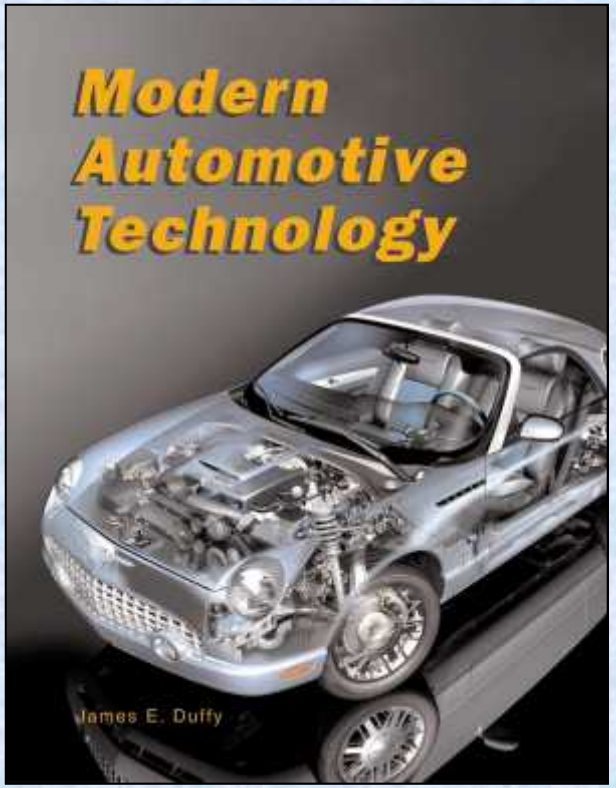
PowerPoint for

Modern Automotive Technology

by

Russell Krick



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Chapter 31

Starting System Fundamentals

Contents

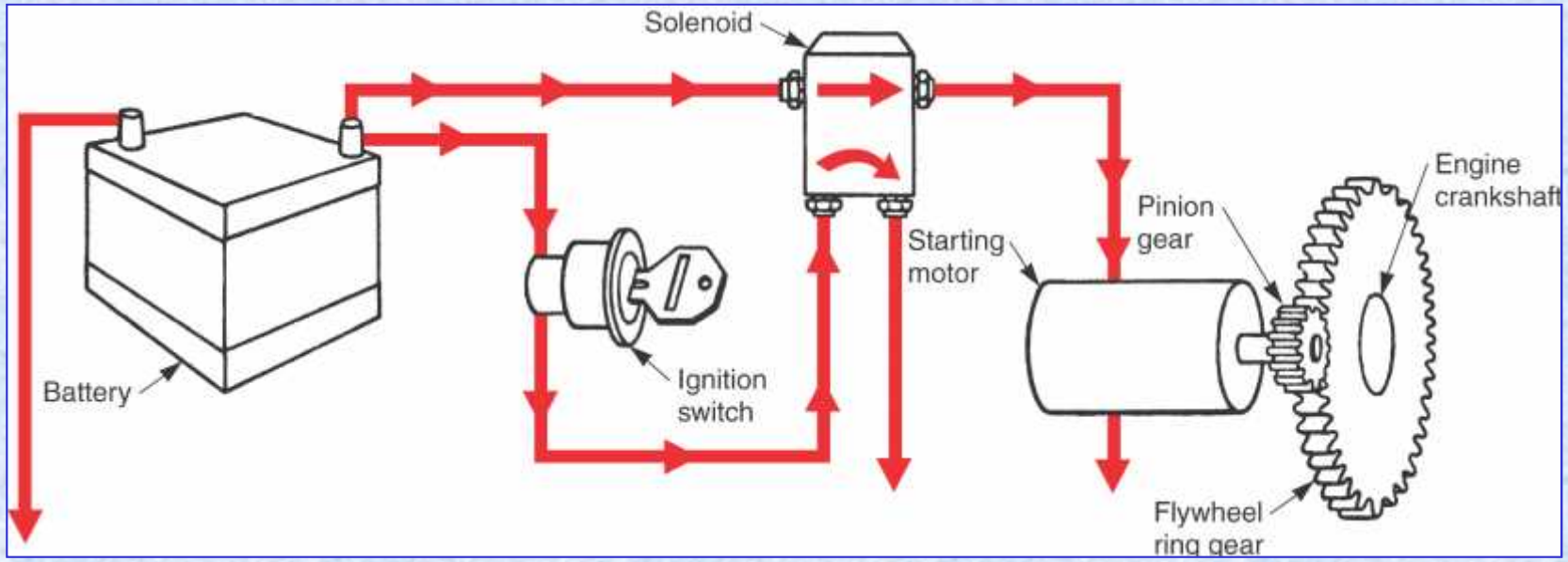
- Starting system principles
- Starting motor construction

Starting System Principles

The starting system uses battery power and an electric motor to turn the engine crankshaft for engine starting

Basic Starting System

- The ignition switch energizes the solenoid
- The solenoid energizes the starting motor



Components

- Battery
  - source of energy
- Ignition switch
  - allows driver to control operation
- Solenoid
  - high current relay (switch)
- Starting motor
  - high torque electric motor

Starting System Energized

- With the ignition key in the “start” position, current flows through the solenoid coil
- Magnetism closes the solenoid contacts, connecting the battery to the starting motor
- The motor turns the flywheel ring gear

Starting System De-energized

- With the ignition key released to the “run” position, no current flows to the solenoid coil
- The solenoid contacts open, the starter stops turning, and the starter gear moves away from the flywheel

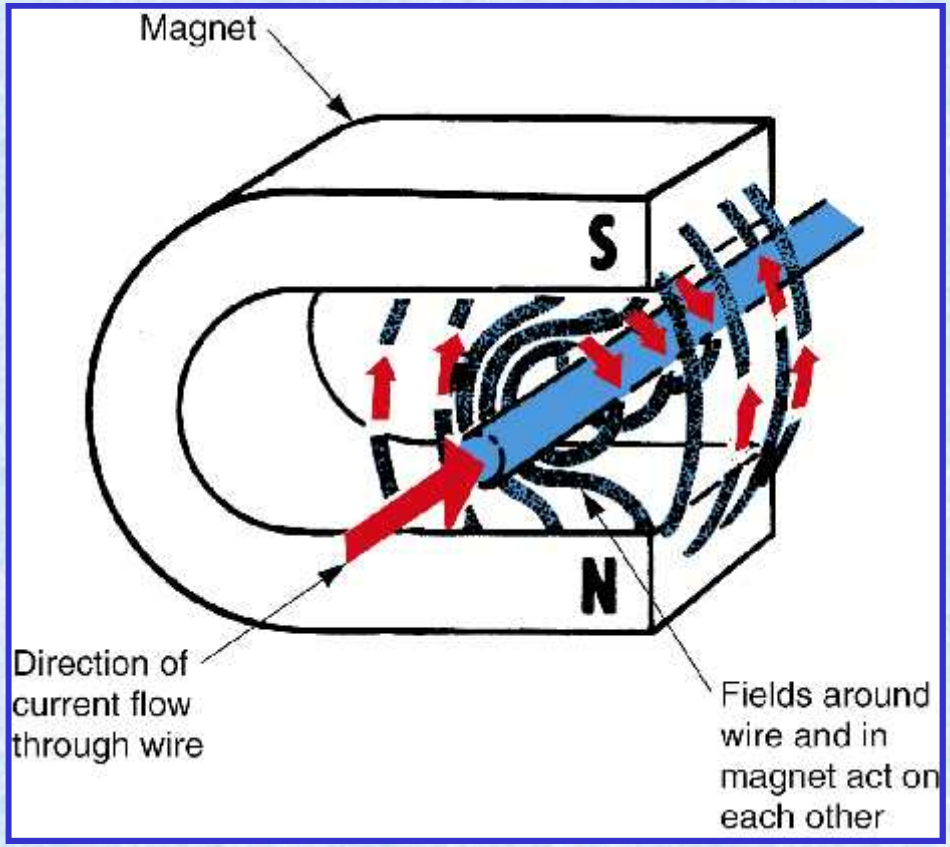
Starting Motor Fundamentals

- Converts electrical energy from the battery to mechanical energy to crank the engine
- Produces a turning force through the interaction of magnetic fields inside the motor assembly

