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★ **NEW INFORMATION** since last filming

Electrical – Battery, Starter, Alternator

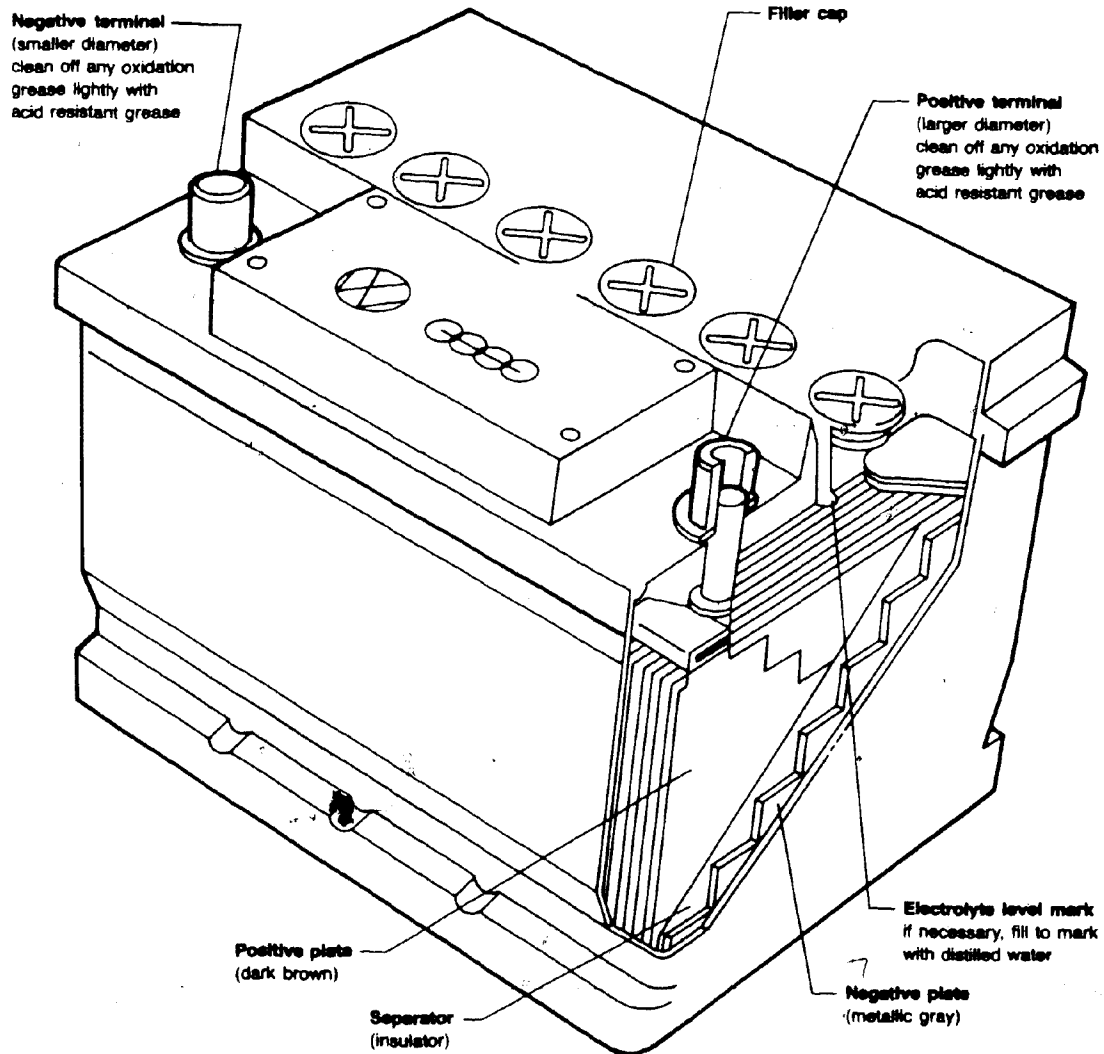
Battery, checking

Battery

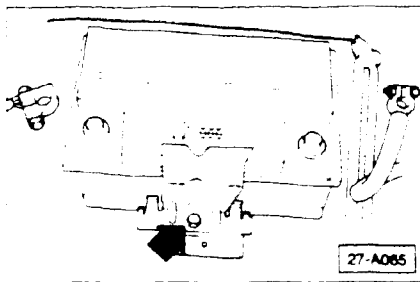
- specific gravity, checking 27.4
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CAUTION

Before beginning repairs on the electrical system, disconnect battery ground strap.



27-A088



Battery, removing and installing

Removing

- disconnect battery ground (–) cable
- disconnect battery positive (+) cable
- remove hold down clamp (arrow)

Installing

- ensure that battery is properly located and seated, attach hold down and tighten
- connect battery positive (+) cable
- connect battery ground (–) cable

WARNING

Battery acid can cause severe burns. When working with electrolyte always wear goggles, rubber gloves, and apron. If electrolyte is spilled on skin or clothing, flush at once with large quantities of water. If it gets into eyes, immediately flush with large quantities of water for several minutes and call a doctor.

Batteries produce explosive gases. Keep flames and sparks away from batteries. Do not smoke near batteries.

Specific gravity	% of charge
1.265	100%
1.225	75%
1.190	50%
1.155	25%
1.120	0%

CAUTION

Do not expose fully discharged battery to freezing temperature because battery will be damaged by freezing.

Battery

Battery precautions

Battery condition, checking

Weak battery can be caused by:

- alternator belt slipping (replace belt when glazed)
- ground straps corroded, loose or broken
- alternator or voltage regulator defective
- alternator warning light bulb burned out
- poor ground connection between warning light socket and circuit board

Battery terminals and cables should be coated with acid resistant grease and cleaned to prevent corrosion and ensure good contact.

Visual checks

- check for
 - cracked or leaking case
 - loose or corroded terminals
 - low electrolyte level. If electrolyte is low, refill with distilled water and fast charge battery for several minutes after cells begin gassing (boiling)

Hydrometer test (specific gravity) (for batteries with removable caps)

- test electrolyte in all cells
 - average specific gravity should be at least 1.225
- correct for electrolyte temperature if necessary
 - for every 10°F above 80°F add .004 to hydrometer reading
 - for every 10°F below 80°F subtract .004 from hydrometer reading

If specific gravity is above 1.225

- load test battery

If specific gravity is below 1.225

- recharge battery

If specific gravity varies by more than .050 between cells

- replace battery

WARNING

Gases given off during charging are explosive. Do **NOT** smoke or allow sparks or flame near a charging battery.

Battery charger **MUST** be turned off when connecting or disconnecting cables on battery.

"Boosting" a sulfated battery at a high charging rate can cause an explosion!

CAUTION

Do not allow battery charging voltage to exceed 17 volts.

If battery begins gassing (boiling) violently when charging, **REDUCE** charging rate.

Do **NOT** disconnect battery while engine is running

Specific gravity	Fast charge up to
1.150 or less	1 hour
1.150 to 1.175	3/4 hour
1.175 to 1.200	1/2 hour
1.200 to 1.225	1/4 hour
above 1.225	slow charge ONLY to 1.250-1.280

Battery, charging

Note

Follow battery charger manufacturer's instructions. Before testing a battery that has been charged, load battery with 15 amps for 1 minute to remove surface charge.

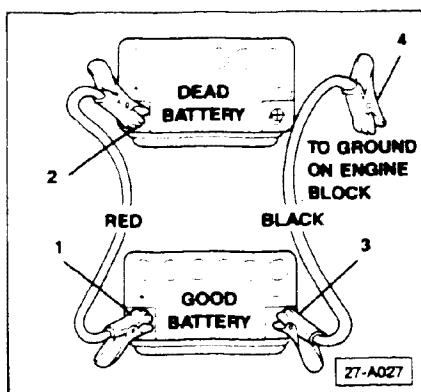
Battery with removable caps

If water is added, fast charge battery for a few minutes after battery begins gassing (boiling). Slow charging current should be approximately 10% of battery capacity. Fast charging should be approximately 80-90% of battery capacity. Remove cell caps while charging.

