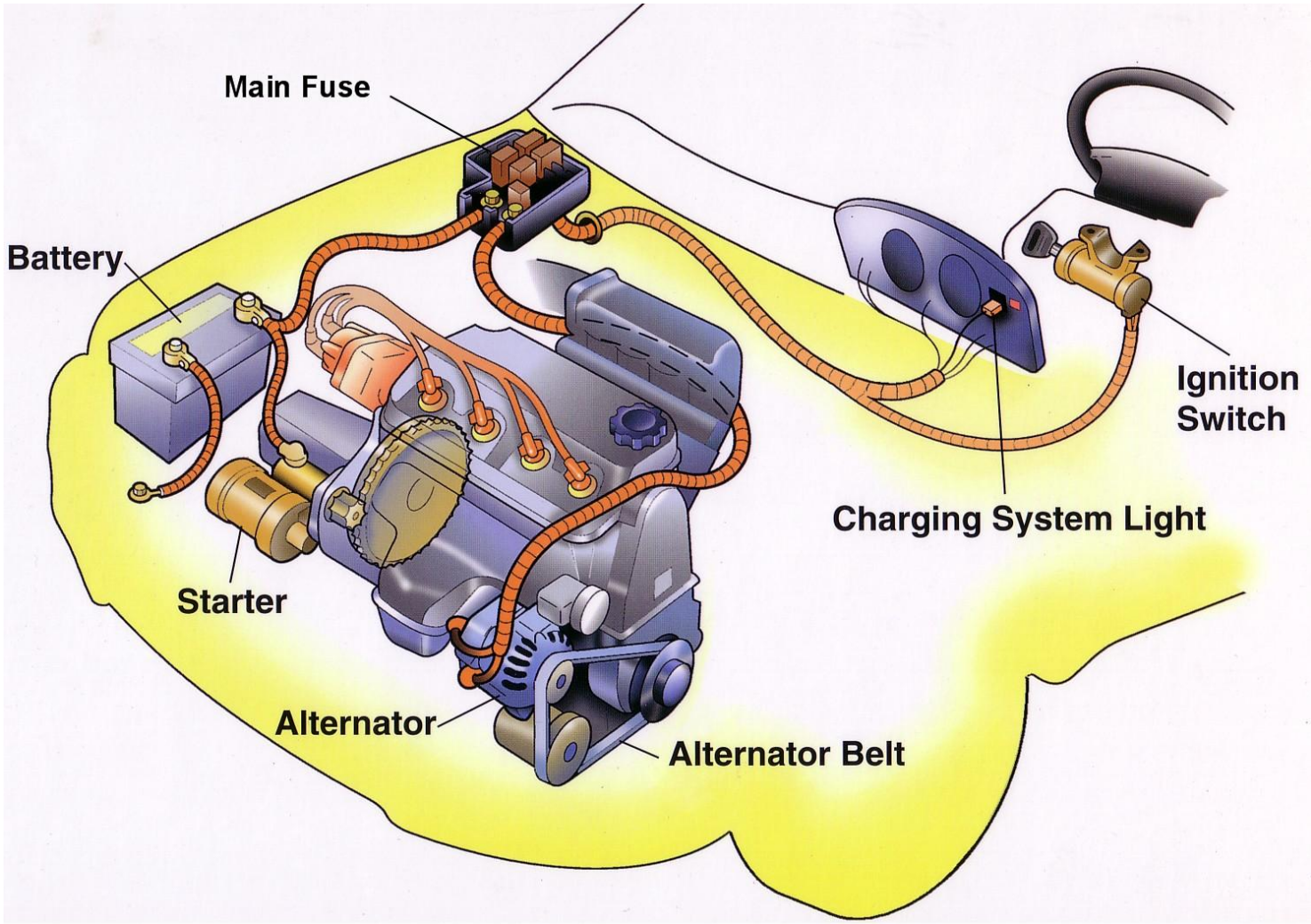
ATASA 5th Starting Systems & Traction Motor Systems

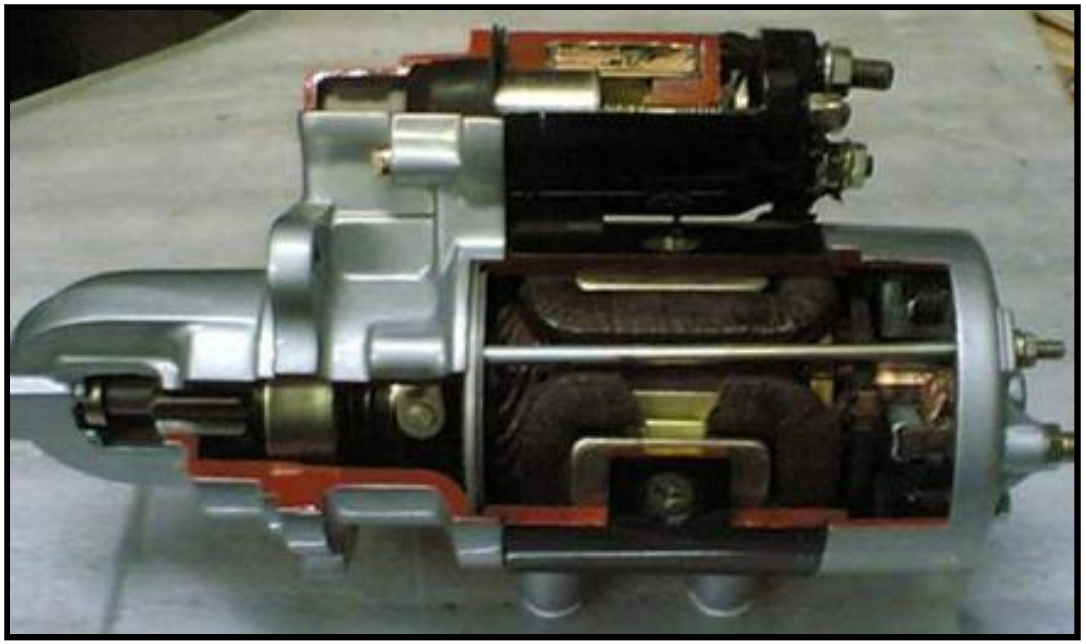
ATASA 5TH Study Guide
Chapter 18 Pages 537-570
Starting & Traction Motor Systems
62 Points

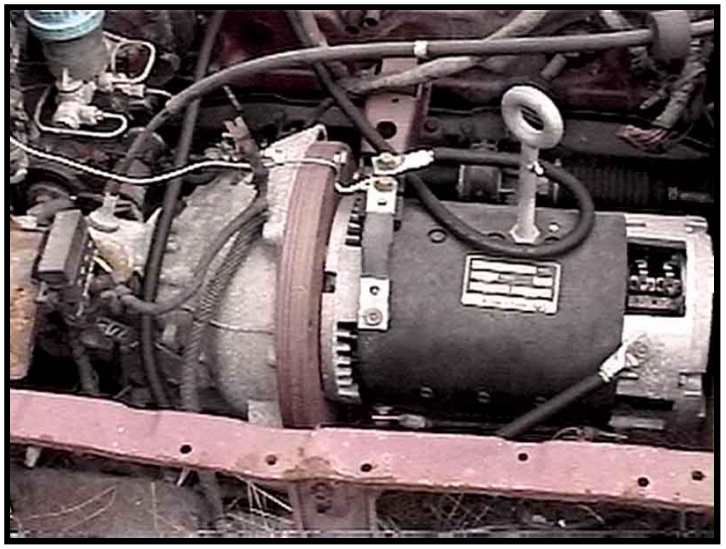
Please Read The Summary

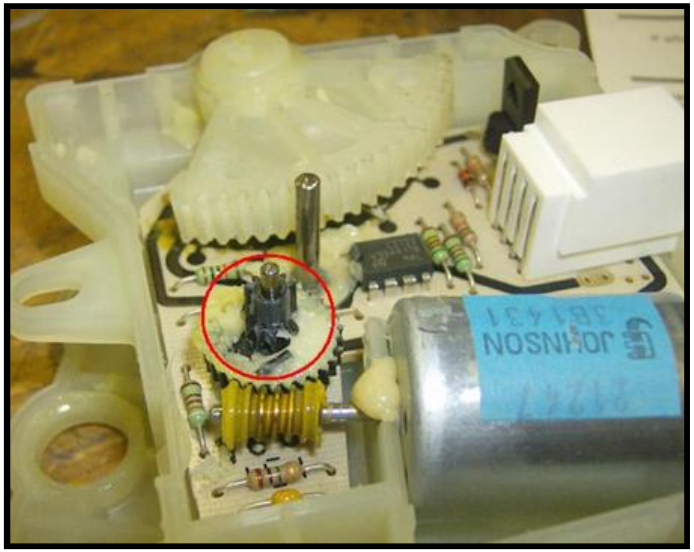


ATASA 5th Starting Systems & Traction Motor Systems

1. Electric _____ are used to start the engine & in hybrids are used to move the vehicle. Motors are also used to operate many different accessories requiring either linear or rotary motion.



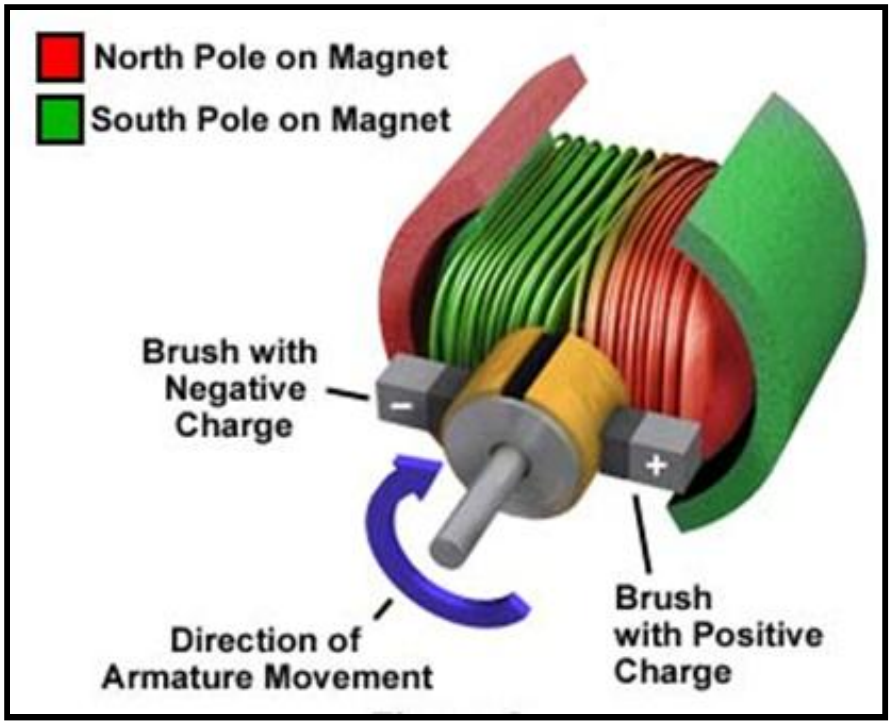


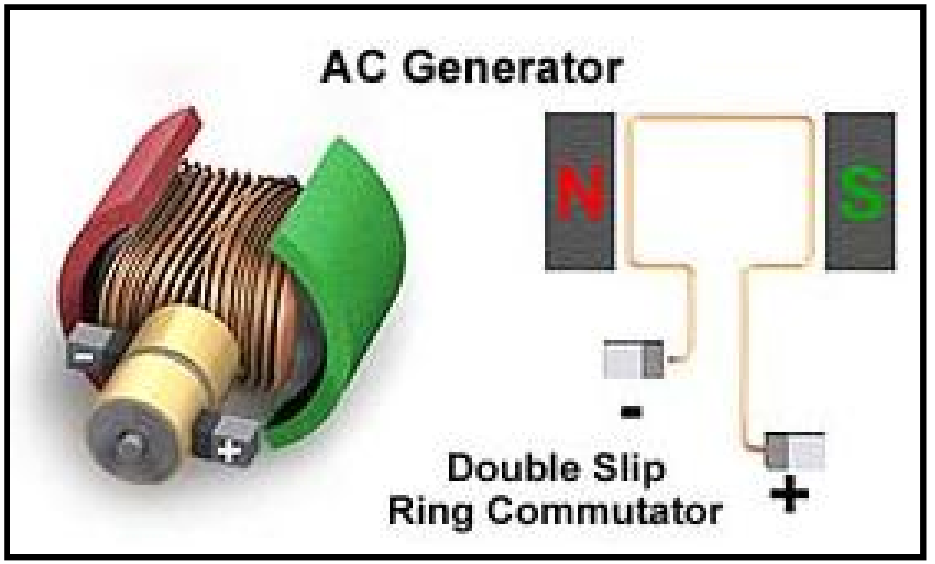


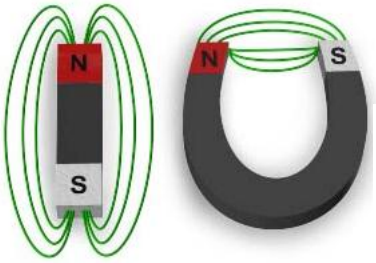
ATASA 5th Starting Systems & Traction Motor Systems

2. Starter motors & accessory motors use ___ voltage while traction or drive motors use ___ voltage.

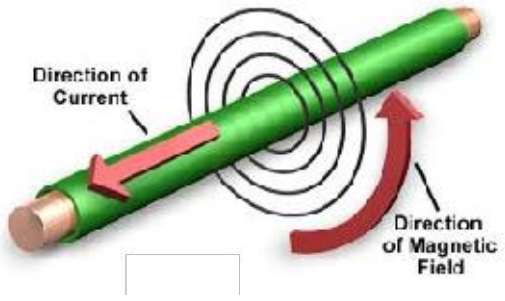
3. _____ & _____ are closely related because one can be used to create the other.

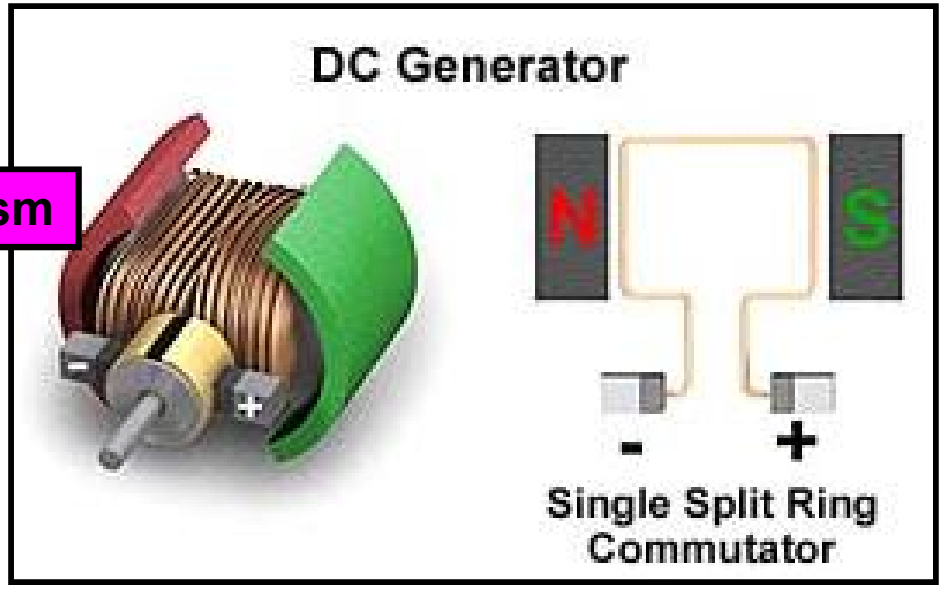






Electricity & Magnetism





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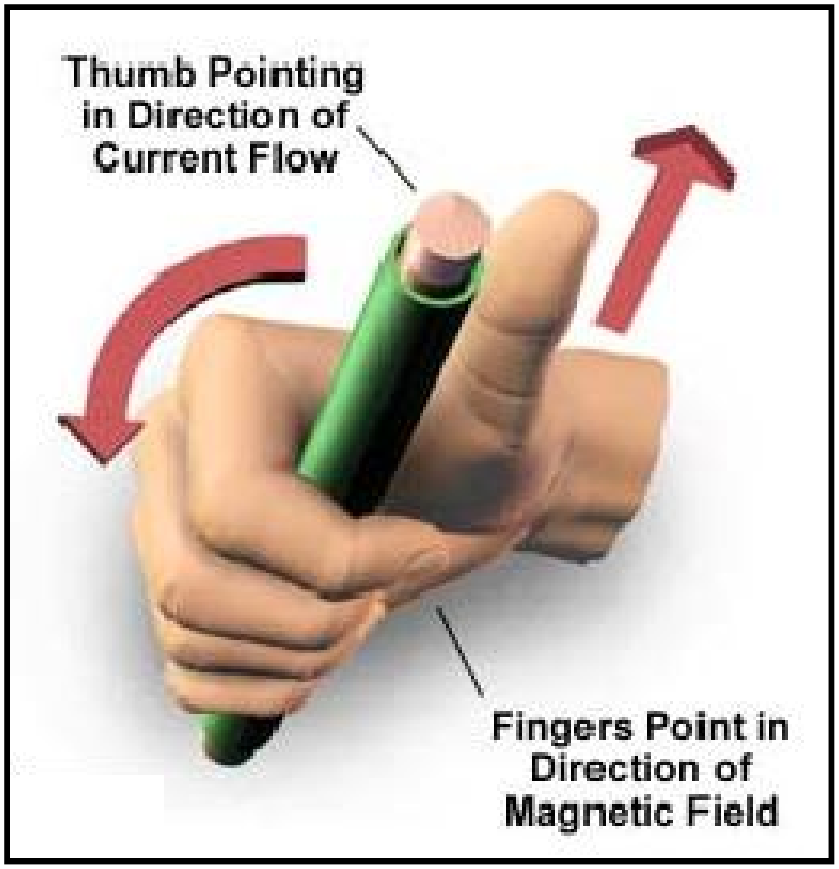
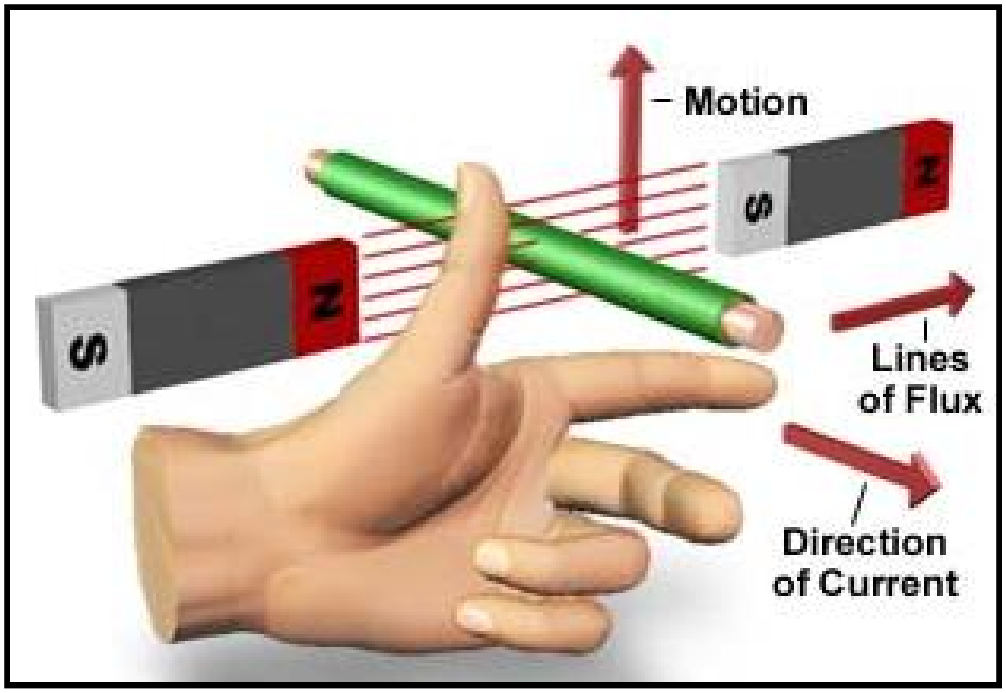
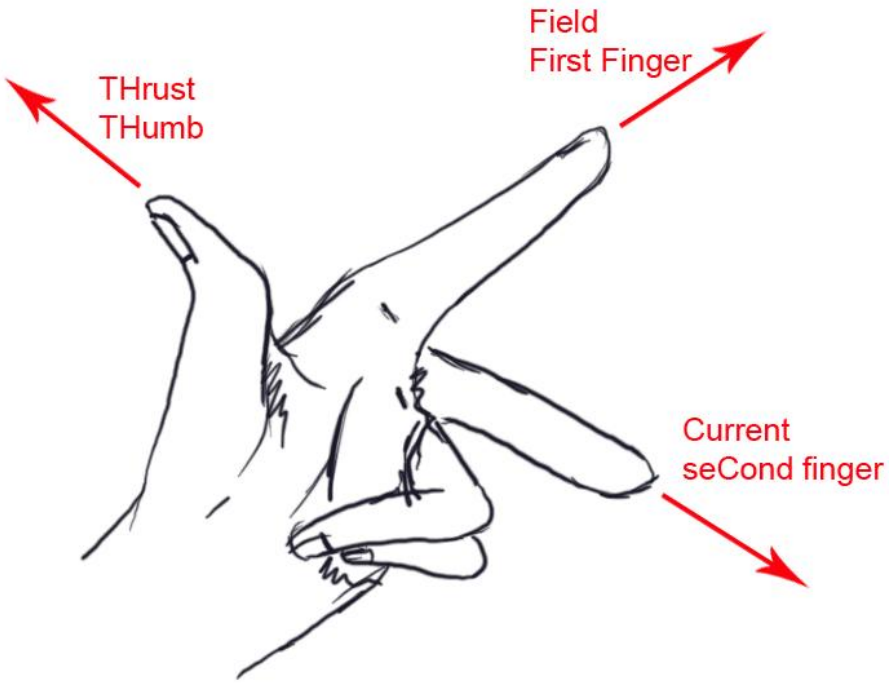
4. _____ flow through a wire creates a magnetic field & moving a _____ through a magnetic field creates current flow in the wire.
Coils or loops of wire just intensify that effect.

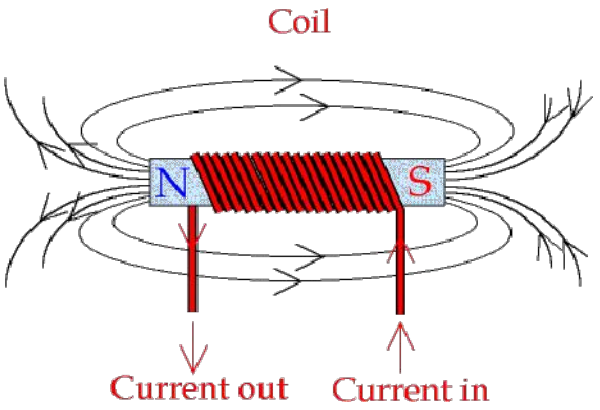


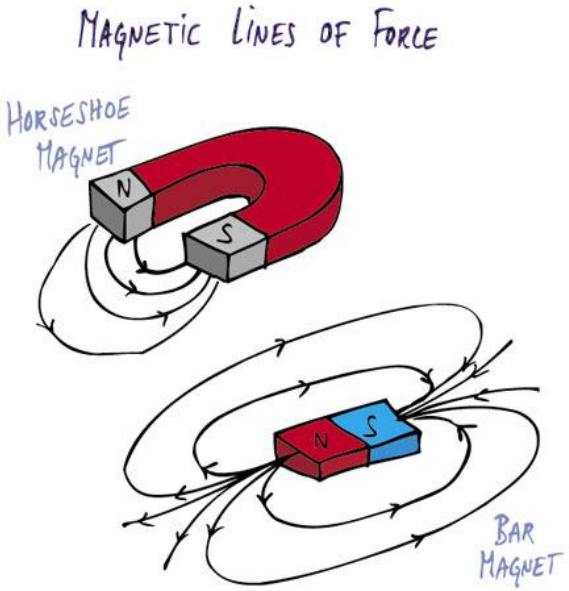


Voltage, Magnet
Current, Coil
Voltage, Coil

5. A magnetic field called, called a _____ _____, exists around every magnet.

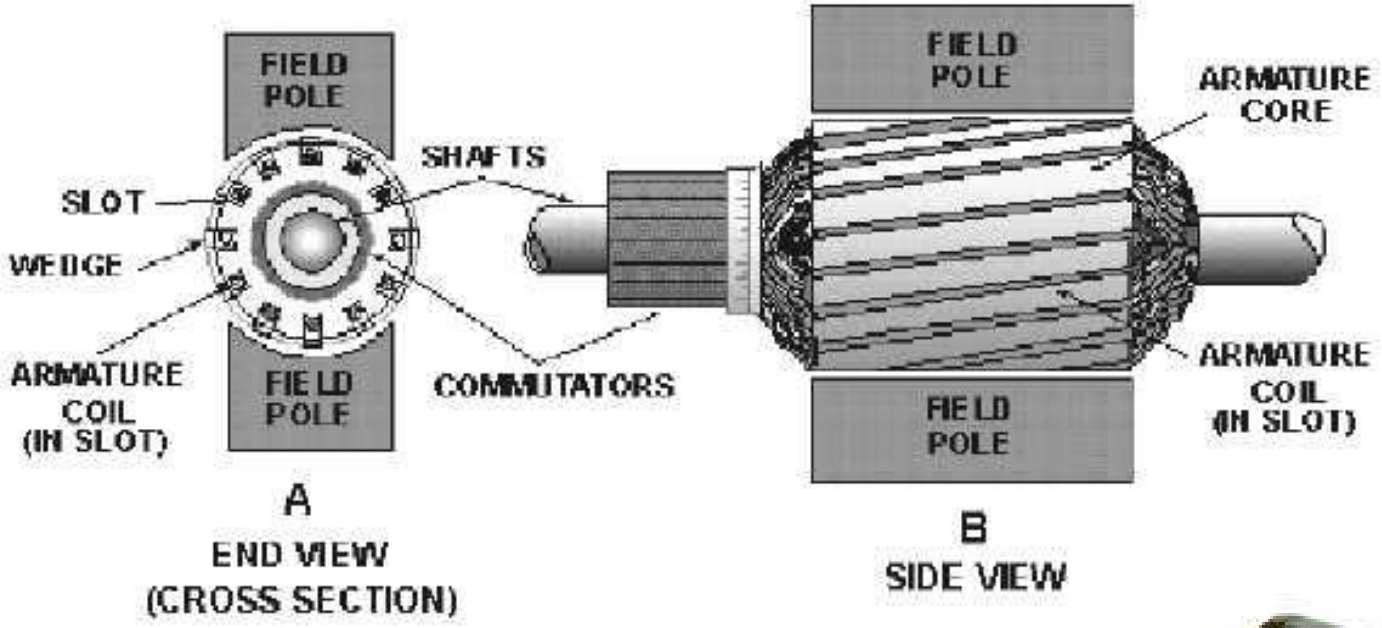






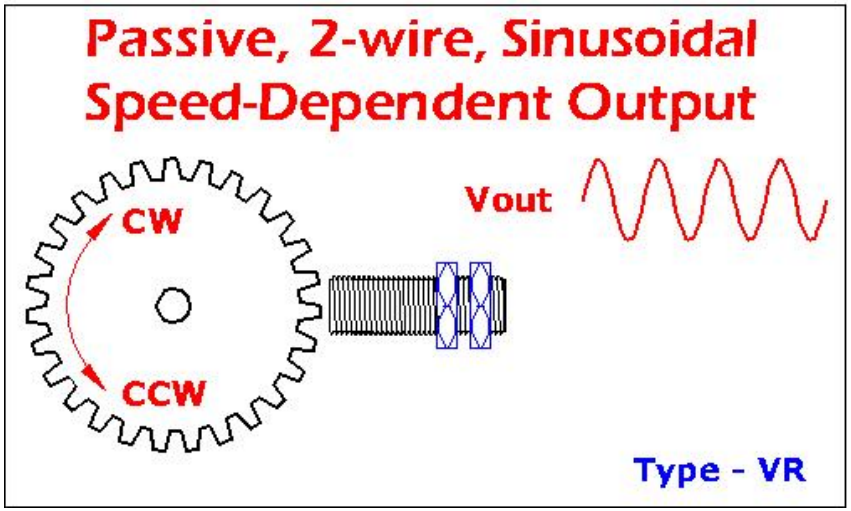
Flux Field
Plowed Field
Flux Density

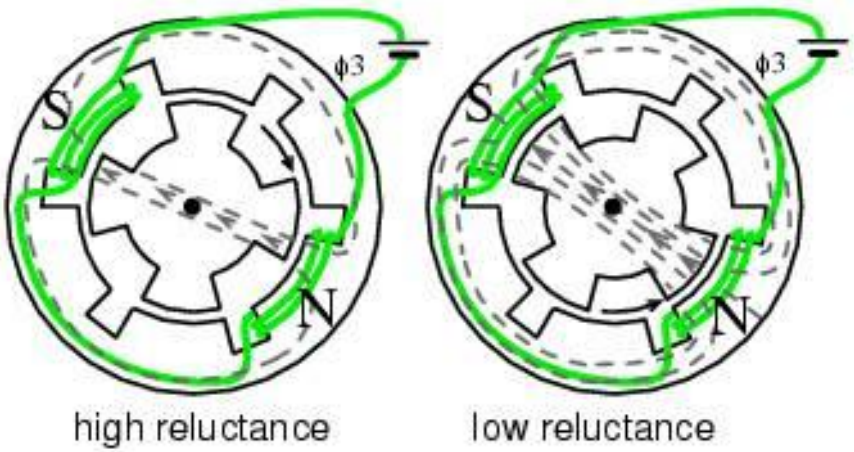
6. Temporary magnets *(armatures)* are made of _____ iron.
Permanent magnets require hard iron.

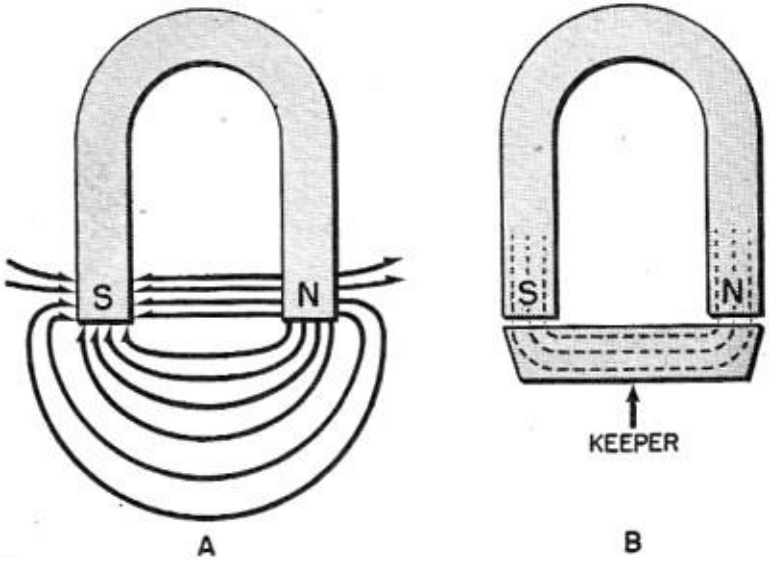


Hard
Medium
Soft

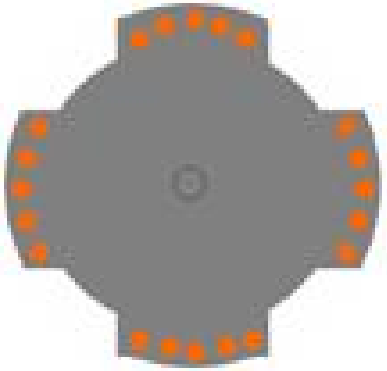
7. The resistance that a material offers to passage of magnetic flux lines is called _____.





