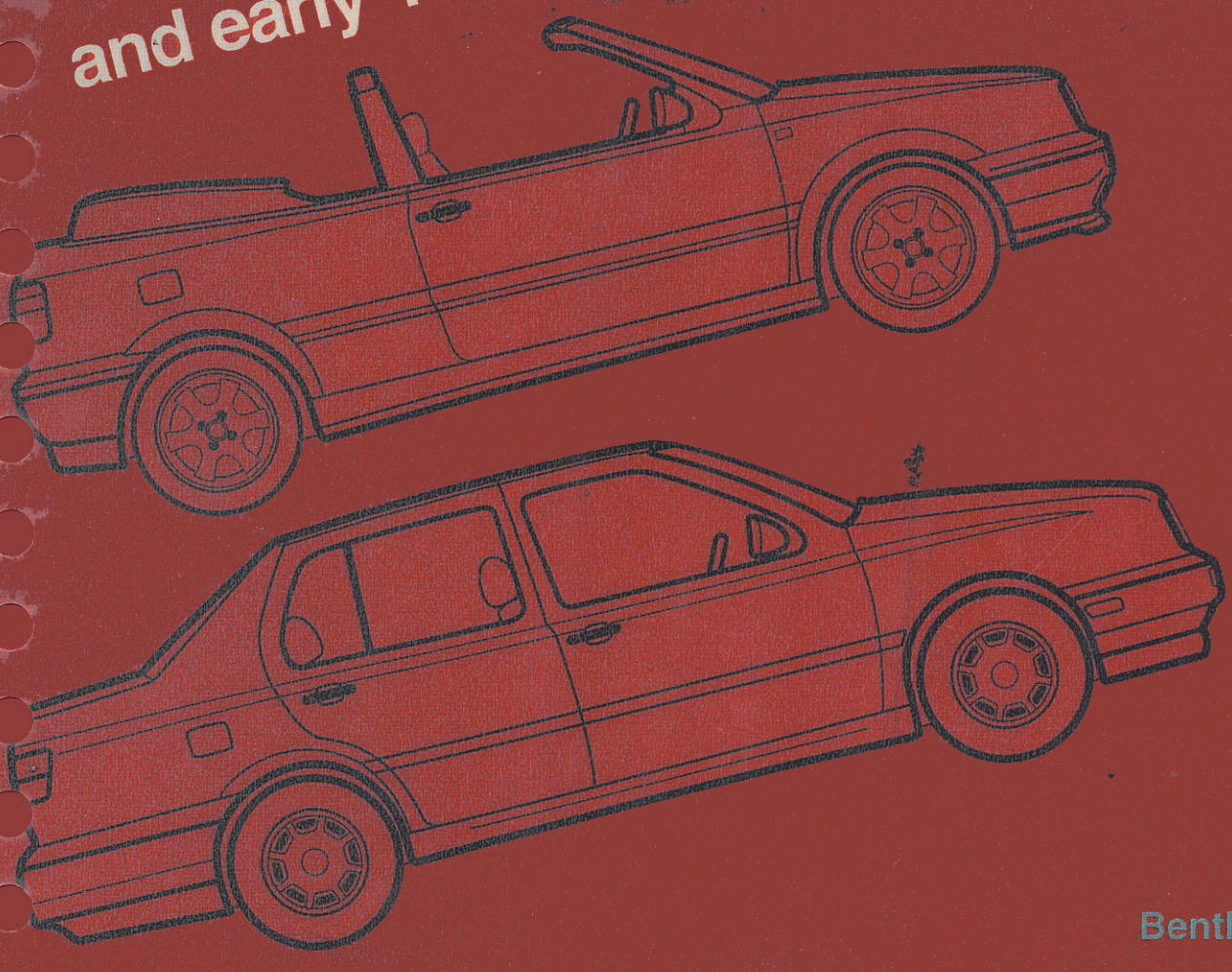
# Volkswagen Jetta, Golf, GTI Cabrio

## Service Manual

Including Jetta III, Golf III, VR6, and TDI
1993, 1994, 1995, 1996, 1997, 1998,
and early 1999



Bentley, Publishers

# Foreword

Service to Volkswagen owners is a top priority of the Volkswagen organization and has always included the continuing development and introduction of new and expanded services. In line with this purpose, Robert Bentley, Inc., in cooperation with Volkswagen of America, Inc., has introduced this Volkswagen Jetta, Golf, GTI, Cabrio Service Manual.

This manual covers Volkswagen Jetta, Golf, GTI, GLX, Cabrio, TDI and special editions for the model years 1993 through early 1999. This manual was created specifically to cover only those models built for sale in the United States and Canada.

Volkswagen and most aftermarket parts suppliers specializing in Volkswagens refer to the Jettas, Golfs, GTIs and Cabrios covered by this manual as the A3 models. The code "A3" is Volkswagen's internal code for the basic platform shared by all of the cars covered by this manual. When ordering parts, especially body parts, knowing the A3 code may be helpful.

For the Volkswagen owner with basic mechanical skills and for independent auto service professionals, this manual includes the specifications and procedures that were available in an authorized Volkswagen dealer service department as this manual went to press. The Volkswagen 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 aim throughout has been clarity and completeness, with step-by-step procedures and accurate specifications.

The Volkswagen owner intending to do maintenance and repair should have screwdrivers, a set of metric wrenches and sockets, and metric hex wrenches, since these basic hand tools are needed for most of the work described in this manual. Most procedures will also require a torque wrench to ensure that fasteners are tightened properly and in accordance with specifications. In some cases, the text refers to special tools that are recommended or required to accomplish adjustments or repairs. These tools are identified by their Volkswagen special tool number and illustrated. A thorough pre-reading of each procedure is recommended to determine in advance the need for particular tools and for essential replacement parts such as gaskets.

Some of the information in this manual applies only to cars of a particular model year or range of years. For example, "1993 m.y." refers to the 1993 model year. The model year 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. Technical changes made in production within a model year are identified in this manual by listing the VIN for the first car produced with this change.

The VIN is a unique sequence of 17 characters assigned by Volkswagen to identify each individual car. 3VWBA21HXPM005678 is an example. Each of the 17 letters and numbers indicates certain facts about the car and its manufacture. VINs used to distinguish information in this manual may refer only to the last eleven digits—the characters 1HXPM005678 in the example above.

Your Volkswagen's VIN can be found on a plate mounted on the top of the instrument panel, 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 example, "P" for 1993 m.y., "R" for 1994 m.y., etc. This manual covers Volkswagen "A3" Jetta, Golf, GTI, GLX, Cabrio, TDI and special editions for the model years 1993 through early 1999. The table below explains some of the various codes in the VIN numbers of models covered by this manual.

| 3 V W | R | A | 8 | 1 H | X | R | M | 1 2 3 4 5 6 |
|---|---|---|---|---|---|---|---|---|
| Manufactuer Information | Body | Engine Type | Restraint Type | Body Type | Check Digit | Model Year | Factory | Sequential Chassis No. |
| 3VW-Mexican Passenger car<br>WVW-German passenger car | Depends on model year | | 0-Seatbelts, active front<br>2-Seatbelts, passive front<br>6-Airbag front & side driver/pass.<br>8-Airbag front only driver/pass | 1H-Golf or Jetta<br>1E-Cabrio | | P-1993<br>R-1994<br>S-1995<br>T-1996<br>V-1997<br>W-1998<br>X-1999 | M- Puebla, Mexico<br>K-Osnabruk, Germany<br>W-Wolfsburg, Germany | 000001-Begin production<br>999999-End production |

We have endeavored to insure 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. The Publisher encourages comments from the readers of this manual with regard to errors, and also, suggestions for improvement in the presentation of the technical material. These communications have been and will be carefully considered in the preparation of this and other manuals. Please write or e-mail to Robert Bentley, Inc., at the address at the beginning of this manual.

Volkswagen offers extensive warranties, especially on components of the fuel delivery and emission control systems. Therefore, before deciding to repair a Volkswagen that may be covered wholly or in part by any warranties issued by Volkswagen of America, Inc., consult your authorized Volkswagen 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 Volkswagen 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 Volkswagen technician is ready to do the job for you.

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

**WARNING—**

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

- Volkswagen 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 Volkswagen dealer about Technical Bulletins that may have been issued since the editorial closing of this manual.

- 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 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.

- Friction materials such as brake or clutch discs may contain asbestos fibers. Do not create dust by grinding, sanding, or by cleaning with compressed air. Avoid breathing asbestos fibers and asbestos dust. Breathing asbestos can cause serious diseases such as asbestosis or cancer, and may result in death.

- 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.

- 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.

- Connect and disconnect battery cables, jumper cables or a battery charger only with the ignition switched off, to prevent sparks. 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 charging 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.

- 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.

- Most cars covered by this manual are equipped with a supplemental restraint system (SRS), that automatically deploys an airbag in the event of a frontal impact. The airbag is inflated by an explosive device. Handled improperly or without adequate safeguards, it can be accidently activated and cause serious injury.

- To prevent personal injury or airbag system failure, **only factory trained Volkswagen service technicians** should test, disassemble or service the airbag system.

- Disconnect the power supply before working on the airbag system, or when doing repairs that require removing airbag system components. Disconnect the battery negative (–) terminal and cover the battery.

**continued on next page**

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

**WARNING** (continued) —

- On airbag-equipped cars, never apply stickers or any other type of covering on the steering wheel. Do not let chemical cleaners, oil or grease come into contact with vinyl covering of the airbag unit.
- Never open or otherwise attempt to repair airbag system parts. Always use new parts. Never leave airbag parts or the partially disassembled airbag system unattended.
- Never use a test light to conduct electrical tests on the airbag system. The system must only be tested by trained Volkswagen Service technicians using the Volkswagen VAG 1551 Scan Tool (ST) or an approved equivalent. The airbag unit must never be electrically tested while it is not installed in the car.
- Do not expose the airbag unit to temperatures above 194°F (90°C), even for brief periods. Keep clear of heat sources such as hot plates, soldering irons, heat lamps and welding equipment.
- When driving or riding in an airbag-equipped vehicle, never hold test equipment in your hands or lap while the vehicle is in motion. Objects between you and the airbag can increase the risk of injury in an accident.
- Greases, lubricants and other automotive chemicals contain toxic substances, many of which are absorbed directly through the skin. Read manufacturer's instructions and warnings carefully. Use hand and eye protection. Avoid direct skin contact.

**CAUTION—**

- 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 Volkswagen dealer or other qualified shop. We especially urge you to consult an authorized Volkswagen dealer before beginning repairs on any car that may still be covered wholly or in part by any of the extensive warranties issued by Volkswagen of America.
- Volkswagen offers extensive warranties, especially on components of fuel delivery and emission control systems. Therefore, before deciding to repair a Volkswagen that may still be covered wholly or in part by any warranties issued by Volkswagen United States, Inc., consult your authorized Volkswagen dealer. You may find that he can make the repair for free, or at minimal cost.
- Volkswagen part numbers listed in this manual are for identification purposes only, not for ordering. Always check with your authorized Volkswagen dealer to verify part numbers and availability before beginning service work that may require new parts.
- Before starting a job, make certain that you have all the necessary tools and parts on hand. Read all the instructions thoroughly, do not attempt shortcuts. Use tools appropriate to the work and use only replacement parts meeting Volkswagen 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. Consult local ordinances that govern the disposal of wastes.
- On cars equipped with anti-theft radios, make sure you know the correct radio activation code before disconnecting the battery or removing the radio. If the wrong code is entered into the radio when power is restored, that radio may lock up and be rendered inoperable, even if the correct code is then entered.
- Connect and disconnect a battery charger only with the battery charger switched off.
- 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.
- 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.

# 0 Maintenance Program



**TABLES**

## GENERAL

All of the maintenance work described in this repair group is important and should be carried out at the specified time or mileage interval. The Owner's Manual, the Maintenance Record, and the Warranty Booklet originally supplied with the car contain the maintenance schedules that apply to your Volkswagen. Following these schedules will ensure safe and dependable operation. In addition, many of the maintenance procedures are necessary to maintain warranty protection.

***NOTE —***

*Volkswagen is constantly updating their recommended maintenance procedures and requirements. The information contained here may not include updates or revisions made by Volkswagen since publication of the Owner's Manual, the Maintenance Record, and the Warranty Booklet supplied with the car. 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 Volkswagen dealer has the latest maintenance information.*

## HOW TO USE THIS MANUAL

The manual is divided into 10 main sections, or partitions:

**0 Maintenance**
**1 Engine**
**2 Fuel, Ignition, and Exhaust Systems**
**3 Clutch, Transmission, and Final Drive**
**4 Suspension, Brakes, and Steering**
**5 Body–Assembly**
**6 Body–Components and Accessories**
**7 Body–Interior Trim**
**8 Heating and Air Conditioning**
**9 Electrical System**

**0 Maintenance Program** covers the recommended schedules and service procedures needed to do the Volkswagen-specified scheduled maintenance work.

The remaining nine partitions (1 through 9) are repair oriented and are broken down into individual repair groups. Each main partition begins with a general information group, e.g. **1 General Information.** These general groups are mostly descriptive in nature, covering topics such as theory of operation and troubleshooting. The remainder of the repair groups contain the more involved and more detailed system repair information.

A master listing of the 10 partitions and the corresponding individual repair groups can be found on the inside book cover.

Thumb tabs are used on the first page of each repair group page to help locate the groups quickly. Page numbers throughout the manual are organized according to the repair group system. For example, you can expect to find information on engine removal and installation (Repair Group 10) beginning on page 10-1. A comprehensive index can be found on the last pages of the manual.

### Warnings, Cautions and Notes

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

***WARNING —***

*The text under this heading 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. Warnings are always contained in a box.*

***CAUTION —***

*A caution calls attention to important precautions to be observed during the repair work that will help prevent accidentally damaging the car or its parts. Cautions are always contained in a box.*

***NOTE —***

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

Please read every **WARNING**, **CAUTION**, and **NOTE** 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 **WARNING**s and **CAUTION**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.

## Work Safety

Although an automobile presents many hazards, common sense and good equipment can help ensure safety. Many 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 vented 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 accidentally contacting the battery or other electrical terminals.*
- *Disconnect the battery negative (–) cable whenever working on or near the fuel system, airbag system or anything that is electrically powered. Accidental electrical contact may damage the electrical system, cause fire, or result in serious personal injury.*
- *Never work under a lifted car unless it is solidly supported on jack stands that are intended for that purpose. Do not support a car on cinder blocks, bricks, or other objects that may shift or crumble under continuous load. Never work under a car that is supported only by a jack.*
- *The fuel system retains pressure even when the ignition is off. 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 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 light 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 accidentally 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 and be difficult to retrieve, become caught in belts or other rotating parts, or cause electrical shorts and damage to the electrical system.*

# IDENTIFICATION PLATES AND LABELS

## Vehicle Identification Number (VIN)

The vehicle year and model can be determined from the VIN or the identification plate. Because stickers can fall off, be painted over, or be moved, it is best to rely on numbers stamped into the chassis.

The VIN (Chassis number) is stamped into the rear cross panel of the engine compartment. It is visible through a window in the plenum chamber cover. See Fig. 1. The identification plate is located on the driver's side of the padded dash panel. Additional vehicle identification information is also found on stickers attached to the driver's side door post and in the trunk.

***NOTE —***

*Additional information on the 17 digit VIN is given in the* Foreword *on page vi, at the front of the manual.*

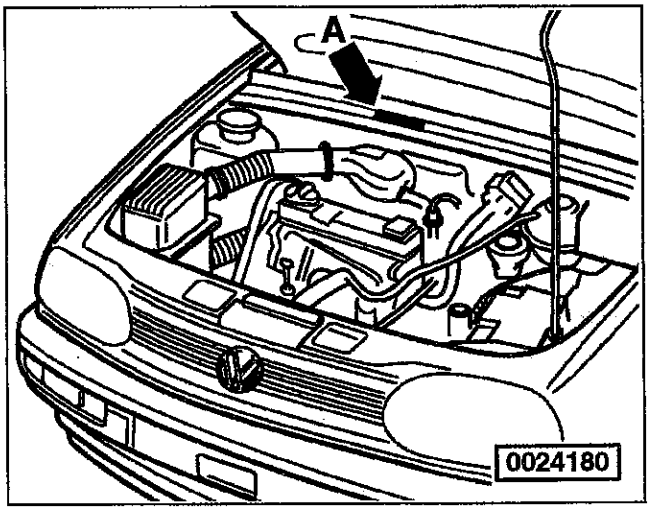



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**Fig. 1.** Partial vehicle identification number (**A**) stamped into rear cross panel of the engine compartment. Full VIN on plate on driver's side of padded dash panel.

## Engine code and engine number

The engines used in the Volkswagens covered by this manual are identified by a three letter code. The engine code and the engine number are located on the engine block. Location depends on engine application.

**Engine codes**

- ACC ..... 1.8 Liter gas
- AAZ, AHU ..... 1.9 Liter diesel
- ABA ..... 2.0 Liter gas
- AAA ..... 2.8 Liter gas

- **ACC and ABA engine** code letters and engine number are located on the front of the engine block, below the separation point between engine block and cylinder head. See Fig. 2.

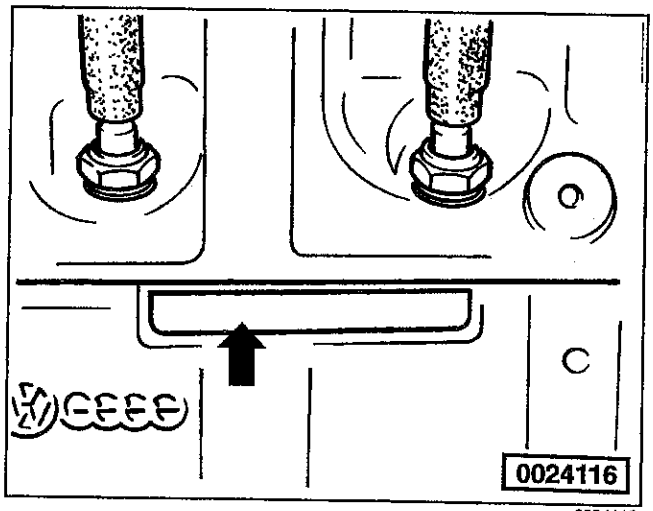


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**Fig. 2.** Engine number location (**arrow**) on ACC and ABA engines.

- **AAZ and AHU engine** code letters and engine number are located between the injection pump and vacuum pump on the cylinder block. See Fig. 3.
- **AAA (VR6) engine** code letters and engine number are located on the cylinder block above the vibration damper. The number is visible by looking through the right suspension strut tower and air cleaner. See Fig. 4.

***NOTE—***

*The engine codes often can also be found on a sticker on the camshaft drive belt guard (4-cyl. engines) or on the cylinder head cover (6-cyl. engines).*

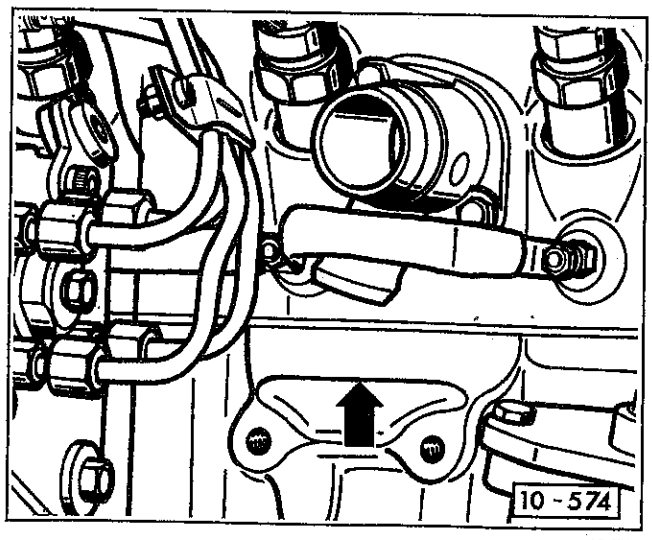


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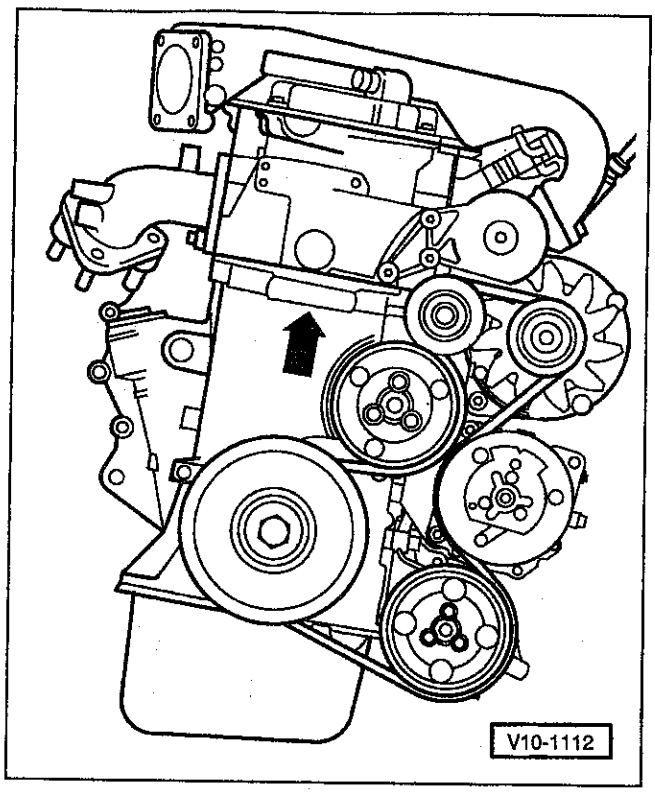
**Fig. 3.** Engine number location (**arrow**) on AAZ diesel engine shown. AHU diesel is similar.




V10-1112

**Fig. 4.** Engine number location (**arrow**) on VR6 engine.

## Transmission identification

Two manual transmissions and two automatic transmissions are used in the cars covered by this manual. Application depends on engine and model year.

**020 5-speed manual transmission** is used in all cars with 4-cylinder engines and manual transmission, except TDI Diesel. See Fig. 5.

**02A 5-speed manual transmission** is used in cars with 6-cylinder engine or TDI Diesel, and manual transmission. See Fig. 6.

**096 4-speed automatic transmission** is used in Golf, Jetta and Cabrio models beginning in 1993. It may be installed in combination with either a 4-cylinder or a 6-cylinder engine. See Fig. 7.

**01M 4-speed automatic** is installed in some 1995 and later cars with 4- or 6-cylinder engines. See Fig. 8.

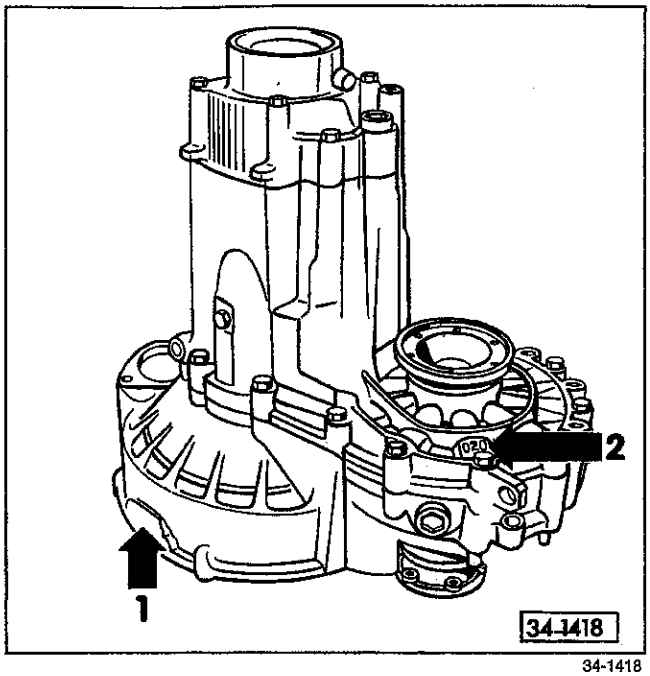



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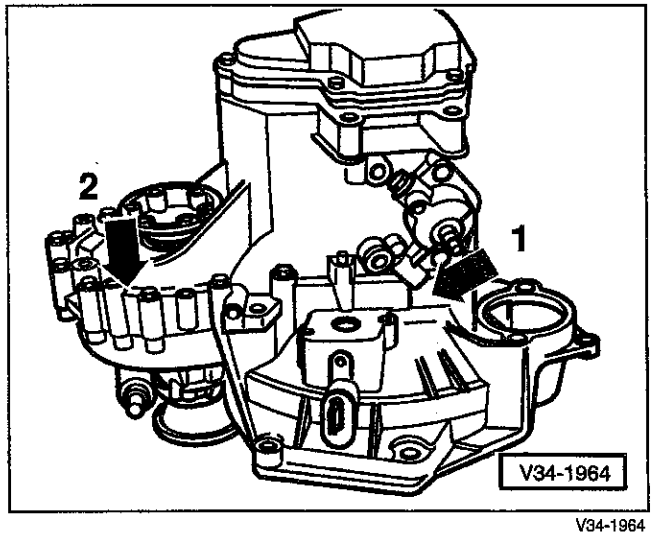
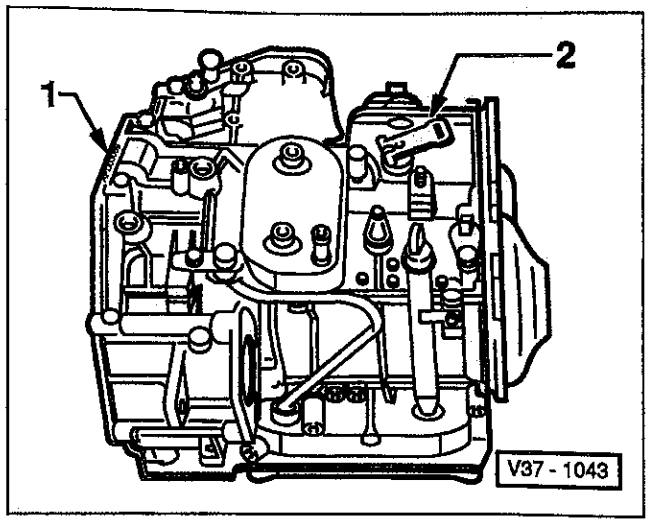
**Fig. 5.** 020 transmission used on cars with 4-cylinder engines. **Arrow 1** indicates location of code letters and date of manufacture. **Arrow 2** indicates location of transmission type.



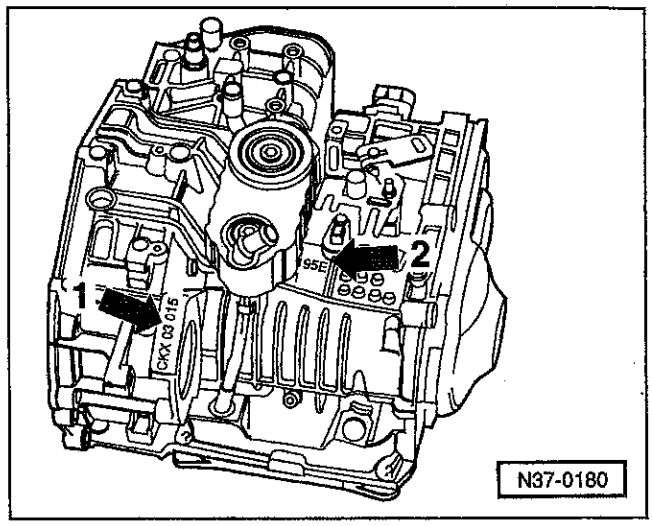

V34-1964

**Fig. 6.** 02A transmission for 6-cylinder vehicles and 4-cylinder TDI vehicles. **Arrow 1** indicates location of code letters and date of manufacture. **Arrow 2** indicates location of transmission type.




V37-1043

**Fig. 7.** 096 automatic transmission (with dipstick). **Arrow 1** indicates location of code letters and date of manufacture. **Arrow 2** indicates location of transmission type.




N37-0180

**Fig. 8.** 01M automatic transmission (without dipstick). **Arrow 1** indicates location of code letters and date of manufacture. **Arrow 2** indicates location of transmission type.

## TOWING

To prevent damage to transmission and the steering column anti-theft lock, the car must always be towed with the front (driven) wheels lifted. Use self-loading wheel dollies or wheel lift equipment. Tow the vehicle only within the manufacturer's recommended speeds and distances.

> ***CAUTION—***
> - *Do not tow Volkswagen models from the rear. Damage to the transmission and steering components will result.*
> - *Do not tow the vehicle with conventional sling type equipment or non-self-loading wheel dollies. Towing with this type of equipment will cause bumper and body panel damage.*
> - *If an automatic transmission equipped vehicle cannot be towed with wheel lift equipment, it must be transported with a car carrier (flat bed) to avoid damage to the transmission.*

## LIFTING VEHICLE

For repairs that require raising the car, the proper jacking points must be used. There are four jack points—two on each side of the car—marked by triangular impressions in the lower panel sheet metal just behind the front wheel or just in front of the rear wheel.

To lift the car with a floor jack or hydraulic lift, use the lifting points shown in Fig. 9 and Fig. 10. At the front, use only the small round member protruding at the bottom of the car under the front door hinge pillar. At the rear, use the flat surface just ahead of the mounting for the rear axle assembly.

To lift the front the of the vehicle, place the floor jack or hoist under the reinforcing plate welded to the floor panel. See Fig. 9.

> ***CAUTION—***
> - *Lifting front of vehicle at other than the front jacking points may cause severe body damage.*
> - *Use a rubberized lifting pad between the jack/lift and the body to avoid damaging the underbody.*

To lift the rear of the car place the floor jack or hoist under the rear vertical reinforcing plate of the lower sill in the area of the marking for the vehicle jack. See Fig. 10.

> ***CAUTION—***
> *Be sure to use a lifting pad to avoid damaging vehicle underbody.*

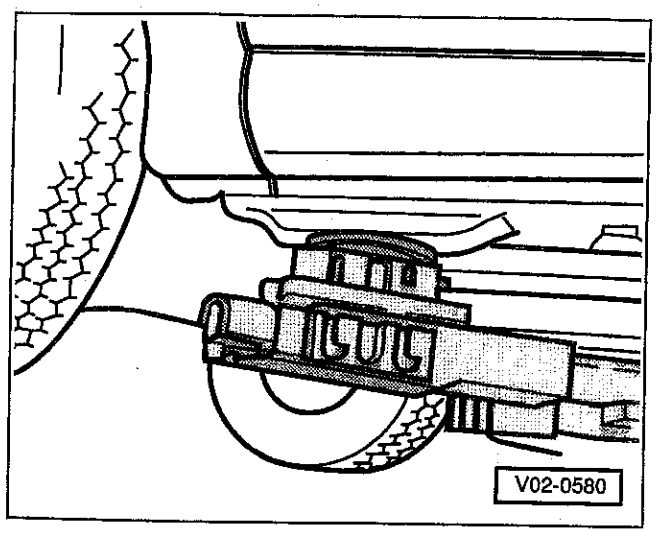



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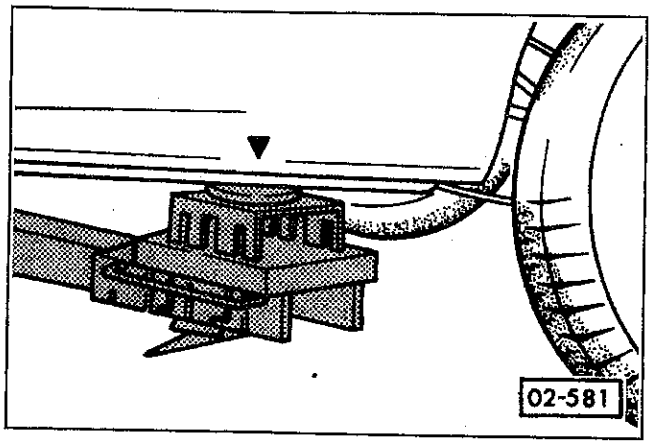
**Fig. 9.** Front jacking point for use with floor jack or hydraulic lift. Lift on reinforced surface under front door hinge pillar.




02-581

**Fig. 10.** Rear jacking point for use with floor jack or hydraulic lift. Lift on flat surface in front of rear axle mount.

### To raise vehicle with a jack

> ***WARNING—***
> - *Do not work under a car that is supported only by a jack. If work has to be done under vehicle, the vehicle must be securely supported with jack stands.*
> - *Never start the vehicle and engage a gear when the vehicle is raised.*

1. Place the car on a flat level area with a surface capable of supporting jacks and jackstands, e.g. concrete.
2. Block the wheels to prevent the car from rolling.

3. Place the jack in position as shown earlier in Fig. 9 or 10.

> ***CAUTION—***
> - *Use a rubberized lifting pad between the jack and the body to avoid damaging the underbody.*
> - *The vehicle must never be lifted on the engine oil pan, transmission, rear axle, front axle or bottom sill. Serious damage can occur.*

4. Operate the jack and raise the car slowly. If working under the car, support the weight of the car using jack stands as described below under **To work under car.**

> ***WARNING—***
> *Watch the jack closely and make sure it remains stable and does not shift or tip.*

## To work under car

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

2. Place at least two jack stands under 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 that are designed for the purpose of supporting a car.

> ***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.*
> - *Place jack stands on a hard level surface (e.g. concrete). Ensure car is stable before working under it.*

3. 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.

> ***WARNING—***
> *Check to make sure car is stable before working under car.*

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

# MAINTENANCE SCHEDULES

The maintenance schedules list all of the routine maintenance specified by Volkswagen, as well as the mileage intervals at which they should be performed. In any instance where the publisher has recommended maintenance or a maintenance interval that differs from that specified by Volkswagen, such recommendations are more conservative, and still meet Volkswagen's maintenance requirements.

In addition to the specified mileage intervals, Volkswagen also recommends that services be carried out on the basis of time. For 1993 to 1996 model years, the time intervals generally occur 6 months from the delivery date and every 6 months thereafter. For 1997 through 1999 model years, the time interval is generally 6 months after delivery, 12 months after delivery, and every 12 months thereafter.

> ***NOTE—***
> *Aside from keeping your Volkswagen in the best possible condition, scheduled maintenance plays a role in maintaining full coverage under Volkswagens extensive warranties. If in doubt about the terms and conditions of your car's warranty, consult an authorized Volkswagen dealer.*

## Table a. 7,500/22,500 mile service (1993-1996 model years)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Change oil and oil filter | * | * | * | |
| Check engine coolant level, add if necessary | | * | | |
| Check and lubricate hood lock (Canada cars only) | | | | |
| **Under car maintenance** | | | | |
| Tires and spare: check condition and pressures | * | | | |
| Rotate tires front to rear | * | | | |
| **Body and interior maintenance** | | | | |
| Service reminder: reset | | | | |
| **Road Test** | | | | |
| Automatic shiftlock: check operation including park/neutral position switch | | | | |

## Table b. 15,000/45,000 mile service (1993-1996 model years)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Change oil and oil filter | * | * | * | |
| Check engine coolant level, add if necessary | | * | | |
| Check brake fluid level, add if necessary | | * | | |
| Check power steering fluid level, add if necessary | | * | | |
| Inspect for fluid leaks | | | | |
| Check and lubricate hood lock (Canada only) | * | | | |
| Dust/pollen filter (where applicable): replace | | * | | |
| Battery: check electrolyte level and add if necessary. DO NOT attempt to check or add fluid to a maintenance free battery. | * | * | | |
| Camshaft drive belt (Diesel only): check tension and condition. | * | | | * |
| Check engine idle speed | * | | | * |
| **Under car maintenance** | | | | |
| Tires and spare: check condition and pressures | * | | | |
| Rotate tires front to rear | * | | | |
| Brake system: check for damage and/or leaks; check pad thickness | * | | | |
| Drive axle shafts: check boots for tears, cracks or damage | | | | |
| Manual transmission: check for leaks | | | | |

(continued)

## Table b. 15,000/45,000 mile service (1993-1996 model years) (continued)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Under car maintenance (cont.)** | | | | |
| Automatic transmission final drive: check level, add if necessary[1)] | * | * | | * |
| Automatic transmission: check ATF level, add if necessary. See **37 Automatic Transmission** | * | * | | * |
| Exhaust system: check for damage and/or leaks | * | | | |
| **Body and interior maintenance** | | | | |
| On Board Diagnostic System: check Diagnostic Trouble Code (DTC) Memory with V.A.G. 1551 Scan tool (ST), and erase stored codes if necessary | * | * | | * |
| Service reminder: reset | | | | |
| **Road Test** | | | | |
| Automatic shift lock: check operation including park/neutral position switch | | | | |
| Check A/T transmission kickdown, braking, steering, heating, ventilation, air conditioning, power accessories and electrical (including exterior lighting) systems | | | | |

1) In the case of severe conditions, such as extremely high temperatures, continuous mountain driving, trailer towing, predominantly stop-and-go traffic conditions, it is necessary to change the ATF every 30,000 miles. During this time the ATF sump should be removed and cleaned and the ATF strainer and sump gasket replaced.

## Table c. 30,000/60,000 mile service (1993-1996 model years)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Change oil and oil filter | * | * | * | |
| Check engine coolant level, add if necessary | | * | | |
| Check brake fluid level, add if necessary | | * | | |
| Check power steering fluid level, add if necessary | | * | | |
| Engine: inspect for fluid leaks | | | | |
| Check and lubricate hood lock (Canada only) | | * | | |
| Diesel engine only: drain water from fuel filter. | * | * | | |
| Diesel engine only: replace fuel filter | * | * | | |
| Dust/pollen filter (where applicable): replace | | * | | |
| Battery: check electrolyte level and add if necessary. DO NOT attempt to check or add fluid to a maintenance free battery. | * | * | | |
| V-belt: check tension and condition, adjust or replace as necessary | * | * | | |
| Poly-ribbed drive belt: check condition, adjust or replace as necessary | * | * | | |

**(continued)**

## Table c. 30,000/60,000 mile service (1993-1996 model years) (continued)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance (cont.)** | | | | |
| Diesel engine only: replace camshaft drive belt every 60K miles | * | * | | * |
| 4-cyl. gasoline engine only: check camshaft drive belt tension and condition [1] | * | * | | * |
| Spark plugs: replace | * | * | | |
| Air cleaner: replace (30k miles or every 2 years) | * | * | | |
| **Under car maintenance** | | | | |
| Tires and spare: check condition and pressures | * | | | |
| Rotate tires front to rear | * | | | |
| Brake system: check for damage and/or leaks; check pad thickness | * | | | |
| Drive axle shafts: check boots for tears, cracks or damage | | | | |
| Front axle: check dust seals on ball joints and tie rod ends | | | | |
| Check ball joints and tie rod ends for play/wear | * | | | |
| Manual transmission: check for leaks | | | | |
| Automatic transmission final drive: check level, add if necessary | * | * | | * |
| Automatic transmission: check ATF level, add if necessary [2] | * | * | | * |
| Manual transmission: check fluid, add if necessary | * | * | | |
| Exhaust system: check for damage and/or leaks | * | | | |
| **Body and interior maintenance** | | | | |
| Check operation of interior and exterior lights | | | | |
| Service reminder: reset | | | | |
| On Board Diagnostic system: check Diagnostic Trouble Code (DTC) Memory with VAG1551 Scan tool (ST) and erase if necessary. | * | * | | * |
| **Road Test** | | | | |
| Automatic shift lock: check operation including park/neutral position switch | | | | |
| Check A/T transmission kickdown, braking, steering, heating, ventilation, air conditioning, power accessories and electrical systems | | | | |
| Check engine idle speed | * | | | * |

1) Volkswagen does not specify a replacement interval for the camshaft drive belt on 4-cyl. gasoline engines. The publisher recommends periodic inspection of the belt and replacement at least every 90k miles or 5 years.

2) In the case of severe conditions, such as extremely high temperatures, continuous mountain driving, trailer towing, predominantly stop-and-go traffic conditions, it is necessary to change the ATF every 30,000 miles. During this time the ATF sump should be removed and cleaned and the ATF strainer and sump gasket replaced.

## Table d. First 5,000 mile service (1997-1999 model years)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Change oil and oil filter | * | * | * | |
| Water separator: drain water (TDI Diesel) | * | | | |
| Timing belt: check condition (TDI Diesel) | * | | | |

## Table e. every 10,000 mile service (1997-1999 model years)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Change oil and oil filter | * | * | * | |
| Water separator: drain water (TDI Diesel) | * | | | |
| Timing belt: check condition (TDI Diesel) | * | | | |
| Windshield washer: check fluid level, add as necessary | | * | | |
| Dust/pollen filter (where applicable): replace[1)] | | * | | |
| **Under car maintenance** | | | | |
| Tires and spare: check condition and pressures | * | | | |
| Rotate tires front to rear | * | | | |
| Brake system: check for damage and/or leaks; check pad thickness and brake fluid level | * | * | | |
| **Road Test** | | | | |
| Automatic shift lock (where applicable): check operation including park/neutral position switch | | | | |

1)Dust and pollen filter: 1997 models replace every 20,000 miles; 1998-99 models, replace every 10,000 miles.

## Table f. every 20,000 mile service (1997-1999 model years)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Change oil and oil filter | * | * | * | |
| Water separator: drain water (TDI Diesel) | * | | | |
| Timing belt: check condition (TDI Diesel) | * | | | |
| Windshield washer: check fluid, add as necessary | | * | | |
| Dust/pollen filter (where applicable): replace[1)] | | * | | |
| Spark plugs: replace (2.0L gasoline engine only) [2)] | * | * | | |
| Battery: check electrolyte level and add if necessary. DO NOT attempt to check or add fluid to a maintenance free battery. | * | * | | |
| Check engine coolant level, add if necessary | | * | | |
| Fuel filter: replace (TDI Diesel)[3)] | * | * | | |
| Brake fluid: check level, add if necessary; replace every 2 years regardless of mileage | * | * | | |
| **Under car maintenance** | | | | |
| Brake system: check for damage and/or leaks; check pad thickness | * | | | |
| Rotate tires front to rear | * | | | |
| Tires and spare: check condition and pressures | * | | | |
| Automatic transmission final drive: check level, add if necessary, check for leaks | * | * | | |
| Manual transmission: check fluid, add if necessary, check for leaks | * | * | | |
| Drive axle shafts: check boots for tears, cracks or damage | | | | |
| **Body and Interior maintenance** | | | | |
| Door check straps: lubricate | | * | | |
| On Board Diagnostic system: check Diagnostic Trouble Code (DTC) Memory with VAG 1551/1552 Scan tool (ST) and erase if necessary. | * | * | | * |
| **Road Test** | | | | |
| Automatic shift lock (where applicable): check operation including park/neutral position switch | | | | |
| Check A/T transmission kickdown, braking, steering, heating, ventilation, air conditioning, power accessories and electrical systems | | | | |
| **After Road Test** | | | | |
| Engine: check for leaks | | | | |
| Power steering: check fluid level | | * | | |
| Exhaust system: check for damage and leaks | | | | |
| On Board Diagnostic system: check Diagnostic Trouble Code (DTC) Memory with VAG 1551/1552 Scan tool (ST) and erase if necessary. | * | | * | * |

1)Dust and pollen filter: 1997 models replace every 20,000 miles; 1998-99 models, replace every 10,000 miles.

2)Spark plugs: 2.0 Liter: 1997, replace every 30,000 miles; 1998-99, replace every 20,000 miles.
1.8 and 2.8 Liter: 1997-99, replace every 40,000 miles.

3)Fuel filter: Gasoline engine fuel filter replacement is not part of Volkswagen's scheduled maintenance.

## Table g. every 40,000 mile service (1997-1999 model years)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Change oil and oil filter | * | * | * | |
| Water separator: drain water (TDI Diesel) | * | | | |
| Timing belt: check tension and condition, adjust if necessary<br>Replace every 60,000 miles (TDI Diesel)[1] | * | * | | * |
| Timing belt tensioner: replace every 60,000 miles (TDI Diesel) | * | * | | * |
| V-belt: check tension and condition, adjust if necessary | * | | | |
| Ribbed belt: check condition | * | | | |
| Windshield washer: check fluid, add as necessary | | * | | |
| Dust/pollen filter (where applicable): replace[2] | | * | | |
| Spark plugs: replace[3] | * | * | | |
| Battery: check electrolyte level and add if necessary. DO NOT attempt to check or add fluid to a maintenance free battery. | * | * | | |
| Check engine coolant level, add if necessary | | * | | |
| Fuel filter: replace (TDI Diesel) | * | * | | |
| Air filter: replace filter element (required every 40,000 miles and every 2 years) | * | * | | |
| Brake fluid: check level, add if necessary; replace every 2 years regardless of mileage | * | * | | |
| **Under car maintenance** | | | | |
| Brake system: check for damage and/or leaks; check pad thickness | * | | | |
| Rotate tires front to rear | * | | | |
| Tires and spare: check condition and pressures | * | | | |
| Automatic transmission final drive: check level, add if necessary, check for leaks | * | * | | |
| Automatic transmission: replace ATF[4] | | | | |
| Manual transmission: check fluid, add if necessary, check for leaks | * | * | | |
| Drive axle shafts: check boots for tears, cracks or damage | | | | |
| Front axle: check dust seals on ball joints and tie rod ends, check tie rods for play/wear | * | | | |

[1] Volkswagen does not specify a replacement interval for the camshaft drive belt on 4-cyl. gasoline engines. The publisher recommends periodic inspection of the belt and replacement at least every 90k miles or 5 years.

[2] Dust and pollen filter: 1997 models replace every 20,000 miles; 1998-99 models, replace every 10,000 miles.

[3] Spark plugs: 2.0 Liter: 1997, replace every 30,000 miles; 1998-99, replace every 20,000 miles.
1.8 and 2.8 Liter: 1997-99, replace every 40,000 miles.

[4] 1997 model year only. 1998 model year requires check level only every 60,000 miles.
In the case of severe conditions, such as extremely high temperatures, continuous mountain driving, trailer towing, predominantly stop-and-go traffic conditions, it is necessary to change the ATF every 30,000 miles. During this time the ATF sump should be removed and cleaned and the ATF strainer and sump gasket replaced.

**(continued)**

## Table g. every 40,000 mile service (1997-1999 model years) (continued)

| Maintenance item | Tools required | New parts/fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Body and interior maintenance** | | | | |
| Door check straps: lubricate | | * | | |
| On Board Diagnostic system: check Diagnostic Trouble Code (DTC) Memory with VAG 1551/1552 Scan tool (ST) and erase if necessary. | * | * | | * |
| **Road Test** | | | | |
| Automatic shift lock (where applicable): check operation including park/neutral position switch | | | | |
| Check A/T transmission kickdown, braking, steering, heating, ventilation, air conditioning, power accessories and electrical systems | | | | |
| **After Road Test** | | | | * |
| Engine: check for leaks | | | | |
| Power steering: check fluid level | | * | | |
| Exhaust system: check for damage and leaks | | | | |
| On Board Diagnostic system: check Diagnostic Trouble Code (DTC) Memory with VAG 1551/1552 Scan tool (ST) and erase if necessary. (Dealer service recommended). | * | | * | * |

## Table h. every 2 year service (all models)

| Maintenance item | Tools required | New parts /fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Engine compartment maintenance** | | | | |
| Brake fluid: replace regardless of mileage | * | * | | |
| Air cleaner: replace regardless of mileage | * | * | | |

## Table i. at 4 years, 8 years, and every 2 years thereafter service (all models)

| Maintenance item | Tools required | New parts /fluids required | Warm engine required | Dealer service recommended |
|---|---|---|---|---|
| **Passenger compartment maintenance** | | | | |
| Air bags: To assure continued reliability, the Air Bag System must be inspected by an authorized Volkswagen dealer at 4 and 8 years from the date of manufacture and every two years thereafter. | * | * | | * |

# ENGINE COMPARTMENT MAINTENANCE

The jobs listed under this heading are the engine compartment maintenance items from the maintenance tables. The jobs follow the same sequence in which they appear in the tables.

## Engine oil level, checking

It is normal for your engine to consume a small amount of oil. The rate of consumption will depend on the quality and viscosity of the oil and the operating conditions. Make it a habit to check the oil level at every fuel filling.

1. After switching engine OFF, wait at least 3 minutes to allow the oil to flow back into the oil pan.
2. Remove dipstick located in front of intake manifold. Wipe dipstick with a clean cloth and reinsert as far as stop.
3. Remove dipstick again and read oil level. The oil level must be at the top edge of the shaded area but on no account above the maximum level mark. See Fig. 11.

> ***CAUTION —***
> *Risk of damage to catalytic converter if oil level is too high.*

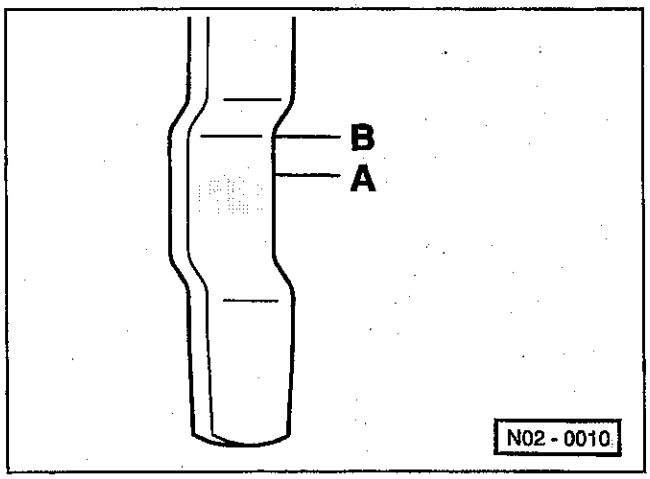



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**Fig. 11.** Oil level must be at the top edge of shaded area **A**. Damage to engine oil seals and/or engine may result if oil is above mark **B**.

4. If oil level is below shaded area, fill to top mark shown in Fig. 11.

Select an oil that conforms to the standards of the American Petroleum Institute (API). A symbol can be found on the oil container with the API rating and viscosity grade.

**Recommended Engine Oil**

- Gasoline engines . . . . . API service rating SG
- Diesel engine . . . . . API service rating CF or CG4

## Engine oil, changing

1. Warm car to normal operating temperature.
2. Shut off engine and apply parking brake.
3. Raise car and support on jackstands designed for the purpose.

> ***WARNING —***
> *Jack stands should be placed on hard level surface (e.g. concrete).*

4. Remove sound dampening pan (belly pan) from beneath engine compartment. Remove drain plug from oil pan and allow oil to drain. See **17 Engine—Lubrication System** for drain plug location.

> ***WARNING —***
> *Hot oil can scald. Wear protective clothing, gloves and eye protection.*

> ***CAUTION —***
> - *Always replace oil-drain plug sealing ring anytime the drain plug is removed.*
> - *Dispose of oil properly at a facility equipped for recycling or storage.*

5. Replace oil filter. See **Oil filter, replacing** for applicable engine.
6. Install oil drain plug with a new seal. Tighten drain plug to proper torque.

**Tightening torques**

- Oil drain plug to oil pan. . . . . 30 Nm (22 ft-lb)

7. Fill engine with proper quantity and type of oil.

**Oil capacity**

- Engine oil capacity (with filter change)
  - ACC, ABA engines . . . . . 4.2 qt. (4.0 liters)
  - AAZ, AHU engines . . . . . 4.7 qt. (4.5 liters)
  - AAA engine . . . . . 5.8 qt. (5.5 liters)

8. Run engine and check for leaks. Shut off engine and re-install sound dampening pan. Check oil level after about 3 minutes.

## Oil filter, replacing (4-cylinder engines)

1. Working at front of engine, loosen oil filter with oil filter strap or suitable wrench. Remove filter.
2. Clean sealing surface on oil filter flange.
3. Lightly lubricate rubber seal with clean oil.
4. Thread on new filter and tighten by hand.

***CAUTION—***
*Do not clean and re-use oil filter.*

## Oil filter, replacing (6-cylinder engine)

1. Drain oil from oil filter housing by removing drain screw. See Fig. 12.

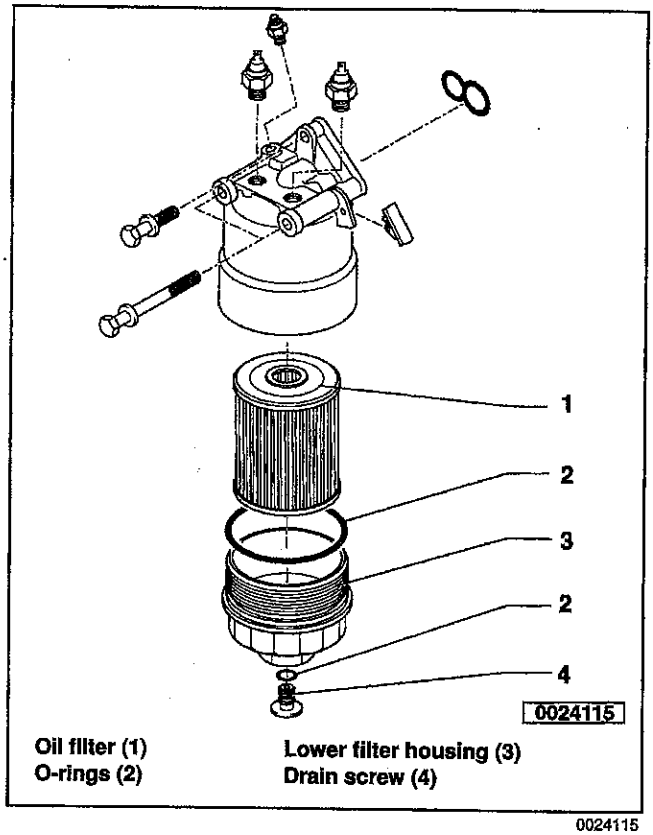


**Fig. 12.** Oil filter assembly used on AAA (VR6) engine.

2. Unscrew lower filter housing. Discard filter and O-ring.
3. Install new filter element and new O-ring to lower filter housing.
   - Lightly lubricate O-ring with clean oil.

***CAUTION—***
*Do not clean and re-use oil filter.*

4. Install and tighten lower filter housing and drain screw.

**Tightening torques**
- Lower filter housing to upper filter housing . . . . . 30 Nm (22 ft-lb)
- Drain screw to lower filter housing (use new O-ring) . . . . . 10 Nm (89 in-lb)

## Coolant, checking

Cooling system maintenance consists of maintaining the coolant level, checking the coolant freezing point, and inspecting the hoses. Coolant flushing is not part of Volkswagen's scheduled maintenance.

***NOTE—***
*Volkswagen does not require replacing the coolant as part of routine maintenance. The cooling system has been filled at the factory with a permanent coolant. For coolant system draining and refilling procedures, see* **19 Engine-Cooling System.**

***WARNING—***
- *Hot coolant can scald. Do not work on the cooling system until it has fully cooled.*
- *Use extreme care when draining and disposing of coolant. Coolant is poisonous and lethal. Children and pets are attracted to it because of its sweet smell and taste. See a doctor or veterinarian immediately if any amount is ingested.*

***CAUTION—***
- *Use only Volkswagen original anti-freeze when filling the cooling system. Use of any other anti-freeze may be harmful to the cooling system. Do not use an anti-freeze containing phosphates.*
- *Do not use tap water in cooling system. Use distilled water only to mix anti-freeze.*

Volkswagen uses two different types of coolant which can be identified by color.

Blue/Green – This coolant/antifreeze is phosphate free and should be used in all water-cooled Volkswagens up to and including 1996 and some early 1997 vehicles. When supplied by Volkswagen, this coolant/antifreeze is generally known as G11.

Red – This coolant/antifreeze is phosphate free and also silicate free. It should be used in all water-cooled Volkswagens from early 1997 production. When supplied by Volkswagen, this coolant/antifreeze is known as G12.

The advantages of G12 over earlier types include improvements in corrosion protection, thermal stability, heat transfer/control, hard water tolerance and environmental protection.

***CAUTION —***

- *G12 (Red Coolant) must NEVER be mixed with ANY other coolant. Engine damage will result!*
- *Contamination of G12 with other colored coolants is identifiable by discoloration (brown, purple, etc.). This mixture causes a foamy deposit to appear in the expansion tank/radiator and MUST be drained immediately.*
- *The cooling system must be completely free of this mixture before refilling with the correct type of coolant/antifreeze.*

A translucent expansion tank, or overflow reservoir, provides easy monitoring of coolant level without opening the system. The coolant level should always be checked when the engine is cold. The coolant level should be between the maximum and the minimum mark on the expansion tank. See Fig. 13.

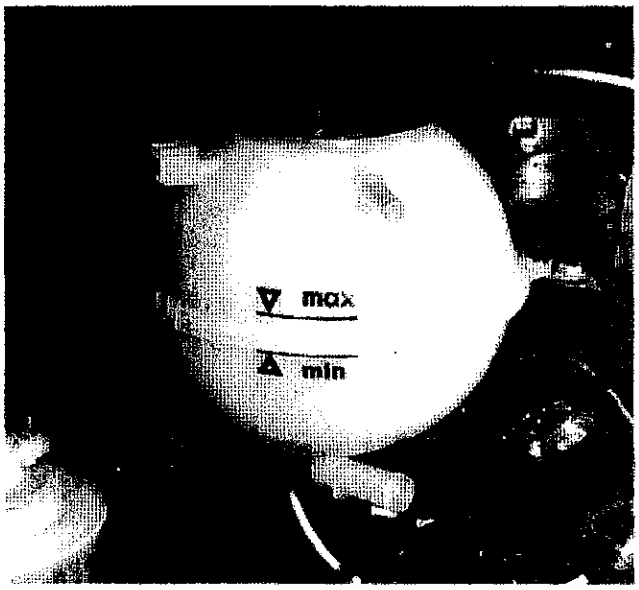


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**Fig. 13.** Coolant level should be between **max** and **min** marks on coolant expansion tank.

Inspect the hose by first checking that all connections are 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. Dried coolant has a chalky appearance. Check the hose condition by pinching them. Hoses should be firm and springy. Replace any hose that is cracked, that has become soft and limp, or has been contaminated by oil or diesel fuel. See Fig. 14.

To check the freezing point of the coolant, use a hydrometer. With the engine cold, remove the cap from the expansion

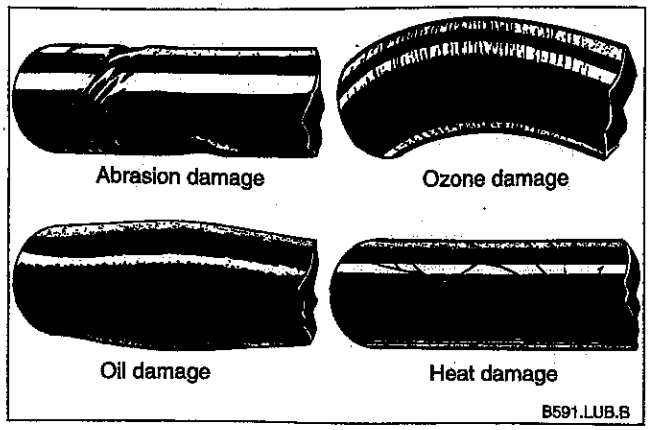


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**Fig. 14.** Examples of damaged coolant hoses. Any of conditions shown is cause for replacement. Courtesy of Gates Rubber Inc.

tank and draw up some coolant with the hydrometer. Volkswagen recommends using a 50/50 mixture of anti-freeze and water, which has a freezing point of -35°F (-38°C). If the freezing point is too high, drain a small amount of coolant from the system and add new anti-freeze until the proper protection level is obtained.

***NOTE —***

*For protection to approx. -40°C (-40°F) the percentage of anti-freeze may be increased up to 60%. The percentage of anti-freeze must not exceed 60%, as higher amounts will decrease frost protection and cooling capacity.*

## Brake fluid level, checking

Routine maintenance of the brake system includes maintaining an adequate level of brake fluid in the reservoir, replacing the brake fluid every 2 years, checking the brake pads for wear, checking the hand brake function, and inspecting the system for fluid leaks or other damage. See **Under Car Maintenance** for pad inspection and brake system inspection.

***WARNING —***

- *Use only new, previously unopened brake fluid conforming to US Standard FMVSS 116 DOT 4.*
- *Brake fluid is poisonous. DO NOT ingest brake fluid. Wash thoroughly with soap and water if brake fluid comes into contact with skin.*

***CAUTION —***

- *DO NOT let brake fluid come in contact with paint. Wash immediately with soap and water.*
- *Brake fluid absorbs moisture from the air and must be stored in an airtight container.*
- *DO NOT allow brake fluid to exceed the maximum level in the fluid reservoir.*

The level of the brake fluid will drop slightly as the brakes wear. Check the fluid level at the brake fluid reservoir, located on the driver's side, near the bulkhead.

**Brake Fluid**

- Type . . . . . FVMSS 116 SAE DOT 4

***WARNING —***

*Do not mix DOT 5 (silicone) brake fluid with DOT 4 brake fluid as severe component corrosion will result. Such corrosion could lead to brake system failure.*

## Brake fluid, replacing

Brake fluid readily absorbs moisture from the atmosphere. This moisture can cause brake system corrosion and adversely affect braking performance. Therefore, the old brake should be flushed out of the system and new, fresh fluid added at least every 2 years, regardless of mileage. See **47 Brakes–Hydraulic System** for brake system bleeding procedures and brake fluid replacement.

***WARNING —***

- *Vehicles equipped with the TEVES 04 ABS/EDL can be bled using conventional methods.*
- *Vehicles equipped with the TEVES 20 GI ABS/EDL can also be bled during maintenance using conventional methods. However, if the reservoir has been completely emptied, the hydraulic unit must be bled using the Volkswagen Scan Tool VAG 1551 or VAG 1552. This is only necessary if the hydraulic unit or control module has been replaced or if there is a leak in the system. This procedure electronically cycles the hydraulic unit and valve body to purge trapped air and is beyond the scope of this manual. See* **45 Anti-Lock Brakes (ABS)** *for application information.*

## Power steering fluid level, checking

When checking the power steering fluid level, the engine should be running and at normal operating temperature and the front wheels should be in the straight ahead position. Note that the power steering system uses a special hydraulic oil and not ATF.

To check the fluid level, remove the dipstick from fluid reservoir and check the level on the dipstick. The level should be between MIN and MAX mark. See Fig. 15. If necessary, top up with Volkswagen power steering hydraulic oil (VW part G 002 000).

**Power Steering Fluid**

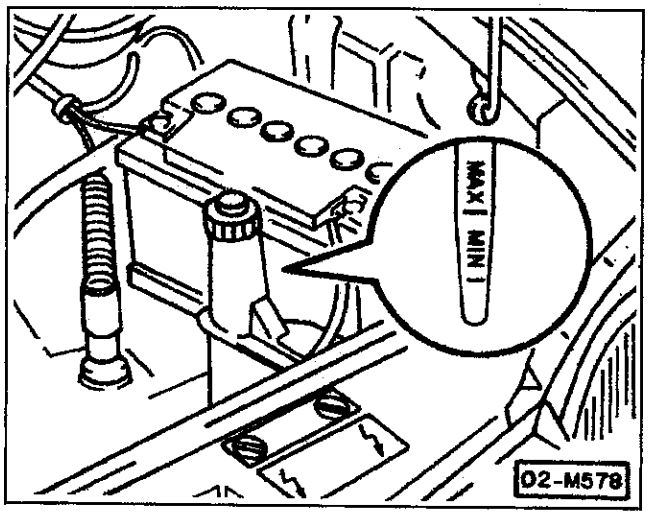
- Type . . . . . hydraulic oil (VW part no. G 002 000)

***CAUTION —***

- *Use only Volkswagen hydraulic oil G 002 000 in the power steering system. Do not use ATF or other non-approved types of power steering fluid. If the wrong fluid is used, power steering components may fail.*
- *Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*

***NOTE —***

*If the hydraulic oil level has dropped to the MIN marking the power steering should be checked. It is not sufficient to just add hydraulic oil.*




02-M578

**Fig. 15.** Power steering reservoir and dipstick (inset).

## Fluid leaks

Check the engine compartment for signs of fluid leaks. Fluid leaks attract dust making them easier to spot. Many expensive repairs can be avoided by prompt repair of minor fluid leaks.

Inspect for leaks in engine, cooling, fuel, and heating system. Visually inspect hoses and hose connections for leaks, worn areas, porosity and brittleness.

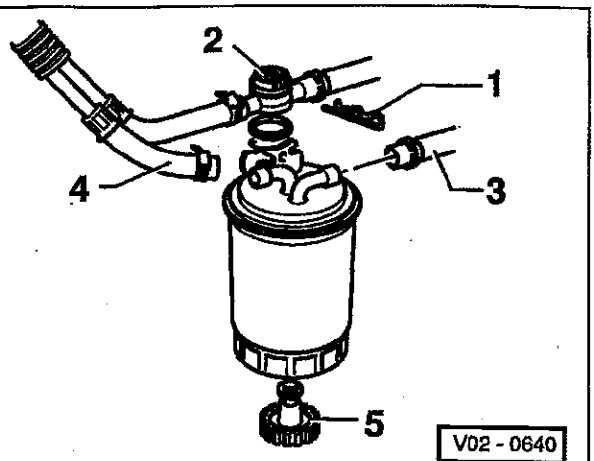
## Fuel filter, draining (diesel engines)

The diesel fuel filter functions to trap water. As water is heavier than diesel fuel, it settles to the bottom of the filter and can be drained off.

***CAUTION —***

*Do not allow diesel fuel to contact coolant hoses or other rubber parts. Wipe diesel fuel off hoses immediately and wash with soap and water.*

1. Remove control valve retaining clip. See Fig. 16.




**Retaining clip (1)**
**Control valve (2)**
**Fuel hose from fuel tank (3)**
**Fuel hose from fuel pump (4)**
**Drain screw (5)**

V02-0640

**Fig. 16.** Fuel filter/water separator used on models with diesel engines.

2. Remove control valve with fuel lines connected.
3. Loosen drain screw (on bottom of filter) and drain approx. 100cc (1.7 oz.) of fuel/water.
4. Install control valve using new O-ring.
5. Attach retaining clip and tighten drain screw.
6. Check fuel system for leaks (visual inspection) with the engine running. Raise engine speed several times and let idle. Fuel flow through transparent pipe must be free of bubbles.

## Fuel filter, replacing (diesel engines)

***NOTE—***
*Refer to Fig. 16 when replacing the fuel filter.*

***WARNING—***
- *Always disconnect the negative battery cable before working on the fuel system.*
- *Before disconnecting battery be sure to obtain radio anti-theft code.*
- *Do not smoke or create sparks when working on fuel system. Have an approved fire extinguisher handy.*
- *Diesel fuel is dangerous to your health. Wear skin, eye and hand protection. Work in a well ventilated area.*

1. Remove control valve retaining clip.
2. Remove control valve with fuel lines connected.
3. Label and disconnect remaining fuel hoses from top of fuel filter.

***NOTE—***
*Do not reverse hoses when installing. Fuel flow direction is indicated by arrows.*

4. Remove filter bracket together with filter.
5. Remove filter from the bracket.
6. Installation is the reverse of removal. Be sure to use a new O-ring at the control valve. After installing filter, check for leaks (visual inspection) with the engine running. Raise engine speed several times and let idle. Fuel flow through transparent pipe must be free of bubbles.

***CAUTION—***
*Always replace the fuel filter control valve O-ring.*

## Fuel filter, replacing (gasoline engines)

Volkswagen specifies that the fuel filter used on gasoline engines is designed to last the life of the car. Replacement is only necessary if the filter becomes clogged due to contaminated fuel or failure to keep the fuel tank sealed.

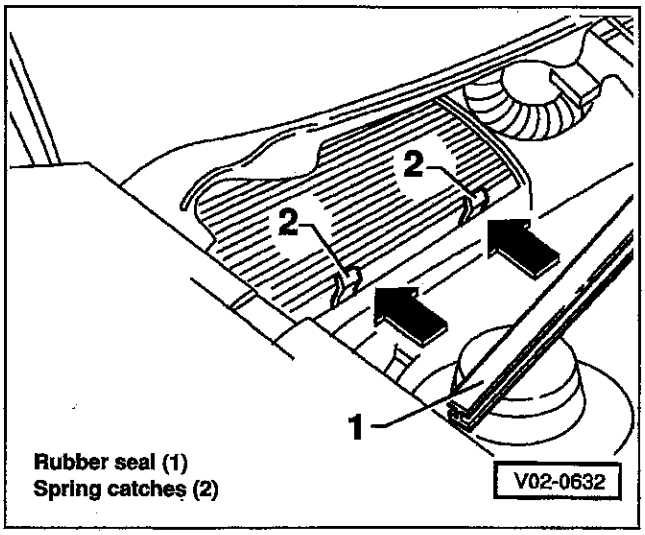
## Dust and pollen filter, replacing

Some models may be equipped with a ventilation air dust and pollen filter. This filter prevents most dusts and pollens from entering the passenger compartment. Volkswagen specifies replacement of this filter at regular mileage intervals.

1. Working in rear of engine compartment (plenum chamber) remove plastic screws attaching the filter cover. See Fig. 17.
2. Partially remove rubber seal at bulkhead partition.
3. Push front of cover upward.
4. Push spring catches for filter element inward and remove filter element.
5. Install new filter element. Install rubber seal and cover.

## Battery Service

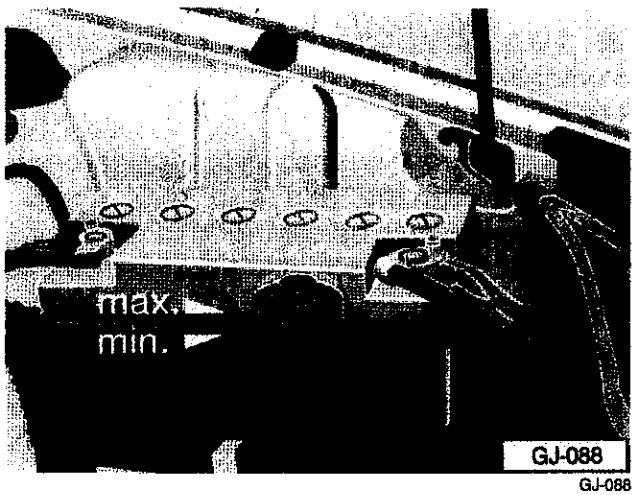
Under normal operating conditions, the battery is maintenance free. At high outside temperatures, however, it is advisable to check the electrolyte level through the translucent battery housing. The electrolyte level should be just above the battery plates and their separators. The battery plates can be seen once the filler caps are removed. If the electrolyte level is low, replenish it by adding distilled water only. See Fig. 17.




**Rubber seal (1)**
**Spring catches (2)**

V02-0632

**Fig. 17.** Dust and pollen filter in rear of engine compartment (right plenum chamber).




GJ-088

**Fig. 18.** Battery electrolyte level should be between **min** and **max** area on translucent battery housing.

***NOTE —***

*For a more detailed discussion of the battery, including testing and charging, see* **27 Engine Electrical**.

***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.Batteries give off explosive hydrogen gas. Keep sparks and open flames away. Do not smoke.*

***CAUTION —***

*Battery electrolyte can damage painted surfaces. If electrolyte is spilled on the car, immediately clean the area with a solution of baking soda and water.*

## Power steering V-belt, inspecting/adjusting (4-cylinder engines)

On 4-cylinder engines, a V-belt is used to drive the power steering pump. Check the condition of V-belt for splits in the base material, separation of layers, fraying of cords, flank wear, glazing, traces of oil or grease. If any of these conditions exist, the belt should be replaced. Check V-belt tension by applying firm thumb pressure to the area of the belt between the two pulleys that are furthest apart. Adjust belt tension if necessary.

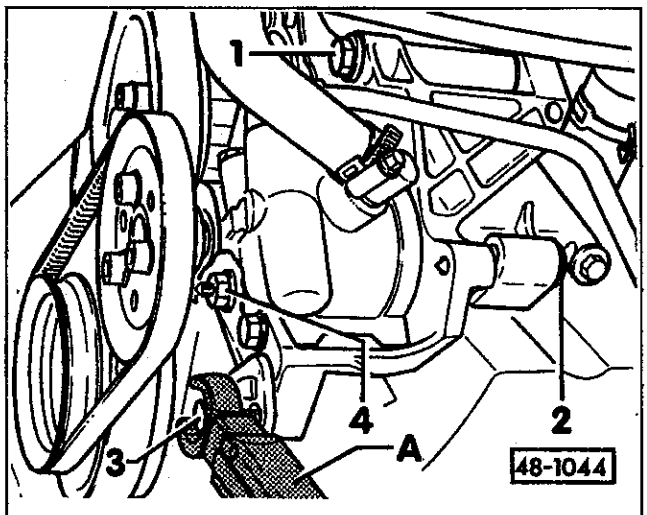
**Power Steering V-belt**

- Belt deflection (used belt) . . . . approx. 5 mm (3/16 in.)

1. Loosen power steering pump securing bolts and nuts until V-belt is loose. See Fig. 19.

***NOTE —***

*Loosen adjustment clamping bolt (Fig. 19, bolt no. 3) at least one full turn.*




**Securing bolts (1 and 2)**
**Clamping bolt and tensioning nut (3)**
**Tensioning bar securing nut (4)**
**Torque wrench with 22 mm crow foot wrench (A)**

48-1044

**Fig. 19.** To loosen V-belt, loosen bolts **1, 2, 3,** and nut **4.** Belt tension is adjusted at tensioning nut using torque wrench **(A).**

2. Adjust V-belt tension by torquing tensioning nut to the specification listed below. Tighten clamping bolt when tension is correct. Tighten remaining securing bolts.

***NOTE—***
*When the tensioning nut is torqued to the specified setting, belt tension will be correct.*

**Tightening torques**
- V-belt tensioning nut (3)
  used belts ..... 4 Nm (35 in-lb)
  new belts ..... 7 Nm (62 in-lb)
- Clamping bolt (3) ..... 25 Nm (18 ft-lb)
- Upper securing bolt (1) ..... 45 Nm (33 ft-lb)
- Lower securing bolt/nut (2/4) ..... 25 Nm (18 ft-lb)

## Poly-ribbed belt, applications

On 4-cylinder engines with a separate tensioner pulley (cars with A/C), and all 6-cylinder engines, the poly-ribbed drive belt is self-adjusting and does not require any routine maintenance aside from periodic inspection for wear.

On 4-cylinder engines without a separate tensioner (cars without A/C), a heavy-duty coil spring is mounted under the alternator. When the alternator mounting bolts are loosened, the coil spring presses up on the alternator and correctly tensions the belt. The alternator mounting bolts are then retightened. This tensioning system does not account for belt wear and/or stretch and must therefore be adjusted at the specified mileage intervals.

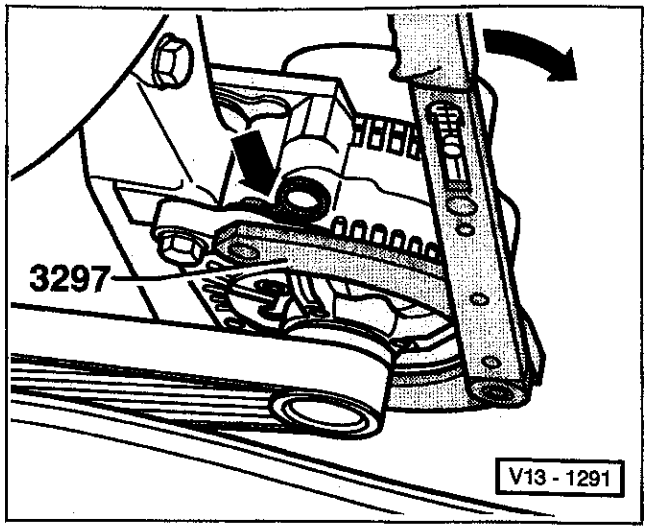
***NOTE—***
*It is not necessary to check and adjust the poly-ribbed belt tension on engines with tensioning pulley. Optimal belt tension is assured by means of the spring-loaded tensioning device.*

## Poly-ribbed belt, adjusting (4-cylinder engines without belt tensioner)

1. Loosen alternator securing bolts.

> ***CAUTION—***
> *Do not remove alternator bolts. Loosen bolts only enough to allow alternator to pivot freely.*

2. Attach tensioning lever (Volkswagen special tool no. 3297) to alternator and secure with locking pin. See Fig. 20.




V13-1291

**Fig. 20.** Alternator belt tension being relieved using Volkswagen special tool no. 3297 and torque wrench. Use locking pin (**left arrow**) to secure tool to alternator.

3. Pivot alternator down to stop three times. Alternator must pivot freely.

4. Remove tensioning lever. Start engine and let idle for at least 10 seconds.

5. Shut off engine and tighten alternator securing bolts.

**Tightening torques**
- Alternator to mounting bracket ..... 25 Nm (18 ft-lb)

## Poly-ribbed belt, removing and installing (4-cylinder engines)

1. Remove power steering V-belt. See **Power Steering V-belt, adjusting (4-cylinder engines).**

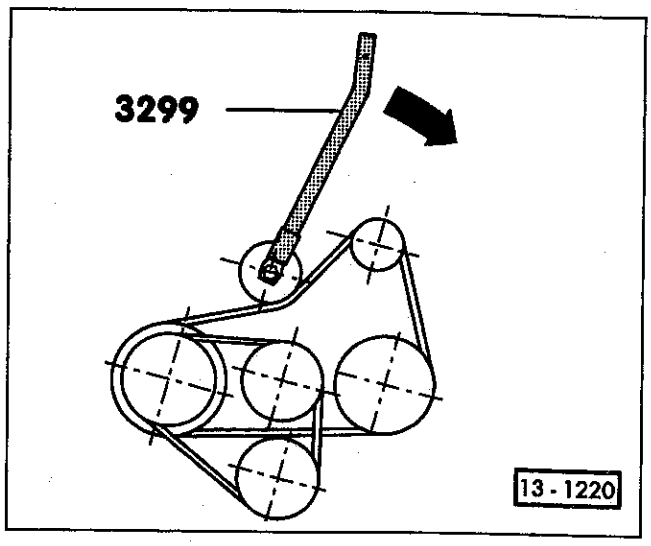
2. On cars without separate belt tensioner, loosen alternator mounting bolts 2 turns. Then press down on the alternator to relieve belt tension. See Fig. 20.

3. On cars with separate belt tensioner, pivot belt tensioner off belt using appropriate spanner wrench (Volkswagen special tool no. 3299). See Fig. 21.

4. If reinstalling the old belt, mark running direction on belt. Remove poly-ribbed belt from pulleys.

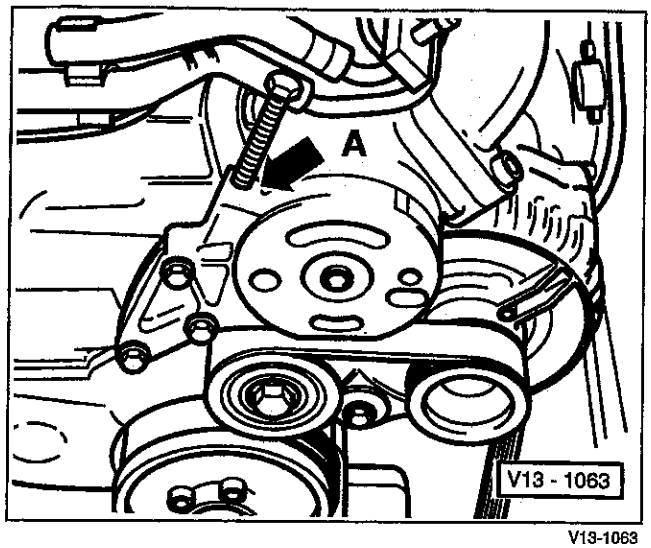
5. Installation is the reverse of removal. Start engine and check that belt runs smoothly.

6. On cars without belt tensioner, adjust the belt tension and tighten alternator mounting bolt as described earlier.




13-1220

**Fig. 21. 4-cyl. engine with belt tensioner:** Belt tensioner being lifted with spanner wrench (Volkswagen special tool no. 3299).




V13-1063

**Fig. 22.** To relieve poly-ribbed belt tension on 6-cylinder engines, thread M8x80 bolt (**A**) into tensioner until belt is free of tension.

## Poly-ribbed belt, removing and installing (6-cylinder engine)

1. Remove evaporative emission (EVAP) cannister purge regulator valve with retaining ring from lower part of air cleaner housing. See **20 Fuel Storage and Supply**.

2. Remove air cleaner housing complete with mass air flow sensor. See **24a Fuel Injection-Motronic**.

3. Temporarily install bolt (M8x80) in threaded hole in tensioner and thread bolt in until poly-ribbed belt is free of tension. See Fig. 22.

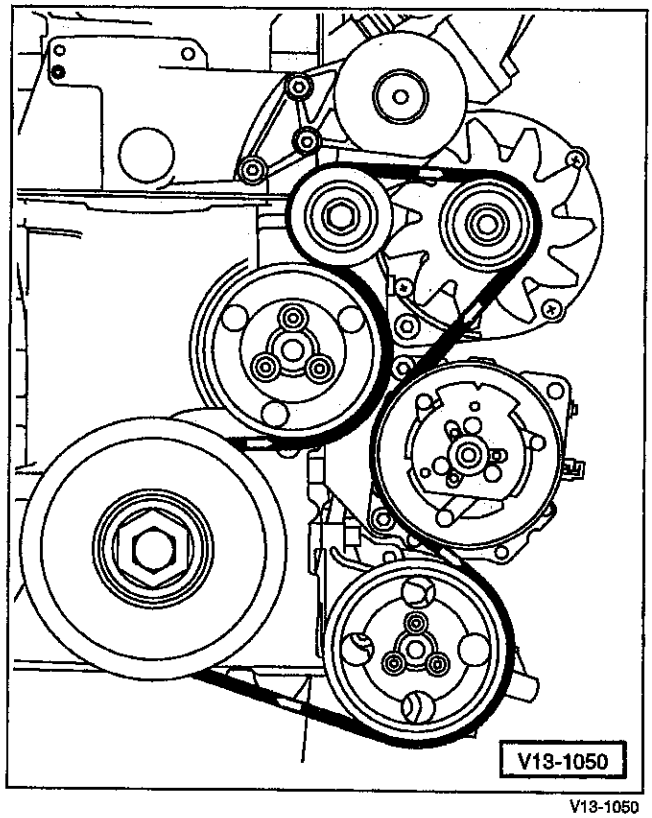
> ***CAUTION —***
> *Do not over tighten bolt. Thread bolt in only until poly-ribbed belt can be removed. The tensioner housing may be damaged if the bolt is overtightened.*

4. If reinstalling the old belt, mark running direction on belt. Remove poly-ribbed belt from pulleys.

5. Install poly-ribbed belt in position. See Fig. 23.

6. Slowly remove M8 bolt from tensioner, making sure belt is correctly seated in pulley grooves.

7. The remainder of installation is the reverse of removal. Start engine and check that belt runs smoothly.




V13-1050

**Fig. 23.** Poly-ribbed belt routing on 6-cylinder engine. **Arrows** indicate direction of travel.

## Camshaft drive belt, checking (4-cylinder engines)

The camshaft drive belt, also called the timing belt, is a toothed rubber belt that drives that camshaft. On diesel engines, the belt also drives the injection pump. The belt is subjected to high temperatures and should be inspected during scheduled maintenance intervals. On diesel engines, Volkswagen specifies replacement of the belt every 60k miles.

***NOTE—***

*Volkswagen does not specify a replacement interval for the camshaft drive belt on gasoline engines. However, the publisher recommends the belt be inspected periodically and replaced at least every 90k miles or 5 years.*

To inspect the drive belt, the upper belt cover must first be removed. Inspect the belt for tears, separation of layers, fraying of belt cords, surface cracks, or traces of oil and grease. Replace the belt if any faults are found. See **15a Cylinder Head and Valvetrain (4-Cylinder Engines)** or **Fuel Injection–Diesel** for replacement procedures.

## Camshaft drive belt, adjusting (diesel engine)

A special toothed belt tensioning gauge (Volkswagen special tool no. VW 210) is needed to accurately check and adjust camshaft drive belt tension.

1. Remove upper belt cover.
2. Install belt tensioning gauge (VW 210) between camshaft sprocket and injection pump sprocket and measure belt tension. See Fig. 24.

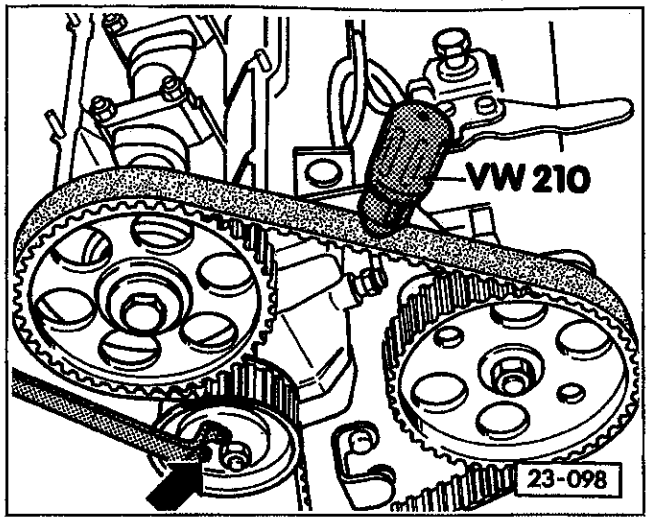
**Camshaft/Injection Pump Drive Belt Tension**

- Drive belt tension (using Volkswagen special tool no. VW 210) . . . . . 12–13 index marks

3. If the belt tension is incorrect (loose), adjust it as follows:
   - Loosen tensioner locknut and turn tensioner clockwise using a spanner wrench. See Fig. 24.
   - Measure belt tension between camshaft sprocket and injection pump sprocket using special tension gauge (Volkswagen special tool no. VW 210).
   - When tension is correct, tighten tensioner locknut and remove tool.

**Tightening Torque**

- Drive belt tensioner locknut . . . . . 45 Nm (33 ft-lb)




23-098

**Fig. 24.** Diesel camshaft drive belt tension being measured with Volkswagen special tool no. VW210. Tensioner being adjusted with spanner wrench (special tool Matra V159).

4. Turn the engine by hand, two full revolutions in the direction of normal rotation (clockwise). Recheck drive belt tension, adjust if necessary. Install upper belt cover.

## Spark plugs, replacing

The spark plugs should be replaced at the specified mileage interval given in the maintenance tables. Use of the proper spark plugs is important for long engine life and low exhaust emissions. Note that special tools should be used to remove the spark plug connectors from the plugs on 6-cylinder engines. See **28 Ignition System** for spark plug application and replacement information.

***NOTE—***

*Spark plug specifications may change during a model year. Always check with an authorized Volkswagen parts department for the latest information.*

## Air cleaner, removing and installing

Air filter elements should be replaced every 2 years or 30,000 mi., whichever comes first. Under severe conditions, dirt roads, desert driving, or dusty conditions, the air filter element should be replaced more frequently.

> ***CAUTION—***
> *DO NOT clean and re-use filter element. Always replace.*

1. Remove mass air flow sensor from air cleaner housing, if equipped. See **24 Fuel Injection**.
2. Unclip and remove air cleaner upper section. Pull filter from housing.
3. Inspect air cleaner upper and lower sections. Clean if necessary.
4. Install a new filter insert and re-assemble in reverse order of removal.

## Distributor cap and rotor, inspecting (4-cylinder gasoline engines)

Volkswagen does not specify distributor cap and ignition rotor inspection, although it is a good idea to inspect these components at 60k miles, and every 30k miles thereafter. Distributor cap and ignition rotor inspection and replacement is described in **28a Ignition System–Gasoline**.

> ***NOTE—***
> *When replacing the distributor cap, label the plug wires before removing them from the cap.*

## Clutch cable, adjusting

All Volkswagen models covered by this manual have self adjusting clutches. The VR6 engine is equipped with a hydraulically-actuated clutch. 4-cylinder engines use a self-adjusting cable to actuate the clutch.

> ***NOTE—***
> *For more information on the clutch actuating mechanisms, see* **30 Clutch (4-Cylinder Engines)** *or* **30b Clutch (6-Cylinder Engine)**.

# UNDER CAR MAINTENANCE

Under car maintenance requires that the car be raised on a lift or properly supported on jackstands. Under car maintenance should not be carried out unless proper (safe) lifting equipment is available. See **Lifting Vehicle** for more information on lifting and working under the car.

> ***WARNING—***
> *• Do not work under a car supported solely by a jack. Jack stands must always be used when working under the car.*
> *• Jack stands must be placed on a hard, level surface (e.g. concrete).*

## Tire service

Tire pressure should be checked on a regular basis. It is best to check pressures when the tires are cold. Refer to the data label on the driver's door jamb for proper inflation pressures. Be sure to also check the spare tire pressure. Check that all tires are the same type and tread pattern. Measure tread depth. If the tread wear has exceeded the minimum specification listed, the tire should be replaced.

| **Tread depth** | |
|---|---|
| • minimum height | 1.6 mm (1/16 in.) |

> ***CAUTION—***
> *Wheel alignment must be checked after replacing tires to ensure maximum tire life.*

The tires should also be checked for abnormal wear patterns.The tread wear pattern on the front tires is an indication of whether the toe and camber settings need to be checked. "Feathering" on the tread indicates incorrect toe. If the tread is worn on one side, this is usually caused by incorrect camber.

To extended tire life and minimize wear, Volkswagen recommends that the tires be rotated front to rear every 7, 500 miles. For more information on tires, see **44 Wheels–Tires, Wheel Allgnment.**

## Brake system, visual inspection

Check the brake master cylinder, vacuum brake booster (also hydraulic unit if anti-lock brake system is fitted), brake pressure regulator, and brake calipers for leaks and damage.

- Brake hoses must not be twisted.
- Brake hoses must not touch any part of the vehicle when steering is at full lock.
- Check brake hoses for porosity and deterioration, brake hoses and brake lines for chafing points.
- Check brake connections and attachments for correct seating, leaks and corrosion.
- Any faults found must be repaired.

## Brake pads (front and rear), checking

To accurately check the front brake pad thickness, the front wheels should be removed. With the wheel removed, measure the thickness of outer and inner pads. See Fig. 25. If pad thickness (incl. backing plate) is 7 mm (0.28 in.) or less, the brake pads should be replaced.

**Disc brakes (front and/or rear)**

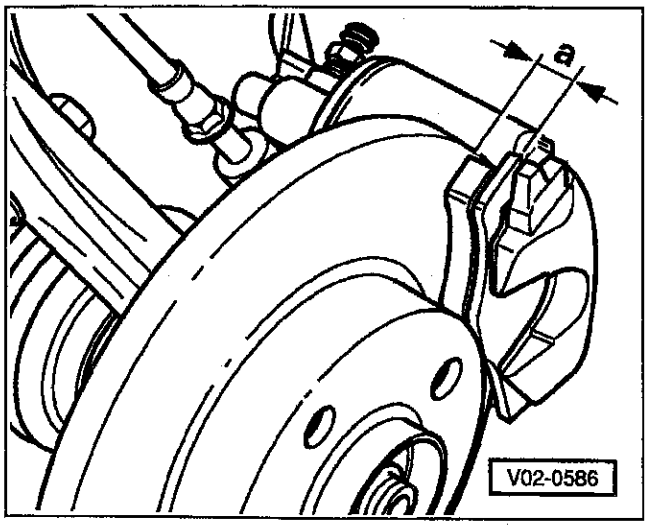
- brake pad wear limit . . . . . 7 mm (0.28 in.)

*NOTE—*

- *Before removing the front wheels, mark their position in relation to the brake rotor so the wheel can be reinstalled in the same position.*
- *Brake pad wear may be minimally greater on the front passenger's side than on the driver's side. It is therefore recommended that inspection always be performed on passenger's side front wheel.*
- *When tightening wheel bolts, tighten the bolts in stages using a criss-cross pattern.*

**Tightening torques**

- Wheel bolt to wheel hub. . . . . 110 Nm (81 ft-lb)




V02-0586

**Fig. 25.** Brake pad thickness must be at least 7 mm (0.28 in.) as indicated by **dimension a.**

On cars with 4-wheel disc brakes, it is not necessary to remove the wheels for rear brake pad inspection. Visually inspect the thickness of outer and inner brake pads through the opening in wheel using a flashlight and mirror if necessary. If pad thickness (incl. backing plate) is 7 mm (0.28 in.) or less, the brake pads should be replaced.

## Brake linings (rear), checking

On cars equipped with rear drum brakes, the rear brake shoe lining thickness can be checked through the inspection holes in the rear of the brake backing plates. If necessary, remove the sealing plugs from the inspection holes. Also check linings for brake fluid or grease contamination.

*NOTE—*

*See* **46 Brakes–Mechanical Components** *for brake application information.*

**Rear Drum Brakes**

- Brake shoe lining wear limit . . . . . 2.5 mm (0.10 in.)

## Parking brake, adjusting

The parking brake acts on the rear brakes and is self-adjusting to compensate for wear. Adjustment of the parking brake is only necessary if brake components are replaced. See **46 Brakes–Mechanical Components** for parking brake adjustment and service procedures. The parking brake should begin to hold after two clicks of the lever.

## Drive axle shafts, checking boots

There is an inner and an outer rubber CV boot on each front axle shaft. The boots should be regularly inspected for tears, cracks, or deterioration. Once the boot is open to the weather, abrasive road debris can enter the joint and quickly destroy it. If boot replacement is carried out promptly, chances are good that the joint can be saved. See **40 Front Suspension and Drive Axles** for drive boot replacement procedures.

## Front suspension components, checking

Check ball joint dust boots for damage and correct seating. Check for play in ball joints. Check inner and outer tie rod end boots for damage and correct seating. Check for play by moving tie rods and wheels. Check attachment of ball joints and tie rod ends. See **40 Front Suspension and Drive Axles** for suspension component replacement.

## Transmission, checking for leaks

Inspect the transmission for signs of fluid leakage. Pay particular attention to the axle seals. Repair any leaks found, see **34a Manual Transmission (ABA, ACC, AAZ Engines), 34b Manual Transmission (AAA, AHU Engines)** or **37 Automatic Transmission.**

## Final drive oil level, checking (cars with automatic transmission)

Transmission and final drive assemblies and lubricants used on the cars covered by this manual vary depending on engine installed and on model year. Be sure to identify the transmission installed before checking the final drive oil level. See **Transmission identification**, given earlier.

| Engine Code | Manual Transmission Code | Automatic Transmission Code |
|---|---|---|
| AAZ, ACC, ABA | 020 | 096 or 01M |
| AAA, AHU | 02A | 096 or 01M |

***CAUTION —***
- *Only genuine VW synthetic ATF (VW part no. part no. G052 162 A1) should be used in the 01M transmission final drive. Use of other ATF types can adversely affect the service life of the transmission.*
- *Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*

On cars with manual transmission, the final drive lubricant shares a common bath with the transmission lubricant. For final drive and transmission fluid level checking, see **Manual transmission oil, checking.**

On cars with automatic transmission, the final drive oil level is checked by removing the speedometer drive gear from the transmission housing and using the drive gear as a dipstick. The car should be on a level surface when making the check. See **39 Differential and Final Drive** for the procedure on checking the final drive fluid level on cars with automatic transmission.

***NOTE —***
*Volkswagen does not specify a final drive lubricant replacement interval. If the fluid needs to be drained, it can be drawn off using a fluid extraction system.*

## Automatic transmission fluid (ATF) level, checking

Two automatic transmission are used in the cars covered by this manual: the "096" (also known as Phase I) and the "01M" (also known as Phase II).

The 096 A/T uses a dipstick to check the ATF level and this procedure is described in detail **37 Automatic Transmission.**

***NOTE —***
*Transmission identification and application information is given under* **Transmission Identification.**

The 01M A/T, on the other hand, does not have a dipstick and the procedure requires measuring and maintaining a specified ATF temperature (which is neither cold nor hot, but somewhere in between) during the ATF level checking. Special Volkswagen tools are required for this operation and it is therefore recommended that ATF level checking on 01M transmission be left to an authorized Volkswagen dealer. See **37 Automatic Transmission** for detailed procedures on checking the 01M A/T fluid level.

## ATF, changing (096 automatic transmission)

Absolute cleanliness is necessary when changing the ATF. It is a good idea to clean the transmission sump and surrounding area before beginning work.

1. With engine and transmission cold, raise car and support on jackstands designed for the purpose.

***WARNING —***
- *Jack stands should be placed on a hard, level surface (e.g. concrete).*
- *Hot ATF can burn and scald. Allow the transmission to cool before beginning work.*

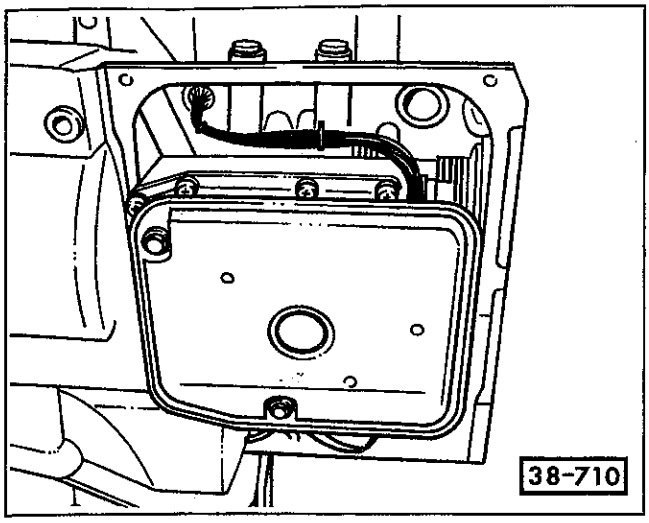
2. Extract the cold ATF from ATF sump using fluid extraction equipment (Volkswagen special tool VAG 1358 A/2 probe and VAG 1358 A).

***NOTE —***
- *There is no drain plug in the ATF sump.*
- *If extraction equipment is not available, the* ***cold*** *ATF can also be drained by loosening the sump bolts slowly until ATF runs out of one corner and into a drain bucket.*

3. Remove ATF filler (dipstick) pipe hold down bolt.
4. Remove sump mounting bolts and carefully remove sump.
5. Remove ATF strainer mounting bolts and remove ATF strainer (filter). See Fig. 26.
6. Thoroughly clean sump.

***CAUTION —***
*Cleanliness is essential when performing the following installation work.*

7. Fit new gasket (O-ring) into new ATF strainer and install strainer.




38-710

**Fig. 26.** 096 automatic transmission fluid strainer.

**Tightening torques**

- ATF strainer to transmission. . . . . 8 Nm (71 in-lb)

8. Fit spacer bushings into new sump gasket and install sump with gasket. Install filler pipe and pipe hold-down bolt.

**Tightening torques**

- ATF sump to transmission . . . . . 12 Nm (9 ft-lb)

9. Pour in 3 liters (3.2 quarts) of ATF using funnel and extension hose.

***CAUTION—***

- *Only ATF with the designation DEXRON may be used. Do not use any lubricant additives.*
- *Too much ATF will cause malfunctions and must therefore be removed.*

**ATF (096 automatic transmission)**

- Lubricant . . . . . Dexron II or III, or Genuine VW/Audi ATF G052 162 A1 or G052 162 A2

10. With engine running and vehicle stationary, shift through all selector lever positions. Check ATF level. See **37 Automatic Transmission.**

## ATF, changing (01M automatic transmission)

Absolute cleanliness is necessary when changing the ATF. It is a good idea to clean the transmission sump and surrounding area before beginning work.

***CAUTION—***

*01M automatic transmissions requires a special Volkswagen synthetic ATF. Do not use other types of ATF. Do not mix Volkswagen ATF with Dexron ATF.*

1. With engine and transmission cold, raise car and support on jackstands designed for the purpose.

***WARNING—***

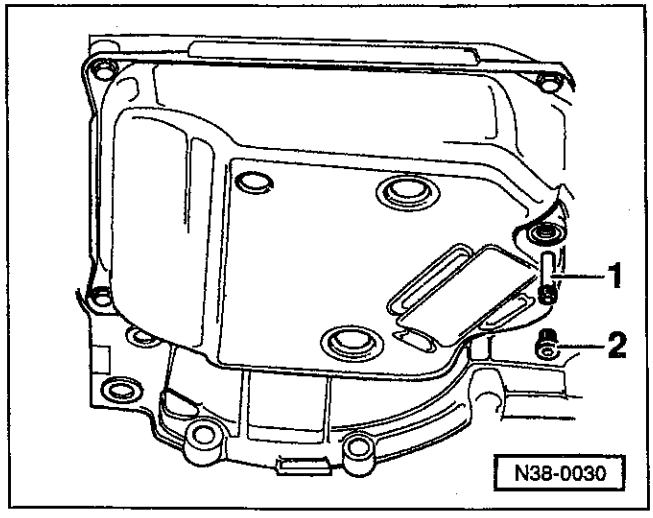
- *Jack stands should be placed on a hard, level surface (e.g. concrete).*
- *Hot ATF can burn and scald. Allow the transmission to cool before beginning work.*

2. Place drain bucket under transmission.

3. Remove level plug and overflow tube and allow ATF to drain. See Fig. 27.

***CAUTION—***

- *When level plug is removed, a small amount of ATF will drain.*
- *When overflow tube is removed, the ATF will drain rapidly. Do not stand beneath the overflow tube. Wear hand and eye protection.*




N38-0030

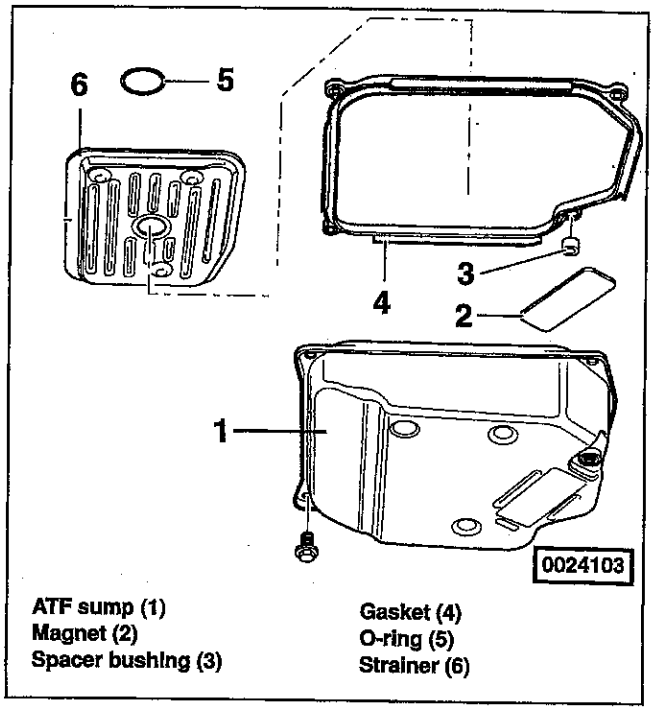
**Fig. 27.** 01M automatic transmission overflow tube (**1**) and level plug (**2**).

4. Remove sump and ATF strainer.

5. Clean sump and sump magnet.

> ***CAUTION—***
> *Cleanliness is essential when performing the following installation work.*

6. Fit new O-ring into the new ATF strainer and install. See Fig. 28.




**ATF sump (1)**
**Magnet (2)**
**Spacer bushing (3)**
**Gasket (4)**
**O-ring (5)**
**Strainer (6)**

0024103

**Fig. 28.** Exploded view of ATF sump on 01M transmission. Be sure to fit spacer bushings into sump gasket.

7. Fit spacer bushings into new gasket. Install magnet into sump. Install oil sump with gasket.

**Tightening torques**
- Oil sump to transmission . . . . . 12 Nm (9 ft-lb)

8. Install overflow tube to stop.

9. Install new seal on level plug and screw in hand tight.

10. Fill with 3 Liters (3.2 qt.) of Volkswagen ATF.

> ***CAUTION—***
> *01M automatic transmissions use a special Volkswagen synthetic ATF.*

**ATF (01M auto. transmission)**
- Lubricant
  1 Liter . . . . . Volkswagen part No. G052 162 A2
  0.5 Liter . . . . . Volkswagen part No. G052 162 A1

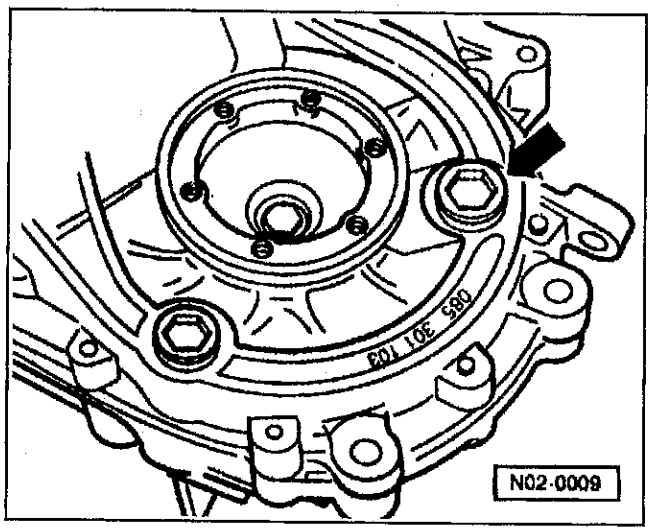
11. Check ATF level. See **37 Automatic Transmission.**

## Manual transmission oil, checking

> ***NOTE—***
> *Replacement of the manual transmission lubricant is not specified as part of Volkswagen's maintenance program.*

> ***CAUTION—***
> *Car must be level to accurately check transmission oil.*

1. Remove oil filler plug. See Fig. 29 or Fig. 30.




N02-0009

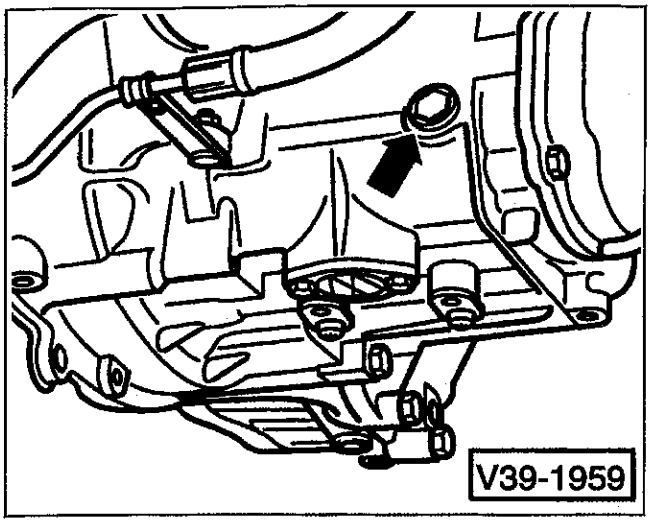
**Fig. 29.** 020 manual transmission used on cars with 4-cylinder engines. Remove oil filler plug (**arrow**) to check oil level.

2. Check that the oil level is up to lower edge of the filler hole.

3. If necessary, top off by adding oil through the filler hole.

**Manual transmission**
- Lubricant. . . . . VW G50 synthetic oil, SAE 75W90

4. Re-install oil filler plug.




V39-1959

**Fig. 30.** 02A manual transmission used on cars with AAA and AHU engines. Remove oil filler plug (**arrow**) to check oil level.

## Exhaust system, checking

> ***WARNING —***
> - *The exhaust system operates at extremely high temperatures. Do not touch the exhaust system while the engine is running.*
> - *Allow exhaust system to cool at least one hour before touching.*

Inspect exhaust system for leaks or damage. Inspect exhaust system mounts. Replace faulty, missing or deteriorated parts.

## Underbody sealant, checking

When performing the visual inspection for damage to the underbody sealant, also check the underbody, wheel housings and sill panels. Any faults found should be promptly repaired.

# BODY AND INTERIOR MAINTENANCE

## Body exterior

Automobile finishes are subjected to abuse from industrial fumes, corrosive road salt, acid rain, and other damaging airborn elements. Regular and correct care will contribute to maintaining and preserving the exterior of your Volkswagen.

> ***NOTE —***
> *Proper care may be a condition for upholding the new car warranty, should corrosion damage or paint defects occur.*

The best protection against environmental influences is frequent washing and waxing. How often this is required depends on the environment where the vehicle is used.

Under certain circumstances weekly washing may be necessary. Under other conditions, a monthly washing and waxing may be adequate. Even if a wax solution is used when washing your vehicle, it is advisable to protect the paint with a coat of hard wax at least twice a year. Check the paint for chips and scratches. Paint defects should be touched up soon after they occur to prevent corrosion.

After the winter, the underside of the vehicle should be thoroughly washed.

Exterior plastic and vinyl should be kept clean. Occasionally apply a colorless vinyl or leather preservative. DO NOT wax plastic or vinyl.

## Exterior lights, checking

Check operation of headlights (high and low beam), marker lights, taillights, turn signal lights, brake lights, reverse lights and emergency flasher lights. Use a helper when checking lights. See **94 Lights, Accessories–Exterior.**

## Interior lights, checking

Check operation of indicator and instrument cluster warning bulbs. Check operation of interior cabin illumination bulbs. See **96 Lights, Accessories-Interior.**

## Airbag unit, visual inspection

Models fitted with driver's side have the inscription "AIRBAG" on steering wheel. On cars with passenger side airbags, the inscription is also on the right-hand side of the instrument panel.

> ***WARNING —***
> - *The padded airbag covers on the steering wheel and instrument panel must not be covered over or have any objects affixed to them.*
> - *Do not apply any chemical treatment to airbag unit covers. Clean with a dry or water moistened cloth only.*

Inspect padded airbag unit covers on steering wheel and instrument panel for signs of external damage. Check with an authorized Volkswagen dealer if any faults are found.

# 1 Engine



## GENERAL

This general information group gives engine application information and general technical data for the various engines used in the cars covered by this manual.

Much of the engine repair information in **1 Engine** is organized according to engine code. Therefore it is helpful to know the code of the engine installed in your Volkswagen.

**Engine Codes**

- AAA . . . . . 2.8L, 6-cyl. (VR6), 172 HP
- ABA . . . . . 2.0L, 4-cyl., 115 HP
- ACC . . . . . 1.8L, 4-cyl., 90 HP (Canada)
- AAZ . . . . . 1.9L, 4-cyl. diesel, 75 HP (Canada)
- AHU . . 1.9L, diesel Turbo Direct Injection (TDI), 90 HP

## AAA ENGINE

The AAA, or VR6 engine, is used in the 6-cylinder GTI and Jetta GLX models. See Fig. 1.

***NOTE—***
*The name VR6 is derived from a combination of Vee (cylinder configuration) and the German word Reihenmotor, which roughly means in-line, or in-line V-6.*

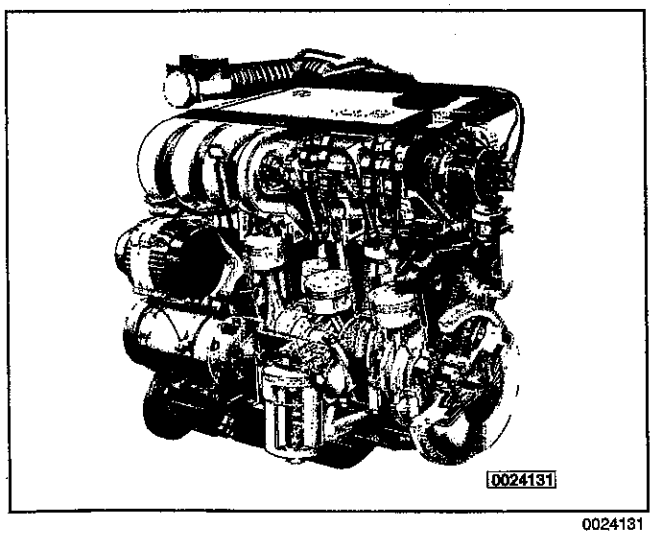



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**Fig. 1.** Cutaway of VR6 engine.

**Technical data–engine code AAA**

- Displacement . . . . . 2.8L (2792 cc)
- Bore diameter . . . . . 81.0 mm (3.19 in.)
- Stroke . . . . . 90.3 mm (3.55 in.)
- V-angle . . . . . 15°
- Compression ratio . . . . . 10:1
- Fuel and ignition systems
  1993-1995 . . . . . Bosch Motronic M2.9
  1996-1999 . . . . . Bosch Motronic M5.9
- Horsepower . . . . . 172 @ 5,800 rpm
- Torque . . . . . 173 ft-lb @ 4,200 rpm

The VR6 engine has a unique 15° V-angle between cylinder banks, as compared to the more traditional 60° or 90° angles used in most other V-6 designs. See Fig. 2. This results in a compact engine that can be installed in small spaces, such as in Volkswagen models previously reserved for 4-cylinder engines.

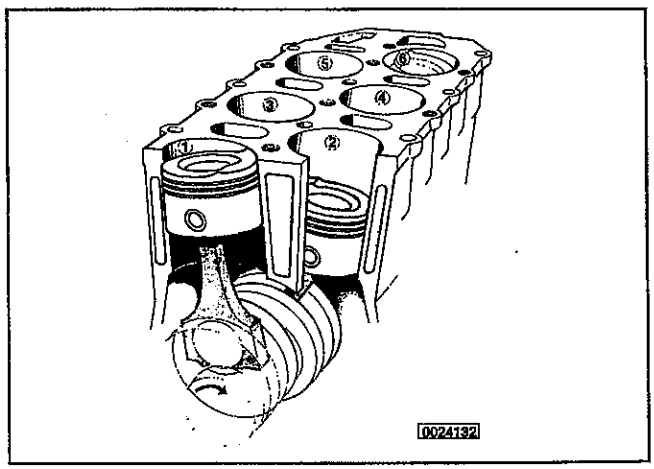


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**Fig. 2.** VR6 cylinders are staggered along the cylinder block at a15° included angle, resulting in a narrower, more compact engine.

The VR6 engine features a cast iron cylinder block with a one piece light-alloy cylinder head. The overhead camshafts are chain driven and operate two valves per cylinder. The ignition system is distributorless and all fuel and ignition requirements are controlled by the Bosch Motronic Engine Management System.

## ABA ENGINE

Fig. 3 shows the ABA engine used in all 4-cylinder Jetta, Golf and GTI models sold in the USA. This 2.0 liter long-stroke engine was manufactured specifically for the North American market. The engine features good fuel economy and a broad torque range.

The ABA engine uses a cross flow cylinder head and a two-piece intake manifold with long intake runners for enhanced low-end torque. The long piston stroke combined with the heightened cylinder block helps depress engine vibrations by reducing the operating angles of the connecting rods.

Other features include a poly-ribbed belt with automatic belt tensioner and a sophisticated Motronic engine management system. A conventional V-belt drives the power steering pump and water pump.

Depending on the date of manufacture, the ABA engine may include any or all of the following: oil spray jets for piston cooling and lubrication; crankshaft/oil pan windage tray, automatic cam/spur belt tensioner and different versions of Bosch Motronic® Engine Management.

**Technical data–engine code ABA**

- Displacement ..... 2.0L (1984 cc)
- Bore diameter ..... 82.5 mm (3.25 in.)
- Stroke ..... 92.8 mm (3.65 in.)
- Compression ratio ..... 10:1
- Fuel and ignition systems
  - 1993-1995 ..... Bosch Motronic M2.9
  - 1996-1999 ..... Bosch Motronic M5.9
- Horsepower ..... 115 @ 5,400 rpm
- Torque ..... 122 ft-lb @ 3,200 rpm

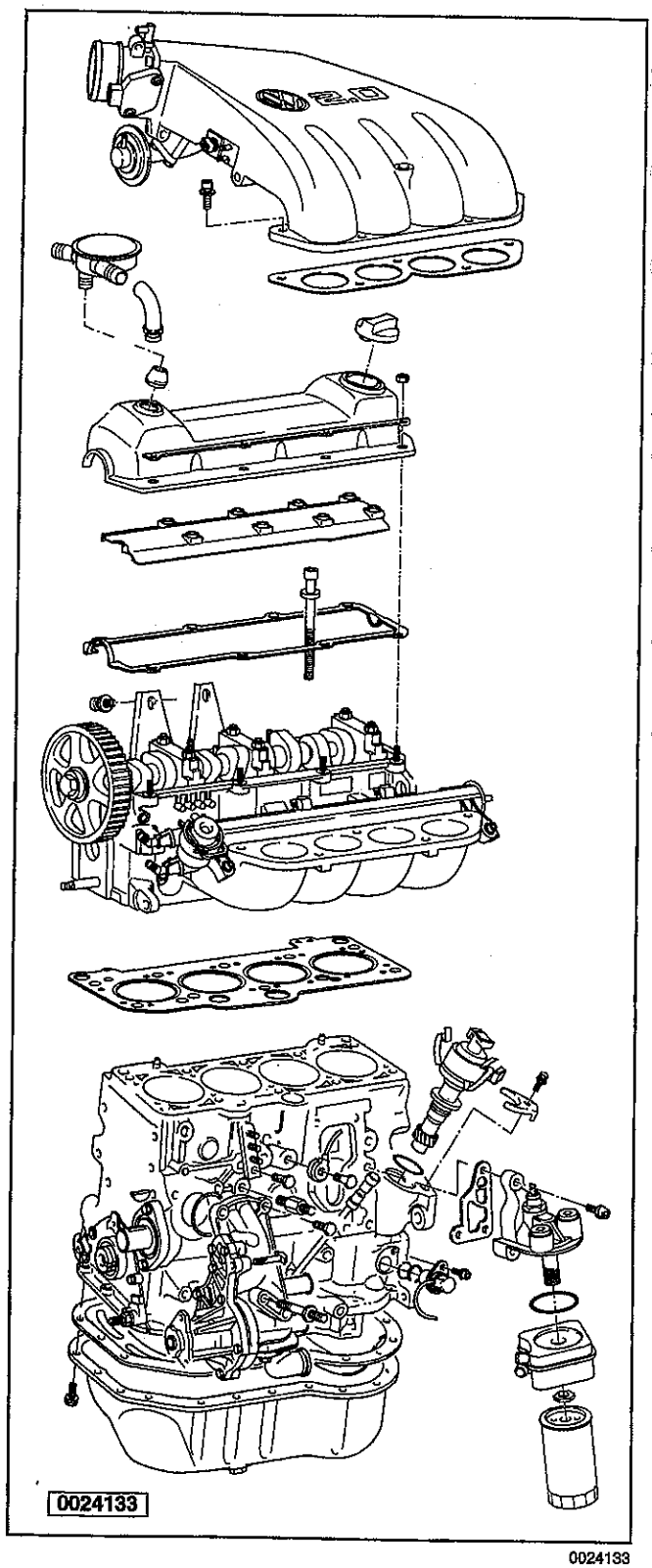


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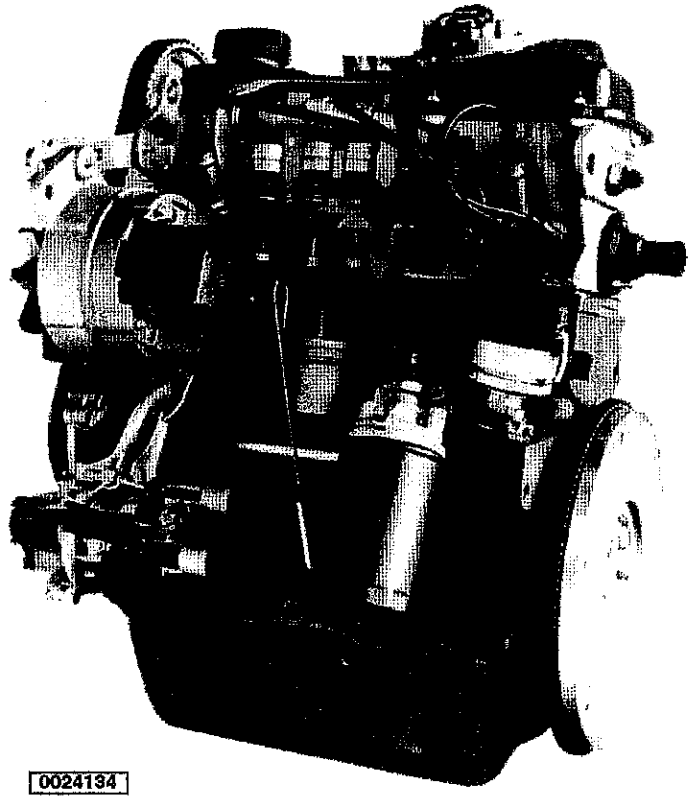
**Fig. 3.** Exploded view of 2.0 liter (ABA) engine.

## ACC ENGINE

The ACC engine is used in the Golf CL model (Canadian market only). This 1.8 liter, 90 hp engine features 9:1 compression ratio and is designed to provide good mid-range torque. The ACC engine is equipped with throttle-body fuel injection, called Mono-Motronic.

**Technical data–engine code ACC**

- Displacement . . . . . 1.8L (1781 cc)
- Bore diameter . . . . . 81.0 mm (3.19 in.)
- Stroke . . . . . 86.4 mm (3.40 in.)
- Compression ratio . . . . . 9.0:1
- Fuel and ignition systems . . . . . Bosch Mono-Motronic
- Horsepower . . . . . 90 @ 5,500 rpm
- Torque . . . . . 107 ft-lb @ 2,500 rpm



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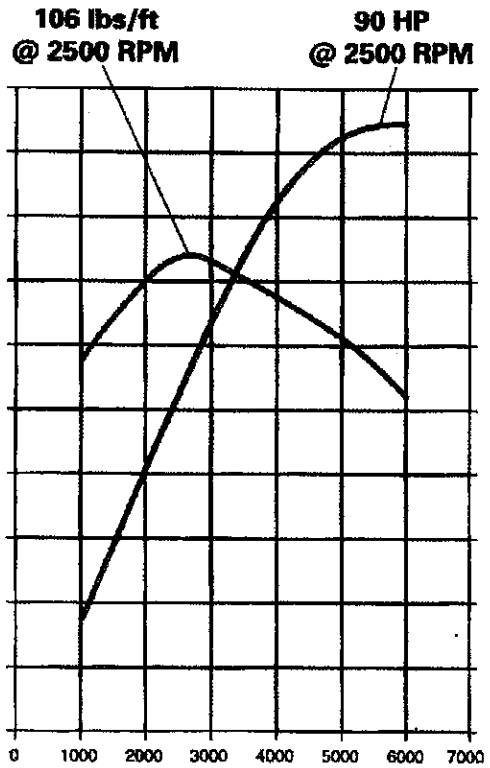


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**Fig. 4.** 1.8 liter ACC engine used in the Golf CL model (Canadian market only). Chart shows engine performance data.

## AAZ ENGINE

The Golf GL, Jetta GL and Jetta GLS models sold in Canada are available with an optional 1.9 liter ECOdiesel engine. The AAZ engine uses a turbocharger for increased performance and reduced particulate emissions. The AAZ engine is equipped with a one-way catalytic converter for reduced hydro-carbon emissions.

**Engine data–engine code AAZ**

- Displacement . . . . . 1.9L (1896 cc)
- Bore diameter . . . . . 79.5 mm (3.19 in.)
- Stroke . . . . . 95.5 mm (3.40 in.)
- Compression ratio . . . . . 22.5:1
- Horsepower . . . . . 75 @ 4,200 rpm
- Torque . . . . . 107 ft-lb @ 2,500 rpm

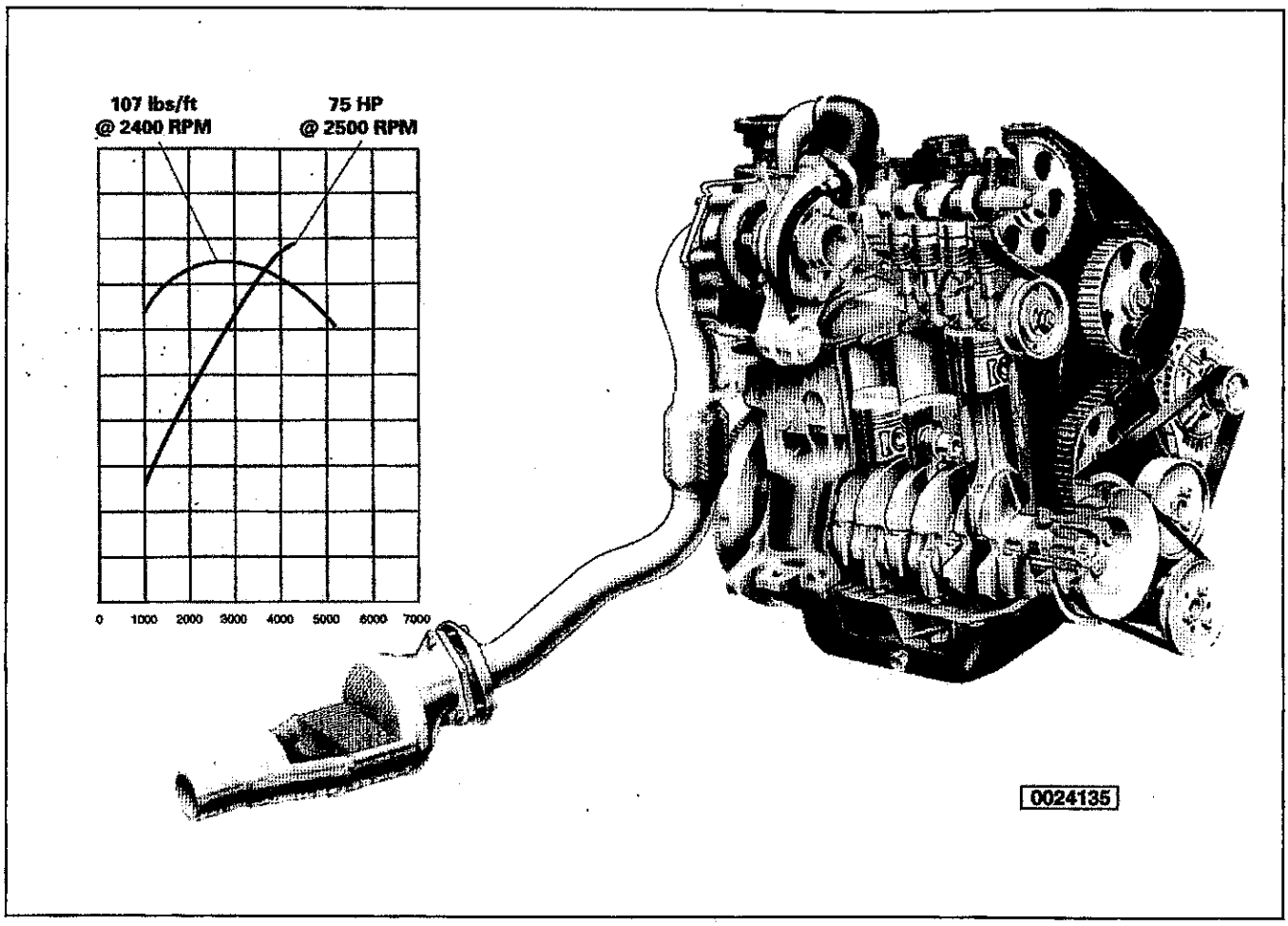


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**Fig. 5.** 1.9 liter AAZ diesel engine available as an option in Golf and Jetta models sold in Canada. Chart shows engine performance data.

## AHU ENGINE

The Jetta model is available with an optional diesel engine. This engine is known as a Turbocharged direct-injection diesel or TDI. The TDI AHU engine features performance on a par with a comparable gasoline engine. It is cleaner than most gas engines and provides significantly better fuel economy. These advantages are achieved through the use of a turbocharger and an intercooler in addition to a sophisticated electronic engine management system and an oxidation catalytic converter.

**Engine data–engine code AHU**

- Displacement ..... 1.9L (1896 cc)
- Bore diameter ..... 79.5 mm (3.19 in.)
- Stroke ..... 95.5 mm (3.40 in.)
- Compression ratio ..... 19.5:1
- Horsepower ..... 90 @ 4,000 rpm
- Torque ..... 149 @ 1,900 rpm

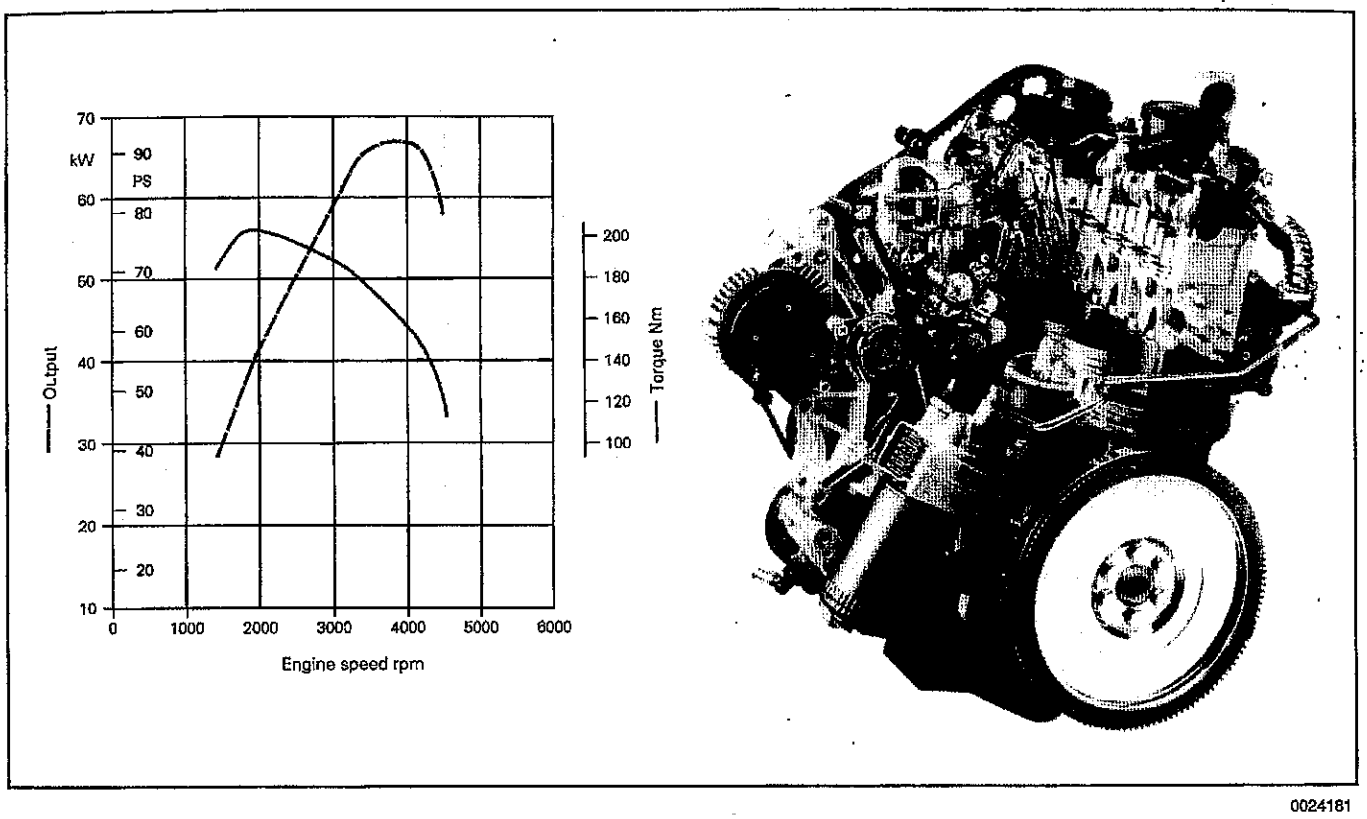



**Fig. 6.** 1.9 liter AHU TDI diesel engine available as an option in Jetta models. Chart shows engine performance data.

# 10 Engine—Removing and Installing





## GENERAL

The engine and transmission are removed as a unit and separated from each other once removed from the car. The assembly is lifted out from the front, requiring that the front body assembly (radiator support) be removed. It is not necessary to remove the hood, unless it will interfere with the type of lifting equipment being used.

The operations needed to remove the engine/transmission assembly fall into three areas: jobs done under the hood, jobs done inside the car, and jobs done under the car. The steps below follow this general sequence. Most of the operations are simple and straight forward. References to additional repair groups are provided in bold type where additional information may be helpful to complete a step.

***NOTE—***
*It will be necessary to cut many wire tie wraps when removing the engine. The tie wraps are installed to prevent the wiring harnesses from chaffing or contacting engine parts. Be sure to make note of all tie wraps removed and install new ones during engine installation.*

## REMOVING AND INSTALLING ENGINE (4-Cylinder)

### To remove engine/transmission assembly (4-cylinder engines)

1. Disconnect the negative (–) battery terminal and then the positive (+) terminal. Remove the battery from car.

***NOTE—***
*Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. On AHU diesel engines, remove the large plastic upper engine cover. On AHU and AAZ diesels, remove lower sound dampening (belly) pan.

3. Drain the cooling system as described in **19 Engine–Cooling System**. Remove the coolant hoses connected to the radiator and the heater core.

***WARNING—***
*Hot coolant can scald. Drain the coolant only with engine cold.*

4. Remove the engine drive belts. See **0 Maintenance Program.**

***NOTE—***
*On poly-ribbed drive belts, mark the running direction on the belt before removing it.*

5. On gasoline engines, disconnect and label the hoses, wires, and cables connected to the throttle body, the intake manifold and cylinder head. For more information on fuel injection components, see **24 Fuel Injection.**

***WARNING—***
*Fuel will be expelled when disconnecting fuel hoses. Wrap a cloth around the fuel line fittings before disconnecting them. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.*

6. Remove the air filter housing together with all intake air ducts. Label and then disconnect the fuel return and fuel supply hoses.

7. On AAZ diesel engines, disconnect the accelerator cable and the cold start accelerator cable from the injection pump. Free the cables from any clamping brackets on the engine. On AAZ and AHU engines, disconnect the fuel supply and return lines from the injection pump. Disconnect the electrical connectors from the pump.

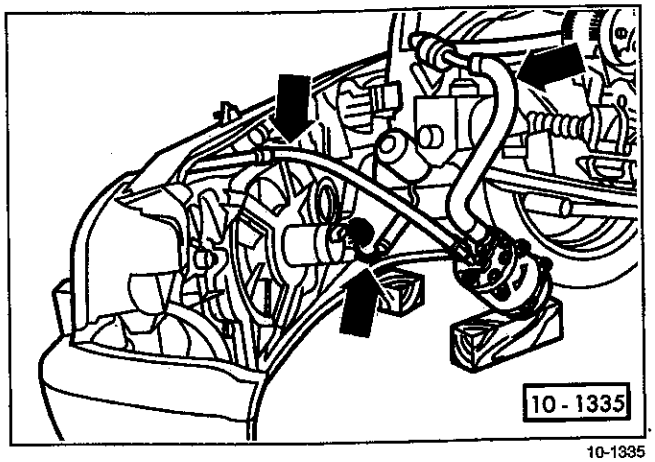
***NOTE—***
*On AHU diesel engines there is no accelerator cable to disconnect from the engine.*

***WARNING—***
*Fuel may be expelled when disconnecting hoses. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.*

8. Remove the upper radiator mounting bolts. Disconnect all electrical connectors and coolant hoses from radiator.

9. On cars with air conditioning, remove the A/C hose clamping bracket from the radiator support. Remove the A/C receiver/dryer mounting nuts at the right front corner of the engine compartment and allow it to hang free.

10. On cars with air conditioning, remove the A/C compressor from the engine without disconnecting any refrigerant lines. Support the compressor so that no lines are stressed. See Fig. 1.




10-1335

**Fig. 1.** A/C compressor shown removed from engine and supported. Do not stress or kink refrigerant lines (arrows).

***CAUTION—***
*Use care to avoid kinking or bending the refrigerant lines.*

11. Remove the front body assembly mounting bolts. Disconnect all electrical connectors and hose brackets from the assembly. Disconnect the hood release cable. Remove the complete assembly with all attachments. See Fig. 2. See also **50 Body–Front.**

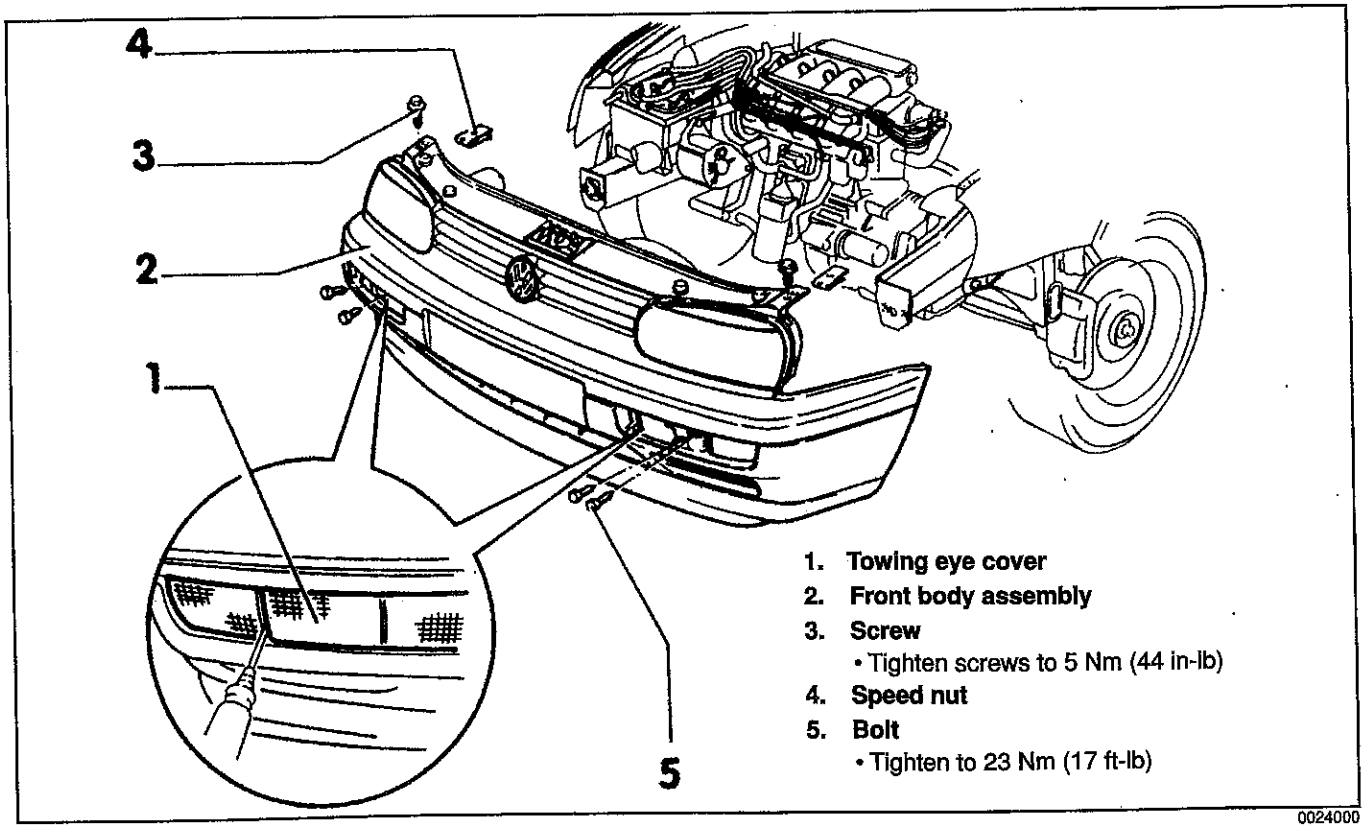



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**Fig. 2.** Front body assembly. Be sure to remove lower screws from wheel housing trim (not shown).

12. On cars with A/C, swing the radiator together with fan and the A/C condenser out and away from the engine. See Fig. 3.

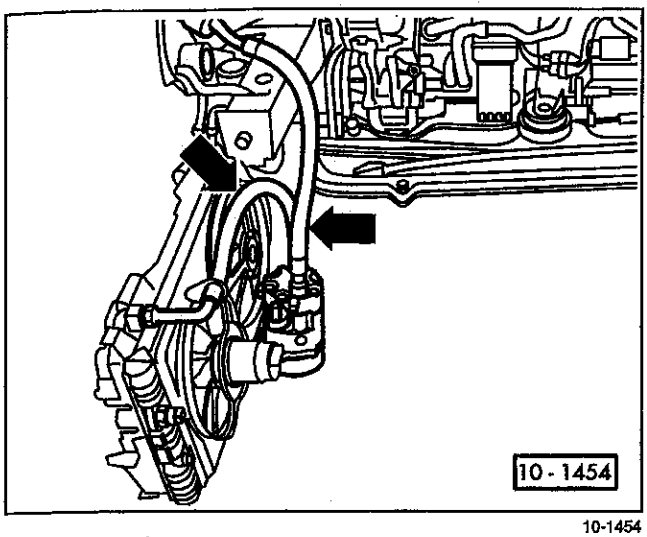


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**Fig. 3.** Radiator assembly on cars with A/C shown positioned in front of engine.

13. Unbolt the power steering pump together with its bracket and set the pump aside without disconnecting the power steering fluid lines.

14. Working under the car, disconnect the drive axle inner constant velocity (CV) joints from the transmission drive flanges, as described in **40 Front Suspension and Drive Axles**. Suspend the axles from the body with stiff wire to avoid damaging the CV joints.

15. Disconnect the exhaust pipe from the exhaust manifold. See **26 Exhaust System/Emission Controls**.

16. Label and disconnect the wiring from the starter and the alternator. Disconnect all remaining electrical connections to the engine and transmission, including ground straps.

17. On cars with automatic transmission, remove the engine vibration damper/pulley from the front of the crankshaft. Remove the coolant pump pulley from the pump.

18. On cars with automatic transmission, remove the harness connectors from the transmission housing. Disconnect the selector lever cable from the transmission lever. Free the cable from its bracket. See Fig. 4.

19. On cars with manual transmission, remove any harness connectors from the transmission. On AHU diesel engines, unbolt the clutch slave cylinder from the transmission housing. On all others, detach the clutch cable. Detach the shift linkage for all versions as described in **34 Manual Transmission**.

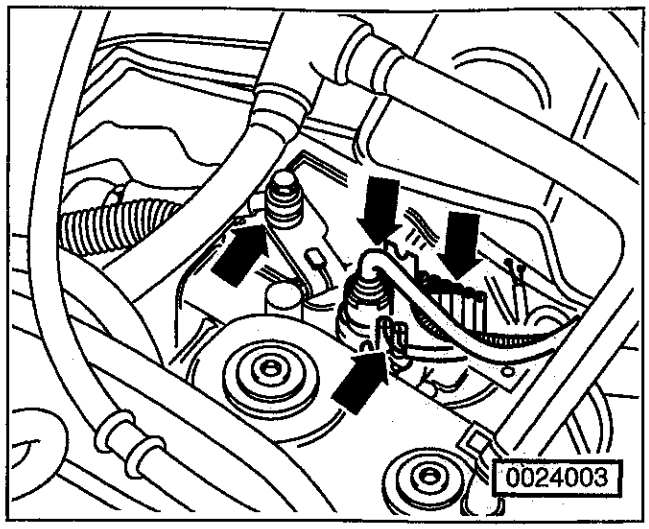


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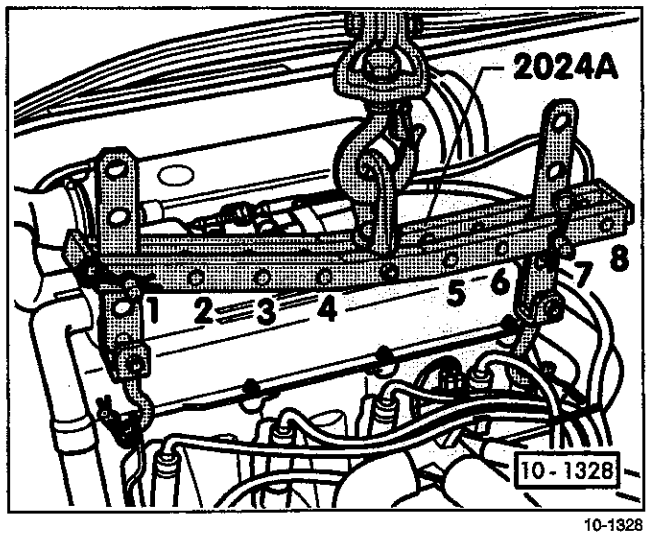
**Fig. 4.** Top view of automatic transmission showing harness connectors and selector lever cable (arrows).

20. Install an engine lifting device, using the lifting points illustrated in Fig. 5 or Fig. 6.

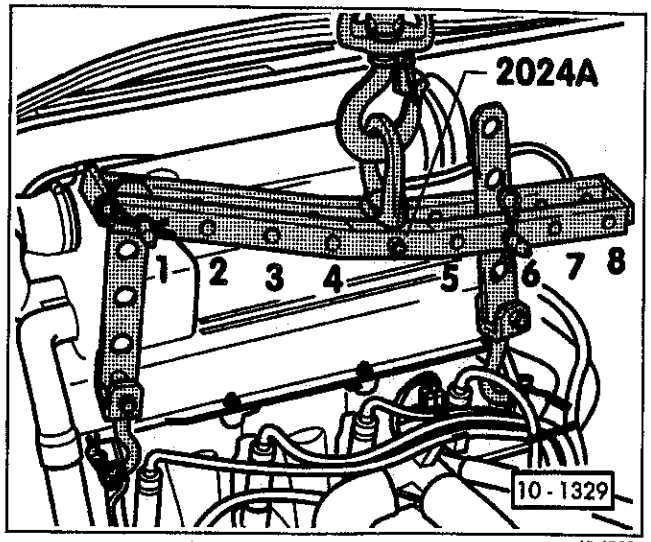



10-1328

**Fig. 5.** Engine hoist chain properly attached for lifting engine with manual transmission from car. Use of hoist as shown is necessary for proper weight distribution. Note position of left and right lifting hooks in relation to crossbar. Always use securing cotter pins on holding pins and hooks, as shown.

21. Raise the hoist slightly, so that the weight of the engine and transmission assembly is supported by it.

22. Remove the bolts from the rear engine mount and the front and rear transmission mounts. See Fig. 7.
    - Front mount is attached the left side crossmember.
    - Left rear mount is attached the left side subframe.
    - Right rear mount is attached to right side subframe.




10-1329

**Fig. 6.** Engine hoist chain properly attached for lifting engine with automatic transmission from car. Use of hoist as shown is necessary for proper weight distribution. Note position of left and right lifting hooks in relation to crossbar. Always use securing cotter pins on holding pins and hooks, as shown.

***CAUTION—***
*The tightening torques given in Fig. 7 apply only to clean and oiled bolts.*

23. Raise and remove the engine and transmission assembly from the car. Proceed slowly. Check frequently to make sure no hoses or wires are interfering with engine removal. If the car has been raised on jack stands, check often to see that it remains stable and adequately supported.

## To install engine/transmission assembly (4-cylinder engines)

1. With the engine lifting device connected, lower the engine into position while aligning the front and rear mounts. See Fig. 8.

***NOTE—***
*Be sure to allow for clearance of the drive axles during engine installation.*

2. Lightly oil and install the engine/transmission mount bolts. Do not tighten the bolts at this time.

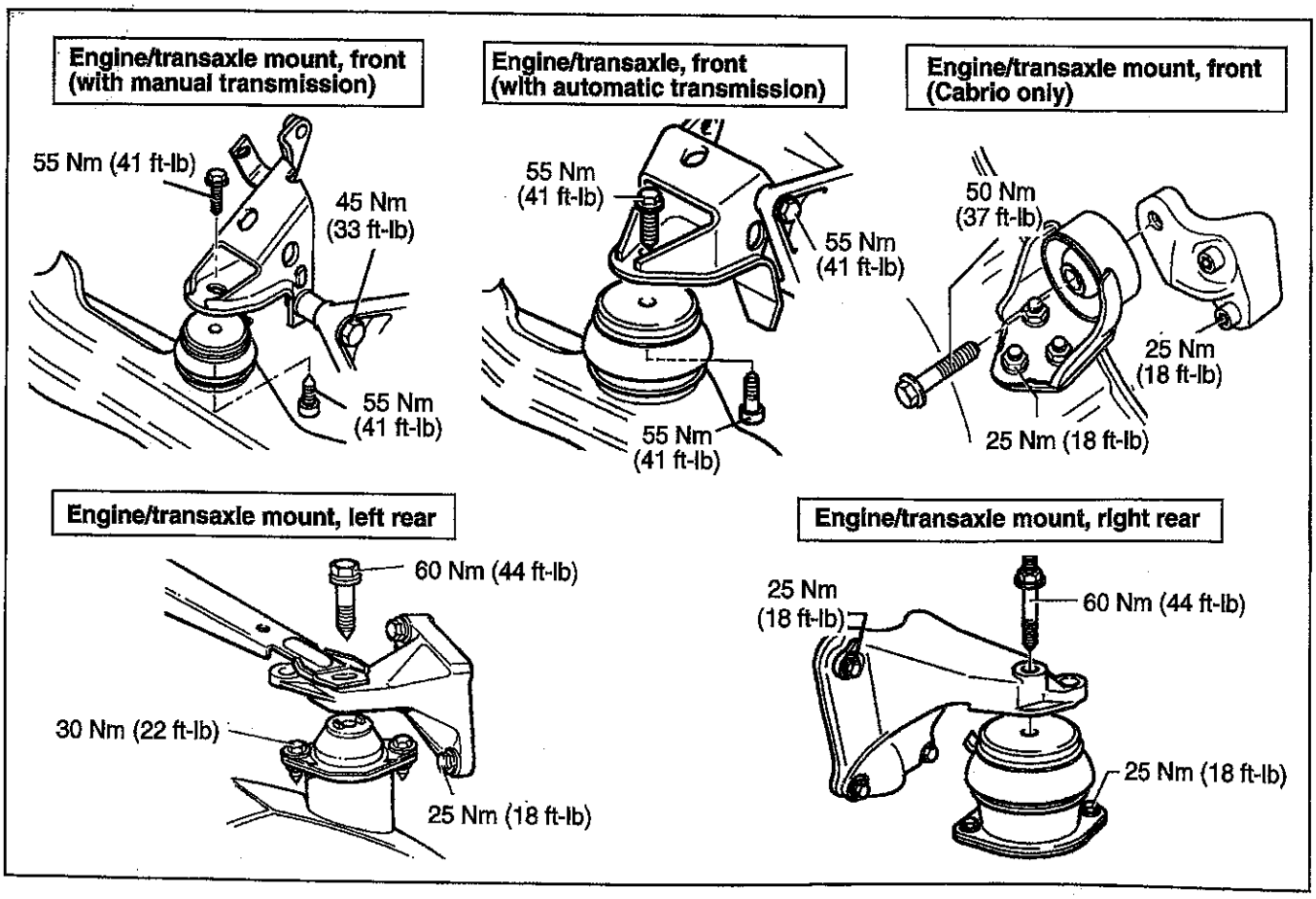



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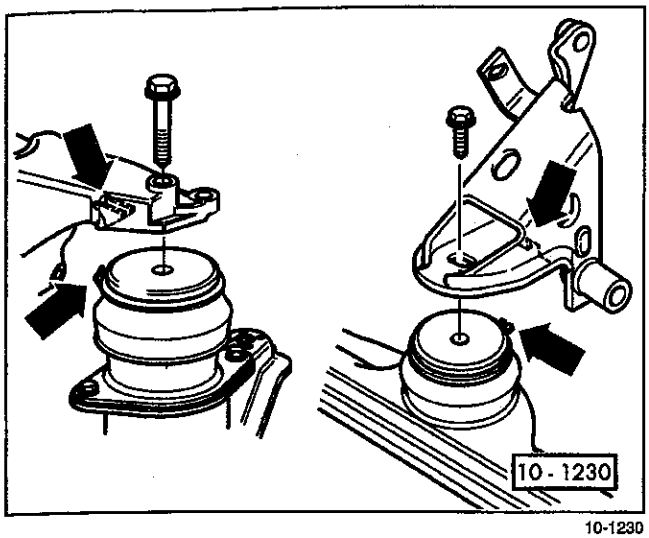
**Fig. 7.** 4-cylinder engine/transmission mount tightening torques, which apply only to clean and lightly oiled bolts.




10-1230

**Fig. 8.** When lowering engine assembly onto mounts, align guide pins on right rear mount (left) and front mount (right) to recesses on brackets (**arrows**).

3. Install the front body assembly using Fig. 2 as a guide. Make sure the assembly is stress free before tightening the bolts.

4. Install all components, connectors, hoses and lines previously removed. Install new hose clamps and wire tie wraps as necessary. Inspect the drive belts and replace if worn.

5. With the car on the ground, shake the engine/transmission assembly to allow it to settle on the mounts. Tighten the engine mount fasteners beginning with the front and right rear mounts. Tighten the left rear mount last. See Fig. 7 for mount tightening torques.

***CAUTION—***
- *The tightening torques given in Fig. 7 apply only to lightly oiled bolts.*
- *Wire tie wraps are installed to prevent wiring harnesses from chaffing or contacting engine parts. Be sure to install new wraps in their original locations.*

**Tightening torques**
- Coolant pump pulley to coolant pump. . . . . 20 Nm (15 ft -lb)
- Drive axle to drive flange. . . . . 45 Nm (33 ft-lb)
- Exhaust pipe to exhaust manifold . . . . 40 Nm (30 ft-lb)
- Vibration damper/pulley to crankshaft hub . . . . . 25 Nm (18 ft-lb)

***NOTE—***
- *After aligning the engine and transmission, check gearshift function. If necessary, adjust the shift mechanism as described in* **3 Clutch, Transmission, and Final Drive.**
- *It may be necessary to adjust headlight aim if a new engine is installed.*

6. Adjust the accelerator cable as described in **24 Fuel Injection.** On 1.8 liter engines, check and adjust ignition timing. See **28 Ignition System.** Check all fluid levels.

7. On diesel engines, reinstall the lower sound dampening (belly) pan and upper engine covers.

# REMOVING AND INSTALLING ENGINE (6-Cylinder)

## To remove engine/transmission assembly (6-cylinder engine)

1. Disconnect the negative (–) battery terminal and then the positive (+) terminal. Remove battery from the car.

***NOTE—***
*Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. Remove the engine drive belt. See **0 Maintenance Program.**

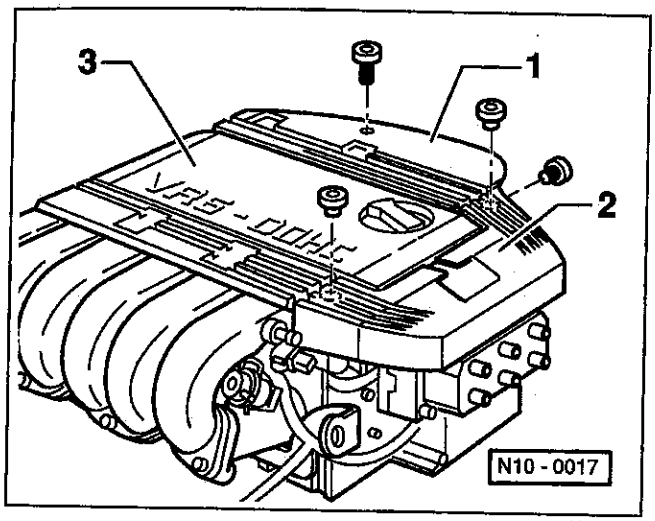
***NOTE—***
*On poly-ribbed drive belts, mark the running direction on the belt before removing it.*

3. Remove the spark plug connectors from the plugs and the coil. Remove the spark plug wire guides with the ignition wires. See Fig. 9.

***NOTE—***
*A special tool (VW tool no. 3277) is available to remove the spark plug connectors from the plugs without damaging them. A version of this tool is clipped to the front hood support bar.*

4. Separate the round 42-pin harness connector near the ignition coil on the rear of the cylinder head.

5. Remove the intake manifold cover from above the intake manifold.




N10-0017

**Fig. 9.** Spark plug wire guides (**1** and **2**). Intake manifold cover shown at **3**.

6. Disconnect and label the hoses and wires connected to the throttle body, the intake manifold and cylinder head. For more information on fuel injection components, see **24 Fuel Injection.**

7. Remove the air filter housing and intake air ducts (with mass air flow sensor).

8. Disconnect the accelerator cable from the throttle and from its support bracket.

***NOTE—***
*It is not necessary to remove the accelerator cable locating clip.*

9. Label and then disconnect the fuel return and fuel supply hoses from the fuel rail. Unclip the fuel lines from the cylinder head and move them out of the way.

***WARNING—***
*Fuel will be expelled when disconnecting fuel hoses. Wrap a cloth around the fuel line fittings before disconnecting them. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.*

10. Drain the cooling system as described in **19 Engine—Cooling System.** Remove the coolant hoses connected to the radiator and heater core.

***WARNING—***
*Hot coolant can scald. Drain coolant only with the engine cold.*

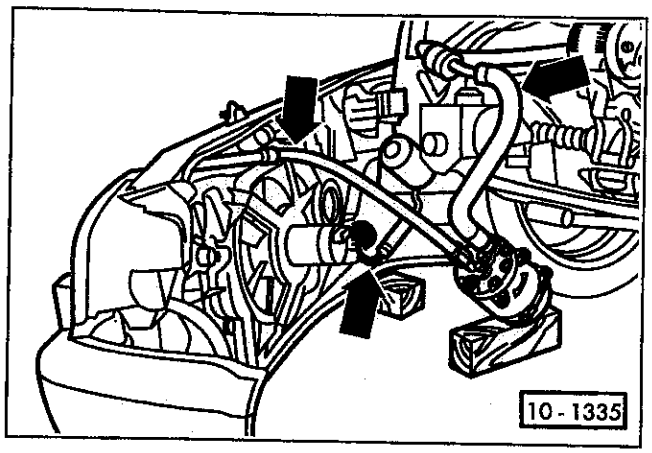
11. Disconnect the exhaust pipes from the exhaust manifolds. See **26 Exhaust System/Emission Controls.**

12. Working under the car, disconnect the drive axle inner constant velocity (CV) joints from the transmission drive flanges, as described in **40 Front Suspension and Drive Axles.** Suspend the axles from the body with stiff wire to avoid damaging the CV joints.

13. Remove the upper radiator mounting bolts.

14. On cars with A/C, remove the A/C hose clamping bracket from the radiator support. Remove the A/C receiver/dryer mounting nuts at the right front corner of the engine compartment and allow it to hang free.

15. On cars with air conditioning, remove the A/C compressor from the engine without disconnecting any refrigerant lines. Support the compressor so that no lines are stressed. See Fig. 10.

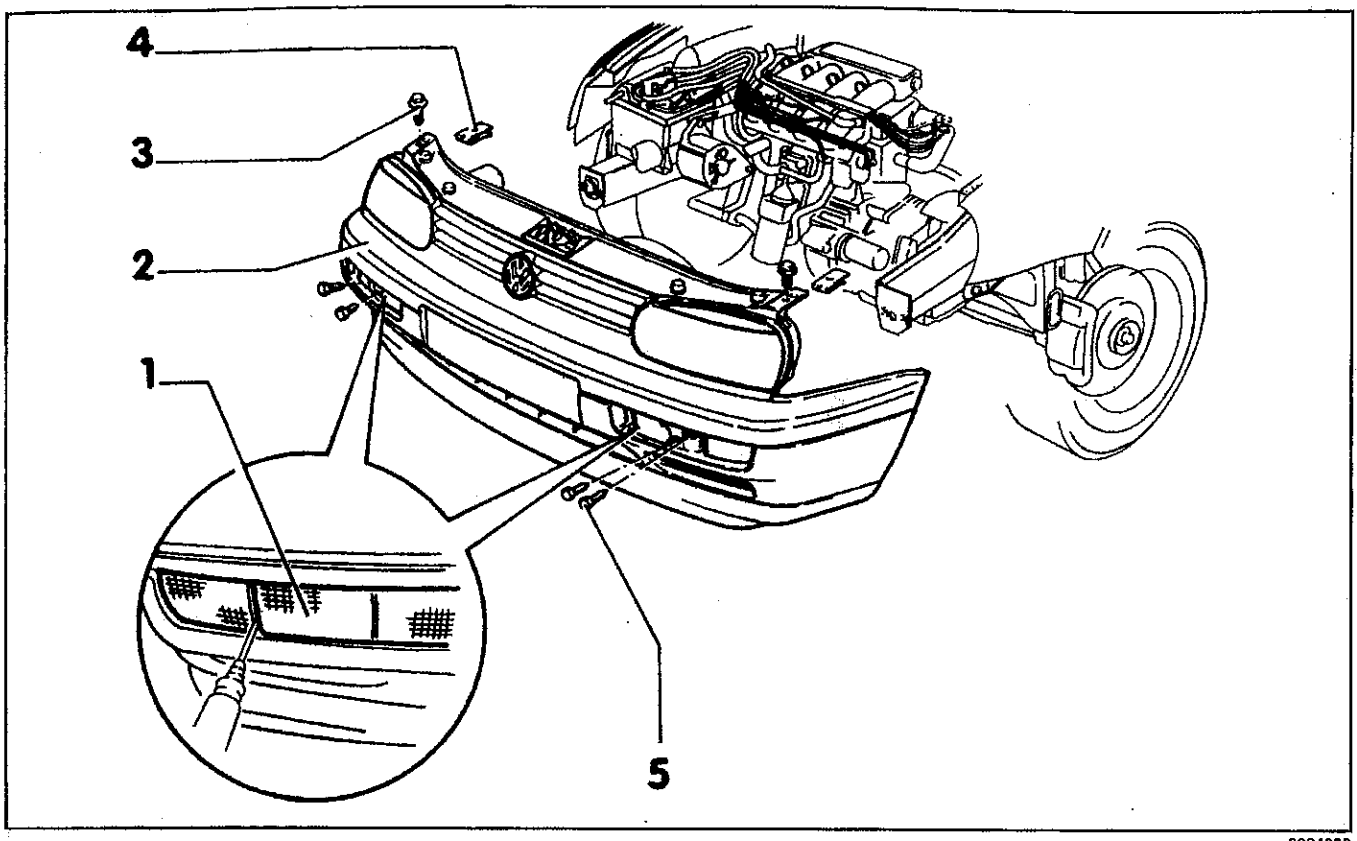



10-1335

**Fig. 10.** A/C compressor shown removed from engine and supported. Do not stress or kink refrigerant lines (**arrows**).

16. Remove the front body assembly mounting bolts. Disconnect all electrical connectors and hose brackets from the assembly and the radiator. Disconnect the hood release cable. Remove the complete assembly with all attachments. See Fig. 11.

17. On cars with A/C, swing the radiator together with fan and the A/C condenser out and away from the engine. See Fig. 3 given earlier.




0024000

**Fig. 11.** Front body assembly. Be sure to remove lower screws from wheel housing trim (not shown).

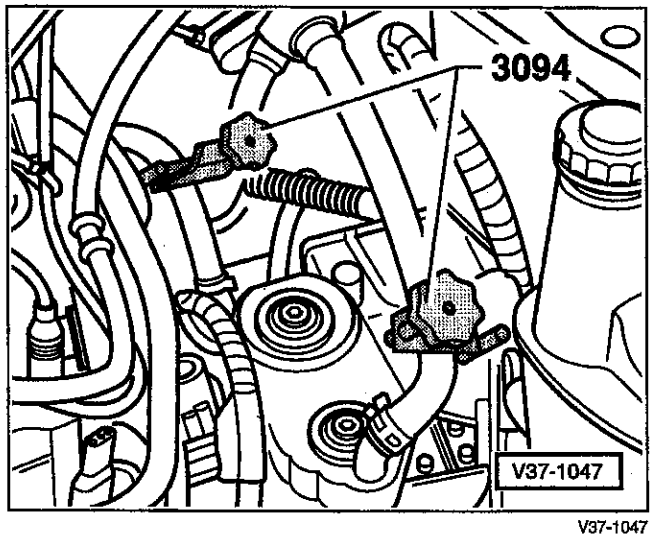
18. Remove all retainers and mounting brackets holding the power steering lines (including the fluid reservoir lines) to the body, the transmission, and the engine. Unbolt the power steering pump together with its bracket and set the pump aside.

19. On cars with automatic transmission, remove the electrical harness connectors from the transmission housing. Clamp off the ATF cooler lines near the cooler and disconnect the lines. See Fig. 12.

20. On cars with manual transmission, unbolt the clutch slave cylinder from the transmission housing. Disconnect the transmission operating cables from the transmission. Disconnect any harness connectors. See **34 Manual Transmission.**

21. On cars with automatic transmissions, place the selector lever in the "Park" position. Remove the accelerator cable and the selector lever cable as shown in **37 Automatic Transmission.**

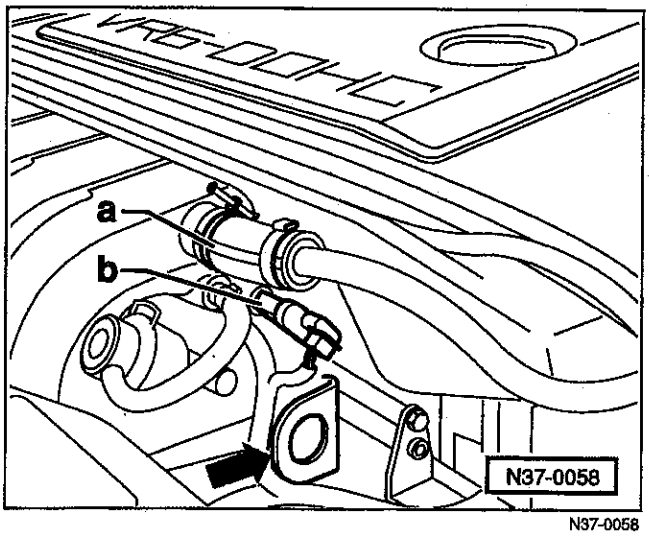
22. Label and disconnect the wiring from the starter and the alternator. See **27 Engine Electrical System.** Disconnect all remaining electrical connections to the engine and transmission, including ground straps.




V37-1047

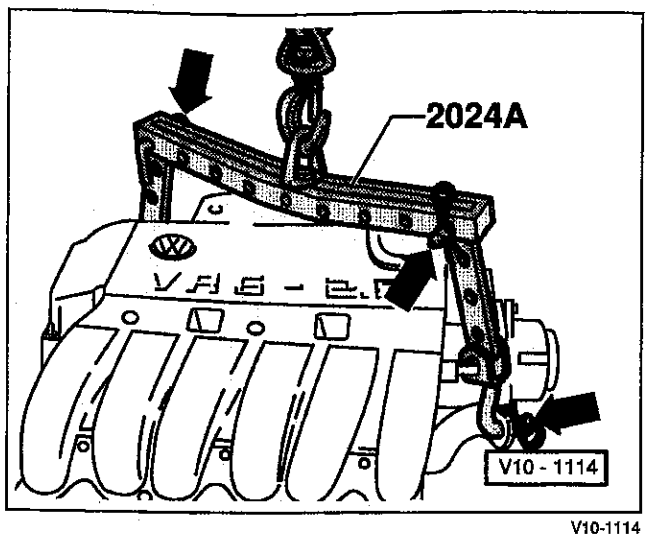
**Fig. 12.** ATF cooler lines shown clamped off. Number indicates VW special tool.

23. Remove the intake air temperature sensor and disconnect the vacuum hose at the upper intake manifold. See Fig. 13.




N37-0058

**Fig. 13.** Remove vacuum hose (**a**) and intake air temperature sensor (**b**) to prevent damage when lifting out engine. Rear lifting eye shown at **arrow**.




V10-1114

**Fig. 14.** Engine hoist chain properly attached for lifting engine with manual transmission. Use of hoist as shown is necessary for proper weight distribution. Note position of left and right lifting hooks in relation to crossbar.

***NOTE—***

*The intake air temperature sensor and the vacuum hose at the intake manifold are very close to the rear engine lifting eye and can be damaged by the engine lifting equipment.*

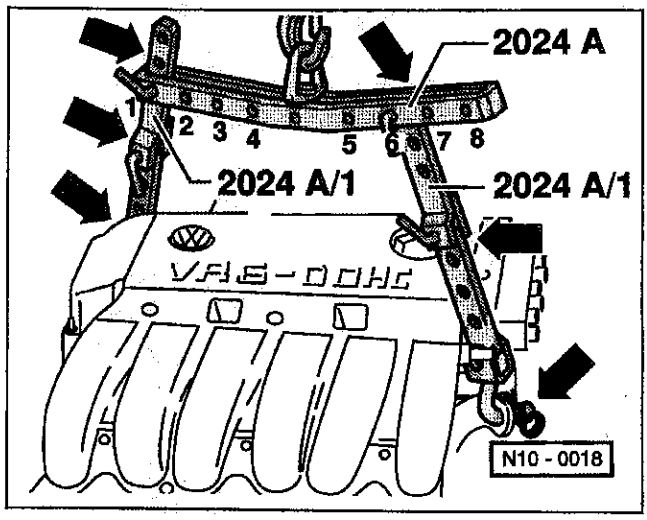
24. Install an engine lifting device, using the lifting points illustrated in Fig. 14 or Fig. 15.

> ***WARNING—***
> *Always use securing cotter pins on holding pins and hooks (arrows).*

25. Raise the hoist slightly, so that the weight of the engine/transmission assembly is supported by it.

26. Remove the bolts from the left and right rear engine/transmission mounts and the front engine/transmission mount. See Fig. 16.

> ***CAUTION—***
> *The tightening torques given in Fig. 16 apply only to clean and oiled bolts.*




N10-0018

**Fig. 15.** Engine hoist chain properly attached for lifting engine with automatic transmission. Use of hoist as shown is necessary for proper weight distribution. Note position of left and right lifting hooks in relation to crossbar.

27. Raise and remove the engine/transmission assembly from the car. Proceed slowly. Check frequently to make sure no hoses or wires are interfering with engine removal. If the car has been raised on jack stands, check often to see that it remains stable and adequately supported.

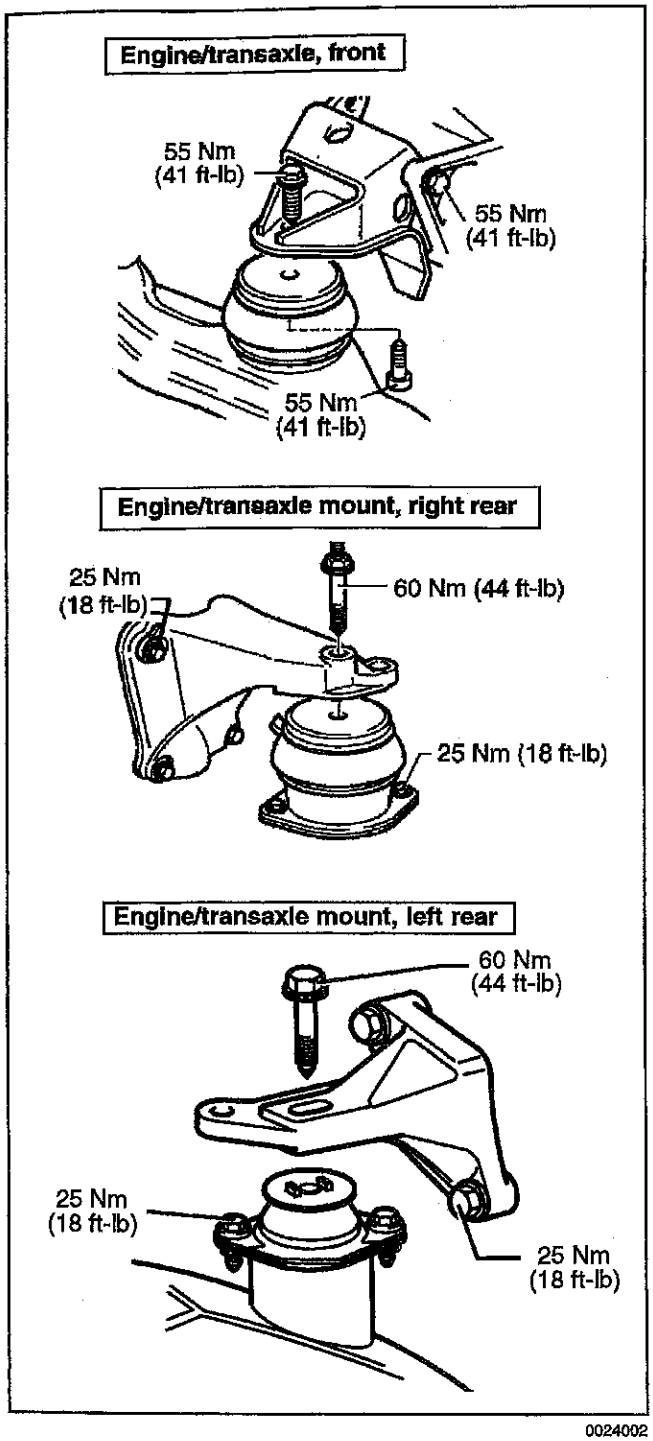



**Fig. 16.** 6-cylinder engine/transmission mount tightening torques (bolts oiled). Right rear mount is attached to engine and right side subframe. Left rear mount is attached to transmission and left side subframe. Front mount is attached to transmission and left side crossmember.

## To install engine/transmission assembly (6-cylinder engine)

1. With the engine lifting device connected, lower the engine into position while aligning the front and rear mounts. See Fig. 17.

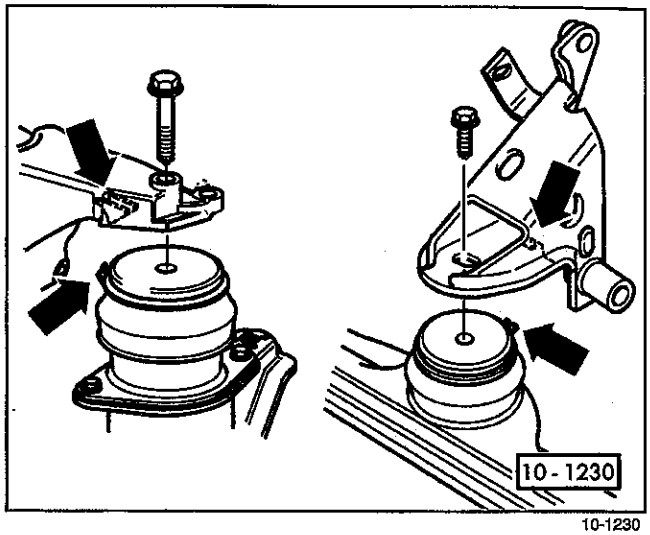



**Fig. 17.** When lowering engine assembly onto mounts, align guide pins on right rear mount (left) and front mount (right) to recesses on brackets (**arrows**).

2. Be sure to allow for clearance of the drive axles during engine installation.

3. Lightly oil and install the engine/transmission mount bolts. Do not tighten the bolts at this time.

4. Install the front body assembly using Fig. 11 as a guide.

5. Install all components, connectors, hoses and lines previously removed. Install new hose clamps and wire tie wraps as necessary. Inspect the drive belt and replace if worn.

6. Additional installation tightening torques are given below. Check all fluids levels as the final step.

> ***CAUTION—***
> *Wire tie wraps are installed to prevent the wiring from chaffing or contacting engine parts. Be sure to install new tie wraps in their original locations.*

**Tightening torques**

- Drive axle to drive flange . . . . . .45 Nm (33 ft-lb)
- Exhaust pipe to exhaust manifold. . . . 40 Nm (30 ft-lb)

7. If necessary, adjust the accelerator cable. See **24 Fuel Injection**.

8. With the car on the ground, shake the engine/transmission assembly to allow it to settle on the mounts. Tighten the engine mount fasteners beginning with the front and right rear mounts. Tighten the left rear mount last. See Fig. 16 for mount tightening torques.

> ***WARNING—***
> *The tightening torques given in Fig. 16 apply only to oiled bolts.*

***NOTE—***

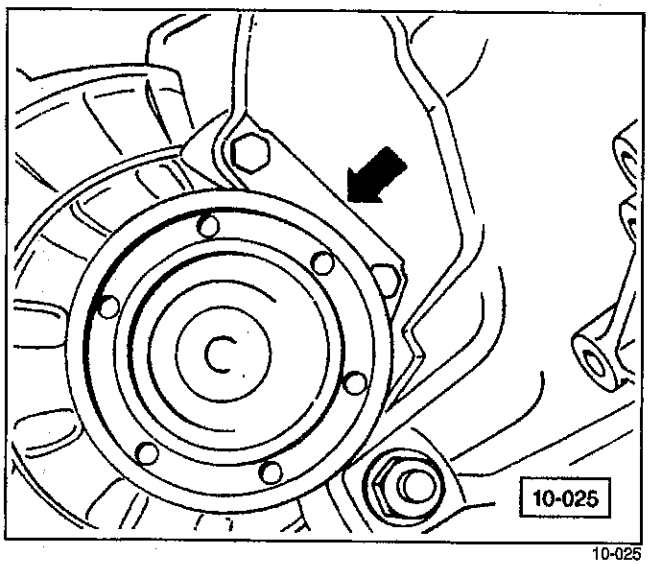
- *After the alignment, check gearshift function. If necessary, adjust the shift mechanism as described* **3 CLUTCH, TRANSMISSION, AND FINAL DRIVE.**
- *It may be necessary to adjust headlight aim if a new engine is installed.*

## SEPARATING ENGINE AND TRANSMISSION

### To separate engine from transmission (all engines)

1. Support the engine and transmission as a unit.

2. On cars with automatic transmission, remove the three nuts holding the torque converter to the drive plate working through the bottom of the transmission. Remove the cover plate. See Fig. 18.




10-025

**Fig. 18.** Cover plate (**arrow**) to be removed. 4-cylinder engine shown.

3. Remove the starter motor and remove the bolts that hold the transmission to the engine.

4. Separate the engine and transmission using care not to place any strain on the transmission mainshaft.

> ***CAUTION—***
> - *On cars with automatic transmission, be sure the drive plate separates cleanly from the torque converter without pulling the torque converter off its support. Once the engine and transmission are separated, install a bar across the open bellhousing to keep the torque converter from falling out.*
> - *On cars with manual transmission, at no time should the weight of either the engine or the transmission be supported by the transmission mainshaft. If it is, the clutch, the clutch pushrod, or the mainshaft may be damaged.*

When reattaching the transmission to the engine, check that the guide sleeves are installed in the engine block. If they are not, install them. Lightly lubricate the transmission mainshaft with molybdenum disulfide ($MoS_2$) grease. Inspect the clutch components for wear. Engine to transmission tightening torques are given below.

> ***CAUTION—***
> *If either the A/T driveplate, the flywheel (6-cylinder engines) or the clutch pressure plate (4-cylinder engines) is removed from the crankshaft, new stretch-type mounting bolts must be used. These fasteners are designed to be used only once and may, in service, fail if retorqued.*

**Tightening torques**

- A/T driveplate, flywheel or pressure plate to crankshaft (stretch bolts–**always replace**)
  - stage I . . . . . 60 Nm (30 ft -lb)
  - stage II . . . . . additional 1/4 turn (90°)
- Engine cover plate to engine/transmission. . . . . 10 Nm (89 in-lb)
- Engine to transmission
  - M10 . . . . . 60 Nm (44 ft-lb)
  - M12 . . . . . 80 Nm (59 ft-lb)
- Starter to engine block. . . . See **27 Engine Electrical**
- Torque converter to drive plate . . . . . 60 Nm (44 ft-lb)

# 13 Crankshaft/Cylinder Block



13

## GENERAL

This repair group provides the special reconditioning information necessary to repair the Volkswagen short block. The information contained here is intended to be used as a reconditioning guide for the professional or experienced automotive technician. Many of the operations and specifications listed here require precision measuring equipment.

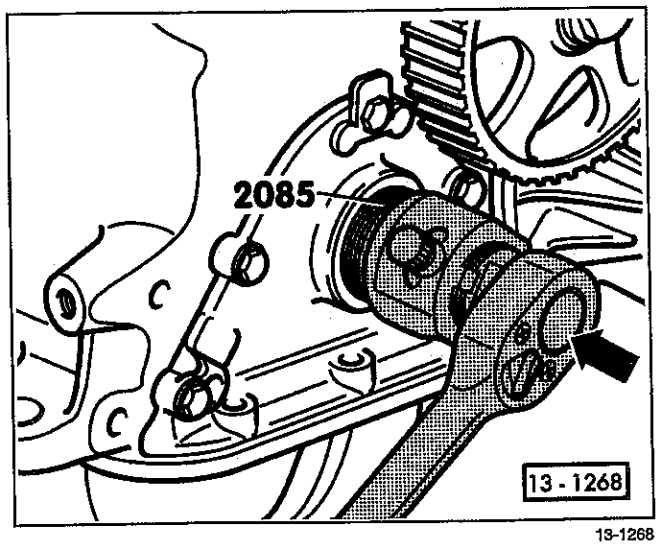
***NOTE—***
*The information given in the repair section is organized based on engine codes. A listing of the engine codes for the engines covered by this manual is given at the beginning of this section. For more specific engine information, see* **1 General Information.**

## CYLINDER BLOCK OIL SEALS

The front crankshaft and, on 4-cylinder engines, the intermediate shaft oil seals can be replaced with the engine installed. Replacement of the rear crankshaft oil seal requires that the transmission be separated from the engine.

### To replace front crankshaft oil seal (4-cylinder engines)

1. Remove the camshaft drive belt as described in **15a Cylinder Head and Valvetrain (4-Cylinder Engines)** for gasoline engines or **23 Fuel Injection–Diesel** for diesel engines.
2. While holding the crankshaft stationary, loosen the crankshaft sprocket (hub) center bolt. Remove the bolt, the hub, and the woodruff key. Discard the bolt.
3. Remove the seal from the its carrier using a seal extractor, or carefully pry it from its housing using a screwdriver. See Fig. 1.




13-1268

**Fig. 1.** Crankshaft front oil seal being removed using Volkswagen special tool no. 2085. Rotate tool clockwise to remove seal.

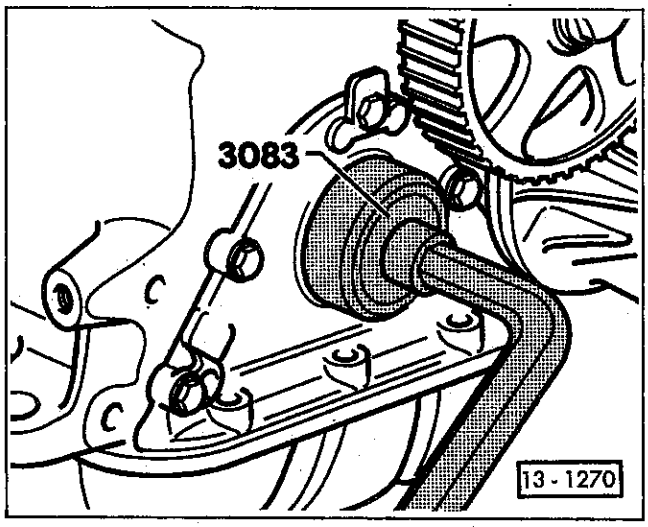
***CAUTION—***
*On cars with diesel engines, the oil pan to front main seal carrier bolts are self-locking. Self-locking bolts are designed to be used only once. Always replace these fasteners with new parts.*

**Tightening torques (4-cylinder engines)**

- Front main seal carrier to engine block
  - M6 ..... 10 Nm (89 in-lb)
  - M8 ..... 25 Nm (18 ft-lb)
- Oil pan to front main seal carrier (M6)
  - gasoline engines ..... 20 Nm (15 ft-lb)
  - diesel engines (self-locking, always replace) ..... 25 Nm (18 ft-lb)

4. Install the new seal, lubricated with clean engine oil, with the closed side facing out. Carefully press it into place until it is fully seated in the seal carrier.

***CAUTION—***
*Use care not to distort the seal as it is installed. For best results, use a seal press such as Volkswagen special tool no. 3083, shown in Fig. 2.*




13-1270

**Fig. 2.** Front crankshaft oil seal being installed using Volkswagen special tool no. 3083.

***NOTE—***
*Replacement seals may be pre-coated with lubricant. It is not necessary to lubricate pre-coated seals with engine oil.*

5. Install the woodruff key into the crankshaft keyway. Using a new mounting bolt, install the crankshaft sprocket while aligning the keyway. Hold the crankshaft stationary and tighten the bolt.

***CAUTION—***
*Always replace the crankshaft sprocket mounting bolt. It is a stretch bolt designed to be used only once. Lightly oil the threads and bolt shoulder before installing.*

**Tightening torques (4-cylinder engines)**

- Crankshaft drive belt sprocket to crankshaft (stretch bolt–**always replace**)
  - stage I ..... 90 Nm (66 ft-lb)
  - stage II ..... additional 1/4 turn (90°)

6. Install the camshaft drive belt as described in **15a Cylinder Head and Valvetrain (4-Cylinder Engines)** or **23 Fuel Injection–Diesel.**

## To replace intermediate shaft oil seal (4-cylinder engines)

1. Remove the camshaft drive belt, as described in **15a Cylinder Head and Valvetrain (4-Cylinder Engines)** for gasoline engines or **23 Fuel Injection–Diesel** for diesel engines.

2. Lock the intermediate shaft sprocket in place and loosen the sprocket center bolt. Remove the bolt and the sprocket. Remove the woodruff key from the shaft.

***NOTE—***
*Hold the intermediate shaft sprocket stationary using a holding fixture (VW special tool 3036, or equivalent) when loosening the sprocket mounting bolt.*

3. Remove the two bolts holding the oil seal carrier to the cylinder block and pull out the seal carrier. Pry or hand-press the seal out of the carrier.

4. Reinstall the seal carrier with a new O-ring.

**Tightening torque**

- Intermediate shaft oil seal carrier to engine block ..... 25 Nm (18 ft-lb)

5. Lightly oil the seal and the shaft sealing surface. Fit the seal into position, and carefully press it into place.

> ***CAUTION—***
> *Use care not to distort the seal as it is installed. For best results, use a seal press such as Volkswagen special tool no. 10-203.*

6. Install the woodruff key to the intermediate shaft and install the sprocket while aligning the keyway. Lock the intermediate shaft sprocket in place and tighten the bolt.

**Tightening torques (4-cylinder engines)**
- Intermediate shaft sprocket to intermediate shaft
  gasoline engines . . . . . 80 Nm (59 ft-lb)
  diesel engine . . . . . 45 Nm (33 ft-lb)

7. Install the camshaft drive belt, as described in **15a Cylinder Head and Valvetrain (4-Cylinder Engines)** or **23 Fuel Injection–Diesel**.

## To replace front crankshaft oil seal (6-cylinder engine)

1. Remove the poly-ribbed drive belt. See **0 Maintenance Program.**

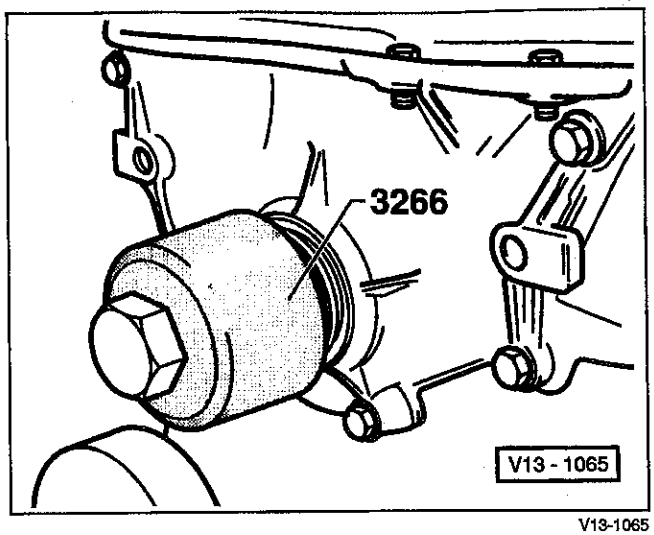
2. While holding the damper stationary using a holding fixture (VW special tool no. 3273 or equivalent) remove the crankshaft vibration damper center bolt. Remove the vibration damper. Discard the bolt.

3. Remove the seal from its carrier using a seal extractor (VW special tool no. 3203, or equivalent), or carefully pry it from its housing using a screwdriver.

4. Install the new seal, lubricated with clean engine oil, with the closed side facing out. Carefully press it into place until it is fully seated. For best results, use a seal press such as Volkswagen special tool no. 3266, shown in Fig. 3.

5. Using a new mounting bolt, install the crankshaft vibration damper. Hold the damper stationary and tighten the bolt.

> ***CAUTION—***
> *Always use a new vibration damper mounting bolt. It is a stretch bolt designed to be used only once.*




V13-1065

**Fig. 3.** Front crankshaft oil seal being installed using Volkswagen special tool no. 3266.

**Tightening torques (6-cylinder engines)**
- Vibration damper to crankshaft
  stage I . . . . . 100 Nm (74 ft-lb)
  stage II . . . . . additional 1/4 turn (90°)

6. Install the drive belt and release the drive belt tensioner. See **0 Maintenance Program.**

## To replace rear crankshaft oil seal (4 and 6 cylinder engines)

1. Remove flywheel or drive plate as described under **Flywheel or Driveplate.**

2. Remove the rear crankshaft oil seal from the flange by carefully prying it out taking care not to scratch the aluminum housing.

3. Install the new seal, lubricated with clean engine oil, with the closed side facing out using a guide sleeve and a suitable seal installation tool.

4. Install remaining components.

## To remove and install rear oil seal flange (4 cylinder engines)

1. Remove flywheel or drive plate as described under **Flywheel or Driveplate.**
2. Unbolt rear flange from the cylinder block and the oil pan and remove. Use care to avoid damaging the oil pan gasket.
3. Use a guide sleeve as necessary to protect the oil seal. Install the flange onto the guide pins on the cylinder block with a new gasket. Torque bolts in a staggered pattern.
4. Install the oil pan.
5. Install the remaining components in reverse order of removal.

**Tightening torques**

- Rear main oil seal flange to engine block (M6)..... 10 Nm (7 ft-lb)

## FLYWHEEL OR DRIVEPLATE

Removal of the flywheel or driveplate requires that the engine be separated from the transmission.

On 4-cylinder engines (except AHU diesel) with manual transmission, the flywheel is bolted to the clutch pressure plate. See Fig. 4.

On 6-cylinder and AHU diesel engines, the flywheel is bolted directly to the crankshaft, with the clutch pressure plate mounted to the flywheel.

***CAUTION—***

- *On cars with automatic transmission, special mounting procedures are required when installing the driveplate. See the information given below.*
- *The clutch pressure plate (4-cylinder engines), the flywheel (6-cylinder and AHU diesel engines), and the driveplate (cars with automatic transmission) are mounted to the crankshaft using one-time stretch bolts. These fasteners must always be replaced any time they are removed or loosened.*

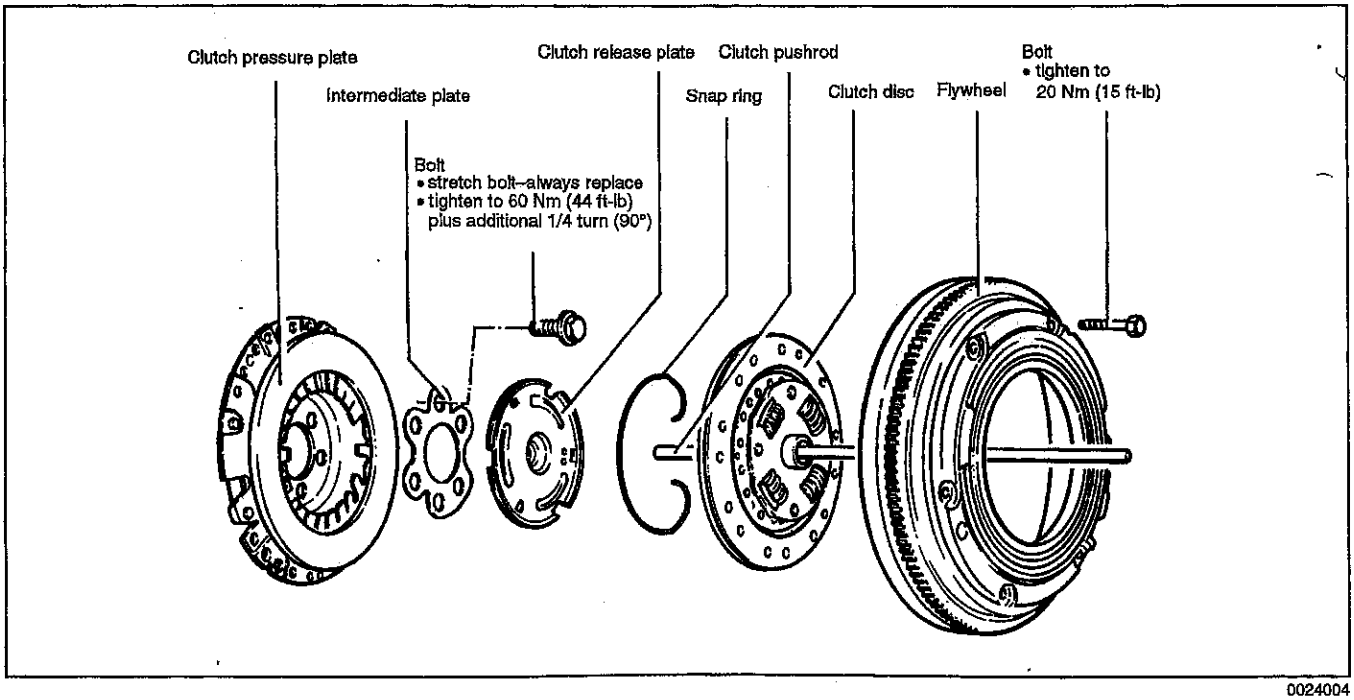



**Fig. 4.** Flywheel and clutch assembly on cars with ACC, ABA, and AAZ engines with manual transmission.

Fig. 5 illustrates the use of a holding fixture, Volkswagen special tool no. VW 558 (order no. TV0 558 000 13 ZEL) to remove and install the flywheel or driveplate.

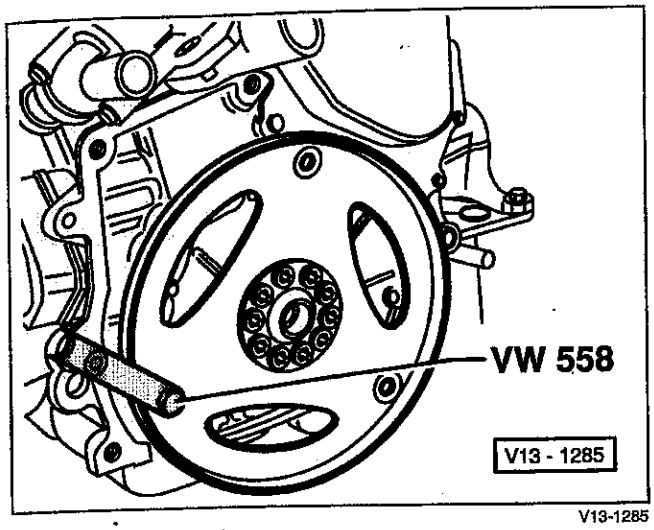



**Fig. 5.** Driveplate secured with holding fixture VW 558. Flywheel is similar.

**Tightening torques**

- Flywheel, pressure plate or driveplate to crankshaft (stretch bolts–**always replace**)
  - stage I . . . . . 60 Nm (44 ft-lb)
  - stage II . . . . . .additional 1/4 turn (90°)

## Driveplate Installation

On cars with automatic transmission, mark the driveplate during disassembly and reinstall it with the same orientation. When reinstalling the driveplate, the clearance between the driveplate and the cylinder block should always be checked and adjusted (shimmed) as necessary.

To check the clearance, install the driveplate using three of the mounting bolts. Tighten the bolts to 30 Nm (22 ft-lb). Then check the clearance as shown in Fig. 6 or Fig. 7. If necessary, remove the driveplate and install an appropriate shim between the driveplate and the crankshaft to achieve the correct dimension.

***NOTE —***

*Shims are available in varying thicknesses. See an authorized Volkswagen dealer for the latest in parts information.*

**Tightening torques**

- Driveplate to crankshaft (stretch bolts–**always replace**)
  - stage I . . . . . 60 Nm (44 ft-lb)
  - stage II . . . . . .additional 1/4 turn (90°)

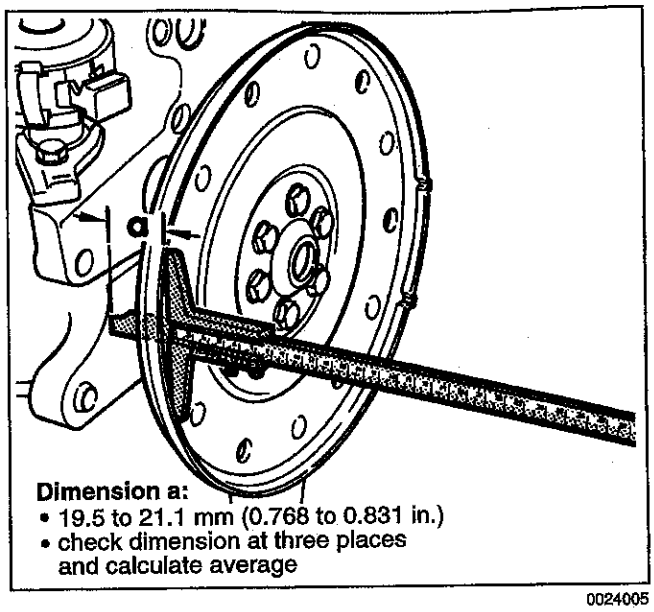



**Fig. 6.** Driveplate to cylinder block dimension (**a**) being measured on 4-cylinder engine. Measure at three points and calculate average. Adjust distance by adding or removing shim between driveplate and crankshaft.

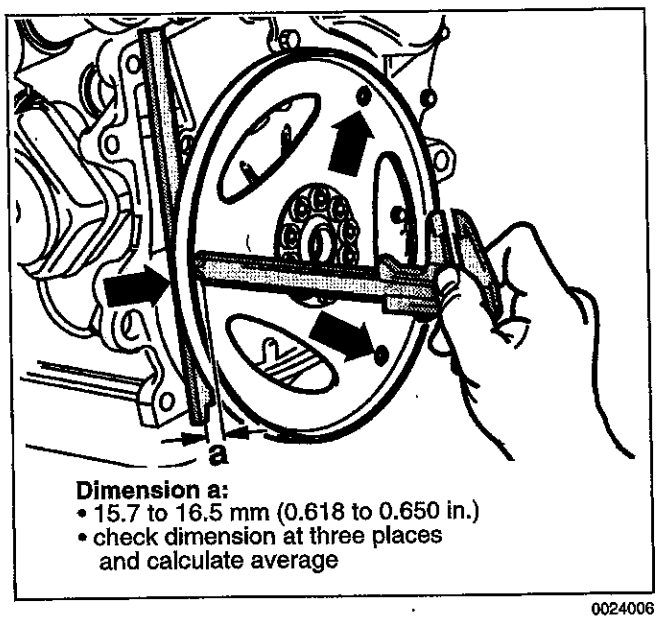



**Fig. 7.** Driveplate to cylinder block dimension (**a**) being measured on 6-cylinder engine. Use straight edge for reference line. Measure at three points (**arrows**) and calculate average. Adjust distance with shim(s) between driveplate and crankshaft.

## CYLINDER BLOCK RECONDITIONING

During engine block disassembly, be sure to mark the position and orientation of all parts as they are removed. Connecting rods, rod caps, rod bearings, pistons, main bearing caps and main bearings are assembled in an exact location and orientation.

To minimize wear during engine start-up, clean engine oil should be used to lubricate all friction surfaces during assembly.

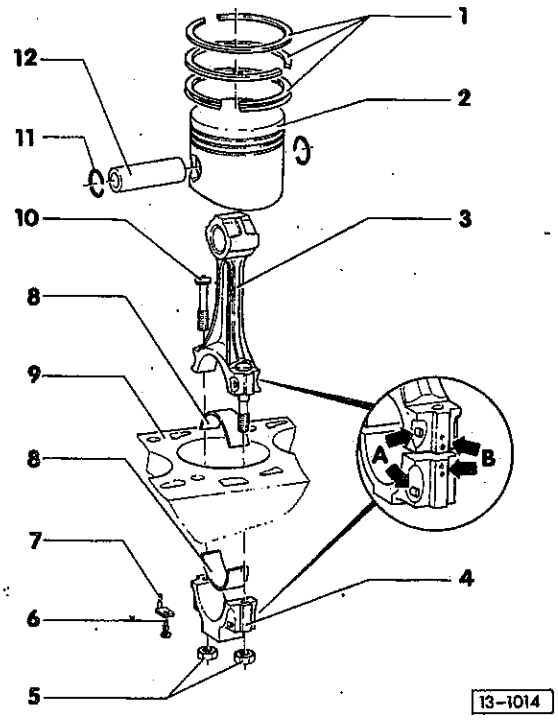
### Pistons and Connecting Rods

Pistons, piston pins, piston rings, connecting rods, and bearings, if they are to be reused, should never be interchanged. If necessary, mark the cylinder number and installation orientation on the pistons, connecting rods and connecting rod caps before removal. Components of one piston and connecting rod assembly are shown in Fig. 8.

Pistons fro AHU engines are not all the same. Valve relief pockets machined into the piston crown for cylinders 1 and 2 are the same. Pockets in cylinders 3 and 4 are also the same, but are different from cylinders 1 and 2. See Fig. 9.

The piston pin should fit such that, with the piston heated to approximately 60°C (140°F) in an oil bath, a light push will move the pin. Replace the piston and the pin if the fit is excessively loose.

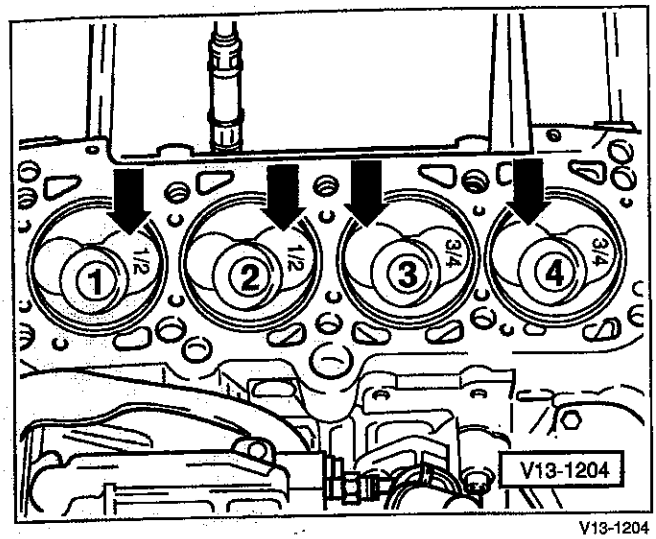
Inspect the connecting rods for any bending, distortion, or other visual damage. Connecting rod specifications are listed below. Connecting rods should always be replaced in complete sets. **Table a** lists connecting rod specifications.




1. **Piston Rings**
   - offset gaps by 120° when installing
   - "TOP" mark faces toward piston crown
2. **Piston**
   - mark installation position and orientation to cylinder block and connecting rod
   - ACC, ABA, AAZ, AHU engines: arrow on piston faces drive belt end
   - AAA engine: high point of piston crown faces toward center of cylinder block
   - AAZ, AHU engines: always check piston deck height during assembly. See Fig. 14
3. **Connecting rods**
   - mark cylinder number on rod and cap (B)
   - marks (A) must be above one another and on same side
4. **Connecting rod bearing cap**
   - note installed position
   - AAZ, AHU engines: dowel pin must fit tightly in connecting rod
5. **Connecting rod nut (ACC and ABA engines only)**
   - oil threads and nut contact surface during installation
   - tighten to 30 Nm (22 ft-lb) plus an additional 1/4 turn (90°).
6. **Oil spray nozzle bolt**
   - ABA engine: tighten to 25 Nm (18 ft-lb)
   - AAZ, AHU engines: install using VW sealant AMV 188 100 02
   - tighten to 10 Nm (89 in-lb)
7. **Oil spray nozzle**
   - not installed on all engines
   - for piston cooling. See **17 Engine-Lubrication System**
8. **Connecting rod bearing shell**
   - note installed position-do not interchange used shells
   - holding tabs must fit tightly in recesses
   - ABA engine: oil hole must face connecting rod
   - AAZ, AHU engines: dowel pin must fit tightly in connecting rod
9. **Cylinder block**
10. **Connecting rod bolt**
    - stretch bolt-always replace
    - oil threads and bolt head surface during installation
    - AAZ and AAA engines: tighten to 30 Nm (22 ft-lb) plus additional 1/4 turn (90°)
11. **Circlip**
    - always replace
12. **Piston pin**
    - if difficult to remove, heat piston to 140°F (60°C)

13-1014

**Fig. 8.** Piston and connecting rod assembly for ABA engine. Connecting rod assemblies on other engines are similar.




V13-1204

**Fig. 9.** Piston orientation in ALH engine. Intake valve relief pocket is larger and points toward flywheel for cylinders 1 and 2 and toward pulley side for cylinders 3 and 4 (**arrows**). Pistons are factory marked for proper location.

***NOTE—***
*When checking radial clearance, lubricate the contact surface of the nut or bolt before tightening. When checking connecting rod radial clearance, tighten the nut or bolt only to 30 Nm (22 ft-lb) and not the additional 1/4 turn.*

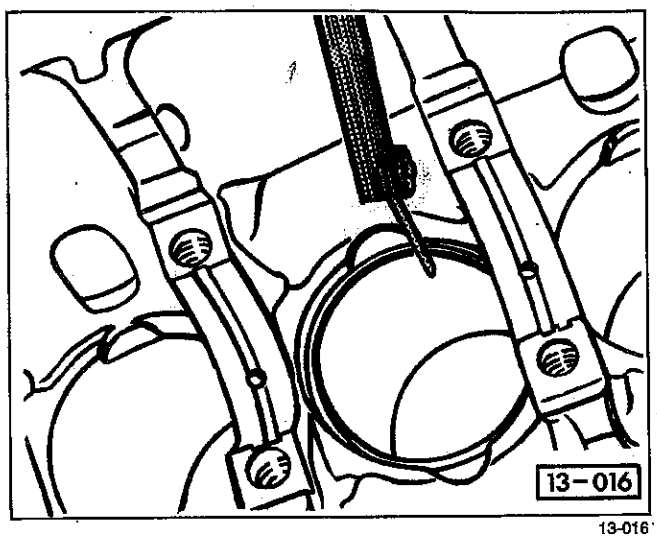
**Table a. Connecting Rods**

| | |
|---|---|
| **Radial clearance (Plastigage®)** | |
| new | 0.01–0.06 mm (0.0004–0.0024 in.) |
| wear limit | |
| ACC, ABA engines | 0.12 mm (0.0047 in.) |
| AAA engine | 0.10 mm (0.0039 in.) |
| AAZ, AHU engines | 0.08 mm (0.0031 in.) |
| **Axial (side) clearance** | |
| new | 0.05–0.31 mm (0.0020–0.0122 in.) |
| wear limit | |
| ACC, ABA, AAZ, AHU engines | 0.37 mm (0.0145 in.) |
| AAA engine | 0.40 mm (0.0157 in.) |
| **Checking torque** | 30 Nm (22 ft-lb) |
| **Assembly torque** | 30 Nm (22 ft-lb) plus 1/4 turn (90°) |

***NOTE—***
*If connecting rod radial clearance is excessive, the crankshaft connecting rod journals should be checked. If the crankshaft journal diameters are within specifications, recheck radial clearance using new bearing shells.*

## Piston Rings

Piston ring end gaps are checked with the piston rings inserted approximately 15 mm (5/8 in.) from the bottom of the cylinder. See Fig. 10. **Table b** lists piston ring gap specifications.




13-016

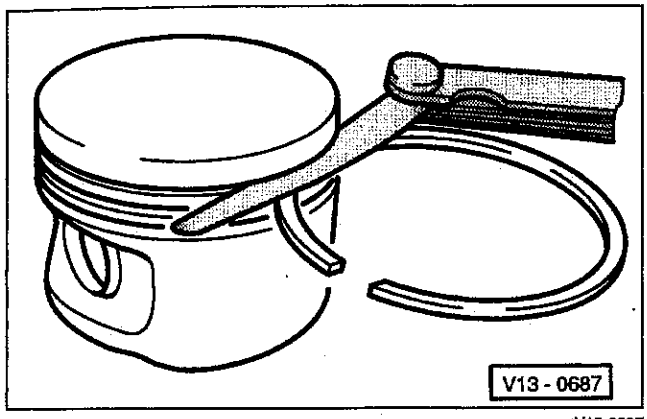
**Fig. 10.** Piston ring end gap being measured.

**Table b. Piston Ring End Gaps**

| | New | Wear limit |
|---|---|---|
| **Top compression ring** | | |
| ACC, ABA, AAA, AHU engines | 0.20–0.40 mm (.0079–.0157 in.) | 1.0 mm (.039 in.) |
| AAZ engine | 0.20–0.40 mm (.0079–.0157 in.) | 1.2 mm (.0472 in.) |
| **Bottom compression ring** | | |
| ACC, ABA, AAA, AHU engines | 0.20–0.40 mm (.0079–.0157 in.) | 1.0 mm (.039 in.) |
| AAZ engine | 0.20–0.40 mm (.0079–.0157 in.) | 0.60 mm (.0236 in.) |
| **Oil scraper ring** | | |
| ACC, ABA, AAA, AHU engines | 0.25–0.50 mm (.0098–.0197 in.) | 1.0 mm (.039 in.) |
| AAZ engine | 0.25–0.50 mm (.0098–.0197 in.) | 1.2 mm (.0472 in.) |

Piston ring side clearance is checked using feeler gauges. Measure each ring in its original groove. See Fig. 11. Piston ring side clearance specifications are listed in **Table c**.

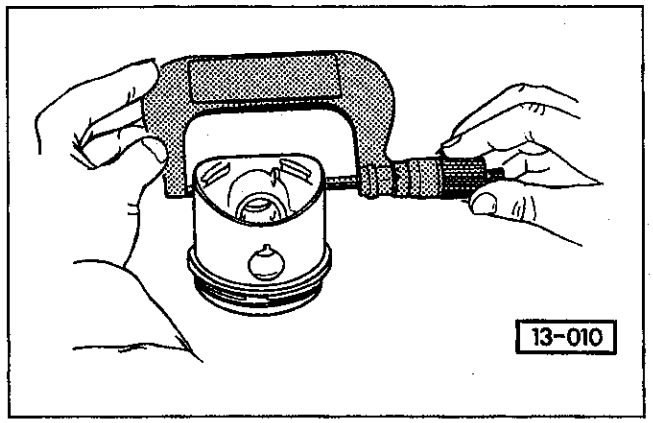
***NOTE—***
*Piston ring grooves should be thoroughly cleaned before checking ring side clearance.*




V13-0687

**Fig. 11.** Piston ring side clearance being measured.

Measure the pistons from the bottom of the piston skirt and at right angles (90°) to the piston pin. See Fig. 12. Piston diameters are given in **Table d.** Nominal piston diameters are also marked on the piston crowns.




13-010

**Fig. 12.** Check piston approximately 6–10 mm (0.2–0.4 in.) from bottom of skirt at right angle to piston pin.

**Piston Wear Limits**

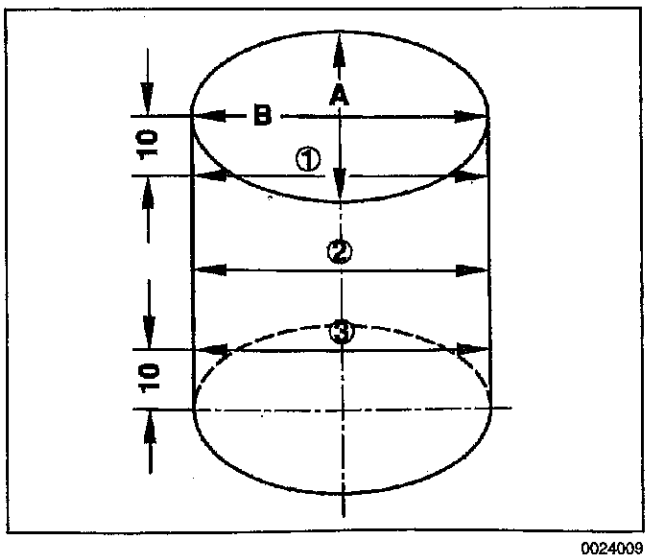
- maximum allowable deviation from nominal piston diameter . . . . . 0.04 mm (0.0016 in.)

**Table c. Piston Ring Side Clearances**

| | New | Wear limit |
|---|---|---|
| **Compression rings** | | |
| ACC, ABA engines | 0.02–0.05 mm (.0008–.0019 in.) | 0.15 mm (.0059 in.) |
| AAA engine | 0.02–0.07 mm (.0008–.0028 in.) | 0.15 mm (.0059 in.) |
| AAZ engine | | |
| top ring | 0.09–0.12 mm (.0035–.0047 in.) | 0.25 mm (.0098 in.) |
| bottom ring | 0.05–0.08 mm (.0020–.0031 in.) | 0.25 mm (.0098 in.) |
| AHU engine | | |
| top ring | 0.06–0.12 mm (.0024–.0047 in.) | 0.25 mm (.0098 in.) |
| bottom ring | 0.05–0.08 mm (.0020–.0031 in.) | 0.25 mm (.0098 in.) |
| **Oil scraper ring** | | |
| ACC, ABA engines | 0.02–0.05 mm (.0008–.0019 in.) | 0.15 mm (.0059 in.) |
| AAA engine | 0.02–0.06 mm (.0008–.0024 in.) | 0.15 mm (.0059 in.) |
| AAZ, AHU engines | 0.03–0.06 mm (.0012–.0024 in.) | 0.15 mm (.0059 in.) |

## Cylinder Block

Measure cylinder bores at approximately the top, the middle, and the bottom of piston travel. Make measurements parallel to the crankshaft and at right angles (90°). See Fig. 13. The top and bottom measurements should be made approximately 10 mm (3/8 in.) from the ends of the cylinder. Nominal piston and cylinder bore diameter specifications are given in **Table d.** Nominal piston diameters are also marked on the piston crowns.




0024009

**Fig. 13.** Measure cylinder bores in direction perpendicular to the crankshaft (**A**) and parallel to the crankshaft (**B**) at the top, middle, and bottom of cylinder.

**Table d. Piston and Cylinder Diameters**

| Engine code | Piston diameter in mm (in.) | Cylinder bores in mm (in.) |
|---|---|---|
| ACC | | |
| standard | 80.985 (3.18838) | 81.01 (3.1894) |
| 1st oversize | 81.235 (3.19822) | 81.26 (3.1992) |
| 2nd oversize | 81.485 (3.20806) | 81.51 (3.2090) |
| AAZ | | |
| standard | 79.48 (3.1291) | 79.51 (3.1303) |
| 1st oversize | 79.73 (3.1390) | 79.76 (3.1402) |
| 2nd oversize | 79.98 (3.1488) | 80.01 (3.1500) |
| ABA | | |
| standard | 82.485 (3.24744) | 82.51 (3.2484) |
| 1st oversize | 82.735 (3.25728) | 82.76 (3.2583) |
| 2nd oversize | 82.985 (3.26713) | 83.01 (3.2681) |
| AAA | | |
| standard | 80.985 (3.18839) | 81.01 (3.1894) |
| 1st oversize | 81.485 (3.20807) | 81.51 (3.2091) |
| 2nd oversize | 81.985 (3.22776) | 82.01 (3.2287) |
| AHU | | |
| standard | 79.48 (3.1291) | 79.51 (3.1303) |
| 1st oversize | 79.72 (3.1385) | 79.76 (3.1402) |
| 2nd oversize | 79.98 (3.1488) | 80.01 (3.1500) |

**Cylinder Wear Limits**

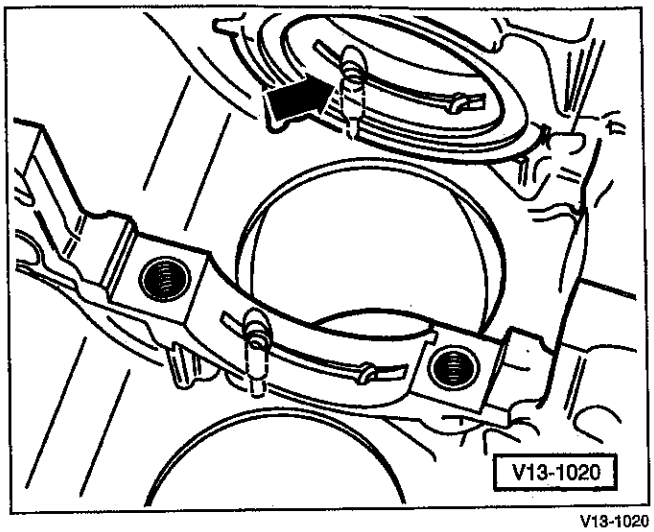
- maximum allowable deviation from nominal diameter cylinder bore . . . . . .0.08 mm (0.0031 in.)

***CAUTION—***
*Mounting the bare cylinder block to an engine stand can distort its shape and cause inaccurate cylinder bore measurements. Always check cylinder bores with the block resting unstressed on a flat surface.*

***NOTE—***
*On AAA engines, the cylinder block is fitted with six oil spray nozzles for piston cooling. To remove the nozzles, first remove the crankshaft and the main bearing shells. Use a 4mm (5/32 in.) drift from behind to drive the nozzles out. See Fig. 14. Install the nozzles using a use a 6mm (7/32 in.) drift.*

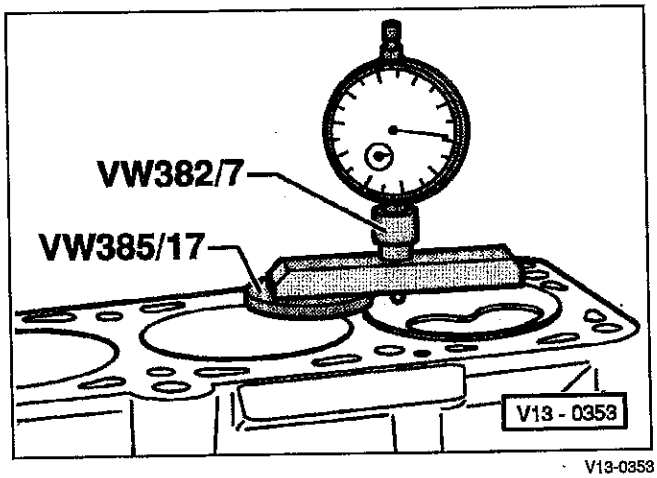
## Diesel Piston Height

Assembling or replacing a diesel engine short block requires that the height of the pistons be measured in order to select the proper cylinder head gasket. Using a dial indicator, measure the amount that each piston protrudes above the top of the cylinder block at Top Dead Center. See Fig. 15. Cylinder head gaskets are available in three thicknesses. Select the correct gasket from **Table e** based on the largest piston height measurement. The different gaskets are identified by the number of marks, either notches or holes, located near the part number stamped on the gasket face.




V13-1020

**Fig. 14.** Oil spray nozzles in engine block of AAA engine **(arrow)**. Nozzles are fitted at main bearings 2 through 7.




V13-0353

**Fig. 15.** Piston height being measured on diesel engine.

**Table e. Diesel Cylinder Head Gasket Selection**

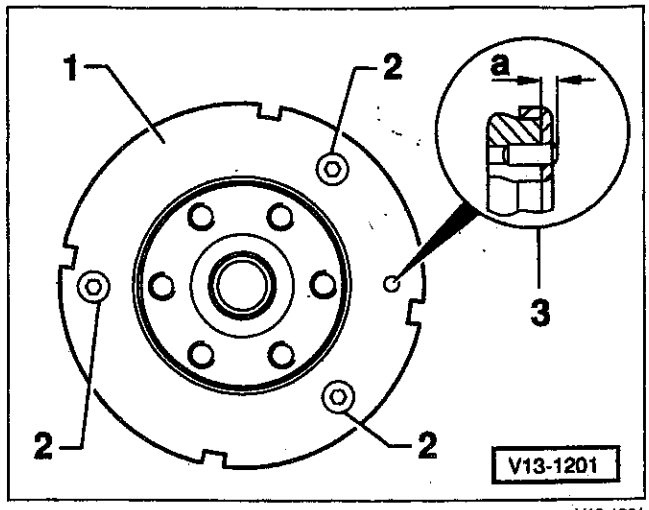
| Piston height above cylinder block | Gasket identification or notches |
|---|---|
| AAZ engine | |
| 0.66–0.86 mm (.0260–.0339 in.) | 1 |
| 0.87–0.90 mm (.0343–.0354 in.) | 2 |
| 0.91–1.02 mm (.0358–.0402 in.) | 3 |
| AHU engine | |
| 0.91–1.00 mm (.0358–.0394 in.) | 1 |
| 1.01–1.10 mm (.0398–.0433 in.) | 2 |
| 1.11–1.20 mm (.0437–.0472 in.) | 3 |

## Crankshaft and Intermediate Shaft

Fig. 17 and Fig. 18 show the crankshaft assemblies for the engines covered by this manual. Crankshaft main bearing caps must not be interchanged. Crankshaft main bearing shells, if they are to be reused, should only be installed in their original positions. On 4-cylinder engines, the distributor must first be removed to remove the intermediate shaft.

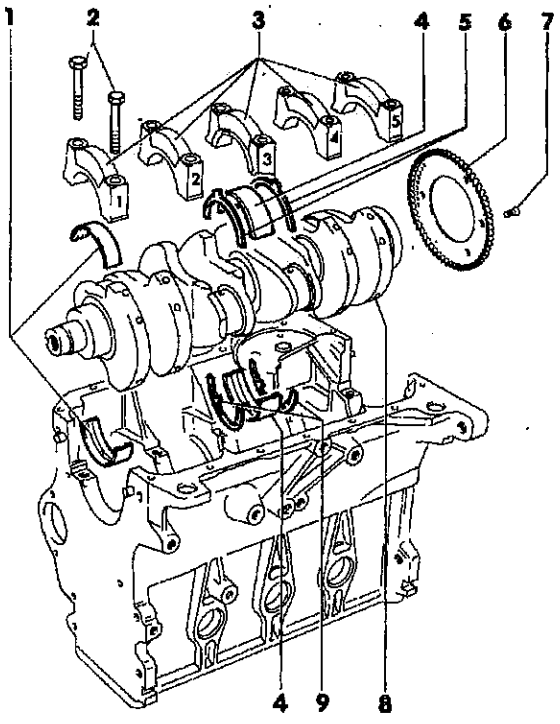
AAA, ABA and AHU crankshafts have sensor wheels for their engine management systems mounted on them. These will only fit on the crankshaft in one position. The sensor wheel on AHU engines uses a dowel pin. See Fig. 16.

***CAUTION—***
*Many of the fasteners used in the cylinder block are stretch bolts that must be replaced once loosened. Review the repair information to identify all bolts and nuts that must be replaced during cylinder block reconditioning.*




V13-1201

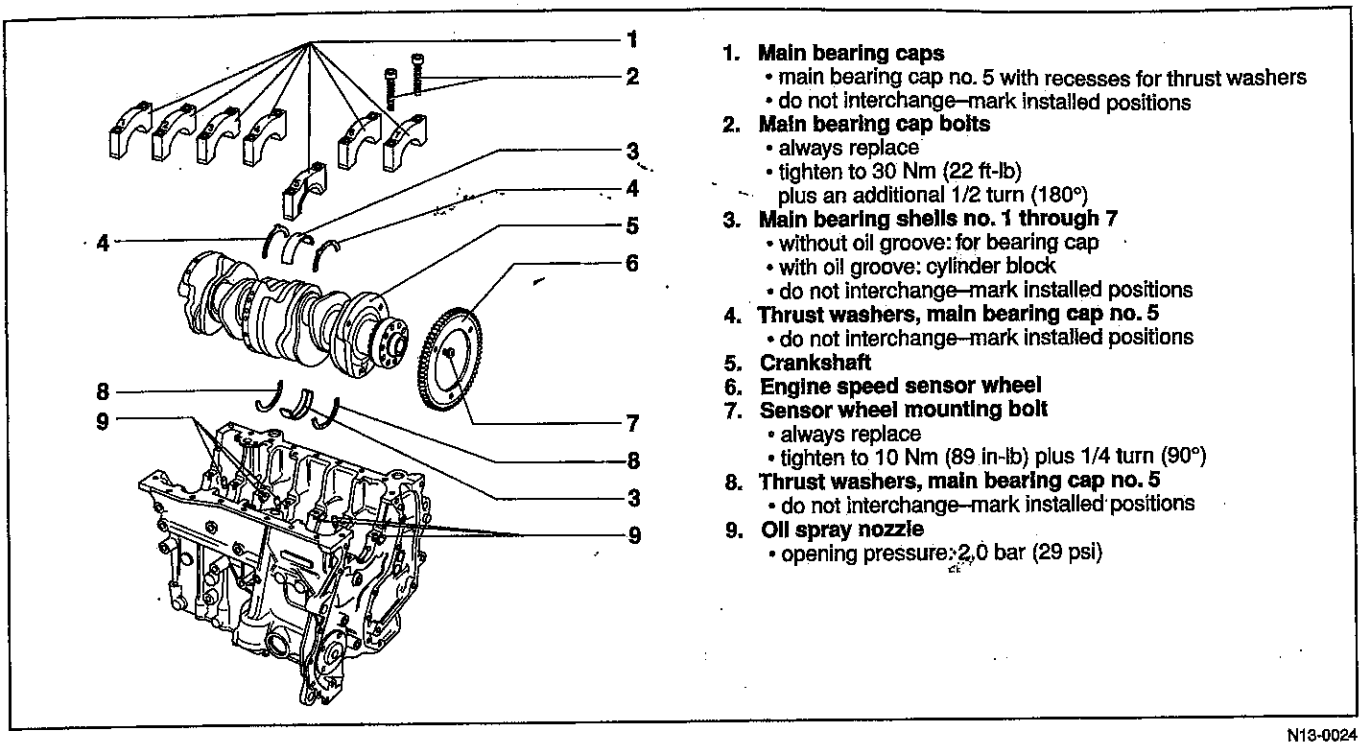
**Fig. 16.** Sensor wheel (**1**) mounted on AHU crankshaft with screws (**2**). A single dowel pin (**3**) extends 2.5 to 3 mm from the flange end, dimension (**a**).




1. **Main bearing shells**
   - without oil groove: for main bearing caps no.1, 2, and 5 (also no. 4 cylinder block shell on diesel engines)
   - with oil groove: for cylinder block and main bearing cap 4 (ex. diesel)
   - do not interchange–mark installed positions
2. **Main bearing cap bolts**
   - new type bolt (replacement) with fully threaded shank tighten to 65 Nm (48 ft-lb) plus 1/4 turn (90°)
   - old type bolt (shown) with partially threaded shank tighten to 65 Nm (48 ft-lb)
   - do not mix old and new type bolts
3. **Main bearing caps**
   - main bearing cap no. 3 with recesses for thrust washers
   - do not interchange–mark installed positions
4. **Main bearing shell no. 3**
   - with oil groove: for cylinder block
   - without oil groove: for bearing cap
5. **Thrust washers, main bearing cap no. 3**
   - do not interchange–mark installed positions
6. **Engine speed sensor wheel (ABA engine only)**
7. **Sensor wheel mounting bolt (ABA engine only)**
   - always replace
   - tighten to 10 Nm (89 in-lb) plus 1/4 turn (90°)
8. **Crankshaft**
9. **Thrust washer, main bearing cap no. 3**
   - do not interchange–mark installed positions

13-1225

**Fig. 17.** Exploded view of crankshaft and related parts for 4-cylinder engines.




1. **Main bearing caps**
   - main bearing cap no. 5 with recesses for thrust washers
   - do not interchange–mark installed positions
2. **Main bearing cap bolts**
   - always replace
   - tighten to 30 Nm (22 ft-lb) plus an additional 1/2 turn (180°)
3. **Main bearing shells no. 1 through 7**
   - without oil groove: for bearing cap
   - with oil groove: cylinder block
   - do not interchange–mark installed positions
4. **Thrust washers, main bearing cap no. 5**
   - do not interchange–mark installed positions
5. **Crankshaft**
6. **Engine speed sensor wheel**
7. **Sensor wheel mounting bolt**
   - always replace
   - tighten to 10 Nm (89 in-lb) plus 1/4 turn (90°)
8. **Thrust washers, main bearing cap no. 5**
   - do not interchange–mark installed positions
9. **Oil spray nozzle**
   - opening pressure: 2.0 bar (29 psi)

N13-0024

**Fig. 18.** Exploded view of crankshaft and related parts for 6-cylinder (AAA) engine.

***NOTE—***

- *On cars with automatic transmission, see* **Flywheel or Driveplate** *given earlier when reinstalling the driveplate. Special installation procedures apply.*
- *On cars with automatic transmission, mark the position of the driveplate on the crankshaft before removing the driveplate.*

Crankshaft journal specifications are listed in **Table f.** Crankshaft and intermediate shaft clearance specifications are listed in **Table g.** If a crankshaft must be replaced, a Volkswagen remanufactured crankshaft is available from an authorized Volkswagen dealer.

***NOTE—***

*The journal diameters given in Table f are nominal diameters and not actual measured dimensions. For example, the first table entry with basic journal diameter of 54.00 mm should actually measure between 53.978 and 53.958, according to the tolerance limits (oil clearance).*

***NOTE—***

*On 4-cylinder engines, crankshaft bearings are available in three undersizes to fit reconditioned crankshafts. On the 6-cylinder engine, check with an authorized Volkswagen dealer on the availability of reconditioned crankshafts.*

**Table f. Crankshaft Journal Diameters**

| Journal diameters (nominal) | mm (in.) |
|---|---|
| **Basic dimension** | |
| ACC, AAZ, ABA, AHU engines | |
| main | 54.00 (2.1260) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| connecting rod | 47.80 (1.8819) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| AAA engine | |
| main | 60.00 (2.3622) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| connecting rod | 54.00 (2.1260) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| **1st undersize (0.25 mm)** | |
| ACC, AAZ, ABA, AHU engines | |
| main | 53.75 (2.1161) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| connecting rod | 47.55 (1.8720) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| **2nd undersize (0.50 mm)** | |
| ACC, AAZ, ABA, AHU engines | |
| main | 53.50 (2.1063) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| connecting rod | 47.30 (1.8622) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| **3rd undersize (0.75 mm)** | |
| ACC, AAZ, ABA, AHU engines | |
| main | 53.25 (2.0965) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |
| connecting rod | 47.05 (1.8524) $^{-0.022\ (0.00087)}_{-0.042\ (0.00165)}$ |

**Table g. Crankshaft and Intermediate Shaft Specifications**

| | |
|---|---|
| **Main bearing radial clearance (Plastigage®)** | |
| new parts | |
| ACC, ABA engines | 0.02–0.06 mm (.0008–.0024 in.) |
| AAZ, AHU engines | 0.03–0.08 mm (.0012–.0031 in.) |
| AAA engine | 0.02–0.06 mm (.0008–.0024 in.) |
| wear limit | |
| ACC, ABA engines | 0.17 mm (.0067 in.) |
| AAZ, AHU engines | 0.17 mm (.0067 in.) |
| AAA engine | 0.10 mm (.0039 in.) |
| **Crankshaft axial play (side clearance)** | |
| new parts | |
| ACC, ABA engines | 0.07–0.17 mm (.0028–.0067 in.) |
| AAZ, AHU engines | 0.07–0.17 mm (.0028–.0067 in.) |
| AAA engine | 0.07–0.23 mm (.0028–.0091 in.) |
| wear limit | |
| ACC, ABA engines | 0.25 mm (.0098 in.) |
| AAZ, AHU engines | 0.37 mm (.0146 in.) |
| AAA engine | 0.30 mm (.0118 in.) |
| **Intermediate shaft axial clearance (side clearance)** | |
| wear limit | 0.25 mm (.0098 in.) |

# 15b Cylinder Head and Valvetrain– (6-Cylinder Engine)





## GENERAL

This engine section covers most cylinder head and valvetrain service and repair for the 6-cylinder VR6 engine. For information on short block engine rebuilding and internal engine specifications, see **13 Crankshaft/Cylinder Block**.

Some of the operations described in this repair group require special equipment and experience. If you lack the skills, tools, or a suitable workplace for servicing or repairing the cylinder head, we suggest you leave these repairs to an authorized Volkswagen dealer or other qualified shop.

## 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 compression test will tell a lot about the condition of the engine without the need for taking it apart. The test is relatively simple. On gasoline engines, it requires only a compression tester and a spark plug wrench. Diesel engines with their higher compression pressures (approximately 500 psi) require a more expensive compression tester. For the most accurate test results, the battery should be fully charged and the engine should be warm.

***NOTE—***
*Because engine temperature may affect compression, the most accurate results are obtained when the engine is at normal operating temperature.*

### To test compression

1. With the ignition off, disable the ignition system by disconnecting the 5-pin harness connector from the coil on the back of the cylinder head.

2. Remove the spark plug wires from the spark plugs.

***NOTE—***
*A special tool (VW tool no. 3277) is needed to remove the spark plug connectors from the plugs without damaging them. A version of this tool may be clipped to the front hood support rod.*

3. Clean the area around the spark plugs using compressed air. Remove the spark plugs and set them aside in order.

***NOTE—***
*Due to the limited clearance around the recessed spark plugs, VW special tool no. 3122B is available to easily remove and install the plugs.*

4. Thread the compression tester into the first cylinder's spark plug hole, just tight enough to seal the plug hole.

5. With the transmission in neutral and the throttle held wide open, crank the engine with the starter about 4 to 5 revolutions. The gauge reading should increase with each engine revolution. Record the gauge value.

6. Release the pressure in the tester and remove it from the spark plug hole.

7. Repeat the test for each of the other cylinders. Record the data and compare with **Table a.**

**Table a. Compression Pressure in psi (bar)**

| Engine code | AAA (2.8 L) |
|---|---|
| new engine | 145–189 (10–13) |
| wear limit | 109 (7.5) |
| maximum difference between cylinders | 44 (3) |

8. Reinstall the spark plugs and the spark plug wires in their original locations. Reconnect the coil harness connector.

**Tightening torque**
- Spark plug to cylinder head
  AAA engine ..... 25 Nm (18 ft-lb)

Low compression is evidence of poorly sealed combustion chambers. Compression pressures which are relatively even but below specifications indicate worn piston rings and/or cylinder walls. Low but erratic values tend to indicate valve leakage. Dramatic differences, such as good values in some cylinders and very low values in one or two cylinders are the sign of a localized failure, such as a burnt valve 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 the location of the air escaping, 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 a leak-down test. Because the test requires special equipment and experience, it may be desirable to have it performed by a Volkswagen dealer or other qualified repair shop.

# CYLINDER HEAD SERVICE

Many cylinder head repairs can be accomplished without removing the cylinder head from the engine. The cylinder head cover gasket, the camshaft, the valve guide oil seals, and the cam followers are all accessible with the cylinder head installed. This heading describes those repairs that can be done with the cylinder head installed.

***NOTE—***
*A special alignment tool (VW special tool no. 3268, order no. T03 267 000 37 ZEL) is specified for most VR6 cylinder head work. The tool is used to accurately set the camshafts at TDC. This plastic tool is relatively inexpensive and should always be used any time the camshaft timing chains are removed from the camshaft sprockets.*

## To remove and install cylinder head cover

1. Remove the spark plug connectors from the plugs. Remove the spark plug wire guides with the ignition wires. See Fig. 1.

***NOTE—***
*A special tool (VW tool no. 3277) is needed to remove the spark plug connectors from the plugs without damaging them. A version of this tool is clipped to the front hood support rod.*

2. Remove the intake manifold cover from above the intake manifold.

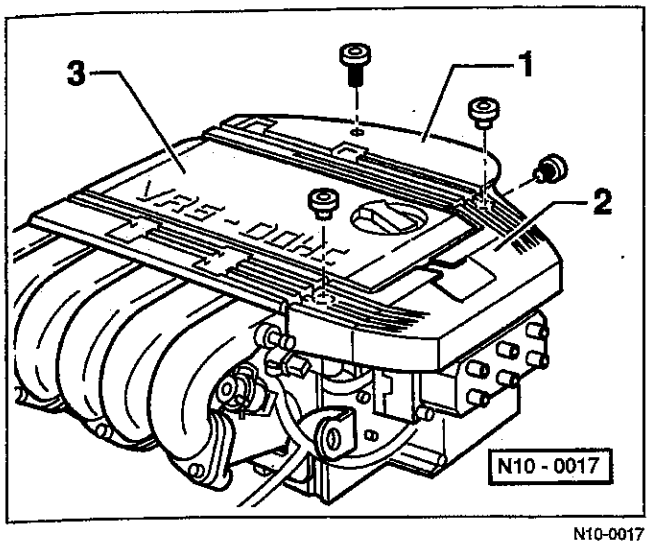
3. Disconnect the Positive Crankcase Ventilation (PCV) breather valve from the cylinder head cover.

4. Disconnect the PCV hose from the upper intake manifold. See Fig. 2.

5. Remove the intake air boot from the throttle housing.

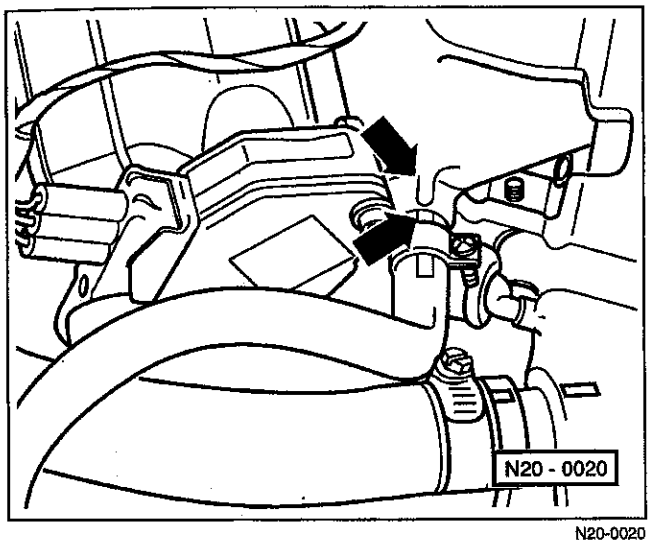
6. Disconnect the accelerator cable from the throttle body and from its support bracket.

7. Release the pressure in the cooling system by loosening the cap on the coolant reservoir. Then clamp off the coolant hose at the throttle housing and disconnect the hose from the housing.




N10-0017

**Fig. 1.** Spark plug wire guides (**1** and **2**). Intake manifold cover shown at **3**.




N20-0020

**Fig. 2.** Charcoal cannister breather hose at upper intake manifold. **Arrows** indicate correct installation orientation: marking on breather hose must align with marking on intake manifold.

8. Disconnect all electrical connectors from the upper intake manifold and the throttle housing. Unclip the fuel lines from the cylinder head cover.

9. Disconnect the vacuum hoses from the fuel pressure regulator and the brake vacuum booster.

10. Remove the oil dipstick guide tube mounting bolt from the lower intake manifold.

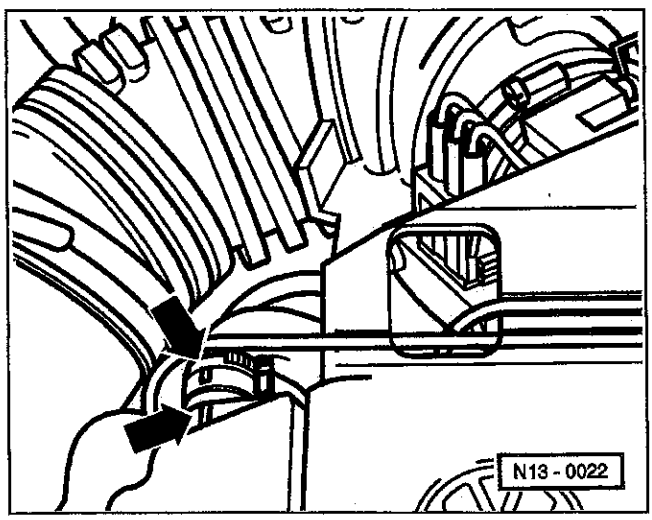
11. Remove the upper intake manifold mounting bolts and manifold support brackets. Remove the manifold together with the throttle housing. Cover the open intake runners using clean shop rags.

12. Remove the ten nuts from the perimeter of the cylinder head cover. Lift off the cylinder head cover and its gasket. Remove the one-piece gasket from the cylinder head or cover.

Installation is the reverse of removal. Use a new gasket between the upper intake manifold and the lower intake manifold. Replace the gasket at the cylinder head cover if it is damaged.

Make sure the charcoal cannister breather hose at the intake manifold is installed correctly as shown in Fig. 2. Check also that the hose is routed over the crankcase breather hose and does not contact any other components. Make sure the crankcase breather hose at the cylinder head cover is also installed correctly as shown in Fig. 3.

***WARNING —***
*Evaporative fuel and oil vapors are potentially explosive and flammable. Make sure all evaporative emission and crankcase breather hoses are in good condition and free of cracks or damage. Make sure all hose connections are tight and secure.*




N13-0022

**Fig. 3.** Charcoal cannister breather hose at cylinder head cover. **Arrows** indicate correct installation orientation: marking on breather hose must align with marking on cover.

**Tightening torques**

- Cylinder head cover to cylinder head . . . . . 10 Nm (89 in-lb)
- Intake manifold cover to intake manifold . . . . . 5 Nm (44 in-lb)
- Upper intake manifold to lower manifold . . . . . 25 Nm (18 ft-lb)

## To remove and install camshafts

The camshafts can be removed with the cylinder head installed. Removing the camshafts allows access to the hydraulic cam followers, the valve springs, and the valve stem oil seals.

***NOTE—***

*A special alignment tool (VW special tool no. 3268) is specified for setting up valve timing during camshaft installation. The tool is relatively inexpensive and highly recommended. See Fig. 10 given later.*

1. Disconnect the battery negative (–) terminal from the battery.

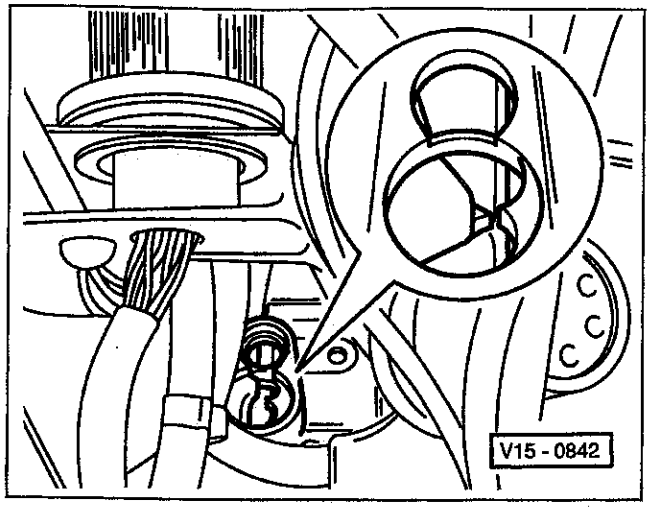
***NOTE—***

*Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. Using a socket wrench on the crankshaft vibration damper center bolt, rotate the engine clockwise by hand to set the No.1 cylinder at Top Dead Center (TDC).
   - On cars with manual transmission, align the timing mark on the pressure plate with the reference mark on the transaxle housing. See Fig. 4.
   - On cars with automatic transmission, align the mark on the torque converter with the reference mark on the transaxle housing. See Fig. 5. Then remove the spark plug from cylinder no. 1. Using a flashlight check that the piston is at the top of the cylinder. If not, turn the crankshaft in 120° increments until the correct mark is aligned. Apply a paint mark to the correct TDC mark on the torque converter for future reference.

***CAUTION—***

*On cars with automatic transmission, always verify TDC through the removed spark plug hole for cylinder no.1. The torque converter can be installed to the driveplate in one of three positions. Therefore, three factory TDC marks (120° apart) are made on the torque converter. This insures that a TDC mark will always be present—regardless of where the torque converter is installed on the driveplate.*

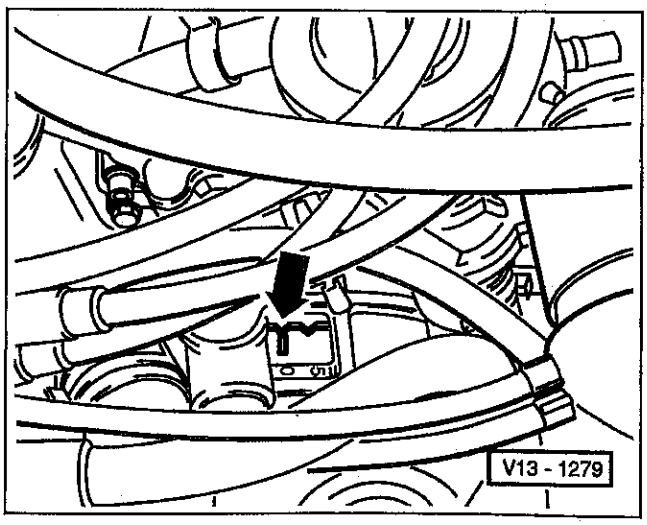



V15-0842

**Fig. 4.** Timing mark on clutch pressure plate aligned with mark on transaxle on cars with manual transmission.

***CAUTION—***

*When turning the crankshaft to verify TDC, turn it only in the direction of normal engine rotation (clockwise when looking at the vibration damper).*




V13-1279

**Fig. 5.** Timing mark (one of three) on torque converter aligned with mark on transaxle housing on cars with automatic transmission.

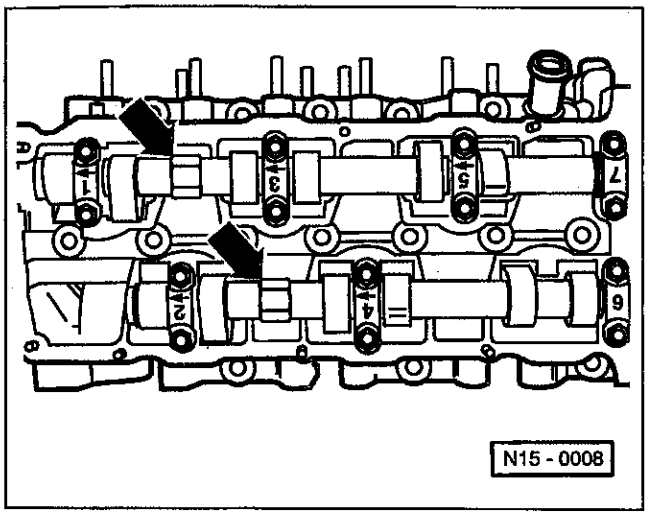
3. Remove the cylinder head cover as described earlier.
4. Remove the ignition coil. See **28 Ignition System.**
5. Remove the upper timing chain tensioner from the camshaft sprocket cover.

6. Remove the camshaft sprocket cover from the front of the cylinder head together with the camshaft position sensor.

***NOTE—***
*When removing the cover, note the two M8 socket-head bolts threaded up through the lower cover and the small O-ring on the rear of the cover.*

7. Remove both camshaft sprocket mounting bolts. Counterhold the camshafts while loosening the bolts. See Fig. 6. Remove the sprockets from the camshafts. Tie the chain up using stiff wire.

***CAUTION—***
*Do not rotate the engine once the camshafts chains are removed from the camshafts. The pistons may contact the open valves.*



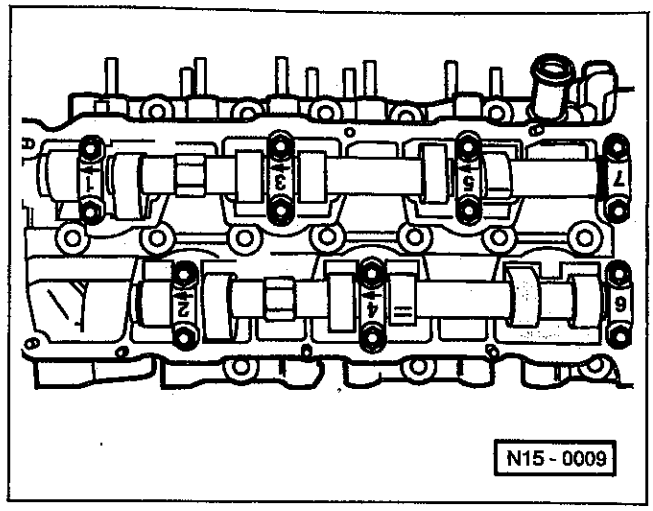

N15-0008

**Fig. 6.** Counterhold camshaft at 24mm hex flats (**arrows**) when loosening or tightening camshaft sprocket bolt.

8. To remove the camshaft for cylinders 1, 3, and 5, first remove bearing caps 1 and 7. Then loosen the nuts on caps 3 and 5, a little at a time so that valve spring tension is relieved evenly. See Fig. 7.

9. To remove the camshaft for cylinders 2, 4, and 6, first remove bearing cap 4. Then loosen the nuts on caps 2 and 6, a little at a time so that valve spring tension is relieved evenly.

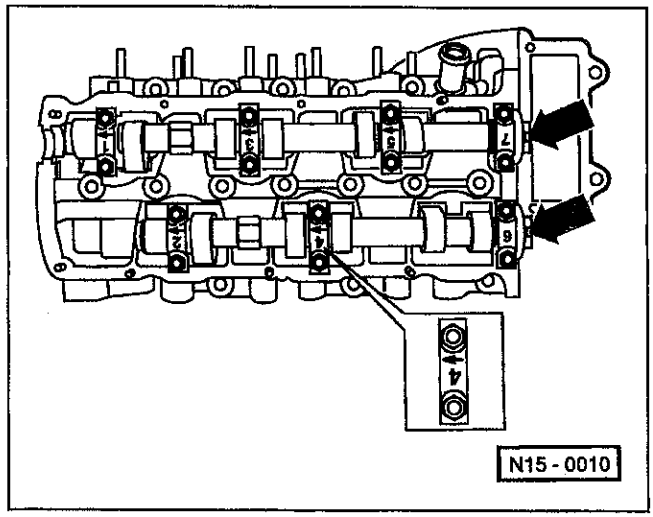
***CAUTION—***
*To avoid uneven and accelerated wear, the bearing caps must be reinstalled in their exact original positions.*




N15-0009

**Fig. 7.** Cylinder head bearing cap identification.

10. Lubricate the contact surfaces of the camshafts and then install them into the cylinder head so that the camshaft sprocket alignment recesses are at the top. See Fig. 8.




N15-0010

**Fig. 8.** Install camshafts so that sprocket alignment recesses are facing up (**arrows**).

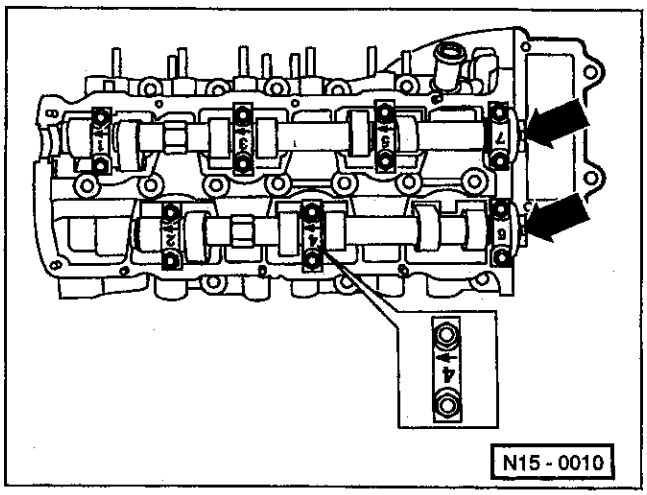
11. Check that cylinder no. 1 is at Top Dead Center (TDC). See Fig. 4 or Fig. 5 shown earlier.

12. Install bearing caps 3 and 5. Gradually tighten all four nuts until the camshaft is drawn down fully and evenly into the bearing saddles. Install bearing caps 1 and 7.

**Tightening torque**

Camshaft bearing caps to cylinder head . . . . . 20 Nm (15 ft-lb)

***CAUTION—***
*Be sure to install the bearing caps correctly. The arrows marked on the caps should point towards the vibration damper end of the engine and the numbers should be readable from the exhaust side of the engine. See Fig. 9.*




N15-0010

**Fig. 9.** Install bearing caps so that arrow faces vibration damper and numbers can be read from exhaust side of engine (inset).

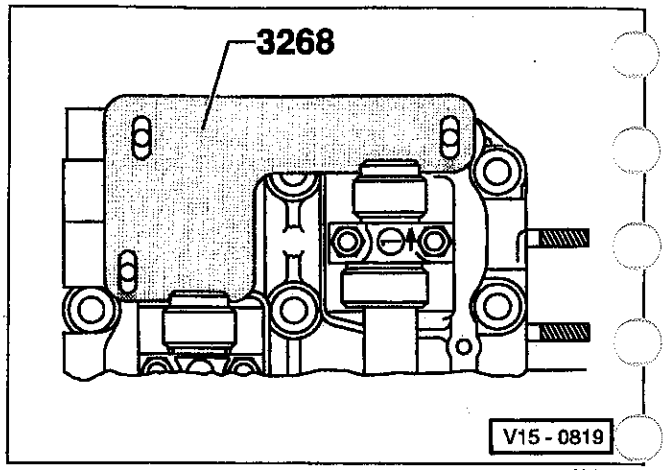
13. Install bearing caps 2 and 6. Gradually tighten all four nuts until the camshaft is drawn down fully and evenly into the bearing saddles. Install bearing cap 4.

**Tightening torque**

Camshaft bearing caps to cylinder head . . . . . 20 Nm (15 ft-lb)

14. Position the camshafts so that the slots in the rear of the shafts accept the VW special tool no. 3268. See Fig. 10. Install the special tool and push it forward into the cutouts.

15. Mount the camshaft sprocket to the shorter camshaft (cylinders no. 2, 4, and 6). Install the mounting bolt hand-tight. Install the chain to the sprocket so that there is no slack between the intermediate shaft sprocket and the cam sprocket.




V15-0819

**Fig. 10.** VW special tool no. 3268 aligns camshafts at TDC. Tool engages slots in rear of camshafts.

16. Install the remaining sprocket into the chain and onto the camshaft so that all the chain slack is at the tensioner side of the chain. Install the mounting bolt together with the camshaft position sensor wheel. Hand tighten the bolt.

***CAUTION—***
*The mating surfaces between the camshaft position sensor wheel and the camshaft sprocket must be dry and free of oil before tightening the center bolt.*

17. Remove the camshaft alignment tool from the rear of the camshafts. Tighten the camshaft sprocket mounting bolts. Counterhold the camshaft when tightening the bolt. See Fig. 6 shown earlier.

***CAUTION—***
*Do not tighten the camshaft bolts with the plastic alignment tool installed. It is easily damaged.*

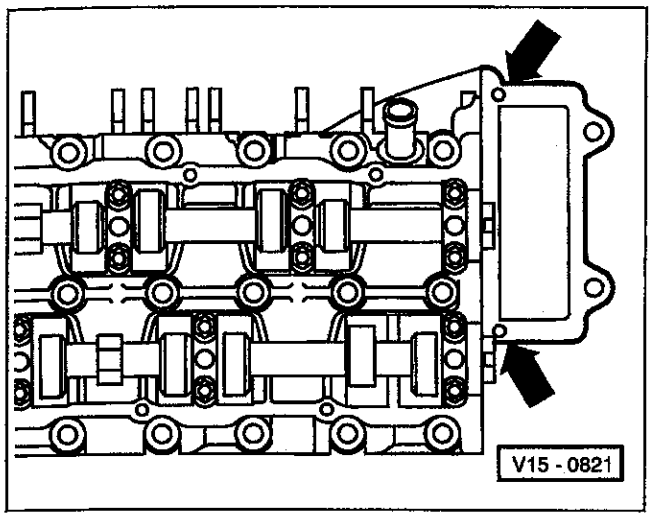
**Tightening torque**

- Camshaft sprockets to camshaft (with bolt contact surface oiled) . . . . 100 Nm (74 ft-lb)

18. Clean any old sealer from the camshaft sprocket cover mating surfaces.

19. Install the camshaft sprocket cover (with new O-ring) using Volkswagen sealant AMV 188 001 01 or an equivalent gasket sealer on the gasket surfaces. See Fig. 11. Tighten the larger M8 bolts first.

***CAUTION—***
*Be sure to install a new O-ring to the rear of the cover. Lightly oil the O-ring and install it into the cover before installation.*




V15-0821

**Fig. 11.** Clean out sealer from 3mm holes (**arrows**) and re-seal holes and gasket surface using Volkswagen sealant AMV 188 001 02 or equivalent.

**Tightening torque**

- Camshaft sprocket cover to cylinder head or lower timing chain cover
  - M6 ..... 10 Nm (89 in-lb)
  - M8 ..... 25 Nm (18 ft-lb)

20. Install the chain tensioner using a new O-ring seal. Oil the seal and install it into the cover before installing the tensioner.

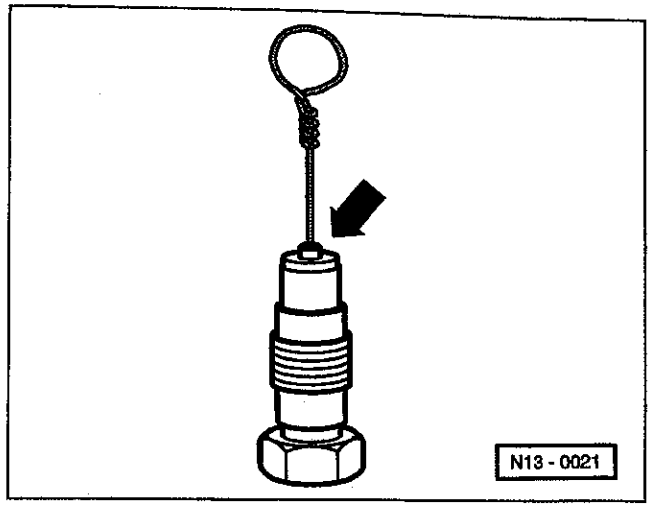
> ***CAUTION—***
> *If the tensioner was taken apart, or if the piston has expanded out, it must be bled down. Use a thin wire through the opening in the tensioner piston. See Fig. 12. Push the wire into the piston while apply light pressure. When the piston check valve opens, the tensioner will collapse.*

**Tightening torque**

- Camshaft chain tensioner to camshaft sprocket cover ..... 30 Nm (22 ft-lb)

21. Turn the engine over by hand in normal engine rotation direction two full revolutions and realign the timing marks shown earlier in Fig. 4 or Fig. 5.

22. Install VW special tool no. 3268 to the camshafts. If the cam timing is setup correctly, the tool will slide smoothly into the camshaft cutouts.




N13-0021

**Fig. 12.** Bleed tensioner by inserting thin wire (0.8 mm) into piston hole (**arrow**). Apply pressure to tensioner piston while pushing on wire. When piston check valve opens, piston will move into tensioner body.

23. The remainder of installation is the reverse of removal. Install the cylinder head cover and upper intake manifold as described under **To remove and install cylinder head cover.**

> ***CAUTION—***
> *If new hydraulic cam followers were installed, the engine must not be run for at least 30 minutes. New cam followers are at a maximum height and should be allowed to bleed down or the valve heads could contact the pistons on start up.*

## Hydraulic Cam Followers

The VR6 engine is equipped with hydraulic cam followers that automatically maintain proper valve clearance. The cam followers are pumped up by engine oil pressure, expanding as necessary to fill the gap between valve and camshaft lobe.

Some valve noise at start-up is normal at times, due to hydraulic cam followers that have bled down while the engine was not running. Before checking noisy cam followers, check to see that the engine oil is new and clean and that the level is correct. Allow a minute or so with the engine running for the lubrication system to properly pump up the cam followers.

> ***CAUTION—***
> *After installing new cam followers, the engine should not be started for at least 30 minutes. New cam followers are at full height and must be allowed to bleed down to their proper height. Failure to do this may cause valve or piston damage.*

## To check hydraulic cam followers

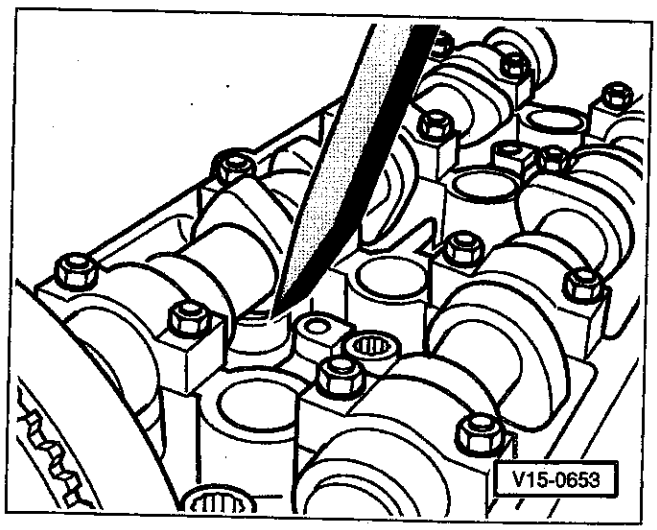
Cam followers should only be checked when the engine is fully warm. Run the engine, preferably drive the car, for 20 to 30 minutes. Raise the engine speed above 2,500 rpm for about two minutes. Then shut the engine off and proceed as soon as possible while the engine is still warm.

1. Remove the cylinder head cover as described in **To remove and install cylinder head cover.**
2. Turn the engine by hand until both the camshaft lobes of one cylinder are pointing approximately up.
3. Using a feeler gauge, check the clearance between the cam follower and the cam lobe. If the clearance exceeds the specified limit, the follower is faulty and should be replaced.

**Hydraulic Cam Follower**

- Wear limit clearance..... 0.1 mm (0.004 in.)

4. If no faults are found in step 3, use a non-metal object such as wood or plastic to apply light pressure to the top of the cam follower. See Fig. 13. Recheck the clearance. If the clearance is excessive, replace the follower.




V15-0653

**Fig. 13.** Hydraulic cam follower being depressed with a non-metal object.

5. Replace a faulty cam follower by removing the camshaft, as described in **To remove and install camshafts** and pulling the follower from the cylinder head.

> ***CAUTION—***
> *Store removed hydraulic cam followers in order on a clean surface with the camshaft contact surface facing down to prevent bleed down. Cover them with a clean, lint-free rag.*

## To replace valve stem oil seals

The sign of faulty valve stem oil seals are excessive oil consumption and oil smoke from the exhaust after starting and during sudden deceleration. Keep in mind that the valve guides may also be worn and the major cause of oil consumption. See **Cylinder Head Reconditioning** for more information on checking valve guides.

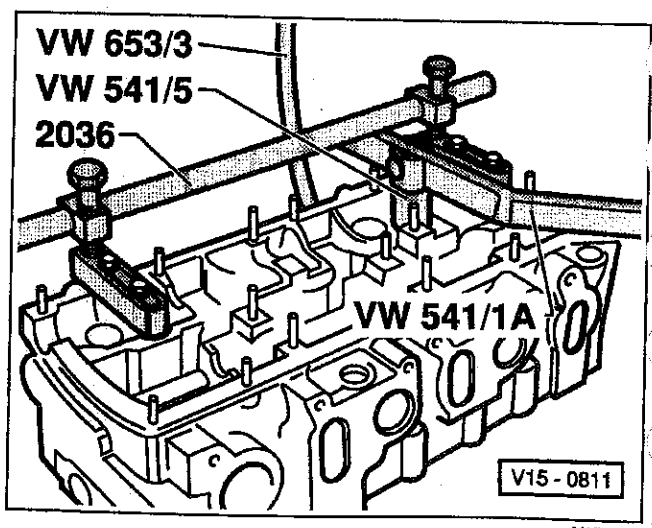
Replacing the oil seals requires that the camshaft, the cam followers, and the valve springs be removed. Valve springs can be removed while the cylinder head is installed with the use of compressed air to hold the valves closed, or with the cylinder head removed. Either method requires the use of a special valve spring compressor.

1. If working with the cylinder head installed, remove the cylinder head cover, as described in **To remove and install cylinder head cover.**
2. Remove the camshafts, as described in **To remove and install camshafts.**
3. Remove the cam followers.

***NOTE—***

- *Keep all parts in order so that they can be reinstalled in their original locations.*
- *Store removed hydraulic cam followers in order on a clean surface with the camshaft contact surface facing down to prevent bleed down. Cover them with a clean, lint-free rag.*

4. If cylinder head is removed, remove the valve springs See Fig. 14.




V15-0811

**Fig. 14.** Valve spring compressors being used to remove valve springs. Numbers identify Volkswagen special tools designed for use on Volkswagen engines. (VW 653/3 is air hose adapter for spark plug hole.)

***NOTE—***
*To prevent the timing chain from jamming when setting the piston to BDC, lift up on and guide the chain while rotating the crankshaft.*

5. If cylinder head is installed, set the cylinder to bottom dead center (BDC). Remove the spark plug and apply compressed air (at least 87 psi) to the cylinder using an appropriate air hose adapter in the spark plug hole.

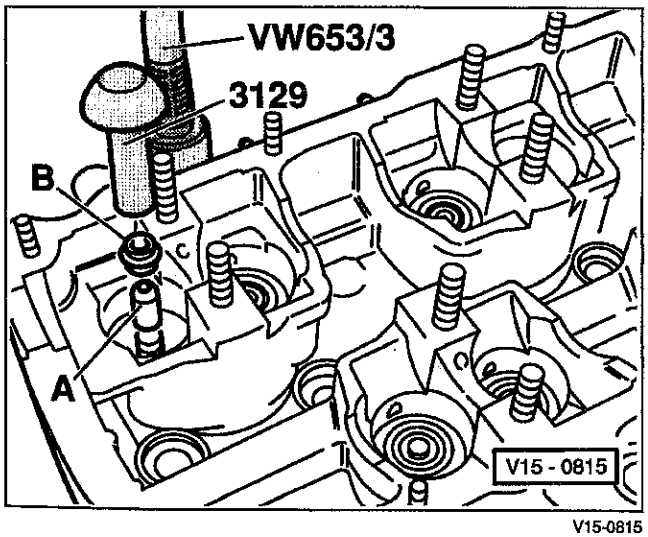
6. Remove the valve springs.

7. Remove the valve stem oil seals from the valve guides.

***NOTE—***
*Volkswagen recommends the use of a slide hammer, VW special tool no. 3047A, to remove the oil seals without damage to the valves or valve guides.*

8. Install each new valve stem oil seal by temporarily fitting the protective plastic cap over the valve stem end. Then hand-press the seal onto the valve guide. See Fig. 15. Remove the protective cap for use on the next valve.

***NOTE—***
*The protective cap protects the seal from being damaged by the keeper grooves in the valve stem. In the absence of a protective cap, temporarily wrap the valve stem with plastic tape.*



V15-0815

**Fig. 15.** Protective cap (**A**) and new valve stem oil seal (**B**). VW special tools (with tool numbers) shown.

9. Reinstall the valve springs. Repeat the procedure for each pair of valves.

10. The remainder of assembly is the reverse of disassembly. See **To remove and install camshafts, Cylinder Head Removal and Installation,** and **To remove and install cylinder head cover.**

**Tightening torque**
- Spark plug to cylinder head
  AAA engine. . . . . 25 Nm (18 ft-lb)

## CYLINDER HEAD REMOVAL AND INSTALLATION

Fig. 16 shows an exploded view of the VR6 cylinder head. The cylinder head can be removed without removing the engine from the vehicle and without removing the camshafts. New cylinder head bolts should be used every time the cylinder head is removed and installed.

If a failed head gasket or warped head is suspected, a compression test, as described earlier under **Diagnostic Testing,** may aid diagnosis and should be performed before the cylinder head is removed. A failed head gasket may be caused by a warped cylinder head. When replacing a failed head gasket, always check the cylinder head for straightness. See **Cylinder Head Reconditioning.**

***NOTE—***
*A special alignment tool (VW special tool no. 3268) is specified for removal and installation of the cylinder head. Read the procedure through before beginning the job.*

### To remove cylinder head

1. Disconnect the battery negative (–) terminal from the battery.

***NOTE—***
*Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. Remove the cylinder head cover as described in **To remove and install cylinder head cover.**

3. Drain the coolant as described in **19 Engine–Cooling System.** Disconnect all coolant hoses from the outlets on the cylinder head.

> ***WARNING—***
> *Hot coolant can scald. Drain the coolant only with the engine cold.*

4. Remove the ignition coil. See **28 Ignition System.**

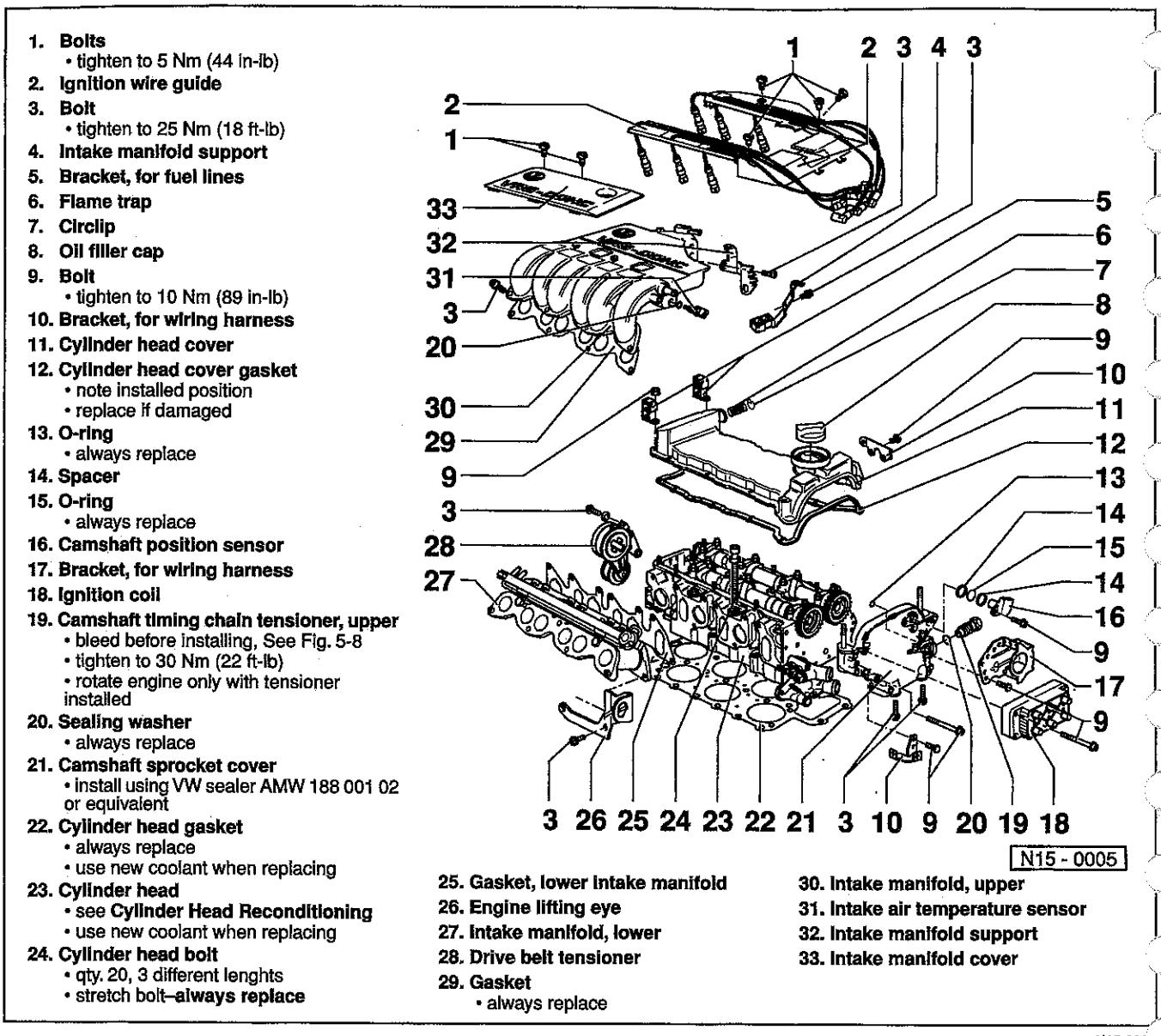
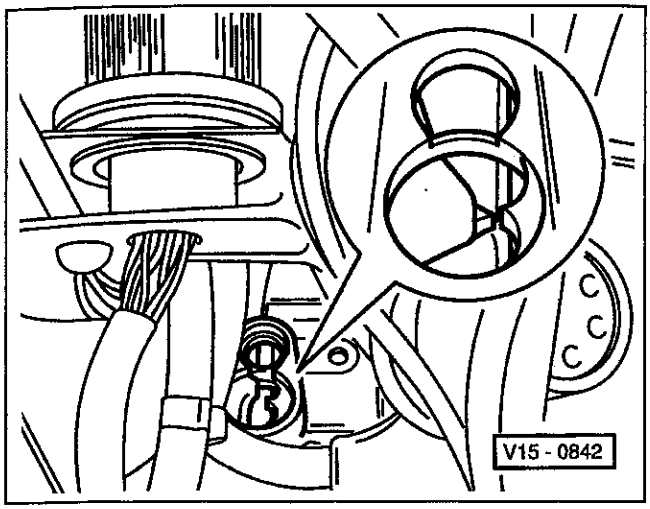



**Fig. 16.** Exploded view of AAA (2.8 liter, VR6) cylinder head.

5. Using a socket wrench on the crankshaft vibration damper center bolt, rotate the engine clockwise by hand to set the No.1 cylinder at Top Dead Center (TDC).
   - On cars with manual transmission, align the timing mark on the pressure plate with the reference mark on the transaxle housing. See Fig. 17.
   - On cars with automatic transmission, align the mark on the torque converter with the reference mark on the transaxle housing. See Fig. 18. Then remove the spark plug from cylinder no. 1. Using a flashlight check that the piston is at the top of the cylinder. If not, turn the crankshaft in 120° increments until the correct mark is aligned. Apply a paint mark to the correct TDC mark on the torque converter for future reference.

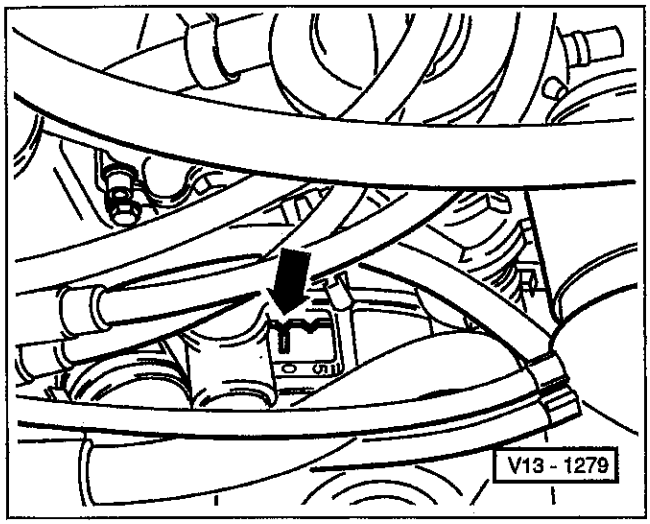
***CAUTION—***

- *On cars with automatic transmission, always verify TDC through the removed spark plug hole for cylinder no.1. The torque converter can be installed to the driveplate in one of three positions. Therefore, three factory TDC marks (120° apart) are made on the torque converter. This insures that a TDC mark will always be present—regardless of how the torque converter is installed.*
- *When turning the crankshaft to verify TDC, turn it only in the direction of normal engine rotation (clockwise when looking at the vibration damper).*




V15-0842

**Fig. 17.** Timing mark on clutch pressure plate aligned with mark on transaxle on cars with manual transmission.




V13-1279

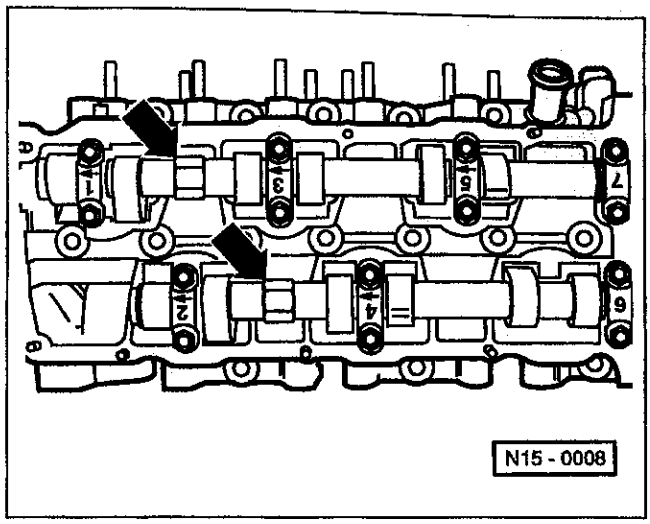
**Fig. 18.** Timing mark (one of three) on torque converter aligned with mark on transaxle housing on cars with automatic transmission.

