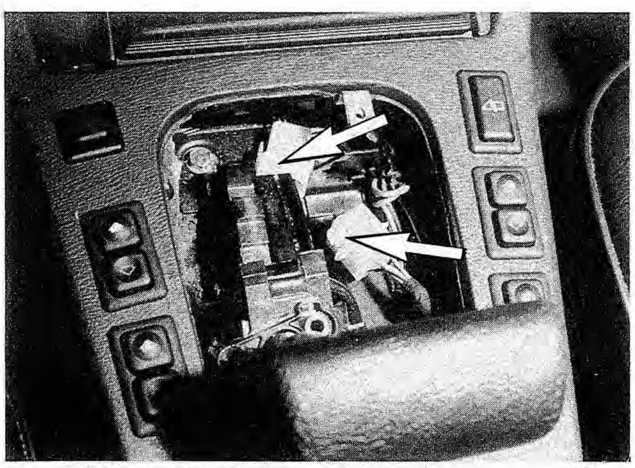


Fig. 10-6. Location of neutral/park/back-up light switch on cars with automatic transmission. Switch harness connector (C306) shown at arrow.

Table o. Neutral/Park/Back-up Light Switch Continuity Tests

Selector Lever Position	Terminals	Test result
Reverse	blue/white wire and green/yellow wire	Continuity
Neutral or Park	blue/white wire and green/black wire	Continuity
Drive, 1, or 2	blue/white wire and green/yellow wire blue/white wire and green/black wire	No continuity No continuity

Parking Lights, Taillights, Side Marker Lights, and License Plate Lights

The parking, side marker, tail, and license plate lights all receive power directly from the battery through the light switch in the first or second position, independent of the ignition switch. If these lights fail together, first look for a failed fuse, then for problems in the switch. Test the headlight switch as described above under **Headlights**. Fig. 10-7 is a circuit diagram for the license plate and rear side marker lights. Fig. 10-8 is a typical circuit diagram for the parking, tail, and front side marker lights.

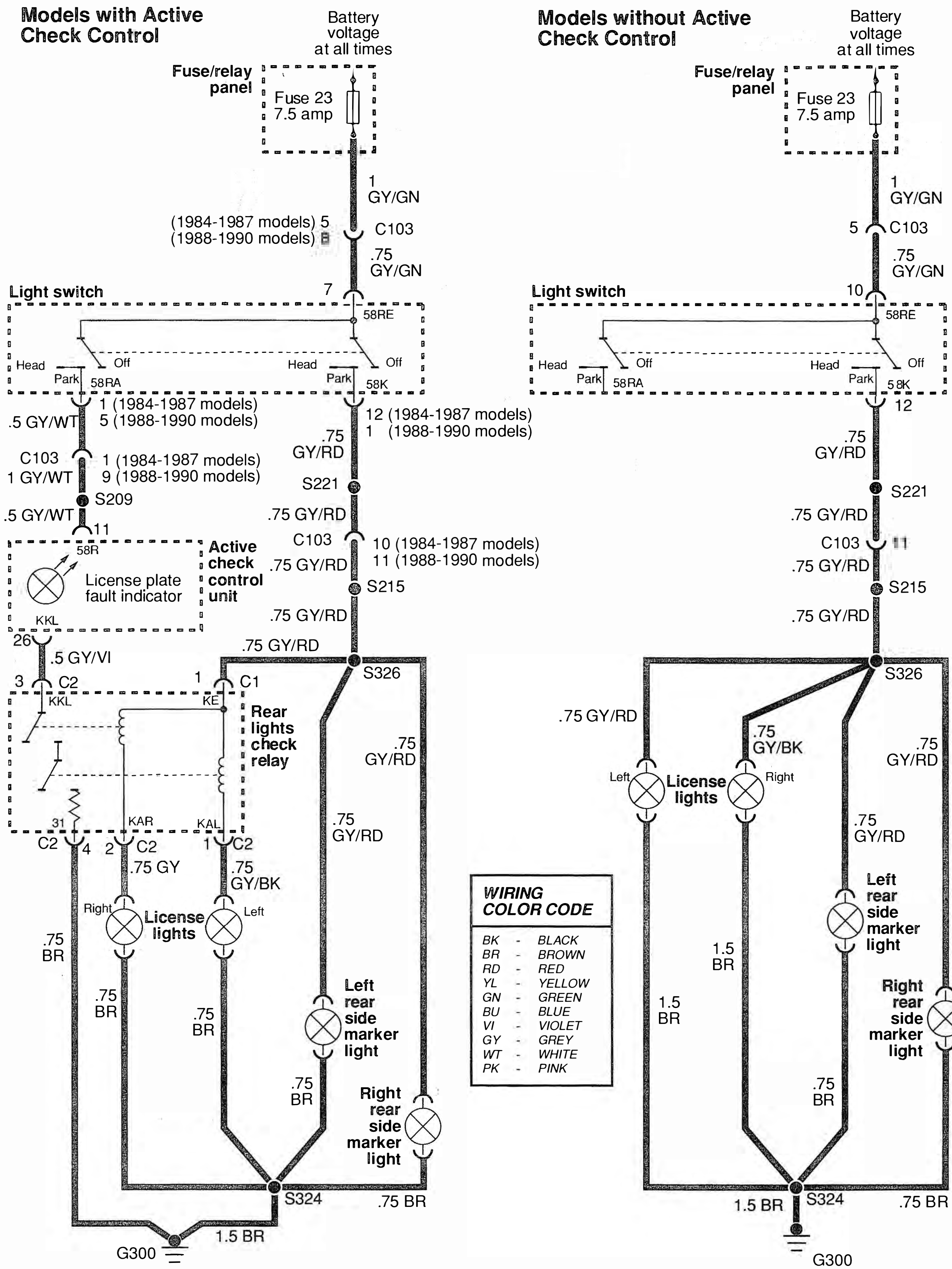
Brake Lights

The brake lights receive their power only when the ignition switch is on. The brake light switch closes when the brake pedal is depressed to complete the circuit to the brake lights. Fig. 10-9 shows the wiring for the brake light circuit.

To quickly check if the problem is in the switch or some other part of the circuit, remove the electrical connector(s) from the brake light switch above the brake pedal. Using a fused jumper wire, bridge the wires in the connector(s) and turn the ignition on.

If the brakes lights come on, either the switch needs adjustment as described in **BRAKES** or the switch is faulty and should be replaced. If the lights do not come on, check for battery voltage between the violet/green wire and ground with the ignition on. If voltage is not present, check the wire between the fuse/relay panel (fuse no. 6) and the brake light switch. If voltage is present, check for faults in the green/red wire between the brake light switch and the brake light assembly.

The circuit for the back-up lights is shown in Fig. 10-10. The information below also includes electrical tests for the neutral/ park/back-up light switch



WIRING COLOR CODE		
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YL	-	YELLOW
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GY	-	GREY
WT	-	WHITE
PK	-	PINK

Fig. 10-7. License plate lights and rear side marker lights circuit.

15

Models with
active check control

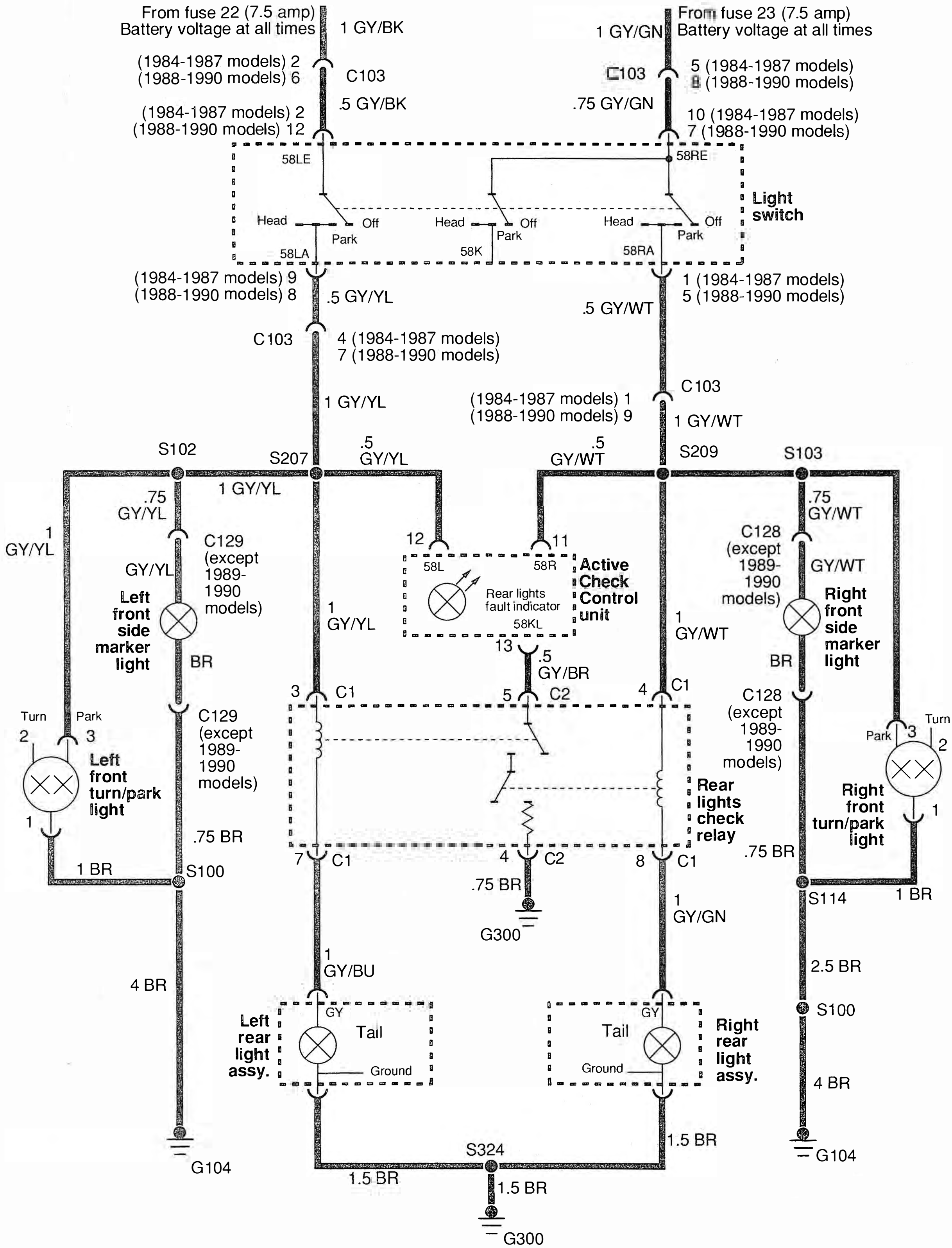
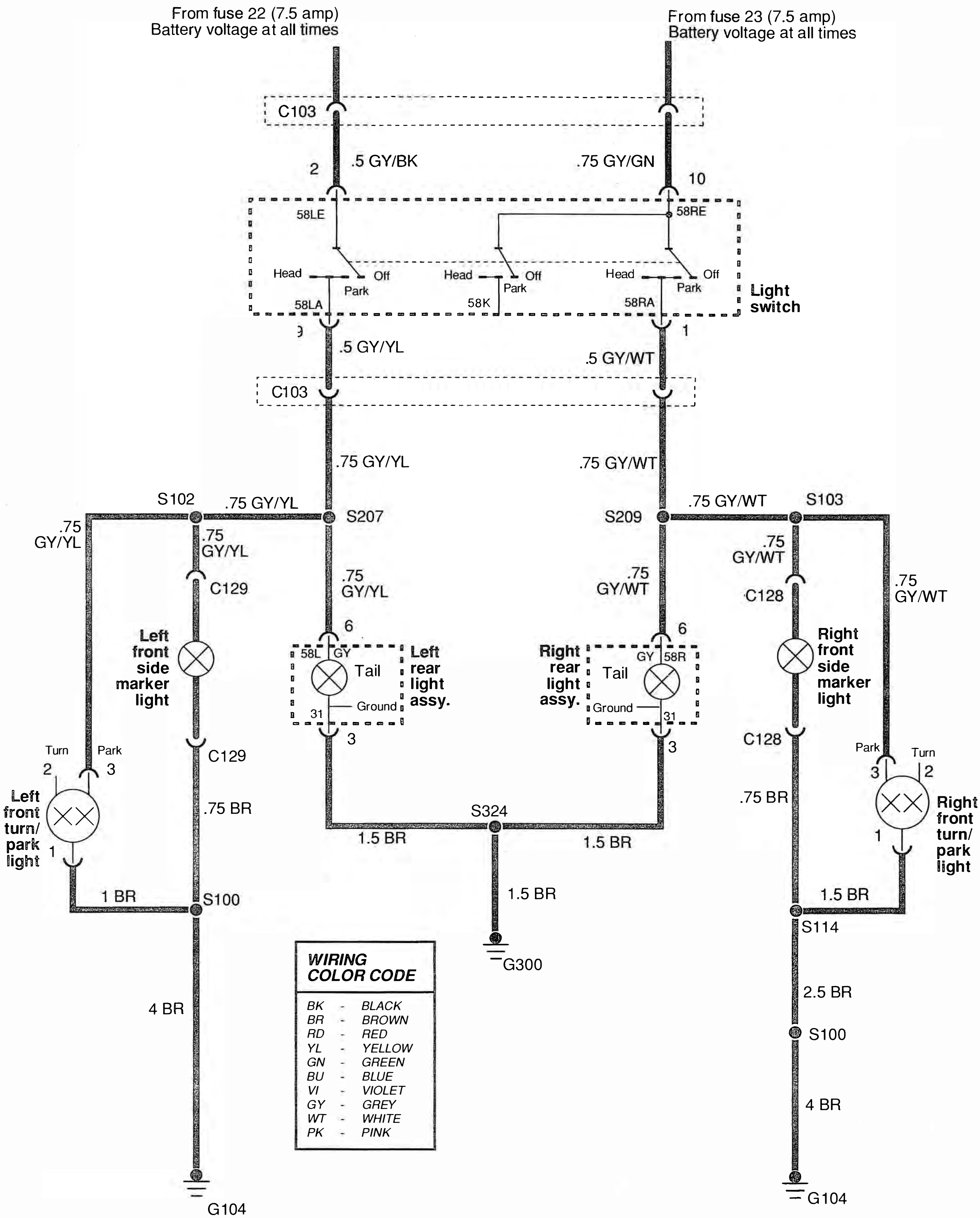


Fig. 10-8. Parking lights, front side marker lights, and tail-lights circuit. Circuit may vary slightly on some models. (continued on next page)

Models without active check control



WIRING COLOR CODE	
BK	- BLACK
BR	- BROWN
RD	- RED
YL	- YELLOW
GN	- GREEN
BU	- BLUE
VI	- VIOLET
GY	- GREY
WT	- WHITE
PK	- PINK

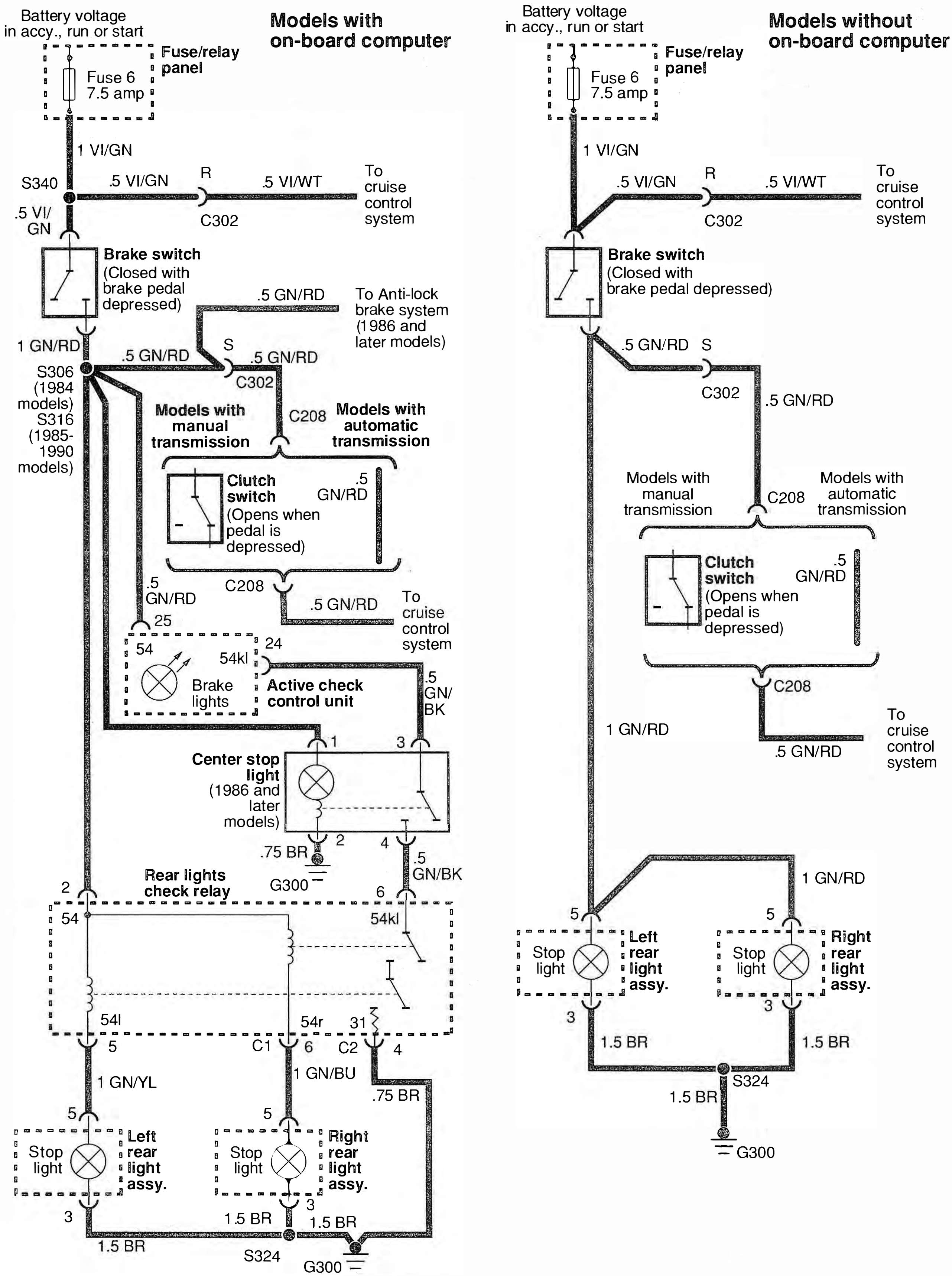


Fig. 10-9. Brake light circuits.

