

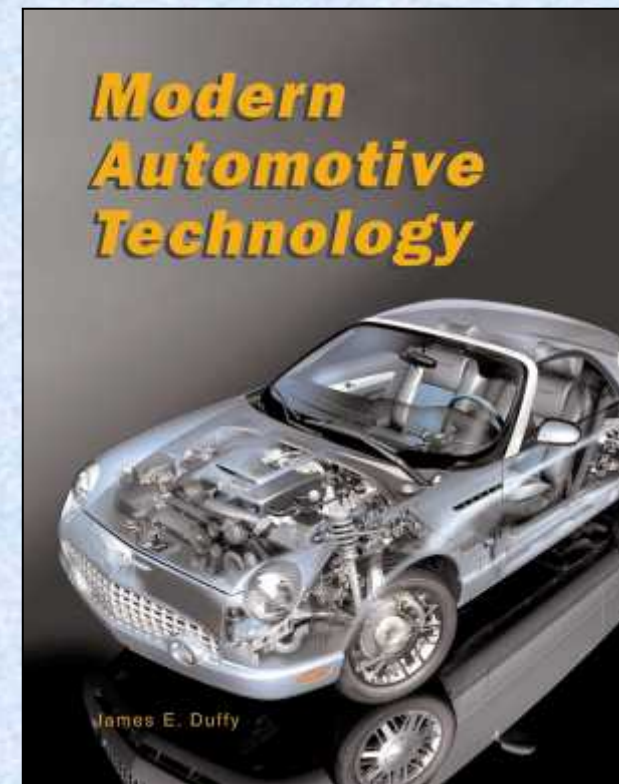
powerpoint for

Modern Automotive Technology

by
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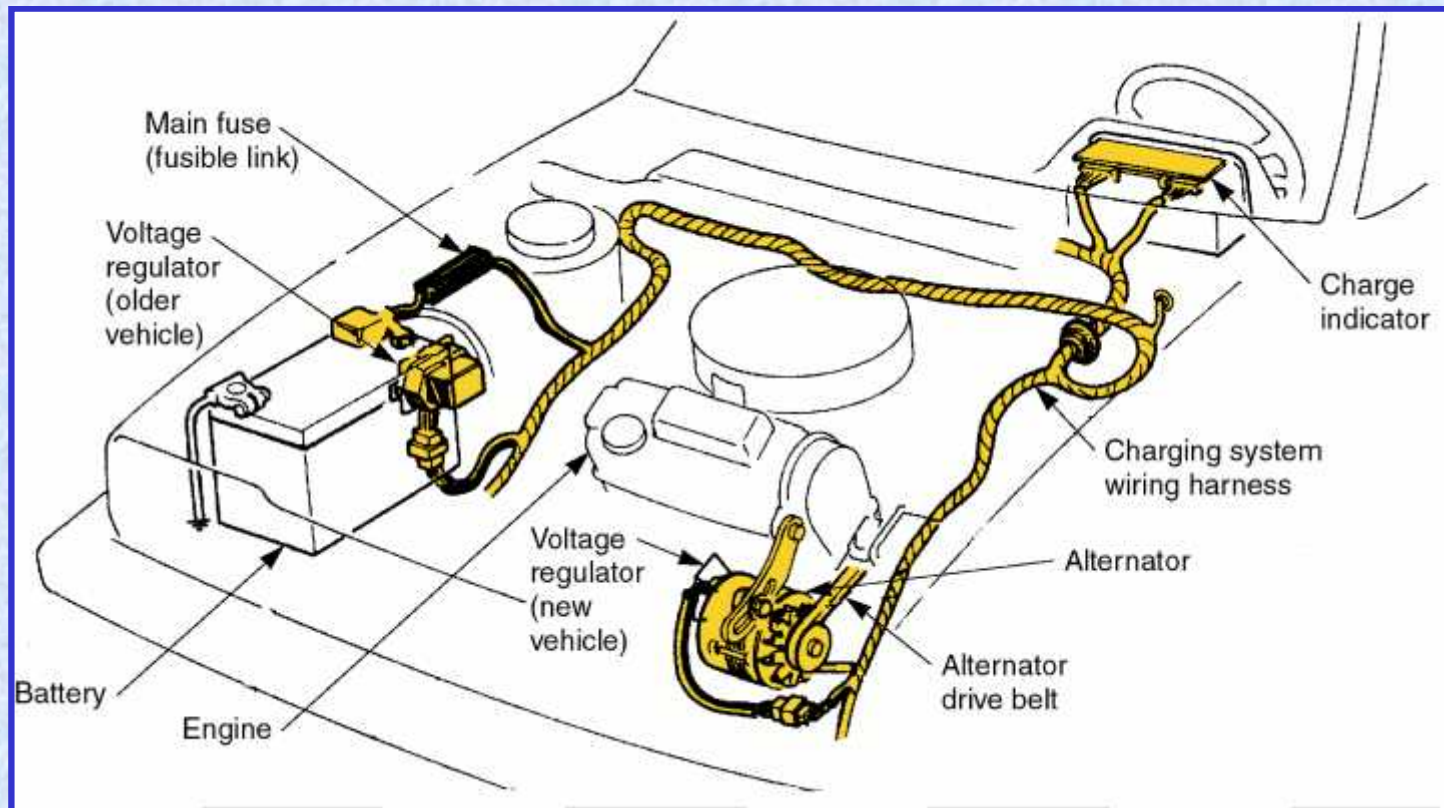
Chapter 33

Charging System Fundamentals

Contents

- ❑ Basic charging system parts
- ❑ Charging system functions
- ❑ Types of charging systems
- ❑ Alternator operation
- ❑ Alternator construction
- ❑ Charge indicators

Basic Charging System Parts



Charging System Parts

❑ Alternator

- generator that uses mechanical power to produce electricity

❑ Voltage regulator

- controls the output voltage of the alternator

❑ Alternator drive belt

- links the engine crankshaft pulley with the alternator pulley
- drives the alternator

Charging System Parts

❑ Charge Indicator

- ammeter, voltmeter, or warning light
- informs driver of the charging system condition

❑ Harness

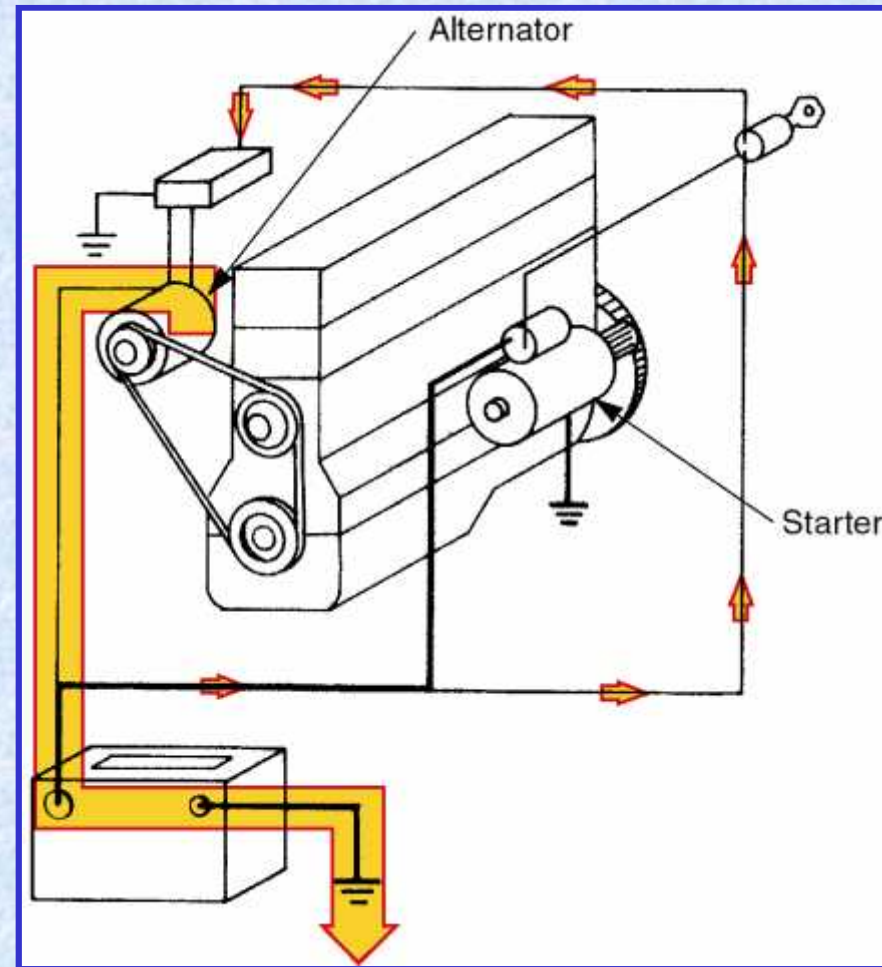
- wiring connecting the parts of the system