6. Remove the upper timing chain tensioner from the camshaft sprocket cover.

7. Remove the camshaft sprocket cover from the front of the cylinder head together with the camshaft position sensor.

***NOTE—***
*When removing the cover, note the two M8 socket-head bolts threaded up through the lower cover and the small O-ring on the rear of the cover.*

8. While counterholding the camshafts using a 24mm open end wrench, remove both camshaft sprocket mounting bolts. See Fig. 19. Remove the sprockets from the camshafts. Tie the chain up using stiff wire.




N15-0008

**Fig. 19.** Counterhold camshaft at 24mm hex flats (**arrows**) when loosening or tightening camshaft sprocket bolt.

9. Disconnect the fuel injector harness connectors. Disconnect and label the hoses, wire connectors and cables connected to cylinder head. For more information on fuel injection components, see **24 Fuel Injection–Gasoline.**

> ***WARNING—***
> *Fuel may be expelled when disconnecting fuel lines. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy.*

10. Disconnect the exhaust pipes from the exhaust manifolds, as described in **26 Exhaust System/Emission Controls.**

11. Gradually and evenly loosen the **twenty** cylinder head bolts, beginning with the outer bolts and working toward the center. Discard the bolts.

12. Remove the cylinder head. Proceed slowly, checking to make sure no hoses or wires are interfering with removal.

***NOTE—***
*If the head is stuck, use a soft-faced mallet or pry gently with a wooden stick to loosen it.*

## To install cylinder head

1. Clean the cylinder head and the gasket surface of the cylinder block. Clean the bolt holes with thread chasers and remove all foreign matter and liquid from the holes.

> ***CAUTION—***
> - *If installing a VW replacement cylinder head (complete with camshafts), protective plastic liners are installed for protection of the open valves. Be sure to remove the protective liners prior to installing the head assembly.*
> - *If the camshafts were removed or if installing a new or remanufactured cylinder head, lubricate the contact surfaces between the cam lobes and the hydraulic cam followers prior to start-up.*

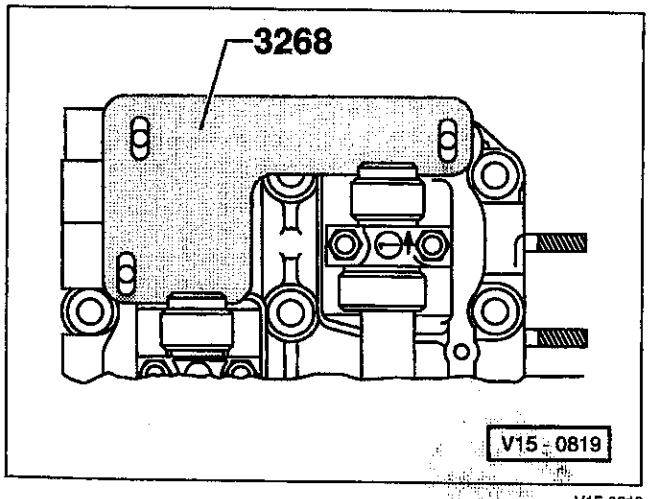
2. Check the gasket surfaces of the cylinder head and the cylinder block for warpage. See **Cylinder Head Reconditioning**.

3. Check that the crankshaft is set to cylinder no. 1 TDC. See Fig. 17 or Fig. 18 given earlier.

4. Place a new cylinder head gasket on the surface of the cylinder block.

> ***CAUTION—***
> *Cylinder head gaskets will give a reliable seal only once. Always use a new gasket that has not previously been compressed by tightening the cylinder head bolts.*

5. Align the camshafts so that the slots in the rear of the shafts are positioned to accept VW special tool no. 3268. See Fig. 20. Install the special tool and push it forward into the cutouts.




V15-0819

**Fig. 20.** VW special tool no. 3268 aligns camshafts at TDC. Tool engages slots in rear of camshafts.

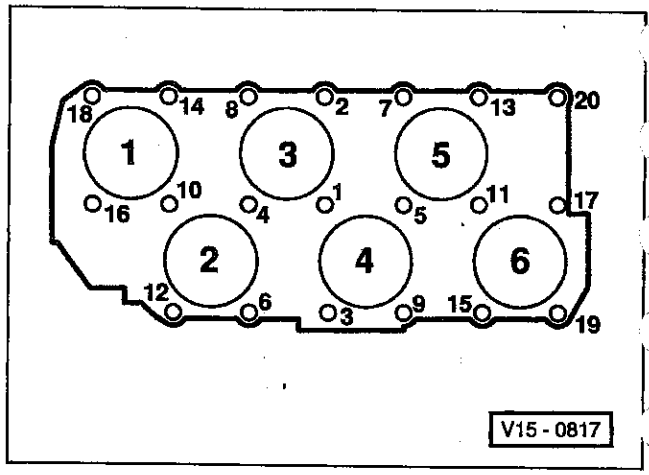
6. Place the cylinder head in position on the cylinder block, noting the two alignment sleeves in the cylinder block.

7. Loosely install the new head bolts with the washers. Then tighten the bolts in stages following the sequence shown in Fig. 21.

> ***CAUTION—***
> *Always replace the cylinder head mounting bolts. They are stretch bolts designed to be used only once.*

**Tightening torques**

- Cylinder head to cylinder block (stretch bolts–**always replace**)
  - stage I ..... 40 Nm (30 ft-lb)
  - stage II ..... 60 Nm (44 ft-lb)
  - stage III ..... additional 1/4 turn (90°)
  - stage IV ..... additional 1/4 turn (90°)




V15-0817

**Fig. 21.** Cylinder head bolt tightening sequence.

8. Mount the camshaft sprocket to the shorter camshaft (cylinders no. 2, 4, and 6). Install the mounting bolt hand-tight. Install the chain to the sprocket so that there is no slack between the intermediate shaft sprocket and the cam sprocket.

9. Install the remaining sprocket into the chain and onto the camshaft so that all the chain slack is at the tensioner side of the chain. Install the mounting bolt together with the camshaft position sensor wheel. Hand tighten the bolt.

> ***CAUTION—***
> *The mating surfaces between the camshaft position sensor wheel and the camshaft sprocket must be dry and free of oil before tightening the center bolt.*

10. Remove the camshaft alignment tool from the rear of the camshafts. Tighten the camshaft sprocket bolts. Counter hold the camshafts when tightening the bolts.

> ***CAUTION—***
> - *Do not tighten the camshaft bolts with the plastic alignment tool installed. It is easily damaged.*
> - *Always counterhold the camshafts at the 24mm cast hex when tightening the camshaft sprocket bolts. See Fig. 19.*

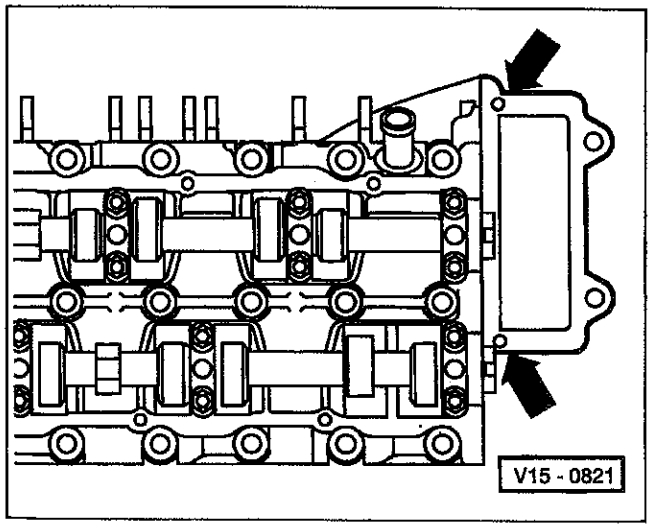
**Tightening torque**

- Camshaft sprockets to camshaft (with bolt contact surface oiled) . . . . 100 Nm (74 ft-lb)

11. Clean any old sealer from the camshaft sprocket cover mating surfaces.

12. Install the camshaft sprocket cover (with new O-ring) using Volkswagen sealant AMV 188 001 01 or an equivalent gasket sealer on the gasket mating surfaces. See Fig. 22. Tighten the larger M8 bolts first.

> ***CAUTION—***
> *Be sure to install a new O-ring to the rear of the cover. Lightly oil the O-ring and install it into the cover before installation.*




V15-0821

**Fig. 22.** Clean out sealer from 3 mm holes (**arrows**) and re-seal holes and gasket surface using Volkswagen sealant AMV 188 001 02 or equivalent.

**Tightening torque**

- Camshaft sprocket cover to cylinder head or lower timing chain cover
  - M6 . . . . . 10 Nm (89 in-lb)
  - M8 . . . . . .25 Nm (18 ft-lb)

13. Install the chain tensioner using a new O-ring seal. Oil the seal and install it into the cover before installing the tensioner.

> ***CAUTION—***
> *If the tensioner was taken apart or if the tensioner piston has expanded out, it must be bled down. See Fig. 12 given earlier.*

**Tightening torque**

- Camshaft chain tensioner to camshaft sprocket cover. . . . . 30 Nm (22 ft-lb)

14. Turn the engine over by hand in normal engine rotation direction two full revolutions and realign the TDC timing marks. Reinstall VW special tool no. 3268 to the camshafts. If the cam timing is setup correctly, the tool will slide smoothly into the camshaft cutouts.

> ***CAUTION—***
> *If VW special tool 3268 does not fit into the camshaft cutout, the chain assembly may not be installed correctly. If only very minor readjustment of the cams allows the tool to slide into place, the assembly is probably setup correctly. If any problems are encountered, reinstall the chains from the beginning of this procedure.*

15. Installation of the remaining parts is the reverse of removal. See **To remove and install cylinder head cover, 24 Fuel Injection–Gasoline**, and **26 Exhaust System/Emission Controls**. Refill the cooling system as described in **19 Engine–Cooling System.**

## CAMSHAFT TIMING CHAINS

Removal and installation of the camshaft timing chains requires that the transaxle be separated from the engine. Fig. 23 shows an exploded view of the camshaft timing chain assembly.

*NOTE—*
*A special alignment tool (VW special tool no. 3268) is specified for setting up camshaft and valve timing. See Fig. 31.*

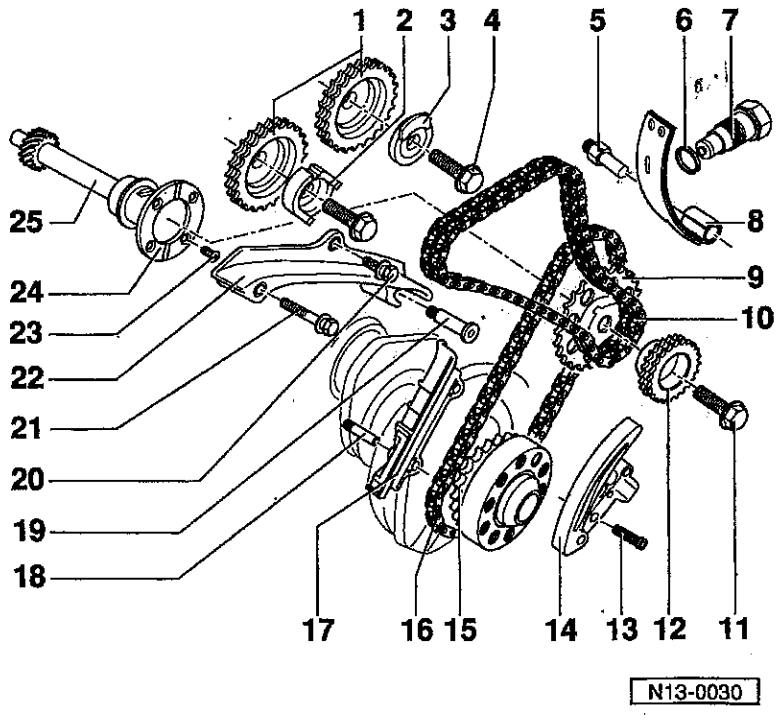
### To remove camshaft timing chains

1. Remove the engine and transaxle from the car and separate the transaxle from the engine. See **10 Engine–Removing and Installing.**

*NOTE—*
*It is also possible to access the chain assembly by removing the transmission from the engine. This way the engine remains in the car. See* **3 CLUTCH, TRANSMISSION, AND FINAL DRIVE** *for transmission removal.*

2. Remove the cylinder head cover. See **To remove and install cylinder head cover.**
3. Remove the ignition coil. See **28 Ignition System.**
4. Using a socket wrench on the crankshaft vibration damper center bolt, rotate the engine clockwise by hand to set the No.1 cylinder at Top Dead Center (TDC).
   - On cars with manual transmission, align the "0/T" mark on the flywheel with the cast reference point mark on the cylinder block. See Fig. 24.
   - On cars with automatic transmission, align the milled mark on the driveplate with the reference point mark on the engine block. See Fig. 25.

1. **Camshaft sprockets**
2. **Not applicable**
3. **Camshaft position sensor (CMP) wheel**
4. **Bolt**
   - tighten to 100 Nm (74 ft-lb)
5. **Tensioner guide pivot pin**
   - tighten to 25 Nm (18 ft-lb)
6. **O-ring**
   - always replace
7. **Upper timing chain tensioner**
   - bleed before installing, See Fig. 5-8
   - tighten to 30 Nm (22 ft-lb)
8. **Tensioner guide**
9. **Intermediate shaft sprocket, inner**
10. **Timing chain, upper (double row)**
    - mark rotation direction before removal
11. **Bolt**
    - tighten to 100 Nm (74 ft-lb)
12. **Intermediate shaft sprocket, outer**
13. **Bolt**
    - tighten to 10 Nm (89 in-lb)
14. **Timing chain tensioner, lower**
15. **Crankshaft with integral sprocket**
    - ground tooth used for TDC timing mark
16. **Timing chain, lower (single row)**
    - mark rotation direction before removal
17. **Guide rail, lower**
18. **Locating pin (w/o collar)**
    - tighten to 25 Nm (18 ft-lb)
19. **Locating pin (with collar)**
    - tighten to 25 Nm (18 ft-lb)
20. **Bolt**
    - install using locking fluid "D6" or equivalent
    - tighten to 20 Nm (15 ft-lb)
21. **Bolt**
    - tighten to 20 Nm (15 ft-lb)



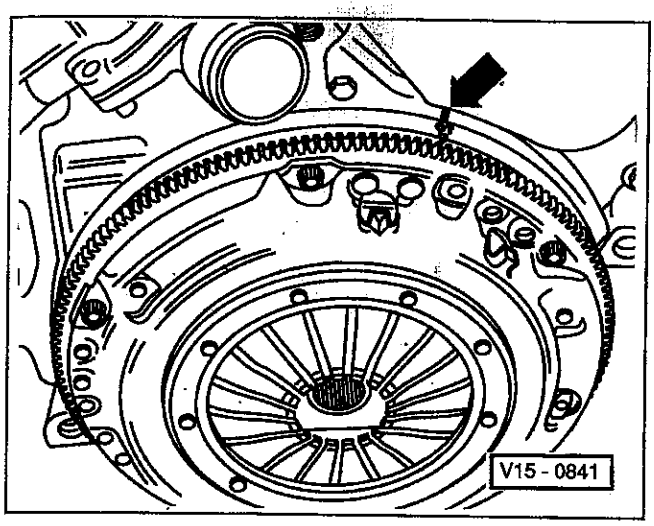

22. **Guide rail, upper**
23. **Bolt**
    - install using locking fluid "D6" or equivalent
    - tighten to 10 Nm (89 in-lb)
24. **24. Thrust washer**
25. **Intermediate shaft**

N13-0030

**Fig. 23.** Camshaft timing chain assembly.

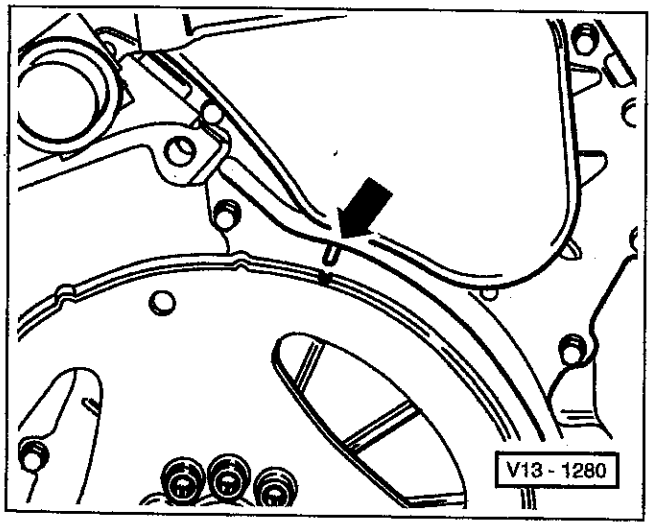
***NOTE—***

*The camshaft timing can be checked at this time using VW special tool no. 3268. With the cylinder head cover removed, slide the tool into the rear camshaft slots (see Fig. 10 given earlier). The tool should slide into the grooves easily without adjustment of the camshafts.*




V15-0841

**Fig. 24.** TDC (0T) mark on flywheel aligned with reference point mark on cylinder block on cars with manual transmission.




V13-1280

**Fig. 25.** TDC mark on driveplate aligned with reference point mark on cylinder block on cars with automatic transmission.

5. Remove the upper timing chain tensioner from the camshaft sprocket cover.

6. Remove the camshaft sprocket cover from the cylinder head together with the camshaft position sensor.

***NOTE—***

*When removing the cover, note the two M8 socket-head bolts threaded up through the lower cover and the small O-ring on the rear of the cover.*

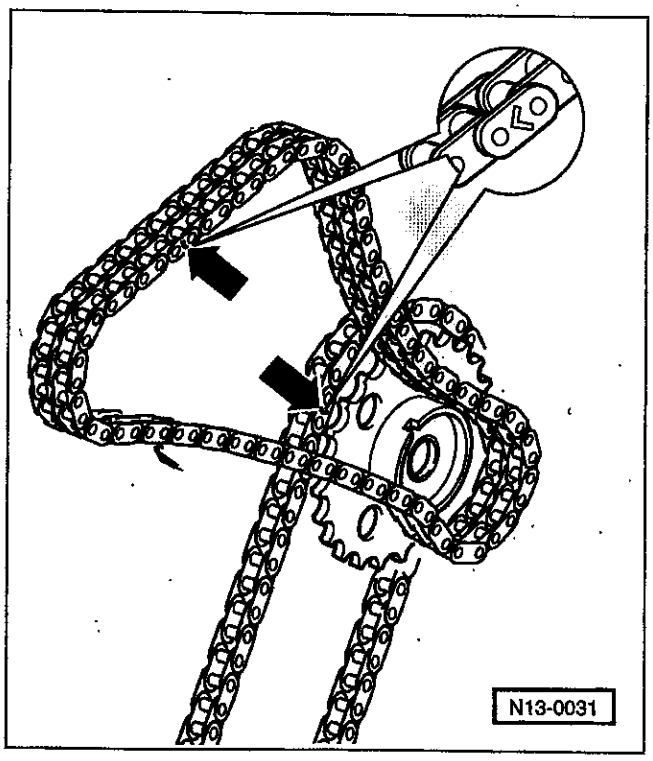
7. Remove the flywheel or driveplate. Discard the mounting bolts. See **Crankshaft/Cylinder Block**.

> ***CAUTION—***
> *Do not reuse the flywheel or driveplate mounting bolts. They are stretch bolts and designed to be used only once.*

8. Remove the lower timing chain cover from the cylinder block and oil pan.

> ***CAUTION—***
> *Use care when removing the lower cover from the oil pan gasket and the cylinder head gasket. If the gaskets are damaged, they will need to be replaced.*

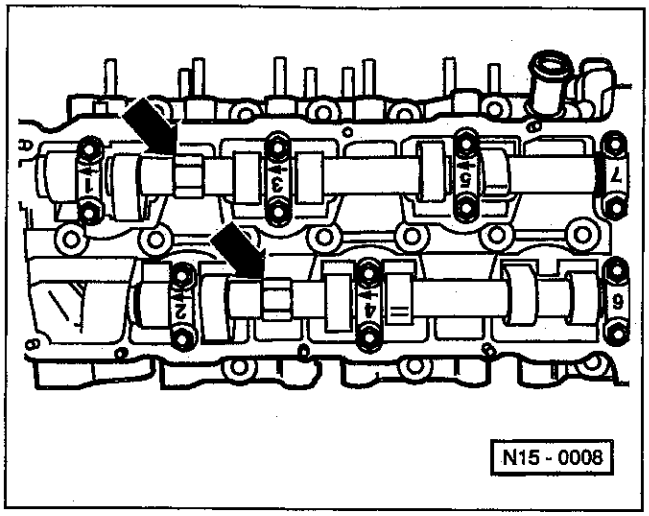
9. Mark the engine rotation direction on the timing chains. See Fig. 26.




N13-0031

**Fig. 26.** Before removing timing chains, mark engine rotation direction on chain link (**arrow**).

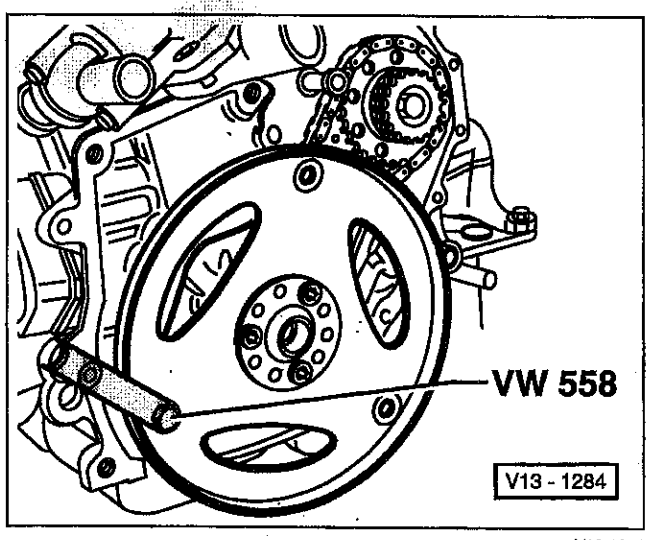
10. Counterhold the camshafts using a 24mm open end wrench and loosen the camshaft sprocket bolt. See Fig. 27. Repeat the procedure on the other sprocket. Remove the sprockets together with the double row chain.




N15-0008

**Fig. 27.** Counterhold camshaft at 24mm hex flats (**arrows**) when loosening or tightening camshaft sprocket bolt.

11. Temporarily install the flywheel or the driveplate using three of the old bolts. Lock the flywheel or the driveplate using a holding tool. See Fig. 28.




V13-1284

**Fig. 28.** Installed driveplate shown locked in position using VW special tool no. 558.

12. With the crankshaft locked, remove the intermediate shaft sprocket mounting bolt.

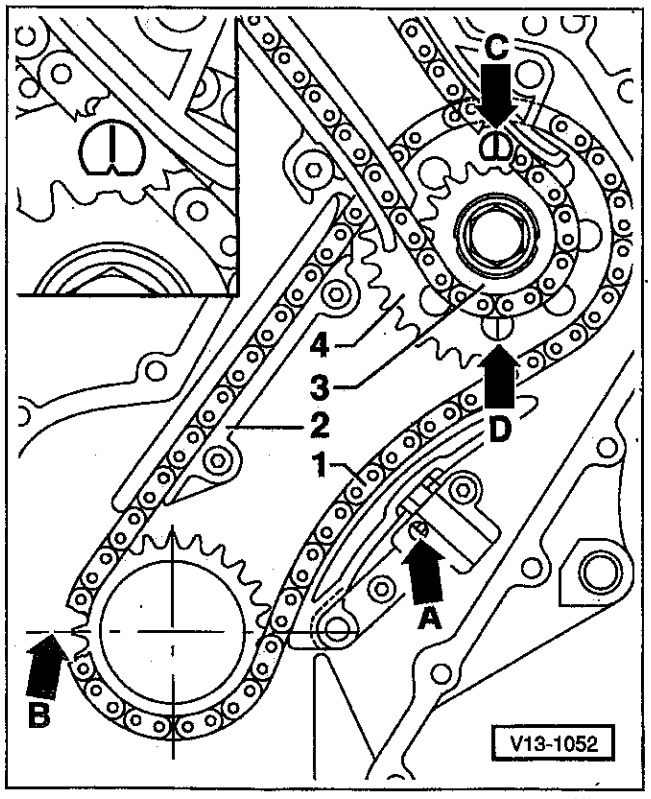
13. Remove the lower timing chain tensioner. Remove the intermediate shaft sprockets together with the lower timing chain and the lower guide rail.

14. Remove the flywheel or driveplate.

15. Inspect the tensioner assemblies and the chain guides for wear or damage. Replace any worn or damaged parts.

## To install camshaft timing chains

1. Set the intermediate shaft and the crankshaft to TDC. See Fig. 29.
   - Temporarily install the intermediate shaft single-tooth sprocket. Rotate the intermediate shaft sprocket so that the mark on the sprocket aligns with the notch on the intermediate shaft thrust washer. Remove the sprocket.
   - Position the crankshaft so the ground-down tooth on the sprocket aligns with the main bearing cap joint.




V13-1052

**Fig. 29.** Align mark on intermediate shaft sprocket (**C**) with notch on thrust washer (see inset). Align ground tooth on crankshaft with main bearing cap joint (**B**).

2. If previously removed, install the lower guide rail locating pin.

**Tightening torque**

- Lower guide rail locating pin (w/o collar) to engine block ..... 25 Nm (18 ft-lb)

3. Install the lower guide rail and the intermediate shaft sprocket to the single-row chain, noting rotation direction marks made earlier.

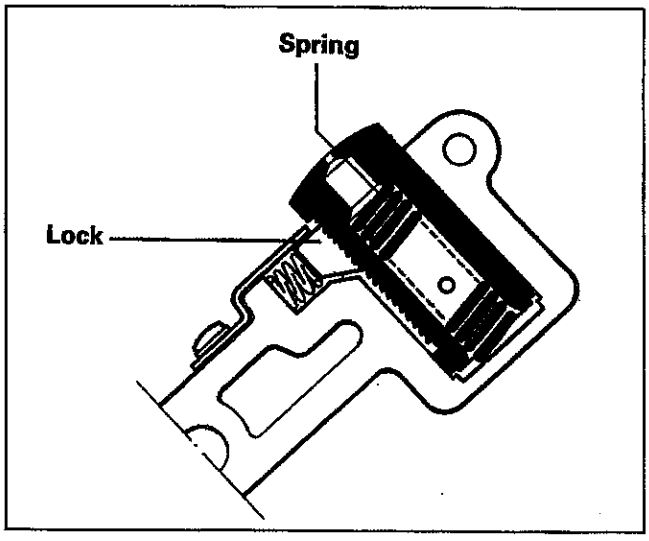
4. Place the chain, guide rail and both intermediate shaft sprockets onto the engine. Install the intermediate shaft sprocket bolt hand tight.

***NOTE—***
*Make sure all chain slack is on the tensioner side of the chain and that the sprocket positions have not been altered. Make sure the intermediate shaft sprockets correctly engage the shaft.*

5. Install the lower chain tensioner. Use a small screwdriver to release the locking spline during installation. See Fig. 30. Install and tighten the tensioner mounting bolt, then lightly press the tensioner plate against the chain to remove all chain slack.

**Tightening torque**

- Lower chain tensioner to engine block ..... 10 Nm (89 in-lb)




0024010

**Fig. 30.** Use small screwdriver to release timing chain tensioner lock.

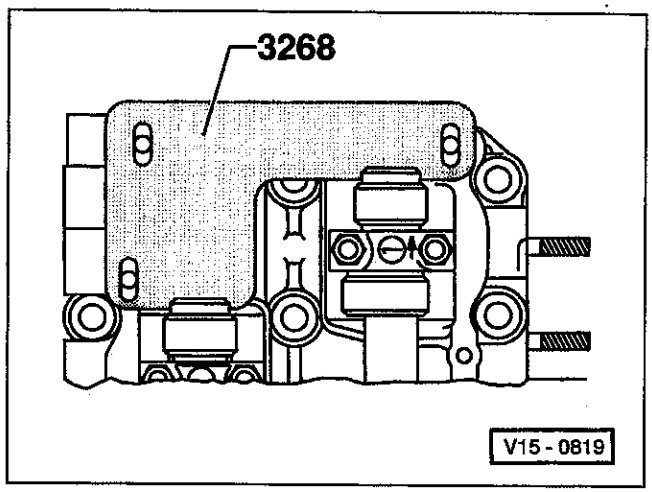
6. Temporarily install the flywheel or driveplate, using at least three of the old bolts.

7. Lock the flywheel or the driveplate using a holding tool. See Fig. 28. Tighten the intermediate shaft sprocket mounting bolt. Recheck the sprocket timing marks.

**Tightening torque**

- Intermediate shaft sprockets to intermediate shaft..... 100 Nm (74 ft-lb)

8. Align the camshafts so that the slots in the rear of the camshafts are positioned to accept the VW special tool no. 3268. Install the special tool and push it forward into the camshaft cutouts. See Fig. 31.




V15-0819

**Fig. 31.** VW special tool no. 3268 aligns camshafts at TDC. Tool engages slots in rear of camshafts.

9. If previously removed, install the tensioner guide pivot pin and the upper guide rail location pin. Place the upper guide rail into position and install the two mounting bolts. Place the chain tensioner guide into position.

***CAUTION—***
*Use care when working near the cylinder head gasket. If the gasket is damaged, it should be replaced.*

***NOTE—***
*Use Volkswagen locking fluid "D6" or equivalent on the shorter guide rail mounting bolt.*

**Tightening torques**

- Tensioner guide pivot pin to engine block .....25 Nm (18 ft-lb)
- Upper guide rail to engine block locating pin (with collar) .....20 Nm (15 ft-lb)
- Hex bolts (use "D6" locking fluid on shorter bolt) ..... 25 Nm (18 ft-lb)

10. Install the double-row chain onto the intermediate shaft, noting rotation direction marks made earlier.

11. Mount the camshaft sprocket to the shorter camshaft (cylinders no. 2, 4, and 6). Install the sprocket mounting bolt hand-tight. Install the chain to the sprocket so that there is no slack between the sprockets.

12. Install the remaining cam sprocket into the chain and onto the camshaft so that all the chain slack is at the tensioner side of the chain. Install the mounting bolt together with the camshaft position sensor wheel. Hand tighten the bolt.

> ***CAUTION—***
> *The mating surfaces between the camshaft position sensor wheel and the camshaft sprocket must be dry and free of oil before tightening the bolt.*

13. Remove the camshaft alignment tool from the rear of the camshafts. While counterholding the camshafts, tighten the camshaft sprocket mounting bolts. See Fig. 31 shown earlier.

> ***CAUTION—***
> *Do not tighten the camshaft bolts with the plastic alignment tool installed. It is easily damaged.*

**Tightening torque**

- Camshaft sprocket to camshaft (with bolt contact surface oiled) . . . . 100 Nm (74 ft-lb)

14. Clean off any old sealer from both sides of the head gasket.

15. Remove the flywheel or driveplate.

16. Install the lower timing chain cover using Volkswagen sealant AMV 188 001 01 or an equivalent gasket sealer on the gasket mating surfaces, including the lower side of the head gasket.

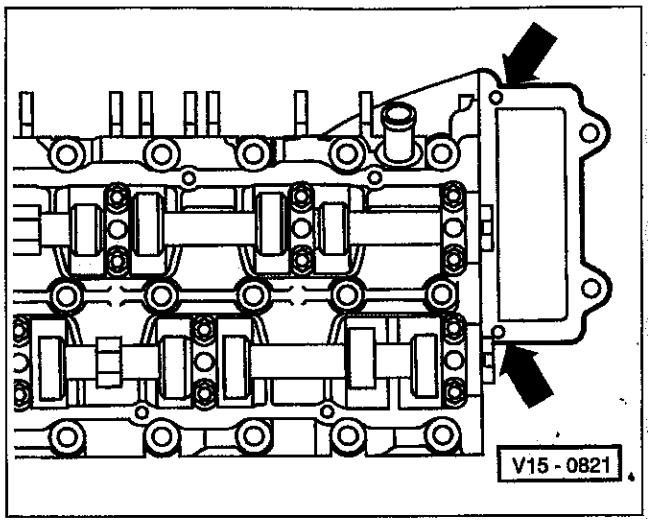
> ***CAUTION—***
> *Use care not to damage the crankshaft seal when installing the lower cover. Coat the seal with a light coat of engine oil before installing the cover.*

**Tightening torque**

- Lower timing chain cover to engine block or oil pan (M6). . . . . 10 Nm (89 in-lb)

17. Install the camshaft sprocket cover (with new O-ring) using Volkswagen sealant AMV 188 001 01 or an equivalent gasket sealer on the gasket mating surfaces. See Fig. 32. Tighten the larger M8 bolts first.

> ***CAUTION—***
> *Be sure to install a new O-ring to the rear of the cover. Lightly oil the O-ring and install it into the cover before installing the cover.*




V15-0821

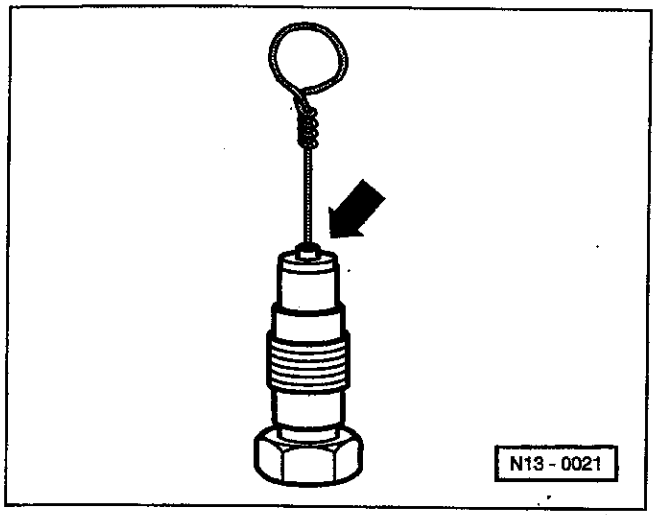
**Fig. 32.** Clean out old sealer from 3 mm holes (**arrows**) and re-seal holes and gasket surface using Volkswagen sealant AMV 188 001 02 or equivalent.

**Tightening torques**

- Camshaft sprocket cover to cylinder head or lower timing chain cover
  - M6 . . . . . 10 Nm (89 in-lb)
  - M8 . . . . . 25 Nm (18 ft-lb)

18. Install the chain tensioner using a new O-ring seal. Oil the seal and install it into the cover before installing the tensioner.

> ***CAUTION—***
> *If the tensioner was taken apart or if the piston has expanded out, it must be bled down. Use a thin wire through the opening in the tensioner piston. See Fig. 33. Push the wire into the piston while apply light pressure. When the piston check valve opens, the tensioner will collapse.*




N13-0021

**Fig. 33.** Bleed tensioner by inserting thin wire (0.8 mm) into piston hole (**arrow**). Apply pressure to tensioner piston while pushing on wire. When piston check valve opens, piston will move into tensioner body.

**Tightening torque**

- Camshaft chain tensioner to camshaft sprocket cover ..... 30 Nm (22 ft-lb)

19. Turn the engine over by hand in normal engine rotation direction two full revolutions and realign the timing marks shown in Fig. 24 or Fig. 25.

20. Install VW special tool no. 3268 to the camshafts. If the chains are setup correctly, the tool will slide smoothly into the camshaft cutouts.

> ***CAUTION—***
> *Do not run the engine if VW special tool no. 3268 does not fit into the camshaft cutouts—the chain assembly may not be installed correctly. If only very minor readjustment of the camshafts allows the tool to slide into place, the assembly is probably setup correctly. If any problems are encountered, reinstall the chains from the beginning of this procedure.*

21. The remainder of installation is the reverse of removal. Be sure to use new mounting bolts on the flywheel or driveplate. Install the cylinder head cover and upper intake manifold as described under **To remove and install cylinder head cover.** Install the engine and transaxle assembly as described under **10 Engine–Removing and Installing.**

**Tightening torques**

- Flywheel or driveplate to crankshaft (stretch bolts–**always replace**)
  stage I ..... 60 Nm (44 ft-lb)
  stage II ..... additional 1/4 turn (90°)

# CYLINDER HEAD RECONDITIONING

## Cylinder Head and Camshafts

An exploded view of the cylinder head is given in Fig. 34. Cylinder heads with small, fine cracks between valve seats and plug threads are usable provided the cracks are not more than 0.5 mm (0.02 in.) wide, and do not extend into more than the first few spark plug threads.

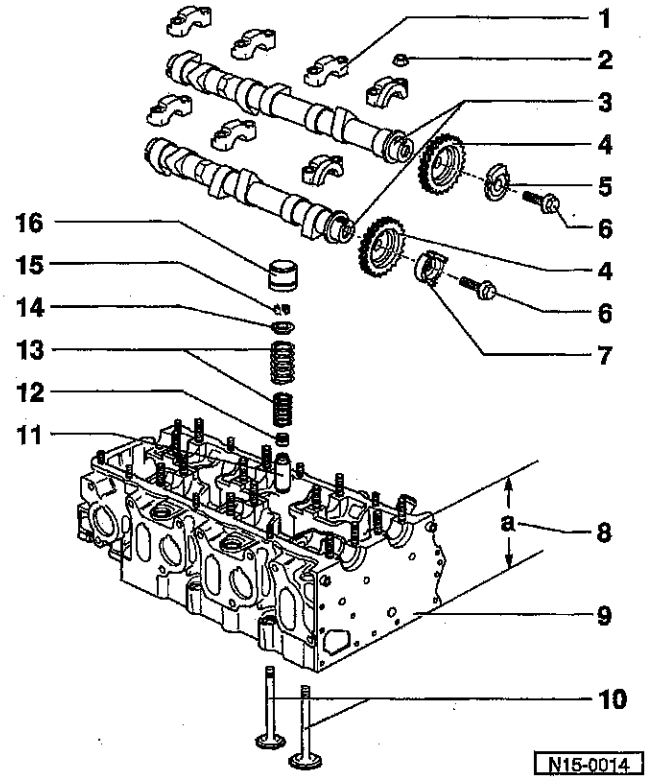
If the camshafts were removed or if installing a new or remanufactured cylinder head, lubricate the contact surfaces between the cam lobes and the hydraulic cam followers prior to start-up.

When removing and installing the camshaft, follow the procedure given under **To remove and install camshaft.** Incorrect camshaft removal or installation can result in a damaged camshaft or cylinder head. Lubricate the contact surfaces between the cam lobes and the hydraulic cam followers prior to start-up.

When replacing the cylinder head or the cylinder head gasket, it is recommended that the old coolant be flushed out and new coolant added. The will help ensure that any metal shavings and contaminants are removed from the engine and the cooling system. See **19 Engine–Cooling System** for draining and flushing procedures.

If the camshafts were removed or if installing a new or remanufactured cylinder head, lubricate the contact surfaces between the cam lobes and the hydraulic cam followers prior to start-up.

Follow the camshaft removal and installation procedures given earlier under **To remove and install camshaft.** Specific procedures, and in some cases, special tools are required for camshaft removal. Refer to this section to prevent damaging the camshaft or the cylinder head.




1. **Camshaft bearing cap**
   • note identification markings.
2. **Camshaft bearing cap nut**
   • 20 Nm (15 ft-lb)
3. **Camshaft**
   • radial clearance (Plastigage®) wear limit 0.1 mm (0.004 in.)
   • runout wear limit 0.01 mm (0.0004 in.)
   • axial clearance (measure with cam followers removed) wear limit 0.15 mm (0.0059 in.)
4. **Camshaft sprockets**
5. **Camshaft position sensor wheel**
   • contact surfaces must be dry of oil when installing
6. **Camshaft sprocket mounting bolt**
   • tighten to 100 Nm (74 ft-lb)
7. **not applicable**
8. **Cylinder head resurfacing height (a)**
   • minimum 139.5 (5.492 in.)
9. **Cylinder head**
   • use new coolant when replacing
10. **Valves**
    • do not reface by grinding, hand-lap only
11. **Valve guide**
12. **Valve stem oil seal**
13. **Valve springs**
14. **Valve spring seat, upper**
15. **Valve keepers**
16. **Hydraulic cam follower**
    • do not interchange between cylinders
    • store with contact surface down
    • oil contact surface when installing

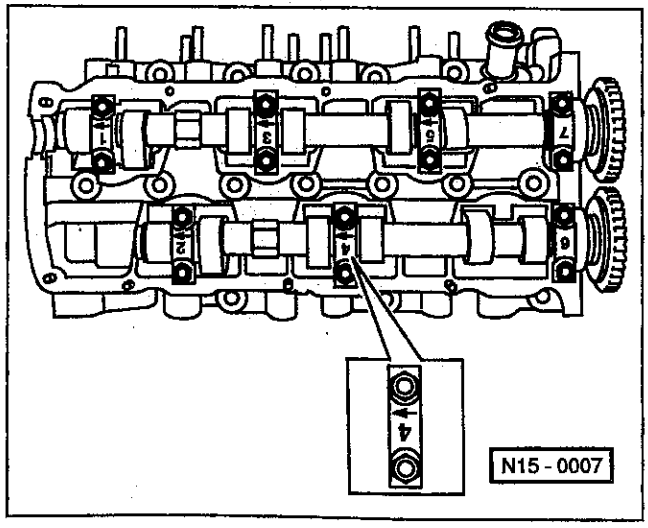
N15-0014

**Fig. 34.** Exploded view of AAA (2.8 liter, VR6) cylinder head.

## Camshafts and Cam Followers

Do not interchange camshaft bearing caps or cam followers. The arrows on the numbered bearing caps should point towards the drive belt end of the engine. See Fig. 35.

> ***CAUTION—***
> *After installing new cam followers, the engine should not be started for at least 30 minutes. New cam followers are at full height and must be allowed to bleed down to their proper height. Failure to do this may cause valve or piston damage.*



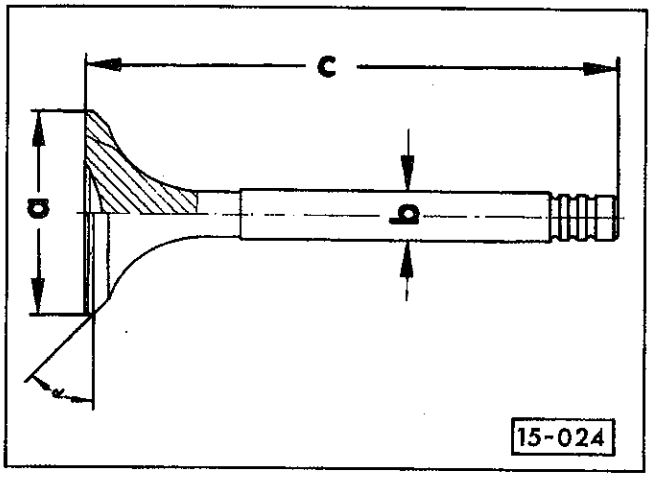

N15-0007

**Fig. 35.** Arrows on bearing caps face drive belt end of engine. Numbers should be readable from exhaust side of engine.

## Valves

Both the intake and exhaust valves are sodium-filled and should be hand-lapped only. Valve and valve spring specifications are given in **Table b**. Refer to Fig. 36 when using the table.

> ***WARNING —***
> *Sodium filled valves, when discarded, must be disposed of properly to avoid personal injury. Always wear protective goggles or glasses. By hand, cut off the valve stem near the head of each valve. Use only a hack saw. Do not use a power saw. Sodium reacts violently with water. Do not let water contact the valve while cutting. Throw the valve parts (no more than 10 valves at a time) into a bucket of water and stand clear. Discard the valves when the reaction has ceased.*




15-024

**Fig. 36.** Valves dimensions to be used in conjunction with **Table b.**

### Table b. Valve Specifications

| Engine Code | AAA |
|---|---|
| Valve head diameter (a)<br>intake<br>exhaust | <br>39.00 mm (1.5354 in.)<br>34.20 mm (1.3465 in.) |
| Valve stem diameter (b)<br>intake<br>exhaust | <br>6.97 mm (0.2744 in.)<br>6.95 mm (0.2736 in.) |
| Valve length (c)<br>intake<br>exhaust | <br>105.95 mm (4.1713 in.)<br>106.95 mm (4.2106 in.) |
| Valve face angle (α)<br>intake<br>exhaust | <br>45°<br>45° |
| Valve margin | N/A |

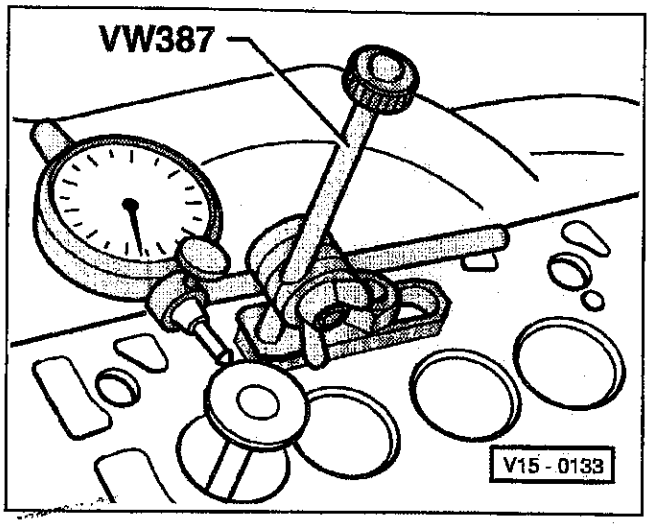
## Valve Guides

Special tools and a press are required to replace valve guides. Check valve guide wear using new valve. See Fig. 37. Inspect the valve seats to ensure that the cylinder head can be reconditioned before installing new valve guides.

> ***CAUTION —***
> *When checking valves guides, be sure to use an exhaust valve on the exhaust side and an intake valve on the intake side. Exhaust and intake valve stem diameters are slightly different. See **Table b**.*

**Valve Guide Wear Limits**

- Maximum play
  - intake . . . . . 1.0 mm (0.039 in.)
  - exhaust . . . . . 1.3 mm (0.051 in.)




V15-0133

**Fig. 37.** Valve guide wear being checked with new valve. Insert valve until stem end is flush with end of guide. Rock valve back and forth to check total travel.

Original valve guides (without shoulders) are pressed out from the camshaft side of the cylinder head. Replacement valve guides (with shoulders) are pressed out from the combustion chamber side of the cylinder head. Lubricate new valve guides with oil and press them in from the camshaft side until the shoulder is fully seated.

> ***NOTE —***
> - *Where available, replace valve guides using Volkswagen special tools. Use of other press tools may damage the cylinder head.*
> - *Use VW tool no. 3121 (order no. T03 121 000 15 ZEL) for valve guide installation and removal. Ream the valves guides using VW special tool no. 3120.*

## Valve Seats

When resurfacing valve seats, there is a limit to the amount of material that can be removed. If too much material is removed, the final assembly will leave too little space for the hydraulic cam follower to function correctly. The maximum refacing dimension—the maximum amount of material that can be removed from the valve seat—is calculated from the measurement shown in Fig. 38.

Measure dimension (**A**) in Fig. 38, and subtract the minimum dimension, as given in **Table c.** The difference is the maximum amount of material that can be removed from the valve seat. Valve seat dimensions are given in table **Table d.**

**Table c. Minimum Dimensions for Calculating Valve Seat Refacing Dimensions**

| Engine Code | Intake | Exhaust |
|---|---|---|
| AAA | 33.9 (1.335 in.) | 34.1 mm (1.343 in.) |

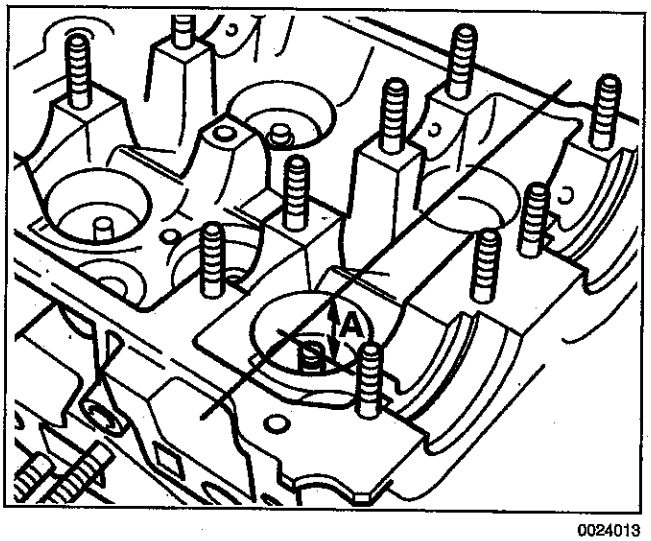
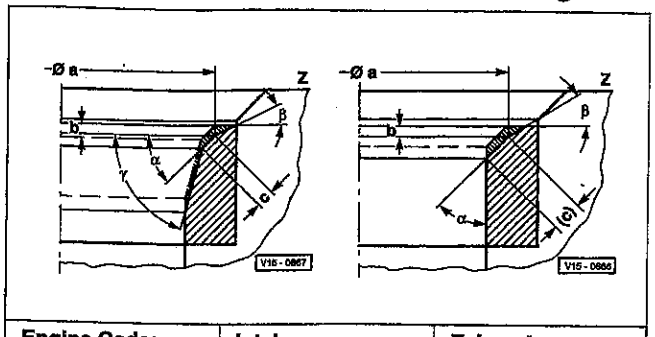



**Fig. 38.** Dimension **A** (distance between top of valve stem and gasket surface of cylinder head) is used to calculate maximum valve seat refacing dimensions.

**Table d. Valve Seat Dimensions: AAA Engine**




| Engine Code: AAA | Intake (V15-0667) | Exhaust (V15-0666) |
|---|---|---|
| Seat diameter (a) | 38.3 mm (1.508 in.) | 33.5 mm (1.319 in.) |
| Maximum refacing dimension (b) | Calculated See Fig. 38. | Calculated See Fig. 38. |
| Seat width (c) | 1.4-2.0 mm (0.055-0.079 in.) | 2.0-2.5 mm (0.079-0.098 in.) |
| Valve seat angle (α) | 45° | 45° |
| Correction angle, upper (β) | 30° | 30° |
| Correction angle, lower (γ) | 75° | N/A |

# 17 Engine–Lubrication System





## GENERAL

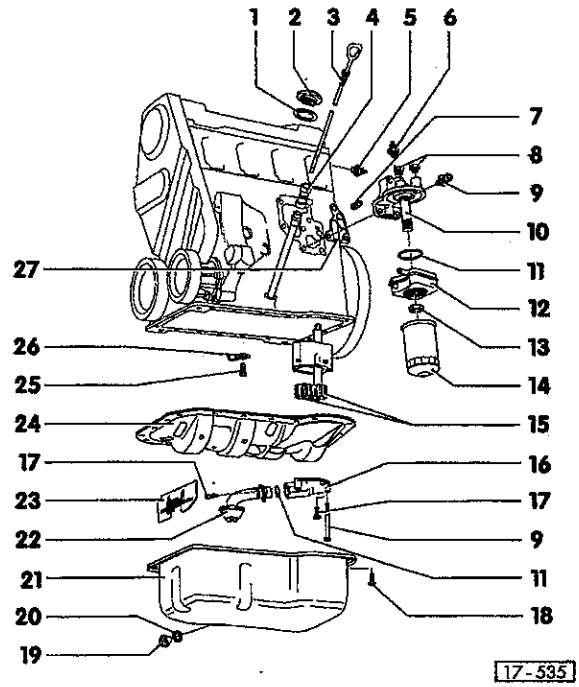
Proper engine lubrication relies on a constant supply of oil, fed to the moving parts under pressure. Pressure is supplied by a gear-type oil pump located inside the oil pan. Engine oil returns to the oil pan where it is stored for pickup by the pump. It is cleaned by circulating through a replaceable filter.

Fig. 1 shows an exploded view of the lubrication system for 4-cylinder engines. Fig. 2 shows an exploded view of the lubrication system for 6-cylinder engines.

***NOTE—***

*Oil change, oil filter changes, and engine oil specifications are covered in greater detail in* **0 Maintenance Program.**

1. **Oil filler cap gasket**
2. **Oil filler cap**
3. **Oil dipstick**
4. **Dipstick tube**
5. **Oil pressure switch**
   - brown: 0.3 bar (4.4 psi)
   - blue: 0.2 bar (3.0 psi)
   - tighten to 25 Nm (18 ft-lb)
6. **Oil pressure switch**
   - white: 1.8 bar (26 psi)
   - grey: 0.9 bar (13 psi)
   - tighten to 25 Nm (18 ft-lb)
7. **Check valve**
   - tighten to 5 Nm (44 in-lb)
8. **Plug**
9. **Bolt**
   - tighten to 20 Nm (15 ft-lb)
10. **Oil filter bracket**
11. **O-ring**
    - always replace
12. **Oil cooler (except ACC engines)**
13. **Oil cooler mounting nut**
    - tighten to 25 Nm (18 ft-lb)
14. **Oil filter**
    - hand tighten when installing
15. **Oil pump gears**
16. **Oil pump cover with pressure relief valve**
    - pressure relief opening pressure: 5.7–6.7 bar (82.5–97 psi)
17. **Bolt**
    - tighten to 10 Nm (89 in-lb)
18. **Bolt**
    - tighten to 20 Nm (15 ft-lb)




19. **Oil drain plug**
    - tighten to 30 Nm (22 ft-lb)
20. **Drain plug seal**
    - always replace
21. **Oil pan**
22. **Oil pump suction line**
23. **Deflector**
24. **Sound baffle (not installed on all versions)**
25. **Pressure relief valve for oil spray nozzle**
    - See **Oil Spray Nozzles** for tightening torques
26. **Oil spray nozzle (not installed on all versions)**
27. **Oil filter housing gasket**
    - always replace

17-535

**Fig. 1.** Exploded view of lubrication system on ABA (2.0 liter) engine. Lubrication system on other 4-cylinder engines is similar.

## OIL PRESSURE WARNING SYSTEM

To prevent serious engine damage, a dynamic oil pressure warning system warns the driver of insufficient oil pressure. Other safety features include a filter by-pass to prevent oil starvation and an oil pump pressure relief valve to prevent excessive system pressure.

The components of the dynamic oil pressure warning system are the two pressure switches, the electronic control unit, the oil pressure warning light in the dash, and the warning buzzer. A low pressure switch provides warning when the oil pressure falls to near zero at any time. A high pressure switch provides earlier warning, at elevated rpm, whenever oil pressure falls below a minimum safe level.

On 4-cylinder engines, the low pressure switch (0.2 bar, blue body) is threaded into the back of the cylinder head and the high pressure switch (1.8 bar, white body) is threaded into the top of the oil filter bracket.

On 6-cylinder engines, both the low pressure switch (0.2 bar, blue body) and the high pressure switch (1.4 bar, black body) are threaded into the top of the oil filter housing. See Fig. 3.

***NOTE—***

- *On some engines, the low pressure switch may have a brown body and a slightly higher opening pressure (0.3 bar).*
- *On some 4-cylinder engines, the low pressure switch may be threaded into the oil filter bracket, beside the high pressure switch.*

The electronic control unit is integrated into the instrument cluster.

1. **Bolt**
   - tighten to 10 Nm (89 in-lb)
2. **Cover for oil pump drive shaft**
3. **O-ring**
   - always replace
   - lubricate with engine oil before installing
4. **Oil pump drive shaft**
5. **Intermediate shaft**
6. **Thrust washer**
7. **Screw**
   - tighten to 10 Nm (89 in-lb)
   - install using locking fluid "D6"
8. **Oil pump**
9. **Bolt**
   - tighten to 25 Nm (18 ft-lb)
10. **Bolt**
    - always replace
    - tighten to 10 Nm (89 in-lb)
    - install using locking fluid "D6"
11. **Oil drain plug**
    - tighten to 30 Nm (22 ft-lb)
12. **Drain plug seal**
    - always replace
13. **Oil spray nozzle**
    - opening pressure: 2.0 bar (29 psi)
14. **Bolt**
    - tighten to 15 Nm (11 ft-lb)
15. **Oil pan gasket**
16. **Oil pan**
17. **Oil cooler**
18. **Oil cooler cover**
    - tighten to 25 Nm (18 ft-lb)
19. **Oil filter housing gasket**
    - always replace
    - lubricate with engine oil before installing
20. **Oil filter housing**
21. **Dipstick**
22. **Dipstick guide tube**
23. **Non-return valve (check valve)**
    - tighten to 5 Nm (44 in-lb)
    - note installation position before removing

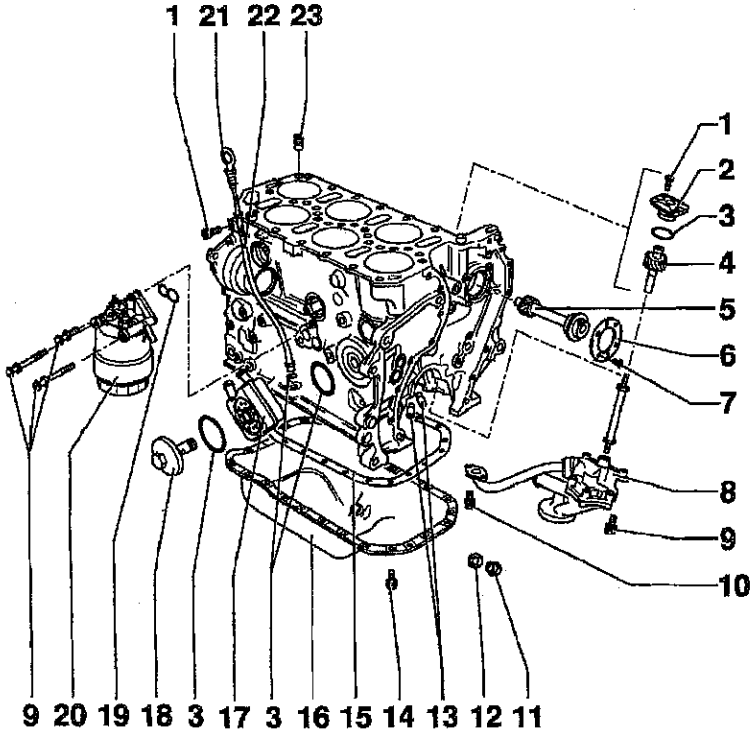



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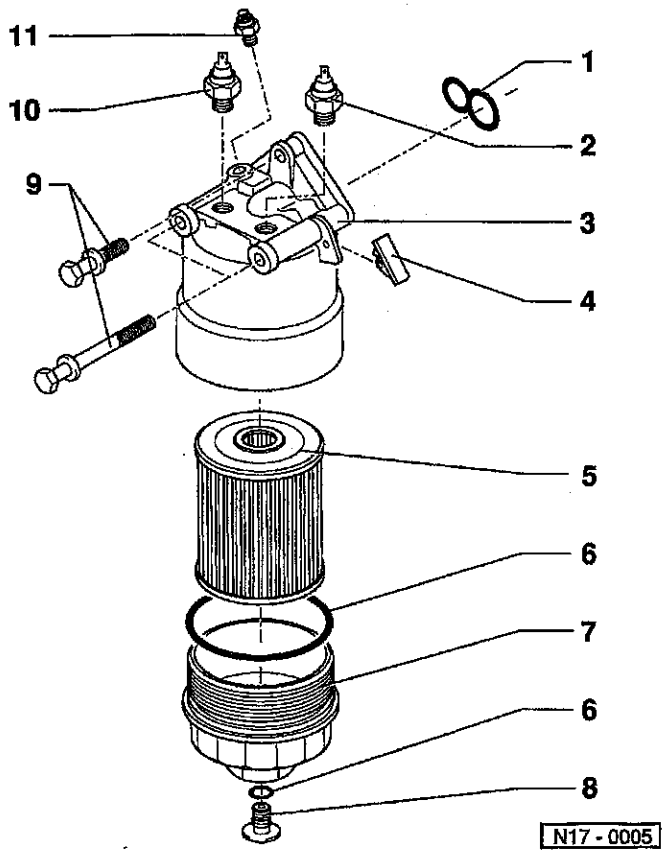
**Fig. 2.** Exploded view of lubrication system on 2.8 liter, VR6 engine.




1. **Gasket**
2. **Oil pressure switch: 0.2 bar (3 psi)**
   - blue body, blue/black wire
   - 25 Nm (18 ft-lb)
3. **Oil filter housing, upper**
4. **Stop plate (for oil cooler)**
5. **Oil filter element**
6. **O-ring**
   - always replace
   - lubricate with engine oil before installing
7. **Oil filter housing, lower**
   - tighten to 30 Nm (22 ft-lb)
8. **Filer housing drain screw**
   - tighten to 10 Nm (89 in-lb)
9. **Bolts**
   - tighten to 25 Nm (18 ft-lb)
10. **Oil pressure switch: 1.4 bar (20 psi)**
    - black body, yellow wire
    - tighten to 25 Nm (18 ft-lb)
11. **Engine oil temperature sensor**
    - tighten to 10 Nm (89 in-lb)

N17-0005

**Fig. 3.** Exploded view of oil filter housing on VR6 engine.

## Checking Low Oil Pressure Warning System

With the ignition off, the low pressure switch is closed (complete circuit to ground). When the ignition is turned on, the indicator flashes (no oil pressure). When the engine is started and oil pressure rises, the switch opens and the indicator goes out. With insufficient oil pressure or a stuck switch, the indicator will continue to flash. The switch opens and closes at specific pressures. See **Testing Oil Pressure Switches.**

> ***CAUTION—***
> *If the warning indicator stays on after the engine is started, or flashes on while driving, always assume that there is insufficient oil pressure. Check oil level and test oil pressure before proceeding with tests of the warning system.*

To quick-check the low pressure switch, simulate a closed switch by removing the blue/black wire and grounding it. With the ignition on, the indicator should flash. If not, the problem is in the circuit or the indicator. If the indicator flashes only when tested in this way, replace the switch.

If the indicator flashes with the engine running, and the oil pressure tests OK, remove the blue/black wire from the switch with the engine running. The indicator should go out. If not, the circuit is shorted to ground between the wire and indicator. If the indicator does go out, the switch is stuck closed and should be replaced.

## Checking Dynamic Oil Pressure Warning System (high rpm)

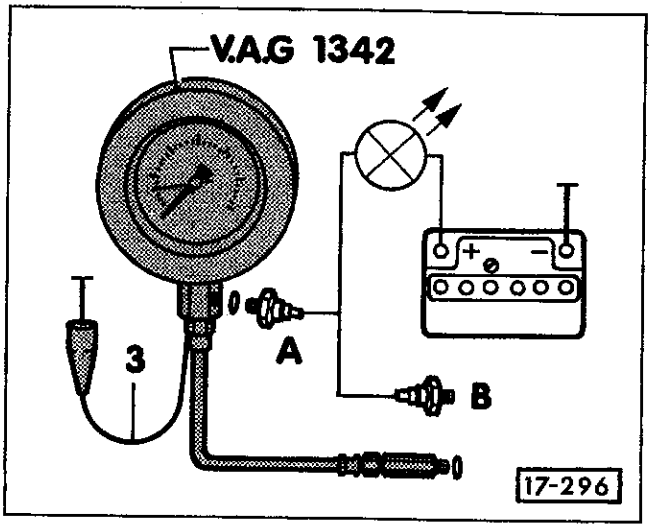
The high pressure switch is normally open (no circuit to ground). When the engine is running above 2,000 rpm, oil pressure closes the switch and completes the circuit to ground. If oil pressure is insufficient to close the pressure switch, or the switch is stuck open, the indicator will flash and the buzzer will sound at engine speeds above 2,000 rpm. The pressure switch opens and closes at specific pressures. See **Testing Oil Pressure Switches.**

To quick-check the pressure switch, disconnect the yellow wire from the switch and raise the engine speed to between 2000 to 2500 rpm. The indicator should flash and the buzzer should sound. If the wire is connected to ground, the warning

should stop. Remove the wire from ground and reconnect to the switch. If the indicator does not go out, replace the switch.

## Testing Oil Pressure Switches

The oil pressure switches can be accurately tested by temporarily installing an oil pressure gauge in parallel with the switch with a T-fitting and monitoring switch operation with a multimeter or test light, as shown in Fig. 3.




17-296

**Fig. 4.** Pressure gauge and test light setup for testing oil pressure switches. V.A.G. 1342 is Volkswagen pressure tester. Remove switch from engine (**B**) and install in tester (**A**). Connect wire (**3**) to ground and monitor switch function using an LED or multimeter.

**Oil Pressure Switch Test Pressures**

- Low pressure switch (engine running, raise idle speed) switch opens . . . . . .0.15-0.45 bar (2.1-6.5 psi)
- Dynamic pressure switch (idle speed above 2,000 rpm) switch closes . . . . . white switch(1.8 bar) . . . . . .1.6-2.0 bar (23-29 psi) black switch (1.4 bar). . . . . 1.2-1.6 bar (17- 23 psi) grey switch (0.9 bar). . . . . .0.7-1.1 bar (10-16 psi)

If the switches are performing properly, the oil pump is producing adequate oil pressure and the system still warns of low oil pressure, then the dynamic oil pressure warning system control unit within the instrument cluster should be replaced.

***NOTE—***

*If an oil pressure switch seal is leaking, a new sealing ring should be installed. The sealing ring is held captive on the switch and needs to be cut off. New sealing rings are available from Volkswagen.*

# OIL PUMP

The oil pump is located inside the engine oil pan, and draws engine oil through a pickup tube from near the bottom of the pan. The pump can be removed for inspection of its internal clearances (a potential source of low oil pressure problems) by first removing the oil pan, although internal replacement parts are not available from Volkswagen.

There is normally no need to remove and inspect the oil pump unless oil pressure is inadequate. Check the oil pressure by installing a pressure gauge in place of one of the oil pressure switches and run the engine. Engine oil pressure at normal operating temperature should as listed below.

**Engine oil pressure**

- engine fully warm (oil temperature @ 80°C (176°F) @2,000rpm . . . . . at least 2.0 bar (29 psi) @higher engine speeds, maximum pressure. . . . . 7.0 bar (101 psi)

## To inspect oil pump

1. Drain the engine oil. See **0 Maintenance Program.**
2. Remove the oil pan retaining bolts and remove the oil pan.

   ***NOTE—***

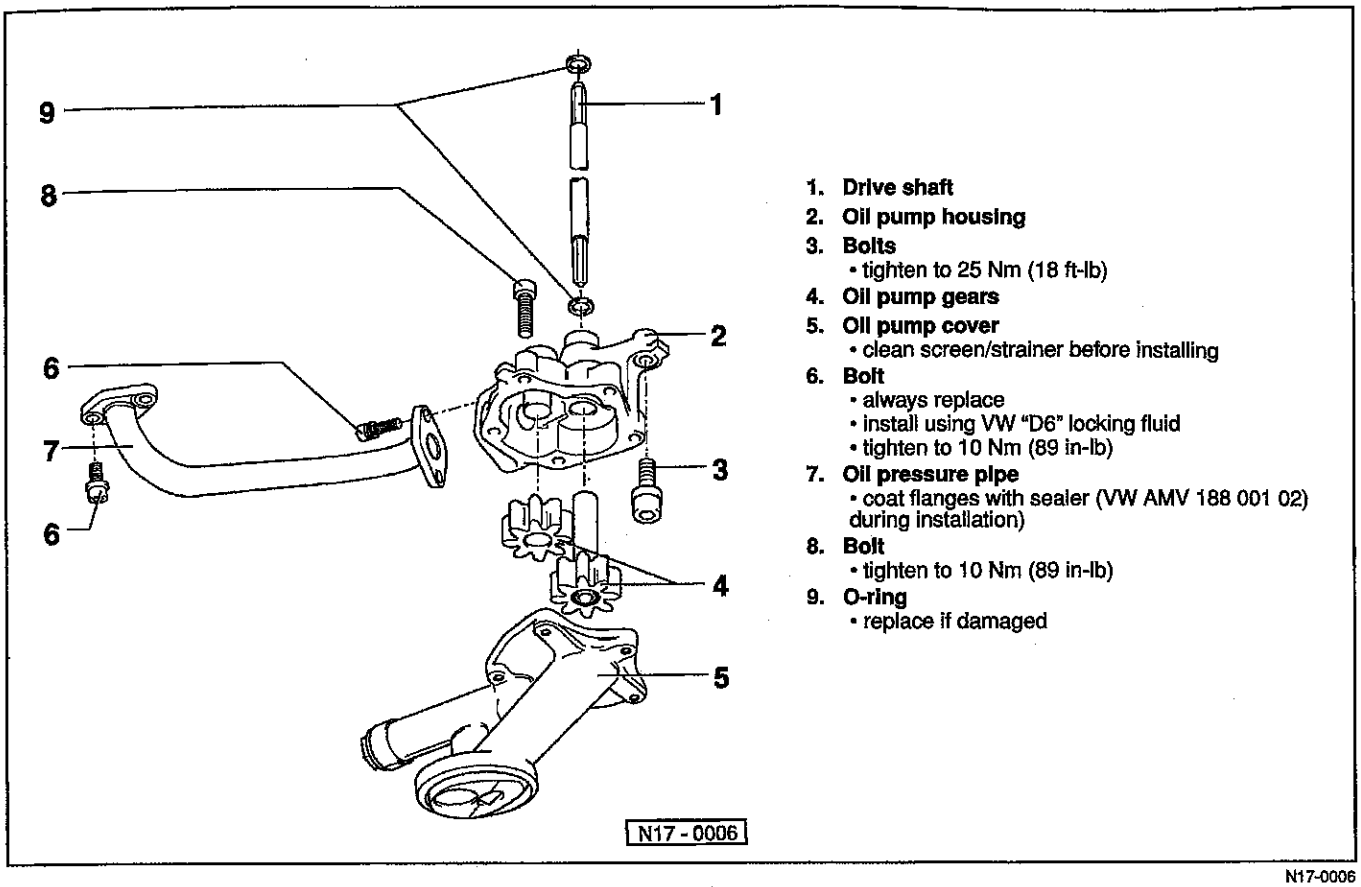
   *On 4-cylinder engines, accessing the oil pan mounting bolts on the flywheel end of the engine may be difficult. If available, use VW special tool no. 3185 (10 mm swivel/extension) when loosening or tightening these bolts.*

3. Remove the pump and disassemble it.
   - On 4-cylinder engines, use Fig. 1 as a guide during oil pump disassembly and assembly.
   - On 6-cylinder engines, see Fig. 5 for oil pump disassembly and assembly.
4. Check the oil pump backlash and axial play. See Fig. 6 and Fig. 7. If either clearance exceeds the specifications shown, the pump should be replaced.

   ***NOTE—***

   *On 4-cylinder engines, always replace the pickup tube O-ring if the tube has been removed from the pump cover.*

5. Assembly of the pump and reinstallation of the oil pan are the reverse of removal. Clean the oil pan sealing surfaces thoroughly. Where applicable, install a new pan gasket. Add engine oil, as described in **0 Maintenance Program.** Tightening torques as follows.




1. **Drive shaft**
2. **Oil pump housing**
3. **Bolts**
   - tighten to 25 Nm (18 ft-lb)
4. **Oil pump gears**
5. **Oil pump cover**
   - clean screen/strainer before installing
6. **Bolt**
   - always replace
   - install using VW "D6" locking fluid
   - tighten to 10 Nm (89 in-lb)
7. **Oil pressure pipe**
   - coat flanges with sealer (VW AMV 188 001 02) during installation)
8. **Bolt**
   - tighten to 10 Nm (89 in-lb)
9. **O-ring**
   - replace if damaged

N17-0006

**Fig. 5.** Exploded view of oil pump on VR6 engine.

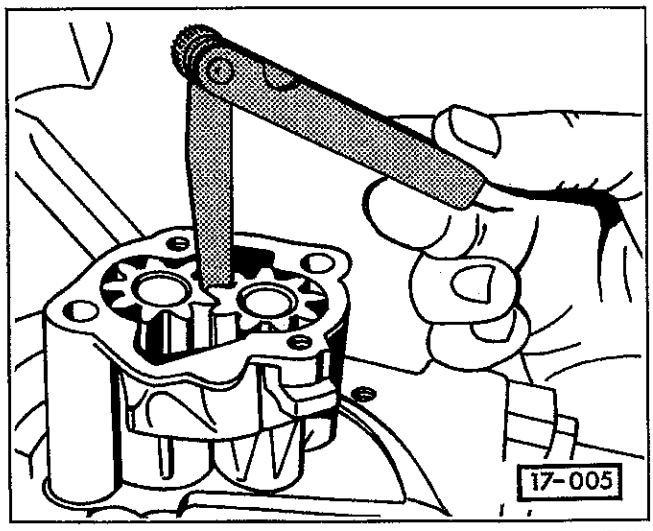



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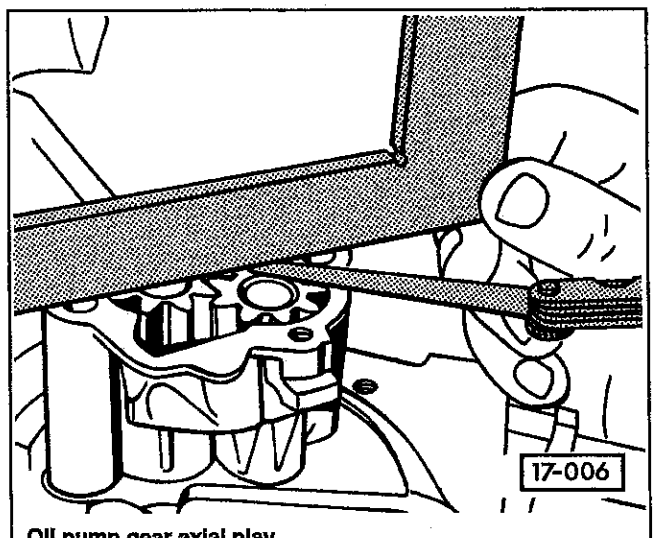
**Fig. 6.** Oil pump gear backlash being measured using feeler gauge. Maximum allowable wear limit: 0.20 mm (0.0079 in.)




**Oil pump gear axial play**
- 4-cylinder: wear limit (max. allowable): 0.15 mm (0.0059 in.)
- 6 cylinder: wear limit (max. allowable): 0.10 mm (0.0039 in.)

17-006

**Fig. 7.** Oil pump gear axial play being measured using straight edge and feeler gauge.

**Tightening torques**

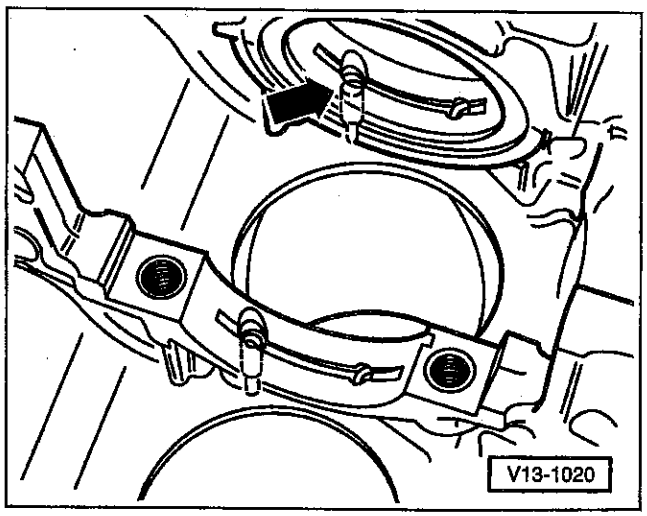
- Oil pan drain plug to oil pan ..... 30 Nm (22 ft-lb)
- Oil pump cover to oil pump ..... 10 Nm (89 in-lb)
- Oil pump to cylinder block
  - 4-cylinder ..... 20 Nm (15 ft-lb)
  - 6-cylinder ..... 25 Nm (18 ft-lb)
- Oil pump pickup tube to oil pump cover (4-cylinder) ..... 10 Nm (89 in-lb)
- Oil pump pressure pipe to oil pump housing (VR6) use "D6" locking fluid on **new** bolts, coat pipe flanges with VW AMV 188 001 02 sealer) ..... 10 Nm (89 in-lb)
- Oil pan to engine block (M6)
  - gasoline engines
  - 4-cylinder ..... 20 Nm (15 ft-lb)
  - 6-cylinder ..... 15 Nm (11 ft-lb)
  - diesel engines ..... 25 Nm (18 ft-lb)

## OIL SPRAY NOZZLES

AAZ (1.9 liter diesel), AHU (1.9 liter diesel), AAA (2.8 liter VR6) and some versions of the ABA (2.0 liter gasoline) engines are equipped with oil spray nozzles. The oil spray nozzles spray oil from the main oil galley against the bottoms of the pistons for added cooling.

On 4-cylinder engines, the oil spray nozzles are bolted to the bottom of the cylinder block. The oil pan must be removed to gain access to the oil spray nozzles. See **13 Engine–Crankshaft/Cylinder Block.**

On 6-cylinder engines, the oil spray nozzles are fitted above the crankshaft main bearing shells in the cylinder block. See Fig. 8. To access the oil spray nozzles on the VR6 engines, the engine and crankshaft must first be removed.




V13-1020

**Fig. 8.** Oil spray nozzles for each piston are fitted above main bearing caps (**arrow**) on VR6 engine.

***NOTE—***

- *The oil spray nozzles should be replaced if metal particles or metal shavings are found in the engine oil. The nozzles cannot be cleaned.*
- *On diesel engines, the oil spray nozzles should be installed with Volkswagen sealer no. AMV 188 100 02, or equivalent.*
- *Part numbers are subject to change. Always rely on an authorized Volkswagen dealer parts department for the latest information.*

**Tightening torques**

- ABA engine
  - Oil spray nozzle pressure relief valve to cylinder block ..... 25 Nm (18 ft-lb)
- AAZ engine
  - Oil spray nozzle mounting bolt to cylinder block (use VW sealer no. AMV 188 100 02) ..... 10 Nm (89 in-lb)

## OIL COOLER

The oil cooler is an oil-to-coolant heat exchanger. Engine oil flows through one part of the cooler and gives up heat to the engine coolant flowing through the other part of the cooler.

During warm-up, the process is reversed and engine coolant gets warm first. This speeds the warm-up process and gets the engine to operating temperature more quickly. See Fig.1 or Fig. 2 given earlier for cooler location.

***CAUTION—***

- *The oil cooler should be replaced if metal particles or metal shavings are found in the engine oil. The cooler cannot be cleaned.*
- *The oil cooler is a potential source of leakage between the lubrication system and the cooling system, and should be considered whenever such leakage is suspected.*

Remove the oil cooler only if it needs to inspected, or replaced. On installation, use sealing paste, Volkswagen sealer no. AMV 188 100 02 on the sealing surfaces and check to see that there is adequate space for the coolant hose connections. Tighten the cooler mounting bolt to the torque specified.

**Tightening torque**

- Oil cooler to oil filter housing or cylinder block ..... 25 Nm (18 ft-lb)

# 19 Engine–Cooling System



19

## GENERAL

This section covers repairs and troubleshooting information for the engine cooling system only. For heater core and related heating and air conditioning components, see **80 Heating and Ventilation.** For information on the engine oil cooler, see **17 Engine–Lubrication System.** For information on the ATF cooler used on models with automatic transmission, see **37 Automatic Transmission.**

Fig. 1 shows a schematic view of the cooling system and hose routing.

### Warnings and Cautions

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

***WARNING —***

- *Hot coolant can scald and result in serious personal injury. Do not work on the cooling system until it has fully cooled.*
- *At normal operating temperature the cooling system is pressurized. Allow the system to cool as long as possible before opening—a minimum of an hour—then release the cap very slowly to allow safe release of pressure.*

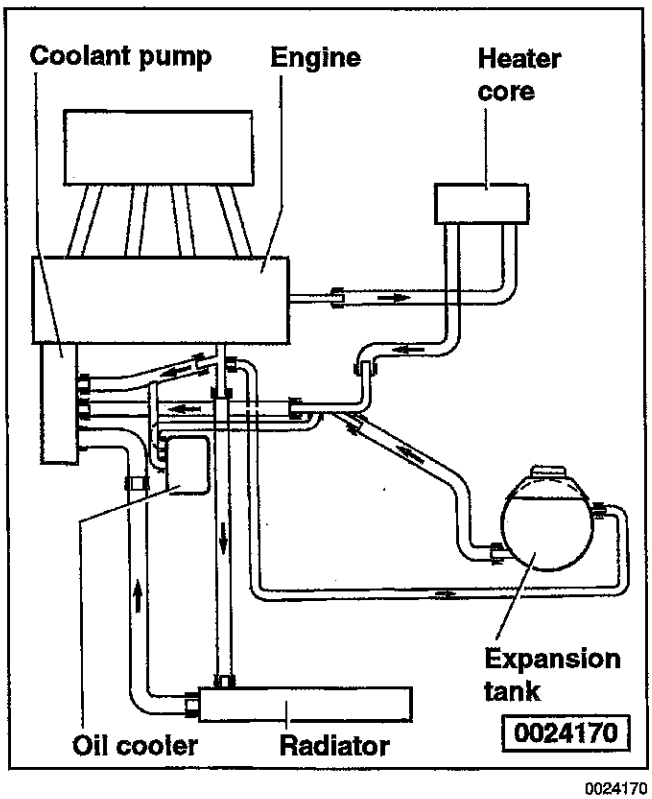



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**Fig. 1.** Schematic view of typical cooling system components and hose routing for 4-cylinder engine. Arrows indicate coolant flow.

***WARNING —***

- *Releasing the cooling system pressure lowers the coolant's boiling point, and the coolant may boil suddenly. Use heavy gloves and wear eye and face protection to guard against scalding.*
- *Use extreme care when working at or near the cooling fan when the engine is hot. The fan can come on at any time–even if the ignition key is off.*
- *Use extreme care when draining and disposing of engine coolant. Coolant is poisonous and lethal. Children and pets are attracted to coolant because of its sweet smell and taste. See a doctor or veterinarian immediately if any amount of coolant is ingested.*

***CAUTION —***

*Avoid adding cold water to the coolant while the engine is hot or overheated. If it is necessary to add coolant to a hot system, do so only with the engine running and coolant pump turning.*

## Coolant, Pump and Thermostat

Volkswagen uses two different types of coolant that are identified by color. The older, blue/green version is known as G11 and the newer red version is G12. Both types have specific characteristics and should not be mixed. **See 0 Maintenance Program** for additional information and cautions.

For best overall performance, the coolant additive proportion must be at least 40%, but not more than 60% to maintain the antifreeze protection and cooling efficiency. Distilled water should always be used. Under no circumstances should 100% coolant/antifreeze be used. This will generally result in overheating and poor heater operation due to the poor heat transfer characteristics of pure coolant/antifreeze. For accurate testing of antifreeze coolant protection, a refractometer such as VW tool CEN5021 should be used, see **Anti-freeze concentration, checking**. A 50/50 mixture will show freeze protection to -34°F (-37°C).

An impeller-type coolant pump is mounted to the cylinder block. The pump is crankshaft-driven by the engine drive belt and circulates coolant through the system whenever the engine is running.

On the VR6 engine, an additional electric coolant pump circulates coolant whenever the ignition key is on. The auxiliary pump also functions as part of the radiator cooling fan after-run system and runs automatically anytime the coolant temperature exceeds 220°F (107°C). See **Cooling Fan and After Run System** given later for more information.

The thermostat controls coolant flow through the radiator. When the engine is cold, the thermostat restricts flow through the radiator to allow the engine to reach operating temperature quicker. As the engine heats up, the thermostat opens and coolant circulates through the whole system, including the radiator.

## Radiator and Cooling Fan

A radiator cooling fan assembly provides auxiliary air flow through the radiator. The fan assembly is electrically operated and thermostatically controlled so that it runs only when extra air flow is required to maintain proper coolant temperature.

The radiator is a cross-flow type constructed of an aluminum core and plastic side tanks. A translucent expansion tank, or overflow reservoir, provides for the expansion of the coolant at higher temperatures and easy monitoring of the coolant level.

An electric radiator cooling fan assembly is controlled by a thermoswitch located in the side of the radiator. At high coolant temperatures, the switch closes to start the cooling fans. Any time the coolant temperature is excessive, the fan will start and continue to run until coolant the temperature is in the correct range. On cars with air conditioning, high refrigerant pressure can also activate the cooling fan.

***WARNING —***

*The electric cooling fan can come on at any time, even if the key is out of the ignition. To avoid personal injury use extreme caution when working at or near the cooling fan if the engine is hot. As a safety precaution, always disconnect the harness connector from the fan when working in the engine compartment.*

On some models, a radiator cooling fan after-run system, operated by a control unit, runs the cooling fan (and on VR6 engines, an auxiliary coolant pump) after the engine is shut off. This helps to eliminate high under hood temperatures.

## TROUBLESHOOTING

When investigating the cause of overheating or coolant loss, begin with a visual inspection of the system. Check the coolant level and for evidence of coolant leaks.

The system becomes pressurized at normal operating temperatures. 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.

If the cooling system holds pressure, the most probable causes of overheating are an electrical fault with the cooling fan, a faulty thermostat, or poor coolant circulation caused by a worn drive belt or clogged system.

**Table a** lists overheating and underheating symptoms, their probable causes, and suggested corrective actions. The bold type refers to areas outside of this repair group for suggested repairs.

**Table a. Cooling System Troubleshooting**

| Symptom | Probable cause | Corrective Action |
|---|---|---|
| 1. Engine overheats | a. Low coolant level | a. Fill the radiator to the **Max.** mark on a cold engine. Check cooling system for leaks with pressure tester. |
| | b. Radiator hose restricted (lower hose may collapse only at highway speeds) | b. Check hoses for soft, spongy areas. Replace faulty hoses. |
| | c. Drive belt worn and slipping | c. Replace drive belt. See **0 Maintenance Program.** |
| | d. Faulty thermostat | d. Remove and test thermostat. Replace as necessary. |
| | e. Radiator fan not switching on | e. Test thermoswitch and fan. Replace faulty parts. |
| | f. Faulty radiator cap | f. Test pressure relief valve in cap. Replace faulty caps. |
| | g. Clogged radiator | g. Clean or replace radiator. |
| | h. Incorrect ignition timing or valve timing | h. Check camshaft drivebelt/chain installation, See **1 ENGINE.** Adjust ignition timing (if applicable). See **28 Ignition System.** |
| | i. Coolant pump faulty | i. Replace coolant pump. |
| | j. Poor air flow through radiator | j. Check for debris buildup on front of radiator. Clean radiator exterior using compressed air. |
| | k. Incorrect coolant concentration | k. Adjust coolant concentration to a mix of 50% coolant additive and 50% distilled water. |
| 2. Temperature gauge reads low, poor heater output | a. Faulty thermostat | a. Remove and test thermostat. |
| | b. Electric fan not switching off | b. Replace thermoswitch for fan. |
| | c. Incorrect coolant concentration | c. Adjust coolant concentration to a mix of 50% coolant additive and 50% distilled water. |
| 3. Temperature gauge reads low, heater output normal | a. Faulty temperature gauge or coolant temperature sensor | a. Test temperature gauge and sensor. Replace instrument cluster if temperature gauge is faulty. See **90 Instruments.** |
| | b. Coolant old, causing inaccurate gauge readings | b. Replace coolant. |
| 4. Temperature gauge reads normal, inadequate heater output | a. Installed position of heater hoses reversed | a. Install heater hoses. **80 Heating and Ventilation.** |
| | b. Heater hose restricted | b. Replace hose. |
| | c. Heat exchanger (heater core) clogged | c. Replace heater core or have core cleaned. See **80 Heating and Ventilation.** |
| | d. Heater or A/C ventilation controls/flaps not operating correctly | d. Check controls and vent operation. See **80 Heating and Ventilation.** |

***NOTE—***

- *Coolant also circulates through the heater core in the passenger compartment. For problems associated with the heater core and the heating system, see* **80 Heating and Ventilation**.
- *Overheating problems may also be caused by an engine fault that leaks hot combustion gasses into the cooling system, or by ignition timing that is out of specification. See* **1 Engine or 28 Ignition System** *for additional information on these subjects.*

## Diagnostic Checks

## To pressure test cooling system

A pressure test uses a special tester to pressurize the system and simulate normal running conditions. If the system is unable to hold pressure, the engine will overheat more easily.

***NOTE—***

*A pressure test also checks for internal leaks. Some of the common sources of internal leaks are a faulty cylinder head gasket, a cracked cylinder head, or a cracked cylinder block.*

1. With the engine at normal operating temperature, pressurize the system using a cooling system pressure tester.
2. Observe the gauge reading. If the pressure drops, there is a leak in the system. A rapid drop may indicate a faulty cylinder head gasket if no external leaks can be found.

***CAUTION—***

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

**Cooling system test pressures**

- system test pressure (max.) . . . . . 1.25 bar (18 psi)
- cap opening pressure. . . . . 1.3–1.6 bar (19–22 psi)

3. Using the correct tester adapter, test the coolant expansion tank cap opening pressure. Compare the opening pressure to the specification listed above.

## To check temperature gauge circuit

The checks given below should be made at the coolant temperature sensor and its harness connector. Sensor location varies depending on the engine code. See Fig. 2.

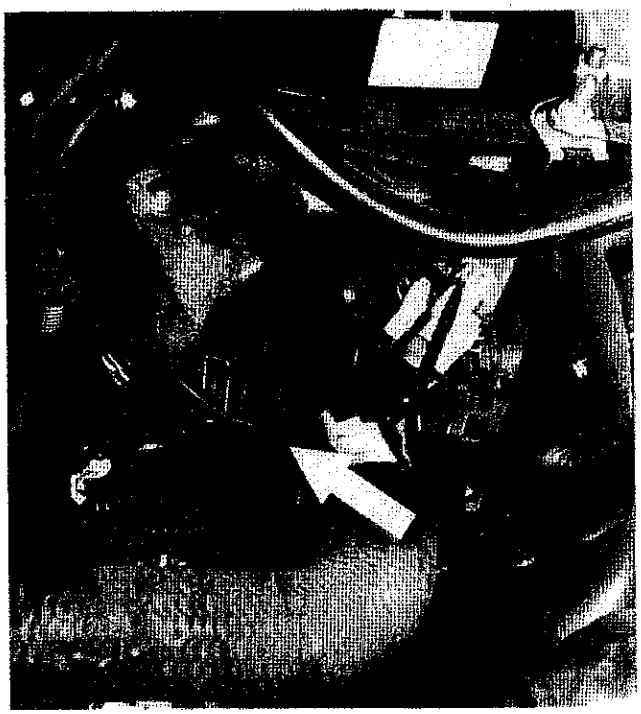

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**Fig. 2.** Engine coolant temperature sensor (4-pin) on rear of cylinder head of ABA (2.0 liter) engine. Other engines are similar.

1. Disconnect the harness connector from the engine coolant temperature sensor.

**Component Location**

Engine coolant temperature sensor and temperature gauge sensor (4-pin connector)

- AAZ, ACC, AHU engines. . . . . side of cylinder head, in coolant outlet
- ABA engine. . . . . rear of cylinder head, in coolant outlet
- AAA engine. . . . . rear of cylinder head, in thermostat housing

2. Check for ground in the harness connector. On 4-cylinder engines, check between terminal 2 and ground. On the 6-cylinder engine, check between terminal 4 and ground. If ground is not present, check for wiring faults using the appropriate wiring diagram.

3. Turn the ignition on and check for voltage in the harness connector. On 4-cylinder engines, check between terminal 4 and ground. On the 6-cylinder engine, check between terminal 2 and ground. If voltage is not present, check for wiring faults using the appropriate wiring diagram. If approximately 5 volts is not present, check the wiring from the instrument cluster.

***NOTE—***

- *Wiring diagrams are given in* **97 Wiring Diagrams, Fuses, and Relays.** *The engine coolant temperature sensor is labeled "G2" on the diagrams.*
- *On ACC and ABA engines, the coolant temperature sensor (G2) for the gauge and the coolant temperature sensor (G62) for the Motronic engine management system are combined in the same housing. Disconnecting the harness connector with the engine running may set a fault code in the On-board Diagnostic (OBD) System. See* **24a Fuel Injection–Motronic** *for OBD fault code information.*

4. Connect an ohmmeter across sensor terminals 2 and 4 in the sensor on a cold engine. Note the resistance.

5. Start the engine and allow it to warm up while observing the ohmmeter. The resistance should decrease steadily as the engine warms up. If any faults are found replace the coolant temperature sensor.

***WARNING—***

*The electric cooling fan can come on at any time, even if the key is out of the ignition. To avoid personal injury use extreme caution when working at or near the cooling fan if the engine is hot. As a safety precaution, always disconnect the harness connector from the fan when working in the engine compartment.*

***NOTE—***

- *Checking the gauge itself is somewhat more difficult owing to the electronic instrument cluster assembly. The signal from the sensor is processed by the instrument cluster electronic circuit. If no faults are found with the sensor and the wiring to the instrument panel is not faulty, the gauge itself may be faulty.*
- *Individual instruments are not available from Volkswagen. If the coolant temperature gauge is found to be faulty, the complete cluster will need to be replaced.*

To replace a faulty coolant temperature sensor, drain the cooling system down below the level of the sensor. Remove the retaining clip and pull the sensor from the coolant outlet.

## To test cooling fan and radiator thermoswitch

Volkswagen cooling systems use 2 speed electric fans on most 4 cylinder engines and 3 speed fans on the VR-6 and both diesel engine versions. All vehicles use a thermo-switch located in the lower section of the radiator to control fan speeds II and I. Additionally, vehicles with air-conditioning use a coolant fan control module to link the air-conditioning system to the coolant fans and provide speed III where appropriate.

The cooling system will overheat if the electric cooling fans are not operating correctly. The fans should switch on and off according to engine coolant temperature or whenever the A/C is on. The electric cooling fan operates when the temperature is high enough to close the radiator thermoswitch or, on cars so equipped, the after-run thermoswitch.

> ***WARNING —***
> *The electric cooling fan can come on at any time, even if the key is out of the ignition. To avoid personal injury use extreme caution when working at or near the cooling fan if the engine is hot. As a safety precaution, always disconnect the harness connector from the fan when working in the engine compartment.*

1. Check the fuse (30 amp) in position 19 and replace it if it is blown.

2. Disconnect the harness connector from the fan's thermoswitch on the left side of the radiator.

3. Using a fused jumper wire, short together the harness connector terminals listed in the appropriate wiring diagram. Check that the fan motor runs at the specified speeds.

   ***NOTE —***
   - *The coolant fan thermo-switch is identified in Volkswagen wiring diagrams as component F18. Most of the wiring diagrams identify which contacts control which speed by printing the numeral I for first speed and the numeral II for the second speed within the F18 symbol. Generally, jumping the red and red/white wires will activate speed I and jumping the red and red/yellow or red and red/black will activate speed II. There can be exceptions for certain vehicles, see* **97 Wiring Diagrams, Fuses and Relays.**
   - *On 1996 4-cylinder vehicles without A/C both the high and low speed fans have a red/black wire. See* **97 Wiring Diagrams, Fuses and Relays.**

4. If the fan does not run, check for battery voltage at terminal no. 3 (red wire) in the thermoswitch connector. Disconnect the harness connector from the fan and check for continuity to ground at the brown wire in the connector. If any faults are found, check the wiring as shown in **97 Wiring Diagrams, Fuses, and Relays.**

5. If voltage and ground are present as specified above and no wiring faults can be found, the fan motor is probably faulty and should be replaced.

   ***NOTE —***
   *On VR-6 and diesel engines, fan speed III is a function of air conditioner operation and is controlled via the coolant fan control module. See* **97 Wiring Diagrams, Fuses, and Relays** *for the coolant fan wiring schematic for these vehicles.*

6. If the fan runs only when powered directly by the jumpered connector, the radiator thermoswitch may be faulty. Switch opening and closing specifications are given below for more accurate testing of the switch. Drain the coolant before replacing a faulty switch.

**Tightening torque**

- Thermoswitch to radiator ..... 35 Nm (26 ft-lb)

**Thermoswitch operating temperatures**

- Stage 1 (low speed)
  - on .....197–206°F (92–97°C)
  - off .....183–195°F (84–91°C)
- Stage II (high speed)
  - on .....210–221°F (99–105°C)
  - off .....195–208°F (91–98°C)

## Thermostat Quick-Check

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.

To quickly check if the thermostat is opening and if coolant is circulating through the radiator, allow a cold engine to reach operating temperature (temperature gauge needle approximately centered). Feel the radiator hoses. If the hoses are hot to the touch, the coolant is circulating. If the hoses are not hot, coolant flow to the radiator is probably restricted. Check for a faulty thermostat or a plugged radiator.

## Anti-freeze concentration, checking

1. Using a refractometer (VW tool CEN5021), take a small amount of coolant and place it onto the measuring prism. See Fig. 3.

2. Close the cover and hold the tester up to a light source.

3. Look into the eyepiece and read the scale for ethylene glycol. The measuring point is where the black and white come together.

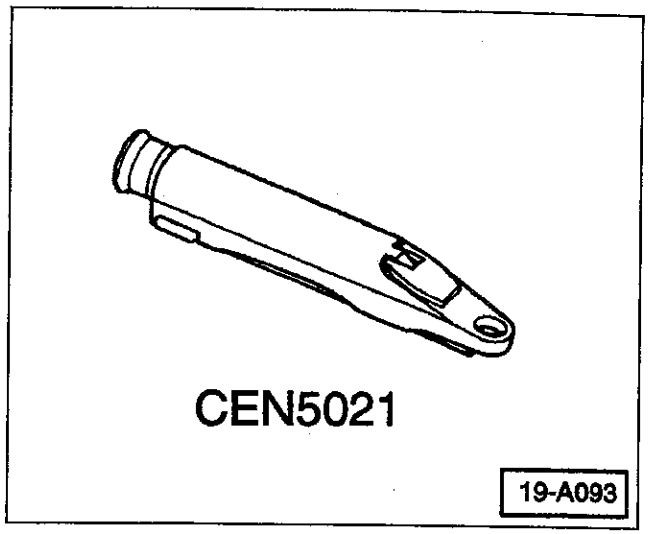


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**Fig. 3.** Anti-freeze tester, VW special tool CEN5021.

4. Rinse the tester clean.

5. Periodically check calibration by placing distilled water onto the prism and closing the cover. The measure point should be at 32°F (0°C) which is the freezing point for pure water. If reading is not obtained, follow instructions that came with the tester for adjustment.

## DRAINING AND FILLING COOLING SYSTEM

Always use genuine VW coolant and distilled water to avoid the formation of harmful deposits in the cooling system. Use of anti-freeze with phosphate solutions or tap water can be harmful to the cooling system.

Do not reuse the coolant when replacing damaged engine parts. If coolant comes in contact with paint or bodywork, immediately rinse the area with water.

### To drain and fill cooling system (4-cylinder engines)

Be sure to have a new coolant pump connector pipe O-ring on hand before draining the coolant.

1. With the engine fully cold, remove the expansion tank cap. Set the temperature control knob in the passenger compartment to full warm.

2. Place a drain pan beneath the coolant pump.

3. Working at the coolant pump, remove the retaining clip from the connector pipe. Pull the connector pipe from the pump housing and disconnect the lower hose from the pump. Allow the coolant to drain. See Fig. 4.

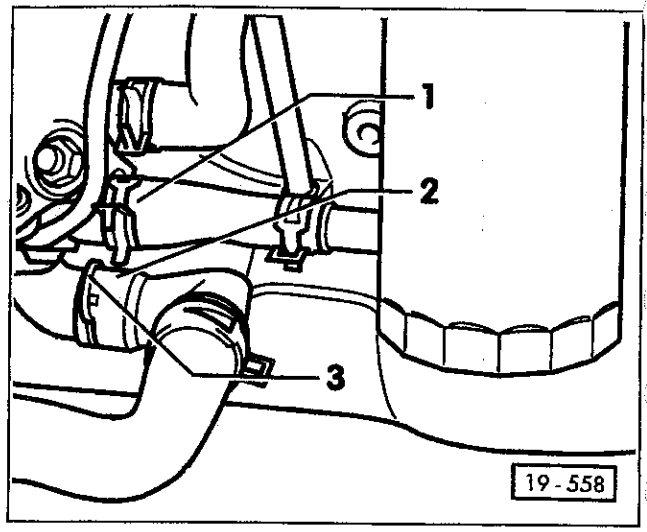


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**Fig. 4.** Drain coolant by removing retaining clip (**3**) and then connector pipe (**2**). Also disconnect hose (**1**).

4. Install the connector pipe using a new O-ring and install the pipe retaining clip. Install the lower hose to the pump.

5. Using a coolant mixture of 50% anti-freeze and 50% distilled water, fill the expansion tank slowly so that air is allowed to escape. Install the expansion tank cap.

6. Run the engine and check for leaks. Allow the radiator cooling fan to cycle on at least once.

**Cooling system capacity (draining and filling)**

- 4-cylinder engines

| | |
|---|---|
| ACC | 5.8 quarts (5.5 liters) |
| ABA | 6.1 quarts (5.8 liters) |
| AAZ, AHU | 6.8 quarts (6.5 liters) |

7. Recheck the coolant level when the engine has cooled.

***NOTE —***

*The coolant level should be at the **MAX** mark at operating temperature and between the **MIN** and **MAX** mark when cold. The final coolant level is best checked when the cooling system is fully cold.*

## To drain and fill cooling system (6-cylinder engine)

Be sure to have a new coolant pipe drain plug O-ring on hand before draining the coolant.

1. With the engine fully cold, remove the expansion tank cap. Set the temperature control knob in the passenger compartment to full warm.

2. Place a drain pan beneath the metal coolant pipe that runs between the coolant pump and the thermostat housing.

3. Remove the drain plug from the coolant pipe. See Fig. 5. Allow the coolant to drain while pressing down on the top radiator hose.

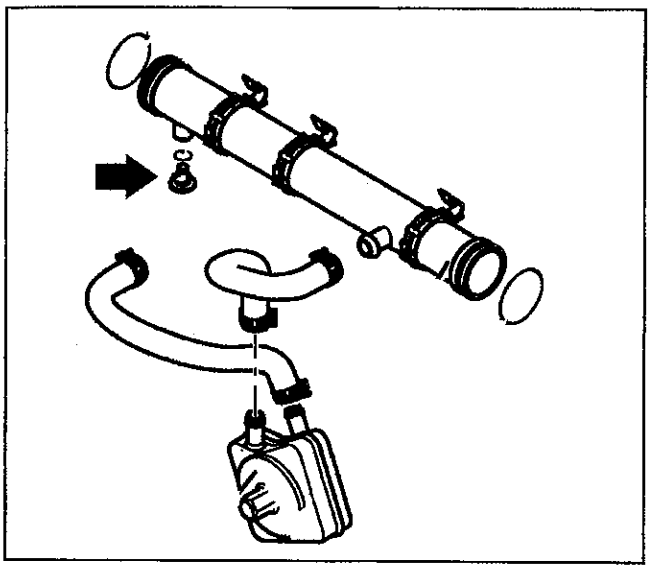

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**Fig. 5.** Coolant pipe with drain plug (**arrow**) on VR6 engine.

4. Install the drain plug.

**Tightening torque**

- Coolant drain plug to coolant pipe . . . 10 Nm (89 in-lb)

5. Using a coolant mixture of 50% anti-freeze and 50% distilled water, fill the expansion tank slowly so that air is allowed to escape. Install the expansion tank cap.

6. Run the engine and check for leaks. Allow the radiator cooling fan to cycle on at least once.

**Cooling system capacity (draining and filling)**

- 6-cylinder engine . . . . . 10.6 quarts (10.0 liters)

7. Recheck the coolant level when the engine has cooled.

***NOTE—***

*The coolant level should be at the **MAX** mark at operating temperature and between the **MIN** and **MAX** mark when cold. The final coolant level is best checked when the cooling system is fully cold.*

# COOLANT PUMP

The engine-driven coolant pump is subject to the same wear as any other rotating engine parts. Complete failure of the pump to circulate coolant is unusual, but excessive wear often results in noise or coolant leaks at the pump shaft.

## To replace coolant pump (4-cylinder engines)

Fig. 6 is an exploded view of the coolant pump used on 4-cylinder engines. Note the stretch-type studs or bolts that mount the pump to the block. These fasteners should not be reused. Be sure to have new fasteners on hand before beginning the job.

1. Disconnect the negative (–) battery cable.

***NOTE—***

*Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. Drain the cooling system as described above and remove the remaining hose(s) from the pump.

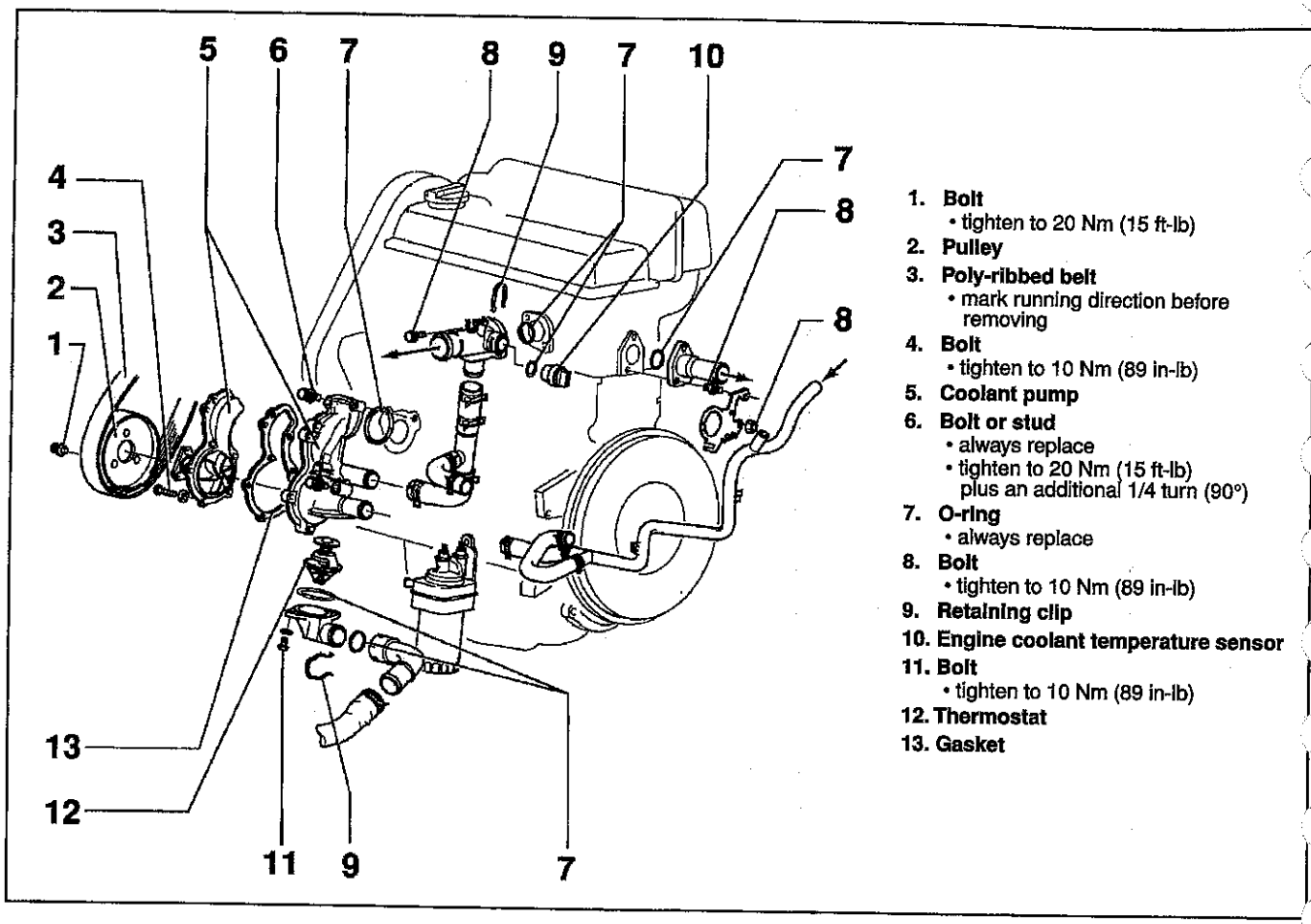
3. Mark the running direction on the poly-ribbed drive belt. Remove the V-belt and the poly-ribbed belt as described in **0 Maintenance Program**

4. Remove the alternator together with its bracket from the engine. See **27 Engine Electrical Equipment.**

5. Remove the air conditioning compressor from its bracket without disconnecting any refrigerant lines. Place the compressor safely out of the way. See **87 Air Conditioning.**

6. Remove the coolant pump from the engine block. Discard the coolant pump mounting studs or bolts.

7. Installation is the reverse of removal. Clean the pump mating surface before installing. Always use new O-rings and gaskets during installation. Fill and bleed the cooling system as described above. Start the engine and check for leaks as the final step.




1. **Bolt**
   • tighten to 20 Nm (15 ft-lb)
2. **Pulley**
3. **Poly-ribbed belt**
   • mark running direction before removing
4. **Bolt**
   • tighten to 10 Nm (89 in-lb)
5. **Coolant pump**
6. **Bolt or stud**
   • always replace
   • tighten to 20 Nm (15 ft-lb) plus an additional 1/4 turn (90°)
7. **O-ring**
   • always replace
8. **Bolt**
   • tighten to 10 Nm (89 in-lb)
9. **Retaining clip**
10. **Engine coolant temperature sensor**
11. **Bolt**
    • tighten to 10 Nm (89 in-lb)
12. **Thermostat**
13. **Gasket**

0024016

**Fig. 6.** Exploded view of coolant pump and related parts on 4-cylinder diesel engine. Other 4-cylinder engines are similar.

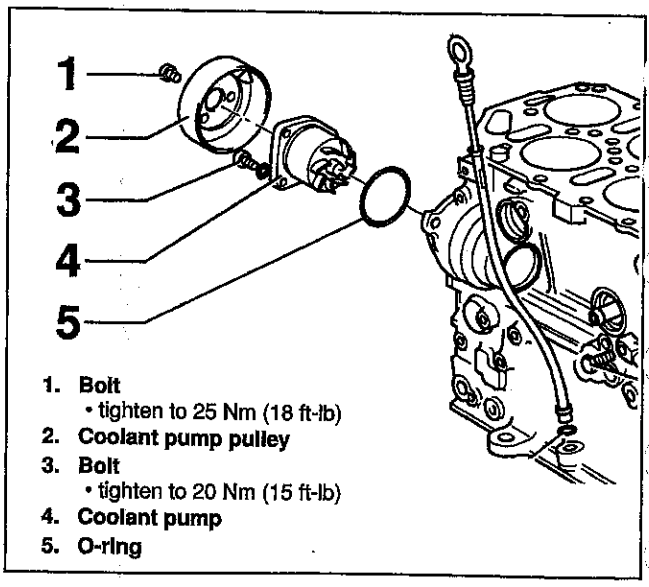
**Tightening torques (4-cylinder engines)**

- Alternator bracket to coolant pump . . . 30 Nm (22 ft-lb)
- Alternator to alternator bracket . . . . . 25 Nm (18 ft-lb)
- A/C compressor . . . . . See **87 Air Conditioning**
- Coolant pump to engine block (stretch bolt–always replace)
  stage I . . . . . 20 Nm (15 ft-lb)
  stage II . . . . . additional 1/4 turn (90°)
- Coolant pump pulley to coolant pump. . . . . 20 Nm (15 in-lb)
- Thermostat housing to coolant pump . . . . . 10 Nm (89 in-lb)

## To replace coolant pump (6-cylinder engine)

Removal of the coolant pump on the VR6 engine requires special engine lifting equipment. Review the procedure to determine what tools, equipment, and supplies will be necessary before beginning the job. Fig. 7 shows an exploded view of the coolant pump assembly.

*COOLANT PUMP*




1. **Bolt**
   • tighten to 25 Nm (18 ft-lb)
2. **Coolant pump pulley**
3. **Bolt**
   • tighten to 20 Nm (15 ft-lb)
4. **Coolant pump**
5. **O-ring**

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**Fig. 7.** Exploded view of coolant pump on 6-cylinder engine.

1. Disconnect the negative (–) battery cable.

***NOTE—***
*Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. Drain the cooling system as described above.

3. Unclip the evaporative cannister purge valve from the side of the air cleaner housing. Remove the air cleaner housing assembly together with the intake air duct and mass air flow sensor.

4. Disconnect the spark plug wires from the coil. Unclip the wires from the wire guides and place the wire assembly on top of the cylinder head. See Fig. 8.

***NOTE—***
*Depending on type of lifting equipment used, it may also be necessary to disconnect the vacuum hose from the fuel pressure regulator and remove the intake air temperature sensor to access the front engine lifting eye.*

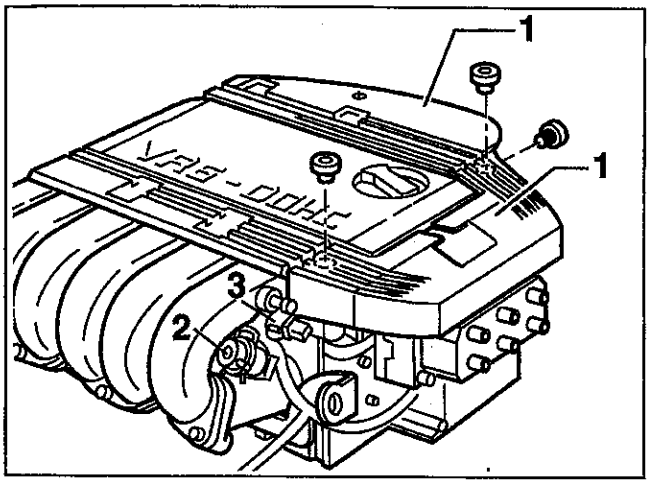


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**Fig. 8.** Spark plug wires guides (**1**), fuel pressure regulator (**2**) and intake air temperature sensor (**3**).

5. With the drive belt installed, loosen the coolant pump pulley bolts.

***NOTE—***
*If necessary, apply slight pressure to the drive belt to hold the pulley stationary as the bolts are loosened.*

6. Mark the running direction on the poly-ribbed drive belt. Release the tension on the belt using an M8X80 bolt. See Fig. 9. Remove the belt from the pulleys.

7. Disconnect the front exhaust pipe from the catalytic converter. See **26 Exhaust System/Emission Controls.**

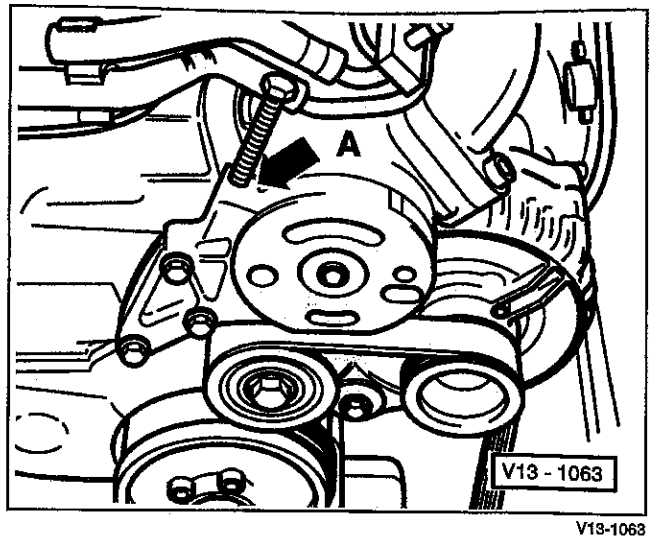


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**Fig. 9.** Thread an 8mm (M8X80) bolt (**A**) into tensioner to release belt tension.

***CAUTION—***
*Thread the M8 bolt in just until the belt can be slipped off the pulleys. Threading the bolt in too far can cause damage to the tensioner assembly.*

8. Without disconnecting the coolant hoses, unbolt the coolant reservoir from its mount and place it out of the way.

9. Install an engine lifting hoist, using the left and right lifting points on the cylinder head. Raise the hoist slightly, so that the weight of the engine/transmission assembly is supported.

10. Remove the bolts from the left and right rear engine/transmission mounts and the front engine/transmission mount. See Fig. 10.

11. Remove the coolant pump pulley from the coolant pump. Remove coolant pump mounting bolts.

12. Carefully raise the engine assembly while pushing it towards the driver's side wheel housing. Raise the engine just until the pump can be withdrawn from the block.

13. Clean the pump mating surface before installing the new pump. Always use a new O-ring during installation.

14. Install the engine on its mounts using the engine alignment procedure outlined in **10 Engine–Removing and Installing.**

15. The remainder of installation is the reverse of removal. Be sure to fill the cooling system and check for leaks as the final step.

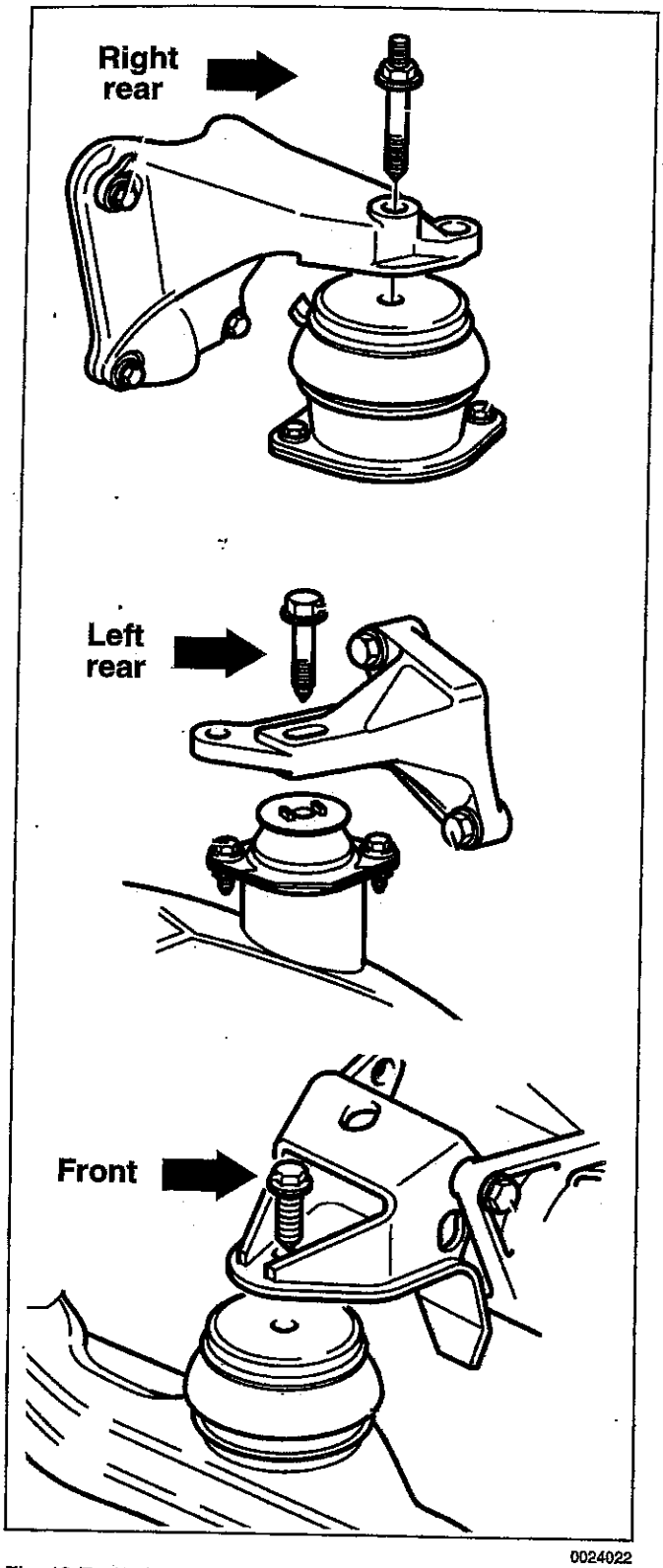


**Fig. 10.** Engine/transmission mount bolts (**arrows**) to be removed. Right rear mount is attached to engine and right side of subframe. Left rear mount is attached to transmission and left side subframe. Front mount is attached to transmission and left side crossmember.

**Tightening torques**

- Coolant drain plug to coolant pipe . . . 10 Nm (89 in-lb)
- Coolant expansion tank to body . . . . 10 Nm (89 in-lb)
- Coolant pump to engine block . . . . . .20 Nm (15 ft-lb)
- Coolant pump pulley to coolant pump . . . . . .25 Nm (18 ft-lb)
- Exhaust pipe to catalytic converter (use new fasteners)
  - M8 nuts . . . . . .25 Nm (18 ft-lb)
  - M10 nuts . . . . . .40 Nm (30 ft-lb)
- Intake air temperature sensor to intake manifold . . . . . 15 Nm (11 ft-lb)

## THERMOSTAT

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

### To replace thermostat

1. Drain the coolant as described above.
2. Remove the outlet flange mounting bolts. Remove the flange and the thermostat.

***NOTE—***

*On 4-cylinder engines, the thermostat is mounted in the bottom of the coolant pump. See Fig. 5 given earlier. On 6-cylinder engines, the thermostat is mounted in the thermostat housing on the rear of the cylinder head. See Fig. 11.*

3. Position the new thermostat and O-ring in the outlet. Install the thermostat housing.

**Tightening torque**

- thermostat flange to thermostat housing or coolant pump . . . . . .10 Nm (89 in-lb)

4. Refill the cooling system as described earlier.

1. **Thermostat housing**
2. **Bolt**
   • tighten to 10 Nm (89 in-lb)
3. **Thermostat**
4. **Outlet flange**
5. **Bolt**
   • tighten to 10 Nm (89 in-lb)
6. **O-rings**
7. **Outlet flange**
8. **Thermo-switch for A/C overheat cut-out and coolant fan speed III**
   • plug installed for non-A/C equipped vehicles
9. **Thermo-sender with switch for coolant temperature gauge and auxiliary electric coolant pump**
10. **Engine coolant temperature sensor (Motronic)**
11. **Retaining clips**

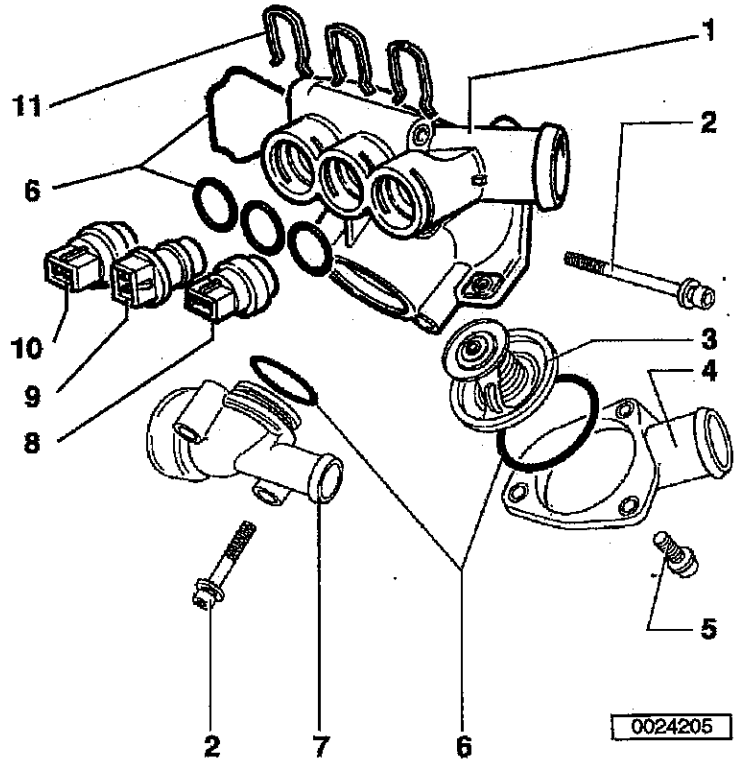


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**Fig. 11.** Thermostat housing assembly on VR6 engine.

## RADIATOR AND COOLING FANS

The cooling fan provides additional air flow through the radiator. A faulty cooling fan motor or thermoswitch may be the cause of insufficient air flow and overheating.

Most 4-cylinder models covered by this manual have a two-speed cooling fan. On 6-cylinder engines, a three speed fan is used. The third speed is used primarily for the cooling fan after-run system.

> ***WARNING —***
> *The electric cooling fan can come on at any time, even if the key is out of the ignition. To avoid personal injury use extreme caution when working at or near the cooling fan if the engine is hot. As a safety precaution, always disconnect the harness connector from the fan when working in the engine compartment.*

### To remove radiator and cooling fan assembly

1. Disconnect the negative (–) battery cable. Disconnect the harness connectors from the fan and the thermoswitch.

   ***NOTE —***
   *Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. Remove the tray from above the radiator and disconnect any A/C hose brackets and electrical harness connectors attached to the radiator and fan assembly.

3. Drain the cooling system as described above. Disconnect all coolant hoses from the radiator.

4. Disconnect the evaporative cannister purge valve from the rear of the air cleaner housing. Label and remove all the hoses from the housing. Remove the air cleaner housing retaining bands and remove housing.

5. Remove the upper radiator mounting pins. See Fig. 12.

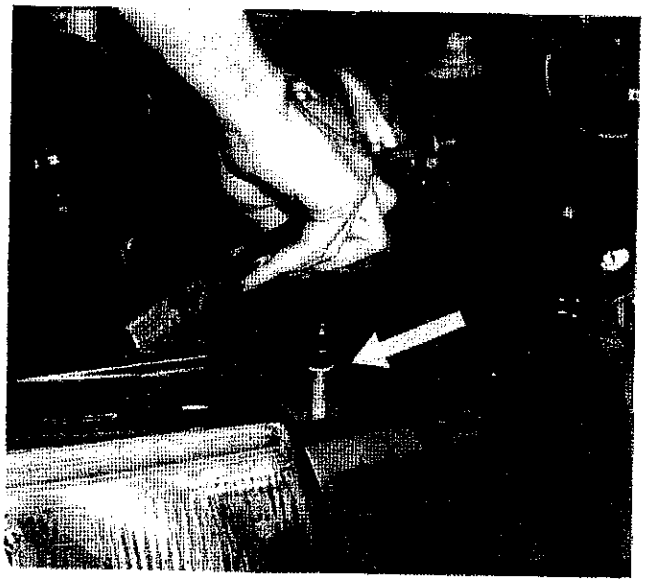

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**Fig. 12.** Right radiator pin being removed (**arrow**). Also remove left pin.

6. Remove the front body assembly (radiator support). See **50 Body–Front.**

7. Remove the radiator from the car. On cars with air conditioning, separate the A/C condenser from the radiator and carefully slide the radiator out.

Installation is the reverse of removal. Inspect the lower rubber radiator mountings and replace any that are damaged. Fill the cooling system as described above.

## Cooling Fan After-Run System

The VR6 engine uses a radiator cooling fan after-run system to moderate under hood temperatures when the engine is turned off. The system includes a thermoswitch, an auxiliary electric coolant pump, the radiator cooling fan (3rd speed), and a cooling fan control module.

High temperature closes the switch, making a ground connection to the cooling fan control module. The control module then runs the auxiliary coolant pump and the radiator cooling fan on high speed.

The after-run thermoswitch is integrated with the coolant temperature sensor in the thermostat housing. The sensor/switch has a four-pin harness connector and the body of the switch is yellow.

To quickly check the circuit, turn the ignition key on briefly and then turn it off. Remove the cover from above the thermostat housing and disconnect the harness connector from the thermoswitch switch. Jumper terminals 1 and 3 (brown/red and brown wires) in the connector. See Fig. 13. The auxiliary coolant pump should run and the radiator cooling fan should come on.

Switch opening and closing specifications are given below for more accurate testing of the switch. For additional troubleshooting of the circuit, use the wiring diagrams found in **Wiring Diagrams, Fuses, and Relays.**

**After-Run Coolant Fan Control Thermoswitch**

- on (switch closed) . . . . . .214–225 °F (101-107°C)
- off (switch open) . . . . . 201–212 °F (94-100°C)

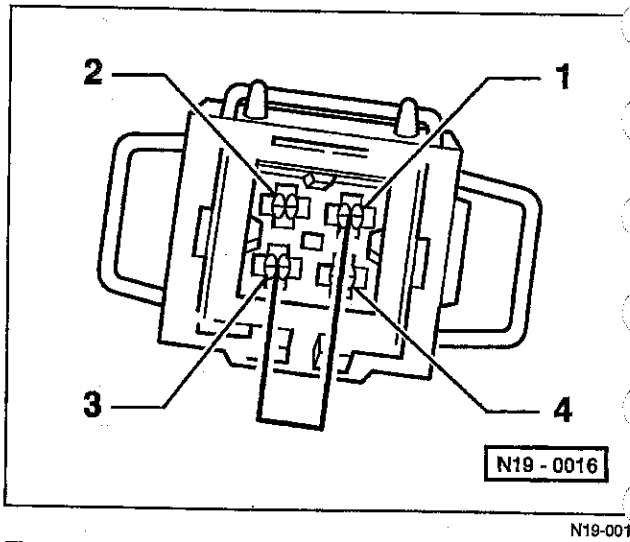


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**Fig. 13.** Terminals 1 and 3 in after-run thermoswitch harness connector shown jumpered.

# 2 Engine Management, Exhaust, and Engine Electrical Systems





## GENERAL

This general information group covers application information and system descriptions for the repair groups listed under **2 Fuel, Ignition, and Exhaust Systems.**

***NOTE—***

- *For general information on the battery, starter, alternator, see* **27 Engine Electrical.**
- *For emission control system application information, see* **26 Exhaust System/Emission Controls.**

## FUEL SUPPLY

The plastic fuel tank is mounted beneath the rear of the car. On gasoline engines, the electric fuel pump with integral fuel level sensor is mounted through the top of the tank. See Fig. 1.

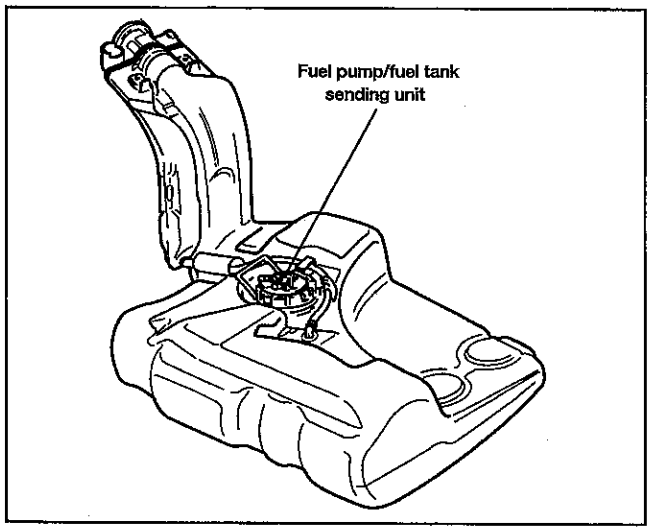


**Fig. 1.** Plastic molded fuel tank. Diesel engines are not equipped with in-tank pump.

The fuel tank is designed to prevent overfilling and allow for fuel expansion. The filler cap contains a valve to prevent vacuum from occurring in the tank.

On gasoline engines, the fuel pump assembly is submersed in the fuel tank. An inlet strainer helps prevent pump clogging. The fuel pump contains a bypass valve to prevent high pressure from damaging the system. There is a check valve at the pump outlet to hold pressure in the system after the pump is turned off. A roll-over valve is installed in the fuel filler neck to prevent fuel from escaping in the event the car rolls over in an accident.

***NOTE—***

*Diesel engines do not use a fuel tank pump. For more information on Diesel fuel injection and fuel supply, see* **23a** *or* **23b Fuel Injection–Diesel.**

## FUEL INJECTION

Three basic types of engine management systems are used on the engines covered in this manual depending on engine and model year. Below is brief description each system.

**Engine Management System Applications**

Engine Code
- ACC (1.8 liter) ..... Mono-Motronic
- ABA (2.0 liter)
  - 1993–1995 ..... Motronic M2.9
  - 1996–1999 ..... Motronic M5.9 (OBD II)
- AAA (2.8 liter)
  - 1993–1999 ..... Motronic M5.9 (OBD II)
- AAZ (1.9 liter, 1993–1997) ..... Diesel Fuel Injection
- AHU
  - (1.9 liter, 1997–1999) ... Diesel Turbo Direct Injection

## Mono-Motronic Engine Management (ACC engine)

Fig. 2 shows the Bosch Mono-Motronic engine management system used on the ACC (1.8 liter) engine. The Mono-Motronic system combines the ignition and fuel functions into one system, managed by a single **Engine Control Module (ECM)**. The system features built-in diagnostics that detect and store coded fault information.

Basic fuel metering is determined by engine speed and engine load (throttle position). The ECM receives an engine speed signal from the **Camshaft Position (CMP) Sensor** and an engine load signal throttle from the **Throttle Position (TP) Sensor**. The ECM then meters fuel to the engine by triggering a single injector at a rate proportional to engine speed and throttle position.

The amount of time the injector remains open determines the basic fuel mixture. The **Engine Coolant Temperature (ECT) Sensor**, the **Heated Oxygen Sensor (HO2S)**, and the **Intake Air Temperature (IAT) Sensor** all supply additional input signals to the ECM to further adapt and correct basic fuel metering.

Based on the input signals, the ECM controls the output signal to the following components:

- **Fuel Injector**
- **Ignition Coil**
- **Throttle Position (TP) Actuator** (for idle speed contr
- **Evaporative (EVAP) Canister Purge Regulator Val**
- **Intake manifold heater**
- **Fuel Pump**

***NOTE—***

*See **24b Fuel Injection—Mono-Motronic** for trouble-shooting and repair information.*

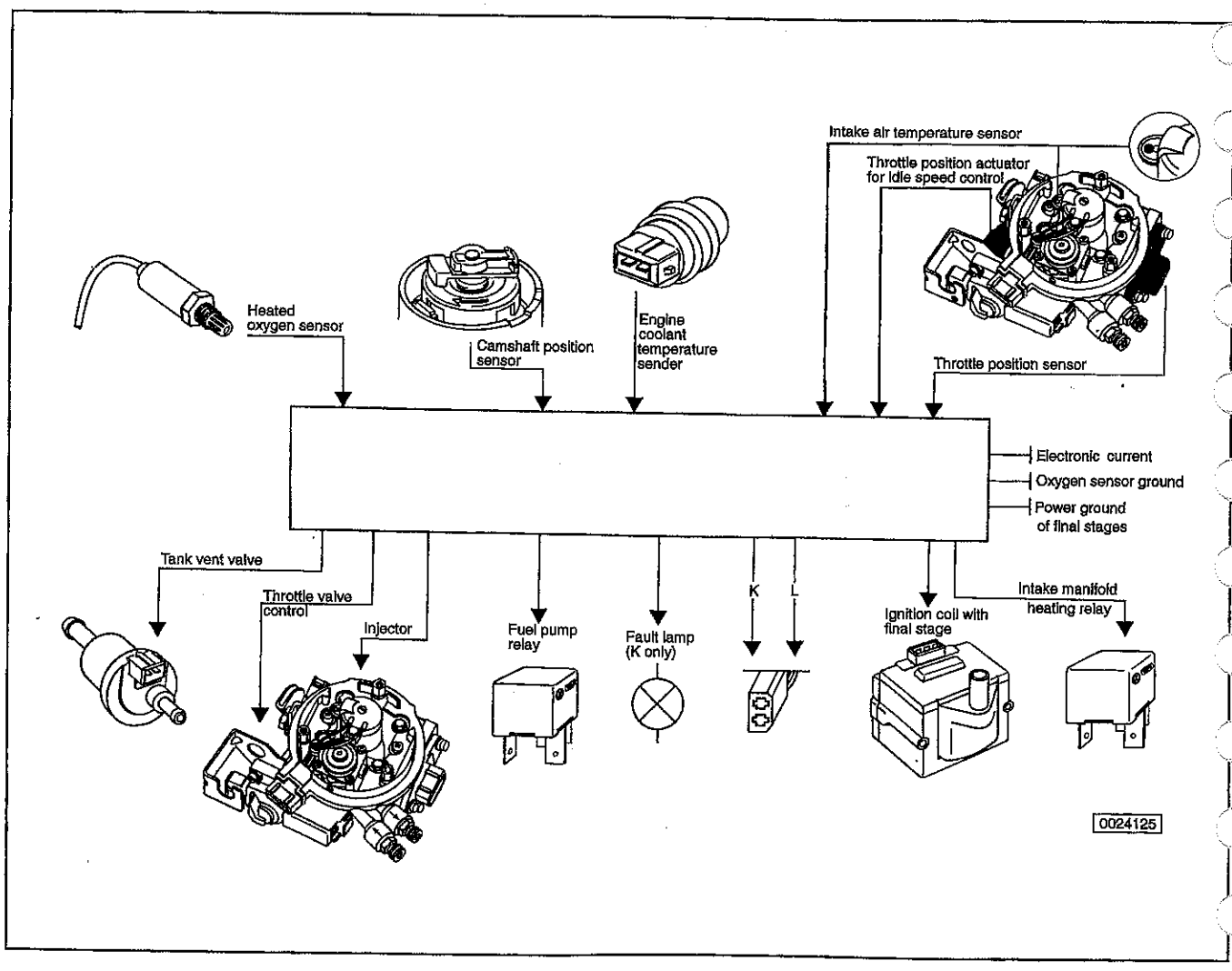


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**Fig. 2.** Mono-Motronic engine management system with ECM inputs (arrows in) and outputs (arrows out). Inputs to ECM are used to control and adapt output signals to components.

## Motronic 2.9 Engine Management (ABA, AAA engines, OBD I, 1993-1995)

The ABA (2.0 liter) and the AAA (2.8 liter) engines are equipped with a sophisticated Bosch Motronic Engine Management System. See Fig. 3. The Motronic system combines the ignition and fuel functions into one system, managed by a single **Engine Control Module (ECM)**. The system is fully adaptive and features built-in diagnostics that detect and store coded fault information. There are no basic adjustments or settings that can be made to the system.

***NOTE—***

*See **24a Fuel Injection—Motronic** for troubleshooting and repair information.*

Basic fuel metering is determined by engine speed and the mass of the air entering the engine. The ECM receives engine rpm and crankshaft position signal from the **Engine Speed (RPM) Sensor** and air mass (engine load) data from the **Mass Air Flow (MAF) Sensor**. The **ECM** then meters fuel to the engine by triggering the injectors at a rate proportional to engine speed and engine load. The amount of time the injectors remain open determines fuel quantity.

The **Camshaft Position (CMP) Sensor** identifies cylinder no. 1 firing position for cylinder-selective injection and ignition knock control. The **Engine Coolant Temperature (ECT) Sensor** supplies engine temperature information to the ECM. The **Throttle Position (TP) Sensor** signals throttle angle. The **Heated Oxygen Sensor (HO2S)** signals combustion efficiency. The **Knock Sensor** supplies engine knock information for ignition timing regulation and the **Intake Air Temperature (IAT) Sensor** is used for idle stabilization and as a correction factor for ignition timing.

Based on the input signals, the ECM precisely controls the following output components:

- **Fuel Injectors**
- **Power Output Stage and Ignition Coil**
- **Idle Air Control (IAC) Valve**
- **Evaporative Canister Purge Valve (EVAP)**
- **Exhaust Gas Recirculation Regulator Valve (EGR)**
- **Fuel Pump and Relay**
- **Heated Oxygen Sensor Relay**

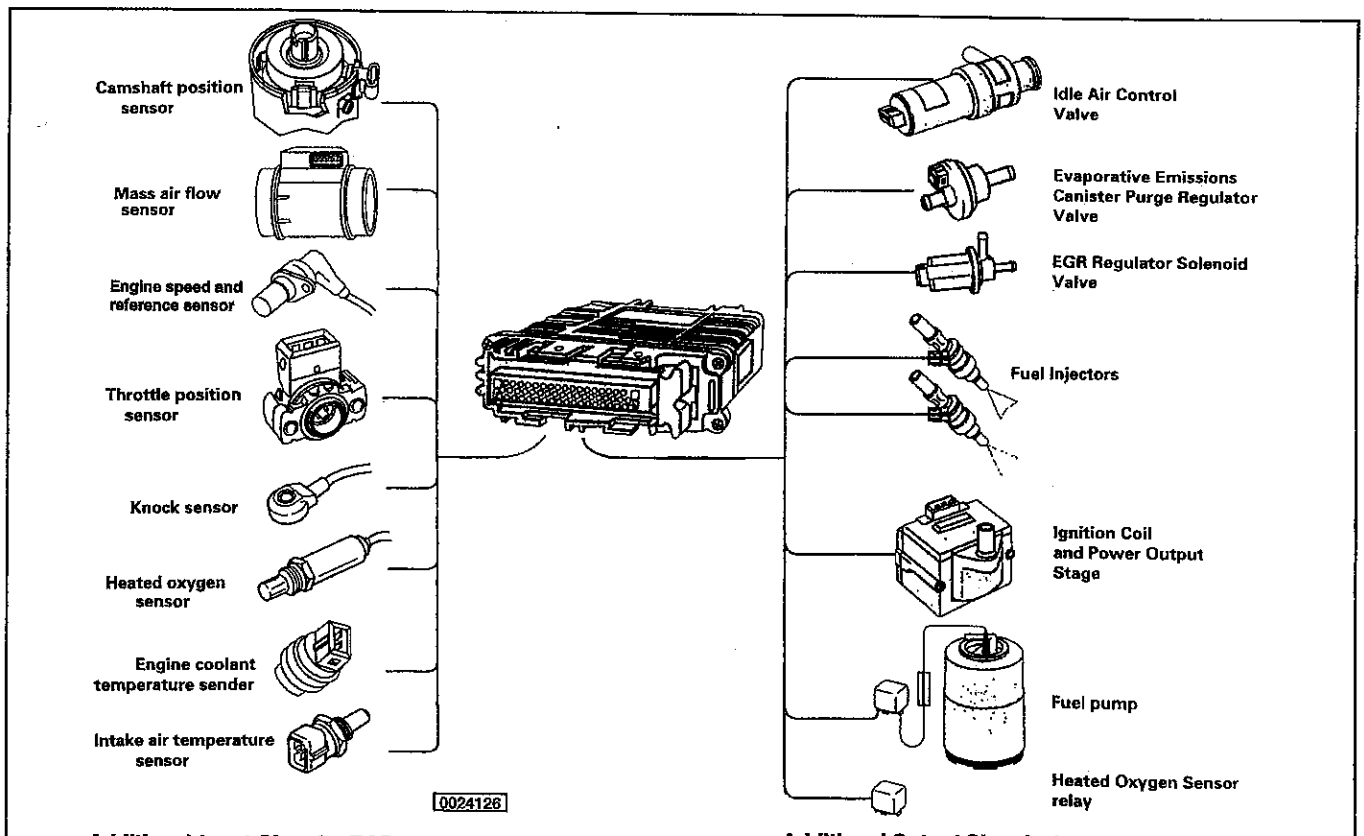


**Fig. 3.** Bosch Motronic 2.9 engine management system. Inputs (**left**) to ECM are used to control and adapt output signals (**right**) to the individual components. Components may vary in some verisons.

## Diesel Fuel Injection (AAZ engine)

The diesel injection pump with boost pressure enrichment is engine-driven by the same toothed belt that drives the camshaft. It handles virtually all fuel functions including drawing fuel from the tank and controlling the timing and the quantity of fuel injected. A timing advance mechanism changes injection timing in response to engine speed and load and during cold-start conditions. At high boost conditions, the fuel mixture is enriched slightly for increased power. See Fig. 4.

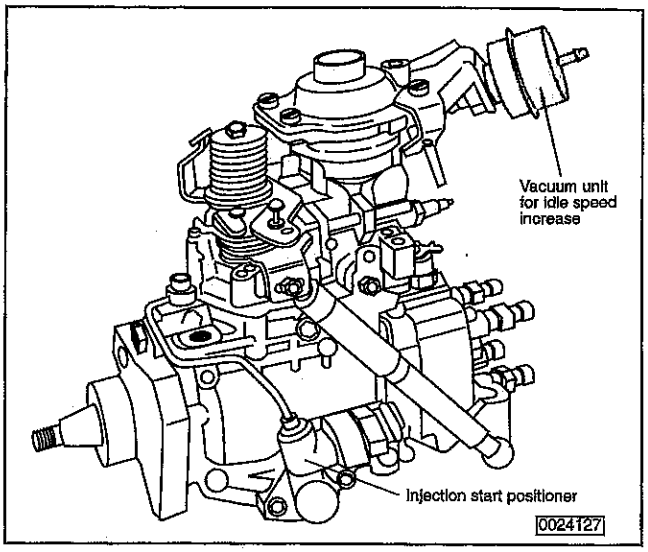


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**Fig. 4.** Diesel injection pump (engine code AAZ).

The pump meters fuel to the injectors at an operating pressure in excess of 120 bar (1706 psi) and incorporates check valves to prevent backflow of fuel from the injectors. All the internal moving parts are lubricated by the diesel fuel, so routine maintenance is not required.

A turbocharger is used on the diesel engine for increased performance. The turbocharger is an exhaust driven pump that forces air into the cylinders at higher than atmospheric pressure. This allows the engine to burn more fuel and therefore produce more power. See Fig. 5.

The turbocharger unit consists of two wheels mounted on a common rotating shaft. One of the wheels, called the turbine, is driven by the exhaust gas. The other wheel, called the impeller, is located in the intake air stream and compresses the intake air.

The turbine is equipped with a waste gate—a pressure controlled valve that automatically bleeds off any excess pressure and allows exhaust gasses to bypass the system. If the boost pressure exceeds the predetermined value, in spite of the waste gate, a pressure switch will temporarily interrupt the fuel supply to the engine.

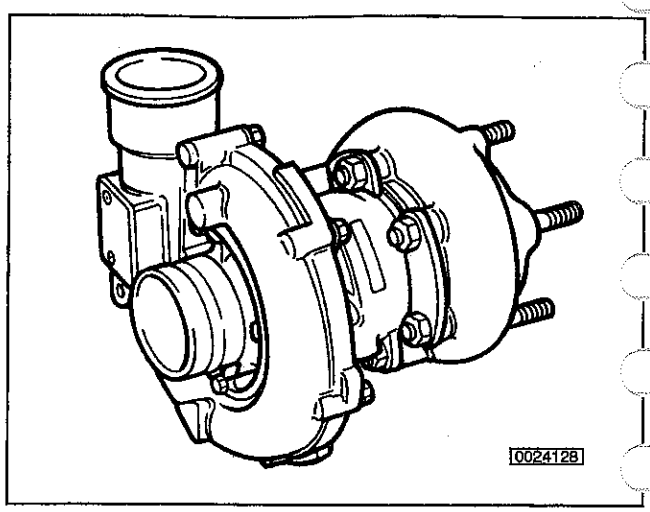


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**Fig. 5.** Turbocharger used on AAZ diesel engine.

## Motronic 5.9 Engine Management (ABA, AAA engines, OBD II, 1996-1999)

The ABA (2.0 liter) and the AAA (2.8 liter) engines fro 1996 to 1998 are equipped with an enhanced version of t sophisticated Bosch Motronic Engine Management System. See Fig. 6. This version complies with the Government man dated OBD II standards. Version 5.9 functions in much t same way as Version 2.9, but with greatly enhanced diagnostics, system monitoring and adaptability. Several compo nents have also been added, and several have be simplified.

Basic fuel metering is determined by engine speed and e gine load. The Engine Control Module (ECM) receives engi speed and crankshaft position information from the Engine Speed and Reference Sensor and engine load informatio from the Mass Air Flow Sensor (MAF). The ECM then mete fuel to the engine by sequentially triggering the Fuel Injectors at a rate proportional to engine speed and load. The length of time the injectors remain open determines fuel quantity.

The ECM uses the same information to determine the correct ignition firing point. A small output signal is generate and sent to the Power Output Stage and Ignition Coil. The Camshaft Position Sensor (CMP), identifies cylinder number 1 firing position for cylinder-selective injection and ignitio knock control. The Engine Coolant Temperature Sens (ECT) supplies engine temperature information to the ECM.

The new Throttle Actuator Control Module (TACM) cor bines four functions. Three are used on the input side: the Throttle Position Sensor (TPS) signals throttle angle, the Closed Throttle Position Switch (TP Switch) signals ful closed throttle plate, and the Throttle Position Feedback Sensor signals position of the electric motor used to stabilize idle speed.

The Pre-Catalyst Heated Oxygen Sensor (HO2S) signals combustion efficiency, and the Post-Catalyst Heated Oxygen Sensor (HO2S) monitors efficiency of the Three-Way Catalytic Converter (TWC).

The Knock Sensor(s) supply engine knock information for ignition timing regulation and the Intake Air Temperature Sensor (IAT) is used for idle stabilization and as a correction factor for ignition timing.

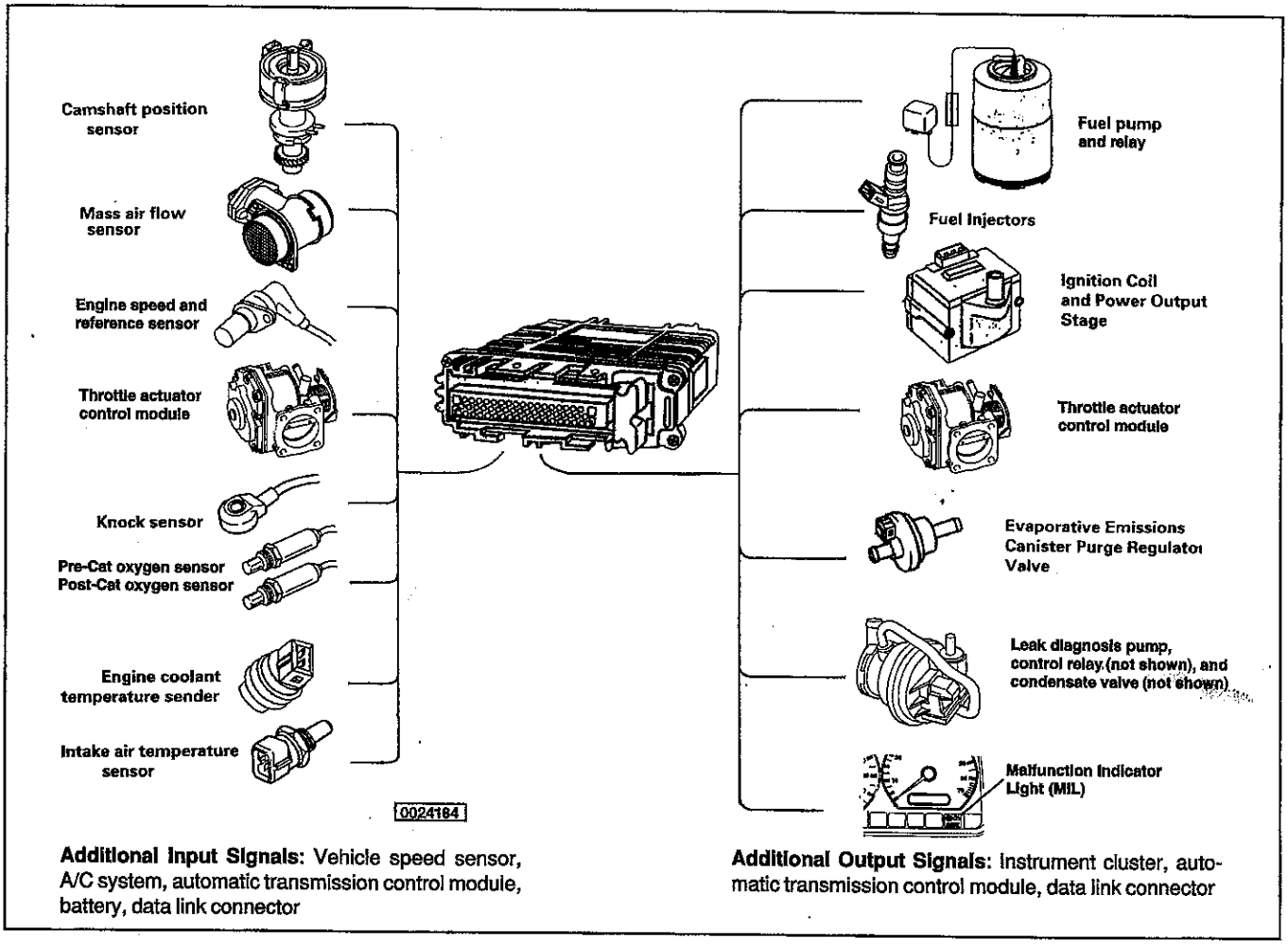
Based on all of the input signals, the ECM precisely controls the following output components:

- **Fuel Injectors**
- **Power Output Stage and Ignition Coil**
- **Throttle Position Actuator**
- **Evaporative Canister Purge Valve (EVAP)**
- **Fuel Pump and Relay**

In addition, certain versions have additional outputs controlled by the ECM:

- **Secondary Air Pump Relay (AIR), Air Injection Solenoid Control Valve, and Secondary Air Injection Pump**
- **Leak Diagnosis Pump (LDP), Control Relay, and Condensate Drain Valve**

All versions have a warning light known as a Malfunction Indicator Lamp (MIL), in the instrument cluster that signals the vehicle operator when certain systems have failed. In some versions, the light can be switched on if relatively small malfunctions have been recorded such as running very low on fuel or leaving off the gas cap. Most malfunctions that occur will cause the light to stay on steadily but certain very serious situations such as an overheating catalytic converter may cause it to blink.




**Additional Input Signals:** Vehicle speed sensor, A/C system, automatic transmission control module, battery, data link connector

**Additional Output Signals:** Instrument cluster, automatic transmission control module, data link connector

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**Fig. 6.** Bosch Motronic 5.9 engine management system. Inputs (**left**) to ECM are used to control and adapt output signals (**right**) to the individual components.

Some of the troubleshooting procedures used for the Motronic 2.9 system will also work on the 5.9 system. However because of its complex nature, proper diagnosis and repair requires the use of a specialized scan tools such as Volkswagen special tool VAG 1551 or VAG 1552.

In addition to diagnostics, Motronic 5.9 systems include the ability to record proper operation of as many as eight monitored functions. These functional checks are called Readiness Codes. Readiness Codes are set when the proper operating parameters are reached at least one time. These codes are important because some areas with emissions testing check these codes first. If the readiness code is NOT set, the vehicle will not pass the test. These codes can be erased if the battery is disconnected or runs low, if the ECM is disconnected, or if faults or DTCs are erased with a scan tool. Generally speaking, the readiness codes in Volkswagen systems will reset themselves after the vehicle has been started and driven under varying conditions several times. They can also be reset using the scan tool.

## Diesel Turbo Direct Injection – TDI (AHU engine)

The AHU (1.9 liter) engine introduced into Jetta models in 1997 is equipped with a management system that is based on the 1Z engine first installed in Passat models for model year 1996. This new Diesel Injection System is different from previous Volkswagen diesel engines and features engine controls that more closely resemble those of a gasoline engine. See Fig. 7. The TDI system combines sophisticated computer control of fuel management and emissions with system monitoring and diagnostics. An exhaust driven turbocharger with an intercooler work with a newly designed combustion chamber and cylinder head to produce more efficient combustion and lower fuel consumption. This also results in reduced engine noise and increased power.

In addition, the accelerator pedal is directly connected to the Engine Control Module (ECM) via a potentiometer. This eliminates the need for an accelerator cable and is known as "drive by wire". The ECM also controls all glow plug functions, all auxiliary coolant glow plug functions and cruise control.

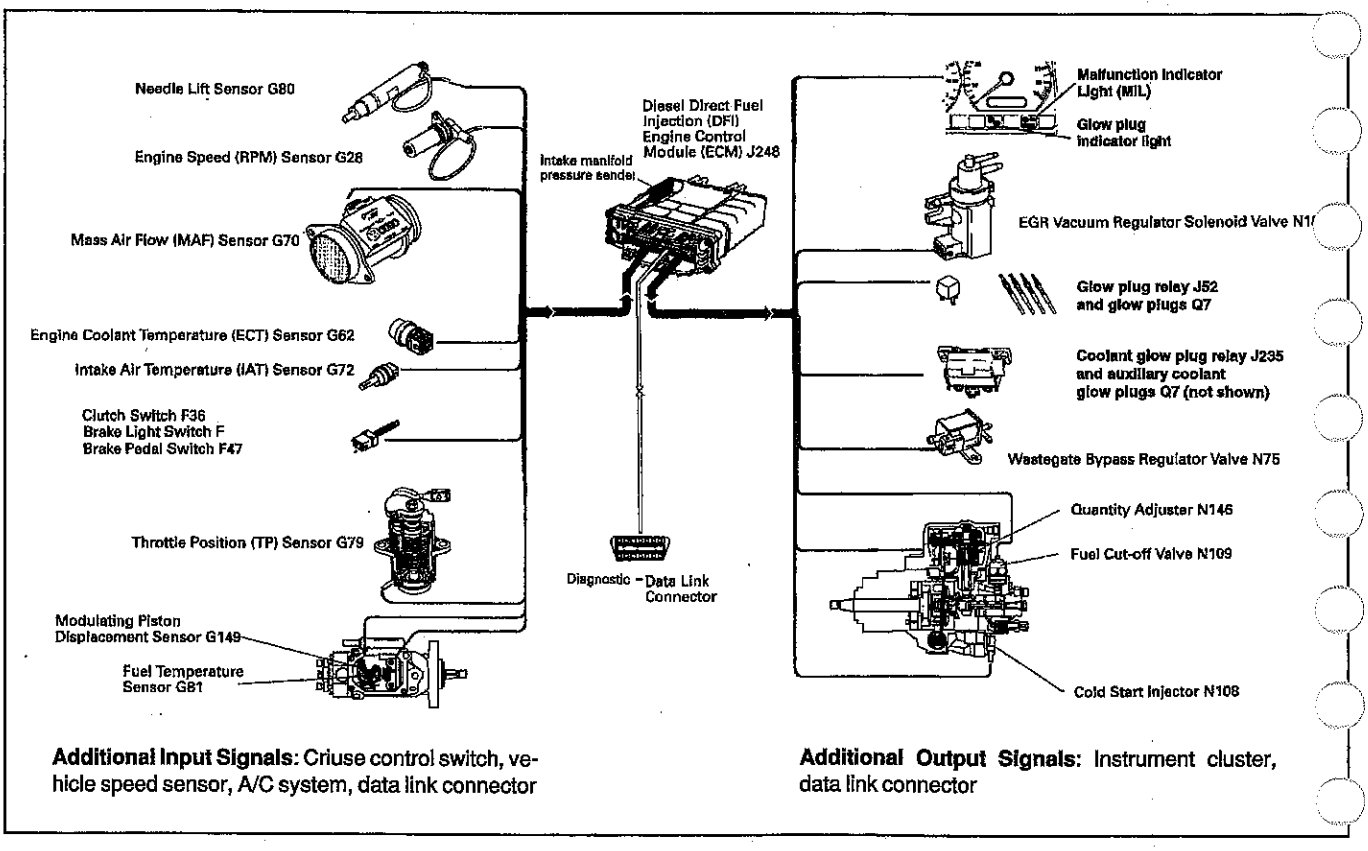


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**Fig. 7.** TDI Engine Management System as installed in 1997 through 1999 Jetta models with engine AHU. Inputs (**left**) to ECM are used to control and adapt output signals (**right**) to the individual components.

Basic fuel metering is determined by engine speed and engine load. When the key is switched on and the engine is started, the fuel cut-off valve opens and fuel flows into the injection pump. The ECM receives engine speed information from the engine speed sensor and engine load information from the Throttle Position Sensor (TPS). These signals are modified by the Engine Coolant Temperature (ECT) sensor, the Mass Air Flow (MAF) sensor, and the fuel temperature sensor. The ECM then signals the quantity adjuster which allows the proper quantity of fuel to be metered sequentially to the mechanical injectors. The ECM also uses the same information to determine the correct moment of injection which is the ignition firing point. An output signal is generated and sent to the cold start valve at the correct time.

The ECM monitors the operation of the quantity adjuster via a signal received from the modulating piston displacement sensor and makes corrections to the fuel quantity as required.

The ECM monitors the operation of the cold start valve via a signal received from the needle lift sensor attached to injector number 3 and again makes corrections as required.

Turbocharger boost pressure is regulated by the ECM based on a signal from the Intake Air Temperature Sensor (IAT), a vacuum connection to the intake manifold, and an ambient pressure signal from an internal Barometric Pressure Sensor (BARO). The wastegate bypass regulator valve receives output from the ECM and controls a vacuum signal sent to the turbocharger wastegate.

In order to prevent possible damage from simultaneous application of the brake, clutch and accelerator pedals, the brake pedal switch, brake light switch, and clutch pedal switch, all signal their respective positions to the ECM. These signals are also used by the ECM during cruise control operation.

Based on all of the input signals, the ECM precisely controls the following output components:

- **Quantity Adjuster**
- **Cold Start Injector**
- **Fuel Cut-off Valve**
- **Wastegate Bypass Regulator Valve**
- **EGR Vacuum Regulator Valve**

In addition, the ECM uses various sensors to control these additional outputs:

- **Glow Plugs**
- **Glow Plug Relay**
- **Auxiliary Heater Coolant Glow Plugs**
- **Coolant Glow Plug Relay**

Tailpipe emissions are further reduced by a two-way oxidation-type catalytic converter.

The TDI equipped cars have two warning lights in the instrument cluster to advise of system status. The glow plug indicator light operates when the key is first turned on to indicate the need to wait for the glow plugs to pre-heat the combustion chambers. The Malfunction Indicator Lamp (MIL) lights if a failure of a monitored component occurs. In some serious failure modes both warning indicators can be lit.

Some troubleshooting procedures used for checking glow plugs are the same as on earlier diesel engines. However because of its complex nature, proper diagnosis and repair requires the use of specialized scan tools such as Volkswagen special tool VAG 1551 or VAG 1552.

## IGNITION SYSTEM

The ignition function is handled through the fuel injection/engine management system. On gasoline engines, the Motronic or Mono-Motronic engine control module (ECM) computes ignition timing based on inputs from various sensors. Crankshaft position is the main input to the ECM and is used for starting. The other sensors are used to adapt the basic timing map for varying operating conditions. Motronic engines incorporate adaptive knock control to adjust the ignition timing for individual cylinders. See **28a Ignition System–Gasoline** for more information.

***NOTE —***

- *On Motronic-equipped engines, crankshaft position is determined by the engine speed (RPM) sensor. The RPM sensor is mounted in the side of the cylinder block and reads a toothed wheel on the end of the crankshaft. See* **24a Fuel Injection–Motronic** *for RPM sensor testing.*
- *On Mono-Motronic cars, crankshaft position is determined by the camshaft position (CMP) sensor, which is located in the ignition distributor. The CMP is an electronic switch and operates based on the Hall effect. See* **24b Fuel Injection–Mono-Motronic** *for testing information.*

## EMISSION CONTROLS

Different engines use different emission control systems. Most of these systems are monitored by the On-Board Diagnostic (OBD) system, which is part of the engine management system. See **26 Exhaust System/Emission Controls** for additional information.

# 20 Fuel Storage and Supply





## GENERAL

This repair group covers the fuel supply portion of the fuel system—the components that store and supply fuel under pressure to the fuel injection system. For a general system description, see **2 General Information.**

***NOTE—***
*Fuel filter replacement is covered in* **0 Maintenance Program.**

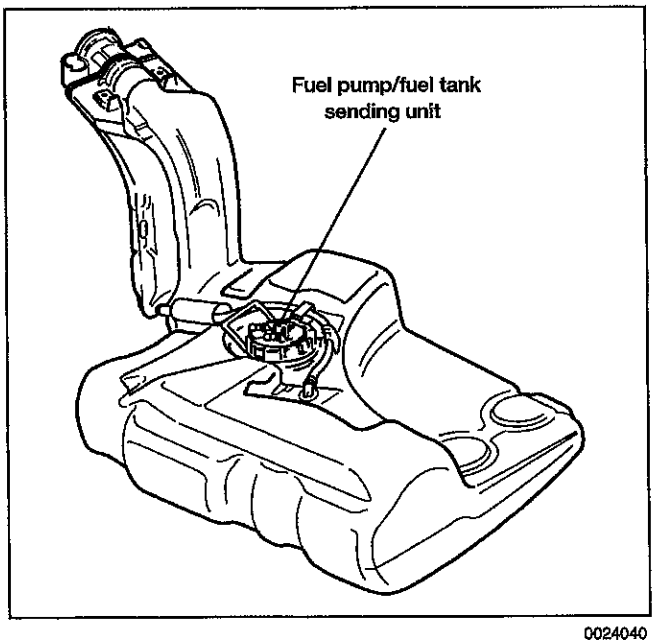


**Fig. 1.** Molded plastic fuel tank for gasoline engines. Cars with diesel engines are not equipped with in-tank fuel pump.

## Safety Precautions

Please read the following warnings and cautions before doing any work on the fuel pump, fuel tank or fuel lines.

***WARNING—***
- *Always disconnect the negative (–) battery cable and cover the terminal with an insulated material whenever working on any fuel related component.*
- *Gasoline is dangerous to your health. Wear hand and skin protection when working on the fuel system. Do not breathe fuel vapors and always work in a well-ventilated area.*
- *Fuel and fuel vapors will be present during many of the operations described in this repair group. Do not smoke or create sparks. Have an approved fire extinguisher handy.*
- *The fuel supply system is designed to maintain pressure in the system after the engine is turned off. Fuel will be expelled under pressure as fuel lines are disconnected. This can be a fire hazard, especially if the engine is warm. Always wrap a clean shop rag around the fitting before loosening or disconnecting any fuel line.*

***CAUTION—***

- *Cleanliness is essential when working on the fuel system. Thoroughly clean fuel line unions and hose fittings before disconnecting them. Use only clean tools.*
- *Use only spring-type clamps on fuel hoses. Do not use screw-type hose clamps.*
- *Keep removed components clean, and seal or cover them with plastic or paper, especially if the repair cannot be finished immediately.*
- *When replacing parts, install only new, clean components. Seals and O-rings should always be replaced rather than reused.*

## FUEL PUMP TROUBLESHOOTING– GASOLINE ENGINES

The fuel supply system is an integral part of the operation of the fuel injection system. Problems such as a no-start condition, hesitation or stalling may be due to poor fuel delivery. There are some preliminary tests to quickly determine if the fuel pump or its electrical circuit are causing the problem. Some of the tests described below require special test equipment, such as a fuel pressure gauge.

The electrical current that operates the fuel pump is controlled by a relay and protected by a 20-amp fuse. This helps to handle the high current load of the pump and also ensures that the pump will not continue to run in the event of an accident or if the engine stalls. If, for any reason, electric power to run the pump is interrupted, the engine will not run.

Begin troubleshooting with a simple check of the fuel pump electrical circuit. The pump should run while cranking the engine with the starter. If necessary, remove the floor cover and access plate in the luggage compartment and listen or feel to see whether the pump is running. If the pump does not run, see **To check fuel pump electrical circuit**.

***CAUTION—***

*In cold weather, water in the fuel may freeze in the pump, causing the circuit to overload and the fuse to fail. Be sure to check the fuse in position 18. See* **97 Wiring Diagrams, Fuses and Relays**.

If the fuel pump runs, begin troubleshooting with a check of the fuel pump delivery rate as described later in this section. The test will indicate whether further tests are necessary. This is especially important on high-mileage cars, where normal pump wear may decrease delivery volume. Also check for correct pump installation and for a clogged pump screen.

The electric fuel pump operates only when the car is running or being started. Because many of the fuel pump and fuel injection tests require that the pump be operated with the engine off, the fuel pump relay can be temporarily bypassed during testing.

### To operate fuel pump for tests

The procedure below uses a temporary wiring connection to bypass the fuel pump relay. The preferred method is to use a remote switch, such as the VW special tool VAG 1348/3(3A) but you can accomplish the same thing with a homemade fused jumper wire and an in-line switch. See Fig. 2.

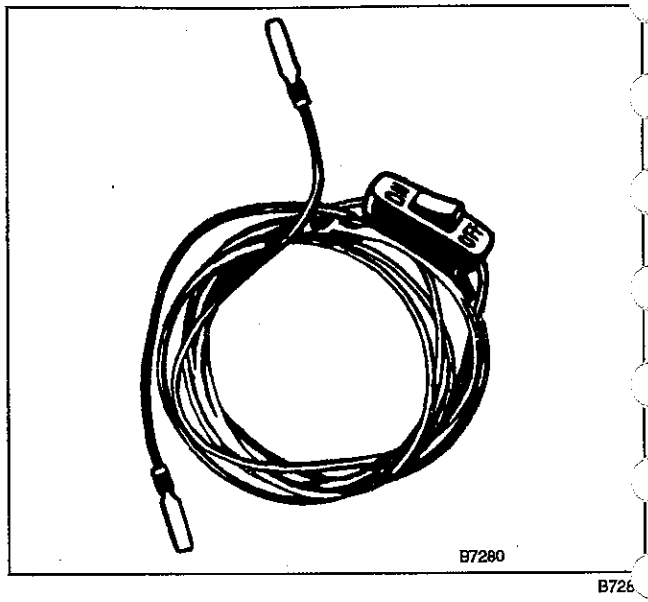


**Fig. 2.** Jumper wire with flat-blade connectors and switch for running fuel pump.

1. Remove the fuel pump relay from the fuse/relay panel. See Fig. 3.

***CAUTION—***

- *A homemade jumper wire with a switch should be at least 1.5 mm metric wire size (14 gauge-AWG) and, for safety, should include a 20 amp in-line fuse.*
- *To avoid damaging the relay sockets, the ends of the jumper wire should be flat-blade connectors that are the same size as the sockets in the relay panel.*
- *Connect and disconnect the remote switch or jumper wire only with the switch in the off position.*
- *Relay locations may vary. The fuel pump relay should have either 67, 80, or 167 stamped on the top of the relay. For more information on relay location, see* **97 Wiring Diagrams, Fuses and Relays**.

2. With the ignition off, connect the battery positive (+) voltage to fuel pump relay terminal 87 using a fused jumper wire.

***NOTE—***

*Terminal numbers should be marked on the fuse/relay panel and on the relay bottom.*

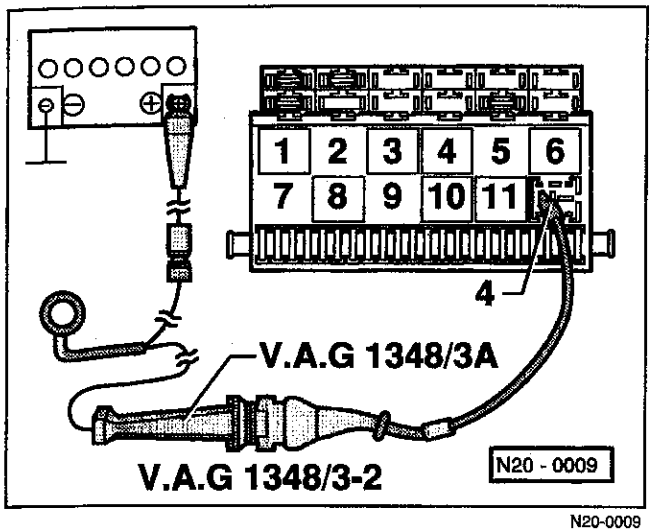


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**Fig. 3.** Fuel pump relay removed from fuse/relay panel. Jumper battery voltage (+) to terminal 87 (**4**) to operate pump.

3. Turn the jumper wire switch on to run the pump.

***NOTE—***
*If the pump runs only when the jumper is connected, the relay, the engine control module (ECM), or the circuit wiring is faulty. If the pump doesn't run with the jumper installed, the problem is most likely in the wiring to the pump or the pump itself is faulty. See* **To check fuel pump electrical circuit.**

## To check fuel pump electrical circuit

The fuel pump receives power from the fuel pump relay and the relay is energized by the engine control module (ECM). The test given below checks the relay's input (ground) from engine control module (ECM) and the relay's output (B+ power) to the pump.

1. Check that the battery is charged and that Fuse no. 18 is intact.

2. Fold down the rear seat and pull back the floor cover from the luggage compartment. Remove the access panel from above the fuel pump (rear right-hand corner).

3. While a helper listens at the fuel pump, turn the ignition key on. The pump should run briefly. If the pump runs, the circuit is probably functioning correctly. If the pump does not run, proceed to step 4.

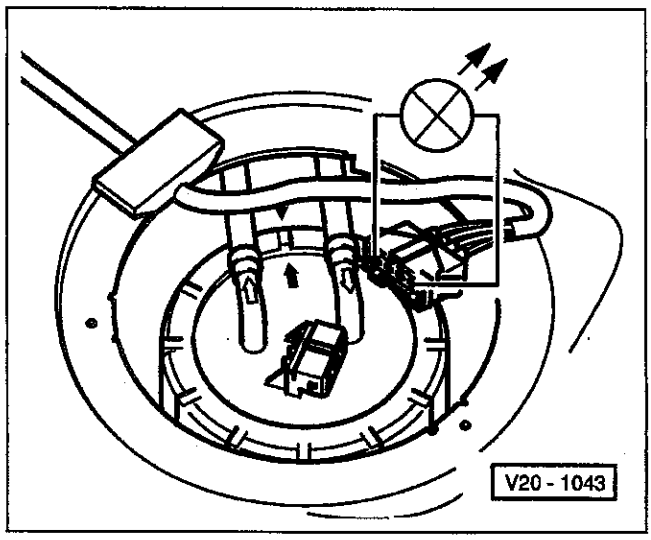
***NOTE—***
*Listen carefully for the pump to run—its operation is barely audible.*

4. Remove the fuel pump relay and run the fuel pump as described in **Operating Fuel Pump for Tests.**
   - If the pump runs, go to step 5.
   - If the pump does not run, go to step 6.

5. Remove the jumper wire from the relay panel. With the ignition key off, connect an ohmmeter between terminal 3 (corresponds to terminal 85 on the relay) in the relay panel and ground. Turn the key on. There should be a momentary ground signal.
   - If ground is present at terminal 85, the relay is probably faulty.
   - If ground is not present, check the wiring between relay panel terminal 85 and the engine control module (ECM). If no wiring faults can be found, the engine control module (ECM) control unit may be faulty. Check the inputs to engine control module (ECM). See **24a Fuel Injection—Motronic** or **24b fuel Injection—Mono-Motronic.**

***NOTE—***
*See* **97 Wiring Diagrams, Fuses and Relays** *for detailed wiring schematics.*

6. If the pump does not run as described in step 4, leave the jumper wire connected and disconnect the harness connector from the fuel pump. Check for voltage at the pump harness connector as shown in Fig. 4.
   - If voltage is not present at the connector, check the wiring between the relay panel and the fuel pump harness connector. Check for power at the relay panel itself. See **97 Wiring Diagrams, Fuses and Relays** for detailed wiring diagrams.
   - If voltage is present, remove the pump and check for internal shorts in the pump wiring. If no faults can be found, the pump is probably faulty.




V20-1043

**Fig. 4.** Voltage supply to fuel pump being checked at outer terminals in connector.

## To check fuel pump delivery rate

The test given below requires a fuel pressure gauge (0-100 psi) with a shutoff valve.

1. Remove the filler cap from the fuel tank.

2. Working in the engine compartment, disconnect the fuel supply line and connect a pressure gauge to the line.
   - On Motronic cars (ABA and AAA engines), disconnect the supply line from the fuel rail. See Fig. 5.
   - On Mono-Motronic cars (ACC engines), disconnect the supply line from the throttle body. See Fig. 6.

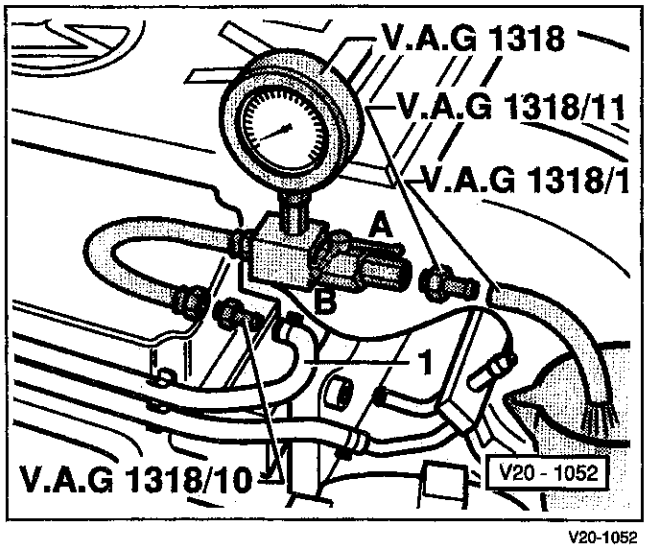



**Fig. 5.** Fuel gauge hook-up on Motronic cars (ABA, AAA engines). Supply line shown at (**1**). Numbers are for VW special tools.

> ***WARNING —***
> *Fuel will be expelled under pressure as the supply line is disconnected. Wrap a cloth around the line before disconnecting it. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.*

3. Route the gauge output line into a measurement container of at least 1000 ml (1 qt.). Make sure the shutoff valve on the gauge is open.

4. Remove the fuel pump relay and run the fuel pump as described in **To operate fuel pump for tests**.

5. Slowly close off the shutoff valve until the gauge reaches the test pressure listed below. Shut the pump off and empty the container. Do not alter the position of the shutoff valve.

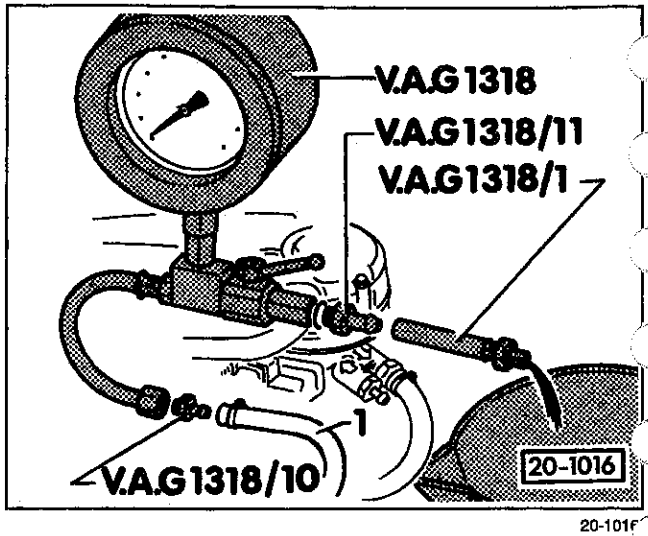



**Fig. 6.** Fuel gauge hook-up on Mono-Motronic cars (ACC engine). Supply line shown at (**1**). Numbers are for VW special tools.

**Fuel delivery test pressure**

- ABA, ACC engines . . . . . .3.0 bar (44 psi)
- AAA engine. . . . . .4.0 bar (58 psi)

6. Operate the pump again for exactly 30 seconds. Compare the amount of fuel collected to the chart shown in Fig. 7.

> ***NOTE —***
> *Fuel pump output varies depends on the voltage at the pump. Always measure the voltage at the pump (with the pump running) before using the chart shown in Fig. 7. In general, pump voltage is 1-2 volts less than battery voltage.*

If fuel delivery is below specifications, check for leaks, blocked or kinked lines, a blocked filter, or a blocked pump strainer/filter. If no faults are found, the fuel pump is probably severely worn or faulty and should be replaced.

> ***NOTE —***
> *Fuel filter replacement is covered in* **0 Maintenance Program.**

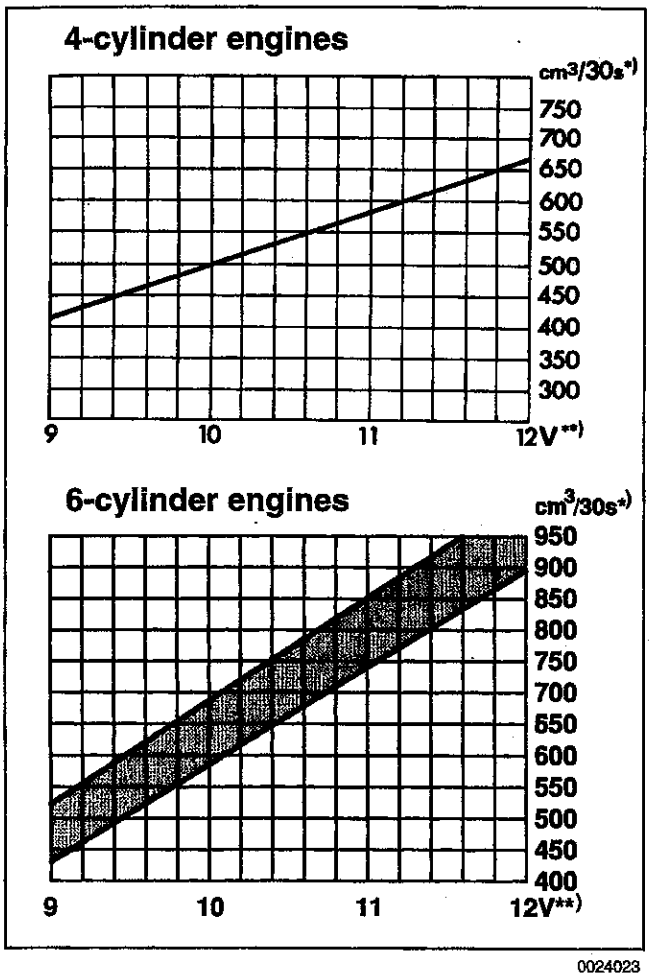



**Fig. 7.** Minimum amount of fuel to be delivered by fuel pump in 30 seconds of operation. Chart shows fuel delivery vs. voltage at fuel pump with pump running (usually 1-2 volts less than battery voltage).

## To test fuel pump check valve

The fuel pump check valve holds residual fuel pressure in the fuel lines after the engine is turned off. This residual pressure aids in quick starting and helps prevent fuel line vapor lock. The fuel pump check valve is part of the pump assembly and not separately replaceable. For additional fuel pressure tests, see **24 Fuel Injection**.

1. Connect the fuel pressure gauge as shown in Fig. 5 or Fig.6.

> ***WARNING —***
> *Fuel will be expelled under pressure when fuel lines are connected and disconnected. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.*

2. Close the pressure gauge shutoff valve. Then run the fuel pump in short intervals until the fuel pressure reaches the initial test pressure listed below. Turn the fuel pump off.
   - Pressure will build quickly—operate the pump in short intervals only. If necessary, open the shutoff valve slowly to bleed off excess pressure.
3. After ten minutes, compare the gauge readings to the specifications listed below.

**Fuel pump residual test pressure**

- initial test pressure
  - ACC engine . . . . . 2.0 bar (29 psi)
  - ABA engine . . . . . 3.0 bar (44 psi)
  - AAA engine . . . . . 4.0 bar (58 psi)
- after ten minutes (minimum pressure)
  - ACC engine . . . . . 1.2 bar (17 psi)
  - ABA engine . . . . . 2.0 bar (29 psi)
  - AAA engine . . . . . 3.0 bar (44 psi)

If the pressure drops too quickly, check for leaks in the fuel lines, fuel injectors, or the throttle body (ACC engine). If no leaks are found, the most likely cause is the fuel pump check valve. To further isolate the problem, repeat the above test and then quickly pinch off the return line to the fuel tank. If the pressure now holds steady, the fault is in the pump check valve. If the pressure still drops off, check for faulty fuel injection components. See **24 Fuel Injection**.

> ***NOTE —***
> *On ABA engines, an in-line check valve is used in the return line near the pump outlet.*

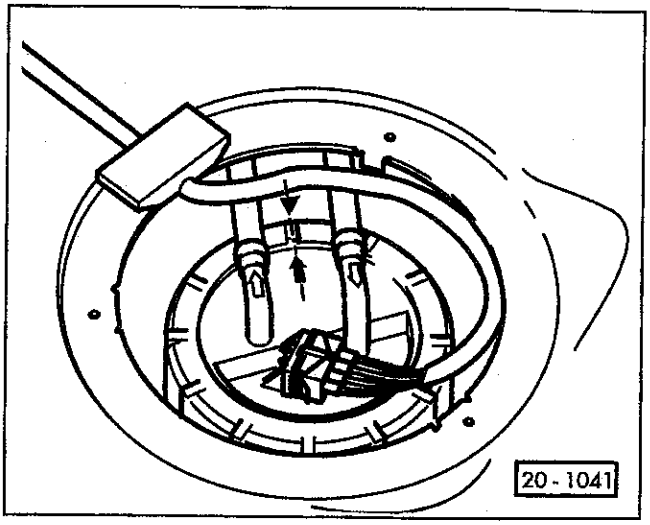
# FUEL PUMP REMOVAL AND INSTALLATION–GASOLINE ENGINES

## To remove fuel pump

1. Disconnect the negative (–) battery cable.

> ***NOTE —***
> *Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

2. Fold down the rear seat and pull back the floor cover and insulation from the luggage compartment. Remove the access panel from above the fuel pump.
3. Disconnect the harness connector, the supply line, and the return line from the fuel pump. See Fig. 8.




20-1041

**Fig. 8.** Fuel pump supply line (black), return line (blue) and harness connector. Note matching marks on tank and pump (**arrows**).

> ***WARNING —***
> *Fuel will be discharged and dangerous fuel vapors will be present. Work in a well ventilated area. Do not disconnect wires that could cause sparks. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.*

4. Unscrew the fuel pump retaining ring. Slowly lift the fuel pump assembly from the tank. Empty the fuel pump module into a container once it is removed.

***NOTE —***
*VW special tool no. 3217 is available to loosen and tighten the fuel pump retaining ring.*

## To install fuel pump

1. Inspect the fuel tank seal and replace it if it is damaged or distorted. Make sure the fuel pump filter screen is clean.

2. Moisten the sealing ring with fuel and install the fuel pump assembly into the tank, using care not to bend the arm for the fuel level float.

***NOTE —***
*Align the pump so that the matching mark on the tank aligns with the mark on the pump. See Fig. 8.*

3. Tighten the cap nut.

4. Reconnect the fuel lines and the harness connector.

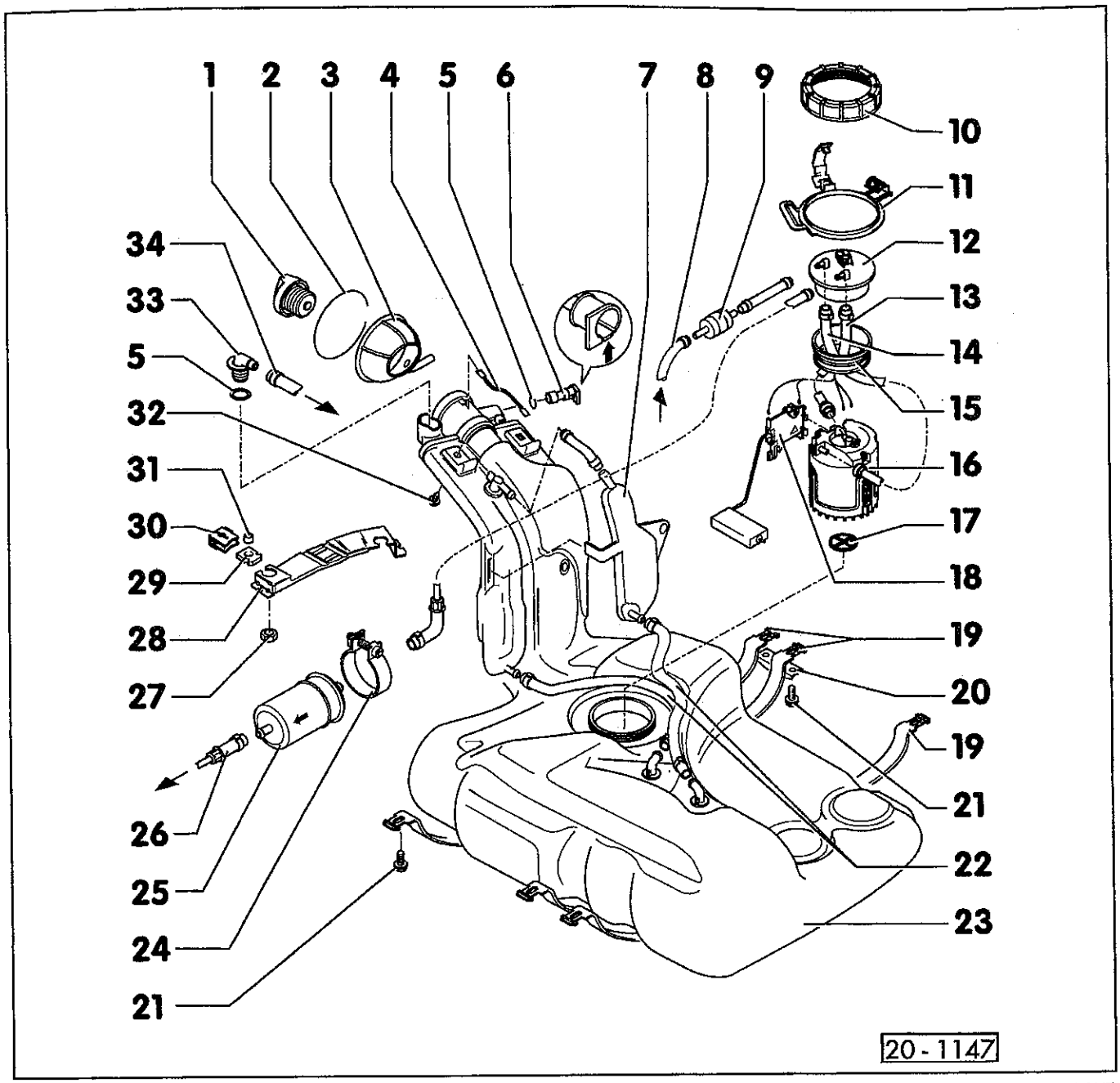
5. Reconnect the negative (–) battery cable. Start the engine and check for leaks.

## FUEL TANK AND LINES– GASOLINE ENGINES

An exploded view of the fuel tank assembly is shown in Fig. 9. When removing and installing the fuel tank, the tank should be as empty as possible. Note the different length mounting straps and all other pertinent information contained in the illustration when servicing the tank or lines.

1. **Filler cap**
2. **Circlip**
3. **Rubber boot**
4. **Ground strap**
5. **O-ring**
   - Always replace
6. **Breather valve**
   - Checking, **see** Ⓐ
7. **Expansion tank**
8. **Return line (blue)**
9. **Check valve (ABA engine only)**
   - Arrow points in direction of flow
10. **Fuel pump cap nut**
11. **Hose guide**
12. **Fuel pump flange**
13. **Fuel pump supply hose**
14. **Fuel pump return hose**
15. **Seal**
    - Lubricate with fuel when installing
    - Replace if damaged
16. **Fuel pump**
17. **Filter screen**
18. **Fuel level sensor**
19. **Tank retaining straps**
    - note different lengths
20. **Bracket**
21. **Bolt**
    - Tighten to 25 Nm (18 ft-lb)
22. **Breather hose**
23. **Fuel tank**
24. **Fuel filter clamp**
25. **Fuel filter**
    - Arrow with "AUS" or "AUSLUF" points in direction of fuel flow
26. **Supply line (black)**

## Fuel tank assembly–gasoline engines




20-1147

**Fig. 9.** Gasoline fuel tank assembly.

**27. Nut**
- Tighten to 20 Nm (15 ft-lb)

**28. Fuel filter bracket**

**29. Rubber buffer**

**30. Spring clip**

**31. Spacer**

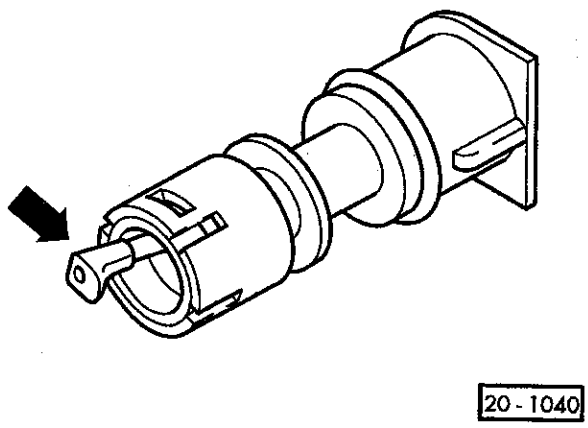
**32. Screw**
- Tighten to 10 Nm (89 in-lb)

**33. Gravity valve**
- Unclip and pull up and out to remove

**34. Hose**
- To evaporative emissions (EVAP) canister

To check the fuel tank breather valve, first remove it from the filler neck by depressing the safety catch and pulling it out. With the valve removed, and the lever in the rest position, the valve should be closed. With the lever pressed, the valve should open. If any faults are found, the breather valve should be replaced.

**A Checking fuel tank breather valve**




20-1040

- **Check by depressing lever.**
- **With lever in rest position, valve should be closed.**
- **With lever depressed (direction of arrow) valve should open.**

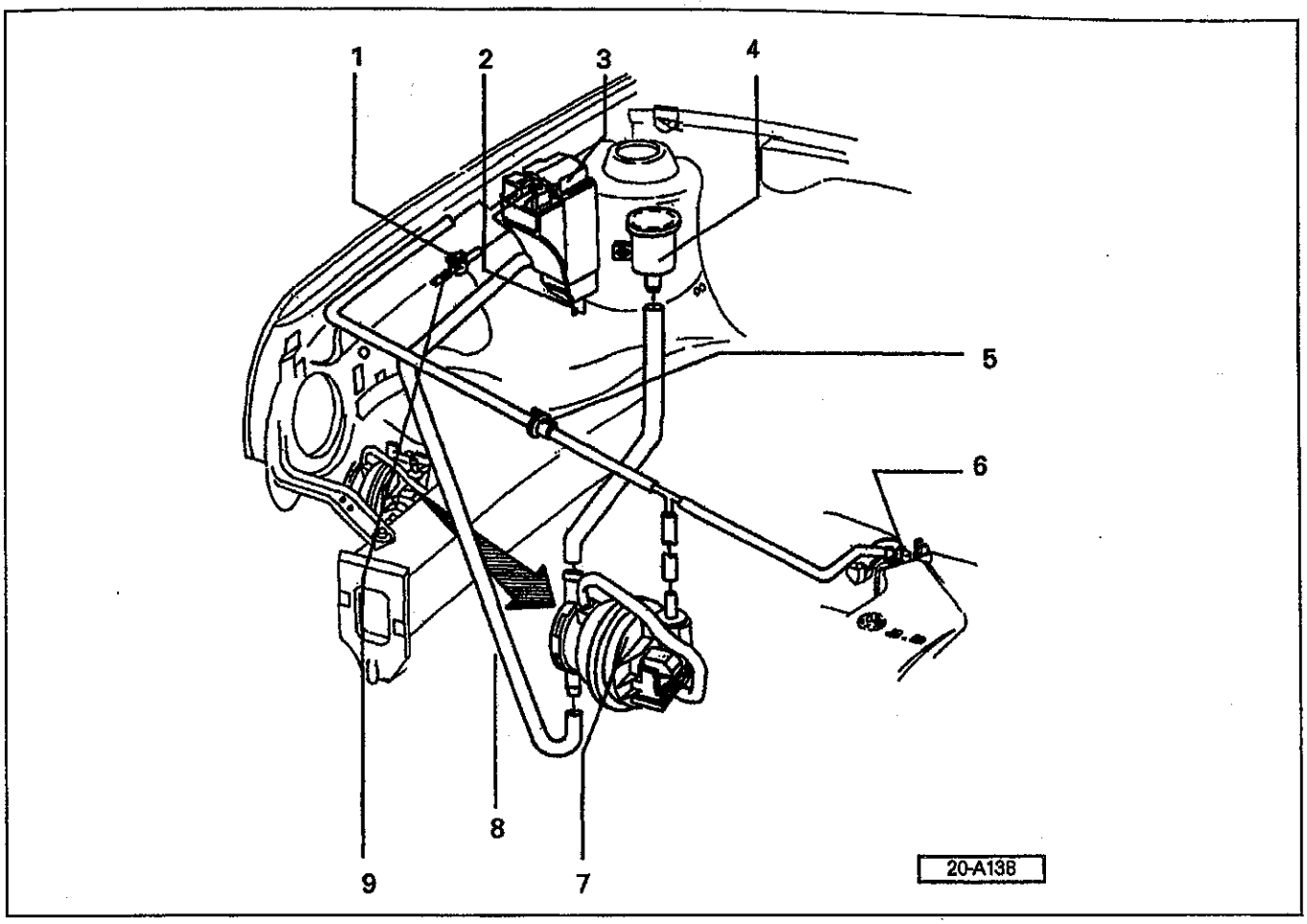
## Evaporative emissions leak detection system–gasoline engines

Some versions of the Motronic 5.9 Engine Management System are equipped with additional evaporative system monitoring. This system is referred to as the Leak Detection System or LDP after one of its major components. See Fig. 10.

The Engine Control Module determines when the appropriate conditions are met and activates a vacuum operated pump in the right front area of the vehicle through an integral solenoid valve. The Leak Detection Pump (LDP) pumps a small amount of air pressure into the fuel tank and lines. At the same time, a timer relay (J335) closes the evaporative canister condensate drain valve and the ECM closes the evaporative canister purge valve. The pump runs until a pre-determined pressure or time is reached. If the system does not hold the correct range of pressures, a fault or DTC is stored in the ECM memory.

Basic troubleshooting should begin with a visual inspection of the evaporative system hoses and components with particular attention paid to the fuel cap and seal. Further testing will require use of a scan tool such as Volkswagen special tool VAG 1551 or VAG 1552.

## Evaporative emissions leak detection system–gasoline engines




20-A138

**Fig. 10.** Evaporative emission leak detection system as installed on gasoline powered cars.

1. **Pressure control valve (flow from fuel tank)**
2. **Condensate drain valve/breather hose**
3. **Evaporative Emissions (EVAP) canister**
4. **Air filter for LDP pump**
5. **Evaporative Emissions (EVAP) canister purge regulator valve**
6. **Throttle body connection (manifold vacuum)**
7. **Leak detection pump (LDP)**
8. **Pressure line form LDP pump to canister**
9. **Fuel tank connection (to item 1)**
10. **Timer relay (not shown)**

## FUEL TANK AND LINES– DIESEL ENGINES

An exploded view of the fuel tank assembly is shown in Fig. 11. When removing and installing the fuel tank, the tank should be as empty as possible. Note the different length mounting straps and all other pertinent information contained in the illustration when servicing the tank or lines.

## Fuel tank assembly–diesel engines

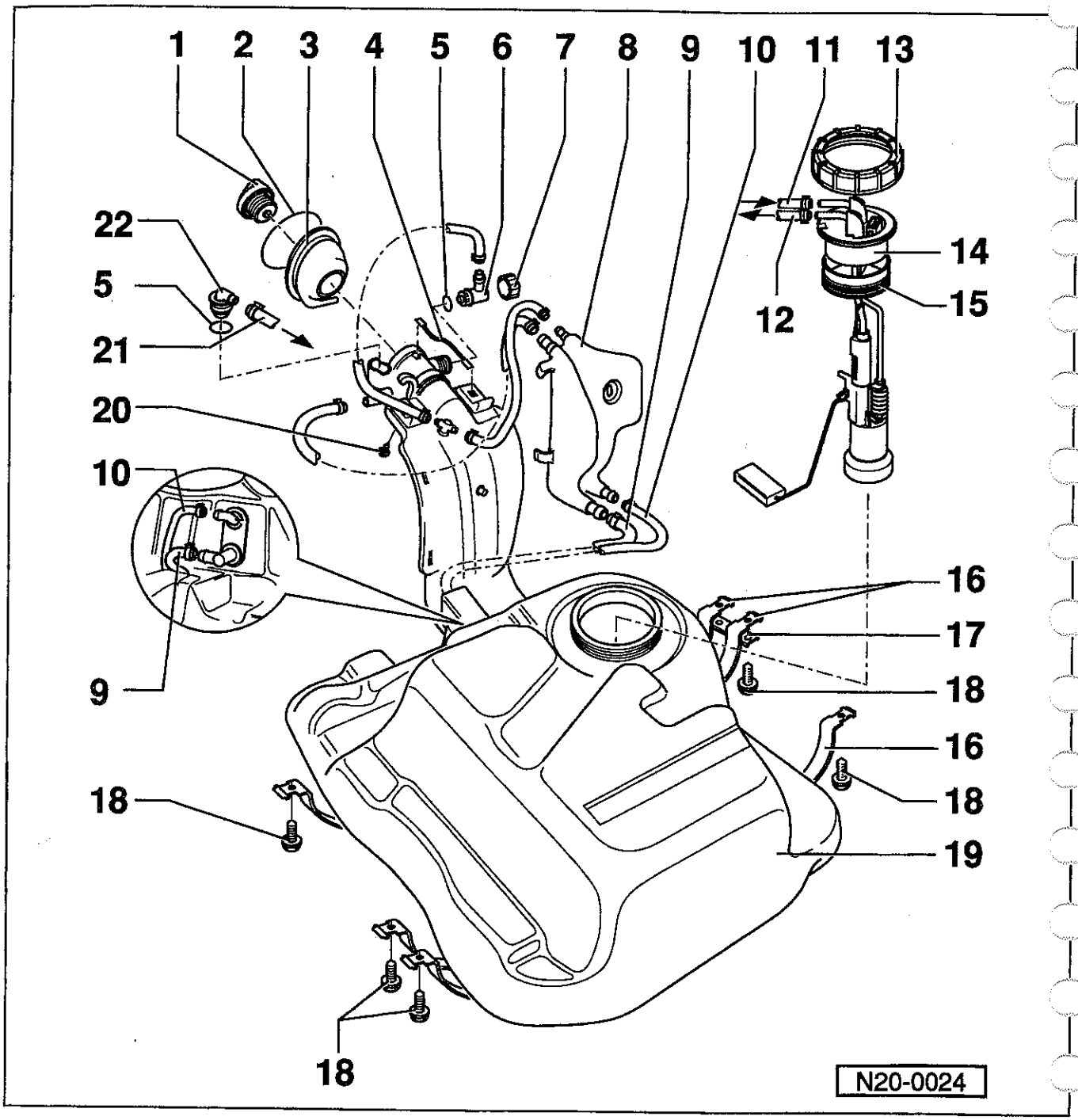



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**Fig. 11.** Diesel fuel tank assembly.

1. **Fuel filler cap**
   - Replace seal if damaged
2. **Retaining ring**
3. **Fuel filler splash shield**
4. **Ground connection**
5. **O-ring**
   - Replace if damaged
6. **Vent valve**
   - Checking, **see** Ⓐ
7. **Union nut**

8. **Overflow tank**

9. **Vent pipe**
   - Filling vent

10. **Vent pipe**
    - Operating vent

11. **Fuel return line**
    - Blue

12. **Fuel supply line**
    - Black

13. **Union nut**
    - Remove and install using Volkswagen special tool, 3218 wrench, or equivalent

14. **Fuel gauge sender**
    - Telescopes with fuel strainer into upper section
    - Note installation position, **see** (B)

15. **Sealing ring**
    - Lubricate with fuel when installing
    - Replace if damaged

16. **Mounting straps**
    - Note different lengths

17. **Bracket**
    - To secure mounting straps

18. **25 Nm (18 ft-lb)**

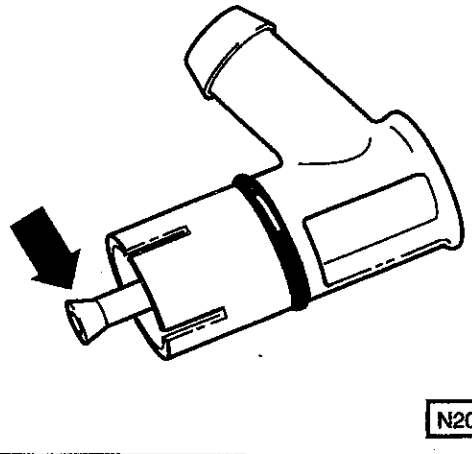
19. **Fuel tank**
    - Support using VAG 1383A engine and transmission jack or equivalent when removing

20. **10 Nm (7 ft-lb)**

21. **Vent pipe**
    - To fuel filter splash shield (3)

22. **Gravity valve**
    - To remove valve, unclip and pull upward out of filler neck
    - Check valve for flow
    - Valve vertical: open
    - Valve tilted 45°: closed

**(A) Checking vent valve**

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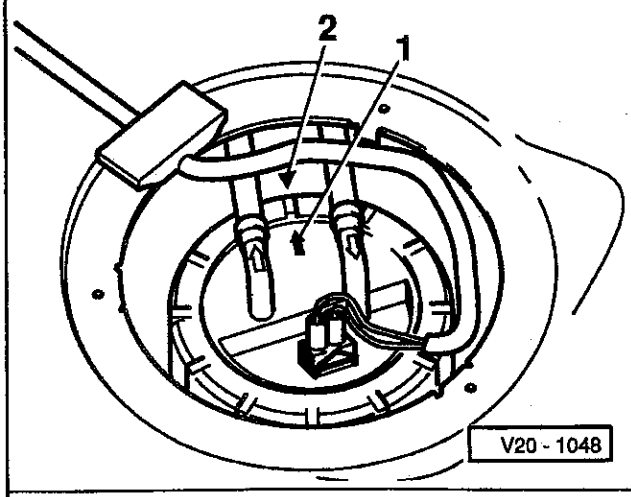
- **With lever in rest position, valve should be closed.**
- **With lever depressed (direction of arrow) valve should open.**

**(B) Installed position of fuel gauge sender**




V20-1048

- **Mark on sensor -1- must be aligned with mark -2- on fuel tank.**

# 24a Fuel Injection–Motronic



## GENERAL

This repair group covers Bosch Motronic fuel injection component troubleshooting and repair for the 1993–1999 2.0 liter ABA engine and the 1994–1999 2.8 liter AAA (VR6) engine. Special testing equipment may be necessary for some of the tests and repair procedures given here.

***NOTE—***

*1996-1999 ABA and AAA engines are equipped with Motronic M5.9 (OBD II). It is recommended that fault diagnosis and troubleshooting be carried out using the special Volkswagen scan tool (VAG 1551), or an appropriate "generic" scan tool.*

**Fuel Injection System Applications**

- ACC (1.8 liter) . . . . . Mono-Motronic
- ABA (2.0 liter)
  - 1993–1995 models . . . . . Motronic M2.9
  - 1996–1999 models . . . . . Motronic M5.9
- AAA (2.8 liter)
  - 1993–1995 models . . . . . Motronic M2.9
  - 1996–1999 models . . . . . Motronic M5.9
- AAZ (1.9 liter) . . . . . Diesel Fuel Injection
- AHU (1.9 liter) . . . . . Diesel TDI

***NOTE—***

- *Fuel pump and fuel tank testing and repair information is covered in* **20 Fuel Storage and Supply**.
- *Emission systems, such as Evaporative (EVAP) emissions, and Exhaust Gas Recirculation (EGR) are covered separately in* **26 Exhaust System/Emission Controls**.
- *Knock sensor testing and repair information is covered in* **28a Ignition System–Gasoline**.

Fig. 1 shows a schematic view of the Bosch Motronic engine management system. The Motronic system combines the ignition and fuel functions into one system, managed by a single engine control module (ECM). The system is fully adaptive and features built-in diagnostics that detect and store coded fault information. There are no basic adjustments or settings that can be made to the system.

***NOTE—***

*A general description of operation for the Motronic engine management system is given in* **2 General Information**.

## Safety Precautions

The following warnings and cautions should be adhered to whenever doing work on the fuel injection system.

***WARNING—***

*Fuel will be discharged during many fuel system test procedures. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy. Work only in a well-ventilated area. Wear suitable hand protection when working with gasoline. Prolonged contact with fuel can cause illnesses and skin disorders.*

***CAUTION—***

- *Connect and disconnect wires and test equipment only with the ignition off.*
- *Before making any electrical tests that require the engine to be cranked using the starter, disable the ignition system as described in* **28a Ignition System–Gasoline**.
- *Always wait at least 40 seconds after turning off ignition before removing the ECM connector. If the connector is removed before this time, residual power in the system relay may damage the ECM.*
- *Cleanliness is essential when working on the fuel system. Thoroughly clean fuel line connections and surrounding areas before loosening. Avoid the use of compressed air, and avoid moving the car. Only install clean parts.*

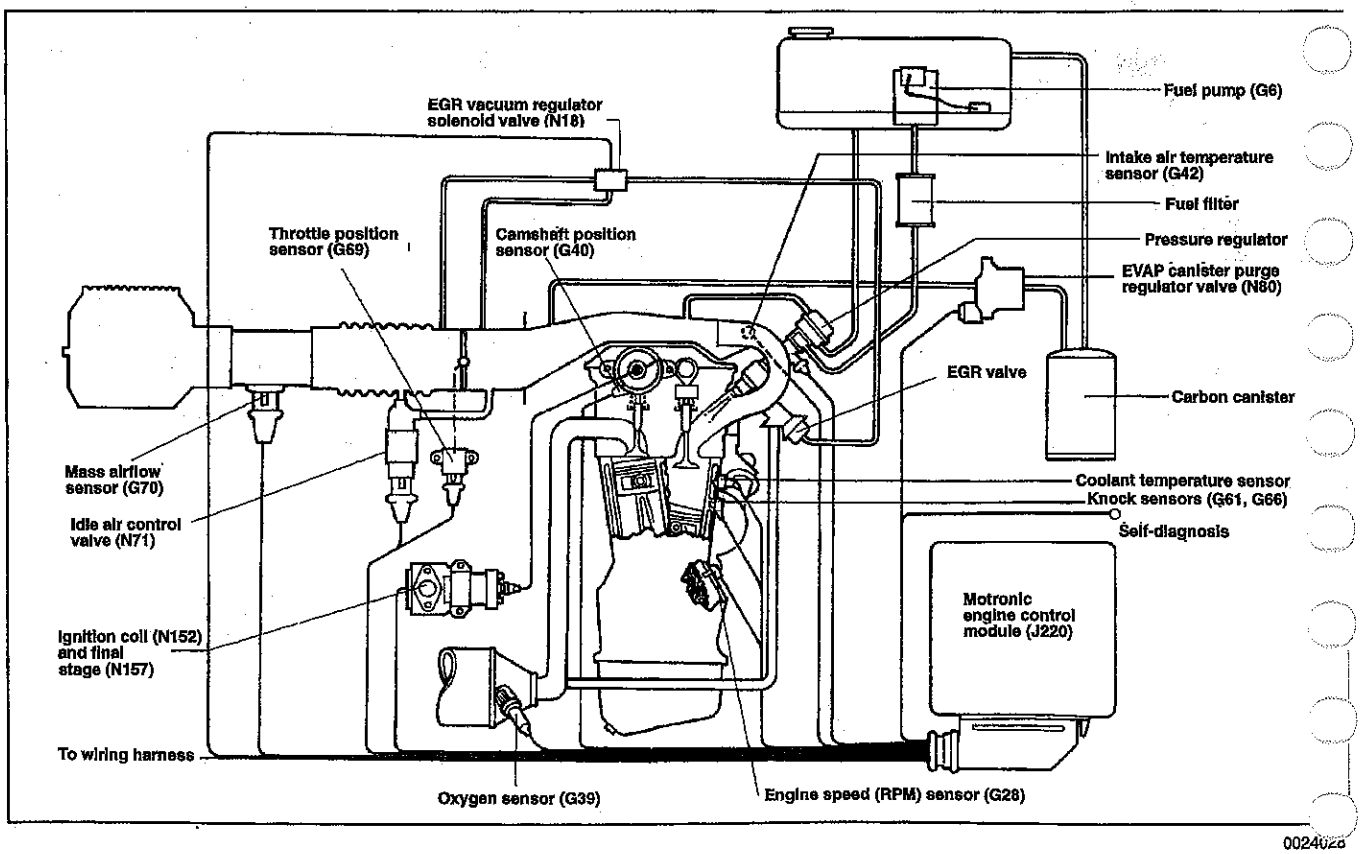



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**Fig. 1.** Schematic view of Motronic engine management system.

## Adaptive Circuitry and On-Board Diagnostics (OBD)

The Motronic system is adaptive. Idle speed, ignition timing, injection timing and quantity automatically compensate for and adapt to changes in the engine due to wear or small problems, such as minor vacuum leaks. As a result, idle speed, fuel mixture (%CO) and ignition timing are non-adjustable.

*NOTE—*

- *Volkswagen identifies electrical components by a letter and/or a number in the electrical schematics. See* **97 Wiring Diagrams, Fuses and Relays.** *These electrical identifiers are listed as an aid to electrical troubleshooting.*
- *The Volkswagen Scan Tool V.A.G. 1551 is used to quickly access the Diagnostic Trouble Codes (DTCs) through the data link connector(s) in the dash. Alternatively, the data link connector(s) can be jumpered and the DTC can be read out through the Check Engine light, also called the Malfunction Indicator Lamp (MIL), in the form of a blink code.*
- *Beginning in 1994 (1993 in California), automakers are required by law to apply uniform terminology, words and terms for certain components. These standardized terms will be used throughout this section.*

The Motronic system features built-in diagnostic circuitry to detect and store Diagnostic Trouble Code (DTC) information. When the system compensates for values that are outside the permitted limits, a fault code is generated and stored in the ECM's permanent memory. For emissions-related faults, the Check Engine or Malfunction Indicator Lamp (MIL) will be turned on. The fault codes can be accessed through the data link connector(s) in the dashboard.

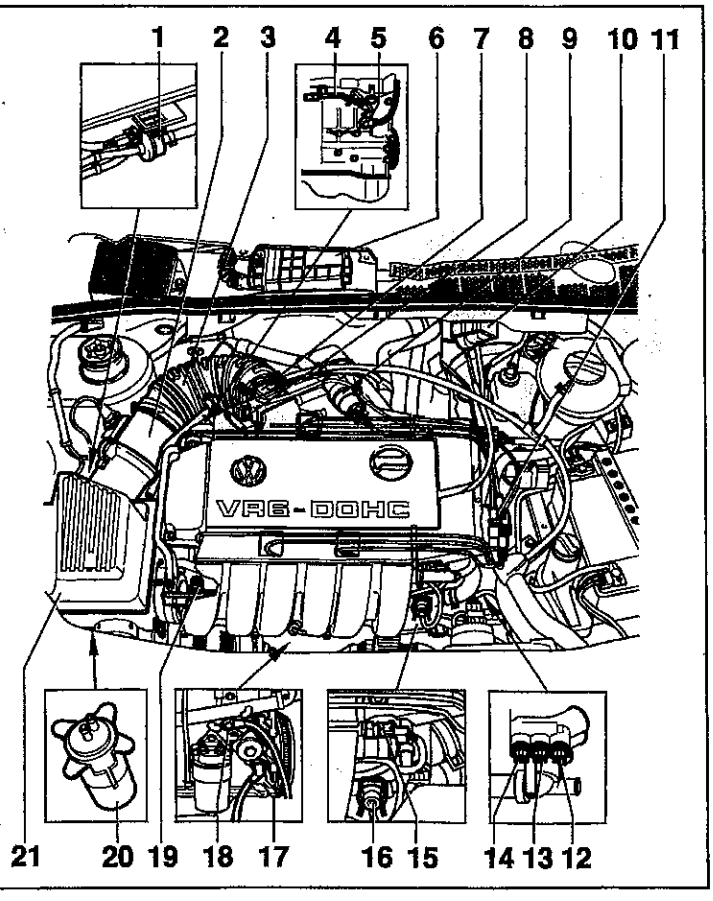
## FAULT DIAGNOSIS (1993–1995 models)

Fig. 2 shows Motronic component locations for the 1993–1995 AAA (VR6) engine. Fig. 3 shows Motronic component locations for the 1993–1995 ABA (4-cylinder) engine.

Because the ignition, fuel injection, and emission control functions are inter-related and controlled together by the Motronic engine management system, it is difficult, if not impossible to isolate general driveability problems by examining components of the fuel injection system alone.

For this reason, the first step in locating trouble is to review the basic requirements list shown below. If no faults are found, continue by checking for Diagnostic Trouble Codes (DTCs), especially if the check engine light is illuminated.

1. **Evaporative (EVAP) emissions canister purge regulator valve (N80)**
2. **Mass air flow (MAF) sensor (G70)**
3. **Intake air duct**
4. **Not applicable to vehicles covered by this manual**
5. **Knock sensor 1 (G61)**
   - see **28 Ignition System** for repair information
6. **Motronic engine control module (ECM) (J220)**
7. **Throttle valve housing**
8. **Throttle position (TP) sensor (G69)**
9. **Idle air control (IAC) valve (N71)**
10. **Not applicable to vehicles covered by this manual**
11. **Ignition coil (N152)**
12. **A/C thermal switch (F45)**
13. **Engine coolant temperature (ECT) sensor (G62)**
    - blue, 2-pin connector
14. **After-run coolant fan control thermal switch (F87)/ coolant temperature sensor for temp. gauge (G2)**
    - yellow, 4-pin connector
15. **Intake air temperature (IAT) sensor (G72)**
16. **Fuel pressure regulator**
17. **Engine speed sensor (G28)**
18. **Knock sensor 2 (G66)**
    - see **28 Ignition System** for repair information
19. **Fuel injector, cyl. no.1 (N30)**
20. **Evaporative (EVAP) emission canister**
21. **Air cleaner (ACL)**




N24-0088

**Fig. 2.** Motronic component location on 1993–1995 AAA (VR6) engines.

## Basic Requirements

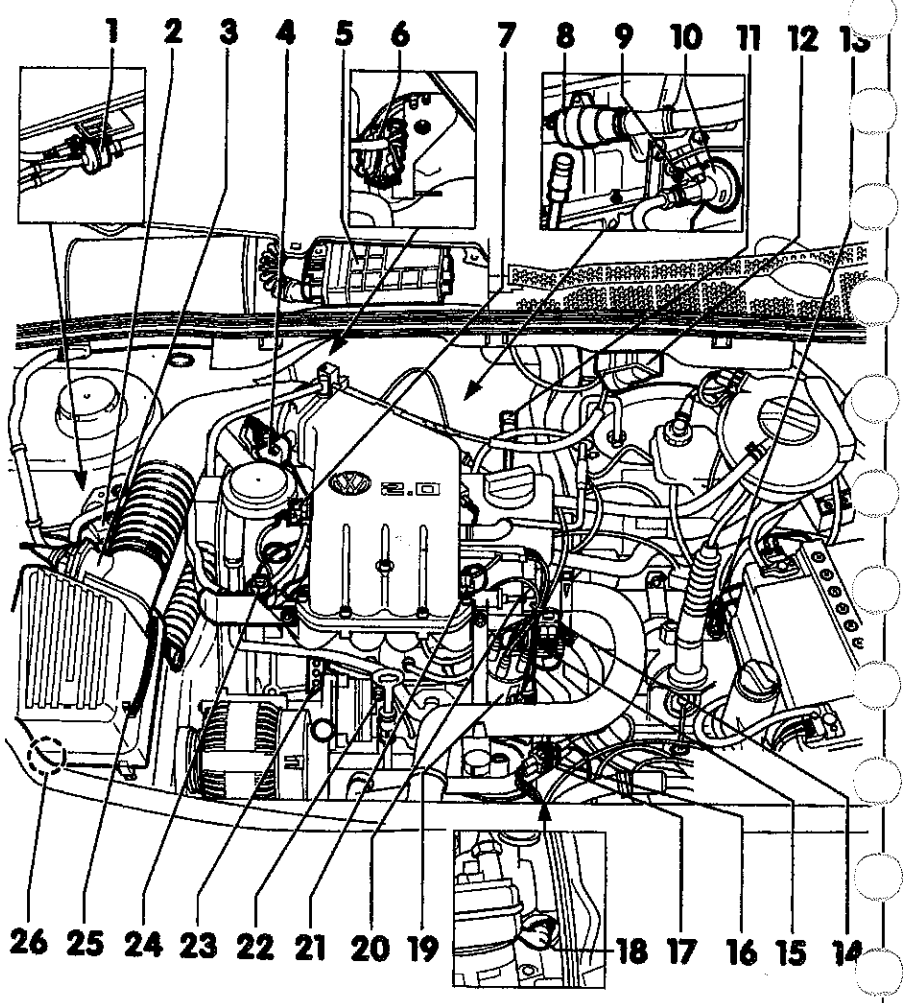
Below are a few basic checks that should be made if the Malfunction Indicator Lamp (MIL) is not illuminated, but engine management driveability problems are encountered.

1. Check intake system for leaks. Check for cracked, loose, or disconnected hoses and duct work. Check that all hose clamps are tight. Check small vacuum hoses, especially close to the fittings, and check the fittings themselves.

***NOTE—***
*An air leak allows unmeasured air to enter the engine, often resulting in an overly lean fuel mixture. This can cause driveability problems and may illuminate the MIL.*

2. On 4-cylinder engines, check the intake air boot mass air flow (MAF) sensor for excessive oil deposits If heavy deposits are found and the engine is experi encing driveability problems, the MAF sensor ma contaminated. Test the air flow sensor as described lat er in this section.

1. **Evaporative (EVAP) emissions canister purge regulator valve (N80)**
2. **Exhaust gas recirculation (EGR) vacuum regulator solenoid valve (N18)**
   • see **26 Exhaust System /Emission Controls** for repair information
3. **Mass air flow (MAF) sensor (G70)**
4. **Throttle position (TP) sensor (G69)**
5. **Motronic engine control module (ECM) (J220)**
6. **Oxygen sensor (G39) harness connector**
7. **Intake air temperature (IAT) sensor (G72)**
8. **Idle air control (IAC) valve (N71)**
9. **EGR temperature sensor (G98)**
   • see **26 Exhaust System/Emission Controls** for repair information
10. **EGR valve**
    • see **26 Exhaust System/Emission Controls** for repair information
11. **Co tap tube**
    • not applicable on all engines
12. **Ignition coil (N152)**
    • see **28 Ignition System** for repair information
13. **Vehicle speed sensor (VSS) (G22)**
14. **Engine coolant temperature (ECT) sensor (G62)/ coolant temperature sensor for temp. gauge (G2)**
    • black, 4-pin connector
15. **Central harness connector**
16. **Knock sensor (G61) harness connector**
17. **Engine speed sensor (G28) harness connector**
18. **Engine speed sensor (G28)**
19. **Ignition distributor with camshaft position sensor (G40)**
    • see **28 Ignition System** for repair information
20. **Fuel pressure measuring tap**
    • not applicable on all engines




21. **Fuel injectors (N30-N33)**
22. **Knock sensor 1 (G61)**
    • repairing, see **28 Ignition System**
23. **Ground connection**
24. **Fuel pressure regulator**
25. **Thermal vacuum valve (TVV)**
    • for intake air preheating
26. **EVAP canister**
    • located below air cleaner

24-M10

**Fig. 3.** Motronic component location on 1993–1995 ABA (4-cylinder) engine.

3. Check that the battery is in good condition. Check that the cables are tight and free of corrosion. Check that all related ground points are firmly connected and in good condition.

4. Check all of the harness connectors for damage and corrosion, especially the connector at the speed sensor (G28), the main 28-pin connector at the rear of the engine, and the knock sensor mounts on the engine block.

***NOTE—***
*4-cylinder engines use one knock sensor. 6-cylinder engines use two knock sensors, one on either side of the engine.*

5. If the engine won't start, check for power and ground at the Motronic ECM. See **97 Wiring Diagrams, Fuses and Relays.** Check the fuses.

6. Make sure there is fuel in the tank and fuse no. 22 is OK.

7. As the final step, check for Diagnostic Trouble Codes (DTC) as described below.

## Diagnostic Trouble Codes (DTC)

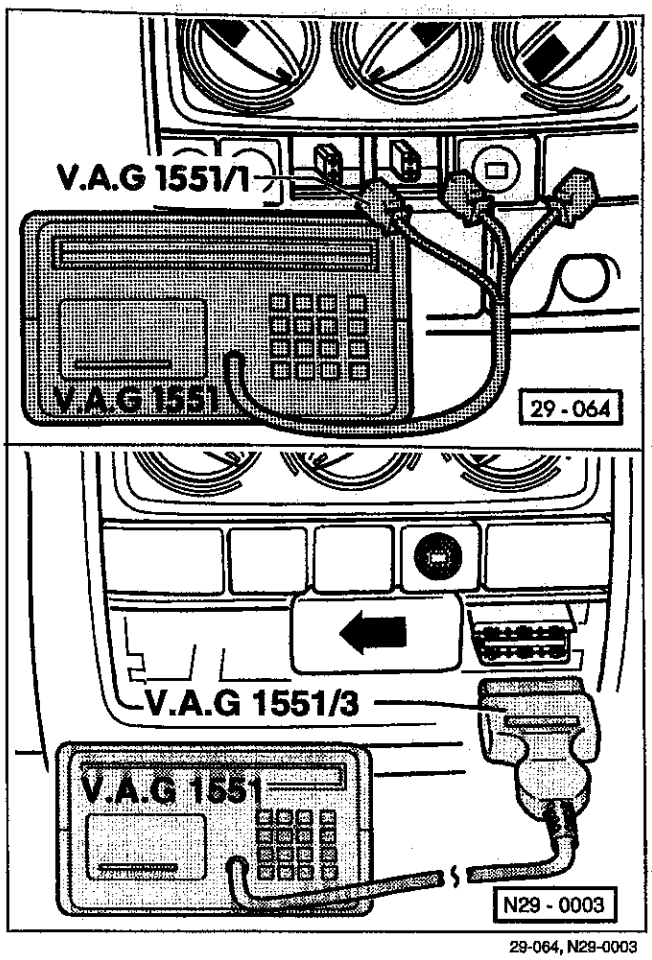
The Motronic systems are equipped with built-in fault diagnostics. Some of the faults will illuminate the check engine light, but many will not.

On 1993-1995 models diagnostic trouble codes (DTC) can be displayed in one of two ways; (1) using the specialized Volkswagen scan tool V.A.G. 1551 or (2) by jumpering the data link connector(s) and interpreting blink codes through the malfunction indicator light (MIL) in the instrument cluster. The procedure below describes the blink code method.

On 1996 and later models the diagnostic trouble codes (DTC) can only be displayed by using the specialized Volkswagen scan tool V.A.G. 1551.

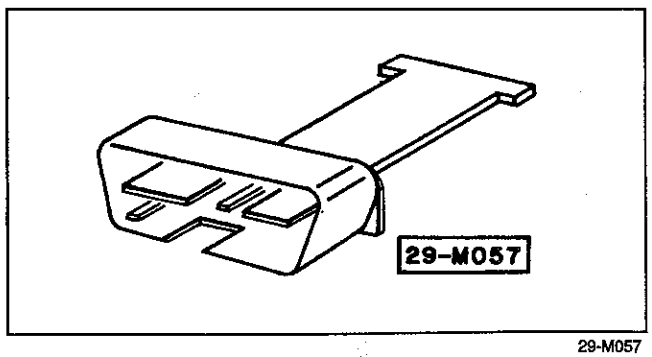
DTCs are accessed through the data link connector(s). The connectors are behind a cover in the center of the dash, below the heating ventilation controls. Two versions of data link connectors are used depending on model year. 1993 and early 1994 cars use two connectors while later model 1994 and later cars use a single connector. See Fig. 4.

***NOTE—***
*On 1995 cars, a special OBD adapter may be stored beneath the rear seat and should be used to access the DTCs. See Fig. 5. On cars with ABS, the connector is stored beneath the ABS coaxial cable next to the ABS control unit. On cars without ABS, the adapter is secured by a wire tie.*




29-064, N29-0003

**Fig. 4.** Data link connectors in center of dash. 1993 and early 1994 (top) cars use two separate connectors. Later model 1994 (bottom) and later cars use single 16-pin connector. Special VW scan tool V.A.G. 1551 shown.



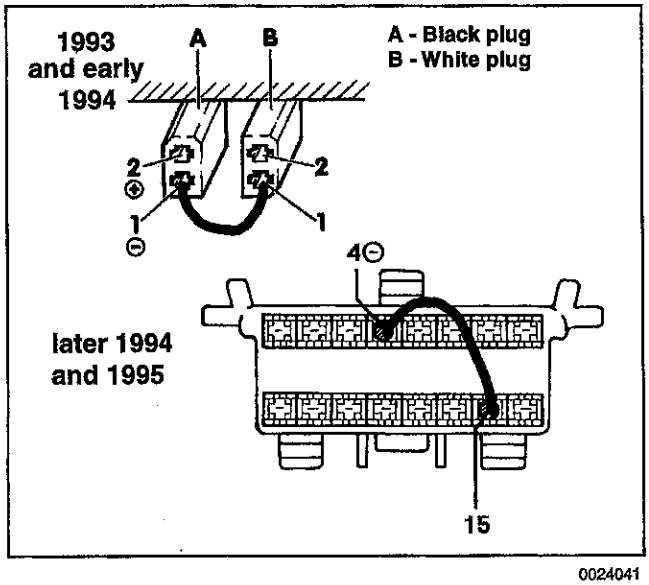

29-M057

**Fig. 5.** OBD adapter used to access blink codes on later 1994 and 1995 model year vehicles. On some 1995 vehicles, adapter may be attached to the wiring harness under the rear seat.

## To display DTCs (models with blink codes)

1. With the ignition key in the on position, jumper the terminals in the data link connector that match the vehicle configuration. See Fig. 6.
   - On 1993 and early 1994 vehicles, jumper position 1 in the black plug to position 1 in the white plug with a suitable jumper wire. This connects the blink code activation signal wire (white plug, position 1) to a ground (black plug, position 1) to initiate the blink signal. The jumper should be connected for about 2-1/2 seconds and then removed.
   - On later 1994 and 1995 vehicles, jumper position 4 of the 16 pin data link connector to position 15 of the data link connector with a suitable jumper wire or adapter. This connects the blink code activation signal wire to a ground to initiate the blink signal. The jumper should be connected for about 2-1/2 seconds and then removed.

> ***CAUTION —***
> *Use care when connecting the jumper wire. Positive (+) battery voltage is present in the connector. A wrong connection can result in damage to ECM or the vehicle's wiring.*




0024041

**Fig. 6.** Jumper wire installed in data link connectors.

2. After one blink of the MIL light, the first 4-digit DTC will be displayed. Approximately one second later, the MIL will blink the first digit, then pause, blink the second digit, then pause, and so on. **Table a** lists DTCs.

> ***NOTE —***
> *A blink code of 2-1-1-1 will always be displayed because the ECM only reads the engine speed (RPM) sensor signal when the engine is running. This code will erase itself once the engine is started.*

3. Once the first DTC has been displayed, reconnect the jumper wire or the adapter for **2.5 seconds** and then remove it. The second DTC code (if present) will be displayed.

> ***NOTE —***
> *Record blink codes on paper for later reference. If an error is made reading blink codes, they can be recalled as many times as needed as long as they have not been erased.*

4. Repeat step 3 until no more codes are displayed.

> ***NOTE —***
> *End of blink code display will be identified by 4 long blinks (0-0-0-0).*

5. When all codes have been displayed and recorded, turn the ignition key off.

## Table a. Motronic Diagnostic Trouble Codes (Blink Codes) 1993–1995 model years

| DTC | Probable fault | Corrective action, first check |
|---|---|---|
| 4444 | **No DTC recognized** | No corrective action necessary. |
| 1231 | **Vehicle speed sensor (VSS) (G22)**–missing or incorrect signal, VSS wiring damaged/open or shorted, VSS faulty. Speedometer faulty. | Check output signal the from speedometer VSS. Check sensor wiring. Check speedometer operation. |
| 2111 | **Engine speed (RPM) sensor (G28)**–missing or incorrect rpm signal. (This code will always be present if the test is run with the engine off. It will erase itself when the engine starts. If the engine will not start, the sensor must be checked manually.) | Check the wiring and the resistance of the speed sensor. Check that the sensor is securely mounted and the sensor wheel is not damaged (sensor wheel is mounted to crankshaft). |
| 2113 | **Camshaft position (CMP) sensor (G40)**–missing or incorrect signal from sensor, CMP wiring damaged/open or shorted, CMP (Hall) sensor faulty. | Check the wiring and signal from of the CMP (Hall) sensor. On 4-cylinder engines, check that the distributor is correctly installed. On 6-cylinder engines, check that the sensor is securely mounted to the cylinder head. Test the signal from the Hall sensor. Check camshaft/valve timing. |
| 2212 | **Throttle position (TP) sensor (G69)**–missing or incorrect signal from TP sensor, TP sensor wiring damaged/open or shorted, TP sensor faulty. | Check the wiring and signal from the TP sensor. |
| 2312 | **Engine coolant temperature (ECT) sensor (G62)**–missing or incorrect signal from ECT sensor, ECT sensor wiring damaged/open or shorted, ECT sensor faulty | Check the wiring and signal from the ECT sensor. Check for corrosion at the connector, causing intermittent (sporadic) malfunctions. |
| 2142 | **Knock sensor (KS) I (G61)**–missing or incorrect signal from knock sensor to ECM, knock sensor wiring damaged/open or shorted, knock sensor faulty or sensor mounting bolt loose | Check the wiring and signal from knock sensor I. Check the torque of the mounting bolt to the block. Check for corrosion between sensor and engine block. See also DTC 2141. If no faults can be found, the ECM may be faulty. |
| 2144 | **Knock sensor (KS) II (G66)**–(6-cylinder engine only) missing or incorrect signal from knock sensor to ECM, knock sensor wiring damaged/open or shorted, knock sensor faulty or sensor mounting bolt loose. ECM faulty. | Check the wiring and signal from knock sensor II. Check the torque of the mounting bolt to the block. Check for corrosion between sensor and engine block. If no faults can be found, the ECM may be faulty. |
| 2342 | **Heated oxygen sensor (G39)**–no oxygen sensor signal to ECM. Sensor heater circuit may be open or faulty. | Check the oxygen sensor output signal (voltage fluctuating between 0 and 1.0 volt). Check oxygen sensor heater circuit. |
| 2412 | **Intake air temperature (IAT) sensor (G72)** – missing or incorrect signal from IAT sensor, IAT sensor wiring damaged/open or shorted, IAT sensor faulty. | Check the wiring and signal from the IAT sensor. |
| 2234 | **Battery voltage**–incorrect system voltage (below 10 volts or over 16 volts with engine running). | Check the charging system, battery connections, and main grounds. |
| 2231 | **Idle air control (IAC)** – self-compensating idle circuit problem (incorrect idle speed or idle mixture too lean or too rich). | Check the IAC valve (dirty, sticking, binding). Check for air leak between MAF sensor and intake manifold. Check EGR valve operation. |
| 2141 | **Knock sensor (KS) I (G61) Control** – faulty knock sensor control in Motronic ECM. | Check the knock sensor (see DTC 2142 above). If no faults can be found, the ECM is probably faulty and should be replaced. |
| 2341 | **Oxygen sensor control**– Incorrect oxygen sensor signal to ECM (fuel mixture too lean or to rich). Sensor heater circuit may be open or faulty. | Check the oxygen sensor heater circuit and sensor output signal first. **Lean:** check exhaust system for leaks between catalytic converter and exhaust manifold, check for intake air leaks (unmeasured air). Check fuel pressure (too low). **Rich:** check ignition system for misfire, check fuel pressure (too high), check for leaking or stuck open fuel injectors, check the Evaporative (EVAP) emission system (purge regulator valve stuck open). |
| 2214 | **Maximum engine speed limit reached**–engine over-revved (incorrect downshift) or signal from engine speed signal incorrect. | Check the engine speed sensor wiring (shielding) for faults. |
| 2314 | **Engine-to-transmission electrical connection**–wire shorted to ground (cars with automatic transmission). | Check the wire between Motronic ECM (pin 18) and transmission control module (TCM) (pin 28). |

**(continued on next page)**

**Table a. Motronic Diagnostic Trouble Codes (Blink Codes) 1993–1995 model years (continued)**

| DTC | Probable fault | Corrective action, first check |
|---|---|---|
| 2243 | **Fuel consumption signal**– signal wire from ECM to instrument cluster shorted to battery positive (B+). | Check wire between ECM (pin 51) and instrument cluster (connector T1e). |
| 2324 | **Mass air flow (MAF) sensor (G70)**–MAF sensor faulty, missing or incorrect signal, MAF sensor wiring damaged/open or shorted. Large intake air leak. | Check the MAF sensor connections and wiring. Check for intake air leaks. On VR6 engines, check for sensor burn-off. On 4-cylinder engines, check for excessive oil deposits on sensor element. |
| 2413 | **Mixture control adjustment**–fuel mixture too lean or too rich. | Check for conditions causing rich or lean running conditions (see DTC 2342 and 2231, 2341). Check the oxygen sensor heater circuit. Check the EVAP canister purge regulator valv (always open). |
| 2411 | **EGR temperature sensor (G98)**–faulty sensor or sensor wire shorted to ground. | Check the wiring and resistance of EGR temperature sensor. |
| 3434 | **Heated Oxygen Sensor Relay (J278)**–heater relay/circuit malfunctioning (6-cylinder engines). | Check the oxygen sensor heater circuit. |
| 4311 | **Secondary air injection solenoid relay (N299)**–faulty relay or wiring to relay damaged/open or shorted. | Check the wiring to relay. Check function of relay. |
| 4313 | **Secondary air injection solenoid valve (N112)**–faulty valve or wiring to valve damaged/open or shorted. | Check the wiring to valve. Check function of solenoid valve. |
| 4332 | **ECM final output stage**–faulty ECM or mechanical fault/ loose connections to ECM output components. | Check the wiring and test all output component functions (IAC valve, fuel injectors, EVAP canister purge regulator valve, ignition coil, fuel pump). If no faults can be found, the ECM i probably faulty and should be replaced. |
| 4343 | **EVAP canister purge regulator valve (N80)**–faulty valve or wiring to valve damaged/open or shorted. | Check the wiring to valve. Check function of solenoid valve. |
| 4411 | **Fuel injector no. 1 (N30)**–injector faulty or wiring to valve damaged/open or shorted. | Check the wiring to valve. Check for injector signal using LED test light or injector signal tester. If signal is present, injector is probably faulty and should be replaced. |
| 4412 | **Fuel injector no. 2 (N31)**–injector faulty or wiring to valve damaged/open or shorted. | See DTC 4411. |
| 4413 | **Fuel injector no. 3 (N32)**–injector faulty or wiring to valve damaged/open or shorted. | See DTC 4411. |
| 4414 | **Fuel injector no. 4 (N33)**–injector faulty or wiring to valve damaged/open or shorted. | See DTC 4411. |
| 4421 | **Fuel injector no. 5 (N83)**–injector faulty or wiring to valve damaged/open or shorted. | See DTC 4411. |
| 4422 | **Fuel injector no. 6 (N84)**–injector faulty or wiring to valve damaged/open or shorted. | See DTC 4411. |
| 4431 | **Idle air control (IAC) Valve (N71)**– faulty IAC valve or wiring to valve damaged/open or shorted. | Check the IAC valve (dirty, sticking, binding). Check for air leak between MAF sensor and intake manifold. Check EGR valve operation. |
| 4433 | **Fuel pump relay (J17)**–relay not operating or wiring shorted to battery positive (B+). | Check the relay wiring. Test relay circuit. see **20 Fuel Storage and Supply.** |
| 4312 | **EGR vacuum regulator solenoid valve (N18)**–faulty valve or wiring to valve damaged/open or shorted. | Check the wiring to valve. Check function of solenoid valve. |
| 1111 | **Motronic engine control module (ECM) (J220)**– ECM faulty (electronic component failure in ECM). | If no other faults can be found, the ECM is probably faulty and should be replaced. |

## To erase DTC memory

1. Connect appropriate jumper or adapter to the DLC as previously described.
2. Switch ignition on, but do not start engine.

***NOTE—***
*Fuel pump will switch on without engine running.*

3. Leave jumper or adapter connected for at least 5 seconds and then disconnect.
4. Reconnect jumper or adapter for 2.5 seconds and then disconnect.
5. The first blink code will be displayed.
6. Repeat step 4 to display all blink codes stored in memory until 4 long blinks (0-0-0-0) are displayed.

***NOTE—***
*All blink codes must be displayed before they can be erased.*

7. Reconnect jumper wire or adapter for 2.5 seconds and remove it. The DTC memory is now erased.
8. Switch the ignition off.

***NOTE—***
*Confirm that the memory has been erased by displaying blink codes. Only blink code 2-1-1-1 should be displayed.*

# FUEL PRESSURE TESTS (1993–1999 models)

Checking the fuel pressure is a fundamental part of troubleshooting and diagnosing the Motronic system. Fuel pressure has a direct effect on fuel mixture and driveability. An accurate fuel pressure gauge with a range of at least 0 to 5 bar (approximately 0 to 100 psi) will be needed to make the tests. Fig. 7 shows the connection of the fuel gauge.

There are two significant fuel pressure values: 1) System pressure—created by the main fuel pump and regulated by the fuel pressure regulator, and 2) Residual pressure—the pressure maintained in the closed system after the engine is shut off.

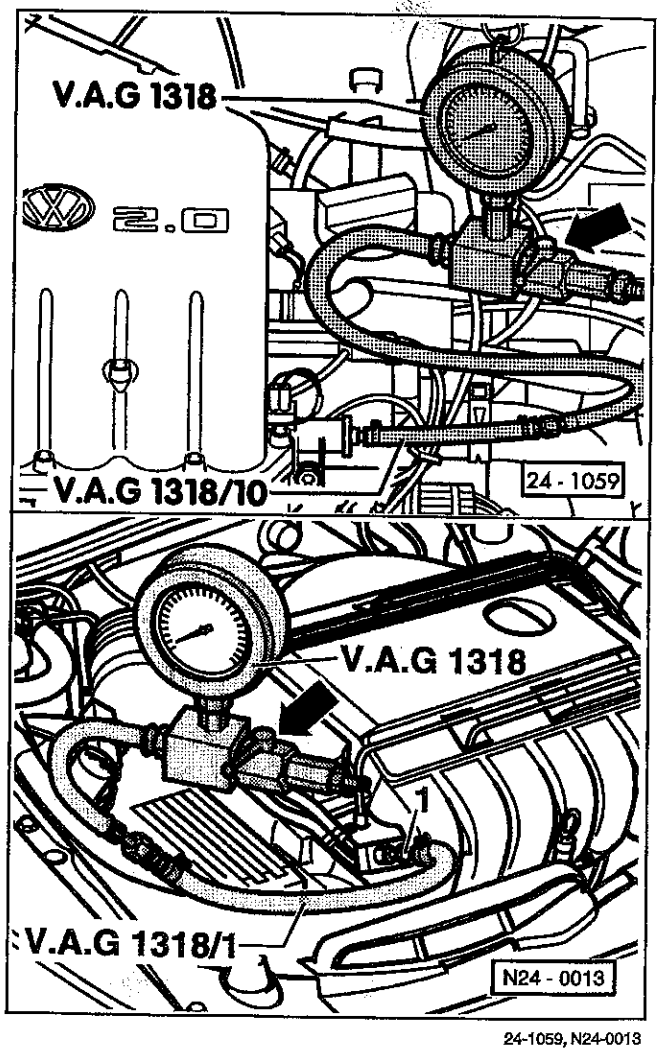
Before making the tests described below, make sure the fuel pump is operating correctly and that the fuel pump delivery rate is within the acceptable limit. See **20 Fuel Storage and Supply**.

***WARNING—***
*Fuel will be discharged when disconnecting fuel lines. Do not smoke or work near heaters or other fire hazards. Have a fire extinguisher handy. Work only in a well- ventilated area. Relieve fuel pressure in the line (as described earlier) or wrap a cloth around the line before disconnecting.*

***NOTE—***
*Some late model cars with the ABA (2.0 liter) engine are not equipped with a fuel rail test port. On these cars, disconnect the fuel supply line and connect the gauge (using a T-fitting) between the fuel rail and the supply line.*

## To check system line pressure

1. Relieve the fuel pressure in the system and connect a fuel pressure gauge as shown in Fig. 7




24-1059, N24-0013

**Fig. 7.** Fuel pressure gauge installation on ABA engine (**top**) and AAA engine (**bottom**). Remove the cap screw from the test port and connect the gauge line.

2. Start the engine and let it idle. See **Table b** for fuel pressure specifications.

***NOTE—***
*If the engine does not start, run the fuel pump by bypassing the fuel pump relay as described in* **20 Fuel Storage and Supply.**

3. With the engine idling, disconnect the small vacuum hose from the fuel pressure regulator (FPR) and check that the fuel pressure increases as specified.

**Table b. Fuel System Line Pressure**

| Engine | Fuel Pressure |
|---|---|
| ABA engine (2.0 liter)<br>vacuum hose @ FPR connected<br>vacuum hose @ FPR disconnected | <br>2.5 bar (36 psi)<br>3.0 bar (43 psi) |
| AAA engine (2.8 liter)<br>vacuum hose @ FPR connected<br>vacuum hose @ FPR disconnected | <br>3.5 bar (51 psi)<br>4.0 bar (58 psi) |

If system pressure is too high, first check for a blocked or damaged fuel return line from the pressure regulator. Also check the return line check valve on ABA engines. If there are no obstructions, replace the pressure regulator.

If system pressure is too low, first check for fuel leaks. Test fuel pump delivery as described in **20 Fuel Storage and Supply.** A restricted fuel filter or a damaged fuel line are also potential causes. If there are no other faults, replace the pressure regulator.

***NOTE—***
*Additional fuel pump tests, including testing the fuel pump relay, are covered in* **20 Fuel Storage and Supply.**

## To check residual pressure

Hot-start problems are usually the only reason to suspect a residual pressure problem, but it deserves a routine check as long as the gauge is connected.

1. Relieve the fuel pressure in the system and connect a fuel pressure gauge as shown earlier in Fig. 7.

2. Run the engine for about 30 seconds to pressurize the system.

3. Turn the engine off.

4. After ten minutes, observe the pressure gauge. See **Table c.**

**Table c. Residual Fuel Pressure (after ten minutes)**

| Engine | Fuel Pressure |
|---|---|
| ABA engine (2.0 liter) | 2.0 bar (29 psi) |
| AAA engine (2.8 liter) | 2.5 bar (36 psi) |

If the pressure drops beyond specification, check for leaks in the fuel lines, at the fuel pump, and at the fuel injectors. there are no leaks, either the pressure regulator or the fuel pump check valve is faulty.

To determine which, run the engine briefly to build pressure. Shut the engine off and immediately clamp shut the fuel return line at the pressure regulator. If pressure still drops, the fuel pump check valve is faulty. See **20 Fuel Storage and Supply** for fuel pump replacement. If residual pressure is now OK, the pressure regulator is faulty.

# ELECTRICAL CHECKS AND COMPONENT TESTING (1993–1995 models)

The electrical tests under this heading will help to locate electrical component failure. Unless a specific diagnostic trouble code (DTC) has been recorded, make the ECM pin-out test first as listed in **Table d.** The checks listed in the table check the components and wiring to the components.

The ECM is mounted in the rear of the engine compartment. With the ignition off for at least a minute, unplug the connector from the ECM. See Fig. 8. Terminals are marked on the harness connector.

***CAUTION—***
- *Use a high-quality digital automotive multimeter to make the tests. An analog (swing-needle) meter should not be used as it can permanently damage electronic components.*
- *Always connect and disconnect the ECM connector and meter probes with the ignition off to avoid damage to electronic components. Wait at least 40 seconds after turning off the ignition before removing the ECM connector.*

References to Motronic components and their connector terminals are used throughout the table. Use the appropriate wiring diagram to identify these terminals. See **97 Wiring Diagrams, Fuses and Relays.**

When making tests at harness connectors, probe from the rear of the connector only to avoid damaging the small connector terminals. Separate the connector housing and remove any seals to gain access to the wiring in the connector.

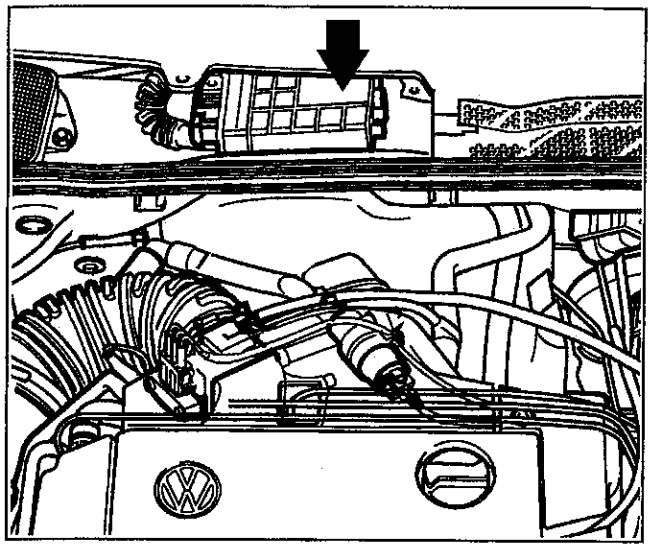



**Fig. 8.** Motronic ECM in rear of engine compartment (**arrow**). Separate harness connector and make connections from rear of connector.

Before making any electrical checks or tests, make sure the following conditions are met:

**Basic Requirements**

- Battery positive (+) voltage OK
- Fuse no. 18 (and no. 21 on AAA engines) OK
- Ground connections on engine and transmission OK, especially the connections at the ground bus below the intake manifold
- Fuel pump and fuel pump relay OK. See **20 Fuel Supply and Storage.**

## Power Supply Components

The Motronic engine management system relies on three relays for proper operation; the power supply relay, the oxygen sensor heater relay, and the fuel pump relay. See Fig. 9.

All three relays are energized (grounded) by the Motronic ECM. The power supply relay supplies power to the ECM and many of the Motronic components when the engine is running. If this relay is faulty, the engine will not start. The oxygen sensor heater relay supplies positive (+) voltage to the oxygen sensor heating element to heat the sensor. The fuel pump relay supplies power to the fuel pump. A basic check of these relays is given in **Table d.**

***NOTE—***

*Fuel pump electrical tests are covered in* **20 Fuel Storage and Supply.**

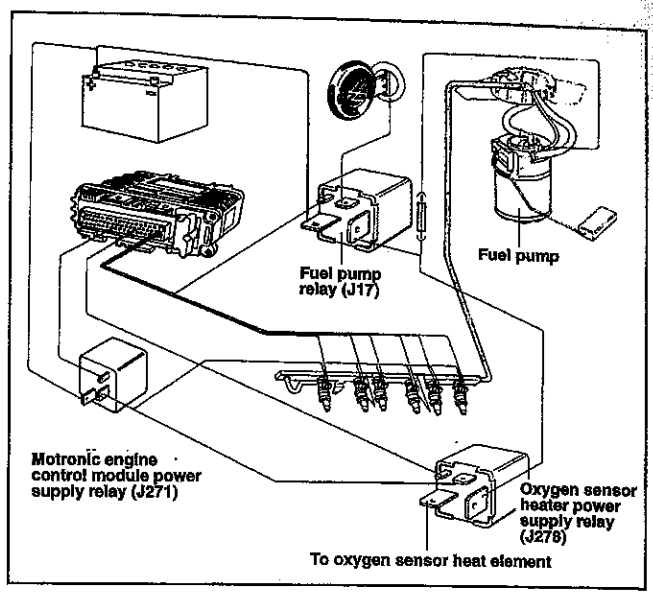



**Fig. 9.** Power supply components.

## To test power supply relay (J16 or J271)

1. Working at the fuse/relay panel, remove the power supply relay. See Fig. 10.

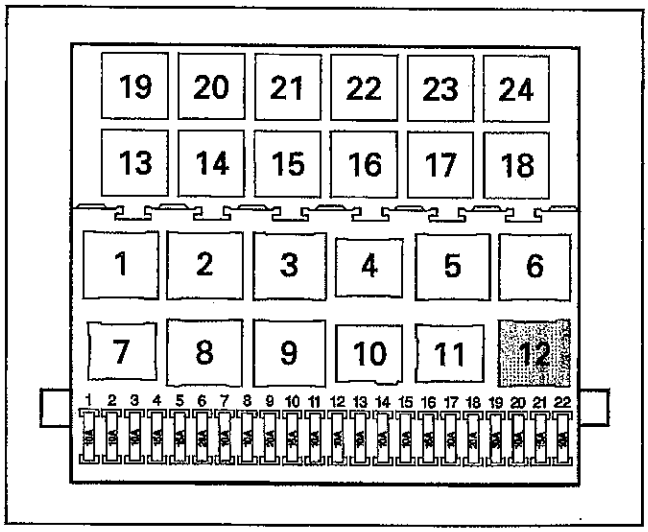



**Fig. 10.** Motronic power supply relay in fuse/relay panel (**position 12**).

2. Check for constant (+) battery voltage at relay terminal 30 in the fuse/relay panel.

3. Reinstall the relay and check that the relay clicks each time the ignition key is turned on.

4. If no faults are found, disconnect the harness connector from the Motronic ECM and separate the connector housing. Reconnect the connector to the ECM.

5. Check for ground at ECM terminal 9 each time the ignition is switched on.
   - If ground is not present, check the wiring between relay terminal 85 in the fuse/relay panel and terminal 9 in the ECM connector (black/brown wire). If no wiring faults are found, the ECM is most likely faulty.

6. Check for positive (+) battery voltage at ECM terminal 23 whenever the ignition is on.
   - If power is not present, check the wiring between relay terminal 87 in the fuse/relay panel and terminal 23 in the ECM connector (red/blue wire). If no wiring faults are found, the relay is most likely faulty.

## To test oxygen sensor heater relay (J208 or J278)

Be sure both the main relay and the fuel pump relay are functioning correctly before testing the oxygen sensor heater relay.

***NOTE —***
*Fuel pump electrical tests are covered in* **20 Fuel Storage and Supply**.

1. Working at the back of the engine, disconnect the oxygen sensor harness connector.

2. Connect a voltmeter between the red/white wire and the brown or brown/red wire in the connector. There should be battery voltage with the engine running. Reconnect the connector.
   - If voltage is present, the relay is working correctly.
   - If voltage is not present continue testing.

3. Working above the main fuse/relay panel, remove the oxygen sensor heater relay (position 13). See Fig. 1

4. Check for battery voltage at relay socket terminal 85 with the ignition key on. Check for battery voltage at relay socket terminal 30 (red/yellow wire) in the relay panel with the engine running.
   - If voltage is not present, check the wiring to the relay sockets. Voltage to terminal 85 is supplied via the power supply relay and voltage to terminal 30 is supplied via the fuel pump relay.

5. Reinstall the relay. Then working through the rear of the relay, check for ground at relay terminal 31 (white wire) with the engine running.
   - If ground is not present, check the wire between the relay and the Motronic ECM (terminal 28). If no wiring faults can be found, the ECM may be faulty.
   - If no electrical faults are found up to this point, the relay is probably faulty and should be replaced.

**Table d. Motronic ECM Electrical Tests**

| Component or circuit | Test terminals (at disconnected ECM connector unless otherwise noted) | Test conditions | Test value |
|---|---|---|---|
| ECM power supply (constant) | 1 (-) and 54 (+) | — | Approx. battery voltage |
| ECM power supply (switched, from power supply relay) | 1 (-) and 23 (+) | Jumper terminals 9 and 55 at ECM connector | Approx. battery voltage (power supply relay will click) |
| Fuel pump relay (J17) | Jumper terminals 6 and 55 | Turn ignition on | Fuel pump runs (fuel pump relay will click) |
| Heated oxygen sensor relay (J208 or J278) | **4-cylinder engine only** Jumper terminals 1 and 28 briefly | Jumper terminals 9 and 55 Turn ignition on | Heated oxygen sensor relay closes/opens (clicks) each time wire is connected |
| Malfunction indicator light (MIL) (K83) | Jumper terminals 5 and 55 | Turn ignition on | MIL lights up |
| Vehicle speed sensor (VSS) (G22) | **4-cylinder engine** 1 and 65 | Ignition on Raise and spin front left wheel Cars with **A/T:** selector lever in "D" Cars with **manual transmission:** shift lever in neutral | 0-4 volts (VAC), fluctuating |
| | **6-cylinder engine** 56 and 65 | | 0-10 volts (VAC), fluctuating |

**(continued on next page)**

**Table d. Motronic ECM Electrical Tests (continued)**

| Component or circuit | Test terminals (at disconnected ECM connector unless otherwise noted) | Test conditions | Test value |
|---|---|---|---|
| Main grounds (GND) | 1 and 54 | — | Approx. battery voltage |
| | 10 and 54 | 4-cylinder engine: NY and Calif. cars only<br>6-cylinder engine: all models | Approx. battery voltage |
| | 33 and 54 | — | Approx. battery voltage |
| | 55 and 54 | — | Approx. battery voltage |
| | 56 and 54 | — | Approx. battery voltage |
| | **with A/T only**<br>58 and 54 | — | Approx. battery voltage |
| | **with man. trans. only**<br>7(-) and 54 | — | Approx. battery voltage |
| Park/neutral position relay wiring (A/T) | **4-cylinder engine**<br>7 and 54 | Selector lever in Park or Neutral<br>Ignition on | Approx. battery voltage |
| | **6-cylinder engine**<br>1 and 7 | Selector lever in Park.<br>Disconnect connector from ignition coil and operate starter | Approx. 2 volts less than battery voltage |
| A/C signal On signal | 55 (-) and 39 (+) | Turn ignition on<br>Turn fresh air blower on<br>Turn A/C on | Approx. battery voltage |
| A/C compressor | Jumper terminals 37 and 38 briefly | Ignition on | A/C compressor clutch clicks each time wire is connected |
| Fuel injector coil resistance<br>**4-cylinder engine**<br>no. 1 (N30)<br>no. 2 (N31)<br>no. 3 (N32)<br>no. 4 (N33) | <br><br>24 and 23<br>2 and 23<br>25 and 23<br>26 and 23 | <br><br>—<br>—<br>—<br>— | <br><br>14-21.5 ohms<br>14-21.5 ohms<br>14-21.5 ohms<br>14-21.5 ohms |
| **6-cylinder engine**<br>no. 1 (N30)<br>no. 2 (N31)<br>no. 3 (N32)<br>no. 4 (N33)<br>no. 5 (N83)<br>no. 6 (N84) | 23 and 24<br>3 and 23<br>23 and 26<br>4 and 23<br>23 and 25<br>2 and 23 | —<br>—<br>—<br>—<br>—<br>— | 14-21.5 ohms<br>14-21.5 ohms<br>14-21.5 ohms<br>14-21.5 ohms<br>14-21.5 ohms<br>14-21.5 ohms |
| Evaporative (EVAP) canister purge regulator valve (N80) | 23 and 31 | — | 40-80 ohms |
| Engine coolant temperature (ECT) sensor (G62) | 14 and 33 | — | Resistance varies with temperature. See **Engine Coolant Temperature (ECT) Sensor (G62)** |
| Data link connector (DLC)–**1993 and early 1994** (See Fig. 6 shown earlier) | 21 of ECM and terminal 1 of white data link connector (DLC) | Ignition off | Maximum 1.5 ohms |
| | 43 of ECM and terminal 2 of white data link connector (DLC) | Ignition off | Maximum 1.5 ohms |
| Data link connector (DLC)–**later 1994 and 1995** (See Fig. 6 shown earlier) | 21 of ECM and terminal 4 of 16-pin DLC (L-wire) | Ignition off | Maximum 1.5 ohms |
| | 43 of ECM and terminal 1 of 16-pin DLC (K-wire) | Ignition off | Maximum 1.5 ohms |

**(continued on next page)**

**Table d. Motronic ECM Electrical Tests (continued)**

| Component or circuit | Test terminals (at disconnected ECM connector unless otherwise noted) | Test conditions | Test value |
|---|---|---|---|
| Wiring to heated oxygen sensor (G39) | 20 and 42 | Disconnect oxygen sensor harness connector (rear of engine) and jumper terminals 3 and 4 | Maximum 1.5 ohms |
| | | Reconnect connector | Infinite ohms |
| Throttle position (TP) sensor (G69) wiring | 33 and 41 | — | 4-cylinder: 1.6 to 2.4 k ohms<br>6-cylinder: 1.5 to 2.5 k ohms |
| | 33 and 40 | Throttle closed | 4-cylinder: 1.0 to 2.0 k ohms<br>6-cylinder: 0.7 to 1.3 k ohms |
| | | Open throttle slowly | Resistance increases steadily |
| | 40 and 41 | Throttle closed | 4-cylinder: 2.5 to 4.0 k ohms<br>6-cylinder: 2.5 to 3.5 k ohms |
| | | Open throttle slowly | Resistance decreases steadily |
| Camshaft position sensor (CMP) (G40) wiring | 44 and 56 | Disconnect harness connector from camshaft position sensor and jumper terminals 1 (white/red wire) and 2 (brown/black or brown/yellow) in connector | Maximum 1.5 ohms |
| **4-cylinder engine**<br>Ignition coil power output stage (N157) wiring | | Disconnect harness connector from ignition coil output stage | |
| | 8 and 55 | Jumper terminals 1 and 2 in connector | Maximum 1.5 ohms |
| | 8 and 38 | Jumper terminals 2 and 3 in connector | Maximum 1.5 ohms |
| **6-cylinder engine**<br>Ignition coil (N152) wiring | | Disconnect harness connector from ignition coil | |
| | 8 and 55 | Jumper terminals 1 and 2 in connector | Maximum 1.5 ohms |
| | 60 and 55 | Jumper terminals 1 and 3 in connector | Maximum 1.5 ohms |
| | 52 and 55 | Jumper terminals 1 and 4 in connector | Maximum 1.5 ohms |
| | 38 and 55 | Jumper terminals 1 and 5 in connector | Maximum 1.5 ohms |
| Knock sensor I (G61) wiring | | Disconnect harness connector to knock sensor I (at rear of engine) | |
| | 33 and 34 | Jumper terminals 1 and 2 in connector | Maximum 1.5 ohms |
| | 34 and 56 | Jumper terminals 1 and 3 in connector | Maximum 1.5 ohms |
| Knock sensor II (G66) wiring | | Disconnect harness connector to knock sensor II (near starter) | |
| | 33 and 56 | Jumper terminals 2 and 3 in connector | Maximum 1.5 ohms |
| | 57 and 56 | Jumper terminals 1 and 3 in connector | Maximum 1.5 ohms |
| Intake air temperature (IAT) sensor (G72) | 33 and 36 | — | Resistance varies depending on temperature. See **To test intake air temperature sensor** |
| Idle air control (IAC) valve (N71) | 27 and 53 | — | 4-cylinder: 7 to 10 ohms<br>6-cylinder: 6 to 12 ohms |

**(continued on next page)**

**Table d. Motronic ECM Electrical Tests (continued)**

| Component or circuit | Test terminals (at disconnected ECM connector unless otherwise noted) | Test conditions | Test value |
|---|---|---|---|
| **4-cylinder engine**<br>Mass air flow (MAF) sensor (G70) wiring | | Disconnect harness connector from MAF sensor | |
| | 1 and 16<br>1 and 23<br>1 and 17 | Jumper terminals 1 and 2 in connector<br>Jumper terminals 1 and 3 in connector<br>Jumper terminals 1 and 4 in connector | Maximum 1.5 ohms<br>Maximum 1.5 ohms<br>Maximum 1.5 ohms |
| **6-cylinder engine**<br>Mass air flow (MAF) sensor (G70) wiring | | Disconnect harness connector from MAF sensor | |
| with 4-pin connector | 16 and 17 | Jumper terminals 2 and 4 in connector | Maximum 1.5 ohms |
| with 6-pin connector | 1 and 16 | Jumper terminals 1 and 2 in connector | Maximum 1.5 ohms |
| | 1 and 17 | Jumper terminals 1 and 3 in connector | |
| | 56 and 59 | Jumper terminals 1 and 4 in connector | |
| | 1 and 23 | Jumper terminals 1 and 5 in connector | |
| Engine speed/reference sensor (G28) | 67 and 68 | — | 500-700 ohms |
| **Cars with EGR**<br>EGR temperature sensor (G98) | 15 and 33 | Disconnect harness connector from EGR solenoid valve (N18) and jumper terminals 1 and 2 in connector | Maximum 1.5 ohms |
| **Cars with EGR**<br>EGR vacuum regulator solenoid valve (N18) | 23 and 30<br>23 and 30 | —<br>Disconnect harness connector from solenoid valve and jumper terminals 1 and 2 in connector | 27-31 ohm<br>Maximum 1.5 ohms |
| Secondary air injection (AIR) pump relay (J299) | Jumper terminals 9 and 55 | Jumper terminals 1 and 49 briefly | AIR pump relay clicks each time wire is connected |
| Secondary air injection (AIR) pump motor (V101) | Jumper terminals 9 and 55 | Jumper terminals 1 and 49 briefly | AIR pump motor runs each time wire is connected |
| Secondary air injection (AIR) solenoid valve (N112) | Jumper terminals 9 and 55<br>Disconnect harness connector from pump motor | Jumper terminals 1 and 50 briefly | AIR solenoid valve clicks each time wire is connected |

## Engine Coolant Temperature (ECT) Sensor (G62)

The ECT sensor is one of the main inputs to the engine management system. Its signal is used to adapt ignition timing, injection time, and idle speed stabilization. In addition, the ECT signal is used to activate the knock control system, the idle speed control system, oxygen sensor operation, fuel tank venting, and exhaust gas recirculation (EGR).

The ECT sensor sends continuous engine temperature information to the Motronic ECM. If there is a break in the signal from the temperature sensor, the ECU will simulate a fixed signal based on an engine temperature of 176 °F (80°C).

On 4-cylinder engines, the ECT sensor (G62) is mounted in the coolant outlet on the rear of the cylinder head. The ECT sensor is combined with the temperature gauge sensor (G2) in a single housing. The sensor body is black and the sensor has four terminals. See Fig. 11.

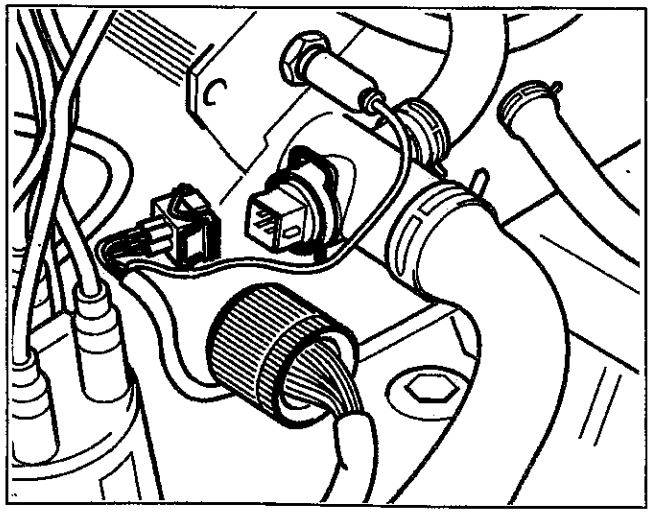



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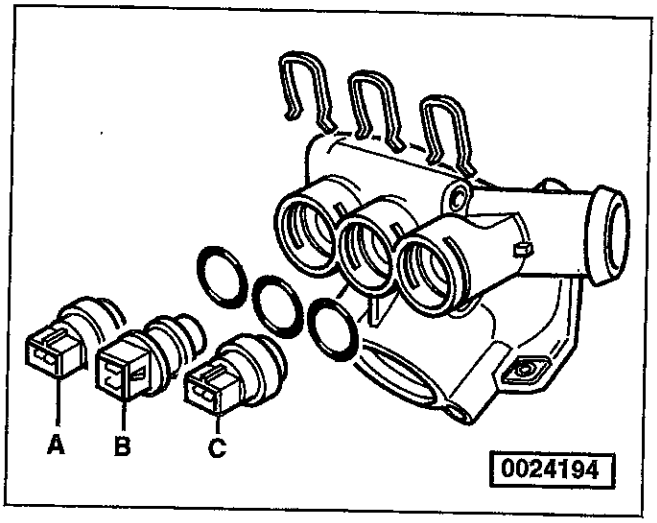
**Fig. 11.** ECT sensor on 4-cylinder engine. Check sensor resistance at terminals 1 (blue wire) and 3 (brown/green wire).

On 6-cylinder engines, the ECT sensor is mounted in the thermostat housing. The sensor body is blue and the sensor has two terminals. See Fig 12.

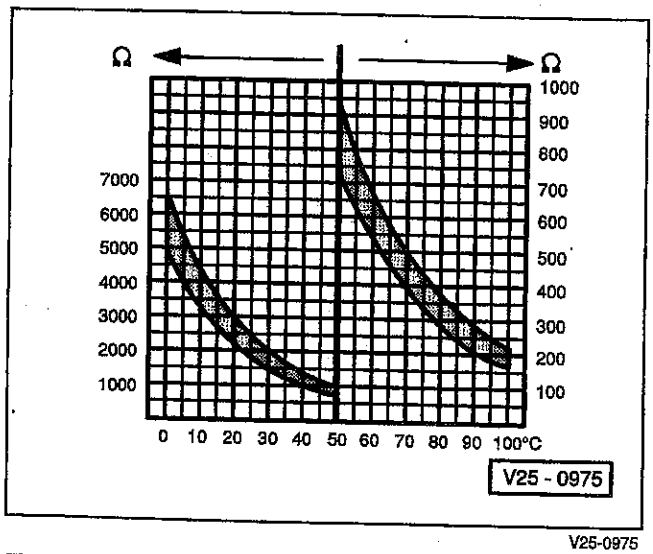



0024194

**Fig. 12.** Coolant sensor arrangement on VR-6 engines. ECT sensor (G62) (**A**-blue), coolant gauge sensor (G2) with after-run fan switch (F87) (**B**-yellow), and A/C thermal cut-out switch (F163) with third speed coolant fan switch (F165) (**C**-brown).

To test the ECT sensor, disconnect the harness connector and connect an ohmmeter across the sensor terminals with the engine cold. Start the engine and allow it to warm up. Compare the meter readings to the graph shown in Fig. 13. If any faults are found, the sensor should be replaced.

***NOTE—***
*On 4-cylinder engines, test across terminals 1 (blue wire) and 3 (brown/green wire) in the sensor.*

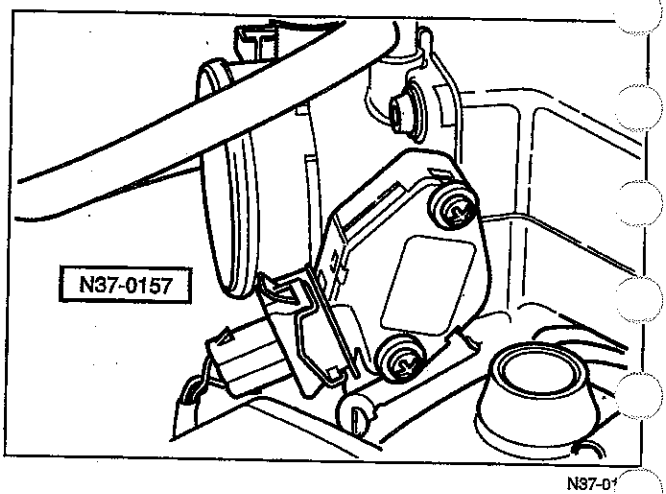



V25-0975

**Fig. 13.** Graph showing coolant temperature sensor resistance vs. temperature.

## Throttle Position (TP) Sensor (G69)

The TP sensor is mounted to the side of the throttle valve housing, directly connected to the throttle valve shaft. See Fig. 14. The ECM sends a 5-volt reference signal into the TP sensor. Depending on throttle position, the output voltage varies in relation to the throttle position.




N37-01

**Fig. 14.** Throttle position sensor mounted to throttle valve housing.

Test the TP sensor using the information given in **Table d** the test results are incorrect, the sensor should be replaced. The sensor is not adjustable. Use a new O-ring at throttle housing when replacing the sensor.

Check the reference voltage between terminals 1 and 3 in the 3-pin harness connector. There should be approximate 5 volts with the ignition on. If any faults are found, check t wiring between the sensor and the ECM. If no wiring faults can be found, the ECM may be faulty.

***CAUTION—***
*The signal from the throttle position (TP) sensor is also used by the automatic transmission control module (TCM). Volkswagen specifies that if the Motronic ECM, the TCM, the TP sensor or the throttle valve housing are replaced, the ECM and TCM "Basic Settings" should be "initiated" using the special V.A.G. 1551 scan tool. If these basic settings are not done, transmission shifting and driveability problems may be encountered.*

## Mass Air Flow (MAF) Sensor (G70)

The mass air flow (MAF) sensor provides the engine load signal to the ECM. The MAF sensor is located at the air filter housing and electronically measures the air entering the engine.

When the engine is running, an electrical current is used to heat a thin wire or film in the sensor. The current flowing through the wire/film is regulated to maintain a constant temperature above that of the intake air temperature. The amount of current required to heat the wire is the basis of the engine load signal. The MAF sensor has no internal moving parts and cannot be serviced, adjusted or accurately tested. See Fig. 15.

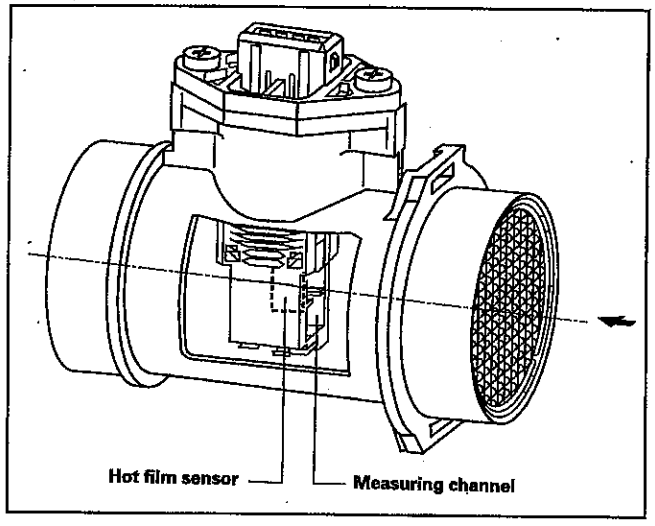



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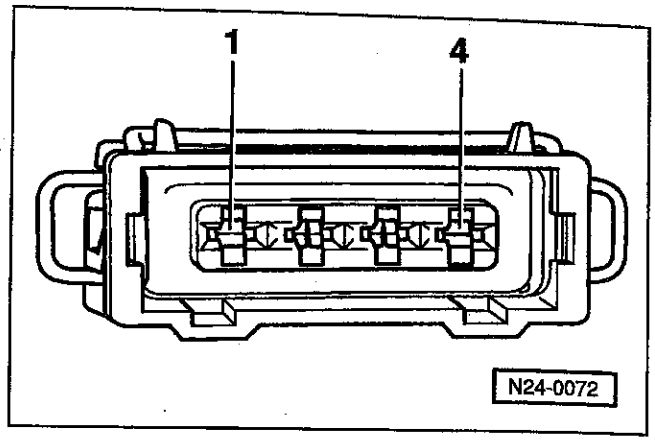
**Fig. 15.** Hot-film mass air flow (MAF) sensor used on 4- and 6-cylinder engines.

If there is no signal from the mass air flow (MAF) sensor, the ECM automatically switches to a "limp-home" mode, turns on the Check Engine light, and stores a DTC fault in permanent memory. The engine can still be started and driven in the "limp-home" mode.

## To check mass air flow (MAF) sensor voltage and ground

1. Disconnect the harness connector from MAF sensor.
2. Turn the ignition key on and check for voltage between terminals 1 (-) and terminal 3 (+) in the harness connector. See Fig. 16 for terminal identification.
   - If any faults are found, check the wiring to the MAF sensor using the appropriate the diagram found in **97 Wiring Diagrams, Fuses, and Relays.**




N24-0072

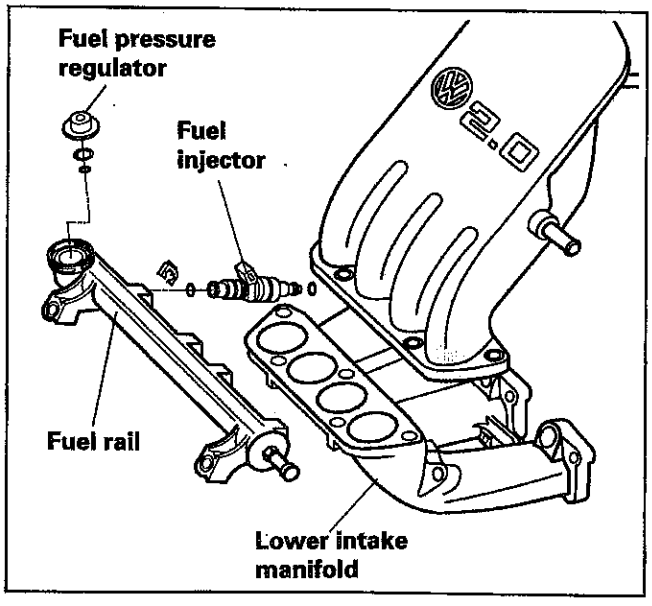
**Fig. 16.** Mass air flow (MAF) sensor harness connector terminal identification.