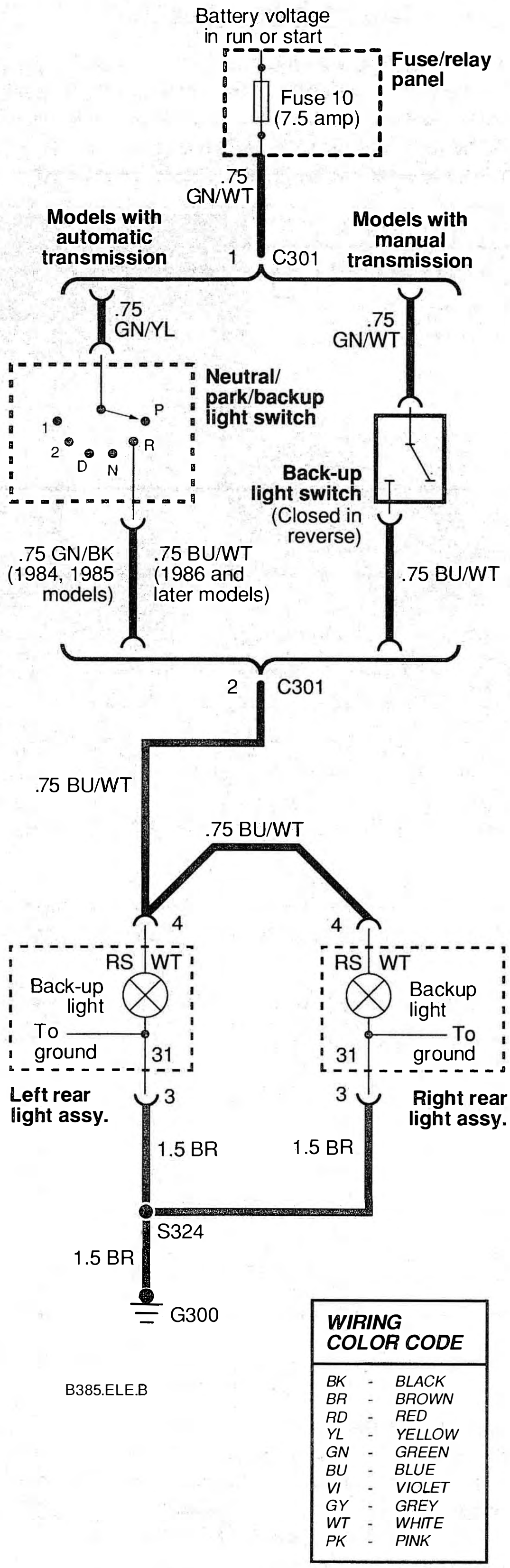


Fig. 10-10. Back-up lights circuit.

10.2 Steering Column Switches

The steering column switches can be tested without being removed simply by removing the lower steering column trim and disconnecting the appropriate harness connectors. For testing the windshield wiper switch, see **8. Windshield Wipers and Washers**. For testing the cruise control switch, see **12. Power Options and Accessories.** Replace faulty switches as described in **SUSPENSION AND STEERING**.

WARNING —

Some of the 1990 cars covered by this manual are equipped with a Supplemental Restraint System (SRS) that automatically deploys an airbag from the steering wheel. The airbag unit uses a pyrotechnical device to electrically ignite a powerful gas. On cars so equipped, any work involving the steering wheel should only be performed by an authorized BMW dealer. Performing repairs without disarming the SRS may cause serious personal injury.

Ignition Switch

Fig. 10-11 is a schematic diagram of the ignition switch. Terminal 30 brings power into the ignition switch from the battery. Terminal 15, terminal R, and terminal 15I provide power to the ignition system and other parts of the electrical system when the ignition key is in the ON position. Terminal 50 switches power to the starter. Terminal C and terminal C1 are part of the seat belt warning system.

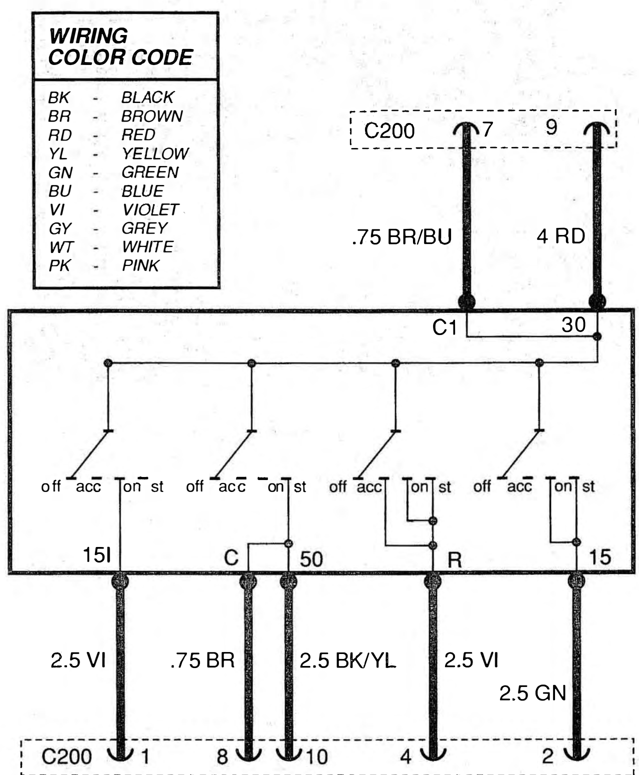


Fig. 10-11. Schematic diagram of ignition switch.

Table p lists ignition switch continuity checks. A switch that fails any of these tests is faulty and should be replaced. Fig. 10-12 identifies the terminals of the ignition switch harness connector beneath the steering column.

CAUTION —

Disconnect the negative (−) battery cable before testing the ignition switch.

Table p. Ignition Switch Continuity Tests

Switch position	Continuity: terminal numbers (wire color)
Ignition ON or Start	30 (C200-9) and 15 (C200-2) 30 (C200-9) and R (C200-4)
Ignition ON only	30 (C200-9) and 15I (C200-1)
Start only	30 (C200-9) and 50 (C200-10) C1 (C200-7) and C (C200-8)

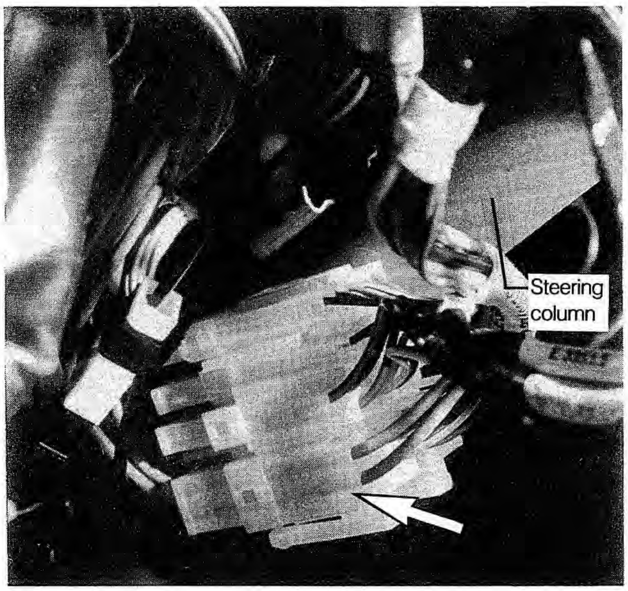


Fig. 10-12. Ignition switch harness connector C200 (arrow). Lower steering column trim removed from steering column. Make continuity tests at switch side of connector.

Headlight Dimmer Switch

Test the headlight dimmer switch at the switch side of the 13-point harness connector shown in Fig. 10-13. Using the information in **Table q**, and Fig. 10-1 above, check for continuity at the harness connector with the ignition off. If any faults are found, the switch is faulty and should be replaced.

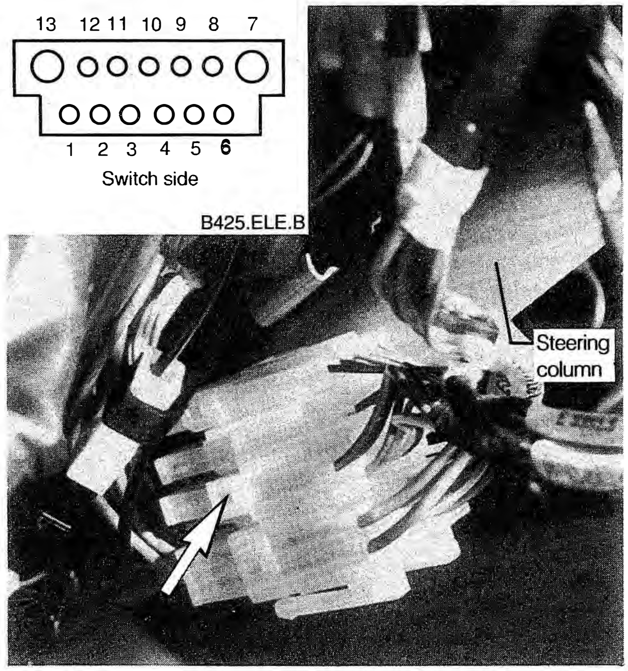


Fig. 10-13. Harness connector (C202) for headlight dimmer switch (arrow). Lower steering column trim panel removed. Inset identifies connector terminals.

Table q. Headlight Dimmer Switch Continuity Tests

Headlight dimmer switch position	Test terminals (wire color)	Correct test results
Low Beams	4 (white) and 3 (yellow) 4 (white) and 8 (brown)	No continuity
High Beams	4 (white) and 3 (yellow)	Continuity
Flash	4 (white) and 8 (brown)	Continuity

Turn Signal Switch

Test the turn signal switch at the switch side of the 13-point harness connector shown in Fig. 10-13 above. Using the information in **Table r** and Fig. 10-4 above, check for continuity at the harness connector with the ignition off. If any faults are found, the switch is faulty and should be replaced.

Table r. Turn Signal Switch Continuity Tests

Turn signal switch position	Test terminals (wire color)	Correct test results
Off (center position)	13 (green/yellow) and 2 (blue/red) 13 (green/yellow) and 5 (blue/black)	No continuity
Left turn	13 (green/yellow) and 2 (blue/red)	Continuity
Right turn	13 (green/yellow) and 5 (blue/black)	Continuity

11. Heating, Ventilation and Air Conditioning

11.1 Air Conditioning

The air conditioning (A/C) system is fully integrated with the heater and ventilation system. The blower motor and the auxiliary cooling fan operate whenever the A/C switch or the recirculation switches are depressed. Test the blower motor as described above. Test the auxiliary cooling fan as described under **COOLING SYSTEM.**

If the air conditioning compressor does not cycle on when the A/C switch is selected, the problem may be due to a faulty wire leading to the compressor or a faulty in-line diode. Use a voltmeter to check for voltage at the disconnected compressor harness connector with the A/C switch and the ignition on. If voltage is not present, use an ohmmeter to check for a failed (open) diode. See Fig. 11-1. Check for loose or corroded connections.

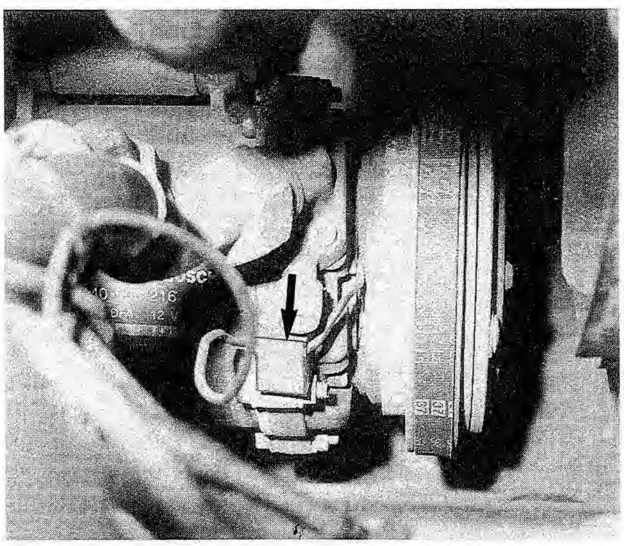


Fig. 11-1. Typical location of air conditioning compressor in-line diode (arrow).

The A/C control switch assembly can be tested after removing it as described in **BODY AND INTERIOR**. Make continuity checks at the electrical connections of the switch assembly with the control switches in the ON and OFF positions. Fig. 11-2 shows a schematic of the A/C control switch assembly.

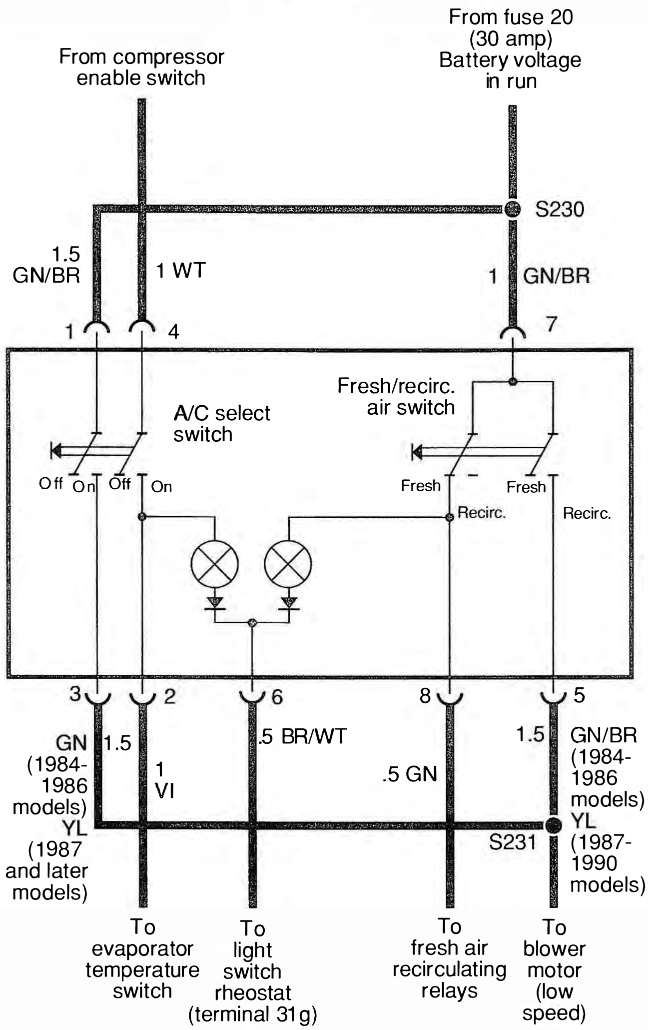


Fig. 11-2. Schematic of air conditioning control switch assembly.