Magnetic Field Action

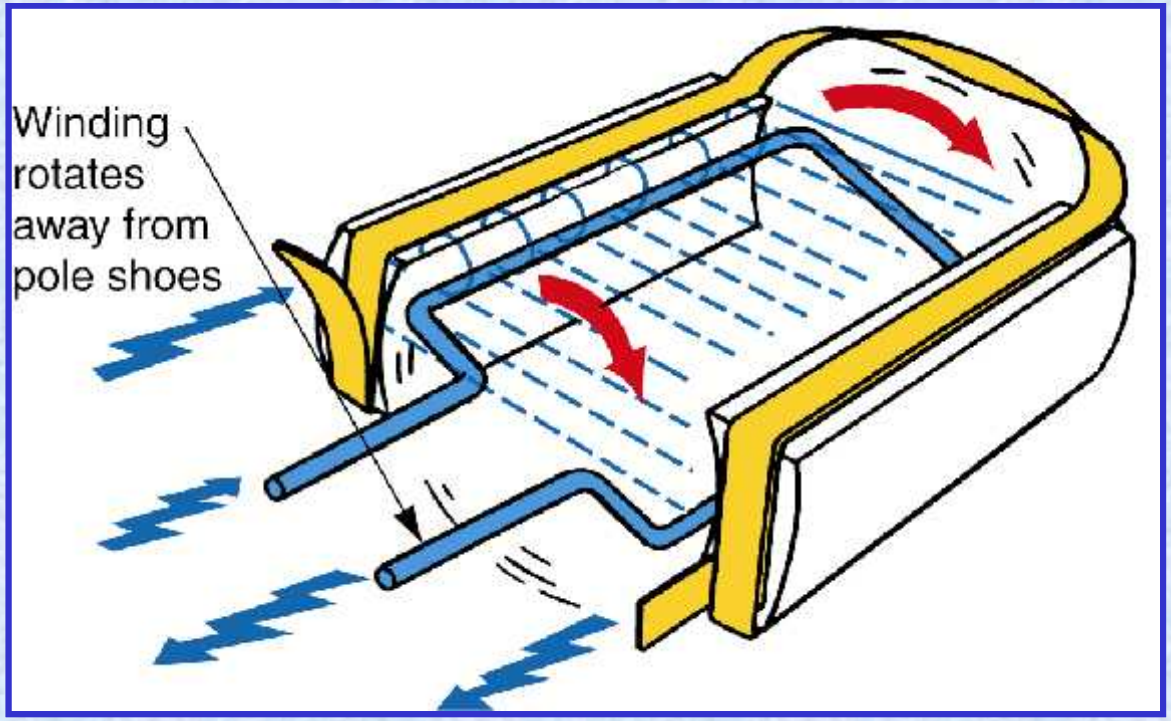
- Made up of invisible lines of force
- Since like charges (fields) repel each other and unlike charges (fields) attract each other, magnetic fields can produce motion

Magnetic Field Action



Simple Electric Motor

If a current-carrying winding is placed inside a magnetic field, the winding rotates away from the pole shoes

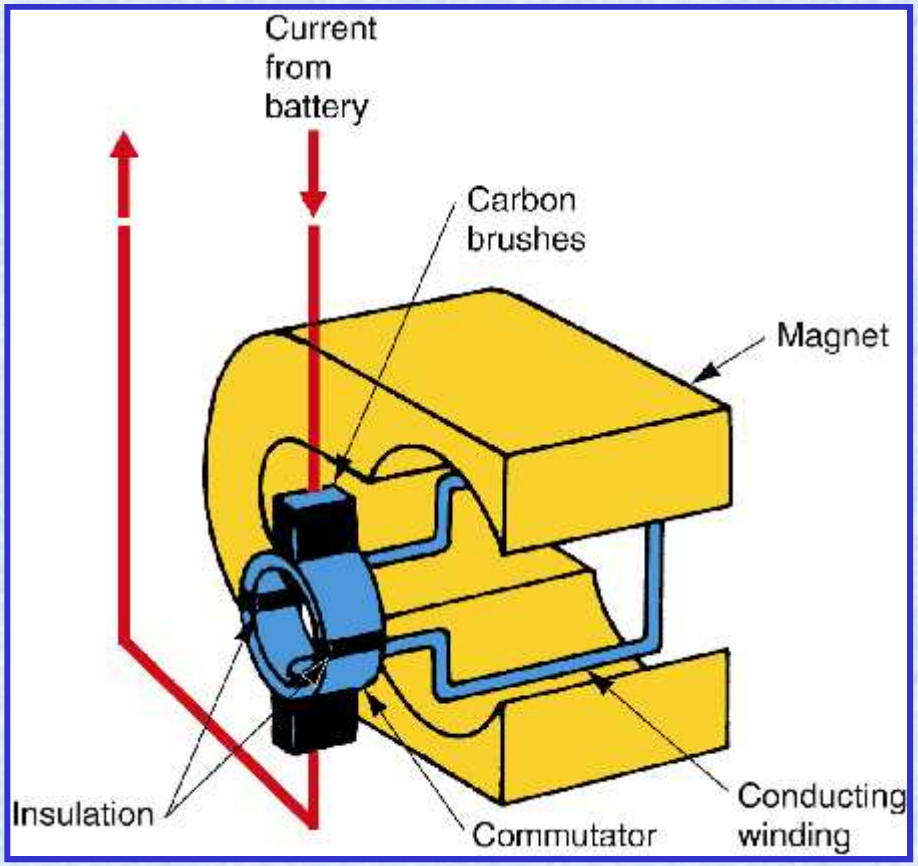


Commutator and Brushes

- Keep a motor turning by controlling the current through the windings
- Together, they serve as a sliding contact between battery power and the windings

Commutator and Brushes

The commutator reverses the electrical connection when the loop rotates around



Increasing Motor Power

- Several windings (loops of wire) and a commutator with many segments are used to increase motor power
- As the motor spins, many windings contribute to the motion

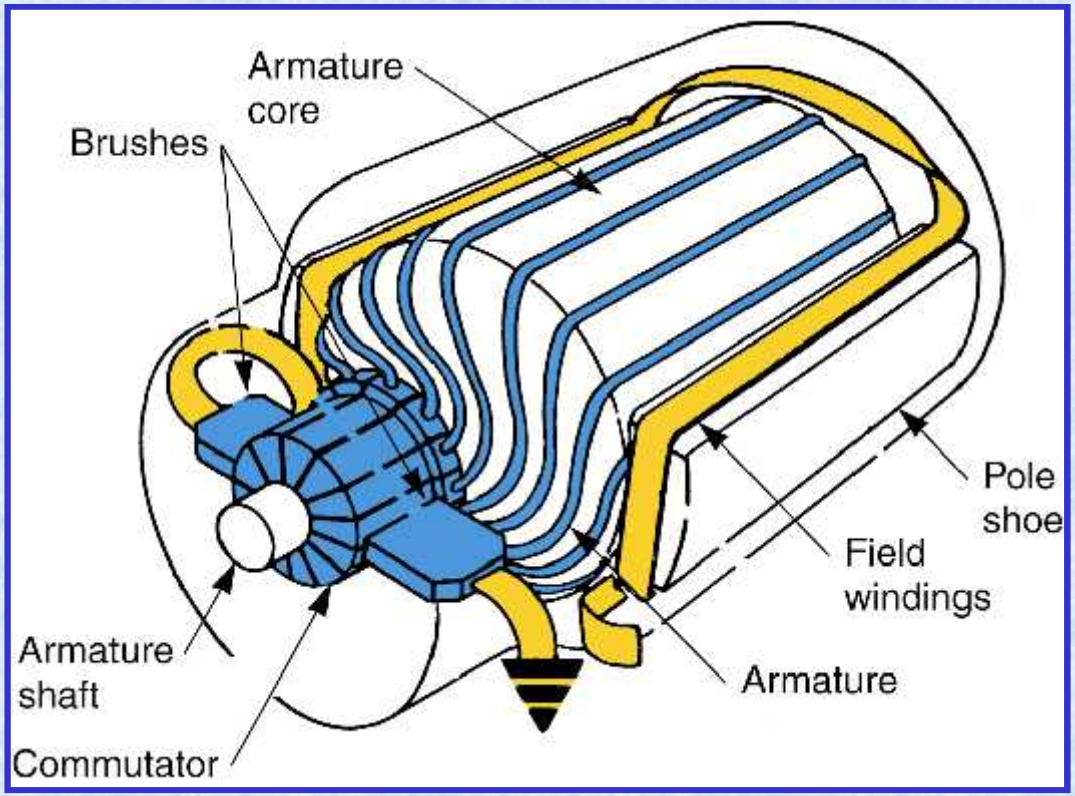
Armature

- Supports the windings
- Increases the strength of each winding’s magnetic field

