

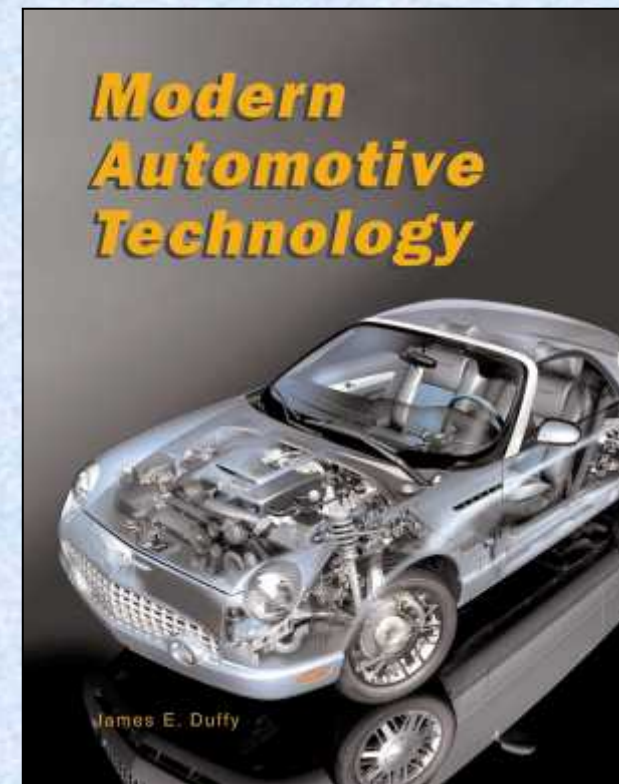
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# Modern Automotive Technology

by  
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# **Chapter 34**

## **Charging System**

### **Diagnosis, Testing, and Repair**



# Contents

- ☐ Charging system diagnosis
- ☐ Charging system precautions
- ☐ Charging system tests
- ☐ Alternator service
- ☐ Regulator service

# **Charging System Diagnosis**



# Common Symptoms

- ❑ Dead battery
  - causes slow or no cranking
- ❑ Overcharged battery
  - signaled by low battery electrolyte
- ❑ Abnormal noise
  - grinding, squealing, and buzzing
- ❑ Indicator light illuminated

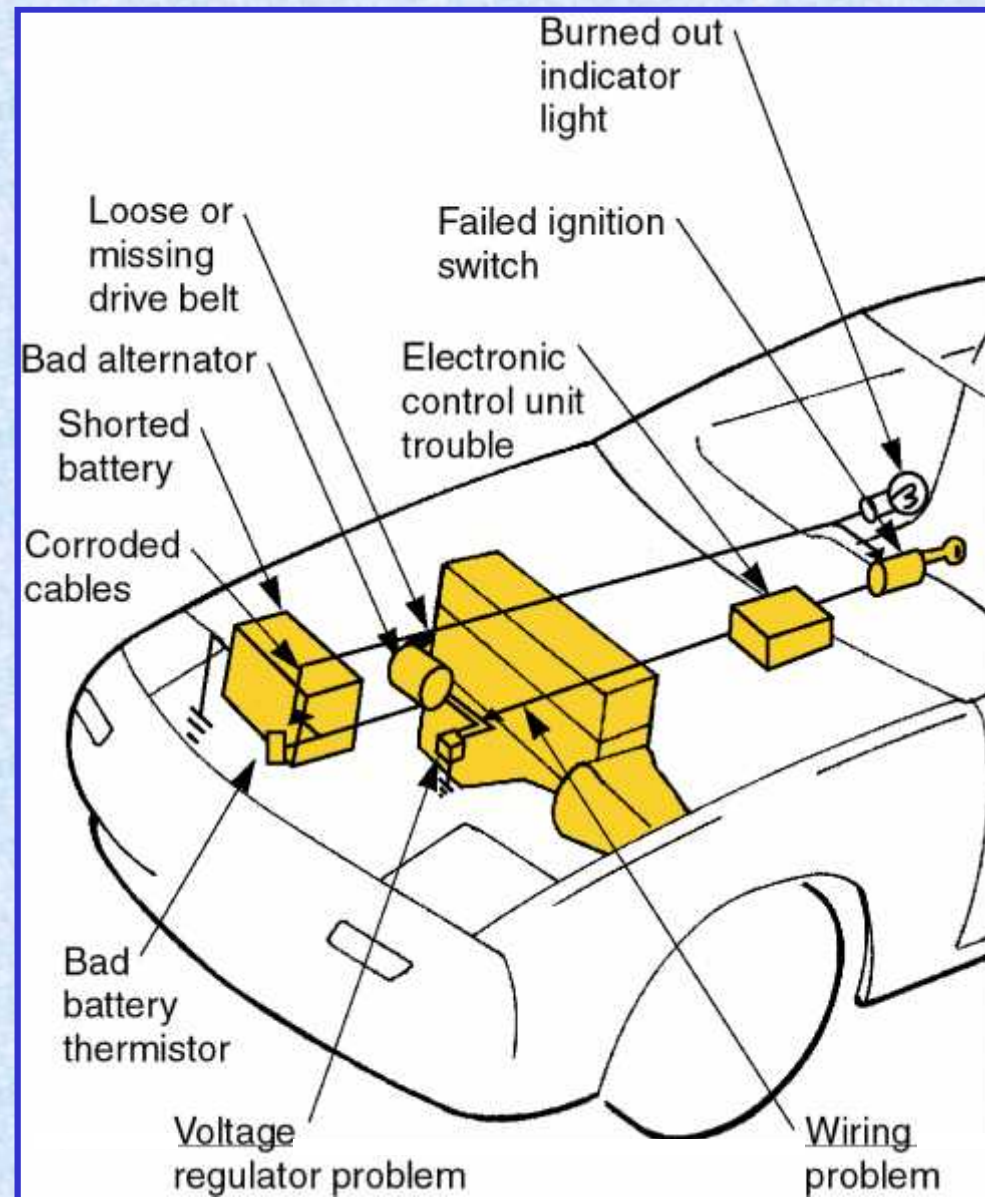
# Visual Inspection

## □ Inspect for:

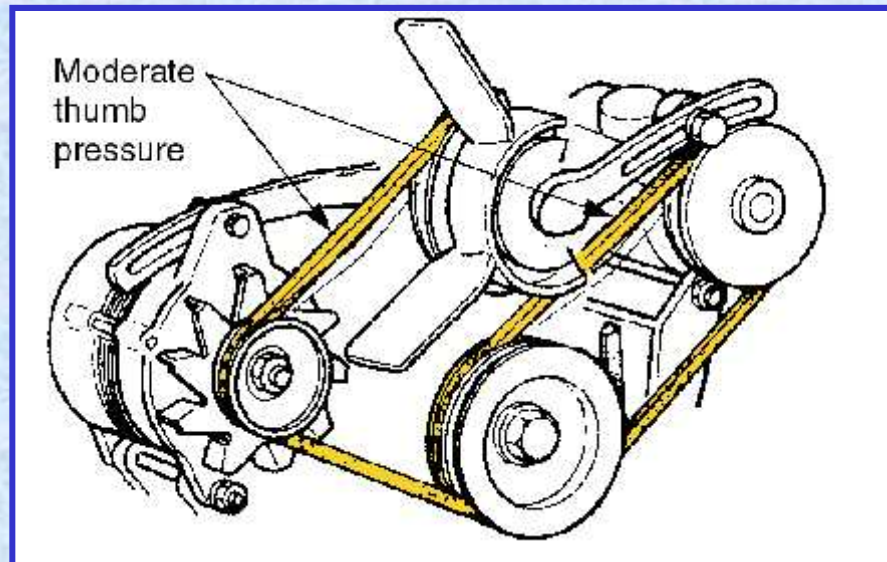
- loose battery cables
- discharged battery
- corroded terminals
- low electrolyte
- damaged battery case
- belt tension and condition
- wiring condition