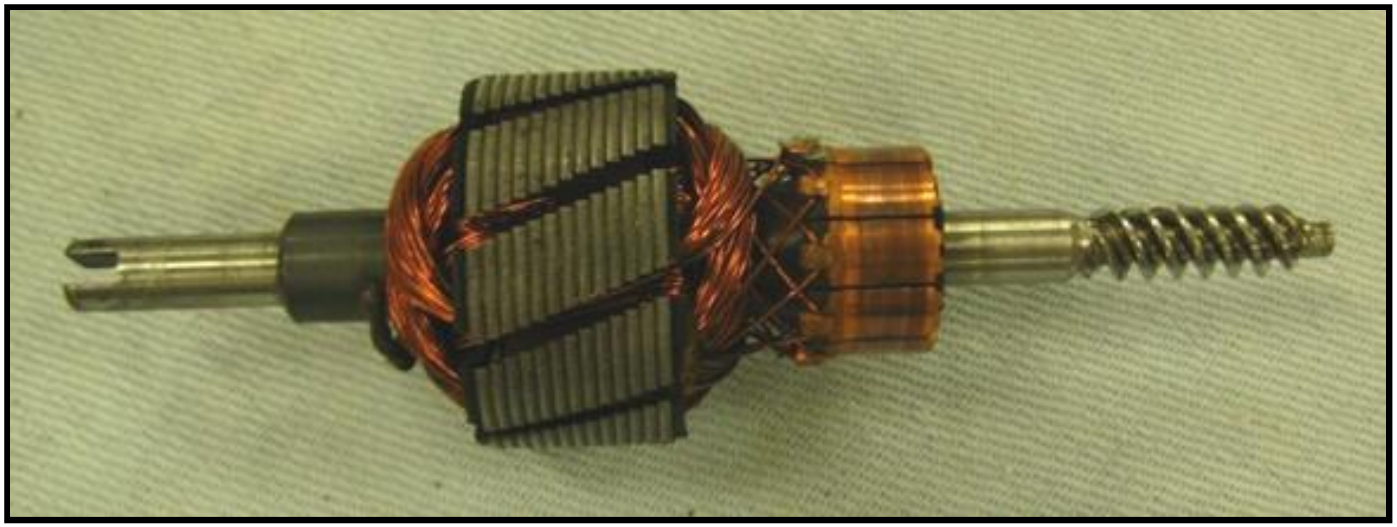


Resistance
Reactance
Reluctance

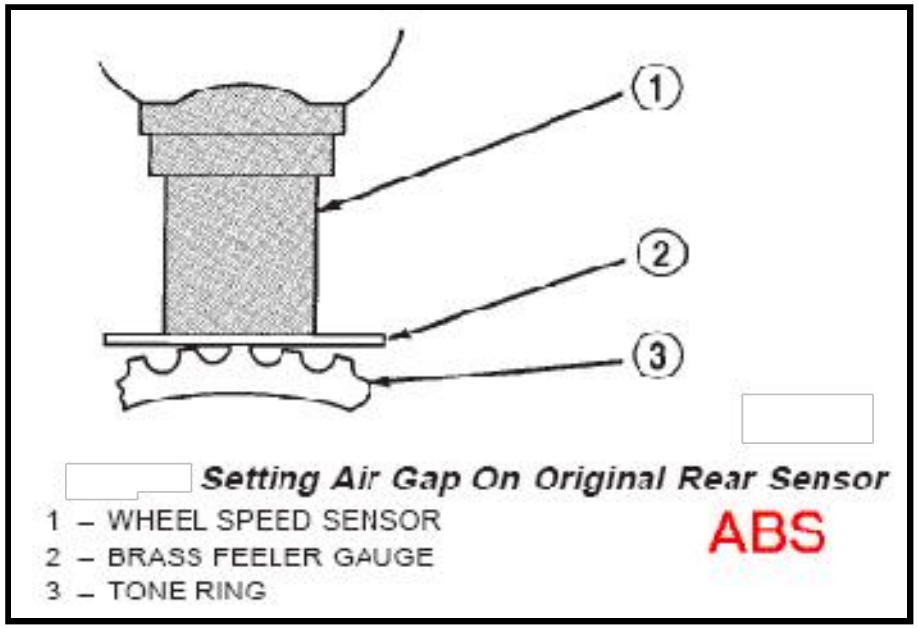


Rotor of Synchronous Reluctance Motor

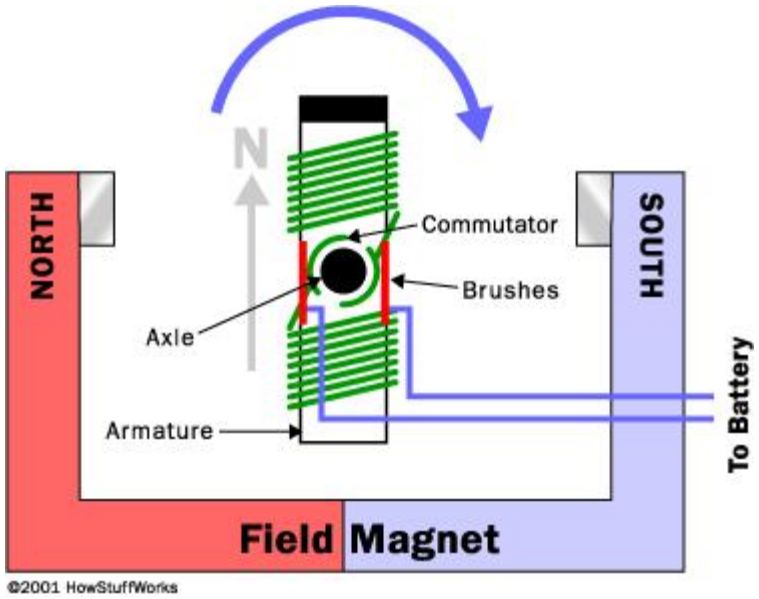
8. Air has _____ reluctance.
   Soft iron cores & armatures have _____ reluctance.



Low, High
High, Low
Medium, Medium

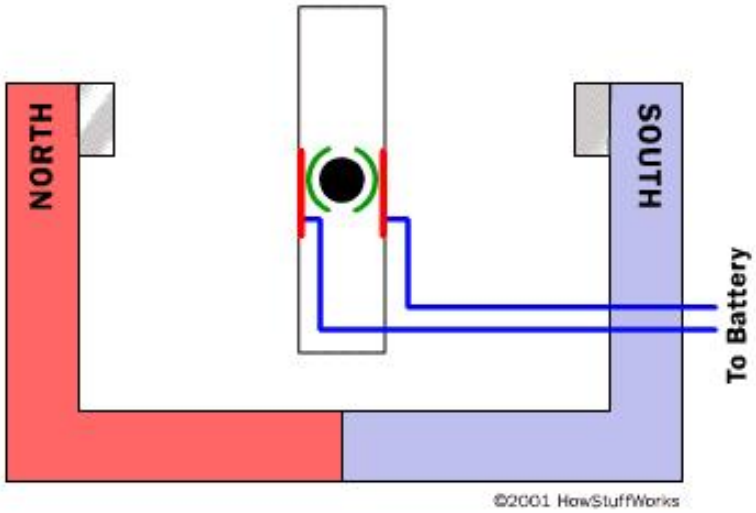


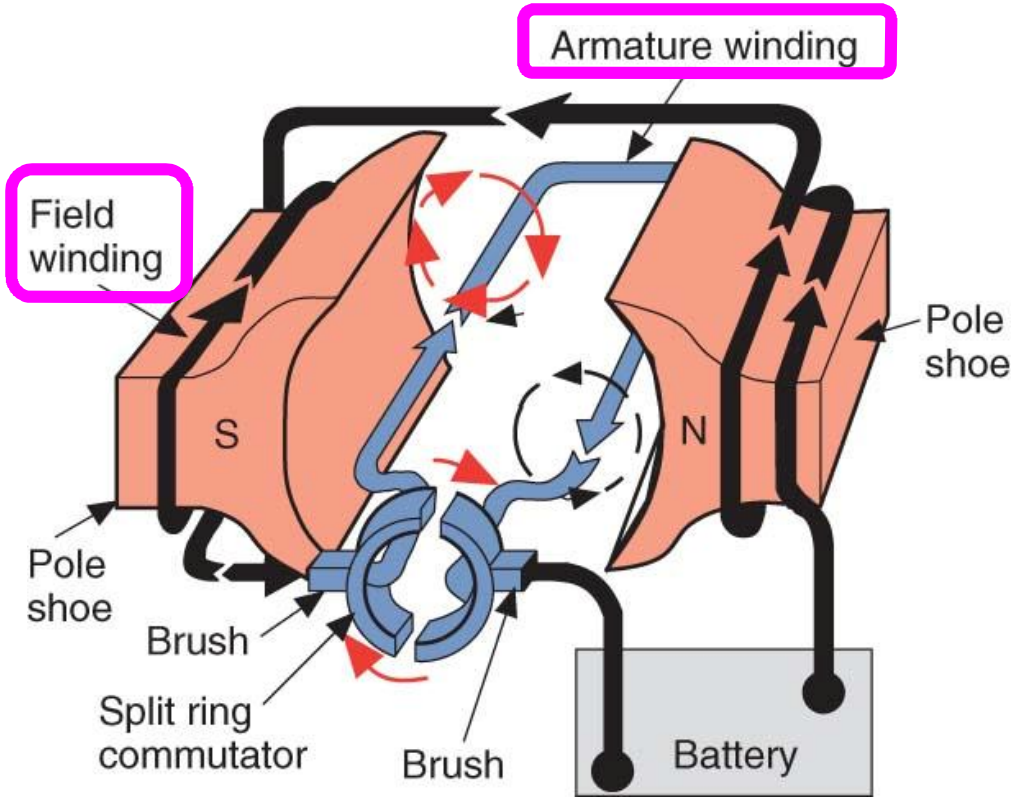
9. An electric motor converts _____ energy into _____ energy.



Chemical, Mechanical
Electrical, Mechanical
Heat, Light

10. Basic components of a motor are the stator or _____ windings, & the rotor or _____.

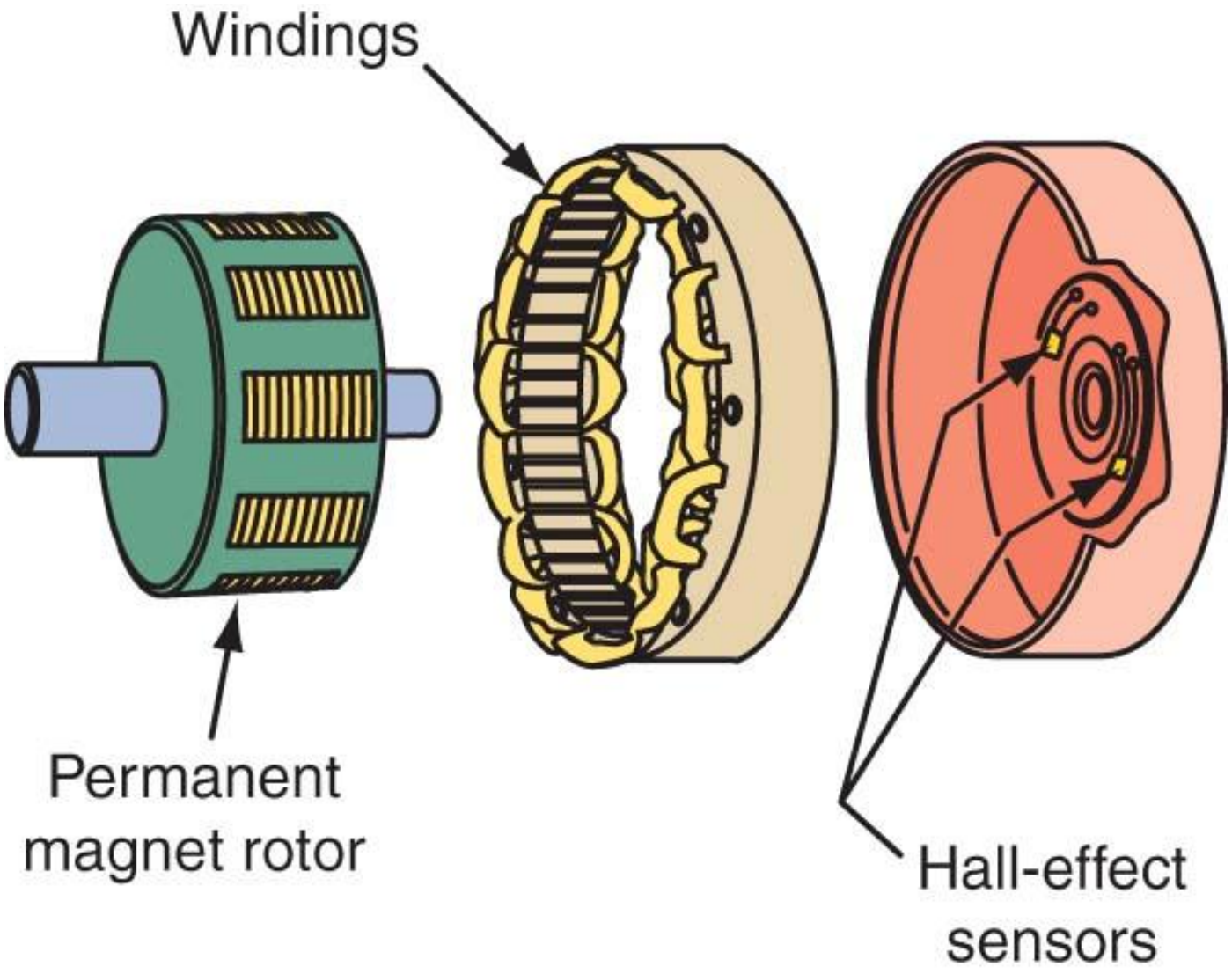




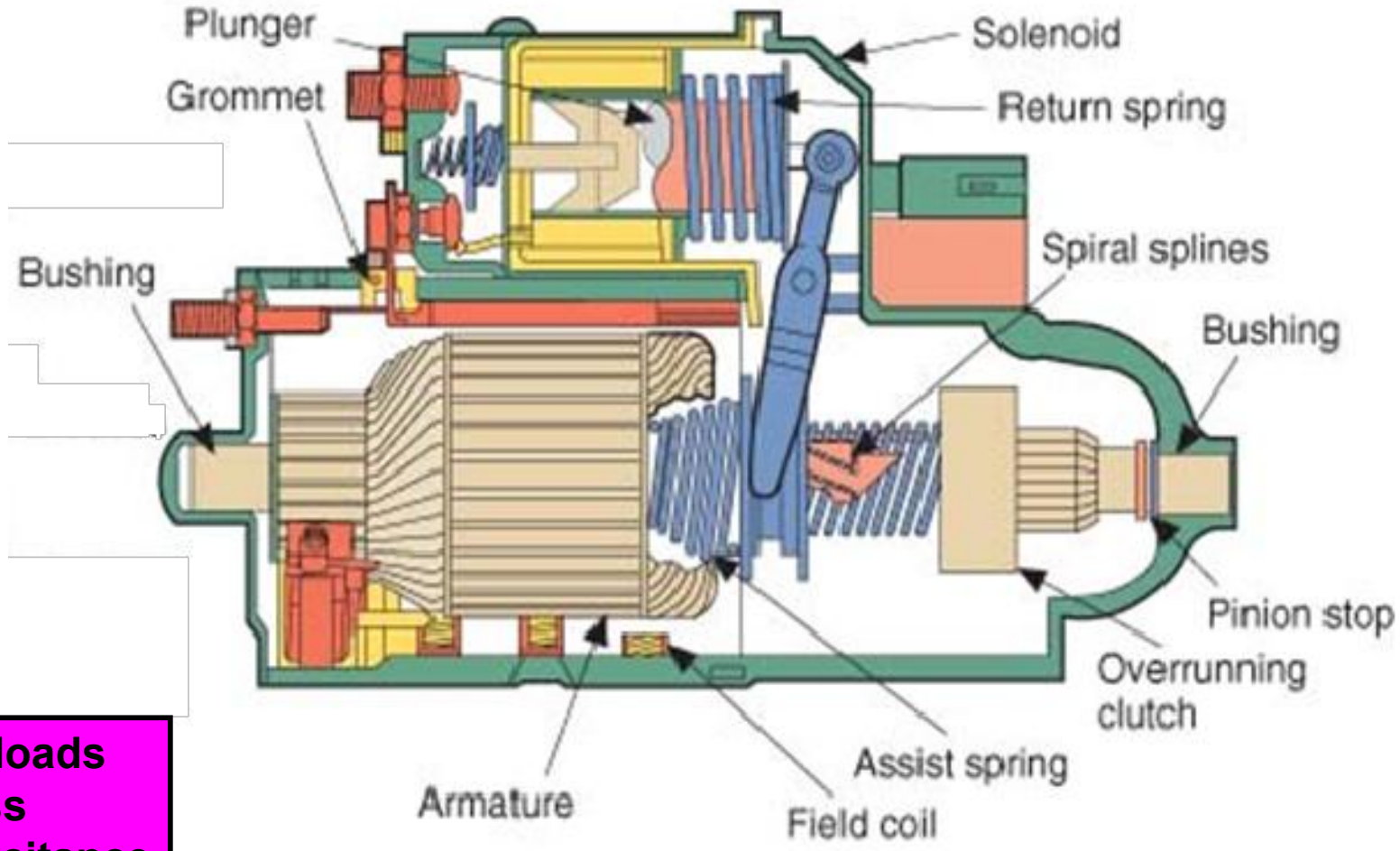
Field, Armature
Armature, Field
Rotor, Stator

11. Either the field windings or the armature can be made of _____ magnets, but not both.

Permanent
Electro
Ceramic



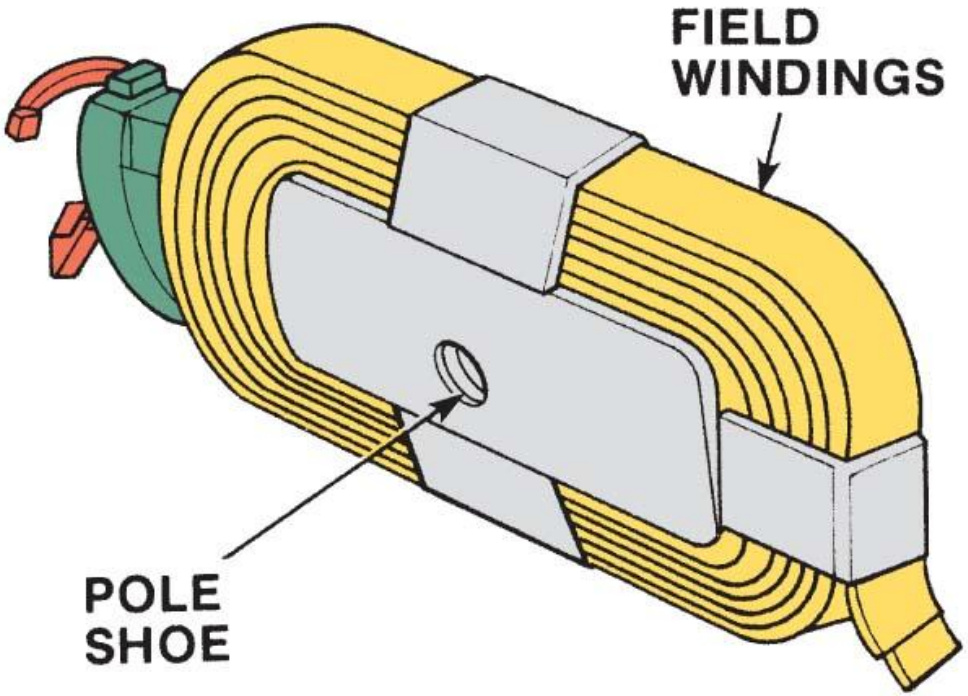
12. The starting motor is designed to operate under great _____ for short periods of time.

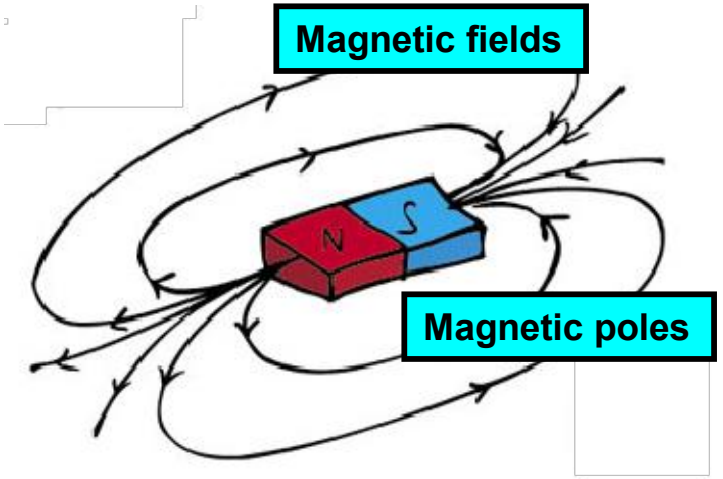


Overloads
Stress
Capacitance

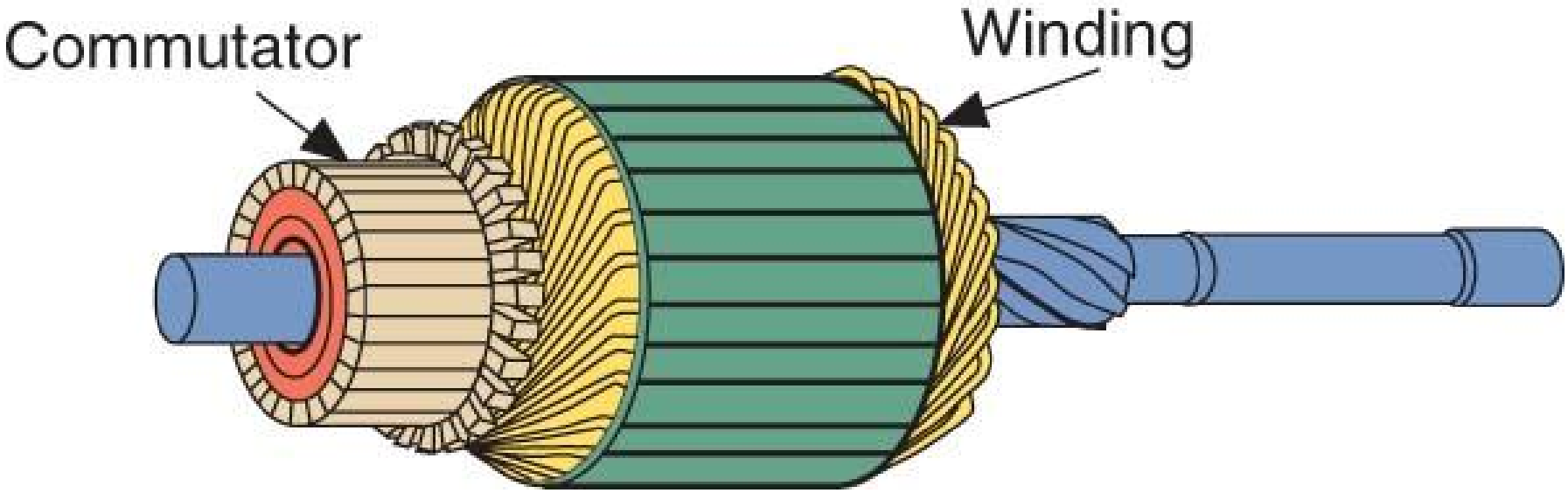
13. The starter frame holds the stationary _____ coils *(flat copper)* & their _____ shoes *(soft iron).*

Pole, Vault
Field, Event
Field, Pole



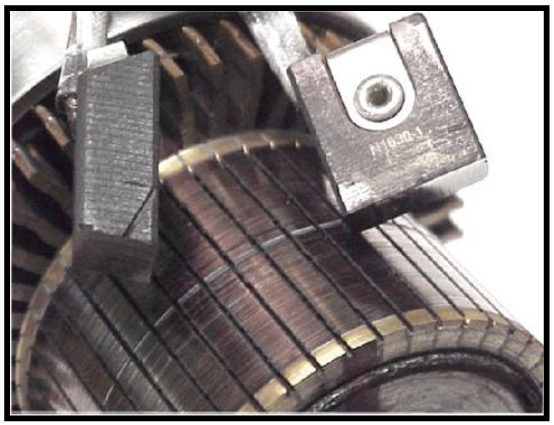


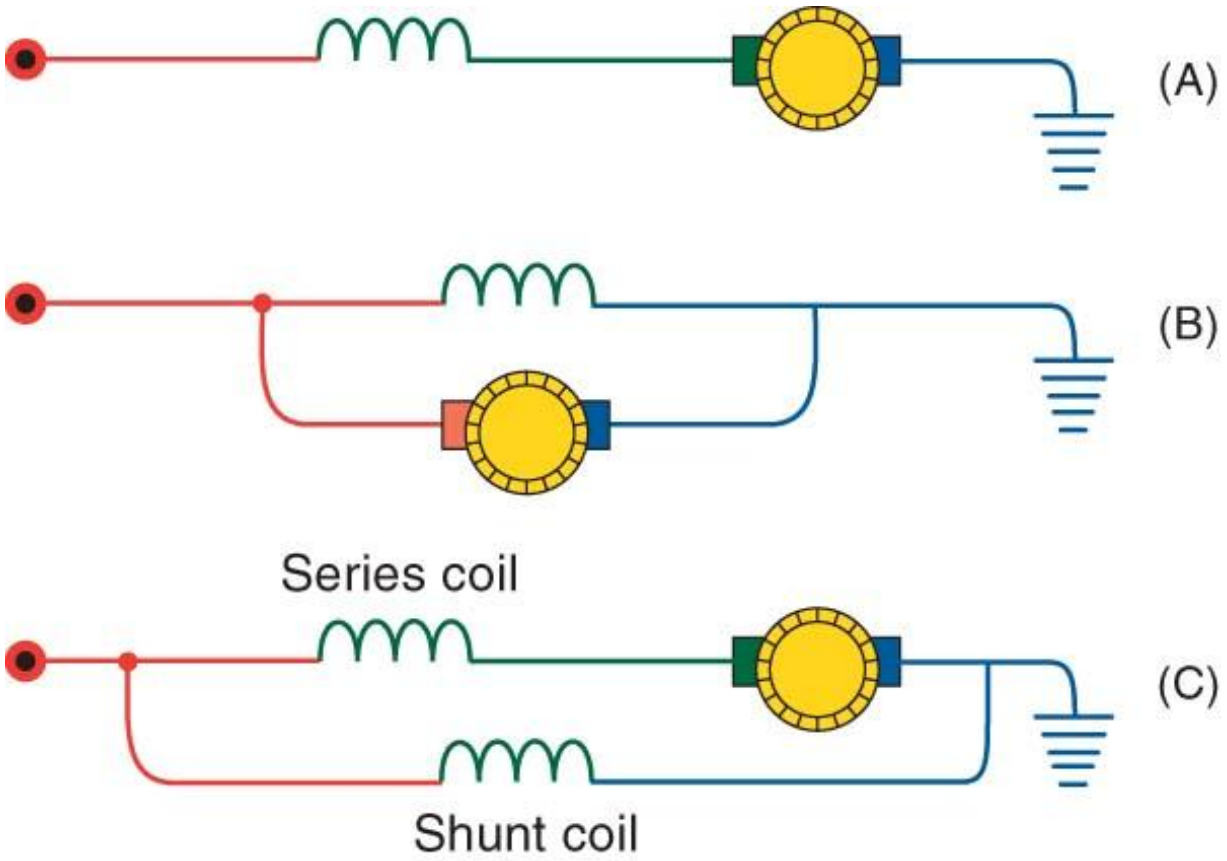
14. The _____ is the rotating part of the starter, made up of windings and the commutator.



Armature
Rotor
Stator

15. Starter _____ connect the armature & the field coils in either a series or parallel arrangement.

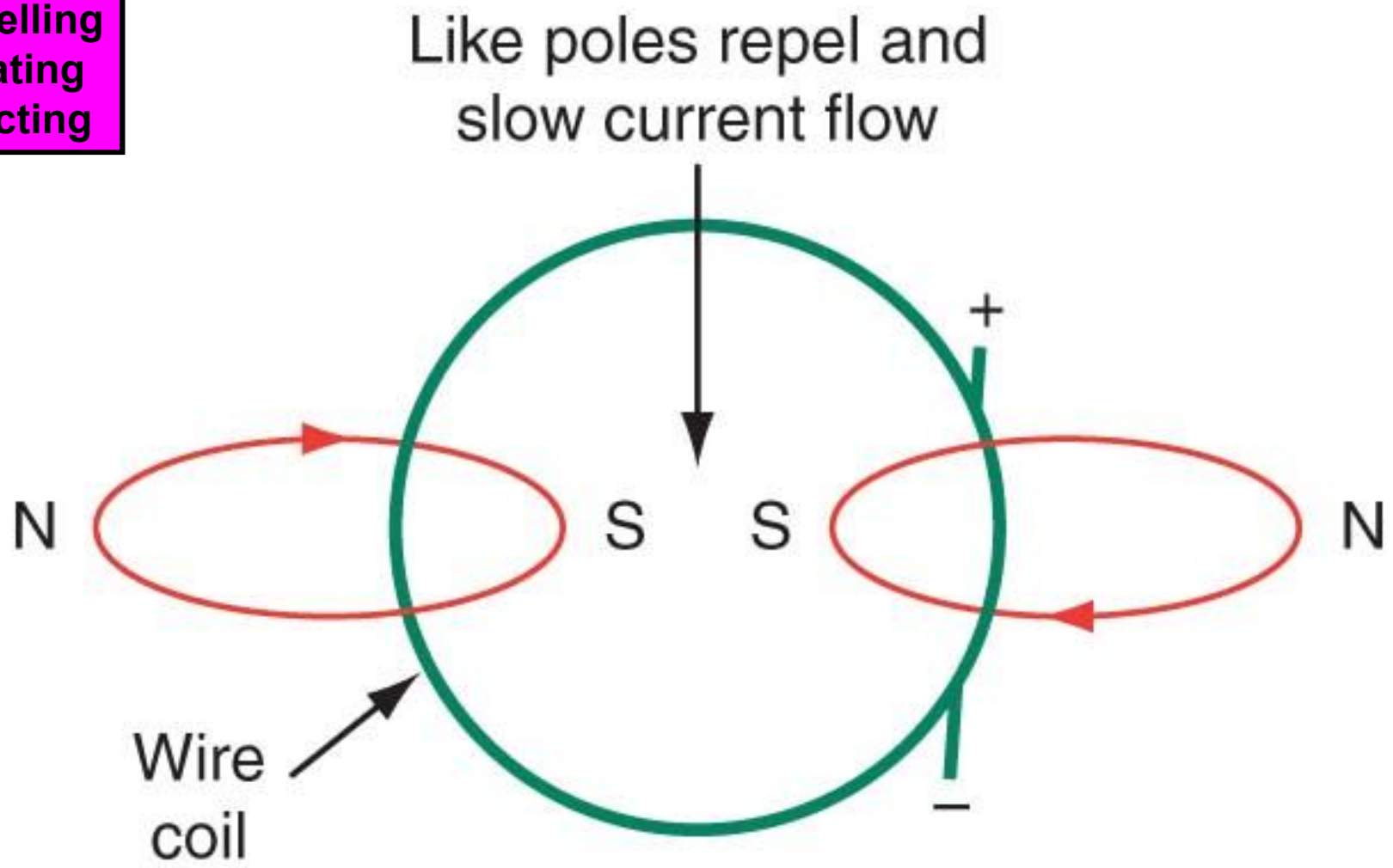




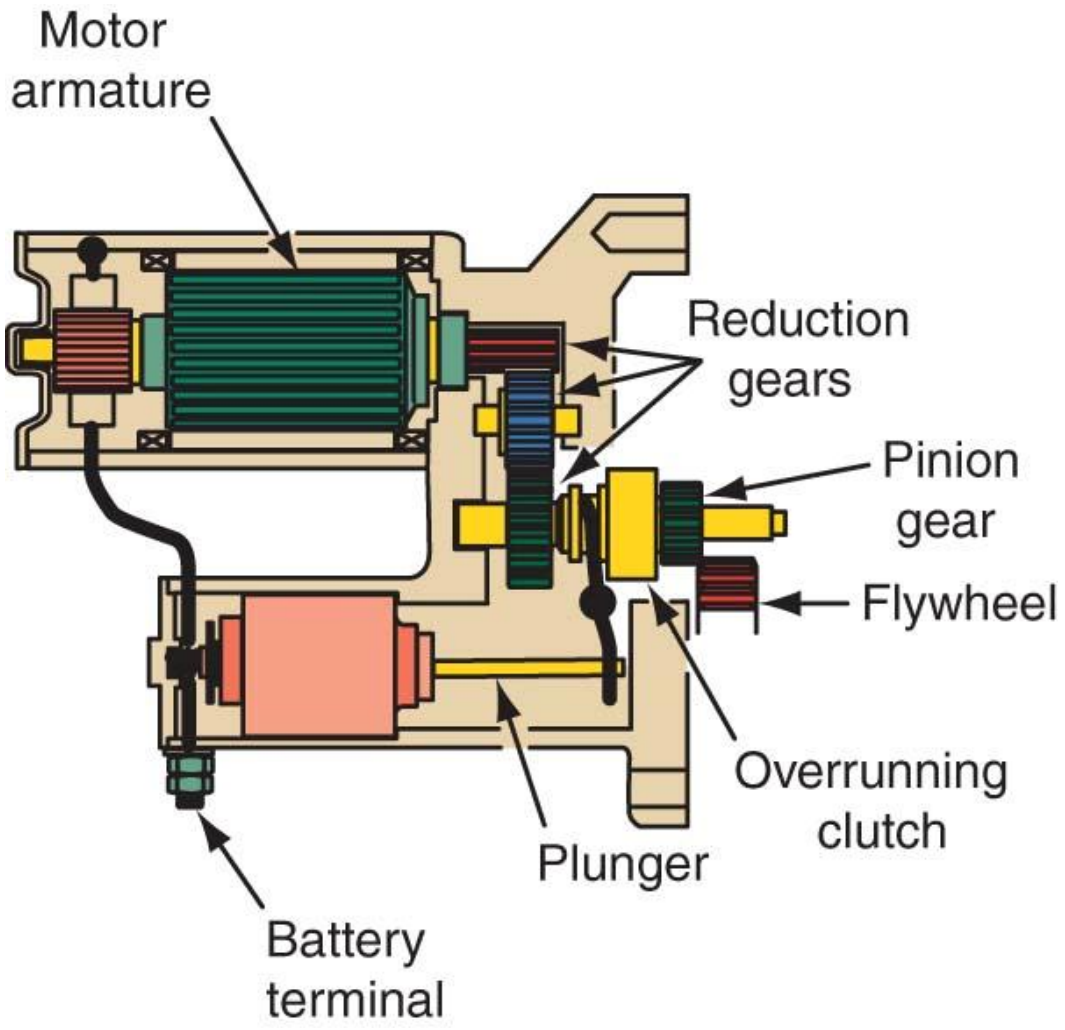
Clutches
Brushes
Bushings

16. _____ magnetic fields cause the motor armature to rotate.