If no faults can be found, have the system checked by an authorized BMW dealer or other qualified shop. If voltage is reaching the compressor clutch, the clutch is faulty and should be replaced.

Most other testing of the A/C system, including the operation of the pressure switches, requires specialized knowledge and equipment, and is beyond the scope of this manual. Servicing by an authorized BMW dealer or other qualified air conditioning shop is highly recommended.

11.2 Fresh Air Blower

Fig. 11-3 shows the electrical circuit for the blower motor and the series resistor.

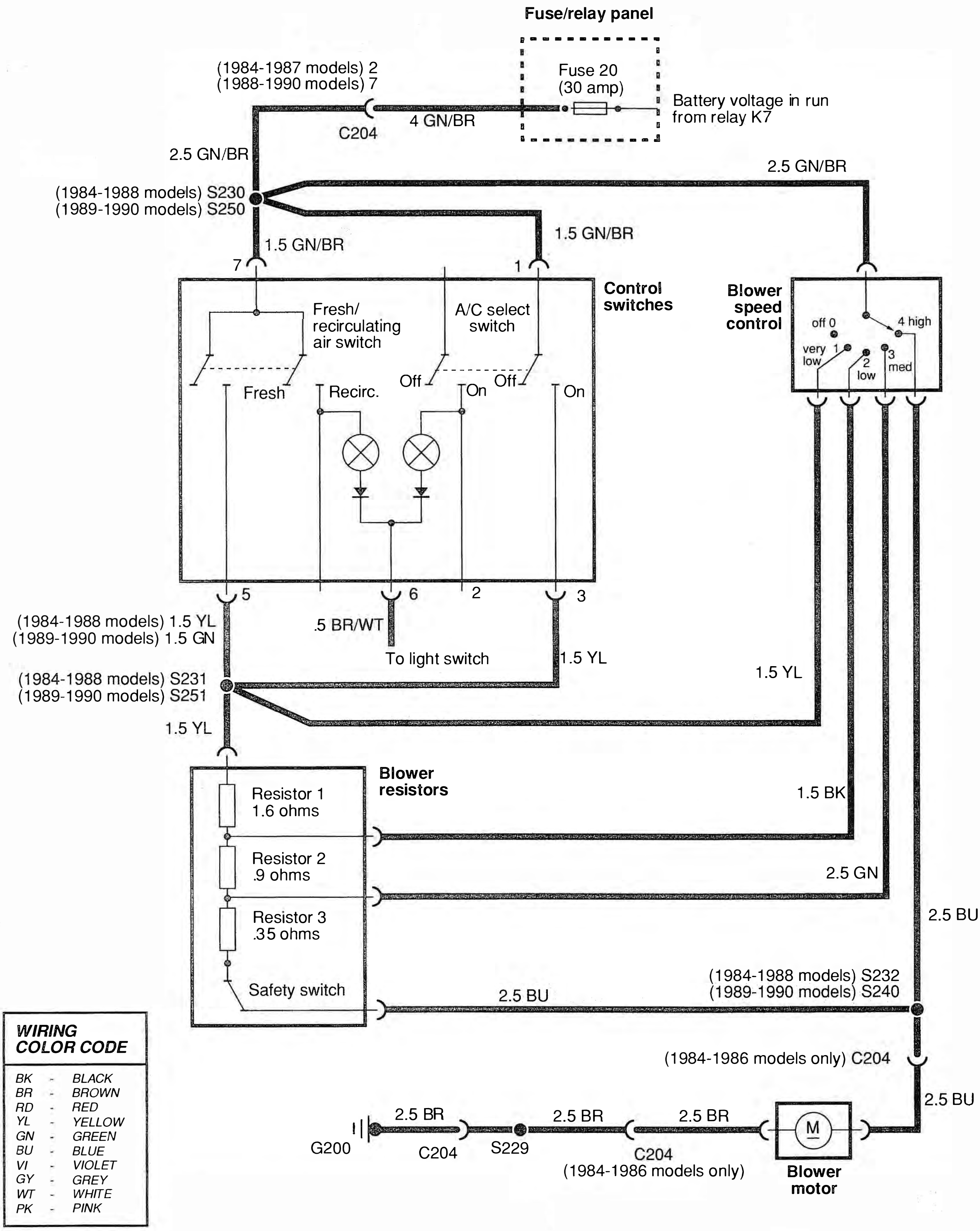


Fig. 11-3. Fresh air blower motor circuit for 1985 and later models. Circuit for 1984 models varies slightly.

The speeds of the fresh air blower motor are controlled by varying resistance. Maximum resistance produces the lowest speed. At high speed, power is supplied directly to the blower motor. On cars with air conditioning, the blower motor will run on low speed if either the air conditioning switch or recirculation switch is selected.

NOTE —
A blower motor that only runs on high speed usually indicates a fault with the blower motor series resistors.

To quickly check for a faulty blower motor, remove the access panel and blower motor housing cover as described in **BODY AND INTERIOR**. Disconnect the harness connectors from the blower motor with the ignition off. Turn the ignition on and tum the blower motor speed switch to the high position. Check for voltage between the harness connectors. If voltage is present the blower motor is faulty and should be replaced as described in **BODY AND INTERIOR.**

If there is no voltage reaching the motor, use an ohmmeter to check the blower motor series resistor and the blower speed switch using the circuit diagram as a guide. Fig. 11-4 shows the location of the series resistor.

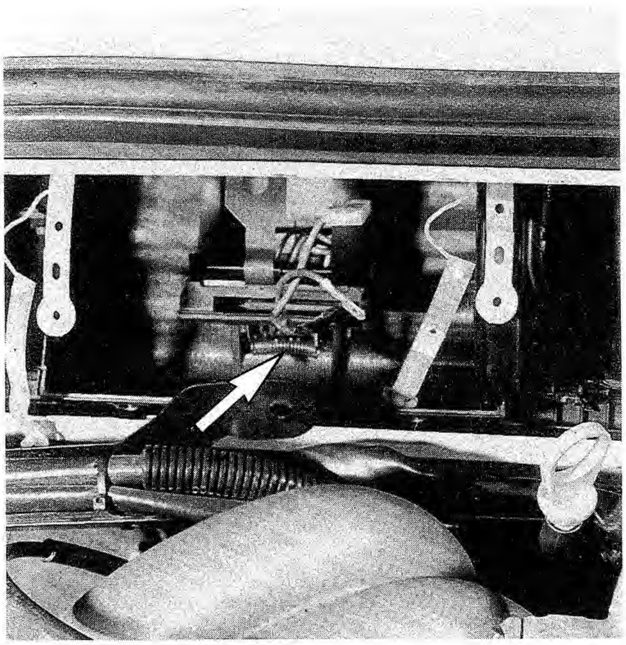


Fig. 11-4. Series resistor plate behind blower motor housing (arrow).

Test the blower motor series resistor using an ohmmeter. On 1984 models with 3-speed blower motors, the resistance ranges from 0.3 ohms (medium speed) to 1.1 ohms (low speed).

On 1985 and later models with 4-speed blower motors, the resistance varies from .35 (medium) and 1.6 (very low speed).

11.3 Rear Window Defogger

Except on convertible models, the rear window defogger is a series of resistance elements that heat up as electrical current passes through them. One or two wires that do not heat up suggests a break in the heating element. Repair material for the element is available from an authorized BMW dealer to repair the breaks as described below. An element that does not operate at all suggests that power is not reaching the heating element.

Check for voltage supply to the window element and check for a good connection to ground. Refer to Fig. 11-5 for details of the rear window defogger circuit on all models except convertibles.

On convertible models, the rear window defogger system uses a single speed blower motor and a heater coil. The blower motor and its relay are mounted behind the center of the rear seat back. The blower motor clears the rear window with heated air and will not operate if the convertible top is in the down position. Fig. 11-6 is a circuit diagram of the rear window defogger on convertible models.

To find and repair heating element breaks:

1. Wrap a small piece of aluminum foil around the negative (−) probe of a voltmeter.

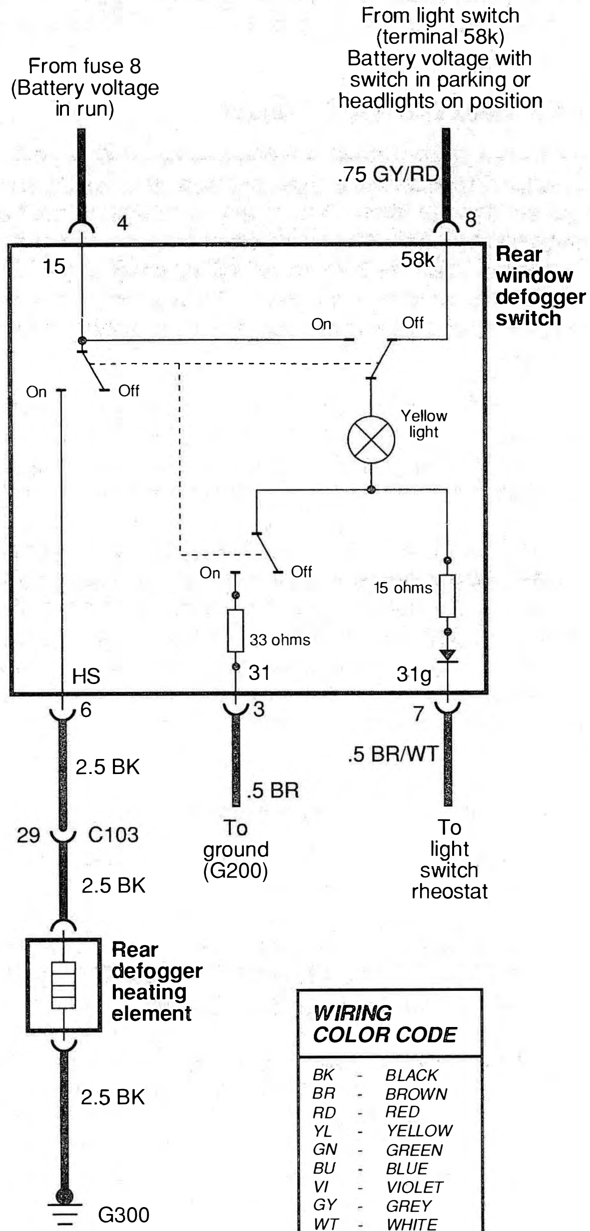
2. With the heating element's wiring connected, touch the positive (+) voltmeter probe to the end of the heater element closest to the incoming voltage source.

3. With the ignition and the defogger switch on, place the foil-covered negative probe on the faulty wire near the positive side of the element and slowly slide it toward the negative side. The point at which the voltmeter deflects from zero volts to several volts is where the wire is broken.

4. Clean the broken wire area thoroughly using alcohol or a mixture of vinegar and water.

5. Apply a strip of masking tape to either side of the break, leaving the break exposed. Apply the repair material over the break and allow it to dry for one hour at room temperature. Remove the tape and retest the wire.

NOTE —
A rear window repair kit (BMW Part No. 81 22 9 407 066) is available from an authorized BMW dealer parts department. The kit contains enough material to repair approximately three feet of heating strip.



WIRING COLOR CODE		
BK	-	BLACK
BR	-	BROWN
RD	-	RED
YL	-	YELLOW
GN	-	GREEN
BU	-	BLUE
VI	-	VIOLET
GY	-	GREY
WT	-	WHITE
PK	-	PINK

Fig. 11-5. Rear window defogger circuit for sedan models.

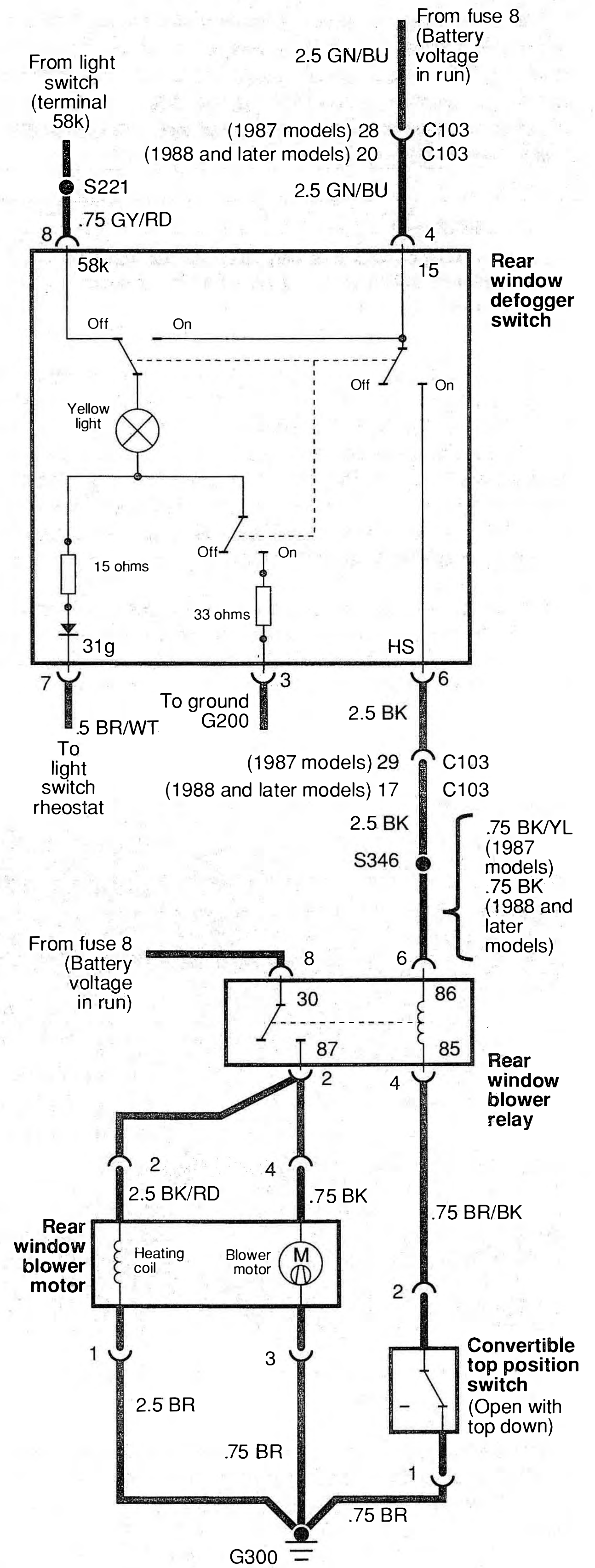


Fig. 11-6. Rear window defogger circuit for convertible models.

12. POWER OPTIONS AND ACCESSORIES

The power windows and the heated seats are powered through one load reduction relay, while the heated/power mirrors and heater/air conditioning are powered through the other reduction relay. If these systems fail together, one likely cause is a faulty relay.

The central locking system receives its power directly from the battery through a fuse. The cruise control is powered only when the ignition is on.

When troubleshooting these systems, check first for blown fuses. Fuses are simple to check and are a likely cause of trouble. A circuit breaker on the instrument panel is used instead of a fuse for the power windows and mirrors.