***NOTE—***

*On 4-cylinder engines, check for oil deposits on the sensor element. Over time oil vapors can collect on the sensor, owing to its mounted position. If the sensor is oil contaminated and a MAF sensor DTC has been stored, the sensor is most likely faulty and should be replaced.*

## Fuel Injectors

The fuel injectors are electrically operated solenoid valves. The injectors are connected to a common fuel supply, called the fuel rail. See Fig. 17.




0024034

**Fig. 17.** Fuel rail is common fuel supply and mounting for fuel injectors.

The injectors are supplied 12 volts by the power supply relay and the ground side of the injectors are sequentially switched on and off by the ECM. Injection quantity is based on the length of time the injectors are open.

## To test fuel injectors

The information below is an electrical test only. The test does not check injector spray patterns or fuel supply to the injectors.

***NOTE—***
*If you think an injector is bad, place a screwdriver or an automotive stethoscope on the injector with the engine running. The injector should be buzzing. If not, check for voltage to the injector and check its resistance as described below. If the injector is buzzing, very briefly unplug the harness connector from the injector with the engine running. If the injector is working correctly, there should be a noticeable, but small, rpm drop.*

1. Disconnect a harness connector from an injector and check the resistance across the injector terminals. Replace the injector if the resistance is incorrect.

| **Injectors** | |
|---|---|
| • resistance | 15 to 21.5 ohms |

2. Connect an LED test light, an injector tester, or a digital voltmeter across the connector terminals. See Fig. 18. When the engine is cranked, the LED should flash or the meter should indicate some voltage.

***CAUTION—***
*Use only a digital voltmeter, an LED test light or an LED injector tester. Use of an analog VOM or incandescent test light may damage the ECM.*

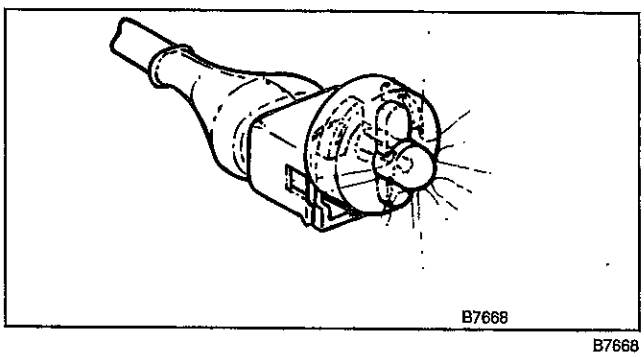


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**Fig. 18.** Special LED fuel injector tester connected to injector harness.

3. If there is no signal at the connector, check for power to the injector. There should be battery voltage (+) at red/blue wire of each injector connector with the ign... on. See Fig. 19. If not, check the wiring to the injector.

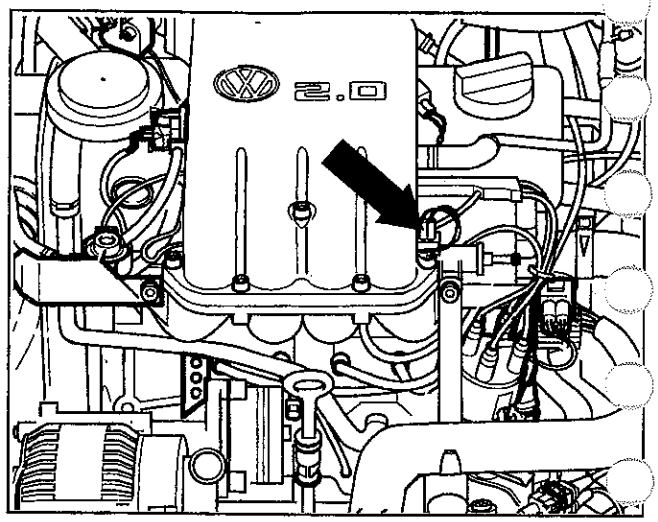

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**Fig. 19.** Check power to injector connector with ignition on. Chec... red-blue wire of connector (**arrow**).

4. If there is positive (+) battery voltage at the conne... but no pulsed ground signal, check the wiring betwe... the ECM and the injectors. If no wiring faults can be found, the ECM may be faulty.

## Oxygen Sensor (G39)

The heated oxygen sensor monitors the exhaust gas and provides the Motronic ECM with feedback about the air-fuel ratio and combustion efficiency. See Fig. 20. Using this in... mation, the ECM continuously adjusts the air-fuel mixture ... ensure optimum driveability and exhaust emissions. The sensor must be at a temperature of at least 600°F to gener... voltage, so it is electrically heated to help it reach operat... temperature more quickly.

The oxygen sensor produces a small voltage (0-1 v... based on the oxygen content in the exhaust gas as compared to the oxygen outside the exhaust pipe. The bigger the differential, the greater the output voltage. When the mixture is ri... there is very little oxygen in the exhaust (high output voltage). When the mixture is lean, there is an excess of oxygen in the exhaust (low output voltage).

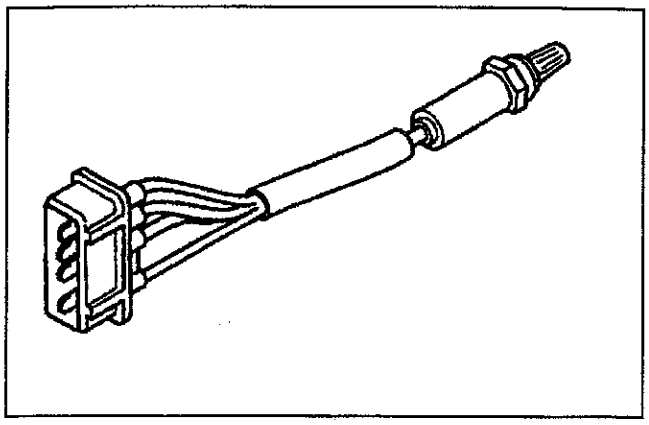
0024033

**Fig. 20.** Heated oxygen sensor monitors exhaust gas.

## To test oxygen sensor

1. Working at the back side of the engine, locate the 4-pin oxygen sensor harness connector.

> ***WARNING —***
> *Use care when working near a hot engine. The exhaust pipes and the engine surfaces can cause severe burns.*

2. Without disconnecting the harness connector, connect the positive lead of a voltmeter to terminal 4 (signal wire) of the connector. See Fig. 21. Connect the negative lead to chassis ground.

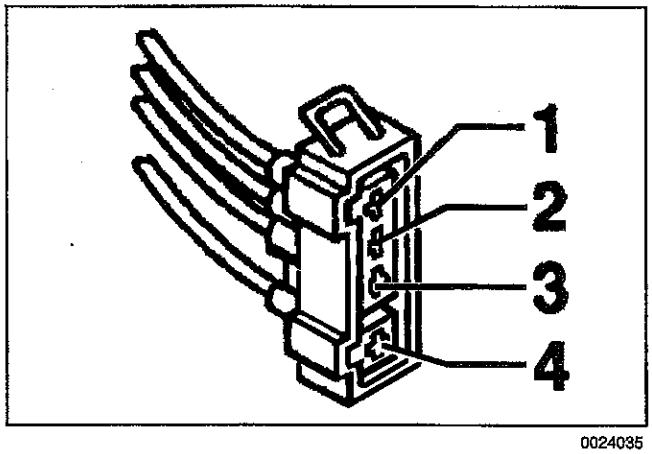

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**Fig. 21.** Oxygen sensor harness connector terminal identification.

3. Start the car and let it idle. The oxygen sensor should start to produce a fluctuating voltage within a short period.

**Oxygen sensor output signal**
- voltage at idle . . . . . 0.3 to 1.0 volt, fluctuating

***NOTE —***
*To further check sensor response to lean and rich mixtures, briefly disconnect an injector connector or pinch off the vacuum hose fuel pressure regulator and observe the sensor response.*

4. If the sensor output is incorrect, turn the engine off and check the sensor heater circuit. Disconnect the four-wire connector and check for battery voltage at terminals 1 and 2 with the engine running.
   - If voltage is not present, check the wiring to the heater.
   - If voltage is present, check the heater coil resistance across terminals 1 and 2 of the sensor side of the connector. If any faults are found, replace the sensor.

**Oxygen sensor**
- heater resistance . . . . . approx. 2 ohms

5. If the oxygen sensor signal is not as specified, and the heater circuit is OK, the sensor may be faulty.

***NOTE —***
*If the sensor signal is either very low or very high and fluctuating slightly, the Motronic adaptability limits may have been reached. Look for signs of rich (low output signal) or lean (high output signal) running characteristics before replacing the oxygen sensor.*

**Tightening Torque**
- Oxygen sensor to exhaust pipe . . . . . 50 Nm (37 ft-lb)

***NOTE —***
*Coat the oxygen sensor threads with an anti-seize compound before installation. Do not get the compound on the sensor tip. This can damage the sensor.*

## Idle Air Control (IAC) System

The Motronic ECM electronically controls the idle speed through the IAC valve (N71). See Fig. 22. The system automatically compensates for engine load and engine operating conditions, so periodic adjustment of the idle speed is unnecessary.

The Motronic ECM monitors engine rpm and other operating conditions such as air conditioning and automatic transmission loads, and then sends an electrical signal to open or close the valve. This changes the amount of air that bypasses the closed throttle valve.

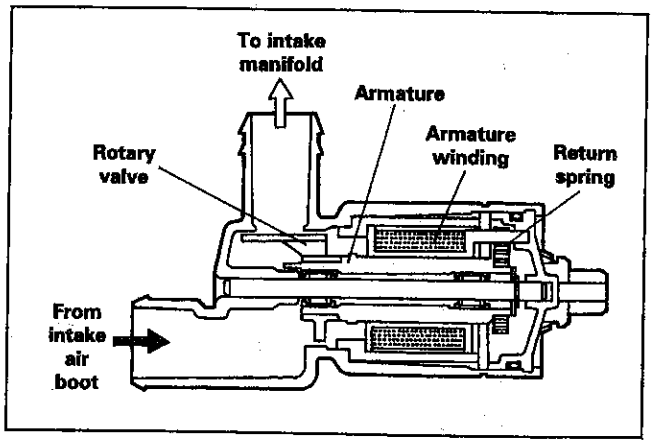


**Fig. 22.** Cutaway of IAC valve.

> ***CAUTION—***
> *Do not attempt to correct a faulty the idle speed by adjusting the position of the throttle valve stop screw. If the factory setting of this screw is altered, the complete throttle housing will need to be replaced—no adjustment specifications are available from Volkswagen. See* **Component Replacement.**

The IAC function is completely adaptive. The ECM remembers how far the valve was open the last time the engine was at idle and reverts to this as a base setting. In addition, the valve has a limp-home feature that maintains a fixed idle speed in the event of an IAC valve failure.

> ***NOTE—***
> *On high mileage cars, enough residue may collect on the throttle valve plate and bore to restrict air flow and affect the IAC system. If heavy residue is found, clean both the IAC valve and the throttle plate and bore before diagnosing IAC problems.*

Before proceeding with troubleshooting an idle problem, check that the throttle position sensor is working correctly as described earlier under **Throttle Position Sensor.**

## To test IAC system

1. With the engine running, grasp the IAC valve and check that it is buzzing.

2. If not, stop the engine and disconnect the harness connector from the valve. Check the resistance of the valve across its terminals. If resistance is incorrect, replace the valve.

> ***NOTE—***
> *If you suspect an intermittent fault, lightly tap the valve while you are testing resistance.*

**IAC Valve**
• resistance . . . . . 6 to 12 ohms

3. Connect an ammeter to the valve and check the valve current draw with the engine idling. If available, connect a duty cycle meter to the valve according to the manufacturer's instructions. Check that the current and duty cycle are within the specified ranges.
   • If there is no signal at the valve, check the wiring between the ECM and the valve. See **97 Wiring Diagrams, Fuses and Relays.**

**IAC Valve**
• current, engine idling . . . . . 620 ± 20 mA
• duty cycle, engine idling . . . . . 30%–50%

> ***NOTE—***
> • *If the idle speed is high and the current draw is also high or if the idle speed is low and the current draw is low, the problem is most likely a faulty electrical input to the ECM, telling it to maintain an incorrect idle speed. (i.e. engine speed signal, throttle position, A/C-on signals, and A/T drive position).*
> • *If the idle speed is low or normal but the current draw is high or if the idle speed is high or normal, but the current draw is low, the problem is most likely a mechanical problem, such as stuck/faulty IAC valve or a maladjusted throttle plate.*

## Camshaft Position (CMP) Sensor (G40)

The camshaft position (Hall) sensor identifies cylinder position for sequential fuel injection and knock regulation. On 4-cylinder engines, the camshaft position sensor is mounted within the ignition distributor. On 6-cylinder engines, the sensor is mounted in the end of the cylinder head, in the camshaft sprocket cover.

## To test CMP sensor

1. Remove fuse 18 from the main fuse/relay panel.

2. Disconnect the harness connector from the camshaft position sensor.

3. Connect a voltmeter between the two outer terminals in the connector and check for voltage with the ignition key on. If voltage is not present, check for wiring faults using the appropriate wiring diagram.
   • On 4-cylinder engines, there should be a minimum of 4-volts.
   • On 6-cylinder engines, there should be a minimum of 10-volts.

4. If voltage is present, peel back the protective rubber boot on the Hall sensor harness connector and then reconnect it to the sensor. Connect an LED test light between the center terminal and either of the outer terminals.

5. When the starter is actuated, the LED should flicker. If there is no reaction, the Hall sensor is defective and should be replaced. See **Component Replacement**.

***NOTE—***
*On 4-cylinder engines, the Hall sensor is not separately available from Volkswagen. If the sensor is faulty, the complete distributor body will need to be replaced.*

## Engine Speed (RPM) Sensor (G28)

The engine speed (rpm) sensor supplies engine speed and crankshaft (cylinder no. 1 TDC) position signals to the Motronic ECM. The sensor is mounted on the intake side of the cylinder block and reads a toothed wheel mounted on the end of the crankshaft. See Fig. 23.

If this sensor is faulty, the engine will not start. To check for a faulty sensor, crank the engine for at least six seconds and then check for a stored fault code (DTC) in the On-board Diagnostic memory as described earlier under **Diagnostic Trouble Codes**.

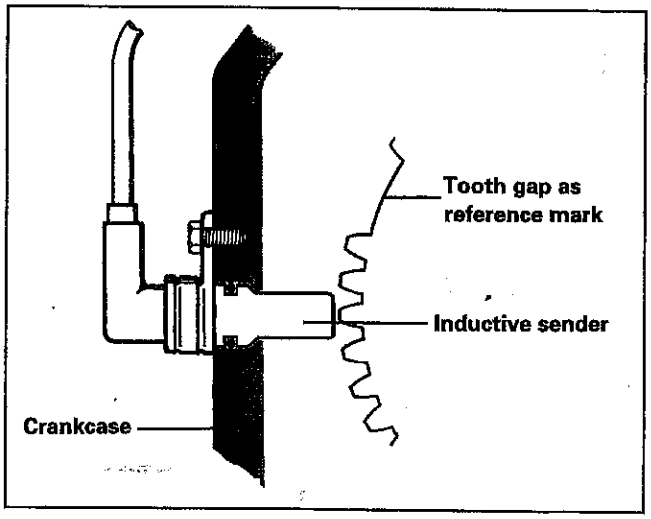


**Fig. 23.** Engine speed (RPM) sensor (G28) supplies engine speed and crankshaft position. TDC is signaled by two-tooth gap in wheel.

Carefully inspect the toothed wheel on the crankshaft for damage or deformed teeth. This can be accomplished through the sensor mounting hole or by removing the oil pan. There should be 58 teeth plus a 2-tooth gap on the wheel for both 4-cylinder and VR-6 engines. The toothed wheel can be replaced, but requires removal of the crankshaft.

| **Engine Speed (RPM) Sensor** | |
|---|---|
| • coil resistance | 500-700 ohms |

## Intake Air Temperature (IAT) Sensor (G72)

The intake air temperature (IAT) sensor sends continuous intake air temperature information to the Motronic ECM. This input is used primarily as a correction factor for ignition timing. If there is a break in the signal from the IAT sensor, the ECU will simulate a fixed signal based on an engine temperature of approximately 68°F (20°C).

To test the IAT sensor, disconnect the harness connector and connect an ohmmeter across the sensor terminals. See Fig. 24. Compare the meter reading to the graph shown earlier in Fig. 13. If any faults are found, the sensor should be replaced.

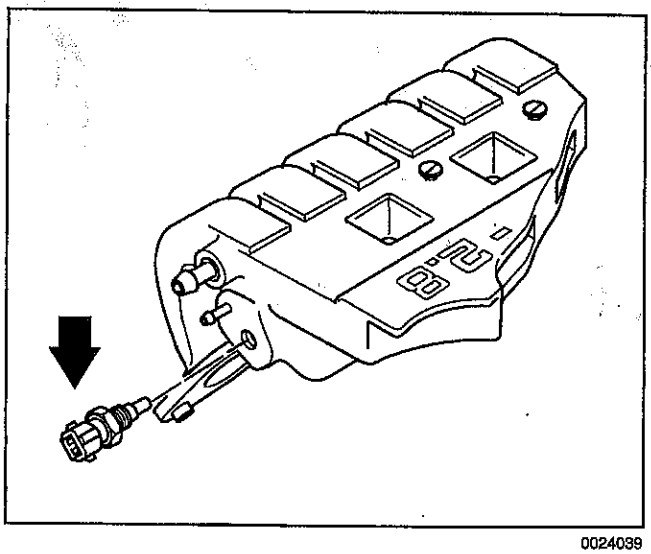


**Fig. 24.** Intake air temperature sensor (**arrow**) in intake manifold (6-cylinder engine shown).

## COMPONENT REPLACEMENT (1993–1995 models)

### To remove and install Motronic Engine Control Module (ECM)

The ECM is mounted in the rear of the engine compartment, in the right-hand side of the air plenum. See Fig. 25.

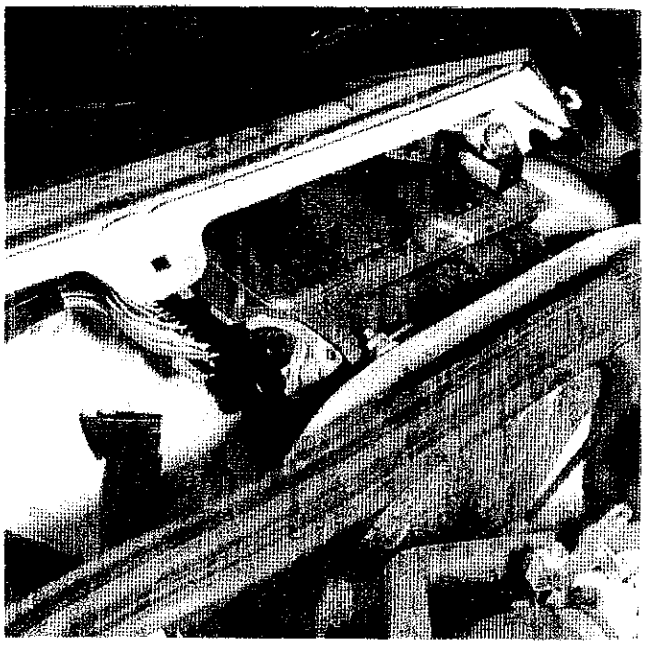

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**Fig. 25.** Motronic ECM in air plenum at rear of engine compartment.

1. Wait at least one minute, then disconnect the negative (–) battery cable.
2. Unplug the harness connector from the ECM by releasing the fastener and then pivoting the connector off the module.
3. Remove the mounting bracket nut and remove the ECM together with its bracket.
4. Installation is the reverse of removal.

### To remove Engine Coolant Temperature (ECT) sensor

For ECT sensor location on 6-cylinder, see Fig. 13 given earlier.

1. Drain approximately one gallon of coolant from the cooling system. This is to prevent coolant from leaking out when the sensor is removed. See **19 Engine–Cooling System**.
2. Disconnect the sensor harness connector.
3. Remove the sensor retaining clip and pull the sens from its housing. See Fig. 26.

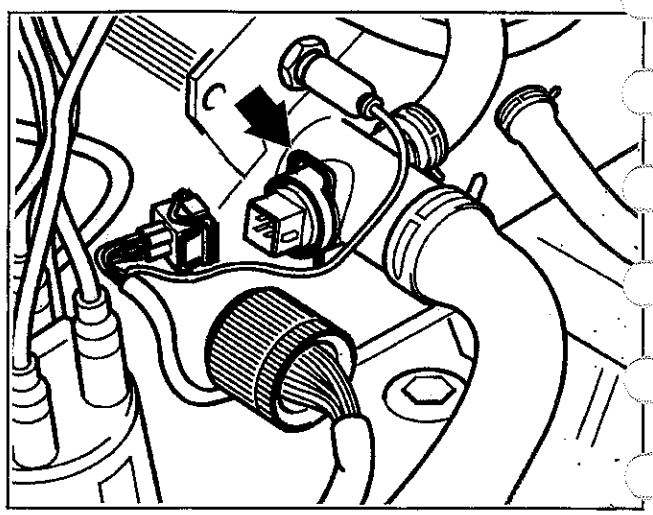

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**Fig. 26.** ECT sensor retaining clip (**arrow**) on 4-cylinder engine.

Installation is the reverse of removal. Clean the sensor sealing surfaces and use a new O-ring when reinstalling th sensor.

### To remove Throttle Position (TP) sensor

Volkswagen specifies that if the TP sensor is replaced, the engine control module (ECM) and transmission control mo ule (TCM) "Basic Settings" should be "initiated" using the special V.A.G. 1551 scan tool. The throttle position signal is used by the ECM and the TCM. If these basic settings are not don using the scan tool, transmission shifting and driveability problems may be encountered.

1. Unplug the harness connector from the sensor. See Fig 14 given earlier.
2. Remove the mounting screws holding the sensor to th side of the throttle valve housing. Remove the sensor and its O-ring.

Installation is the reverse of removal. Use a new O-ring and tighten the screws to the specified torque.

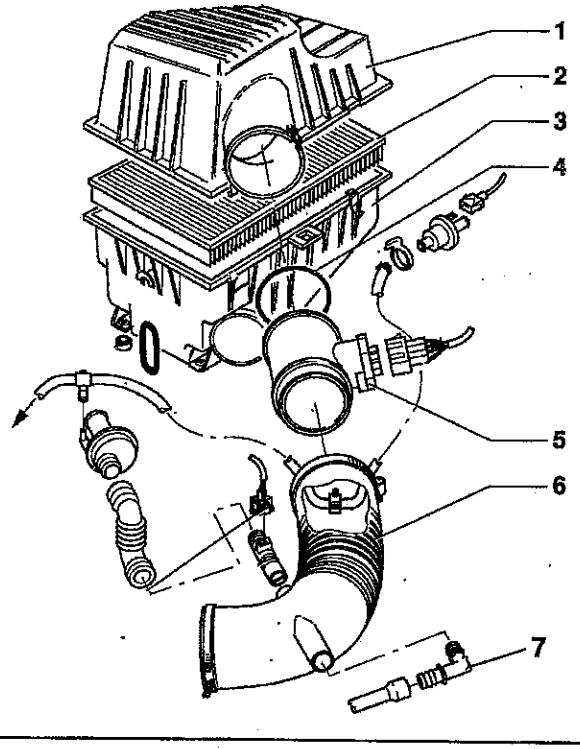
**Tightening torque**

- TP sensor to throttle valve housing . . . 3 Nm (27 in-lb)

## To remove Mass Air Flow (MAF) sensor

1. Loosen the large hose clamp securing the rubber duct to the mass air flow (MAF) sensor. Remove the duct from the sensor.
2. Disconnect the harness connector from the MAF sensor.
3. On 4-cylinder engines, remove the two mounting screws holding the MAF sensor to the upper air cleaner housing.
4. On 6-cylinder engines, loosen the clamping band holding the MAF sensor to the upper air cleaner housing. See Fig. 27.

1. **Air cleaner housing, upper**
2. **Air cleaner element**
3. **Air cleaner housing, lower**
4. **O-ring**
5. **MAF sensor**
6. **Intake air duct**
7. **Fitting for idle stabilizer valve**
   - not applicable for OBD II




0024045

**Fig. 27.** Mass air flow (MAF) sensor on 6-cylinder engine.

5. Remove the mass air flow (MAF) sensor from the air cleaner housing.

Installation is the reverse of removal. Replace the O-ring if it is damaged.

**Tightening torque**

- MAF sensor to air cleaner housing (4-cylinder) . . . . . 10 Nm (89 in-lb)

## To remove fuel injectors

Cleanliness is important when working with fuel circuit components. Thoroughly clean the unions before disconnecting any fuel lines. Use clean tools.

> ***WARNING —***
> *Fuel will be expelled when fuel lines are disconnected. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.*

1. Remove the upper intake manifold and related components. Cover the open intake runners using clean shop rags. See **15a** or **15b Cylinder Head and Valvetrain.**
2. Unplug the wiring harness connectors from the injectors.
3. Disconnect the fuel supply and return hoses from the fuel rail. See Fig. 28.

> ***WARNING —***
> *Wrap a clean shop towel around the fuel line fittings before loosening them.*

> ***NOTE —***
> *The fuel supply line is marked with white and the return line is marked with blue.*

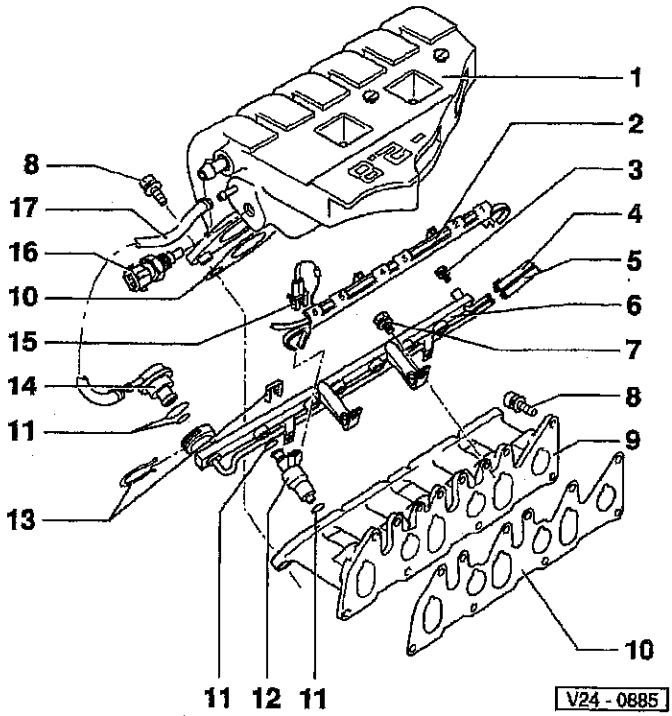
4. Remove the bolts that hold the fuel rail to the intake manifold and pull the fuel rail away complete with injectors.
5. To remove the injectors from the fuel rail, pry off the retaining clips, then twist the injectors slightly and pull them off.

When installing the injectors, lightly lubricate the O-rings with engine oil. Install the injectors to the fuel rail but do not install the retaining clips. Position the fuel rail and injectors on the intake manifold. Make sure that injectors and the fuel rail are fully seated and then install the retaining clips and mounting bolts. Reconnect the fuel hoses to the fuel rail. Install the upper intake manifold using a new gasket.

**Tightening torques**

- Upper intake manifold to lower intake manifold
  4-cylinder engine . . . . . 20 Nm (15 ft-lb)
  6-cylinder engine . . . . . 25 Nm (18 ft-lb)

1. **Intake manifold, upper**
2. **Wiring harness**
3. **Test connection plug**
4. **Fuel supply line**
5. **Fuel return line**
6. **Fuel rail**
7. **Bolt**
   • tighten to 10 Nm (89 in-lb)
8. **Bolt**
   • tighten to 25 Nm (18 ft-lb)
9. **Intake manifold, lower**
10. **Gasket**
    • always replace
11. **O-ring**
    • replace
12. **Fuel injector**
13. **Retaining clip**
14. **Fuel pressure regulator**
15. **Injector harness connector**
16. **Intake air temperature (IAT) sensor**
    • tighten to 10 Nm (7 ft-lb)
17. **Vacuum line**




V24-0885

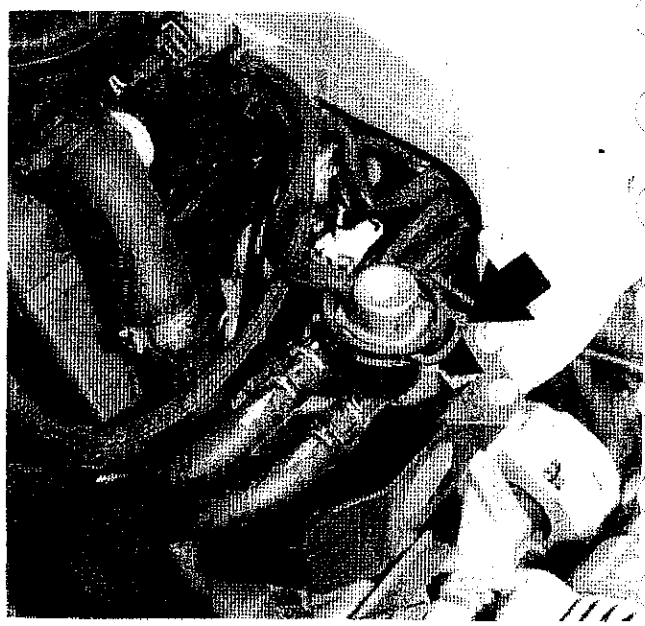
**Fig. 28.** Fuel rail assembly on 6-cylinder engine.

## To remove fuel pressure regulator

> ***WARNING —***
> *Fuel under pressure will be expelled when the fuel pressure regulator is removed. Do not smoke or work near heaters or other fire hazards. Keep a fire extinguisher handy.*

1. Disconnect the vacuum hose from the regulator. See Fig. 29.
2. Remove the fuel pressure regulator retaining clip. Wrap a shop towel around the regulator and then pull it from the fuel rail.

Installation is the reverse of removal. Inspect the O-rings and replace them if damaged.



0024053

**Fig. 29.** Fuel pressure regulator retaining clip (**arrow**).

## To remove Idle Air Control (IAC) valve

1. Disconnect the harness connector from the IAC valve.
2. Loosen the valve's hose clamps and disconnect the hoses from the valve.
3. On 4-cylinder engines, loosen the clamping bolt on the valve's bracket. See Fig. 30.
4. Remove the valve from its bracket.

Installation is reverse of removal.

0024051

**Fig. 30.** IAC valve clamping bracket on 4-cylinder engine (**arrow**).

## To remove throttle valve housing

Volkswagen specifies that if the throttle valve housing is replaced, the engine control module (ECM) and transmission control module (TCM) "Basic Settings" should be "initiated" using the special V.A.G. 1551 scan tool. If these basic settings are not done using the scan tool, transmission shifting and driveability problems may be encountered.

1. Remove intake air duct from the throttle valve housing.
2. Disconnect the throttle position sensor harness connector and the accelerator cable from the throttle valve housing.
3. On 4-cylinder engines, disconnect the evaporative emissions vent hose from the throttle valve housing.
4. On 6-cylinder engines, relieve the cooling system pressure by removing the cap from the coolant expansion tank. Clamp off the coolant hoses at the throttle valve housing and remove the hoses.
5. Remove the bolts holding the throttle valve housing to the intake manifold and remove the housing.

Installation is the reverse of removal. Use a new gasket during installation. If replacing the throttle valve housing, transfer all parts from the old housing to the new one. On cars with manual transmission, adjust the throttle dashpot as described below.

**Tightening torques**

- Throttle position sensor to throttle valve housing . . . . . 3 Nm (27 in-lb)
- Throttle valve housing to intake manifold
  - 4-cylinder engine . . . . . 25 Nm (18 ft-lb)
  - 6-cylinder engine
    - M6 . . . . . 10 Nm (89 in-lb)
    - M8 . . . . . 20 Nm (14 ft-lb)

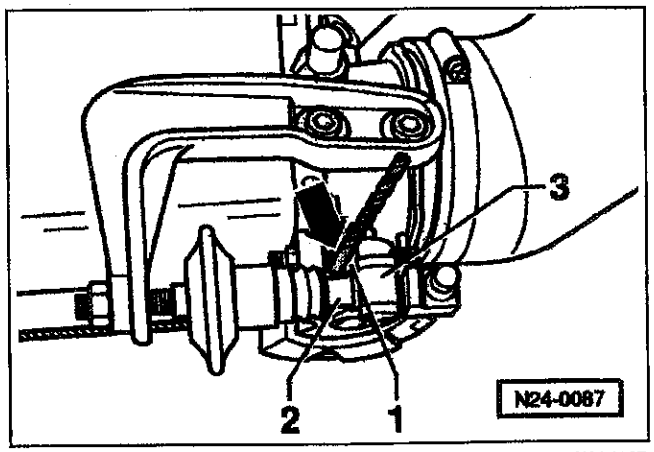
## To adjust throttle dashpot (cars with manual transmission)

The dashpot is mounted to the throttle valve housing and holds the throttle valve open for a moment when the throttle is suddenly closed. This helps reduce exhaust emission of unburned fuel.

***NOTE—***

*Before making the adjustment below, check that the throttle valve stop screw position has not been altered. If the factory setting of this screw has been tampered with, the throttle valve housing will need to be replaced—no adjustment specifications are available from Volkswagen.*

1. Insert a 3 mm drill bit or feeler gauge between the throttle valve stop screw and the throttle lever. See Fig. 31




N24-0087

**Fig. 31.** Drill bit (3 mm) inserted between throttle valve stop screw and throttle lever on 4-cylinder engine.

2. Loosen the dashpot lock nut. Turn the dashpot until its rod just makes contact with the lever roller. Tighten the locknut. Remove the drill bit.

**Dashpot Adjustment Specifications**

- Checking. . . . . 2.5–3.5 mm (0.98–0.138)
- Adjusting. . . . . 3.0 mm (0.118 in.)

## ON BOARD DIAGNOSTICS II (1996–1999 models)

On Board Diagnostics, OBD, found on Motronic Engine Management Systems through model year 1995 monitor many aspects of engine operation. Beginning with the 1996 model year, a second generation OBD system known as OBD II was integrated into all Volkswagen engines using the Motronic 5.9 engine management system sold in the United States. The OBD II system refines and enhances previous OBD systems. For a complete description of the system and an overview of operation, see **2 Fuel, Ignition, and Exhaust Systems**.

Because of the large number of operating parameters monitored and the vast quantity of data available, fault diagnosis can no longer be displayed via blink codes as on earlier models. All fault diagnosis must be done using Volkswagen special tool VAG 1551 or VAG 1552. The engine control module or ECM also supports certain limited functions in a government mandated generic scan tool mode. These functions are standardized for all OBD II compliant vehicles but are not as comprehensive as those found by using the VAG 1551/1552 in the original mode of operation.

During repairs where the battery must be disconnected, consideration must now be given to the effect that this will have on the engine management system.

- Diagnostic Trouble Codes will be erased.
- Readiness codes will be erased.
- Fault counters that monitor certain functions will be reset to zero.
- Adaptive leaning values will be set to default.

The engine control module (ECM) must be supplied with appropriate power sources and grounds to function properly. In addition, the ECM must "know" what equipment is installed in the vehicle in which it is operating. This process is known as coding and must be performed whenever the ECM is replaced. Coding memory is, however, retained when the battery is disconnected. This coding process can only be done with Volkswagen scan tool VAG 1551, VAG 1552 or equivalent.

Because the ignition, fuel injection, and emission control functions are even more inter-related than on previous Motronic versions, it is difficult, if not impossible to isolate general driveability problems by examining individual components of the system, although some are tested the same way in both versions.

For this reason, a suitable scan tool must be used for diagnosis if driveability problems occur or if the malfunction indicator light is illuminated.

Fig. 32 shows OBD II Motronic component locations for the AAA (VR-6) engine. Fig. 33 shows OBD II Motronic component locations for the ABA (4-cylinder) engine.

## OBD II component locations (AAA engine, 1996–1999 models)

***NOTE—***
*Volkswagen identifies electrical components by a letter and/or a number in the electrical schematics. See* **97 Wiring Diagrams, Fuses and Relays.** *These electrical identifiers are listed as an aid to electrical troubleshooting.*

1. **Evaporative Emissions (EVAP) canister purge regulator valve (N80)**
   •EVAP canister system
2. **Mass Air Flow (MAF) sensor (G70)**
3. **Intake air duct**
   •With connections for Positive Crankcase Ventilation (PCV) heating element (N79)
4. **Knock sensor 1 (G61)**
5. **Engine control module (J220)**
6. **Throttle valve control module (J338)**
7. **Ground connection**
8. **Ignition coil (N152)**
9. **A/C cut-out thermal switch (F163) and third speed coolant fan control thermal switch (F165)**
   •Brown, 4-pin
   •On vehicles with A/C
10. **Engine Coolant Temperature (ECT) sensor (G62)**
    •Blue, 2-pin
    •For Motronic ECM
11. **After-run coolant fan control thermal switch (F[illegible] and ECT sensor (G2)**
    •Yellow, 4-pin
12. **Intake Air Temperature (IAT) sensor (G72)**
13. **Fuel pressure regulator**
14. **Engine speed (RPM) sensor (G28)**
15. **Knock sensor 2 (G66)**
16. **Secondary Air Injection (AIR) pump motor (V101)**

## OBD II component locations (AAA engine, 1996–1999 models)

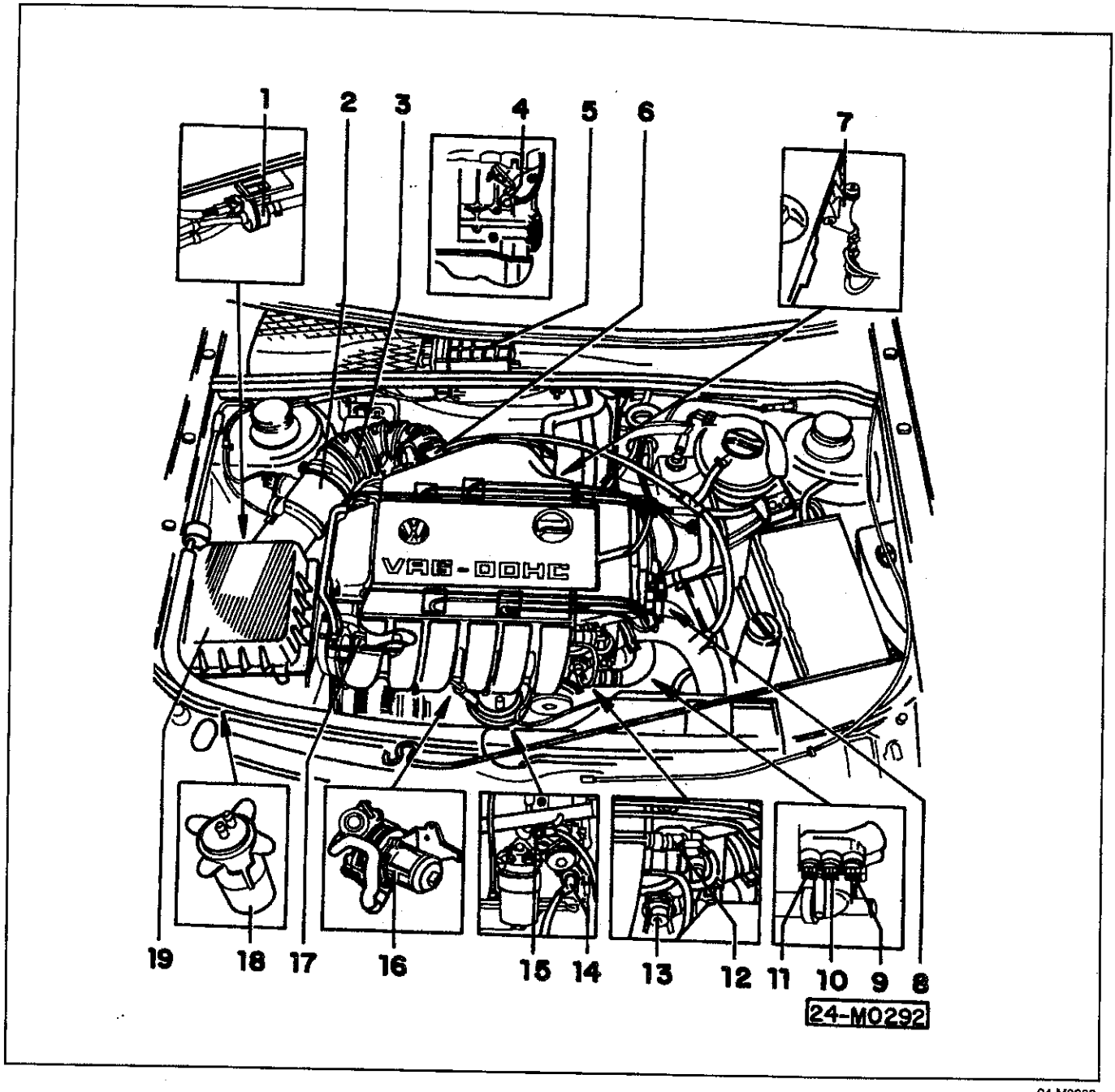



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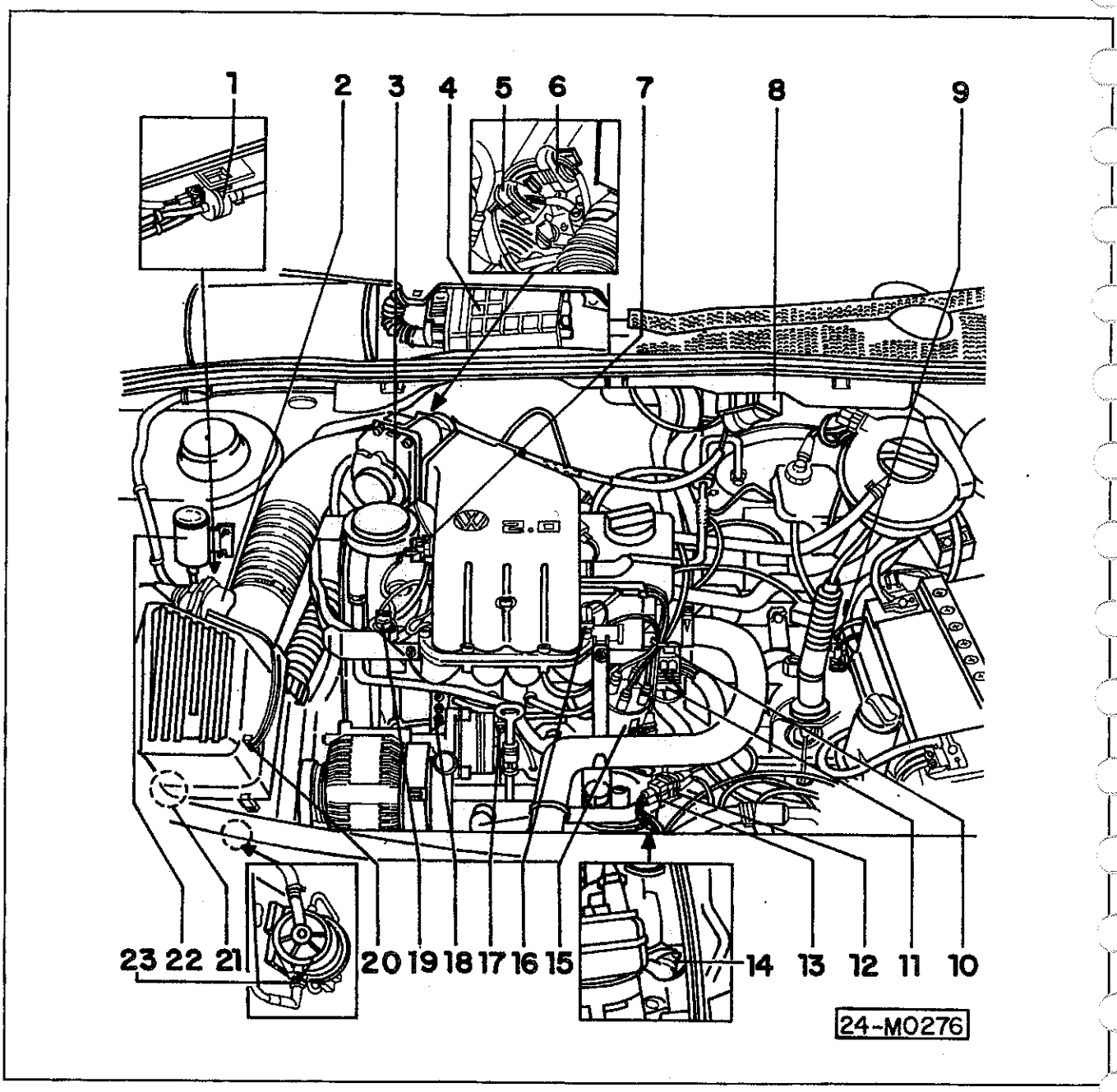
**Fig. 32.** Motronic component location on AAA (VR-6) OBD II engine, 1996-1999.

**17. Fuel injectors**
- •Cylinder 1 (N30)
- •Cylinder 2 (N31)
- •Cylinder 3 (N32)
- •Cylinder 4 (N33)
- •Cylinder 5 (N83)
- •Cylinder 6 (N84)

**18. EVAP canister**
- •Below air cleaner
- •EVAP system

**19. Air cleaner**

## OBD II component locations (ABA engine, 1996–1999 models)




24-M027(

**Fig. 33.** Motronic component location on ABA (4-cylinder) OBD II engine, 1996-1999.

1. **Evaporative Emissions (EVAP) canister purge regulator valve (N80)**
   - EVAP canister system
2. **Mass Air Flow (MAF) sensor (G70)**
3. **Throttle valve control module (J338)**
   - With connections for Positive Crankcase Ventilation (PCV) heating element (N79)
4. **Engine Control Module (J220)**
5. **Connector**
   - Brown, 4-pin
   - For Heated Oxygen Sensor (HO2S) (G108) and Oxygen Sensor (O2S) heating (after three way catalytic converter)
   - Installation position: Three Way Catalytic Converter (TWC)

6. **Connector**
   - •Black, 4-pin
   - •For HO2S (G39) and O2S heating (before three way catalytic converter)
   - •Installation position: front exhaust pipe
7. **Intake Air Temperature (IAT) (G72)**
8. **Ignition coil (N152)**
9. **Speedometer Vehicle Speed Sensor (VSS) (G22)**
10. **Engine Coolant Temperature (ECT) sensor (G62)**
    - •Black, with ECT sensor (G2)
11. **Center connector**
12. **3-pin connector**
    - •For knock sensor
    - •Blue
13. **3-pin connector**
    - •For engine speed sensor
    - •White
14. **Engine speed (RPM) sensor (G28)**
15. **Distributor with Camshaft Position (CMP) sensor (G40)**
16. **Fuel injectors**
    - •Cylinder 1 (N30)
    - •Cylinder 2 (N31)
    - •Cylinder 3 (N32)
    - •Cylinder 4 (N33)
17. **Knock sensor (G61)**
18. **Ground connection**
19. **Fuel pressure regulator**
20. **Temperature regulator Thermal Vacuum Valve (TVV)**
    - •For intake air preheating
21. **EVAP canister**
    - •Below air cleaner (Cabrio)
    - •Behind right front wheel housing (Golf, Jetta)
    - •EVAP system
22. **Leak Diagnosis Pump (LDP) filter**
    - •Golf, Jetta
23. **Leak Diagnosis Pump (LDP)**

***NOTE—***

*Volkswagen identifies electrical components by a letter and/or a number in the electrical schematics. See* **97 Wiring Diagrams, Fuses and Relays.** *These electrical identifiers are listed as an aid to electrical troubleshooting.*

## Readiness Codes

Recent legislation requires that all auto manufacturers build into their engine management systems the ability to check for proper operation of up to 8 functions. For the Motronic Engine Management System, the exact number depends on the equipment level of each particular vehicle. Most of the time, the readiness code will set itself after the appropriate conditions have been met. These may include a cold or a hot start, operation at a certain load or speed for a certain period of time, or operation at different temperatures. After repairs, it may be advantageous to confirm repairs rather than wait to see if they set on their own. Other than waiting, there are two methods of setting the readiness codes on the Motronic M5.9 system. The first method requires Volkswagen Scan Tool VAG 1551 or VAG 1552 and extensive knowledge of its operation and capabilities. The second method also requires a scan tool such as VAG 1551 or VAG 1552, or a Generic Scan Tool (GST). The following procedure shows the screens as they appear when the VAG 1551 or VAG 1552 is operated in the GST mode. Generic Scan Tools supplied by other manufacturers should have nearly identical displays due to legislation.

## To check readiness codes

1. Connect the scan tool to the vehicle data link connector, (DLC), below the heater controls as shown in Fig. 4, given earlier. The scan tool will be powered up when plugged into DLC. Turn the key to the on position, but do not start the engine. Observe the following sequence in the scan tool display window.
   - • 1 – Rapid Data
   - • Address Word 33 – OBD II
   - • Select mode – 41
   - • The display will show four fields of information

> ***CAUTION—***
> *These instructions assume that the technician already has a good working knowledge of the operation and use of the VAG 1551 or VAG 1552 scan tool.*

2. Fig. 34 shows the information as it appears on the screen. Disregard the information that is shown here as the letter X. These spaces will have either a "1" or a "0" and do not affect this procedure. The readiness code is the 8 digit number in field 4 on the far right. If the display shows a "1" in any position, the readiness code needs to be set.

| Mode 41 | PID 1 | Module 10 | |
|---|---|---|---|
| XXXXXXXX | XXXXXXXX | XXXXXXXX | 01101101 |

0024195

**Fig. 34.** Display that shows that readiness code is not set and should be. Disregard all Xs.

3. If the screen displays all zeros in the fourth field (far right), the readiness code is set and no further action is required. See Fig. 35.

| Mode 41 | PID 1 | Module 10 | |
|---|---|---|---|
| XXXXXXXX | XXXXXXXX | XXXXXXXX | 00000000 |

0024196

**Fig. 35.** Display that shows that readiness code is set and no further action is required.

4. If readiness code is set, disconnect the scan tool and reinstall the appropriate parts.

5. If readiness code is not set, unplug the scan tool and proceed as follows.

## To set readiness codes

***NOTE—***

- *The engine must not be switched off during the test sequence.*
- *If a test sequence procedure is interrupted or not adhered to, the readiness code will not be set.*

1. Switch ignition on for approximately 30 seconds but do not start engine.

2. Start engine and let run at idle.

3. Increase engine speed to 3000-3500 RPM for 90 seconds to heat up the Three Way Catalytic Converter (TWC).

4. With the vehicle stationary, run the engine at idle for 40 seconds.

5. Test drive for a minimum of 13 minutes.
   - Automatic transmission: driving range 3
   - Manual transmission: 3rd gear
   - Test drive must be carried out without interruption which means steady pressure on the throttle so that deceleration fuel shut-off is not activated nor is the throttle allowed back to the idle position.

6. Allow the engine to run at idle for a minimum of 13 minutes.

7. After completion of the test sequence, re-connect th scan tool and observe display. See **To check readi ness codes**.
   - If display appears as shown in Fig. 35, code has se and no further action is required. Disconnect scan tool and reinstall appropriate parts.
   - If display appears as shown in Fig. 34, code has no been set. Unplug scan tool and repeat from step 1. If code does not set after second attempt, it is li that there is a malfunction in the system. Consu scan tool directions for additional information on checking for DTCs.

# 26 Exhaust System/Emission Controls



## GENERAL

This repair group covers repair and troubleshooting for the emission control systems and removal and installation of exhaust components.

***NOTE —***

- *Oxygen sensor (Lambda) system repair and troubleshooting is covered in* **24a Fuel Injection—Motronic or 24b Fuel Injection—Mono-Motronic.**
- *All cars have a self-diagnostic program to detect emissions-related problems and store coded fault information in electronic memory. When diagnosing an emissions-related faults, first check for stored fault codes, especially if the Malfunction Indicator (Check Engine) Lamp is illuminated. See* **24a Fuel Injection—Motronic or 24b Fuel Injection—Mono-Motronic.**
- *The cars covered by this manual have a vacuum hose routing diagram (sticker) located in the engine compartment which can be helpful when working with the vacuum hoses.*

### Service Precautions

To help guard against personal injury or damage to car components, the following warnings and cautions apply when servicing the exhaust system.

***WARNING —***

*Exhaust gases are colorless, odorless, and very toxic. Run the engine only in a well-ventilated area. Immediately repair any leaks in the exhaust system or structural damage to the car body that might allow exhaust gases to enter the passenger compartment.*

***WARNING —***

- *The exhaust system, catalytic converter and other emission control systems operate at very high temperatures. Allow these components to cool before servicing, or wear protective clothing to prevent burns. Do not use flammable chemicals near a hot catalytic converter.*
- *Old corroded exhaust system components crumble easily and often have exposed sharp edges. To avoid injury, wear eye protection and heavy gloves when working with such parts.*
- *Do not work under a lifted car unless it is solidly supported on jack stands designed for that purpose. Never work under a car that is supported solely by a jack.*

## EXHAUST SYSTEM

For safe and proper exhaust system operation, all components must be free of holes and all connections must be airtight. Check the system immediately if it becomes noisy or an exhaust odor is detected inside the car.

***NOTE —***

*Excessive exhaust system back pressure can cause driveability problems such as a rough idle or stalling. Back pressure problems are caused by external damage such as crushed or collapsed parts, or internal damage such as a plugged catalytic converter.*

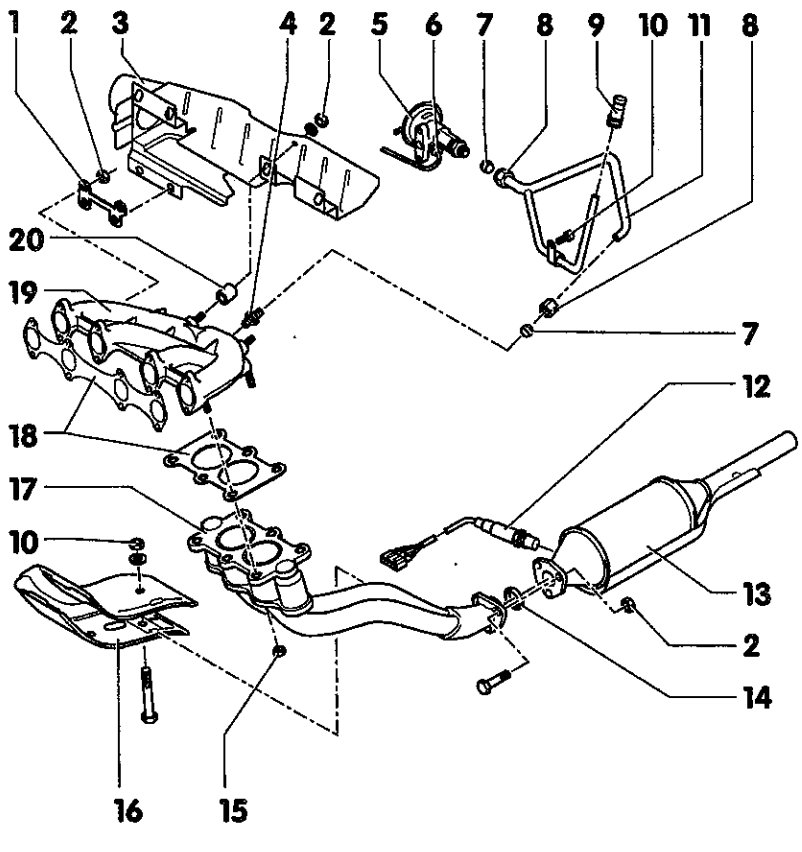
## Exhaust System Replacement

Fig.1 and Fig. 2 show the exhaust system used on the ABA (2.0 liter) 4-cylinder engine. Fig. 3 shows the exhaust system used on the AAA (2.8 liter) 6-cylinder engine. Figs. 4–6 show the exhaust systems used on the AAZ and AHU (TDI) diesel engines. Use these illustrations as a guide for removal and installation. Tightening torques and other relevant installation information are given in the illustrations.

A liberal application of penetrating oil to cold exhaust system nuts, bolts and slip joints will make removal easier. New fasteners, clamps and rubber mounts are always recommended when replacing exhaust components. Gaskets should be replaced whenever flange joints are disconnected. Use anti-seize compound on threaded fasteners to extend their service life and make future replacement easier. Some slight smoking and/or odor is normal as new exhaust system parts become hot for the first time.

***WARNING —***
*Inspect the exhaust system heat shields on the car underbody and repair or replace any damaged parts. Heat shields protect the car occupants, undercoating, and various other components from excessive heat. Damaged or missing shields, particularly those above the catalytic converter, will increase interior temperatures and create a fire hazard.*

1. **Bracket**
2. **Nut**
   - tighten to 25 Nm (18 ft-lb)
3. **Heat deflector**
4. **Stud**
   - tighten to 35 Nm (30 ft-lb)
5. **EGR valve (where applicable)**
6. **EGR temperature sensor (where applicable)**
7. **Fitting**
8. **Nut**
   - tighten to 30 Nm (22ft-lb)
9. **Cap, for CO tap tube**
10. **Bolt Nut**
    - tighten to 10 Nm (89 in-lb)
11. **CO tap tube (where applicable)**
12. **Heated oxygen sensor (HO2S)**
    - tighten to 50 Nm (36 ft-lb)
    - use anti-seize when installing
    - testing, see **24 Fuel Injection**
13. **Three-way catalytic converter (TWC)**
14. **Sealing ring**
    - always replace
15. **Nut**
    - tighten to 40 Nm (30 ft-lb)
16. **Heat shield**
17. **Front exhaust pipe**
    - when installing pipe to manifold: tighten bolts gradually and evenly, starting from the center and working outward
18. **Gasket**
    - always replace
19. **Exhaust manifold**
20. **Spacer**




26-887

**Fig. 1.** Front section of exhaust system for ABA (2.0 liter) 4-cylinder engine.

1. **Nut**
   • tighten to 40 Nm (30 ft-lb)
2. **Locking clamp**
3. **Intermediate pipe**
4. **Bracket**
5. **Bolt**
   • tighten to 25 Nm (18 ft-lb)
6. **Front and rear muffler**
   • available as separate replacement parts
   • when replacing individual muffler: cut connecting pipe at point 9 (**inset B**) and connect using double clamp
7. **Dimension c: approx. 10 mm (0.40 in.)**
8. **Marking for double clamp position**
   • marked 3 times on pipe circumference
9. **Cutting point for replacing individual muffler**
10. **Dimension b: approx. 5 mm (0.20 in.)**
11. **Marking for clamp position**
    • marked 3 times on pipe circumference
12. **Retaining ring**
13. **Bracket**
14. **Nut**
    • tighten to 20 Nm (15 ft-lb)
15. **Bracket**

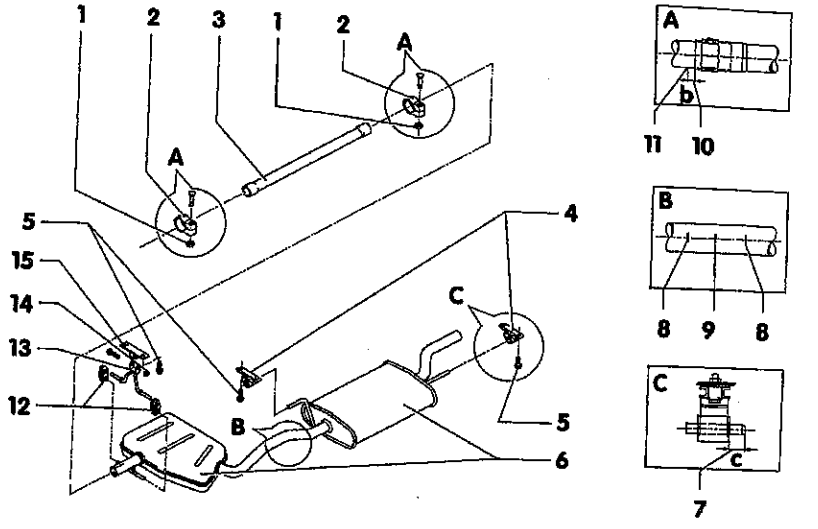
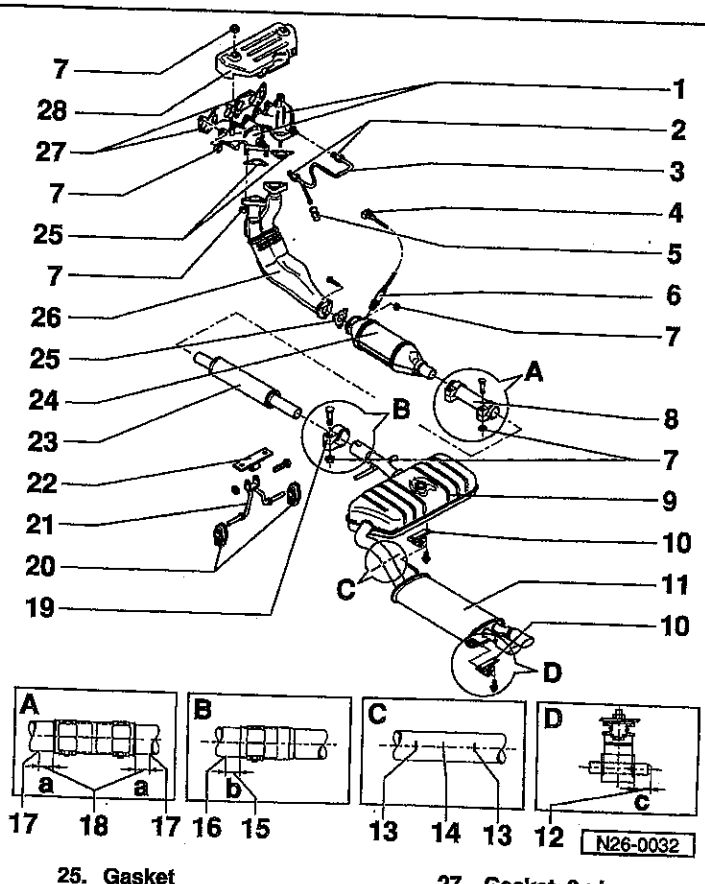


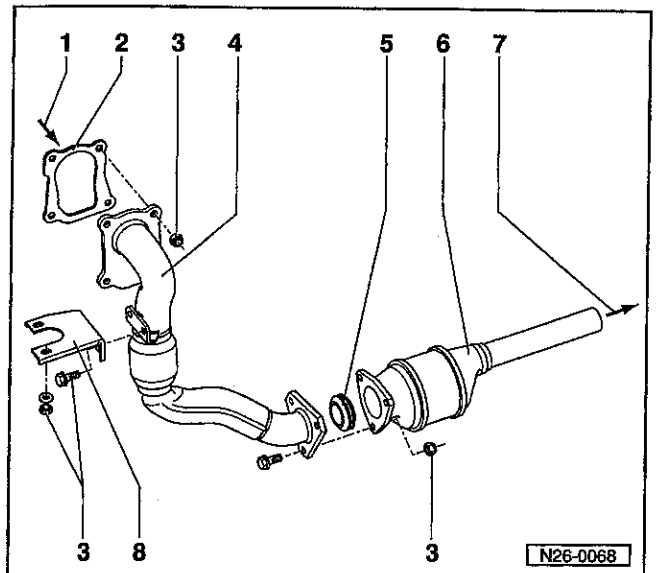

**Fig. 2.** Rear section of exhaust system for ABA (2.0 liter) 4-cylinder engine. 0024058

1. **Exhaust manifold, two-piece**
2. **Nut**
   • tighten to 25 Nm (18 ft-lb)
3. **CO tap tube (where applicable)**
4. **Harness Connector, 4-pin**
5. **Cap, for CO tap tube**
6. **Heated oxygen sensor (HO2S)**
   • tighten to 50 Nm (36 ft-lb)
   • use anti-seize on threads when installing
   • testing, see **24 Fuel Injection**
7. **Nuts**
   • M8: tighten to 25 Nm (18 ft-lb)
   • M10: tighten to 40 Nm (30 ft-lb)
8. **Double clamp**
9. **Center muffler**
10. **Mounting**
11. **Rear muffler**
12. **Dimension c: approx. 10 mm (0.40 in.)**
13. **Marking for clamp position**
    • marked 3 times on pipe circumference
14. **Cutting point for replacing individual muffler**
15. **Dimension b: approx. 5 mm (0.20 in.)**
16. **Marking for clamp position**
    • marked 3 times on pipe circumference
17. **Marking for clamp position**
    • marked 3 times on pipe circumference
18. **Dimension a: approx. 5 mm (0.20 in.)**
19. **Clamp**
20. **Support**
21. **Mounting**
    • note installed position
22. **Mounting**
23. **Front silencer**
24. **Three-way catalytic converter (TWC)**




25. **Gasket**
    • always replace
26. **Front exhaust pipe**
27. **Gasket, 2-piece**
    • always replace
28. **Heat shield**

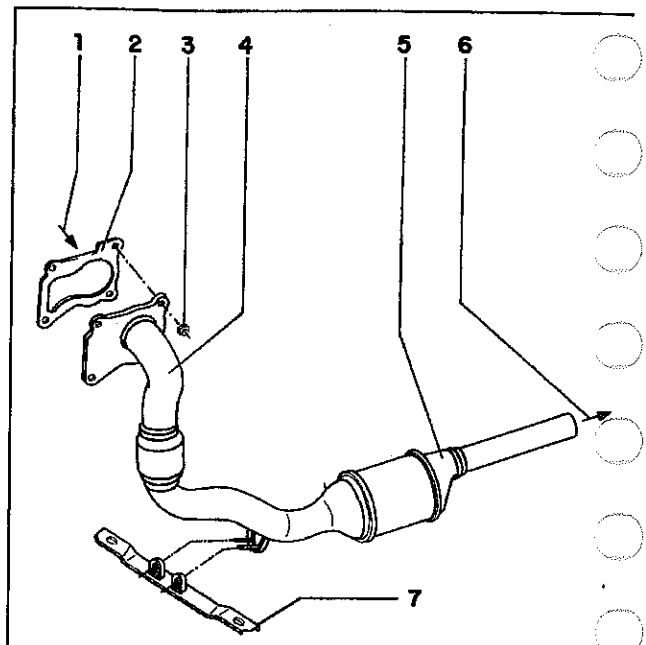
**Fig. 3.** Exhaust system for AAA (2.8 liter) 6-cylinder engine. N26-0032




1. **From turbocharger**
2. **Gasket**
   - Always replace
3. **25 Nm (18 ft-lb)**
4. **Front exhaust pipe**
5. **Sealing ring**
   - Replace if damaged
6. **Oxidation catalytic converter**
7. **To intermediate pipe**
8. **Retainer**
   - Between exhaust pipe and exhaust manifold

N26-0068

**Fig. 4.** Front section of exhaust system for AAZ (1.9 liter) 4-cylinder diesel.

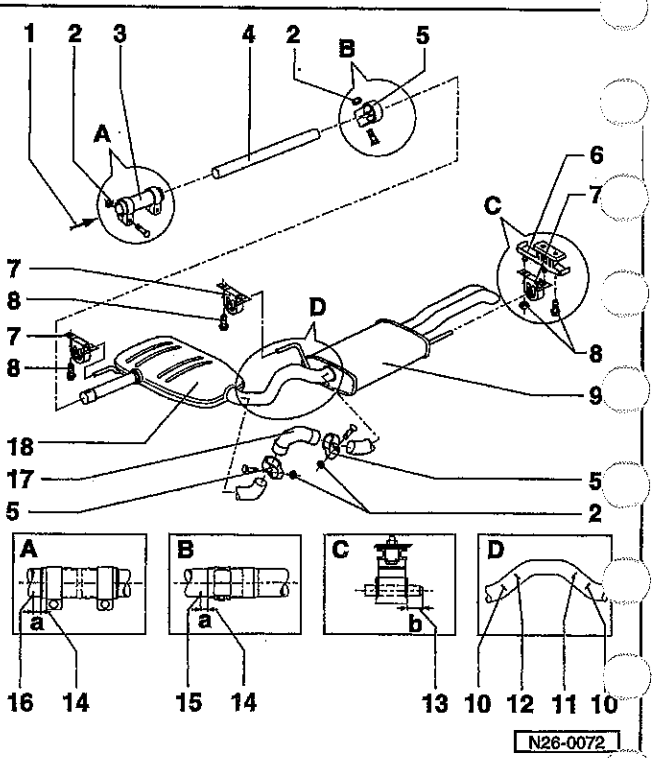



1. **From turbocharger**
2. **Flange gasket**
   - Always replace
3. **25 Nm (18 ft-lb)**
4. **Front exhaust pipe**
5. **Oxidation catalytic converter**
6. **To intermediate tube**
7. **Mounting bracket**

002

**Fig. 5.** Front section of exhaust system for AHU (1.9 liter) 4-cylinder TDI diesel.

1. **From oxidation catalytic converter**
2. **40 Nm (30 ft-lb)**
3. **Double clamp**
4. **Intermediate pipe**
5. **Clamp**
6. **Console**
7. **Mount**
8. **25 Nm (18 ft-lb)**
9. **Rear muffler**
10. **Marking**
    - For clamp
    - Clamp to marking (dimension -a- of item 14)
11. **Separation point**
    - Allows replacement of center muffler only
12. **Separation point**
    - Allows replacement of rear muffler only
13. **Dimension -b-**
    - Approx. 10 mm (0.4 in.)
14. **Dimension -a-**
    - Approx. 5mm (0.2 in.)
15. **Marking**
16. **Marking**
    - S: Manual transmission
    - A: Automatic transmission
17. **Connection pipe**
    - Repair pieces for use when replacing single muffler
18. **Center muffler**
    - AHU shown, AAZ is similar




N26-0

**Fig. 6.** Rear section of exhaust system for AHU (1.9 liter) 4-cylinder TDI diesel. AAZ engine is similar.

## EMISSION CONTROLS

Different engines use different emission control systems. See the following application table.

**Table a. Emission control system applications**

| Engine | Emission control systems used |
|---|---|
| **ACC (1.8 liter)** | Positive Crankcase Ventilation (PCV)<br>Evaporative Emission (EVAP) System<br>Oxygen Sensor (Lambda) System<br>Three-way catalytic converter |
| **ABA (2.0 liter)** | Positive Crankcase Ventilation (PCV)<br>Evaporative Emission (EVAP) System<br>Exhaust Gas Recirculation (EGR) System (where applicable)<br>Oxygen Sensor (Lambda) System<br>Three-way catalytic converter |
| **ABA OBD II (1996-1998)** | Leak Detection Pump (LDP) (where applicable)<br>Secondary Air Injection (AIR) (where applicable) |
| **AAA (2.8 liter)** | Positive Crankcase Ventilation (PCV)<br>Evaporative Emission (EVAP) System<br>Exhaust Gas Recirculation (EGR) System (where applicable)<br>Oxygen Sensor (Lambda) System<br>Secondary Air Injection (AIR) System<br>Three-way catalytic converter |
| **AAA OBD II (1996-1998)** | Leak Detection Pump (LDP) (where applicable) |
| **AAZ (1.9 liter, diesel)** | Positive Crankcase Ventilation (PCV)<br>Oxidation Catalytic Converter |
| **AHU (1.9 liter, TDI Diesel** | OBD II<br>Positive Crankcase Ventilation (PCV)<br>Oxidation Catalytic Converter<br>Exhaust Gas Recirculation (EGR) |

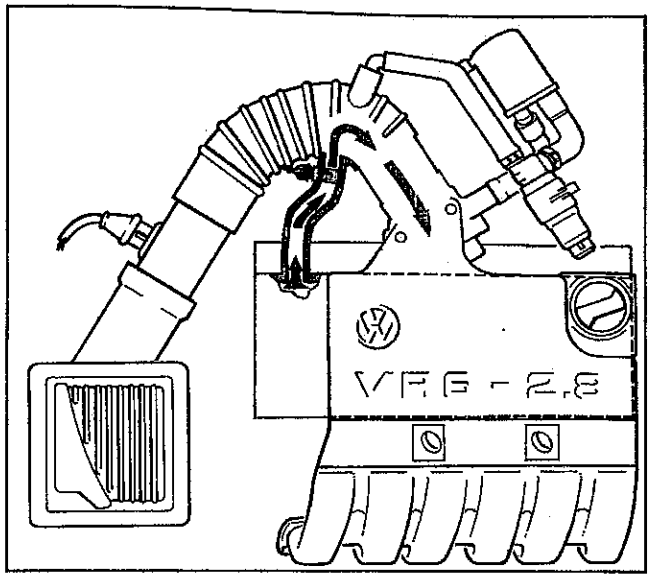
## Positive Crankcase Ventilation (PCV)

The PCV system traps crankcase vapors and routes them back into the intake air stream to be burned.

On 4-cylinder engines, the system consists of a crankcase breather valve on the side of the cylinder block and connecting hoses to the intake air stream. On ABA, AAZ and AHU engines, a replaceable pressure regulating valve is used in the top of the valve cover.

On 6-cylinder engines, the system consists simply of a breather hose between the valve cover and the intake air boot. The valve cover contains a flame trap to prevent ignition of the crankcase vapors in the event of a backfire. To prevent icing during cold weather, a heating element is integrated into the breather hose. See Fig. 7.

> ***CAUTION—***
> *Replace PCV hoses only with parts designed for PCV or fuel system service. Conventional vacuum and heater hoses deteriorate rapidly when exposed to oil vapors and combustion gasses.*




0024054

**Fig. 7.** PCV system on AAA (2.8 liter) engine. OBD I with idle stabilizer shown.

Most crankcase ventilation problems result when the hoses or valves become clogged with oily residues. Restrictions create excessive crankcase pressure that can eventually cause driveability problems. PCV system service is limited to inspecting and cleaning the breather valves, hoses, and replacing faulty parts.

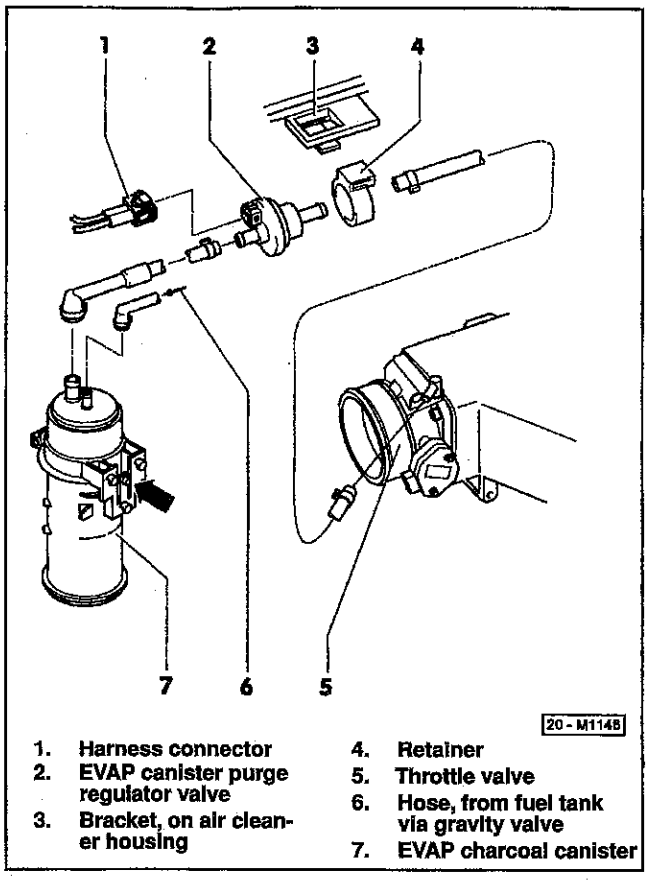
## Evaporative Emission (EVAP) 1993–1995

The EVAP system uses a charcoal-filter canister to absorb vapors from the fuel tank. The fuel tank is vented to the canister and the canister is in turn vented to the intake manifold via the EVAP canister purge regulator valve.

During certain engine operating conditions, the accumulated vapors in the canister are drawn through the open EVAP regulator valve and into the engine to be burned. The EVAP regulator valve is cycled on and off by the engine control module (ECM).

The charcoal canister is mounted in the driver's side wheel well, behind the headlight. The EVAP canister purge regulator valve is mounted on the side of the air cleaner housing. See Fig. 8.

The EVAP canister purge regulator valve controls the amount of fuel vapors drawn into the engine and therefore can affect the fuel mixture and exhaust emissions. A fault in the EVAP system usually results in overly rich driveability problems, especially at idle. Check the purge regulator valve with the engine idling. The valve should be sporadically clicking on and off. The clicking should vary in intensity depending on engine speed.




1. Harness connector
2. EVAP canister purge regulator valve
3. Bracket, on air cleaner housing
4. Retainer
5. Throttle valve
6. Hose, from fuel tank via gravity valve
7. EVAP charcoal canister

**Fig. 8.** Evaporative emission (EVAP) system on ABA (2.0 liter) engine.

The electric valve can be tested by disconnecting its harness connector and supplying battery voltage to the valve minals. The valve should click open when voltage is supplied If no faults are found, check for voltage to the valve's connector with the engine running. There should be battery vol between the red/black or red wire and ground. If voltage is present, check for faults using the appropriate wiring diagram shown in **97 Wiring Diagrams, Fuses and Relays.**

## Evaporative Emission (EVAP) 1996–1999

The evaporative emissions system found on 1996 to 1999 gas engines operates in much the same manner as on previous versions. Additional components required as a result of OB standards allow the system to be monitored for leaks. This system can only be properly tested using a scan tool such as VAG 1551 or VAG 1552 and proper operation is included in the tem readiness codes. See **20 Fuel Storage and Supply.**

## Exhaust Gas Recirculation (EGR) – Gas Engines

The EGR system reduces emissions by directing a s quantity of exhaust gases back into the intake manifold to dilute the air/fuel mixture effectively. This reduces the amount of oxides of nitrogen ($NO_x$) pollutants in the exhaust.

A schematic view of the EGR system is shown below. See Fig. 9.

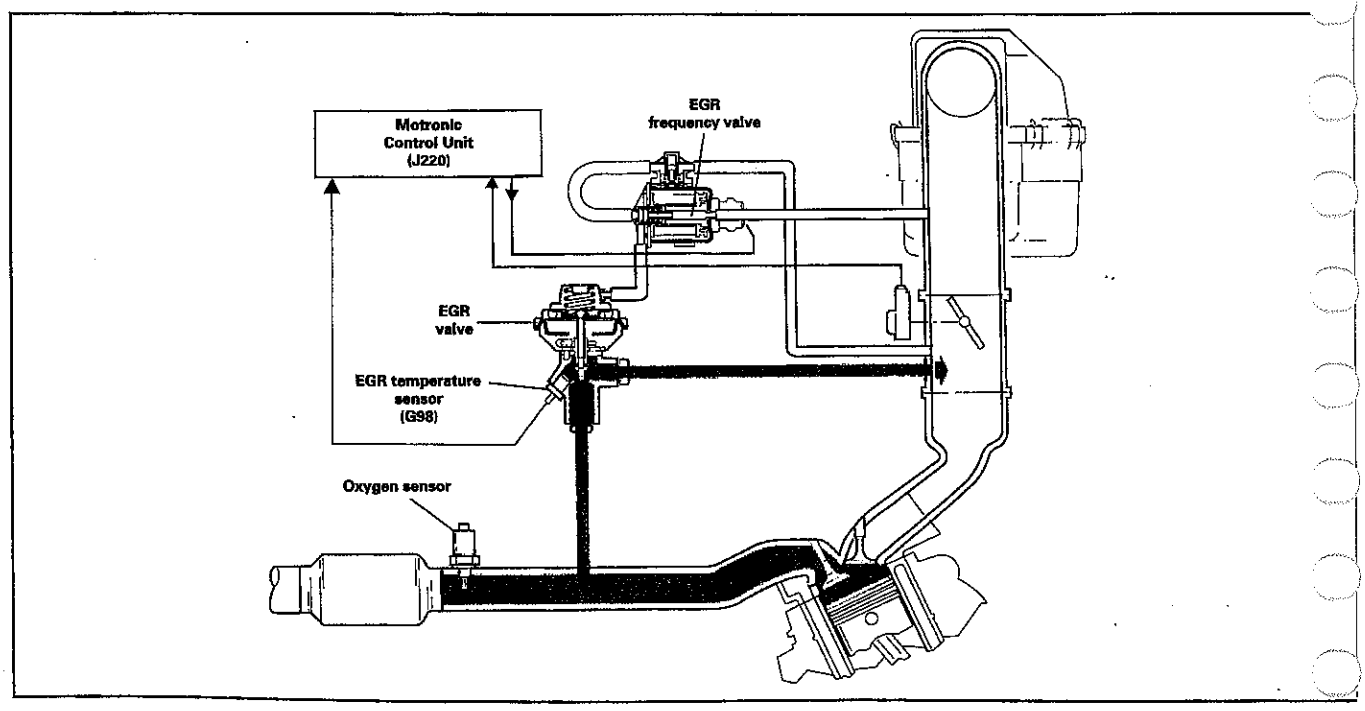



**Fig. 9.** Schematic view of electronic EGR system.

The system consists of the EGR vacuum regulator solenoid valve, the EGR temperature sensor, and the mechanical EGR valve. The EGR solenoid valve controls the amount of vacuum supplied to the EGR valve based on engine speed and engine load. The EGR temperature sensor monitors the opening and closing of the EGR valve as part of the on-board diagnostic system.

> ***CAUTION—***
> *Use care when handling the temperature sender. The sender is sensitive to shock and impact and can be easily damaged.*

A rough idle may indicate that the EGR valve is sticking open. Stalling or part-throttle surging when the engine is cold may indicate that the EGR valve is incorrectly opening before the engine is fully warmed.

## To test EGR system – gas engines

1. Check that the EGR system vacuum hoses are routed correctly and free from obstructions and leaks. See Fig. 10.

> ***WARNING—***
> *Parts of the EGR system valve carry engine exhaust gasses and operate at high temperatures. Exhaust gases are poisonous and they may cause severe burns if handled without proper protection. Wear heavy gloves when working with the EGR valve. Work in a well ventilated area.*

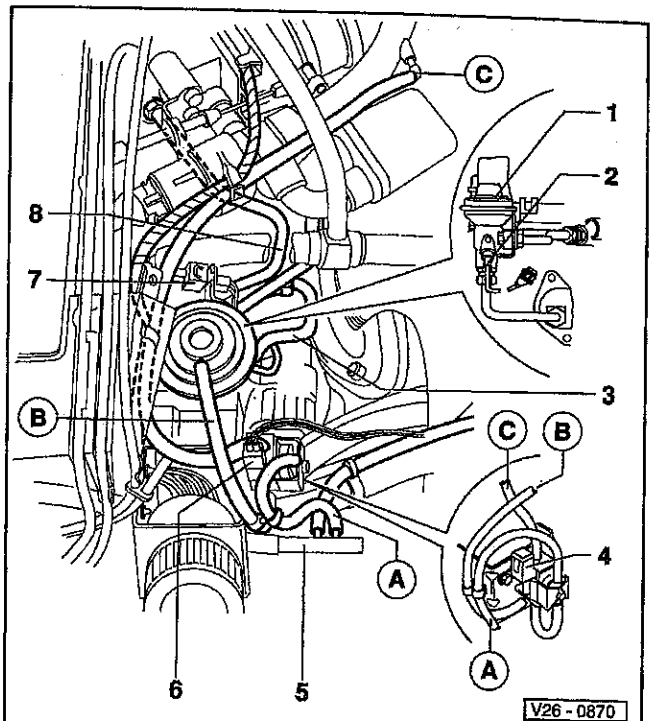
2. With the engine fully warm and idling, disconnect the vacuum hose from the EGR valve. The idle speed should not change.

3. Raise the idle speed and check for varying amounts of vacuum at the disconnected hose. If necessary, connect a vacuum gauge to the hose.

> ***NOTE—***
> *Vacuum at the hose will vary depending on engine load and speed. A vacuum gauge is sensitive enough to pickup the fluctuating vacuum source.*

4. If there is vacuum, attach a hand vacuum pump to the EGR valve vacuum fitting and apply vacuum to the valve. The idle speed should drop noticeably and the engine may even stall.

> ***NOTE—***
> *If there is no change in idle speed, the EGR valve is not opening mechanically and needs to be cleaned or replaced.*




1. **EGR valve**
2. **EGR temperature sensor (G69)**
3. **Exhaust pipe, inlet**
4. **EGR vacuum regulator valve**
5. **Vacuum connection**
6. **Harness connector**
7. **Harness connector**
8. **Exhaust pipe, outlet**

V26-0870

**Fig. 10.** EGR system layout on AAA engine (2.8 liter).

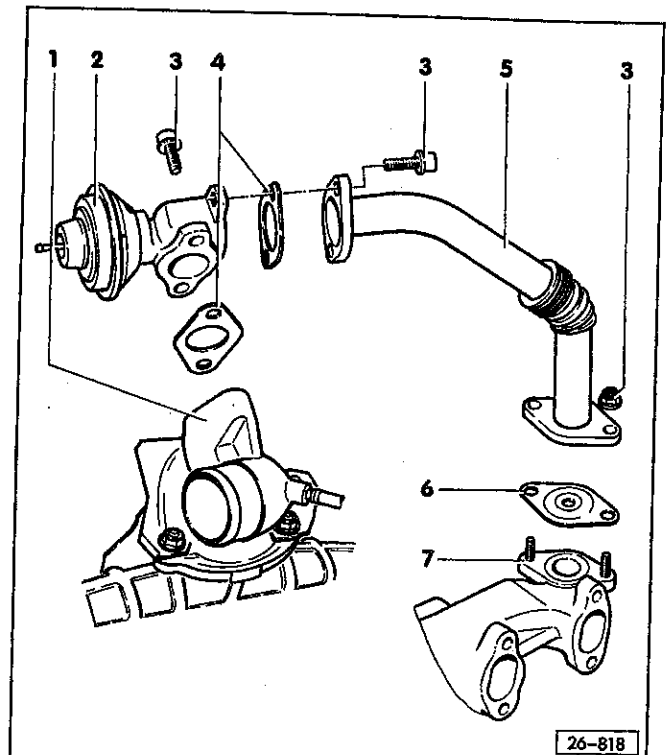
5. If there is no vacuum, check the EGR vacuum regulator solenoid valve. Check the wiring to the valve and check for a duty cycle (on-off) signal at the valve. If no faults can be found, the signal from the engine control module (ECM) may be missing or the valve or ECM may be faulty.

> ***NOTE—***
> *If the Malfunction Indicator Lamp (Check Engine) light is illuminated, a Diagnostic Trouble Code (DTC) has been stored in the OBD system memory and should be erased. See* **24a Fuel Injection–Motronic or 24b Fuel Injection–Mono-Motronic.**

## Exhaust Gas Recirculation (EGR) – AAZ diesel engines

The EGR system on the AAZ Diesel engine reduces the emissions in much the same way as on the gasoline engines. The EGR valve is switched on during certain part-throttle applications. It is switched off at idle and at full throttle, and also during high altitude operation. Control of the EGR system is through the Automatic Glow Time Control Module (J179) by way of input from the EGR Part Throttle Switch (F166) on the injection pump, and Engine Temperature Sensor (G27) on the

cylinder head. At the appropriate time, the Automatic Glow Time Control Module sends a signal to the EGR Two-Way Valve where vacuum from the vacuum pump is directed to the EGR Valve. The EGR Valve opens and exhaust gas is directed into the intake manifold. This process effectively reduces the Nitrogen Oxide (NOx) component of the exhaust.. See Fig. 11.




1. **Intake manifold**
2. **EGR valve**
3. **25 Nm (18 ft-lb)**
4. **Gasket**
   - Always replace
5. **Connecting pipe**
6. **Gasket**
   - Always replace
   - Restriction hole 9 mm (0.35 in.) dia.
7. **Exhaust manifold**

V26-0870

**Fig. 11.** EGR valve and related components fro AAZ diesel engine.

## To test EGR valve – AAZ diesel engines

1. Start engine and allow to run until the oil temperature is a minimum of 122°F (50°C).

2. From an idle, slowly raise engine speed to over 1200 RPM. Diaphragm rod in EGR valve should be seen to move towards intake manifold for approximately 2 seconds and then move back. Diaphragm rod is visible through opening in the EGR valve. See Fig. 12.

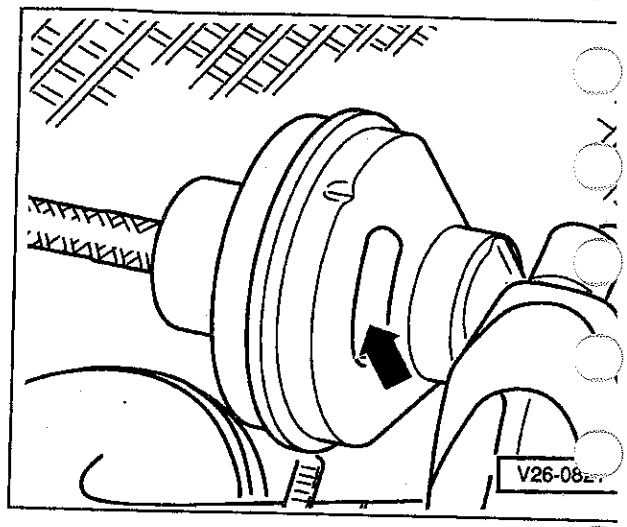



**Fig. 12.** EGR valve mounted to intake manifold on AAZ Diesel engi Diaphragm rod is visible through opening in the valve (**arro** Rod should move towards the vacuum line connectio

3. Movement of the rod indicates normal operation. If t rod does not move, visually inspect the vacuum nections to the EGR valve and the Two-Way valv compare them to the vacuum hose layout sticker und the hood.

4. If no problems are found with the hoses, continue t mechanically checking the EGR valve.

5. Disconnect the vacuum hose from the valve and attac a hand operated vacuum pump such as Volkswage special tool VAG 1390 or US 8026. Operate the um pump and observe the diaphragm rod. It sho move when vacuum is applied.

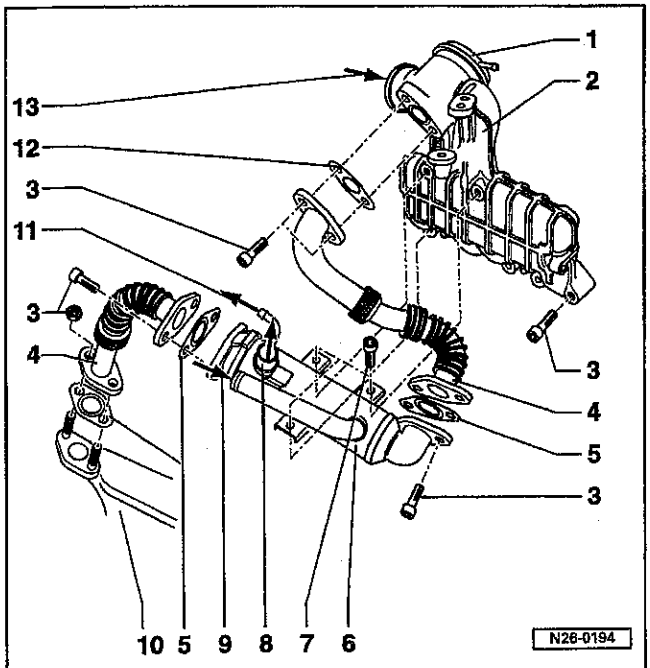
If the diaphragm rod does not move, there is a mecha malfunction with the valve and it should be replaced. If the d aphragm rod moves when vacuum is applied, but does no move under the control of the Automatic Glow Time C Module, there may be an electrical fault in the system. Chec the wiring to the Two-Way valve, the Engine Temperatur Sensor and the Part Throttle Switch. If no faults can be fo the signal from the Automatic Glow Time Control Module ma be missing or faulty, or the Two-Way Valve, Temperatur Sensor or Part Throttle Switch may be faulty. See **97 W Diagrams, Fuses, and Relays.**

## Exhaust Gas Recirculation (EGR) syste AHU TDI diesel engines

The EGR system on the AHU TDI Diesel engine redu the emissions in much the same way as on the AAZ Diesel engine. The EGR valve is functionally controlled by the Engine Control Module (J248) which uses input from the various gine sensors to precisely control the quantity of exhaust gas-

es returned to the intake manifold. The exhaust gas is pulled from a port in the exhaust manifold through large diameter pipes and passed through a cooler. From there, it goes to the EGR valve which is integrated into the intake manifold.

The EGR cooler is connected to the engine cooling system outlet on the cylinder head and the coolant reservoir. See Fig. 13. In operation, the ECM sends a signal to the EGR Vacuum Regulator Solenoid (N18) which controls the vacuum signal sent to the EGR valve. Because the Diesel engine has no throttle plate, exhaust gas recirculation will sometimes occur at idle in addition to part throttle.




1. **EGR valve**
2. **Intake manifold**
3. **25 Nm (18 ft-lb)**
4. **Connecting pipe**
   - When installing, tighten all bolts finger tight first
5. **Gasket**
   - Always replace
6. **EGR cooler**
7. **10 Nm (7 ft-lb)**
8. **To heater core**
9. **From cylinder head**
10. **Exhaust manifold**
11. **To overflow reservoir**
12. **Flange gasket**
    - Always replace
13. **From intercooler**

N26-0194

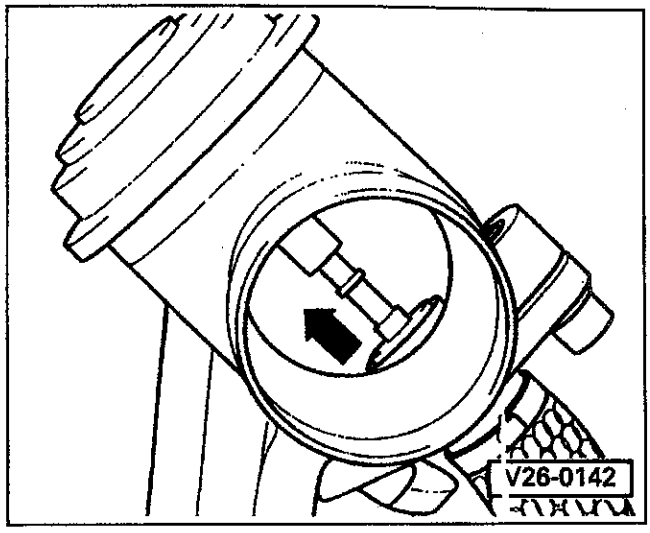
**Fig. 13.** EGR valve, EGR cooler and related components for AHU TDI diesel engine.

## To test EGR valve – AHU TDI diesel engines

***NOTE—***

*Proper diagnosis and testing of the EGR system requires Volkswagen scan tool VAG 1551 or VAG 1552. The EGR valve itself can be mechanically tested.*

1. Remove the connecting pipe from the intercooler to the intake manifold.
2. Disconnect the vacuum hose from the EGR valve.
3. Connect a hand operated vacuum pump such as VAG 1390 or US 8026 to the EGR valve.
4. Look into the exposed end of the intake manifold, identify the valve plate, and operate the hand pump. The valve plate must lift from the valve seat when vacuum is applied to the EGR valve. See Fig. 14.




V26-0142

**Fig. 14.** EGR valve as viewed through the open end of the intake manifold with the pipe from the intercooler disconnected. Valve must move in the direction of the **arrow** when vacuum from a hand operated pump is applied to the valve.

5. Disconnect the vacuum pump and listen for an audible sound as the valve snaps closed against the seat.
6. If valve functions properly, further testing using Volkswagen scan tools VAG 1551 or VAG 1552 must be performed.
7. If the valve fails to open or if it fails to fully close, the intake manifold with the integral EGR valve must be replaced.

## Secondary Air Injection (AIR)

The secondary air injection system uses an air pump to inject fresh air behind the exhaust valves for approximately 65 seconds during cold starting (engine coolant between 58°F and 95°F). As part of the on-board diagnostic system, the pump also runs briefly after a restart with the engine warm.

The purpose of the AIR system is to reduce exhaust emissions during engine warm-up when the Motronic engine management system is in open loop.

The system consists of the electric air pump, the vacuum-operated shut-off valve, the inlet (solenoid) valve, and the related duct work. See Fig. 15.

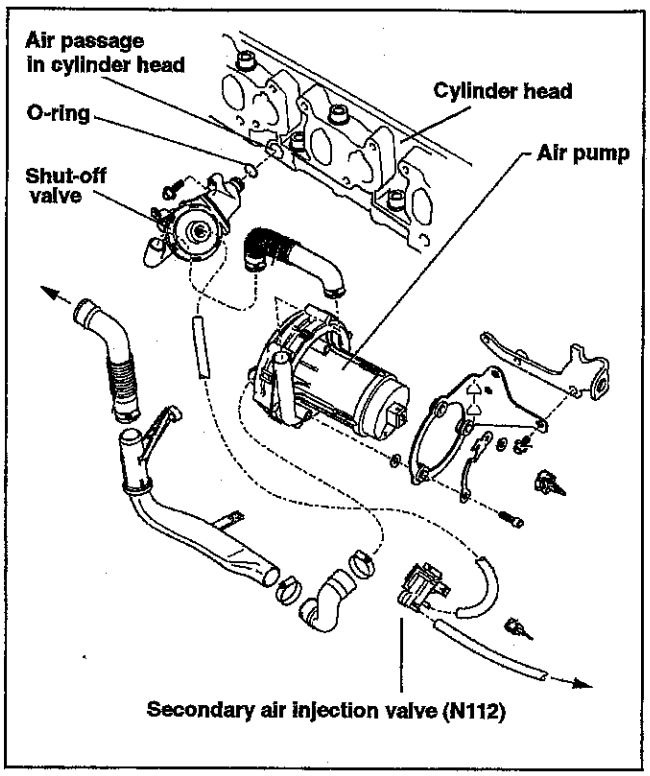



**Fig. 15.** Secondary air injection (AIR) system used on VR6 engines. 4-cylinder ABA engines are similar.

## To test AIR system

1. Disconnect the air hose from the outlet on the top of the air pump.

2. With the engine fully warm, start and allow the engine to idle. Approximately 20 seconds after starting, the air pump should run for about five seconds and secondary air should be felt coming from the pump outlet.
   - If the air pump does not run, check the in-line 30 amp fuse and the secondary air injection (AIR) pump relay (J299). See Fig. 16.

   ***NOTE—***
   *Wiring diagrams are given in **97 Wiring Diagrams, Fuses and Relays.** If no faults are found, continue testing.*

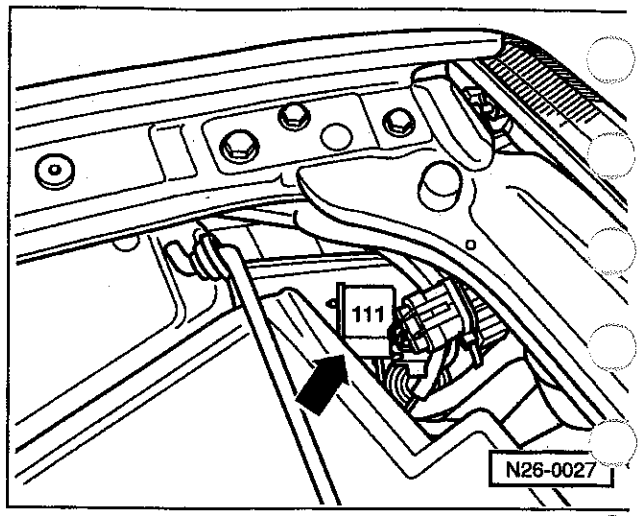



**Fig. 16.** In-line fuse and relay for secondary air injection (AIR) pump (**row**). Fuse and relay are located behind left headlight assembly

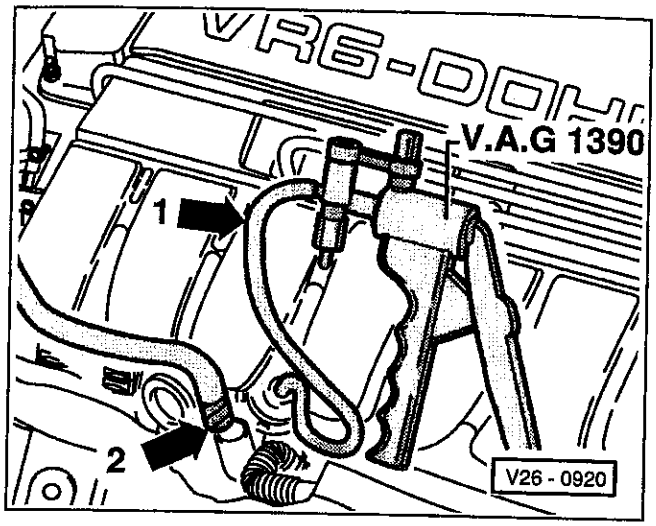
3. If the pump does not run and no wiring faults ca found, check the signal from the ECM to the pump. Dis connect the harness connector from the pump connect a voltmeter to the connector. Start the e while checking for voltage 20 seconds after starting.
   - If voltage is present, the pump is most likely fau and should be replaced.
   - If voltage is not present, check the wiring at the AIF relay and between the ECM and the AIR relay. If faults are found, the relay or ECM may be faulty

4. Check the shut-off valve by disconnecting the two hos es from the valve. Attach a hand vacuum pump t valve's vacuum fitting and apply vacuum. Check th valve opens by blowing air through the large hose fi ting. See Fig. 17. Release the vacuum and check the valve closes (air does not pass through large hos fitting).

   ***CAUTION—***
   *Do not use compressed air to check shut off valve.*

5. Check the AIR solenoid valve by disconnecting the shut-off valve the vacuum hose between the sole noid valve and the shut-off valve. Start the engine wh checking for vacuum at the hose 20 seconds after ing. If vacuum is present, the valve is functioning cor rectly.

6. If vacuum is not present, disconnect the harness con nector from the solenoid valve and connect a voltmete to the harness connector. Start the engine while ch ing for voltage 20 seconds after starting.
   - If voltage is present, the solenoid valve is most likely faulty and should be replaced.
   - If voltage is not present, check the wire between solenoid valve and the ECM. If no faults are found, the ECM may be faulty.




V25-0920

**Fig. 17.** Hand pump connected to AIR shut-off valve (**1**). Connect pump and apply vacuum while blowing through auxiliary hose (**2**).

## To remove AIR system pump

1. With the ignition off, disconnect the negative battery cable from the battery.
2. Remove the trim cover from above the radiator.
3. Remove the air cleaner housing.
4. Remove the clamps holding the A/C hoses to the radiator and the front body assembly.

> ***CAUTION —***
> *Use care not to kink or bend the air A/C hoses.*

5. Remove the lock carrier (radiator support) from the front of the car, complete with headlights. See **50 Body–Front**.
6. Remove the poly-ribbed drive belt. See **0 Maintenance Program**.
7. Remove the alternator. See **27 Engine Electrical Systems**.
8. Remove the air hoses from the air pump and disconnect the vacuum hose from the shut-off valve.
9. Disconnect the dipstick tube from the lower intake manifold.
10. Disconnect the harness connectors from the air pump and the AIR inlet (solenoid) valve. Move the wiring out of the way.
11. Remove the bolts holding the air pump to the engine lifting bracket.

Installation is the reverse of removal.

**Tightening torques**

- Air pump to air pump bracket . . . . . 10 Nm (89 in-lb)
- Air pump bracket to engine lifting eye. . . . . 25 Nm (18 ft-lb)
- Shut-off valve to cylinder head . . . . . 15 Nm (11 ft-lb)

## Catalytic Converter

The three-way catalytic converter chemically reduces pollutants in the engine exhaust. A properly operating converter provides a 90-95 percent reduction of the three major exhaust gas pollutants (nitrogen ($NO_x$), carbon monoxide (CO), and unburned hydrocarbons (HC).

The catalytic converter works correctly only when the air/fuel ratio is kept within a very narrow range. The oxygen sensor provides the feedback for control of the air/fuel mixture. For more information see **24a Fuel Injection–Motronic or 24b Fuel Injection–Mono-Motronic.**

The catalytic converter itself does not require any routine maintenance. However, any problem that increases converter temperature beyond its normal operating range (incorrect ignition timing or air/fuel mixture, engine misfire, prolonged idling or extended high engine loads) can damage the converter. Reduced power, stalling, exhaust system rattles and excessive emissions are symptoms that may be caused by a faulty catalytic converter.

Catalytic converters found on OBD II equipped vehicles use a second heated oxygen sensor to monitor the operation of the catalyst. If the converter fails to properly oxidize the spent combustion gasses, the heated oxygen sensor will detect this malfunction and a fault or diagnostic trouble code, DTC, will be stored in the engine control module, ECM.

Exhaust leaks anywhere in the system, but especially between the cylinder head and the catalytic converter, can cause running problems, false DTCs or converter failure.

> ***WARNING —***
> *Do not operate the starter for long periods if the engine fails to start. Extended cranking may allow excess fuel to enter the catalytic converter, creating a fire hazard and possibly damaging the converter.*

Accurately testing the function of the catalytic converter requires an infrared exhaust gas analyzer to check the air/fuel mixture adjustment (% CO) at the exhaust system test port upstream of the catalytic converter, and then again at the tailpipe. If the converter is working properly, the tailpipe reading will be lower than the test port reading. If the reading is the same or only slightly less, the converter is probably faulty.

# 27 Engine Electrical





## GENERAL

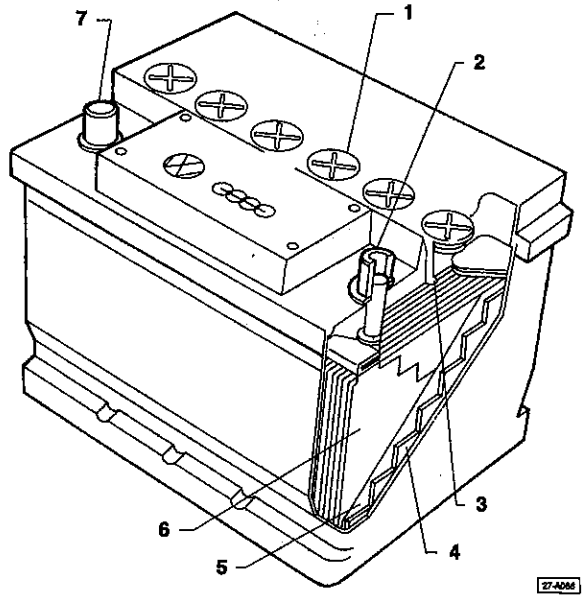
This repair group covers battery, starter, and alternator (generator) troubleshooting and repair.

***NOTE—***
*The alternator is identified as alternator (generator) throughout this repair section. Beginning with model year 1994, car makers must by law use uniform words and terms (nomenclature) to describe certain components and or systems. The uniform word for alternator is generator. Therefore, the component labeled "Generator (GEN)" in the wiring diagrams is the alternator.*

***NOTE—***
*Wiring diagrams for the battery, charging system and starter motor are given in* **97 Wiring Diagrams, Fuses and Relays**.

The six-cell, 12-volt lead-acid battery capacity is rated in Ampere/hours (Ah) and cold cranking amps (CCA). 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 rating is determined by the battery's ability to deliver starting current at 0°F (–18°C). The battery is installed in the engine compartment, behind the left headlight assembly.

The charging system consists of a belt-driven 14-volt alternator (generator) and a voltage regulator. The voltage regulator, which is mounted on the alternator (generator), also serves as the alternator (generator) brush holder. The charging system provides the current necessary to keep the battery charged and to operate the vehicle's electrical accessories.




1. **Filler cap**
2. **Positive (B+) terminal**
3. **Electrolyte level indicator**
4. **Negative plate (grey)**
5. **Separator (insulator)**
6. **Positive plate (dark brown)**
7. **Negative (–) terminal**

27-A066

**Fig. 1.** Battery.

Please read the following warnings and cautions before doing any work on any parts of the engine electrical system.

***WARNING—***

- *Wear goggles, rubber gloves, and a rubber apron when working around batteries and battery acid (electrolyte). Battery acid contains sulfuric acid and can cause skin irritation and burning. If acid 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 that are being charged or are fully charged give off explosive hydrogen gas. Keep sparks and open flames away. Do not smoke.*

***CAUTION—***

- *Disconnecting the negative (-) battery cable may erase fault codes and basic settings in the engine management and automatic transmission control unit memory. Some driveability problems may be noticed until the system re-adapts to operating conditions. OBD II readiness codes, which may be required for emissions testing, may also be erased.*
- *Do not disconnect the battery cables while the engine is running. The alternator (generator) will be damaged.*
- *Never operate the alternator (generator) with its output terminal (B+ or 30) disconnected and the other terminals connected. Never short, bridge, or ground any terminals of the charging system.*
- *Always disconnect the negative (–) battery cable when working at or near the alternator (generator). Battery voltage is always present at the rear of the alternator (generator), even with the ignition key off.*
- *Always allow a frozen battery to thaw before attempting to recharge it.*
- *Always disconnect the battery cables during battery charging. This will prevent damage to the alternator (generator) and any solid-state components. Do not exceed 16.5 volts at the battery.*
- *Never reverse the battery terminals. Even a momentary wrong connection can damage the alternator (generator) or electrical components.*
- *Replace the battery if the case is cracked or leaking. Electrolyte can damage the car. If electrolyte is spilled, clean the area with a solution of baking soda and water.*

## BATTERY SERVICE

If the battery quickly discharges, there may be a constant drain or current draw causing it to discharge when the ignition is off. Depending on the draw and the condition of the batter a full discharge can happen overnight or it may take s weeks. Although a small static drain on the battery is n (for example to operate the clock or radio memory), a larg drain such as a relay sticking on or a faulty switch will caus the battery to quickly discharge. Make a static current test as the first step when experiencing battery discharge.

If the current draw on the battery is not excessive an battery still discharges, the condition of the battery should tested. Battery testing determines the state of battery charg The most common methods are open-circuit and load vo testing. Batteries with filler caps can also be tested by ch ing the specific gravity of the electrolyte. Inexpensive specif gravity testers are available at most auto supply stores.

### To check static current draw

1. Make sure the ignition and all electrical accessories ar switched off.
2. Disconnect the negative (–) cable from the battery

***CAUTION—***
*Be sure to have the anti-theft radio code on hand before disconnecting the battery.*

3. Connect a digital ammeter between the battery n tive post and the negative battery cable and measur the current draw. See Fig. 2.

A range of about 0 to 100 milliamps is normal, depending o the number of accessories that need constant power. A currer of 500 milliamps (0.5 amp) or more indicates a problem. T termine the circuit or component causing the problem, rem one fuse at a time until the current drops to a normal range Use the wiring diagrams shown in **97 Wiring Diagrams, F es and Relays** to locate wiring or component faults.

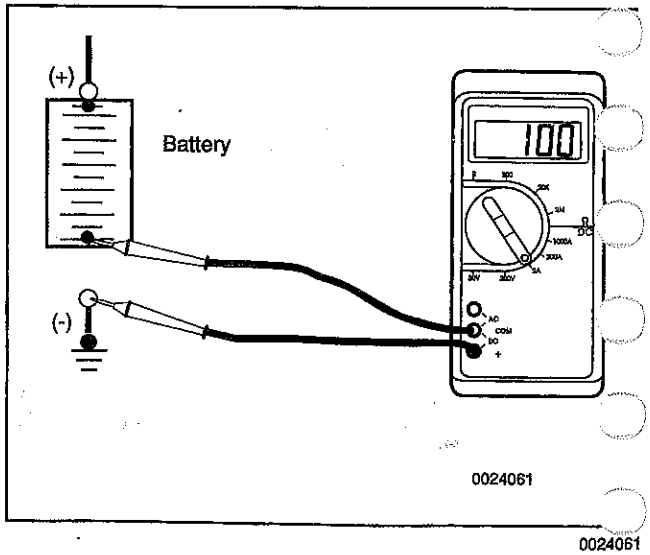



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**Fig. 2.** Electrical system static current draw being measured.

## 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, for example by turning on the headlights without the engine running. See **Table a** for open-circuit voltage levels and their corresponding percentages of charge.

**Table a. 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 still 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 is made by connecting a specific resistive load to the battery terminals and then measuring the battery's voltage. The test requires a special tester and can generally be performed quickly and inexpensively by an authorized VW dealer or other qualified repair facility.

The battery should be fully charged and at room temperature for the most accurate results. If the equipment is available, disconnect the negative (–) battery cable. Then apply the specified load for 15 seconds and measure the battery's voltage. If the voltage is below that listed, the battery should be replaced. **Table b** lists load current and minimum voltages for original-equipment VW batteries.

***WARNING —***
*Always wear protective goggles and clothing when performing a load test.*

## Battery Charging

Discharged batteries can be recharged using a battery charger. Prolonged charging causes gassing that will evaporate the electrolyte to a level that can damage the battery.

**Table b. Battery Load Current and Minimum Voltage**

| Battery Capacity | Cold Cranking Amps (CCA) | Load Current | Minimum voltage |
|---|---|---|---|
| 54 Amp-hour | 265 | 200 | 9.4 |
| 63 Amp-hour | 300 | 200 | 9.5 |
| 72 Amp-hour | 395 | 300 | 9.5 |
| 88 Amp-hour | 395 | 300 | 9.5 |

***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.*

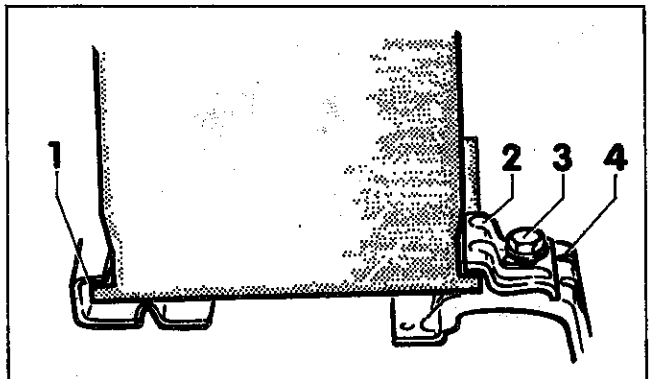
Always read and follow the instructions provided by the battery charger's manufacturer. A slow-charging rate (10% of battery capacity) is best to prevent battery damage caused by overheating.

## To remove and install battery

1. Disconnect the battery cable at the negative (–) terminal.

***NOTE —***
*Be sure to have the anti-theft radio on hand before disconnecting the battery cables.*

2. Disconnect the battery cable at the positive (+) terminal.
3. Remove the battery hold down nut and clamp. See Fig. 3.




1. **Lower clamping strip**
2. **Hold-down clamp**
3. **Nut**
   - tighten to 20 Nm (15 ft-lb)
4. **Battery securing bracket**

27-595

**Fig. 3.** Battery hold-down assembly.

4. Position the battery into the lower clamping strip first. Then retain the other side of the battery using the hold-clamp and bolt. Tighten the hold-down bolt and the battery cables to the specified torque.

> ***CAUTION—***
> *A secure battery hold-down is important. Normal shock and vibration can cause premature damage to a loosely mounted battery.*

**Tightening torques**

- Battery hold-down bracket . . . . . 20 Nm (15 ft-lb)
- Battery cables to battery . . . . . 5 Nm (44 in-lb)

## CHARGING SYSTEM SERVICE

Charging system trouble is indicated by an illuminated alternator (generator) warning light on the instrument panel, or by an under- or overcharged battery.

The alternator (generator) generates electrical current by electrical induction. When the engine is running, 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 (generator) warning light in the instrument cluster. If the lamp burns out, the alternator (generator) will not charge the battery properly.

> ***CAUTION—***
> *Always disconnect the negative (–) battery cable before servicing the charging system. The large red wire at the rear of the alternator (generator) comes directly from the battery and is not fuse protected.*

As a quick-check, measure the voltage across the battery terminal with the key off and then again with the engine running. The battery voltage should be about 12.6 volts with key off and approximately 14.0 volts with the engine running. If the voltage does not increase when the engine is running, there is a fault in the charging system.

> ***NOTE—***
> *The regulated voltage (engine running) should be roughly between 13.8 and 14.5 volts, depending on temperature and operating conditions. If the voltage is much higher than 14.5 volts, the voltage regulator is most likely faulty.*

### To test charging system

1. Inspect the poly-ribbed drive belt for cracking, glazing or wear. Replace the belt if any faults are found. Check that the belt is not slipping and that the belt tension is correct.
2. Make sure the battery is fully charged and capable holding a charge. Make sure the battery terminals a clean and tight.
3. Check that the charge warning lamp comes on wh the key is on. If the light comes on, proceed to s If the light does not come on, repair any wiring o faults before continuing to test.

> ***NOTE—***
> *The charge warning light must come on when the ignition is switched on or the system will not charge. If any faults are found, see* **97 Wiring Diagrams, Fuses and Relays** *for electrical schematics.*

4. Check for battery voltage between ground and te **B+** (large red wire) at the back of the generator. Che that the wire is securely fastened.
5. Turn the ignition key on and check for battery vol between terminal **D+** and ground. If voltage is n present, check the wiring from the warning light instrument cluster.
6. If no faults are found up to this point, have the alter (generator) tested with a load tester, such as th VAT40.

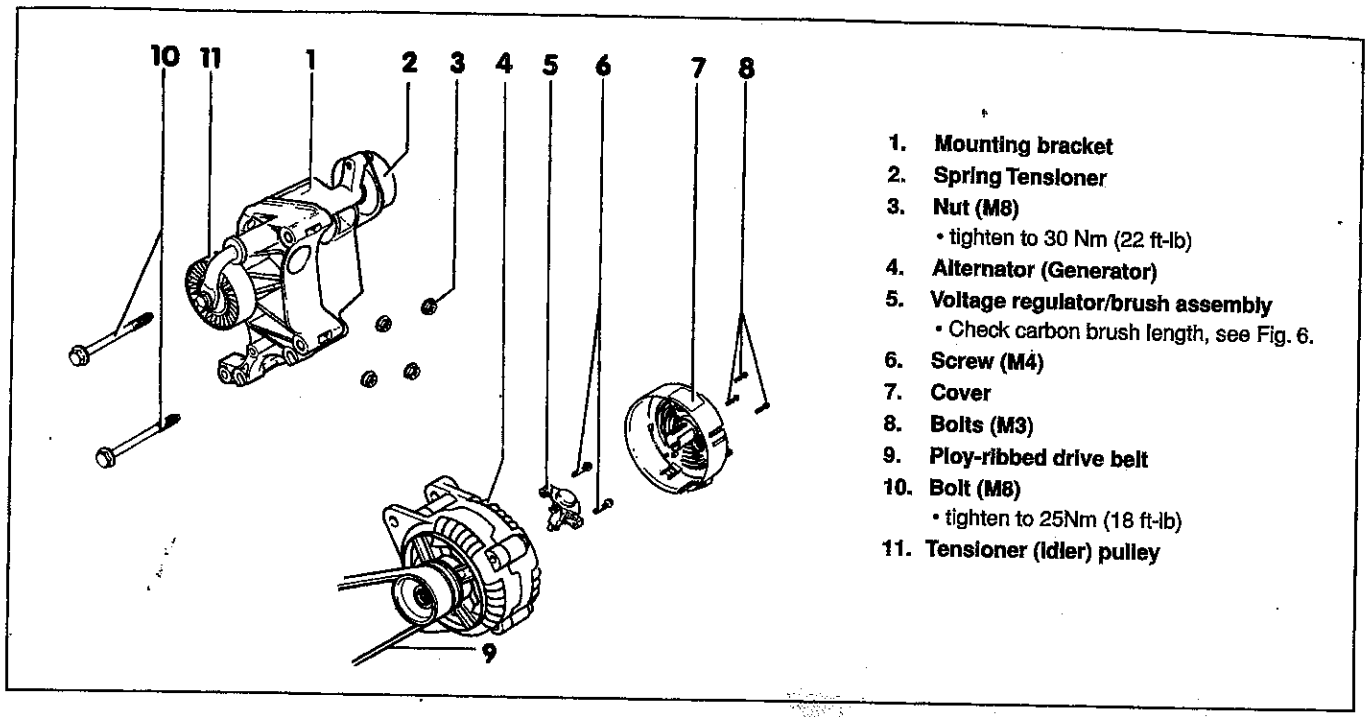
> ***NOTE—***
> *If a load test is not possible, an imperfect output test can be done by running the engine at about 2000 rpm and turning on many of the electrical loads such as fans, lights and heated window, wipers, etc. When loaded, the battery should still be 12 volts or higher.*

### To remove and install alternator (generator)

1. Disconnect the negative (–) battery cable.

> ***NOTE—***
> *Be sure to have the anti-theft radio on hand before disconnecting the battery cables.*

2. Mark the running direction on the poly-ribbed driv and then remove the belt from the alternator (genera tor) pulley. See **0 Maintenance Program.**
3. Disconnect the wiring from the rear of the alterna (generator).
4. On 6-cylinder engines, unbolt the belt tensioner the cylinder head.
5. Remove the upper and lower alternator (gene through-bolts and remove the alternator (generato from its bracket. See Fig. 4 or Fig. 5.
6. Installation is the reverse of removal. Tighte torques are given in the illustrations.




1. **Mounting bracket**
2. **Spring Tensioner**
3. **Nut (M8)**
   • tighten to 30 Nm (22 ft-lb)
4. **Alternator (Generator)**
5. **Voltage regulator/brush assembly**
   • Check carbon brush length, see Fig. 6.
6. **Screw (M4)**
7. **Cover**
8. **Bolts (M3)**
9. **Ploy-ribbed drive belt**
10. **Bolt (M8)**
    • tighten to 25Nm (18 ft-lb)
11. **Tensioner (idler) pulley**

27-682

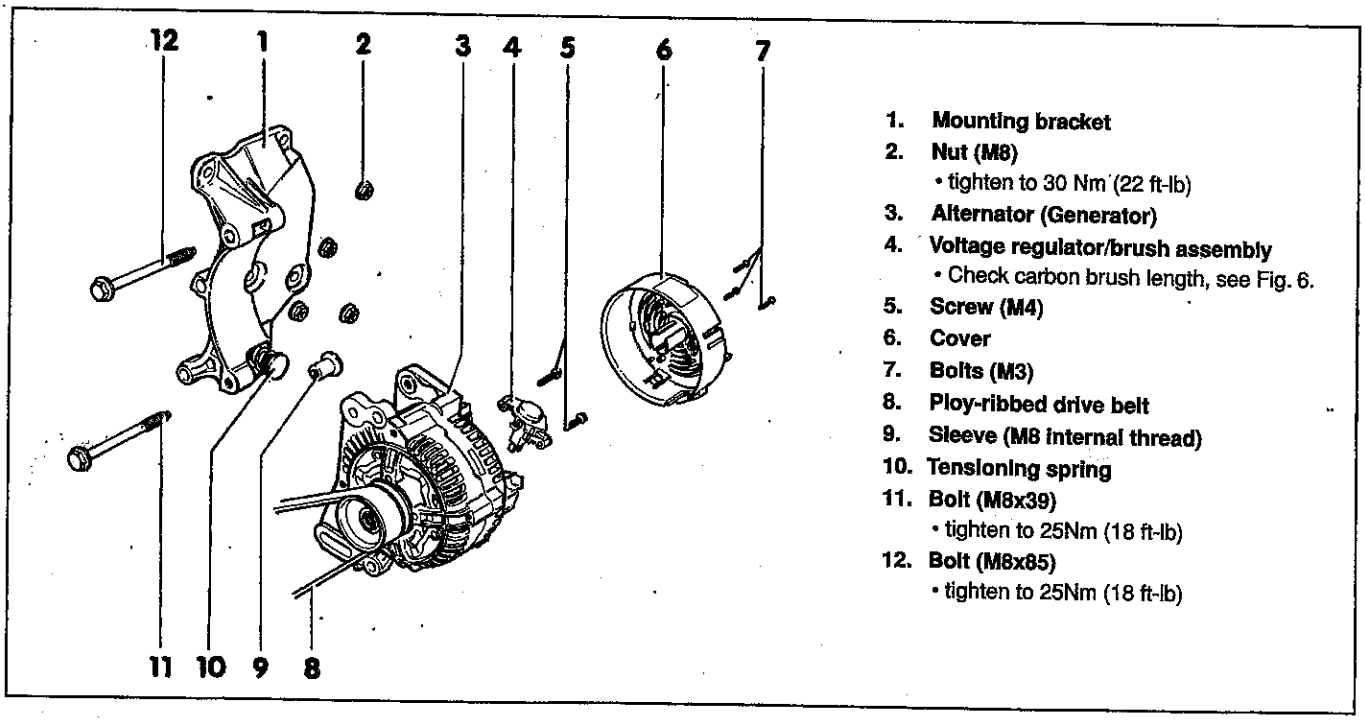
**Fig. 4.** Alternator (Generator) mounting bracket and related parts (cars with A/C).

***NOTE —***

*On cars without A/C, start and run the engine for at least ten seconds before tightening the alternator (generator) mounting bolts, then tighten the top first.*

***NOTE —***

*Be sure to reinstall the insulating boots to the wire terminals on the back of the alternator (generator).*




1. **Mounting bracket**
2. **Nut (M8)**
   • tighten to 30 Nm (22 ft-lb)
3. **Alternator (Generator)**
4. **Voltage regulator/brush assembly**
   • Check carbon brush length, see Fig. 6.
5. **Screw (M4)**
6. **Cover**
7. **Bolts (M3)**
8. **Ploy-ribbed drive belt**
9. **Sleeve (M8 internal thread)**
10. **Tensioning spring**
11. **Bolt (M8x39)**
    • tighten to 25Nm (18 ft-lb)
12. **Bolt (M8x85)**
    • tighten to 25Nm (18 ft-lb)

27-681

**Fig. 5.** Alternator (Generator) mounting bracket and related parts (cars without A/C).

## Regulator/brush assembly

The voltage regulator is easily removed from the back of the alternator (generator) by removing the two mounting screws. The regulator with brushes is available as a replacement part.

With the regulator removed, measure the brush length. See Fig. 6. Replace the brushes in sets if the length is less than the minimum length specified. Replacing the brushes requires a soldering iron and electric/electronic type solder.

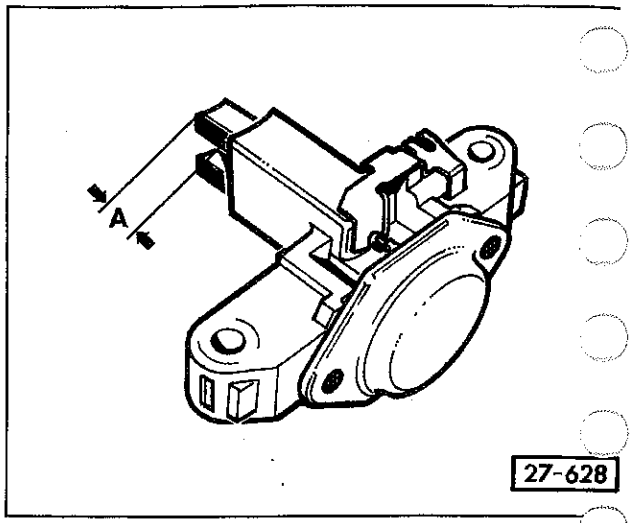



**Fig. 6.** Regulator brush length (**A**). Brushes shorter than 5 mm (0.2 in.) should be replaced.

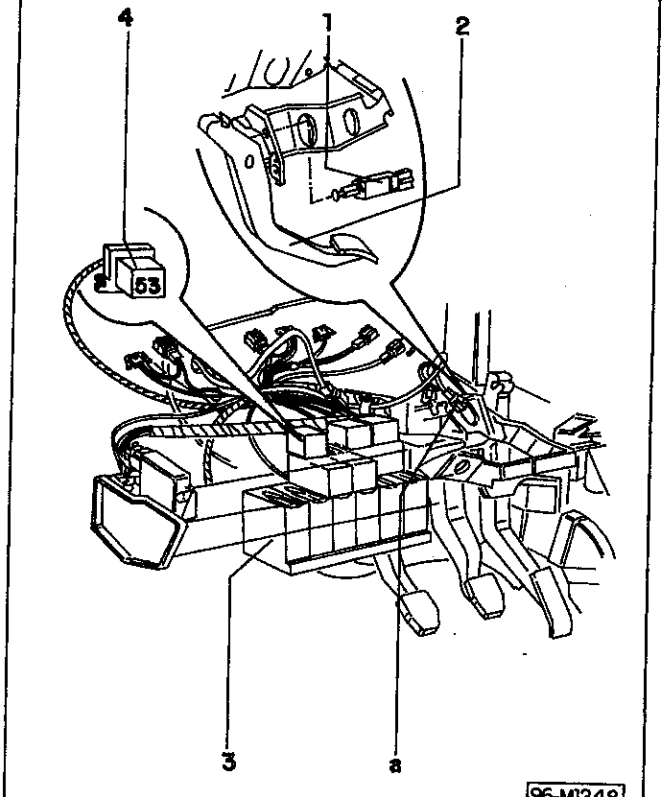
## STARTER SERVICE

The starter is located at the left-hand (driver's) side of the engine block, just above the oil pan. The starter and solenoid are removed together as an assembly. The solenoid can be separated from the starter motor once the starter has been removed. Although the starter is generally replaced as an exchanged unit, the solenoid and other parts are available from an authorized VW dealer.

Manual transmission vehicles produced from May 1996 have a starter lock-out function requiring the clutch pedal to be depressed before the starter can be activated. This system consists of a pedal switch and a relay on the fuse-relay panel. See Fig. 7, given later.

**Table c. Starter 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) | a. Test for voltage at terminal 50 of solenoid with ignition at START. If not at least 8 volts, test for voltage at terminal 50 of ignition switch with switch at START. Replace ignition switch or eliminate open circuit between ignition switch and solenoid. |
| | b. Solenoid faulty (less than 8 volts to starter motor) | b. Test for voltage at field-winding strap with ignition at START. If not at least 8 volts, test solenoid. |
| | c. Starter motor faulty | c. Test for voltage at field-winding strap with ignition at START. If 8 volts or more, repair or replace starter motor. |
| | d. Automatic transmission start inhibitor switch faulty (models with A/T) | d. Test switch. See **97 Wiring Diagrams, Fuses and Relays** and **37 Automatic Transmission.** |
| | e. Starter lock-out switch or relay faulty (models with manual trans) | e. Test switch and relay. See **97 Wiring Diagrams, Fuses and Relays.** |
| 2. Starter turns slowly or fails to turn engine | a. Dirty, loose, or corroded starter connections | a. Clean, and tighten connections. If necessary check voltage between the battery and the starter as described in **9 Electrical System—General.** |
| | 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 |
| 3. Starter operates, but does not turn engine | a. Flywheel or driveplate teeth missing or damaged | a. Replace flywheel or driveplate. See **1 ENGINE.** |
| | b. Starter drive or armature shaft faulty | b. Repair or replace starter |
| | c. Solenoid mechanism faulty | c. Replace starter solenoid |




1. **Starter lock-out switch**
   - To remove: disconnect 2-pin harness connector (a). Press and turn switch and pull out of bracket away from clutch pedal (2).
2. **Clutch pedal**
3. **fuse/relay panel**
4. **Relay**
   - Relay position 21

96-M1248

**Fig. 7.** Starter lock-out switch and relay location found on vehicles with manual transmission starting with May 1996 production.

Before troubleshooting the starter, make sure the battery is fully charged and the battery cables and ground connections are free of corrosion and in good condition. Troubleshooting information for the starting system appears in **Table c.**

***NOTE—***

*Starter cranking speed is affected by engine oil viscosity. This is especially true in cold weather. Make sure the correct oil is in the engine. See* **0 Maintenance Program.**

## To remove and install starter

The procedure given below requires the use of engine lifting equipment to support the weight of the engine from above while the starter motor is removed.

1. Disconnect the negative (–) battery cable.
2. Install an engine support bridge and support the weight of the engine. See Fig. 8.

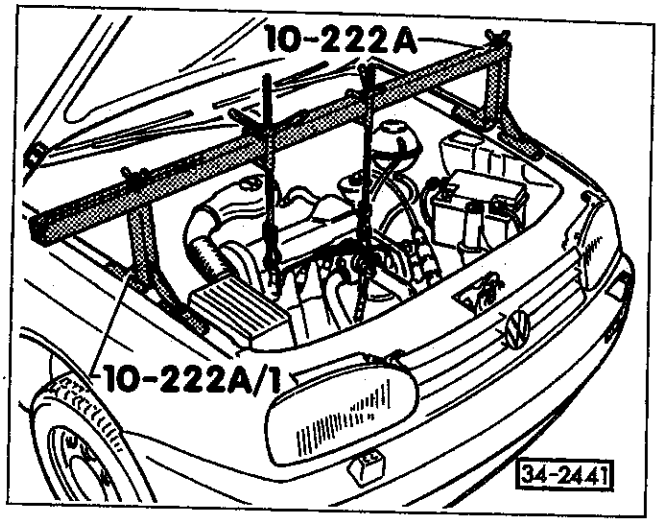



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**Fig. 8.** Engine support installed across engine bay. (VW special tools 10-222A and 10-222A/1 shown).

3. Working in the driver's side of the engine compartment, remove the black plastic cover and the harness connector from above the starter motor. See Fig. 9.

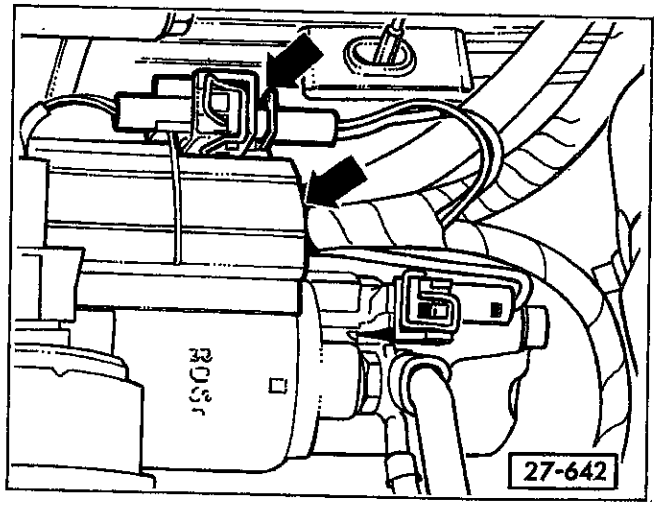


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**Fig. 9.** Electrical harness connector and plastic cover (**arrows**) to be removed at starter motor.

4. Remove the harness connector and the large wire from the rear of the starter motor.

5. With the engine supported, remove the cable securing bracket from the starter motor. Then remove the M10 nut and M12 bolt (4-cylinder engines only) from the underside of the starter motor. See Fig. 10.

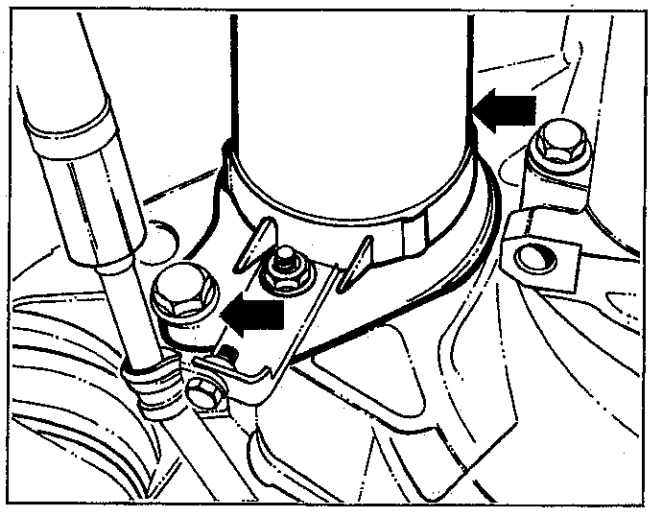

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**Fig. 10.** M10 nut and M12 bolt to be removed from starter (**arrows**).

6. While supporting the starter motor, remove the upper mounting bolt (M10) and remove the starter motor.

7. Installation is the reverse of removal.

**Tightening torques**

- Starter motor to engine block or motor mount
  - M8 nut . . . . . 10 Nm (89 in-lb)
  - M10 nut or bolt . . . . . 60 Nm (44 ft-lb)
  - M12 bolt . . . . . 45 Nm (33 ft-lb)
- Wiring at solenoid terminal 30 . . . . . 13 Nm (10 ft-lb)

# 28a Ignition System–Gasoline





## GENERAL

The ignition function is handled through the fuel injection/engine management system. See **Table a.** On gasoline engines, the Motronic or Mono-Motronic engine control module (ECM) computes ignition timing based on inputs from various sensors. See Fig. 1. Crankshaft position is the main input to the ECM and is used for starting. The other sensors are used to adapt the basic timing map for varying operating conditions. Motronic engines incorporate adaptive knock control to adjust the ignition timing for individual cylinders.

**Table a. Engine Management System Applications**

| Engine code | System |
|---|---|
| ACC (1.8 liter) | Mono-Motronic |
| AAZ (1.9 liter) | Diesel Fuel Injection |
| AHU (1.9 liter) | TDI Diesel Fuel Injection |
| ABA (2.0 liter) | Motronic M2.9/M5.9* |
| AAA (2.8 liter, VR6) | Motronic M2.9/M5.9* |

*1993–1995 models are equipped with Motronic M2.9. 1996 and later models are equipped with Motronic M5.9

***NOTE—***

*The engine management/ ignition system has a built in diagnostic circuit that monitors the ignition system components and detects and stores system faults. Before troubleshooting the ignition system, be sure to check for diagnostic trouble codes (DTCs) as described in* **24a Motronic** *or* **24b Mono-Motronic.**

***NOTE—***

- *On Motronic-equipped engines, crankshaft position is determined by the engine speed (RPM) sensor. The RPM sensor is mounted in the side of the cylinder block and reads a toothed wheel on the end of the crankshaft. See* **24a Fuel Injection–Motronic** *for RPM sensor testing.*
- *On Mono-Motronic cars, crankshaft position is determined by the camshaft position (CMP) sensor, which is located in the ignition distributor. The CMP is an electronic switch and operates based on the Hall effect. See* **24b Fuel Injection–Mono-Motronic** *for testing information.*

### Service Precautions

Ignition system service and repair work must be carried out carefully. The ignition system contains sensitive electronic components. To guard against system damage, and for general safety, the following warnings apply to any ignition system troubleshooting, maintenance or repair work.

***WARNING—***

*Ignition systems operate 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 vehicle with the ignition on or the engine running.*

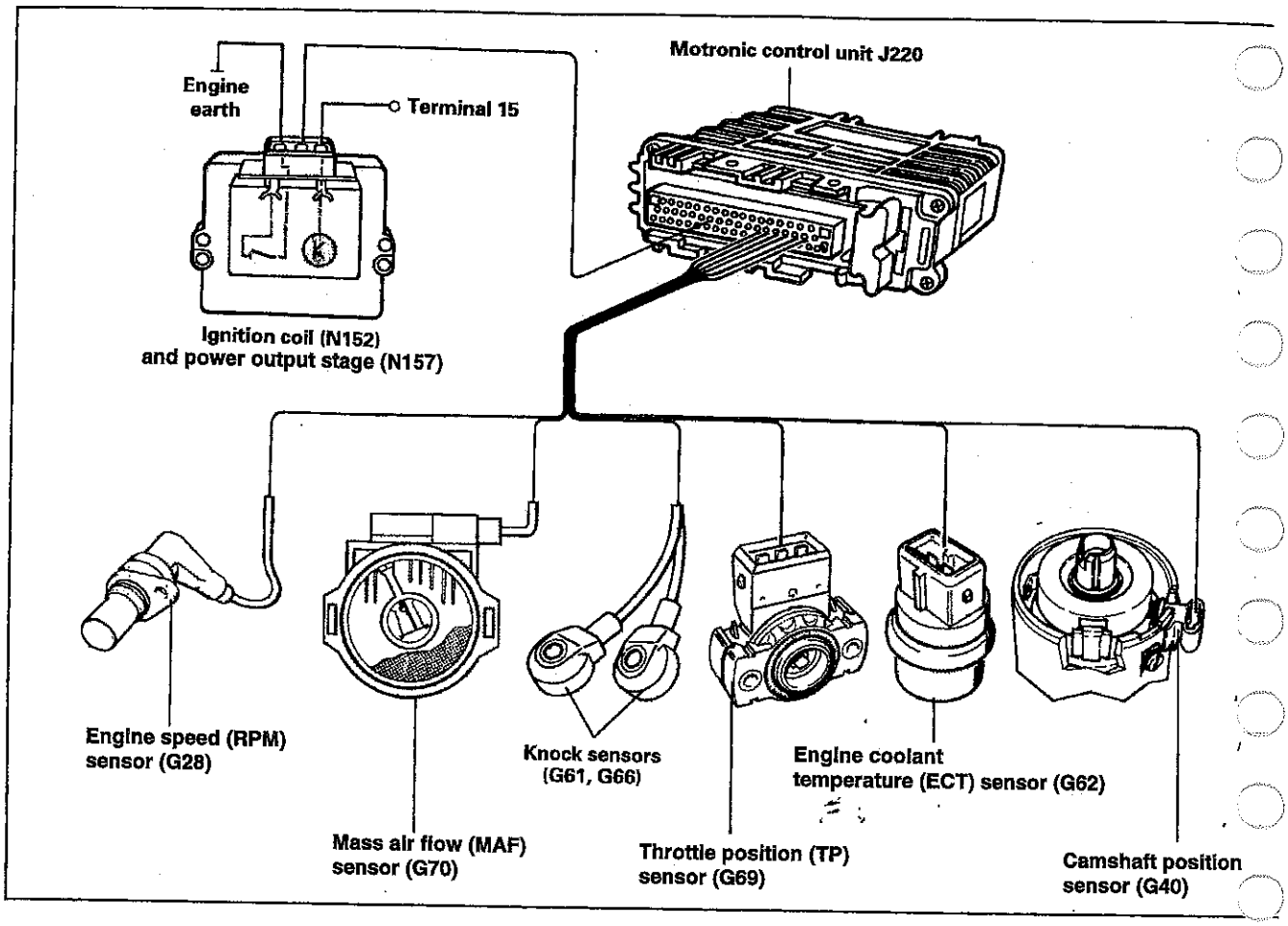


**Fig. 1.** Ignition system input signals for Motronic-equipped engines.

***WARNING —***

*Connect and disconnect ignition system wires, multiple connectors, and test equipment leads only while the ignition is off. Do not touch or disconnect any of the high voltage wires from the coil, distributor or spark plugs while the engine is running or being cranked by the starter.*

***CAUTION —***

- *Never let the spark gap (between electrode and ground) exceed 5 mm (0.20 in.) when checking the ignition system, as when checking for a spark, as the control unit may be damaged. Always ground the plug on the engine when checking for spark.*
- *Before operating the starter without starting the engine (as when making a compression test), always disable the ignition as described below.*
- *A weak spark or no spark can overload the catalytic converter with unburned fuel, leading to converter overheating or plugging. An overheated catalytic converter can be a fire hazard.*

***CAUTION —***

- *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. Use only a low-current LED test light.*
- *Do not connect test instruments with a 12-volt supply to terminal 15(+) of the ignition coil. The voltage backflow can damage the ignition control unit.*
- *Do not disconnect terminal 4 (center terminal) from the coil or remove the distributor cap to disable the ignition.*

## Disabling Ignition System

The ignition system should be disabled to prevent the engine from starting and to prevent the discharge of dangerous high voltage any time work is done on the ignition system. The ignition system should also be disabled any time work is being done in the engine compartment with the ignition key on or the starter needs to be operated without running the engine, such as when making an engine compression test.

To disable the ignition system, disconnect the harness connector from the ignition coil power output stage.

On 4-cylinder engines, the ignition coil with power output stage is mounted in the rear of the engine compartment, against the firewall. See Fig. 2.

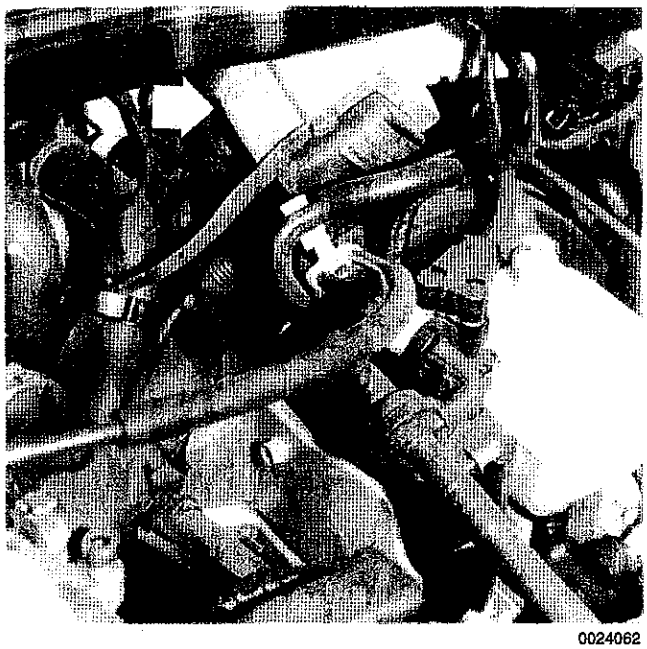

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**Fig. 2.** Harness connector (**arrow**) for ignition coil with integrated power output stage on 4-cylinder engines. Component is mounted in rear of engine compartment.

On 6-cylinder engines, the ignition coil with integrated power output stage is mounted on the rear of the cylinder head. To access the coil harness connector first remove the plastic intake manifold cover from above the intake manifold, then remove the spark plug wire guides with the ignition wires from the top of the cylinder head. See Fig. 3.

***NOTE—***

*If necessary, a special tool (VW tool no. 3277) is needed to remove the spark plug connectors from the plugs without damaging them. A version of this tool is clipped to the front hood support rod.*

## IGNITION SYSTEM 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, it is often difficult to know where to begin looking for problems. For this reason, when troubleshooting always consider these systems in unison, as one major system.

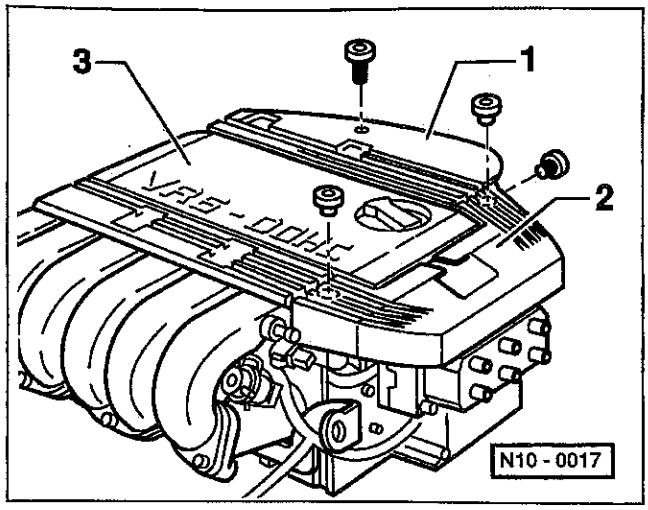


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**Fig. 3.** VR6 spark plug wire guides (**1** and **2**). Intake manifold cover shown at **3**.

A complete failure of the ignition system to produce spark at the spark plugs is self-evident. For other problems such as rough idle, misfiring, or poor starting the cause may not be so clear. The engine management system has a built in diagnostic circuit that monitors the ignition system components and detects and stores system faults. Before troubleshooting the ignition system, always check for diagnostic trouble codes (DTCs) as described in **24a Motronic** or **24b Mono-Motronic**.

### Quick-Check of Ignition System

The first step in troubleshooting a no-start condition is to determine whether the problem is caused by the ignition system or some other system, such as a fuel delivery problem. This is done by checking that the spark plugs are firing. If no spark is present, a more detailed testing of the ignition system is necessary.

To make the check, turn the ignition off and remove a spark plug wire from a spark plug. Connect to the plug wire to a known good spark plug. Position the plug so that the outer electrode is grounded on the engine. For accurate test results, the battery should be fully charged.

***CAUTION—***

*Never let the spark plug gap (between electrode and ground) exceed 5 mm (0.20 in.) when checking the ignition system, as when checking for a spark, as the control unit may be damaged. Always ground the plug on the engine when checking for spark.*

While a helper actuates the starter, look and listen for a spark at the plug. A bright blue spark indicates a healthy ignition system. If there is no spark, first make sure that the speed (RPM) sensor (Motronic-equipped cars) or the camshaft position (CMP) sensor (Mono-Motronic-equipped cars) are functioning correctly. See description in **24 Fuel Injection**. Then test the ignition coil output stage and the ignition coil as described below.

***WARNING—***
- *Do not hold the spark plug or its connector during the test, even if using insulated pliers.*
- *If ignition system failure is not the problem, the engine may start during this test. Be prepared to switch the ignition off immediately. Running the engine with a spark plug wire disconnected may damage the catalytic converter.*

## Firing Order

The firing order of the cylinders is given below. Cylinder no. 1 is at the drive belt end of the engine.

**Ignition Firing Order**
- 4-cylinder engine . . . . . 1–3–4–2
- 6-cylinder engine . . . . . 1–5–3–6–2–4

# COMPONENT TESTING

Be sure to review the information given in **24a Fuel Injection–Motronic** or **24b Mono-Motronic** for retrieving diagnostic trouble codes (DTCs) and applicable ECM pin-out tests before making the electrical checks and tests given below.

***NOTE—***
*The test given below assumes that the camshaft position (CMP) sensor and the speed (RPM) sensor (where applicable) are functioning correctly. See* **24a Fuel Injection—Motronic** *or* **24b Fuel Injection—Mono-Motronic** *for testing information.*

**Basic Requirements**
- Battery positive (+) voltage OK
- Fuse no. 15 and no. 18 OK
- Ground connections on cylinder head OK

***NOTE—***
*For engine management and ignition wiring diagrams, see* **97 Wiring Diagrams, Fuses and Relays.**

***CAUTION—***
- *Use a high-quality digital automotive multimeter or an LED test light to make the tests. An analog (swing-needle) meter should not be used as it can permanently damage electronic components.*
- *Always connect and disconnect the ECM connector and meter probes with the ignition off to avoid damage to electronic components.*
- *When disconnecting the large harness connector from the engine control module (ECM), wait at least a minute with the ignition off before separating the connector from the ECM.*

## To test ignition coil and power output sta (4-cylinder engines)

The ignition coil used on the 4-cylinder engines is mount in the rear of the engine compartment, against the bulkhea The coil is integrated with the coil power output stage. the test below in the order given, repair any faults before mo ing on to the next step.

1. Disconnect the 3-pin connector from the power o stage. See Fig. 2, given earlier.
2. Connect a voltmeter across terminals 1(–) and 3 the connector. Turn the ignition on and check for batte voltage. See Fig. 4.

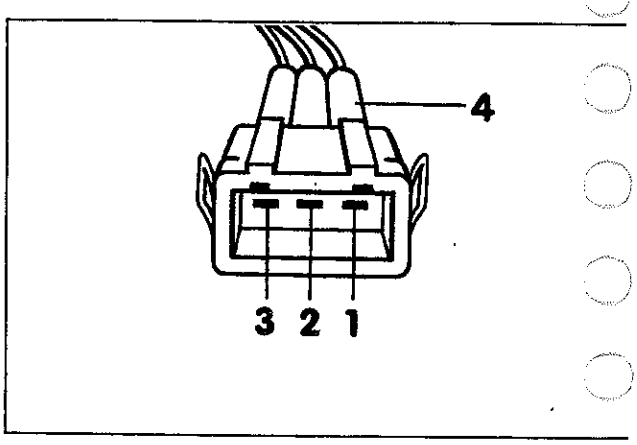



**Fig. 4.** 3-pin connector from 4-cylinder coil power output sta

***NOTE—***
*If voltage is not present, check the wiring to connector. See* **97 Wiring Diagrams, Fuses and Relays.**

3. Connect an LED light across terminals 2 and 3 in th power output stage connector.
4. Remove fuse no. 18 (fuel pump, HO2S control module from the fuse relay panel.

5. On Motronic cars, disconnect the harness connectors from fuel injectors 1 and 4.

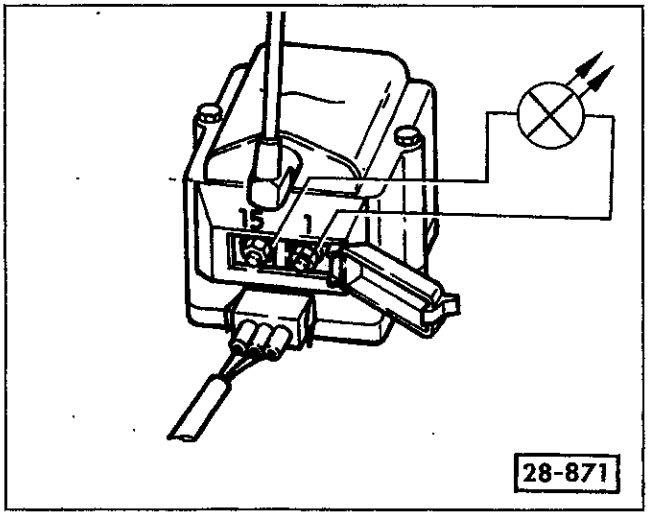
6. On Mono-Motronic cars, disconnect the harness connector from the single fuel injector.

7. Actuate the starter and check that the LED flashes. Reconnect the 3-pin connector to the coil power output stage.

***NOTE—***
*If the LED does not flash, the ignition (ground) signal from the ECM is missing. Check the wire between the ECM and the coil power output stage. If no wiring faults can be found, the ECM may be faulty. See* **24 Fuel Injection** *for an ECM pin-out test.*

8. Pry back the cover from the coil terminals. Connect an LED test light across terminals 1 and 15. See Fig. 5.

***WARNING—***
*Do not hold the LED test light during the test. Dangerously high voltage is present.*




28-871

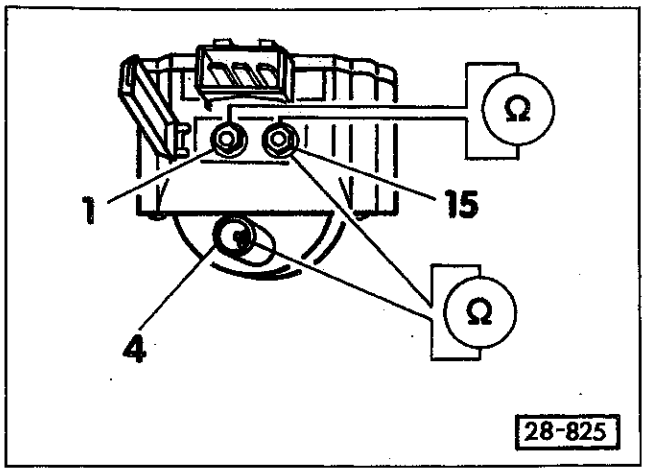
**Fig. 5.** LED test light (shown schematically) connected across coil terminals.

9. Switch the ignition on and check that the light illuminates for 1 to 2 seconds. Actuate the starter and check that the LED flashes. Switch the ignition off.

***NOTE—***
- *If the LED does not light up or does not flash, the coil power output stage is faulty.*
- *The ignition coil and the power output stage are available as individual replacement parts.*

10. If no faults are found up to this point, measure the coil primary and secondary circuit resistance as shown in Fig. 6. If the coil resistance is not as specified, it should be replaced.

**Ignition coil resistance**
- Primary
  (terminals 1 and 15) . . . . . .0.5–0.7 ohms
- Secondary
  (terminals 4 and 15) . . . . . .3,000–4,000 ohms




28-825

**Fig. 6.** Ignition coil primary and secondary resistance being measured (shown schematically).

11. Reconnect the harness connectors to the fuel injector(s) and reinstall fuse no. 18.

## To test ignition coil and power output stage (6-cylinder engine)

The ignition coil used on the VR6 engine is comprised of three "double-ended" coils within one housing. When the power output stage triggers one of the three ignition coils, spark is supplied to two spark plugs at once—one plug fires during the compression stroke and the other plug fires during the exhaust stroke. A heat sink and power output stage is mounted to the back of the ignition coil.

Make the test below in the order given, repair any faults before moving on to the next step.

***NOTE—***
*The test given below assumes the speed (RPM) sensor and the camshaft position (CMP) sensor are functioning correctly. See* **24a Fuel Injection—Motronic** *for testing information.*

1. Disconnect the 5-pin harness connector from the ignition coil power output stage.

2. Connect a voltmeter across terminals 1(–) and 5(+) in the connector. Turn the ignition on and check that battery voltage is present.

***NOTE—***

*If voltage is not present, check the wiring to the connector. See* **97 Wiring Diagrams, Fuses and Relays.**

3. Remove fuse no. 18 (fuel pump, HO2S control module) from the fuse/relay panel.

4. Connect an LED test light across terminal 5 and terminal 2 in the harness connector. Actuate the starter and check that the LED flashes. See Fig. 7.
   - If the LED does not flash, the ignition (ground) signal for cylinders 1 and 6 is not present. Check the wiring between the coil and the ECM connector. If no faults can be found, the ECM may be faulty.
   - If the LED does flash, but the spark plugs for cylinder no. 1 and cylinder no. 6 do not fire, the ignition coil/power output stage is faulty and should be replaced.

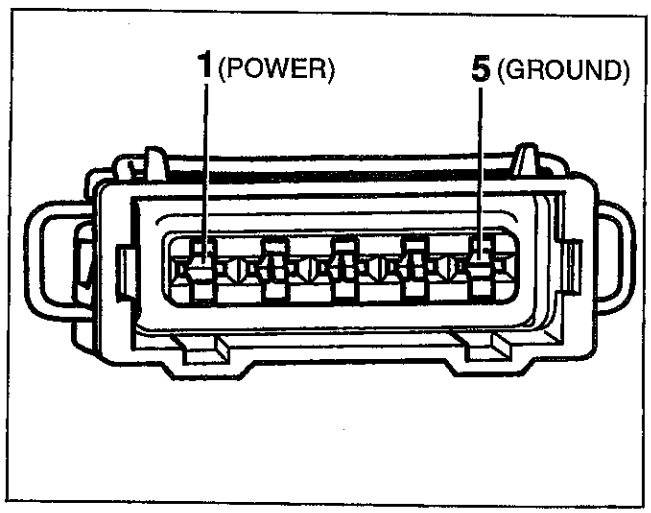



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**Fig. 7.** 5-pin harness connector for 6-cylinder coil power output stage.

5. Repeat above step across terminals 5 and 3 (cylinders 3/4) and terminals 5 and 4 (cylinders 2/5). If any faults are found replace ignition coil/power output stage.

***NOTE—***

*The coils and power output stage are an integrated unit. Individual parts are not separately available for 6-cylinder engines.*

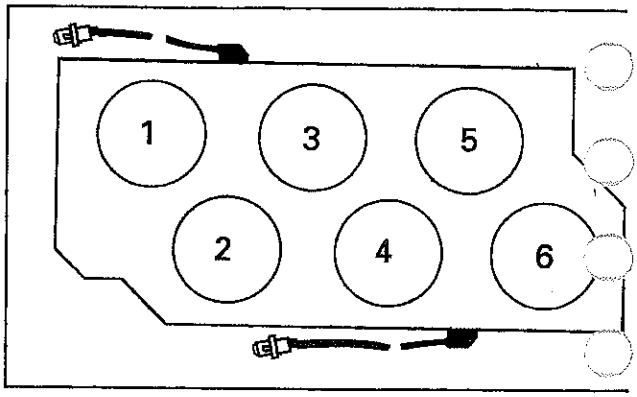
6. Turn the ignition off and reinstall fuse no. 18.

## To test knock sensor

A knock sensor functions like a microphone and co mechanical vibration (knock) into electrical signals. T Motronic ECM is programmed to react to the signals wh frequencies are characteristic of combustion chamber and change ignition timing accordingly. If the signal from t knock sensor is missing for any reason, the Motronic ECM v retard the timing about 12° to prevent engine damage.

***NOTE—***

- *4-cylinder engines use a single knock sensor. The sensor is mounted on the front side of the cylinder block, beneath the intake manifold, between cylinders two and three.*
- *6-cylinder engines are equipped with two knock sensors. One sensor monitors cylinders 1, 2, and 3, while the other monitors cylinder 4, 5 and 6. See Fig. 8.*




002405

**Fig. 8.** 6-cylinder engine uses two knock sensors. Knock regu is done cylinder-selectively on Motronic engines.

1. Remove the knock sensor from the cylinder bloc disconnect the 3-pin connector.

2. Using the knock sensor mounting bolt, a washer, nut, tighten the bolt through the knock sensor to th specified torque.

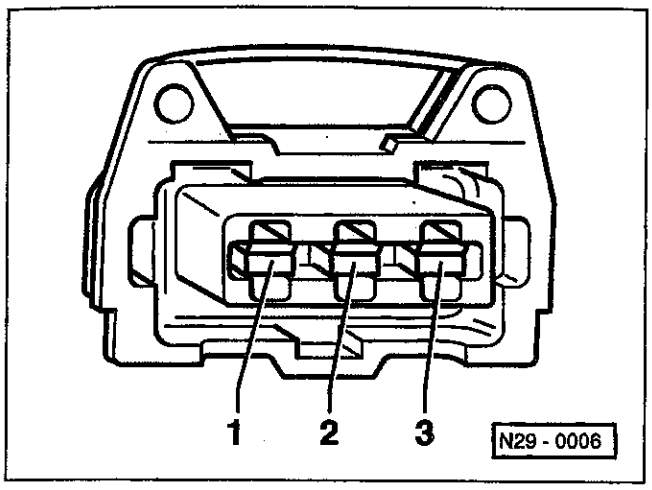
***NOTE—***

*Be sure to tighten the knock sensor mounting bolt to the specified torque. Correct mounting bolt torque is critical to knock sensor operation.*

**Tightening torques**

- Knock sensor to cylinder block . . . . . 20 Nm (15 ft-lb)

3. Connect a voltmeter (DC volts) to terminals 1 and 2 i the connector. See Fig. 9.




N29-0006

**Fig. 9.** Terminal identification for knock sensor connector.

4. Using a metal object, lightly tap on the mounting bolt. The voltmeter should register small fluctuating amounts of voltage. Voltage will vary based on the intensity of the tapping.

5. If any faults are found the sensor is faulty and should be replaced.

## To check ignition wires

1. Remove one ignition wire and separate the spark plug connector and the interference suppression connector from the wire.

2. Check the wires by gently bending them in several places to expose cracks in the insulation. Wires that are cracked, oil-soaked or dry and brittle should be replaced.

3. Measure the resistance of the individual components. Replace any faulty parts found.

**Ignition wire resistances**

- Spark plug connector . . . . . 4,000–6,000 ohms
- Interference suppression connector . . . . . 600–1400 ohms
- Ignition wire (ends removed) . . . . . continuity

4. Assemble and reinstall the wire. Repeat the check for the remaining wires.

## To check distributor cap and rotor (4-cylinder engines)

The distributor cap and rotor are subject to wear and electrical breakdown.

1. Unclip and remove the distributor cap.

2. Inspect the contacts inside the distributor cap and at the tip of the rotor for carbon tracks, wear, or pitting. See Fig. 10.

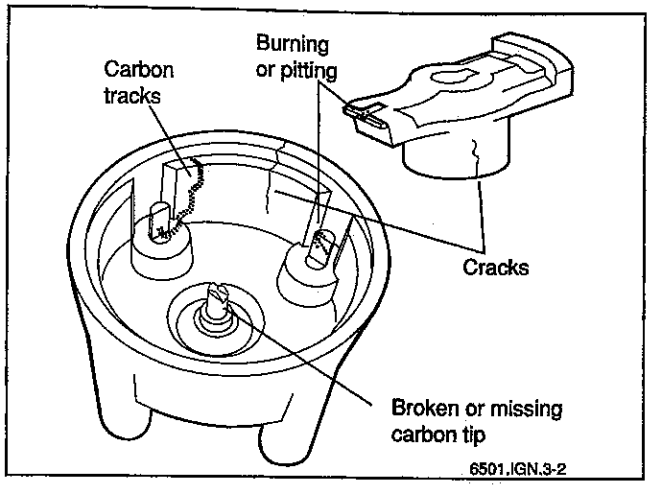



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**Fig. 10.** Distributor cap and rotor. Inspect cap and rotor at contact points.

3. If any faults are found, replace the cap and/or rotor.

# COMPONENT REMOVAL AND REPLACEMENT

## To remove and install distributor (4-cylinder engines)

Individual replacement parts for the distributor are not available from VW. The entire distributor assembly must be replaced if the camshaft position (CMP) sensor is found to be faulty.

***NOTE—***

*On ACC engines, ignition timing must be checked and adjusted any time the distributor is disassembled or removed. See* **To check and adjust ignition timing (ACC engine)** *given later.*

1. 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. 10.

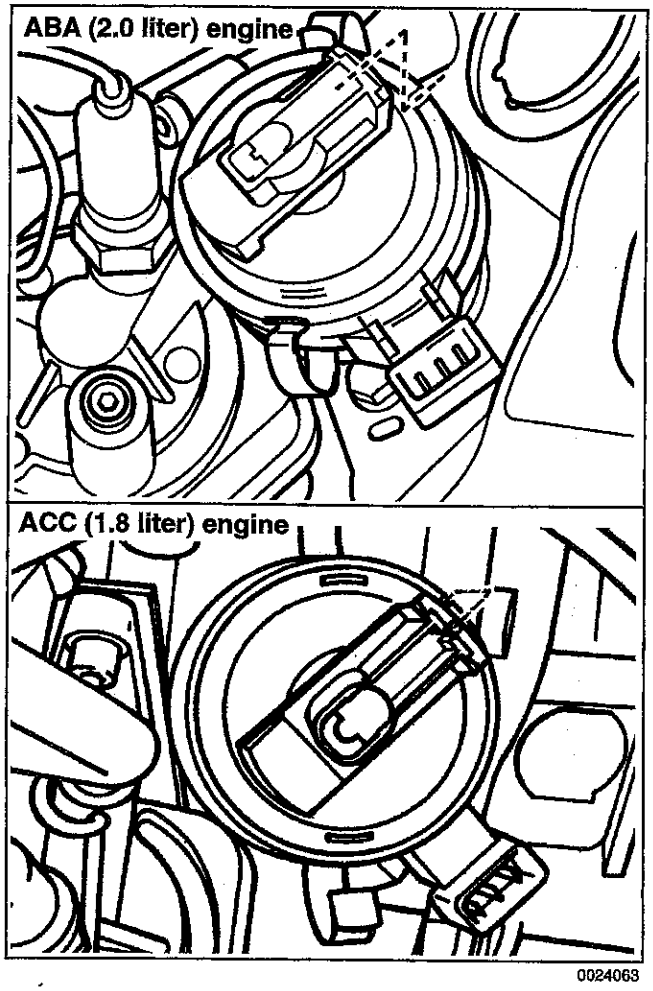



**Fig. 11.** Ignition rotor aligned with mark on distributor body.

2. Disconnect the electrical connector from the distributor.

3. Remove the distributor hold-down and remove the distributor by pulling it straight out.

4. Retrieve the sealing O-ring from the bottom of the distributor. Cover the opening.

5. If the crankshaft has been turned since the distributor was removed, rotate the crankshaft so that the cylinder no. 1 is at TDC. See Fig. 12.

6. Align the oil pump drive shaft as shown in Fig. 13. Use a screwdriver to turn it if necessary.

7. Using a new O-ring, install the distributor. Align the rotor with the distributor housing, as shown in Fig. 10 earlier.

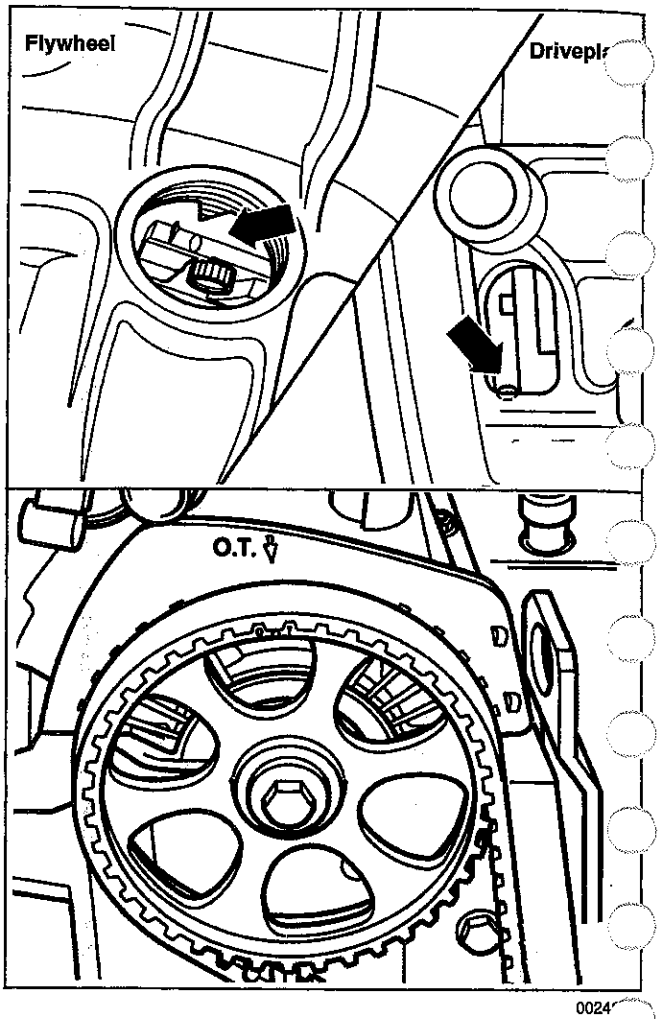



**Fig. 12.** Engine set to TDC, cylinder no. 1. Position crankshaft (top) and camshaft (bottom) so that TDC marks align as shown.

8. Install the distributor hold-down and the distributor cap. Reconnect the electrical connector.
   - On ABA engines, position the two distributor locating pins so that they are locked in place by the hold down bolt. See Fig. 14.
   - On ACC engines, adjust the ignition timing as described under **Ignition Timing.**

***NOTE—***

*Distributor locating pins may not be present on later production engines or replacement distributors.*

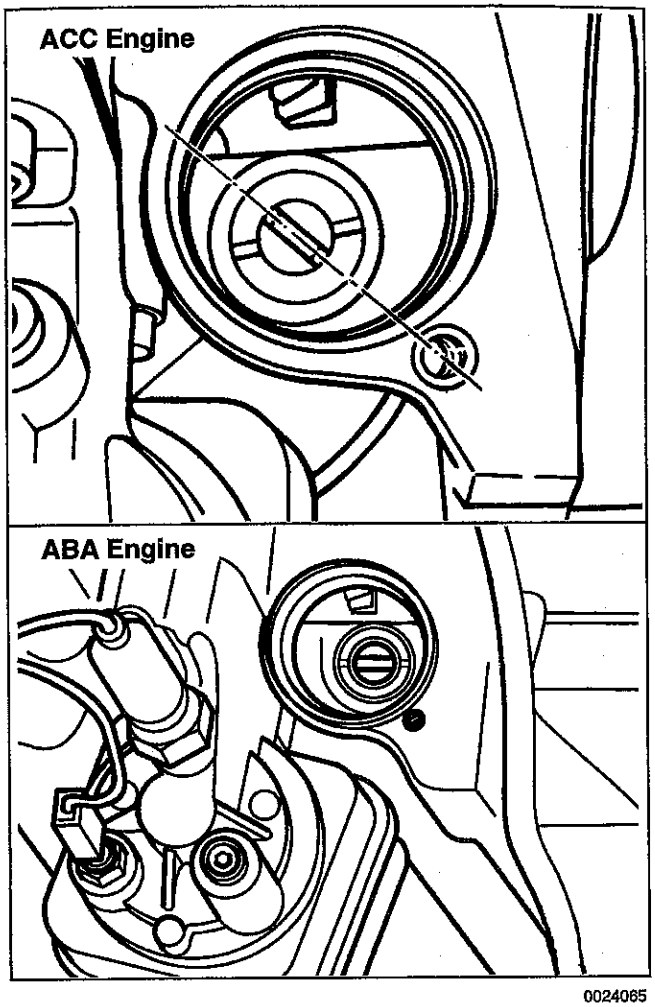



**Fig. 13.** **ACC (1.8) engine:** slot on oil pump drive shaft aligned with distributor mounting bolt hole.
**ABA (2.0) engine:** slot on oil pump drive shaft aligned parallel to crankshaft.

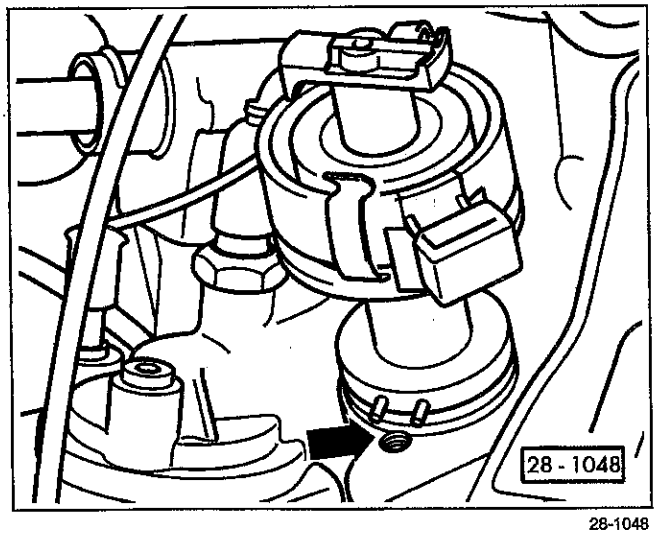



**Fig. 14.** On ABA (2.0 liter) engines, position distributor so that mounting bolt locks distributor in place using alignment pins (if applicable).

## To replace spark plugs

1. With the ignition off, disable the ignition system by disconnecting the harness connector from the coil power output stage.

2. Remove the spark plug wires from the spark plugs.

***NOTE—***
*On 6-cylinder engines, a special tool (VW tool no. 3277) is needed to remove the spark plug connectors from the plugs without damaging them. A plastic version of this tool is clipped to the front hood support rod. Do not pull on the wires.*

3. Clean the area around the spark plugs using compressed air. Remove the spark plugs and set them aside in order.

***NOTE—***
*On all engines use a 5/8 inch spark plug socket with an extension or VW special tool no. 3122B to remove and install the spark plugs.*

4. Install the new spark plugs, making sure the electrode gap is correct before installation. Tighten the plugs to the specified torque.

***CAUTION—***
**Table b** *lists general spark applications and specifications. Spark plug designations should be used for reference only. Original spark plugs applications are often changed and updated by the manufacturer over time. Check with an authorized VW dealer for the most up-to-date parts information.*

### Table b. Spark Plug Applications

| | |
|---|---|
| **ABA (2.0 liter)** | |
| electrode gap | 0.6 mm (0.024 in.) |
| tightening torque | 30 Nm (22 ft-lb) |
| manufacturer's designation | |
| Bosch | FR 8 DS |
| **AAA (2.8 liter, VR6)** | |
| electrode gap | 0.7 mm (0.028 in.) |
| tightening torque | 25 Nm (18 ft-lb) |
| manufacturer's designation | |
| NGK | BKR 5 EKU |
| **ACC (1.8 liter, Canada)** | |
| electrode gap | 0.7-0.9 mm (0.028-0.035 in.) |
| tightening torque | 25 Nm (18 ft-lb) |
| manufacturer's designation | |
| Bosch | W 7 DTC |
| NGK | BUR 6 ET |
| Beru | 4-7 DTC |

## IGNITION TIMING

### To check and adjust ignition timing (ACC engine)

1. On cars with manual transmission, remove the plastic plug from the timing check hole at the top of the transaxle bellhousing.

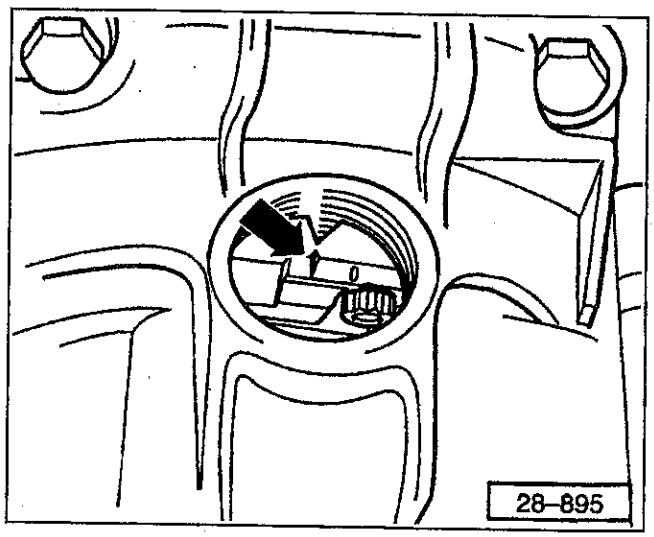
***NOTE—***
*The entire plug must be removed. The small center plug (if applicable) is for use with a special timing indicator used by Volkswagen dealer technicians.*

2. With the ignition off, connect a timing light according to the instrument manufacturers' instructions.

3. Start the engine and allow it to fully warm up.
   - Oil temperature should be at least 176°F (80°C). The radiator cooling fan should cycle on and off at least once.

4. With the engine idling, aim the timing light at the timing check hole in the bell housing. The timing mark on the flywheel should appear adjacent to the pointer in the hole. See Fig. 15.

***NOTE—***
*Watch carefully to be sure that the pointer lines up with the notch in the flywheel and not the "0" which denotes top dead center (TDC).*




28-895

**Fig. 15.** Timing mark on flywheel aligned with pointer in timing check hole (**arrow**). Do not align pointer with the 0 mark on the flywheel. This denotes top dead center (TDC).

***WARNING—***
*Keep hands and other objects clear of the radiator cooling fan. The fan may start at any time, even when the ignition is switched off.*

**Ignition Timing Specifications**

- Ignition timing
  checking ..... 4-8 ° BT
  adjusting ..... 6° ± 1° BTDC
- Idle speed (non-adjustable) ..... 770-1000 r
- Firing order ..... 1-3-

5. If no adjustment is necessary, switch off the ign and disconnect the test equipment.

6. If adjustment is necessary, switch off the ignition loosen the distributor hold-down bolt.

***NOTE—***
*The distributor should be just loose enough to be moved by hand with deliberate effort. The distributor must not move by itself while the engine is running.*

7. Start the engine and let it idle. Adjust ignition timing by gradually turning the distributor housing until the tir mark, viewed with the timing light, meets with the sp ifications listed above.

8. Stop the engine and tighten the distributor hold-d bolt. Start the engine and recheck the ignition timing.

**Tightening torques**

- Distributor hold down to distributor .. 25 Nm (18 ft-lb)

9. Turn the ignition off and remove the test equipment. Reinstall the plastic plug in the timing check hole.

# 3 Clutch, Transmission, and Final Drive



## GENERAL

This general information group covers application information and system descriptions for the repair groups listed under **3 Clutch, Transmission, and Final Drive**. This includes the two manual and two automatic transmissions that are available for use in the Jetta, Golf, GTI, and Cabrio models. For transmission identification, see **0 Maintenance Program**.

**Transmission applications**

- 020 . . . . . 5-speed manual (ABA, ACC, AAZ engines)
- 02A . . . . . 5-speed manual (AAA, AHU engines)
- 096 . . . . . 4-speed automatic, phase I (ABA, ACC, AAA engines, 1993-1995 models)
- 01M . . . . . 4-speed automatic, phase II (ABA, ACC, AAA engines, 1995-1997 models)
- 01M . . . . . 4-speed automatic, phase II, "ETA" (ABA, ACC, AAA engines, 1997-1999 models)

## MANUAL TRANSMISSIONS

The transmission gears are of the constant-mesh type with balk ring synchronizers. Each gear (1st through 5th) is actually a pair of gears, and constant-mesh simply means the mating gears are always in contact. When shifting, synchronizers cause the moving parts to rotate at the same speed before engaging. This prevents damage to the gears, minimizes wear, and eases shifting. The 3rd, 4th, and 5th gear synchronizers are on the main shaft; the 1st and 2nd gear synchronizers are on the pinion shaft.

The **020 transmission** uses a mechanical clutch release mechanism and a rod operated shift mechanism. See Fig. 1.

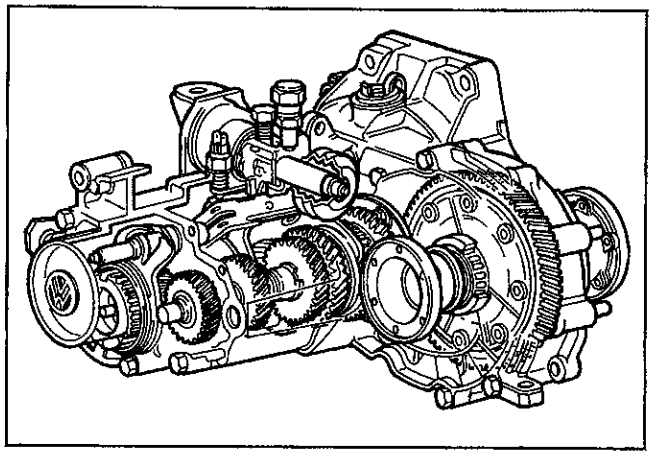


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**Fig. 1.** Cut-away view of the 020 manual transmission (02A is similar).

The close ratio **02A transmission** uses a hydraulic clutch release mechanism and a cable operated shift mechanism.

**Table a** lists the engine applications, gear ratios, and other data for the various manual transmissions.

**Table a. Manual Transmission Specifications**

| Designation | | 020 | | | 02A | |
|---|---|---|---|---|---|---|
| Engine (engine code) | | 1.8L, 90hp (ACC) | 1.9L, 75hp (AAZ) | 2.0L,115hp (ABA) | 1.9L, 90hp (AHU) | 2.8L,172hp (AAA) |
| Ratio: $Z_2$:$Z_1$ | Final drive | 66:18 = 3.667 | 66:18 = 3.667 | 66:18 = 3.667 | 60:19 = 3.157 | 61:18 = 3.38 |
| | 1st gear | 38:11 = 3.455 | 38:11 = 3.455 | 38:11 = 3.455 | 34:9 = 3.777 | 33:10 = 3.300 |
| | 2nd gear | 35:18 = 1.944 | 35:18 = 1.944 | 35:18 = 1.944 | 36:17 = 2.117 | 35:18 = 1.94 |
| | 3rd gear | 37:27 = 1.370 | 36:28 = 1.286 | 36:28 = 1.286 | 34:25 = 1.360 | 34:26 = 1.308 |
| | 4th gear | 32:31 = 1.032 | 30:33 = 0.909 | 31:32 = 0.969 | 34:35 = 0.971 | 30:29 = 1.03 |
| | 5th gear | 34:40 = 0.850 | 38:51 = 0.745 | 33:41 = 0805 | 34:45 = 0.755 | 31:37 = 0.838 |
| | Reverse gear | 38:12 = 3.167 | 38:12 = 3.167 | 38:12 = 3.167 | 20:9 x 36:20 = 3.999 | 17:10 x 36:20 3.060 |
| Lubricant | Capacity | 1.9 Liters (2.0 qt.) | | | 2.0 L (2.1 qt.) | |
| | Specification | G50 synthetic oil, SAE 75W/90 | | | | |
| Clutch release mechanism | | mechanical | | | hydraulic | |
| Clutch disc diameter | | 210 mm | | | 228 mm | |
| Ratio, overall in top gear | | 3.117 | 2.732 | 2.952 | 2.385 | 2.840 |

## AUTOMATIC TRANSMISSIONS

The two automatic transmissions (096 and 01M) are electro-hydraulically controlled with four forward gears. The 01M does not have a dipstick and has a unique system for checking and changing the transmission fluid. See **0 Maintenance Program.**

The automatic transmission can best be understood by dividing it into five subsystems. These are the torque converter, the ATF pump, the planetary gear system, the hydraulic controls, and the final drive. Fig. 2 shows a cross-section of an automatic transmission.

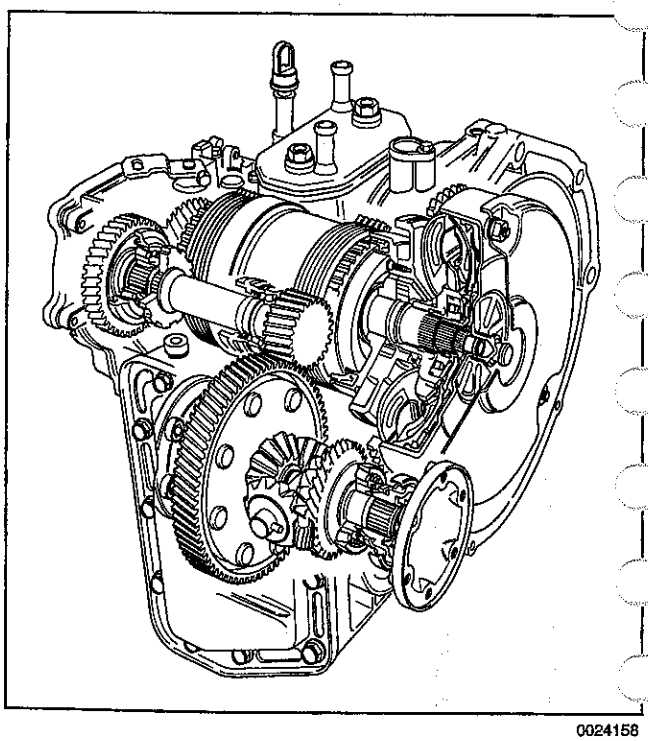

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**Fig. 2.** Cross-section of Volkswagen automatic transmission.

### Torque Converter

The torque converter is a doughnut-shaped assembly located between the engine and the transaxle inside the bellhousing. The torque converter is driven by the engine and in turn drives the transmission. The torque converter provides the desired torque multiplication at low speed to propel the vehicle away from a stop and serves as an efficient fluid coupling at high speed.

### ATF Pump

The automatic transmission fluid (ATF) circulates through the transmission under pressure whenever the engine is running. The ATF pump that creates this pressure is located behind the torque converter.

## Planetary Gear System

A torque converter alone cannot supply the torque multiplication needed for all driving conditions. The torque converter therefore drives through a planetary gear system which can operate at different drive ratios. The planetary gear system consists of three plate clutches, two plate brakes, one planetary gearset, and one roller freewheel.

The plate clutches and plate brakes are operated hydraulically from the valve body. They provide the power flow between converter and planetary gears.

## Electro-Hydraulic Controls

The hydraulic control system directs and regulates hydraulic pressure from the ATF pump to control shifting of the planetary gear system. The selector lever cable gives the Transmission Control Module (TCM) information about the position of the selector lever via the multi-function switch. At the same time the selector lever cable and a rod operate the manual valve in the valve body. The manual valve is thus moved into a basic position, in which, in lever position "D", the full automatic program is available.

The TCM switches the solenoid valves in the valve body according to the input signals from engine and transmission sensors. The solenoid valves operate shifting valves in the valve body which supply ATF oil pressure to the shift components (plate clutches and brakes) in the gearbox. Via the shift components the engine torque is transmitted to the planetary gears.

The 096 and 01M transmissions feature adaptive programming and On-Board Diagnostic (OBD) capabilities.

Adaptive programming functions to match driving patterns to one of two shift programs stored in the TCM. When accelerating quickly (throttle at or close to full load), the Sport program is automatically selected and the shift points occur at higher engine speeds. The TCM will automatically shift to the Economy shift program (shift points occur at lower engine speeds) if the throttle is held below the full load range for a predetermined amount of time.

The TCM self-diagnosis system monitors the electrical signals from various sensors and carries out a self check of the TCM. If a fault is detected, it is permanently stored in the TCM, even when the battery is disconnected. This coded fault information can be retrieved using the special Volkswagen scan tool, V.A.G 1551.

## Final Drive

The final drive consists of the drive pinion, the intermediate gear, the ring gear, and the differential. The teeth on the intermediate and ring gear, and the drive pinion are helically-cut for quieter running. The differential allows the front wheels to turn at different speeds, as is necessary when turning. **Table b** lists the final drive ratios for the various automatic transmissions.

***NOTE—***

- *On automatic transmissions, the final drive lubricant is separate from the ATF. Volkswagen does not specify a final drive lubricant replacement interval; it is "filled for life". However, the fluid should be checked regularly.*
- *To check final drive level see* **39 Differential and Final Drive.** *To check ATF level see* **0 Maintenance Program.**

**Table b. Automatic Transmission Final Drive**

| Code letters | Engine application | Final drive ratio |
|---|---|---|
| CFA, CFF, CLB | 2.8 L (AAA) | 3.700:1 |
| CFC, CFH, CNK, CLK | 2.0 L (ABA) | 4.222:1 |
| CKZ | 1.9 L (AAZ) | 3.273:1 |
| CFD, CFK, CRR, CKY | 1.8 L (ACC) | 4.529:1 |

## Identification and application

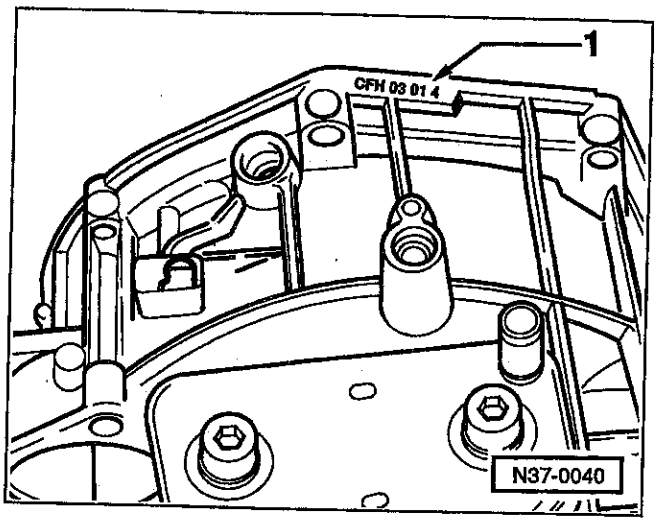
The transmission code letters and date of manufacture can be found on the vehicle data plate and stamped on the transmission itself. Fig. 3 and 4 show the location of the code letters for two versions of available automatic transmissions.

**Table c. Automatic Transmission Identification**

| **Example:** | CFH | 03 | 01 | 4 |
|---|---|---|---|---|
| | Transmission code letters | Day | Month | Year |
| | | Date (e.g. 3 Jan., 1994) | | |

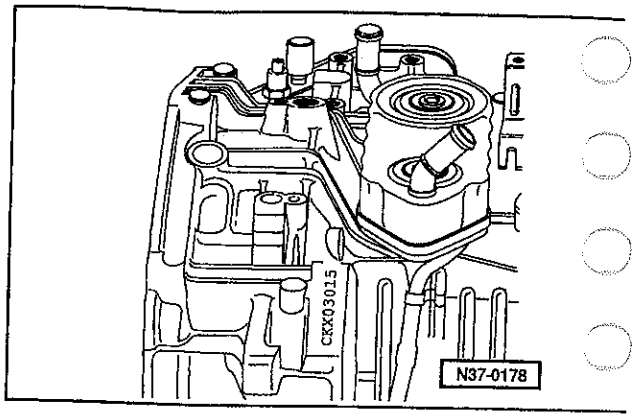
There are several versions of the two (096 and 01M) automatic transmissions depending on model and model year. See table **d.**

***CAUTION—***
*Only genuine VW synthetic ATF should be used in the 01M transmission. Do not use other types of ATF. Do not mix Volkswagen ATF with Dexron ATF.*




N37-0040

**Fig. 3.** Code letters (**arrow 1**) for 096 automatic transmission.




N37-

**Fig. 4.** Code letters for 01M automatic transmission.

**Table d. Automatic Transmission Specifications**

| Designation | | 096 | | 01M |
|---|---|---|---|---|
| Model and model year | | Golf from 1993<br>Jetta from 1993 | Golf from 1993<br>Jetta from 1993<br>Jetta GLX from 1994 | Golf from 1995<br>Jetta from 1995<br>Cabrio from 1995 |
| Code letters | | CFA, CFC, CFD | CFF, CFH, CFK, CNK, CRR | CLB, CLK, CKY, C |
| Ratio | 1st gear | 2.714:1 | 2.714:1 | 2.714:1 |
| | 2nd gear | 1.551:1 | 1.441:1 | 1.441:1 |
| | 3rd gear | 1.000:1 | 1.000:1 | 1.000:1 |
| | 4th gear | 0.679:1 | 0.743:1 | 0.743:1 |
| | Reverse gear | 2.111:1 | 2.884:1 | 2.884:1 |
| Transmission lubricant | Initial filling | 5.6 Liters (5.9 qt.) | | 5.3 L (5.6 qt) |
| | Oil change | approx. 3.0 Liters (3.2 qt.) | | approx. 3.0 L (3.2 qt.) |
| | Type | ATF Dexron | | Special VW ATF |
| Final drive lubricant | Initial filling | 0.75 Liter (0.79 qt.) | | 0.75 Liter (0.79 qt.) |
| | Type | G50 synthetic oil, SAE 75W/90 | | Special VW ATF |

# 30b Clutch (AAA, AHU Engines)





## GENERAL

Servicing of the clutch assembly requires that the transmission be removed from the engine. Special tools and equipment are required to remove the transmission and service the clutch. See **34 Manual Transmission** for transmission removal procedures. Read the procedures through to fully understand the scope and nature of the job.

***WARNING —***
- *The cars covered by this manual use an airbag system that automatically deploys an airbag(s) in the event of a frontal impact. The airbag(s) is inflated by an explosive device. Handled improperly or without adequate safeguards, the system can be very dangerous. Special precautions must be observed prior to any work at or near the steering wheel or steering column, including the pedal assembly. See* **69 Seatbelts, Airbags**.
- *To guard against personal injury or airbag system failure, only trained Volkswagen service technicians should test, disassemble or service the airbag system.*

***NOTE —***
*When servicing the transmission or clutch mechanism, always observe the general repair instructions outlined in* **3a Clutch, Transmission, and Final Drive—General.**

## CLUTCH ACTUATING MECHANISM

Fig. 1 shows an exploded view of the pedal assembly. Be sure to lubricate all bearings and friction surfaces with MoS2 grease (VW Part No. G 000 602). Always replace self-locking nuts and circlips during repairs.

***CAUTION —***
*Before working on pedal cluster, always obtain anti-theft radio code and then disconnect battery ground strap.*

## Pedal cluster, assembly

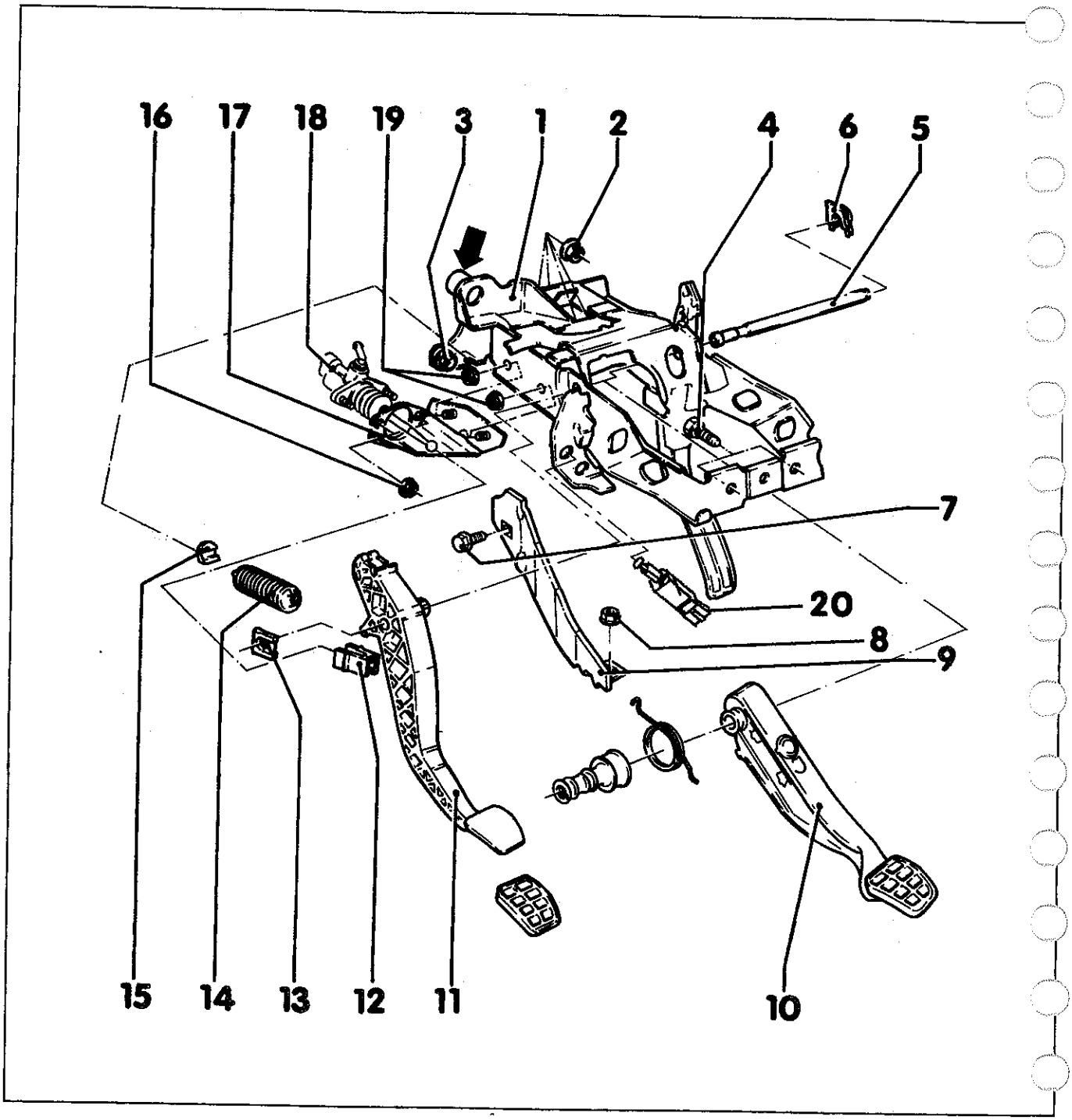



**Fig. 1.** Exploded view of clutch actuating mechanism and related parts.

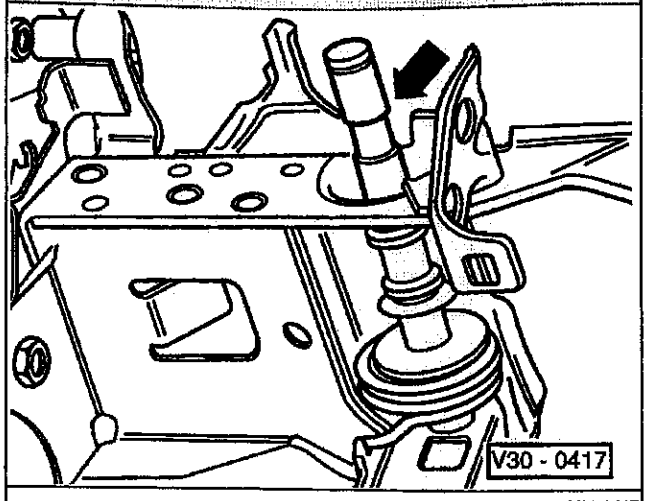
1. **Pedal cluster mounting bracket**
   - Removing: first remove steering column with column tube. See **48 Steering**
   - Disconnect brake pedal from push rod of brake master cylinder. See **47 Brakes–Hydraulic System.**

***WARNING —***
*Observe airbag system precautions as described in* **69 Seatbelts, Airbags.** *Always disconnect the negative battery terminal before working at or near steering column.*

*NOTE—*
*Before installing the new pedal cluster bracket on a vehicle with hydraulic clutch control, the guide tube must be removed. Saw it off flush with bracket.*

2. **Self-locking nut**
   - Always replace
   - Tightening torque: 25 Nm (18 ft-lb)
   - For attaching bracket to threaded stud on installation plate
3. **Self-locking nut**
   - Always replace
   - Tightening torque: 25 Nm (18 ft-lb)
   - For attaching bracket to threaded studs on vacuum brake booster
4. **Self-locking bolt**
   - Quantity: 2
   - Always replace
   - Tightening torque: 25 Nm (18 ft-lb)
   - For attaching bracket to assembly support,
5. **Pivot pin**
   - For clutch and brake pedals
   - Installation position, **see (A)**
6. **Securing clip**
7. **Bolt**
   - Tightening torque: 25 Nm (18 ft-lb)
   - For attaching additional support (9) to pedal bracket
8. **Self-locking nut**
   - Always replace
   - Tightening torque: 25 Nm (18 ft-lb)
   - For attaching additional support (9) to floor panel
9. **Support**
10. **Brake pedal**
11. **Clutch pedal**
12. **Retainer**
13. **Securing clip**
    - Secures pivot pin (5)
14. **Over-center spring**
15. **Over-center spring mount**
    - Install in mounting bracket
16. **Self-locking nut**
    - Always replace
    - Tightening torque: 25 Nm (18 ft-lb)
    - For attaching master cylinder to mounting bracket
17. **Mounting bracket**
    - Removing: first remove clutch pedal and master cylinder
18. **Master cylinder**
19. **Self-locking nut**
    - Always replace
    - Tightening torque: 25 Nm (18 ft-lb)
20. **Starter lock-out switch**
    - Manual transmission only
    - On cars built from May 1996, **see (B)**

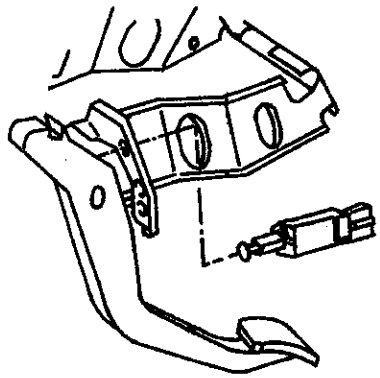
**(A) Installation position for brake pedal and clutch pedal pivot pin**




V30-0417

- **Recess (arrow) is on clutch-pedal side.**

**(B) Starter lock-out switch on clutch pedal (cars built from May 1996)**

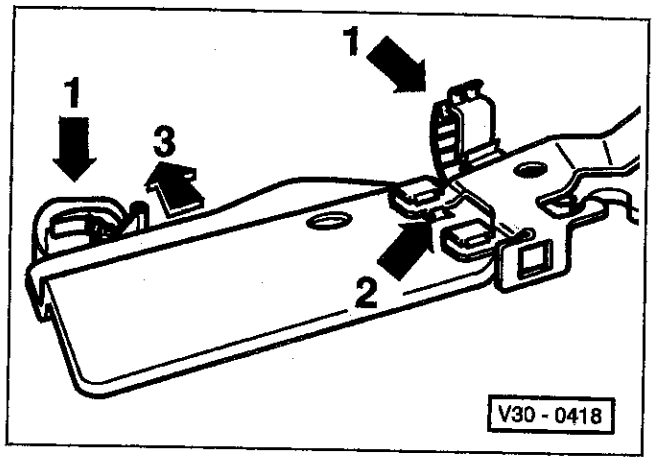


V30-0417

- **Manual transmission vehicles have a starter lock-out function that requires the clutch pedal be depressed before the starter can be activated.**
- **A relay identified as 53 is installed in the fuse/relay panel to complete the circuit to the starter.**

## Over-center spring, removing

1. Remove interior trim panel at lower left driver's side.
2. Remove cover plate below pedal cluster (foam rubber liner remains in vehicle.)
3. Unhook relay plate from bracket.
4. Remove guard plate from between relay panel and pedal cluster as follows (Fig. 2):
   - Remove electrical wires from retainers (arrow 1)
   - Press clips (arrow 2) toward pedal cluster.
   - Press guard plate up toward instrument panel (arrow 3) until it can be removed from its mounting.
   - Remove guard plate from below, working carefully to avoid damage to wiring.




V30-0418

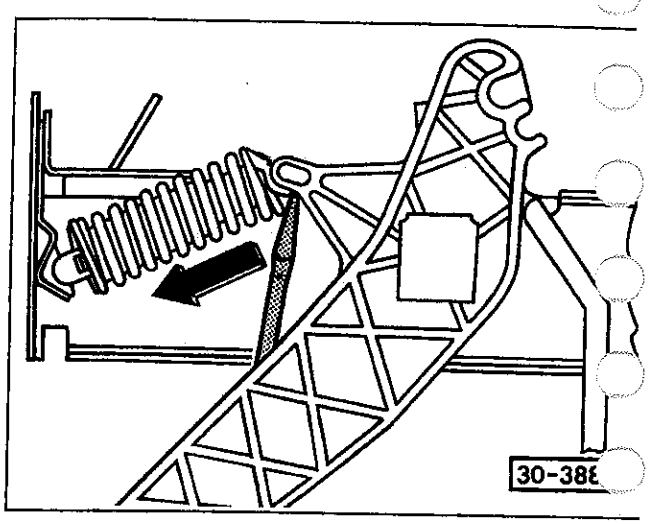
**Fig. 2.** Relay panel guard plate. Remove wiring from retainers (**1**), press detent (**2**) toward pedal cluster and then press guard plate up toward instrument panel to remove (**3**).

5. Insert screwdriver between steering column and clutch pedal and press it against over-center spring. See Fig. 3.
6. Depress clutch pedal and disconnect over-center spring from pedal in direction indicated by arrow in Fig. 3.

## Over-center spring, installing

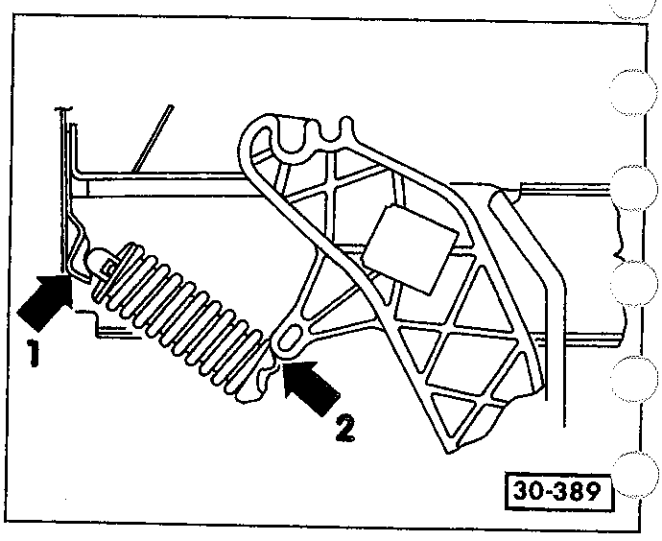
Install spring in reverse order of removal, noting the following:

- When installing over-center spring, locate relay plate in its left mounting.
- Working in passenger compartment, pull clutch pedal into passenger compartment.
- Guide over-center spring between pedal and relay panel holder until it is in position in the mounting bracket and located directly below clutch pedal mounting lug. See Fig. 4.
- Press over-center spring onto pedal support, depressing clutch pedal slightly if necessary.




30-388

**Fig. 3.** Insert screwdriver between steering column and clutch pe then depress clutch pedal and disconnect spring by levering off pedal lug (direction of **arrow**).



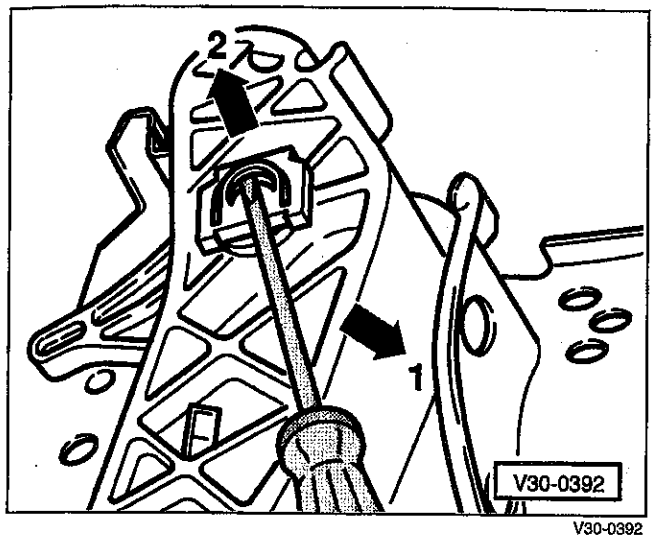

30-3

**Fig. 4.** Install clutch over-center spring by inserting into bracket and then pressing into pedal mounting lug (**2**).

## Clutch pedal, removing

1. Open clutch slave cylinder bleeder valve and conne drain hose to bleeder valve. See **Clutch Hydrau System.**
2. Remove over-center spring. See **Over-center sprin removing and installing.**
3. Disconnect clutch pedal from master cylinder. S **Master cylinder, removing and installing.**
4. Press master cylinder operating rod toward engi compartment until reaching stop.

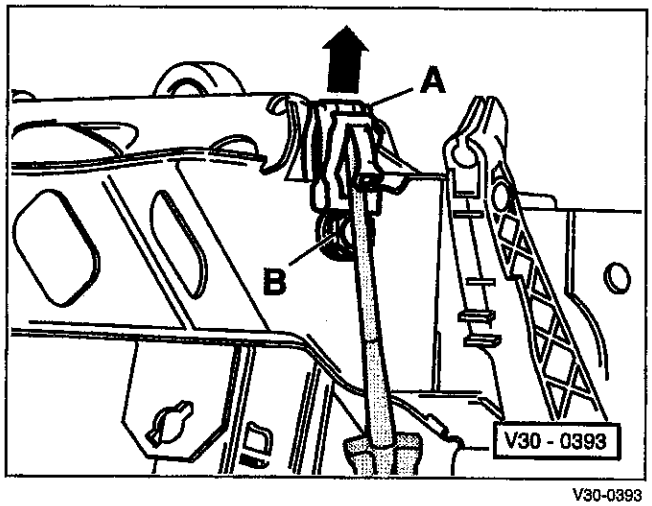
5. Remove clutch pedal retaining clip from pivot pin. See Fig. 5.




V30-0392

**Fig. 5.** Clutch pedal retaining clip being removed. Pry up tab (arrow **1**), then press off clip (arrow **2**).

6. On brake pedal side, remove retaining clip from pivot pin. See Fig. 6.




V30-0393

**Fig. 6.** B rake pedal pivot pin retaining clip being removed. Pry up tab (**A**), then press off clip (**arrow**).

7. Pull pivot pin out toward right side until clutch pedal can be removed.

## Clutch pedal, installing

Install in reverse order of removal and note the following:

- Before installing securing clip on brake pedal side, position pivot pin so that flats (B in Fig. 6) are vertical.
- When connecting clutch pedal to master cylinder operating rod, see **Master cylinder, removing and installing.**
- Refill brake fluid reservoir to "max" marking with brake fluid and bleed hydraulic system.

***NOTE —***

*The clutch hydraulic system must be bled if the brake fluid level has dropped below the "min" marking. See* **Clutch hydraulic system, bleeding.**

# CLUTCH HYDRAULIC SYSTEM

Fig. 7 shows an exploded view of the clutch hydraulic system. Thoroughly clean the area around hydraulic line fittings before removing or loosening fluid lines. Plug all openings to prevent dirt from entering the system. During installation, start hydraulic line fittings by hand to prevent cross-threading.

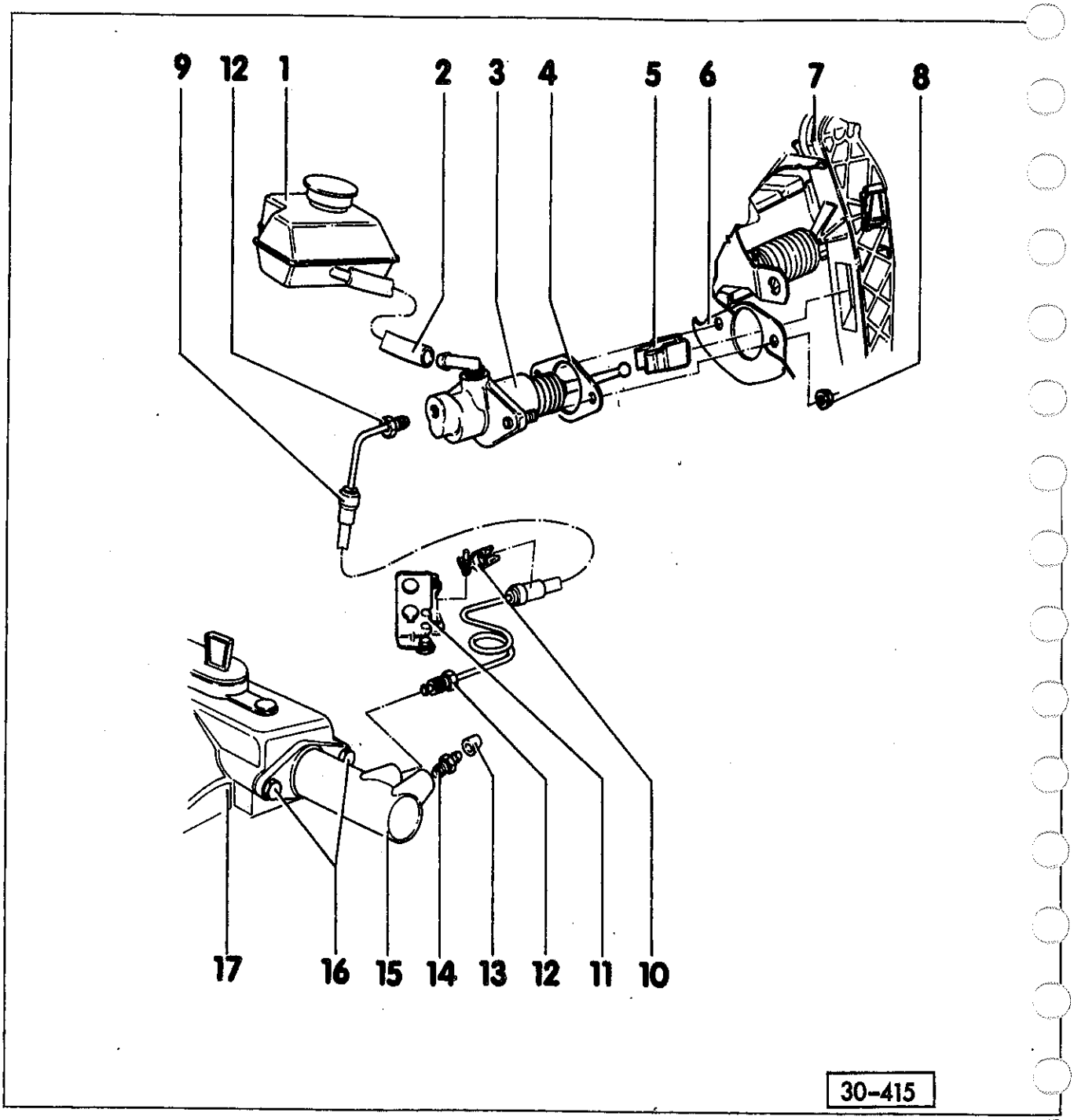
***WARNING —***

- *The clutch hydraulic system operates on DOT 4 brake fluid. Brake fluid is poisonous. Wear eye and hand protection when working with brake fluid.*
- *Brake fluid is a hazardous waste. Recycle or dispose of brake fluid in a manner that is mindful of the environment and meets ordinances governing the disposal of such wastes.*

***CAUTION —***

*Brake fluid is very harmful, especially to paint and rubber parts. Spilled brake fluid should be cleaned up immediately.*

## Clutch hydraulic system, assembly



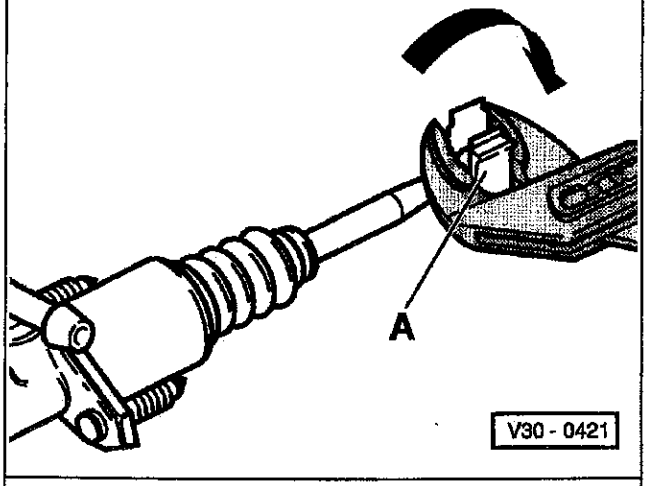

30-415

**Fig. 7.** Exploded view of clutch hydraulic system.

1. **Brake fluid reservoir**
   - Supplies brake fluid to operate hydraulic clutch
   - Internal baffle prevents hydraulic system from using fluid below approximately 1/2 capacity so that brake system always has a reserve
2. **Supply hose**
3. **Clutch master cylinder**
4. **Gasket**
   - Always replace

5. **Retainer**
   - Replace only with master cylinder removed
   - Removing, **see** (A)
   - Pressing on, **see** (B)
6. **Mounting bracket**
7. **Clutch pedal**
8. **Self-locking nut**
   - Always replace
   - Tightening torque: 25 Nm (18 ft-lb)
9. **Brake line/hose**
10. **Retainer**
    - Mounted to support bracket (11)
11. **Support bracket**
    - For gear shift cable routing
12. **Brake line fitting**
    - Tightening torque: 20 Nm (15 ft-lb)
13. **Dust cap**
14. **Bleeder valve**
15. **Slave cylinder**
    - Before removing: remove gear selector cable from transmission gear selector lever and remove relay lever and actuating arm for gate selector cable. See **34 Manual Transmission**
    - After installing: adjust gear selector mechanism. See **34 Manual Transmission**
16. **Bolt**
    - Tightening torque: 25 Nm (18 ft-lb)
17. **Transmission**

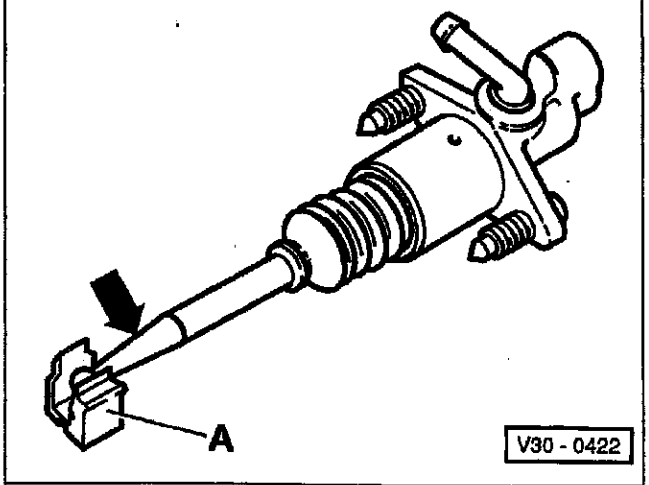
**(A) Removing retainer for master cylinder operating rod**




V30-0421

- **Pry off master cylinder operating rod retainer (A) in direction indicated by arrow.**

**(B) Pressing on retainer for master cylinder operating rod**




V30-0422

- **Press master cylinder operating rod into guide (A) in direction indicated by arrow.**

## Master cylinder, removing

1. Remove coolant expansion tank and lay to one side.

> ***CAUTION—***
> *Do not open the cooling system.*

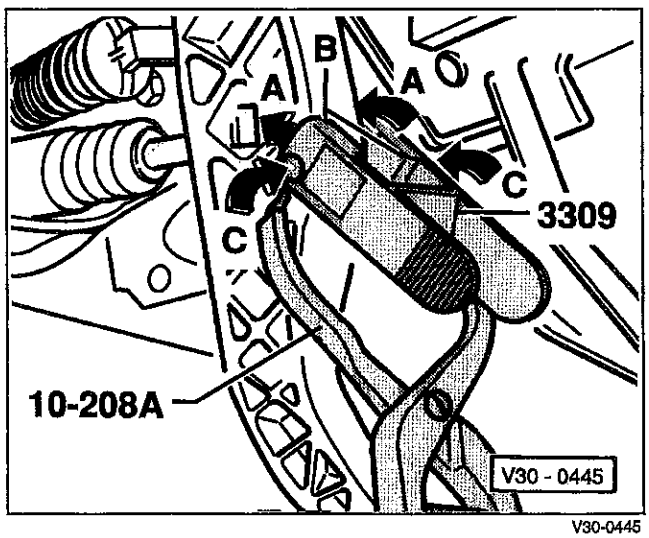
2. Disconnect brake line from master cylinder. Cap or seal off the open line.

3. Disconnect supply hose from brake fluid reservoir. Cap or seal off the open hose.

4. Unhook relay plate from left retainer.

5. Remove protective plate between relay plate and pedal cluster. See Fig. 2, given earlier.

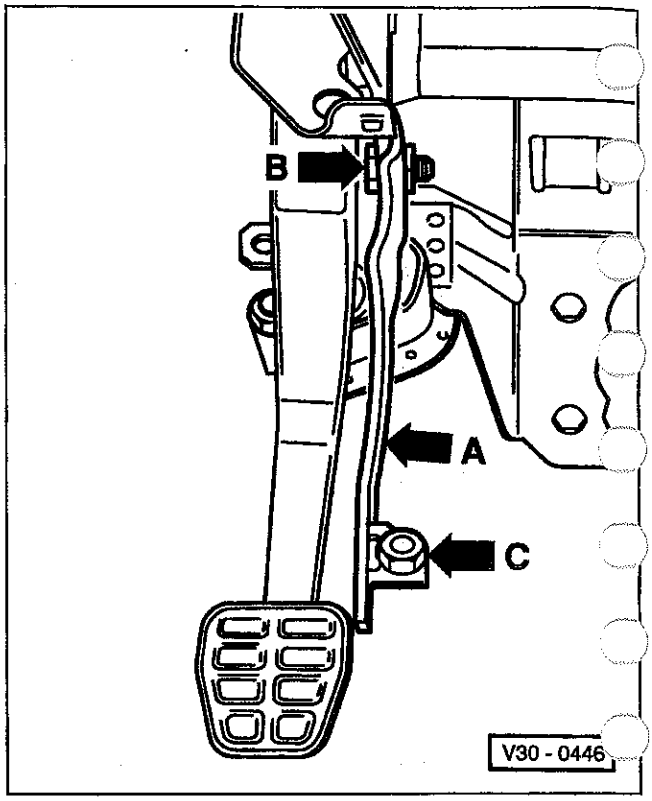
6. Disconnect master cylinder push rod from pedal cluster, as follows: (See Fig. 8)
   - Insert special release tool into cut-outs on clutch pedal (arrows A). Tool inscription "top/oben" faces toward instrument panel
   - Place special pliers in recesses of release tool (arrows C) and press jaws together.




V30-0445

**Fig. 8.** Special tools being used to remove master cylinder pushrod from clutch pedal. Insert VW special tool no. 3309 (**B**) into cutouts in pedal (**arrows A**). Then insert special pliers (Volkswagen special tool no. 10-208A) at **arrows C** to unlock pushrod from clutch.

7. Remove mounting bracket support by removing bolt and nut shown in Fig. 9




V30-0[illegible]

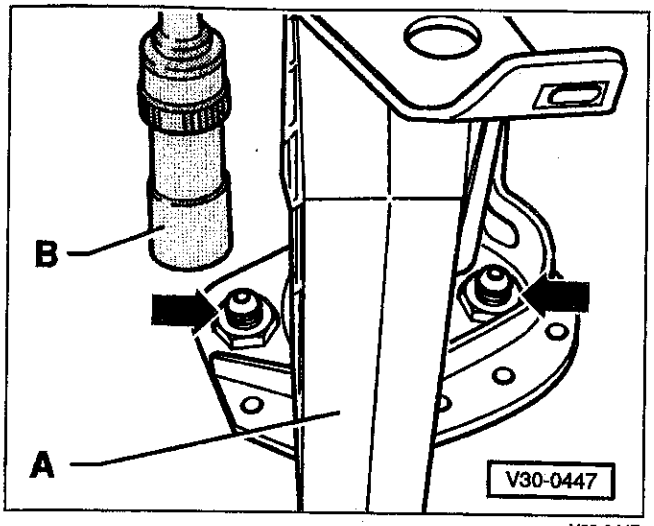
**Fig. 9.** Remove bolt (**B**) and nut (**C**) to remove support bracket [illegible]

8. Remove master cylinder from passenger compartm by removing mounting nuts on each side of clutch ped al. See Fig. 10.

## Master cylinder, installing

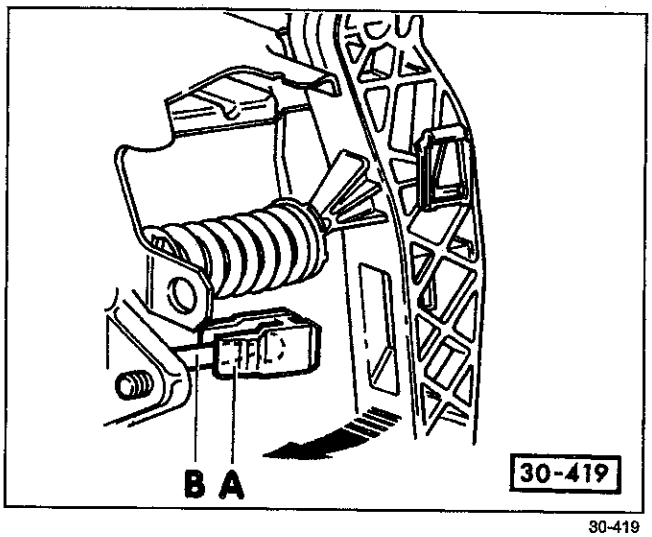
Install in reverse order of removal. While doing so, note following (Fig. 11):

- Retainer must be installed on master cylinder operating rod.
- To engage retainer, press clutch pedal toward bulkhead (direction indicated by arrow). Make sure retainer is located correctly.
- Bleed clutch hydraulic system after installing master cylinder.




V30-0447

**Fig. 10.** Master cylinder mounting nuts (**arrows**). Use a 13 mm deep-well socket (**B**) to remove nuts. Clutch pedal shown at (**A**).




30-419

**Fig. 11.** When engaging master cylinder pushrod to clutch pedal, make sure retainer (**A**) is installed on pushrod (**B**). To engage retainer to pedal, depress pedal. Make sure retainer locks in pedal.

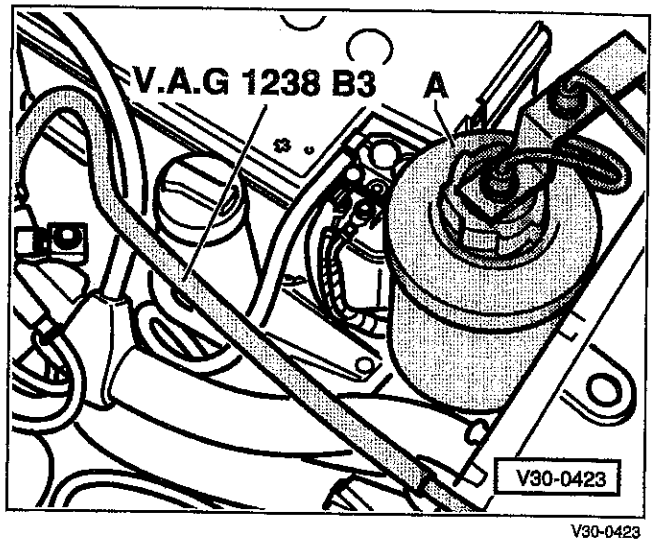
## Clutch hydraulic system, bleeding

Bleed clutch hydraulic system using VAG 1238/1 or VAG 1238B brake filling and bleeding unit or equivalent power bleeding equipment.

1. To bleed system, connect 670 mm (26.38 in.) of bleeder hose to pressure hose fitting on collector bottle. See Fig. 12.

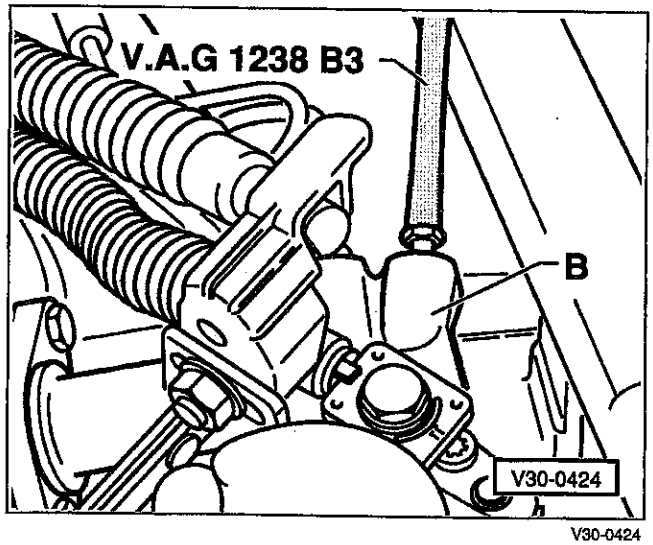
2. Connect bleeder hose to slave cylinder and open bleeder valve to bleed system. See Fig. 13.

3. Depress clutch pedal several times after completing bleeding process.




V30-0423

**Fig. 12.** Brake filling and bleeding unit (**A**). Note long bleeder hose to slave cylinder (V.A.G.1238 B3).




V30-0424

**Fig. 13.** Bleeder hose shown connected to bleeder valve on slave cylinder (**B**).

## CLUTCH RELEASE MECHANISM

Fig. 14 shows an exploded view of clutch release mechanism. The clutch slave cylinder can be replaced with the transmission installed in the car. Replacement of the other clutch release components require that the transmission be removed from the car. See **34 Manual Transmission** for transmission removal and replacement procedures.

## Clutch release mechanism, assembly

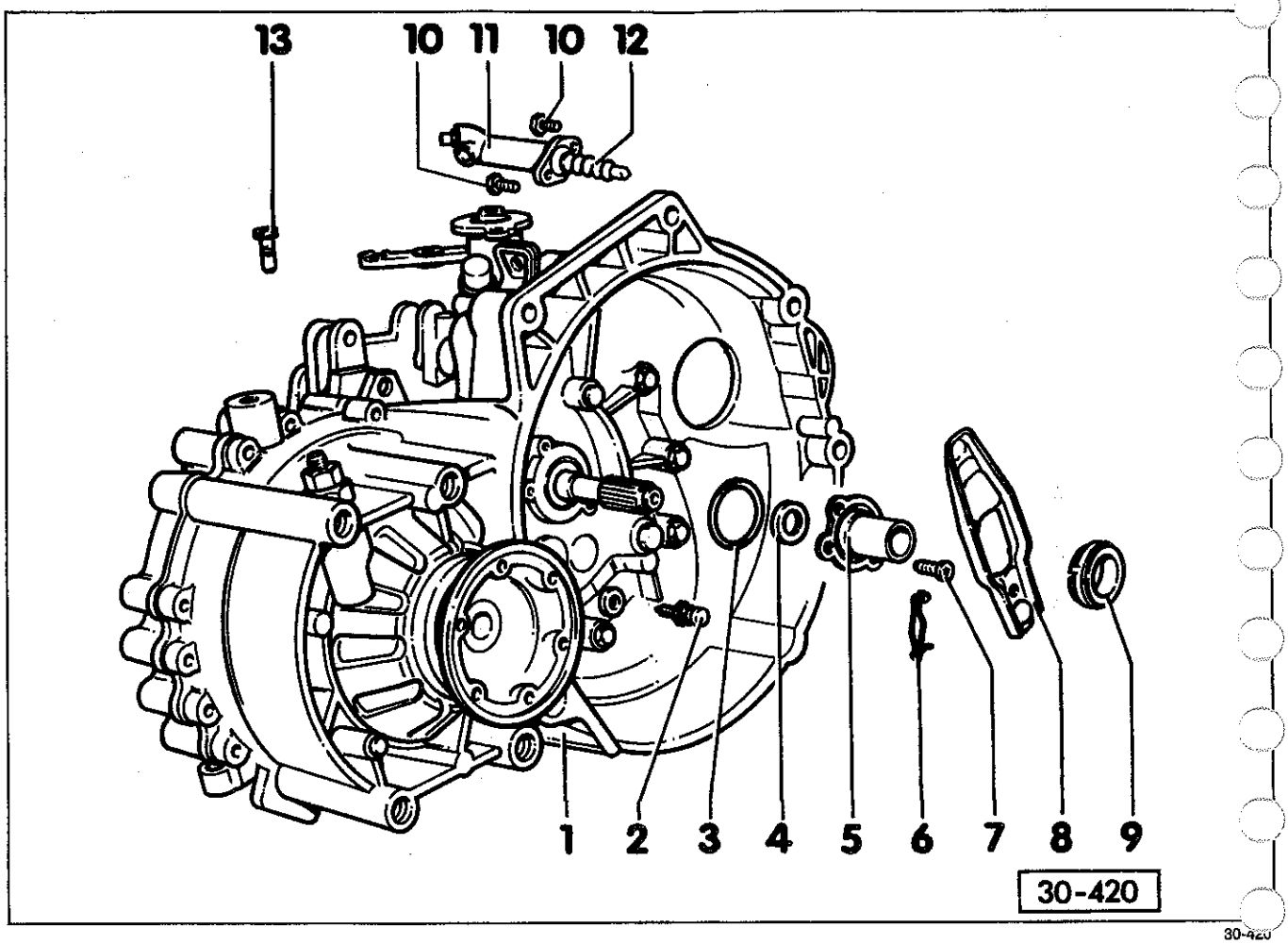
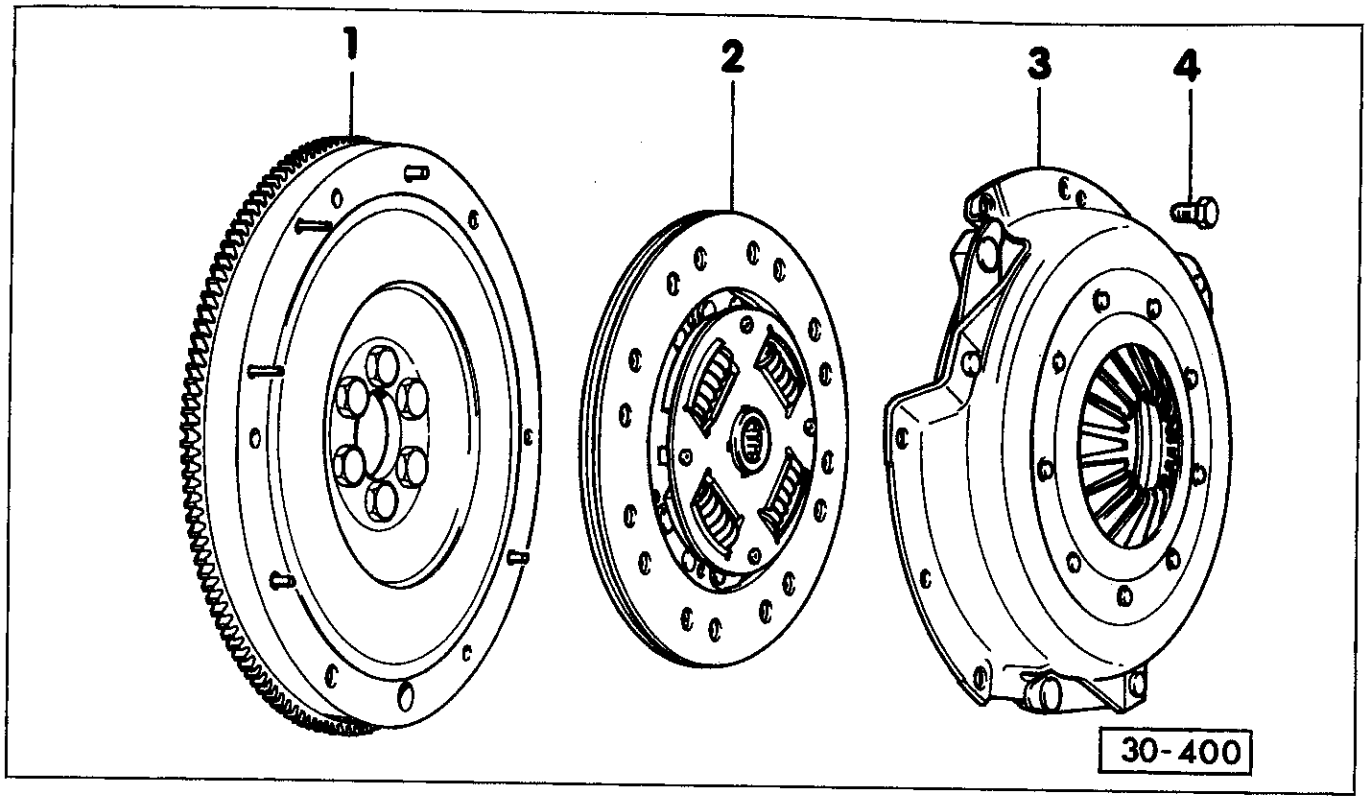



**Fig. 14.** Exploded view of clutch release mechanism.

1. **Transmission**
2. **Ball stud**
   - Tightening torque: 25 Nm (18 ft-lb)
   - Lubricate with MoS2 grease
3. **O-ring**
   - Always replace
4. **Input shaft oil seal**
5. **Guide sleeve**
   - Lubricate with MoS2 grease in area of release bearing
6. **Retaining spring**
   - Attach to clutch release lever
7. **Mounting bolt**
   - Tightening torque: 20 Nm (15 ft-lb)
8. **Clutch release lever**
9. **Release bearing**
   - DO NOT wash bearing (wipe off instead)
   - Replace noisy bearings
   - Lubricate surfaces that contact clutch release lever with MoS2 grease
10. **Mounting bolt**
    - Tightening torque: 20 Nm (15 ft-lb)
11. **Slave cylinder**
12. **Push rod**
    - Lubricate end of push rod with MoS2 grease
13. **Assembly pin**
    - Secures clutch release lever while installing transmission.
    - Remove after transmission has been installed.
    - A M8x35 bolt, can be used as a substitute if assembly pin (13) is not available.

# CLUTCH, SERVICING (TRANSMISSION REMOVED)

## Clutch assembly




30-400

**Fig. 15.** Exploded view of clutch assembly.

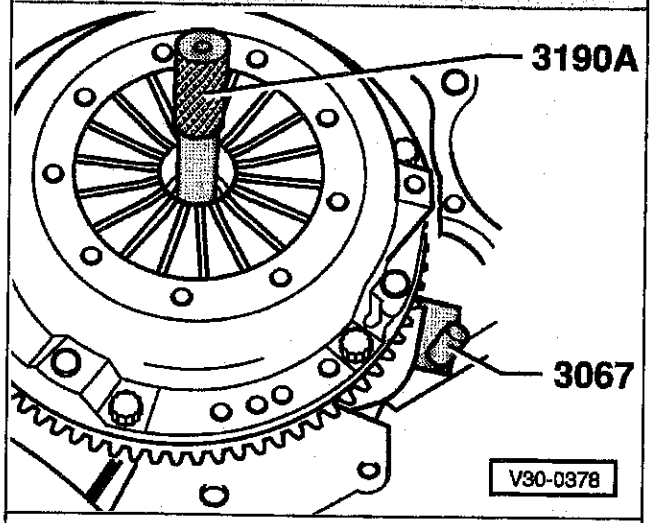
> ***NOTE —***
> *Make sure that the correct replacement clutch disc and pressure plate are selected according to the engine code.*

1. **Flywheel**
   - Make sure centering dowel pins fit tightly
   - Contact surface for clutch disc must be free of grooves, oil and grease
   - Removing/installing. See **13 Crankshaft/Cylinder Block**
2. **Clutch disc**
   - Note installation position: spring cage faces toward pressure plate
   - Centering, **see** (A)
   - Place the clutch disc on the input shaft and make sure it moves back and forth freely.
   - Remove excess grease.

> ***NOTE —***
> *Before installing clutch disc remove corrosion from input shaft splines and clutch disc hub splines, clean and apply only a very thin coating of grease, Part No. G 000 100, to the splines of the input shaft only.*

3. **Pressure plate**
   - Removing and installing, **see** (A)
   - Check ends of diaphragm spring, **see** (B)
4. **12-point bolt**
   - Tightening torque: 20 Nm (15 ft-lb)
   - Loosen and tighten in stages, evenly and in a diagonal pattern

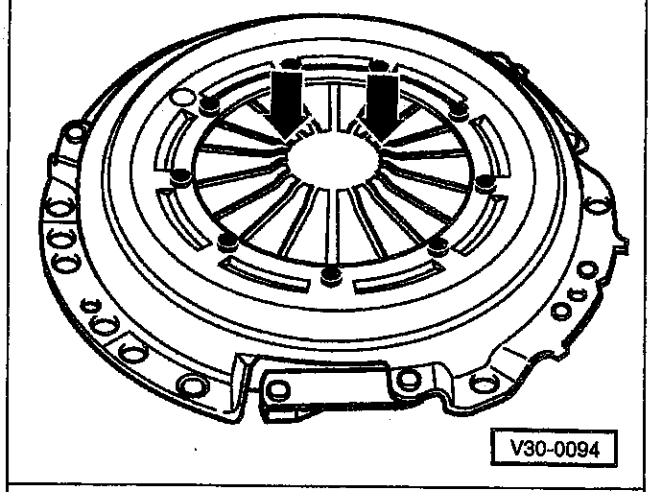
**A Centering clutch disc and removing and installing pressure plate**




V30-0378

- **VW special tool no 3190A being used to center clutch disc when installing pressure plate. Be sure to loosen and tighten bolts in stages, evenly and diagonally. When removing, reverse position of flywheel locking tool (VW tool no. 3067).**

**B Checking diaphragm spring**




V30-0094

- **Check pressure plate diaphragm spring for wear (arrows). Maximum wear--up to half of original diaphragm spring thickness.**

# 34b Manual Transmission (AAA, AHU Engines)



## GENERAL

This repair group covers repair information for the cable-operated gear shift mechanism. Also covered here is the removal and installation of the 02A manual transmission. This repair group does not cover transaxle or transmission teardown and disassembly.

***NOTE—***

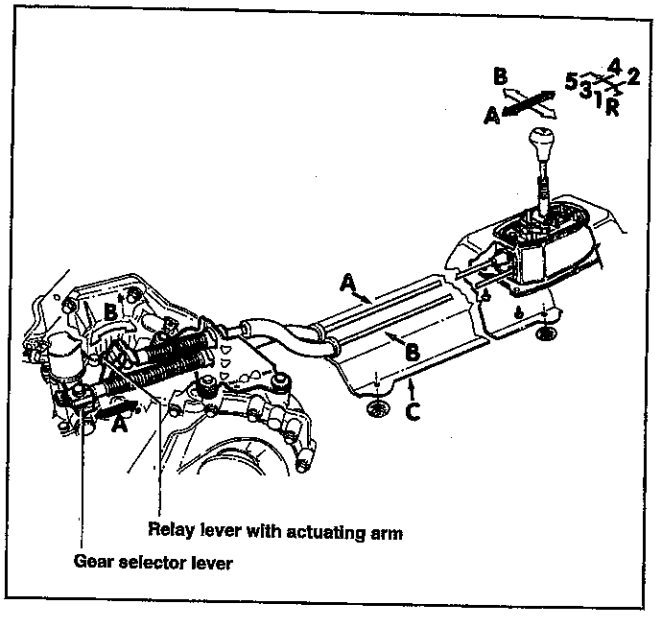
- *For information on drive axles, including drive flange oil seals, see* **39 Differential and Final Drive.**
- *To check manual transmission oil, see* **0 Maintenance Program.**

## GEAR SELECTOR MECHANISM

Fig. 1 shows the operation of the gear selector mechanism. Note that the gear selector is cable operated—one cable controls forward/back movement of the shift lever and the other cable controls left/right movement. Access to the gear selector mechanism is difficult without partially removing the exhaust system. For easiest access to the shift mechanism, the catalytic converter and its heat shield should first be removed as described in **26 Exhaust System/Emission Controls.**

***NOTE—***

- *Before servicing or repairing the manual transmission or shift linkage, review the general repair information given in* **3 General Information.**
- *Always remove the exhaust system heat shield before removing gear selector mechanism.*
- *To replace the selector cables, first remove the complete gear selector mechanism. Be careful not to kink the selector cables during removal.*
- *During reassembly, lubricate all mounting and contact surfaces with MoS2 grease. As the final step, adjust the gear selector mechanism, see* **Gear selector mechanism, adjusting.**




0024068

**Fig. 1.** Operational view of shift lever control. Gear change cable (**A**) controls forward/back travel. Gear shift cable (**B**) controls side-to-side travel. Heat shield (**C**) holds cables in position.

***CAUTION—***

- *Before servicing the gear selector mechanism, always disconnect the negative (–) battery cable in the engine compartment.*
- *On vehicles equipped with an anti-theft radio code, make sure you know the correct radio activation code before disconnecting the battery.*

## Gear selector control cable, assembly

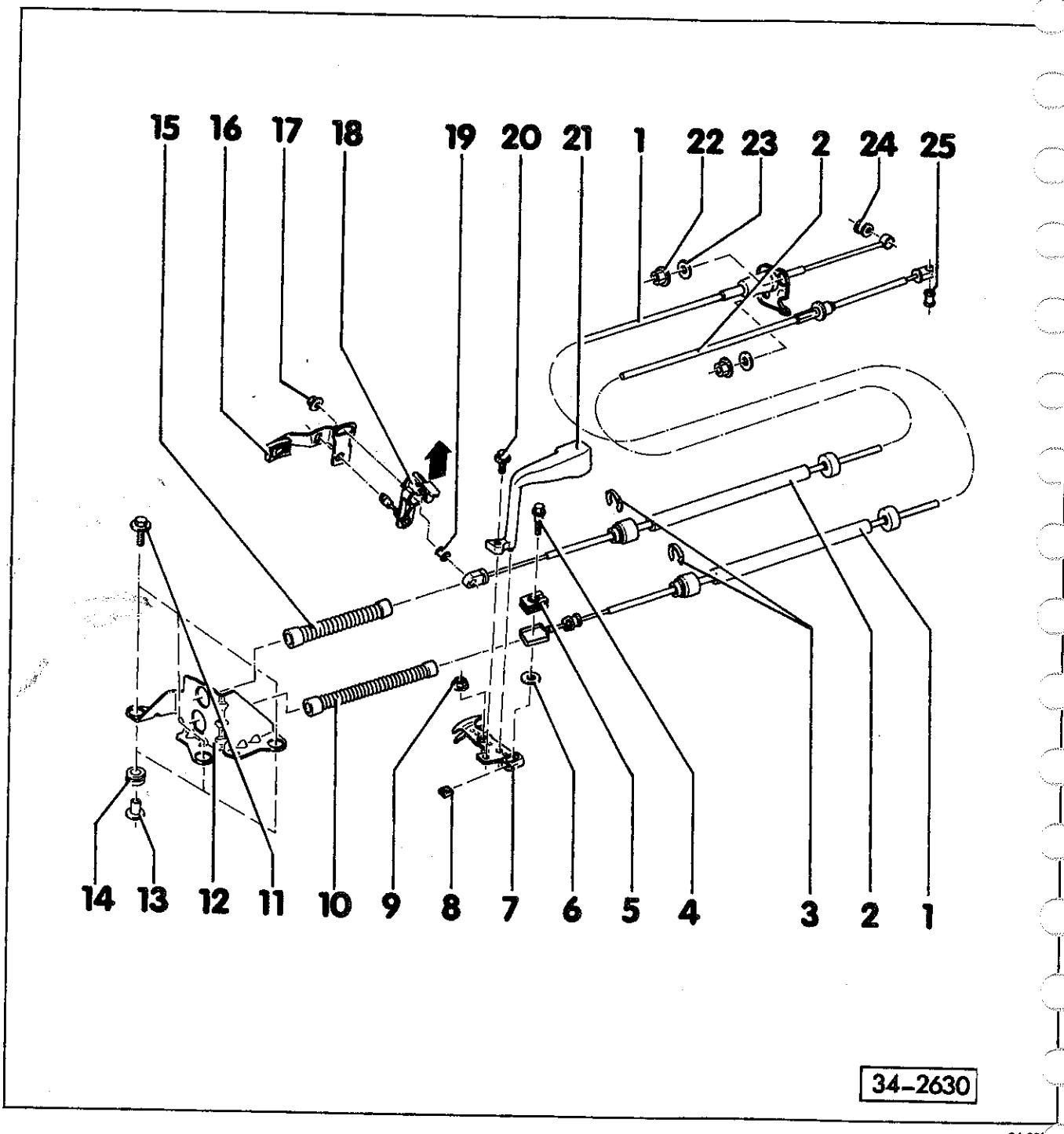



**Fig. 2.** Shift lever control cable and related parts.

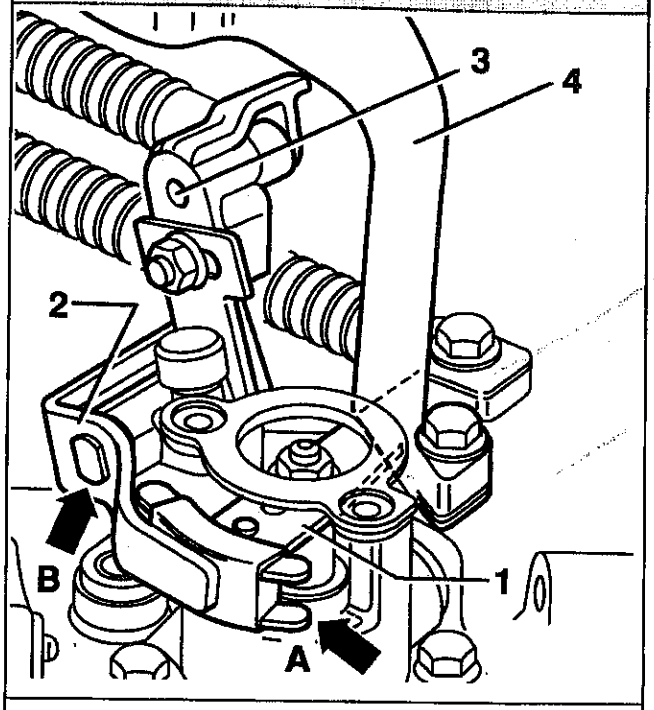
1. **Gear selector cable**

> ***NOTE —***
> *Lubricate all mountings and contact surfaces with MoS2 grease.*

2. **Gate selector cable**
   - Pull off actuating arm (18) by pulling lug in direction indicated by arrow
   - Install before installing gear selector cable
3. **Circlip**
   - Be careful to avoid damaging boot when removing

4. **Hex bolt**
   - With shoulder
   - Tightening torque: 25 Nm (18 ft-lb)
   - Attaches gear selector cable to gear selector lever (7)
5. **Rubber bushing**
   - For gear selector cable connection to gear selector lever (7)
   - Press out of cable end piece when replacing boot
6. **Washer**
   - Install between gear selector cable and gear selector lever (7)
7. **Gear selector lever**
   - Fits in one position only
   - After installing, adjust gear selector mechanism, see **Gear selector mechanism, adjusting**
   - Installation position, **see** (A)
8. **Square nut**
   - Insert into gear selector lever
9. **Self-locking hex nut**
   - Always replace
   - Tightening torque: 25 Nm (18 ft-lb)
10. **Boot**
    - Carefully pull over gear selector cable end piece
11. **Hex bolt**
    - For support bracket (12)
    - Tightening torque: 25 Nm (18 ft-lb)
12. **Support bracket**
13. **Spacer**
14. **Bushing**
    - For mounting support bracket to transmission
15. **Boot**
    - Carefully pull over gear selector cable end piece
16. **Relay lever**
    - Remove from transmission before removing clutch controls
    - Installation position, **see** (A)
17. **Self-locking hex nut**
    - Always replace
    - Tightening torque: 15 Nm (11 ft-lb)
    - Loosen only to adjust gear selector mechanism
18. **Actuating arm**
    - With pivot pin to mount relay lever
    - Installation position, **see** (A)
19. **Rubber bushing**
    - For gate selector cable connection to actuating arm
    - Drive out/drive in with drift
20. **Self-locking hex bolt**
    - Always replace
    - Tightening torque: 20 Nm (15 ft-lb)
21. **Balance weight**
    - Remove to adjust gear selector mechanism
22. **Self-locking hex nut**
    - For gear selector cable to selector housing
    - Always replace
    - Tightening torque: 15 Nm (11 ft-lb)
23. **Rubber washer**
24. **Rubber bushing**
    - For gear selector cable connection to shift lever
    - Drive out/drive in with drift
25. **Bushing**
    - For gate selector cable connection to selector bracket
    - Drive out/drive in with drift

**(A) Gear selector lever and relay lever, installation position**

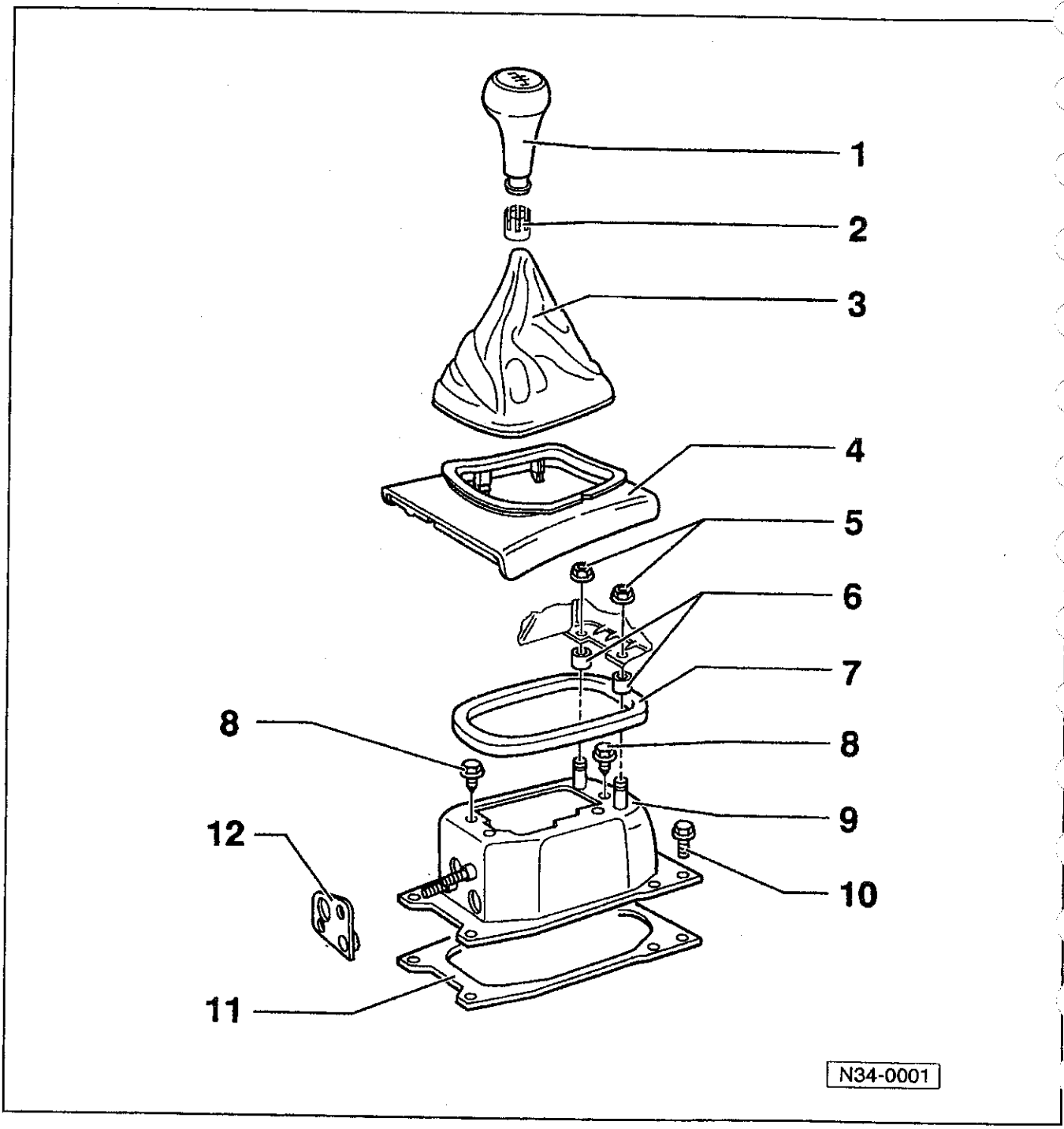



0024069

1. **Gear selector lever**
2. **Relay lever**
   - Engages in guide rail of gear selector lever (A)
   - Lubricate with MoS2 grease
3. **Actuating arm**
   - Flats (B) on pivot pin for relay lever mounting;
   - can be installed in one position only
4. **Balance weight**
   - Fasten to gear selector lever see Fig. 2

***NOTE—***
*Linkage and back-up light switch not shown in illustration.*

## Gear selector housing, assembly




N34-0001

**Fig. 3.** Gear selector housing and related parts.

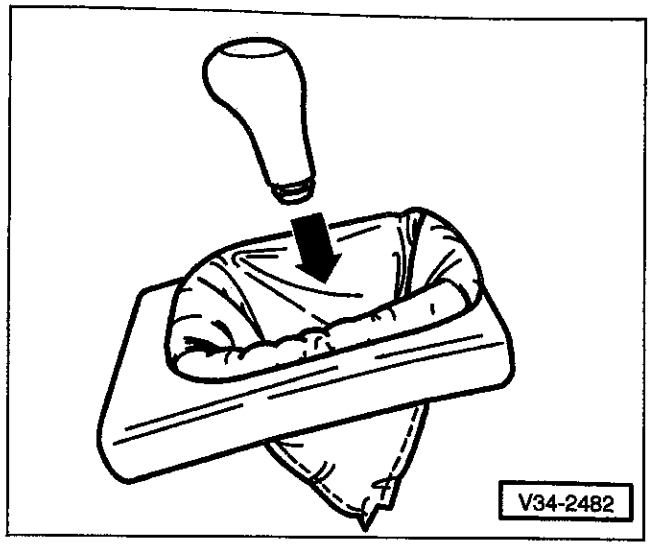
1. **Shift knob**
   - Unscrew from shift lever to remove
2. **Sleeve**
3. **Boot**
   - When removing, lift off with frame from center console
4. **Frame**
5. **Hex nut**
   - Attaches console to gearshift housing (9)
   - Remove before removing gear selector mechanism

(continued from prevrious page)

6. **Spacer**
   - Installed between console and gearshift housing (9)
7. **Gasket**
   - Between gearshift housing and floor
   - Self-adhesive
   - Attach to gearshift housing
8. **Hex bolt**
   - For mounting plate to gearshift housing
   - Tightening torque: 15 Nm (11 ft-lb)
9. **Gearshift housing**
10. **Hex bolt**
    - Quantity: 4
    - Tightening torque: 25 Nm (18 ft-lb)
11. **Gasket**
    - Self-adhesive
    - Attach to underside of gearshift housing
12. **Gasket**
    - Install between selector cables and gearshift housing

## Shift lever boot, installing

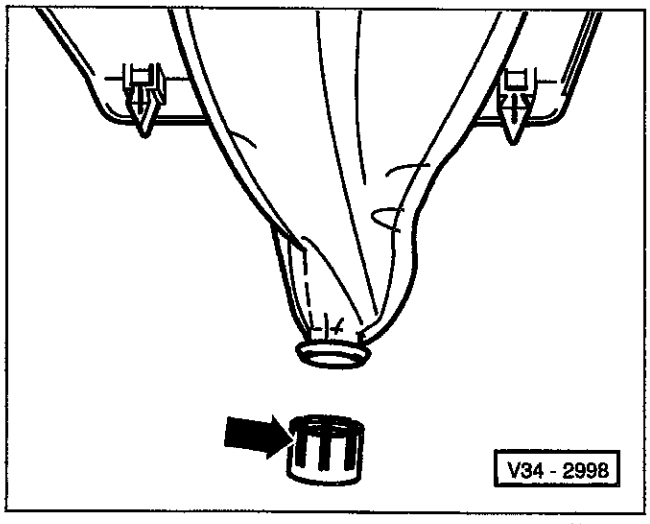
1. Turn boot inside out and position the knob end into the boot opening. See Fig. 4




34-2482

**Fig. 4.** Turn shift boot inside out and install knob into boot.

2. Attach shift knob to boot with sleeve. See Fig. 5




V34-2998

**Fig. 5.** Shift lever boot retaining sleeve (**arrow**).

3. Install shift knob and boot together.

## Shift lever, assembly

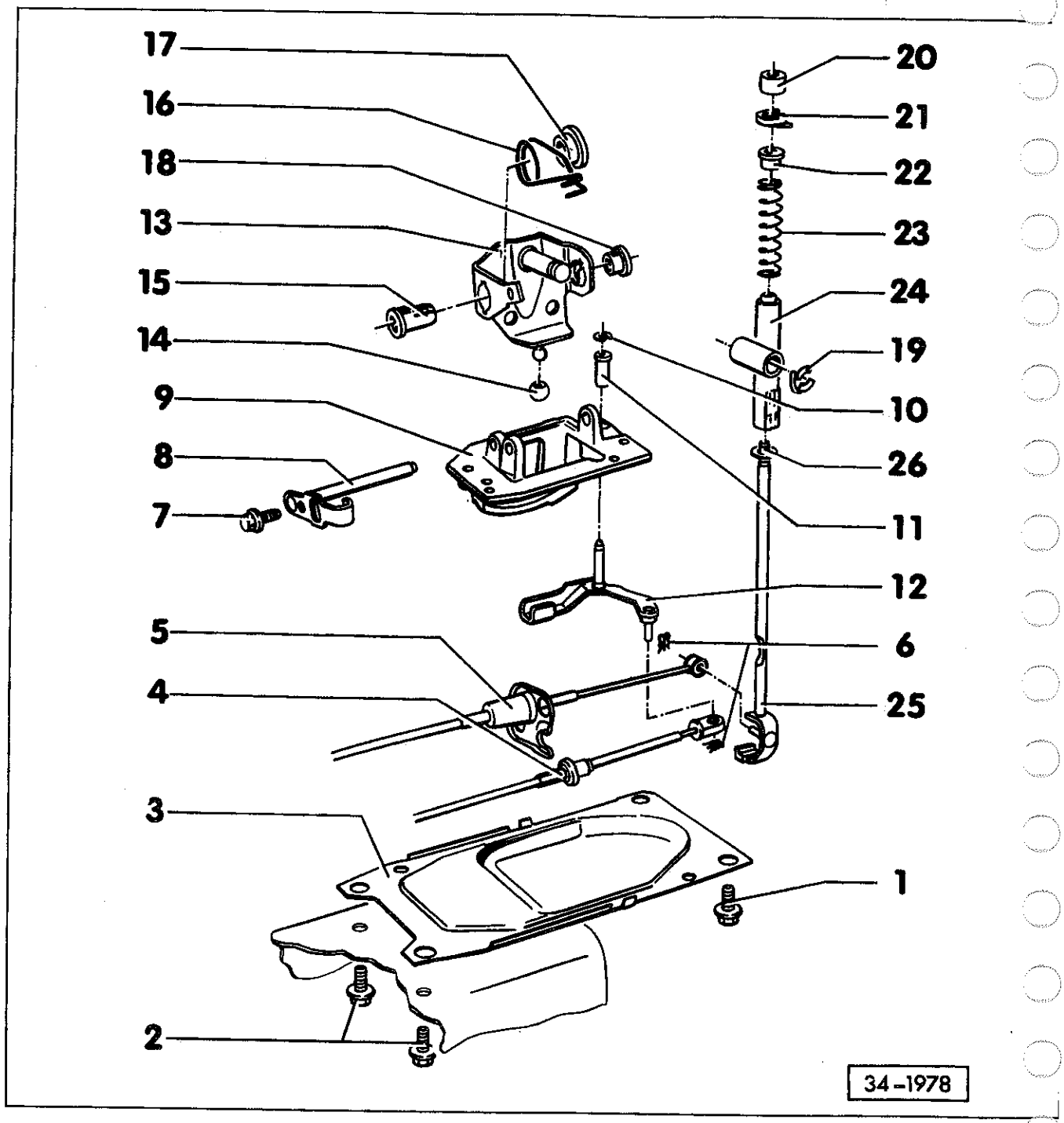



**Fig. 6.** Shift lever assembly.

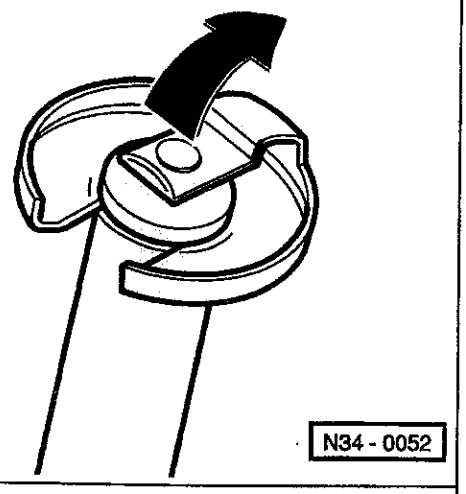
1. **Hex bolt**
   • Tightening torque: 25 Nm (18 ft-lb)

> ***NOTE —***
> *Lubricate all and contact surfaces with MoS2 grease.*

2. **Hex bolt**
   • Tightening torque: 25 Nm (18 ft-lb)
3. **Cover plate**
4. **Gate selector cable**
   • On gate selector bracket

5. **Gear selector cable**
   - On gear selector lever
6. **Spring clip**
7. **Bolt**
   - Pivot pin (8) to mounting plate
   - Tightening torque: 15 Nm (11 ft-lb)
8. **Pivot pin**
9. **Mounting plate**
10. **Lock plate**
    - Removing and installing, **see** (A)
11. **Bushing**
    - Fits in one position only
12. **Gate selector bracket**
13. **Gate selector housing**
    - Fit into mounting plate after installing complete shift lever
14. **Cap**
    - Assembling, **see** (B)
15. **Bushing**
    - Fits in one position only
16. **Spring**
17. **Guide bushing**
    - Assemble with bushing (15)
18. **Bushing**
19. **Circlip**
20. **Sleeve**
    - Where applicable
21. **Circlip**
    - Removing and installing, **see** (C)
22. **Spacer sleeve**
23. **Spring**
24. **Shift lever guide**
25. **Shift lever**
26. **Damping washer**

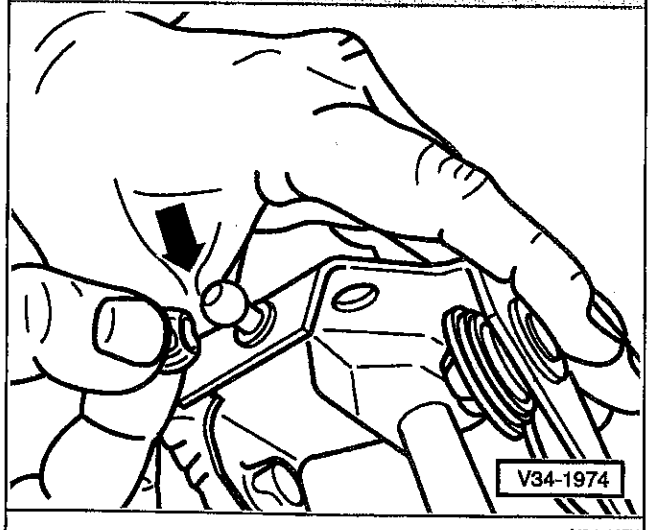
**(A) Removing lock plate for gate selector bracket**




N34-0052

- **Lift clamp in direction of (arrow).**

**(B) Installing gate selector housing cap**

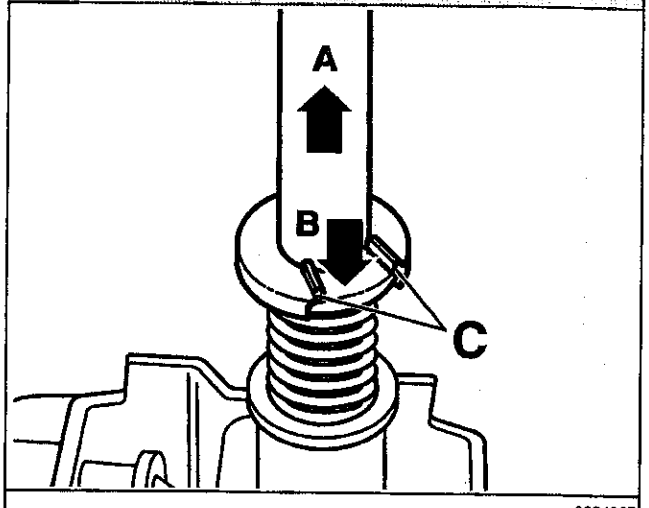



V34-1974

- **Press on from side (arrow).**
- **Press together opening to form a slot.**

***NOTE—***
*If necessary, heat cap in hot water to soften.*

**C Circlip for shift lever guide, removing and installing**




0024065

- **Pull shift lever in direction of arrow (A) and simultaneously use screwdriver to push spacer bushing in direction of arrow (B) to stop.**

***NOTE—***

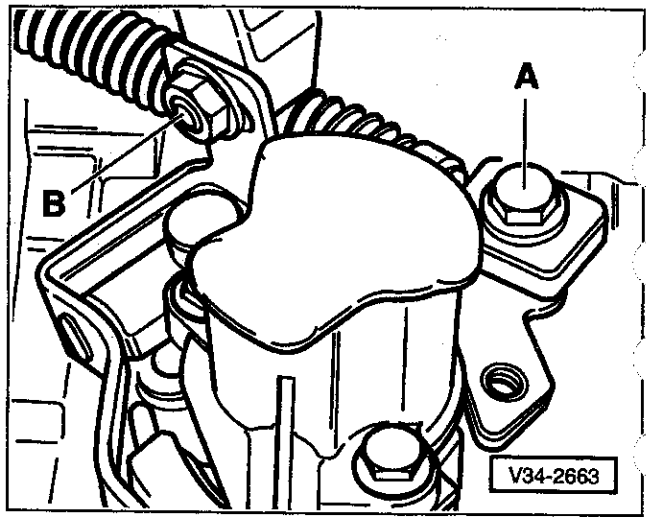
*Do not tilt the spacer bushing when pushing down on it. The holding slot in the shift lever for the lock washer must remain accessible.*

## Gear selector mechanism, adjusting

***NOTE—***

*Special VW tools are required to accurately adjust the shift mechanism. Read the procedure through to determine what tools will be necessary.*

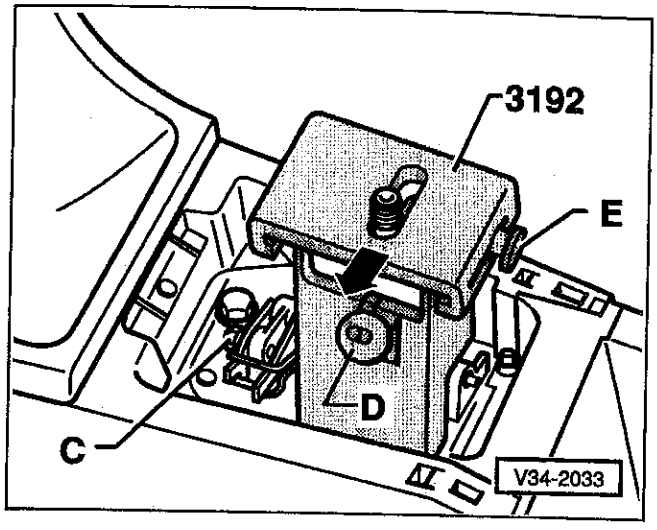
1. Place transmission in neutral.
2. Remove shift knob together with shift boot.
3. Working at the transmission, remove the balanc weight from the shift lever. See Fig. 2, given earlier.
4. Loosen bolt and nut for gear selector cables. See Fi 7. Gear selector cables and actuating arm/gate selector cable should now move freely in elongated holes.




V34-2663

**Fig. 7.** Gear selector cables mounting bolt (**A**) and nut (**B**).

5. Working in the shift lever housing, loosen bolt shown i Fig. 8.
6. Install shift linkage gauge (VW special tool 3192) over shift lever. Then pivot gauge mounting hook unde mounting plate and tighten clamping nut (D in Fig. 8).
7. Press shift lever into left-hand detent of slide. Then pres on shift lever and slide toward left stop (direction of arrow in Fig. 8). Tighten clamping bolt (bolt E in Fig. 8).
8. Press shift lever toward right-hand detent and then tighten shift lever housing bolt previously loosened (bolt C in Fig. 8).



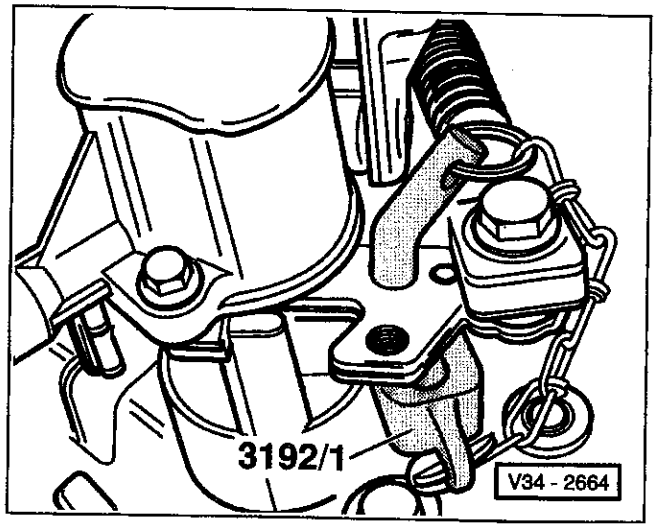

V34-2033

**Fig. 8.** Shift lever housing mounting bolt to be loosened (**C**). Shift linkage alignment gauge (VW special tool no 3192) shown installed over shift lever.

9. Install special wedge and pin to shift mechanism. See Fig. 9. Slide wedge between gear selector lever and selector cover plate so that there is no play.

***NOTE—***

*When installing the wedge, use care so that the wedge does not cause the shift lever to lift.*




V34-2664

**Fig. 9.** Shift lever alignment wedge and pin (VW special tool 3192/1) shown installed to shift linkage at transmission.

10. Secure gear selector cable and actuating arm/selector cable by tightening nut and bolt shown in Fig. 7. Check that the wedge is still correctly positioned.

11. Remove shift linkage alignment gauge, wedge, and pin.

12. Install balance weight, shift lever knob and boot.

## Gear selector mechanism, functional check

1. With transmission in neutral, make sure shift lever is in 3rd gear/4th gear gate

2. Depress clutch pedal and start engine.

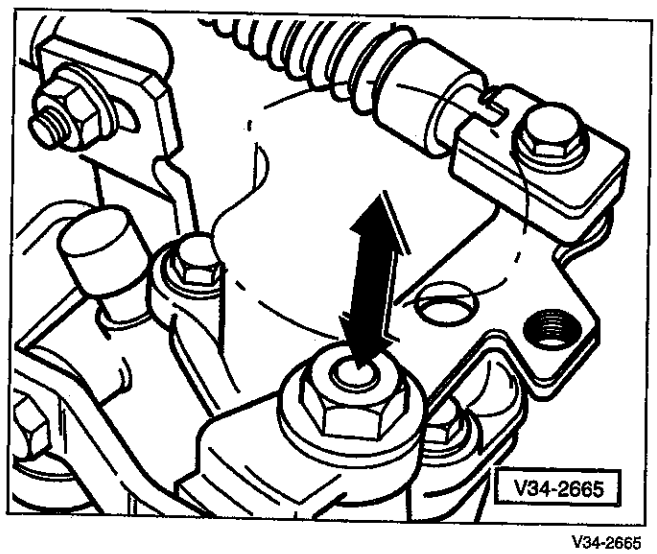
3. Wait approximately 3-6 seconds to allow transmission input shaft to come to a standstill.

4. Select each gear several times, checking all gears. Pay particular attention to operation of reverse gear.

***NOTE—***

*Should any gear fail to engage smoothly after being selected repeatedly, the selector shaft play (lift) should be checked as described below.*

5. Have a helper select 1st gear and then press shift lever to left stop, then release. At same time, observe selector shaft on transmission. The selector shaft must move approx. 1 mm (0.04 in.) in the direction shown in Fig. 10.