Repelling
Rotating
Reacting

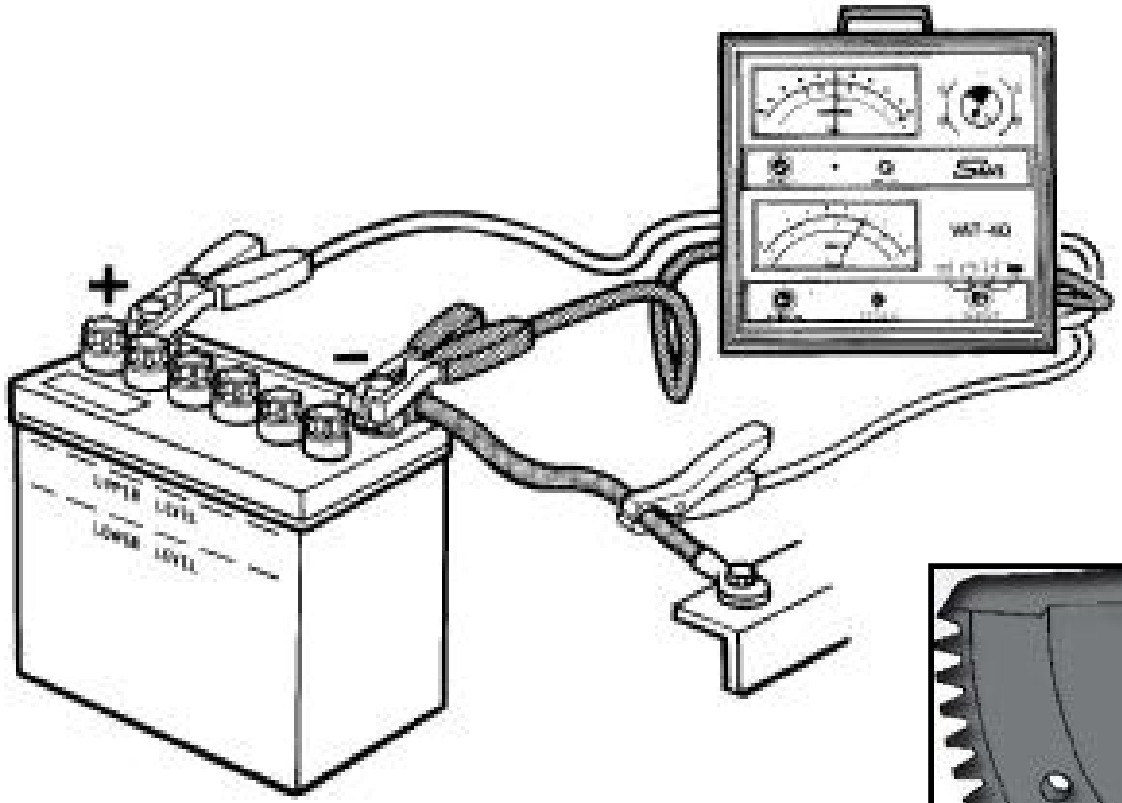


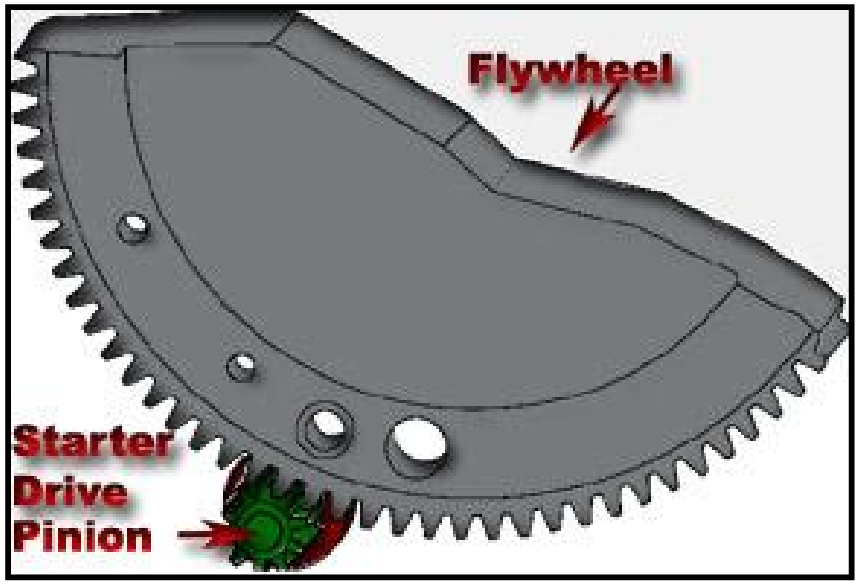
17. _____ magnet starter motors may have a planetary gear reduction to increase torque.



Permanent
Temporary
Electro

18. The slower the motor turns, the _____ current it will draw.
Maximum current is drawn when it is engaged, but armature is not rotating.

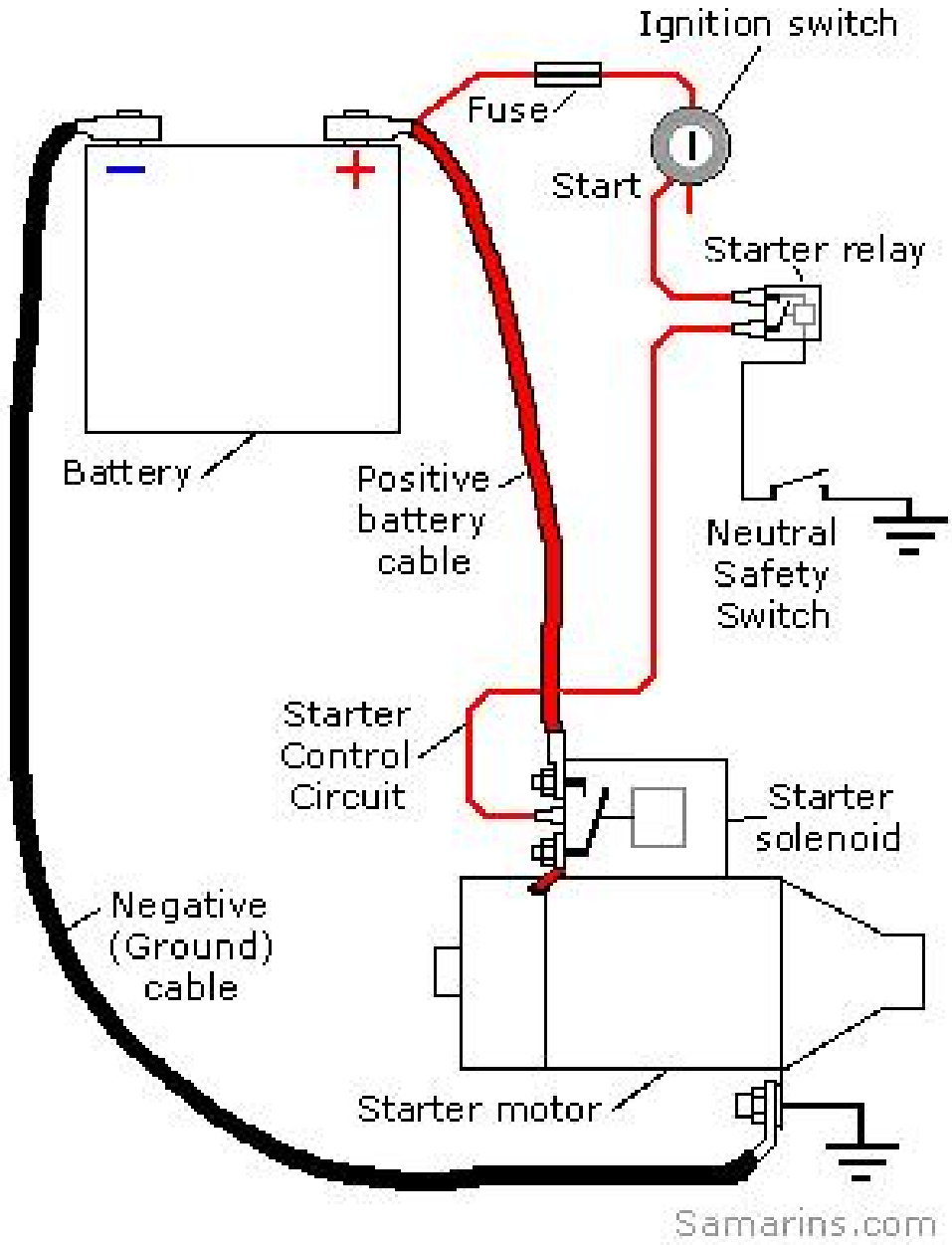




Less
Same
More

19. The starting system has two distinct circuits:
    1) the _____
    (motor feed-high amps) circuit,

    2) the _____
    (low amps-switching) circuit.



Starter, Control
Starter, Solenoid
Solenoid, Control

** Explain how a starter solenoid can be part of both circuits:

The Pull-in Winding is part of the control circuit.
The Plunger Contacts are part of the motor feed circuit.

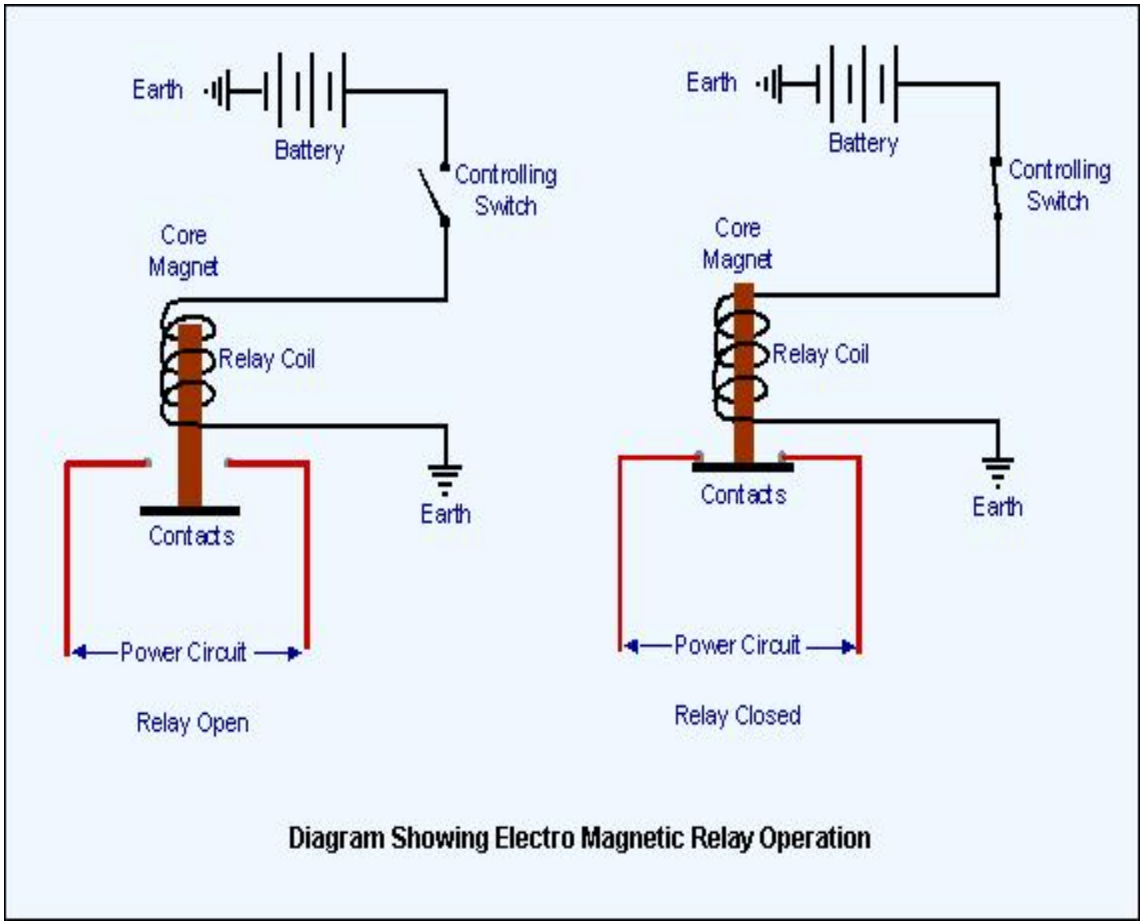
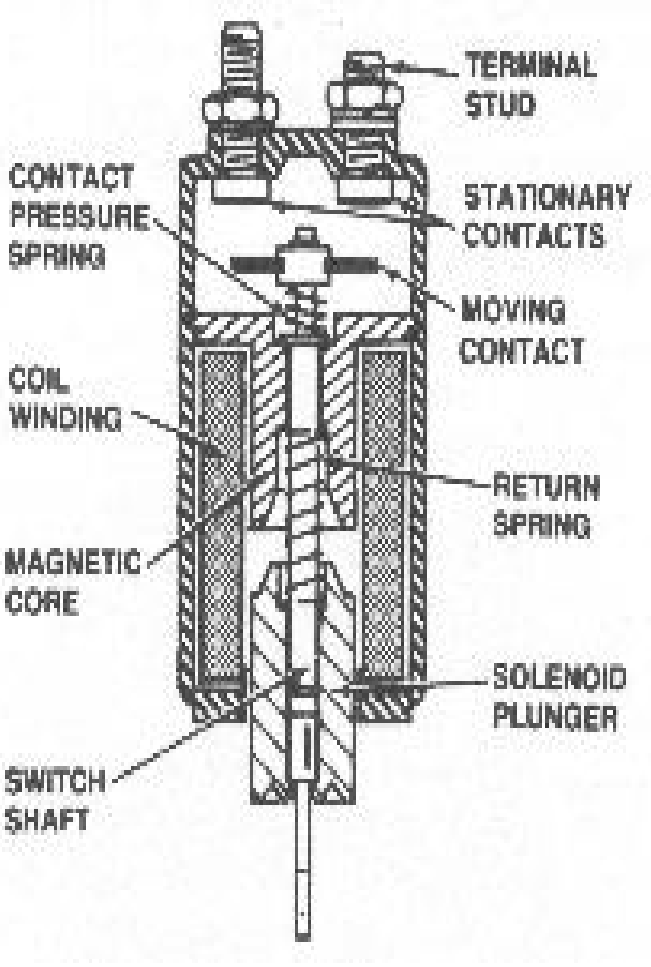
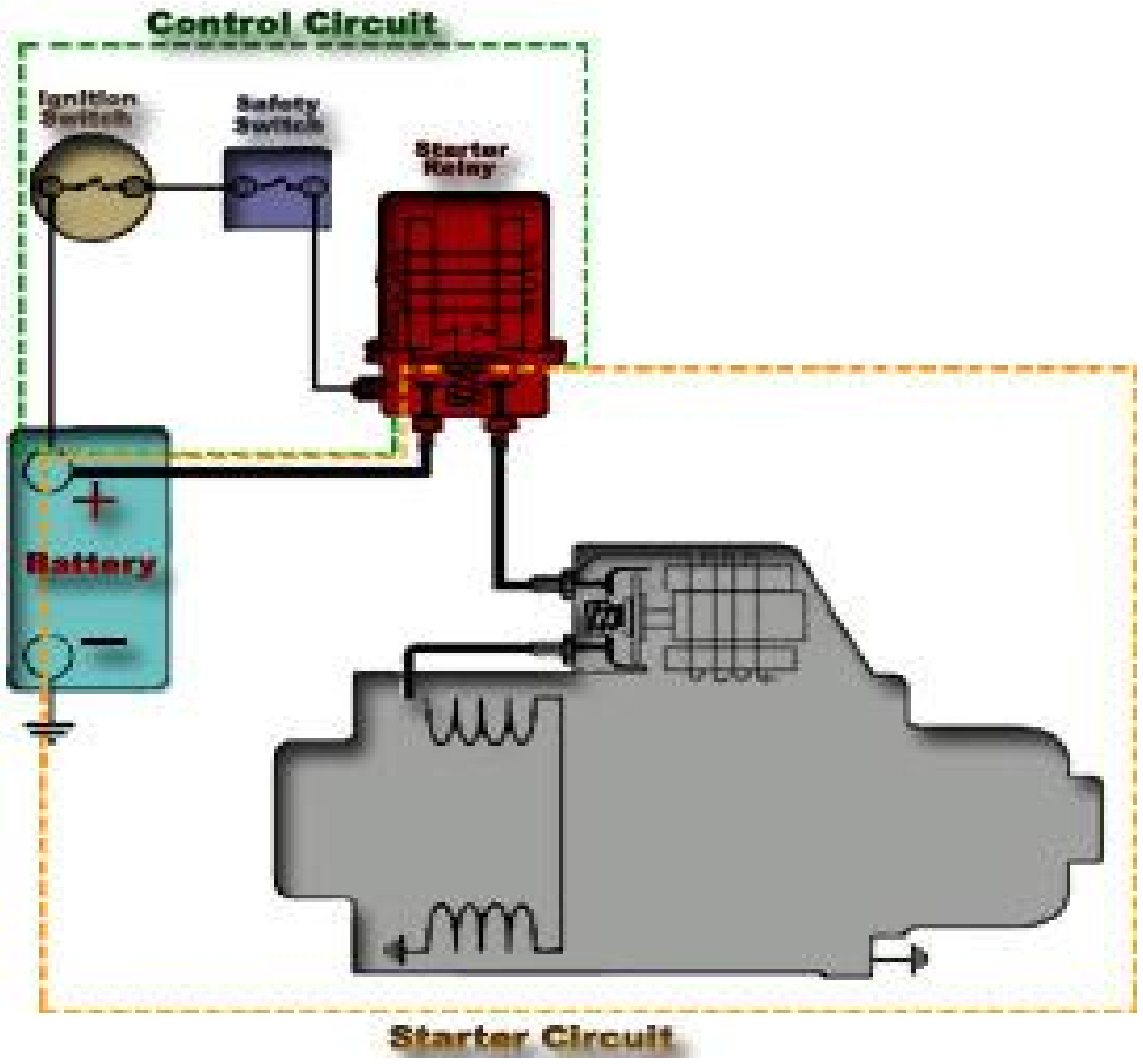


Diagram Showing Electro Magnetic Relay Operation

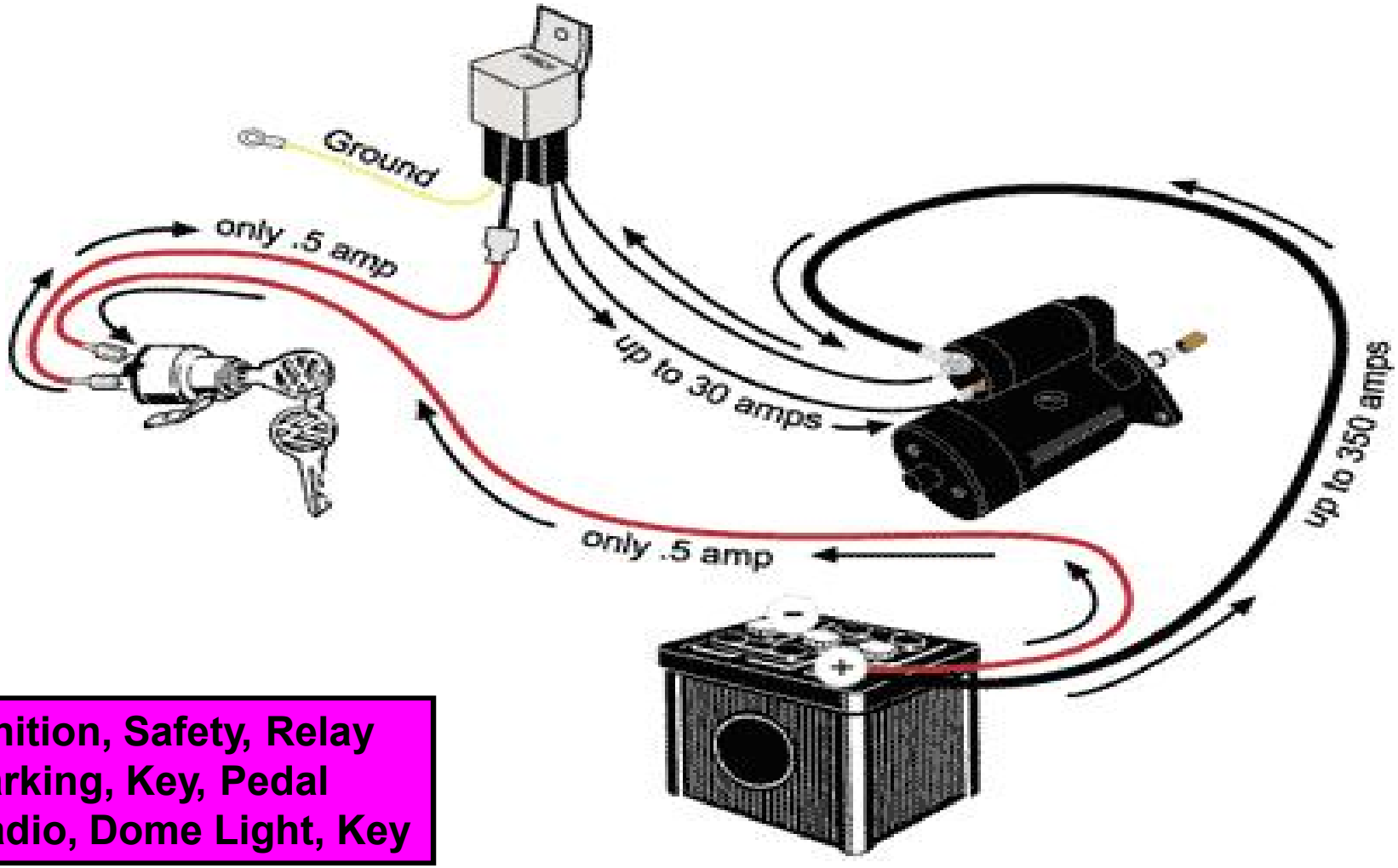


20. The motor feed circuit contains the battery & cables, the _____, & the starter motor.



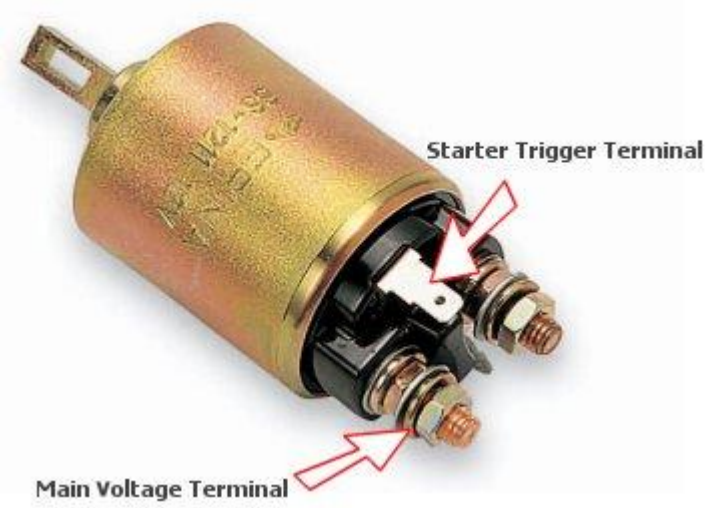
Relay
Solenoid
Fusible Link

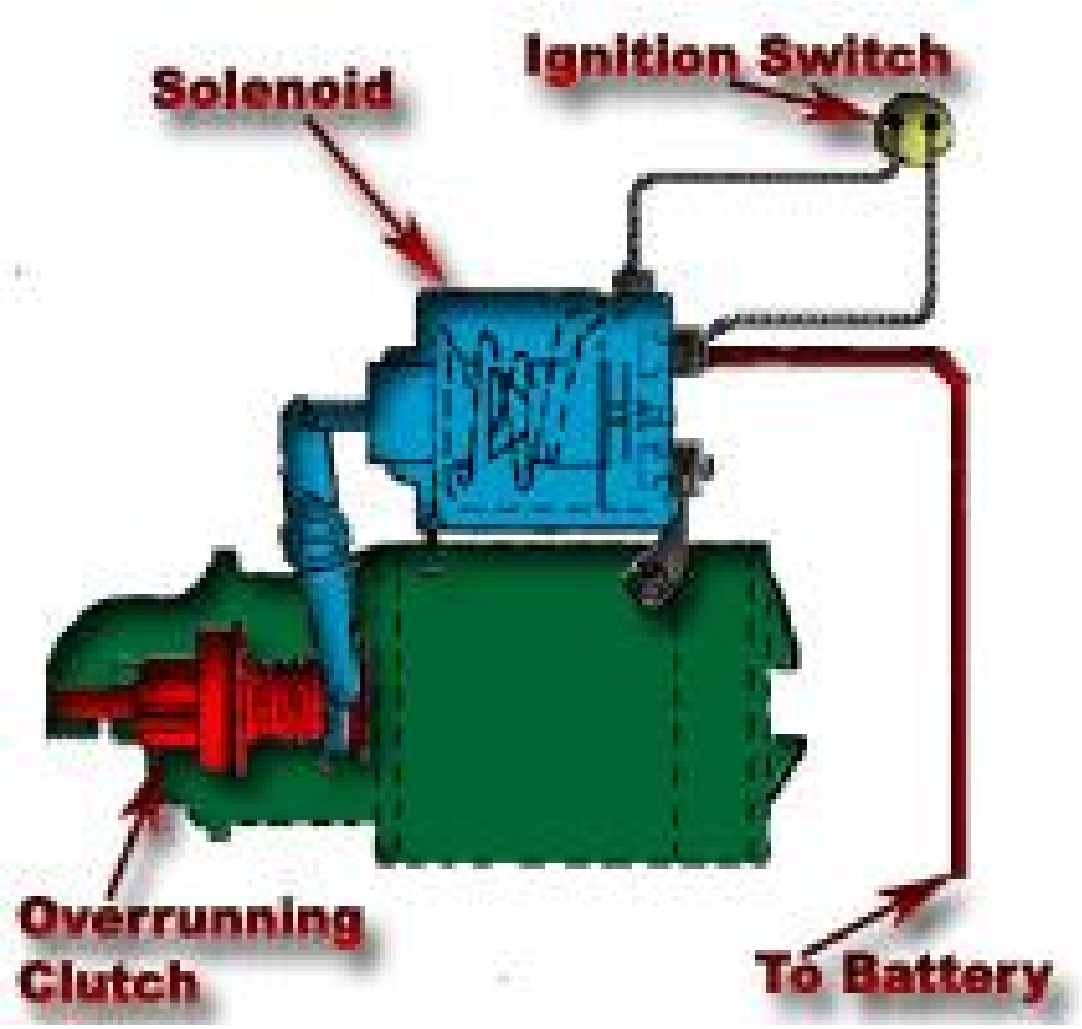
21. The control circuit contains the _____ switch, starting _____ switch, a _____ or a solenoid *(to use low amps to control higher amps)*, the battery, fuses, and normal-gauge wiring.



Ignition, Safety, Relay
Parking, Key, Pedal
Radio, Dome Light, Key

22. The _____ plunger is used to move the starter pinion gear & its contacts serve as a relay switch to energize the motor once the *drive pinion* engages the flywheel/flex plate ring gear.

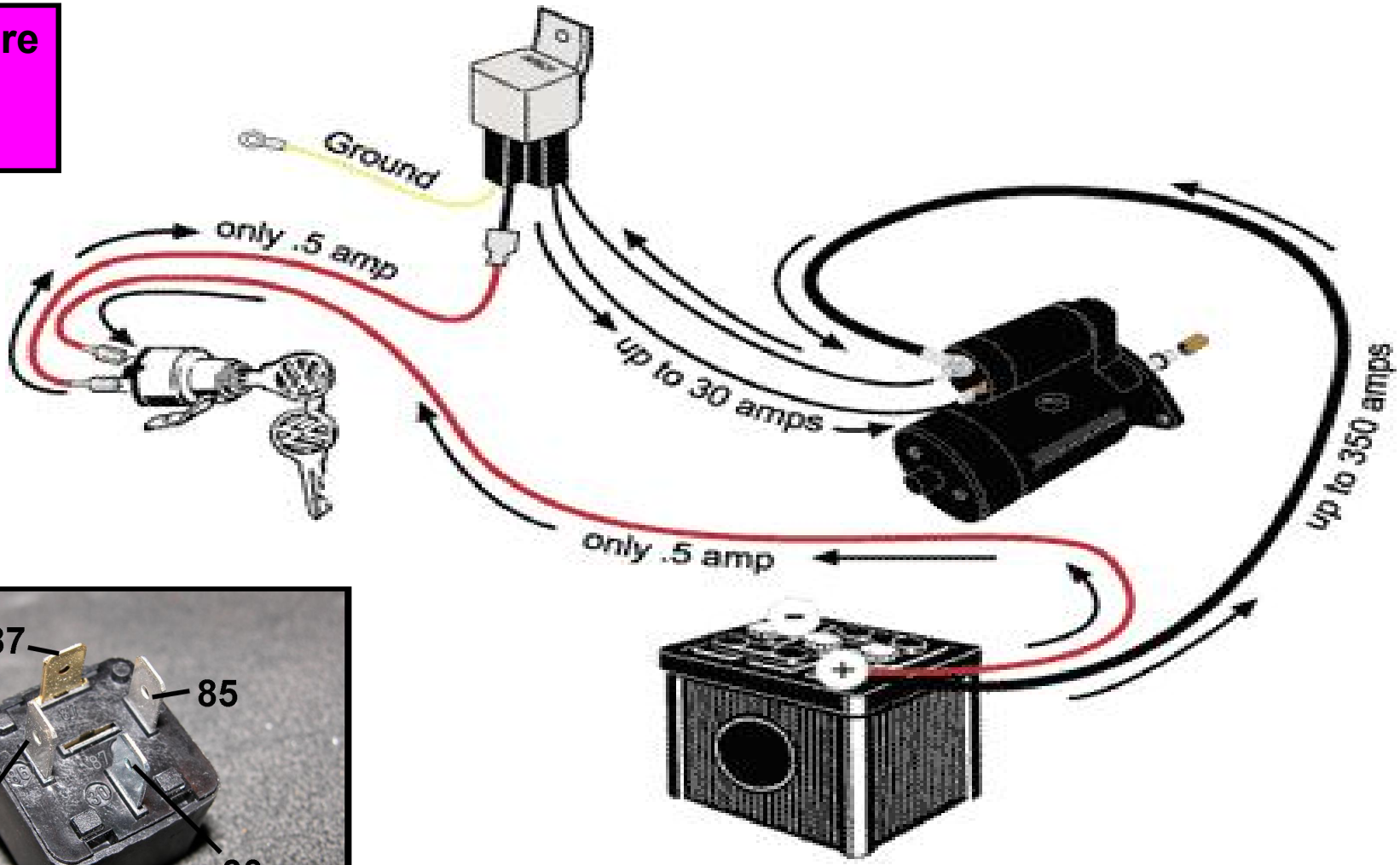


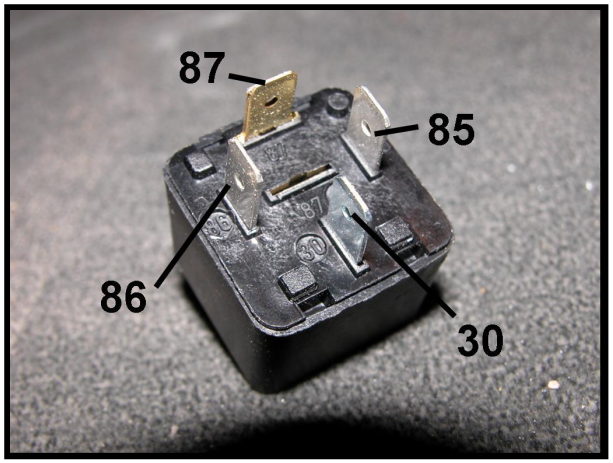


Solenoid
Relay
Stator

23. A starter _____ is similar to a solenoid, switches high current using low current, but does not pull-in a plunger to actuate a starter drive.