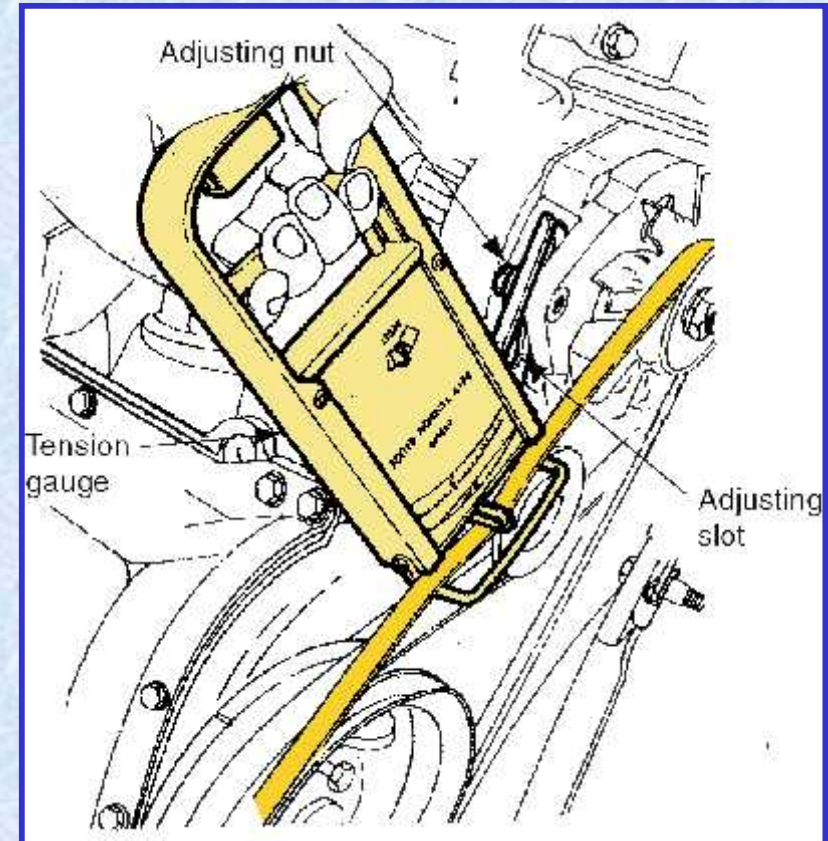
# Common Problems



# Belt Tension



1/2" deflection

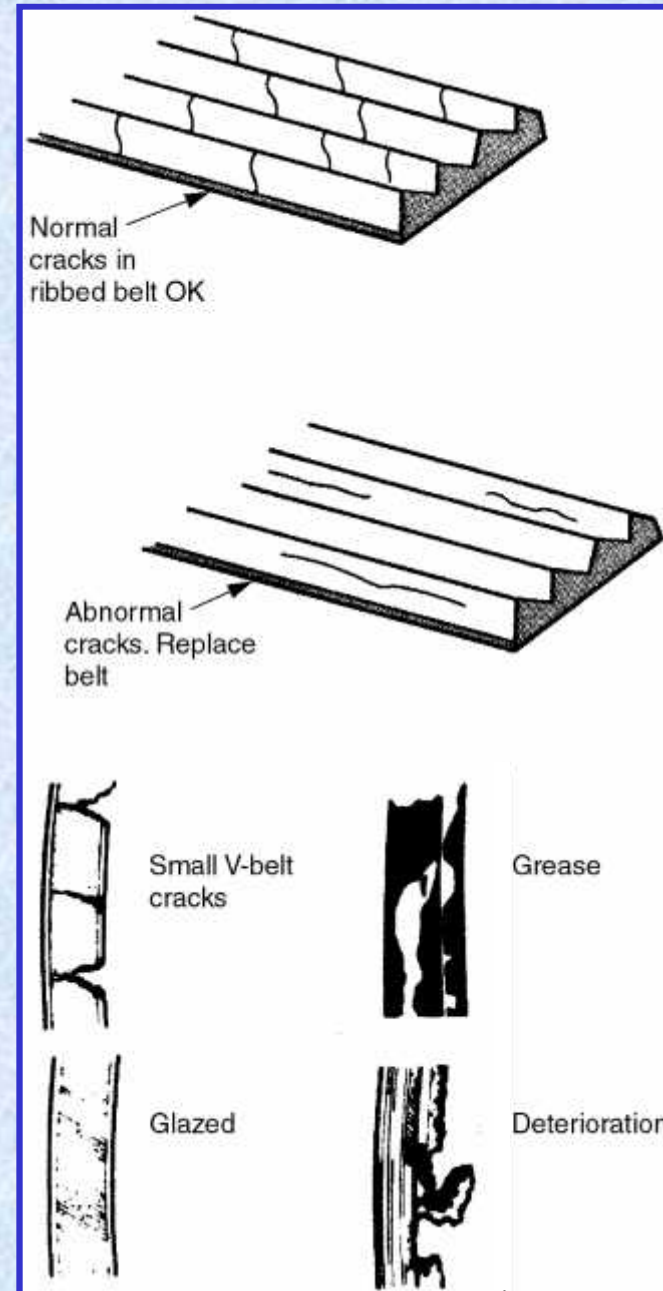


Belt tension gauge



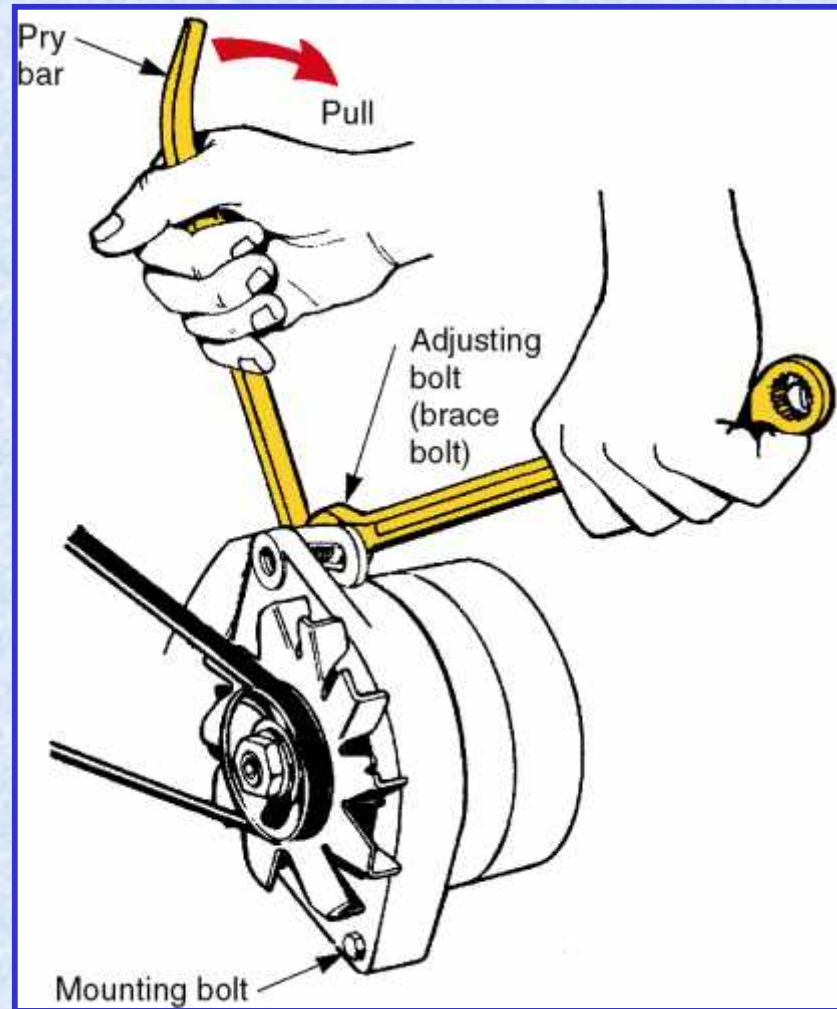
# Belt Problems

Inspect belts for these kinds of problems



# Belt Adjustment

Loosen the bolts and pry on a thick area of the end frame





# Scanning

- ❑ Vehicles with self-diagnostic systems allow you to connect a scan tool for diagnostics
- ❑ Scan for diagnostic trouble codes
- ❑ Display charging data:
  - voltage
  - battery temperature

# Charging System

## Precautions

- ☐ Disconnect the battery before servicing
- ☐ Never reverse the polarity
- ☐ Do not operate the alternator with the output wire disconnected
- ☐ Never short or ground the terminals unless instructed to do so by the shop manual
- ☐ Never polarize an alternator



# Charging System Tests

- ☐ Output test
- ☐ Regulator voltage test
- ☐ Regulator bypass test
- ☐ Scope testing
- ☐ Circuit resistance tests
- ☐ Voltmeter testing

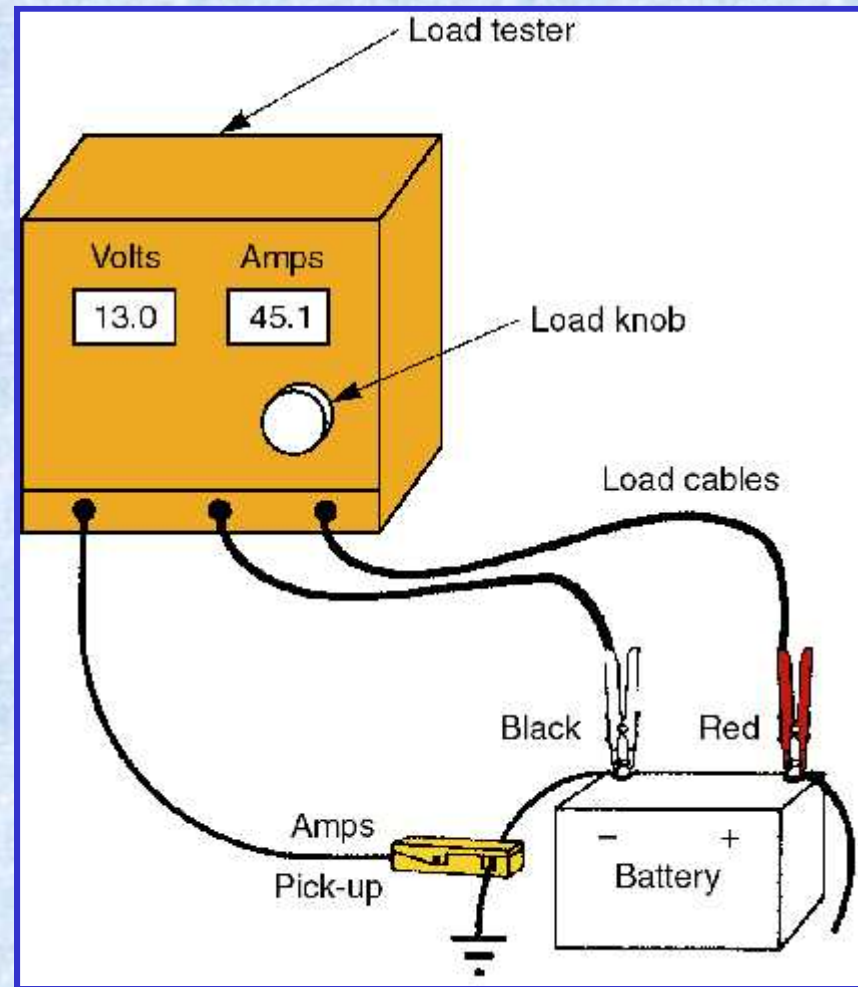
# Output Test

- ❑ Measures system current and voltage under maximum load
- ❑ Use a load tester with a voltmeter and an ammeter



# Equipment Connection

Connect the  
voltmeter leads  
across battery and  
the inductive pickup  
on the battery's  
ground cable



# Output Test Procedure

- ☐ Ignition on, record ammeter reading
- ☐ Start engine, operate at 2000 rpm
- ☐ Load battery until ammeter reads specified output current
- ☐ Do not let voltage fall below 12 volts



# Output Test Results

- ❑ Add the two amperage readings together
  - key on, engine off + engine running
- ❑ The result is the alternator output in amperes
- ❑ Compare to specifications

# Regulator Voltage Test

- ☐ Checks the regulator calibration
- ☐ Connect the load tester
- ☐ With the load control off, run the engine at 2000 rpm
- ☐ Compare the battery voltage to specifications
- ☐ Most are in a range of 13.5–14.5 volts
- ☐ Some regulators are adjustable

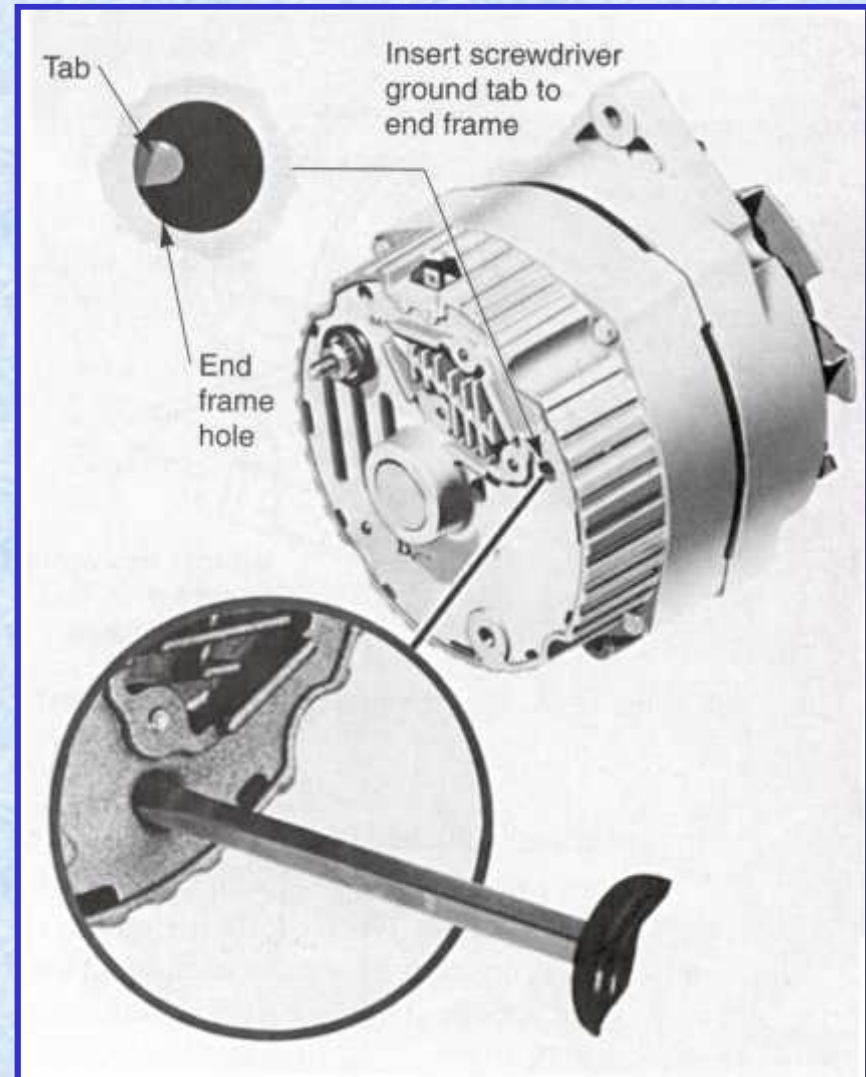


# Regulator Bypass Test

- ❑ Performed if the output test has failed
- ❑ The regulator is removed from the field circuit, applying full voltage to the field
- ❑ Follow the shop manual procedures
  - the insulated screw head or test tab may be grounded
  - a jumper wire may be installed between the alternator's battery and field terminals