❑ Battery

- provides current to initially energize the alternator field
- stabilizes the alternator output

Charging System

Recharges the battery and supplies electricity when the engine is running



Charging System Functions

- ☐ Recharges the battery after cranking
- ☐ Supplies the car's electricity when the engine is running
- ☐ Provides an output voltage slightly higher than the battery voltage
- ☐ Changes the output to meet varying loads

Types of Charging Systems

- Two types:
 - DC generator
 - AC generator (alternator)

DC Generator

- ❑ Similar to an electric motor
- ❑ Stationary magnetic field
- ❑ The output conductor unit (armature) spins inside the field
- ❑ Induces current from within the armature

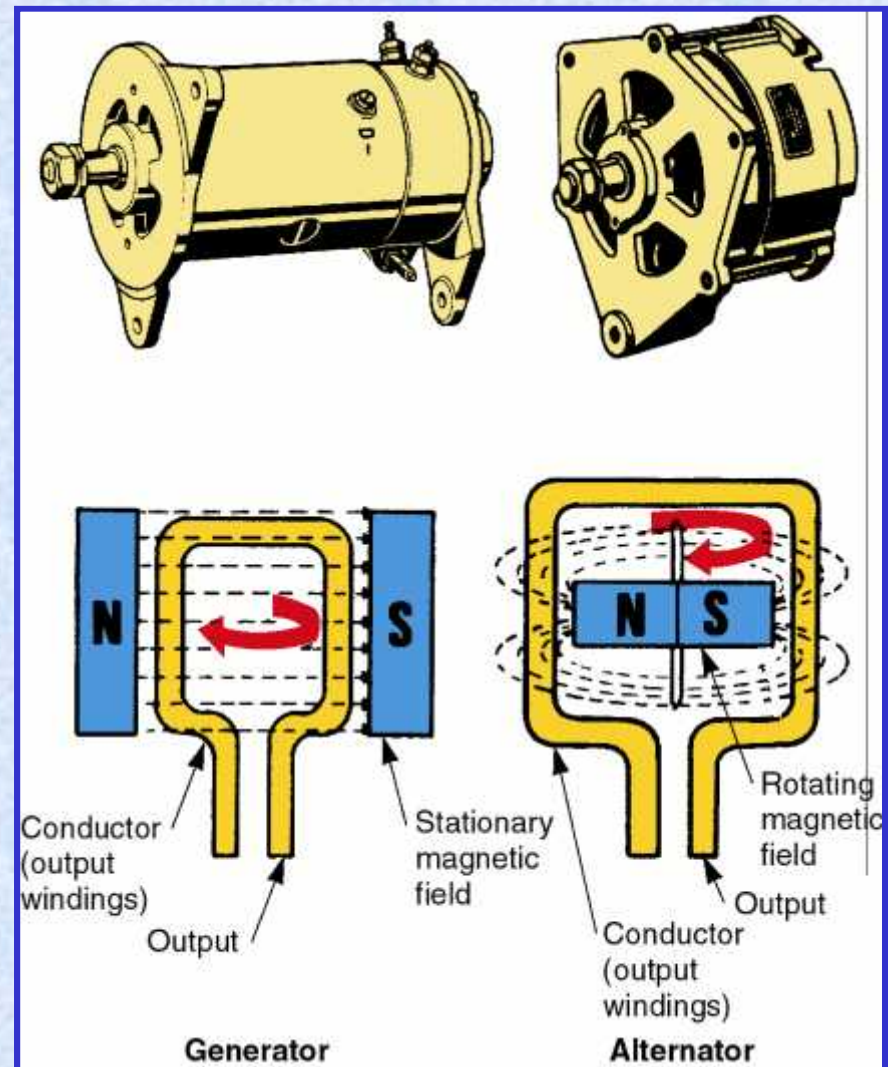
AC Generator (Alternator)

- Advantages:
 - more efficient
 - smaller and lighter
 - more dependable
 - more output at idle

AC Generator (Alternator) Theory

- ❑ The magnetic field rotates
- ❑ The output conductors (windings) are stationary
- ❑ The field rotates, inducing current in the output windings

Generator versus Alternator



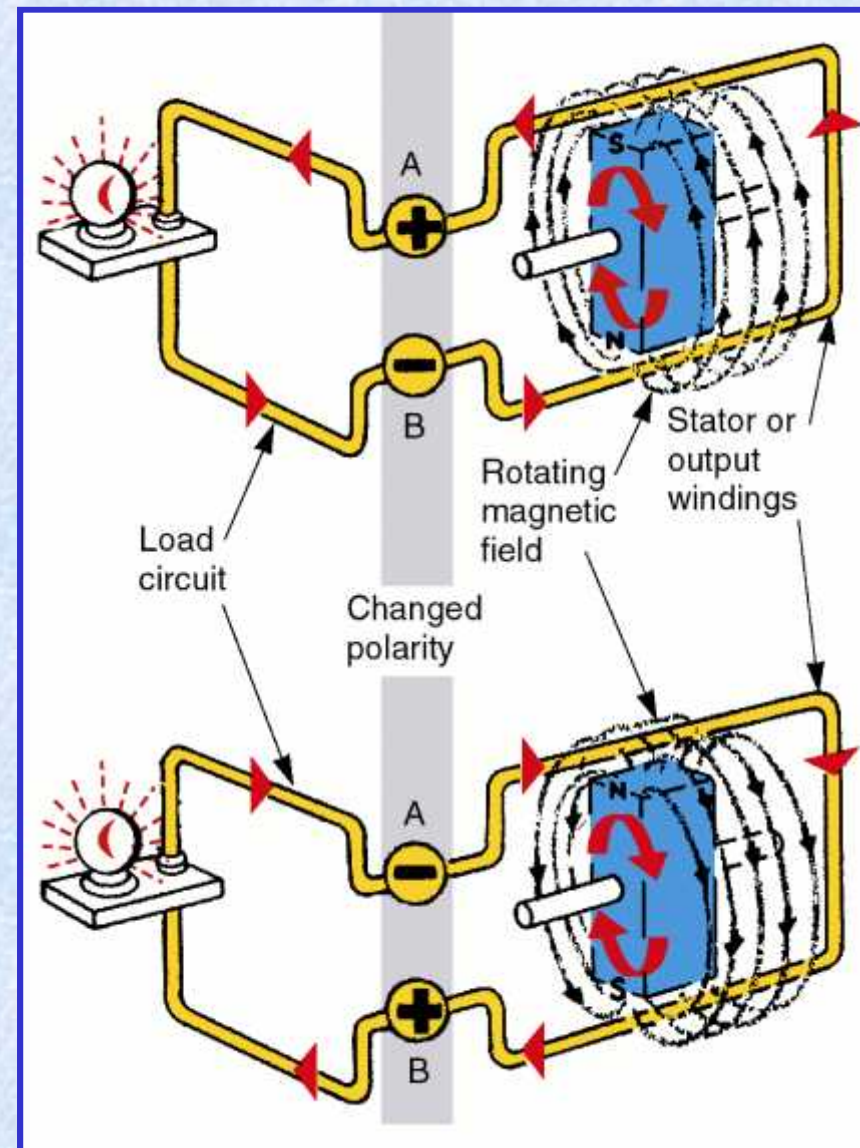
Alternator Operation

- ❑ Two main parts, rotor and stator
- ❑ The rotor is located in the center
 - creates a rotating magnetic field when turned by the drive belt
- ❑ The stator is a stationary set of windings surrounding the rotor
 - output winding in the alternator

Alternator Operation

- ❑ When the rotor spins, its strong magnetic field cuts across the stator windings
- ❑ Current is induced in the stator windings