■ charge battery according to following table:

Sealed batteries

Only **slow** charge sealed batteries. Sealed batteries, sometimes called "maintenance free," will not accept high rate of charge, making it necessary to charge it for up to twice as long as battery with removable caps. Also, voltage reading will **NOT** increase as rapidly as when charging battery with removable caps.



Battery, jump starting

- car with good battery must **NOT** be running when connecting jumper cables
- connect jumper cables in following order:
 - 1 — one end of positive cable to + post of good battery
 - 2 — other end of positive cable to + post of dead battery
 - 3 — one end of negative cable to - post of good battery
 - 4 — other end of negative cable to engine block of car with dead battery
- start car which has good battery first
- next start car which has dead battery
- disconnect jumper cables in reverse order

Electrical – Battery, Starter, Alternator

Voltage	% of charge
12.6 or more	100%
12.4	75%
12.2	50%
12.0	25%
11.7 or less	0%

Battery voltage test — engine not running (for sealed batteries only)

- turn headlights on high beam for 1 minute to remove surface charge
- disconnect battery ground strap
- check battery voltage using multimeter US 1119
 - 12.4 volts minimum
- If above
- load test battery
- If below
- charge until 12.4 volts minimum

Load test

Note

Before load testing, battery must be at least 75% charged.

- connect load tester according to manufacturer's instructions
- load battery to 3 times amp/hour rating or 1/2 0°F cold cranking current rating
- wait 15 seconds and read voltage
 - battery voltage at room temperature should be 9.6 volts minimum

If NO

- replace battery

Note

If battery is colder than room temperature, voltage under load will be **lower**.

If battery must be tested cold:

- use table

Approximate electrolyte temp. °F (°C)	Minimum acceptable voltage under load
60 (16)	9.5
50 (10)	9.4
40 (4)	9.3
30 (-1)	9.1
20 (-7)	8.9
10 (-12)	8.7
0 (-18)	8.5

Electrical – Battery, Starter, Alternator

Battery discharges — troubleshooting

Current draw suspected

Check these first:

- fully charged battery
- clock disconnected

Battery discharges

Possible causes

- corroded terminals
- worn insulation
- internal short circuits in electrical equipment

- disconnect battery ground (–) strap
- connect test light between negative (–) battery terminal and ground strap
- turn off all electrical consumers
- close all doors

Test light lights up

Test light does not light up

- eliminate individual circuits by removing fuses
- if test light goes out in one of interrupted circuits, source of fault is to be found there

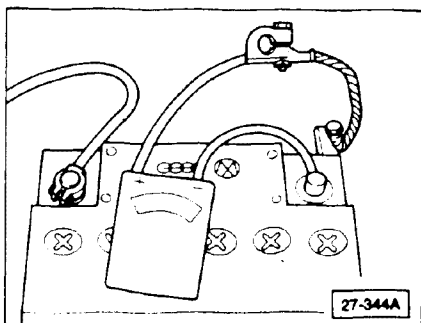
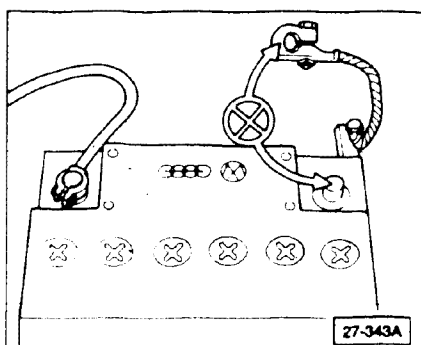
- in place of test light, connect ammeter (measuring range 0-200 Amp) between negative (–) battery terminal and battery ground strap
- reduce measuring range until a clear reading is shown (1-3 mA is permissible)

- eliminate individual circuits by removing fuses
- if reading drops to zero in one of interrupted circuits, source of fault is to be found there

- if no faults are found in fused circuits, disconnect wiring connectors from nonfused components:
 - alternator
 - starter
 - ignition system
 - cluster instruments
 - coolant fan and so on until defective circuit or component is discovered