# Regulator Bypass Test

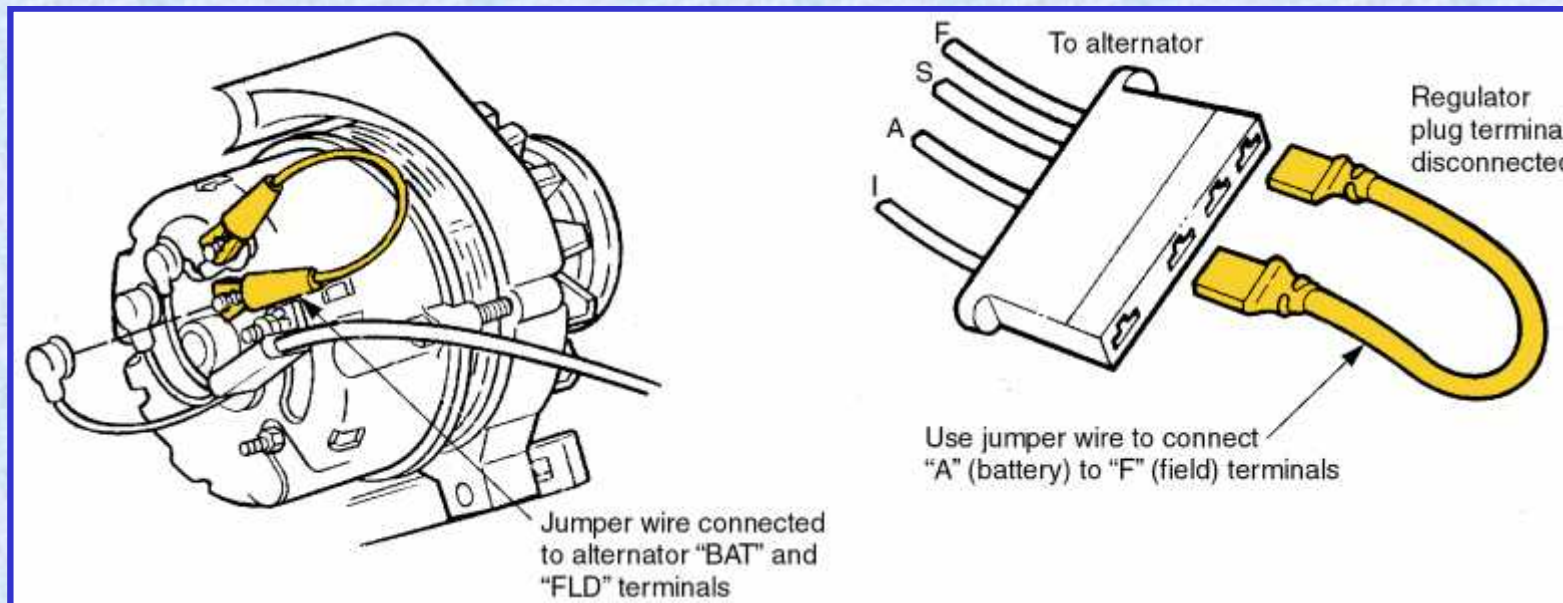
Shorting the tab should make this alternator produce the maximum output





# Regulator Bypass Test

Two methods of bypassing the regulator



# Regulator Bypass Test Results

- ☐ If the charging voltage and current increase to normal when the regulator is bypassed, the regulator is bad
- ☐ If the output remains the same, the alternator is bad or there is a wiring problem

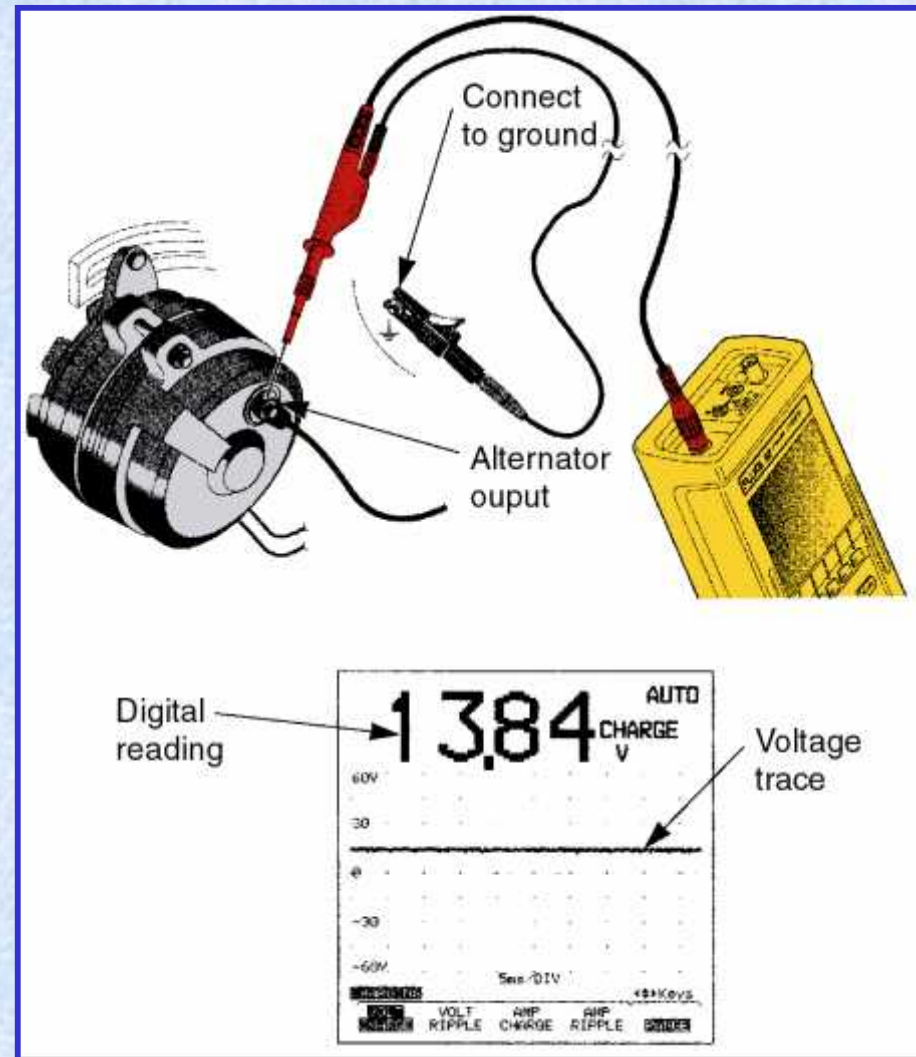


# Charging System Scope Testing

- ❑ An oscilloscope may be used to diagnose problems with the alternator or field control
- ❑ A scope may be connected between the alternator output terminal or field terminal and ground

# Hand-Held Oscilloscope

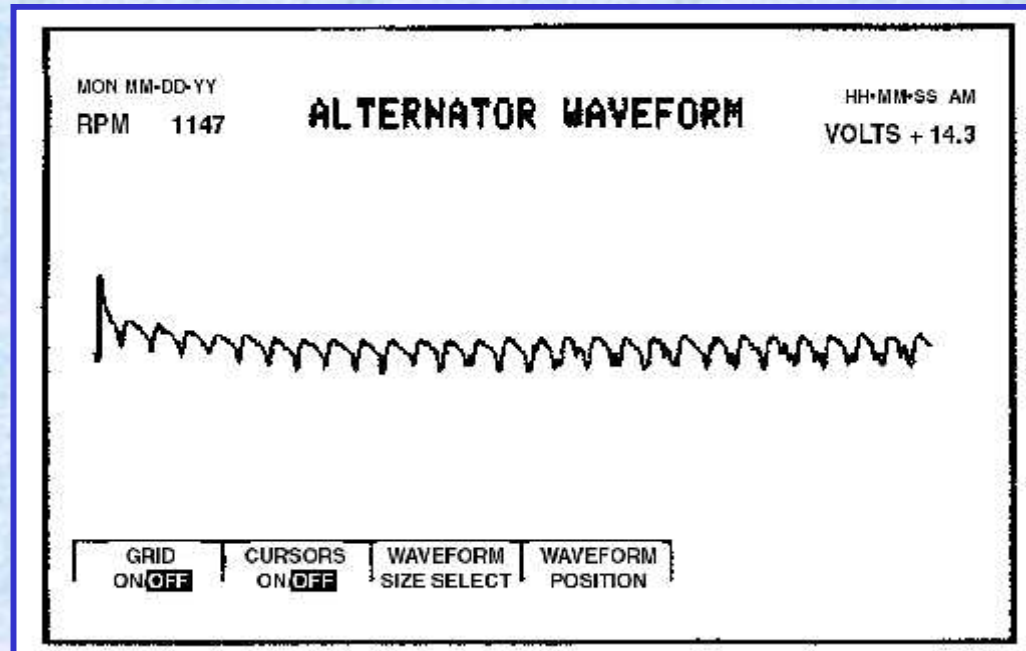
Note the connections and the output trace





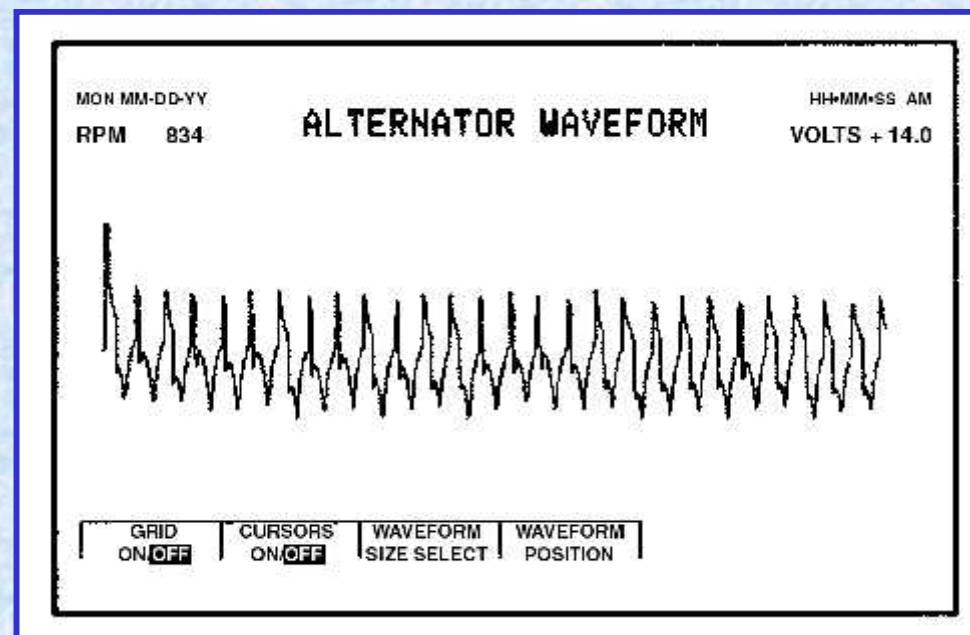
# Normal Output

Small, regularly spaced, even ripples



# Normal Output Electronic Regulator

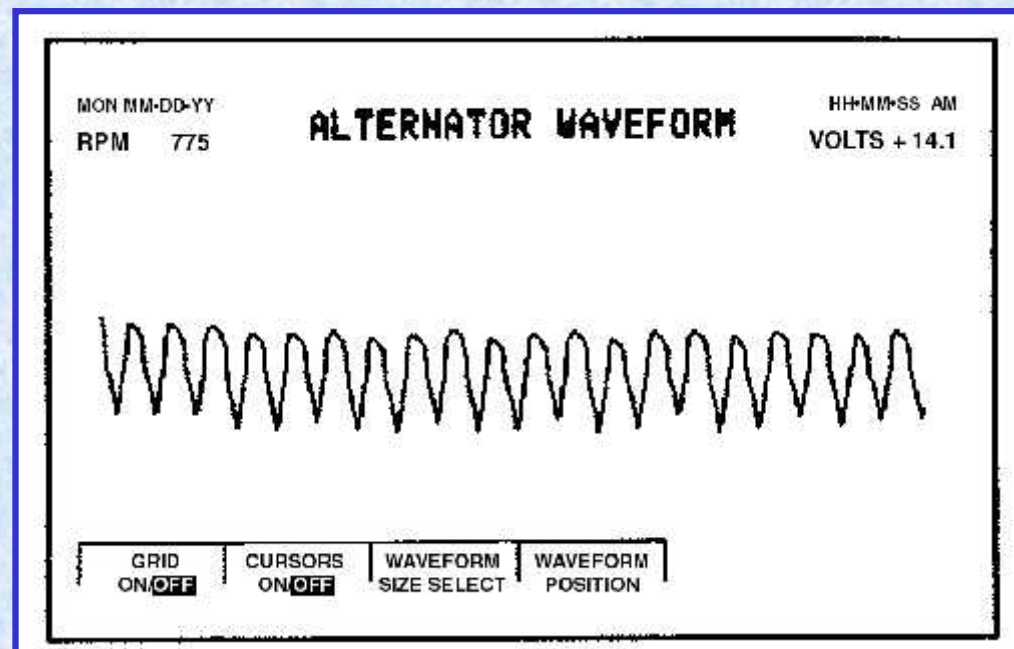
The regulator is “duty cycling” the field