Alternator Operation



AC Output

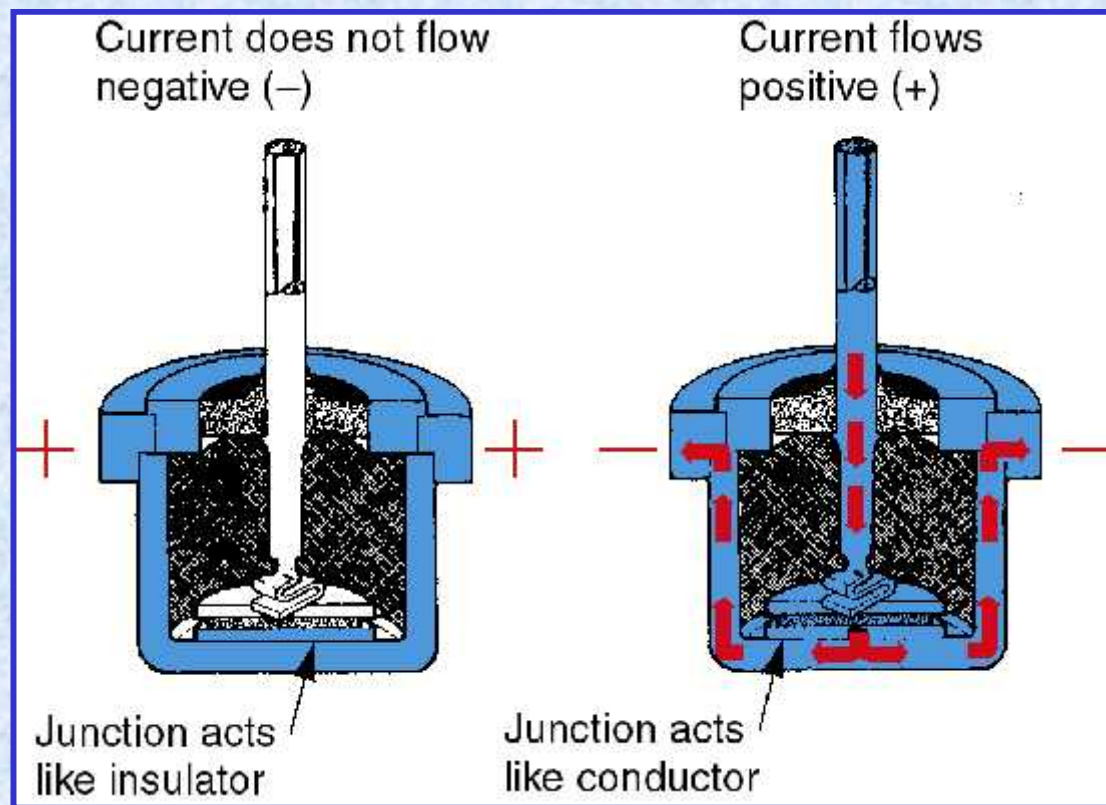
- ❑ Alternating current flows one way, then the other
- ❑ As the rotor turns into one stator winding, current is induced
- ❑ When the same rotor pole moves into the other stator winding, the current reverses direction

Rectified AC Current

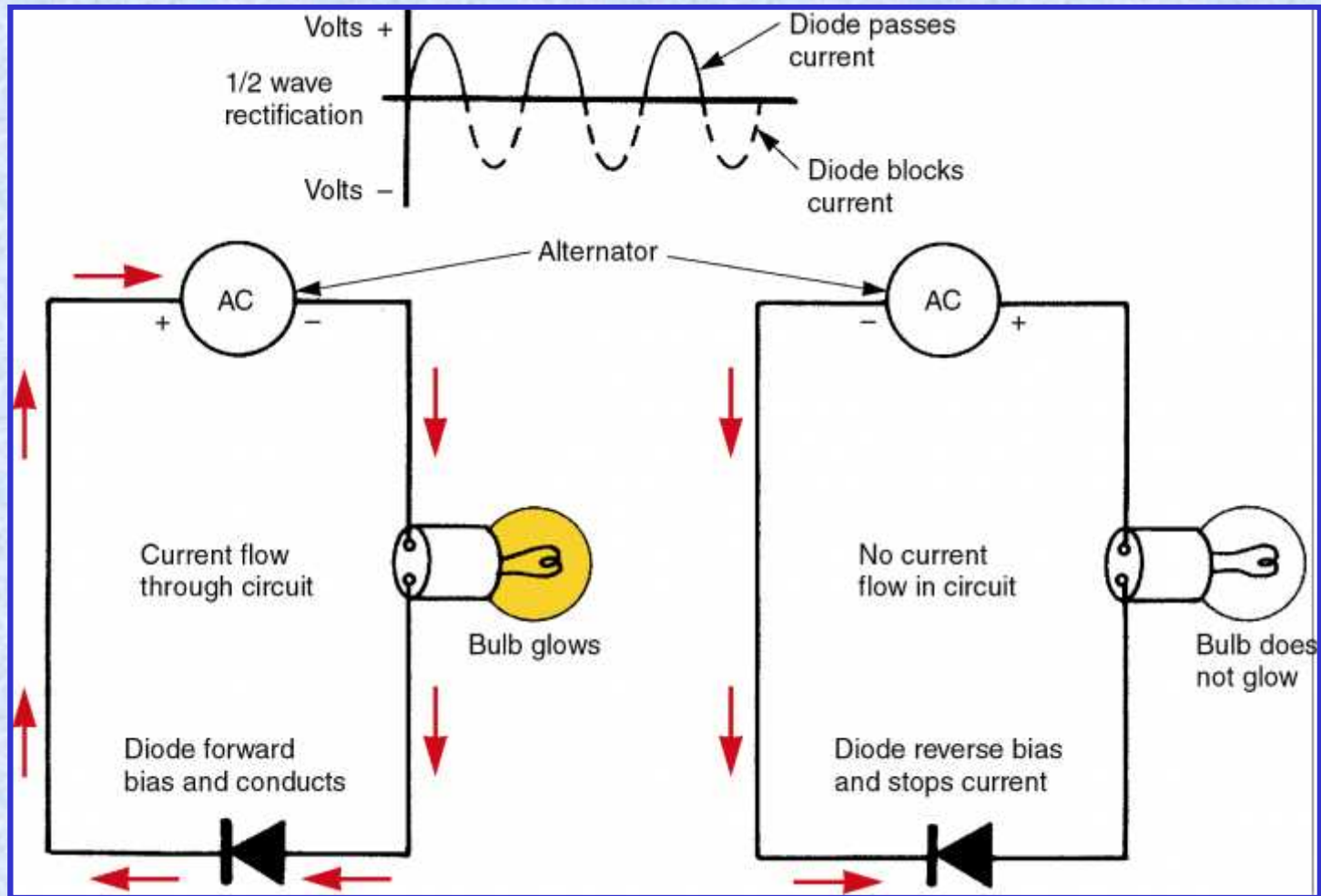
- ❑ An automobile's electrical system requires direct current (DC), which flows one way
- ❑ Alternator output must be *rectified* (changed) from AC to DC
- ❑ A diode allows current flow in only one direction
- ❑ Several diodes are connected into a rectifier circuit

Diode

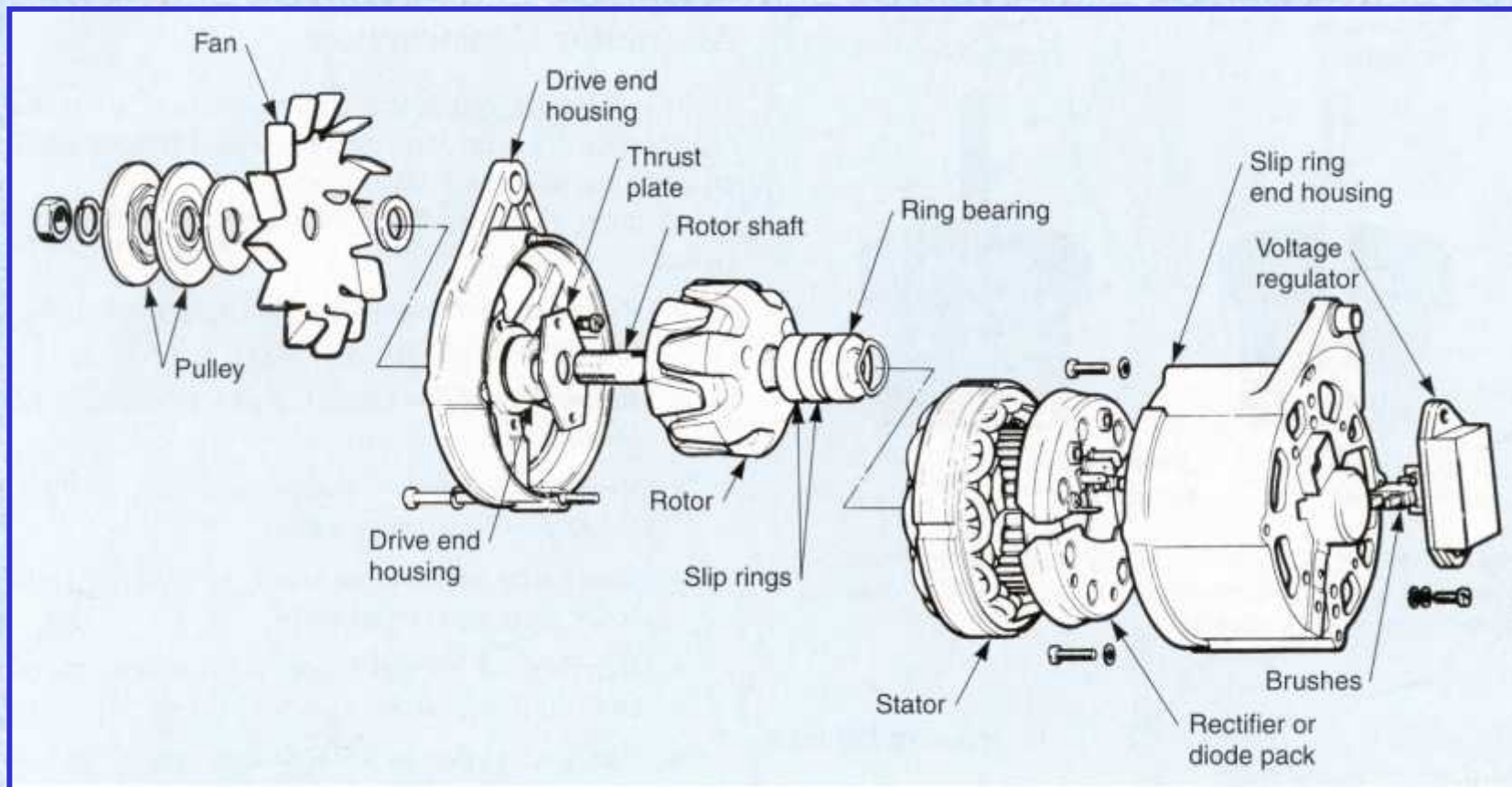
Acts as a one-way electrical check valve