Armature
Relay
Stator





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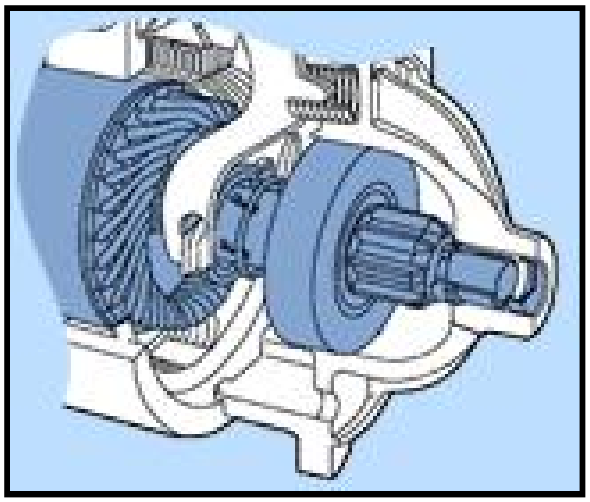
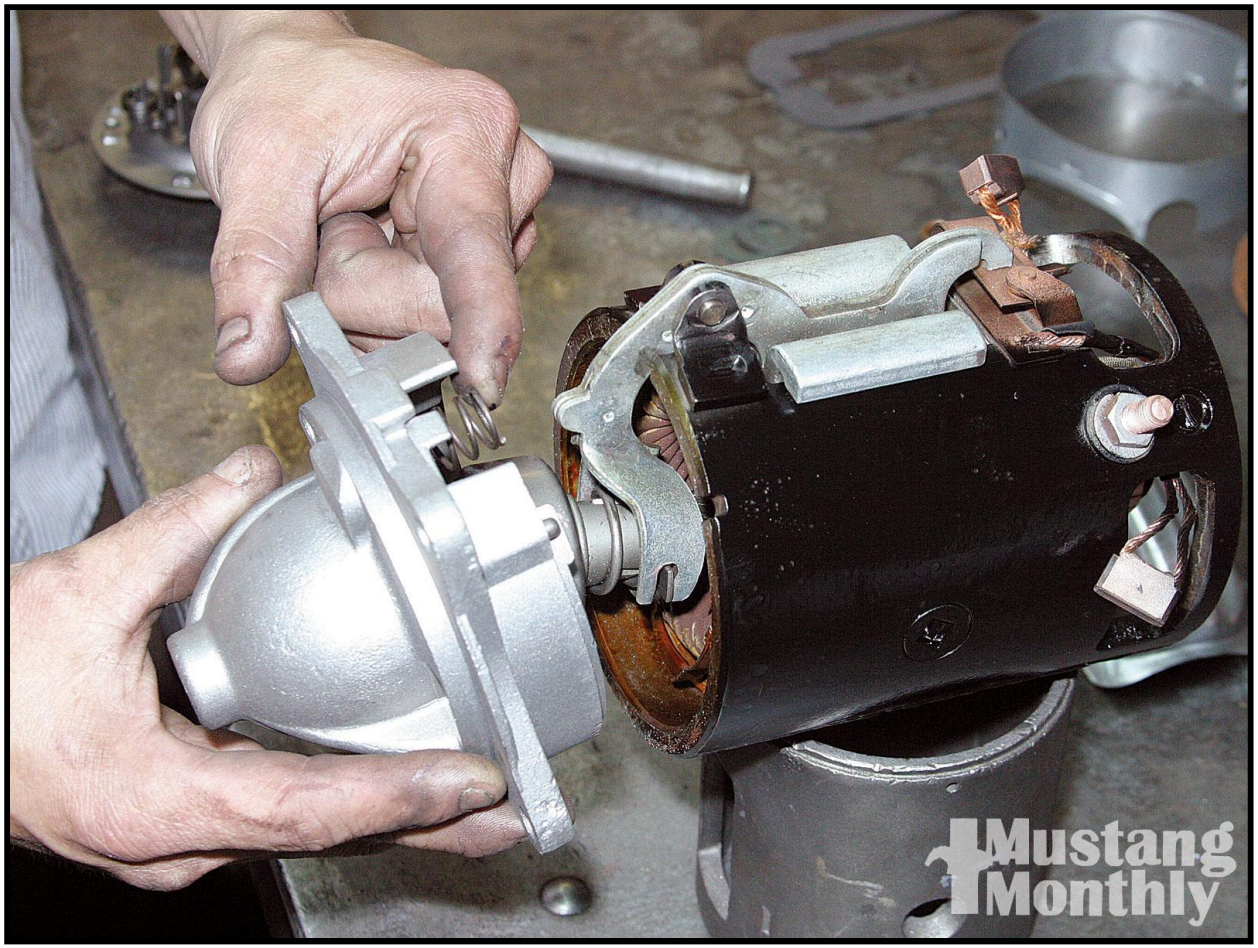
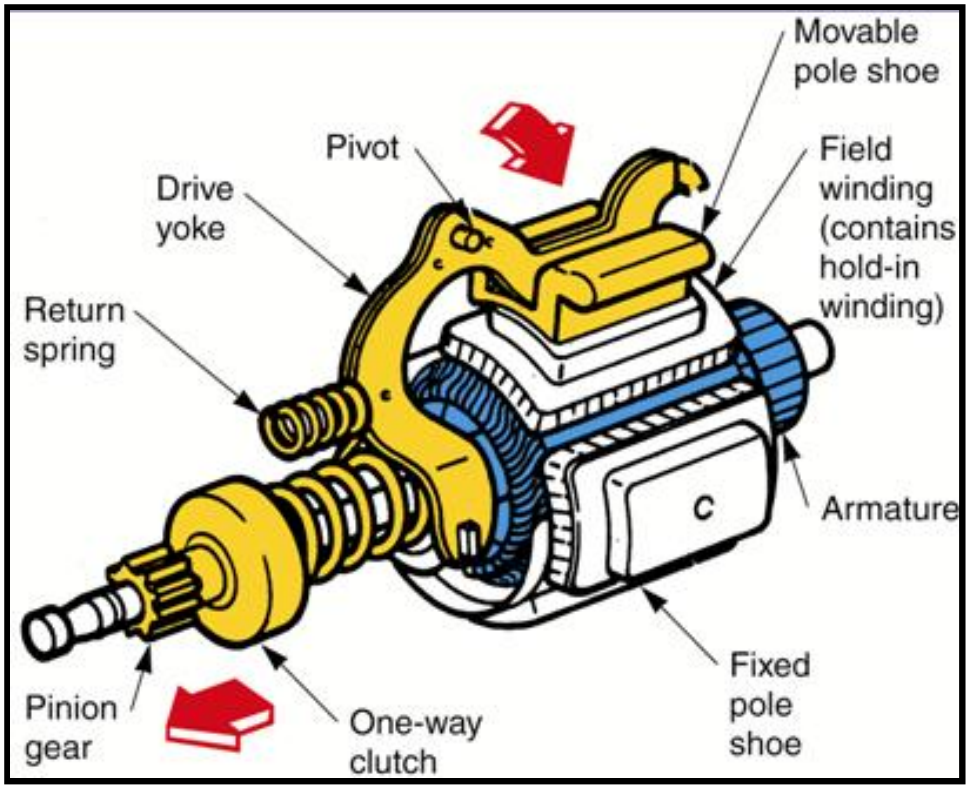
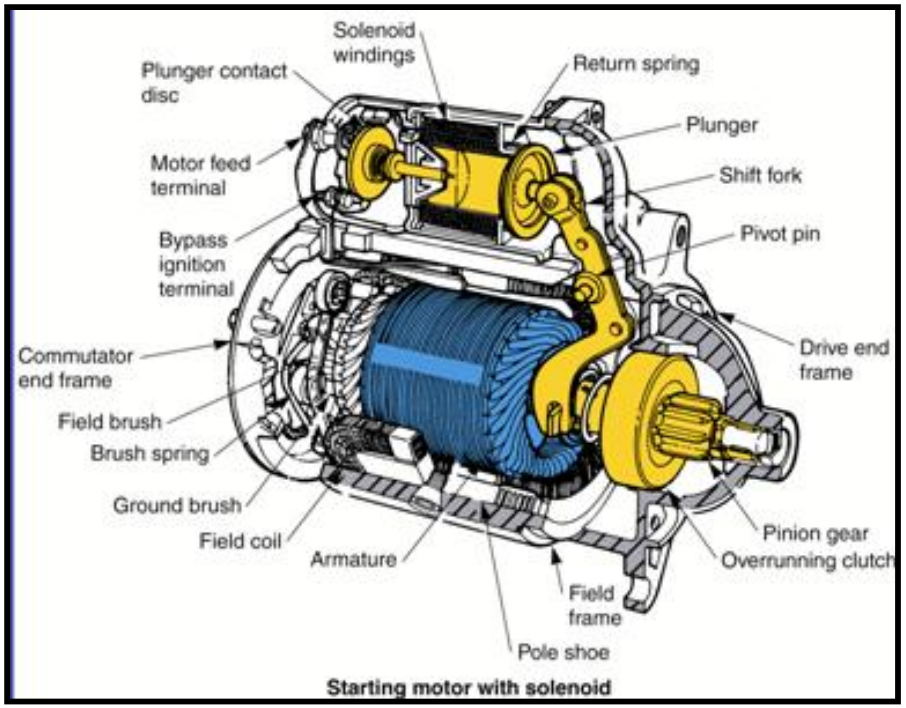
24. A movable ___ ___ starter does not use a starter motor mounted solenoid.





Pole Shoe
Brake Shoe
Horse Shoe

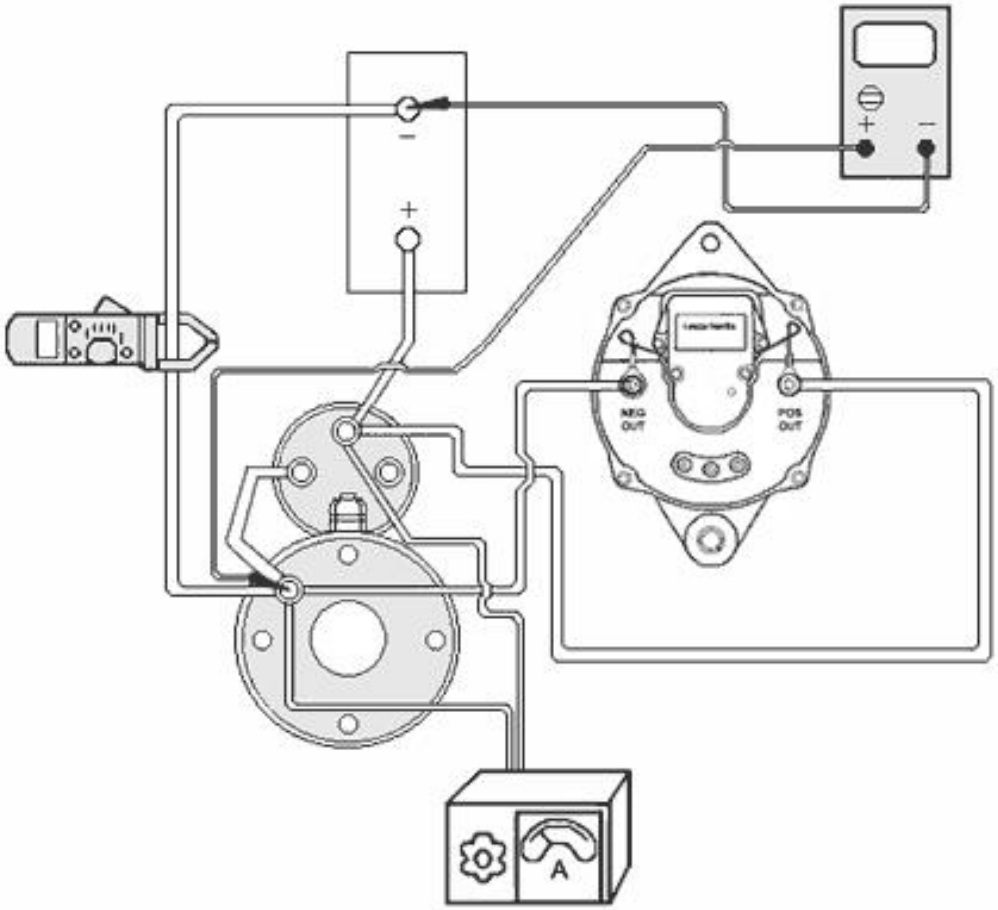




Starting motor with solenoid

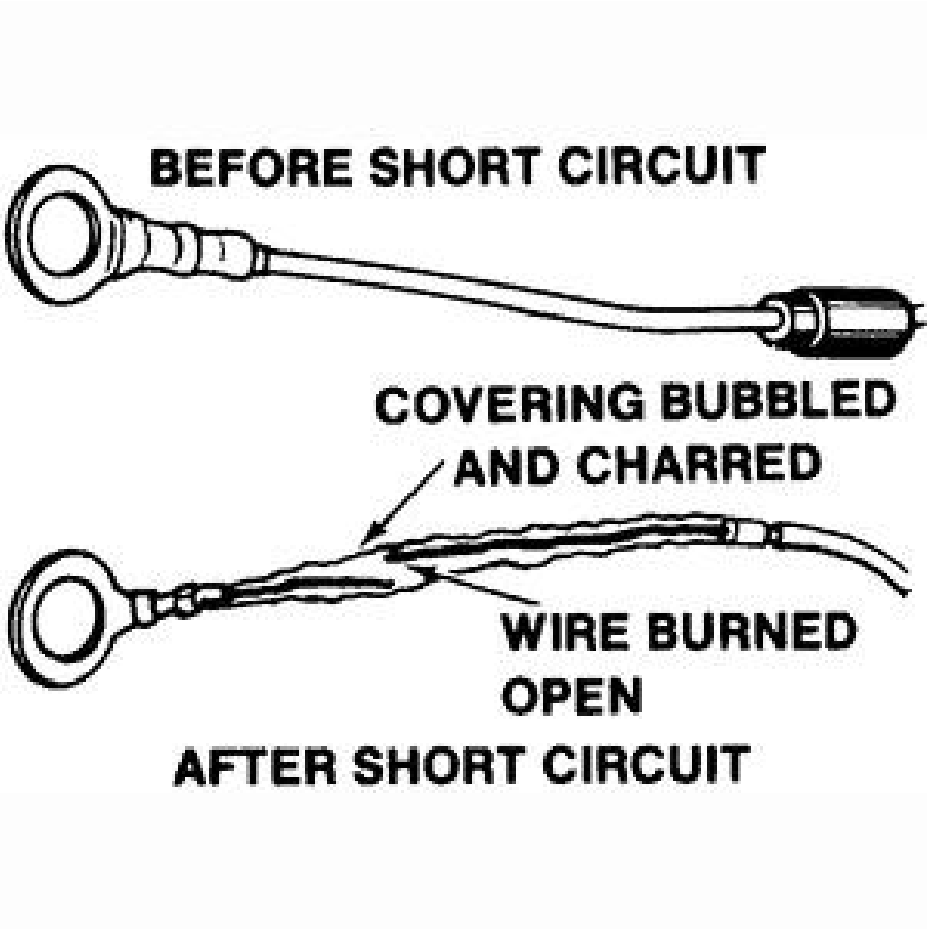
Note: Corroded battery cables can lead to increased resistance and a <u>voltage</u> drop in the motor feed circuit.

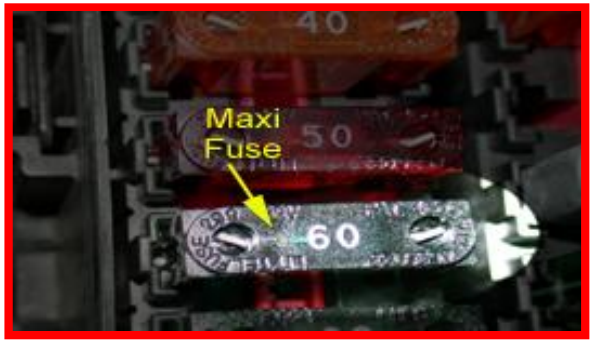
Frayed positive cables can lead to a short to ground and serious electrical damage.

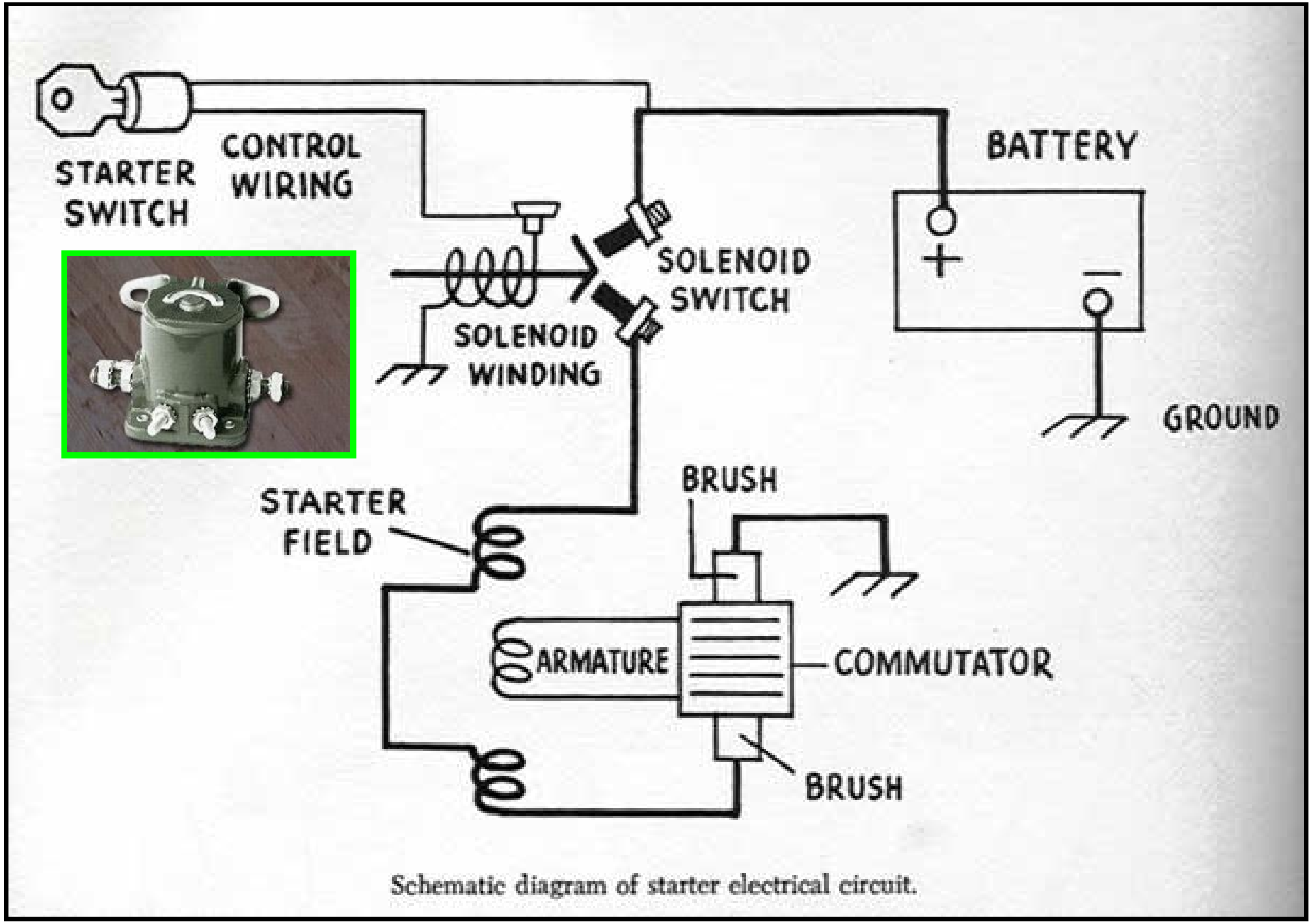


Note: A fusible link or a maxi-fuse in the motor feed circuit *never blows without a reason…*

…The reason is increased amperage flow due to a decrease in resistance (like a short to ground).



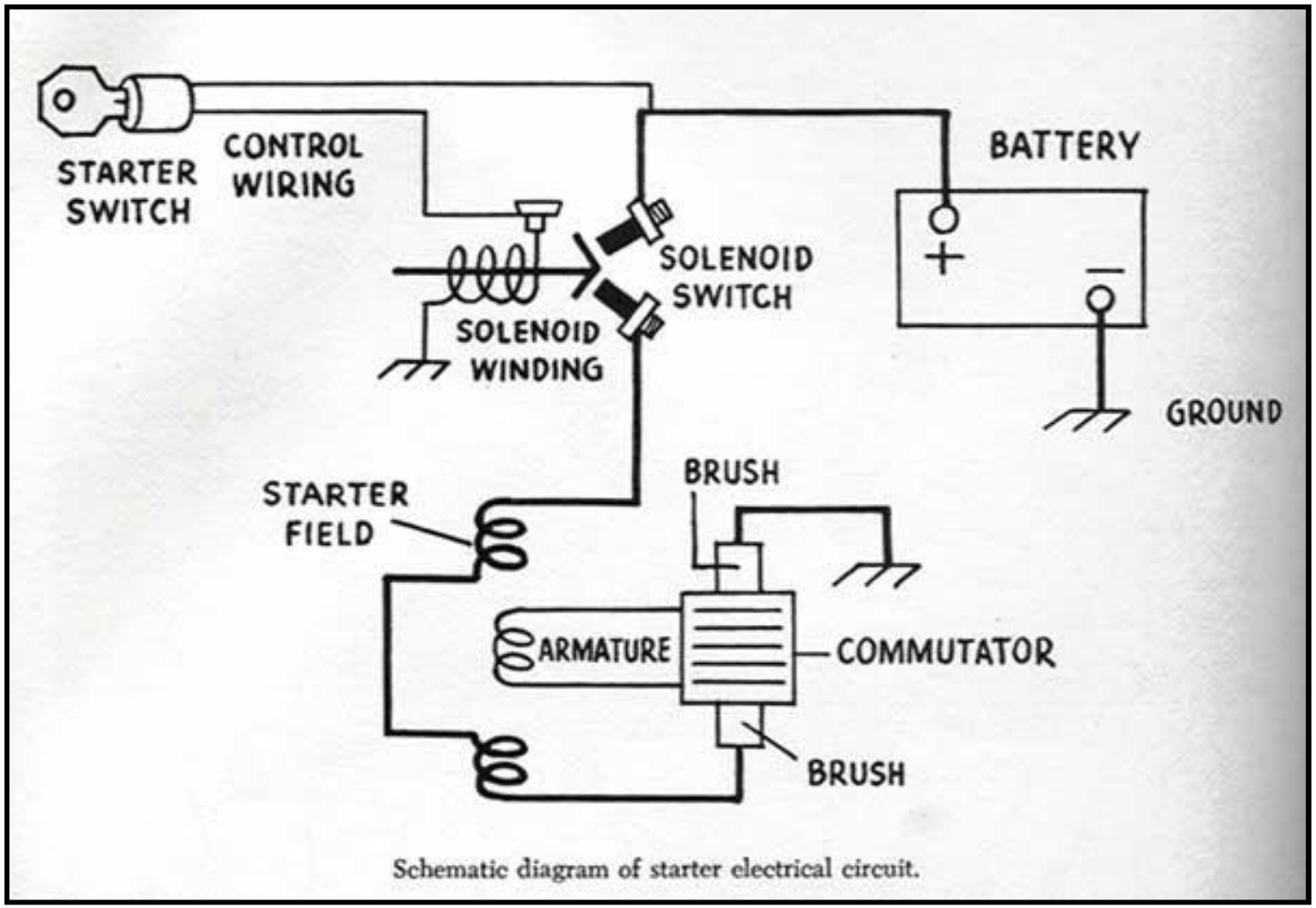




Schematic diagram of starter electrical circuit.

** Explain how a solenoid is similar in operation to a relay:

Both solenoids & relays energize a low amps coil to close a circuit that will switch higher amps.



Schematic diagram of starter electrical circuit.

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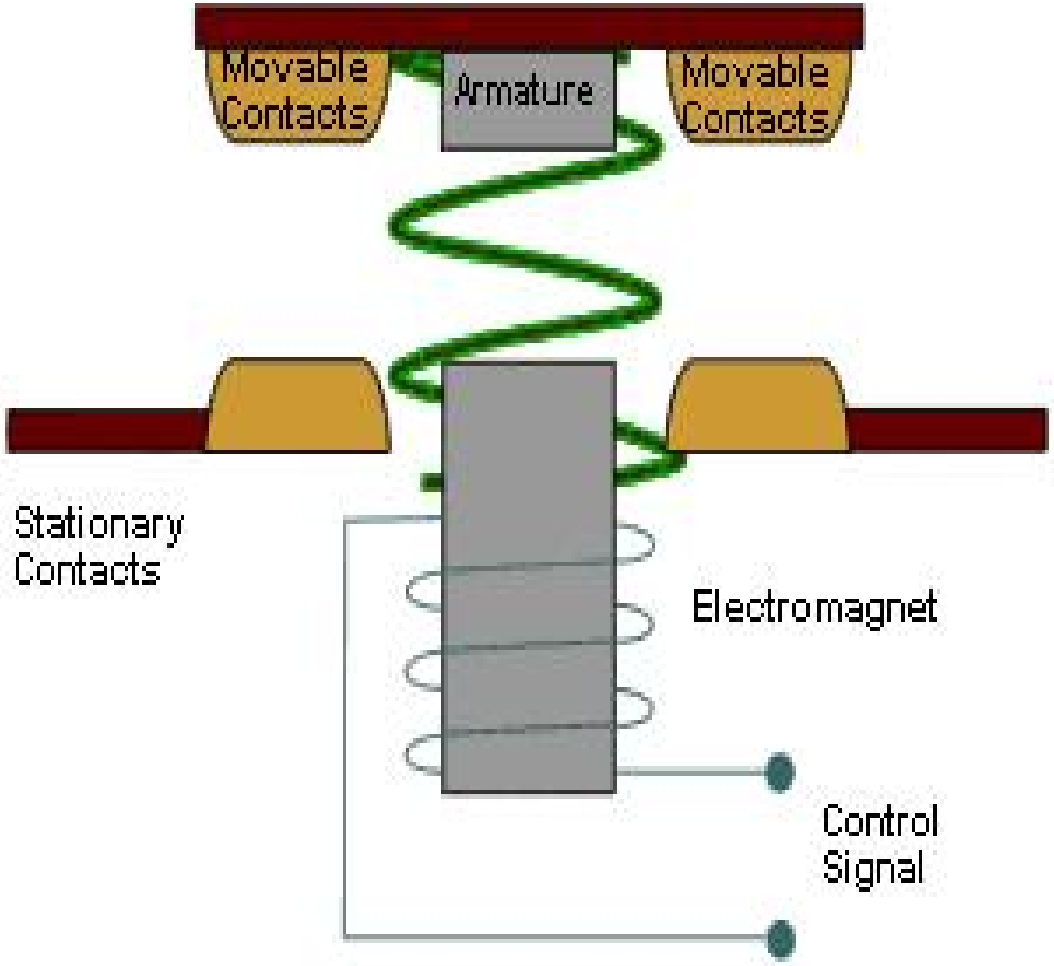
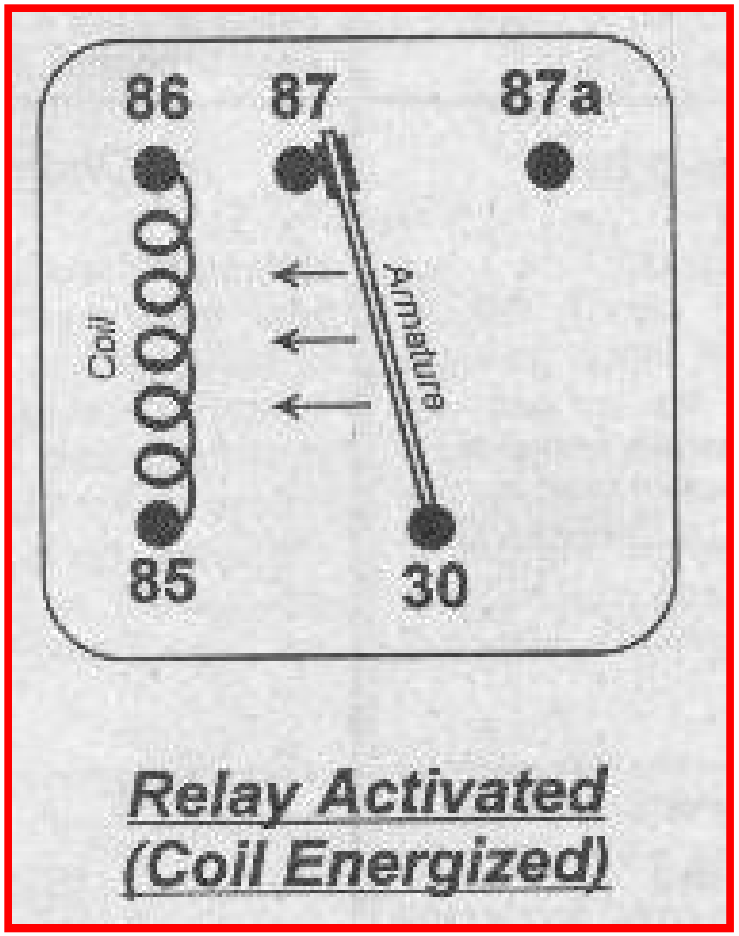
**** Explain how as solenoid differs from a relay:**

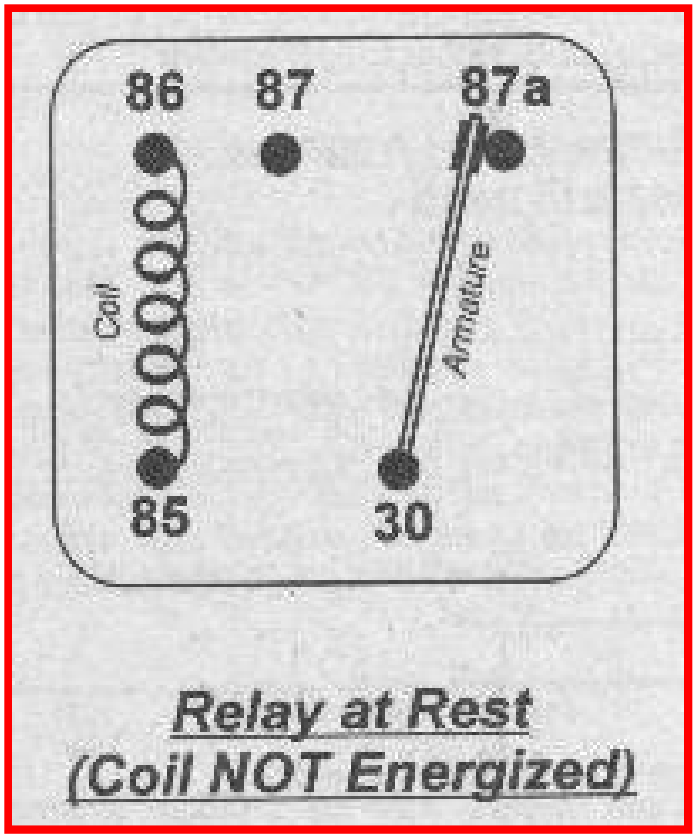
The starter relay uses a coil & contact points & switches smaller amps.
The starter solenoid uses a hollow coil & a plunger & switches higher amps.

