A/C Generator Systems

What is the function of the charging system?

Provide power for all electrical loads

Recharge the starting battery

What happens if the charging systems puts out too much power?

↑ Voltage goes UP ↑

What happens if the charging system puts out too little power?

↓ Voltage goes DOWN ↓

What is the proper system voltage?

13.8 - 14.8 volts

27.4 – 28.4 volts

What controls the system voltage?

Voltage regulator

How many volts in a fully charged battery?

12.6 volts

25.2 volts

After removing surface charge

How do you check for an Over-charging alternator?

Insure battery is fully charged

Run the engine

Turn Off electrical loads

System voltage below…

…14.8 Volts or 28.4 volts

When less than 8 amps enter battery

What can cause the charging system to Over-charge?

Defective Voltage Regulator

Volt Drop in Voltage Sensing Wire

Volt Drop in regulator ground

Having regulator inside generator eliminates volt drop as a cause for Over-Charging

How do you check for an Under-charging alternator?

Insure battery is fully charged

Run **ALL** electrical loads

Run engine at 1,500 RPM

System voltage above…

…13.8 Volts or 27.4 volts

How else do you check for an undercharging alternator?

Run engine at 1,500 RPM

Load battery with carbon pile to 13 volts (26 volts)

Measure amps leaving generator

Should be at least 90% of rated capacity

What can cause the charging system to under-charge?

Loose fan belt

Low engine RPM

Excessive load requirements (add on accessories)

What can cause the charging system to under-charge?

Short driving trips

Defective generator

Defective voltage regulator

Defective wiring

Understand the A/C Generator (Alternator)

Identify the following components

Rotor

Stator

Slip rings

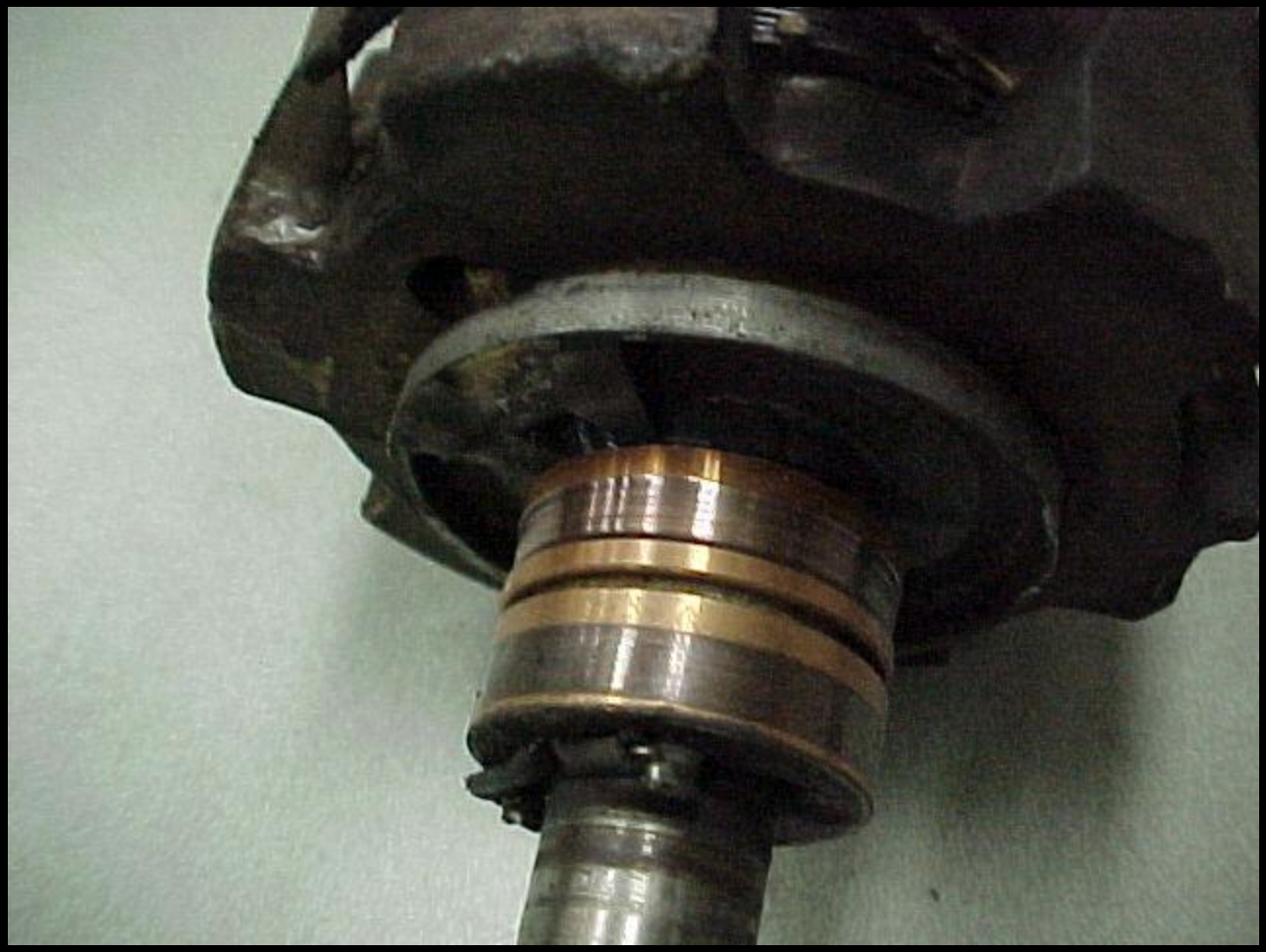
Brushes

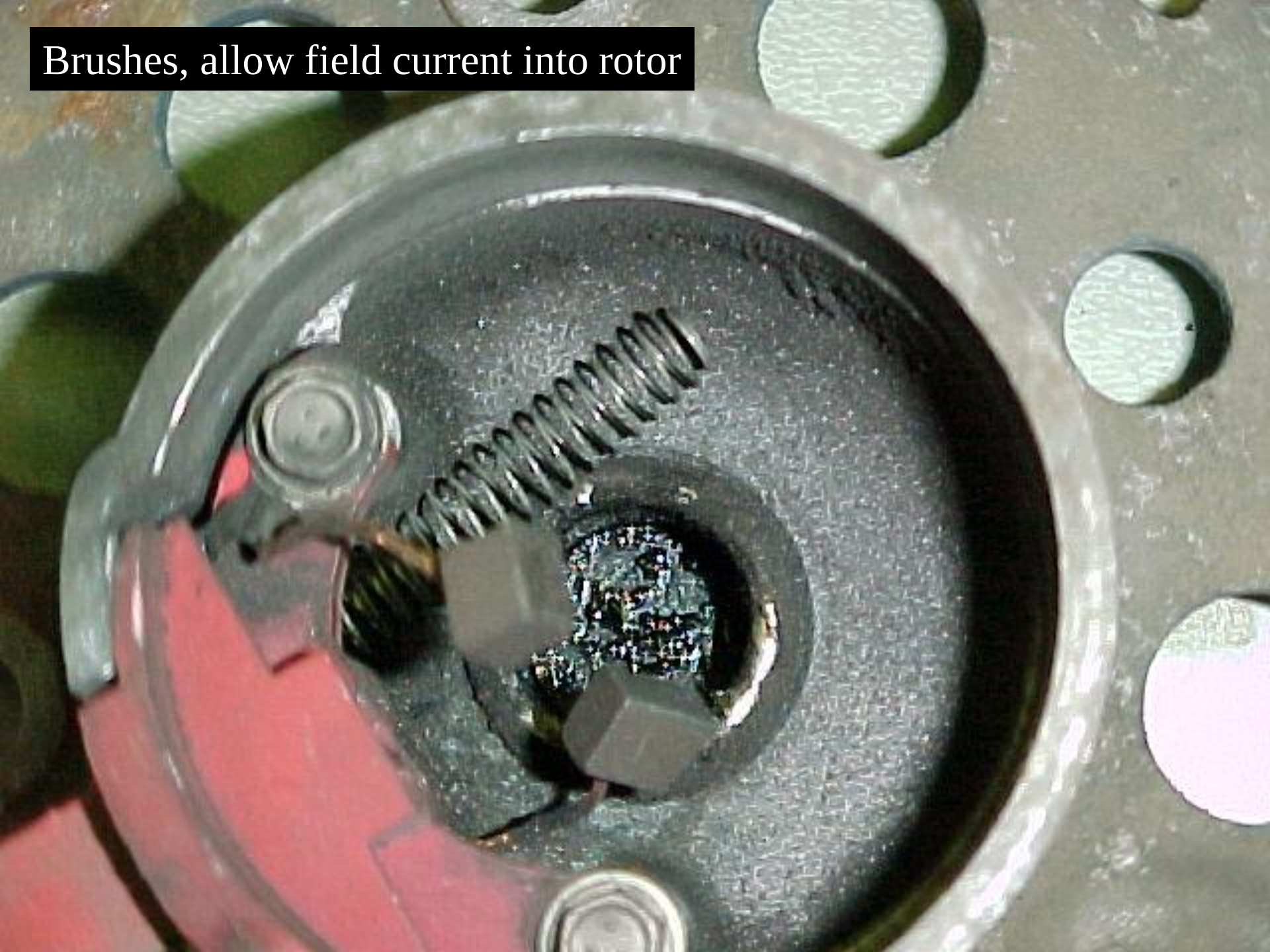
Diodes or Rectifier

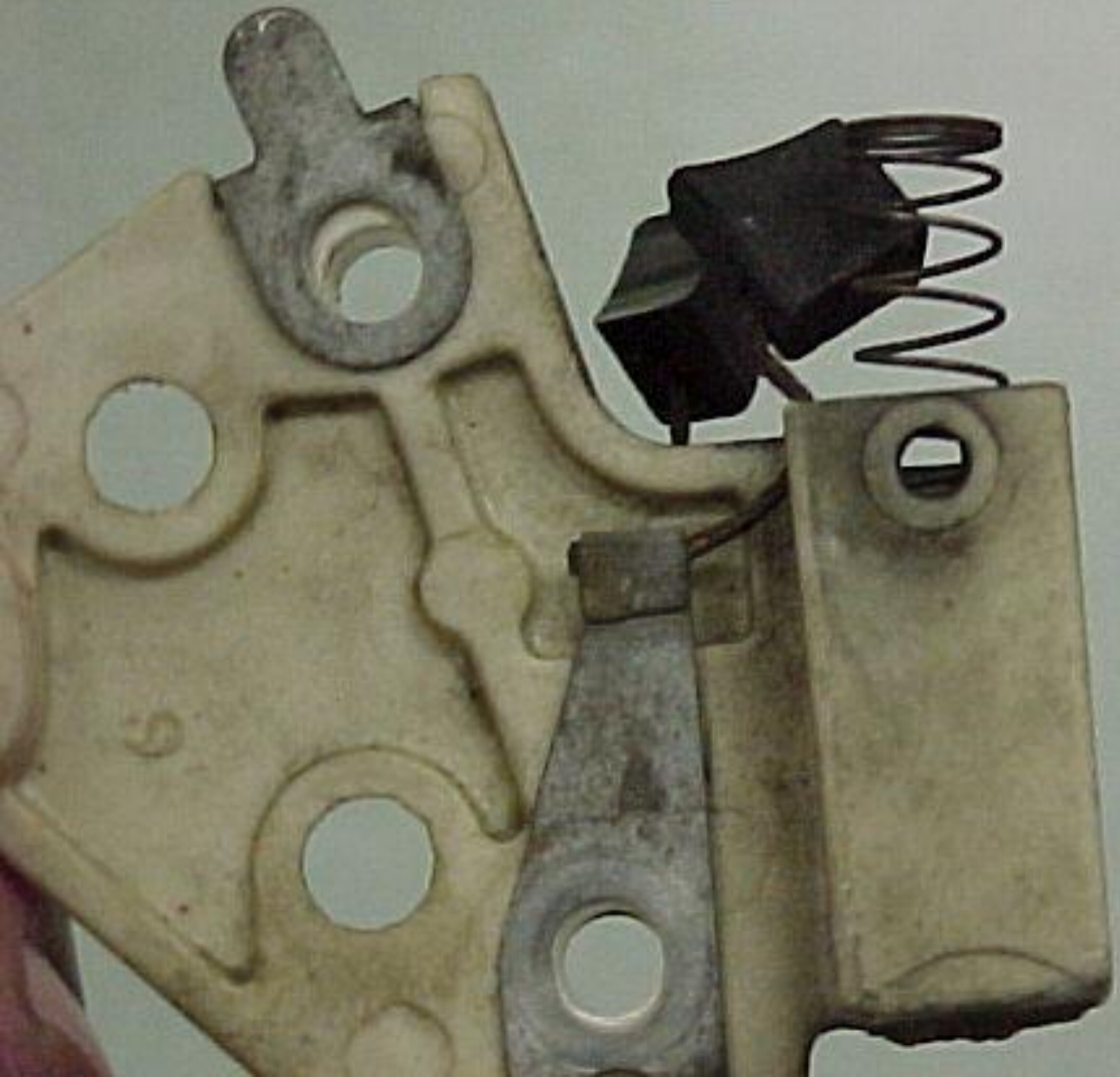

Rotor, creates spinning magnetic field


Stator, creates alternating current

Slip Rings, allow field current into the rotor




Brushes, allow field current into rotor

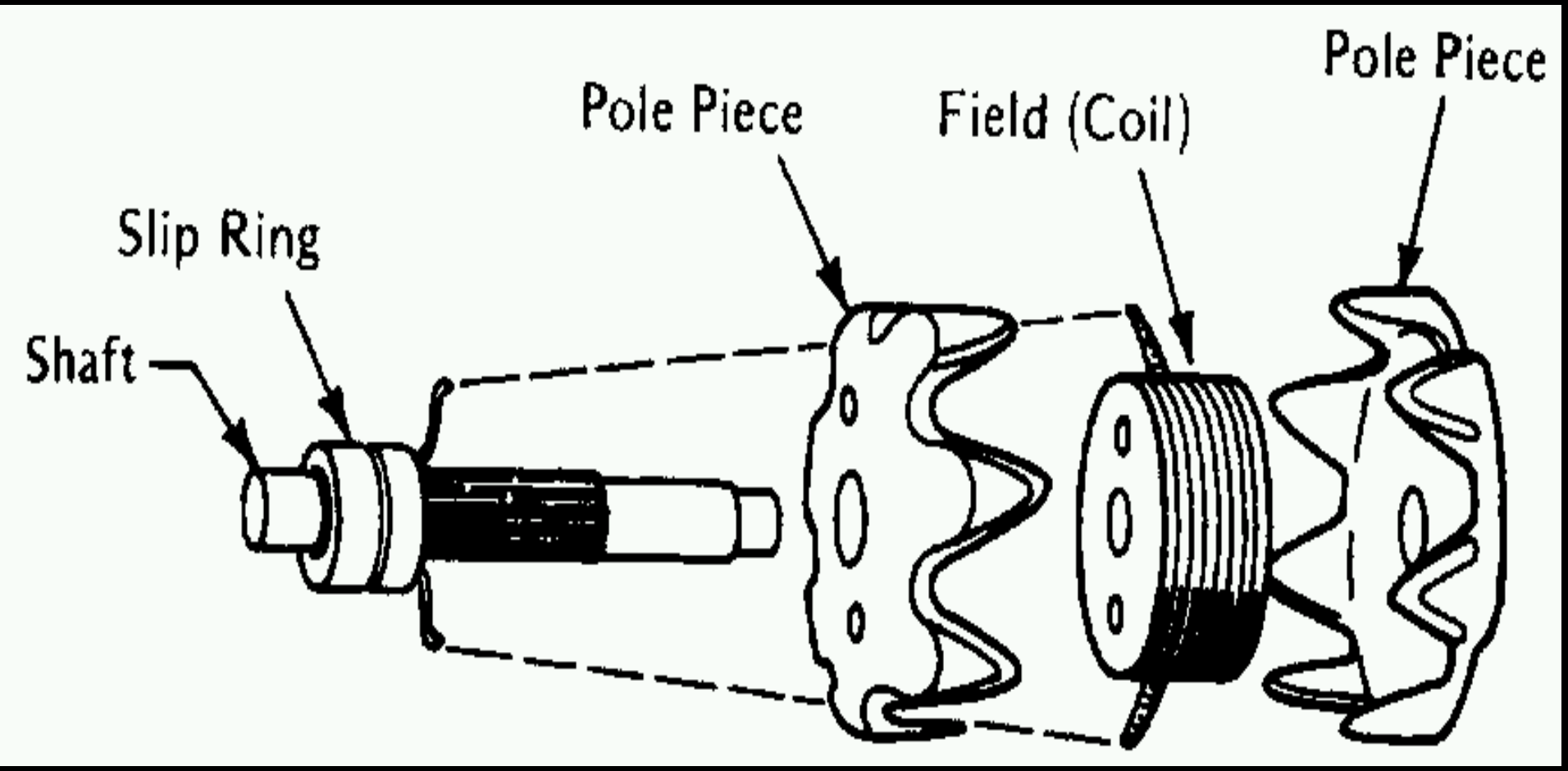


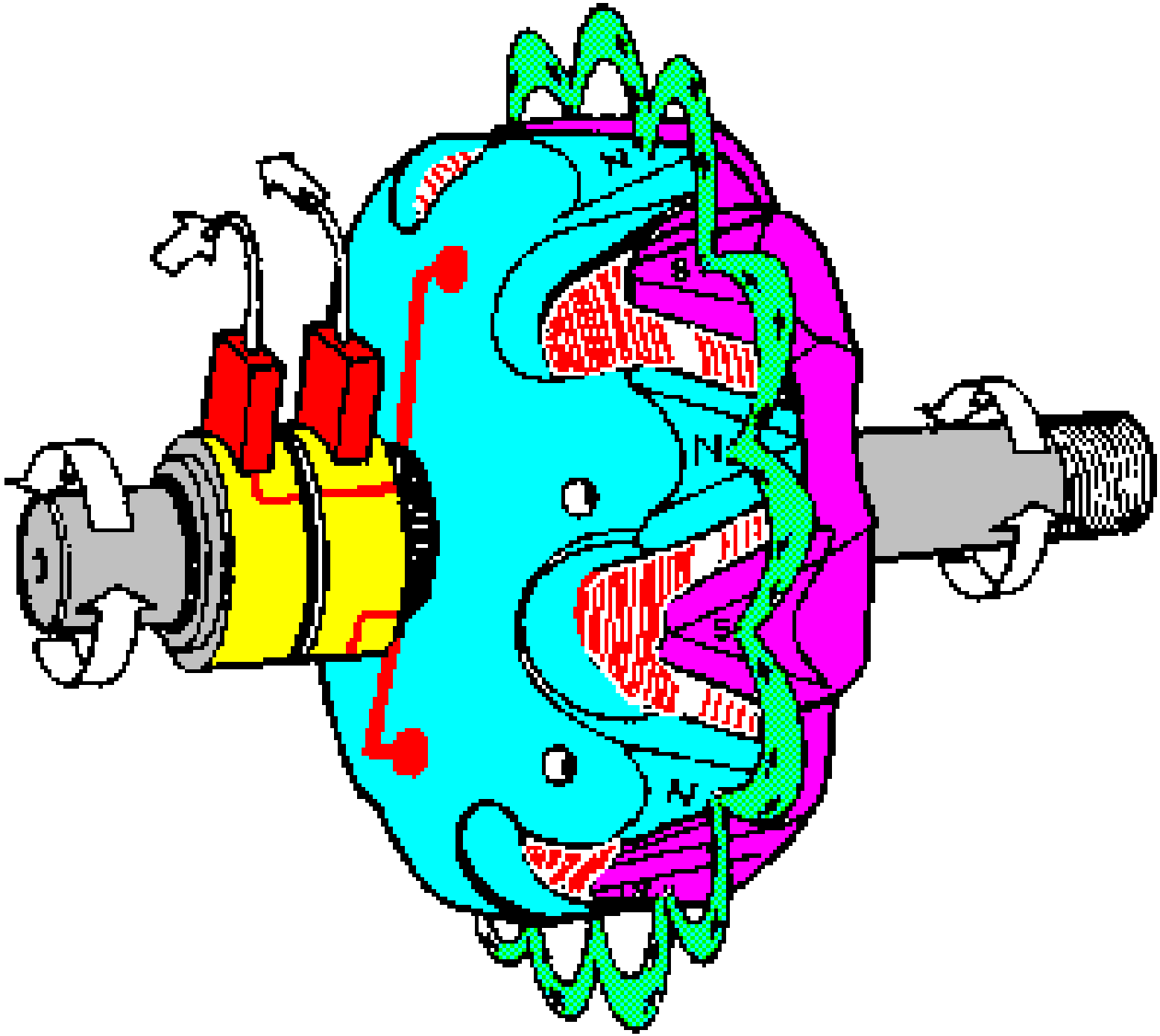

High tech brush installation tool

Rotor (Field)

What does the Rotor do?

