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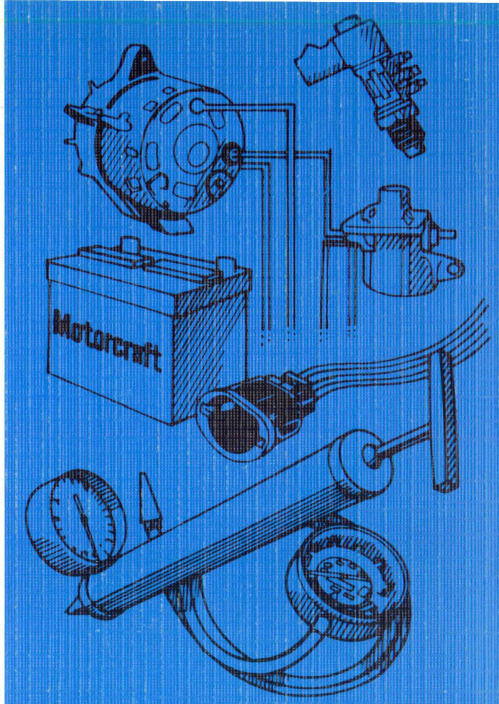
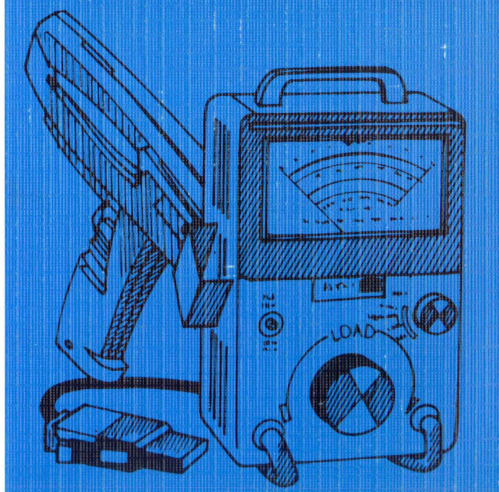
Electrical & Vacuum Trouble-Shooting Manual





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ELECTRICAL AND VACUUM TROUBLESHOOTING MANUAL

FPS — 12129 - 88

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IMPORTANT SAFETY NOTICE

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as the personal safety of the individual doing the work. This Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

Publishers note: this page contains hyperlinks pages

This manual contains the following diagnostic information:

- Electrical and Vacuum Schematics
- Component Location Indexes and Views
- Troubleshooting Hints
- Descriptions of Circuit Operation
- Component Testing

The vehicle's entire electrical system is broken down into individual systems. There are also sections for the vehicle's ground and power distribution circuitry. Each system section begins with a wiring schematic. The **Schematics** should always be your starting point in using this manual. These schematics show the paths of electrical current during proper circuit operation. The source of voltage (circuit breaker or fuse) is shown at the top of the page. All wire, connectors, splices, switches, and motors are shown in the flow of current to ground at the bottom of the page. Connector end views of switches and other components are shown to help with bench testing. Each circuit component is named (underlined titles). Wire and connector colors are listed (standard Ford color abbreviations are used). These abbreviations are:

COLOR ABBREVIATIONS

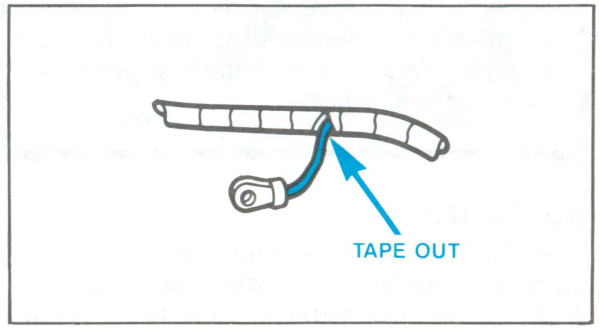
BL	**Blue**	**N**	**Natural**
BK	**Black**	**O**	**Orange**
BR	**Brown**	**PK**	**Pink**
DB	**Dark Blue**	**R**	**Red**
DG	**Dark Green**	**P**	**Purple**
GR	**Green**	**T**	**Tan**
GY	**Gray**	**W**	**White**
LB	**Light Blue**	**Y**	**Yellow**
LG	**Light Green**		

Where two colors are shown for a wire, the first color is the basic color of the wire. The second color is the stripe marking.

The **Component Location** section of each system helps you locate the circuit's components in the vehicle. A brief statement of the location is given as well as a reference to an illustrative figure in the manual. There is also a full listing of connector, ground, and splice locations in the **Location Index** in the back of the manual.

OTHER ABBREVIATIONS

T/O (Tape Out) **The point at which a harness branches to feed a component.**



The **Troubleshooting Hints** offer shortcuts or tests that help you determine the cause of an electrical problem. They are not intended to be a rigid procedure for solving an electrical situation. Rather, Troubleshooting Hints represent a common-sense approach that is based on an understanding of the circuit.

A description of **How the Circuit Works** is written to help you understand the operation of the circuit as a whole. Emphasis is placed on how the components and circuitry interact in a properly working system.

A **Component Testing** section provides procedures to determine whether a component is good or bad.

Notes, Cautions, and **Warnings** appear in boxes on text pages and contain important vehicle and mechanic **safety** information.

Notes give added information to help complete a particular procedure. Cautions are included to prevent making an error that could damage the vehicle. Warnings highlight areas where carelessness can cause personal injury. The following list contains some general **Warnings** that should be followed when working on a vehicle.

- Always wear safety glasses for eye protection.
- Use safety stands whenever a procedure requires being under a vehicle.
- Be sure that the **Ignition Switch** is always in the OFF position, unless otherwise required by the procedure.
- Set the parking brake when working on any vehicle. An automatic transmission should be in PARK. A manual transmission should be in NEUTRAL.
- Operate the engine only in a well-ventilated area to avoid the danger of carbon monoxide.
- Keep away from moving parts when the engine is running, especially the fan and belts.
- To prevent serious burns, avoid contact with hot metal parts such as the radiator, exhaust manifold, tail pipe, catalytic converter, and muffler.
- Do not allow flame or sparks near the battery. Gases are always present in and around the battery cell. An explosion could occur.
- Do not smoke.
- To avoid injury, always remove rings, watches, loose hanging jewelry, and loose clothing.

TROUBLESHOOTING STEPS

These six steps present an orderly method of troubleshooting:

Step 1. Verify the problem.

- Operate the complete system and see all symptoms for yourself in order to:
  - —check the accuracy and completeness of the customer's complaint.
  - —learn more that might give a clue to the nature and location of the problem.

Step 2. Narrow the problem.

- Using this manual, narrow down the possible causes and locations of the problem in order to more quickly find the exact cause.
- Read the description of *How the Circuit Works* and study the wiring diagram. You should then know enough about the circuit operation to figure out where to check for this trouble.

Step 3. Test the cause.

- Use electrical test procedures to find the specific cause of the symptoms.
- *Troubleshooting Hints* will give some helpful ideas.
- The *Component Location* charts and the pictures will help you find components, grounds, and connectors.

Step 4. Verify the cause.

- Confirm the fact that you have found the correct cause through operating the parts of the circuit you think are good.

Step 5. Make the repair.

- Repair or replace the faulty component.

Step 6. Verify the repair.

- Operate the system as in Step 1 and check that your repair has removed all symptoms, and also has not caused any new symptoms.

Some engine circuits may need special test equipment and special procedures. See the *Shop Manual* and other service books for details. You will find the circuits in this manual to be helpful with these special tests.

TROUBLESHOOTING TOOLS

JUMPER WIRE

This is a test lead used to connect two points of a circuit. A **Jumper Wire** can complete a circuit by bypassing an open.

Uses: Bypassing Switches or Open Circuits

WARNING

Never use a jumper wire across loads (motors, etc.) connected between hot and ground. This direct battery short may cause injury or fire.

VOLTMETER

A DC **Voltmeter** measures circuit voltage. Connect negative (- or black) lead to ground, and positive (+ or red) lead to voltage measuring point.

OHMMETER

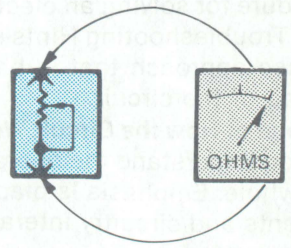


Figure 1— Resistance Check

An **Ohmmeter** shows the resistance between two connected points (Figure 1).

TEST LIGHT

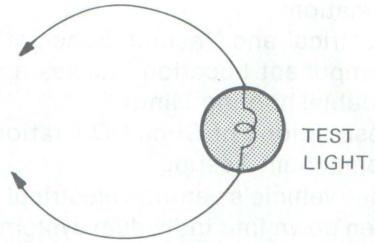


Figure 2 —Test Light

A **Test Light** is a 12-volt bulb with two test leads (Figure 2).

Uses: Voltage Check. Short Check

SELF-POWERED TEST LIGHT

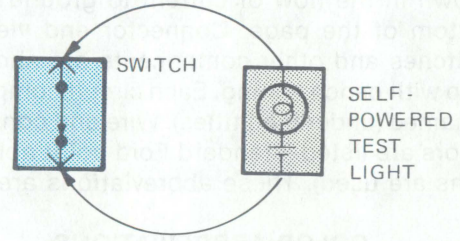


Figure 3—Continuity Check

The **Self-Powered Test Light** is a bulb, battery and set of test leads wired in series (Figure 3). When connected to two points of a continuous circuit, the bulb glows.

Uses: Continuity Check. Ground Check

CAUTION

When using a self-powered test light or ohmmeter, be sure power is off in circuit during testing. Hot circuits can cause equipment damage and false readings.