12.1 Power Sunroof

Fig. 12-1 is a diagram of the sunroof circuits. On 1987 and later models, the sunroof switch is illuminated. Removal of the sunroof and related parts are covered in **BODY AND INTERIOR.**

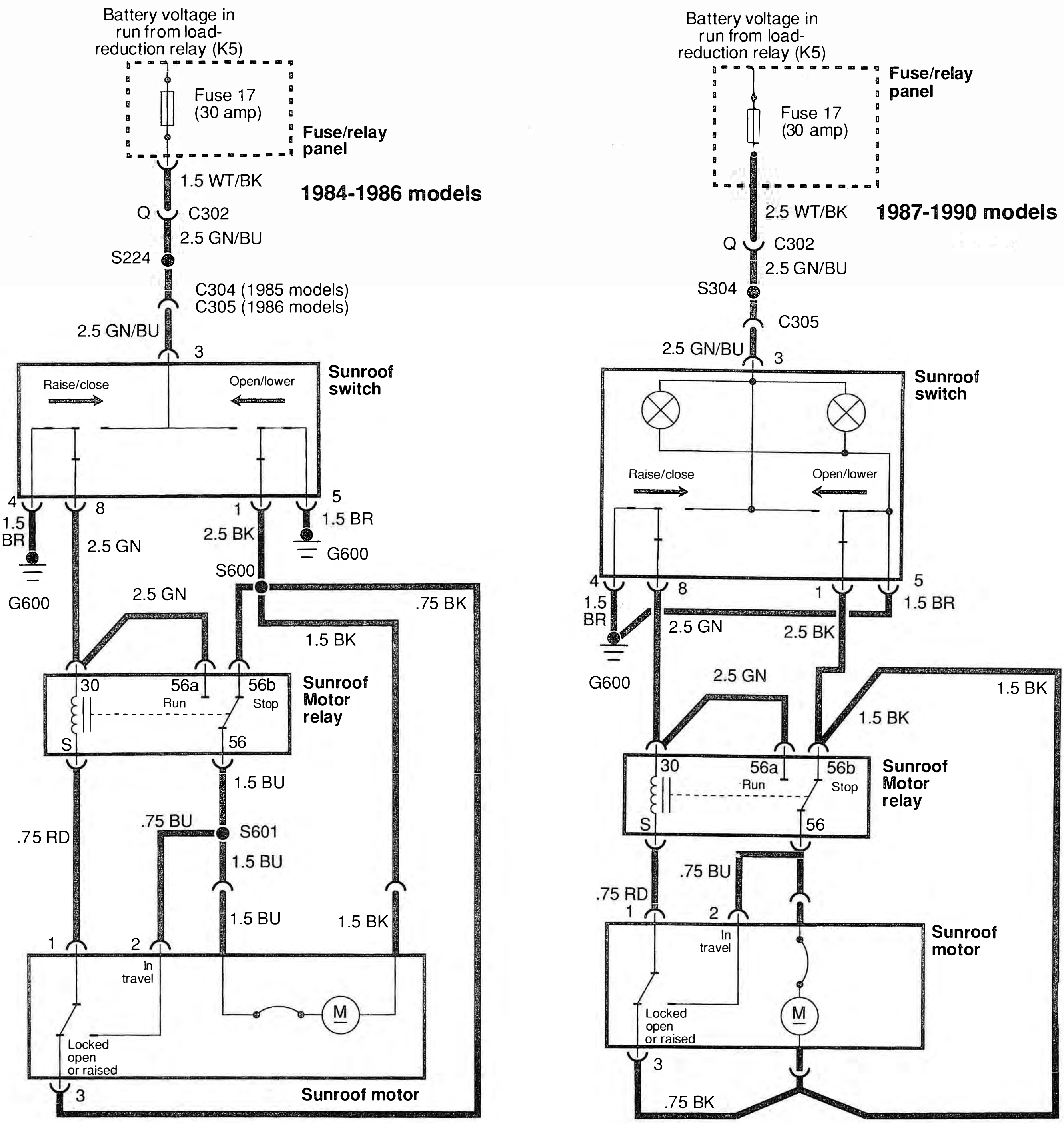


Fig. 12-1. Circuit diagram for the power sunroof on 1984 through 1986 models (left) and 1987 through 1990 models (right).

12.2 On-Board Computer

The major components of the on-board computer are the electronic computer module with integral digital display, the on-board computer horn, the chime module, the relay box, and the remote switch on the steering column.

The on-board computer computes its information using inputs from the following sensors and components: the outside temperature sensor, the speedometer, the fuel gauge and the low fuel warning switch in the fuel tank, and the Motronic or L-Jetronic control unit.

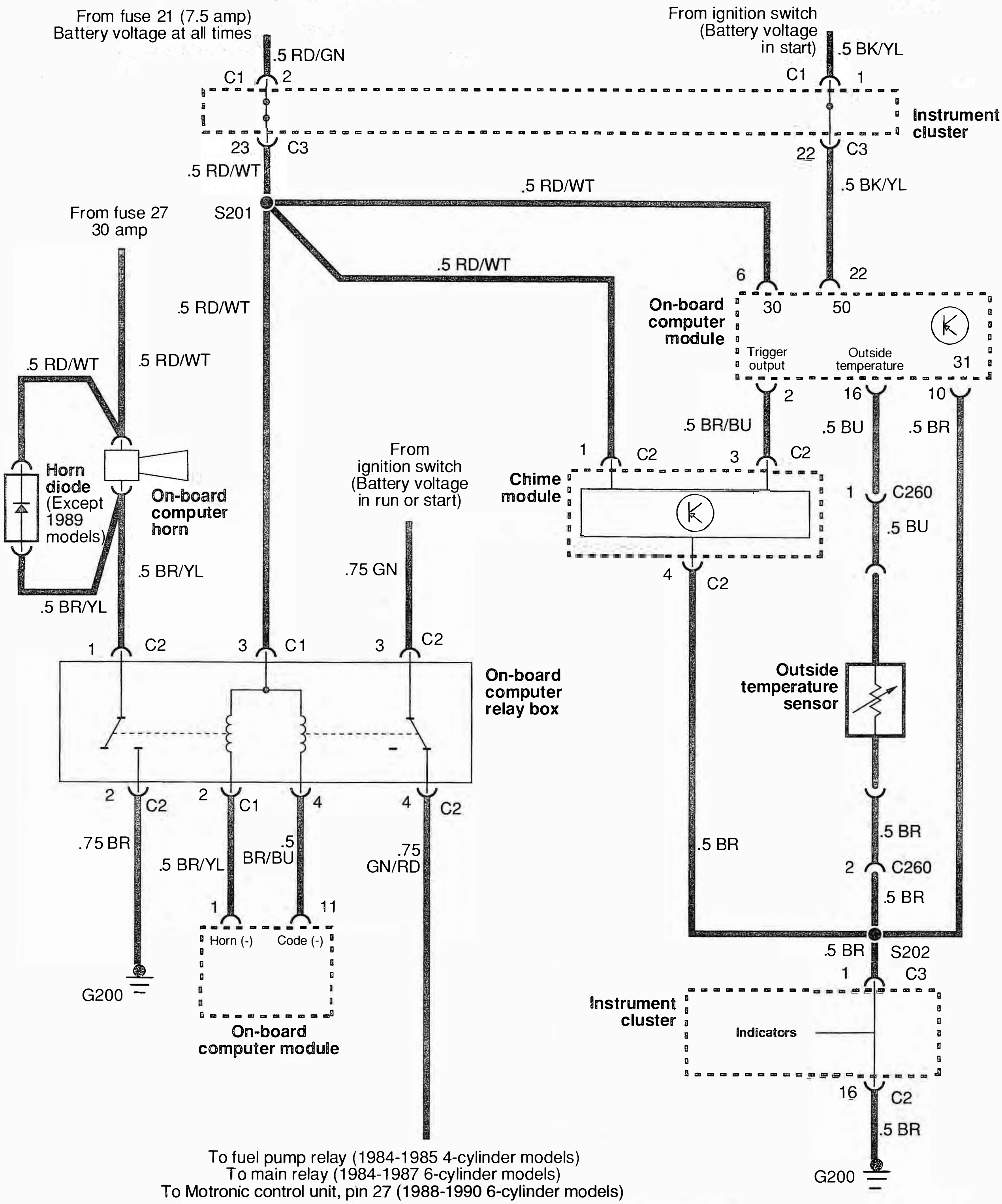
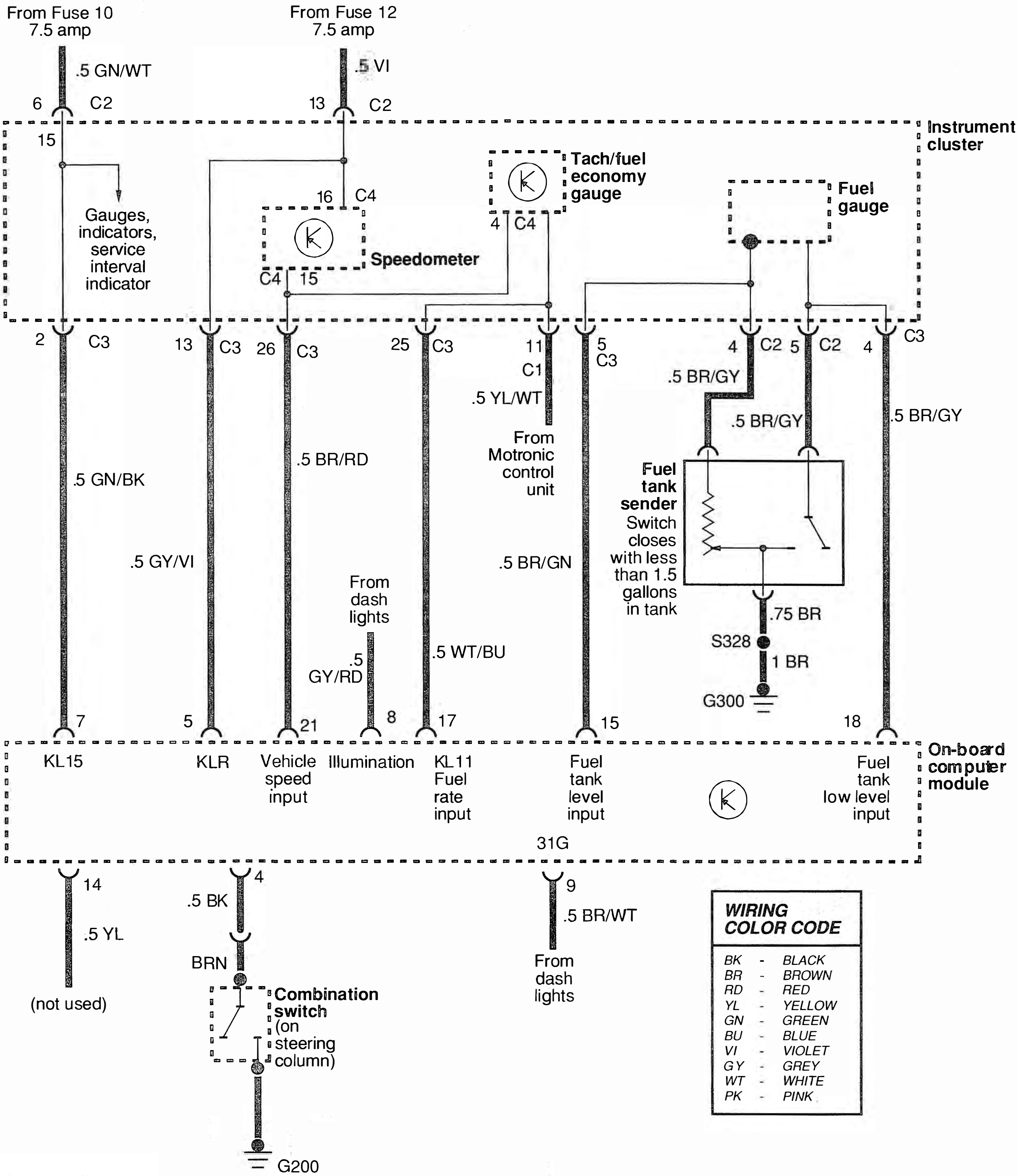


Fig. 12-2. On-board computer circuit. (continued on next page)

No adjustments can be made to the system. Use the circuit diagram as shown in Fig. 12-2 to help find any faults in the wiring. If no faults can be found, the control module or the coding plug on the rear of the control module may be faulty. If the system is completely inoperative, a fuse may have blown. There are five replaceable fuses in the on-board computer circuit: 10, 12, 21, 23, and 27.

NOTE

If the on-board computer digital readout displays either AAAA or PPPP, the system has detected an electronic fault. If either of these fault codes appear, have the system checked by an authorized BMW dealer.



WIRING COLOR CODE		
BK	-	BLACK
BR	-	BROWN
RD	-	RED
YL	-	YELLOW
GN	-	GREEN
BU	-	BLUE
VI	-	VIOLET
GY	-	GREY
WT	-	WHITE
PK	-	PINK

12.3 Active Check Control

Fig. 12-3 is a circuit diagram for the active check control. The active check control uses various relays, switches and an oil level sensor to monitor the lights and engine fluids. Testing procedures for the oil level sensor can be found in **ENGINE.** The check control panel can be easily removed by pushing it up and prying it out from the bottom.