Creates a spinning magnetic field inside the A/C generator


Pole Piece
Field (Coil)
Pole Piece
Slip Ring
Shaft

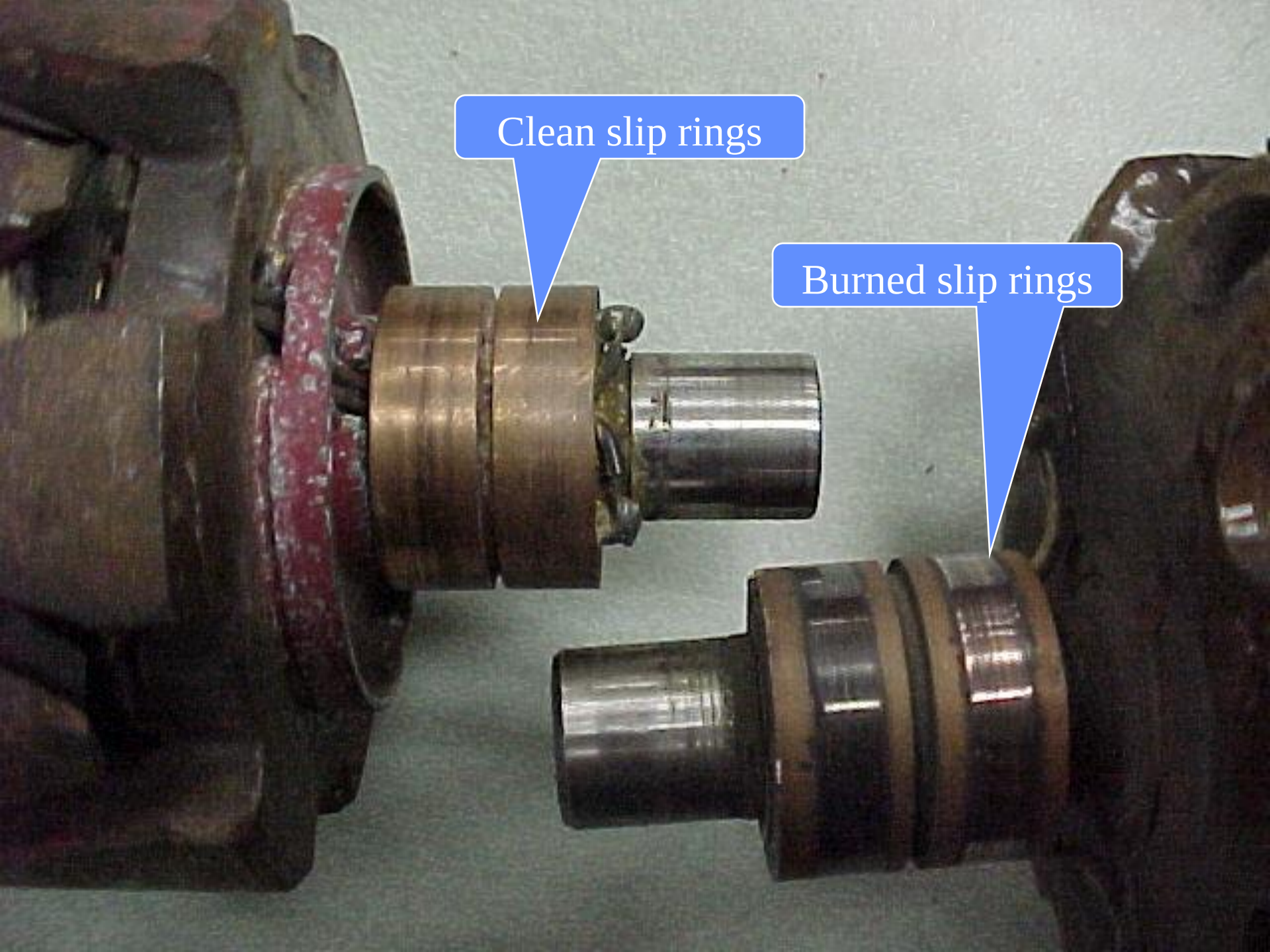


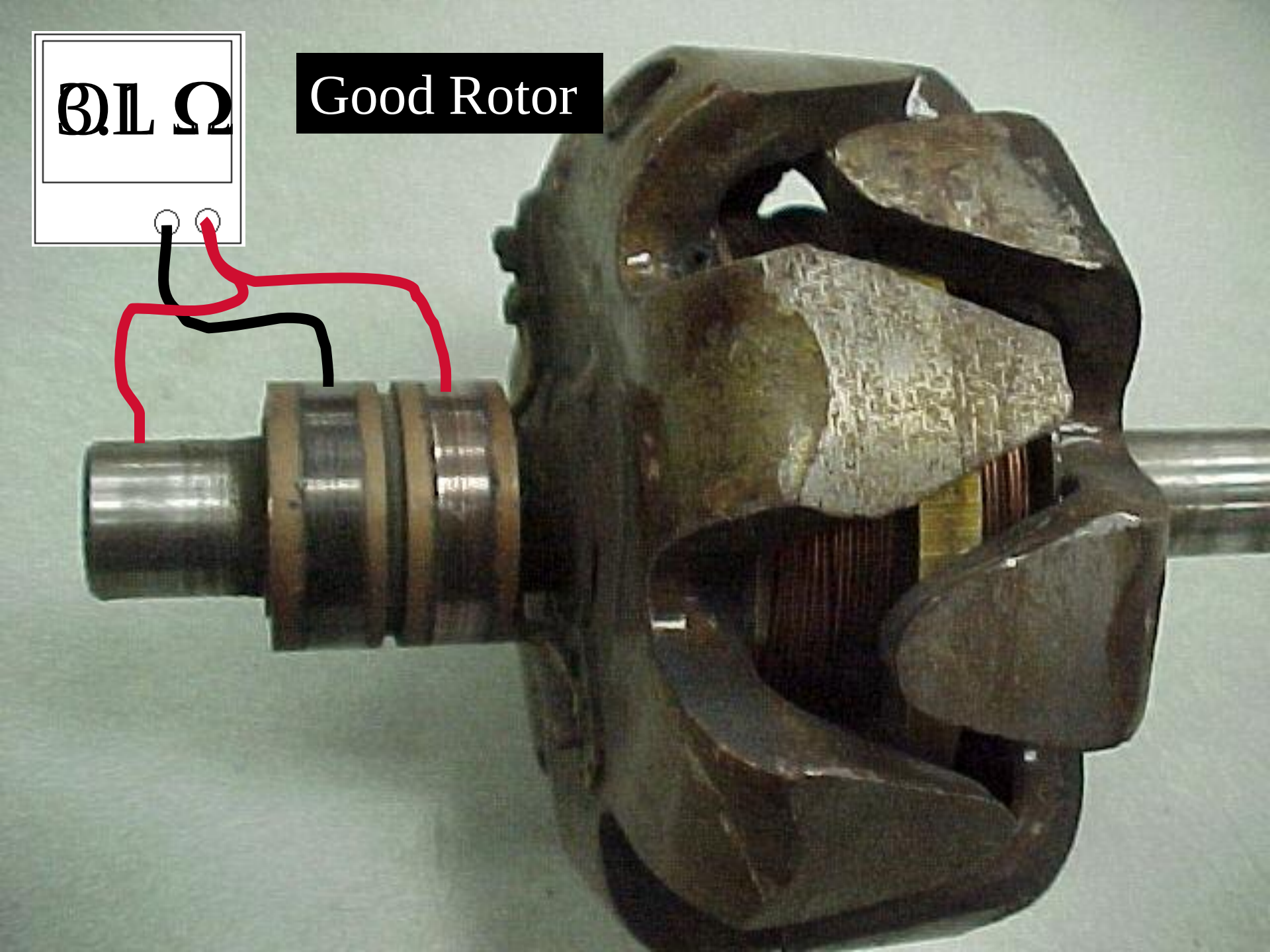
How do you test the rotor?

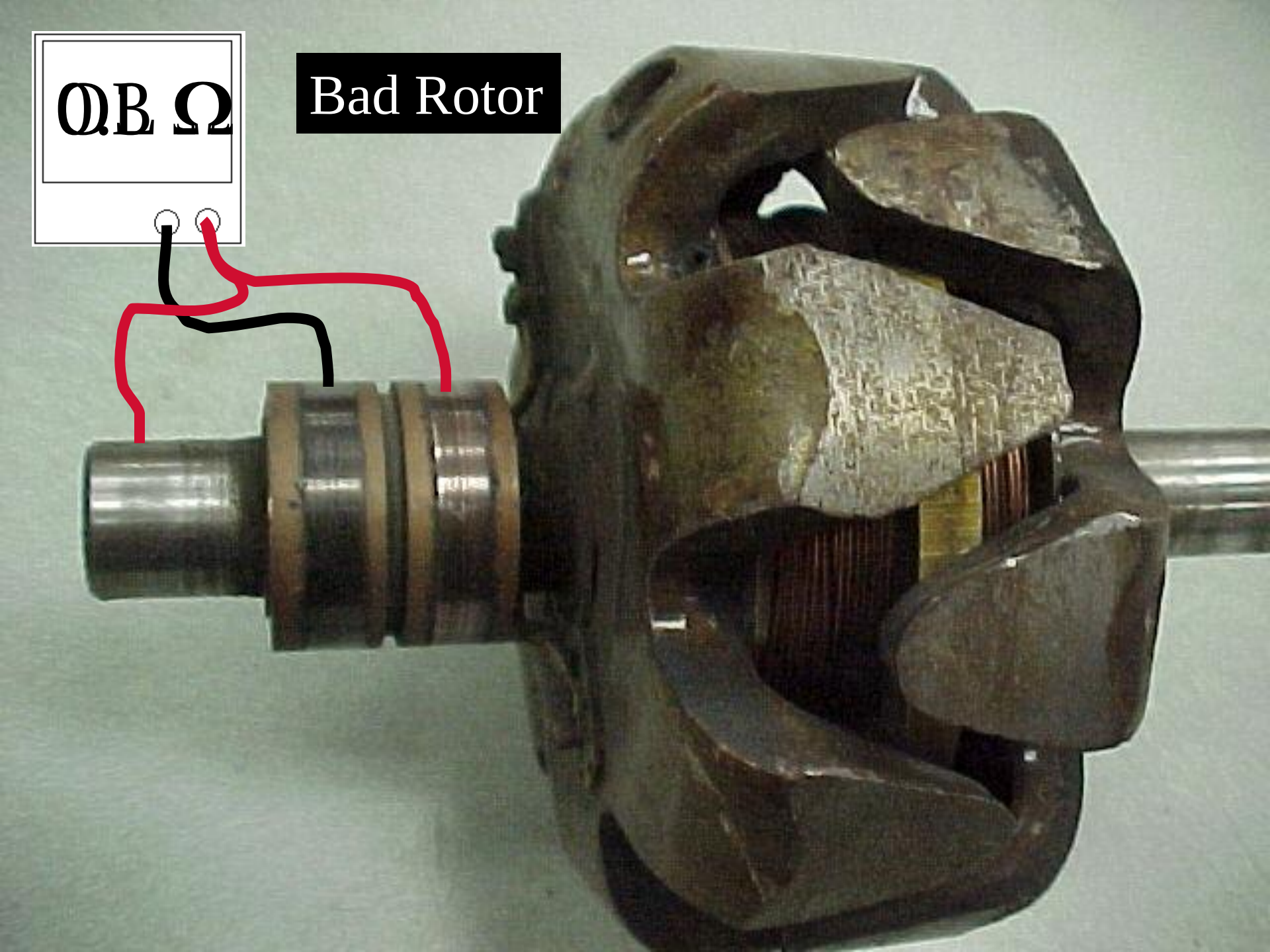
Slip rings must be clean and smooth

Field windings must not be open circuit

Field windings must not be shorted to ground


Clean slip rings
Burned slip rings


Good Rotor


Bad Rotor

Stator Windings

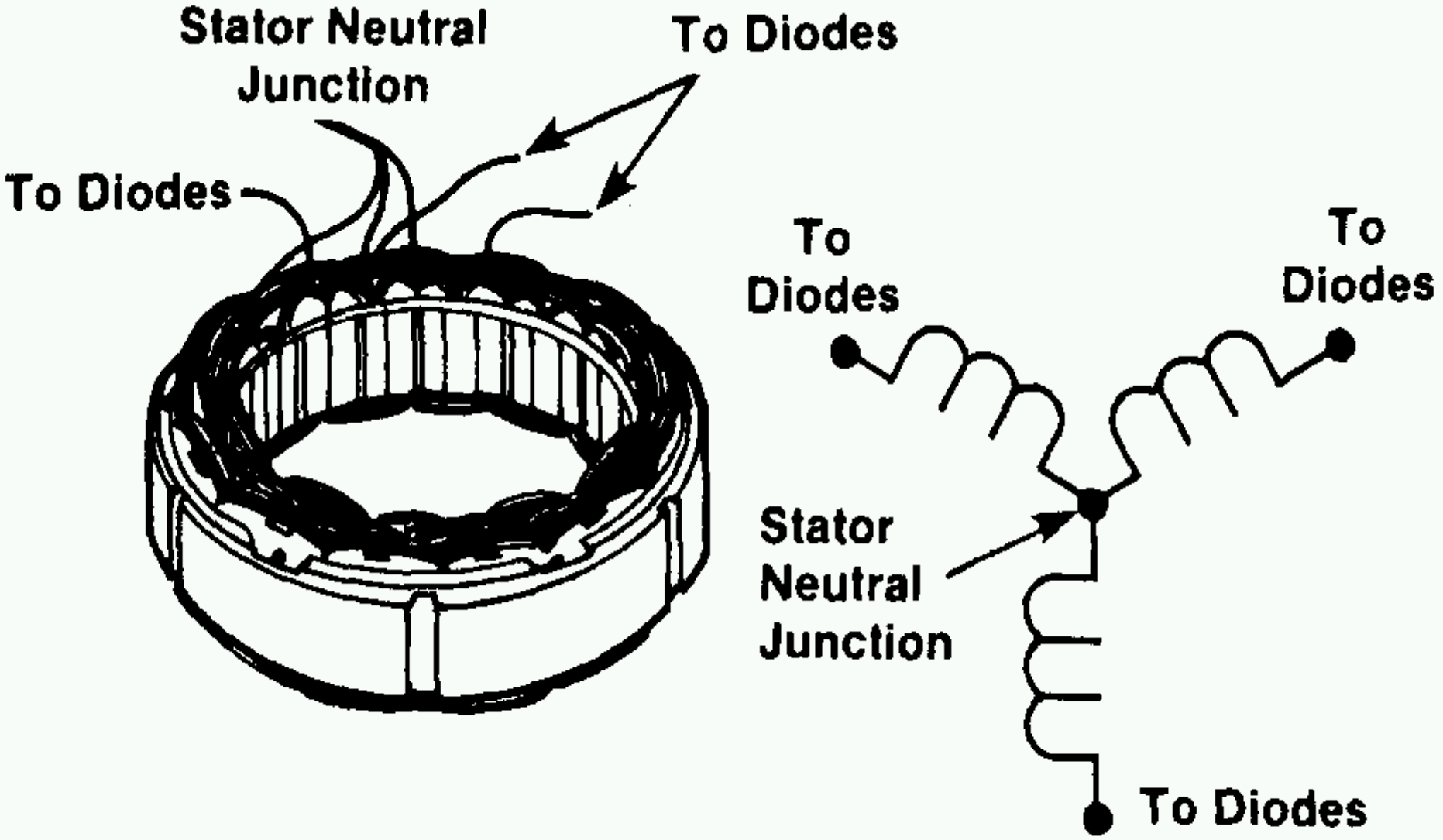
What does the Stator do?

Creates electrical power when a magnetic field is moved past it

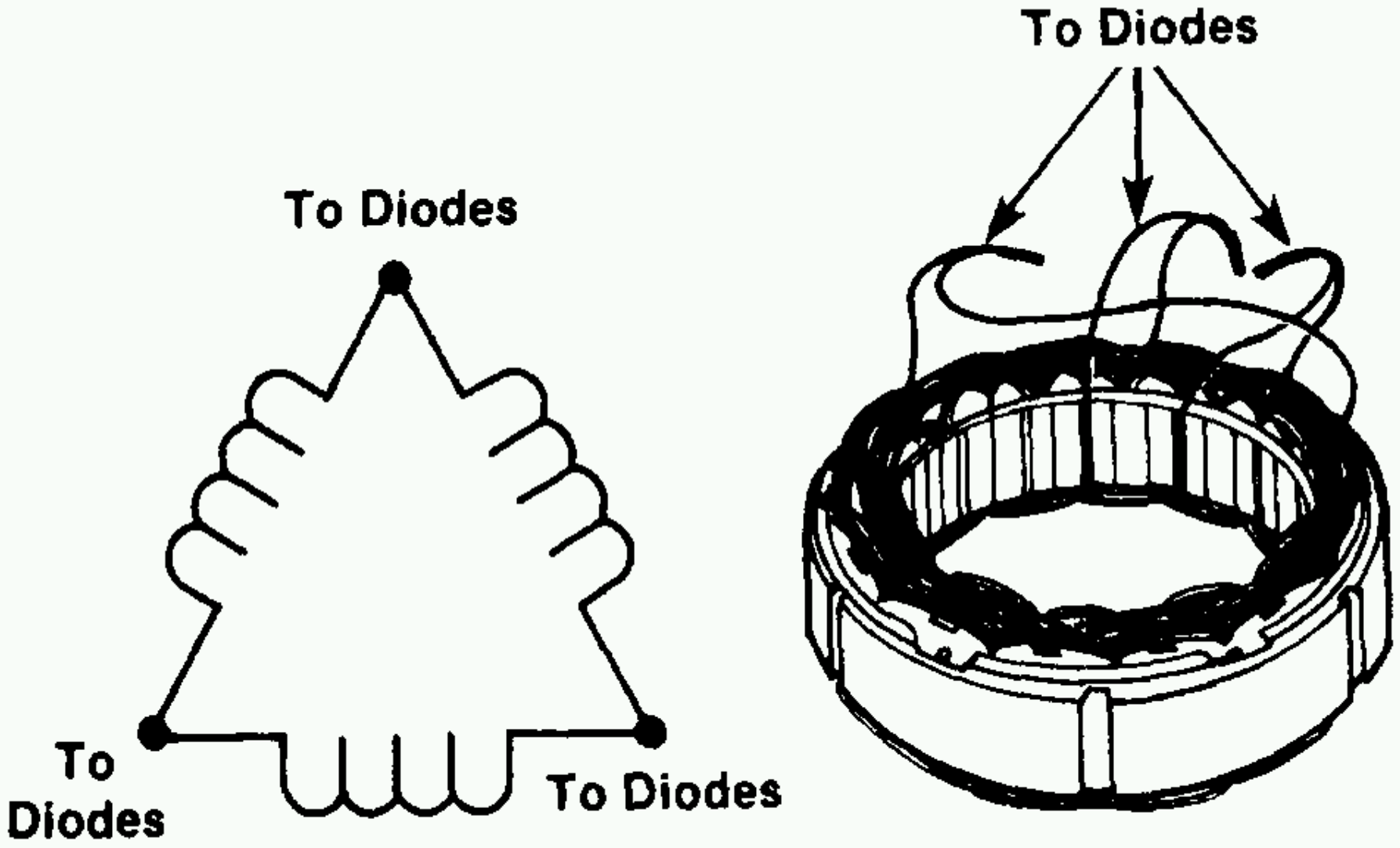
Creates power to recharge battery and run electrical loads

What does the Stator do?