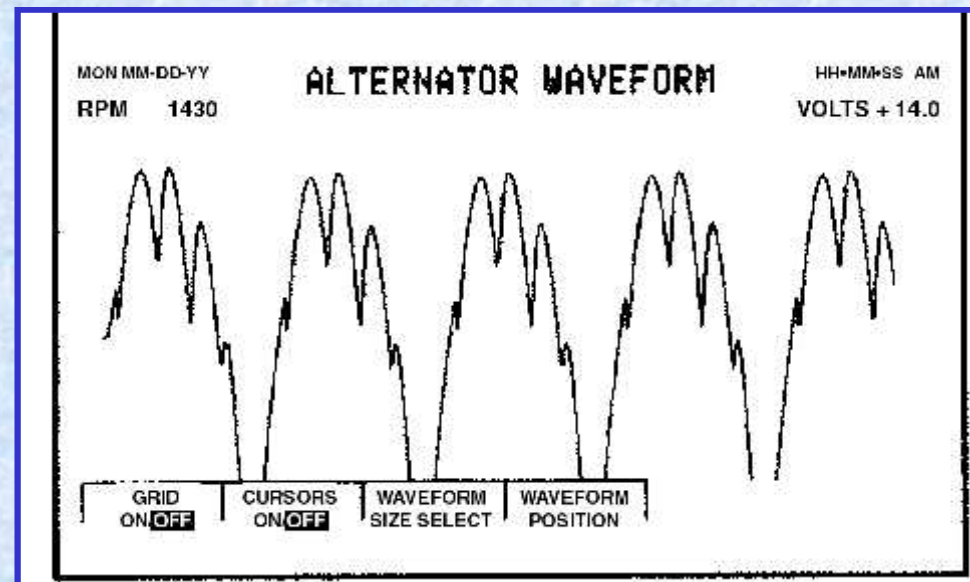
# Normal Output Heavy Load

High ripple from increased output



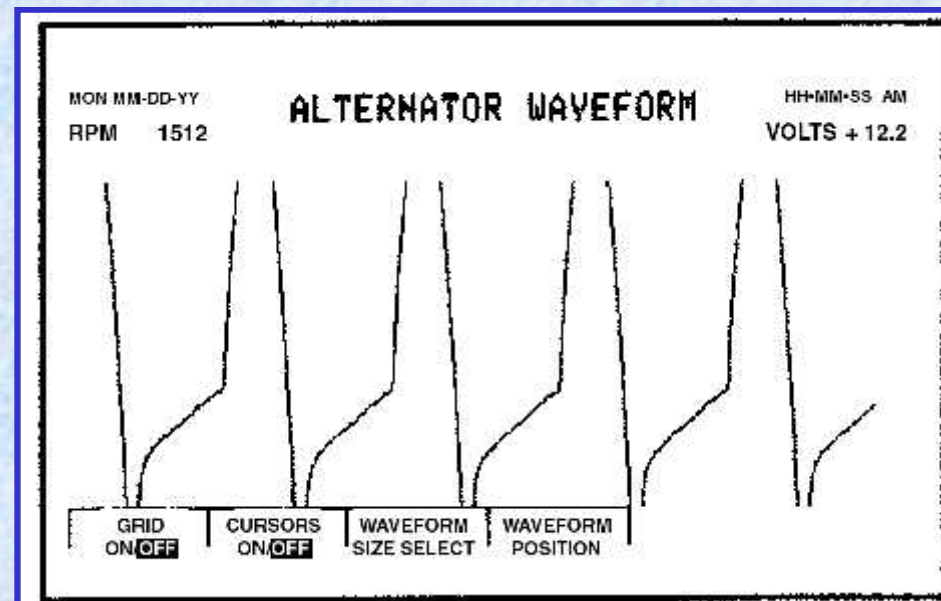
# Open Diode

An open diode is causing the high spikes



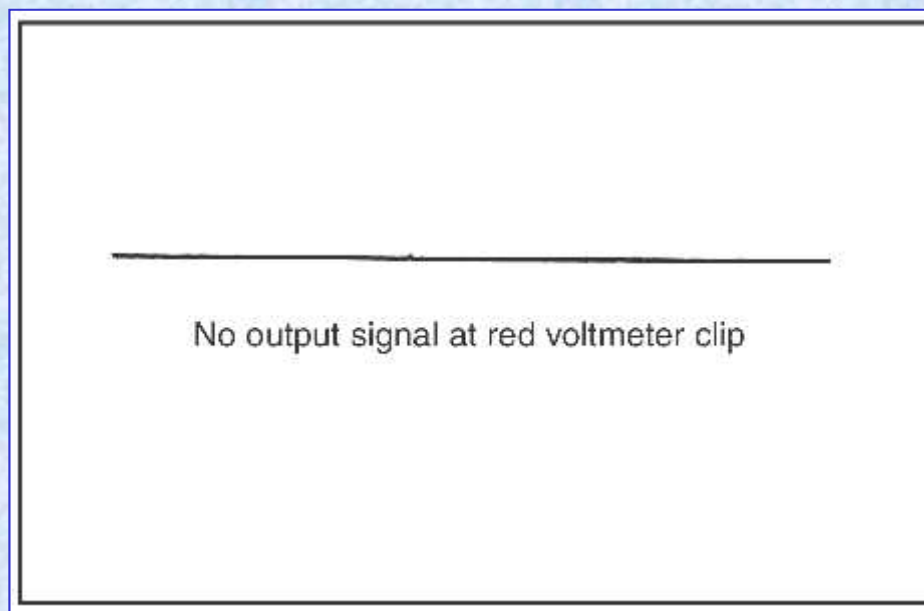


# One Open, One Shorted Diode



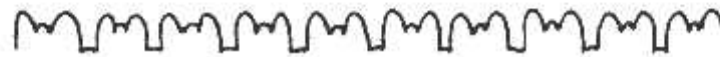
# No Output

A solid, straight line indicates no output





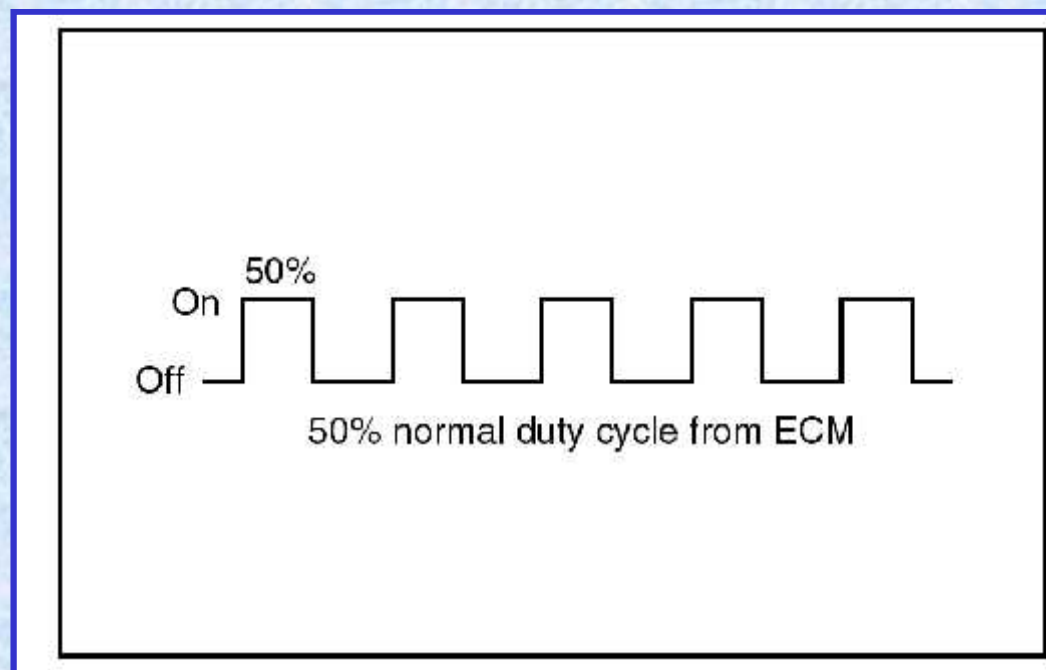
# Shorted Diodes or Stator



Shorted diodes or stator

# Field Control Pattern

Applying a high load should cause the duty cycle to show more “on-time”





# Circuit Resistance Tests

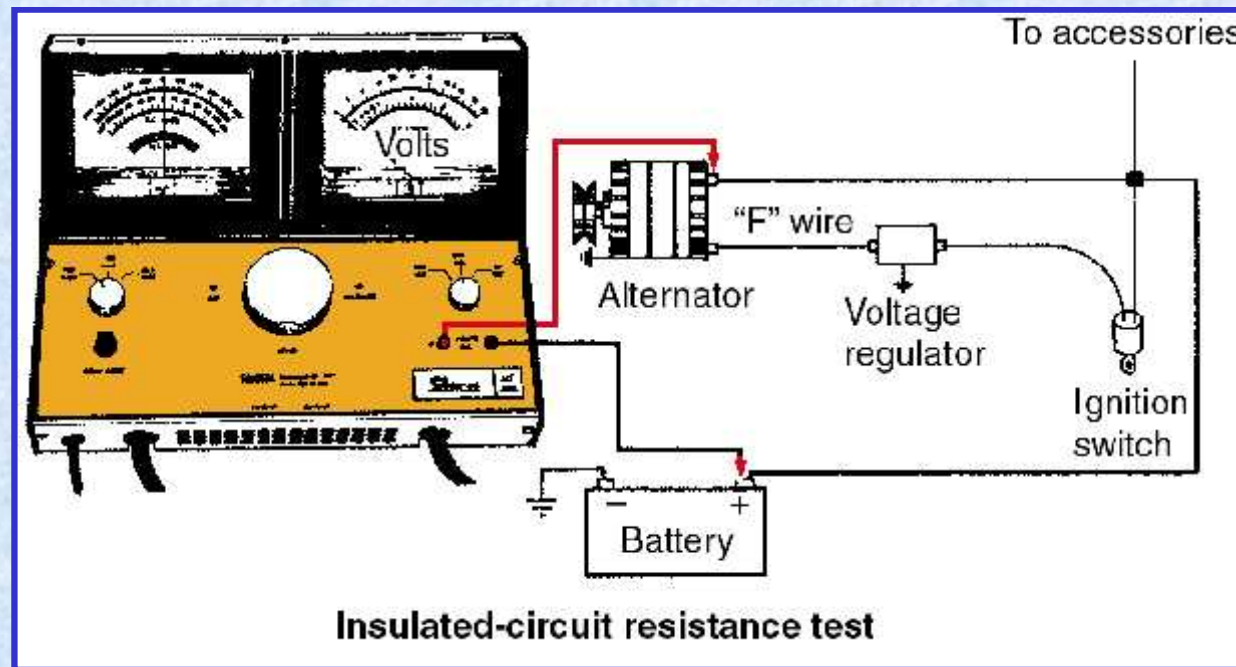
- ❑ Used to locate wiring problems
- ❑ Two tests may be used:
  - insulated circuit resistance test
  - ground circuit resistance test

# Insulated Circuit Resistance Test

- ☐ Connect the load tester with the voltmeter leads between the alternator's output terminal and the battery's positive terminal
- ☐ Operate the engine at fast idle
- ☐ Load the battery to obtain a 20 amp alternator output
- ☐ The voltage drop should not exceed 0.7 volts (0.1 volt per electrical connection)