Diode Operation



Alternator Construction

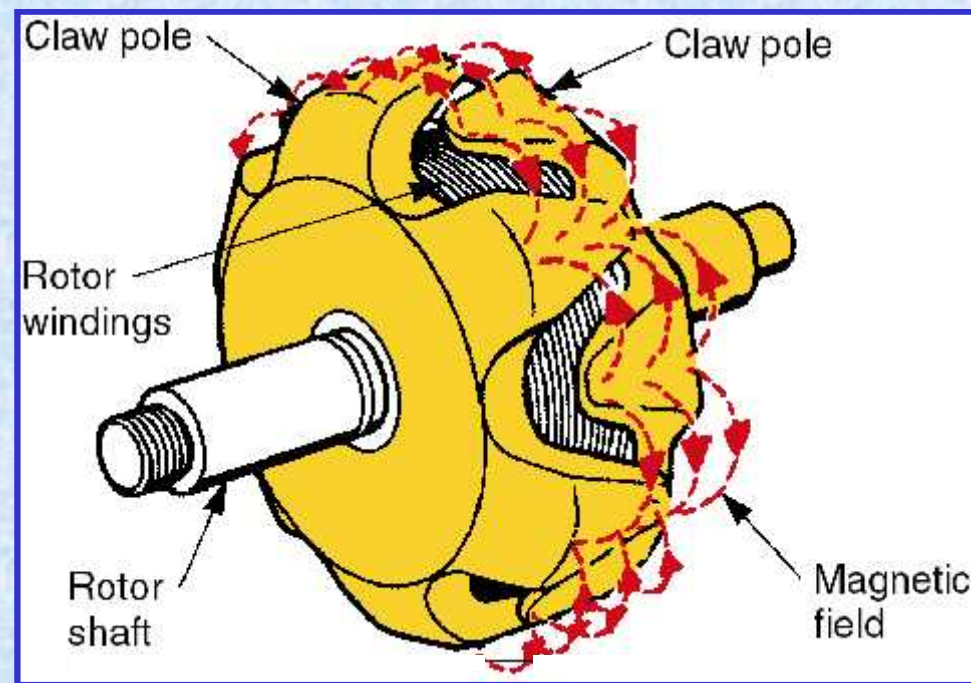


Rotor

- ❑ Field windings mounted on a shaft
- ❑ Two claw-shaped pole pieces surround the windings, increasing magnetic field
- ❑ The fingers on one pole piece produce south magnetic poles
- ❑ The fingers on the other pole piece produce north magnetic poles

Rotor Operation

As the rotor spins, alternating polarity produces alternating current



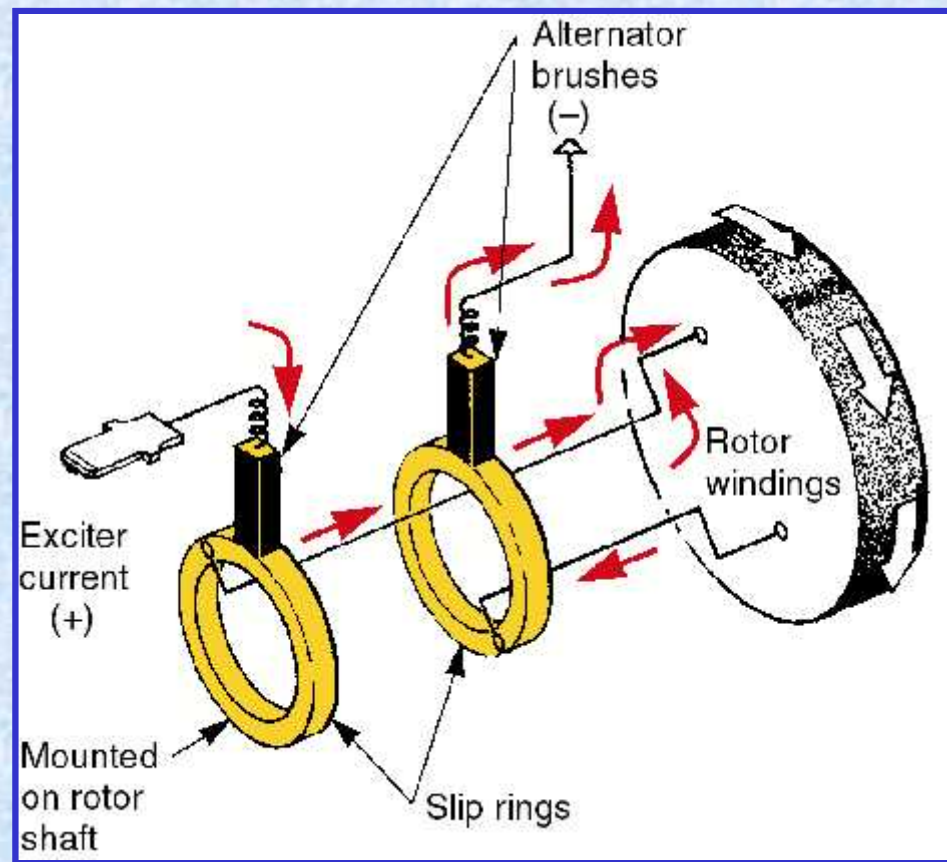
Slip Rings

- ☐ Mounted on the rotor shaft
- ☐ Provide current to the rotor windings
- ☐ An external source of electricity is needed to excite the field

Brushes

- ❑ Ride on the slip rings
- ❑ Provide a sliding electrical connection
- ❑ Feed battery current into the slip rings and rotor windings
- ❑ Springs hold the brushes in contact with the slip rings