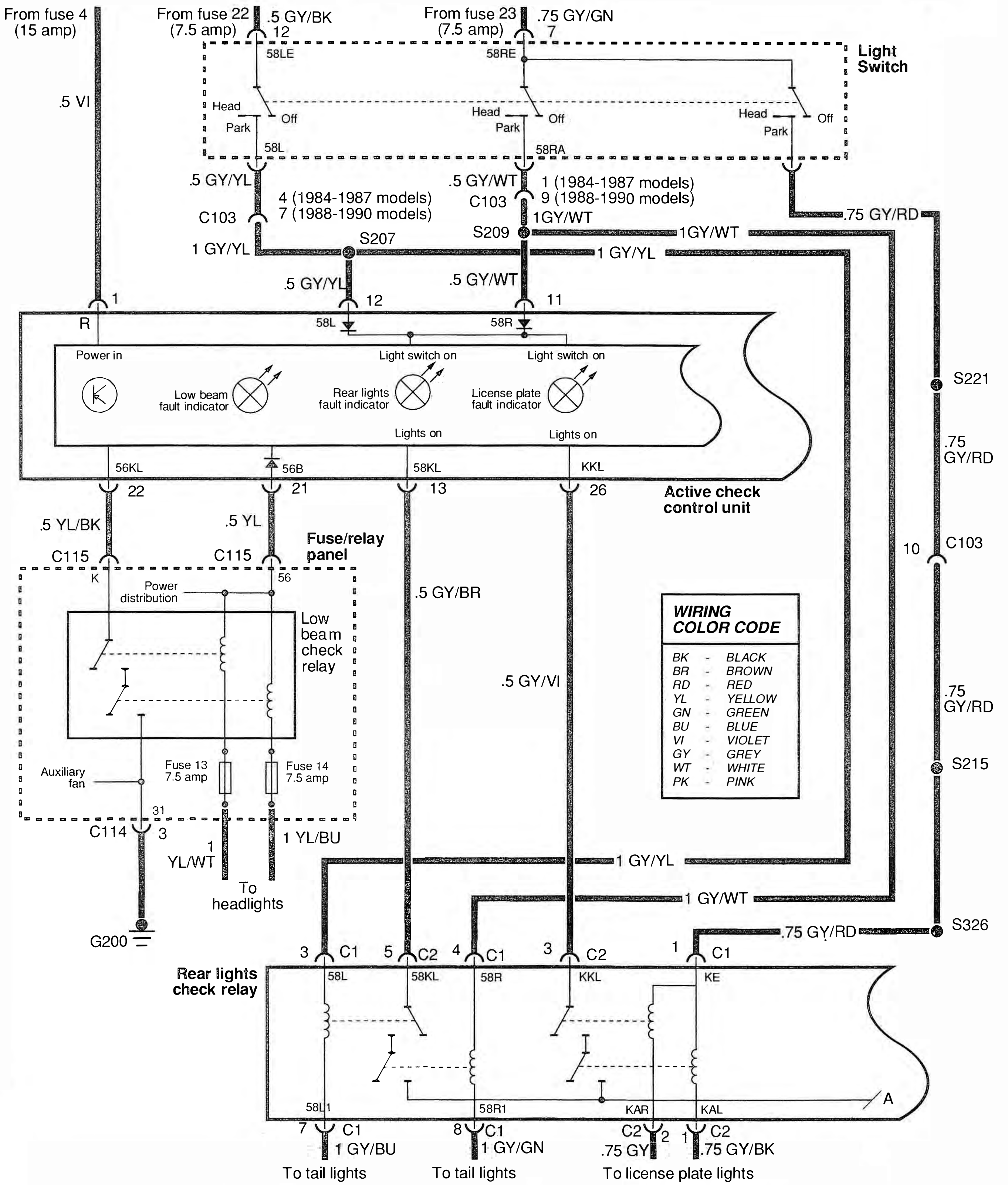
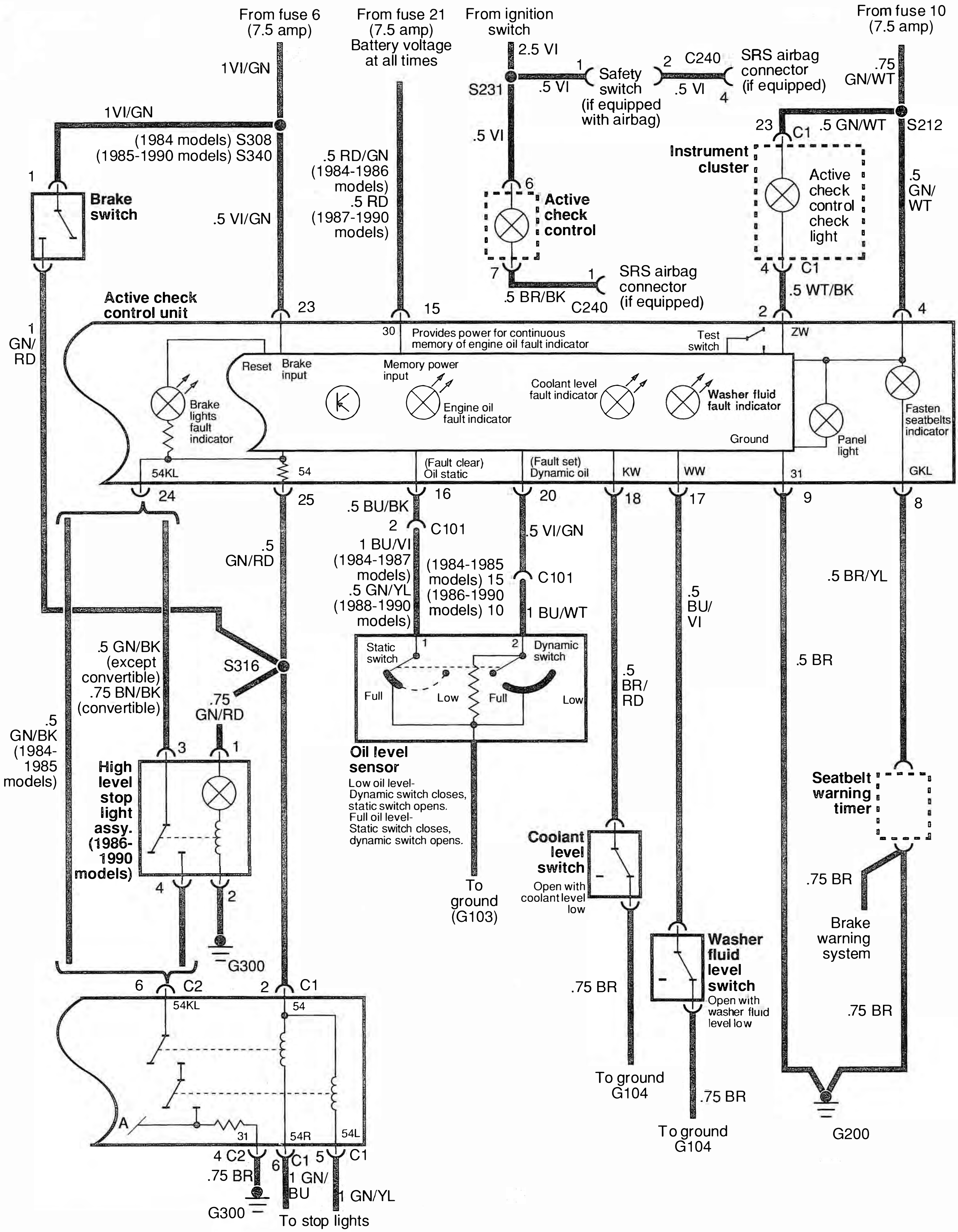


Fig. 12-3. Active check control circuit. Circuit may vary slightly on some models. (continued on next page)


From fuse 6 (7.5 amp)
From fuse 21 (7.5 amp) Battery voltage at all times
From ignition switch
From fuse 10 (7.5 amp)
1 VI/GN
2.5 VI
S231
.5 VI
1
Safety switch (if equipped with airbag)
2 C240
.5 VI
4
SRS airbag connector (if equipped)
.75 GN/WT
S212
(1984 models) S308
(1985-1990 models) S340
Brake switch
.5 VI/GN
.5 RD/GN (1984-1986 models) .5 RD (1987-1990 models)
.5 VI
Active check control
Instrument cluster
23 C1 .5 GN/WT
Active check control check light
.5 GN/WT
4 C1
.5 WT/BK
SRS airbag connector (if equipped)
.5 BR/BK
C240
Active check control unit
1 GN/RD
23
15
2
4
30
Provides power for continuous memory of engine oil fault indicator
Test switch
ZW
Reset
Brake input
Memory power input
Coolant level fault indicator
Washer fluid fault indicator
Brake lights fault indicator
Engine oil fault indicator
Fasten seatbelts indicator
Panel light
Ground
54KL
54
(Fault clear) Oil static
(Fault set) Dynamic oil
KW
WW
31
GKL
24
25
16
20
18
17
9
8
.5 BU/BK
2 C101
1 BU/VI (1984-1987 models) .5 GN/YL (1988-1990 models)
(1984-1985 models) 15 (1986-1990 models) 10
.5 VI/GN
C101
1 BU/WT
.5 GN/RD
.5 BU/VI
.5 BR/YL
.5 BR
.5 GN/BK (except convertible) .75 BN/BK (convertible)
S316
.75 GN/RD
.5 GN/BK (1984-1985 models)
Static switch
Dynamic switch
Full
Low
Full
Low
Oil level sensor
Low oil level- Dynamic switch closes, static switch opens.
Full oil level- Static switch closes, dynamic switch opens.
.5 BR/RD
3
1
High level stop light assy. (1986-1990 models)
4
2
G300
To ground (G103)
Coolant level switch
Open with coolant level low
Seatbelt warning timer
.75 BR
Brake warning system
Washer fluid level switch
Open with washer fluid level low
.75 BR
.75 BR
To ground G104
.75 BR
To ground G104
G200
6 C2
2 C1
54KL
54
A
31
54R
54L
4 C2
.75 BR
6 C1
5 C1
1 GN/BU
1 GN/YL
G300
To stop lights

12.4 Power Windows

The power windows are operated by polarity-reversing motors. Depending on the position of the switches, current is routed to change the rotation direction of the motor. On 4-door models, the rear window lockout switch prevents operation of the rear windows by interrupting the voltage supply to the rear window switches. For removal and replacement of the power window motor assemblies, see **BODY AND INTERIOR**. The console-mounted switches and the rear door switches are pressed into place and can be carefully pried out for testing.

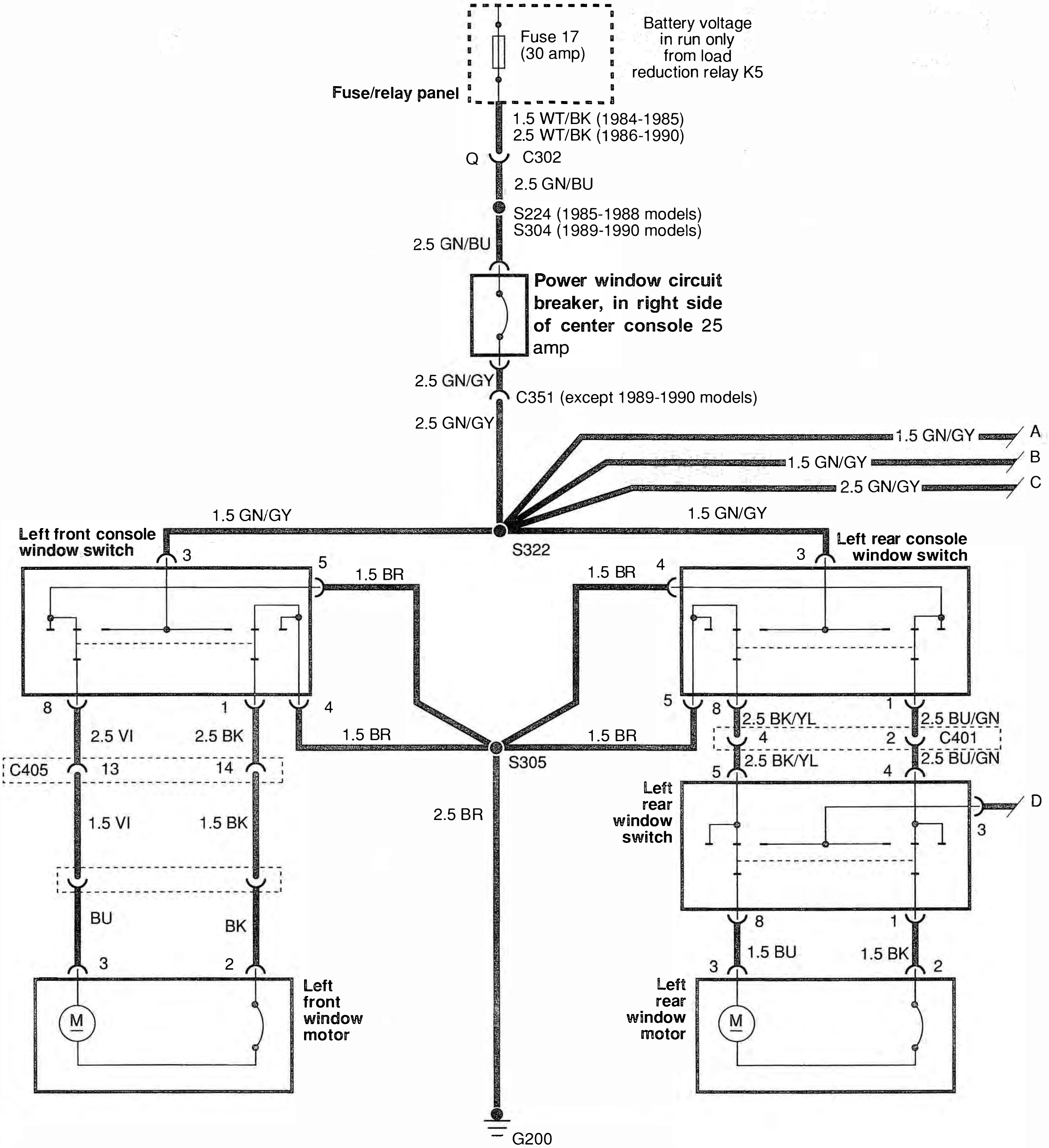
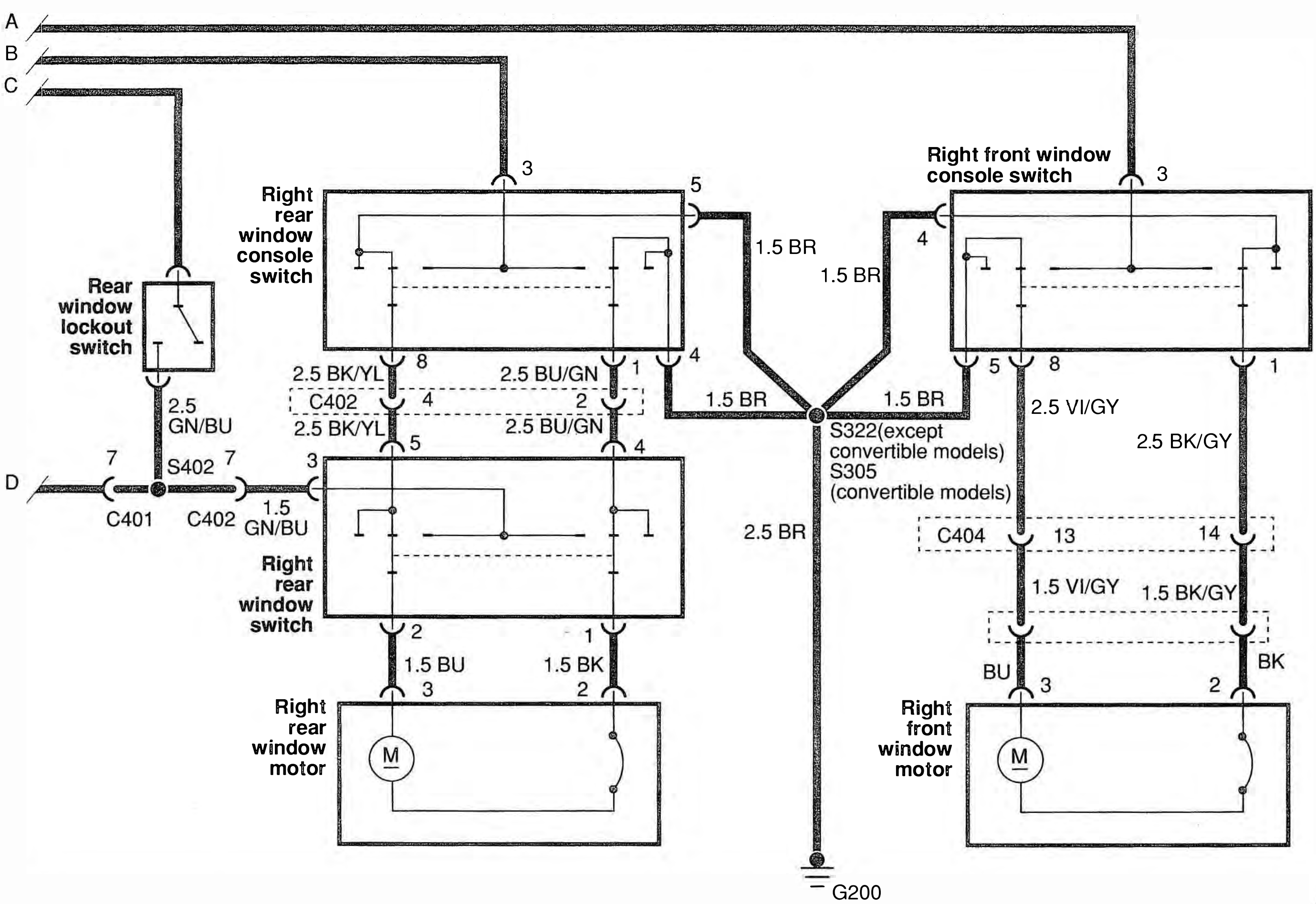


Fig. 12-4. Power window circuit for 4-door sedan and convertible models. Late 1986 through 1990 models use lighted switches (not shown). Circuit on convertible model may vary slightly. (continued on next page)

A single power window that does not operate can be tested without disassembling the door. Remove the rocker switch and disconnect its harness connector. Turn the ignition on and check for voltage at the connector. Also check ground. If voltage is reaching the switch and there is a good ground, check continuity on the switch. Fig. 12-4 and 12-5 show power window circuits for 4-door and 2-door models.