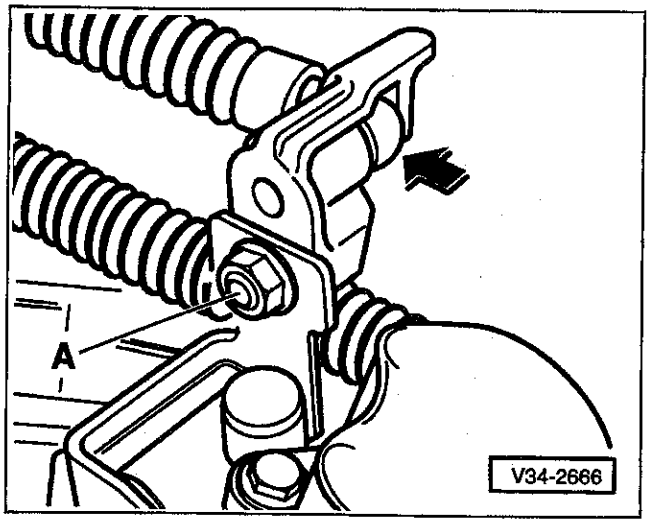

V34-2665

**Fig. 10.** When moving shift lever to 1st gear stop, transmission selector lever should move in direction of arrow approx. 1.0 mm (0.04 in.).

6. If any faults are found, disengage 1st gear.

7. Then loosen nut at actuating arm/gate selector cable mounting. See Fig. 11. Take up gate selector cable play by lightly pressing on actuating arm and retighten nut.

***NOTE—***
*Gate selector cable has some play at mounting due to transfer elements, i.e. some minimal play at mounting is normal.*




V34-2666

**Fig. 11.** Actuating arm/gate selector cable mounting nut (**A**). With nut loosened, press lightly on actuating arm (direction of **arrow**) and retighten nut.

## TRANSMISSION REMOVAL AND INSTALLATION

This heading describes removal and installation of the manual transmission used on 6-cylinder engines. Special engine lifting and jacking equipment is needed to support and reposition the engine as the transmission is removed from below. Read the procedure through to determine what tools and equipment are needed for the job.

### Transmission, removing

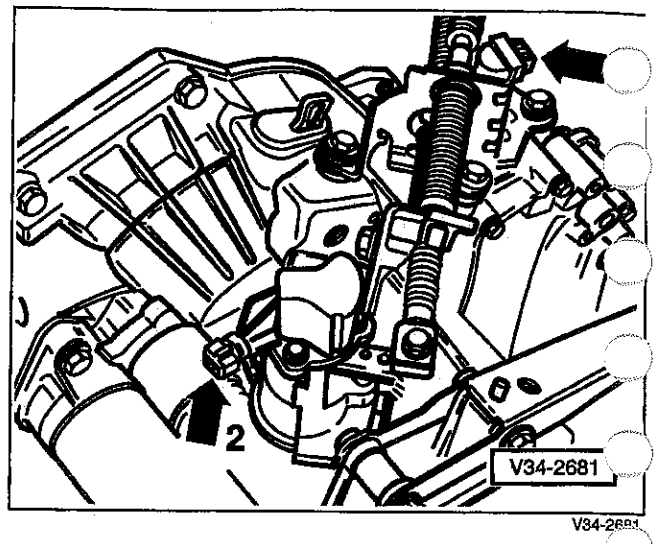
1. Disconnect battery ground strap and remove battery.

> ***CAUTION—***
> *On vehicles equipped with an anti-theft radio, make sure you know the correct radio activation code before disconnecting the battery.*

2. Remove power steering fluid reservoir from battery bracket.

3. Remove battery bracket.

4. Disconnect harness connectors from transmission See Fig. 12.

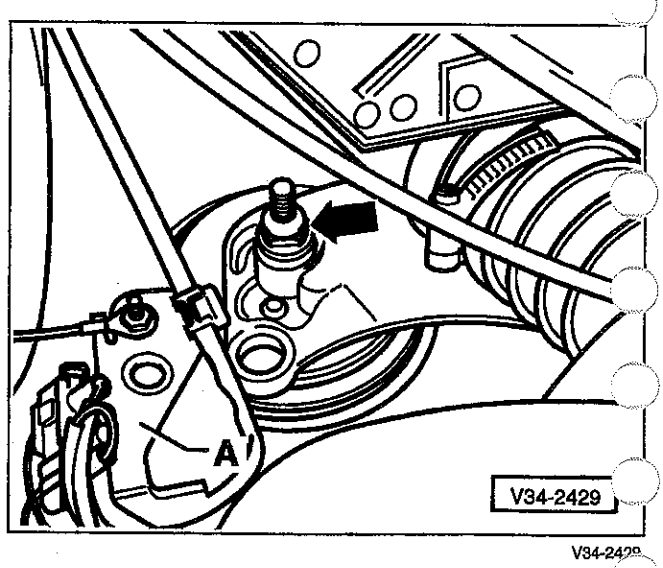



V34-2681

**Fig. 12.** Vehicle speed sensor (**1**) and backup light switch (**2**) harn connectors to be disconnected from transmission.

5. Disconnect all other electrical connections and gro connections from engine/transmission mounting bolts.

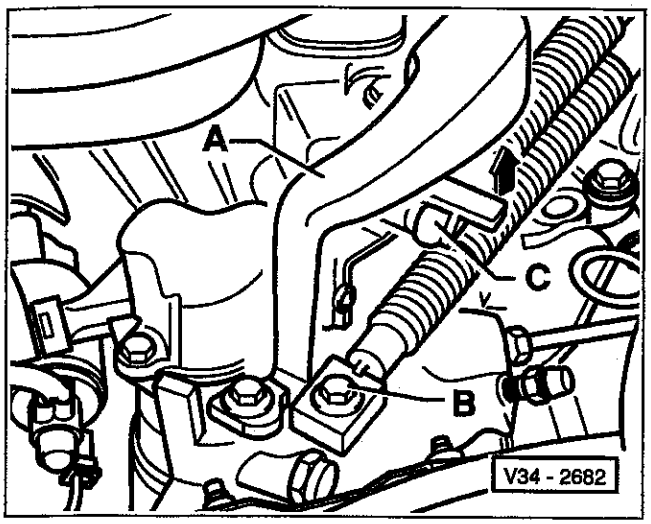
6. Remove mounting bolt and harness connector mo ing bracket (if applicable) from right-side engine mount. See Fig. 13.




V34-2429

**Fig. 13.** Right-side engine mount bolt (**arrow**) and harness connec mounting bracket (**A**).

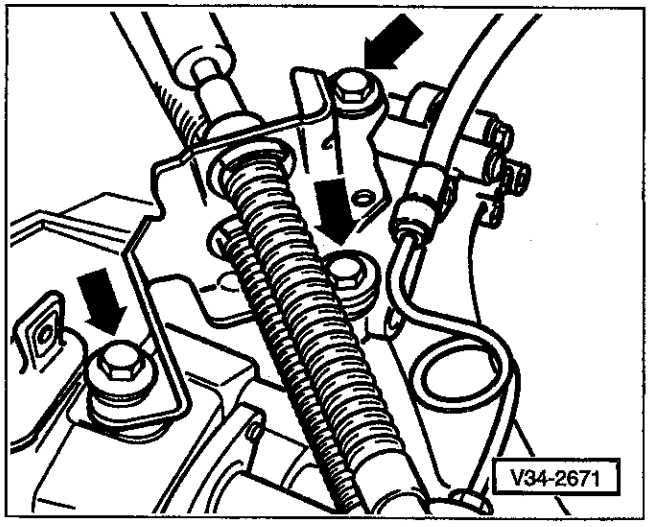
7. Remove balance weight from gear selector lever. Th disconnect gear selector cables from gear shift linkage on transmission. See Fig. 14.




V34-2682

**Fig. 14.** Gear selector-lever balance weight (**A**) on transmission shift lever. Disconnect gear selector cable by removing bolt at (**B**). Disconnect gate selector cable at actuating arm/relay lever (**C**) by pulling tab in direction of **arrow.**

8. Remove cable retaining bracket from transmission. See Fig. 15.

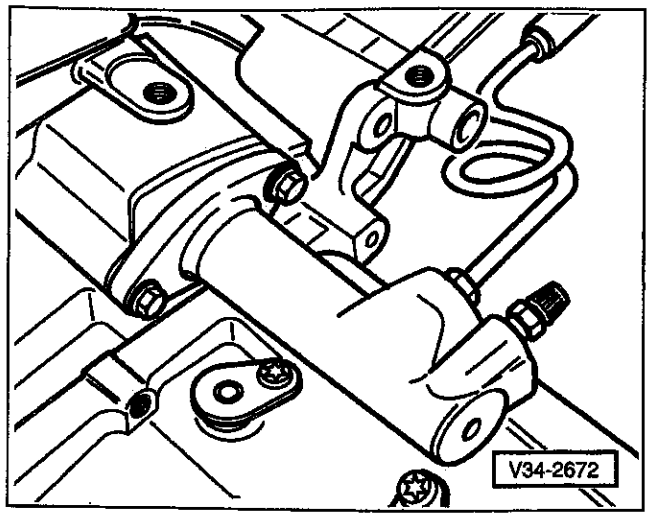



V34-2671

**Fig. 15.** Cable retaining bracket mounting bolts (**arrows**).

9. Remove clutch slave cylinder from transmission and lay to one side. See Fig. 16.

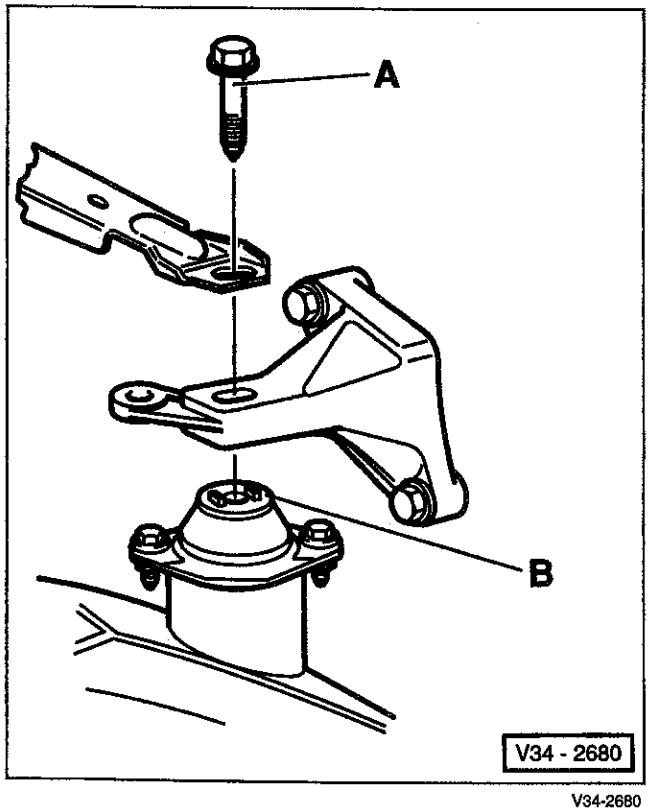
> ***CAUTION—***
> *Do not open clutch hydraulic system or loosen fluid lines. Secure clutch slave cylinder in place with wire.*




V34-2672

**Fig. 16.** Clutch slave cylinder on transmission.

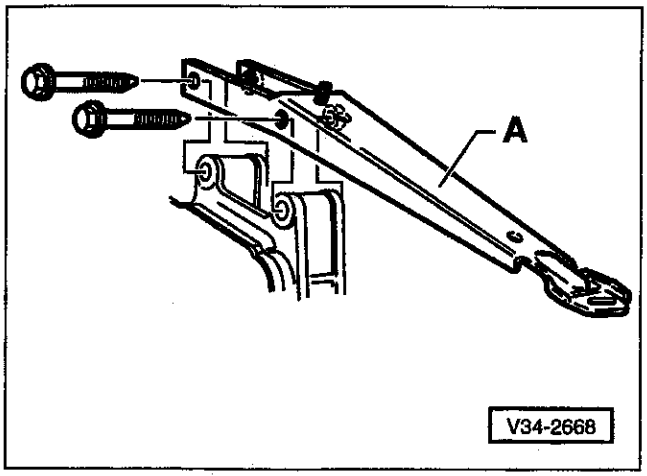
10. Disconnect coolant overflow reservoir and lay it aside. See **19 Engine–Cooling System.** Then remove bolt from left transmission mount. See Fig. 17.




V34-2680

**Fig. 17.** Mounting bolt (**A**) in left transmission mount (**B**).

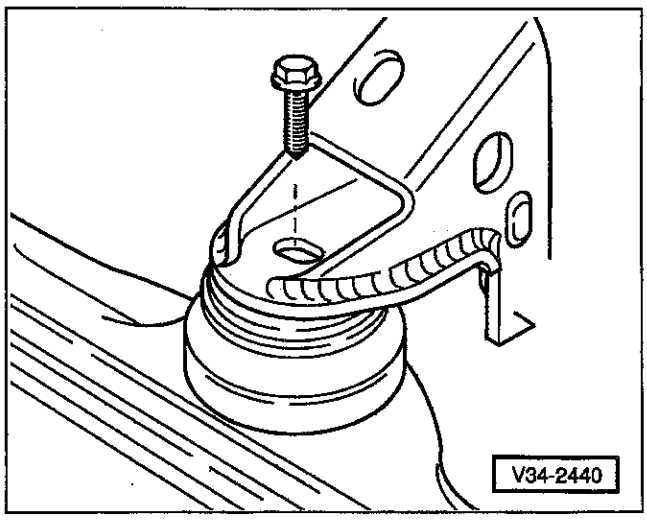
11. Remove transmission support from transmission and any attached brackets (where applicable). See Fig. 18.




V34-2668

**Fig. 18.** Transmission support (**A**) used on some models.

12. Remove mounting bolt from front engine mount. See Fig. 19.



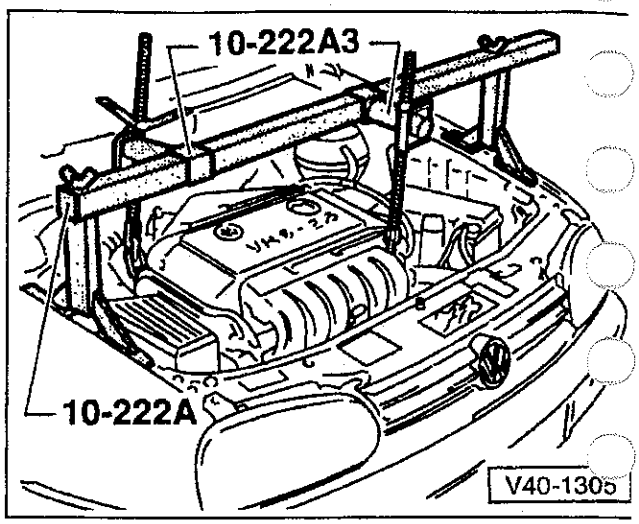

V34-2440

**Fig. 19.** Mounting bolt for front engine mount.

13. Remove the upper engine-to-transmission mounting bolts.

14. Attach engine lifting equipment (VW sling 10-222A and adjust 10-222A3 adapters, or equivalent) to engine lifting eyes. Adjust the lifting sling until the weight of the engine is fully supported. See Fig. 20.

> ***CAUTION—***
> *Before installing the adapter hooks, disconnect all hoses and wiring in the vicinity of the engine lifting eyes, to prevent damage.*




V40-1305

**Fig. 20.** Engine lifting equipment used to support weight of en... Numbers shown are for VW special tools.

15. If applicable, remove the insulation shield beneat... gine/transmission.

16. Remove the starter. See **27 Engine Electrical.**

> ***NOTE—***
> *Before removing lower mounting engine-to-transmission bolts, first disconnect power steering hose from the bracket at transmission.*

17. Remove the front engine bracket from the engine block

18. Disconnect axle shafts from axle flanges (both s... turn steering all the way to the left, and tie axle shaft aside, as high as possible.

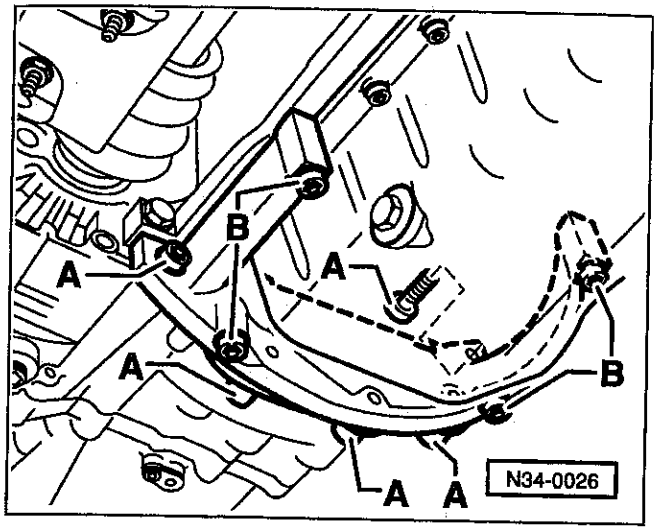
> ***CAUTION—***
> *Take care not to damage the axle boots.*

19. Remove support between transmission and engi... applicable). See Fig. 21.

20. Remove small clutch cover plate behind axle flan...

21. Push engine/transmission assembly as far to the right as possible.

22. Using the engine lifting equipment, raise engine/transmission assembly until exhaust system just cor... exhaust system heat shield.

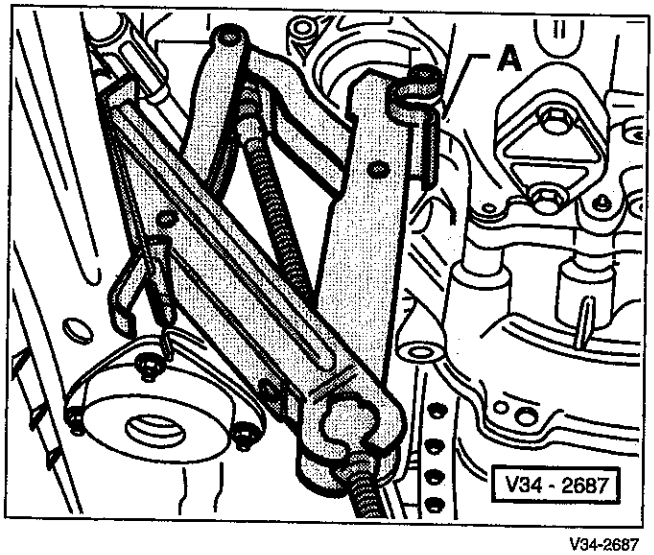



N34-0026

**Fig. 21.** Engine-to-transmission support mounting bolts (**A** and **B**).

23. Mount scissors jack between engine and body. See Fig. 22. Then press engine/transmission assembly rearward, toward firewall.

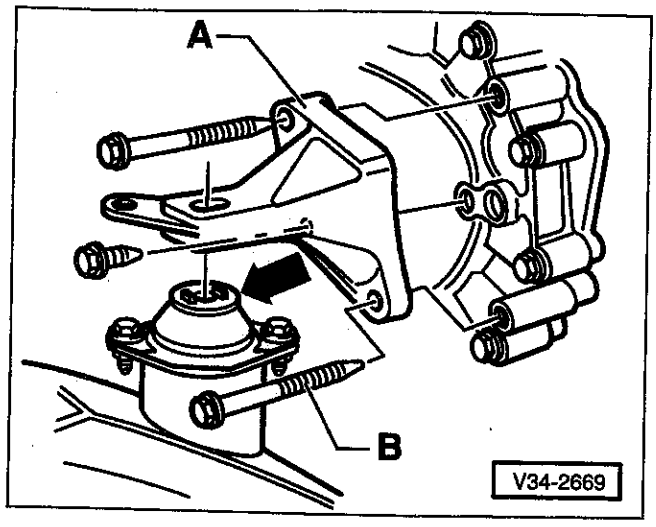
> ***CAUTION—***
> *Use care not to damage the power steering lines as the engine/transmission assembly is pressed rearward.*




V34-2687

**Fig. 22.** Scissors jack being used to press engine/transmission assembly rearward. Be sure to mount scissors jack to engine at casting lug (**A**).

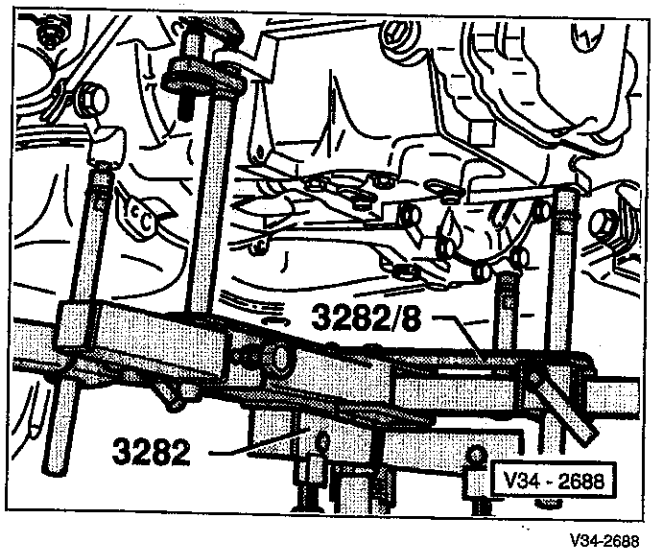
24. Remove transmission mount from transmission. See Fig. 23.
25. Lower engine/transmission assembly to its previous position, with the left side being slightly lower than the right side.
26. Remove clutch cover plate.




V34-2669

**Fig. 23.** Mounting bolts (**B**) for transmission mount (**A**).

27. Remove bolt at engine/transmission mount above right axle flange.
28. Place transmission jack under vehicle. See Fig. 24.




V34-2688

**Fig. 24.** Transmission jack correctly positioned under transmission. Numbers shown are for VW transmission jack and adapters.

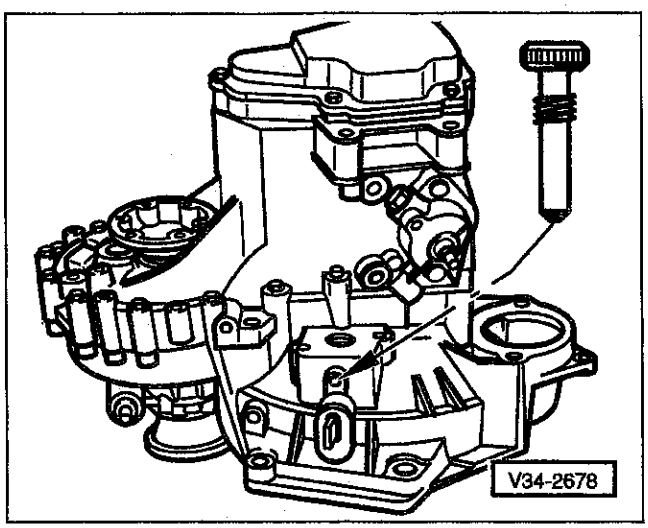
29. Remove bolt for lower engine/transmission attachment.
30. Press transmission off alignment dowel sleeves and lower carefully while pushing forward slightly on engine/transmission assembly.

> ***CAUTION—***
> *While lowering transmission avoid damaging power steering lines.*

## Transmission, installing

Install the transmission in the reverse order of removal. Check that all engine-to-transmission dowel pins are installed in the engine block. Replace any that are missing. Clean the hub splines of the transmission input shaft and apply a light coat of G 000 100 grease before installing. If replacing the transmission assembly, transfer the vehicle speed sensor, the back-up light switch, and the transmission relay lever to the new transmission.

Before installing the transmission to the engine, press the clutch release lever toward the transmission case and secure the lever in position using a M8x35 bolt. See Fig. 25.



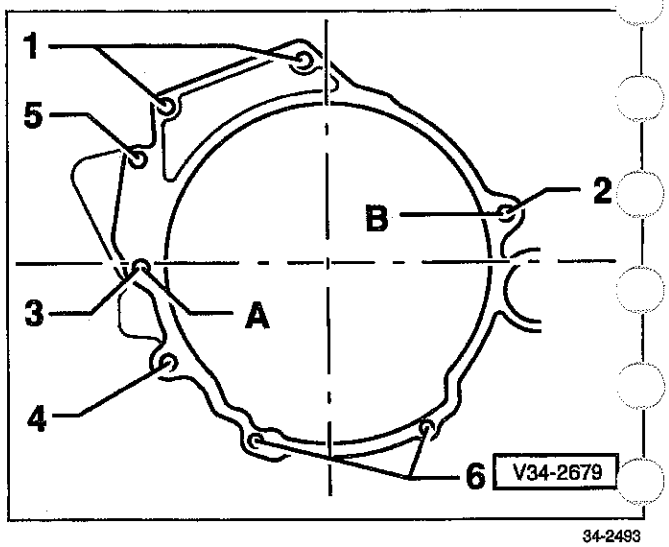

V34-2678

**Fig. 25.** Press clutch release lever into operating position and secure by inserting M8x35 bolt through bellhousing. Remove bolt once transmission is installed.

Installation tightening torques are given below. Use Fig. 26 and Fig. 27 together with **Table a** and **Table b** as a guide. Fig. 28 shows installation torques for the engine/transmission support, where applicable. Make a final check of transmission installation, noting the following:

**Final installation checks**

- Install the engine/transmission mounts so that they ar free of tension. See **10 Engine–Removing and Installing** for specific engine/transaxle installation procedures.
- Ensure that the intermediate plate is positioned correc
- Check the transmission oil level. See **0 Maintenance Program.**
- Adjust gear selector mechanism, see **Gear selector mechanism, adjusting.**
- Check the operation of the clutch hydraulics. See **30b Clutch (AAA, AHU Engines).**



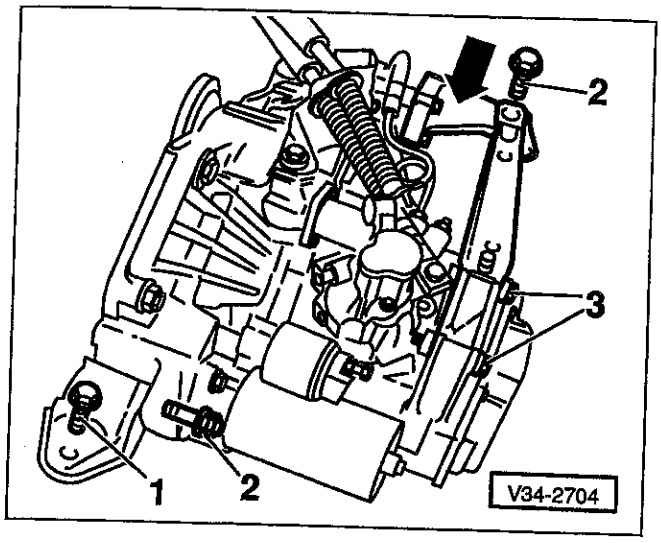

34-2493

**Fig. 26.** Transmission-to-engine mounting bolt locations to be used conjunction with **Table a.** Alignment dowel pins shown at and **B.**

**Table a. Transmission to engine fasteners**

| Fastener | Size | Qty. | Tightening torque |
|---|---|---|---|
| 1 | M12 X 55 | 2 | 80 Nm (59 ft-lb) |
| 2 | M12 X 62 | 1 | 80 Nm (59 ft-lb) |
| 3* | M12 X 62 | 1 | 80 Nm (59 ft-lb) |
| 4 | M12 X 46 | 1 | 80 Nm (59 ft-lb) |
| 5** | M10 X 160 | 1 | 60 Nm (44 ft-lb) |
| 6*** | M7 X 12 | 2 | 10 Nm (89 in lb) |

* Also for bracket at front of transmission
** Also for starter and bracket at front of transmission
*** Flywheel shield plate



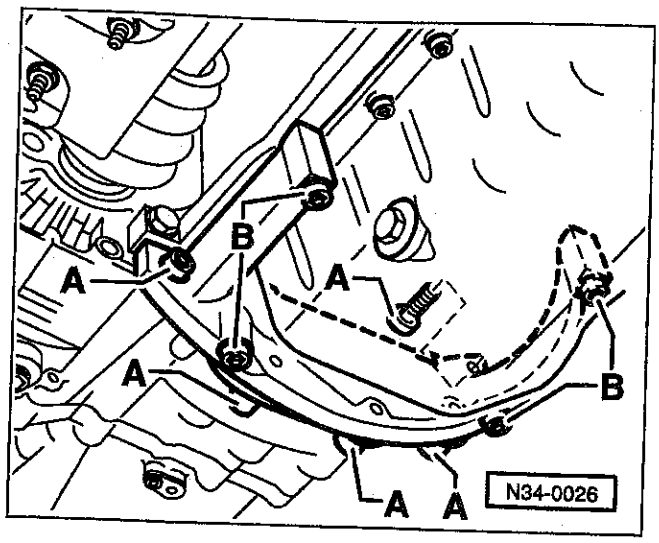

V34-2704

**Fig. 27.** Transmission assembly mounts to be used in conjunction with **Table b.**

**Table b. Transmission/engine assembly mounts**

| Fastener | Size | Qty. | Tightening torque |
|---|---|---|---|
| 1 | M10 X 30 | 1 | 50 Nm (37 ft-lb) |
| 2 | M10 X 45 | 2 | 50 Nm (37 ft-lb) |
| 3* | M10 X 60 | 2 | 45 Nm (33 ft-lb) |
| *Not applicable on all models | | | |

When reinstalling the engine to transmission support, tighten the support bolts in the specified sequence shown in Fig. 28.




N34-0026

**Fig. 28.** Tightening sequence for support between engine and transmission (if applicable). First tighten all bolts by hand. Then tighten bolts to torques listed.

**Tightening torques**

- Lower starter mounting bolt to transmission . . . . . 60 Nm (44 ft-lb)
- Left transmission bracket to transmission (arrow in Fig. 27). . . . . 25 Nm (18 ft-lb)
- Right engine bracket to subframe. . . . 60 Nm (44 ft-lb)
- Axle shaft to axle flange . . . . . 45 Nm (33 ft-lb)
- Support between engine and transmission (A and B in Fig. 28). . . . . 45 Nm (33 ft-lb)

# 39 Differential and Final Drive



39

## GENERAL

Transmission and final drive assemblies used on the cars covered by this manual vary depending on engine installed and on model year.

| Engine Code | Manual Transmission Code | Automatic Transmission Code |
|---|---|---|
| AAZ, ACC, ABA (4-cylinder gasoline engines) | **020** | **096** or **01M*** |
| AAA (6-cylinder engine) | **02A** | **096** or **01M*** |
| AHU (4-cylinder TDI diesel) | **02A** | **01M*** |

*See **3 Clutch, Transmission and Final Drive–General** for specific identification and application information.

***NOTE—***
*On cars with manual transmission, the differential shares the same gear oil as the transmission. For information on draining and filling the manual transmission and differential oil, see* **0 Maintenance Program.**

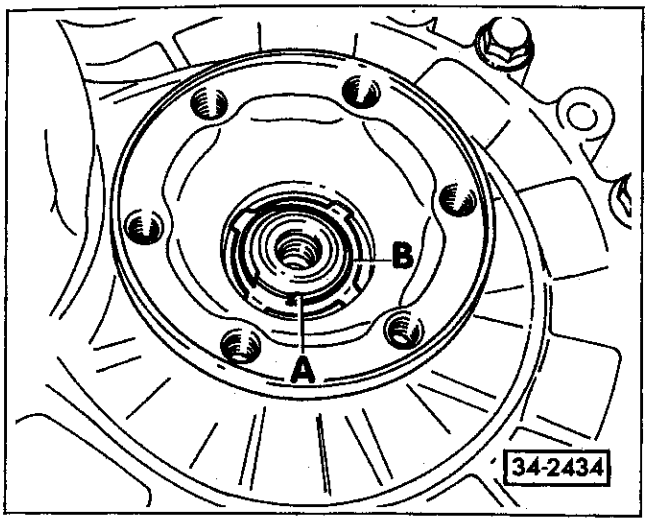
## 020 MANUAL TRANSMISSION

Illustrations shown under this heading are for the left-side drive flange assembly only. Removal and installation of the right-side drive flange and oil seal are identical, unless noted otherwise.

### Drive flange oil seal, removing (020 transmission)

1. If replacing right drive flange oil seal, disconnect drive axle at right side of transmission, push drive axle upward and suspend with stiff wire.
2. If replacing left drive flange oil seal, remove left drive axle. See **40 Front Suspension and Drive Axles.**
3. Pry off cover in center of drive flange by piercing center of cover with screwdriver.
4. Carefully remove circlip and dished washer from drive flange. See Fig. 1.

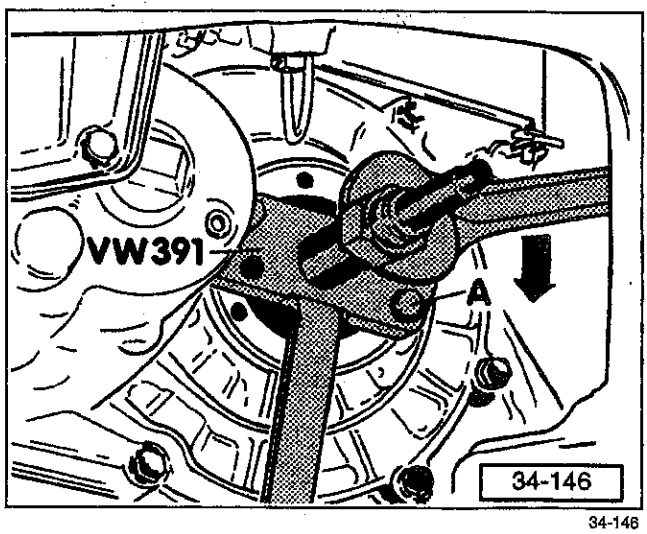
***WARNING—***
*The drive flange is under spring force. Once the circlip is removed, the drive flange may release suddenly. Use extreme care when removing the circlip.*




34-2434

**Fig. 1.** Drive flange retaining circlip (**A**) and dished washer (**B**). Note orientation of dished washer before removing.

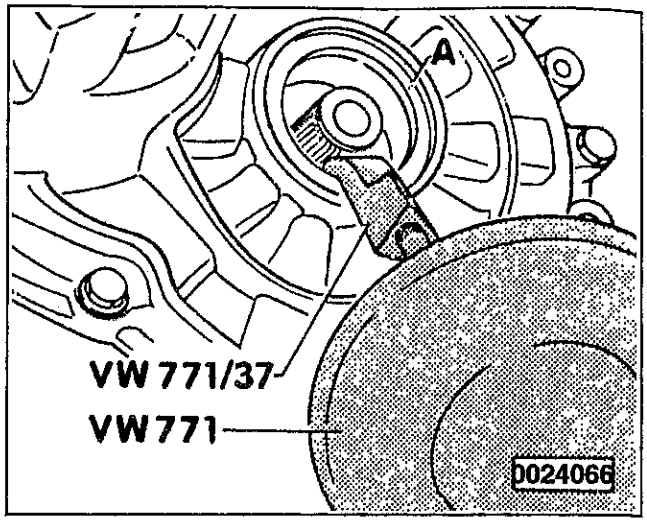
5. If necessary, use a press (VW special tool no. VW391 or equivalent) to remove the drive flange together with its spring. See Fig. 2.




34-146

**Fig. 2.** Drive flange being pressed off output shaft using Volkswagen special tool no. VW 391.

6. Pry out drive flange oil seal from differential housing. See Fig. 3.



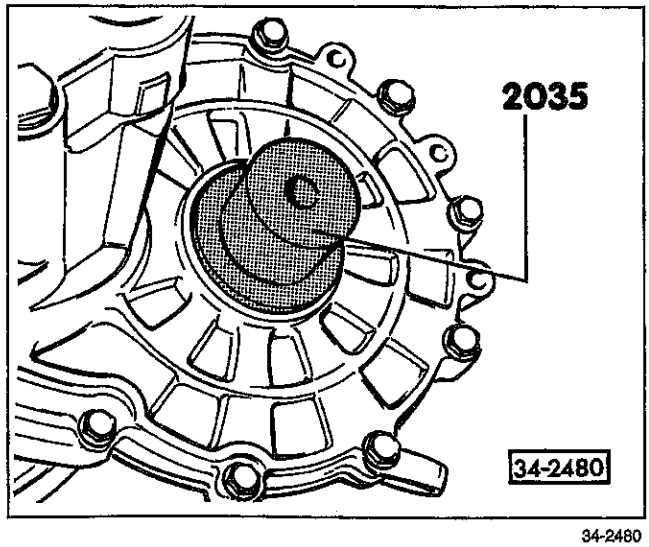

0024066

**Fig. 3.** Drive flange oil seal (**A**) being removed with seal extractor (VW special tool no. VW 771 and VW 771/37).

## Drive flange oil seal, installing (020 transmission)

> ***CAUTION—***
> *Be sure to have the correct transmission code on hand when ordering parts. Drive flange oil seal applications vary depending on transmission application.*

1. Fill space between lips of new oil seal with multi-purpose grease. Then drive seal in against shoulder. See Fig. 4.



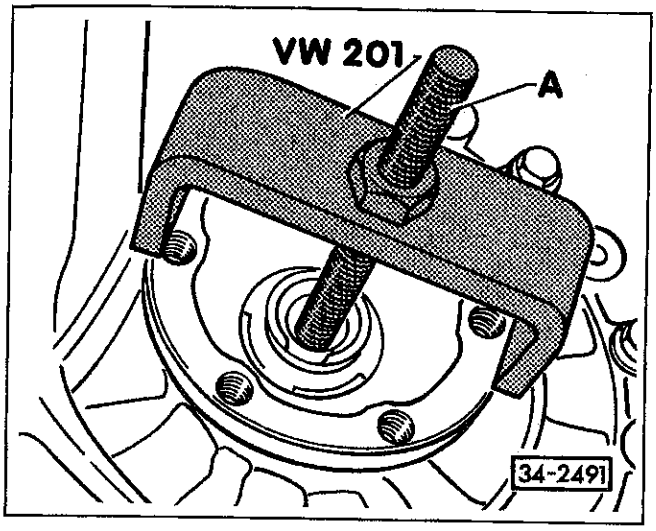

34-2480

**Fig. 4.** Drive flange oil seal being installed with seal driver (Volkswagen special tool no. 2035).

2. Install spring to drive flange.

3. Carefully heat drive flange on hot-plate to approx. 80°C (176°F). Press the drive flange into position. See Fig. 5.

> ***WARNING —***
> *Use extreme care when handling the heated drive flange. Wear heavy gloves and arm protection to guard against burns and personal injury.*




34-2491

**Fig. 5.** Drive flange being installed using press (VW special tool no. VW 201 with threaded stud and M10 nut (**A**).

4. Install dished washer so that the concave faces in, toward the differential.

5. Fit new circlip to shaft and press down until seated in groove.

6. Press new sealing cover into center of drive flange.

7. Tightening torques are given below. Be sure to check transmission oil level, adding as necessary. See **0 Maintenance Program**.

**Tightening torques**

- Drive axle to axle flange . . . . . 45 Nm (33 ft-lb)
- Wheel to wheel hub . . . . . 110 Nm (81 ft-lb)

## 02A MANUAL TRANSMISSION

Two versions of drive flange assemblies are used on the 02A manual transmission. One version uses bolts to retain the spring-loaded drive flanges. The other version is not spring-loaded and uses circlips to retain the drive flanges.

To determine which version is installed, the drive axle must first be removed from the drive flange. If a bolt is used to retain the flange, springs are used. If a bolt is not present, the drive flange is retained by a blind circlip.

### Drive flange oil seal, removing (02A transmission–without springs)

> ***NOTE —***
> *Illustrations shown under this heading are for the left-side drive flange assembly only. Removal and installation of the right-side drive flange and oil seal are identical.*

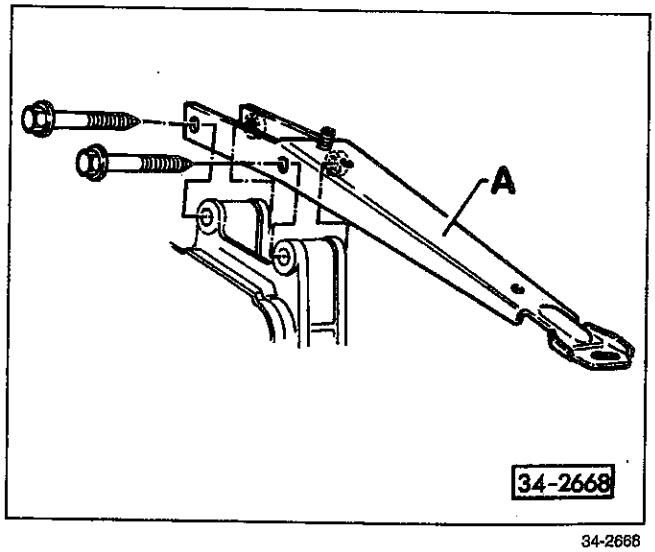
1. Turn steering wheel completely to right lock.

2. Disconnect axle shaft from axle flange. Push drive axle upward as far as possible and suspend with stiff wire.

> ***CAUTION —***
> *Avoid damaging the protective surface on the axle shaft.*

3. If replacing left-side oil seal, remove the road wheel. Also remove transmission support, where applicable. See Fig. 6.

> ***NOTE —***
> *For better access to the transmission support, disconnect coolant overflow reservoir and lay it to one side.*



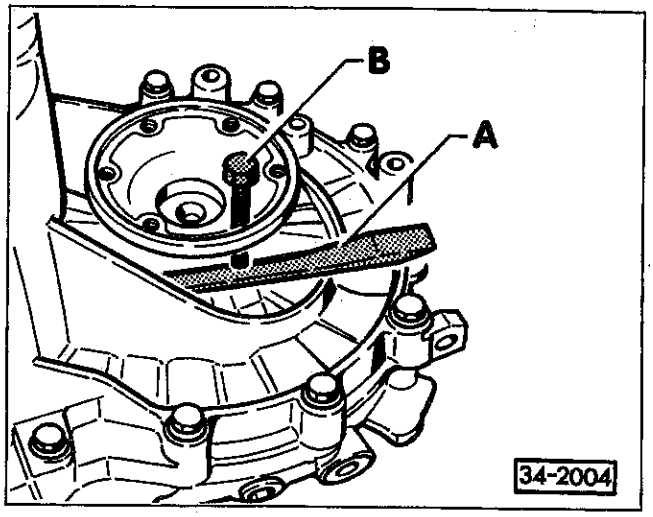

34-2668

**Fig. 6.** Transmission support (**A**) used on some early models.

4. Pry off cover in center of drive flange by piercing center of cover with screwdriver.

5. Press axle flange from transmission until the circlip releases. See Fig. 7.

***NOTE—***
*If the drive flange fails to come straight off, use an additional spacer and bolt positioned opposite the first bolt and spacer. Tighten both bolts alternately and evenly.*



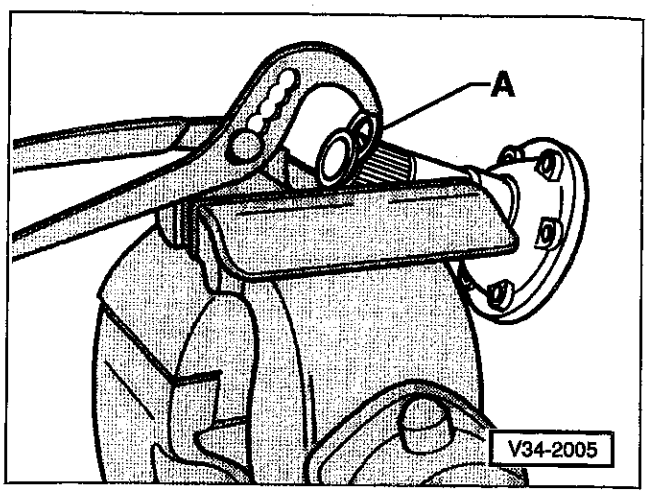

34-2004

**Fig. 7.** Remove drive flange/axle shaft by placing spacer (**A**) beneath flange and pull flange from differential by threading bolt onto spacer (cold chisel shown).

6. Clamp axle shaft in vise (fitted with protective jaws). Then press old circlip out of shaft groove by installing new circlip. See Fig. 8.

***CAUTION—***
*Always replace drive flange circlip—do not reuse old circlip.*

7. Remove drive flange oil seal using a seal extractor (VW 681 extractor lever or equivalent).




V34-2005

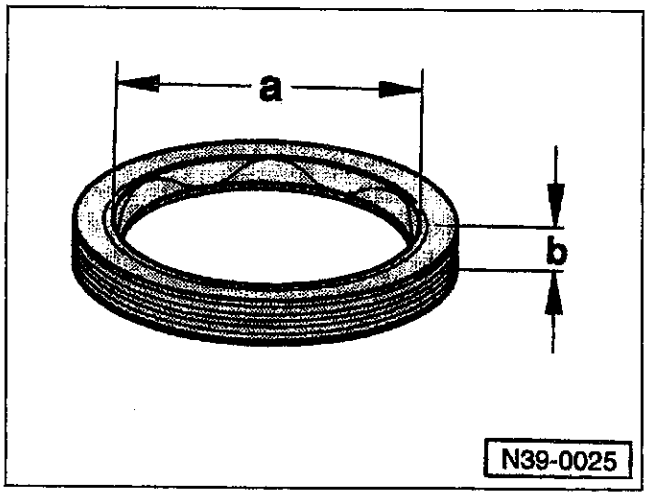
**Fig. 8.** New circlip being pressed onto axle shaft to remove old circlip.

## Drive flange oil seal, installing (02A transmission–without springs)

Oil seal applications vary depending on drive flange version installed. The oil seal used on 02A transmissions without springs is shown in Fig. 9.

**Drive Flange Oil Seal Dimensions**

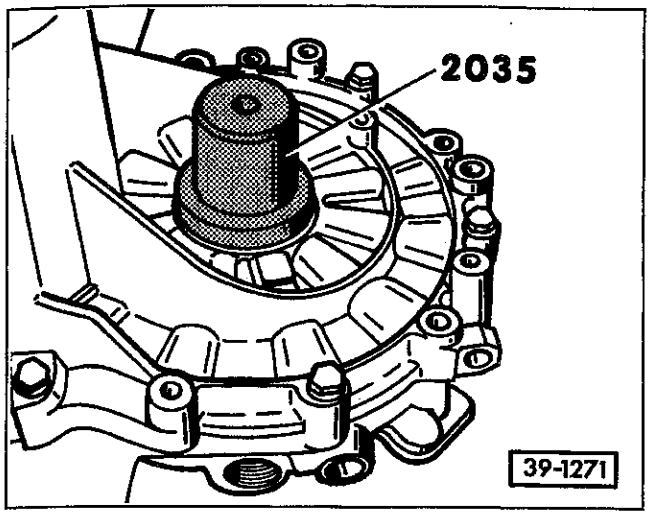
- Diameter (**a**) . . . . . 40.0 mm (1.575 in.)
- Height (**b**) . . . . . 10.0 mm (0.394 in.)




N39-0025

**Fig. 9.** Drive flange oil seal for 02A transmission without drive flange springs.

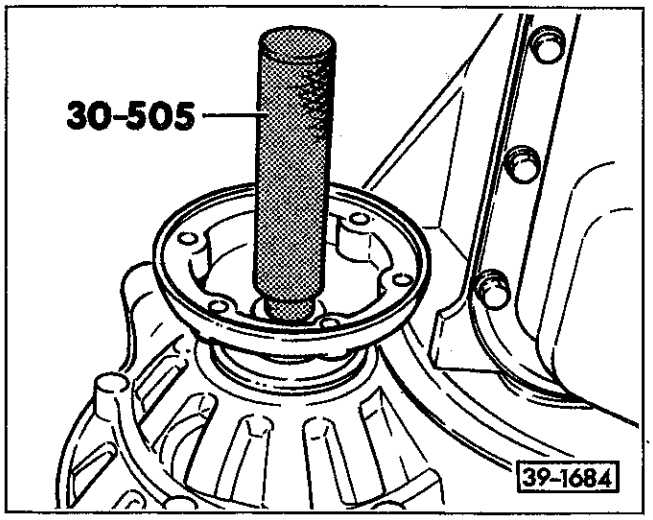
1. Fill space between lips of new oil seal with multi-purpose grease. Then drive seal in against shoulder. See Fig. 10.




39-1271

**Fig. 10.** Drive flange oil seal being installed Volkswagen special tool no. VW 2035.

2. Install and drive the drive flange in until the retaining circlip engages circlip groove. See Fig. 11.




39-1684

**Fig. 11.** Drive flange being installed using Volkswagen special tool no. 30-505.

3. Press new sealing cover into center of drive flange.

4. Tightening torques are given below. Be sure to check transmission oil level as described in **0 Maintenance Program.**

**Tightening torques**

- Transmission support to transmission . . . . . 45 Nm (33 ft-lb)
- Transmission support to transmission mount . . . . . 50 Nm (37 ft-lb)
- Wheel to wheel hub . . . . . 110 Nm (81 ft-lb)

## Drive flange oil seal, removing (02A transmission–with springs)

***NOTE—***
*Illustrations shown under this heading are for the left-side drive flange assembly only. Removal and installation of the right-side drive flange and oil seal are identical.*

1. Turn steering completely to right (full-lock).

2. Disconnect axle shaft from drive flange.

3. Push drive axle upward as far as possible and push drive axle upward and suspend with stiff wire.

***CAUTION—***
*Avoid damaging protective surface on the drive axle.*

4. Pry off cover in center of drive flange by piercing center of cover with screwdriver.

5. If replacing left-side oil seal, remove the road wheel. Also remove transmission support, where applicable. See Fig. 6, given earlier.

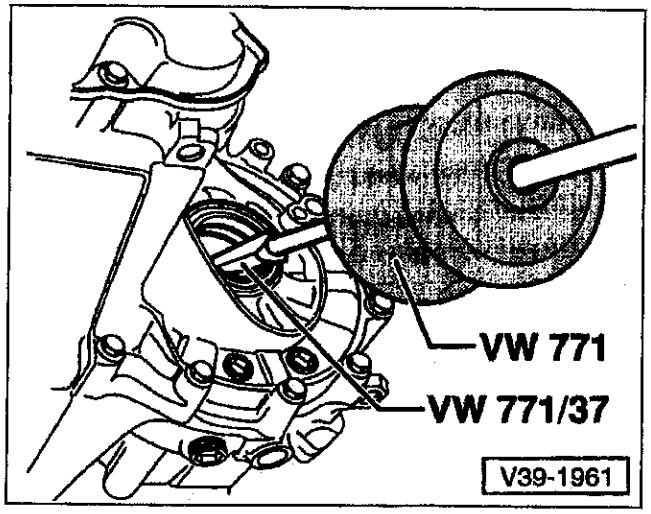
***NOTE—***
*For better access to the transmission support, disconnect coolant overflow reservoir and lay it to one side.*

6. Carefully remove drive flange retaining bolt.

***WARNING—***
*The drive flange is under spring force. Once the bolt is removed, the drive flange may release suddenly. Use extreme care when loosening the bolt.*

7. Place oil pan underneath and remove drive flange.

8. Remove oil seal from transmission housing. See Fig. 12.

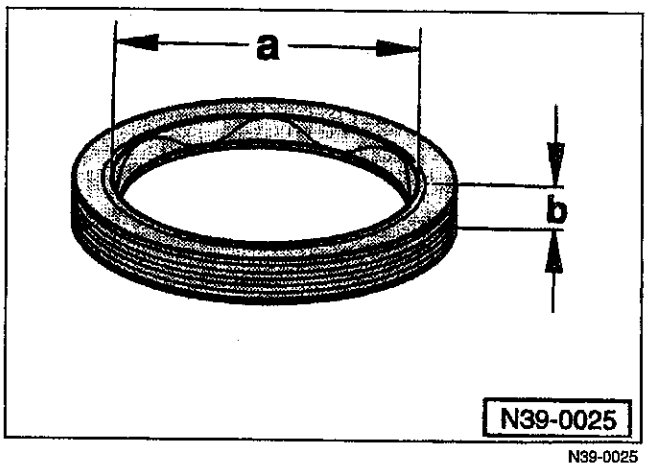



V39-1961

**Fig. 12.** Drive flange oil seal being removed using slide hammer and hooked adapter (Volkswagen special tool no. VW 771 and VW 771/37).

## Drive flange oil seal, installing (02A transmission–with springs)

Oil seal applications vary depending on drive flange version installed. The oil seal used on 02A transmissions with springs is shown in Fig. 13.



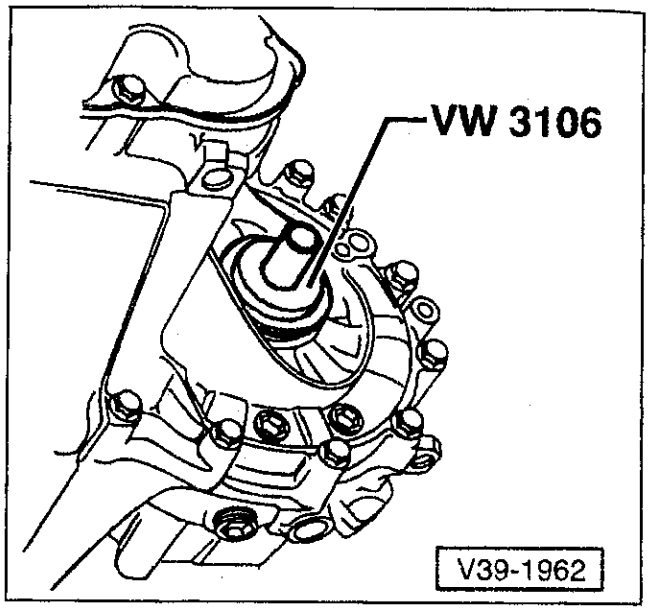

N39-0025

**Fig. 13.** Drive flange oil seal for 02A transmission with drive flange springs.

**Seal dimensions**

- Diameter (**a**) . . . . . 48.0 mm (1.890 in.)
- Height (**b**) . . . . . 6.8 mm (0.268 in.)

1. Fill space between lips of new oil seal with multi-purpose grease. Then drive seal in against shoulder. See Fig. 14.




V39-1962

**Fig. 14.** Drive flange oil seal being installed with seal driver (Volkswagen special tool no. VW 3106).

2. Install drive flange and flange retaining bolt.

**Tightening torques**

- Drive flange to differential housing . . . 25 Nm (18 ft-lb)

3. Press new sealing cover into center of drive flange.

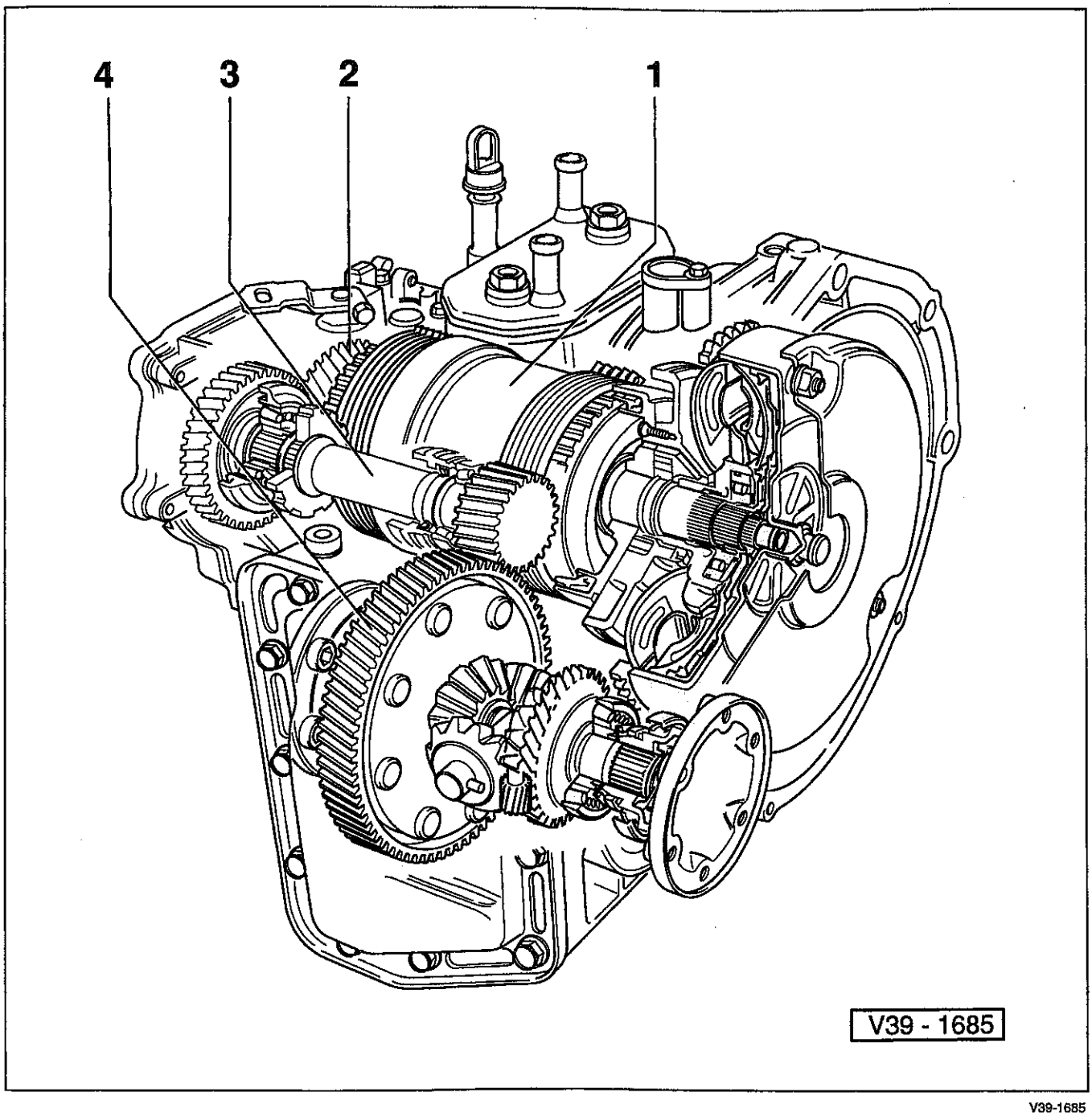
4. Additional tightening torques are given below. Be sure to check transmission oil level. See **0 Maintenance Program**.

**Tightening torques**

- Drive axle to axle flange . . . . . 45 Nm (33 ft-lb)
- Transmission support to transmission . . . . . 45 Nm (33 ft-lb)
- Transmission support to transmission mount . . . . . 50 Nm (37 ft-lb)
- Wheel to wheel hub . . . . . 110 Nm (81 ft-lb)

## AUTOMATIC TRANSMISSION

Fig. 15 shows a cutaway view of the final drive for 096 transmission. Unless otherwise stated, the repair procedures and specifications given under this heading apply to both the 096 and the 01M automatic transmissions.




V39-1685

**Fig. 15.** 096 automatic transmission shown, 01M is similar.

1. **Planetary gear set**
2. **Input gear**
3. **Drive pinion**
4. **Differential**

## Final drive oil level, checking (096 and 01M automatic transmission)

On cars with automatic transmission, the final drive oil level should be checked regularly as specified in **0 Maintenance Program**. It is checked by removing the speedometer drive gear from the transmission housing and using the drive gear as a dipstick. The car should be on a level surface when making the check.

***NOTE—***

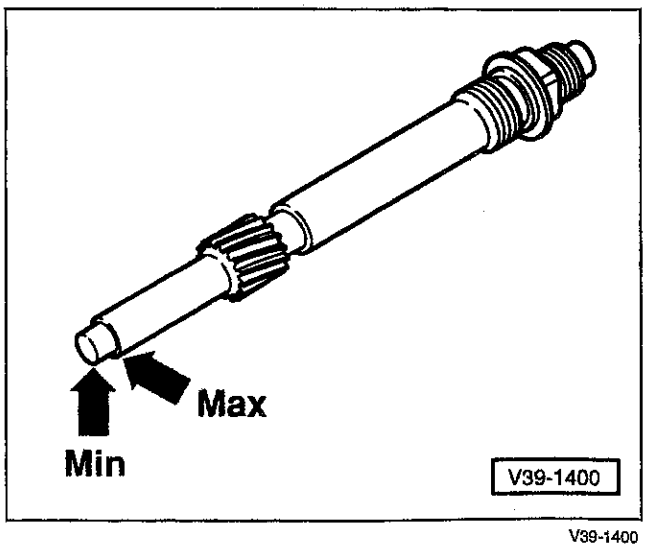
- *On cars with manual transmission, the final drive lubricant shares a common bath with the transmission lubricant. Checking the final drive/transmission lubricant is covered in* **0 Maintenance Program.**
- *Volkswagen does not specify a final drive lubricant replacement interval. If the fluid needs to be drained, it can be drawn off using a fluid extraction/pumping system.*

1. Remove harness connector from speedometer drive gear. Then unscrew drive gear from differential housing.

***NOTE—***

*The speedometer drive gear is mounted through the top left-hand side of the transmission, above the final drive end cover.*

2. Clean speedometer drive gear using a clean cloth. Then install and remove speedometer drive gear to check the oil level. See Fig. 16.




V39-1400

**Fig. 16.** Speedometer drive gear used to check final drive oil level. Level should be between **Min** and **Max** marks.

3. Add lubricant as necessary. Reinstall drive gear.

***NOTE—***

*The difference between the "Min" and "Max" marks on the speedometer drive gear is approx. 0.1 liter (3.4 fl. oz.).*

***CAUTION—***

*Use only genuine VW ATF in the 01M transmission. Use of other ATF types can adversely affect the service life of the transmission.*

**Lubricant and capacity**

- **096 automatic transmission final drive**
  lubricant . . . . . SAE 75W/90 synthetic gear oil
  capacity . . . . . 0.75 L (0.79 qt.)
- **01M automatic transmission final drive**
  lubricant . . . . . Genuine VW Synthetic ATF
  capacity . . . . . 0.75 L (0.79 qt.)

## Drive flange oil seal, removing and installing (096 and 01M automatic transmission)

1. If replacing right-hand oil seal, first remove the heavy metal balance weight from body. Then disconnect drive axle from drive flange. Set drive axle to one side and hold axle in place using stiff wire.

2. If replacing left-hand oil seal, first disconnect drive axle from drive flange. Then proceed as follows:
   - mark position of ball joint to control arm
   - remove bolts **A**, loosen bolt **B**. See Fig. 17.
   - turn steering to right lock.

3. Swing ball joint out and place left-hand drive shaft to one side.

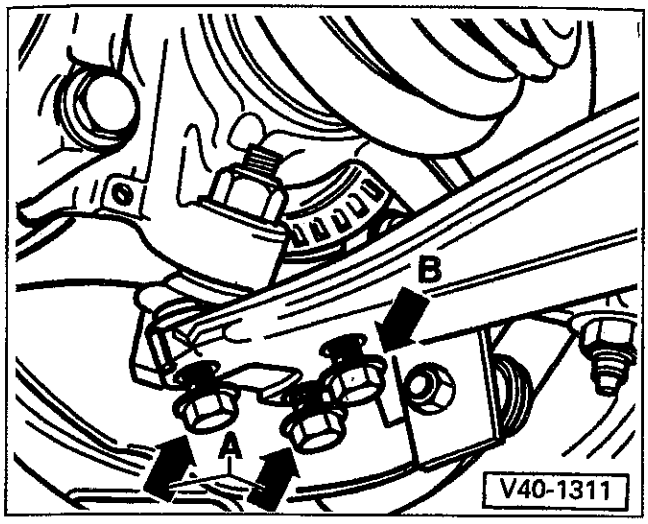
4. Pry off cover in center of drive flange by piercing center of cover with screwdriver.

5. Mount press tool to drive flange. See Fig. 18. Screw threaded rod (M10) into axle shaft. Then turn nut on tool clockwise to compress spring.

***WARNING—***

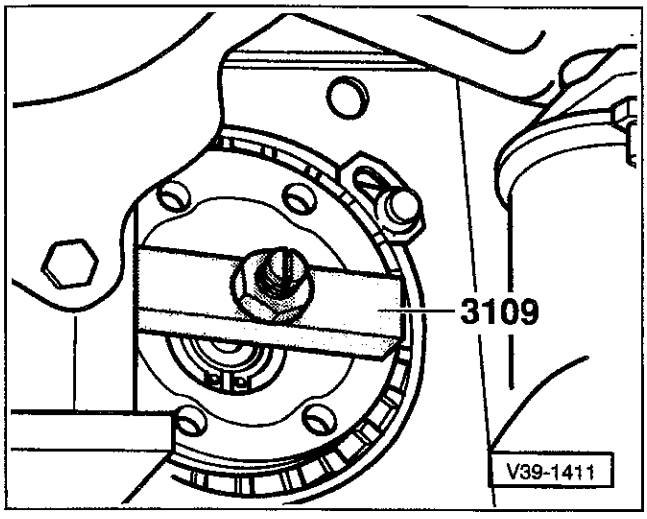
*The drive flange is under spring force. Once the circlip is removed, the drive flange may release suddenly. Use extreme care when removing the circlip.*

6. Remove circlip and spring (dished) washer. Note orientation of washer before removing.




V40-1311

**Fig. 17.** Ball joint mounting bolts. Loosen bolt (**B**) and remove bolts (**A**).



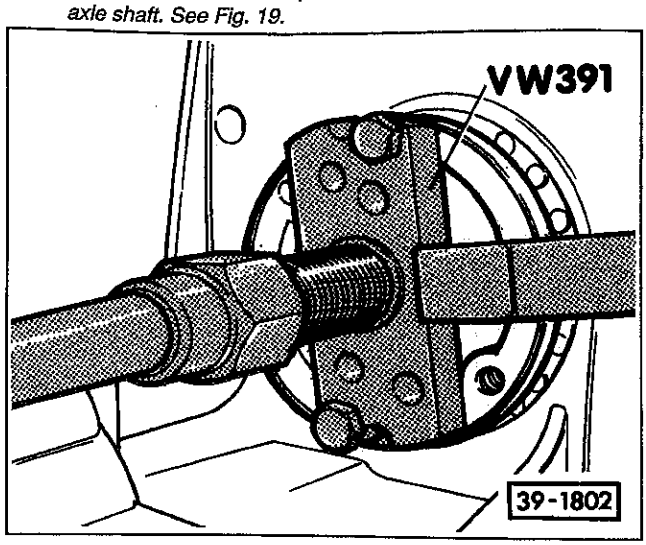

V39-1411

**Fig. 18.** VW special tool no. 3109 being used to compress spring behind drive flange so that circlip can be removed.

7. Remove press tool, drive flange, and spring.

***NOTE—***

*If the drive flange does not release easily, use VW special tool no. VW 391 to press the drive flange off the axle shaft. See Fig. 19.*




39-1802

**Fig. 19.** VW special tool no. VW391 being used to press drive flange off axle shaft.

8. Carefully drive new seal into position. Fill space between new oil seal and dust lip with multi-purpose grease.

9. Install drive flange with spring. Then pull drive flange into position using VW special tool no. 3109 or equivalent. See Fig. 18, given earlier.

***NOTE—***

*Install dished washer so that the concave faces in, toward the differential.*

10. Seal drive flange using a new sealing cover.

11. Install drive axle. Reconnect ball joint to control arm. Tightening torques are given below.

12. Check final drive oil level as described earlier.

**Tightening torques**

- Drive axle to drive flange . . . . . 45 Nm (33 ft-lb)
- Ball joint to control arm . . . . . 35 Nm (26 ft-lb)

# 4 Suspension, Brakes, and Steering



## GENERAL

This general information group covers application information and system descriptions for the repair groups listed under **4 Suspension, Brakes, and Steering.**

## SUSPENSION

Volkswagen Jetta, Golf, GTI and Cabrio models are equipped with a strut-type independent front suspension and a torsion-type rear axle beam with trailing arms. The front suspension struts are integral spring and shock absorber units, while the rear suspension has separate shocks mounted inside the coil springs. This type of suspension system provides excellent steering and handling in a compact size with comparatively light weight.

Two suspension systems are used on the Jetta, Golf, GTI and Cabrio models. The "base" suspension is used on most 4-cylinder models, while the "plus" suspension is used on the more performance oriented 6-cylinder models. The plus suspension features larger anti-sway bars and brakes, different front struts, and five lug wheels (the base suspension uses four lug wheels).

### Front suspension

Fig. 1 shows a system view of the front suspension. The front suspension struts have been designed to provide a negative steering roll radius. That is, the steering axis of each strut intersects the road surface at a point outboard of the wheel's vertical centerline. This geometry tends to steer the car automatically in the direction of a skid caused by unequal front wheel traction. Conventional front suspension geometry, which places the steering axes inboard of the tire centerlines, tends to steer the car in the opposite direction, thereby increasing the severity of the skid.

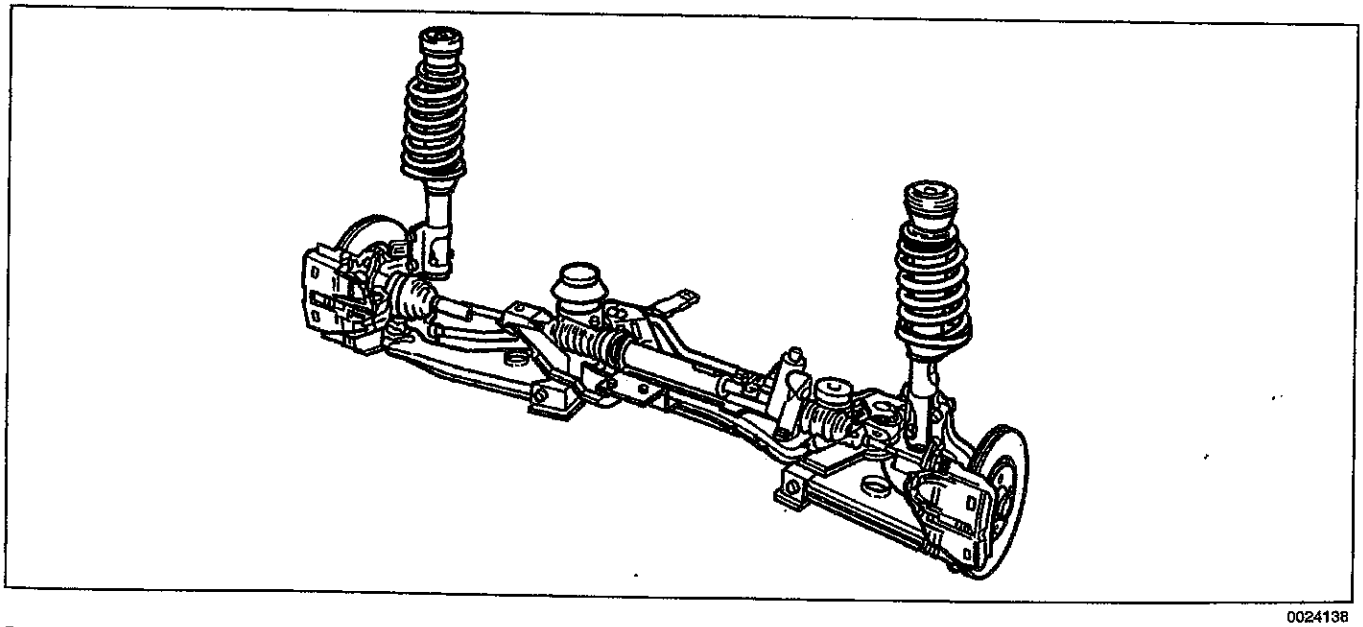


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**Fig. 1.** Front suspension.

The front suspension struts and control arms can be disassembled for repair, but much of this work requires special tools and experience. If you lack the skills, tools, or a suitable workshop for suspension work, we suggest you leave such repairs to an authorized Volkswagen dealer or other qualified repair shop. Please consult your Volkswagen dealer before beginning any repairs on a car that may be subject to warranty coverage. **Table a** contains suspension technical data

## Rear suspension

The rear suspension has been designed for low unsprung weight, easy replacement of springs and shock absorbers, and good ride and handling qualities. A "V" profile independent torsion beam rear axle with integral trailing arms and sway bar is used on both the base and sport suspension models. The advantage of this design is that rear wheel camber and toe remain virtually unaffected by suspension movement. The torsion beam rear axle is mounted to the vehicle with track-correcting bushings. These bushings are asymmetrically shaped and minimize steering effect from the rear wheels during cornering. The rear axle beam is somewhat flexible. Uneven rear suspension loads cause the axle beam to twist slightly, thus acting as a stabilizer bar. This suspension design yields many desired performance benefits.**Table a** contains suspension technical data and Fig. 2 shows the rear suspension components.

**Table a. Suspension technical data**

| Model | | Golf/Jetta/Cabrio with base suspension | GTI/Jetta GLX with Plus suspension |
|---|---|---|---|
| Wheelbase | mm (in.) | 2475 (97.44) | |
| Front track (unladen) | mm (in.) | 1478 (58.19) - wheel offset 38mm<br>1464 (57.64) - wheel offset 45mm | 1460 (57.48) - wheel offset 38mm<br>1450 (57.09) - wheel offset 43mm |
| Rear track (unladen) | mm (in.) | 1460 (57.48) - wheel offset 38mm<br>1446 (56.93) - wheel offset 45mm | 1442 (56.77) - wheel offset 38mm<br>1432 (56.38) - wheel offset 43mm |
| Turning circle | meters (feet) | 10.7 (35.1) | 11.0 (36.1) |
| Steering roll radius (negative) | mm (in.) | 3.2 (0.126)- wheel offset 38mm<br>10.2 (0.402) - wheel offset 45mm | 13.8 (0.543) - wheel offset 38mm<br>18.8 (0.740) - wheel offset 43mm |
| Wheel lock angle | inner<br>outer | 38°<br>34° | 37°<br>34° |
| Ground clearance at permitted total weight | mm (in.) | 123 (4.84) | 103 (4.06) |

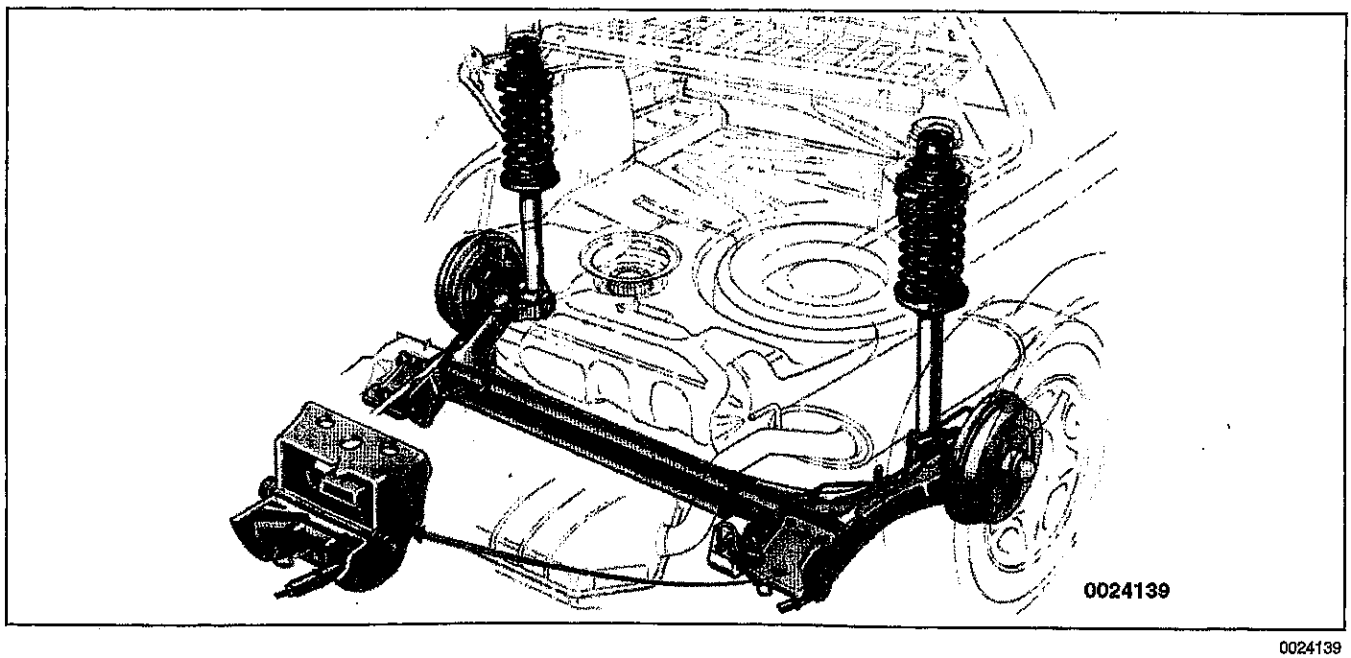


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**Fig. 2.** Phantom view of rear suspension with detail of track-correcting bushing.

## Wheels

Various tire and wheel combinations are available for use on the models covered by this manual. Different wheel offsets ensure that the tire and wheel combinations are flush with the vehicle body contours. The wheel offset affects front and rear track, and steering roll radius. Some of the tire/wheel combinations available from Volkswagen are listed in **Table b**.

**Table b. Tire/wheel Combinations**

| Model | Wheel | Tire | Offset (mm) |
|---|---|---|---|
| CL | 5.5 x 13 steel | 175 x 70 | 38 |
| GL, GLS (early production w/manual transmission) | 6J x 14 steel/alloy | 185 x 60 R14H | 45 |
| GL, GLS, Cabrio, TDI, K2, TREK, Wolfsburg Limited Edition, Sport, GTI (4 cyl.), | 6Jx 14 steel/alloy | 195 x 60 R14H | 45 |
| VR-6 GTI, GLX | 6.5J x 15 alloy | 205 x 50 R15V | 43 |

## Brakes

The Jetta, Golf, GTI, and Cabrio models are equipped with several different brake systems. All models have a dual diagonal hydraulic brake system with a load dependent brake pressure regulator located on the left side of the rear axle. The brake pressure regulator controls the amount of brake pressure to the rear wheels. **Table c** provides dimensions and technical data for the various brake systems.

VR6 models come standard with an anti-lock brake system (ABS). This is a three channel system which permits individual control of the front wheel and a joint "select low" control of the rear wheels. There is also a vacuum booster that will allow the brakes to operate conventionally with vacuum power assistance if the hydraulic pump should fail.

In addition to ABS, VR6 models also come with a low speed traction control system (Electronic Differential Lock or EDL). The traction control works in conjunction with the ABS system by applying the front brakes to control wheel spin during low speed acceleration. By controlling wheel spin when the vehicle is starting to move from a stop, more power can be transmitted from the vehicle to the road surface. This increases traction and vehicle control when starting off in slippery conditions. Fig. 3 shows the system layout for the anti-lock brake and traction control systems.

**Table c. Brake Technical Data**

| Engine/version | | 1.8/1.9 Liter CL, GL | 1.9/2.0 Liter GL, GLS, Cabrio, TDI, K2, TREK, Wolfsburg Limited Edition, Sport, GTI (4 cyl.) | 2.8 Liter VR6 GTI, GLX |
|---|---|---|---|---|
| Front brake disc | diameter – mm (in.) | 239 (9.41) | 256 (10.08) | 280 (11.02) |
| Front brake disc thickness | mm (in.) | 12 (0.47) | 20 (0.79) | 22 (0.87) - thru 12/94<br>25 (0.99) - from 1/95 |
| Front brake disc wear limit | mm (in.) | 10 (0.39) | 18 (0.71) | 20 (0.79) - thru 12/94<br>23 (0.90) - from 1/95 |
| Front brake pad thickness | mm (in.) | 14 (0.55) | | |
| Front brake pad wear limit | mm (in.) | 7 (0.28) including backing plate | | |
| Rear brake drum (if applicable) | diameter – mm (in.) | 200 (7.87) | | (not applicable) |
| Rear brake lining thickness (if applicable) | mm (in.) | 5 (0.20) | | (not applicable) |
| Brake lining width (if applicable) | mm (in.) | 40 (1.57) | | (not applicable) |
| Rear brake disc thickness (if applicable) | mm (in.) | – | 10 (0.39) | |
| Rear brake pad thickness (if applicable) | mm (in.) | – | 12 (0.47) | |

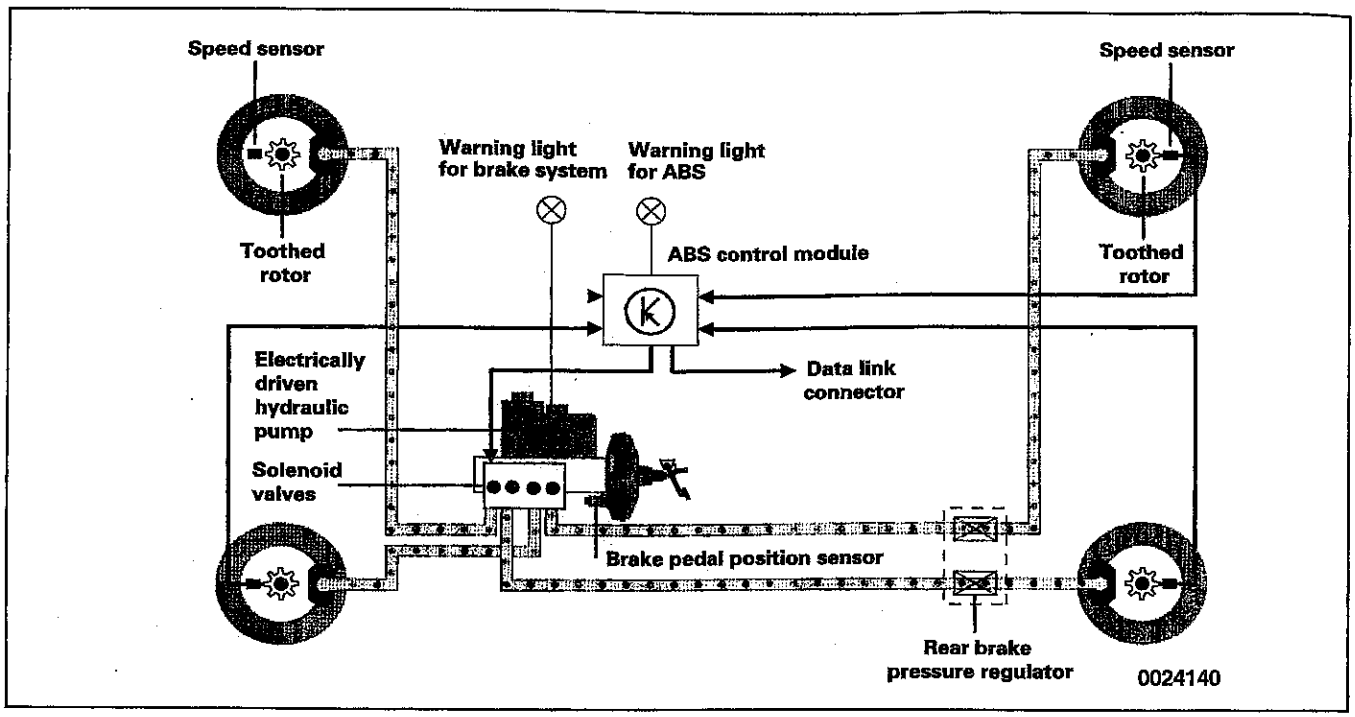


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**Fig. 3.** System layout for ABS and traction control used on VR6 models.

## Steering

Power assisted rack and pinion steering is standard on all models covered by this manual. The power steering pump is a vane type pump. The hydraulic (power steering fluid) oil is a mineral based oil. The reservoir for the power steering pump has been designed with a long filler neck for easy access.

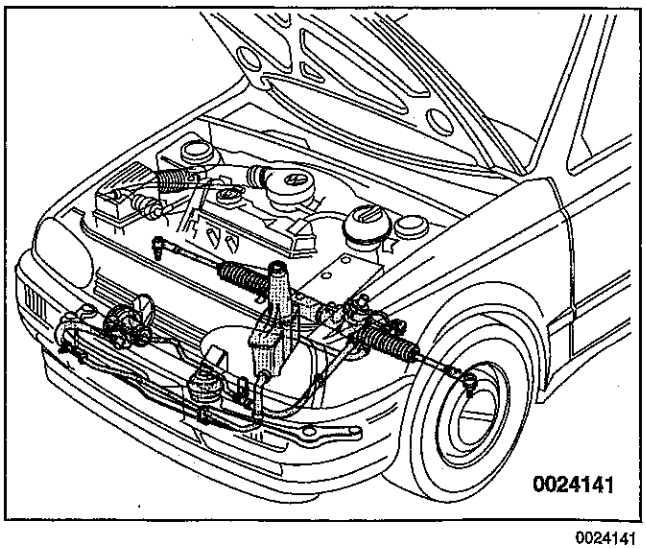


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**Fig. 4.** Power-assisted, rack and pinion steering system.

***NOTE—***
*For power steering fill capacity, see* **0 Maintenance Program.**

The steering column is connected to the steering gear by a universal joint shaft. The universal joint shaft is angled in order to prevent collision impacts from forcing the steering wheel toward the driver. The steering wheel is energy absorbing and acts as a crumple zone. The steering column can retract as much as 170 mm (6.7 in.).

### Table d. Steering Specifications

| Model | Golf, GTI, Jetta, Cabrio |
|---|---|
| Steering gear | Power-assisted |
| Steering wheel turns, lock-to-lock | 3.17 |
| Overall steering ratio | 17.5:1 |

***NOTE—***
*For wheel alignment specifications see* **44 Wheels–Tires, Wheel Alignment.**

# 40 Front Suspension and Drive Axles





## GENERAL

Special tools and procedures are required for most front suspension repair and component replacement. In addition, front wheel alignment is almost always disturbed when suspension components are removed or replaced.

For general information on front and rear suspension operation, see **4 General Information.** For rear suspension servicing and repair information, see **42 Rear Suspension.** For wheel alignment specifications see **44 Wheels–Tires, Wheel Alignment.**

Most cars covered by this manual are equipped with the "base" front suspension, while the more performance-oriented cars are equipped with the "plus" suspension. Cars with the "plus" suspension system can be identified by the five-lug wheels (base suspension uses four-lug wheels) and ventilated front brake rotors.

***WARNING —***
- *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, cotter pins. For replacements, always use new parts.*

***WARNING —***
- *Do not reinstall bolts and nuts coated with undercoating wax as correct tightening torque cannot be ensured. Always clean the threads of removed bolts and nuts with a solvent before installation, or replace them with new parts.*

## SUBFRAME AND CONTROL ARMS

Fig. 1 shows an exploded view of the front subframe and related parts. The control arm is mounted in replaceable rubber bushings that are subject to wear. The subframe supports the weight of the engine/transmission assembly. Note that the engine assembly must be supported before removing the subframe.

***WARNING —***
- *Always replace self-locking nuts.*
- *Always replace corroded bolts, nuts, washers.*
- *DO NOT attempt to straighten or weld suspension strut, wheel bearing housing, control arm or any other wheel locating or load bearing components of the front suspension.*

## Subframe/stabilizer bar/control arm, assembly

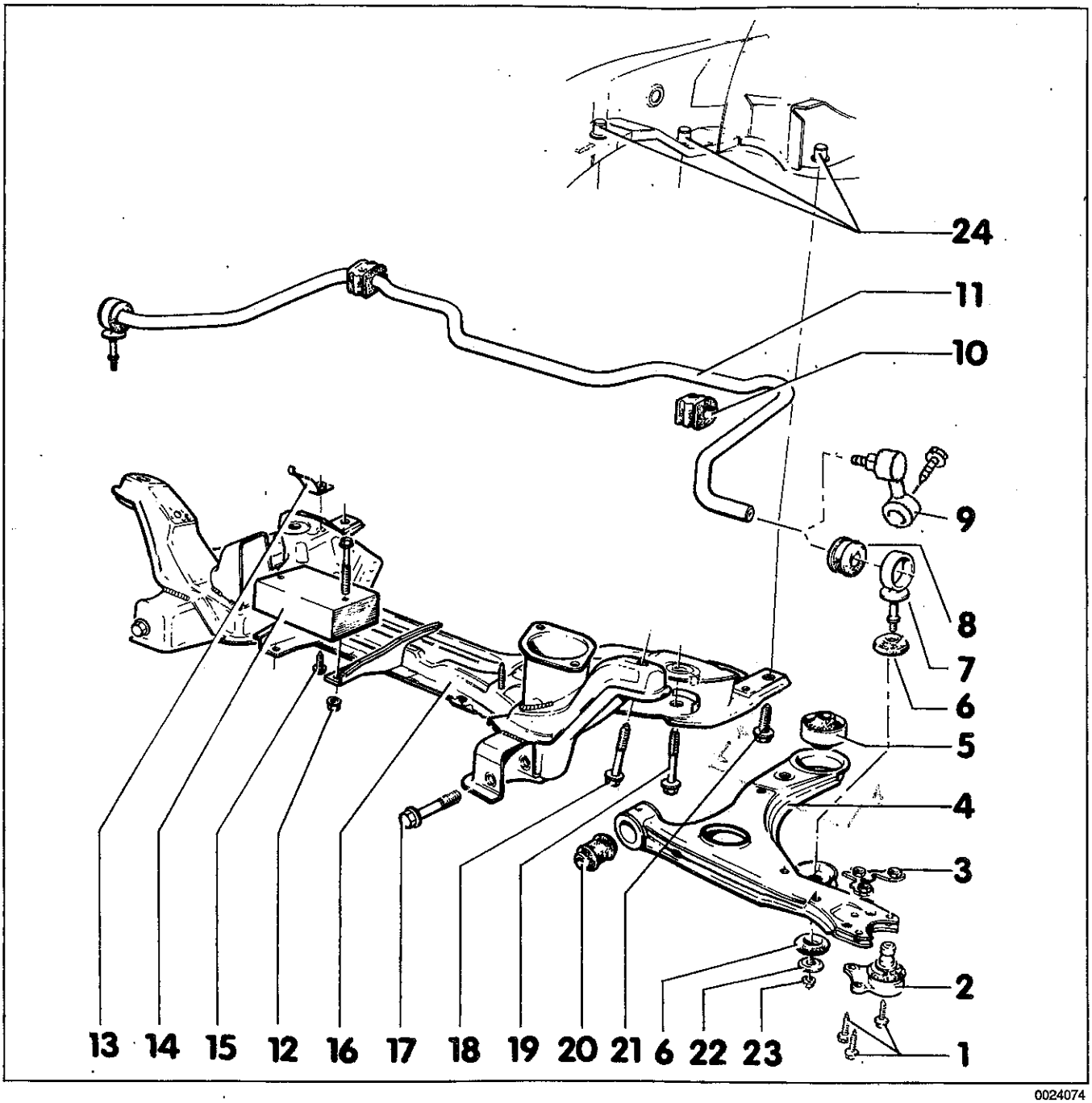



**Fig. 1.** Exploded view of subframe, stabilizer bar, and control arm.

> ***CAUTION —***
> *If a vehicle has to be moved (rolled) after removing the drive axle, install an outer constant velocity joint into the wheel hub and tighten to 50 Nm (37 ft-lb) to prevent damage to wheel bearing.*

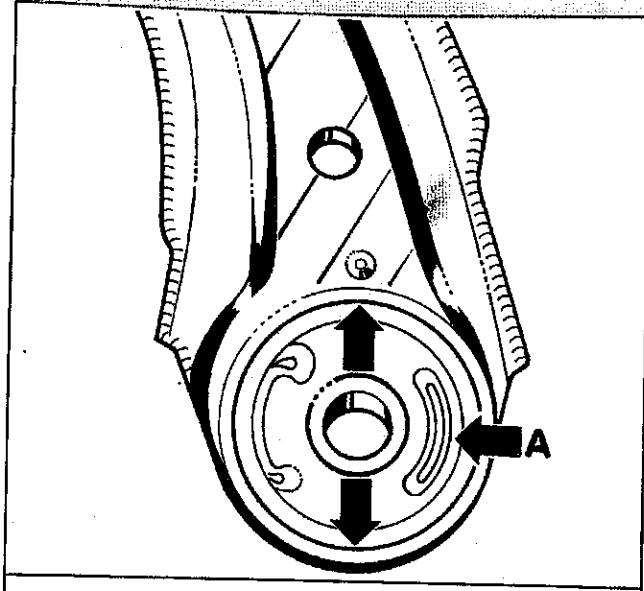
1. **Bolts**
   Tighten to 35 Nm (26 ft-lb)

2. **Ball joint**
   - Checking, see **Ball joint, checking**
   - Mark installation position before removing
   - If replacing, install part centered in elongated hole and align front end
   - Elongated holes are NOT intended for camber adjustment

3. **Mounting plate**

4. **Control arm**
5. **Rear bushing for control arm**
   - Installed position, **see** (A)
   - Pressing out/in, **see** (B)
6. **Link rod bearing (base suspension only)**
   - Conical side faces control arm
7. **Link rod (base suspension only)**
8. **Rubber mounting (base suspension only)**
   - Coat with lubricant (e.g. soft soap) before pressing in
9. **Link rod (plus suspension only)**
10. **Stabilizer bar mounting**
11. **Stabilizer bar**
    - Diameter varies depending on system installed
12. **Nut**
    - Tighten to 25 Nm (18 ft-lb)
13. **Clamp**
14. **Vibration damper**
15. **Bolt**
    - Tighten to 25 Nm (18 ft-lb)
16. **Subframe**
    - Support weight of engine before removing, **see** (C)
    - After installing:
      - align engine and transmission assembly. See **10 Engine-Removing and Installing.**
      - align front wheels if steering gear/subframe attachment has been loosened. See **44 Wheels–Tires, Wheel Alignment**
17. **Bolt**
    - M12 x 1.5 x 82
    - Tighten to 50 Nm (37 ft-lb) plus 1/4 turn (90°)
18. **Bolt**
    - M12 x 1.5 x 65
    - Tighten to 70 Nm (52 ft-lb) plus 1/4 turn (90°)
19. **Bolt**
    - M12 x 1.5 x 78
    - Tighten to 70 Nm (52 ft-lb) plus 1/4 turn (90°)
20. **Front bushing for control arm**
    - Press in/out using hydraulic press
    - **Installing, see** (D)
21. **Bolt**
    - Tighten to 65 Nm (48 ft-lb)
22. **Washer (base suspension only)**
    - Collar faces away from control arm
23. **Nut (base suspension only)**
    - Tighten to 25 Nm (18 ft-lb)
24. **Cap nut**

**(A) Rear bushing for control arm, installed position**

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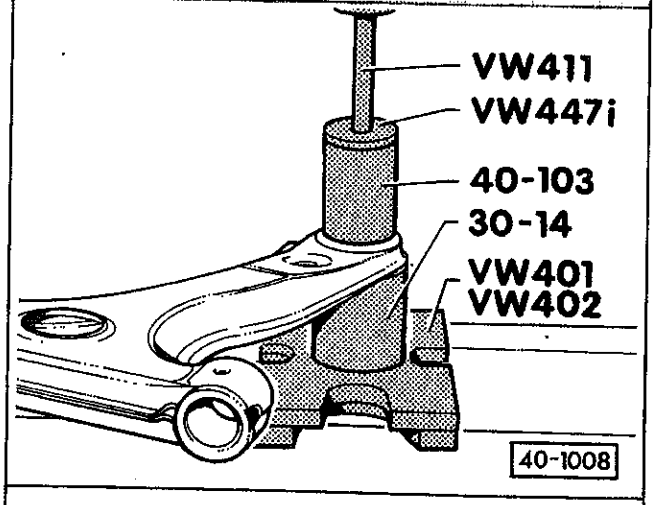
- **One of two arrows on bushing must point toward recess in control arm.**
- **Kidney shaped opening (arrow A) must point toward center of vehicle.**

**(B) Rear bushing for control arm, pressing out/in**

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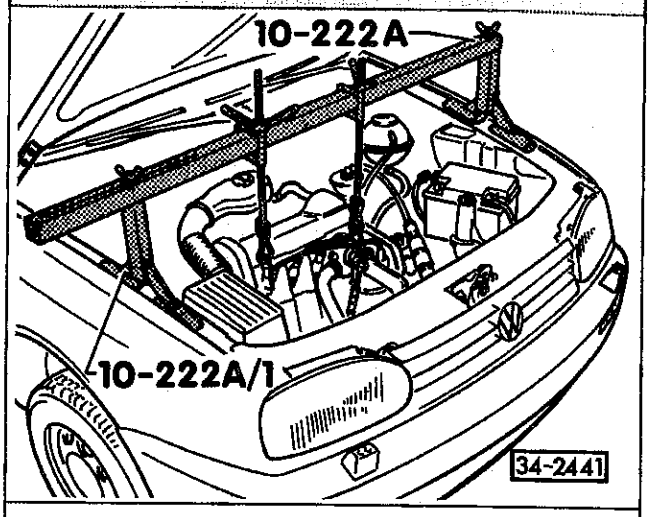
- **Press the bushing using Volkswagen special tools as shown, or equivalent.**
- **Installed position, see** (A) **above**

**C** **Supporting engine/transmission assembly for subframe removal**

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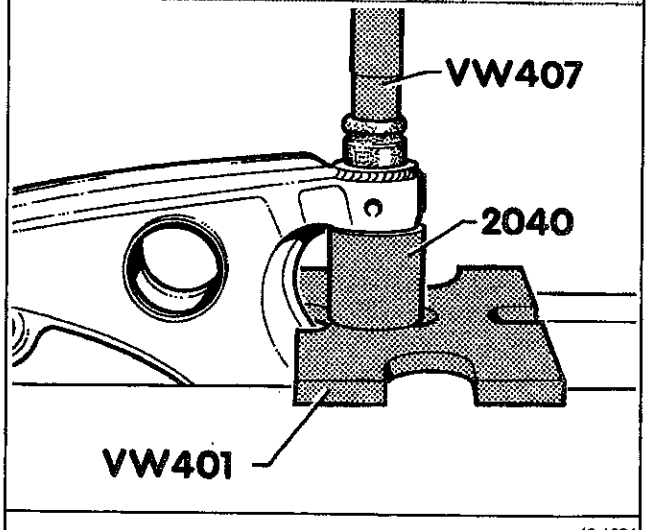
- **Before removing subframe support engine/transmission assembly using Volkswagen special tools 10-222A and 10-222A/1, or equivalent.**

**D** **Front control arm bushing, installing**

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- **Before installing front bushing coat with an acid-free lubricant (e.g. soft soap). Install using a hydraulic press and Volkswagen special tools as shown.**

## Ball joint, checking

The ball joint can be checked for wear by checking for side-to-side and up-down play in the joint.

1. Check the ball joint axial (up-down) play as shown in Fig. 2. Replace the joint if any play is present.

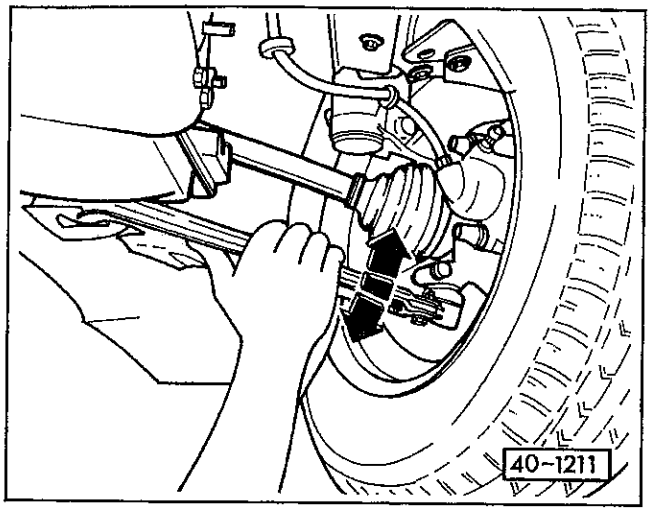


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**Fig. 2.** Ball joint axial play being checked. Push/pull control arm (**arrows**) to check for play.

***NOTE—***

*When checking ball joint wear, be sure to consider wheel bearing and upper strut mount play before condemning the ball joint.*

2. Check ball joint radial (side-to-side) play as shown in Fig. 3. Replace the joint if any play is present.

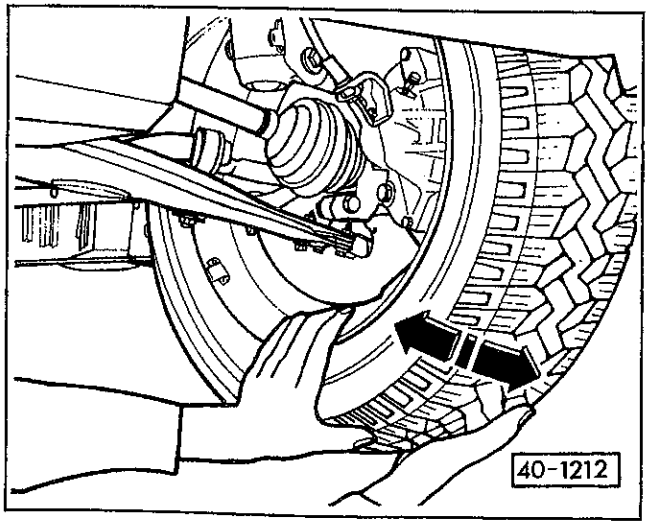


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**Fig. 3.** Ball joint radial play being checked. Push/pull lower part of wheel (**arrows**) to check for play.

## Ball joint, removing and installing

Replacement of the ball joint affects front wheel alignment. Be sure to have the front wheels aligned as the final step in the job.

1. Disconnect drive axle from transmission drive flange. See **Drive Axles.**

2. Mark the installed position of the ball joint in relation to the control arm. Then remove ball joint bolts. See Fig. 4.

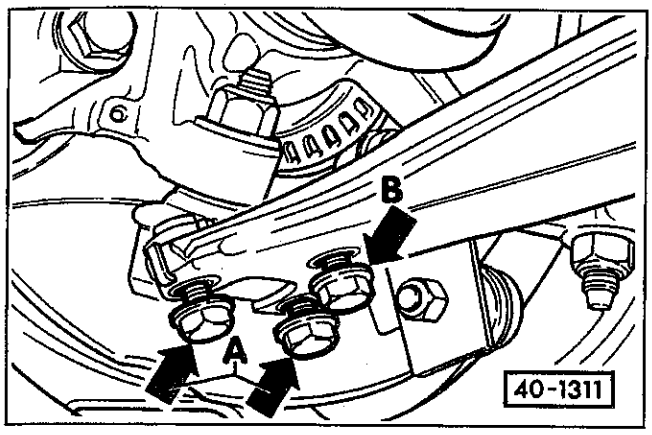


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**Fig. 4.** Ball joint mounting bolts (**arrows**). Mark installed position of ball joint to control arm before loosening bolts.

3. Separate ball joint from control arm.

4. Swing wheel and suspension strut outwards and support in position using a block of wood, or equivalent.

5. On cars with base suspension, remove the ball joint clamping nut and bolt. Remove the ball joint from the wheel bearing housing.

6. On cars with plus suspension, loosen the nut on top of the ball joint, but do not fully remove it. Press the ball joint loose. Remove the press and the ball joint. See Fig. 5.

> ***CAUTION —***
> *Use care when pressing the ball joint out of the wheel bearing housing. Once the ball joint breaks loose, the press will want to fall to the ground.*

7. Installation is the reverse of removal. Use a new self-locking nut at the wheel bearing housing. Make sure the matching marks made earlier are exactly aligned before tightening bolts. Check and adjust front wheel alignment.

> ***NOTE —***
> *On cars with plus suspension, use a 6mm hex key to counter hold the ball joint shaft when tightening the self-locking nut.*

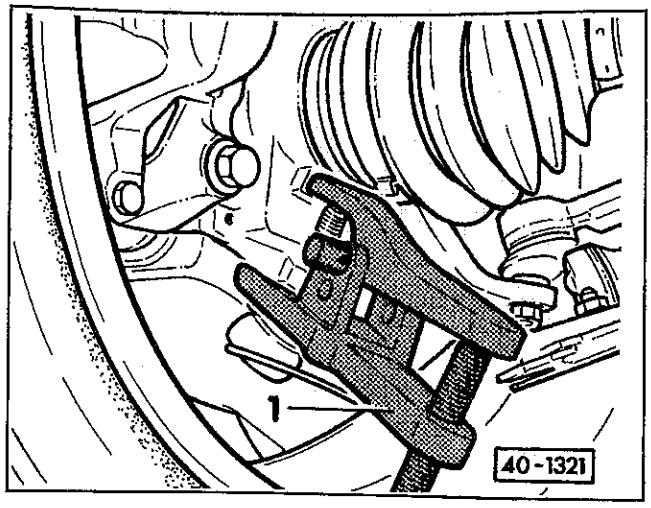


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**Fig. 5.** Ball joint being pressed out of wheel bearing housing on cars with plus suspension.

**Tightening torques**

- Ball joint to wheel bearing housing
  base suspension . . . . . 50 Nm (37 ft-lb)
  plus suspension. . . . . 45 Nm (33 ft-lb)
- Ball joint to control arm. . . . . 35 Nm (26 ft-lb)

## WHEEL BEARINGS

Removal and/or replacement of the front wheel bearings requires special tools. Note that the wheel is bearing is destroyed any time it is removed. Fig. 6 shows an exploded view of the front wheel bearing housing.

Observe the safety cautions before repairing or servicing the wheel bearing housing or any of its related parts.

> ***WARNING —***
> - *DO NOT attempt to straighten or weld suspension strut, wheel bearing housing, control arm or any other wheel locating or load bearing components of the front suspension.*
> - *Always replace self-locking nuts. Replace any corroded bolts, nuts, washers.*
> - *Wheel alignment must be checked and adjusted if ball joint or front strut assembly is removed.*
> - *If a vehicle has to be moved (rolled) once the drive axle is removed, install the outer CV joint into the wheel bearing housing and tighten the retaining nut to 50 Nm (37 ft-lb) to prevent damage to the wheel bearing.*

## Front wheel bearing housing, assembly

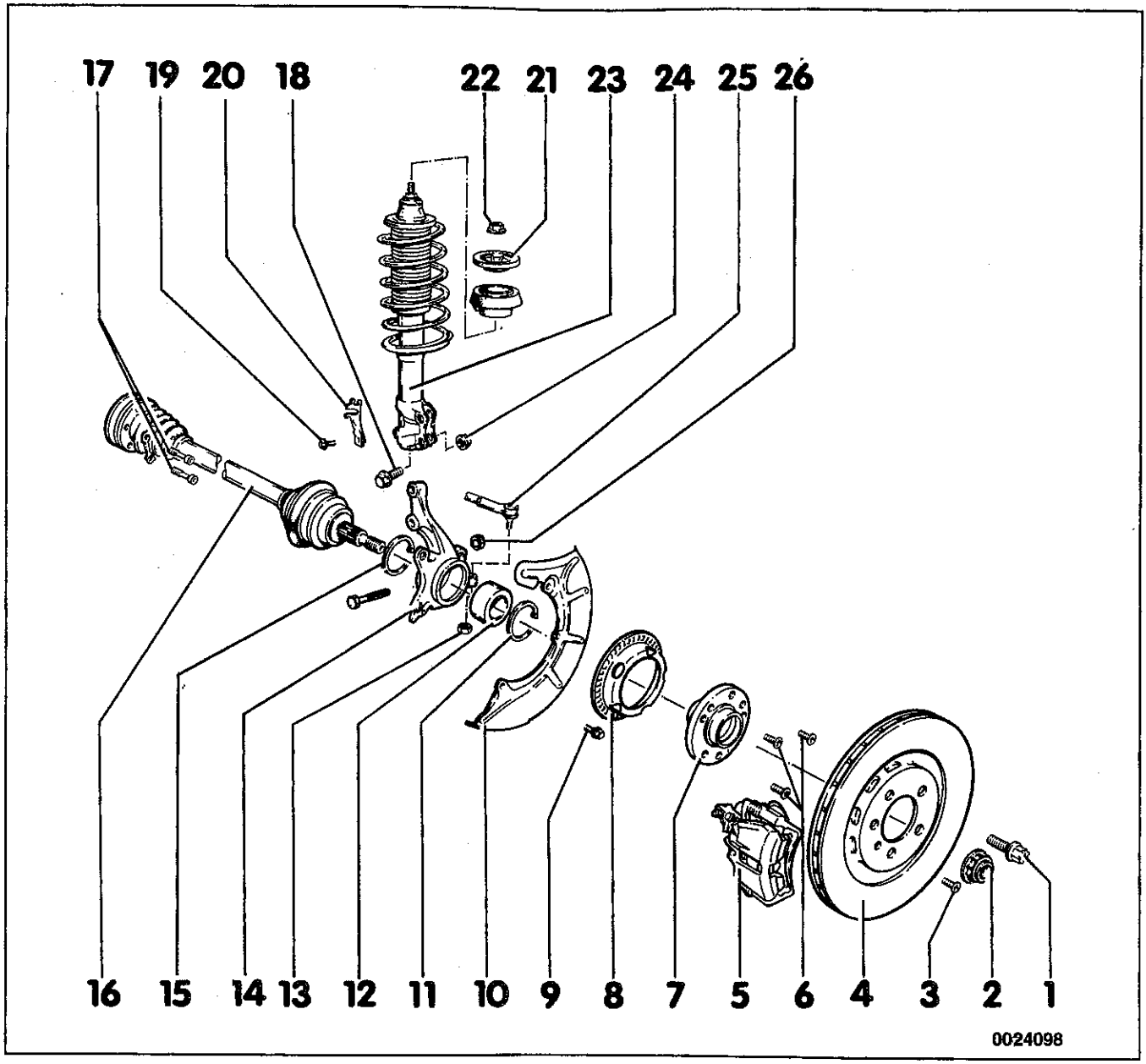


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**Fig. 6.** Front wheel bearing housing and related components. Note ventilated rotor and ABS wheel speed rotor used on cars with plus suspension.

1. **Lug bolt**
   - Tighten to 110 Nm (81 ft-lb)
2. **Nut**
   - Special tightening procedures apply–See **Drive Axle**
3. **Screw**
4. **Brake Rotor**
   - See **46 Brakes–Mechanical Components**
5. **Brake Caliper**
   - Do not loosen/open hydraulic brake connections when servicing suspension
   - Do not let caliper hang by hose; hang from body using stiff wire.
6. **Screw**
7. **Wheel hub**
   - Removing/installing, see **Wheel bearing, removing and installing**

8. **Rotor for ABS wheel speed sensor**
   - Only for vehicles with ABS
9. **Bolt**
   - Tighten to 10 Nm (89 in-lb)
10. **Splash shield**
11. **Circlip, outer**
    - always replace
12. **Wheel bearing**
    - Always replace (wheel bearing is destroyed when removed)

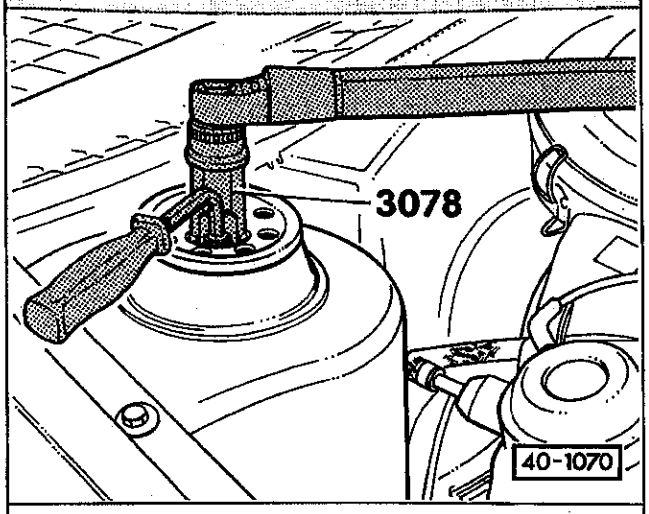
> ***CAUTION—***
> *Always replace wheel bearing after removing. It is destroyed during removal.*

13. **Nut**
    - Tighten to 35 Nm (26 ft-lb)
14. **Wheel bearing housing**
15. **Circlip, inner (base suspension only)**
    - always replace
16. **Drive axle**
    - Removing, installing, repairing, see **Drive Axle**
    - Clean paint residue and corrosion on threads of outer CV joint before nut (2) is installed
17. **Bolt**
18. **Bolt**
    - Mark installed position before loosening nut (22). See **44 Wheels–Tires, Wheel Alignment**
19. **Bolt**
20. **Bracket**
21. **Stop**
22. **Nut**
    - Loosening/tightening, **see** (A)
    - Tighten to 60 Nm (44 ft-lb)
23. **Suspension strut**
    - Removing, installing, disassembling, see **Front Suspension Struts**

> ***WARNING—***
> DO NOT disassemble strut assembly without spring compressor tools designed for the purpose. See **Front Suspension Struts.**

24. **Nut**
    - Mark position of bolt (18) before loosening
    - Tighten to 95 Nm (70 ft-lb)
25. **Tie rod**
    - Removing/installing, see **48 Steering**
26. **Nut (base suspension only)**
    - For ball joint clamping bolt
    - Tighten to 50 Nm (37 ft-lb)

(A) **Front strut, top mount**

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- **Loosening strut to body mount using Volkswagen special tool 3078, or equivalent.**

## Wheel bearing, removing and installing

The front wheel bearing is a permanently lubricated, sealed, double row ball bearing. The wheel bearing is pressed into the wheel bearing housing and held in place with a circlip(s). The wheel hub is in turn pressed into the wheel bearing.

> ***CAUTION—***
> - *Wheel bearing replacement requires the use of a hydraulic press and other specialized tools. Read the procedure through to determine what tools will be necessary.*
> - *Removal of the wheel hub destroys the wheel bearing. If wheel hub is removed, the wheel bearing must be replaced.*
> - *Wheel bearing replacement alters front wheel alignment. The wheels must be professionally aligned any time the wheel bearing housing is removed.*

1. Remove front brake caliper, pads and brake rotor. See **46 Brakes–Mechanical Components.**
2. On cars with ABS, remove ABS wheel speed sensor.
3. Remove drive axle from wheel bearing housing. See **Drive Axles.**

4. Remove suspension strut and steering tie rod end from the wheel bearing housing and remove the housing. See Fig. 6.

5. Using press equipment, press wheel hub out of wheel bearing.See Fig. 7.

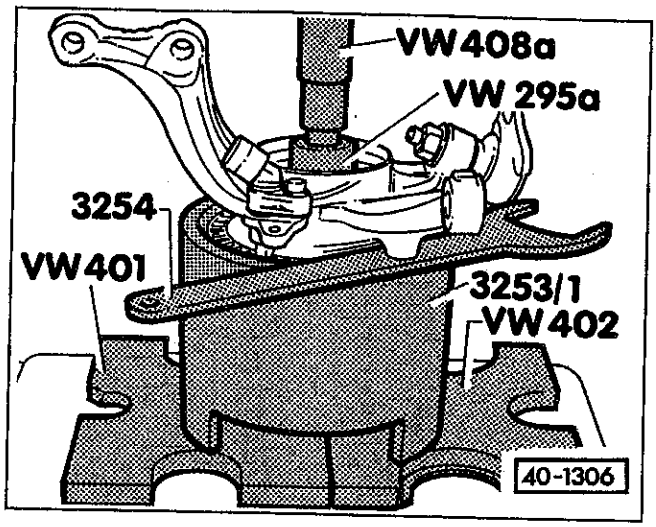


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**Fig. 7.** Wheel hub being pressed out of wheel bearing. Numbers indicate Volkswagen special tools. Wheel bearing housing for plus suspension shown.

6. Pull inner wheel bearing race off wheel hub. See Fig. 8.

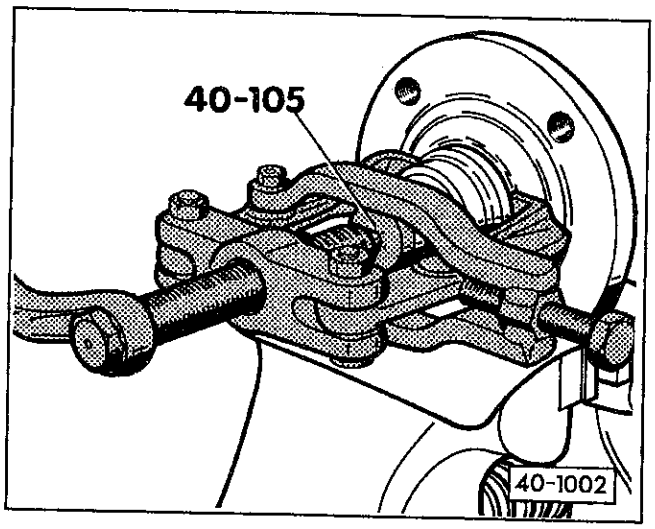


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**Fig. 8.** Wheel bearing inner race being removed from wheel hub with puller and adapter.

7. Remove circlip(s) from wheel bearing housing (See Fig. 6, given earlier). Press wheel bearing out of housing.

***NOTE—***
*Cars with base suspension use two circlips; cars with plus suspension use only one circlip.*

8. Clean wheel bearing housing bearing surface and oil lightly.

9. Install new inner circlip (if applicable).

> ***CAUTION—***
> *DO NOT re-use circlips.*

10. Using a hydraulic press and adapters, press wheel bearing into wheel bearing housing until it contacts inner circlip (base suspension) or shoulder (plus suspension).

11. On car with base suspension, install outer circlip.

12. Install ABS rotor onto wheel hub (if applicable). Then press wheel hub into wheel bearing.

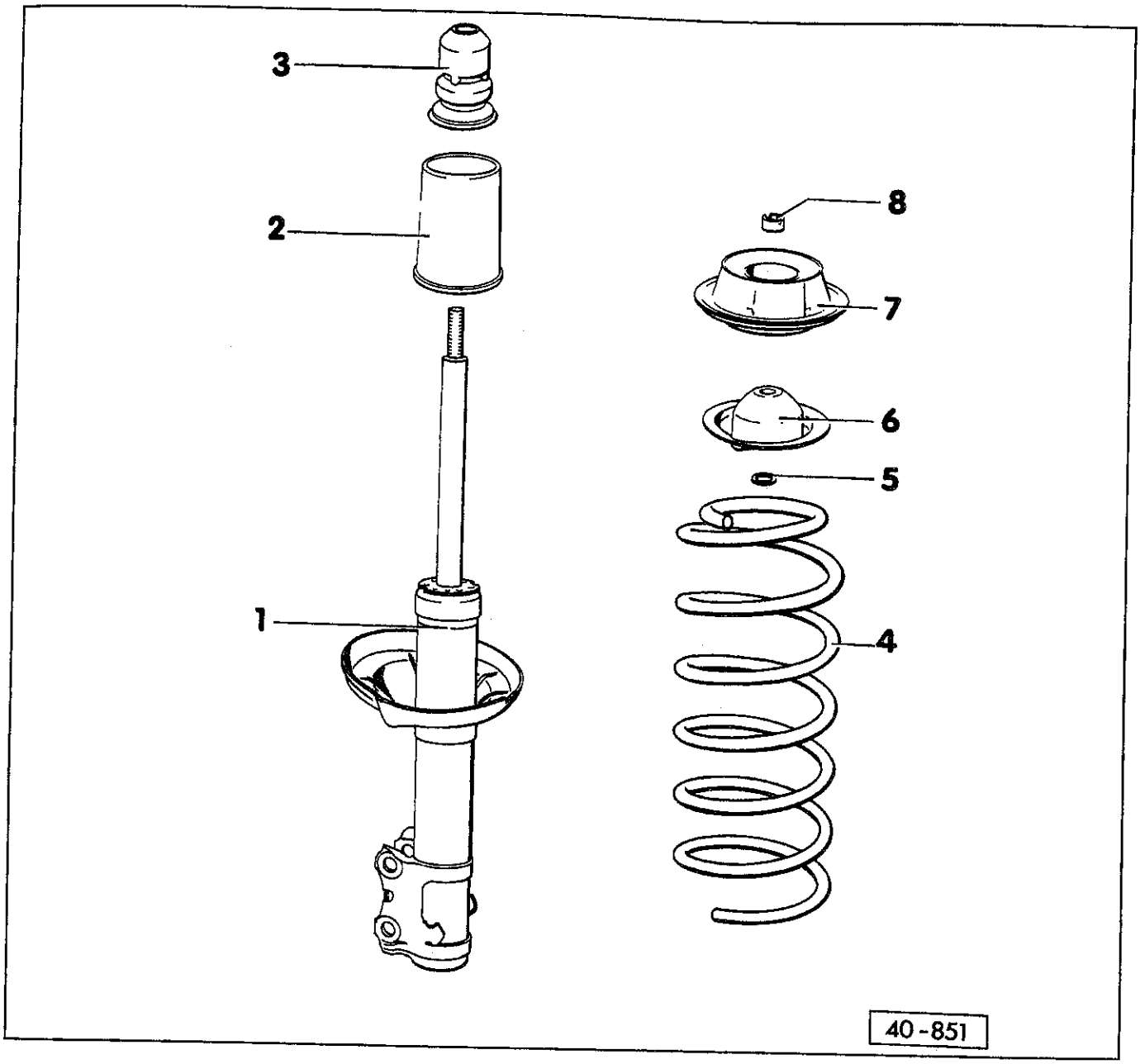
13. The remainder of installation is the reverse of removal. Install brake components as described in **47 Brakes–Mechanical Components**. Once installation is complete check and adjust front wheel alignment.

## FRONT SUSPENSION STRUTS

Front suspension strut application varies depending on suspension system installed. Fig. 9 shows the strut assembly used on cars with base suspension. Fig. 10 shows the strut assembly used on cars with plus suspension.

> ***WARNING—***
> - *Suspension strut springs are compressed and under pressure when installed on struts.*
> - *DO NOT attempt to disassemble or repair suspension without proper tools and experience. Serious injury will result from improper tools or procedures.*

## Front strut, assembly (base suspension)



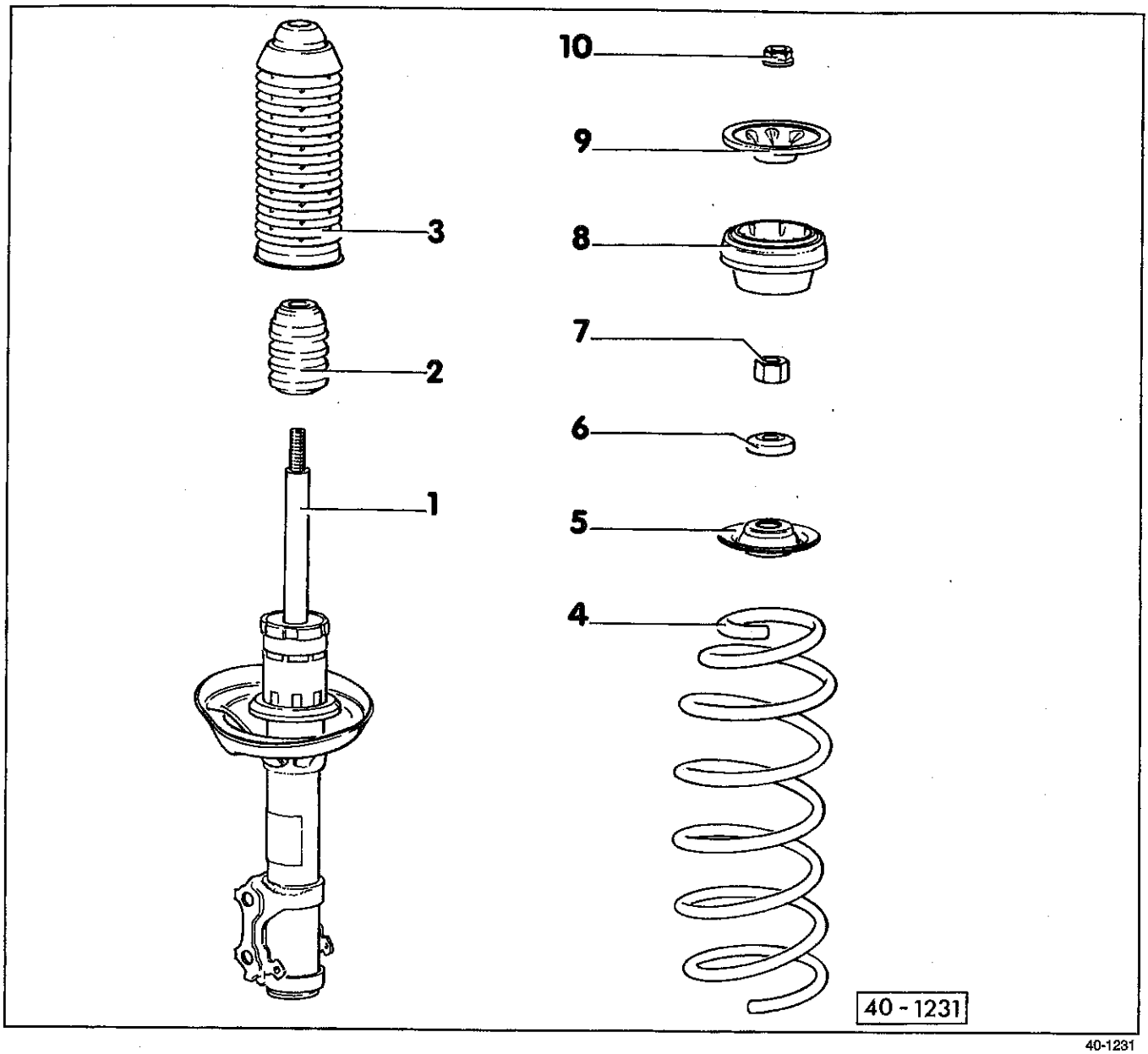

40-851

**Fig. 9.** Exploded view of front strut assembly used on cars with base suspension.

1. **Shock absorber insert**
   - Insert may be replaced individually
   - Slight traces of oil do not necessitate replacement
2. **Protective sleeve**
3. **Bump stop**
4. **Coil spring**
   - Note color-code identification when replacing
   - Outer surface of spring must not be damaged
5. **Washer**
6. **Spring retainer**
7. **Strut bearing**
   - Replace complete part
8. **Slotted nut**
   - Tighten to 40 Nm (30 ft-lb)
   - Compress coil spring before loosening nut.

> ***WARNING —***
> ***DO NOT*** *loosen nut unless coil spring is compressed. The spring must not be exerting force on the nut.*

## Front strut, assembly (plus suspension)




40-1231

**Fig. 10.** Exploded view of front strut assembly used on cars with plus suspension.

1. **Shock absorber insert**
   - Insert can be replaced individually
   - Slight traces of oil do not necessitate replacement
2. **Bump stop**
3. **Protective sleeve**
4. **Coil spring**
   - See **Front strut, disassembling (plus suspension)**
   - Note color-code marking for identification
   - Outer surface of spring must not be damaged
5. **Spring retainer**
6. **Bearing**
7. **Hex nut**
   - Tighten to 60 Nm (44 ft-lb)
   - Compress coil spring before loosening

> ***WARNING —***
> *DO NOT loosen nut (7) unless coil spring is compressed. The spring must not be exerting force on the nut.*

8. **Strut bearing**
9. **Stop**
10. **Self-locking nut**
    - Tighten to 60 Nm (44 ft-lb)

## Front strut, removing and installing

> ***WARNING —***
> - *Suspension strut springs are compressed and under pressure when installed on struts.*
> - *DO NOT attempt to disassemble or repair suspension without proper tools and experience. Serious injury will result from improper tools or procedures.*
> - *Suspension strut is removed and installed as an assembly. DO NOT disassemble or repair in car.*
> - *Front wheel alignment (camber) is altered when the strut assembly is removed. Wheel alignment must be checked and adjusted any time the strut assembly is removed or it mounting bolts are loosened.*

1. Raise the car and support it on jack stands.

> ***CAUTION —***
> *Use jack stands designed for the purpose. The jack stands should be on a level hard surface*

2. Remove the wheel.

3. Remove the nuts from the two bolts that hold the strut to the wheel bearing housing, leaving the bolts in place. See Fig. 11.

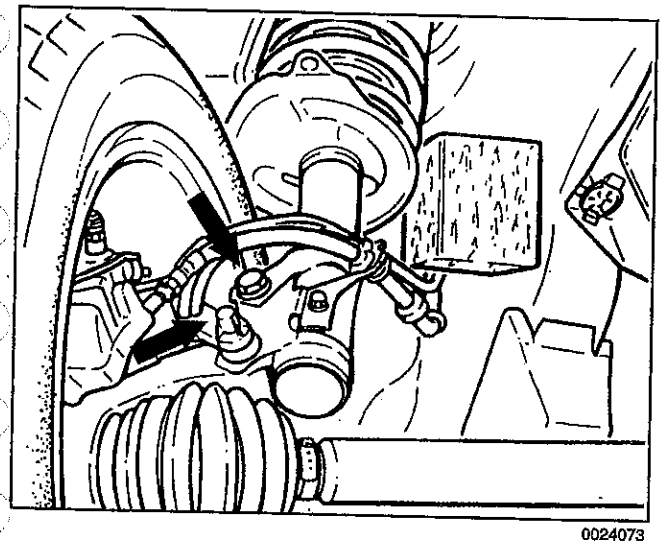


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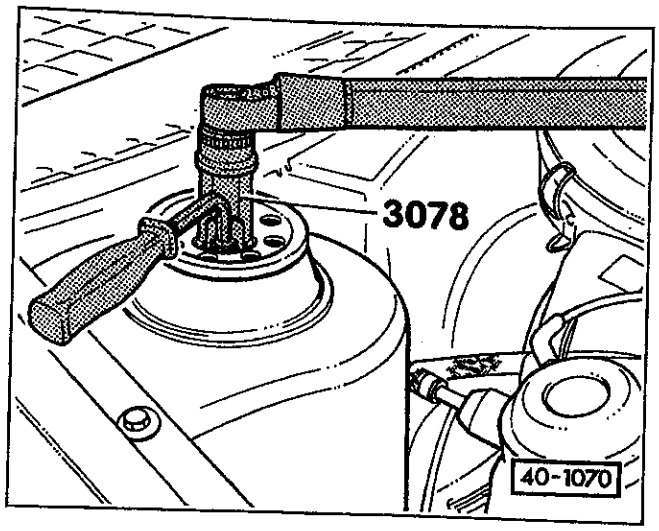
**Fig. 11.** Strut to wheel bearing housing mounting bolts (**arrow**).

4. Disconnect ABS speed sensor wiring (if applicable) and unhook the brake line from the strut and secure out of the way.

5. Support lower control arm and brake assembly so that it will not fall when the strut is removed.

6. Remove the flange nut at the top of the strut. See Fig. 12.




40-1070

**Fig. 12.** Flange nut being loosened with Volkswagen special tool 3078, hex wrench holds shock absorber shaft.

7. Remove lower strut bolts and remove the strut assembly from the car.

8. Install the strut in the reverse order of removal. Check and adjust front wheel alignment once installation is complete.

**Tightening torques**

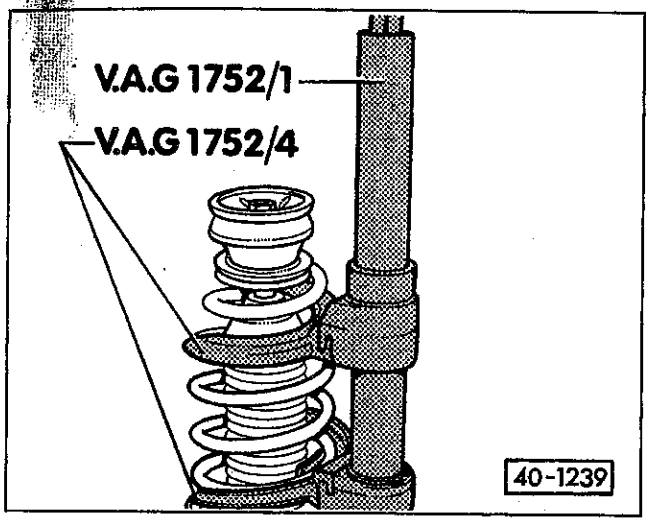
- Flange nut on top of strut . . . . . 60 Nm (44 ft-lb)
- Strut assembly to wheel bearing housing . . . . . 95 Nm (70 ft-lb)

## Front strut, disassembling and assembling

1. Remove front strut from the car. See **Front strut, removing and installing.**

2. Compress coil spring using a spring compressor designed for the purpose. With the spring compressed, there should be no spring pressure on the strut bearing. See Fig. 13.

> ***WARNING —***
> *Suspension coil springs are compressed and under pressure when installed on struts. DO NOT attempt to disassemble or repair suspension struts without proper tools and experience. Serious injury will result from improper tools or procedures.*




40-1239

**Fig. 13.** Front coil spring being compressed. (Numbers indicate Volkswagen special tools.)

3. Remove the nut from the shock absorber rod. Use a wrench to hold the shock absorber shaft.

***NOTE—***

*On cars with base suspension, the retaining nut (Fig. 9, item 8) is a special slotted nut. Use Volkswagen special tool no. VW 524, or equivalent, to loosen and tighten the nut.*

4. Assemble the strut by fully extending the shock rod by hand. Install all parts to the strut. With the spring compressed and no pressure on the upper strut bearing, tighten the nut. Align the ends of the coil spring to mate properly with the spring retainers and slowly release the spring compressor.

***NOTE—***

- *Check the strut bearing for signs of wear and replace it if it does not turn smoothly or if any play is present.*
- *If the coils springs are to be replaced, note the color marking on the spring and always replace in matched pairs.*

**Tightening torques**

- Slotted nut on top of strut (base suspension) ..... 40 Nm (30 ft-lb)
- Hex nut on top strut (plus suspension) ..... 60 Nm (44 ft-lb)

5. Install the strut assembly as described under **Suspension strut, removing and installing**. Check and adjust front wheel alignment.

## DRIVE AXLES

The drive axles are equipped at each end with constant velocity (CV) joints which allow power to be continuously delivered to the drive wheels. See Fig. 17. The inner CV joints attach to the transaxle drive flanges, while the outer CV joints are equipped with splined stub axles that engage the splines of the wheel hubs and are secured by the large nut.

Although some inspection of the CV joints is possible while the drive axles are installed, complete inspection and thorough lubrication of the joints require that the drive axles be removed from the car. If the drive axles themselves are damaged, complete remanufactured drive axle assemblies are available from an authorized Volkswagen dealer at lower cost than a new unit.

***CAUTION—***

- *Drive axles should be removed and installed as a complete unit. DO NOT repair or disassemble drive axles without first removing from vehicle.*
- *Moving (rolling) a car with drive axles removed will damage the wheel bearings. If moving the car is necessary, always secure the bearing races by temporarily installing an outer CV joint in the hub and tighten the retaining nut to 50 Nm (37 ft-lb).*

### Drive axle, removing and installing (base suspension)

***NOTE—***

*Vehicles with base suspension use a standard self-locking hex nut on the end of the drive axle; vehicles with plus suspension use a special 12-point self-locking nut.*

1. With the vehicle on the ground, pry off the dust cap in the center of the front wheel hub and loosen, but do not remove, the axle shaft nut.

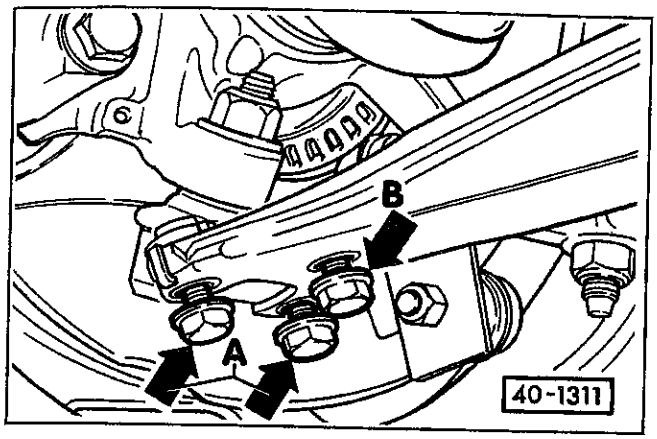
***WARNING—***

*Loosen axle shaft nut only while the car is on the ground. The leverage required to do this could topple the car from a lift or jack stand.*

2. Raise the front of the vehicle and support it securely on jack stands. Make matching marks on the control arm and ball joint, then remove the ball joint mounting bolts. See Fig. 14.

3. Clean around the inner CV joint and remove the 12-point socket-head bolts that hold the inner CV joint to the transmission drive flange.

4. Remove the axle shaft nut and pull the drive axle out of the wheel hub. Cover the exposed inner CV joints to prevent contamination.




40-1311

**Fig. 14.** Remove ball joint bolts **A** and **B**.

5. Installation is the reverse of removal, noting the following:
   - Use a new self-locking nut to secure drive axle to wheel hub.
   - Align the ball joint and control arm marks made during removal.
   - Tighten the axle shaft nut as much as possible (to seat CV joint in wheel hub) with the car raised. Make the final tightening torque only with the weight of the car on the ground.
   - Check and adjust front wheel alignment once installation is complete.

***WARNING —***
*Torque the axle shaft nut only while the car is on the ground. The leverage required to do this could topple the car off a lift or jack stand.*

**Tightening torques**

- Outer CV joint to wheel hub . . . . . 265 Nm (195 ft-lb)
- Inner CV joint to drive flange . . . . . 45 Nm (33 ft-lb)
- Ball joint to control arm . . . . . 35 Nm (26 ft-lb)

## Drive axle, removing and installing (plus suspension)

***NOTE —***
*Vehicles with base suspension use a standard self-locking hex nut on the end of the drive axle; vehicles with plus suspension use a special 12-point self-locking nut.*

Two types of wheel hubs have been installed on the cars covered by this manual. The early-type hub uses a locking fluid on the CV joint shaft splines. The later type hub uses a modified spline design and no locking fluid. Be sure to note if sealant is present on the drive axle and wheel hub splines when removing the axle. If sealant is present, the drive axle must be reinstalled into the original hub using the specified locking compound.

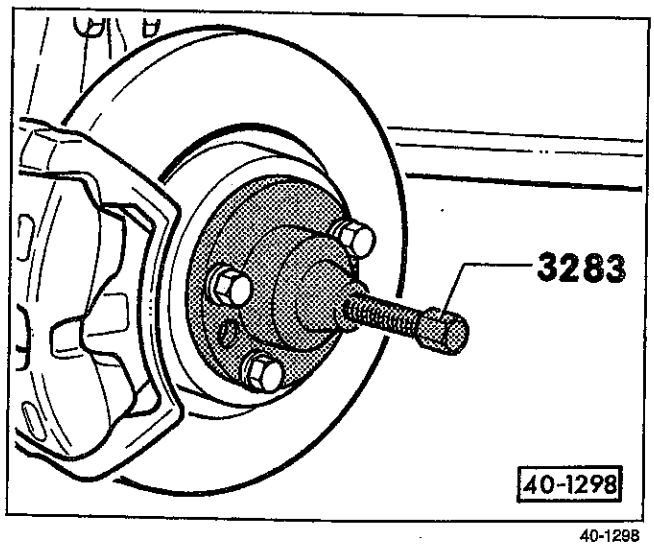
1. With the vehicle on the ground, pry off the dust cap in the center of the front wheel hub and loosen, but do not remove, the axle shaft nut.

***WARNING —***
*Loosen axle shaft nut only while the car is on the ground. The leverage required to do this could topple the car from a lift or jack stand.*

2. Raise the front of the car and support it on jack stands. Make matching marks on the control arm and ball joint, then remove the ball joint mounting bolts. See Fig. 14.

3. Clean around the inner CV joint and remove the 12-point socket-head bolts that hold the inner CV joint to the transmission drive flange.

4. Remove the axle shaft nut and remove the drive axle from the wheel hub. If necessary, press the axle out of the wheel hub. See Fig. 15. Cover the exposed inner CV joint.




40-1298

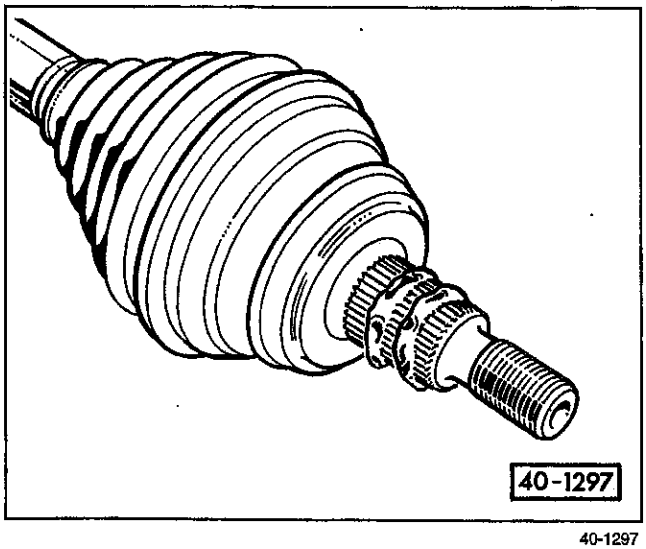
**Fig. 15.** Axle shaft being pressed out of wheel hub. Number indicates VW special tool.

5. Installation is the reverse of removal, noting the following:
   - Use new 12-point self-locking nut to secure drive axle to wheel hub. Note special tightening torques.
   - On cars **without modified wheel hub** (sealant used on axle splines): use special locking sealant (VW part no. D 185 400A2) on the axle splines if reinstalling the drive axle into the same wheel hub. See Fig. 16.
   - On cars **with modified wheel hub** (sealant not used on axle splines): lubricate contact surfaces of nut with oil when installing., tighten axle shaft nut with the car lowered but wheel not touching ground, and brakes applied (requires helper).
   - Align the ball joint and control arm marks made during removal.
   - Check and adjust front wheel alignment once installation is complete.

**Tightening torques**

- Outer CV joint to wheel hub (w/o modified wheel hub) (use sealant, VW part no. D 185 400 A2)
  - stage 1 ..... 90 Nm (66 ft-lb)
  - stage 2 ..... additional $^1/_8$ turn (45°)
- Outer CV joint to wheel hub (with modified wheel hub)
  - stage 1 ..... 200 Nm (148 ft-lb)
  - stage 2 ..... loosen one turn
  - stage 3 ..... 50 Nm (37 ft-lb)
  - stage 4 ..... tighten $^1/_{12}$ turn (30°)
- Ball joint to control arm ..... 35 Nm (26 ft-lb)
- Inner CV joint to drive flange ..... 45 Nm (33 ft-lb)

***CAUTION—***
*Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*




40-1297

**Fig. 16.** Apply 3 mm (1/8 in.) bead of sealant (VW part no. D 185 400 A2) to CV joint splines on cars without modified wheel hub.

## Drive axle, assembly

Fig.17 shows an exploded view of the drive axle components. Applicable tightening torques as well as other pertinent repair information are given with the illustration.

1. **Outer CV joint (90 mm diameter)**
   - Replace complete part only
   - See **CV joints, servicing**
2. **Circlip**
   - Seats (springs) into groove
   - Always replace
   - Insert in groove in shaft
3. **Thrust washer**
4. **Dished washer**
   - Splined on inside diameter
   - Installed position: outer diameter (concave side) faces thrust washer
5. **Outer clamp**
   - Always replace
   - Use pliers designed to install CV boot clamp, such as Snap-On YA 3080
6. **Boot**
   - For 90 mm constant velocity joint (1)
   - Check for tears and chafing
   - Ventilate boot before tensioning small clamp
7. **Inner clamp**
   - Always replace
   - Use pliers designed to install CV boot clamp such as Snap-On YA 3080
8. **Vibration damper**
   - Not applicable to all models
9. **Drive Axle**
10. **Boot**
    - For 100 mm diameter CV joint (12)
    - Installed up to 1/93 with vent hole
    - Check for tears and chafing
11. **Dished washer**
    - Splined on inside diameter
    - Installed position: outer diameter (concave side) faces thrust washer
12. **Inner CV joint (100 mm diameter)**
13. **Gasket**
    - Always replace (self-adhesive backing)
14. **Circlip**
    - Always replace

## Drive axle, assembly

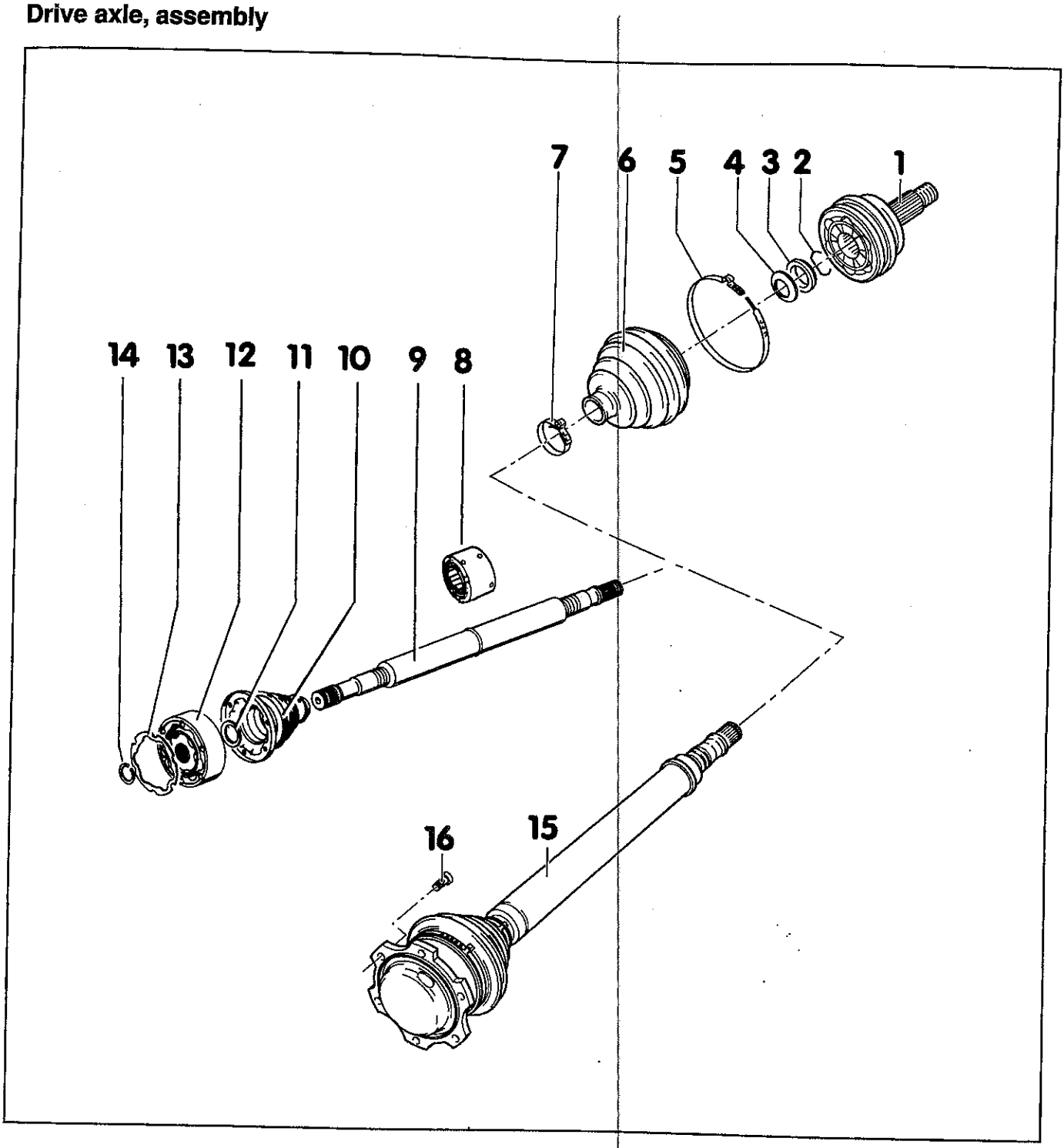



**Fig. 17.** Drive axle components. Note drive axle with triple-roller inner CV joint used on cars with 4-cylinder engine with automatic transmission.

**15. Drive axle with triple-roller inner CV joint**
- Installed on 4-cylinder engine with auto. trans.
- Replace as complete unit (shaft, joint, and boot)

**16. Multi-point socket head bolt**
- Tighten to 45 Nm (33 ft-lb)

## Drive axle with triple-roller joint, removing and installing (left-hand axle only)

Axle shafts with triple-roller joints are installed on vehicles with 4-cylinder engine and automatic transmission. These joints have three offset rollers in a triangular star carrier. If removing the left-hand drive axle, the engine assembly must be supported from above and moved forward off its mounts in order to gain enough clearance to remove the axle.

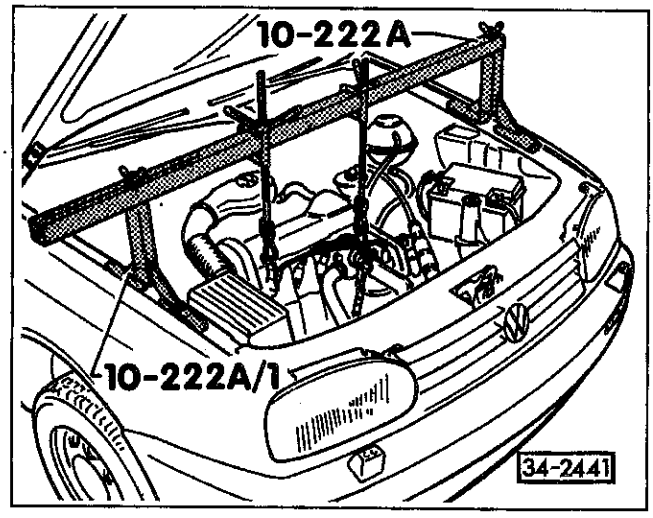
***NOTE—***

- *At the time of publication, replacement parts for triple-roller CV joints were not available from Volkswagen.*
- *Removal and installation for the right side drive axle is covered above under* **Drive axle, removing and installing**.

1. With the vehicle on the ground, pry off the dust cap in the center of the front wheel hub and loosen, but do not remove, the axle shaft nut.

> ***WARNING—***
> *Loosen axle shaft nut only while the car is on the ground. The leverage required to do this could topple the car from a lift or jack stand.*

2. Install engine support equipment across the top of the engine. See Fig. 18.




34-2441

**Fig. 18.** Engine/transmission assembly being supported. (Numbers indicate Volkswagen special tools.)

3. Remove bolt from rear transmission mount and front engine mount. Lift engine/transmission assembly so that engine/transmission weight is fully supported.

4. Raise the front of the vehicle and support it securely on jack stands. Make matching marks on the control arm and ball joint, then remove the ball joint mounting bolts. See Fig. 14.

5. Remove the 12-point socket-head bolts that hold the inner CV joint to the transmission drive flange.

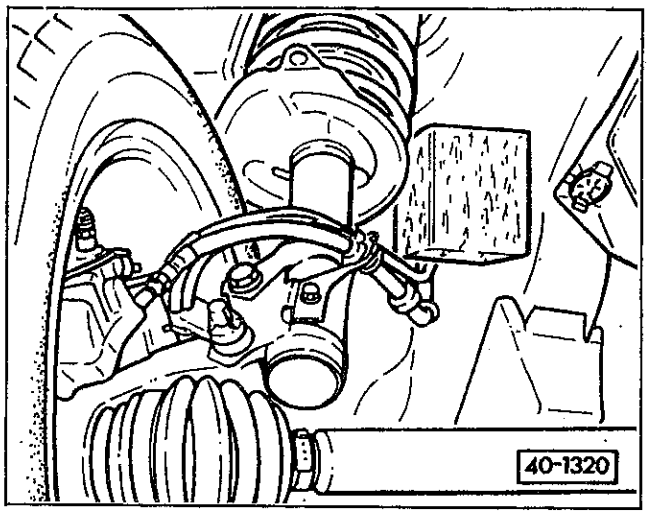
6. Remove the axle shaft nut.

7. Push engine/transmission assembly toward front of car and support in this position.

8. Swing wheel outward and pull drive axle out of wheel hub. Remove axle from car.

***NOTE—***

*If necessary, place block of wood or equivalent between strut and wheel housing to hold strut in position. See Fig. 19.*




V40-1320

**Fig. 19.** Wood block placed between strut and wheel housing to facilitate axle removal.

9. Installation is the reverse of removal, noting the following:
   - Use a new self-locking nut to secure drive axle to hub. Tighten the axle shaft nut as much as possible (to seat CV joint in wheel hub) with the car raised. Make the final tightening torque only with the weight of the car on the ground.
   - Align the ball joint and control arm marks made during removal.
   - Check and adjust front wheel alignment once installation is complete.

> ***WARNING—***
> *Torque for axle shaft nut applies only to conventional hex-type self-locking nut. Torque does not apply to special 12-point self-locking nut.*

**Tightening torques**

- Outer CV joint to wheel hub . . . . . 265 Nm (195 ft-lb)
- Inner CV joint to drive flange . . . . . 45 Nm (33 ft-lb)
- Ball joint to control arm. . . . . 35 Nm (26 ft-lb)

## CV JOINTS, SERVICING

The components of each CV joint are precisely matched during manufacture and they cannot be serviced individually. The joint can be disassembled to replace the grease or to check the balls and ball tracks for wear and damage.

> ***CAUTION—***
> - *CV joints must be removed from the axle shaft prior to disassembly.*
> - *DO NOT re-use drive axle circlips or CV boot clamps.*
> - *DO NOT interchange parts between CV joints.*

**CV Joint Grease Quantity**

- Outer CV joint..... 110 grams
- Inner CV joint..... 120 grams

### Outer CV joint and boot, removing and installing

1. Remove drive axle from car. See **Drive Axles**.
2. Mark position of CV boot on drive axle.
3. Remove drive axle boot clamps. Disconnect boot from CV joint and cut boot from drive axle.
4. Carefully drive CV joint off drive axle with firm blow from soft mallet. See Fig. 20.

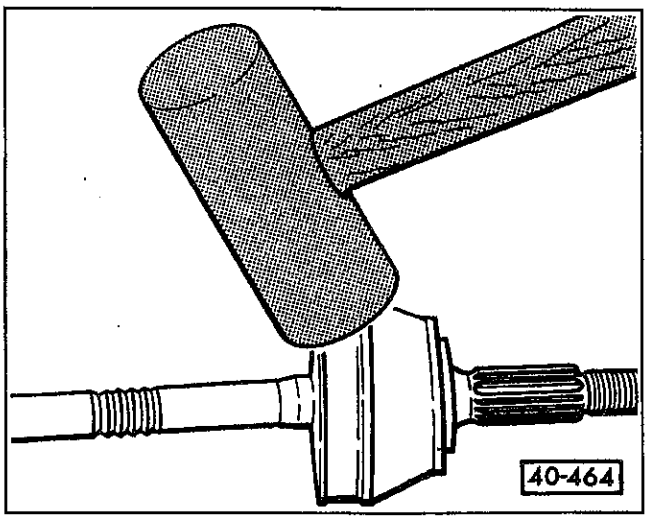



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**Fig. 20.** CV joint being driven off axle with soft mallet.

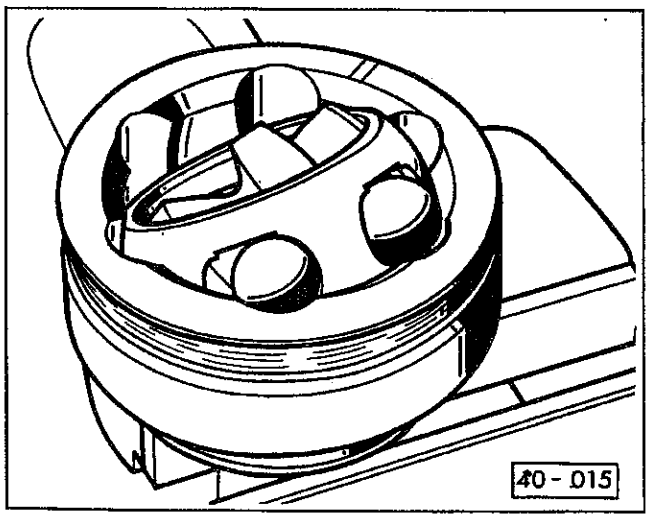
5. Remove thrust washer and dished washer.
6. Clean drive axle. Install new circlip on drive axle.
7. Slide inner (small) CV boot clamp onto drive axle.
8. Slide new CV boot onto drive axle. Position CV boot on axle, aligning marks made earlier.
9. Pack CV boot with CV joint grease (55 grams).
10. Install dished washer and thrust washer onto axle. Dished washer outer diameter faces thrust washer.
11. Pack CV joint with 55 grams of CV joint grease.
12. Using a soft mallet drive the CV joint onto the axle until the circlip is seated (springs into groove).
13. Install grease packed boot to CV joint. Boot should fit into groove in CV joint.
14. Install outer clamp and crimp.

> ***NOTE—***
> *Special pliers should be used to crimp CV boot clamps. Use Snap-On YA 3080 pliers, or equivalent.*

15. Lift the boot slightly off the joint to ventilate and equalize pressure. Then slide inner clamp onto boot and crimp.

### Outer CV joint, disassembling and assembling

1. Remove CV joint as described above.
2. Mark position of ball hub in relation to ball cage and housing with electric scriber.
3. Swivel ball hub and ball cage so that balls are exposed. See Fig. 21.

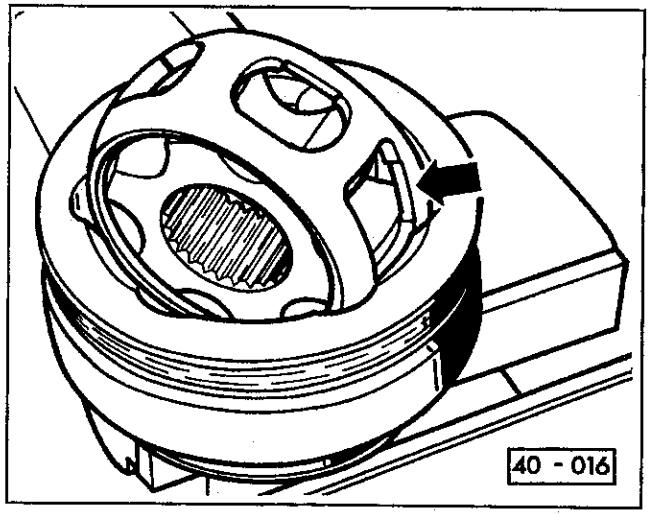



40-015

**Fig. 21.** Ball track swivelled for ball removal.

4. Remove each ball in turn, swiveling the ball hub and cage as necessary.

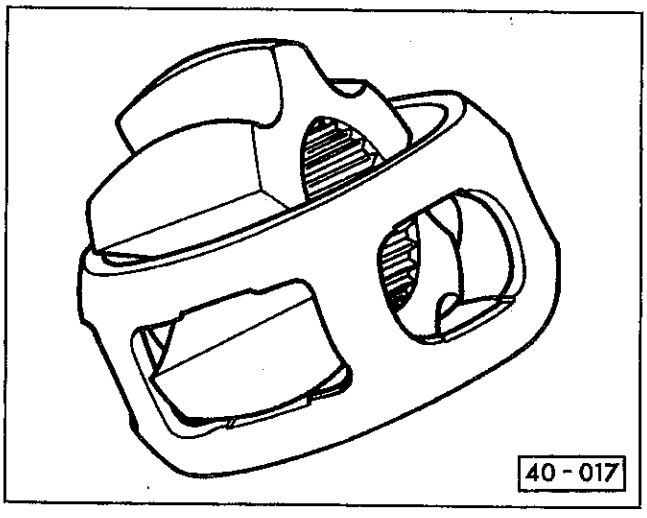
5. Turn cage until rectangular openings on either side of ball cage align with joint housing and lift out ball cage together with hub. See Fig. 22.




40-016

**Fig. 22.** Rectangular openings (**arrow**) aligned with housing.

6. Remove ball hub from ball cage by swinging segment of hub into rectangular opening of cage and tilting hub out of cage. See Fig. 23.




40-017

**Fig. 23.** Hub being aligned with rectangular opening in cage.

7. Check housing, hub, cage, and balls for pitting and signs of seizure.

***NOTE—***

*Excessive backlash in the joint will be noticed as a knock when changing from acceleration to overrun or vice versa. Replace the joint if necessary. Do not replace the joint because of a polished appearance or because ball tracks are visible.*

8. Insert ball hub into ball cage at rectangular opening. See Fig. 23.

9. Pack CV joint housing with 55 grams CV joint grease.

10. Install cage together with hub into joint housing while aligning rectangular openings in ball cage. Make sure marks made earlier align when installing the cage into the housing.

11. Press in balls separately from alternate sides. Ensure original position of hub in relation to cage.

12. Install CV joint to drive axle as described above.

## Inner CV joint and boot, removing and installing

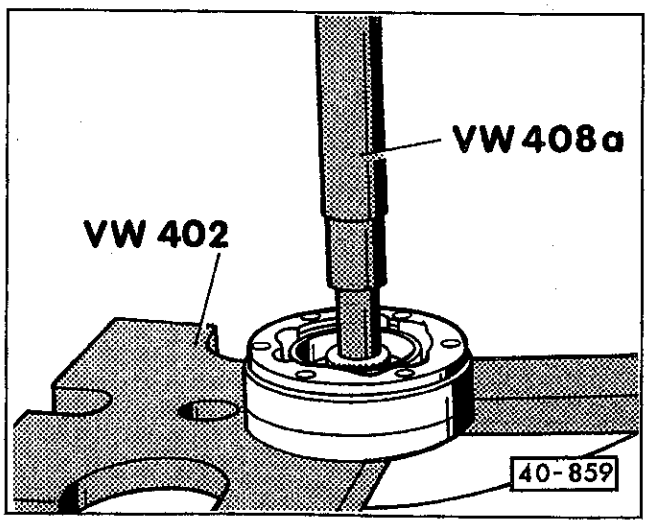
1. Remove drive axle from car. See **Drive Axles**.

2. Mark the position of the inner CV boot on the drive axle.

3. Wipe away the grease from the end of the drive axle. Remove the circlip holding the inner CV joint to the end of the drive axle.

4. Using a drift, tap off the CV joint boot protective cap The cap is pressed onto the CV joint.

5. While supporting the ball hub, press the drive axle out of the CV joint. Remove the dished washer from the axle. See Fig. 24.




40-859

**Fig. 24.** Axle shaft being pressed out of inner CV joint. Numbers indicate VW special tools.

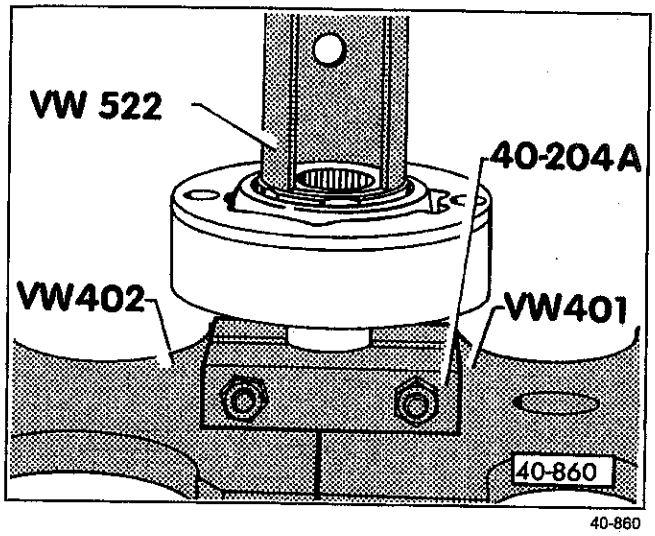
6. Remove the CV boot clamp and slide the boot off.

7. Clean drive axle.

8. Slide inner (small) CV boot clamp onto axle.

9. Slide CV boot onto drive axle.
10. Pack boot with 60 grams of CV joint grease.
11. Install dished washer so that dished washer outer diameter faces CV joint.
12. Pack CV joint with 60 grams of CV joint grease.
13. Press CV joint onto axle and install circlip. See Fig. 25.

***NOTE—***
*Chamfer on inner ball hub (splined diameter) must face the contact shoulder on the drive axle.*




40-860

**Fig. 25.** Inner CV joint being pressed onto drive axle. Numbers indicate Volkswagen special tools.

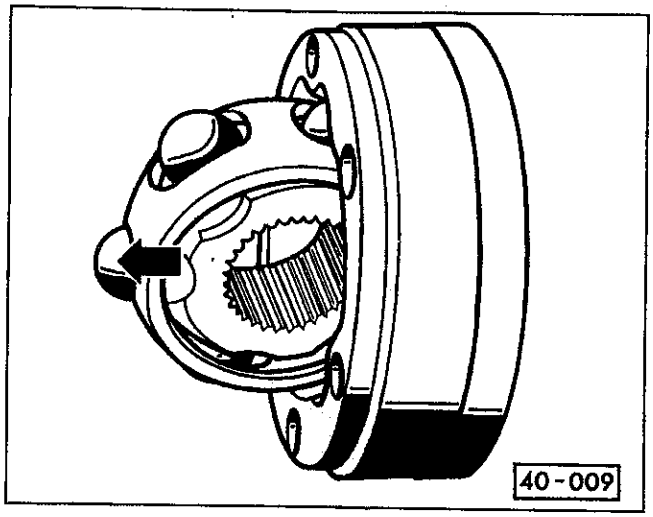
14. Slide axle flange bolts through protective cap and into openings in CV joint. Press protective cap onto CV joint.
15. Slide inner clamp onto boot and crimp.

***NOTE—***
*Special pliers should be used to crimp CV boot clamps. Use Snap-On YA 3080 pliers, or equivalent.*

## Inner CV joint, disassembling and assembling

***NOTE—***
*This section does not cover triple-roller inner CV joints used on cars with 4-cylinder engine and automatic transmission. At the time of this publication, replacement parts for triple-roller CV joints were not separately available from Volkswagen.*

1. Remove CV joint from drive axle as described previously.
2. Mark position of ball hub in relation to ball cage and housing with electric scriber.
3. Swivel ball hub and ball cage 90°. Pull ball hub together with cage and balls from housing. See Fig. 26.



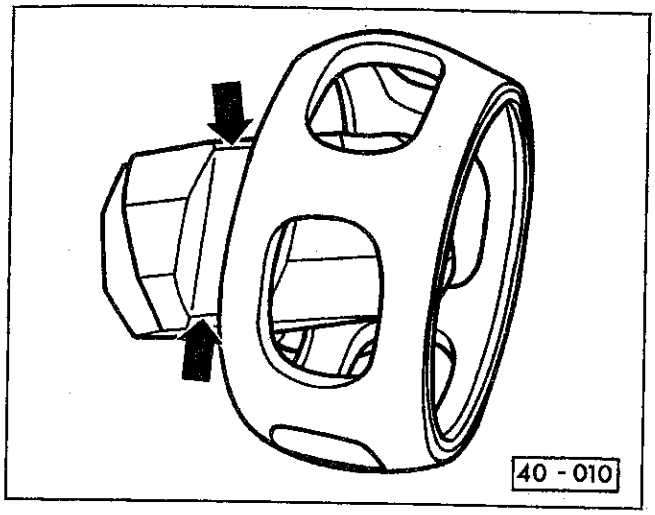

40-009

**Fig. 26.** Ball hub and cage being removed from housing. Pull in direction of **arrow**.

4. Press balls out of cage. Tilt ball hub so that ball tracks are aligned with edge of ball cage and remove hub from cage. See Fig. 27.
5. Check housing, hub, cage, and balls for pitting and signs of seizure.

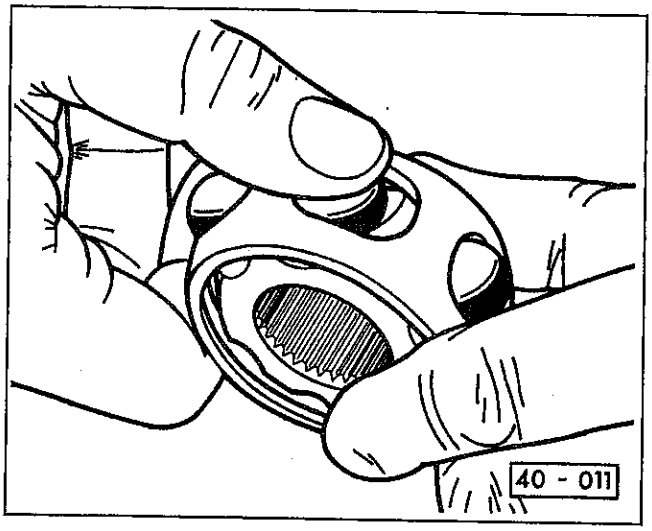
***NOTE—***
*Excessive backlash in the joint will be noticed as a knock when changing from acceleration to overrun and vice versa. Replace the joint if necessary. Do not replace a joint because of polished areas or because the ball tracks are visible.*

6. Insert ball hub over both chamfers into ball cage.
7. Align ball hub to cage using marks made earlier. Press balls into cage. See Fig. 28.




40-010

**Fig. 27.** Align ball tracks (**arrows**) on hub with ball cage edge when installing hub into cage.



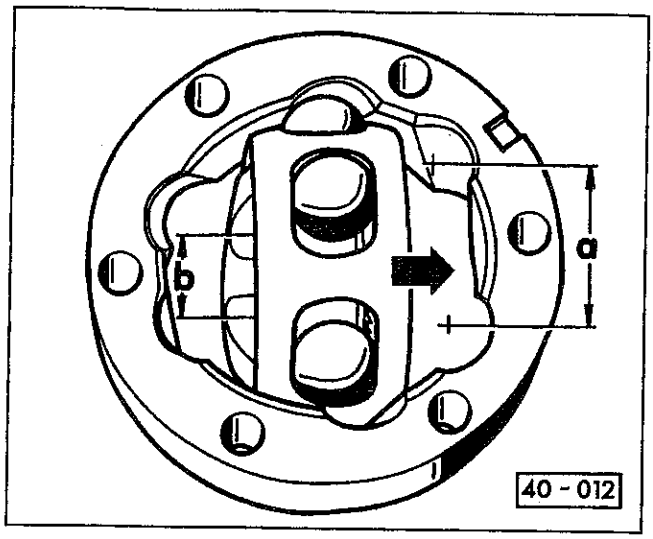

40-011

**Fig. 28.** Balls being pressed into cage.

8. Insert hub with cage and balls into joint at right angles, ensuring the following (see Fig. 29):
   - Wide ball groove in outer ring (**a**) and narrow groove in hub (**b**) are together on one side when hub is pivoted into housing.
   - Matching marks on hub, cage, and housing are aligned.
   - Chamfer on inside diameter of ball hub faces larger diameter of joint.

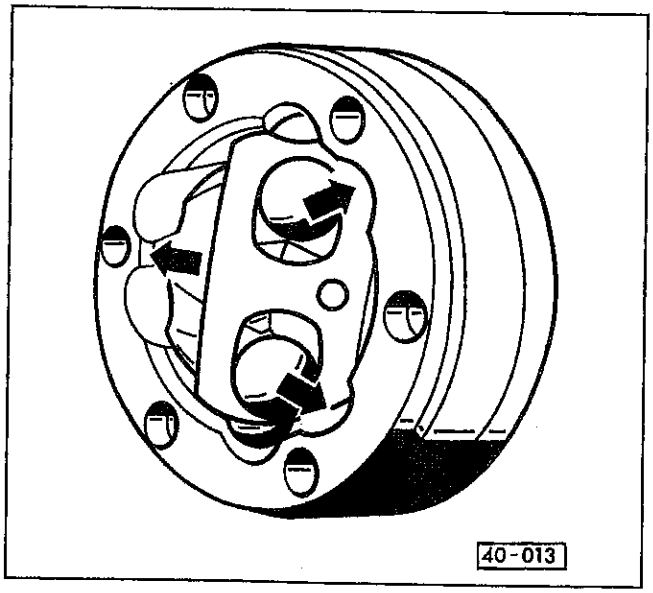
9. Swivel ball hub with cage and balls into housing. Pivoting hub and cage until balls align. See Fig. 30.

10. Press cage firmly by hand until hub swings fully into position.




40-012

**Fig. 29.** Hub assembly correctly in housing with wide ball groove in housing (**a**) and a narrow groove in hub (**b**) together on one side.




40-013

**Fig. 30.** Ball hub correctly installed into housing. Pivot hub out of cage (**arrows**) until balls are spaced to fit grooves.

***NOTE—***

*The joint is correctly assembled when the ball hub can be moved in and out over the full range of axial movement by hand.*

11. Pack CV joint with 60 grams of CV joint grease. Pack grease from both sides and put an additional 60 grams in the CV boot.

12. Install CV joint to axle using a new circlip.

# 42 Rear Suspension



## GENERAL

The beam-type rear axle is a one-piece welded assembly of axle beam and trailing arms. Rear wheel stub axles are bolted to the trailing arms. The rear strut or shock absorber assemblies are separate coil springs mounted concentrically with shock absorbers. The shocks are easily removed and installed and, unlike the front suspension, the rear springs and shock absorbers can be safely disassembled without the use of a spring compressor. For general information on the suspension system used on the cars covered by this manual, see **4 General Information.**

When performing service or repair of the rear suspension, observe the following warnings and cautions.

***WARNING —***

- *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, cotter pins. For replacements always use new parts.*
- *Do not reinstall bolts and nuts coated with undercoating wax as correct tightening torque cannot be assured on installation. Always clean the threads of removed bolts and nuts with a solvent before installation, or replace them with new parts.*

***WARNING —***

- *If the axle beam has been removed, or if for any other reason the brake lines have been disconnected, reassembly must include bleeding air from the brake system and readjusting the brakes as described in* **46 Brakes–Mechanical Components** *and* **47 Brakes–Hydraulic System.**
- *Do not weld or attempt to straighten a damaged rear axle beam or rear stub axles.*

***CAUTION —***

*Use only multipurpose (lithium) grease to lubricate the rear wheel bearings. Other greases will not maintain adequate lubrication and may lead to premature bearing failure.*

## REAR SUSPENSION COMPONENTS

Fig. 1 shows the rear suspension components. Special repair information and tightening torques are given in the illustration's numbered list.

## Rear suspension, assembly

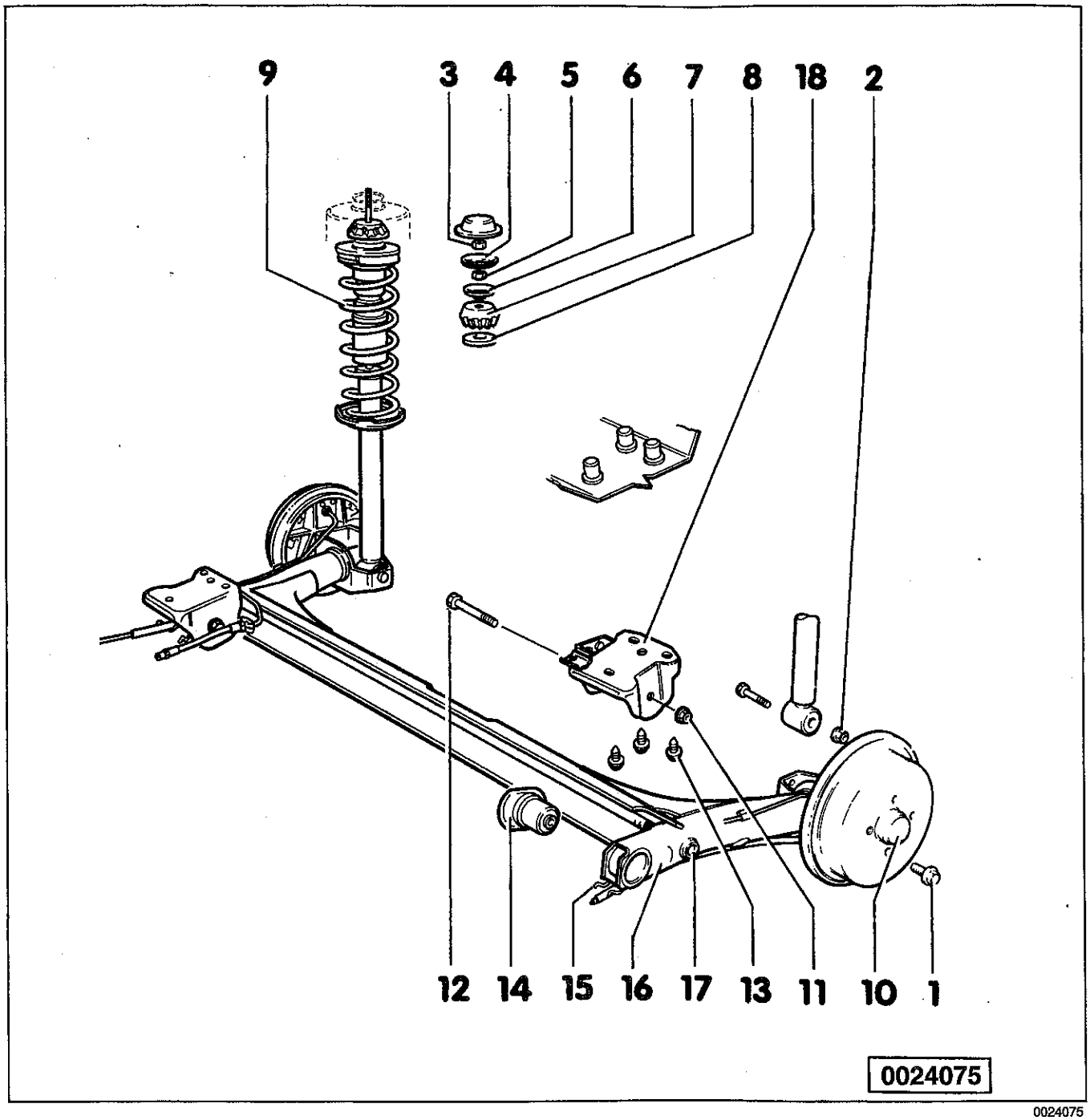



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**Fig. 1.** Exploded view of rear suspension components. Rear suspension with drum brakes shown.

1. **Wheel lug bolt**
   - Tighten to 110 Nm (81 ft-lb)
2. **Nut**
   - Tighten to 70 Nm (52 ft-lb)
   - Axle beam must be in horizontal position (vehicle on ground, not loaded) when tightening nut
3. **Nut (locknut)**
   - Tighten to 25 Nm (18 ft-lb)
4. **Dished washer**
5. **Nut**
   - Tighten to 15 Nm (11 ft-lb)

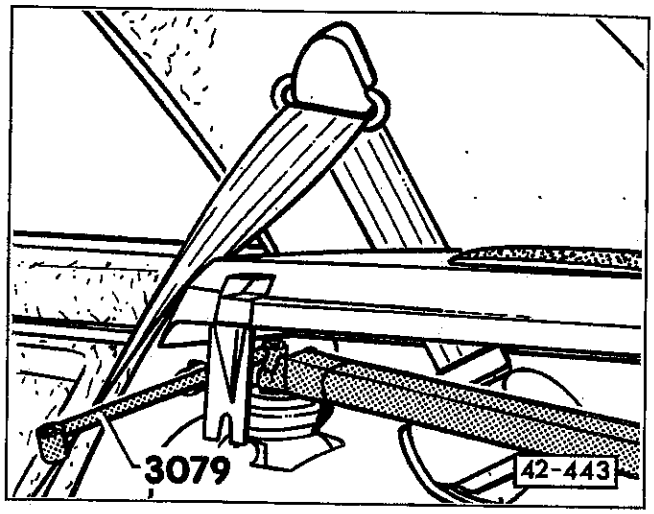
6. **Cover (large)**
7. **Upper mounting ring (rubber)**
8. **Cover (small)**
9. **Shock absorber assembly**
10. **Grease cap**
11. **Nut**
    - Tighten to 80 Nm (59 ft-lb)
    - Use only self-locking nut with captive washer
    - Axle beam must be in horizontal position (vehicle on ground, not loaded) when tightening nut
12. **Bolt**
    - Install from center of vehicle
13. **Bolt**
    - Tighten to 70 Nm (52 ft-lb)
    - If threads in cap nut are damaged, drill out and re-tap
14. **Axle beam bushing**
    - See **Rear axle beam bushing, replacing**
15. **Bracket**
    - For parking brake cable
16. **Axle beam**
    - Keep contact surface and threaded holes for stub axles free of paint and dirt
    - See **Rear axle beam**
17. **Stabilizer bar**
18. **Mounting bracket**
    - Positioning on axle beam, see **Rear axle beam, installing**
    - With bracket for mounting brake pressure regulator
    - Do not loosen bracket nut and bolt (for bushing) when removing rear axle beam

# REAR SHOCK ABSORBERS

## Rear shock, removing and installing

> ***CAUTION —***
> *Remove and install the rear shock absorber assemblies one side at a time in order to prevent the rear axle from hanging unsupported and damaging the brake lines.*

1. Pry off the cap from the upper shock mount. While holding the shock shaft stationary, loosen and remove the lock nut and dished washer. See Fig. 2.




42-443

**Fig. 2.** Lock nut being removed from shock. Volkswagen special tool no. 3079 is used to hold shock shaft stationary.

2. Remove the second (lower) nut from the shock and remove the upper mounting hardware.

3. Raise the car slowly until the coil spring is unloaded and the top of the shock absorber begins to pull away from the body. Support the car safely.

   ***NOTE —***
   *Do not use any part of the suspension as a lifting point. The axle beam must not be supporting the car.*

4. Remove the bolt from the lower shock mount and remove the shock from the car.

5. Installation is the reverse of removal. Install the lower shock mounting bolt with a new self-locking nut. Tighten the nut after the car has been lowered to the ground.

**Tightening torques**

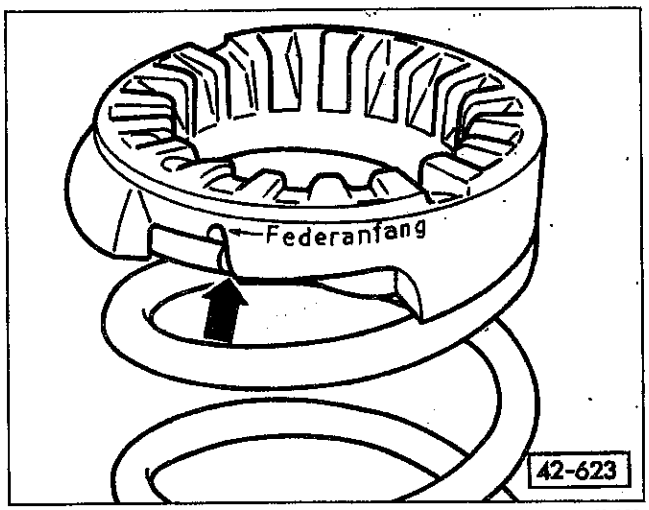
- Upper shock to body . . . . . 15 Nm (11 ft-lb)
- Locknut to shock mounting nut . . . . . 25 Nm (18 ft-lb)
- Lower shock mount to rear axle . . . . . 70 Nm (52 ft-lb)

## Rear shock, disassembling and assembling

Fig. 5 shows an exploded view of the rear shock absorber assembly. Note that the upper mounting hardware is not shown in the illustration.

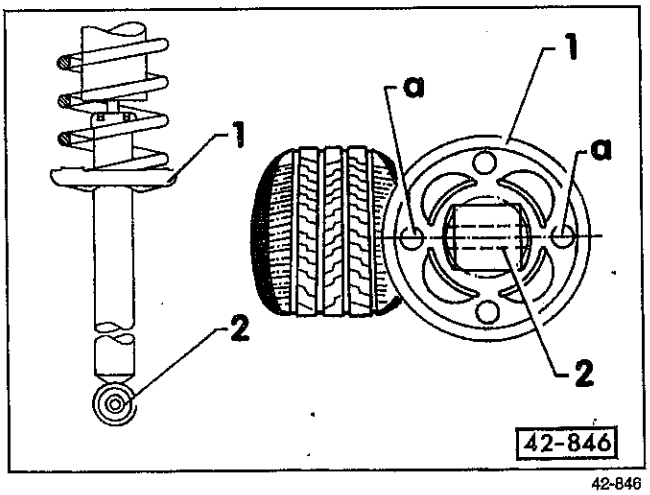
When assembling the shock, make sure the spring ends fit correctly into the spring seats. See Fig. 3. Make sure the lower spring seat is properly aligned. See Fig. 4

> ***CAUTION—***
> *The lower spring seat must be installed so that the holes in the seat align with the shock bushing eye. If not, the spring seat could interfere with the tire. See Fig. 4.*




42-623

**Fig. 3.** End of coil spring aligned with notch in upper spring seat (**arrow**).




42-846

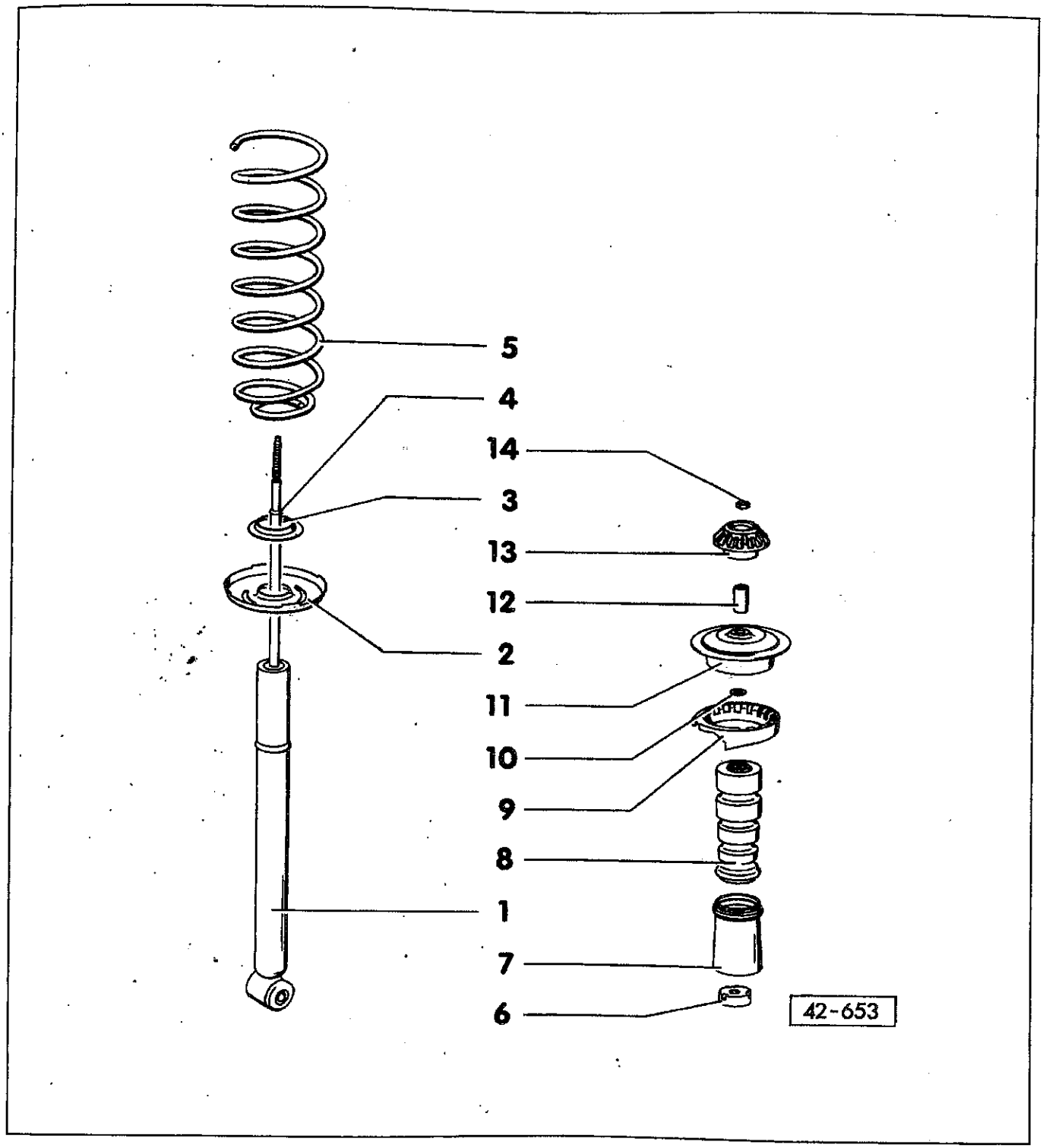
**Fig. 4.** Hole (**a**) in spring seat (**1**) must be aligned with bushing eye (**2**) in shock absorber.

## Rear shock absorber, assembly

Fig. 5 shows an exploded view of the rear shock assembly. Applicable tightening torques as well as other pertinent repair information are given with the illustration.

1. **Shock absorber**
   - Slight traces of oil do not necessitate replacement
2. **Lower spring seat**
   - Installation position, see **Rear shock, disassembling and assembling**
3. **Insulator**
4. **Circlip**
5. **Coil spring**
6. **Protective cap**
7. **Protective tube**
8. **Bump stop**
9. **Upper spring seat**
   - Installation position, see **Rear shock, disassembling and assembling**
10. **Washer**
11. **Spring support**
12. **Spacer**
13. **Rubber lower mounting**
14. **Nut**
    - Tighten to 15 Nm (11 ft-lb)

## Rear shock absorber, assembly




42-653

**Fig. 5.** Rear shock absorber components.

## REAR AXLE BEAM

The rear suspension can be removed and installed as a complete unit for replacement or for facilitating rear body repairs. The axle beam is mounted to the body by brackets at the front of the axle, supported by replaceable rubber bushings. Replacement of the axle beam bushings require removal of the axle assembly and mounting brackets. Note that a special Volkswagen tool (protractor) is available to set up the axle beam mounting brackets prior to installation of the axle.

### Rear axle beam, removing

1. With the car raised and properly supported, remove the rear wheels.

   ***NOTE—***
   *The car must be raised high enough to remove the axle assembly, so a lift, or a jack and suitable jack stands are required. Removal of the axle assembly also requires disconnecting brake lines to the rear wheels, and bleeding the brakes when reinstallation is complete.*

2. Working between the front seats, disconnect the parking brake cables at the parking brake lever. See **46 Brakes–Mechanical Components**.

3. Disconnect the flexible rear brake hoses from the rigid brake lines near the forward edge of the axle beam. Cap both ends of the open connection.

4. While supporting the axle beam from below, disconnect the rear shock absorbers at the axle beam.

5. If applicable, disconnect the brake pressure regulator spring from the bracket attached to the axle beam.

   ***NOTE—***
   *Not all cars are fitted with a brake pressure regulator.*

6. While supporting the front of the axle beam, loosen and remove the bolts which hold the axle beam mounting brackets to the body.

7. Remove the rear suspension by pulling out to the rear.

### Rear axle beam, installing

1. If the axle beam mounting brackets have been removed from the axle beam, or if the bracket pivot bolts have been loosened, align the brackets at 12° ± 2° to the axle beam. Then tighten the pivot bolts and nuts. See Fig. 8.

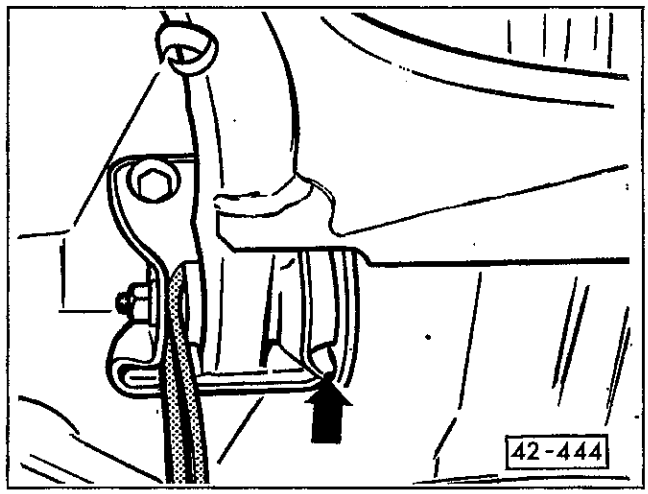
**Tightening torques**
- Mounting bracket to bushing . . . . . 80 Nm (59 ft-lb)

2. Position the rear suspension assembly under the car and loosely install the mounting bolts.

3. Position the right (passenger-side) mounting bracket so that the bolts are centered in the elongated holes. Tighten right bracket bolts.

**Tightening torques**
- Mounting bracket to body . . . . . 70 Nm (52 ft-lb)

4. Use a set of prybars, lever the left mounting bracket so that only a minimal gap is left between the inside of bushing and mounting bracket. See Fig. 6. Tighten the left bracket mounting bolts.




42-444

**Fig. 6.** Press left axle beam mounting bracket to left so that only small gap exists on right side of bracket (**arrow**).

5. Clean the brake line unions and reconnect the flexible brake hoses to the rigid brake lines.

**Tightening torques**
- Brake line unions . . . . . 15 Nm (11 ft-lb)

6. Remount the rear shock absorbers.

7. Reconnect the parking brake cables.

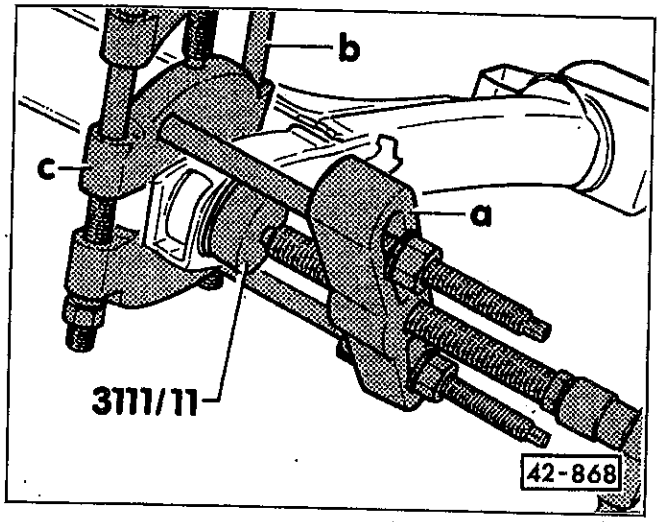
8. Install the rear wheels and carefully lower the car. Install and tighten the shock mounts as described under **Rear shock, removing and installing**.

9. Bleed the brakes and adjust the parking brake as described in **47 Brakes–Hydraulic System** and **46 Brakes–Mechanical Components**.

## Rear axle beam bushing, replacing

1. Remove rear axle beam as described previously.
2. Remove pivot bolt and nut from mounting bracket and remove bracket from the axle beam.
3. Using an appropriate press tool, press bushing out of axle. See Fig. 7.

***NOTE —***
*Remove any corrosion near bushing before pressing out.*

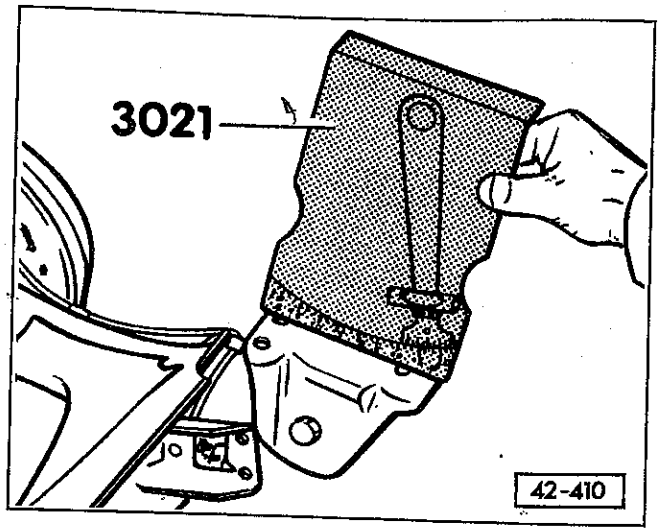



42-868

**Fig. 7.** Rear axle bushing being pressed out. Numbers indicate Volkswagen special tools.

4. Press new bushing into the axle, noting the following:
   - The new bushing must protrude from axle 8.0 mm ± 1.0 mm (0.32 + 0.04 in.).
   - Prior to installing rear axle, adjust the mounting bracket to 12° ± 2° to the axle and then tighten the bracket mounting nut. See Fig. 8.
5. The remainder of installation is the reverse of removal.

**Tightening torques**
- Mounting bracket to bushing ..... 80 Nm (59 ft-lb)




42-410

**Fig. 8.** Axle beam mounting bracket being aligned at 12° ± 2° angle to axle beam prior to axle beam installation. Protractor shown is Volkswagen special tool no. 3021.

## WHEEL BEARINGS

The rear wheel bearings are of the tapered-roller design. Aside from periodically adjusting play, the rear wheel bearings are generally maintenance free. When replacing the wheel bearings, press equipment should be used to install the bearing races into the brake hub.

Fig. 10 shows an exploded view of the wheel bearing and stub axle assembly for cars with 4-wheel disc brakes. Fig. 11 shows an exploded view of the wheel bearing and stub axle assembly for vehicles with rear drum brakes.

***CAUTION —***
- *Do not use solvent to clean bearings. Wipe with clean rag and repack before installing.*
- *Adjust wheel bearing play carefully.*
- *Proper sealing, cleanliness and precise adjustment are essential to long wheel bearing service life.*

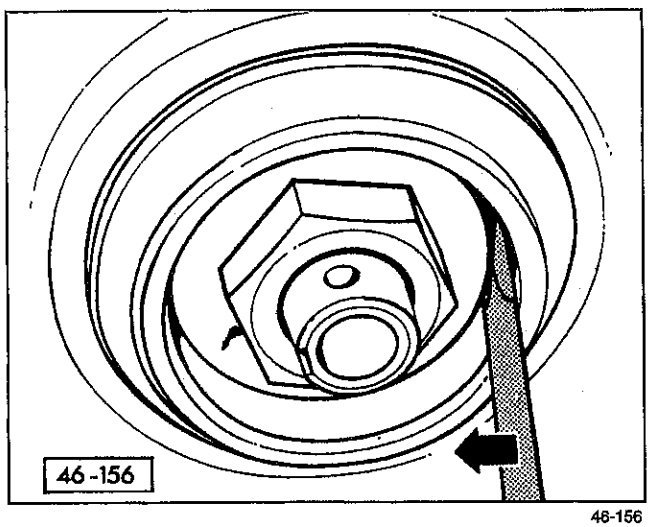
## Wheel bearing play, adjusting

1. Raise the car and support it on jack stands. Remove the wheel.
2. Carefully pry off the grease cap in the center of the brake drum or disc. Remove the cotter pin and lock ring.
3. Loosen and then tighten the axle nut to the torque given below while rotating the disc/drum.

**Tightening torques**

- Wheel bearing axle nut
  stage 1 ..... 10 Nm (87 in-lb)

4. Loosen the nut slightly.
5. While rotating the disc/drum, tighten the axle nut slowly in small increments until the thrust washer can just barely be moved back and forth with a light push on the tip of a screwdriver (do not pry or twist screwdriver). See Fig. 9.




46-156

**Fig. 9.** Wheel bearing adjustment being checked. Axle nut is tightened correctly when thrust washer moves only with slight pressure.

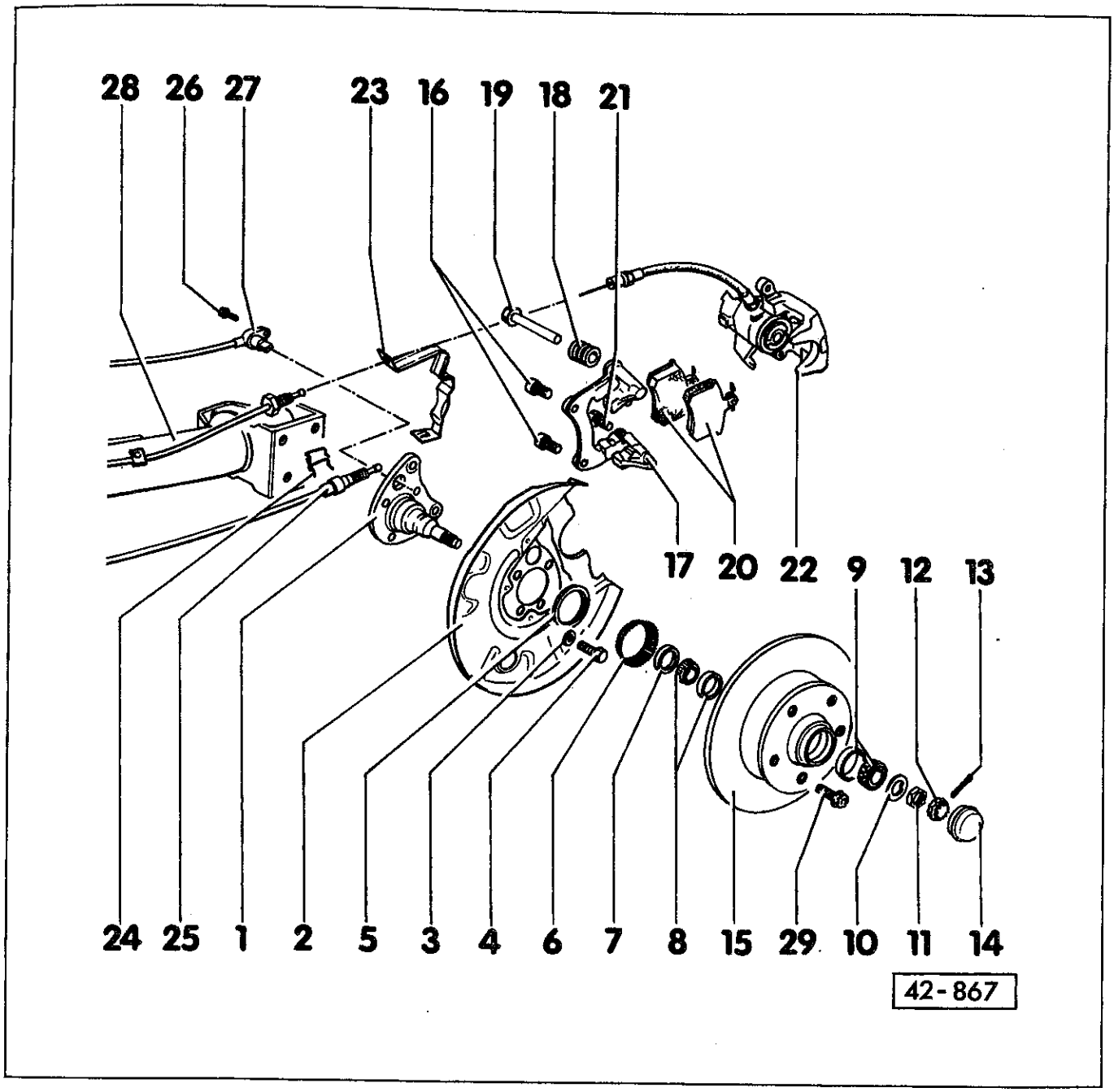
6. Secure nut with locking ring and new cotter pin. Install the grease cap. If necessary, tighten the axle nut slightly so that the locking ring aligns with the hole in the stub axle.

> ***CAUTION—***
> *Always use a new cotter pin. Do not reuse the previously installed cotter pin.*

## Wheel bearing and axle (disc brakes), assembly

1. **Stub axle**
   - Contact surface against axle beam must be completely clean
   - Do not attempt to straighten
2. **Splash shield**
3. **Dished washer**
   - Large contact surface (concave side) faces splash shield
4. **Bolt**
   - Tighten to 60 Nm (44 ft-lb)
5. **Cover ring**
6. **Rotor for ABS Wheel Speed Sensor**
   - Only for vehicles with ABS
7. **Seal**
   - Fill area between sealing lips with grease when installing
8. **Inner wheel bearing**
   - Drive race out with copper drift
   - See **Rear wheel bearing, installing (disc brakes)**
9. **Outer wheel bearing**
   - Drive outer race out with copper drift
   - See **Wheel bearings, replacing**
10. **Thrust washer**
11. **Hex nut**
    - Tighten to adjust wheel bearing. See **Wheel bearing play, adjusting**.
12. **Lock ring**
13. **Cotter pin**
    - Always replace
14. **Grease cap**
15. **Brake disc**
    - Coat inside of hub with grease before installing
16. **Bolt**
    - Tighten to 56 Nm (41 ft-lb)
17. **Brake pad carrier**
18. **Protective cap**
19. **Guide bolt**
20. **Brake pads**
21. **Bolt**
    - Tighten to 35 Nm (26 ft-lb)
    - Always replace
22. **Brake caliper**
    - See **47 Brakes–Hydraulic System**
23. **Brake hose bracket**

## Wheel bearing and axle (disc brakes), assembly




42-867

**Fig. 10.** Exploded view of rear wheel bearings and stub axle for cars with 4-wheel disc brakes.

24. **Spring clamp**
25. **Parking brake cable**
    - Adjusting See **46 Brakes–Mechanical Components**
26. **Bolt**
    - Tighten to 10 Nm (89 in-lb)
27. **ABS wheel speed sensor**
    - Only for vehicles with ABS
28. **Axle beam**
29. **Wheel lug bolt**
    - Tighten to 110 Nm (81 ft-lb)

## Wheel bearing and axle (drum brakes), assembly

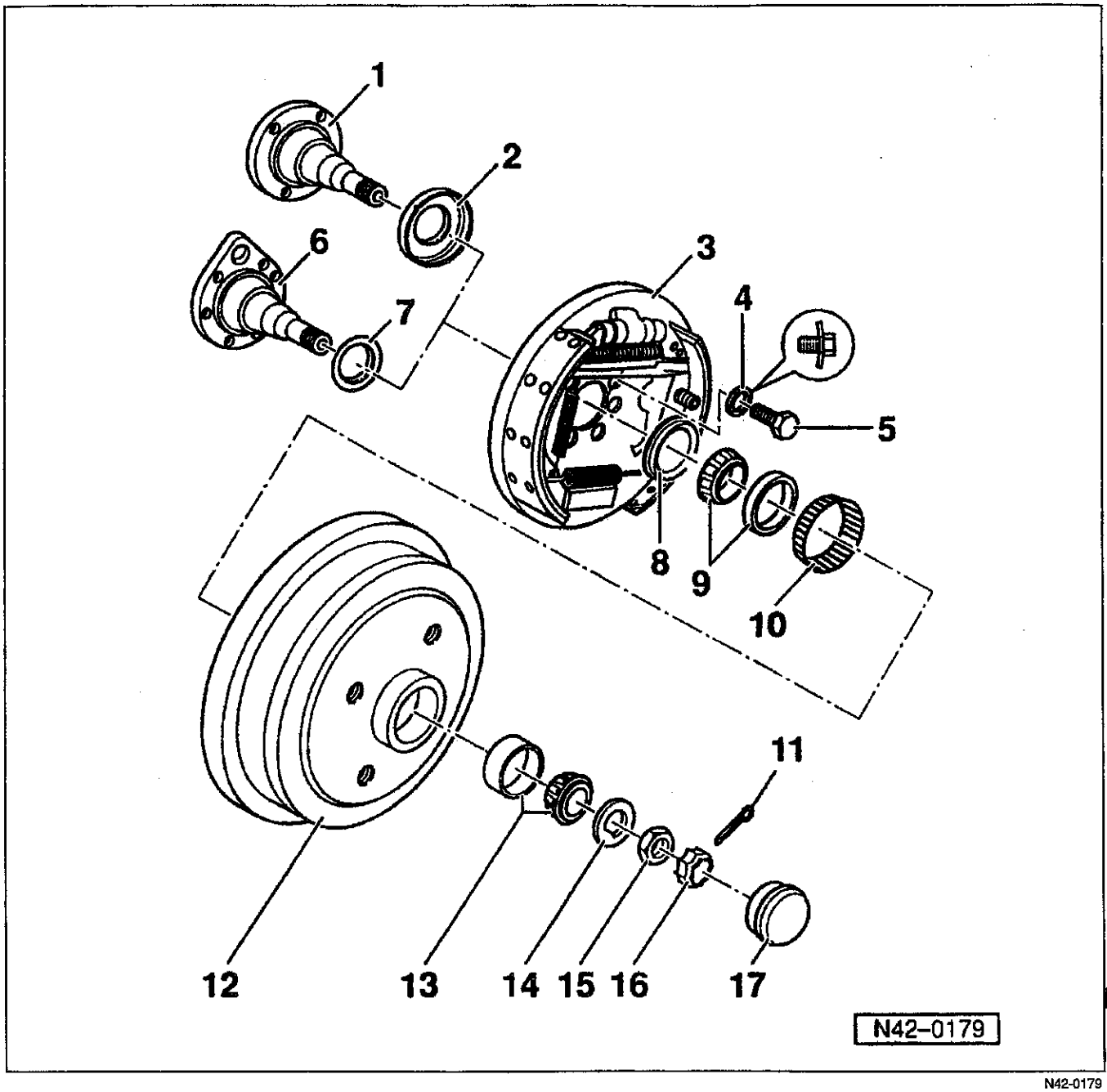



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**Fig. 11.** Exploded view of rear wheel bearings and stub axle for cars with rear drum brakes, with and without ABS.

1. **Stub axle**
   - Contact surface against axle beam must be clean
   - Do not attempt to straighten
2. **Cover ring for vehicles without ABS**
3. **Backing plate**
   - Bolt onto rear axle beam along with stub axle
4. **Dished washer**
   - Large contact surface (concave side) faces brake backing plate
5. **60 Nm (44 ft-lb)**
6. **Stub axle for vehicles with ABS**
   - Do not attempt to straighten

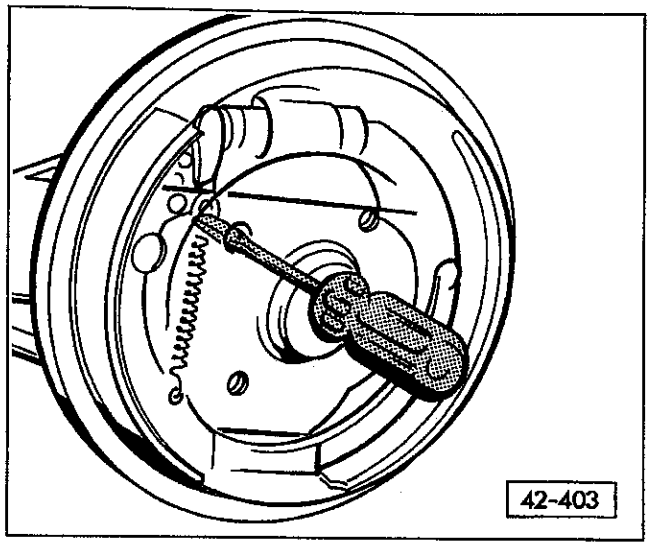
7. **Cover ring for vehicles with ABS**
8. **Seal**
   - Fill gaps between sealing lips with grease
9. **Inner wheel bearing**
   - Drive race out with copper drift
   - See **Wheel bearings, replacing**
10. **Rotor**
    - Only on vehicles with ABS
11. **Cotter pin**
    - Always replace
12. **Brake drum**
    - Release brake shoe adjusting wedge through wheel bolt hole before removing. See **Wheel bearings, replacing**
    - When removing make sure outer wheel bearing does not fall out
    - Coat inside of hub with grease before installing
13. **Outer wheel bearing**
    - Drive race out with copper drift
14. **Thrust washer**
15. **Hex nut**
    - Tighten/loosen to adjust wheel bearing play. See **Wheel bearing play, adjusting**
16. **Lock ring**
17. **Grease cap**

## Wheel bearings, replacing

1. Raise the car and support it on jack stands. Remove the wheel.

> ***WARNING—***
> *Jack stands should be placed on a hard level surface (e.g. concrete).*

2. On cars with rear drum brakes, release brake shoes by inserting a screwdriver through front, top wheel bolt hole and pushing up adjusting wedge. See Fig. 12.



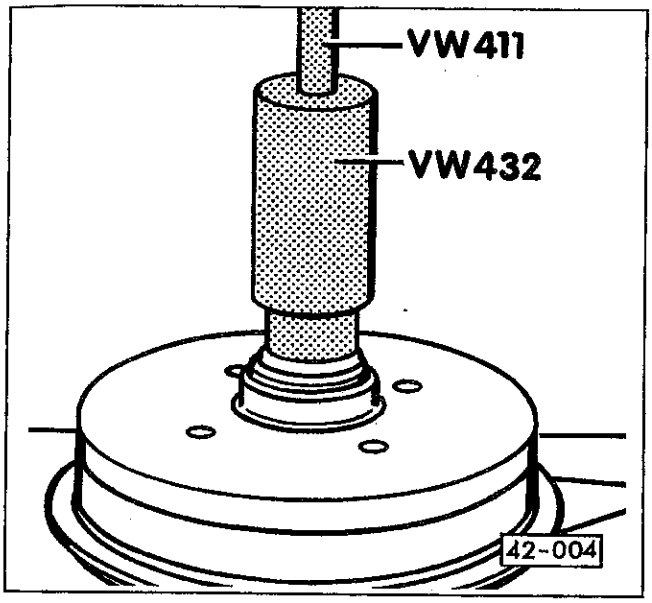

42-403

**Fig. 12.** To remove brake drum, release brake shoes by inserting screwdriver through wheel bolt hole while pushing up on adjusting wedge.

3. On cars with 4-wheel rear disc brakes, remove brake caliper. See **46 Brakes–Mechanical Components.**
4. Remove grease cap from center of brake drum/rotor.
5. Remove cotter pin and lock ring from stub axle. Remove wheel bearing nut. Slide brake drum/rotor straight off axle.

> ***NOTE—***
> *If necessary, rock the brake drum/rotor side-to-side to aid removal of the washer and outer wheel bearing.*

6. Remove grease seal and inner wheel bearing from brake drum/rotor.
7. Using a drift, drive the wheel bearing races from the brake drum or brake rotor.
8. Press new races into the brake rotor or brake drum. See Fig. 13.
9. Pack wheel bearings with lithium-based wheel bearing grease. Lightly coat bearing races and hub with grease.




42-004

**Fig. 13.** Outer bearing race being pressed into brake drum. Numbers indicate Volkswagen special tools.

> ***CAUTION—***
> *Proper packing of wheel bearings is essential for long bearing service life. Use a wheel bearing packing tool if available.*

10. Place inner wheel bearing in race and install new inner seal.

11. Apply grease to gap between sealing lips on inner seal.

12. Slide the brake drum or rotor onto the stub axle. Use caution to avoid damaging the grease seal.

13. Install the outer wheel bearing, thrust washer and axle nut. Tighten the axle nut while rotating the brake drum or rotor.

14. Adjust rear wheel bearing play as described earlier under, **Wheel bearing play, adjusting**. Install lock ring and new cotter pin.

15. Fill grease cap with 10 grams of grease and install.

16. The remainder of installation is the reverse of removal.
    - On cars with disc brakes, install the caliper and adjust the parking brake as described in **46 Brakes–Mechanical**.
    - On cars with rear drum brakes, adjust the rear brake shoes and parking brake as described in **46 Brakes–Mechanical**.

**Tightening torques**

- Road wheel to wheel hub. . . . . 110 Nm (81 ft-lb)

# 44 Wheels–Tires, Wheel Alignment



**TABLES**



## GENERAL

This repair group covers basic tire, wheel, and wheel alignment information. Also covered here is wheel alignment specifications to be used in conjunction with professional alignment tools and measuring equipment.

### Wheels and tires

Wheels and tires approved by the manufacturer have been matched to the vehicle and contribute largely to road handling and driving characteristics. To retain the handling characteristics, it is recommended that the tires be replaced only with tires having the same specifications with regard to size, design, load carrying capacity, speed rating, tread pattern, tread depth, etc. This information can be found on the tire's sidewall. See Fig. 1.

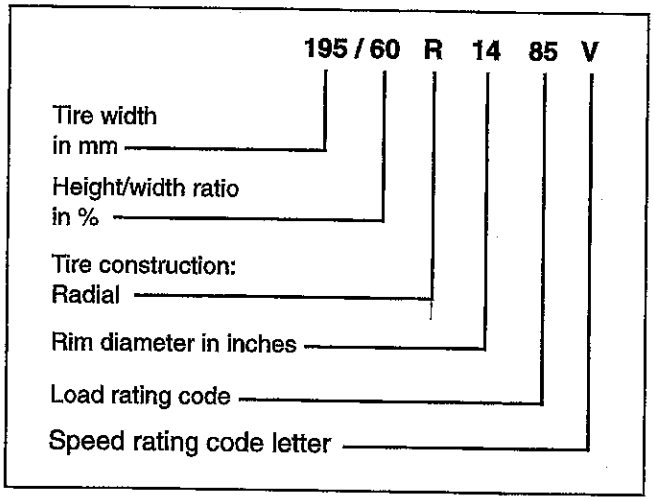



**Fig. 1.** Tire sidewalls are marked with important tire specifications.

Volkswagen recommends that the tires be rotated front to back, with the tires remaining on the same side of the vehicle. Only when tires show unusual wear should they be rotated diagonally. See **0 Maintenance Program** for maintenance schedules regarding tire rotation.

## WHEEL ALIGNMENT

Tire pressures, tire wear, and wheel alignment will all influence how the car feels and responds on the road. For stability and control, all four wheels and tires must be in good condition, balanced, and be properly aligned. Precise wheel alignment can only be accomplished when the tires, the suspension, and the steering are in good condition. Reputable wheel alignment technicians will always inspect the front and rear suspension and the steering for worn parts before an alignment, and will recommend that any necessary repairs be made before proceeding. The important front wheel alignment angles are camber, caster, and toe. In the rear, the important angles are camber, toe and thrust line. Although rear alignment angles are not generally adjustable, they should be checked because of the effect that they have on rear tire wear and straight-line stability of the vehicle.

**Camber** is the angle that the wheels tilt from vertical when viewed from front or rear, as illustrated in Fig. 2. Wheels which tilt out at the top have positive (+) camber. Wheels that tilt in at the top have negative (–) camber. On the Volkswagens covered by this manual, camber adjustment is not normally required, although there are provisions for making camber adjustments if necessary.

Camber influences cornering, directional stability, and tire wear. Different camber on the two front wheels may cause the car to pull to one side. Incorrectly adjusted camber will cause uneven tire wear.

**Caster** is the angle at which the steering axis deviates from vertical, as shown in Fig. 3. Most cars are designed with positive caster, which improves directional stability and tends to make the steering more self-centering. Caster angle should be checked as part of wheel alignment, but it is not adjustable on cars covered by this manual.

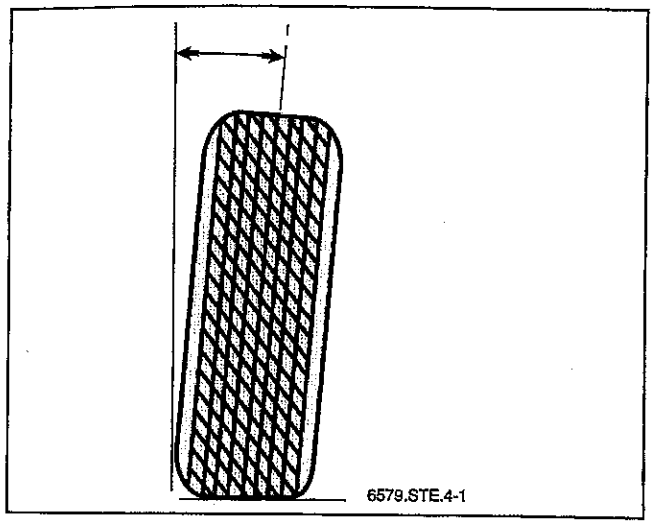



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**Fig. 2.** Camber is the wheel/tire deviation from vertical as viewed from front or rear.

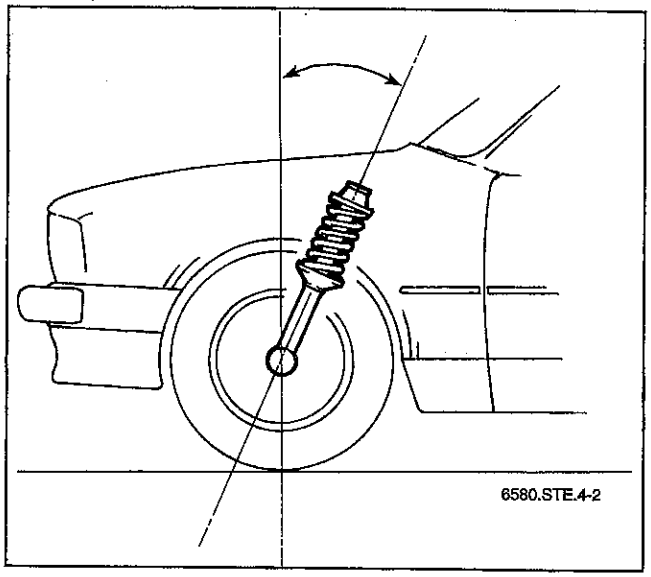


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**Fig. 3.** Caster is the angle of steering axis inclination from vertical.

**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). Toe affects directional stability and tire wear. Toe also affects response to steering input. Too much toe will cause tires to scrub and to wear unevenly and quickly. Too little toe may cause the car to be less stable and wander at highway speeds. Toe-in is illustrated in Fig. 4.

## Wheel alignment, checking

Wheel alignment specifications are given in **Table a** and **Table b.** Be sure the checking requirements are met before carrying out a wheel alignment.

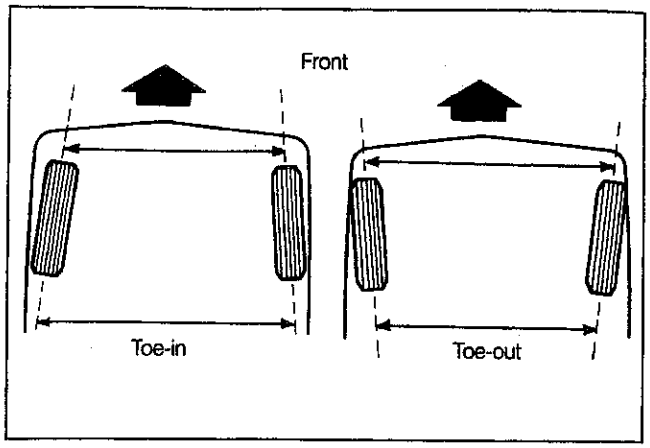


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**Fig. 4.** Front wheel toe.

**Checking requirements**

- Vehicle at curb weight [1]
- Tires correctly inflated [2]
- Suspension bounced several times
- No excessive play or damage to steering or linkage
- No excessive play or damage to suspension

[1] Curb weight is defined as the weight of vehicle ready for the road:
- Full fuel tank
- Equipped with spare wheel
- Equipped with tool kit, if included
- Equipped with vehicle jack

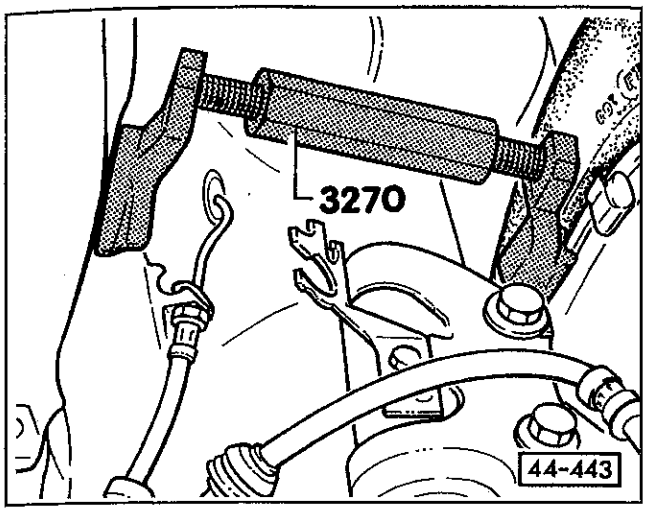
[2] Tire sizes and pressures, see specification label on vehicle, located on passenger-side rear door pillar (B-pillar on 2-door vehicles, C-pillar on 4-door vehicles)

## Front wheel camber, adjusting

Front wheel camber can be adjusted as part of a front wheel alignment. The procedure requires a special Volkswagen tool.

> ***CAUTION—***
> *This adjustment procedure must only be carried out on specialized wheel alignment equipment, as part of a front wheel alignment.*

1. Working in the front wheel housing, install Volkswagen special tool no. 3270 between the front wheel and the body as shown in Fig. 5. Tension the tool slightly so that all slack is removed.
2. Loosen the two bolts connecting the suspension strut to wheel bearing housing.
3. Set camber to specification by turning the threaded spindle on the tool.
4. Once the adjustment is correct, tighten the suspension strut/wheel bearing housing bolts.




44-443

**Fig. 5.** Volkswagen special tool no. 3270 shown installed in wheel housing.

**Tightening torques**

- Strut assembly to wheel bearing housing . . . . . 95 Nm (70 ft-lb)

5. Check camber and repeat procedure if necessary.

## Table a. Wheel Alignment Data—Front Suspension

| Suspension | Base Suspension 1993-1994 | | Base Suspension 1995-1999 | Plus Suspension 1993-1999 |
|---|---|---|---|---|
| **Engine** | 1.8 Liter (ACC)<br>1.9 Liter (AAZ) | 2.0 Liter (ABA) | All 4-cylinder engines | All VR-6 engines |
| **Total toe** [1] (wheels not pressed) | 0° ± 10' | | | |
| **Camber** [2] (in straight-ahead position) | –30' ± 20' | –35' ± 20' | –36' ± 20' | –40' ± 20' |
| Maximum permissible difference between left and right | 20' | | | |
| Toe angle difference at 20° lock from left to right | –1° 5' ± 20' | | | –1° 30' ± 20' |
| **Caster** (not adjustable) | +1° 45' ± 30' | +1° 50' ± 30' | | +3° 25' ± 30' |
| Maximum permissible difference between left and right | 30' | | | |

[1] Adjust total toe on right tie rod only, set left tie rod to length. See **48 Steering**
[2] Camber can be corrected only at wheel bearing housing/suspension strut connection

## Table b. Wheel Alignment Data—Rear Suspension (non-adjustable)

| | |
|---|---|
| **Camber** | –1° 30' ± 10' |
| Maximum permissible difference between left and right | 20' |
| **Total toe** (with specified camber) | +20' ± 10' |
| Maximum permissible deviation from direction of travel (see Fig. 4) | 20' |

# 45 Anti-Lock Brakes (ABS)



## GENERAL

Various ABS systems with and without traction control are used on the cars covered by this manual, depending on model and date of manufacture. The traction control system, called EDL (electronic differential lock), works in conjunction with the ABS system by alternately applying the front brakes to control wheel spin during low speed acceleration. For more general information on ABS and traction control, see **4 General Information.**

This repair group covers basic troubleshooting and service to the Anti-Lock Braking Systems. System function, component locations, and adjustments are covered in detail. In-depth electrical/electronic troubleshooting and diagnosis are not included as part of in this repair group, as special Volkswagen test equipment is needed to properly diagnose the system.

***NOTE—***

- *The ABS system features built-in diagnostic circuitry that detects and stores Diagnostic Trouble Code (DTC) information. When the system detects a fault, a DTC is generated and stored in the ABS control module's permanent memory. These fault codes can be accessed through the data link connector(s) in the dashboard using Volkswagen Scan Tool V.A.G. 1551.*
- *If an ABS malfunction is stored, ABS is switched off and the ABS warning light comes on. Malfunctions of the ABS system do not influence the brake system in normal braking conditions.*

## Special precautions for ABS cars

The ABS control module processes precise, low-level electrical signals and can be sensitive to changes in the power supply and the environment. The following precautions apply to cars with ABS.

***WARNING—***

- *ABS is a vehicle safety system; appropriate knowledge and special equipment are necessary to work on the system.*
- *The ABS/EDL system must be bled after work that requires opening the brake hydraulic system. See **47 Brakes-Hydraulic System.***

***CAUTION—***

- *On vehicles with an anti-theft radio, obtain the radio code before disconnecting the battery.*
- *Always disconnect the battery terminals before quick-charging the battery. Never disconnect the battery while the engine is running. Never use a battery charger or auxiliary battery producing more than 16 volts when jump-starting.*
- *Remove the ABS control module from the car before repairs that involve high temperatures. The control module should never be exposed to temperatures greater than 176° F (80° C).*
- *Do not work with compressed air or move the vehicle when the hydraulic system is open.*
- *Do not drive car with harness connector disconnected from ABS control module.*

***CAUTION—***

- *Always disconnect the negative (–) battery terminal before working on the ABS or ABS/EDL system.*
- *Before doing any welding on the vehicle with an electric welder disconnect the ABS control module.*
- *Absolute cleanliness is required when working on the ABS system. DO NOT use mineral oils, grease or aggressive cleaning agents such as brake cleaner, gasoline or thinners.*
- *Use clean lint-free cloths and take care to seal or cover opened components if a repair cannot be completed immediately.*

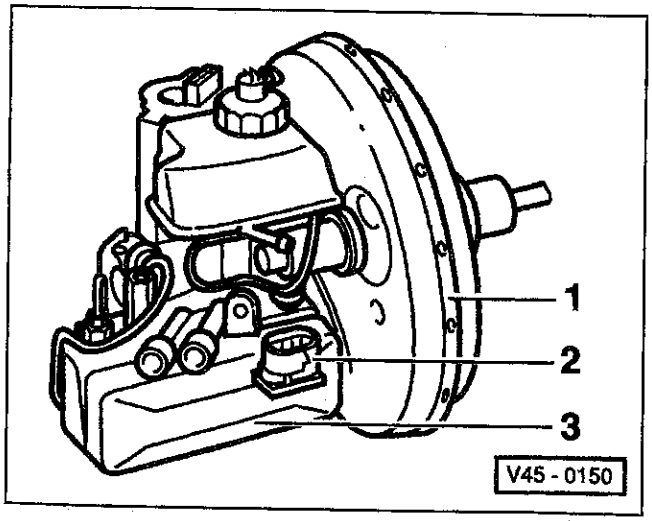
## Applications–identifying features

Most early cars are equipped with the "Teves 04" ABS system (also referred to as "Mark IV"). Late cars are equipped with the "Teves 20 GI" ABS system. In addition, both systems are available with traction control, called EDL.

***NOTE—***

*EDL stands for electronic differential lock, although the ABS/EDL system does not act on the differential.*

The Teves 04 and the Teves 20 GI systems are easily distinguishable from each other. Fig. 1 shows the Teves 04 ABS/EDL unit. Fig. 2 shows the Teves 20 GI ABS/EDL unit. Distinguishing features are listed below each illustration.




V45-0150

**Fig. 1.** Teves 04 ABS/EDL unit with vacuum brake servo (**1**), harness connector (**2**), and valve block (**3**).

**Distinguishing features–Teves 04 ABS/EDL**

- **ABS only**
  - -10" brake servo (**1**)
  - -10 pins used on 15-pin harness connector (**2**)
- **ABS with EDL**
  - -10" brake servo (**1**)
  - -14 pins used on 15-pin harness connector (**2**)
  - -Longer valve block (**3**) for ABS/EDL than for ABS alone
  - -Series resistor for EDL (see Fig. 3, given later)

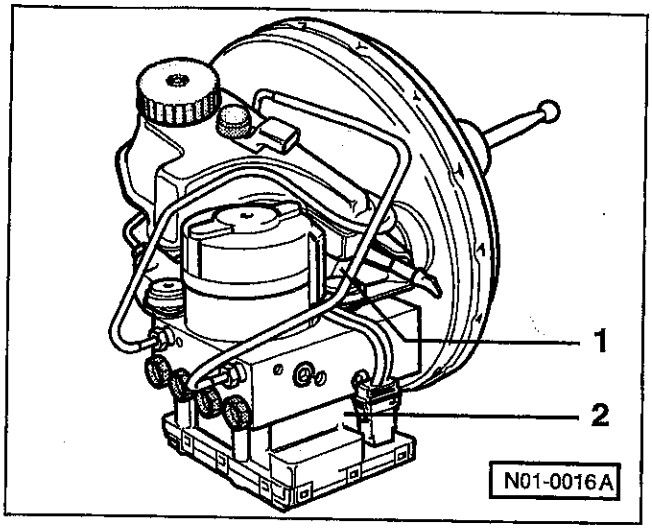



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**Fig. 2.** Teves 20 GI ABS/EDL unit. The ABS hydraulic unit (**1**) and the ABS control module (**2**) together make up one component.

**Distinguishing features–Teves 20 GI ABS/EDL**

- **ABS only**
  - - 10" brake servo
  - - 8-valve hydraulic unit (valve sleeves are visible when ABS control module is separated from ABS hydraulic unit)
- **ABS with EDL**
  - - 10" brake servo
  - - 10-valve hydraulic unit (valve sleeves are visible when ABS control module is separated from ABS hydraulic unit)
  - -Longer valve block for ABS/EDL than for ABS alone

***NOTE—***

*Volkswagen identifies electrical components alpha-numerically in the electrical schematics. See* **97 Wiring Diagrams, Fuses and Relays.** *Where applicable, these alpha-numeric codes will be listed with the component as an aid to electrical troubleshooting.*

# ABS, ABS/ EDL–TEVES 04

The Teves 04 ABS /EDL system is a three channel system; the front brakes are controlled independently and the rear wheels are controlled as one circuit. The system utilizes dual diagonal brake circuits. On cars equipped with the VR6 engine, a low speed traction control system, called EDL, is integrated into the ABS system.

## Self-diagnosis function–Teves 04

After switching the ignition on, the ABS warning light lights up for approx. 2 seconds. During this period a self-test sequence is carried out by the ABS control module with checks of the following functions:

- Hydraulic pump runs at low speed
- Brief valve activation after switching the ignition on

If an ABS malfunction is stored, ABS is switched off and the ABS warning light comes on. If an EDL malfunction is stored, the EDL system is also switched off, although these malfunctions are not indicated by the ABS warning light. If ABS or ABS/EDL is switched off due to a malfunction, the conventional hydraulic brake system remains fully operational.

***NOTE—***

- *If the ABS warning light does not light up, but the brake system is not functioning correctly, then the malfunction must be diagnosed in the conventional braking system (e.g. leaks in the brake hydraulic system).*
- *In some cases, certain ABS malfunctions may not be recognized at speeds below 40 km/h (24 mph).*

## Fault diagnosis–Teves 04

Fig. 5 shows the electrical/electronic components for the Teves 04 system. When troubleshooting the ABS/EDL system, make sure the requirements listed below are met. Check that the ground connection for the ABS control module is tight and in good condition. Location of the ground point depends on production date. See Fig. 3 and Fig. 4.

***NOTE—***

*If no faults can be found after reviewing the troubleshooting information given under this heading, have the system serviced by an authorized VW dealer who is equipped and trained to properly diagnose and service the Teves 04 ABS/EDL system.*

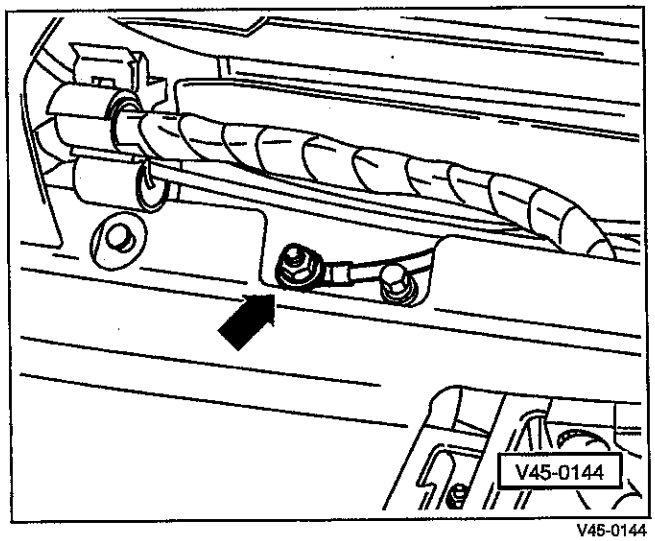
**Troubleshooting requirements**

- Tires on all four wheels must be of the same (approved) size, inflated to correct pressure.
- Conventional brake system OK, including brake light switch and brake lights.
- Brake hydraulic lines and connections not leaking (visual check of ABS hydraulic unit, brake calipers).

**(cont.)**

**Troubleshooting requirements (cont.)**

- Wheel bearings and wheel bearing play OK.
- Connector on ABS control module correctly attached (retainer is engaged).
- Check terminals and sockets on ABS or ABS/EDL components for damage and correct seating.
- ABS relay, ABS hydraulic pump relay and electronic differential lock relay correctly installed/connected
- All fuses according to wiring diagram OK (remove fuse from fuse holder to check).
- Battery (supply) voltage OK (at least 10.5 V).
- ABS control module ground connection OK.




V45-0144

**Fig. 3.** ABS/EDL control module ground location (**arrow**) on cars built up to 01/93 is under right (passenger side) sill panel trim.

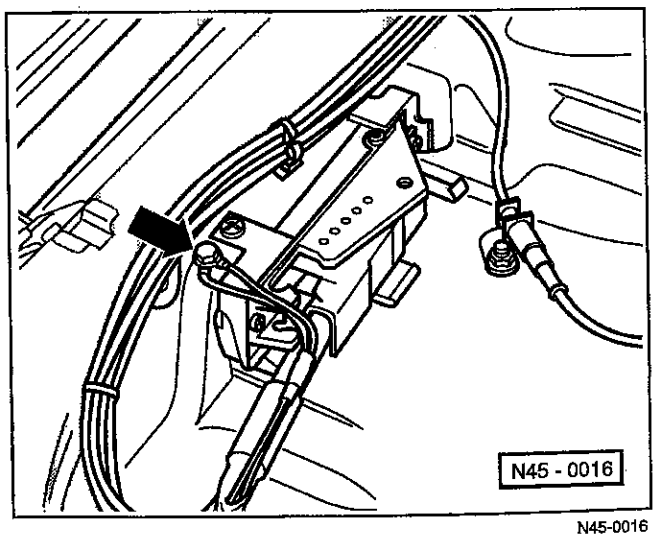



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**Fig. 4.** ABS/EDL control module ground location (**arrow**) on cars built after 01/93 is under rear seat near ABS control module.

## Component locations–Teves 04

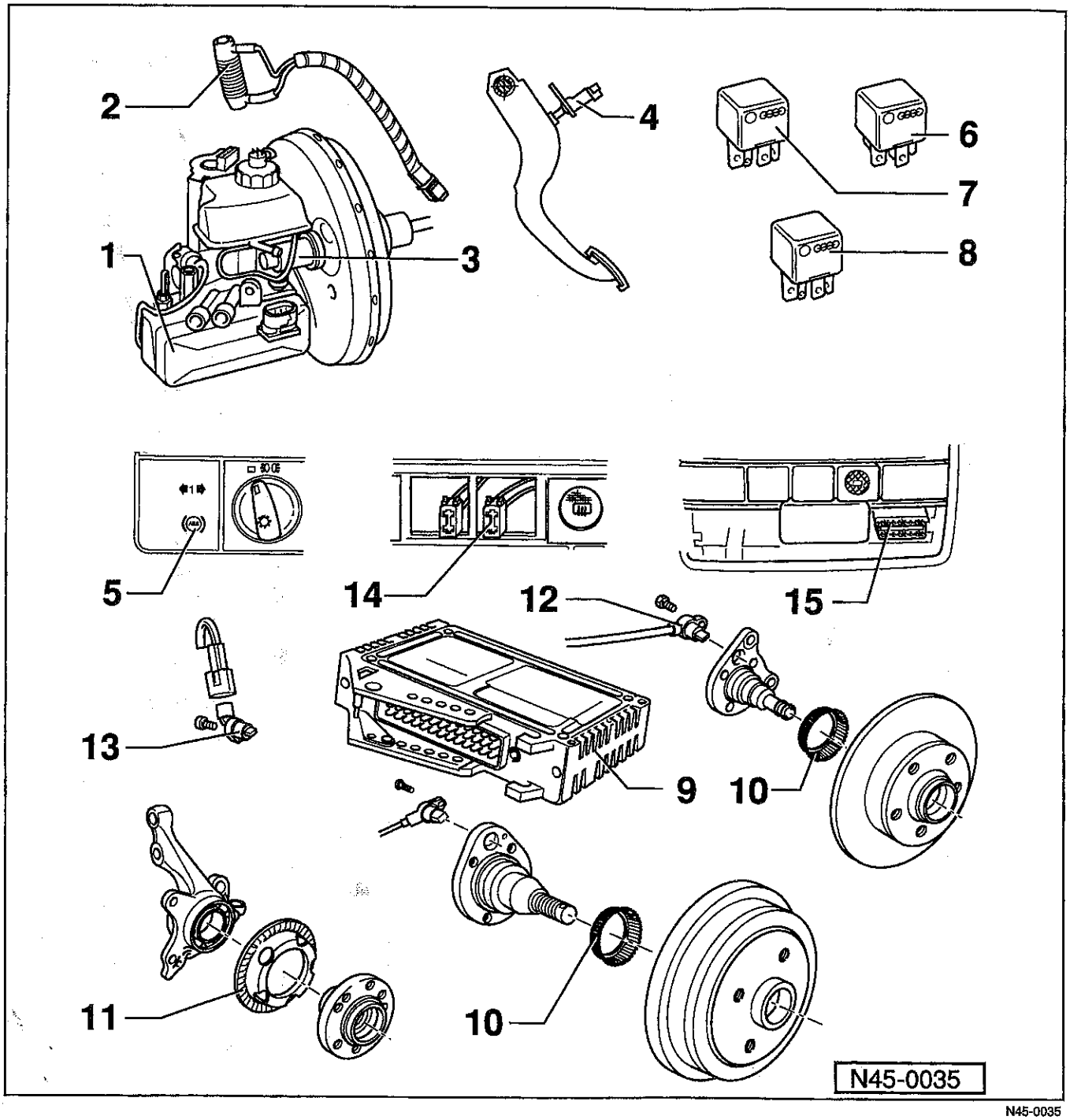


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**Fig. 5.** Teves 04 ABS and ABS/EDL electrical/electronic components.

1. **ABS hydraulic unit (N55)**
   - with ABS hydraulic pump (V64)* and valve block
   - ABS hydraulic pump and valve block must not be separated from one another
2. **EDL series resistance (N159)***
   - Location: on ABS hydraulic unit (N55)
3. **Brake pedal position sensor (G100)***

***NOTE—***
*Components marked with an asterisk (*) are monitored by On Board Diagnostic (OBD) system.*

4. **Brake light switch (F)***
   - Open in the rest position; see **Brake light switch, adjusting**
5. **ABS warning light (K47)**
   - Function: lights for a few seconds after switching ignition on, remains on if one or more malfunctions are recognized
6. **ABS relay (J102)**
   - Location: above relay panel
7. **ABS hydraulic pump relay (J185)**
   - Location: above relay panel
8. **EDL relay (J310)***
   - Location: above relay panel
9. **ABS control module (J104)***
   - Location:
     - Cars built up to 01/93: in footwell, right front below floor mat in front of passenger seat
     - Cars built from 01/93: under rear seat, right side

> ***NOTE—***
> *The vehicle production date can be found on the safety compliance sticker on driver's door jamb (B-pillar).*

10. **Impulse rotor**
    - For left-rear and right-rear ABS wheel speed sensors
11. **Impulse rotor**
    - For left-front and right-front ABS wheel speed sensors
12. **Left-rear/right-rear ABS wheel speed sensor (G44)*/(G46)***
    - Before inserting the sensor, clean the inner surface of the sensor mounting and coat with lubricating paste G 000 650
    - When connecting the ABS wheel speed sensor wire, make sure it is not twisted in wheel housing
    - Mounting bolt tightening torque: 10 Nm (89 in-lb)
    - Resistance: 1.0–1.3 k ohms
13. **Left-front/right-front ABS wheel speed sensor (G45)*/(G47)***
    - Before inserting the sensor, clean the inner surface of the sensor mounting and coat with lubricating paste G 000 650
    - When connecting the ABS wheel speed sensor wire, make sure it is not twisted in wheel housing
    - Mounting bolt tightening torque: 10 Nm (89 in-lb)
    - Resistance: 1.0–1.3 k ohms
14. **Data Link Connectors (DLC) for vehicles built up to 07/93**
    - Location: below the heating/ventilation controls, next to heated rear window switch
15. **Data Link Connectors (DLC) for vehicles built from 08/93**
    - Location: behind cover, near ashtray

## Control module, removing and installing–Teves 04

Location of the ABS control module depends on the production date. On early cars (built up to 01/93), the ABS control module is in the left front footwell under the floor covering in front of the passenger seat. On later cars (built after 01/93), the ABS control module is under the right-hand side of the rear seat.

> ***CAUTION—***
> *Disconnecting the harness connector from the ABS control module may erase the diagnostic trouble code (DTC) memory. If the system is malfunctioning, check for DTCs using the Volkswagen diagnostic scan tool before disconnecting connector.*

1. Make sure ignition is off. Press the ABS control module fastening clips together and pull out.

> ***CAUTION—***
> *The ignition must be off when disconnecting the harness connector from the ABS control module.*

2. Release the connector latch (fold latch down) and pull connector off.
3. Installation is the reverse order of the removal.
   - When positioning the harness connector into the control module, make sure the retaining lugs align with the grooves on ABS control module before pressing the connector onto the module. See Fig. 6.

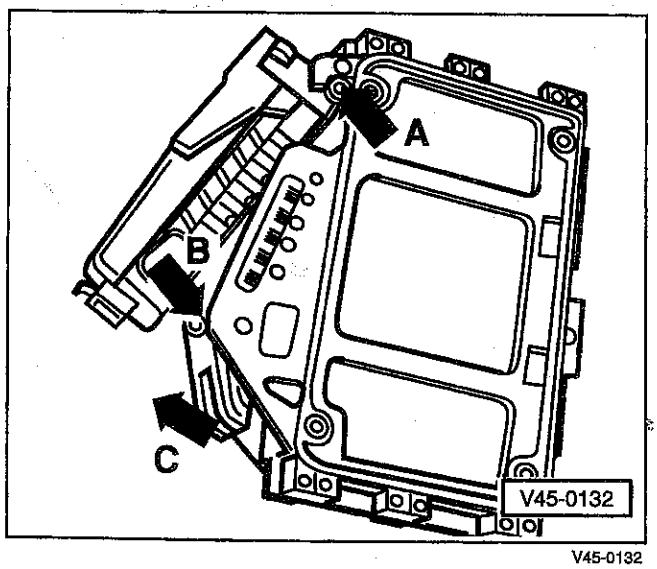


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**Fig. 6.** Connector being installed into ABS control unit. Align lugs with grooves (**arrow A**), press connector into control module (**arrow B**), and lock in place using latch (**arrow C**).

## Hydraulic unit, removing and installing–Teves 04

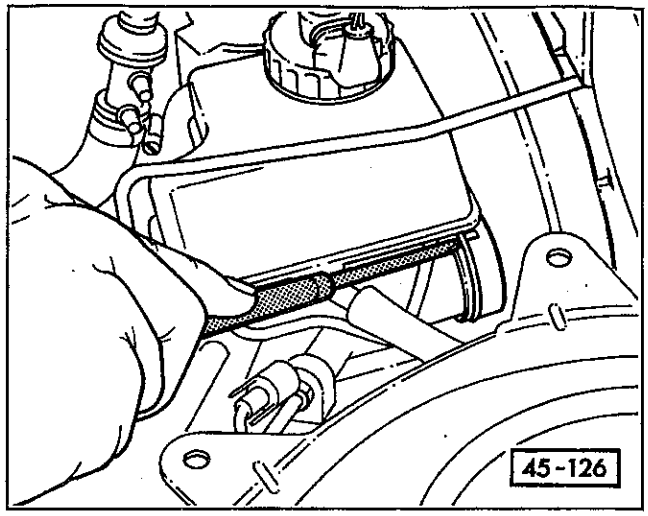
> ***WARNING —***
> - *Review Warnings, Cautions, and Notes on page 45-1 before removing hydraulic unit.*
> - *ABS hydraulic units supplied by Volkswagen as replacement parts may be filled with hydraulic fluid and pre-bled. Check with an authorized Volkswagen dealer parts department for the latest parts information when replacing the hydraulic unit.*

1. Disconnect negative (-) battery cable.
2. Disconnect all electrical connections from ABS hydraulic unit.
3. Remove brake fluid from reservoir (use a clean syringe).
4. Thoroughly clean around all hydraulic lines on ABS hydraulic unit. Then remove lines and seal/plug open connections.
5. Remove shelf below left side instrument panel.
6. Disconnect brake pedal from vacuum brake booster. See **47 Brakes-Hydraulic System**. Remove nuts securing vacuum brake booster to bulkhead.
7. Remove ABS hydraulic unit, complete with brake master cylinder and vacuum brake booster, from engine compartment.
8. Installation is the reverse of removal. Once installation is complete, bleed brake system, see **47 Brakes–Hydraulic System**. Reconnect the battery.

**Tightening torques**
- Brake booster to bulkhead . . . . . 25 Nm (18 ft-lb)
- Hydraulic lines to ABS (M10 or M12) . . 15 Nm (11 ft-lb)

## Brake pedal position sensor, removing and installing–Teves 04

1. Release vacuum from brake booster by operating brake pedal several times.
2. Move coolant expansion tank to one side.
3. Remove wiring harness connector from brake pedal position sensor.
4. Pry out circlip from brake pedal position sensor with scribe or similar tool. See Fig. 7.

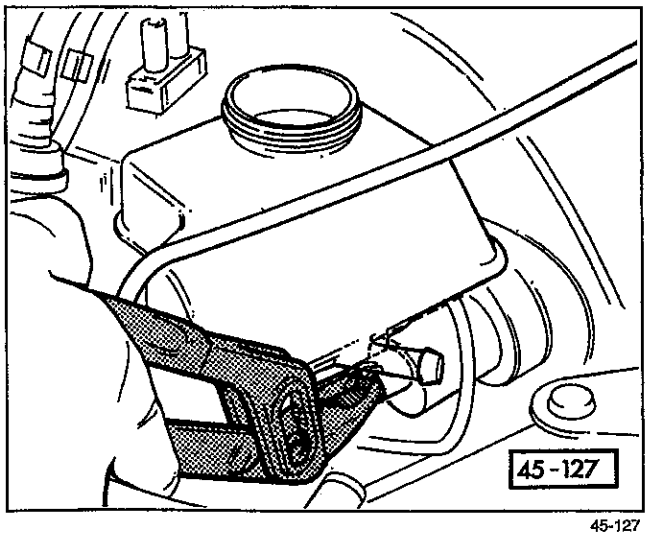



45-126

**Fig. 7.** Circlip being removed from brake pedal position sensor.

5. Pull brake pedal position sensor from brake booster. See Fig. 8.

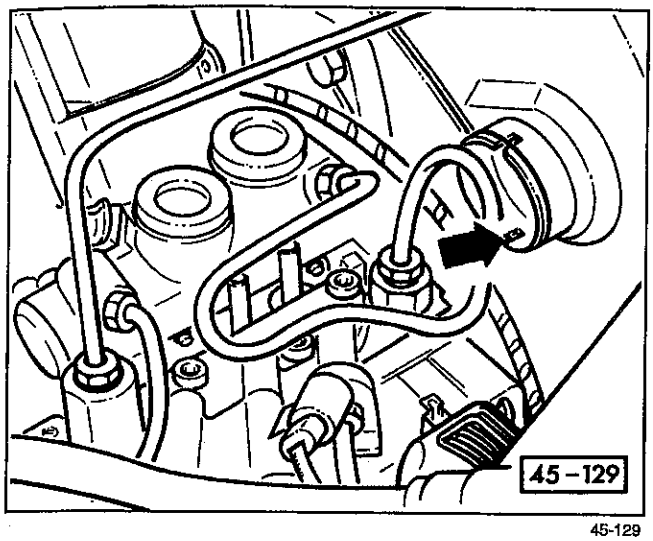
> ***CAUTION —***
> *The brake pedal position sensor is supplied from Volkswagen as a replacement part in repair kit form. The kit contains the O-ring, circlip and four different spacer caps of different length and color (white, green, blue, and red). The replacement brake pedal position sensor spacer cap must be the same color as the part removed from the vehicle. The color is also marked on the top of the brake booster housing near the sensor.*




45-127

**Fig. 8.** Brake pedal position sensor being removed from brake booster.

6. Install new circlip so that gap in circlip points downward. See Fig. 9.




45-129

**Fig. 9.** Install circlip so that gap in circlip points down (**arrow**).

7. Coat new O-ring seal with lubricant (e.g. soft soap) and install on sensor.

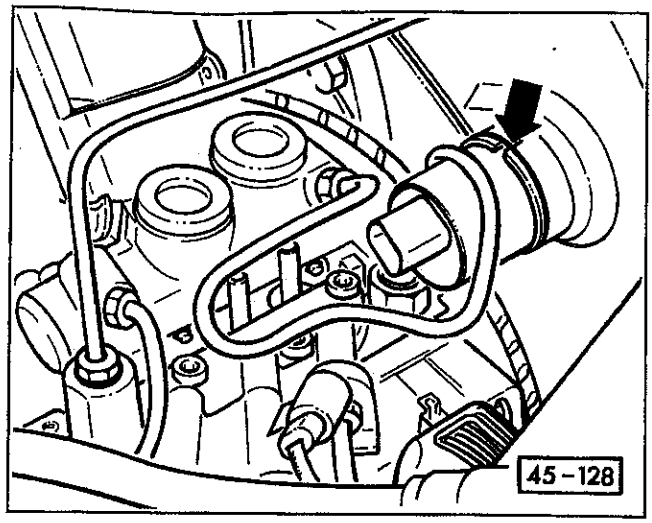
> ***CAUTION—***
> *If the O-ring does not seal properly, insufficient braking power and poor idling might result.*

8. Insert the sensor into the brake booster so that the groove in the sensor is 180° opposed to the circlip gap. See Fig. 10.

***NOTE—***

- *Listen for a click as circlip locks into groove of sensor. Gently pull on sensor by hand to ensure that it is seated.*
- *Fig. 10 shows the brake fluid reservoir removed for illustration purposes only.*

9. Reconnect wiring harness connector. Move coolant expansion tank back to original position.




45-128

**Fig. 10.** Install brake pedal position sensor so that groove (**arrow**) is 180° opposed to circlip gap.

## Brake light switch, adjusting–Teves 04

> ***CAUTION—***
> *Shut off engine and apply parking brake before removing brake light switch.*

1. Remove brake light switch by rotating it 90° clockwise.

***NOTE—***

- *It is necessary to first remove brake light switch to adjust it. Brake light switch is located above brake pedal in pedal bracket.*
- *Once removed, the brake light switch plunger should extend fully out. If not, switch is defective.*

2. Press brake pedal down as far as possible by hand.
3. Guide brake light switch through pedal bracket opening until plunger contacts brake pedal.
4. Lock in position by turning 90° counter-clockwise.
5. Release brake pedal and check function of brake lights.

## Hydraulic unit, vacuum booster and master cylinder–Teves 04 ABS/EDL, assembly

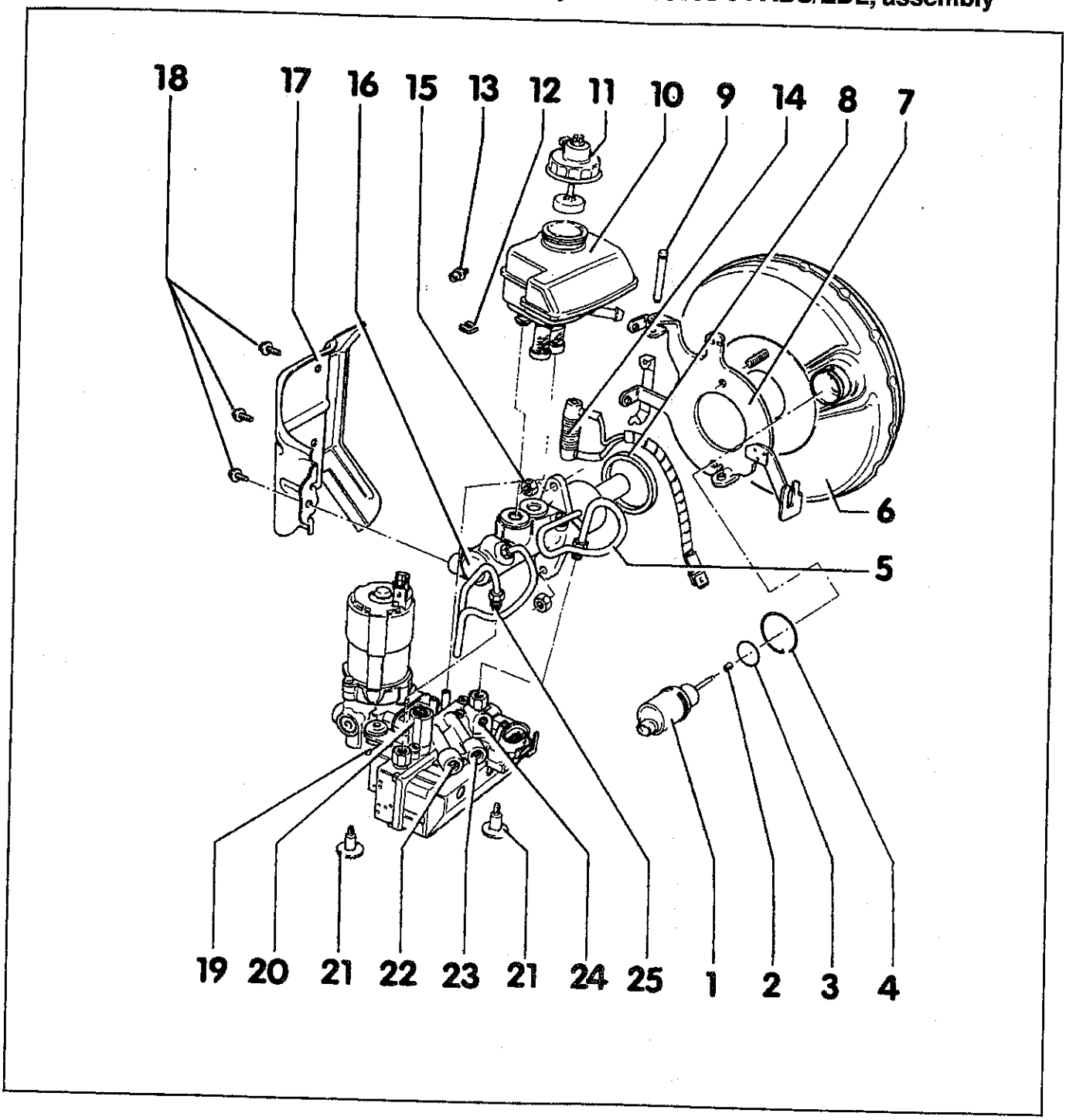



**Fig. 11.** Exploded view of the Teves 04 ABS/EDL unit.

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1. **Brake pedal position sensor (G100)**
   - See **Brake pedal position sensor, removing/installing.**
2. **Spacer cap**
   - Four versions, see **Brake pedal position sensor, installing.**
3. **O-ring**
   - Always replace
4. **Circlip**
   - Always replace

5. **Hydraulic line**
   - Brake master cylinder (primary piston circuit) to ABS hydraulic (N55)
6. **Vacuum brake booster**
7. **Bracket**
8. **Seal**
9. **Pin**
10. **Brake fluid reservoir**
11. **Cap**
12. **Clip**
13. **Screw**
14. **EDL series resistance (N159)**
    - On Board Diagnostic (OBD) component
15. **Self-locking nut**
    - Tightening torque: 25 Nm (18 ft-lb)
16. **Brake master cylinder**
17. **Shield**
18. **Bolt**
19. **ABS/EDL hydraulic unit (N55)**
    - See **Hydraulic unit, removing/installing–Teves 04**
20. **Hydraulic line connection**
    - To right-front brake caliper
21. **Torx bolts (T25)**
22. **Hydraulic line connection**
    - To left-rear brake caliper
23. **Hydraulic line connection**
    - To right-rear brake caliper
24. **Hydraulic line connection**
    - To left-front brake caliper
25. **Hydraulic line**
    - Brake master cylinder (secondary piston circuit) to ABS hydraulic unit (N55)

# ABS, ABS/EDL–TEVES 20 GI

The Teves 20 GI ABS system is a compact design that incorporates the ABS control module as an integral part of the ABS hydraulic unit. On cars equipped with the VR6 engine, a low speed traction control system, called EDL, is also integrated into the ABS system. Fig. 12 shows the Teves 20 GI ABS electrical/electronic components.

Most service and repair to the Teves 20 GI ABS/EDL brake system requires the use of the Volkswagen V.A.G. 1551 scan tool. This includes "coding" of replacement control modules and brake bleeding. Therefore, it is recommended that if no faults can be found after reviewing the information given in this repair group, the system be serviced by an authorized VW dealer who is equipped and trained to service the Teves 20 GI ABS and ABS/EDL systems.

***CAUTION—***

- *Special Volkswagen test equipment is needed to bleed the brakes on cars with Teves 20 GI ABS/EDL. The test equipment tool is used to electronically cycle the ABS hydraulic unit on and off to purge the hydraulic unit/valve body of trapped air.*
- *The Teves 20 GI ABS/EDL control module is "coded" for the specific vehicle application. New ABS control modules from Volkswagen are not coded and must be coded by an authorized Volkswagen dealer. DO NOT use an ABS control module from another vehicle as coding may be different.*

## Self-diagnosis function–Teves 20 GI

After switching the ignition on, the ABS warning light and the warning light for the brake system light up for approx. 2 seconds. During this period a self-test sequence is carried out by the ABS control module to check the following:

- Battery positive voltage (B+); must be at least 10.0 volts
- ABS control module, including valve windings
- ABS wheel speed sensors (electrical test; fully completed at approx. 12 mph)
- ABS control module coding

## Fault diagnosis–Teves 20 GI

If an ABS malfunction is recognized, ABS is switched off and the ABS warning light comes on.

***NOTE—***

*ABS malfunctions are indicated by the ABS warning light coming on; certain malfunctions will only be recognized at speeds above 12 mph; carry out a road test.*

If the ABS warning light does not go out after completion of self-test sequence, the possible malfunctions are:

- Battery voltage (B+) is below 10 volts.
- Sensor malfunction (sporadic) after last starting the vehicle.
- Open circuit between the ABS warning light module and ABS control module or ABS warning light module faulty.
- Malfunction in ABS circuit.

***NOTE—***
*In the case of a sporadic sensor malfunction, the ABS warning light will go out after restarting the engine and reaching a speed in excess of 12 mph.*

If ABS warning light goes out, but brake system warning light remains on, the possible malfunctions are:

- The parking brake is pulled on.
- The brake fluid level is too low.
- Malfunction in control of warning light for brake system. See **97 Wiring Diagrams, Fuses and Relays**.

***NOTE—***
*If both the ABS warning light and the brake system warning light stay on, then ABS and electronic brake pressure distribution (EBPD) is non-functional. In this case, there will be a change in braking performance, as the brake pressure to the rear wheels will not be regulated.*

## Brake light switch, adjusting–Teves 20 GI

***CAUTION—***
*Shut off engine and apply parking brake before removing brake light switch.*

***NOTE—***
*It is necessary to first remove brake light switch to adjust it. Brake light switch is located above brake pedal in pedal bracket.*

1. Remove brake light switch by rotating it 90° clockwise.

***NOTE—***
*Once removed, the brake light switch plunger should extend fully out. If not, the switch is defective.*

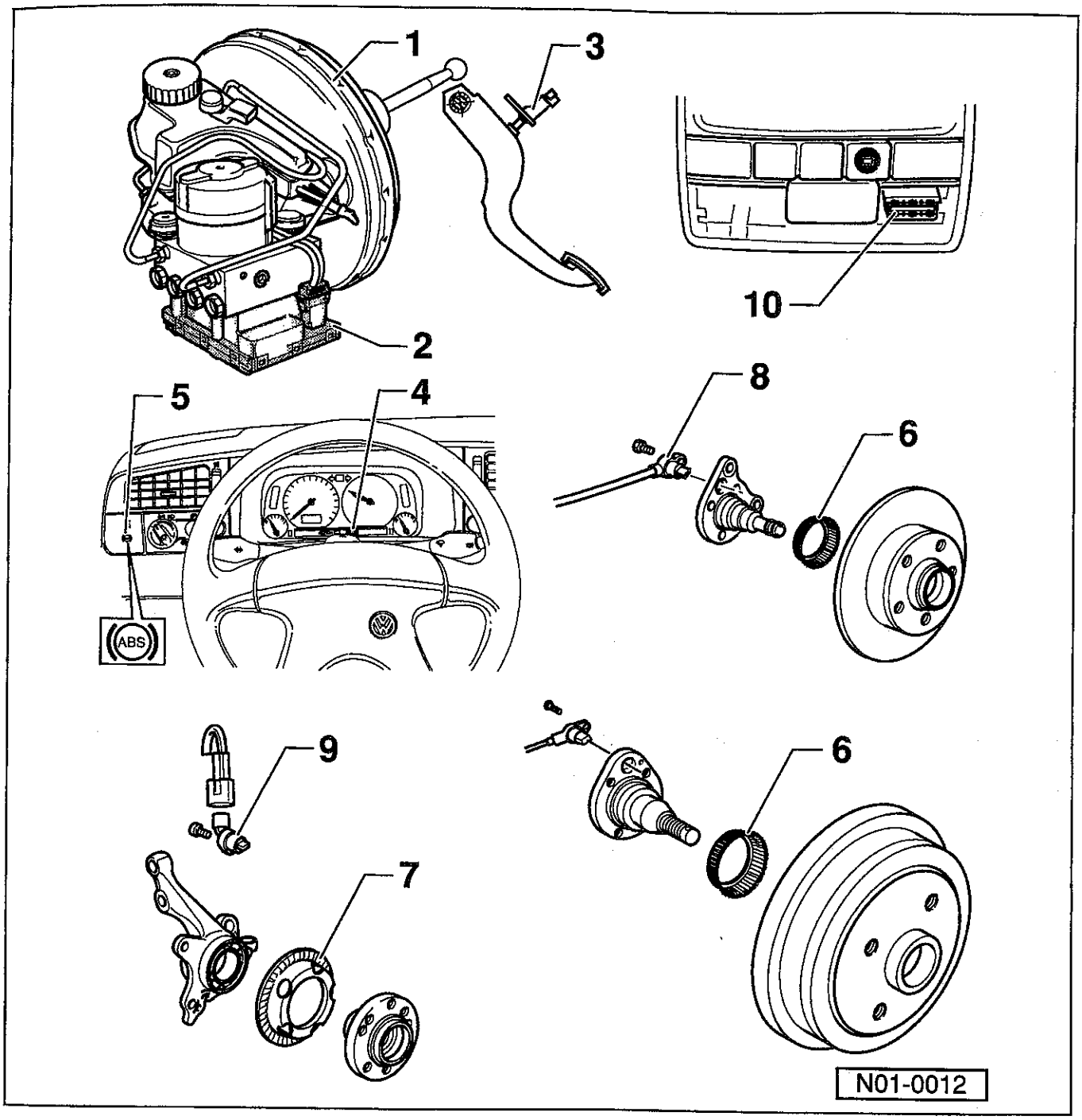
2. Press brake pedal down as far as possible by hand.
3. Guide brake light switch through pedal bracket opening until plunger contacts brake pedal.
4. Lock in position by turning 90° counter-clockwise.
5. Release brake pedal.
6. Check function of brake lights.

1. **ABS hydraulic unit (N55)**
   - with ABS hydraulic pump (V64)* and valve block
   - ABS hydraulic pump and valve block must not be separated
2. **ABS control module (J104)***
   - Located on ABS hydraulic unit in left side of engine compartment

***NOTE—***
*Components marked with an asterisk (*) are monitored by On Board Diagnostic (OBD).*

3. **Brake light switch (F)**
   - The brake light switch is open in the rest position
   - Adjusting see **Brake light switch, adjusting**
4. **Warning light for brake system (K118)**
   - Location: in instrument cluster
   - Function-lights up for approx. 2 seconds after ignition is switched on and/or engine is started. Remains on when parking brake is applied or brake fluid level too low, or when the ABS warning light lights up and there is a loss of electronic brake pressure distribution
5. **ABS warning light (K47)**
   - Location: left next to instrument cluster
   - Function-lights up for approx. 2 seconds after ignition is switched on and/or engine is started. Remains on if one or more ABS malfunctions are detected (e.g. ABS wheel speed sensor open circuit)
6. **Impulse rotor**
   - For right- and left-rear speed sensors
   - Removing and installing see **46 Brakes-Mechanical Components**
7. **Impulse rotor**
   - For right- and left-front speed sensors removing and installing see **40 Front Suspension and Drive Axles**
8. **Right-rear/left-rear ABS wheel speed sensor (G44)*/(G46)***
   - Before installing sensor, clean inner surface of mounting and coat with lubricating paste G 000 650
   - When connecting the ABS wheel speed sensor wire, make sure it is not twisted in the wheel housing
   - Mounting bolt tightening torque: 10 Nm (89 in-lb)
   - Resistance: 1.0–1.3 k ohms

## Component locations–Teves 20 GI




N01-0012

**Fig. 12.** Teves 20 GI ABS and ABS/EDL electrical/electronic components.

**9. Right-front/left-front ABS wheel speed sensor (G45)*/(G47)***

- Before installing sensor, clean inner surface of mounting and coat with lubricating paste G 000 650
- When connecting the ABS wheel speed sensor wire, make sure it is not twisted in the wheel housing
- Mounting bolt tightening torque: 10 Nm (89 in-lb)
- Resistance: 1.0–1.3 k ohms

**10. Data Link Connector (DLC)**

- Location: behind a cover on the right next to the ashtray

# 46 Brakes–Mechanical Components



## GENERAL

This repair groups covers service and repair to the brake friction components; brake pads, rotors, shoes and drums. Also included here is parking brake service.

Cars covered by this manual are equipped either with front disc brakes and rear drum brakes, or with disc brakes on all four wheels. Some cars with four-wheel disc brakes are also equipped with Anti-Lock Brakes (ABS).

***NOTE—***

- *For brake caliper and rear brake wheel cylinder repair information, see* **47 Brakes–Hydraulic System.**
- *For information on the ABS hydraulic unit and ABS service, see* **45 Anti-Lock Brakes (ABS).**
- *Brake fluid should be flushed from the system every two years. See* **47 Brakes–Hydraulic System.**

***WARNING—***

- *A properly functioning brake system is essential to safe driving. If the red brake/parking warning light or ABS warning light illuminates while driving, it is imperative that the system be given a thorough check, even if braking action still seems satisfactory. The brakes should be inspected regularly.*
- *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 by mouth.*
- *New brake pads and shoes 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—***

- *All brake work must be done with cleanliness, careful attention to specifications, and proper working procedures. If you lack the skills, the tools, or a clean workplace for servicing the brake system, we suggest you leave these repairs to an authorized VW dealer or other qualified shop.*
- *After replacing brake components, depress the brake pedal firmly several times to seat the brakes in their normal operating position. The pedal should be firm and at its normal height, if not, further work is required before driving vehicle.*
- *Brake fluid is very damaging to paint. Immediately wipe up any brake fluid that spills on the vehicle.*

## FRONT BRAKES

Two types of front discs–solid and ventilated–are used on the cars covered by this manual. Cars with ventilated rotors use a two-piece caliper assembly. Cars with solid rotors use a single piece caliper. Repair procedures vary depending on rotor/caliper application.

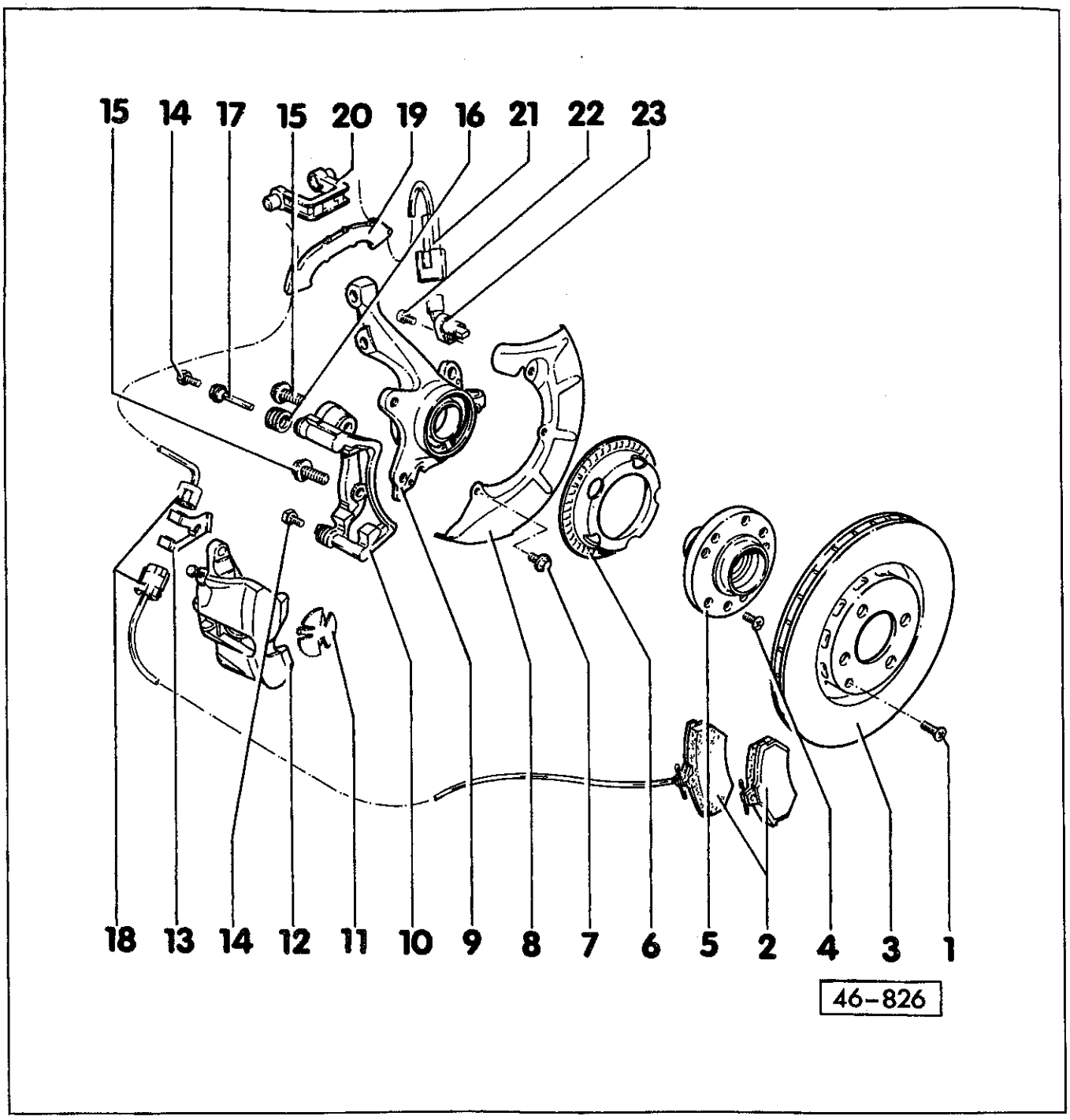
Fig. 1 shows the brake system with ventilated rotors. Fig. 5 shows the front brake system with solid rotor.

Rotors should be inspected for cracks, scoring, glazing and warpage. Rotors must be replaced in pairs if any faults are found. Rotors must always be replaced if either disc is worn below the minimum thickness specification.