Creates an Alternating Current

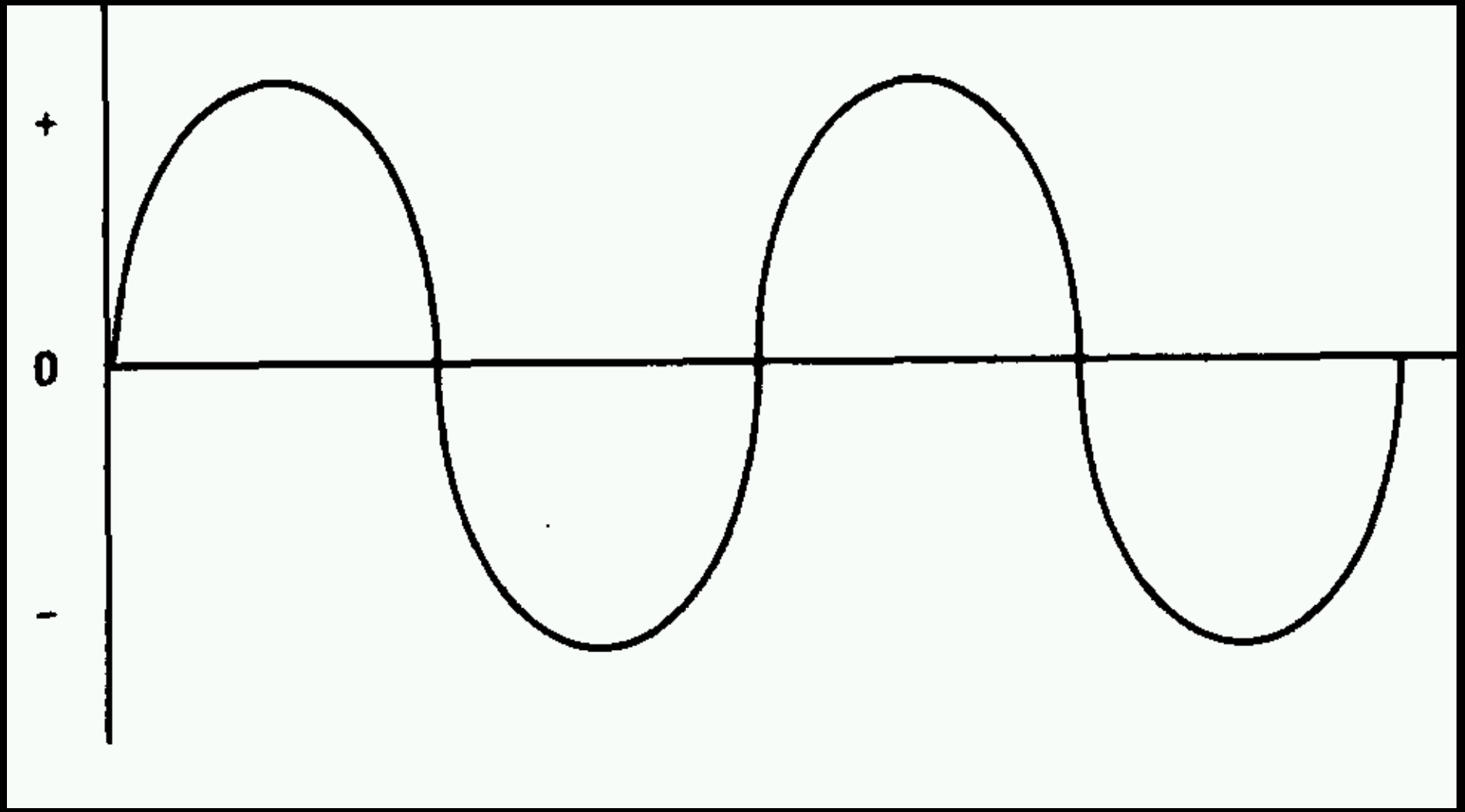


WYE CONNECTION

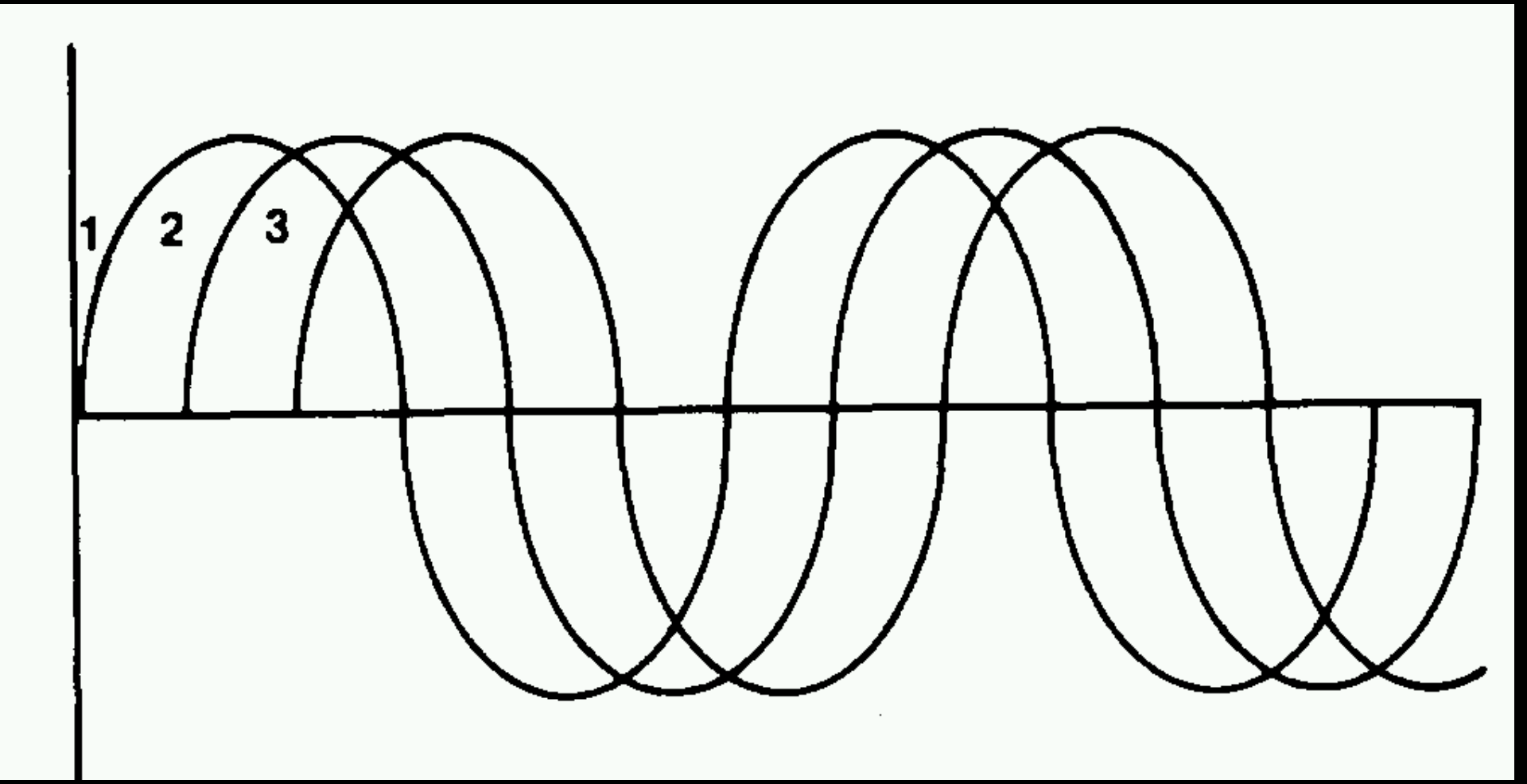


DELTA CONNECTION

Voltage Trace for One Stator Winding



Voltage Trace for Three Stator Windings

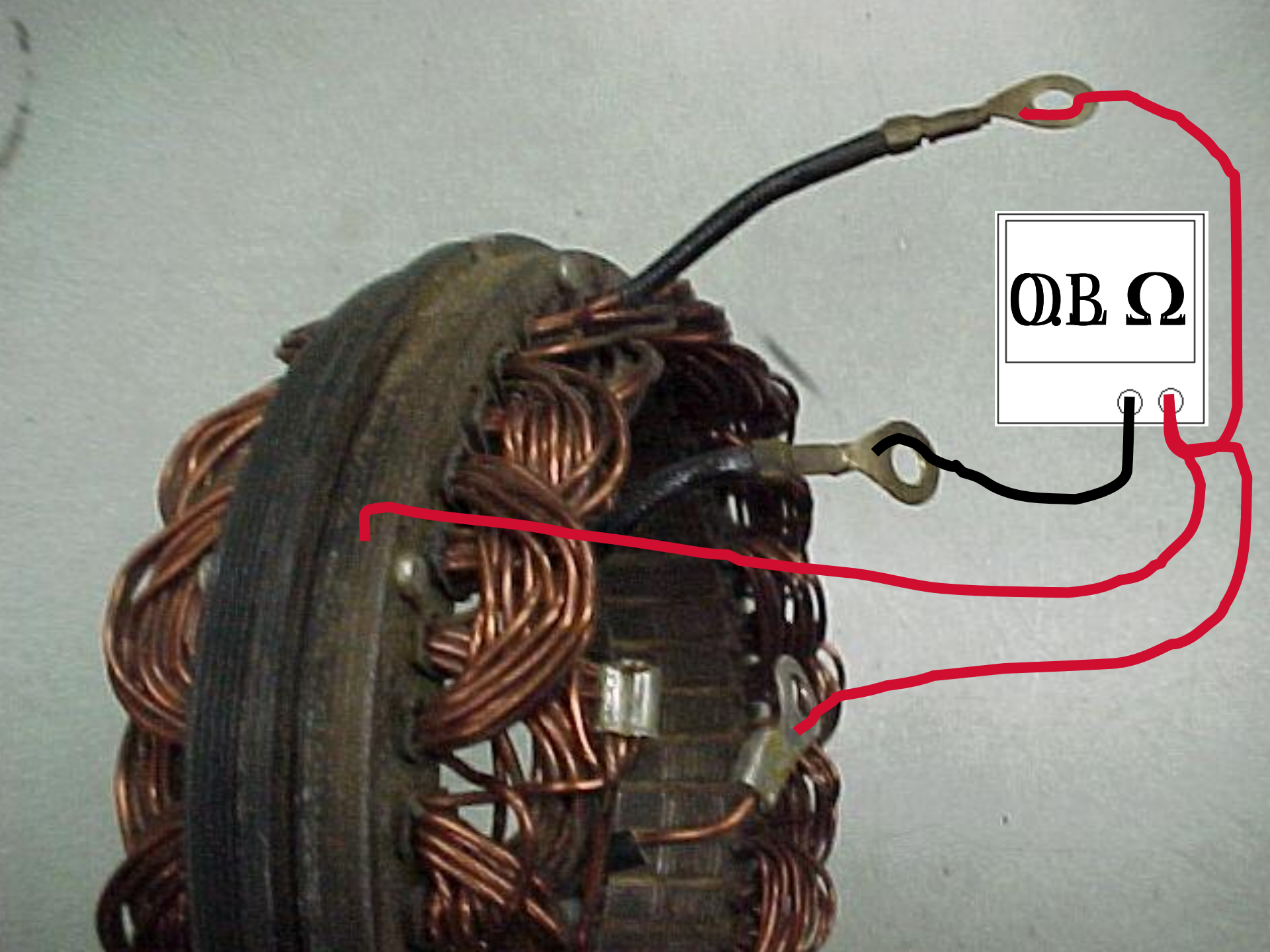


How do you test the Stator?

Test for open circuits in the windings

Test for grounded windings

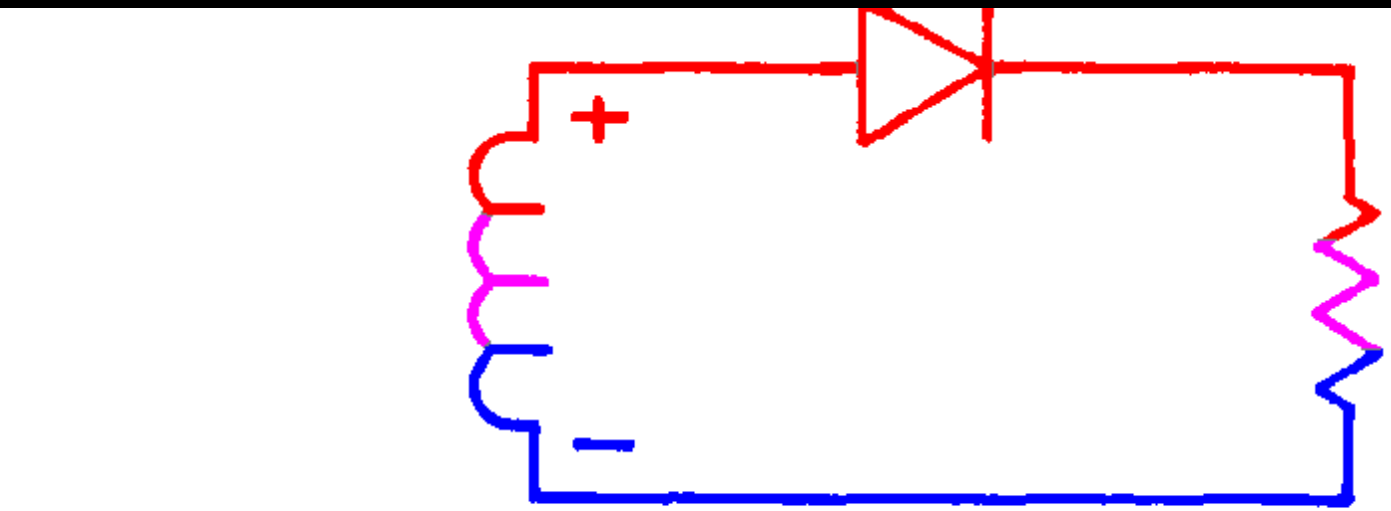
Visually inspect for burning or overheated windings

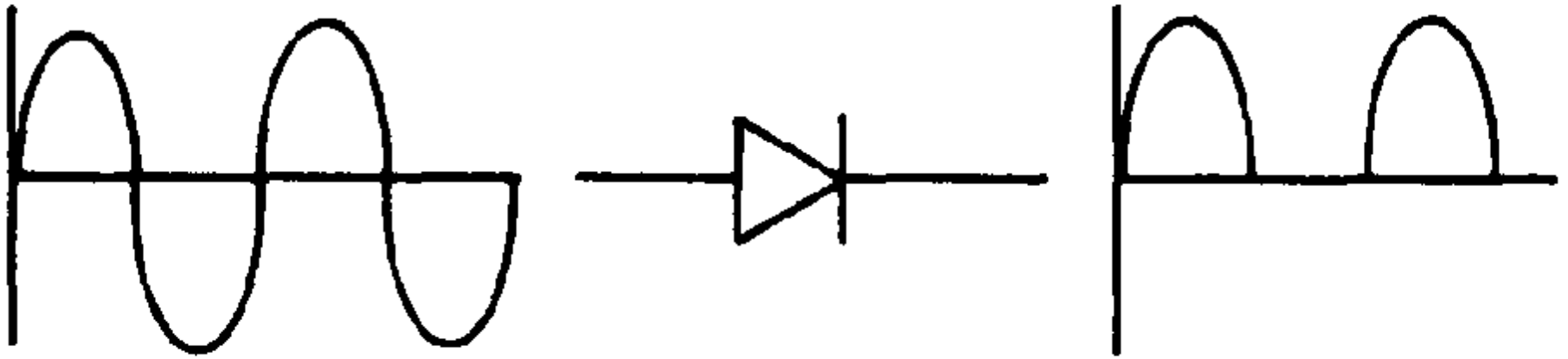

Ω Ω

How does the A/C current change into D/C current

Diodes are used for
Full Wave Rectification

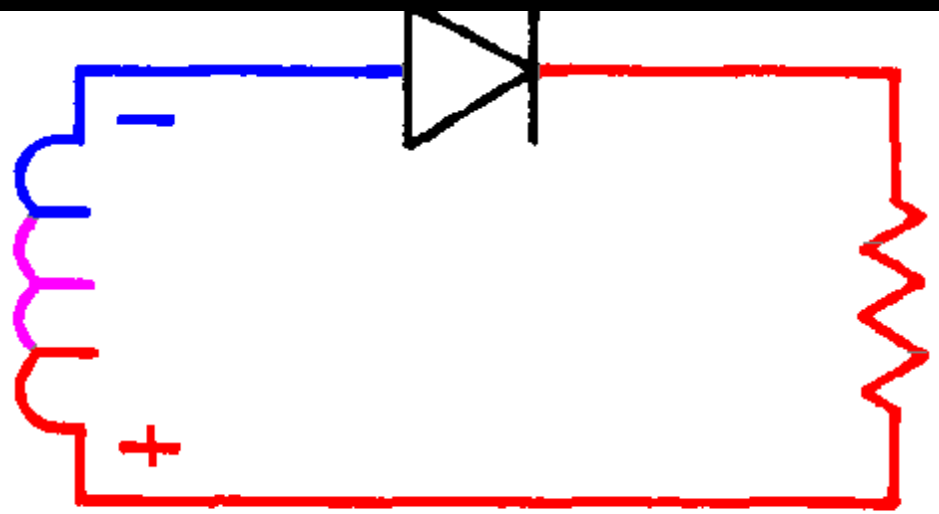
Diodes are often called rectifiers

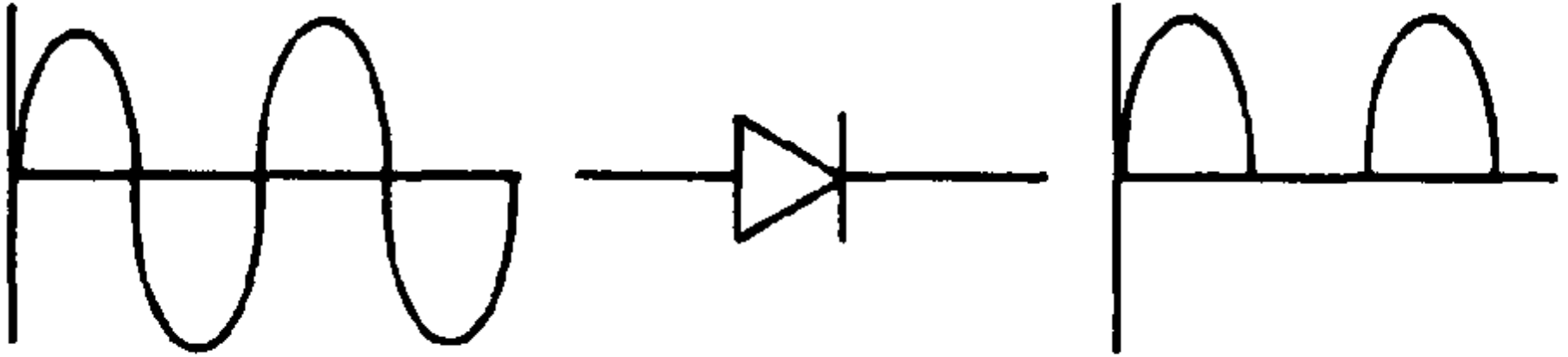




Half Wave Rectification

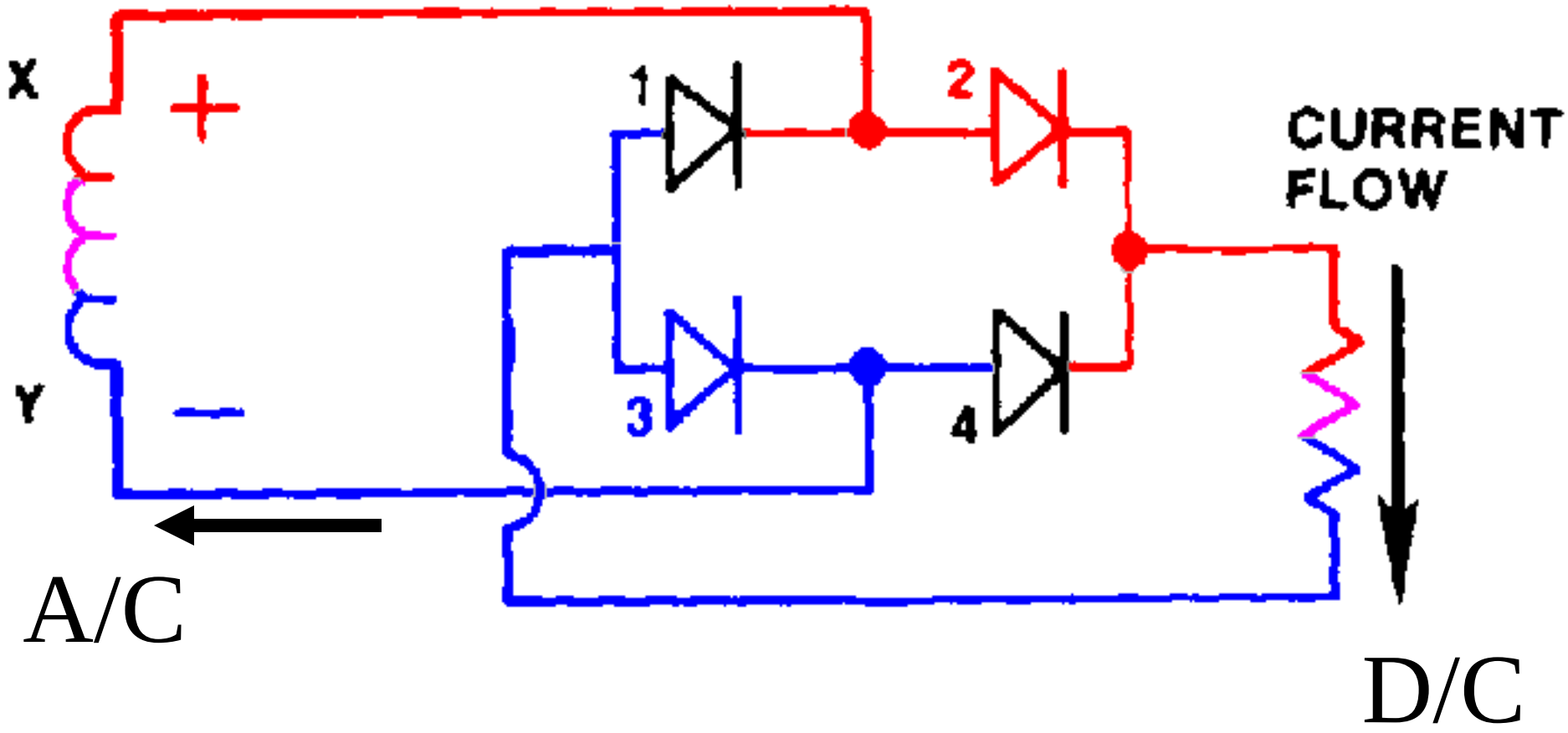
Diode is positive biased **Current is flowing**



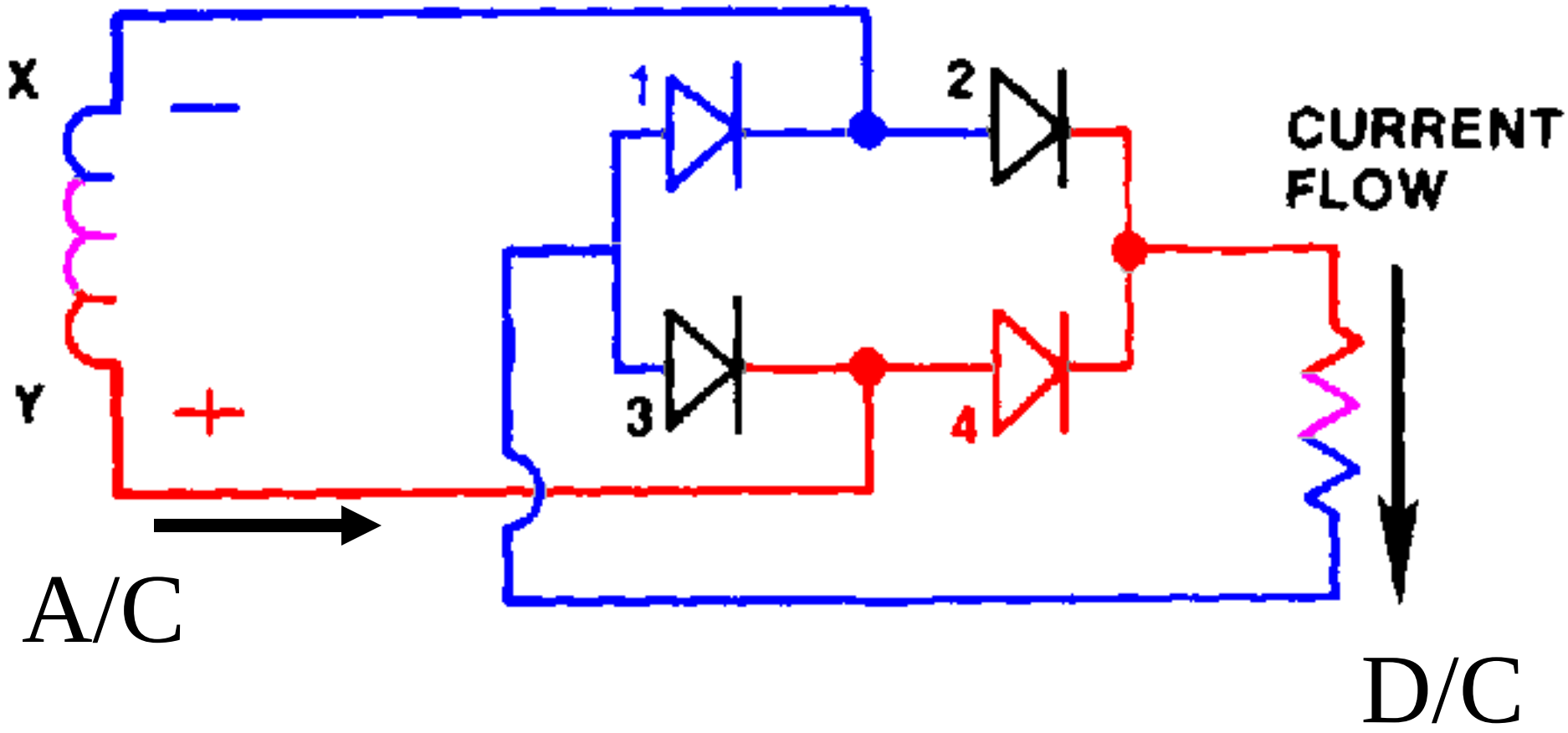


Half Wave Rectification

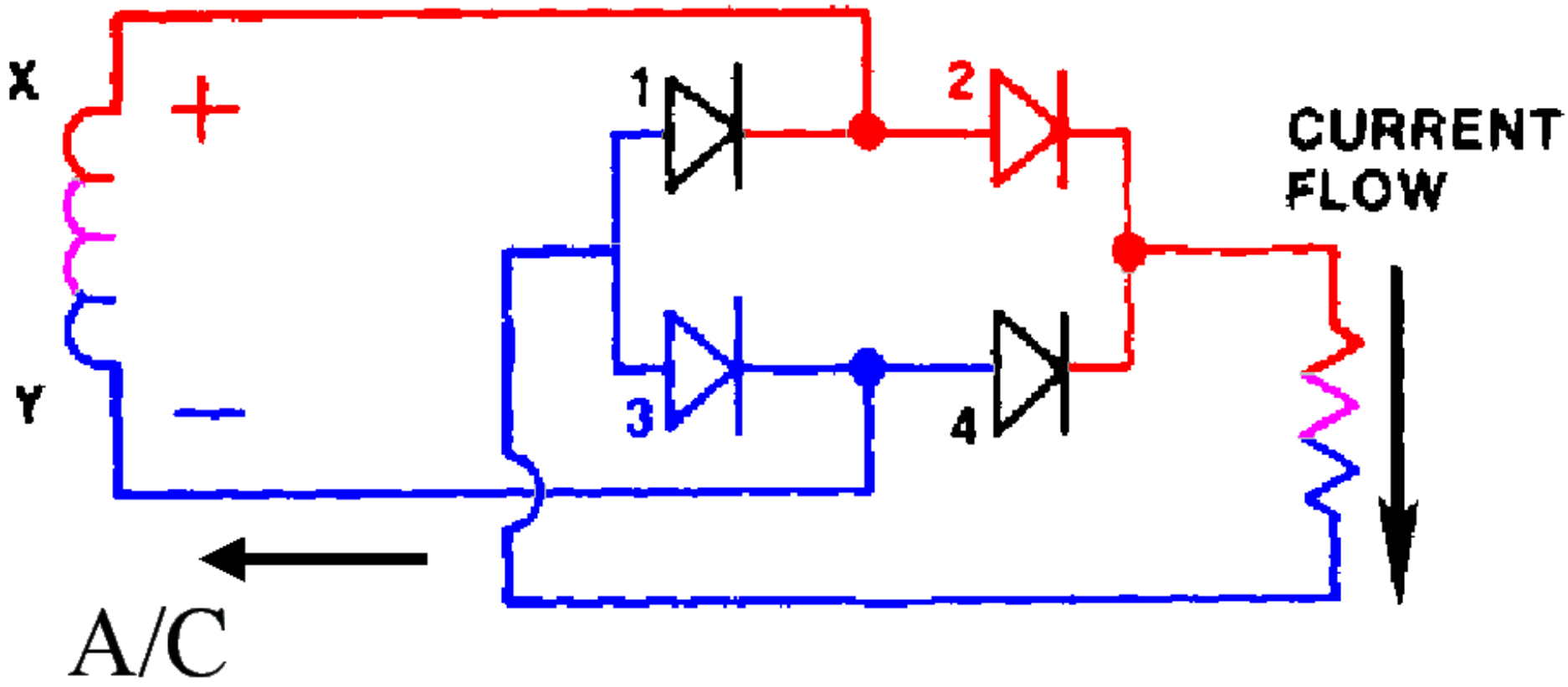
Diode is reverse biased **Current is blocked**