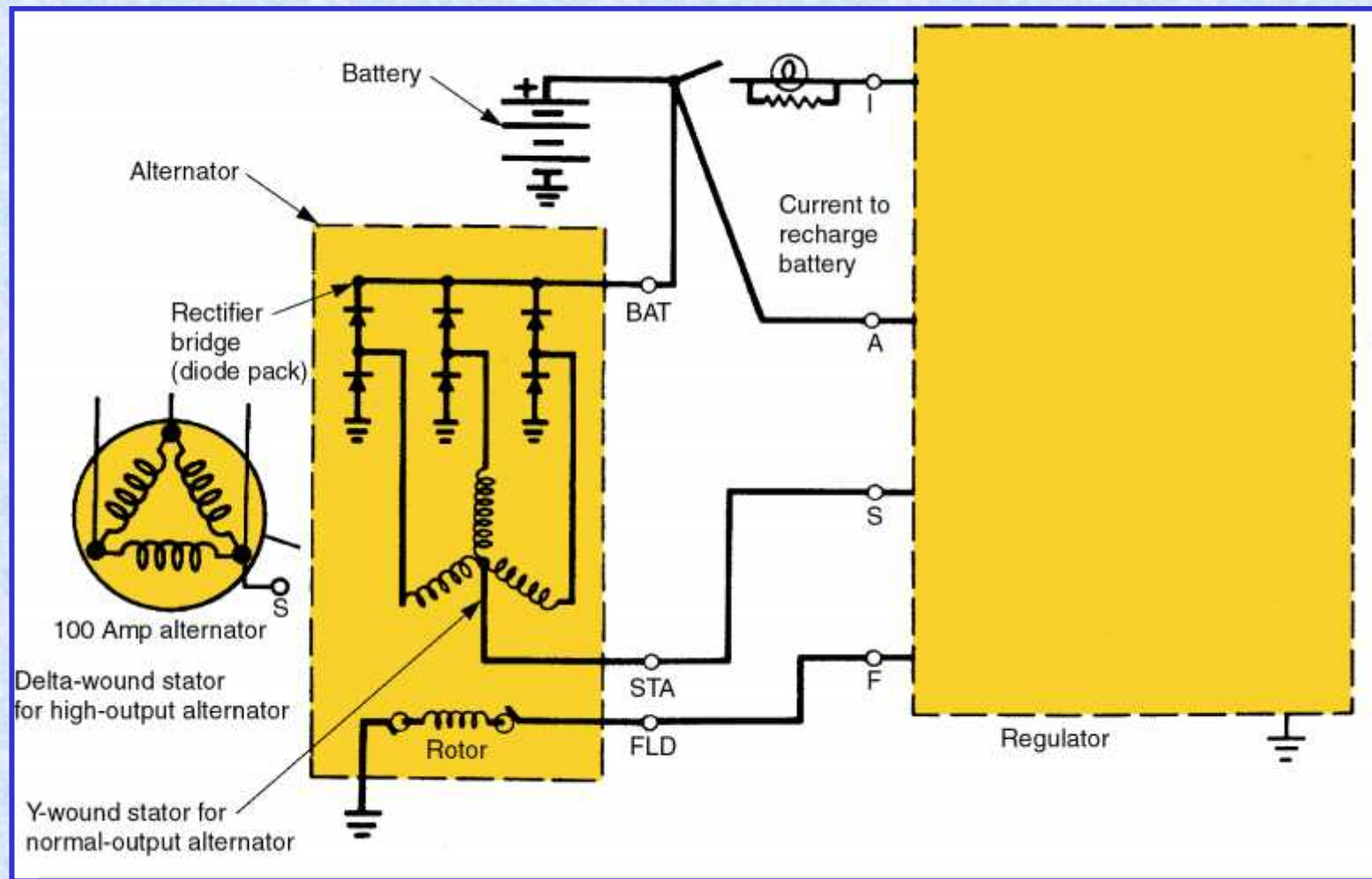
Brushes and Slip Rings



Rectifier

- ❑ Six diodes convert stator output to direct current
- ❑ Provides ***full-wave rectification***
- ❑ Changes both positive and negative outputs into direct current
- ❑ Diode trio may be used to feed power from the stator to the field (rotor)

Charging Circuit

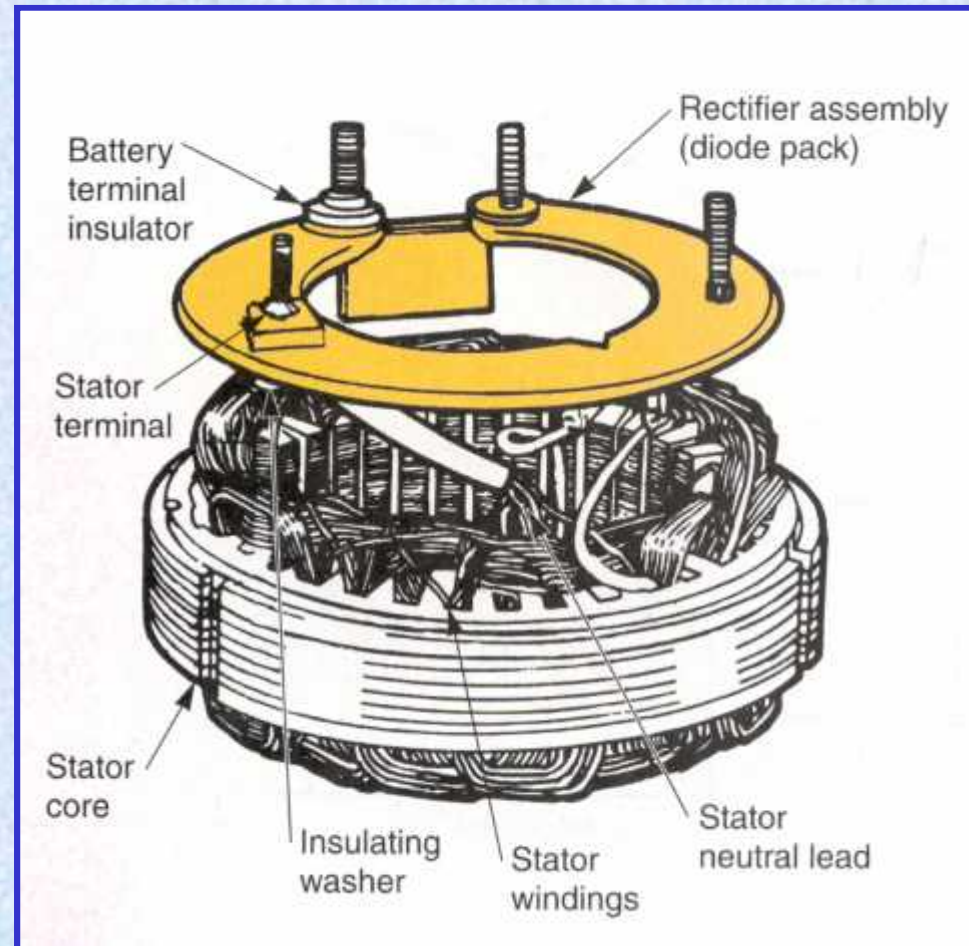


Stator

- ❑ Three groups of windings wrapped around a soft, laminated iron core (ring)
- ❑ Produces an electrical output
- ❑ The iron core concentrates the field around the windings

Stator and Rectifier

A rectifier consists of six diodes, connected to the stator windings



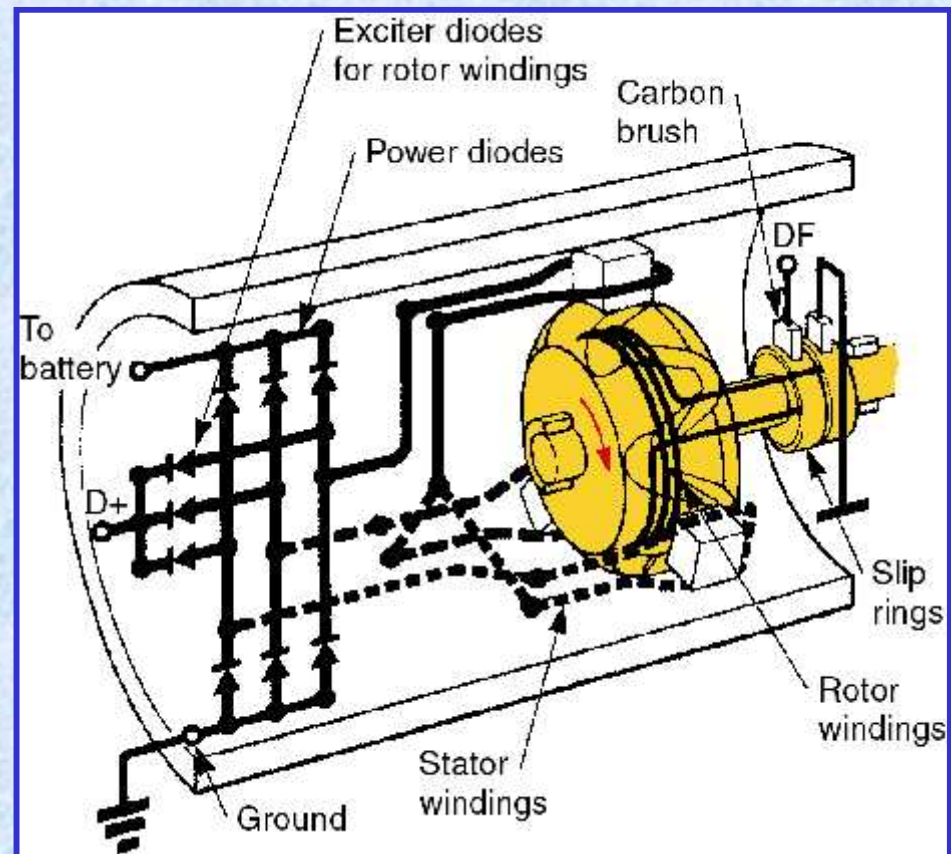
Y-Type Stator

- ❑ The wire ends from the three windings are connected to a neutral junction
- ❑ Looks like a letter “Y”
- ❑ Provides good output current at low speeds

Delta-Type Stator

- ❑ The stator wires are connected end to end
- ❑ Two circuit paths are formed during each phase of operation
- ❑ Provides high output