- repair or replace as necessary

End

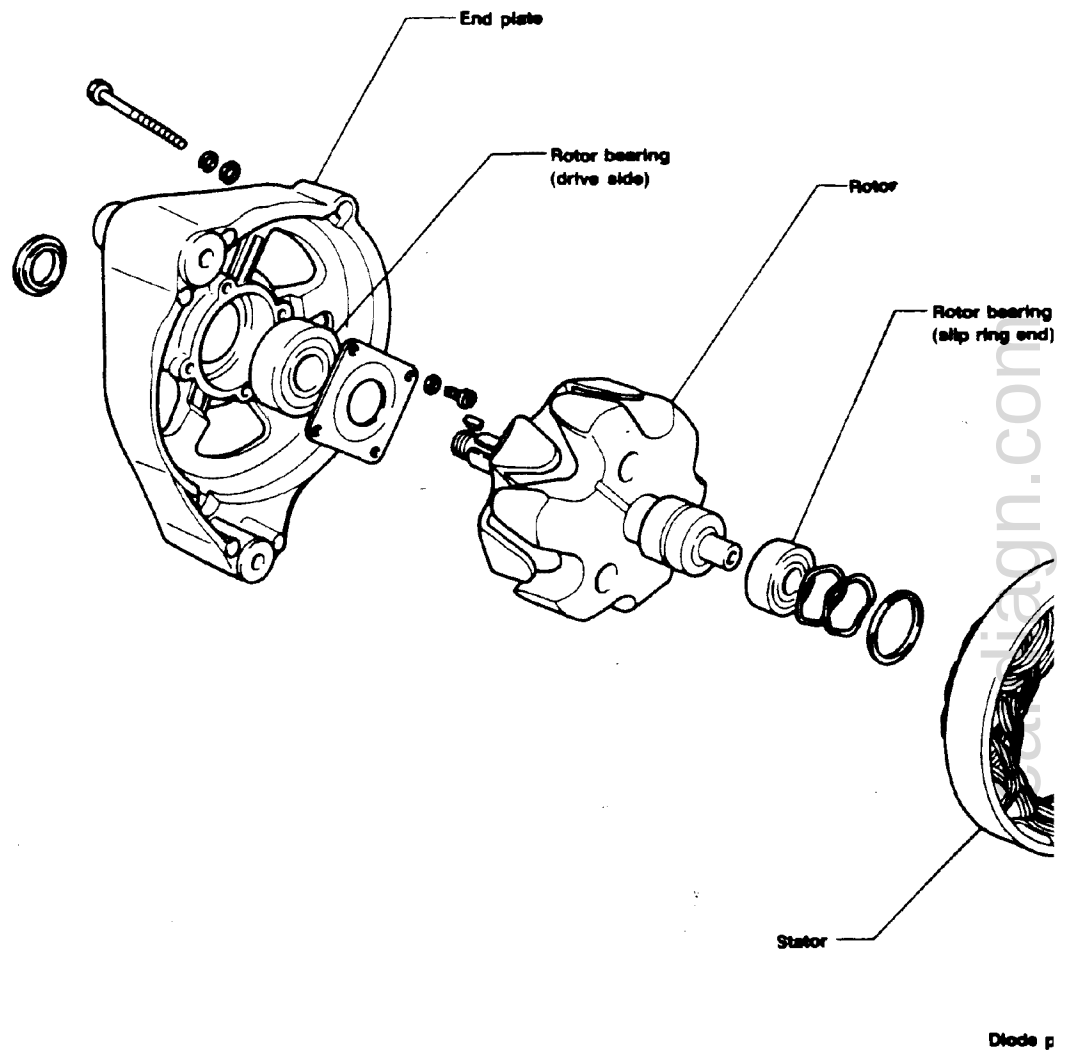


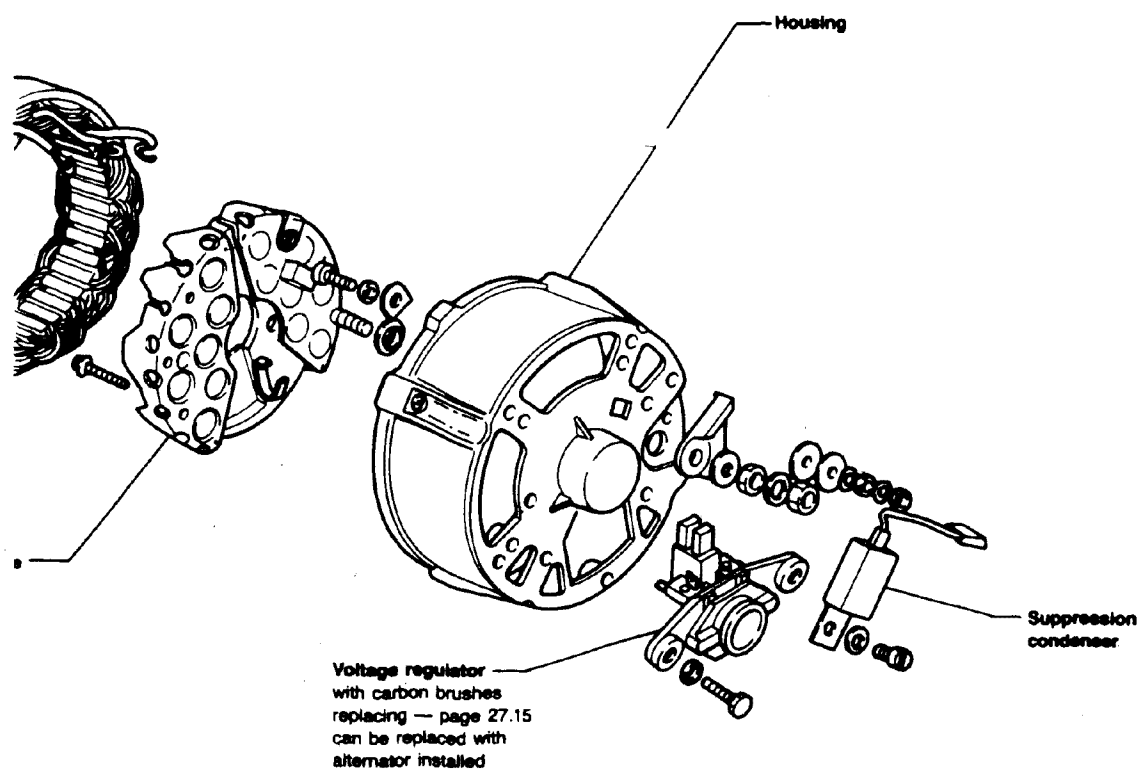
Alternator 110 amp, exploded view

Output checking, 27.11

Exciter circuit, checking, 27.12

Alternator light, troubleshooting, 27.16





Alternator output, checking

Using the SUN VAT-40 (or VAT-60)

- connect black clamp to battery negative (-)
- connect red clamp to battery positive (+)
- connect green clamp (inductive pickup) to alternator D + ; either at alternator or battery
- start engine
- raise engine speed and hold at 2000 RPM
- slowly adjust load control of **VAT-40** (or **VAT-60**) until highest possible reading is obtained
 - must be within 10% of manufacturers specifications

CAUTION

Test must be performed and completed within fifteen seconds to avoid overloading and damaging the electrical system.

Alternator exciter circuit, checking

Note

If the complaint "battery isn't being charged" is received even though the warning light comes on when the ignition is switched **ON** and goes out when the ignition is switched **OFF**; check the exciter circuit as follows:

- verify that battery voltage is approximately 12 volts minimum, charge as necessary
- disconnect blue wire from alternator terminal 61
- switch multimeter **VAG 1526 (US 1119)** to 200 mA range
- connect multimeter between disconnected blue wire and alternator terminal 61
- switch **ON** ignition
 - current must fall between 150 and 185 mA

If reading is lower than 150 mA

- check blue wire between alternator and instrument panel or replace printed circuit in instrument cluster

Exciter circuit, resistance checking

If the complaint "battery isn't being charged" is received, even though the warning light comes on when the ignition is switched **ON** and goes out when the ignition is switched **OFF**, check the exciter circuit resistance as follows:

- disconnect battery ground (–) cable
- disconnect blue wire (D+/61) from back of alternator
- switch multimeter **US 1119** to 200 Ω range and connect between disconnected blue wire and battery positive terminal
- switch ignition **ON**
 - 140 to 160 Ω

If infinite Ω

- a — printed circuit must be replaced
- or
- b — multimeter probes are reversed, in which case you would reverse the connections and measure again

Electrical – Battery, Starter, Alternator

Alternator V-belt tension, checking/adjusting

Due to increased alternator output, V-belt tension checking is more important than before.

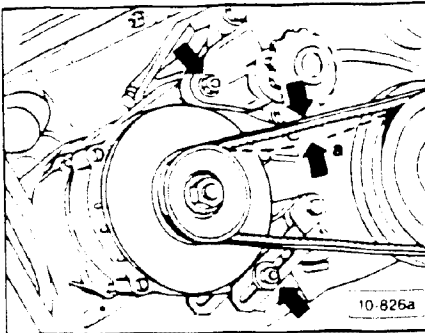
The following values apply for checking tension using the "thumb test."

V-belts up to 1000 mm long (39.4 in.) maximum deflection **a**:

- new V-belt – approximately 2 mm (0.079 in.)
- used V-belt – approximately 5 mm (0.197 in.)

V-belts over 1000 mm long (39.4 in.) maximum deflection **a**:

- new V-belt – approximately 10 mm (0.39 in.)
- used V-belt – approximately 15 mm (0.59 in.)



Note

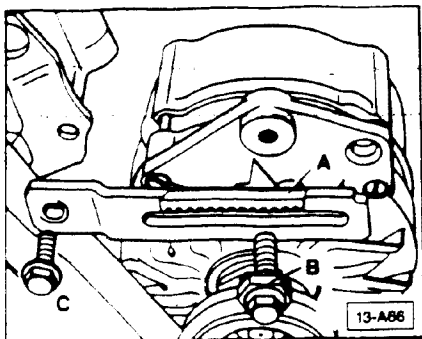
The values given are retroactive for all vehicles currently manufactured.

Adjusting

(engines without toothed rack mechanism)

- loosen bolts (**arrows**)
- push alternator outward until specification **a** is achieved
- tighten mounting bolts (**arrows**)

Electrical – Battery, Starter, Alternator



Adjusting (engines with toothed rack mechanism)

- loosen bolts **B**, **C**, and pivot bolt in cradle (not shown)

Note

The mounting bolts should be loose enough for the alternator to swing freely under its own weight.

- tension the V-belt by rotating tensioning gear **B** with torque wrench
 - 8 Nm (71 in. lb)
- torque bolt **B**, while maintaining this wrench setting
 - 35 Nm (26 ft lb)
- torque bolt **C**
 - 20 Nm (15 ft lb)
- torque cradle bolt
 - 35 Nm (26 ft lb)
- start engine and allow to idle for 5 minutes
- turn off engine
- retension V-belt by rotating tensioning gear **B** with torque wrench
 - 8 Nm (71 in. lb)

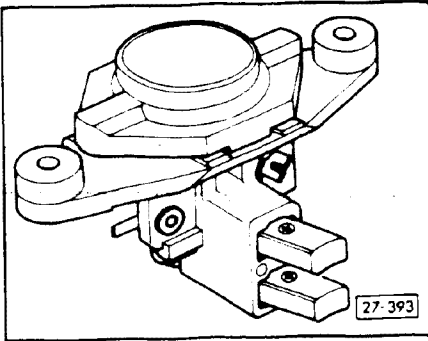
Revised torque for alternator pulley nuts (90 Amp)

Some alternator pulleys are mounted **without** woodruff keys

- pulley nut torque – 50 Nm (37 ft lb)

Alternator pulleys using woodruff key

- pulley nut torque – 35 Nm (26 ft lb)