TROUBLESHOOTING CHECKS

SWITCH CIRCUIT CHECK

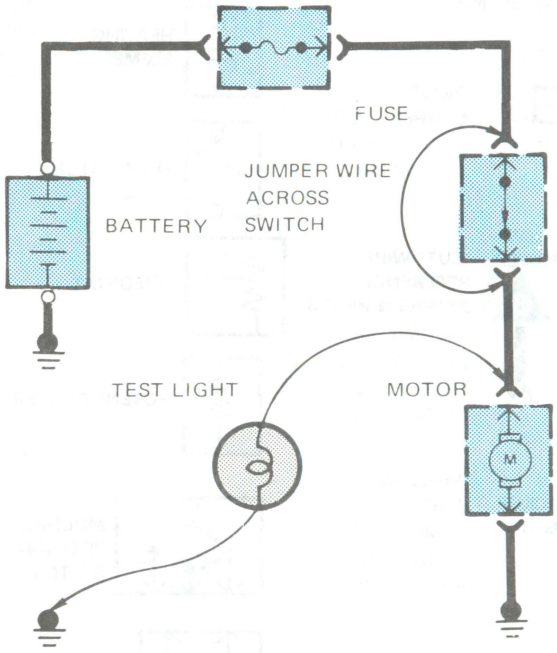


Figure 4—Switch Circuit Check and Voltage Check

In a bad circuit with a switch in series with the load, jumper the terminals of the switch to power the load. If jumping the terminals powers the circuit, the switch is bad (Figure 4).

CONTINUITY CHECK (Locating open circuits)

With power off, connect one lead of **Self-Powered Test Light** or **Ohmmeter** to each end of circuit (Figure 3). Light will glow if circuit is closed. Switches and fuses can be checked in the same way.

VOLTAGE CHECK

Connect one lead of **Test Light** to a known good ground or the negative (-) battery terminal. Test for voltage by touching the other lead to the test point. Bulb goes on when the test point has voltage (Figure 4).

SHORT CHECK (short to ground)

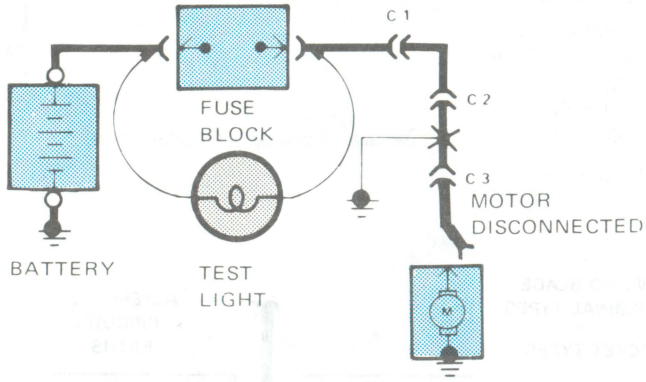


Figure 5— Short Check

A fuse that repeatedly blows is usually caused by a short to ground. It's important to be able to locate such a short quickly (Figure 5).

1) Turn off everything powered through the fuse.
2) Disconnect other loads powered through the fuse:
   - Motors: disconnect motor connector.
   - Lights: remove bulbs.
3) Turn **Ignition Switch** to RUN (if necessary) to power fuse.
4) Connect one **Test Light** lead to hot end of blown fuse. Connect other lead to ground. Bulb should glow showing power to fuse. *(This step is just a check to be sure you have power to the circuit.)*
5) Disconnect the **Test Light** lead from ground and reconnect it to the load side of the fuse.
   - If the **Test Light** is off, the short is in the disconnected equipment.
   - If the **Test Light** goes on, the short is in the wiring. You must find the short by disconnecting the circuit connectors one at a time until the **Test Light** goes out. For example: with a ground at X, the bulb goes out when C1 or C2 is disconnected, but stays on after disconnecting C3. This means the ground is between C2 and C3.

"GOOD GROUND" CHECK

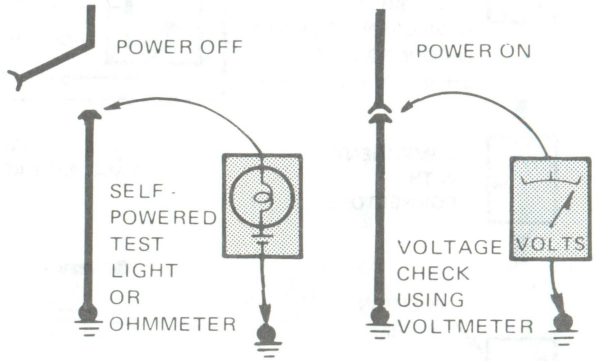


Figure 6 — Grounds Checks

Turn on power to circuit. Perform Voltage Check between suspected bad ground and frame. Any voltage means ground is bad.

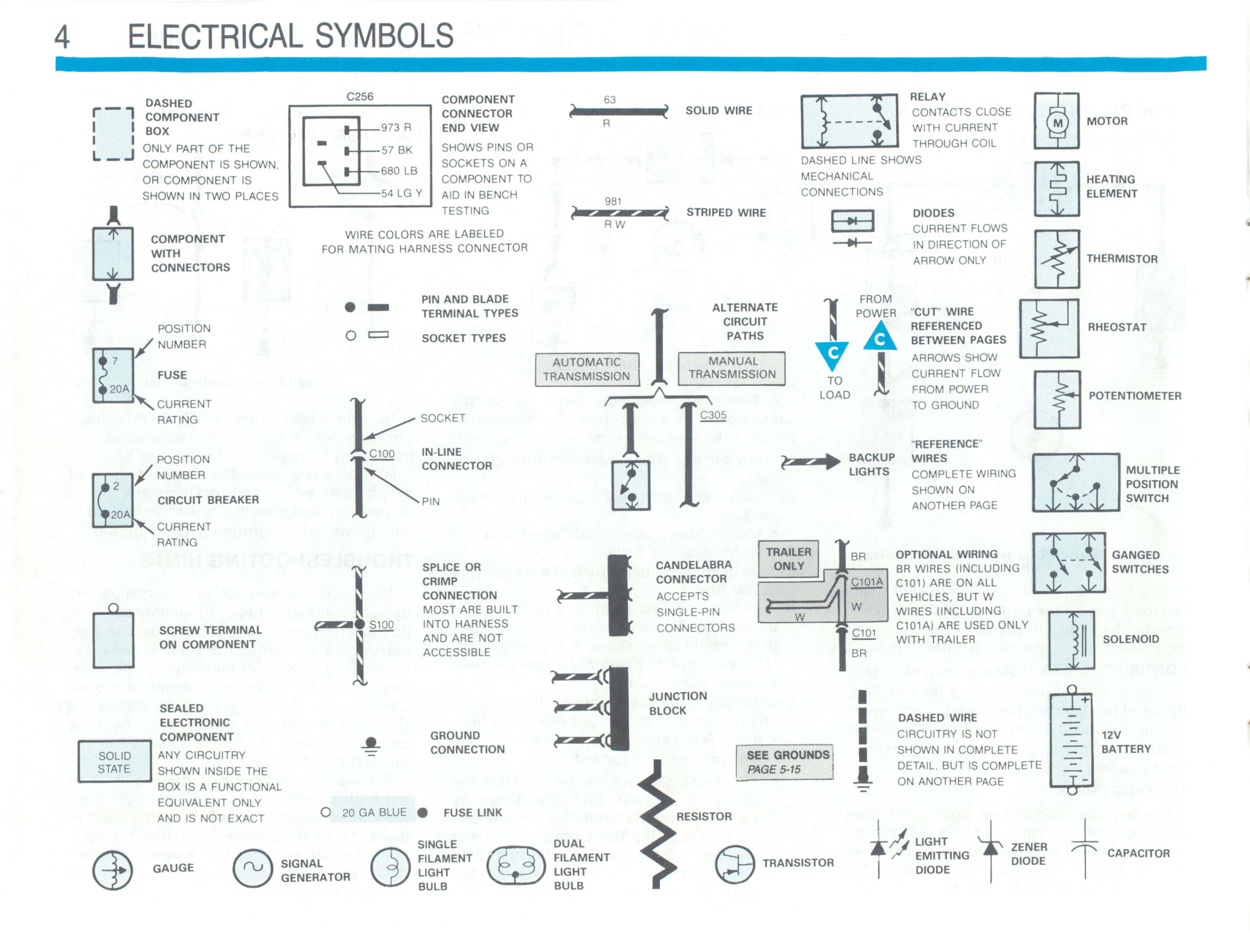
Turn off power to circuit. Connect one lead of **Self-Powered Test Light** or **Ohmmeter** to wire in question, and the other to known ground. If bulb glows, circuit ground is OK (Figure 6).