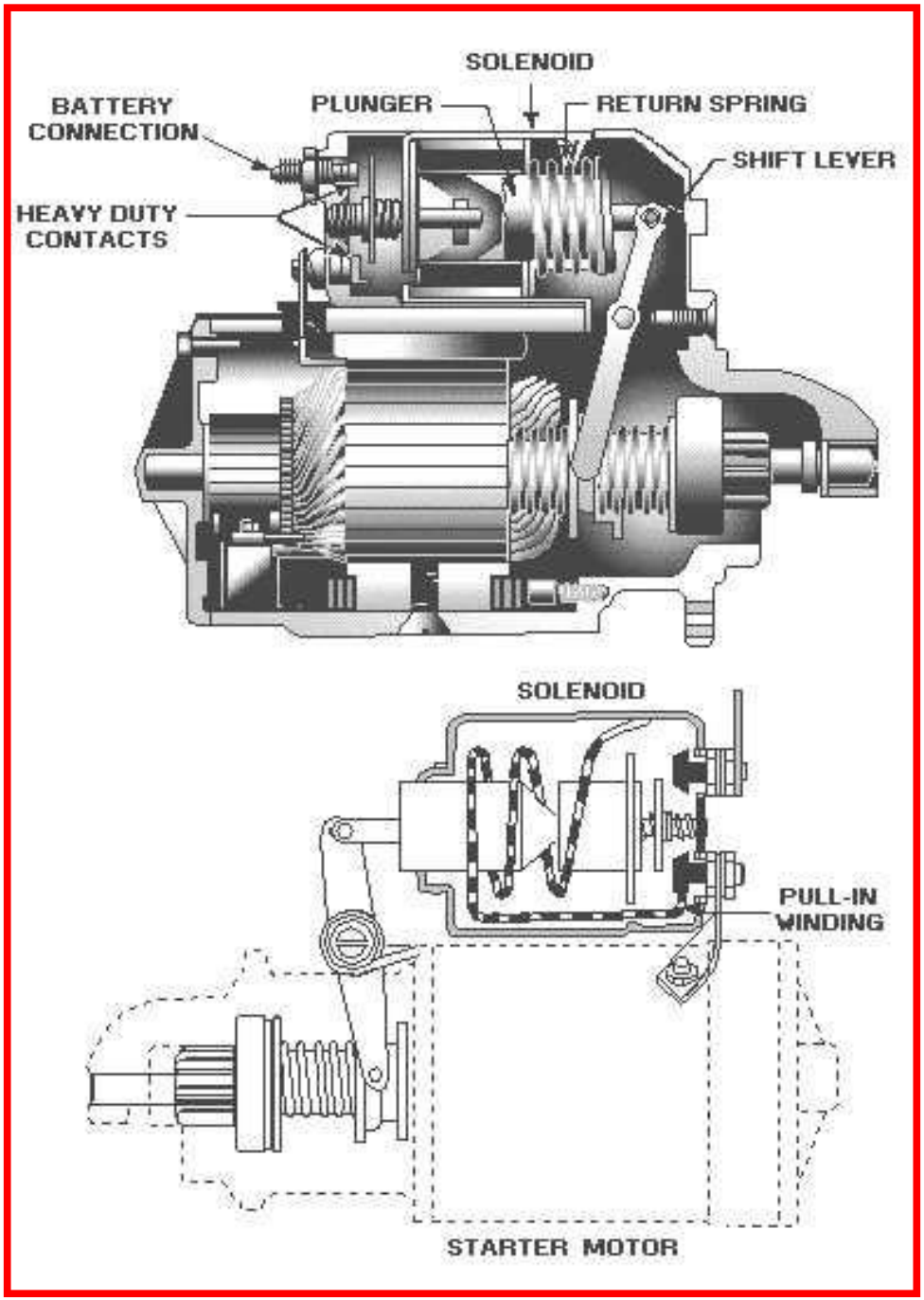




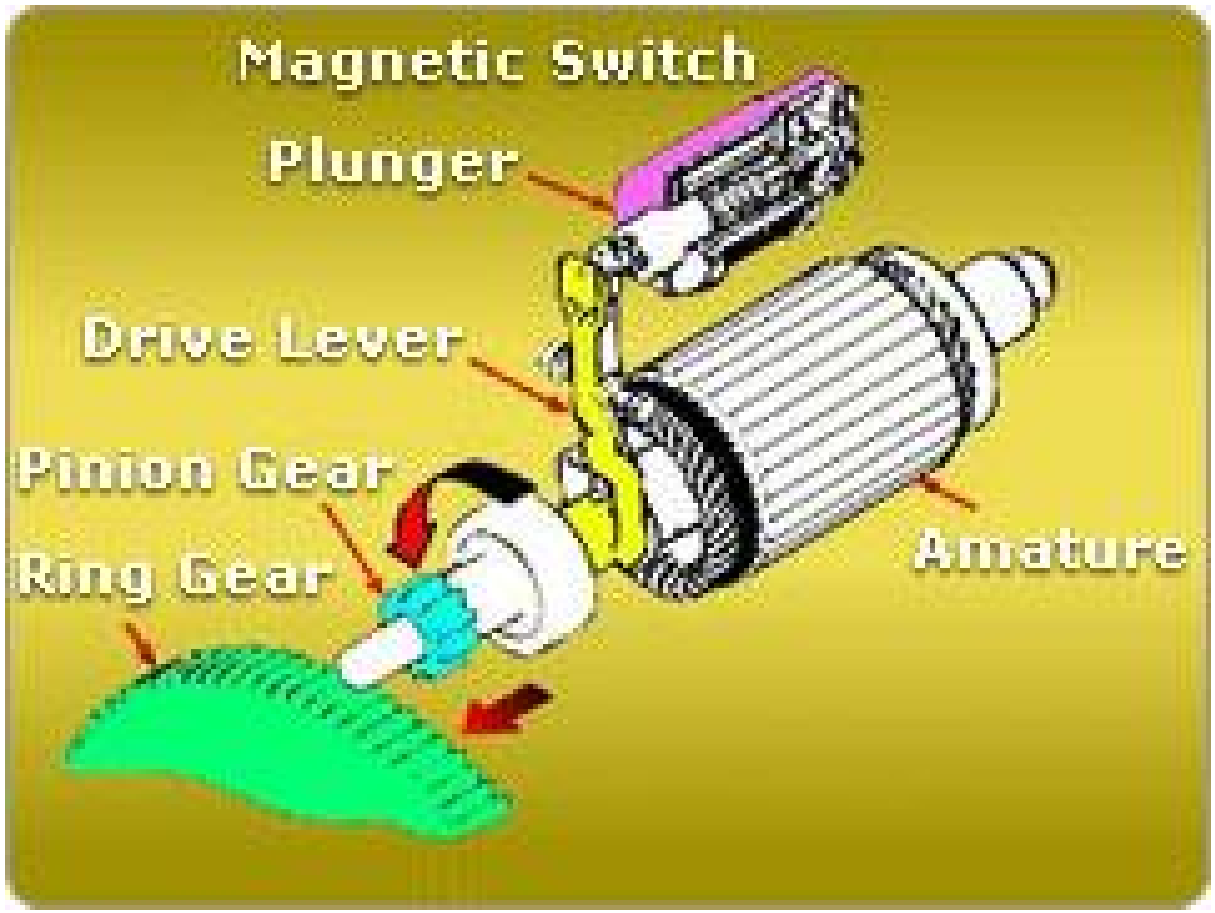
Solenoid may also move a starter drive into mesh with the flywheel ring gear.

Relay doesn't have the plunger or the power to move a starter drive





ATASA 5th Starting Systems & Traction Motor Systems



15 Teeth on Pinion

150 Teeth on Flywheel

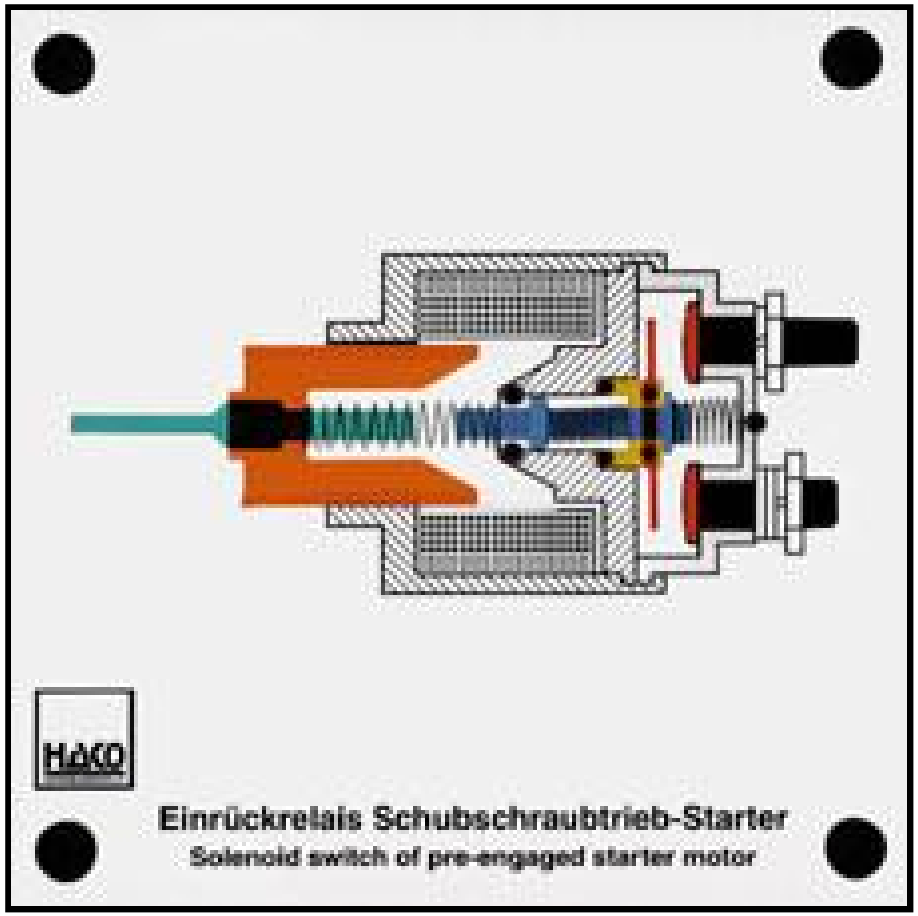
10:1 Gear Reduction

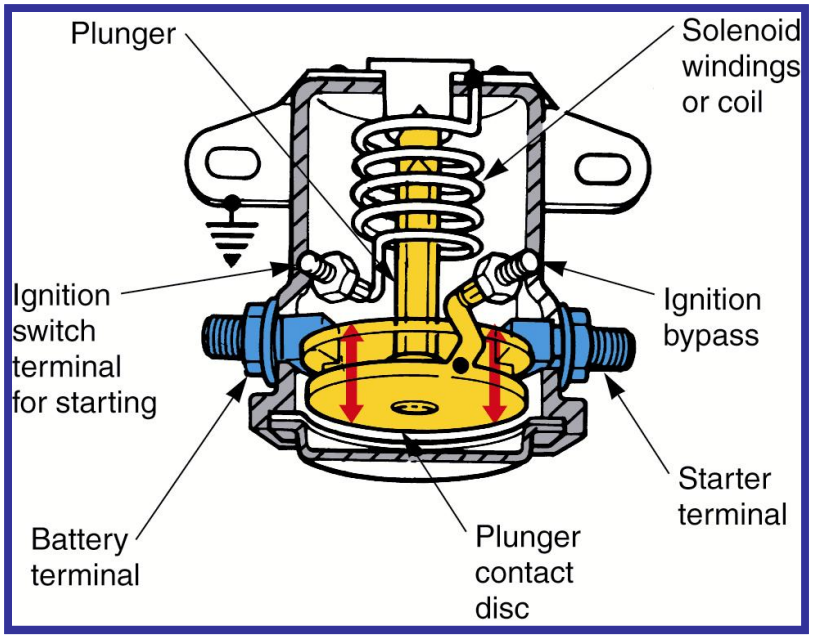
Reduction in Speed
Gain in torque

ATASA 5th Starting Systems & Traction Motor Systems

Note: Solenoids *may have both* a pull-in and a hold-in winding.

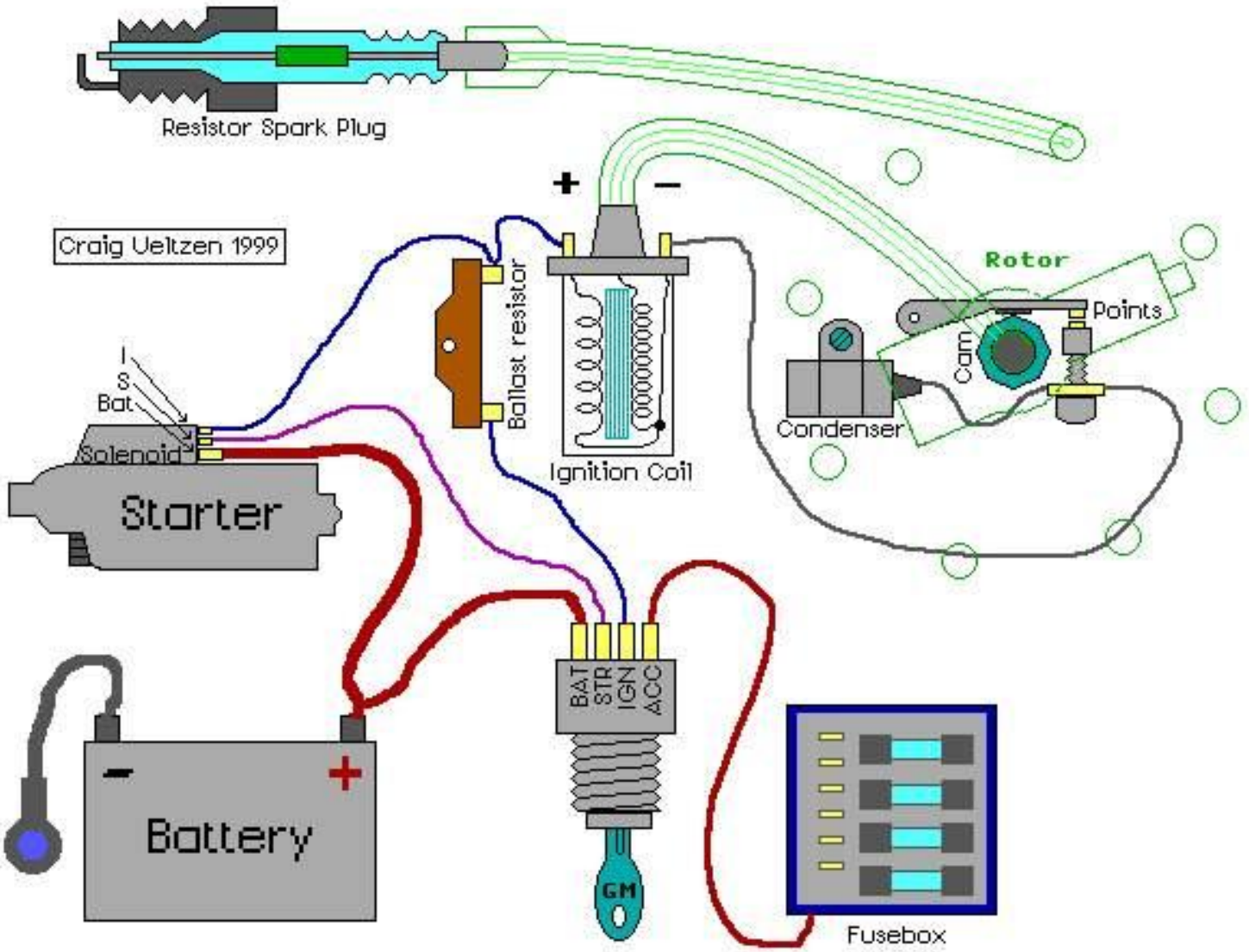
Cranking systems *may use both* a starter relay and a starter solenoid.

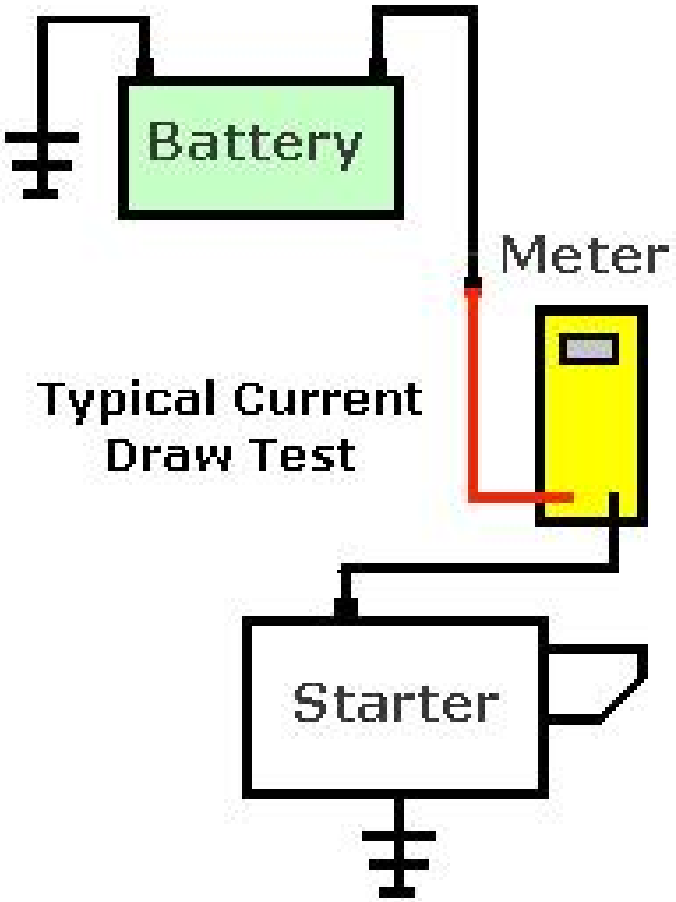


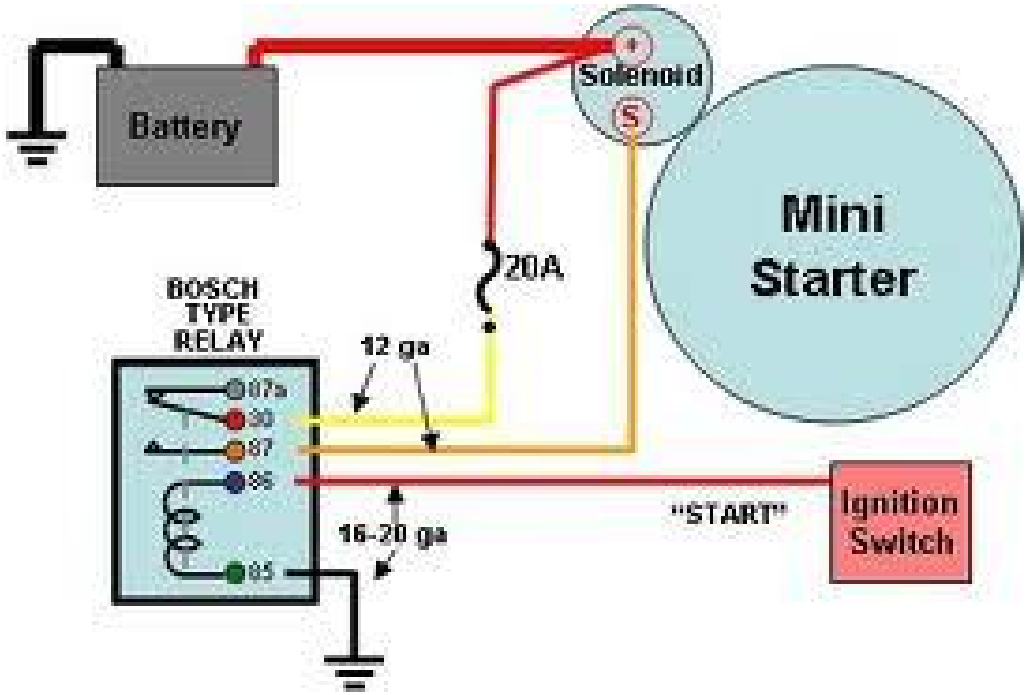


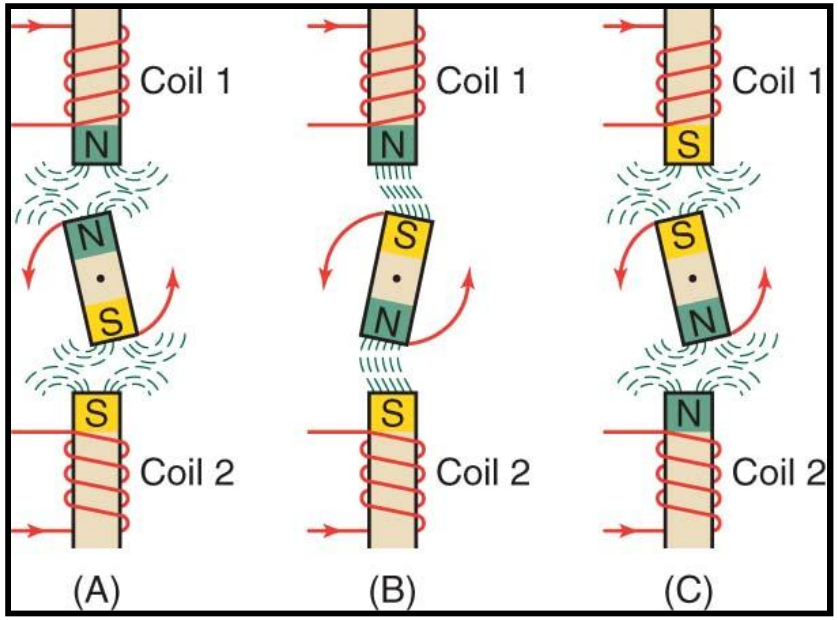
ATASA 5th Starting Systems & Traction Motor Systems

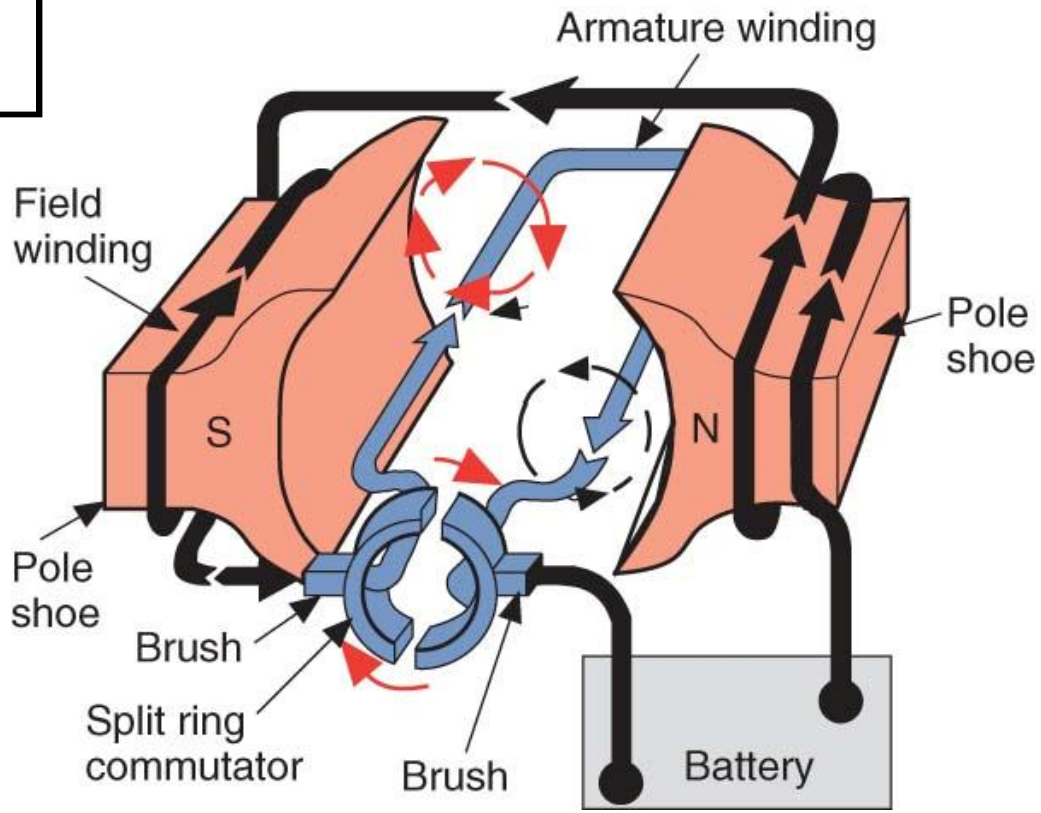
Note: Some solenoids *(older cars)* provide a 12-volt source to the ignition coil during cranking.

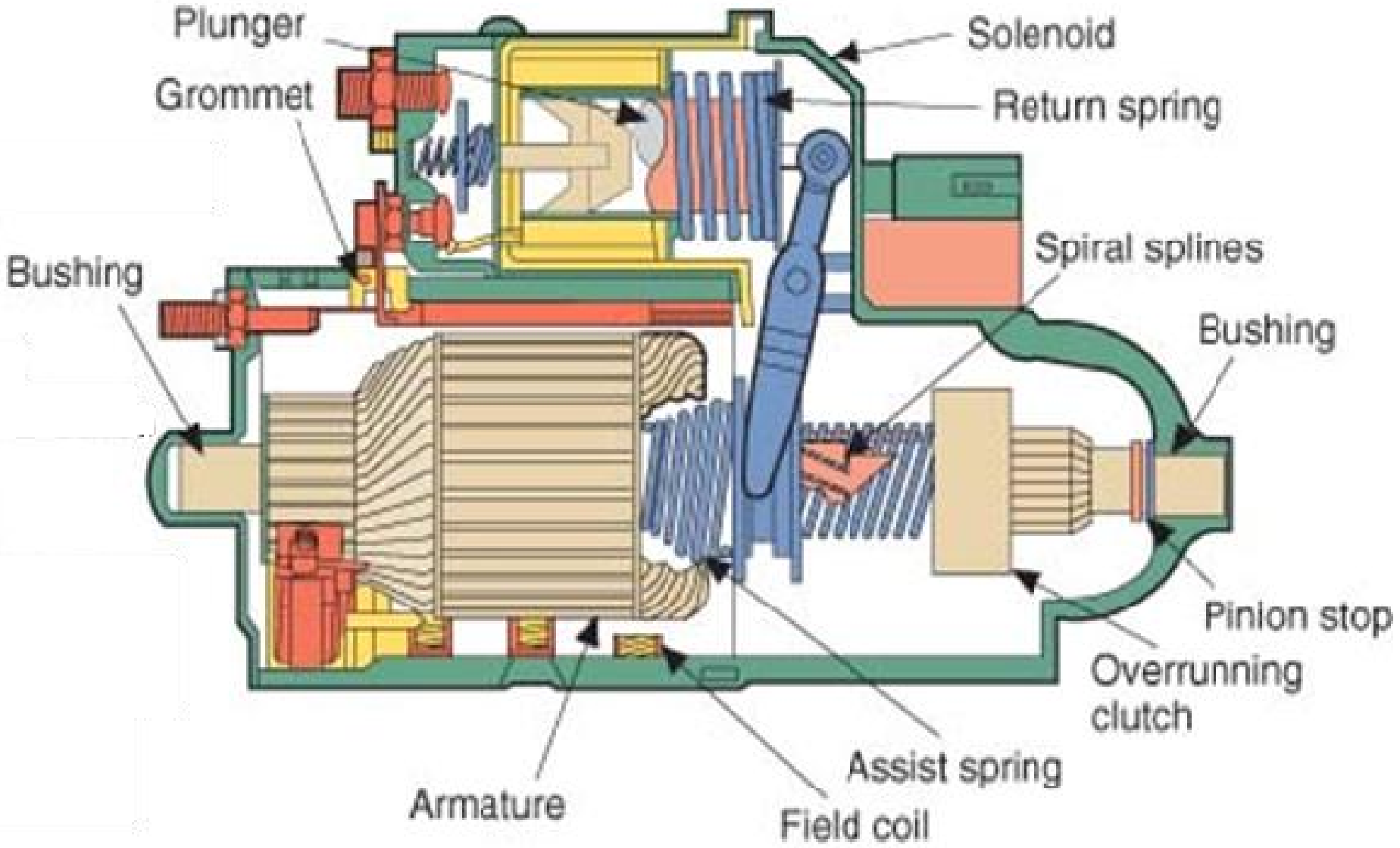


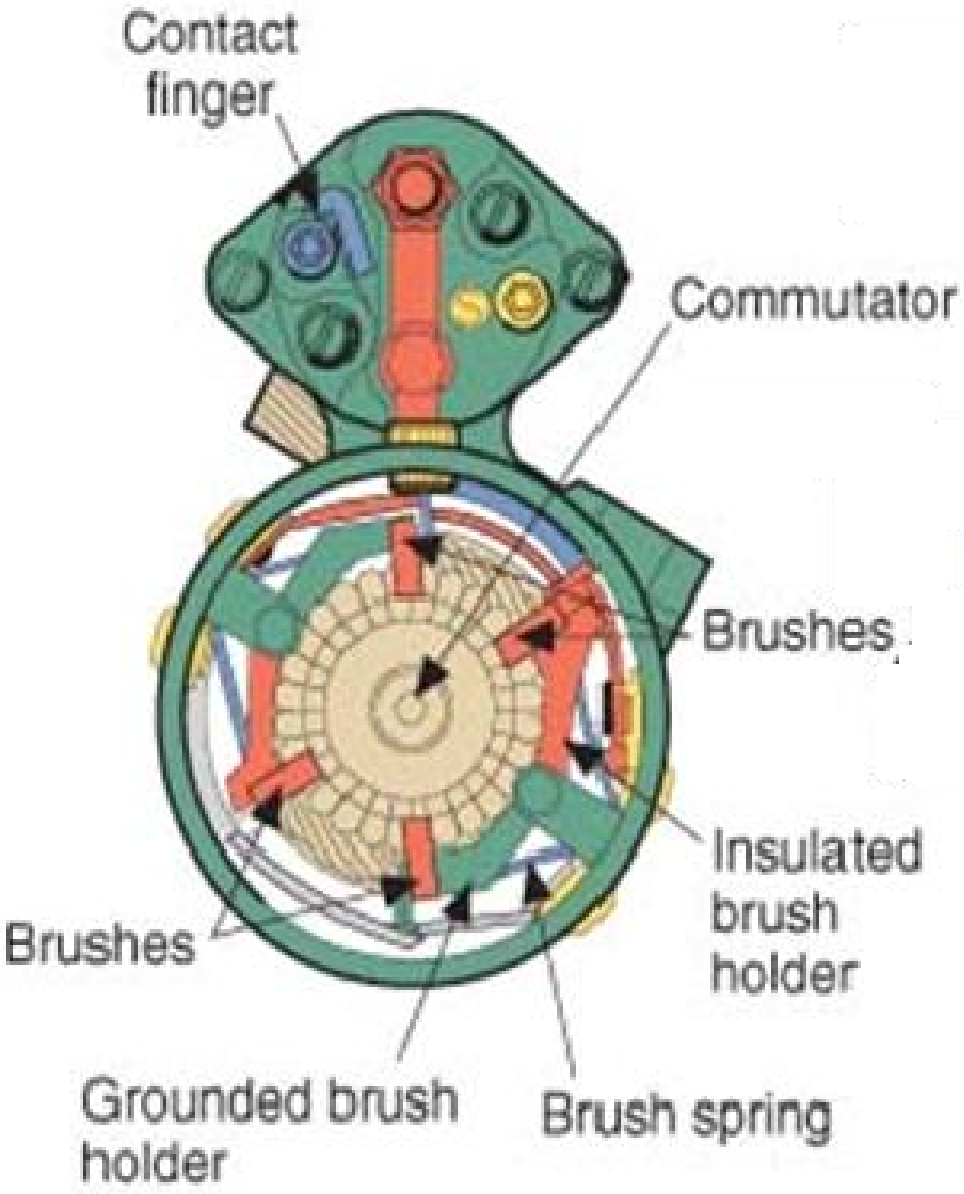

Battery
Meter
Typical Current
Draw Test
Starter


Battery
Solenoid
S
Mini
Starter
20A
BOSCH
TYPE
RELAY
12 ga
87a
30
87
86
85
16-20 ga
"START"
Ignition
Switch

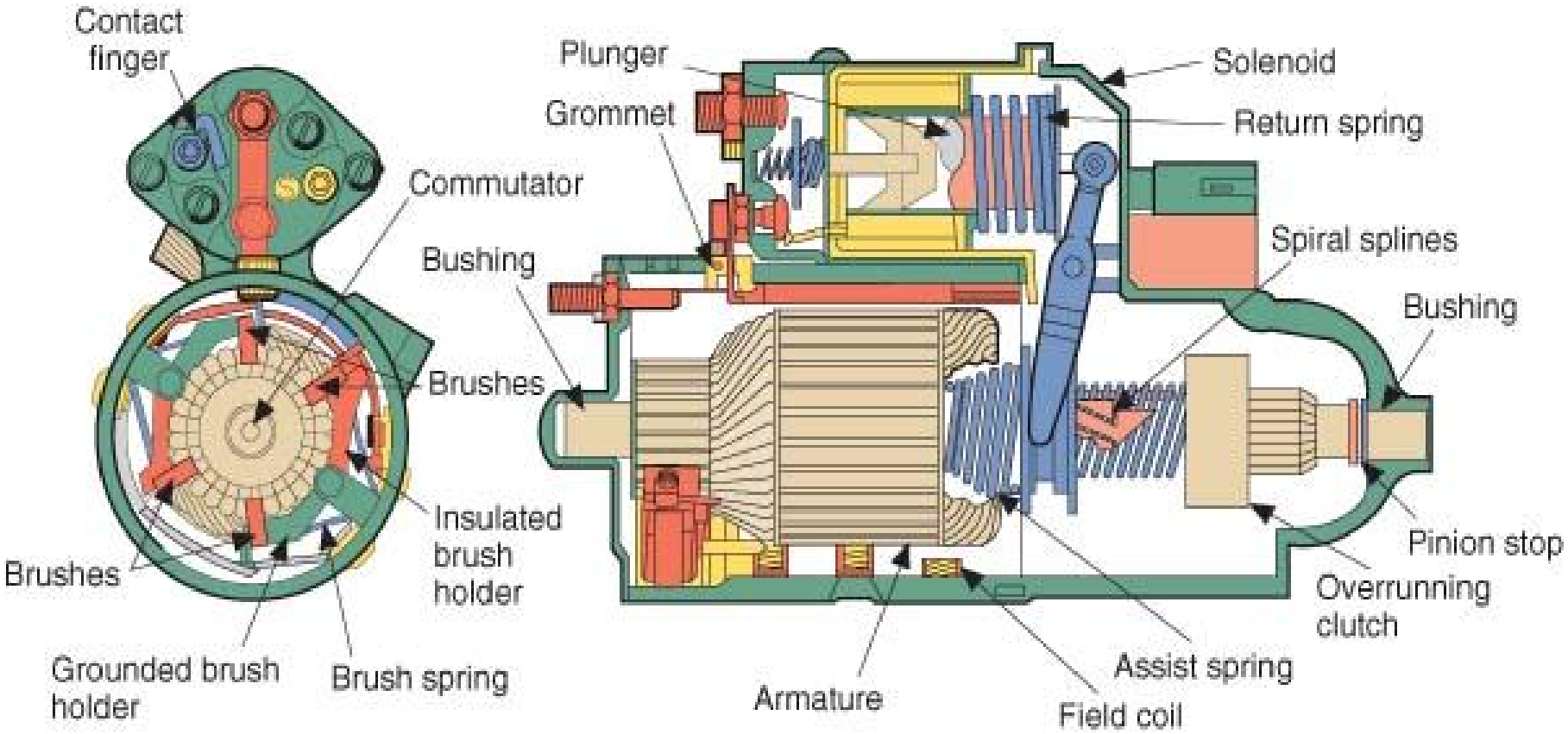

Coil 1
N
N
S
S
Coil 2
(A)
Coil 1
N
S
N
S
Coil 2
(B)
Coil 1
S
S
N
N
Coil 2
(C)