***NOTE—***

*The minimum brake rotor thickness specification is stamped into the rotor's hub.*

## Front brake assembly (ventilated rotor, two-piece caliper)




46-826

**Fig. 1.** Exploded view of front brake with ventilated rotor and two-piece caliper.

1. **Screw**
2. **Brake pads**
   - VR6 engine: with pad wear indicators
   - Thickness: 14 mm (0.551 in.)
   - Wear limit: 7 mm (0.276 in.) including backing plate
   - Always replace all pads on one axle at the same time
3. **Ventilated brake rotor**
   - Remove brake caliper before removing
   - VR6 versions; larger diameter
4. **Screw**

5. **Wheel hub**
   - Removing/installing see **40 Front Suspension and Drive Axles.**
6. **ABS rotor**
   - For ABS wheel speed sensor, where applicable
7. **Bolt**
   - Tighten to 10 Nm (89 in-lb)
8. **Splash shield**
9. **Wheel bearing housing**
10. **Brake pad carrier**

> ***NOTE—***
> *If either the guide bolts or the protective caps are damaged, a repair kit may be available from Volkswagen. Check with an authorized Volkswagen parts department for the latest parts information.*

11. **Heat deflector**
    - Insert in piston
12. **Brake caliper**
    - Do not loosen hydraulic line when replacing pads
13. **Bracket**
14. **Self-locking nut**
    - Tighten to 35 Nm (26 ft-lb)
    - Always replace
15. **Bolt**
    - Tighten to 125 Nm (92 ft-lb)
16. **Protective cap**
17. **Guide bolt**
18. **Connector**
    - For brake pad wear indicator (where applicable)
19. **Bracket**
20. **Bracket**
21. **Connector**
    - For ABS Wheel Speed Sensor
22. **Bolt**
    - Tighten to 10 Nm (89 in-lb)
23. **ABS wheel speed sensor**
    - Before installing, clean and coat with lubricating paste (VW part no. G 000 650)

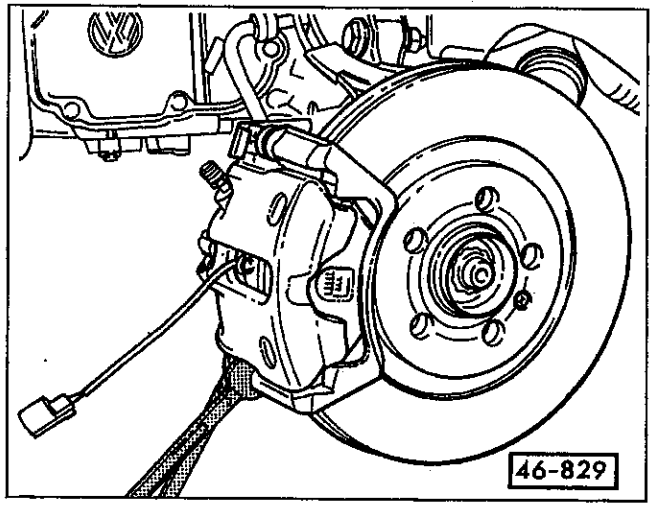
> ***CAUTION—***
> *Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*

## Front pads, removing and installing (ventilated rotors, two-piece caliper)

1. Raise the car and support on jack stands.

> ***WARNING—***
> *Jack stands should be placed on a hard level surface (e.g. concrete).*

2. Remove the front wheels.
3. Separate connector for brake pad wear indicator, where applicable.
4. Remove lower caliper mounting bolt while holding guide bolt stationary. See Fig. 2.




46-829

**Fig. 2.** Lower caliper mounting bolt being removed. Use wrench to hold guide bolt when removing mounting bolt.

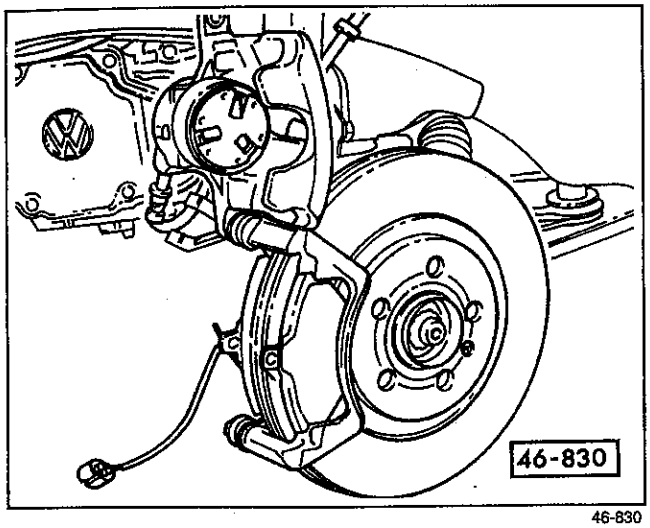
5. Swing brake caliper housing upward and off brake pads. Remove brake pads from pad carrier. See Fig. 3.
6. Press piston into caliper housing. See Fig. 4.

> ***CAUTION—***
> *Always remove some brake fluid from the reservoir before installing new brake pads. When the caliper piston is pushed in, fluid is forced up into the reservoir.*

7. Install heat shield and brake pads.

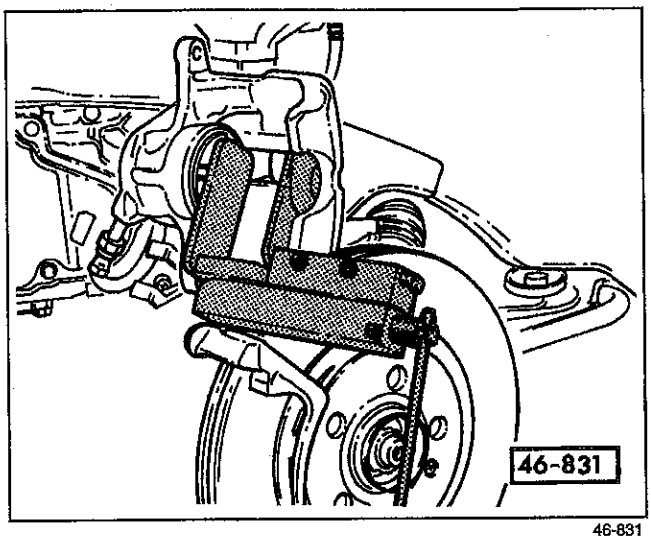
> ***NOTE—***
> *On pads with wear indicators (cars with VR6 engine), the pad with the wear indicator is the inner pad.*

8. Swing brake caliper down.




46-830

**Fig. 3.** Pivot caliper up to access pads.




46-831

**Fig. 4.** Caliper piston being pressed into caliper using VW special tool.

9. Install and tighten new caliper mounting bolt while holding guide bolt stationary. Reconnect wear indicator, where applicable.

> ***WARNING—***
> *Always replace the lower caliper bolt. It is a one-time only self-locking bolt.*

**Tightening torques**

- Caliper mounting bolt to guide bolt (self-locking) . . . . . 35 Nm (26 ft-lb)

10. Depress brake pedal firmly several times to seat brake pads. Check brake fluid level and add as necessary. The remainder of installation is the reverse of removal.

## Front brake assembly (solid rotor, one-piece caliper)

1. **Brake rotor**
   - Always replace rotors in pairs
   - Use penetrating oil to loosen rotor from wheel hub if necessary; do not use force to remove rotors
2. **Bolt**
   - Tighten to 10 Nm (89 in-lb)
3. **Splash shield**
4. **Wheel bearing housing**
5. **Brake pad retaining spring**
   - Mount before installing brake pads
   - Replace when changing brake pads
6. **Brake pads**
   - Thickness: 14 mm (0.551 in.)
   - Wear limit: 7 mm (0.276 in.)
   - Pad with larger friction area fits on outside (where applicable)
   - Always replace pads on both sides
7. **Brake caliper**
8. **Upper sleeve**
9. **Lower sleeve**
10. **Upper bushing**
11. **Lower bushing**
12. **Upper spacer sleeve**
13. **Lower spacer sleeve**
14. **Socket-head bolt, upper**
    - Tighten to 25 Nm (18 ft-lb)
15. **Socket-head bolt, lower**
    - Tighten to 25 Nm (18 ft-lb)
16. **Wheel bolt**
    - Tighten to 110 Nm (81 ft-lb)
17. **ABS Rotor**
    - For ABS wheel speed sensor, where applicable
18. **ABS wheel speed sensor**
    - Before installing, clean and coat with lubricating paste (VW part no. G 000 650)

> ***CAUTION—***
> *Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*

19. **Bolt (cars with ABS)**
    - Tighten to 10 Nm (89 in-lb)

## Front brake assembly (solid rotor, one-piece caliper)

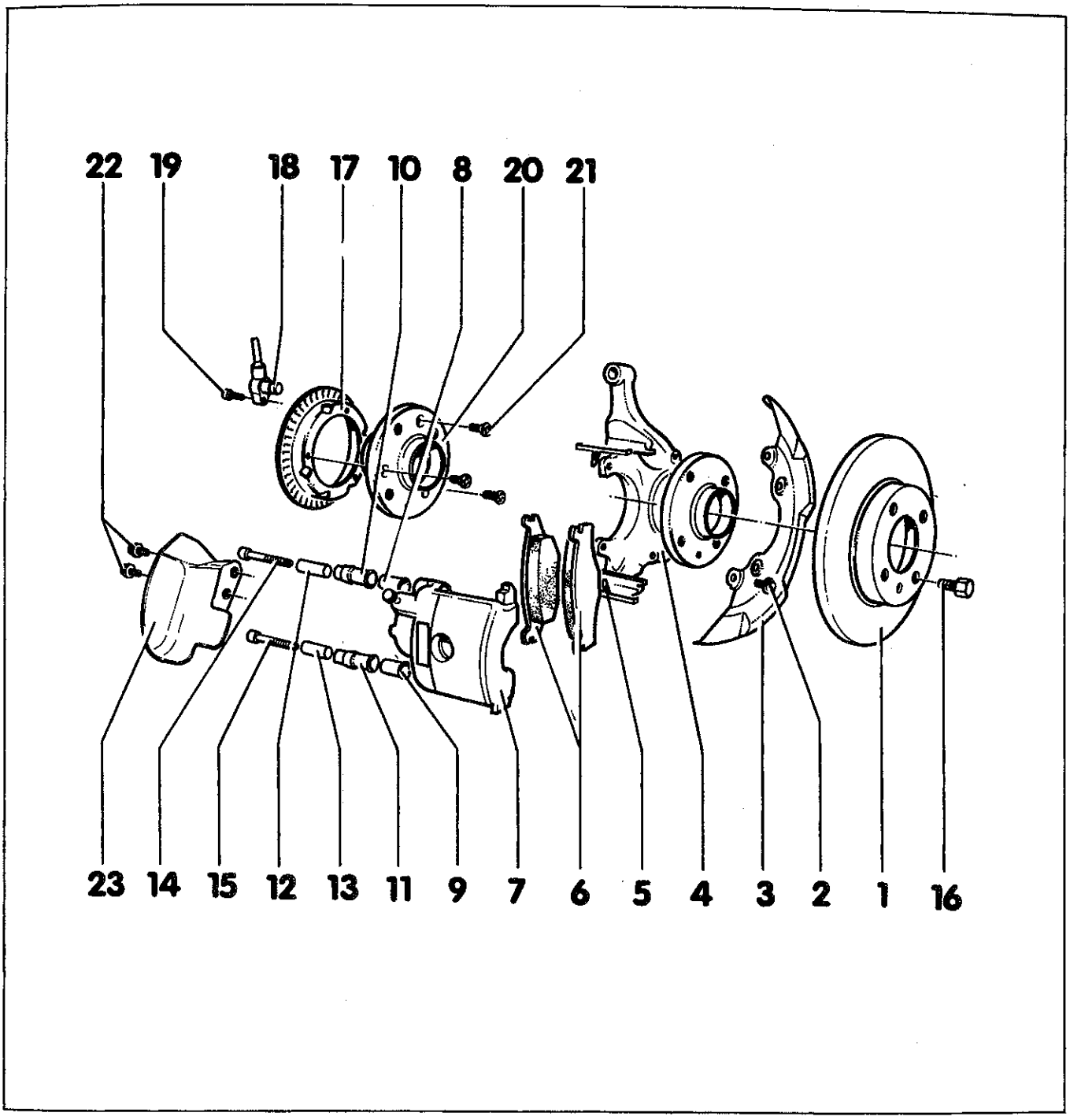



**Fig. 5.** Exploded view of front disc brake with solid brake rotor and one-piece caliper.

**20. Wheel hub (cars with ABS)**
- See **40 Front Suspension and Drive Axles**

**21. Screw**

**22. Bolts**
- Tighten to 15 Nm (11 ft-lb)

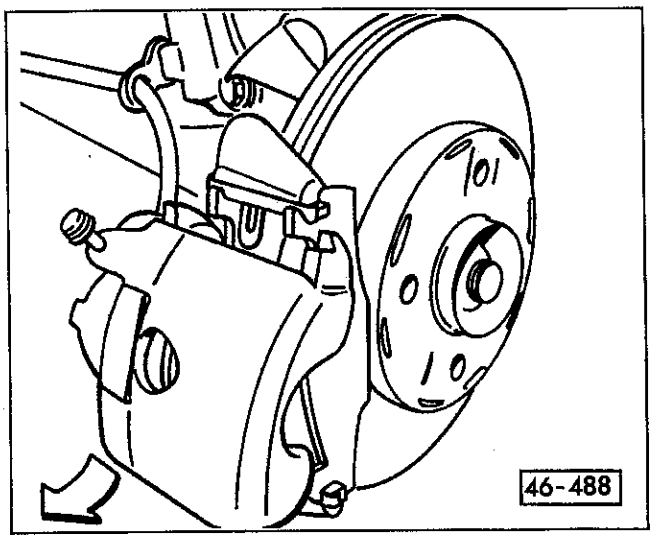
**23. Air deflector plate**

## Front pads, removing and installing (solid rotors, one-piece caliper)

1. Raise the car and support on jack stands. Remove the front wheels.

> ***WARNING—***
> *Jack stands should be placed on a hard level surface (e.g. concrete).*

2. Remove bolts securing caliper to wheel bearing housing. Swing caliper out from bottom to top. See Fig. 6.
   - Support caliper from body using stiff wire. Do not disconnect hydraulic line from brake caliper.




46-488

**Fig. 6.** Caliper being removed from wheel bearing housing. Swing caliper out from bottom first.

3. Remove brake pad retaining springs and brake pads.
4. Install inner brake pad and pad retaining springs on wheel bearing housing. Install outer brake pad.
   - Pad with larger friction surface is the outer pad.
5. Push piston into caliper housing.

> ***CAUTION—***
> *Always remove some brake fluid from the reservoir before pushing in piston. When the piston is pushed in, fluid is forced up into the reservoir.*

6. Carefully mount caliper just far enough to start caliper mounting bolts. Tighten caliper mounting bolts.

> ***NOTE—***
> *The pad retaining springs could be bent if the caliper is pushed on too far. Bent springs can cause noise when braking.*

**Tightening torques**
- Caliper to wheel bearing housing . . . . 25 Nm (18 ft-lb)

7. Depress brake pedal firmly several times to seat brake pads. Check brake fluid level and add as necessary. The remainder of installation is the reverse of removal.

## Front brake rotor, removing and installing (ventilated and solid rotors)

1. Raise corner of car and support on jack stand. Remove the front wheel.

> ***WARNING—***
> *Jack stands should be placed on a hard level surface (e.g. concrete).*

2. On cars with ventilated rotors, remove bolts securing brake pad carrier to wheel bearing housing.

> ***CAUTION—***
> *On cars with ventilated rotors, do not remove the caliper from the brake pad carrier. The caliper is mounted to the guide bolts using self-locking bolts that must be replaced once removed.*

3. On cars with solid rotors, remove the caliper and brakes pads as described earlier under **Front Brake pads, removing and installing (solid rotors).**
4. Remove countersunk screw from front of rotor hub and remove rotor from wheel hub.

> ***NOTE—***
> *If necessary, use a rust-penetrating oil to free the brake rotor from the hub. Do not use force to remove the rotor.*

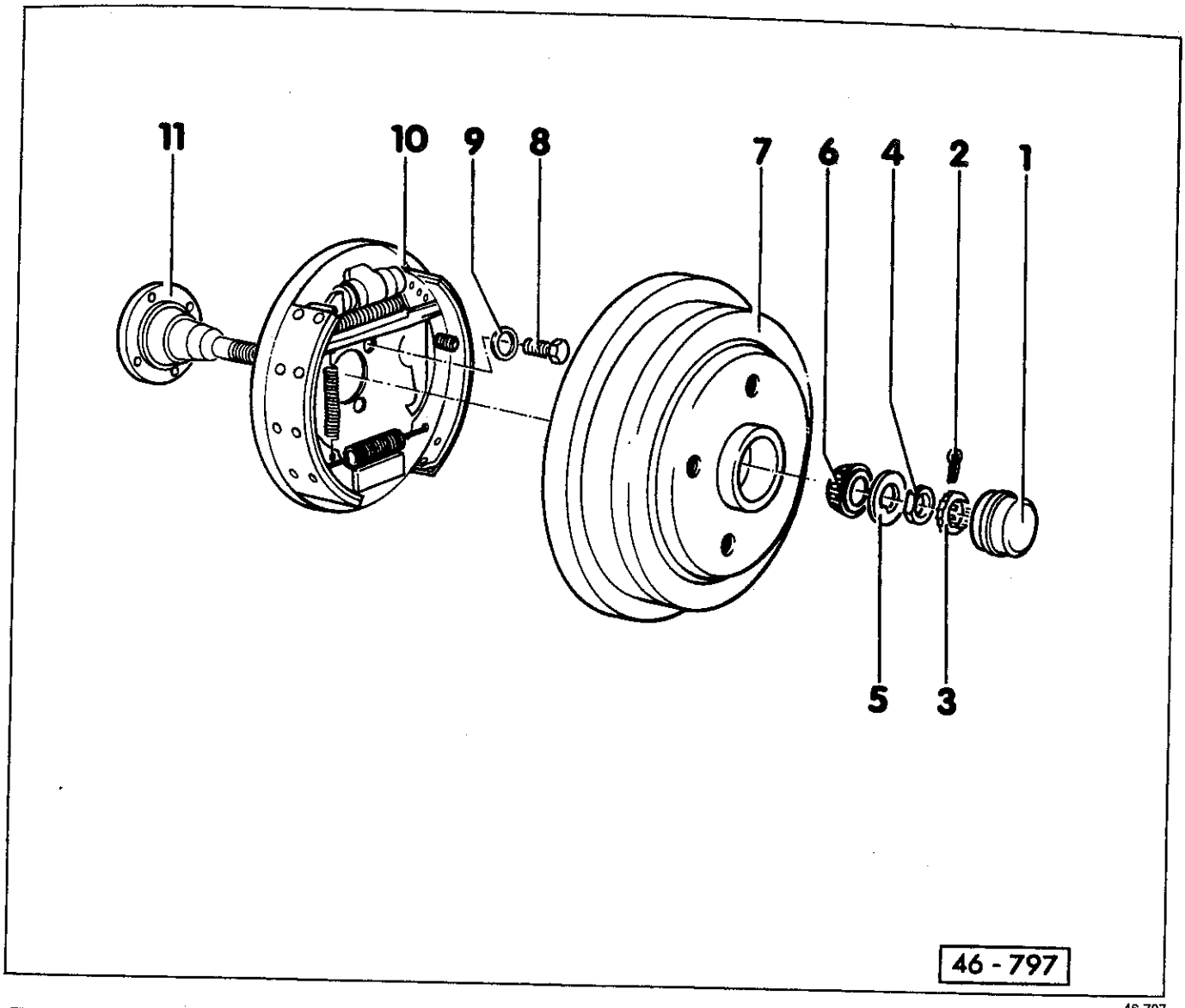
5. Installation is reverse of removal. Depress brake pedal firmly several times to seat brake pads.

**Tightening torques**
- Brake pad carrier to wheel bearing housing (ventilated rotor, 2-piece caliper) . . . 125 Nm (92 ft-lb)
- Brake caliper to wheel bearing housing (solid rotor, 1-piece caliper) . . . . . 25 Nm (18 ft-lb)
- Wheel to wheel hub . . . . . 110 Nm (81 ft-lb)

# REAR BRAKES

Two types of rear brake systems–drum and disc–are used on the cars covered by this manual. Fig. 7 shows an exploded view of the rear drum brake system. Fig. 8 shows an exploded view the rear disc brake system.

## Rear drum brake, assembly

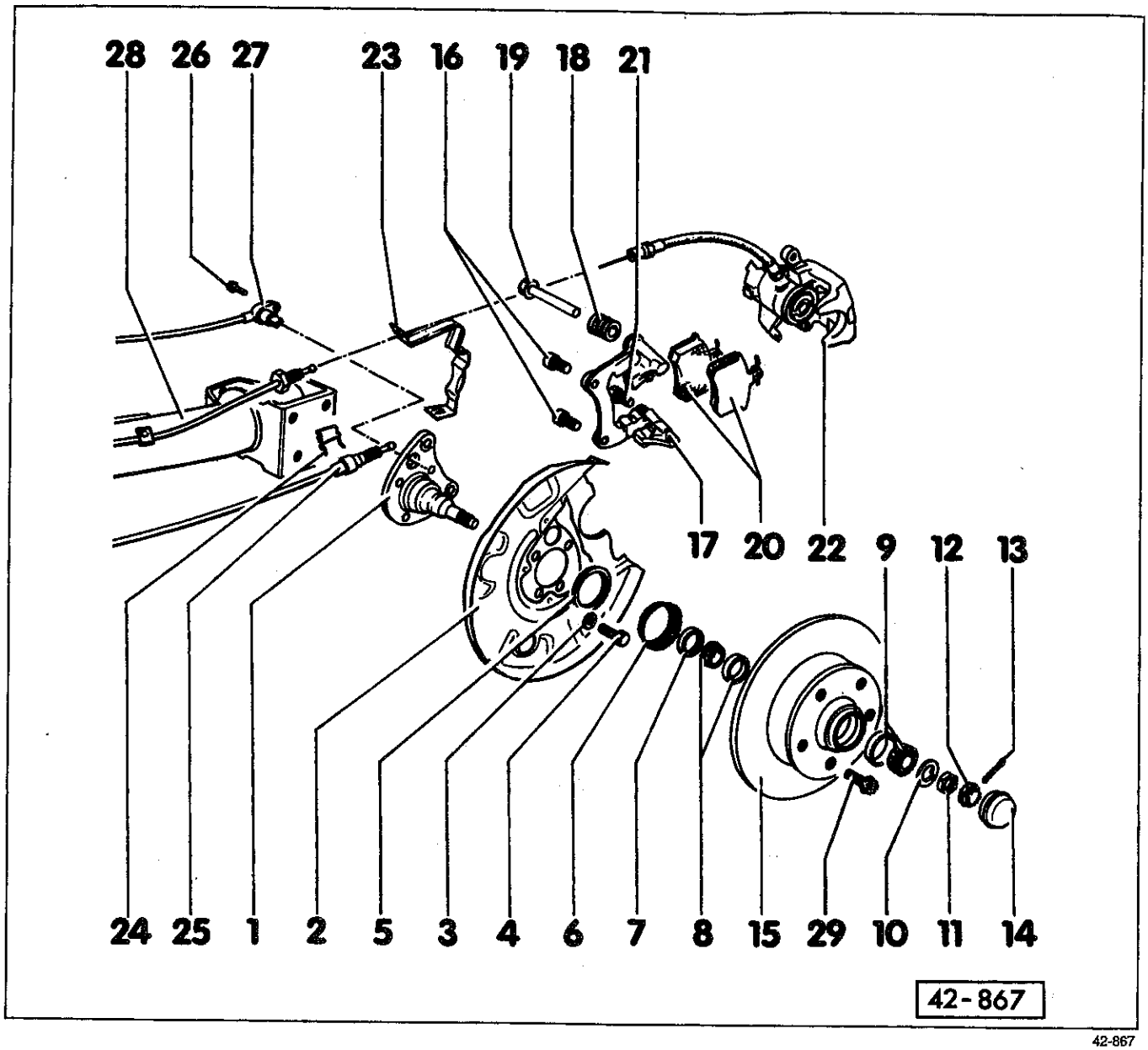



46-797

**Fig. 7.** Rear drum brake assembly.

1. **Grease cap**
2. **Cotter pin**
   - Always replace
3. **Lock ring**
4. **Nut**
   - Adjusting wheel bearing play, see **42 Rear Suspension**
5. **Thrust washer**
6. **Outer wheel bearing**
7. **Brake drum**
   - Diameter: 200 mm (7.874 in.)
   - Wear limit: 201 mm (7.913 in.)
   - Clean thoroughly, check for wear, damage, damaged wheel bolt threads and check dimensions
8. **Bolt**
   - Tighten to 60 Nm (44 ft-lb)
9. **Dished washer**
10. **Brake carrier**
11. **Stub axle**

## Rear disc brake, assembly




42-867

**Fig. 8.** Exploded view of rear disc brake assembly. Components shown are for 5-bolt wheels, assembly and service are the same for vehicle with 4-bolt wheels.

1. **Stub axle**
2. **Splash shield**
3. **Dished washer**
   - Large contact surface faces splash shield (2)
4. **Bolt**
   - Tighten to 60 Nm (44 ft-lb)
5. **Cover ring**
   - Distance from cover ring collar to splash shield: 9.5 mm (0.374 in.)
6. **ABS Rotor**
   - Where applicable
   - To drive off, insert drift through wheel bolt holes
   - Drive on with suitable sleeve
7. **Seal**
8. **Inner wheel bearing**
9. **Outer wheel bearing**
10. **Thrust washer**

**11. Nut**
- Adjusting wheel bearing play, see **42 Rear Suspension**
- Secure with lock ring (12) and new cotter pin (13)

**12. Lock ring**

**13. Cotter pin**
- always replace

**14. Grease cap**

**15. Brake rotor**
- Thickness: 10 mm (0.394 in.)
- Wear limit: 8 mm (0.315 in.)
- When worn always replace rotors on both sides

**16. Bolts**
- Tighten to 56 Nm (41 ft-lb)

**17. Brake carrier**
- With guide bolts and protective caps

***NOTE—***
*If either the guide bolts or the protective caps are damaged, a repair kit may be available from Volkswagen. Check with an authorized Volkswagen parts department for the latest parts information.*

**18. Protective cap**

**19. Guide bolt**

**20. Brake pads**
- Thickness: 12 mm (0.472 in.)
- Wear limit: 7 mm (0.276 in.) (includes backing plate)
- Checking thickness, see **0 Maintenance Program**
- Always replace both sides

**21. Self-locking bolt**
- Always replace
- Hold guide bolt (19) when loosening/tightening
- Tighten to 35 Nm (26 ft-lb)

**22. Brake caliper**

**23. Brake hose bracket**

**24. Spring clip**

**25. Parking brake cable**

**26. Bolt**
- Tighten to 10 Nm (89 in-lb)

**27. ABS wheel speed sensor**
- Lubricate with grease (VW part no. G 000 650, when installing)

***CAUTION—***
*Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*

**28. Rear axle beam**

**29. Wheel bolt**
- Tighten to 110 Nm (81 ft-lb)

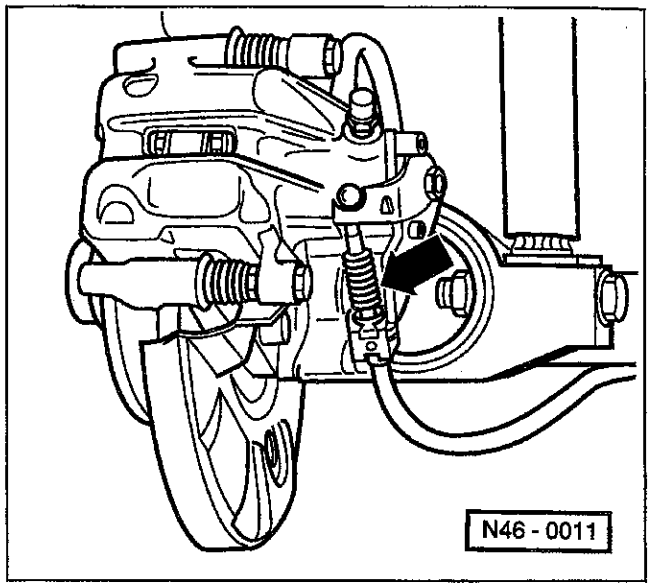
## Rear pads, removing and installing

1. Raise the car and support on jack stands.

***WARNING—***
*Jack stands should be placed on a hard level surface (e.g. concrete).*

2. Remove rear wheels.

3. Disconnect parking brake cable from caliper. See Fig. 9.




N46-0011

**Fig. 9.** Parking brake cable (**arrow**) at rear brake caliper.

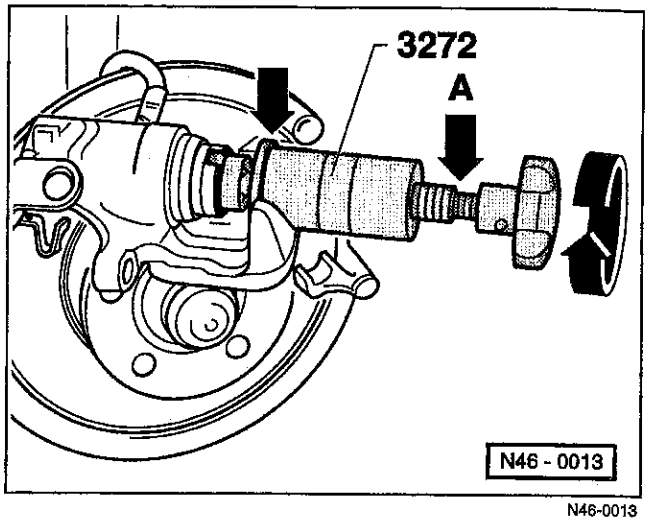
4. While holding caliper guide bolt stationary, remove caliper mounting bolts. Remove brake caliper and brake pads.

***NOTE—***
*If brake pads are to be reused, mark pad location.*

5. Reset the caliper's automatic adjustment mechanism by turning the piston clockwise while pushing the piston in. See Fig. 10.

***CAUTION—***
- *If the piston is not reset correctly, or if the brake pedal is operated with the caliper removed, the automatic adjustment mechanism will be destroyed.*
- *Always remove some brake fluid from the reservoir before resetting and pushing the caliper piston in. When the piston is pushed in, fluid is forced up into the reservoir.*

6. Install brake pads onto pad carrier.




N46-0013

**Fig. 10.** Automatic adjustment mechanism being reset using Volkswagen special tool 3272. Turn piston clockwise (**rotational arrow**) while pushing piston in.

7. Install brake caliper housing using new self-locking bolts.

> ***WARNING —***
> *Always replace the caliper mounting bolts. They are one-time only self-locking bolts.*

**Tightening torques**

- Caliper mounting bolt to guide bolt (self-locking) . . . . . 35 Nm (26 ft-lb)

8. Connect parking brake cable to lever on caliper.

9. Depress brake pedal firmly several times to seat brake pads. Check brake fluid level and add as necessary. The remainder of installation is the reverse of removal.

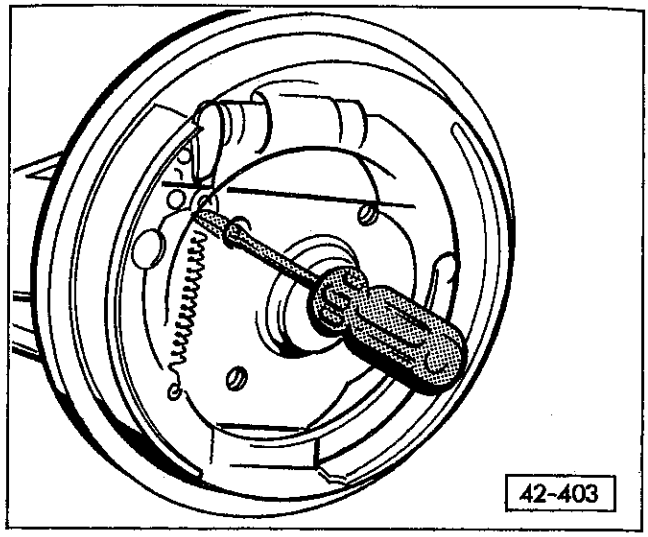
## Rear brake drum, removing and installing

> ***NOTE —***
> *The rear brake drum contains the wheel bearings and bearing races. The procedure given below covers only removal and installation of the brake drum and not wheel bearing service. If the brake drum is being replaced, the wheel bearing assembly must be transferred to the new drum. Wheel bearing replacement and adjustment is covered in* **42 Rear Suspension.**

1. Raise the car and support it on jack stands. Remove the wheels.

> ***WARNING —***
> *Jack stands should be placed on a hard level surface (e.g. concrete).*

2. Release the brake shoes by inserting a screwdriver through the front, top wheel bolt hole and pushing up the adjusting wedge. See Fig. 11.




42-403

**Fig. 11.** Using a screwdriver through wheel bolt hole, push adjusting wedge upward.

3. Pry off grease cap from front of brake drum.

4. Remove cotter pin and lock ring. Remove wheel bearing adjusting nut.

5. Rock brake drum from side to side and remove washer and outer wheel bearing. Slide brake drum straight off axle.

6. Apply grease to gap between sealing lips on inner grease seal in brake drum. Slide the brake drum onto the stub axle.

> ***CAUTION —***
> *Use care to avoid damaging the grease seal when installing the brake drum.*

7. Install the outer wheel bearing, thrust washer and axle nut. Adjust rear wheel bearing play as described in **42 Rear Suspension.** Install lock ring and new cotter pin.

> ***CAUTION —***
> *Do not reuse cotter pin. Always install a new cotter pin.*

8. Fill grease cap with 10 grams of grease and install. The remainder of installation is the reverse of removal.

> ***NOTE —***
> *After working on the rear brakes, release the parking brake, depress the brake pedal firmly and then adjust the parking brake, see* **Parking Brake.**

## Rear brake shoes, assembly

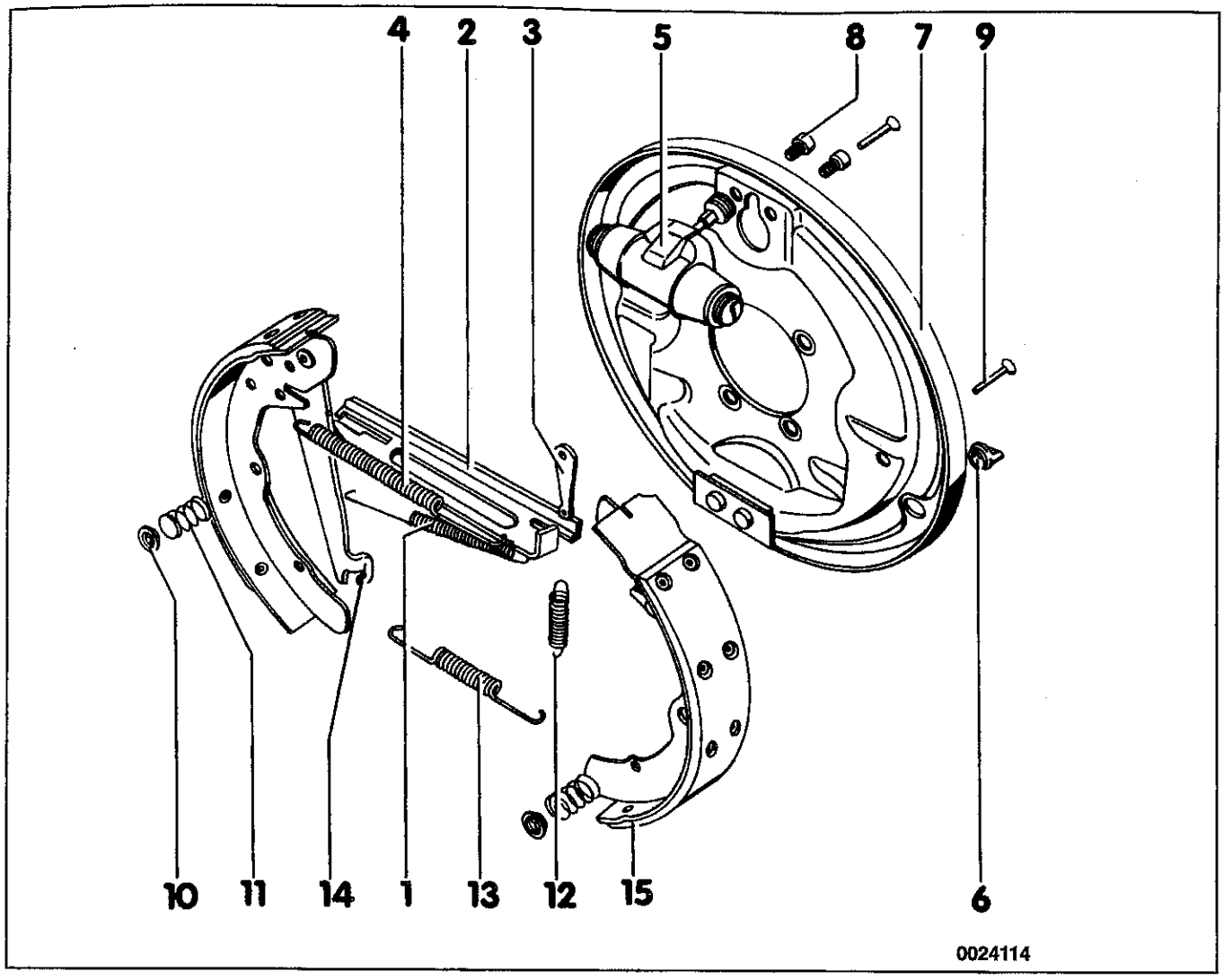



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**Fig. 12.** Rear brake shoes and related hardware.

1. **Upper return spring**
2. **Push rod**
   - Lubricate contact points with grease
3. **Adjusting wedge**
   - To remove/install brake drum: work through wheel bolt hole to push wedge up first
4. **Locating spring**
5. **Wheel cylinder**
   - If brake fluid is found under dust seal, replace wheel cylinder.
6. **Cap**
7. **Backing plate**
8. **Socket-head bolt**
   - Tighten to 10 Nm (89 in-lb)
9. **Tensioning pin**
10. **Spring retainer**
    - To remove push against spring and turn 90°
11. **Spring**
12. **Wedge spring**
13. **Lower return spring**
    - Lubricate contact points with grease
14. **Brake shoe with lever for parking brake**
    - Minimum lining thickness: 2.5 mm (0.098 in.)
15. **Brake shoe**
    - Minimum lining thickness: 2.5 mm (0.098 in.)

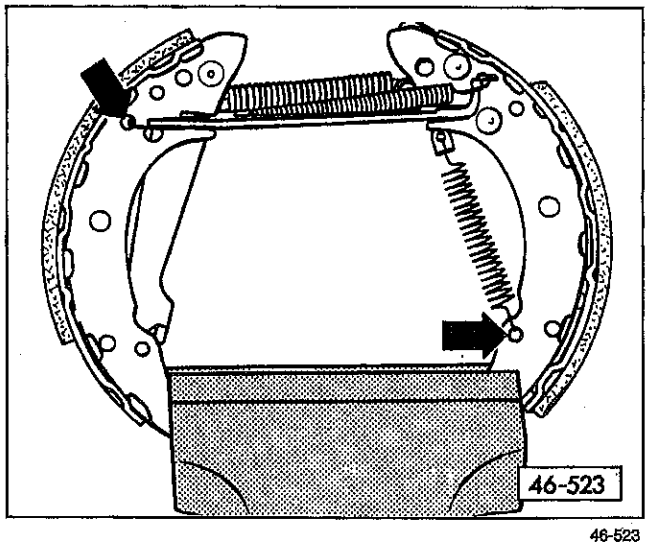
## Rear brake shoes, removing

***NOTE—***
*Use Fig. 12 as a guide when removing and installing brake shoes.*

1. Remove brake drum as described earlier.
2. Remove spring retainers from front of brake shoes.
3. Unhook lower return spring from brake shoe.
4. Remove brake shoes from backing plate and wheel cylinder.

***NOTE—***
*Install a strong rubber band around the wheel cylinder to hold the wheel cylinder pistons in place while the brake shoes are removed.*

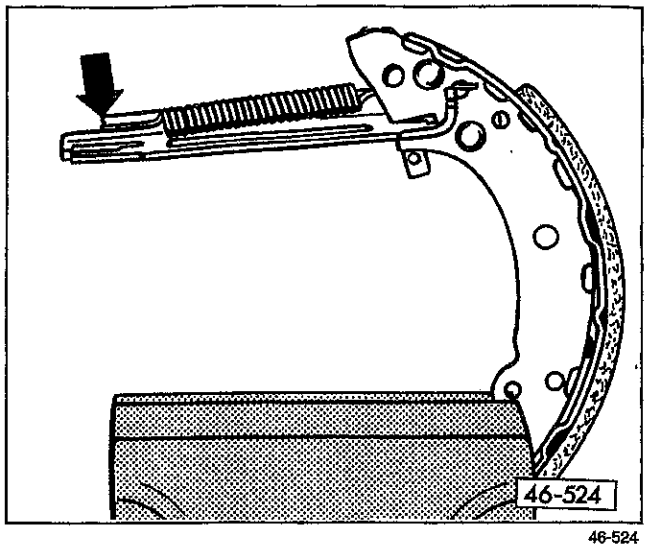
5. Unhook parking brake cable from brake shoe lever.
6. Clamp brake shoes in vice. Then remove wedge spring and upper return spring from brake shoes. See Fig. 13.




46-523

**Fig. 13.** Remove wedge spring (**right arrow**) and upper return spring (**left arrow**) with shoes in vice.

7. Unhook locating spring from push rod and remove from brake shoe. See Fig. 14.

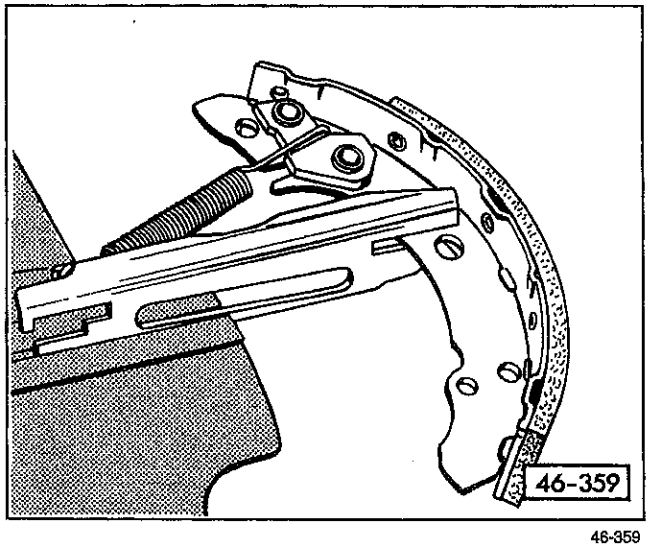



46-524

**Fig. 14.** Unhook locating spring from push rod (**arrow**) and remove from brake shoe.

## Rear brake shoes, installing

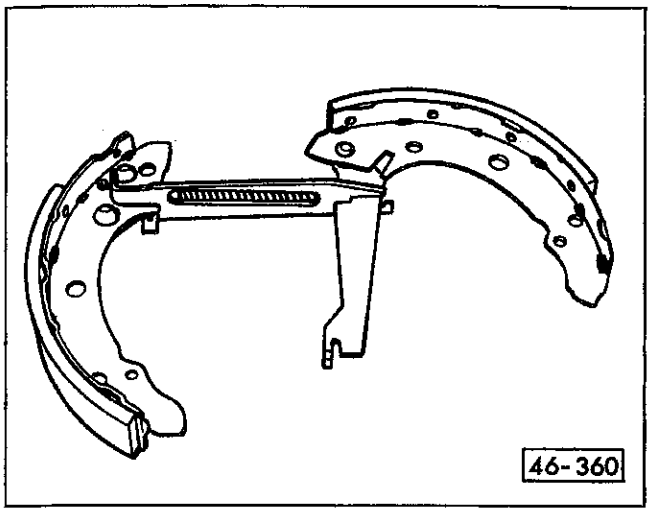
1. Connect locating spring and insert brake shoe into slot in push rod. See Fig. 15.




46-359

**Fig. 15.** Connect locating spring and insert brake shoe into slot in push rod.

2. Insert adjusting wedge into slot.
3. Insert brake shoe with brake lever in push rod. See Fig. 16.
4. Install upper return spring to shoe assembly.
5. Connect parking brake cable to brake lever.




46-360

**Fig. 16.** Insert brake shoe with brake lever in push rod.

6. Place brake shoes into position on wheel cylinder pistons.
7. Install lower return spring and install brake shoes onto lower support.
8. Install wedge spring and connect to wedge.
9. Install retaining springs and retainers.
10. Install brake drum and adjust wheel bearing play as described in **42 Rear Suspension**.
11. Depress brake pedal firmly to set self-adjusting mechanism. Adjust parking brake as described below.

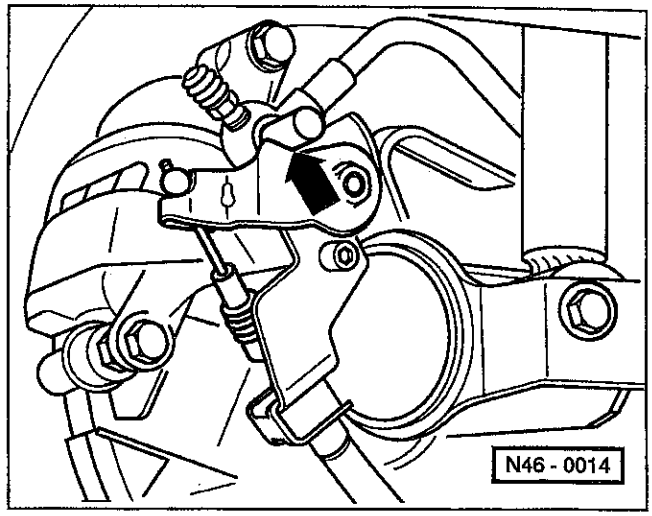
## PARKING BRAKE

Fig. 18 shows the parking brake lever assembly. The cable-operated parking brake mechanically actuates either the rear brake shoes or the rear caliper pistons, independent of the hydraulic brake system. On cars with rear disc brakes, the caliper contains a self-adjusting mechanism to compensate for brake pad wear.

Adjustment of the parking brake is only necessary if rear brake components or the parking brake cables have been replaced.

### Parking brake, adjusting (rear disc brakes)

1. Release parking brake. Remove the trim from parking brake lever. Loosen locknuts at cable ends.
2. Tighten adjusting nuts at base of parking brake lever until levers on brake calipers just begin to lift off of stops on caliper. See Fig. 17.
   - Max. gap between lever and stop: 1.5 mm (0.059 in.)




N46-0014

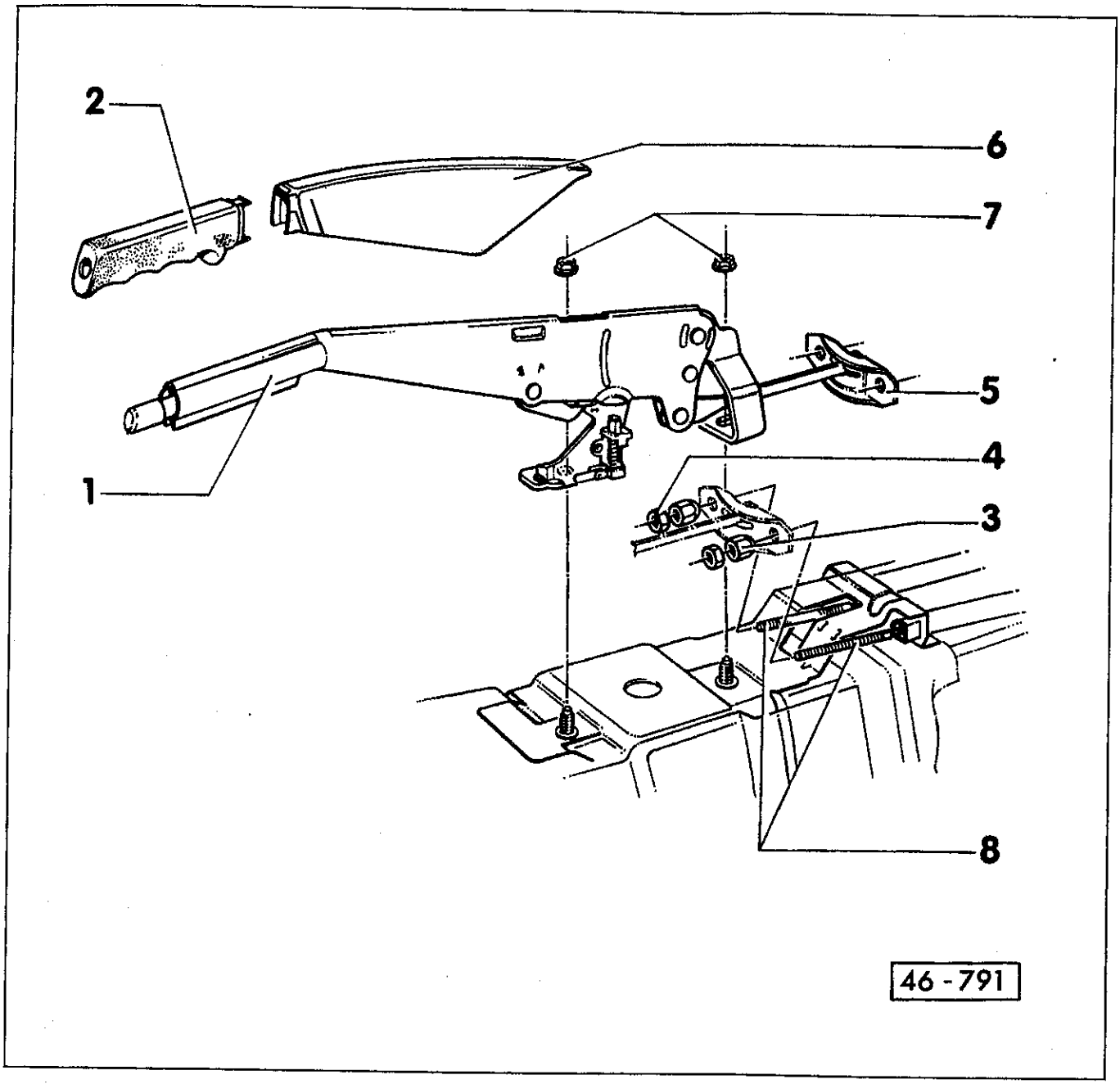
**Fig. 17.** Adjust parking brake cables just until lever on caliper (**arrow**) lifts off stop. Check adjustment at both calipers.

3. Pull up on parking brake and then release. Check that both wheels turn freely. Tighten cable locknuts.

### Parking brake, adjusting (rear drum brakes)

1. Release parking brake. Remove trim from parking brake lever. Loosen locknuts at cable ends.
2. Depress brake pedal firmly one time.
3. Pull parking brake lever up until four clicks are heard.
4. Turn adjustment nuts until both rear wheels can just be turned by hand.
5. Release parking brake and check that both rear wheels rotate freely. Tighten cable locknuts.

## Parking brake lever, assembly




46-791

**Fig. 18.** Parking brake lever and related components.

1. **Parking brake lever**
   - Different version for rear drum and rear disc brakes
   - Before removal, remove center console
2. **Hand grip**
   - Pull down locating tab under hand-grip and pull forward to remove
3. **Adjusting nut**
   - See **Parking brake, adjusting**
4. **Lock nut**
   - To lock adjusting nut (3) in position
5. **Compensator**
6. **Parking brake lever trim**
   - First pull off hand grip (2) then pull trim forward
7. **Hex nut**
8. **Parking brake cable**
   - Different versions for rear drum and rear disc brakes

# 47 Brakes–Hydraulic System



## GENERAL

This repair group covers service and repair to the hydraulic and vacuum-assist brake system components. Also included here is brake bleeding. Cars covered by this manual are equipped either with front disc brakes and rear drum brakes, or with disc brakes on all four wheels. Some cars with four-wheel disc brakes are also equipped with Anti-Lock Brakes (ABS)

***CAUTION —***

- *This repair group does not cover the anti-lock braking system hydraulic unit (with integral master cylinder). For information on the ABS hydraulic unit and ABS service, see* **45 Anti-Lock Brakes (ABS).**
- *Vehicles equipped with the TEVES 04 ABS/EDL can be bled using conventional methods.*
- *Vehicles equipped with the TEVES 20 GI ABS/EDL can also be bled using conventional methods. However, if the reservoir has been completely emptied, the hydraulic unit must be bled using the Volkswagen Scan Tool VAG 1551 or VAG 1552. This procedure electronically cycles the hydraulic unit and valve body to purge trapped air and is beyond the scope of this manual.*

### Brake service precautions

The following warnings, cautions, and notes should be read before servicing the brake hydraulic system:

***WARNING —***

*Brake fluid is poisonous. Wear safety glasses and rubber gloves when working with brake fluid. Prevent brake fluid from entering the bloodstream through cuts or scratches. Do not siphon brake fluid by mouth.*

***WARNING —***

- *DO NOT mix DOT 5 silicone type brake fluid with DOT 4 brake fluid as severe corrosion will result. Such corrosion could lead to complete brake system failure. Use only new, approved brake fluid that complies with MVSS 116 DOT 4*
- *Brake pads and brake shoes may contain asbestos fibers. Do not create dust by grinding, sanding, or cleaning pads with compressed air. Avoid breathing any brake material fibers or dust as this may result in serious diseases or death.*
- *A properly functioning brake system is essential to safe driving. If the red brake/parking warning light or the ABS warning light illuminates while driving, it is imperative that the system be given a thorough check, even if braking action still seems satisfactory. The brakes should be inspected regularly.*

***CAUTION —***

- *Always disconnect battery negative (–) cable when working at or near pedal cluster.*
- *Before disconnecting the battery be sure to obtain the anti-theft radio code.*
- *After replacing brake components, depress the brake pedal firmly several times to seat the brakes in their normal operating position. The pedal should be firm and at its normal height, if not, further work is required before driving vehicle.*
- *Brake fluid is very damaging to paint. Immediately wipe up any brake fluid that spills on the vehicle.*

## MASTER CYLINDER, VACUUM BOOSTER, BRAKE PEDAL

Fig. 3 shows the vacuum booster and master cylinder assembly used on cars without anti-lock braking (ABS).

***NOTE—***
*This repair group does not cover the master cylinder/ABS hydraulic unit used on cars with anti-lock braking. See* **45 Anti-Lock Brakes (ABS).**

### Master cylinder, removing and installing (cars without ABS)

1. Disconnect the battery negative (–) terminal.
2. Remove the fluid reservoir cap. Remove the fluid from the reservoir using a clean syringe.

> ***WARNING—***
> *Brake fluid is poisonous. Do not siphon brake fluid with your mouth.*

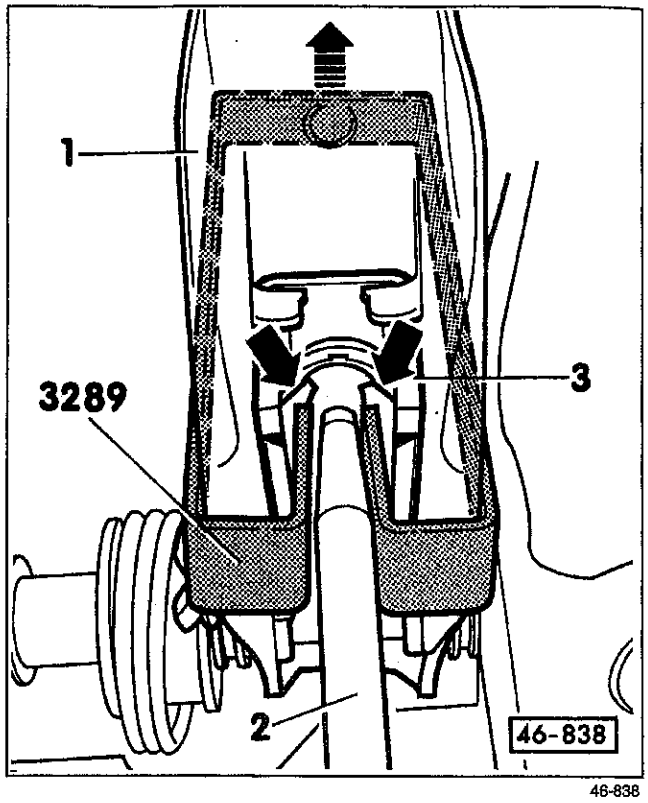
3. Disconnect the brake lines from the master cylinder.
4. Remove the two nuts holding the master cylinder to the vacuum booster and remove the master cylinder.
5. Fill the master cylinder with new, fresh brake fluid and pre-bleed.
6. Using a new O-ring and new locking washers behind the mounting nuts, install the master cylinder. Bleed the brakes as described under **Brake Bleeding**.

**Tightening torques**
- Master cylinder to vacuum booster . . 10 Nm (89 in-lb)

### Brake pedal, separating from vacuum booster

The brake pedal is retained to the vacuum booster pushrod using a ball-and-socket type fitting. The separating procedure described below shows the use of a special Volkswagen tool.

1. Disconnect negative (–) battery cable.
2. Remove trim under instrument panel on left side.
3. Remove brake light switch from its bracket.
4. Push brake pedal in direction of vacuum brake booster, and hold in this position.
5. Install VW special tool no. 3289 to pedal cluster and pull tool toward rear while holding brake pedal stationary (pedal must not be allowed to move back). See Fig. 1.

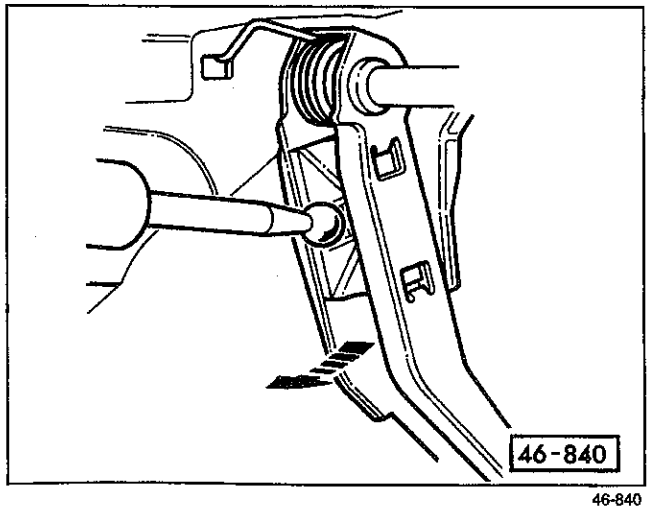



46-838

**Fig. 1.** VW special tool no. 3289 being used to separate brake pedal (**1**) from brake booster pushrod (**2**). Ball retaining tabs shown at **arrows**.

6. Pull special tool and brake pedal together toward the rear until pedal separates from pushrod.

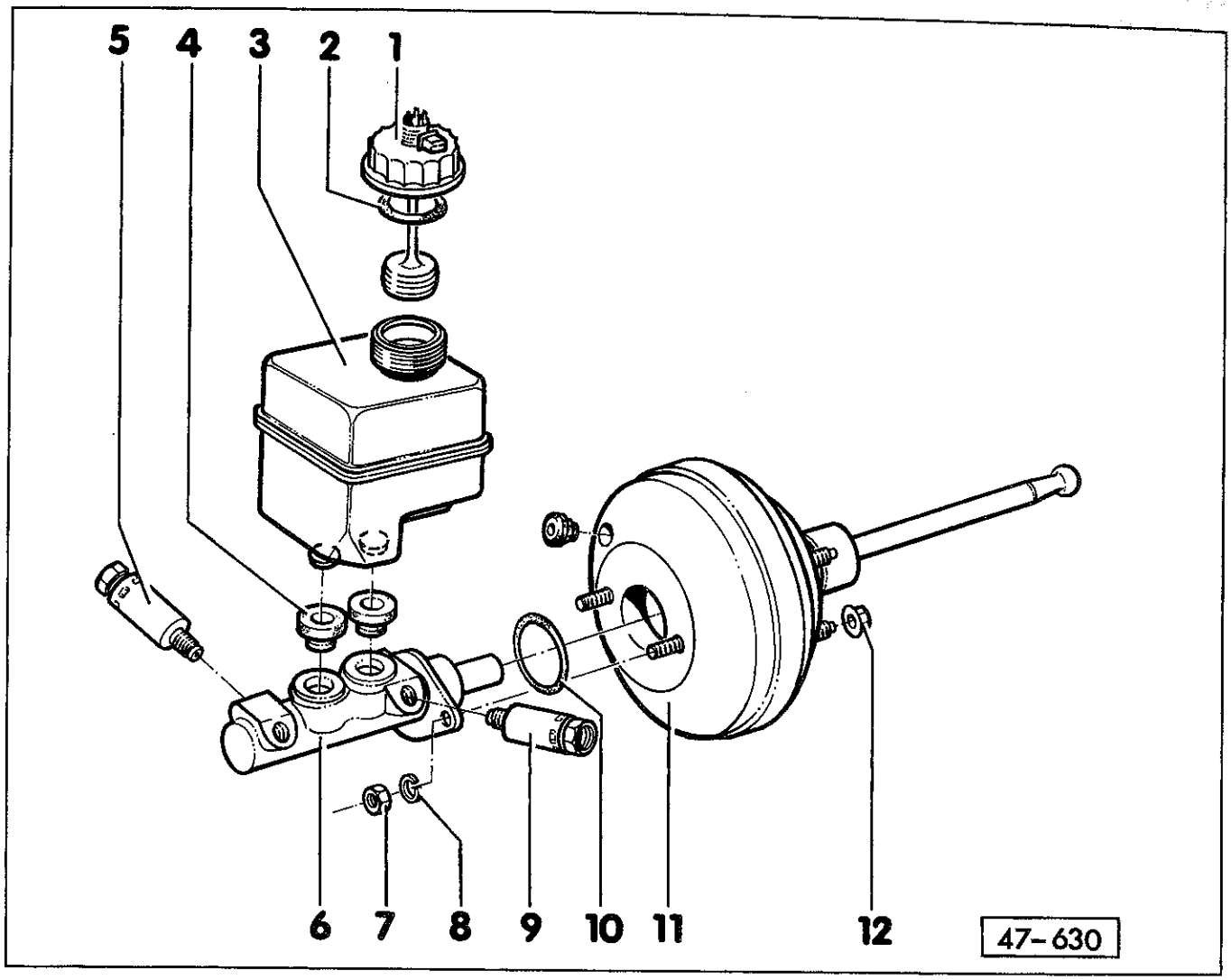
To reconnect pedal to pushrod, hold ball-head of pushrod and push pedal in until parts lock together with an audible click. See Fig. 2.




46-840

**Fig. 2.** Brake pedal being installed to vacuum booster pushrod. Pedal should engage pushrod with an audible click.

## Master cylinder and vacuum booster, assembly



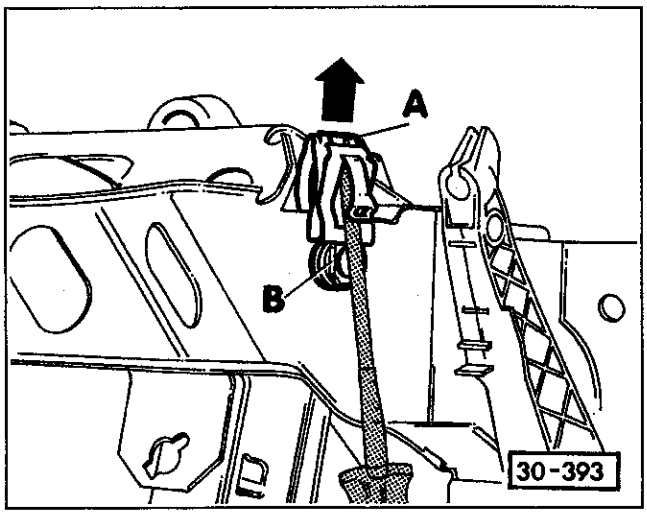

47-630

**Fig. 3.** Exploded view of master cylinder and vacuum booster for cars without ABS.

1. **Cap (with level sensor)**
2. **Seal**
3. **Brake fluid reservoir**
4. **Plug**
   - Moisten with brake fluid and press into reservoir
5. **Not for USA/Canada models**
6. **Master cylinder**
7. **Nut**
   - Tighten to 20 Nm (15 ft-lb)
8. **Lock washer**
   - Always replace
9. **Not for USA/Canada models**
10. **Seal**
    - Always replace
11. **Vacuum brake booster**
    - Checking function:
      Depress brake pedal several times with engine not running. Depress and hold brake pedal while starting engine. If booster function is OK, pedal will drop slightly as vacuum builds and boost takes effect.
    - Cannot be repaired, replace complete unit if necessary
    - Check valve installed in vacuum line
      It should be possible to blow air through valve in direction of arrow. Blowing air through valve in opposite direction should close valve.
12. **Nut**

## Brake pedal, removing and installing

1. Disconnect negative (–) battery cable.
2. Disconnect brake pedal from vacuum booster pushrod as described earlier.
3. Remove over-center spring for clutch pedal, see **30a Clutch (4-Cylinder Engines) or 30b Clutch (6-Cylinder Engine).**
4. Remove pedal shaft retaining clip. See Fig. 4.

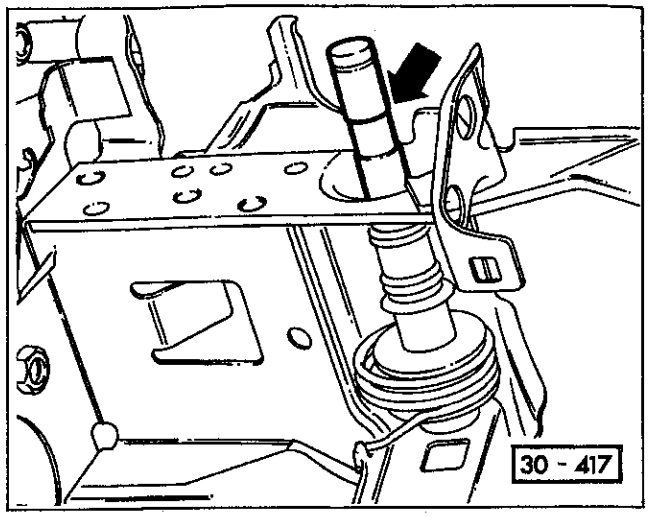



30-393

**Fig. 4.** Remove pedal shaft clip (**A**) by prying up and off (direction of arrow). When installing clip, flats on shaft (**B**) must be vertical.

5. Unhook spring from brake pedal.
6. Pull out pedal shaft to left side and remove brake pedal.
7. Install in reverse order of removal. Make sure the pedal shaft is installed with the narrow section on the left. See Fig. 5.

***NOTE—***
*When installing the retaining clip, make sure the retaining clip flats on the pedal shaft are vertical.*



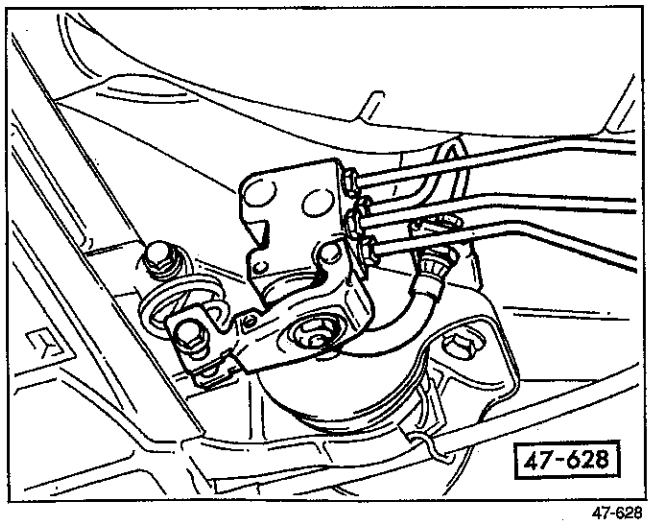

30-393

**Fig. 5.** Install pedal shaft so that narrow section of shaft (**arrow**) goes in on left side.

## Brake pressure regulator, checking

The load-sensing brake pressure regulator is mounted underneath the car with an actuating lever connected to the rear axle beam by a small spring. See Fig. 6. When the axle changes position, due to a heavy load or during hard braking, the pressure regulator varies the pressure to the rear brakes.

***NOTE—***
*The brake pressure regulator should be checked and if necessary adjusted following repairs to the rear suspension, or when there is excessive rear brake wear.*




47-628

**Fig. 6.** Brake pressure regulator mounted in front of rear axle beam.

With the car resting on all four wheels and the fuel tank full, observe the pressure regulator actuating lever while a helper depresses and quickly releases the brake pedal. The lever should move slightly when the brake is quickly released. If not, the regulator is faulty and should be replaced.

***NOTE—***
*For this check to be accurate, the car should be emptied of all cargo and occupants, except driver.*

Testing and adjusting the pressure-regulating function requires measuring brake system pressure at each wheel caliper, using two pressure gauges with a range of at least 160 bar (2320 psi). Because of the need for this specialized equipment, we recommend having this test performed by an authorized Volkswagen dealer.

## FRONT BRAKE CALIPER

Two types of front brake calipers are used depending on type of brake rotor installed. Cars with ventilated rotors use a two-piece caliper assembly. Cars with solid rotors use a single piece caliper. Repair procedures vary depending on caliper application. See **46 Brakes–Mechanical Components** for more information on front brake assemblies.

***NOTE—***
*Complete replacement of the caliper is recommended to remedy a leaking caliper and avoid future problems. A damaged caliper dust seal can be replaced separately.*

### Front brake caliper, removing and installing

1. Raise the car and support it on jack stands. Remove the front wheel.

***WARNING—***
*Jack stands should be placed on a hard level surface (e.g. concrete).*

2. Loosen the flexible front brake hose at the caliper.

3. On cars with ventilated rotors, hold the guide bolts stationary and remove the bolts securing the brake caliper to the pad carrier. Remove the caliper.

***CAUTION—***
*On cars with ventilated rotors, the caliper is mounted to the guide bolts using self-locking bolts that must be replaced once removed.*

4. On cars with solid rotors, remove the bolts securing the brake caliper to the wheel bearing housing. Swing the caliper out from bottom to top to remove.

5. Disconnect the pad wear sensor connector, where applicable. Unscrew the caliper from the brake hose.

6. Installation is the reverse of removal. Fill the caliper with brake fluid and pre-bleed before installing, if not supplied as such. Bleed the brakes as described under **Brake Bleeding**.

**Tightening torques**
- Brake pad carrier to wheel bearing housing (ventilated rotor, 2-piece caliper) . . . 125 Nm (92 ft-lb)
- Brake caliper to guide bolts (ventilated rotor, 2-piece caliper) self-locking bolts (always replace) . . . 35 Nm (26 ft-lb)
- Brake caliper to wheel bearing housing (solid rotor, 1-piece caliper) . . . . . 25 Nm (18 ft-lb)
- Wheel to wheel hub . . . . . 110 Nm (81 ft-lb)

## REAR BRAKES

Two types of rear brake systems–disc and drum–are used on the cars covered by this manual.

### Rear brake caliper, removing and installing (rear disc brakes)

Replace the caliper if fluid is leaking at parking brake lever connection.

1. Raise the car and support on jack stands.

***CAUTION—***
*Jack stands should be placed on a hard level surface (e.g. concrete).*

2. Remove the rear wheel.

3. Loosen the flexible brake hose at the caliper.

4. Disconnect the parking brake cable from the caliper.

5. While holding the guide bolts stationary, remove the bolts securing the caliper to the brake pad carrier. Remove the caliper.

***CAUTION—***
*The caliper is mounted to the guide bolts using self-locking bolts that must be replaced once removed.*

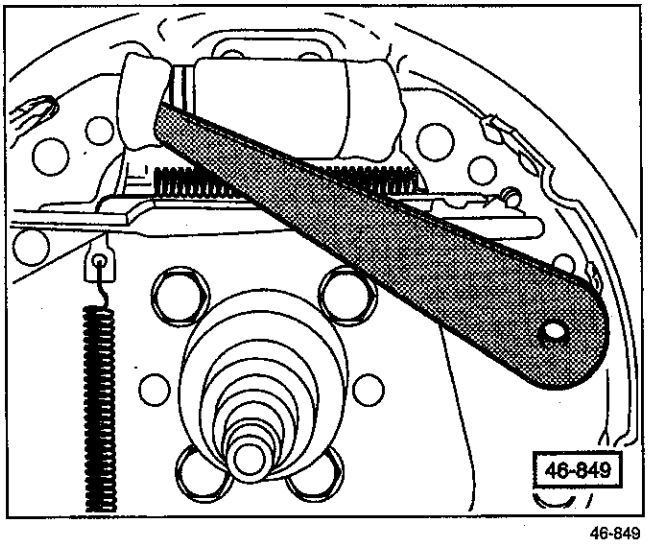
6. Unscrew the caliper from the brake hose. Cap the open hose connection to prevent contamination.

7. Install parts in reverse order of disassembly, noting the following installation instructions:
   - Lightly lubricate the guide bolts with grease.
   - Before tightening the bleeder screw, lubricate the threads with brake fluid.
   - Fill the caliper with brake fluid and pre-bleed before installing, if not supplied as such. Bleed the brakes as described under **Brake Bleeding**.

**Tightening torques**
- Brake pad carrier to stub axle . . . . . 56 Nm (41 ft-lb)
- Brake caliper to guide bolts (ventilated rotor, 2-piece caliper) self-locking bolts (always replace) . . .. 35 Nm (26 ft-lb)
- Wheel to wheel hub . . . . . 110 Nm (81 ft-lb)

## Rear brake wheel cylinder, removing and installing (rear drum brakes)

Complete replacement of the brake cylinder is recommended to remedy a leaking cylinder and avoid future problems. If brake fluid is present under the dust seal, the wheel cylinder is leaking and should be replaced. See Fig. 7.




46-849

**Fig. 7.** Dust seal being removed from wheel cylinder to check for leakage.

1. Remove the rear brake shoes. See **46 Brakes–Mechanical Components.**

2. Working from the rear of the backing plate, disconnect the brake line from the wheel cylinder.

3. Remove the bolts that fasten the wheel cylinder to the backing plate. See Fig. 8.

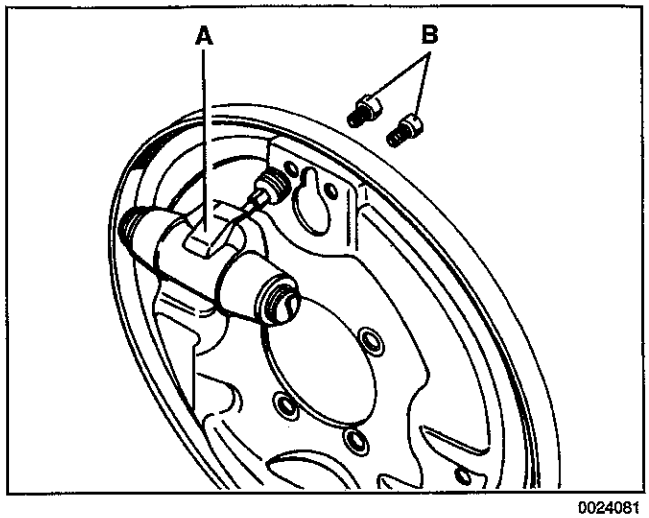



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**Fig. 8.** Rear brake cylinder (**A**) with allen head mounting bolts (**B**).

4. Remove the wheel cylinder from the backing plate.

***NOTE—***
*Cap the open brake line to prevent contamination while the wheel cylinder is removed.*

5. Installation is reverse of removal. Fill the wheel cylinder with brake fluid and pre-bleed before installing. Bleed the brakes as described below under **Brake Bleeding.**

**Tightening torques**
- Rear brake wheel cylinder to backing plate . . . . . 10 Nm (7 ft-lb)

## BRAKE BLEEDING

The procedure given here applies to all vehicles covered in this manual with and without ABS.

The brake system can be bled using a pressure bleeder or manually using a helper. Pressure bleeding, if the equipment is available, is the fastest. Manual bleeding requires a helper, but is easy and requires no special tools.

***WARNING —***

- *Vehicles equipped with the TEVES 20 GI ABS/EDL can also be bled during maintenance using conventional methods. However, if the reservoir has been completely emptied, the hydraulic unit must be bled using the Volkswagen Scan Tool VAG 1551 or VAG 1552. This is only necessary if the hydraulic unit or control module has been replaced or if there is a leak in the system. This procedure electronically cycles the hydraulic unit and valve body to purge trapped air and is beyond the scope of this manual. See* **45 Anti-Lock Brakes (ABS)** *for application information.*
- *DO NOT mix DOT 5 silicone type brake fluid with DOT 4 brake fluid as severe corrosion will result. Such corrosion could lead to complete brake system failure.*
- *Brake fluid is poisonous. Wear safety glasses and rubber gloves when working with brake fluid. Prevent brake fluid from entering the bloodstream through cuts or scratches. Do not siphon brake fluid by mouth.*

***CAUTION —***

- *Brake fluid is very damaging to paint. Immediately wipe up any brake fluid that spills on the vehicle.*
- *Use only new, approved brake fluid that complies with MVSS 116 DOT 4*

### Bleeding, with pressure bleeder (all systems)

Pressure bleeding using Volkswagen special tool US1116 or equivalent is the preferred method of removing air from all brake systems because it does a more thorough purge.

1. Connect pressure bleeder with regulated compressed air supply to fluid reservoir according to manufacturer's instructions.
2. Connect hose from bleeder bottle to caliper/wheel cylinder bleeder screw and bleed brakes in following sequence:
   - 1 - Right rear caliper or wheel cylinder
   - 2 - Left rear caliper or wheel cylinder
   - 3 - Right front caliper
   - 4 - Left front caliper
3. Brake fluid should be allowed to flow from the bleeder valve/screw until it runs clear.

***CAUTION —***

*The brake fluid level in the reservoir must not fall below the MIN mark during bleeding.*

***NOTE —***

- *If installed, the brake pressure regulator lever must be pressed toward the rear during rear brake bleeding (see Fig. 6, given earlier).*
- *Depress the brake pedal several times during the bleeding operation.*

### Bleeding, manually (all systems)

1. Connect hose from bleeder bottle to brake bleeder screw at the right rear caliper or wheel cylinder.

***CAUTION —***

*The brake fluid level in the reservoir must not fall below the MIN mark during bleeding.*

***NOTE —***

- *If installed, the brake pressure regulator lever must be pressed toward the rear during rear brake bleeding (see Fig. 6, given earlier).*
- *Depress the brake pedal several times during the bleeding operation.*

2. Have a helper pump the brake pedal several times and then hold pedal down.
3. Open bleeder screw at the caliper or wheel cylinder and collect fluid.
4. Close bleeder screw and then release brake pedal. Repeat operation until brake fluid runs clear and flows without air bubbles.
5. Repeat the above procedure at the remaining wheels, using the following sequence:
   - Left rear caliper/wheel cylinder
   - Right front caliper
   - Left front caliper/wheel cylinder

Vehicles equipped with the TEVES 20 GI ABS/EDL can also be bled during maintenance using conventional methods. However, if the reservoir has been completely emptied, the hydraulic unit must be bled using the Volkswagen Scan Tool VAG 1551 or VAG 1552. This is only necessary if the hydraulic unit or control module has been replaced or if there is a leak in the system. This procedure electronically cycles the hydraulic unit and valve body to purge trapped air and is beyond the scope of this manual. See **45 Anti-Lock Brakes (ABS)** for application information.

# 48 Steering



48

## GENERAL

Power assisted rack and pinion steering is standard on all models covered in this manual. A belt driven vane type pump provides hydraulic pressure to the rack and pinion steering gear. Service of the steering gear, including repair of housing seal leaks, is by replacement only. The power assisted steering gear is available only as a complete unit.

Special tools and procedures may be required for steering system repair and component replacement. In addition, front wheel alignment is almost always disturbed when steering components are removed or replaced. For wheel alignment specifications, see **44 Wheels–Tires, Wheel Alignment**.

***WARNING —***
- *Most cars covered by this manual are equipped with an airbag system. The airbag is a dangerous device if handled improperly. Before starting any work on the steering components of an airbag equipped car, read the safety precautions listed in* **69–Seatbelts, Airbags.**
- *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, cotter pins. For replacements, always use new parts.*

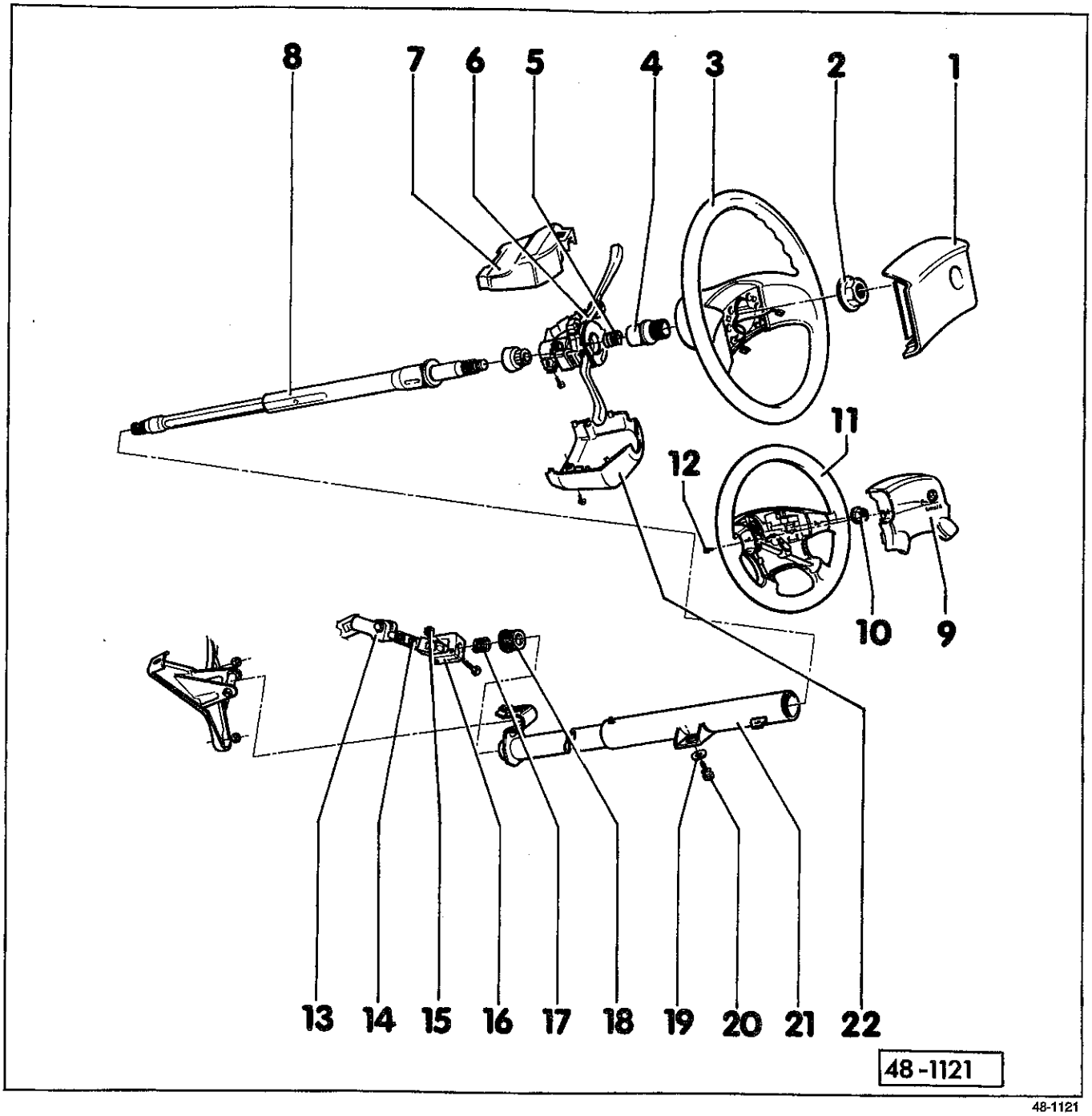
***WARNING —***
- *Do not reinstall bolts and nuts coated with undercoating wax as correct tightening torque cannot be assured. Always clean the threads of removed bolts and nuts with a solvent before installation, or replace them with new parts.*
- *Do not attempt to repair damaged steering components by welding or straightening.*

***CAUTION —***
- *Front wheel alignment should be checked after replacement of steering components.*
- *Do not hold the steering wheel at full lock for extended periods with the engine running. The constant load may overheat and damage the power steering pump.*

## STEERING WHEEL AND STEERING COLUMN

Fig. 1 shows the steering column assembly. Fig. 2 shows the steering column tube assembly for cars with height adjustable steering. Note that most models are equipped with a driver's side airbag unit mounted to the front of the steering wheel. Special service precautions should be followed when servicing vehicles with airbag(s).

## Steering wheel and column, assembly



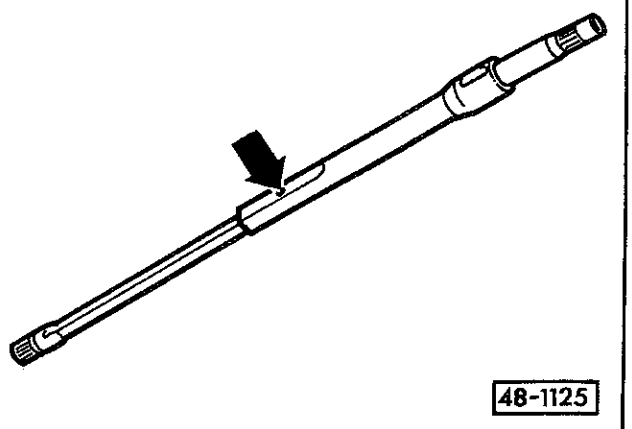

48-1121

**Fig. 1.** Steering wheel, column, and column tube exploded view. Steering wheel with and without airbag shown.

1. **Cover plate**
   - For vehicles without airbag
   - Removing: lift at bottom and pull from steering wheel
2. **Hex nut**
   - Tighten to 50 Nm (37 ft-lb)
   - For vehicles without airbag
3. **Steering wheel**
   - For vehicles without airbag
   - Remove/Install with wheels in centered position
   - Make matching marks on wheel and steering column before removing

4. **Splined adapter sleeve**
   - Removing: pull off using use puller with clamping leg
   - Installing: press on using steering wheel nut
5. **Spring**
6. **Steering column switch/steering lock housing**
   - Gap between steering wheel and steering column switch is not adjustable
7. **Upper trim**
8. **Steering column**
   - Remove by pulling upward out of column tube
   - Checking length, **see** (A)
9. **Airbag unit**
   - See **Steering wheel, removing/installing (with airbag)**
10. **Hex nut**
    - Tighten to 50 Nm (37 ft-lb)
11. **Steering wheel for airbag**
    - See **Steering wheel, removing/installing (with airbag)**
12. **Socket-head bolt,**
    - Tighten to 6.5 Nm (58 in-lb)
    - Always replace
13. **Hex bolt**
    - Tighten to 30 Nm (22 ft-lb)
14. **Hex bolt**
    - Tighten to 25 Nm (18 ft-lb)
15. **Hex nut**
    - Tighten to 30 Nm (22 ft-lb) plus additional 1/8-turn (45°)
16. **Steering column universal joint**
17. **Spring**
18. **Lower steering column bearing**
    - Pull in with VW 771 and large washer
    - Drive out downward with a tube
19. **Washer**
20. **Shear bolt**
    - Drill out to remove
    - Tighten new bolt until head shears off
21. **Column tube**
    - Column tube
    - Cars with height-adjustable steering wheel, see Fig. 2
22. **Lower trim**

**(A) Checking length of steering column**

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- **The small sheet metal lug on the lower part must be visible in the hole in the upper part (arrow). If necessary pull both parts firmly apart onto stop.**

## Steering column tube, assembly (height-adjustable steering wheel)

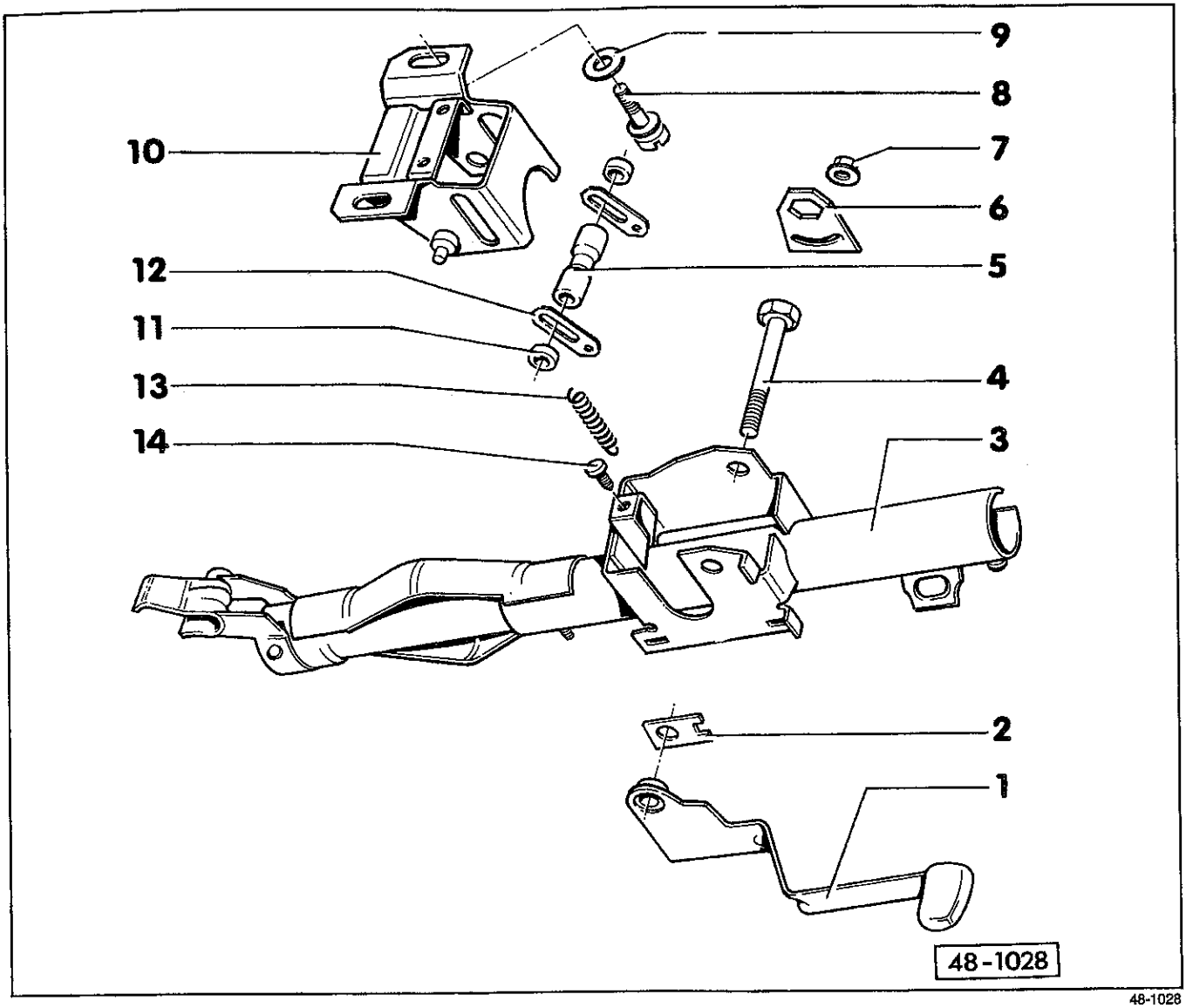
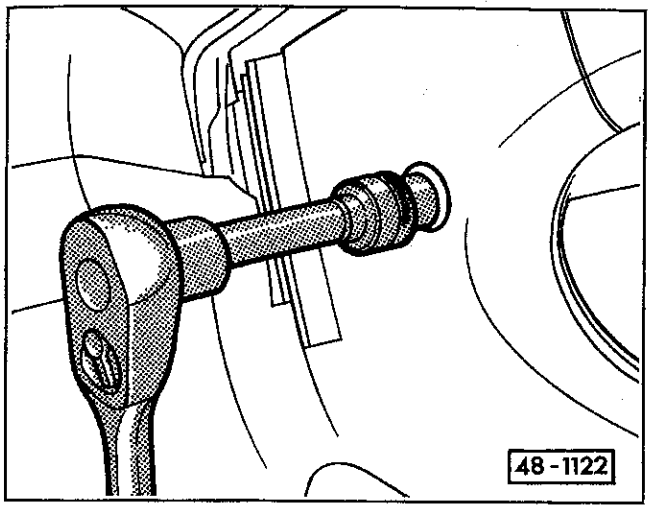



**Fig. 2.** Exploded view of steering column tube for height-adjustable steering wheel.

1. **Operating lever**
2. **Packing plate**
3. **Column tube**
   - Square housing fits over mounting bracket
4. **Bolt with left-hand thread**
   - Tighten to 22 Nm (16 ft-lb) with lever on upper stop
   - After tightening install lock plate
5. **Clamping sleeve**
6. **Lock plate**
7. **Nut**
   - Always replace
   - Tighten to 8 Nm (71 in-lb)
8. **Shear bolt**
   - Tighten until head shears off
9. **Washer**
10. **Mounting bracket**
    - Coat sliding surfaces with MoS2 grease before assembling
11. **Thrust washer**
12. **Plate**
13. **Return spring**
    - Hooked into mounting bracket on column tube
14. **Rubber stop**

## Steering wheel, removing and installing (with airbag)

1. Disconnect the negative (-) battery cable.
2. Center steering wheel in straight-ahead position.
3. Remove both socket head screws from rear of steering wheel (airbag unit mounting screws). See Fig. 3.




48-1122

**Fig. 3.** Socket-head (self-locking) screw being removed from rear of steering wheel.

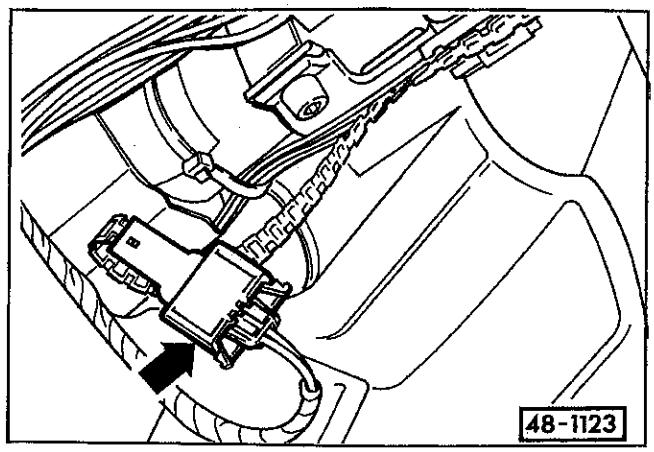
4. Carefully remove airbag unit from steering wheel and disconnect harness connector from rear of unit.

> ***WARNING —***
> *Store the removed airbag in a safe place with the airbag pad facing up.*

5. Remove trim below steering column switch. Disconnect wiring harness connector (remove foam sleeve from connector if fitted). See Fig. 4.
6. Remove hex nut in center of steering wheel. Make matching marks on steering wheel and steering column. Pull steering wheel off steering column.

> ***CAUTION —***
> - *The airbag spiral spring on the rear of the steering wheel must be "locked" in its centered position. To do this, hold the wheel in the normally installed position. Then with wire on the spiral spring facing downward, turn the connecting ring just until the spiral spring locks in position. See Fig. 5.*
> - *Replacement of the airbag spiral spring is covered in* **69 Seatbelts, Airbags.**

7. Reinstall steering wheel in reverse order of removal. Use new self-locking bolts to mount airbag to steering wheel. When installing trim, ensure that airbag harness connector sits in recess in trim.




48-1123

**Fig. 4.** Wiring harness connector (**arrow**) for airbag unit.

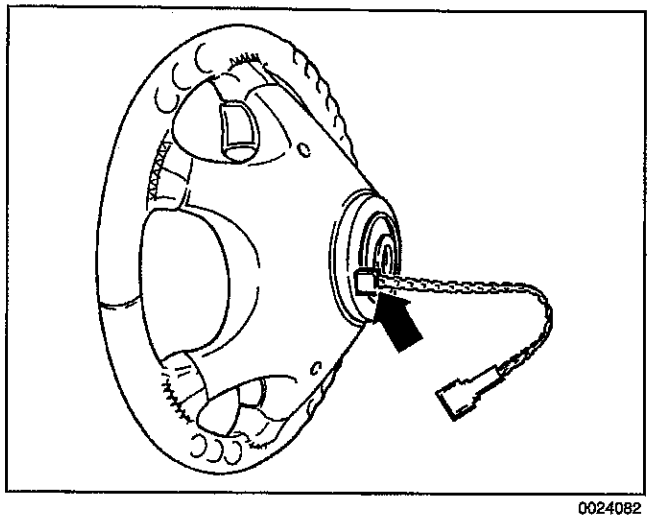


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**Fig. 5.** Wire (**arrow**) on spiral spring should be in downward position so that spiral spring locks in center position.

8. After installing airbag unit and reconnecting airbag electrical connectors, switch ignition on. Then reconnect battery negative (–) cable.

> ***WARNING —***
> - *DO NOT reconnect the battery cable until airbag and steering wheel installation is complete, including reconnection of all harness connectors.*
> - *The ignition switch must be turned on BEFORE reconnecting the negative (–) battery cable.*
> - *Ensure that no one is in the vehicle when reconnecting the negative (–) battery cable.*

**Tightening torques**

- Airbag to steering wheel (self-locking bolts) . . . . . 6.5 Nm (58 in-lb)
- Steering wheel to steering column . . . 50 Nm (37 ft-lb)

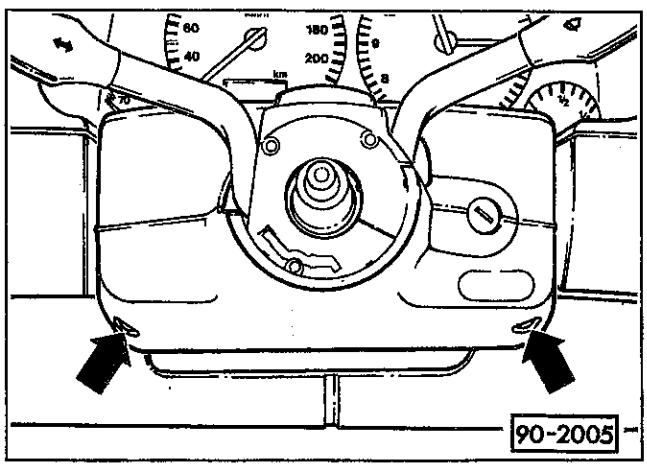
## Steering column switches, replacing

The turn signal switch and the windshield wiper and washer switch are fastened to the top of the steering column housing by three screws. The steering wheel and airbag (if applicable) must first be removed to access the switches. **Table a** lists terminals identification for the column switches.

1. Disconnect the negative (–) battery cable.
2. Center steering wheel in straight-ahead position.
3. Remove the airbag (if equipped) and steering wheel. See **Steering wheel, removing and installing (with airbag).**

> ***WARNING —***
> *The airbag is a dangerous device if handled improperly. Always disconnect the negative (–) battery cable before beginning work on an airbag equipped vehicle. Read the safety precautions listed in* **69–Seatbelts, Airbags.**

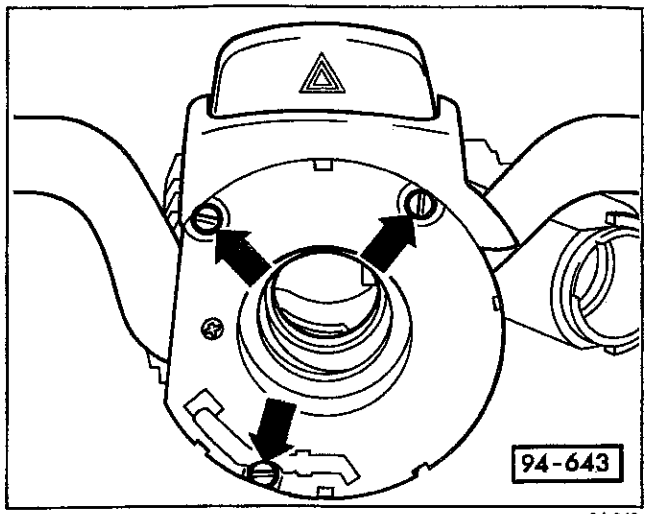
4. Remove screws holding steering column trim and remove lower and upper trim covers. See Fig. 6.




90-2005

**Fig. 6.** Steering column trim securing screws (**arrows**).

5. Remove the screws holding the switches to the steering column. See Fig. 7.
6. Pull the switches off the steering column and disconnect the wiring harness connectors from the switches.

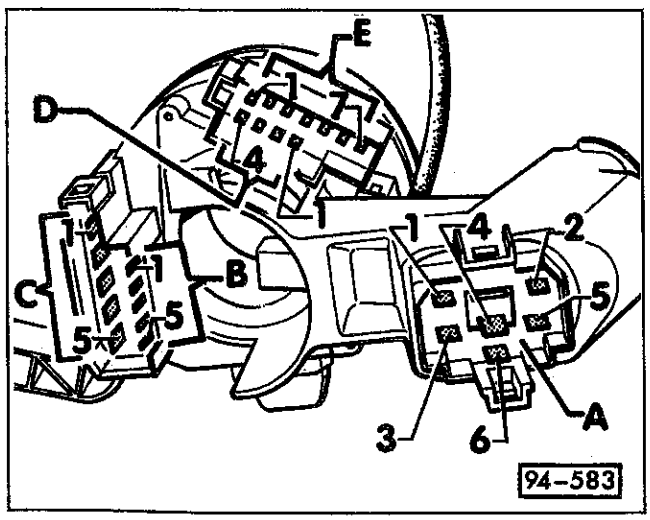



94-643

**Fig. 7.** Steering column switch securing screws (**arrows**).

7. Installation is the reverse of removal. Be sure to follow the airbag installation procedures. See **Steering wheel, removing and installing (with airbag).**

> ***WARNING —***
> - *DO NOT reconnect the battery cable until airbag and steering wheel installation is complete, including reconnection of all harness connectors.*
> - *The ignition switch must be turned on BEFORE reconnecting the negative (–) battery cable.*
> - *Ensure that no one is in the vehicle when reconnecting the negative (–) battery cable.*




94-583

**Fig. 8.** Terminal identification for the electrical connectors on rear of steering column switch assembly. Use with **Table a** to make electrical tests.

**Table a. Terminal identification, steering column switches**

| Terminal Number | A) Ignition/starter switch | B) 5-point connector | C) 5-point connector | D) 4-point connector | E) 7-point connector |
|---|---|---|---|---|---|
| 1 | Ignition/starter switch - Terminal 15 (B+ with key on) | Windshield wiper/wash switch- Terminal 53b | Emergency flasher switch - Terminal 49 | Windshield wiper/wash switch- Terminal L | Horn button - Terminal 72 |
| 2 | Ignition/starter switch - Terminal X (B+ with key on) | Windshield wiper/wash switch- Terminal 53a | Headlight dimmer/ flasher switch - Terminal 56b | Windshield wiper/wash switch- Terminal T | Emergency flasher switch - Terminal 49a |
| 3 | Ignition/starter switch - Terminal 50 | Windshield wiper/wash switch- Terminal 53 | Headlight dimmer/ flasher switch - Terminal 56 | Windshield wiper/washer switch - Terminal 31 (GND) | Turn signal switch - Terminal L |
| 4 | Ignition/starter switch - Terminal 30 (B+) | Windshield wiper/wash switch- Terminal 53e | Headlight dimmer/ flasher switch - Terminal 56a | Emergency flasher switch- Terminal 15 (B+ with key on) | Parking light switch - Terminal PL |
| 5 | Ignition/starter switch - Terminal SU | Windshield wiper/wash switch- Terminal J | Headlight dimmer/ flasher switch - Terminal 30 (B+) | – | Parking light switch - Terminal P |
| 6 | Ignition/starter switch - Terminal P | – | – | – | Parking light switch - Terminal PR |
| 7 | – | – | – | – | Turn signal switch - Terminal R |

## Steering lock housing, removing and installing

1. Disconnect the negative (–) battery cable.
2. Center steering wheel in straight-ahead position.
3. Remove the airbag (if equipped) and steering wheel. See **Steering wheel, removing and installing (with airbag).**

> ***WARNING —***
> *The airbag is a dangerous device if handled improperly. Always disconnect the negative (–) battery cable before beginning work on an airbag equipped vehicle. Read the safety precautions listed in* **69– Seatbelts, Airbags.**

4. Remove steering column switches as described earlier.
5. On cars with automatic transmission, disconnect the shift-lock cable from the ignition lock housing. See **37 Automatic Transmission.**
6. Using an appropriate puller, remove splined adapter sleeve from steering column (see Fig. 1).
7. Remove spring and horn contact ring.
8. Remove shear bolt that clamps ignition lock housing to steering column tube. If necessary, drill bolt head and remove using screw extractor.
9. Insert ignition key and unlock lock cylinder. Disconnect wiring connectors from ignition switch. Slide steering lock housing off of steering column.
10. Installation is the reverse of removal. Use a new shear bolt when installing the steering lock housing. Be sure to follow the airbag installation procedures. See **Steering wheel, removing and installing (with airbag).** On cars with automatic transmission, adjust the shift lock cable. See **37 Automatic Transmission.**

> ***WARNING —***
> - *DO NOT reconnect the battery cable until airbag and steering wheel installation is complete, including reconnection of all harness connectors.*
> - *The ignition switch must be turned on BEFORE reconnecting the negative (–) battery cable.*
> - *Ensure that no one is in the vehicle when reconnecting the negative (–) battery cable.*

## Ignition lock cylinder, replacing

1. Remove steering lock housing as described earlier.
2. Mark drilling location on lock housing using Fig. 9 as a guide. Drill 3 mm (1/8 in.) hole into steering lock housing at mark until stop spring is visible
3. Compress stop spring using opposite end of drill and pull lock cylinder out of housing.
4. Insert lock cylinder into steering lock housing.
5. Insert key into lock cylinder.

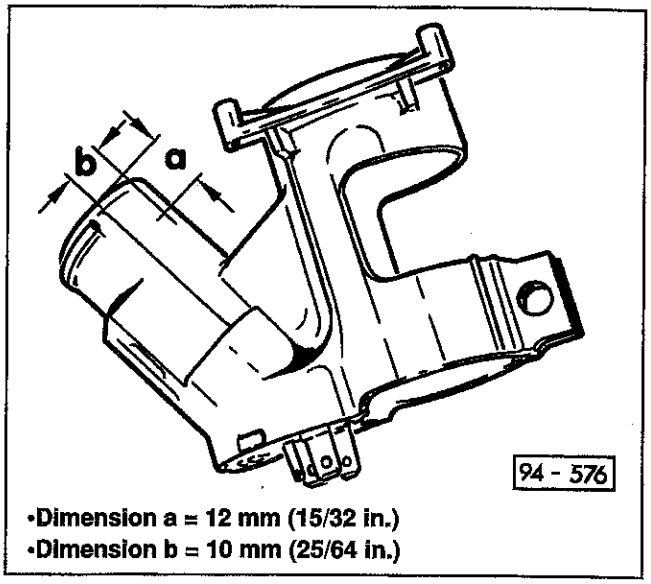



**Fig. 9.** Mark location at dimension **a** and **b** and drill 3mm (1/8 in.) hole, approx. 3 mm (1/8 in.) deep.

6. Push lock cylinder fully into housing while gently turning key.

7. The remainder of installation is the reverse of removal. Use a new shear bolt when installing the steering lock housing to the steering column. Be sure to follow the airbag installation procedures. See **Steering wheel, removing and installing (with airbag)**.

> ***WARNING —***
> - *DO NOT reconnect the battery cable until airbag and steering wheel installation is complete, including reconnection of all harness connectors.*
> - *The ignition switch must be turned on BEFORE reconnecting the negative (–) battery cable.*
> - *Ensure that no one is in the vehicle when reconnecting the negative (–) battery cable.*

## POWER STEERING GEAR

Two variants of power steering racks are installed on the cars covered by this manual; TRW manufactured and ZF manufactured. See Fig. 10 and Fig. 11. Removal and installation procedures are identical for both racks, however parts between the two systems are not interchangeable.

> ***CAUTION —***
> - *Always replace self-locking nuts and bolts.*
> - *Pay special attention to the rules for cleanliness when working on the power steering. Thoroughly clean all connections and adjacent areas before disconnecting.*

### Steering gear, assembly (TRW)

1. **Nut**
   - Tighten to 35 Nm (26 ft-lb)
2. **Nuts**
   - Tighten to 30 Nm (22 ft-lb)
3. **Clamp**
4. **Rubber mounting**
5. **Tie rod, right**
   - Tighten to 70 Nm (52 ft-lb)
   - Install inner joint with locking compound (Volkswagen "D6" or equivalent). See **Tie rods, removing and installing**
6. **Tie rod, left**
   - Tighten to 70 Nm (52 ft-lb)
   - Install inner joint with locking compound (Volkswagen "D6" or equivalent).
   - Adjusting basic length, see **Tie rods, removing and installing**
7. **Nut**
   - Tighten to 50 Nm (37 ft-lb)
8. **Boot**
   - Can be replaced with steering gear installed
   - Must not be twisted after adjusting toe
   - Not interchangeable with boot for ZF steering gear
9. **Steering gear**
   - See **Steering gear, removing and installing**
   - See **Steering gear play, adjusting**
10. **Tie rod end**
    - Pressing off, see **Power steering gear, removing and installing**
    - Checking see **0a Maintenance Program**
11. **Nut**
    - Tighten to 30 Nm (22 ft-lb) plus additional 1/8-turn (45°)
12. **Universal joint shaft**
13. **Fitting**
    - Tighten to 30 Nm (22 ft-lb)
14. **O-ring**
    - Always replace
15. **Clamp**
    - Always replace
    - Tensioning, see **Tie rods, installing**

## Steering gear, assembly (TRW)

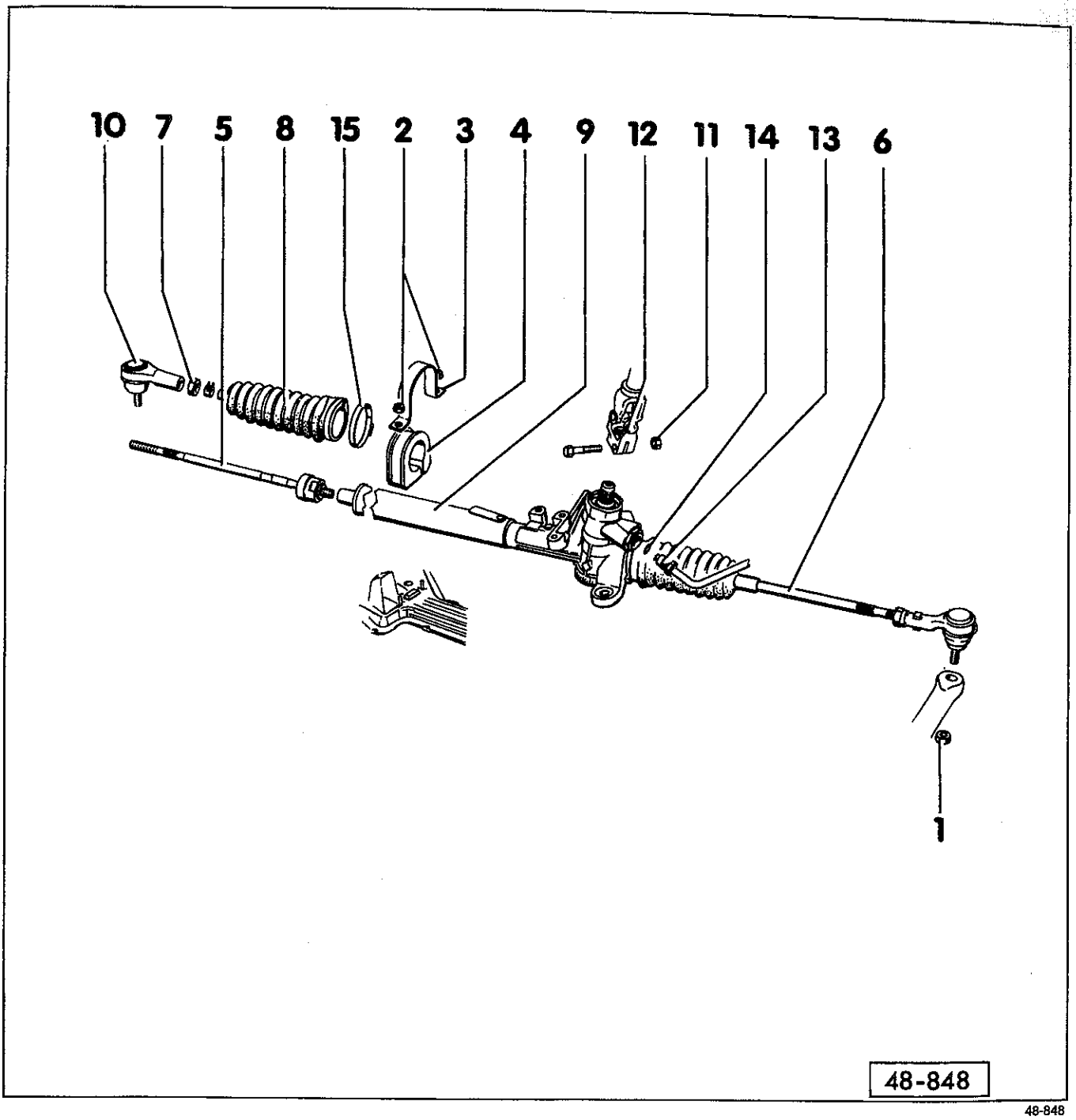



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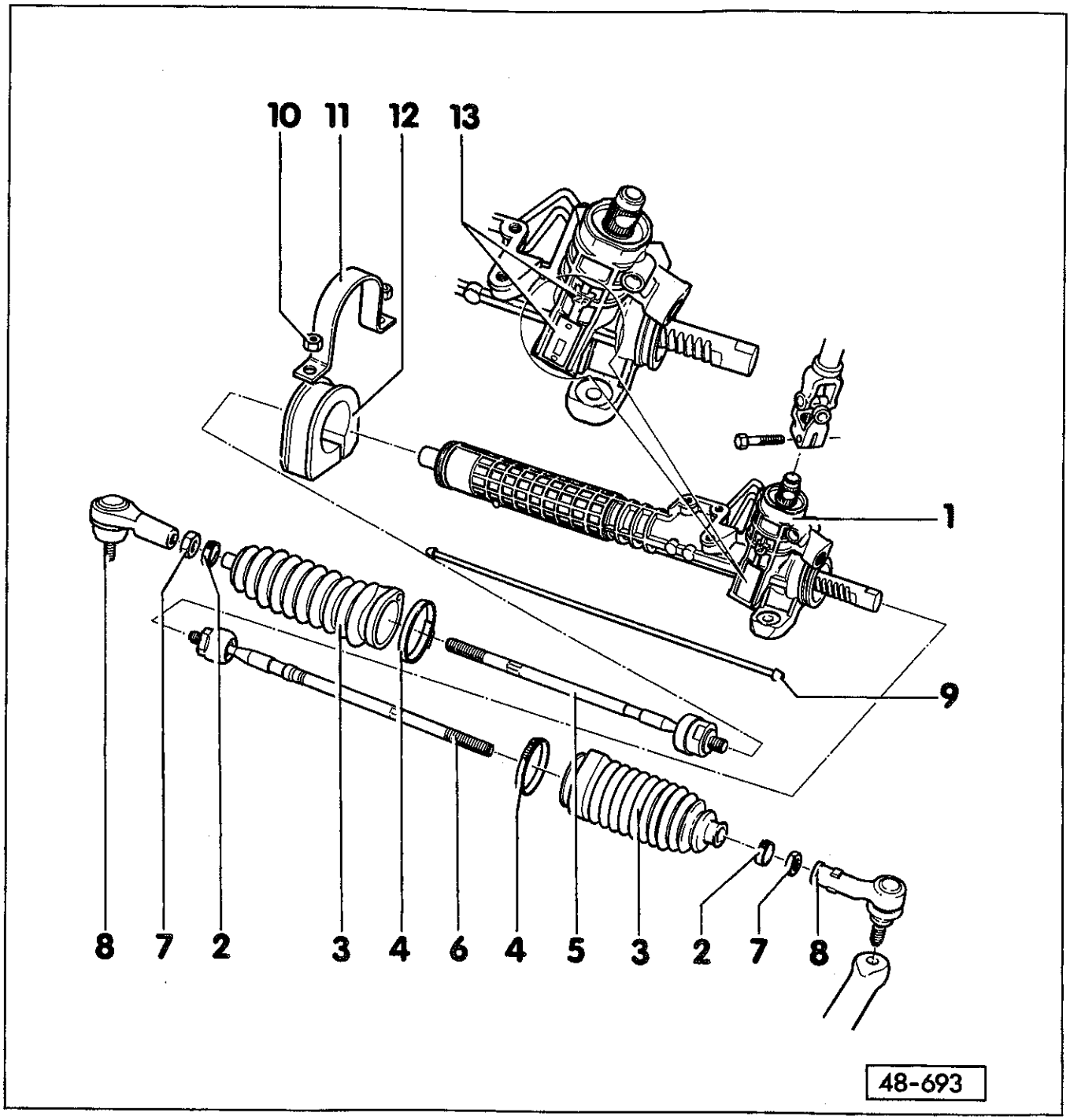
**Fig. 10.** Exploded view of TRW steering gear assembly.

## Steering gear, assembly (ZF)




48-693

**Fig. 11.** Exploded view of ZF steering gear assembly.

1. **Steering gear**
   - See **Power steering gear, removing and installing**
   - See **Steering gear play, adjusting**

2. **Clamp**
   - To remove, cut open with pliers
   - Tensioning, see **Tie rods, installing**
   - Not interchangeable with clamp for TRW steering gear

3. **Boot**
   - Remove tie rod end before removing
   - Check for wear (cuts, cracks), check sealing surfaces and sealing lips for cleanliness/damage
   - Not interchangeable with boot for TRW steering gear
4. **Clamp**
   - Always replace
   - Tensioning, see **Tie rods, installing**
   - Not interchangeable with clamp for TRW steering gear
5. **Tie rod, right**
   - Install inner joint with locking compound (Volkswagen "D6" or equivalent). See **Tie rods, removing and installing**
   - Not interchangeable with tie rod for TRW steering gear
6. **Tie rod, left**
   - Install inner joint with locking compound (Volkswagen "D6" or equivalent).
   - Adjusting basic length, see **Tie rods, removing and installing**
   - Not interchangeable with tie rod for TRW steering gear
7. **Nut**
   - Tighten to 50 Nm (37 ft-lb)
8. **Tie rod end**
   - Pressing off, see **Power steering gear, removing**
   - Checking see **0 Maintenance Program**
9. **Pressure compensation line**
10. **Nut**
    - Tighten to 30 Nm (22 ft-lb)
11. **Clamp**
12. **Rubber bushing**
13. **Manufacturer data plate**

## Power steering gear, removing and installing

***NOTE—***

*Removal and installation of the steering gear requires the use of engine support equipment. The support equipment is needed to lower and raise the engine and subframe assembly.*

1. Raise the car and support on jack stands.

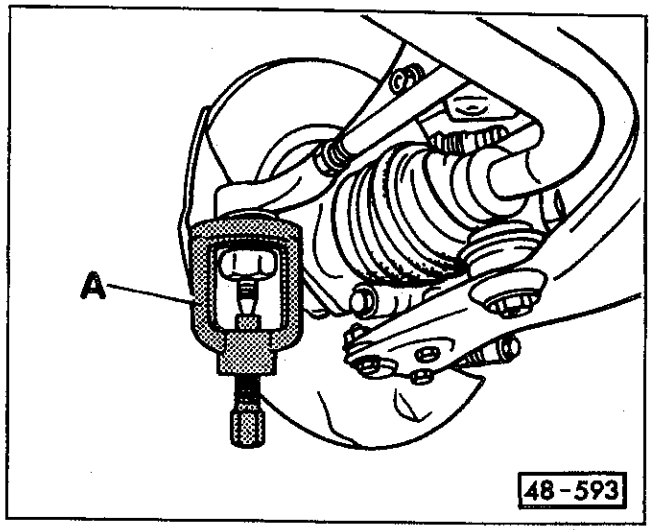
***CAUTION—***

*Jack stands should be placed on a hard level service (e.g. concrete).*

2. Separate tie rods ends from wheel bearing housing. See Fig. 12.

***CAUTION—***

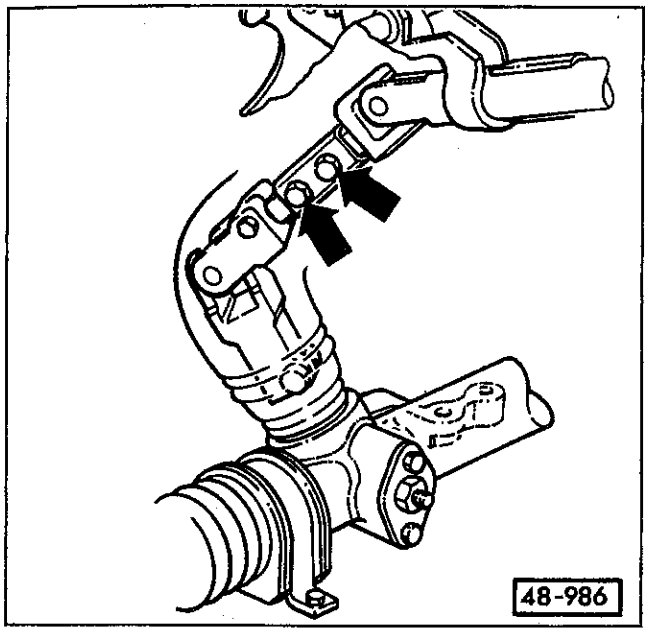
*DO NOT use a ball joint fork to separate tie rods. The tie rod end boots or the tie rod could be damaged.*




48-593

**Fig. 12.** Tie rod end being separated using press (**A**).

3. Remove bolts from universal joint shaft. See Fig. 13.
4. Disconnect universal joint protective boot from its seat on steering gear.
5. Support weight of engine/transmission assembly with appropriate engine lifting equipment. See Fig. 14.
6. Place a drain pan below the power steering pump. Remove lower hose from the pump and drain power steering fluid.




48-966

**Fig. 13.** Universal joint shaft bolts (**arrows**).

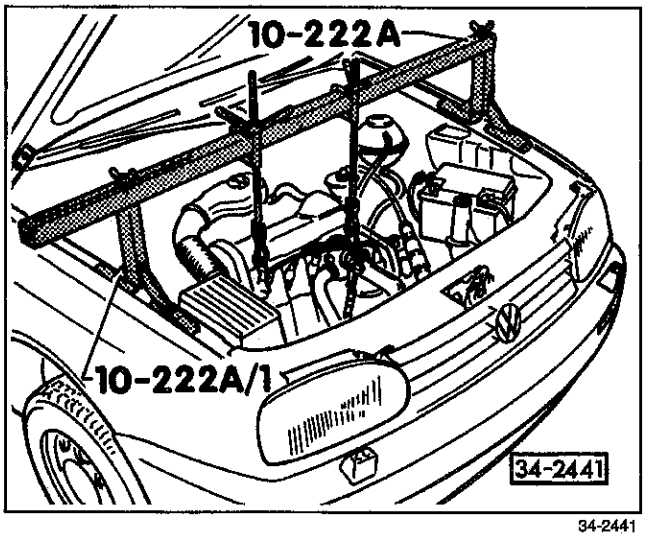



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**Fig. 14.** Engine/transmission assembly being supported from above. Volkswagen special tools shown.

7. With engine/transmission assembly supported, remove subframe bolts.

8. Lower engine/transmission assembly slowly until two halves of universal joint separate.

9. Disconnect hydraulic lines from steering gear and seal lines with plastic bags and tape.

***NOTE—***

*Seal or plug threaded holes on steering gear.*

10. Remove steering gear retaining nuts (steering gear bolts remain in subframe). Remove steering gear towards the rear.

11. Install in reverse order of removal. Align front end and check position of steering wheel. Tightening torques are given below. Fill system with specified hydraulic fluid as specified below.

***NOTE—***

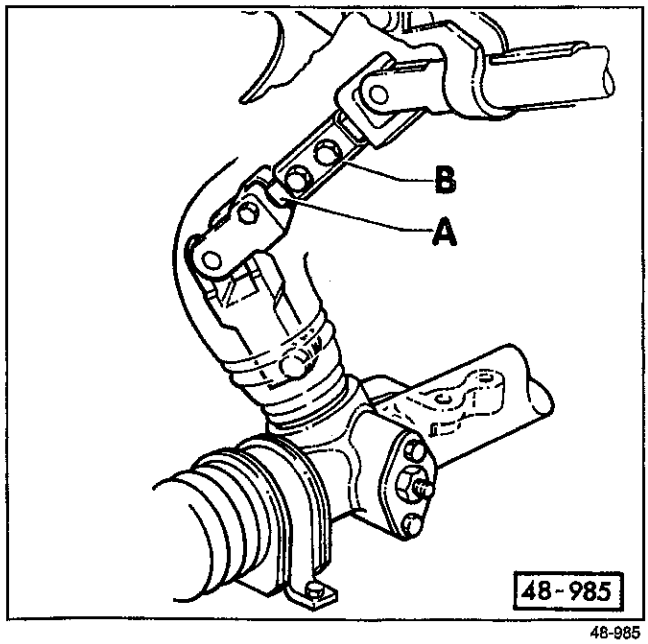
- *When lifting the engine/transmission assembly, the lower half of the U-joint shaft must be guided into the upper half of U-joint shaft (helper required). See Fig. 15.*
- *Coat U-joint protective boot with lubricant, or soap, before pulling onto the steering gear.*

**Tightening torques**

- Universal joint shaft halves . . . . . 25 Nm (18 ft-lb)
- Steering gear to subframe . . . . . 30 Nm (22 ft-lb)
- Tie rod end to wheel bearing housing 35 Nm (26 ft-lb)
- Subframe to body (front and rear)
  stage I . . . . . 70 Nm (52 ft-lb)
  stage II. . . . . additional 1/4 turn (90°)
- Rear subframe bracket to body . . . . . 65 Nm (48 ft-lb)

**Power steering specifications**

- Oil type . . . . . Hydraulic oil (VW Part No. G 002 000)
- Oil capacity. . . . . 0.7-0.9 liter (0.74-0.95 qt.)




48-985

**Fig. 15.** When lifting engine/transmission assembly, lower half of joint shaft (**A**) must be guided into upper half of joint shaft (**B**).

## Steering gear play, adjusting

Two persons are required to adjust steering gear play. The adjustment should also be made with the car on a lift and the steering and suspension system in its normal position.

***NOTE—***
*On cars with TRW steering gear, a special Volkswagen tool is required to make the adjustment.*

1. Raise the vehicle on a lift.
2. Place wheels in straight-ahead position.
3. Turn steering wheel back and forth (about 30° from center position) and listen for rattling noise which will be heard if there is excessive steering gear play.
4. If excessive play is present, adjust steering gear play.
   - On cars with TRW steering gear, use Volkswagen special tool no. 524 to turn adjusting screw in until knocking noise can no longer be heard inside vehicle. See Fig. 16.
   - On cars with ZF steering gear, loosen locknut and turn in adjusting screw in until knocking noise can no longer be heard inside vehicle. Tighten locknut. See Fig. 17.

***CAUTION—***
*Do not overtighten adjusting screw. Only minor adjustments should be necessary. Make adjustments in small increments, just until the rattling noise is no longer heard inside the car.*

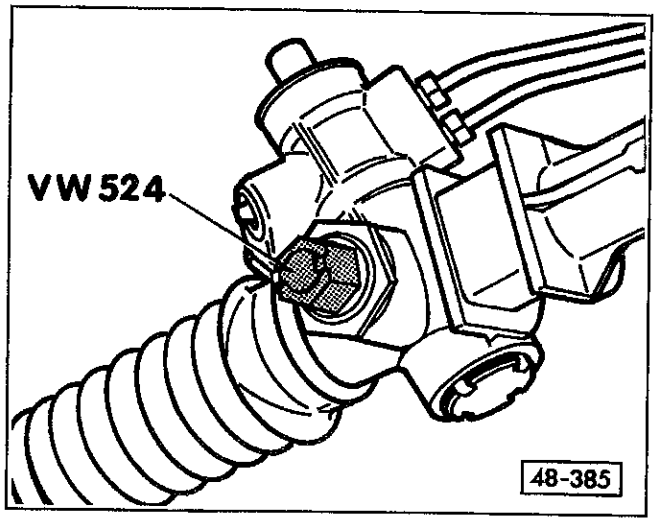



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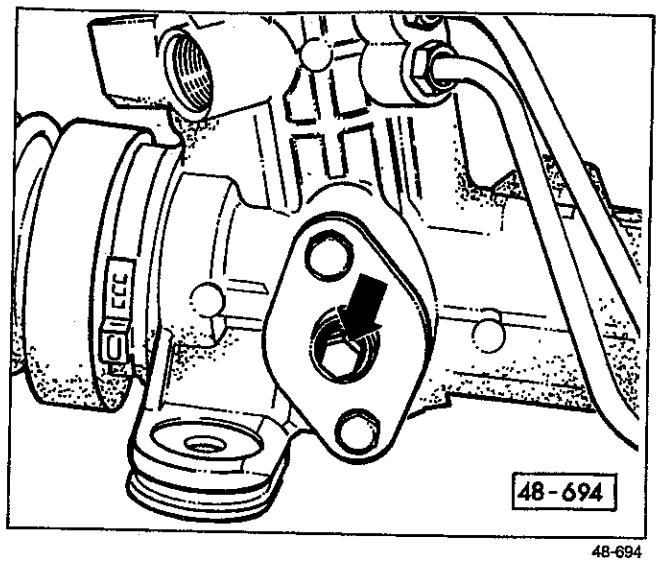
**Fig. 16.** TRW steering gear being adjusted. Volkswagen special tool VW 524 shown.




48-694

**Fig. 17.** ZF steering gear adjusting screw (**arrow**).

5. Road test vehicle and ensure that steering self-centers without binding after negotiating a corner. Repeat adjustment procedure if necessary.

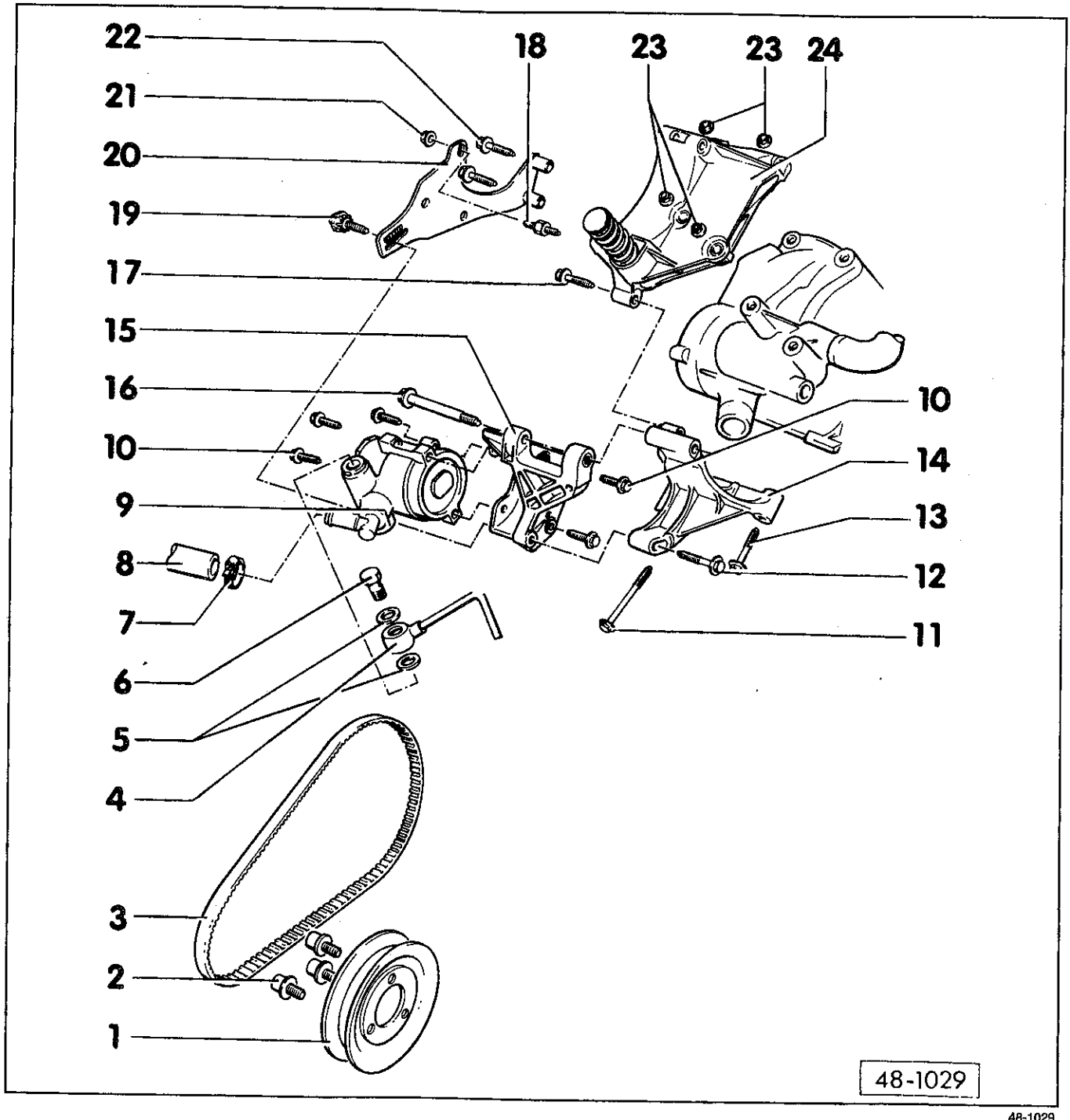
***NOTE—***
*The power steering gear must be replaced as a complete unit if faulty.*

## POWER STEERING PUMP (4-CYLINDER ENGINES)

***CAUTION—***
- *Always replace seals.*
- *Do not use hydraulic oil that has been drained.*

Fig. 18 shows an exploded view of the power steering pump and related mounting hardware used on cars with 4-cylinder engines. Be sure to bleed the pump before starting the engine.

## Power steering pump assembly (4-cylinder engines)




48-1029

**Fig. 18.** Power steering pump assembly used on cars with 4-cylinder engines.

1. **V-belt pulley**
   - When installing, ensure alignment with crankshaft pulley
2. **Bolts**
   - Tighten to 25 Nm (18 ft-lb)
3. **V-belt**
   - See **V-belt, removing and installing (4-cylinder engines)**
4. **Pressure line**
5. **Seal**
   - always replace

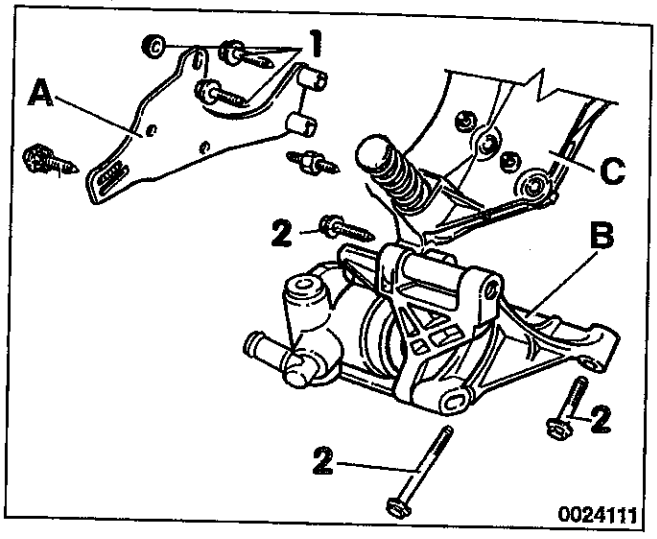
6. **Banjo bolt**
   - Tighten to 30 Nm (22 ft-lb)
7. **Hose clamp**
8. **Suction hose**
9. **Power steering pump**
   - See **Power steering pump, removing and installing (4-cylinder engines)**

> ***NOTE—***
> *Replacement pumps are not filled with oil. Always fill with hydraulic oil (Volkswagen part No. G 000 200) and turn by hand before installing.*

10. **Bolt M8 x 32**
    - Tighten to 20 Nm (15 ft-lb)
11. **Bolt M8 x 85**
    - Tighten to 25 Nm (18 ft-lb)
12. **Bolt M8 x 50**
    - Tighten to 20 Nm (15 ft-lb)
13. **Bolt M8 x 50**
    - Tighten to 20 Nm (15 ft-lb)
14. **Pump pivot bracket**
    - Must be installed free of tension
15. **Pump mount bracket**
    - Must be installed free of tension
16. **Bolt M10 x 98**
    - Tighten to 25 Nm (18 ft-lb)
17. **Bolt M8 x 42**
    - Tighten to 20 Nm (15 ft-lb)
18. **Stud**
    - Tighten to 25 Nm (18 ft-lb)
    - Only for gasoline engines
19. **Adjustment bolt**
    - Tighten to 25 Nm (18 ft-lb)
20. **Adjusting bracket**
21. **Nut**
    - Tighten to 25 Nm (18 ft-lb)
    - Only for gasoline engines
22. **Bolt M8 x 42**
    - Tighten to 20 Nm (15 ft-lb)
23. **Nuts**
    - Tighten to 25 Nm (18 ft-lb)
24. **Mounting bracket**

## Power steering pump, removing and installing (4-cylinder engines)

1. Remove power steering V-belt. See **Power Steering Pump V-belt, removing and installing (4-cylinder engines).**
2. Remove hoses from power steering pump and catch draining fluid. Seal hose connections on pump.
3. Remove bolts/nuts from adjusting bracket and remove bracket. See Fig. 19.




0024111

**Fig. 19.** Power steering pump adjusting bracket (**A**), pivot bracket (**B**) and mounting bracket (**C**). To remove adjusting bracket remove bolts and nuts at **1**. To remove pump and pivot bracket remove bolts at **2**.

4. Remove bolts from pivot bracket and remove pump together with pivot bracket.
5. Install pump with brackets to the engine block and mounting bracket. Install adjusting bracket to engine block and pump. Do not tighten pivot bracket bolts at this time. See Fig. 20.
6. Install pump adjusting bracket. Use Fig. 18 for tightening torques.

> ***NOTE—***
> *If replacing the pump, transfer the pump pulley and brackets to the new pump. Refer to Fig. 18 for tightening torques.*

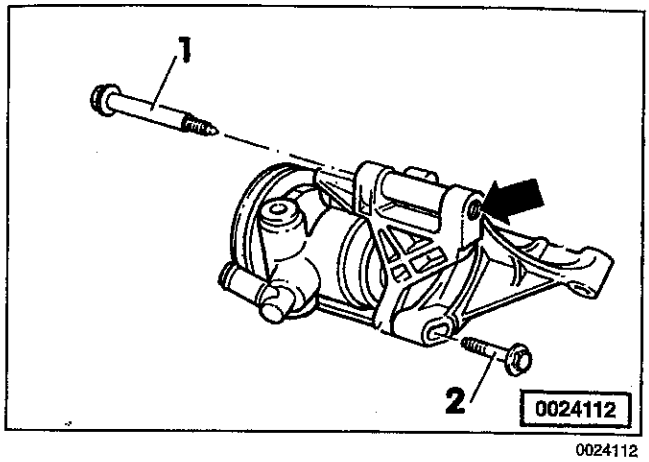



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**Fig. 20.** Before installing pump, make sure pivot bolts (**1** and **2**) are loose. Threaded bushing shown at **arrow**.

7. Install suction (lower) hose to pump and fill power steering fluid reservoir with hydraulic oil. Rotate the pump pulley by hand to bleed pump.

> ***CAUTION—***
> - *The power steering pump must be filled with hydraulic oil and bled by hand prior to starting engine. The pump may become damaged or noisy during operation if improperly bled.*
> - *Use only hydraulic oil (Volkswagen part No. G 002 000) in the power steering system. Do not reuse drained hydraulic oil.*
> - *Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*

**Power steering system hydraulic oil capacity**

- 4-cylinder engines . . . . . 0.7-0.9 liter (0.74-0.95 qt.)

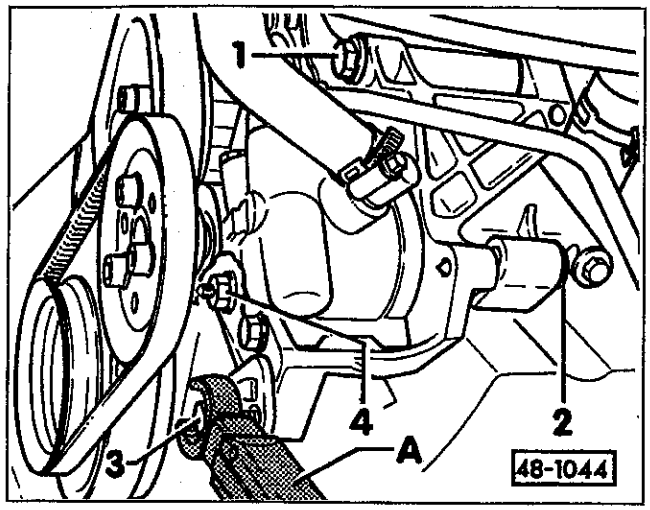
8. Once the pump is bled, connect the pressure line to the pump using new sealing washers. Install V-belt and adjust tension. Recheck hydraulic oil level.

> ***CAUTION—***
> *Always replace sealing washers.*

## Power steering pump V-belt, removing and installing (4-cylinder engines)

1. Loosen power steering pump bolts and nuts shown in Fig. 21. Remove belt from pulleys.

> ***NOTE—***
> *Loosen adjustment clamping bolt (Fig. 21, bolt no. 3) at least one full turn.*




48-1044

**Fig. 21.** To remove V-belt, loosen bolts **1**, **2**, **3**, and nut **4**. Belt tension is adjusted at tensioning nut using torque wrench (**A**).

2. Install the V-belt. Adjust V-belt tension by tightening tensioning nut with torque wrench. Tighten clamping bolt when tension is correct.

> ***NOTE—***
> - *When the tensioning nut is torqued to the specified setting, belt tension will be correct. See Fig. 21.*
> - *Refer to Fig. 18 for tightening torques.*

**Tightening torques**

- V-belt tensioning nut
  - used belts . . . . . 4 Nm (35 in-lb)
  - new belts . . . . . 7 Nm (62 in-lb)
- Clamping bolt . . . . . 25 Nm (18 ft-lb)

## POWER STEERING PUMP (6-CYLINDER ENGINE)

Fig. 22 shows an exploded view of the power steering pump and related mounting hardware used on cars with 6-cylinder engine. Use Fig. 22 as a guide to remove and install the pump. Be sure to bleed the pump before starting the engine.

## Power steering pump, assembly (VR-6 engine)

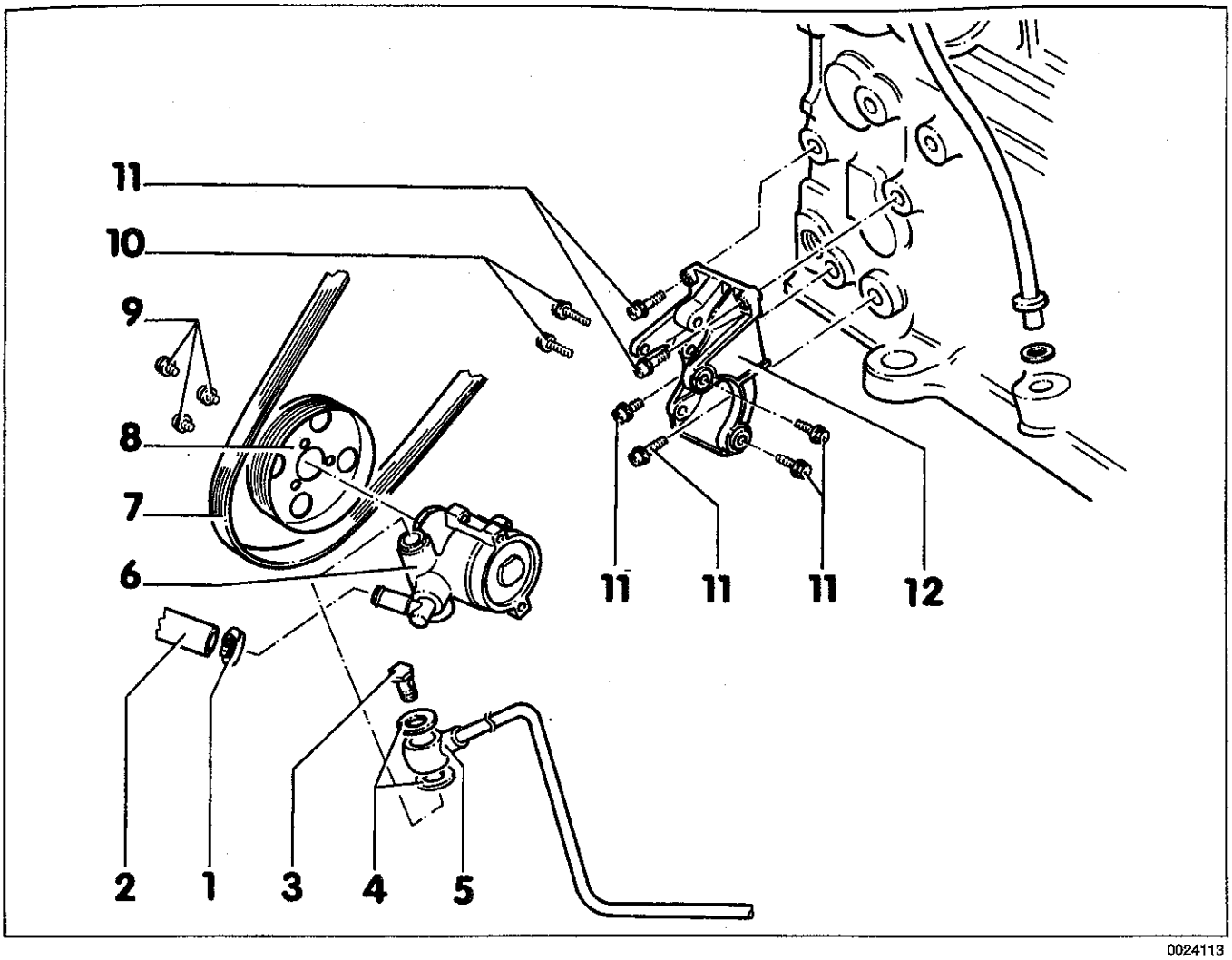



**Fig. 22.** Exploded view of power steering pump assembly used on cars with VR-6 engine.

1. **Hose clamp**
2. **Suction hose**
3. **Banjo bolt**
   - Tighten to 30 Nm (22 ft-lb)
4. **Seal**
5. **Pressure line**
6. **Power steering pump**
   - Delivery pressure: 85-95 bar (1233-1377 psi)
   - Fill with hydraulic fluid before installing

> ***CAUTION —***
> *Replacement pumps are not filled with oil. Always fill with hydraulic oil (Volkswagen part No. G 000 200) and turn by hand before installing.*

7. **Poly-ribbed belt**
   - Removing and checking, see **0 Maintenance Program**
   - Tensioned by spring-operated roller

> ***CAUTION —***
> *On poly-ribbed drive belts, mark the running direction on the belt before removing it.*

8. **Pulley**
9. **Bolts**
   - Tighten to 20 Nm (15 ft-lb)
10. **Bolt M8 x 30**
    - Tighten to 25 Nm (18 ft-lb)
11. **Bolt**
    - Tighten to 25 Nm(18 ft-lb)
12. **Bracket**

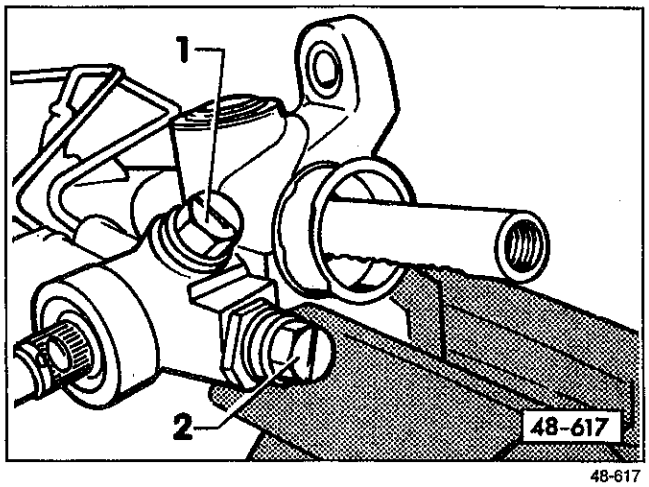
*POWER STEERING PUMP (6-CYLINDER ENGINE)*

# TIE RODS

## Tie rods, removing and installing

*NOTE —*
*Removal and installation procedure given here applies to both TRW and ZF power steering gears.*

1. Remove the power steering rack, see **Power Steering Gear.** Seal hydraulic line connections in steering gear. See Fig. 23.




48-617

**Fig. 23.** Hydraulic line connections sealed with plastic plugs (**1** and **2**).

2. Clean outside of steering gear in area of boot. Then open boot clamp and push back boot.

3. Clamp steering gear in vice and remove tie rod using a 32 mm open end wrench. See Fig. 24.

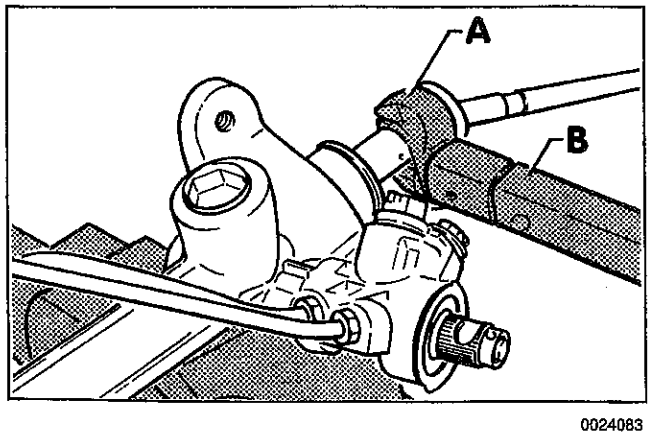



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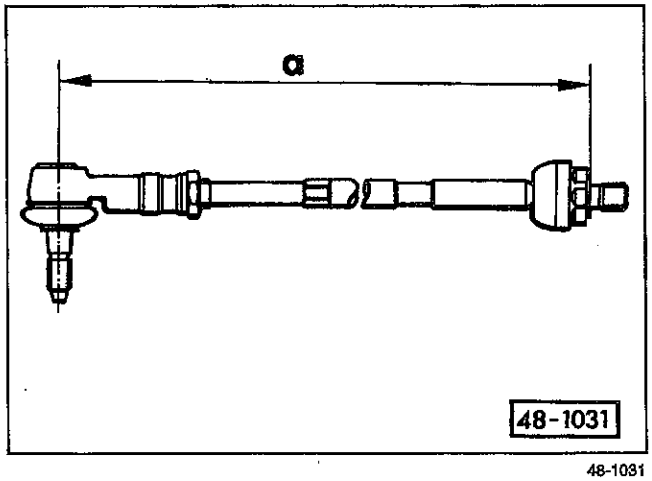
**Fig. 24.** Tie rod being removed from steering gear with 32 mm wrench.

4. Install in the reverse order of removal, noting the following:
   - Be sure to lock the tie rod end to the steering gear rack. Use locking compound (Volkswagen "D6" or equivalent) on the inner joint when installing to the rack.
   - When installing the left-hand tie rod, check that the tie rod length is correct. See Fig. 25.
   - Align the front wheels when installation is complete.

**Tightening torques**

- Tie rod to steering gear ..... 80 Nm (59 ft-lb)

*CAUTION —*
- *Only adjust toe on the right tie rod.*
- *If the left tie rod end must be removed, adjust to correct length (dimension **a**) when reinstalling. Also, new left tie rods must be checked and, if necessary, adjusted before installation.*
- *On cars with TRW steering gear, use care not to damage sticker when installing boot.*
- *Ensure that the boots and the pressure compensating line are correctly fitted.*
- *Use only original equipment type replacement clamps on steering gear boots.*




48-1031

**Fig. 25.** Left tie rod length (dimension **a**) = 406 ± 1 mm (15.98 ± 0.04 in.)

# 5 Body–Assembly



## GENERAL

This general information group covers application information and system descriptions for the repair groups listed under **5 Body–Assembly, 6 Body–Components and Accessories,** and **7 Body–Interior Trim.**

## BODY ASSEMBLY

The front fenders, radiator support, grille, both bumpers, doors, hood, and rear lid are bolted to the main body structure for easy replacement in the event of damage.

### Jetta, Golf, GTI

The body assemblies for the Jetta, Golf, and GTI are designed to form a very rigid passenger cell around the interior passenger compartment. The lower door sills have been significantly changed in profile and the metal thickness increased to provide good lateral protection. Side impact cross-members are bolted into each door to form profiled stiffening sections for additional side impact protection. See Fig. 1.

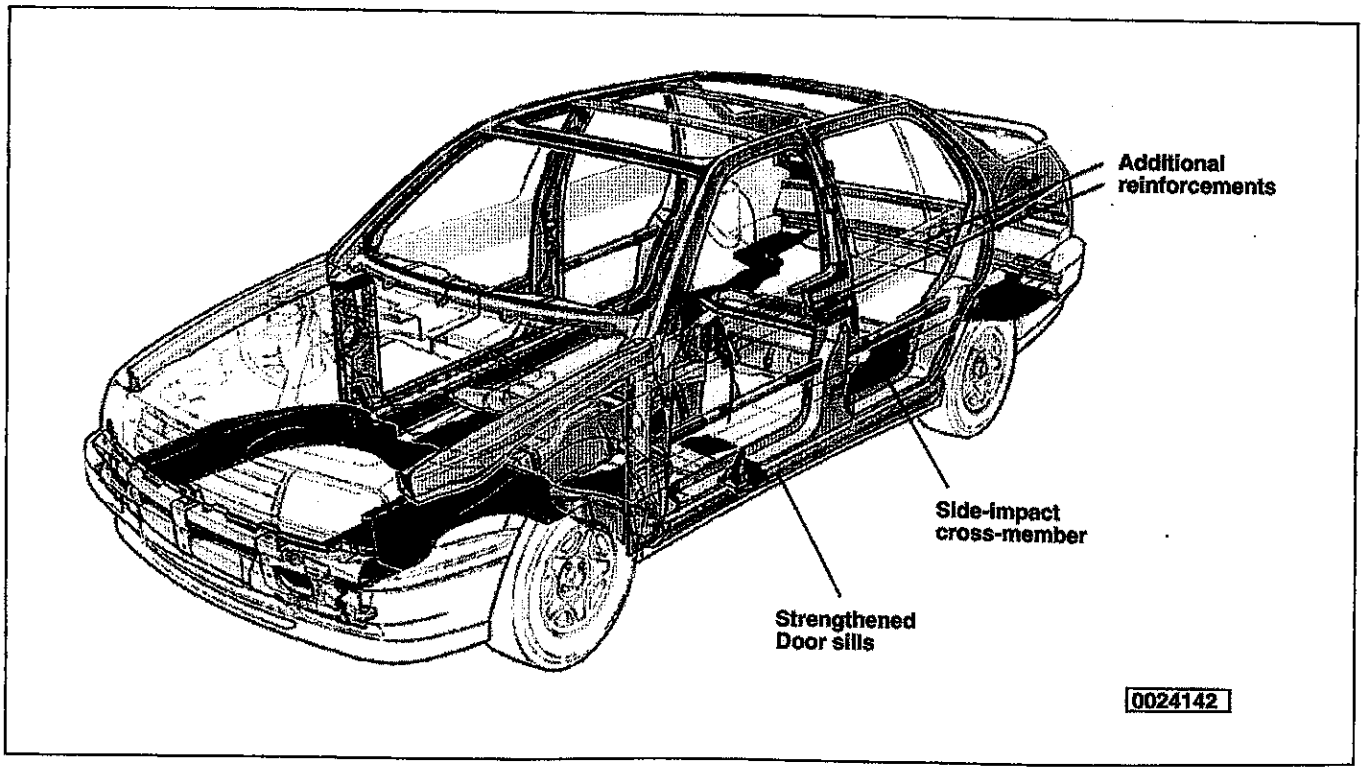



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**Fig. 1.** Structural body members of Jetta models (Golf and GTI similar).

## Cabrio

The Cabrio is a modification of a basic two-door unitized body. When the steel roof is deleted and the convertible top and its mounting frame are added, extra body-strengthening members and a steel roll-bar are also added to maintain body structure.

Two elastically suspended masses are utilized to reduce body shake that is common in convertibles. The mass at the front (engine and transmission) is suspended from specially designed mounts that allow the engine and transmission to dampen front to rear shake. The rear mass is located in the left side of the trunk. It weighs approximately 20 pounds and reduces side to side shake. See Fig. 2.

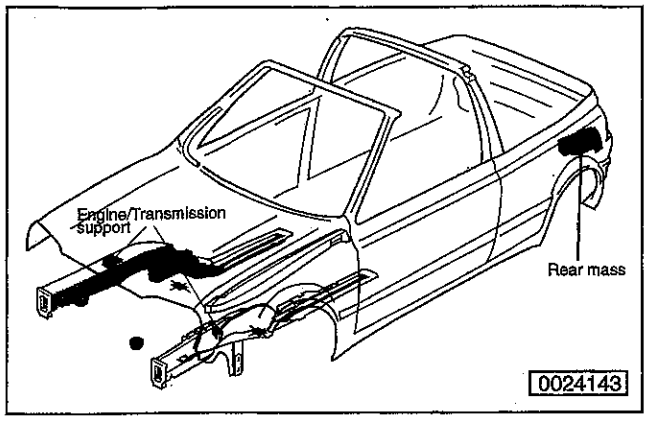


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**Fig. 2.** Structural components specifically designed for Cabrio model.

## Front bulkhead/dashboard module

The dashboard unit, together with the heating and air conditioning unit, steering column, and pedal cluster with master cylinder, are assembled as a module outside the vehicle. These components are attached to the reinforcement cross-member and a bulkhead cross panel. The entire assembly is then installed in the vehicle. For service work, the dashboard can be removed from the reinforcement cross-member by unbolting it.

This modular construction permits many of the more difficult assembly procedures on these units to be performed outside the vehicle where access to the components is easier. This same technique is also used on the front end, door assemblies and sunroof.

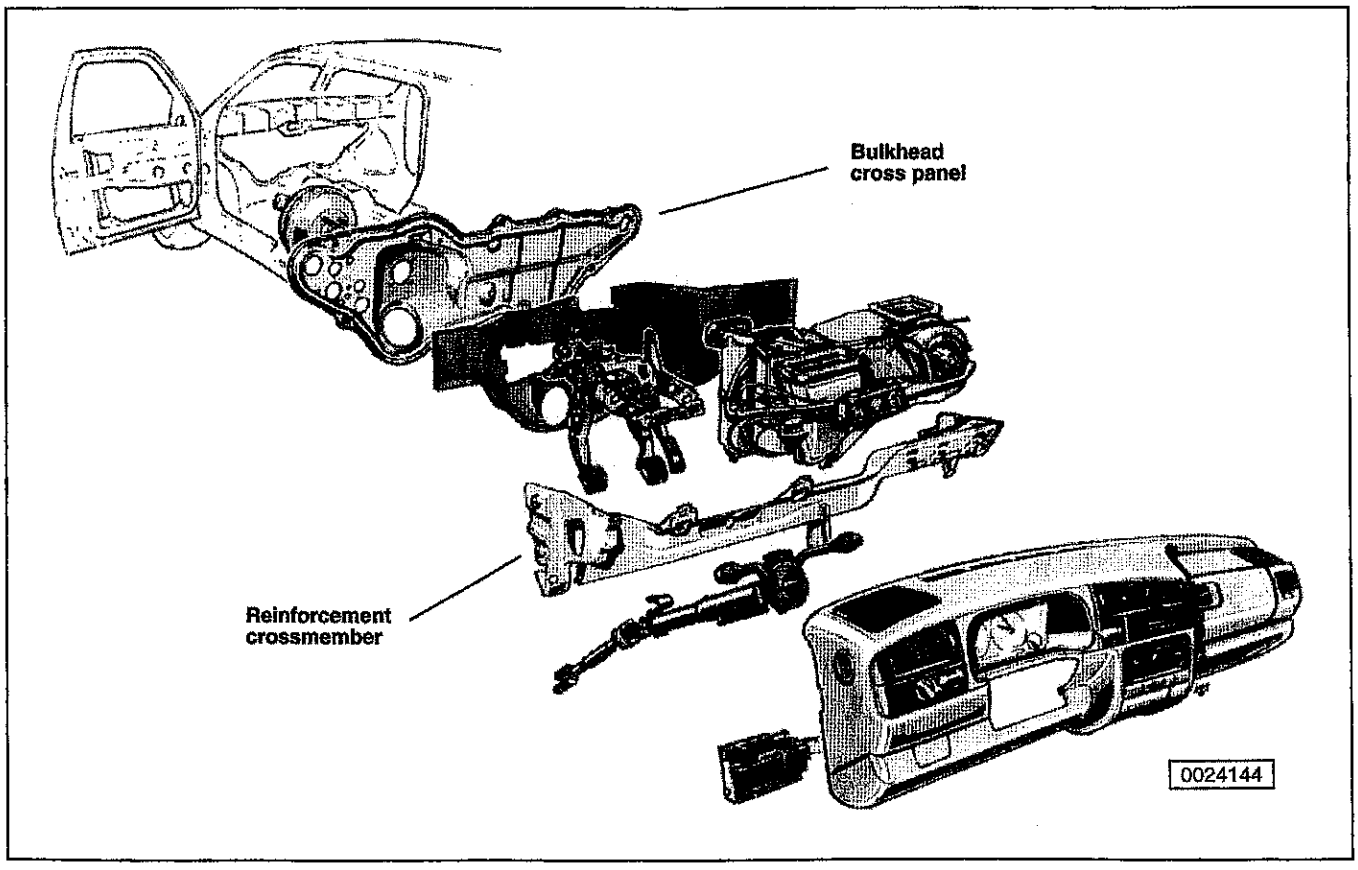


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**Fig. 3.** Bulkhead/dashboard module.

## Bumpers

The bumper assemblies on the all models utilize a cross-member that is bolted directly to the body structure, instead of using brackets. A molded styrofoam insert is installed over this cross-member. The body colored bumper covers are then bolted to the bumper cross-members with the styrofoam insert sandwiched in-between. See Fig. 4.

The bumper covers use special plastics to optimize their ability to absorb minor impacts. The styrofoam insert will compress and absorb major impacts. The bumper cover can be removed to replace this insert. This design spreads the impact over a larger area and limits unnecessary bumper weight.

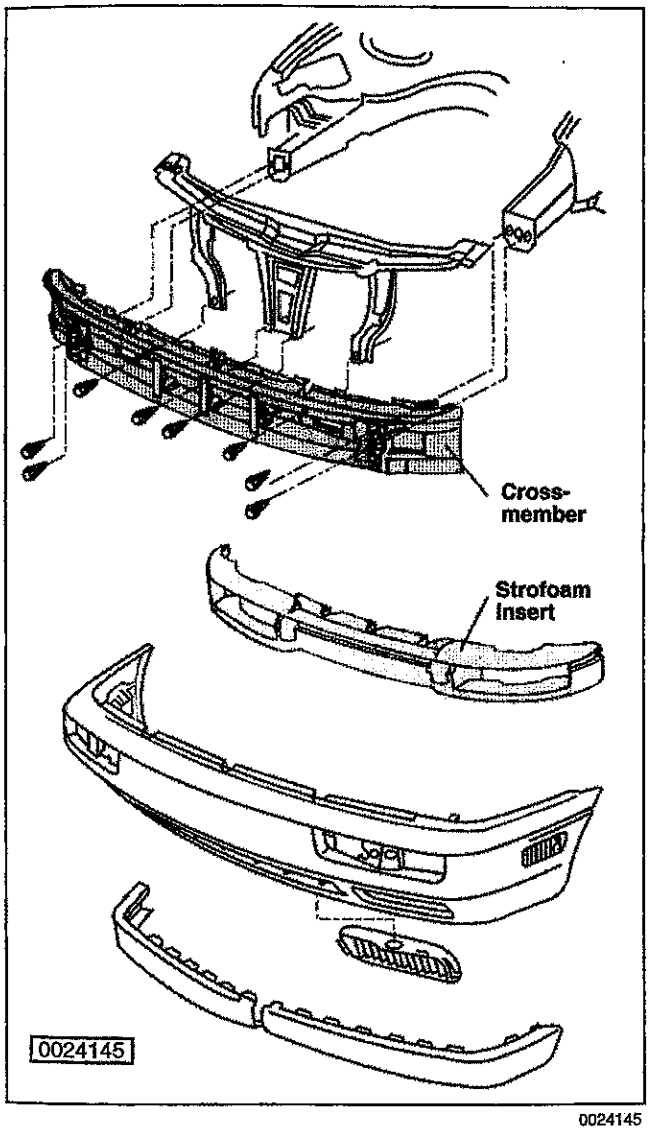


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**Fig. 4.** Front bumper assembly.

## POWER WINDOWS

Models equipped with power windows feature the ability to raise and lower all four windows by using the key in either front door lock.

By holding the key in the locked position for more than 1 second, all windows that are opened will be raised to the closed position at the same time. This feature is known as convenience close. See Fig. 5.

In addition, if the vehicle is equipped with a sunroof, it will close with the power windows in one of two ways. The sunroof will either close while the windows are in motion or it will close after all of the power windows are raised to the fully closed position. The sunroof and the windows will stop as soon as the key is released.

As a ventilation aid in hot weather, all four windows can be lowered. By holding the key in the unlock position for more than 2 seconds, all four windows will be lowered at the same time. The sunroof, however, will not open with this function.

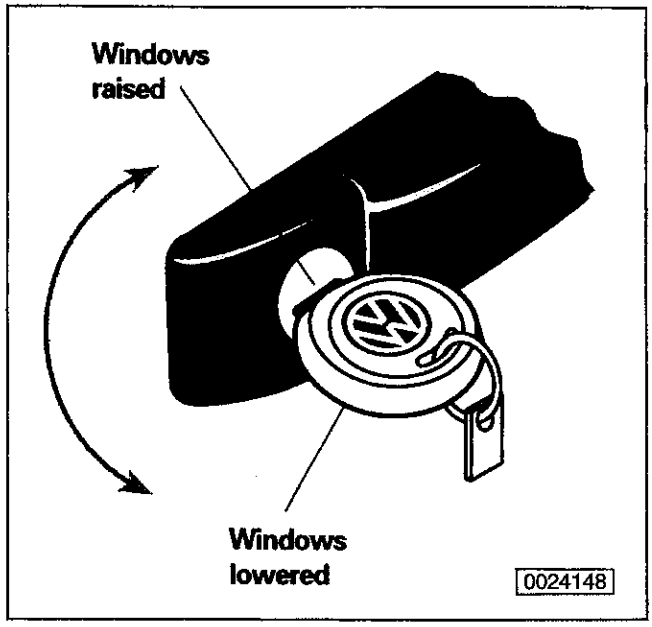


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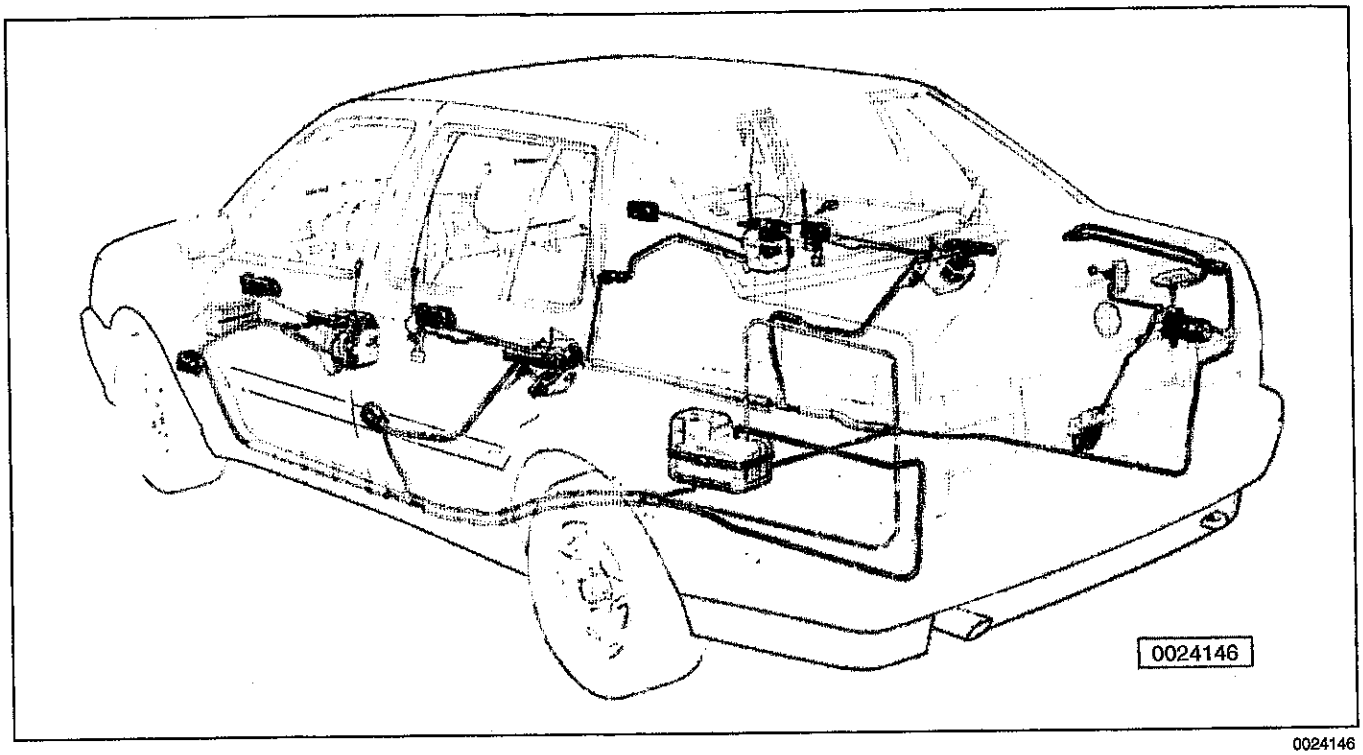
**Fig. 5.** On models with power windows, the windows and sunroof can be operated via the door lock.

## CENTRAL LOCKING

All models are equipped with central locking for the doors. Some versions also lock the rear lid and the fuel filler door. A vacuum servo is part of each latching assembly. A microswitch that is operated by the front door lock cylinders activates the central locking system and the alarm system. Fig. 6 shows the location of the various components of the central locking system.

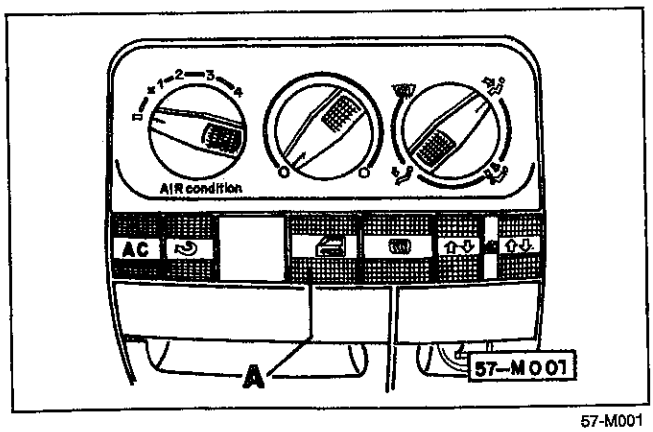



0024146

**Fig. 6.** Central locking system component locations.

Later production vehicles have several enhancements to the central locking system.

- The master locking switch has been relocated from the inside driver's door lock button to a dash mounted rocker switch for easier access by both front seat passengers. If the alarm system is set, this switched is deactivated. See Fig. 7.
- When opening a locked vehicle from the outside with the key, there are now two options. If the key is turned once, only that particular door will unlock. If the key is quickly turned twice, all of the doors will be unlocked. This function is called selective unlocking.
- Central locking is connected to the factory installed Keyless Remote System and the vehicle can be locked and unlocked with the remote transmitter. Selective unlocking does not function in this mode of operation.

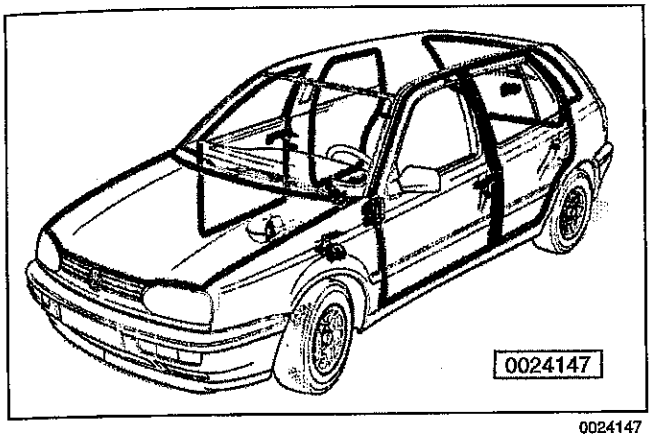



57-M001

**Fig. 7.** Master door lock switch, **A**, that was previously part of the driver's side door lock and latch assembly is now dash mounted. All door locks can be locked and unlocked with it.

## ALARM SYSTEM

All models are equipped with a factory installed alarm system that is linked to the central locking system. The alarm system is armed when either front door is locked with the ignition key, and the trunk lid, hood and all doors are closed. The alarm will not arm if a door or lid is open. See Fig. 8.




0024147

**Fig. 8.** Volkswagen central alarm system (Golf shown, others similar).

When set, the alarm system will trigger if the trunk or any door is opened without the key. It will also be triggered if the hood is opened or the factory installed radio is disturbed. It will also trigger if it detects that the ignition has been switched on.

When triggered, the separate alarm horn will sound and the directional signals will flash. The starter motor circuit will also be interrupted. The system can have multiple triggers. If, for example, the trunk is breached, the alarm will trigger and the horn and lights will operate for the prescribed period and then switch off. The alarm system remains armed. Disturbing a door will trigger the system again in the same way. This can happen as often as the system is breached.

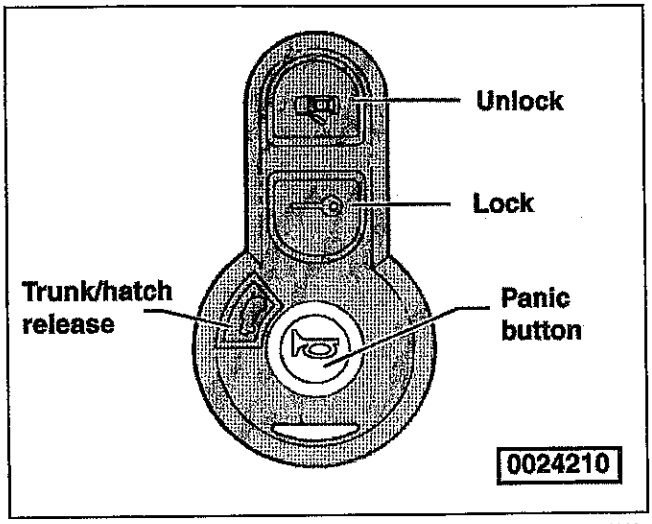
The system has a defeat switch in the luggage compartment lock that allows the luggage compartment to be opened using the key, without activating the alarm.

To prevent the alarm system from becoming a nuisance, the alarm horn and directional lights will stop after approximately 30 seconds. The starter disable will, however, still function to deter vehicle theft.

The alarm control module is located behind the upper left side of the dashboard, next to the left side dashboard fresh air vent. An LED is located next to the driver's door lock knob. This LED will flash at 1-second intervals after the doors are locked to indicate that the system will soon be armed. After 30 seconds, the LED will begin to flash faster to indicate that the system is armed. To prevent battery drain, some versions of the system will turn off the flashing LED after approximately 24 hours. Other versions let it continue to flash indefinitely. In all versions, however, the alarm system will remain armed until deactivated with a key in a door.

## KEYLESS REMOTE LOCKING

Beginning with the 1998 model year, a factory installed keyless remote locking system is standard equipment. This enhancement to the central locking and alarm systems uses a remote radio frequency transmitter about the size and shape of a regular vehicle key. Four system functions can be enabled through this battery-powered transmitter up to a range of approximately 10 feet. See Fig. 9.




0024210

**Fig. 9.** Radio frequency remote transmitter used in Golf and Jetta vehicles beginning with 1998 model year.

The four functions of the keyless remote transmitter are:

- Lock the vehicle and arm the alarm.
- Unlock the vehicle and dis-arm the alarm.
- Dis-arm the alarm and open the trunk or hatch. The system will re-arm when the trunk or hatch is closed if the alarm system had previously been armed.
- Red panic button to trigger the alarm at any time.

The selective unlock feature of the central locking and the convenience close feature of the power windows do not function with the keyless remote system.

If the vehicle has been unlocked using the keyless remote transmitter and a door is not opened within approximately 30 seconds, the system will re-lock all of the doors and re-arm the alarm system.

Up to 4 transmitters can be programmed into each vehicle's system. Each transmitter uses two "button cell" batteries that are readily obtainable and easily replaced. See **96 Lights, Accessories-Interior.**

Several different keyless remote systems are available in the aftermarket for earlier vehicles. These include systems offered by Volkswagen through authorized dealers. See Fig. 10.

Because these systems vary considerably in operation and installation, they are outside the scope of this manual.

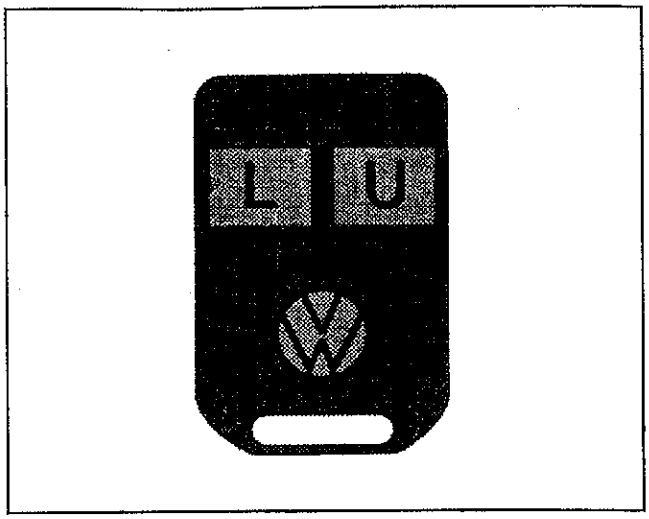



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**Fig. 10.** Typical aftermarket 2 function keyless remote transmitter supplied by Volkswagen.

# 50 Body–Front



## GENERAL

The repair group covers the front body section (radiator support) and front fender replacement. The radiator support can be removed from the car as one unit to facilitate repairs, such as engine removal. The front fenders are easily removable panels, although some new parts may be required for fender installation.

## FRONT BODY ASSEMBLY

### Radiator support, removing and installing

The radiator support assembly is shown in Fig. 1.

1. Disconnect the battery negative (–) cable.
2. Disconnect all wiring harness connectors and other electrical connections from radiator support as required.
3. Disconnect hood lock cable from hood lock on radiator support. See **55 Hood and Lids**.

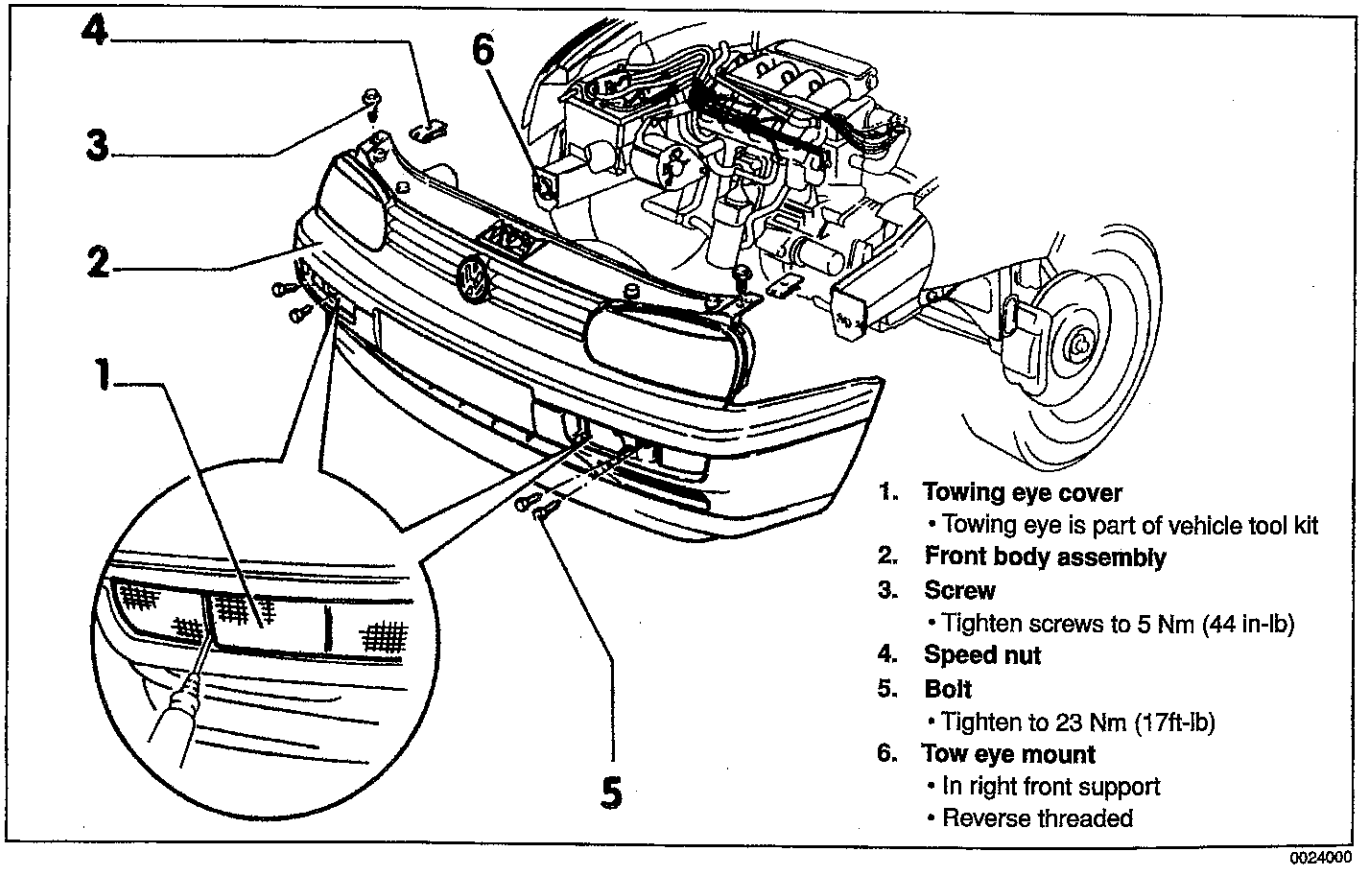



**Fig. 1.** Radiator support assembly. Remove upper bolts from fenders and lower bolts from bumper. Also remove screws from wheel housing trim (not shown). Inset shows towing eye covers that must be removed to access lower bolts.

4. Loosen A/C refrigerant lines from mounting brackets and hose clamps on radiator support (cars with air conditioning only). Do not disconnect or loosen any refrigerant lines or fittings.

> ***WARNING —***
> *Loosening or disconnecting A/C refrigerant lines will allow the refrigerant to be discharged under pressure, possibly causing personal injury. In addition, a discharged A/C system will need to be recharged using special equipment.*

5. Remove upper radiator mounting pins. Lift the radiator up and off up the lower mounts. See **19 Engine–Cooling System.**

6. Unbolt A/C condenser from radiator support. See **87 Air Conditioning.**

> ***CAUTION —***
> *Use care not to bend or kink A/C refrigerant lines.*

7. Remove mounting bolts shown in Fig. 1 and lower screws from wheel housing liner and air guides.

8. Remove the radiator support with all attachments.

## Front fender, removing and installing

1. Remove radiator grille and wheel housing liner. See **66 Body Accessories–Exterior.**

2. Remove front bumper. See **63 Bumpers.**

3. If applicable, remove radio antenna from fender.

4. Remove fender mounting hardware. See Fig. 2.

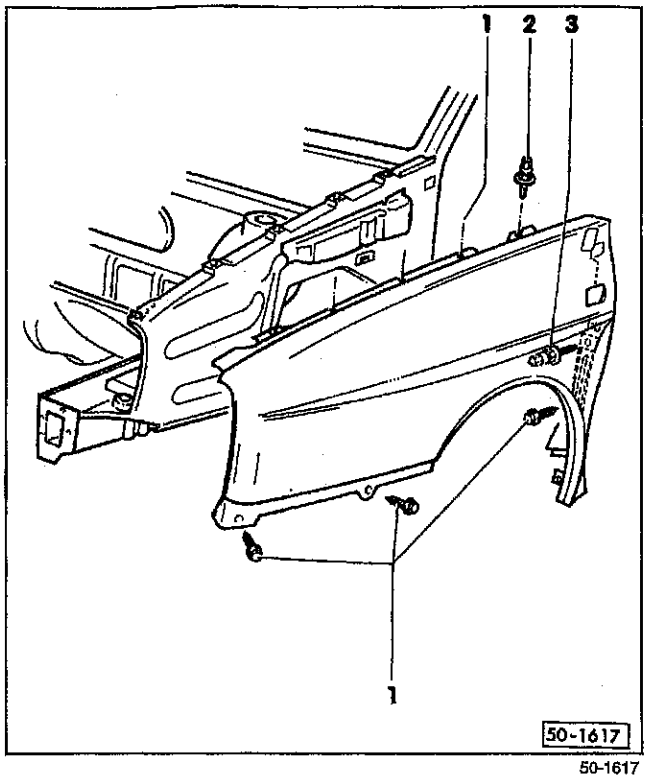
5. Heat fender in area of A-pillar with a hot air blower and remove fender.

> ***CAUTION —***
> *Heat PVC slightly and for a short time only. Do not discolor PVC or blister paint.*

> ***NOTE —***
> *If necessary, cut through the PVC with an upholstery knife while a helper pulls out on fender.*

6. Installation is the reverse of removal. Before installing fender, install zinc foil plates (Volkswagen part No. AKL 381 035 50) at each mounting point in the wheel housing/A-pillar area.

> ***CAUTION —***
> *Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*



50-1617

**Fig. 2.** Front fender attachment bolts (**1,2,3**).

# 55 Hood and Lids



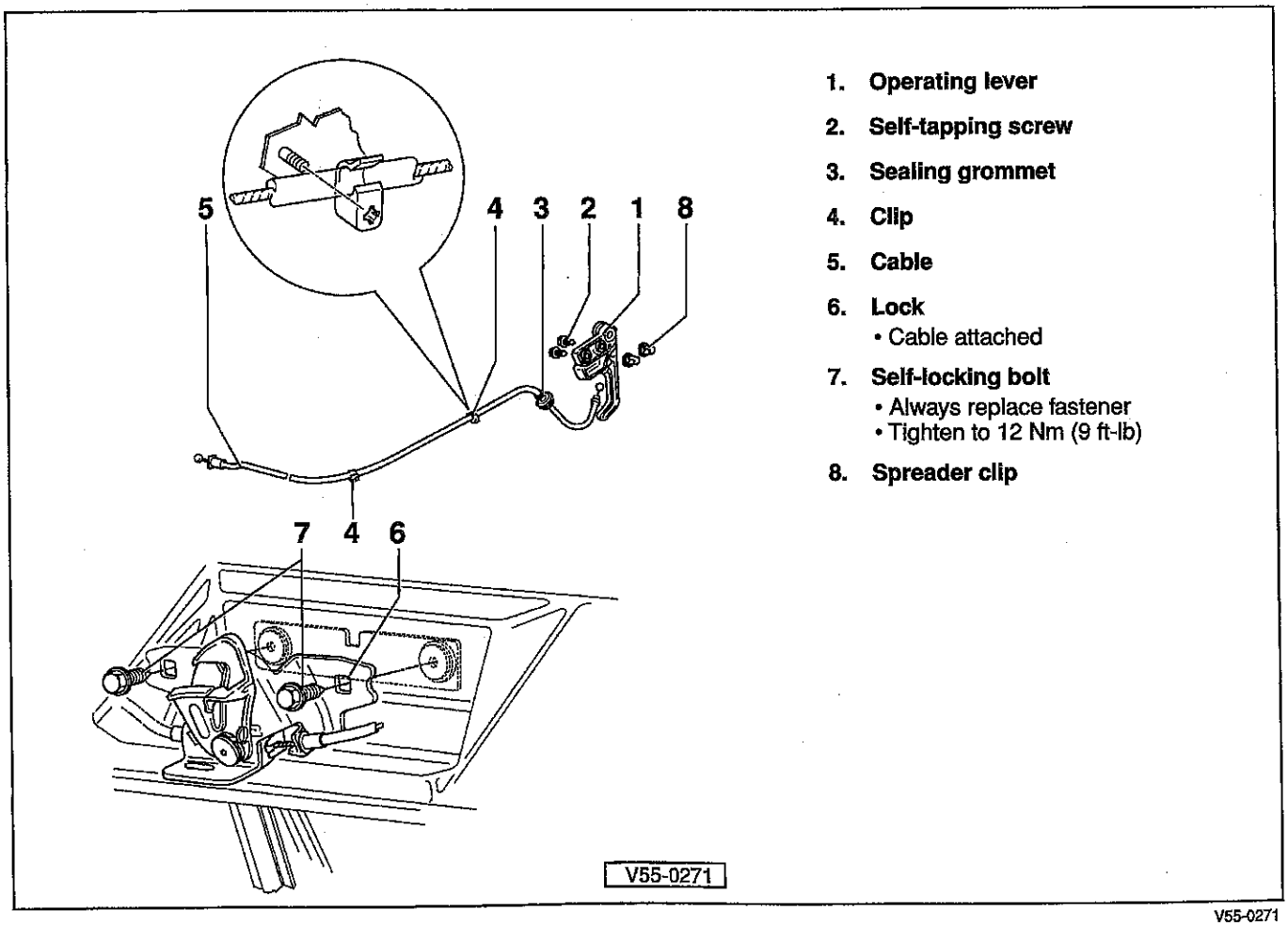
## GENERAL

The hood and rear lid are easily unbolted and removed with the aid of a helper. Where applicable, the support struts should first be disconnected. Be sure to mark the lid location in reference to the hinges for proper alignment during installation.

## HOOD LOCK

The hood lock cable assembly is shown in Fig. 1. To replace the cable, remove the operating lever and the hood lock and disconnect the cable ends. Then pull the cable out through the bulkhead. When installing the new cable, be sure to install the sealing grommet on the cable.

### Hood lock cable, assembly




1. **Operating lever**
2. **Self-tapping screw**
3. **Sealing grommet**
4. **Clip**
5. **Cable**
6. **Lock**
   - Cable attached
7. **Self-locking bolt**
   - Always replace fastener
   - Tighten to 12 Nm (9 ft-lb)
8. **Spreader clip**

V55-0271

**Fig. 1.** Hood lock cable assembly.

# REAR LID

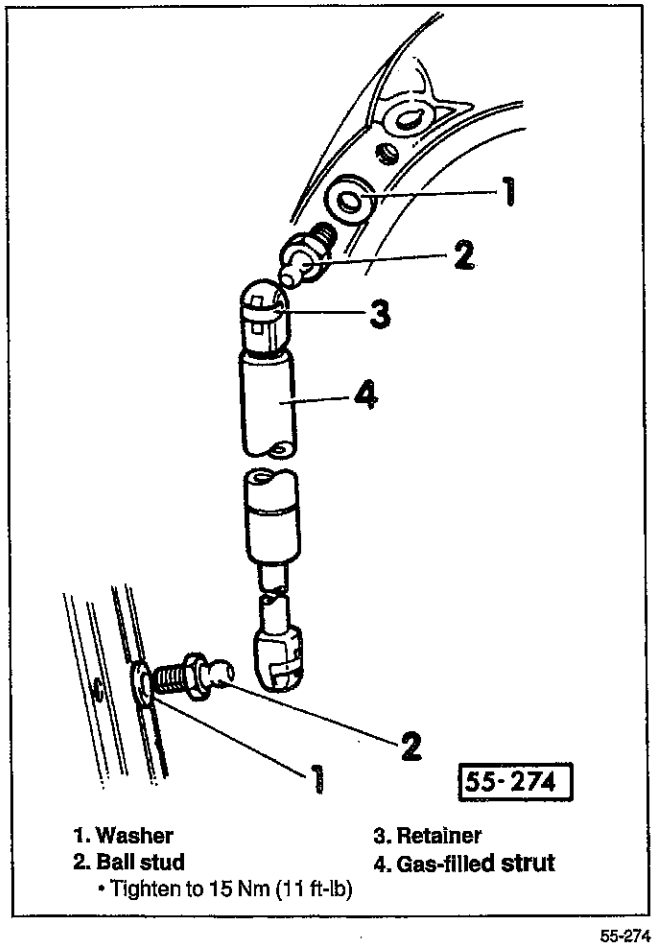
***NOTE—***
*For repair information on the power locking system, see* **57 Doors–Front.**

## Gas-filled strut for rear lid, replacing

Fig. 2 shows the strut used on Golf and GTI models. Fig. 3 shows the strut used on Jetta models. To remove the strut, support the rear lid, then carefully pry out the retainers from the strut ends using a screwdriver. Pry the strut ends off of the ball studs.

***WARNING—***
*Be sure to support rear lid before removing strut.*

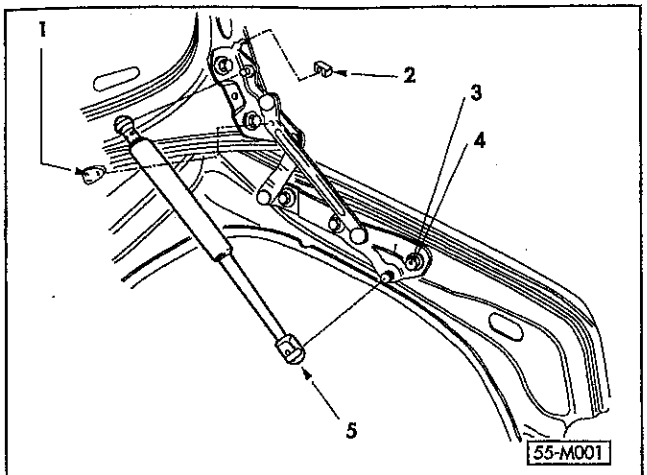
***NOTE—***
*If reinstalling the strut, do not remove the retainer from the strut. If the retainer is fully removed, it will be damaged. The retainer is available as a replacement part from Volkswagen.*




**1. Washer**
**2. Ball stud**
• Tighten to 15 Nm (11 ft-lb)
**3. Retainer**
**4. Gas-filled strut**

55-274

**Fig. 2.** Gas-filled strut for Golf and GTI rear lid (Cabrio is similar).




**1. Rubber damper**
**2. Rubber damper**
**3. Screw**
• Tighten to 7.5 Nm (66 in-lb)
**4. Spring washer**
**5. Gas-filled strut**

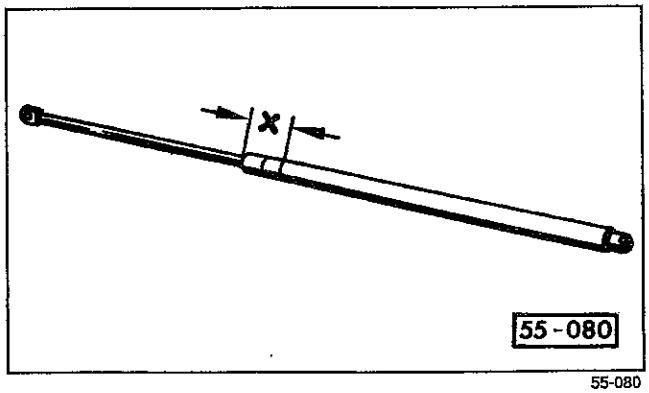
55-M001

**Fig. 3.** Gas-filled strut for Jetta models.

## Gas-filled strut, discarding

The gas charge in the strut should always be released before scrapping the strut.

1. Clamp strut in vise in area shown in Fig. 4.




55-080

**Fig. 4.** Clamp strut in vise at first 2 inches (x) of strut housing.

2. Make a mark on the first 1/3 of the strut housing, as measured from piston rod end of the housing. Then using a hacksaw, saw through the housing at the mark.

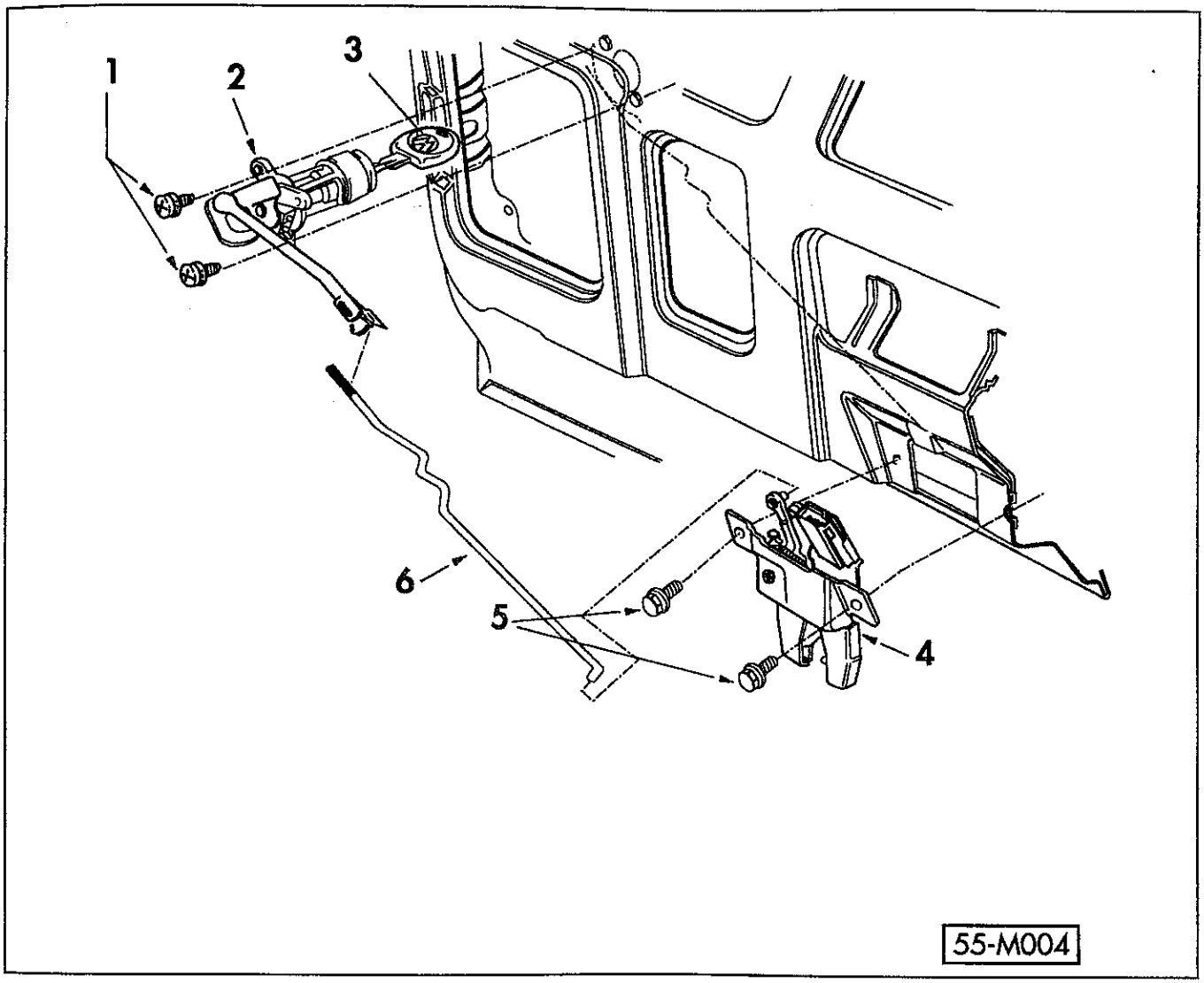
***WARNING—***
*Protective goggles must be worn during sawing. In addition, it is recommended that the area of the saw cut be covered with a rag in order to catch oil spray*

3. Dispose of strut.

## Rear lid lock

The rear lid lock assembly is shown in Fig. 5. To access the lock assembly, remove the trim from the trunk or rear hatch. Fig. 6 shows the remote trunk lid opener, used on some Jetta models.

## Rear lid lock, assembly

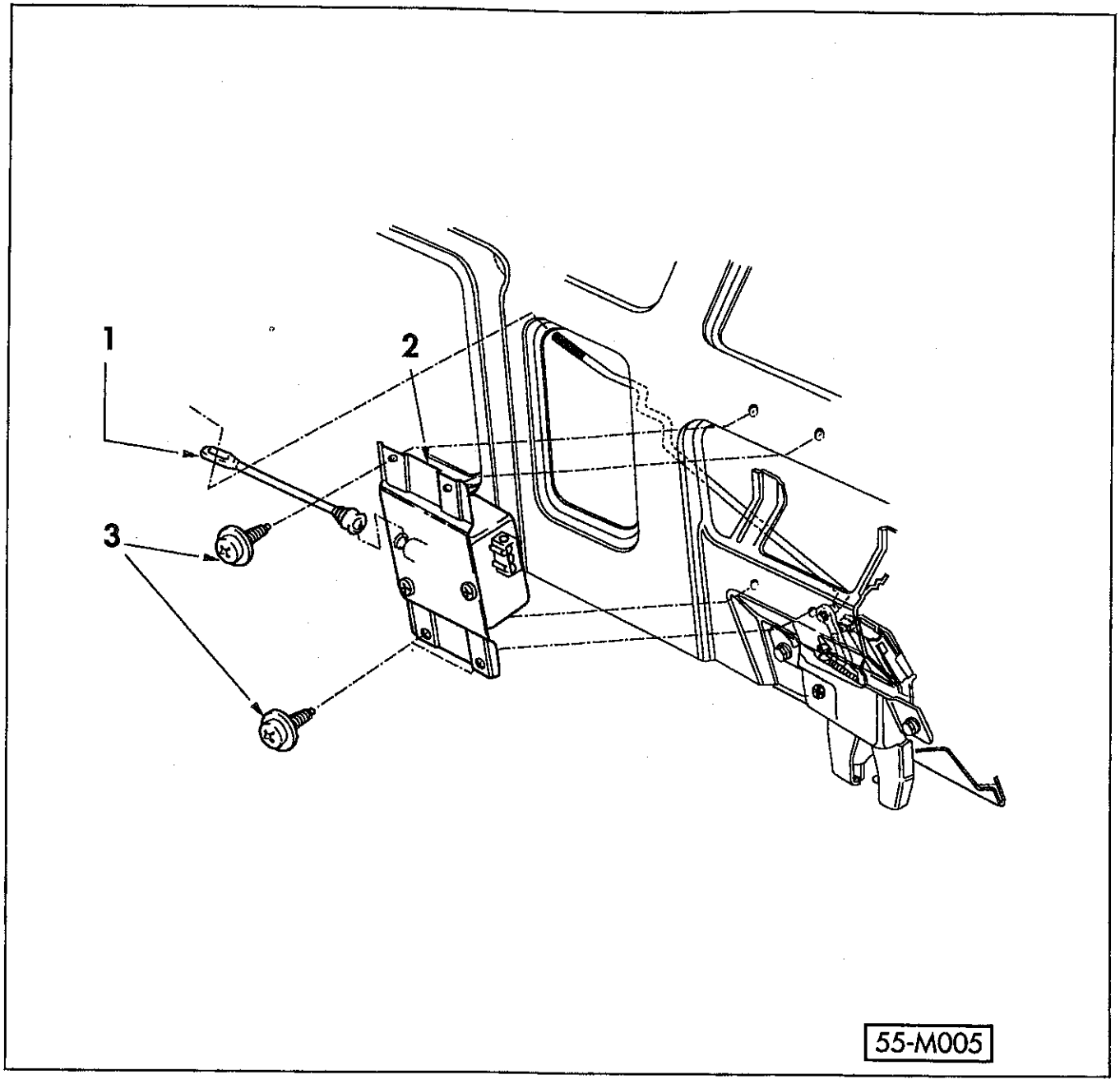



55-M004

**Fig. 5.** Rear lid lock mechanism. Mark location of latch (4) before loosening mounting screws.

1. **Screw**
   - Tighten to 4 Nm (35 in-lb)
2. **Rear lid lock assembly**
   - Removing:
     remove screws (1), disconnect push rod (6) from lock assembly
3. **Key**
   Must be inserted to remove lock
4. **Rear lid latch**
5. **Screw**
   - Tighten to 7 Nm (62 in-lb)
6. **Push rod**

## Remote opening actuator, assembly




55-M005

**Fig. 6.** Remote rear lid electric actuator assembly used on some Jetta models.

1. **Push rod**
   - Color: orange
2. **Actuator**
   - To remove, push rod (1) must be disconnected
3. **Screw**
   - Tighten to 2 Nm (18 in-lb)

# 57 Doors–Front



## GENERAL

This repair group covers removal and installation of the door assembly, the door glass and window regulators, and service to door lock assemblies, including the central locking system.

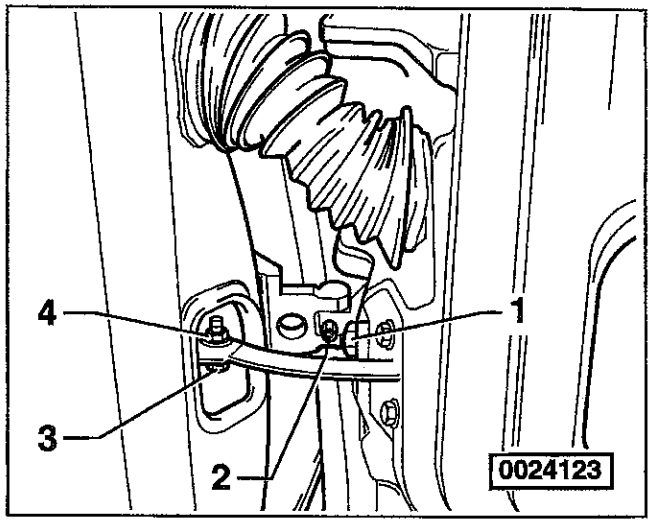
***NOTE—***
*Interior door panel removal and installation instructions are given in* **70 Trim–Interior**.

## FRONT DOOR, SERVICING

An exploded view of the front door assembly is shown in Fig. 2.

### Front door, removing and installing

1. Disconnect harness connector at A-pillar. On vehicles with central locking, disconnect bi-pressure line in harness connector (see Fig. 18, given later).
2. Remove door stop bolt at A-pillar. Remove threaded pin bolt from upper and lower hinges. See Fig. 1.
3. Lift door upward and off of hinge brackets. If necessary, use a helper when lifting off door.
4. Installation is the reverse of removal. Door adjustment should not be necessary unless the hinge mounting bolts have been loosened.



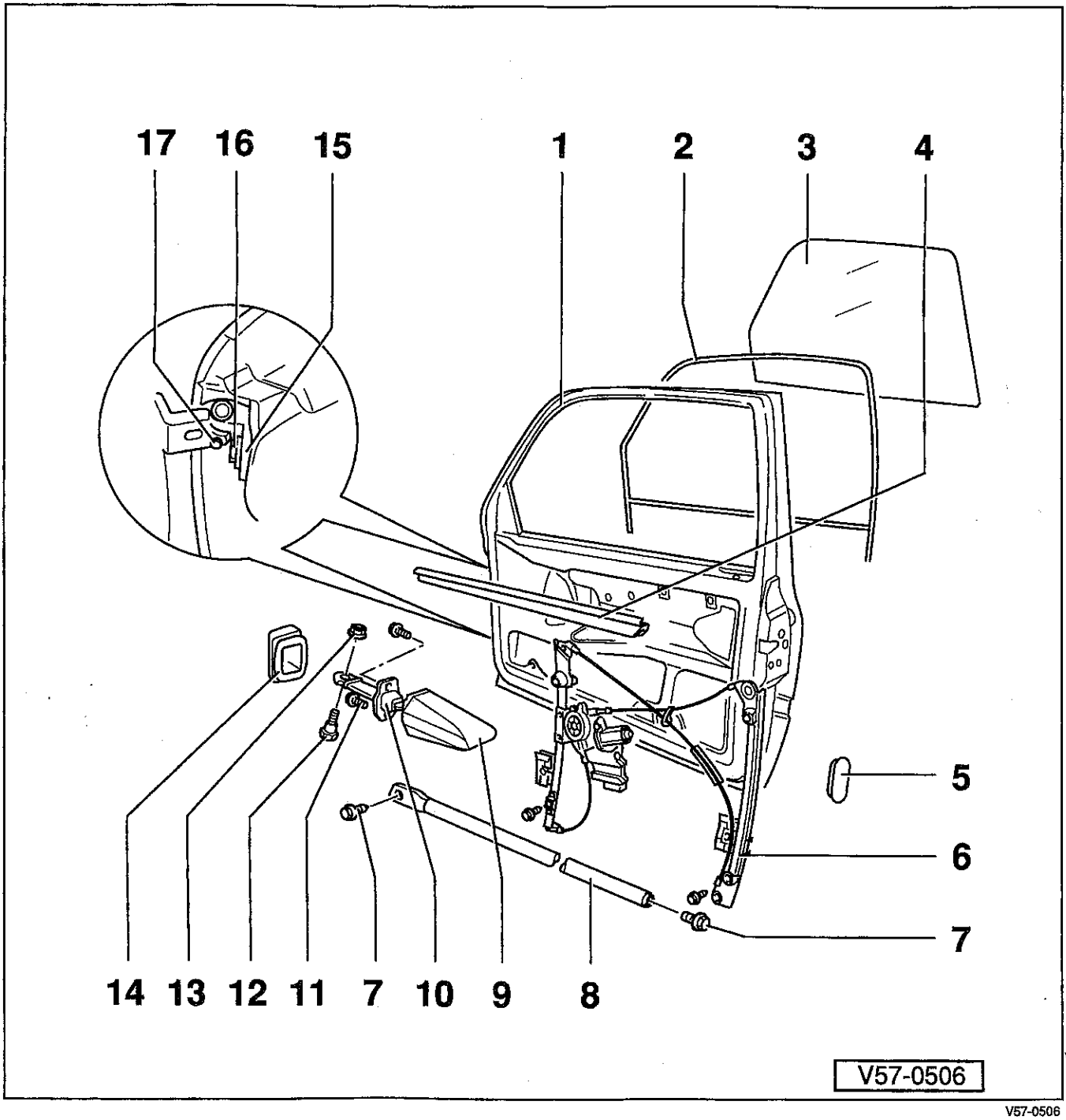

0024123

**Fig. 1.** Door stop bolt (**3**) and nut (**4**). Threaded pin bolt shown at **2**. Hinge bolt (T45 torx bit) shown at **1**.

**Tightening torques**
- Hinge to door or body ..... 36 Nm (27 ft-lb)
- Hinge screw to hinge ..... 23 Nm (17 ft-lb)

***NOTE—***
*If the door requires adjustment, the hinge bolts can be loosened and the door can be repositioned in the bolt's elongated holes. A misaligned door can result in wind noise, incorrect latching, and possible paint damage.*

## Front door, assembly




V57-0506

**Fig. 2.** Exploded view of front door assembly for Golf, GTI, or Jetta (Cabrio is similar).

1. **Door**
   - Adjust at hinge within oversized holes
2. **Window channel**
   - Fastened into window frame
3. **Door window**
   - See **Door glass, removing and installing**
4. **Window slot seal**
   - Pushed onto flange

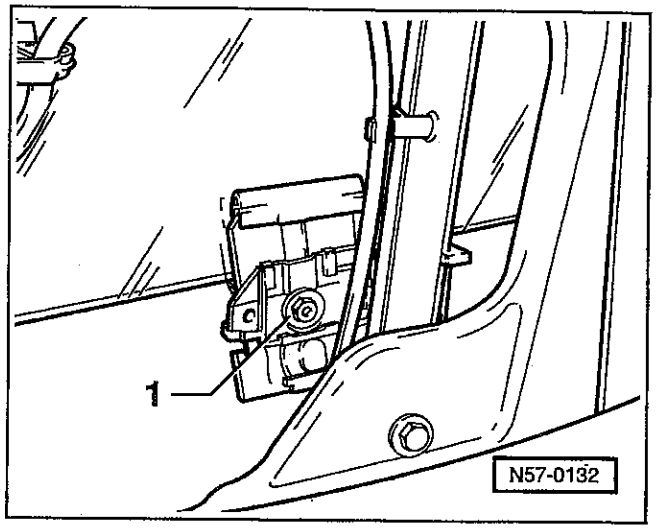
5. **Cover**
   - To close off impact member installation opening
6. **Window regulator**
   - See **Window regulator, removing and installing**
7. **Hex bolt**
   - Tighten to 23 Nm (17 ft-lb)
8. **Impact member**
9. **Door stop sleeve**
10. **Door stop**
11. **Hex-head screw**
    - Tighten to 7.5 Nm (66 in-lb)
12. **Bolt**
13. **Locking nut**
    - Tighten to 6.5 Nm (58 in-lb)
14. **Door check strap cover**
    - Self-adhesive, attached to A-pillar
15. **Door hinge**
    - Bolted to door and A-pillar
16. **Torx bolt T45**
    - Tighten to 36 Nm (27 ft-lb)
17. **Screw**
    - Tighten to 23 Nm (17 ft-lb)

## Door glass, removing and installing

1. Remove interior door panel and vapor barrier. See **70 Trim–Interior**.

> ***CAUTION—***
> *Use care when removing the vapor barrier. Water leaks will occur if the vapor barrier is damaged or wrinkled when installed. Always replace vapor barrier if damaged.*

2. Pry off window slot seal. Lower door glass into door.
3. Remove hex nuts from the front and rear clamping jaws. Press jaws apart. See Fig. 3.




N57-0132

**Fig. 3.** Rear clamping jaw nut (**1**). Door glass shown lowered into door. Golf, GTI, Jetta shown (Cabrio is similar).

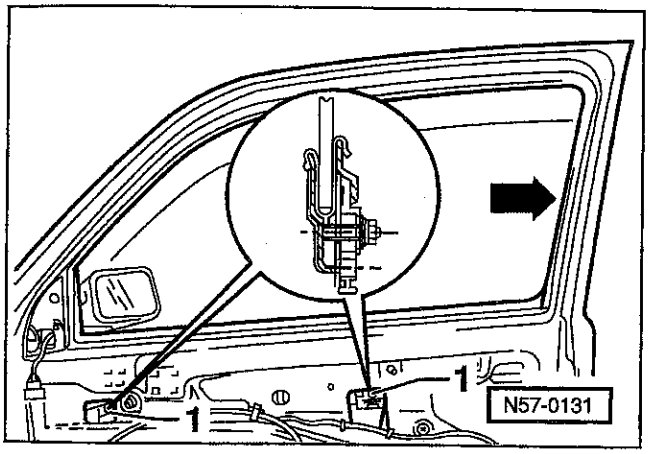
4. Pull door glass upward, tilt toward front and lift out of window slot.
5. Install in the reverse order of removal. Adjust the glass as described below.

## Door glass, adjusting (Golf, GTI, Jetta)

1. Remove interior door panel and vapor barrier. See **70 Trim–Interior**.
2. Crank door window up or down until clamping jaws are located in the installation openings. See Fig. 4.
3. Loosen clamping jaw nuts, then push door window into rear window channel and tighten nuts.

**Tightening torques**

- Clamping jaw hex nuts . . . . . 10 Nm (7 ft-lb)




N57-0131

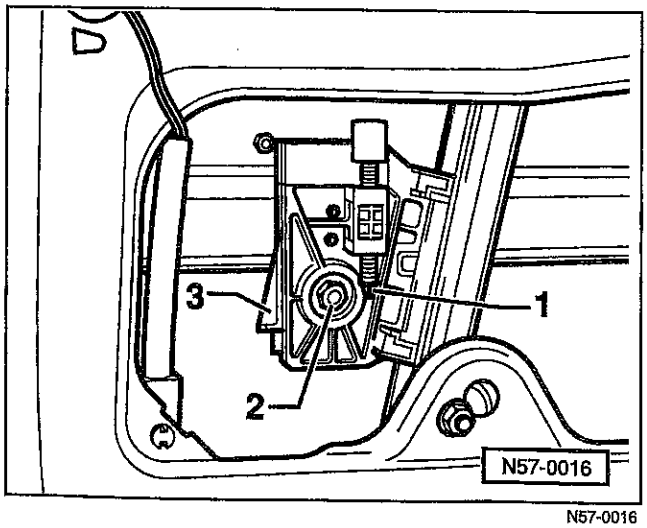
**Fig. 4.** Clamping jaws positioned in installation openings. Adjust window by pushing into rear window channel (**arrow**). Inset shows clamping jaws.

## Door glass, adjusting (Cabrio)

On Cabrio models, the front power window regulators are cable operated. There are two height adjusters per window regulator, one in the front and one in the rear. The height adjustment can be done with the door panel installed by inserting a Torx driver through the openings in the underside of the door frame. The top of the window can also be adjusted inward or outward by repositioning wedges. A wedge is located on each window carrier. See Fig. 5.

***NOTE—***

*Before adjusting the glass, door to body and convertible top to windshield frame adjustments should be correct. See* **61 Convertible Top** *for top adjustments.*




N57-0016

**Fig. 5.** Cabrio door glass adjustment mechanism as viewed with door panel removed. Height adjustment screw is shown at **1**. Clamping jaw nut shown at **2**. Adjusting wedge shown at **3**.

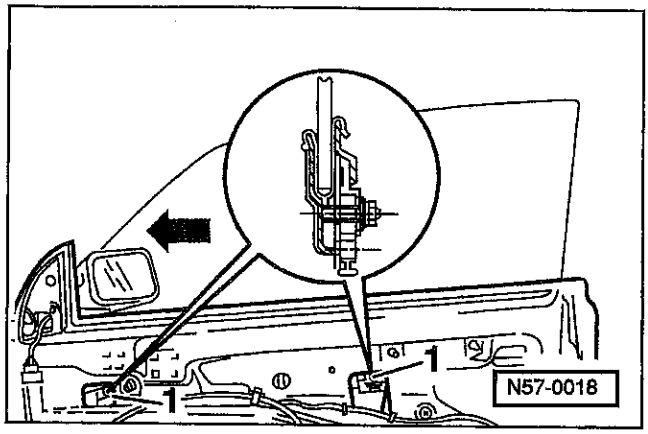
1. Remove interior door panel and vapor barrier. See **70 Trim–Interior.**

> ***CAUTION—***
> *Use care when removing the vapor barrier. Always replace the vapor barrier if damaged.*

2. **Window to front window channel adjustment:**
   - Position window such that clamping jaws are visible in installation opening. Loosen nut on front and rear clamping jaws and loosen jaws. See Fig. 6.
   - Push window firmly into front window channel and tighten clamping nuts.

**Tightening torques**

- Clamping jaw hex nuts . . . . . 10 Nm (7 ft-lb)

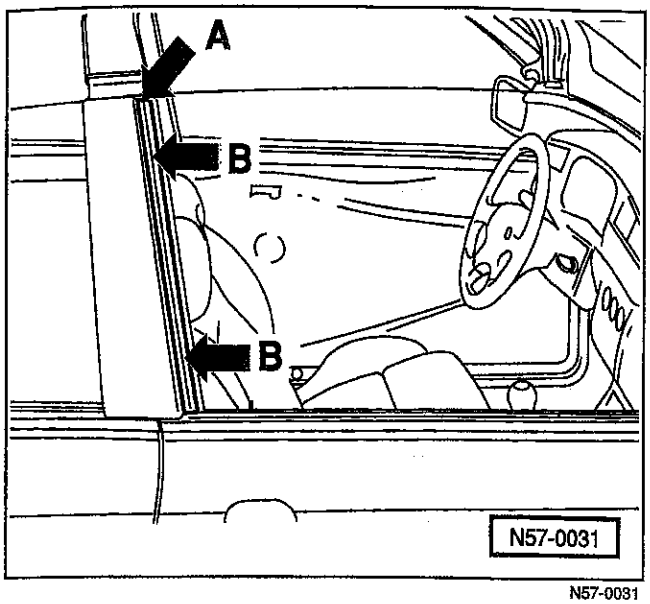



N57-0018

**Fig. 6.** With window clamping jaws loose, press window into front window channel (direction of **arrow**). Inset shows clamping jaws.

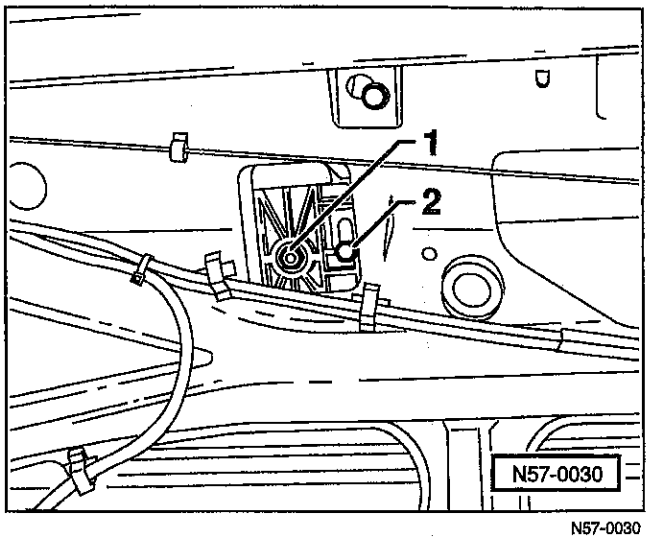
3. **Window height adjustment (rear):**
   - Lower window. Working through underside of door, fully lower front height adjustment screw using Torx driver. See Fig. 5.
   - Raise window and check that top of glass meets upper edge of door/side window seal. See Fig. 7. If necessary, adjust height by turning rear height adjustment screw at the rear window carrier.

4. **Window B-pillar adjustment:**
   - With clamping jaws visible in installation openings, loosen clamping jaws and height adjustment bolt. See Fig. 8.
   - Adjust glass so that it is parallel to B-pillar seal. Move adjustment wedges to center position (align with lower edge of clamping jaws) and tighten bolt and nuts.
   - With window raised and door closed, check window contour in relation to B-pillar using a strip of paper between glass and glass seal. The paper should be able to be pushed along length of window with the same force. If necessary, adjust window by repositioning adjustment wedge.




N57-0031

**Fig. 7.** Adjust rear corner of window so top of glass meets edge of rear door/window seal (**A**). Also adjust gap at B-pillar to be parallel with window seal (**B**).

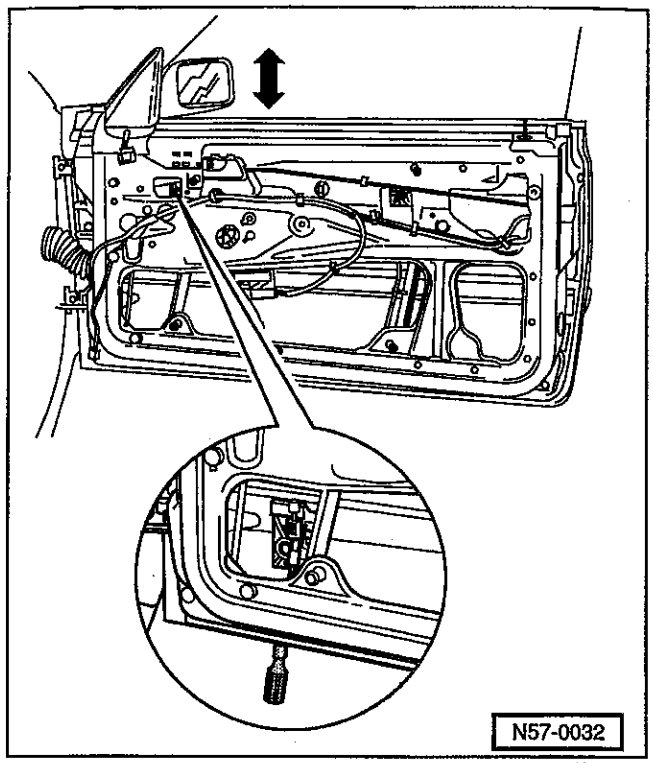



N57-0030

**Fig. 8.** Rear clamping jaw nut (**1**) and height adjustment bolt (**2**).

5. **Window height adjustment (front):**
   - Raise door window. Then check for play at front height adjustment/stop screw. Lower window slightly (approx. 2 in.) and turn (raise) front height adjustment screw until no play exists. Raise window and check adjustment. Repeat adjustment as necessary. See Fig. 9.

6. **Window pretension adjustment:**
   - Fully raise window. Loosen tension wedge bolt and press wedge against glass using a screwdriver through opening and tighten bolt. See Fig. 10.

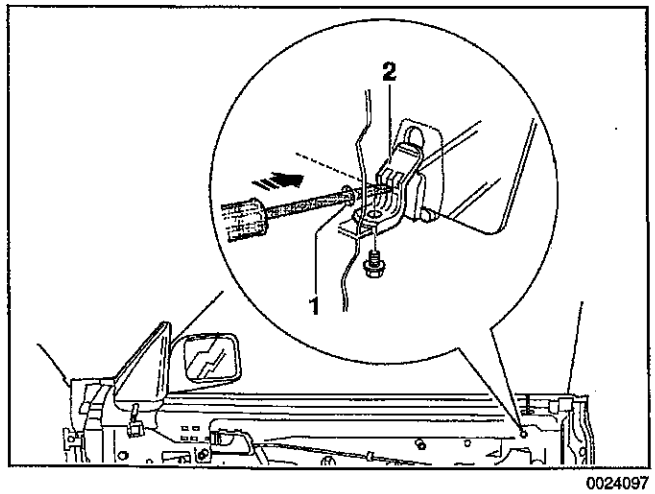



N57-0032

**Fig. 9.** Adjust front adjustment screw until no play exists when pulling on window (direction of **arrow**). Adjust window height with Torx driver (inset).

**Tightening torques**

- Hex bolt for pretension wedge ..... 10 Nm (7 ft-lb)




0024097

**Fig. 10.** Adjust pretension on door glass by pressing wedge (**2**) against glass and tightening bolt.

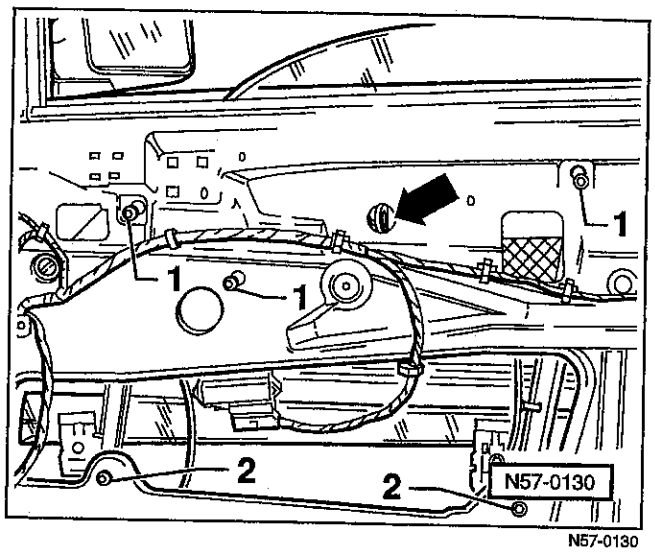
## Window regulator, removing and installing

1. Remove interior door panel and vapor barrier. See **70 Trim–Interior.**

> ***CAUTION—***
> *Use care when removing the vapor barrier. Water leaks will occur if the vapor barrier is damaged or wrinkled when installed. Always replace vapor barrier if damaged.*

2. Remove the front window as described earlier. See **Door glass, removing and installing.**

3. Remove regulator mounting screws and nuts. If applicable remove cable clip. See Fig. 11.




N57-0130

**Fig. 11.** Remove hex head screws and nuts (**1** and **2**). On cars with electric window regulators, unclip harness retaining clip (**arrow**).

4. Lift window regulator slightly so that screws can be pulled through installation openings.

5. Pull window regulator downward through opening.

6. On electric regulators, disconnect harness connector by sliding connector forward and down off of regulator motor.

7. Install in reverse order of removal.

**Tightening torques**

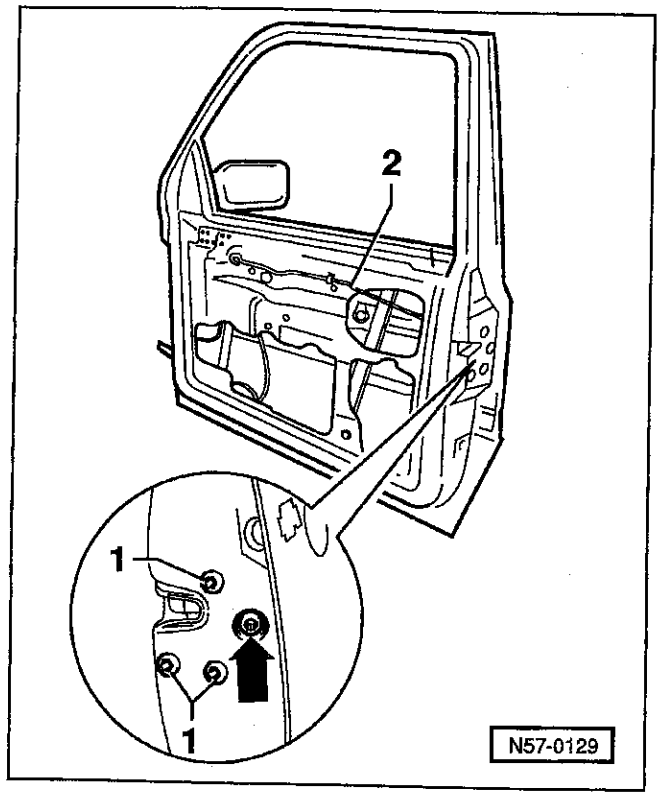
- Window regulator to door . . . . . 10 Nm (89 in-lb)

## Door latch, removing and installing

1. Remove interior door panel and vapor barrier. See **70 Trim–Interior.**

> ***CAUTION—***
> *Use care when removing the vapor barrier. Water leaks will occur if the vapor barrier is damaged or wrinkled when installed. Always replace vapor barrier if damaged.*

2. Close door window. Remove outside door handle as described later. Remove door latch mounting screws. See Fig. 12.




N57-0129

**Fig. 12.** Door latch screws (**1**), pull rod (**2**). Door latch adjusting screw shown at arrow.

3. Disconnect pull rod from latch and remove latch.

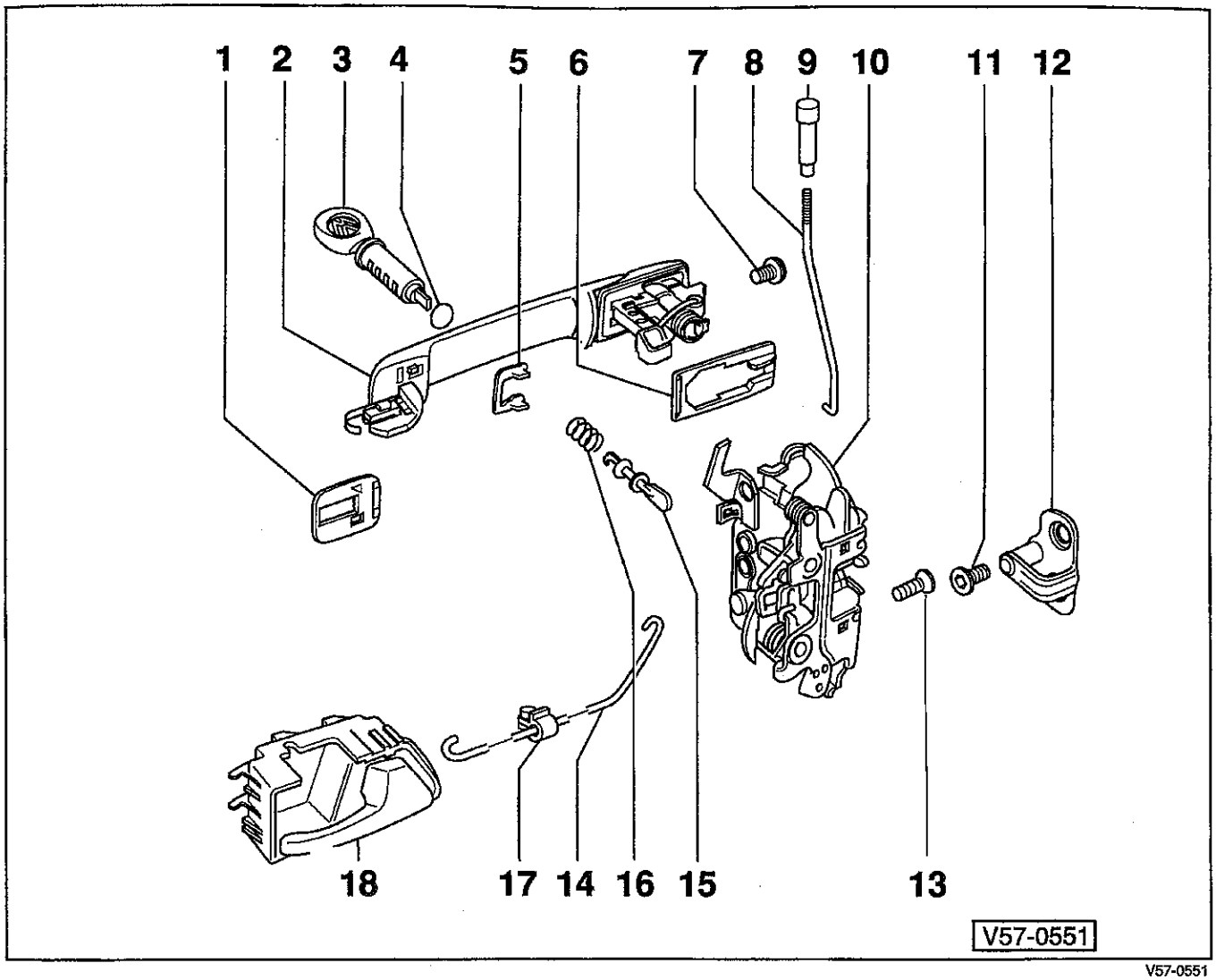
4. Installation is reverse of removal. Loosen latch adjusting screw (see Fig. 12) before installing latch. Tighten adjusting screw after installing door handle.

> ***NOTE—***
> *Screw on left-side latch has right-hand threads. Screw on right-side latch has left-hand threads.*

**Tightening torques**

- Door latch to body . . . . . 8 Nm (71 in-lb)
- Door latch adjusting screw (Torx T20) . . . 3 Nm (27 in-lb

## Door lock mechanism, assembly




V57-0551

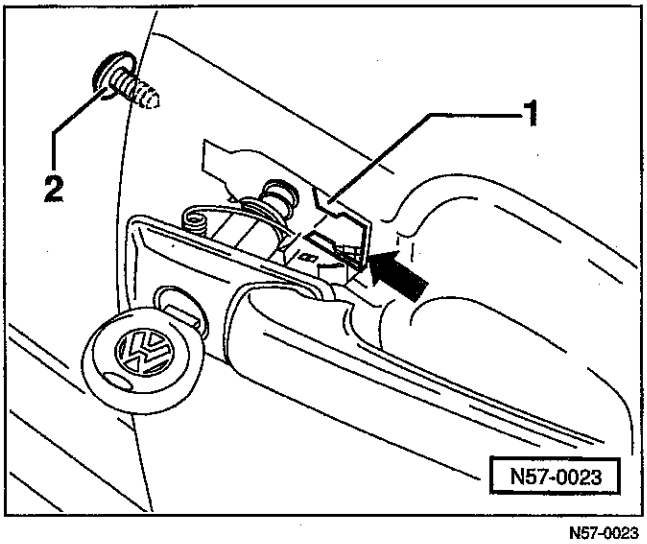
**Fig. 13.** Exploded view of door lock and operating mechanism.

1. **Backing piece**
2. **Door handle**
3. **Lock cylinder**
   - Only remove with key inserted
   - Lubricate with G 000 400 prior to installation
   - Some 1998 models with factory installed keyless remote may not have passenger side lock cylinder
4. **Seal**
5. **Clip**
6. **Backing piece**
7. **Socket-head screw with collar**
   - Tighten to 8 Nm (71 in-lb)
8. **Locking rod**
9. **Locking button**
   - Threaded on
10. **Door latch**
    - Door window must be closed for removal and installation
11. **Countersunk screw**
    - Tighten to 8 Nm (71 in-lb)
12. **Striker pin**
13. **Socket-head screw with collar**
    - Tighten to 8 Nm (71 in-lb)
14. **Pull rod**
15. **Connecting rod**
    - Attached to lock cylinder housing
16. **Spring**
17. **Clip**
18. **Inside door handle**

## Outside door handle, removing and installing

1. Remove socket-head screw from side of door. See Fig. 14.

2. Slide door handle forward and pivot door handle out of door.
   - On driver's door, insert key and turn key 1/4-turn before pivoting handle out of door (when key is turned, door handle carrier releases operating lever.)




N57-0023

**Fig. 14.** Door handle mounting screw (**2**). Check clip (**1**) and replace if damaged.

3. Before installing door handle, make sure carrier for connecting rod is in the vertical position. See Fig. 15.

4. Pivot door handle into door and install door handle screw.

**Tightening torques**

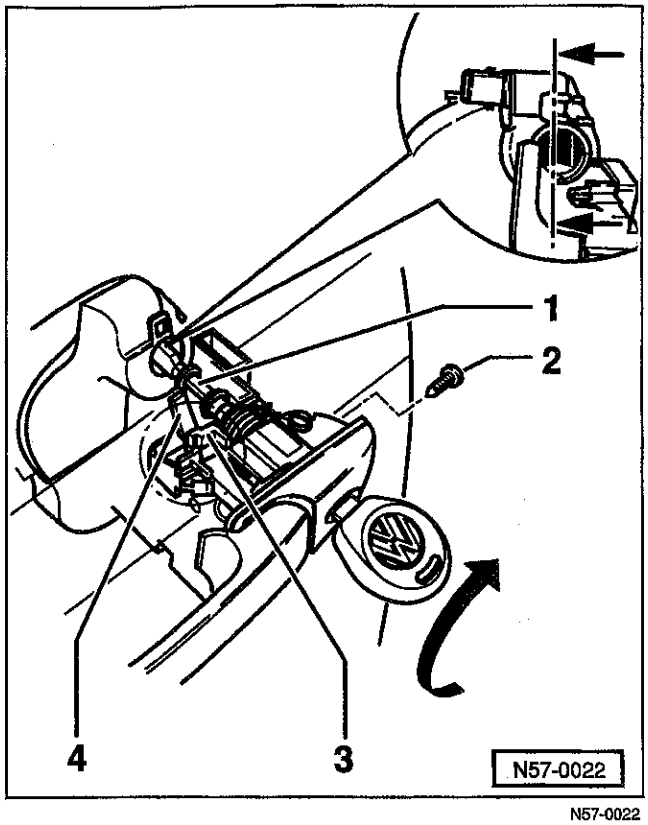
- Door handle socket-head screw. . . . . 8 Nm (71 in-lb)

## Inside door handle, removing and installing

1. Depress retaining (locking) clip and then slide handle assembly forward and off door. See Fig. 16.

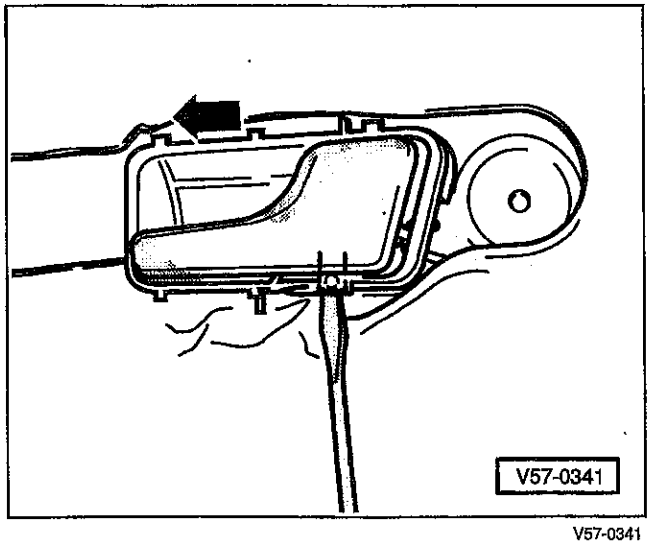
2. Disconnect link rod from handle and remove from handle.

3. Installation is the reverse order of removal.




N57-0022

**Fig. 15.** When installing driver's door handle, connecting rod carrier (**1**) must be in vertical position (inset) before installing handle. Door handle carrier shown at **3** and operating lever shown at **4**.




V57-0341

**Fig. 16.** Pry out retaining clip with screwdriver and slide handle forward (**arrow**) to remove.

## CENTRAL LOCKING SYSTEM

All models covered by this manual are equipped with central locking for the doors, rear lid and fuel filler door. The central locking bi-pressure pump with integral electronic control module are located in the luggage compartment. The pump supplies vacuum to the lock activators for locking and pressure for unlocking, hence the term bi-pressure. See Fig. 18.

The driver's door lock assembly contains a micro-switch that activates 4 functions:

- Activates central locking for lock and unlock
- Arms and dis-arms alarm system
- Activates power windows for convenience close and open
- Closes sunroof during convenience close

These same functions are also activated by the passenger's side door lock assembly when the passenger's side is equipped with a lock cylinder.

Vehicles from 1998 model year are equipped with a factory installed keyless remote system and may not have a lock cylinder installed in the passenger's side outside door handle.

Servos to operate the locks are integrated into the door lock assemblies. Some versions also have servos for the gas flap and the trunk or hatch. The servos are connected to the bi-pressure pump through a series of hard plastic pipes and flexible rubber hoses that are sometimes glued together. Starting with mid-1995 production, all versions use quick disconnect couplers on all components. Most of the parts supplied as replacements also use the quick disconnect couplers. Several adapter fittings are available to mate the newer style quick disconnect servos to the older style systems.

### Central locking system, functional test

A properly functioning system should lock all doors, luggage compartment and fuel filler door within approx. 2 seconds. If the central locking system pump and control module runs for longer than 5 seconds, there is most likely a vacuum/pressure leak in the system.

If the pump shuts off after approx. 5 seconds and starts up again after 12 seconds, the most likely fault is that at least one of the door knobs was not operated or the activator switching point was not reached (mechanically).

1. Begin the functional test with doors, rear lid and fuel tank flap closed and door windows completely open.

2. Push down lock knob on driver door. Check locking on every door, rear lid and fuel tank flap.
   - All lock knobs must go down.
   - All doors and the rear lid should be locked.
   - Fuel tank flap should be locked.

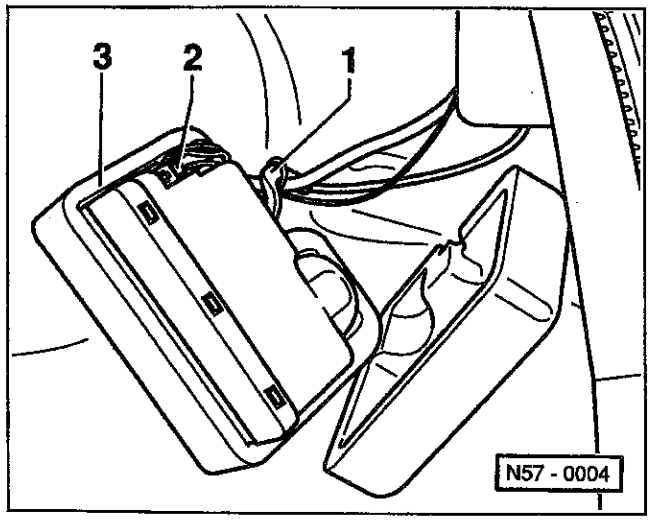
3. To test anti-theft system, lock driver's door with key. then quickly pull all lock knobs up within 12 seconds.
   - 12 seconds after locking, the central locking system pump and control module must run, and all doors should be locked again.

4. After another 15 seconds, try to pull all lock knobs up in succession (wait at least 24 seconds after locking with key).
   - It must not be possible to pull the lock knobs into the unlocked position. The pump starts up and pulls the lock knob back. At the same time, the door lock is deactivated and it is no longer possible to open the door. In this process, there is an audible locking sound as the door locks are deactivated.

5. Repeat the test at the passenger door.

### Pump and control module, removing and installing

1. Working in luggage compartment, open wire ties or disconnect retainer straps and remove pump/control module housing covers. See Fig. 17.



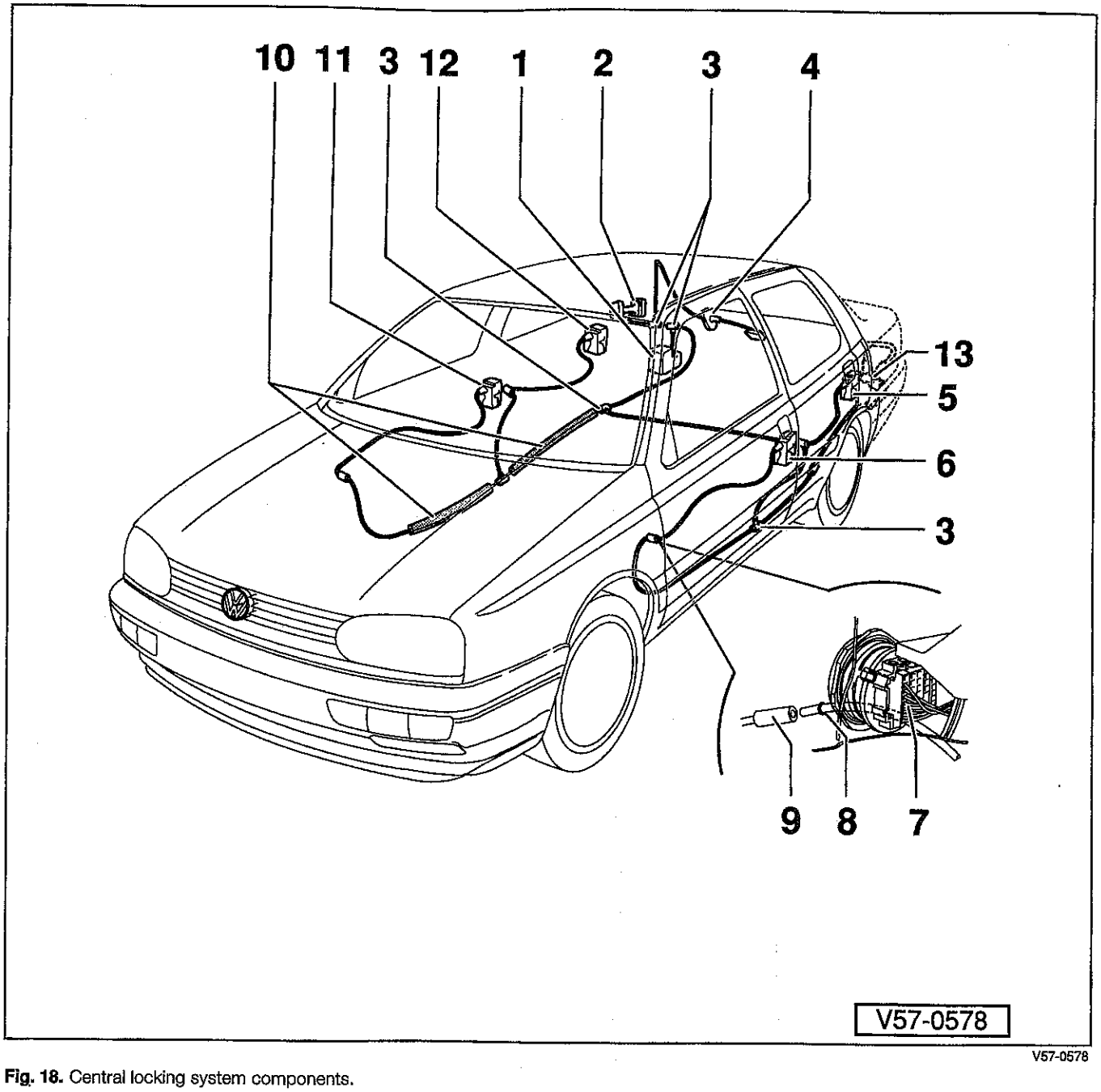

N57-0004

**Fig. 17.** Central locking system pump and control module (**2**), housing covers (**3**) and multi-pin connector with bi-pressure hose (**1**). Note the bi-pressure hose connection when removing multi-pin connector.

2. Separate multi-pin connector and bi-pressure hose from pump.

3. Installation is the reverse of removal. When connecting multi-pin connector, make sure bi-pressure hose is also properly connected.

## Central locking system, assembly




V57-0578

**Fig. 18.** Central locking system components.

1. **Central locking system pump and control module (V69) (Golf)**
   - Located in rear luggage compartment, right hand side
   - See **Pump and control module, removing and installing**
2. **Activator, fuel tank door**
   - To remove, loosen luggage compartment trim near wheel housing
   - See **Fuel tank door activator, removing and installing**
3. **T-connector**
   - Location: near B-pillar/rocker panel, covered by sill molding

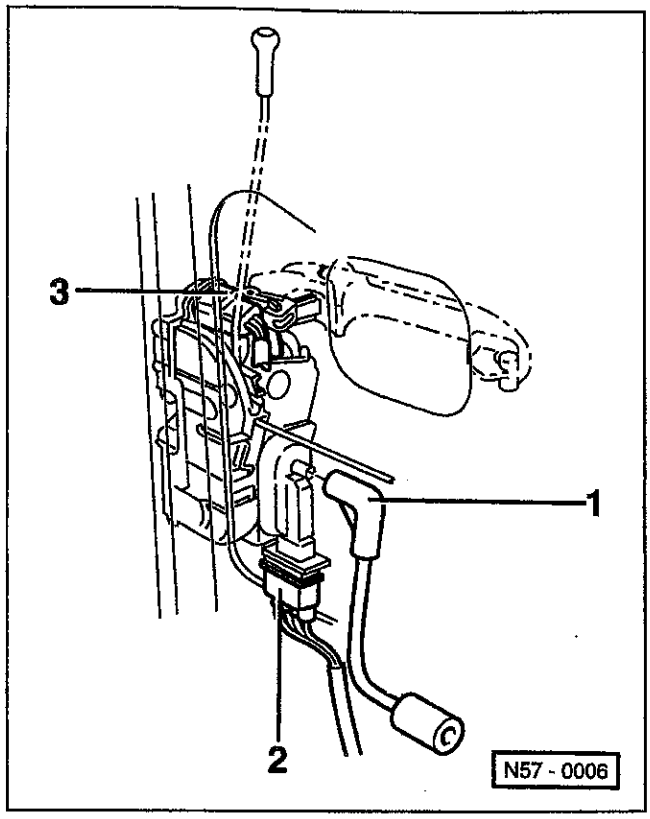
4. **Activator, rear lid**
   - See **Rear lid activator, removing and installing**
5. **Activator, rear door lock**
   - See **Rear door activator, removing and installing**
6. **Activator, front door lock**
   - Includes driver's door central locking system switch
   - See **Front door activator, removing and installing**
7. **Multi-pin connector**
   - Location: near A-pillar (also near B-pillar on 4-door vehicles)
8. **Color marking**
   - Bi-pressure hoses must be pushed into bi-pressure hose connectors (9) up to color marking
9. **Bi-pressure hose connector**
   - Two types:
     Integral with multi-pin connector (7), or separate
   - Integral type:
     Multi-pin connector must be separated to allow connection of bi-pressure hose
   - Separate type:
     Bi-pressure hose connector (9) must be pushed back into multi-pin connector (7) after bi-pressure hose is connected
10. **Foam tube**
    - Passenger's side only
11. **Activator, front door lock**
    - Includes passenger's door central locking switch
12. **Activator, rear door lock**
13. **Central locking system pump and control module**
    - See **Pump and control module, removing and installing**

## Front door activator, removing and installing

1. Remove interior door panel and partially remove vapor barrier. See **70 Trim–Interior.**

> ***CAUTION—***
> *Use care when removing the vapor barrier. Water leaks will occur if the vapor barrier is damaged or wrinkled when installed. Always replace vapor barrier if damaged.*

2. Disconnect bi-pressure hose and harness connectors from activator and central locking switch. See Fig. 19.



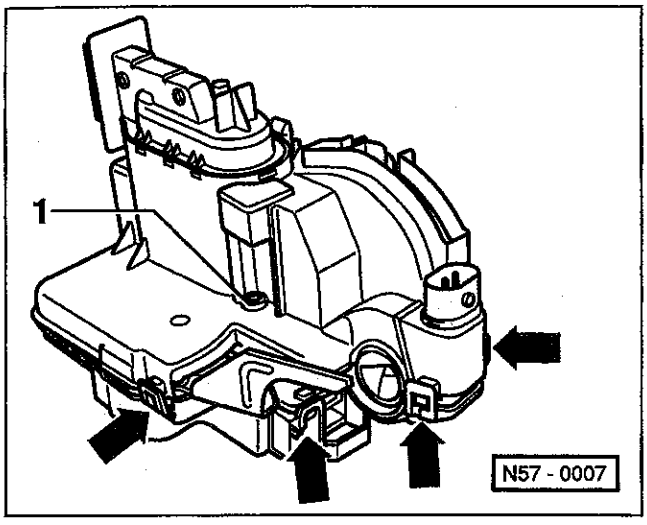

N57-0006

**Fig. 19.** Front door activator. Bi-pressure hose shown at **1** and harness connectors shown at **2** and **3**.

3. Remove door latch/lock with activator, see **Door latch, removing and installing.**

> ***NOTE—***
> *On four-door vehicles the window regulator should be temporarily loosened for better access.*

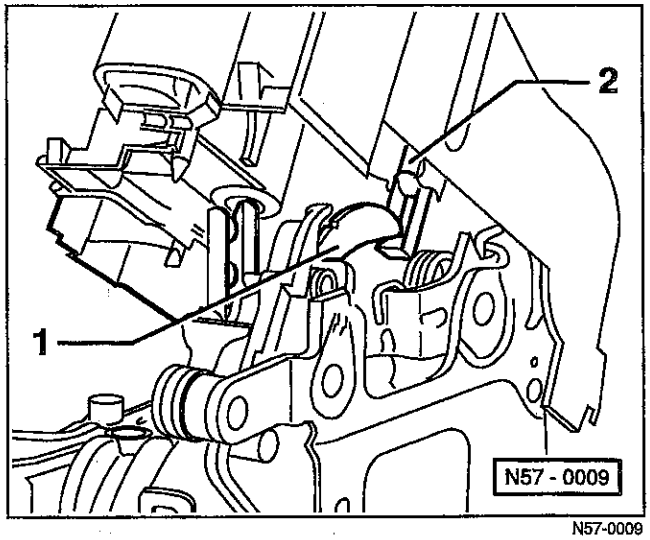
4. Separate activator from lock assembly;
   - Turn lock rotor to "closed" position. Then remove Torx screw (T15) and pry back retainers while separating activator from lock. See Fig. 20.




N57-0007

**Fig. 20.** Separate activator from door latch/lock by removing Torx screw (**1**) and prying back retainers (**arrows**).

5. Installation is the reverse of removal. When installing activator to lock assembly, check that locking lever engages slot in striker. See Fig. 21.




N57-0009

**Fig. 21.** When installing activator, slide locking lever (**1**) into striker slot (**2**).

***NOTE—***

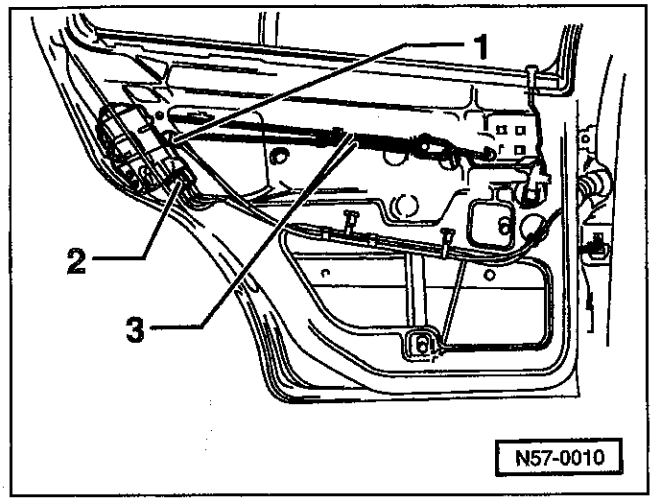
*If the door latch/lock does not operate properly after the activator is replaced, the complete assembly should be replaced as a unit.*

## Rear door activator, removing and installing

1. Remove interior door panel and partially remove vapor barrier. See **70 Trim–Interior.**

> ***CAUTION—***
> *Use care when removing the vapor barrier. Water leaks will occur if the vapor barrier is damaged or wrinkled when installed. Always replace vapor barrier if damaged.*

2. Disconnect bi-pressure hose from activator and separate multi-pin connector. Unhook pull rod and lock rod from activator. See Fig. 22.




N57-0010

**Fig. 22.** Disconnect hose (**1**) and electrical connector (**2**) from rear door activator. Pull and lock rods shown at **3**.

3. Unbolt lock from door and remove rear door lock with activator.

4. Separate activator from lock assembly;
   - Turn lock rotor to "closed" position. Then remove Torx screw (T15) and pry back retainers while separating activator from lock. See Fig. 20.

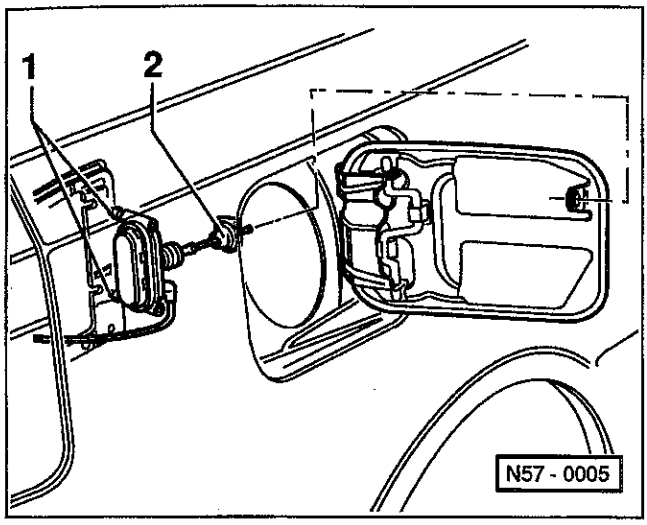
5. Installation is the reverse of removal. When installing activator to lock assembly, check that locking lever engages slot in striker.

***NOTE—***

*If the door latch/lock does not operate properly after the activator is replaced, the complete assembly should be replaced as a unit.*

## Fuel tank door activator, removing and installing

1. Remove central locking system pump and control module as described earlier.
2. Partially remove luggage compartment trim on fuel tank door side.
3. Remove activator screws and pull activator with locking rod out of stop. See Fig. 23.



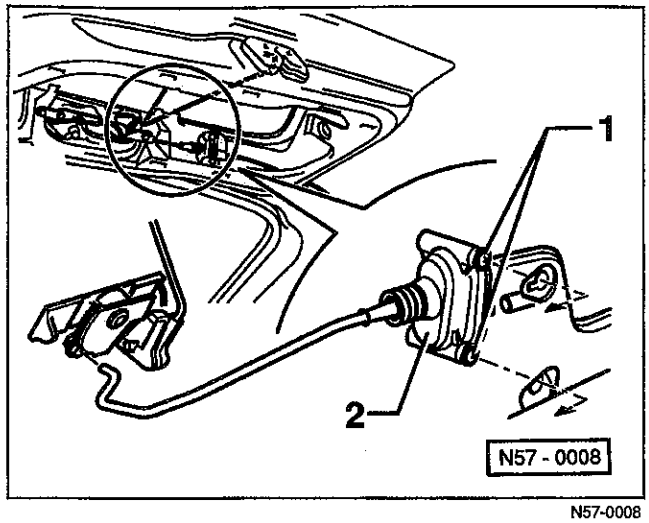

N57-0005

**Fig. 23.** Fuel tank door activator mounting screws (**1**) and stop (**2**).

4. Disconnect bi-pressure hose from activator.
5. Installation is the reverse of removal.

## Rear lid activator, removing and installing

1. Remove handle and trim piece from rear lid.
2. Disconnect locking rod from rear lid latch push button, and disconnect bi-pressure hose.
3. Remove activator mounting screws and pull activator with locking rod out of rear lid. See Fig. 24.




N57-0008

**Fig. 24.** Rear lid activator (**2**) and activator mounting screws (**1**).

4. Installation is the reverse of removal.

# 58 Doors–Rear



## GENERAL

This repair group covers removal and installation of the rear door assembly, and removal and adjustment of the door glass.

***NOTE—***
- *Service to door lock assemblies, including the central locking system is covered in* **57 Doors–Front**.
- *Interior door panel removal and installation instructions are given in* **70 Trim–Interior**.

## REAR DOOR, SERVICING

An exploded view of the rear door assembly is shown in Fig. 2.

### Rear door, removing and installing

1. Disconnect harness connector at B-pillar. Disconnect central locking bi-pressure line in harness connector.

***NOTE—***
*Tape or wire tie the removed harness connector to the B-pillar. If the connector falls into the pillar, it will be difficult to retrieve.*

2. Remove door check strap bolt at B-pillar. Remove threaded pin bolt from upper and lower hinges. See Fig. 2.
3. Lift door upward and off of hinge brackets.
4. Installation is the reverse of removal.

**Tightening torques**
- Hinge to door or body . . . . . 40 Nm (30 ft-lb)
- Hinge screw to hinge . . . . . 23 Nm (17 ft-lb)

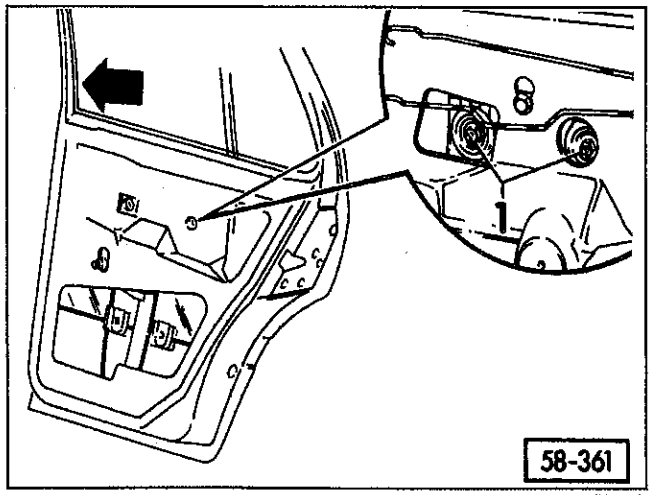
***NOTE—***
*If the door requires adjustment, the hinge bolts can be loosened and the door can be repositioned in the bolt's elongated holes. A misaligned door can result in wind noise, incorrect latching, and possible paint damage.*

### Door glass, removing and installing

1. Remove interior door panel and vapor barrier. See **70 Trim–Interior**.

***CAUTION—***
*Use care when removing the vapor barrier. Water leaks will occur if the vapor barrier is damaged or wrinkled when installed. Always replace vapor barrier if damaged.*

2. Remove nuts from glass clamping jaws. Press jaws apart. See Fig. 1.



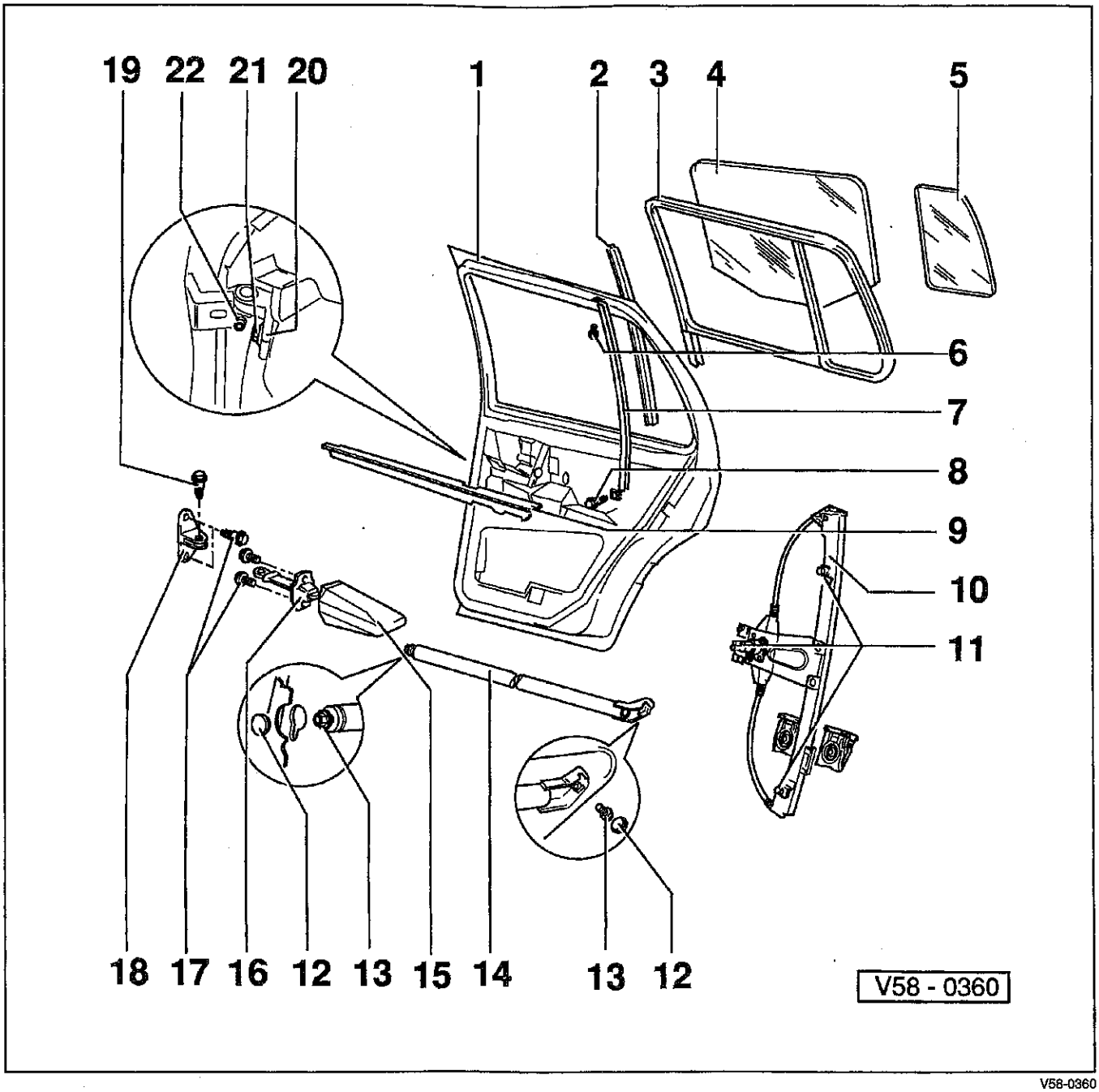

58-361

**Fig. 1.** Glass clamping jaw nuts (1). Door glass shown lowered into door.

3. Lower door glass into door. Pull window channel out of door frame and remove center connector. See Fig. 2.
4. Pull door glass upward, tilt toward front and lift out of window slot.
5. Install in the reverse order of removal. Adjust the glass as described later.

**Tightening torques**
- Clamping jaw hex nuts . . . . . 10 Nm (7 ft-lb)

## Rear door, assembly




V58-0360

**Fig. 2.** Exploded view of rear door assembly.

1. **Door**
   - Adjust at hinge within over-sized holes
2. **Window channel connector**
3. **Window channel**
4. **Door window**
5. **Vent window**
6. **Screw**
   - Tighten to 3.5 Nm (31 in-lb)
7. **Center connector**
8. **Hex-head screw**
   - Tighten to 6 Nm (53 in-lb)
9. **Window slot seal**

**10. Window regulator**

**11. Hex-head screws**
- Only loosened for removal of window regulator
- Tighten to 10 Nm (7 ft-lb)

**12. Cover**

**13. Bolt**
- Tighten to 25 Nm (18 ft-lb)

**14. Impact member**

**15. Door check strap sleeve**

**16. Door check strap**

**17. Hex-head screw**
- Tighten to 7.5 Nm (66 in-lb)

**18. Console**

**19. Bolt**
- Tighten to 9 Nm (80 in-lb)

**20. Door hinge**

**21. Bolt (Torx T45)**
- Tighten to 40 Nm (30 ft-lb)

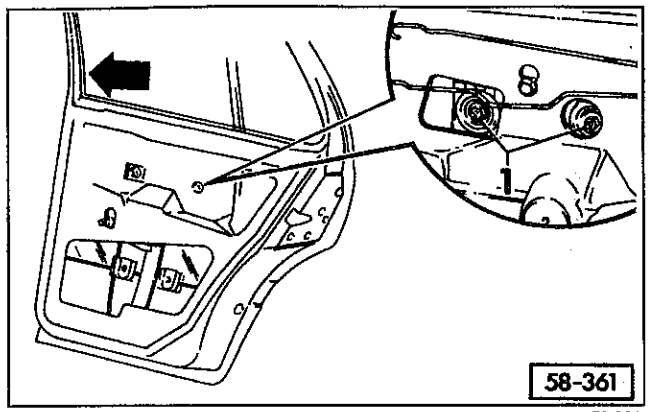
**22. Threaded pin bolt**
- Tighten to 23 Nm (17 ft-lb)

## Door glass, adjusting

1. Remove interior door panel and vapor barrier. See **70 Trim–Interior.**

> ***CAUTION—***
> *Use care when removing the vapor barrier. Water leaks will occur if the vapor barrier is damaged or wrinkled when installed. Always replace vapor barrier if damaged.*

2. Crank door window up or down until glass clamping jaws are located in the installation openings. See Fig. 3.




58-361

**Fig. 3.** Clamping jaws positioned in installation openings. Adjust window by pushing into front window channel (**arrow**). Inset shows clamping jaws.

3. Loosen clamping jaw nuts, then push door window into front window channel and tighten nuts. The remainder of installation is the reverse of removal.

**Tightening torques**
- Clamping jaw hex nuts . . . . . 10 Nm (7 ft-lb)

# 60 Sunroof



## GENERAL

The power sunroof is a two-way design that tilts open or slides back into the roof. The sunroof is a glass panel with an interior sliding shade (headliner). An electronic control unit is combined with the sunroof motor and regulates the motor operation.

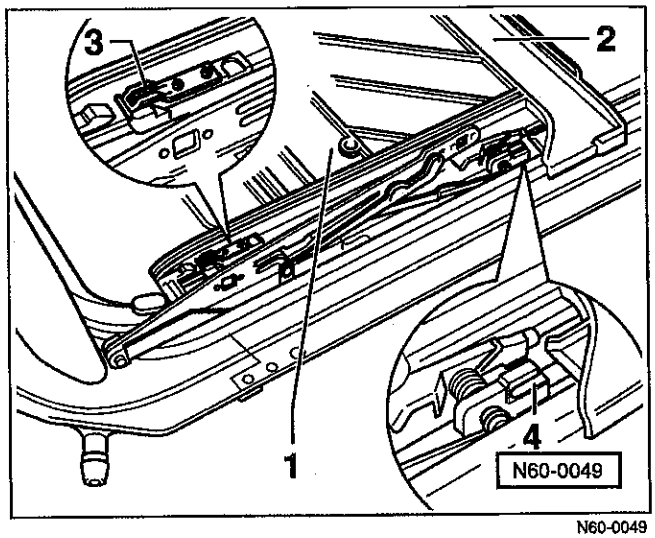
## SUNROOF, SERVICING

Fig. 3 shows an exploded view of the sunroof assembly.

### Sunroof glass panel, removing

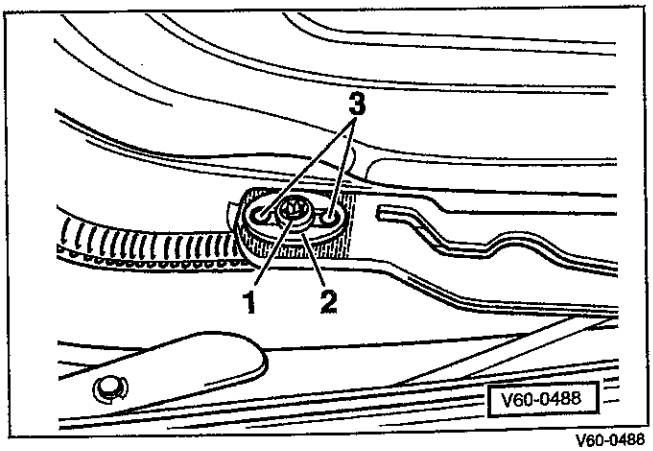
1. Tilt sunroof open and slide shade to rear.
2. Unclip and slide trim frame to rear. Trim frame is clipped into front guide. See Fig. 1.
3. Remove screws (Torx T25) and adjusting plates from each corner of sunroof panel. See Fig. 2.
4. Carefully push sunroof panel upward and out.

***NOTE—***
*If necessary, remove trim frame by pulling forward and upward out of roof cutout.*




N60-0049

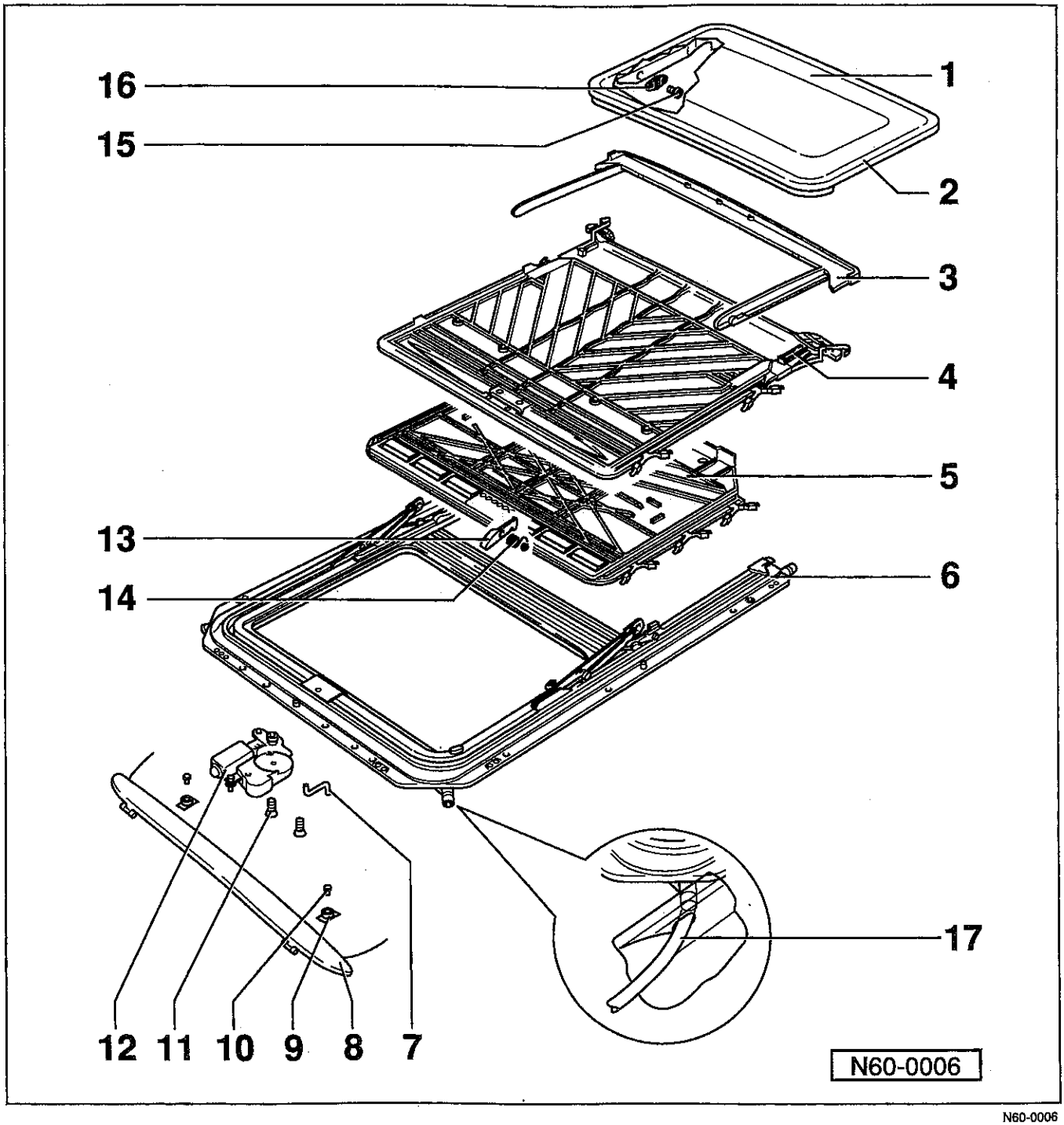
**Fig. 1.** Slide headliner (**1**) and trim frame (**2**) to rear. Insets show trim frame clip (**3**) and trim frame guide (**4**).




V60-0488

**Fig. 2.** Sunroof mounting screws (**1**). Note position of mounting plates (**2**) in reference to guide pins (**3**) for installation. Front right mounting screw shown.