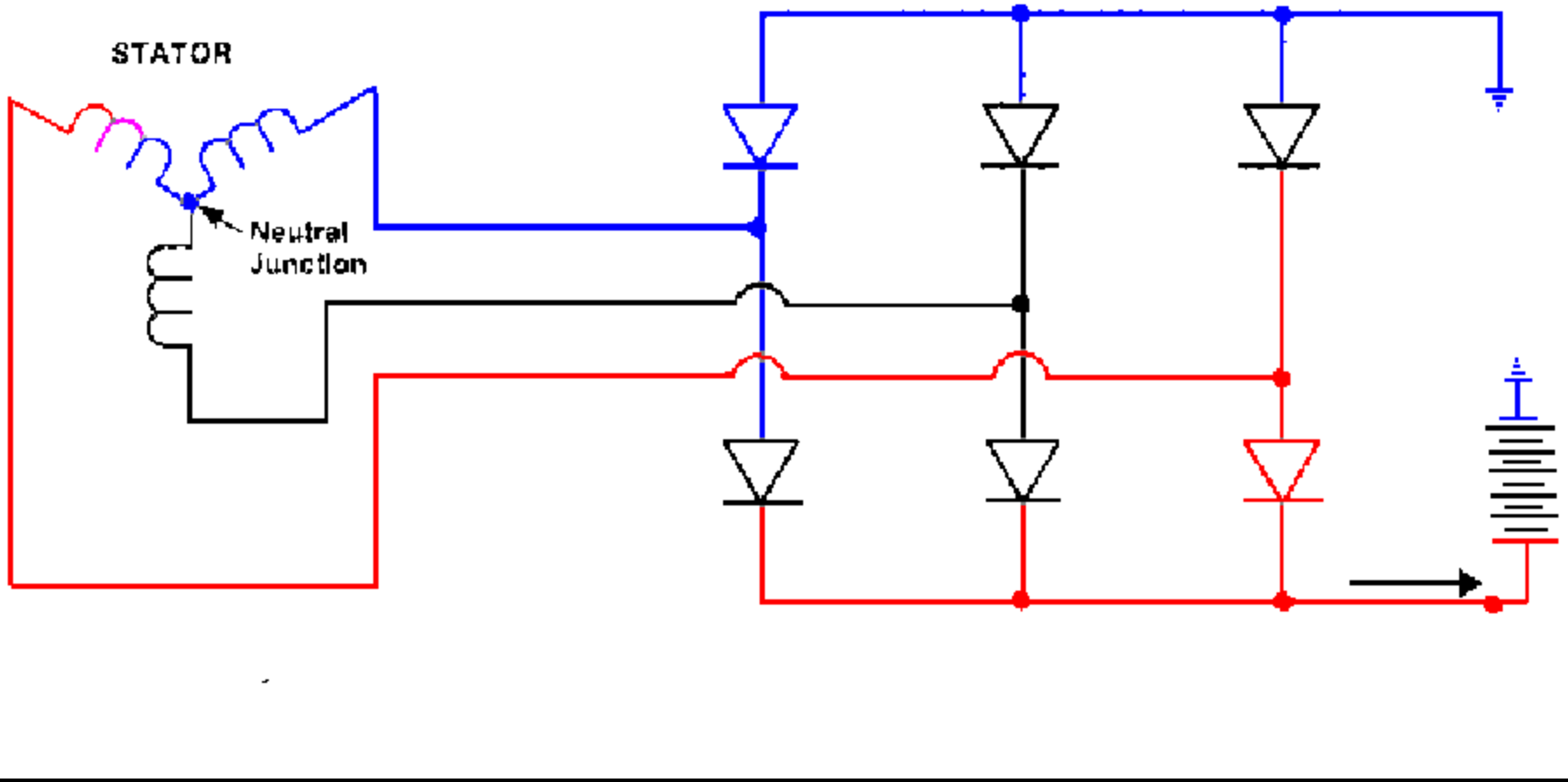
Full Wave Rectification …
… one stator winding



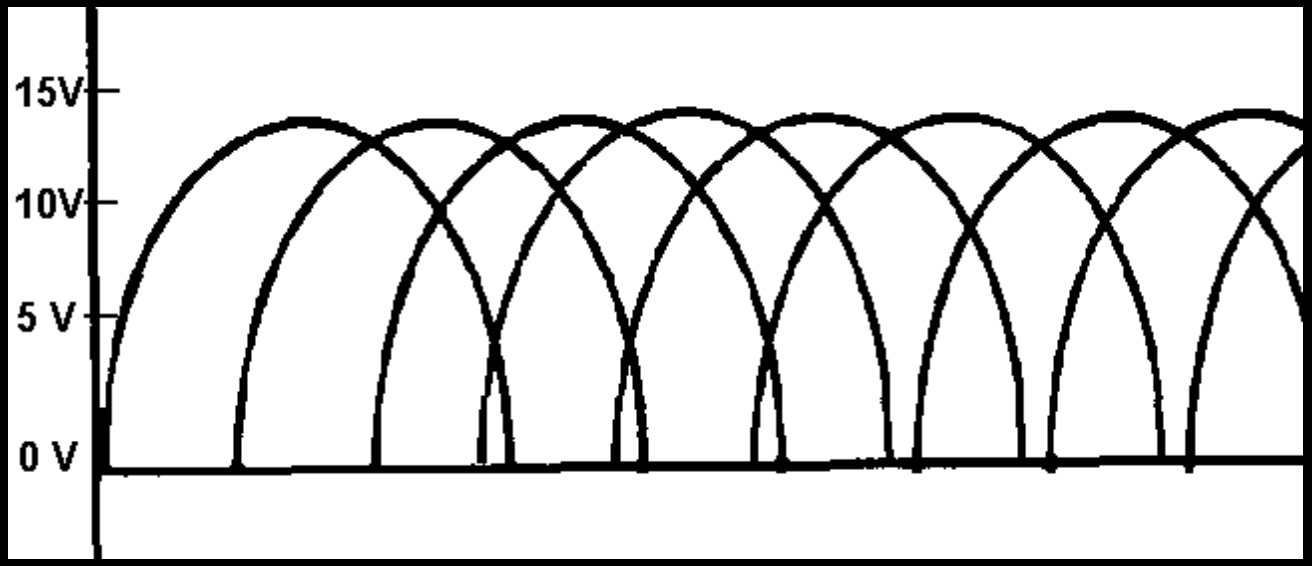
Full Wave Rectification …
… one stator winding



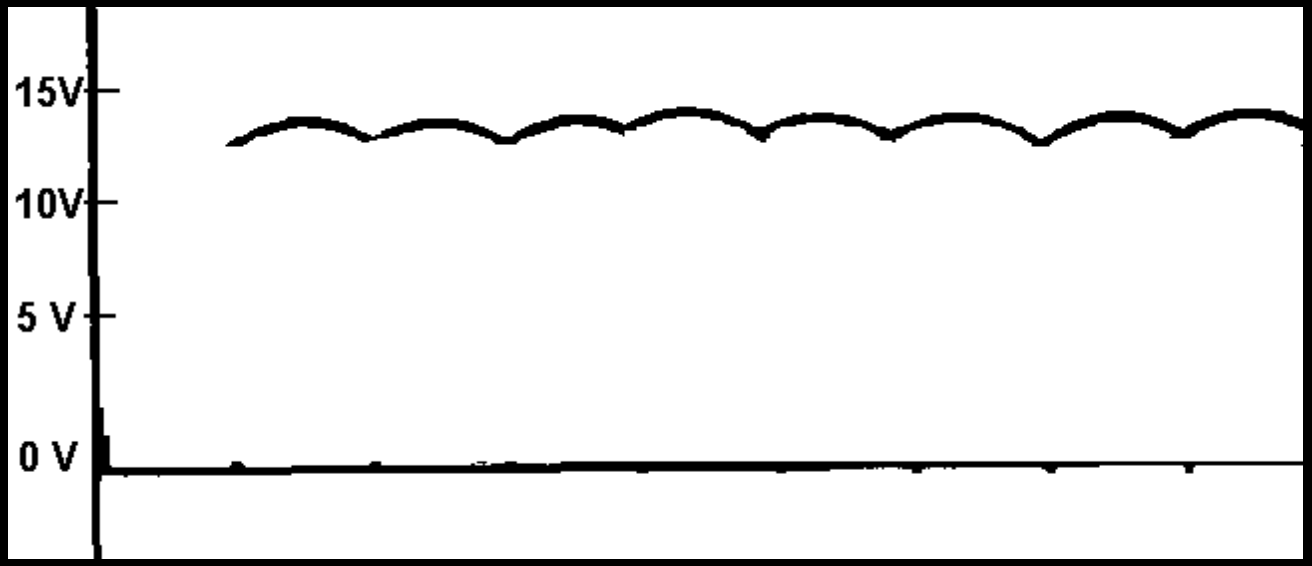
Full Wave Rectification …
… one stator winding



Full Wave Rectification …
… three stator windings

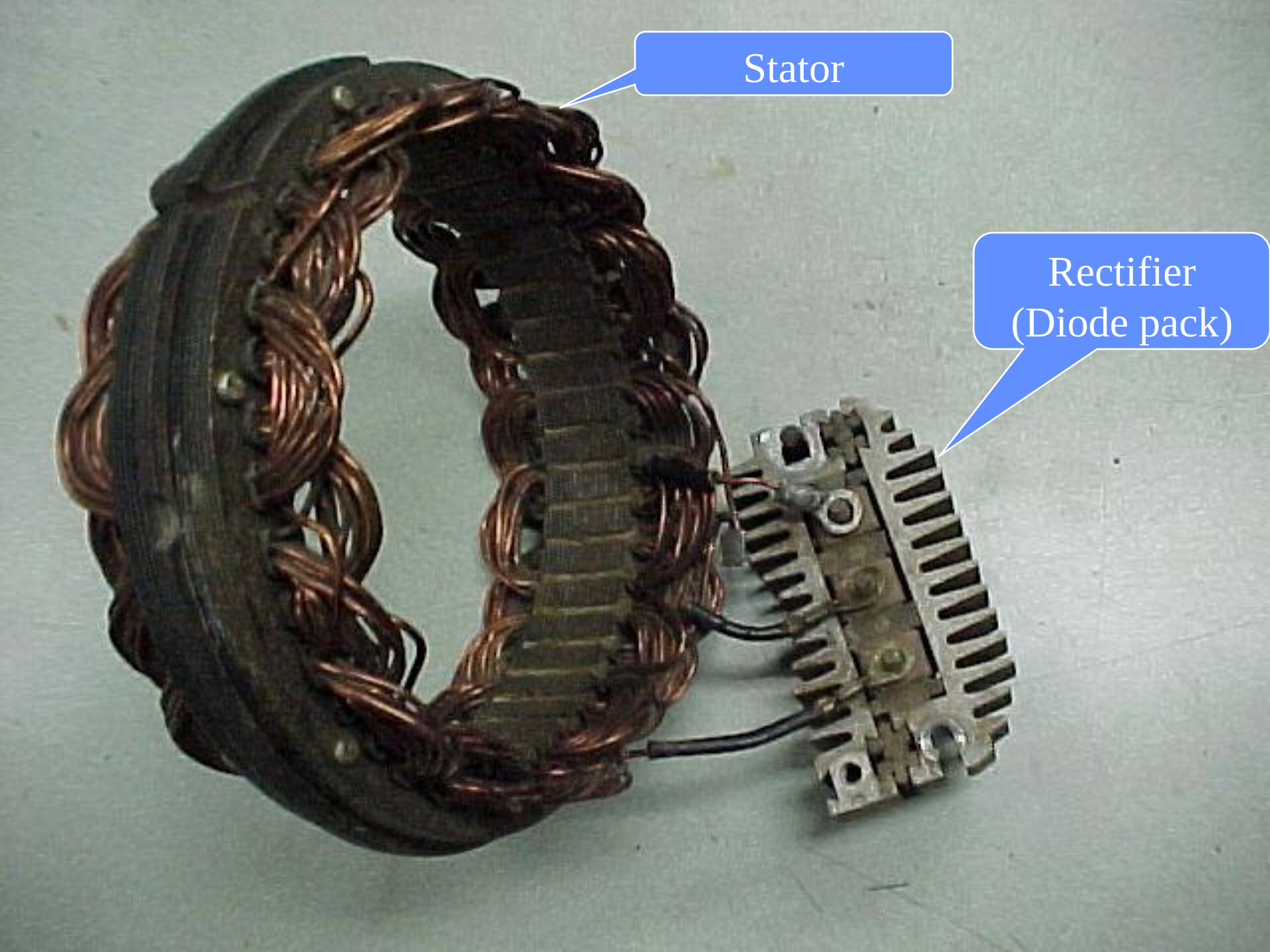


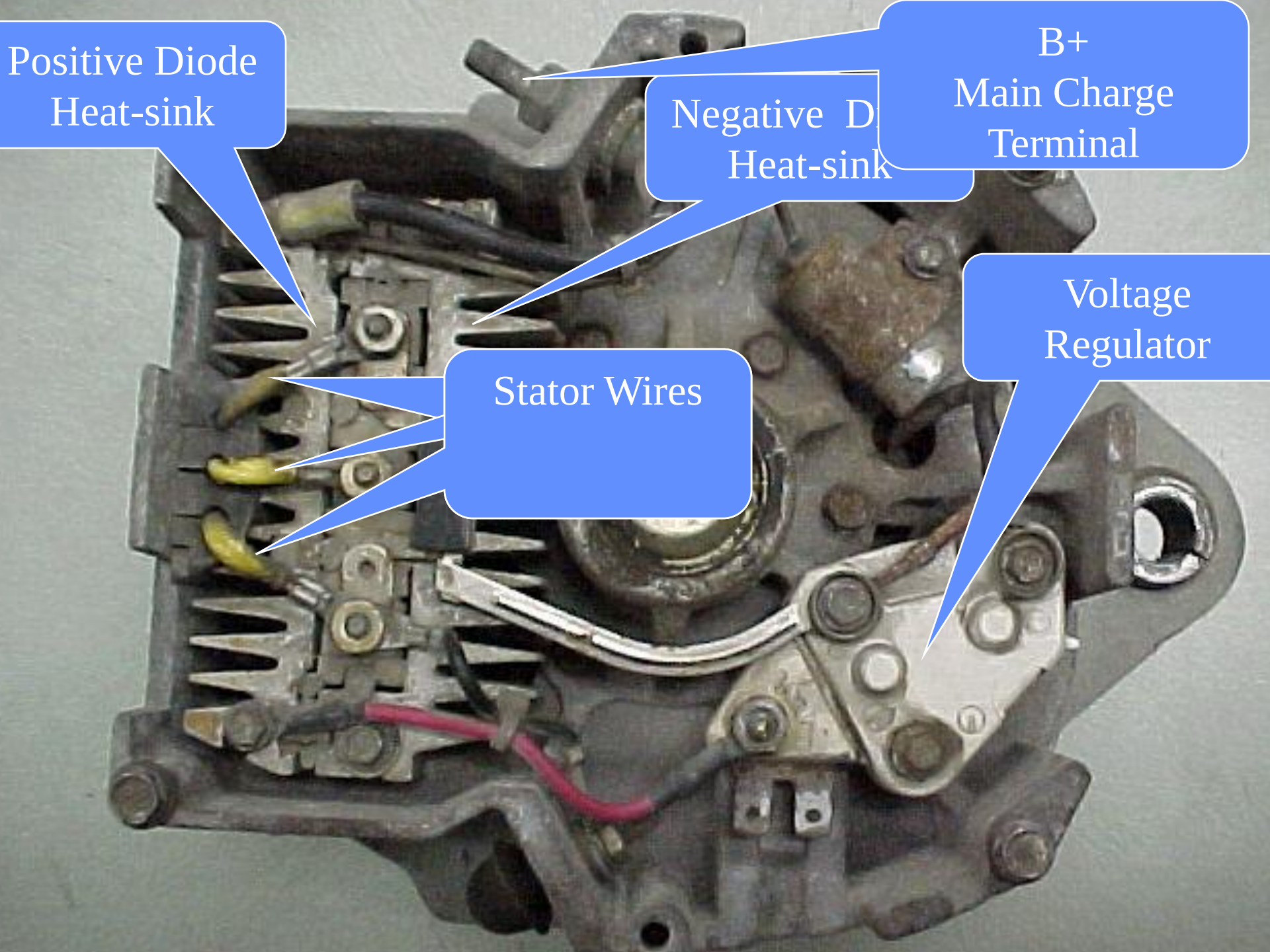
Actual voltage trace of each stator winding after full wave rectification

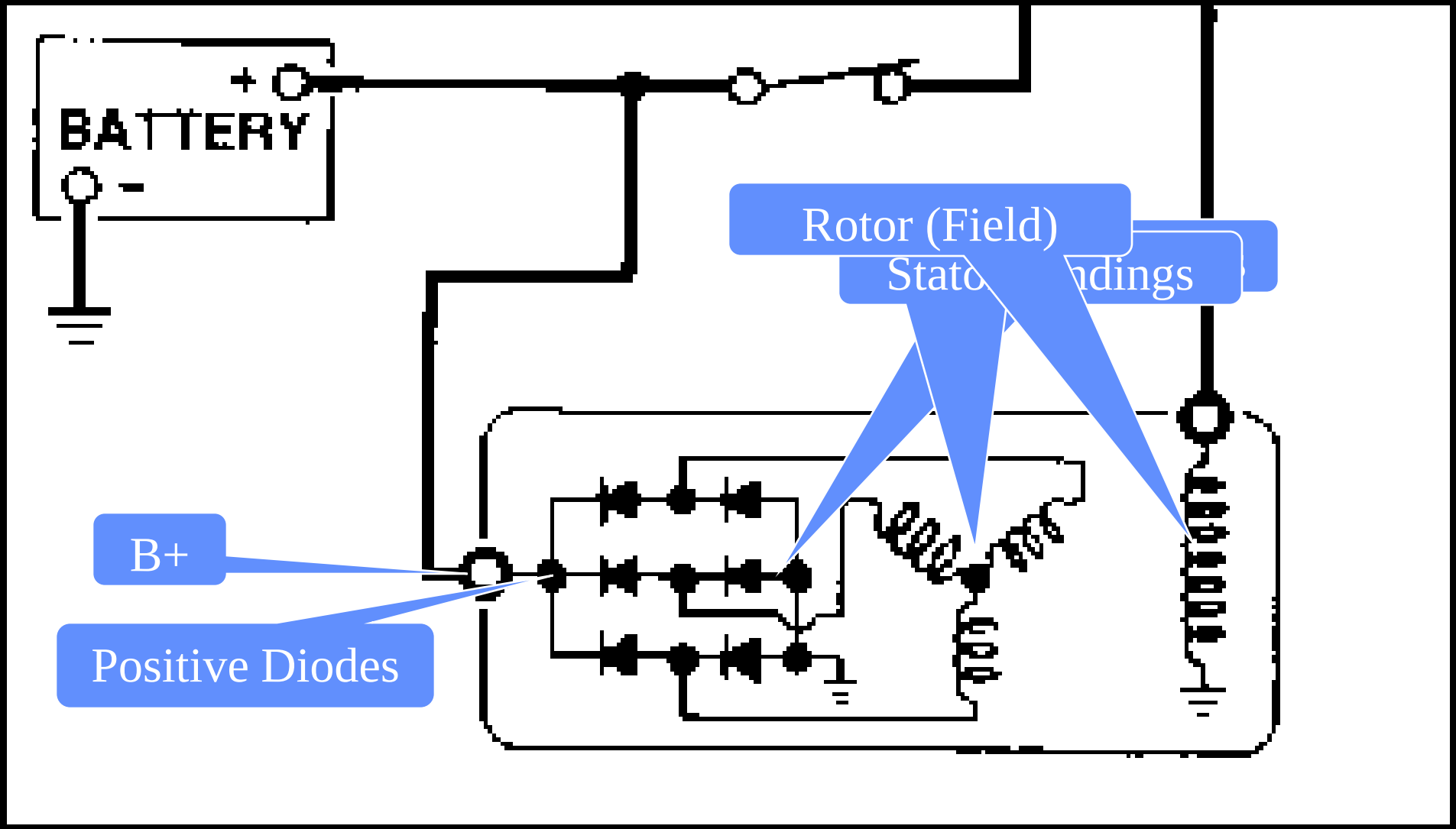


voltage trace on oscilloscope

(diode pattern)


Stator
Rectifier
(Diode pack)