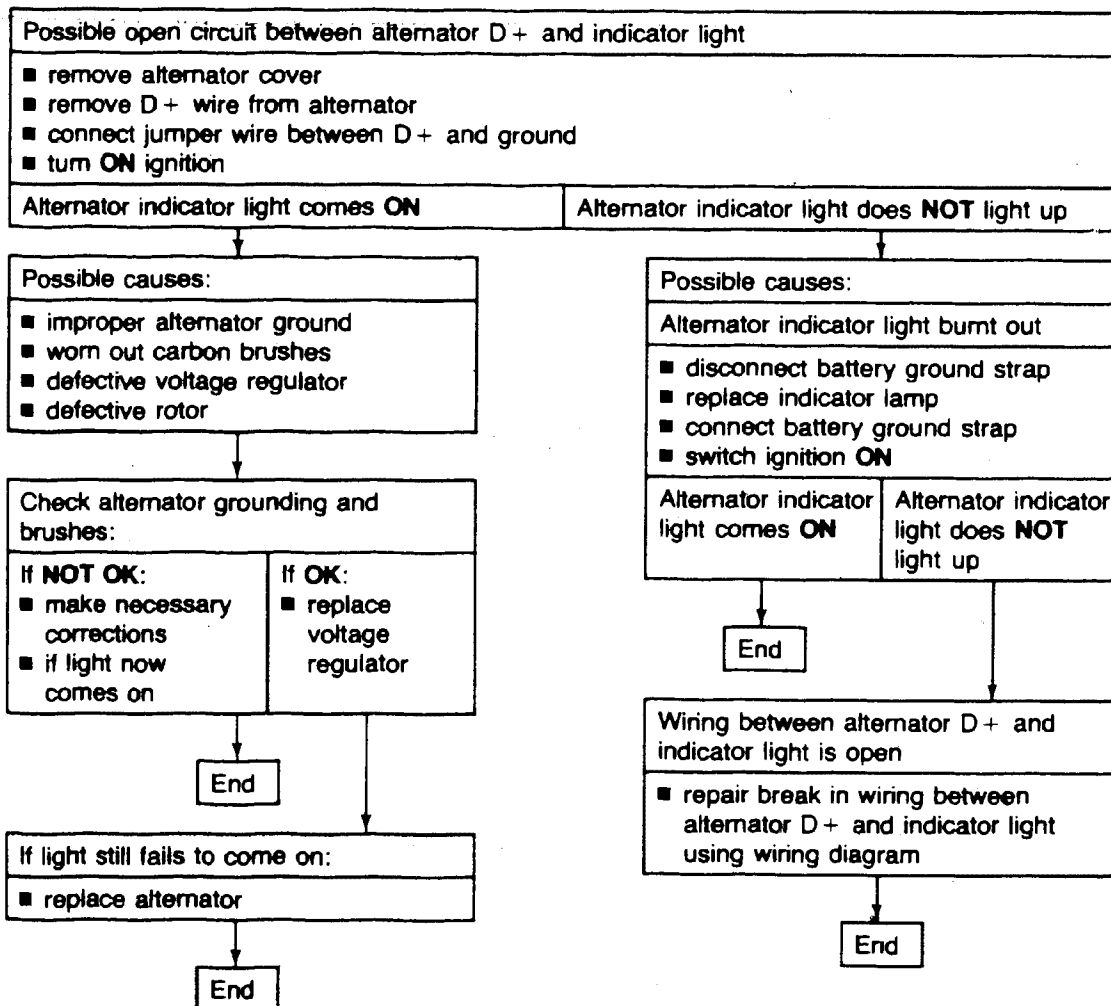
Voltage regulator carbon brushes, replacing

Carbon brush lengths:

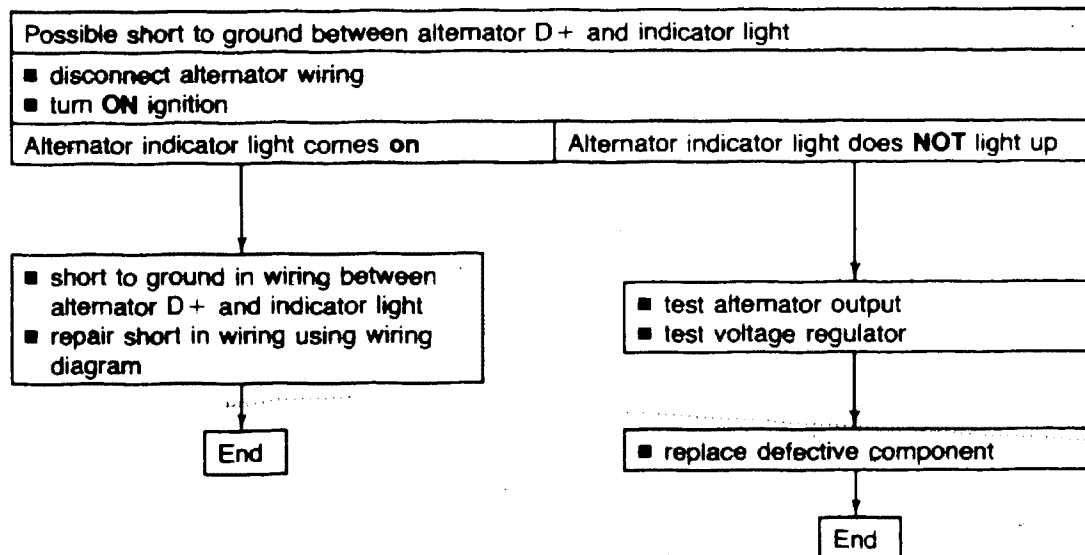
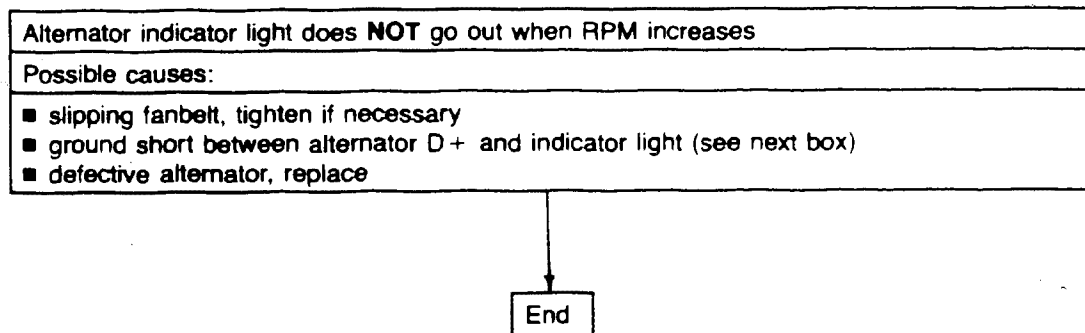
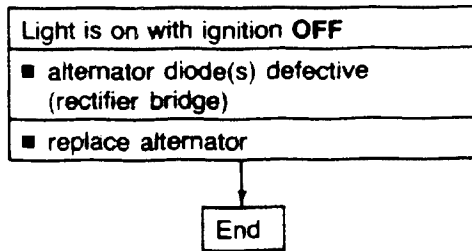
- new approximately 13 mm (0.512 in.),
wear limit approximately 5 mm (0.197 in.)