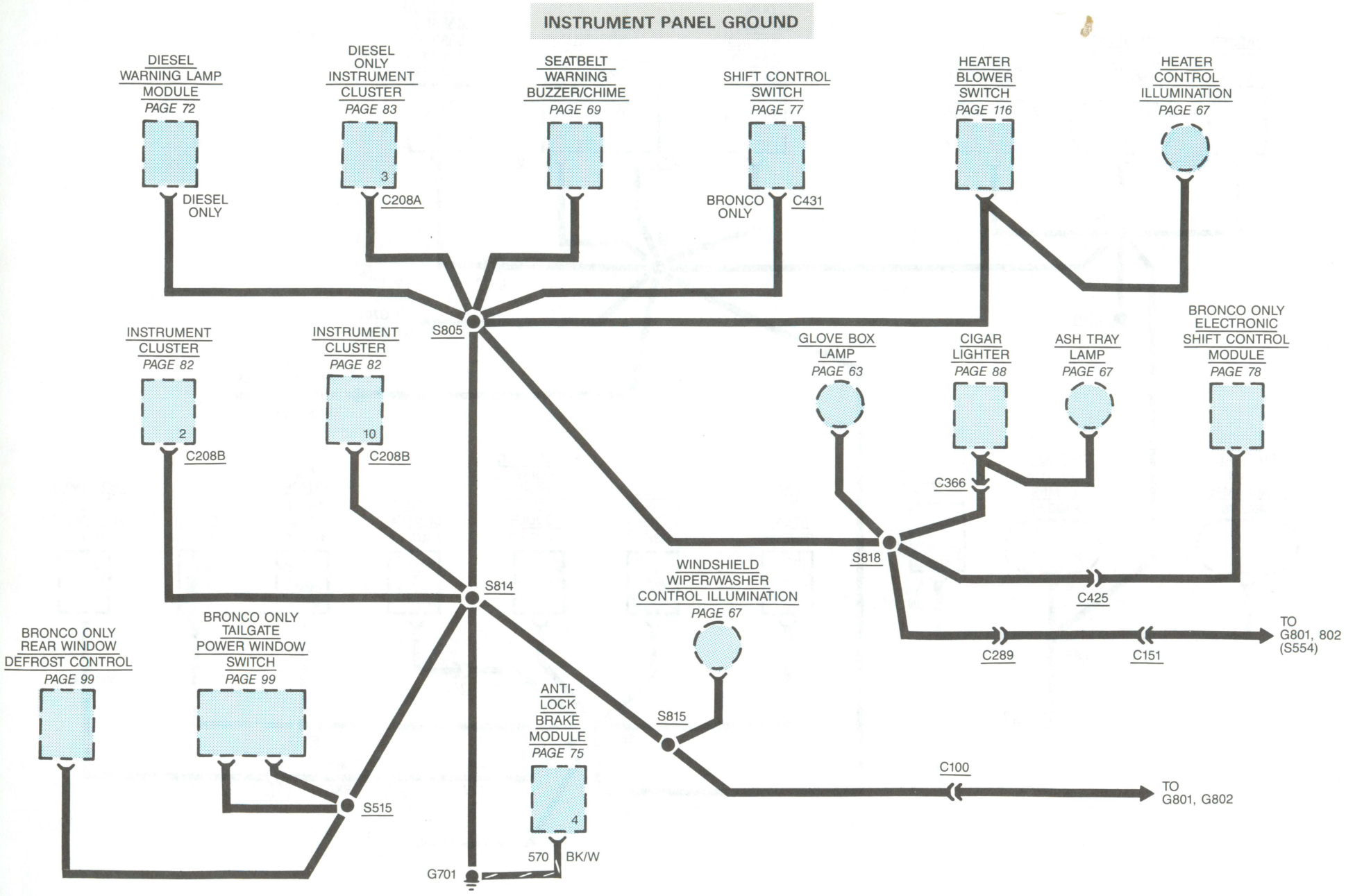
TROUBLESHOOTING HINTS

The circuit schematics in this manual are designed to make it easy to identify common points in circuits. This knowledge can help narrow the problem to a specific area. For example, if several circuits fail at the same time, check for a common power or ground connection. (See *Power Distribution* or *Grounds).* If part of a circuit fails, check the connections between the part that works and the part that doesn't work.

For example, if low beam headlights work but high beams and the indicator light don't work, then power and ground paths must be good. Since the dimmer switch is the component which switches this power to the high beam lights and indicator, it is most likely the cause of failure.