Field Windings

- Stationary insulated wire wrapped in a circular shape
- When current flows, the magnetic field between the pole shoes becomes very large
- This field acts against the armature's field, producing motion

Armature and Field Windings

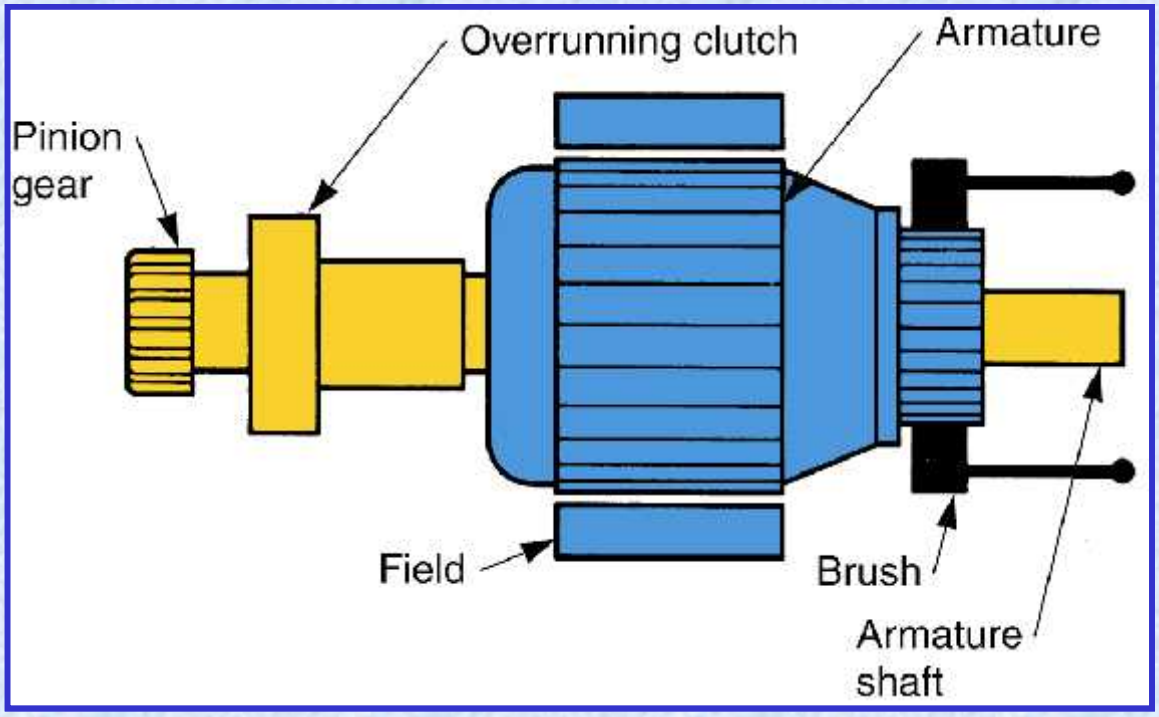


Starter Pinion Gear

- Small gear on the armature shaft
- Engages a large ring gear on the engine flywheel
- Moves into and meshes with the flywheel ring gear

Starter Pinion Gear

Part of the pinion drive mechanism

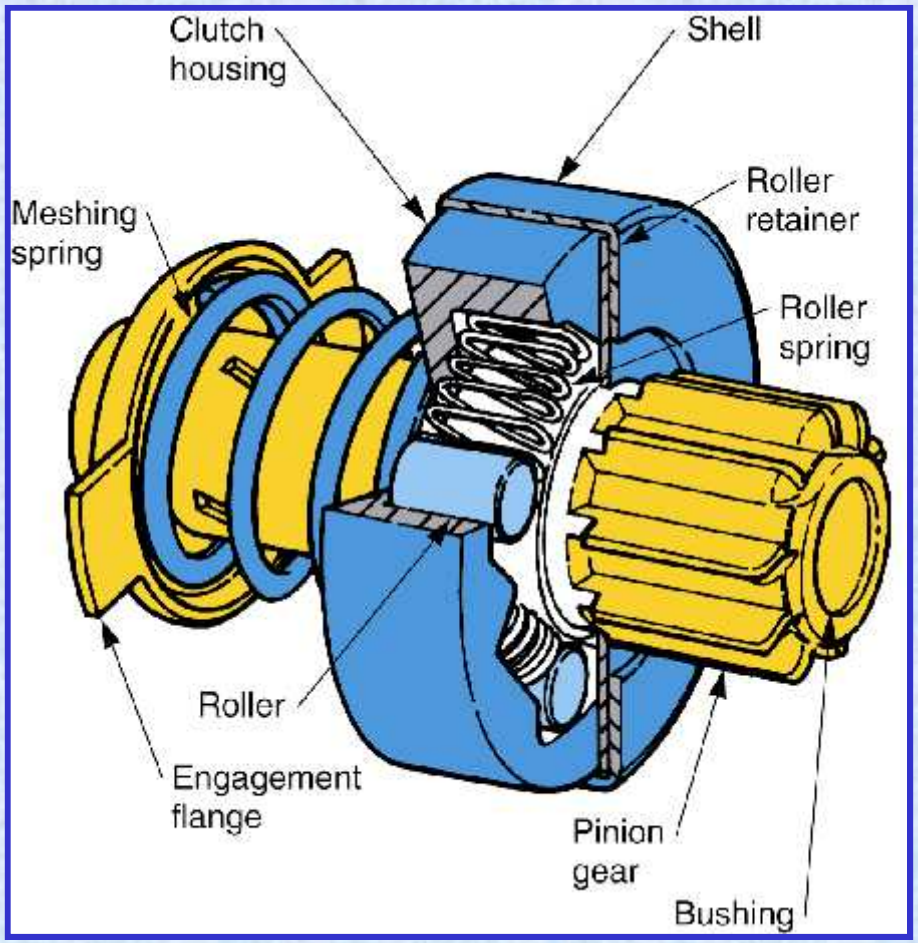


Overrunning Clutch

- Locks in one direction
- Releases in the other direction
- Allows the pinion gear to turn the flywheel ring gear for starting
- Lets the pinion gear freewheel when the engine starts

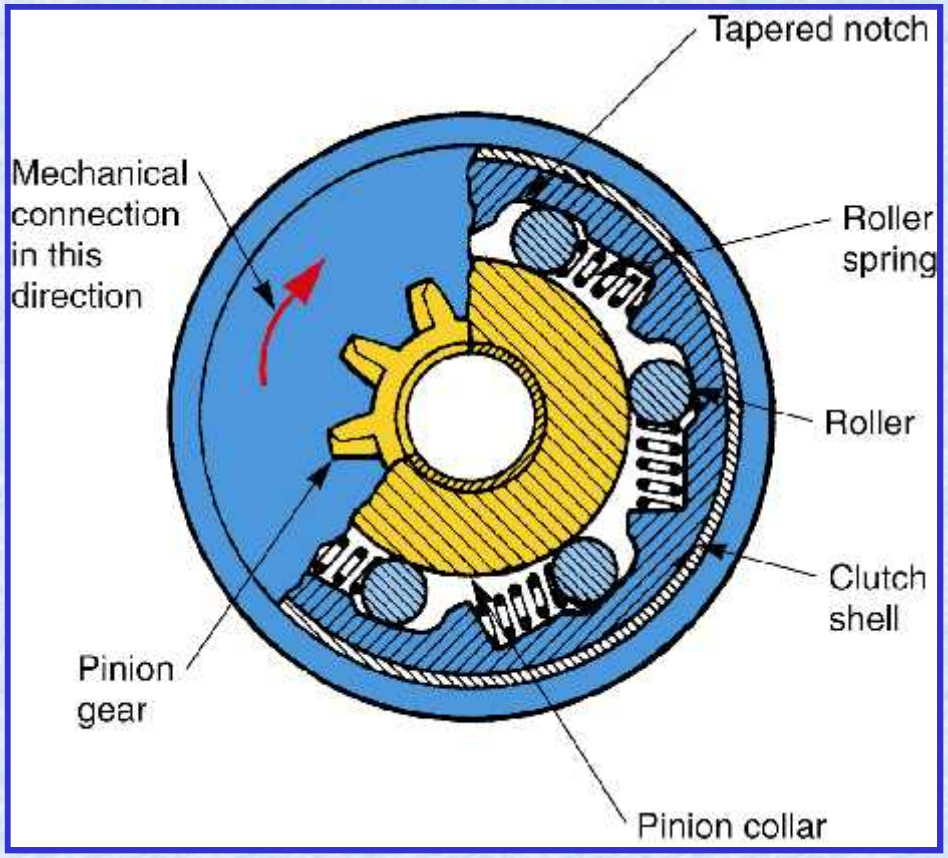
Overrunning Clutch

Locks the flange to the pinion gear in one direction and releases in the other direction