Alternator Wiring

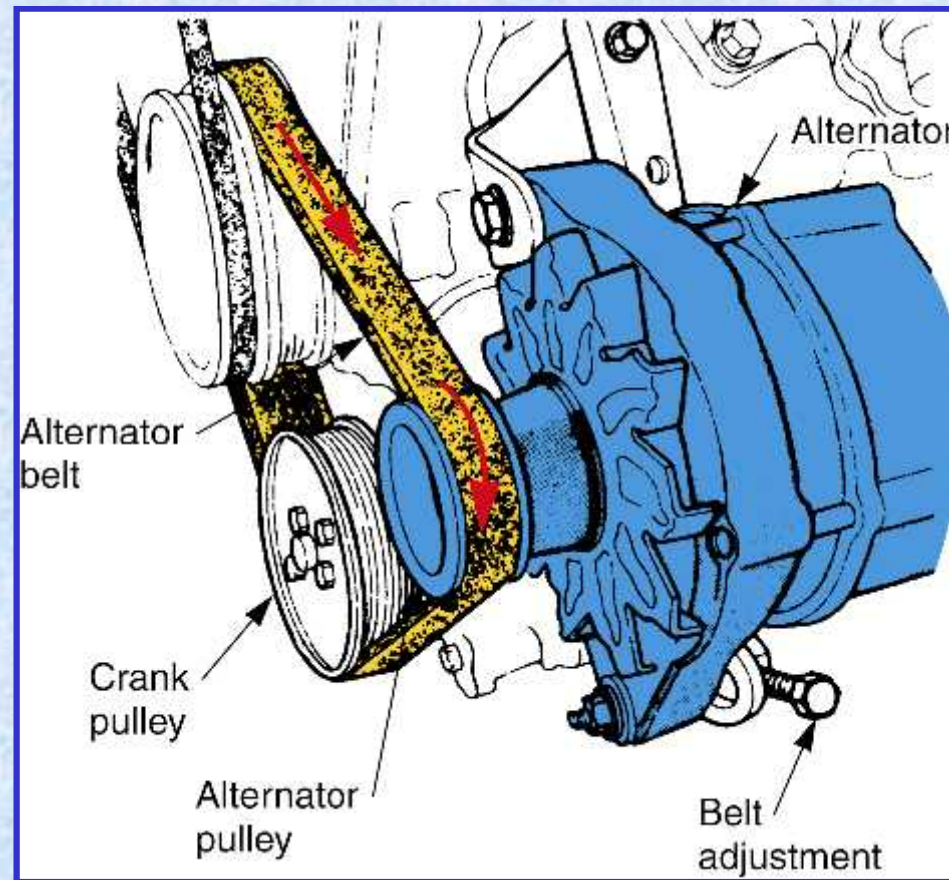


Alternator Fan

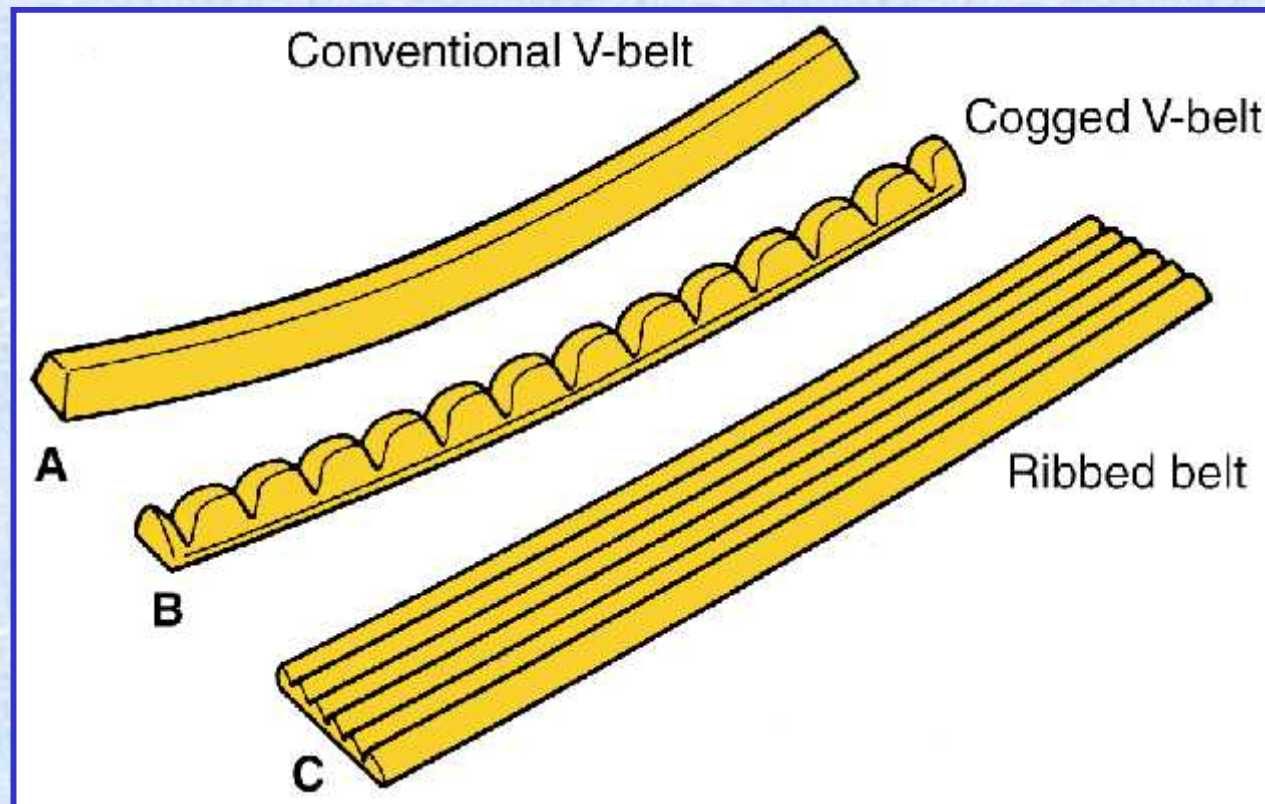
- ❑ Mounted on the front of the rotor shaft
- ❑ Draws air through and over the alternator
- ❑ Cools the windings and diodes