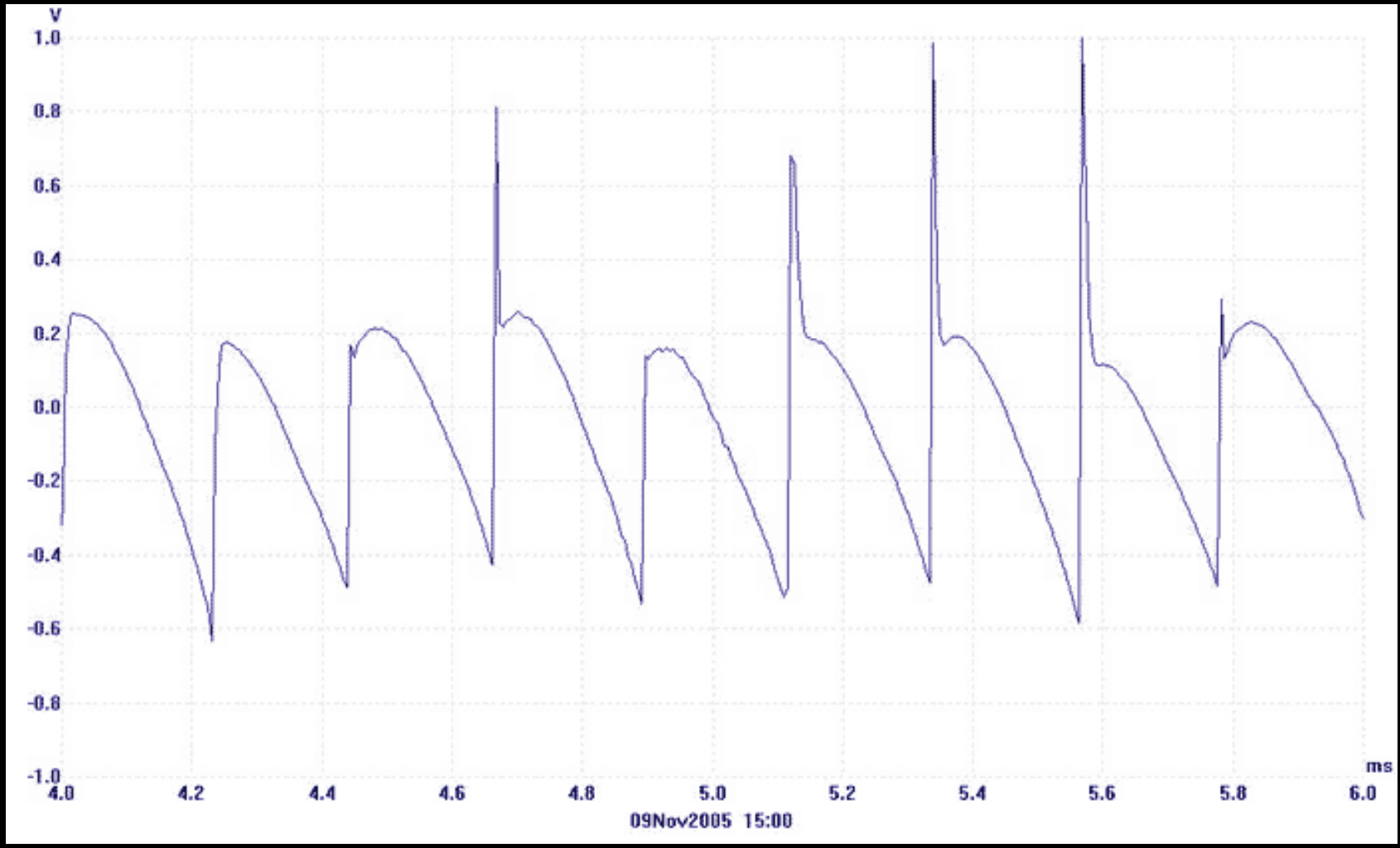

Positive Diode
Heat-sink
Negative D
Heat-sink
B+
Main Charge
Terminal
Voltage
Regulator
Stator Wires


+
BATTERY
-
Rotor (Field)
B+
Positive Diodes

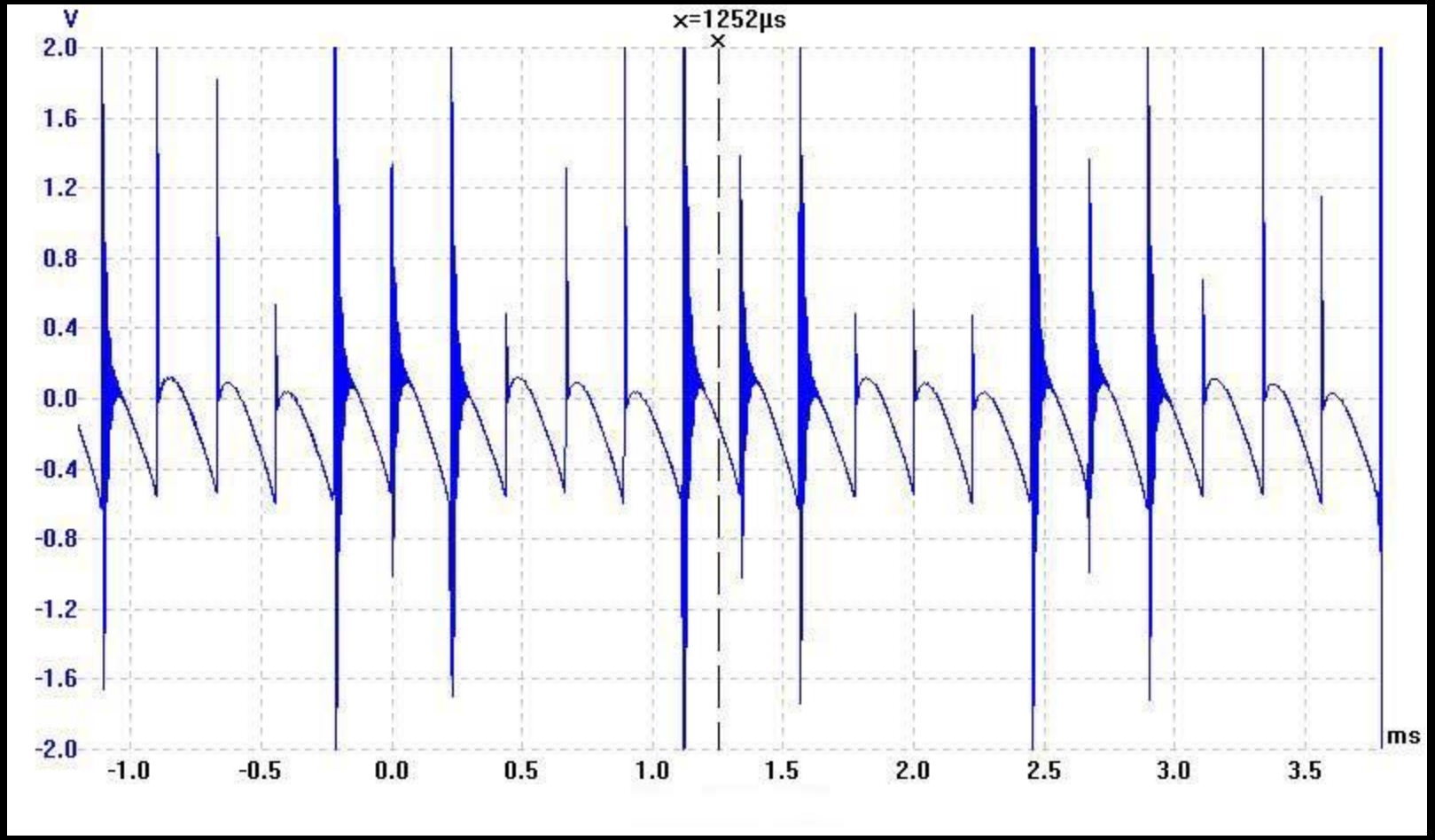
Test the electrical integrity of the diodes

Use an A/C voltmeter, or oscilloscope while the alternator is loaded

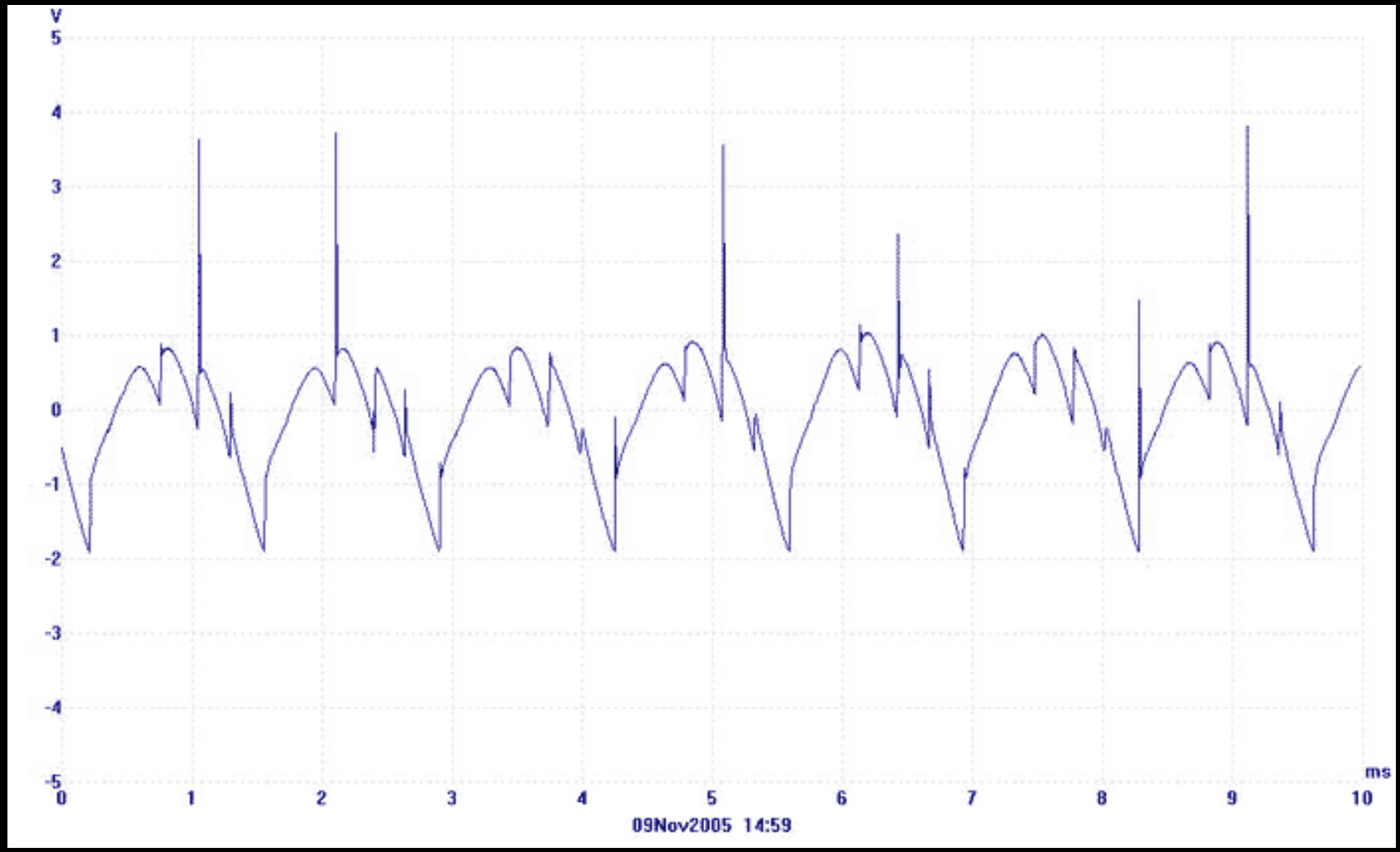
Turn on accessories, or put 40 amp draw on carbon pile



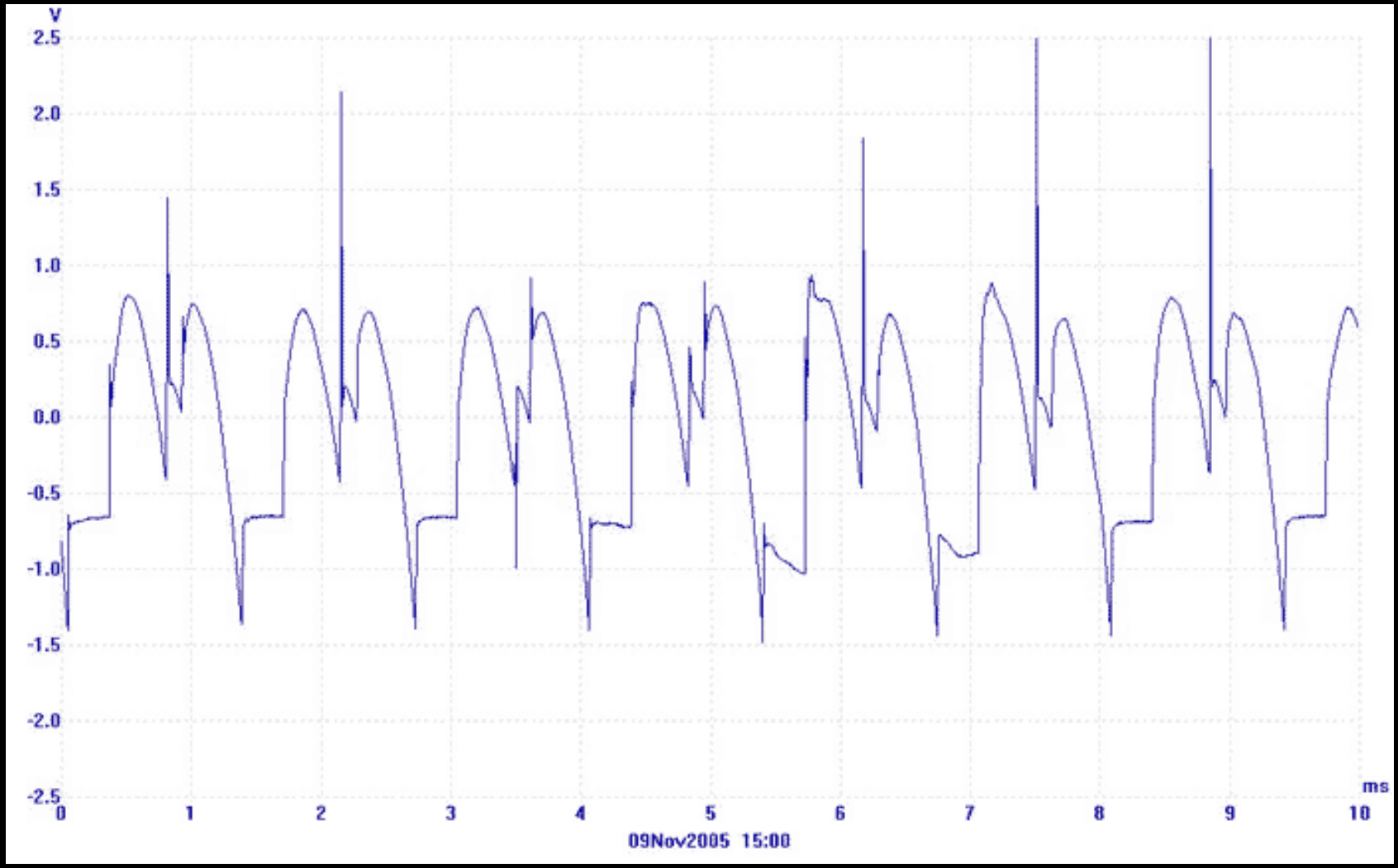
Here is a normal diode pattern



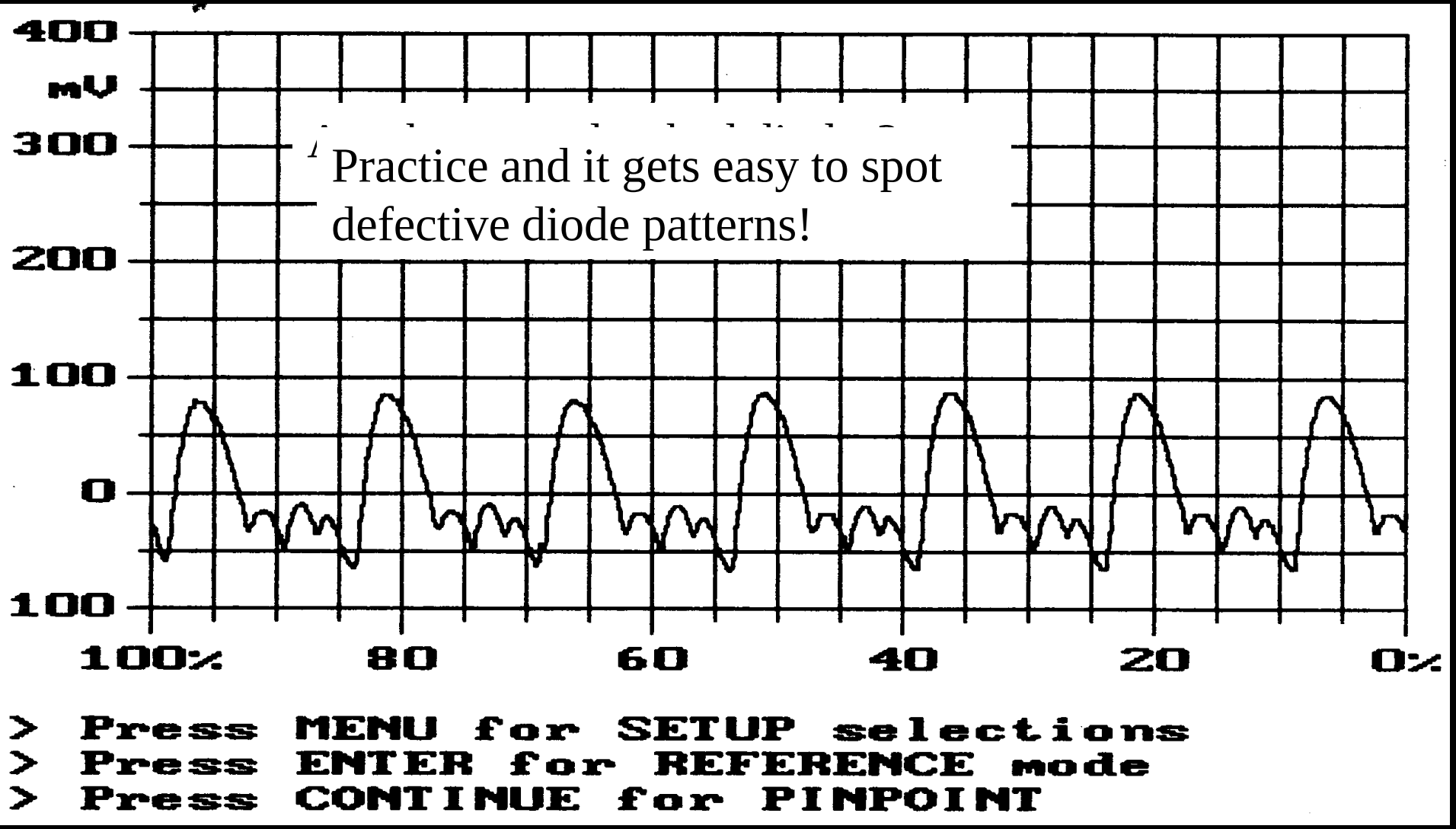
Here is a normal diode pattern



Open diode pattern



Shorted diode pattern



Scope set for A/C voltage

Practice with Diode Patterns

- Different alternator diodes give slightly different diode patterns
- If you look at many different alternator diode patterns you will learn to quickly spot bad diodes
- Defective diodes can cause many engine performance problems
- Do not forget to load the system

How can you increase the amperage coming out of the generator?

Increase engine RPM

(This is limited to about 2500 RPM)

Increase the rotor's magnetic field strength

Use a Delta stator winding

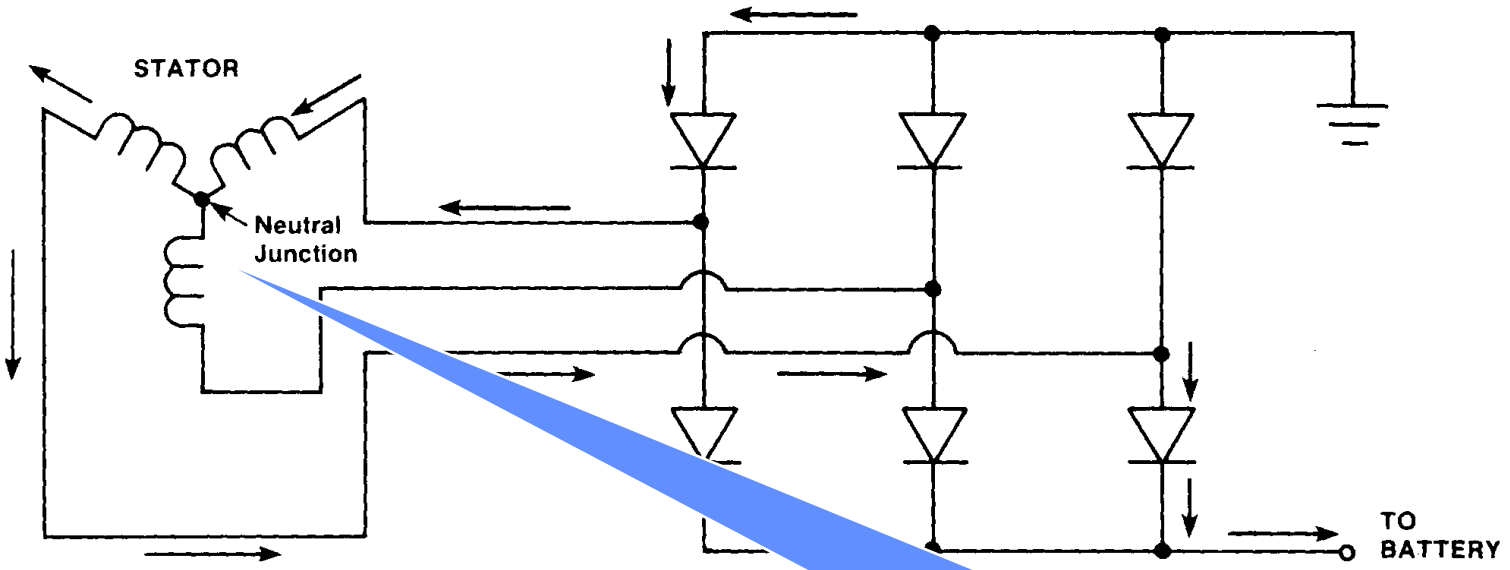


Figure 10–13 Wye stator wired to six diodes

Delta stator = higher output

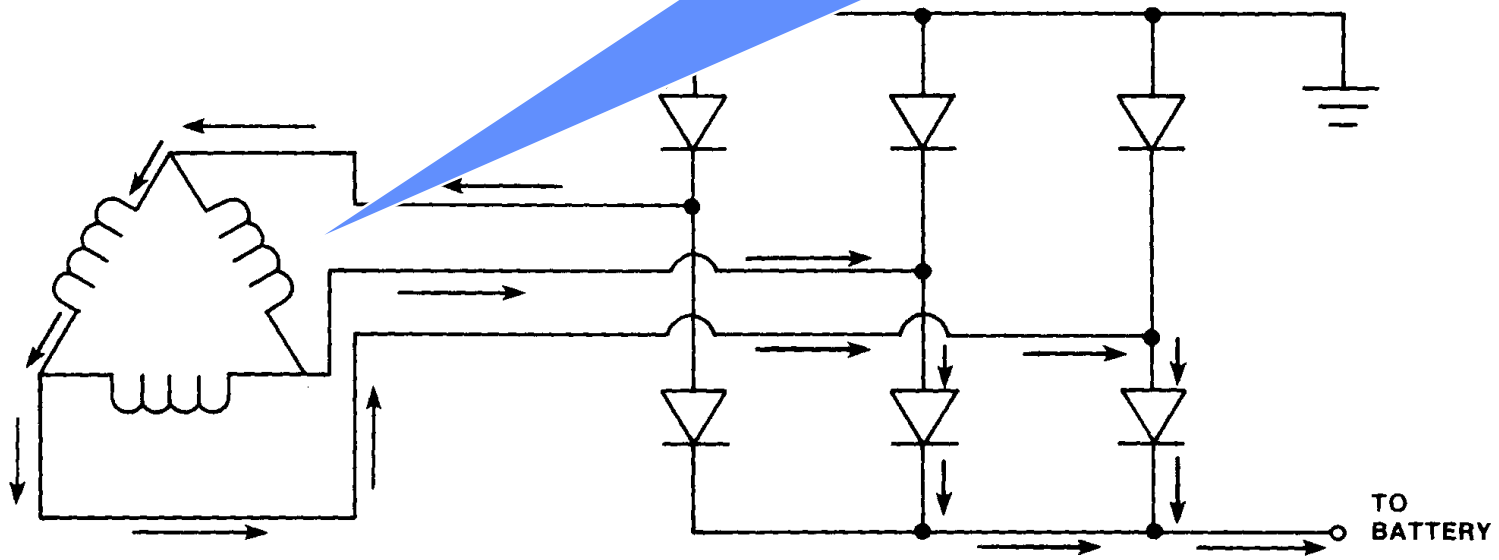


Figure 10–14 Delta stator wired to six diodes

How does the voltage regulator control the A/C generator?