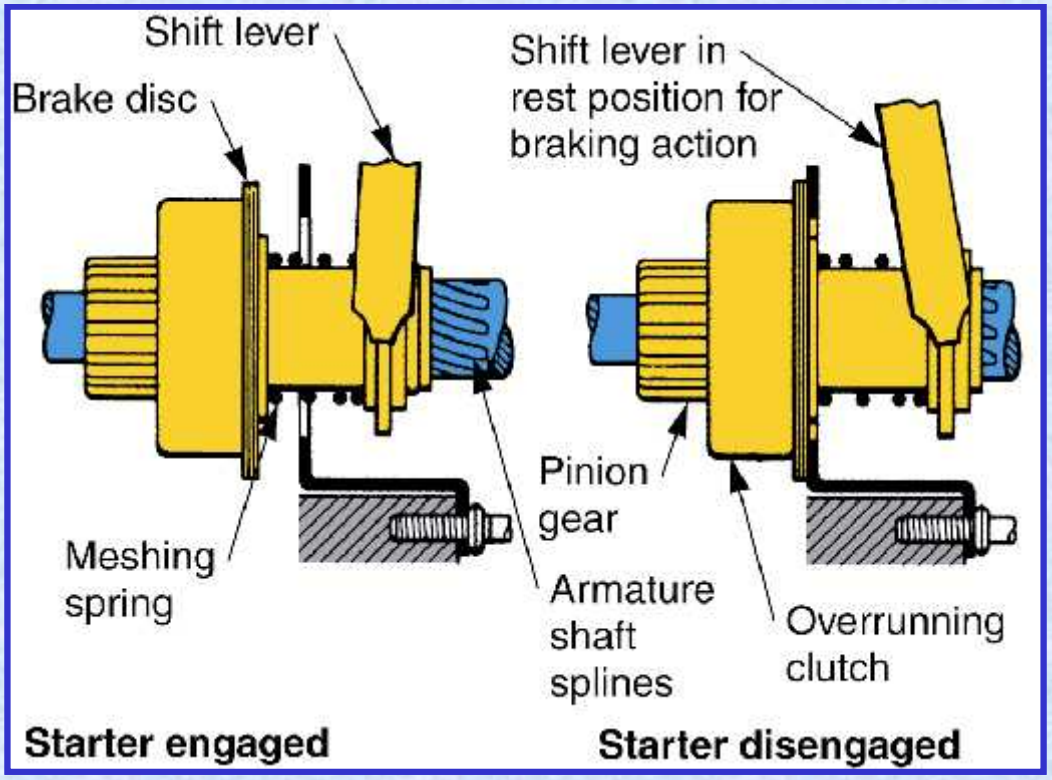
Overrunning Clutch Operation

Rollers jam and lock in one direction and release in the other direction



Pinion Gear Assembly

Pinion gear assembly slides on the shaft for engagement

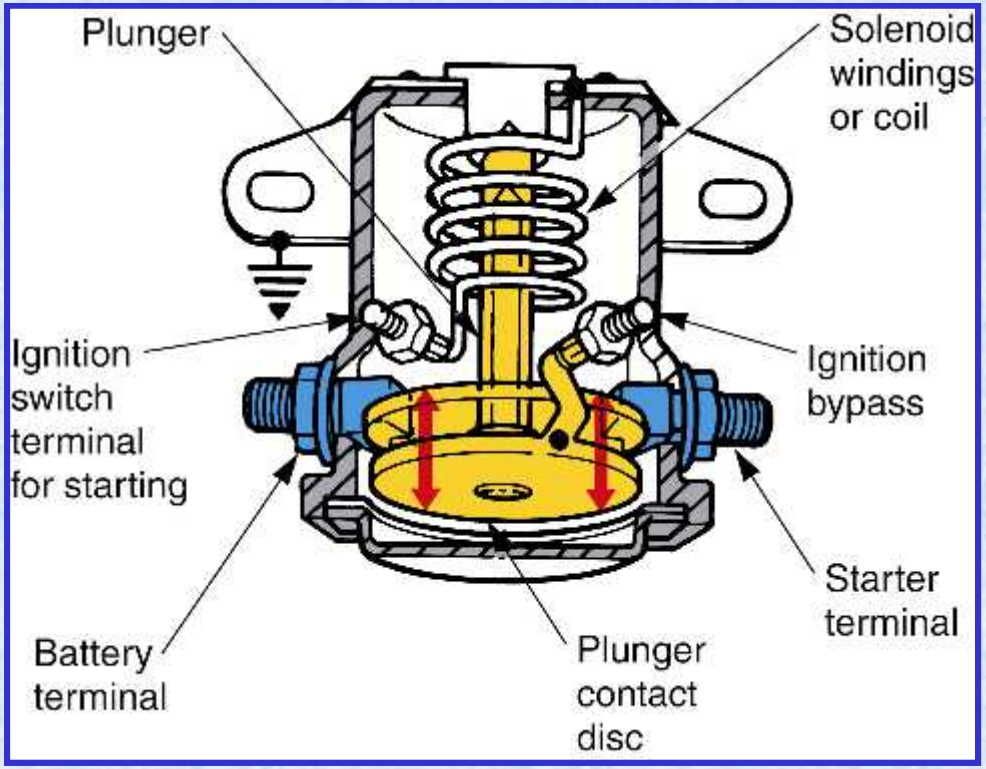


Starter Solenoid

- An electromagnetic switch
- Makes an electrical connection between the battery and the starting motor
- Allows the low current ignition switch circuit to control the high current starting motor

Starter Solenoid

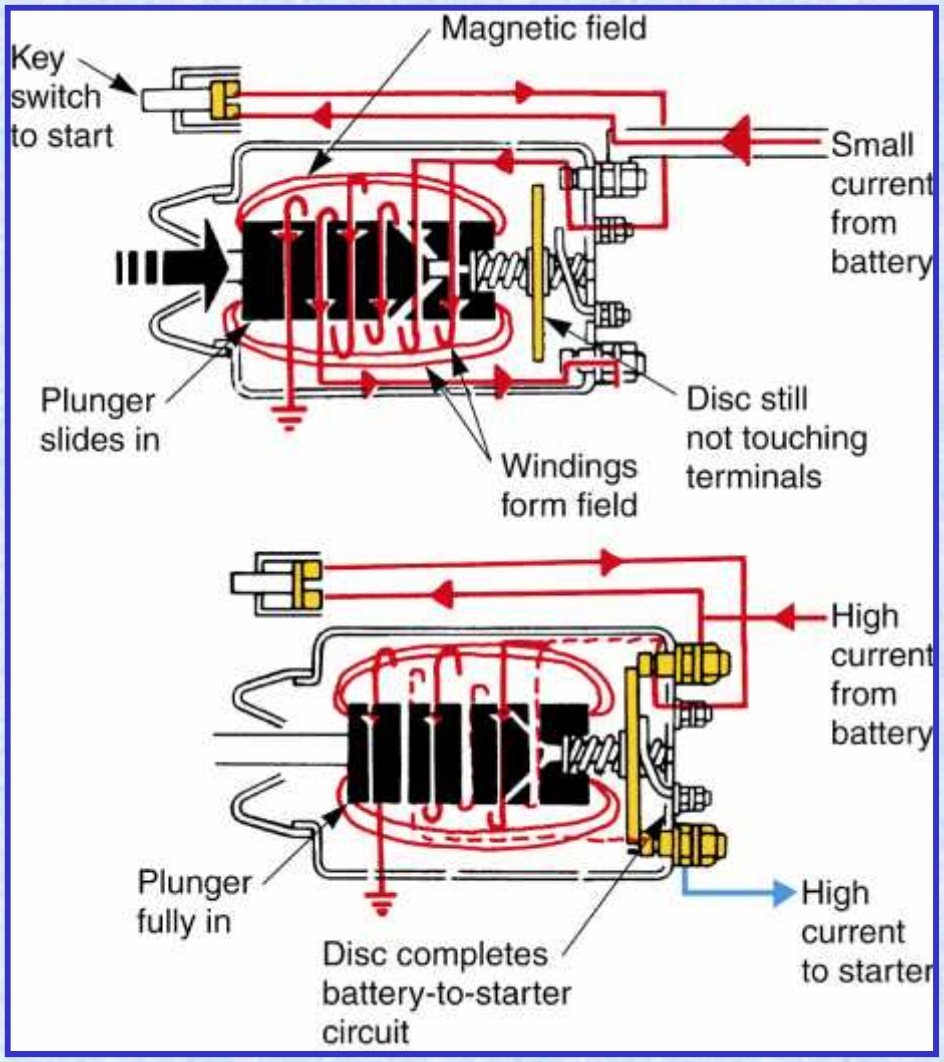
Plunger movement pulls the disc into contact with two battery terminals to activate the starter