Pulley and Belt

The crankshaft turns the alternator belt



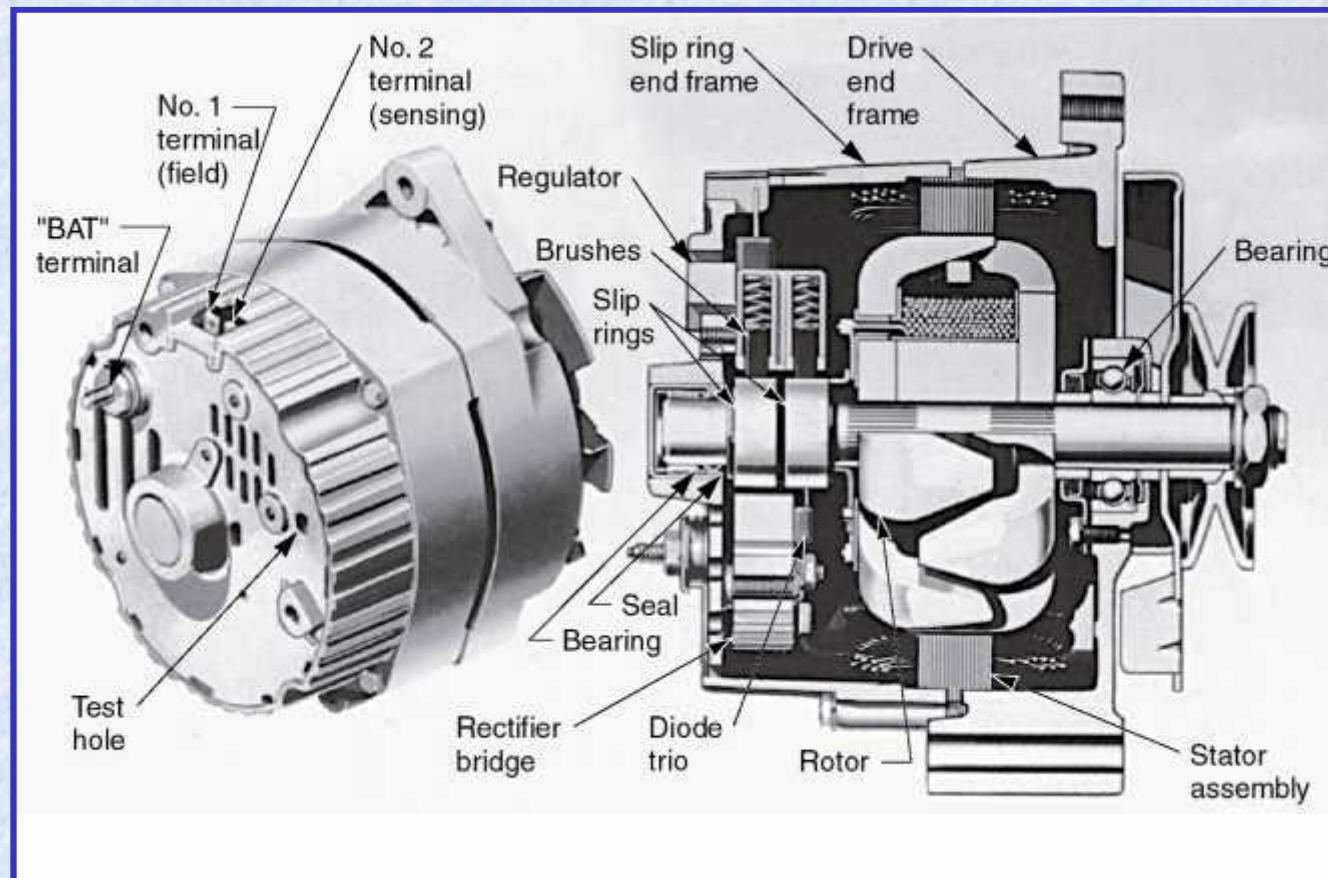
Types of Belts



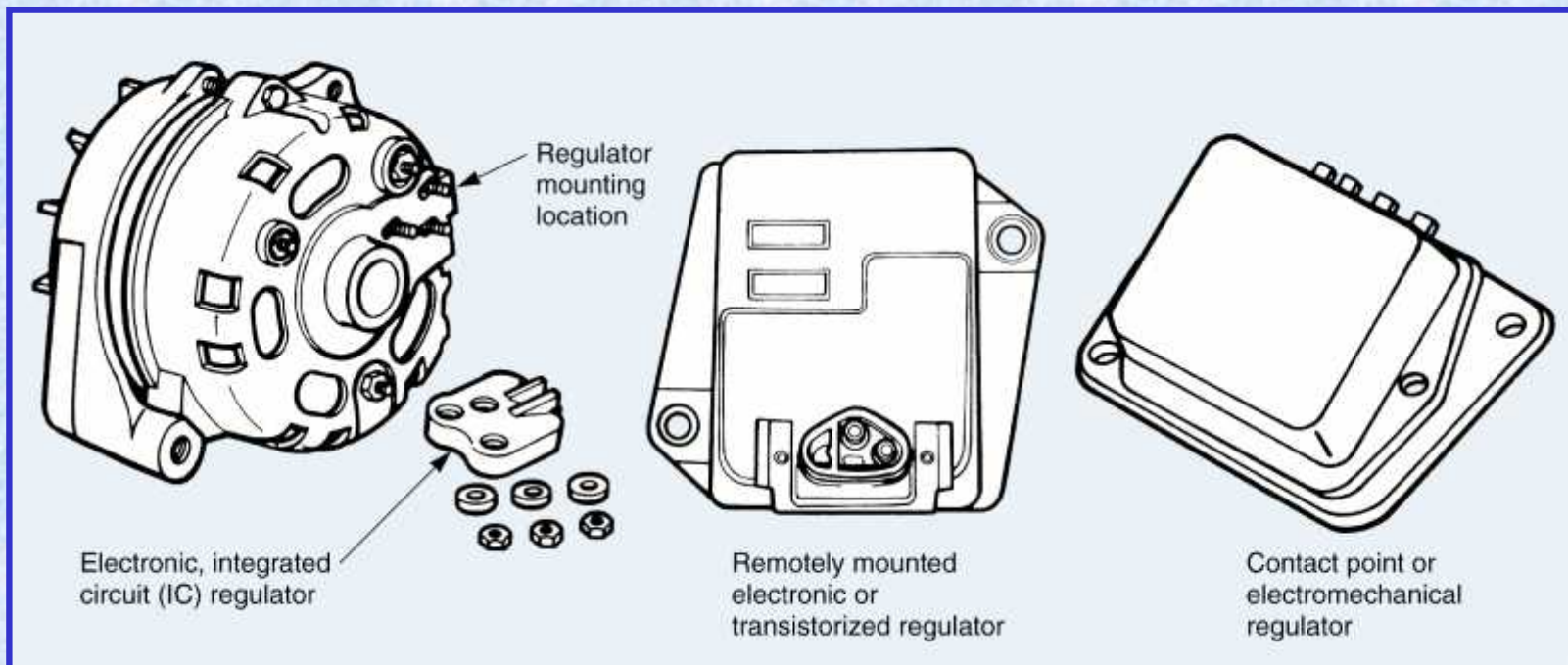
Voltage Regulator

- ❑ Controls the alternator output voltage
- ❑ Changes the amount of current flowing through the rotor windings
- ❑ The engine control module (ECM or PCM) may serve as the voltage regulator

Internally Regulated Alternator



Voltage Regulators



Electronic Voltage Regulator Operation

- ❑ To increase the alternator output, the regulator allows more current into the rotor windings
- ❑ The magnetic field around the rotor is increased
- ❑ More current is induced in the stator windings, increasing output

Battery Thermistor

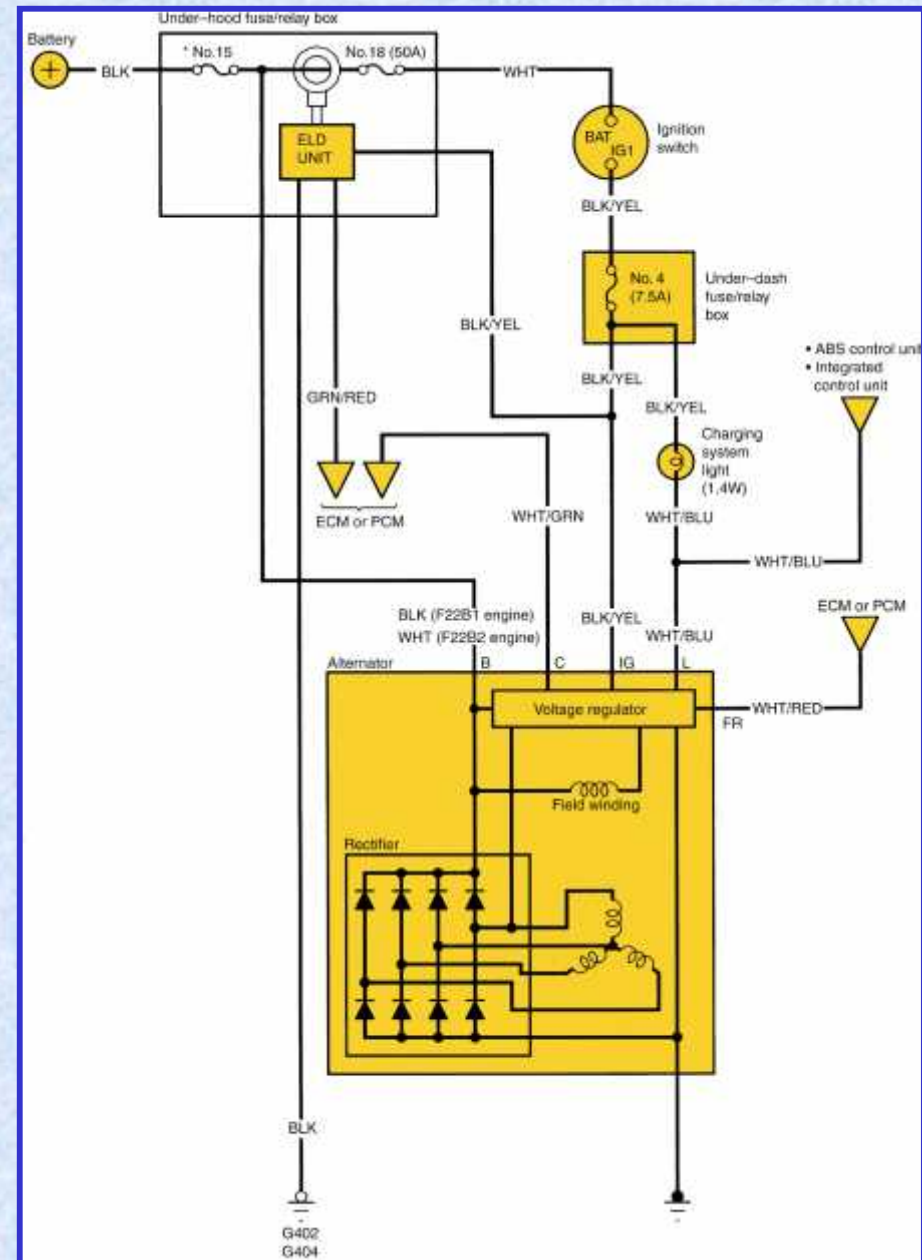
- ☐ Measures battery temperature
- ☐ Allows the charging system to alter output as needed
- ☐ A cold battery requires more voltage for charging than a hot battery
- ☐ Often mounted on the positive battery cable