The regulator will turn on/off current to the field windings (rotor)

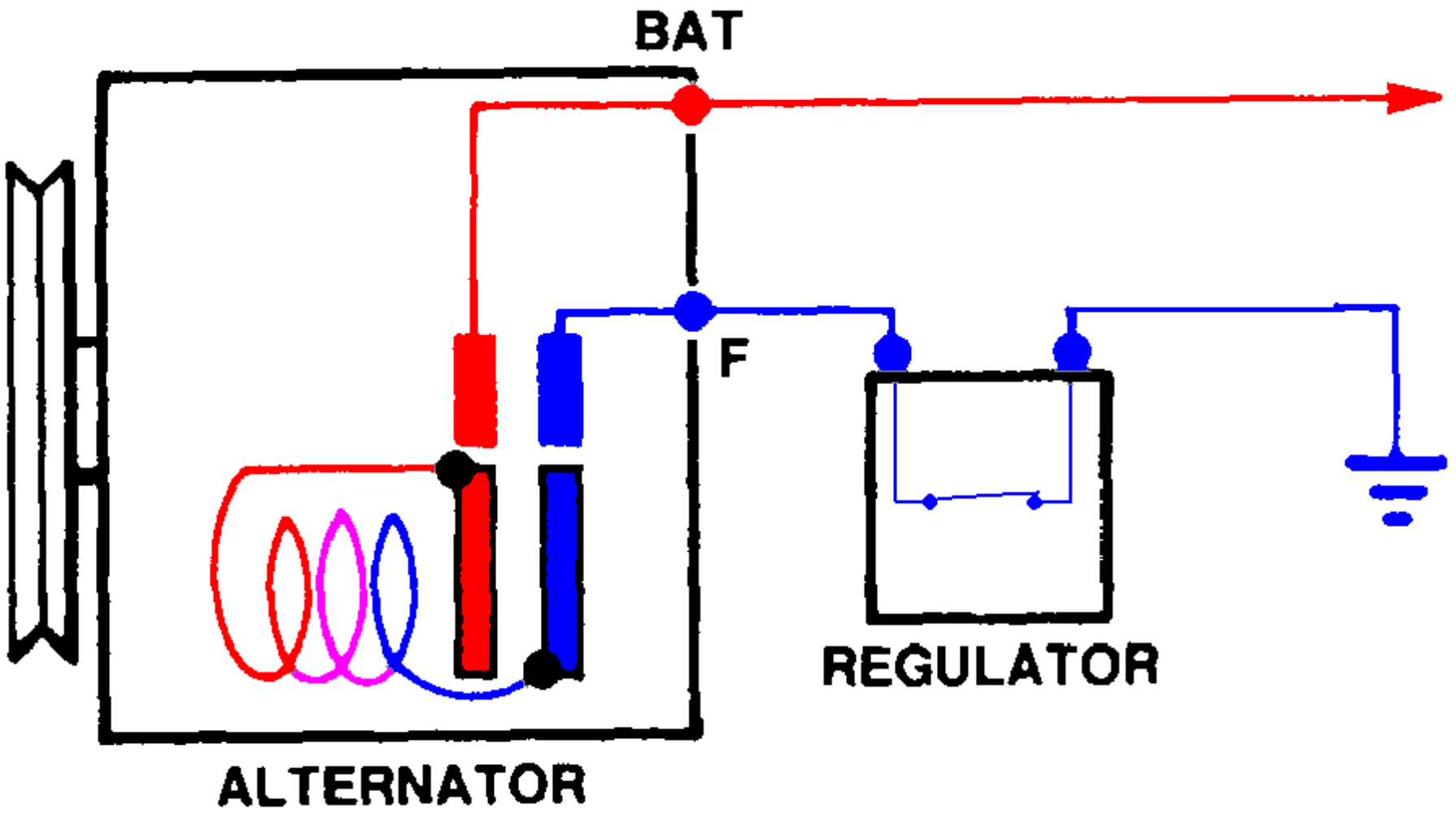
Increasing current to the rotor…

…will increase generator output

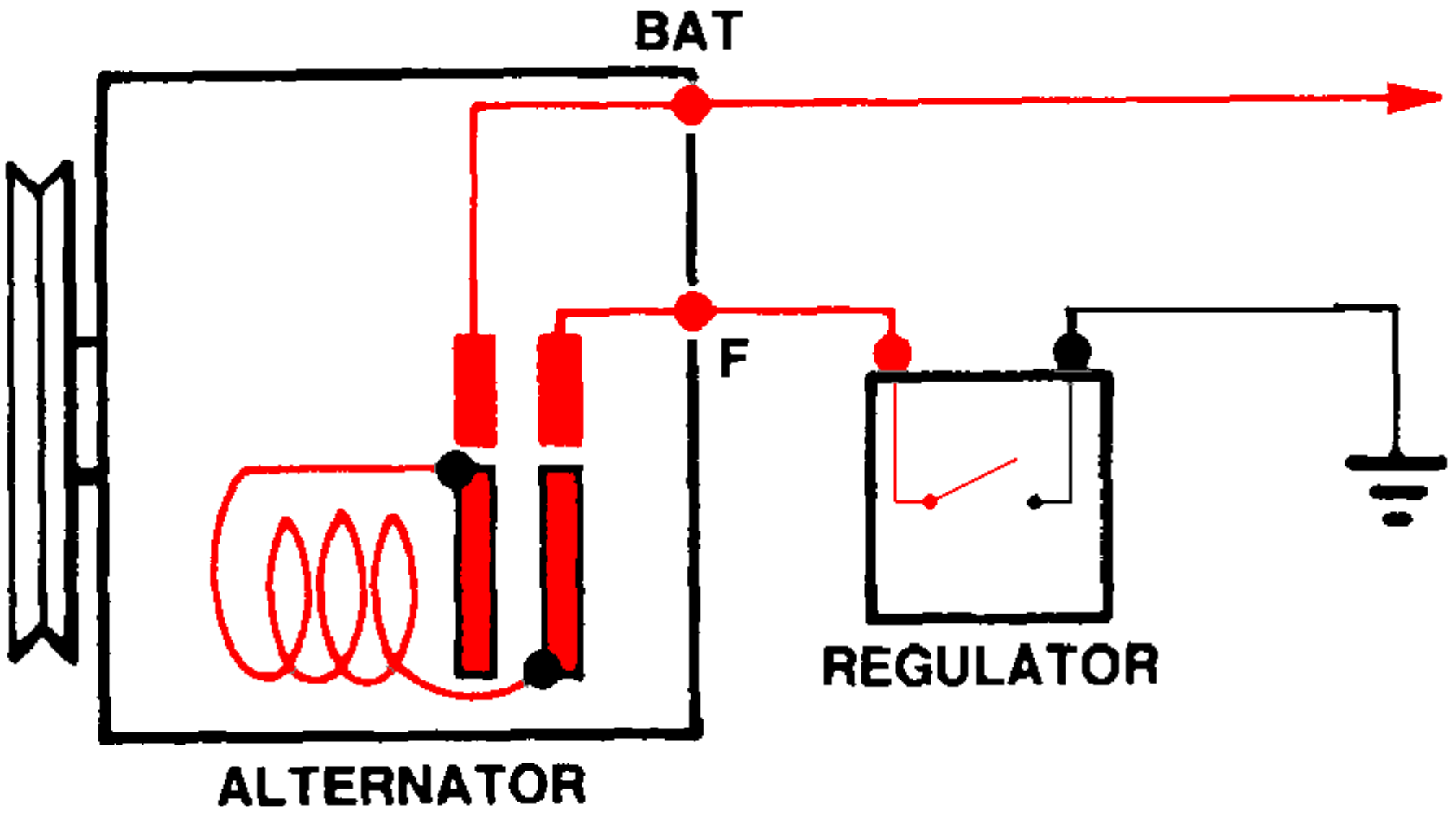
How does the voltage regulator control the A/C generator?

Regulators are wired to the Ground side of the Rotor in an A type circuit

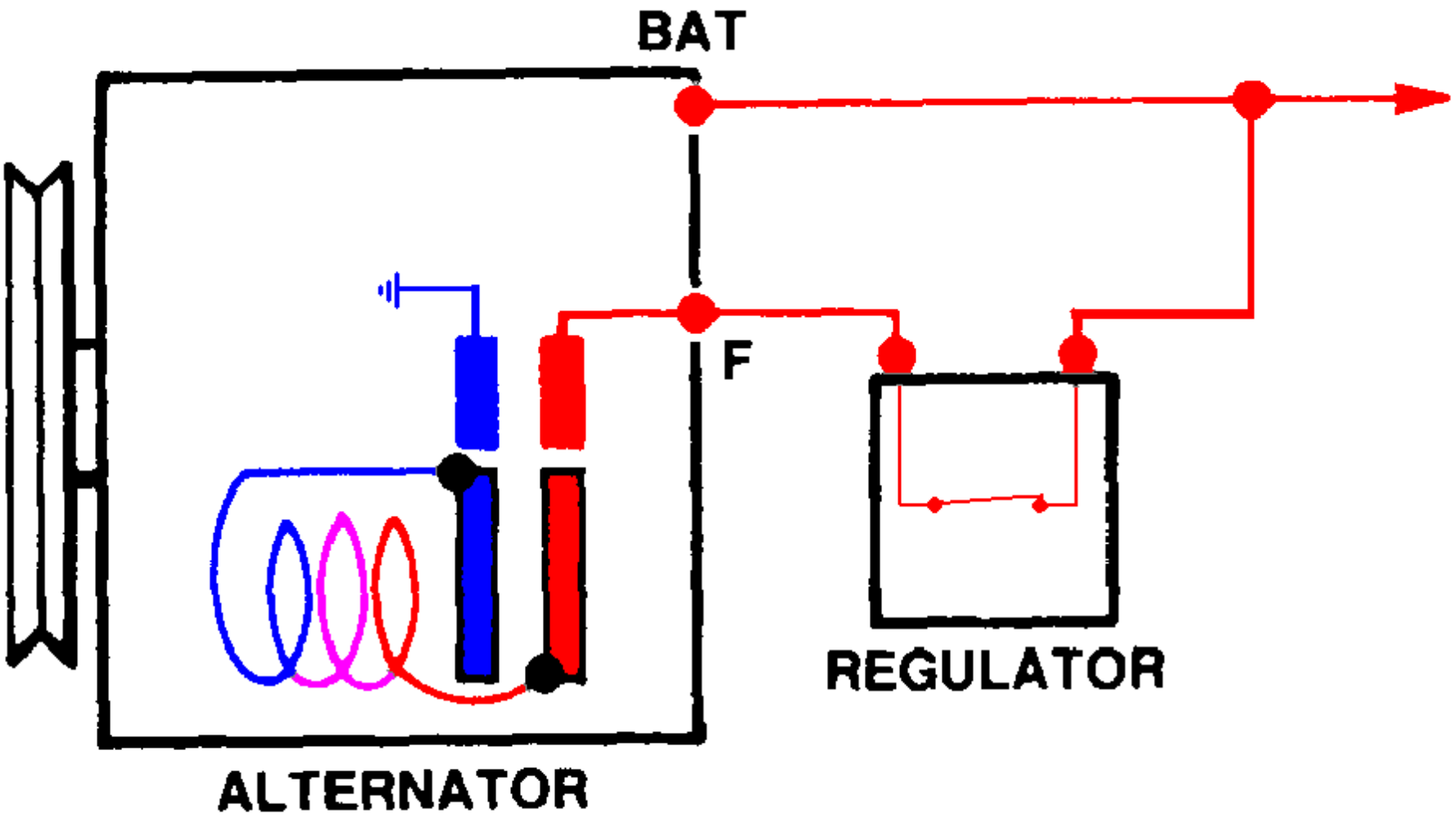
and wired to the **B**attery side of the Rotor in a B type circuit