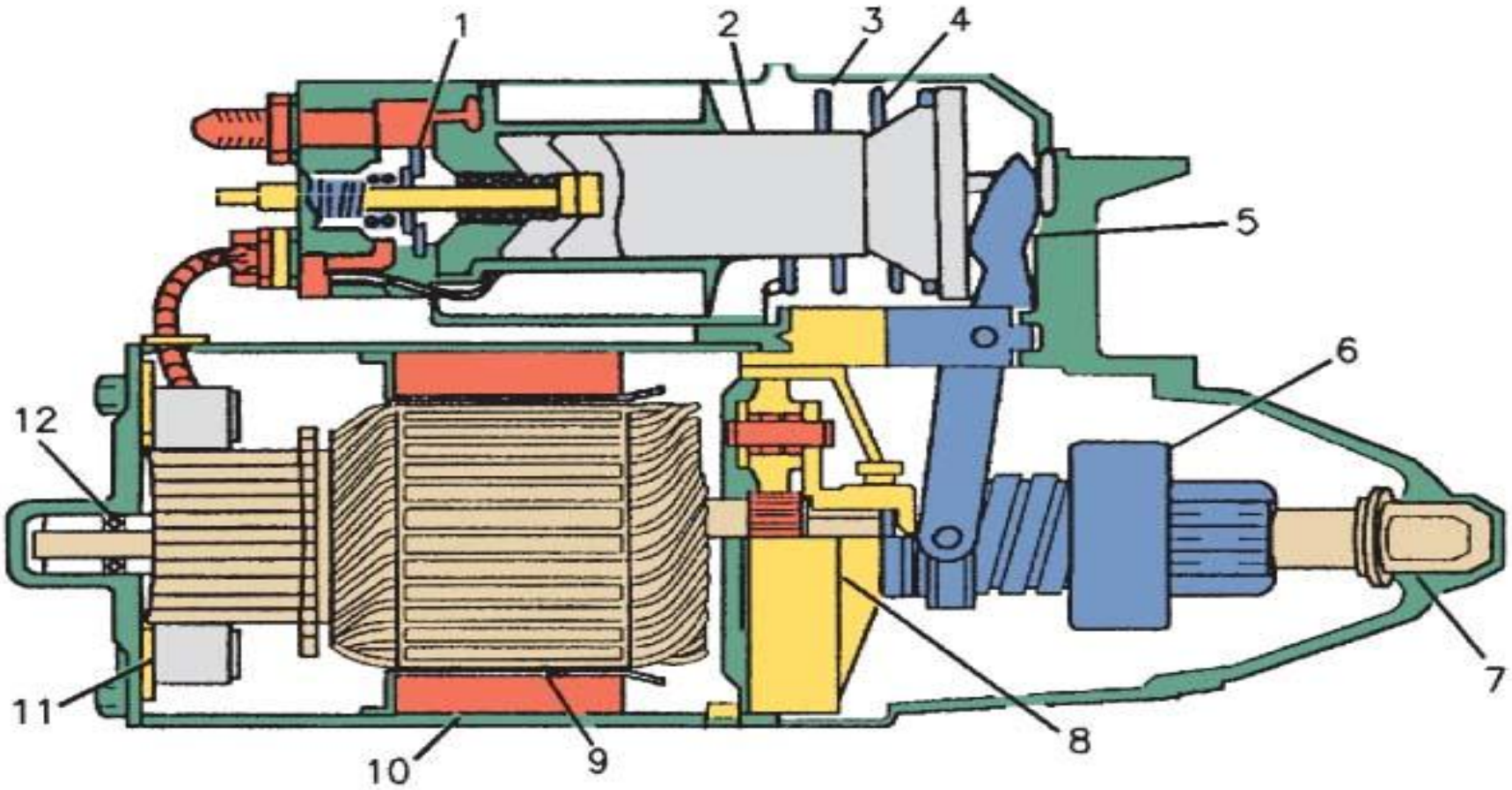

Armature winding
Field winding
Pole shoe
S
N
Pole shoe
Brush
Split ring commutator
Brush
Battery


Plunger
Grommet
Solenoid
Return spring
Spiral splines
Bushing
Bushing
Pinion stop
Overrunning clutch
Assist spring
Armature
Field coil

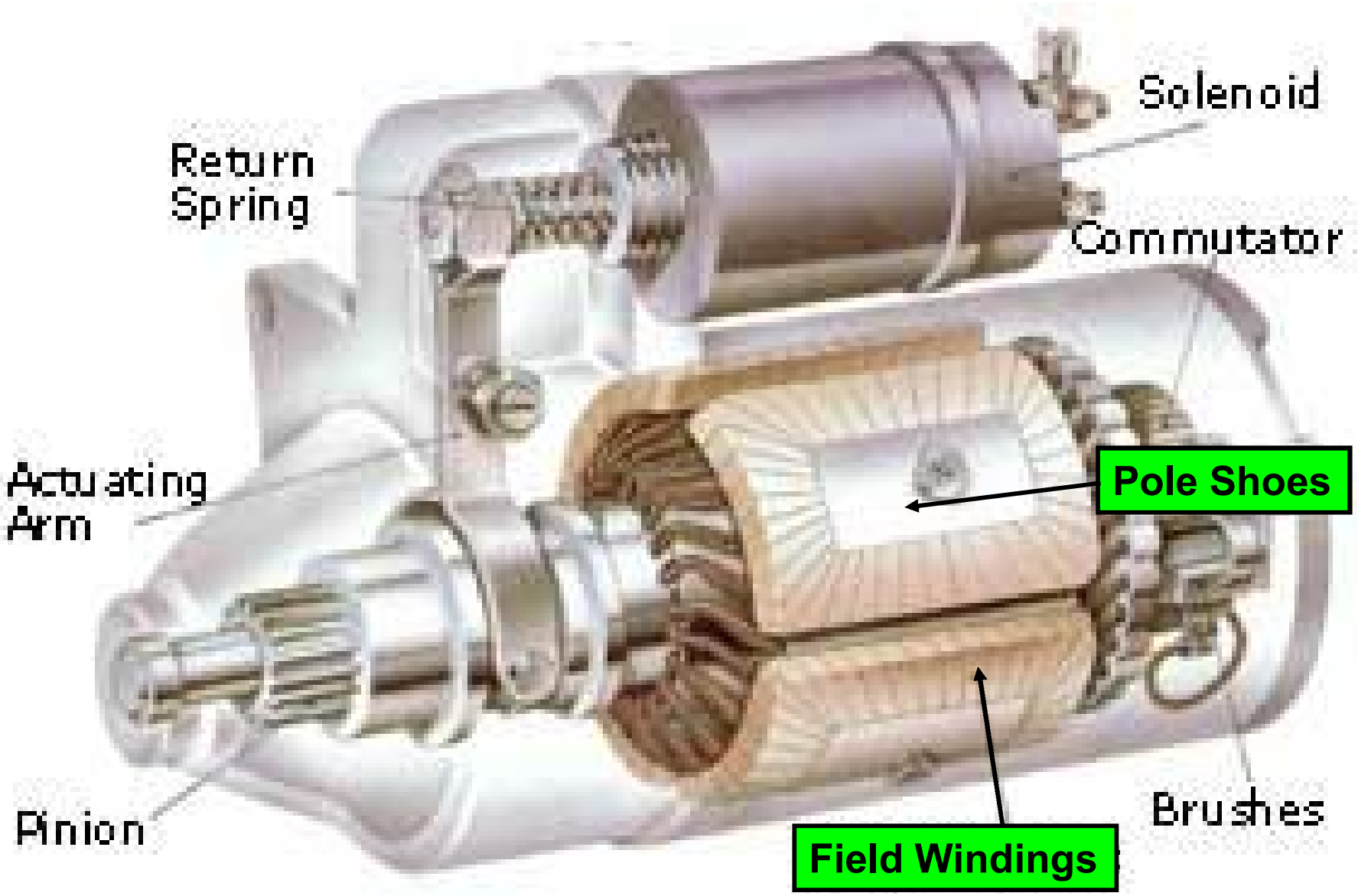

Contact finger
Commutator
Brushes
Insulated brush holder
Brushes
Grounded brush holder
Brush spring

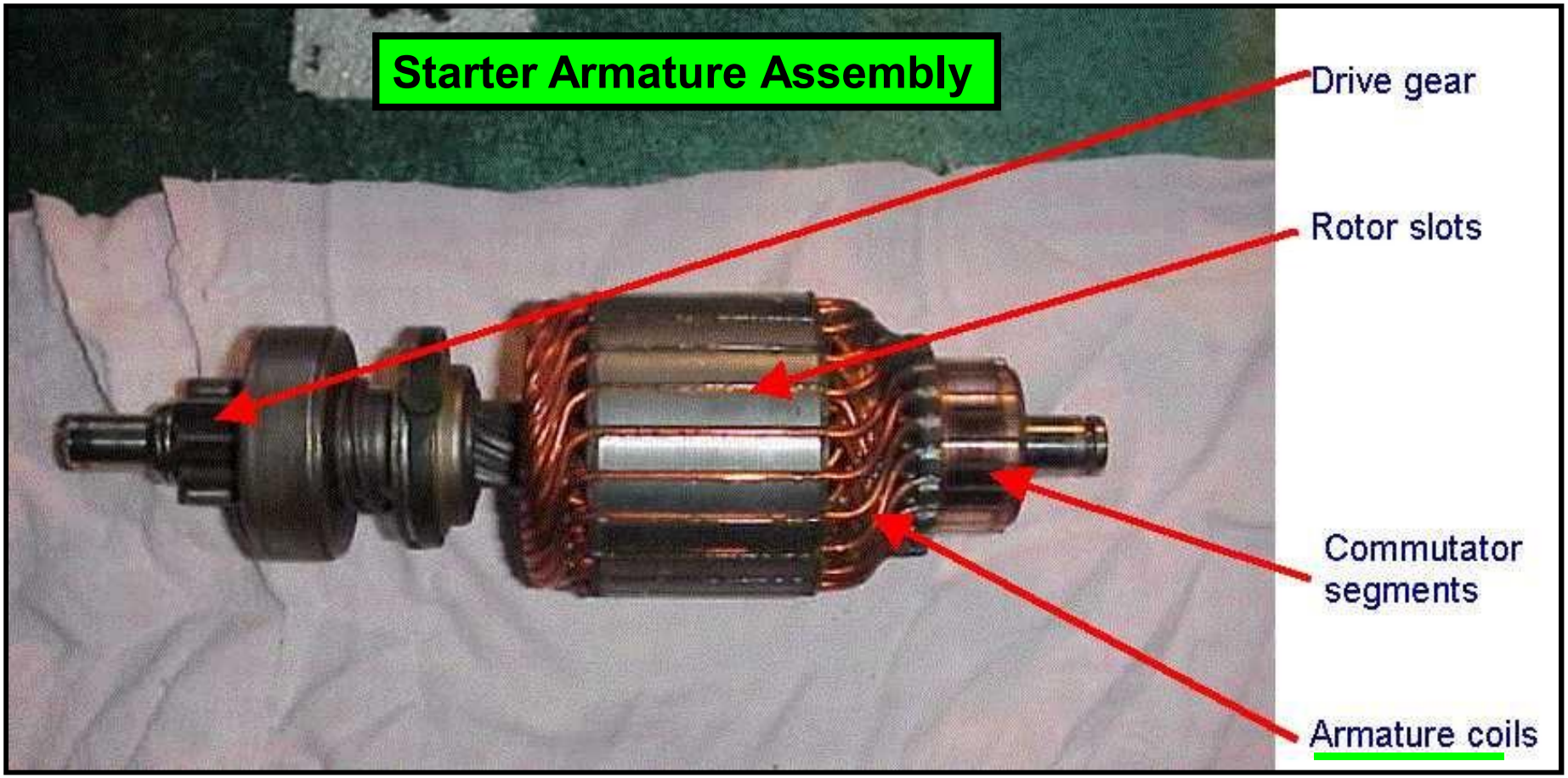
ATASA 5th Starting Systems & Traction Motor Systems



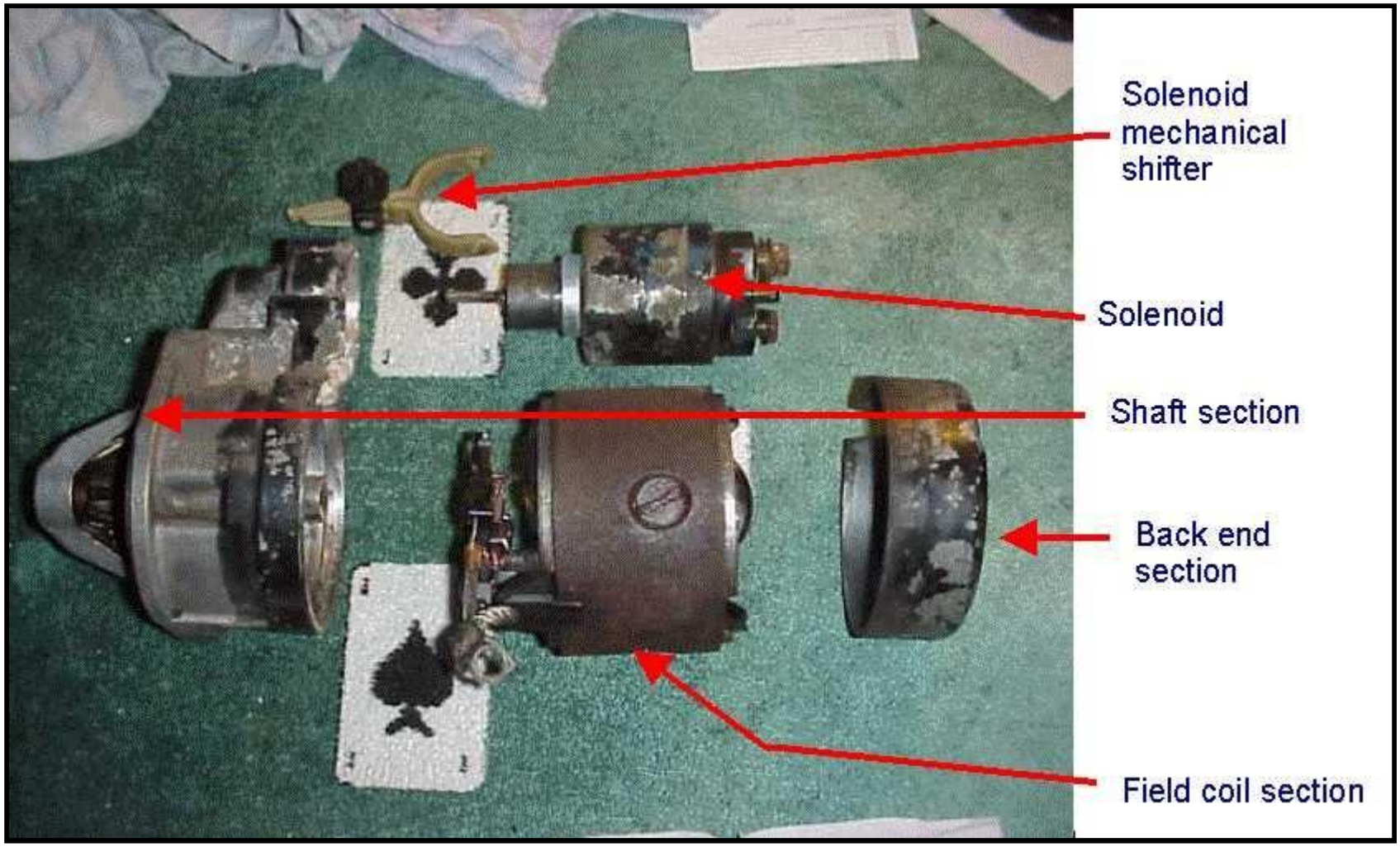


1 CONTACT DISC
2 PLUNGER
3 SOLENOID
4 RETURN SPRING
5 SHIFT LEVER
6 DRIVE ASSEMBLY
7 ROLLER BEARING
8 PLANETARY GEAR REDUCTION ASSEMBLY
9 ARMATURE
10 PERMANENT MAGNETS
11 BRUSH
12 BALL BEARINGS

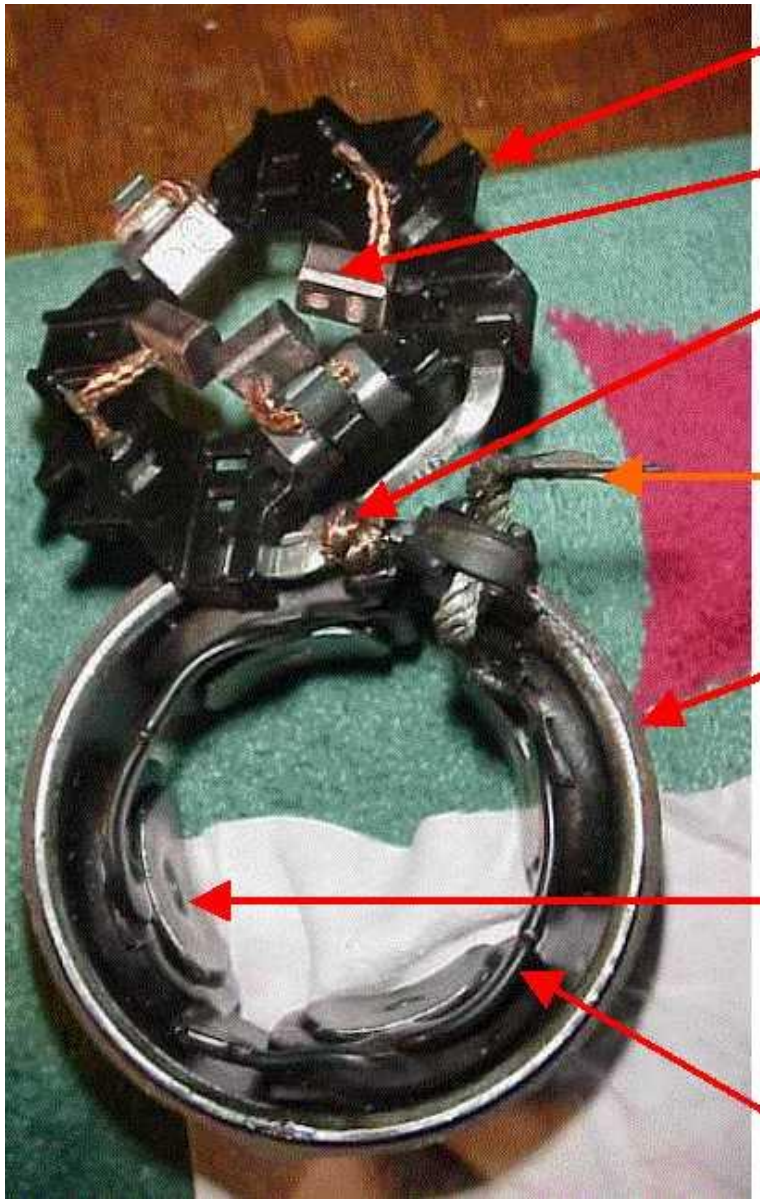

Solenoid
Return Spring
Commutator
Actuating Arm
Pole Shoes
Pinion
Field Windings
Brushes


Starter Armature Assembly
Drive gear
Rotor slots
Commutator segments
Armature coils

Note: The starter motor has both a drive end <u>frame</u> *(casting)* and a <u>brush</u> end frame *(metal cap).*



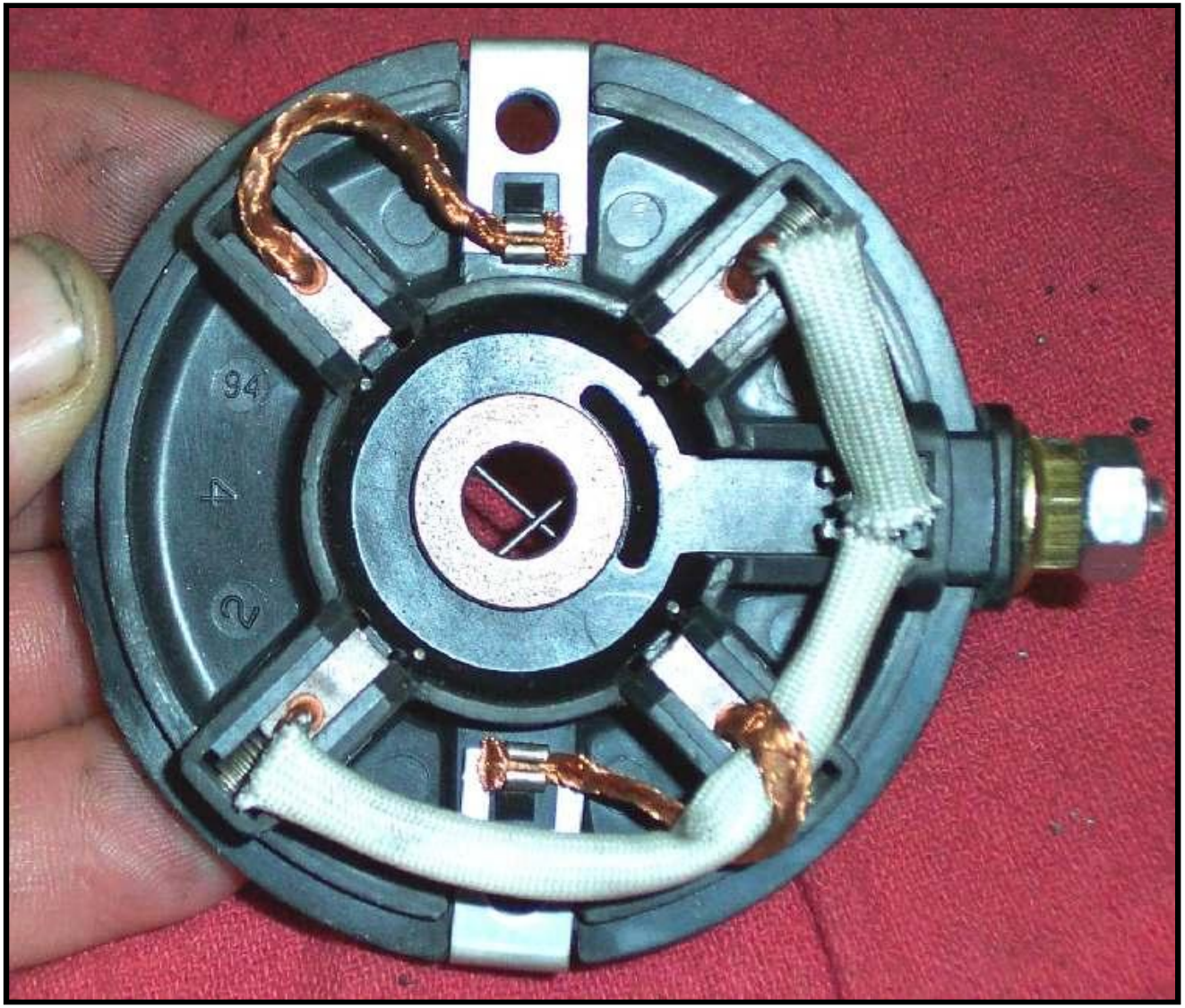
ATASA 5th Starting Systems & Traction Motor Systems



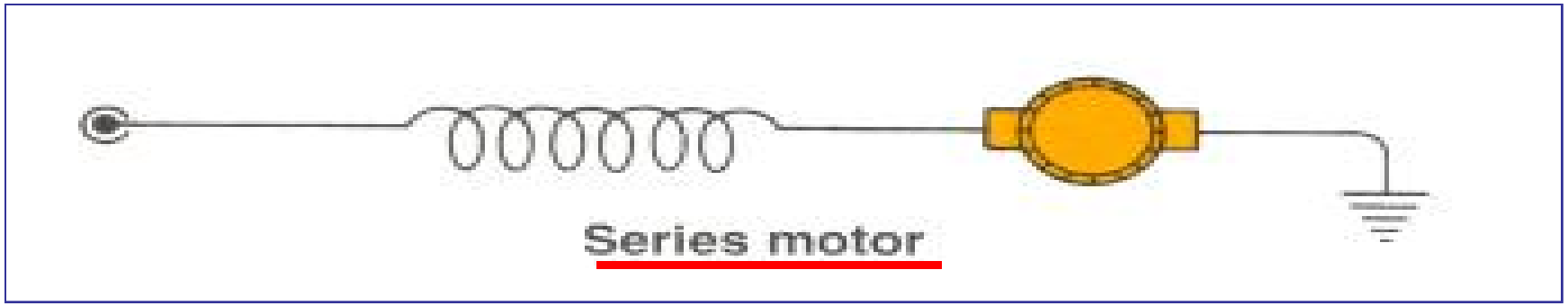
The stationary magnetic fields the field windings repel the armature windings to create rotary motion.

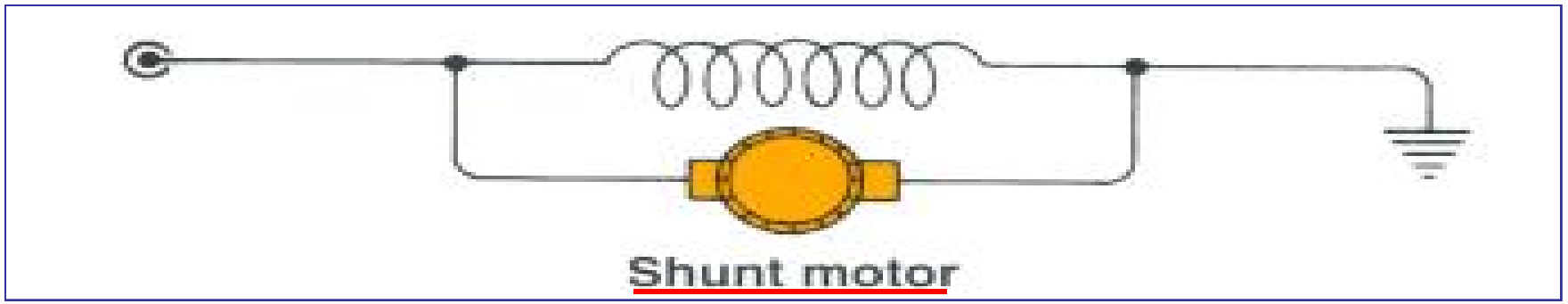
Note: The slower a starter motor turns, the more current it will draw *(CEMF).*

Copper Brushes are used to carry lots of amps with very little resistance.



Note: Series -wound motors develop maximum torque at startup. Shunt or parallel-wound motors develop less torque at start-up but maintain a constant speed at all operating loads.

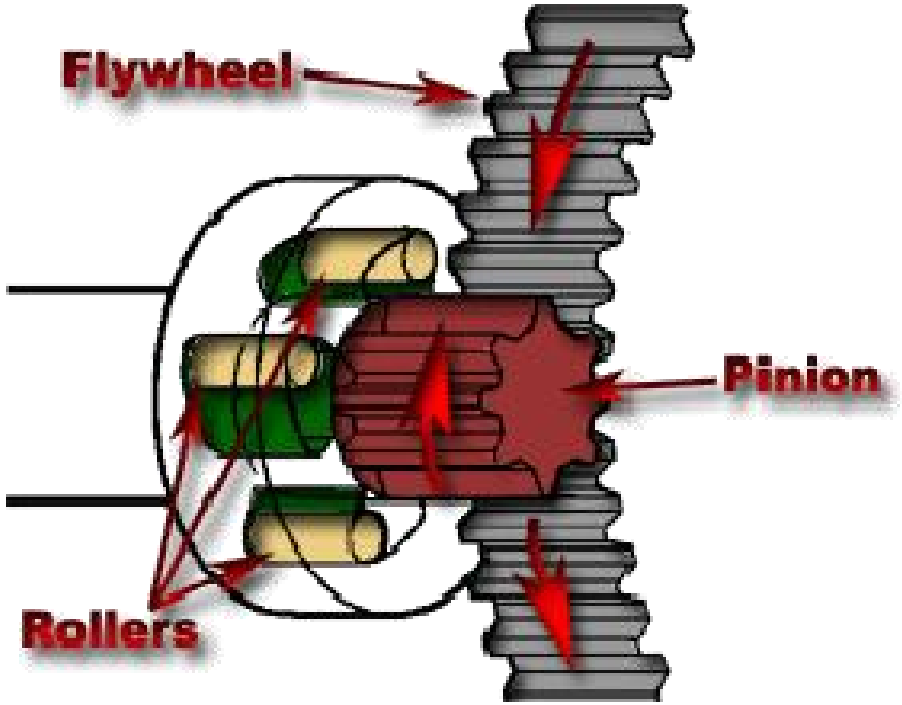


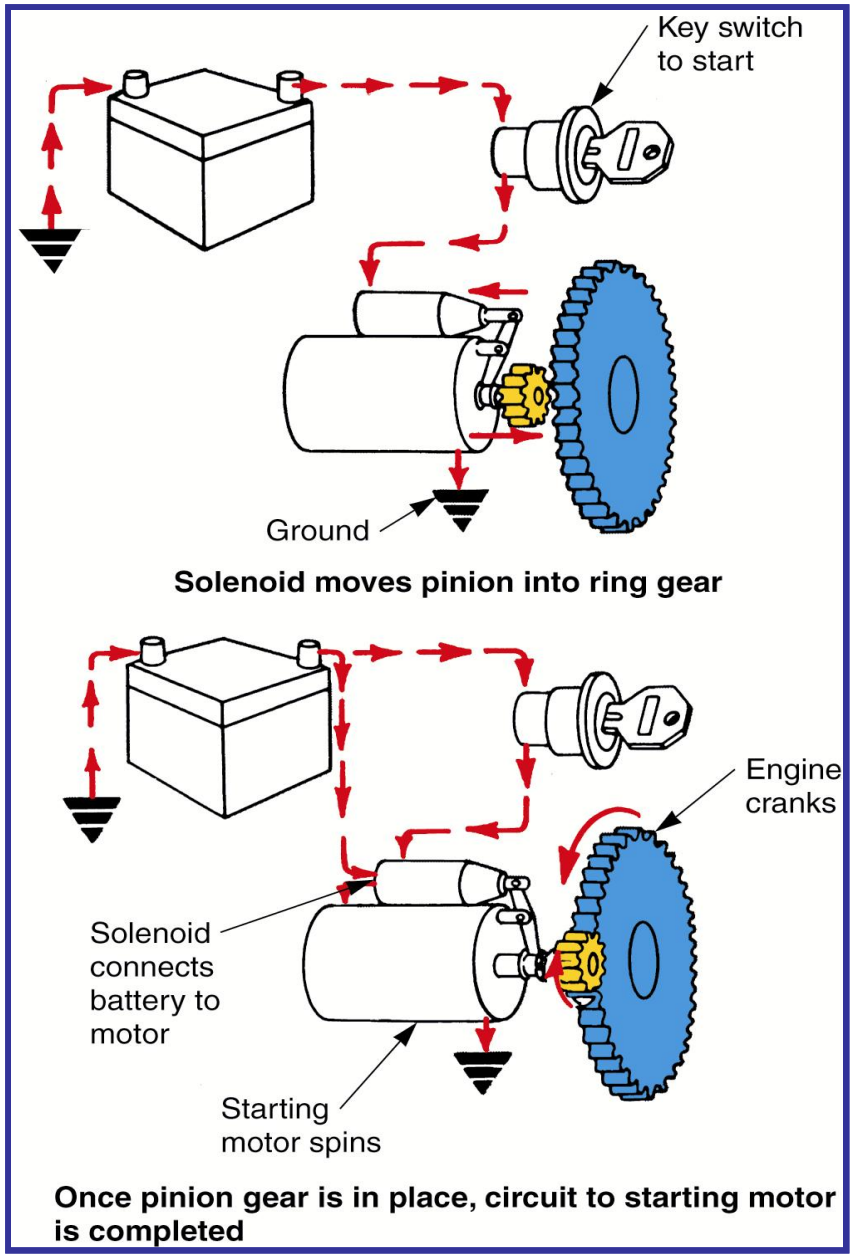


ATASA 5th Starting Systems & Traction Motor Systems

The starter drive pinion gear meshes with the flywheel or flex plate ring gear to provide the necessary gear reduction to crank the engine.