## Sunroof, assembly




N60-0006

**Fig. 3.** Exploded view of sunroof assembly.

1. **Glass sunroof panel**
   - Single pane green safety glass

2. **Sunroof panel seal**
   - Seal joint is in center of right side section
   - Use water to lubricate panel seal clamping channel before installing

3. **Trim frame**
   - See **Sunroof glass panel, removing**
4. **Headliner (cars built up to 8/94)**
5. **Headliner (cars built from 9/94)**
   - See **Sunroof headliner, removing and installing**
6. **Carrier unit**

   Carrier unit consists of the following parts:
   - U frame with guide channels
     (If required, guide channels are to be lubricated with special grease (VW part no. G 000 450 02) only. Multipurpose grease must not be used under any circumstances.)
   - Rear guides with cables
   - Front guides

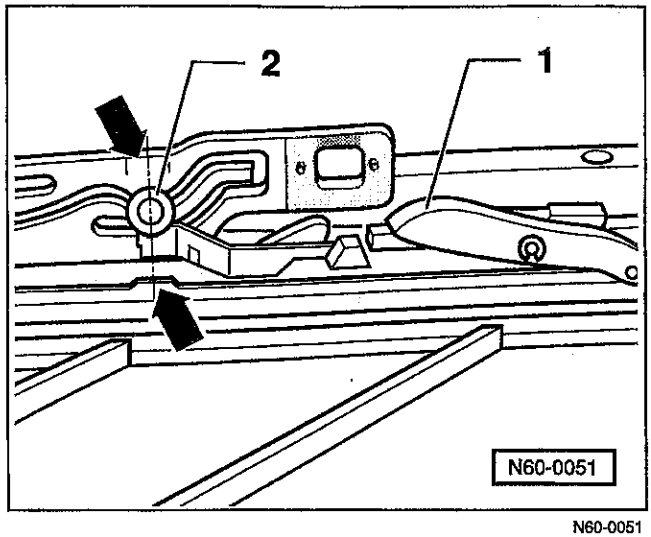
   Some individual parts are available for the carrier unit

   ***CAUTION —***
   *Part numbers are listed for reference only. Always check with an authorized Volkswagen parts department for the latest parts information.*
7. **Hex key for emergency operation**
   - Clipped onto cable driver
8. **Wind deflector**
   - Removing: open panel and remove screws (10)
9. **Threaded fitting**
   - Thread must be at an angle toward the rear
10. **Screw**
    - For wind deflector (8)
11. **Countersunk self-locking screws**
    - Always replace
    - Tightening torque 3 Nm (27 in-lb)
12. **Sunroof motor with cable drive and sunroof control module**
    - See **Cable drive closed position, checking**
13. **Locating hooks**
14. **Locating hook spring**
15. **Torx screw**
    - Torx T25
    - Tighten to 6 Nm (53 in-lb)
16. **Adjusting plate**
    - Quantity: 4
17. **Water drain hose**
    - See **Water drain hoses, cleaning**

## Sunroof glass panel, installing

1. Begin with sunroof panel in the closed position.
2. Check that locating hooks and pins on both sides of carrier unit are correctly positioned. See Fig. 4.

***NOTE —***
*If the pins are not correctly aligned, see* **Parallel running, checking and adjusting.**




N60-0051

**Fig. 4.** Before installing sunroof panel, locating hooks (**1**) must be in guide rails and pins (**2**) must be within marks or notches (**arrows**).

3. Place sunroof in position from above and install adjusting plates and securing screws. Lightly tighten screws (Torx T25).

***NOTE —***
*When installing adjusting plates, make sure guide pins are in elongated holes of adjusting plate. See Fig. 2.*

4. Position panel to correct height in opening and tighten sunroof panel securing screws. See **Sunroof panel height, adjusting.**

**Tightening torques**
- Sunroof panel to carrier unit
  (Torx T25 screws) . . . . . 6 Nm (53 in-lb)

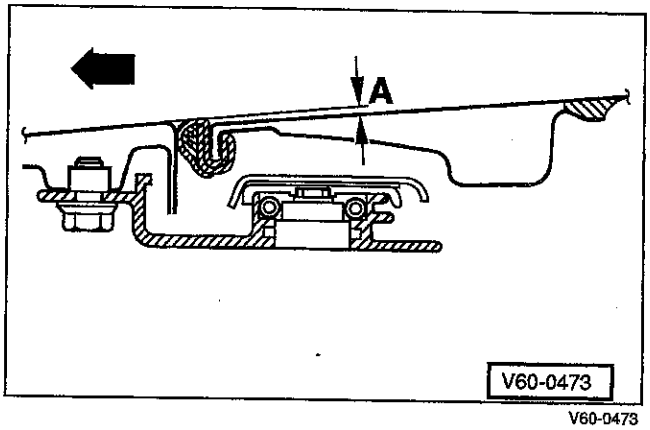
## Sunroof panel height, adjusting

Before adjusting sunroof panel height, ensure that sunroof runs parallel, see **Parallel running, checking and adjusting.**

1. Tilt sunroof panel open and push back sunroof headliner.
2. Unclip and slide trim frame to rear. Trim frame is clipped into front guide. See Fig. 1, given earlier.
3. Close glass panel.
4. Loosen all four screws (Torx T25) and adjusting plates on sunroof panel. See Fig. 2.
5. Carry out front and rear height adjustment as shown in Fig. 5 and 6.
   - Dimension A = 1 mm lower than roof
   - Dimension B = 1 mm higher than roof
6. Tighten glass panel mounting screws. Slide trim frame forward and clip in place.

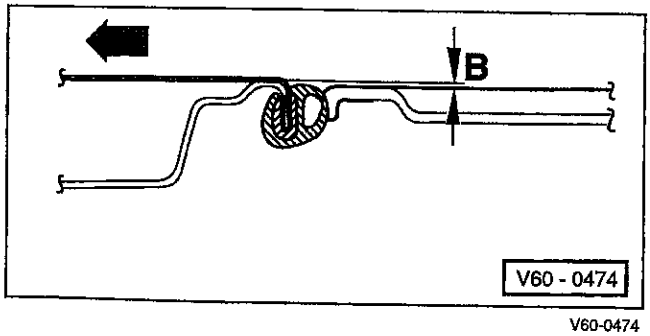
**Tightening torques**

- Glass panel mounting screws . . . . . 6 Nm (53 in-lb)




V60-0473

**Fig. 5.** Front of sunroof panel should be 1mm (dimension **A**) lower than body (roof). Arrow indicates direction of travel.




V60-0474

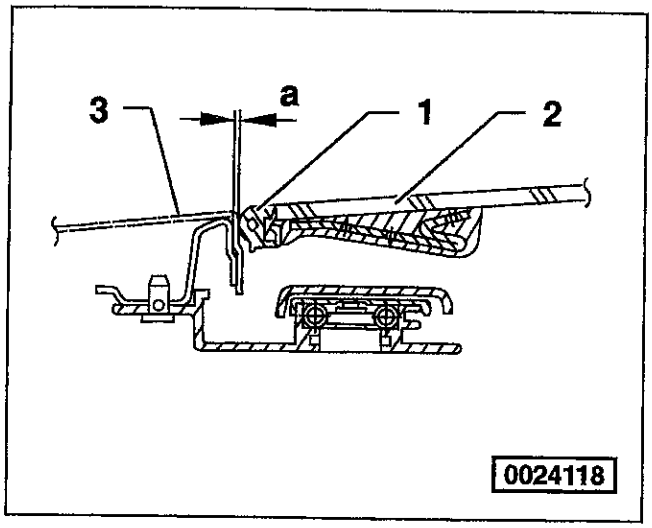
**Fig. 6.** Rear of sunroof panel should be 1mm (dimension **b**) higher than body (roof). Arrow indicates direction of travel.

## Sunroof panel seal, adjusting

The preload between the sunroof panel seal and the body should be uniform on all sides. See Fig. 7.

**Panel seal gap**

- Dimension a . . . . . 0.3 mm (0.012 in.)




0024118

**Fig. 7.** Gap (**a**) between panel seal (**1**) and body (**3**) should be 0.3 mm (0.012 in), or about the thickness of a business card.

Check panel seal preload using strip of paper 0.3 mm (0.012 in.) thick, such as a business card. When seal is correctly adjusted, it should be possible to pull paper strip through, between panel seal and body, with some resistance.

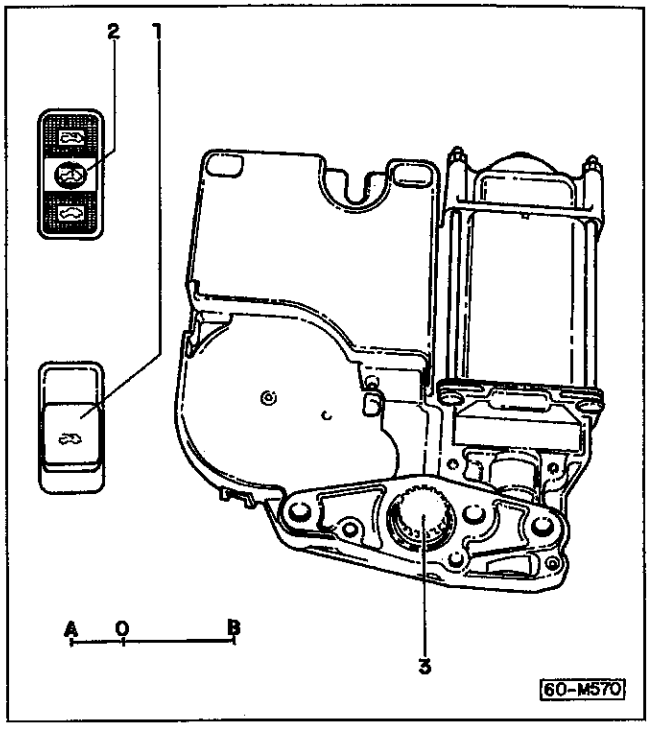
If necessary, remove sunroof panel to adjust seal preload. Spread seal apart using a wedge to increase preload or push seal together to reduce preload.

## Cable drive closed position, checking

This procedure should be carried out when replacing the sunroof motor/cable drive. The purpose of this procedure is to position the motor in the closed position before installing it to the cable drive. Before making the check, ensure that the sunroof runs parallel, see **Parallel running, checking and adjusting**.

1. Begin with sunroof panel closed and motor removed from sunroof carrier, connect power harness connector to motor.
2. Operate sunroof switch, and count cable drive pinion rotations until end-switch-off position is reached. See Fig. 8.

3. Operate sunroof switch again to reach closed position.
   - The closed position is 2 full turns from the tilting switch-off position (**A** in shown Fig. 8) and 8.25 turns from the open end-switch-off position (**B** shown in Fig. 8).




60-M570

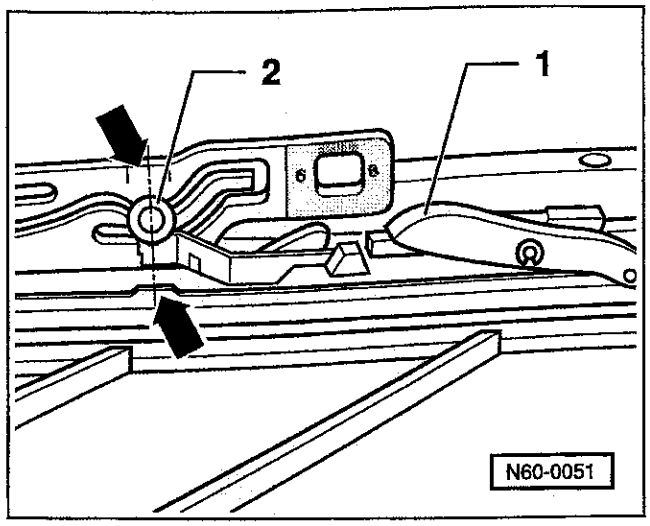
**Fig. 8.** Drive pinion shown at **3**. Sunroof motor switch-off positions represented at **A** (tilt) and **B** (full-open). Closed position represented at **O**.

4. Install sunroof motor to sunroof carrier using new self-locking screws.

> ***CAUTION—***
> *Always use new self-locking screws.*

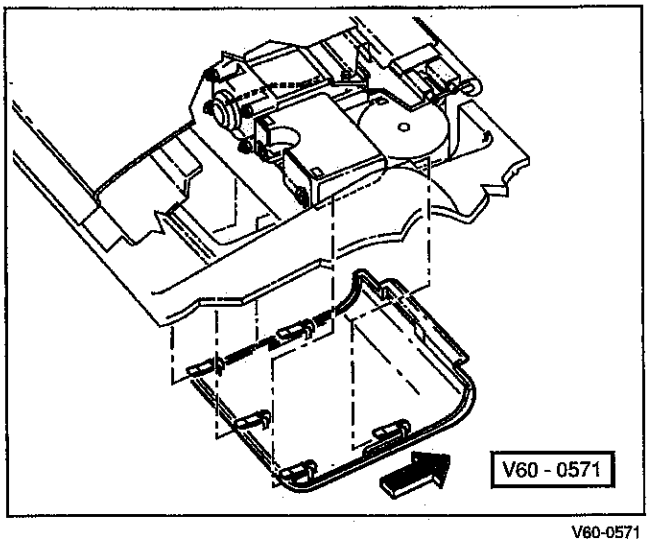
## Parallel running, checking and adjusting

1. Begin with sunroof panel closed and sliding headliner (sunshade) pushed back.
2. Unclip and slide trim frame to rear. Trim frame is clipped into front guide. See Fig. 1, given earlier.
3. Check alignment of left and right locating hooks and pins in relation to carrier. See Fig. 9.
   - Pins must be aligned within marks on carrier and locating hooks must be engaged in guide rails.
4. If cable drive is out of parallel alignment, disconnect the negative (-) battery cable.
5. Remove motor access cover by sliding toward rear. See Fig. 10.




N60-0051

**Fig. 9.** Locating hooks (**1**) must be in guide rails and pins (**2**) must be within marks or notches (**arrows**) for parallel operation.




V60-0571

**Fig. 10.** Remove motor access cover by sliding in direction of arrow.

6. Remove sunroof motor mounting screws and motor.
7. Align cable drive for parallel operation. See Fig. 9.
   - Engage locating hooks in guide rails.
   - Slide guide pins from front to rear to align with marks.
8. Install sunroof motor using new self locking screws.

> ***CAUTION—***
> *Always use new self-locking screws.*

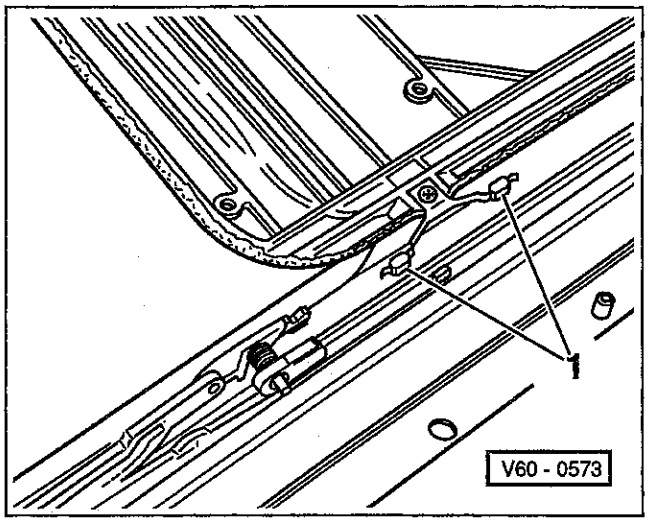
**Tightening torques**

- Sunroof motor mounting screws. . . . . 3 Nm (27 in-lb)

## Sunroof headliner, removing and installing (cars built up to 8/94)

1. Remove sunroof glass panel as described earlier. Position sunroof unit in closed position.

2. Remove screw that mounts slide to headliner (one side only). Pull slide out of carrier unit. See Fig. 11.




V60-0573

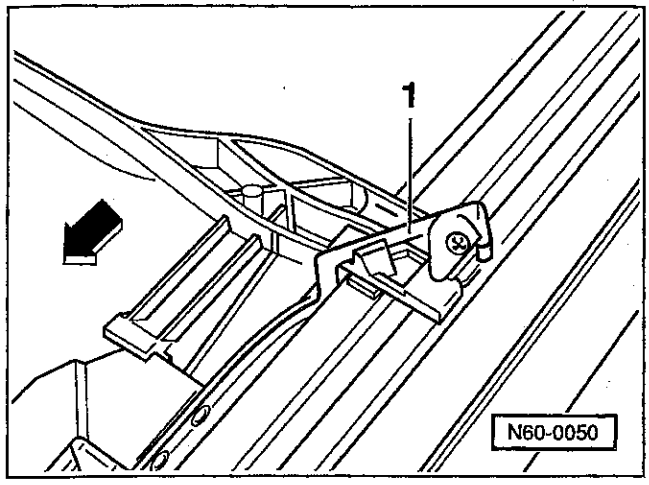
**Fig. 11.** Remove screw that mounts slide (**1**) (remove from one side only).

3. Remove screws that release headliner springs on both sides and pull headliner forward out of roof cutout. See Fig. 12.

***NOTE —***

- *The headliner must be angled when removing from roof cutout.*
- *When installed, springs are difficult to see.*

4. Before installing headliner, remove left and right springs from headliner.
5. Insert headliner in roof cutout.
6. Insert headliner slide in guide channel. See Fig. 11.
7. Insert slide on other side into guide channel and secure with new self-locking screw.
   - Always use new self-locking screws.
8. Install left and right springs with new self-locking screws.
9. Slide headliner to rear, until springs engage.



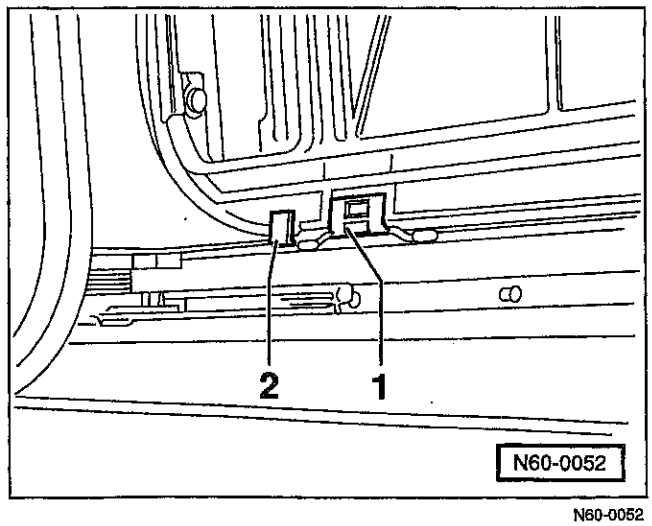

N60-0050

**Fig. 12.** Release left and right springs (**1**) and pull headliner forward and out of roof cut-out.

## Sunroof headliner, removing and installing (cars built from 9/94)

1. Remove sunroof glass panel as described earlier. Position sunroof unit in closed position.

2. Unclip stop on one side and press headliner towards this side. See Fig. 13.




N60-0052

**Fig. 13.** Unclip stop (**2**) on one side, press headliner toward this side. Slide shown at (**1**).

3. On opposite side, carefully pry slide out of guide channel, working from front to rear.

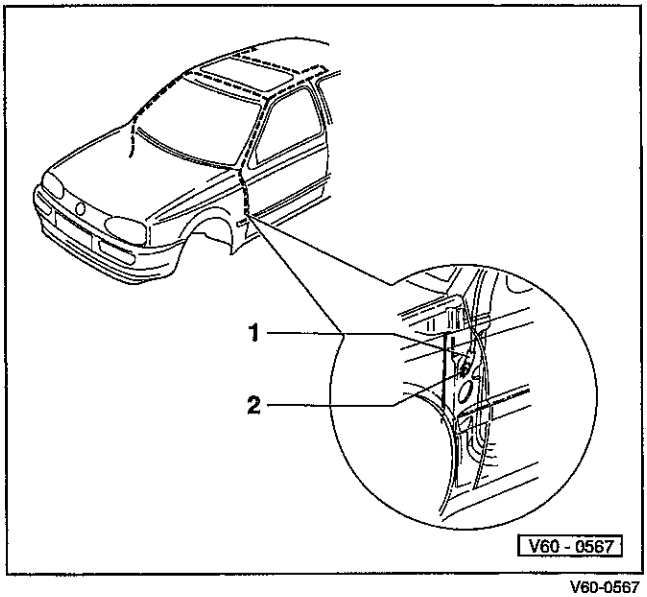
4. Swing headliner out of assembly frame.

5. To install, insert headliner in the roof cutout.
6. Insert headliner slide into guide channel (slide engaged into headliner).
7. Insert slide on opposite side into guide channel. Fit side stops.
8. The remainder of installation is the reverse of removal.

## Water drain hoses, cleaning

The front water drain hoses are routed through the A-pillars and terminate between the door and A-pillar. Cleaning is done from the sunroof panel opening. See Fig. 14.

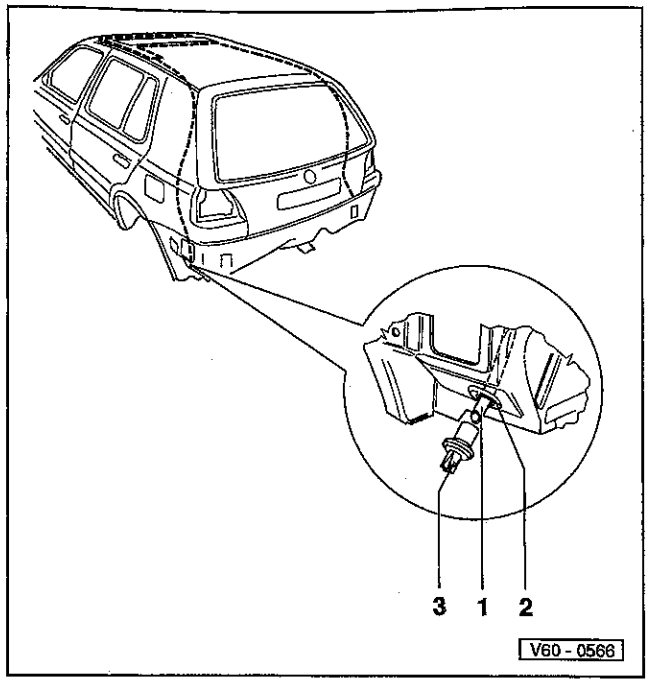
***NOTE—***
*A speedometer inner cable, approx. 2300 mm (7.5 ft), or equivalent is best to clear the hoses.*




V60-0567

**Fig. 14.** Front water drain hoses (**1**) and water drain valve (**2**).

The rear water drain hoses are routed in the C-pillars and terminate at the sides behind the bumper cover. See Fig. 15. Cleaning the rear hoses should be done from the lower end, after removing the bumper, as described in **63 Bumpers**.




V60-0566

**Fig. 15.** Rear water drain hoses (**1**) with grommet (**2**) and drain valve (**3**).

# 63 Bumpers



## GENERAL

The bumpers consist of a cross-member that is bolted directly to the body structure. A molded styrofoam insert is installed over this cross-member. The bumper covers are then bolted to the bumper cross-member over the styrofoam insert.

### Towing eye cover, removing and installing

A tow hook (eye), which is included in the vehicle tow kit, can be threaded into the front bumper cross-member after removing the plastic access cover.

1. Insert screwdriver between turn signal housing and towing eye cover. Carefully lift cover from plastic retaining clips on turn signal housing. See Fig. 1.

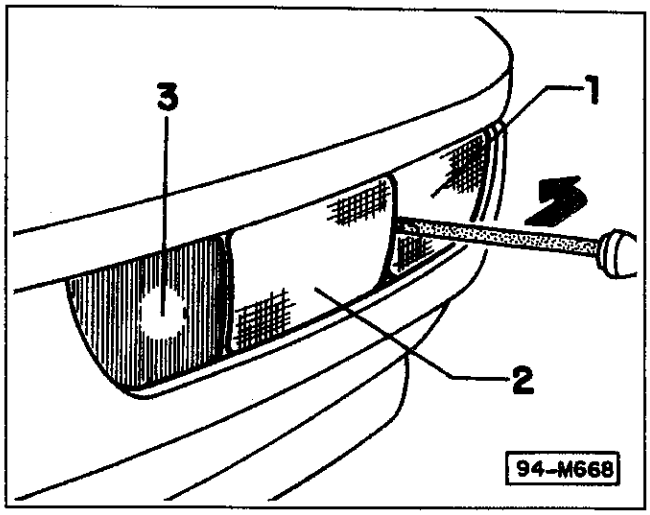
> ***CAUTION—***
> *To avoid damaging the retaining clips, insert the screwdriver between the housing and towing eye cover lens and NOT between the cover and bumper opening or fog light.*

2. Detach spring clips from opposite side or from fog light housing (if equipped) and remove cover from opening.

> ***NOTE—***
> *Before installing cover, inspect plastic retainer clips located on turn signal housing. Clips must not be broken or deformed.*

3. To install, insert cover at 30° angle into turn signal housing clips and make sure metal pin on rear of cover engages fully.

> ***CAUTION—***
> *To avoid damaging the retaining clips, do not insert cover at more than a 45° angle.*




94-M668

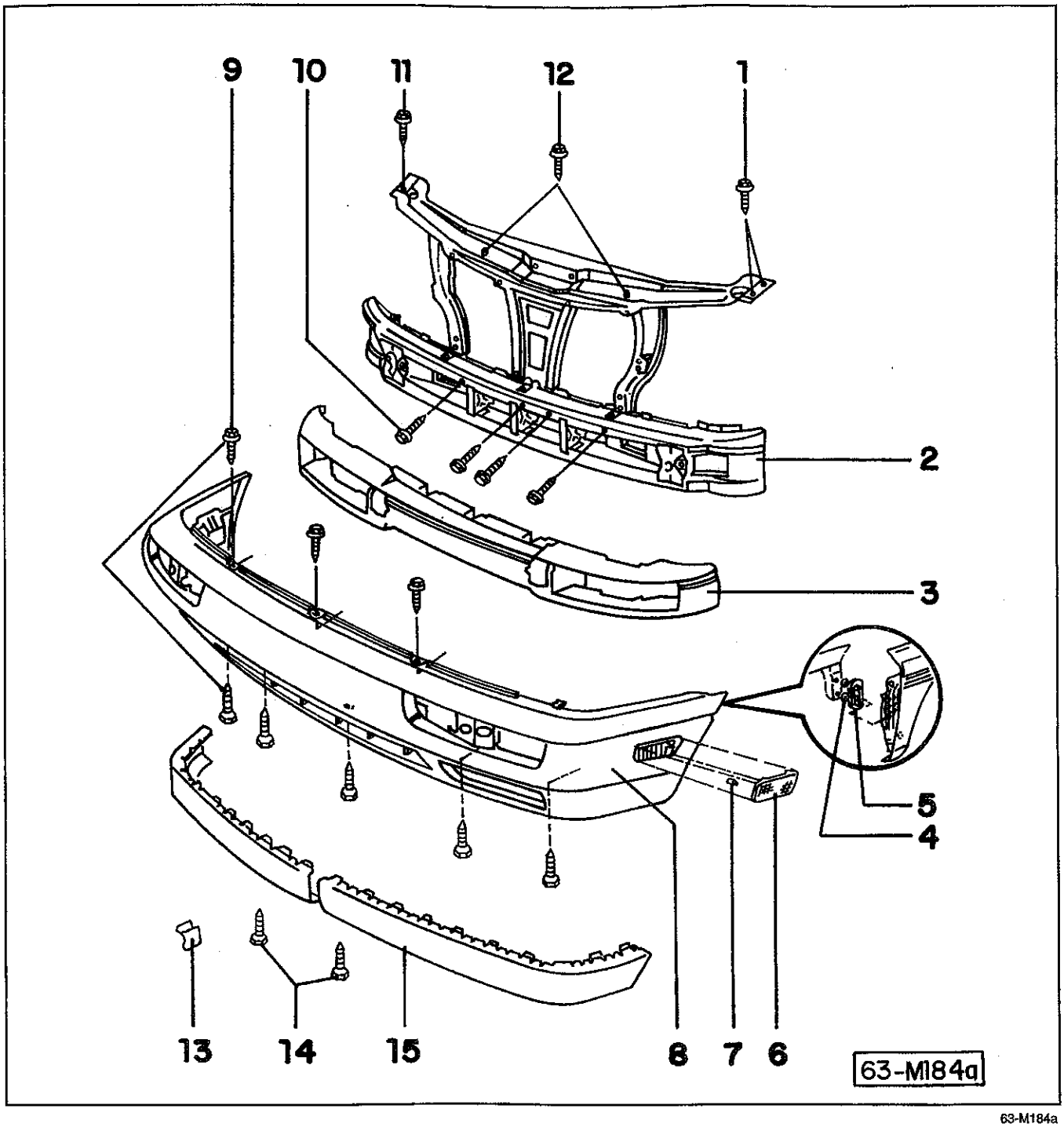
**Fig. 1.** Carefully lift cover (**2**) in direction of arrow from retaining clips and detach from spring clips.

4. Carefully swing cover into opening and engage spring clips.

## BUMPERS, SERVICING

Fig. 2 shows an exploded view of the front bumper assembly and Fig. 4 shows the rear bumper assembly. The bumper covers can be removed for replacement of the styrofoam insert.

## Front bumper, assembly




63-M184a

**Fig. 2.** Exploded view of front bumper assembly.

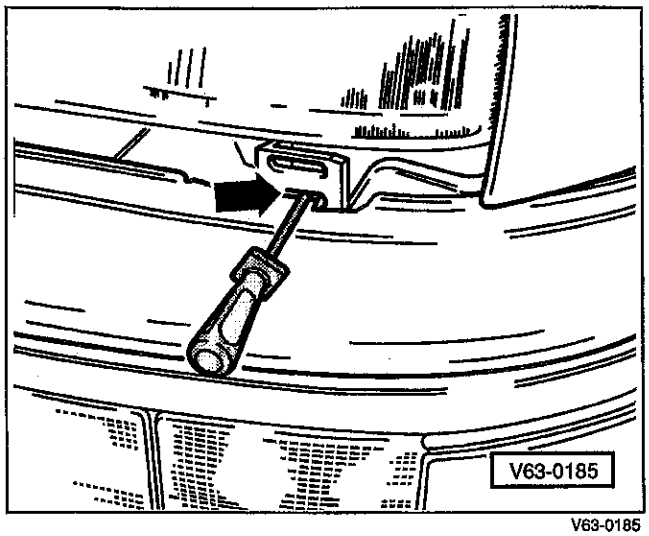
1. **Hex-head screws**
   - Qty: 4
   - Tighten to 10 Nm (7 ft-lb)
2. **Carrier**
3. **Plastic foam**
4. **Plastic insulator**

5. **Guide**
   - Remove/install cover (8) by pulling out/pushing into left and right guides in parallel
6. **Front side marker light (M11)**
7. **Spreader rivet**
   - Connects cover to wheel housing liner.
8. **Cover**
   - Material: PP/EPDM
9. **Hex-head screw**
   - Qty: 8
   - Tighten to 23-25 Nm (17-18 ft-lb)
10. **Hex-head screw**
    - Qty: 4
    - Tighten to 30 Nm (22 ft-lb)
11. **Hex-head screw**
    - Qty: 2
    - Tighten to 5 Nm (44 in-lb)
12. **Hex-head screw**
    - Qty: 2
    - Tighten to 10 Nm (7 ft-lb)
13. **Cover element**
    - For painted covers only
14. **Hex-head screw**
    - Qty: 5
    - Tighten to 4.5 Nm (40 in-lb)
15. **Spoiler**
    - Fits into cover

## Front bumper cover, removing and installing

***NOTE —***
*Removal of the rear bumper cover is similar.*

1. Remove radiator grille and spreader clips. See **66 Body Accessories–Exterior**.
2. Remove bumper cover mounting screws. See Fig. 2.
3. Disconnect spoiler (air guides) from bumper cover.
4. Disconnect harness connectors from lighting.
5. Push down on left/right retainers with screwdriver and pull bumper cover out of side guides, keeping cover parallel. See Fig. 3.

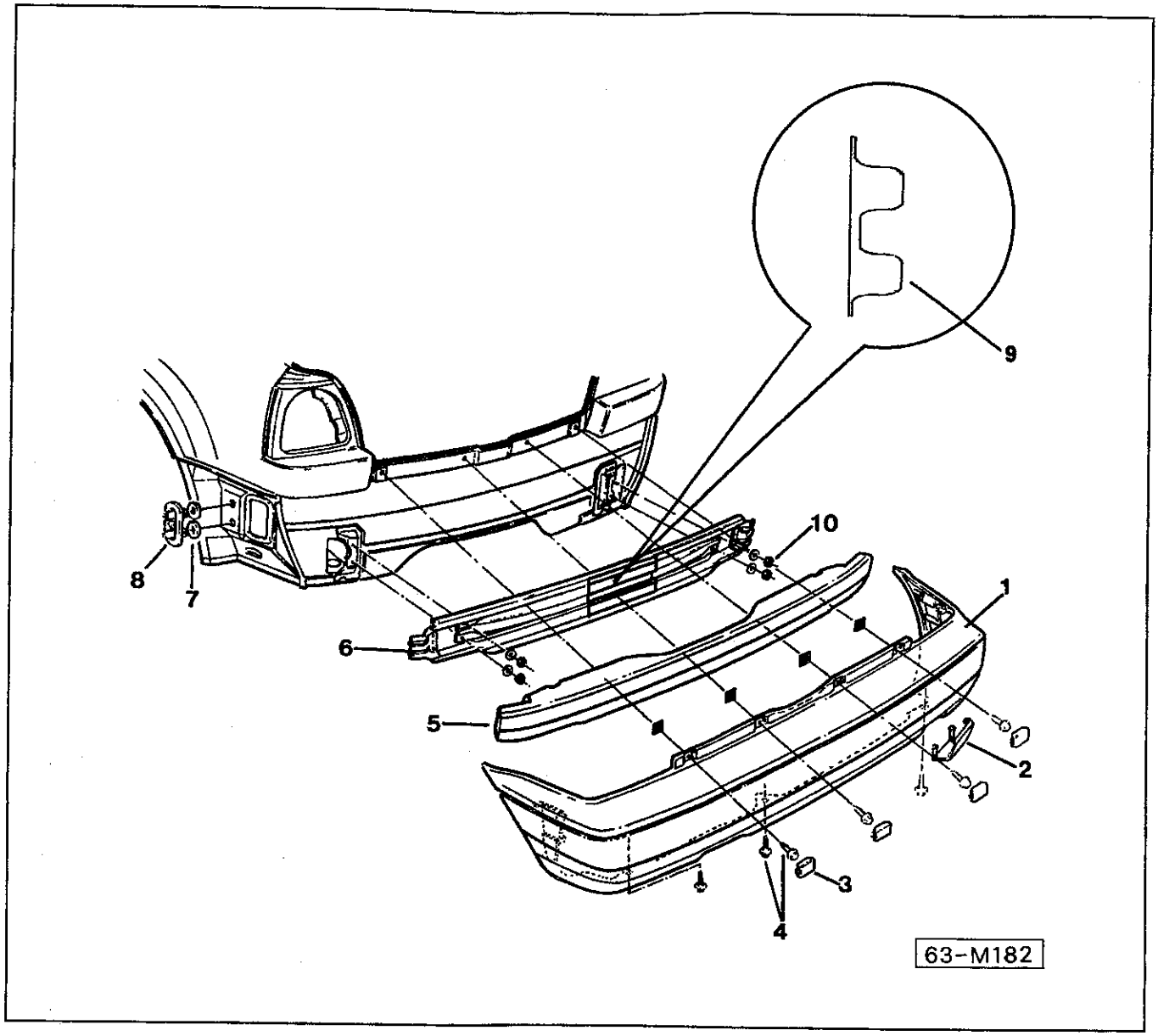


V63-0185

**Fig. 3.** Push down on left/right retainers when removing bumper cover.

6. Install in reverse order of removal.

## Rear bumper, assembly




63-M182

**Fig. 4.** Exploded view of rear bumper assembly.

1. **Cover**
   - Material: PP/EPDM
   - To remove:
     Open rear lid and pry off four covers (3)
     Remove seven hex-head screws (4)
     Pull bumper out of side guides (8)
2. **Towing eye cover**
3. **Cover for upper hex-head screws**
4. **Hex-head screws**
   - Qty: 7
   - Tighten to 4.5 Nm (40 in-lb)
5. **Plastic foam insert**
6. **Carrier**
   - Remove four nuts with washers (10) and pull carrier out
7. **Plastic insulator**
8. **Guide**
9. **Carrier reinforcement**
10. **Nuts and washers**
    - Qty: 4
    - Tighten to 11-13 Nm (8-10 ft-lb)

# 66 Body Accessories–Exterior



## GENERAL

This repair group covers various exterior trim items including the wheel housing liner, the front grille assembly, the rear spoiler, and the side-view mirror.

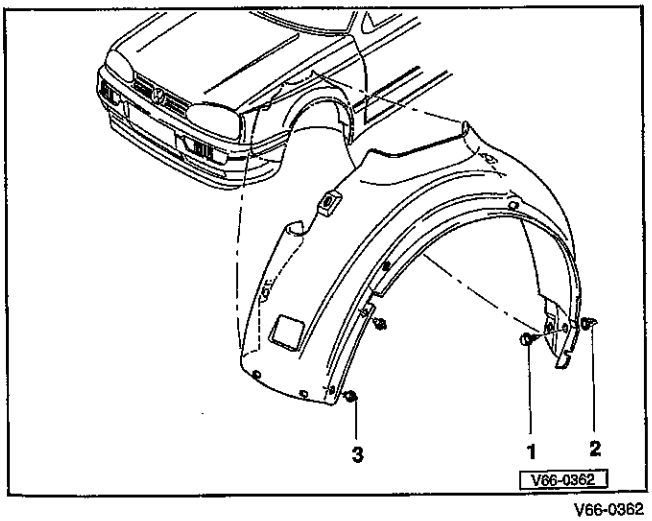
## EXTERIOR COMPONENTS

### Wheel housing liner, removing and installing

1. Raise car and support on jack stands. Remove wheel.

> ***CAUTION—***
> *Jack stands should be placed on a hard level surface (e.g. concrete).*

2. Remove seven screws from expander nuts. See Fig. 1.




V66-0362

**Fig. 1.** Wheel housing liner mounting screw (**1**), expander nut (**2**), and expander rivet (**3**).

3. Remove expander rivets that connect wheel housing liner and front bumper panel.

4. Remove wheel housing liner from wheel house.

5. Installation is the reverse of removal. Replace any damaged fasteners.

**Tightening torques**
- Wheel to wheel hub (lug bolt) ..... 81 Nm (110 ft-lb)

### Radiator grille, removing and installing

Fig. 2 shows an exploded view of the grilles for the Golf, GTI, and Cabrio models. The grille used on Jetta models is similar. Refer to this illustration when removing and installing the grille.

1. Open hood and remove four screws from top of grille.

2. Using a screwdriver, release/unlock lower catches at each end of grille. Then release/unlock remaining lower catches.

3. Using both hands, pull radiator grille upward off radiator support evenly.

4. Insert small tool (e.g. ice pick) into top mounting holes to release catches and remove, then remove radiator grille.

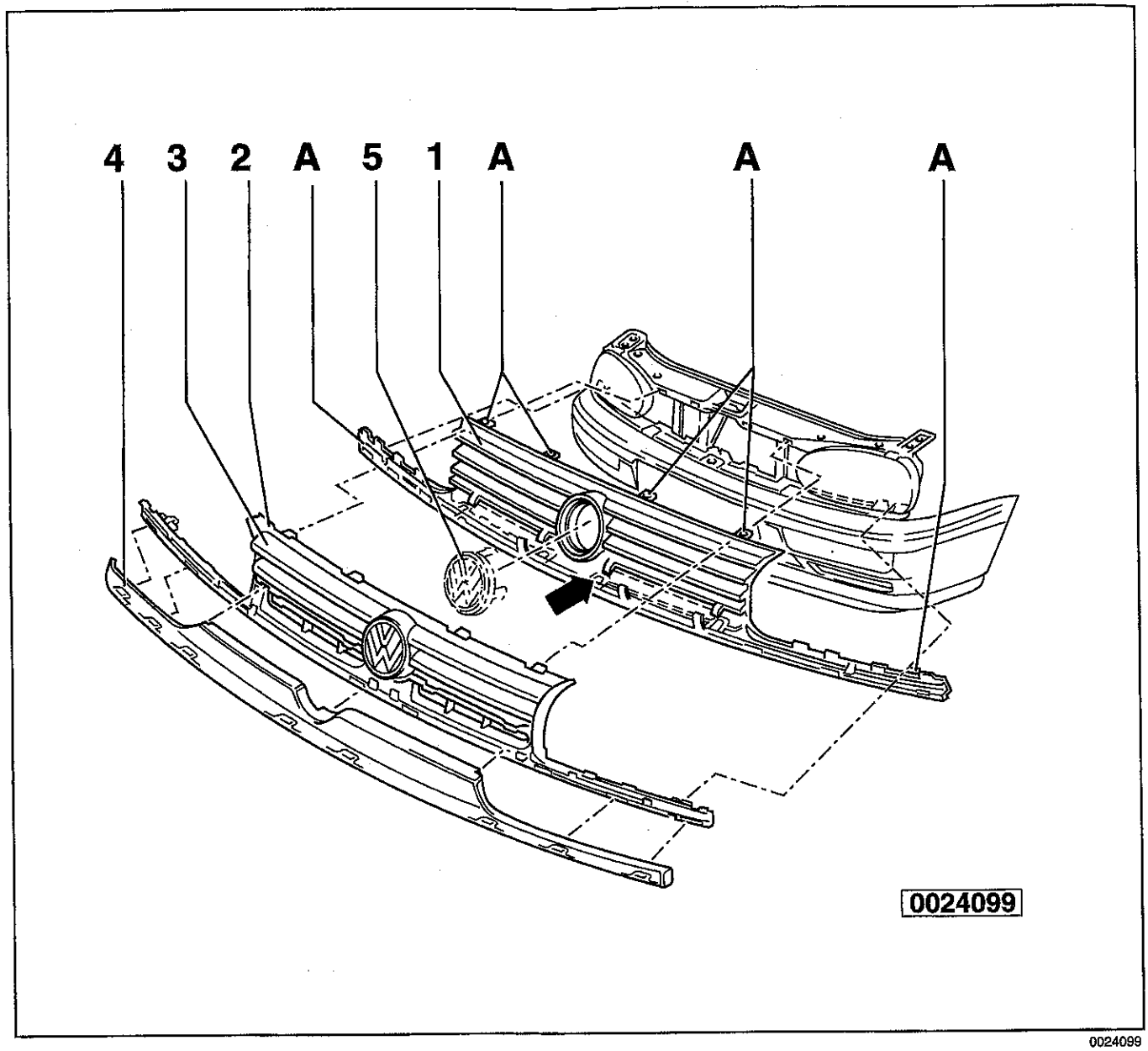
5. Align radiator grille with center positioner (see arrow in Fig. 2).

6. Place grille into radiator support and fasten lower catches, making sure end catches are fastened last.

7. Fasten top catches.

8. Install and tighten mounting screws.

## Radiator grille, assembly



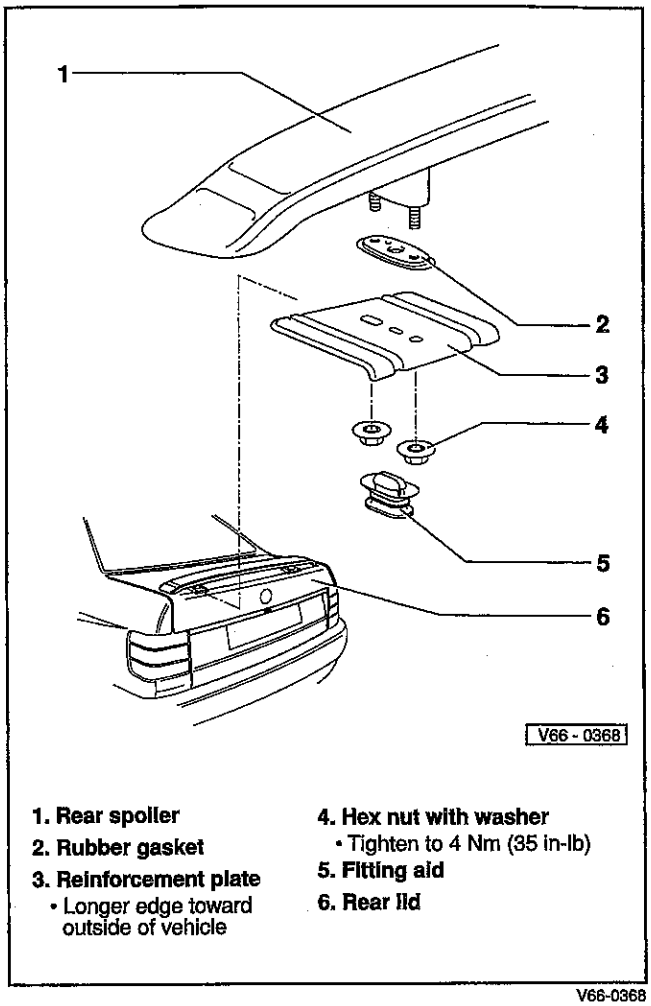

0024099

**Fig. 2.** Exploded view of radiator grille used Golf, GTI, and Cabrio models. Grille used on Jetta models is similar.

1. **Radiator grille (Golf)**
   - Material: ASA
   - Screws (A)
   - Center positioner (arrow)
2. **Radiator grille (GTI, Cabrio)**
   - Material: ASA
3. **Radiator grille fins (GTI, Cabrio)**
   - Material: ABS (acrylic-nitrile butadiene-styrene copolymeride)
   - Clipped in radiator grille (2).
   - Painted in body color
4. **Panel**
   - Removing: remove radiator grille and unclip panel from radiator grille
   - Painted in body color
5. **VW emblem**
   - Clipped in radiator grille

> ***CAUTION—***
> *Remove and install the VW emblem carefully to avoid damaging the paint finish.*

## Rear spoiler (Jetta)



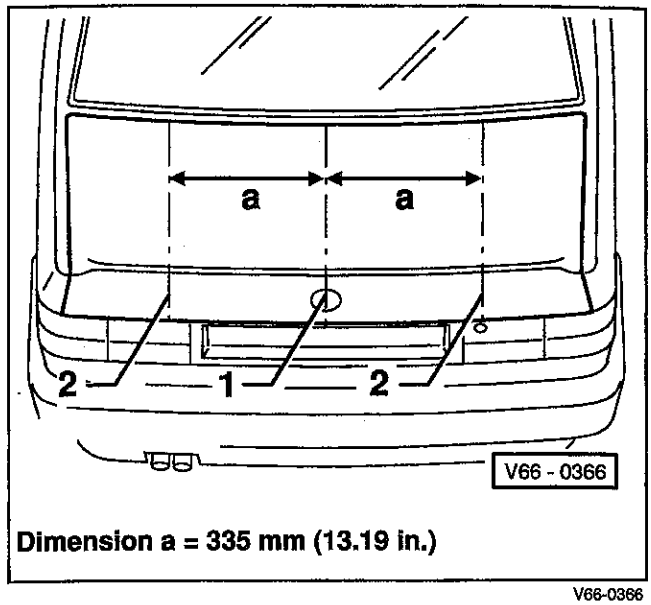

1. **Rear spoiler**
2. **Rubber gasket**
3. **Reinforcement plate**
   - Longer edge toward outside of vehicle
4. **Hex nut with washer**
   - Tighten to 4 Nm (35 in-lb)
5. **Fitting aid**
6. **Rear lid**

V66-0368

**Fig. 3.** Rear spoiler assembly for Jetta models. Fitting aid (**5**) is not applicable when retrofitting spoiler.

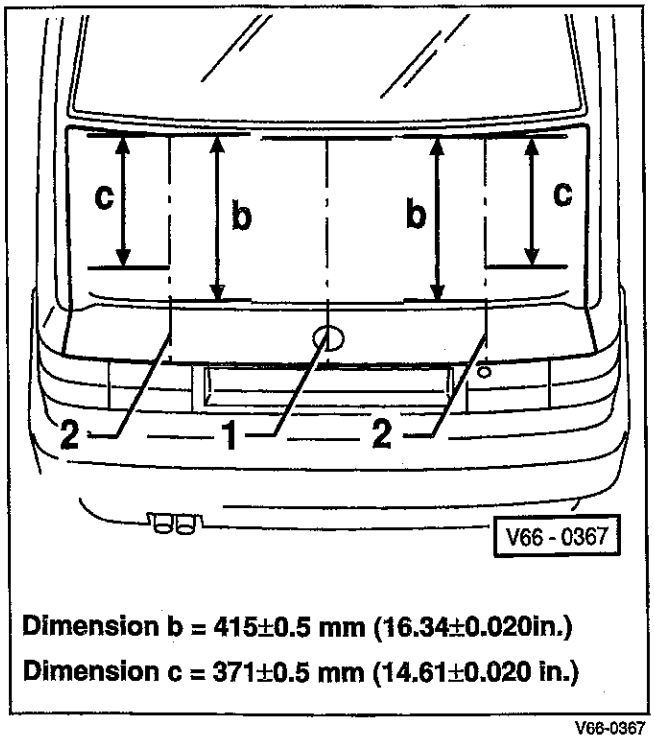
## Rear spoiler, retrofitting (Jetta)

1. Place a 50 mm (2 in.) wide strip of adhesive tape on center of rear lid.
2. Determine center line of rear lid with a tape measure and mark on adhesive tape.
3. Apply adhesive tape and mark lines as shown in Fig. 4.
4. Mark position for holes as shown in Fig. 5.
5. Carefully center punch holes and drill with 7.5 mm (9/32 in) drill.
6. Remove burrs from holes.
7. If necessary, rework the holes slightly with a round file to fit the rear spoiler.




V66-0366

**Fig. 4.** Draw lines (**2**) after applying adhesive tape to trunk surface.




V66-0367

**Fig. 5.** Mark position of holes on line **2** at dimensions **b** and **c**.

8. After completing the painting/corrosion protection measures, place rubber gaskets and spoiler on rear lid. See Fig. 6.

> ***CAUTION —***
> *Corrosion and paint protection at drilled holes must be carried out.*

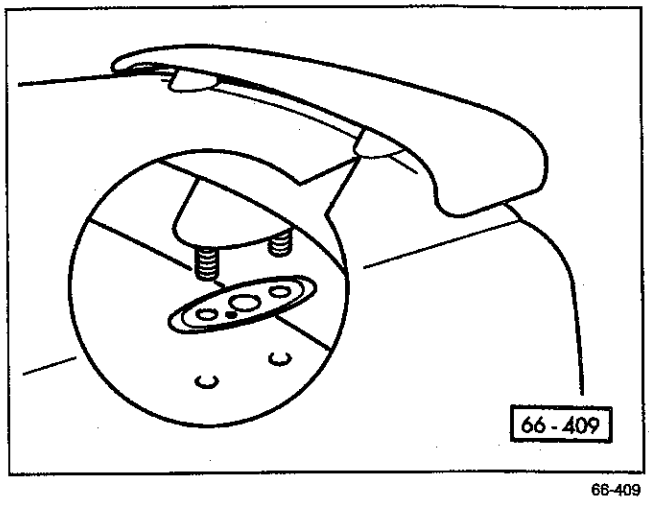



**Fig. 6.** Place rubber gaskets and spoiler on rear lid (inset).

9. From inside rear lid, install left and right reinforcement plates, with longer edge toward outside of vehicle. Tighten hex nuts. See Fig. 7.

**Tightening torques**

- Spoiler hex nuts . . . . . 4 Nm (35 in-lb)

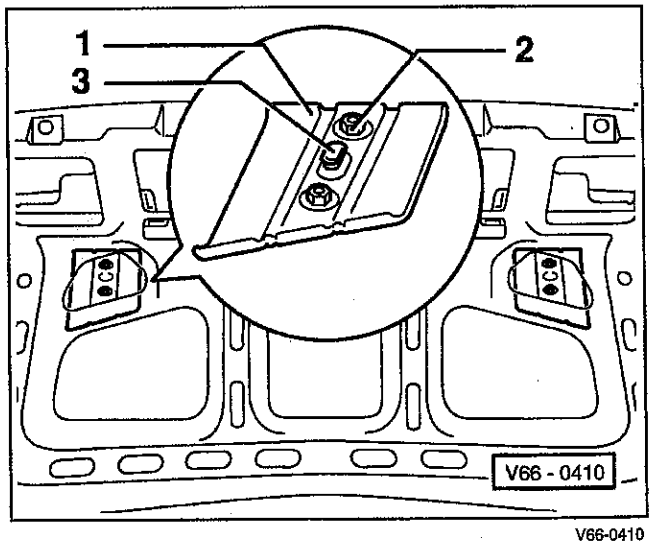
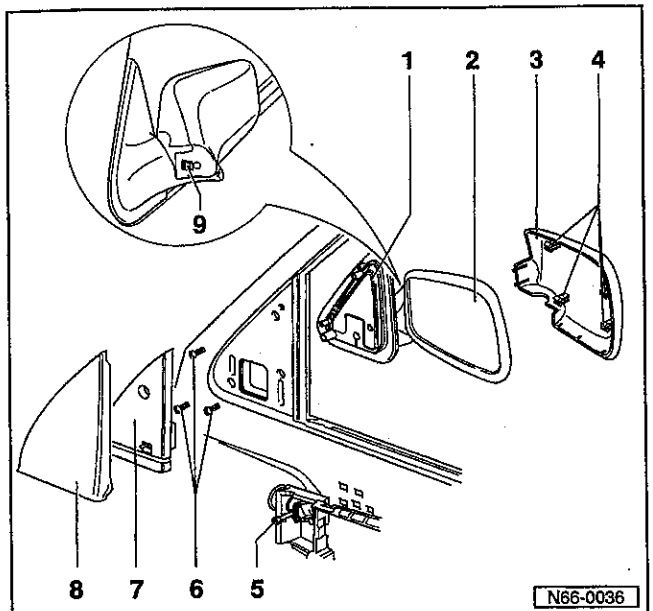



**Fig. 7.** Install left and right spoiler reinforcement plates (**1**), if applicable, remove fitting aid (**3**), and tighten hex nut (**2**).

## Side-view mirror, assembly

Fig. 8 shows an exploded view of the side-view mirror assembly. The mirror glass is clipped into the mirror housing. A special assembly lever (Volkswagen special tool no. 800-200) is available to aid in removal of the glass.




**1. Mirror housing**
**2. Mirror glass**
- clipped in

**3. Housing cap**
- Removing: remove mirror glass and squeeze catches (4) and (9) while pulling off cap

**4. Catches**
**5. Mirror actuator**
**6. Oval head screw**
- Tighten to 2 Nm (17 in-lb)

**7. Insulation**
**8. Cover**
**9. Catches**

N66-0036

**Fig. 8.** Exploded view of side-view mirror assembly for all models.

# 69 Seatbelts, Airbags



## GENERAL

This repair group covers seat belt assemblies and removal and installation of the airbag system components. This repair group does not cover airbag system fault diagnosis or repair. Service and repair to the airbag system requires special test equipment, knowledge and training and should only be carried out by an authorized Volkswagen dealer.

***WARNING —***

- *The airbag(s) are inflated by an explosive device. Handled improperly or without adequate safeguards, the system can be very dangerous. Special precautions must be observed prior to any work at or near the steering wheel or steering column, including the pedal assembly.*
- *The airbag is a vehicle safety system. To guard against personal injury or airbag system failure, only trained Volkswagen service technicians should test, disassemble or service the airbag system.*
- *Always replace any airbag system component that has been mechanically damaged (example: dented or cracked).*
- *Supplementary child restraint anchorage equipment is available from an authorized VW dealer. Depending on the child restraint system being used, additional anchorage points may be required. Check with your Volkswagen dealer for proper installation and positioning of one or more anchorage points and the required hardware for the attachment of the tether.*

### Seat belts, inspecting

***WARNING —***

*After every accident the seat belt system must be inspected systematically. If damage is found when inspecting the checkpoints, it is necessary to replace the belts.*

Inspect front and rear belt webbing, and replace belts with broken or pulled threads, cut loops at the belt edge, bowed 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 in the webbing. If the belt cannot be cleaned using only a mild soap solution, 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, and replace any corroded hardware.

On three-point seat belts, check the belt lock-up mechanism by grasping the webbing near the retractor and tugging quickly. Replace any belt that does not lock up.

A road test should also be performed to check belt lock-up mechanism. Drive in an open area away from other cars. At approximately 5 to 15 mph, with the belt securely fastened, quickly stop the car. Replace any belt that does not lock up.

***WARNING —***

*For safety reasons, road test should be carried out in a traffic free area to ensure that other motorists or pedestrians are not endangered.*

Check the belt latching mechanism by pushing belt tongue into latch until it engages with an audible "click". Give the belt a firm pull to ensure that mechanism is properly engaged. If belt tongue fails even only once to engage properly in belt latch during at least 5 tests, replace seat belt and belt latch.

Check the release of belt latching mechanism by pressing button on belt latch with finger pressure. When belt is slack, tongue must spring out of belt latch on its own. If it fails to do this only once in 5 tests, replace seat belt and latch.

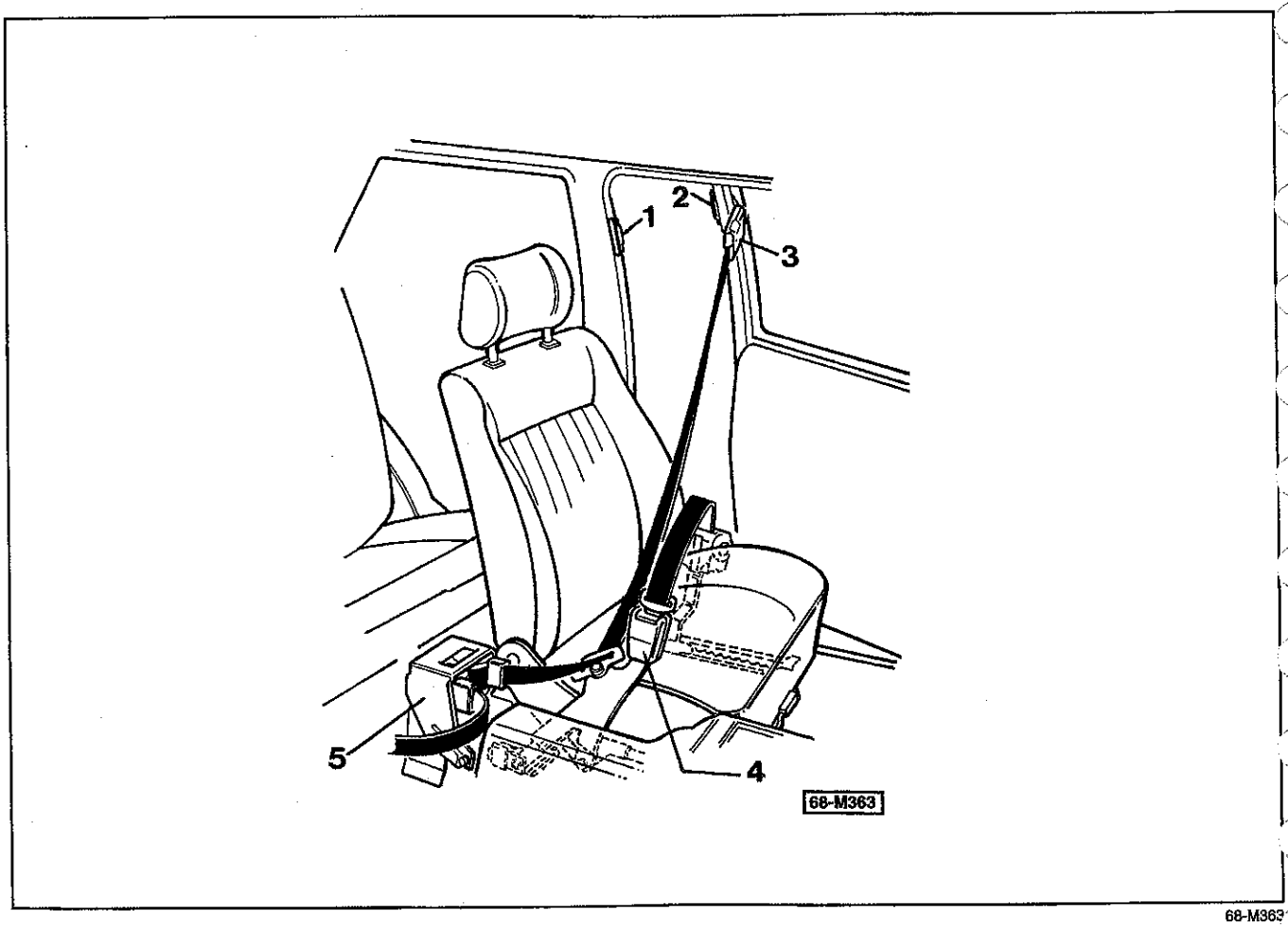
***WARNING —***
*Never use lubricant to eliminate noise or stiffness at seat belt lock buttons.*

## FRONT SEAT BELTS

Fig. 1 shows the front seat belt used on cars without airbags. Fig. 2 shows the front seat belt used on cars with airbags and emergency tensioning seat belt retractors. The illustrations that immediately follow Fig. 1 and Fig. 2 show detailed information on front seat belt mounting points.

***WARNING —***
*The seat belt retractor tensioning unit shown in Fig. 2 is an explosive device. Handled improperly or without adequate safeguards, it can be very dangerous. Special precautions must be observed prior to any work on the tensioning unit. See* **Emergency tensioning seat belt retractors.**

### Front seat belt, assembly (cars without airbags)

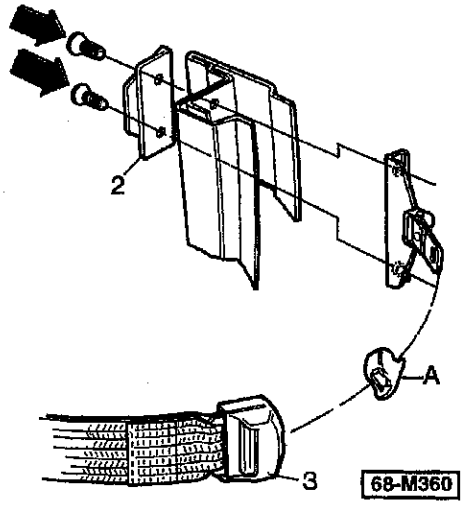



68-M363

**Fig. 1.** Front seat belt system used on cars without airbag.

1. **Upper pillar catch**
   - Tighten screws to 15 Nm (11 ft-lb)
2. **Upper door catch**
   - Removing, see (A)
3. **Upper belt buckle**
4. **Lap belt buckle**
   - Removing, see (B)
5. **Lower mounting point**
   - Removing, see (C)

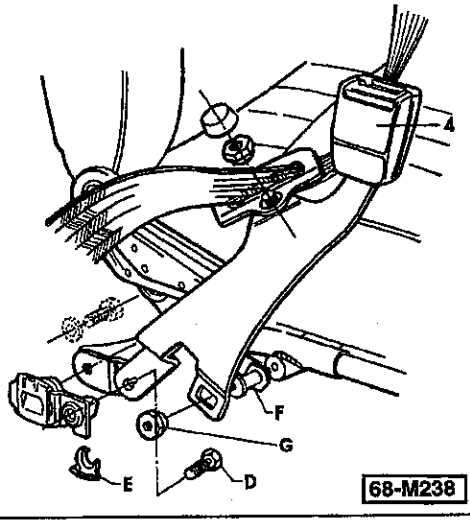
## A Upper door catch, removing (front seat belts, cars without airbag)




68-M360

- Remove trim (A)
- Pull off inner window seal near latch
- Remove screws (arrows)
  Tighten to 15 Nm (11 ft-lb)

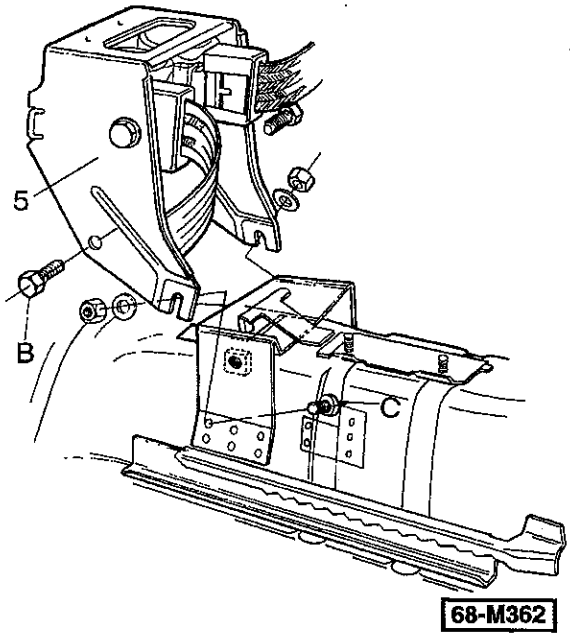
## B Lap belt buckle, removing (front seat belts, cars without airbag)




68-M238

- Unbolt nut (G) and bolt (D)
- Do not misplace the spacer bushing (F) or clip (E)
- To install, tighten nut (G) to 25 Nm (18 ft-lb) and bolt (D) to 60 Nm (44 ft-lb).

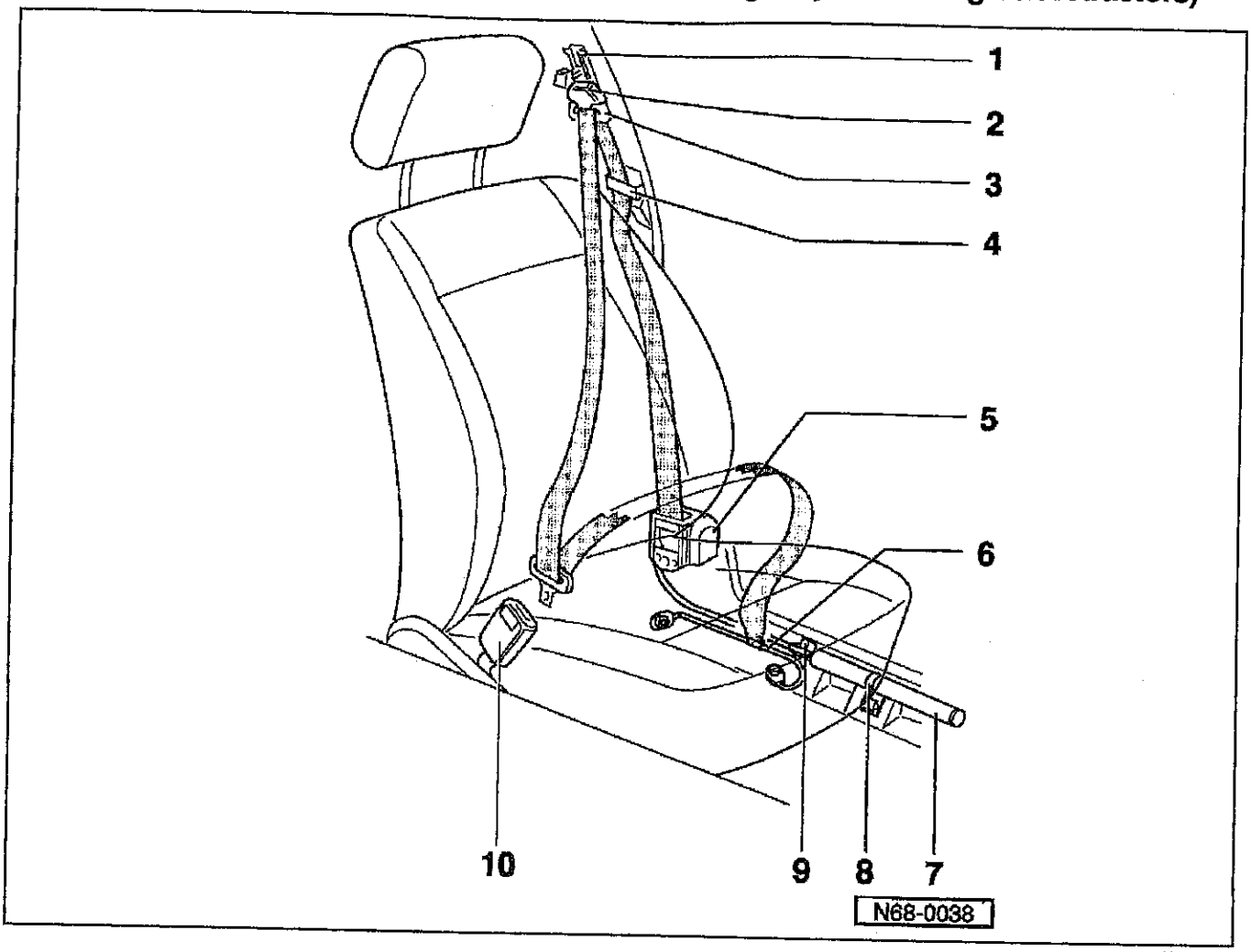
## C Lower mounting point, removing (front seat belts, cars without airbag)




68-M362

- First remove front seat, see 72 Seats
- Remove hex bolts (B) and (C)
- Remove lower mounting point
- Install in reverse order of removal
  Tighten (B) to 40 Nm (30 ft-lb)
  Tighten (C) to 19 Nm (14 ft-lb)

## Front seat belt assembly (cars with airbag and emergency tensioning belt retractors)




N68-0038

**Fig. 2.** Front seat belt system used on cars with airbag and emergency tensioning seat belt retractors. Illustration shows 2-door and Cabrio models, 4-door is similar with the exception of front anchor (**6**).

1. **Belt height adjustment fitting**
   - See **Belt height adjustment, assembly**
2. **Cap**
3. **Belt relay (upper anchor loop)**
4. **Belt guide**
   - Tighten to 1.5 Nm (13 in-lb)
5. **Belt reel (cars without emergency tensioning unit)**
   - Tighten (hex bolt) to 40 Nm (30 ft-lb)
6. **Front anchor**

> ***CAUTION—***
> *Very Important! There are three different types of front anchors, depending on model.*

- 4-door models, **see** Ⓐ
- 2-door models, **see** Ⓑ
- Cabrio models, **see** Ⓒ

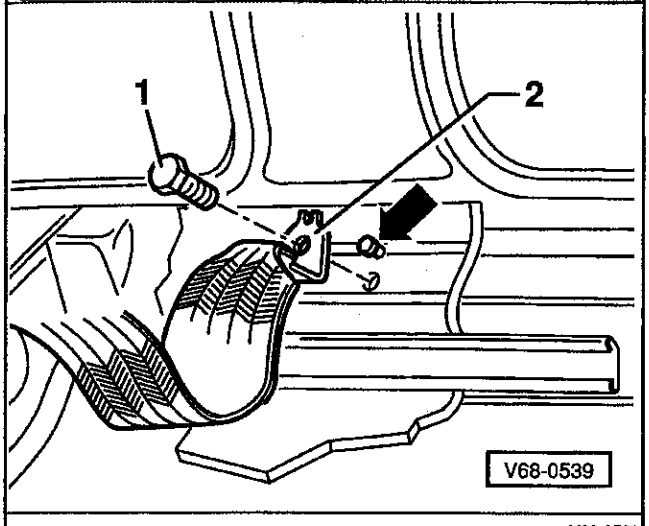
7. **Tensioning unit**

> ***WARNING—***
> *The tensioning unit is an explosive device. Handled improperly or without adequate safeguards, it can be very dangerous. Special precautions must be observed prior to any work on the tensioning unit. See* **Emergency Tensioning Seat Belt Retractors.**

> ***NOTE—***
> *Some cars with airbags may not be equipped with tensioning unit.*

8. **Bracket**
9. **Locking nut**
10. **Front belt buckle (latch)**
    - Removing, **see** Ⓓ

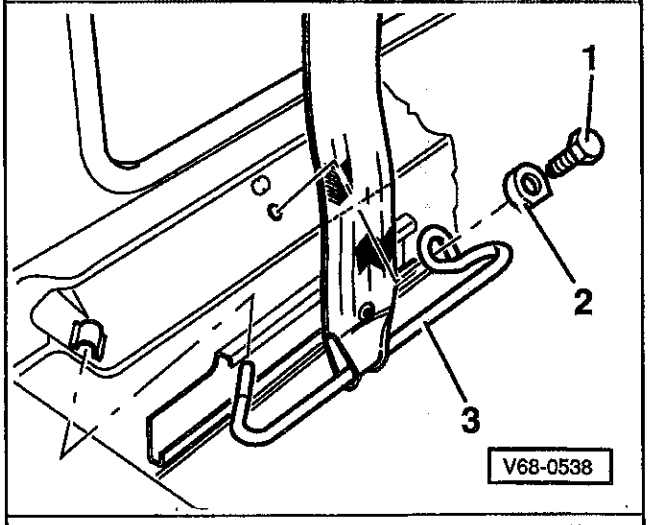
## A Front anchor, 4-door models (front seat belts, cars with airbag)




V68-0539

- Hex bolt (1)
  Tighten to 40 Nm (30 ft-lb)
- Seat belt (2)
  Align metal fitting with retaining lug (arrow) to install.

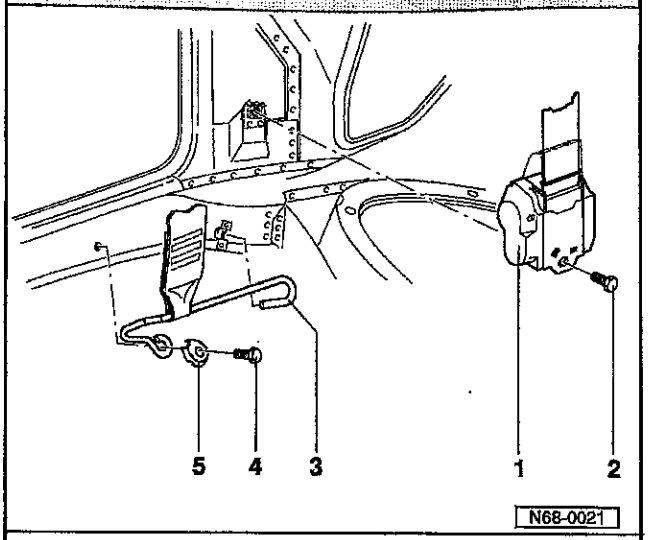
## B Front anchor, 2-door models (front seat belts, cars with airbag)




V68-0538

- Hex bolt (1)
  Tighten to 40 Nm (30 ft-lb)
- Cap (2)
- Anchor rail (3)

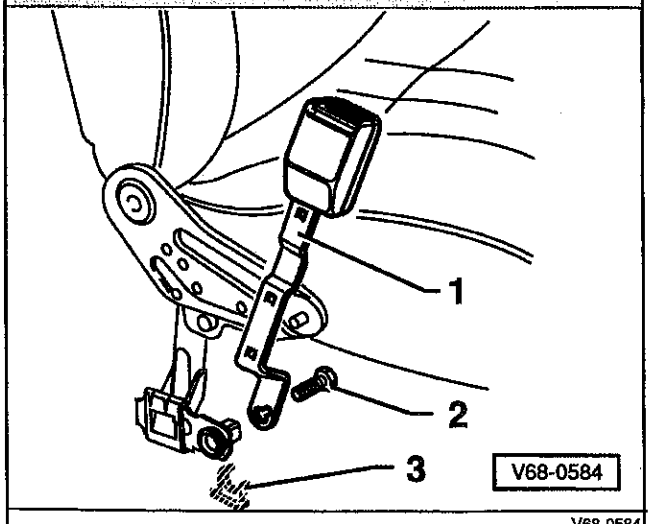
## C Front anchor/belt reel, Cabrio models (front seat belts, cars with airbag)




N68-0584

- Front belt reel (1)
  Retaining lugs determine mounting position
- Hex bolt (2): tighten to 40 Nm (30 ft-lb)
- Anchor rail (3)
- Hex bolt (4): tighten to 40 Nm (30 ft-lb)
- Eye cap (5)

## D Belt buckle (front seat belts, cars with airbag)

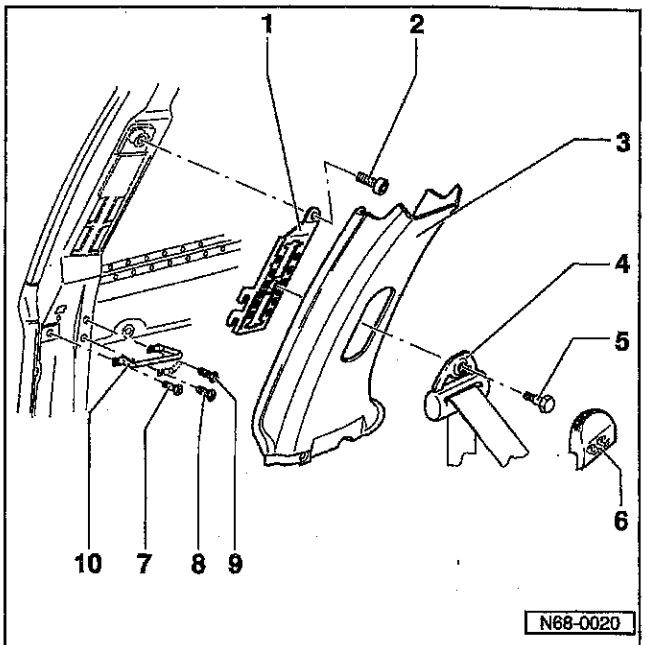



V68-0584

- Belt buckle (1)
- Hex bolt (2): tighten to 40 Nm (30 ft-lb)
- Clip (3)
  slide on/off

## Seat belt height adjustment

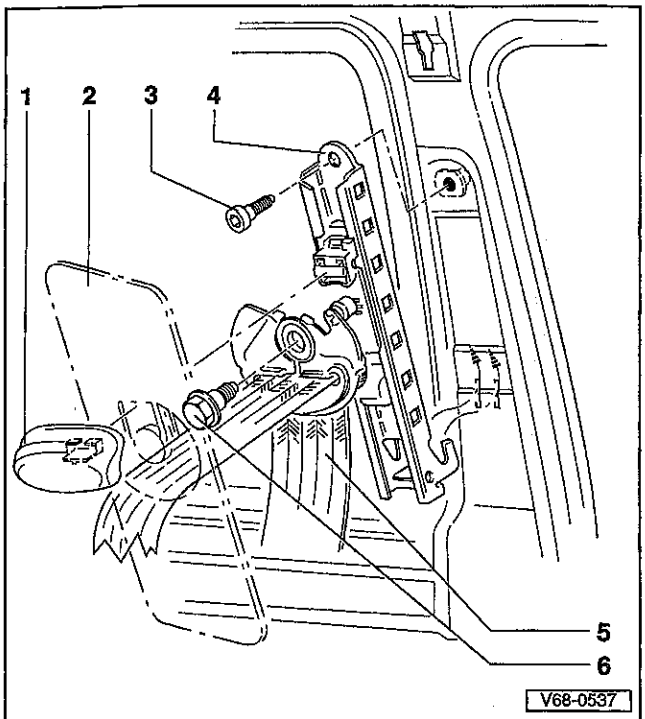
Fig. 3 and Fig. 4 show seat belt height adjustment mechanisms. The illustrations contain removal and installation information, including tightening torques.




1. **Seat belt height adjustment fitting**
   - Removing: remove socket-head bolt (2) and pull belt relay (4) upward
2. **Sockethead bolt**
   - Tighten to 23 Nm (17 ft-lb)
3. **B-pillar trim**
   - Removing, see **70 Trim–Interior**
4. **Belt relay**
5. **Hex bolt**
   - Tighten to 40 Nm (30 ft-lb)
6. **Cover**
   - Pushed on
7. **Screw**
   - Tighten to 1.5 Nm (13 in-lb)
8. **Screw (right-hand side only)**
   - Tighten to 1.5 Nm (13 in-lb)
9. **Screw (left-hand side only)**
   - Tighten to 1.5 Nm (13 in-lb)
10. **Belt relay**

N68-0020

**Fig. 3.** Exploded view of seat belt height adjustment for Cabrio only.




1. **Seat belt height adjustment control**
   - Pull out
2. **Slide**
3. **Sockethead screw**
   - Tighten to 23 Nm (17 ft-lb)
4. **Seat belt height adjustment fitting**
   - Front: To remove, upper B-pillar trim must be removed first
   - Rear: To remove, side parcel shelf support and C-pillar trim must be removed first
5. **Seat belt**
6. **Threaded pin**
   - Tighten to 1.5 Nm (13 in-lb)
7. **Screw (left-hand side only)**
   - Tighten to 1.5 Nm (13 in-lb)
8. **Belt relay**

V68-0537

**Fig. 4.** Exploded view of seat belt height adjustment fittings for cars with airbag.

# EMERGENCY TENSIONING SEAT BELT RETRACTORS

***NOTE —***

*Some early cars with airbags may not be equipped with the emergency seat belt retractors.*

The emergency tensioning seat belt retractor uses a pyrotechnic device to tension the front seat belts during frontal impacts. The tensioning unit is a potentially dangerous device that requires special handling and disposal. The tensioning unit has no expiration date and is an integral part of the seat belt retractor (belt reel). Fig. 5 shows the tensioning unit/retractor used on 4-door models. Fig. 6 shows the tensioning unit/retractor used on 2-door and Cabrio models.

Always follow the prescribed work sequence when removing or installing the tensioning unit and retractor. Pay attention to all warnings associated with the replacement of this component.

***WARNING —***

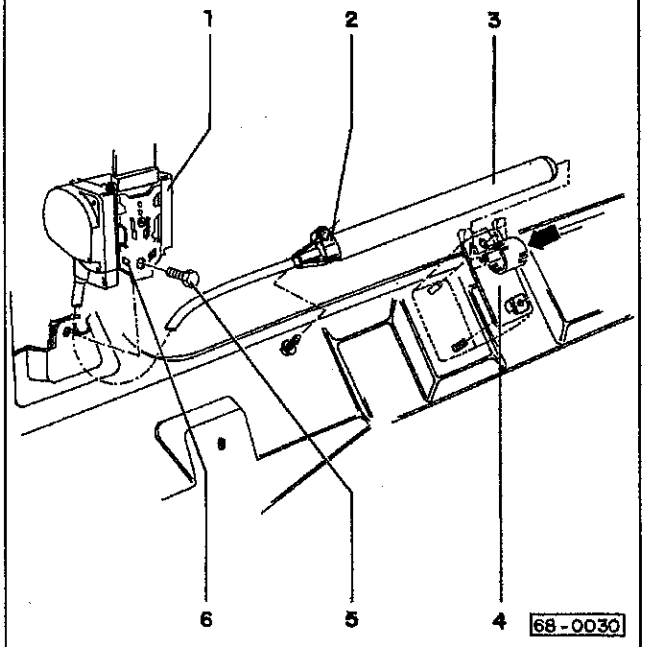
- *After an accident in which one or both belt tensioners have been activated, both seat belts must be replaced (the belts will no longer retract).*
- *Handle tensioning unit with extreme care. DO NOT drop tensioning unit. Belt tensioner units that have been dropped on the floor must not be installed in a vehicle.*
- *Belt tensioning unit testing, removing, and installing should only be carried out by qualified personnel.*
- *Belt tensioner components may be neither opened or repaired; always use new parts.*
- *Belt tensioner units that are mechanically damaged (dents, cracks) must be replaced.*
- *The belt tensioner unit must not be treated with grease, cleaning solution or similar substances.*
- *Belt tensioner units MUST NOT be exposed to temperatures above 100° C (212° F).*
- *The belt tensioner unit should be installed immediately after removing it from its packaging.*
- *The belt tensioner unit gas generator must be made unusable before disposal. It is a pyrotechnic device that can cause injury if activated improperly (e.g. scrapping with a cutting torch). Consult your authorized Volkswagen dealer for tensioning unit disposal.*
- *Before starting any body disassembly, straightening or other body repair work, the belt tensioning units must be removed.*

## Front belt reel with tensioning unit, removing and installing (4-door models)

1. Remove upper and lower B-pillar trim. Remove sill plate trim. See **70 Trim–Interior.**
2. Loosen tensioning unit locknut, this detaches the tensioning unit and makes it inactive. See Fig. 5.
3. Remove belt reel mounting bolts and remove reel.
4. Pull tensioning unit out of guide in mounting bracket.
5. Installation is the reverse order or removal. Fig. 5 lists assembly tightening torques.

## Front belt reel with tensioning unit, removing and installing (2-door and Cabrio models)

1. Remove B-pillar trim and sill plate trim. See **70 Trim–Interior.**
2. Loosen tensioning unit locknut. This detaches the tensioning unit and makes it inactive. See Fig. 6.
3. Remove front anchor rail. See Fig. 2 given earlier.
4. Remove cover cap from upper belt relay and remove relay fitting and belt guide. See Fig. 2 given earlier
5. Remove belt reel.
6. Pull tensioning unit out of bracket and remove.
7. Installation is the reverse order or removal. Fig. 6 lists assembly tightening torques.

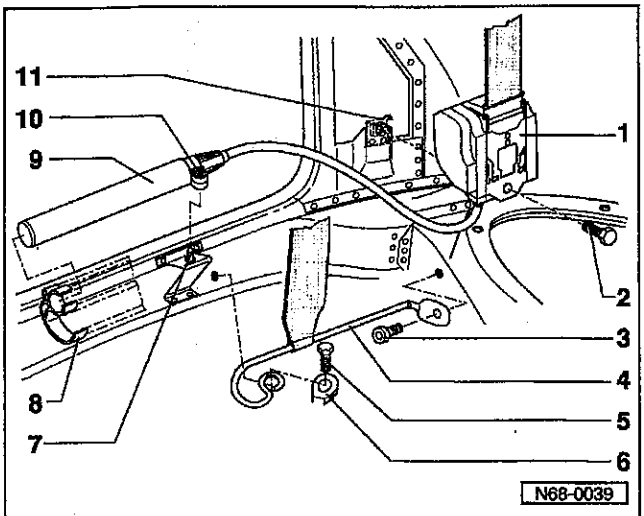



1. **Belt reel**
2. **Lock nut**
   - Tighten to 23 Nm (17 ft-lb)
3. **Tensioning unit**
   - Pyrotechnic device

   ***WARNING —***
   *The tensioning unit is an explosive device. Handled improperly or without adequate safeguards, it can be very dangerous.*
4. **Cable channel/mounting bracket for tensioning unit**
5. **Hex bolt**
   - Tighten to 40 Nm (30 ft-lb)
6. **Retaining slots**
   - Engage with mounting lugs to determine belt reel mounting position

68-0030

**Fig. 5.** Front belt reel tensioning unit for 4-door models.




1. **Belt reel**
2. **Hex bolt**
   - Tighten to 40 Nm (30 ft-lb)
3. **Socket head cap screw**
   - Pyrotechnic device
4. **Anchor rail**
5. **Hex bolt**
   - Tighten to 40 Nm (30 ft-lb)
6. **Cap**
7. **Threaded bolt**
8. **Cable channel/mounting for tensioning unit**
9. **Tensioning unit**
   - Pyrotechnic device

   ***WARNING —***
   *The tensioning unit is an explosive device. Handled improperly or without adequate safeguards, it can be very dangerous.*
10. **Lock nut**
    - Tighten to 20 Nm (15 ft-lb)
11. **Retaining lugs**
    - Determines belt reel mounting position

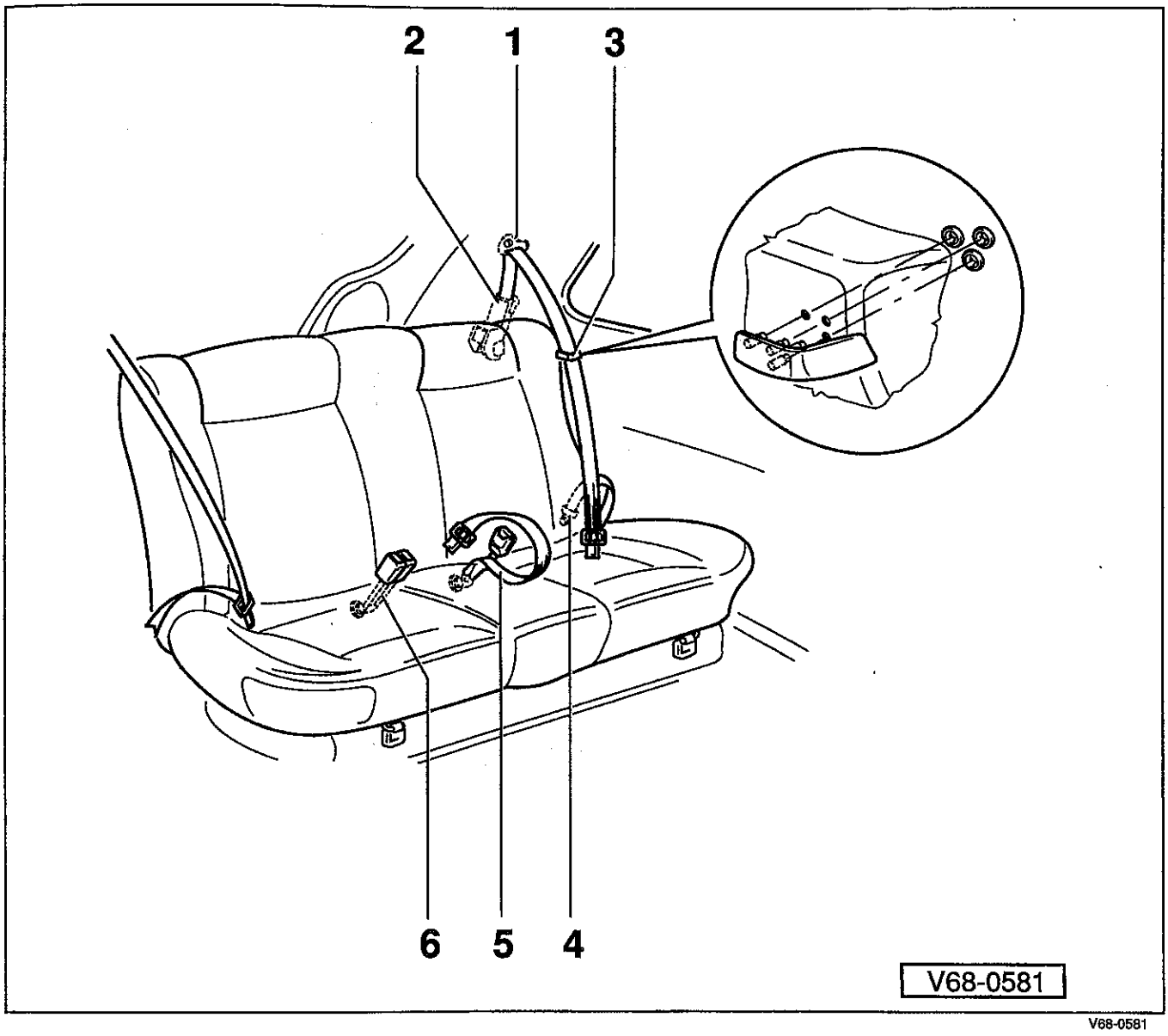
N68-0039

**Fig. 6.** Front belt reel tensioning unit for 2-door and Cabrio models.

# REAR SEAT BELTS

Fig. 7 shows the rear seat belts used on the Golf, GTI, and Jetta models. The illustrations that immediately follow Fig. 7 show detailed information on rear seat belt mounting points.

## Rear seat belts, assembly

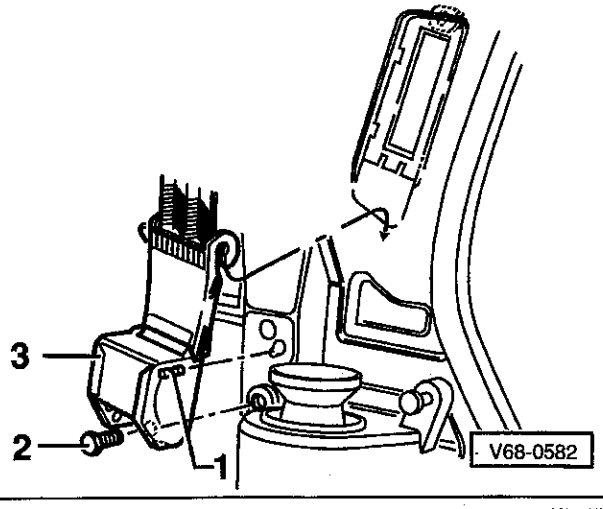



V68-0581

**Fig. 7.** Rear seat belt assembly for Golf, GTI and Jetta models.

1. **Seat belt height adjustment fitting**
2. **Belt reel**
   - Removing and installing
     **Golf, GTI, Jetta:** remove wheel housing panel, side liner for hat rack, and C-pillar trim to access, **see** Ⓐ.
     **Cabrio, see** Ⓑ
3. **Clasp (2-door models only)**
   - Secured to side trim panel with three spring nuts
4. **Rear belt anchor**
   - Tighten mounting bolt to 40 Nm (30 ft-lb)
5. **Lap belt**
   - Tighten mounting bolt to 40 Nm (30 ft-lb)
   - Removing and installing, **see** Ⓒ
6. **Double buckle**
   - Tighten mounting bolt to 40 Nm (30 ft-lb)
   - Removing and installing, **see** Ⓒ

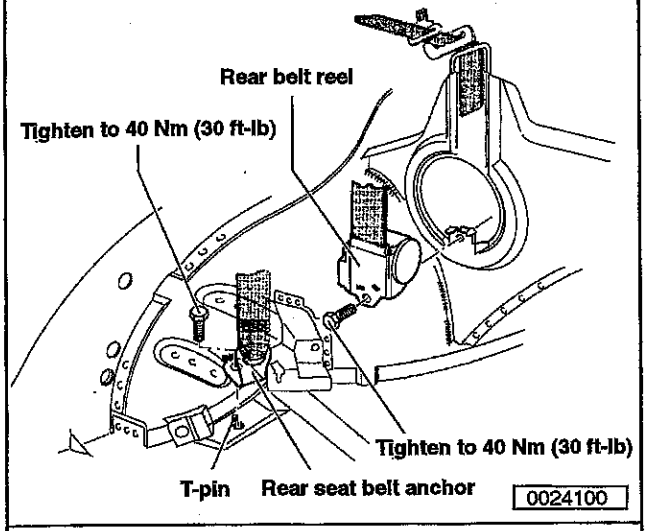
## A Seat belt reel (Golf, GTI, Jetta) (rear seat belts)




V68-0582

- Locating lug (1)
  Serves to position the belt reel
- Hex head bolt (2)
  Tighten to 40 Nm (30 ft-lb)
- Belt reel
  Attached in side panel at top

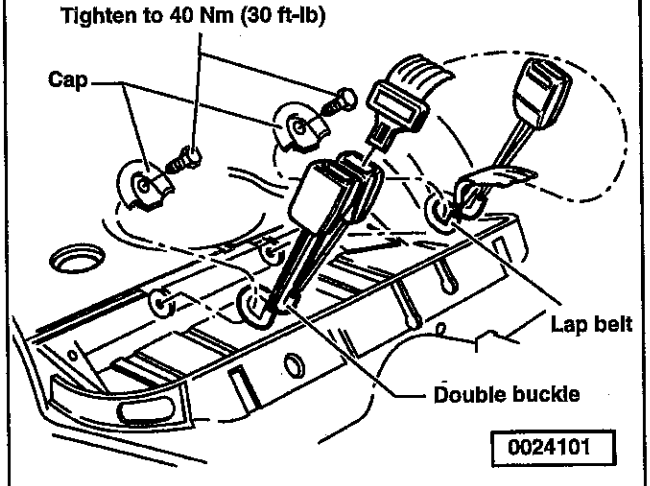
## B Seat belt reel (Cabrio), removing and installing (rear seat belts)




0024100

- Remove seat backrest, fold seat forward, and loosen upper part of rear seat backrest to access.
- Anchor and belt must be pulled through upper part of rear backrest
- T-pin determines mounting position of belt anchor

## C Lap belt and double buckle (rear seat belts)




0024101

- For non-retracting center lap belt.

# AIRBAGS

The heading covers only the removal and installation of the airbag units from the steering wheel, the passenger side instrument panel and the front seats on cars so equipped. Airbag system repair and fault diagnosis is not covered here. Diagnostics, component testing, and repair should be carried out by properly trained Volkswagen technicians using specialized test equipment.

When the ignition key is turned on, the indicator light will illuminate for approximately 5 seconds. The illuminated light indicates the self-test of the electronic control/monitoring module, the ignitors and sensor circuits, and the system wiring. The airbag system should be inspected by an authorized Volkswagen dealer if the indicator light does not come on, if it does not go out in approximately five seconds after switching on the ignition, or if the light comes on during driving. If the system has detected a fault, the light will come on and stay on.

If the vehicle has been involved in an accident where the airbag was deployed, Volkswagen specifies that the following components must be replaced:

- All airbag units that have been deployed
- Passenger's side airbag retaining frame
- Airbag control module with holder
- Airbag spiral spring
- Backrest padding with triggered side airbag and sensor
- Driver's side seat belt
- Front passenger's side seat belt (if in use at the time of the accident)

In addition, the following must also be replaced if necessary (visual check):

- All damaged components

If the vehicle was in an accident that did not involve the use of the airbag(s) and the warning lamp does not indicate any malfunctions, it is not necessary to replace the airbag components.

> ***WARNING —***
> *The seat belts should be checked separately. See* **Seat belts, inspecting**.

## General

The airbag system in all vehicles consists of the following components: an electronic control unit/monitoring module, an indicator light in the instrument panel, an inflatable airbag with integral gas generator in the steering wheel, and an inflatable airbag with integral gas generator in the right side of the padded dash.

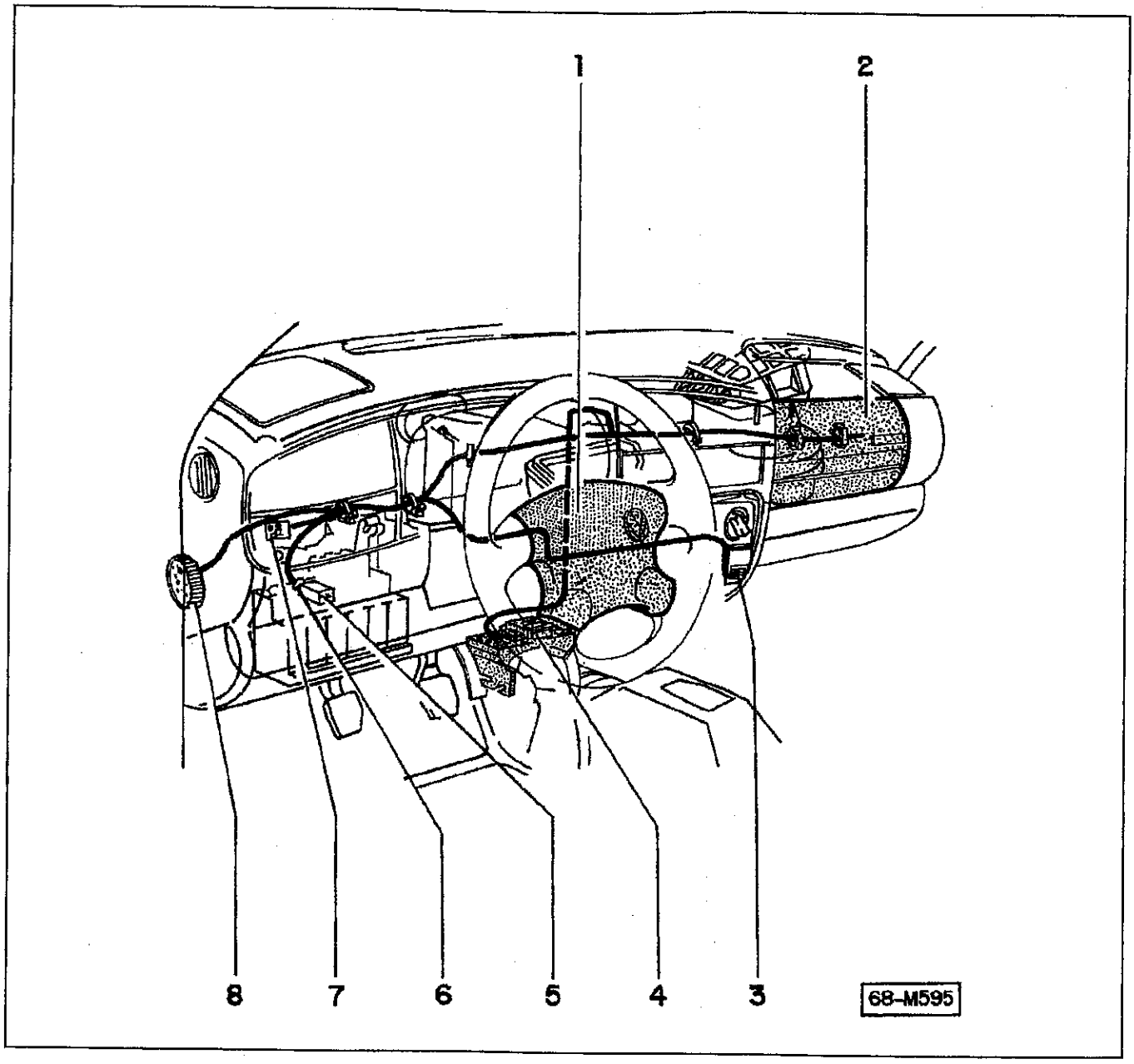
In addition some vehicles are equipped with optional side airbags which add the following extra components: inflatable airbags with integral gas generators in both outer front seat backrests and lateral crash sensors mounted on the floor under the front seats. All vehicles are also equipped with knee bars for extra protection. See Fig. 8.

## Airbag, safety precautions

Special precautions must be observed prior to any work at or near the airbag units, the steering wheel or steering column, including the pedal assembly.

> ***WARNING —***
> - *Always disconnect the negative (–) battery cable before working on or near any part of the airbag system. Accidental electrical contact may damage the electrical system, cause fire, or result in serious personal injury.*
> - *The airbag(s) is inflated by an explosive device. Handled improperly or without adequate safeguards, the system can be very dangerous.*
> - *The airbag is a vehicle safety system. To guard against personal injury or airbag system failure, only trained Volkswagen service technicians should test, disassemble or service the airbag system.*
> - *Always replace any airbag system component that has been mechanically damaged (example: dented or cracked).*
> - *Always disconnect the negative (–) battery cable before working on or near the airbag(s).*
> - *No waiting time is necessary after disconnecting the battery before working on the airbag system.*
> - *When reconnecting the battery, there must be NO person inside the vehicle.*
> - *DO NOT leave an undeployed airbag unit unattended.*
> - *If the airbag unit or airbag control module has been dropped from a height of 0.5 meter (19.7 in.) or more, DO NOT install.*
> - *Always place an airbag unit that has been removed from its packaging with the padded side facing upward.*
> - *Airbag units that have NOT been activated, which have been removed from vehicles, should be marked and returned to an authorized Volkswagen dealer for proper disposal (use packaging from replacement airbag unit).*
> - *Airbags that have been deployed DO NOT have to be disposed of as hazardous waste and can be discarded in the normal manner. It is recommended to have the unit recycled.*
> - *The storage, transportation and disposal of airbag units are subject to the laws for flammable solids.*

## Front airbag components, overview




68-M595

**Fig. 8.** Overview of airbag components. Car with dual airbags shown.

1. **Driver's side airbag unit**
   - See **Driver's side airbag, removing and installing**
2. **Passenger's side airbag unit**
   - See **Passenger's side airbag, removing and installing**
3. **Diagnostic (data link) connector**
4. **Airbag control module**
5. **Horn relay**
6. **Wiring harness distributor**
7. **Airbag Malfunction Indicator Lamp (MIL)**
8. **Central ground terminal**

## Driver's side airbag unit, removing and installing

> ***WARNING —***
> *Before removing the airbag unit, read the warnings given earlier under* **Airbag, safety precautions**

1. Disconnect negative (–) battery cable. Insulate battery cable end to prevent it from accidentally touching battery post.

> ***CAUTION —***
> *Before disconnecting battery be sure to obtain the radio anti-theft code.*

2. Turn steering wheel to center position (wheels straight ahead).

3. Working from rear of steering wheel, remove socket-head bolts that mount the airbag to steering wheel.

4. Carefully pull airbag unit from steering wheel and unplug red connector from airbag unit.

5. With battery negative (–) cable disconnected, reconnect harness connector to airbag unit and reinstall to steering wheel.

**Tightening torques**

- Airbag to steering wheel (socket-head bolts)..... 6.5 Nm (58 in-lb)

6. Once airbag unit installation is complete, switch ignition ON. Leave vehicle and close driver's door.

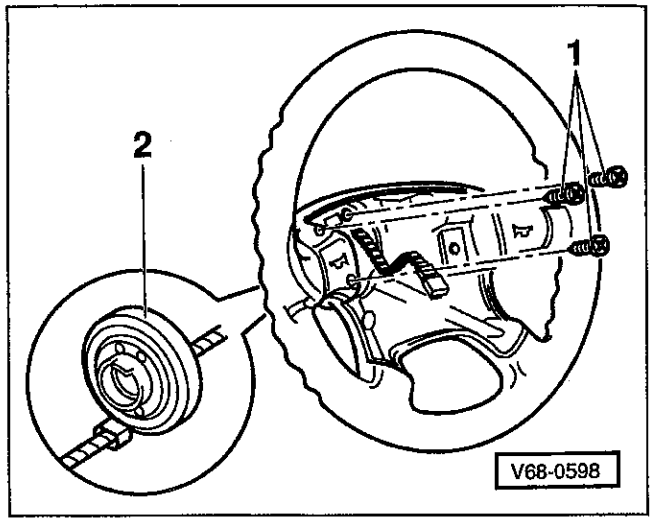
7. Connect battery negative (–) cable. Check that no malfunctions exist, as indicated by an illuminated or malfunctioning warning light.

> ***WARNING —***
> *Ensure that there is no person inside the vehicle before reconnecting battery. Always connect the battery as the very last step.*

> ***CAUTION —***
> *If the ignition is not switched on BEFORE connecting the ground strap, the airbag control unit could be damaged.*

> ***NOTE —***
> *Steering wheel removal is described on* **48 Steering**. *Be sure the steering wheel is in the center position (wheels straight ahead) when the steering wheel is removed.*

> ***NOTE —***
> *Note that the airbag spiral spring is mounted to the rear of the steering wheel. See Fig. 9. If the steering wheel is removed, be sure to lock the airbag spiral spring in its center position. To lock the spiral spring, hold the steering wheel in the normal operating position. Then turn the spiral spring housing left and/or right just until the spiral spring locks in place.*




V68-0598

**Fig. 9.** Airbag spiral spring (**2**) is mounted to rear of steering wheel. Be sure to lock spiral spring in center position once wheel is removed.

## Passenger's side airbag unit, removing and installing

1. Disconnect negative (–) battery cable.

> ***CAUTION —***
> *Before disconnecting battery be sure to obtain radio anti-theft code.*

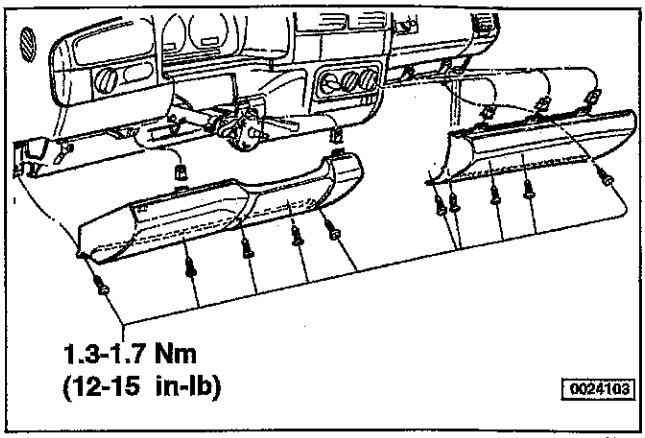
2. Remove passenger side knee bar. The knee bar is held by five screws on the bottom and three catches on top. See Fig. 10.

3. Remove right-hand air vent from instrument panel by pulling it off its housing. See Fig. 11.

4. Remove air vent housing from instrument panel by removing two screws. On cars with VR6 engine, unplug harness connector from air vent housing.

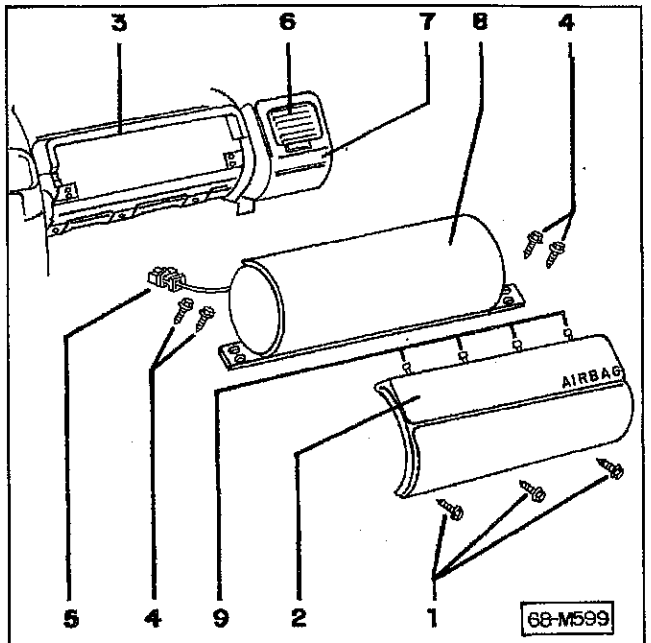
5. Remove airbag cover mounting bolts from lower part of instrument panel. Then slide cover to right and remove cover.

6. Remove retaining frame from instrument panel.




0024103

**Fig. 10.** Knee bars used on cars with airbags.




1. **Hex bolt**
2. **Cover**
   - Remove screws (1) and slide to right to remove
3. **Retaining frame**
   - Always replace after airbag has been deployed
4. **Hex bolt**
   - Tighten to 6.5 Nm (58 in-lb)
5. **Airbag unit connector**
6. **Air vent**
7. **Air venting housing**
8. **Passenger's side airbag unit**
9. **Guide pins**

68-M599

**Fig. 11.** Components of passenger side airbag for vehicles produced before March 1996. Vehicles produced after March 1996 are similar.

7. Remove airbag mounting bolts. Remove airbag unit and disconnect airbag unit connector.

8. With battery negative (–) cable disconnected, reconnect harness connector to airbag unit and reinstall into instrument panel.

**Tightening torques**

- Airbag to instrument panel (up to March 1996 production) . . . . . 6.5 Nm (58 in-lb)
- Airbag to instrument panel (from March 1996 production) . . . . . 10 Nm (7 ft-lb)

9. Reinstall air vent housing, air vent, and airbag retaining frame.

10. Install airbag cover.
    - Lock airbag cover in place by aligning its four pins with holes in retaining frame, slide cover to left and install lower mounting bolts.

11. Install knee bar.

**Tightening torques**

- Knee bar to instrument panel . . . . . 1.3-1.7 Nm (12-15 in-lb)

12. Once airbag unit installation is complete, switch ignition ON. Leave vehicle and close driver's door.

13. Connect battery negative (–) cable. Check that no malfunctions exist, as indicated by an illuminated or malfunctioning warning light.

***WARNING —***
*Ensure that there is no person inside the vehicle before reconnecting battery. Always connect the battery as the very last step.*

***CAUTION —***
*If the ignition is not switched on BEFORE connecting the ground strap, the airbag control unit could be damaged.*

## Side airbag unit, driver's and front passenger side

Side airbags built into the outside sections of both front seat backrests are available as an option beginning with model year 1998.

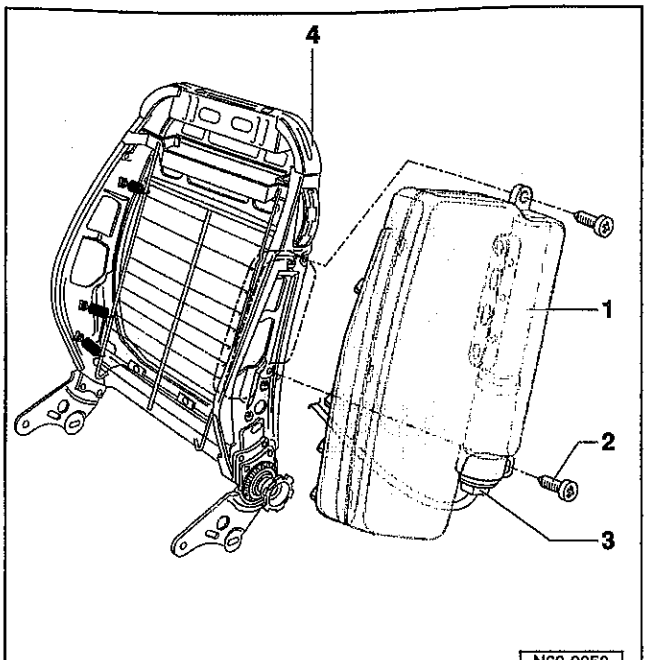
These airbags are deployed when side deceleration forces reach predetermined levels and can operate independently of the front airbags. Deployment is controlled by the airbag control module and one additional crash sensor per side. The side crash sensors are mounted under each front seat and detect lateral deceleration.

***WARNING —***
*Volkswagen of America has issued a directive specifically warning against the installation of aftermarket upholstery on any vehicle equipped with side airbags. The factory-installed upholstery is designed to separate in specific places at specific rates, and in specific directions. Installation of non-factory upholstery including, but not limited to, "beads" and "sheepskins", may cause seat mounted airbags to deploy when they are not supposed to; fail to deploy when they should; or to deploy in some manner other than designed. This is a safety hazard and could result in serious injury or death to occupants of the vehicle.*

## Side airbag unit, removing and installing

1. Disconnect negative (–) battery cable.
2. Remove backrest frame. See **72 Seats**.
3. Loosen backrest upholstery and work it up to a point where the side airbag mounting bolts are visible. See Fig. 12.
4. Remove both mounting bolts.
5. Disconnect electrical connector from airbag unit and remove airbag from backrest.
6. Installation is the reverse of removal, noting the following:
   - Negative (–) battery cable remains disconnected
   - Switch ignition on
   - Close doors
   - Re-connect negative (–) battery cable

***WARNING —***
*Make sure that no one is in the vehicle when reconnecting the negative (–) battery cable.*



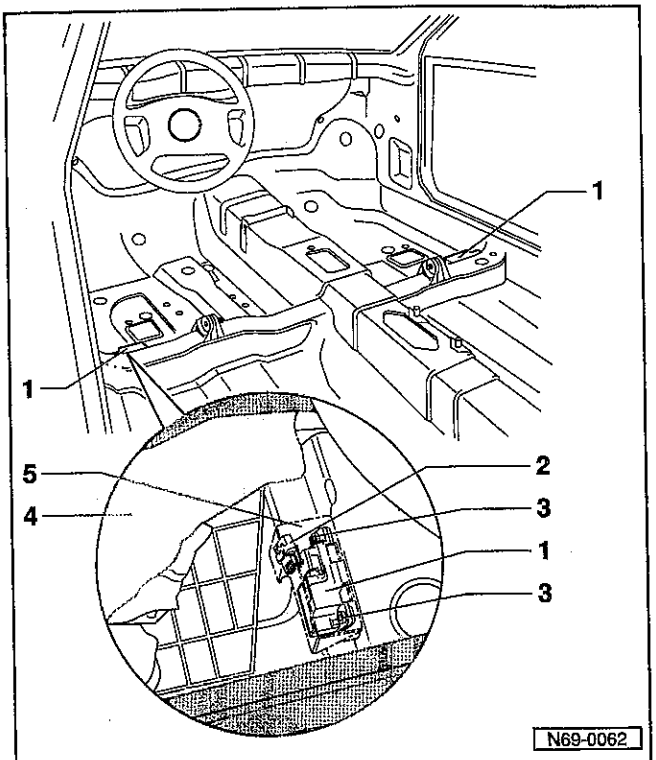

1. **Side airbag unit, driver's and front passenger side**
2. **Bolt**
   - Ground wire secured with bolt -2-
   - Tightening torque: 7 Nm (62 in-lb)
3. **Connector**
4. **Backrest frame**

N69-0050

**Fig. 12.** Side airbag unit with front seat backrest frame. Driver's side shown, passenger side is symmetrically opposite.

## Crash sensor for side airbag, removing and installing

1. Disconnect negative (–) battery cable.
2. Remove driver's or front passenger seat. See **72 Seats**.
3. Release carpet and insulation mat in area of sensor. See Fig. 13.
4. Carefully pry off cover.
5. Disconnect electrical connector and remove mounting screws.




1. **Crash sensor for side airbag, driver's and front passenger side**
2. **Connector**
3. **Bolt**
   - Tightening torque: 10 Nm (7 ft-lb)
4. **Carpet**
5. **Cover**

N69-0062

**Fig. 13.** Side airbag crash sensors mounted to the seat supports on the floor. One sensor is used for each side airbag.

6. Installation is the reverse of removal, noting the following:
   - Negative (–) battery cable remains disconnected
   - Switch ignition on
   - Close doors
   - Re-connect negative (–) battery cable

> ***WARNING —***
> *Make sure that no one is in the vehicle when reconnecting the negative (–) battery cable.*

# 70 Trim–Interior



## GENERAL

This group covers removal and installation of the interior trim, including the headliner.

***NOTE—***

- *Instrument cluster removal and installation is covered in* **90 Instruments.**

> ***CAUTION—***
> *Before disconnecting battery be sure to obtain radio anti-theft code.*

## CENTER CONSOLE AND INSTRUMENT PANEL

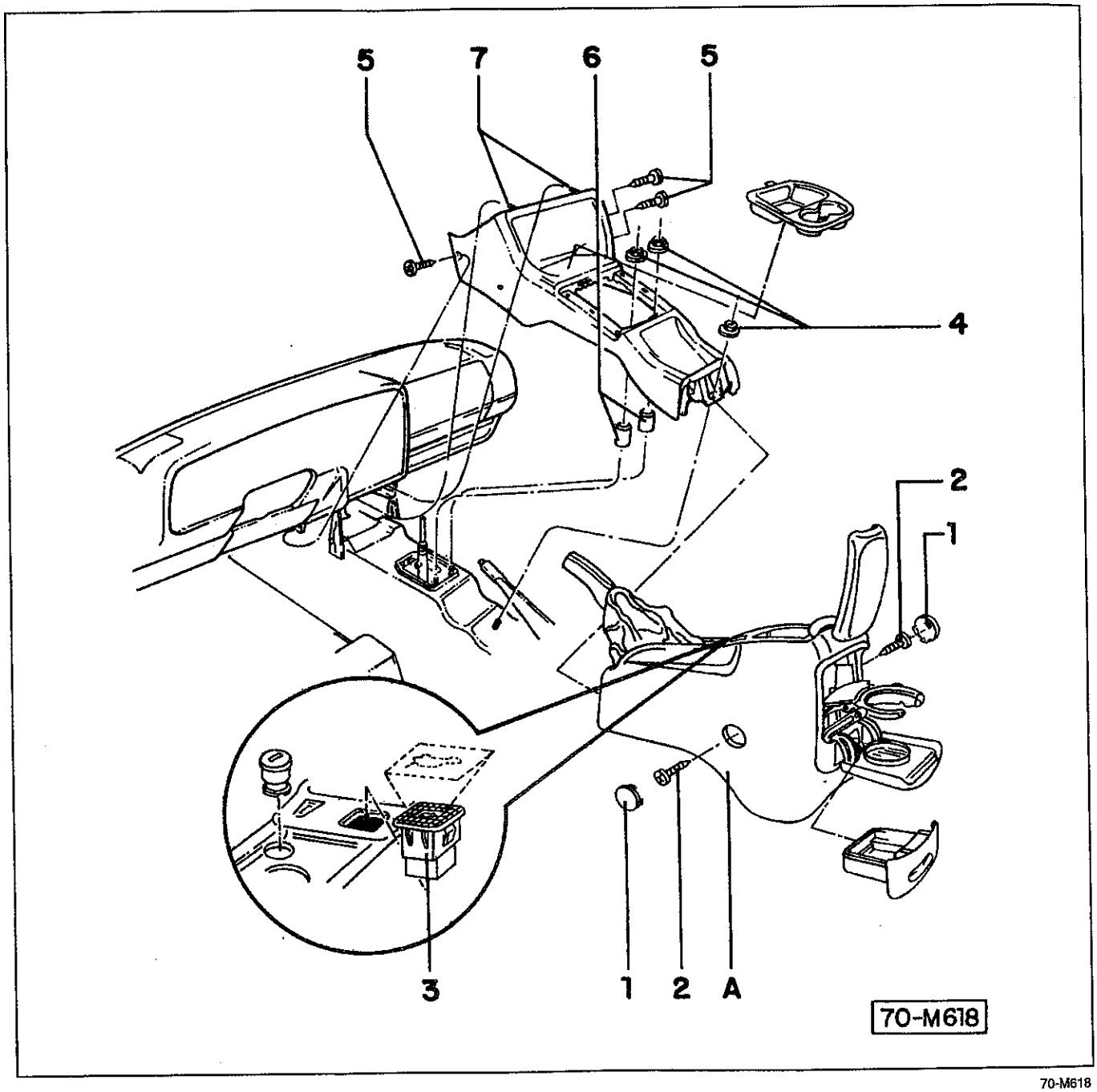
Fig. 1 and Fig. 2 show center console assemblies, depending on whether or not the vehicle is equipped with an airbag(s).

### Center console, removing and installing (cars with airbag)

Use Fig. 1 as a guide when removing and installing the center console used on cars with airbag.

1. Disconnect negative (–) battery cable. Insulate battery cable end.
2. Remove shift lever boot or selector lever cover from center console. See **3 Clutch, Transmission, and Final Drive.**
3. Carefully pry off screw covers and then remove left and right parking brake lever console mounting screws.
4. Pull out and disconnect connector from remote rear trunk opener (where applicable).
5. Slide parking brake lever console to rear.
6. Remove three mounting nuts from the center console.
7. Remove screws from center console (one on left-side, two on right-side).
8. Lift rear end of console slightly and remove it from instrument panel.
9. Install center console in reverse order of removal. Be sure the spacer bushings and locating pins are positioned correctly when installing console.

## Center console, assembly (cars with airbag)



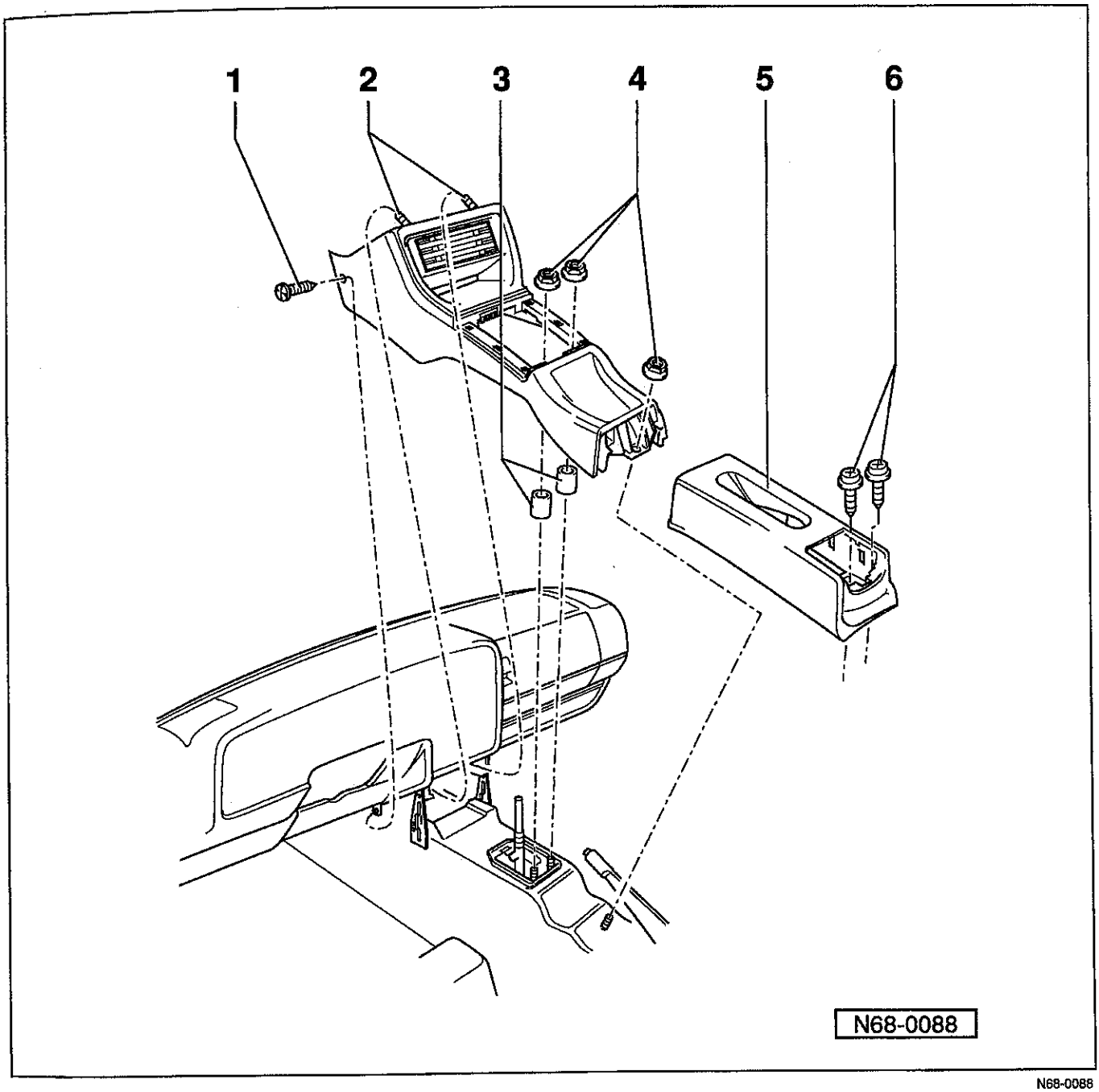

70-M618

**Fig. 1.** Exploded view of center console for vehicles equipped with airbags.

1. **Screw covers**
2. **Screws**
3. **Remote trunk switch**
   Location varies
   - Under lid in console
   - On driver's seat trim panel
   - In glove box on early cars without airbags
4. **Nuts**
5. **Screws**
   - One on left, and two on right side
6. **Spacers**
7. **Locating/retaining pins**

A. **Parking brake lever console**

## Center console assembly (cars without airbag)




N68-0088

**Fig. 2.** Exploded view of center console for vehicles without airbags.

1. **Screws**
   - On left and right side
2. **Locating/retaining pins**
3. **Spacers**
4. **Hex nuts**
5. **Parking brake lever console**
6. **Hex head screw**

## Center console, removing and installing (cars without airbag)

Use Fig. 2 as a guide when removing and installing the center console used on cars without airbag.

1. Pull out ashtray and remove screws from rear of parking brake lever console.
2. Remove shift lever boot or selector lever cover from center console. See **3 Clutch, Transmission, and Final Drive**.
3. Slide parking brake lever console to rear and disconnect all electrical connectors.
4. Remove hex nuts.
5. Remove screws on left and right sides.
6. Lift rear end of console slightly and remove from instrument panel. Separate electrical connectors and remove console from car.
7. Install center console in reverse order of removal. Be sure the spacer bushings and locating pins are positioned correctly when installing console.

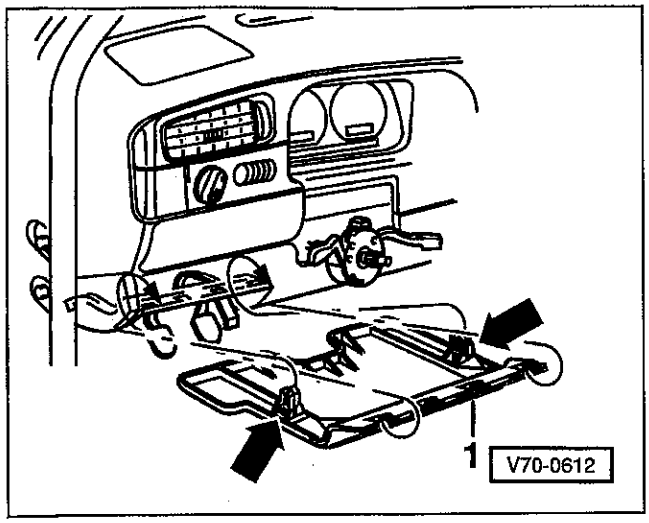
## Instrument panel, removing and installing

Center console, radio, steering wheel and steering column switch must first be removed before the instrument panel can be removed.

1. Disconnect negative (–) battery cable. Insulate battery cable end.

> ***CAUTION—***
> *Before disconnecting the battery, be sure to obtain the radio anti-theft code.*

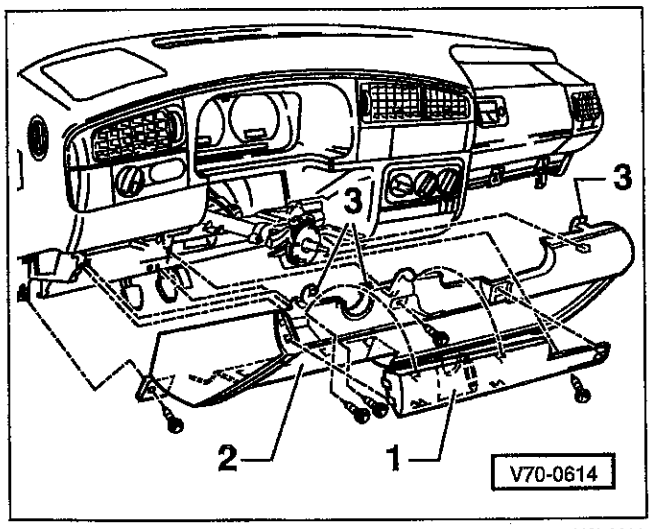
2. Remove center console as described previously.
3. Remove radio as described in **91 Radio**.
4. Remove steering wheel. See **48 Steering**.
5. Remove passenger side airbag unit as described in **69 Seat belts, Airbags**.
6. Remove relay panel cover from under left-hand side of instrument panel. See Fig. 3.




V70-0612

**Fig. 3.** Press locking buttons (**arrows**) to remove relay cover (**1**).

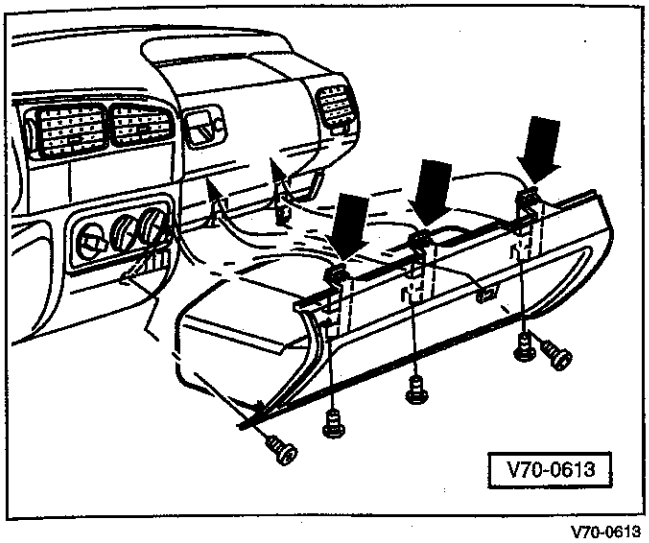
7. Remove lower instrument panel trim:
   - Pry off center cover on driver's side, remove screws, and pull large tray downward at an angle. Make sure that all guides disengage. See Fig. 4.




V70-0614

**Fig. 4.** Pry off center cover (**1**), remove screws, and pull down tray (**2**), making sure that guides (**3**) disengage.

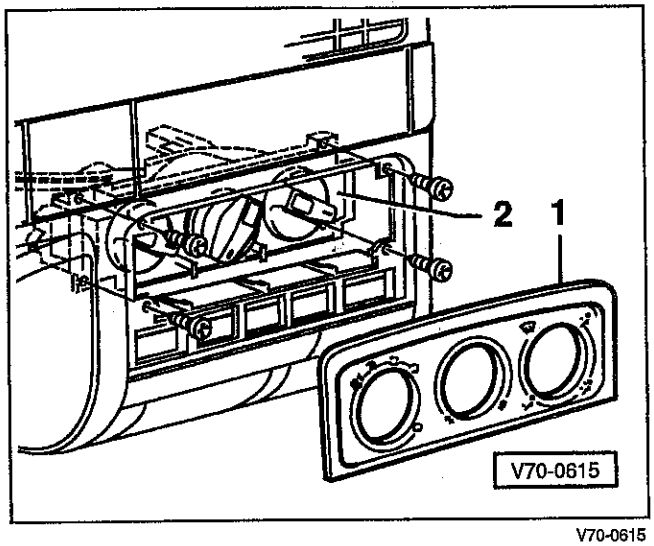
8. Remove screws and pull passenger side storage shelf downward at an angle. Make sure that tabs disengage. See Fig. 5. For vehicles equipped with an airbag and glovebox, remove the glovebox as described later in **Glovebox**.




V70-0613

**Fig. 5.** Remove screws and pull passenger side shelf downward at an angle, making sure tabs (**arrows**) disengage.

9. Pry off cover for heating and ventilating controls. Remove control panel screws and position heating and ventilating controls (with attached cables) below instrument panel. See Fig. 6.

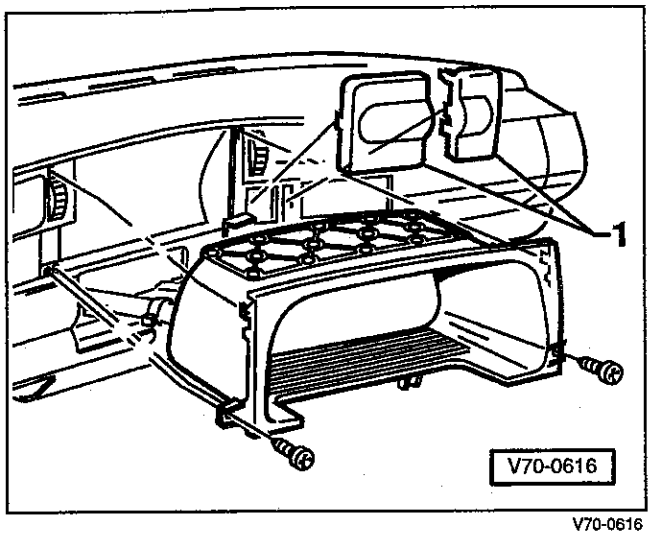



V70-0615

**Fig. 6.** Pry off cover (**1**) and press controls (with cables attached) under instrument panel.

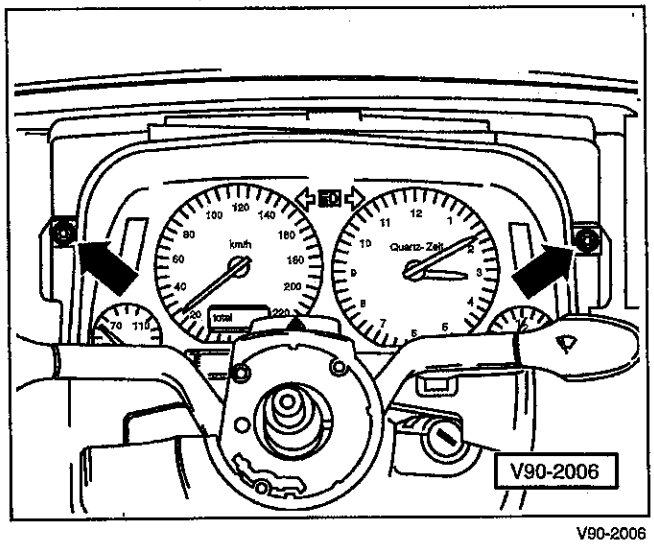
10. Unclip covers and light switch from instrument panel. Remove screws and pull out instrument cluster cover. See Fig. 7.

11. Remove instrument cluster securing screws, tip instrument cluster forward, and disconnect multi-pin connector on rear of instrument cluster. See Fig. 8.




V70-0616

**Fig. 7.** Unclip covers (**1**), and remove headlight switch. Then remove screws and pull out instrument cluster cover.




V90-2006

**Fig. 8.** Instrument cluster securing screws (**arrows**).

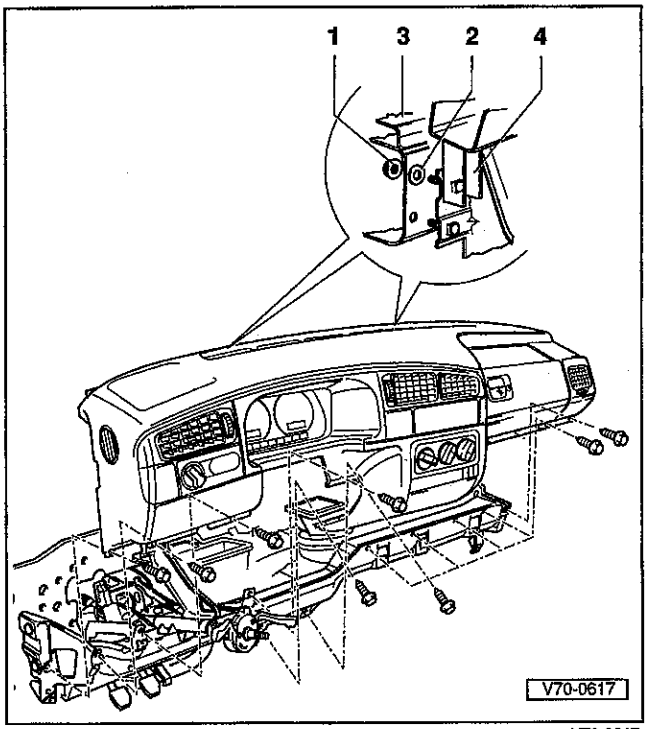
12. Remove instrument cluster.

13. Remove instrument panel mounting screws (11 screws, including glove box) and hex nuts (located in plenum chamber). See Fig. 9.

14. Partially remove instrument panel from carrier and disconnect wiring harnesses from instrument panel.

15. Remove instrument panel.

16. Installation is the reverse of removal. Replace any wire-ties cut during removal. Make sure the mounting nut insulating washers are reinstalled during installation (see Fig. 9).




V70-0617

**Fig. 9.** Instrument panel mounting hardware. Nuts (**1**) are accessed through plenum chamber. Note insulating washers (**2**) that must be reinstalled.

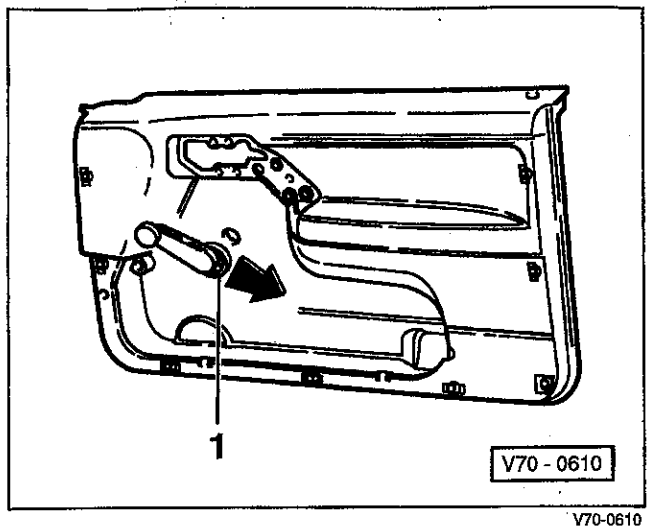
# DOOR TRIM

## Front window crank, removing and installing

1. Raise window fully. Note installed position of crank handle.
2. Slide spacer ring at base of crank to rear to unlock crank retaining clip. Then pull crank off. See Fig. 10.
3. Installation is the reverse of removal. Be sure to reinstall crank in original position.

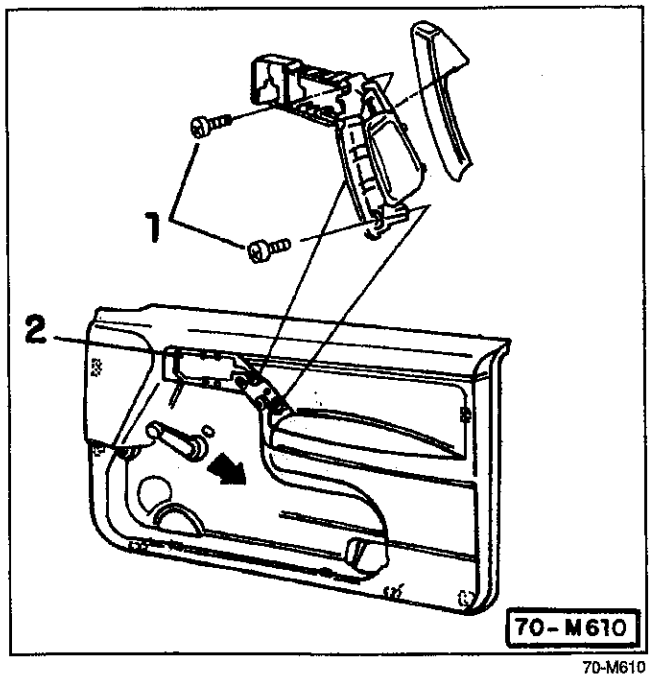
## Front door trim panel, removing

1. Unscrew lock knob.
2. Unclip grab handle trim and remove grab handle attachment screws together with handle. See Fig. 11.
3. Remove window crank as described earlier.
4. Using both hands, place fingers behind outside remote rear-view mirror control knob and pull forward to remove knob.
5. Pull inside door latch release lever trim piece straight out, bottom first then top.




V70-0610

**Fig. 10.** Slide spacer ring (**1**) in direction of arrow to unlock window crank retaining clip.

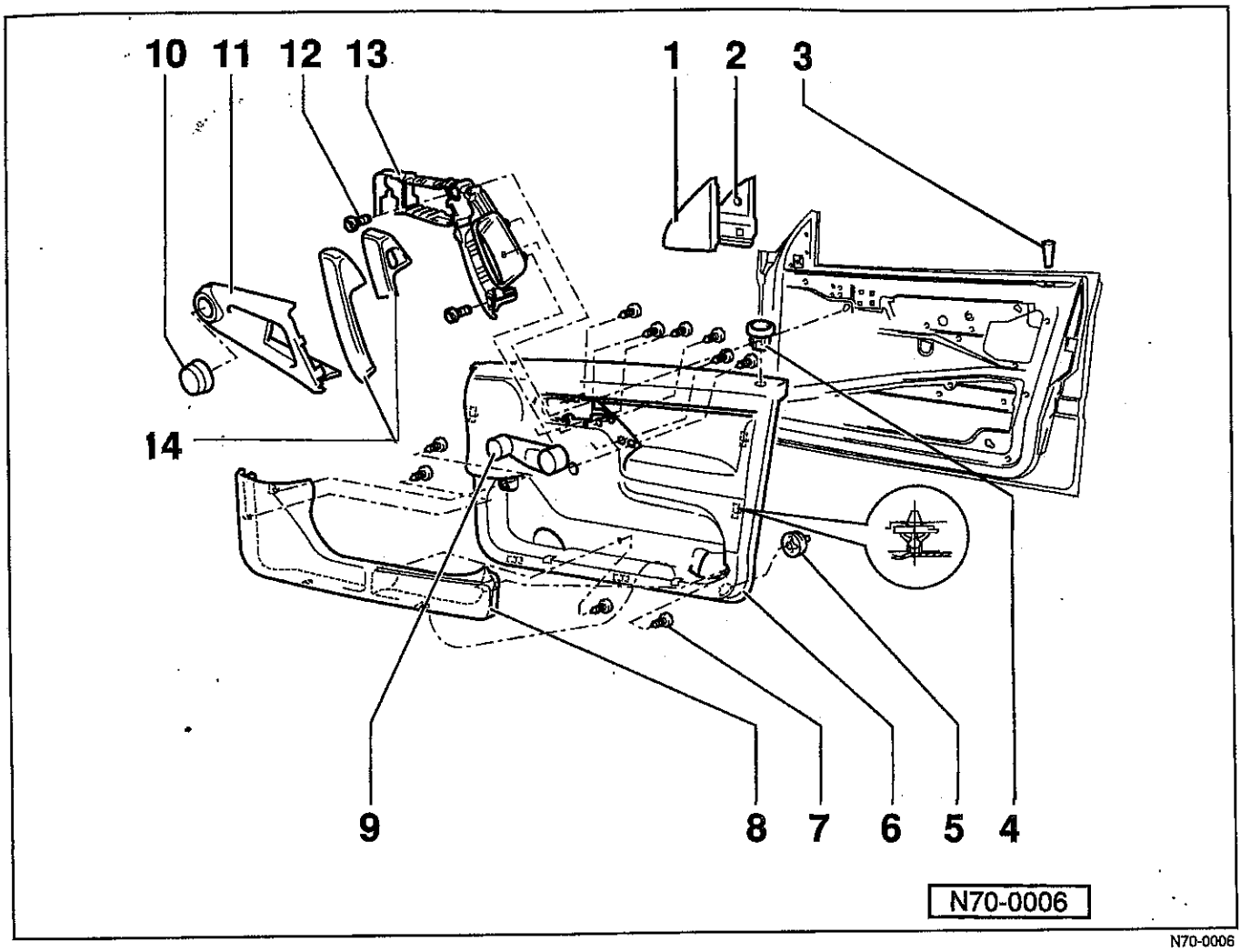



70-M610

**Fig. 11.** Grab handle retaining screws (1).

6. Remove top screw (in front of inside door release lever housing) for outside remote rear-view mirror control housing and door trim panel.
7. Remove six door trim panel attachment screws from perimeter of door panel.
8. Separate door panel from trim piece at top of door, starting from either end, not both. Do not pull hard, this will cause the door panel to break.
9. Disconnect electrical connector for speaker. Disconnect electrical connector for anti-theft alarm system (driver's door only).

## Front door trim, assembly




N70-0006

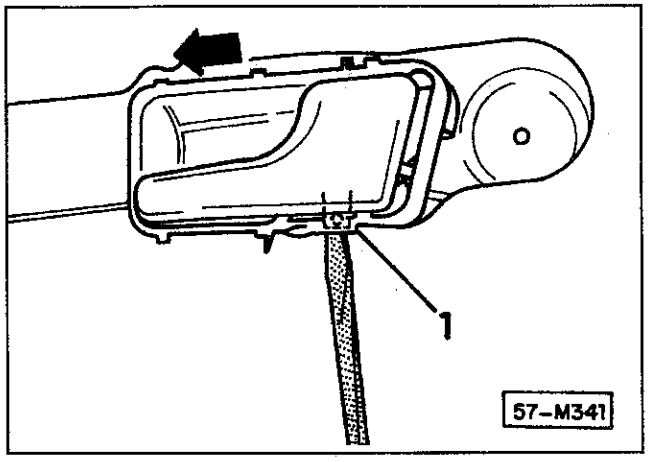
**Fig. 12.** Exploded view of door trim for Cabrio (other models similar).

1. **Cover plate**
   - clipped to door frame
2. **Insulating plate**
3. **Locking knob**
4. **Trim ring**
5. **Securing clip**
   - Two-piece
6. **Trim panel**
7. **Countersunk screw**
8. **Door tray**
   - Removed only after first removing trim panel
9. **Window crank**
10. **Mirror control knob**
    - Pushed onto control
11. **Inner door release trim panel**
    - Clipped into door/door pull
12. **Countersunk screw**
13. **Door pull**
14. **Cover**
    - Connected on inside opener plate
    - Clipped into door/door pull

## Vapor barrier, removing and installing

The vapor barrier seals off the passenger compartment from water, noise, and drafts. Replacement vapor barriers are supplied from Volkswagen with self-adhesive surfaces.

1. Remove interior door panel trim.
2. Remove inside door release housing. See Fig. 13.

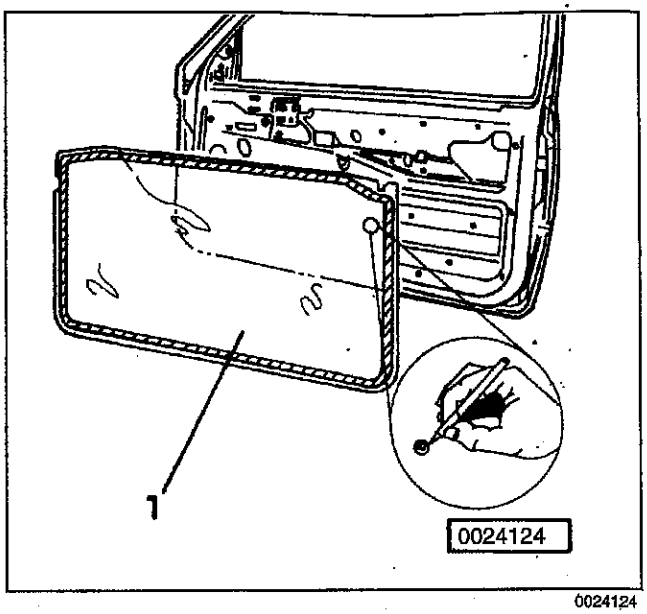



57-M341

**Fig. 13.** Remove door release housing by releasing locking tab (**1**) and sliding housing forward (**arrow**). If necessary, unhook link rod from release mechanism.

3. Carefully peel back vapor barrier, starting from either top edge.
4. Using a razor blade, carefully cut vapor barrier around trim panel securing clip retainers. See Fig. 14.

***NOTE—***
*Scratches in paint caused by cutting the vapor barrier should be repaired with touch up paint to prevent corrosion.*




0024124

**Fig. 14.** Trim around securing clip, then pull vapor barrier (**1**) down only as far as is necessary.

5. Peel vapor barrier from door.

***CAUTION—***
*Do not remove vapor barrier completely, unless absolutely necessary.*

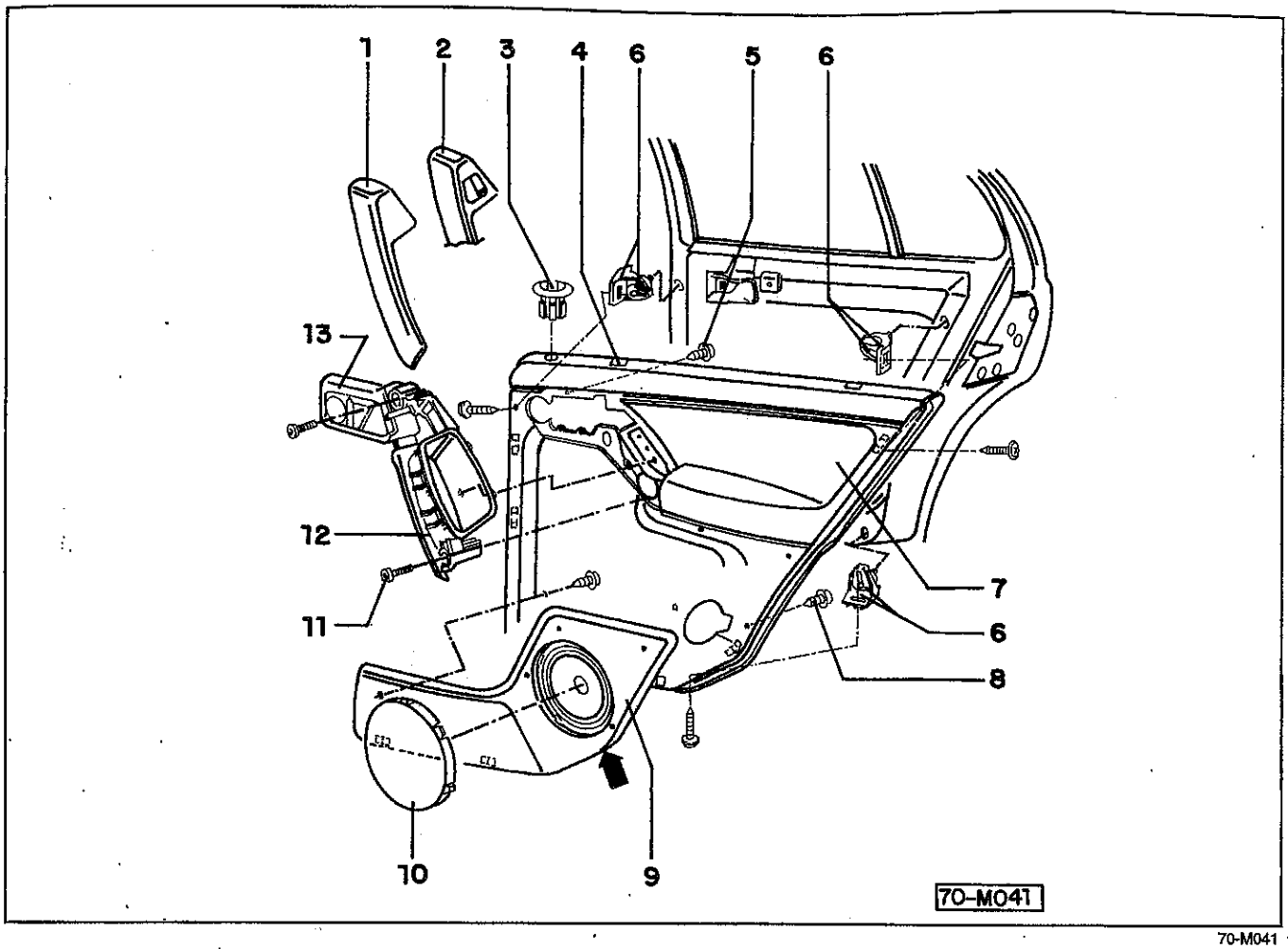
6. Installation is the reverse of removal.

***CAUTION—***
*When installing vapor barrier, there must not be any wrinkles in the barrier. This will cause water to leak onto the door panel and into the vehicle.*

## Rear door trim, removing and installing

Fig. 15 is an exploded view of the rear door interior trim. Use the illustration as a guide for removal and installation of the door trim.

## Rear door trim, assembly




70-M041

**Fig. 15.** Exploded view of rear door trim for 4-door models for 1993 through 1995 models. Door speakers on 1996 and later models relocated to rear parcel shelf.

1. **Door pull trim**
   - For vehicles without electric windows
   - Clipped into door/door pull
2. **Door pull trim**
   - For vehicles with electric windows
   - Clipped into door/door pull
3. **Trim ring**
4. **Clip**
5. **Screw**
6. **Trim clip**
7. **Trim**
   Removing:
   - Unscrew locking knob
   - Remove window crank (if applicable)
   - Unclip door pull trim (1) or (2)
   - Remove screws (11)
   - Pry off trim
   - Disconnect electric wiring (window switch, speaker)
8. **Screw**
9. **Door tray**
   - Secured by screws through rear of trim
   - Speaker fastened to door tray
10. **Speaker cover**
    - Removing: press down on retaining lugs with screwdriver through opening in door tray (arrow)
11. **Screw**
12. **Door pull**
    - Secured by screws through rear of trim
13. **Cover**
    - Clipped into door pull
    - Mounting location for speaker (tweeter)
    - If speaker is installed, remove only after removing door trim and disassembling door pull (danger of damage)

## OTHER INTERIOR TRIM

### A-pillar trim, upper, (Jetta, Golf, GTI), removing and installing

1. Remove upper part of B-pillar trim. See **B-pillar trim (4-door Golf, Jetta), removing and installing**.
2. Remove trim retaining screw. Pull trim from clips and then unhook from lower retaining lugs. See Fig. 16.

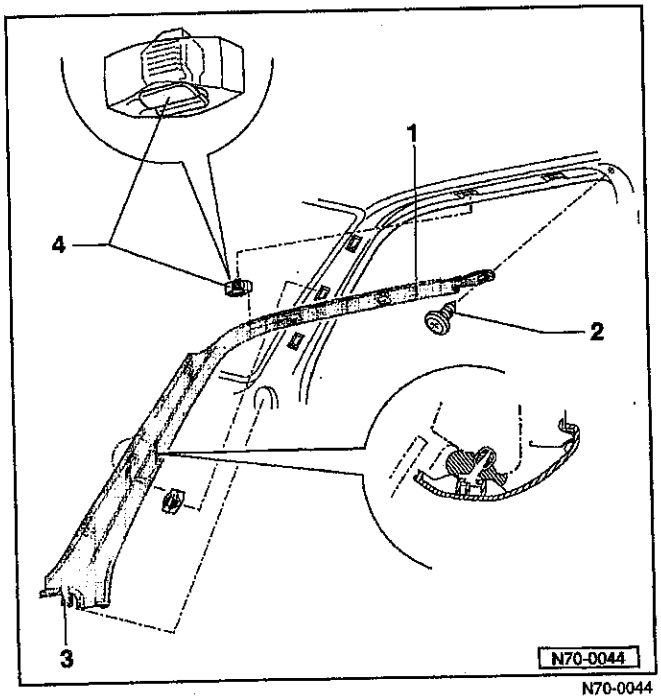



**Fig. 16.** A-pillar trim (**1**), trim screw (**2**), retaining lugs (**3**), and clips (**4**). Upper inset shows detail of mounting clip with foam padding.

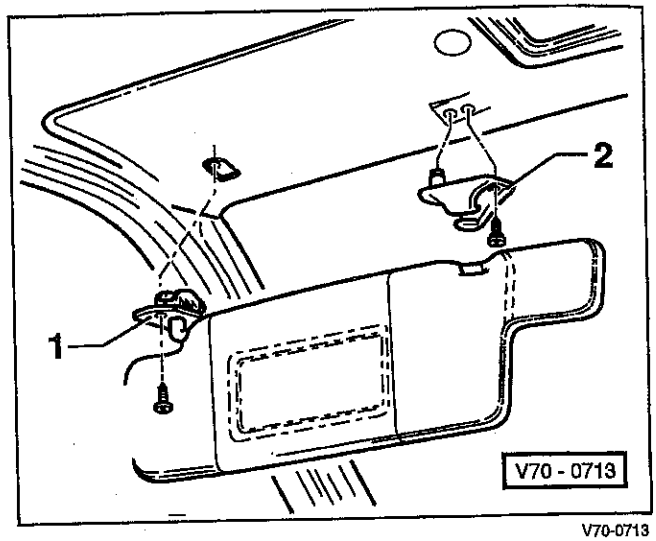
***NOTE—***
*Trim fits over sealing flange of door inner seal, see sectional view.*

***CAUTION—***
*Use care when pulling trim from clips. Tabs on trim are easily damaged.*

3. Installation is the reverse of removal. Before installing trim, ensure that mounting clips are properly seated in slots on trim and not damaged.

### A-pillar trim (Cabrio), removing and installing

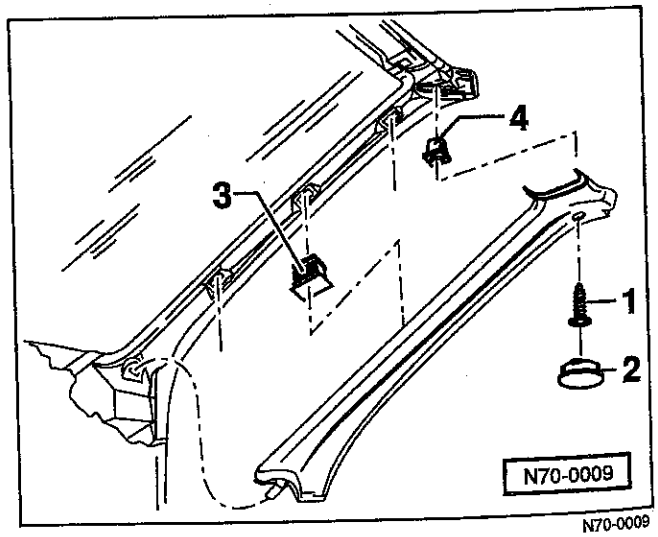
1. Remove wind protector trim as follows:
   - Disconnect negative (–) battery ground strap.
   - Pry out interior light above rear view mirror and separate electrical connectors.
   - Remove sun visor. See Fig. 17.




V70-0713

**Fig. 17.** Sun visor mounts (**1** and **2**) on Cabrio models. Remove sun visor by turning 90°.

2. Remove wind protector trim.
3. Pry off screw cover, remove screw, and pull A-pillar trim upward. See Fig. 18.




N70-0009

**Fig. 18.** Pry off screw cover (**2**), remove screw (**1**), and pull A-pillar trim upward to remove.

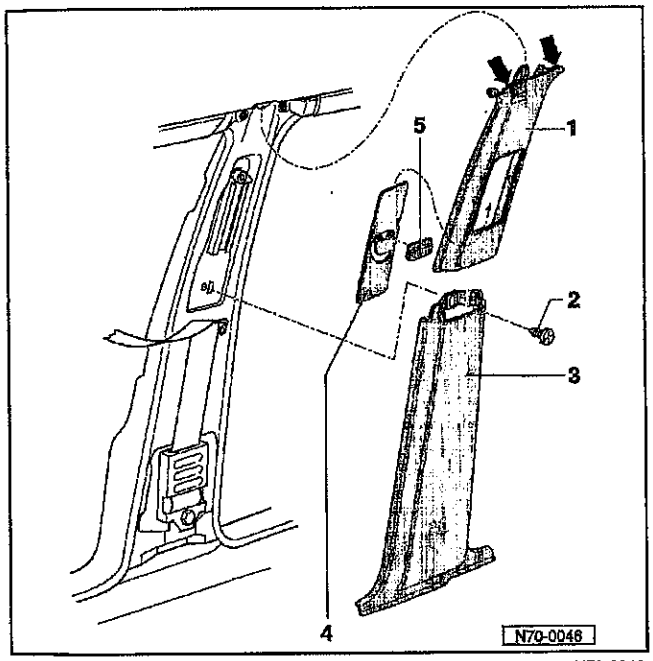
4. Before installing trim, remove clip from A-pillar (see Fig. 18) and re-insert clip into trim. The remainder of installation is the reverse of removal.

## B-pillar trim (4-door Golf, Jetta), removing and installing

1. Remove sill panel trim, see **Sill panel trim assembly**, given later.
2. Remove front seat belt anchor. See **69 Seat belts, Airbags.**
3. Pull upper trim off, starting from bottom. See Fig. 19.

***NOTE—***

*For 2-door model with one piece B-pillar trim, follow steps 1 and 2 (above), remove rear side panel trim, and pull B-pillar trim off starting from the bottom.*




N70-0046

**Fig. 19.** B-pillar trim for 4-door models (2-door models have one piece B-pillar trim).

4. Remove lower trim retaining screw and pull lower trim off, starting from top.
5. Install in reverse order of removal, noting the following.
   - For upper trim piece, first locate retaining lugs in A-pillar and C-pillar trim.
   - Position seat belt height adjuster cover and adjuster (items 4 and 5 in Fig. 20) behind upper trim.
   - Check function of belt height adjuster.

## C-pillar trim (Jetta), removing and installing

The C-pillar trim used on the Jetta models is shown in Fig. 20. C-pillar trim used on other models is similar.

1. Remove sill panel trim, see **Sill panel trim, assembly.**
2. Remove upper B-pillar trim, as described previously.
3. Remove trim retaining screw and pull off trim along roof edge, removing squarely from mounting clips. See Fig. 20.
4. Unhook parcel shelf trim.
5. Remove lower trim piece at C-pillar.
6. Remove rear seat belt anchor.
7. Installation is the reverse of removal. Before installing, check seating of clips and correct if necessary. Be sure to check function of belt height adjuster once installation is complete.

## C-pillar trim (Jetta), assembly

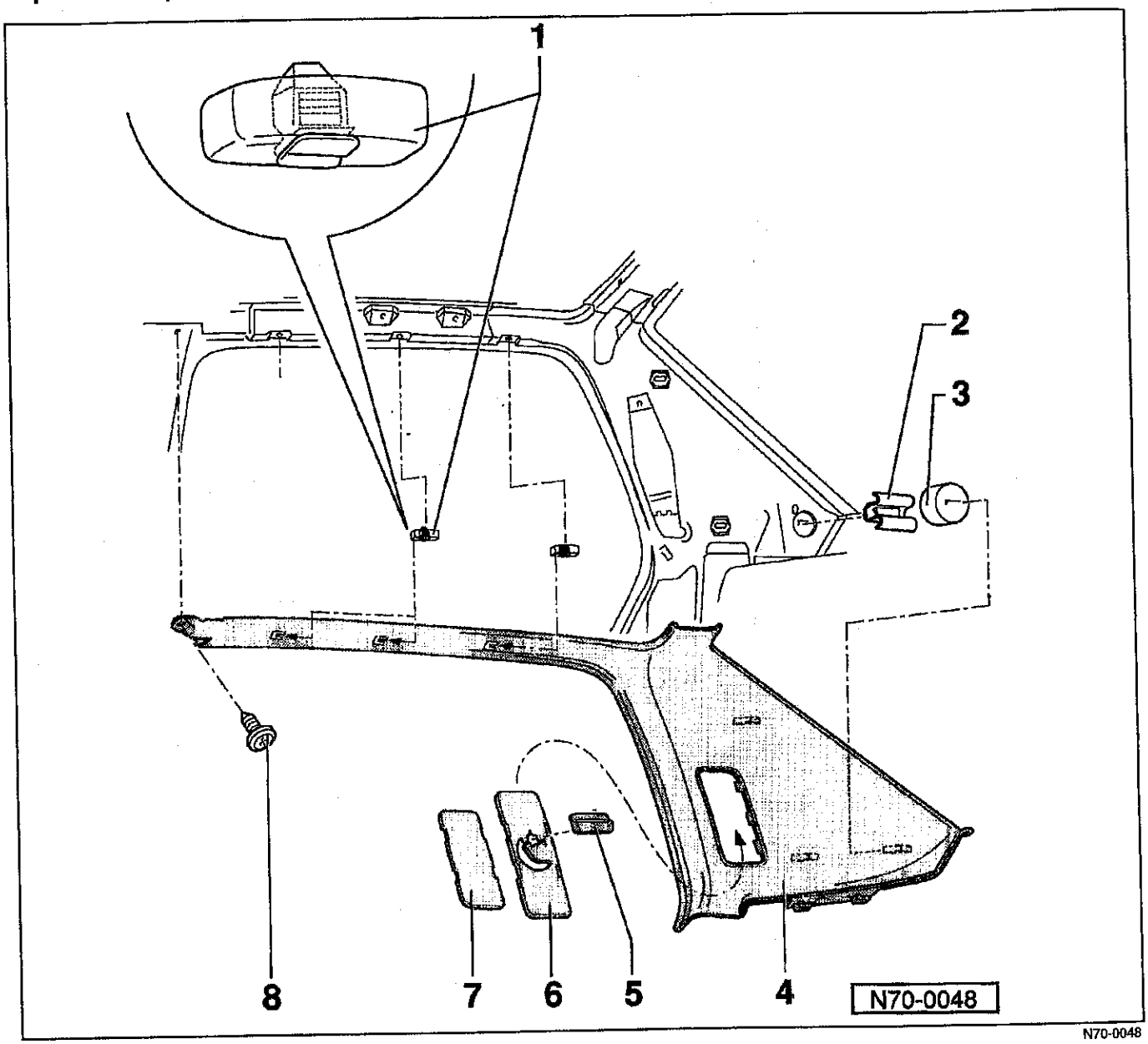


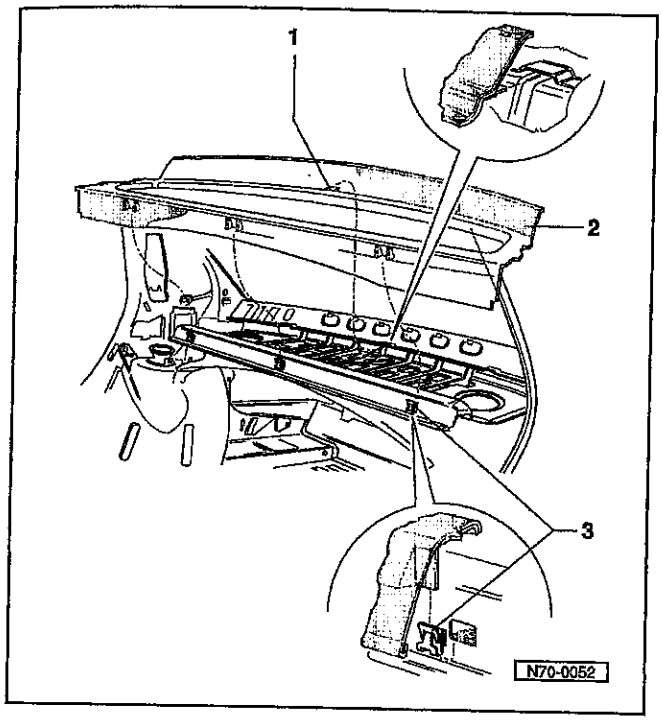

**Fig. 20.** C-pillar trim for Jetta models (other models similar).

1. **Clip**
   - With foam padding
   - Pushed into trim mounting
2. **Clip**
3. **Foam padding**
4. **Trim**
5. **Adjuster**
6. **Cover**
7. **Cover**
   - Only for vehicles without rear seat belts
8. **Screw**

## Parcel shelf trim (Jetta), removing

1. Remove upper B-pillar trim and upper C-pillar trim as described previously.

2. Lift front edge of trim piece and unhook from mounting clips. Pull trim forward off of securing pins. See Fig. 21.



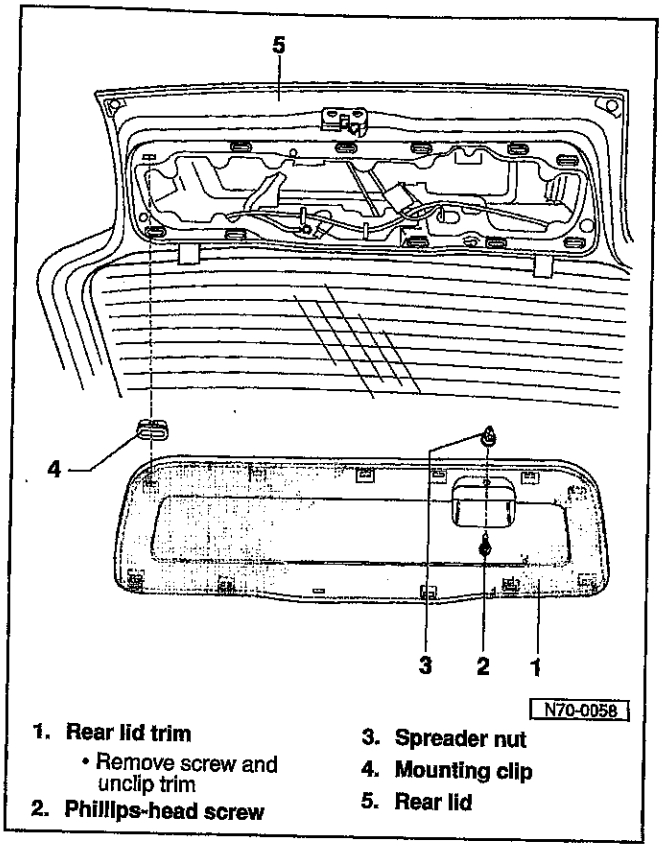

N70-0052

**Fig. 21.** Parcel shelf trim (**2**) for Jetta models. Upper inset shows securing pin (**1**) and lower inset shows mounting clips (**3**).

3. Installation is the reverse of removal. Replace any damaged mounting clips.

## Rear lid trim (Golf, GTI)

Fig. 22 shows the rear lid trim used on Golf and GTI models. Use the illustration as a guide for removal and installation of the rear lid trim.




1. **Rear lid trim**
   - Remove screw and unclip trim
2. **Phillips-head screw**
3. **Spreader nut**
4. **Mounting clip**
5. **Rear lid**

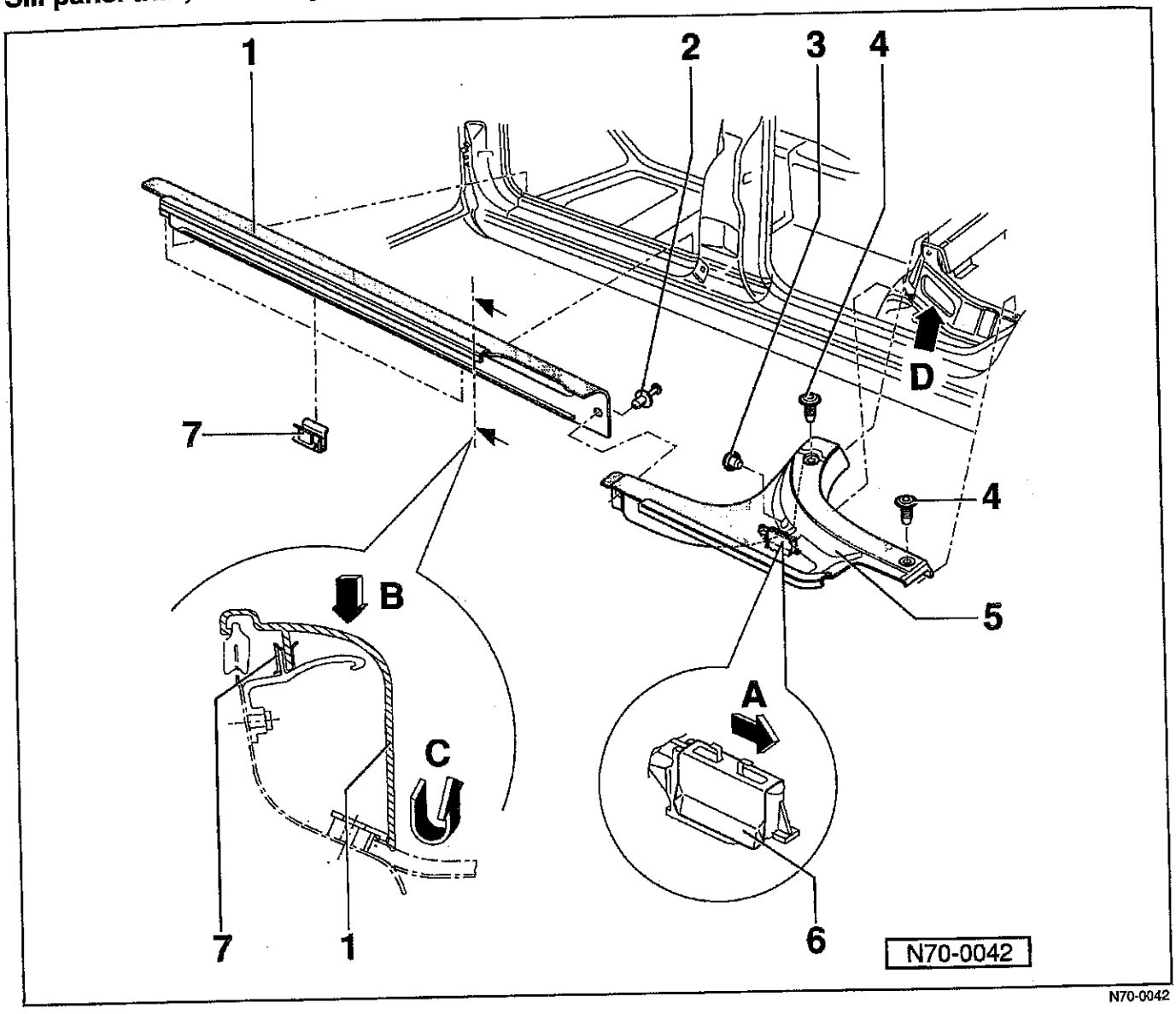
N70-0058

**Fig. 22.** Rear lid trim for Golf and GTI .

## Sill panel trim, removing and installing

Fig. 23 shows an exploded view of the sill panel trim used on 4-door Jetta models. Use the illustration as a guide for removal and installation of the sill panel trim.

## Sill panel trim, assembly




N70-0042

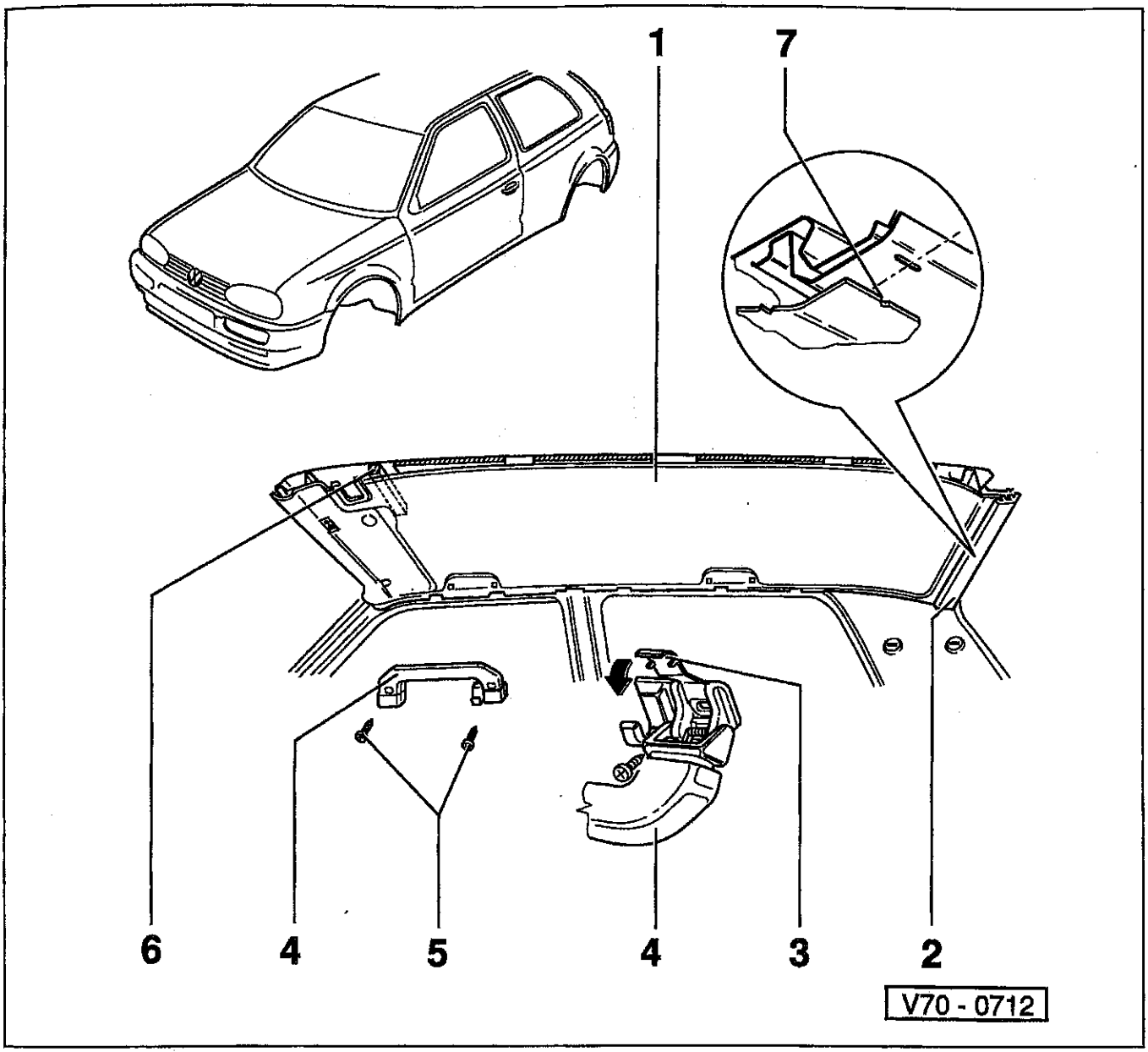
**Fig. 23.** Exploded view of front and rear door sill panel trim for 4-door Jetta models. Other models are similar.

1. **Sill panel trim**
   - Removing:
     Remove securing clip (2)
     Press down sill panel trim (arrow B) and simultaneously unhook bottom of sill panel trim (arrow C). Pull sill panel trim off clips (7).
2. **Securing clip**
   - Unscrew to remove
   - Press outer part into mounting hole to install, then press inner part
3. **Press button**
   - Unscrew or press on
4. **Plug**
   - Carefully pry out
5. **Rear trim**
   - Removing:
     Unscrew securing clip (2) and remove sill panel trim (1)
     Unscrew press button (3) and pry out plugs (4)
     Slide clip (6) rearward (arrow A). To do this, grip from inside of seat frame through opening (arrow D)
     Remove trim
   - Installing:
     First slide clip (6) back onto its seat. Remainder of installation is reverse of removal.
6. **Clip**
7. **Clip**

## HEADLINER

Fig. 24 shows the one-piece headliner assembly. A helper should be used when removing the headliner from the vehicle.

### Headliner, assembly




V70-0712

**Fig. 24.** Components of molded one-piece headliner. (Does not apply to Cabrio models).

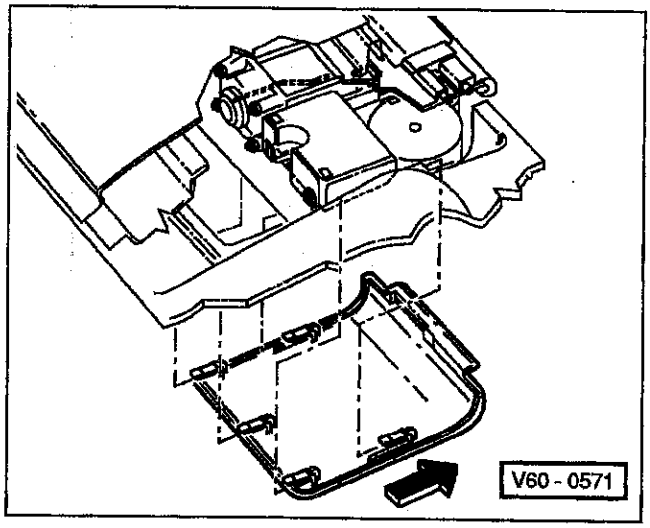
1. **Headliner**
   - See **Headliner, removing**
2. **Rear trim strip**
   - Clipped onto roof frame
3. **Cover cap/grab handle**
4. **Grab handle**
5. **Screw**
6. **Spacer/interior light**
   - On vehicles with sunroof, spacer is located in front of cut-out/interior light.
7. **Center marking**
   - Align to center of vehicle (center clip hole)

## Headliner, removing

1. Disconnect negative (–) battery cable.

> ***CAUTION —***
> *Before disconnecting battery be sure to obtain radio anti-theft code.*

2. On 2-door Golf and GTI models, remove sill panel trim, and side panel trim as described earlier.
3. On all Golf and GTI models, remove luggage compartment cover supports.
4. On sunroof equipped cars, remove sunroof motor access cover. See Fig. 25.

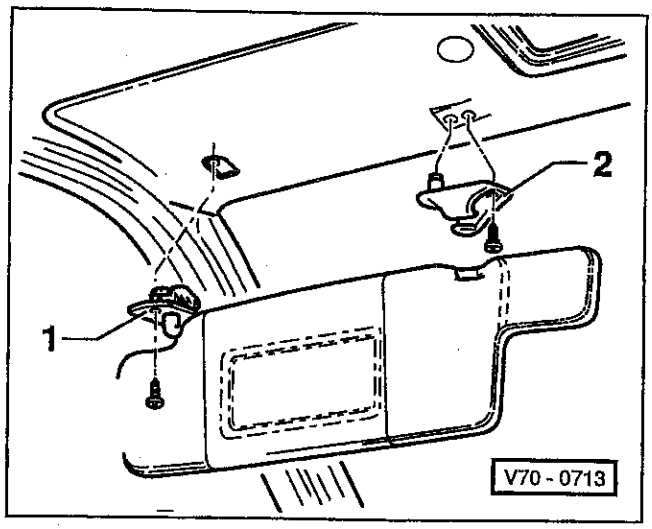



V60-0571

**Fig. 25.** Remove sunroof motor cover by sliding to rear (**arrow**).

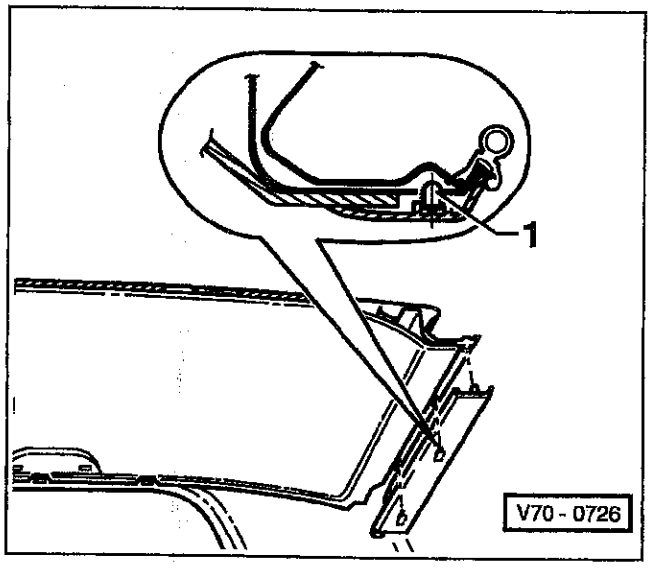
5. Pry out interior light above rear view mirror and separate electrical connectors.
6. Remove sun visors. Separate electrical connector for vanity light, if applicable. See Fig. 26.
7. Remove upper A-pillar, B-pillar, and C-pillar trim as described previously.
8. Pry off headliner rear trim strip. See Fig. 27.
9. Remove roof handles (mounting screws under plastic covers).

> ***NOTE —***
> *The roof handles for sunroof equipped vehicles are marked with a "V" (front) or an "H" (rear).*




V70-0713

**Fig. 26.** Remove sun visor mounting screws then turn mount (**1**) 90° to remove.




V70-0726

**Fig. 27.** Headliner rear trim strip. Inset shows detail of mounting clip (**1**).

10. Using a helper, lower headliner and remove from vehicle.

> ***CAUTION —***
> *Removing the headliner without a helper could result in damage to headliner.*

## GLOVEBOX

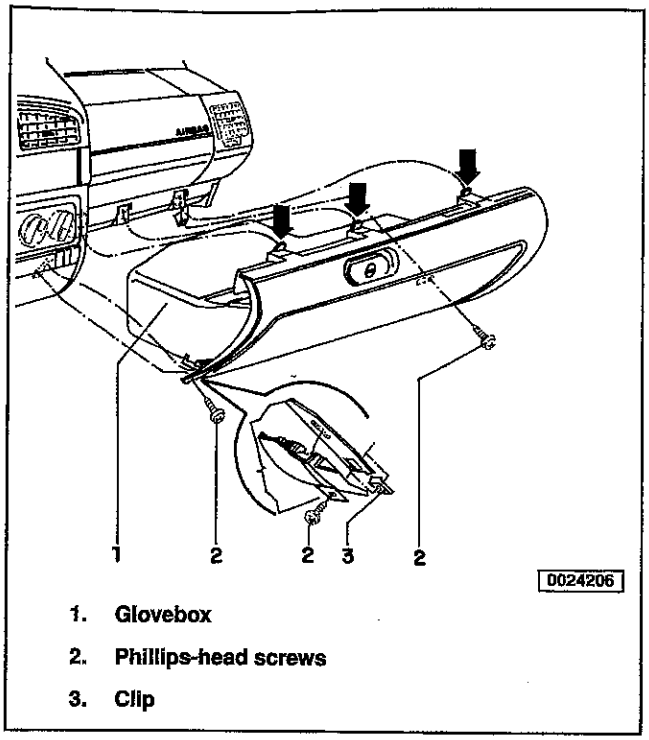
Several different glove box configurations have been used on Golf, Jetta and Cabrio vehicles depending on the model year, production date and if equipped with airbags. Glove boxes in the upper dash area are part of the padded dash. Lower dash glove boxes are built into the knee bar structure on the passenger side and the door is part of the passenger protection.

**Table a. Glove box applications by year**

| Year | Glove Box | Airbags |
|---|---|---|
| 1993 | Yes - upper dash | No |
| 1994 - early | Yes - upper dash | No |
| 1994 - late | No | Yes |
| 1995 | No | Yes |
| 1996 - early | No | Yes |
| 1996 - late | Yes - lower dash | Yes |
| 1997 | Yes - lower dash | Yes |
| 1998 | Yes - lower dash | Yes |
| 1999 | Yes - lower dash | Yes |

Vehicles without glove boxes should not have them retrofitted due to the differing structure of the body in this area. Alterations to the dashboard crossmember and knee bar will change their performance in a collision resulting in a safety hazard.

> ***WARNING —***
> *Volkswagen of America has issued a directive specifically warning against the installation of aftermarket glove boxes into 1994, 1995, and 1996 Golf, Jetta and Cabrio vehicles not originally equipped with them. Installation may change compliance with Federal Motor Vehicle Safety Standards.*




1. **Glovebox**
2. **Phillips-head screws**
3. **Clip**

0024206

**Fig. 28.** Glovebox in knee bar as installed in later vehicles that have a passenger side airbag. Be sure tabs (**arrows**) are disengaged when removing.

## Glove box in knee bar, removing and installing, vehicles with passenger side airbag

1. Remove the lower Phillips head screws. See Fig. 28.
2. Pull the glovebox downward making sure that the tabs are disengaged. Remove glovebox.
3. Installation is the reverse of removal. Make sure that the clips are properly located and that the phillips-head screws are properly installed.

# 72 Seats



## GENERAL

This repair group covers front and rear seat removal and partial seat installation.

***NOTE—***
*For wiring schematics of electrically heated front seats, see* **97 Wiring Diagrams, Fuses and Relays.**

## FRONT SEATS

### Front seat, removing and installing

Front seats on some models have side airbags built into the backrests. These are part of the airbag system. Special precautions must be observed prior to any work on or near the front seats on vehicles equipped with side airbags.

***WARNING—***
*Before removing or working on the front seats of side airbag equipped vehicles, read the warnings under* ***Airbag, safety precautions,*** *see* ***69 Seatbelts, Airbags.***

Fig. 1 shows the front seat mounting points. Use this illustration as a guide when removing and installing the front seat.

1. Remove side cover clip and pull cover off guide rail toward rear.
2. Pull wedge from back of cap using pliers.
3. Slide seat forward, remove cap nut and remove stop screw.

***NOTE—***
*On Cabrio models, a stop pin may be used in place of the stop screw. To remove the pin, slide seat forward and press pin together and pull out of seat track.*

4. Slide seat back out of guide rails.
5. Install front seat in reverse order of removal. Check left, right, and front slides for wear or damage; replace if necessary. Lubricate slides with multi-purpose grease.

**Tightening torques**
- Front seat stop (screw and cap nut) . . . 8 Nm (71 in-lb)

### Front seat backrest, removing and installing

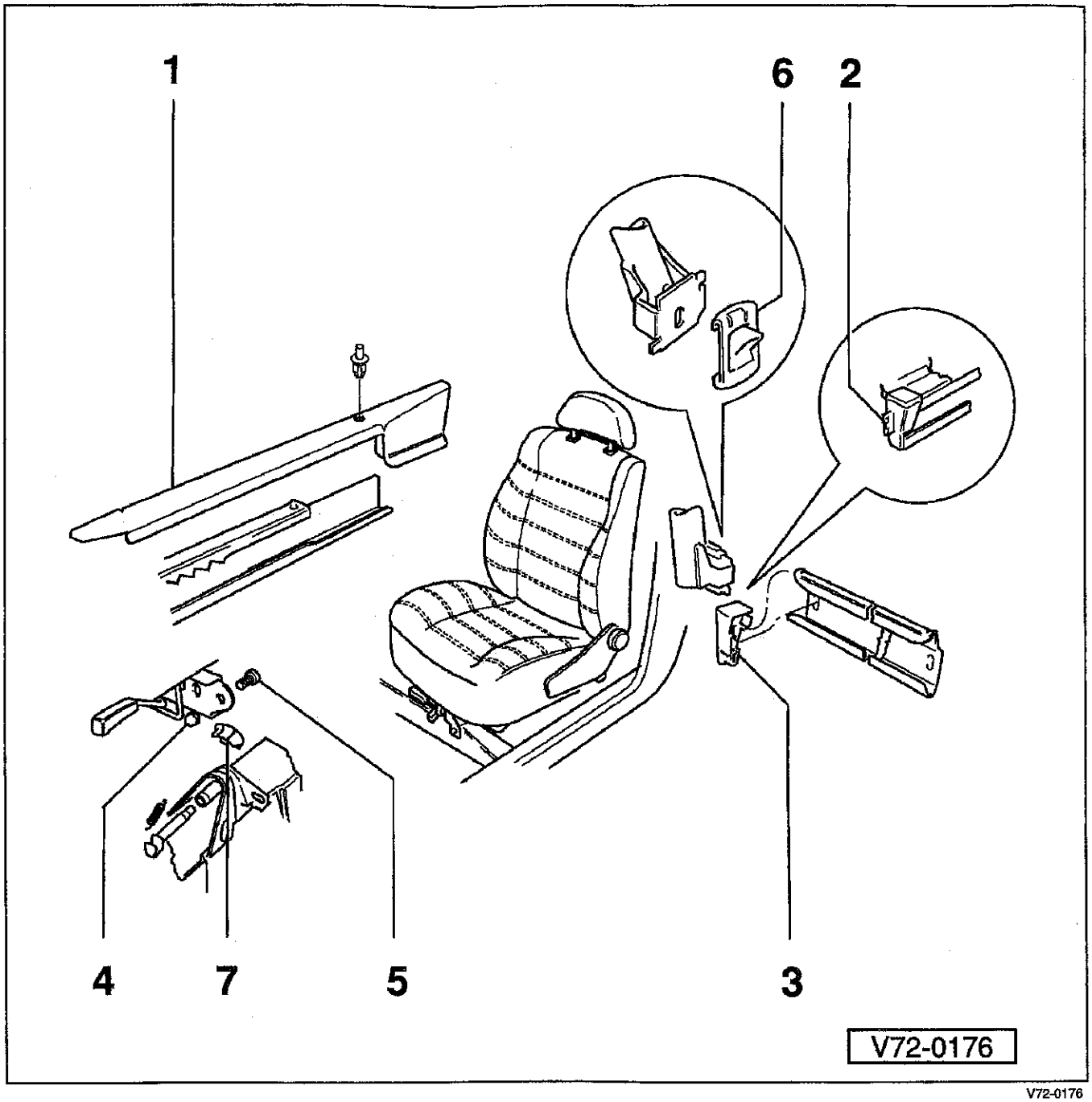
Fig. 2 shows the front seat backrest trim and mounting hardware. Use this illustration as a guide when removing and installing the seat backrest.

1. Remove front seat from vehicle as described earlier.
2. Pull off control knob from side of seat.
3. Drive side cover expander pins (left and right sides) in, toward seat center.

***NOTE—***
*The front expander pins will contact the seat frame when driving them in. Use a screwdriver from above to press the pin downward to clear the seat frame.*

4. Remove side cover from backrest frame.
5. Remove bushing retaining screws.
6. Remove retainers (left and right sides) from backrest frame.
7. Pull backrest frame off mounting pin.
8. Installation is the reverse of removal, noting the following:
   - Check the bushings (left and right sides) for wear or damage; replace if necessary.
   - Use new self-locking screws (item 11 in Fig. 2) at the bushings and remove any locking compound from nut threads with tap or thread chaser.

## Front seat, mounting



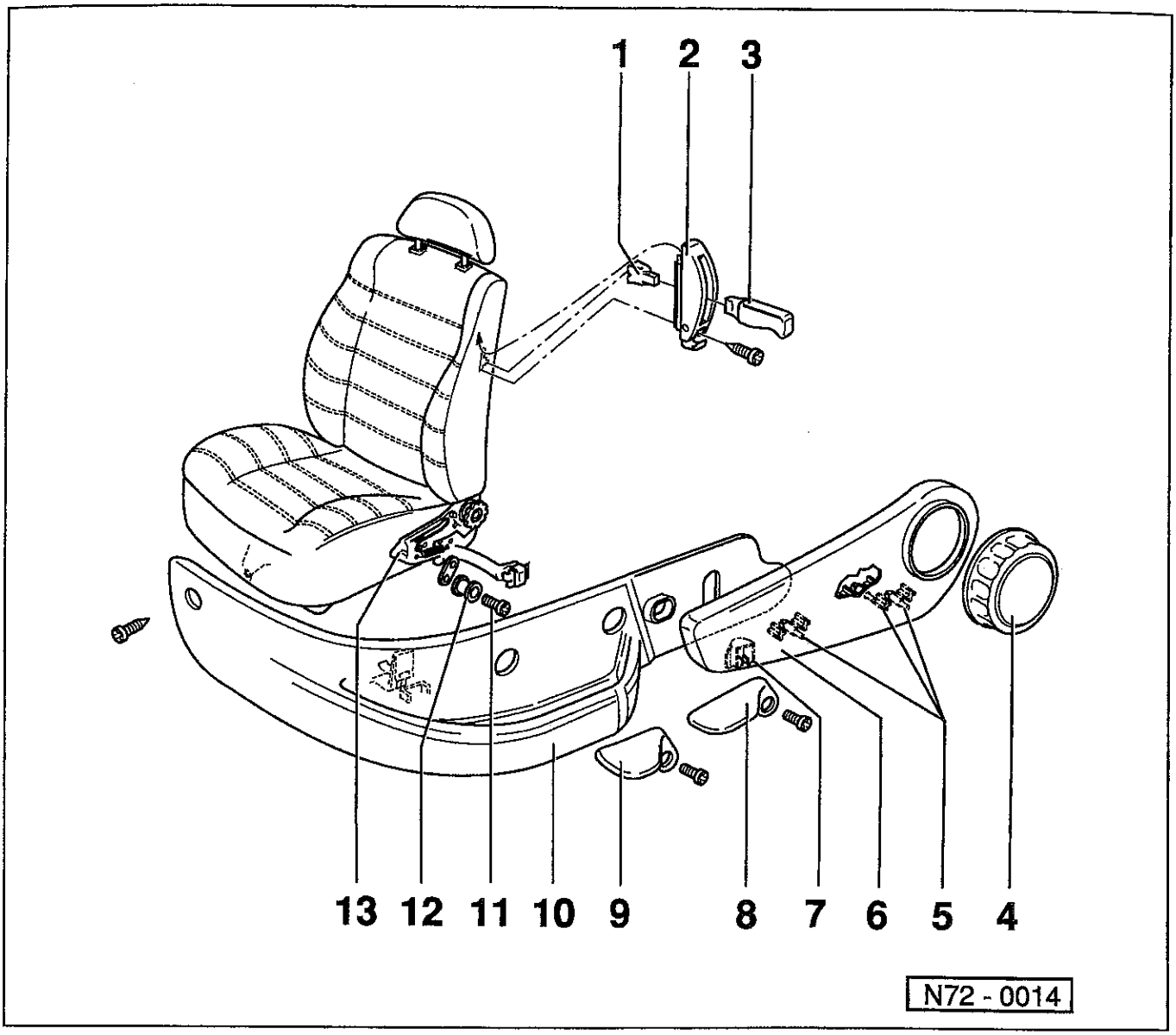

V72-0176

**Fig. 1.** Front seat securing hardware and related components on Jetta models. Other models are similar.

> ***WARNING —***
> *Before removing or working on front seats with side airbags, read the warnings under **Airbag, safety precautions**, see **69 Seatbelts, Airbags**.*

1. **Cover**
2. **Wedge**
3. **Cap**
4. **Cap nut**
5. **Stop screw**
6. **Slide (left/right)**
7. **Slide (front)**

## Front seat backrest, assembly




N72-0014

**Fig. 2.** Exploded view of front seat back rest components.

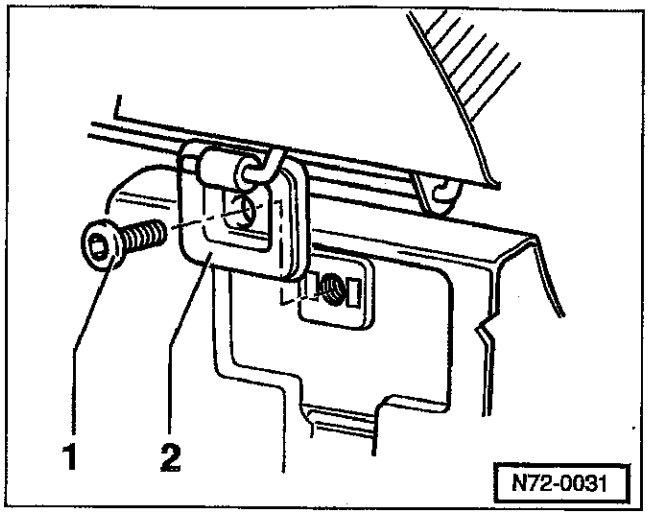
> ***WARNING —***
> *Before removing or working on front seats with side airbags, read the warnings under* ***Airbag, safety precautions****, see* ***69 Seatbelts, Airbags.***

1. **Securing clip**
2. **Trim**
3. **Release knob**
4. **Control knob**
   - Seats with height adjustment only
5. **Expander pins**
6. **Cover**
7. **Retainer**
8. **Control handle (height adjustment only)**
9. **Control handle (comfort seat only)**
10. **Trim panel**
    - Seats with height adjustment only
    - Mounts remote trunk switch on some vehicles
11. **Screw**
    - Self-locking, always replace
12. **Bushing**
13. **Mounting pin**

# REAR SEATS

## Rear seats, removing

1. Working at front of rear seat, remove bolts from seat hinges and remove seat bench using pull strap. See Fig. 3.

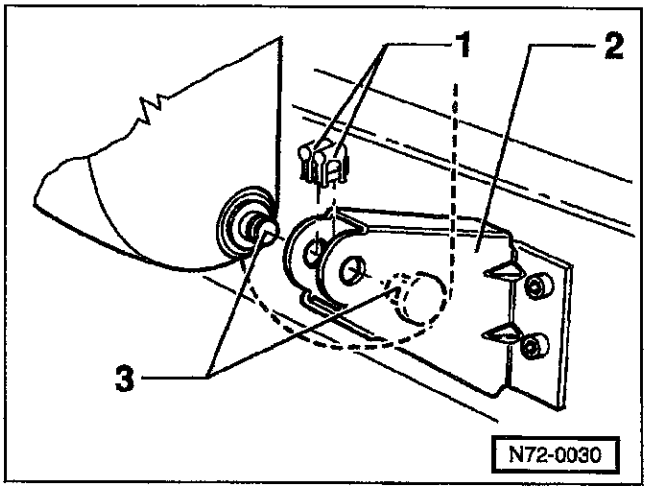



N72-0031

**Fig. 3.** Rear seat bench hinge retaining screw (**1**).

2. Fold down seat back(s).

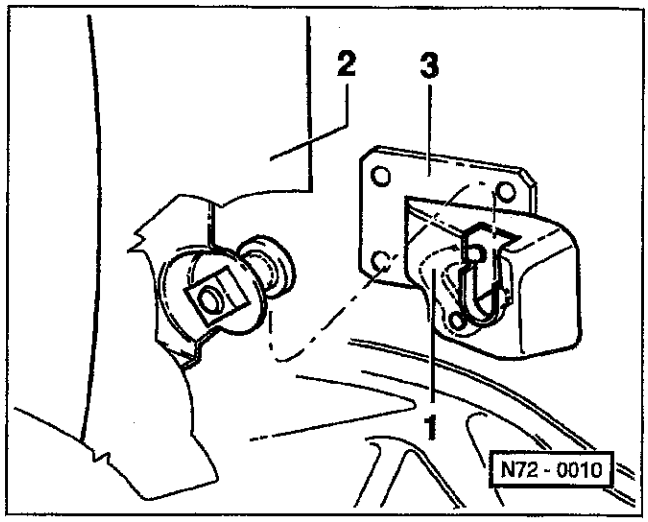
3. Remove pivot pin locks from adapters on pivot bracket. See Fig. 4. (Not applicable for Cabrio or vehicles without split seat).




N72-0030

**Fig. 4.** Remove locks (**1**) on adapters (**3**) at rear seat back center bracket (**2**). (Split rear seat only).

4. Press back latching hook on left and/or right mounting bracket, with screwdriver, and pull seat back upward out of the seat back bracket. See Fig. 5.




N72-0010

**Fig. 5.** Release latching hook (**1**) with screwdriver and pull seat back (**2**) out of seat back bracket (**3**).

5. Pull seat back out of center bracket and remove from vehicle.

***NOTE —***

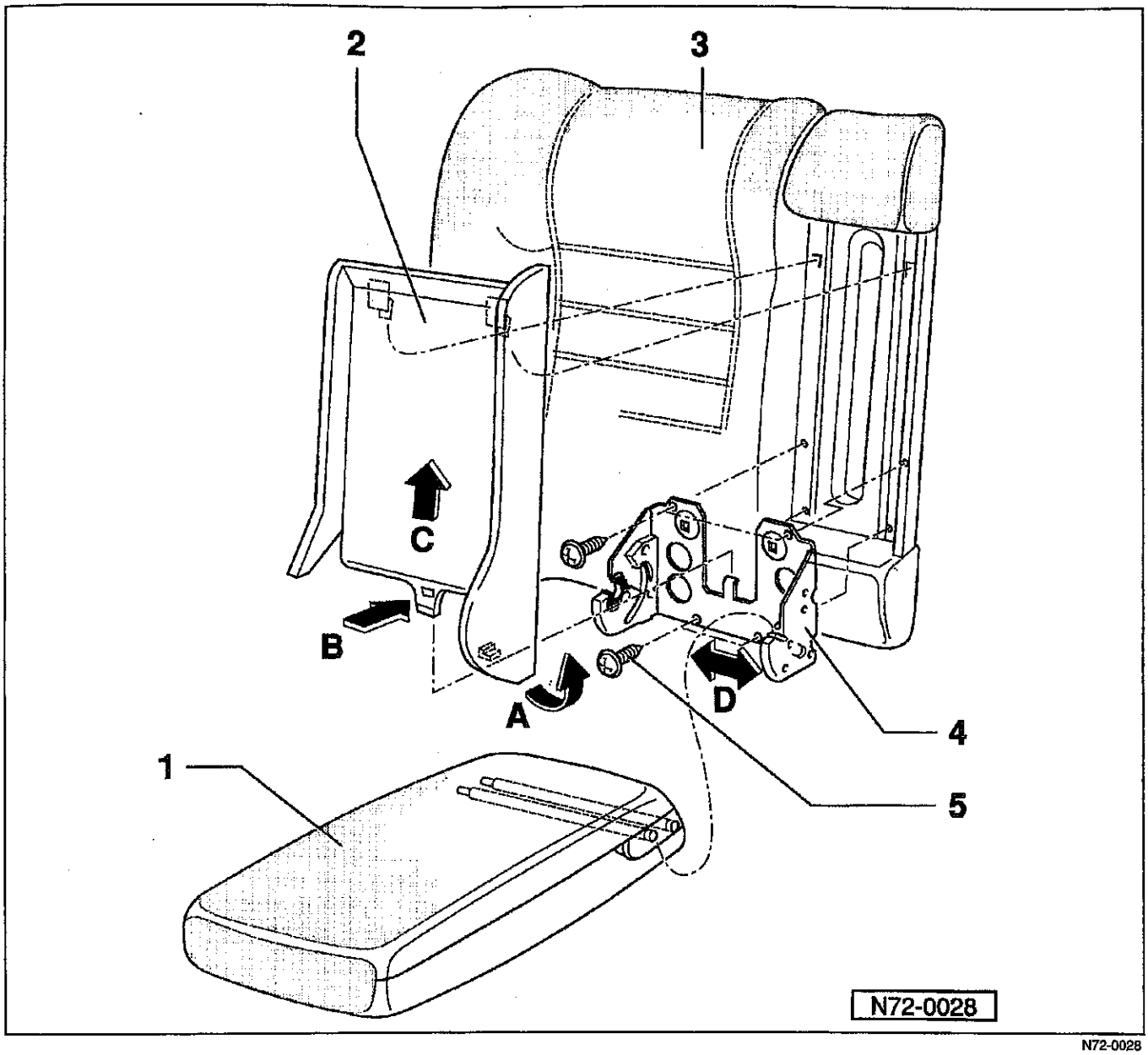
- *On Cabrio models, to remove the upper backrest, fold seat bottom up and remove the lower backrest as described above. Pry off the rear bulkhead trim from the seat backrest flange (glued in place). Remove the left and right seat belt anchor and remove upper backrest.*
- *On Cabrio models, the upper area of the rear bulkhead trim is bonded to the upper backrest. Use a universal adhesive when installing.*

**Tightening torques**

- Rear seat belt anchor to body (Cabrio model only) . . . . . 40 Nm (30 ft-lb)

## Center arm rest

The center arm rest assembly for Jetta models is shown in Fig. 6. Arm rest removal instructions are contained within the numbered list.



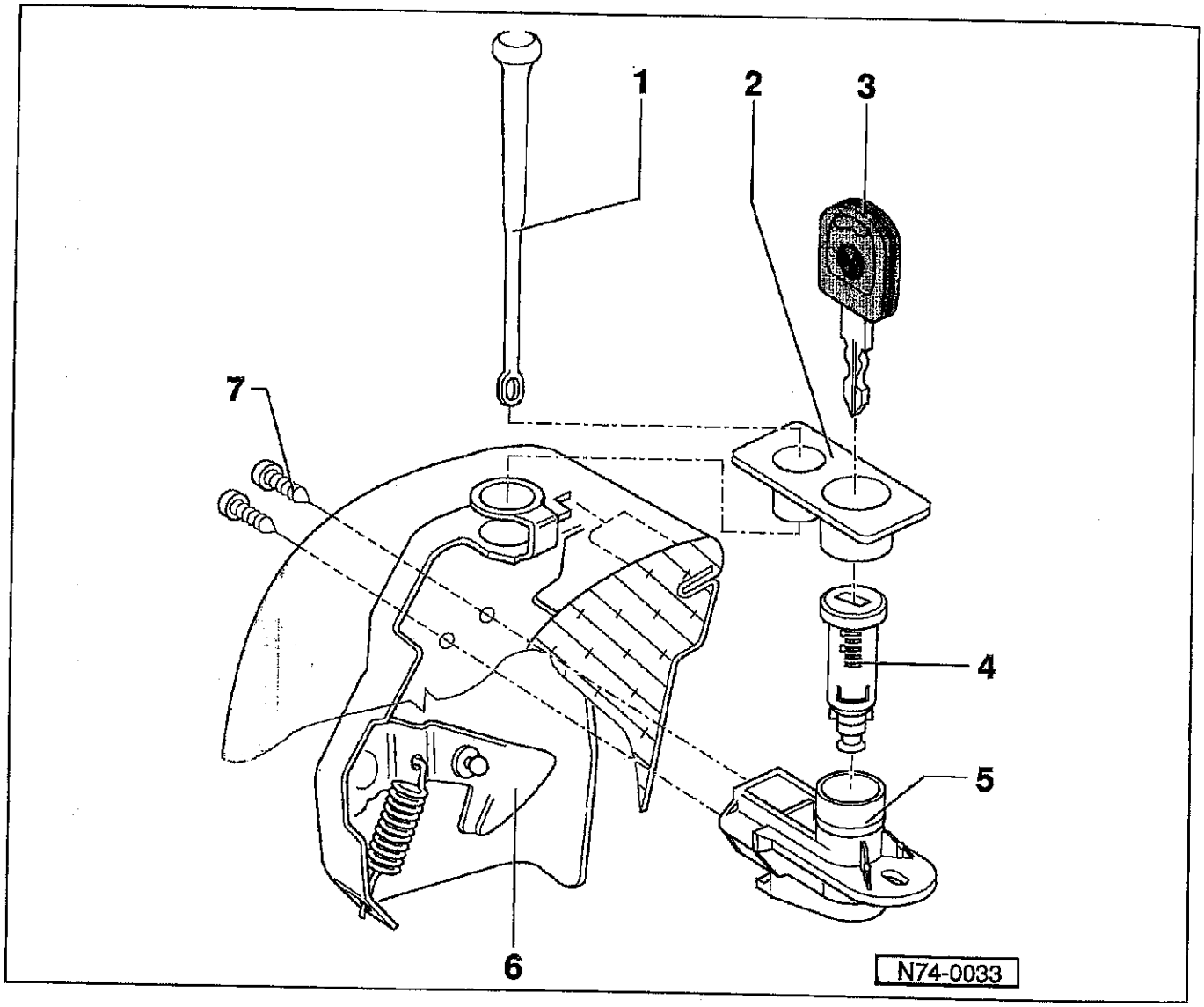

N72-0028

**Fig. 6.** Exploded view of center arm rest (rear seat) for Jetta models.

1. **Center arm rest**
   - Removing:
     Remove split seat back rest (3)
     Fold down center arm rest
     Remove trim (2) and screws (5)
     Spread bearing on bracket (4) apart (arrow D) and disconnect bearing rod for center arm rest. (bearing rod cannot be taken out through the opening on the bearing).
2. **Trim**
   - Disconnect side tab (arrow A), center tab (arrow B), and push trim upward (arrow C) to remove.
3. **Back rest (split seat)**
4. **Arm rest bracket**
5. **Screw**

## Seat back lock

The seat back lock assembly for Jetta models is shown in Fig. 7. Use the illustration as a guide when removing and installing lock components.




N74-0033

**Fig. 7.** Exploded view of rear seat back lock for Jetta models.

1. **Pull rod**
2. **Cover**
3. **Key**
4. **Lock cylinder**
   - Press out carefully, only with key inserted
5. **Lock**
   - Removing:
     Loosen cover (2) from rear area of lock
     Pry off pull rod (1) from locking hook (6) and pull out
     Pull off cover (2)
     Remove screws (7)
6. **Locking hook**
7. **Screw**

# 8 Heating and Air Conditioning



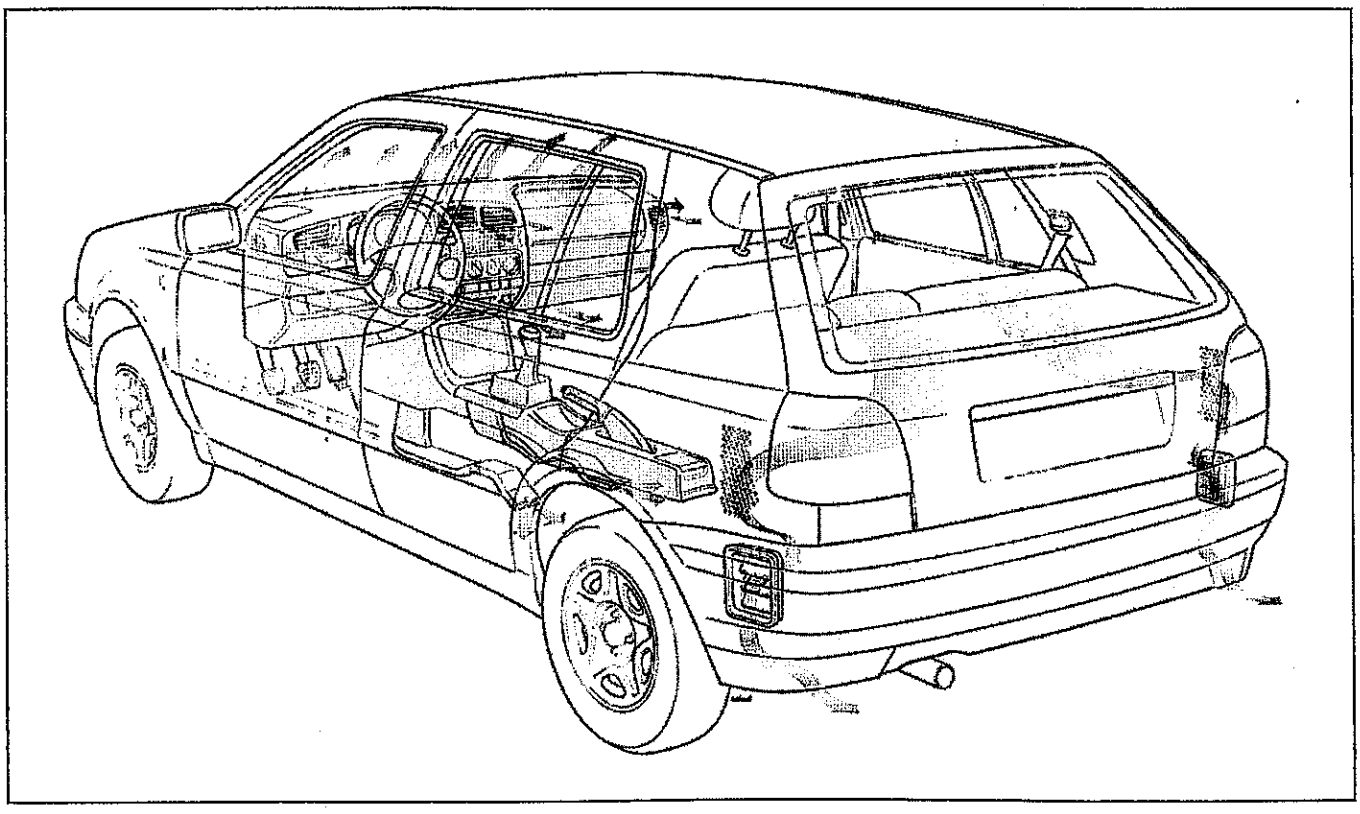
## GENERAL

This general information group gives a basic explanation of the heating and ventilation system. More specific information is provided in **80 Heating and Ventilation** for cars without air conditioning and **87 Air Conditioning** for cars with air conditioning.

## AIR FLOW

Ventilation is by a flow-through system. Fresh air enters through the grille below the engine hood and into the passenger compartment via the dashboard and footwell vents. The interior air is extracted through vents that are located in the rear of the vehicle, behind the bumper covers. This is a relatively neutral pressure zone, which results in the flow of air being quiet and less affected by changes in vehicle speed.

The duct work is designed to provide two layers of air flow for good occupant comfort. The air flowing from the center dashboard vents moves at a higher speed than air from the footwell and rear heating vents. This results in an upper layer of air that is slightly cooler than the lower air layer around the feet and legs. See Fig. 1.



0024088

**Fig. 1.** Phantom view of Golf showing vehicle airflow.

## HEATING AND VENTILATION

The heating and ventilation system is a blend type system. A heater on/off valve is not used. Coolant flows unrestricted through the heat exchanger. Interior temperature is regulated by a blend door that controls the amount of air that is passed over the heater core. This blend door is operated by a cable connected to the temperature control dial. See Fig. 2.

Three round dials are used to control blower speed, air temperature and air distribution. The fresh air blower has four speeds. The series resistance for the blower is located in the blower motor housing.

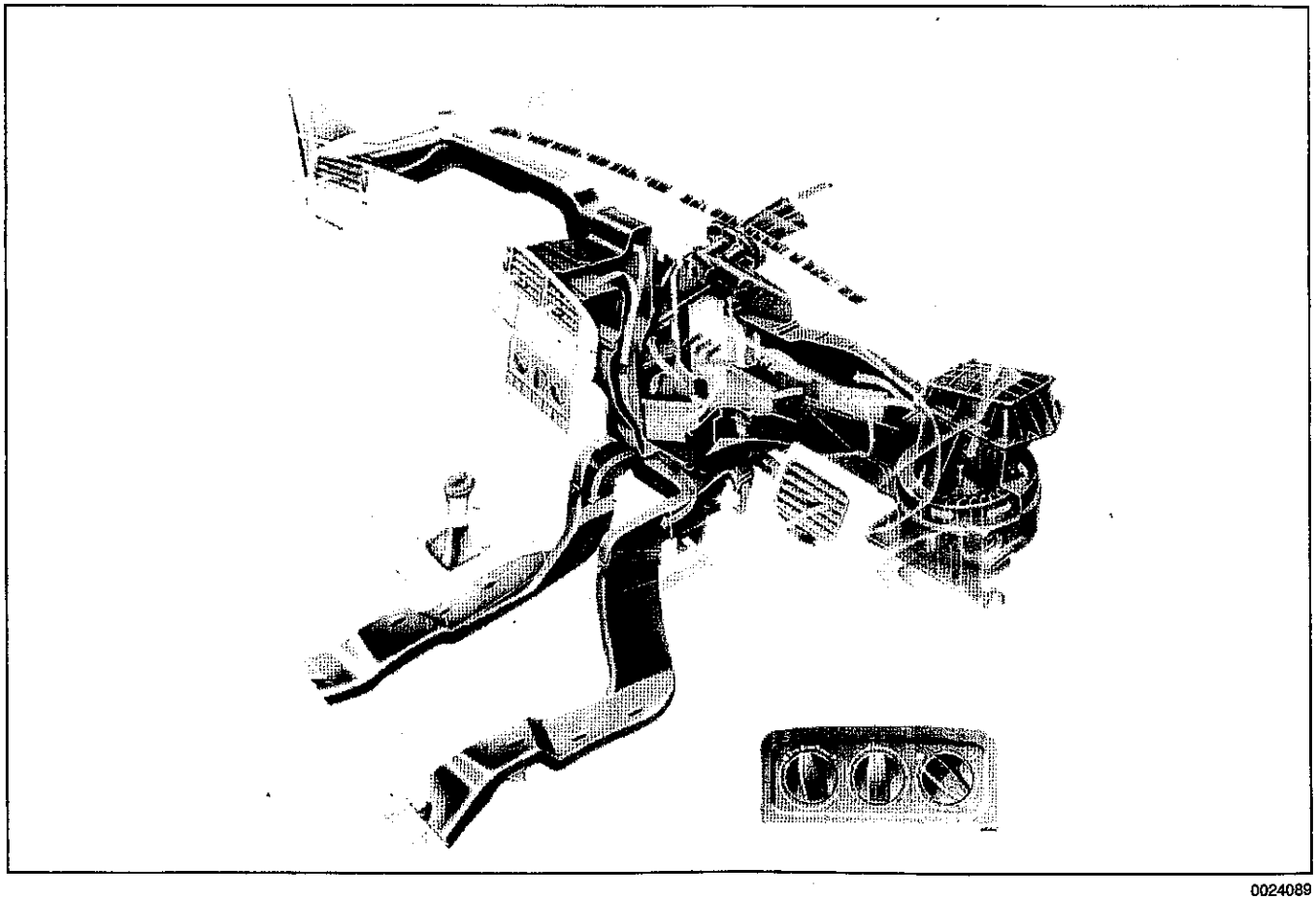
## AIR CONDITIONING (A/C)

On cars with A/C, a blend type system is also used. Fresh air is first drawn in and passed through the evaporator to be cooled and dehumidified when the A/C compressor is switched on. A portion of this air can then be directed over the heat exchanger by the temperature regulation door to maintain the desired temperature. See Fig. 3.

Vehicles with A/C have two additional buttons on the ventilation controls. The A/C button turns the A/C compressor on and off. A second button is used to switch closed the air recirculation door for maximum cooling. The air circulation door is also closed when the blower switch is turned off.

The series resistance for the blower motor is located in the A/C Evaporator case.

The A/C refrigerant system uses a variable displacement A/C compressor. The A/C compressor does not cycle on and off when the A/C is switched on. Instead, the displacement of the A/C compressor will increase or decrease to match the cooling load on the A/C system. This eliminates the surging caused by a cycling A/C compressor clutch and increases the thermal efficiency of the system.



0024089

**Fig. 2.** Blend-type heating and ventilation system on cars without A/C. Air flows past heater core and blending door before entering passenger compartment.

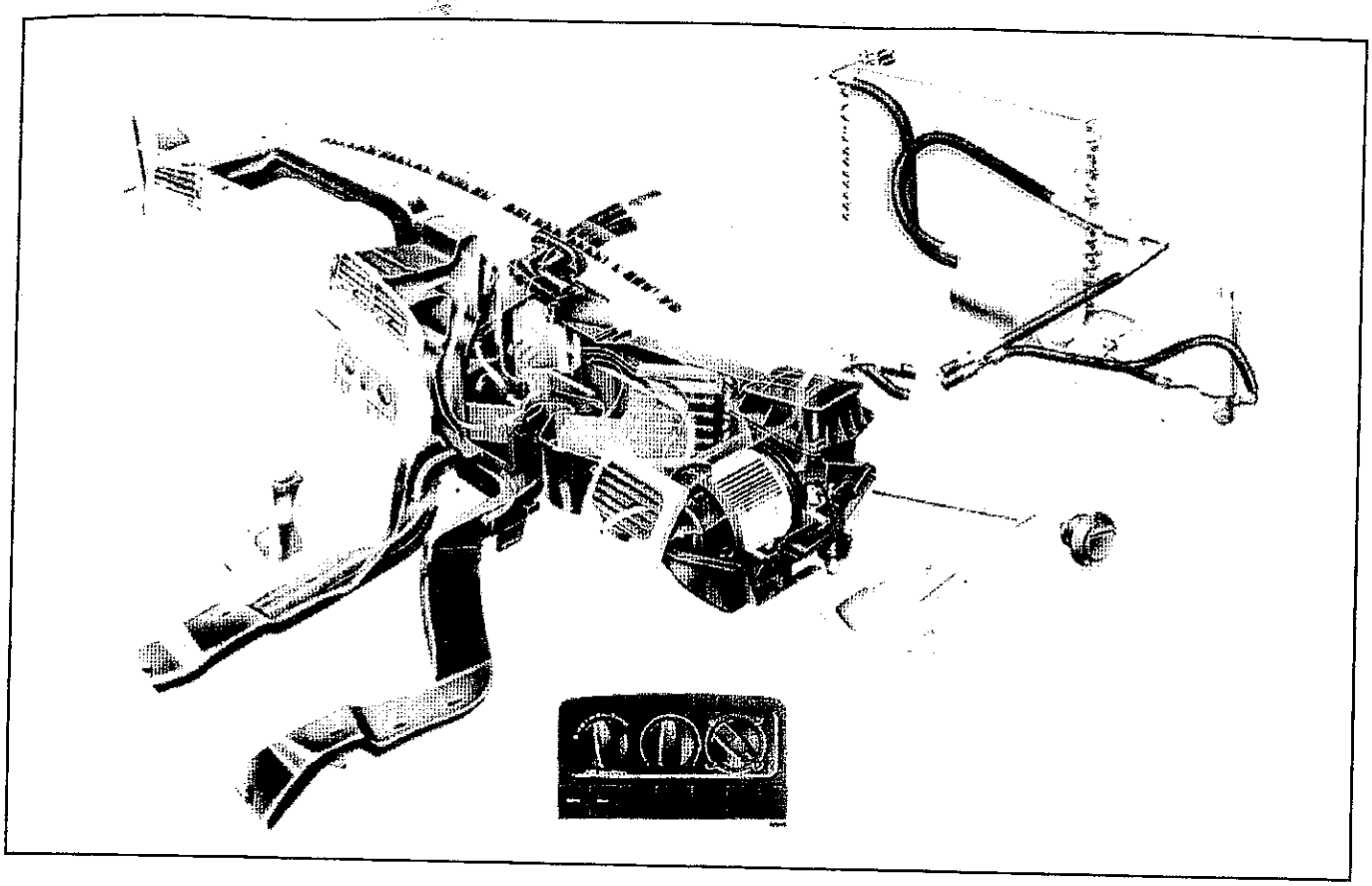


**Fig. 3.** Phantom view of A/C system. 0024090

## R134a refrigerant

1993 and later Volkswagens use R-134a A/C refrigerant. All of the system's components are specially made to be compatible with R-134a. These components must not be interchanged with other systems which use R-12 or other refrigerants. Fig. 4 shows an overall view of the A/C system components.

Due to the harmful effect that R-12 refrigerant has on the Earth's ozone layer, R-12 refrigerant was replaced by R-134a refrigerant. The benefit of using R-134a (hydrofluorocarbon) refrigerant is that it is chlorine free. Chlorinated fluorocarbons (CFCs), present in R-12, destroy the ozone in the stratosphere through chemical reaction.

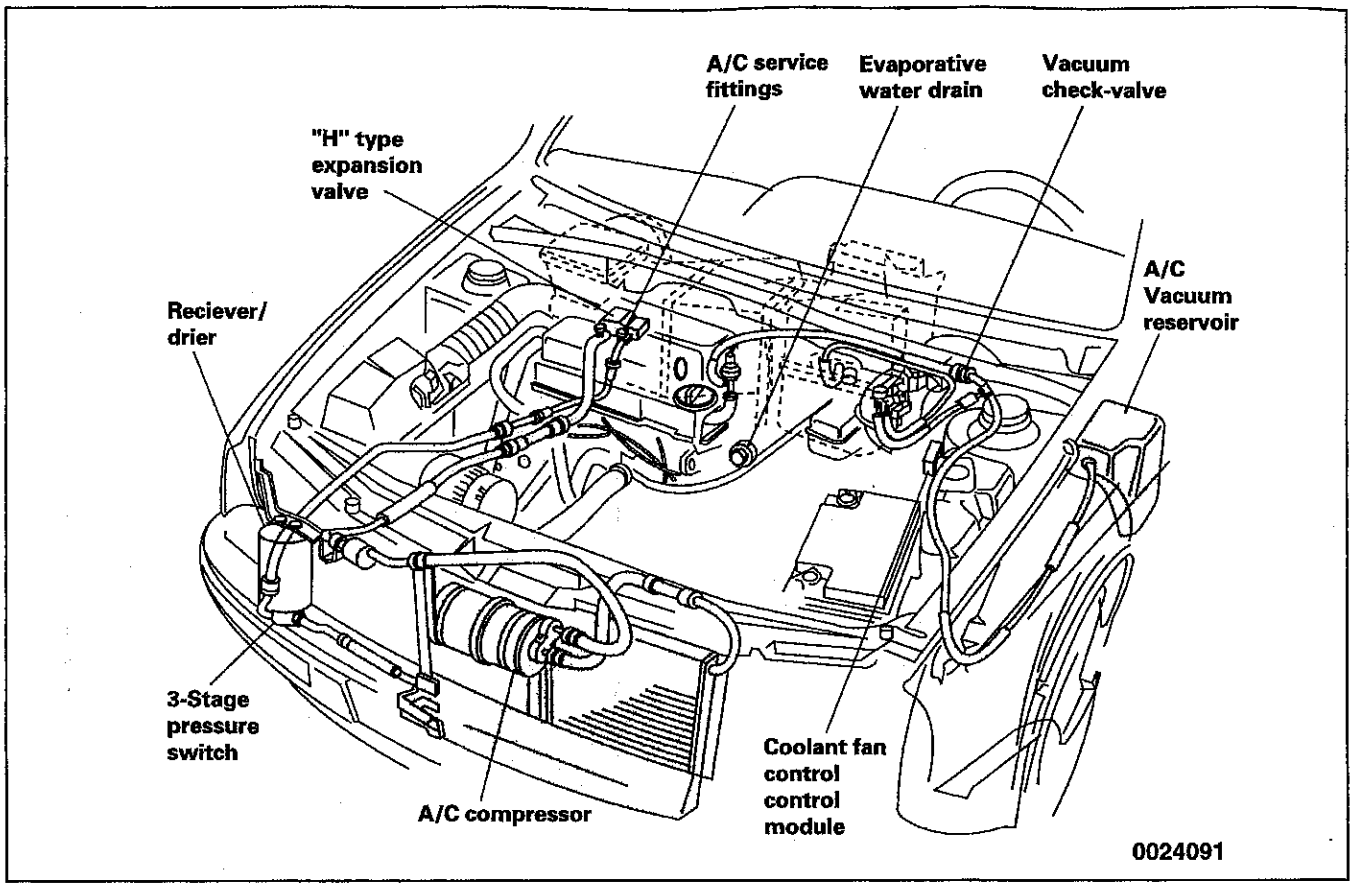
The R-134a and the R-12 A/C systems are very similar in appearance; don't let this fool you. There are differences in the refrigerant, lubrication, components and servicing.

A/C components used in R-134a systems can be identified by green markings. For example, the A/C hoses have a green stripe on the hose; the identification label for the A/C compressor is green.See Fig. 5.

***CAUTION—***

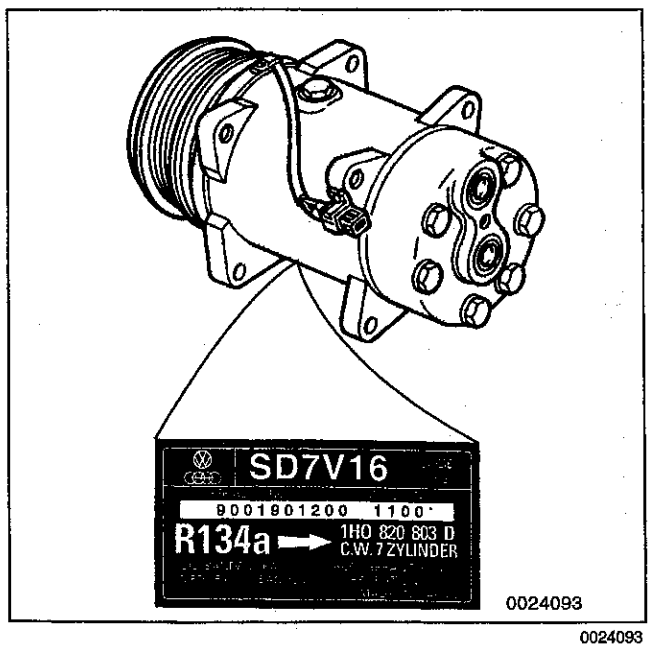
- *R-134a components, refrigerants, and refrigerant oils must not be interchanged with other system components or refrigerants which use R-12 or other refrigerants.*
- *The equipment needed to service an R-134a system is different than the equipment needed to service an R-12 system . Do not use R-12 equipment on an R-134a system.*

The refrigerant oil used in R-134a A/C systems is a synthetic oil (polyalkyleneglycol) otherwise known as PAG oil. The R-12 systems use very different mineral based refrigerant oil. The two refrigerants and refrigerant oils must not be mixed under any circumstances or component failure will result. There are also different kinds of PAG oils, so make sure to use the correct oil for the R-134a system.




0024091

**Fig. 4.** Air conditioning components.




0024093

**Fig. 5.** A/C components used in the R134a system can be identified by green markings. The ID label on the A/C compressor is green and the A/C hoses have a green stripe.

# 80 Heating and Ventilation



## GENERAL

This section primarily applies to cars without air conditioning (A/C). For cars with A/C, the system must be professionally discharged before working on most of the heating and ventilation components. See **87 Air Conditioning**.

***WARNING —***
*On cars with A/C, replacement of the heater and ventilation components may require discharging/charging the A/C system. This requires special equipment and training. For more information, see* **87 Air Conditioning**.

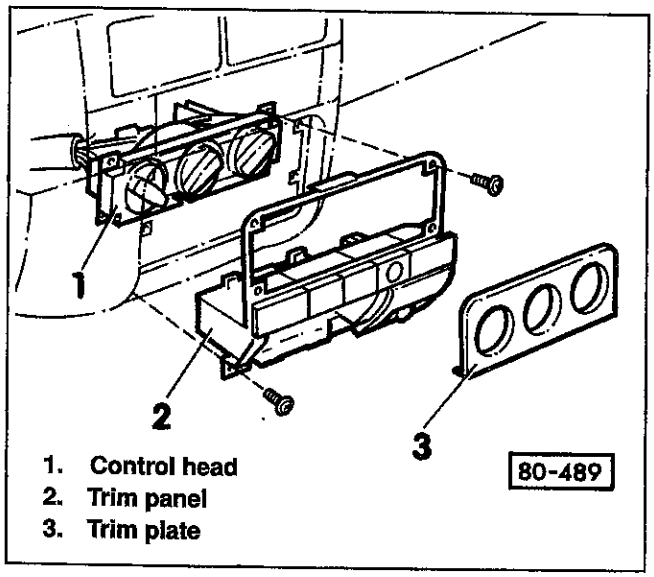
## HEATING AND VENTILATION, SERVICING

***WARNING —***
*Hot coolant is under pressure and can scald. Allow engine to cool before performing any work which requires contact with heating or cooling system.*

***CAUTION —***
- *Before working on the electrical system disconnect negative (–) battery cable.*
- *Be sure to have radio anti-theft code before disconnecting battery.*

### Ventilation control head, removing and installing

1. Carefully remove trim plate. See Fig. 1.




1. **Control head**
2. **Trim panel**
3. **Trim plate**

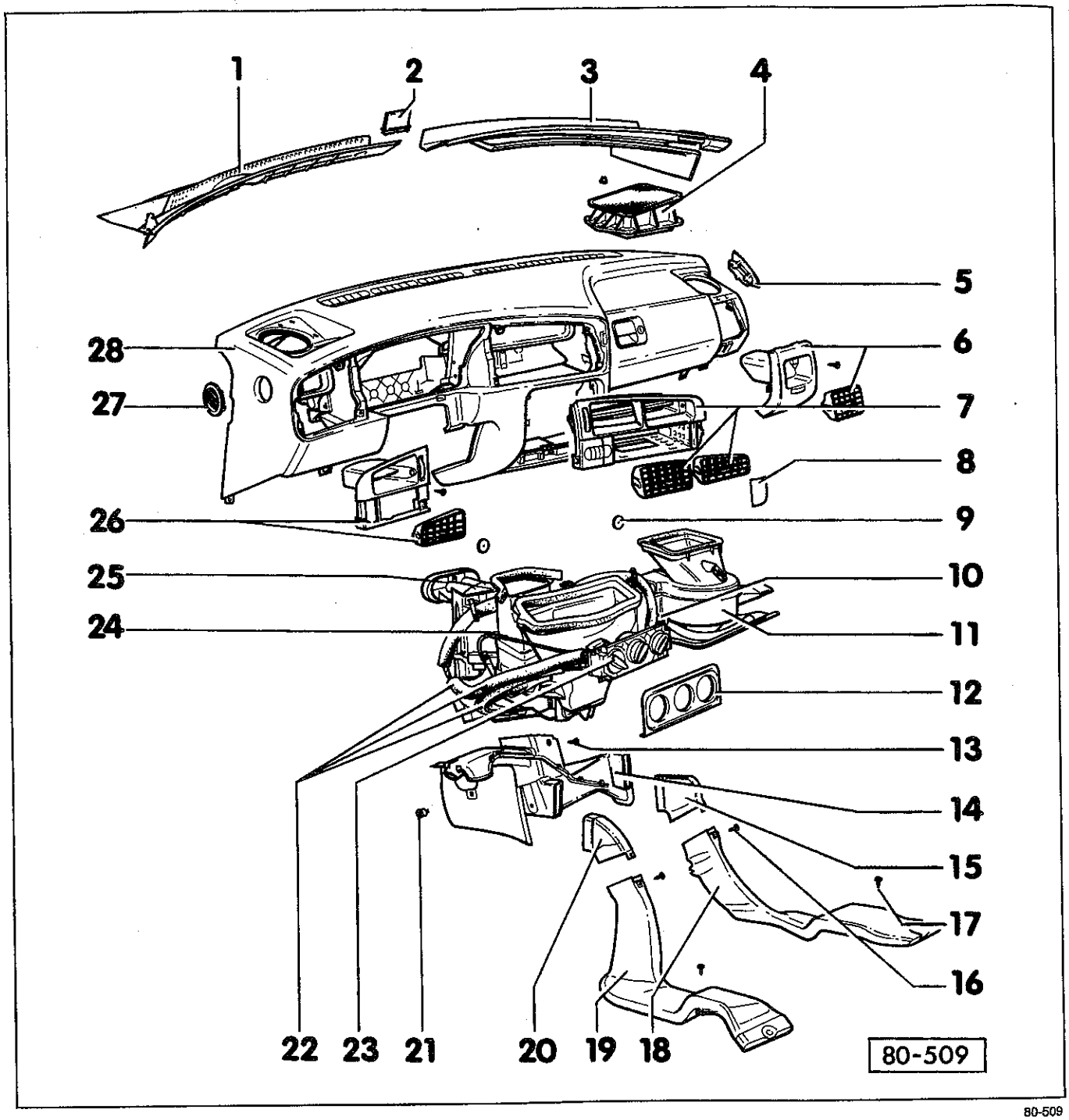
80-489

**Fig. 1.** Ventilation control head and trim.

2. Remove screws and remove trim panel.
3. Pull ventilation control head from instrument panel.
4. Disconnect control cables from control head and remove control head. See **Control Cables**.
5. Install in reverse order of removal.

***NOTE —***
*Install control cables on the control head before installing the control head into instrument panel. See* **Control Cables**.

## Heater assembly (cars without A/C)




80-509

**Fig. 2.** Exploded view of heating and ventilation system used on cars without A/C.

1. **Left plenum cover**
2. **Connecting clip**
3. **Right plenum cover**
4. **Air intake adapter**
   - Dust and pollen filter (if applicable), removing/installing, **see 0 Maintenance Program**
5. **Side window air outlet**

6. **Right air outlet**
7. **Center air outlet**
8. **Trim cover**
9. **Nut**
10. **Fresh air blower series resistance with fuse (N24)**

> *NOTE—*
> *Volkswagen identifies electrical components by a letter and/or a number in the electrical schematics. These electrical identifiers are listed as an aid to electrical troubleshooting.*

- Removing/installing (with A/C) see **87 Air Conditioning**
- Removing/installing (without A/C), **see (A)**

11. **Fresh air blower (V2)**
- Removing/installing (without A/C), **see (A)**
- Removing/installing (with A/C), see **87 Air Conditioning**

12. **Trim plate**
13. **Self-tapping screw**
14. **Footwell air outlet**
- To remove, first remove center console

15. **Rear footwell air duct connector, right**
16. **Self-tapping screw**
17. **Self-tapping screw**
18. **Rear footwell air duct, right**
19. **Rear footwell air duct, left**
20. **Rear footwell air duct connector, left**
21. **Clip**
22. **Control cables**
- See **Control cables installing/adjusting**

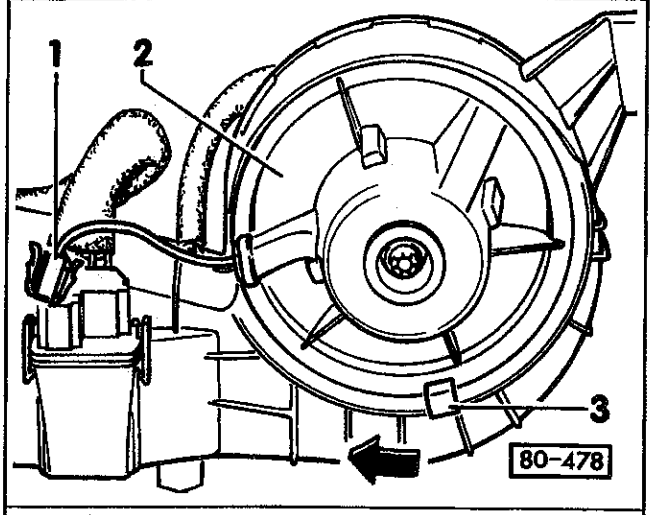
23. **Ventilation control head**
- See **Control cables, installing and adjusting**

24. **Heater box/evaporator housing**
- To remove, see **Heater box, removing**

25. **Heater core**
26. **Left air outlet**
- Removing/installing, **see (B)**

27. **Side window air outlet**
28. **Instrument panel**
- Do not disassemble further than shown
- Removing/installing see **70 Trim-Interior**

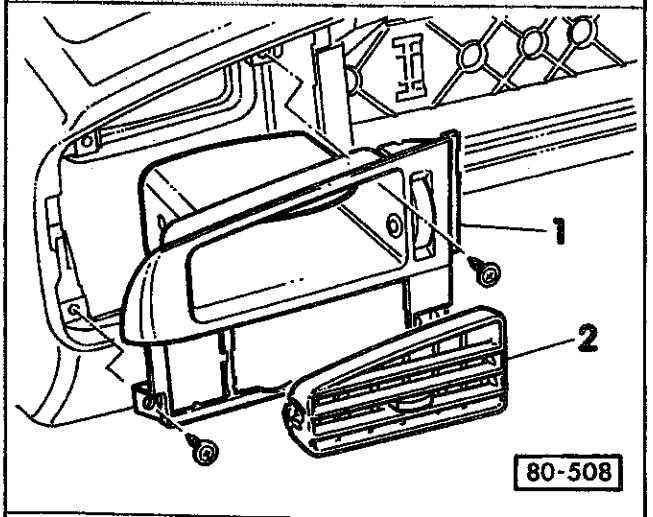
## (A) Fresh air blower series resistance, removing/installing (cars without A/C)




80-478

- **To remove series resistance: disconnect wire connector (1) from series resistance unit. Unclip series resistance unit from fresh air blower housing.**
- **To remove blower motor: Remove clip (3), rotate fresh air blower (2) in direction of arrow and remove.**

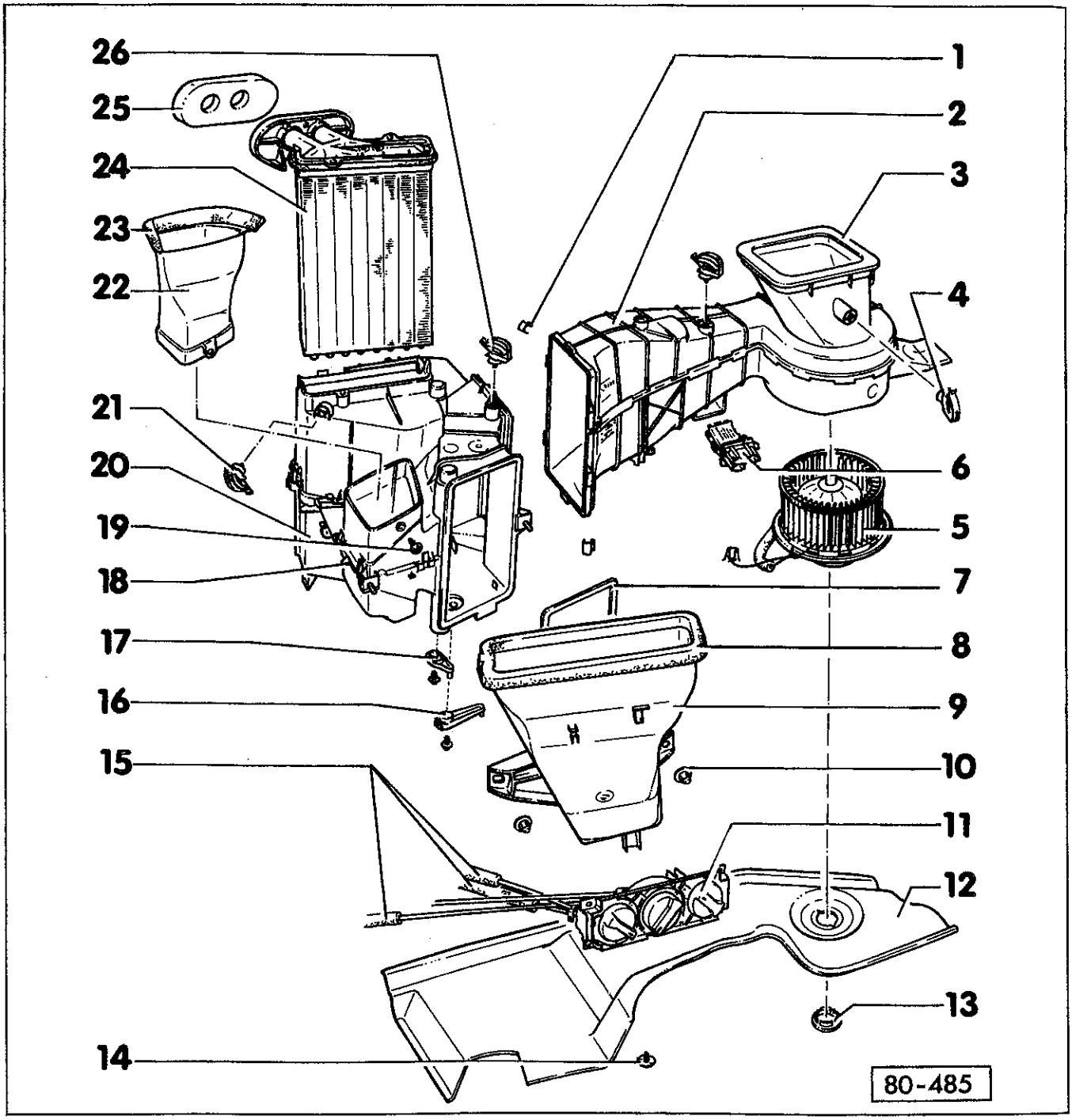
## (B) Left air outlet, removing




80-508

- **Remove headlight switch, see 96 Lights–Interior**
- **Using long nose pliers, carefully pull out grill (2).**
- **Remove screws and remove air outlet (1).**

## Heater box/evaporator housing, assembly




80-485

**Fig. 3.** Heater box/evaporator housing and related components.

1. **Clip**
2. **Air duct with main shut-off flap**
   • Do not disassemble further
3. **Gasket**
4. **Wire clip**
5. **Fresh air blower (V2)**
6. **Fresh air blower series resistance with fuse (N24)**

7. **Gasket**
8. **Gasket**
   - Always replace
9. **Air duct**
10. **Nut**
11. **Ventilation control head**
12. **Cover**
13. **Plug**
14. **Clip**
15. **Control cables**
    - When replacing, first remove cover (12)
    - Cars without A/C, see **Control Cables**
    - Cars with A/C, see **87 Air Conditioning**
16. **Central flap lever**
17. **Temperature flap lever**
18. **Footwell/defrost flap lever**
19. **Self-tapping screw**
20. **Air distribution housing**
    - Do not disassemble further
21. **Wire clip**
22. **Air duct connector**
23. **Gasket**
    - Always replace
24. **Heater core**
    - Install seals around perimeter of heater core so there are no gaps.
    - If heater core does not lock into place during installation, fasten to heater box using screws on top of heater core.
    - Installing vacuum hose adaptor, **see Heater core, replacing**

> ***NOTE—***
> *After replacing heater core, the coolant should be drained and refilled with coolant. See* **19 Engine–Cooling System**

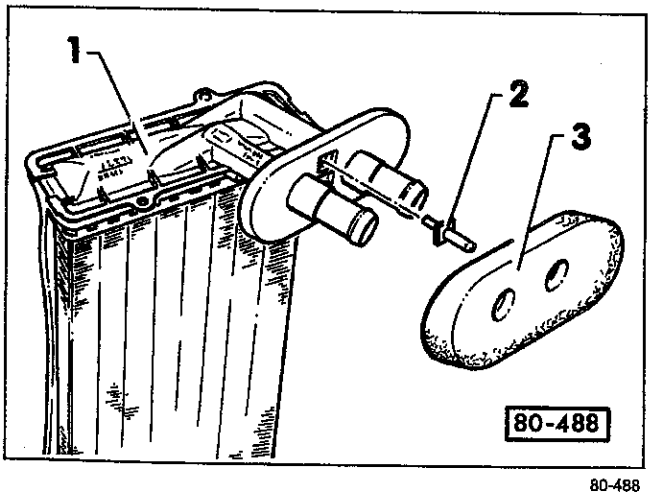
25. **Gasket**
    - Always replace
26. **Wire clip**

## Heater core, replacing

> ***WARNING—***
> *On cars with A/C, replacement of the heater core will require discharging/charging the A/C system. This requires special equipment and training. For more information see* **87 Air Conditioning**.

1. Discharge A/C refrigerant system.
2. Drain engine coolant. See **19 Engine-Cooling System.**
3. Remove instrument panel and support bracket. See **70 Trim-Interior.**
4. Working in engine compartment, label and disconnect heater hoses and wiring as necessary.
5. Plug A/C lines and fittings immediately after disconnecting.
6. Remove heater box/evaporator housing from car. See Fig. 3.
7. Unclip heater core housing and pull heater core straight out of heater box.
8. Installation is the reverse of removal. When installing, make sure seals are installed around perimeter of heater core so there are no gaps. Seal grooves and contact surfaces with silicone rubber sealant. On cars with A/C be sure to reinstall vacuum connection. See Fig. 4.

> ***CAUTION—***
> *A/C system must be evacuated for at least 30 minutes before recharging. See* **87 Air Conditioning**.



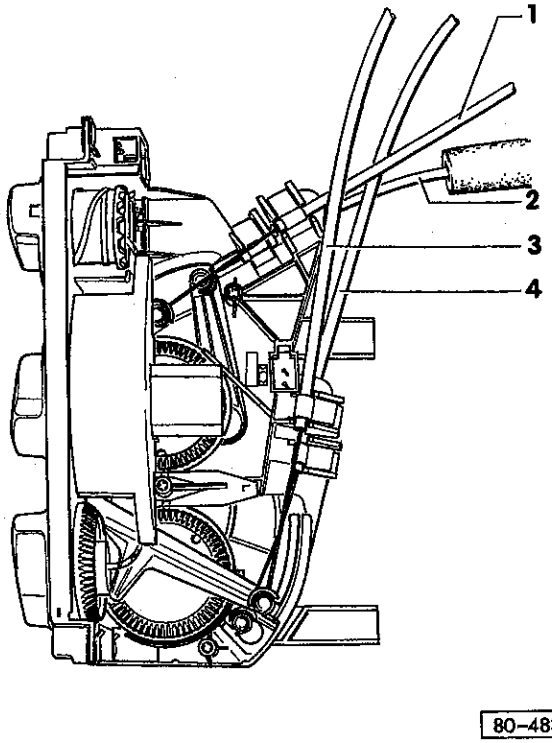

80-488

**Fig. 4.** Install vacuum hose adapter (**2**) and replace gasket (**3**) when installing new heater core (**1**) on cars with A/C.

## CONTROL CABLES

Use Fig. 5 as a guide when installing and adjusting control cables.

### Control cables, assembly




1. **Main shut-off flap cable**
   - Connects blower control knob to main shut-off flap
   - Black sleeve
   - Length: 807 mm (31.8 in.)
   - Not applicable to A/C equipped cars
2. **Temperature flap cable**
   - Connects temp. control knob to temp. flap
   - Blue sleeve
   - Length: 585 mm (23.0 in.)
3. **Footwell/defroster flap cable**
   - Connects upper control lever to footwell/defroster flap
   - Black sleeve
   - Length: 488 mm (19.2 in.)
4. **Central flap cable**
   - Connects lower control lever to central flap
   - Black sleeve
   - Length: 639 mm (25.2 in.)

80-483

**Fig. 5.** Exploded view of control cables on ventilation control head (control head shown for cars without A/C, others similar).

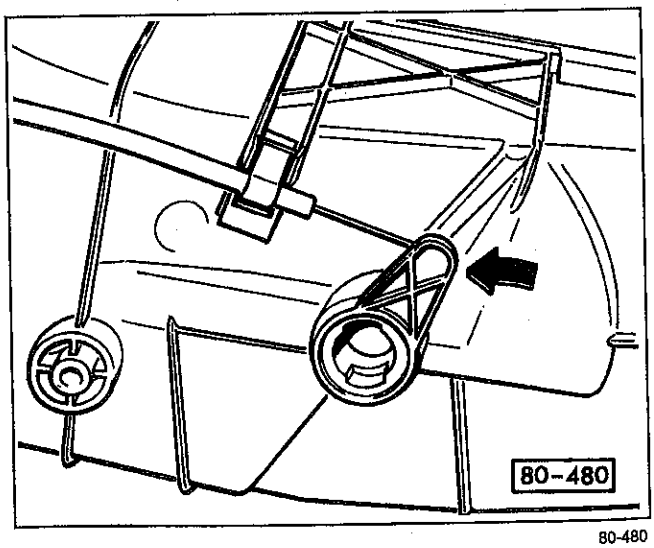
### Control cables, installing and adjusting

1. Install cable ends identified with colored bands to control head levers.
2. Install cables to control head before installing on evaporator/heater box levers.
3. After connecting cables to control head levers, position cable sleeves against stops and fasten to control head using clips.
4. Adjust cables at flap levers with control head installed.
5. When control knobs are turned stop to stop, flaps must move and audibly contact stops.

### Main shut-off flap cable, adjusting

*NOTE—*
*Main shut-off flap cable is only installed on cars without A/C.*

1. Install ventilation control head into instrument panel. See **Ventilation control head, removing and installing.**
2. Adjust fresh air blower switch to stop at position "0".
3. Connect main shut-off flap cable (black sleeve) to main shut-off flap lever.
4. Push lever to stop. See Fig. 6.



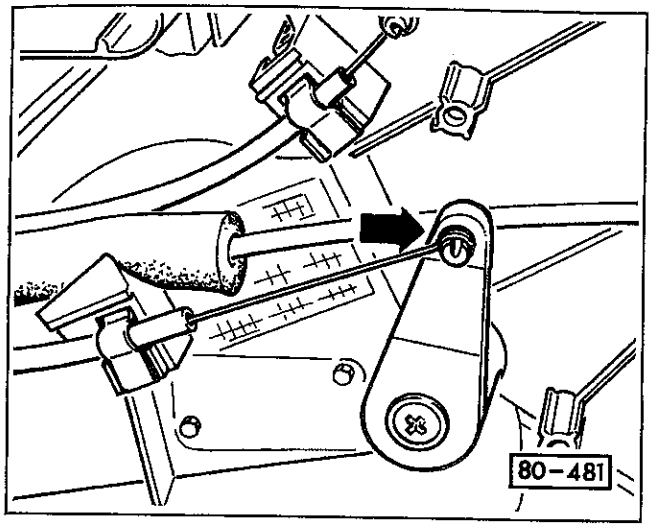

80-480

**Fig. 6.** Push main shut-off lever against stop (direction of arrow), then install cable retaining clip.

5. Hold lever in position and install cable retaining clip.

## Temperature flap cable, adjusting

1. Install ventilation control head into instrument panel. See **Ventilation control head, removing and installing.**
2. Adjust temperature control knob to full cold.
3. Connect temperature flap cable (blue sleeve) to temperature flap lever.
4. Push lever to stop. See Fig. 7.



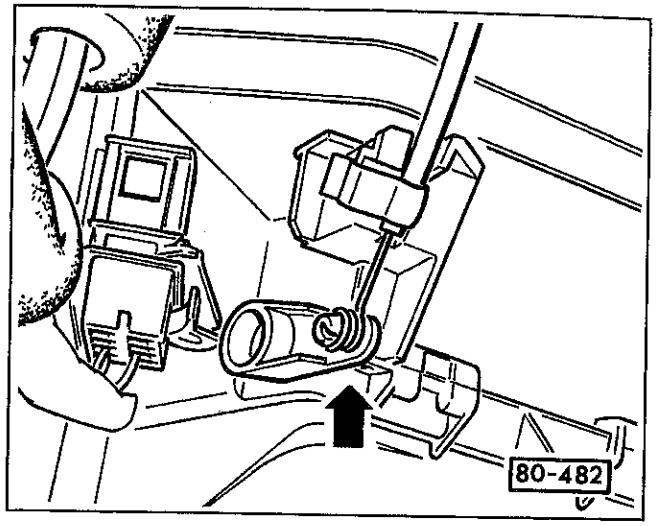

80-481

**Fig. 7.** Push temperature lever against stop (direction of arrow), then install cable retaining clip.

5. Hold lever in this position and install cable retaining clip.

## Footwell/defroster flap cable, adjusting

1. Install ventilation control head into instrument panel. See **Ventilation control head, removing and installing.**
2. Adjust air flow distribution knob to DEFROST position (against stop).
3. Connect footwell/defroster flap cable (black sleeve) to footwell/defroster flap lever.
4. Push lever to stop. See Fig. 8.
5. Hold lever in this position and install cable retaining clip.

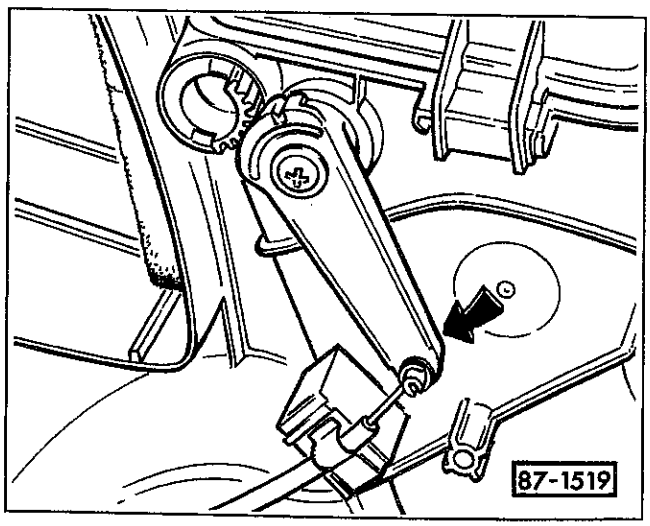



80-482

**Fig. 8.** Push footwell/defroster lever against stop (direction of arrow), then install cable retaining clip.

## Central flap cable, adjusting

1. Install ventilation control head into instrument panel. See **Ventilation control head, removing and installing.**
2. Adjust air flow distribution knob to DEFROST position (against stop).
3. Connect central flap cable (black sleeve) to central flap lever.
4. Push lever to stop. See Fig. 9.




87-1519

**Fig. 9.** Push central flap lever against stop, then install cable retaining clip.

5. Hold lever in this position and install cable retaining clip.

# 9 Electrical System



## GENERAL

This general information group covers a brief description of the principal parts of the electrical system. Also covered here is general electrical system troubleshooting and instructions on using Volkswagen wiring diagrams.

### Voltage and polarity

Volkswagen electrical systems are 12-volt direct current (DC) negative-ground systems. A voltage regulator controls the output of the alternator to approximately 13.5 volts. All circuits are grounded by direct or indirect connection to the negative (–) terminal of the battery. A number of ground connections throughout the car connect the wiring harness to chassis ground. These circuits are completed by the battery cable or ground strap between the body and the battery negative (–) terminal.

### Electrical system safety precautions

Please read the following warnings and cautions before doing any work on your electrical system.

***WARNING —***

- *Ignition systems operate 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 vehicle with the ignition on or the engine running.*
- *On cars equipped with Airbags, special precautions apply to any electrical system testing or repair. The airbag unit is an explosive device and must be handled with extreme care. Before starting any work on an airbag equipped car, refer to the warnings and cautions in* **69 Seatbelts, Airbags.**

***WARNING —***

*Before operating the starter without starting the engine (as when making a compression test), disable ignition system as described in* **28 Ignition System.**

***CAUTION —***

- *Always switch the ignition off and remove the negative (–) battery cable before removing any electrical components.*
- *Before disconnecting battery be sure to obtain radio anti-theft code.*
- *Connect and disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is switched off.*
- *Do not disconnect battery while the engine is running. Never reverse the battery terminal connections. Even a momentary wrong connection can damage the alternator or electrical components. If the polarity markings on the battery are not visible, confirm the polarity of battery using a voltmeter.*
- *Always remove the battery cables before quick-charging the battery. Never use a quick-charger as a booster for starting the car. Do not exceed 16.5 volts at the battery.*
- *Many solid-state modules operate on very low current and can be permanently damaged if exposed to static discharge. Always handle the modules using proper static prevention equipment and techniques.*
- *Always switch a test meter to the appropriate function and range before making test connections.*
- *Disconnect the battery before doing any electric welding on the car.*
- *Do not wash the engine while it is running, or anytime the ignition is switched on.*
- *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.*

## Electrical test equipment

Many of the electrical tests described in this manual call for measuring voltage, current or resistance using a digital multimeter (DMM). DMMs are preferred for precise measurements and for electronics work because they are generally more accurate than analog meters. The DMM is also safe for most solid state components whereas an analog meter can damage some components.

An LED test light is a safe, inexpensive tool that can be used to perform many simple electrical tests that would otherwise require a multimeter. The LED indicates when voltage is present between any two test-points in a circuit.

***CAUTION—***

- *Choose test equipment carefully. Use a meter with at least 10 megohm input impedance, or an LED test light. An analog meter (swing-needle) or a test light with a normal incandescent bulb may draw enough current to damage sensitive electronic components.*
- *An analog meter must not be used to measure resistance on solid state components such as control units or time delay relays.*
- *Always disconnect the battery before making resistance (ohm) measurements on the circuit.*

## Wiring diagrams, 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.

With the exception of the battery charging system, all electrical power is routed from the ignition switch or the battery through the fuse panel, located in the passenger compartment behind the driver's left side knee bar. Fuses prevent excessive current from damaging components and wiring. Fuses are color coded to indicate their different current capacities. Most relays are electro-mechanical switches that operate on low current to switch a high-current circuit on and off.

The wiring diagrams shown in **97 Wiring Diagrams, Fuses and Relays** are organized according to model year and engine type, with complete diagrams for each year.

# ELECTRICAL TROUBLESHOOTING

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 or a return to the voltage source. Most problems can be found using only a digital 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. Be sure to analyze the problem. Use the wiring diagrams to determine the most likely cause of the problem. Get an understanding of how the circuit works by following the circuit from ground back to the power source.

***CAUTION—***

*When making test connections at connectors and components, use care to avoid spreading or damaging the connectors or terminals. Some electrical tests may require jumper wires to bypass components. When connecting jumper wires, use blade connectors at the wire ends that match the size of the terminal being tested. The small internal contacts are easily spread apart, and this can cause intermittent or faulty connections that can lead to more problems.*

## Checking for voltage and ground

Checking for the presence of voltage or ground is usually the first step in troubleshooting a problem circuit. For example, if a parking light does not work, a check for voltage at the bulb socket will quickly determine if the circuit is functioning properly or if the bulb itself is faulty. If voltage and ground are found at the socket, then the bulb is most likely faulty.

Another valuable troubleshooting technique is a voltage drop test. This is a good test to make if current is flowing through the circuit, but the circuit is not operating correctly. Sluggish wipers or dim headlights are examples of this. A voltage drop test will help to pinpoint a corroded ground strap or a faulty switch. Normally, there should be less than 1 volt drop across most wires or closed switches. A voltage drop across a connector or short cable should not exceed 0.5 volts.

A voltage drop is caused by higher than normal resistance in a circuit. This additional resistance actually decreases or stops the flow of current. 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.

A voltage drop can be checked only when current is flowing 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.

***NOTE—***

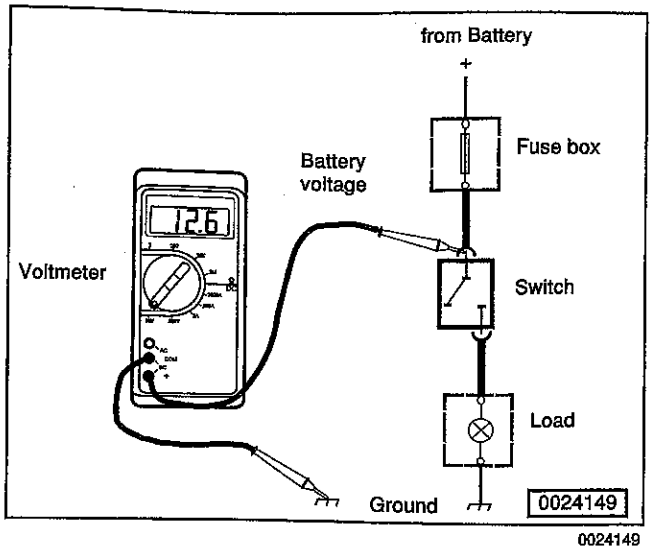
- *A voltage drop test is generally more accurate than a simple resistance check because the resistances involved are often too small to measure with most ohmmeters. For example, a resistance as small as 0.02 ohms would result in a 3 Volt drop in a typical 150 amp starter circuit (150 amps x 0.02 ohms = 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 14.0 volts. Measure voltage at the battery with the ignition on and then with the engine running to get exact measurements.*

## To measure voltage

1. Set voltage meter to 20V DC scale and connect the negative lead to a reliable ground point on the car.
2. Connect the voltmeter positive lead to the point in the circuit you wish to measure. See Fig. 1.
3. If a reading is obtained, there is voltage at that point in the circuit. The voltage reading should not deviate more than 1 volt from the voltage at the battery. If the voltage is less than this, there is probably a fault in the circuit, such as a corroded connector or a loose ground wire.

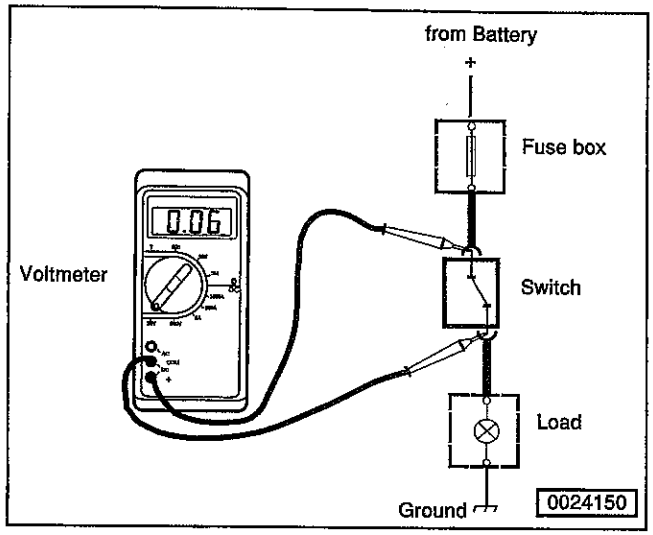
## To check for voltage drop

1. Connect the digital voltmeter positive lead to positive (+) connector of component to be tested.
2. Connect the voltmeter negative lead to the negative (–) connector of the component being tested. See Fig. 2.




0024149

**Fig. 1.** Voltmeter being used to check for voltage.




0024150

**Fig. 2.** Voltmeter being used to check for voltage drop across switch.

3. With the power on and the circuit working, the meter shows the voltage drop (the difference between the two points). This value should not exceed 1 volt.

***NOTE—***

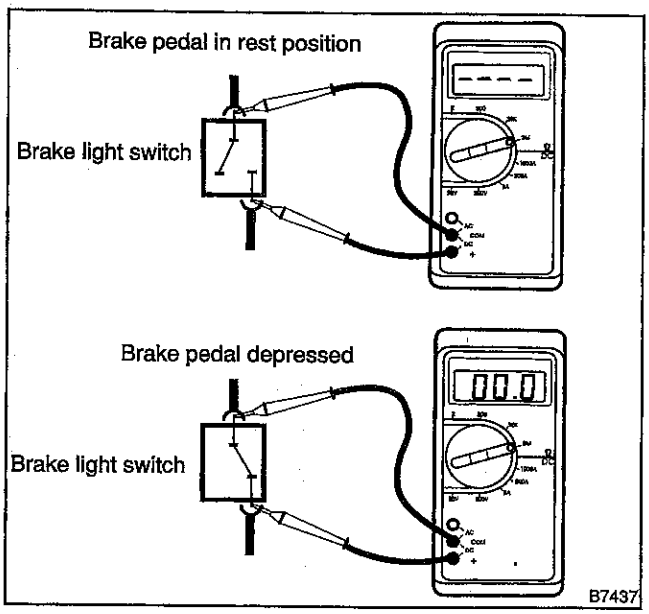
*The maximum voltage drop in an automotive circuit, as recommended by the Society of Automotive Engineers (SAE), is as follows: 0 Volts for small wire connections; 0.1 Volts for high current connections; 0.2 Volts for high current cables; and 0.3 Volts for switch or solenoid contacts. On longer wires or cables, the drop may be slightly higher. In any case, a voltage drop of more than 1.0 Volt usually indicates a problem.*

## Checking for continuity

The continuity test can be used to check the basic integrity of a circuit or 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. 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.

> ***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 electronic components.*

When checking continuity, the ignition should be off. On circuits that are powered at all times, the battery should be disconnected. 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 shows a continuity test being made on a brake light switch.




B7437

**Fig. 3.** Brake light switch being tested for continuity (battery disconnected). 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).

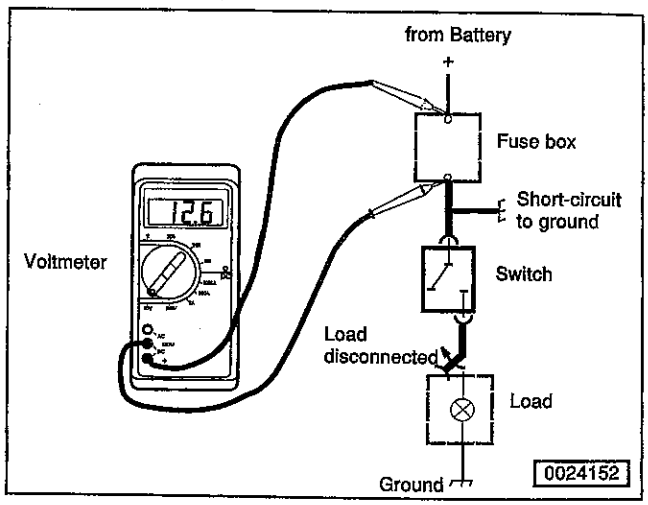
## Checking for short circuits

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), the direct current flow to ground will blow a fuse or damage an unfused circuit.

> ***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.*
> • *When replacing blown fuses, use only fuses having the correct rating. Always confirm the correct fuse rating printed on the fuse panel cover.*

## To check for short circuit with voltmeter

1. Remove the blown fuse from the circuit.
2. Disconnect the harness connector from the circuit's load or consumer.
3. Using a voltmeter, connect the test leads across the fuse terminals. See Fig. 4. Make sure power is present in the circuit. If necessary, turn the key on.




0024152

**Fig. 4.** Voltmeter being used to find short circuit.

4. If voltage is indicated at the voltmeter, there is a short to ground somewhere in the circuit.
5. If voltage is not indicated, work from the wire harness nearest to the fuse panel and move or wiggle the wires while observing the meter. Continue to move down the harness until the meter displays a reading. This is the location of the short to ground.
6. 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.

# 90 Instruments

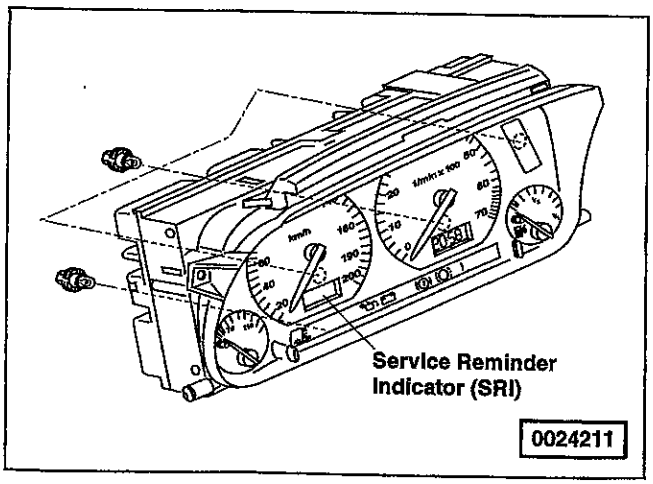


## GENERAL

An electronic speedometer with an LCD digital odometer display is used on all models. The display will switch between trip mileage or elapsed mileage if the odometer reset button is pushed quickly. Trip mileage is reset when the button is pushed and held for more than 2 seconds. The speedometer receives an electronic signal from Hall sender G22 on the transmission. Mileage is permanently held in memory and will be retained if power to the instrument cluster is interrupted.

Jetta GLX and GTI VR-6 models include the multi-function indicator system. Vehicles with the VR6 engine also have a front brake pad wear indicator system. A light will come on in the instrument cluster indicating brake wear. See Fig. 1.

With the exception of the light bulbs used for indicator lights and for illumination, individual components for the instrument cluster are not available from Volkswagen and therefore disassembly of the cluster is not recommended. Remanufactured instrument cluster assemblies are available through the Volkswagen parts department.




0024211

**Fig. 1.** Instrument cluster assembly. Service reminder indicator (used on some models) appears in the odometer display at start-up.