ELECTRICAL SYMBOLS

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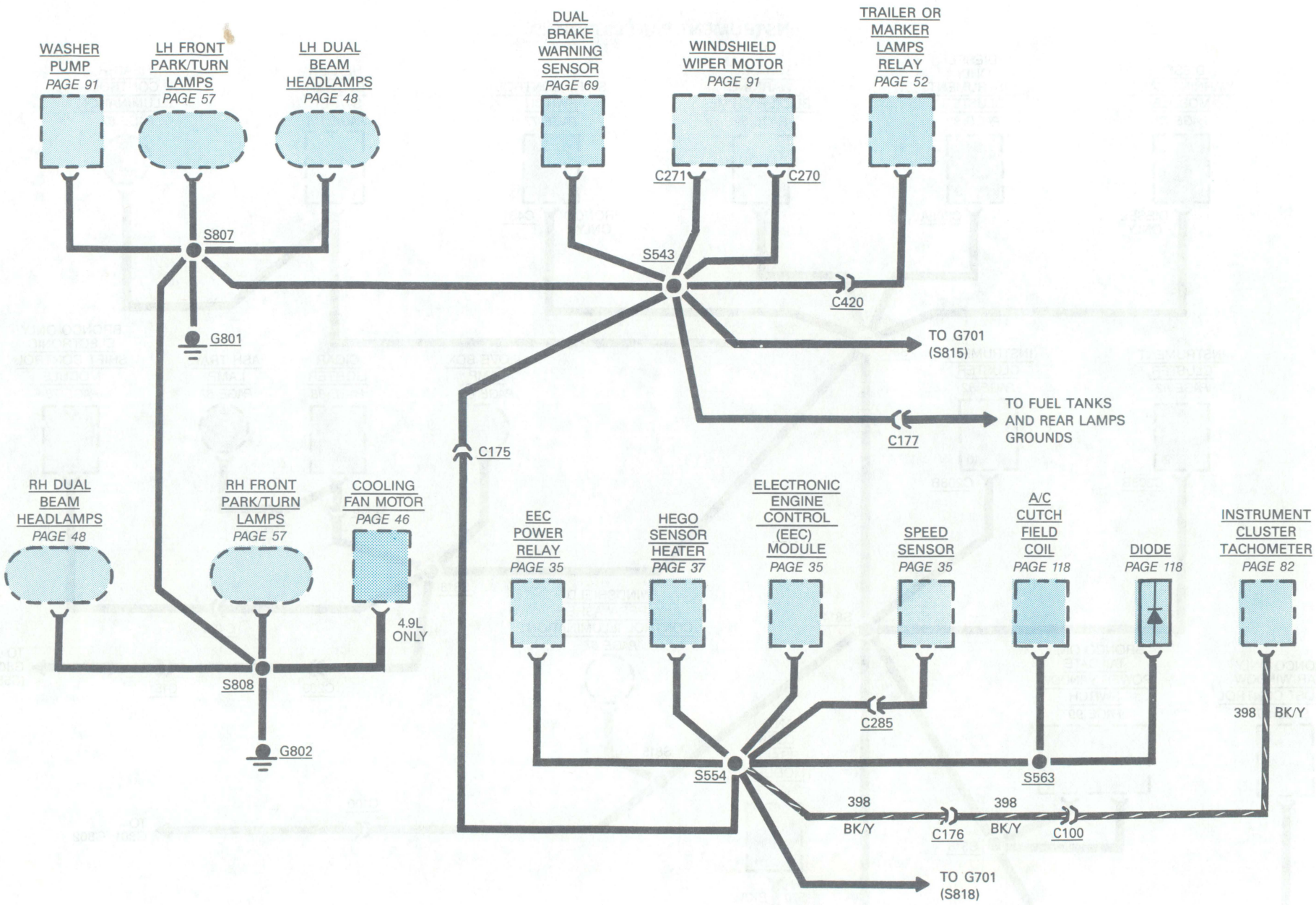
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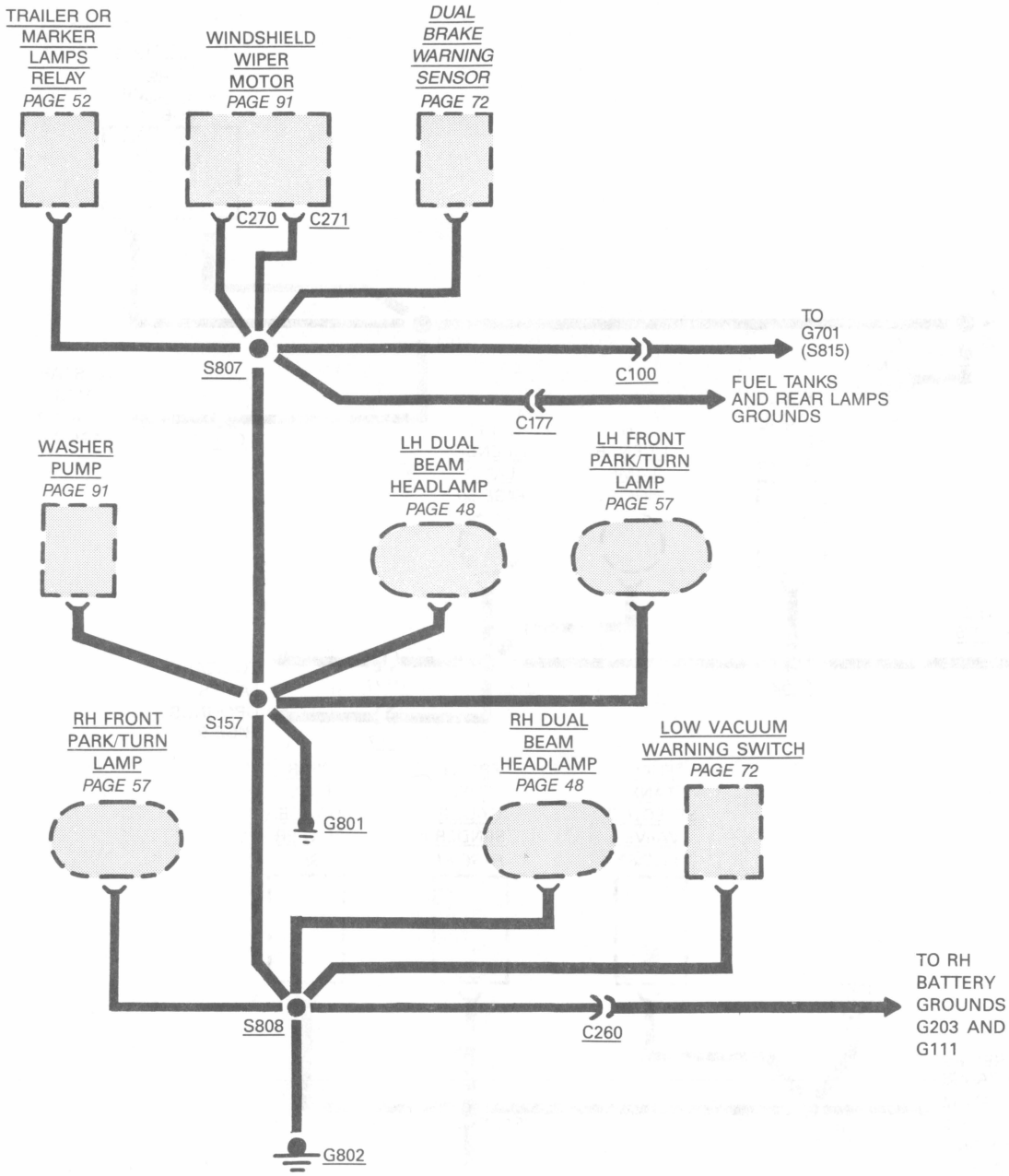
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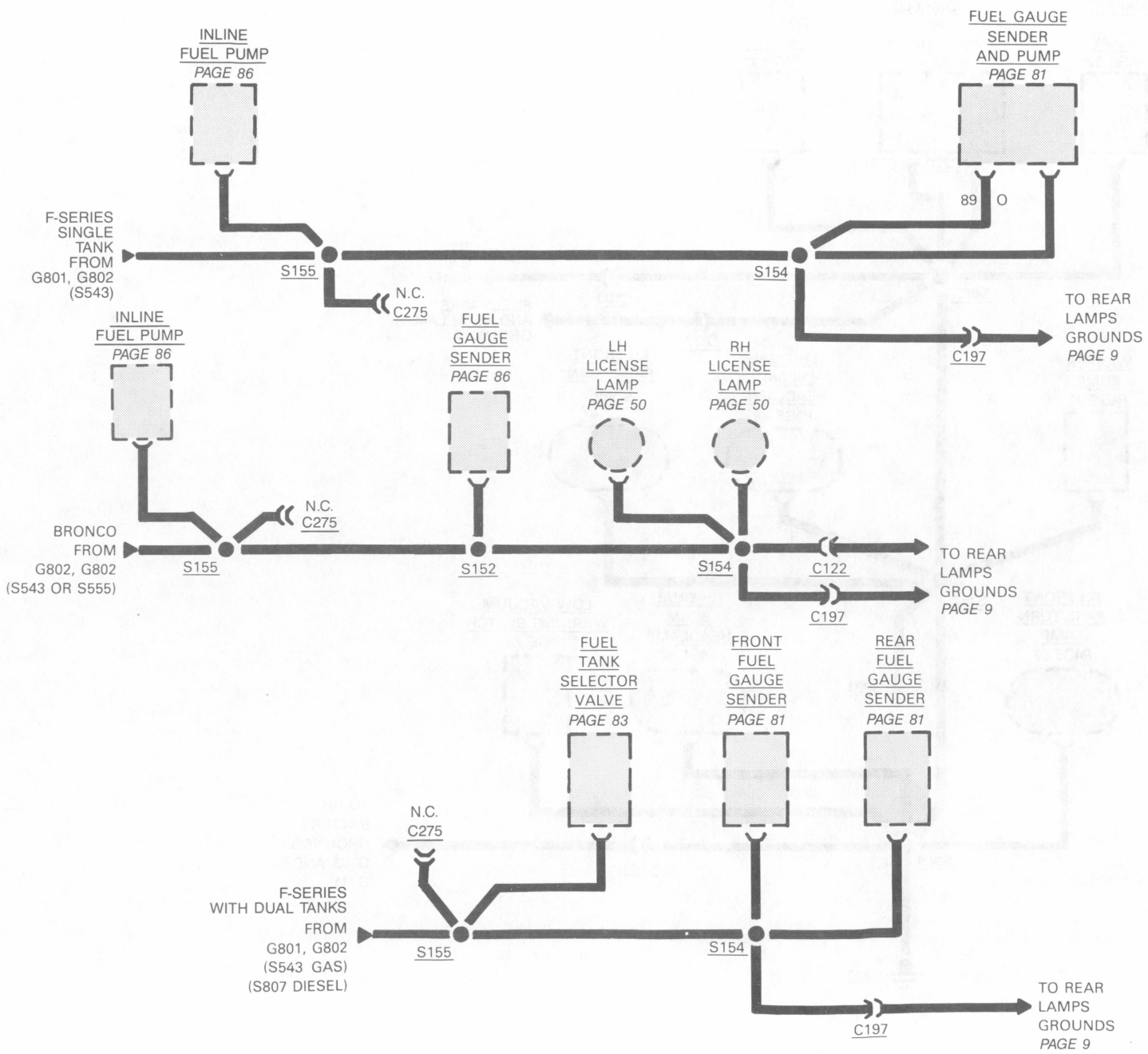
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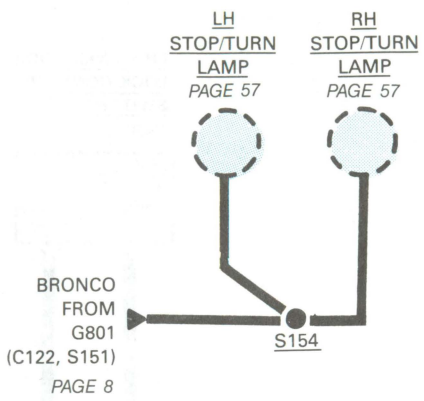
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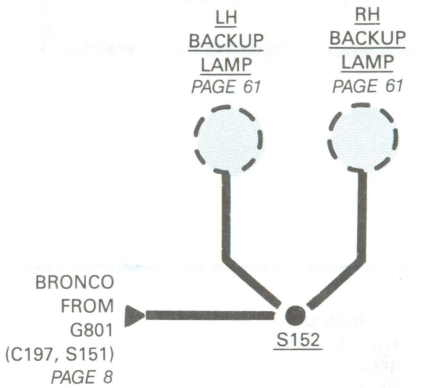
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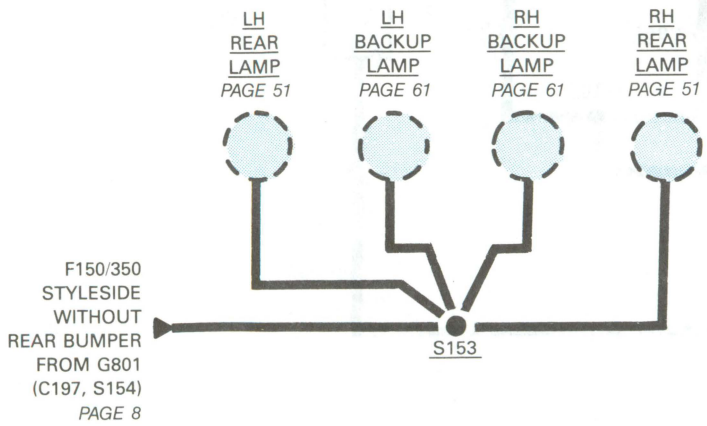
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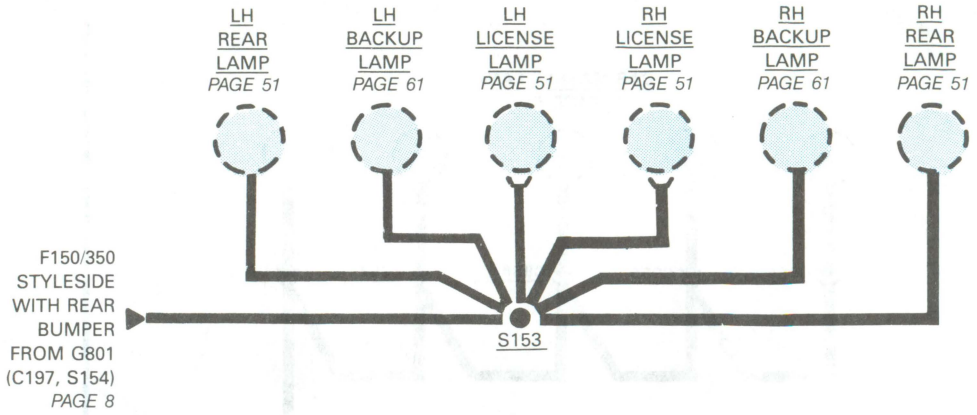
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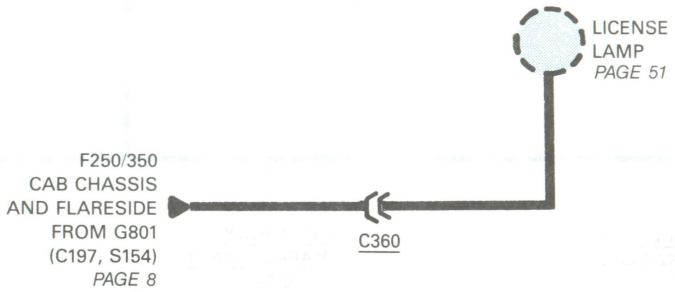
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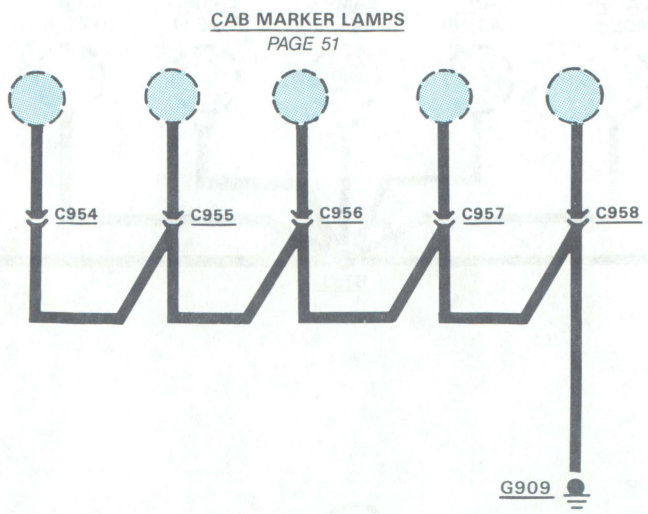
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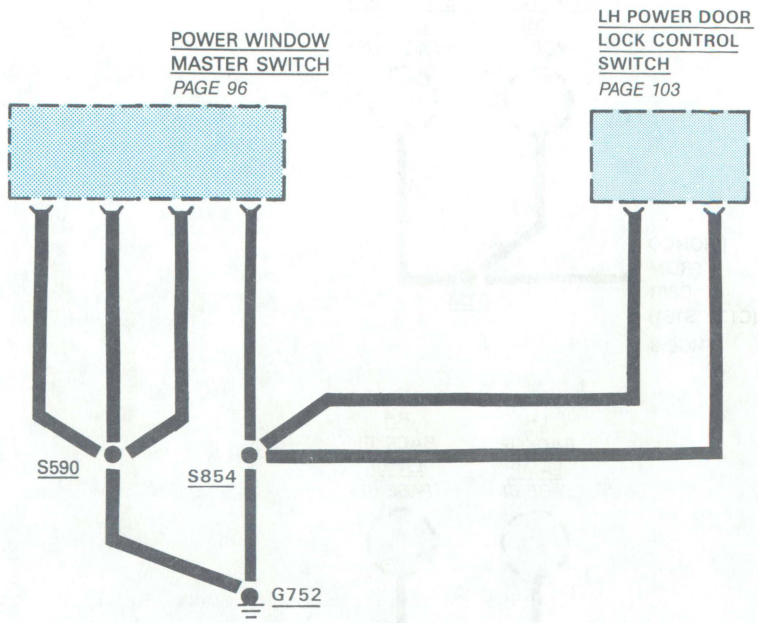
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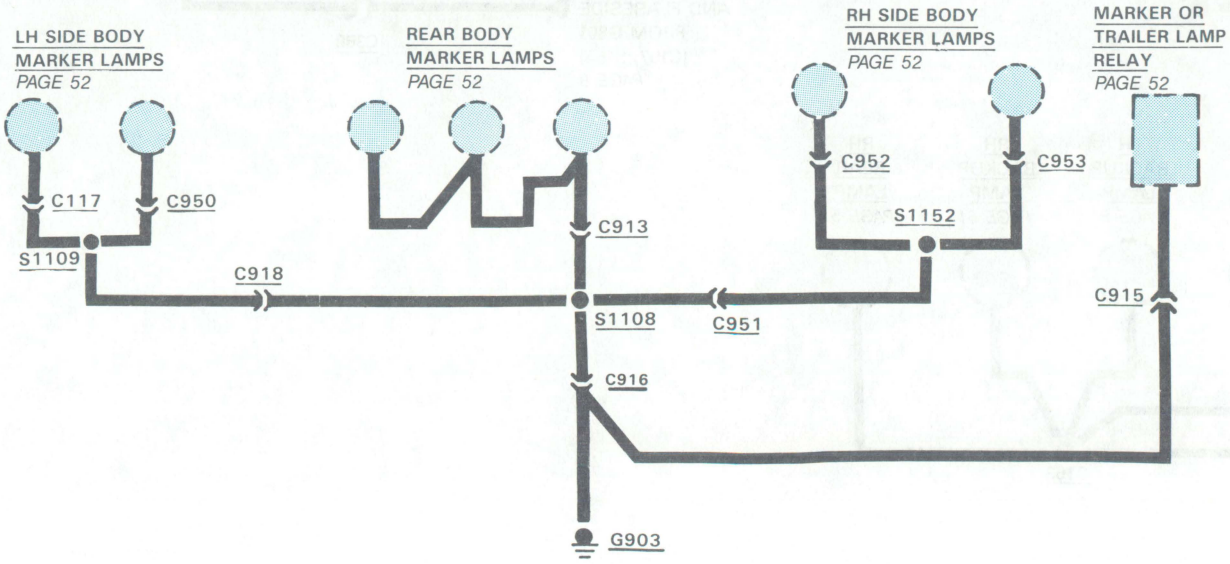
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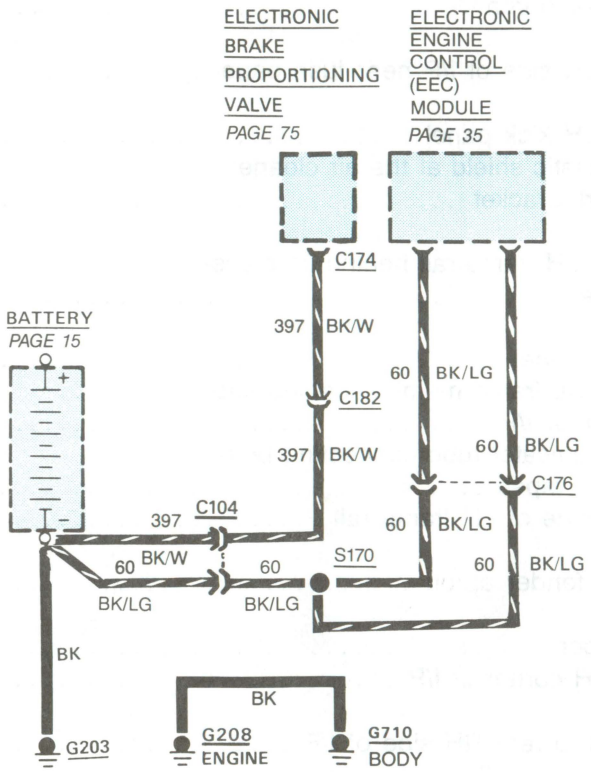
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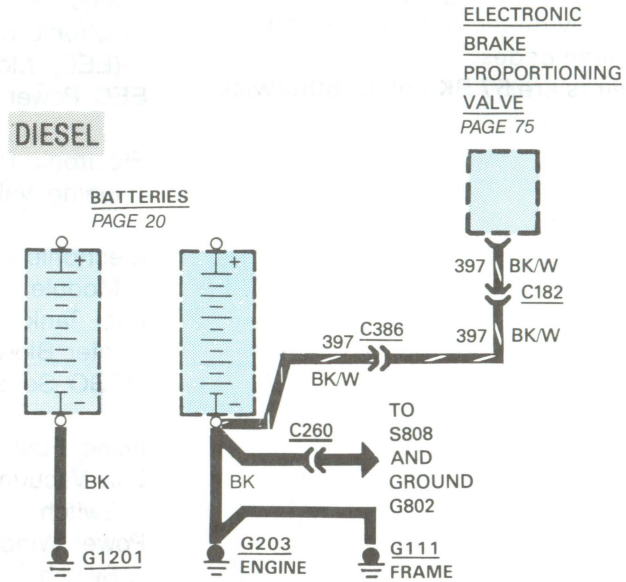