Solenoid Operation

- Low current flows through the windings
- The magnetic field pulls the solenoid plunger and disc toward the windings
- The disc touches both of the high-current terminals
- High current flows to the starter motor

Solenoid Operation



Solenoid Functions

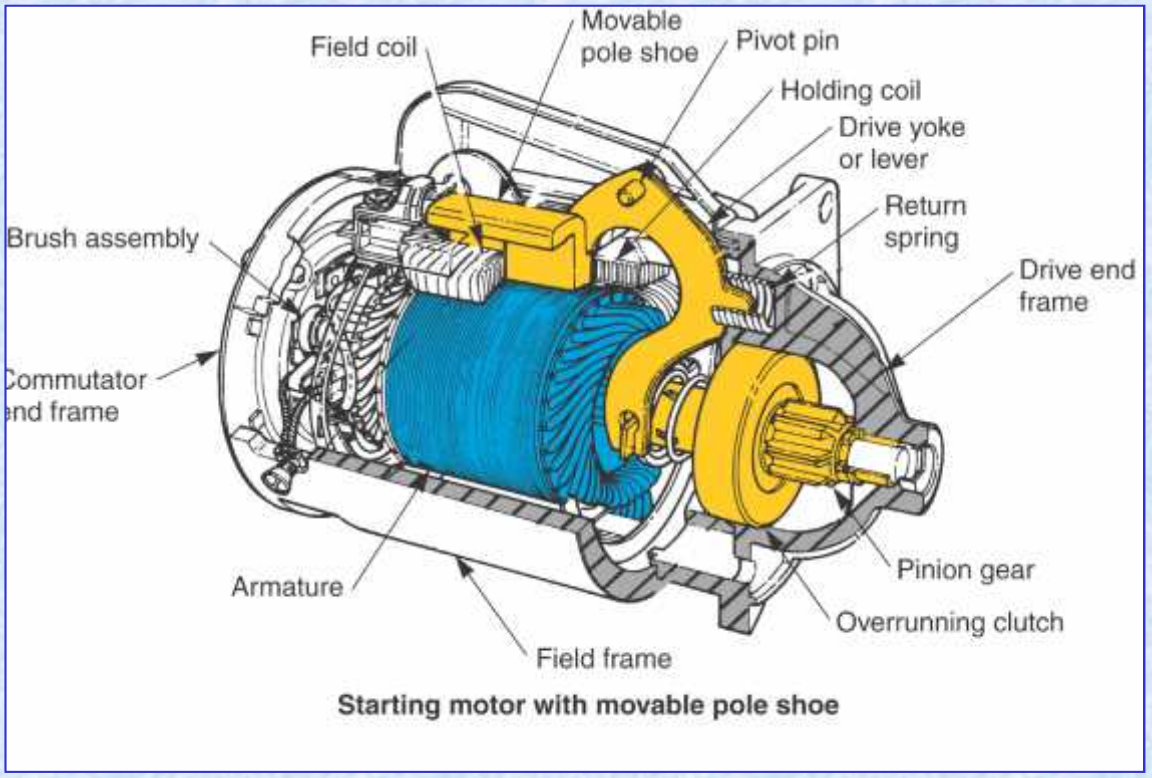
- Closes the battery-to-starter circuit
- Pushes the starter pinion gear into mesh with the flywheel ring gear
- Bypasses the resistance wire in the ignition circuit

Starting Motor Construction

- Two types:
  - movable pole shoe starting motor
  - starter-mounted solenoid (starting motor with solenoid)

Movable Pole Shoe Starting Motor

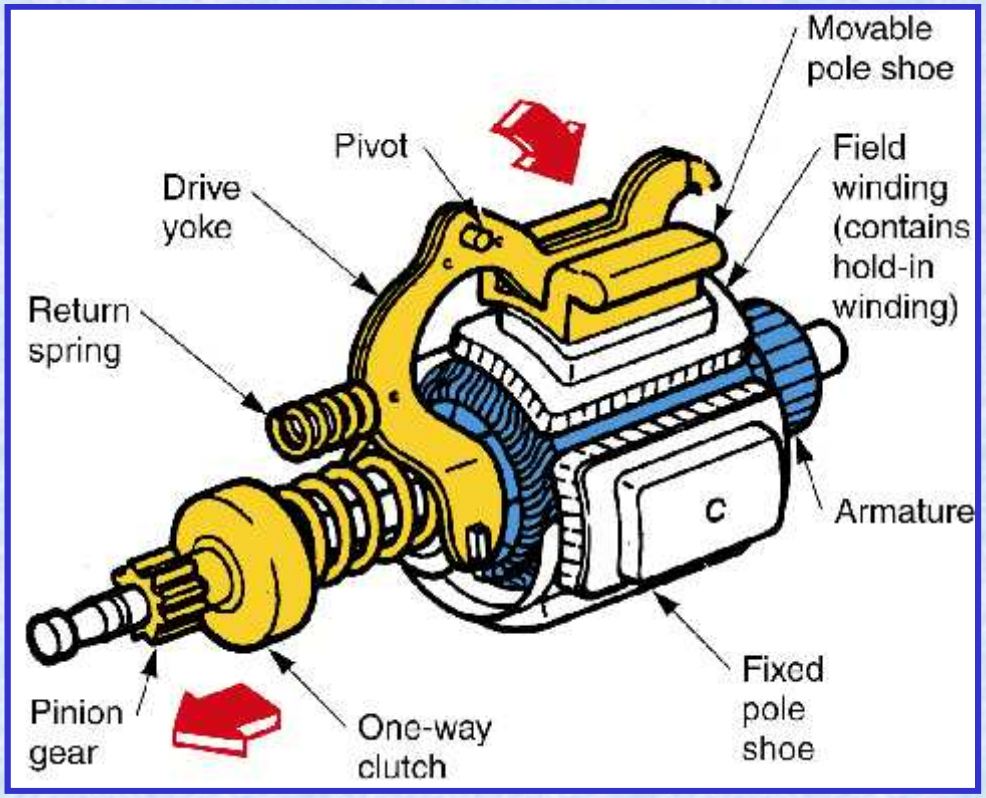
Uses a yoke lever to move the pinion gear into contact with the flywheel