## INSTRUMENT CLUSTER

### Instrument cluster, removing and installing

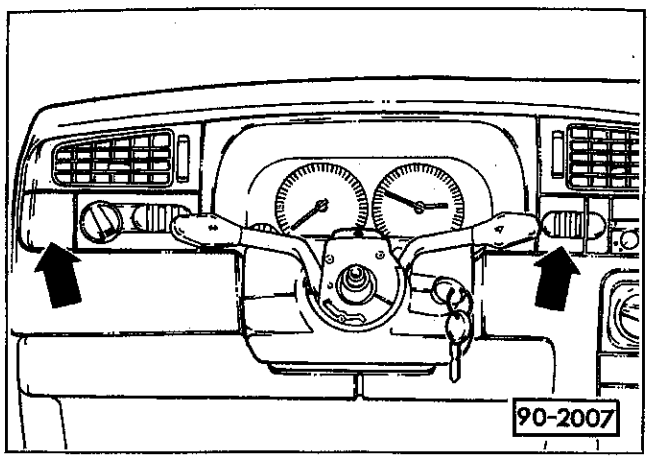
***WARNING —***
*The illustrations given on the following pages show the steering wheel removed in order to better illustrate the procedure. It is not necessary to remove the steering wheel and not recommended on cars equipped with airbags.*

1. Disconnect (–) negative battery cable.

***CAUTION —***
- *Before working on the electrical system disconnect negative (–) battery cable.*
- *Before disconnecting the battery, be sure to obtain radio anti-theft code.*

2. Carefully pry off left and right side trim panels. See Fig. 2.
3. Remove light switch by pressing release button on upper left-hand corner of light switch behind trim panel. If necessary, see **96 Lights, Accessories–Interior.**

***NOTE —***
- *Some vehicles may not have left and right trim panel but will have additional switches or warning lamps, depending on vehicle equipment level.*
- *On vehicles equipped with heated seats, the heater switches are located on the right and left sides of the instrument cluster and must be removed. See* **96 Lights, Accessories–Interior.**

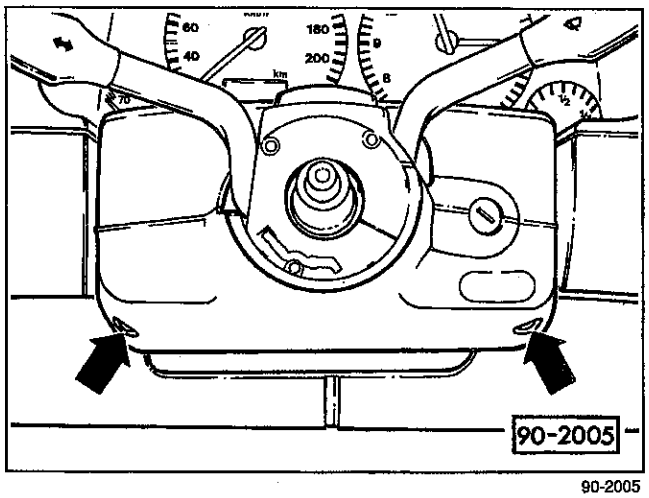



90-2007

**Fig. 2.** Left and right side trim panels (**arrows**).

4. Remove upper part of steering column trim. See Fig. 3.

> ***WARNING —***
> - *DO NOT remove steering wheel. Steering wheel is shown removed for clarity of illustrations.*
> - *The cars covered by this manual use an airbag which is inflated by an explosive device. Handled improperly or without adequate safeguards, the system can be very dangerous. Special precautions must be observed prior to any work at or near the steering wheel or steering column. See* **69 Seatbelts, Airbags.**

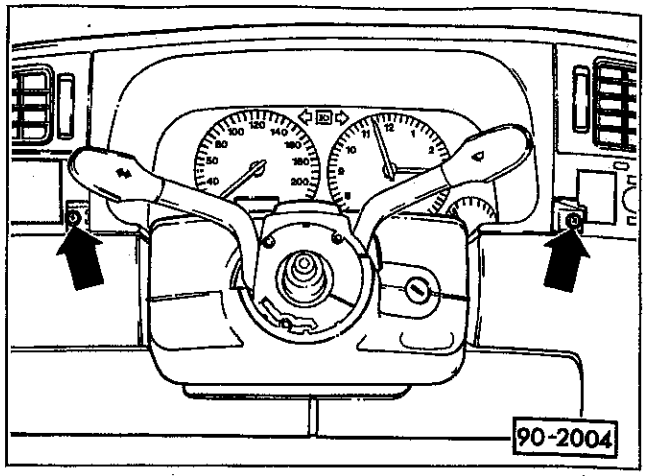



90-2005

**Fig. 3.** Steering column trim retaining screws (**arrows**).

5. Remove two screws securing instrument panel trim. See Fig. 4.

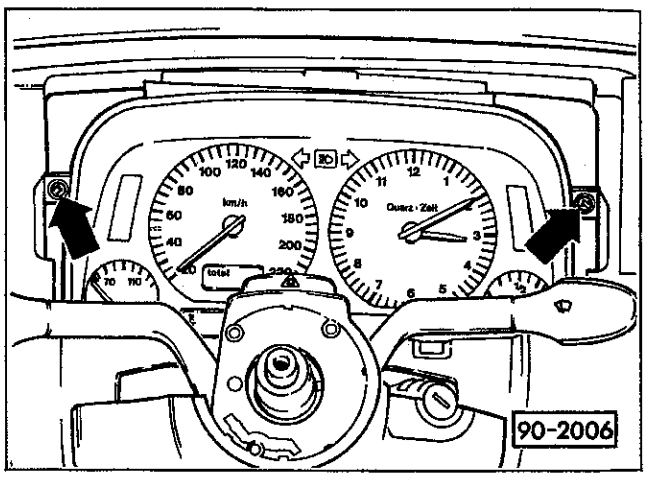
6. Release instrument cluster trim side retainers by pulling firmly at top and remove instrument cluster trim.




90-2004

**Fig. 4.** Instrument panel trim retaining screws (**arrows**).

7. Remove mounting screws for instrument cluster. See Fig. 5.




90-2006

**Fig. 5.** Instrument cluster retaining screws (**arrows**).

8. Tilt instrument cluster downward from the top.

9. Disconnect two multi-point connectors from back of instrument cluster.

10. Remove instrument cluster.

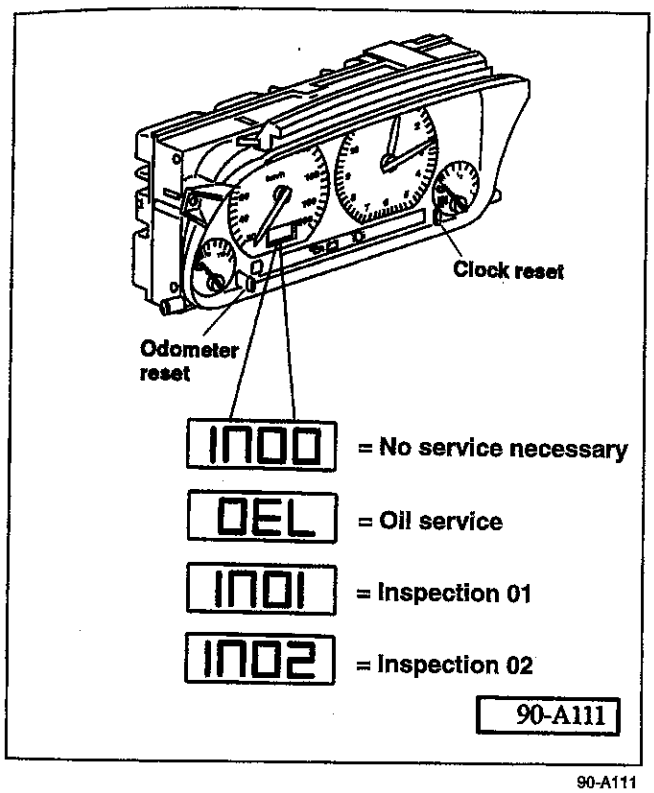
11. Installation is the reverse of removal.

> ***CAUTION —***
> *Be careful to push connectors straight on to avoid bending or damaging pins.*

## Service reminder indicator (SRI)

The Service Reminder Indicator (SRI) is used on some vehicles covered by this manual to indicate when vehicle service is necessary. The SRI monitors vehicle mileage and time and appears in the odometer display window below the speedometer. The SRI will only be shown for 3 seconds after the ignition is switched on (engine not running).

When the ignition is switched on, one of the following displays will appear for approximately three seconds indicating the service required:




90-A111

**Fig. 6.** Instrument cluster with service reminder display.

**IN00:** No service necessary

**OEL:** 7500 MILE (12,000 km)/6-month engine oil change

**IN01:** 15,000 mile (24,000 km)/12-month maintenance (inspection service)

**IN02:** 30,000 mile (48,000 km)/24-month maintenance (inspection service)

After a service has been performed on the vehicle, each affected display must be reset individually. For example, if the 30,000 mile maintenance has just been completed, the OEL, IN 01 and IN 02 displays must be reset.

The SRI uses a hard permanent-type memory and will not be erased if the battery is disconnected.

## SRI, resetting

1. Switch ignition ON.
2. Press and hold the odometer reset button located below speedometer.
3. Switch ignition OFF and release odometer reset button. OEL will now appear in SRI display
4. Press and hold the lower digital clock reset button or the analog clock reset button until five dashes (- - - - -) appear in display. OEL SRI is now reset for 7,500 miles (12,000 km) or 6 months, whichever comes first.

Once OEL is reset, the other displays can be reset the same way without switching the ignition on and off again.

5. Press odometer reset button to proceed to IN 01 display (15,000 mile maintenance) and reset using clock reset button.
6. If necessary, repeat procedure to reset IN 02 (30,000 mile maintenance) display.
7. To escape reset mode: Switch ignition ON; when display IN 01 appears, switch ignition OFF.

## Instrument cluster, rear view

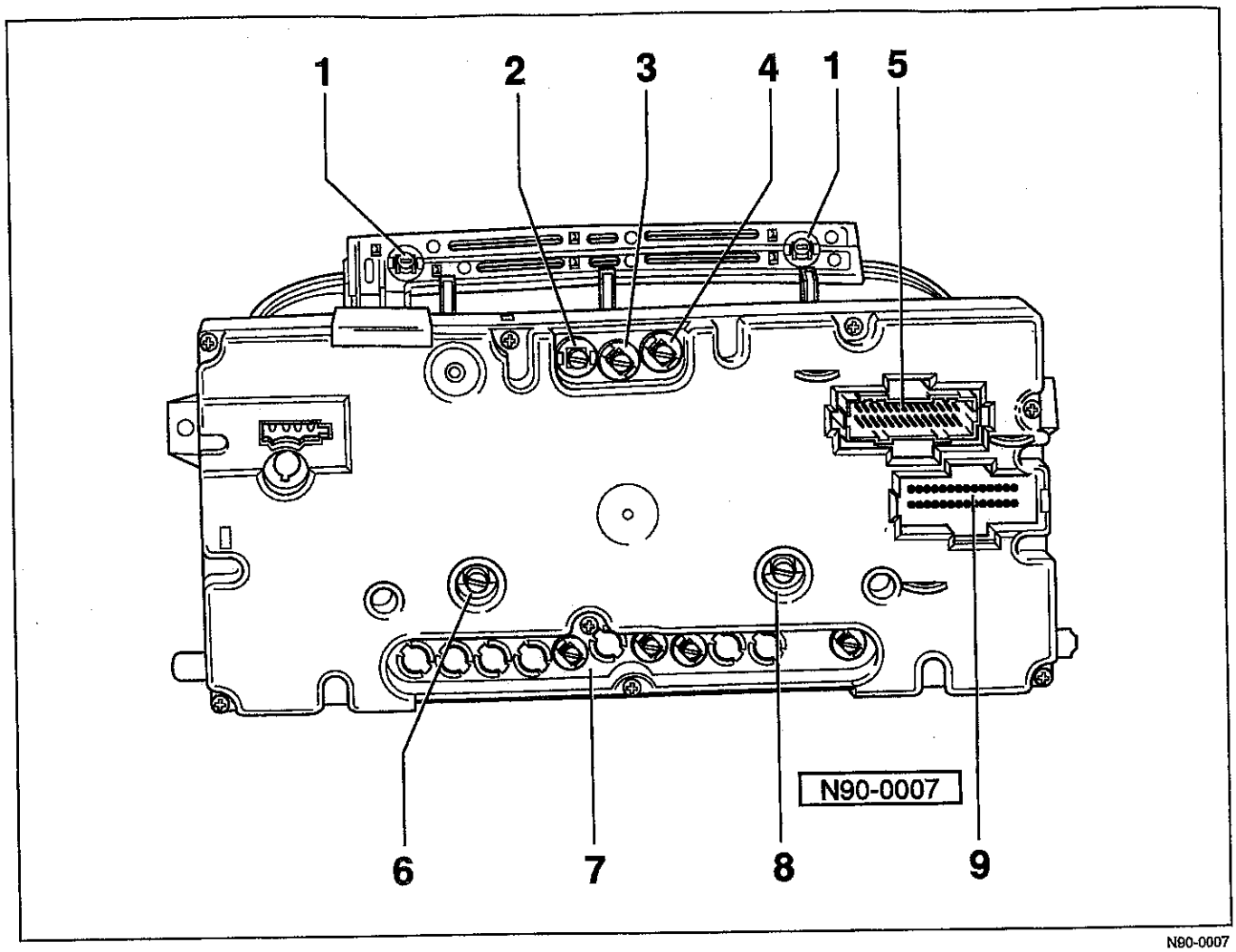


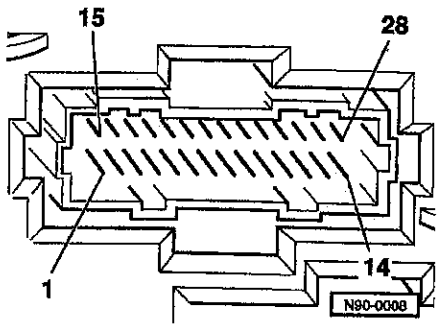

**Fig. 7.** Rear view of instrument cluster.

1. **Instrument cluster light (L10)**
   - 12V/2W bulb
2. **Right turn signal indicator light (K94)**
   - 12 V/1.1W bulb
3. **Headlight high beam indicator light (K1)**
   - 12V/1.1W bulb
4. **Left turn signal indicator light (K65)**
   - 12 V/1.1W bulb
5. **28-pin connector socket 1 (T28)**
   - Terminal identification, **see table a**
6. **Digital display light (L75)**
   - Illumination for digital clock or multi-function indicator
   - 12V/1.1W bulb
7. **Indicator warning lights**
   - Applications vary depending on vehicle equipment
   - 12V/1.1W bulbs
8. **Illumination for speedometer (G21) and odometer**
   - 12V/1.1W bulb
9. **28-pin connector socket 2 (T28b)**
   - Terminal identification, **see table b**

***CAUTION —***

- *Do not use anything except a digital multi-meter to test instrument cluster or wiring to instrument cluster. Use of test lights, analog meters, etc. may cause expensive damage.*
- *Individual components for the instrument cluster are not available from Volkswagen and therefore disassembly of the cluster is not recommended.*

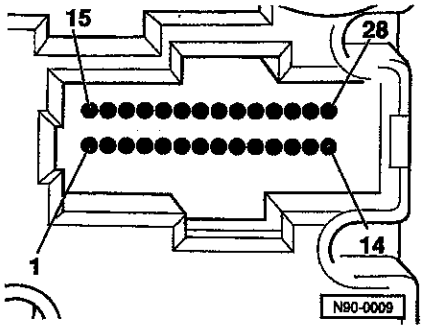
**Table a. Instrument cluster 28-pin connector (T28) terminal identification**




| Terminal | Circuit |
|---|---|
| 1 | Outside Air Temperature Sensor (G17), ground * |
| 2 | Engine Coolant Level (ECL) Sensor (G32) |
| 3 | Terminal 31, Ground (GND) |
| 4 | Multi-Function Indicator Memory Switch (E109) (reset)* |
| 5 | Terminal 31, Ground (GND) |
| 6 | Multi-Function Indicator Memory Switch (E109) (memory)* |
| 7 | Vehicle Speed Sensor (VSS), output |
| 8 | Oil Pressure Switch (F1), 1.8 bar |
| 9 | 0.3 Bar Oil Pressure Switch (F22) |
| 10 | Terminal 1/Terminal W |
| 11 | Terminal 30, Battery Positive Voltage (B+) |
| 12 | Terminal 58b, lighting |
| 13 | Terminal 15 (B+ with ignition switched on) |
| 14 | Open |
| 15 | Multi-Function Indicator Mode Select Switch (E86)* |
| 16 | Generator (GEN) Warning Light (K2), terminal 61 |
| 17 | Engine Oil Temperature Sensor (G8)* |
| 18 | Brake and Parking Brake Warning Light (K7) |
| 19 | Outside Air Temperature Sensor (G17), signal* |
| 20 | Malfunction Indicator Lamp (MIL) (K83), or Glow Plug Indicator Light (K29) (Diesel) |
| 21 | Fuel Gauge (G1) |
| 22 | Left Turn Signal Indicator Light (K65) |
| 23 | Engine Coolant Temperature (ECT) Gauge (G3) |
| 24 | Right Turn Signal Indicator Light (K94) |
| 25 | Headlight High Beam Indicator Light (K1) |
| 26 | Input signal, fuel consumption* |
| 27 | Vehicle speed signal from speedometer Vehicle Speed Sensor (VSS) (G22) |
| 28 | Transmission Range (TR) Sel. Lever display (AG4) |

*(*)Only applicable to cars with multi-function indicator (J119).*

**Table b. Instrument cluster 28-pin connector (T28b) terminal identification**




| Terminal | Circuit |
|---|---|
| 1 | Outside Air Temperature Sensor (G17), Ground * |
| 2 | Airbag control wire ** |
| 3 | Seat Belt Warning Light (K19) |
| 4 | Open |
| 5 | Open |
| 6 | Rear Hatch/Trunk Lid Ajar Warning Light (K102) |
| 7 | Open |
| 8 | Open |
| 9 | Open |
| 10 | Open |
| 11 | Open |
| 12 | Airbag terminal 15 ** |
| 13 | Airbag terminal 31 ** |
| 14 | Open |
| 15 | Open |
| 16 | Open |
| 17 | Open |
| 18 | Open |
| 19 | Open |
| 20 | Open |
| 21 | Open |
| 22 | Open |
| 23 | Open |
| 24 | Open |
| 25 | Open |
| 26 | Open |
| 27 | Open |
| 28 | Open |

*(*)Only applicable to cars with multi-function indicator (J119).*
*(**) Only applicable to vehicles with airbag warning light mounted in dash. Early vehicles have airbag warning light and/or ABS warning light mounted into the left side trim panel. See Fig. 2.*

## Speedometer vehicle speed sensor, VSS G22, checking

The speedometer is electronically operated by a sensor driven by the transmission differential. This three wire sensor is a Hall-type sensor. Manual transmission vehicles have only the single sensor on the transmission. Automatic transmission vehicles could have as many as three sensors on the transmission. The number depends on the version and may include vehicle speed sensor G68 and transmission speed sensor G38. These two wire inductive sensors send information to the transmission control module, TCM, for use by the automatic transmission only.

1. Disconnect the 3-pin connector from the vehicle speed sensor.

2. Switch the ignition on.

3. Connect a multimeter between terminals 1 and 3 (the two outermost terminals). Meter should read between 9 volts and 14.5 volts. If no voltage is present, check appropriate wiring diagram for a break in the wiring.

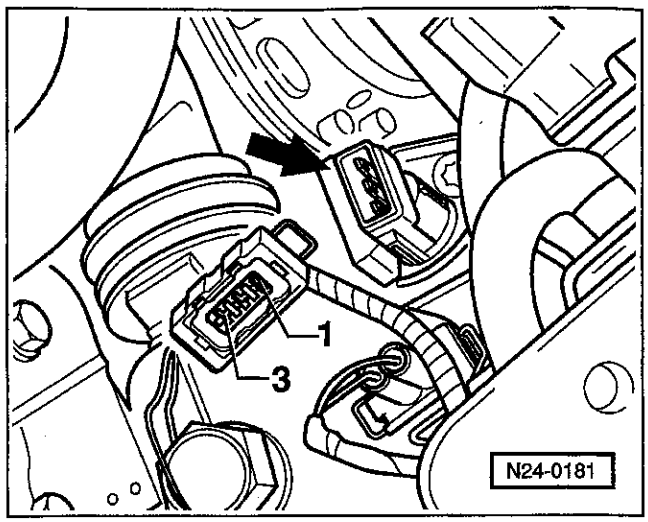
4. If voltage is present, re-connect the 3-pin connector. Attach one lead of the multimeter to the battery positive terminal. Backprobe the center terminal of the connected 3-pin connector with the other multimeter lead.

5. Raise one front wheel sufficiently to allow wheel to be turned by hand. Slowly turn wheel. Voltage must change between low and high when wheel is rotated. Low voltage is typically around 2.5 volts and high voltage is approximately battery voltage.

6. If voltage is not present, speed sensor is defective. If the low/high voltage signal is present, sensor is good.

7. If sensor is good, but speedometer does not work, test the cruise control (if equipped) as described in **96 Lights, Accessories–Interior.** If the signal for the cruise control is good, speedometer is probably defective.

8. The vehicle speed sensor, VSS G22, can also be tested with the VAG 1551/1552 through the engine control module. These procedures are outside of the scope of this repair manual.




N24-0181

**Fig. 8.** Disconnected harness connector from the vehicle speed sensor, G22 (**arrow**). Harness connector terminals 1 and 3 supply power and ground.

# 91 Radio



## GENERAL

This section covers the Volkswagen installed stereo system, including: radio recoding, radio removal and installation and the antenna assembly. For specific circuit tracing it is necessary to see **97 Wiring Diagrams, Fuses and Relays**.

Volkswagen has offered several different model radios, all featuring ignition switch power shutoff, blinking security LED, and anti-theft coding. See Fig. 1, 2, and 3. Some feature the ability to control an optional CD changer. Four different types of radio antennas are used.

- Roof mounted/amplified/flexible; GLX, GTI, TREK
- Fender mounted/amplified/flexible; Cabrio
- Fender mounted/telescopic mast; Golf, Jetta
- Fender mounted/fixed length mast; Golf, Jetta, Cabrio

Starting with the 1998 model year, Volkswagen radios are capable of communicating with scan tool VAG 1551/1552 through the Data Link Connector (DLC). These radios can store Diagnostic Trouble Codes, DTCs, and must be coded via the scan tool in order to function properly. The correct code varies depending on the type of vehicle, the type of antenna and if equipped with a CD changer.

***NOTE—***

*Radio malfunctions and equipment changes requiring the use of scan tool VAG 1551/1552 should be handled by an authorized Volkswagen dealer or other qualified repair facility. Repairs of this nature fall outside the scope of this repair manual.*

Volkswagen offered several radio models, all featuring ignition switch power shutoff, blinking security LED and anti-theft coding. Two radio antennas are used. GTI and GLX models use a roof mounted antenna with an integral amplifier. All other models use a telescoping antenna mounted in the left front fender.

***CAUTION—***

- *The radio is wired to the vehicle alarm system. If the alarm system is armed, removing the radio will activate the alarm even if the proper tools are used. Do not attempt to remove the radio without disarming alarm.*
- *Do not remove radio or disconnect battery without obtaining anti-theft code.*
- *The factory installed connectors are designed for Genuine Volkswagen Radios. If installing a different radio, remember that the radio may fit poorly into the space provided, the electrical connections may not be compatible and different terminals may be needed.*
- *Keep in mind that factory installed radios are electrically linked to the ignition and alarm system circuits in all cars and the data link connector in some cars.*

## STEREO SYSTEM

***CAUTION—***

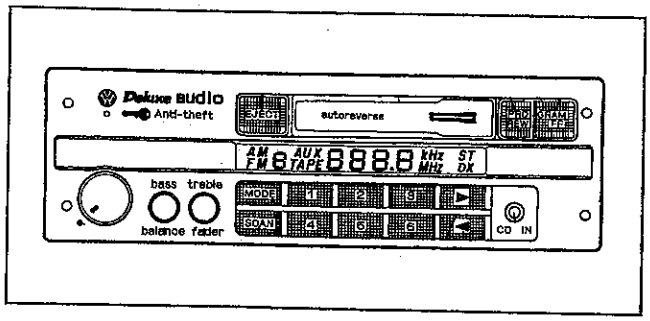
- *Before beginning work on radio or stereo system verify that the radio is an original equipment Volkswagen radio and that the wiring harness has not been modified.*
- *Aftermarket radios, amplifiers, speakers, etc. are beyond the scope of this manual. Servicing of aftermarket sound equipment should be referred to an authorized agent of the equipment in question.*

## Radio, re-entering anti-theft code ("Deluxe" and "Premium", 1993–1997)

When the power to the radio is interrupted, the radio will electronically lock-up. The word "SAFE" appears in the frequency display when the radio is switched on and it will be necessary to enter the anti-theft code to make the radio operational again.

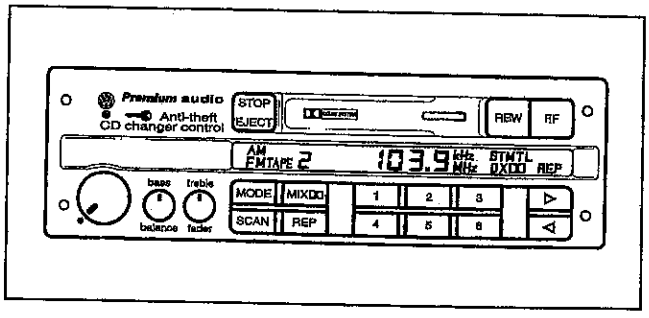
1. Turn on the radio and press the MODE and SCAN buttons simultaneously and hold them down until "1000" lights up in the display. Release the buttons! See Fig. 1 or Fig. 2.

> ***CAUTION—***
> *Do not continue to hold MODE and SCAN buttons after "1000" appears in display or press them again. This would enter the number "1000" as the input code number.*




0024207

**Fig. 1.** Volkswagen installed "Deluxe" sound system. This unit has a front panel input for a portable CD player.




0024208

**Fig. 2.** Volkswagen installed "Premium" sound system. This unit can control a trunk mounted CD changer. These units are supplied by two different manufacturers and look the same but the optional CD changers and cables are not interchangeable.

2. Use station buttons 1 to 4 to input the correct anti-theft code number. Use button 1 to input the first digit, button 2 for the second, and so on.

> ***NOTE—***
> *The first digit of the anti-theft code can only be a 1 or left blank.*

3. Once the anti-theft code is shown in the display, hold the MODE and SCAN buttons down until the word "SAFE" appears in the frequency display. Release buttons! Soon afterward, a radio frequency will be displayed and the radio will be operational.

> ***NOTE—***
> - *Should you inadvertently input the incorrect code number, the word "SAFE" will appear in the display – first blinking and then continuous. It is possible to repeat the coding procedure* **once.**
> - *If the incorrect code is again entered, the radio will be locked up for approximately one hour. Leave the radio switched on. After an hour, the display with the number of attempts goes out and you can again re-enter the anti-theft code as described above. The two attempt, one hour lock-up cycle will continue to apply.*

## Radio, re-entering anti-theft code, ("Sound System", 1998–1999)

When the power to the radio is interrupted, the radio will electronically lock-up. The word "SAFE" appears in the frequency display when the radio is switched on and it will be necessary to enter the correct anti-theft code to make the radio operational again.

1. Turn on the radio. The word "SAFE" will appear for 3 seconds and then the number "1000" will automatically appear in the display.

2. Use the radio station preset buttons 1 to 4 to enter the correct anti-theft code number. Use button 1 to enter the first digit, button 2 for the second digit, and so on.

***NOTE—***

*The value range for each of the 4 digits is between 0 and 9. The digit will increase by 1 each time you tap the preset button and will return to 0 after 9.*

3. After you finish entering the code, press the right side ">" of the SEEK button (Fig. 3, button A) for longer than 2 seconds until you hear an audible signal.

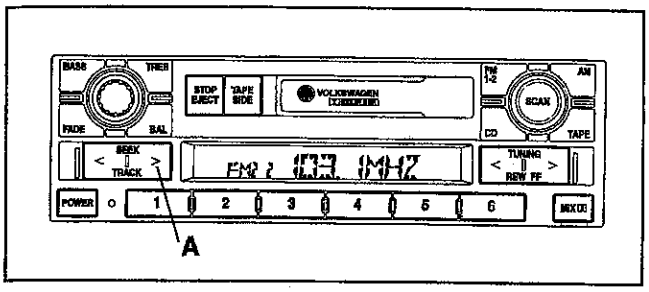



**Fig. 3.** Volkswagen installed "Sound System" used for the 1998 and 1999 model year. This unit can also control a trunk mounted CD changer, however, the changer is different from those used with other sound system versions. This sound system has built-in diagnostics and is connected to the vehicle Data Link Connector (DLC).

4. If you've entered the code correctly, the display will show "FM1 88.3MHZ" and the unit is ready to use again.

***NOTE—***

- *Should you inadvertently enter a wrong code number, "SAFE" will appear in the display. Initially it will flash, then stay on. You can repeat the procedure one time. The number of attempts will appear in the display.*
- *If the incorrect code is again entered, the radio will be locked up for approximately one hour. Leave the radio switched on. After an hour, the display with the number of attempts goes out and you can again re-enter the anti-theft code as described above. The two attempt, one hour lock-up cycle will continue to apply.*
- *If you lose your Radio Card, contact your authorized Volkswagen Dealer.*

## Radio connector, terminal identification ("Deluxe" and "Premium", 1993-1997)

The top connector shown in Fig. 4 is not used. The connections for the two other 8-pin connectors are listed below.

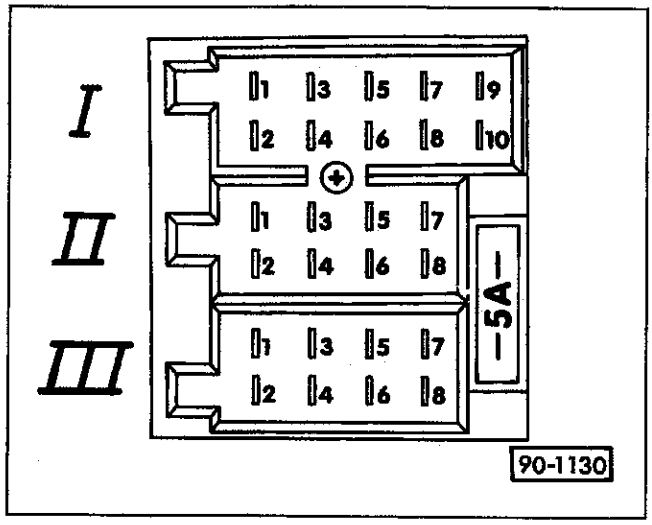



**Fig. 4.** Radio connectors and fuse on rear of radio . Top connector (I) is not used.

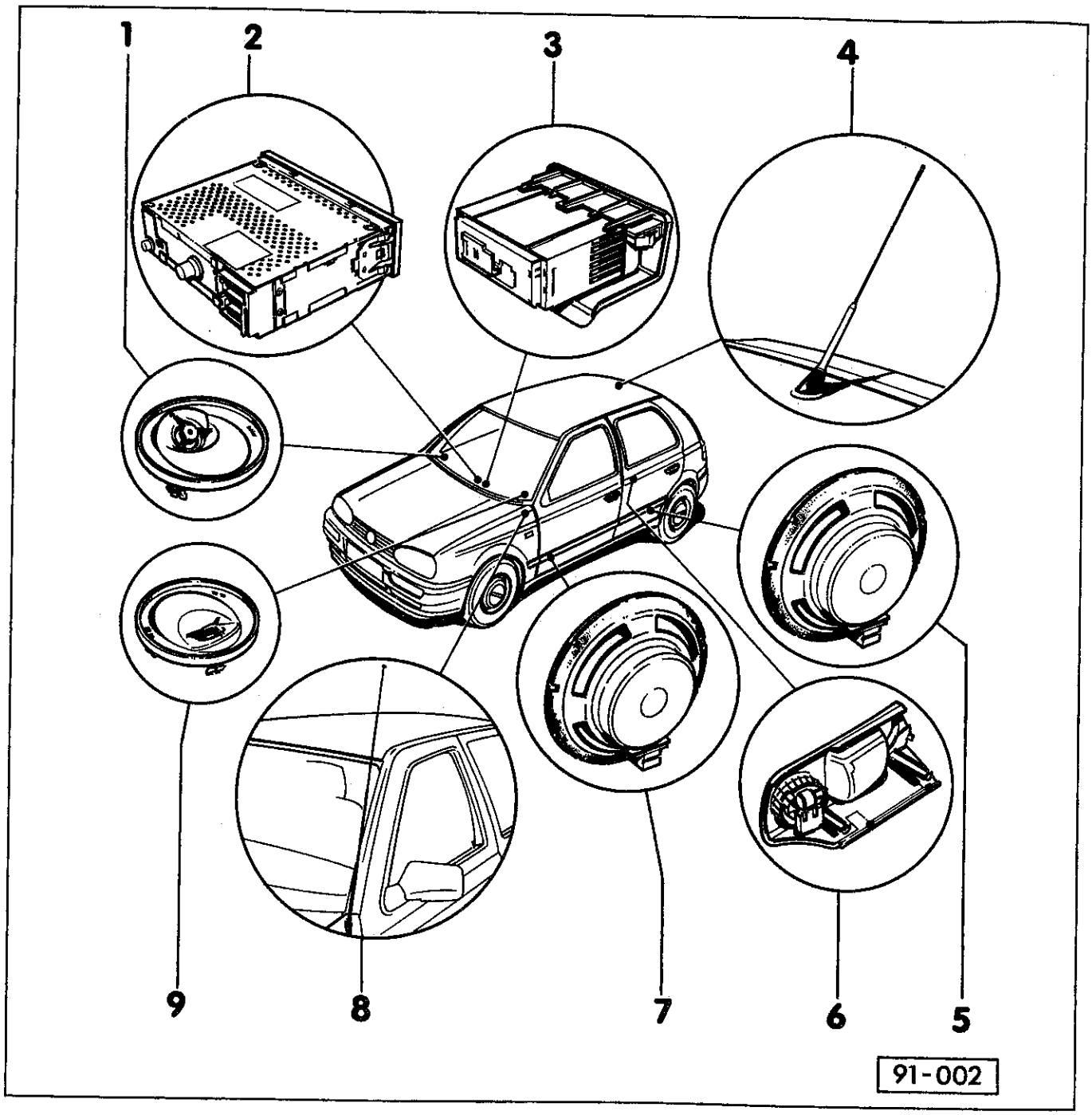
**Multi-pin connector II, T8g, 8-pin, brown**

| | |
|---|---|
| 1 | Right rear speaker (+) |
| 2 | Right rear speaker (-) |
| 3 | Right front speaker (+) |
| 4 | Right front speaker (-) |
| 5 | Left front speaker (+) |
| 6 | Left front speaker (-) |
| 7 | Left rear speaker (+) |
| 8 | Left rear speaker (-) |

**Multi-pin connector III, T8, 8-pin, black**

| | |
|---|---|
| 1 | to Alarm System Control Module (J284) |
| 2 | Open |
| 3 | Open |
| 4 | Ignition key on/off connection (from ignition/starter switch, terminal SU) |
| 5 | Switched positive voltage (B+) (for amplified roof antenna) |
| 6 | Radio illumination, terminal 58b |
| 7 | Battery Positive Voltage (B+) (terminal 30 from fuse S22) |
| 8 | Ground (GND), terminal 31 |

## Stereo system, component layout




91-002

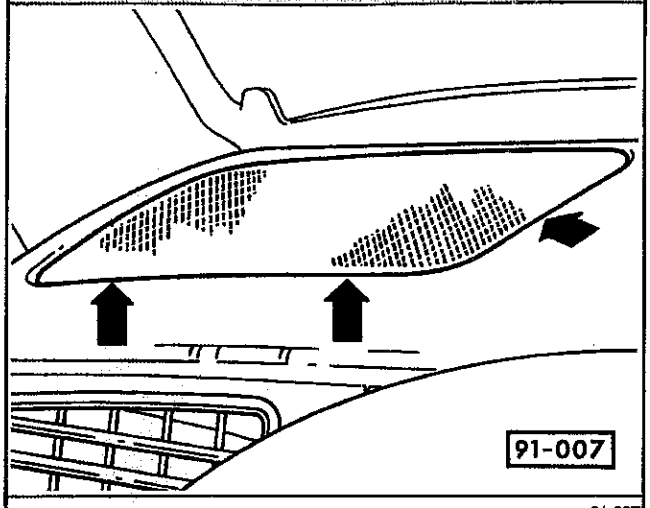
**Fig. 5.** Volkswagen stereo components. Speaker locations may vary on 1996 and later Jetta models.

***CAUTION—***
*Before disconnecting battery be sure to obtain radio anti-theft code.*

1. **Right front tweeter (R22)**
   - Dome tweeter
   - Diameter: 100 mm (3.9 in.)
   - Mounted on base in instrument panel
   - Removing and installing, **see** Ⓐ

2. **Stereo radio (Deluxe and Premium)**
   - See **Stereo radio, removing and installing**
3. **Cassette storage (where applicable)**
   - Installed in front of center console
4. **Roof-mounted antenna, amplified**
   - Installed on certain models only; replaces telescoping antenna (8)
   - See **Amplified roof-mounted antenna, assembly**
5. **Left rear woofer (R15)**
   - Diameter: 168 mm (6.6 in.)
   - In rear side (2-door) or door panel (4-door), **see** (B)
   - Relocated to parcel shelf in 1996 m.y. Jettas
6. **Left rear tweeter (R14)**
   - Dome tweeter
   - Connected to rear base speaker
   - Right rear tweeter is identical
   - 2-door: Mounted on rear side panel, **see** (C)
   - 4-door: Mounted near door pull, **see** (D)
   - Relocated to parcel shelf in 1996 m.y. Jettas
7. **Left front woofer (R21)**
   - Diameter: 168 mm (6.6 in.)
   - In front door panel, removing/installing **see** (B)
8. **Telescoping antenna (R11)**
   - Installed on certain models only, where roof-mounted antenna (4) is not used
   - See Telescoping antenna, assembly
9. **Left front tweeter (R20)**
   - Dome tweeter
   - Diameter: 100 mm (3.9 in.)
   - Mounted on base in instrument panel
   - Removing and installing, **see** (A)

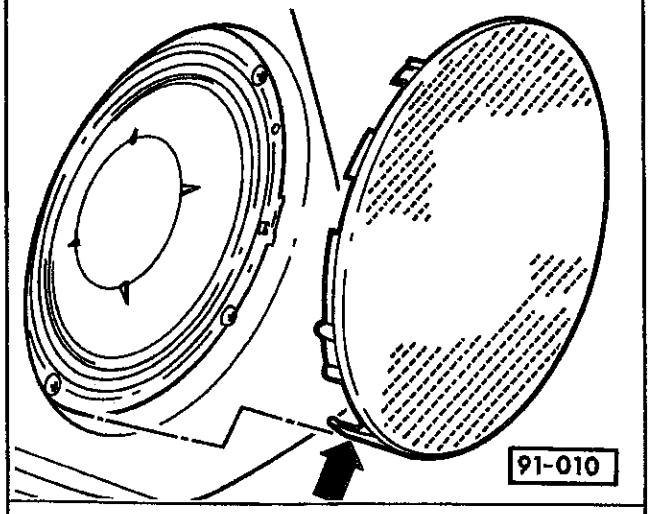
## (A) Front tweeter, removing and installing




91-007

- **Carefully pry up speaker cover (arrows) with screwdriver.**
- **Pry out tweeter mounting base and remove connector.**
- **Install in reverse order of removal noting installation marks on speaker.**

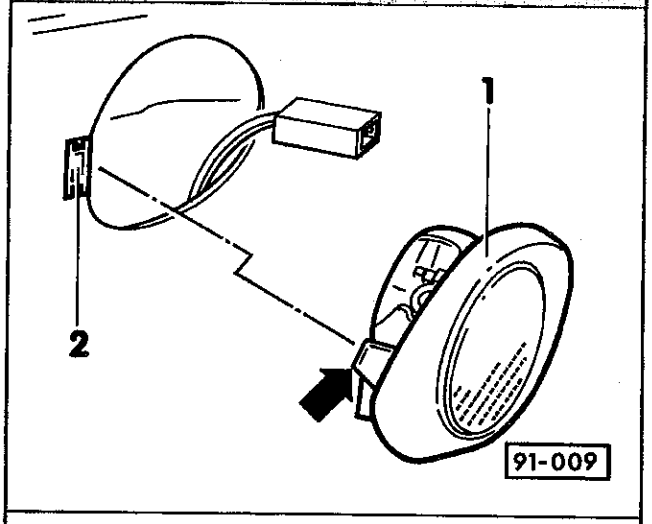
## (B) Removing and installing woofer (except Jetta from 1996 m.y.)




91-010

- **Using screwdriver, carefully pry off speaker cover.**
- **Remove four screws, pull speaker from panel and remove connector.**
- **Install in reverse order of removal noting installation marks on speaker.**
- **Install cover; ensure tab (arrow) is properly positioned.**

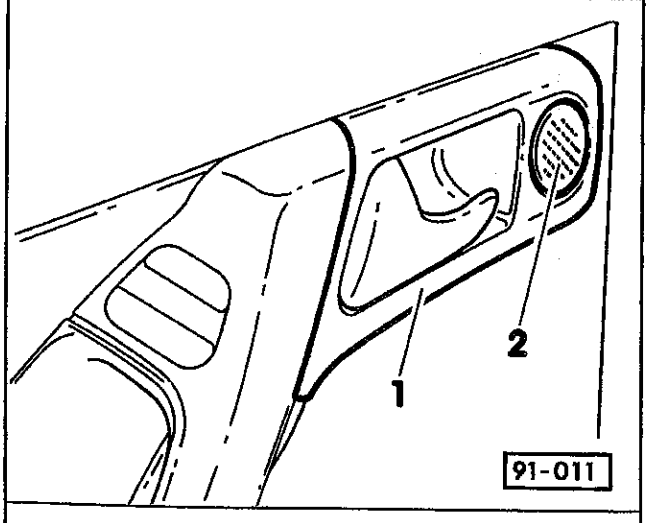
### C Removing and installing rear tweeter (2-door models)




91-009

- **Using screwdriver, carefully pry out speaker (1) and remove connector.**
- **Install in reverse order of removal ensuring clip (2) is positioned properly.**
- **Install speaker so tab (arrow) fits into clip (2).**

### D Removing and installing rear tweeter (4-door models)



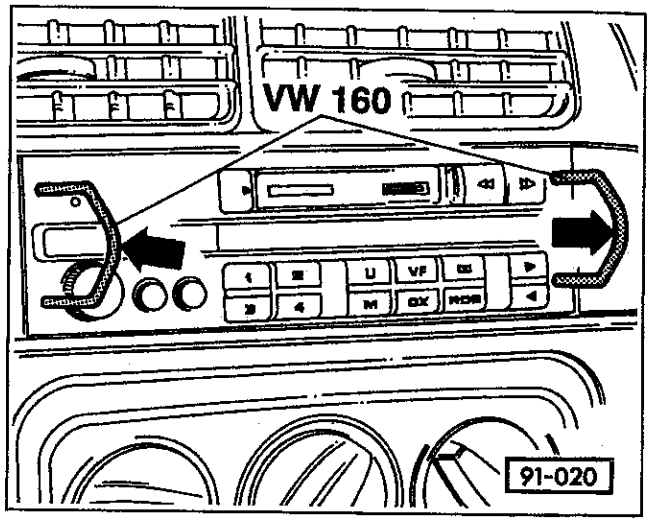

91011

- **Carefully remove door release lever trim (1) with tweeter (2) and remove connector.**
- **Install in reverse order of removal.**

## Stereo radio, removing and installing ("Deluxe" and "Premium", 1993-1997)

***CAUTION—***
*Before disconnecting battery be sure to obtain radio anti-theft code.*

1. Disconnect negative (–) battery cable.
2. Insert radio removal clips (Volkswagen special tool no. VW 160) into radio. See Fig. 6.

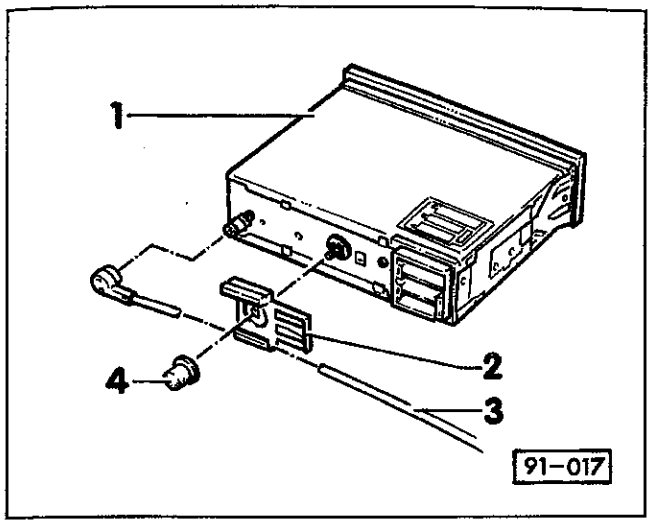



91-020

**Fig. 6.** Press special removal clips outward (**arrows**) to remove radio.

3. Press removal clips outward while pulling the radio from instrument panel.
4. Remove connectors, antenna cable, and remove radio.
5. Install all radio connectors.
6. Install antenna cable and secure to radio. See Fig. 7.
7. With removal clips removed, slide radio into instrument panel until radio locks into place
   - Rubber bushing on rear of radio must contact stop.
   - Radio must lock into place.

***CAUTION—***
*Do not pinch or damage wires when installing radio.*



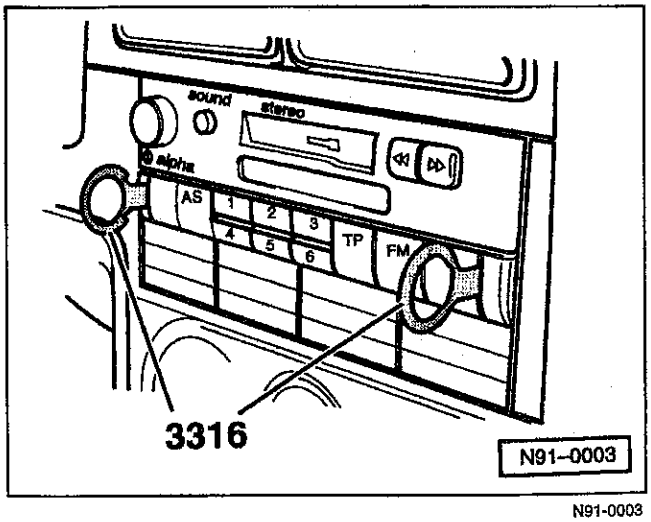

91-017

**Fig. 7.** Radio (1), cable guide (2), antenna cable (3), rubber bushing (4).

## Radio, removing and installing ("Sound System", 1998-1999)

> ***CAUTION—***
> *Before disconnecting battery be sure to obtain radio anti-theft code.*

1. Disconnect negative (-) battery cable.
2. Insert radio removal tools (Volkswagen special tool number 3316) into vertical slots in radio face until they are felt to lock into place. See Fig. 8.

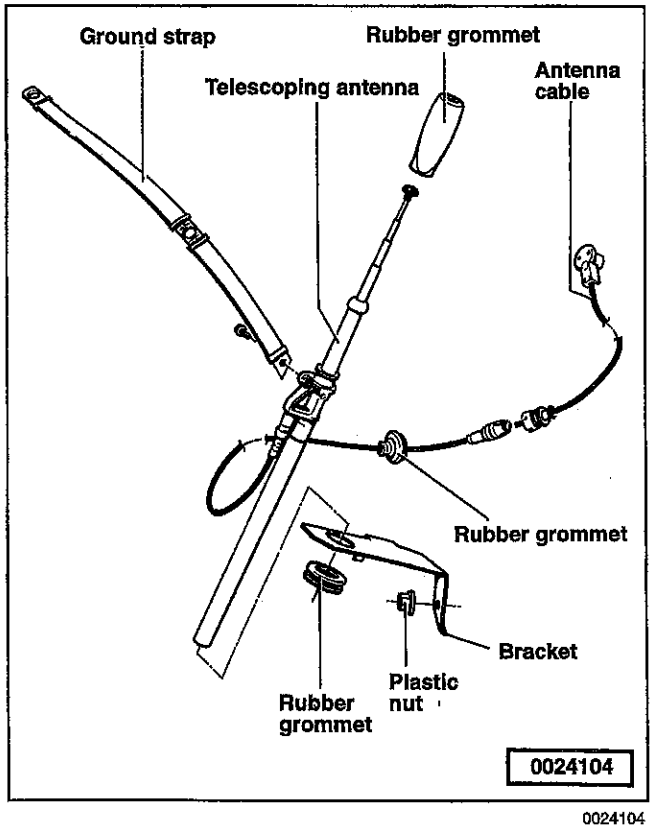



N91-0003

**Fig. 8.** Radio removal tools 3316 shown in position in representative radio. Take the tools out before reinstalling the radio.

3. Gently pull radio straight out from opening in instrument panel using loops in the tools as handles.
4. Disconnect electrical connectors and antenna wire from rear of radio.
5. Remove tools from radio by pressing the release locking tabs on side of radio before re-installing.
6. Installation is the reverse of removal, noting the following:
   - Remove tools before installing
   - Reconnect electrical connectors and antenna wire. See Fig. 7, given earlier.
   - Insert radio into opening and push straight in until locking tabs are felt to engage
   - Enter anti-theft code

## Telescoping antenna, assembly

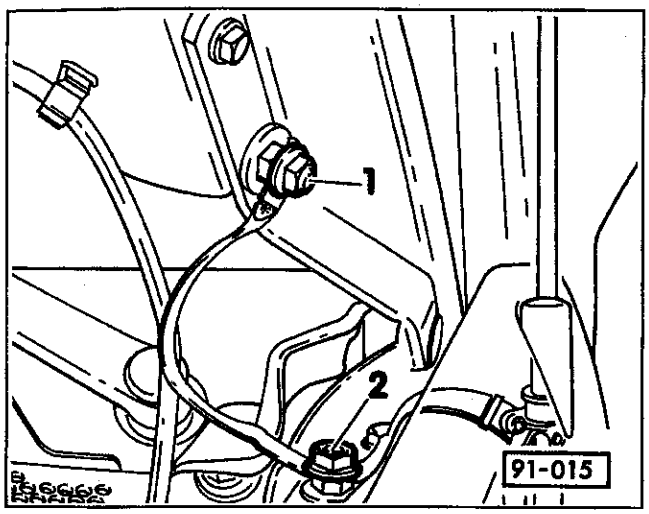



0024104

**Fig. 9.** Telescoping antenna and related mounting hardware.

## Telescoping antenna, removing and installing

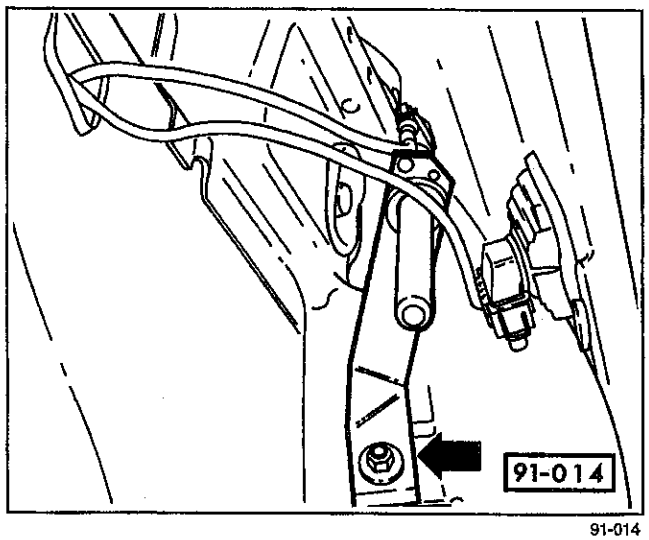
1. Remove antenna ground strap. See Fig. 10.




91-015

**Fig. 10.** Antenna ground strap on hood (**1**) and left wheel housing (**2**).

2. Disconnect antenna cable connector from behind lower left A-pillar side trim.
3. Pull antenna cable into air intake plenum.
4. Remove left wheel housing liner as described in **66 Body Accessories–Exterior.**
5. Working from underneath vehicle, remove antenna mounting bracket. See Fig. 11.



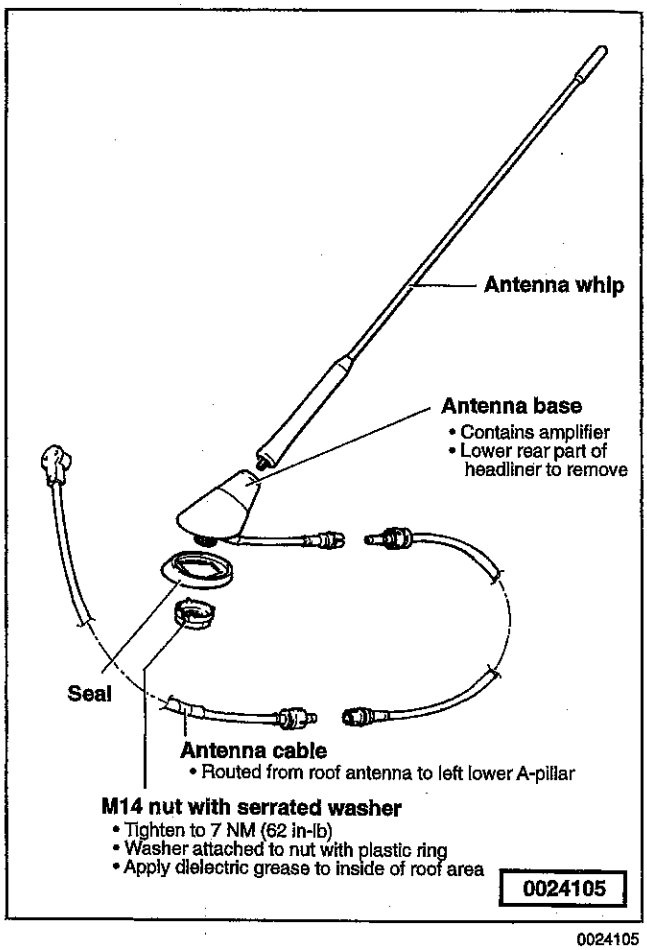

91-014

**Fig. 11.** Remove bracket (**arrow**) from antenna.

6. Pull antenna downwards and remove fender grommet.
7. Install in reverse order of removal.
8. Hold fender grommet in position and push antenna into grommet.

## Amplified roof-mounted antenna, assembly

All of the radios listed in this section supply power to the amplified antenna through the center coaxial cable wire that supplies the signal back to the radio. This is known as a "Phantom" power supply. For this reason, a separate 12 volt wire is not needed for the amplifier in the antenna. Fig. 12 shows the amplified roof-mounted antenna assembly.




0024105

**Fig. 12.** Amplified roof-mounted antenna assembly.

***NOTE—***

- *The majority of the electrical consumers/components in the vehicle are noise suppressed to ensure minimal electrical interference with radio reception. On vehicles equipped from the factory with a radio or radio prep wiring, the following components are also suppressed: coolant fan, windshield wiper motor, and rear window wiper motor.*
- *In addition, vehicles with a radio or radio prep wiring will have the following additional ground connections: ground strap from left wheel housing to hood and from ignition coil to engine cylinder block (vehicles with gasoline spark-ignition engine only).*

# 92 Wipers and Washers



## GENERAL

The front windshield wipers have 2 speeds and an intermittent position. The rear wiper (Golf, GTI) runs intermittently. The front wipers, rear wipers, and washers are controlled by the wiper switch on the right side of the steering column.

The front and rear washers share a common washer pump and washer fluid reservoir. The front washers are mounted in the hood. The rear washer is mounted in the rear wiper arm pivot.

## WIPERS AND WASHERS

***CAUTION —***

- *Worn or dirty wiper blades will reduce visibility, making driving hazardous. Clean blades regularly to remove road film and car wash wax build-up. Use an alcohol based cleaning solution, a lint free cloth, and wipe along the rubber blade.*
- *Clean all inside and outside glass regularly. Use an alcohol based cleaning solution and wipe dry with a lint free cloth.*
- *Do not use the wiper/washer in freezing weather without first warming the windshield with the defroster, otherwise the washer solution may freeze on the windshield and obscure your vision.*
- *Avoid running the wiper blades over a dry windshield to prevent scratching the glass. A scratched windshield will reduce visibility and increase glare.*

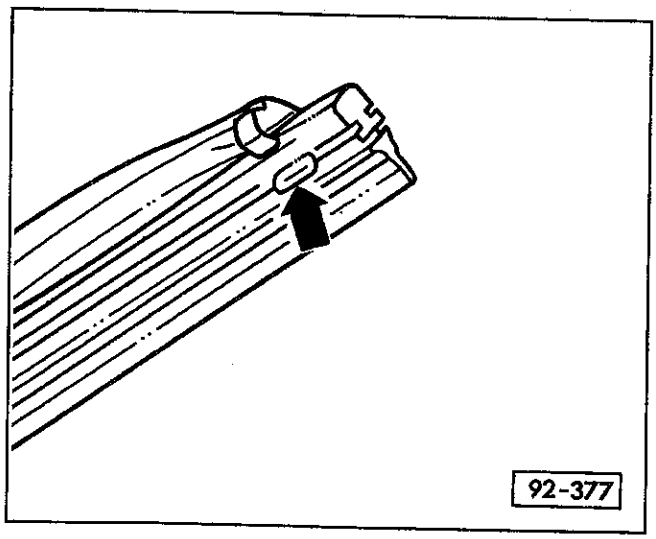
### Rubber wiper inserts, replacing

1. Free end of wiper insert from retaining hooks by squeezing metal strip in insert with pliers.
2. Slide rubber insert from retaining hooks.
3. Slide rubber insert into lower retaining hooks of wiper blade.

***NOTE —***

*If necessary, transfer metal strips from old insert to new insert. Notches in metal strips must face rubber and engage rubber lugs in groove.*

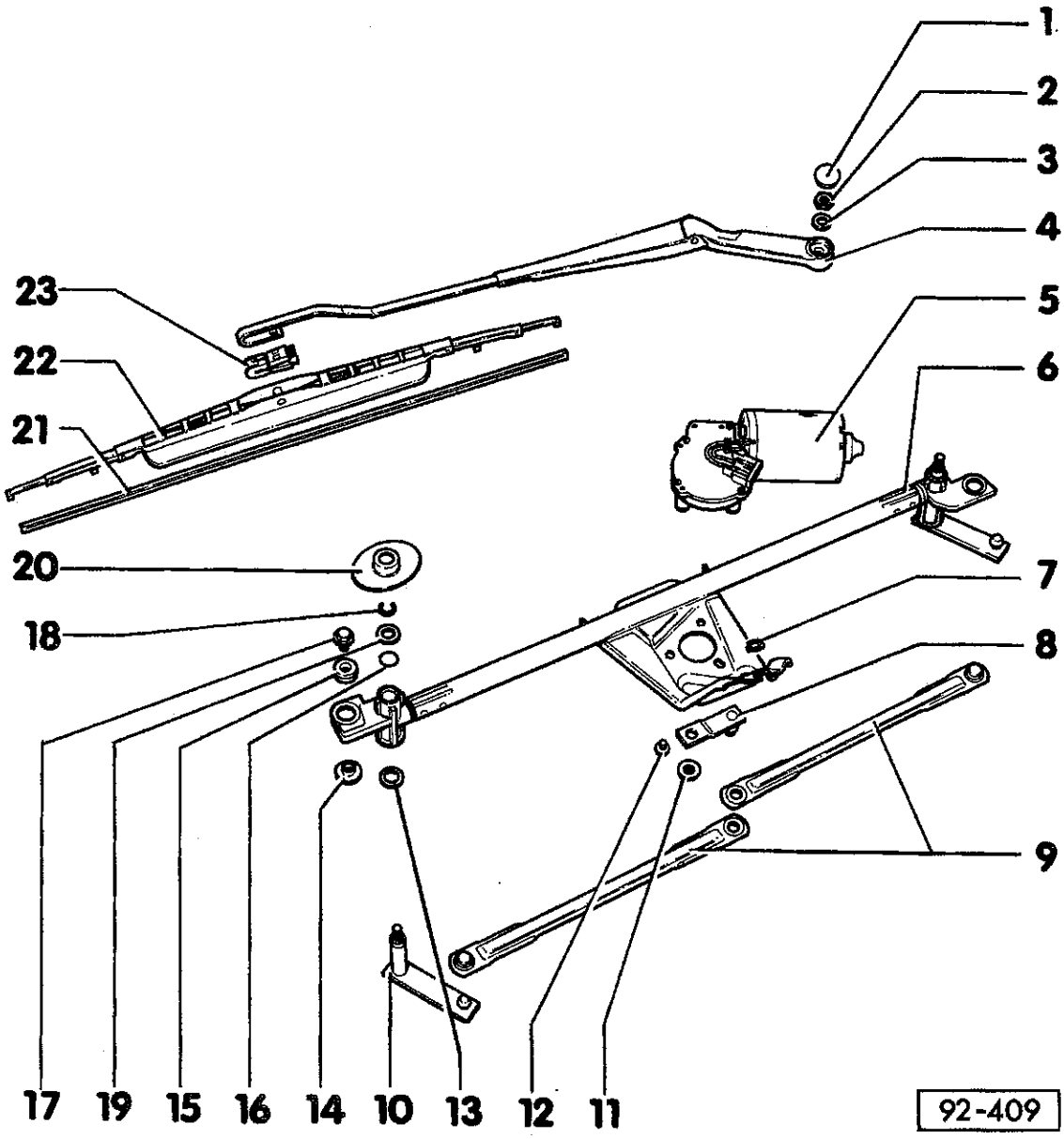
4. Squeeze metal strips at open end of rubber insert using pliers and install insert into hooks so that hook engages rubber retaining slot on insert. See Fig. 1.




92-377

**Fig. 1.** Install rubber insert so that hook engages rubber retaining slot (**arrow**).

## Windshield wiper, assembly



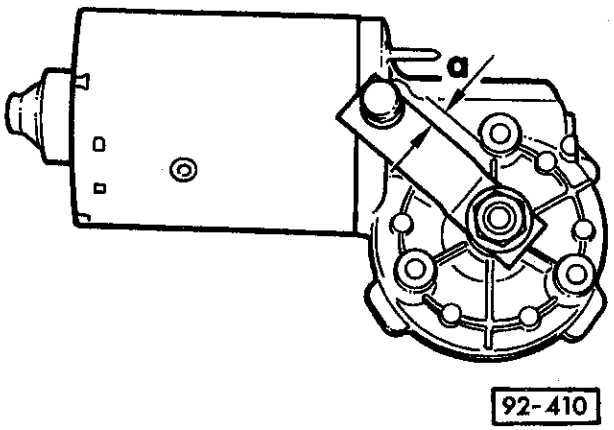

92-409

**Fig. 2.** Windshield wiper assembly.

1. **Cap**
2. **M8 hex nut**
   • Tighten to 20 Nm (15 ft-lb)
3. **Washer**
4. **Wiper arm**
5. **Windshield wiper motor**
   • Removing: first remove wiper frame (6)
6. **Wiper frame**
7. **M6 hex nut**
8. **Crank**
   • Installing and adjusting, **see** Ⓐ

9. **Relay rods**
10. **Wiper shaft**
11. **M8 hex nut**
    - Tighten to 20 Nm (15 ft-lb)
12. **M6 hex bolt**
    - Tighten to 5 Nm (44 in-lb)
13. **Spring washer**
14. **Washer**
15. **Rubber seal**
16. **O-ring**
17. **M6 hex bolt**
    - Tighten to 5 Nm (44 in-lb)
18. **Snap ring**
19. **Washer**
20. **Cap**
21. **Rubber wiper insert**
22. **Wiper blade**
23. **Retaining clip**

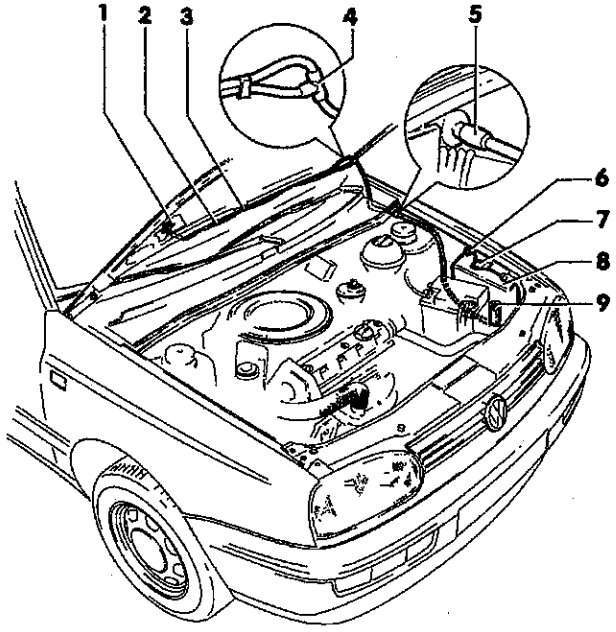
### A Wiper motor crank, installing and adjusting




92-410

- **Wiper motor must be in the "park" position before installing the crank.**
- **Run wiper motor to stop.**
- **Install crank and align.**
  **Dimension (a) = 10 mm (0.39 in.)**

## Windshield washer system

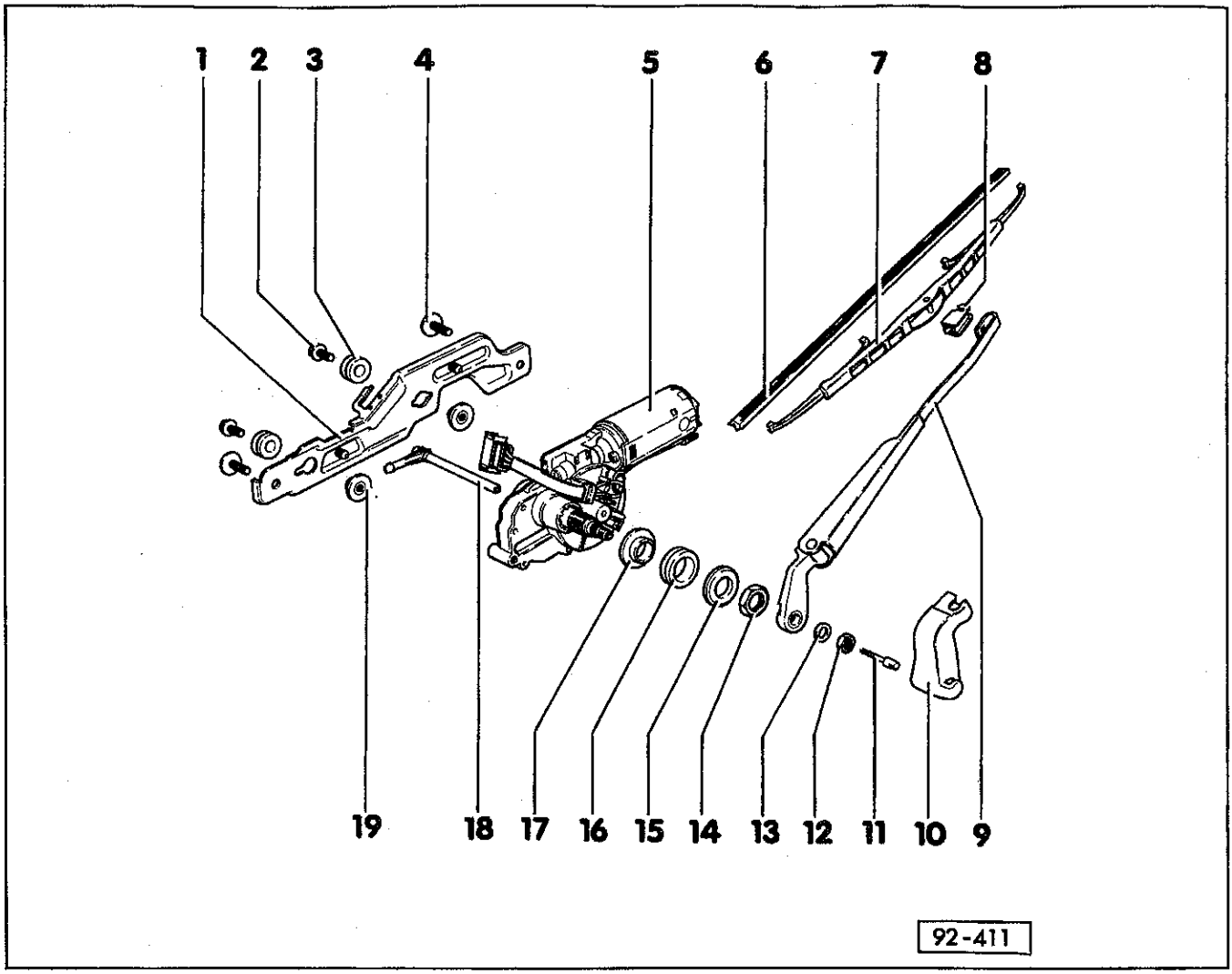



1. **Washer nozzles**
2. **Hose**
3. **Retaining clip**
4. **T-fitting**
5. **Hose connector**
6. **M5 plastic nut**
7. **Washer fluid reservoir cap**
8. **Washer fluid reservoir**
   - Capacity: 4.0 liters (4.2 qt)
9. **Windshield washer pump**
   - Mark hose connections before removing

92-408

**Fig. 3.** Windshield washer system components.

## Rear window wiper, assembly




92-411

**Fig. 4.** Rear window wiper assembly.

1. **Wiper motor bracket**
2. **M6 hex bolt**
   • Tighten to 5 Nm (44 in-lb)
3. **Rubber washer**
4. **M6 hex bolt**
   • Tighten to 5 Nm (44 in-lb)
5. **Rear window wiper motor**
6. **Rubber wiper insert**
7. **Wiper blade**
   • Adjust to one inch from bottom window seal
8. **Retaining clip**
9. **Wiper arm**
10. **Cap**
11. **Spray nozzle**
    • Aim spray nozzle toward center of wiper coverage
12. **M8 hex nut**
    • Tighten to 15 Nm (11 ft-lb)
13. **Washer**
14. **M16 hex nut**
    • Tighten to 7 Nm (62 in-lb)
15. **Plastic washer**
16. **Rubber washer**
17. **Spacer ring**
18. **Connector tube for spray nozzle**
    • Routed through wiper motor shaft to spray nozzle
19. **Washer**

# 94 Lights, Accessories–Exterior



## GENERAL

The models covered by this manual come with different headlight systems depending on the model and country (USA and Canada). Base models are equipped with single bulb headlights. GTI and Cabrio models are equipped with dual bulb headlights. GTI and Jetta GLX models are equipped with sealed beam type fog lights. All lights have replaceable bulbs.

### Daytime running lights

Daytime running lights have been installed on Canadian Golf and Jetta vehicles starting with the 1993 model year and on USA models beginning with the 1995 model year. Several different versions are in use depending on the year. All versions turn on the headlights when the key is switched on and the handbrake is released and turn off the headlights when the handbrake is applied. Some versions operate the headlights at a reduced brightness. Some switch on the taillights and dashlights. See **97 Wiring Diagrams, Fuses and Relays** for fuse/relay positions and schematic for the vehicle in question.

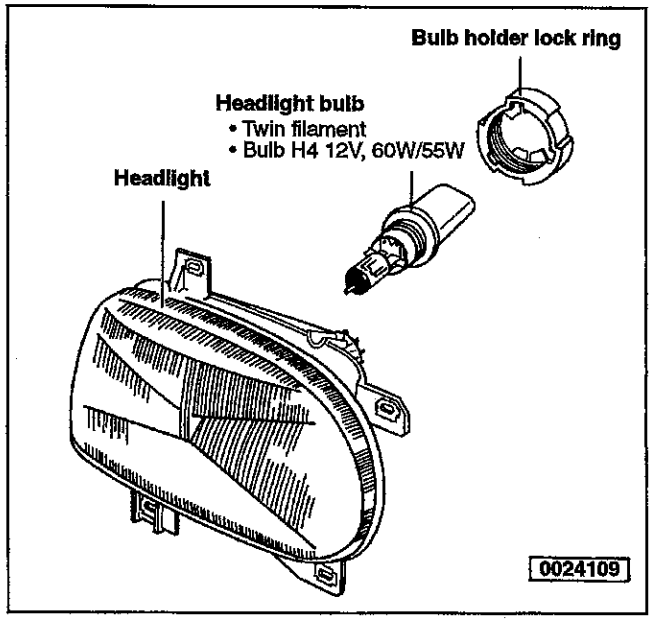
***NOTE—***
*If daytime running light relay (marked "25") is noisy install insulator (VW part no. 1HM 963 571) over relay.*

**Daytime running light relay position**
- Gasoline vehicles . . . . . position 23
- Diesel vehicles . . . . . position 19

## EXTERIOR LIGHTS

***CAUTION—***
- *Before working on electrical system, disconnect battery negative (–) cable.*
- *Before disconnecting battery be sure to obtain radio anti-theft code.*

### Headlight bulb, replacing (single bulb)




0024109

**Fig. 1.** Single bulb headlight assembly.

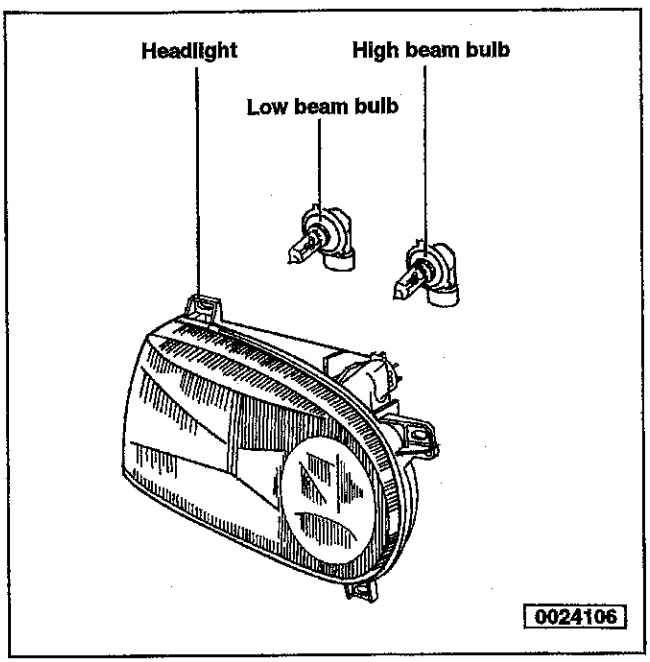
***NOTE—***
*Check and adjust headlights after performing any work that may affect headlight aim.*

1. Remove headlight harness connector and cut tie-wrap (if installed). See Fig. 1.
2. Twist bulb holder lock ring counter-clockwise approx. 1/4 turn and remove.
3. Pull bulb holder from headlight housing and remove bulb from socket holder.
4. Insert new bulb into bulb socket.

> ***CAUTION—***
> *Do not touch bulb glass with bare fingers. Skin oil will evaporate when bulb gets hot, dulling reflector and/or damaging bulb.*

5. Align lugs on bulb holder with grooves in reflector housing and install holder into housing.
6. Install bulb holder lock ring and twist 1/4 turn clockwise to lock.
7. Reconnect headlight connector and new tie-wrap. Check headlight operation.

## Headlight, replacing (two bulb system)




0024106

**Fig. 2.** Headlight assembly for two bulb system.

1. Disconnect headlight bulb connector.
2. Twist bulb counter-clockwise approx. 1/8 turn and remove from headlight housing. See Fig. 2.
3. Align lugs on bulb with grooves on headlight housing and install bulb into housing.
4. Twist bulb approx. 1/8 turn until it locks into place.
5. Reconnect headlight and check headlight aim.

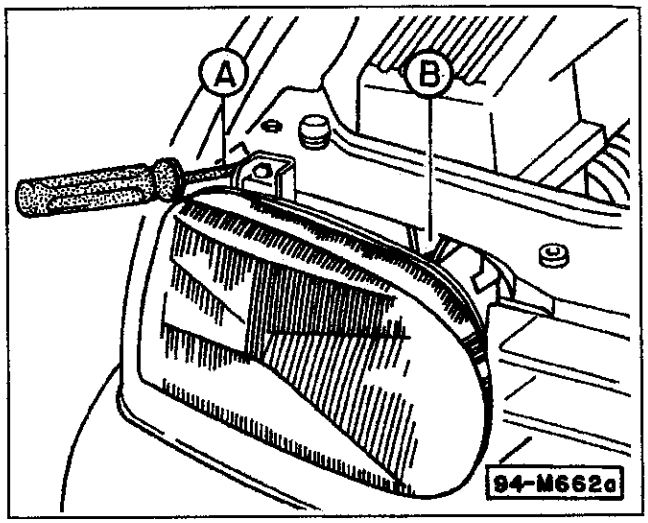
## Headlights, adjusting

Accurately aiming the headlights requires special adaptors and equipment. Authorized Volkswagen dealers and most automotive repair facilities are equipped to make these adjustments.

To adjust horizontal and vertical headlight aim, turn the respective adjuster with a screwdriver through the slots above or below the headlight. See Fig. 3.

**Headlight adjusting requirements:**

- Tires inflated to the correct pressure.
- Fuel tank at least half full.
- Lenses and lens reflectors clean and not damaged.
- Driver's seat loaded with approx. 75 kg (165 lbs)
- Vehicle and headlight beam adjusting equipment standing on level ground and properly aligned.

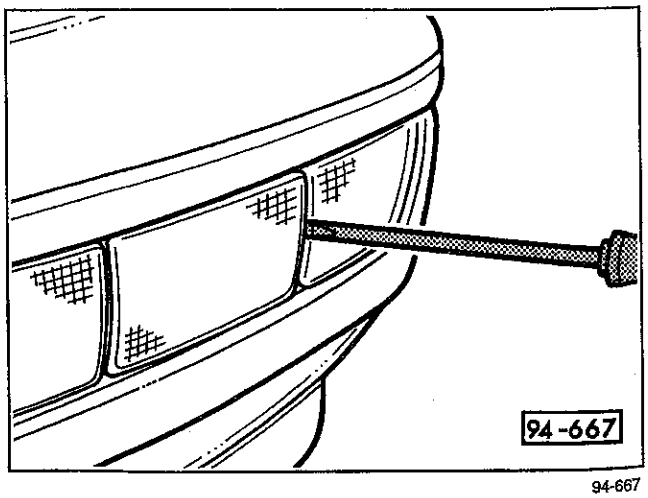



94-M662a

**Fig. 3.** Vertical adjustment (**A**) and horizontal adjustment (**B**).

## Front turn signal housing, removing and installing

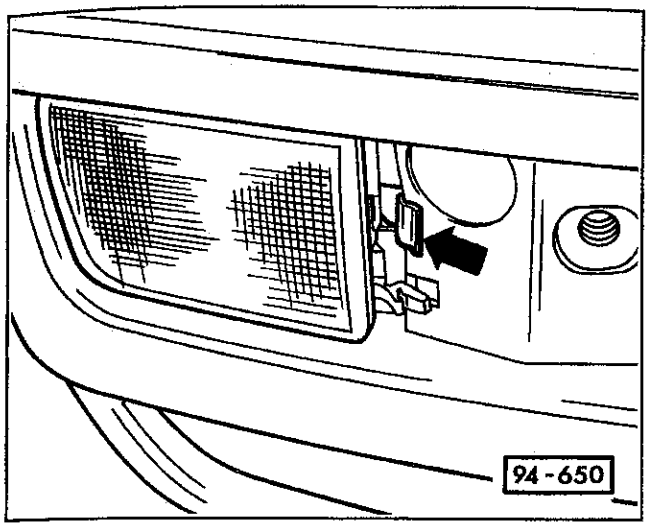
1. Remove towing eye lens cover. See Fig. 4.




94-667

**Fig. 4.** Use screwdriver to carefully pry out towing eye cover.

2. Push in locking tab and pull turn signal housing from bumper. See Fig. 5.




94-650

**Fig. 5.** Front turn signal locking tab (**arrow**).

3. Disconnect connector and remove turn signal housing.

4. Install in reverse order of removal.

## Front turn signal bulb, removing and installing

1. Remove turn signal housing as described above.

2. Twist bulb holder from rear of turn signal housing approx. 1/8 turn counter-clockwise and remove from housing.

3. Remove bulb from holder.

4. When installing, twist bulb holder clockwise approx. 1/8 turn until holder locks into turn signal housing. The remainder of the installation is the reverse of the removal.

## Fog light housing, removing and installing

1. Remove towing eye (lens) cover. See Fig. 4.

2. Remove fog light housing mounting screws. See Fig. 6.

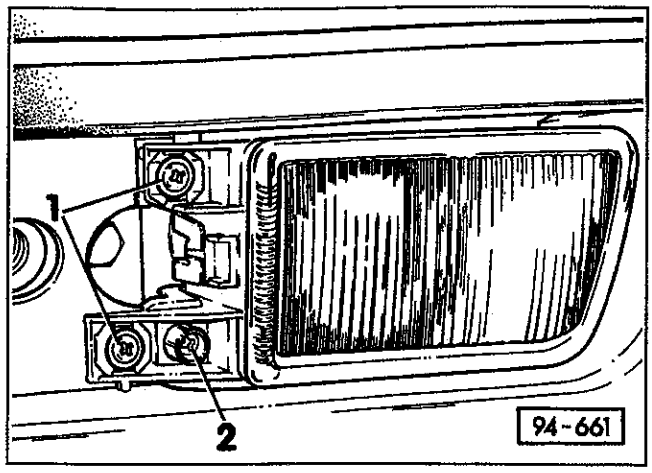
3. Pull fog light housing from bumper and disconnect connector.

4. Install in reverse order of removal.

5. Adjust fog lights by turning adjusting screw counter-clockwise to lower beam or clockwise to raise beam.

***NOTE—***

*Horizontal (side-to-side) fog light aim is fixed and can not be adjusted.*




94-661

**Fig. 6.** Fog light mounting screws (**1**) and adjuster (**2**).

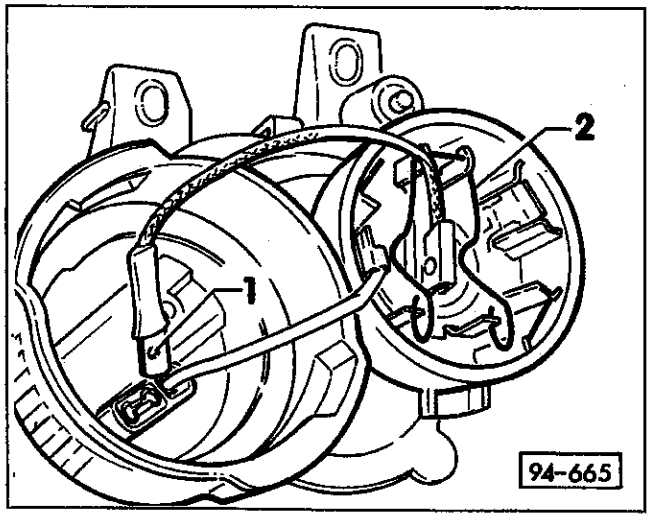
## Fog light bulb, removing and installing

1. Remove fog light housing as described above.

2. Twist bulb cover counter-clockwise and remove.

3. Disconnect fog light bulb connector (inside of cover).

4. Unclip bulb spring retaining clips and swing clips out. See Fig. 7.




94-665

**Fig. 7.** Fog light bulb connector (**1**) and spring clip (**2**).

5. Remove bulb from housing.

***CAUTION—***

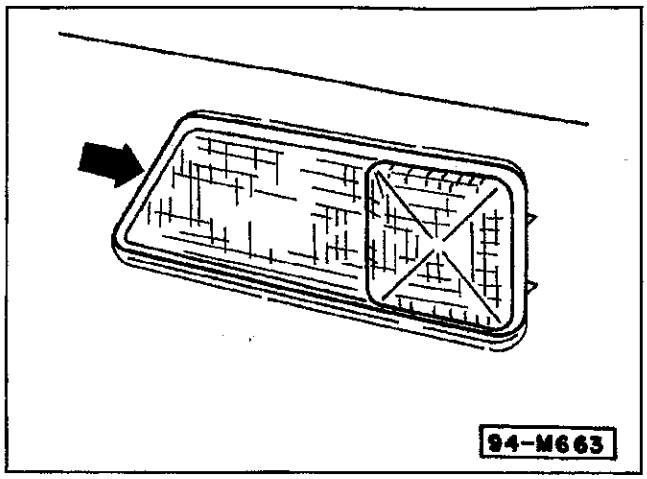
*Do not touch glass of halogen bulb with bare fingers. Skin oil will evaporate when bulb gets hot, dulling reflector and/or damaging bulb.*

6. Insert bulb so that recess in bulb holder aligns with housing guide lug.
   - Halogen bulb: 12 V/55 W

7. The remainder of installation is the reverse of removal.

## Side marker light bulb, removing and installing

1. Using a small screwdriver, carefully pry side marker light lens from bumper cover until retaining lug is released. See Fig. 8.




94-M663

**Fig. 8.** Side marker light lens retaining lug (**arrow**).

2. Disconnect connector and remove side marker light bulb.

3. Installation is the reverse of removal. Push side marker light into bumper cover until retaining lug engages.

## License plate bulb, removing and installing

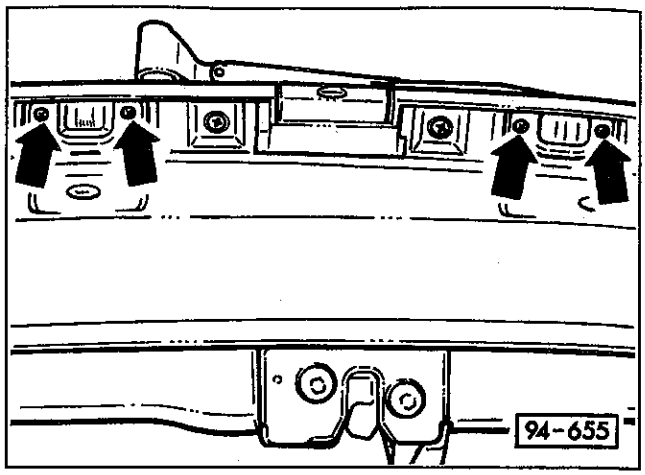
1. Remove plastic molding from underside of rear hatch/trunk lip.

2. Remove license plate light retaining screws. See Fig. 9.

3. Remove lens and pull bulb straight out of holder.
   - Bulb: 12 V/5 W

   ***NOTE—***
   *Do not twist bulb when removing from holder.*

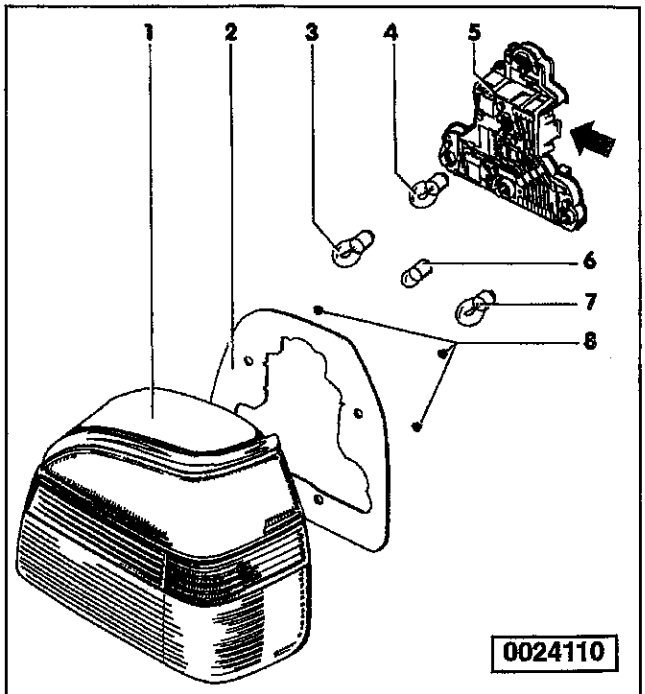
4. Installation is the reverse of removal.




94-655

**Fig. 9.** License plate light retaining screws (**arrows**).

## Taillight, assembly




1. **Housing**
2. **Gasket**
3. **Back-up light bulb**
   - 12 V/21 W
4. **Turn signal bulb**
   - 12 V/21 W
5. **Bulb holder**
   - Squeeze tabs (arrow) to remove
6. **Taillight bulb**
   - 12 V/10 W
7. **Brake light bulb**
   - 12 V/21 W
8. **Nut M5**

0024110

**Fig. 10.** Brake lights, taillights, back-up lights and turn signals.

# 96 Lights, Accessories–Interior



## GENERAL

This section covers electrical equipment located in the passenger compartment; instrument panel switches, door switches, alarm system, cruise control. Items such as radio, heating and A/C that require detailed coverage have their own repair groups. See **97 Wiring Diagrams, Fuses and Relays** for additional information.

> ***CAUTION—***
> - *Before working on electrical system disconnect negative (–) battery cable.*
> - *Before disconnecting battery be sure to obtain radio anti-theft code.*

> ***WARNING—***
> *Volkswagen identifies electrical components by a letter and/or a number in the electrical schematics. These electrical identifiers are listed in this repair group as an aid to electrical troubleshooting.*

***NOTE—***
*If the battery has been disconnected, or if the power window regulator is being connected for the first time, it will be necessary for the electronic control system to establish a reference point for the upper window frame. This is accomplished by the programming procedure that follows.*

## ELECTRICAL SWITCHES

### Power window child safety system, programming (limited production, from March 1995)

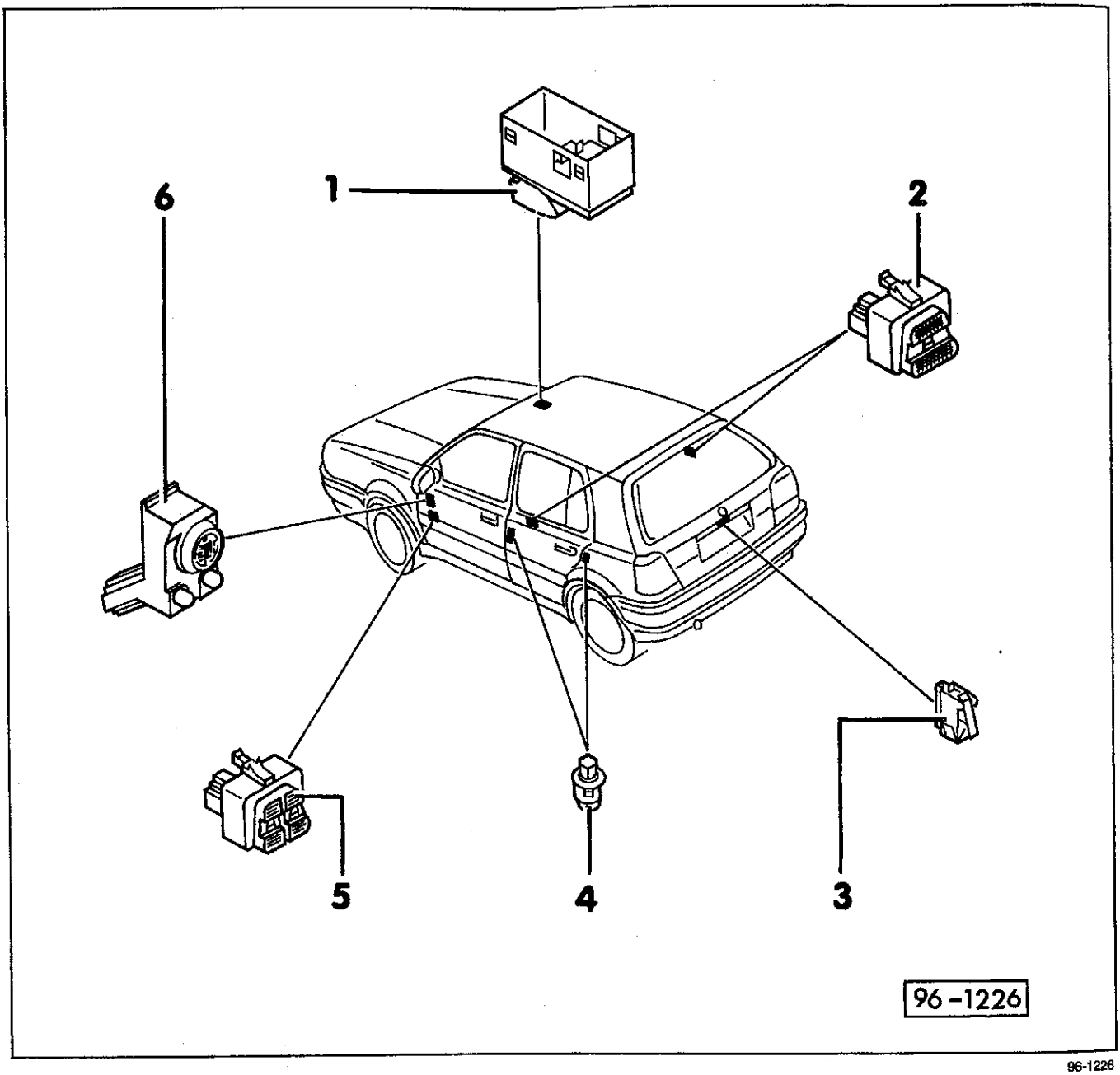
A very limited number of vehicles produced from March 1995 had power windows that feature a "one touch up" function. This feature was NOT built into the majority of vehicles equipped with power windows. If equipped, this feature works when the upper part of the power window switch is pushed briefly (approx. 0.3 seconds). The window will be raised automatically.

If the system detects an obstruction of any kind during window closing, the window is lowered again automatically. The safety function is activated if an obstruction is detected in the range from 200mm to 4 mm (7-7/8 to 5/32 in.) below the upper window frame.

1. From outside vehicle, raise windows using key (front door).

2. Turn key two times in "closed" direction, then wait at least three seconds.
   - At this point the safety function is programmed, and objects that interfere with the window being closed will cause it to be lowered again. Once the power window regulator is programmed, it will not be necessary to repeat the procedure unless the battery is disconnected.

## Door, rear lid, and power roof switches

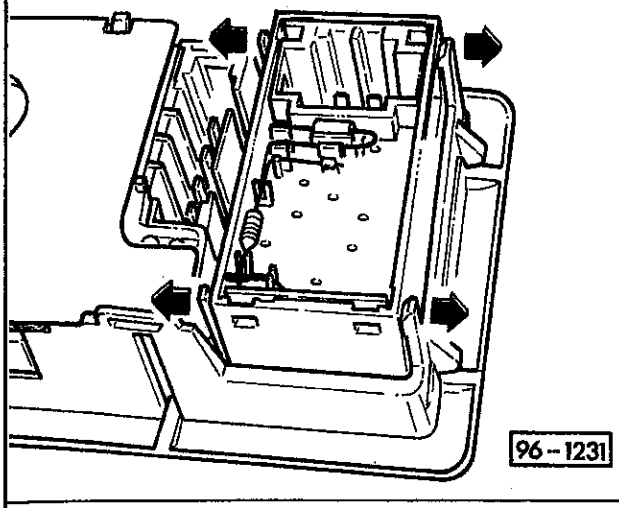



96-1226

**Fig. 1.** Switch locations for power accessories.

1. **Sunroof switch (E8)**
   - Removing and installing, **see** Ⓐ
2. **Left rear window switch (E52)**
   - See **Power window child safety system, programming**
   - Removing and installing, **see** Ⓑ
3. **Luggage compartment light switch (F5)**
   - Removing and installing, **see** Ⓒ
4. **Left front door contact switch (F2)**
   - Remove rubber boot and pry out with screwdriver
5. **Left front power window switch (E40)**
   - See **Power window child safety system, programming**
   - Removing and installing, **see** Ⓑ
6. **Mirror adjustment switch (E43) with mirror selector switch (E48)**
   - Removing and installing, **see** Ⓓ

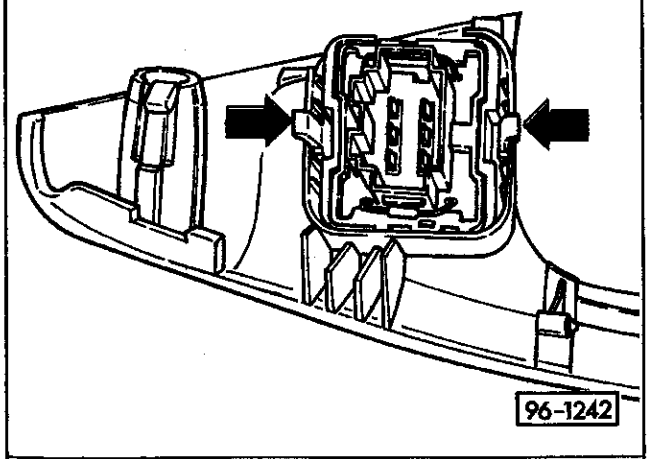
## A Sunroof switch, removing and installing




96-1231

- Remove front interior light and sunroof switch connector.
- Spread switch retaining tabs (arrows) and pry switch from interior light assembly.
- Install in reverse order of removal.

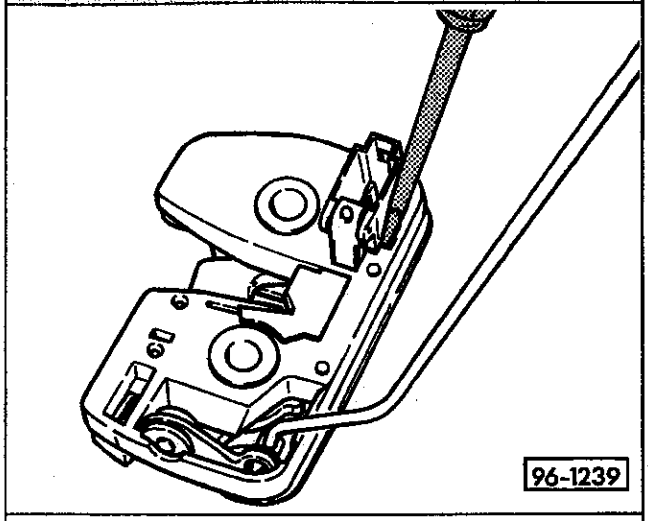
## B Power window switches, removing and installing




96-1242

- Carefully pry off upper trim of door grab handle and remove window switch connector.
- Squeeze switch retaining tabs (arrows) and remove switch.
- Install in reverse order of removal.

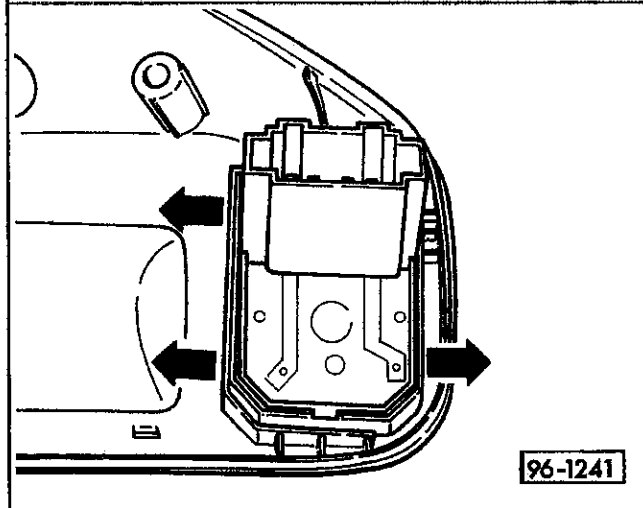
## C Luggage compartment light switch, removing and installing




96-1239

- Located on the rear hatch/trunk lid lock assembly.
- Remove rear lid latch, see 55 Hood and Lids.
- Remove switch connector.
- Using a screwdriver, disengage retaining tabs and pull switch from lock assembly.
- Install in reverse order of removal.

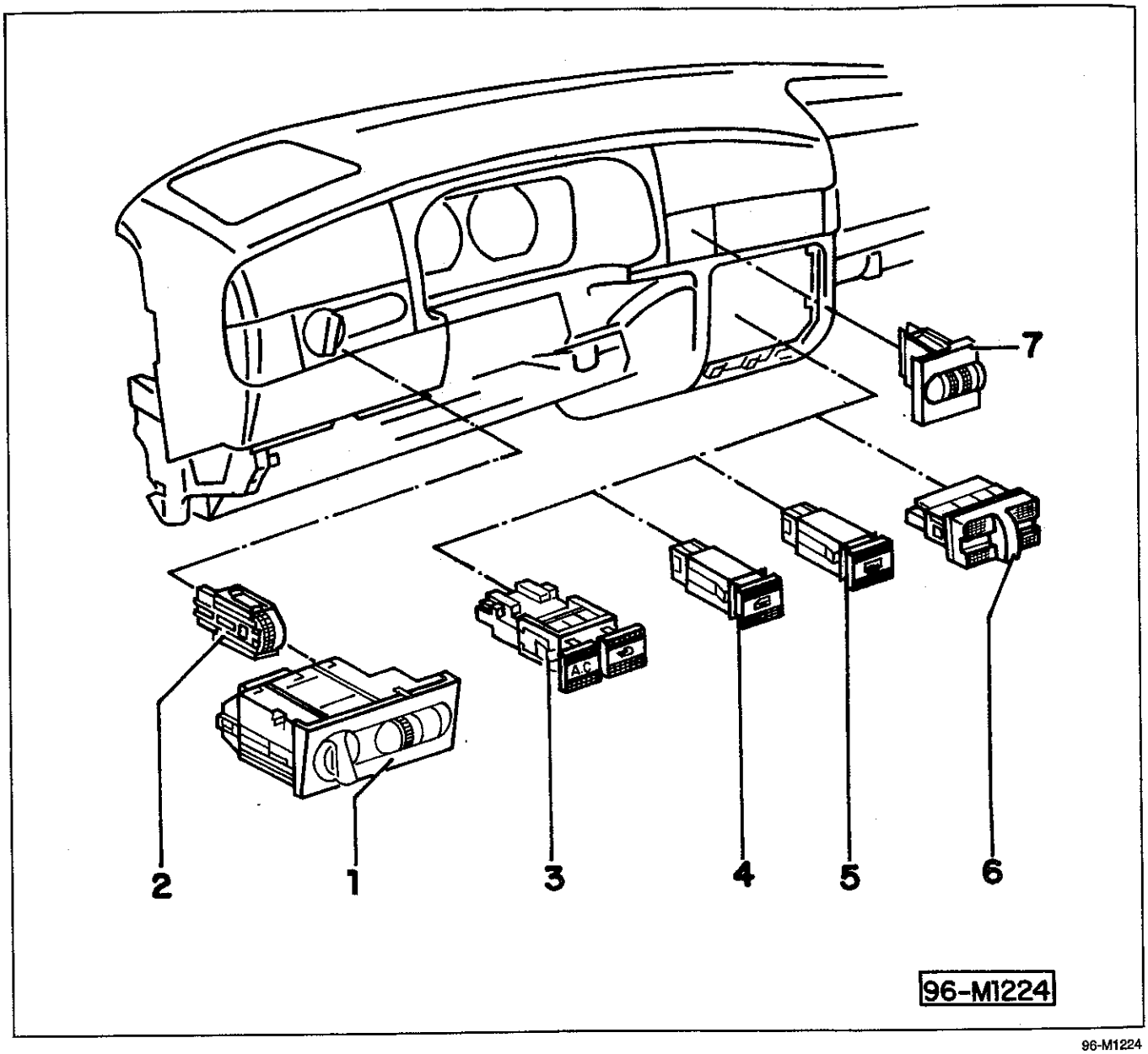
## D Mirror adjustment switch with selector switch, removing and installing




96-1241

- Pry off door handle trim and remove switch connector.
- Disengage switch retaining tabs (arrows) and remove switch from trim.
- Install in reverse order of removal.

## Instrument panel switches

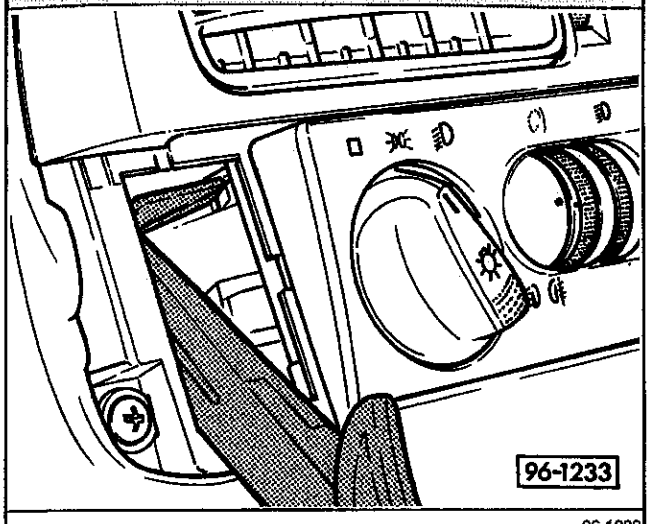



96-M1224

**Fig. 2.** Instrument panel switches for 1996 model year, other model years are similar.

1. **Light switch (E1)**
   - For parking lights, headlights and fog lights
   - Removing and installing, **see** (A)
2. **Headlight adjuster**
   - Not applicable to cars sold in USA and Canada
3. **A/C switch (E35)**
   - Removing, **see** (B)
4. **Door lock switch (E150)**
   - Not applicable to all models
   - Removing, **see** (B)
5. **Rear window defogger switch (E15)**
   - Removing, **see** (B)
6. **Window lockout switch (E39) with left and right rear window switch (E53 and E55)**
   - Jetta only
   - See **Power window child safety system, programming**
   - Removing, **see** (B)
7. **Adjuster for heated driver's and passenger's seat (E94 and E95)**
   - Jetta only
   - Removing and installing, **see** (C)

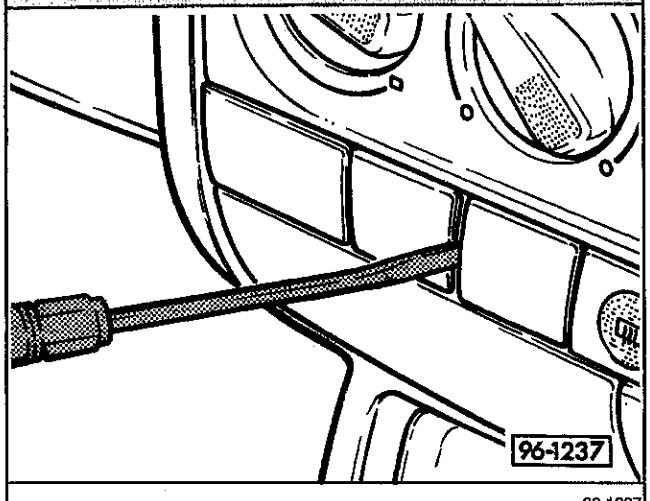
## A Light switch, removing and installing




96-1233

- Light switch shown in illustrations differs slightly from light switch installed in vehicle.
- Carefully pry off trim piece on left side of light switch.
- Press switch release button on side of switch as shown in illustration.
- Pull light switch from instrument panel, remove connector and light switch.
- Install in reverse order of removal.

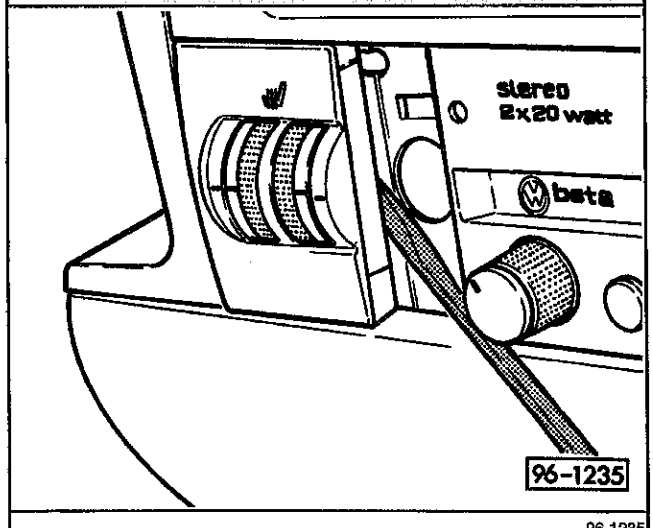
## B Switches below heater controls, removing




96-1237

- The procedure applies to rear window defogger switch, A/C switch, window lockout switch, left rear window switch, right rear window switch, and door lock switch.
- Carefully pry off cover plate (not all models).
- Insert screwdriver between switch housing and instrument panel, carefully pry out switch and remove connector.

## C Heated seat switch (Jetta only)

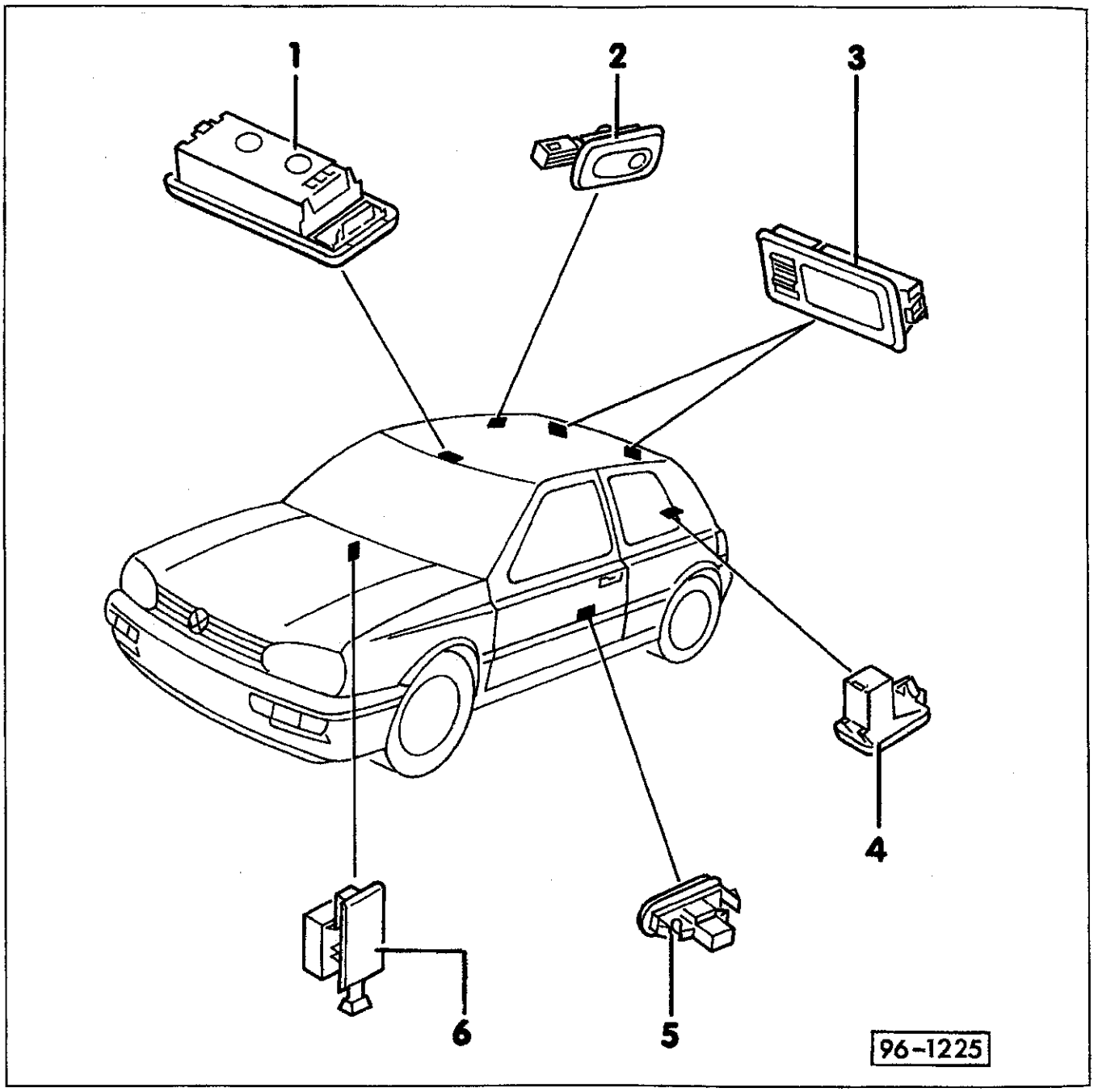



96-1235

- Carefully pry off trim plate located to right of switch.
- Insert screwdriver on right side of switch between switch housing and instrument panel, carefully pry out switch and remove connector.

## INTERIOR ACCESSORIES

### Interior lights

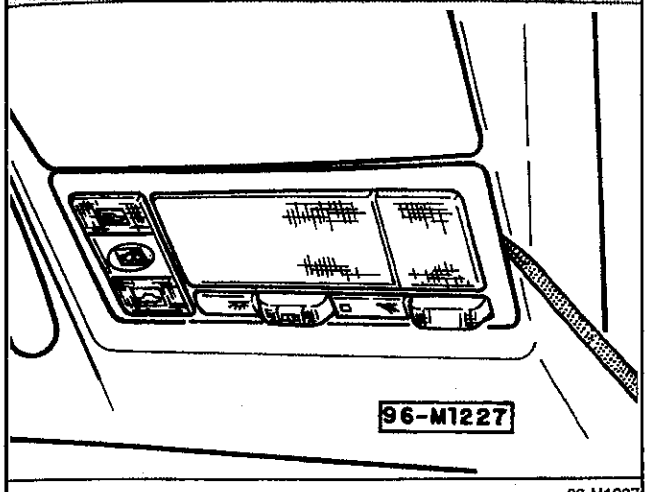



96-1225

**Fig. 3.** Interior lighting.

1. **Front interior light (W)**
   - Includes right front map/reading light (W13) and sunroof switch (E8)
   - Removing and installing, **see** Ⓐ and Ⓑ
2. **Right rear reading light (W12) (Jetta only)**
   - Left rear reading light (W11) also installed in Jetta
3. **Rear/luggage compartment interior light (W1)**
   - Not applicable to cars sold in USA and Canada
4. **Luggage compartment light (W3)**
   - Replacing, **see** Ⓒ
5. **Door courtesy light (Jetta only)**
6. **Glove compartment light (W6)**
   - Replacing, **see** Ⓓ

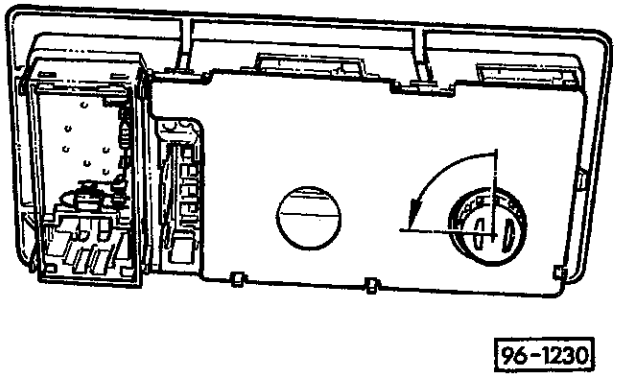
## A Front interior light, removing




96-M1227

- Using a screwdriver, carefully pry out front interior light assembly from headliner and remove wire connectors.
- When checking or replacing the front interior light bulb, remove only the lens; it is not necessary to remove the entire light assembly.

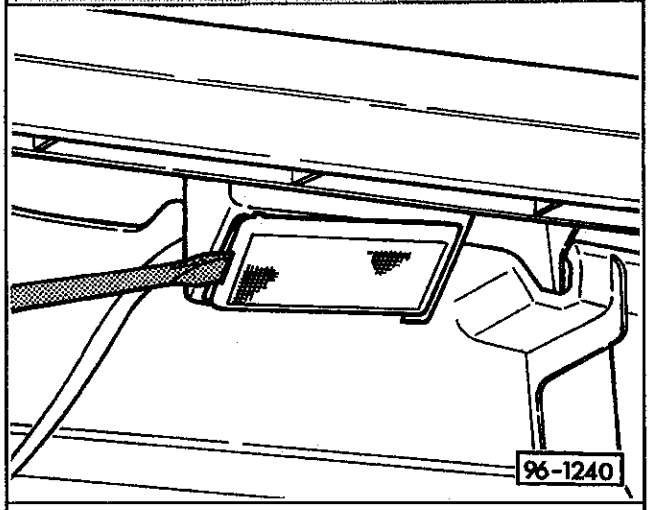
## B Right front map/reading light bulb, removing/replacing




96-1230

- Remove front interior light assembly.
- Twist bulb holder counter-clockwise (arrow) and remove from interior light.
- Pull bulb (12V/5W) straight out of holder (do not twist), replace with new bulb as necessary.

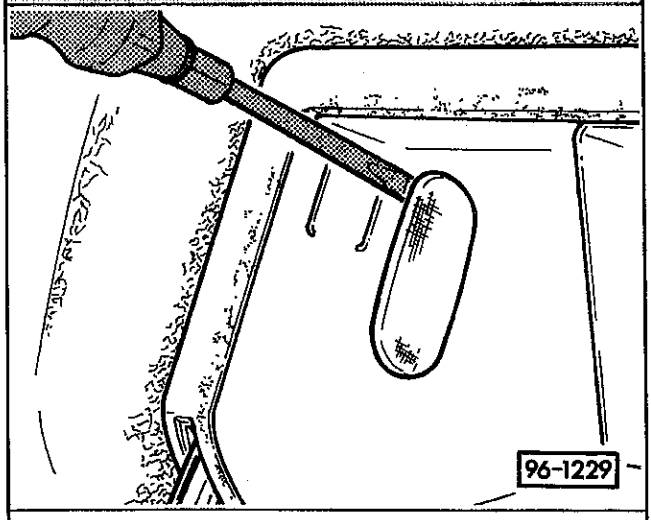
## C Luggage compartment light, replacing




96-1240

- Using a screwdriver, carefully pry out luggage compartment light.
- Remove wire connector and replace bulb (12V/3W) as necessary.

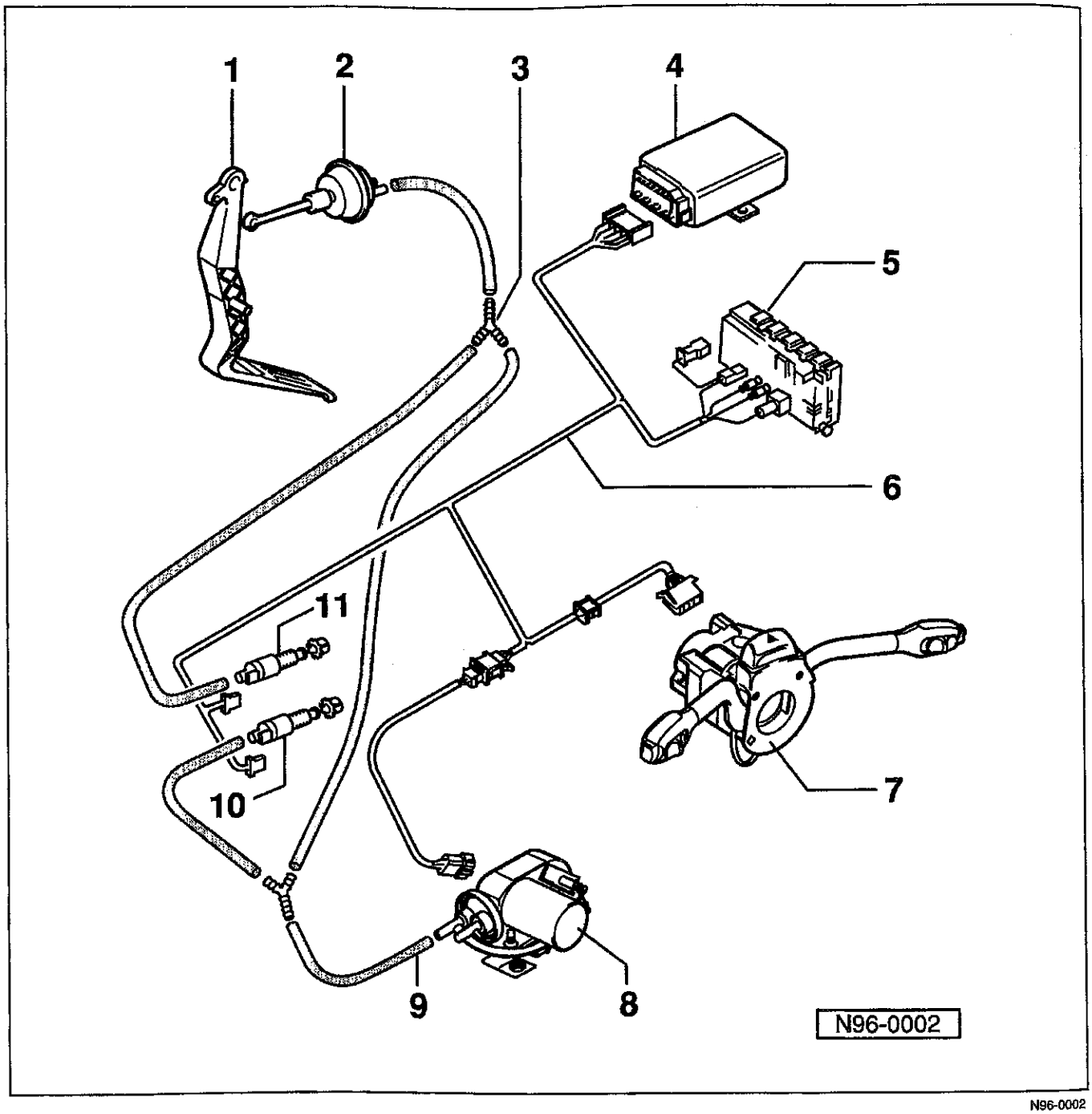
## D Glove compartment light, replacing (cars without passenger's side airbag)




96-1229

- Position screwdriver at top portion of glove compartment light as shown and carefully pry out light.
- Remove lens, bulb holder and microswitch and replace bulb (12V/3W) as necessary.

## Cruise control system, (except AHU TDI engine) assembly




N96-0002

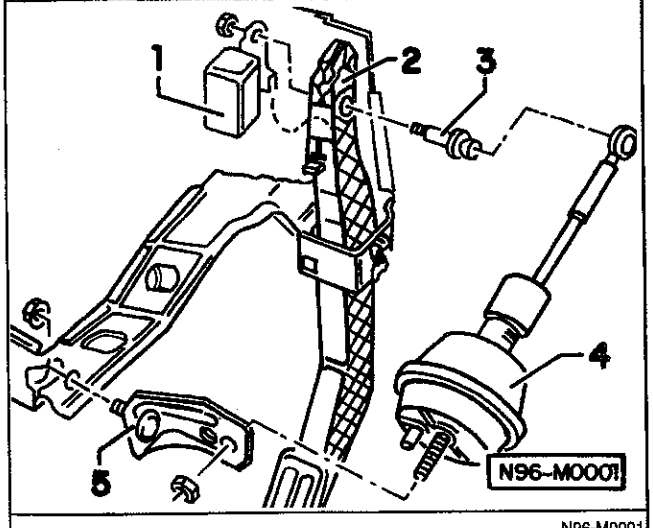
**Fig. 4.** Cruise control system components.

***CAUTION —***
- *Before working on electrical system disconnect negative (–) battery cable.*
- *Before disconnecting battery be sure to obtain radio anti-theft code.*

1. **Accelerator Pedal**
2. **Throttle control diaphragm**
   - Check for leaks
   - Removing, **see** Ⓐ
   - Adjusting, **see** Ⓑ

3. **T-connector**
4. **Cruise control control module (J213)**
   - Located in driver's side A-pillar
   - See **Cruise control control module, removing**
5. **Relay panel**
6. **Wiring harness**
7. **Cruise control switch (E45)**
   - Removing and installing, see **48 Steering**
8. **Cruise control vacuum pump (V18)**
   - See **Cruise control vacuum pump, removing and installing**
9. **Vacuum hose**
   - Check for leaks
10. **Vacuum vent valve with cruise control clutch pedal position (CPP) switch (F36)**
    - Vehicles with manual transmission only
11. **Vacuum vent valve with cruise control brake pedal position (BPP) switch (F47)**

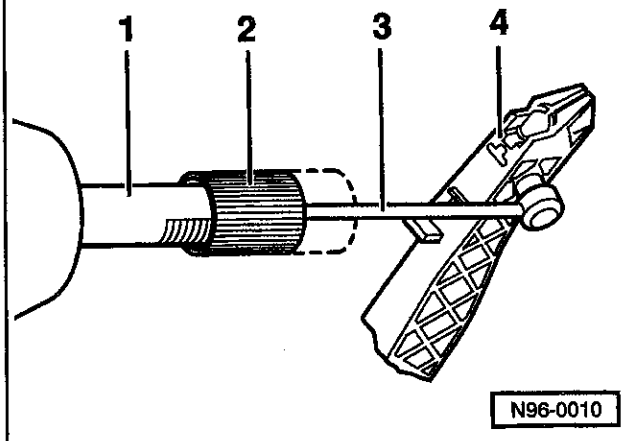
### A Throttle control diaphragm, removing




N96-M0001

- **Balance weight (not installed on all vehicles) (1)**
- **Accelerator pedal (2)**
- **Remove M8 securing nut and throttle control element (4) from bracket (5).**
- **Carefully pull throttle control rod off ball socket (3).**

### B Throttle control diaphragm, adjusting




N96-0010

- **Remove adjusting sleeve (2) from throttle control diaphragm(1) and push fully forward.**
- **Adjust accelerator pedal cable (3).**
- **Pull adjusting sleeve to rear until there is maximum play of 1 mm (0.04 in.) and lock by turning clockwise onto stop.**

## Cruise control system, (except AHU TDI engine) troubleshooting

Factory installed cruise control is available as an option or as standard equipment on most Golf and Jetta models. All of these systems are essentially the same differing only in the location of fuses. The single exception is the Jetta TDI. Due to the fully electronic nature of this diesel engine management system, cruise control is simply added into the function of the engine control module eliminating the need for any external components except for the column mounted switch. Diagnosis and troubleshooting requires the use of Volkswagen scan tool VAG 1551 or VAG 1552 and is beyond the scope of this repair manual.

***NOTE—***
*Always have the correct wiring diagram available before starting any repairs or troubleshooting.*

***CAUTION—***
*Use only a multimeter and jumper wires that have the correct terminal ends. Damage to the harness connector terminals could result if incorrect terminals are used.*

1. Disconnect the 12 terminal harness connector from the cruise control ECU under the left side of the dash near the fuse/relay panel.
2. Use appropriate adapters and carefully probe the harness connector or jumper it as required, see **table a.** The cruise control ECU terminals are clearly marked on both the housing and the ECU.
3. When troubleshooting is completed, be sure to remove all jumper wires including the power source to fuse S51. Reinstall fuse.
4. If all tests are OK, substitute a known good cruise control ECU and road test.

**Table a. Troubleshooting cruise control (except AHU TDI engine)**

| Step | Item to be checked | Connect multimeter to cruise control harness connector terminals | Test procedures and/or extra steps | Expected results | Area to check if result is NOT obtained |
|---|---|---|---|---|---|
| **1-Automatic Transmission** | Voltage supply, terminal 15 | 9 and vehicle **GROUND** | **Automatic Transmission:** Using a helper to read multimeter, road test car with transmission in **D, 3,** or **2** and accelerate to above 25 m.p.h. Switch on cruise control. | Battery voltage | Voltage is supplied from TCM when step 1A conditions are met<br>• Check TCM or break in wiring from TCM<br>• Check for voltage at terminals 1 and 4 of cruise control switch (E45)<br>• Check for break in wiring between cruise control switch (E45) and cruise control ECU (J213) |
| **1A-Automatic Transmission** | | | **Automatic Transmission, to continue testing after above test is completed:** Remove fuse S51. Using a fused jumper, supply 12 volts back into the socket of the removed fuse. Try both terminals until battery voltage is indicated on multimeter. Switch ignition on. Switch on cruise control. Leave jumper in place for all remaining tests. | | • Check wiring according to wiring diagrams, see **97 Wiring Diagrams, Fuses and Relays**<br>• Confirm that fused jumper wire works |

**continued on next page**

## Table a. Troubleshooting cruise control (except AHU TDI engine)

| Step | Item to be checked | Connect multimeter to cruise control harness connector terminals | Test procedures and/or extra steps | Expected results | Area to check if result is NOT obtained |
|---|---|---|---|---|---|
| **1-Manual Transmission** | Voltage supply, terminal 15 | **9** and vehicle **GROUND** | **Manual Transmission:** Switch on ignition and cruise control | Battery voltage | • Check appropriate fuse in fuse/relay panel<br>• Check for voltage at terminals 1 and 4 of cruise control switch (E45)<br>• Check for break in wiring between cruise control switch (E45) and cruise control ECU (J213) |
| **2** | ECU grounds, terminal 31 | **9** and **4**<br>**9** and **12** (some cars) | Switch on ignition and cruise control | Battery voltage | • Check for break in wiring between cruise control ECU and ground |
| **3** | Cruise control switch (E45), set function | **8** and **4** | Switch on ignition and cruise control. Push and hold set button. | Battery voltage | • Check for voltage at terminal 3 of cruise control switch (E45)<br>• Check for break in wiring between cruise control switch (E45) and cruise control ECU (J213) |
| **4** | Cruise control switch (E45), resume function | **5** and **4** | Switch on ignition and cruise control. Push and hold resume button. | Battery voltage | • Check for voltage at terminal 2 of cruise control switch (E45)<br>• Check for break in wiring between cruise control switch (E45) and cruise control ECU (J213) |
| **5** | Cruise control brake pedal position switch (F47) and clutch pedal position switch (F36) (as applicable) | **3** and **9** | Switch on ignition and cruise control. | Battery voltage | The cruise control ECU senses continuity to ground through this part of the circuit. This check tests the circuit using the brake lights.<br>• At least one brake light must work properly<br>• Check brake pedal position and/or clutch pedal position switches for adjustment<br>• Check brake and/or clutch adjustment |
| | | | Switch on ignition and cruise control. Depress brake pedal. Depress clutch pedal. | No voltage when either pedal is depressed | |
| **6** | Vehicle speed sensor (G22) | **7** and **4** | Switch on ignition. Raise one front wheel sufficiently to allow wheel to be turned by hand. Slowly turn wheel. | Voltage must change between low and high as noted below (typical values) when wheel is rotated.<br>• Low voltage: 0-4 volts<br>• High voltage: 7-12 volts | The cruise control ECU uses the same Hall speed sensor as the speedometer.<br>• Speedometer must work properly<br>• Check for break in wiring between speedometer and fuse/relay panel and fuse/relay panel and cruise control ECU |

**continued on next page**

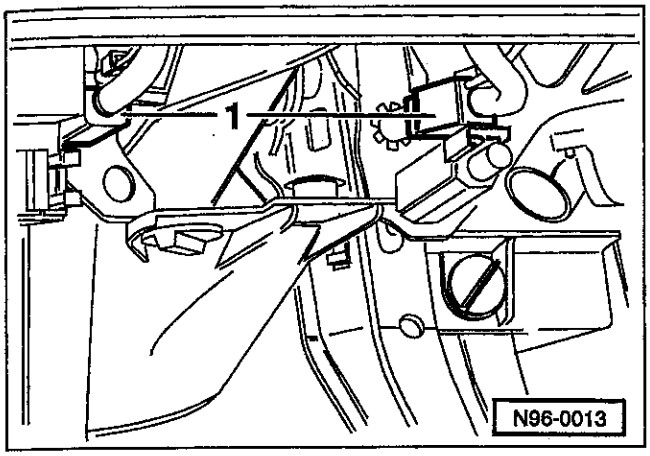
**Table a. Troubleshooting cruise control (except AHU TDI engine)**

| Step | Item to be checked | Connect multimeter to cruise control harness connector terminals | Test procedures and/or extra steps | Expected results | Area to check if result is NOT obtained |
|---|---|---|---|---|---|
| 7 | Vacuum pump and valve (V18), servo, connecting hoses, brake and clutch vacuum components, pedal position switches | No multimeter connections required for this step | Use suitable jumper wires. Jumper all of these harness connector terminals:<br>9 and 11<br>1 and 4<br>2 and 4<br>Switch on ignition<br>Do not start engine!<br>Switch on cruise control | Cruise control vacuum pump (V18) runs and throttle opens fully (goes to floor) | • Check cruise control vacuum pump<br>• Check wiring between cruise control vacuum pump and ECU<br>• Check vacuum servo and all connecting hoses for cracks and leaks |
| | | | Depress brake pedal (jumpers remain in place) | Throttle must close fully (return) | • Check brake pedal position switch and adjustment |
| | | | Release brake pedal (jumpers remain in place) | Throttle must open fully (goes to floor) | – |
| | | | Depress clutch pedal (manual transmission only) (jumpers remain in place) | Throttle must close fully (return) | • Check clutch pedal position switch and adjustment |
| | | | Release clutch pedal (manual transmission only) (jumpers remain in place) | Throttle must open fully (goes to floor) | – |
| | | | Disconnect jumper from **2** and **4** | Cruise control vacuum pump must shut off and throttle must stay open (on the floor) | • Check vacuum servo and all connecting hoses for cracks and leaks |
| | | | Remove remaining jumpers | Throttle must close fully (return). Operation must be smooth. | • Check cruise control vacuum pump<br>• Check servo and linkage for mechanical problems and binding |

## Cruise control vacuum vent valve, removing and installing

1. Remove driver' side lower trim from below instrument panel, see **70 Trim-Interior.**

2. Remove wiring connector and vacuum hose from vent valve. Unscrew vent valve from bracket. See Fig. 5.




N96-0013

**Fig. 5.** Cruise control vacuum vent valves (**1**).

3. To install, screw vent valve into bracket to stop.

4. Using pedal, pull vent valve back to pedal rest position. Vacuum vent valve is now adjusted.

5. Reconnect harness connector and vacuum hose.

## Cruise control control module, removing

Control module is located behind bracket on left A-pillar.

1. Remove driver's side lower trim from below instrument panel, see **70 Trim-Interior.**

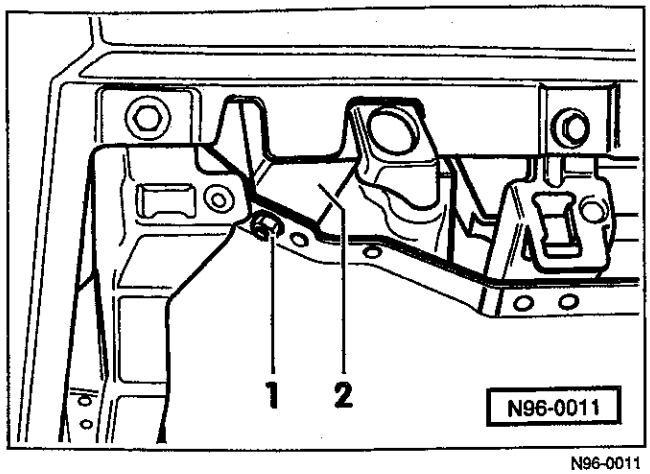
2. Disconnect 12-pin connector from cruise control control module.

3. Disconnect 6-pin and 10-pin connectors from Alarm system control module.

***NOTE —***
*The alarm system control module and cruise control control module are located on the same mounting bracket.*

4. Remove assembly carrier by removing retaining nut. See Fig. 6.

5. Pull control module mounting plate locking lugs out from carrier and remove mounting plate with control module.




N96-0011

**Fig. 6.** Cruise control control module (**2**) and assembly carrier retaining nut (**1**).

6. Remove control module mounting bolts from mounting plate and remove control module.

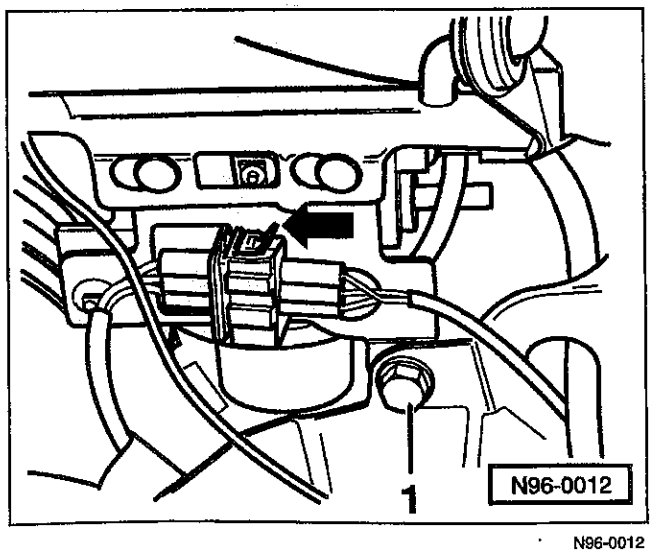
## Cruise control vacuum pump, removing

1. Remove battery, see **27 Engine Electrical.**

2. Remove windshield washer fluid reservoir.

3. Separate 3-pin connector.

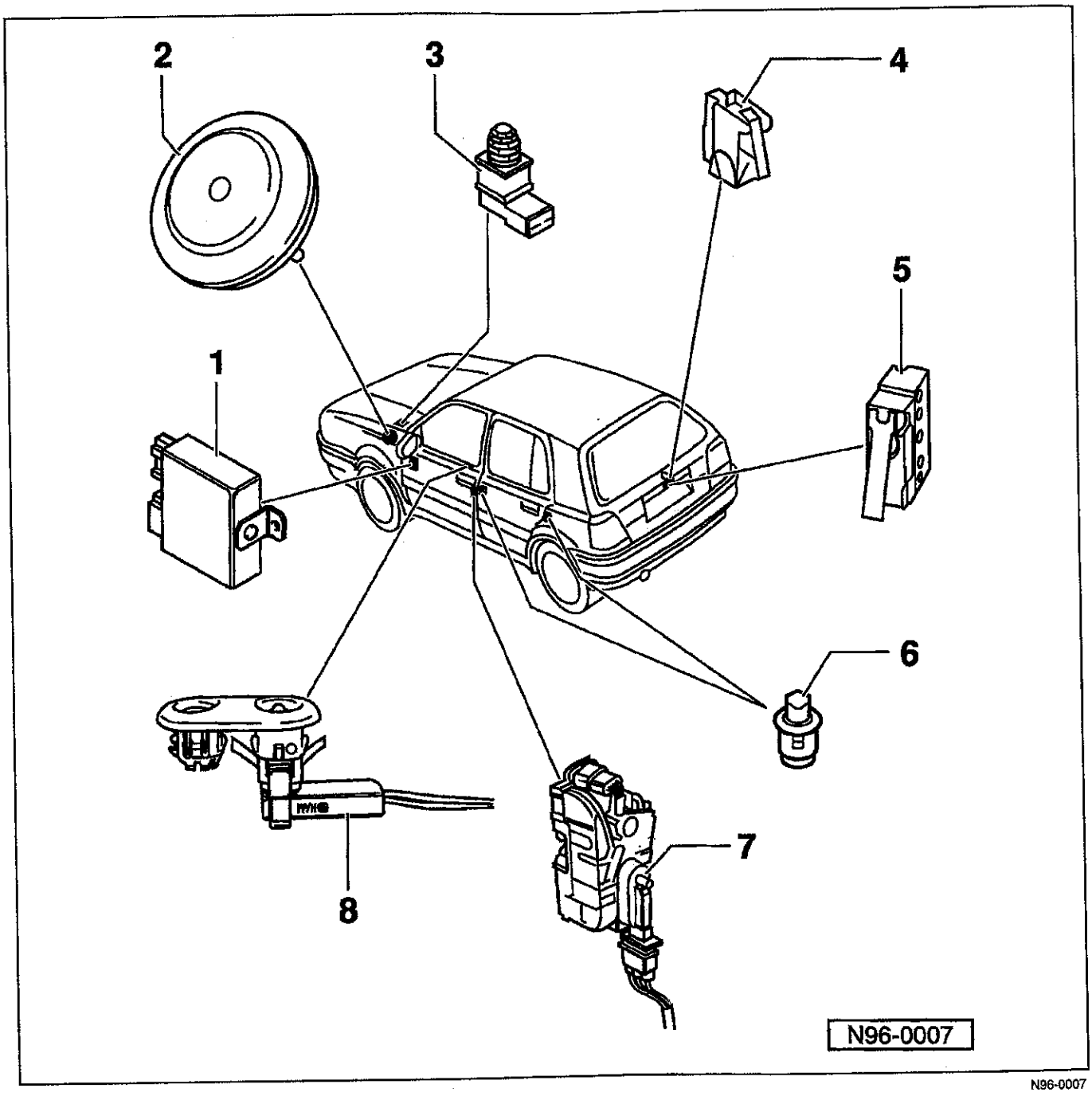
4. Remove vacuum pump mounting bracket bolt. Then slide bracket with pump from its mount. See Fig. 7.




N96-0012

**Fig. 7.** Remove bolt (**1**) and slide mounting bracket in direction of arrow.

## Anti-theft alarm system, components

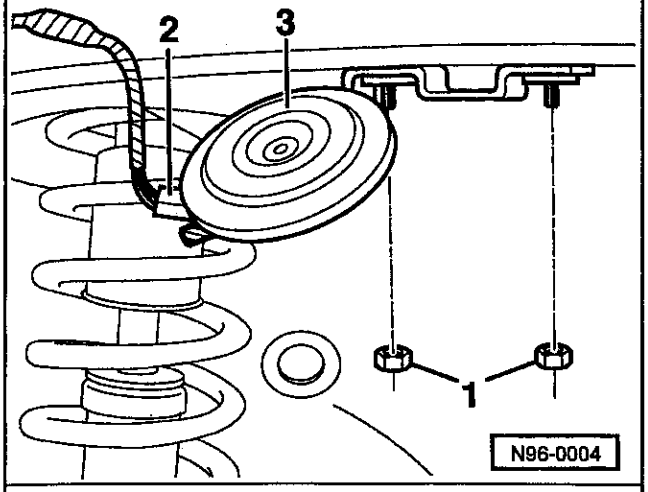



N96-0007

**Fig. 8.** Anti-theft alarm system, components.

1. **Alarm system control module (J284)**
2. **Alarm horn (H8)**
   - Removing and installing, **see** Ⓐ
3. **Hood alarm switch (F120)**
   - Removing and installing, **see** Ⓑ
4. **Trunk lid alarm switch (F123)**
5. **Trunk lock alarm/central locking switch (F124)**
6. **Door contact switch (F2, F3, F10, F11)**
7. **Driver's door central locking system switch (F59)**
8. **Alarm system indicator light (K95)**
   - Removing and installing, **see** Ⓒ

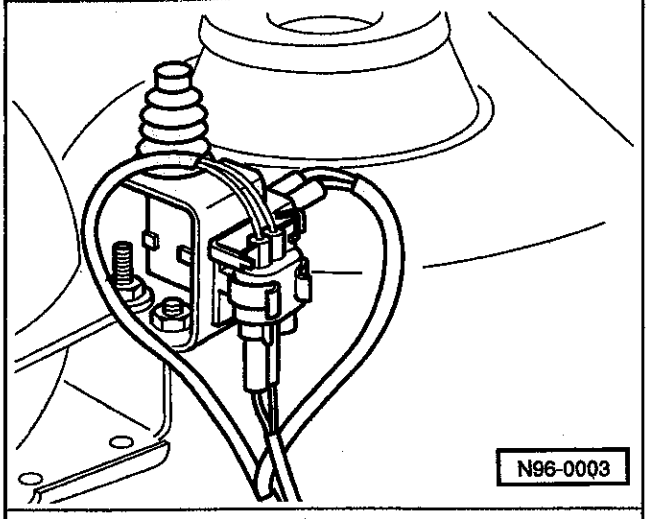
## A Alarm horn, removing




N96-0004

- Located in front left wheel housing, near suspension strut.
- Remove front left wheel housing, see 66 Body Accessories–Exterior.
- Disconnect 2-pin connector (2) from alarm horn (3).
- Remove securing nuts (1) and alarm horn.

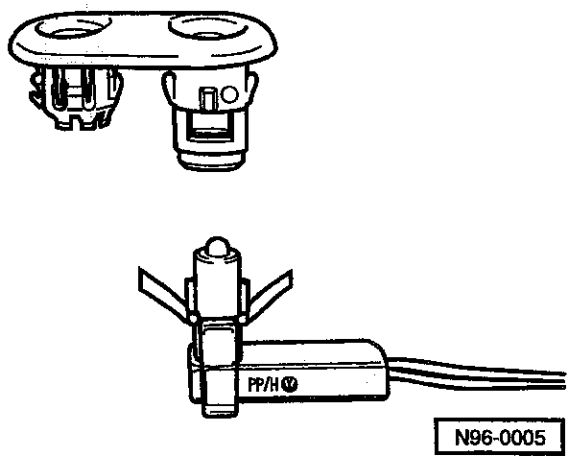
## B Hood alarm switch, removing




N96-0003

- Located in left side of engine compartment, near shock tower.
- Remove 2-pin connector from switch and remove contact switch from mounting bracket.

## C Alarm system indicator light, removing




N96-0005

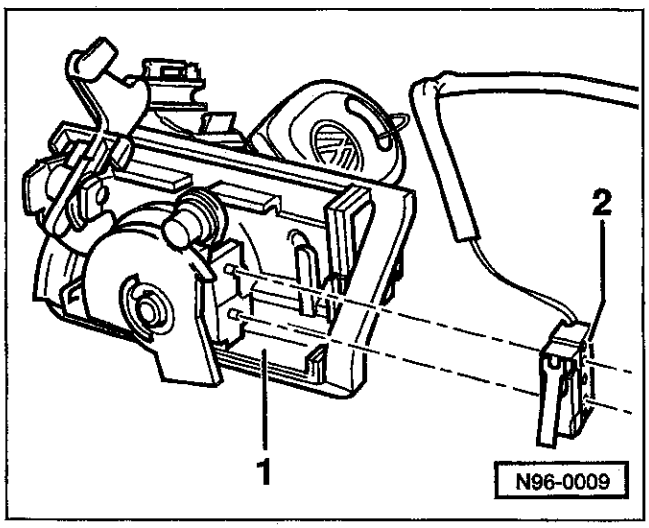
- Remove door trim (see 70 Trim-Interior), and disconnect 2-pin connector.
- Release warning lamp lower section from locating device and pull out. Pull upper section out of door trim.

## Trunk lock microswitch, removing and installing

The trunk lock microswitch functions as part of the alarm/central locking system.

***NOTE—***
*The following procedure describes removal and installation of the switch for Golf models. The procedure is similar for Jetta and Cabrio.*

1. Remove rear lid trim.
2. Disconnect 2-pin connector from microswitch.
3. Remove rear lid lock, see **55 Hood and Lids**.
4. Insert key into lock cylinder and turn lock cylinder clockwise to stop.
5. Carefully pry microswitch from locating pins. See Fig. 9.




N96-0009

**Fig. 9.** Trunk lock alarm/central locking mechanism with microswitch (**2**) and installation location (**1**).

6. Install in reverse order of removal, ensuring that:
   - switch correctly engages locating pins
   - wiring is correctly routed on rear deck lid lock
   - lock cylinder operates correctly before installing rear lid lock

***NOTE—***
*Various types of switches have been used in production. Installing the incorrect contact switch will render the alarm inoperable on vehicles with central locking.*

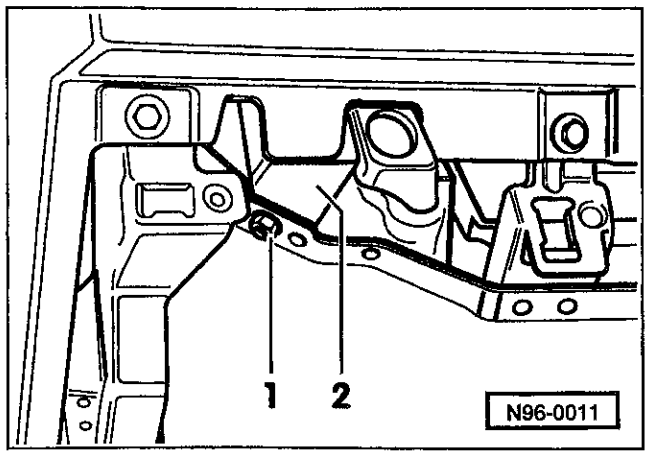
## Alarm system control module, removing and installing

Control module is located behind bracket on left A-pillar.

1. Remove driver' side lower trim from below instrument panel, see **70 Trim-Interior.**
2. Disconnect 6-pin and 10-pin connectors from alarm system control module.
3. Disconnect 12-pin connector from cruise control control module. Control module is located behind bracket on left A-pillar.

***NOTE—***
*The alarm system control module and cruise control control module are located on the same mounting plate.*

4. Remove hex nut from carrier bracket. See Fig. 10.




N96-0011

**Fig. 10.** Alarm system control module (**2**) and assembly carrier retaining nut (**1**).

5. Pull mounting plate locking lugs out from bracket and remove mounting plate with control module.
6. Remove control module mounting bolts from mounting plate and remove control module.
7. Install in reverse order of removal.

## Keyless remote entry transmitter, programming (m.y. 1998-1999)

Beginning with the 1998 model year, a factory installed keyless remote locking system is standard equipment. This enhancement to the central locking and alarm systems uses a remote radio frequency transmitter about the size and shape of a regular vehicle key. See **5 Body–Assembly, General Information** for a description of the keyless remote system and its various functions.

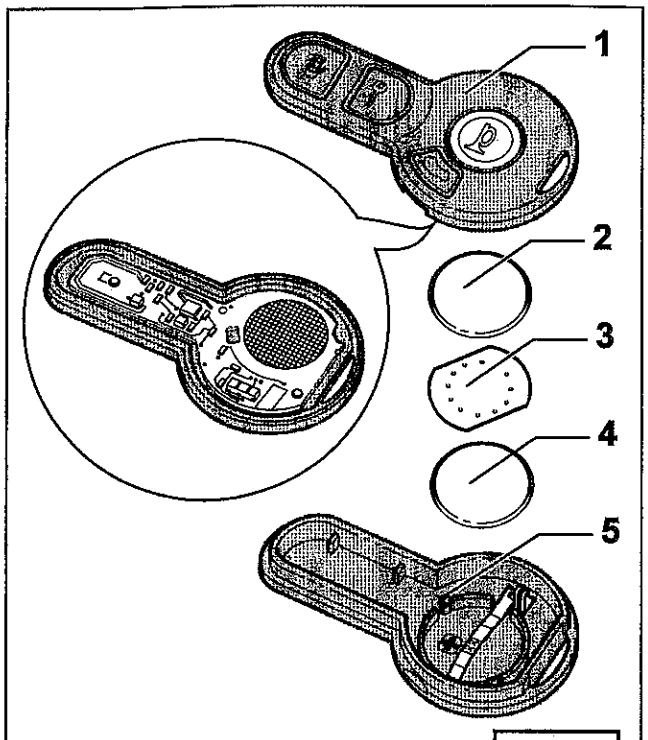
If new or additional keyless remote entry transmitters are required, use the following procedure to program the vehicle to accept the new transmitter or reprogram existing transmitters. Up to a maximum of 4 transmitters can be programmed into each vehicle. If one transmitter is activated 200 times consecutively out of range of the vehicle, all transmitters may require reprogramming.

***NOTE—***
*This procedure requires 2 keys and must be completed within one (1) minute.*

1. Switch ignition ON.
2. Close all doors and rear hatch/trunk lid.
3. Using a second key in driver's door, turn key to UNLOCK position and hold for approximately 10 seconds or until alarm horn sounds 3 times.
4. Press the UNLOCK/DISARM button on the first transmitter (alarm horn will briefly sound once to confirm programming).
5. Press the UNLOCK/DISARM button on the second transmitter (alarm horn will briefly sound twice to confirm programming).
6. Repeat the procedure for the remaining transmitters up to a maximum of 4.
7. Turn and hold the key in the driver's door to the UNLOCK position for 10 seconds or until the alarm horn sounds 3 times.
8. Switch off ignition and remove all keys.

## Keyless remote entry transmitter, replacing battery (m.y. 1998-1999)

The keyless remote entry transmitters are powered by a pair of batteries and are simply snapped together. See Fig. 11.




1. **Upper housing**
2. **Battery**
3. **Metal contact**
4. **Battery**
5. **Lower housing**

N01-0171

**Fig. 11.** Exploded view of radio frequency keyless remote entry transmitter. Observe polarity of batteries when replacing.

1. Using a screwdriver or a coin, separate the upper housing from the lower housing at an appropriate location.
2. Note the polarity of the upper battery and using a screwdriver or small pick, remove the upper battery.
3. Under the upper battery is a metal contact plate. Carefully turn the contact plate until the flat edges line up with the catches and remove the contact plate.
4. Note the polarity of the lower battery and remove.
5. Installation is the reverse. Note the polarity of the batteries. The positive side goes down into the lower housing.
6. When all components are properly positioned, snap both housing sections together.

# 97 Wiring Diagrams, Fuses and Relays



## GENERAL

This section contains wiring diagrams for 1993 through 1999 m.y. Golf, Jetta, and Cabrio models. Also included here are the fuse and relay positions.

***WARNING —***
*On cars equipped with Airbags, special precautions apply to any electrical system testing or repair. The airbag unit is an explosive device and must be handled with extreme care. Before starting any work on an airbag equipped car, refer to the warnings and cautions in* **69 Seatbelts, Airbags.**

***CAUTION —***
- *Always switch the ignition off and remove the negative (–) battery cable before removing any electrical components.*
- *Before disconnecting battery, be sure to obtain radio anti-theft code. Connect and disconnect ignition system wires, multiple connectors, and ignition test equipment leads only while the ignition is switched off.*
- *Always switch a test meter to the appropriate function and range before making test connections.*

### How to find an electric circuit

1. Locate the index page for your Volkswagen by model year, model, and engine in the table of contents above.
2. Go to the applicable index page and find the electrical component or electrical circuit you are interested in diagnosing.
3. Go to the applicable wiring diagram page.
4. Using the list at the bottom of the wiring diagram page, find the component code for the circuit in question. Then find the component on the wiring diagram.

***NOTE —***
*The page listed on the wiring diagram index is where a particular circuit starts. Circuits or systems will frequently run across more than one page. This is indicated by arrows at either end of the fuse/relay panel (gray bar) at the top of the diagrams.*

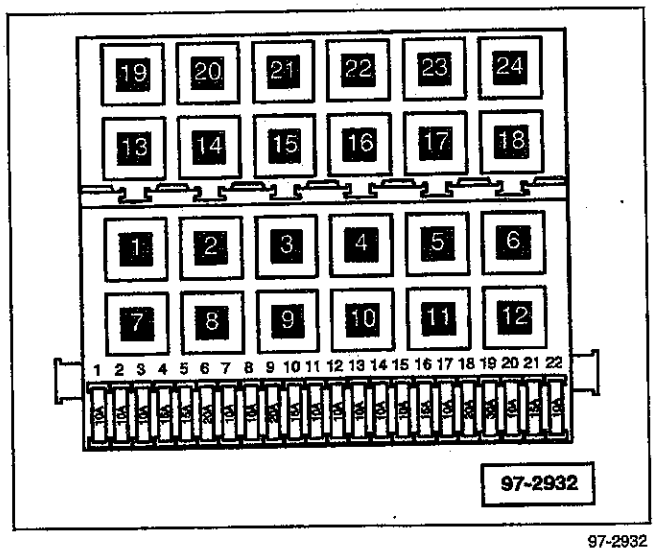
## FUSES AND RELAYS

The fuse/relay panel is located under the left side of the dash board. The wiring harness connectors are attached to the back of the panel. A sliding lock is located between two rows of harness connectors. The lock will only slide and lock into place when all the connectors are fully seated.

### Fuse positions

***NOTE—***

- *Fuse locations may not exactly match those listed below depending on vehicle accessories and optional equipment.*
- *Fuse locations for options not listed below can be found in the corresponding wiring diagram.*




97-2932

**Fig. 1.** Fuses are located on the bottom of the fuse/relay panel.

**Table a. Fuse identification**

| Fuse position | Description | Rating in Amps |
|---|---|---|
| 1 | Headlight, low beam, left | 10 |
| 2 | Headlight, low beam, right | 10 |
| 3 | License plate lights | 10 |
| 4 | Rear window wiper and washer system | 15 |
| 5 | Windshield wiper/washer | 15 |
| 6 | Fresh air blower, A/C | 20 |
| 7 | Tail lights, side marker lights, right | 10 |
| 8 | Tail lights, side marker lights, left | 10 |
| 9 | Rear window defogger | 20 |
| 10 | Fog lights | 15 |
| 11 | Headlight, high beam, left | 10 |
| 12 | Headlight, high beam, right | 10 |
| 13 | Horn | 10 |
| 14 | Back-up lights | 10 |
| 15 | Engine electronics | 10 |
| 16 | Power sunroof, front map/reading light | 15 |
| 17 | Emergency flashers | 10 |
| 18 | Fuel pump, heated oxygen sensor (HO2S) control module | 20 |
| 19 | Coolant fan, A/C relay | 30 |
| 20 | Brake lights | 10 |
| 21 | Interior lights, clock, luggage compartment light | 15 |
| 22 | Cigarette lighter, radio, luggage compartment release | 10 |

The fuses come in different colors that correspond to different 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.

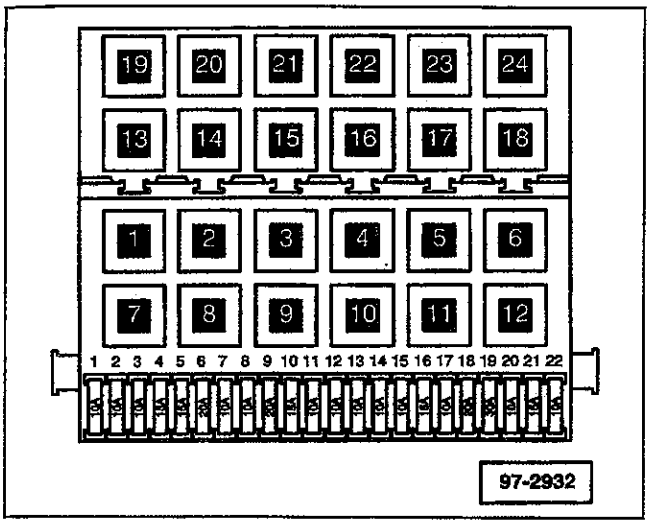
**Fuse colors**

- green ..... 30A
- white ..... 25A
- yellow ..... 20A
- blue ..... 15A
- red ..... 10A

***CAUTION—***
*To avoid damaging the electrical system, turn off all lights and accessories and remove the ignition key before replacing a fuse.*

## Relay positions

***NOTE—***
*Relay locations may not exactly match those listed below depending on vehicle accessories and optional equipment. Relay locations are indicated in wiring diagrams.*




97-2932

**Fig. 2.** Relay locations are numbered as shown.

***NOTE—***
*A large number is stamped on each relay. This is the production control number and can be used as an aid to identification.*

### Table b. Relay identification

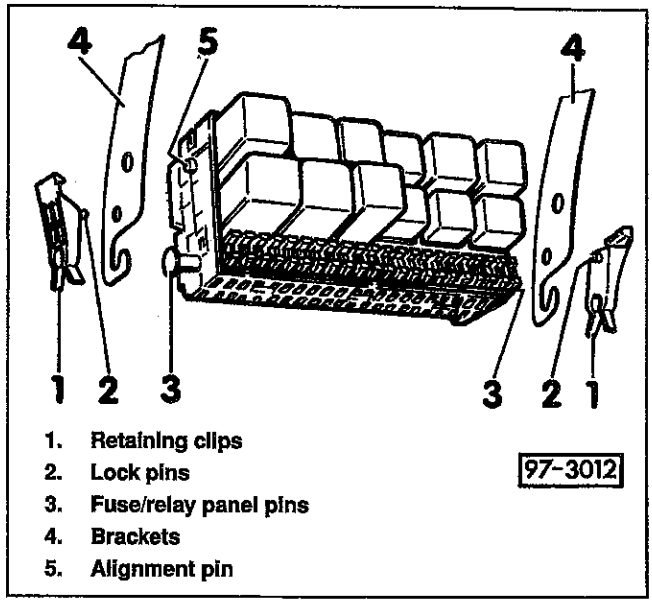
| Relay position | Description | Control number |
|---|---|---|
| 1 | Air conditioning | 13 |
| 2 | Rear window wiper/washer relay | 72 |
| 3 | ECM (engine control module) power supply | 30,109, 288 |
| 4 | Load reduction | 18 |
| 5 | Open | |
| 6 | Emergency flasher relay | 21 |
| 7 | Open | |
| 8 | Intermittent washer/wiper | 19,99 |
| 9 | Seat belt warning system | 4, 29 |
| 10 | Fog light relay | |
| 11 | Dual-horn relay or bridge for horn | 53 |
| 12 | Fuel pump relay<br>– or –<br>glow plug relay | 67,80,167<br><br>102,104 |
| 13 | Heated oxygen sensor (HO2S) Control Module | |
| 14 | Park/neutral position relay | 150 |
| 15 thru 24 | Available for optional equipment | |

## Fuse/relay panel, removing and installing

1. Disconnect negative (–) battery cable.

> ***CAUTION—***
> *Before disconnecting battery be sure to obtain radio anti-theft code.*

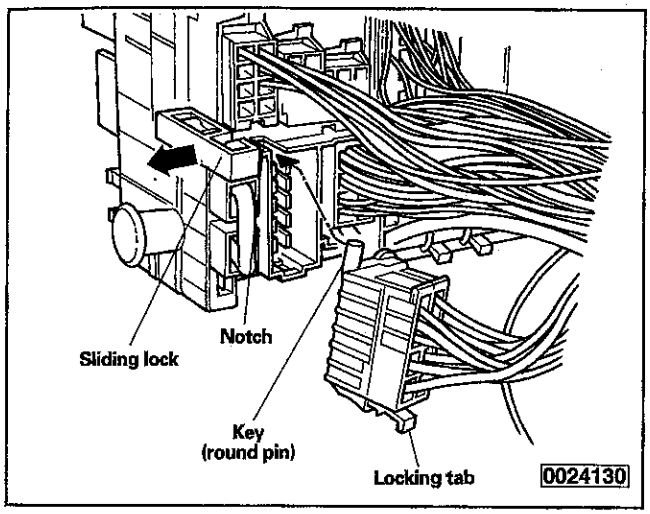
2. Remove knee bar from left side of instrument panel. See **69 Seatbelts, Airbags.**
3. Remove lower instrument panel trim. See **70 Trim–Interior.**
4. Disengage retaining clip lock pins from brackets. See Fig. 3.




97-3012

**Fig. 3.** Fuse/relay panel with mounting hardware.

5. Swing retaining clips forward and pull from fuse/relay panel pins.
6. Spread left retaining bracket and disengage from alignment pin.
7. Lift fuse/relay panel from brackets.
8. Pull out sliding lock on back of fuse/relay panel. See Fig. 4.
9. Depress connector locking tabs and pull multi-point connectors from fuse/relay panel.
10. Remove fuse/relay panel.
11. Install in the reverse order of removal, making sure to position alignment pins properly and to engage retaining clips in brackets. See Fig. 3.



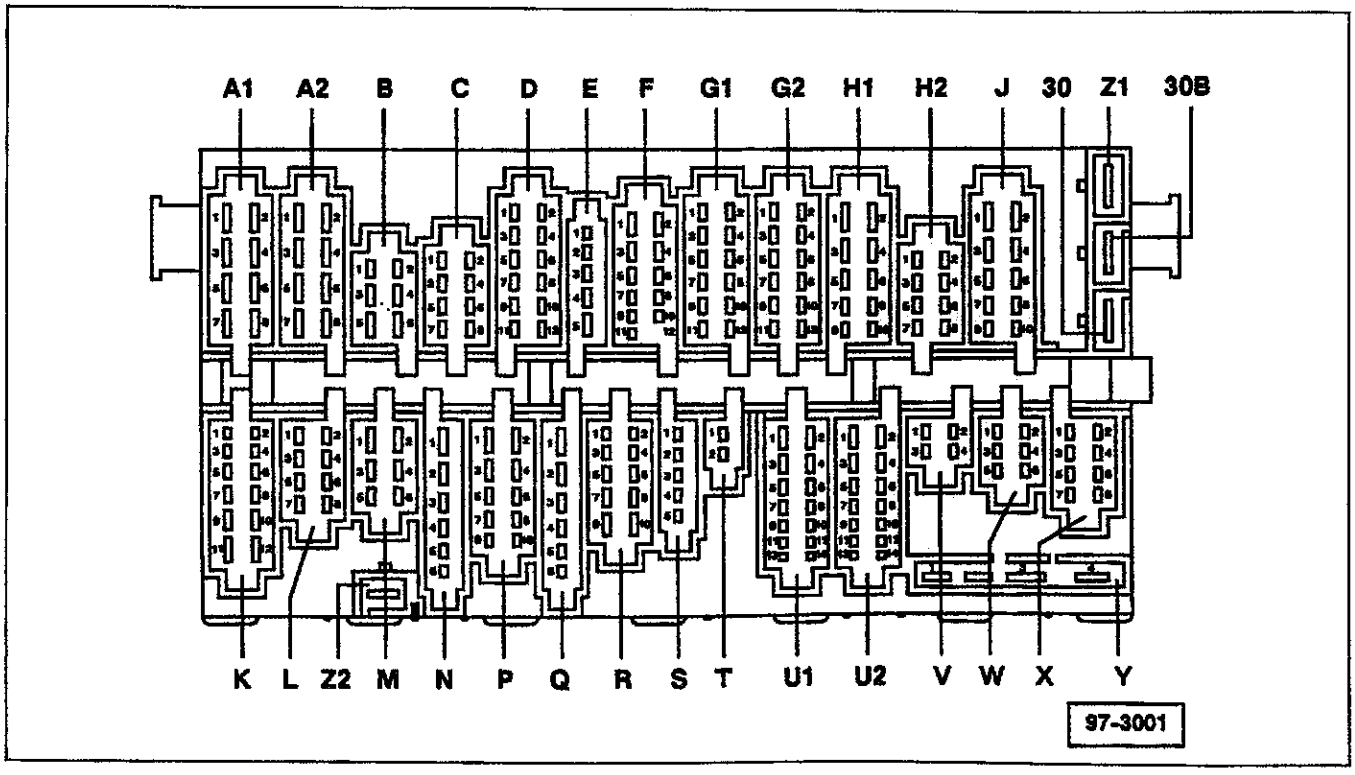

0024130

**Fig. 4.** Pull sliding lock in direction of arrow and depress locking tab to remove multi-point connectors.

## Connections and plugs on fuse/relay panel

Each connector on the fuse/relay panel has a unique combination of pins and placement. The connectors are keyed to align with notches in the appropriate receptacle. This ensures that the connectors will not be incorrectly positioned. See Fig. 4.

The locations of the multi-point connectors on the back side of the fuse/relay panel are shown in Fig. 5. **Table c** identifies connector terminals.




97-3001

**Fig. 5.** Multi-point connector locations on back of fuse/relay panel.

**Table c. Fuse/relay panel connections**

| Position | No. of pins | Description | Color |
|---|---|---|---|
| A1 | 8-pin | Headlight wiring harness | yellow |
| A2 | 8-pin | Headlight wiring harness | yellow |
| B | 6-pin | Headlight washer system wiring harness | green |
| C | 8-pin | Headlight wiring harness | green |
| D | 12-pin | Optional equipment wiring harness | green |
| E | 5-pin | Instrument wiring harness | green |
| F | 9-pin | Engine compartment wiring harness | white |
| G1 | 12-pin | Engine compartment wiring harness | white |
| G2 | 12-pin | Engine compartment wiring harness | white |
| H1 | 10-pin | Steering column switch harness | red |
| H2 | 8-pin | Steering column switch harness | red |
| J | 10-pin | Steering column switch harness | red |
| K | 12-pin | Rear wiring harness | black |
| L | 7-pin | Rear wiring harness | black |
| M | 6-pin | Rear wiring harness to fuel tank | black |
| N | 6-pin | Headlight wiring harness | green |
| P | 9-pin | Rear window defroster/fog light switch wiring harness | blue |
| Q | 6-pin | Instrument wiring harness | blue |
| R | 10-pin | Light switch wiring harness | blue |
| S | 5-pin | Engine compartment wiring harness | white |
| T | 2-pin | Connector | green |
| U1 | 14-pin | Instrument cluster wiring harness | blue |
| U2 | 14-pin | Instrument cluster wiring harness | blue |
| V | 4-pin | Steering column (multi-function indicator) wiring harness | green |
| W | 6-pin | Optional equipment connector | green |
| X | 8-pin | Warning lamp harness | green |
| Y | 1-pin | Four single connectors, (terminal 30) (B+) | |
| Z1 | 1-pin | Single connector | |
| Z2 | 1-pin | Single connector (terminal 31, ground) | |
| 30 | 1-pin | Single connector (terminal 30, B+) | |
| 30B | | Single connector | |

## USING WIRING DIAGRAMS

A great deal of information is included in each wiring diagram. For example, you will notice that all electrical components are identified using a unique number. Each component with it's corresponding number is identified below the diagrams.

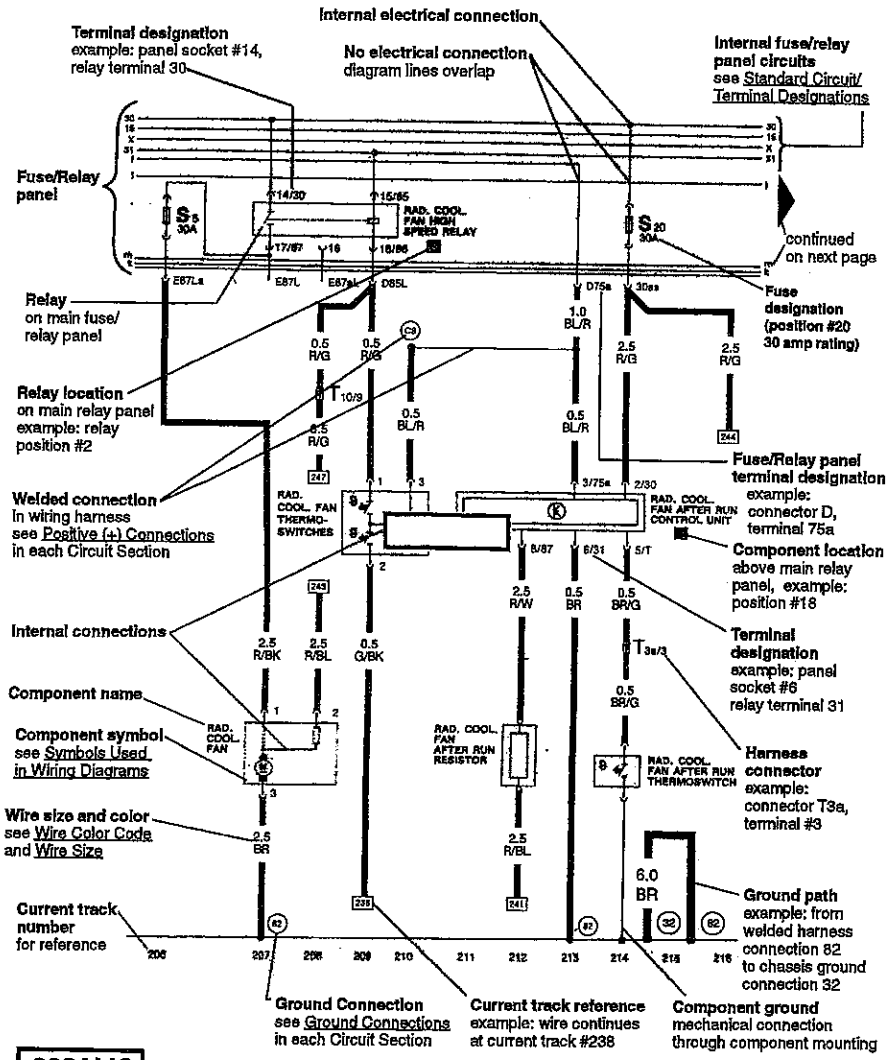
Reading the wiring diagrams is detailed under **How to read wiring diagrams**. An explanation of the various symbols used in the diagrams can be found under **Symbols used in wiring diagrams.**

Most terminals are identified by numbers on the components and harness connectors. The terminal numbers for major electrical connections are shown in the diagrams. Though many terminal numbers appear only once, several other numbers appear in numerous places throughout the electrical system and identify certain types of circuits. A listing of the most common standard circuit numbers can be found in **Standard circuits.**

All wire colors in the diagrams are abbreviated. Combined color codes indicate a multi-colored wire. For example the code ws/bl indicates a white wire with a blue stripe. Wire color abbreviations are listed in **Terminal designations.** Immediately preceding the wire color is the nominal cross-sectional area of the wire given in $mm^2$.

***NOTE —***

*Sometimes the color of an installed wire may be different than the one on the wiring diagram. Don't be concerned, just be sure to confirm that the wire connects to the proper terminals.*

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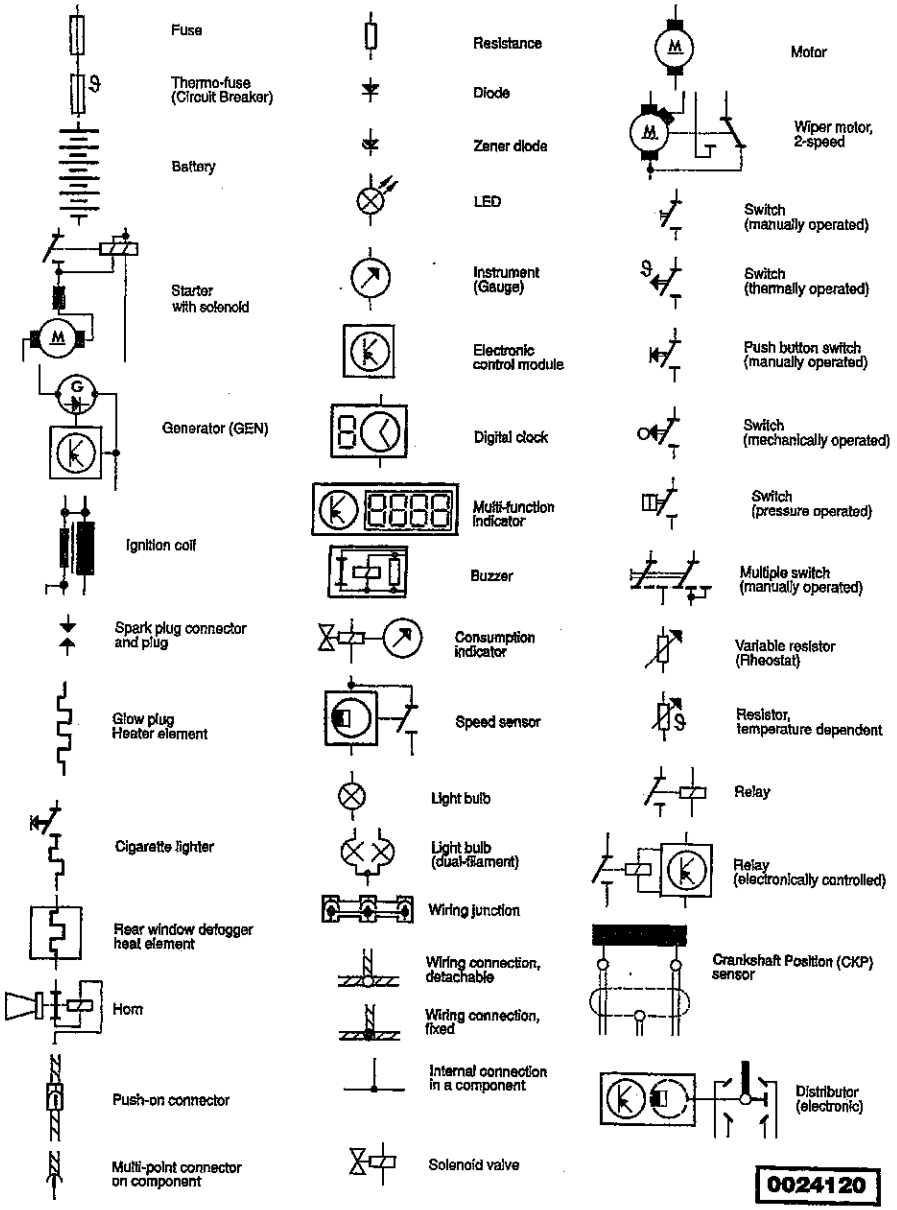


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**Standard Circuit/Terminal Designations**

| Circuit Number | Circuit Description | Most Common Wire Color |
|---|---|---|
| 30 | Battery positive (+) voltage whenever battery is connected | Red (ro) |
| 15 | Battery positive (+) voltage with ignition On | Black (bk) |
| X | Load-reduction circuit<br>Battery positive (+) voltage via load-reduction relay (with ignition On)<br>Interrupted for starting (ignition in "Start" position) | Black/yellow (bk/ye) |
| 31 | Ground or battery negative (–) | Brown (br) |
| 50 | Starter circuit<br>Battery positive (+) voltage (with ignition in "Start" position) | Red/black (ro/bk) |
| B+ | Alternator output (charging voltage to battery) | Red (ro) |
| D+ | Alternator warning light and field energizing circuit | — |
| 85 | Ground (–) for switching relay | Brown (br) |
| 86 | Power input (+) for switching relay | — |
| 87 | Relay change-over contact | — |

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## Wire Color-Code

| | |
|---|---|
| ws ..... white | bl ..... blue |
| sw ..... black | gr ..... grey |
| ro ..... red | li ..... lilac |
| br ..... brown | ge ..... yellow |
| gn ..... green | |

Combined color codes indicate a multi-colored wire.

example: The code ro/gn indicates a red wire with a green tracer stripe.

Sometimes the wire color on the car may be different than the one indicated on the wiring diagram. Don't be concerned. Just be sure to confirm that the wires in question connect to the proper terminals.

## Wire Size

The wiring diagrams in this manual identify wires by their metric wire size—their cross-sectional area in square millimeters ($mm^2$). The table below lists metric wire sizes and their approximate equivalents in American Wire Gauge (AWG) sizes.

| Metric ($mm^2$) | American Wire Gauge (AWG) |
|---|---|
| 0.35 | 22 |
| 0.5 | 20 |
| 1.0 | 16 |
| 1.5 | 14 |
| 2.5 | 12 |
| 6.0 | 8 |
| 16.0 | 4 |
| 25.0 | 2 |
| 32.0 | 2 |

## Connectors

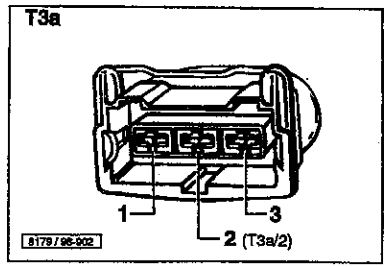
T1 ..... Single-point
T2 ..... 2-point
T3 ..... 3-point
T4 ..... 4-point
T5 ..... 5-point
T6 ..... 6-point
T8 ..... 8-point
T10 ..... 10-point
T12 ..... 12-point
T19 ..... 19-point
T21 ..... 21-point
T28 ..... 28-point
T30 ..... 30-point
T32 ..... 32-point
T38 ..... 38-point
T45 ..... 45-point
T68 ..... 68-point

In any particular diagram, each connector has a unique number.

example: T6, T6a, and T6b are three different 6-point connectors

Wiring diagrams usually identify a particular connector terminal for each wire connection

example: T3a/2 indicates connector T3a, terminal #2



## Golf, Jetta, Cabrio — 2.0L gas engine (ABA)

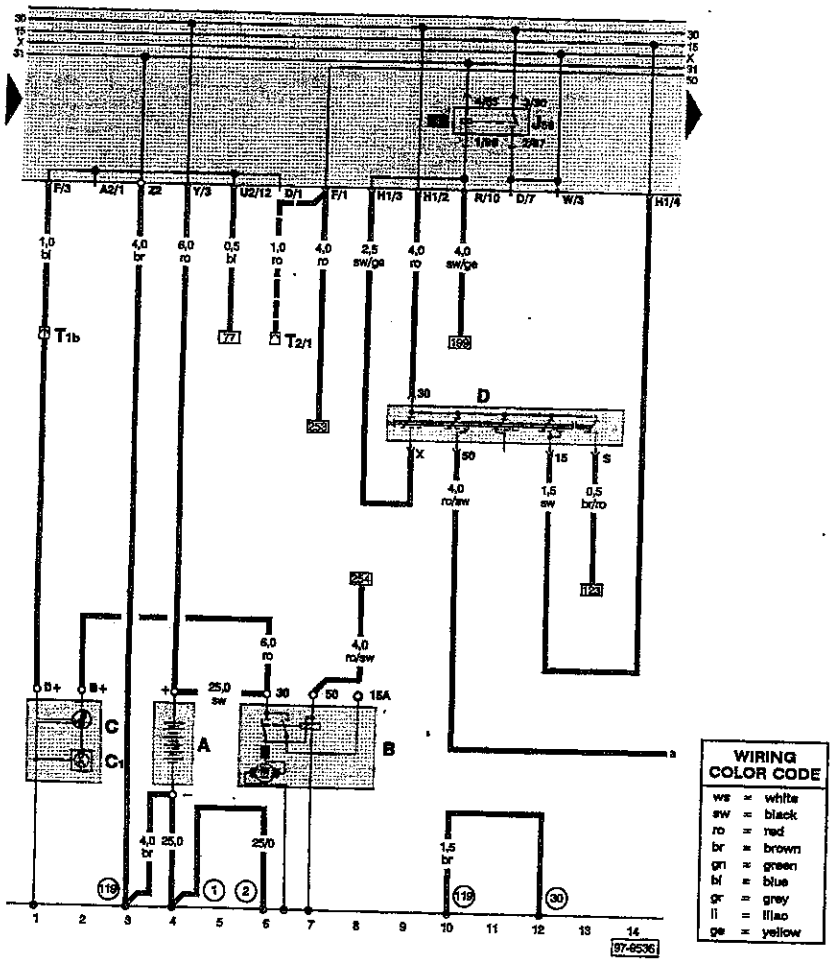


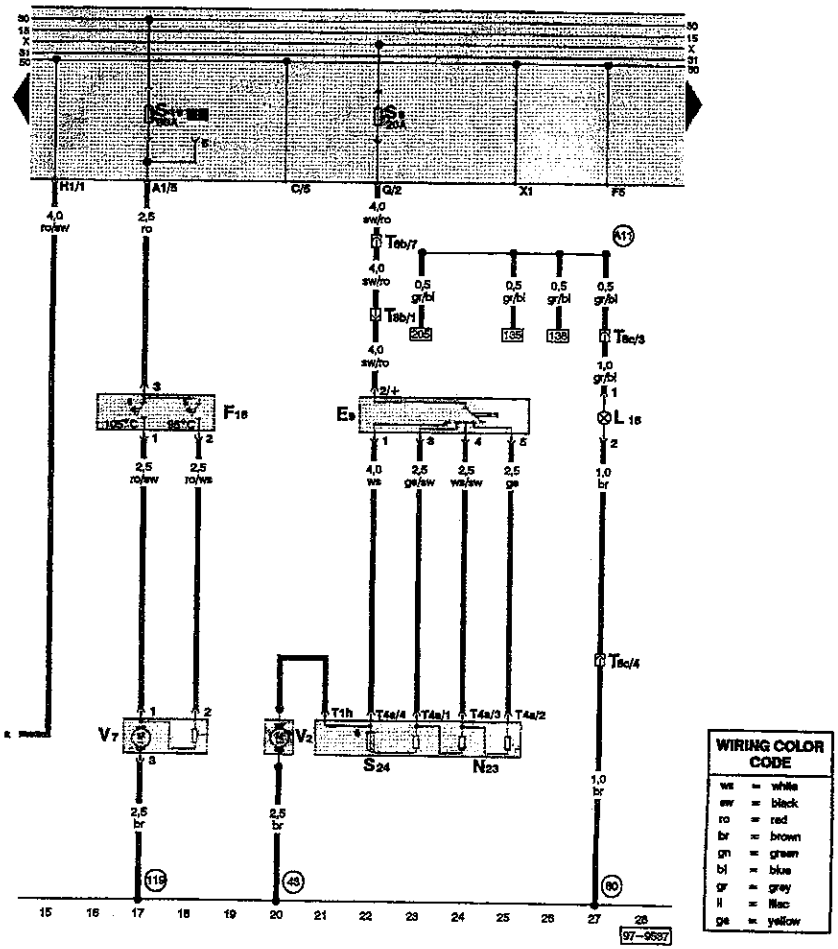
## Golf — 1.8L gas engine (ACC), Canada only

## Golf, Jetta — 1.9L Eco diesel engine (AAZ), Canada only



## Golf, Jetta — 2.8L gas engine (AAA)



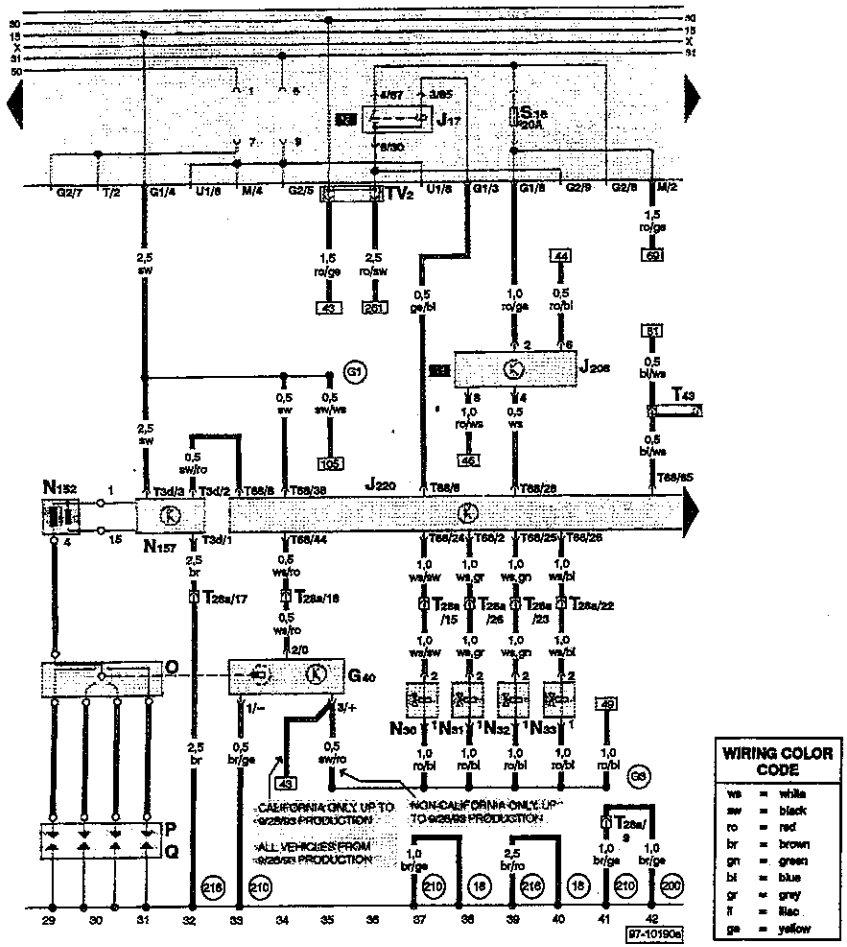




A – Battery
B – Starter
C – Generator (Gen)
C1 – Voltage Regulator (VR)
D – Ignition/Starter Switch
J59 – Load Reduction Relay
T1b – Connector, Single, near battery
T2 – Connector, Double, behind fuse/relay panel, only on automatic transmission

(1) – Ground strap, battery to body
(2) – Ground strap, transmission to body
(30) – Ground connection – beside fuse/relay panel
(119) – Ground connection –1–, in headlight wiring harness
– – – Automatic transmission only

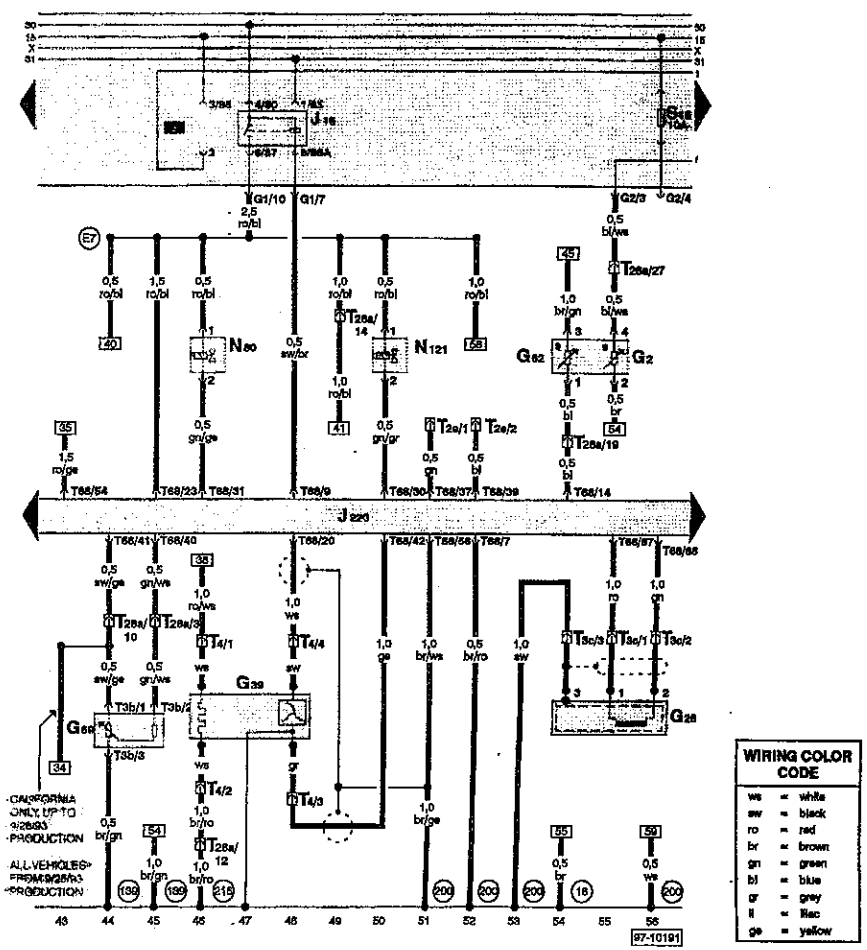
E9 – Fresh Air Blower Switch
F18 – Coolant Fan Control (FC) Thermal Switch
L16 – Fresh Air Control Lever Light
N23 – Fresh Air Blower Series Resistance
S24 – Heater, A/C Clutch Fuse
V2 – Fresh Air Blower
V7 – Coolant Fan
T1h – Connector, Single, behind right side of dash
T4a – Connector, 4 Pin, behind right side of dash
T8b – Connector, 8 Pin, behind fuse/relay panel
T8c – Connector, 8 Pin, behind lower center of dash panel

(43) – Ground connection, on right A–pillar, lower part
(80) – Ground connection –1–, in instrument panel wiring harness
(119) – Ground connection –1–, in headlight wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness



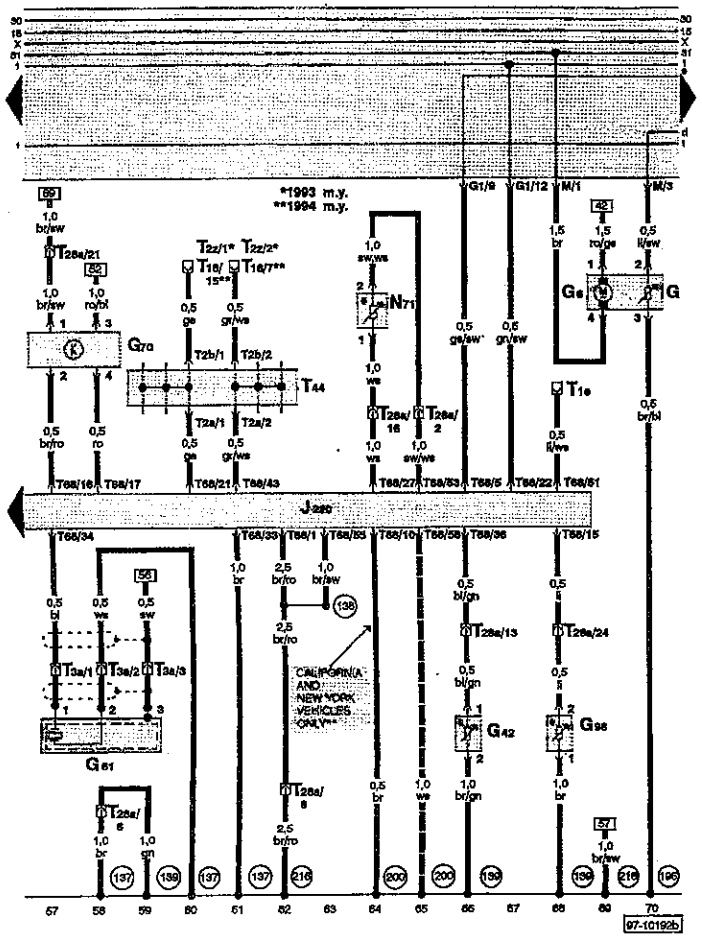

| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

G40 – Camshaft Position (CMP) Sensor
J17 – Fuel Pump (FP) Relay
J208 – Heated Oxygen Sensor (HO2S) Control Module
J220 – Motronic Engine Control Module (ECM)
N30 – Injector, Cyl. 1
N31 – Injector, Cyl. 2
N32 – Injector, Cyl. 3
N33 – Injector, Cyl. 4
N152 – Ignition Coil
N157 – Ignition Coil Power Output Stage
O – Ignition Distributor
Q – Spark Plugs
P – Spark Plug Connector
T3d – Connector, 3 Pin, left rear of engine compartment
T28a – Connector, 28 Pin, left side of engine, near distributor
T43 – Connector, vehicle speed signal
T68 – Connector, 68 Pin, under right side of hood, on Motronic Engine Control Module (ECM)
TV2 – Wire connector, terminal 30 (B+)
(18) – Ground connection, on engine block
(200) – Ground connection, (shielding) in engine compartment wiring harness
(210) – Ground connection –1–, in Motronic Multiport Fuel Injection (MFI) wiring harness
(216) – Ground connection –2–, in Motronic Multiport Fuel Injection (MFI) wiring harness
(G1) – Plus connection, in Multiport Fuel Injection (MFI) wiring harness
(G3) – Plus connection, in injector wiring harness




| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

G2 – Engine Coolant Temperature (ECT) Sensor
G28 – Engine Speed (RPM) Sensor
G39 – Heated Oxygen Sensor (HO2S)
G62 – Engine Coolant Temperature (ECT) Sensor
G69 – Throttle Position (TP) Sensor
J16 – Power Supply Relay
J220 – Motronic Engine Control Module (ECM)
N80 – Evaporative Emission (EVAP) Canister Purge Regulator Valve
N121 – EGR Vacuum Regulator Valve (California models only)
T2e – Double Connector, behind fuse/relay panel, A/C connection
T3b – 3–Pin Connector, on throttle position sensor
T3c – 3–Pin Connector, left front of engine
T4 – 4–Pin Connector, bottom right rear of engine compartment
T28a – 28–Pin Connector, left side of engine, near distributor
T68 – 68–Pin Connector, under right side of hood, on Motronic Engine Control Module (ECM)
(18) – Ground connection, on engine block
(139) – Ground connection (sensor ground), in Motronic Multiport Fuel Injection (MFI) wiring harness
(200) – Ground connection, (shielding) in engine compartment wiring harness
(216) – Ground connection –2–, in Motronic Multiport Fuel Injection (MFI) wiring harness
(E7) – Plus connection (87a), in Multiport Fuel Injection (MFI) wiring harness

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|---|---|
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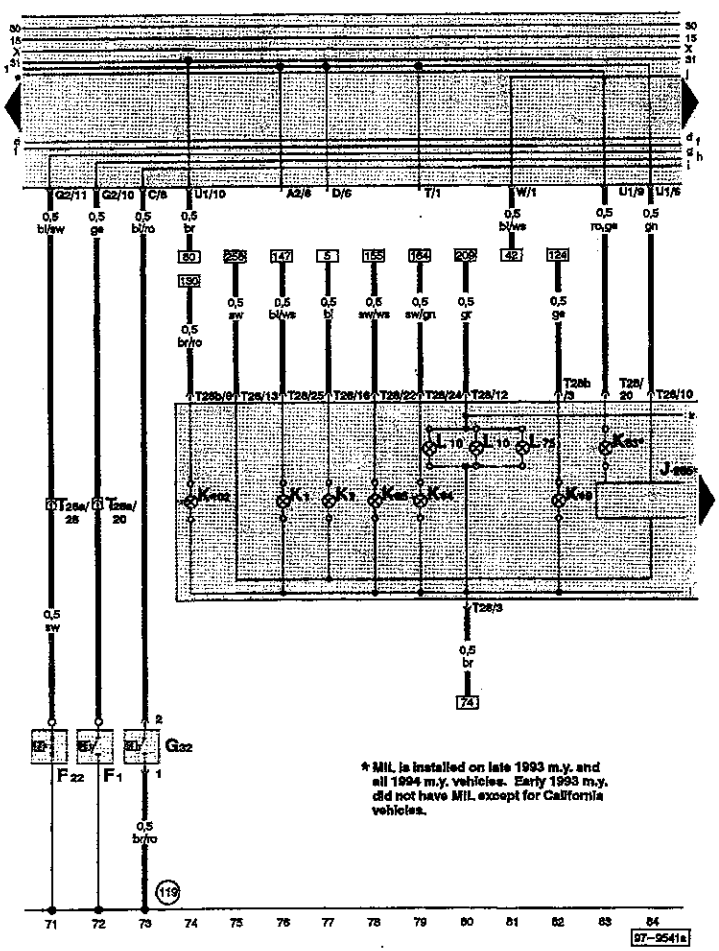
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

G – Fuel Level Sensor
G6 – Fuel Pump (FP)
G42 – Intake Air Temperature (IAT) Sensor
G61 – Knock Sensor (KS) 1
G70 – Mass Air Flow (MAF) Sensor
G98 – EGR Temperature Sensor (California models only)
J220 – Motronic Engine Control Module (ECM)
N71 – Idle Air Control (IAC) Valve
T1e – Single Connector, behind fuse/relay panel
T2a – Double Connector, on junction connector (T44) above fuse/relay panel
T2b – Double Connector, on junction connector (T44) above fuse/relay panel
T2z – Data Link Connector (DLC), behind center of dash panel
T3a – 3–Pin Connector, on engine
T16 – Data Link Connector (DLC), behind center of dash panel
T28a – 28–Pin Connector, left side of engine, near distributor
T44 – Junction Box for On Board Diagnostic, above fuse/relay panel
T68 – 68–Pin Connector, under right side of hood, on Motronic Engine Control Module (ECM)
(197) – Ground connection (end stage), in Motronic Multiport Fuel Injection (MFI) wiring harness
(198) – Ground connection (control module) in Motronic Multiport Fuel Injection (MFI) wiring harness
(199) – Ground connection (sensor ground), in Motronic Multiport Fuel Injection (MFI) wiring harness
(196) – Ground connection –1–, in rear wiring harness
(200) – Ground connection, (shielding) in engine compartment wiring harness
(216) – Ground connection –2–, in Motronic Multiport Fuel Injection (MFI) wiring harness
– – – Automatic transmission only

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|---|---|
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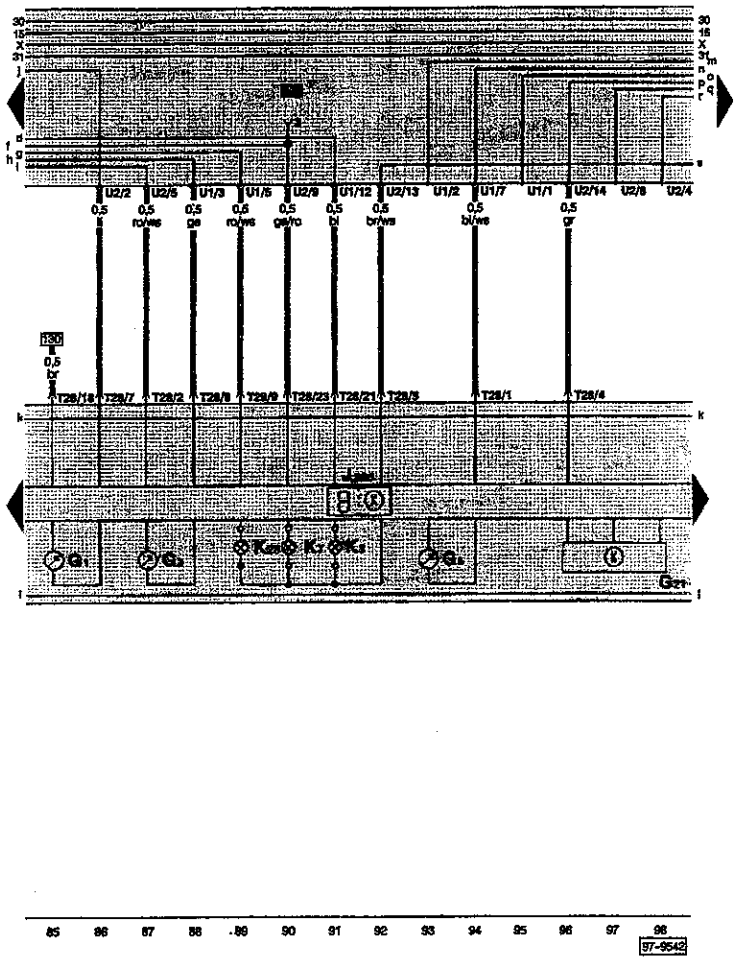
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

F1 – Engine Oil Pressure Switch
F22 – Engine Oil Pressure Switch (0.5 Bar)
G32 – Engine Coolant Level (ECL) Sensor
J285 – Control Module With Display Unit In Instrument Cluster
K1 – Headlight High Beam Indicator Light
K2 – Generator (GEN) Warning Light
K19 – Seat Belt Warning Light
K65 – Turn Signal Indicator Light, Left
K83 – Malfunction Indicator Lamp (MIL)
K94 – Turn Signal Indicator Light, Right
K102 – Rear Hatch/Trunk Ajar Warning Light
L10 – Instrument Cluster Light
L75 – Digital Display Light
T28 – Connector, 28 Pin, instrument cluster
T28a – Connector, 28 Pin, left side of engine, near distributor
T28b – Connector, 28 Pin, on instrument cluster
(119) – Ground connection –1–, in headlight wiring harness




| WIRING COLOR CODE | |
|---|---|
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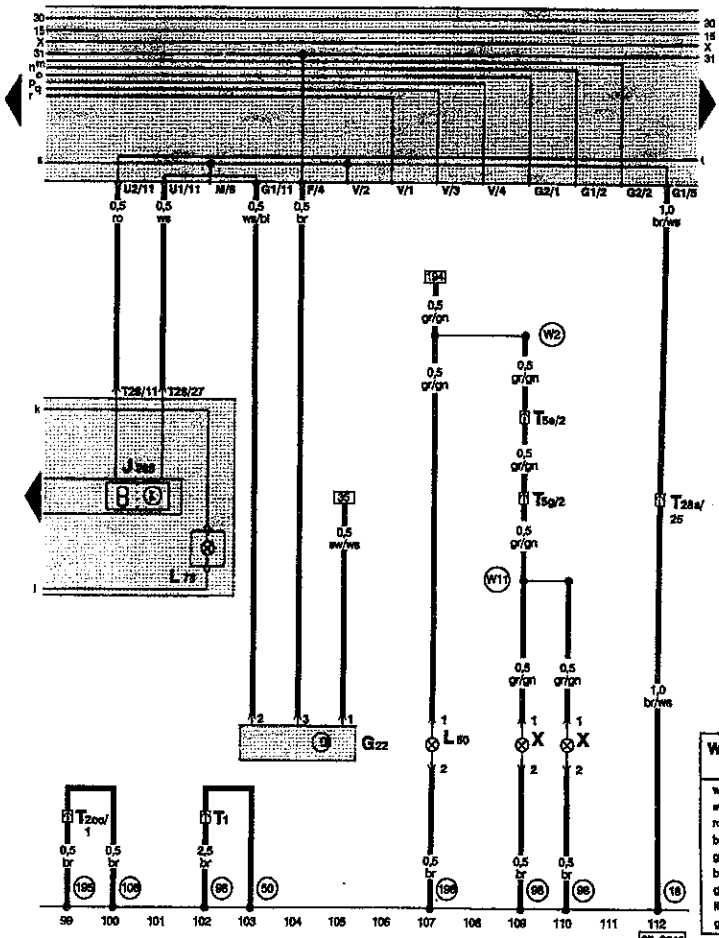
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

G1 – Fuel Gauge
G3 – Engine Coolant Temperature (ECT) Gauge
G5 – Tachometer
G21 – Speedometer
J285 – Control Module With Display Unit In Instrument Cluster
K3 – Oil Pressure Warning Light
K7 – Brake and Parking Brake Indicator Light
K28 – Engine Coolant Level/Temperature (ECL/ECT) Warning Light
T28 – Connector, 28 Pin, instrument cluster

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|---|---|
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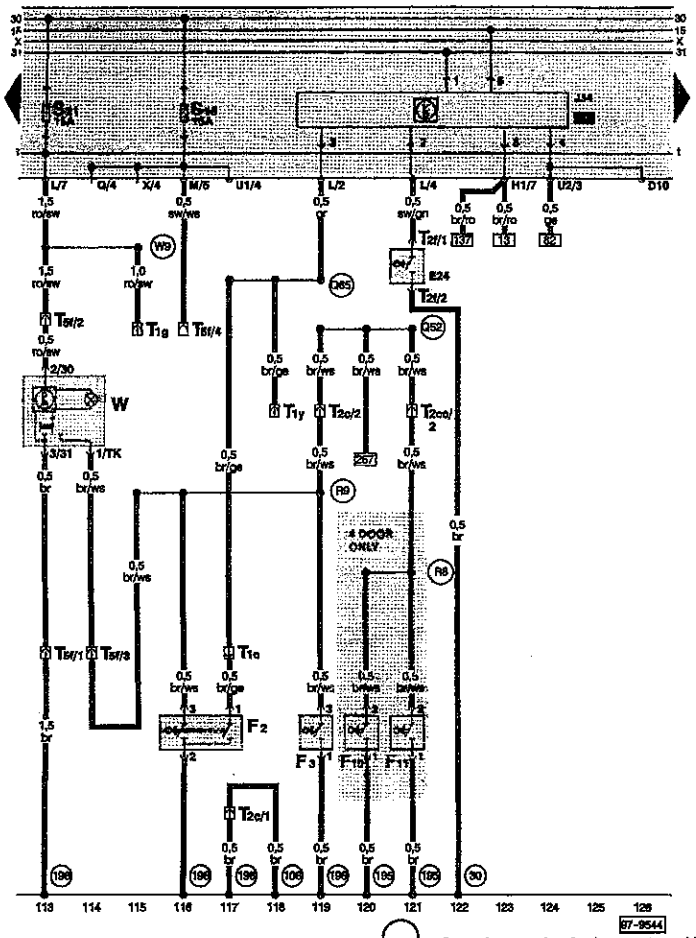
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

G22 – Vehicle Speed Sensor (VSS), Speedometer
J285 – Control Module With Display Unit In Instrument Cluster
L50 – Center Rear Ashtray Light
L75 – Digital Display Light
X – License Plate Light
T1 – Connector, single, in luggage compartment lid
T2cc – Connector, double, on lower right "A" pillar
T5e – Connector, 5 Pin, in luggage compartment, left
T5g – Connector, 5 Pin, in luggage compartment lid
T28 – Connector, 28 Pin, instrument cluster
T28a – Connector, 28 Pin, left side of engine, near distributor
(18) – Ground connection, on engine block
(50) – Ground connection, in luggage compartment, left
(98) – Ground connection, in rear lid wiring harness
(106) – Ground connection, in alarm system wiring harness
(195) – Ground connection, in rear door contact switch wiring harness
(196) – Ground connection – 1 – in rear wiring harness
W2 – Plus connection (58), in rear wiring harness
W11 – Wiring connection (58), in rear lid wiring harness

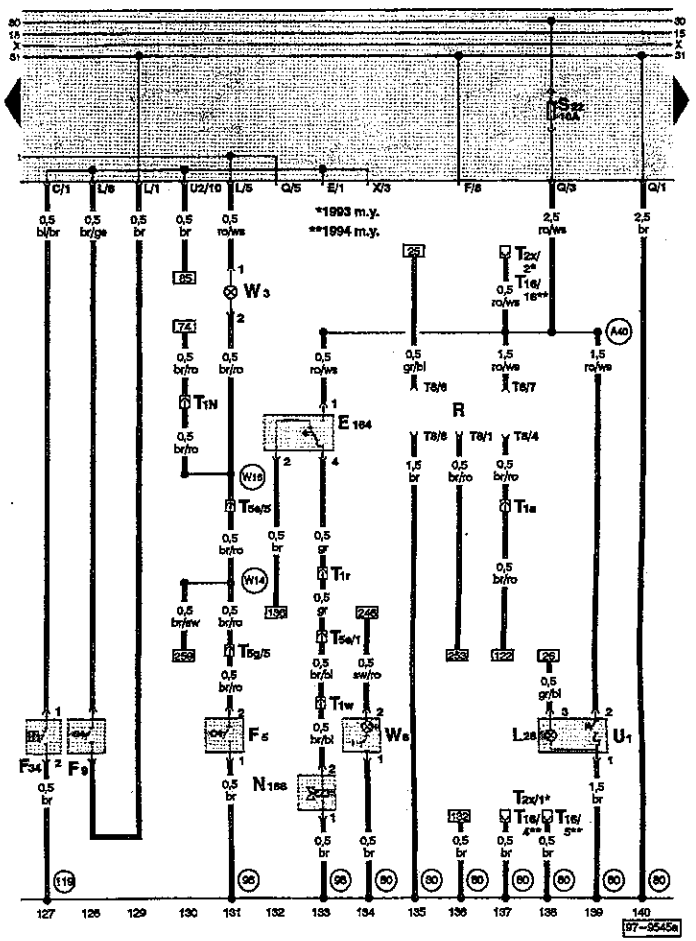



E24 – Seat Belt Switch, Left
F2 – Door Contact Switch, Left Front
F3 – Door Contact Switch, Right Front
F10 – Door Contact Switch, Left Rear
F11 – Door Contact Switch, Right Rear
J34 – Seat Belt Warning System Relay
W – Interior Light, Front
T1c – Connector, Single, behind fuse/relay panel
T1g – Connector, Single, behind fuse/relay panel
T1y – Connector, Single, behind fuse/relay panel
T2c – Connector, Double, on lower right "A" pillar
T2cc – Connector, double, on lower right "A" pillar
T2f – Connector, Double, behind rear of center console
T5f – Connector, 5 Pin, above fuse/relay panel
(30) – Ground connection – beside fuse/relay panel

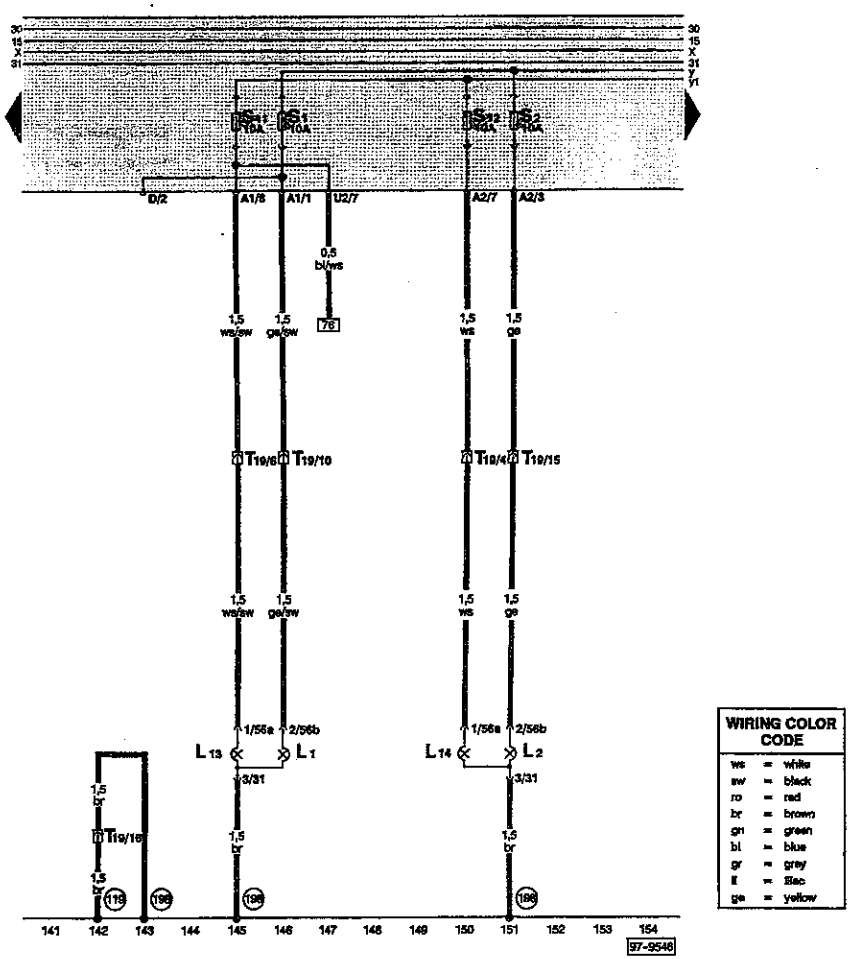
(106) – Ground connection, in alarm system wiring harness
(195) – Ground connection, in rear door contact switch wiring harness
(Q52) – Wire connection (door contact switch), in alarm system wiring harness
(Q65) – Wire connection, in seat belt warning system wiring harness
(R8) – Wire connection (door contact switch) in rear door contact switch wiring harness
(R9) – Wire connection (30), in rear wiring harness
(W9) – Plus connection (30), in rear wiring harness





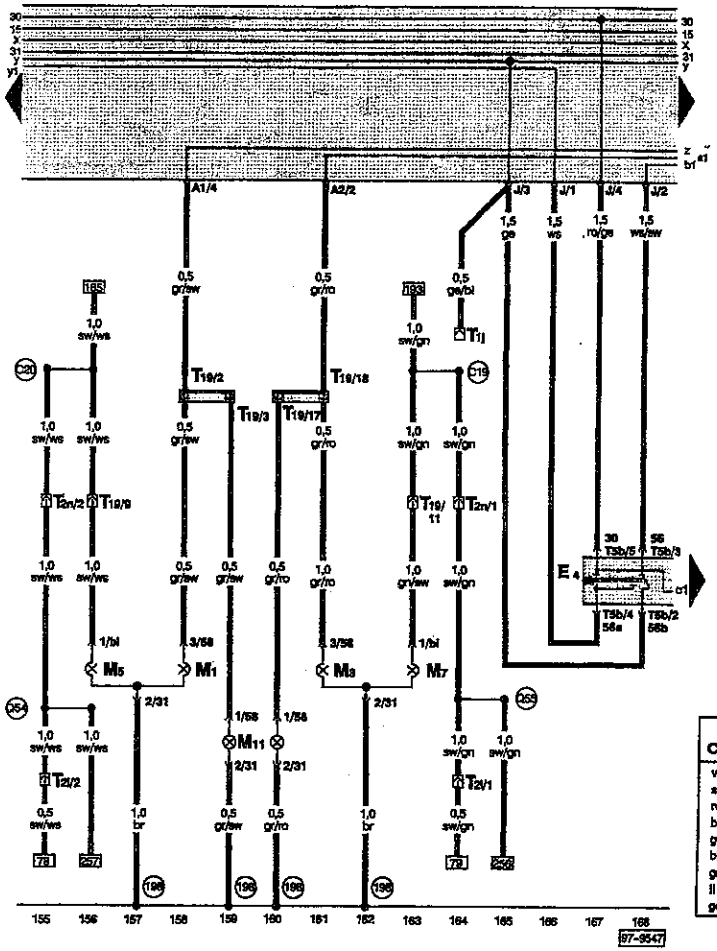



E184 – Luggage Compartment Release Switch
F5 – Luggage Compartment Light Switch
F9 – Parking Brake Warning Light Switch
F34 – Brake Fluid Level Warning Switch
L26 – Cigarette Lighter Light
N168 – Luggage Compartment Release Solenoid
R – Radio
U1 – Cigarette Lighter
W3 – Luggage Compartment Light
W5 – Glove Compartment Light
T1a – Connector, Single, behind fuse/relay panel
T1n – Connector, Single, behind fuse/relay panel
T1r – Connector, Single, behind fuse/relay panel
T1w – Connector, Single, on luggage compartment lid
T2x – Data Link Connector (DLC), behind center of dash panel
T5a – Connector, 5 Pin, in luggage compartment, left
T5g – Connector, 5 Pin, in luggage compartment lid
T6 – Connector, 6 Pin, on radio
T16 – Data Link Connector (DLC), behind center of dash panel
(30) – Ground connection – beside fuse/relay panel
(80) – Ground connection –1–, in instrument panel wiring harness
(95) – Ground connection, in rear lid wiring harness
(119) – Ground connection –1–, in headlight wiring harness
(A40) – Plus connection (30), in instrument panel wiring harness
(W14) – Wire connection (31a), in rear wiring harness
(W16) – Wire connection (31a), in rear warning harness



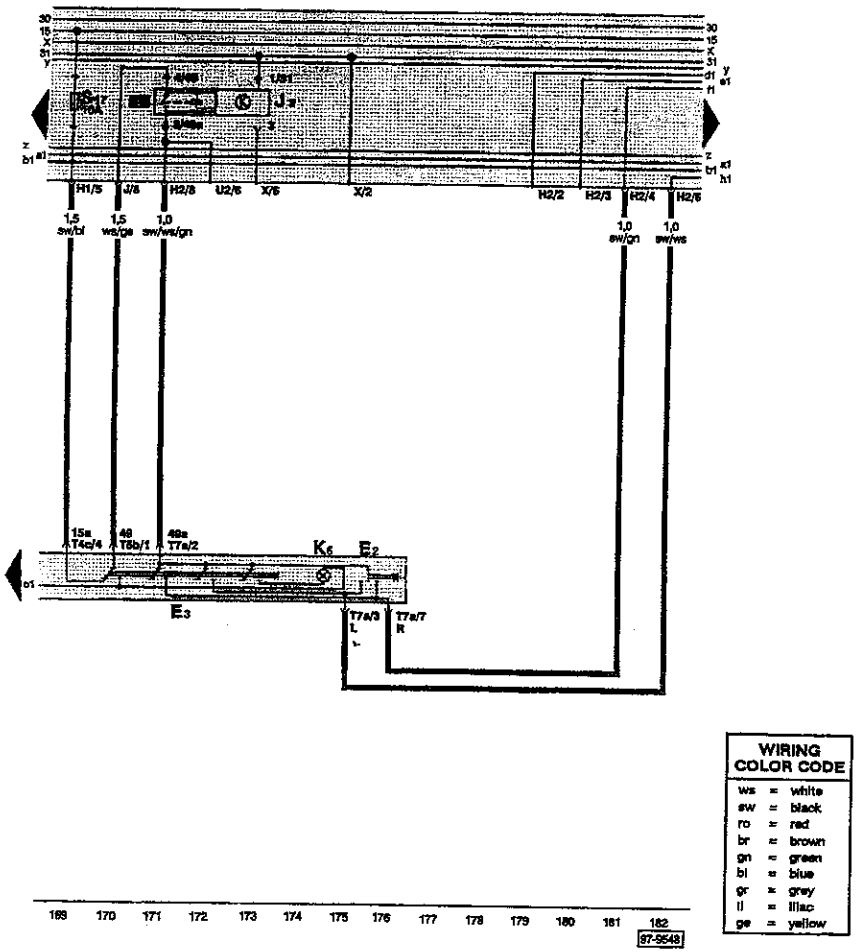

| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

L1 – Headlight, Left
L2 – Headlight, Right
L13 – High Beam Headlight, Left
L14 – High Beam Headlight, Right
T19 – Connector, 19 Pin, behind radiator grill, center
(119) – Ground connection –1–, in headlight wiring harness
(196) – Ground connection, in front light wiring harness




| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E4 – Headlight Dimmer/Flasher Switch
M1 – Parking Light, Left
M3 – Parking Light, Right
M5 – Turn Signal Light, Left Front
M7 – Turn Signal Light, Right Front
M11 – Side Marker Lights, Front
T1j – Connector, Single, behind fuse/relay panel
T2l – Connector, Double, behind fuse/relay panel
T2n – Connector, Double, behind fuse/relay panel
T5b – Connector, 5 Pin, behind steering column switch trim
T19 – Connector, 19 Pin, behind radiator grill, center
(198) – Ground connection, in front light wiring harness
(C19) – Wire connection (right turn signal), in headlight wiring harness
(C20) – Wire connection (left turn signal), in headlight wiring harness
(Q54) – Wire connection (left turn signal), in alarm system wiring harness
(Q55) – Wire connection (right turn signal), in alarm system wiring harness

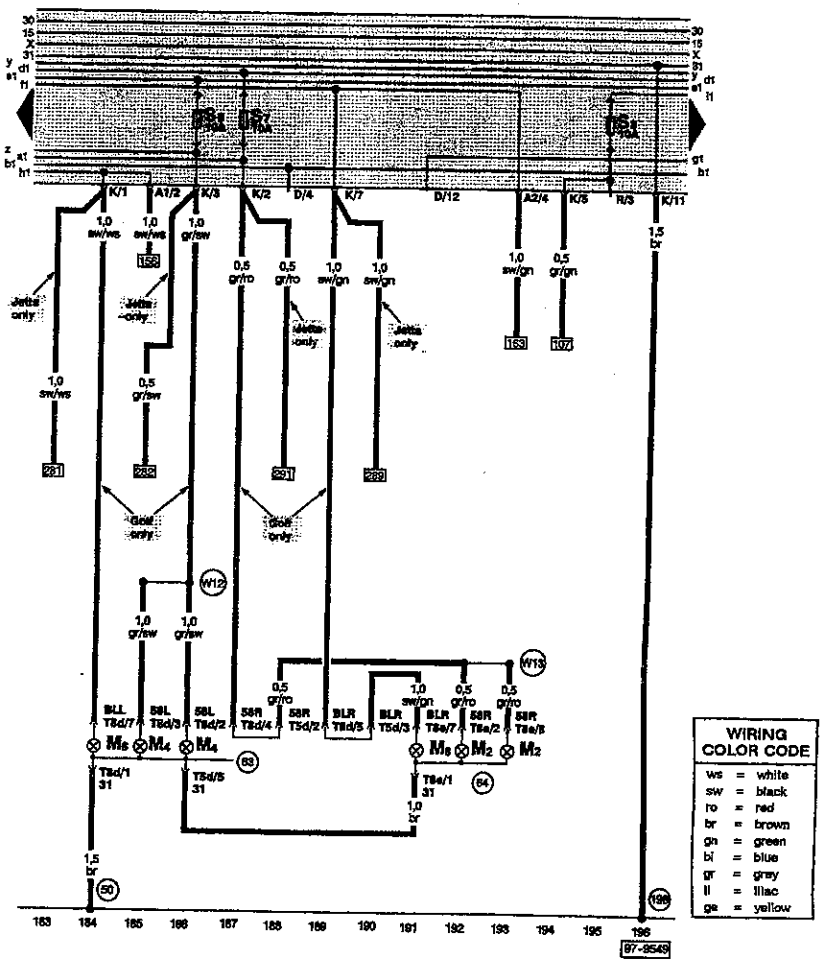



| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E2 – Turn Signal Switch
E3 – Emergency Flasher Switch
J2 – Emergency Flasher Relay
K6 – Emergency Flasher Warning Light
T4c – Connector, 4 Pin, behind steering column switch trim
T5b – Connector, 5 Pin, behind steering column switch trim
T7a – Connector, 7 Pin, behind steering column switch trim

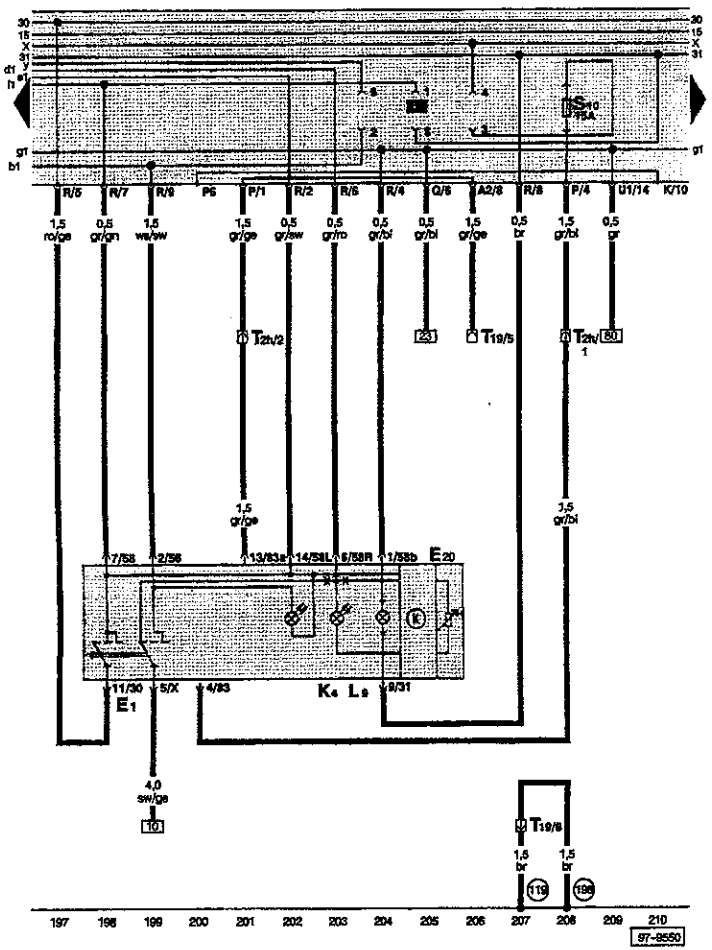







| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

M2 – Tail Light, Right
M4 – Tail Light, Left
M6 – Turn Signal Light, Left Rear
M8 – Turn Signal Light, Right Rear
T5d – Connector, 5 Pin, on taillight, left
T8d – Connector, 8 Pin, on taillight, left
T8e – Connector, 8 Pin, on taillight right
(50) – Ground connection, in luggage compartment, left
(63) – Ground connection, on left taillight bulb holder
(64) – Ground connection, on right taillight bulb holder
(196) – Ground connection -1-, in rear wiring harness
(W12) – Wire connection (58L), in rear wiring harness
(W13) – Wire connection (58R), in rear wiring harness

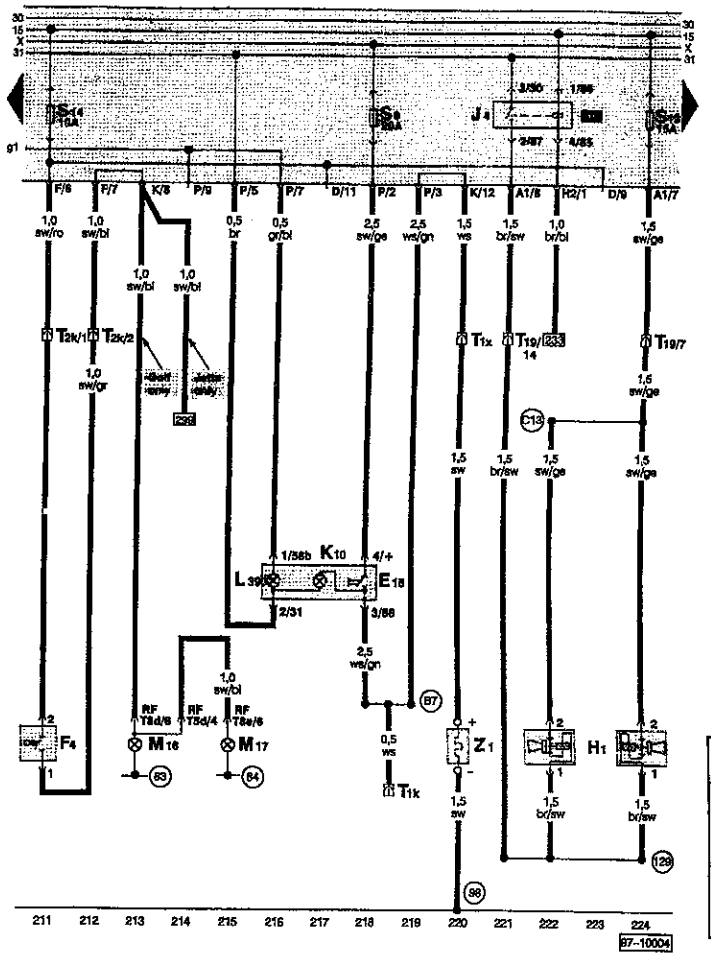



| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E1 – Light Switch
E20 – Instrument Panel Light Dimmer Switch
K4 – Park Light Indicator Light
L9 – Headlight Switch Light
T2h – Connector, Double, behind fuse/relay panel
T19 – Connector, 19 Pin, behind radiator grill, center
(119) – Ground connection -1-, in headlight wiring harness
(198) – Ground connection, in front light wiring harness

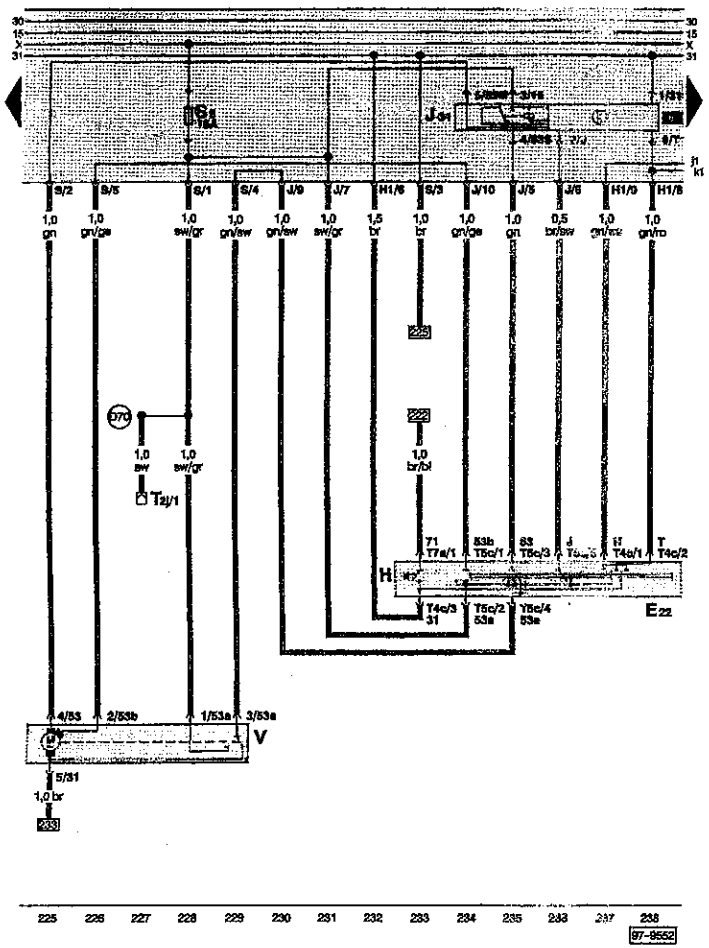







| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E15 – Rear Window Defogger Switch
F4 – Back-Up Light Switch
H1 – Dual Horns
J4 – Dual Horn Relay
K10 – Rear Window Defogger Indicator Light
L39 – Rear Window Defogger Switch Light
M16 – Back-Up Light, Left
M17 – Back-Up Light, Right
Z1 – Rear Window Defogger (Heat Element)
T1k – Connector, Single, behind fuse/relay panel
T1x – Connector, Single, in luggage compartment, left
T2k – Connector, Double, behind fuse/relay panel
T5d – Connector, 5 Pin, on taillight, left
T8d – Connector, 8 Pin, on taillight, left
T8e – Connector, 8 Pin, on taillight right
T19 – Connector, 19 Pin, behind radiator grill, center
(63) – Ground connection, on left taillight bulb holder
(64) – Ground connection, on right taillight bulb holder
(98) – Ground connection, in rear lid wiring harness
(129) – Ground connection, in dual tone horn wiring harness
(87) – Wire connection (86), in rear window defogger wiring harness
(C13) – Plus connection, in dual tone horn wiring harness

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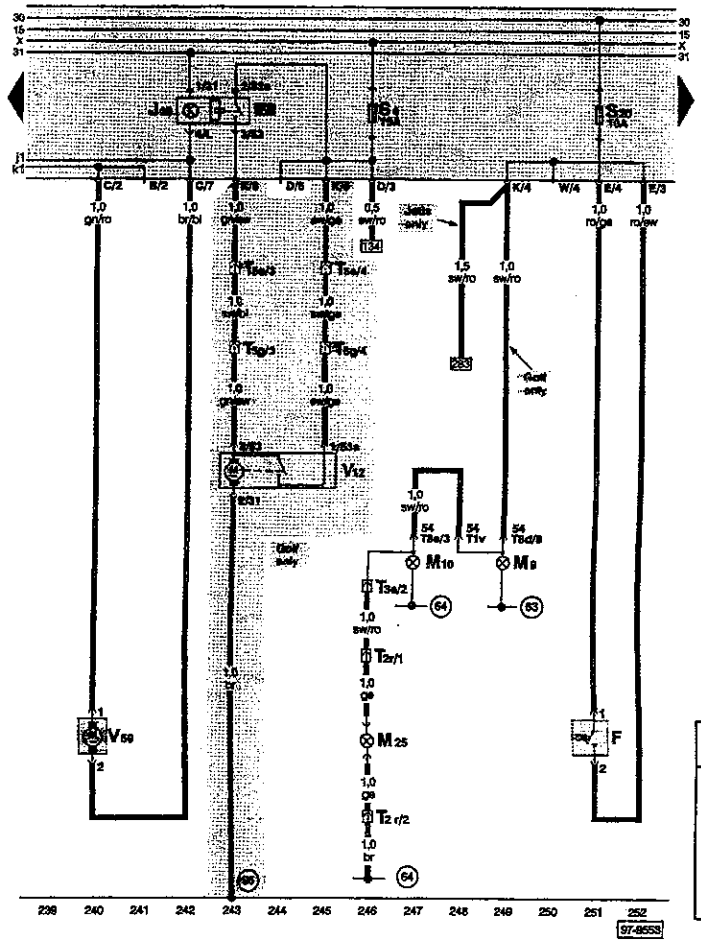
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E22 – Windshield Wiper Intermittent Switch
H – Horn Button
J31 – Washer/Wiper Intermittent Relay
V – Windshield Wiper Motor
T2j – Connector, Double, behind fuse/relay panel
T4c – Connector, 4 Pin, behind steering column switch trim
T5c – Connector, 5 Pin, behind steering column switch trim
T7a – Connector, 7 Pin, behind steering column switch trim
(D70) – Wire connection (53a), in engine compartment wiring harness

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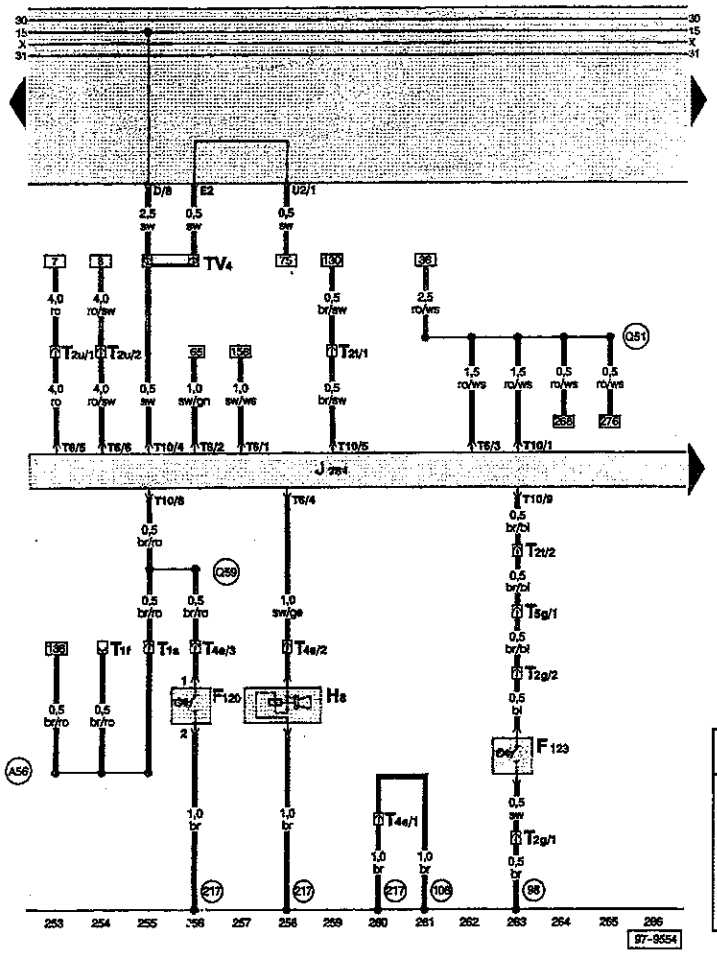
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

F – Brake Light Switch
J30 – Rear Window Wiper/Washer Relay
M9 – Brake Light, Left
M10 – Brake Light, Right
M25 – High-Mount Brake Light
V12 – Rear Window Wiper Motor
V59 – Windshield and Rear Window Washer Pump
T1v – Connector, Single, on taillight, left
T2r – Connector, Double, behind right grommet, on luggage compartment lid
T3e – Connector, 3 Pin, on tail light, right
T5e – Connector, 5 Pin, in luggage compartment, left
T5g – Connector, 5 Pin, in luggage compartment lid
T8d – Connector, 8 Pin, on taillight, left
T8e – Connector, 8 Pin, on taillight right
(63) – Ground connection, on left taillight bulb holder
(84) – Ground connection, on right taillight bulb holder
(98) – Ground connection, in rear lid wiring harness

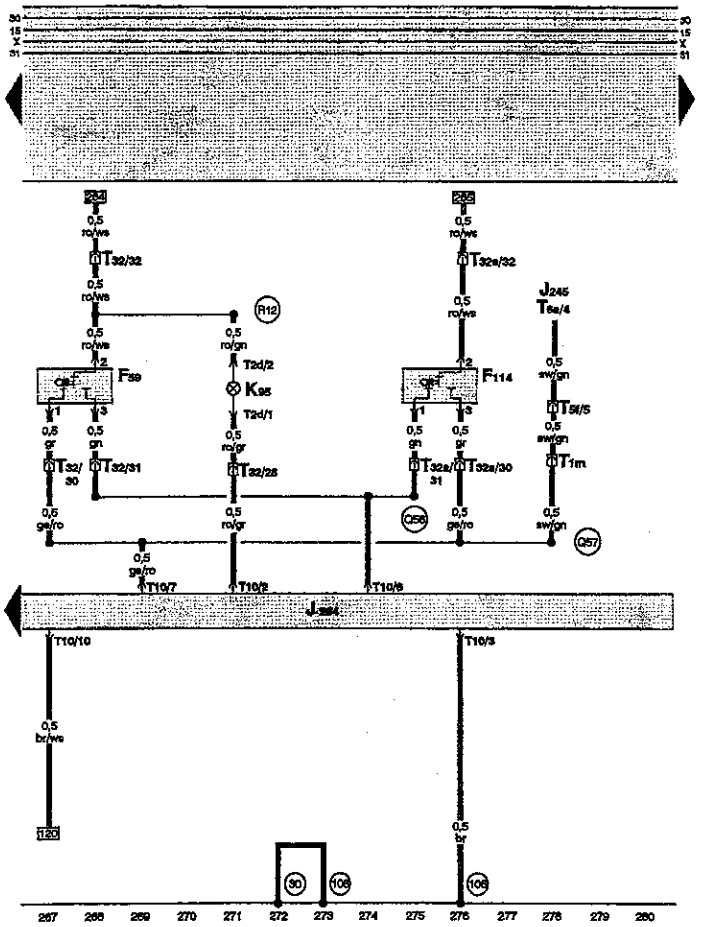
Alarm system




| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

F120 – Alarm Switch, Hood
F123 – Alarm Switch, Luggage Compartment Lid
H8 – Alarm Horn
J284 – Alarm System Control Module
T1f – Connector, Single, behind dash panel, center, behind radio
T1a – Connector, Single, behind fuse/relay panel
T2g – Connector, Double, on luggage compartment lid
T2t – Connector, Double, on luggage compartment left
T2u – Connector, Double, behind fuse/relay panel
T4e – Connector, 4 Pin, behind fuse/relay panel
T5g – Connector, 5 Pin, in luggage compartment lid
T6 – Connector, 6 Pin, behind dash panel, left, on Alarm System Control Module
T10 – Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
TV4 – Connector, terminal 15

(98) – Ground connection, in rear lid wiring harness
(106) – Ground connection, in alarm system wiring harness
(217) – Ground connection, in alarm horn wiring harness
(A56) – Wire connection (31SDS) in instrument panel wiring harness
(Q51) – Plus connection (30), in alarm system wiring harness
(Q59) – Wire connection (MHKS) in alarm system wiring harness




| WIRING COLOR CODE | |
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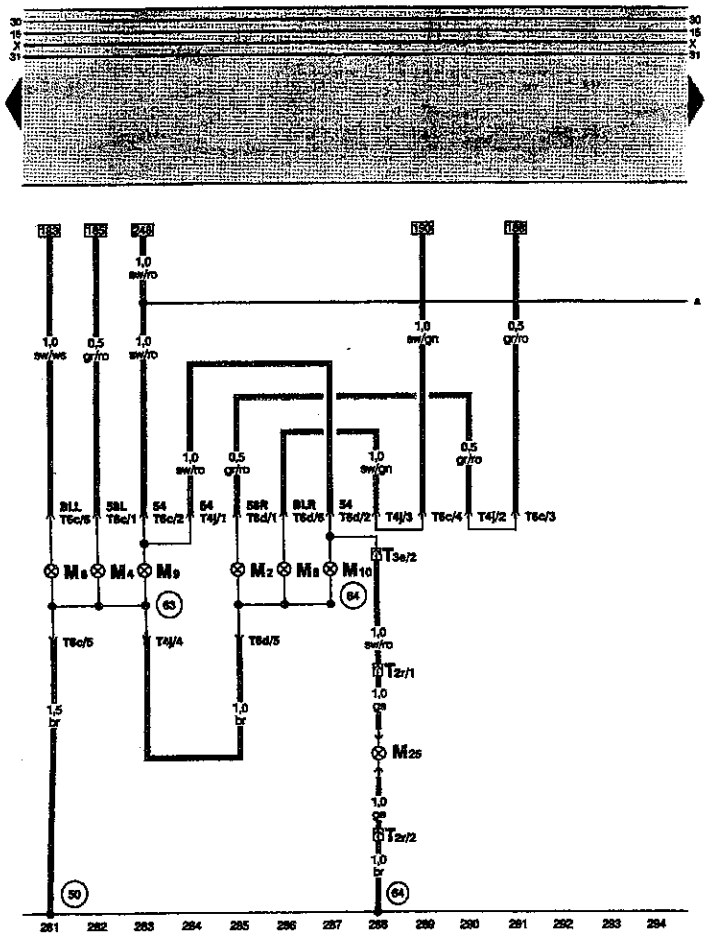
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

F59 – Central Locking System Door Switch, Driver's Door
F114 – Central Locking System Door Switch, Passenger's Door
J245 – Power Sunroof Control Module
J284 – Alarm System Control Module
K95 – Alarm System Indicator Light
T1m – Connector, Single, behind fuse/relay panel
T2d – Connector, Double, in left front door
T2m – Connector, Double, in right front door
T5f – Connector, 5 Pin, above fuse/relay panel
T6a – Connector, 6 Pin, behind interior light, on Power Sunroof Control Module
T10 – Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T32 – Connector, 32 Pin, on A–pillar, lower left
T32a – Connector, 32 Pin, on A–pillar, lower right

(30) – Ground connection – beside fuse/relay panel
(106) – Ground connection, in alarm system wiring harness
(Q58) – Wire connection (open), in alarm system wiring harness
(Q57) – Wire connection (closed), in alarm system wiring harness
(R12) – Plus connection –3– (30), in driver's door wiring harness



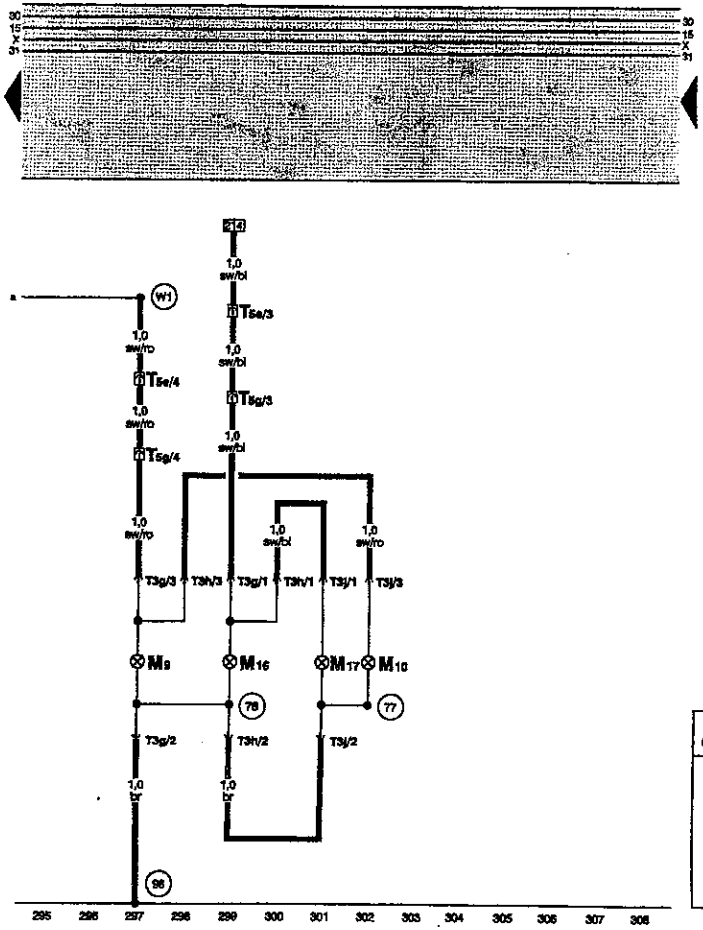

| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

M2 – Tail Light, Right
M4 – Tail Light, Left
M6 – Turn Signal Light, Left Rear
M8 – Turn Signal Light, Right Rear
M10 – Brake Light, Right
M25 – High Mount Brake Light
T2r – Connector, double, behind right grommet, on luggage compartment lid
T3e – Connector, 3 pin, on tail light, right
T4j – Connector, 4 pin, on tail light, left
T6c – Connector, 6 pin, on tail light, left
T6d – Connector, 6 pin, on tail light, right

(50) – Ground connection, in luggage compartment lid
(63) – Ground connection, on left tail light bulb holder
(64) – Ground connection, on right tail light bulb holder



1993–1994

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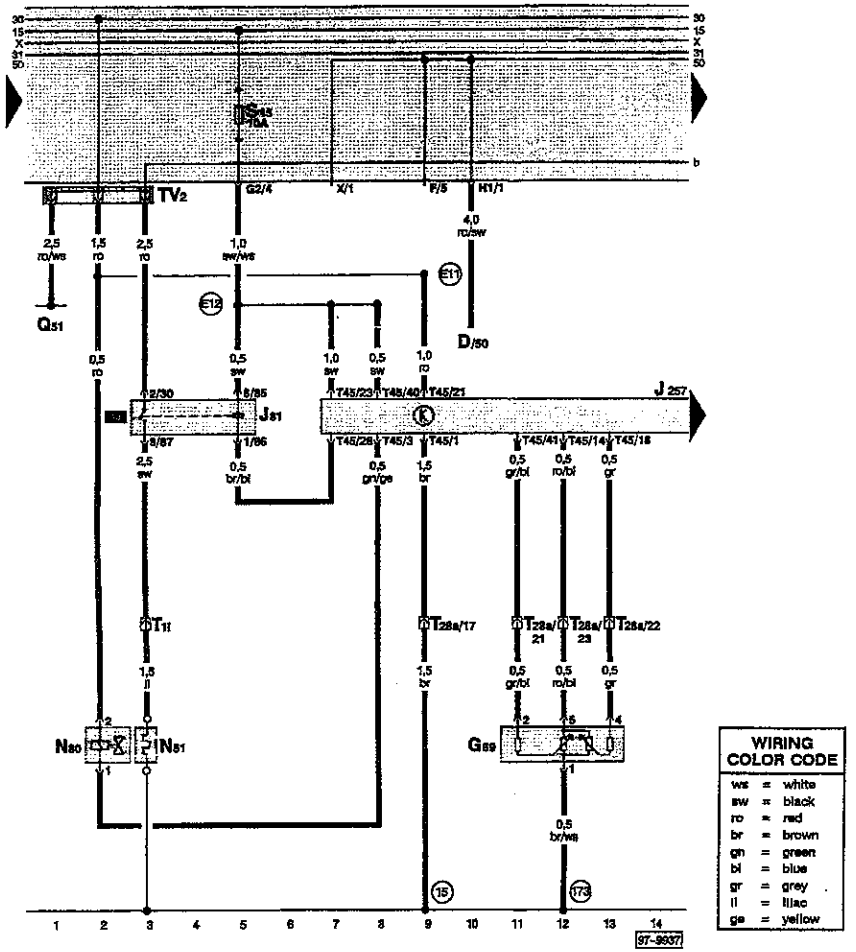
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

M9 – Brake Light, Left
M10 – Brake Light, Right
M16 – Back-up Light, Left
M17 – Back-up Light, Right
T3g – Connector, 3 pin, on back-up/brake light, left
T3h – Connector, 3 pin, on back-up/brake light, left
T3j – Connector, 3 pin, on back-up/brake light, right
T5e – Connector, 5 pin, on luggage compartment lid
T5g – Connector, 5 pin, on luggage compartment lid

(W1) – Plus connection, (54), in rear wiring harness
(76) – Ground connection, on left back-up/brake light bulb holder
(77) – Ground connection, on right back-up/brake light bulb holder

1993-1994

Engine electronics

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|---|---|
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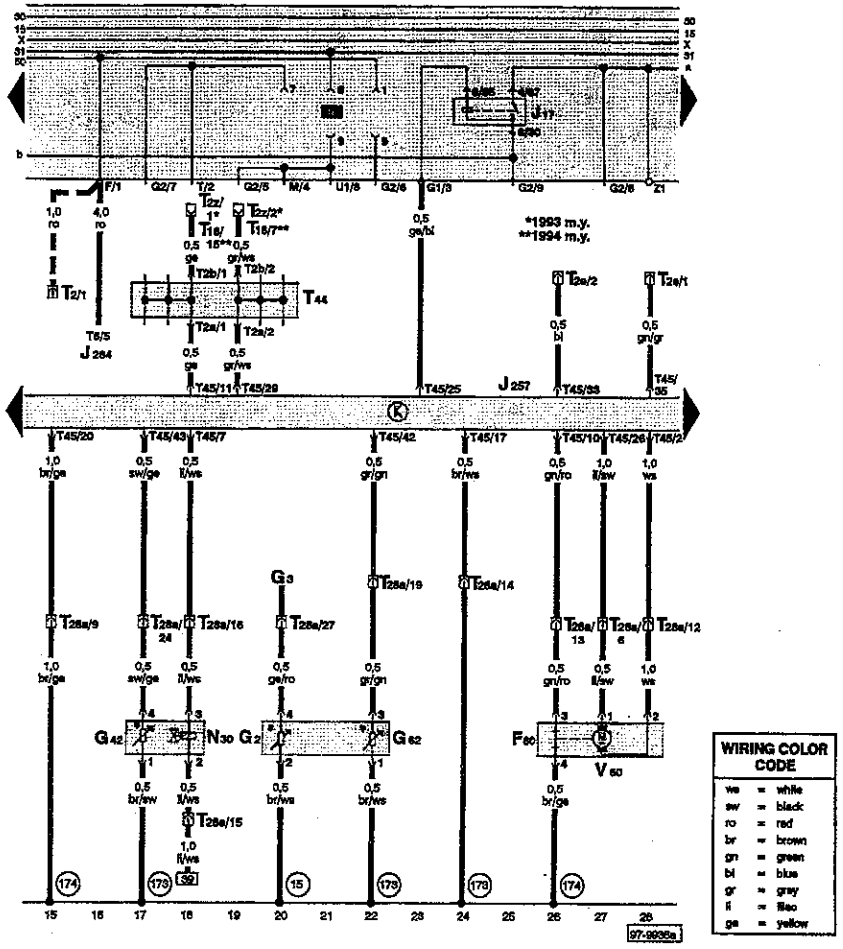
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

D – Ignition/Starter Switch
G69 – Throttle Position (TP) Sensor
J81 – Early Fuel Evaporation (EFE) Relay
J257 – Mono-Motronic Engine Control Module
N51 – Early Fuel Evaporation (EFE) Heating Element
N80 – Evaporative Emission (EVAP) Canister Purge Regulator Valve
T1l – Connector, Single, left rear of engine
T28a – Connector, 28 Pin, on engine
T45 – Connector, 45 Pin, on Mono-Motronic Engine Control Module (ECM)
TV2 – Wire connector, terminal 30 (B+)

(15) – Ground connection, on cylinder head
(173) – Ground connection –1–, in Mono-Motronic Throttle Body Fuel Injection (TBI) wiring harness
(E11) – Plus connection (30) in Throttle Body Fuel Injection (TBI) wiring harness
(E12) – Plus connection –1–(15) in Throttle Body Fuel Injection (TBI) wiring harness
(Q51) – Plus connection (30), in alarm system wiring harness
– – – Automatic transmission only




| WIRING COLOR CODE | |
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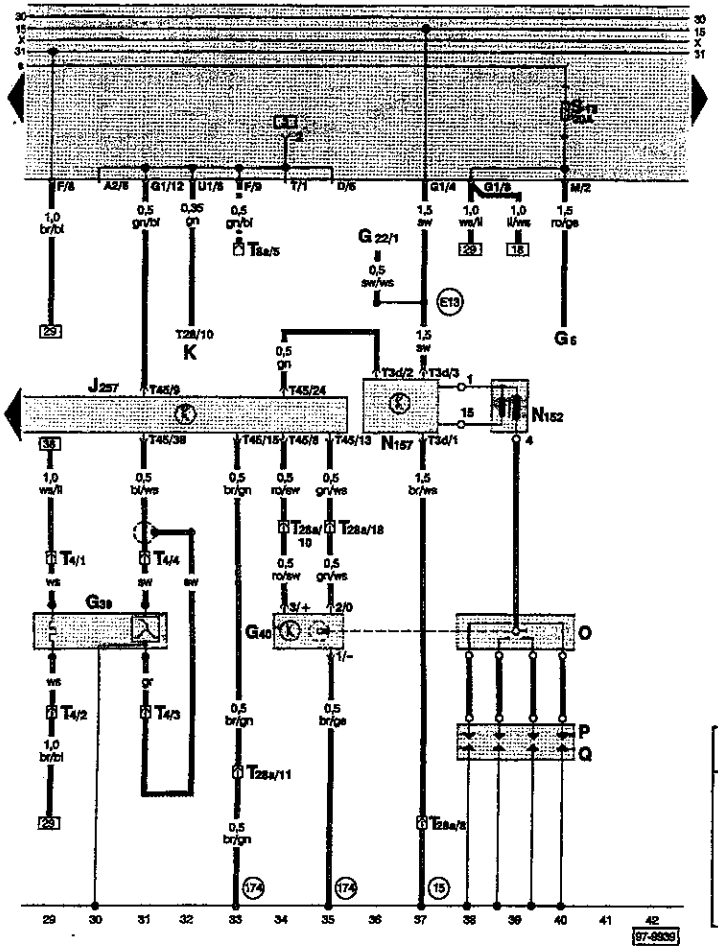
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = gray |
| li | = lilac |
| ge | = yellow |

F60 – Closed Throttle Position (CTP) Switch
G2 – Engine Coolant Temperature (ECT) Sensor
G3 – Engine Coolant Temperature (ECT) Gauge
G42 – Intake Air Temperature (IAT) Sensor
G62 – Engine Coolant Temperature (ECT) Sensor
J17 – Fuel Pump (FP) Relay
J257 – Mono-Motronic Engine Control Module
J284 – Alarm System Control Module
N30 – Injector, Cyl. 1
V60 – Throttle Position (TP) Actuator
T2 – Connector, Double, behind fuse/relay panel, only on automatic transmission
T2a – Connector, Double, on junction connector (T44) above fuse/relay panel
T2b – Connector, Double, on junction connector (T44) above fuse/relay panel
T2e – Connector, Double, behind fuse/relay panel, A/C connection
T2z – Data Link Connector (DLC), behind center of dash panel
T5 – Connector, 5 Pin, behind dash panel, left, on Alarm System Control Module
T16 – Data Link Connector (DLC), behind center of dash panel
T28a – Connector, 28 Pin, left side of engine, near distributor
T44 – Junction Box for On Board Diagnostic, above fuse/relay panel
T45 – Connector, 45 Pin, on Mono-Motronic Engine Control Module (ECM)
(15) – Ground connection, on cylinder head
(173) – Ground connection –1–, in Mono-Motronic Throttle Body Fuel Injection (TBI) wiring harness
(174) – Ground connection –2–, in Mono-Motronic Throttle Body Fuel Injection (TBI) wiring harness
– – – Automatic transmission only

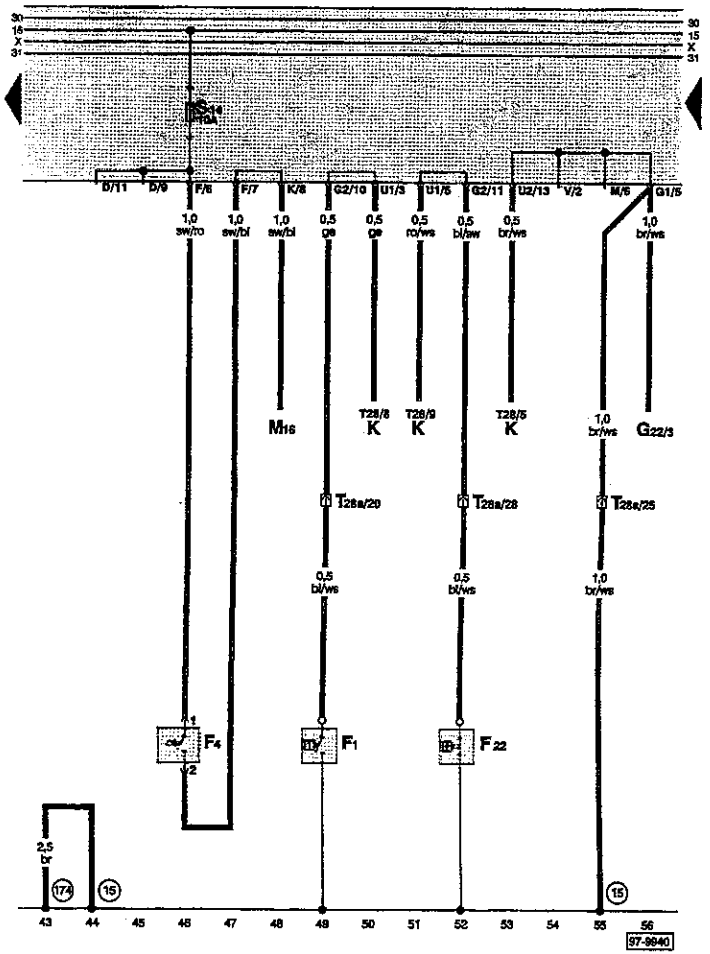



| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

G6 – Fuel Pump (FP)
G22 – Vehicle Speed Sensor (VSS), Speedometer
G39 – Heated Oxygen Sensor (HO2S)
G40 – Camshaft Position (CMP) Sensor
J257 – Mono-Motronic Engine Control Module
K – Instrument Cluster
N152 – Ignition Coil
N157 – Ignition Coil Power Output Stage
O – Ignition Distributor
Q – Spark Plugs
P – Spark Plug Connector
T3d – Connector, 3 Pin, left rear of engine compartment
T4 – Connector, 4 Pin, bottom right rear of engine compartment
T8a – Connector, 8 Pin, behind fuse/relay panel
T28 – Connector, 28 Pin, instrument cluster
T28a – Connector, 28 Pin, left side of engine, near distributor
T45 – Connector, 45 Pin, on Mono-Motronic Engine Control Module (ECM)
(15) – Ground connection, on cylinder head
(174) – Ground connection -2-, in Mono-Motronic Throttle Body Fuel Injection (TBI) wiring harness
(E13) – Plus connection -2- (15) in Throttle Body Fuel Injection (TBI) wiring harness








| WIRING COLOR CODE | |
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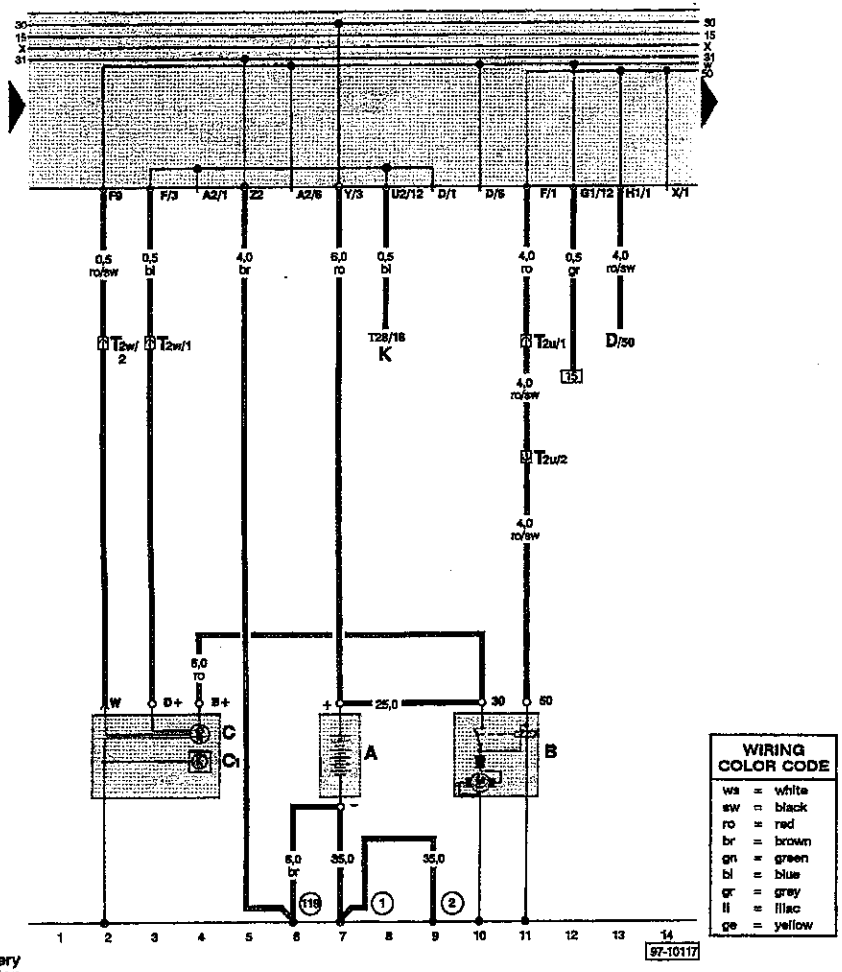
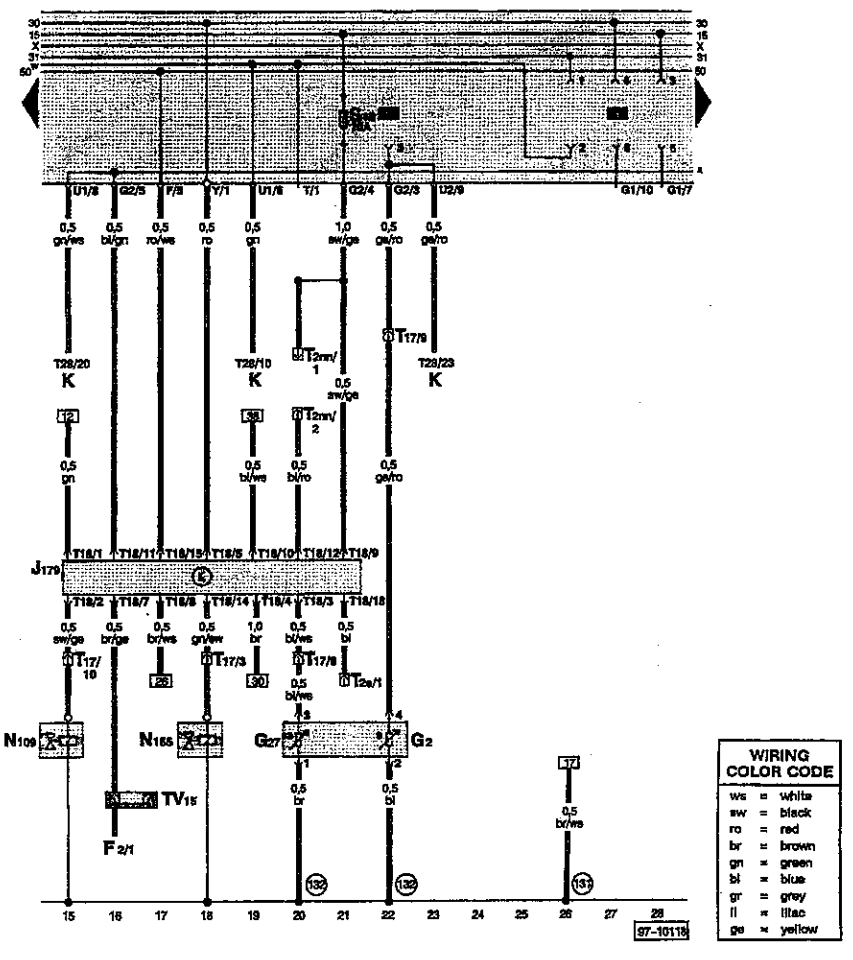
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

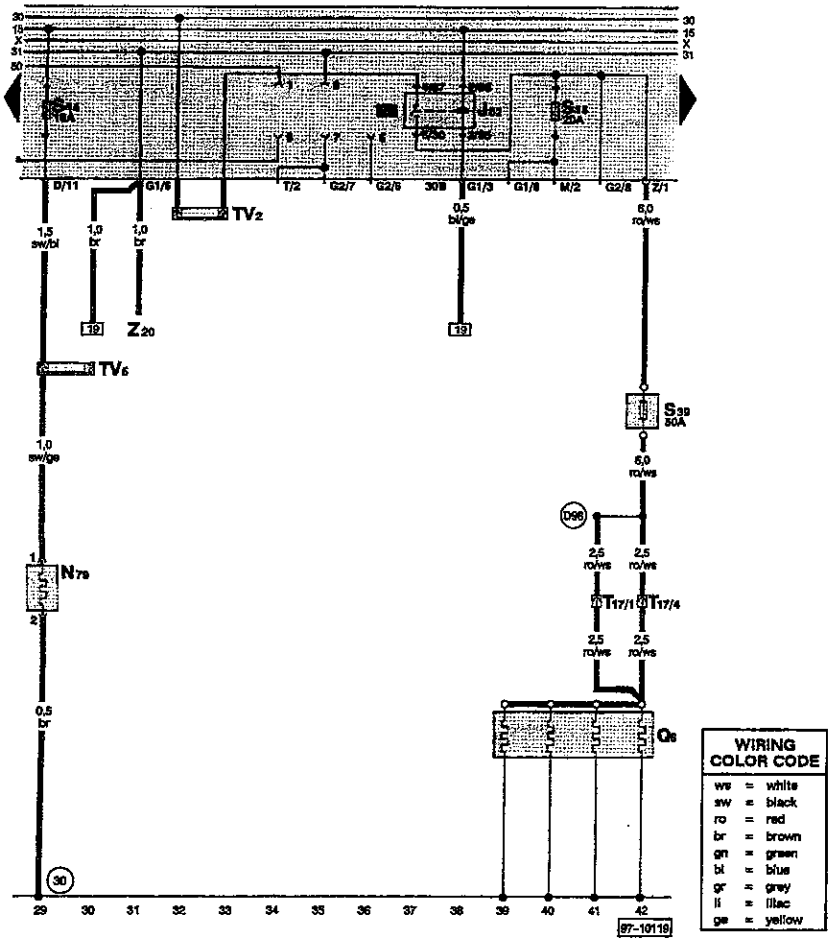
F1 – Oil Pressure Switch
F4 – Back-Up Light Switch
F22 – Oil Pressure Switch (0.3 Bar)
G22 – Vehicle Speed Sensor (VSS), Speedometer
K – Instrument Cluster
M16 – Back-Up Light, Left
T28 – Connector, 28 Pin, Instrument cluster
T28a – Connector, 28 Pin, left side of engine, near distributor
(15) – Ground connection, on cylinder head
(174) – Ground connection -2-, in Mono-Motronic Throttle Body Fuel Injection (TBI) wiring harness




A – Battery
B – Starter
C – Generator (Gen)
C1 – Voltage Regulator (VR)
D – Ignition/Starter Switch
K – Instrument Cluster
T2u – Connector, Double, behind fuse/relay panel
T2w – Connector, Double, near battery
T28 – Connector, 28 Pin, instrument cluster
(1) – Ground strap, battery to body
(2) – Ground strap, transmission to body
(119) – Ground connection -1-, in headlight wiring harness



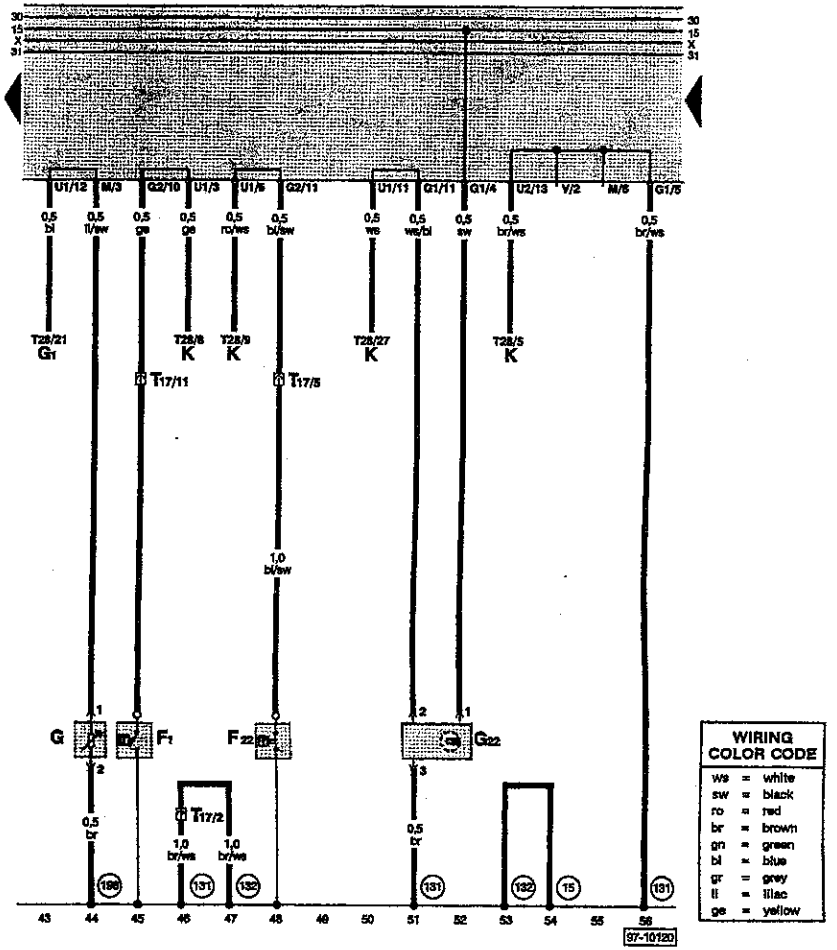

F2 – Door Contact Switch, Left Front
G2 – Engine Coolant Temperature (ECT) Sensor
G27 – Engine Temperature Sensor
J179 – Automatic Glow Time Control Module
K – Instrument Cluster
N109 – Fuel Cut-off Valve
N165 – Injection Start Positioner
T1y – Connector, Single, behind fuse/relay panel
T2nn – Connector, Double
T2e – Connector, Double, behind fuse/relay panel, A/C connection
T17 – Connector, 17 Pin, on engine
T18 – Connector, 18 Pin on Automatic Glow Time Control Module
T28 – Connector, 28 Pin, instrument cluster
TV15 – Wire Connector, door contact switch
(131) – Ground connection -2- in engine compartment wiring harness
(132) – Ground connection -3- in engine compartment wiring harness




J52 – Glow Plug Relay
N79 – Positive Crankcase Ventilation (PCV) Heating Element
Q6 – Glow Plug
S39 – Glow Plug Fuse Strip, 50A
Z20 – Washer Nozzle Heater, Left
T17 – Connector, 17 Pin, on engine
TV2 – Wire connector, terminal 30 (B+)
TV5 – Connector, terminal 15a

(30) – Ground connection, beside fuse/relay panel

(D98) – Wire connection, (glow plugs) in engine compartment wiring harness, right



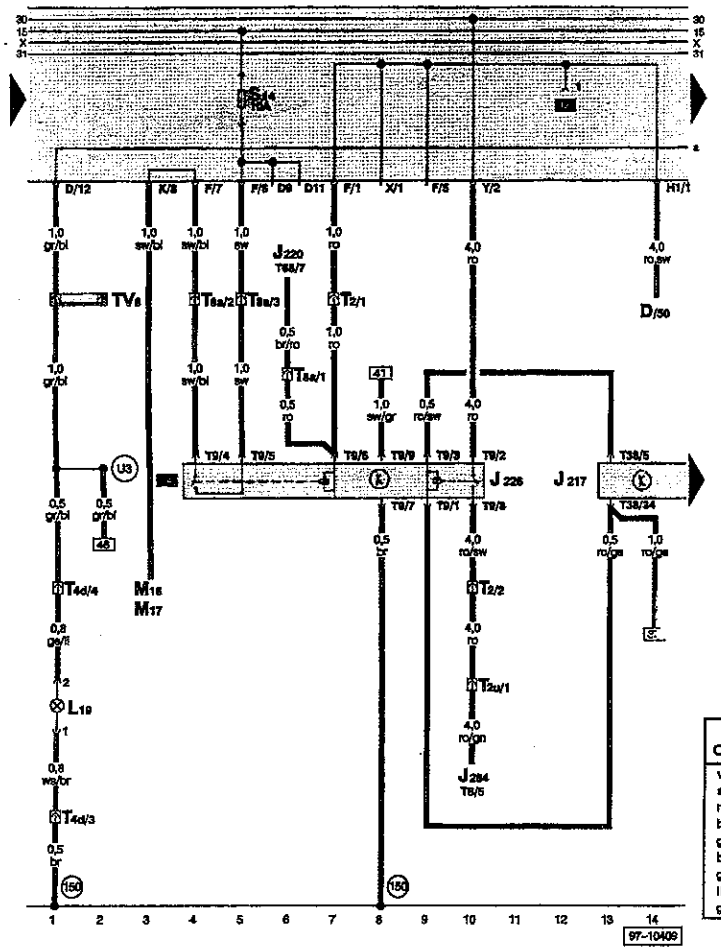

F1 – Oil Pressure Switch
F22 – Oil Pressure Switch (0.3 Bar)
G – Fuel Level Sensor
G1 – Fuel Gauge
G22 – Vehicle Speed Sensor (VSS), Speedometer
K – Instrument Cluster
T17 – Connector, 17 Pin, on engine
T28 – Connector, 28 Pin, instrument cluster

(15) – Ground connection, on cylinder head

(131) – Ground connection -2- in engine compartment wiring harness

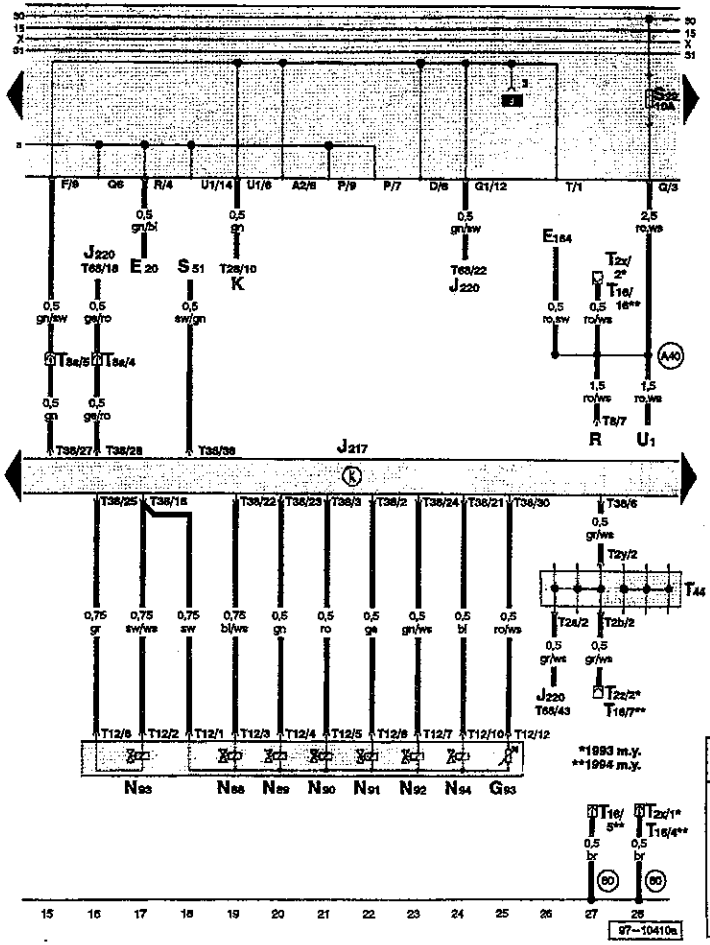
(132) – Ground Connection -3- in engine compartment wiring harness