DIESEL
BATTERIES
PAGE 20
ELECTRONIC BRAKE PROPORTIONING VALVE
PAGE 75
397 BK/W
C182
397 C386
397 BK/W
BK/W
C260
TO S808 AND GROUND G802
BK
BK
G1201
G203
ENGINE
G111
FRAME

HOW THE CIRCUIT WORKS

The ground circuits shown here are complete and connect several components together to screw terminal ground points. On other pages only parts of these circuits may be shown. Partial ground circuits are shown dashed on those pages.

All simple or component ground circuits are shown on the individual circuit pages and are complete on those pages.

All ground wires are **57 BK** unless otherwise noted.

COMPONENT LOCATION

		Page-Figure
A/C Clutch Field Coil	Part of compressor	
Anti-Lock Brake Module	Behind I/P left of center	
Brake Sensor	Part of master cylinder	
Cooling Fan Motor	RH fender apron	
Diesel/Warning Lamp Module	Behind LH side of I/P near fuse panel	
Electronic Engine Control (EEC) Module	Behind LH kick panel	
EEC Power Relay	Under plastic shield at the air cleaner support bracket	
Electronic Brake Proportioning Valve	Inside of LH frame rail behind #1 cross-member	
Electronic Shift Control Module	RH cowl panel	
Fuel Tank Selector Valve	On LH side frame member behind cab	85-1
Heater Blower Switch	At center of I/P	
HEGO Sensor	In communicator tube connecting both exhaust pipes	29-3,122-2
Inline Fuel Pump	Inboard side of LH frame rail	
Low Vacuum Warning Switch	7.3L RH fender apron	
Power Window Master Switch	In LH door	
Rear Defrost Control	Under LH corner of I/P	
Seatbelt Warning Buzzer/Chime	Attached to rear RH side of I/P	101-2
Shift Control Switch	On LH side of I/P	
Speed Sensor	At transmission	
Tailgate Power Window Motor	In center of tailgate	102-3
Washer Pump	In washer reservoir	
Windshield Wiper Motor	Attached to center of dash panel	

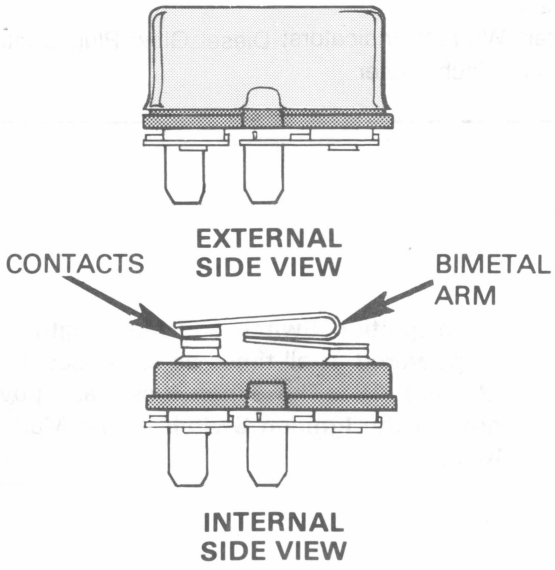
Refer to the **Location Index** in the back of the manual for connector, ground, and splice descriptions and locations.

REPLACEMENT OF FUSES/ CIRCUIT BREAKERS

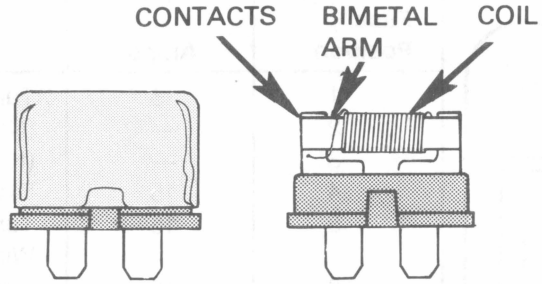
GOOD FUSE BLOWN FUSE

Fuses are mounted either in the **Fuse Panel** or in-line. They are identified by the numbered value in amperes, and by a color code. Some positions may have either a fuse with adapter or a circuit breaker. Be sure to replace a fuse or circuit breaker with the same kind of unit and with the same ampere rating. Remove fuses in order to check them.