# Insulated Circuit Resistance Test

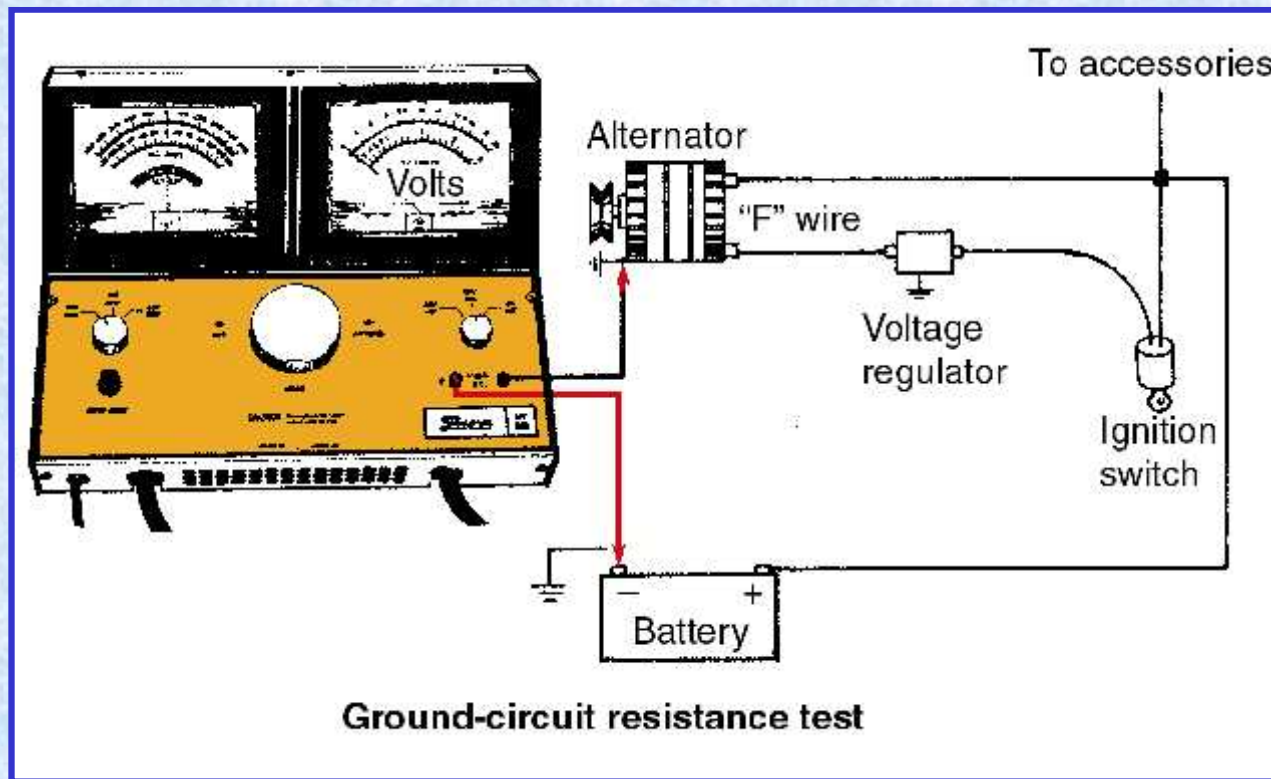


# Ground Circuit Resistance Test

- ☐ Connect the load tester with the voltmeter leads between the battery negative terminal and the alternator housing
- ☐ Operate the engine at fast idle
- ☐ Load the battery to obtain a 20 amp alternator output
- ☐ The maximum voltage drop should not exceed 0.1 volt per connection



# Ground Circuit Resistance Test



# Voltmeter Testing

- ☐ May be done when a load tester is not available
- ☐ An indicator of current output
- ☐ Connect a voltmeter across the battery terminals



# Measurements

- ❑ Base voltage

  - battery voltage, engine off

- ❑ No-load voltage

  - engine running, accessories off

- ❑ Load voltage

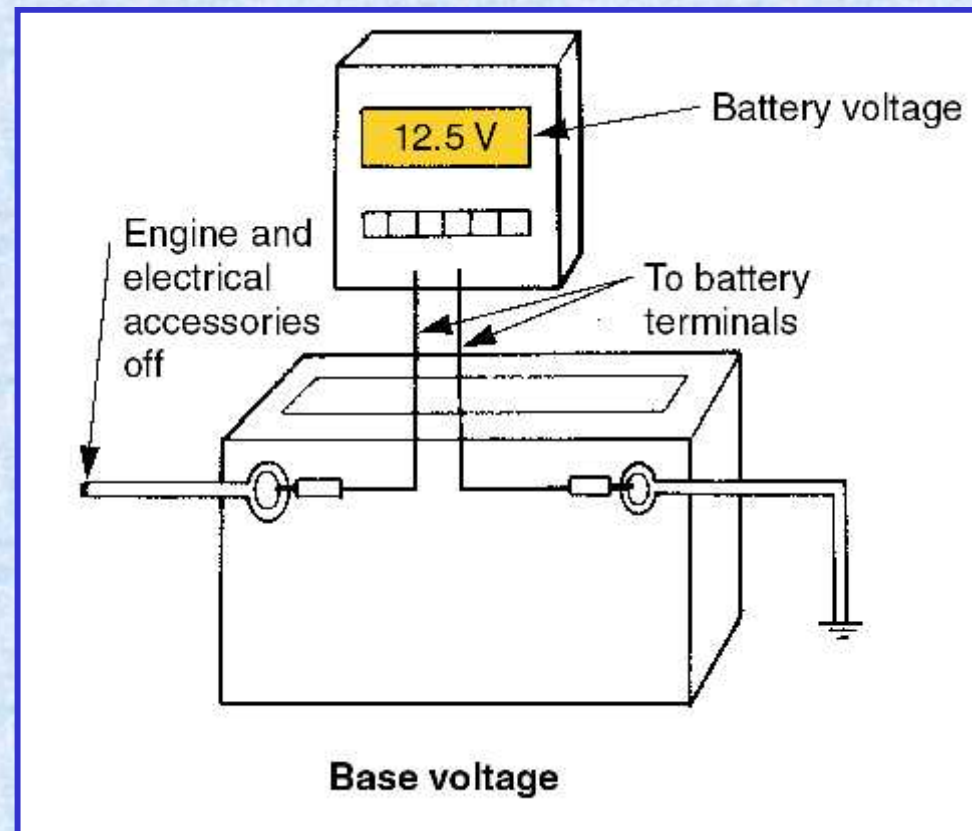
  - engine running, all accessories on

- ❑ Charge voltage

  - load voltage minus battery voltage

# Base Voltage

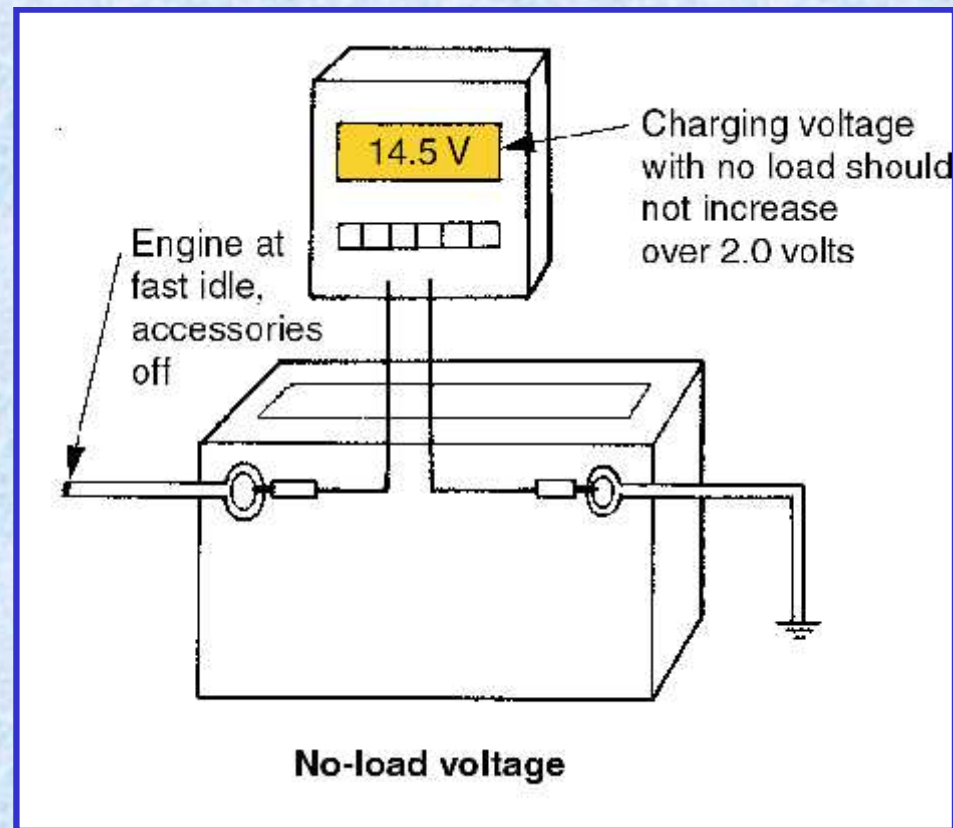
The reading should be about 12.6 volts





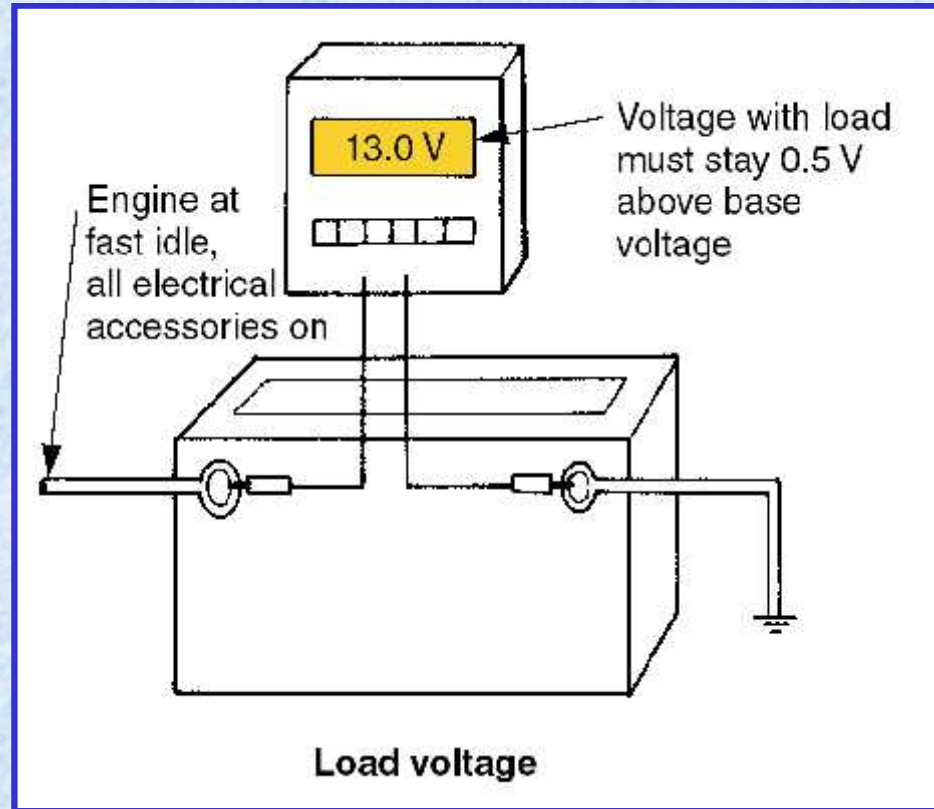
# No-Load Voltage

0.5 to 2 volts higher than base voltage



# Load Voltage

If the reading is not at least 0.5 volts above base voltage, a system fault exists