(196) – Ground connection -1-, in rear wiring harness




| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

D – Ignition/Starter Switch
J217 – Transmission Control Module (TCM)
J220 – Motronic Engine Control Module (ECM)
J226 – Park/Neutral Position (PNP) Relay
J284 – Alarm System Control Module
L19 – Automatic Transmission Console Light
M16 – Back-Up Light, Left
M17 – Back-Up Light, Right
T2 – Connector, Double, behind fuse/relay panel, only on automatic transmission
T2u – Connector, Double, behind fuse/relay panel
T4d – Connector, 4 Pin, below center console
T6 – Connector, 6 Pin, behind dash panel, left, on Alarm System Control Module
T8a – Connector, 8 Pin, behind fuse/relay panel
T9 – Connector, 9 Pin, on Park/Neutral Position (PNP) Relay
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T68 – Connector, 68 Pin, under right side of hood, on Motronic Engine Control Module (ECM)
TV8 – Connector, terminal 58b
(150) – Ground connection, in automatic transmission wiring harness
(U3) – Wire connection, in automatic transmission wire harness

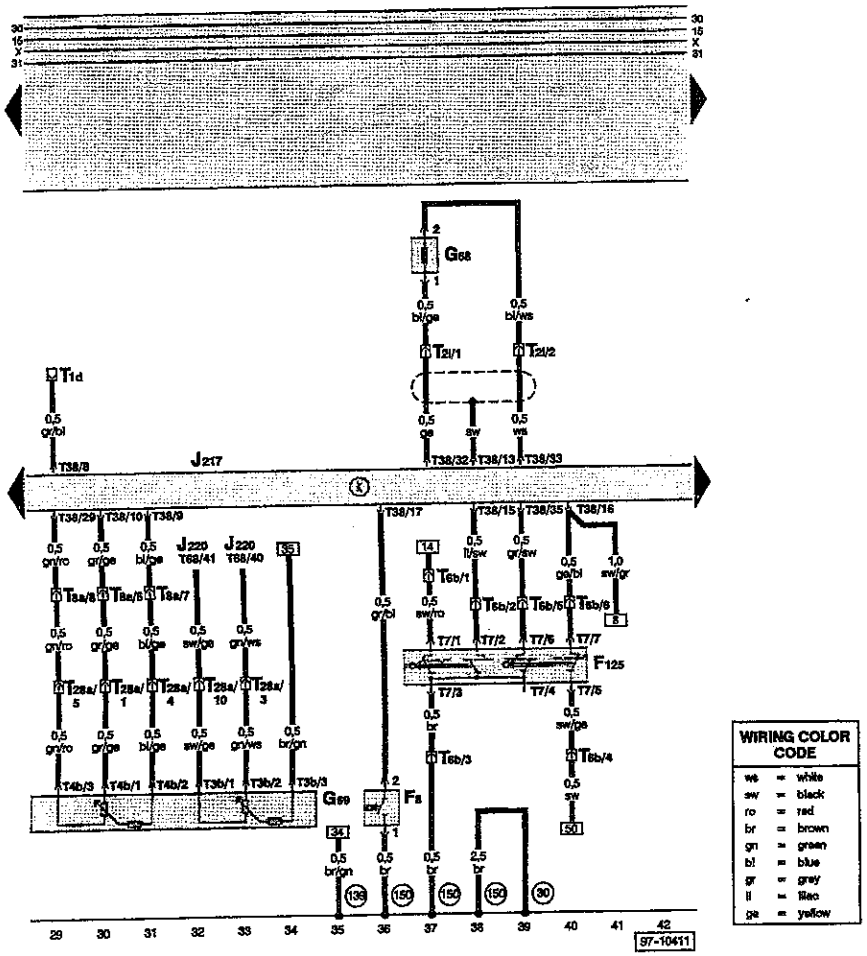


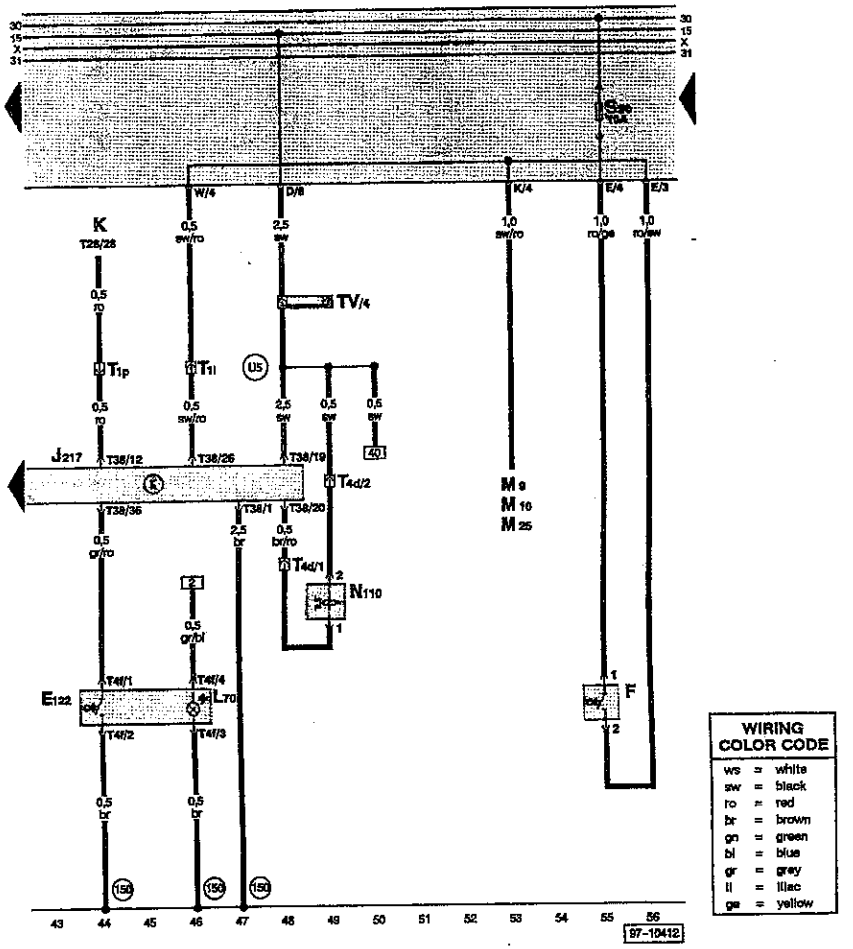

*1993 m.y.
**1994 m.y.

| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E20 – Instrument Panel Light Dimmer Switch
E164 – Luggage Compartment Release Switch
G93 – Transmission Fluid Temperature Sensor
J217 – Transmission Control Module (TCM)
J220 – Motronic Engine Control Module (ECM)
K – Instrument Cluster
N83 – Solenoid Valve 1
N89 – Solenoid Valve 2
N90 – Solenoid Valve 3
N91 – Solenoid Valve 4
N92 – Solenoid Valve 5
N93 – Solenoid Valve 6
N94 – Solenoid Valve 7
R – Radio
S51 – Fuse
U1 – Cigarette Lighter
T2a – Connector, Double, on junction connector (T44) above fuse/relay panel
T2b – Connector, Double, on junction connector (T44) above fuse/relay panel
T2x – Data Link Connector (DLC), behind center of dash panel
T2y – Connector, Double, on junction connector (T44) above fuse/relay panel
T2z – Data Link Connector (DLC), behind center of dash panel
T8 – Connector, 8 Pin, on radio
T8a – Connector, 8 Pin, behind fuse/relay panel
T12 – Connector, 12 Pin, on transmission
T16 – Data Link Connector (DLC), behind center of dash panel
T28 – Connector, 28 Pin, instrument cluster
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T44 – Junction Box for On Board Diagnostic, above fuse/relay panel
T68 – Connector, 68 Pin, under right side of hood, on Motronic Engine Control Module (ECM)
(80) – Ground connection –1–, in instrument panel wiring harness
(A40) – Plus connection (30), in instrument panel wiring harness

Automatic transmission




F8 – Kick Down Switch
F125 – Multi–Function Transmission Range (TR) Switch
G68 – Vehicle Speed Sensor (VSS)
G69 – Throttle Position (TP) Sensor
J217 – Transmission Control Module (TCM)
J220 – Motronic Engine Control Module (ECM)
T1d – Connector, Single, behind fuse/relay panel
T2i – Connector, Double, below battery
T3b – Connector, 3 Pin, on throttle position sensor
T4b – Connector, 4 Pin, on throttle position sensor
T6b – Connector, 6 Pin, below battery
T7 – Connector, 7 Pin, on transmission
T8a – Connector, 8 Pin, behind fuse/relay panel

T28a – Connector, 28 Pin, left side of engine, near distributor
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T68 – Connector, 68 Pin, under right side of hood, on Motronic Engine Control Module (ECM)

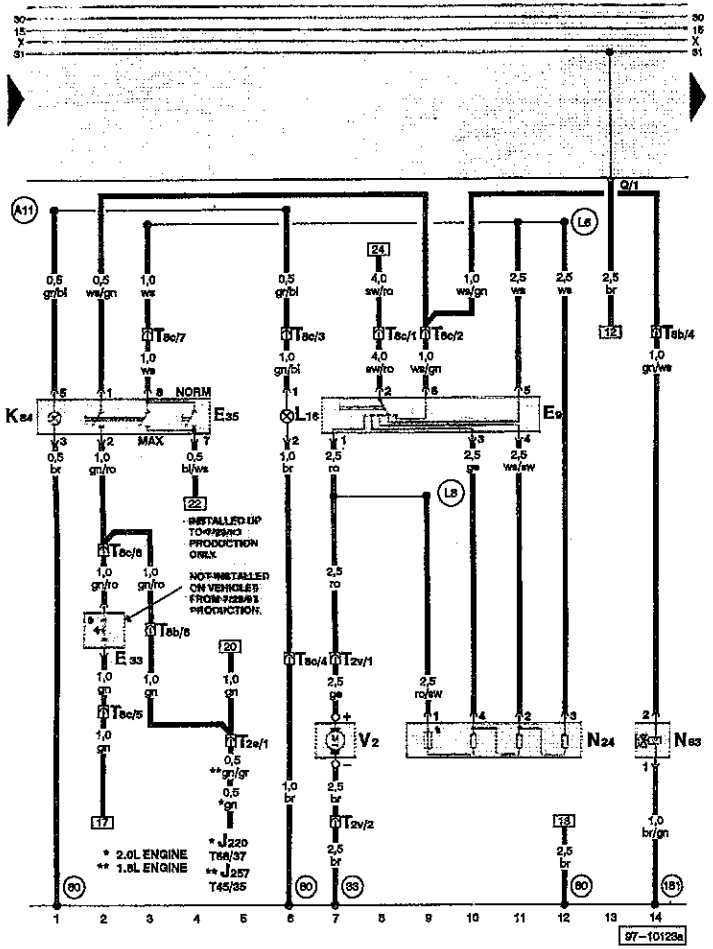
(80) – Ground connection – beside fuse/relay panel
(139) – Ground connection (sensor ground), in Motronic Multiport Fuel Injection (MFI) wiring harness
(150) – Ground connection, in automatic transmission wiring harness

E122 – Transmission Range (TR) Program Switch
F – Brake Light Switch
J217 – Transmission Control Module (TCM)
K – Instrument Cluster
L70 – Program Switch Illumination
M9 – Brake Light, Left
M10 – Brake Light, Right
M25 – High–Mount Brake Light
N110 – Shift Lock Solenoid
T1i – Connector, Single, behind fuse/relay panel
T1p – Connector, Single, behind fuse/relay panel
T1v – Connector, Single, on taillight, left
T4d – Connector, 4 Pin, below center console

T4f – Connector, 4 Pin, on Transmission Range (TR) Program Switch
T8d – Connector, 8 Pin, on taillight, left
T8e – Connector, 8 Pin, on taillight right
T28 – Connector, 28 Pin, instrument cluster
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
TV4 – Connector, terminal 15

(150) – Ground connection, in automatic transmission wiring harness
(U5) – Wire connection –2– (15), in automatic transmission wiring harness

Air conditioning




| WIRING COLOR CODE | |
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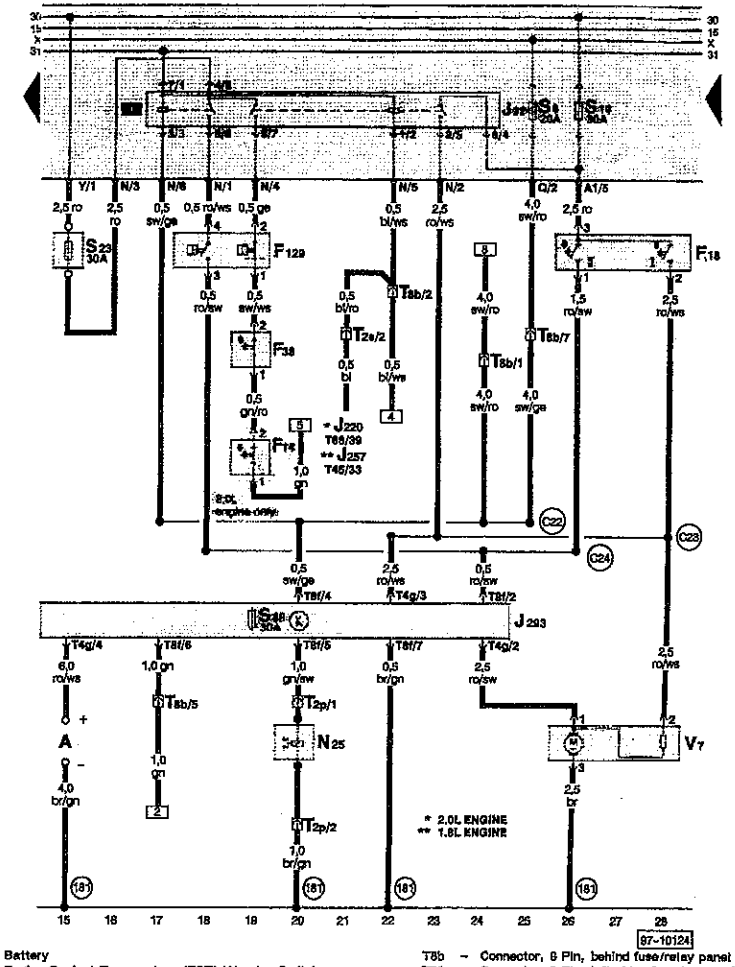
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E9 – Fresh Air Blower Switch
E33 – A/C Evaporator Temperature Switch
E35 – A/C Switch
J220 – Motronic Engine Control Module (ECM)
J257 – Mono–Motronic Engine Control Module (ECM)
K84 – A/C Indicator Light
L16 – Fresh Air Control Lever Light
N24 – Fresh Air Blower Series Resistance with Fuse
N63 – Fresh Air/Recirculating Flap Two–Way Valve
V2 – Fresh Air Blower
T2e – Double Connector, behind fuse/relay panel, A/C Connection
T2v – Double Connector, below right side of dash at blower motor
T8b – 8–Pin Connector, behind fuse/relay panel
T8c – 8–Pin Connector, behind lower center of dash panel
T45 – 45–Pin Connector, on Mono–Motronic Engine Control Module (ECM)
T68 – 68–Pin Connector, under right side of hood, on Motronic Engine Control Module
(93) – Ground connection, behind instrument panel, right
(80) – Ground connection –1–, in instrument panel wiring harness
(181) – Ground connection (for A/C), in engine compartment wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(L6) – Wire connection –2–, in evaporator housing wiring harness
(L8) – Wire connection –4–, in evaporator housing wiring harness




| WIRING COLOR CODE | |
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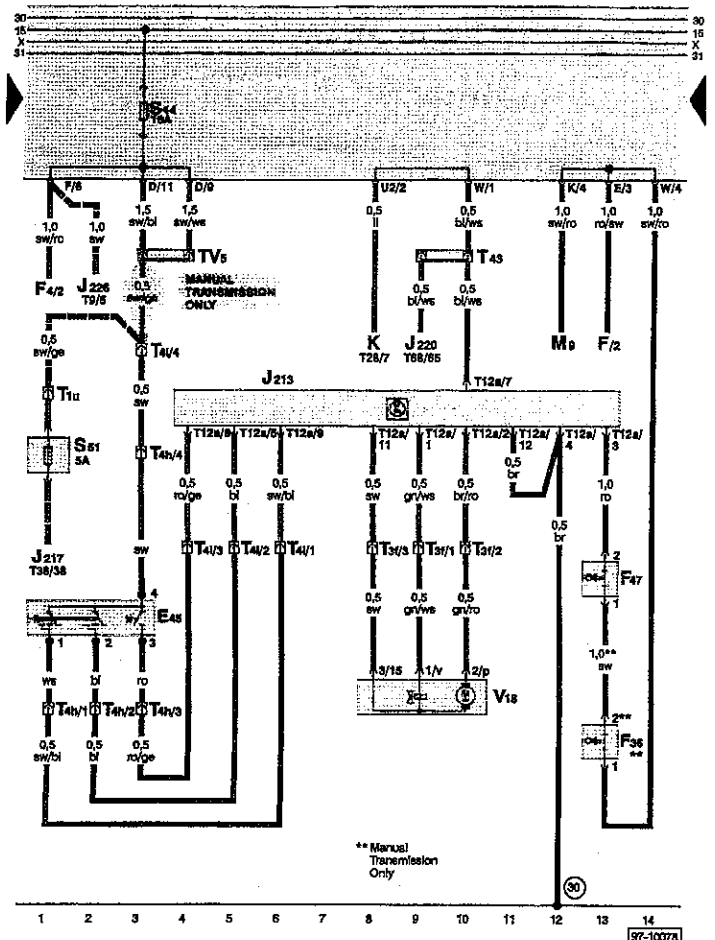
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

A – Battery
F14 – Engine Coolant Temperature (ECT) Warning Switch
F18 – Coolant Fan Control (FC) Thermal Switch
F38 – Ambient Temperature Switch
F129 – A/C Pressure Switch
J32 – A/C Relay
J220 – Motronic Engine Control Module (ECM)
J257 – Mono–Motronic Engine Control Module (ECM)
J293 – Coolant Fan Control (FC) Module
N25 – A/C Clutch
S23 – Heater Fuse
S88 – Fuse Strip
V7 – Coolant Fan
T2e – Connector, Double, behind fuse/relay panel, A/C connection
T2p – Connector, Double, on compressor
T4g – Connector, 4 Pin, left side of engine, on Coolant Fan Control (FC) Module
T8b – Connector, 8 Pin, behind fuse/relay panel
T8f – Connector, 8 Pin, left side of engine, on Coolant Fan Control (FC) Module
T45 – Connector, 45 Pin, on Mono–Motronic Engine Control Module (ECM)
T68 – Connector, 68 Pin, under right side of hood, on Motronic Engine Control Module (ECM)
(181) – Ground connection (for A/C), in engine compartment wiring harness
(C22) – Wire connection (X), in headlight/air conditioner wiring harness
(C23) – Wire connection (blower, 1st speed) in headlight/air conditioner wiring harness
(C24) – Wire connection (blower, 2nd speed) in headlight/air conditioner wiring harness

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| sw | black |
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| br | brown |
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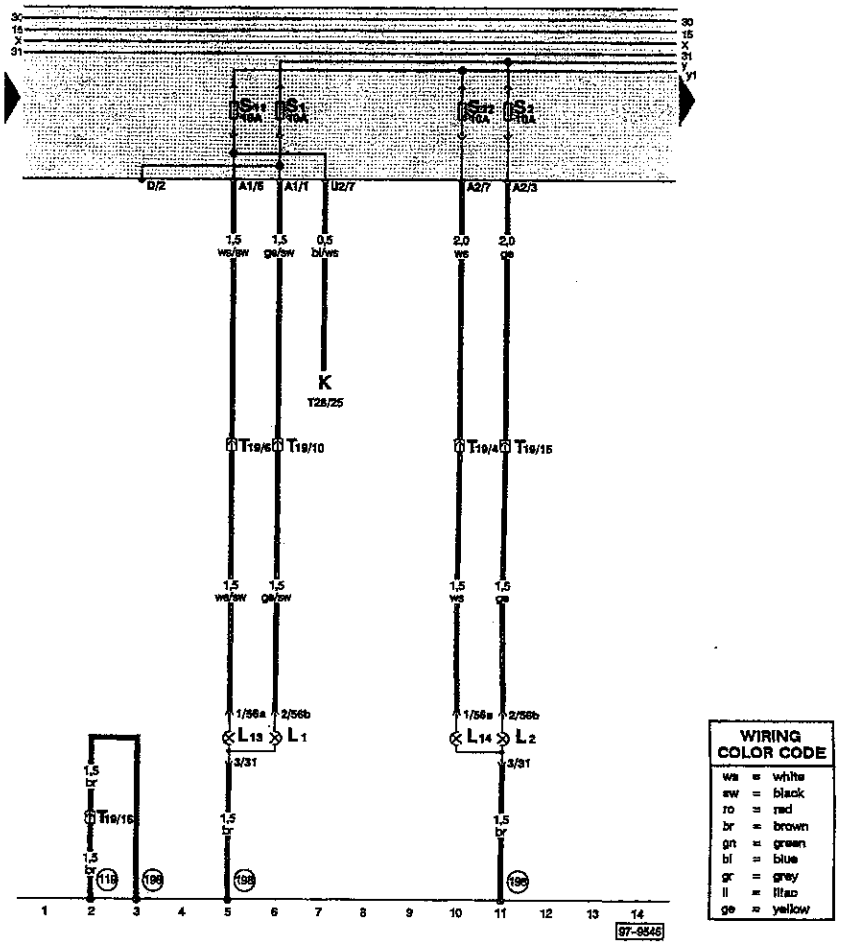
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E45 – Cruise Control Switch
F – Brake Light Switch
F4 – Back-Up Light Switch
F36 – Cruise Control Clutch Pedal Position Switch
F47 – Cruise Control Brake Pedal Position Switch
J213 – Cruise Control Module
J217 – Transmission Control Module (TCM)
J220 – Motronic Engine Control Module (ECM)
J226 – Park/Neutral Position (PNP) Relay
K – Instrument Cluster
M9 – Brake Light, Left
S51 – Fuse
V18 – Cruise Control Vacuum Pump
T1u – Connector, Single, behind fuse/relay panel
T3f – Connector, 3 Pin, below left side of dash
T4h – Connector, 4 Pin, behind steering column switch trim
T4l – Connector, 4 Pin, behind fuse/relay panel
T9 – Connector, 9 Pin, on Park/Neutral Position (PNP) Relay
T12a – Connector, 12 Pin, on Cruise Control Module
T28 – Connector, 28 Pin, instrument cluster
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T43 – Connector, vehicle speed signal
T68 – Connector, 68 Pin, under right side of hood, on Motronic Engine Control Module (ECM)
TV5 – Connector, terminal 15a
(30) – Ground connection – beside fuse/relay panel
– – – Automatic transmission only

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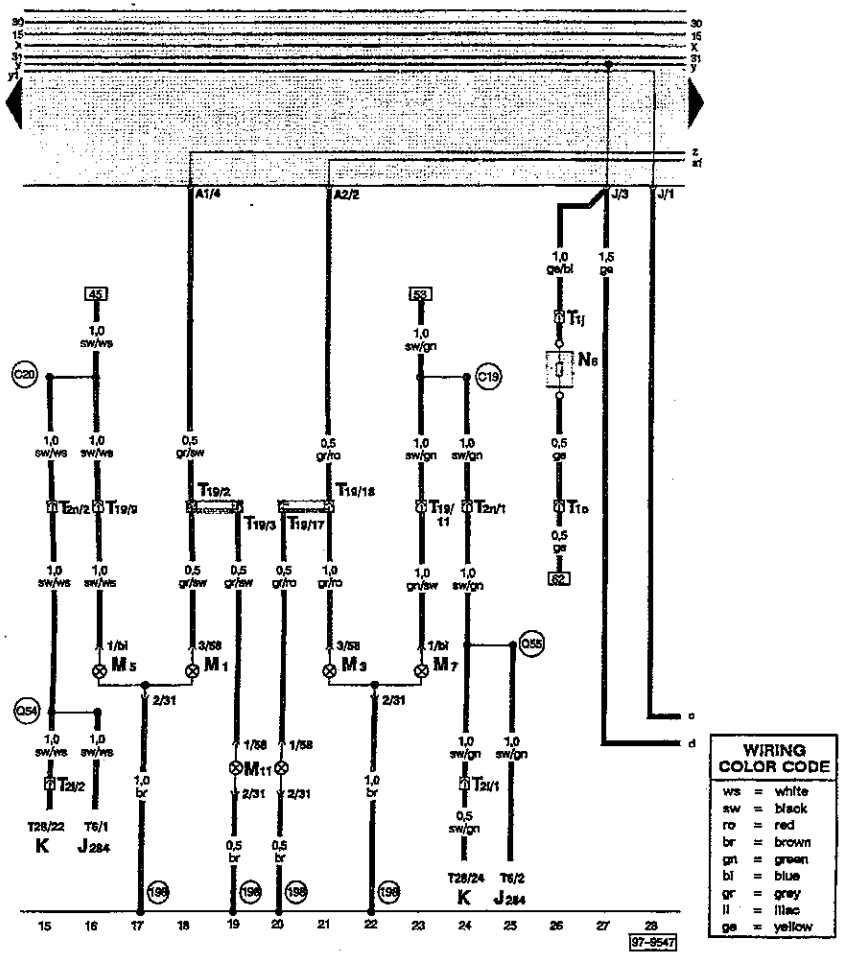
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

K – Instrument Cluster
L1 – Headlight, Left
L2 – Headlight, Right
L13 – High Beam Headlight, Left
L14 – High Beam Headlight, Right
T19 – Connector, 19 Pin, behind radiator grill, center
T28 – Connector, 28 Pin, instrument cluster
(119) – Ground connection –1–, in headlight wiring harness
(198) – Ground connection, in front light wiring harness

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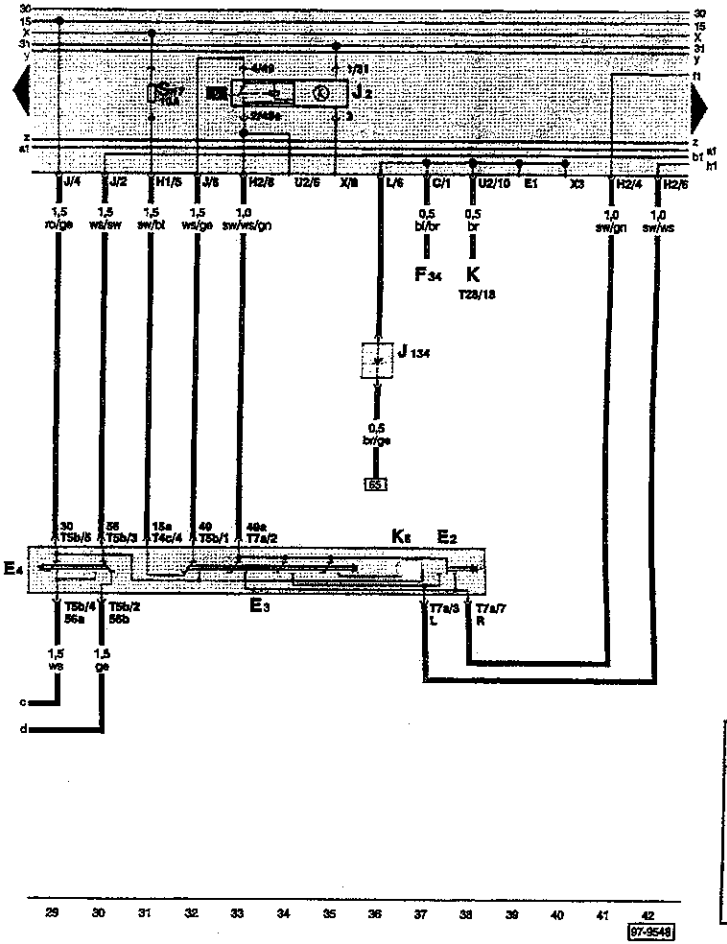
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

J284 – Alarm System Control Module
K – Instrument Cluster
M1 – Parking Light, Left
M3 – Parking Light, Right
M5 – Turn Signal Light, Left Front
M7 – Turn Signal Light, Right Front
M11 – Side Marker Lights, Front
N6 – Series Resistance
T1j – Connector, Single, behind fuse/relay panel
T1o – Connector, Single, behind fuse/relay panel
T2l – Connector, Double, behind fuse/relay panel
T2n – Connector, Double, behind fuse/relay panel
T6 – Connector, 6 Pin, behind dash panel, left, on Alarm System Control Module

T19 – Connector, 19 Pin, behind radiator grill, center
T28 – Connector, 28 Pin, instrument cluster
(198) – Ground connection, in front light wiring harness
(C19) – Wire connection (right turn signal), in headlight wiring harness
(C20) – Wire connection (left turn signal), in headlight wiring harness
(Q54) – Wire connection (left turn signal), in alarm system wiring harness
(Q55) – Wire connection (right turn signal), in alarm system wiring harness





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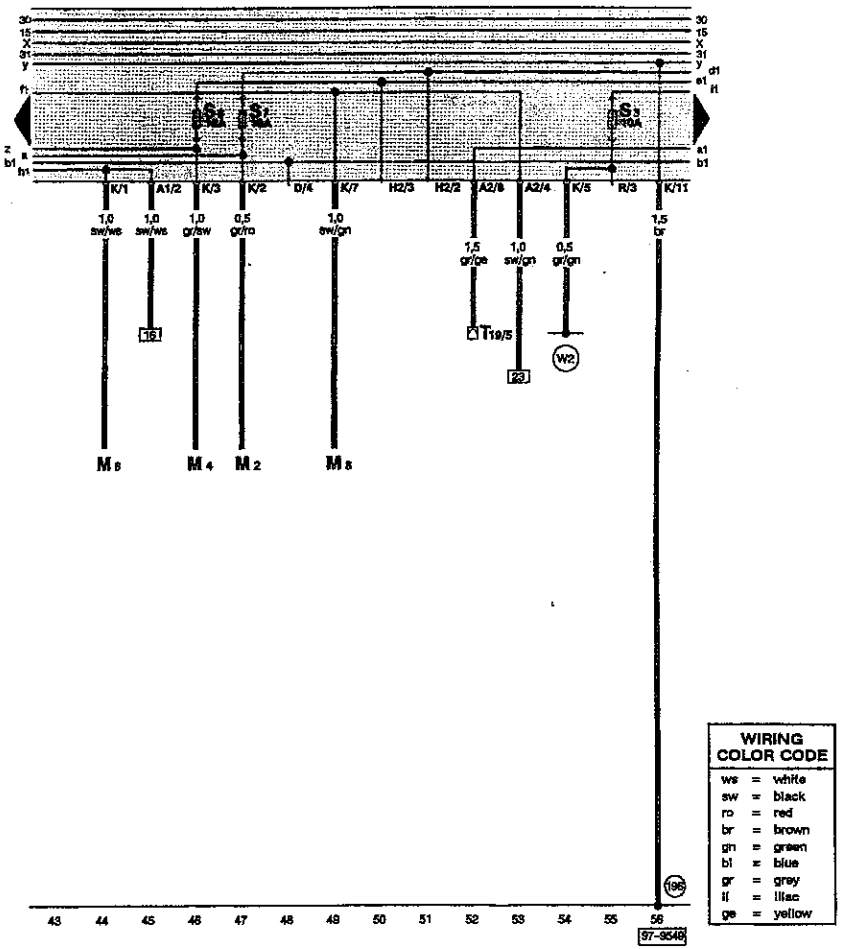
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E2 – Turn Signal Switch
E3 – Emergency Flasher Switch
E4 – Headlight Dimmer/Flasher Switch
F34 – Brake Fluid Level Warning Switch
J2 – Emergency Flasher Relay
J134 – Daytime Running Light Diode
K – Instrument Cluster
K6 – Emergency Flasher Warning Light
T4c – Connector, 4 Pin, behind steering column switch trim
T5b – Connector, 5 Pin, behind steering column switch trim
T7a – Connector, 7 Pin, behind steering column switch trim
T28 – Connector, 28 Pin, instrument cluster

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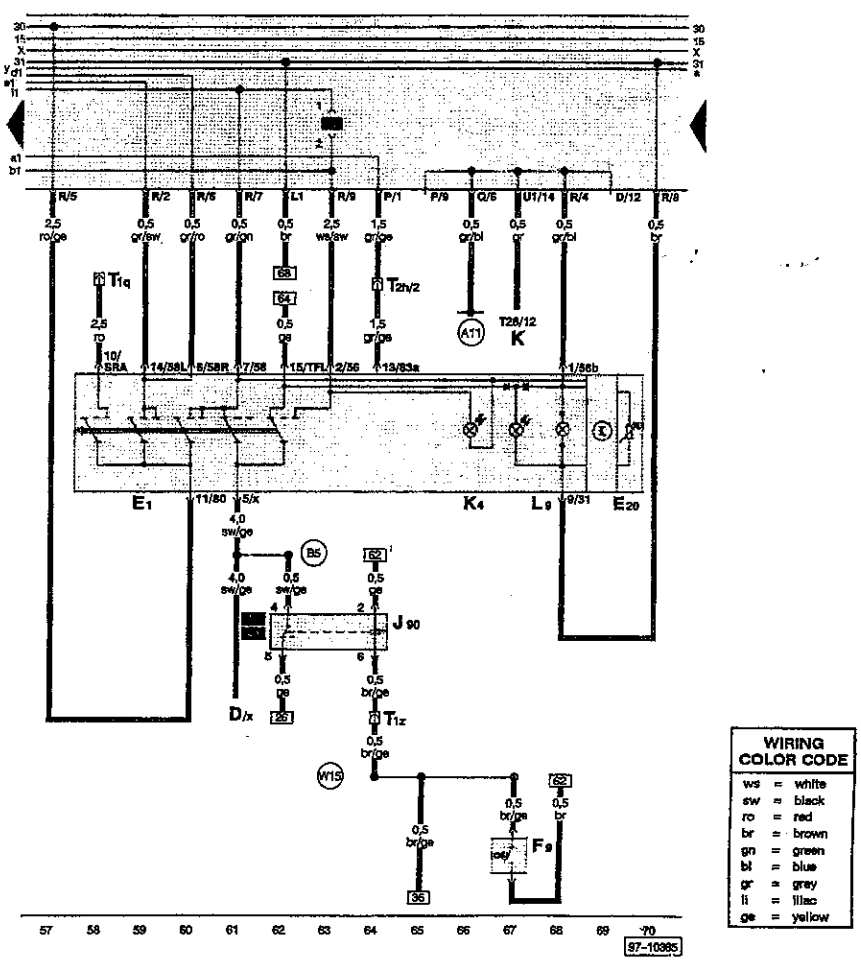
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

M2 – Tail Light, Right
M4 – Tail Light, Left
M6 – Turn Signal Light, Left Rear
M8 – Turn Signal Light, Right Rear
T19 – Connector, 19 Pin, behind radiator grill, center
(196) – Ground connection -1-, in rear wiring harness
(W2) – Plus connection (58), in rear wiring harness





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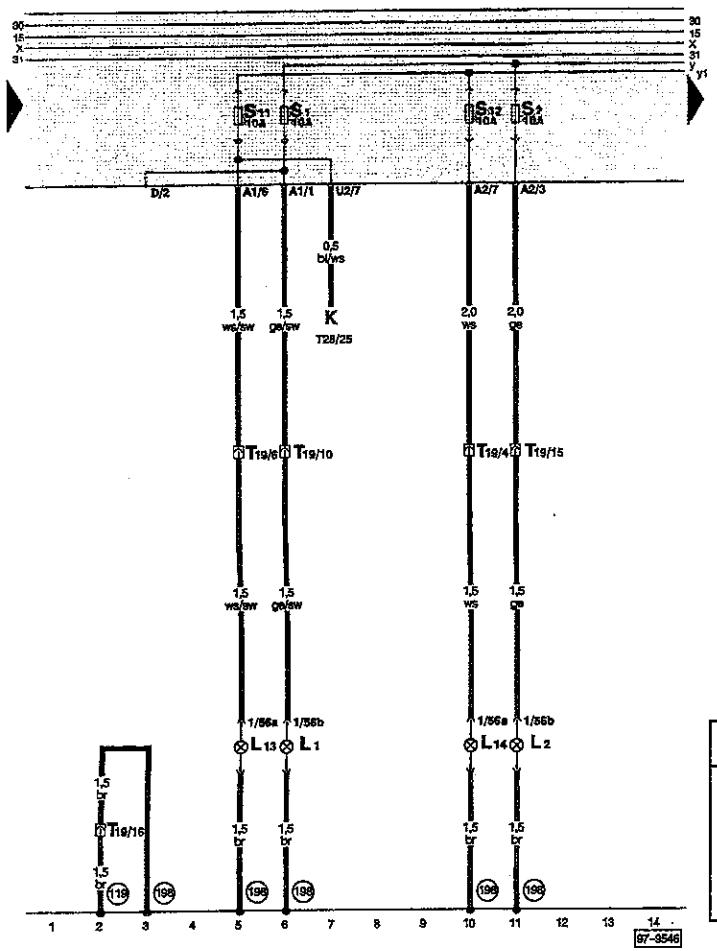
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

D – Ignition/Starter Switch
E1 – Light Switch
E20 – Instrument Panel Light Dimmer Switch
F9 – Parking Brake Warning Light Switch
J90 – Daytime Running Lights Relay (Switch on)
K – Instrument Cluster
K4 – Park Light Indicator Light
L9 – Headlight Switch Light
T1q – Connector, Single, behind fuse/relay panel
T1z – Connector, Single, behind fuse/relay panel
T2h – Connector, Double, behind fuse/relay panel
T28 – Connector, 28 Pin, instrument cluster
(A11) – Plus connection (58b), in instrument panel wiring harness
(B5) – Wire connection, (X), in headlight switch wiring harness
(W15) – Wiring connection, (HB) in rear wiring harness

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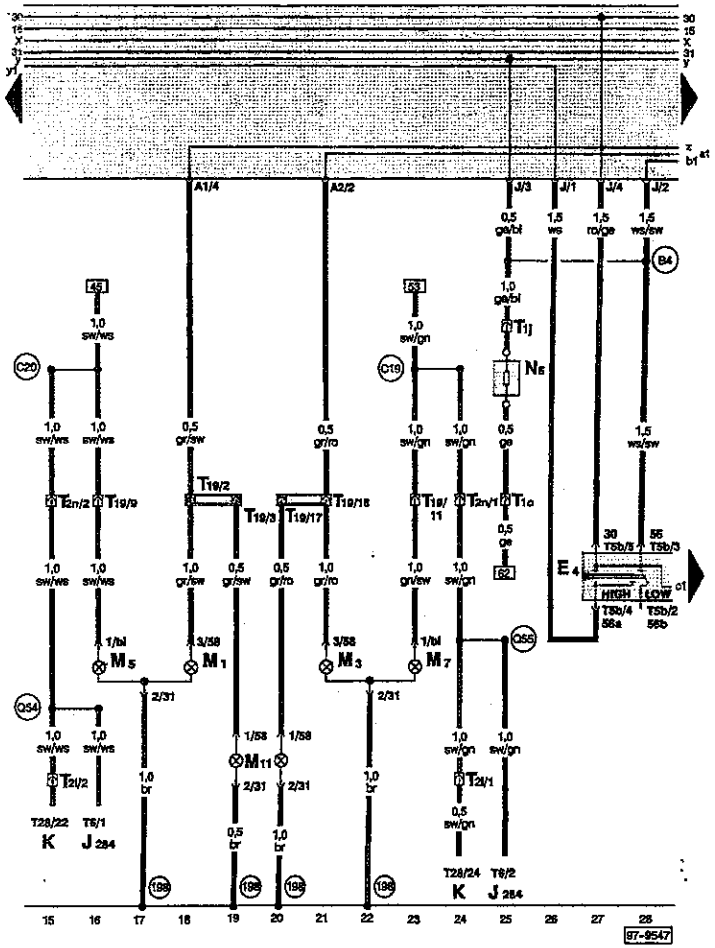
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

K – Instrument Cluster
L1 – Headlight, Left
L2 – Headlight, Right
L13 – High Beam Headlight, Left
L14 – High Beam Headlight, Right
T19 – Connector, 19 Pin, behind radiator grill, center
T28 – Connector, 28 Pin, instrument cluster
(119) – Ground connection –i–, in headlight wiring harness
(198) – Ground connection, in front light wiring harness





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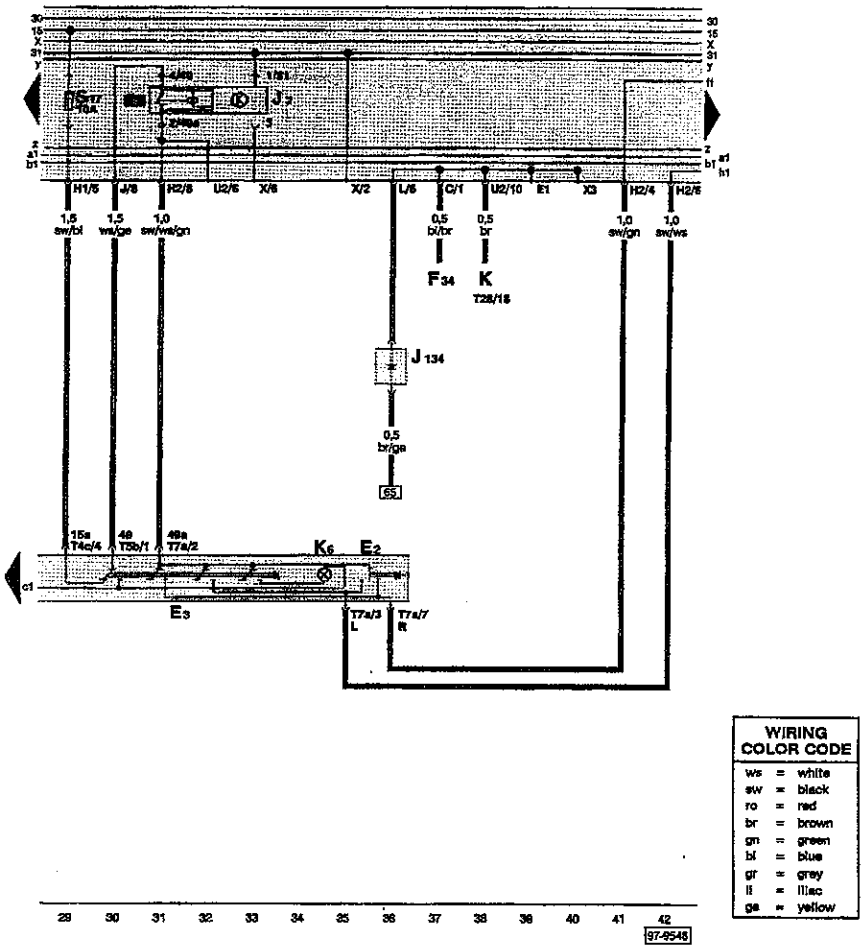
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

B4 – Headlight Dimmer/Flasher Switch
J284 – Alarm System Control Module
K – Instrument Cluster
M1 – Parking Light, Left
M3 – Parking Light, Right
M5 – Turn Signal Light, Left Front
M7 – Turn Signal Light, Right Front
M11 – Side Marker Lights, Front
N5 – Series Resistance
T1j – Connector, Single, behind fuse/relay panel
T1o – Connector, Single, behind fuse/relay panel
T2i – Connector, Double, behind fuse/relay panel
T2n – Connector, Double, behind fuse/relay panel
T5b – Connector, 5 Pin, behind steering column switch trim
T6 – Connector, 6 Pin, behind dash panel, left, on Alarm System Control Module
T19 – Connector, 19 Pin, behind radiator grill, center
T28 – Connector, 28 Pin, instrument cluster
(198) – Ground connection, in front light wiring harness
(B4) – Plus connection, 58e in light switch wiring harness
(C19) – Wire connection (right turn signal), in headlight wiring harness
(C20) – Wire connection (left turn signal), in headlight wiring harness
(Q54) – Wire connection (left turn signal), in alarm system wiring harness
(Q55) – Wire connection (right turn signal), in alarm system wiring harness

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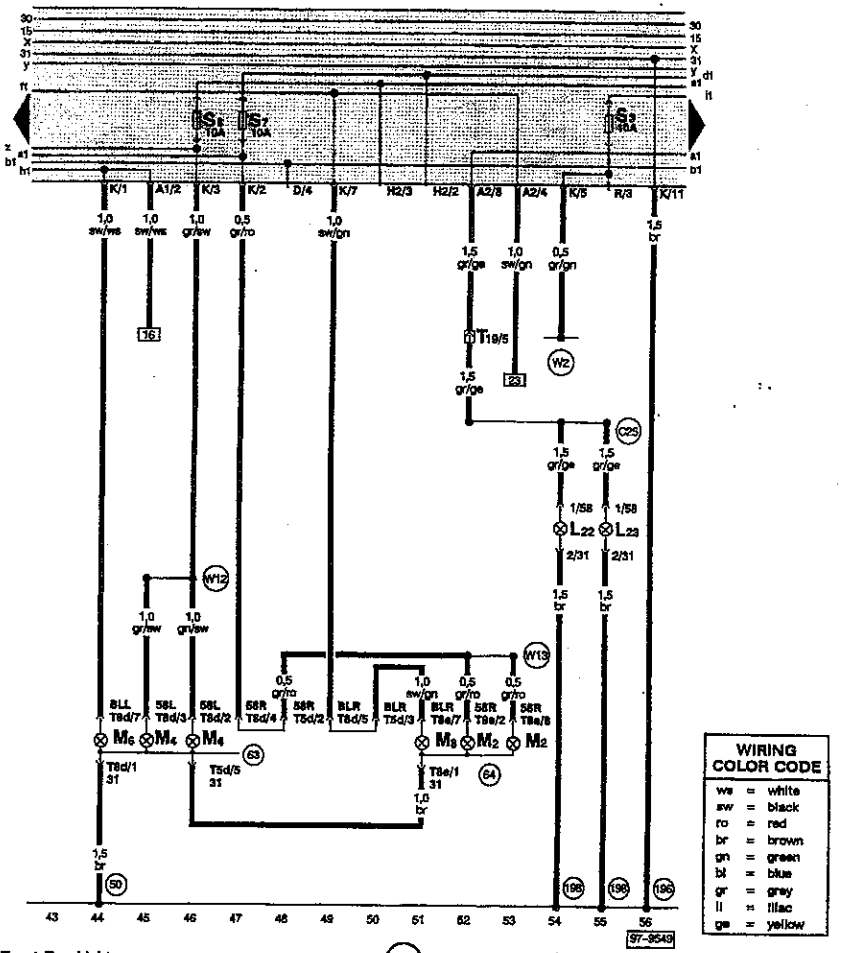
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E2 – Turn Signal Switch
E3 – Emergency Flasher Switch
F34 – Brake Fluid Level Warning Switch
J2 – Emergency Flasher Relay
J134 – Daytime Running Light Diode
K – Instrument Cluster
K6 – Emergency Flasher Warning Light
T4c – Connector, 4 Pin, behind steering column switch trim
T5b – Connector, 5 Pin, behind steering column switch trim
T7a – Connector, 7 Pin, behind steering column switch trim
T28 – Connector, 28 Pin, instrument cluster





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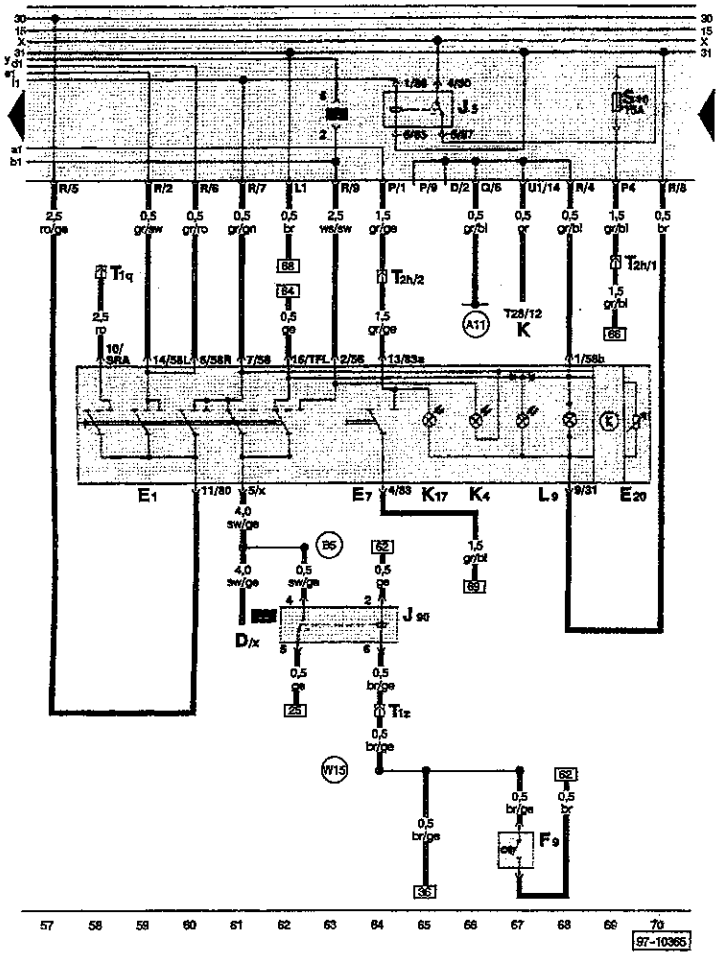
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

L22 – Left Front Fog Light
L23 – Right Front Fog Light
M2 – Tail Light, Right
M4 – Tail Light, Left
M6 – Turn Signal Light, Left Rear
M8 – Turn Signal Light, Right Rear
T5d – Connector, 5 Pin, on taillight, left
T8d – Connector, 8 Pin, on taillight, left
T8e – Connector, 8 Pin, on taillight, right
T19 – Connector, 19 Pin, behind radiator grill, center
(50) – Ground connection, in luggage compartment, left
(63) – Ground connection, on left taillight bulb holder
(64) – Ground connection, on right taillight bulb holder
(196) – Ground connection -1-, in rear wiring harness
(198) – Ground connection, in front light wiring harness
(C25) – Wire connection (fog lights), in front left wiring harness
(W2) – Plus connection (58), in rear wiring harness
(W12) – Wire connection (58L), in rear wiring harness
(W13) – Wire connection (58R), in rear wiring harness




WIRING COLOR CODE

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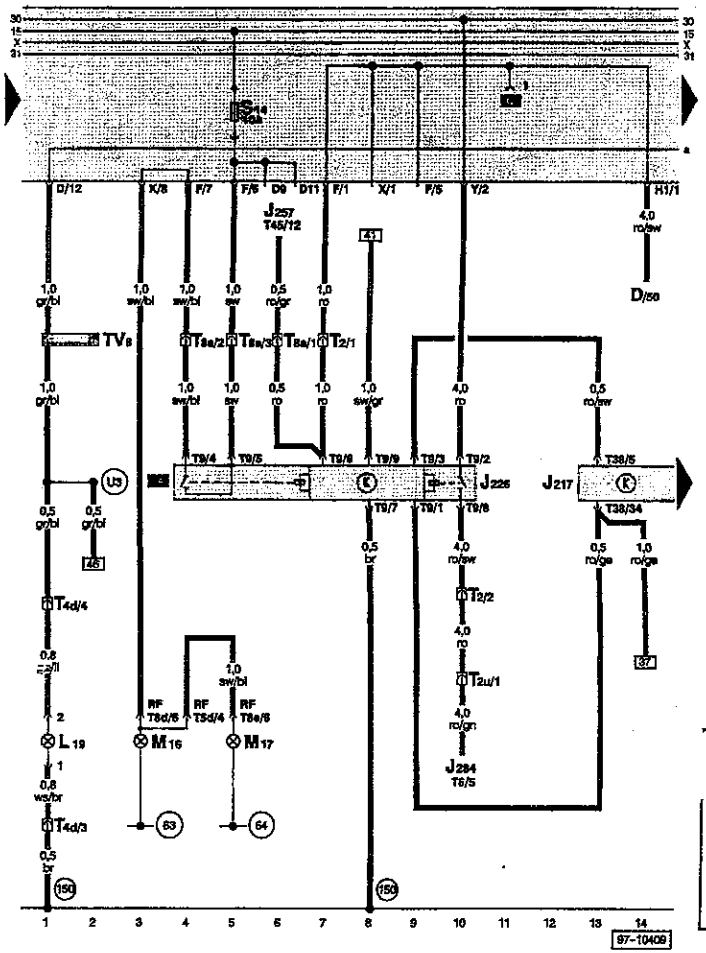
| br | = | brown |
| gn | = | green |
| bl | = | blue |
| gr | = | grey |
| li | = | lilac |
| ge | = | yellow |

D – Ignition/Starter Switch
E1 – Light Switch
E7 – Fog Light Switch
E20 – Instrument Panel Light Dimmer Switch
F9 – Parking Brake Warning Light Switch
J5 – Fog Light Relay
J90 – Daytime Running Lights Relay (Switch on)
K – Instrument Cluster
K4 – Park Light Indicator Light
K17 – Fog Light Indicator Light
L9 – Headlight Switch Light
T1q – Connector, Single, behind fuse/relay panel

T1z – Connector, Single, behind fuse/relay panel
T2h – Connector, Double, behind fuse/relay panel
T28 – Connector, 28 Pin, instrument cluster
(A11) – Plus connection (58b), in instrument panel wiring harness
(B5) – Wire connection, (X), in headlight switch wiring harness
(W15) – Wiring connection, (HB) in rear wiring harness




WIRING COLOR CODE

| | | |
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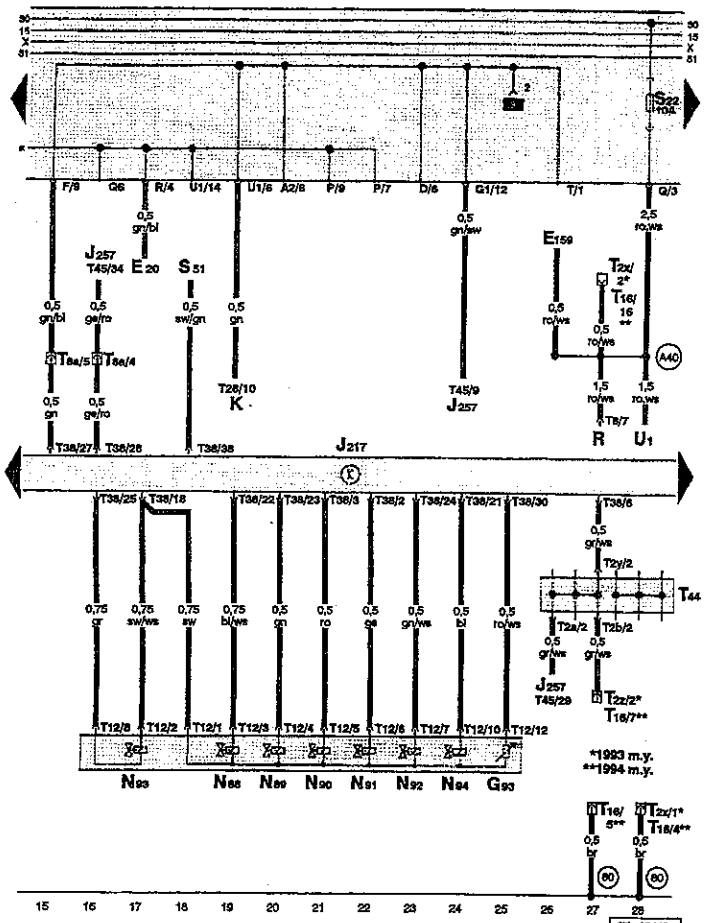
| sw | = | black |
| ro | = | red |
| br | = | brown |
| gn | = | green |
| bl | = | blue |
| gr | = | grey |
| li | = | lilac |
| ge | = | yellow |

D – Ignition/Starter Switch
J217 – Transmission Control Module (TCM)
J226 – Park/Neutral Position (PNP) Relay
J257 – Mono-Motronic Engine Control Module
J284 – Alarm System Control Module
L19 – Automatic Transmission Console Light
M16 – Back-Up Light, Left
M17 – Back-Up Light, Right
T2 – Connector, Double, behind fuse/relay panel, only on automatic transmission
T2u – Connector, Double, behind fuse/relay panel
T4d – Connector, 4 Pin, below center console
T5d – Connector, 5 Pin, on taillight, left
T6 – Connector, 6 Pin, behind dash panel, left, on Alarm System Control Module
T8a – Connector, 8 Pin, behind fuse/relay panel
T8d – Connector, 8 Pin, on taillight, left
T8e – Connector, 8 Pin, on taillight, right
T9 – Connector, 9 Pin, on Park/Neutral Position (PNP) Relay
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T45 – Connector, 45 Pin, on Mono-Motronic Engine Control Module (ECM)
TV8 – Connector, terminal 58b
(63) – Ground connection, on left taillight bulb holder
(64) – Ground connection, on right taillight bulb holder
(150) – Ground connection, in automatic transmission wiring harness
(U3) – Wire connection, in automatic transmission wire harness




| WIRING COLOR CODE | |
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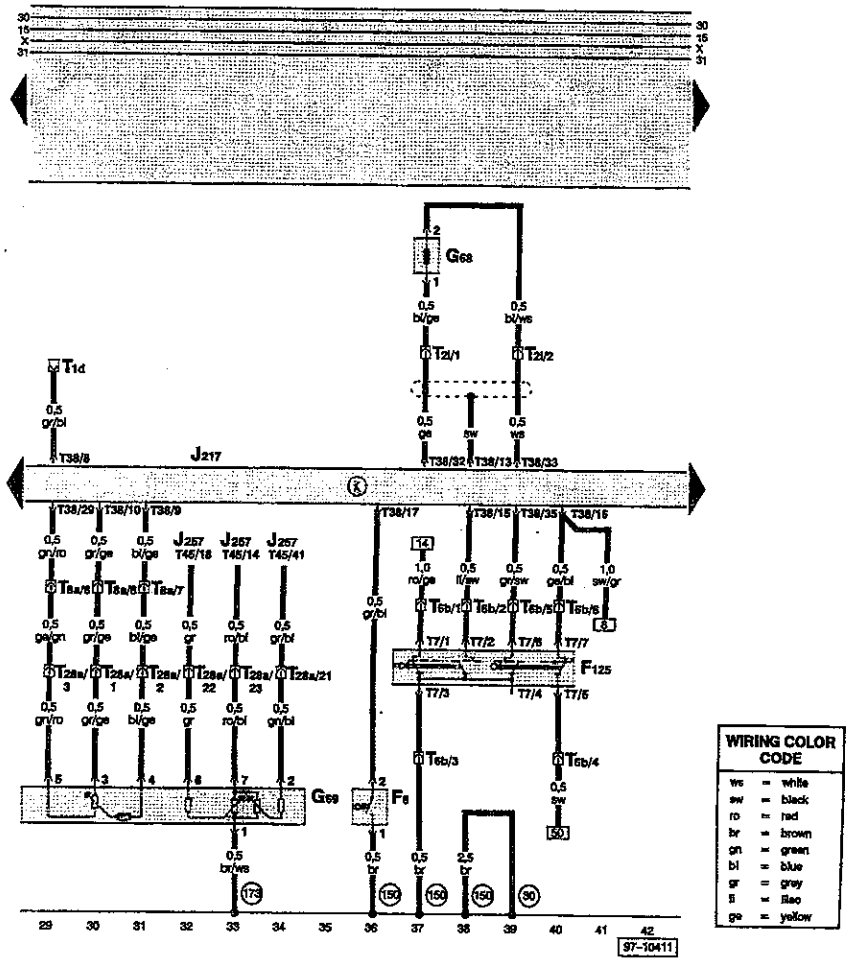
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E20 – Instrument Panel Light Dimmer Switch
E159 – Luggage Compartment Release Switch
G93 – Transmission Fluid Temperature Sensor
J217 – Transmission Control Module (TCM)
J257 – Mono–Motronic Engine Control Module
K – Instrument Cluster
N88 – Solenoid Valve 1
N89 – Solenoid Valve 2
N90 – Solenoid Valve 3
N91 – Solenoid Valve 4
N92 – Solenoid Valve 5
N93 – Solenoid Valve 6
N94 – Solenoid Valve 7
R – Radio
S51 – Fuse
U1 – Cigarette Lighter
T2a – Connector, Double, on junction connector (T44) above fuse/relay panel
T2b – Connector, Double, on junction connector (T44) above fuse/relay panel
T2x – Data Link Connector (DLC), behind center of dash panel
T2y – Connector, Double, on junction connector (T44) above fuse/relay panel
T2z – Data Link Connector (DLC), behind center of dash panel
T8 – Connector, 8 Pin, on radio
T8a – Connector, 8 Pin, behind fuse/relay panel
T12 – Connector, 12 Pin, on transmission
T16 – Data Link Connector (DLC), behind center of dash panel
T28 – Connector, 28 Pin, instrument cluster
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T44 – Junction Box for On Board Diagnostic, above fuse/relay panel
T45 – Connector, 45 Pin, on Mono–Motronic Engine Control Module (ECM)
(80) – Ground connection –1–, in instrument panel wiring harness
(A40) – Plus connection (30), in instrument panel wiring harness








| WIRING COLOR CODE | |
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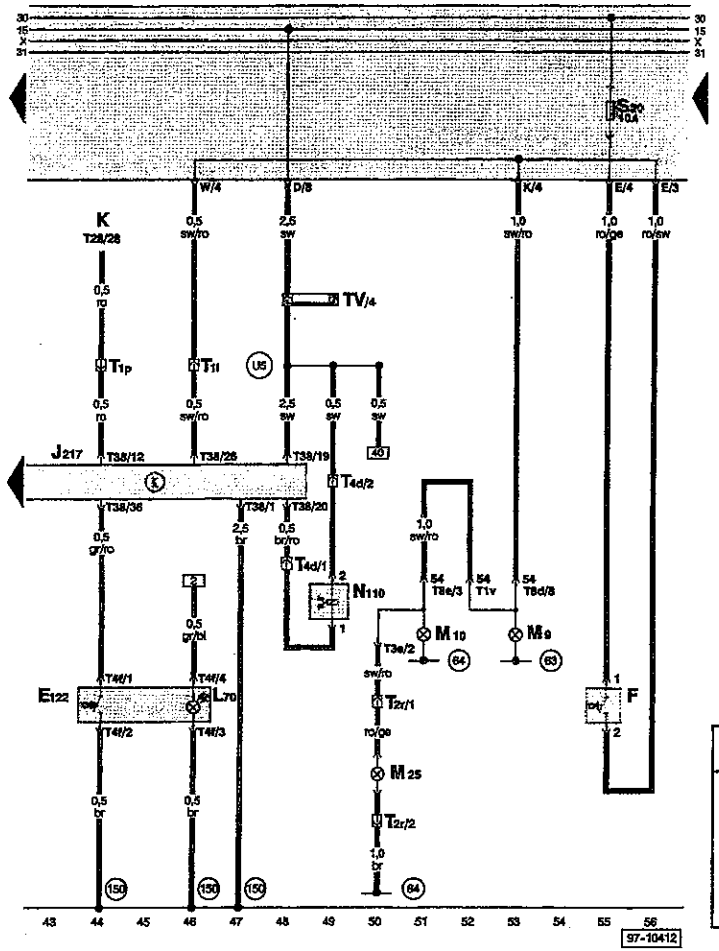
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

F8 – Kick Down Switch
F125 – Multi–Function Transmission Range (TR) Switch
G68 – Vehicle Speed Sensor (VSS)
G69 – Throttle Position (TP) Sensor
J217 – Transmission Control Module (TCM)
J257 – Mono–Motronic Engine Control Module
T1d – Connector, Single, behind fuse/relay panel
T2l – Connector, Double, below battery
T6b – Connector, 6 Pin, below battery
T7 – Connector, 7 Pin, on transmission
T8a – Connector, 8 Pin, behind fuse/relay panel
T28a – Connector, 28 Pin, left side of engine, near distributor
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T45 – Connector, 45 Pin, on Mono–Motronic Engine Control Module (ECM)
(30) – Ground connection – beside fuse/relay panel
(150) – Ground connection, in automatic transmission wiring harness
(179) – Ground connection –1–, in Mono–Motronic Throttle Body Fuel Injection (TBI) wiring harness

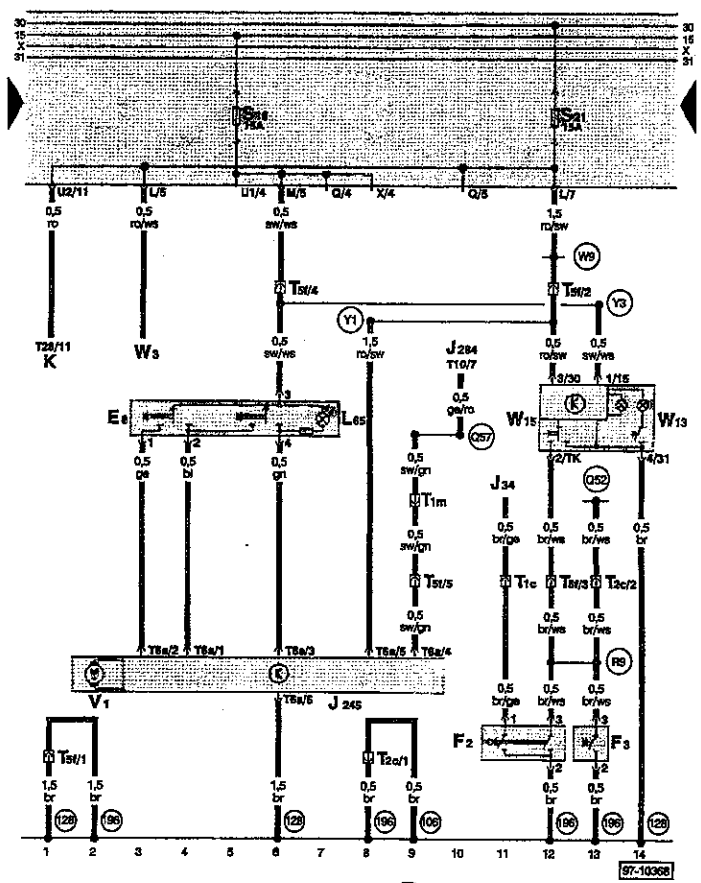



| WIRING COLOR CODE | |
|---|---|
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E122 – Transmission Range (TR) Program Switch
F – Brake Light Switch
J217 – Transmission Control Module (TCM)
K – Instrument Cluster
L70 – Program Switch Illumination
M9 – Brake Light, Left
M10 – Brake Light, Right
M25 – High-Mount Brake Light
N110 – Shift Lock Solenoid
T1i – Connector, Single, behind fuse/relay panel
T1p – Connector, Single, behind fuse/relay panel
T1v – Connector, Single, on taillight, left
T2r – Connector, Double, behind right grommet, on luggage compartment lid
T3e – Connector, 3 Pin, on taillight, right
T4d – Connector, 4 Pin, below center console
T4f – Connector, 4 Pin, on Transmission Range (TR) Program Switch
T8d – Connector, 8 Pin, on taillight, left
T8e – Connector, 8 Pin, on taillight right
T28 – Connector, 28 Pin, instrument cluster
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
TV4 – Connector, terminal 15
(63) – Ground connection, on left taillight bulb holder
(64) – Ground connection, on right taillight bulb holder
(150) – Ground connection, in automatic transmission wiring harness
(U5) – Wire connection –2– (15), in automatic transmission wiring harness








| WIRING COLOR CODE | |
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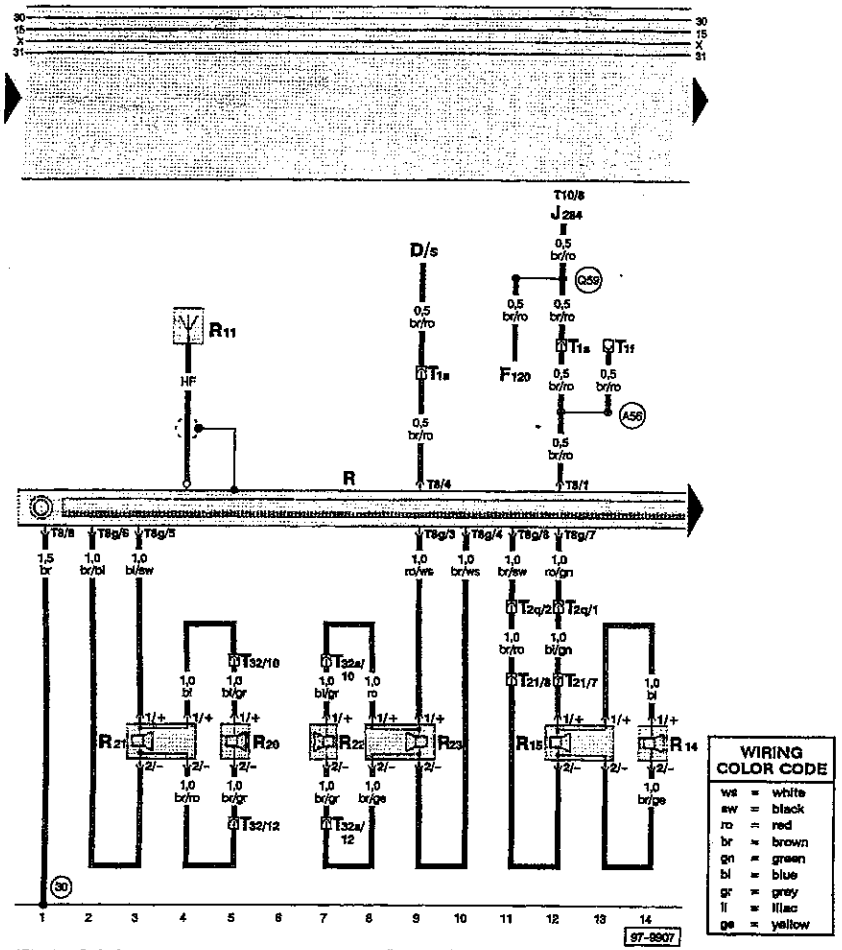
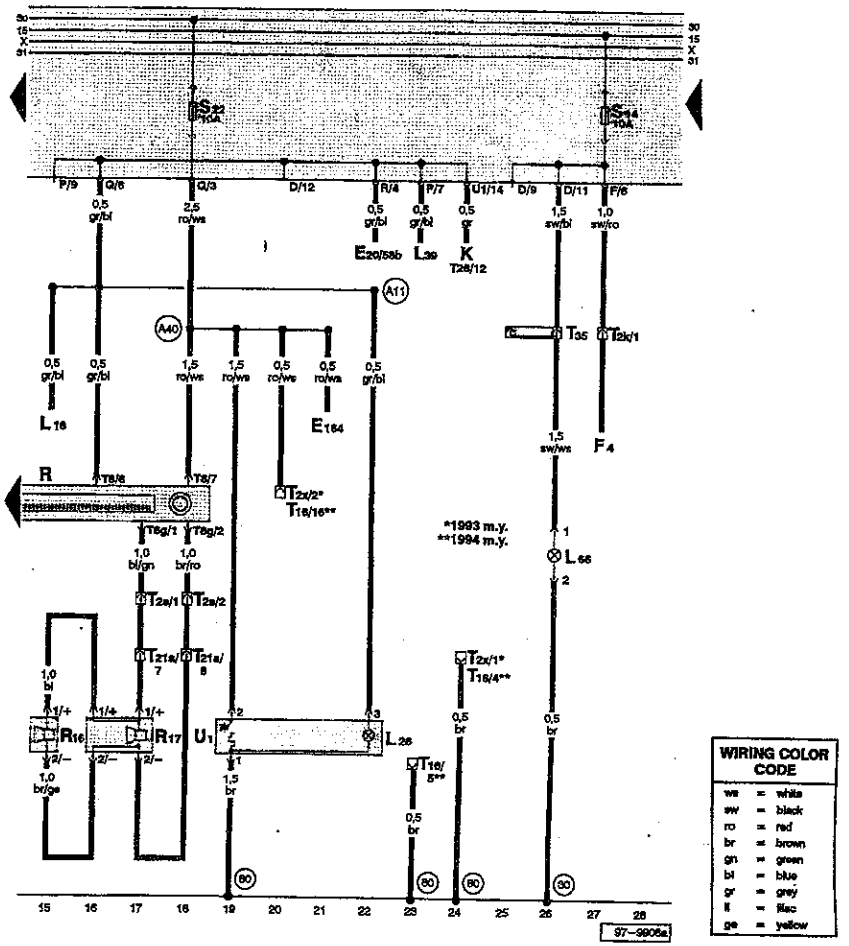
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

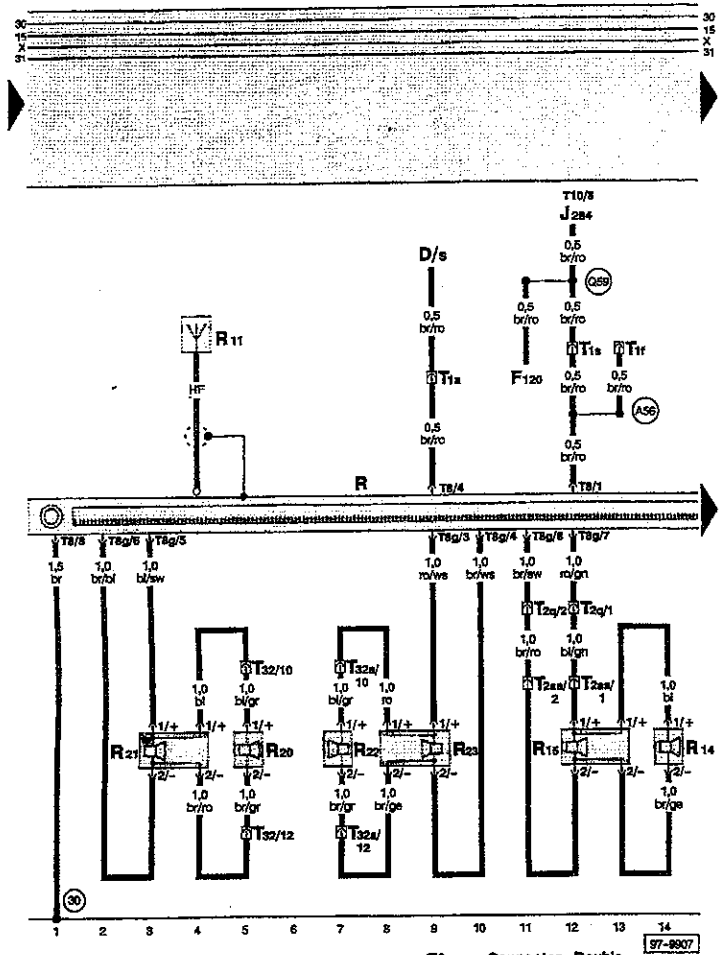
E6 – Sunroof Switch
F2 – Door Contact Switch, Left Front
F3 – Door Contact Switch, Right Front
J34 – Seat Belt Warning System Relay
J245 – Power Sunroof Control Module
J284 – Alarm System Control Module
K – Instrument Cluster
L65 – Sunroof Switch Light
V1 – Sunroof Motor
W3 – Luggage Compartment Light
W13 – Map/Reading Light, Right Front
W15 – Interior Light With Delay Switch
T1c – Connector, Single, behind fuse/relay panel
T1m – Connector, Single, behind fuse/relay panel
T2c – Connector, Double, on lower right "A" pillar
T5f – Connector, 5 Pin, above fuse/relay panel
T8a – Connector, 8 Pin, behind interior light, on Power Sunroof Control Module
T10 – Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T28 – Connector, 28 Pin, instrument cluster
(106) – Ground connection, in alarm system wiring harness
(128) – Ground connection –1–, in interior light wiring harness
(196) – Ground connection –1–, in rear wiring harness
(Q52) – Wire connection (door contact switch), in alarm system wiring harness
(Q57) – Wire connection (closed), in alarm system wiring harness
(R9) – Wire connection (30), in rear wiring harness
(W9) – Plus connection (30), in rear wiring harness
(Y1) – Plus connection (30), in interior light wiring harness
(Y3) – Plus connection (15) in interior light/sunroof wiring harness




D – Ignition/Starter Switch
F120 – Alarm Switch, Hood
J284 – Alarm System Control Module
R – Radio
R11 – Antenna
R14 – Tweeter, Left Rear
R15 – Woofer, Left Rear
R20 – Tweeter, Left Front
R21 – Woofer, Left Front
R22 – Tweeter, Right Front
R23 – Woofer, Right Front
T1a – Connector, Single, behind fuse/relay panel
T1f – Connector, Single, behind dash panel, center, behind radio
T1s – Connector, Single, behind fuse/relay panel
T2q – Connector, Double, on lower left "A" pillar
T8 – Connector, 8 Pin, on radio
T8g – Connector, 8 Pin, on radio
T10 – Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T21 – Connector, 21 pin, on left B-pillar
T32 – Connector, 32 Pin, on A-pillar, lower left
T32a – Connector, 32 Pin, on A-pillar, lower right
(30) – Ground connection – beside fuse/relay panel
(A56) – Wire connection (31SDS) in instrument panel wiring harness
(Q59) – Wire connection (MHKS) in alarm system wiring harness




E20 – Instrument Panel Light Dimmer Switch
E164 – Luggage Compartment Release Switch
F4 – Back-Up Light Switch
K – Instrument Cluster
L16 – Fresh Air Control Lever Light
L28 – Cigarette Lighter Light
L39 – Rear Window Defogger Switch Light
L66 – Cassette Storage Light
R – Radio
R16 – Tweeter, Right Rear
R17 – Woofer, Right Rear
U1 – Cigarette Lighter
T2k – Connector, Double, behind fuse/relay panel
T2s – Connector, Double, on lower right "A" pillar
T2x – Data Link Connector (DLC), behind center of dash panel
T8 – Connector, 8 Pin, on radio
T8g – Connector, 8 Pin, on radio
T16 – Data Link Connector (DLC), behind center of dash panel
T21a – Connector, 21 pin, on right B-pillar
T28 – Connector, 28 Pin, instrument cluster
T35 – Connector, terminal 15
(30) – Ground connection – beside fuse/relay panel
(80) – Ground connection –1–, in instrument panel wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(A40) – Plus connection (30), in instrument panel wiring harness

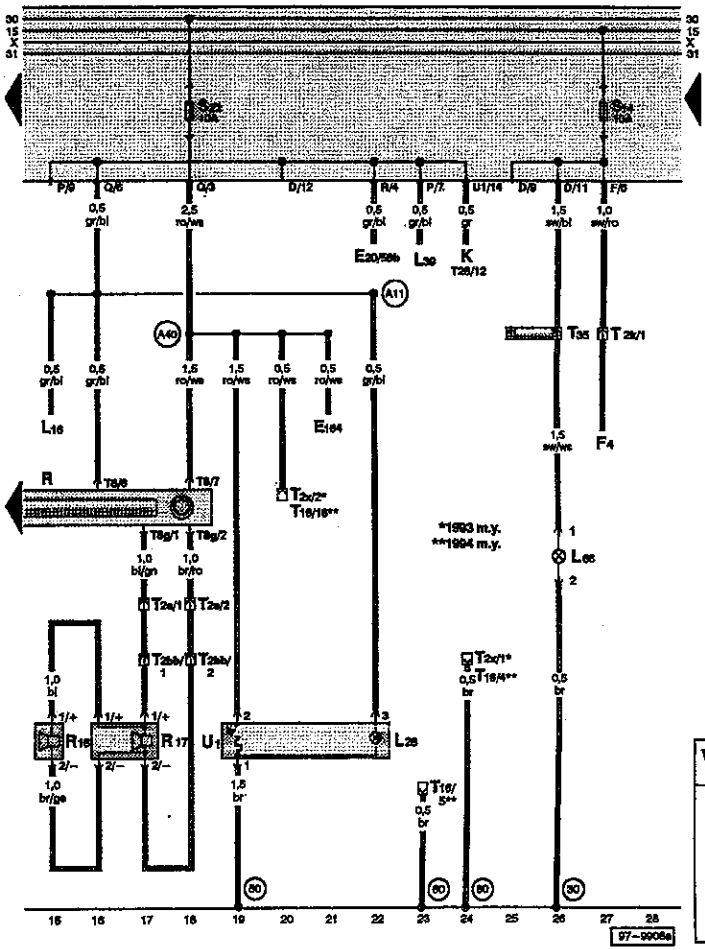



| WIRING COLOR CODE | |
|---|---|
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

D – Ignition/Starter Switch
F120 – Alarm Switch, Hood
J284 – Alarm System Control Module
R – Radio
R11 – Antenna
R14 – Tweeter, Left Rear
R15 – Woofer, Left Rear
R20 – Tweeter, Left Front
R21 – Woofer, Left Front
R22 – Tweeter, Right Front
R23 – Woofer, Right Front
T1a – Connector, Single, behind fuse/relay panel
T1f – Connector, Single, behind dash panel, center, behind radio
T1s – Connector, Single, behind fuse/relay panel
T2aa – Connector, Double
T2q – Connector, Double, on lower left "A" pillar
T8 – Connector, 8 Pin, on radio
T8g – Connector, 8 Pin, on radio
T10 – Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T32 – Connector, 32 Pin, on A-pillar, lower left
T32a – Connector, 32 Pin, on A-pillar, lower right
(30) – Ground connection – beside fuse/relay panel
(A56) – Wire connection (31SDS) in instrument panel wiring harness
(Q59) – Wire connection (MHKS) in alarm system wiring harness

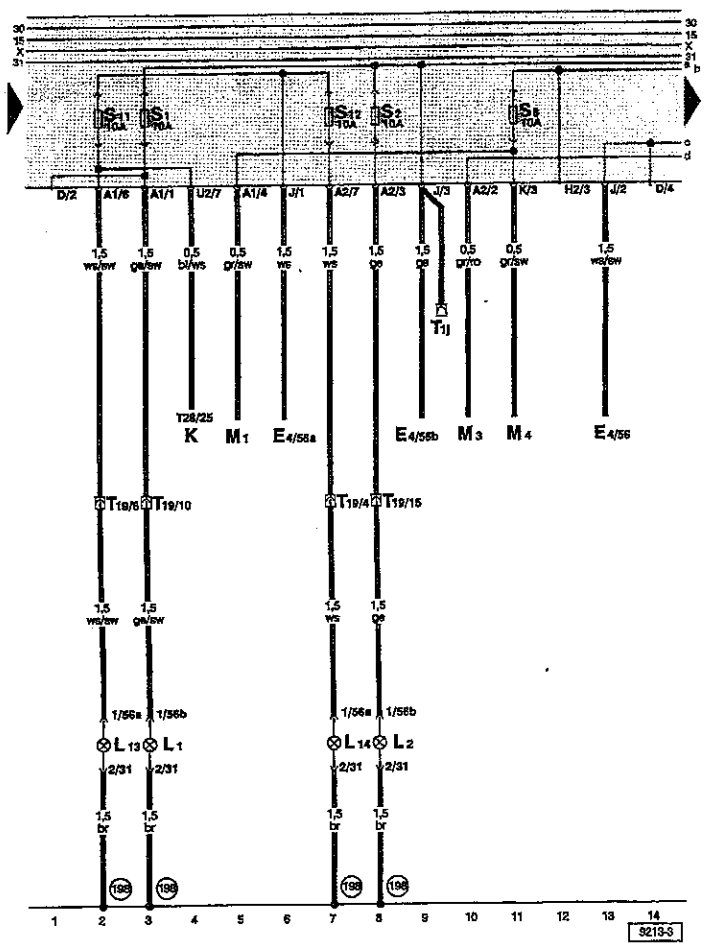







| WIRING COLOR CODE | |
|---|---|
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E20 – Instrument Panel Light Dimmer Switch
E164 – Luggage Compartment Release Switch
F4 – Back–Up Light Switch
K – Instrument Cluster
L16 – Fresh Air Control Lever Light
L28 – Cigarette Lighter Light
L39 – Rear Window Defogger Switch Light
L66 – Cassette Storage Light
R – Radio
R16 – Tweeter, Right Rear
R17 – Woofer, Right Rear
U1 – Cigarette Lighter
T2bb – Connector, Double
T2k – Connector, Double, behind fuse/relay panel
T2s – Connector, Double, on lower right "A" pillar
T2x – Data Link Connector (DLC), behind center of dash panel
T8 – Connector, 8 Pin, on radio
T8g – Connector, 8 Pin, on radio
T16 – Data Link Connector (DLC), behind center of dash panel
T28 – Connector, 28 Pin, instrument cluster
T35 – Connector, terminal 15
(30) – Ground connection – beside fuse/relay panel
(80) – Ground connection –1–, in instrument panel wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(A40) – Plus connection (30), in instrument panel wiring harness




| WIRING COLOR CODE | |
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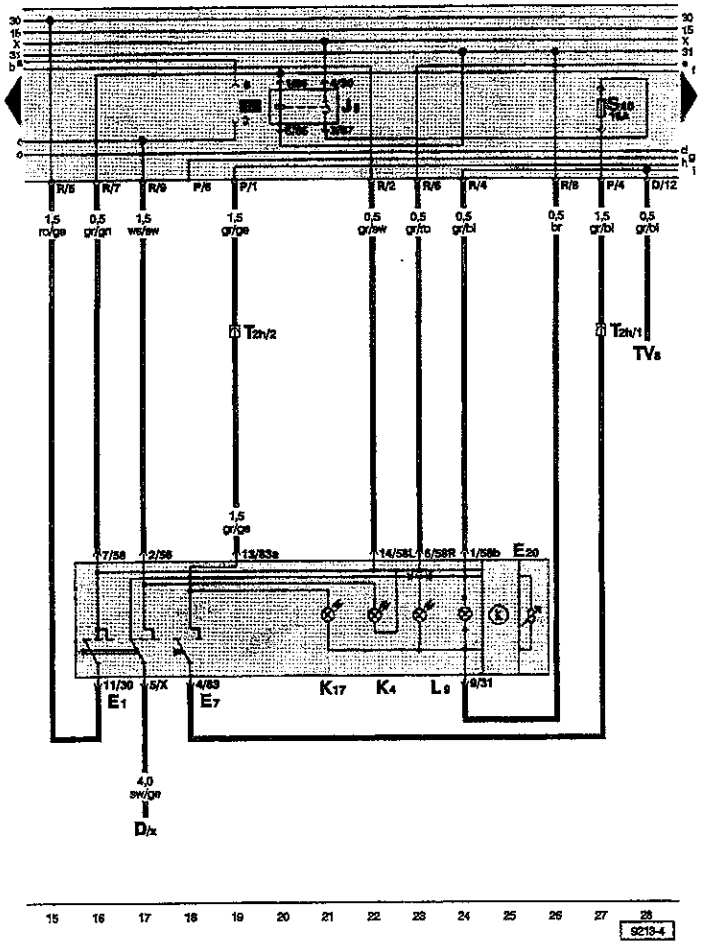
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E4 – Headlight Dimmer/Flasher Switch
K – Instrument Cluster
L1 – Headlight, Left
L2 – Headlight, Right
L13 – High Beam Headlight, Left
L14 – High Beam Headlight, Right
M1 – Parking Light, Left
M3 – Parking Light, Right
M4 – Tail Light, Left
T1j – Connector, Single, behind fuse/relay panel
T19 – Connector, 19 Pin, behind radiator grill, center
T28 – Connector, 28 Pin, instrument cluster
(198) – Ground connection, in front light wiring harness








| WIRING COLOR CODE | |
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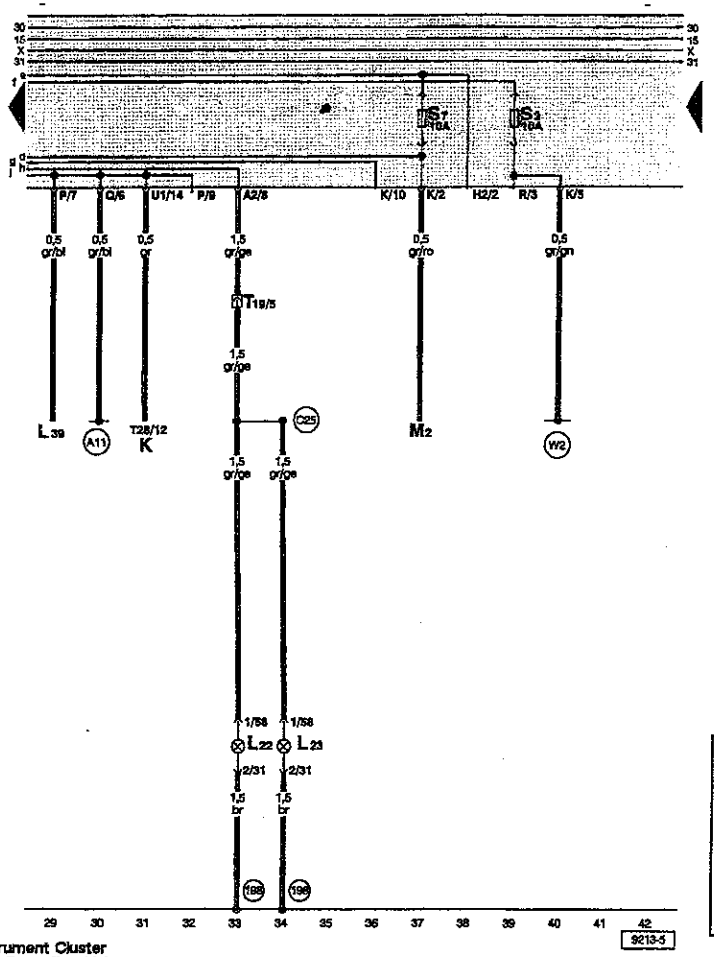
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

D – Ignition/Starter Switch
E1 – Light Switch
E7 – Fog Light Switch
E20 – Instrument Panel Light Dimmer Switch
J5 – Fog Light Relay
K4 – Park Light Indicator Light
K17 – Fog Light Indicator Light
L9 – Headlight Switch Light
T2h – Connector, Double, behind fuse/relay panel
TV8 – Connector, terminal 58b




| WIRING COLOR CODE | |
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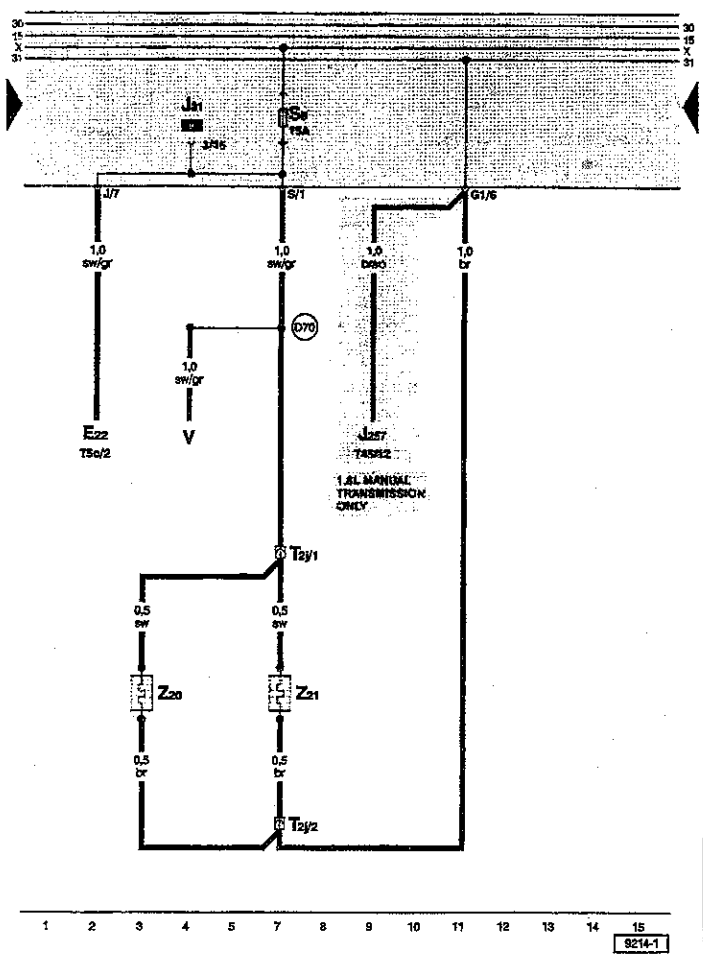
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

K – Instrument Cluster
L22 – Left Front Fog Light
L23 – Right Front Fog Light
L39 – Rear Window Defogger Switch Light
M2 – Tail Light, Right
T19 – Connector, 19 Pin, behind radiator grill, center
T28 – Connector, 28 Pin, instrument cluster
(198) – Ground connection, in front light wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(C25) – Wire connection (fog lights), in front left wiring harness
(W2) – Plus connection (58), in rear wiring harness




| WIRING COLOR CODE | |
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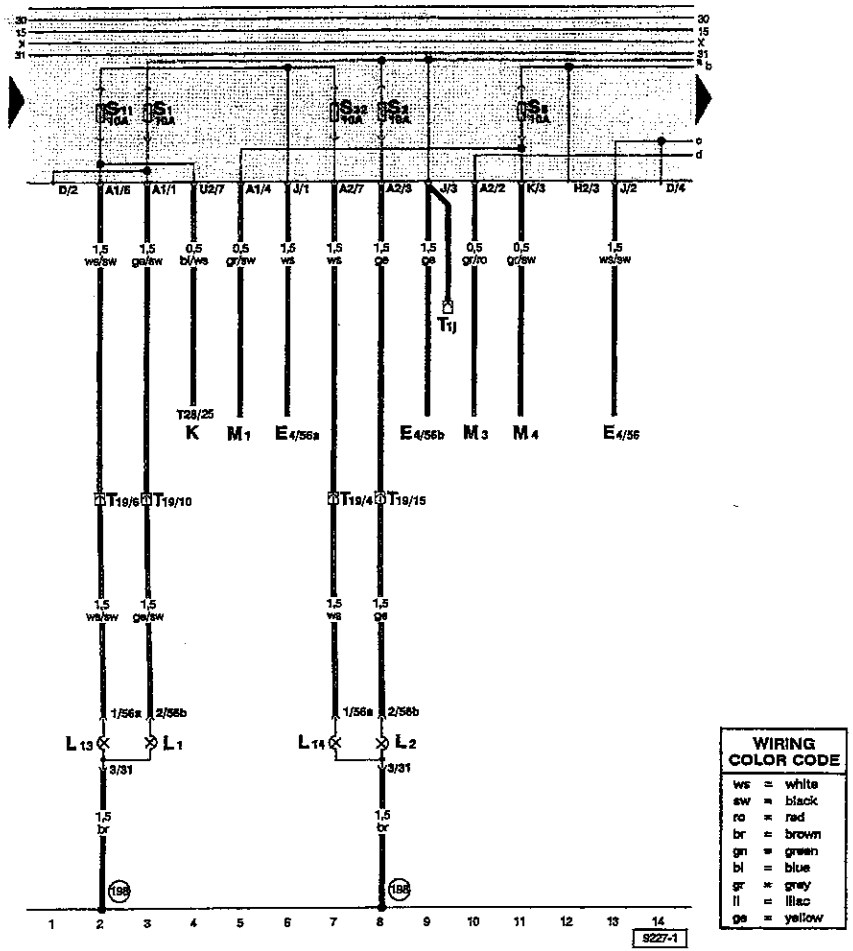
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E22 – Windshield Wiper Intermittent Switch
J31 – Washer/Wiper Intermittent Relay
J257 – Mono-Motronic Engine Control Module
V – Windshield Wiper Motor
Z20 – Washer Nozzle Heater, Left
Z21 – Washer Nozzle Heater, Right
T2j – Connector, Double, behind fuse/relay panel
T5c – Connector, 5 Pin, behind steering column switch trim
T45 – Connector, 45 Pin, on Mono-Motronic Engine Control Module (ECM)
(D70) – Wire connection (53a), in engine compartment wiring harness




| WIRING COLOR CODE | |
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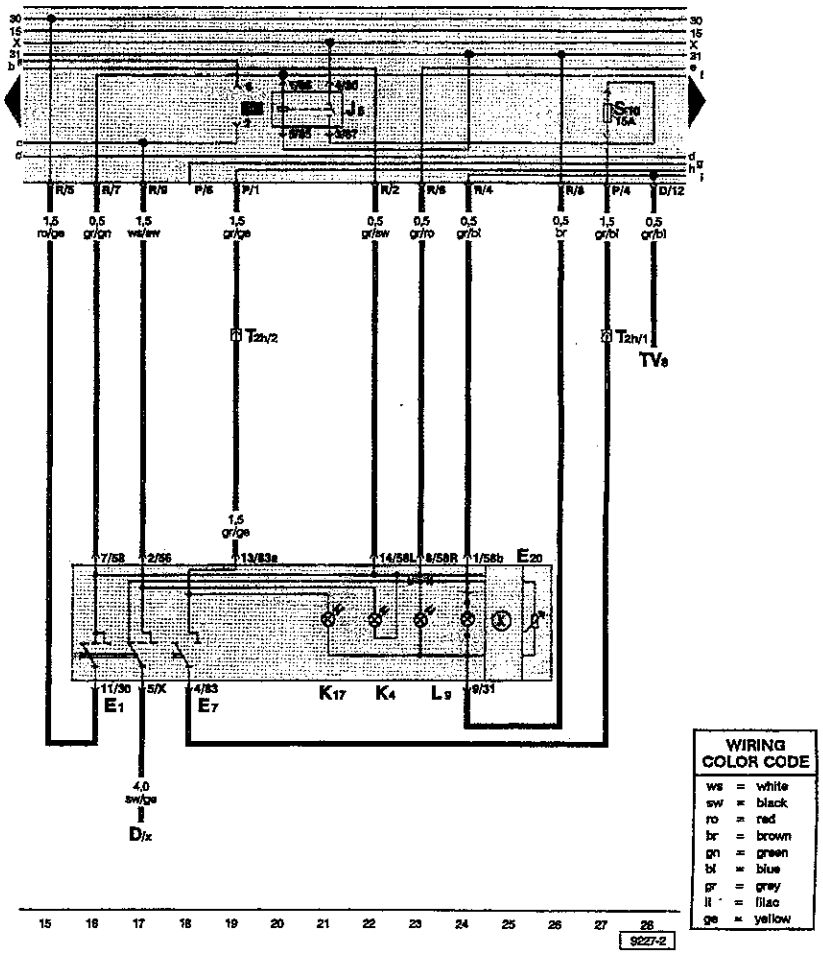
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E4 - Headlight Dimmer/Flasher Switch
K - Instrument Cluster
L1 - Headlight, Left
L2 - Headlight, Right
L13 - High Beam Headlight, Left
L14 - High Beam Headlight, Right
M1 - Parking Light, Left
M3 - Parking Light, Right
M4 - Tail Light, Left
T1j - Connector, Single, behind fuse/relay panel
T19 - Connector, 19 Pin, behind radiator grill, center
T28 - Connector, 28 Pin, on instrument cluster
(198) - Ground connection, in front light wiring harness








| WIRING COLOR CODE | |
|---|---|
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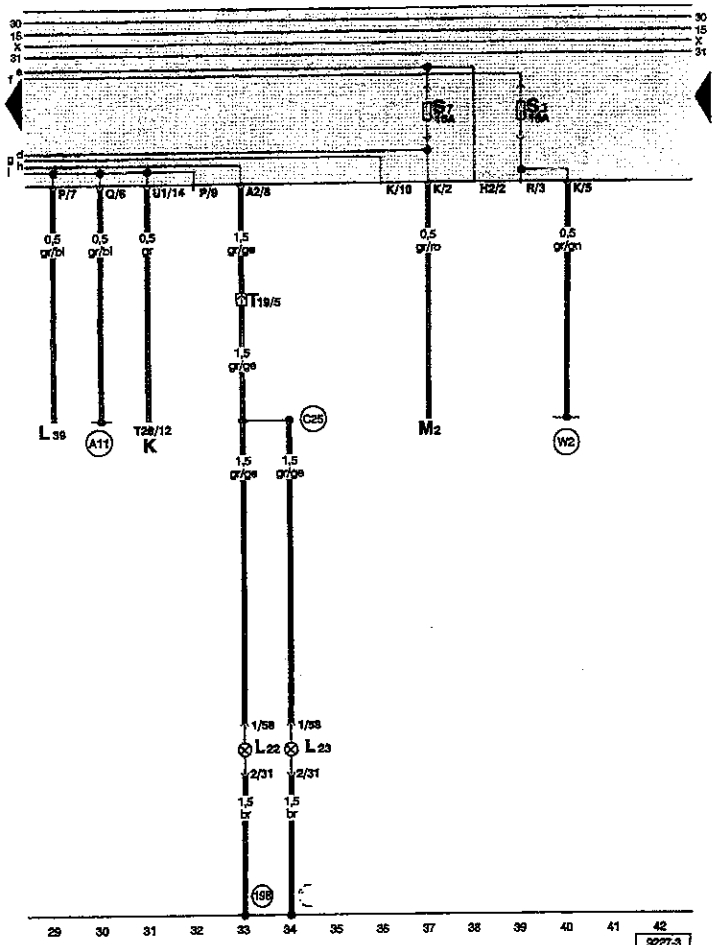
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

D - Ignition/Starter Switch
E1 - Light Switch
E7 - Fog Light Switch
E20 - Instrument Panel Light Dimmer Switch
J5 - Fog Light Relay
K4 - Park Light Indicator Light
K17 - Fog Light Indicator Light
L9 - Headlight Switch Light
T2h - Connector, Double, behind fuse/relay panel
TV8 - Connector, terminal 58b



| WIRING COLOR CODE | |
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| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

K - Instrument Cluster
L22 - Left Front Fog Light
L23 - Right Front Fog Light
L39 - Rear Window Defogger Switch Light
M2 - Tail Light, Right
T19 - Connector, 19 Pin, behind radiator grill, center
T28 - Connector, 28 Pin, on instrument cluster

(198) - Ground connection, in front light wiring harness

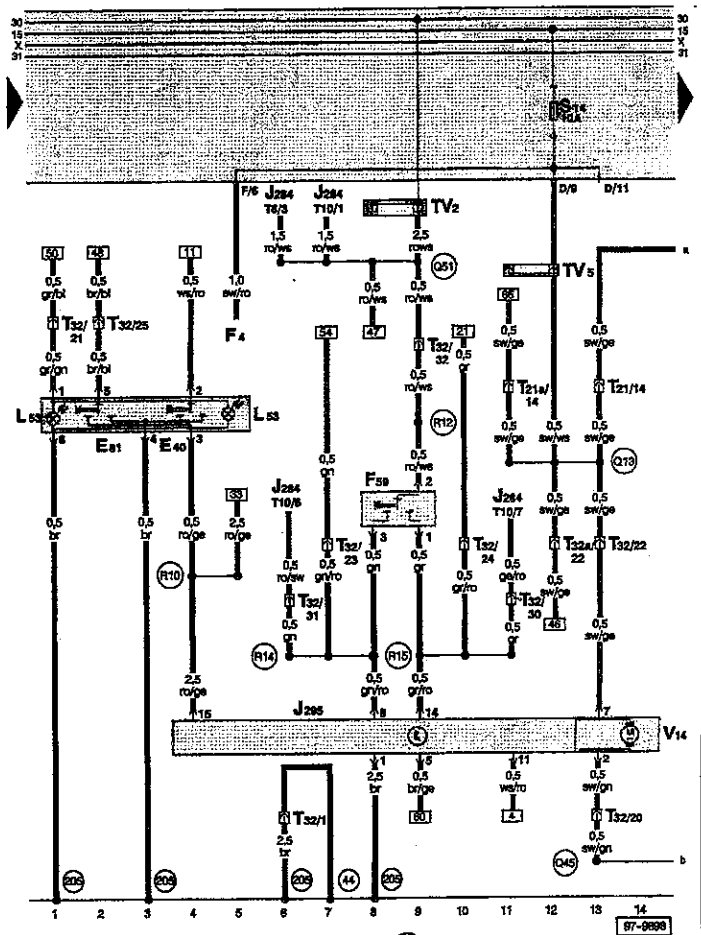
(A11) - Plus connection (58b), in instrument panel wiring harness

(C25) - Wire connection (fog lights), in front left wiring harness

(W2) - Plus connection (58), in rear wiring harness







| WIRING COLOR CODE | |
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| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E40 - Window Switch, Left Front
E81 - Right Front Window Switch (in Driver's Door)
F4 - Back-Up Light Switch
F59 - Central Locking System Door Switch, Driver's Door
J284 - Alarm System Control Module
J295 - Power Window Control Module, Left Front
L53 - Power Window Switch Light
V14 - Window Motor, Left
T6 - Connector, 6 Pin, behind dash panel, left, on Alarm System Control Module
T10 - Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T21 - Connector, 21 pin, on left B-pillar
T21a - Connector, 21 pin, on right B-pillar
T32 - Connector, 32 Pin, on A-pillar, lower left
T32a - Connector, 32 Pin, on A-pillar, lower right
TV2 - Wire connector, terminal 30 (B+)
TV5 - Connector, terminal 15a

(44) - Ground connection, on left "A" pillar, lower part

(205) - Ground connection, in driver's door wiring harness

(Q13) - Plus connection (75as/15), in power window/central locking system and door contact switch wiring harness

(Q45) - Wire connection (comfort), in power window wiring harness

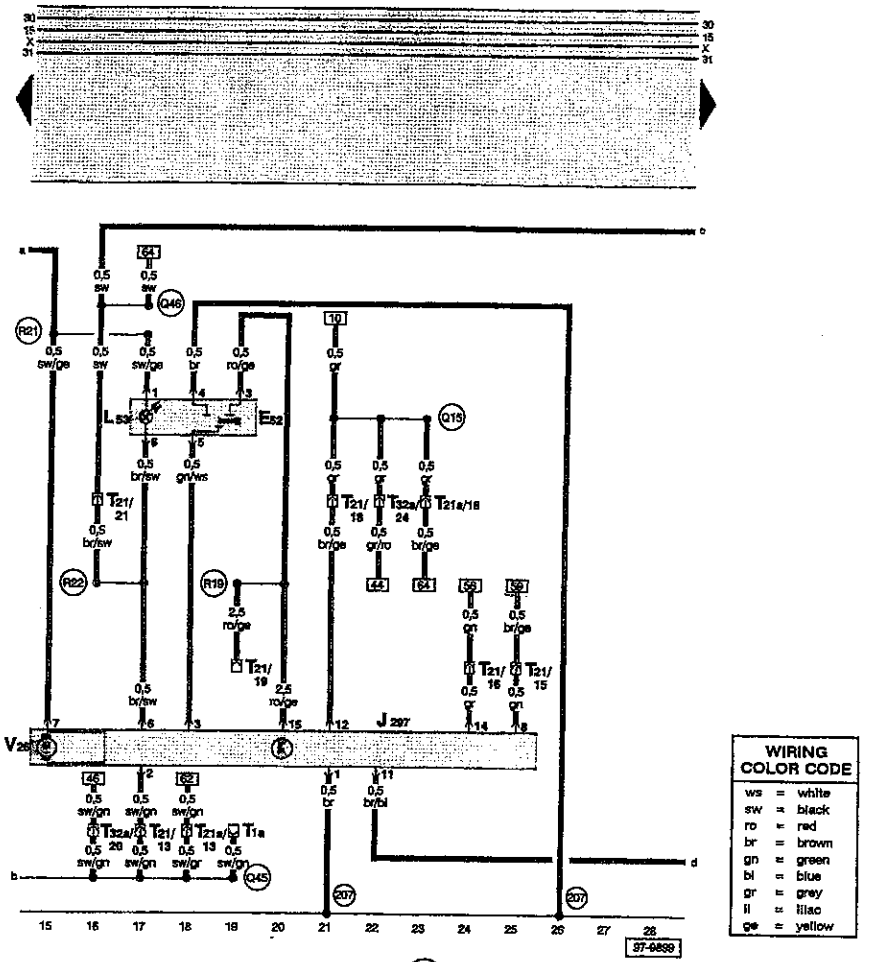
(Q51) - Plus connection (30), in alarm system wiring harness

(R10) - Plus connection, -1- (30), in driver's door wiring harness

(R12) - Plus connection -3- (30), in driver's door wiring harness

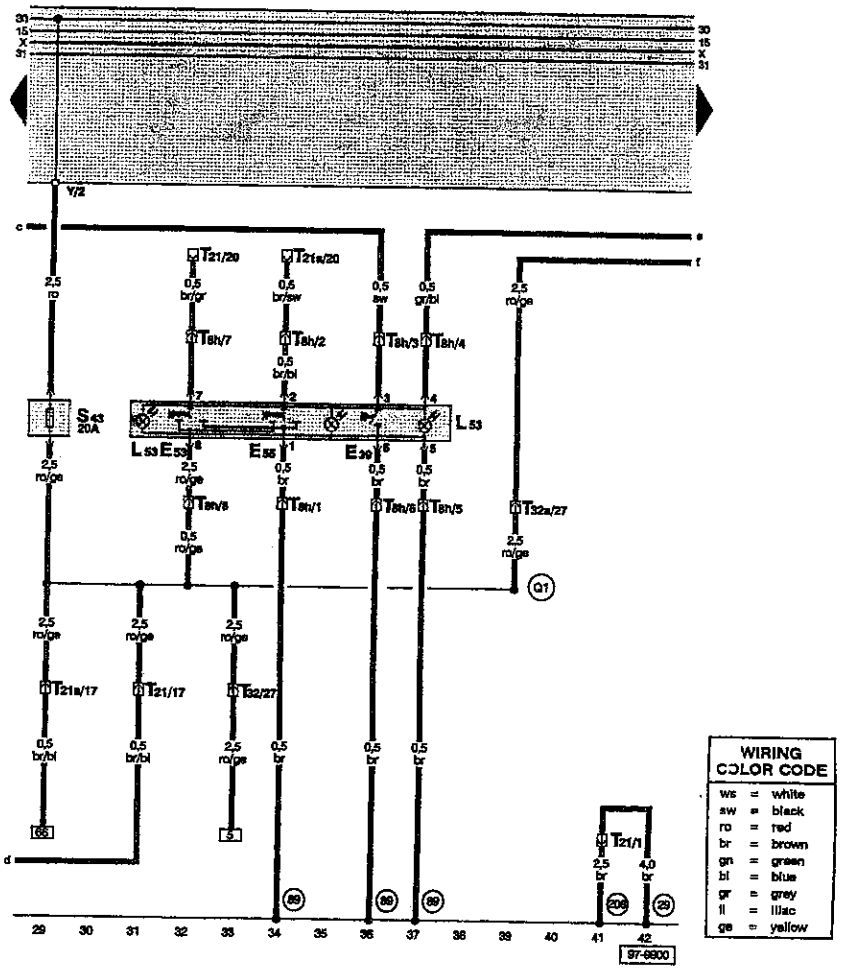
(R14) - Wire connection, -1- (open), in driver's door wiring harness

(R15) - Wire connection, -2- (closed), in driver's door wiring harness



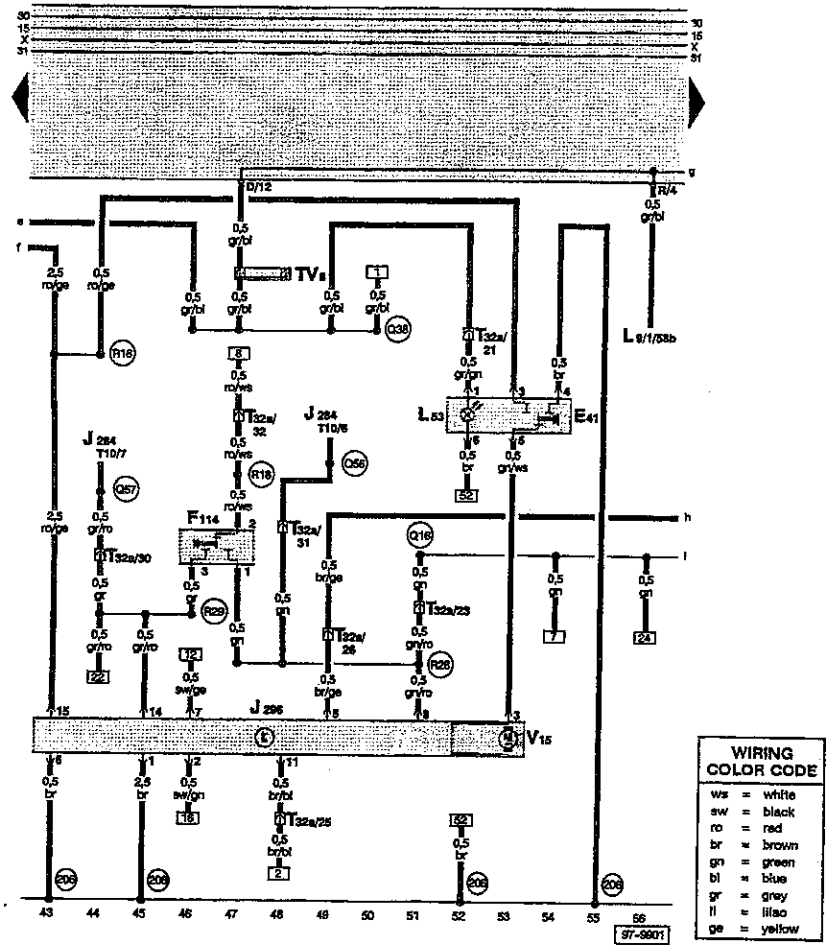

E52 - Left Rear Window Switch, (in Door)
J297 - Power Window Control Module, Left Rear
L53 - Power Window Switch Light
V26 - Window Motor, Left Rear Door
T1a - Connector, Single, behind fuse/relay panel
T21 - Connector, 21 pin, on left B-pillar
T21a - Connecter, 21 pin, on right B-pillar
T32a - Connector, 32 Pin, on A-pillar, lower right
(207) - Ground connection, in left rear door wiring harness
(Q15) - Wire connection in power window wiring harness
(Q45) - Wire connection (comfort), in power window wiring harness
(Q46) - Wire connection (child lock) in power window wiring harness
(R19) - Plus connection -1- (30), in left rear door wiring harness
(R21) - Plus connection,-3- (15), in left rear door wiring harness
(R22) - Wire connection (child lock) in left rear door wiring harness





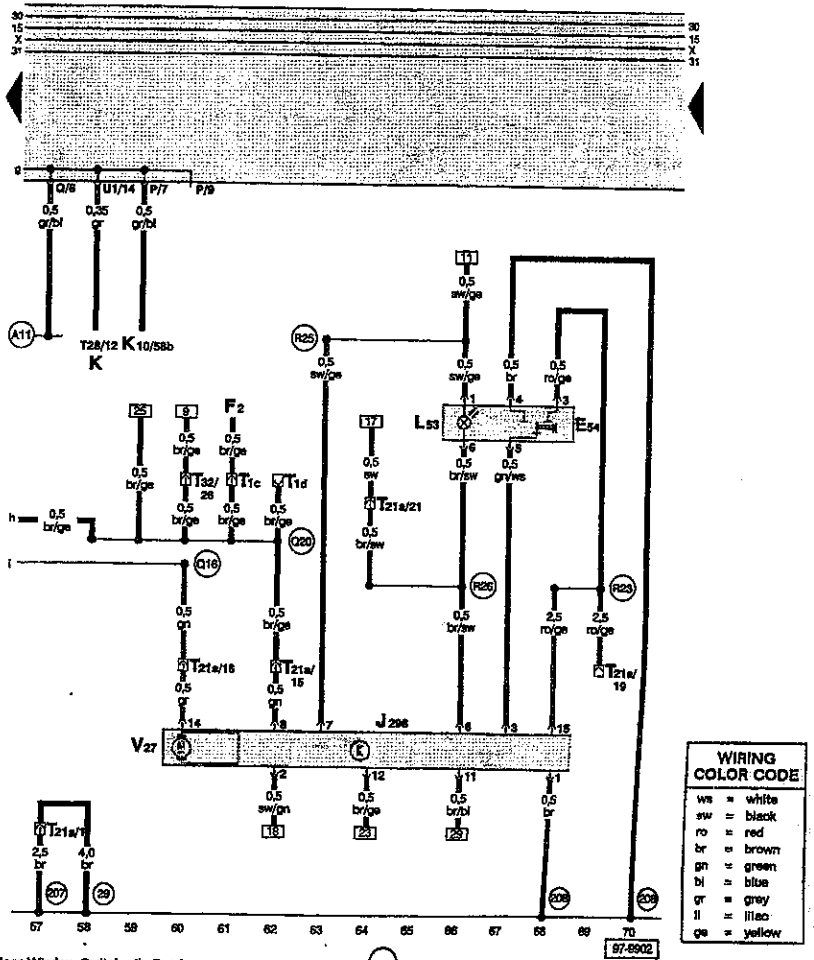

E39 - Window Lockout Switch
E53 - Left Rear Window Switch (in Console)
E55 - Right Rear Window Switch (in Console)
L53 - Power Window Switch Light
S43 - Fuse, power windows
T8h - Connector, 8 pin, behind center of dash panel
T21 - Connector, 21 pin, on left B-pillar
T21a - Connecter, 21 pin, on right B-pillar
T32 - Connector, 32 Pin, on A-pillar, lower left
T32a - Connector, 32 Pin, on A-pillar, lower right
(29) - Ground connection, near "B" pillar, right
(89) - Ground connection, in power window wiring harness
(208) - Ground connection, in right rear door wiring harness
(Q1) - Plus connection (30) in power window wiring harness

Power windows



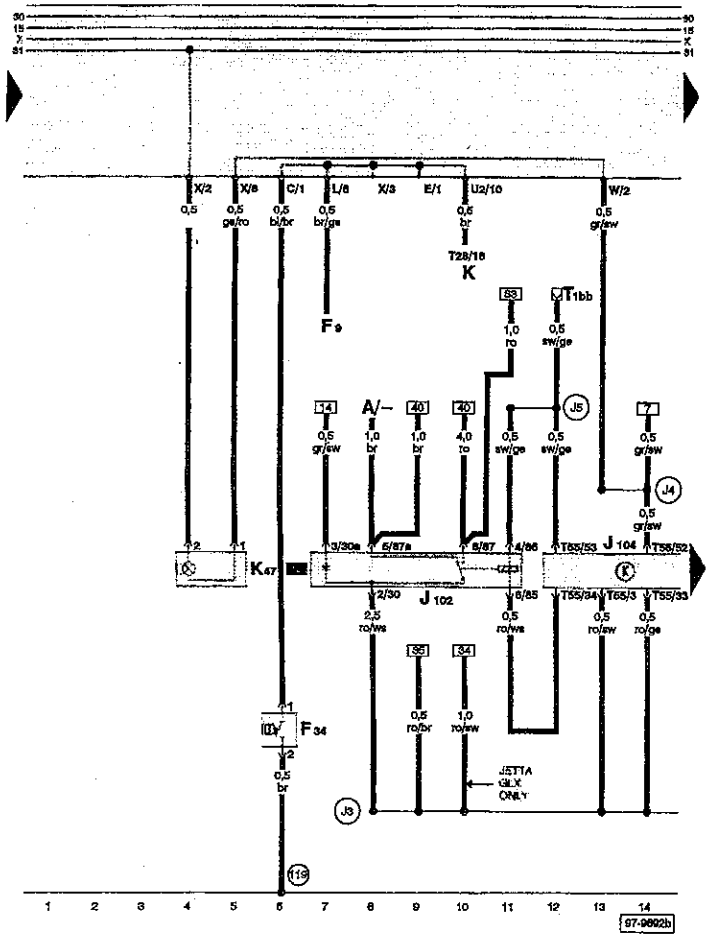

| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E41 – Window Switch, Right Front
F114 – Central Locking System Door Switch, Passenger's Door
J284 – Alarm System Control Module
J296 – Power Window Control Module, Right Front
L9 – Headlight Switch Light
L53 – Power Window Switch Light
V15 – Window Motor, Right
T10 – Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T32a – Connector, 32 Pin, on A-pillar, lower right
TV8 – Connector, terminal 58b
(206) – Ground connection, in passenger's door wiring harness
(Q16) – Wire connection, in power window wiring harness (left down)
(Q38) – Plus connection (58b) –1– in power window wiring harness
(Q56) – Wire connection (open), in alarm system wiring harness
(Q57) – Wire connection (closed), in alarm system wiring harness
(R16) – Plus connection –1– (30), in passenger's door wiring harness
(R18) – Plus connection –3– (30), in passenger's door wiring harness
(R28) – Wire connection, (open), in passenger's door wiring harness
(R29) – Wire connection, (closed), in passenger's door wiring harness




| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E54 – Right Rear Window Switch, (in Door)
F2 – Door Contact Switch, Left Front
J296 – Power Window Control Module, Right Rear
K – Instrument Cluster
K10 – Rear Window Defogger Indicator Light
L53 – Power Window Switch Light
V27 – Window Motor, Right Rear Door
T1c – Connector, Single, behind fuse/relay panel
T1d – Connector, Single, behind fuse/relay panel
T21a – Connector, 21 pin, on right B-pillar
T28 – Connector, 28 Pin, on instrument cluster
T32 – Connector, 32 Pin, on A-pillar, lower left
(29) – Ground connection, near "B"-pillar, right
(207) – Ground connection, in left rear door wiring harness
(208) – Ground connection, in right rear door wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(Q16) – Wire connection, in power window wiring harness (left down)
(Q20) – Wire connection –1– (door contact switch), in power window wiring harness
(R23) – Plus connection –1– (30), in right rear door wiring harness
(R25) – Plus connection –3– (15), in right rear door wiring harness
(R26) – Wire connection (child lock), in right rear door wiring harness

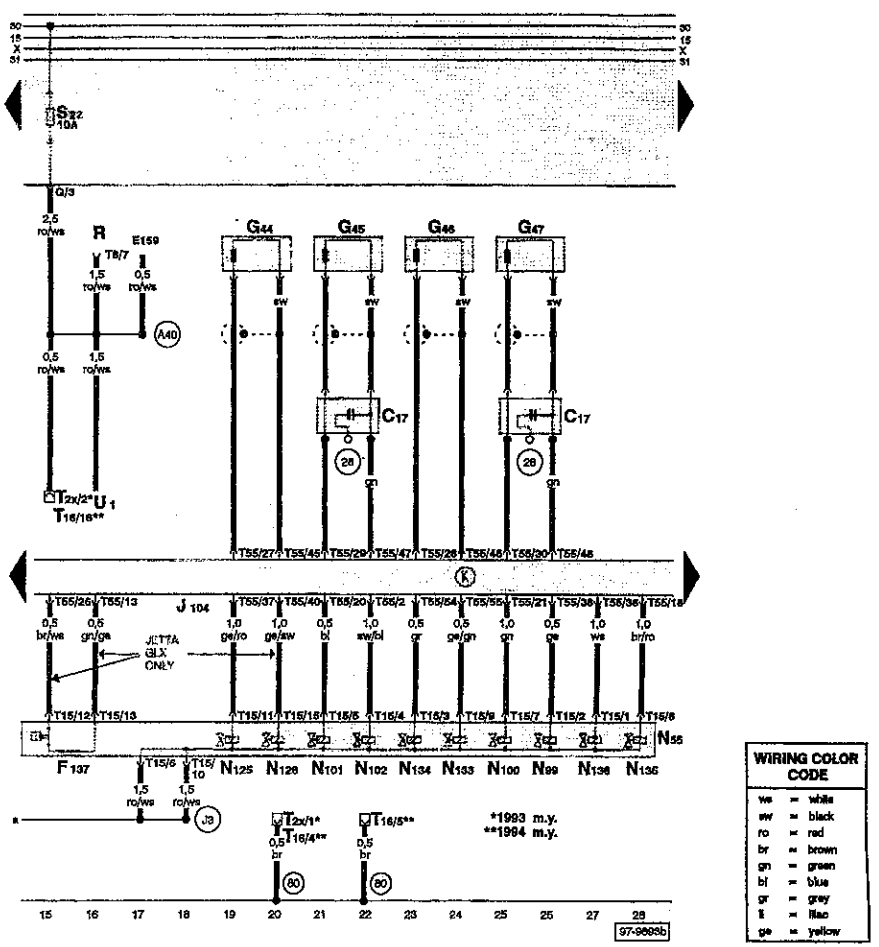



| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

A – Battery
F9 – Parking Brake Warning Light Switch
F34 – Brake Fluid Level Warning Switch
J102 – ABS Relay
J104 – ABS (with EDL) Control Module
K – Instrument Cluster
K47 – ABS Warning Light
T1bb – Single Connector, behind fuse/relay panel
T28 – 28–Pin Connector, on instrument cluster
T55 – 55–Pin Connector, on ABS Control Module
(119) – Ground connection –1–, in headlight wiring harness

(J3) – Wire connection –1–, in ABS wiring harness
(J4) – Wire connection (OBD), in ABS wiring harness
(J5) – Wire connection –2–, in ABS wiring harness



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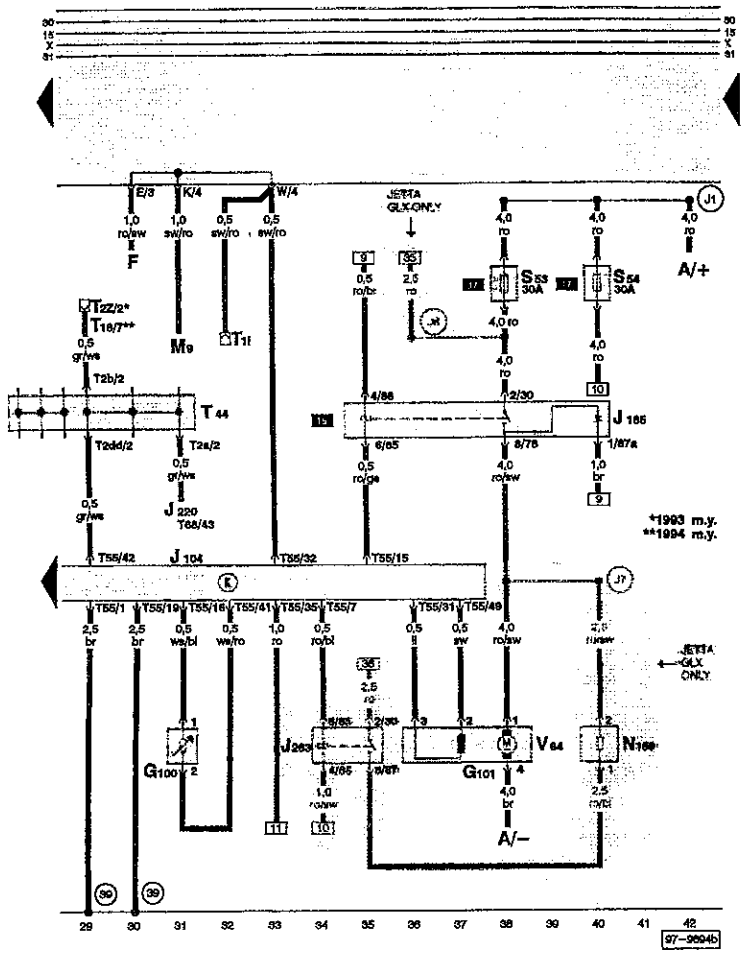
C17 – ABS Speed Sensor Capacitor
E159 – Fresh Air/Recirculating Flap Switch
F137 – ABS Pressure Control Switch
G44 – Right Rear ABS Wheel Speed Sensor
G45 – Right Front ABS Wheel Speed Sensor
G46 – Left Rear ABS Wheel Speed Sensor
G47 – Left Front ABS Wheel Speed Sensor
J104 – ABS (with EDL) Control Module
N55 – ABS Hydraulic Unit
N99 – Right Front ABS Inlet Valve
N100 – Right Front ABS Outlet Valve
N101 – Left Front ABS Inlet Valve
N102 – Left Front ABS Outlet Valve
N125 – Differential Lock Valve 1
N126 – Differential Lock Valve 2
N133 – Right Rear ABS Inlet Valve
N134 – Left Rear ABS Inlet Valve
N135 – Right Rear ABS Outlet Valve
N136 – Left Rear ABS Outlet Valve
R – Radio
U1 – Cigarette Lighter
T2x – Data Link Connector (DLC), behind center of dash panel
T8 – 8–Pin Connector, on radio
T15 – 15–Pin Connector, on ABS Hydraulic Unit
T16 – Data Link Connector (DLC), behind center of dash panel
T55 – 55–Pin Connector, on ABS Control Module
(28) – Ground connection, on firewall
(80) – Ground connection –1–, in instrument panel wiring harness
(A40) – Plus connection (30), in instrument panel wiring harness
(J3) – Wire connection –1–, in ABS wiring harness

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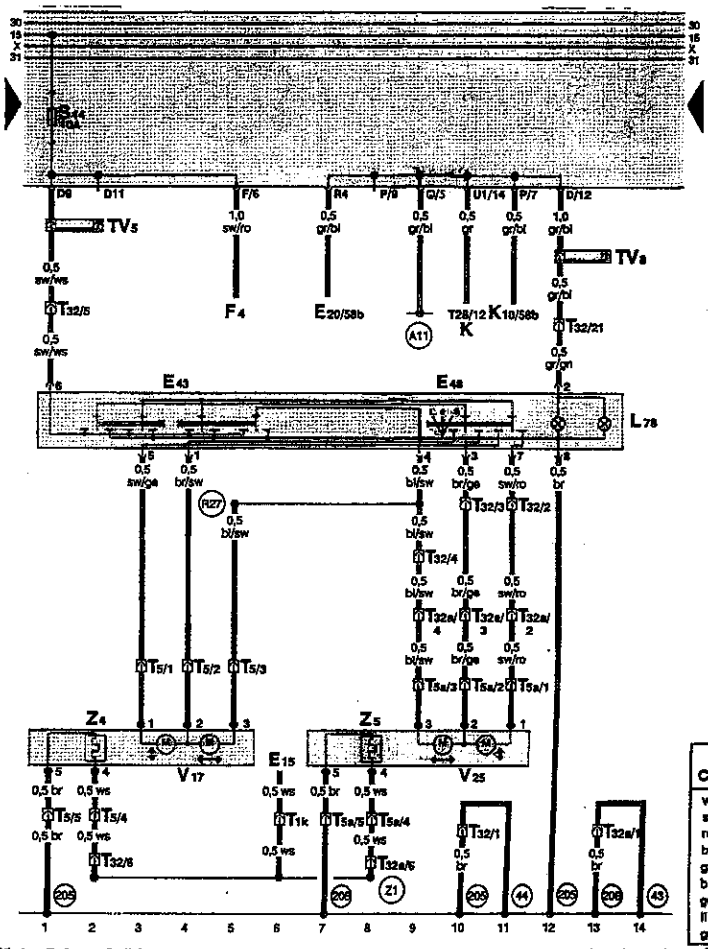
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

A – Battery
F – Brake Light Switch
G100 – Brake Pedal Position Sensor
G101 – Hydraulic Pump Sensor
J104 – ABS (with EDL) Control Module
J185 – ABS Hydraulic Pump Relay
J220 – Motronic Engine Control Module (ECM)
J263 – Electronic Differential Lock Cut–Off Relay
M9 – Left Brake Light
N159 – Electronic Differential Lock Series Resistance
S53 – ABS Hydraulic Pump Fuse
S54 – ABS Valves Fuse
V64 – ABS Hydraulic Pump
T1i – Single Connector, behind fuse/relay panel
T2a – Double Connector, on junction connector (T44) above fuse/relay panel
T2b – Double Connector, on junction connector (T44) above fuse/relay panel
T2dd – Double Connector, on junction connector (T44) behind fuse/relay panel
T2z – Data Link Connector (DLC), behind center of dash panel
T16 – Data Link Connector (DLC), behind center of dash panel
T44 – Junction Box for On Board Diagnostic, above fuse/relay panel
T55 – 55–Pin Connector, on ABS Control Module
T88 – 88–Pin Connector, under right side of bonnet, on Motronic Engine Control Module (ECM)
(30) – Ground connection, below rear seat bench, left
(J1) – Plus connection (30) in ABS wiring harness
(J6) – Plus connection –2– (30), in ABS wiring harness
(J7) – Wire connection –3–, in ABS wiring harness

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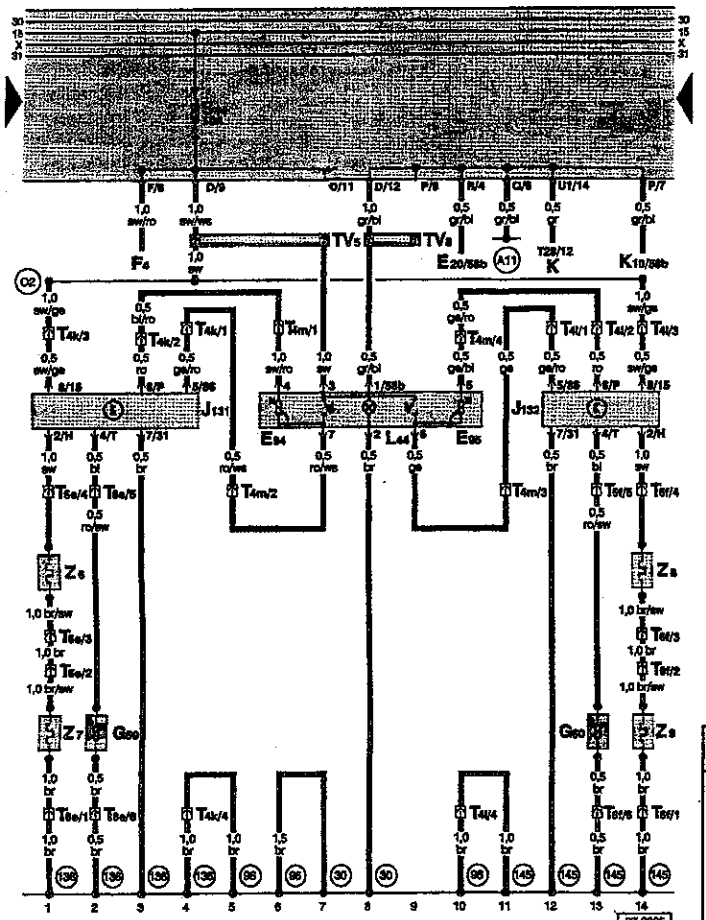
| ge | yellow |

E15 – Rear Window Defogger Switch
E20 – Instrument Panel Light Dimmer Switch
E43 – Mirror Adjustment Switch
E48 – Mirror Select Switch
F4 – Back–Up Light Switch
K – Instrument Cluster
K10 – Rear Window Defogger Indicator Light
L78 – Mirror Adjusting Switch Light
V17 – Driver's Side Mirror Adjustment Motor
V25 – Passenger's Side Heated Mirror Adjustment Motor
Z4 – Driver's Side Heated Mirror
Z5 – Passenger's Side Heated Mirror
T1k – Connector, Single, behind fuse/relay panel
T5 – Connector, 5 pin, in driver's door
T5a – Connector, 5 pin, in passenger's door
T28 – Connector, 28 Pin, on instrument cluster
T32 – Connector, 32 Pin, on A–pillar, lower left
T32a – Connector, 32 Pin, on A–pillar, lower right
TV5 – Connector, terminal 15a
TV8 – Connector, terminal 58b
(43) – Ground connection, on right A–pillar, lower part
(44) – Ground connection, on left "A" pillar, lower part
(205) – Ground connection, in driver's door wiring harness
(206) – Ground connection, in passenger's door wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(R27) – Wire connection (power mirror), in driver's door wiring harness
(Z1) – Wire connection, –1–, in power heated mirror wiring harness



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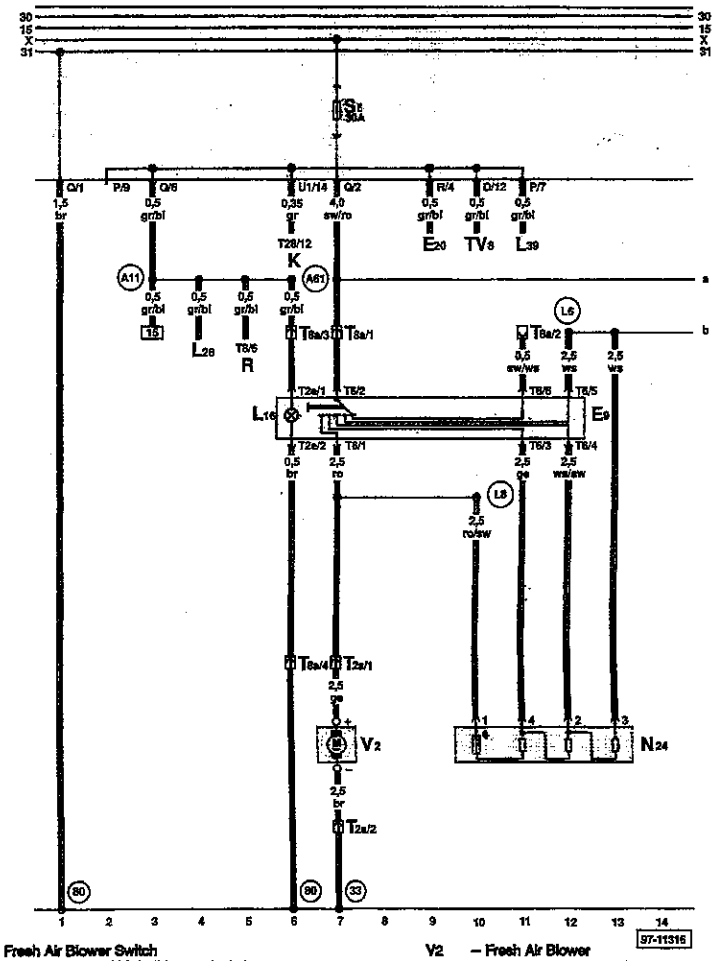
| ge | = yellow |

E20 – Instrument Panel Light Dimmer Switch
E94 – Heat Regulating Switch, Driver's Seat
E95 – Heat Regulating Switch, Passenger's Seat
F4 – Back-Up Light Switch
G59 – Driver's Seat Heater Temperature Sensor
G60 – Passenger's Seat Heater Temperature Sensor
J131 – Driver's Seat Heater Control Module
J132 – Passenger's Seat Heater Control Module
K – Instrument Cluster
K10 – Rear Window Defogger Indicator Light
L44 – Seat Heater Switch Illumination Light
Z6 – Driver's Seat Heat Element
Z7 – Driver's Backrest Heat Element
Z8 – Passenger's Seat Heat Element
Z9 – Passenger's Backrest Heat Element
T4k – Connector, 4 pin
T4l – Connector, 4 pin
T4m – Connector, 4 pin
T8a – Connector, 8 pin
T8f – Connector, 6 pin
T26 – Connector, 26 pin, on instrument cluster
TV5 – Connector, terminal 15a
TV8 – Connector, terminal 58b
(30) – Ground connection – beside fuse/relay panel
(98) – Ground connection –1–, in heated seats wiring harness
(136) – Ground connection –2–, in heated seats wiring harness
(145) – Ground connection –3–, in heated seats wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(C2) – Plus connection (15) in heated seats wiring harness



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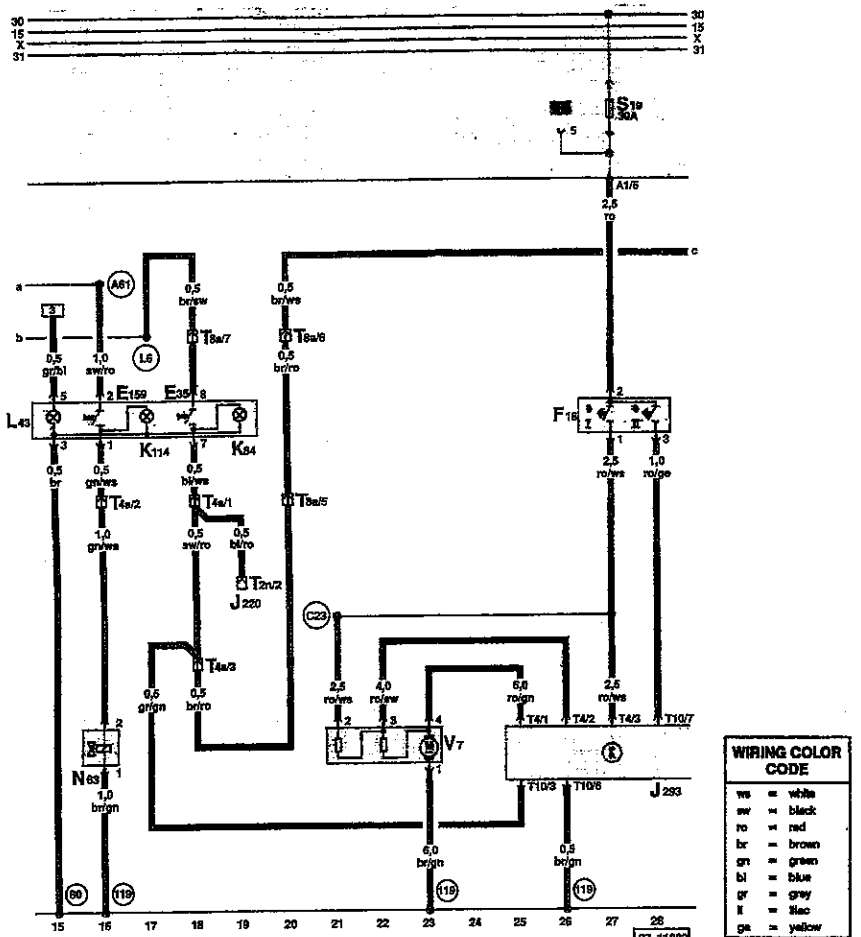
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

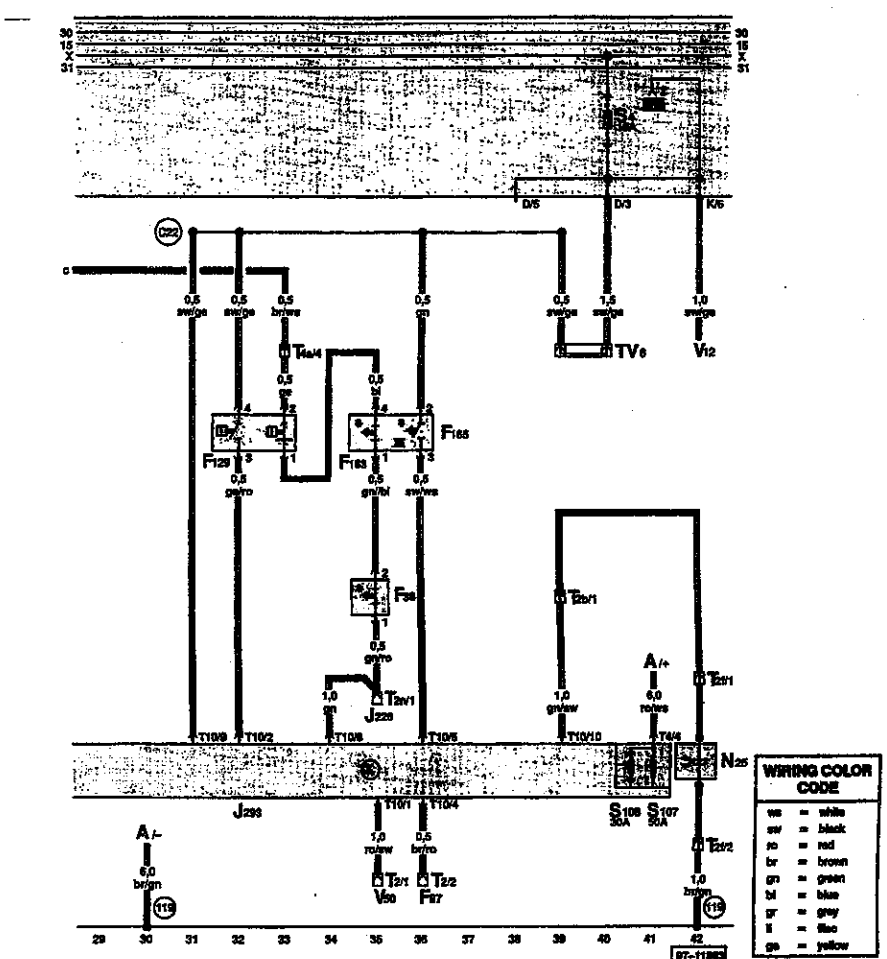
E9 – Fresh Air Blower Switch
E20 – Instrument Panel Light Dimmer Switch
K – Instrument Cluster
L16 – Fresh Air Control Lever Light
L28 – Cigarette Lighter Light
L39 – Rear Window Defogger Switch Light
N24 – Fresh Air Blower Series Resistance with fuse
R – Radio
T2a – Double Connector, behind instrument panel, right
T2e – Double Connector, on E9
T6 – 6-Pin Connector, on E9
T8 – 8-Pin Connector, on radio
T8a – 8-Pin Connector, behind instrument panel, center
T26 – 26-Pin Connector, on instrument cluster
TV8 – Terminal 58b Wire Connector, above fuse/relay panel
V2 – Fresh Air Blower
(33) – Ground connection, behind instrument panel, right
(80) – Ground connector -1-, in instrument panel wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(A61) – Plus connection (X), in instrument cluster wiring harness
(L6) – Wire connection -2-, in evaporator housing wiring harness
(L8) – Wire connection -4-, in evaporator housing wiring harness

Air conditioning




E35 – A/C Switch
E159 – Fresh Air/Recirculation Flap Switch
F18 – Coolant Fan Control (FC) Thermal Switch
J220 – Motronic Engine Control Module (ECM)
J293 – Coolant Fan Control (FC) Control Module, in left side of engine compartment
K84 – A/C Indicator Light
K114 – Fresh Air and Recirculating Air Mode Indicator Light
L43 – A/C Switch Illumination Light
N63 – Fresh Air/Recirculating Flap Two-Way Valve (00605), in rear of engine compartment
T2n – Double Connector, behind fuse/relay panel
T4 – 4-Pin Connector, on J293
T4a – 4-Pin Connector, behind fuse/relay panel
T8a – 8-Pin Connector, behind instrument panel, center
T10 – 10-Pin Connector, on J293
V7 – Coolant Fan

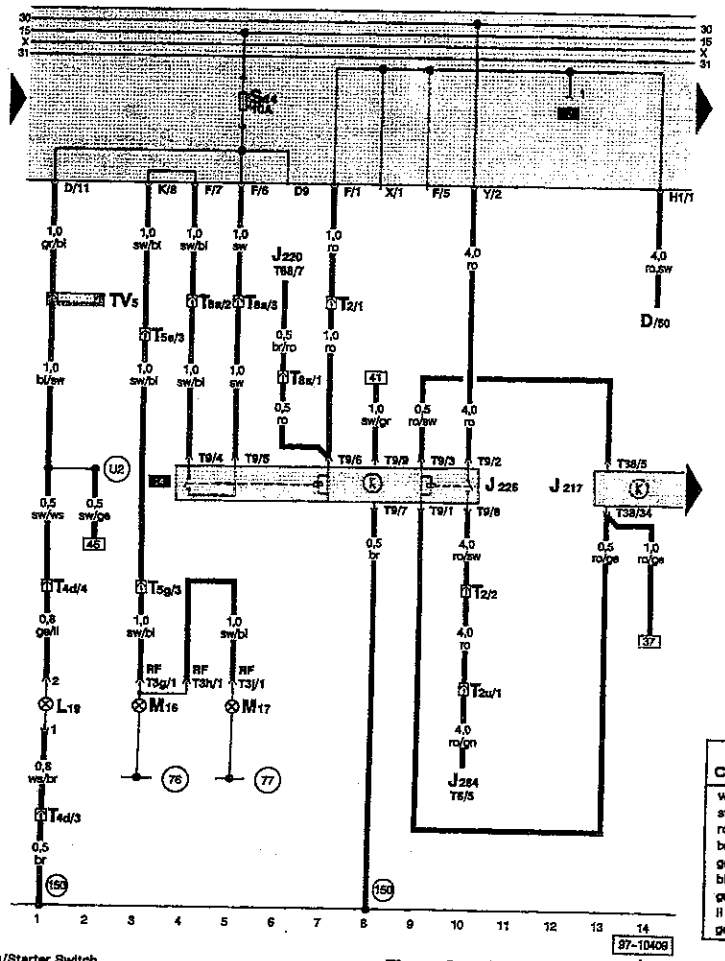
(80) – Ground connection -1-, in instrument panel wiring harness
(119) – Ground connection -1-, in headlight wiring harness
(A61) – Plus connection (X), in instrument cluster wiring harness
(C23) – Wire connection (blower, 1st speed) in headlight/air conditioner wiring harness
(L6) – Wire connection -2-, in evaporator housing wiring harness




A – Battery
F36 – Ambient Temperature Switch, near horn
F87 – After-Run Coolant Fan Control (FC) Thermal Switch
F129 – A/C Pressure Switch, in right side of engine compartment
F165 – A/C Cut-Out Thermal Switch, in center of engine compartment
F165 – Third Speed Coolant Fan Control (FC) Thermal Switch, in center of engine compartment
J220 – Motronic Engine Control Module (ECM)
J293 – Coolant Fan Control (FC) Control Module
N25 – A/C Clutch
S107 – Coolant Fan Second and Third Speed Fuse
S106 – Coolant Fan First Speed and A/C Clutch Fuse
T2 – Double Connector, in engine compartment, left
T2b – Double Connector, in engine compartment, front
T2f – Double Connector, near compressor
T2n – Double Connector, behind fuse/relay panel
T4a – 4-Pin Connector, behind fuse/relay panel
TV6 – Terminal X Wire Connector, above fuse/relay panel
V12 – Rear Window Wiper Motor (not applicable to Jetta III)
V50 – Coolant Pump

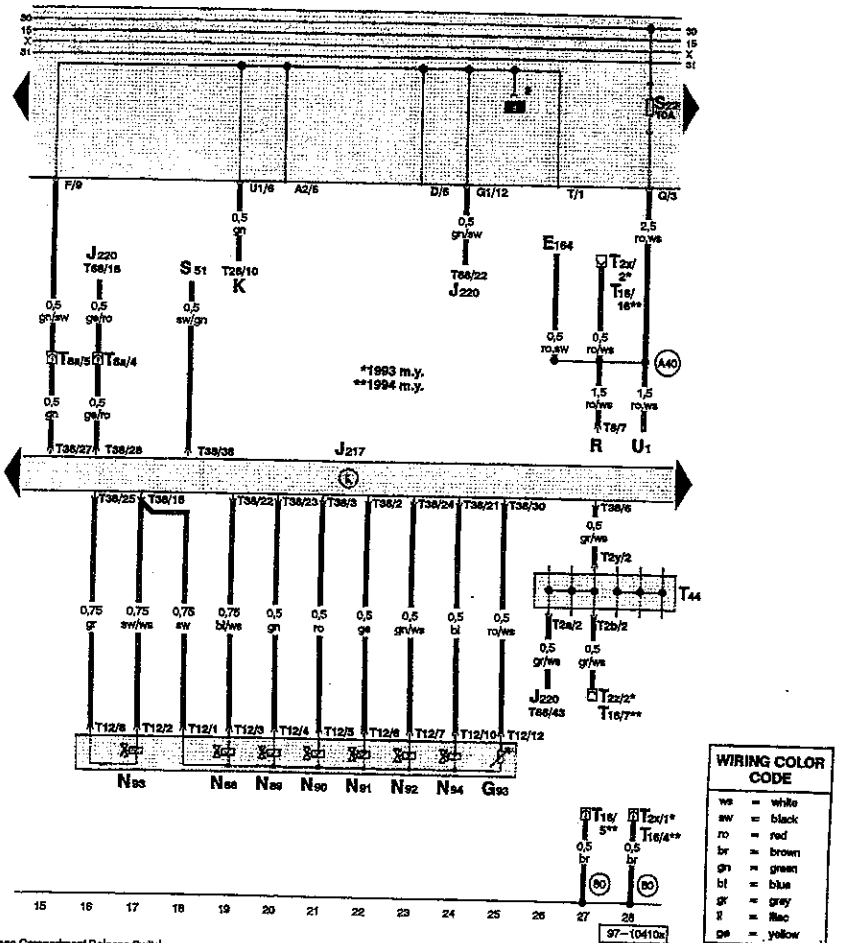
(119) – Ground connection -1-, in headlight wiring harness
(C22) – Wire connection (X), in headlight/air conditioner wiring harness

Automatic transmission




| WIRING COLOR CODE | |
|---|---|
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

D – Ignition/Starter Switch
J217 – Transmission Control Module (TCM)
J220 – Motronic Engine Control Module (ECM)
J226 – Park/Neutral Position (PNP) Relay
J284 – Alarm System Control Module
L19 – Automatic Transmission Console Light
M16 – Back-Up Light, Left
M17 – Back-Up Light, Right
T2 – Connector, Double, behind fuse/relay panel, only on automatic transmission
T2u – Connector, Double, behind fuse/relay panel
T3g – Connector, 3 pin, on back-up/brake light, left
T3h – Connector, 3 pin, on back-up/brake light, left
T3j – Connector, 3 pin, on back-up/brake light, right
T4d – Connector, 4 Pin, below center console
T5e – Connector, 5 Pin, in luggage compartment, left
T5g – Connector, 5 Pin, in luggage compartment lid
T6 – Connector, 6 Pin, behind dash panel, left, on Alarm System Control Module
T8a – Connector, 8 Pin, behind fuse/relay panel
T9 – Connector, 9 Pin, on Park/Neutral Position (PNP) Relay
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T68 – Connector, 68 Pin, under right side of bonnet, on Motronic Engine Control Module (ECM)
TV5 – Connector, terminal 15a
(76) – Ground connection, on left back-up/brake light bulb holder
(77) – Ground connection, on right back-up/brake light bulb holder
(150) – Ground connection, in automatic transmission wiring harness
(U2) – Wire connection –1– (15), in automatic transmission wiring harness

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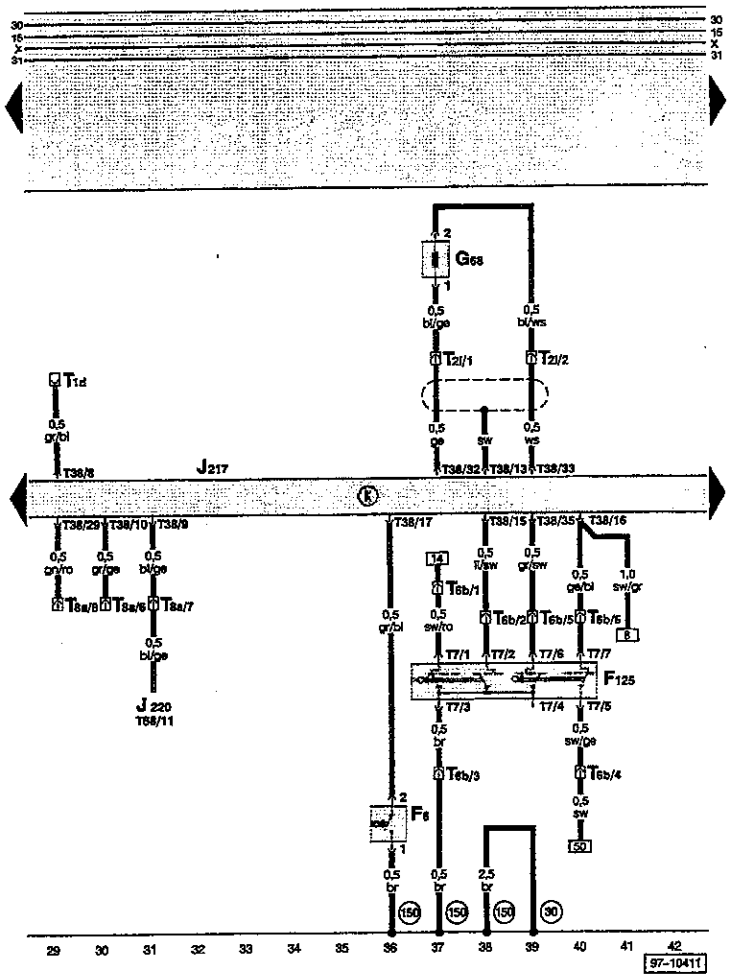
E164 – Luggage Compartment Release Switch
G93 – Transmission Fluid Temperature Sensor
J217 – Transmission Control Module (TCM)
J220 – Motronic Engine Control Module (ECM)
K – Instrument Cluster
N88 – Solenoid Valve 1
N89 – Solenoid Valve 2
N90 – Solenoid Valve 3
N91 – Solenoid Valve 4
N92 – Solenoid Valve 5
N93 – Solenoid Valve 6
N94 – Solenoid Valve 7
R – Radio
S51 – Fuse
U1 – Cigarette Lighter
T2a – Connector, Double, on junction connector (T44) above fuse/relay panel
T2b – Connector, Double, on junction connector (T44) above fuse/relay panel
T2x – Data Link Connector (DLC), behind center of dash panel
T2y – Connector, Double, on junction connector (T44) above fuse/relay panel
T2z – Data Link Connector (DLC), behind center of dash panel
T8 – Connector, 8 Pin, on radio
T8a – Connector, 8 Pin, behind fuse/relay panel
T12 – Connector, 12 Pin, on transmission
T16 – Data Link Connector (DLC), behind center of dash panel
T26 – Connector, 26 Pin, on instrument cluster
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T44 – Junction Box for On Board Diagnostic, above fuse/relay panel
T68 – Connector, 68 Pin, under right side of bonnet, on Motronic Engine Control Module (ECM)
(80) – Ground connection –1–, in instrument panel wiring harness
(A40) – Plus connection (30), in instrument panel wiring harness

Automatic transmission

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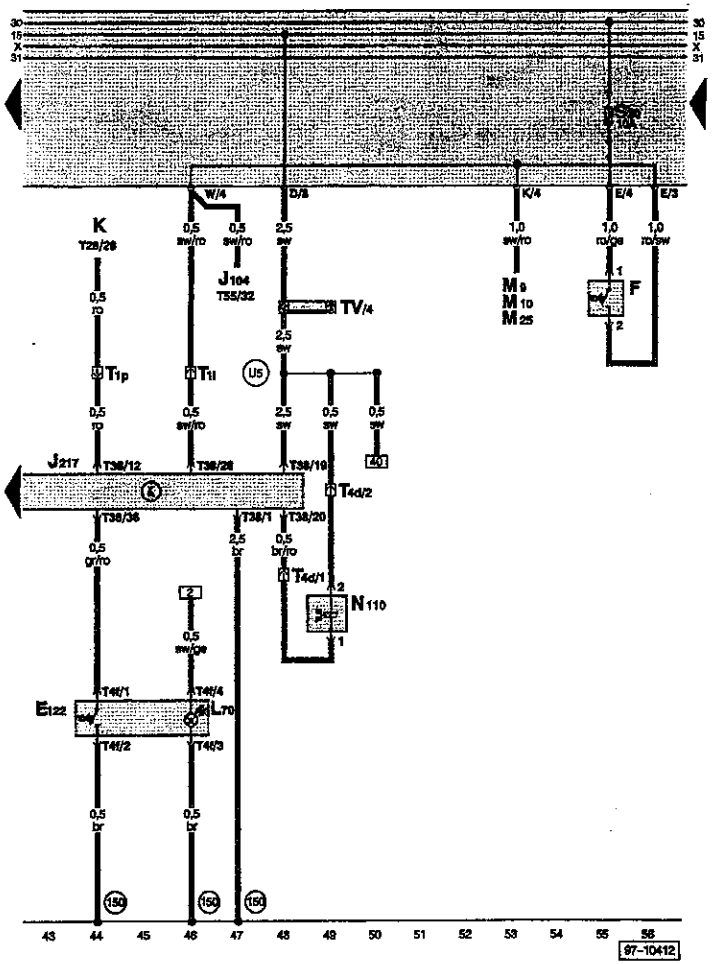
| ge | = yellow |

F8 – Kick Down Switch
F125 – Multi–Function Transmission Range (TR) Switch
G68 – Vehicle Speed Sensor (VSS)
J217 – Transmission Control Module (TCM)
J220 – Motronic Engine Control Module (ECM)
T1d – Connector, Single, behind fuse/relay panel
T2l – Connector, Double, below battery
T6b – Connector, 6 Pin, below battery
T7 – Connector, 7 Pin, on transmission
T8a – Connector, 8 Pin, behind fuse/relay panel
T38 – Connector, 38 Pin, below right front seat, on Transmission Control Module (TCM)
T68 – Connector, 68 Pin, under right side of bonnet, on Motronic Engine Control Module (ECM)
(30) – Ground connection – beside fuse/relay panel
(150) – Ground connection, in automatic transmission wiring harness

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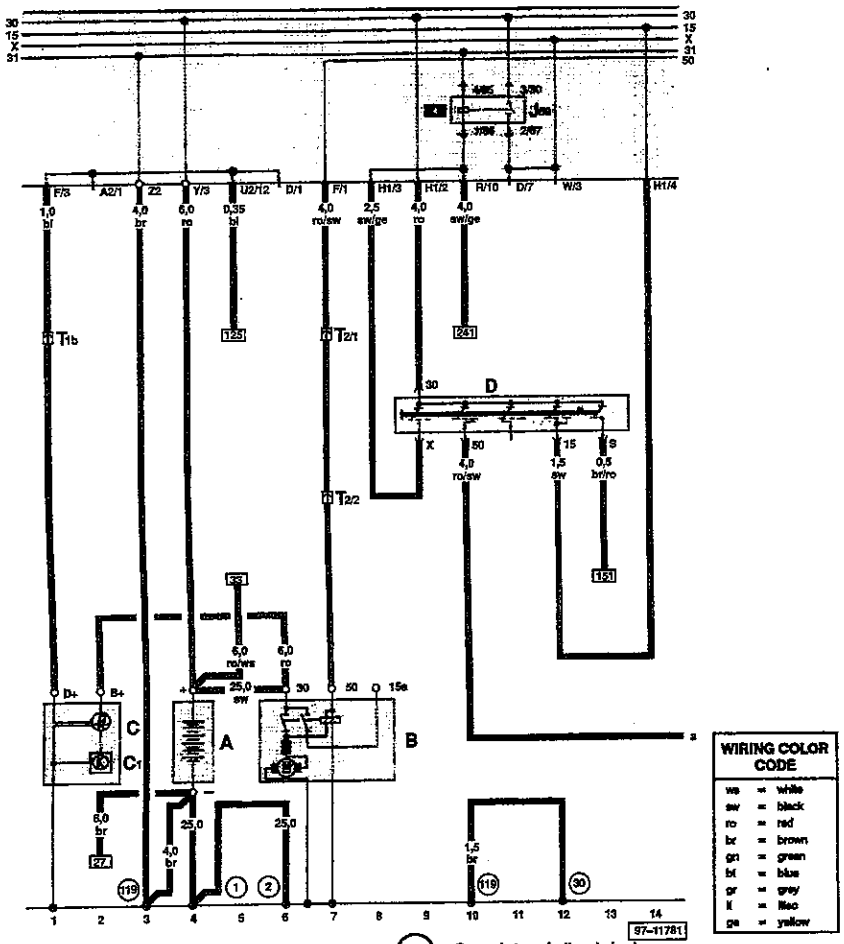
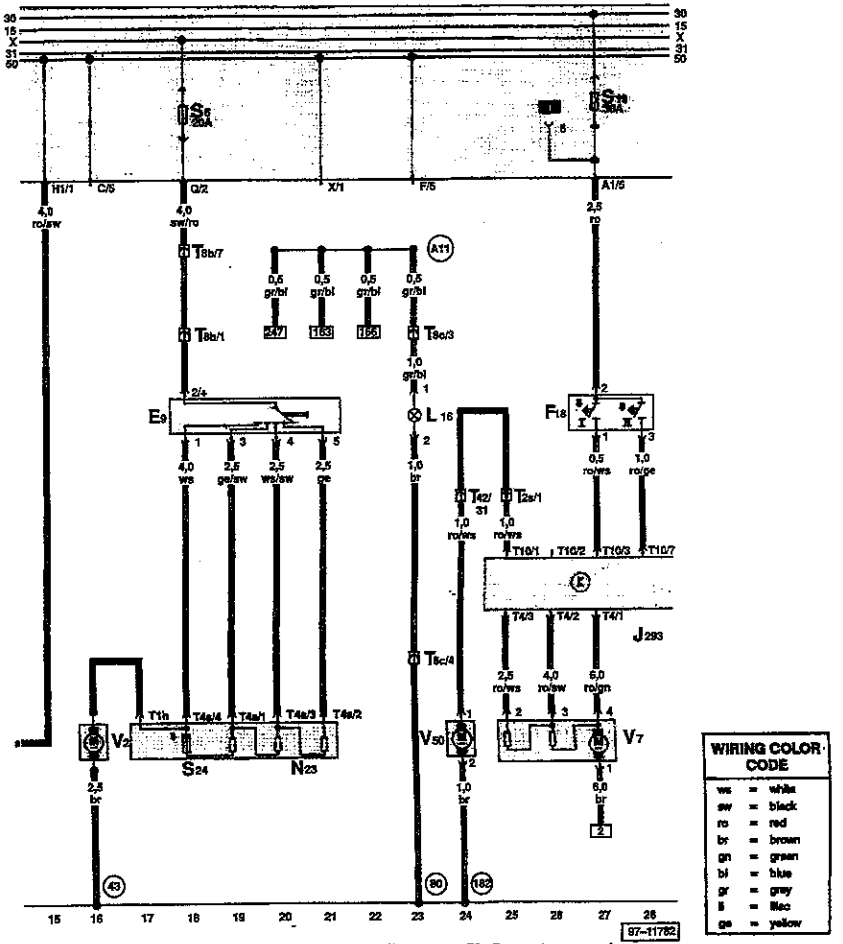
E122 – Transmission Range (TR) Program Switch
F – Brake Light Switch
J104 – ABS Control Module (w/EDL)
J217 – Transmission Control Module (TCM)
K – Instrument Cluster
L70 – Program Switch Illumination
M9 – Brake Light, Left
M10 – Brake Light, Right
M25 – High–Mount Brake Light
N110 – Shift Lock Solenoid
T1l – Connector, Single, behind fuse/relay panel
T1p – Connector, Single, behind fuse/relay panel
T4d – Connector, 4 Pin, below center console
T4f – Connector, 4 Pin, on Transmission Range (TR) Program Switch
T28 – Connector, 28 Pin, on instrument cluster
T38 – Connector, 38 Pin, below right front seat, on Transmission Co
T55 – Connector, 55 pins, on ABS Control Module
TV4 – Connector, terminal 15
(150) – Ground connection, in automatic transmission wiring harness
(U5) – Wire connection –2– (15), in automatic transmission wiring harness
(W1) – Plus connection (54), in rear wiring harness




A – Battery
B – Starter
C – Generator (GEN)
C1 – Voltage Regulator (VR)
D – Ignition/Starter Switch
J59 – Load Reduction Relay
T1b – Single Connector, near battery
T2 – Double Connector, behind fuse/relay panel

(1) – Ground strap, battery to body
(2) – Ground strap, transmission to body
(30) – Ground connection -1-, beside fuse/relay panel
(119) – Ground connection -1-, in headlight wiring harness

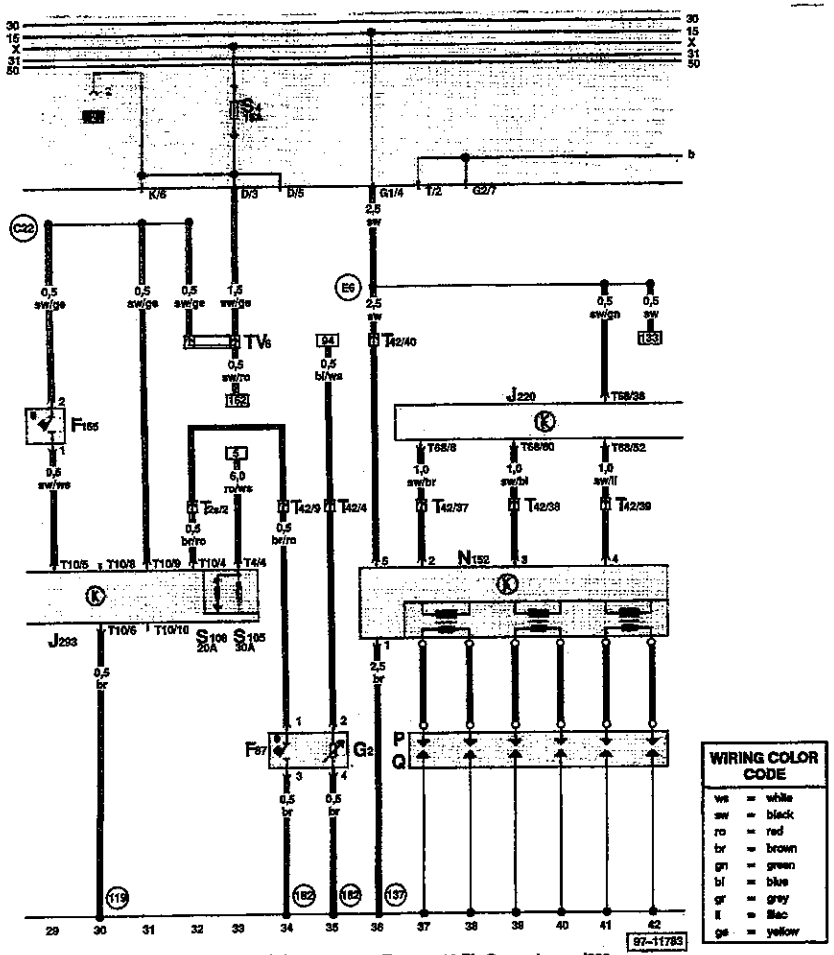





E9 – Fresh Air Blower Switch
F18 – Coolant Fan Control (FC) Thermal Switch
J293 – Coolant Fan Control (FC) Control Module
L16 – Fresh Air Control Lever Light
N23 – Fresh Air Blower Series Resistance
S24 – Heater, A/C Clutch Fuse (6A)
T1h – Single Connector, on N23
T2s – Double Connector, behind fuse/relay panel
T4 – 4-Pin Connector, on J293
T4a – 4-Pin Connector, on N23
T8b – 8-Pin Connector, behind instrument panel, center
T8c – 8-Pin Connector, behind instrument panel, center
T10 – 10-Pin Connector, on J293
T42 – 42-Pin Connector, on engine
V2 – Fresh Air Blower (01273-4124)
V7 – Coolant Fan (01018-5433)
V50 – Coolant Pump (00739)

(43) – Ground connection, on right A-pillar, lower part
(80) – Ground connection -1-, in instrument panel wiring harness
(182) – Ground connection -1-, in engine compartment wiring harness (6 cylinder)
(A11) – Plus connection (58b), in instrument panel wiring harness

## Engine control module, ignition coil, coolant fan control module

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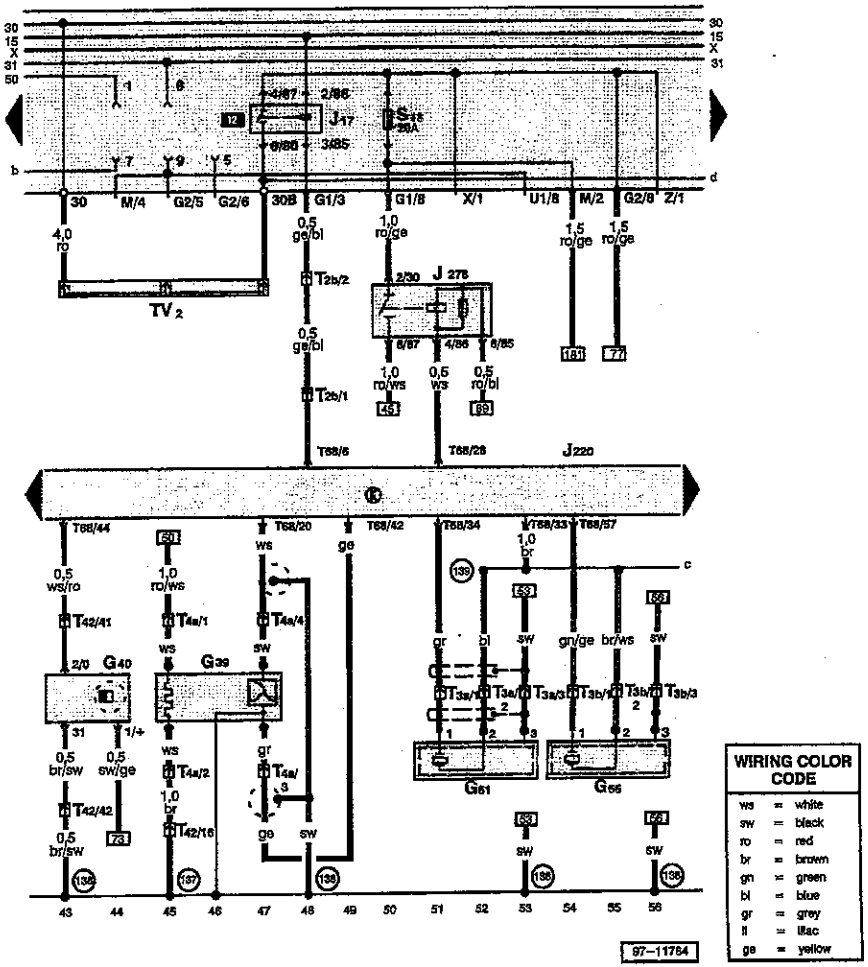
F87 – After-Run Coolant Fan Control (FC) Thermal Switch
F165 – Third Speed Coolant Fan Control (FC) Thermal Switch
G2 – Engine Coolant Temperature (ECT) Sensor (01080)
J220 – Motronic Engine Control Module (ECM)
J293 – Coolant Fan Control (FC) Control Module
N152 – Ignition Coil
P – Spark Plug Connector
Q – Spark Plugs
S105 – First Speed Coolant Fan Fuse
S106 – Coolant Fan First Speed and A/C Clutch Fuse
T2s – Double Connector, behind fuse/relay panel
T4 – 4-Pin Connector, on J293
T10 – 10-Pin Connector, on J293
T42 – 42-Pin Connector, on engine
T68 – 68-Pin Connector, on J220
TV6 – Terminal X Wire Connector
(119) – Ground connection -1-, in headlight wiring harness
(137) – Ground connection (end stage), in Motronic Multiport Fuel injection (MFI) wiring harness
(182) – Ground connection -1-, in engine compartment wiring harness (6 cylinder)
(C22) – Wire connection (X), in headlight/air conditioner wiring harness
(E6) – Plus connection -1- (15), in Motronic Multiport Fuel Injection (MFI) wiring harness



## Engine control module, heated oxygen sensor, knock sensors

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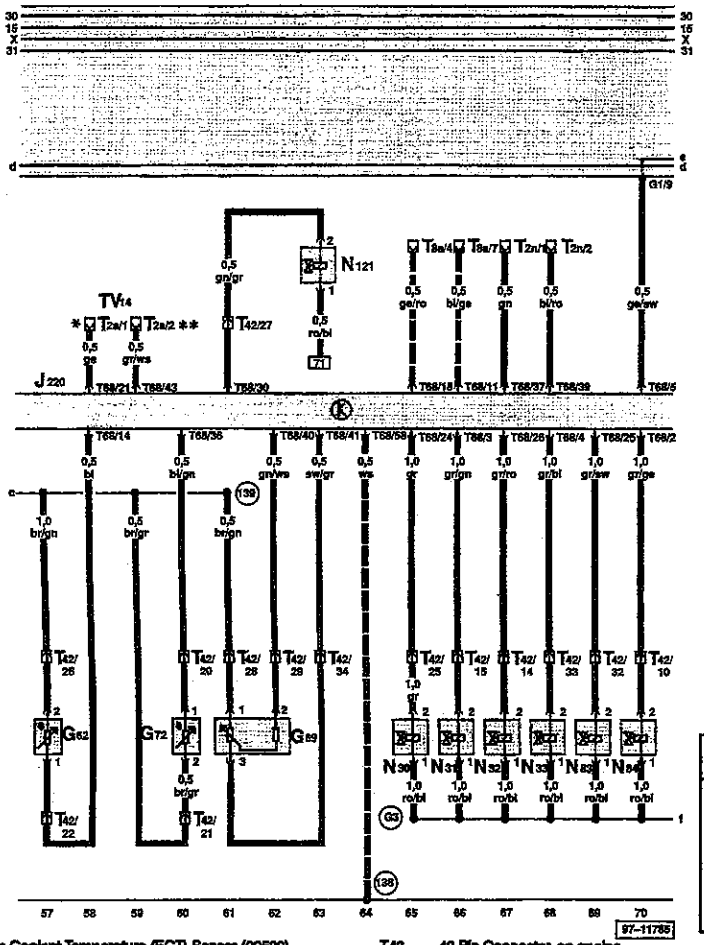
G39 – Heated Oxygen Sensor (H02S) (00525)
G40 – Camshaft Position (CMP) Sensor (00515)
G61 – Knock Sensor (KS) 1 (00524)
G66 – Knock Sensor (KS) 2 (00549)
J17 – Fuel Pump (FP) Relay (01259)
J220 – Motronic Engine Control Module (ECM)
J278 – Heated Oxygen Sensor (HO2S) Relay (00640)
T2b – 2-Pin Connector, behind fuse/relay panel
T3a – 3-Pin Connector, near intake manifold
T3b – 3-Pin Connector, near intake manifold
T4a – 4-Pin Connector, near intake manifold
T42 – 42-Pin Connector, on engine
T68 – 68-Pin Connector, on J220
TV2 – Terminal 30 (B+) Wire Connector
(137) – Ground connection (end stage), in Motronic Multiport Fuel Injection (MFI) wiring harness
(138) – Ground connection (control module), in Motronic Multiport Fuel Injection (MFI) wiring harness
(139) – Ground Connection (sensor ground), in Motronic Multiport Fuel Injection (MFI) wiring harness




| WIRING COLOR CODE | |
|---|---|
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

G62 – Engine Coolant Temperature (ECT) Sensor (00522)
G69 – Throttle Position (TP) Sensor (00518)
G72 – Intake Air Temperature (IAT) Sensor (00527)
J220 – Motronic Engine Control Module (ECM)
N30 – Cylinder 1 Fuel Injector (01249)
N31 – Cylinder 2 Fuel Injector (01250)
N32 – Cylinder 3 Fuel Injector (01251)
N33 – Cylinder 4 Fuel Injector (01252)
N83 – Cylinder 5 Fuel Injector (01253)
N84 – Cylinder 6 Fuel Injector (01254)
N121 – EGR Vacuum Regulator Valve
T2a – Double Connector, behind fuse/relay panel
T2n – Double Connector, behind fuse/relay panel
T8a – 8-Pin Connector, behind fuse/relay panel
T16 – Data Link Connector (DLC), behind center of dash panel

T42 – 42-Pin Connector, on engine
T68 – 68-Pin Connector, on J220
TV14 – Data Link Connector (DLC) wire connector

(138) – Ground connection (control module), in Motronic Multiport Fuel Injection (MFI) wiring harness

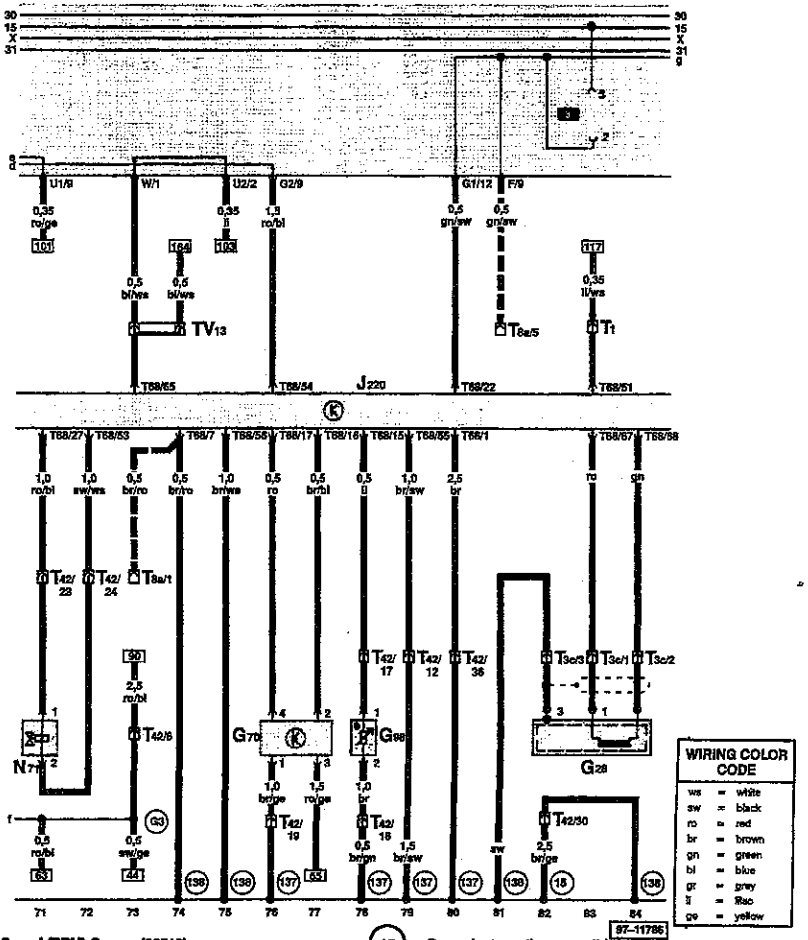
(139) – Ground connection (sensor ground), in Motronic Multiport Fuel Injection (MFI) wiring harness

(G3) – Plus connection in fuel injector wiring harness

= = = Automatic transmission only

* Connector T2a/1 connected to Data Link Connector T16/15

** Connector T2a/2 connected to Data Link Connector T16/7

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| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

G28 – Engine Speed (RPM) Sensor (00513)
G70 – Mass Air Flow (MAF) Sensor (00553)
G96 – EGR Temperature Sensor (00565)
J220 – Motronic Engine Control Module (ECM)
N71 – Idle Air Control (IAC) Valve (01257)
T1 – Single Connector, behind fuse/relay panel
T3c – 3-Pin Connector, near starter
T8a – 8-Pin Connector, behind fuse/relay panel
T42 – 42-Pin Connector, on engine
T68 – 68-Pin Connector, on J220
TV13 – Vehicle Speed Signal Wire Connector

(15) – Ground connection, on cylinder head

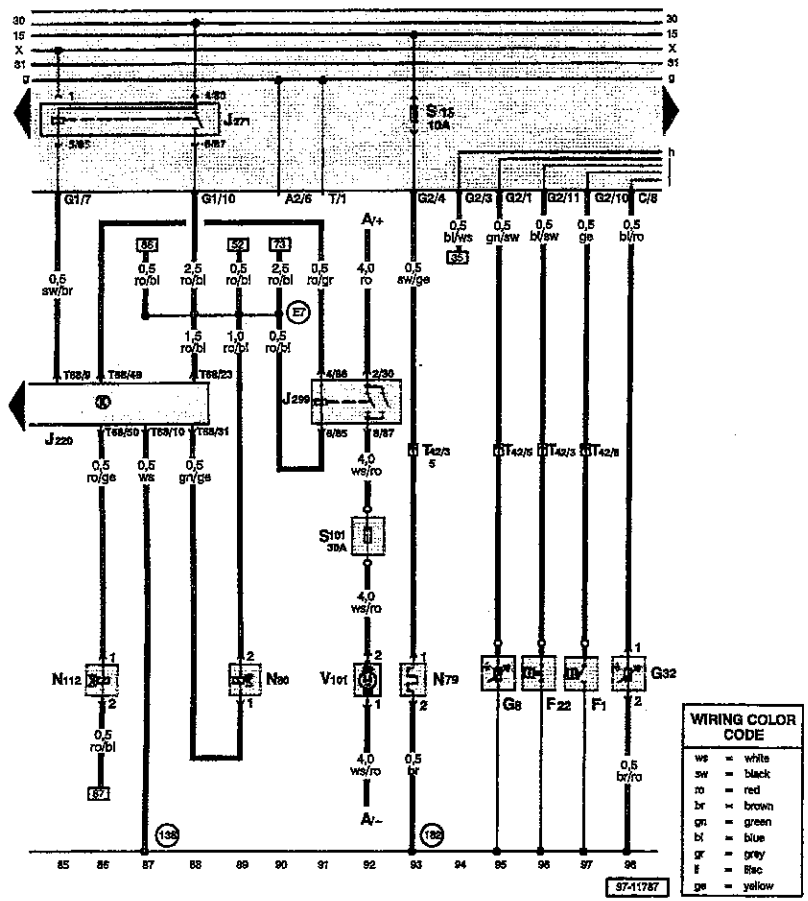
(137) – Ground connection (end stage), in Motronic Multiport Fuel Injection (MFI) wiring harness

(138) – Ground connection (control module), in Motronic Multiport Fuel Injection (MFI) wiring harness

(G3) – Plus connection, in fuel injector wiring harness

= = = Automatic transmission only

## Engine control module, secondary air injection, engine sensors/switches

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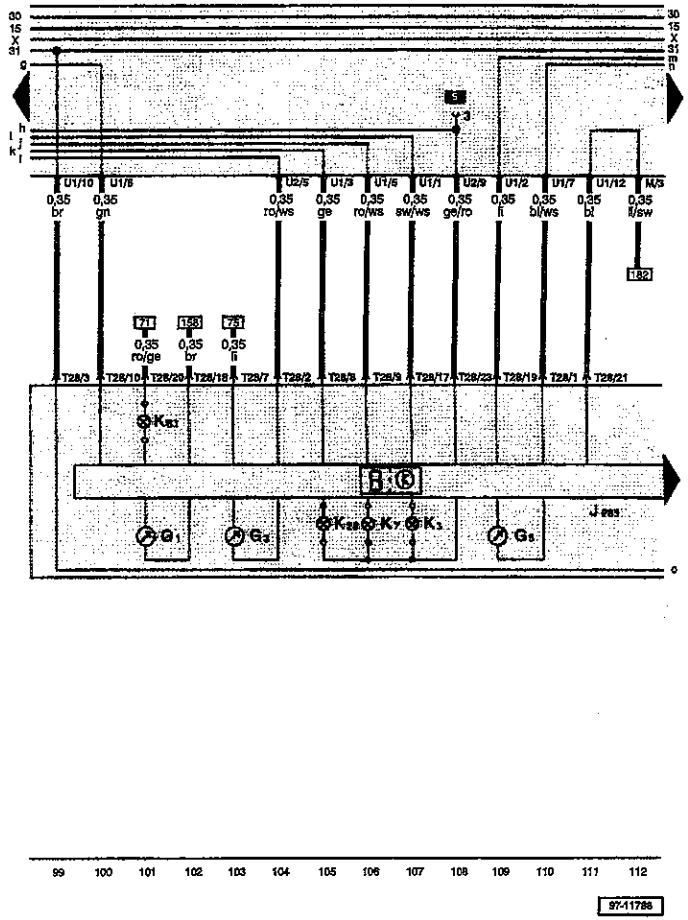
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

A – Battery
F1 – Engine Oil Pressure Switch
F22 – 0.3 Bar Engine Oil Pressure Switch (00772)
G8 – Engine Oil Temperature Sensor
G32 – Engine Coolant Level (ECL) Sensor
J271 – Motronic Engine Control Module (ECM) Power Supply Relay
J299 – Secondary Air Injection (AIR) Pump Relay (01264)
N79 – Positive Crankcase Ventilation (PCV) Heating Element
N80 – Evaporative Emission (EVAP) Canister Purge Regulator Valve (01247)
N112 – Secondary Air Injection (AIR) Solenoid Valve (01235)
S101 – A/C Climatronic Control Module Fuse
T42 – 42-Pin Connector, on engine
T68 – 68-Pin Connector, on J220
V101 – Secondary Air Injection (AIR) Pump Motor
(138) – Ground connection (Control Module), in Motronic Multiport Fuel Injection (MFI) wiring harness
(182) – Ground connection –1–, in engine compartment wiring harness (6 cylinder)
(E7) – Ground connection (87a), in Motronic Multiport Fuel Injection (MFI) wiring harness



## Instrument cluster, warning lights, gauges

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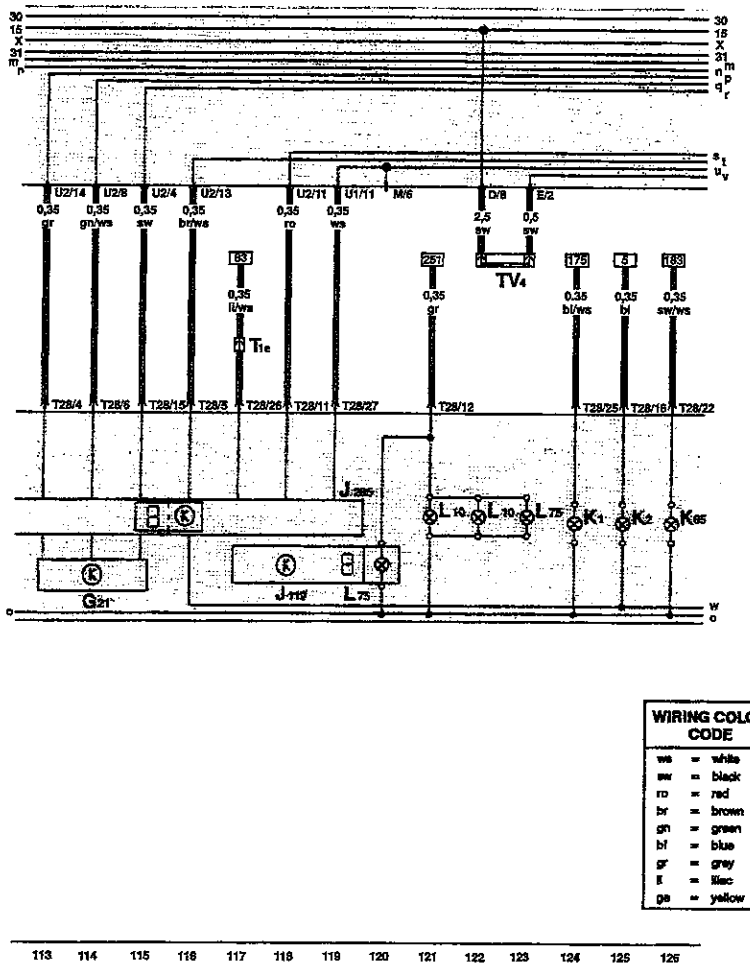
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

G1 – Fuel Gauge (00664)
G3 – Engine Coolant Temperature (ECT) Gauge
G5 – Tachometer (00662)
J285 – Control Module With Display Unit In Instrument Cluster
K3 – Oil Pressure Warning Light (00755)
K7 – Brake and Parking Brake Warning Light (01047)
K28 – Engine Coolant Level/Temperature (ECL/ECT) Warning Light
K83 – Multi-Function Indicator (MIL)
T28 – 28-Pin Connector, on instrument cluster

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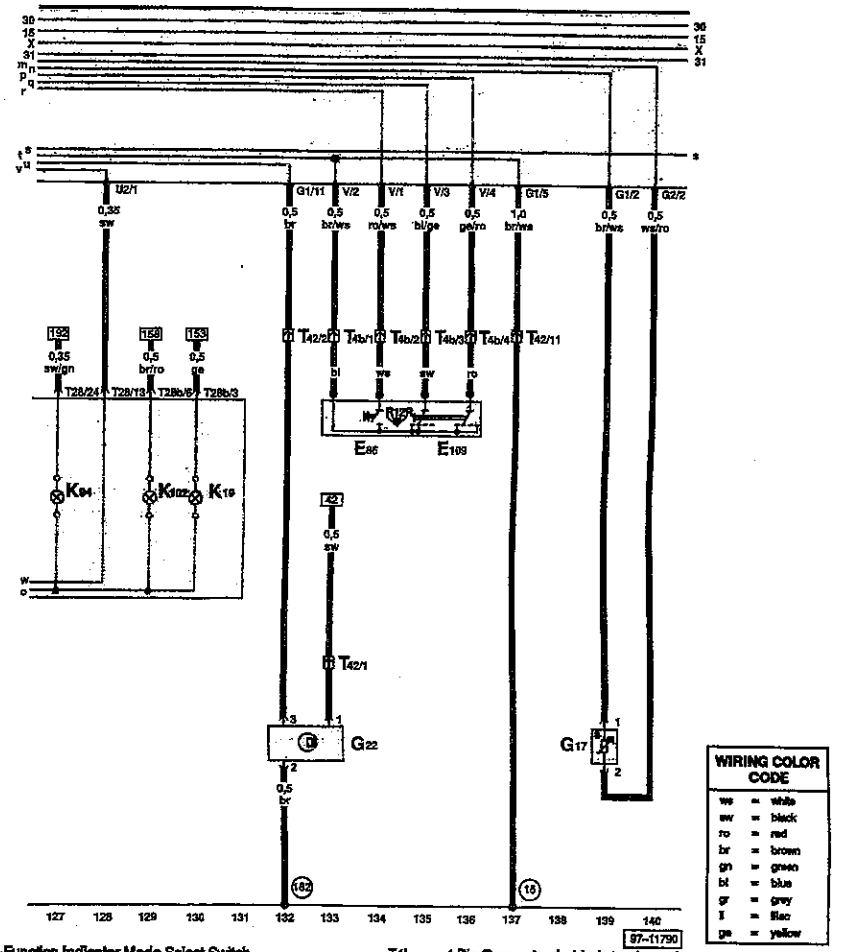
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

G21 – Speedometer (00663)
J119 – Multi-Function Indicator
J285 – Control Module with Display Unit in Instrument Cluster
K1 – Headlight High Beam Indicator Light
K2 – Generator (GEN) Warning Light
K85 – Left Turn Signal Indicator Light
L10 – Instrument Cluster Light
L75 – Digital Display Light
T1e – Single Connector, behind fuse/relay panel
T28 – 28-Pin Connector, on instrument cluster
TV4 – Terminal 15 Wire Connector

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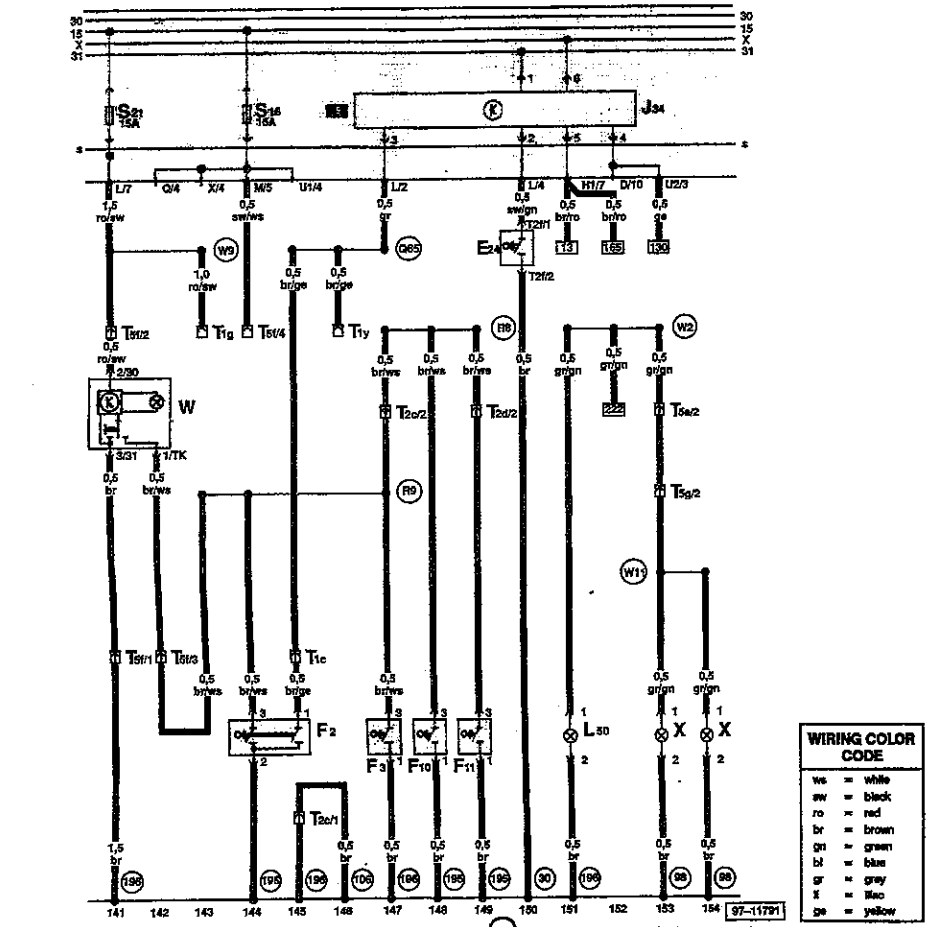
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E86 – Multi-Function Indicator Mode Select Switch
E109 – Multi-Function Indicator Memory Switch
G17 – Outside Air Temperature Sensor (00779-3133)
G22 – Speedometer Vehicle Speed Sensor (VSS) (01086), on transmission
K19 – Seat Belt Warning Light (00665)
K94 – Right Turn Signal Indicator Light
K102 – Rear Hatch/Trunk Lid Ajar Warning Light
T4b – 4-Pin Connector, behind steering column switch cover
T28b – 28-Pin Connector, on instrument cluster
T42 – 42-Pin Connector, on engine
(15) - Ground connection, on cylinder head
(182) - Ground connection -1-, in engine compartment wiring harness (6 cylinder)

## Interior lights, door contact switches, seat belt warning system relay



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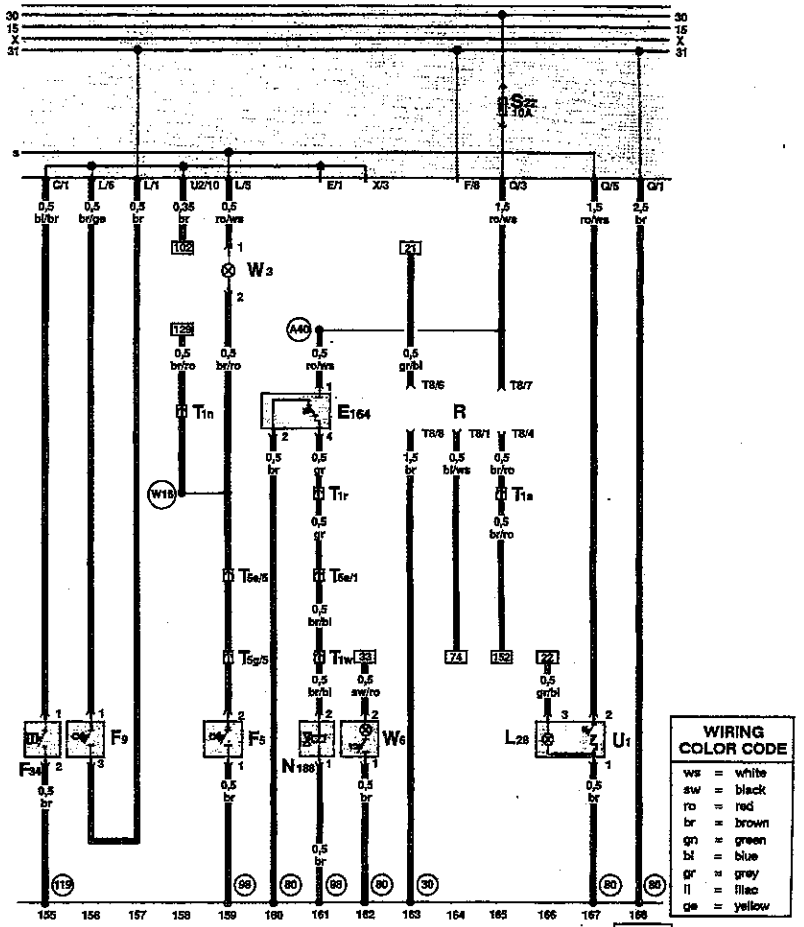
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E24 – Left Seat Belt Switch (00501)
F2 – Left Front Door Contact Switch
F3 – Right Front Door Contact Switch
F10 – Left Rear Door Contact Switch
F11 – Right Rear Door Contact Switch
J34 – Seat Belt Warning System Relay
L50 – Center Rear Ashtray Light
T1o – Single Connector, behind fuse/relay panel
T1g – Single Connector, behind fuse/relay panel
T1y – Single Connector, behind fuse/relay panel
T2c – Double Connector, on right A-pillar, lower part
T2d – Double Connector, on left A-pillar, lower part
T2f – Double Connector, behind console
T5e – 5-Pin Connector, in luggage compartment, left rear
T5l – 5-Pin Connector, behind fuse/relay panel
T5g – 5-Pin Connector, on rear apron
W – Front Interior Light
X – License Plate Light

(30) – Ground connection -1-, beside fuse/relay panel
(98) – Ground connection, in rear lid wiring harness
(105) – Ground connection -1-, in alarm system wiring harness
(195) – Ground connection, in rear door contact switch wiring harness
(196) – Ground connection -1-, in rear wiring harness
C65 – Wire connection, in seat belt warning system wiring harness
R8 – Wire connection (door contact switch), in rear door contact switch wiring harness
R9 – Wire connection (door contact switch), in rear door wiring harness
W2 – Plus connection (58), in rear wiring harness
W9 – Plus connection (30), in rear wiring harness
W11 – Wire connection (58), in rear lid wiring harness



## Luggage compartment release solenoid, luggage compartment light, brake switches



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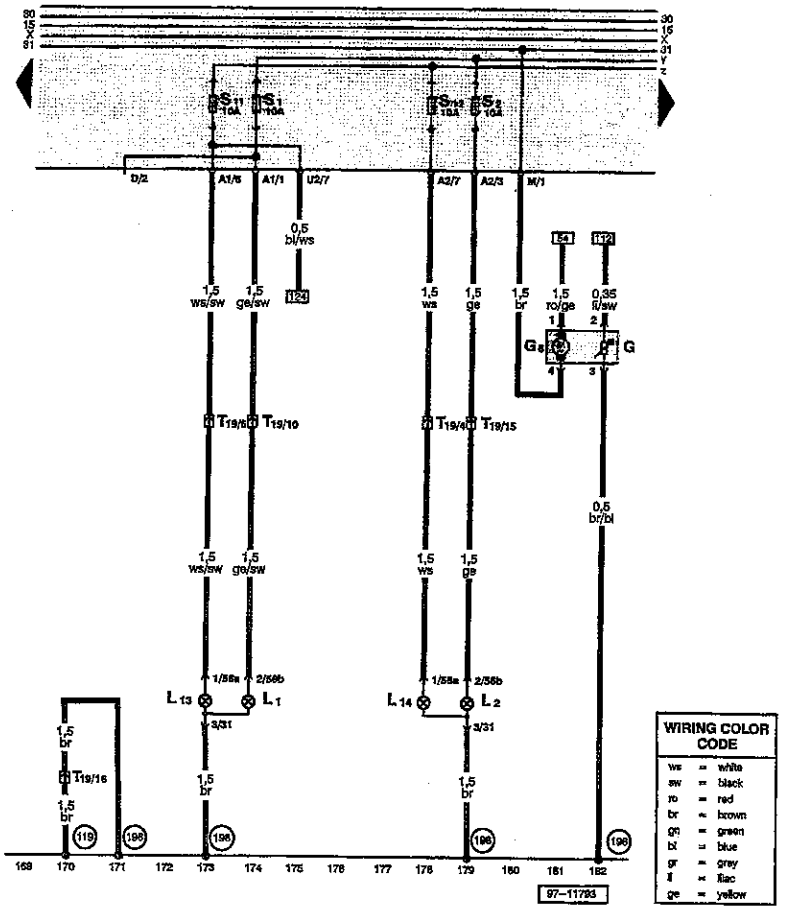
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E164 – Luggage Compartment Release Switch
F5 – Luggage Compartment Light Switch
F9 – Parking Brake Warning Light Switch (01114)
F34 – Brake Fluid Level Warning Switch
L28 – Cigarette Lighter Light
N188 – Luggage Compartment Release Solenoid
R – Radio
T1a – Single Connector, behind fuse/relay panel
T1r – Single Connector, behind fuse/relay panel
T1w – Single Connector, on rear apron
T1h – Single Connector, behind fuse/relay panel
T5e – 5-Pin Connector, in luggage compartment, left rear
T5g – 5-Pin Connector, on rear apron
T8 – 8-Pin Connector, on radio
U1 – Cigarette Lighter
W3 – Luggage Compartment Light
W6 – Glove Compartment Light (not applicable on vehicles wit passenger side airbag)

(30) – Ground connection -1-, beside fuse/relay panel
(80) – Ground connection -1-, in instrument panel wiring harness
(98) – Ground connection, in rear lid wiring harness
(119) – Ground connection -1-, in headlight wiring harness
A40 – Plus connection (30), in instrument cluster wiring harness
W16 – Wire connection, in rear lid wiring harness




WIRING COLOR CODE

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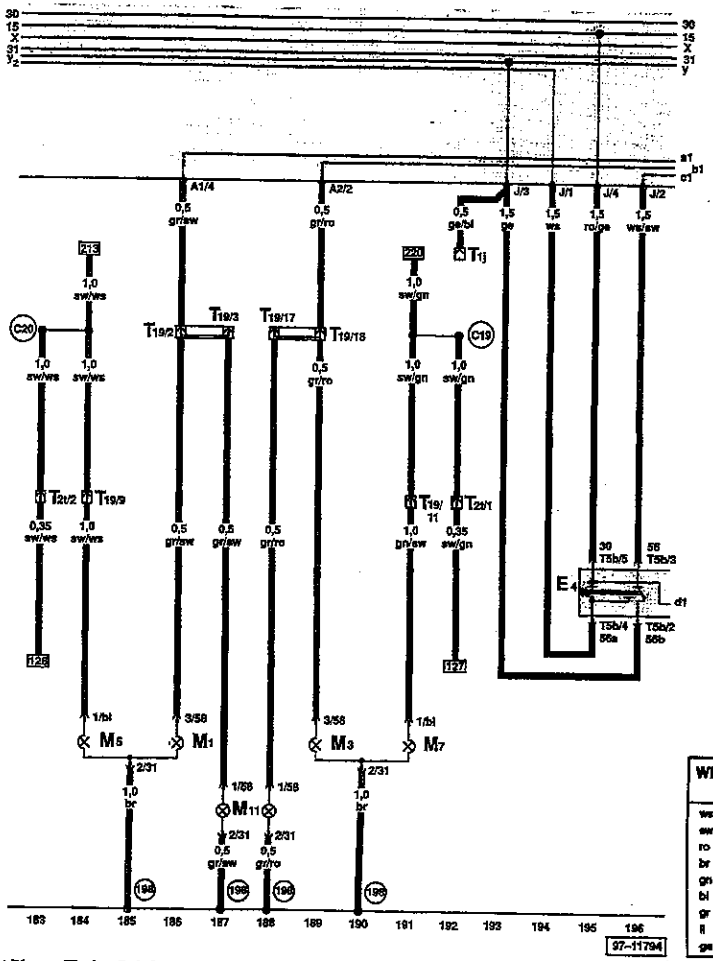
| ro | = | red |
| br | = | brown |
| gn | = | green |
| bl | = | blue |
| gr | = | grey |
| li | = | lilac |
| ge | = | yellow |

G – Fuel Level Sensor
G6 – Fuel Pump (FP)
L1 – Left Headlight
L2 – Right Headlight
L13 – Left High Beam Headlight
L14 – Right High Beam Headlight
T19 – 19-Pin Connector, behind radiator grill, center
(119) – Ground connection –1–, in headlight wiring harness
(196) – Ground connection –1–, in rear wiring harness
(198) – Ground connection, in front light wiring harness




WIRING COLOR CODE

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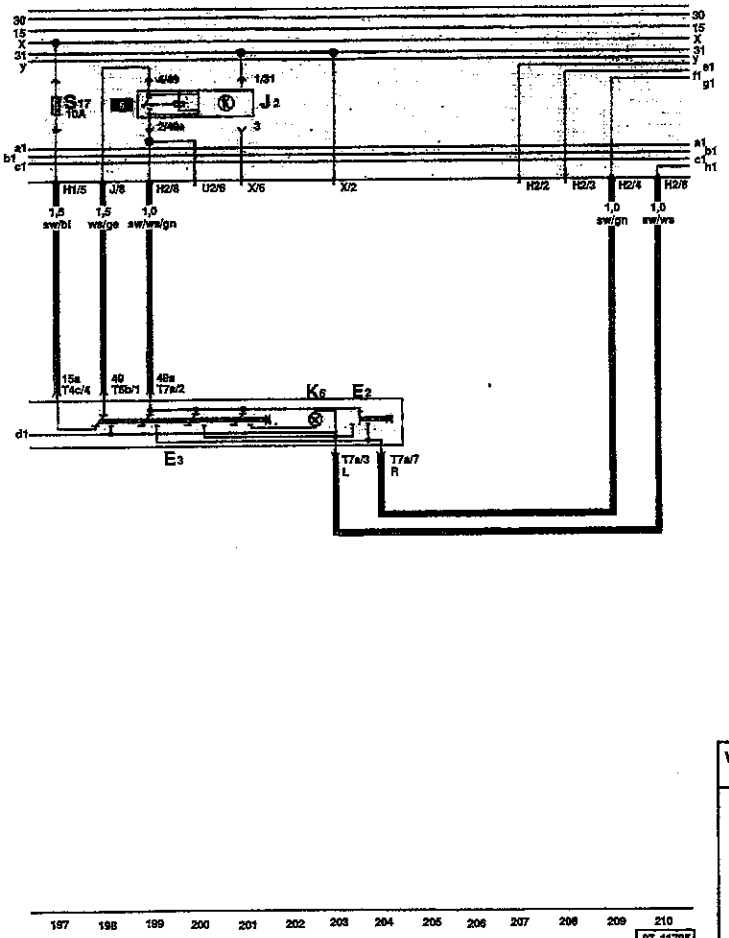
| sw | = | black |
| ro | = | red |
| br | = | brown |
| gn | = | green |
| bl | = | blue |
| gr | = | grey |
| li | = | lilac |
| ge | = | yellow |

E4 – Headlight Dimmer/Flasher Switch
M1 – Left Parking Light
M3 – Right Parking Light
M5 – Left Front Turn Signal Light
M7 – Right Front Turn Signal Light
M11 – Front Side Marker Lights
T1j – Single Connector, behind fuse/relay panel
T2t – Double Connector, behind fuse/relay panel
T5b – 5-Pin Connector, behind steering column switch cover
T19 – 19-Pin Connector, behind radiator grille, right
(198) – Ground connection, in front light wiring harness
(C19) – Wire connection (right turn signal), in headlight wiring harness
(C20) – Wire connection (left turn signal), in headlight wiring harness

## Turn signal switch, emergency flasher switch/relay

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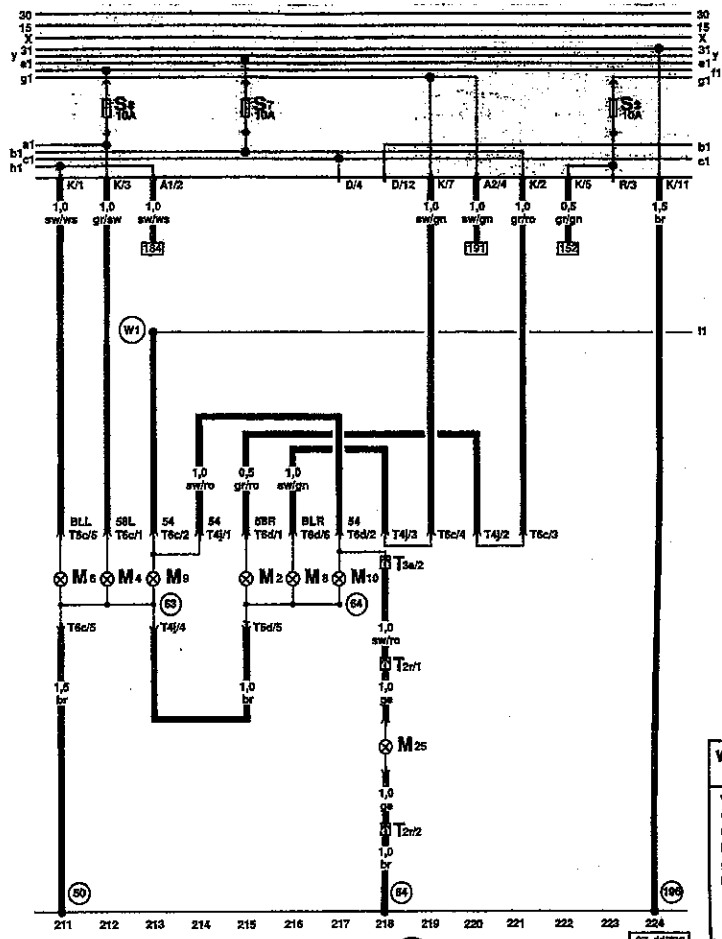
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E2 – Turn Signal Switch
E3 – Emergency Flasher Switch
J2 – Emergency Flasher Relay
K6 – Emergency Flasher Warning Light

T4c – 4-Pin Connector, behind steering column switch cover
T5b – 5-Pin Connector, behind steering column switch cover
T7a – 7-Pin Connector, behind steering column switch cover








| WIRING COLOR CODE | |
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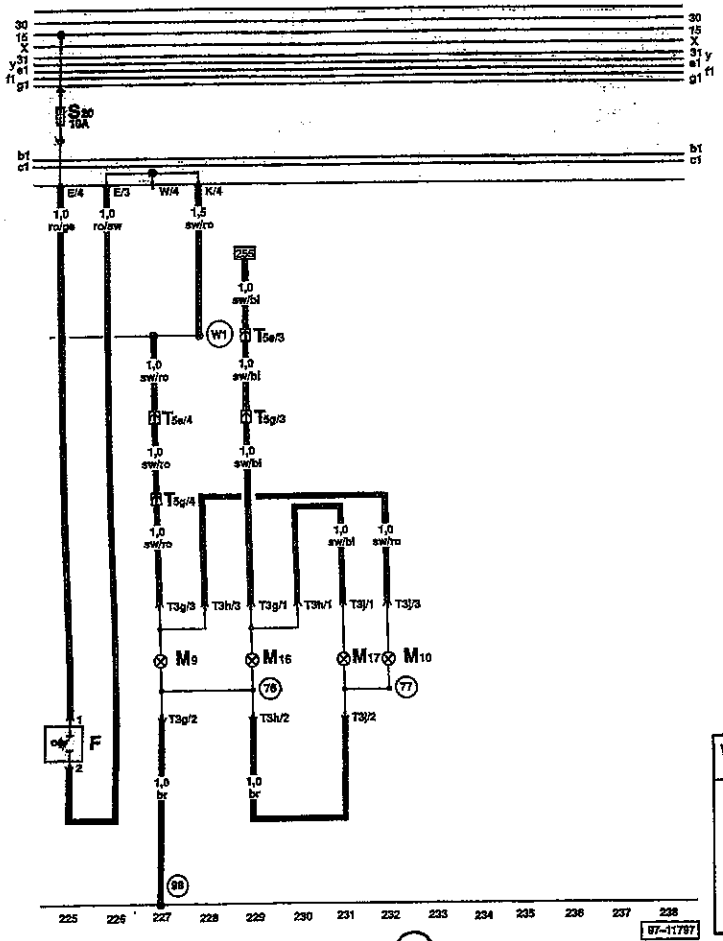
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

M2 – Right Taillight
M4 – Left Taillight
M6 – Left Rear Turn Signal Light
M8 – Right Rear Turn Signal Light
M9 – Left Brake Light
M10 – Right Brake Light
M25 – High-Mount Brake Light
T2r – Double Connector, in luggage compartment, right rear
T3e – 3-Pin Connector, on right taillight
T4j – 4-Pin Connector, on left taillight
T6c – 6-Pin Connector, on left taillight
T6d – 6-Pin Connector, on right taillight

50 – Ground connection, in luggage compartment, left
63 – Ground connection, on left taillight bulb holder
64 – Ground connection, on right taillight bulb holder
196 – Ground connection -1-, in rear wiring harness
W1 – Plus connection (54), in rear wiring harness




| WIRING COLOR CODE | |
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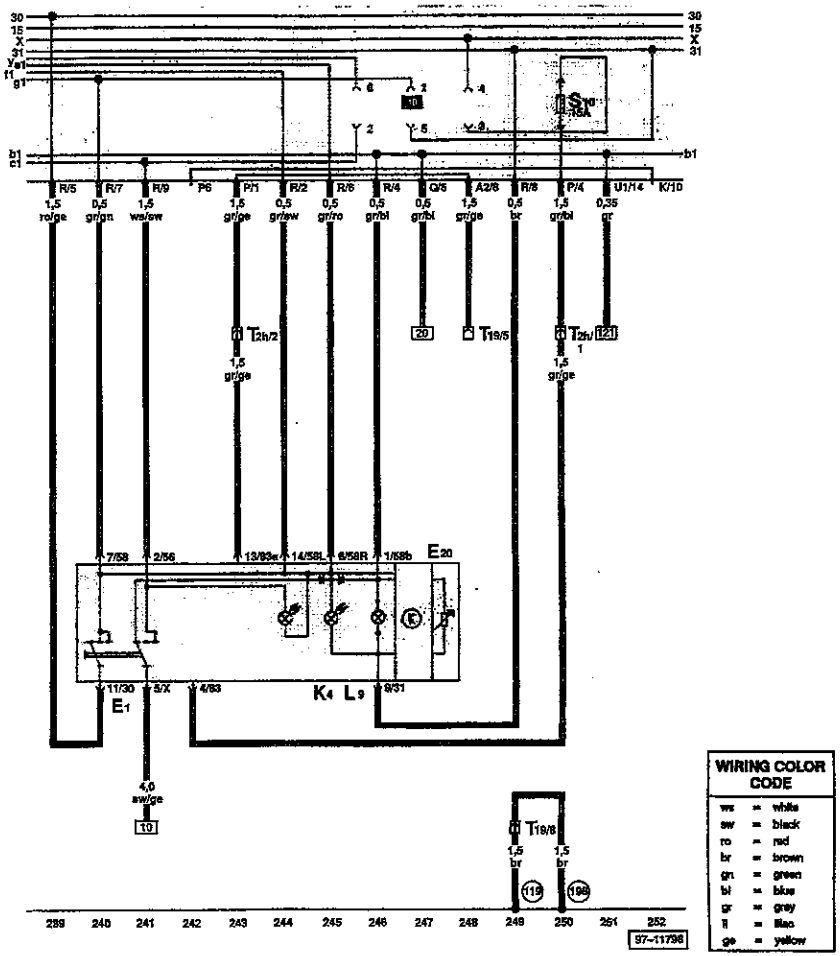
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

F – Brake Light Switch (00526-2131)
M9 – Left Brake Light
M10 – Right Brake Light
M16 – Left Back-Up Light
M17 – Right Back-Up Light
T3j – 3-Pin Connector, on right taillight
T3h – 3-Pin Connector, on left taillight
T3g – 3-Pin Connector, on left taillight
T5e – 5-Pin Connector, on rear apron
T5g – 5-Pin Connector, on rear apron

76 – Ground connection, on left taillight bulb holder
77 – Ground connection, on right taillight bulb holder
98 – Ground connection, in rear lid wiring harness
W1 – Plus connection (54), in rear wiring harness




| WIRING COLOR CODE | |
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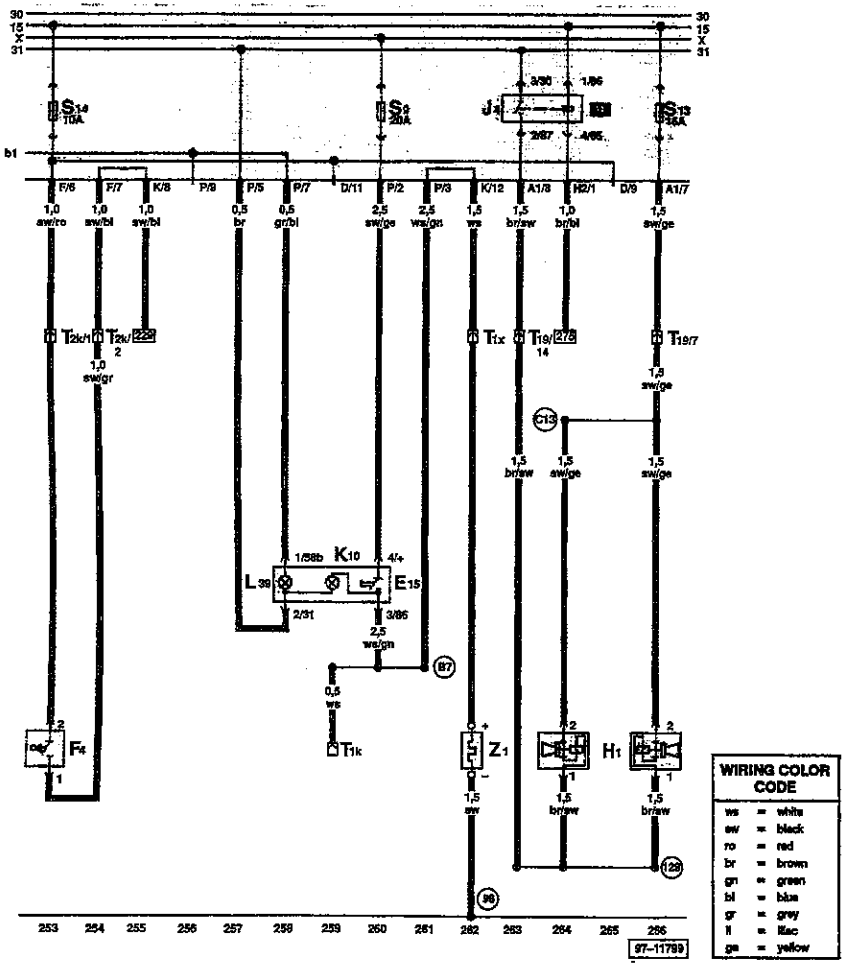
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E1 – Light Switch
E20 – Instrument Panel Light Dimmer Switch
K4 – Park Light Indicator Light
L9 – Headlight Switch Light
T2h – Double Connector, behind fuse/relay panel
T19 – 19-Pin Connector, behind radiator grille, right

119 – Ground connection -1-, in headlight wiring harness
198 – Ground connection, in front light wiring harness

## Horns, rear window defogger



| WIRING COLOR CODE | |
|---|---|
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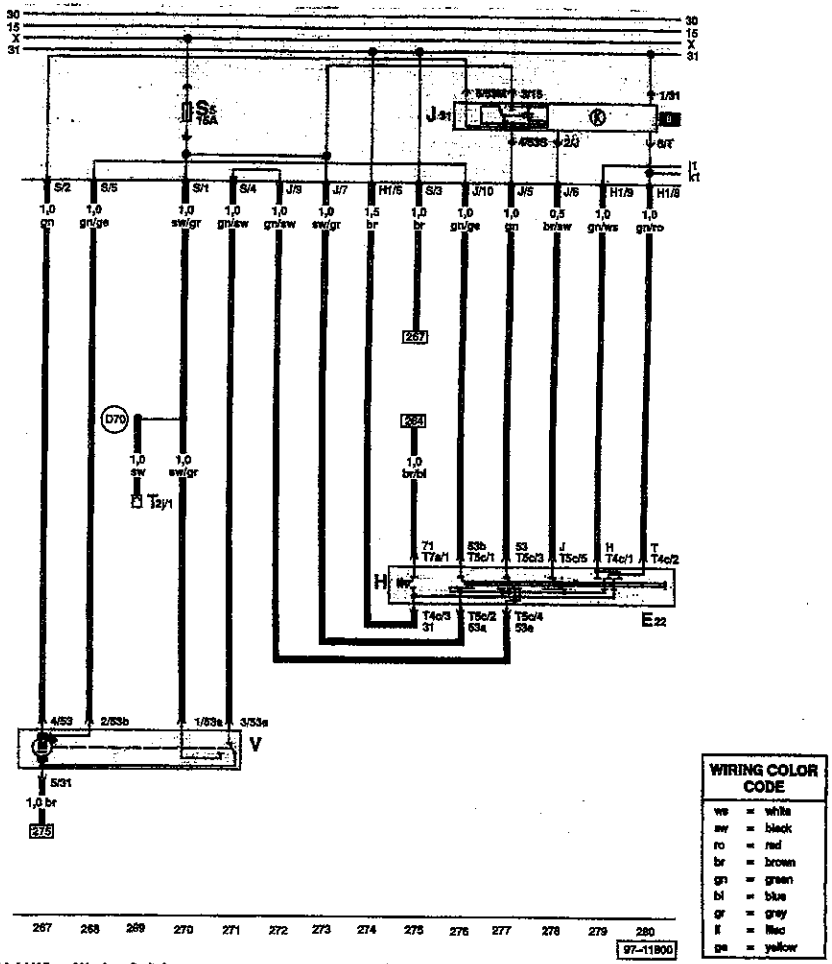
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E15 – Rear Window Defogger Switch
F4 – Back-Up Light Switch
H1 – Dual Horns
J4 – Dual Horn Relay
K10 – Rear Window Defogger Indicator Light
L39 – Rear Window Defogger Switch Light
T1x – Single Connector, in luggage compartment, left
T1k – Single Connector, behind fuse/relay panel
T2k – Double Connector, behind fuse/relay panel
T19 – 19-Pin Connector, behind radiator grille, right
Z1 – Rear Window Defogger/Heat Element
(129) – Ground connection, in dual-tone horn wiring harness
(B7) – Wire connection (86), in rear window defogger wiring harness
(C13) – Plus connection, in dual-tone horn wiring harness



## Windshield wiper motor, windshield wiper/washer switch



| WIRING COLOR CODE | |
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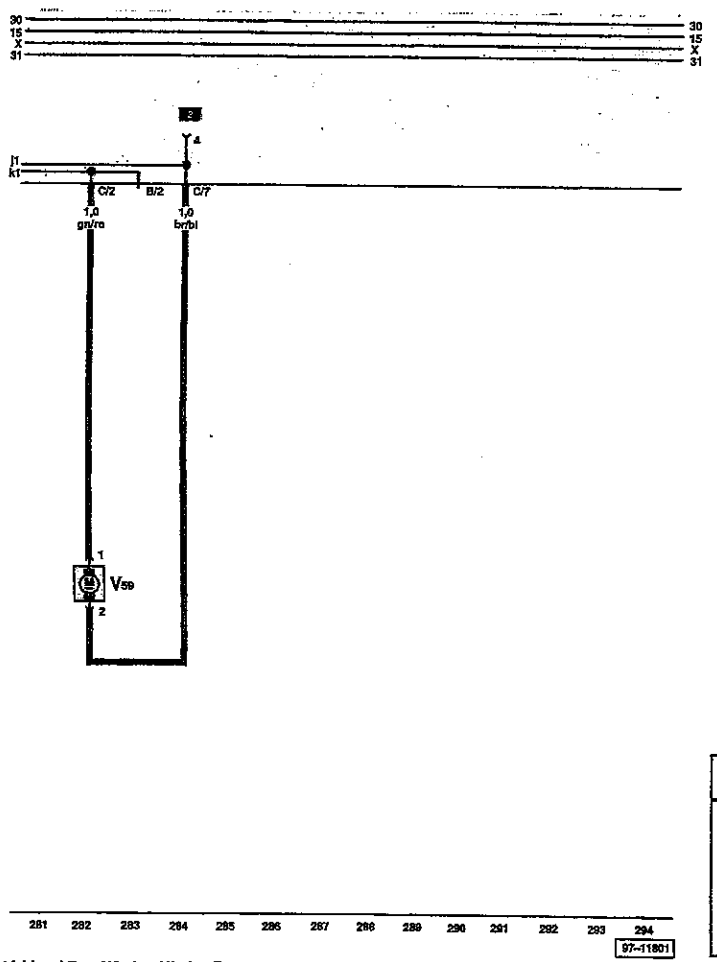
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E22 – Windshield Wiper/Washer Switch
H – Horn Button
J31 – Wiper/Washer Intermittent Relay
T2j – Double Connector, behind fuse/relay panel
T4c – 4-Pin Connector, on E22
T5c – 5-Pin Connector, behind steering column switch cover
T7a – 7-Pin Connector, behind steering column switch cover
V – Windshield Wiper Motor
(D70) – Wire connection (58a), in engine compartment wiring harness




V59 – Windshield and Rear Window Washer Pump

| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
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| li | = lilac |
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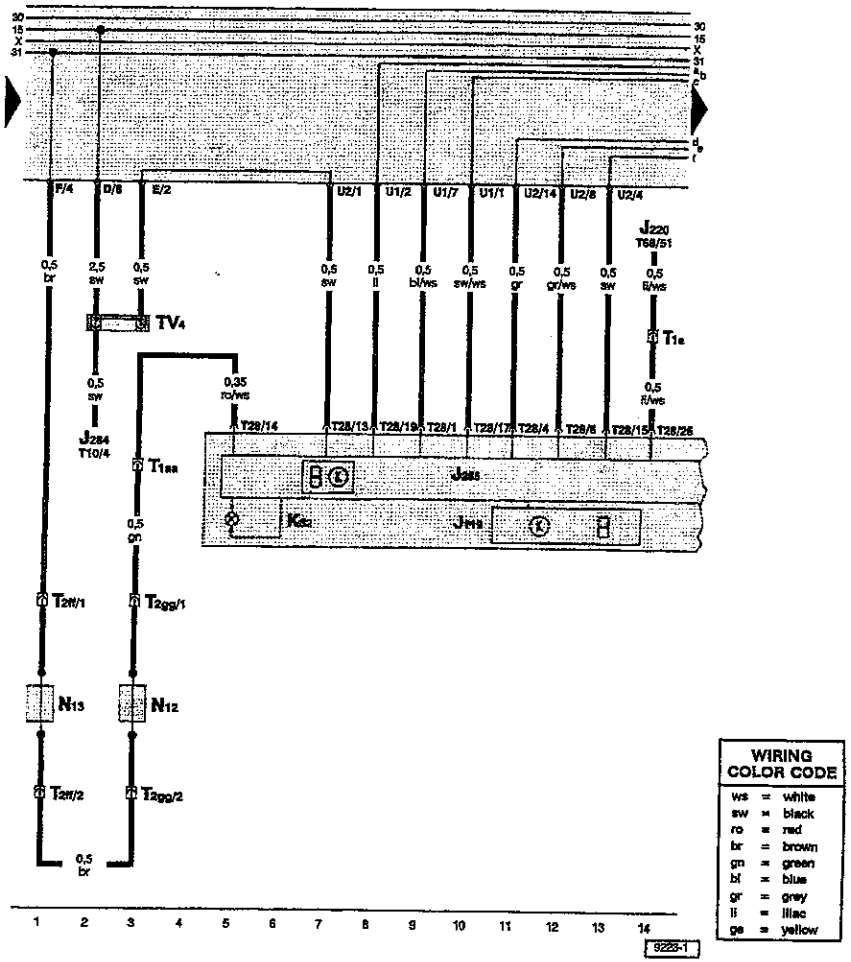


| WIRING COLOR CODE | |
|---|---|
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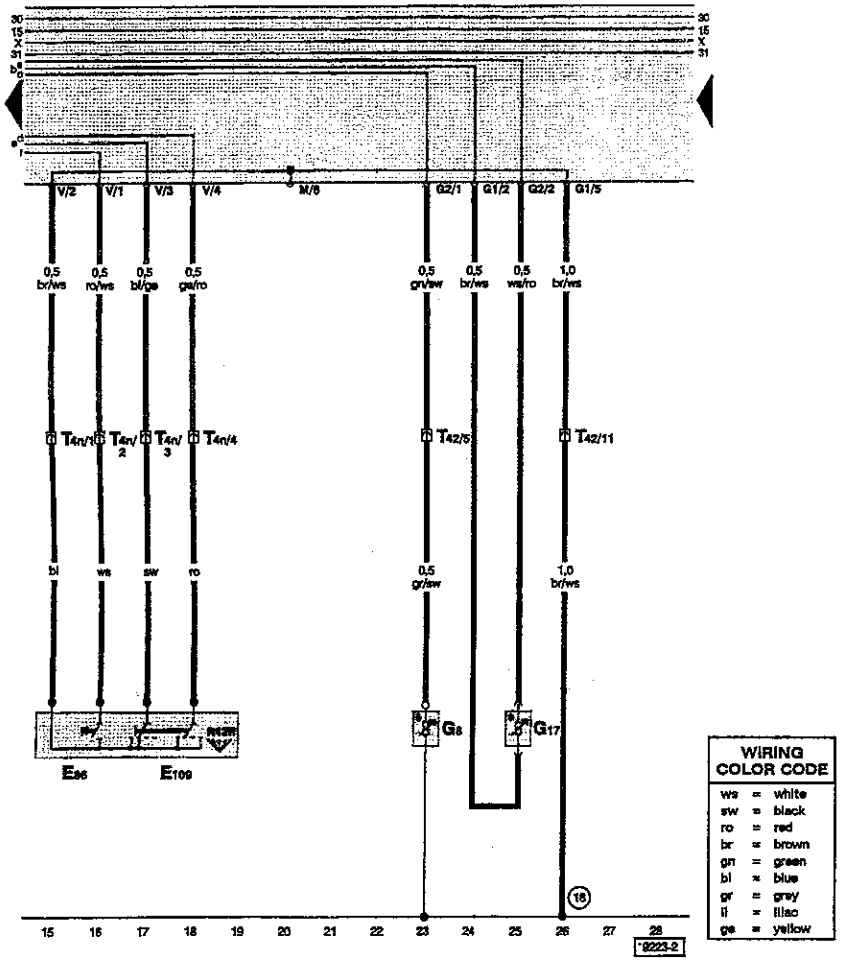
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

J119 - Multi-Function Indicator
J220 - Motronic Engine Control Module (ECM)
J284 - Alarm System Control Module
J285 - Control Module With Display Unit In Instrument Cluster
K32 - Brake Pad Wear Indicator Light
N12 - Brake Pad Wear Indicator, Right (Sheer Element)
N13 - Brake Pad Wear Indicator, Left (Sheer Element)
T1aa - Connector, Single, behind fuse/relay panel
T1e - Connector, Single, behind fuse/relay panel
T2ff - Connector, Double, behind fuse/relay panel
T2gg - Connector, Double, engine compartment, right
T10 - Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T28 - Connector, 28 Pin, on instrument cluster
T68 - Connector, 68 Pin, under right side of bonnet, on Motronic Engine Control Module (ECM)
TV4 - Connector, terminal 15

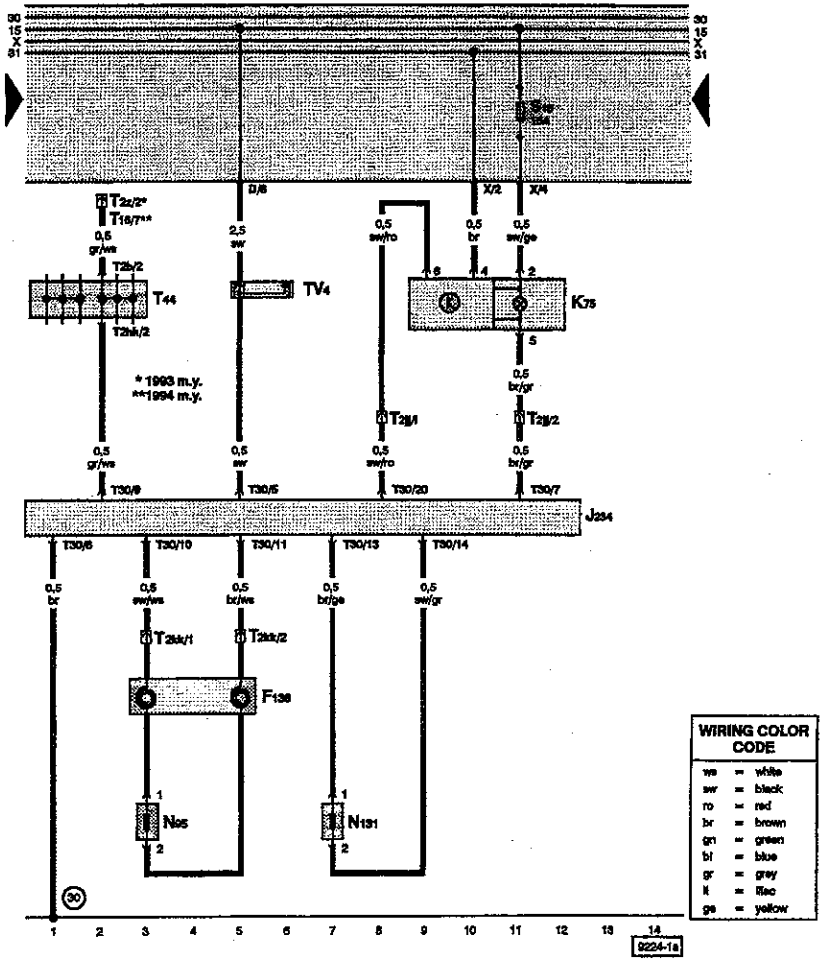
## Brake wear sensor, multi-function indicator



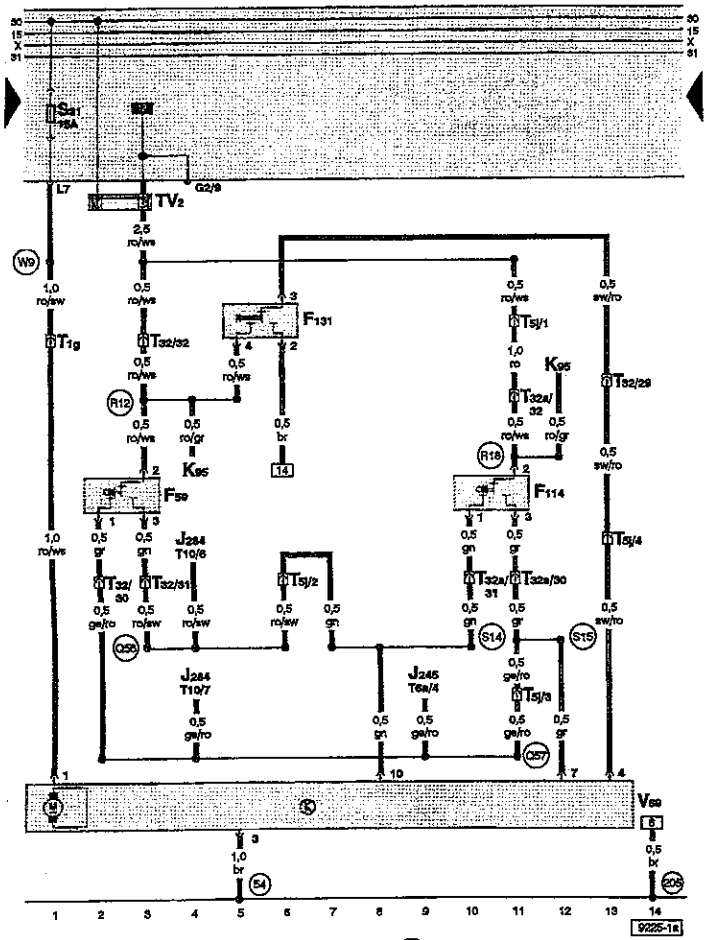

E86 - Multi-Function Indicator Mode Select Switch
E109 - Multi-Function Indicator Memory Switch
G8 - Oil Temperature Sensor
G17 - Outside Air Temperature Sensor
T4n - Connector 4 pin
T42 - Connector, 42 pin, left side of engine
(18) - Ground connection, on engine block



## Driver and front passenger airbags




F138 - Airbag Spiral Spring
J234 - Airbag Control Module
K75 - Airbag Malfunction Indicator Lamp (MIL)
N95 - Driver's Side Airbag Ignitor
N131 - Passenger's Side Airbag Ignitor 1
T2b - Connector, Double, on junction connector (T44) above fuse/relay panel
T2hh - Connector, Double, on junction connector (T44) above fuse/relay panel
T2jj - Connector, Double, behind fuse/relay panel
T2kk - Connector, Double, behind fuse/relay panel
T2z - Data Link Connector (DLC), behind center of dash panel
T16 - Data Link Connector (DLC), behind center of dash panel
T30 - Connector, 30 pin, on Airbag Control Module
T44 - Junction Box for On Board Diagnostic, above fuse/relay panel
TV4 - Connector, terminal 15
(30) - Ground connection, beside fuse/relay panel

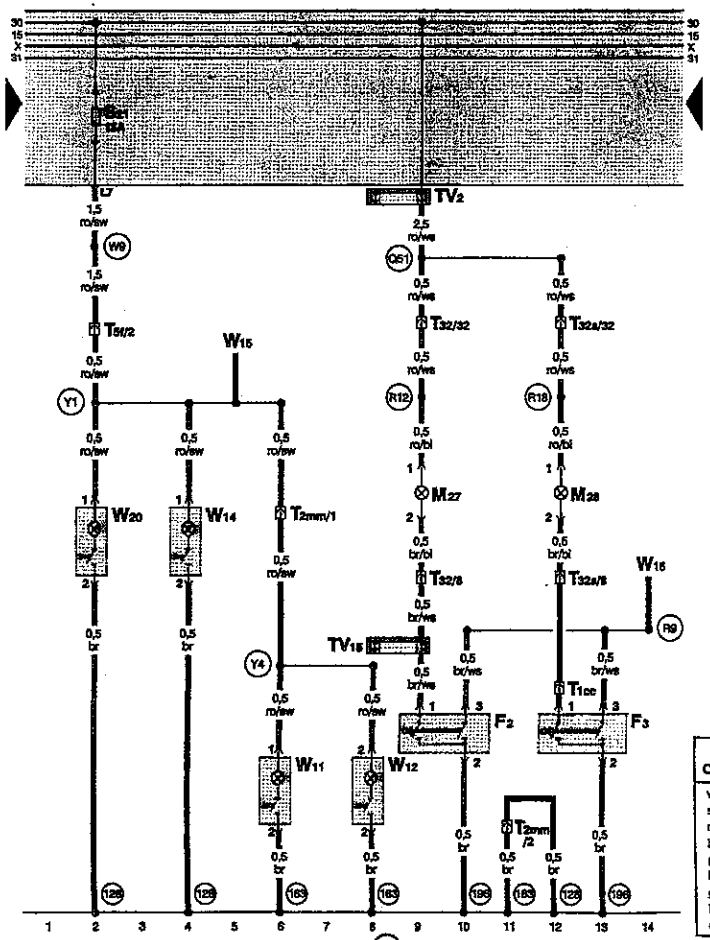


| WIRING COLOR CODE | | |
|---|---|---|
| ws | = | white |
| sw | = | black |
| ro | = | red |
| br | = | brown |
| gn | = | green |
| bl | = | blue |
| gr | = | grey |
| li | = | lilac |
| ge | = | yellow |

F59 - Central Locking System Door Switch, Driver's Door
F114 - Central Locking System Door Switch, Passenger's Door
F131 - Left Front Central Locking System Activator/Switch
J245 - Power Sunroof Control Module
J284 - Alarm System Control Module
K95 - Alarm System Indicator Light
V99 - Central Locking System Pump and Control Module
T1g - Connector, Single, behind fuse/relay panel
T5f - Connector, 5 pin, behind dash, left
T6a - Connector, 6 Pin, behind interior light, on Power Sunroof Control Module
T10 - Connector, 10 Pin, behind dash panel, left, on Alarm System Control Module
T32 - Connector, 32 Pin, on A-pillar, lower left
T32a - Connector, 32 Pin, on A-pillar, lower right
TV2 - Wire connector, terminal 30 (B+)
(54) - Ground connection, on rear apron

(205) - Ground connection, in driver's door wiring harness
(Q56) - Wire connection (open), in alarm system wiring harness
(Q57) - Wire connection (closed), in alarm system wiring harness
(R12) - Plus connection -3- (30), in driver's door wiring harness
(R18) - Plus connection -3- (30), in passenger's door wiring harness
(S14) - Wire connection (open) in central locking system wiring harness
(S15) - Wire connection (closed) in central locking system wiring harness
(W9) - Plus connection (30), in rear wiring harness





| WIRING COLOR CODE | | |
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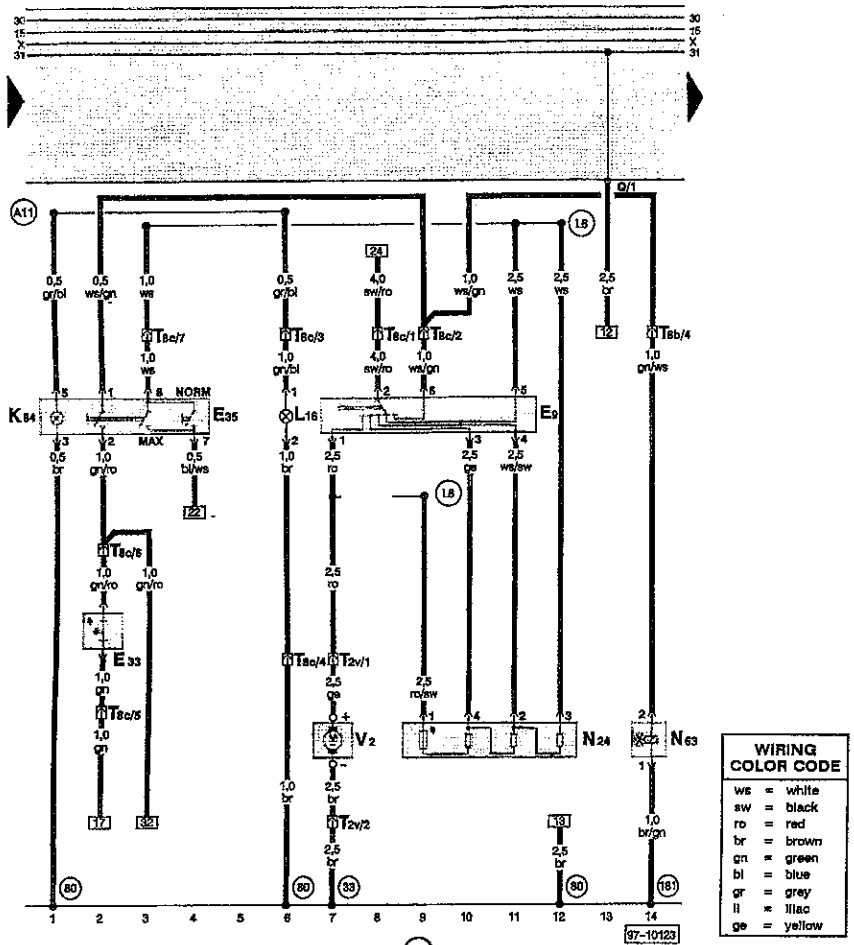
| ws | = | white |
| sw | = | black |
| ro | = | red |
| br | = | brown |
| gn | = | green |
| bl | = | blue |
| gr | = | grey |
| li | = | lilac |
| ge | = | yellow |

F2 - Door Contact Switch, Left Front
F3 - Door Contact Switch, Right Front
M27 - Left Door Warning Light
M28 - Right Door Warning Light
W11 - Reading Light, Left Rear
W12 - Reading Light, Right Rear
W14 - Make-up Mirror Light, Right
W15 - Interior Light with Delay Switch
W20 - Make-up Mirror Light, Left
T1cc - Connector, Single, behind fuse/relay panel
T2mm - Connector, Double
T5f - Connector, 5 Pin, above fuse/relay panel
T32 - Connector, 32 Pin, on A-pillar, lower left
T32a - Connector, 32 Pin, on A-pillar, lower right
TV2 - Wire connector, terminal 30
TV15 - Wire connector, door contact switch
(Q51) - Plus connection (30), in alarm system wiring harness

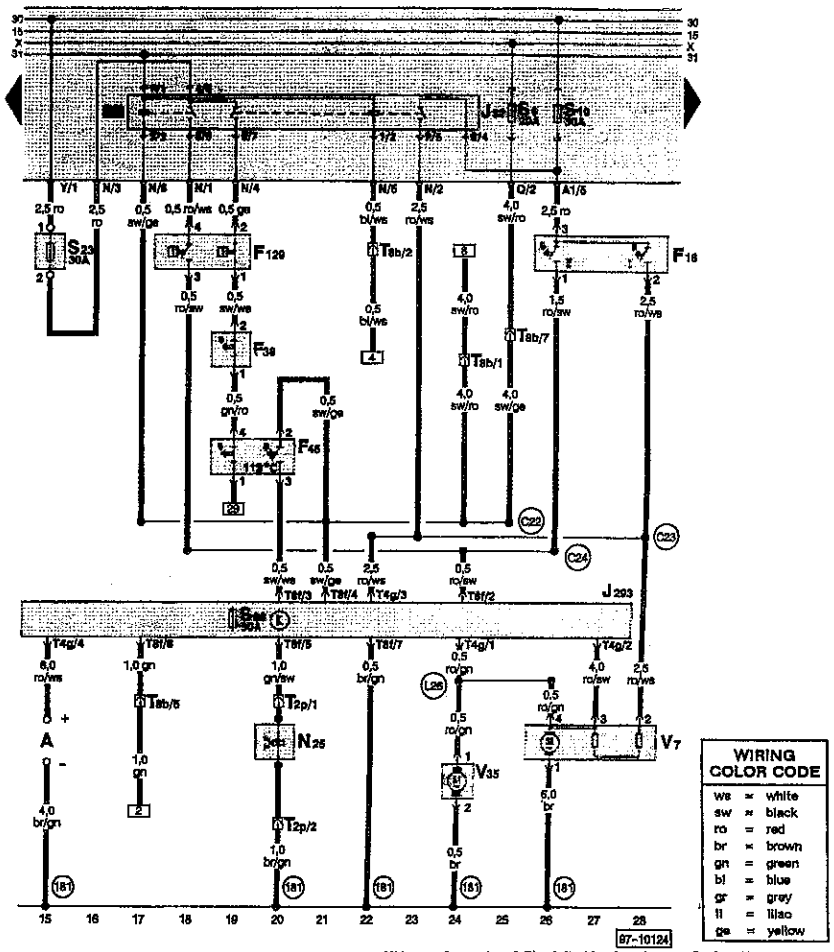
(R9) - Wire connection (30), in rear wiring harness 9227-4
(R12) - Plus connection -3- (30), in driver's door wiring harness
(R18) - Plus connection -3- (30), in passenger's door wiring harness
(W9) - Plus connection (30), in rear wiring harness
(Y1) - Plus connection (30), in interior light wiring harness
(Y4) - Plus connection (30), in reading light wiring harness
(128) - Ground connection -1-, in interior light wiring harness
(163) - Ground connection -2-, in interior light wiring harness
(196) - Ground connection -1-, in rear wiring harness

Air conditioning



| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E9 – Fresh Air Blower Switch
E33 – A/C Evaporator Temperature Switch
E35 – A/C Switch
K84 – A/C Indicator Light
L16 – Fresh Air Control Lever Light
N24 – Fresh Air Blower Series Resistance with Fuse
N63 – Fresh Air/Recirculating Flap Two-Way Valve
V2 – Fresh Air Blower
T2v – Connector, Double, below right side of dash at blower motor
T8b – Connector, 8 Pin, behind fuse/relay panel
T8c – Connector, 8 Pin, behind lower center of dash panel
(33) – Ground connection, behind instrument panel, right
(80) – Ground connection -1-, in instrument panel wiring harness
(181) – Ground connection (for A/C), in Engine compartment wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(L6) – Wire connection -2-, in evaporator housing wiring harness
(L8) – Wire connection -4-, in evaporator housing wiring harness



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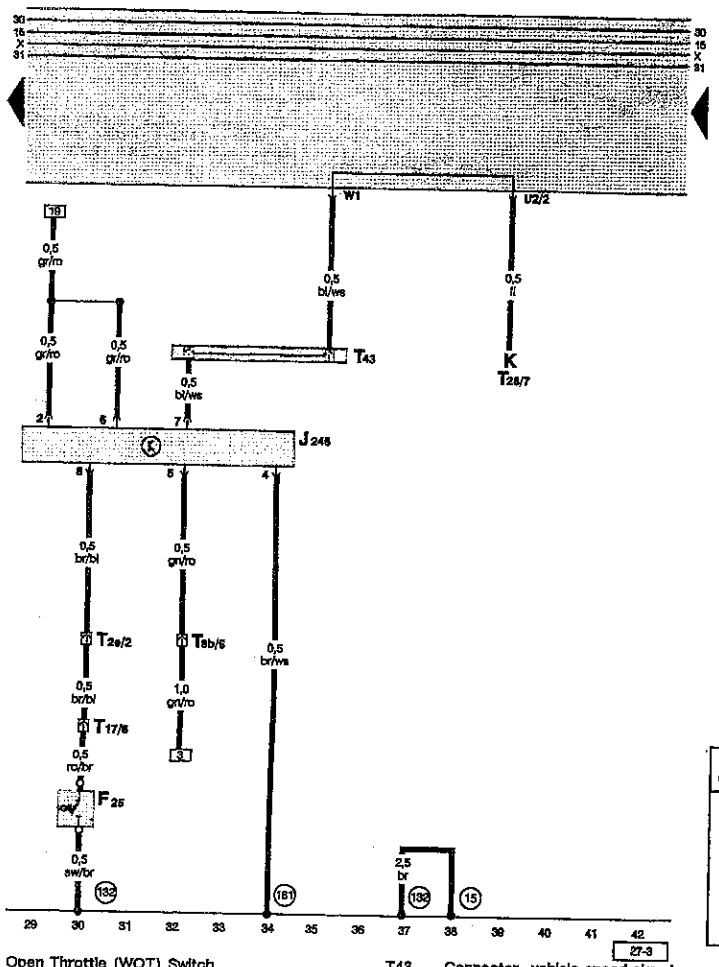
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

A – Battery
F18 – Coolant Fan Control (FC) Thermal Switch
F38 – Ambient Temperature Switch
F45 – A/C Thermal Switch
F129 – A/C Pressure Switch
J32 – A/C Relay
J293 – Coolant Fan Control (FC) Module
N25 – A/C Clutch
S23 – Heater Fuse
V7 – Coolant Fan
V35 – Coolant Fan, Right
T2p – Connector, Double, on compressor
T4g – Connector, 4 Pin, left side of engine, on Coolant Fan Control (FC) Module
T8b – Connector, 8 Pin, behind fuse/relay panel
T8f – Connector, 8 Pin, left side of engine, on Coolant Fan Control (FC) Module
(181) – Ground connection (for A/C), in Engine compartment wiring harness
(C22) – Wire connection (X), in headlight/air conditioner wiring harness
(C23) – Wire connection (blower, 1st speed) in headlight/air conditioner wiring harness
(C24) – Wire connection (blower, 2nd speed) in headlight/air conditioner wiring harness
(L26) – Wire connection (coolant fan), in Engine compartment wiring harness

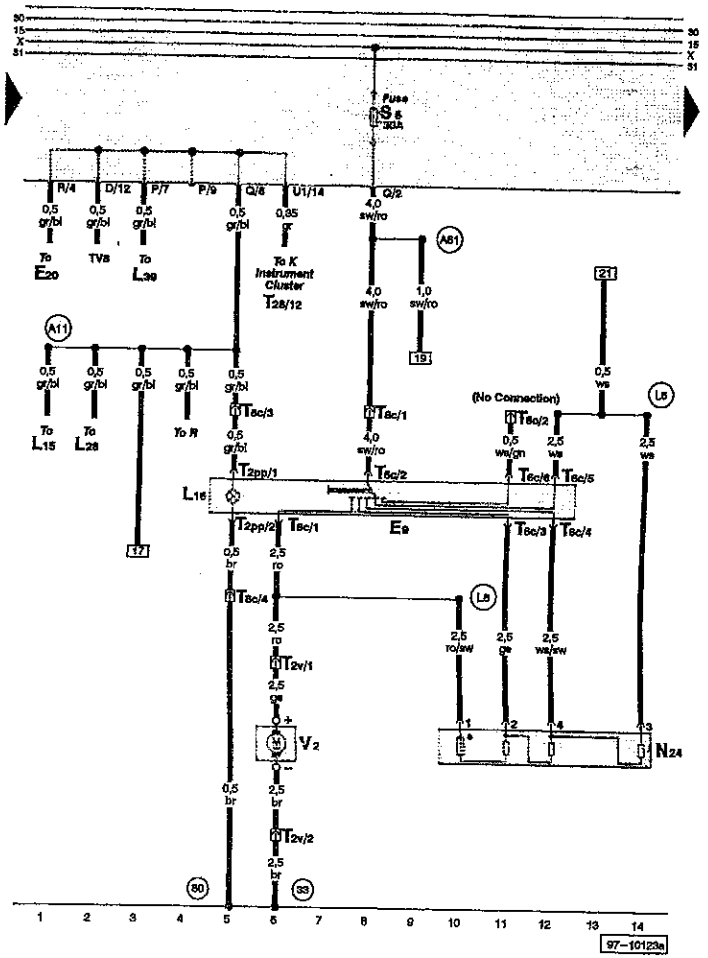
Air conditioning




F25 – Wide Open Throttle (WOT) Switch
J245 – A/C Clutch Cut Off Relay
K – Instrument Cluster
T2e – Connector, Double, behind fuse/relay panel, A/C connection
T8b – Connector, 8 pin, behind fuse/relay panel
T17 – Connector, 17 pin, on engine
T28 – Connector, 28 pin on instrument cluster

T43 – Connector, vehicle speed signal
(132) – Ground connection-3-in engine compartment wiring harness
(181) – Ground connection (for A/C), in Engine Compartment Wiring Harness
(15) – Ground connection, on cylinder head

| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

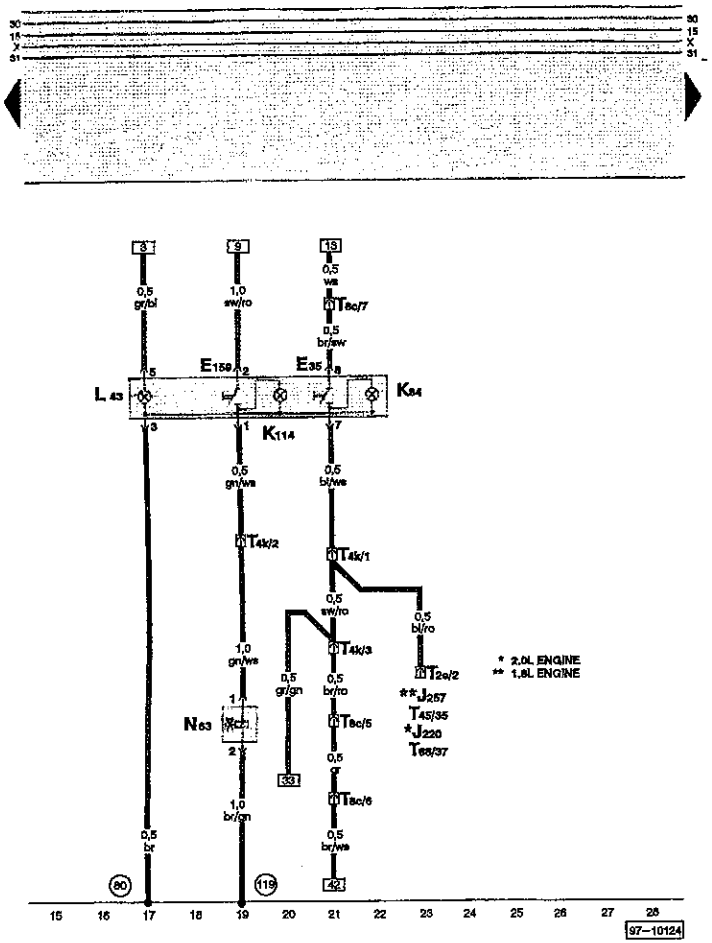



| WIRING COLOR CODE | |
|---|---|
| ws | = white |
| sw | = black |
| ro | = red |
| br | = brown |
| gn | = green |
| bl | = blue |
| gr | = grey |
| li | = lilac |
| ge | = yellow |

E9 – Fresh Air Blower Switch
E20 – Instrument Panel Light Dimmer Switch
K – Instrument Cluster
L15 – Ashtray Light
L16 – Fresh Air Control Lever Light
L28 – Cigarette Lighter Light
L39 – Rear Window Defogger Switch Light
N24 – Fresh Air Blower Series Resistance with Fuse
R – Radio
V2 – Fresh Air Blower
T2pp – Double Connector, on Fresh Air Blower Switch
T2v – Double Connector, below right side of dash at blower motor
T6c – 6-Pin Connector, on Fresh Air Blower Switch
T8c – 8-Pin Connector, behind lower center of dash panel
T28 – 28-Pin Connector, on Instrument Cluster

TV8 – Terminal 58b Wire Connector, top of fuse/relay panel
(33) – Ground connection, behind instrument panel, right
(80) – Ground connection -1-, in instrument panel wiring harness
(A11) – Plus connection (58b), in instrument panel wiring harness
(A61) – Plus connection (X), in instrument panel wiring harness
(L6) – Wire connection -2-, in evaporator housing wiring harness
(L8) – Wire connection -4-, in evaporator housing wiring harness

Air conditioning




| WIRING COLOR CODE | |
|---|---|
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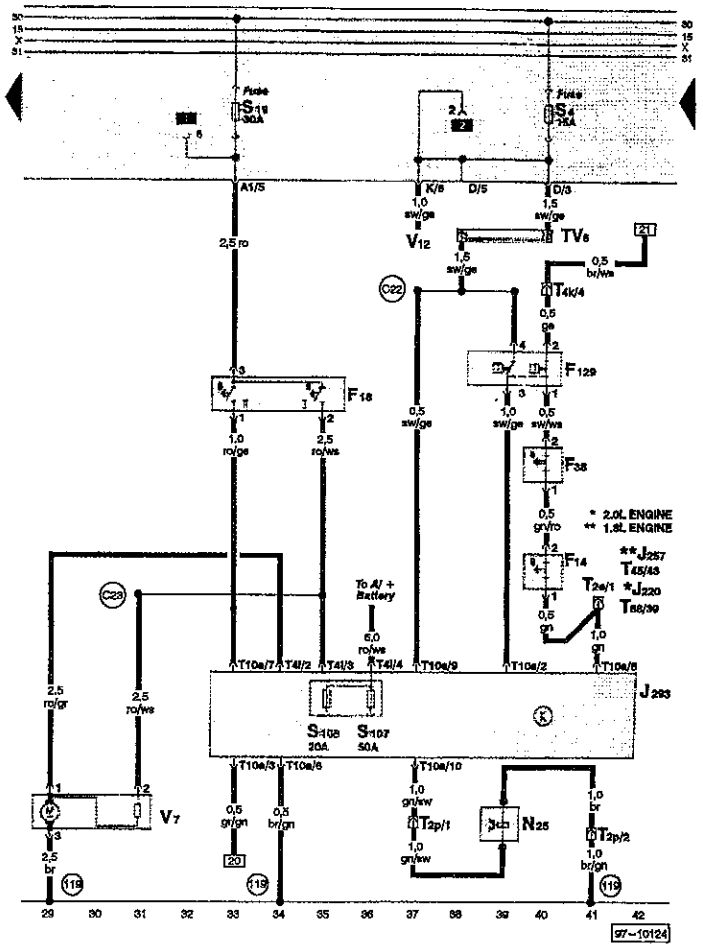
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

E35 – A/C Switch
E159 – Fresh Air/Recirculating Flap Switch
J220 – Motronic Engine Control Module (ECM)
J257 – Mono–Motronic Engine Control Module (ECM)
K84 – A/C Indicator Light
K114 – Fresh Air and Recirculation Air Mode Indicator Light
L43 – A/C Switch Illumination Light
N63 – Fresh Air/Recirculating Flap Two–Way Valve
T2e – Double Connector, behind fuse/relay panel, A/C Connection

T4k – 4–Pin Connector, behind fuse/relay panel
T8c – 8–Pin Connector, behind lower center of dash panel
T45 – 45–Pin Connector, on Mono–Motronic Engine Control Module (ECM)
T68 – 68–Pin Connector, under right side of hood, on Motronic Engine Control Module
(80) – Ground connection –1–, in instrument panel wiring harness
(119) – Ground connection –1–, in headlight wiring harness




| WIRING COLOR CODE | |
|---|---|
| ws | white |
| sw | black |
| ro | red |
| br | brown |
| gn | green |
| bl | blue |
| gr | grey |
| li | lilac |
| ge | yellow |

A – Battery
F14 – Engine Coolant Temperature (ECT) Warning Switch
F18 – Coolant Fan Control (FC) Thermal Switch
F38 – Ambient Temperature Switch
F129 – A/C Pressure Switch
J220 – Motronic Engine Control Module (ECM)
J257 – Mono–Motronic Engine Control Module (ECM)
J293 – Coolant Fan Control (FC) Control Module
N25 – A/C Clutch
V7 – Coolant Fan
V12 – Rear Window Wiper Motor
S107 – Coolant Fan Second and Third Speed Fuse
S108 – Coolant Fan First Speed and A/C Clutch Fuse
T2e – Double Connector, behind fuse/relay panel, A/C connection
T2p – Double Connector, on A/C compressor

T4k – 4–Pin Connector, behind fuse/relay panel
T4l – 4–Pin Connector, on Coolant Fan Control (FC) Control Module
T10a – 10–Pin Connector, on Coolant Fan Control (FC) Control Module
T45 – 45–Pin Connector, on Mono–Motronic Engine Control Module (ECM)
T68 – 68–Pin Connector, under right side of hood, on Motronic Engine Control Module (ECM)
TV6 – Terminal X Wire Connector, top of fuse/relay panel
(119) – Ground connection –1–, in headlight wiring harness
(C22) – Wire connection (X), in headlight/air conditioner wiring harness
(C23) – Wire connection (blower, 1st speed), in headlight/air conditioner wiring harness

**WARNING**

Your common sense, good judgement, and general alertness are crucial to safe and successful service work. Before attempting any work on your Volkswagen, read the warnings and cautions on page vii and the copyright page at the front of the manual. Review these warnings and cautions each time you prepare to work on your Volkswagen. Please also read any warnings and cautions that accompany the procedures in the manual.

## A



## B

# 2 INDEX

**WARNING**

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## F

**WARNING**

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# QUICK DATA

***WARNING —***

*Your common sense, good judgement, and general alertness are crucial to safe and successful service work. Before attempting any work on your Volkswagen, read the warnings and cautions on page vii and the copyright page at the front of the manual. Review these warnings and cautions each time you prepare to work on your Volkswagen. Please also read any warnings and cautions that accompany the procedures in the manual.*

## Engine (Repair Groups 10, 13, 15, 17)

| | |
|---|---|
| **Engine codes** | |
| ACC | 1.8 liter (Canada) |
| AAZ | 1.9 liter (Diesel) |
| AHU | 1.9 liter (TDI) |
| ABA | 2.0 liter, 8-valve |
| AAA | 2.8 liter (VR6) |
| Cylinder compression pressures (new engine) | |
| ACC engine | 130-174 psi (9-12 bar) |
| AAZ, AHU engine | 493 psi (34 bar) |
| ABA, AAA engine | 145–189 psi (10-13 bar) |
| **Engine oil capacity (with filter change)** | |
| ACC, ABA | 4.2 qt. (4.0 liters) |
| AAZ, AHU | 4.7 qt. (4.5 liters) |
| AAA engine | 5.8 qt. (5.5 liters) |
| **Engine oil drain plug** | |
| tightening torque | 30 Nm (22 ft-lb) |

## Cooling System (Repair Group 19)

| | |
|---|---|
| **Coolant mixture** | 50% anti-freeze/50% distilled water |
| **Coolant type** | Volkswagen G11 Anti-freeze |
| **System capacity** | |
| ACC, ABA engines | 5.8 qt. (5.5 liters) |
| AAZ engine | 6.8 qt. (6.5 liters) |
| AAA engine | 10.6 qt. (10.0 liters) |

## Fuel System (Repair Groups 20, 23, 24)

| | |
|---|---|
| **Fuel injection system** | |
| ACC | Bosch Mono-Motronic |
| AAZ | Diesel fuel injection |
| AHU | Turbo direct injection (diesel) |
| ABA, AAA | Bosch Motronic |
| **Fuel requirements** | |
| gasoline engines | unleaded RON 95 (min.) |
| diesel engines | CN 45 (min.) |
| **Fuel tank capacity** (approx.) | 14.5 gal. (55 liters) |
| **Idle speed** (non-adjustable) | |
| ACC engine | 750-1000 rpm |
| AAZ, AHU engine | 900±30 rpm |
| ABA engine | 840±40 rpm |
| AAA engine | 650-750 rpm |
| **Idle mixture** (gasoline engines) | |
| pre-catalytic converter | 0.2 to 1.2% CO |

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## Ignition System (Repair Group 28)

| | |
|---|---|
| **Spark plugs** | |
| ACC engine | Bosch W7DTC |
| ABA engine | Bosch FR8DS |
| AAA engine | NGK BKR 5 EKU |
| **Spark plug electrode gap** | |
| ABA engine | 0.6 mm (0.024 in.) |
| ACC engine | 0.7-0.9 mm (0.028-0.035 in.) |
| AAA engine | 0.7 mm (0.028 in.) |
| **Spark plug tightening torque** | |
| ABA engine | 30 Nm (25 ft-lb) |
| AAA, ACC engines | 25 Nm (18 ft-lb |
| **Firing order** | |
| 4-cyl. engines | 1–3–4– |
| 6-cyl. engine | 1–5–3–6–2– |
| **Ignition timing** | |
| ACC engine (adjustable) | 4-8° BTC |
| ABA engine (non-adjustable) | 2-15° BTDC |
| AAA engine (non-adjustable) | 3-9° BTDC* |

*Timing will vary depending on engine operating conditions

## Manual Transmission (Repair Groups 30, 34)

| | |
|---|---|
| **02A transmission (AAA, AHU engine)** | |
| fluid type | G50 synthetic oil, SAE 75W/90 |
| fluid capacity | 2.0 liters (2.1 qt.) |
| **020 transmission (ACC, AAZ, ABA engines)** | |
| fluid type | G50 synthetic oil, SAE 75W/90 |
| fluid capacity | 1.9 liters (2.0 qt.) |

## Automatic Transmission (Repair Group 37)

| | |
|---|---|
| **096 (Phase I) A/T** | |
| Transmission lubricant | Dexron ATF |
| Transmission capacity (drain and fill) | 3.0 liters (3.2 qt.) |
| Final drive lubricant | SAE 75W/90 synthetic gear oil |
| Final drive capacity | 0.75 L (0.79 qt.) |
| **01M (Phase II) A/T** | |
| Transmission lubricant | Genuine VW Synthetic ATF |
| **Transmission capacity** | |
| (drain and fill) | 3.0 liters (3.2 qt.) |
| **Final drive lubricant** | Genuine VW Synthetic ATF |
| **Final drive capacity** | 0.75 L (0.79 qt.) |

***CAUTION —***

*The 096 A/T uses Dexron ATF, while the 01M A/T uses a special VW-only ATF. Dexron is purple/brownish in color. VW ATF is yellowish in color. See* **3 Clutch, Transmission, and Final Drive–General** *for application information.*

## Brake System (Repair Groups 45, 46, 47)

| | |
|---|---|
| **Brake fluid** | SAE DOT 4 |
| **Brake pad wear limit, front and rear** | 7 mm (0.276 in.) |

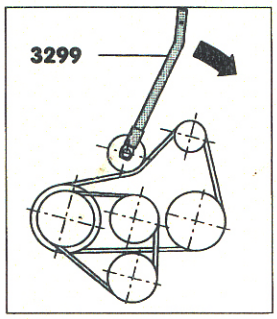
## Power Steering System (Repair Group 48)

| | |
|---|---|
| **System type** | power-assisted rack and pinion |
| **Fluid type** (hydraulic oil) | VW part no. G 002 000 |
| **Fluid capacity** | 0.7-0.9 liter (0.74-0.95 qt.) |

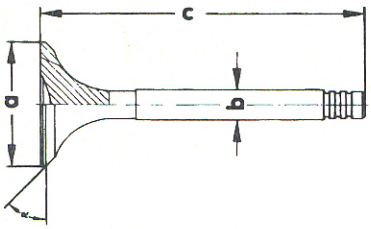
# Volkswagen
# Jetta, Golf, GTI, Cabrio
# 1993 through early 1999

Service to Volkswagen owners is of top priority to the Volkswagen organization and has always included the continuing development and introduction of new and expanded services. The aim throughout this manual has been simplicity, clarity and completeness, with practical explanations, step-by-step procedures, and accurate specifications. Whether you're a professional or a do-it-yourself Volkswagen owner, this manual will help you understand, care for, and repair your Volkswagen.

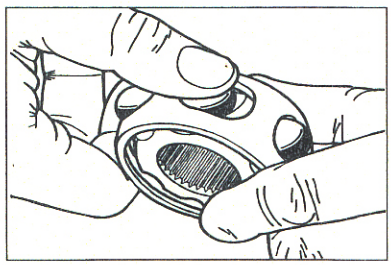
Though the do-it-yourself Volkswagen owner will find this manual indispensable as a source of the same detailed maintenance and repair information available at an authorized Volkswagen dealer, the Volkswagen owner who has no intention of working on his or her car will find that reading and owning this manual will make it possible to discuss repairs more intelligently with a professional technician.



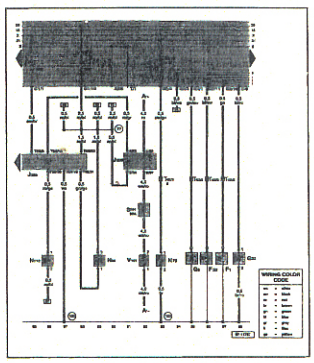

*See how to perform routine maintenance procedures, such as replacing the poly-ribbed drive belt.* **0 Maintenance Program**, *page 0-18*




*Cylinder head service and reconditioning, with valve specifications for 4-cylinder and 6-cylinder engines.* **15 Cylinder Head and Valvetrain**, *page 15a-14*



*Suspension troubleshooting, adjustment and repair, with procedures for inspecting and repairing CV joints.* **40 Front Suspension and Drive Axles**, *page 40-20*



*Electrical wiring diagrams for all models covered in this manual.* **97 Wiring Diagrams, Fuses and Relays**, *page 97-230*

**Features:**

- Covers all Volkswagen A3 models with "1H" or "1E" at position number 7 and 8 of 17-digit Vehicle Identification Number (VIN).
- Includes *Golf$_{III}$ and Jetta$_{III}$, CL, GL, LE, GLS, GLX, GTI, City, Wolfsburg, Trek and K2* editions (A3 models).
- Tune-up and maintenance procedures, including resetting the Service Reminder Indicator (SRI).
- Engine and cylinder head service, repair and reconditioning, including VR6 timing chain setup and adjustment.
- Troubleshooting and repair of Bosch Motronic, Bosch Mono-Motronic engine management systems and Diesel fuel injection.
- Emission control tests, repairs and adjustments, including Exhaust Gas Recirculation (EGR) and Secondary Air Injection (AIR) system.
- Transmission maintenance, troubleshooting, adjustment and repair, including 6-cylinder clutch hydraulics and automatic transmission cable shift.
- Complete adjustment and repair for "Plus" and "Base" suspension, including power-assisted rack and pinion service and repair.
- Disc/drum brake repair and troubleshooting, including anti-lock brakes (ABS) and traction control (EDL).
- Heating and ventilation repair, including blower motor replacement and air conditioning trouble diagnosis on CFC-free (R134a refrigerant) A/C system.
- Body adjustments and repairs, including Cabrio top and sunroof replacement and adjustment.
- Complete electrical wiring diagrams.
- Comprehensive Volkswagen factory tolerances, wear limits, adjustments, and tightening torques that you've come to expect from Bentley manuals.

***Engines and transmissions covered:***

**1.8 liter gasoline (engine code ACC)**
**1.9 liter turbo-diesel (engine code AAZ)**
**1.9 liter turbo-direct injection (engine code AHU)**
**2.0 liter gasoline (engine code ABA)**
**2.8 liter VR6 gasoline (engine code AAA)**
**020 and 02A 5-speed manual transmissions**
**096 and 01M 4-speed adaptive auto. transmissions**

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