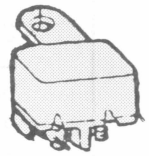
CIRCUIT BREAKER OPERATION



Cycling Fuse Block Type



Non-Cycling Fuse Block Type



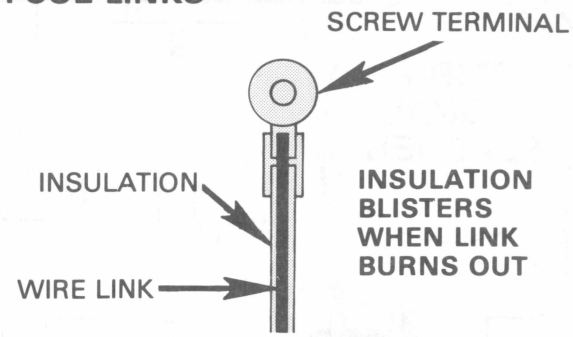
Cycling In-Line Type

Some circuits are protected by circuit breakers. (Abbreviated "c.b." in fuse chart.) They can be **Fuse Panel** mounted or in-line. Like fuses, they are rated in amperes.

Each circuit breaker conducts current through an arm made of two types of metal bonded together (bimetal arm). If the arm starts to carry too much current, it heats up. As one metal expands faster than the other, the arm bends, opening the contacts. Current flow is broken. In the cycling type, the arm cools and straightens out. This closes the circuit again. This cycle repeats as long as the overcurrent exists, with power applied.

In the non-cycling type, there is also a coil wrapped around the bimetal arm. When an overcurrent exists and the contacts open, a small current passes through the coil. This current through the coil is not large enough to operate a load, but it does heat up both the coil and bimetal arm. This keeps the arm in the open position until power is removed.

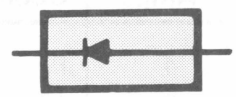
FUSE LINKS



The fuse link is a short length of wire smaller in gage than the wire in the protected circuit. The wire is covered with a thick non-flammable insulation. An overload causes the link to heat and the insulation to blister. If the overload remains, the link will melt, causing an open circuit.

When replacing, make tight crimp joints or hot solder joints for good connections.

DIODES



Diodes are electrical devices that permit current to flow in one direction only. The current flows in the direction indicated by the arrow.

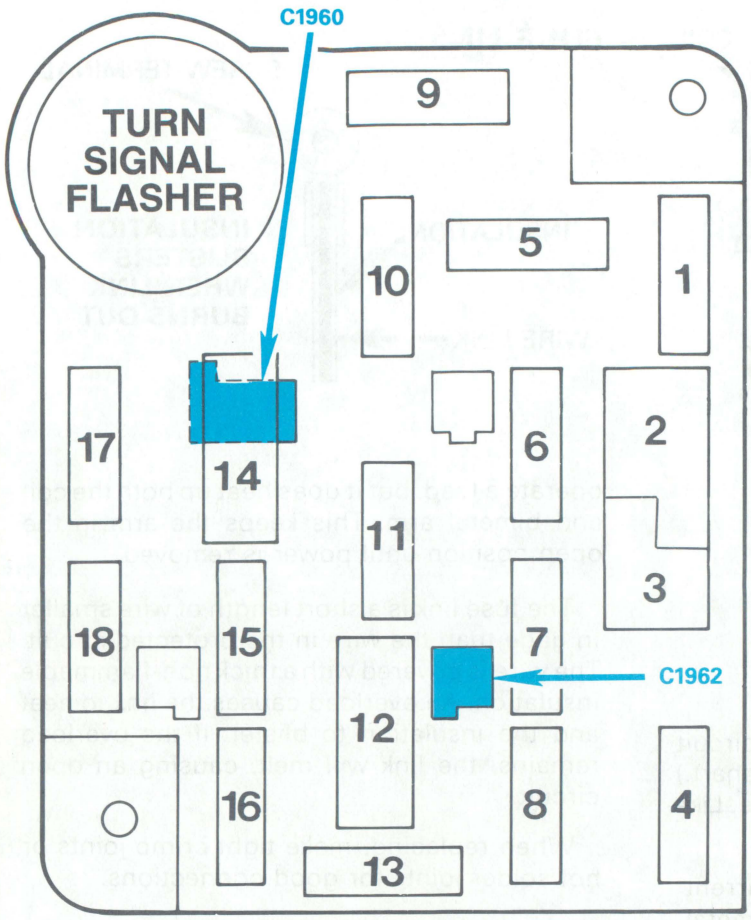


Figure 1 - Fuse Panel

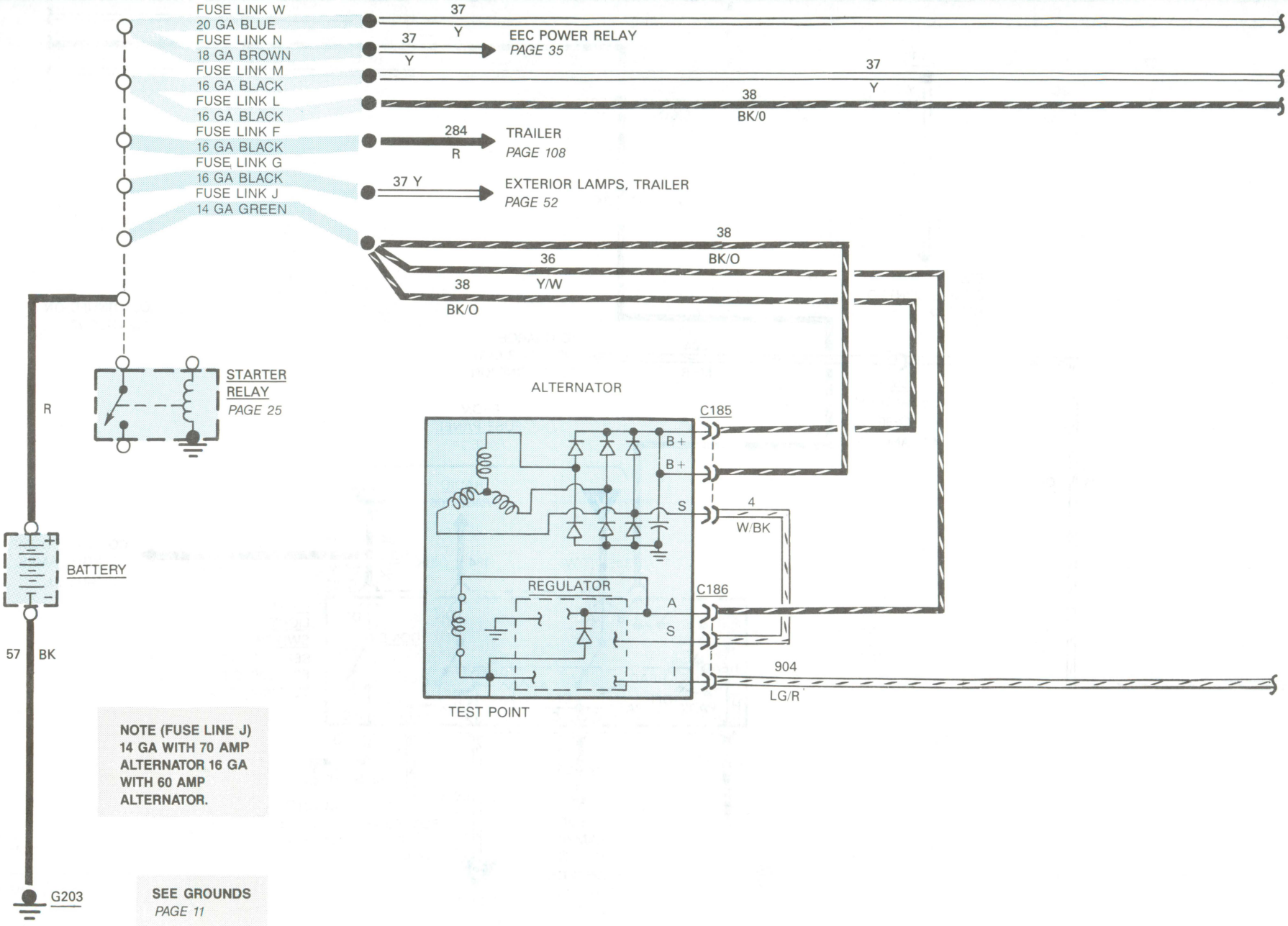
Fuse Value Amps	Color Code
4	Pink
5	Tan
10	Red
15	Light Blue
20	Yellow
25	Natural
30	Light Green