# Alternator Service

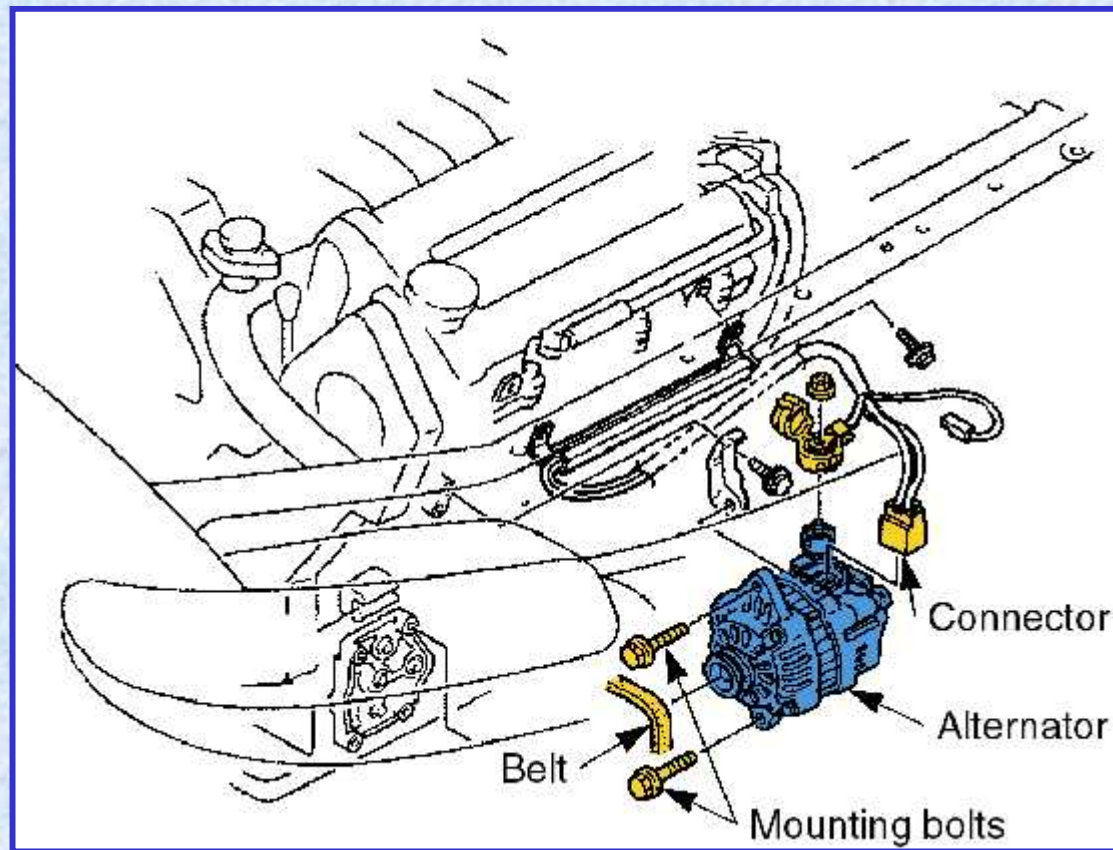
- ☐ Removal
- ☐ Disassembly
- ☐ Component service
- ☐ Assembly
- ☐ Installation

# Alternator Removal

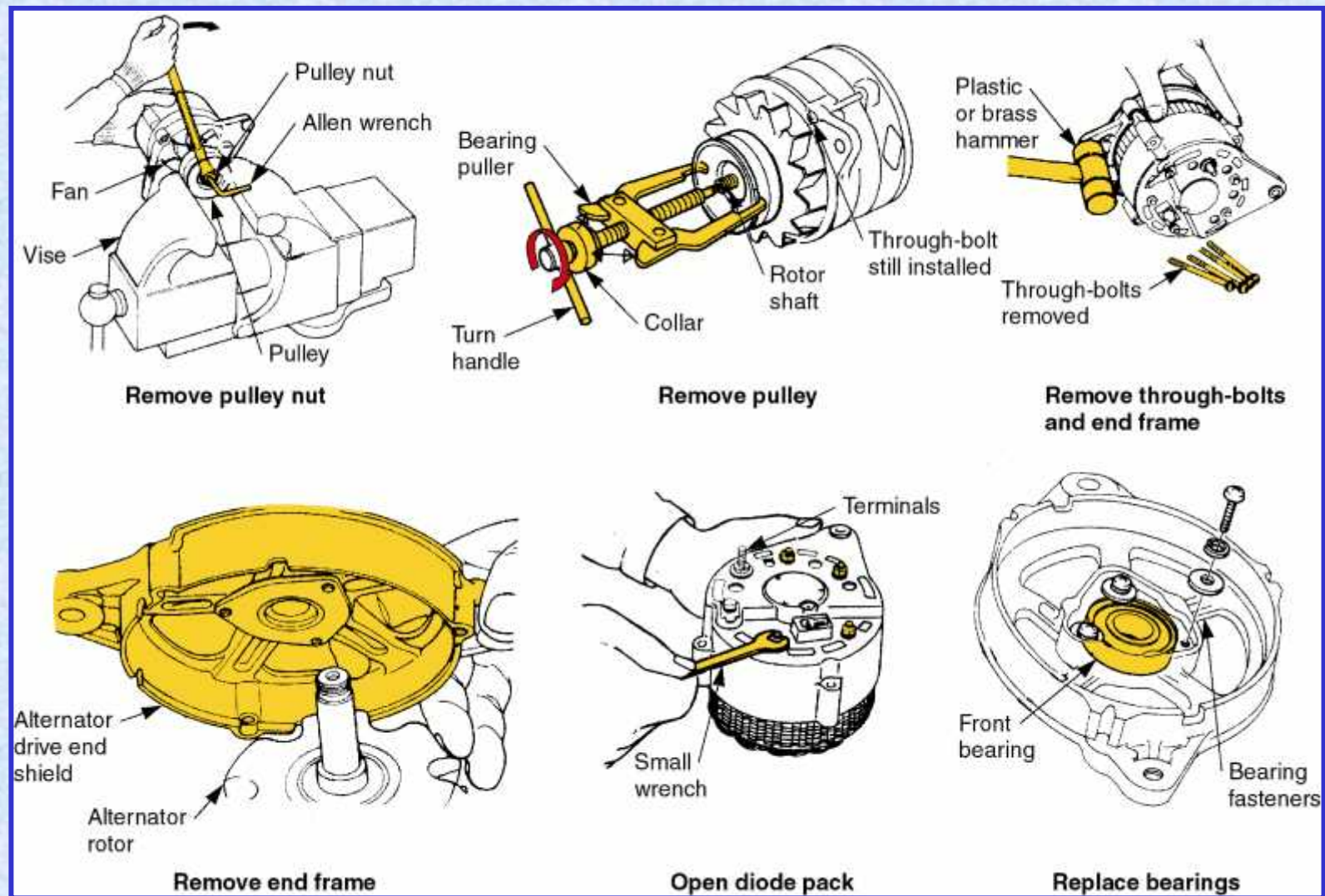
- ☐ Disconnect the battery
- ☐ Loosen the mounting bolts
- ☐ Remove the belt
- ☐ Remove the wires, noting their location
- ☐ Remove the bolts and the alternator



# Alternator Removal



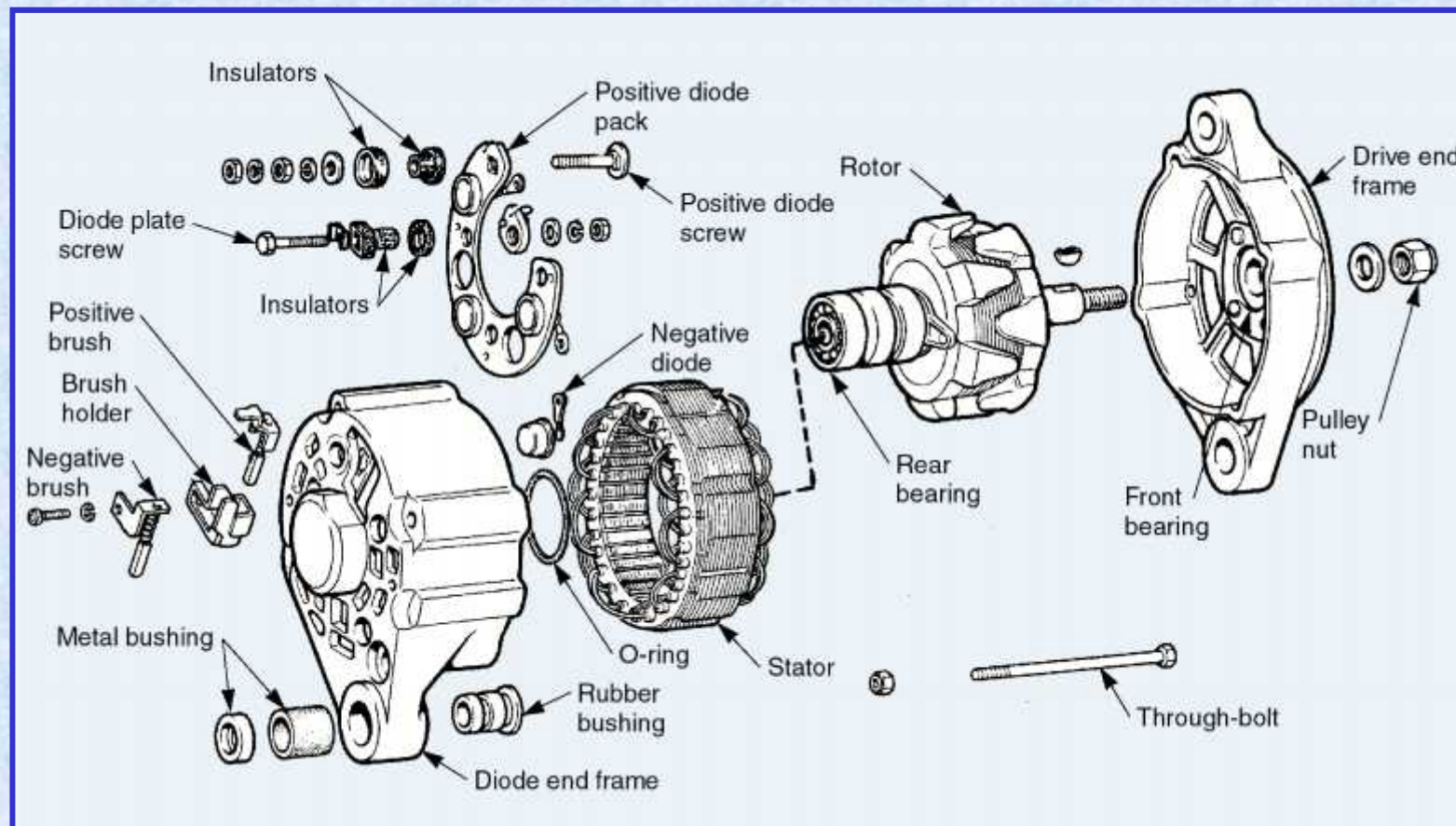
# Alternator Disassembly





# Disassembled Alternator

Do not clean electrical parts in solvent



# Rotor Service

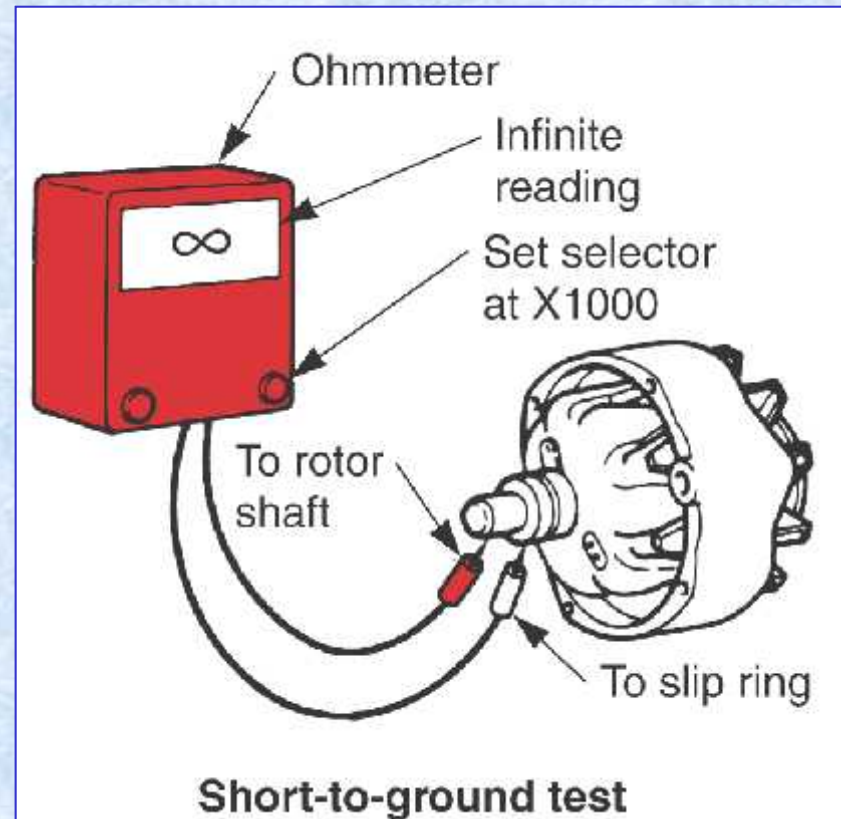
- ❑ The rotor can have a bent shaft, scored slip rings, or open, grounded, or shorted windings
- ❑ There are several tests designed to check a rotor