Starting motor with movable pole shoe

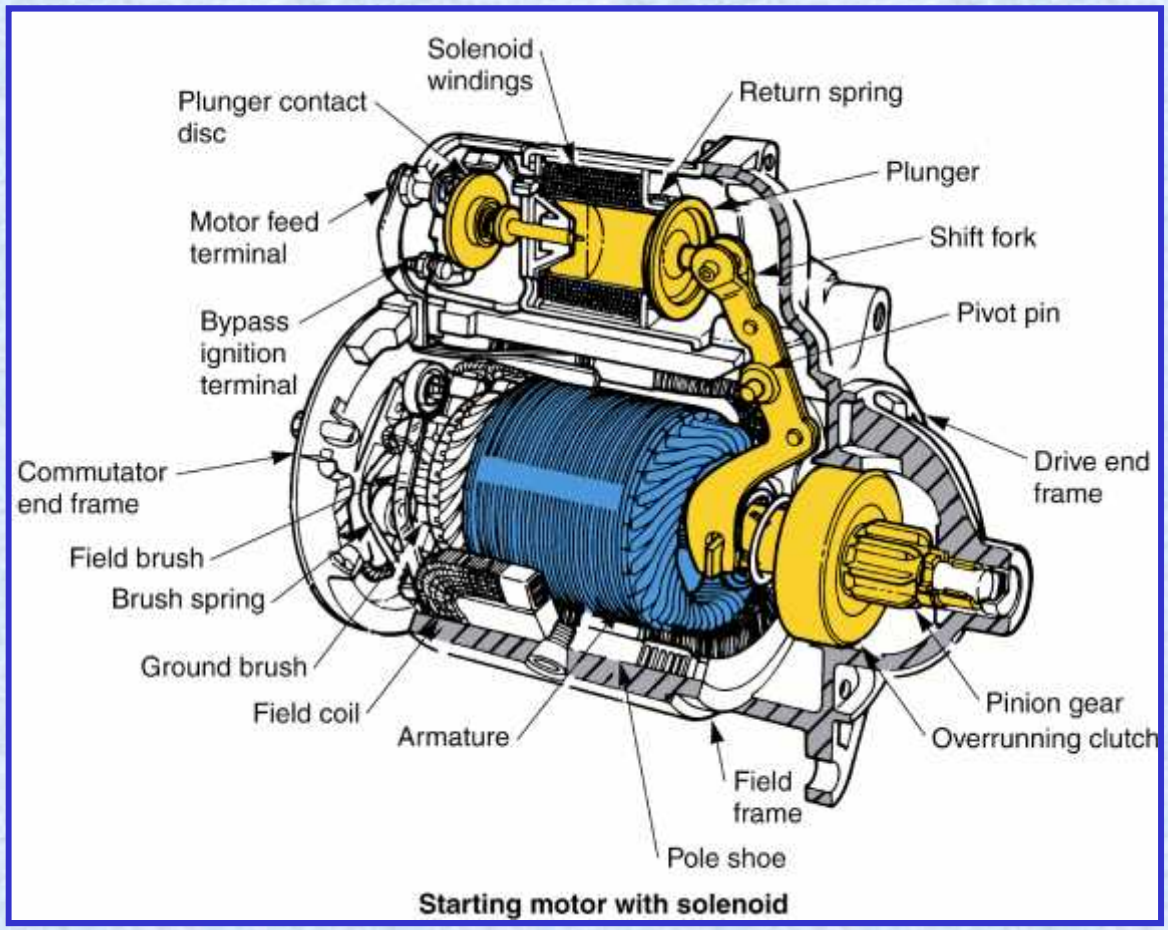
Movable Pole Shoe Starting Motor

Magnetic field pulls the pole shoe downward, causing gear engagement as the armature starts to spin



Starter-Mounted Solenoid

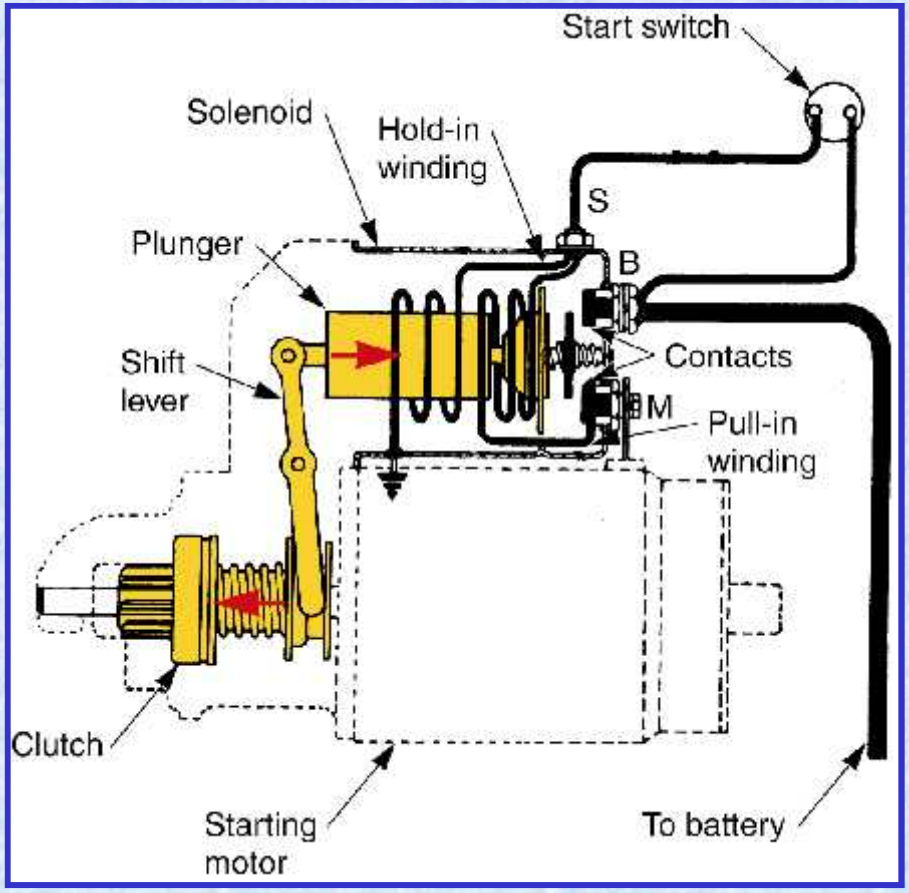
Solenoid plunger moves a shift lever to engage the pinion gear