WIRING COLOR CODE

BK	-	*BLACK*
BR	-	*BROWN*
RD	-	*RED*
YL	-	*YELLOW*
GN	-	*GREEN*
BU	-	*BLUE*
VI	-	*VIOLET*
GY	-	*GREY*
WT	-	*WHITE*
PK	-	*PINK*



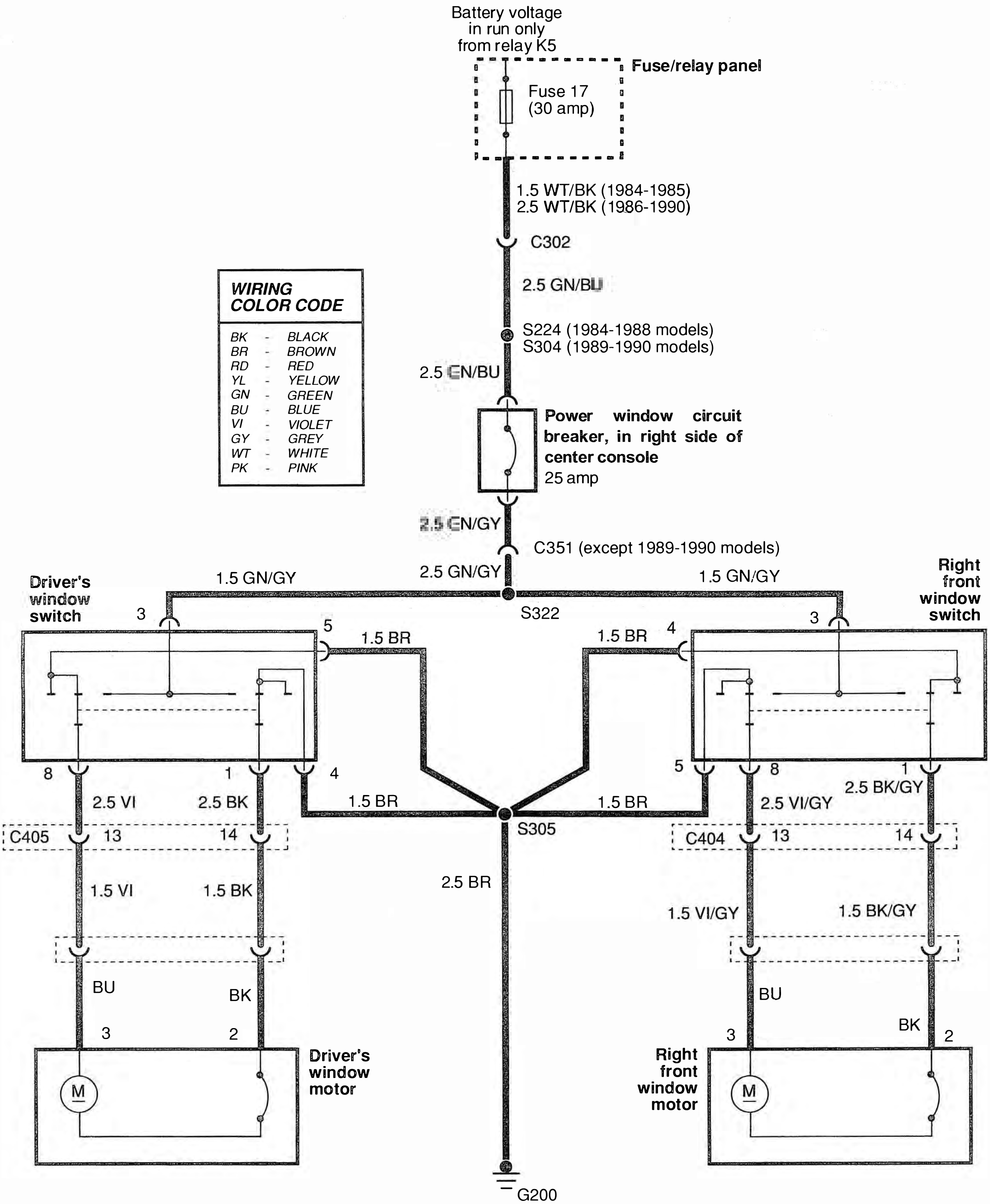


Fig. 12-5. Power window circuit for 2-door sedan models. Late 1986 through 1990 models use lighted switches (not shown).

12.5 Power Outside Mirrors

The mirror motors are operated by a door-mounted switch. Some 1984 and 1985 models have dual motors in each mirror. One is for left and right movements and one is for up and down movements. On all other models, a single motor controls the mirror's movement via a magnetic clutch. For removal and replacement of the mirror assemblies or motors, see **BODY AND INTERIOR**. The door-mounted switch is pressed into place and can be carefully pried out for testing. Fig. 12-6 is a circuit diagram for the electric mirrors.

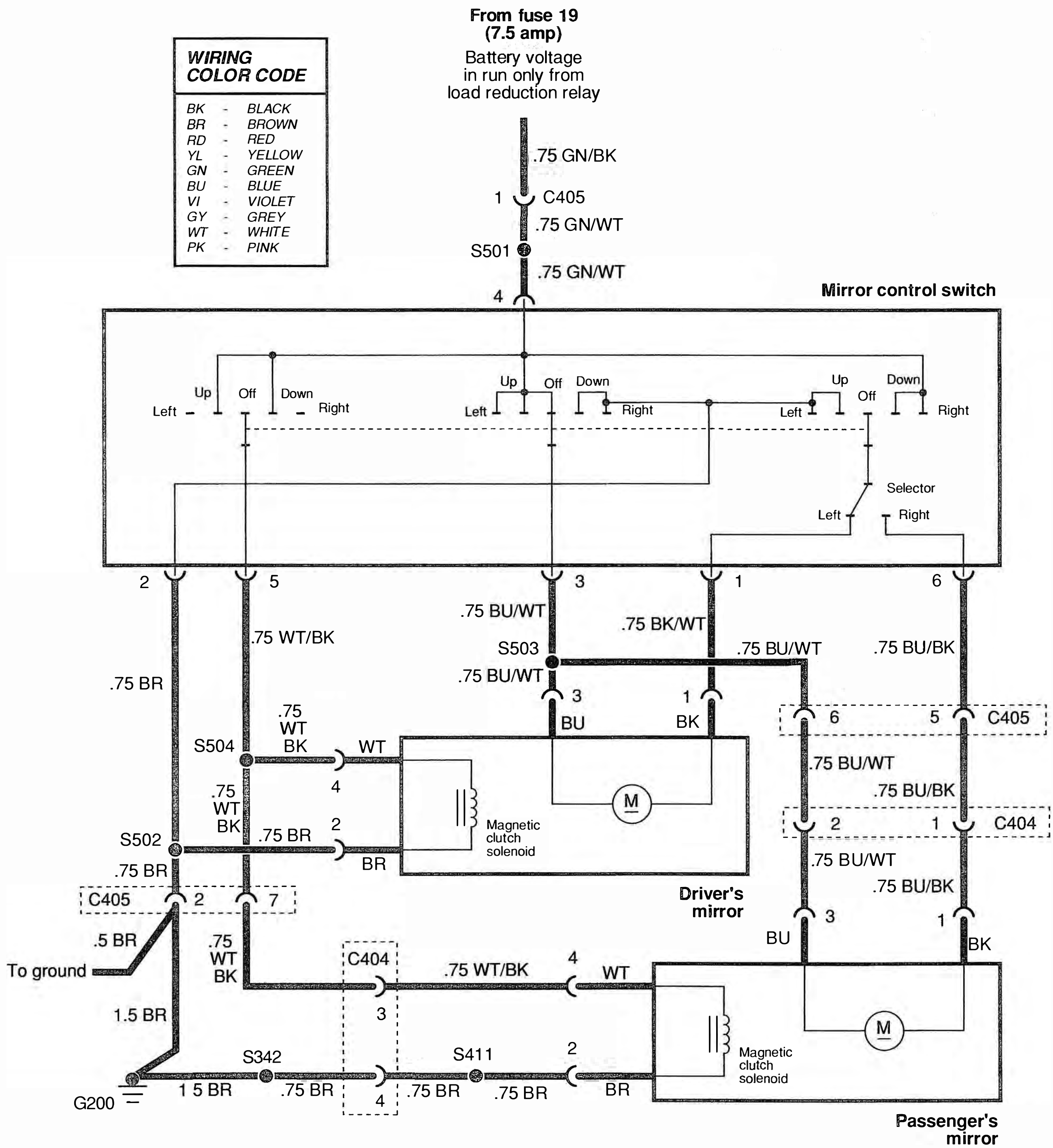


Fig. 12-6. Power mirrors circuit. Mirrors with single motor shown. Mirrors with dual motors are similar.

12.6 Central Locking System

The electric locking system is controlled by a central electronic control unit that is mounted below the left front speaker in the driver's side footwell. A ground signal to the control unit is provided by micro-switches in the front door locks and the trunk lid lock. Depending on the position of the micro-switch, current is routed to change the rotation direction of the drive. An additional feature allows automatic unlocking of the doors in the event of an accident. Use Fig. 12-7 or Fig. 12-8 as a guide when troubleshooting the central locking system. For removal and replacement of the central locking drive assemblies, see **BODY AND INTERIOR**.

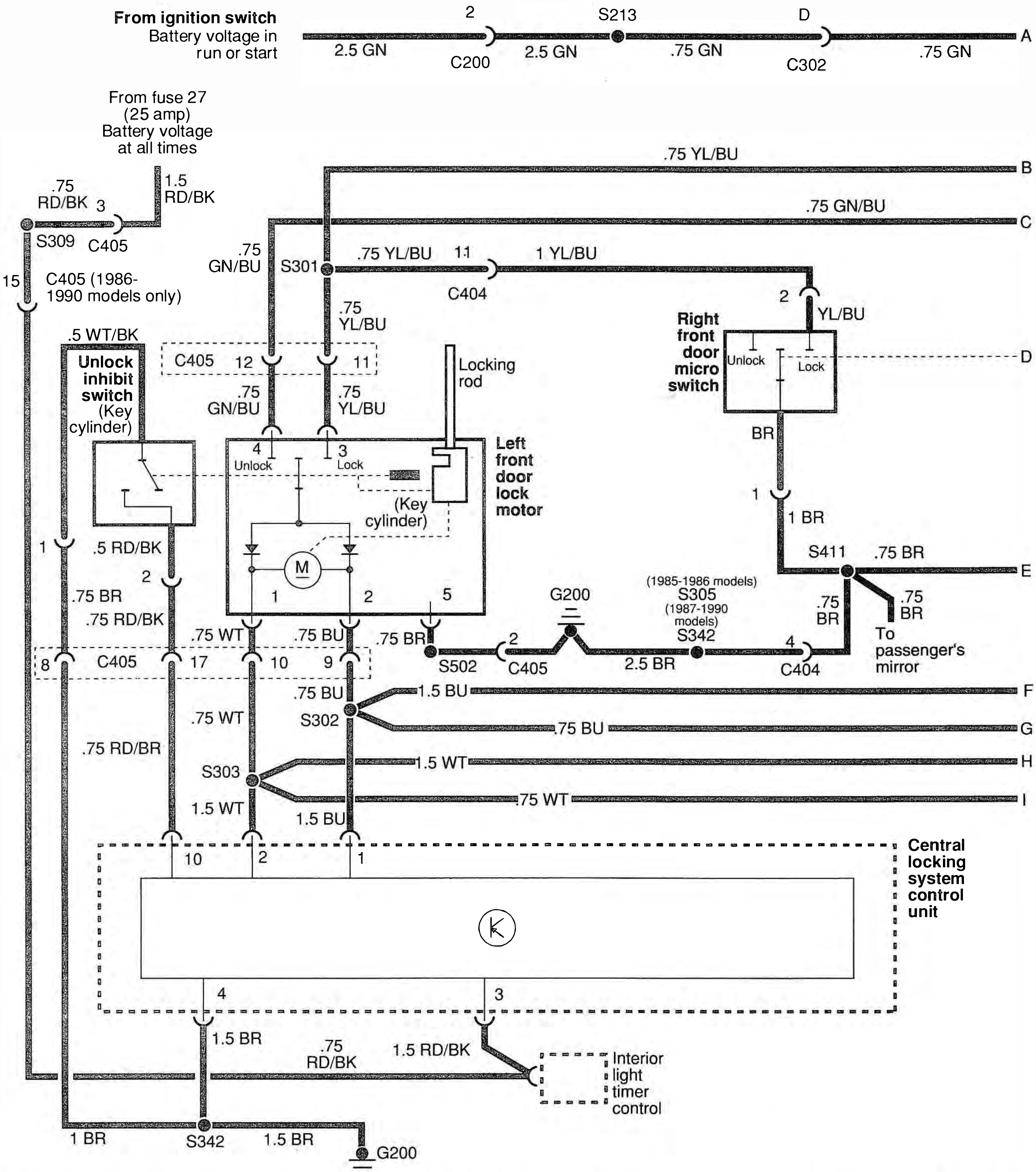
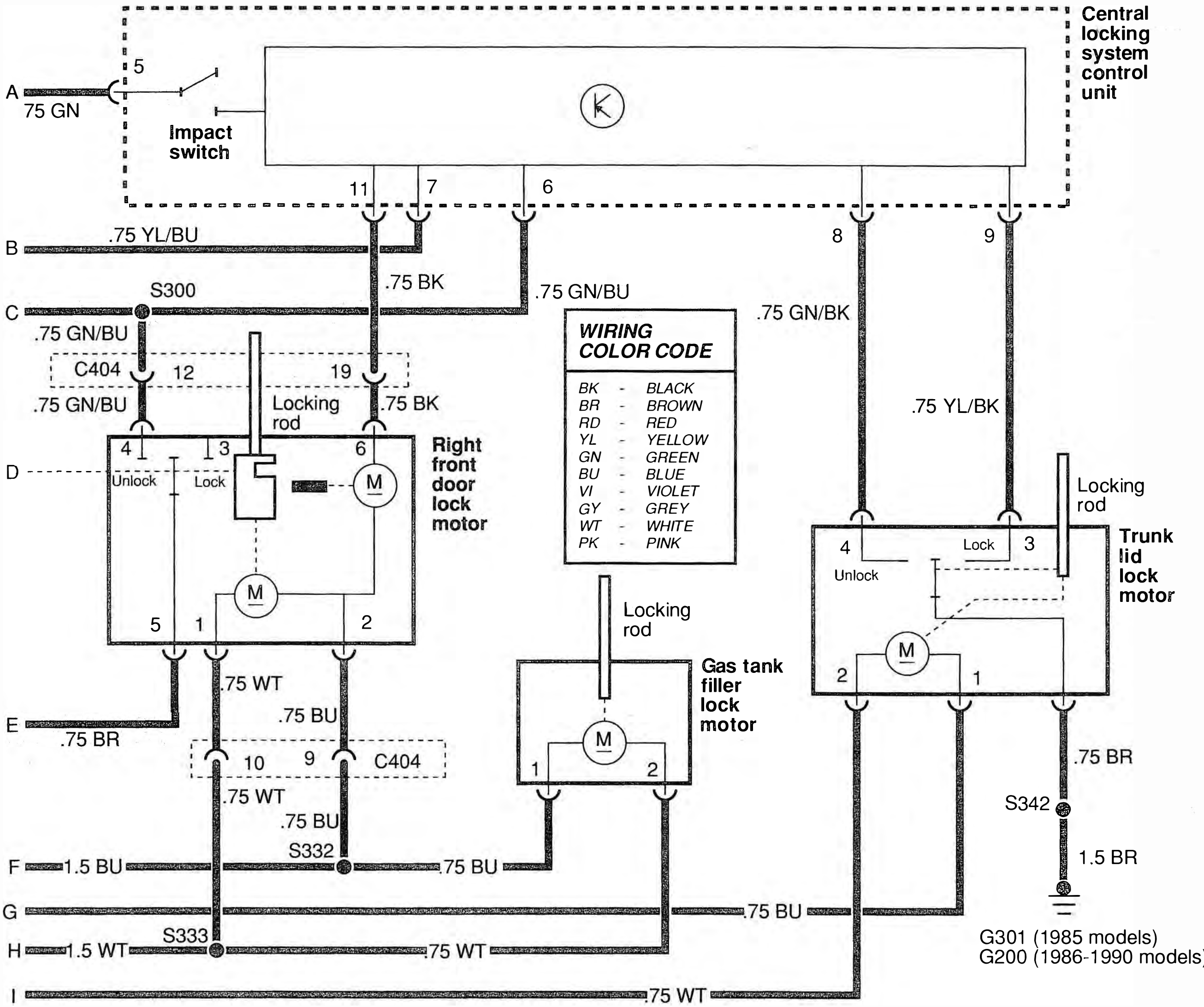


Fig. 12-7. Central locking system circuit for 2-door sedan and convertible models. Circuit on 1984 models may vary slightly. (continued on next page)



CAUTION —

The control unit may be damaged if the central locking system is operated in quick succession more than eight times. On most 1986 and later models (produced after September 1985), a safety feature has been integrated into the central locking system control unit circuitry that will turn the system off momentarily if the system is overloaded.

CAUTION —

Remove and install the control unit only with the battery disconnected. Do not operate the system with the control unit removed from its mounting or the control unit may be damaged.

NOTE —

As a general rule, blue wires are used for the locking side of the circuit and white wires are used for the unlocking side of the circuit.