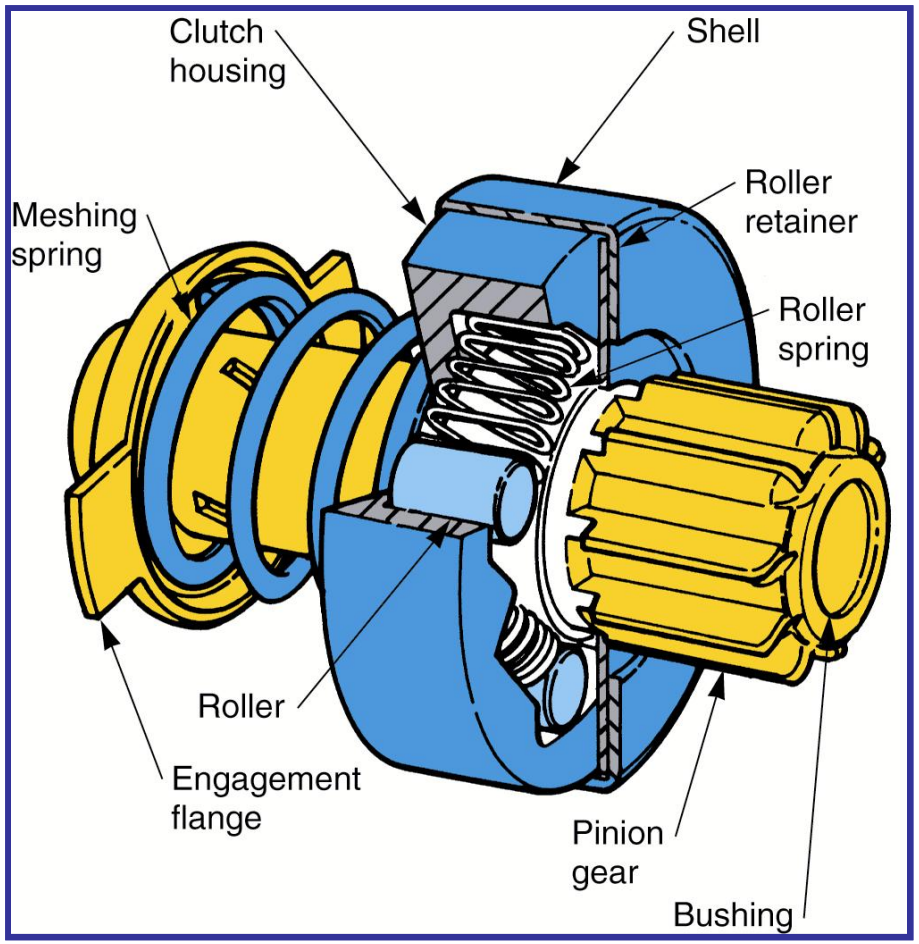
Ratio is greater than 1:1 with a gain in torque & a loss of speed

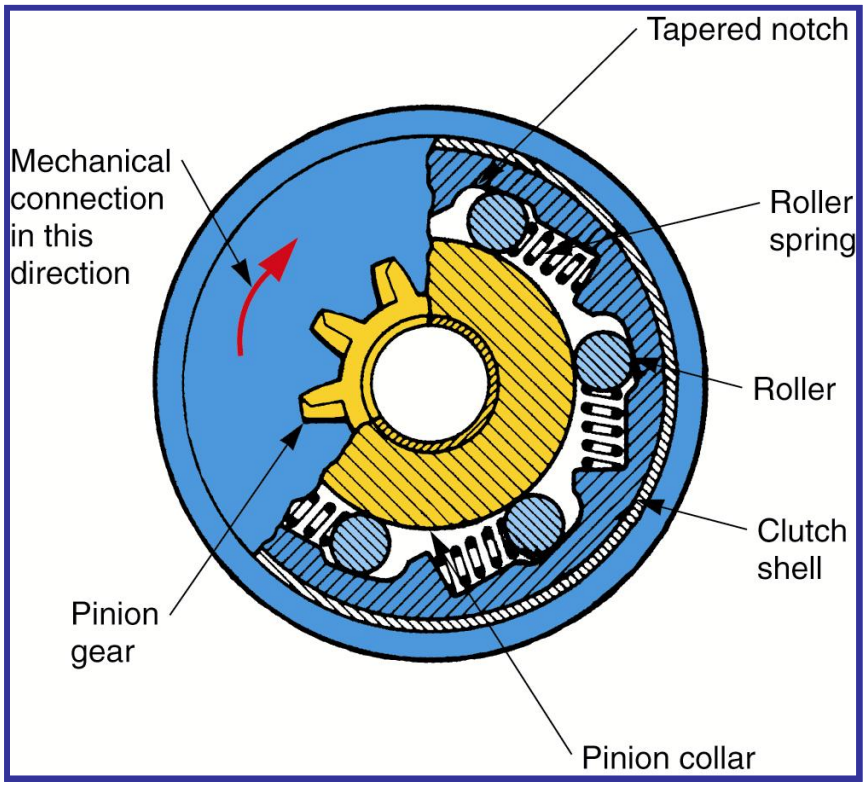




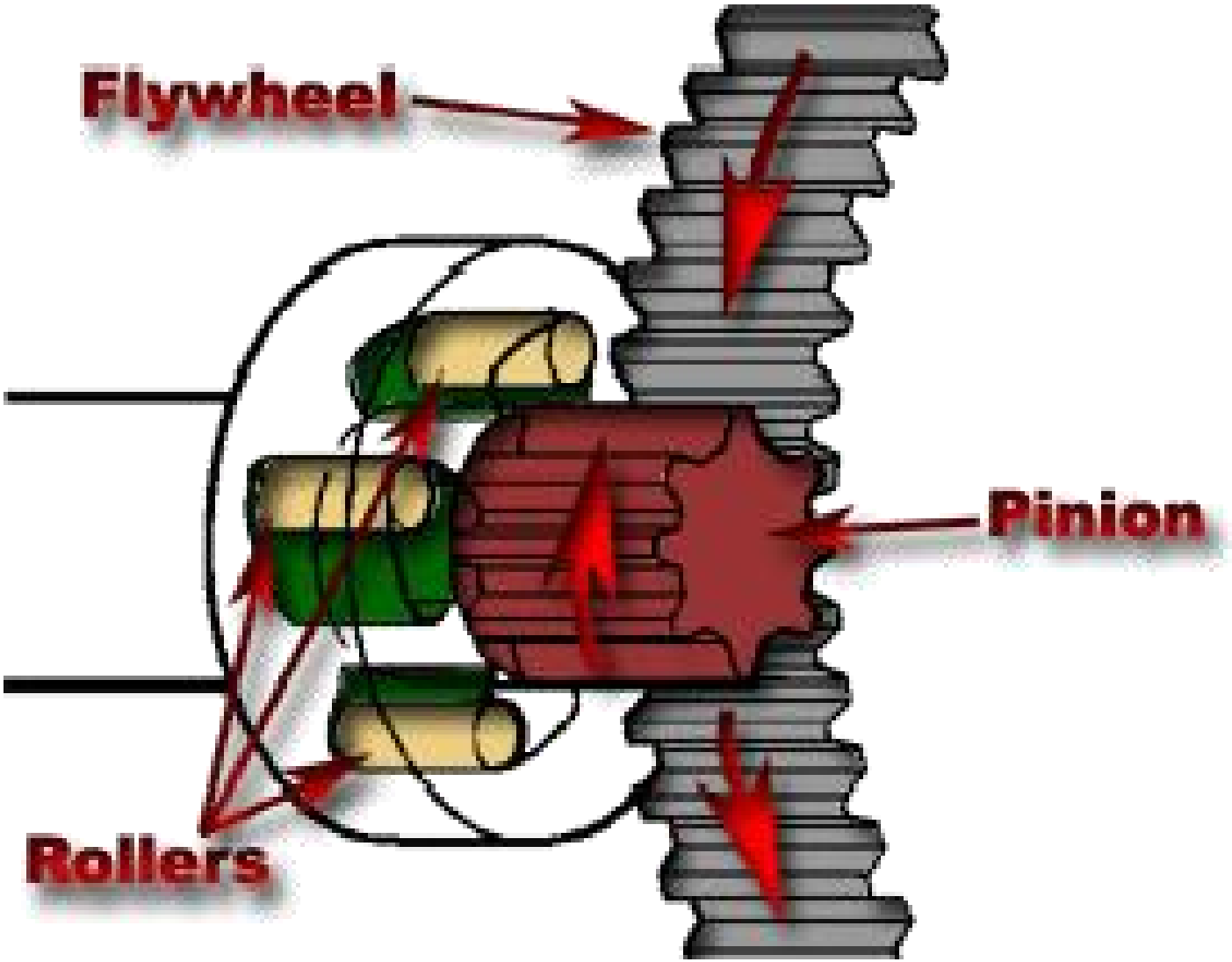
25. To prevent the pinion gear from driving the armature at engine speed an _____ clutch is built into the starter drive mechanism.

One-Way Overrunning Roller



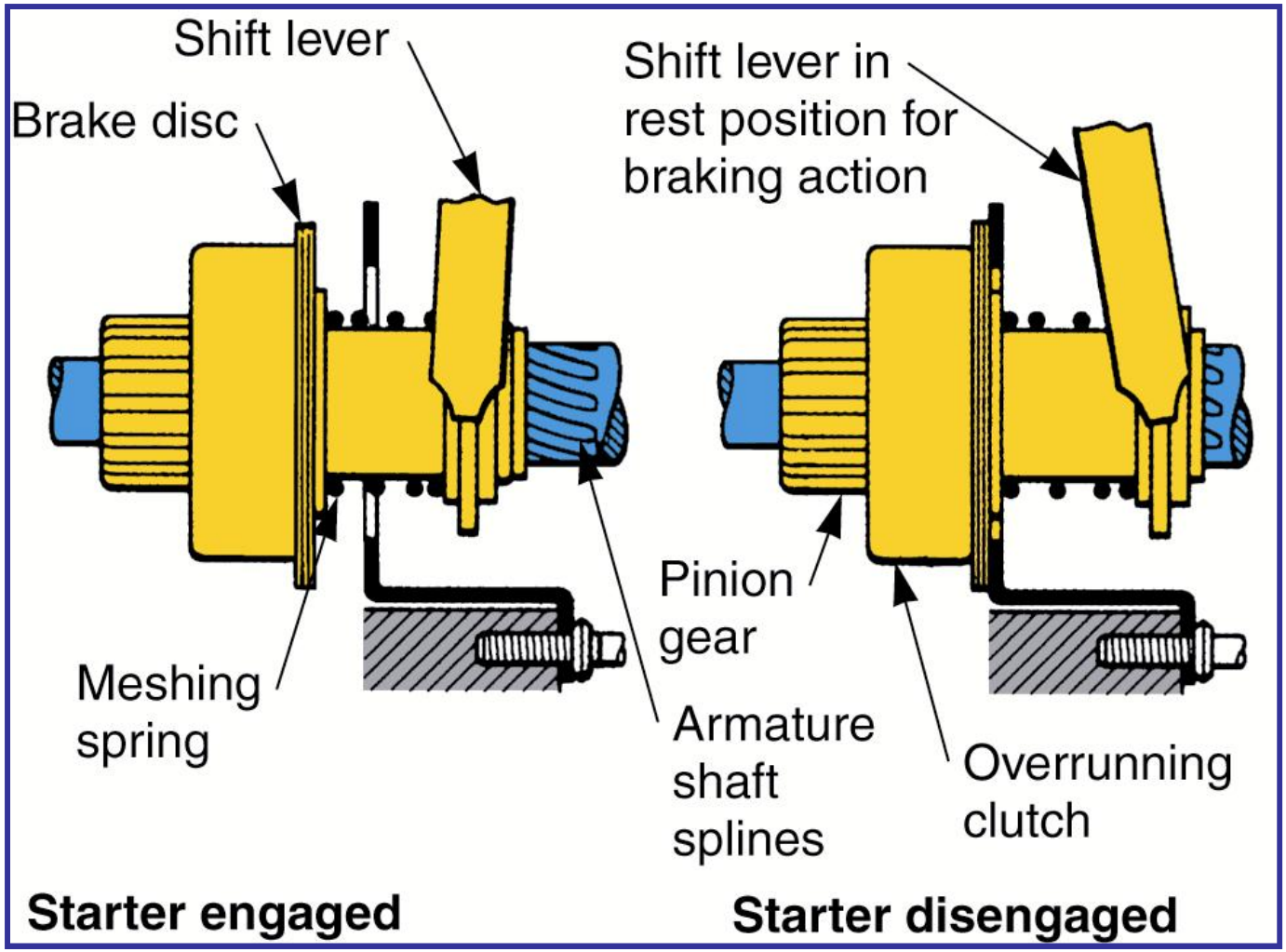


26. Starter drive-to-ring gear ratio is a gear reduction to provide a torque increase. ***True or False***

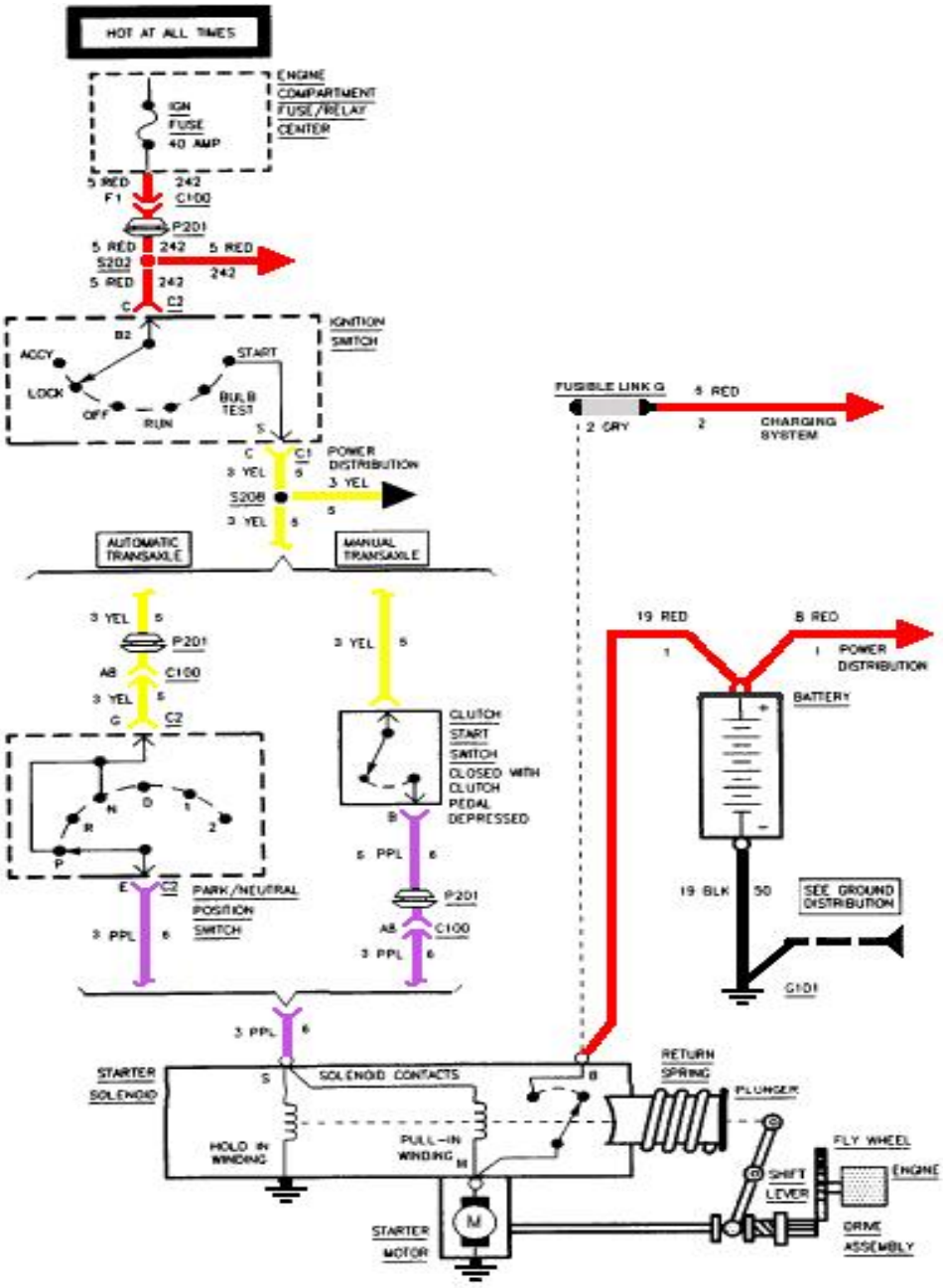


Note: The starter drive fork or lever and the solenoid spring are responsible for pulling the pinion out of engagement after cranking.

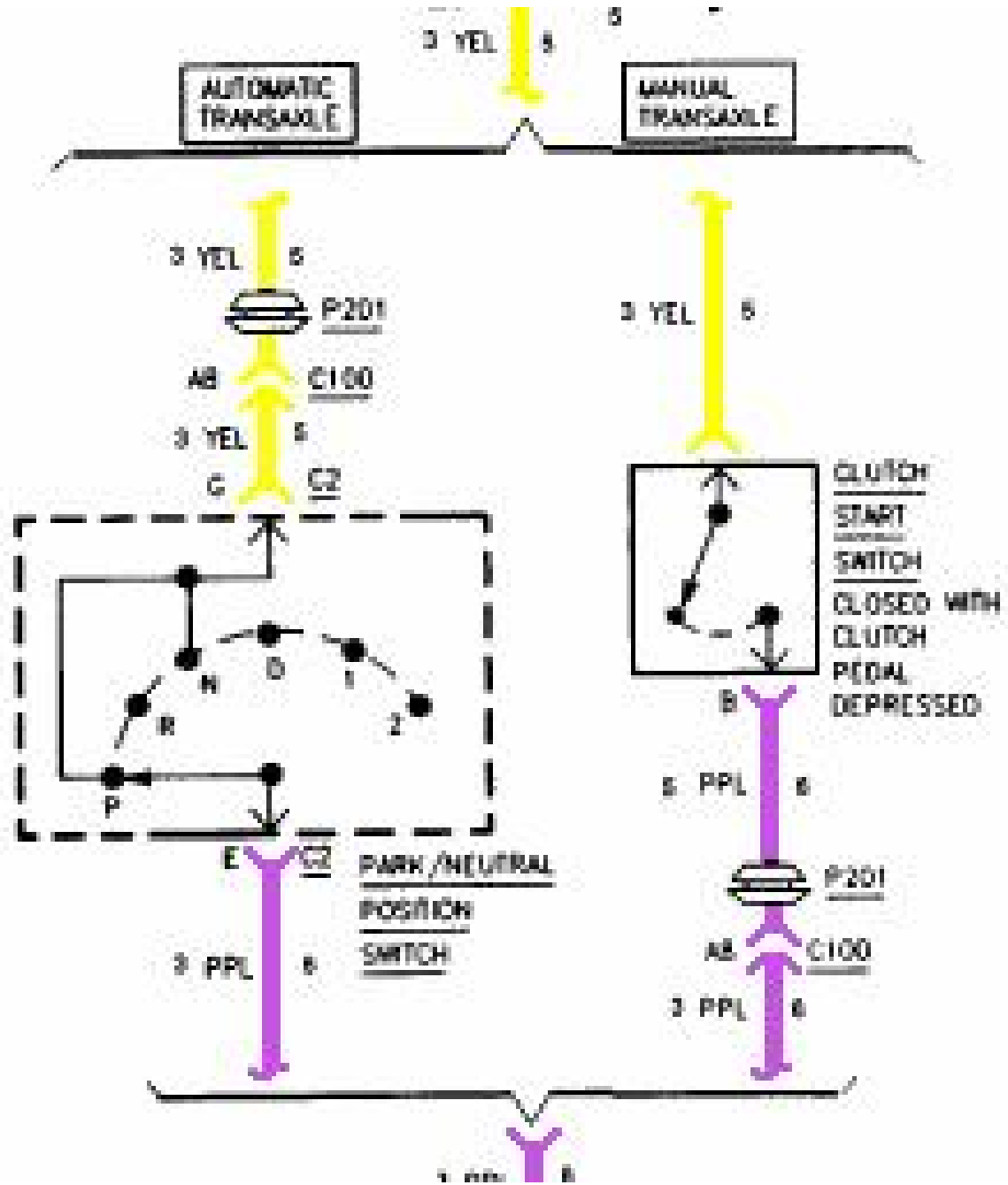
15:1 is the approximate starter pinion : flywheel ring gear ratio



27. The *starting safety switch* allows the <u>control circuit to be energized only if</u> the *automatic trans* is in either the _____ or _____ position and only if the *manual transmission* has the clutch pedal fully pushed to the floor to disengage the transmission from the engine.



1st or 2nd
Park or Neutral
Park or Reverse


3 YEL 5
AUTOMATIC TRANSAXLE
MANUAL TRANSAXLE
3 YEL 5
P201
A8 C100
3 YEL 5
C C2
3 YEL 5
CLUTCH START SWITCH
CLOSED WITH CLUTCH PEDAL DEPRESSED
N
D
1
2
R
P
B
5 PPL 6
E C2 PARK/NEUTRAL POSITION SWITCH
P201
A8 C100
3 PPL 6
3 PPL 6

28. Perform a _____ load test before performing any starting system tests. *Note: Loose or dirty connections will cause excessive voltage drops in the motor feed circuit.*

Battery Parasitic Accessory

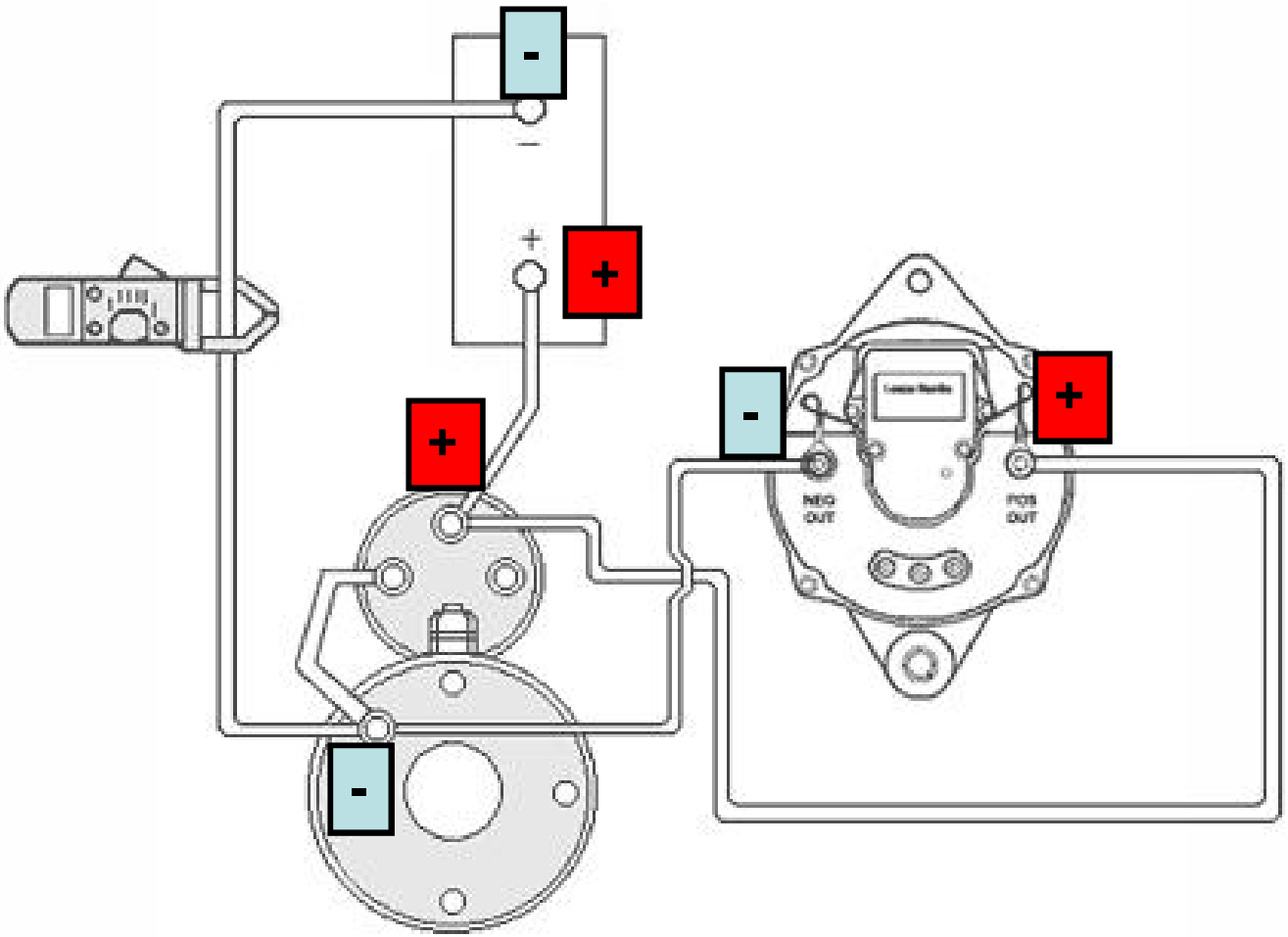
29. Battery volts should not drop below _____ volts during the 15 seconds of cranking voltage test.

12.0 volts
9.6 volts
3.0 volts

30. Cranking current *(amperage)* should be between <u>100-250 amps</u> for most gas engines. *True or False*

31. A <u>voltage drop</u> test of both the _____ side (+ to+) and the ground side (- to -) of the motor feed circuit should show between 0.2 to 0.6 volts if the battery/starter cables are in good condition.

Uninsulated
Insulated
Resistive

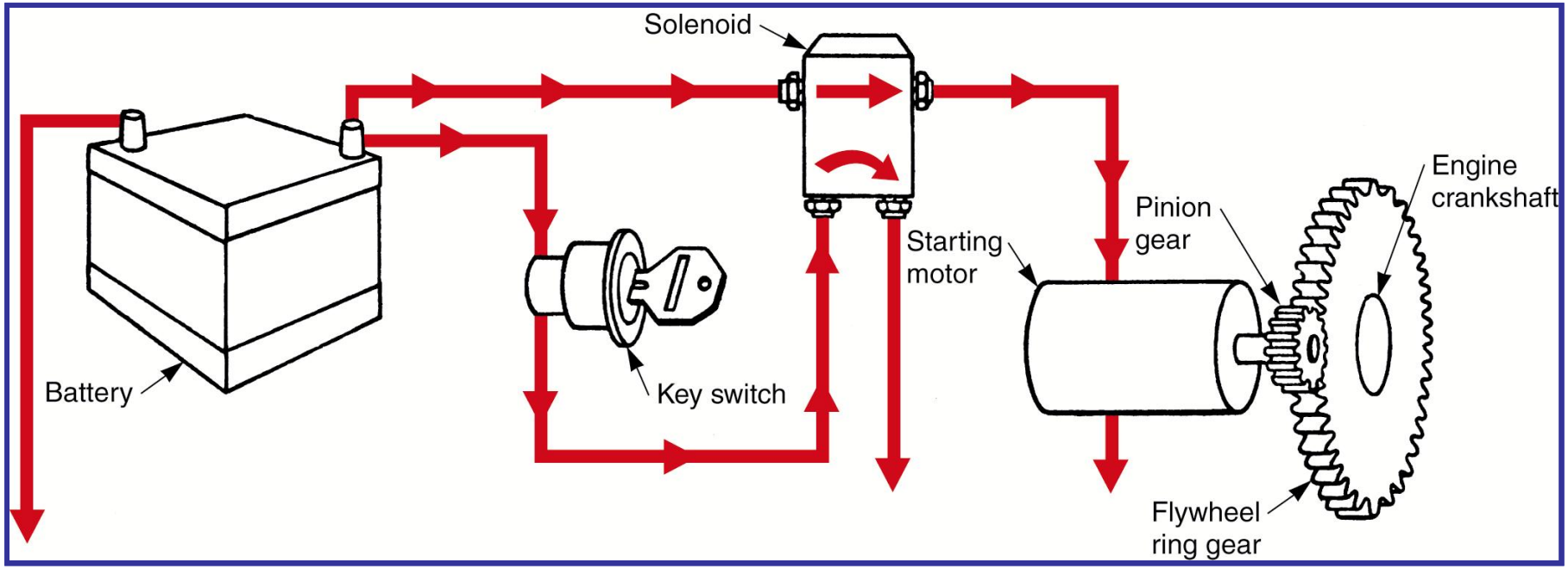


32. <u>Starter solenoids can be by-passed</u> or *jumped* to verify their condition.
True or False

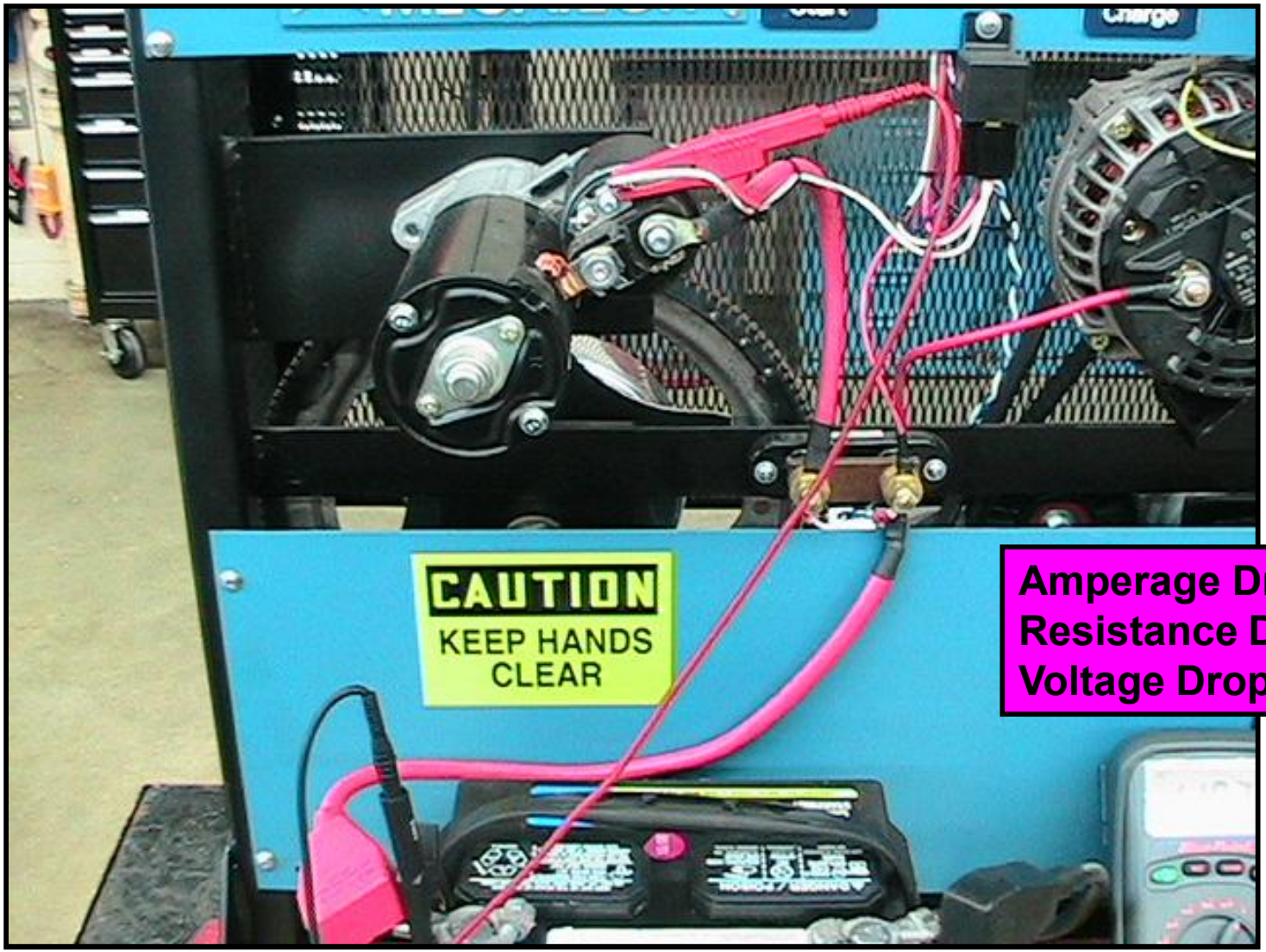
Typical Ignition Switch & Starter Circuit

Battery → Ignition Switch → Park/Neutral Safety Switch → Brake Pedal Safety Switch or Clutch Pedal Safety Switch → Starter Solenoid or Relay → Starter Motor

33. <u>Ignition switches can be by-passed</u> or *jumped* to verify their condition. ***True or False***



34. Even the low amps, control circuit can be _____ _____ (+ to +) tested *during cranking* to determine the condition *(resistance)* of the wiring. *Good, low amps circuits should be under 0.2 VD.*



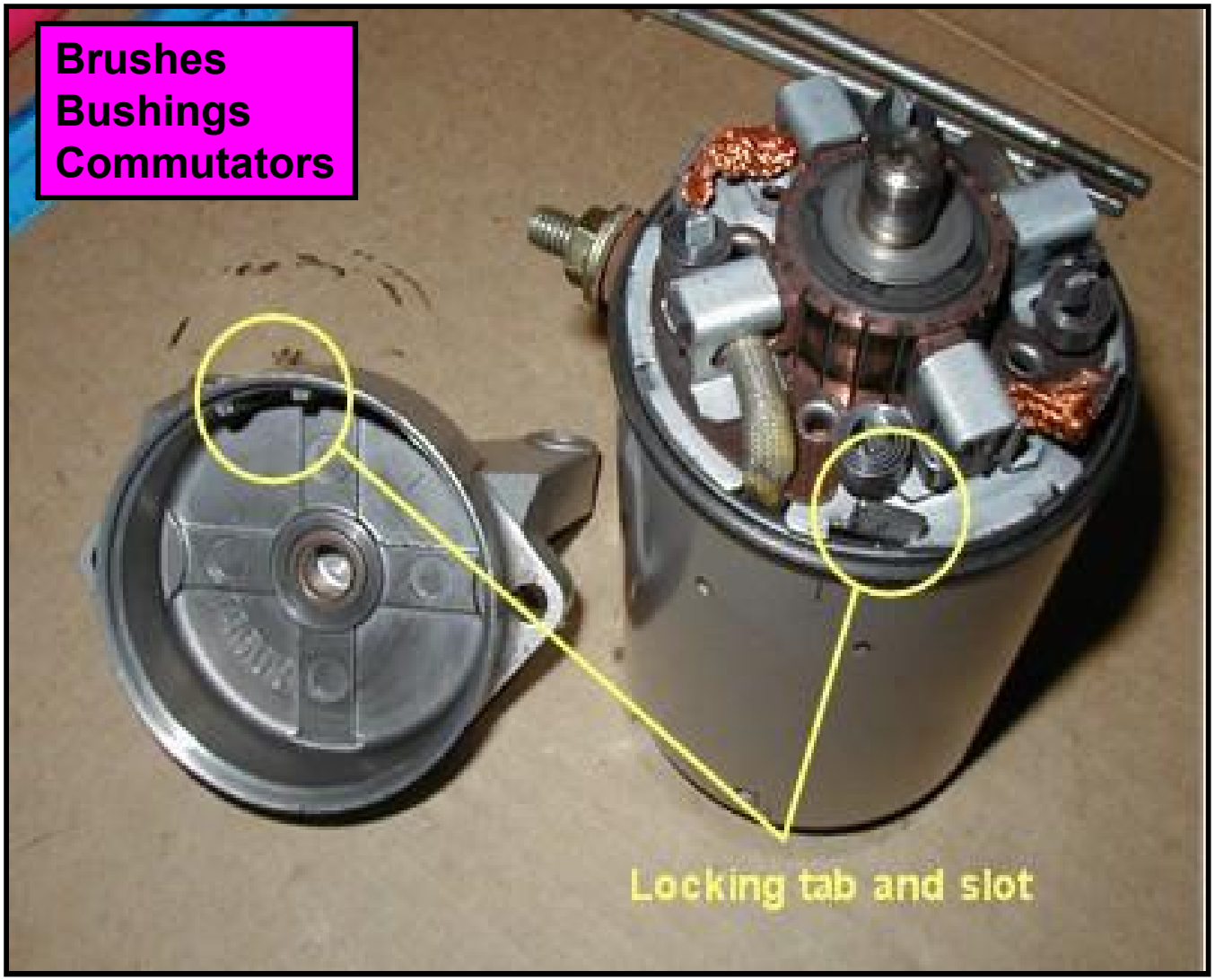
Amperage Drop
Resistance Drop
Voltage Drop

33. A starter no-load or free speed bench test can be low on RPM's if a pole _____ drags against the armature. This could be caused by a loose shoe or by worn drive and brush end bushings.