Alternator Indicator light, troubleshooting

Does not illuminate with Ignition ON (engine NOT started)



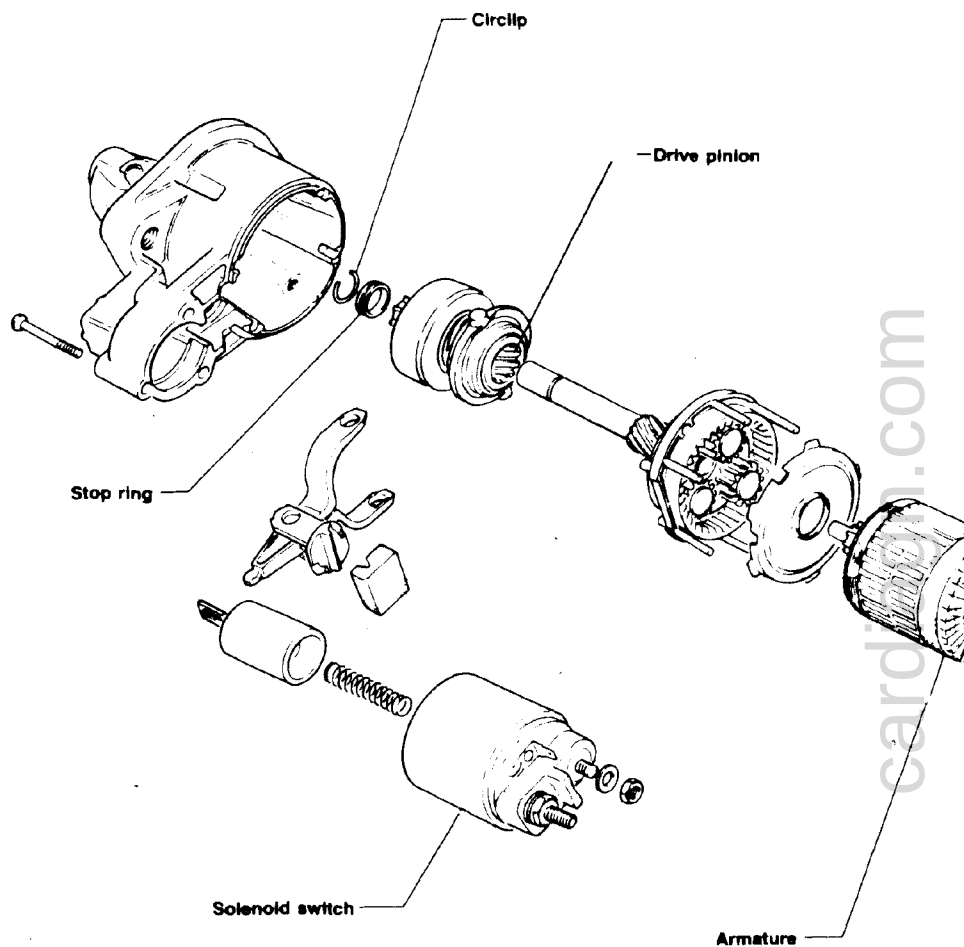
Alternator Indicator light, troubleshooting



Starter, exploded view

CAUTION

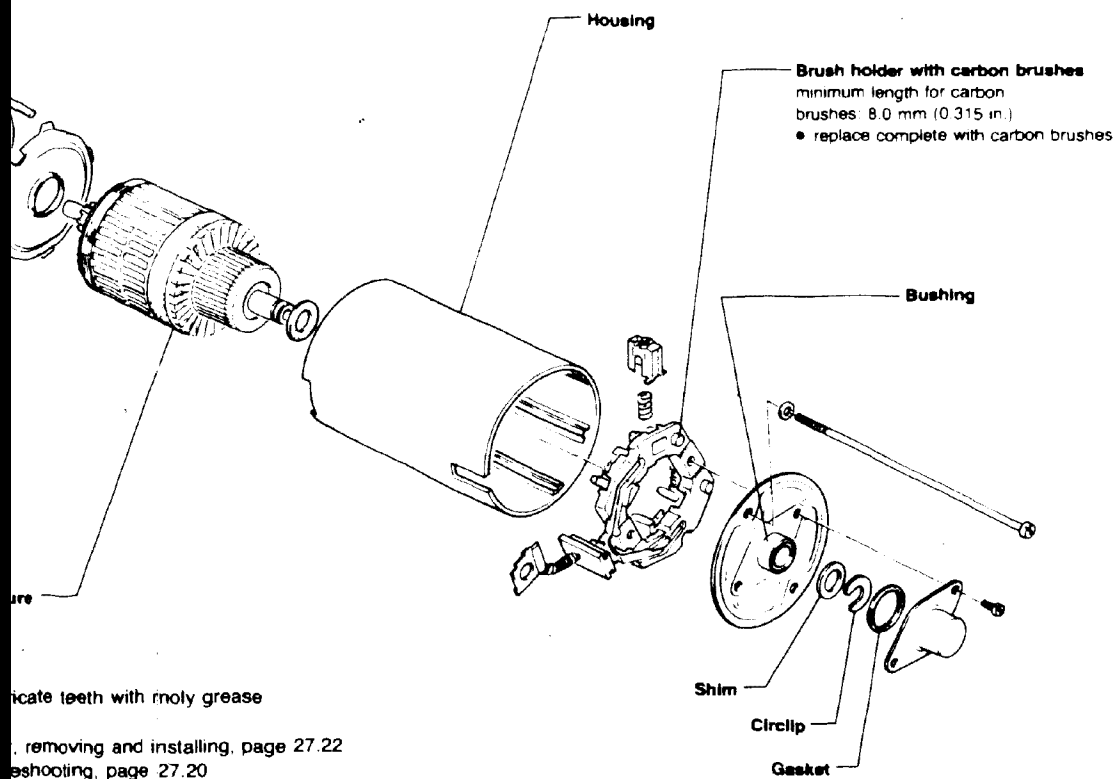
Starter with reduction gear set is susceptible to impact, which can result in magnet damage or demagnetization.



Note

— lubricate teeth with moly

Starter, removing and instal
Troubleshooting, page 27.2

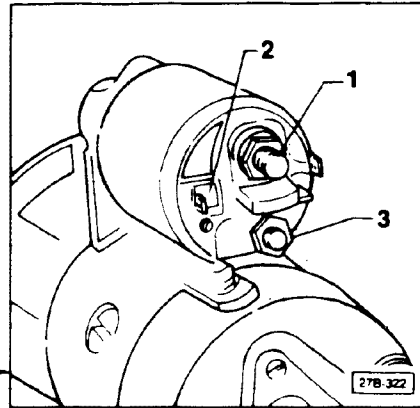


Starter

Does not turn engine when ignition/starter switch is operated

Check these first:

- solenoid switch connections **OK**
- ground straps between engine and body tight and corrosion free
- battery fully charged
- use multimeter **US 1119** for measurements



Terminal locations

- 1 — terminal 30 — from positive (+) battery terminal
- 2 — terminal 50 — from ignition/starter switch
- 3 — connection for field windings

Note

See routing of wire 50 in wiring diagram.

■ measure voltage at terminal 50 of solenoid switch while cranking • 8 volts minimum	
No voltage or less than 8 volts	Voltage OK

Note This measurement assumes terminal 30 current at ignition switch. ■ measure voltage at terminal 50 of ignition/starter switch (min. 8 volts)	
No voltage	Voltage OK

■ replace ignition/starter switch

End

■ check wiring between terminal 50 on ignition/starter switch and terminal 50 on starter solenoid and make necessary repairs

End

■ measure voltage at connection 3 for field winding on solenoid switch • 8 volts minimum	
No voltage	Voltage OK

■ replace solenoid switch

End

■ replace starter

End

Starter

Turns engine too slowly or engages and will not turn engine

- ensure that engine is filled with oil of recommended viscosity
- check V-belt tension
- check battery voltage and charge if necessary
- clean battery terminals and check wire connections for tightness

Starter turns engine

Starter does not turn engine

End

- clean starter terminals and tighten connections
- clean and tighten ground strap between transmission and body at transmission

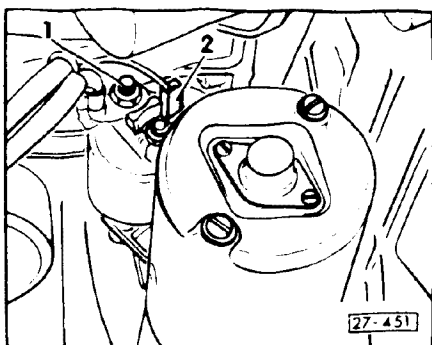
Starter turns engine

Starter does not turn engine

End

Starter defective
■ replace starter

End



Starter, removing and installing

- disconnect battery ground strap
- disconnect wiring at following terminals:
 - 1 — terminal 30 (wiring from battery to starter and starter to alternator)
 - 2 — terminal 50 (to ignition/starter switch)
- remove starter mounting bolts on engine/transmission
- remove starter