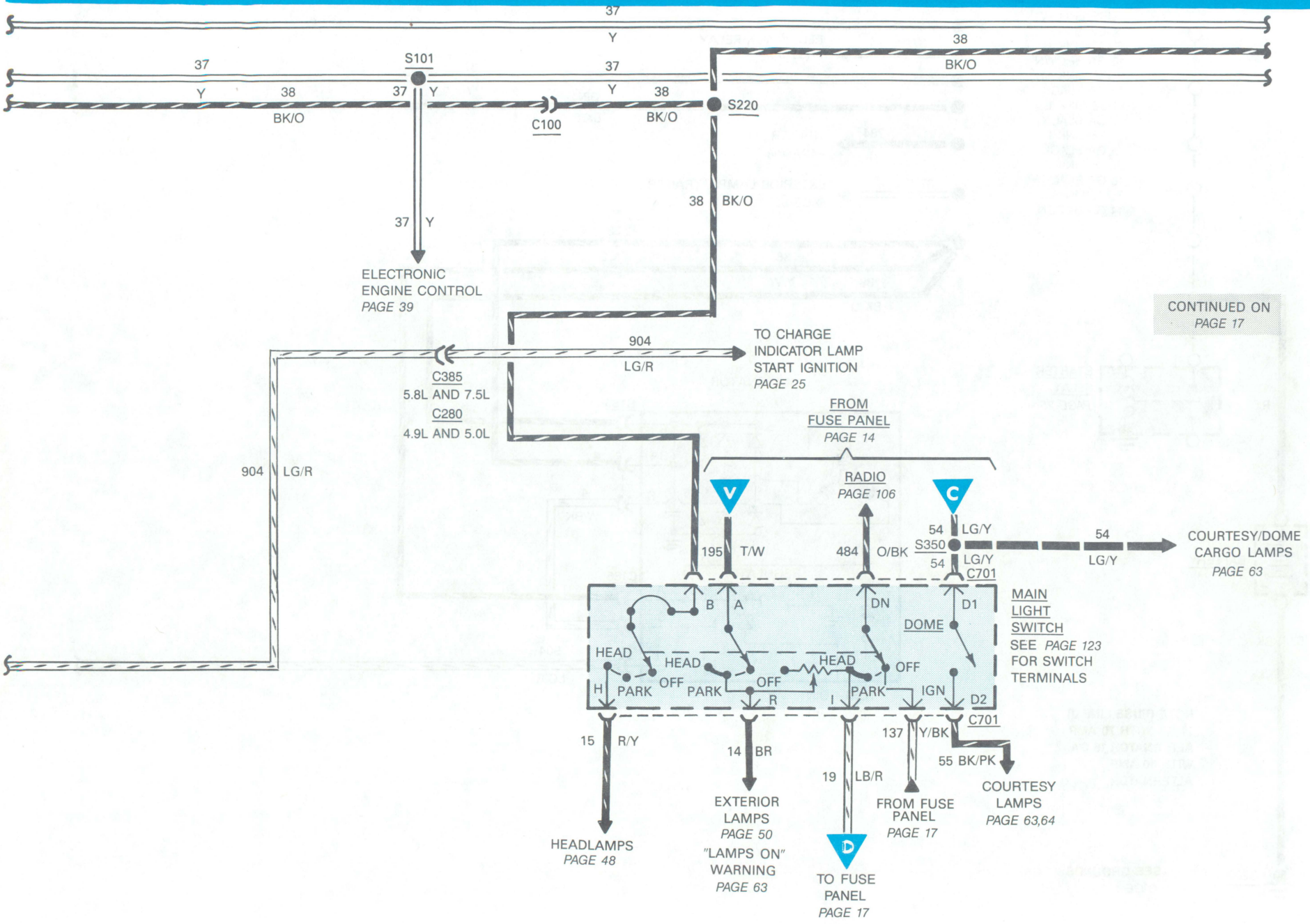
Fuse Position	Amps	Circuits Protection
1	15	Turn/Stop/Hazard Lamps; Speed Control
2	—	(Not used)
3	—	(Not used)
4	15	Exterior Lamps; Instrument Illumination
5	15	Turn Lamps; Backup Lamps; Rear Window Defrost
6	15	Speed Control; Electronic Shift-4 Wheel Drive
7	—	(Not Used)
8	15	Courtesy, Dome, Cargo Lamps; Warning Buzzer
9	30	Heater; A/C-Heater
10	5	Instrument Illumination; Clock Dimming
11	15	Radio; Main Light Switch; Clock Illumination
12	25	Tailgate Power Window; Power Mirrors
	30 c.b.	Power Door Locks; Electronic Shift-4 Wheel Drive
13	—	(Not used)
14	25	Tailgate Power Window
	30 c.b.	Power Windows
15	10	Auxiliary Fuel Tank Selector
16	30	Horn; Cigar Lighter; Speed Control; 4.9L EFI After Run Blower
17	20	Anti-lock Brakes
18	15	Seatbelt Buzzer; Warning Indicators; Diesel Glow Plug Control; Diesel Indicators; Tachometer

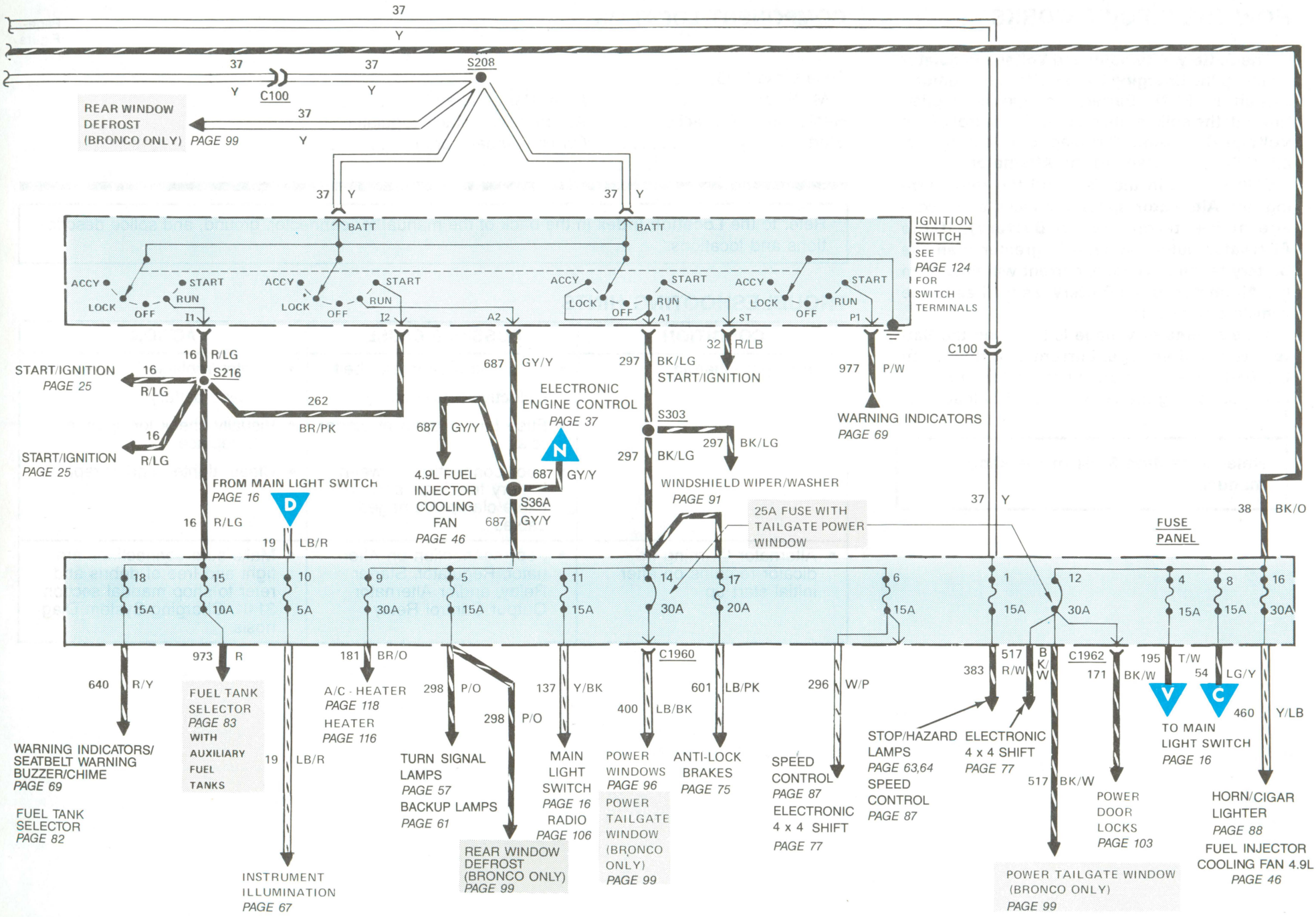
Power Distribution

The **Alternator** and **Battery** are connected together at the **Starter Relay** hot terminal. Other circuits originate at the **Starter Relay** hot terminal and are protected by fuse links. Low power circuits are also protected by fuses.

The **Ignition Switch** and **Main Light Switch** are powered at all times as are **Fuses 1, 4, 8, 12,** and **16.** The other fuses are powered through the **Ignition Switch** or the Main Light Switch.


FUSE LINK W
20 GA BLUE
FUSE LINK N
18 GA BROWN
FUSE LINK M
16 GA BLACK
FUSE LINK L
16 GA BLACK
FUSE LINK F
16 GA BLACK
FUSE LINK G
16 GA BLACK
FUSE LINK J
14 GA GREEN
37 Y
37 Y
EEC POWER RELAY
PAGE 35
37 Y
38 BK/0
284 R
TRAILER
PAGE 108
37 Y
EXTERIOR LAMPS, TRAILER
PAGE 52
38 BK/O
36 BK/O
38 Y/W
38 BK/O
STARTER RELAY
PAGE 25
R
ALTERNATOR
C185
B+
B+
S
4 W/BK
REGULATOR
C186
A
S
I
904 LG/R
TEST POINT
BATTERY
57 BK
G203
NOTE (FUSE LINE J) 14 GA WITH 70 AMP ALTERNATOR 16 GA WITH 60 AMP ALTERNATOR.
SEE GROUNDS
PAGE 11


37
Y
38
BK/O
S101
37
Y
38
BK/O
C100
37
Y
38
BK/O
S220
37
Y
38
BK/O
ELECTRONIC
ENGINE CONTROL
PAGE 39
CONTINUED ON
PAGE 17
904
LG/R
TO CHARGE
INDICATOR LAMP
START IGNITION
PAGE 25
C385
5.8L AND 7.5L
C280
4.9L AND 5.0L
904
LG/R
FROM
FUSE PANEL
PAGE 14
RADIO
PAGE 106
V
C
195
T/W
484
O/BK
54
LG/Y
S350
54
LG/Y
C701
54
LG/Y
COURTESY/DOME
CARGO LAMPS
PAGE 63
MAIN
LIGHT
SWITCH
SEE PAGE 123
FOR SWITCH
TERMINALS
B
A
DN
D1
DOME
HEAD
HEAD
HEAD
OFF
H
PARK
OFF
PARK
OFF
R
I
PARK
IGN
D2
C701
15
R/Y
14
BR
19
LB/R
137
Y/BK
55
BK/PK
HEADLAMPS
PAGE 48
EXTERIOR
LAMPS
PAGE 50
"LAMPS ON"
WARNING
PAGE 63
D
TO FUSE
PANEL
PAGE 17
FROM FUSE
PANEL
PAGE 17
COURTESY
LAMPS
PAGE 63,64