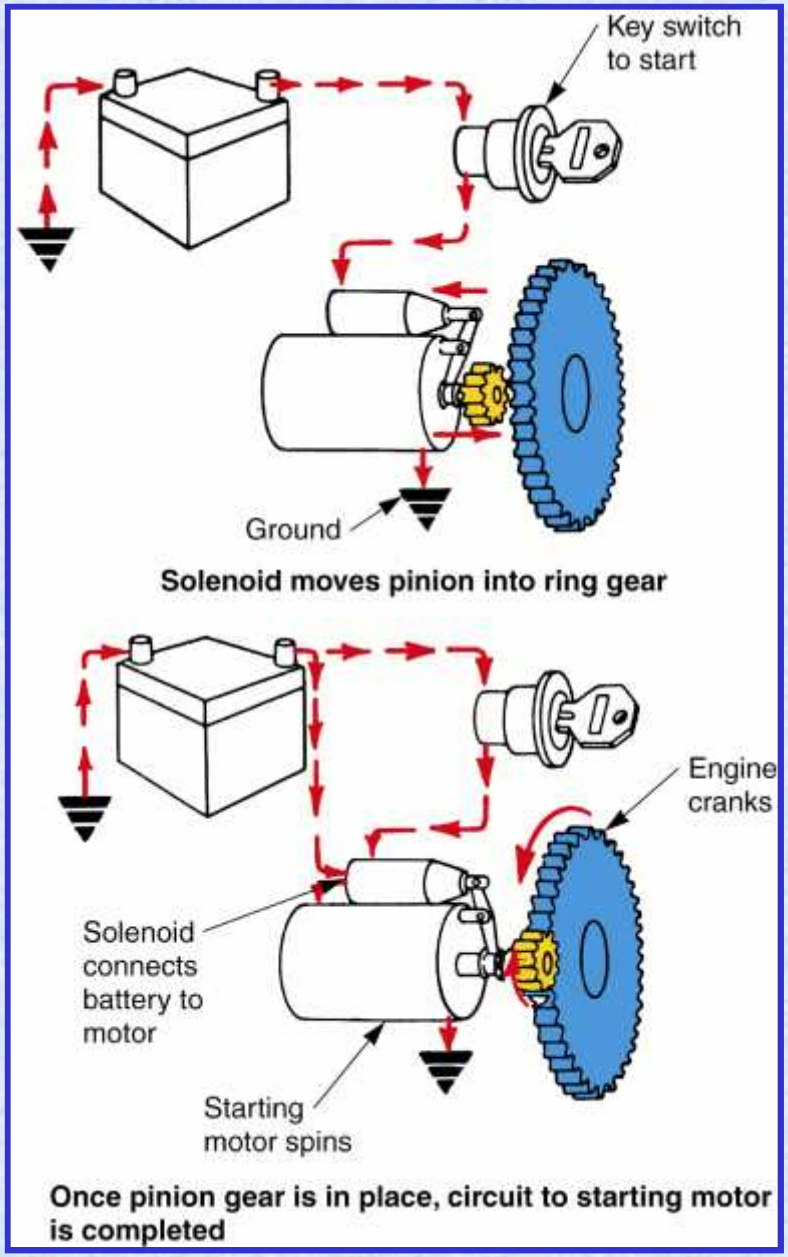
Starting motor with solenoid

Starter-Mounted Solenoid

Solenoid completes the battery-to-starter circuit

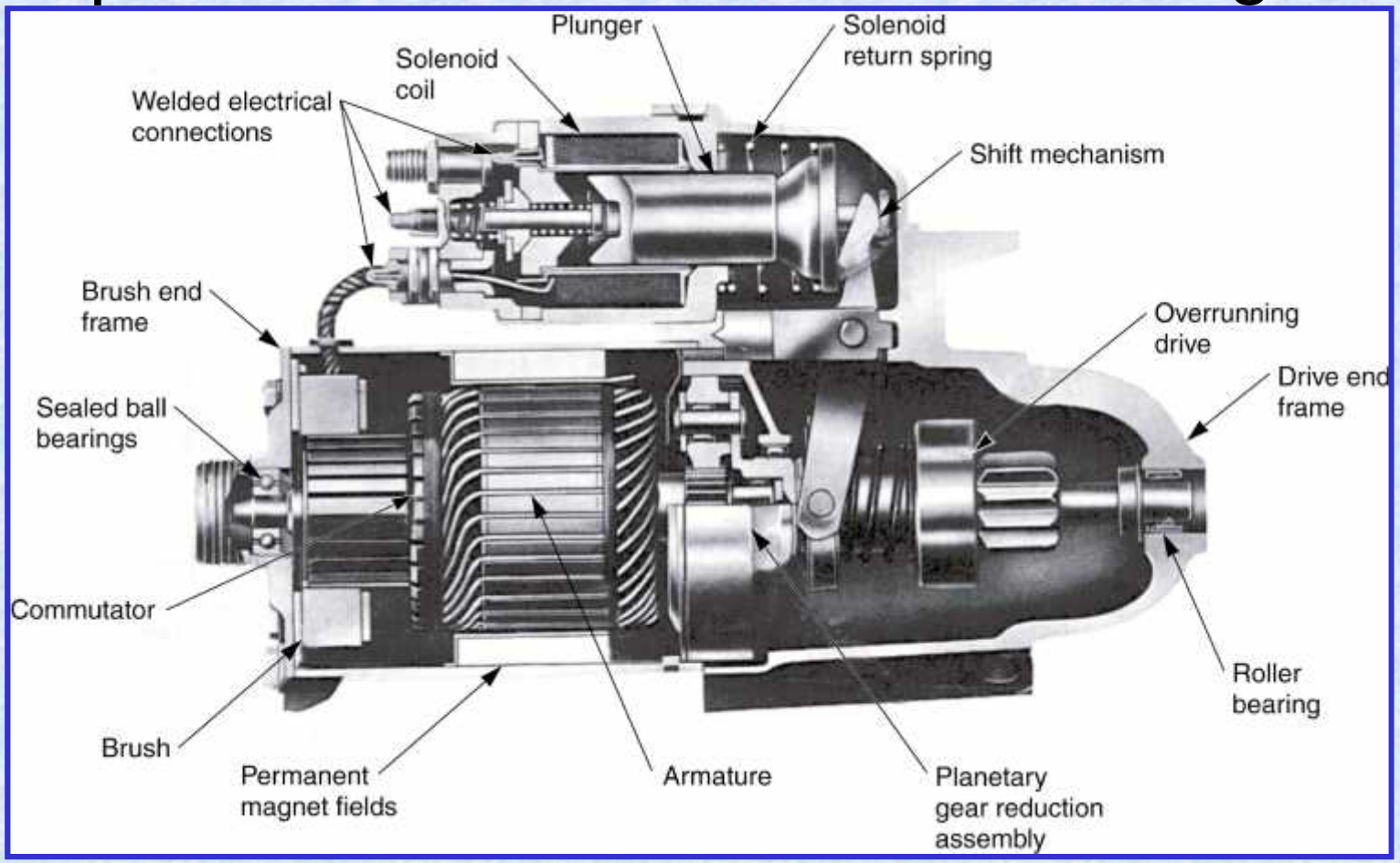


Solenoid Operation



Permanent-Magnet Starter

Uses special high-strength magnets in place of conventional field windings

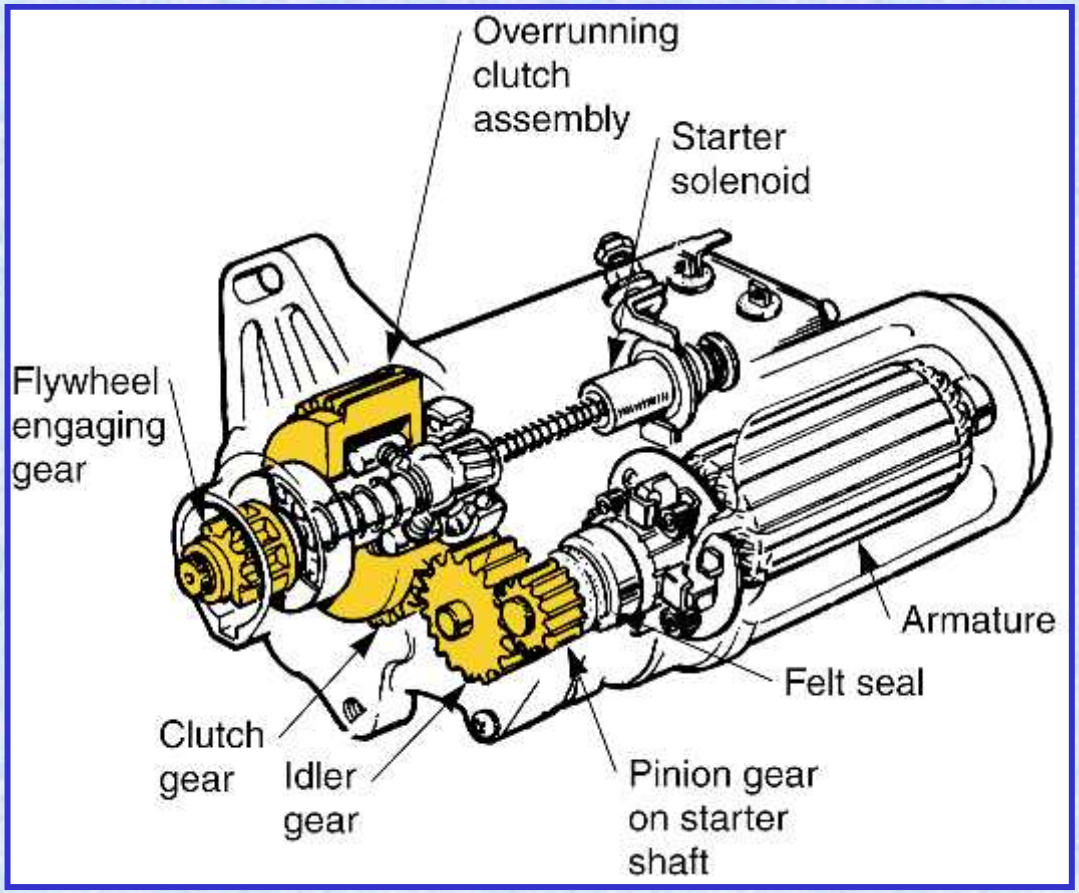


Starting Motor Torque

- A starting motor must produce high torque
- Difference in gear size between the small pinion and large flywheel ring gear increases turning torque