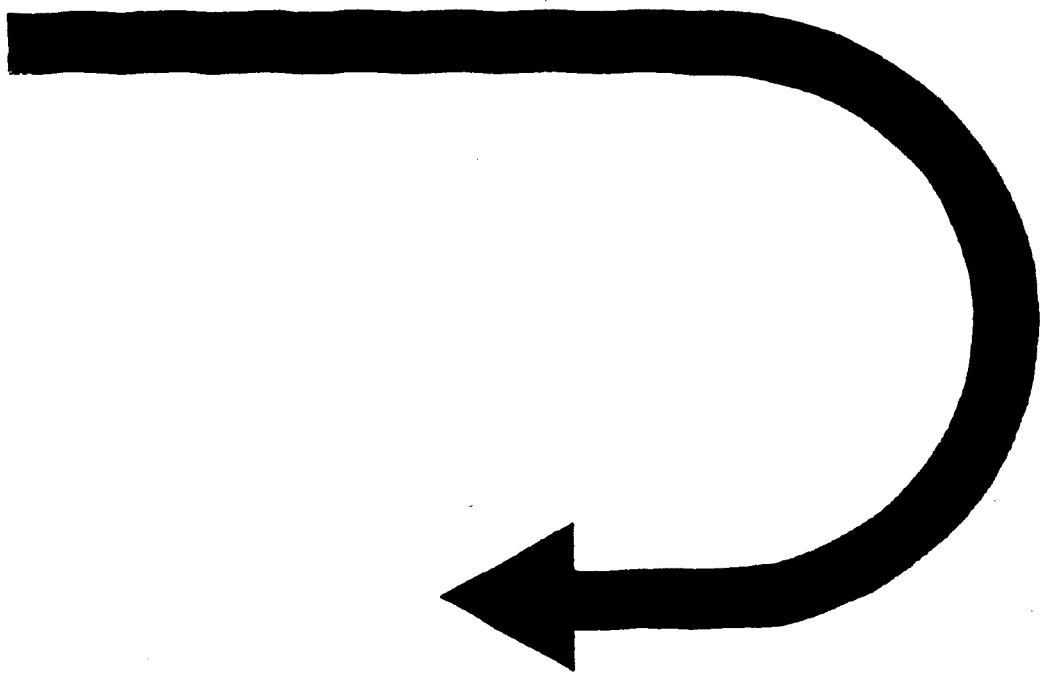
Starter Installation

- reverse of removal procedure
- torque mounting bolts
 - 25 Nm (18 ft lb)

CAUTION

Observe proper polarity when connecting all wiring, otherwise serious damage could occur.

CONTINUED IN THE
BEGINNING OF NEXT ROW



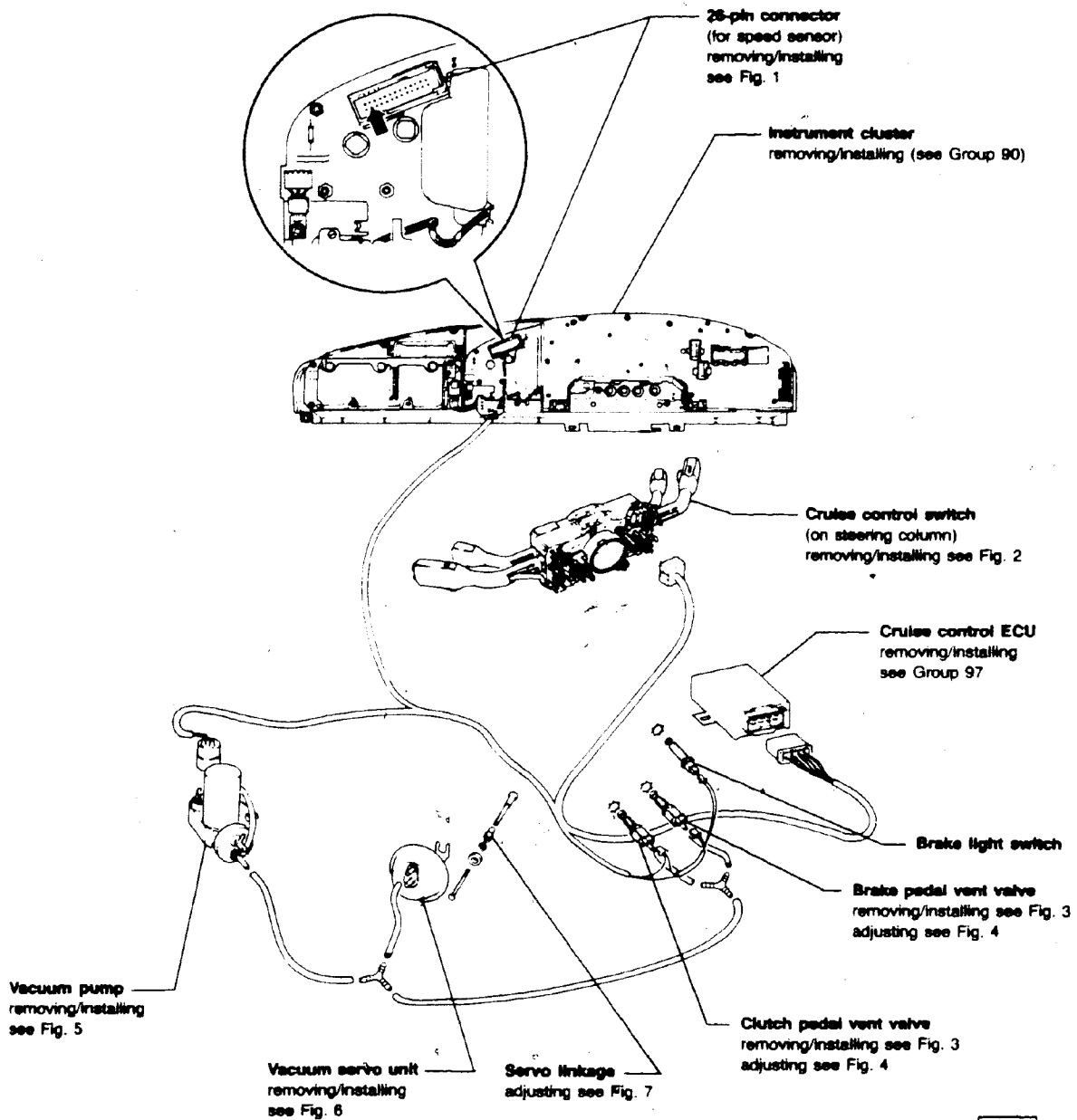
Cruise control system, troubleshooting

Note

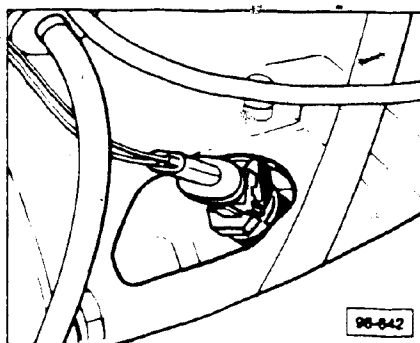
An inoperative cruise control system may be caused by vacuum loss due to cracked or leaking hoses.

To repair

- check all vacuum hoses for cracks
- replace all leaking hoses



90-401

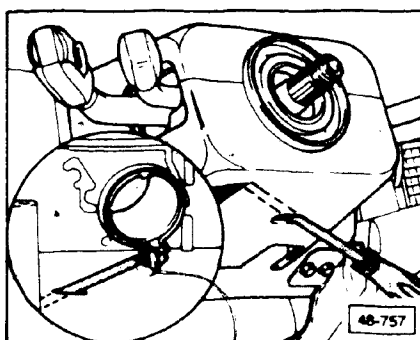


► Fig. 1 Speed sensor, removing and installing (automatic transmission)

Note

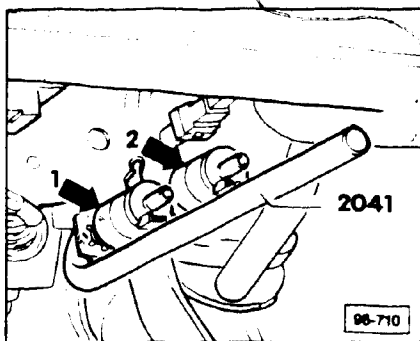
The sensor is installed at the left of the transmission housing, near the driveshaft flange.