# Short to Ground Test

Measures the resistance between the rotor shaft and the windings

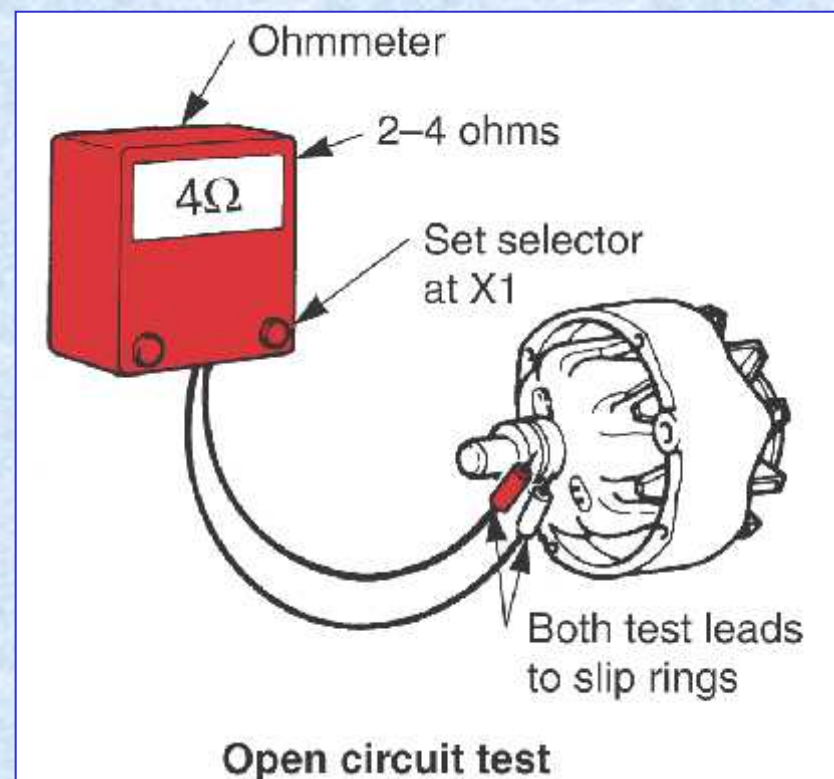
The ohmmeter should read infinity



# Open Circuit Test

Measures the resistance between the slip rings

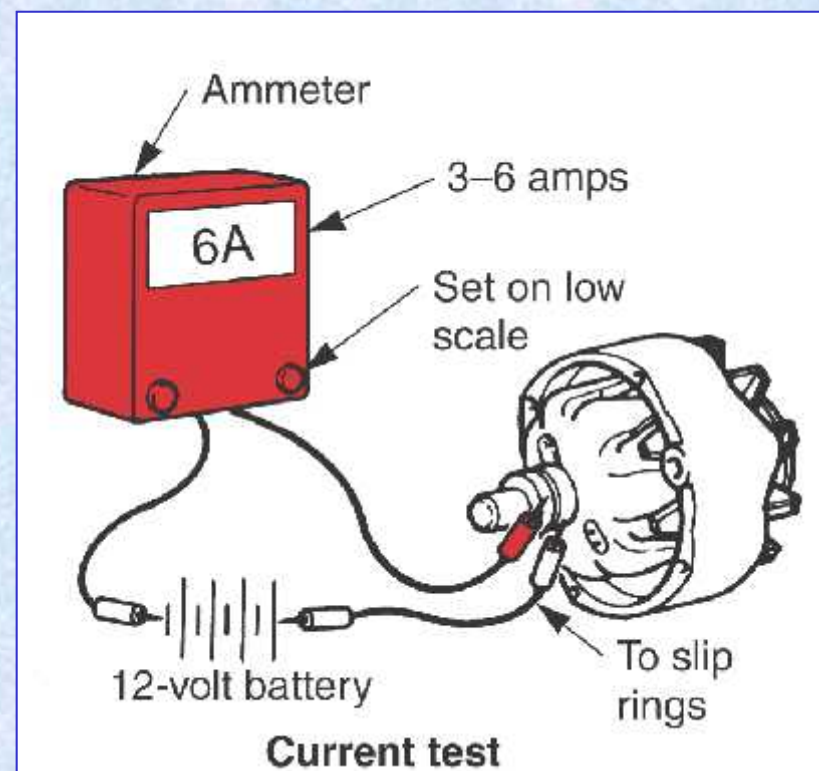
The ohmmeter should read low resistance (see the manufacturer's specifications)





# Rotor Current Test

Connect a 12 volt battery and an ammeter to the slip rings  
Compare the current to specifications

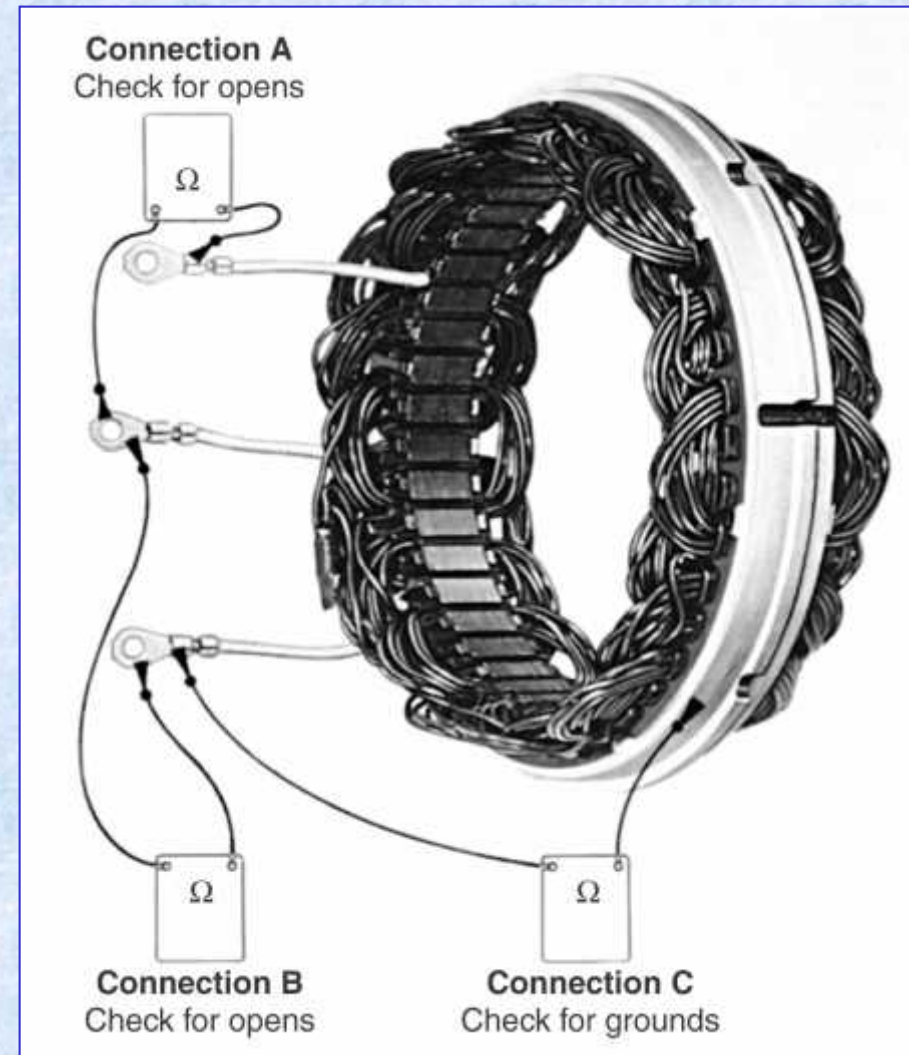


# Stator Service

- ☐ The stator can have open or shorted windings
- ☐ Inspect for signs of burning (shorts)
- ☐ Use an ohmmeter to check for opens and grounds



# Ohmmeter Connections

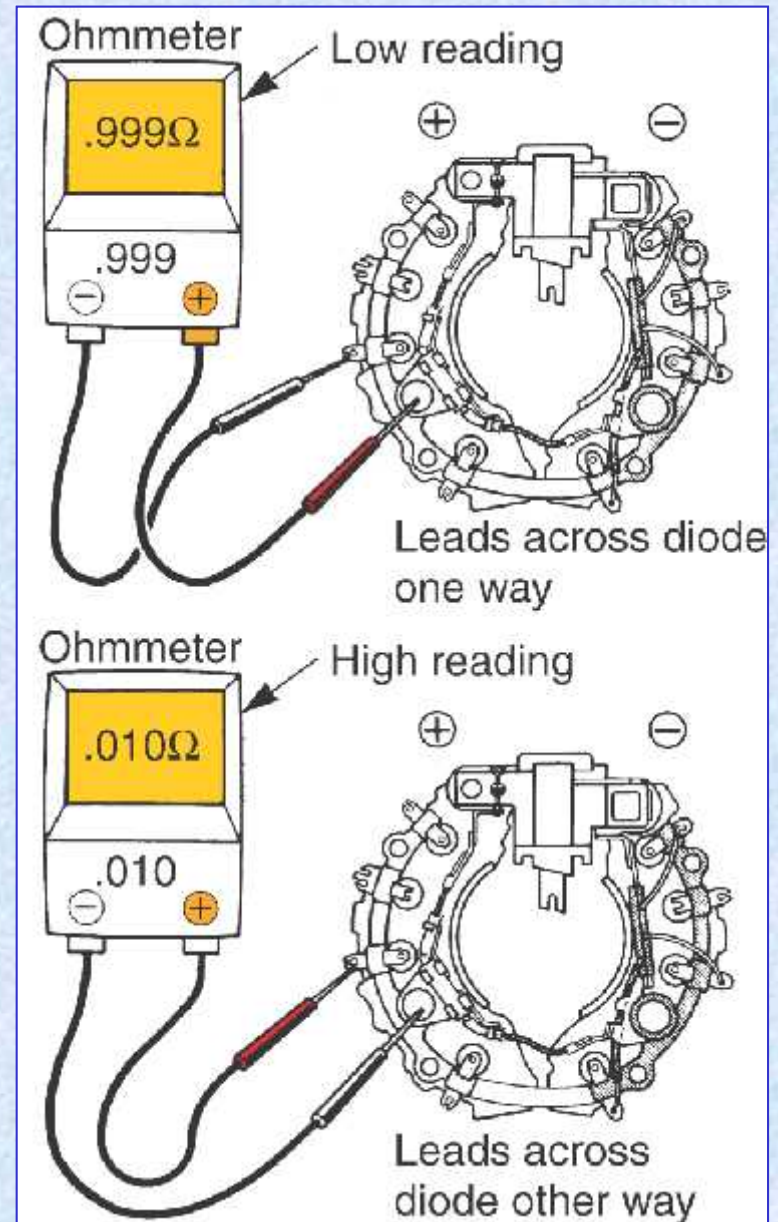


# Diode Service

- ☐ Bad diodes can reduce alternator output or cause voltage ripple
- ☐ Connect an ohmmeter across the diode in one direction (polarity) and then the other
- ☐ The meter should read high resistance in one direction and low resistance in the other