37 Y
S208
C100
REAR WINDOW DEFROST (BRONCO ONLY) PAGE 99
IGNITION SWITCH SEE PAGE 124 FOR SWITCH TERMINALS
BATT
ACCY
LOCK
OFF
RUN
START
I1
I2
A2
A1
ST
P1
START/IGNITION PAGE 25
S216
262 BR/PK
687 GY/Y
297 BK/LG
32 R/LB
977 P/W
WARNING INDICATORS PAGE 69
ELECTRONIC ENGINE CONTROL PAGE 37
S303
297 BK/LG
WINDSHIELD WIPER/WASHER PAGE 91
4.9L FUEL INJECTOR COOLING FAN PAGE 46
S36A
FROM MAIN LIGHT SWITCH PAGE 16
25A FUSE WITH TAILGATE POWER WINDOW
FUSE PANEL
38 BK/O
640 R/Y
973 R
181 BR/O
298 P/O
137 Y/BK
400 LB/BK
601 LB/PK
296 W/P
383
517 R/W
517 BK/W
C1960
C1962
171
195 T/W
54 LG/Y
460 Y/LB
WARNING INDICATORS/ SEATBELT WARNING BUZZER/CHIME PAGE 69
FUEL TANK SELECTOR PAGE 82
FUEL TANK SELECTOR PAGE 83 WITH AUXILIARY FUEL TANKS
INSTRUMENT ILLUMINATION PAGE 67
A/C - HEATER PAGE 118
HEATER PAGE 116
TURN SIGNAL LAMPS PAGE 57
BACKUP LAMPS PAGE 61
REAR WINDOW DEFROST (BRONCO ONLY) PAGE 99
MAIN LIGHT SWITCH PAGE 16
RADIO PAGE 106
POWER WINDOWS PAGE 96
POWER TAILGATE WINDOW (BRONCO ONLY) PAGE 99
ANTI-LOCK BRAKES PAGE 75
SPEED CONTROL PAGE 87
ELECTRONIC 4 x 4 SHIFT PAGE 77
STOP/HAZARD LAMPS PAGE 63,64
SPEED CONTROL PAGE 87
ELECTRONIC 4 x 4 SHIFT PAGE 77
POWER TAILGATE WINDOW (BRONCO ONLY) PAGE 99
POWER DOOR LOCKS PAGE 103
TO MAIN LIGHT SWITCH PAGE 16
HORN/CIGAR LIGHTER PAGE 88
FUEL INJECTOR COOLING FAN 4.9L PAGE 46

HOW THE CIRCUIT WORKS

The **Battery, Alternator** and **Voltage Regulator** make up the **Charging System.** With the **Ignition Switch** in RUN, **Battery** voltage is applied through the solid-state electronic control of the **Voltage Regulator.** The electronic control applies **Battery** voltage to the **Alternator** field.

With current in the field and the rotor turning, the **Alternator** stator produces a DC voltage at B+ terminals (to **Battery**). If the **Alternator** output voltage is greater than the **Battery** terminal voltage, current will flow from the **Alternator** to the **Battery**, as well as to the vehicle electrical load.

If the **Alternator** voltage is less than the **Battery** terminal voltage, current will flow from the **Battery** to supplement the alternator output in supplying the vehicle electrical load.

Refer to section 31-01 of the shop manual.

COMPONENT LOCATION

	Page-Figure
Fuse Links F, G, J, L, M, N, W	Near starter relay
Radio Noise Capacitor	Attached to voltage regulator
Starter Relay	On RH fender apron

Refer to the **Location Index** in the back of the manual for connector, ground, and splice descriptions and locations.

TROUBLESHOOTING HINTS

CONDITION	POSSIBLE CAUSE	ACTION
• Improper Charging	• Loose/worn alternator belt	• Tighten/replace
	• Defective/dead battery	• Replace battery
	• Fuse Link J open at starter relay	• Visually check for open in link, replace
	• Poor connection between battery terminals and cable clamps/damaged cables	• Clean, tighten and/or replace
• Alternator Warning Indicator remains on after initial start up	• Poor connection on Alternator, Regulator, Starter Relay, and/or Alternator Output Control Relay	• Make sure connections are tight and free of debris and refer to shop manual section 31-01, Charging System Diagnosis

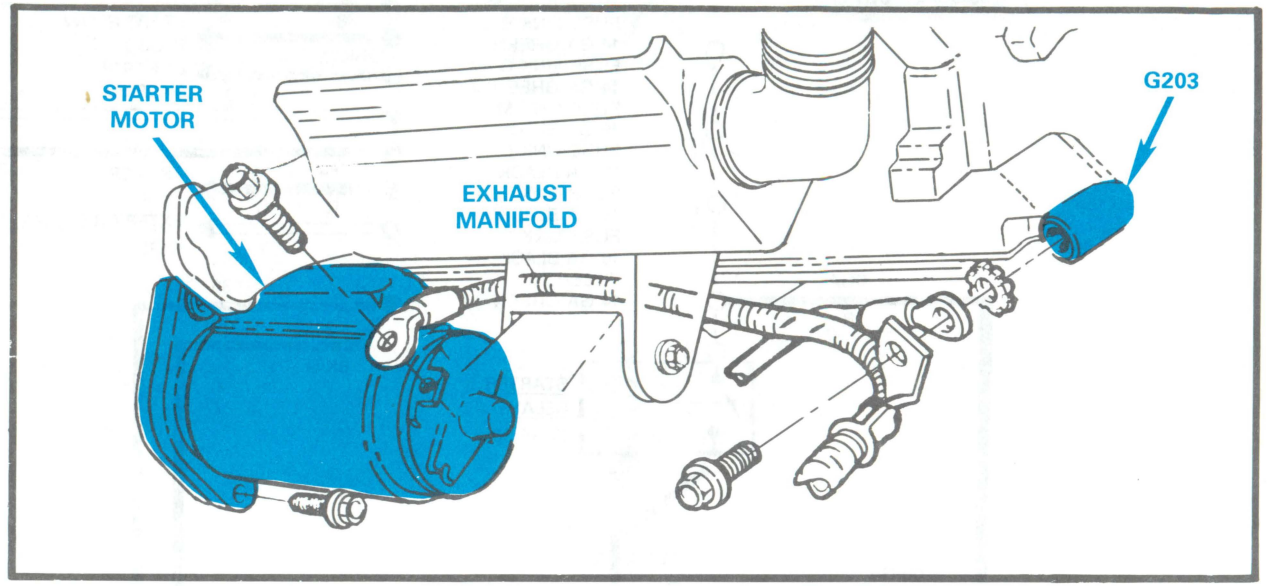


Figure 1 — Lower RH Side of Engine (5.0L, 5.8L, 7.5L, 8 Cyl.)

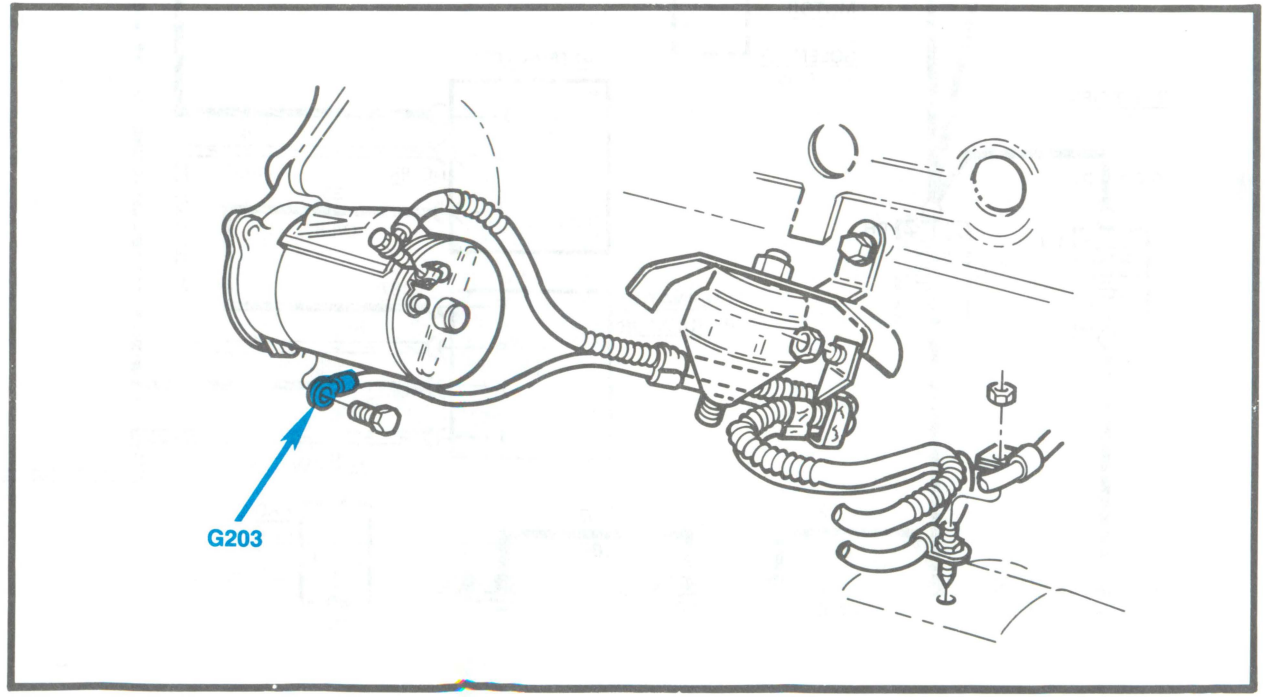


Figure 2 — Lower RH Side of Engine (4.9L 6 Cyl. ONLY)