- remove speed sensor harness connector and unscrew speed sensor from transmission



► Fig. 2 Steering column switch with control switch for cruise control, removing and installing

- pull up steering wheel cover and remove
- unscrew steering wheel and remove
 - tightening torque: 40 Nm (30 ft lb)
- loosen steering column switch clamp and pull up steering column switch (separate the connectors)

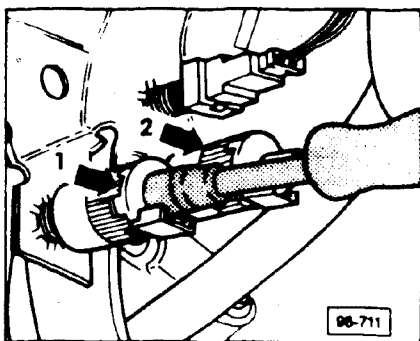


► Fig. 3 Clutch pedal vent valve 1 and brake pedal vent valve 2, removing

- remove cover and air duct under the left side of instrument panel
- remove harness connector and vacuum hose from vent valve
- pull vent valve out through bushing using tool 2041

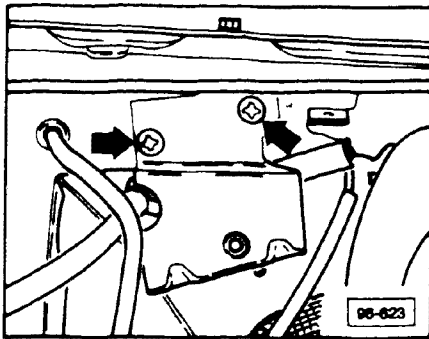
CAUTION

The vent valve cannot be reinstalled. The threads are ruined after removal.



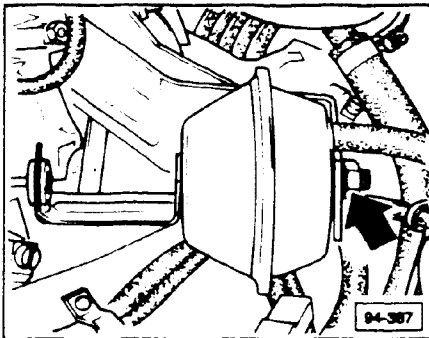
► Fig. 4 Clutch pedal vent valve 1 and brake pedal vent valve 2, installing and adjusting

- insert vent valve into bushing
- push vent valve through bushing until seated using 10 mm socket wrench
- pull back clutch and/or brake pedal up to stop to adjust the vent valves



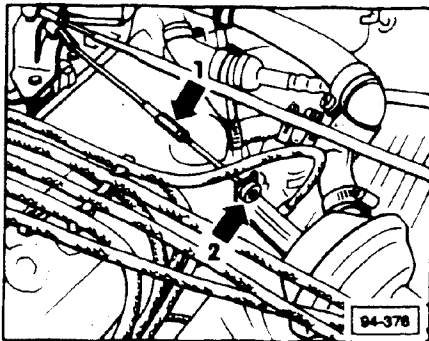
► Fig. 5 Vacuum pump, removing and installing

- remove coolant overflow reservoir
- remove vacuum pump with bracket (arrows)



► Fig. 6 Servo unit, removing and installing

- disengage linkage
- remove vacuum hose
- remove servo unit from bracket (arrow)
 - tightening torque: 25 Nm (18 ft lb)



► Fig. 7 Servo unit linkage, adjusting (MC engine, Turbo)

- set throttle valve at idle, adjust linkage using adjusting nut 1
 - play of 0.1 to 0.3 mm (0.004 to 0.012 in.) is felt between bushing and stop 2

Cruise control, troubleshooting

Check these first:

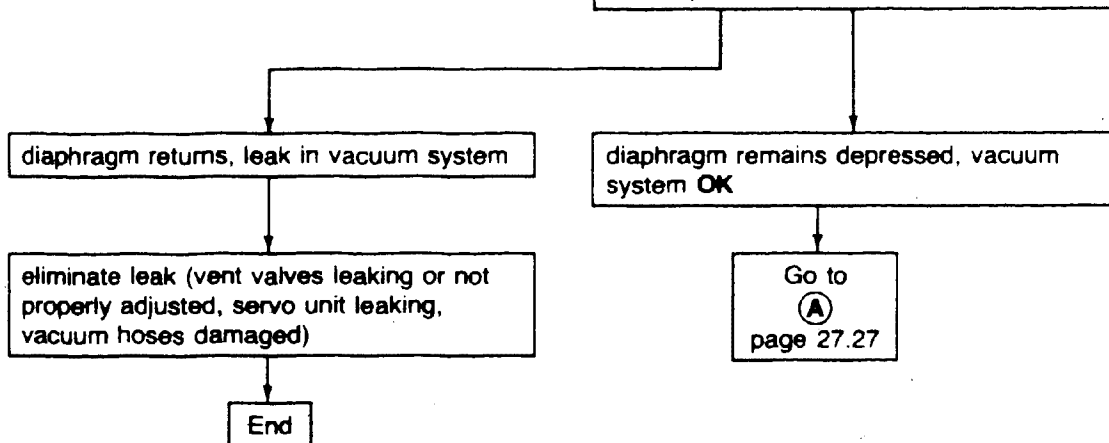
- fuses 3 and 12 are OK
- brake light bulbs OK
- perform all electrical measurements using multimeter US 1119

CAUTION

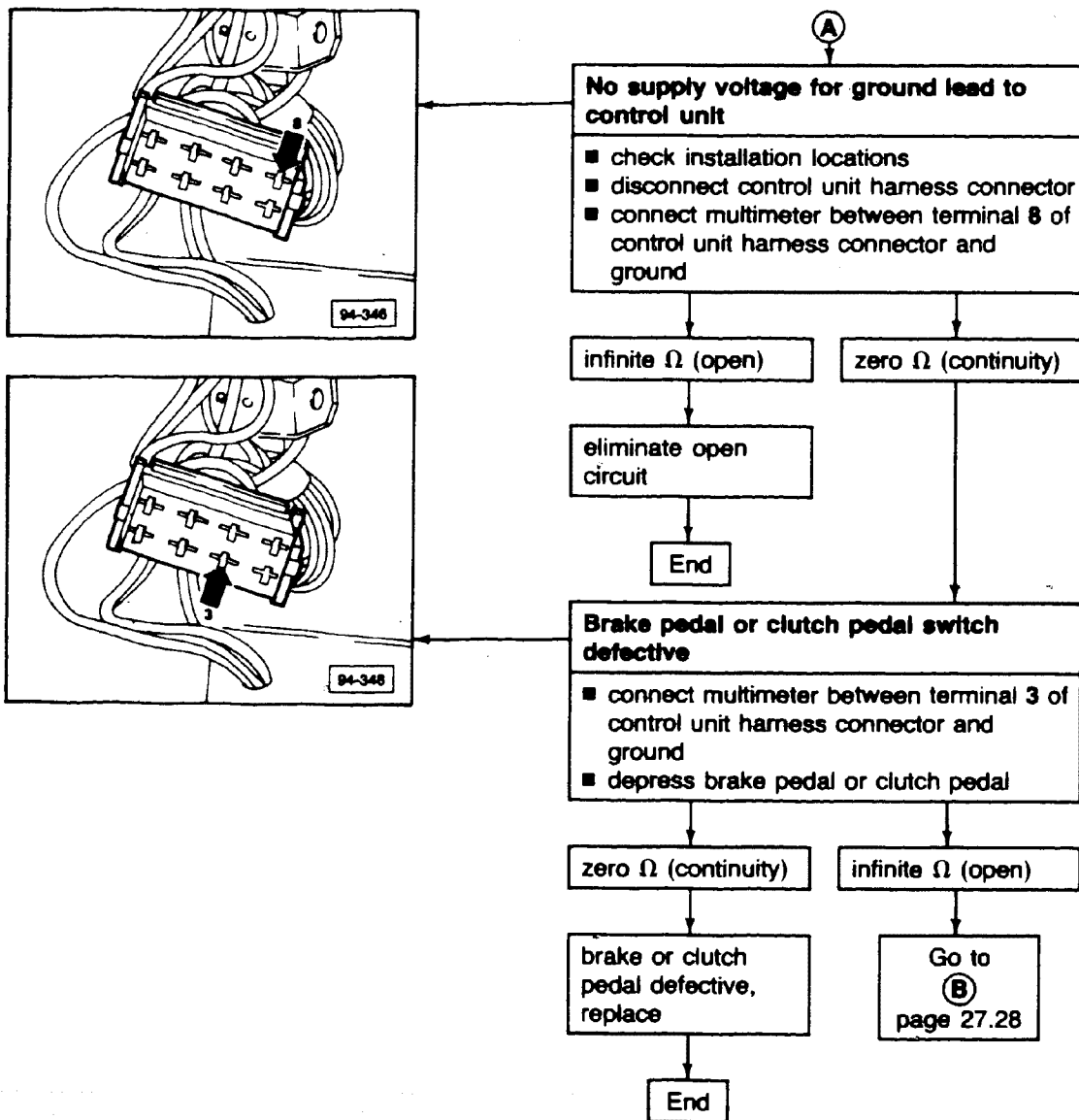
If an inoperative component is found during the following checks, first check the wiring between the control unit harness connector and the component.