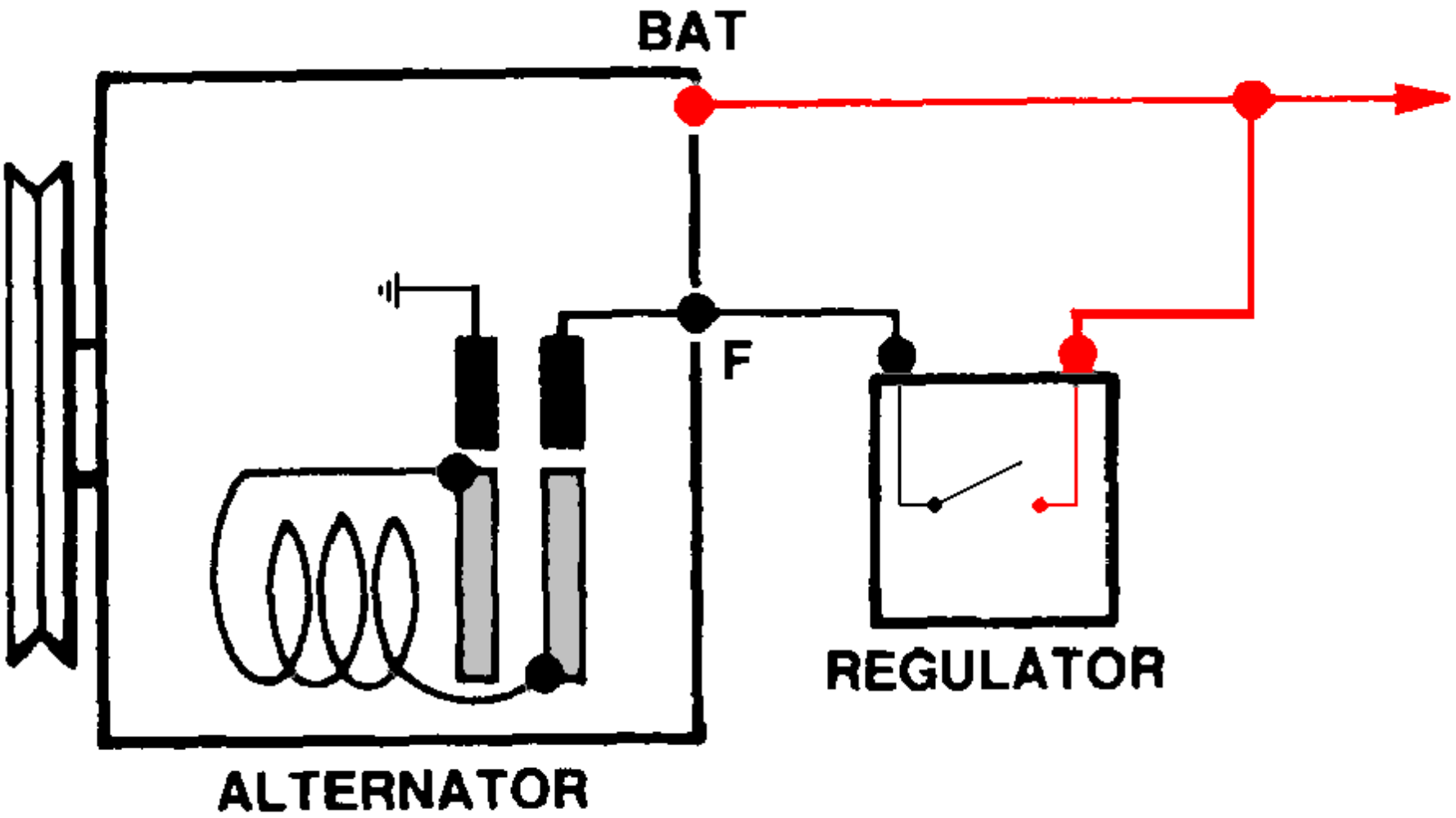
“A” circuit regulator



“A” circuit regulator



“B” circuit regulator

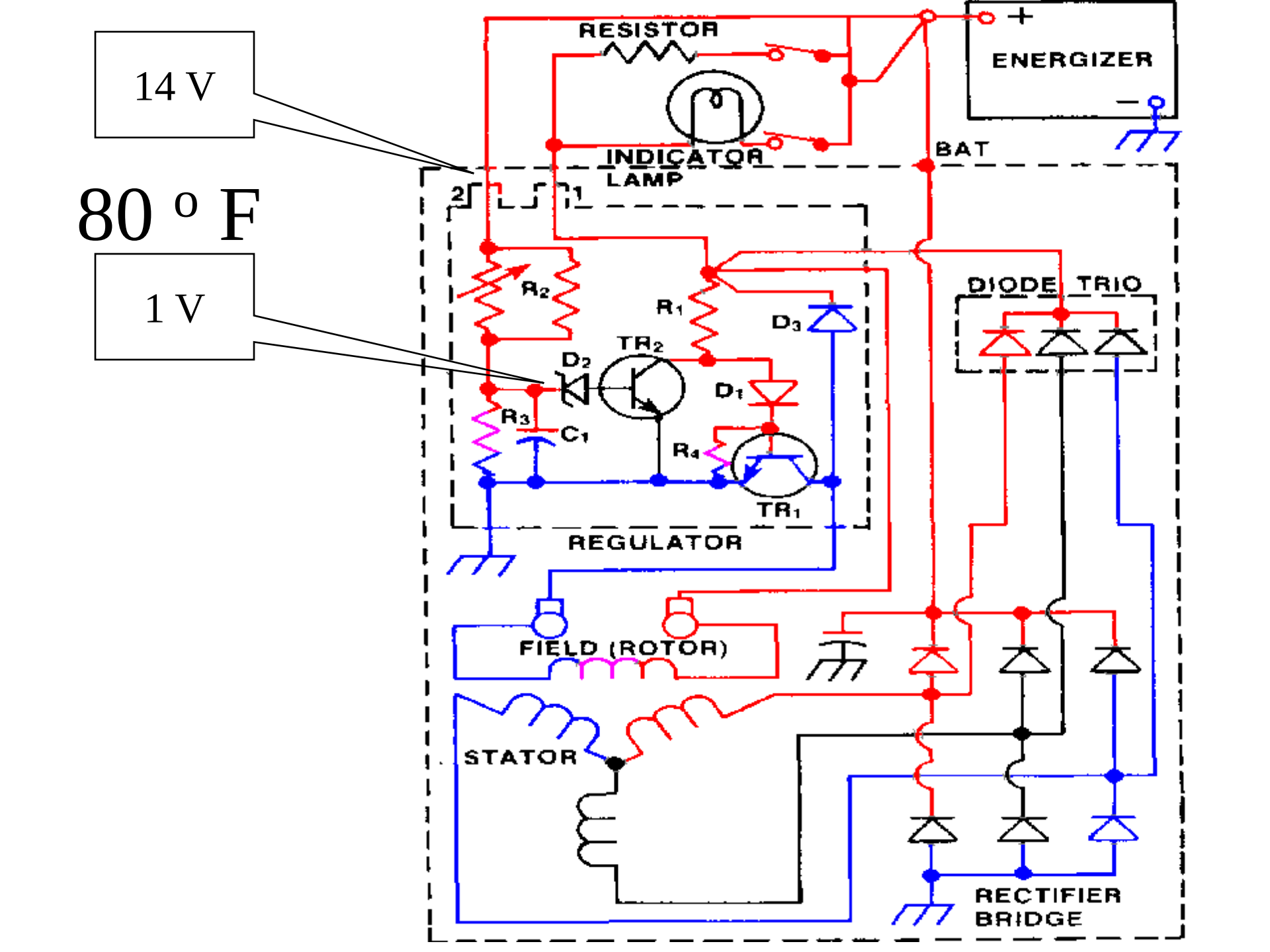


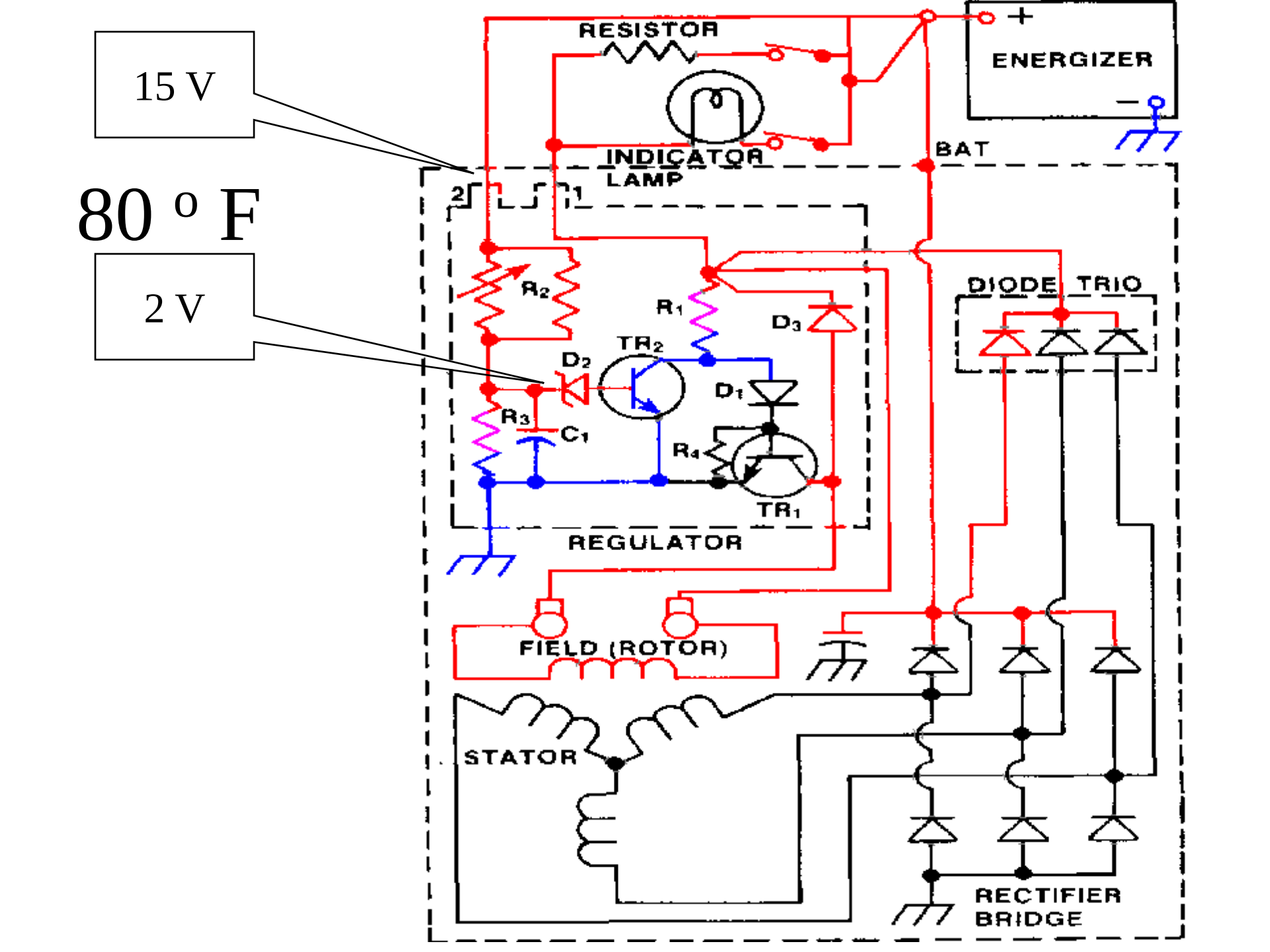
“B” circuit regulator

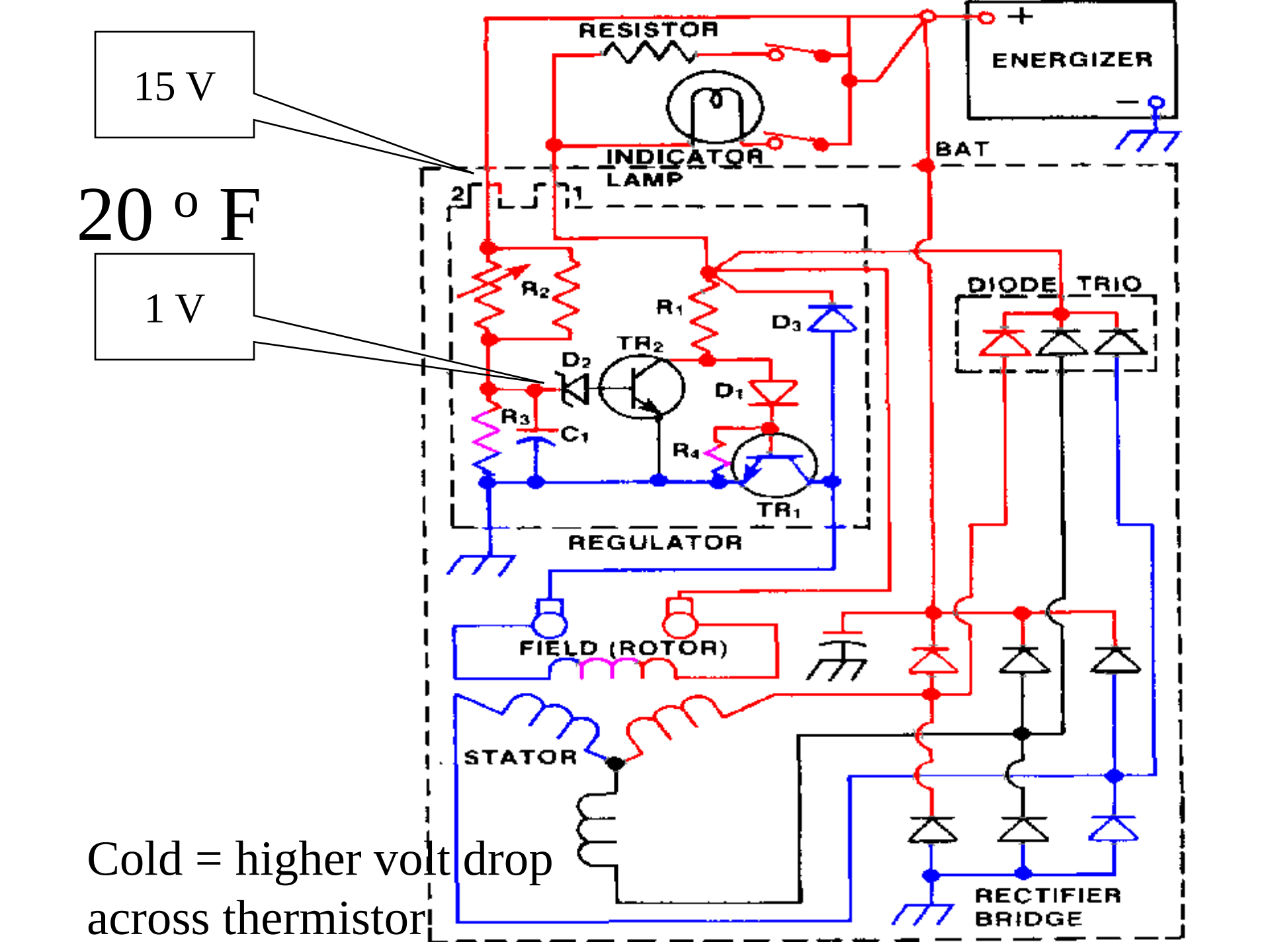
Voltage regulators monitor

Voltage

Temperature


14 V
80 º F
1 V
RESISTOR
INDICATOR LAMP
ENERGIZER
+
–
BAT
2
1
R2
R1
D3
TR2
D2
D1
R3
C1
R4
TR1
REGULATOR
DIODE TRIO
FIELD (ROTOR)
STATOR
RECTIFIER BRIDGE


15 V
80 º F
2 V
RESISTOR
ENERGIZER
INDICATOR LAMP
BAT
2
1
R2
R1
D3
TR2
D2
D1
R3
C1
R4
TR1
REGULATOR
DIODE TRIO
FIELD (ROTOR)
STATOR
RECTIFIER BRIDGE

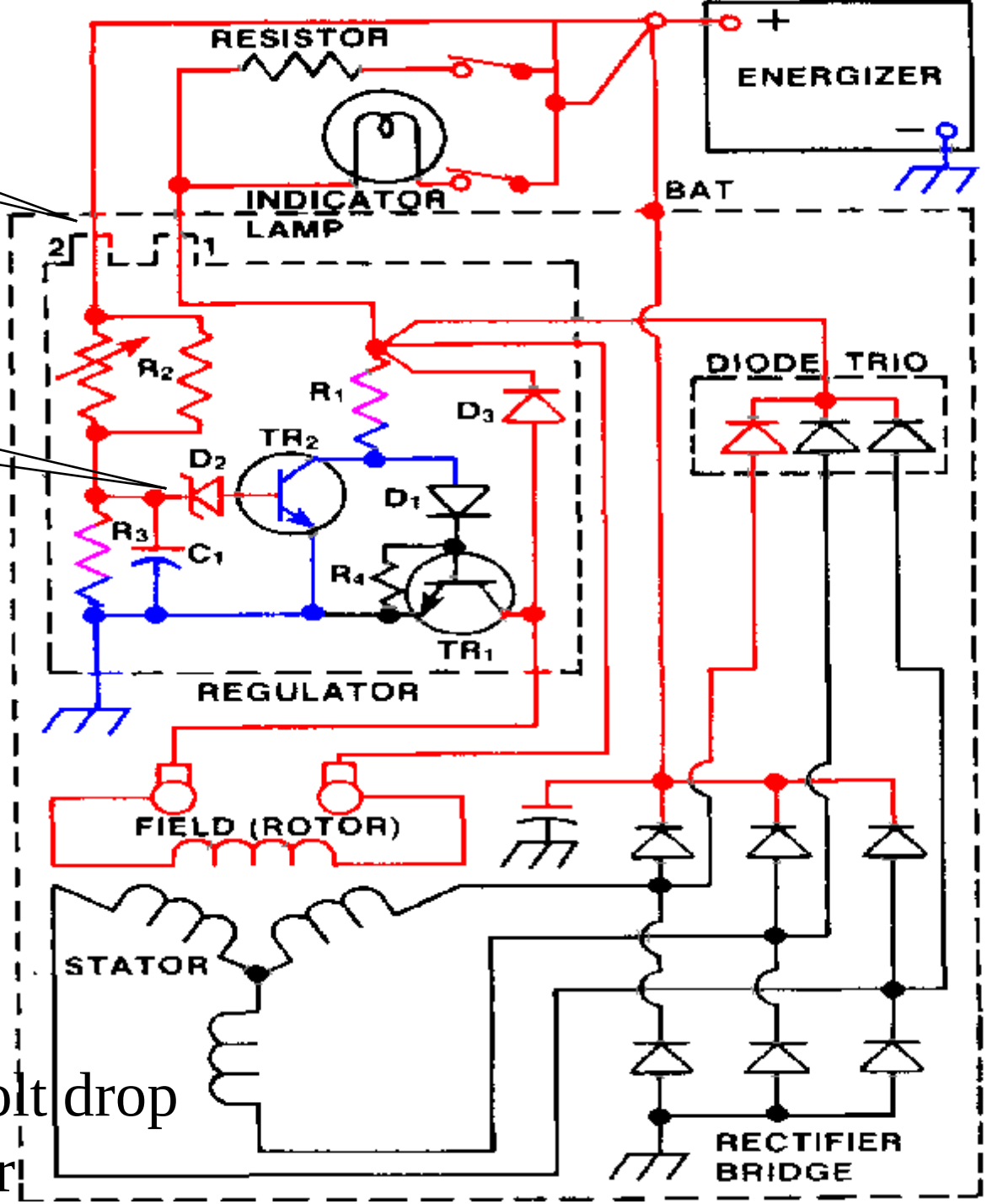


Cold = higher volt drop across thermistor

16 V

20 º F

2 V

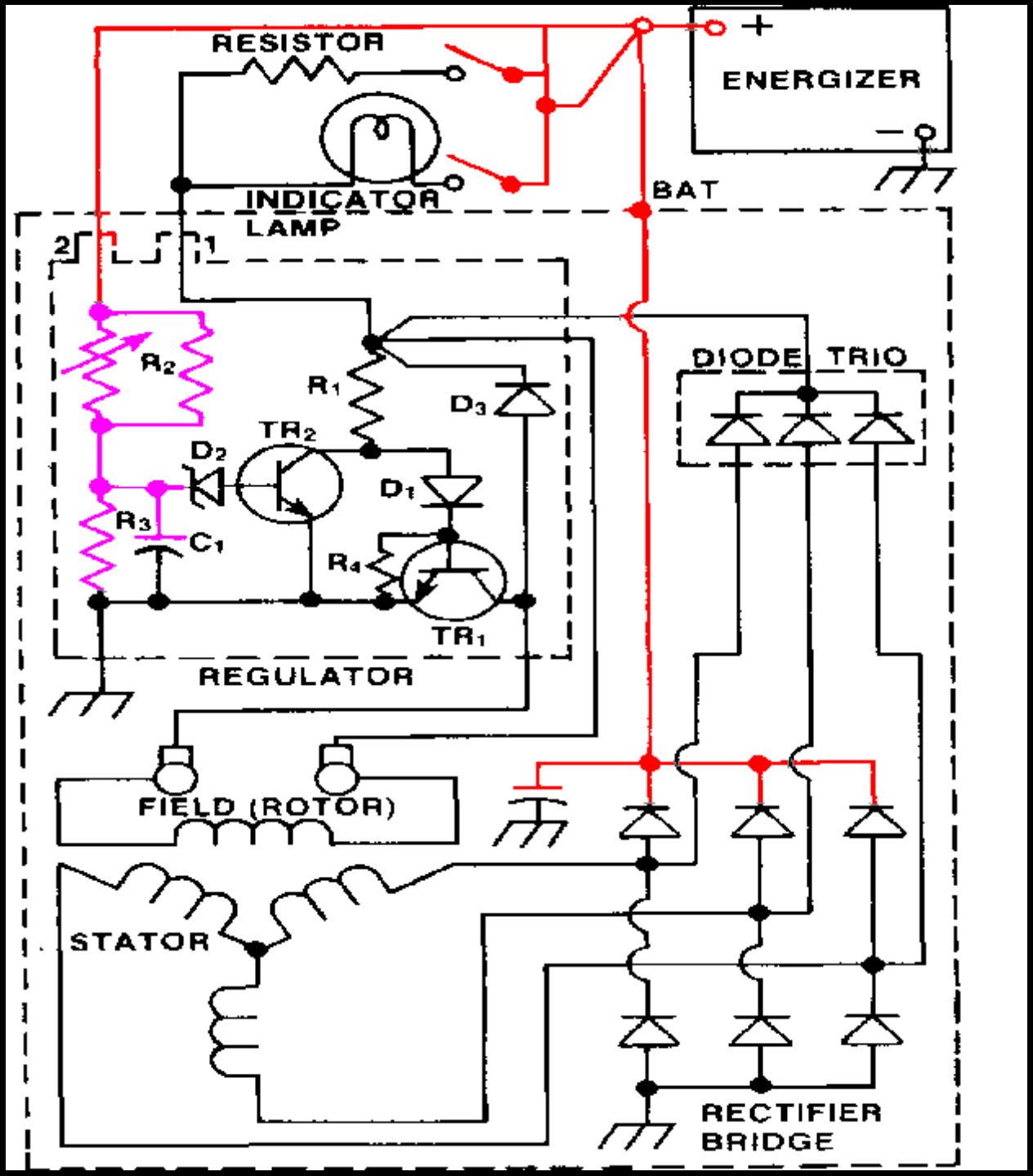


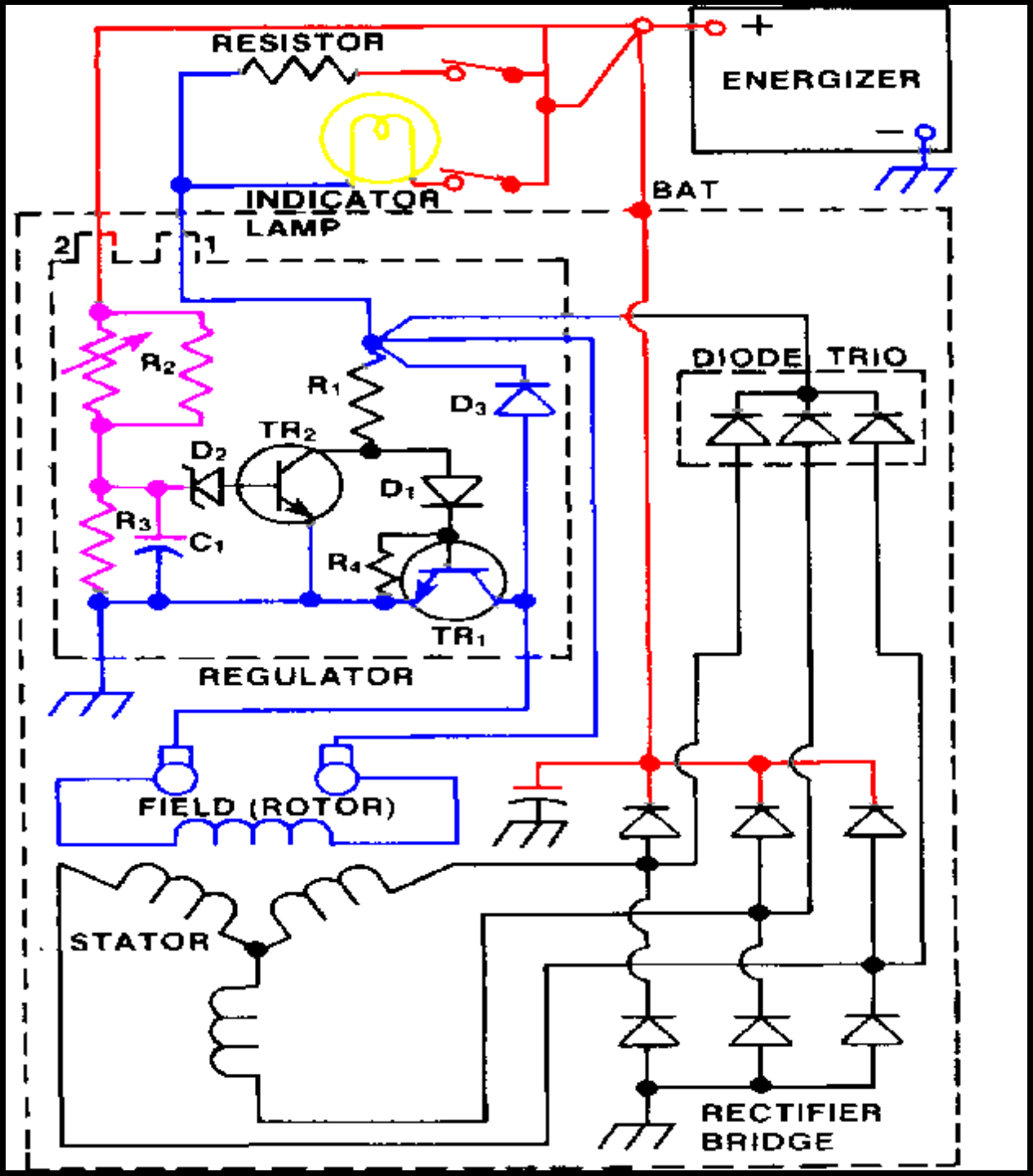
Cold = higher volt drop across thermistor

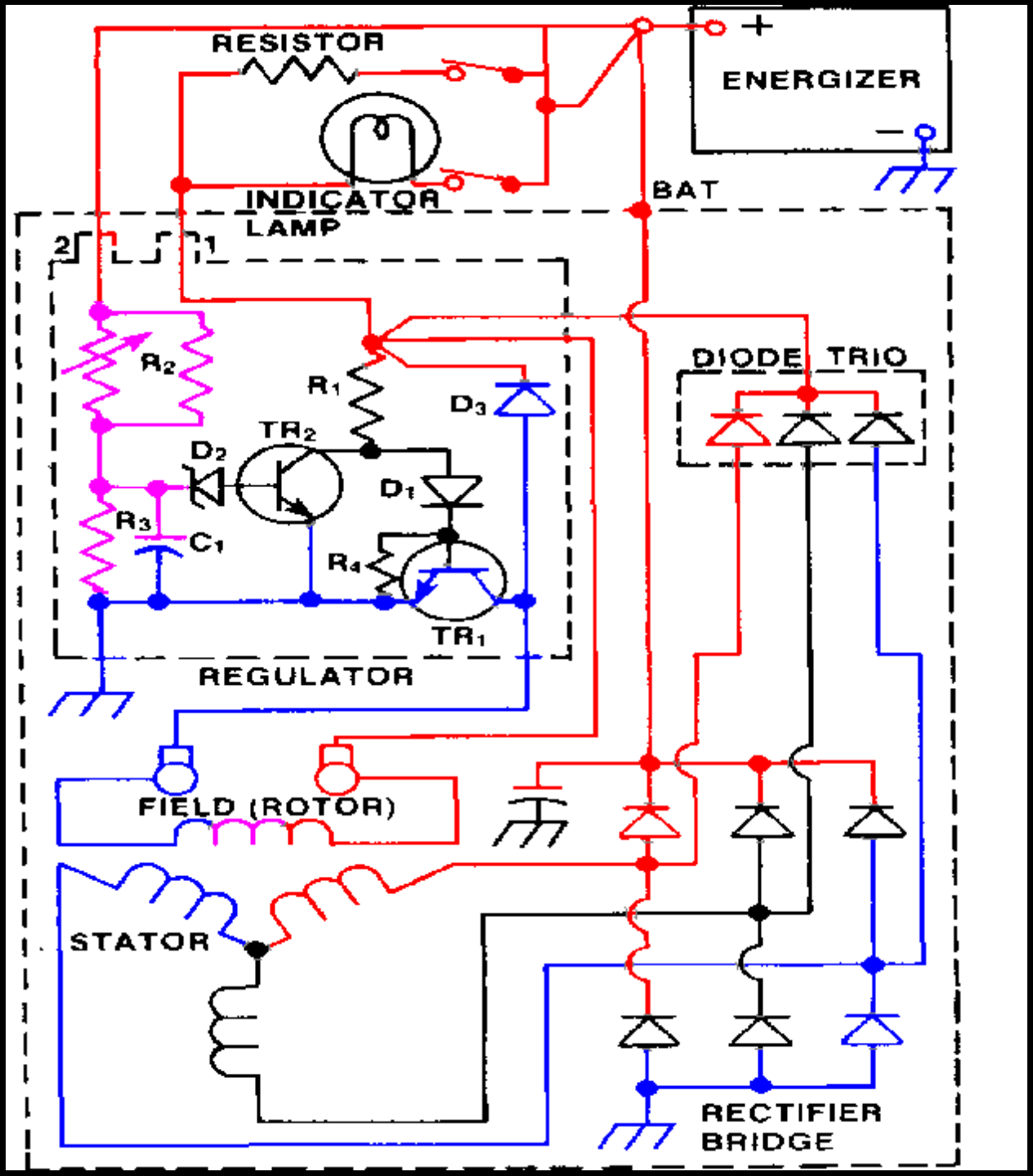
Voltage should:
increase when cold,
decrease when hot.