Computer Monitor and Control

- ❑ The powertrain control module (PCM) can supplement or replace the voltage regulator
- ❑ The PCM can react to changing operating conditions
 - shuts the alternator off at wide-open throttle for better acceleration
 - accurately controls the charge rate, allowing a smaller, lighter battery

Charging System

Internally regulated alternator

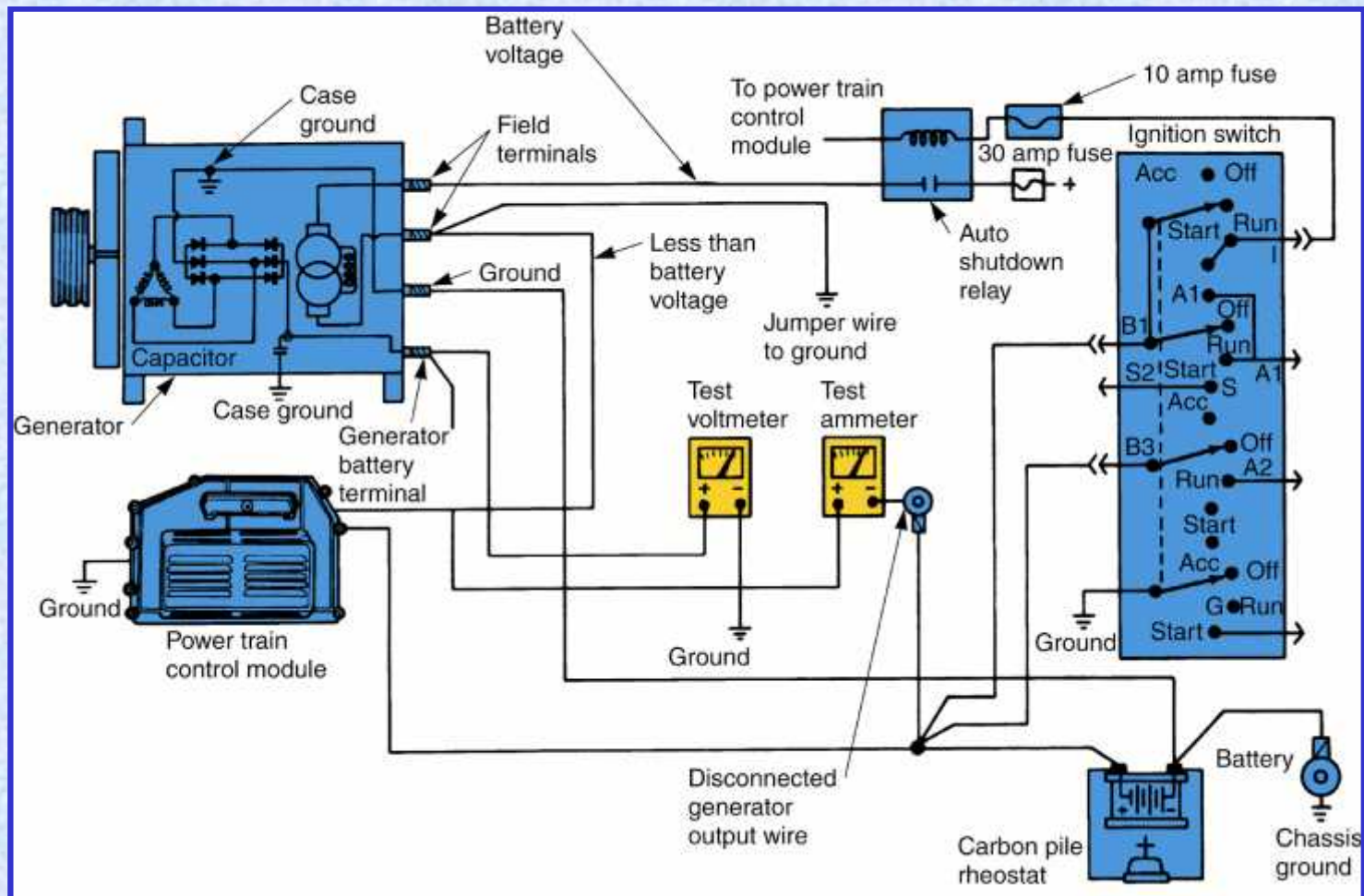


Note computer monitoring, and battery thermistor



Charging System

The PCM contains the regulator circuit



Fail-Safe Circuit

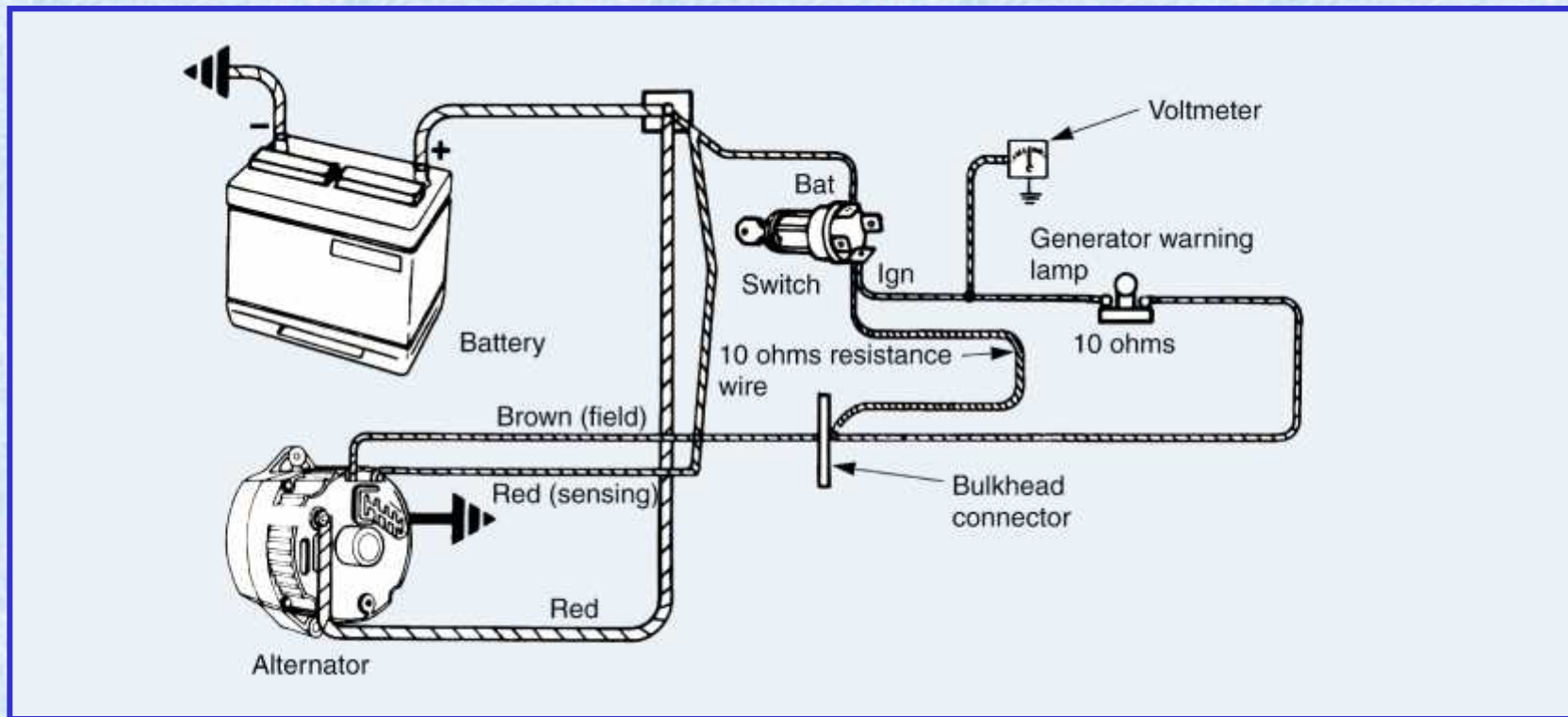
- ❑ Disconnects the alternator output if voltage levels become too high
- ❑ Protects the on-board electronics

Charge Indicators

- ❑ Informs the driver of the operating condition or output of the charging system
- ❑ Types:
 - warning light
 - voltmeter indicator
 - ammeter indicator

Charging Circuit

The warning light glows when the alternator output drops to a specified level



Voltmeter Indicator

- ☐ A battery has 12.6 volts when fully charged
- ☐ Alternator output must be higher:
 - ☐ 13–15 volts
- ☐ A voltmeter shows the voltage

Ammeter Indicator

- ☐ Shows the current output in amperes
- ☐ Reads to the right if the battery is being charged
- ☐ Reads to the left if the battery is discharging

Charging Circuit

Basic connections
for an ammeter
indicator