34. When testing an armature with a growler, a vibrating strap indicates a _____ armature, continuity from commutator bars to the armature frame indicates a *prematurely grounded motor*, and no continuity from commutator bar to commutator bar indicates an _____ condition which will result in "dead spots" during cranking.

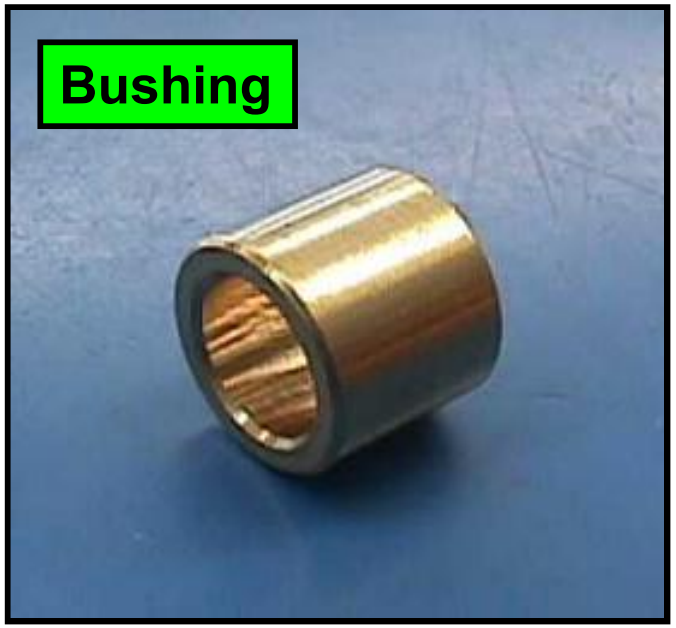
Open
Shorted
High Resistance

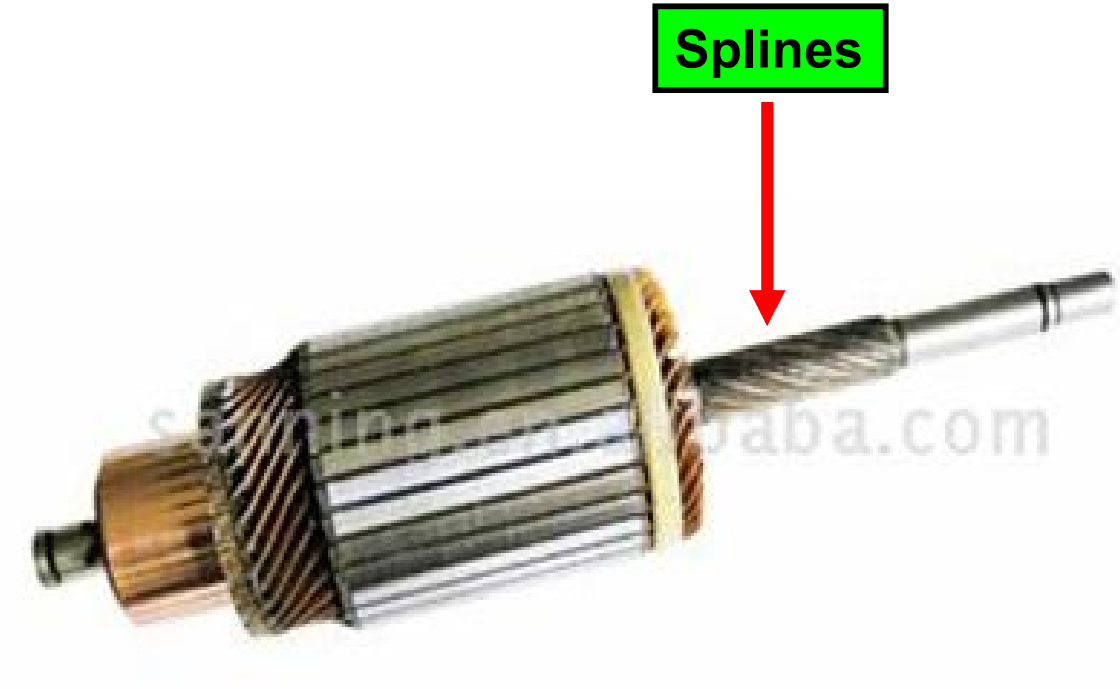
35. _____ should be of the proper length, commutator bars should be smooth, and the *mica strips* of insulation between the commutator bars should be properly *undercut* to a uniform depth.

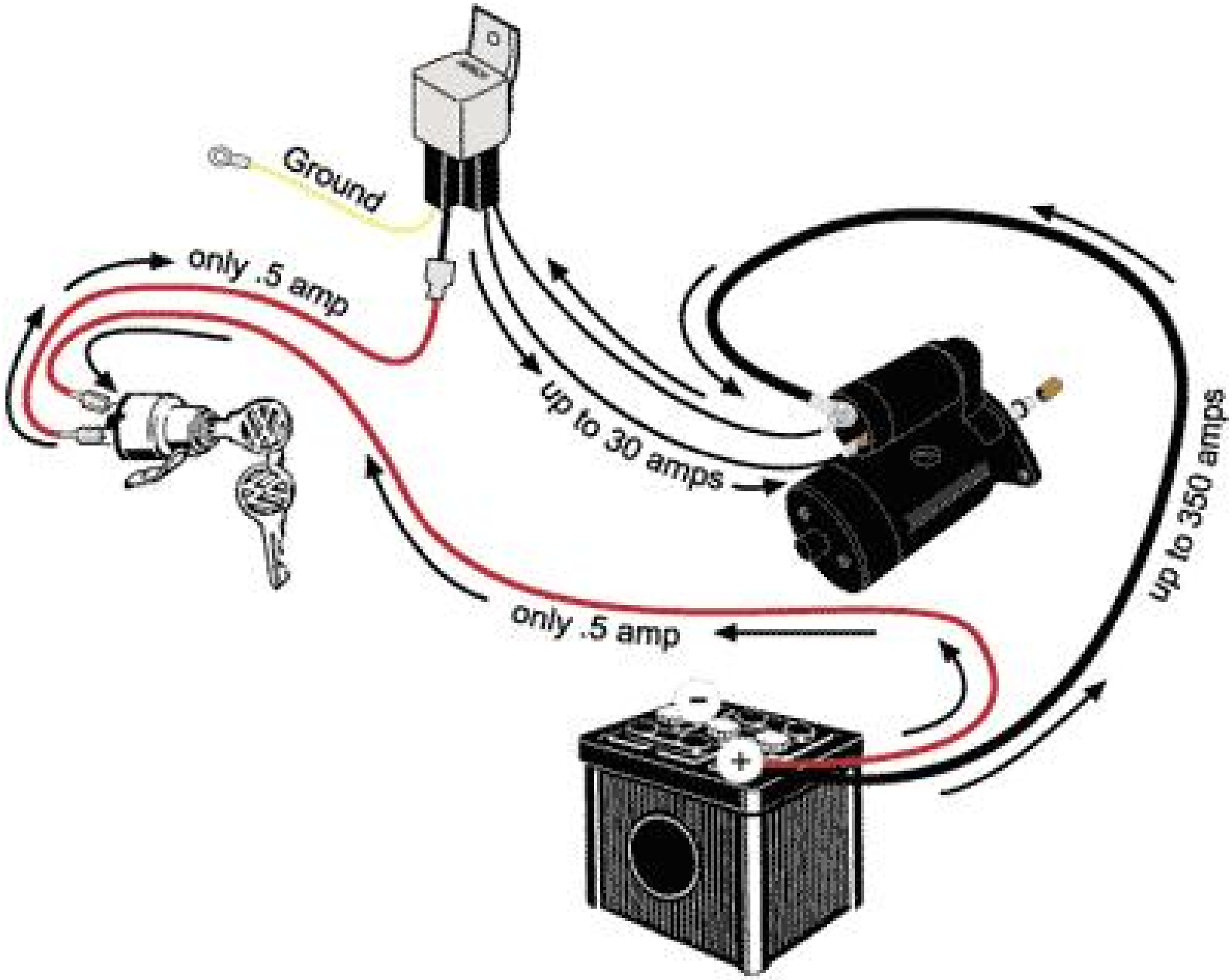


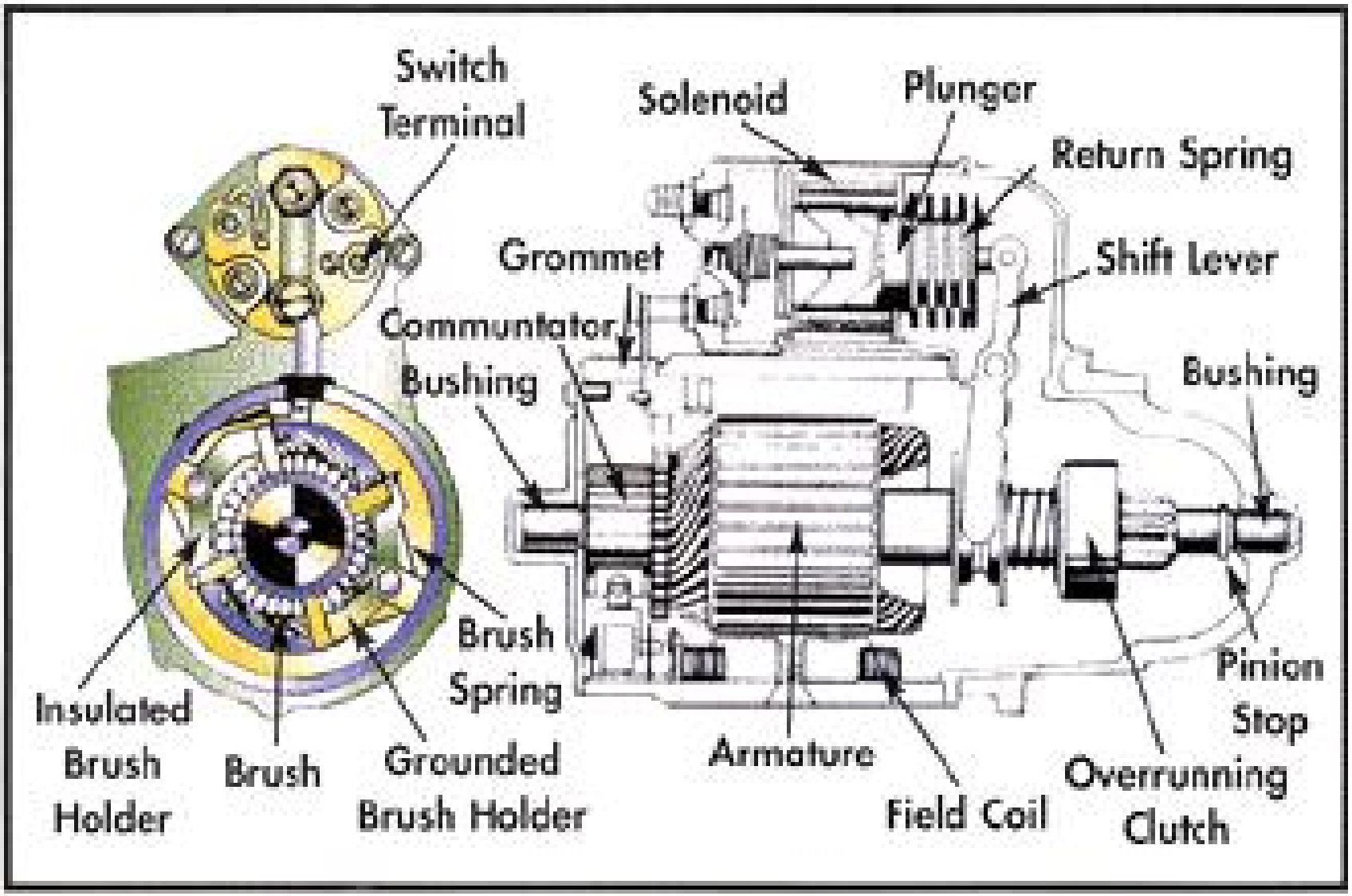
36. Starter drive _____ on the armature shaft and both armature _____ should be *lightly lubricated with high temperature grease* during rebuilding procedures.

Splines, Bushings
Splines, Brushes
Splines, Commutator Bars

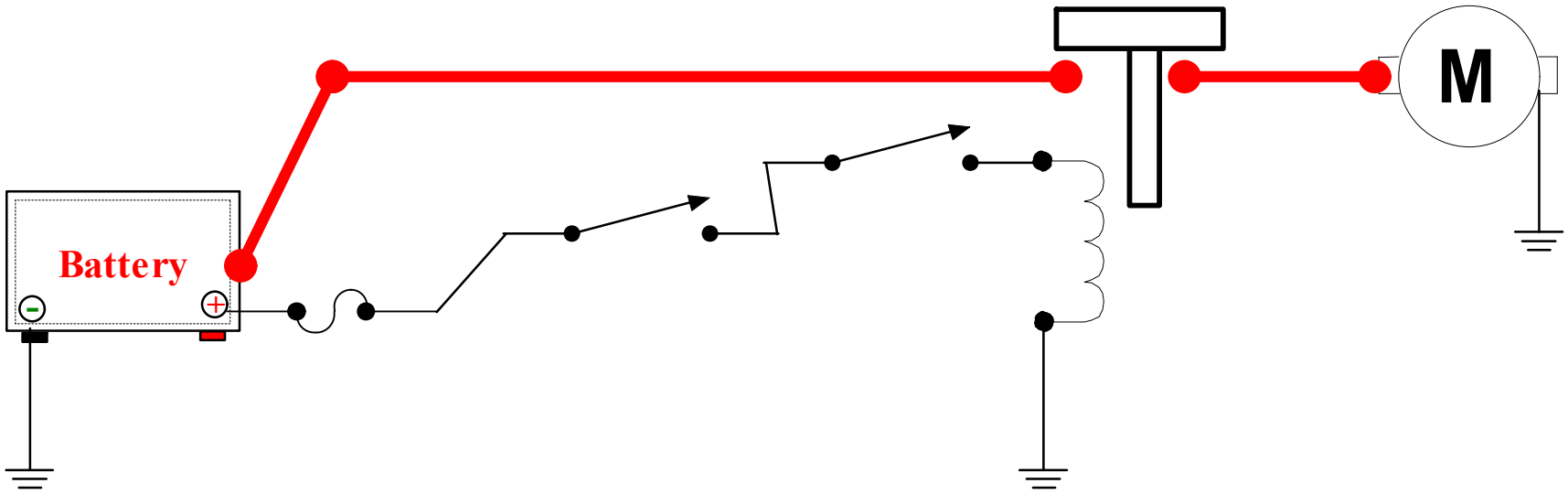





Ground
only .5 amp
up to 30 amps
only .5 amp
up to 350 amps

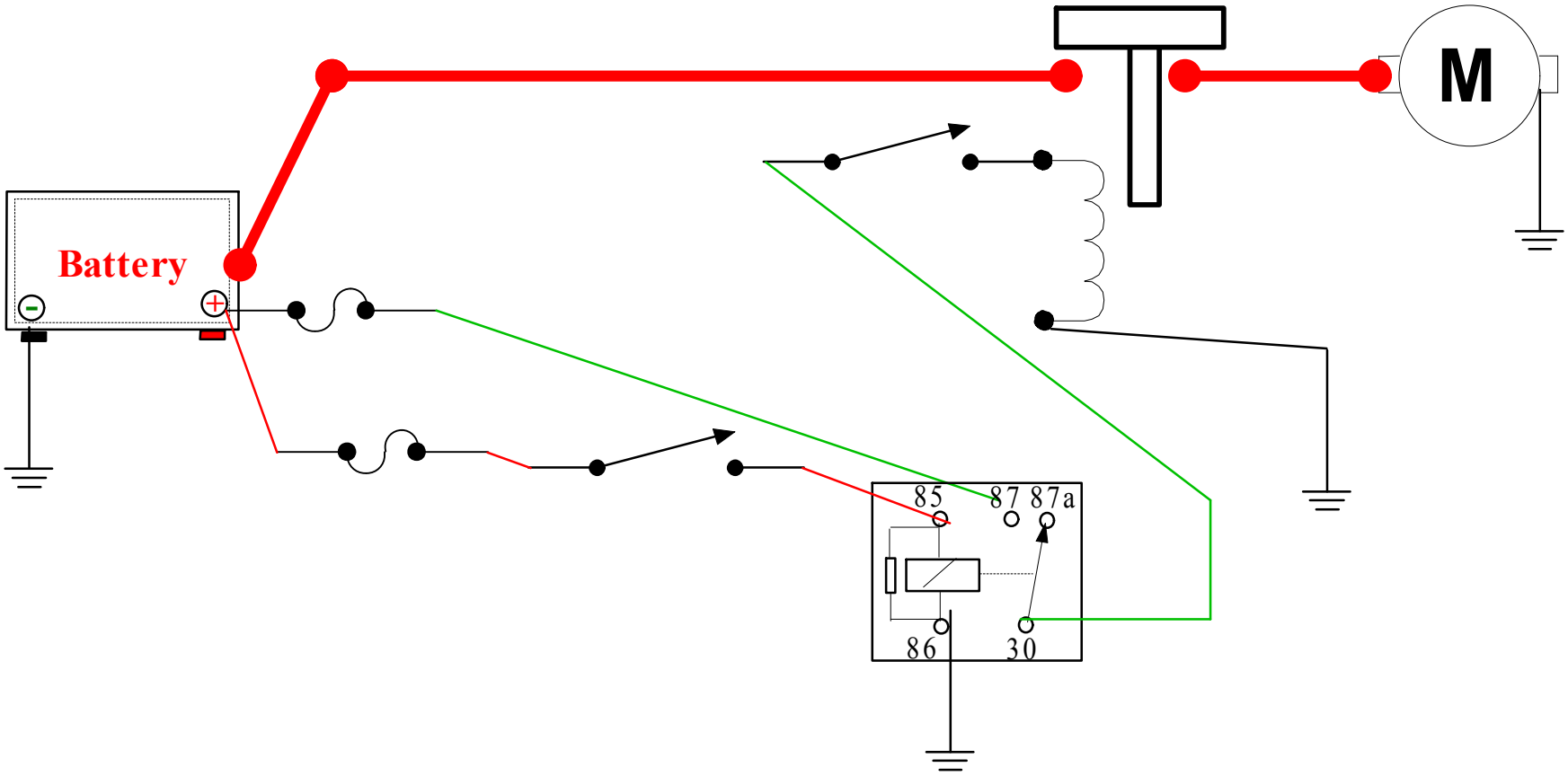

Switch Terminal
Solenoid
Plunger
Return Spring
Grommet
Shift Lever
Communtator Bushing
Bushing
Brush Spring
Insulated Brush Holder
Brush
Grounded Brush Holder
Armature
Field Coil
Overrunning Clutch
Pinion Stop

**** Cranking Circuit schematically drawn with solenoid.**

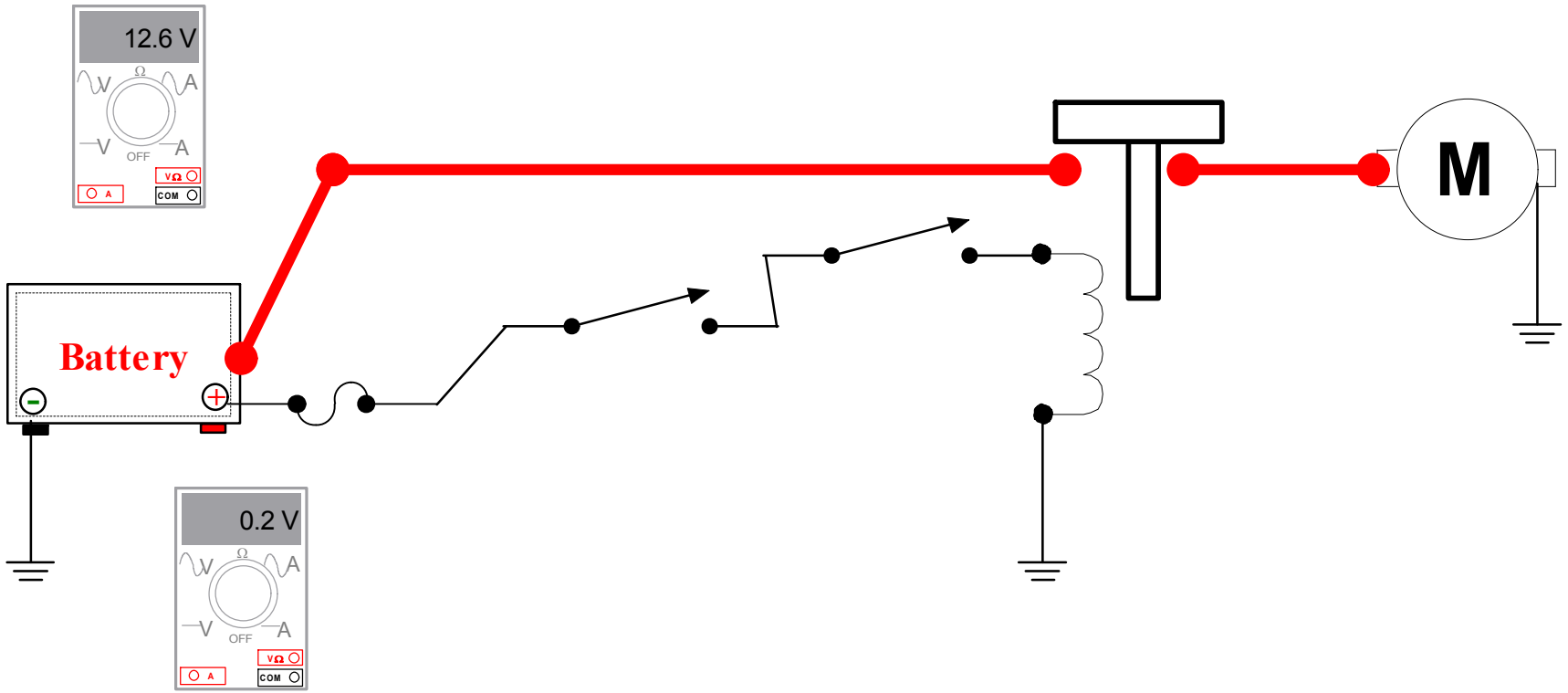


ATASA 5th Starting Systems & Traction Motor Systems

**** Cranking Circuit schematically drawn with relay & solenoid.**

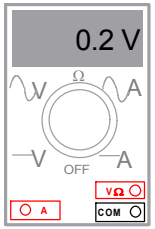


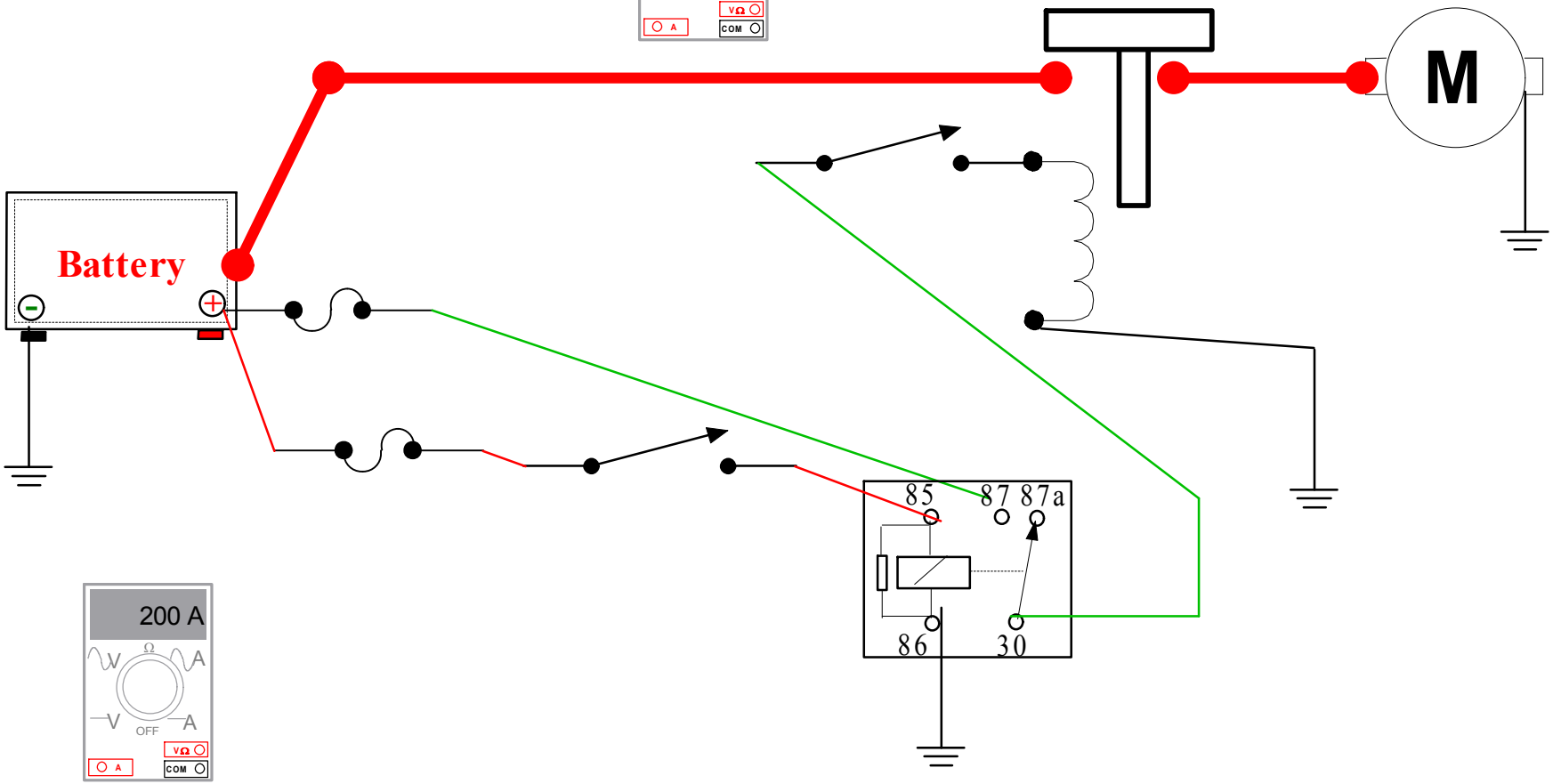
Connect this meter for battery OCV



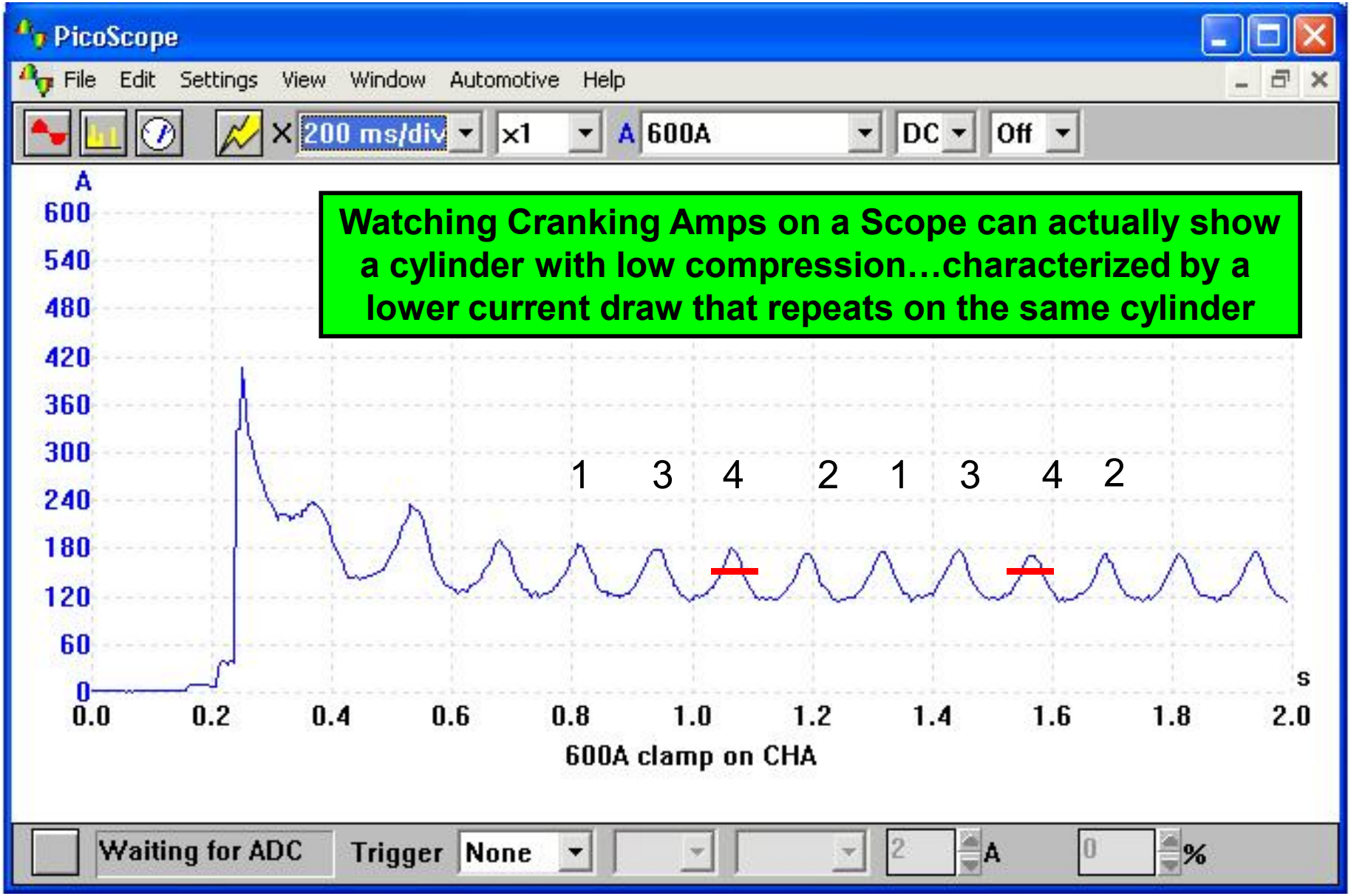
Connect this meter for control circuit Voltage Drop

Connect this meter for motor feed voltage drop





Inductively connect this meter to measure starter current draw


PicoScope
File Edit Settings View Window Automotive Help
200 ms/div
x1
A 600A
DC
Off
A
600
540
480
420
360
300
240
180
120
60
0
Watching Cranking Amps on a Scope can actually show a cylinder with low compression…characterized by a lower current draw that repeats on the same cylinder
1 3 4 2 1 3 4 2
s
0.0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 1.8 2.0
600A clamp on CHA
Waiting for ADC
Trigger
None
2
A
0
%