Explain how charging system indicators work

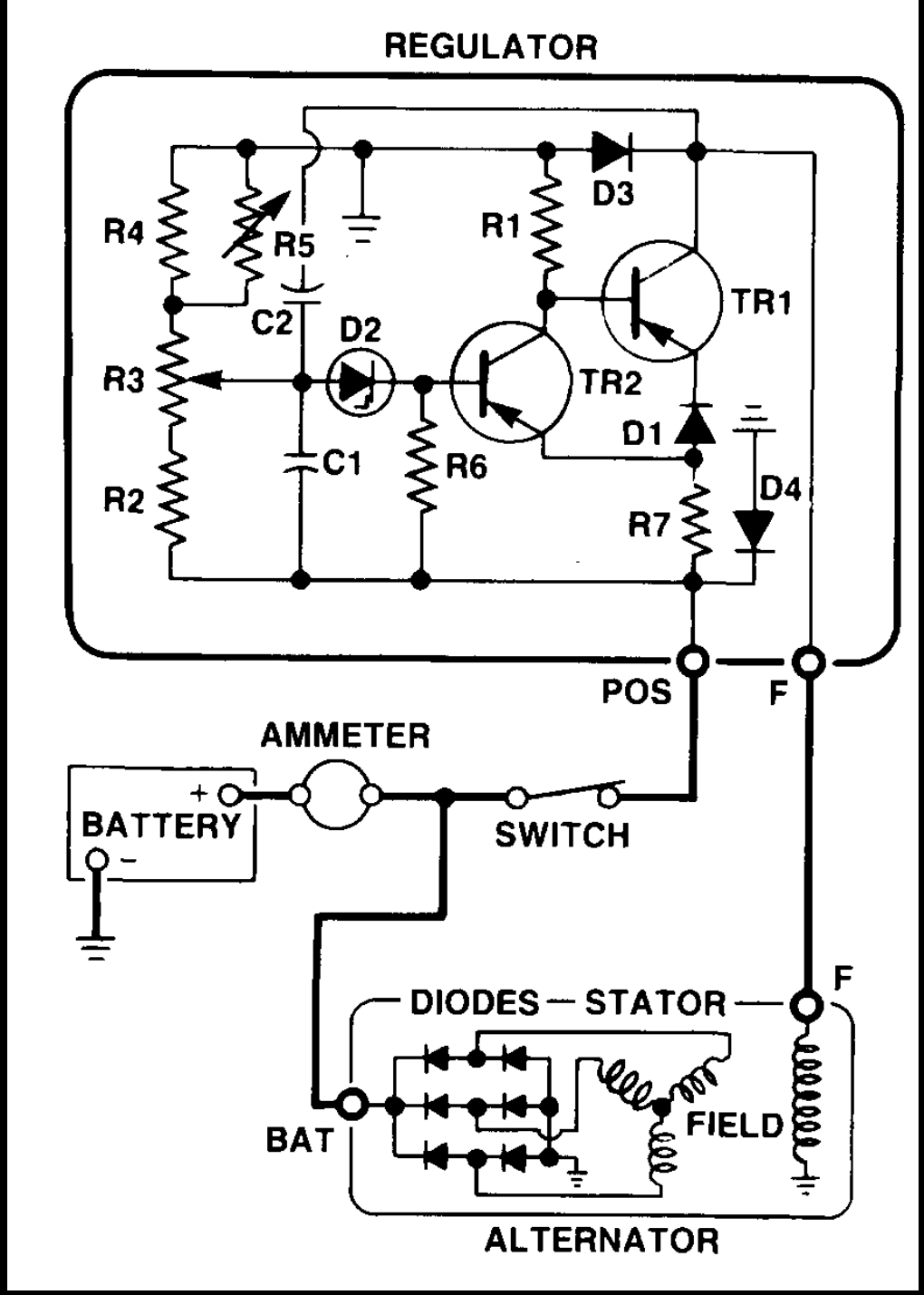
Idiot light


RESISTOR
INDICATOR LAMP
ENERGIZER
+
−
BAT
2
1
R2
R1
D3
TR2
D2
D1
R3
C1
R4
TR1
REGULATOR
DIODE TRIO
FIELD (ROTOR)
STATOR
RECTIFIER BRIDGE


RESISTOR
+
ENERGIZER
−
INDICATOR LAMP
BAT
2
1
R2
R1
D3
TR2
D2
D1
R3
C1
R4
TR1
REGULATOR
DIODE TRIO
FIELD (ROTOR)
STATOR
RECTIFIER BRIDGE


RESISTOR
INDICATOR LAMP
+
ENERGIZER
−
BAT
2
1
R2
R1
D3
TR2
D2
D1
R3
C1
R4
TR1
REGULATOR
DIODE TRIO
FIELD (ROTOR)
STATOR
RECTIFIER BRIDGE

- Explain how charging system indicators work
  - Idiot light
  - Voltmeter
  - Ammeter


REGULATOR
R4
R5
C2
R3
R2
C1
D2
R1
D3
TR1
TR2
D1
R6
R7
D4
POS
F
AMMETER
BATTERY
+
-
SWITCH
F
DIODES — STATOR
BAT
FIELD
ALTERNATOR

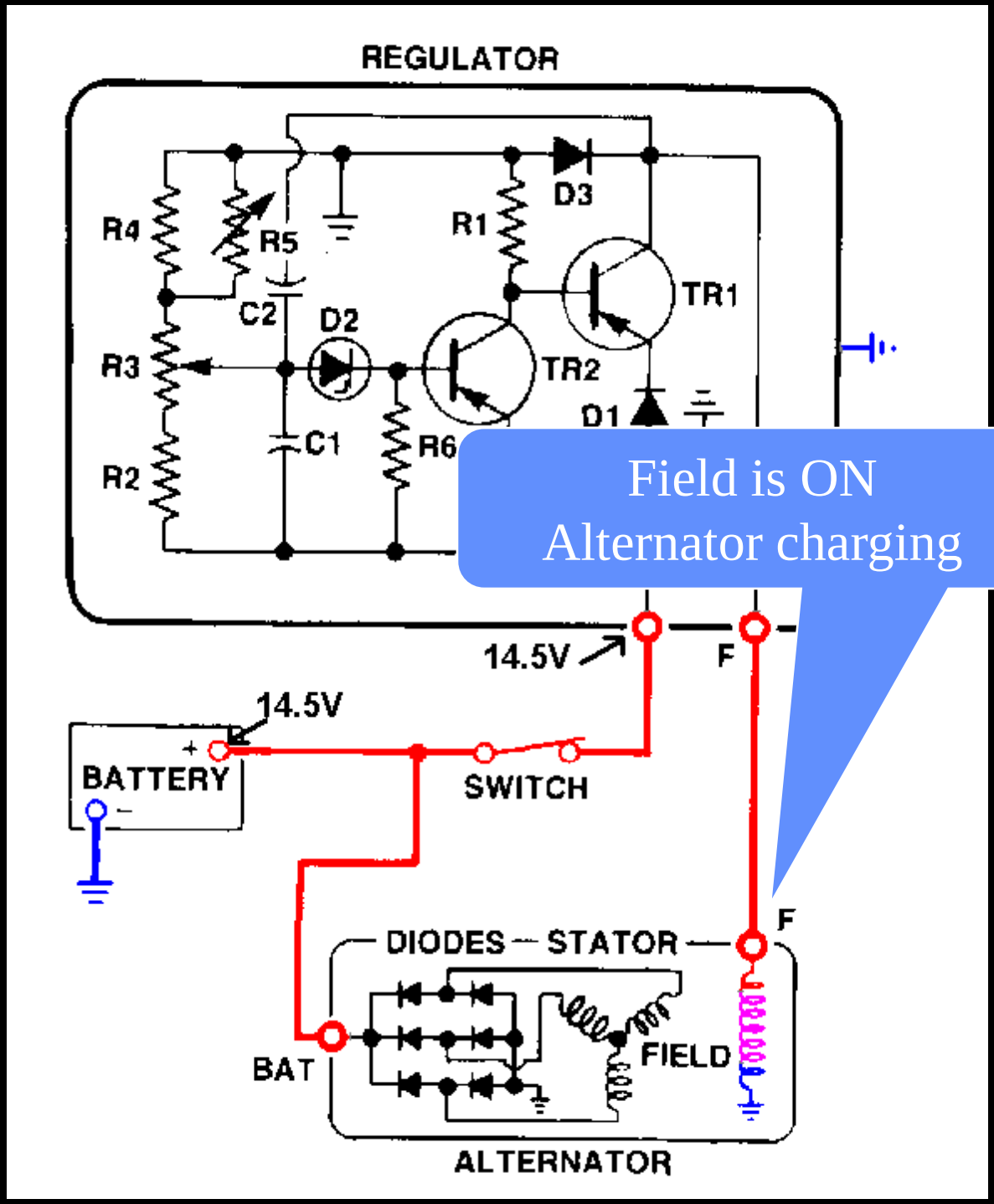
Diagnose Over/Under Charging

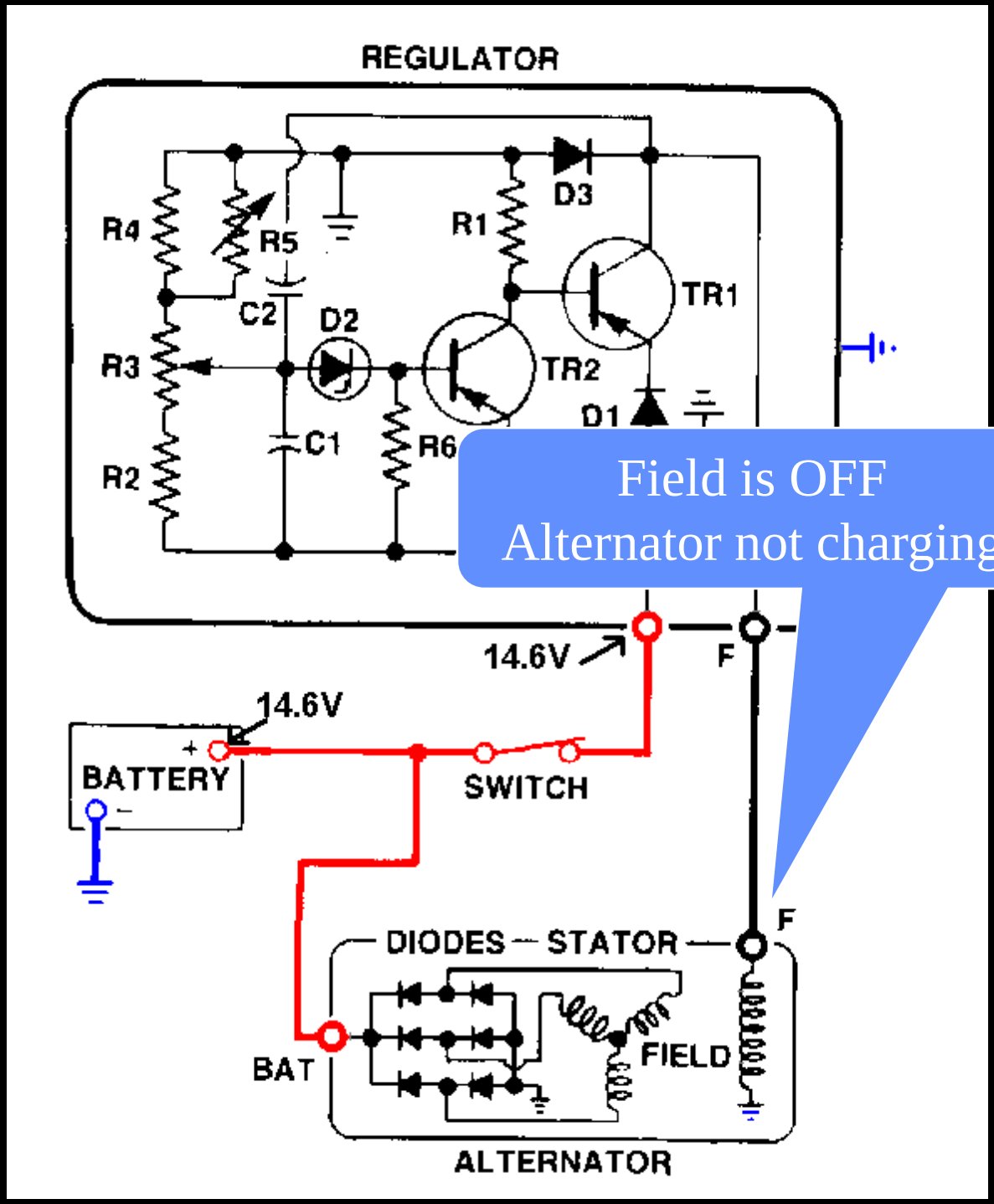
Insure there is no Voltage drop in wiring harness

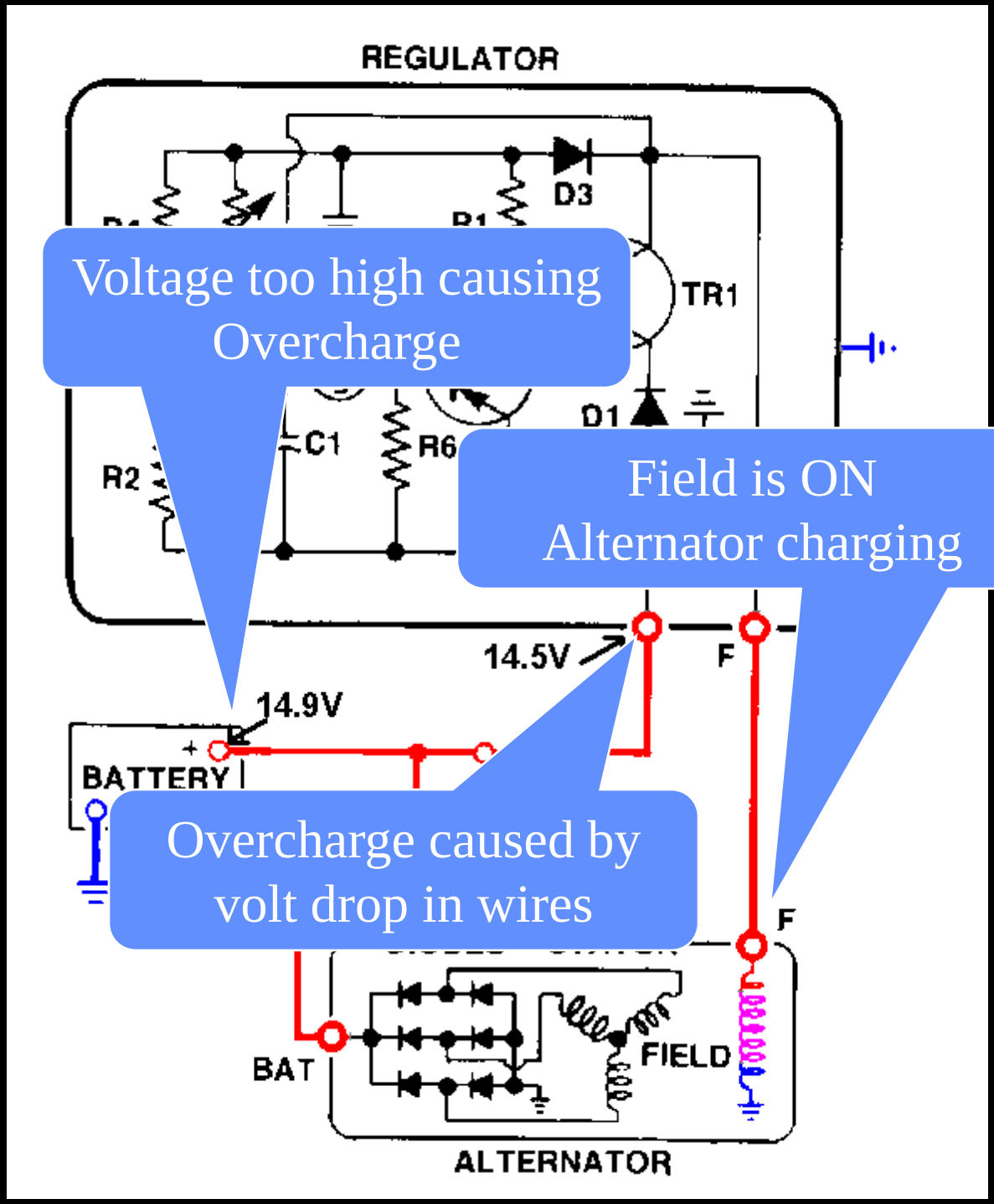
Undercharge is bad alternator or regulator

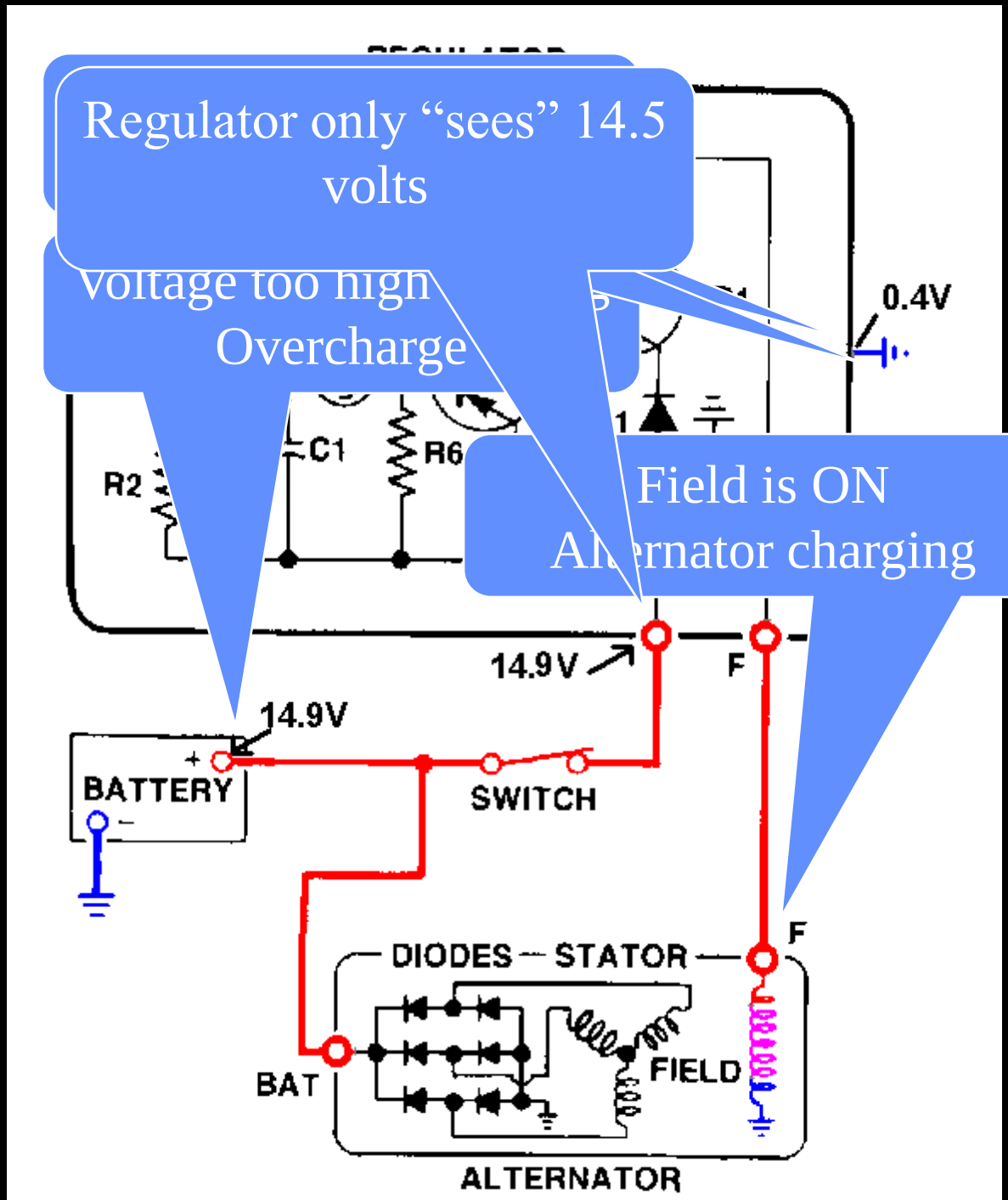
Overcharge is bad regulator

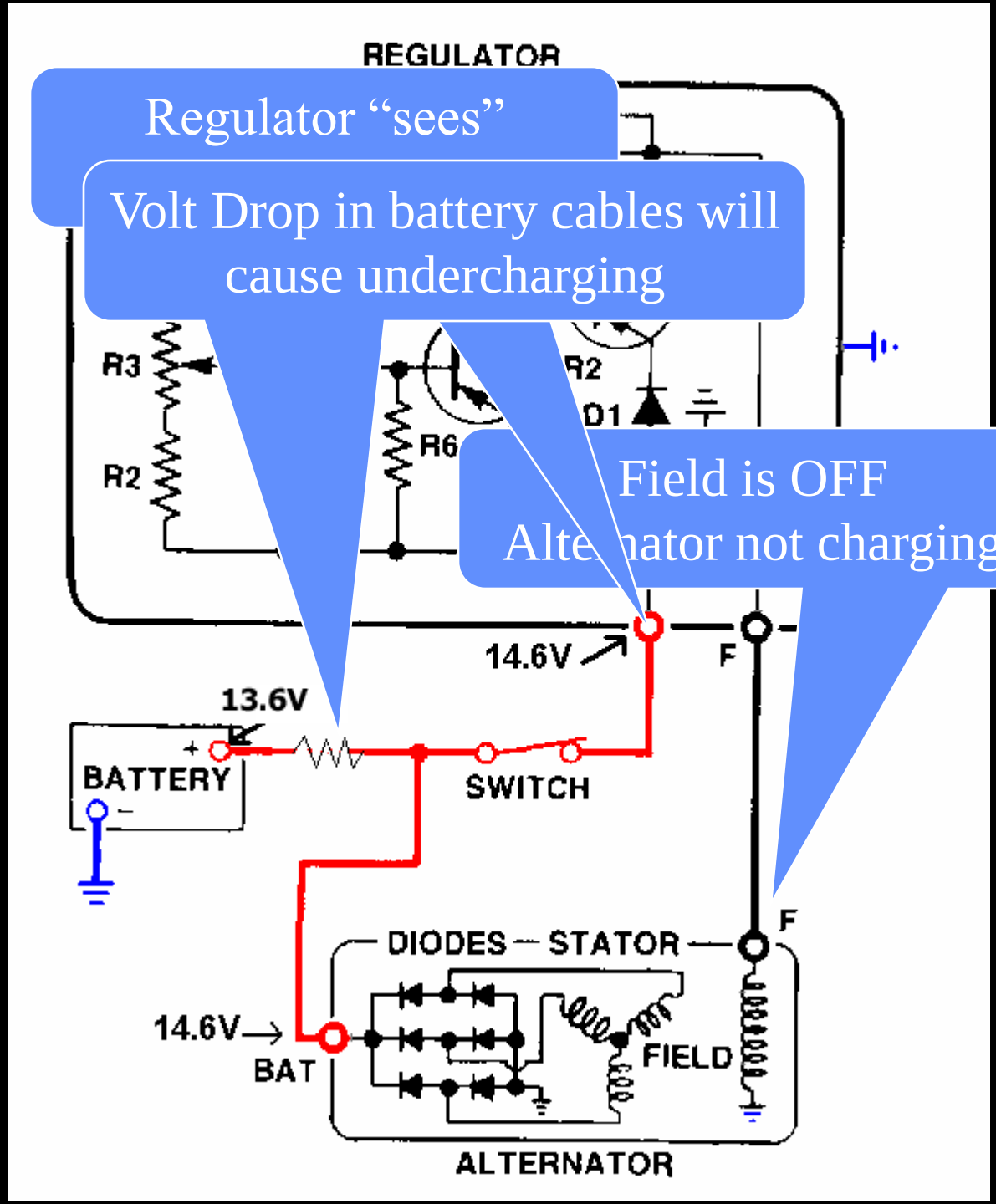
IF there are no bad wires or connections


REGULATOR
R4
R5
C2
D3
R1
TR1
D2
R3
TR2
D1
C1
R6
R2
Field is ON
Alternator charging
14.5V
F
14.5V
BATTERY
+
–
SWITCH
F
DIODES
STATOR
BAT
FIELD
ALTERNATOR


REGULATOR
R4
R5
C2
D2
R3
R2
C1
R6
R1
D3
TR1
TR2
D1
Field is OFF
Alternator not charging
14.6V
F
14.6V
+
BATTERY
–
SWITCH
DIODES
STATOR
F
BAT
FIELD
ALTERNATOR


REGULATOR
D3
TR1
D1
C1
R6
R2
14.5V
F
14.9V
BATTERY
F
BAT
FIELD
ALTERNATOR
Voltage too high causing Overcharge
Field is ON Alternator charging
Overcharge caused by volt drop in wires


Regulator only “sees” 14.5 volts
Voltage too high
Overcharge
Field is ON
Alternator charging
0.4V
C1
R6
R2
14.9V
F
14.9V
BATTERY
+
–
SWITCH
F
DIODES
STATOR
BAT
FIELD
ALTERNATOR


REGULATOR
Regulator “sees”
Volt Drop in battery cables will cause undercharging
Field is OFF
Alte nator not charging
R3
R2
R6
R2
D1
14.6V
F
13.6V
BATTERY
SWITCH
DIODES
STATOR
F
14.6V
BAT
FIELD
ALTERNATOR

Test the Charging System

- Test belts, battery condition and wiring to ensure trouble free power
- Test for Overcharging
  (with full charge on battery)
- Test for Undercharging
- Test for A/C voltage