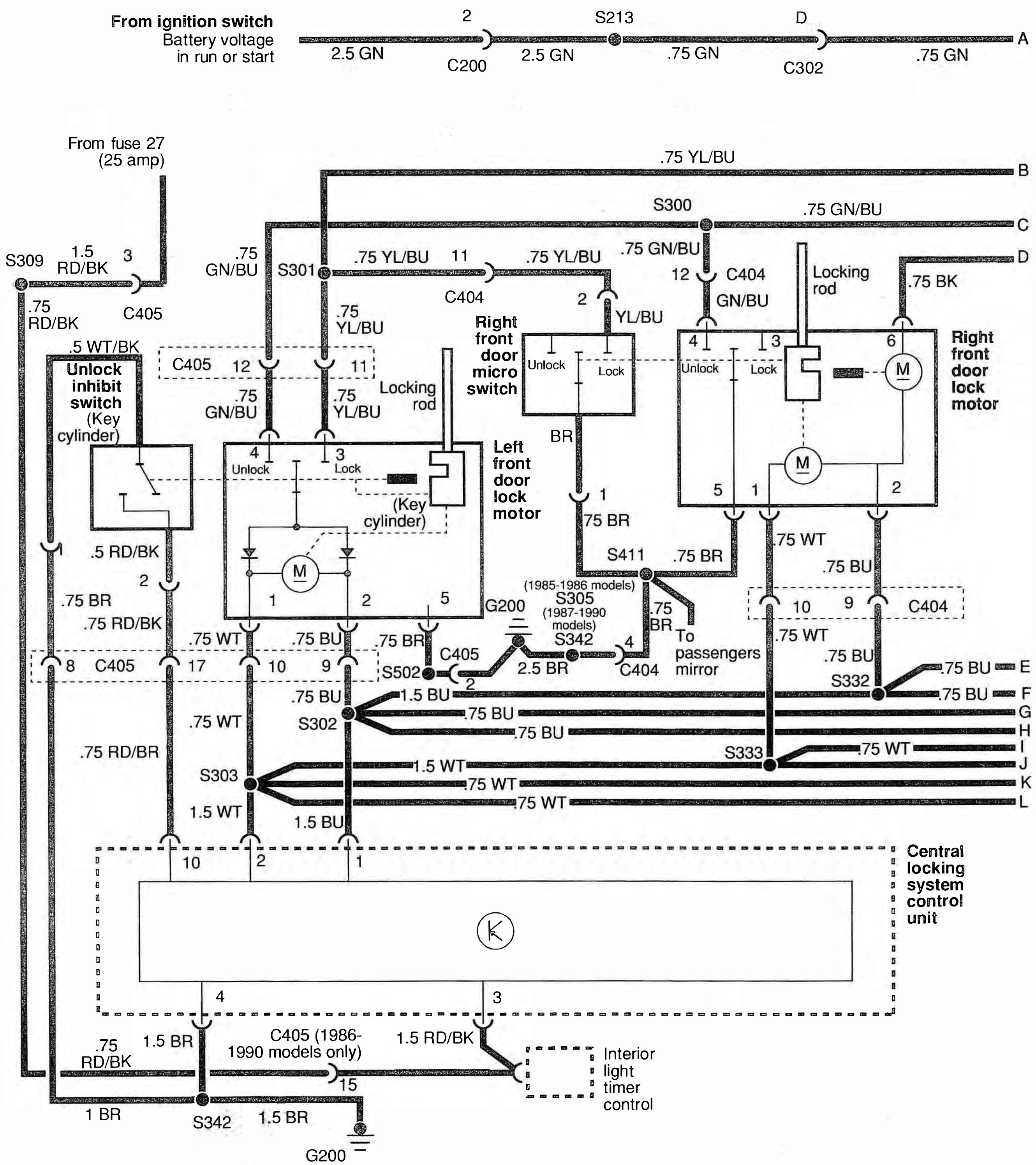
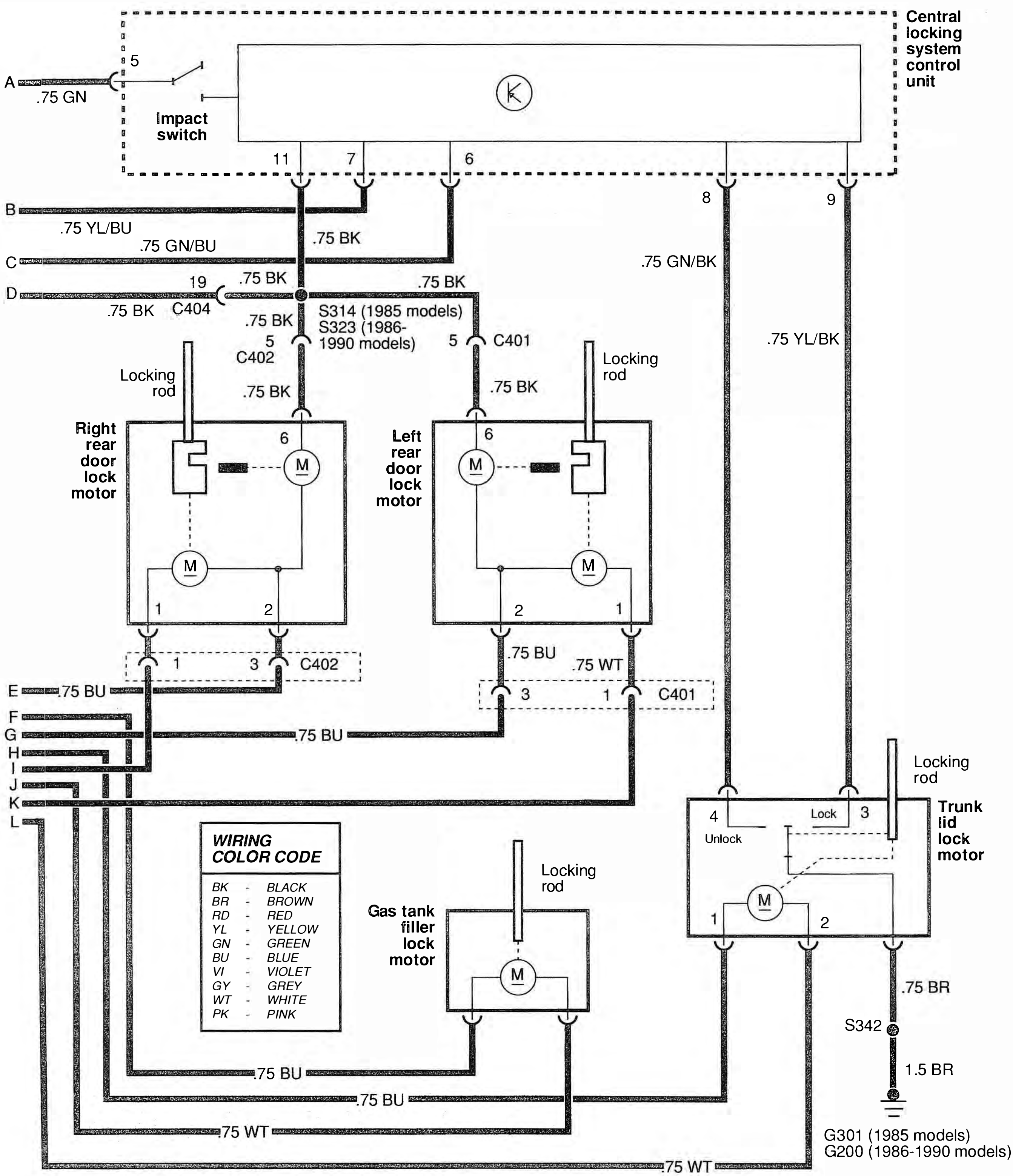


Fig. 12-8. Central locking system circuit for 4-door sedan models. (continued on next page)


Central locking system control unit
A
.75 GN
5
Impact switch
11
7
6
8
9
B
.75 YL/BU
.75 GN/BU
C
.75 BK
19
D
.75 BK
C404
S314 (1985 models)
S323 (1986-1990 models)
C402
C401
.75 GN/BK
.75 YL/BK
Locking rod
Right rear door lock motor
Left rear door lock motor
M
1
2
3
.75 BU
.75 WT
E
F
G
H
I
J
K
L
WIRING COLOR CODE
BK - BLACK
BR - BROWN
RD - RED
YL - YELLOW
GN - GREEN
BU - BLUE
VI - VIOLET
GY - GREY
WT - WHITE
PK - PINK
Gas tank filler lock motor
Trunk lid lock motor
4
Unlock
Lock
.75 BR
S342
1.5 BR
G301 (1985 models)
G200 (1986-1990 models)

12.7 Cruise Control

The circuit of the cruise control is shown in Fig. 12-9. The cruise control system consists of an electronic control unit, a cruise control servo, a cruise control switch on the steering column, and switches at the brake and clutch pedals. The cruise control operates at speeds above 28 mph (45 km/h).

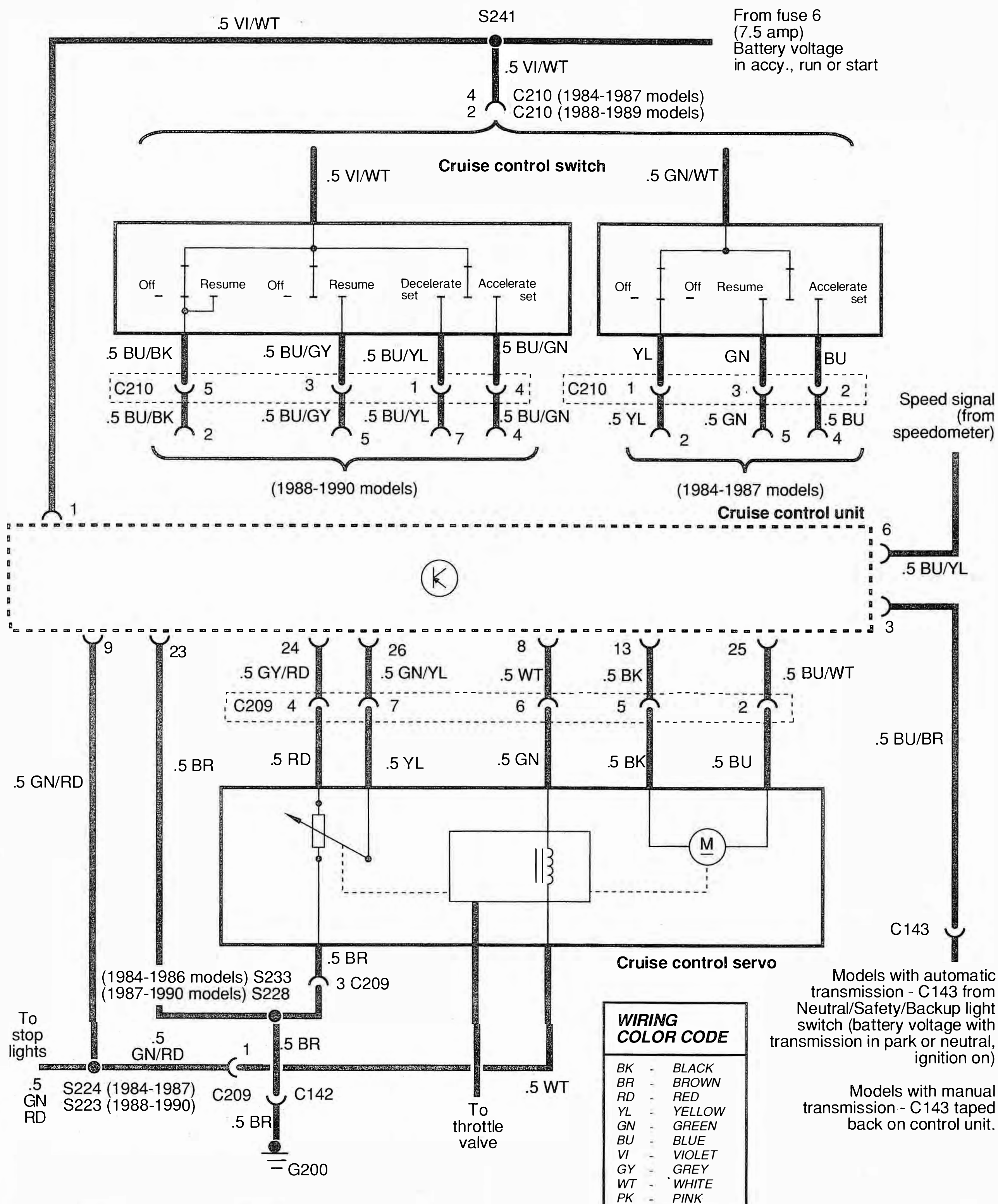


Fig. 12-9. Cruise control circuit.

The control unit, using the signal from the speedometer, compares the car's true speed to the cruise control speed selected by the driver. The control unit then turns on the control motor in the servo to open or close the throttle via a cable. If the driver steps on either the brake pedal or clutch pedal, the cruise control is switched off.

When troubleshooting the cruise control system, first check for faulty a fuse (no. 6). Check that the brake light bulbs are operating correctly. The cruise control system can not be engaged unless there is ground at pin 9 of the control unit. This ground comes from the chassis through the brake light bulbs. Check the operation of the clutch switch and the brake light switch by making continuity checks at the connectors with the pedals depressed and released. Check that the actuating cable is not kinked or damaged.

The control unit is located beneath the dashboard above the glove compartment, directly above the fuel injection control unit. The cruise control servo motor is mounted on the forward part of the driver's side fender.

13. Harness Connector, Ground, Splice, and Component Locations

Table s, **Table t**, **Table u**, **Table v**, and **Table w** list the locations of the various harness connectors, grounds, splices (welded connections in the wiring harness), and various relays and components used throughout the circuit diagrams contained in this section. For the exact positions of the fuses and relays, see **14. Fuse/Relay Panel** below.

Table s. Wiring Harness Connector Locations

Connector	Location
C1	Rear of instrument cluster (blue, 26-pin)
C2	Rear of instrument cluster (white, 26-pin)
C3	Rear of instrument cluster (yellow, 26-pin)
C4	Rear of instrument cluster, under rear panel (16-pin)
C5	Rear of instrument cluster, under rear panel (19-pin)
C101	1984–1985—On side of fuse/relay panel (19-pin) 1986–1990—On rear fire wall, near fuse relay panel (20-pin)

continued

Table s. Wiring Harness Connector Locations (continued)

Connector	Location
C103	1984–1988—Beneath instrument panel, on steering column (29-pin) 1989–1990—Beneath instrument panel, on steering column (30-pin)
C114	Underside of fuse relay panel (8-pin)
C115	Underside of fuse relay panel (2-pin)
C128	Behind right front side marker light (2-pin)
C200	1984–1988—Beneath instrument panel, near steering column (9-pin) 1989–1990—Beneath instrument panel, near steering column (10-pin)
C201	Beneath instrument panel, on steering column (6-pin)
C202	Beneath instrument panel, on steering column (13-pin)
C204	1984–1987—Beneath left side of instrument panel, on right side of steering column (9-pin) 1988–1990—Beneath left side of instrument panel, on right side of steering column (12-pin)
C208	Automatic transmission—Beneath instrument panel, connected to C204 (2-pin)
C209	Manual transmission—Beneath instrument panel, on clutch pedal support (2-pin)
C210	1984–1988—Beneath instrument panel, near steering column (4-pin) 1989–1990—Beneath instrument panel, near steering column (7-pin)
C240	Beneath left side of instrument panel (6-pin)
C241	Beneath instrument panel, near steering column (1-pin)
C260	Beneath left side of instrument panel, near chime module (2-pin)
C301	In center console, at base of shift lever (2-pin)
C302	Beneath left side of instrument panel (25-pin)
C304	At base of driver's side B-pillar (3-pin)
C305	Beneath left side of instrument panel, near C302 (1-pin)

continued on next page

Table s. Wiring Harness Connector Locations (continued)

Connector	Location
C306	In center console, near base of shift lever (9-pin)
C351	Beneath left side of instrument panel (1-pin)
C401	1984—Above passenger's side footwell speaker (13-pin) 1985–1990—In driver's side B-pillar (7-pin)
C402	1984—Above driver's side footwell speaker (13-pin) 1985–1990—In passenger's side B-pillar (7-pin)
C404	Above passenger's side door jamb switch (21-pin)
C405	Above driver's side door jamb switch (21-pin)