Reduction Starter

Extra gears further increase torque

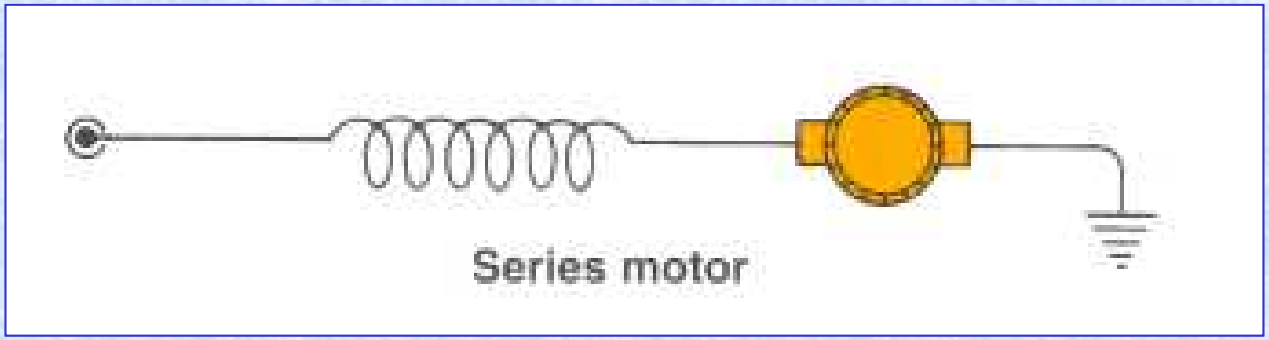


Internal Motor Circuits

- Series-wound motor
- Shunt-wound motor
- Compound-wound motor

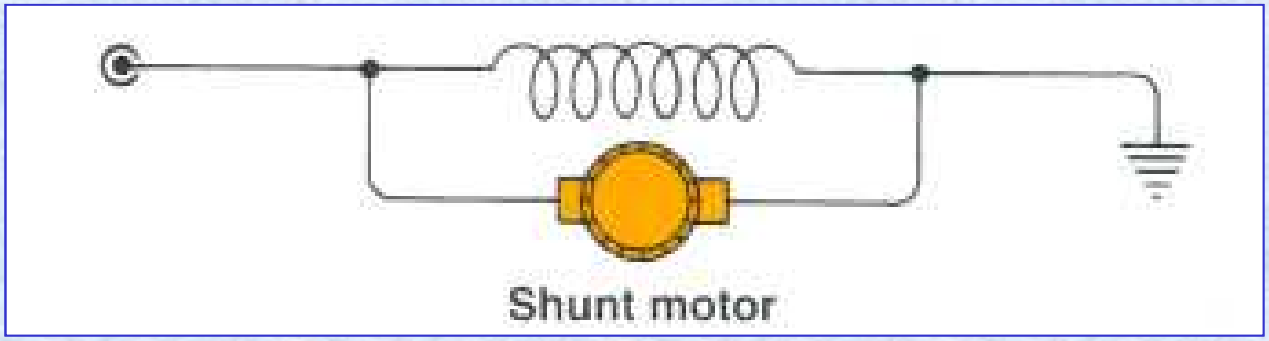
Series-Wound Motor

Develops maximum torque at initial start-up and decreases as motor speed increases



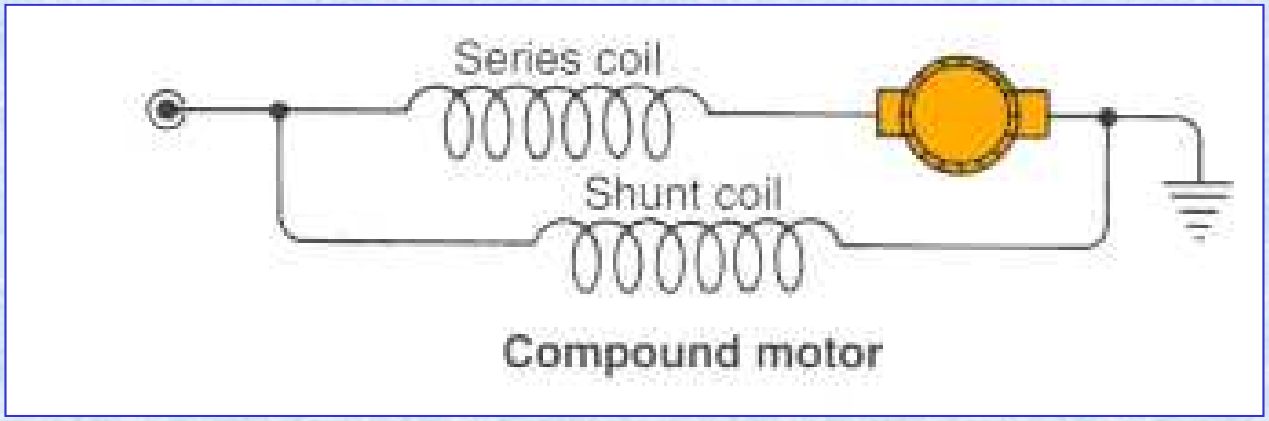
Shunt-Wound Motor

Produces less starting torque but more constant torque at varying speeds



Compound-Wound Motor

Has both series and shunt windings and produces good starting power and constant operating speed



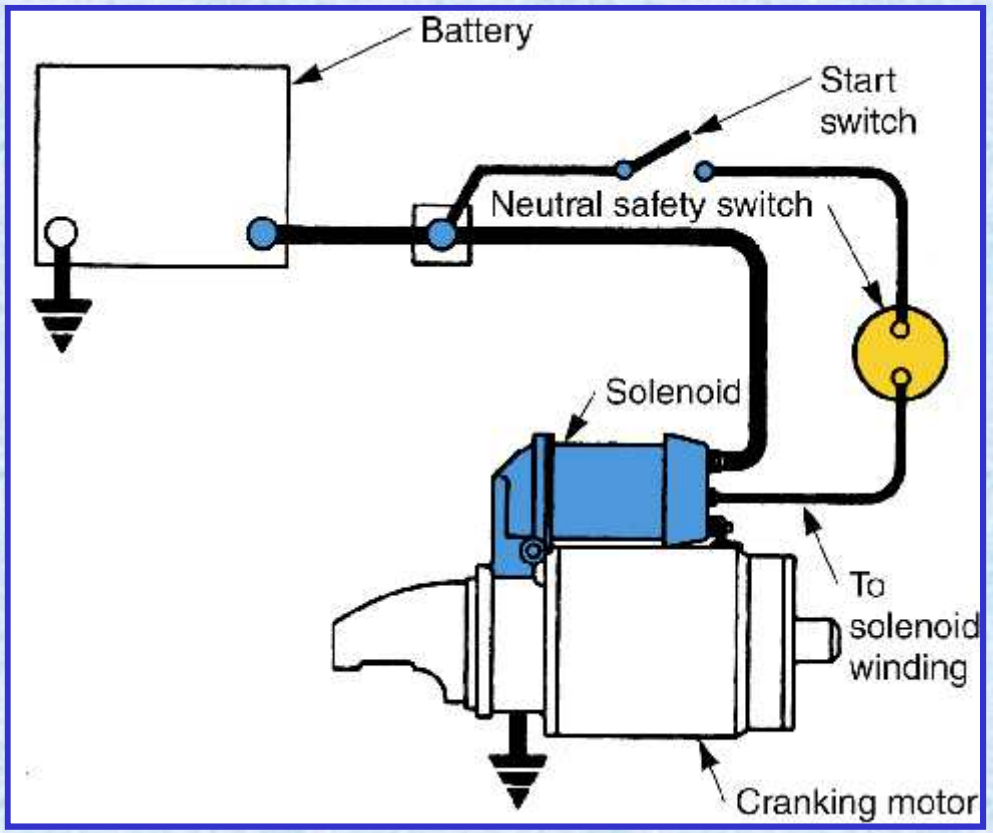
Compound motor

Neutral Safety Switch

- Prevents the engine from cranking unless the shift selector is in neutral or park
- Mounted on the shift lever or on the transmission

Neutral Safety Switch

Wired in series with the starter solenoid



Starter Relay

- Opens or closes one circuit by responding to an electrical signal from another circuit
- Uses a small current from the ignition switch to control a larger current through the starter solenoid
- Reduces the load on the ignition switch

Starter Relay Operation

- Ignition switch is turned to “start”
- Current flows through the relay windings
- Magnetism closes the relay contacts
- Contacts complete the circuit to the solenoid windings, operating the starter motor

Starting System Circuit