# Diode Test Connections



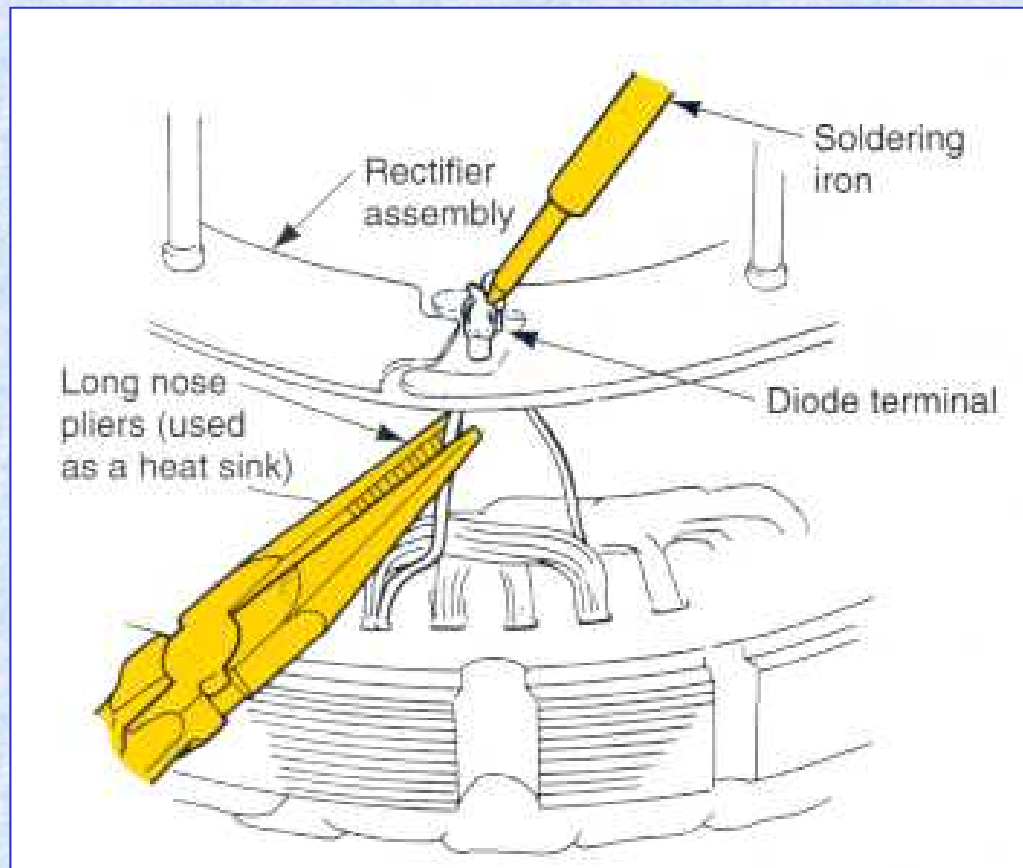
# Diode Test Results

- ❑ Open diode
  - high (infinite) resistance in both directions
- ❑ Shorted diode
  - low resistance in both directions
- ❑ Either condition requires diode replacement



# Diode Replacement

If diode replacement requires soldering,  
use rosin-core solder



# Bearing Service

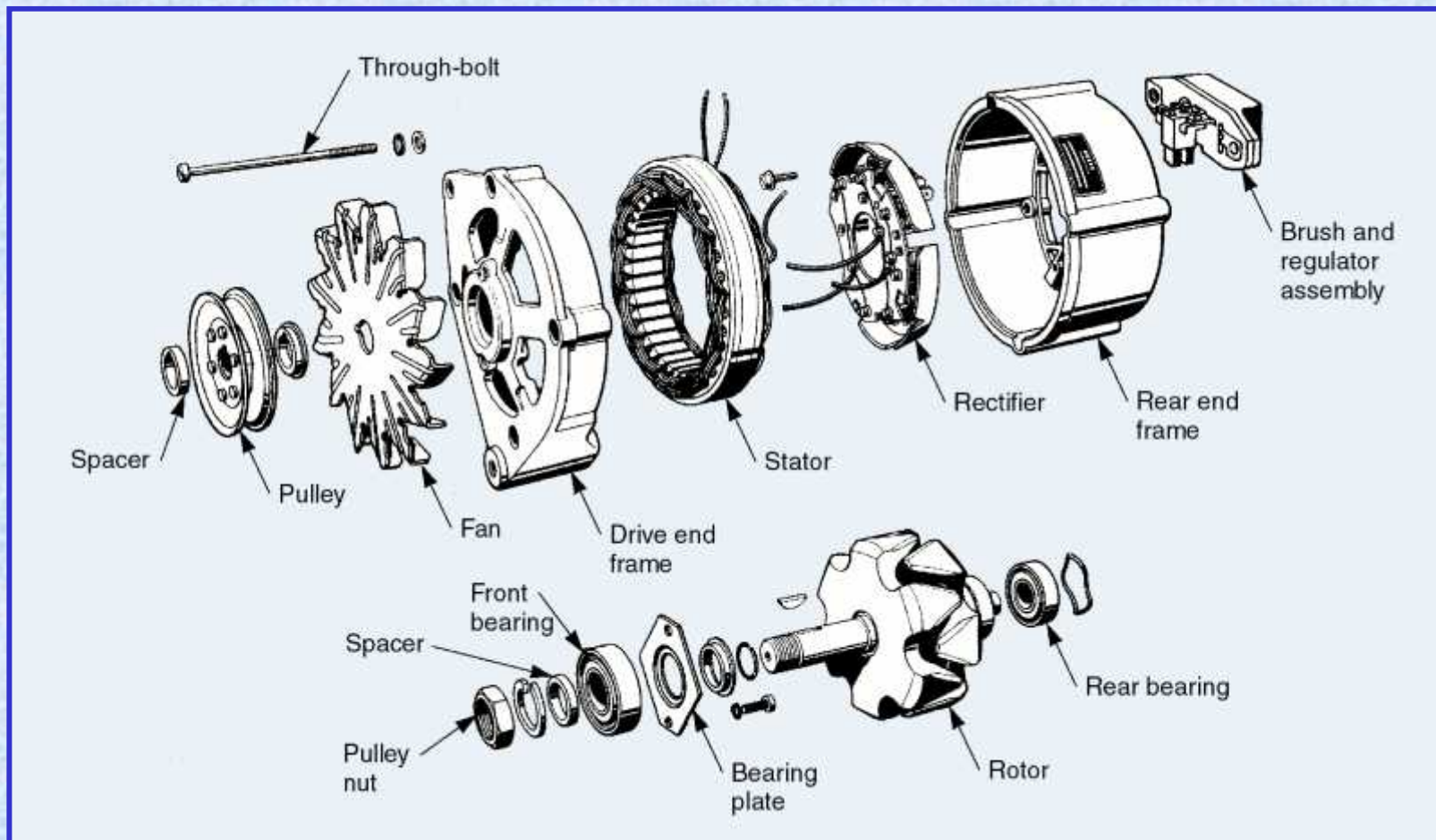
- ☐ Worn bearings can cause rumbling or grinding noises or become loose
- ☐ If the front bearing is held in with a cover plate, remove the screws and lift it out
- ☐ The rear bearing may be press-fit
- ☐ Press or carefully drive the bearing out of rear housing
- ☐ Grease the new bearing slightly



# Brush Service

- ❑ As the brushes wear, the spring tension and brush pressure on the slip rings will be reduced
- ❑ Inspect the brushes and compare the length to specifications
- ❑ Replace the brushes if they are soaked with oil or grease

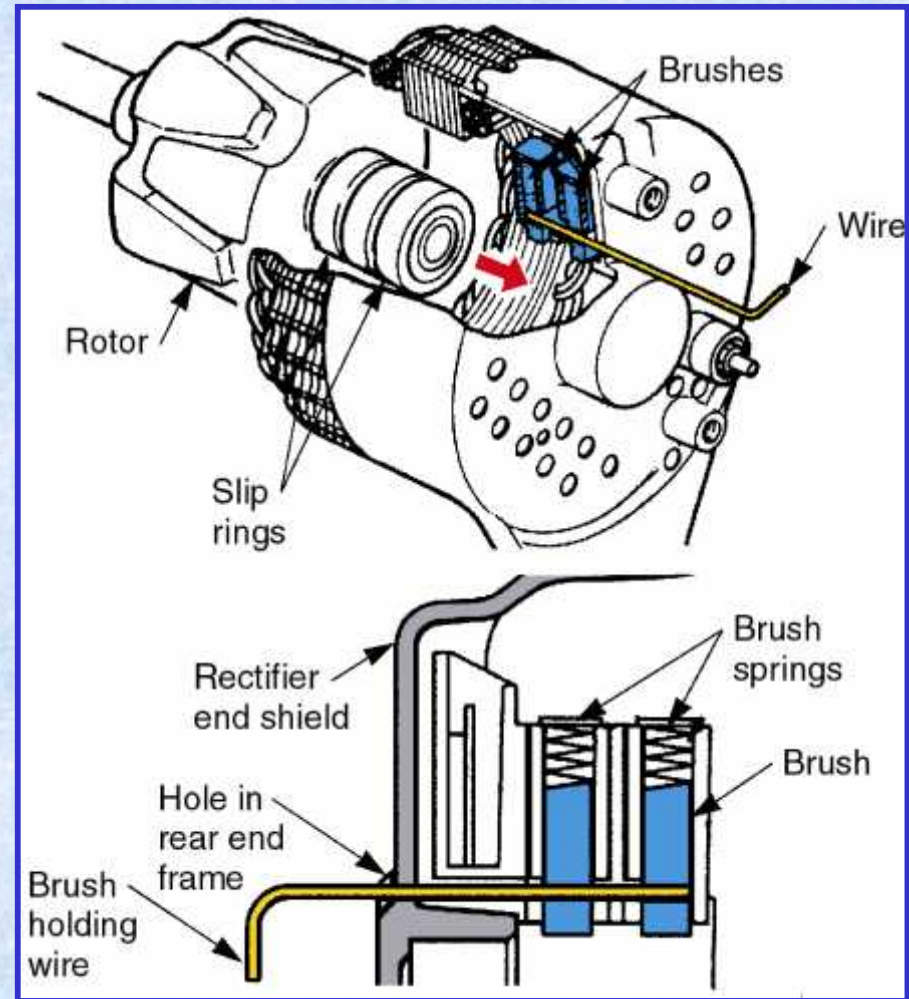
# Alternator Assembly





# Alternator Assembly

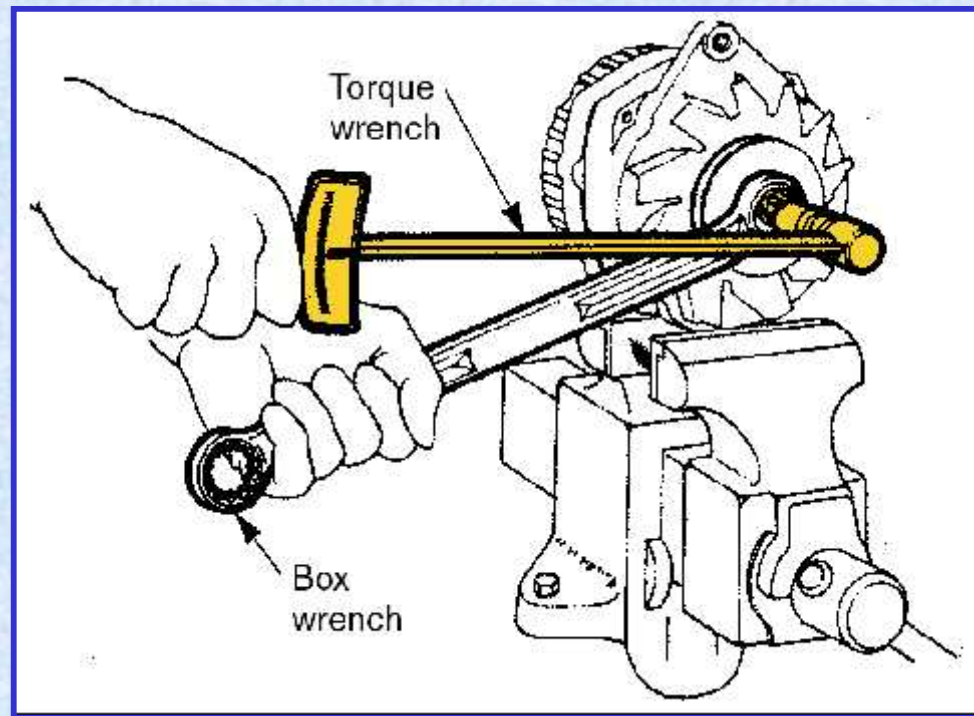
A stiff wire may be needed to hold spring-loaded brushes in position for assembly



# Alternator Assembly

Install the spacer,  
fan, front pulley,  
lock washer, and  
nut

Torque to  
specification





# Alternator Installation

- ☐ Install the wires on the back of the alternator
- ☐ Hand start the mounting bolts
- ☐ Check the belt condition and alignment
- ☐ Adjust the belt tension
- ☐ Tighten the bolts
- ☐ Reconnect the battery
- ☐ Test the alternator output to verify repairs

# Regulator Service

- Location:

- inside or on the back of the alternator
- external, in the engine compartment

- Some regulators may be adjustable

- a small adjusting screw may be turned to adjust the voltage setting