Table t. Wiring Harness Ground Locations

Ground point	Location
G100	In luggage compartment, behind battery (6-cylinder models with trunk-mounted battery) In engine compartment on right shock tower (all models with engine compartment-mounted battery)
G102	On top rear of engine (4-cylinder engine only)
G103	On right front shock tower (2.5i engine only) On left side of engine block, above starter (2.7e engine only)
G104	On front fender, behind left headlights
G200	Beneath instrument panel, above brake pedal
G201	On steering column, near horn brush/slip ring
G300	Beneath left side of rear seat bottom
G301	In luggage compartment
G600	In windshield header

Table u. Wiring Harness Splice Locations

Splice (welded connection in wiring harness)	Harness and Approximate Location
S100	Main harness, front left corner in engine compartment
S102	Main harness, front left corner in engine compartment
S103	Main harness, front right corner in engine compartment
S107	1984–1985 318i—Engine harness, top of engine 1986–1990 325—Engine harness, beneath left side of instrument panel, above glove compartment
S114	Main hamess, front center in engine compartment
S201	On-board computer harness, beneath center of instrument cluster
S202	On-board computer harness, beneath center of instrument panel, beneath heating and ventilation controls
S207	1984–1986—Main harness, behind instrument panel 1987–1990—Main harness, beneath left side of driver's seat
S209	1984–1986—Main harness, behind instrument panel 1987–1990—Main harness, beneath left side of driver's seat
S210	1984–1986—Main harness, behind instrument panel 1987–1990—Main harness, beneath left side of driver's seat
S211	1984–1986—Main harness, behind instrument panel 1987–1990—Main harness, beneath left side of driver's seat
S212	1984–1986—Main harness, behind instrument panel 1987–1990—Main harness, beneath left side of driver's seat
S213	Main harness, behind instrument panel
S215	1984–1986—Main harness, on driver's side floor, beneath instrument panel 1987–1990—Main harness, beneath left side of driver's seat
S221	1984–1986 Instrument panel harness, beneath center of instrument cluster 1987–1990 Instrument panel harness, beneath left side of instrument panel
S223	Cruise control harness
S224	Multi function clock harness
S228	Cruise control harness

continued on next page

Table u. Wiring Harness Splice Locations (continued)

Splice (welded connection in wiring harness)	Harness and Approximate Location
S229	Air conditioning harness
S230	Main harness, behind left side of instrument cluster
S231	Main harness, behind left side of instrument cluster
S232	Main harness, behind center of instrument cluster
S233	Main harness, beneath left side of driver's seat
S240	Air conditioning harness
S241	Main harness, in rear left quarter of luggage compartment
S250	Air conditioning harness
S251	Air conditioning harness
S300	Door harness, in driver's side footwell
S301	Door harness, beneath front edge of drivers door
S303	Door harness, beneath left side of driver's seat
S304	Door harness, in driver's side footwell
S305	Door harness, beneath door switch assembly in center console
S306	1984–1986—Instrument panel harness, beneath center of instrument panel, beneath heating and ventilation controls 1987–1990—Instrument panel harness, beneath left side of instrument panel
S308	Door harness, inside door in front of mirror switch
S309	Door harness, inside door in front of mirror switch
S316	Main harness, on driver's side floor beneath instrument panel
S322	Main harness, beneath right side of driver's seat
S324	Main harness, left rear corner of luggage compartment
S326	Main harness, left rear corner of luggage compartment
S328	Main harness, beneath right side of rear seat
S332	Door harness, beneath right side of passenger's seat

continued

Table u. Wiring Harness Splice Locations (continued)

Splice (welded connection in wiring harness)	Harness and Approximate Location
S333	Door harness, beneath right side of passenger's seat
S340	Main harness, on driver's side floor, beneath instrument panel
S342	Door harness, beneath left side of driver's seat
S346	Main harness
S402	1984–1988—Door Harness, beneath driver's seat 1989–1990—Door harness, beneath passenger's seat
S411	Door harness, inside passenger's door, front edge
S501	Door harness, inside driver's door
S502	Door harness, inside driver's door
S503	Door harness, inside driver's door
S504	Door harness, inside driver's door
S600	Sunroof harness
S601	Sunroof harness

Table v. Relay Locations

Relay	Location
Fuel pump	Auxiliary relay panel. See **14. Fuse/Relay Panel**
Fog light relay	In fuse/relay panel
High beam relay	In fuse/relay panel
Horn relay	In fuse/relay panel
Load reduction relay	In fuse/relay panel
Low beam relay	In fuse/relay panel
Low beam check relay	Integrated into fuse/relay panel and part of printed circuit board
On-board computer relay	Beneath left side of instrument panel, behind ABS control unit
Rear lights check relay	Luggage compartment, near power antenna
Rear window blower relay (convertible only)	Behind center of rear seat, attached to blower motor
Start relay (automatic transmission only)	Upper left corner of driver's footwell
Sunroof motor relay	In windshield header
Wiper control unit relay	In fuse/relay panel

Table w. Other Electrical Component Locations

Other Components	Location
ABS control unit	Beneath driver's side of instrument panel
Active check control unit	In windshield header
Back-up light switch	On transmission side
Brake light switch	Above brake pedal
Central locking system control unit	In driver's footwell, below speaker
Chime module	Beneath driver's side of instrument panel, attached to lower trim panel
Clutch switch	Above clutch pedal
Coolant level switch	In coolant expansion tank
Convertible top position switch	Driver's side of top stowage compartment
Cruise control unit	Beneath instrument panel, above glove compartment on top of fuel injection control unit
Cruise control servo	In engine compartment, in front of left shock tower
Flasher	In steering column, above lower steering column trim
Fuel tank sender	Under rear seat, driver's side of fuel tank
Fresh air blower motor	Behind firewall trim panel
Fresh air blower resistors	Behind firewall trim panel, attached to blower motor housing
Interior light timer control	In driver's footwell, below speaker
Neutral/park/backup light switch	In center console, at base of shift lever
Oil level sensor	In oil pan, left side of engine
On-board computer horn and diode	Under driver's side of front bumper
On-board computer module	In center of instrument panel, to right of radio
Rear window blower motor (convertible only)	Behind center of rear seat back
Seat belt warning timer	Beneath driver's side of instrument panel, left side of steering column
Starter	Left side of engine, rear
Sunroof motor	In windshield header
Windshield washer fluid level switch	In washer fluid reservoir in engine compartment
Windshield washer pump	In washer fluid reservoir in engine compartment
Wiper motor	Rear of engine compartment, behind firewall panel
Horns	Above left and right side of front bumper, behind splash guard
Horn brush/slip ring assembly	Beneath steering wheel on steering column

14. FUSE/RELAY PANEL

The fuses and relays are arranged together in one unit located in the engine compartment on the driver's side of the car.

Relays

Fig. 14-1 shows the fuse/relay panel location and identifies the relays.

NOTE —

Relay locations are subject to change, and may vary from car to car, depending on options. If questions arise, please remember that an authorized BMW dealer is the best source for the most accurate and up-to-date information.

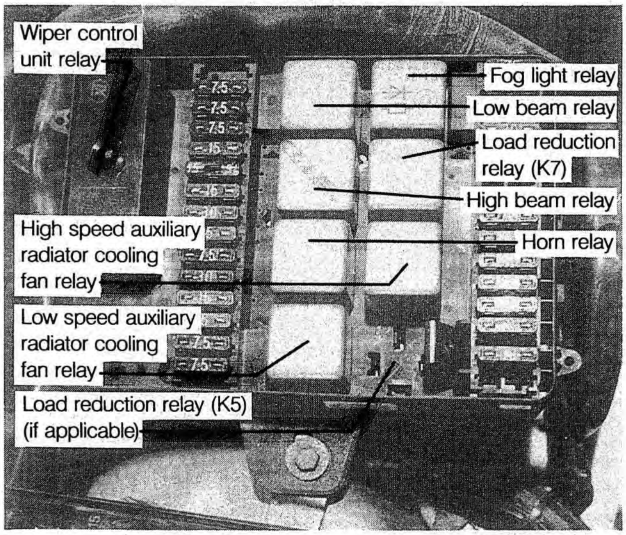


Fig. 14-1. Fuse/relay panel on BMW models covered by this manual. Low beam check relay is on underside of panel and is integrated into panel's printed circuit.

On models with 6-cylinder engine, the auxiliary relay panel holds the fuel pump relay, the main relay, and the oxygen sensor heater relay. On models with 4-cylinder engine, the auxiliary relay panel contains the fuel pump relay and the vacuum advance relay. On 1984 and early 1985 models, the third relay is for deceleration fuel shut-off. On all other models, the third relay is for idle speed stabilization.

An additional relay panel is located in the engine compartment, in front of the left shock tower. To access the relays, lift off the protective cover as shown in Fig. 14-2.

Fig. 14-2. Auxiliary relay panel protective cover being removed. Depress the catch (arrow) and lift off cover.

Fuses

The fuses come in different colors that correspond to different current ratings. Each fuse is specifically chosen to protect its circuit against excess current flow that might damage the circuit components. When replacing fuses, it is never appropriate to substitute a fuse of a higher rating. Fig. 14-3 shows fuse locations. **Table x** identifies the fuse circuits and the correct fuse rating.

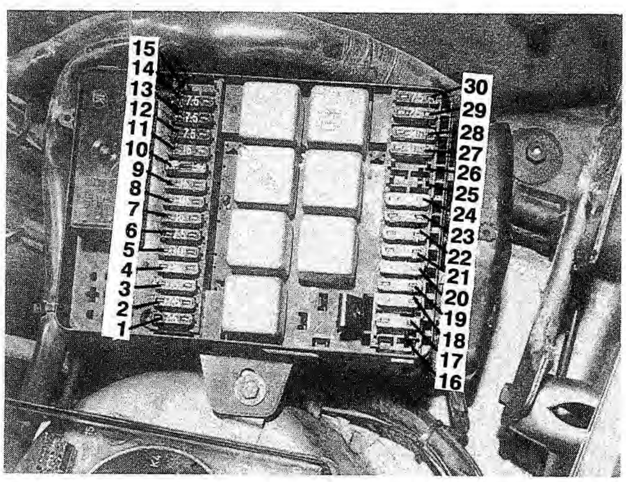


Fig. 14-3. Fuse/relay panel showing fuse locations.

CAUTION —
Only replace fuses with those of the same rating. Installing a fuse with higher rating will cause severe damage to the car's wiring and may also start a fire.

CAUTION —
A fuse with a lower rating may consistently blow, especially when the circuit is turned on. If the fuse in one particular location fails repeatedly, that is an indication of a problem in the circuit or in a component that should be repaired.

NOTE —
Fuse designations and locations are subject to change, and may vary from car to car, depending on options. If questions arise, please remember that an authorized BMW dealer is the best source for the most accurate and up-to-date information.

Table x. Fuse Location and Designation

Fuse	Rating and color	Description
1	7.5 amp (brown)	Headlight, left high beam
2	7.5 amp (brown)	Headlight, right high beam
3	15 amp (lt. blue)	Auxiliary radiator cooling fan, low speed (also see fuses 18, 19, and 20)
4	15 amp (lt. blue)	Turn signal and emergency flasher lights (also see fuse 24) Active check control (also see fuses 6, 10, 21, 22, and 23) Digital clock (also see fuse 21)
5	30 amp (lt. green)	Windshield wipers and washer
6	7.5 amp (brown)	Stop lights Cruise control (also see fuse 10) Active check control (also see fuses 4, 10, 21, 22, and 23) Anti-lock Braking System (ABS) (1986 and later models) Interior lighting (also see fuse 19, 21, 27)
7	15 amp (lt. blue)	Horns
8	30 amp (lt. green)	Rear defogger (also see fuse 23)

continued on next page

Table x. Fuse Location and Designation (continued)

Fuse	Rating and color	Description
9	15 amp (lt. blue)	Fuel delivery (also see fuse 10 and 21) Idle speed (also see fuse 10)
10	7.5 amp (brown)	Seat belt warning system (also see fuse 21) Service interval indicator (also see fuse 21) Tachometer/fuel economy gauge (also see fuse 21) Instrument gauges and indicators Brake warning system Back-up lights On-board computer (also see fuses 12, 21, 23, and 27) Starter Fuel delivery (also see fuse 9 and 21) Idle speed (also see fuse 9) Active check control (also see fuse 21) Stop lights/cruise control (also see fuse 6)
11	15 amp (lt. blue) 1984–1987 7.5 amp (brown) 1988–1990	Fuel delivery (fuel pump)
12	7.5 amp (brown)	Radio, power (also see fuses 21, 27, and 28) Speedometer and instrument indicators (also see fuse 8) On-board computer (also see fuses 10, 21, 23, and 27) Multi-function clock (also see fuses 21 and 23)
13	7.5 amp (brown)	Headlight, left low beam
14	7.5 amp (brown)	Headlight, right low beam
15		Not used
16	15 amp (lt. blue)	Heated seats
17	30 amp (lt. green)	Sunroof Power windows
18	30 amp (lt. green)	Auxiliary radiator cooling fan, high speed (also see fuses 3, 19, and 20)
19	7.5 amp (brown)	Auxiliary radiator cooling fan (also see fuses 3 and 18) Interior lights (also see fuses 6, 21, and 27) Power mirrors
20	30 amp (lt. green)	Heater/air conditioning (also see fuse 28) Auxiliary radiator cooling fan (also see fuses 3, 18, and 19)

continued

Table x. Fuse Location and Designation (continued)

Fuse	Rating and color	Description
21	7.5 amp (brown)	Glove box light and flashlight Ignition key warning/seat belt warning (also see fuse 10) Interior lights (also see fuses 6, 19 and 27) Radio memory (also see fuse 12, 27, and 28) Luggage compartment light Active check control (also see fuses 4, 6, 10, 22, 23) Service interval indicator (also see 10) On-board computer (also see fuses 10, 12, 23, and 27) Fuel delivery-except 318i (also see fuses 9 and 10) Tachometer/fuel economy gauge (also see fuse 10) Digital clock (also see fuse 4) Multi-function clock (also see fuses 12 and 23)
22	7.5 amp (brown)	Active check control (also see fuses 4, 6, 10, 21 and 23) Front parking lights (also see fuse 23) Rear taillights (also see fuse 23) Front side marker lights (also see fuse 23)
23	7.5 amp (brown)	Instrument panel lights Front parking lights (also see fuse 22) Rear taillights (also see fuse 22) Rear side marker and license plate lights Active check control (also see fuses 4, 6, 10, 21, and 22) Rear defogger (also see fuse 8) Multi-function clock (also see fuses 12 and 21) On-board computer (1987 and later)(also see fuses 10, 12, 21, and 27)
24	15 amp (lt. blue)	Turn signal and emergency flasher lights (also see fuse 4)
25		Not used
26		Not used
27	30 amp (lt. green)	Interior lights (also see fuses 6, 19, and 21) Central locking system On-board computer (also see fuses 10, 12, 21, and 23) Radio—amplifier (also see fuses 12, 21, and 28)
28	30 amp (lt. green)	Cigar lighter Radio—power antenna (also see fuses 12, 21, and 27)
29	7.5 amp (brown)	Fog light, left (also see fuse 30)
30	7.5 amp (brown)	Fog light, right (also see fuse 29)
NA	25 amp	Power window circuit breaker

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Subjects are indexed by section number in bold, followed by the page number(s) within the section where the subject can be found.
For example **1**:4 refers to section **1** FUNDAMENTALS, page 4.
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2 LUBRICATION AND MAINTENANCE
3 ENGINE MANAGEMENT—DRIVEABILITY
4 ENGINE
5 IGNITION
6 FUEL SYSTEM
7 COOLING SYSTEM
8 EXHAUST SYSTEMAND EMISSION
9 MANUAL TRANSMISSION AND CLUTCH
10 AUTOMATIC TRANSMISSION
11 DRIVESHAFT AND FINAL DRIVE
12 BRAKES
13 SUSPENSION AND STEERING
14 BODY AND INTERIOR
15 ELECTRICAL SYSTEM

WARNING —
- *Automotive service and repair is serious business. You must be alert, use common sense, and exercise good judgement to prevent personal injury and complete the work safely.*
- *Before beginning any work on your vehicle, thoroughly read all the Cautions and Warnings listed near the front of this manual.*
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Maintenance History

Date	Mileage	Description