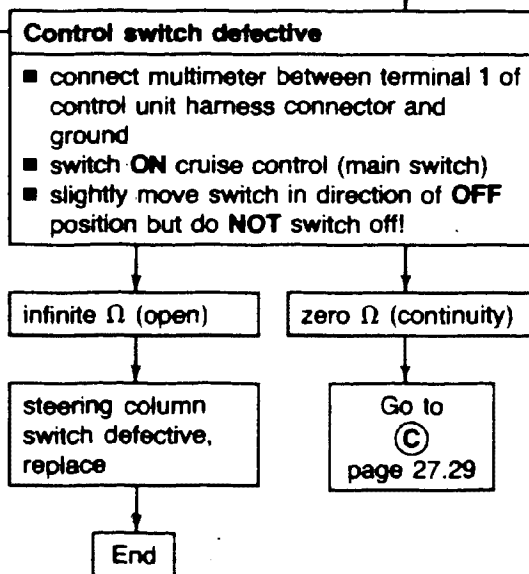
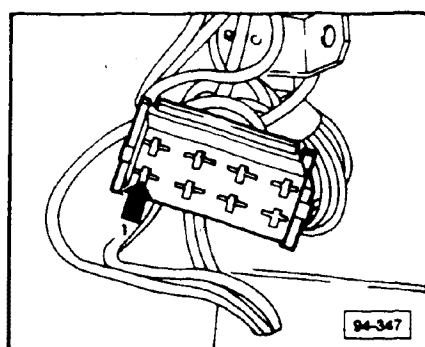
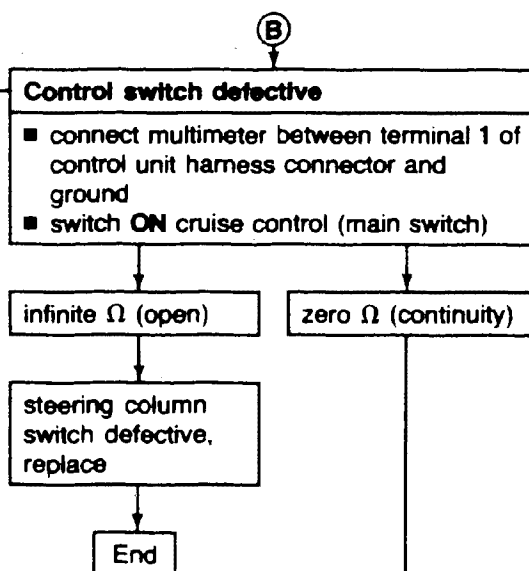
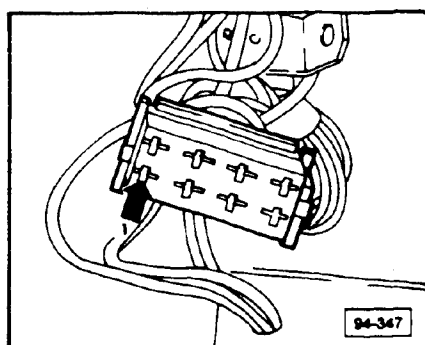
Vacuum system, leak checking

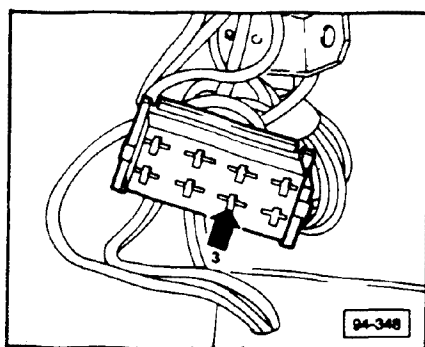
- disconnect vacuum hose from vacuum pump
- depress servo unit diaphragm
- plug disconnected vacuum hose
 - servo unit diaphragm must remain depressed and **NOT** move



Electrical – Battery, Starter, Alternator







Control switch defective

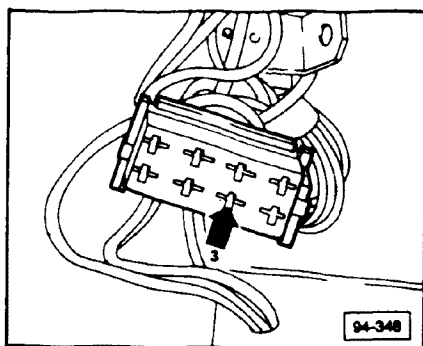
- connect multimeter between terminal 3 of control unit harness connector and ground
- switch cruise control ON and OFF at steering column switch

value: **constant**

steering column switch defective, replace

End

value: **ON:** zero Ω
OFF: infinite Ω



Control switch defective

- connect multimeter between terminal 3 of control unit harness connector and ground
- switch ON cruise control (main switch)
- slightly move switch in direction of OFF position but do NOT switch off!

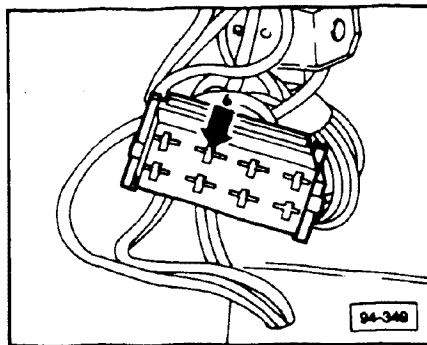
zero Ω (continuity)

steering column switch defective, replace

End

infinite Ω (open)

Go to
Ⓓ
page 27.30



94-348

Control switch defective

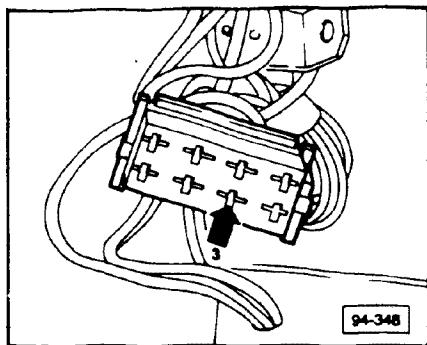
- connect multimeter between terminal 6 of control unit harness connector and ground
- push switch to **RESUME** position

infinite Ω (open)

zero Ω (continuity)

steering column switch defective, replace

End



94-348

Control switch defective

- connect multimeter between terminal 3 of control unit harness connector and ground
- push switch to **RESUME** position

infinite Ω (open)

zero Ω (continuity)

steering column switch defective, replace

End

Go to
Ⓔ
page 27.31

Electrical – Battery, Starter, Alternator

